International Association of Hydrogeologists

Philip E. LaMoreaux
Editor-in-Chief

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Hydrology of Limestone Terranes

Annotated Bibliography of Carbonate Rocks, Volume Four

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Contents

Foreword

Escalating interest in the hydrology of carbonate terranes by the scientific community and the general public requires access to the published material available on this subject. Responsibility for compiling and publishing a comprehensive list of karst reports was previously accepted by the Work Group on the Hydrology of Carbonate Terranes of the U.S. National Committee for the International Hydrological Decade who worked with the Alabama Geological Survey, USA. As a result of those efforts two reports were published as bulletins: (1) Bulletin 94-A, Geological Survey of Alabama, Hydrology of Limestone Terranes - Annotated Bibliography of Carbonate Rocks, published in 1970; and (2) Bulletin 94-E, Geological Survey of Alabama, Hydrology of Limestone Terranes, Progress of Knowledge About Hydrology of Carbonate Terranes with an Annotated Bibliography of Carbonate Rocks, published in 1975.

The International Association of Hydrogeologists (IAH) is a scientific and educational non-profit international organization established to exchange hydrogeologic information and to advance the science. IAH, which promotes cooperation between scientists who are working on hydrogeologic problems, is affiliated with the International Union of Geological Sciences (IUGS).

The principal activities of IAH are to:

Promote international interest among scientists in hydrogeologic studies.

Sponsor hydrogeologic meetings. IAH has held more than 23 scientific conferences in the past 20 years.

Publish hydrogeologic reports. For example: Karst Hydrogeology, 1977; Hydrogeology of Great Sedimentary Basins, 1976; Hydrogeological Map of Europe, and Methods for Evaluation of Ground Water Resources, 1979.

Establish commissions to investigate topics of concern to hydrogeologists. The work of IAH is accomplished by several special Commissions.

During a meeting of the Karst Commission of the International Association of Hydrogeologists (IAH) in Cambridge, England, on September 8, 1985, the Association voted to issue the third volume of the Annotated Bibliography in the Spring of 1986, and additional volumes of the bibliography every other year. This bulletin represents the second of this new series of IAH bulletins on karst terranes.

The first and second karst bibliographies, Bulletins 94-A and 94-E of the Alabama Geological Survey, were published under the direction of Philip E. LaMoreaux who was at that time State Geologist of Alabama. The Alabama Geological Survey was contacted, and by letter, released future rights to publish the bibliography to the Karst Commission of IAH. (July 23, 1985, letter to Dr. P. E. LaMoreaux from Ernest A. Mancini, State Geologist and Oil and Gas Supervisor.)

The Karst Commission of IAH is comprised of scientists from many different research agencies around the world. Coordinating closely with the preparation of this issue of the bibliography were Henri Paloc, France; Andre Burger, Switzerland; David Burdon, Ireland; Vladimir Kovalevsky, Moscow; Dan Dancau, Romania; Budimir Filipovic, Yugoslavia; Petar Milanovic, Yugoslavia; and James F. Quinlan, United States. Current (1987) members of the Karst Commission of IAH are as follows:

Avias, J.F
7200 UCEL par Aubenas — France

Back, W.
U.S. Geological Survey
Mail Stop 432
Reston, Virginia 22092 — USA

Boecker, T.
Aluterv-FKI
Pozsonyi ut 56
H-1133 Budapest — Hongrie

Boni, C.
Istituto di Geologia
Citta Universitaria
Piazzale delle Scienze
1-00100 Roma — Italia

Bono, P.
Istituto di Geologia
Citta Universitaria
Piazzale delle Scienze
1-00100 Roma — Italia

Burdon, J.
Rathclare House
Buttevant, Co. Cork — Ireland

Burger, A.
Berthoudes 58
CH-2000 Neuchatel — Switzerland

Castany, G.
3 Residence du Petit Chambord
F-92340, Bourg-La-Reine — France

Daoxian, Y.
Institute of Karst Research
Guida Road
Guilin, Guangxi — Chine

Drew, D.P.
Trinity College
Dublin 2 — Ireland

Drogue, C.
Laboratoire d'Hydrogeologie - USTL
Place Eugene Bataillon
F- 34060 Montpellier Cedex — France

Guenay, G.
Karst Water Resources Research
Center Project Engineering Faculty
Hacettepe University
Beytepe, Ankara — Turkey

Gunn, J.
Department of Env. and Geogr. Studies
Manchester Polytechnic
Chester Street
Manchester MI 5 DG — United Kingdom

Hoetzl, H.
Geologisches Institut
Universita et Karlsruhe
Kaiserstrasse, 12
7500 Karlsruhe — Federal Republic of Germany

Issar, A.S.
Head Water Resources Unit
Ben-Gurion University of the Negev
Sde Boqer Campus — Israel

Kiraly, L.
Centre d'Hydrogeologie
11, rue Emile-Argand
CH-2000 Neuchatel 7 — Switzerland

Komatina, M.
Geozavod
Karadjordjeva 48
11000, Beograd — Yougoslavie

Kovalevsky, V.
Institute of Water Problems
Academy of Sciences of the USSR
Chernogriazskay 13/3
Moscow-Sadovay — USSR

Kullman, E.
Geologicky ustave D. Stura
Mlynska dolina 1
809 40 Bratislava — Tchecoslovaquie

LaMoreaux, P.E.
Editor-in-Chief
Annotated Bibliography of Carbonate Rocks
P.O. Box 2310
Tuscaloosa, Alabama 35403 — USA

LeGrand, H.E.
U.S. Geological Survey
331 Yadkin Drive
Raleigh, North Carolina — USA

Lopez, J.
Departamento de Geologia y Geoquimica
Facultad de Ciencias
Universidad Autonoma
Canto Blanko
Madrid — Espagne

Malinowsky, J.
Nadalinskiego 50/52 N11
02581, Warszawa — Pologne

Mangin, A.
Laboratoire Souterrain du CNRS
09410, Moulis — France

Marinos, P.G.
Democritos University of Thraki
School of Engineering
Xanthi — Greece

Mijatovic, B.
Institut de Recherches
Geologiques et Geophysiques
Geozavod
Karadjordjeva 48
11000 Beograd — Yougoslavie

Milanovic, P.
Karst Water Research Institut
Strumicka 197
11000 Beograd — Yougoslavie

Paloc, H.
President, Karst Commission
Directeur du Service
Geologique Regional
Languedoc-Roussillon BRGM
1039, rue de Pinville
F-34000, Montpellier — France

Quinlan, J.
Uplands Research Lab.
Box 8
Mammoth Cave, Kentucky 42259 — USA

Rezac, B.
Vaclaskova 176/2
Praha 6 - Desvice — Tchecoslovaquie

Romijn, E.
IAH General Secretary
Provincial Waterboard of Gelderland
Markstraat 1 - P.O. Box 9090
NL-6800 GX Arnheim — Netherlands

Rozxowski, A.
Bialego 1
41200 Sosnowiec — Pologne

Stringfield, V.T.
4208 50th Street N.W.
Washington, D.C. 20016 — USA

Vegter, J.R.
Chief, Division of Geohydrology
Department of Water Affairs
Private Bag X313
0001, Pretoria — Republic of South Africa

Zoetl, J.A.
4293 Gutau 40 — Autriche

The next issue of the bibliography will be published in April 1990 and contributions will be greatly appreciated. They should be forwarded to:

Dr. Philip E. LaMoreaux, Editor-in-Chief
Annotated Bibliography of Carbonate Rocks
Karst Commission
International Association of Hydrogeologists
P.O. Box 2310
Tuscaloosa, Alabama 35403 USA

Introduction

Constructive and thorough discussions on karst are carried out by a broad circle of interested scientists and researchers. Various regional symposia and colloquia have been organized worldwide over the past 20 years by IAH, IASH, FAO, and UNESCO within the International Hydrologic Decade (IHD) and International Hydrologic Programme (IHP). The IHD included a Commission for the study of carbonate rocks in Mediterranean countries, and since 1970 a permanent Commission for karst hydrogeology exists within IAH.

The reasons for such an increasing interest in karst include the rapid technologic development of our civilization; problems of water resources and their systematic study, rational utilization, and protection; and management of hydrological and hydrogeological systems. Karst occurs in many parts of the globe (frequently covering a substantial part of the national territory of individual countries), whose water supplies represent the sole or most important natural resource which directly affects their social and economic development. Under such conditions, the problems of study, utilization, and protection of water resources, or using contemporary terminology, management and control of water resource systems obtain an exceptional importance. This has resulted in an increasing effect on the orientation of research.

Limestone areas comprise approximately one-fifth of the earth's surface. These rocks are extremely complex physically, produce a great variety of topographic and geologic conditions, and have been the subject of much research by geologists, geomorphologists, speleologists, geophysicists, and other scientific disciplines. The literature regarding limestone is diverse and the subject has been published in a wide range of articles in newspapers and scientific and technical journals. During the past few years several major reference and text books have been published on this subject and are listed as follows:

Back, W. and LaMoreaux, P.E., editors (1983) - V.T. Stringfield Symposium - processes in karst hydrology. A selection of papers presented at the symposium in honor of V.T. Stringfield during the annual meeting of the Geological Society of America, Atlanta, GA, U.S., 1980: Journal Hydrology, G1:1-3, 355 p.

Boegli, A. (1980) - Karst hydrology and physical speleology [translated by June C. Schmid]: Berlin and New York; Springer-Verlag.

Burger, A. and Dubertret, L., editors (1975) - Hydrogeology of karstic terrains: Paris; IAH, 190 p.

Dilamarter, R.R. and Csallany, S.C., editors (1977) - Hydrologic problems in karst regions; international symposium, Bowling Green, KY, U.S., 1976: U.S.; Western Kentucky University, 479 p.

Herak, M. and Stringfield, V.T., editors (1972) - Karst; important karst regions of the northern hemisphere: Amsterdam; Elsevier Publishing, 551 p.

Jakucs, L. (1977) - Morphogenetics of karst regions [translated by B. Balkay]: U.S.; John Wiley, 283 p.

Jennings, J.N. (1971) - Karst: U.S., Boston; M.I.T. Press, 252 p.

LaMoreaux, P.E.; Wilson, B.M.; and Memon, B.A., editors (1984) - Guide to the hydrology of carbonate rocks [studies and reports in hydrology, no. 41]: UNESCO, 345 p.

Milanovic, P. (1981) - Karst hydrogeology [translated by J. J. Buhac]: U.S., Colorado; Water Resources Publications, 434 p.

Petrik, M. and Herak, M., editors (1969) - Krs Jugoslavije (Carsus Iugoslaviae): Zagreb; 622 p.

Sweeting, M.M. (1972) - Karst landforms: U.S., New York; The MacMillan Press Ltd., 363 p.

Yevjevich, V., editor (1981) - Karst water research needs: U.S.; Water Resources Publications.

Yevjevich, V., editor (1976) - Karst hydrology and water resources; proceedings of the U.S.-Yugoslavian Symposium, Dubrovnik, June 1975: U.S.; Water Resources Publications, 2 vol., 873p.

Zoetl, J. (1974) - Karsthydrogeologie: Wien and New York; Springer- Verlag, 291 p.

Limestone terranes are generally characterized by broad rolling plains; however, in some areas they are characterized by steep bluffs, canyons, and valleys. Owing to the variability in topography and solubility of limestone under diverse climatic conditions, man's development in limestone areas has often been difficult. In some limestone areas there are fertile soils, valued for the production of large quantities of food; in other areas, the surface of the limestone rocks is eroded and barren. In some areas, ground-water supplies are abundant; in others, supplies are sparse and difficult to locate. It is perhaps this diversity of geologic, topographic, and hydrologic conditions that makes the study of carbonate rock terranes so fascinating, complex, and challenging.

During the past 20 years, under the auspices of the Work Group on the Hydrology of Carbonate Terranes of the International Hydrological Decade, and the Working Group on the Hydrology of Limestone Rocks in the Mediterranean Basin of the FAO/IHD, much emphasis has been placed on the study of carbonate rocks. In addition to individual project activities, there have been over 25 field conferences, formal meetings, and congresses, at which results of research on the hydrology of carbonate rocks have been discussed indicating the interest in this subject since the last bibliography was published in 1975. A list of these follows:

Symposia and Conferences on Hydrology of Carbonate Rocks

Location	Title	Sponsor(s)	Date
St. Petersburg, Florida USA	3rd Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst	University of Central Florida, Florida Sinkhole Research Institute	Oct. 1-4, 1989
Guilin City, Guangxi Zhaung Region, China	21st Congress, Karst Hydrogeology and Karst Environmental Protection	Inter. Association of Hydrogeologists	Oct. 10-15, 1988
Melbourne, Australia	4th Inter. Symposium on Interactions Between Sediments and Water	Inter. Assocation for Sediment Water Science	1987
Vienna, Austria	Inter. Symposium on Isotope Techniques in Water Resources Development	Inter. Atomic Energy Agency	1987
Tomar, Portugal	4th Inter. Meeting of Applied and Environmental Geology, "Karst Systems of the Atlantic Border"	University of Lisbon, Center of Geology and Department of Geology	1987
Orlando, Florida USA	2nd Multidisciplinary Conference on Sinkholes and the Environmental Impacts of Karst	University of Central Florida, Florida Sinkhole Research Institute	1987
Athens, Greece	5th Inter. Symposium on Underground Water Tracing	Institute of Geology and Mineral Exploration and Inter. Working Group on Tracer Methods in Hydrology	1986
Cairo, Egypt	Inter. Symposium,"Water for Mankind in the Year 2000"	Universal Movement for Scientific Responsibility; UNESCO	1986
Spain	Inter. Symposium on the EusKadi's Karst		1986
Beytepe, Ankara, Turkey	Inter. Symposium on Karst Water Resources	Karst Water Resources Research Center, Hacettepe University and UNESCO	1985
Puerto Rico	Friends of the Karst Meeting		1984
Orlando, Florida USA	First Multidisciplinary Conference on Sinkholes	Florida Sinkhole Research Institute	1984
Havana, Cuba	Inter. Workshop on Karst Hydrology of the Caribbean Region	UNESCO Division of Water Sciences	1983

Location	Title	Sponsor(s)	Date
Bucharest, Romania	1st Symposium on Theoretical and Applied Karstology	Institutul de Speologie "Emil Racovita", Entreprise for Geological and Geophysical Prospecting	1983
Havana, Cuba	International Workshop on Karst Hydrology of the Caribbean Region	UNESCO Division of Water Sciences	1982
Bari, Italy	Utilizazione delle-Aree Carsiche - 2 Simposio Internazionale		1982
Neuchatel-Bescancon, France	3eme Colloque d'Hydrologie en Pays Calcaires	Univ. Besancon	1982
Bowling Green, Kentucky USA	8th Inter. Congress of Speleology	International Union of Speleology and National Speleological Society	1981
Besancon, France	1 er Colloque National sur la Protectiondes Eaux Southerraines Karstiques	la CPEPESC	1981
Trieste, Italy	Utilization of Karst Areas -- International Symposium	Union Int.de Speleologie, Societa Speleologica Italiana	1980
	Symposium -- Table Ronde Franco -- Allemande	Assoc. Francaise de Karstologie	1980
Atlanta, Georgia USA	V.T. Stringfiled Symposium -- Processes in Karst Hydrology	Geological Society of America	1980
Washington, D.C. USA	Research Needs in Hydrology and Water Resources of Karstified Carbonate Terranes	National Science Foundation	1980
Oymapinar, Turkey	Inter. Symposium on Karst Hydrogeology	State Hydraulic Works, United Nations Development Program	1979
Budapest, Hungary	International Symposium on Karst Hydrology	Hungarian Speleological Society, Hungarian Geological Society, and Hungarian Meteorological Society	1978
Tarbes, Frane	Le Karst: Son Originalite Physique; son Importance Economique	l'AGSO a Tarbes	1978
Bowling Green, Kentucky USA	Inter. Symposium on Hydrologic Problems in Karst Regions	Western Kentucky University	1976

Location	Title	Sponsor(s)	Date
Budapest, Hungary	Hydrogeology of Great Sedimentary Basins	Hungarian Geological Institute, Inter. Association of Hydrological Sciences, and UNESCO	1976
Besancon - Neuchatel, France	2eme Colloque d'Hydrologie en Pays Calcaires	Univ. Beasancon	1976
Ljubljana, Yugoslavia	3rd Inter. Symposium of Underground Water Resources	Yogoslav Committee for Inter. Hydrological Program	1976
Dubrovnik, Yugoslavia	U.S.--Yugoslavian Symposium on Karst Hydrology and Water Resources	Bilateral U.S.--Yugoslavian Research Project on Karst Hydrology and Water Resources	1975
Huntsville, Alabama USA	12th Inter. Congress, Inter. Association of Hydrogeologists--Karst Hydrogeology	Inter. Association of Hydrogeologists	1975
Kranj, Yugoslavia	8th Conference, Slovenia Speleologists and Karst Explorers in Serbo Croata		1974
Hannover, Germany	Sinkholes and Subsidence--Proceedings of a Symposium	Inter. Association of Engineering Geology	1973
Olomouc, Czechoslovakia	6th Inter. Congress of Speleology	Inter. Union of Speleology	1973
Besancon, France	1 er Colloque d'Hydrologie en Pays Calcaires	Univ. Besancon	1971

Organization, Composition, and Availability of Annotations and Indexes

Annotated bibliographic citations are listed alphabetically by principal author and numerically by document number.

The annotated citations are followed by secondary author, location, and subject indexes. The subject index is preceded by a key to level terms used. The location index is by country, and secondarily by individual state. Each index lists the pertinent citations by document number.

The bibliography primarily represents citations for the past two years (1986 through 1987) from the following data sources: a computer controlled search of the American Geological Institute (AGI) GEOREF database, which contains the AGI publications; Bibliography and Index of North American Geology (1961-1970); Bibliography of Theses in Geology (1965-1966); Geophysical Abstracts (1966-1971); Bibliography and Index of Geology Exclusive of North America (1967-1968); and Bibliography and Index of Geology (1969 to the present). Manual searches of the Index to Scientific and Technical Proceedings, and U.S.G.S. Water Resources Abstracts were also conducted. In addition, numerous manual searches of the published literature were made.

To assume that any bibliography on the subject of karst hydrology is comprehensive would be a mistake. However, a concerted effort has been made to compile as many works on the subject matter as possible from 1986 to 1987 for this issue. The omissions of published literature discovered during future work on this project will be included in the next issue to be published in 1990.

A multidisciplined staff of geologists, hydrologists, geophysicists, and geochemists were assigned to the project. The project also benefited from the cooperation of many individual scientists and numerous organizations throughout the world. As a result, this bibliography is primarily composed of references to geology, hydrology, geochemistry, and geophysics of carbonate rocks.

Special acknowledgements are made to Dr. Esad Prohic and Dr. Josef Zoetl whose contributions to the Annotated Bibliography, Volume 4, are sincerely appreciated.

The manuscript processing was provided by the following staff of P.E. LaMoreaux & Associates, whose efforts are acknowledged and appreciated: Nancy Green, Librarian; Barbara Metternich, Computer Programmer; Ann McCarley, Computer Programmer; LaBridgette Ellis, Computer Programmer; and Vicki Sanders, Computer Programmer.

The bibliographical material is stored on diskettes of an IBM computer at P.E. LaMoreaux & Associates, Post Office Box 2310, Tuscaloosa, Alabama, 35403, USA This stored information is available in whole or in part and may be obtained in printout form.

Special Contributions

The following persons have contributed their time, energy, and interest to compile individual works representative of karst research in their respective countries. The Commission deeply appreciates their efforts and is grateful for their contributions.

Mr. George O. Bachman
Consultant
4008 Hannett Ave., N.E.
Albuquerque, New Mexico 87110
USA

Dr. Henry S. Brown
North Carolina State University
Dept. of Marine, Earth and
Atmospheric
Box 8208
Raleigh, North Carolina 27695-8208
USA

Dr. David J. Burdon
Minerex Limited
Northumberland House
Northumberland Avenue
Dun Laoghaire
County Dubin
Ireland

Professeur Andre Burger
Centre d'Hydrogeologie
University de Neuchatel
11, rue Emile Argand
CH 2000
Suisse

Dr. Dan Dancau
Institutul de Speologie
"Emile Racovita"
Str. Frumoasa NR. 11
Sectorul 6
Bucuresti 12
Romania

Dr. Budimir Filipovic
Rudarsko Geoloski Fakulet
Oour Grupa Za Hidrogeologiju
11000 Beograd
Djusina br. 7
Yugoslavia

Dr. Petar Milanovic
Geological Engineer
Karst Water Research Institute
L. Vukalovica 3
89101 Tebinje
Yugoslavia

Dr. Henri Paloc
BRGM
1039, rue de Pinville
F 34000 Montpellier
France

Dr. James F. Quinlan
U.S. Department of the Interior
National Park Service
Box 8
Mammoth Cave, Kentucky 42254
USA

Dr. Tony C. Waltham
Civil Engineering
Trent Polytechnic
Nottingham NG1 4BU
Great Britain

Dr. Josef Zoetl
Institute for Geothermics and
Hydrogeology
A-4293 Gutau 40
Austria

Other valuable contributions were regrettably received too late for inclusion in this volume and will be preserved for incorporation into the next edition.

Philip E. LaMoreaux
Editor-In-Chief

Abbreviations Used in This Text

Amer.	-	American
Ann.	-	Annals
Asso.	-	Association
Biol.	-	Biology
Bull.	-	Bulletin
Bur.	-	Bureau
Chem.	-	Chemical or Chemistry
Congr.	-	Congress
Contrib.	-	Contribution
Depos.	-	Deposition
Econ.	-	Economy or Economic
Environ.	-	Environment or Environmental
F.R.	-	Federal Republic
FAO	-	Food and Agricultural Organization
Figs.	-	Figures
Foram.	-	Foraminiferal
Found.	-	Foundation
Geogr.	-	Geography
Geol.	-	Geology or Geological
Geophys.	-	Geophysical
GUA	-	Goeteburgs Universitets Arsskrift
IAH	-	International Association of Hydrogeologists
IASH	-	International Association of Scientific Hydrology
IHD	-	International Hydrologic Decade
IHP	-	International Hydrologic Programme
Inter.	-	International
Invest.	-	Investigation
Journ.	-	Journal
Mar.	-	Marine
Mem.	-	Memoir
Min.	-	Mineralogy
Misc.	-	Miscellaneous
Nat.	-	Natural
Natl.	-	National
NSS	-	National Speleological Society
Oceanogr.	-	Oceanography
p.	-	Pages
Paleontol.	-	Paleontology or Palaeontology
Petro.	-	Petrography or Petrographical
Petrol.	-	Petroleum
Proc.	-	Proceedings
Prof.	-	Professional
Publ.	-	Publication
Reg.	-	Regional
Rept.	-	Report
Res.	-	Research
Sci.	-	Science
Sect.	-	Section
Sed.	-	Sediment, Sedimentary, or Sedimentology
Ser.	-	Series
Sess.	-	Session
Soc.	-	Society
Spec.	-	Special
Spele.	-	Speleology or Speleological
Surv.	-	Survey
Symp.	-	Symposium
Techn.	-	Technological
Trans.	-	Translator
U.S.	-	United States
UNESCO	-	United Nations Educational, Scientific and Cultural Organization
Univ.	-	University
Vol.	-	Volume
Z.	-	Zeitschrift

Bibliography of the History of Karst Research

Josef G. Zoetl
Institute for Geothermics and
Hydrogeology FGJ
Elisabethstrasse 16
A-8010 GRAZ
Austria

COMMENTS

The term "karst" has been used in the generic sense only since the 19th century. There are, however, descriptions of karst dating from antiquity, when caves and underground rivers were a part of Greek mythology.

Greek and Roman philosophers saw the general water cycle in karst hydrology and ultimately came amazingly close to modern ideas. The Middle Ages, however, brought a relapse into darkest superstition. The situation improved radically in the 18th century when the Enlightenment brought about rapid developments in the natural sciences, including the earth sciences.

In the 20th century, karst research has prospered with modern scientific empiricism and mathematical logic. The results include such new techniques as isotope hydrology and models.

Speleology has developed into a very popular new field that has also developed a variety of new techniques. As a science, however, it cannot be separated from karst research and karst hydrology.

INTRODUCTION

Long before the word "karst" came into use, karst phenomena were being described. In prehistory and early antiquity, the karst phenomena that most fascinated humans were caves, large karst springs and streams that disappeared into the underground (ponors and katavothrons).

In prehistoric time, caves provided humans with living space and protection; by the Later Paleolithic they were the scene of remarkable artistic activity. Cave paintings and drawings range from primitive scribbles to creations bearing witness to remarkable artistic talent (**Figure 1**). The difficult underground entrances to the chosen living areas (for which other entrances have often been added for tourists) and the preference for sites with underground water or exits to nearby surface streams, indicate that the cave dwellers familiarized themselves thoroughly with the entire cave system. This interest in caves and karst streams is an early root of speleology and karst hydrology.

In Europe, the caves with prehistoric drawings and murals are mainly in the karst regions of western and southern France, in the Pyrenees and in northern Spain, i.e. outside of the sphere of influence of the Pleistocene glaciers. In Northern Europe and North America, cave pictures are seldom connected with karst phenomena (S. Kuehn, 1952).

WRITTEN TRADITION DATING FROM ANTIQUITY

The first written reports concerning karst phenomena date from antiquity. Due to the influence of antiquity on European culture, attention is drawn mainly to relevant reports by Greek and Roman scholars. There are a remarkable number of such references.

Deciphering of cuneiform, however, brought the surprise that the first karst-hydrological research known to have been planned and recorded in writing was an expedition led in 852 BC by the Assyrian King Salmanassar III to the headwaters of the Tigris (Opitz, 1929, p.60). A source of the Tigris rises as a karst spring and near its origin flows through a rock tunnel that formerly was

viewed erroneously as the source cave. Above the tunnel there are two more large caves with thick stalagmites up to 6 m high (geographical position approximately 40° E, 38° 30'N, in what is now northern Turkey). As early as 1100 BC, Tiglatpilesar I visited the entrance to the rock tunnel and had his royal likeness and an inscription hewn upon it.

Salmanassar III immortalized his visit to the cave in 852 BC not only with his likeness and an inscription, but also left a picture of his expedition on strips of bronze on the wing of a portal in his palace in Imgur-Ellil, the later Balawat (approximately 40° 90'E, 36° 20'N, now in northern Iraq). The pictures show the parade of warriors, the sacrificial animals and their slaughter. The upper strip includes the first known representation of stalagmites, and the lower one, the entrance to the cave and torchbearers standing in the water awaiting the arrival of the king. Sculptors hew the royal likeness in rock at the cave entrance **(Figure 2)**.

The most important contributions to karst history in antiquity are, however, as mentioned above, to be found in Greek and Roman writings. Large parts of Greece are taken up by karstifiable rocks and even today, most of the rural population of Greece is familiar with the more remarkable karst phenomena. The term "katavothron" for the site where a surface stream disappears into the underground (swallow hole, ponor or the ambiguous term "sinkhole") is of Ancient Greek origin.[1] Karst phenomena come to play a role in Greek mythology. The cave is the entrance to the underworld (Hades), reached after crossing the river Styx with the help of the ferryman Charon.[2] It is very likely that the place upon which this image is based is an inaccessible cave and gorge location at an altitude of some 2,000 m in Chelmos, a massif in the northern Central Peloponnesus. The area is unpopulated and, even today, is avoided by shepherds (cf. Philippson, vol. III, 1959, p.219-221).

D. Pfeiffer (1963) has collected descriptions of karst hydrological phenomena in antiquity. The oldest report known to him of a katavothron is the description by Sophocles (496-406 BC) of the disappearance of the river Inachos (today Aspropotamus, SW Greece), its underground course and its reemergence. This report has, however, only reached us second hand in a quotation by the geographer Strabon (63 BC-28 AD).

Strabon provides us with the most important karst hydrographical information dating from antiquity. He was born around 60 BC in the Greek town of Amasia in what was then the Roman province of Pontus in Asia Minor (now Turkey), traveled extensively in the Mediterranean area and settled in Rome in 29 BC. He compiled a large historical work in 47 volumes; this work has been lost. His "Geographica" in 17 volumes has been preserved in its entirety. It is based on the work of Strabon's predecessors and material from his own travels and is the most important geographical work from this period. Strabon lived to be very old and died in 28 AD.

An example of knowledge handed down to younger generations are the karst springs of Timavo which were known as early as about 500 BC to the Greek geographer Skilax of Karyanda (Pfeiffer, 1963, p.16). Their relationship to the present Reka sinkhole near Skozian (St. Kanzian) on the Yugoslavian-Italian border east of Triest was first recognized by Poseidonios (135-50 BC) of whom Strabon (Geographia V, 1) says:

C.215 *ὀνομάζειν τὸν τόπον. Ποσειδώνιος δέ φησι ποταμὸν τὸν Τίμαυον ἐκ τῶν ὀρῶν φερόμενον καταπίπτειν εἰς βέρεθρον, εἶθ' ὑπὸ γῆς ἐνεχθέντα περὶ ἑκατὸν καὶ τριάκοντα σταδίους ἐπὶ τῇ θαλάττῃ τὴν ἐκβολὴν ποιεῖσθαι.*

(But Poseidonios says that a river, the Timavius, runs out of the mountains, falls down into an (underground) cave, and then, after running underground about a hundred and thirty stadia, makes its exit near the sea (Strabon, Greek-English, Geography, 5, I. 8-9).

A distance of 130 stadia would be about 25 km; the actual distance of the Timavo springs from the Reka sinkhole is some 40 km. This is nonetheless a remarkable karst-hydrological finding, considering that this matter is still the object of research today **(Figures 3 and 4)**.

Vergil (70-19 BC) also sang of the Timavus springs in Istria in his Aeneid (First Canto, 242-246); he was followed by a series of Greek and Roman naturalists who described the Timavus (Polybius, Cornelius Nepos, Martial, Lucanos and others).

Strabon devotes himself in his 8th book to the karst phenomenon of the poljes as well. Undrained basins in the Peloponnesus, like the poljes of Stymphalia and Pheneos interested him as much as the variations in level of the Kopais Lake, that was first drained at the end of the 19th century to improve the agricultural situation.

The connection between the katavothra in the polje of Pheneos to the Ladon spring (Peloponnesus, Greece) was also recognized in antiquity, as was the problem of blockage of the katavothra and hindrance of the flow of winter floods as well as catastrophic increase in spring output when the blockage in a katavothron broke up (Strabon, Book 8, quoting a report by Eratosthenes, 276-194 BC, cf.).

The Jordan spring had also attracted interest by the beginning of the Christian era. K.H. Roegner (1979) mentions the report of the Jewish historian Josephus Flavius (37 AD to approximately 100 AD) wrote, "...The probable source of the Jordan is the Paneion [3], which, however, itself is supplied by underground flow from the so-called Phiale. This is located on the road near Trachonitis [4]...Because of its round shape this water basin is called Phiale...The Tetrarch of Trachonitis showed that the source of the Jordan must be here...He had chaff thrown into the Phiale, that reappeared in the Paneion, which had earlier been thought to be the source of the river...the visible course of the Jordan begins at the cave here" (Josephus Flavius, History of the Jewish War, II, 10, 7).

This is in fact a written report of a groundwater tracing experiment. But we cannot be so sure that the experiment was actually successful; there are two reasons for this uncertainty: a) E. Orni (1976 , p.119) sees in the Phiale (today Berekhat Ram) a crater lake comparable to the maar lakes in the Eifel in Western Germany, while K.J. Roegner (1979, p.59) assumes a collapse doline in the Cretaceous limestone under the basalt cap. b) Modern experience has shown that floating bodies (pieces of wood, chaff, etc.) are not suitable tracers and (with the exception of microscopically small lycopodium spores in suspension) insoluble materials have never been used successfully as tracers.

It should be noted that in antiquity, the general theories on the "element" of water were not significantly influenced by karst phenomena (e.g. springs and movement of underground water). Water was one of the four elements in Greek philosophy (water, earth, fire, air). These theories were mainly developed by Empedokles (490-430 BC) and Aristoteles (384-322 BC), who had already recognized the water cycle, i.e. ocean - evaporation - precipitation - runoff, although intermixed with mythical ideas about some details (underground discharge).

To my mind, some of the most important information on karst hydrology that has not yet been recognized as such, came from Lucius Annaeus Seneca (4 BC-65 AD). Seneca was the most important Roman philosopher and writer, and a last great Classical intellect in the moral swamp of the early Roman Empire. Caligula (12-41 AD) made him a senator, while Claudius (10 BC-54 AD) had him exiled to Corsica at the instigation of his wife Messalina. Eight years later, however, Seneca was recalled to Rome. He was tutor to Nero (37-68 AD), upon whom he had at first a favorable influence and by whom he was made consul; owing to intrigues on the part of his opponents, he was later sentenced to death and committed suicide.

In Book III of his "Naturales Questiones", Seneca concerns himself mainly with water and its many differences in temperature, specific gravity and color. He concentrates on water in the ground and only occasionally mentions the sea. The hypotheses of his Greek predecessors are presented in his work either with no remarks or brief comments. In his work, Seneca found the varying specific

gravities of waters as a function of dissolved minerals and thus discovered the relationship of water to rock, which is the basic prerequisite for the process of karstification. He relates the solution process to the development of large underground caves and so explains the disappearance and reappearance of streams (Book III, 26, 3).

The interesting epoch of the history of karst bibliography in antiquity ends with the Later Roman Empire. It is my belief that Seneca's tragic death was also the end of the magnificent world of ideas that was Classical philosophy in a free dominion of thought. The cloud of intolerance whose bloody beginning we see in the persecution of Christians by Nero, cast a long shadow over the coming centuries. The end of antiquity, generally taken to be the fall of the Roman Empire in the West in 476 AD, was, for our purposes, actually Seneca's death.

KARSTWATER IN THE MEDIEVAL VIEW

Two factors influenced medieval science and thus descriptions of karst hydrology: classical tradition and the Bible.

The widening of the ancient world to include west, middle and northern Europe had little effect, as written records were long only kept in Latin, and the art of reading and writing was mainly limited to monasteries.

In this period, karst hydrography first reappeared in mythology, with the description of the river of paradise by Severian of Cabala (born 409 AD), based presumably on the disappearance of a river into the ground. These imaginative pictures are far below the level of classical Greek mythology. Both the encyclopedia "Libri originum seu ethymologiarum" (20 volumes) by Isidor of Sevilla (560-636) and the 22 volumes "De universo" by Hrabanus Maurus (776-856) fail to live up to earlier standards.

Unfortunately, we know too little about what was happening in the important Arabian culture of this period. There was, for example, the famous Arabian writer Abdul-Hasan Ali Mas'udi (+ 956), who lived at the time of Harun Al Raschid and traveled extensively in Asia and North Africa. Translations of his numerous works are few and difficult to obtain. There were intensive relations between Damascus and the Frankish Kingdom under Karl the Great (742-814), who surrounded himself with scholars, which must have led to cultural exchange.

An encyclopedia of the knowledge of the time was compiled around 970 AD by members of the Arabian order of the "Brothers of Purity" in the form of 51 tracts. There is an early manuscript of this work (Paris Codex, 11th century), which in the 19th century was translated into German by Friedrich Heinrich Dieterici (1861, second edition 1876), an Oriental scholar living in Berlin. These Arabian monks also write of caves inside of mountains and springs discharging the water stored in the caves. The few examples available to us of Arabian natural science from this period suggest that they had reached a much higher level than Europeans had achieved at the time. The large number of medieval manuscripts dealing with the circulation of water have nothing to do with karst hydrology. There is only work that is of cartographic interest.

Maps in antiquity tended to present the whole world as it was known at the time (e.g. map by Hekataios around 500 BC, map by Ptolemy around 150 AD). These maps show the major rivers that were known at the time, but rarely their sources (an exception is the map of the Earth by Eratosthenes around 220 BC with what he thought to know the sources of the Nile). I believe there is reason to mention here the Tabula Peutingeriana, the only major medieval atlas.

Among the priceless treasures of the Hofbibliothek in Vienna are 11 sheets of parchment known as the "Peutingersche Tafel" (Tabula Peutingeriana). Until it was divided into 11 sheets in 1863, this was a roll of parchment 34 cm wide and 6.82 m long. This map roll is the only remaining copy of an original drawn in Roman times (second to fourth centuries AD). The copy dates from the 11th or 12th century. It was discovered in 1507 by the Viennese humanist Konrad Celtes and was later bequeathed to Konrad Peutinger, city clerk in Augsburg.[5]

The unknown Roman cartographer drew on world maps of his era as well as itineraries giving distances for Roman legions and traveling merchants. The purpose of the itineraries was served both by roll format and intentional distortion (bodies of water are reduced in size). It is a matter of karst-hydrological interest that while rivers are generally very much neglected on the Tabula Peutingeriana, it does clearly show the Fonte Timavi (Timavo springs).

THE MODERN ERA UP TO THE 18TH CENTURY

Modern history began with the monumental event of the discovery of America by Christopher Columbus in 1492. This also had far-reaching effects on natural science. Antiquity had known the world to be spherical and this view was propagated by Anaximander (611-547 BC), then Pythagoras (582-507) and Plato (427-347) down to Seneca (4 BC-65 AD). The Middle Ages insisted that the world was flat. After Columbus, the world was round again and the circumnavigation of the globe by Ferdinand Magellan in 1519-22 brought about a completely new concept of the world which among other things devastated the Roman Catholic Church (the Reformation began in 1517).

At the beginning of the modern era it took some time before general hydrographic views began to improve, but finally individual phenomena began to be observed and described carefully. Melchior Goldast describes in Chapter XV of his work "Suevicarium rerum scriptores aliquot" the Blautopf, one of the largest karst springs in Germany, in the section "De Blauio flumine et eius origine, et de loco Blauburensi, et de monastiri institutione, et aliis condependentibus".[6]

D. Pfeiffer (1963., p.47) tells us that earlier authors (e.g. F. Faber, 1441-1502) believed that the dolines on the plateau of the Swabian Alb, "ubi videntur multae foueae quasi calices in funde per fo ratae (i.e. where once can see many containers buried like pots), were the catchments for the large spring outlets. So far as I know, this is the first mention of the dolines as a karst phenomenon; the designation doline is of course much more recent.

In the 16th and 17th centuries, descriptions of karst phenomena in the classical karst of the Austrian Monarchy become more frequent. Interest is mainly focused on the polje landscape in the hinterlands of Ljubljana and there particularly on the Zirknitzer Polje, partly for economic reasons.

In his "Cosmographia", Sebastian Munster (1489-1552) describes the varying water level in the Zirknitzer Polje "where in summer one sows corn and in the winter catches fish". Nikodemus Frischlin (1547-1590) even wrote a Latin ode to the Zirknitzer Lake, "De lacu Circnitioad Casparum Godesch, Circnitianum Carmen" (D. Pfeiffer, 1963, p.49, taken from Valvasor, 1689, vol.4, p.450). In this context, Pfeiffer handles the considerable literature relating the water balance of the poljes to the general hydrology and water balance of the Earth (p.50-69). He shows what strange things happen when karst phenomena are generalized without regard to the geological structure. It is hard to believe that A. Kirchner (1665) correctly related the fluctuations in the Zirknitzer Polje to the seasons, but also believed that were underground streams connecting the seas, the seas to the continents and finally the poles to each other.

It was not generally recognized that there were differences in the hydrographic situations in karstified and nonkarstified areas. Thus, until the 18th century, karst groundwater was not given any special position in the general groundwater questions.

THE 18TH CENTURY

In the 18th century the transition from irrational fantasy to realistic karst hydrology began. Publications at the beginning of the 18th century first show a relapse into confused thinking far below the level attained in antiquity. Three authors, J.C. Sulzer (1746), J.J. Scheuchzer (1746) and F.J. Buck (1768) all believe that rivers have their sources in water enclosed in mountains after the Great Flood.

The change to realistic karst hydrology had an economic basis. The yearly flooding of the poljes disrupted cultivation of a large part of the area around the Zirknitzer Polje. The fact that there were many such karst phenomena in the former Habsburgian Duchy of Krain led to intensified inves-

tigations of the matter (**Figure 6**).[7] In 1748, Johannes Antonius Nagel was sent as Imperial Court mathematician to study the poljes and caves in Krain (for his report to Kaiser Franz I; see references). Nagel reports position and periodic extension of the Zirknitzer Lake, outlets and ponors. His explanation that the lake had a number of inputs with catchments above the level of the lake, is correct. But his finding that the underground "discharge appears at St. Canzian" is incorrect.

There is another description by Franz Anton von Steinberg (1761) which is generally correct, but his pictures show a number of errors and he apparently gave free rein to his imagination.

Between 1778 and 1789 Balthasar Hacquet described in his four-volume work "Oryctographia carniolica, oder Physikalische Erdbeschreibung des Herzogtums Krain" (Physical Geography of the duchy of Krain) a number of karst-hydrological phenomena and discussed Steinberg critically.

Hacquet (1778) concerned himself not only with the phenomenon of the Zirknitzer Lake but also went far beyond it. He discussed the solution of limestone and noted that even after prolonged rainfall there was no surface runoff from the mountains. But he interprets not only the solution but also the precipitation ("incrustationes") in the form of dripstones and calcite incrustations, and recognizes the fact that "the joints can be closed by clay and marl", as "all limestone mountains that do not show excessive height" are covered with residual red clay. All that is missing are the terms "karst" and "terra rossa". As Hacquet also assumed an extensive groundwater level in limestone, which was supposed to be connected hydraulically to the related receiving streams, I should like to designate him as the "father of karst hydrology", who anticipated problems that were still the subject of controversy in the 20th century.

Tobias Gruber is on a par with Hacquet. Gruber's work "Briefe hydrographischen und physikalischen Inhalts aus Krain" was directed to Ignaz Edler von Born and subsequently published (1781). Gruber also developed his most important theoretical considerations from the interpretation of the karst-water phenomena of the Zirknitzer Lake. His drawings based thereon are the first to come close to the actual karst-hydrographic situation, and to show no artifice.

In **Figure 7**, T. Gruber remarks that in the dry season, water flows off via the paths BBB under the bottom of the lake. When, however, these paths are suddenly filled and the water is under pressure, it breaks with "incredible force" out of holes CCC. But when the pressure drops, it sinks back into the holes CCC. Gruber assumes a uniform groundwater body under the lake. He does not believe it possible to create a water balance for the Zirknitzer Lake, although that "could lead to many useful conclusions". He says that the size of the catchment, the depths of precipitation and evapotranspiration, the amount of water flowing off under the basin and the locations of the watersheds are all unknown, meaning that he recognized that they did not coincide with the orographic altitudes. His perception is to go down in history. The major step achieved in the period when Hacquet and Gruber were active was the realization of the special position of karst groundwater.

No one has yet spoken of "karst phenomena", but that event is coming closer, as we can tell from a letter by Gruber. After reporting the "unbelievable number of dolines on the surface of the mountains", he raises the question (p.107):

> Allein warum behaupte ich dieſe Eigenſchaft blos vom Lande Krain? Das ganze gebirgigte Friaul, Iſtrien, und die Dalmatiſche Küſte iſt von gleichter Beſchaffenheit der Gebirgs- und Steinarten. Faſt eben ſo viele Bäche werden darinn von Klüften verſchlungen, und nach einem größeren oder kleineren unterirdiſchen Lauf wieder ausgeſpien. Nichts als Wunderwerke der Allmacht!

(Why do I only say this of Krain? The mountains of Friaul, Istria and the Dalmatian coast are the same kinds of mountains and rocks. That so many streams are swallowed by joints therein

and then spat out again after a greater or lesser underground course -- nothing but wondrous works of the Almighty!)

THE ULTIMATE BREAKTHROUGH OF NATURAL-SCIENTIFIC THOUGHT IN THE 19TH CENTURY

Although they had already become obvious, serious questions and studies of the karstification process only appeared decades after Hacquet and Gruber.

The Frenchman Abbe Paramelle was the first to attempt in 1856 to determine the extent of underground karstification and so indirectly to determine the path of groundwater in karst. This was followed by the attempt by F. Pfaff in 1872 to quantify limestone solution. He determined that a limestone slab exposed to the weather erodes by 1/72 mm yearly, or by one meter in 72 000 years (i.e. O.O13 mm/yr). This value is within the limits that are valid today, depending on climate (cf. Table 1, J. Zoetl, 1979, p.191.[8])

By including the large polje landscapes in Dalmatia and the Croatians and Bosnian hinterland, E. Tietze (1873) broadened the scope of study which had previously emphasized the classical karst in the hinterland of Triest and around Adelsberg and the Zirknitzer Polje; with reference to these areas, he spoke of "karst formation" in general. The proper name "karst" designating a certain mountain range (see Figure 6) was eponymous for this type of geomorphologic-hydrogeological landscape.

K. Wessely (1876) is the first to mention this new meaning of the word "karst" directly, saying "Karst?--Actually that used to be only the name for that rocky, barren area that the traveler hurries through above our large maritime commercial city of Triest, but today "karst" is the general designation of all those areas that had the misfortune to degenerate like the above-mentioned into a rocky desert" (1876, p.153).

The root for "karst" is the Indogermanic word "kar", i.e. German "Fels", or English "rock". The Italian is "carso", the Slovene, "krs".

According to P. Skok (Westermanns Lexikon der Geographie, vol. II, p.726), this word could also be derived from the Illyrian "carsus" (Illyrians: Indogermanic tribe, at the beginning of the Christian era there was a Roman province of Illyria; later, from 1806-1849 it was a kingdom within the Austrian Empire).

A closer geographical delimitation of the "classical karst" is found in Meyers Konversationslexikon, 5th ed., vol.IX, 1896, p.966: "among the karst ridges, two are especially noticeable in Austria. The more northern consists of the "Ternovaner Wald" (Ternovan Forest) between the rivers Isonzo, Wippach and Idra with the Mersawetz as the highest peak (1508 m), the "Birnbaumer Wald" (Birnbaum Forest) south of the former and the plateaus of the Windisch Mark. The more southern, lower range is the actual or Triestine karst which to the south drops 350 m to the sea at Triest" (cf. Figure 6). This latter area is still designated as "karst" in modern atlases (cf. Goldmanns Grosser Weltatlas, Wilhelm Goldmann Verlag, Munich 1955, p.88 and 108).

Karst research in the 19th century was importantly influenced by the political situation, which in turn was still undergoing the effects of the 18th-century Enlightenment. In the Austrian Empire, the influence of the French Revolution (1789-1799) was felt in the "enlightened absolutism" in which the Emperor perceived himself to be the first servant of his Empire (Josef II., regent from 1780-1792).[9] The Revolution of 1848 brought to an end the last phase of absolutism under Metternich. Austria-Hungary was now a conventional monarchy, and after the occupation of Bosnia and Herzegovinia, which ended the ineffectual Turkish domination of those regions, was in possession of a further open field for karst research. The new efforts toward economic development of these regions, now the so-called "Dinaric Karst", employed unrestricted natural sciences, whose practioners were often possessed by a "pioneer spirit" typical for the age.

State interest in this area was focussed not only on agriculture in the poljes, but also on reforestation of further karst regions (E.V. Guttenberg, 1882), and the opening up of the land by construction of roads and railroads (the first railway from Inner Austria to Triest was built in 1850-1857). In many cases, civil engineers were confronted with karst situations that required explanation and practical measures. The Croatian geographer J. Roglic (University of Zagreb) wrote, "It is normal that perialpine Vienna, at that time one of the leading scientific centers in the world, also became the center of geomorphologic investigations, especially those concerning the karst" (1972, p.1).

The situation is typically represented by an official request by the commander of this area, which was under military administration, to the Office of the Director of the Imperial Geological Institute, that " a clear, generally comprehensible presentation of the geological conditions of the area be made, with special consideration of the particular hydrographical characteristics of the area, as it is the intention of the Imperial commanding general to alleviate possible on the basis of scientific studies the emergencies in that region that result from occasional water shortages." (Tietze, 1873, p.28).

E. Tietze then produces a sober geological description of the areas with consideration of the available literature and the basic lithology, along with a discussion of tectonics and stratigraphy that is surprisingly sophisticated for its time. For the first time, we see a scientific discussion of the "terra rossa" (p.40 f), and a treatment of limestone and dolomite solution according to criteria still valid today. The striking difference between arid highlands with plentiful precipitation and large springs at the foot of the massifs presented by Tietze as the most difficult problem in the practical solution to the question of water supply; 60 years later, O. Lehmann (1932) presented this "karst-hydrographic contrast" as a major discovery. The care that Tietze took in his work is seen in his finding that the temperature of large karst springs is often under the average annual temperature of the places where they are found (cf. J. Zoetl, 1957, 1961). Tietze's treatment of the doline is extensive and clearly separates the wheat from the chaff (he rejects the idea of "plutonic activities" and explosion funnels). The poljes are an especially important phenomenon for him (p.53 f). In accordance with the assignment, he also deals with the problems of water supply. His socioeconomic considerations are remarkable, and they are still relevant for karst areas today.[10] The reader is surprised to find that Tietze is able to distinguish between bare and covered karst (p.62, 63). Concerning water problems in poljes see also W. Putik (1887, 1888).

His suggestion for planning regional water conduits on the one hand and the building of large cisterns on the other has local and chronological components and takes the distribution of precipitation into consideration.

Tietze again published extensively in 1880, discussing mainly the opposing ideas on the development of the poljes and the "karst funnels and giant vessels" (dolines), as well as the karrens. He also mentioned A. Schmidl (1854), who was first to differentiate funnel-shaped dolines from karst shafts (Slovene "jama").

F. Simony devoted an entire chapter (1886, p.226 f) to the karrens and thereby also compared the Northern Limestone Alps to the karst phenomena.

Karst research in the second half of the 19th century was, however, primarily devoted to the "Dinaric Karst" in western Bosnia.[11] Very contradictory positions came to be taken by geologists of the Viennese School, and especially by E. Tietze and E. Mojsisovics et al. (1880). The summarizing work of J. Cvijic (1893) marked the end of the 19th and the beginning of the 20th centuries.

KARST RESEARCH OUTSIDE OF THE CLASSICAL KARST IN THE 18TH AND 19TH CENTURIES

Discussion of the development of the dolines began in France earlier than in the classical karst. J. Virlet (1834) explained the dolines in the southern Jura as effects of the collapse of roofs of subsurface cavities, an opinion that was also supported in generalized form by J. Fournet (1852). J. Paramelle (1856), who performed a number of studies in the classical karst, has already been

mentioned. He compared the underground karst drainage with a surface drainage system, equating karst drainage to the cave rivers, an opinion that E.A. Martel (1910) later also shared.

The Vaucluse spring (Latin "vallis clausa") at the beginning of the Sorgue Valley in the South of France became famous early on. Initially however, this fame was due less to karst research than the fact that the Italian lyricist and scholar Francesco Petrarch (1304-1374) had bought a little house at the spring. Petrarch, who had a close relationship to the Pope in exile in Avignon, wrote his loveliest verses here. The discharge of the Vaucluse has been observed systematically since 1853, and in the 19th century its name was used generically to describe karst springs with pronounced variations in discharge.

Early French karst research, however, tended to emphasize speleology.

Early German karst literature has already been mentioned within the context of the general history of karst in Middle Europe (F. Faber in the 15th century). In the 18th century, G.H. Behrens (1703, reprinted 1899) described an episodic lake (Hunger Lake) that appeared at different times with different quantities of water in the Harz near Augsdorff; he suspected an underground connection with a limestone cave.

Outside of the classical karst, the most discussed karst phenomenon of Middle Europe is surely the loss of water by the Danube where it crosses the Swabian Alb. The water reappears in the Aach spring, a tributary of the Rhine **(Figure 8)**.

The conclusion of this chapter will be devoted to the first comprehensive piece of karst research of the Kingdom of Serbia, today a part of Yugoslavia. Cvijic cooperated closely with the most important Middle European geographer at the time, Albrecht Penck, who was at the University of Vienna. Penck published a periodical, "Geographical Proceedings" ("Geographische Abhandlungen"), which presented Cvijic's monograph on karst as Vol. V, 3 (1893, **Figure 9**). This fifth volume of these Proceedings was dedicated by the publisher to Friedrich Simony, the grand master of geography and founder of the first Department of Geography at the University of Vienna (1871); by doing so, he strengthened the position of karst research within the natural sciences.

Cvijic's work gave systematic treatment to karrens, dolines, karst rivers, karst valleys, poljes, the Adriatic coast and the distribution of karst phenomena. He also used the literature available at the time (see his footnotes, p.221-225). The karrens at that time had as yet received little attention as a karst phenomenon. While Simony (1847, p.225) back in his time considered various solution forms of the water flowing over the rock surface (cf. also the literature of the 20th century, esp. A Boegli, 1978), Cvijic considered as karren only what today is thought of as rillen karren. The designation "karren" was assimilated into most languages, although in French, the term taken over by Renevier (1890, p.499), "lapiez", continued in general use. Cvijic corrected such false concepts as the limitation of karren formation to certain altitude levels in the Alps, and mentioned such formations in the Jura, Maehren and in Mediterranean karst areas. Cvijic's belief that there is no karren formation under vegetation has, however, since been disproved.

In the chapter on dolines, Cvijic was first concerned with the definition and the terminology. The English term "sinkhole", very popular today, will be discussed in the section on literature of the 20th century. The term "jama" (shaft) is no longer used for dolines. As a geomorphologist, Cvijic was especially concerned with the form of dolines (p.226-257), and their local distribution is presented impressively (p.260-261), although he does not explain it. As to their formation, using more than 60 items of literature, Cvijic was the first to reach the correct conclusion that these are usually solution forms, although "no one can deny that in a karst area with underlying caves, occasional dolines can be caused by collapse" (p.271). Among those cited by Cvijic are: A. Schmidl, 1854, W. Putik, 1887, E.A. Martel 1891, E. Tietze 1880, A. Boue, 1861 and De Launay and Martel 1891. In his chapters on karst rivers ("Karstfluesse") and karst valleys ("Karsttaeler"), Cvijic limited himself to individual descriptions and made no distinctions among the large karst springs that were mentioned repeatedly. As the geomorphologist Cvijic did not devote a separate chapter to the special subject of karst hydrology, the hydrological problems are not apparent and springs, ponors and estavelles do

not appear in this work organized according to a geomorphological point of view. Karst-hydrological questions are mainly expressed in the chapter on poljes (p.291-313).

KARST RESEARCH AND AUXILIARY RESEARCH IN THE 20TH CENTURY

Corrosion, the Solution Processes in Karstifiable Rocks

We have already mentioned the surprisingly early attempt to quantify lime solution of the surface of rocks.

The carbonate rocks limestone ($CaCO_3$) and dolomite ($MgCa(CO_2)_2$) have limited solubility that mainly depends on the CO_2 content of the water, the purity of the carbonate rock, its joint pattern and tectonics, temperature and climate (F. Bauer 1964; J. Corbel, 1959; J. Dresch, 1968; A. Gerstenhauer, 1972; H.S. Harned et al. 1941; J.-J. Miserez, 1971; D.F. Morehause, 1968; H. Paloc, 1964; M.M. Sweeting, 1964, 1972; M.M. Sweeting and A. Gerstenhauer, 1960).

A. Boegli, 1978 (p.29-50) includes an exhaustive treatment of solution processes in carbonate rocks. A major finding here is the confirmation of the correctness of the division, made previously by E. Tietze (1873, p.62-63), between "bare" karst and karst that is covered by soil and vegetation. I have suggested (Zoetl, 1974, p.1-9) that a distinction be made between the latter and karst that has other rock sequences lying upon it. Boegli also corrected the overemphasis that O. Lehmann (1932, p.16 ff) had placed on "ur-caves" (oversized crevices present before karstification), and also provided an explanation for the rapid karstification of moist tropical areas. A. Grund (1903) believed mistakenly that dolomite was not capable of karstification, but he corrected himself (1910) in view of criticism by W.V. Knebel (1906). His recognition of corrosion caused by mixing of different karst waters, so-called "mixing corrosion" (Mischungskorrosion) made Boegli world famous (1964; see references; A. Burger, 1975, p.75-89).

The corrosion of carbonate rocks is a reversible chemical process, i.e. when the CO_2 content in water drops, dissolved carbonate rock precipitates out in the form of sinter or calcareous tuffa.

Very special formations are to be found in a sediment area of Quaternary sinter covering over 600 km2 and some tens of meters thick north of the Turkish city of Antalya (Hydrogeologic map of Antalya Travertine Area, 1:50 000, DI-UNDP Project TUR/77/0q5, Ankara, 1977), or in the sinter dams of the Plivitz Lakes in NW Yugoslavia. Other areas see J. Avias and L. Dubertret (1975, p.33-35).

The corrosion of gypsum and rock salt is a reversible physical solution and its result is designated as gypsum or salt karst, respectively (for solution process see Boegli, 1978, p.13 and 15).

Geographically and chronologically, gypsum and salt were "deposited to quite different extents, depending on the respective distribution of land and sea and according to the climate" (Eastern Alps see E. Spengler, 1951, p.304; Gypsum Karst of Pre Alps, G. Goetzinger, 1957). D. Pfeiffer and J. Hahn (1972, p.196) estimate the salt deposits alone in middle and northern Germany at some 100,000 km^3, corresponding roughly to the distribution of limestone in West Germany.

The most fascinating report on saline waters or brines (mineral content of the water higher than ocean water, i.e. 35 g/kg or 36 g/l) at great depths and their movements may well be the description of deep subterranean aquifers of the Angara-Lena basin by E.V. Pinneker (1967, p.289-310). There are also important descriptions of gypsum and salt karst in Siberia (I.V. Popov et al. 1972, p.387).

Gypsum as a transformational product of anhydrite is very jointed and on account of the high solubility tends to cave formation, as well as rapid decay. The caves are usually smaller than those in carbonate rocks; remarkable exceptions are the Optimisticeskaja and Ozernaja Petschera in Podolia which Boegli (1978, Table 17.1, p.243) classified as the third- and fourth-longest caves in the world (119 and 103 km). Karren in salt and gypsum do not last long and they are usually only to be found in arid areas with rare, episodic precipitation (Zoetl, 1974, p.10, Fig. 2, and Priesnitz, 1969).

The subterranean solution processes cause slow subsidence of the overlying rock and the result is solution dolines and small basins, or also collapse dolines. For subsidence rates see F. Reuter (1973); corrosion forms in the caves are treated by K. Gripp (1912), A. Brandt et al. (1976) and R. Voelker (1973).

Irreversible chemical solution forms in silicate rocks in warm, moist climates are called "pseudokarst" (W. Klaer, 1956; H. Wilhelmy, 1958). They have to do with karst as does the so-called "thermokarst" (M.M. Zhukov, 1963), that is not used to apply to karstification processes in the permafrost zone, but rather to forms resulting from the freezing and thawing cycle.

A final reference with regard to "hypersoluble" rocks (salt, gypsum), "hyposoluble" rocks (pseudokarst) and "thermokarst" is the article by Jacques Avias and Louis Dubertret (1975, p.31-40, with references). The term "thermokarst" even in the sense that it is used here, is to be rejected. Karst is karst, and that is it.

Karst Hydrology

The monograph "Das Karstphaenomen" by J. Cvijic (1893) was little concerned with the problems of drainage of karstified mountains, but was followed--also in A. Penck's Geographical Proceedings-- by A. Grund's extensive work, "Die Karsthydrographie" (1903). There, the author came to the conclusion that evenly distributed "karst water" with vertical and horizontal flow, flows above the stagnating "ground water" to the base level of erosion. Grund assumed a surface rising from the sea land inward, under which all the joints would be filled with stagnant water (1903, p.173). He made a number of inaccurate generalizations, which provided his later opponents with so much material that the main principles of his theories were buried by their criticism (W. Knebel, 1906, W. Lozinski, 1907, L.R. Sawicki, 1909, G.A. Perko, 1909; L. Waagen, 1910).

F. Lukas edited posthumous works of E. Richter (1907) that were also concerned with water movement in karstified mountains. Richter was in general agreement with Grund but suggested, among other things, that ground water in karst in Grund's sense should better be called "joint water" (p.476).

In my opinion, however, it is better to limit "joint water" to noncarbonated rocks or joints that have not expanded by solution. In karst areas, the term "karst water" would be the most suitable.

The geography of Istria gave N. Krebs (1907) the opportunity to compare the views of Grund and Knebel with his own findings. Krebs' view was that even if some veins dominated and assumed the appearance of streams, these waters were nonetheless connected underground (p.56 f).

In opposition to Krebs (and Grund), as early as 1908 F. Katzer took the position that the basic element of karst hydrography was the underground streams. Shortly thereafter (1909), Katzer went into detail on the problems of karst hydrography and categorically rejected extensive connections between karst ground waters (p.43). So far as he is concerned, there can be "no fixed.borders" for the altitude of underground karst streams and their outlets (p.79). Katzer again took up the distinction between bare and covered karst and also distinguished between shallow and deep karst; these concepts became established in the karst literature. Katzer and Grund thus represented the two extremes in a lively discussion that went on for years. Both of them supported their arguments with extensive works of P. Ballif (1896).

Like N. Krebs (1909) and J. Cvijic (1909), L.R. Sawicki (1909) also treated the special question of cyclical development in karst. Not only were new ideas on the development of karst hydrography presented and opposed with vehemence and bitterness. E.A. Martel (1910) rejected a groundwater level ("nappe d'eau de fond", p.128) in karst in an extended discussion of Perko's article. This is not surprising to any one who is familiar with the underground river of Bramabiau in the Grands Causses; the study of this area was the life work of E.A. Martel.

Fruitless exchanges between Waagen (1911) and Grund (1912), as well as between Katzer (1912) and Grund (1912) were followed by publications by H. Bock (1913) favoring the underground stream theory.

One of the most interesting studies at the time was certainly that of K. Terzaghi in the Croatian karst (1912/13). In this very precise work, Terzaghi preferred Grund's karst water theory (p.317), but was correct in rejecting, among other things, Grund's assumption that karstified mountains are uniformly jointed down to great depths (p.318). The discussion finally died down, without any synthesis of the extreme positions.

The greatest and longest-lasting influence upon karst hydrological thought in the German-speaking world was exerted beyond doubt by O. Lehmann's "Hydrographie des Karstes" (1932). Lehmann's hypotheses can be summarized, as follows: Karst runoff is usually through rocky subterranean caves in readily soluble rocks and occurs whenever the following kinds of cavities exist, or develop tectonically: (1) Broad primordial fissures with diameters of the order of magnitude of meters, (2) Supercapillary and large capillary joints and pipes. Furthermore, Lehmann was convinced that karst water flows in individual ways, water levels do not exist in karstified rocks, and that there is no relation between karstwater flow and base level of erosion. Lehmann's "Hydrographie des Karstes" did manage to almost paralyze karst-hydrological research in central Europe (W. Krieg, 1954, 1955; E. Arnberger, 1955; H. Trimmel, 1955).

This led to the publication of contributions to the problems of karst hydrography with special consideration of the question of the base level of erosion (J. Zoetl, 1958). Research methods new at the time were a great help in that work. The hypotheses of Lehmann (1932) were ultimately laid to rest with "Karsthydrogeologie" by J. Zoetl (1974). A. Boegli (1978) said of this work in the introduction to his "Karsthydrographie and physische Spelaeologie" that "for the first time, the untenability of the hypotheses of O. Lehmann has been so presented as one might wish. Thus a spell has been broken which for a long time divided progress but at the same time stimulated contradiction and thus inspired new work".

In the time after O. Lehmann, the karst research in Central Europe lost its leading role.

Selected historical references and recent bibliographies with emphasis to the worldwide progress in the development of karst research are presented by P.E. LaMoreaux, H.E. LeGrand, and V.T. Stringfield (1975, p.41-52).

Karstwater Tracing Techniques

The use of artificial markers to trace subterranean karst waters has a history of its own, which at the same time is the history of the Symposia on Underground Water Tracing (SUWT).

If we neglect such unsuitable attempts as the use of straw, chaff, sawdust, etc. then the first large, quantitative karst water tracing experiments were the injections of sodium fluorescein and potassium chloride (1878) into sinkholes of the Danube (W. Kaess, 1969, p.215-246).

Another tracing experiment was performed in November 1908 using a different Danube sinkhole further downriver near Fridingen (**Figure 8**). In this case, 500 hundredweights of sodium chloride were injected. This effort, performed some 80 years ago, produced what were probably the first documentary pictures of an artificial karst water tracing (**Figure 10**). Previous to that, two dyeing tests with injections of 5 kg each of sodium fluorescein into a sinkhole in the municipality of Tuttlingen had failed in 1904 because the amount of dye used was too small (W. Kaess in H. Batsche et al., 1970, p.141).

There was also curiosities, such as the use of marked eels in the Reka, that actually emerged in Timavo. Plant spores were used first in the year 1926, when club moss (lycopodium clavatum) spores were used as a tracer (G. Vornatscher, 1962); these spores only later came into common use for this purpose. In 1927, G. Kyrle made unsuccessful experiments with sodium chloride, fluorescein dye, cork shavings and wooden beads in the Lurbach cave system in the Cen-

tral Styrian Karst. This work would have never become as well known as it did, if the preparation, performance and results had not been described in such detail (G. Kyrle, 1928). The conclusion from these failed experiments simply provoked a discussion and repetition of the experiment. The economic and political circumstances in the 1930s and 1940s delayed this repetition until 1952, when it was performed under the leadership of V. Maurin from May 10 to May 15 (V. Maurin, 1951, V. Maurin and J. Zoetl, 1959).

This was the first karst water tracing experiment in Central Europe after World War II, and it was an historical event for all involved. It was only possible at the time because the American Marshall Plan for Central Europe also subsidized scientific research. Eight hundred kg of commercial salt were injected into the Lurbach system. W. Back and J. Zoetl (1975, p.116, Fig. 59) indicate the result of this and later experiments in this area.

New methods sought improved detection of known tracer materials as well as application of new tracers. Initially only the sodium fluorescein uranin became established as a fluorescence tracer. To determine the catchment and protected area of springs supplying water to Vienna (First Viennese High Spring Aqueduct), F. Dosch injected 9 kg of Oranin into a doline in the central plateau area of the Schneeberg karst massif. In order to detect smaller concentrations, he extracted the fluorescein with ether; it could then be detected more sensitively with the quartz lamp (F. Dosch, 1956). This method was time consuming and an experienced eye was needed to determine concentrations by comparing water samples with prepared comparison solutions using the quartz lamp (G. Lukas, 1959, p.94-105). At the time, fluorometers were still wishful thinking for smaller laboratories. Between 1928 and 1953, experience was also being collected elsewhere. K. Kisskalt (1940) was involved with the quantitative determination of dyes and salts injected into ground waters. E. Dudich applied these methods to the solution of hydrological problems in the Baradla cave near Aggtelek (Hungary, 1932). L. Popp (1953) also worked with dyes and salts, and G. Richter (1944) reported comparisons of the use of dyes and salts in the Wartstein springs (Germany). Viewed retrospectively, it is interesting to note that as early as 1907 and 1908, Timeus and Vortmann were doing studies in the Istrian karst with lithium chloride and even with radioactive substances (V.G. Timeus, 1912). These experiments were not repeated, in the case of lithium salt because it was so much more expensive than NaCl or KCl. Less was also known at the time about the dangers of radioactive materials and so Timeus used pitch blend, the only radioactive substance available at the time, with its long-lived uranium and radium, in quantities that, calculated from Timeus' data, must have been a million times greater than what would be permissible today (H. Mitter, 1959, p.122). Mitter (loc. cit.) also mentions that later on, "work was done very carelessly", relying on the fact that there was a great dilution underground between sinkhole and springs; in this context he mentions R. Hours (1955), A. Montens (1953/54) and E. Sons (1952/53).

Lycopodium spores, in contrast, turned out to be a safe tracer material that has come to be used throughout the world. The first use of these spores in 1926 (Vornatscher, 1962) had in the meanwhile been forgotten and in 1954, A. Mayr presented the use of club-moss spores as a new method for following underground waterways. The difference between lycopodium and other tracing materials that had been used up to then is that the spores do not dissolve but form an emulsion as solid bodies. Due to their small size (average diameter 33 micrometers), they remain suspended in water and do not float (cf. J. Zoetl, 1974, p.56-60). Their breakthrough in karst hydrology came with the development by M. Dechant of permanent staining for the spores in five different colors (Dechant, 1959, p.145-149; 1967, p.241-247; cf. also J. Zoetl, 1957, p.107-117; V. Maurin and J. Zoetl, 1969, p.125-139; A. Hofer, 1959, p.140-144; J. Zoetl, 1961, p.108-123; J.G. Zoetl, 1967, p.235-239; F. Bauer, 1967, p.243-265; J.G. Zoetl, 1979, p.56-60).

When they were introduced, drifting spores were the only tracer that, when with different colors, permitted multiple injections simultaneously, i.e. under the same hydrological conditions, in a large area. The first large-scale application of dyed lycopodium spores was a study of the eastern part of the Dachstein massif (Northern Limestone Alps) covering 284 km^2, and this put on the map (J. Zoetl, 1957). The experiment was repeated more elaborately in 1958 and confirmed the results obtained the first time (**Figure 11**). There were a few slight improvements in the spore-drift method in the next years (the material in the plankton nets was changed from silk gauze to nylon). Only recently have new dye techniques been developed (dyeing of the spores with fluorescein dyes); this

makes them easier to count and has improved detection by a factor of one thousand in some instances (M. Bricelj et al., 1980).

Regular contacts that were developing among experts practicing groundwater tracing were an important contribution to the further development and application of ground water tracing techniques. What was originally proposed as a panel meeting turned into the first "Specialists' Conference on the Tracing of Subterranean Waters" in Graz, Austria from March 28-April 1, 1966. It was attended by 125 participants from the Federal Republic of Germany, Czechoslovakia, German Democratic Republic, France, Yugoslavia, the Netherlands, Poland, Rumania, Sweden, Switzerland, the USSR, Hungary and Austria. Also present were official representative of the FAO, the IAEA, the national committees for the International Hydrological Decade, and the Union Internationale de Speleologie (Paris). The theoretical part of the meeting (31 papers and extensive discussion) was followed by two field tests. These involved one sinkhole in each of two smaller karst areas in the Central Styrian karst west and north of the city of Graz, respectively. Geological and hydrological data were available for both. Different tracers were injected into them simultaneously and the output at the spring outlets measured. These were "combined tests" that were not to explore karst systems that were already known, but to compare the efficiency of the different tracers. Since the weather-dependent range of passage times of the subterranean water from the injection point to the outlet was already known, it was also possible to use isotopes as tracers. This is usually only possible in small areas and for special purposes, due to the potential danger to the environment. In the two test areas, the following tracers were used: test area Buchkogel--alkyl-benzolsulfonate, tritium, chrome-51, NaCl, KCl, sulforhodamine G, lycopodium spores of violet color. Alkylbenzolsulfonate was injected by scientists from the University of Erlangen (FRG). It was tested not only for its qualities as a tracer, but also for its ecological effects. The results obtained in this study contributed to the fact that this substance, a so-called "hard" detergent, was discontinued by industry and replaced by "soft" detergents.

The application of 5 Ci of tritium was supervised by experts from the Bundesversuchs- und Forschungsanstalt Arsenal in Vienna and evaluated in conjunction with radiologists from the "Forschungsstel-le fuer Radiohydrometrie" in Munich (since 1987 known as the Institute fuer Hydrologie of the Gesellschaft fuer Strahlenforschung (GSF) Munich, FRG). Tritium has also ceased to be used as an artificial tracer, with the exception of special studies (dam construction projects for reservoirs in karstified rocks). The factors involved here were the dosage and radiation stress to the environment, as well as the desire to conserve the usefulness of natural Tritium in precipitation as a source of information.

The chrome-51 in the form of chrome-51-EDTA was made available by the Chalmers University, Goeteborg (Sweden, production by E. Edroth and J.V. Liljenzin, see G. Knutsson, 1967).

With regard to the use of isotopes as artificial tracers, it must be mentioned that in a first comparative test as preparation for the meeting, T. Papdimitrcpoulos tested the "activation-analytical method" in the Buchkogel area in Graz (K. Buchtela. et al., 1964, p.6-11). Nonradioactive bromine was used in the form of NH_4Br. The water samples were irradiated with neutrons in a reactor to make the bromide radioactive and measurable. This activation-analysis method with different EDTA complexes had seemed like a good idea; the radioactivity could be measured very precisely and the injection did not involve radiation stress. As new tracers were developed, however, this method fell into disuse owing to its disadvantages; the need of a rector, complications with regard to transportation, etc.

Zeiss had made available a spectral photometer with flame attachment for use at this meeting, making it possible to measure the cations sodium and potassium separately when they had been applied together. Total chloride output was also measured in addition to the cations. The second test area used at the meeting in 1966 in Graz was Semriach-Peggau, and tritium, I-131, manganese EDTA, spores and uranin (sodium fluorescein) were injected.

Iodine was measured in a flow-through container directly at the spring outlet, in collective samples and later with a gamma spectrometer. Tritium was detected with sample measurements in a liquid scintillation counter.

Manganese application and measurement were supervised by the Atominstitute of the Austrian universities (K. Buchtela). The sodium salt EDTA was added to manganese as a sulfate in aqueous solution to form a complex bond with manganese. The activation analysis was performed in the research reactor in Vienna.

As a drifting medium 10 kg of brown-dyed lycopodium spores were injected at the location used for all the other tracers. Utilizing the very complete observation capacity, green lycopodium spores were also injected into another ponor: An extended application of sodium fluorescein was also tested successfully at this meeting. I still have no idea as to how the news of this proposed meeting in 1966 reached the USA. In any case, William B. White (Pennsylvania State University) submitted a contribution entitled "Modification of fluorescein dye ground-water tracing techniques" for publication (Proceedings, 1967, p.151-158). In this article, White describes what he calls the Dunn method of charcoal detection. It is based on the fact that charcoal adsorbs sodium fluorescein and does not give it up again to water. The charcoal can be stored dry for an indefinite time; the dye is then extracted with a solution of potassium hydroxide in ethanol. The Dunn method was also tested by T.D. Turner (1958) in the karst of central Pennsylvania. This method is especially significant for tracing experiments involving springs in remote places. This method was then taken up by A. Lallemand and H. Paloc (1964); F. Bauer (1967, p.169-178) then came to rely on their work and subsequently made a number of practical improvements (Normed nylon-yarn bags that can be suspended in the water; drying, transport and extraction of fluorescein with a mixture of 96% alcohol and 15% KOH solution, 1:1. The fact that it is only a semiquantitative method is made up for by unlimited suspension (= observation) time and the accumulation of even the most minute concentrations of the solution from the water. Tracer hydrology would be unthinkable today without this method.

This first Specialists' Conference on the Tracing of Subterranean Waters in Graz in 1966 led to contacts that have been surprisingly enduring.

Just a year later, in 1967, representatives of nineteen institutions in the FRG, Yugoslavia and Austria agreed to work together on open questions on seepage of Danube waters in the Swabian Alb with modern precision methods. Long-term hydrological and isotopic measurements carried out from 1967-1969 formed the basis for an extensive combined karst water tracing experiment in fall of 1969 (H. Batsche et al., 1970, p.5-165). The results brought new information on the subterranean distribution of infiltrating water from the Danube (see Figure 8). The successful use of aromatic substances remained a curiosity (H. Batsche et al, 1970, p.118-120; W.A. Schnitzer and W. Wagner, 1967, 1969).

The Second Specialists' Conference on Groundwater Tracing Techniques in 1970 in Freiburg im Breisgau, FRG, presented the results of the long-term preliminary studies in 1967-69 and of the karst water tracing experiments in 1969 in the Danube-Aach region. At the final session, the proposal of the Yugoslavian delegates to devote the next joint studies to the "classical karst" was accepted unanimously. The Yugoslavian Committee for the International Hydrological Decade (IHD) assumed responsibility for the organization of the Third International Symposium on Underground Water Tracing (3rd SUWT). The organizing committee included specialists from the Karst Research Institute of the Slovenian Academy of Sciences and Arts in Postojna (Institute za raziskovanje krasa SAZU) and the former Hydrometeorological Institute in Slovenia (Meteroloski zavod Slovenje, Ljubljana). The president of the committee was the Minister of Slovenia, Boris Mikos. The working group included specialists from 14 institutions in Yugoslavia, Austria, FRG and Switzerland. The studies made were the most extensive international cooperative effort to date on the hydrogeology and hydrology of the classical karst, i.e. the catchment area of the Ljubljanica River. The results were published in English (eds. R. Gospodaric and P. Habic, 1976), German (eds. R. Gospodaric and J. Zoetl, 1976) and Slovenian (eds. R. Gospodaric and P. Habic, 1976).

Technical results of this cooperation were a new spectrofluorimetric analytic method developed for four fluorescent dyes (uranin A, eosine, amidorhodamine G-extra, and rhodamine FB (Behrens, 1971, 1973; Zupan, 1970, p.125; Rochart et al., 1975). Tinopal CBS-X proved successful

as a new tracer (Behrens; Zupan and; M. Zupan, 1976, p.125-129). Tinopal, an optical brightener, was used and tested here for the first time.

A new technique for fluorimetric determination of water samples containing a mixture of fluorescein traces in different concentrations was discussed by F.P. Bub, H. Hoetzl and K. Wisser (1979, p.129-141). Preliminary separation of the tracers is achieved with high pressure liquid chromatography, as used in analytical chemistry.

The high points to date in the study of karst terrains for preparation of a tracer symposium were the "Karsthydrologische Untersuchungen mit natuerlichen und kuenstlichen Tracern im Neuenburger Jura" (Karst-hydrological studies with natural and artificial tracers in the Neuenburger Jura, I. Mueller and J.G. Zoetl, eds., 1980, p.5-100) and "Hydrologische Untersuchungen im Karst des hinteren Muotatales" (Hydrogeological studies in the karst of the upper Muota Valley, A. Boegli and T. Harum, eds., 1981). Both of these karst areas are in Switzerland, but their geological structure and hydrological behavior are very different. The studies were the result of joint field work on the part of teams from Austrian, Federal Republic of Germany, Swiss and Yugoslavian institutions which had cooperated in the 2nd and 3rd SUWT and had agreed to prepare the 4th SUWT, which was held in Bern, Switzerland in 1982. The long experience of the Centre d'Hydrogeologie of the University of Neuchatel under the direction of A. Burger and the assistance of the Swiss National Fund for the Advancement of Science made possible optimal planning, performance and evaluation of the very expensive measurements of environmental isotopes and the combined artificial tracer studies, especially in the karst of Neuenburg Jura (cf. I. Mueller et al., 1980, p.17-47; R. Gospodaric et al., 1980, p.87-90, L. Kiraly et al., 1980 p.92-95). These investigations became a guide-line for modern karst hydrological studies.

The 5th SUWT in Athens, Greece in 1986 emphasized the results of joint karst hydrogeological studies in the central and eastern Peloponnesus by experts from Greece, Austria, FRG, Switzerland and Yugoslavia (A. Morfis and H. Zojer, eds., 1986). Time and expense of this large-scale project show the limits of these efforts. A decision to limit joint research to a particular subject in a certain place is most likely to insure the further existence of this unique institution.

Isotope Hydrology and Karst

Systematic measurements of environmental isotopes in water for hydrological and thus also for karst hydrological research began in the 1950s and progressed most rapidly after the atmospheric H-bomb tests (1962, 1963).

Measurement of the radioisotope tritium (T or ^{3}H, half life 10.26 years) as well as of the stable isotopes deuterium (D, ^{2}H) and oxygen-18 (^{18}O) is routine today and is of increasing importance in karst research. Carbon-14 measurements from deep ground waters stored in the Paleokarst provide invaluable data for estimating storage capacity and the balance of deep ground waters.

A survey of the development of isotope methods applied to ground-water hydrology is to be found in A. Nir (1967) and J.R. Gat (1974, 1976, and 1981).

Around 1960, the International Atomic Energy Agency established a Section of Isotope Hydrology. Under the direction of Dr. H.C. Bryan R. Payne, this relatively small department turned out to be a logical place for the large national research institutes throughout the world to share their experience. Delegates to the first symposium on isotopes in hydrology in Vienna discussed karst water research mainly in the sessions five and six, on geochronology and environmental studies (J.C. Fontes, R. Letolle, P. Olive and B. Blavoux, Proceedings 1967, p.401-413; J. Guizerix, R. Margrita, M. Launay and P. Rugy, Proceedings, 1967, p.433-449; G.H. Davis, T. Dincer, T. Florkowski, B.R. Payne, and T. Gattinger, Proceedings 1967, p.451-467). An important detail was the finding that water from large karst springs contained the same amount of the stable isotopes deuterium and oxygen-18 as are found at the median altitude of the catchment. This finding, due to the effects of altitude and temperature, confirms statements made in 1957 on the basis of numerous temperature measurements in karst springs in the Dachstein area (J. Zoetl, 1957, p.182-205, 1961, p.161).

The first "Guidebook on Nuclear Techniques in Hydrology" (Technical reports series No. 91) appeared in 1968. The topic of Section 1.3. (p.5-14) is "environmental isotopes". Figure 2 of this section shows the variation of tritium concentration in precipitation in Valentia and Vienna from 1961-1965 as an example that "in most areas it is possible to establish correlations between stations and thus reconstruct possible past history for a location from data accumulated in other stations" (p.8). Furthermore, carbon-14, silicon-32 and the noble gas radon are described briefly and practical advice for water sampling is given.

The tritium content of precipitation is useful in the calculation of the water in karst areas. As the hydrogen atom tritium is a part of the water molecule, absorption into the ground does not cause any value change. In the karst water body, there is a mixture of different tritium contents from individual precipitation events; springs in shallow karst generally have values around the monthly average of precipitation. A summary of annual tritium variations and long-term trends is given in C. Job (1970, p.217-223).

The second major symposium on the use of isotopes in hydrology was held by the IAEA in cooperation with UNESCO in March, 1970 in Vienna (Proceedings Isotope Hydrology 1970). The study presented at this by R. Margrita, J. Evan, J. Flandrin and H. Paloc of the water balance of the Fontaine de Vaucluse catchment is an excellent example of the importance of isotope hydrology in a karst area (Proceedings, 1970, p.333-346). Further karst water case studies using isotopes were presented by D.B. Bredenkamp and J.C. Vogel (Proceedings, 1970, p.349-370) and U. Siegenthaler, H. Oeschger and E. Tongiorgi. G. Magri and G.S. Tazioli provide an interesting contribution on radon in karst waters of dolomitic and calcareous aquifers in Apulia (Proceedings 1970, p.835-844). Further references to case studies in the IAEA Proceedings are G. Durozoy et al. (1965), J. Evin et al. (1967), J. Flandrin, R. Margrita, and H. Paloc (1967), J.F. Enslin (1967), J.F. Enslin and J.P. Kriel (1967).

Of the many projects processed internally by the Section of Isotope Hydrology of the IAEA, only a few have been published. The few exceptions are extraordinarily instructive. T. Dincer and B.R. Payne provided excellent material on karst areas in southwest Turkey (1971, p.234-245), with special emphasis on the question of economic effects of a possible decrease in the water level of the Beysehir Lake on the output of the giant springs on the Manavgat River. T. Dincer and J. Payne (1971, p.245) and F. Sentuerk et al. (1970, p.153-161) treated similar problems with regard to springs of the Koepruecay River.

The clarification of the water balance of the "Totes Gebirge" karst massif in the Northern Limestone Alps in Austria is a good example of applied isotope hydrology over a period of years (T. Dincer, B.R. Payne, C.K. Yen and J. Zoetl, 1972).

The isotope hydrological studies by J.R. Gat in the phreatic coastal aquifer of Israel and in a largely confined limestone aquifer are of more than local interest (Proceedings, 1974 Symposium, p.51-59; see also M. Magaritz, 1973).

At the symposium in Neuherberg in 1978, jointly organized by the IAEA and UNESCO, U. Schotterer et al. presented a paper on isotope study in the alpine karst region of Rawil, Switzerland (Proceedings 1979, p.351-365). The results are comparable to those from Totes Gebirge. Schotterer et al. calculated models of two possible reservoir mechanisms. Further references are A. Wildberger et al. (1978), U. Siegenthaler and U. Schotterer (1977), and U. Siegenthaler et al. (1970).

A number of papers on environmental isotopes were presented at the symposium on isotope hydrology in 1983 (IAEA Proceedings, Vienna 1984). Thus authors published papers in these proceedings on the Swiss Jura (U. Siegenthaler, U. Schotterer, I. Mueller, p.153-172), central Italy (P. Celico et al., p.173-192), Greece (I.L. Leontiadis et al., p.193-206), central Europe (L. Eichinger et al., p.271- 289), Mali (T. Dincer et al., p.341-365). Other relevant papers were presented by I. Mueller (1982), P. Moerchler et al. (1982), U. Schotterer and I. Mueller (1982), P. Celico (1983), C.F. Boni (1973), P. Celico (1978), C. Bartolomei et al. (1980), P. Celico (1981), B.M. Zuppi (1974), I.L. Leontiadis (1980, 1981), G. Kallergis and I.L. Leontiadis (1983), B.R. Payne et al. (1976), K.

Rozanski, C. Sonntag and K.O. Muennich (1982), K.O. Muennich and J.C. Vogel (1967), C. Sonntag et al. (1979).

In the rather long intervals between symposia, the Section of Isotope Hydrology holds a number of panel meetings at which karst problems are also covered.

The isotope hydrology of large areas was an important part of studies on karst terrain as preparation for extensive karst water tracing experiments. Tritium and carbon-14 measurements in springs in the Danube infiltration area showed that the spring waters were mixed waters including three components: Danube water, accumulated precipitation water with a storage time of less than one year, and water in the deeper karst water body with a mean residence time of more than ten years (M.A. Geyh and J. Mairhofer, 1970, p.63-81). The interpretation of tritium, deuterium and oxygen-18 measurements in the catchment of the Ljubljanica was more difficult, as the springs are affected to very different extents by surface runoff from the poljes (H. Moser, V. Rajner, D. Rank and W. Stichler, 1976, p.88-107). An excellent interpretation of tritium and O-18 and O-16 measurements in the Areuse catchment (Neuenburger Jura, Switzerland) is given by U. Schotterer and U. Siegenthaler (I. Mueller, L. Kiraly, U. Schotterer and U. Siegenthaler, 1980, p.31-37). Measurements of the content of deuterium, O-18 and tritium in water samples by H. Moser, W. Stichler, D. Fank and V. Rajner showed the proportions of direct and delayed water flow in the total flow in the upper Muota Valley in the Swiss Limestone Alps (1981, p.155-171). Studies using environmental isotopes in the area of the Feneos basin and the Ladon spring on the Peloponnesus (Greece) were published by G. Probst, P. Ramspacher and H. Zojer (1986, p.113-115) and H. Hoetzl, H. Moser, T. Roeckel, and W. Stichler (1986, p.144-148).

The references mentioned are only a small sample of examples of use of radiohydrometric methods in karst hydrology. Inclusion of all the case studies that have been performed throughout the world would exceed the scope of this project. But these methods show two typical characteristics: the brief interval from their introduction to their full establishment in karst hydrology, and the expansion of their application from the solution of isolated problems to their use in a worldwide measurement network to solve regional problems. Carbon-14 measurements became an important tool for studies of the Paleoclimate (Fontes, 1983). In conclusion, it should be mentioned that beyond the use of environmental isotopes in karst hydrology, studies of the direct infiltration of radioactive fission products into the karst water bodies are becoming increasingly important. In the event of thermonuclear explosions or reactor accidents, these isotopes can be introduced into the water cycle via the atmosphere and can be more damaging to karst waters than to open surface waters. K. Aurand, G. Matthes and R. Wolter (1971) studied the content of strontium-90, ruthenium-106 and caesium-137 in various waters used for supply purposes.

The newest contribution is the attempt to use the uranium isotope disequilibrium as a natural tracer to show water origin.

Karst Landforms

The description of karst landforms is the synthesis of information gathered in the course of scientific studies.

The attempts of Majorie M. Sweeting (1972) in this direction have so far been the most successful. With the assistance of 25 co-authors, M. Herak and V.T. Stringfield (1972) produced a description of important karst regions in the northern hemisphere containing interesting information on karst terrain in different countries, i.e. within political boundaries. Another synthesis is found in the cooperative efforts of 15 authors in a volume edited by P. Fenelon entitled "Phenomenes Karstiques" (1968), the fourth in the series Memoires et Documents of the Centre National de la Recherche Scientifique, Paris, published by J. Dresch.

Basic solution process and small landforms on the surface of the earth (karren, dolines and uvals) are covered by H. Boegli (1978, p.13-63, including plentiful references), M.M. Sweeting (1972, p.24-102 with references), H. Roques (1964, 1968).

There has as yet been no systematic description of the poljes. B.F. Mijatovic says, "Even today disagreements exist in the interested scientific circles on the genesis and evolution of karst poljes in Dinarides" (1984, p.93). This is correct, however it is difficult to follow Mijatovic when he writes: "They (i.e. karst poljes) are known over the entire Alpine orogene range, from Pyrenees to Middle Asia, as well as on some larger Atlantic and Pacific islands (Jamaica, Cuba, Java, Borneo), but the most outstanding representatives in the Dinarides (1984, p.87).

It does not seem possible to "lump" intramontane karst plains with subterranean drainage in tropical areas together with forms in the Alps or Dinaric karst. Poljes are not all alike, and the most outstanding landforms change and depend on basic tectonics and climate. For tectonics of the Dinarides see B. Ciric (1960-1963, p.565-582; 1974, p.341-391; 1984, p.18-41), T. Dragasevic (1973-74, p.14-15), L. Kober (1952), M. Herak (1972, p.29-58, 1986, p.1-42), A. Sarin (1984, p.42-52), M. Herak, S. Bahun and A. Magdalinic (1969, p.72-78). The geological profiles in B.F. Mijatovic (1984, p.104, 105) are so much generalized that they only vaguely suggest the actual tectonic relationship (for comparison see Fig. 52 in M. Herak, 1972, p.49). For information on the geological prerequisites for the formation of poljes in Slovenia, see A. Melik (1955), I. Rakovec (1955, 1956), P. Habic (1976, p.27-38).

As classical geomorphological forms, the poljes in Greece, whether on the mainland (Joannina, Evinos) or in the Peloponnesus, are by no means inferior to those in Croatia (A. Philippson, 1930, 1959; D.I. Burdon, 1963, 1965; J. Dercourt, 1964; H. Eckl, 1979; G. Kowalczyk et al, 1977; E.A. Martel, 1892, 1901; O. Maull, 1921; K. Petrovic, 1958; B. Reichert, 1986; D. Renz, 1940; D. Richter, 1974; D. Richter and Mariolakos, 1972, and T. Roeckel, 1986; B. Sikosek and W. Medwenitsch, 1965).

The Swiss Jura shows a completely different relationship between karst basins without outlets and tectonics than is found in southeastern Europe. And the numerous, generally small poljes in the Apennines also have their own distinctive character (G. Nangeroni, 1957, 1960; H. Lehmann, 1959; A. Sestini, 1963; J. Demangert, 1965; S. Belloni et al., 1972, p.108-109).

Closer study of the literature shows that the phenomenon of the poljes is determined by different local geological and climatic factors. In this review, the karst basins of Jamaica, Cuba, Java and Borneo that Mijatovic (1972, p.87) counts as poljes are to discuss within the context of tropical karst landforms.

Thinking with regard to karstification of coastal regions is still unclear. J. Roglic (1969. p.35) writes that, "Water circulates even at great depths, and quite independent of sea level, while on the karst shores submarine springs (vrulje) are common."

There are indeed submarine springs, hundreds of them, not only along the coast of Yugoslavia, Albania and Greece, but around the entire Mediterranean, the Persian Gulf, etc. They were also described early by J. Lorenz (1859).

Understanding of the geomorphology of the coastal karst depends primarily on knowledge and study of the local effects of the eustatic variations in sea level and tendencies of the sea level to rise. The sea had and still has a determinative effect as the base level of karstification but it is difficult to unravel the different stages, especially since local tectonic lifts and subsidences also confuse the picture. The level of the Tyrrhenian terrace extending around the Mediterranean is a valuable aid to orientation for the Quaternary Period (P. Woldstedt, 1961-1965, 1969; Keller, 1963; T. Nilsson, 1983). Today there is a variety of karstification horizons and submarine springs of varying depth and size. S. Alfirevic (1969, p.202) showed that in some cases, these used to be former surface dolines. Their variety in discharge can be explained by their hydraulic function, which varies with seasons and tides (Herak, 1972, p.15 and 65; Stringfield, 1969). The problems of coastal karst have received attention all over the world (E.C. Pirkle, V.T. Stringfield, 1969; E. Pirkle, W.H. Yoko, and C.W. Hendry, Jr., 1970; Donald J. Colquhoun and Mark J. Brooks, 1986; A. Guilcher, 1969; G. Hope, 1983; E.A. Colhoun, 1983; T. Nilsson, 1983; R.J. Russel, 1961; S.P. Chatterjee, 1961; E.D. Gill, 1961; T. Nakang, 1961; D. Alt and H.K. Brooks, 1965; MacNeil and F. Stearns, 1950; H.D. Tjia, S.

Fujii and K. Kigoski, 1977; H. Felber et al, 1984; H. Hoetzl et al., 1974). An important paper concerning brackish karstic springs was written by M. Brenik (1973).

This completes the transition to the most remarkable of all the karst landforms, the tropical karst. These are karst areas in the humid tropics, predominated either by "cone karst" as in the cockpit countries of Jamaica, Puerto Rico and Cuba, or by "tower karst", as in China, Vietnam, and Thailand. M.M. Sweeting has paid particular attention to these forms (1970, p.270-300). The following are the most important contributions to the literature. The important impulses generated by H. Lehmann (1936) were followed by H. Lehmann 1953, 1954, 1956, 1960; J.N. Jennings and M.M. Sweeting, 1963, 1968; A. Gerstenhauer, 1960, 1966; H.R. Versey, 1959; H.T.L. Verstappen, 1960, 1964; J.N. Jennings, and M. Bik, 1962; D. Balazs, 1962, 1968; G.E. Wilford and J.R.D. Wall, 1965; 1966; M.C. Brown, 1966; J.F. Gellert, 1960; H. Wissmann, 1954; H. Flathe and D. Pfeiffer, 1965; J. Silar, 1965; C.F.T. Aub, 1964; V. Panos and O. Stelcl, 1968; F.D. Miotke, 1971, 1973; W.H. Monroe, 1964; C.J.H. Paton, 1963; F. Blondel, 1929; P. Birot, J. Corbel and R. Muxait, 1968; P.W. Williams, 1971; F. Voss, 1970; H.V. Wissmann, 1954.

Karst in the arid tropics is mostly relict or fossil or so-called paleo-karst, with the exception of very small rillen karren formed by the solution of thaw. Nonetheless, large subterranean karst paths in the desert (e.g. eastern Arabia) can significantly replenish old subterranean water supplies (H.V. Wissmann, 1957; H. Felber et al., 1978; cf. southern Africa, A.B.A. Brink and T.C. Patridge, 1965; J.F. Enslin, 1967, 1969).

Regionalization of karst can be made from different point of view (M. Komatina, 1975). It is obvious that climate is one of the most effective factors **(Figures 12a, b, c, d)**.

Speleology

From the very beginning of our historical consideration of karst forms, we have seen a special interest on the part of man in caves. Systematic scientific research developed step by step and relatively soon used its own working methods. It is, however, going too far to separate caves from the concepts of "karst phenomena" and "karst research", as Cvijic in fact did, and J. Trimmel (1968, p.29) attempted to do theoretically. Caves in carbonate, salt and gypsum are a form of underground karstification process and speleology is an adjunct of karst research and not vice versa.

The scientific work begins either in connection with the following of underground waterways or with surveying of underground cavities.

According to H. Trimmel (1968, p.201), one of the oldest preserved cave maps is that of the "Veteranic Cave" west of Orsola on the former Hungarian-Turkish border. The map was made in 1698 because of the strategic position of the cave. For surveys made in the 17th centuries, see H. Trimmel loc. cit.

The first known temperature measurement was made by Nagel in 1747 in the Geldloch on the Oetscher (Lower Austria; H. Trimmel, p.202). Only in 1796 did it become known that bone remnants from cave bears came from animals that had lived in the caves and had not, as previously supposed, been deposited in a flood that originated in the tropics and swept over Central Europe.

From the second half of the 18th century onwards, cave surveys go hand in hand with study of new cave systems all over the world. Because these efforts were not directly related to karst research--people went into caves just for the sake of the cave--a lot of important information was lost. It is typical for the situation that an outsider, the philosopher Immanuel Kant (1724-1804) in Koenigsberg, Germany, evaluating rather scanty material of karst-hydrographic nature in his lectures printed in 1801 and 1802, came to some quite correct conclusions with regard to the development of caves. The well-read speleologist Trimmel fails to mention the Frenchman Abbe Paramelle, who based his thoughts on the extent of underground karstification on springs and known caves; he also neglects the publications of the superlative cave explorer H. Bock (1913), who classified speleology under landscape development. The separation of speleology from karst research by G. Kyrle, the founder of an Institute of Speleology at the University of Vienna in 1922 was a stillbirth.

This digression requires supplementation. There is no doubt that speleological work demands a special structure. Cave expeditions cannot be made alone. The exploration of the karst phenomenon cave calls for trained and well-organized groups of idealists, as it demands exertion, sacrifice, risk and perseverance on the part of those involved. The result of these facts is that numerous regional and national speleological organizations have been formed.

Active local groups are the single most important factor in the advancement of cave research. They in turn require practical experience and special equipment from clothing to measuring devices. E.A. Martel (1890) made a special contribution by developing and compiling equipment for speleologists. But he was a practicing speleologist as well as a researcher and natural scientist with a European reputation and well deserves the monument dedicated to him in his beloved Grand Causses.

In the Soviet Union, karst and speleological conferences are held by the Soviet Academy of Sciences.The most important Yugoslavian institution dealing with speleology is located in Postojna in the midst of the classical karst with the name "Karst Institute" (Institute zaraziskovanje krasa Sazu).

Speleologists of course are also concerned with the cave as a biotope (biospeleology, anthropospeleology) and with economic exploitation of caves, but these are not reasons to separate speleology from study of karst.

Here, however, the bibliography must go its own way. The large number of amateurs and volunteers surveying and describing individual objects led to large numbers of popular scientific efforts that go far beyond the scope of karst research. The enormous physical exertion was often rewarded in the naming of caves and cave and sinter formations; this often gives speleological reports a unique romantic flavor.

In publishing a karst bibliography, it must be borne in mind that there already are two major speleological bibliographies: The "Bulletin Bibliographic Speleologique" (Switzerland) has been published for years and has included more than 25,600 citations to date in French, English and German; and there is also the "Internationale Bibliographie fuer Spelaelogie", Vienna 1954-1971 with almost 17,000 titles from 35 countries in the original languages. Most of the major works cited in these bibliographies are concerned with caves as karst phenomena.

James F. Quinlan is noted for his contributions to cave research in general in the USA, and the Mammoth Cave in particular. We have him to thank for mention of the translation, "Problems of the Study of Karst of the Russian Plain", eds. N.A. Gvozdetsky and A.G. Chekishev (1966), which includes a bibliography of pertinent Russian karst literature from 1961-1965. The small periodical "Caves and Karst", published by the Cave Research Associates, includes Quinlan as one of its editors and would deserve more extensive distribution.

I should like to let Alfred Boegli have the last word on the question of speleology and karst research. Boegli's major contributions stem on the one hand from his research on solution processes in karstifiable rocks, and on the other from his study of the Hoelloch, the longest surveyed karst cave in Europe (135 km).[12] This cave is located in the Schwyzer Limestone Alps east of the Vierwaldstaetter Lake in central Switzerland (A. Boegli, 1970, p.12). In his work, "Karsthydrographie und physische Spelaeologie" (1978, p.III), Boegli writes: "Karst hydrography and physical speleology are thus two sides of the underground karst phenomenon and should be viewed from one uniform viewpoint." Boegli also sees the aspects mentioned above of scientific study on the one hand and observation and documentation of caves by ambitious amateurs on the other; without the contributions of the latter, the scientist would never have the necessary material and work force.

FINAL REMARKS

A study of the history of karst research shows that it is easier to find the early roots of the subject than to untangle to most recent growth. The greatest problems are posed by the rapid development of karst research in relation to the explosive development of technology within the last

decades. An example of this is the importance of isotope hydrology, which was virtually unknown before World War II and then within 30 years developed into one of the most important allied sciences for karst hydrology. It all comes to a gradual end in the introduction to the Bibliography of carbonate rocks, Vol.III (LaMoreaux 1986).

Some of the very newest techniques were not included in this review as they are still in a developmental stage; remote sensing is one such technique. Furthermore it was not possible to include the significant work of P.T. Milanovic (1981) on technical and engineering geology in this historical survey. The same applies to the numerous papers edited by V. Yevjevich (1976) in the Proceedings of the Yugoslavian Symposium, Dubrovnik, June 2-7, 1975. The titles were published by P.E. LaMoreaux, J.M. Tanner, P.S. ShoreDavis, Vol. III (1986).

As is currently true for virtually every scientific and technical discipline today, there is more literature available than can possibly be surveyed.

Early on in the history of karst, we noted a connection between science and philosophy that unfortunately is less evident today. Nietsche remarked that time is motion. We live our short lives in an age where things seem to keep going faster and faster. Geology is a science of time and motion and their effects on our physical world. We should be reminded of the delicate system of checks and balances that keeps that world viable for us.

ACKNOWLEDGEMENTS

Writing a history of karst research was an interesting task. The idea came from Philip E. LaMoreaux, who encouraged me to take on the project. I am indebted to him for his editorial comments and material based on his comprehensive knowledge of karst and karst research.

This brief and incomplete digest is a bibliography and something else besides. A knowledge of the historical and philosophical roots of the subject was a great help to me, along with personal experience in the classical karst region. I shall never forget the fascinating excursions led by Henry Paloc to the Grandes Causses, by David Burdon in Ireland and by Philip LaMoreaux and his colleagues from the U.S. Geological Survey in the USA. They were all very generous to me with their time and hospitality. R. Gospodaric and M. Habic cooperated with me in Yugoslavia, and it was Mr. Habic who made available to me the excellent photograph of the Skozjanska jama. I am grateful for technical help from my colleagues at SUWT, and for support in isotope hydrology to the IAEA staff in Vienna, especially its former director Bryan R. Payne, as well as George H. Davis and Turgut Dincer. I am very obliged to all the people who discussed the problems of karst and karst hydrology with me, and most especially to the enthusiastic English geographer Marjorie M. Sweeting.

FOOTNOTES

(1) Oral information provided Dr. Ernst Doblhofer, professor emeritus of classics: The word "katavothra" is not found in this form in classical Greek but its meaning is readily apparent, i.e. swallowing or gulping down, etc. Vothra could be identical to the Βε'ςεδςον used by Strabon (also Βαςαδον or Βε'ςεθον further development to Βο'θςα and Modern Greek VOTHRA). The Indogermanic word root from Βεςεθςονις "quer", i.e. "verschlingen" (swallow).

(2) The Old High German word "hel" in Germanic mythology is also the common root of the German words "Hoelle" (hell) and "Hoehle" (cave).

(3) Probably a shrine to the Greek god Pan in the later Roman Caesarea Philippi and present town of Banyas in northern Israel.

(4) Area in southern Syria.

(5) A number of copies were made between the 16th and 18th centuries, causing considerable damage to the parchment. An invaluable aid in the study of the parchment (the Codex Vin-

dobonesis 324) is a complete facsimile in the original scale published by the Akademische Druck- und Verlagsanstalt, Graz, Austria.

(6) "On the river Blau and its source on the locality of Blaubeuren and the establishment of the monastery and other related matters".

(7) Krain comes from the word krajina, border. Slavs first settled there in the sixth century. Karl the Great made the area part of his kingdom. It came under Habsburg rule in 1135 and with the exception of the period of the Napoleonic wars, 1809 - 13, when it was a part of France, was an "Inner-Austrian" land. From 1849 - 1919 it was administered as an "independent Crown land" (duchy). Since the Peace of St. Germain (1919) it has been a part of northwest Yugoslavia. Until 1944, it included a self-contained German-speaking area, the Gottscheer Land (Figure 6).

(8) J. Corbel (1957) calculated for various regions in Iceland a surface erosion by limestone dissolution between 0.120 and 0.010 mm, P. Williams (1963) 0.025 mm, R. Moser in the Alps (1956, 1967) 0.010 - 0.015 mm, A. Boegli (1978) 0.014 -0.081 mm aboveground and 0.010 - 0.057 belowground, and J. G. Zoetl (1979) 0.025 mm for Yorkshire par year.

(9) This intellectual awakening was worldwide. Voltaire (family name Francois-Marie Arouquet, 1694 - 1778) and Jean-Jacques Rousseau (1712 - 1778) provided the philosophical basis for both the American (1776 - 1783) and French Revolutions (cf. Lafayette, 1757 - 1834, and Joel Barlow, 1754 - 1812). Thomas Paine (1759 - 1809), an advocate of freedom of inquiry, found a patron in Thomas Jefferson (1743 - 1826). The natural sciences were freed of religious remnants of outdated, literal interpretations of biblical traditions. According to the German philosopher Imanuel Kant (Koenigsberg, 1724 - 1804), humanity only came of age with the Enlightement. The Age of Enlightement was succeeded in the 19th century by the Romantic era, but continued to exert a major influence in the natural sciences.

(10) E. Tietze, 1873, p. 61: "One must consider the loss in time and working power due to the fact that a large part of the population of entire localities needed seven hours a day, including the necessary rest at the spring, for themselves and some of them draft animals just to get the most minimal amount of water."

(11) The expression "Dinaric Karst" came from the name of the Dinara, a mountain range in excess of 1900 m a.s.l. The Dinara is self-contained, bare and karstified and trends NW-SE along the Yugoslavian (Dalmatian) Ardriatic coast.

(12) The Hoelloch is the second-longest cave system in the world, after the Flint-Mammoth Cave system with 322 km of surveyed passages as of 1977. The Mammoth Cave has been found to be connected to the Flint Cave System, creating a unified cave system see Boegli, 1978, Table 17.1)

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FIGURES

Figure 1
Reindeer. Prehistoric drawing (Magdalenian) in the Font de Gaume cave, ESE of the town of Eyzies, Dordogne, western France. The drawing is scratched into the rock and shaded with red clay and charcoal. From F. Eppel, 1963, p.14 (see also color picture and precise description in H. Kuehn, 1952, p.33).

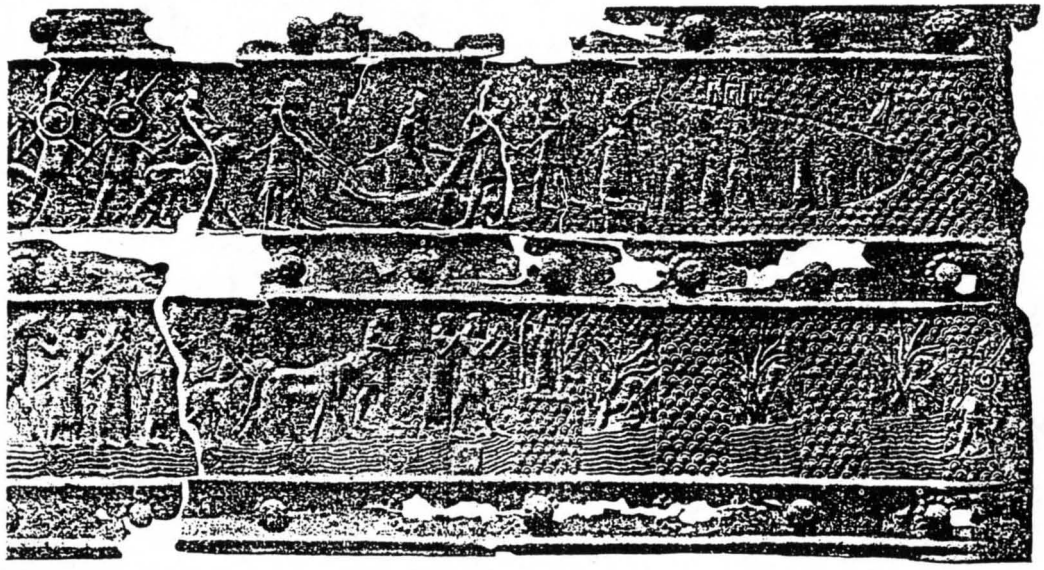


Figure 2
In 832 BC, Assyrian soldiers with their King Salmanassar III explore the water cave of the Tigris near Lidje and the overlying large cave with stalagmites. Shown on bronze strips decorating a doorway of the palace in Imgur-Ellil (from D. Opitz, 1929, p.59).

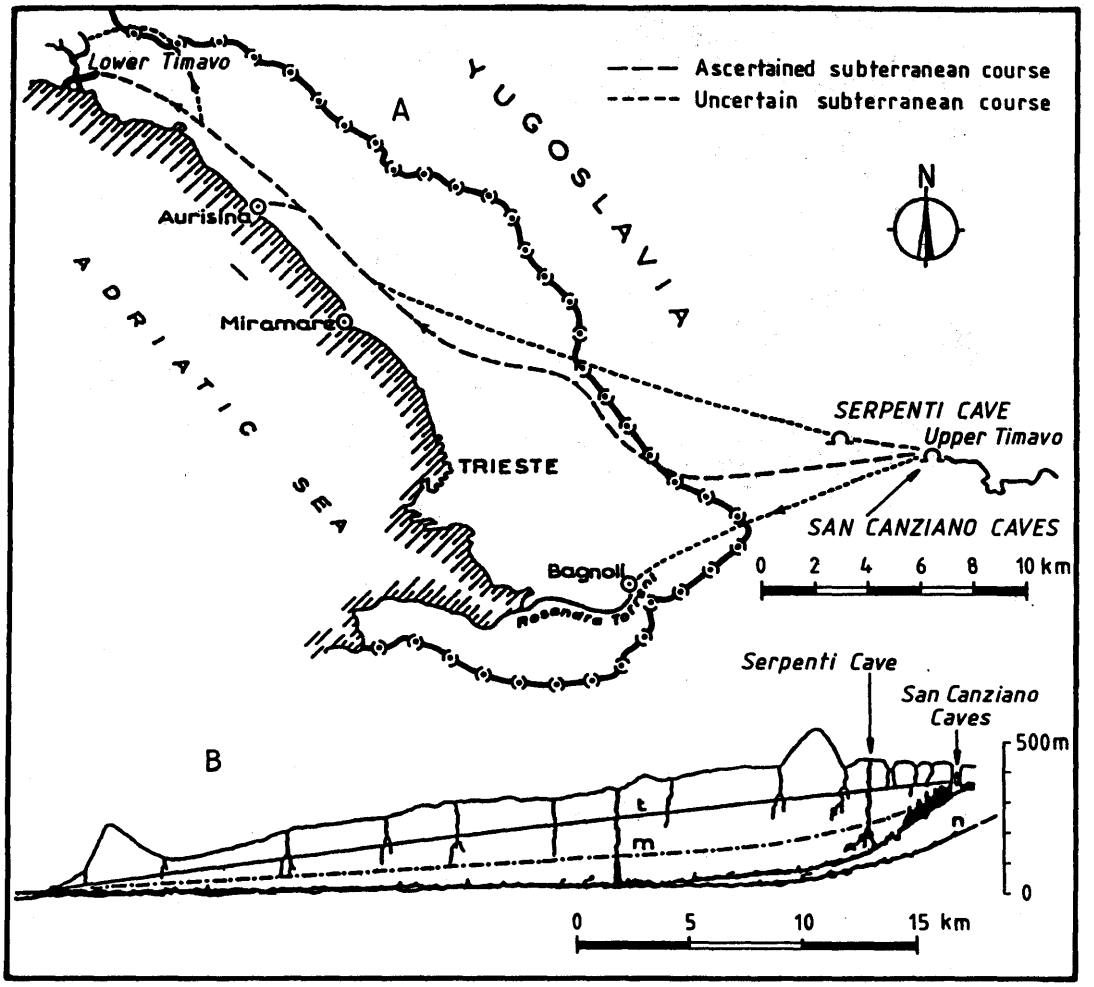


Figure 3

The River Reka (know in antiquity and in modern Italy a the "Upper Timavo"), its entrance into the Skozijanska jama (San Canziano caves) and the springs of aurisina and Lower Timavo north of Triest (from S. Belloni et al, 1972, p.119). A = map; B = profile; t = theoretical hydrostatic level during high water; m = average maximum; n = minimum hydrostatic level.

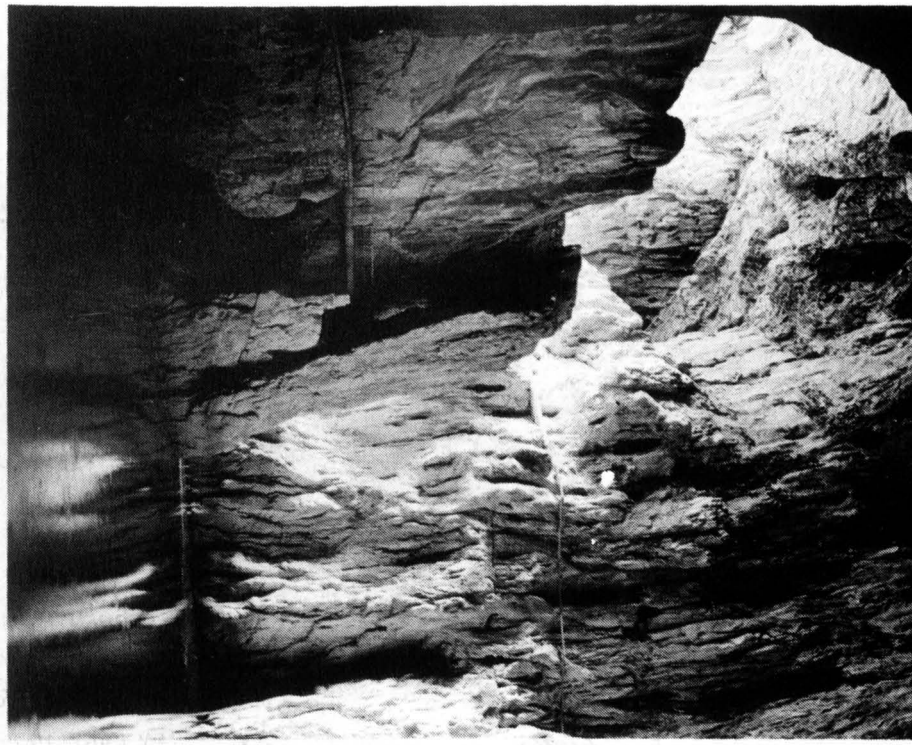


Figure 4
View from the Majorcic cave (upstream from the main Skozijanska jama) toward the entrance of the River Reka into the cave system (photograph: P. Habic).

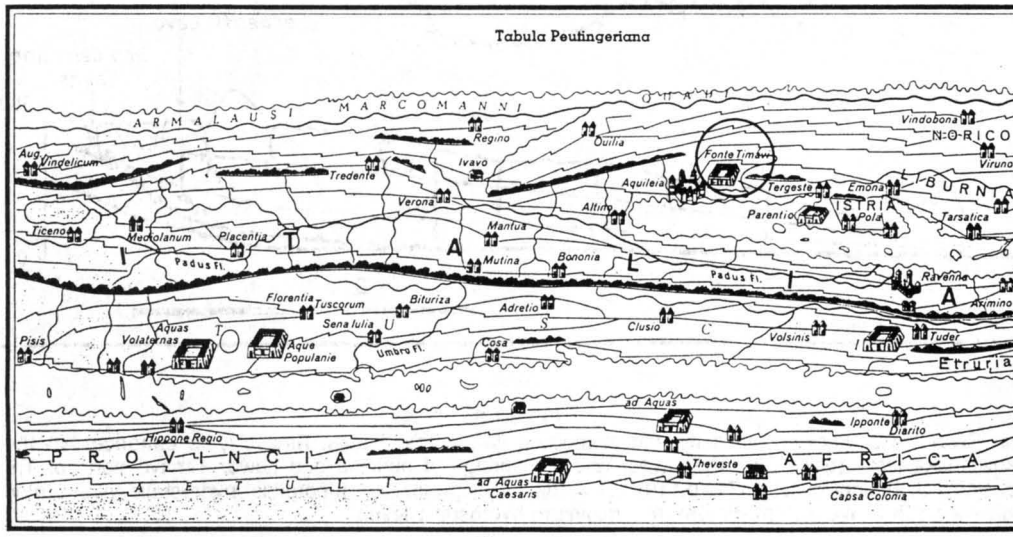


Figure 5
Section of the Tabula Peutingeriana with the Timavo springs (Fonte Timavi, indicated with a circle). From I. Miller, 1962.

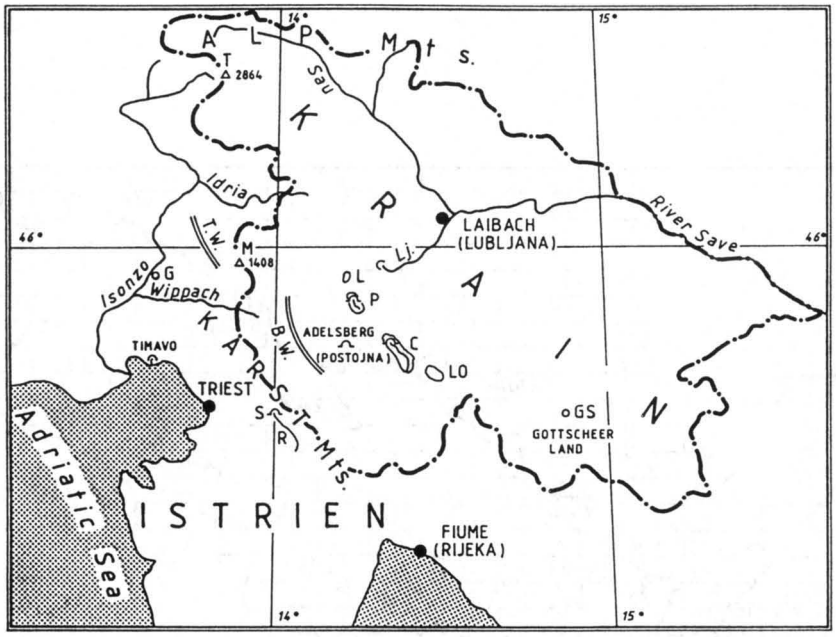


Figure 6

Sketch of the Duchy of Krain in the 19th century, simplified after the "Krain Kuestenland" map ("Coastal Krain" in Meyers Konversationslexikon, vol. 10, p.618-619, Leipzig/Vienna, 1896. Since 1919, this area has in its entirety belonged to NW Yugoslavia. Polje series: Lo = Loz polje, C = Zirknita (Cerknisko) polje, P = Planina polje (Planinska P.), L = Logasko polje, T = Ternowan Forest, BW = Birnbaum Forest, G = Goerz (Gorizia), S = St. Kanzian (Skozijanska jama, or San Canziano caves), R = Reka River (It. Upper Timavo), GS = Gotschee.

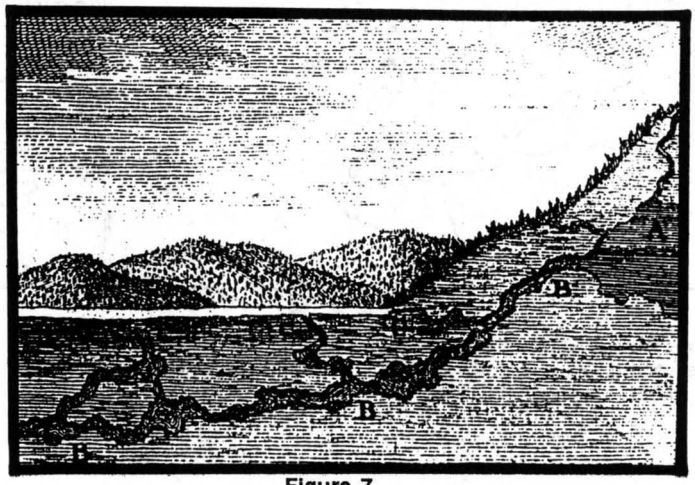


Figure 7

"Durchschnitt des Gebirges, um das An- und Ablaufen des Zirknitzer See zu erklaeren" (T. Gruber, 1781, p.131) ("Profile through the mountains to explain the flooding and drainage of the Zirknitz Lake"). This picture comes close to modern standards in accordance with the "progress in the natural sciences in the last few years in Austria" (Ignaz Edler von Born in the preface to R. Gruber, 1781, p.2). Photoenlargement, University Library, Graz, 1972.

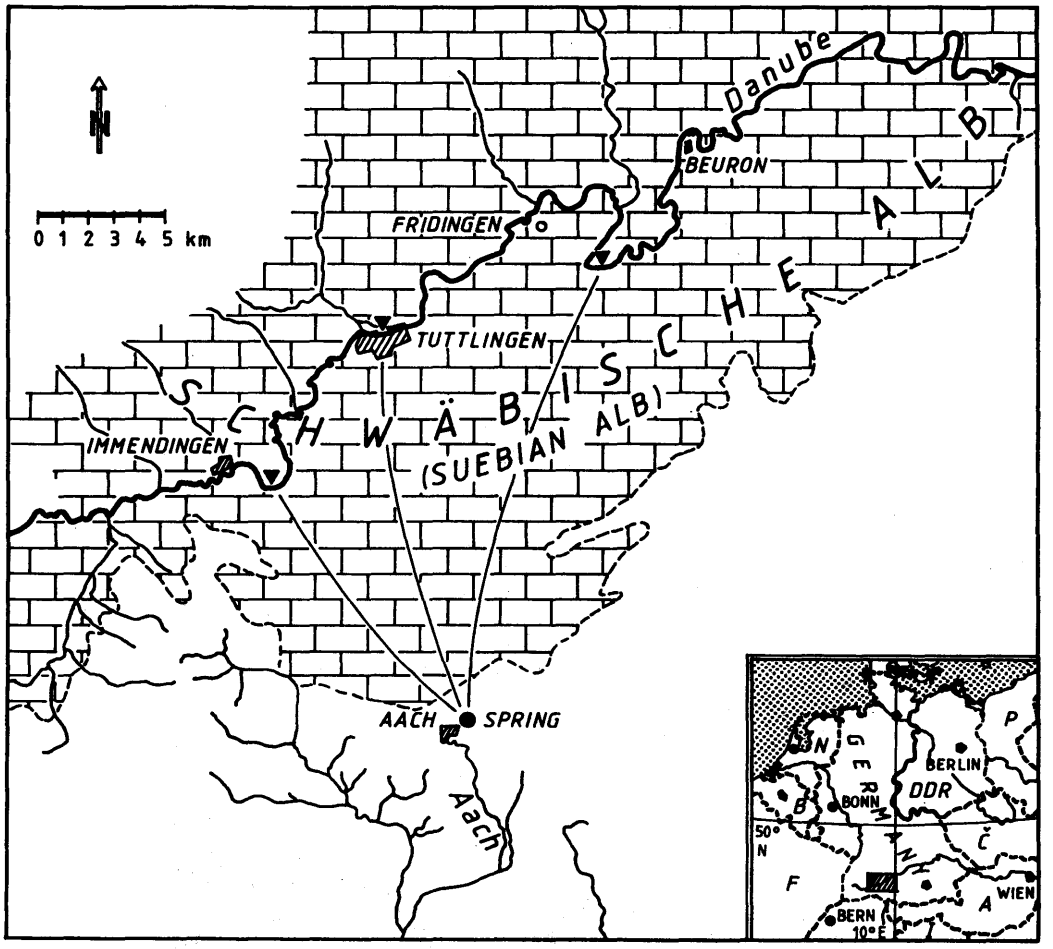
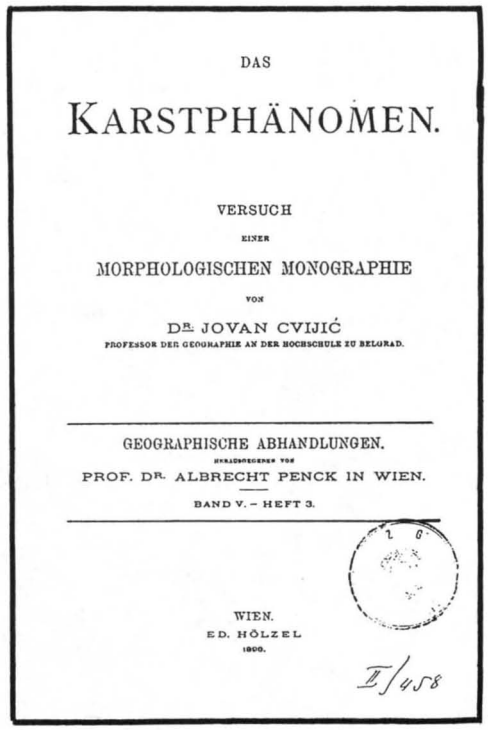


Figure 8

The Danube crossing the karst of the Swabian Alb. Due to water losses between Immendingen and Beuron, the river bed is dry after long periods of drought. The water reappears in the Asch spring, a tributary of the Rhine.



DAS

KARSTPHÄNOMEN.

VERSUCH

EINER

MORPHOLOGISCHEN MONOGRAPHIE

VON

DR. JOVAN CVIJIĆ

PROFESSOR DER GEOGRAPHIE AN DER HOCHSCHULE ZU BELGRAD.

GEOGRAPHISCHE ABHANDLUNGEN.

HERAUSGEGEBEN VON

PROF. DR. ALBRECHT PENCK IN WIEN.

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Figure 9
Title page of the first monograph on the subject of karst by J. Cvijic.

Figure 10
Solution of salt (sodium chloride) for injection into a sinkhole in the Danube below Fridingen on November 11, 1908. Photographer unknown. Copy of Fig. 3 from W. Kaess, 1969, p.226.

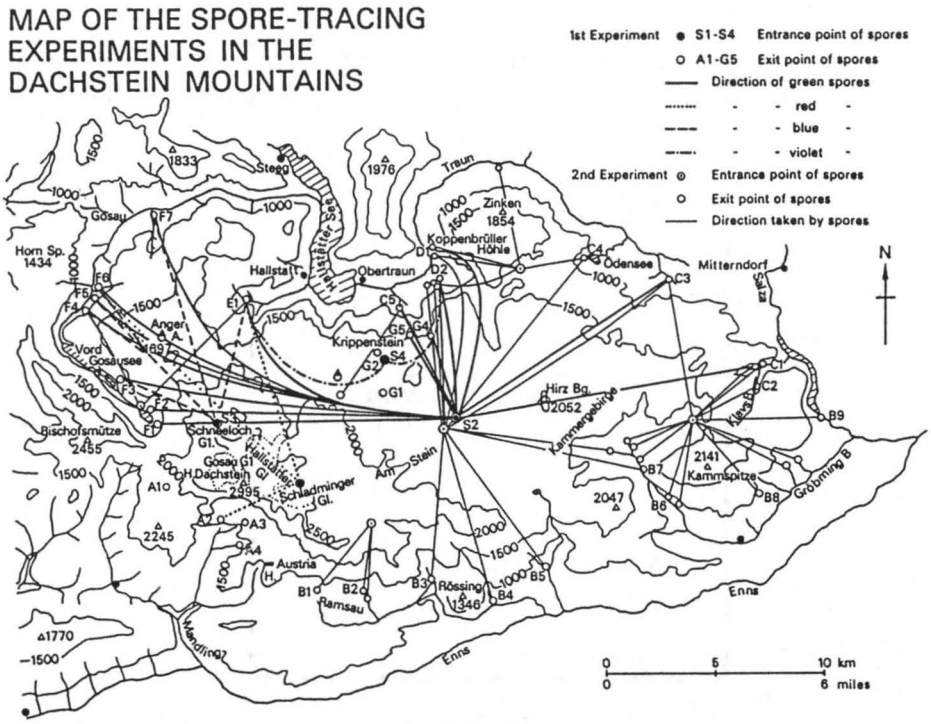


Figure 11

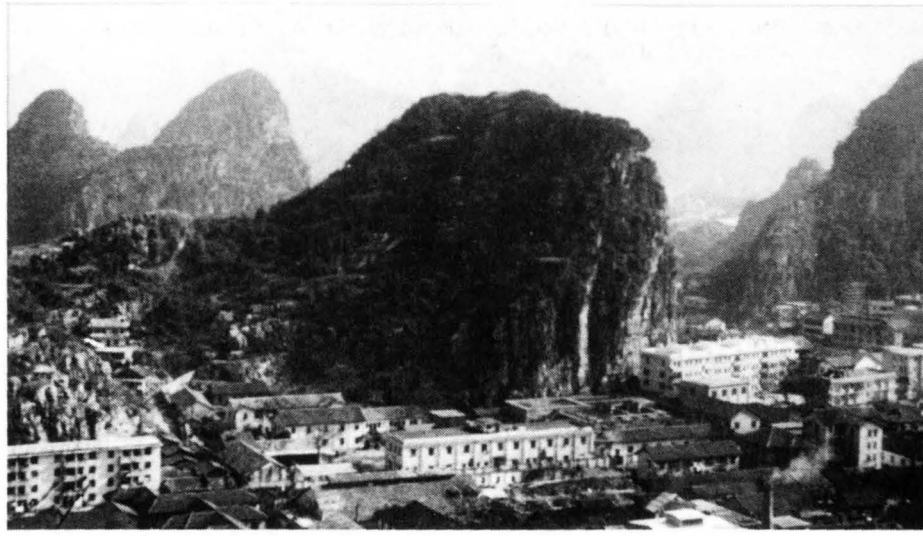
Results of the first karst water tracing with dyed lycopodium spores in the Dachstein massif, Northern Limestone, Alps, Austria, 1957.

Figure 12

Karst landforms:

12 a) Plateau of the karst massif of the Tennengebirge (average altitude 2,400 m a.s.l.), Northern Limestone Alps, Austria. Photograph: B. Toussaint, 1971).

12 b) Flooded area of the Livanjsko polje in the Dinaric Karst. The "Dinara" is in the background. Photograph: J.G. Zoetl, 1961.



12 c) Tower karst in Guilin, China. Photograph: J.G. Zoetl, 1983.

12 d) Fossil karst in arid tropics. Desert of the As Summan plateau, Saudi Arabia. Photograph: J.G. Zoetl, 1986.

Pollution Assessment in Carbonate Terranes -- A Review

Esad Prohic
Institute of Geology
Sachsova 2, POB 283
41000 Zagreb, Yugoslavia

INTRODUCTION

This review is concerned with the evaluation of pollution problems in carbonate terranes resulting from activities of man upon the carbonate environment. The annotated bibliography, which is the integral part of this review, represents citations from 1986 through 1987 as the fourth in the series, Hydrology of Limestone Terranes: Annotated Bibliography of Carbonate Rocks. Not all references concerning pollution problems in carbonate terranes published during the years prior to 1986 were necessarily included in the previous Volumes I through III of the Annotated Bibliography of Carbonate Rocks, although there are some citations included under the topic of quality of water or ground-water contamination. In Volume Four, the numerous data regarding pollution in carbonate terranes were limited to the last decade, in which by far the most papers about the problem in question were published. This review is an extension of pollution data cited in Volume III in which as many as 36 pollution-related citations were mentioned.

The introductory chapter of "Pollution Assessment in Carbonate Terranes" is necessary due to the lack of general information about pollution in specific carbonate drainage ages. To the author's knowledge, no book exclusively deals with the aforementioned problems, although there are numerous case studies and books which include pollution studies in carbonate environments as a part of general studies concerning pollution assessment in aquatic and/or terrestrial environments. Selected books partly dealing with pollution in carbonate terranes are cited in the references at the end of this chapter.

Ground-water pollution exists in nearly all sedimentary terranes and in many areas of metamorphic and igneous rocks groundwater is in contact with carbonate minerals during at least part of its flow history (Freeze and Cherry, 1979). It is thus hard to strictly define "carbonate" groundwater. For the purpose of this review and annotated bibliography, the designation "groundwater in carbonate terranes" will refer to groundwater which derives its composition, physicochemical parameters, and present state mainly from interactions with carbonate rocks, i.e. limestones and dolomites. In this definition we do not include any measurable values, thus estimation is subjective.

Pollution studies are generally very complex and usually comprise a variety of parameters to be monitored and measured together with mutual, multiple, component interactions. Before considering carbonate rocks per se, it is necessary to briefly discuss the definition of pollution, types and sources of pollutants, and ways of evaluating past, present, and future pollution and its behavior pattern in the natural ecosystem. As we become familiar with the general framework, the "carbonate-system pollution mosaic" develops.

GENERAL REMARKS

Purpose and Scope

Unlike the rest of wildlife, Homo sapiens has used its senses to choose the most beautiful places for settlements, and has used its intellect to find a place to satisfy his natural sense of being practicable. Man has chosen places along waterways, near the mouths of rivers, and in closed environments which enable him to trade, travel, utilize the natural goods and gifts of nature, as well as to rid himself of used, undesirable, and unnecessary products of his life. Once chosen for its beauty, human environments progressively degrade in beauty and quality, and in many cases becomes hazardous for humans. As man continually seeks to change his environment, improvement of environmental quality is a crucial consideration. Unfortunately for some ecosystems, it is too late for improvement. However, environmental problems of most ecosystems can be alleviated if man

becomes aware of the severity of these problems. "Minamata disease" in the early 1950's (mercury poisoning) or "itai-itai disease" (cadmium poisoning), for example, are extreme cases of environmental ills, which, alas, are becoming more commonplace. The cadmium concentration level in the Rhine River has risen more than 100 times within the last 80 years. Some famous recreational areas have been closed due to serious changes in environmental quality. Some areas established to improve human health, nevertheless, have become dangerous to man's health. Wastes directly introduced into the environment can change its quality, as can other activities of man, such as the diminishing of natural surface- and ground-water flows, built-up dams, deepening of navigable channels, and extension of useful space of harbors (Salomons and Forstner, 1980). All of these actions can lead to intensification of pollutant activity in the natural ecosystem. This is why all of man's activities leading to any change of environmental parameters must be examined carefully with complete scientific and human responsibility.

Contamination and Pollution -- Definition

Pollution is interdisciplinary and is a very complex problem. Therefore, no definition can be universally applicable to all individual cases. Whitehead and Lack (1982) cited some authoritative statements about the definition of pollution published since 1952. These authors proposed the acceptable definition of pollution to be as follows:

> "Any modification either natural or artificial, which, directly or indirectly, changes the quality of water and disturbs or destroys the balance of ecosystems and natural resources, so that it (1) causes hazards to public health, (2) detracts from the convenience, efficiency and well-being of man and his communities, and (3) impairs the beneficial uses of water."

A shorter definition is given by Fried (1975):

> ". . . a modification of the physical, chemical and biological properties of water, restricting or preventing its use in the various applications where it normally plays a part."

More important than the definition itself is the introduction of a distinction between "contaminant and contamination" and "pollutant and pollution" which have different meanings in various published papers. The State of California, for example, in a 1950 law, defines contamination as the "impairment of water quality by sewage or industrial waste causing an actual hazard to public health or an equivalent effect." This law regards pollution as anything which "adversely and unreasonably impairs the beneficial use of water even though an actual health hazard is not involved." In some European and African countries, contamination of water is linked with biological agents which play a role in transmissible diseases. In these countries, pollution is connected with physical agents or chemical substances which cause health hazards or impair the uses of water (Whitehead and Lack, 1982). According to Walker (1969), the pollution of groundwater was defined as "an impairment of water quality by chemicals, heat, or bacteria to a degree that does not necessarily create an actual public health hazard, but does adversely affect such waters for normal domestic, farm, municipal, or industrial use." The term "contamination" denotes impairment of water quality by chemical or bacterial pollution to a degree that creates an actual health hazard to public health through poisoning or the spread of disease. In contrast, Freeze and Cherry (1979) stated the following:

> "all solutes introduced into the hydrologic environment as a result of man's activities are referred to as *contaminants* regardless of whether or not the concentrations reach levels that cause significant degradation of water quality. The term *pollution* is reserved for situations where contaminant concentrations attain levels that are considered to be objectionable."

In this review, we follow the statement proposed by later authors.

Types of Pollutants and General Issues

Considering the number of chemical compounds which are known and recorded in Chemical Abstracts (more than 3 million), the number of chemicals which have become serious pollutants is comparably small. According to Hutzinger and others (1977), the most important question for every environmental scientist is:

> "What makes a chemical compound a pollutant; what features make some chemical real or potential environmental hazards and others not?"

There are many statements with respect to that fundamental question. According to the Chemical Substances Control Law in Japan, a country suffering very much from health injury through environmental pollution, all new chemical substances introduced into the environment must not have more than one of such hazardous properties as non-biodegradability persistence or a high degree of bioaccumulation or chronic toxicity (Sasaki, 1977). Many, if not all, governments have issued a list of hazardous substances, along with the allowable level of concentrations and the limits above which some substances can be regarded as a pollutant. However, there are only arbitrary levels for temperature, oxygen concentration, pH, hardness of water, and other modifying factors which can effect greatly the toxicity of the pollutants. Therefore, it appears that the most accurate definition of "pollutant" is by Hutzinger and others (1977), which is:

> ". . . a chemical compound is more likely to be a serious pollutant if it fulfills most if not all, of the following criteria: large (industrial) production, use which makes environmental leakage likely, high dispersion tendency, pronounced persistence, tendency to bioaccumulate and high toxicity."

All of these criteria relate to: (1) the intrinsic toxic property of the chemicals, and (2) three rate factors related to behavior of the environment (ecokinetics), i.e. rate of release into the environment, rate of disappearance from the environment, and rate at which the compound or its degradation product becomes available to an organism in question (Hutzinger and others, 1977).

According to Forstner and Wittmann (1979), two groups of substances in particular have a lasting effect on the natural balance in an aquatic system: (1) nutrients, which promote unrestricted biologic growth, and in turn, oxygen depletion, and (2) sparingly degradable ("refractory") synthetic chemicals and other waste substances which often induce multiple effects on aquatic ecosystems. The latter group includes, among others, trace metals, which are by far the most dangerous because trace metals are not usually eliminated from the aquatic ecosystem by natural processes, unlike most organic pollutants; and secondly, most metal pollutants are enriched in mineral and organic substances. Most toxic metals tend to accumulate in sediments from which they may be released by various processes of remobilization. Then through the biologic chain the toxic metals reach humans and cause chronic and acute ailments.

Assuming deleterious effects of pollutants to be excess plant production, deoxygenation, and toxic or similar deleterious physiological effects on organisms, Connell and Miller (1984) divided pollutants into six main groups as follows: (1) organic matter; (2) plant nutrients; (3) toxic substances (including trace metals); (4) suspended solids; (5) energy (including thermal discharges); and (6) pathogenic microorganisms. These six classes provide a good basis for discussion of the overall interaction of pollutants with ecosystems. Likewise, salt intrusion in coastal regions of carbonate terranes must be included as an additional source of pollution.

Concerning sources of pollution, the very first step is to distinguish diffused non-point and point sources. Non-point sources (for example, atmospheric sources) originate from vast regional areas, while point sources (for example, land disposal sites or mining effluents) are essentially localized. Forstner and Wittmann (1979) dealt with metal pollution of the environment in distinguishing the following five different sources: (1) geologic weathering, (2) industrial processing of ores and metals, (3) the use of metals and metal components, (4) leaching of metals from garbage and solid waste dumps, and (5) animal and human excretions which contain heavy metals. Regarding ground-water pollution, Fried (1975) was able to distinguish four main origins: (1) industrial, (2) domestic, (3)

agricultural, and (4) environmental. In that context, *industrial pollution* is carried to the aquifer by: (a) used waters which contain chemical compounds and trace elements (radioactive pollution can also be transported in this manner), (b) rain infiltrating through waste disposals, and (c) accidents, such as the breaking of a pipeline. *Domestic pollution* is carried to the aquifer by: (a) rain infiltrating through sanitary landfills, and (b) accidents such as the breaking of septic tanks. *Agricultural pollution* is due to irrigation water or rain carrying away chemicals. *Environmental pollution* is mainly due to sea-water intrusion in coastal aquifers.

Freeze and Cherry (1979) cited the following as sources of contamination of groundwater: (1) land disposal of solid wastes, (2) sewage disposal on land, (3) agricultural activities, (4) petroleum leakage and spills, (5) disposal of radioactive waste, (6) deep-well disposal of liquid wastes, and (7) other sources in which they included contamination from salts in vicinity of roads, activities of the mining industry, seepage from industrial waste lagoons, etc. In the author's opinion, the best elaboration of the sources of pollution was given by Whitehead and Lack (1982) as follows:

A. Sources capable of control at a point (point sources):

   1) Household and domestic wastes
   2) Industrial wastes
      a) organic
      b) inorganic
      c) heat
      d) radioactive substances
   3) Surface wastes from impermeable areas
      a) inadvertently discharged pollutants
      b) avoidably discharged wastes
   4) Wastes from specifically drained sites
      a) suspended solids from construction sites, quarries, and mines
      b) runoff from spoil heaps
      c) leachates from lined landfill sites
      d) mine drainage water (dissolved pollutants)
   5) Illegal discharges

B. Diffuse (non-point) sources:

   1) Contaminated ground water and natural drainage flows
   2) Resuspended sediments
   3) Contaminated rainfall and atmospheric fallout
   4) Accidental discharges, unpredictable in time and space.

A new group, which probably will be included, is dredged and fill materials, i.e., sediments removed from the bottom of streams, rivers, lakes, and coastal waters; fill materials are transported via ship, barge or pipeline and discharged to land or water. Dredging activities can cause serious problems in site (disturbing the system by resuspension, changing the pH and Eh parameters of the ecosystem), leading to release of some trace metals to overlying water, and in the disposal site due to accumulation of contaminated sediments in a restricted area of water or land.

There are several other attempts concerning the sources of pollution, but they follow, more or less, the sources cited above.

Pollutant Behavior and the Environmental Fate of Pollutants

In the previous section, pollution potential was discussed as the conditions which chemicals must fulfill to be treated as a pollutant. However, there is another important subject in pollution studies which must be considered -- the receiving capacity or medium for accepting the particular pollutant(s). For a given input, the concentrations found in the receiving medium are affected by (1) the dilution and dispersion occurring within the problem area, (2) the reactions occurring between pollutants, and (3) chemical and biological interactions with the surrounding environment during

transportation (Whitehead and Lack, 1982). The very first requirement for a chemical to be treated as a pollutant is its availability, i.e. bioavailability, which means that the chemical in question must be present in dissolved form in time and space of consumption.

Subsequently, another important feature of pollution is *residence time* of the pollutant in an aquatic system. The equation which enables us to predict whether a certain chemical tends to remain solubilized or to adhere to the particulate material is given by Barth (1952):

$$T = \frac{A}{dA/dt}$$

Where:

A = the total amount of the element in suspension or solution in a specific water body, and

dA/dt = is the amount introduced into the water body within a specific interval of time.

It has been noted that in most rivers equilibrium cannot be completely achieved between the solution and the solid phases due to the short residence time. Nonetheless, the use of contaminated water for drinking water purposes is often possible only because of the tendency of most of the heavy metals to adhere to solid particles, in particular, when the metal concentration is markedly high (Forstner and Wittmann, 1979). Thus, the "conservative" or "non-conservative" behavior of pollutants in the aquatic system depends on numerous factors during the transport and deposition of pollutants.

According to Connell and Miller (1984), the transport and transformation of pollutants in the environment are related to physicochemical properties of pollutants, transport processes in the environment, and pollutant transformation processes. The introduction of a chemical into the environment will result in intercompartmental transfers to establish equilibrium which is dependent on the physicochemical properties of the substance. The distribution of pollutants in aquatic environments is strongly influenced by a number of interactive transport processes, such as volatilization, precipitation from air, leaching, and runoff. Some transport processes, such as volatilization, decrease the concentrations in water, whereas other processes increase the concentrations. In addition, soil and sediments play major roles in the transport and removal of environmental pollutants by providing sorption surfaces, acting as buffer systems, and serving as sinks for pollutants (Connell and Miller, 1984). Although sediments have been characterized as a "sink" to pollutants in fresh-water ecosystems, two-directional exchange does occur across the sediment-water interface. The magnitude of exchange in both directions is clearly dependent on both the character of the sediments and the overlying water; the ratio of the sedimentary input to losses to the water varies from ecosystem to ecosystem. The input-release equilibrium is strongly influenced by: (1) the mineral composition of the sediments; (2) grain-size distribution; (3) types of bonding among elements and sedimentary components, and (4) physicochemical parameters, mainly pH and Eh at sediment-water interface. Although the whole metal (or other pollutant) concentration in the sediment can be surprisingly high, only a limited part of it can be involved in relatively short-time geochemical processes at the sediment- water boundary. However, these small quantities may represent a substantial environmental impact based on their associated bioavailability and toxicity. Therefore, with regard to the study of polluted sediments, the bonding strength of particular pollutants in the sediment must be clearly established, together with the type and amount of pollutants which can be released to contaminate the aquatic bio- system, as well as environmental circumstances. The latter assumption is associated with the prediction of environmental changes which can disturb the input-release equilibrium toward the significant release of pollutants from sediments to the overlying water body. Speciation or partitioning pattern of chemicals, both in sediments and water, is very important with regard to bioavailability, toxicity, and transport of particular pollutants. The characteristic partitioning pattern of elements in carbonate rocks will be discussed in more detail in the section on pollution in carbonate sediments. In this section, the main sites of elements in sediments are briefly discussed. According to Engler (1980), with regard to elemental partitioning, the following categories of sediment components should be considered:

1. Interstitial water,
2. Mineral exchange phase,
3. Reducible phase (hydrous oxides of iron and manganese as well as hydroxides of Fe and Mn),
4. Organic phase, and
5. Residual phase.

A particular element or molecule can then be present (partitioned) in a sediment in one or more locations. Possible locations include: (1) the lattice of crystalline minerals, (2) the interlayer position of phyllosilicate (clay) minerals, (3) adsorption on mineral surfaces, (4) association with hydrous iron and manganese oxides, (5) absorption or adsorption with organic matter, and (6) dissolved in the sediment interstitial water. These represent a range in the degree by which an element may become released to the overlying water from stable components in the mineral lattices (inert for the aquatic system) to soluble compounds in the sediment interstitial water, which are readily mobile and thus the most dangerous to aquatic life and directly or indirectly via food chain to humans. At least five major processes control the release of metals from sediment to overlying water (Forstner, 1979):

1. Elevated salt concentrations,
2. Changes in redox conditions,
3. pH changes,
4. Presence of complexing agents, and
5. Biochemical transformation.

When trace metals enter natural waters and become part of this system, their distribution processes are controlled by a dynamic set of physicochemical interactions and equilibria (Stumm and Morgan, 1981). The solubility of trace metals in natural waters is principally controlled by pH, type and concentration of liquids and chelating agents, and oxidation state of the mineral components and the redox environment of the system (Leckie and James, 1974).

In this section, the main processes are discussed with regard to governing the behavior of pollutants, mainly trace metals, in the aquatic ecosystem. Usually more than one process acts simultaneously which emphasizes the delicate question of providing the most useful analytical approach for measuring the environmental parameters and impact of particular pollutants upon the ecosystem.

Pollution Monitoring

The previous section dealt with the ecological relationships between pollutants and the environment. The present section is concerned with environmental pollution management. The effective management of pollution requires knowledge of the detrimental effect that occurs in the natural environment and the pollution factors causing these effects (Connell and Miller, 1984). According to Holdgate (1979), a knowledge of the following factors is needed for an effective monitoring program:

1. The specific pollutants entering the environment, and their quantities, sources, and distribution;
2. The effects of those substances;
3. Trends in concentration and effect, and the causes of these changes;
4. How far these inputs, concentrations, effects, and trends can be modified, and by what means and what cost.

One of the major problems encountered with the measurement and evaluation of toxic substances in sediments and water is that pollutants rarely occur alone. More often, one is faced with a combination of different pollutants with a varied ratio of chemical speciation. These combinations may exert a synergistic or antagonistic effect on aquatic organisms, with the effect varying widely among species as to tolerance or susceptibility to pollution (Jennet and others, 1980). Unfortunately, the analyses of most toxic pollutants are performed for each individual element with no evaluation of combined effects of pollutants. Another important consideration is the duration of exposed effects on aquatic organisms and human health, and the question of short-and long-term effects.

In concise form, this problem is summarized in the United Nations Environmental Programme (UNEP) Report (1977) as follows:

> The present concern about chemical pollutants in water is not so much with the acute effects on human health (although they do occur), as with the possible long-term effects of low level exposures which are often unspecific and difficult to detect. In addition to the possible effects of ingestion and other direct water contracts, chemicals may influence man's health indirectly by disturbing the aquatic ecosystems or by accumulating in aquatic organisms used as human food. Investigations need to be undertaken on the long-term effects of the various contaminants with considerations of their chemical and biochemical transformation which may take place.

Quantitative and qualitative measurements of pollution in one ecosystem can be done in several ways. Measurement strategies can be classified into three main groups, according to:

1. Method of measurement and observation,
2. Object of measurement, and
3. The part of the ecosystem that is measured and observed.

According to the first strategy, the pollution measurement can be divided into (Whitehead and Lack, 1982):

1. MONITORING: The continuous, standardized measurement and observation of the environment;
2. SURVEY: A series of intensive programs of finite duration, designed to measure and observe the environment in detail for a specific purpose; and
3. SURVEILLANCE: The continuous specific observation and measurement of the environment relative to control or management.

Within the environment itself, the objectives of environmental management, in relation to monitoring, can be met by focusing on two aspects:

1. Monitoring the pollutant in different parts of the environment, generally described as *factor monitoring*;
2. Monitoring the effects of the pollutant on the natural ecosystem and associated biota, described as *target monitoring* (Connell and Miller, 1984).

With regard to the part of the ecosystem in which the pollution is tracing, one can distinguish air monitoring, water monitoring, sediment monitoring, and biomonitoring. For advantages and disadvantages of each type of monitoring, the reader is referred to Forstner and Wittmann (1979) or Connell and Miller (1984).

All above-mentioned strategies in measurement and observation of pollution effects on the environment are suitable for evaluating the environmental impact of various pollutants. The choice of a particular approach depends on the nature of the pollution problem.

POLLUTION PROBLEMS IN CARBONATE DRAINAGE AREAS

Introduction

In addition to the general sources and methods of pollution cited in previous sections, the carbonate drainage areas exhibit some very specific pollution patterns. In general, pollution in carbonate terranes can be regard as occurring with very high probability, mainly due to the following:

1. In many areas the soil is thin (or may even be missing) which results in poor filtering and a rapid passage of surface water to the ground.
2. There are practically no fine-grained aquifers so that natural purification (self-purification) of water through mechanical processes is not probable.

3. The size of the voids in aquifers is large and allows water to flow through with high velocities. Polluted water may therefore require only a short time to cover the distance from its point of entry into the ground to the point of its emergence -- perhaps a few days only. This time span is usually not sufficient for the achievement of biological self-purification processes.
4. Due to the frequency, multiplicity, and ubiquity of fissures and of their interconnections, possible pollution may be suspected from the surface, even at small distances from the point of water emergence (Herak, 1972).

These features, together with features specific to aquifers in coastal regions (salt intrusion) or shallow aquifers (improperly designed abandoned wells), encourage us to emphasize that carbonate drainage areas are probably the most dangerous for severe pollution to occur. Natural depressions, common in areas of karst topography, appear convenient for solid waste disposal, especially household and domestic wastes. There are numerous examples of karst depressions being used in this way, ignoring the fact that there are practically no differences in disposal of garbage to the bottom of dolines or pits or directly to the groundwater. So, speleologists and tourists investigating and visiting caves and pits are faced not only with the beauty of the underground world, but with the products of civilization, such as cans, plastics, dead animals, and so forth.

Pollution in carbonate terranes can be traced in several ways, two of which are air monitoring and biomonitoring. These methods are probably not convenient for carbonate drainage areas. Air monitoring is suitable in the vicinity of large cities and industrial zones and is not specifically associated with carbonate terranes. The latter method, biomonitoring, is primarily associated with the observation and measurement of pollutant levels in marine or brackish organisms, rarely in fresh-water organisms. Although most method of pollution monitoring are associated with carbonate rocks and water passing over and through these rocks, they are, however, beyond the scope of this review. The remaining ones, i.e. sediment and water monitoring, will be the points of our discussion and will include carbonate rocks (limestones and dolomites), and water (surface- and groundwater) in carbonate-bearing rocks.

Pollution in carbonate terranes is influenced by introduction of anthropogenic and industrial materials into the system and by specific interactions at (carbonate) sediments or mineral-water interfaces. For better understanding of later interactions, it is necessary to treat both phases (i.e. sediment and water) separately.

Pollution Recorded in Carbonate Sediments

Determination of the concentration of heavy metals in sediments has become a common means of assessing the extent to which an area is impacted by anthropogenic input (Santschi and others, 1984; Roy and Crawford, 1984; Dominik and others, 1984; Armannsson and others, 1985; Prohic, 1984; Prohic and Juracic, 1987; Prohic and Kniewald, 1987).

Chemical analysis alone, without taking into account the petrography and the origin of sediments, can lead to over-estimation of the anthropogenic contribution of a particular heavy metal (Whitehead and others, 1986). Sediments, if they are not of man-made origin, are products of large- scale chemical, mechanical, and physical breakdown processes. It is therefore necessary to collect as much relevant information as possible on the origin of sediments, their physicochemical and mineralogical characteristics, and on environmental factors controlling weathering, transport, and deposition processes (Prohic and Juracic, 1987).

One of the major tasks in determining the extent and the source of pollution by means of trace element concentrations in carbonate sediments is to estimate the natural concentration of the specific element, which should represent the "pre-industrial" level. Concentrations above this value are presumed to be anthropogenically influenced. Estimates of the natural concentration for the specific element in carbonate sediment are not straightforward because they depend on: a) changes in the chemistry of the source region; b) physical and chemical conditions during weathering, transport, and deposition; c) diagenesis; and d) the chemistry and movement of groundwater (Forstner, 1983; Plant and Raiswell, 1984; Armannsson, 1985). Additional factors which complicate the situation and may

lead to considerable variations are parameters in host sediments such as grain size, mineral composition, and organic content (Parker, 1982). Because all the necessary data are not accessible, several methods have been suggested to establish background values for trace elements (Forstner and Wittmann, 1979; Forstner, 1982), e.g. to take as a background value:

(a) Average shale composition,
(b) Fossil sediments presumed to be a source rock,
(c) Recent deposits in relatively unpolluted areas, and
(d) Dated sedimentary cores, where all the events are recorded, taking the values from deeper parts which are time-defined as "pre-industrial."

Assuming the average shale composition as the background value, although very popular with some authors, is only conditionally acceptable for carbonate matrices. Carbonate systems are known to exhibit large variations in the matrix, its mineral composition, and the type and quantity of organic content. Trace element levels in shales are generally higher than in carbonate sediments (except for elements which tend to substitute Ca^{2+} in carbonates) mainly due to the adsorption onto a clay mineral surface, and due to organic-metal interactions.

The source rock in karst areas is difficult to estimate, due to specific hydrology. Consequently, using background values for the trace element concentrations from fossil sediments may lead to erroneous estimates. Moreover, changes during weathering, transport, and deposition may alter primary material significantly, and therefore the background value is not easily established.

If the composition of the recent deposit in a relatively unpolluted area is used as a background value for pollution assessment, completely erroneous conclusions may be reached, if the geology and petrography of the drainage area is not considered (Whitehead and others, 1986). The example of the natural, relatively high concentration of chromium in southern Adriatic, which is due to chromium-bearing basic and ultrabasic rocks in the source region, was given by Paul and Meischner (1976).

The fourth method of determining background value appears to be the most realistic. In dated sedimentary cores, surface layers exposed to pollution and deeper layers with deposits belonging to the "pre- civilization" time with no anthropogenic influence can be analyzed simultaneously. Therefore, if there are no dramatic changes in the source region, transport medium, and the basin itself, the values from the layer deposited a few hundred years before can be presumed as background values. Some problems can arise if changes in grain size or mineral composition occur with depth. In such cases some standardization must be done (Forstner and Wittmann, 1979; Salomons and Forstner, 1980; Ackermann, 1980). To minimize the grain-size effect, the best method is to analyze the fraction below 32/μm (or 2/μm) because most heavy metals are bound to that fraction. Only exceptionally the coarser fraction does have significant trace element concentrations. Additional information is needed on the geochemical behavior in order to understand the post-depositional migration of the investigated trace elements (Prohic and Juracic, 1987). Useful information about natural and anthropogenic concentration levels for selected trace elements in Dinaric karst areas (Yugoslavia) can be found in the following papers: Prohic, 1984; Prohic and Juracic, 1987; Prohic and Kniewald, 1987; Juracic and others, 1984; Jelaska and others, 1984; and in several unpublished reports by Prohic and collaborators.

In the study of pollution effects in carbonate sediments, carbonate minerals are usually not regarded as scavenging agents for heavy metals (Mn, Zn, and possibly Pb being notable exceptions) due to the similarity of their ionic radii with the Ca^{2+} ion. Furthermore, the surplus of metal contaminants introduced into the aquatic system as anthropogenic input usually exists in comparatively unstable chemical forms and is not incorporated into the crystal lattices of minerals (Forstner and others, 1982). The extent of heavy metal sorption on carbonates has been a source of conflicting opinion for many years (Forstner and Wittmann, 1979). Currently, more information has become known about the processes of carbonate sorptions. It appears that the surface energy of carbonate minerals is generally sufficient to effect adsorption, at least in the order of magnitude observed for clay minerals such as kaolinite (Suess, 1973). Data obtained by Deurer and others (1978), Prohic (1984), Prohic and Kniewald (1987) and Juracic and others (1984), among others, imply that coprecipitation with carbonate minerals may be an important mechanism for a number of metals, i.e.

zinc, manganese, lead, etc. For some elements, similarity in ionic radii with the Ca^{2+} ion supports this idea. However, for those in which the ionic radii differ greatly from that of Ca^{2+}, and which are associated with carbonate minerals (Prohic, 1984, Prohic and Kniewald, 1987), some additional mechanisms of carbonate scavenging must be determined. The presence of organic or inorganic (mainly Mn-oxides or hydroxides) coatings on the surface of the carbonate mineral particles may enhance their adsorptive properties. This may explain some "unusual" carbonate minerals-metals associations. However, for particles smaller than about 1/μm or of specific surface area greater than a few square meters per gram, surface energy may become sufficiently large to influence surface properties. Similarly, the free energy of a solid may be influenced by lattice defects such as dislocation and other surface heterogeneities (Stumm and Morgan, 1981). Both conditions, small particle size and surface heterogeneities, can be expected to occur in carbonate drainage areas, especially in areas of intensive mechanical activities together with corrosion processes. These two forces, however, are the main forces in creation of most, if not all, morphological forms in karst terranes.

An undisturbed sediment sink can contain a historical record of chemical conditions. If a sufficiently large and stable sink can be found and studied, the investigator can establish area baseline levels with which existing conditions can be compared. Under changing environmental or physicochemical conditions (like pH, Eh, dissolved oxygen, bacterial action), sediment-bound trace metals can dissolve into the water column, possibly enter the food chain, and have a significant environmental impact; or several inert or otherwise environmentally harmless inorganic constituents can degrade, or react with others, to form soluble and potentially toxic forms. Finally, bottom sediments of rivers and streams should be regarded as a major, if not the major, source of suspended sediment. Under changing hydrologic conditions (such as a heavy storm or spring runoff), a localized pollution problem can suddenly become widespread and result in significant environmental impact (Horowitz, 1981). Sediment-chemical data are a requisites for the development of a comprehensive understanding of the impact of trace metals on water quality, as well as transport modelling, for estimating geochemical cycles and for establishing the availability of various trace metals in an ecological system. To date, according to Forstner and Salomons (1980), the principal problems with regard to the presence of contaminants in sediments in the environment are:

> The potential availability of the contaminants in the sediments for aquatic life ("bioavailability"), and
> The problem whether remobilization occurs, and if so, under which circumstances.

The above-mentioned problems cannot be solved by trace metal analyses of the bulk sample alone. Use of the total metal concentration as a criterion to assess the potential effects of sediment contamination implies that all chemical forms of a given metal have an equal impact on the environment, which is highly improbable (Tessier and others, 1979). Sequential extraction procedures, as opposed to bulk sample analysis, allow differentiation of the relative binding strength of the trace metals to the various groups of solid phases by successive leaching with chemicals of increasing "strength" and "selectivity" (Kersten and Forstner, 1985). Although this procedure is more time consuming and may involve incomplete selectivity of the reagents used, it does provide much more data on the origin of pollutants, their pathways, biological and physicochemical availability, and possible remobilization, than bulk sample analysis does.

Another advantage is that the chosen fractions are likely to be affected by various environmental conditions. This means that one may, to a certain extent, simulate natural conditions in the laboratory which become rather important in discussing the possible environmental impact of heavy metals in sediments. The critical review of sequential extraction procedures that are used can be found in specialized papers, e.g. Salomons and Forstner, 1980; Forstner, 1982; Forstner, 1983; Forstner and Patchineelam, 1980; Forstner and others, 1982; Prohic, 1984; Rapin and Forstner, 1983. Most of the published papers of sequential extraction analysis deal with polluted clastic sediments, and relatively few attempts have been made to evaluate partitioning effect in sediments of carbonate catchment areas (Deurer and others, 1978; Prohic, 1984; Prohic and Kniewald, 1987; Juracic and others, 1984). In these papers, the authors present elaborate schemes for analysis of carbonate sediments.

Although the following assumption is not true for all carbonate systems, for simplicity, the sediments in carbonate drainage areas can be treated as monomineralic, i.e., composed entirely of carbonate minerals, calcite, and dolomite. For remobilization of elements bound to carbonate phase to occur, the simplest approach is to consider the conditions or change certain environmental parameters, which can lead to dissolution of carbonate phase, accompanied by release of associated metals to overlying water. Dissolution of $CaCO_3$ can occur as a consequence of:

Introducing the CO_2 into the system;
Decreasing in temperature (if CO_2 is not present) or increasing the hydrostatic pressure (if partial pressure of CO_2 is kept constant);
Decreasing in salinity;
Powering the pH (acidification), etc.

Consequently the opposite process, $CaCO_3$ precipitation, can lead to purification of water and must be taken into account as well. According to Mueller and others (1972), the conditions for $CaCO_3$ precipitation can be classified as follows:

CO_2 loss or extraction as a result of changes in the pT conditions or by plant assimilation, either by macrophyta or by microphyta;
Evaporation concentration; or
Mixing of different water bodies.

With respect to the coprecipitation of trace elements in carbonate, the third possibility is of special interest. If an alkaline water body comes into contact with and becomes mixed in river water with normal Ca^{2+} and HCO_3^- levels under neutral pH conditions, the pH will increase. Consequently, the solubility product of calcium carbonate is drastically reduced and $CaCO_3$ is precipitated in the mixing zone, carrying heavy metals from solution with it (Forstner and Wittmann, 1979).

In the preceding discussion, it was shown that aquatic systems that are physically dynamic are also chemically dynamic. The key to understanding and predicting metal transport and environmental availability is the identification and quantification of the metal associations in sediments and the reactions among sediment, water, and biota. Because aquatic system are chemically dynamic, the goal of water-quality projects should be not only to describe existing conditions at some point in time and infer their effect on the environment, but also to attempt to predict likely occurrences later when physicochemical conditions change (Horowitz, 1935). In the preceding discussion, some changes were outlined which likely can disturb the equilibrium in carbonate drainage areas, thus emphasizing the role of carbonate sediments as possible non- ultimate sink for pollutants, namely heavy metals.

Pollution Assessment In Water of Carbonate Drainage Areas

Pollution in Natural Waters--Introduction

The geochemistry of natural waters deals with the distribution and mobility of chemical species and compounds at or below the earth's surface and dynamic mutual interactions of the atmosphere, lithosphere, hydrosphere, and biosphere. The quality of natural waters depends on the mineralogical composition of the aquifer and additional inputs due to man's activities. During the movement of water through an aquifer, its composition will gradually change due to dissolution of rocks, chemical reactions with solids, liquids, and gases with which they come into contact during various parts of the hydrological cycle. These reactions generate various geochemical parameters, i.e. pH, Eh, ionic strengths, and microbial processes which are created by these parameters. These assumptions are valid for all natural systems and especially for systems which involve the relatively easily soluble rocks, as carbonates are.

In this discussion, the expression "natural waters" is used in order to denote that, as far as water quality and water pollution are concerned, there is practically no distinction between surface and subsurface (ground) waters. As was cited by Greenfield (1971): "the line of demarcation between ground water is indistinct." It is not a line but a continuum, variable from place to place and time to

time. Groundwater becomes surface water and vice versa. Both are parts of the same system, the hydrosphere. This connection and interchange is nowhere so obvious as in karst terranes because of the close relationship between rivers and groundwater, characterized by abrupt losses of stream into fissures and ponors (swallow-hole) to recharge groundwater, and equally abrupt discharges of groundwater back into the surface flow system (Kudelin, 1984).

Several decades ago the increased awareness of the vulnerability of aquifer systems to pollution initiated comprehensive studies of the water quality of large American and European rivers. It is difficult to imagine that prior to the last 10 to 20 years there were no studies of ground-water pollution. The simple descriptions of ground-water aquifers in the past -- often defined only in terms of bulk hydraulic gradients -- are no longer sufficient to define the physical, geochemical, and microbial systems which control the propagation and attenuation of pollutants in groundwater (Young, 1985). Pollution of groundwater is, however, more serious than subsurface water pollution. Because of heterogeneities inherent in subsurface systems, it is more difficult to predict the path and rate of pollutant movement, primarily due to:

Complex geochemical reactions and transport mechanisms in subsurface waters are not well understood;
Time required for the subsurface pollution to be detectable;
Long time required for pollutants to be flushed from ground water in order to establish previous conditions;
Cost of ground-water systems to be replenished.

Knowledge of these factors is necessary to minimize the effects of existing agricultural, industrial and municipal activities upon ground- water quality.

As stated in EPA's Project Summary by Lobel (1986)

> ". . . in the United States, approximately 56 quadrillion liters of water are stored within 0.8 kilometers of the land surface. Ground water supplies about 25 percent of all fresh water used. Fifty percent of U.S. citizens obtain all or part of their drinking water from ground water; and 95 percent of rural households depend totally upon it. Commercially, ground water is extensively employed in agricultural practices, particularly for irrigation, and in various industries."

Although less poisoning occurs from drinking water than via the food chain, the amount of groundwater used per country is alarming.

Chemical Quality of Ground Waters in Carbonate Aquifers

Regarding groundwater in areas consisting exclusively of carbonate rocks, the most important controlling processes which influence the chemical quality of groundwater before it reaches the spring orifice or well head, according to Langmuir (1984), are:

1. The composition of the atmospheric precipitation which becomes ground-water recharge;
2. Evapotranspiration losses from ground-water recharge and shallow ground waters;
3. The acidity and degree of undersaturation of ground-water recharge and ground water with respect to the carbonate rocks;
4. The availability and solubility of carbonate and associated rocks including halite, gypsum, and anhydrite;
5. Rates of solution of these rocks and contact time of the ground water with them;
6. Hydrologic processes such as dilution by fresh ground-water recharge and mixing of dissimilar ground waters;
7. Anthropogenic processes, including ground-water pollution by liquid wastes or leachates from solid wastes.

Only the last two processes are usually regarded as degrading the quality of groundwater in carbonate terranes. Moreover, the dissolution of carbonate rocks is not considered as a process

which significantly contributes to water quality state (or only, for example, for Mg and impurities such as Sr and Fe). However, as indicated in section 3.1, calcite trace metal associations, mostly by coprecipitation and partly by adsorption processes, can be significant in the case of several trace metals, i.e., Zn, Pb, Cd (for more detailed data of amounts of trace metals present in calcite, the reader is referred to Deurer and others, 1978; Prohic, 1984; and Prohic and Kniewald, 1984). Additionally, pure limestones and dolomites are rare in nature and primarily contain considerable amounts of insoluble residuum, composed chiefly of clay minerals and iron and manganese oxides and oxihydrates of low crystallinity, together with variable amounts of organic matter and sedimentary sulfides, particularly pyrite. Although the noncarbonated fraction of limestones and dolomites rarely exceeds 5 to 10% of total rock, it can play a notable role in binding trace metals because of the great tendency of these substances toward adsorption of toxic trace metals due to a large charged surface area (clay minerals and Mn and Fe- compound) and/or accessible functional groups (organic matter). The binding strengths among metals and those substances usually are not strong thus metals can easily be released to overlying or underlying water in amounts likely to be treated as dangerous for the ecosystem. In any case, the problem inherent in pollution studies is the qualification, versus quantification, of data.

In general, the toxicity and/or bioavailability of trace metals in the aquatic ecosystem is associated with the partitioning pattern, i.e. speciation of a particular metal in the water (the extreme cases being mercury, copper, and zinc speciation-toxicity relationship; see for example, Stumm and Morgan, 1981, Forstner and Wittmann, 1979, among others). This is true not only for heavy metals, but for gaseous and organic compounds, as well. Increased concentrations of dissolved N_2 and N_2O are not detrimental to drinking water, but, in contrast, NO_3^{2-} at concentrations above 45 mg/l, renders water unfit for consumption by human infants. If water contains more than 450 mg/l of NO_3, it is unsuitable for consumption by livestock (Freeze and Cherry, 1979). Species of the individual metal present affect not only the toxicity and bioavailability but the mobility of the particular metal in aquatic system. Another very important environmental parameter is to predict how far from the point of emission a particular metal can be expected and/or if that distance is large enough for dilution to decrease the environmental impact of the particular chemical. For limestones and dolomites deposited in the reducing condition, which is very common in carbonate basins (lagoon type or carbonate rocks from a restricted shelf) see, for example, Fluegel (1982), the content of organic matter can be appreciably high; in extreme cases involve bituminous limestones or dolomites. Many organic substances have extremely low solubility in natural waters. This, in general, limits the possibility for appreciable migration of large quantities in groundwater. However, because many of these substances are toxic at very low concentrations, solubility constraints are often not capable of totally preventing migration at significant concentration levels.

In general, the most dangerous organic substances present in ground water are those that are relatively soluble, nonvolatile and nondegradable ("refractory" organic substances). Most organic substances are toxic, and they can include appreciable amounts of loosely-bound heavy metals which can be easily desorbed during the oxidation of organic matter.

Limestones and dolomites originated from reducing environments, except organic matter, as a rule, comprise sedimentary sulfides, mostly pyrite, usually finely dispersed in a carbonate matrix of micrite type. Coprecipitation of heavy metals (Zn, Ni, Co, etc.) with pyrite is a very common process, thus pyrite can be regarded as a very important heavy metal scavenging agent which significantly partakes in the accumulation- release metal processes in carbonate rocks. In addition to the coprecipitation effect with heavy metals, pyrite present in carbonate rocks can play a very important role in regulating pH of the system. The oxidation of the sulfide of the pyrite to sulfate (which can be done when pyrite is exposed to air and oxygenated water) released dissolved ferrous iron and acidity into the water. Subsequently, the dissolved ferrous iron undergoes oxygenation to ferric iron, which then hydrolizes to form insoluble "ferric hydroxide," releasing more acidity to the water, so the concentration of sulfate or acidity in the water can be directly correlated with the amount of pyrite that has been dissolved (Stumm and Morgan, 1981). The decomposition of pyrite is among the most acidic of all weathering reactions because of the great insolubility of Fe (III). The dissolution of pyrite can have an environmental impact due to: (1) release of coprecipitated heavy metals, and (2) lowering the pH which can prolong the dissolution of calcite and dolomite, and increase the mobility of metals already present in the water. The process of pyrite oxidation is usually associated with

mining effluents (usually coal mining) which are, certainly, the most pronounced origin of pyrite. It would, however, be a great mistake to neglect the role of sedimentary pyrite which is already present in carbonate rocks as a diagenetic or post-diagenetic product.

In previous discussions it was shown that the trace metals-organic matter- adsorption (or coprecipitation) capability of groundwater in carbonate terranes may greatly vary due to the pH-pE regime; if man's activities disturb that regime, a zone that had a strong capability for trace metal adsorption may lose this trait and the reverse situation, i.e. desorption, can occur.

Once released in groundwater, chemicals can be spread in the aquatic media following very complicated physical and chemical forces and processes. For more detailed data about transport mechanisms of pollutants in groundwater, the reader is referred to Fried, 1975, or Freeze and Cherry, 1979.

Calcite and Dolomite Dissolution in Groundwater

In the previous section, the controlling processes in carbonate ground- water geochemistry were discussed. The main factors which influence the calcite and/or dolomite dissolution in groundwater are now discussed. More detailed study of that subject can be found in Plummer and others (1978), Stumm and Morgan (1981), Langmuir (1984), and in many other papers which the reader can find cited in the mentioned papers.

According to Plummer and others (1978), three mechanism reactions in calcite dissolution are operating simultaneously:

1. $CaCO_3 + H^+ \longrightarrow Ca^{2+} + HCO_3^-$
2. $CaCO_3 + H_2CO^3 \longrightarrow Ca^{2+} + 2HCO_3^-$
3. $CaCO_3 + H_2O \longrightarrow Ca^{2+} + HCO_3 + OH$

The above-mentioned mechanism reactions and a literature review, allow determination of the main factors which govern the calcite (and dolomite) to be as follows:

1. Partial pressure of CO_2;
2. pH;
3. Temperature;
4. Hydrostatic pressure;
5. Mixing of different carbonate ground waters;
6. Miscellaneous factors (impurities in calcite and dolomite, imperfection of crystals, particle size, origin).

By far the most important factor in calcite-dolomite solubility is *partial pressure* (i.e. concentration) of CO_2. There are numerous investigations found in the literature about the relationships between carbonate minerals solubility and partial pressure of CO_2. In general, the solubility of calcite and dolomite increases with the cube root of the CO_2 pressure (Stumm and Morgan, 1981). The partial pressure of waters in equilibrium with the atmosphere (pCO_2 = 10-3.5 atm) is different from the CO_2 pressure in waters in contact with soils. Because of respiration by organisms, the CO_2 composition in soils is up to a few hundred times higher than that in the atmosphere. Consequently, water which passes through soils in its path to the subsurface has greater corrosion activity toward the calcite. As the soil cover in karst terranes greatly varies, often being completely absent, some additional factors of water corrosion activity must be taken into account. However, the connection between surface and subsurface through numerous fissures, joints, and cavities allows the CO_2 consumed in the dissolution processes to be easily replenished from the surface.

The influence of pH on calcite and dolomite solubility was discussed in previous chapters. Generally, the decrease in pH increases the carbonate minerals solubility.

The solubilities of many inorganic salts increase with temperature, but a number of compounds, such as calcite and dolomite, decrease in solubility with an increase in temperature (Stumm and Morgan, 1981). Consequently, if the ground-water chemistry is controlled almost entirely by interactions with carbonate minerals, it is possible for differences in temperature along the flow paths to cause decreases in total dissolved solids. Water moves from recharge areas in which temperature can be low, to deeper zones at higher temperatures, and then back to shallow colder zones in the discharge areas. For waters that become saturated with respect to calcite and dolomite in the recharge areas, the deeper zones would be calcite or dolomite precipitation zones. Furthermore in the colder discharge areas, dissolution would once again occur (Freeze and Cherry, 1979). Of course, this is a very simple approach since many other factors can be involved together with the presence of "strange" ions and because differences in temperature in carbonate aquifers need not to be notable regarding the calcite-dolomite solubility. Although very simple, this mechanism can explain the regional relationship between carbonate minerals solubility and temperature of water.

Pressure, in general, does not greatly influence the carbonate minerals solubility, especially not low pressure. For example, the solubility product of $CaCO_3$ will increase with increased pressure by approximately 0.2 logarithmic units for a pressure of 200 atm (Stumm and Morgan, 1981).

Mixing of groundwaters of different origin and composition is very common in carbonate aquifers. Mixing also occurs between ground-water recharge and groundwater in the capillary zone or at the water table (Langmuir, 1984). The most important consequence of mixing of carbonate groundwaters is that water resulted from mixing has greater corrosivity than component waters, and thus can cause additional dissolution of present carbonate rocks. This process is valid and possibly very important in creating subsurface cavities but has some qualifications which are summarized by Langmuir (1984).

Impurities present in calcite may retard its dissolution. Insidious trace quantities of organic matter and phosphate inhibit the dissolution of calcite in undersaturated water. Finely divided solids have a greater solubility than large crystals. The same effect on solubility can be assumed for lattice defects such as dislocations and surface heterogeneities. Also there are some opinions that calcite of biogenetic origin is more soluble than calcite of inorganic origin.

In contrast to calcite, dolomite solubility in natural waters is not well understood, especially the conditions under which dolomite precipitates in nature. However, there are some opinions (i.e. Langmuir, 1984) that dolomite and dolomite with calcite are more soluble than calcite itself.

Sources of Pollution in Carbonate Groundwaters

In Section 2.3, the main pollution sources in groundwater were indicated. Most, if not all of them, can be regarded as sources of pollution in carbonate groundwaters, but not with the same response. With regard to response or frequency, the pollution sources in carbonate ground waters can be divided as follows:

1. Pollution sources which have not, or have only exclusive influence on the carbonate ground-water quality;
2. Pollution sources of the same frequency as in other aquifers of different composition;
3. Pollution sources almost exclusively present in the vicinity of carbonate rocks and carbonate groundwater.

Radioactive waste disposal and deep-well injection of liquid wastes belong to the first group. Because of the chemical and physical inconvenience of carbonate rocks, it is a generally accepted strategy not to store such type of wastes in them (unless we speak of "evaporite karst terranes").

Most sources of pollution belong to the second group. This is, for example, sanitary landfills or land disposal of solid wastes and sewage disposal on land, together with agricultural activities and main drainage water. Unfortunately, the former activities are very common in carbonate terranes, either as legal or illegal discharges. According to Freeze and Cherry (1979), it is estimated that 90% of the industrial wastes that are considered to be hazardous are landfilled. The leachate from sanitary landfills contains large numbers of organic and inorganic pollutants, in suitable hydrologic conditions,

which reach groundwater. Physical and chemical processes are sometimes incapable of causing appreciable attenuation of many of the toxic substances enrolled with the leachate plume. The case histories of such pollution in carbonate terranes can be found for example in Apgar and Langmuir (1972) and LeGrand (1984). Natural depressions, so numerous in karst terranes, become very common in semilegal or illegal waste disposal sites. Most of the sinkholes, pits, and ponors (swallow-holes) announced as phenomena, are today far from being "natural." S. Bozicevic (1986) presents a comprehensive review of illegal discharges of wastes in karst depression of Dinaric karst areas in Yugoslavia. Smith and Atkinson (1979), among others, warn us of dangerous practices to dispose of wastes in carbonate depressions. But is that enough? These are primarily domestic wastes from nearby temporary or permanent settlements. But there are several examples of disposal of industrial wastes in ponds in the vicinity of factories. The ponds are sometimes improperly grouted, or improperly designed. In karst terranes, "red mud" left after recovering alumina from bauxite is commonly deposited in the karst depressions. Even if it is properly grouted, these ponds usually are not covered and wind can spray very concentrated hazardous chemicals (NaOH among others) over a great distance (Bozicevic, 1986). Another common and dangerous practice is to spread sewage sludge on agricultural or forested lands from which it very easily reaches the groundwater. Agricultural activities can greatly influence ground-water quality. Among the main activities that can cause degradation of ground- water quality are the usage of fertilizers and pesticides and the storage or disposal of livestock or foul wastes on land (Freeze and Cherry, 1979). NO_3 originating from such activities was detected in many carbonate groundwaters (the reader is referred to the bibliography in the second part of this book). One of the most difficult aspects of aquifer protection in all types of rock aquifers, as well as in carbonate terranes, is the control of abandoned wells. Likewise, improper well construction can cause shallow groundwater or surface water to migrate downward into the aquifer (Bouwer, 1978). Prohic (1984) and Juracic and others (1984) supposed the source of lead in recent estuarine carbonate sediments in the Dinaric karst area to be from the combustion of leaded gasoline from nearby highways, and a probable source of enriched copper from antifouling copper paints used for ship bottoms. Dredging activities, which can seriously change environmental stability, are today very common practices in carbonate water courses, as they are in other terranes.

In the third group of pollution sources, we include the sources which are likely to occur exclusively or almost exclusively, in carbonate terranes. The best known source of that kind is salt-water intrusion common in coastal regions. Saline-water aquifers underlie up to two-thirds of the land area of the continental United States, so the problems of water encroachment are not limited to coastal areas (Bouwer, 1978). Simply, when groundwater is pumped from aquifers that are in hydraulic connection with the sea, the gradients that are set up may induce a flow of salt water from the sea toward the well (for salt-water intrusion in coastal areas see, for example, Mijatovic, 1984), or in the inland areas it can be induced by a phenomenon known as upconing (see, for example, Bouwer, 1978). Furthermore, carbonate groundwater is usually hard water and for drinking purposes the TDS ("total dissolved solids") must be lowered with the aid of some "softener". But it is possible that a "water-salt softener" can be a serious ground-water pollutant, as well (Hoffman and Fetter, 1978).

The most important and most widespread of man's activities which can degrade the carbonate ground-water quality have been mentioned. There are several other point and non-point sources which can have local, but sometimes even regional, significance upon the water quality.

The Task of Carbonate Ground-Water Protection – Alternatives and Avenues

As stated by Orloci and others (1985), there are four groups of alternatives to cope with the problems of water pollution:

1. To tolerate pollution and purify water at each specific withdrawal or use;
2. To tolerate pollution and improve water quality within the water source by dilution or other measures;
3. To collect and treat the polluted waters before entering the recipient;
4. To control the sources of pollution.

According to Orloci and others (1985),

"the first, second and third alternatives are relatively easy to administer, but their costs are becoming prohibitively high as the number of pollutants increases and diversifies. Acceptable long-term solutions can only be found by proper reliance on the fourth alternative, i.e. by the gradual introduction and extension of non-polluting or low-pollution technologies with a view of reaching and maintaining a reasonable balance and proper combination among the four groups of alternatives according to the overall social and national interest."

In the author's opinion, in addition, the prediction of pollutant behavior in the subsurface is one of the most important avenues in ground-water protection programs. The relative influences of various processes and conditions on the behavior of a pollutant can vary, dramatically affecting the accuracy of predictions (Lobel, 1986), thus the ultimate aim of subsurface study is to develop definitive information concerning the behavior of the pollutant in groundwater to provide a valid scientific basis for protection of its quality. According to Hounslow (1985), the three basic aspects of this type of study are:

1. The prediction of the impact on ground-water quality of pollutants in the environment;
2. The optimization of existing conditions so as to enhance the attenuating biotic or abiotic processes affecting pollutant in subsurface environments;
3. The development of cost-effective methods of rehabilitating contaminated aquifers.

An additional important task for ground-water protection programs is to evaluate the receiving capacity of a medium for given pollutants and ground- water pollution potential. The former evaluation is the last conclusion after complex and detailed studies were performed. Regarding the latter evaluation, the reader is referred to an interesting approach of quantifications of ground-water pollution potential which was presented by Canter (1985).

However, the less expensive and sometimes the easiest approach to ground- water protection is the control of pollution sources. Until more is known about subsurface properties and their interactions with specific pollutants, source control remains the primary method for preventing ground-water pollution (Lobel, 1986). One of the most critical aspects of preventing carbonate ground-water pollution is the identification of the recharge areas. Once it is established, hazardous wastes must be excluded from such areas, and in such areas protection of aquifers is vital. In carbonate terranes, waste disposal in any morphologic form which has a hydrologic connection with the subsurface (as a matter of fact, most if not all sinkholes, ponors, and pits satisfied this condition) should be completely avoided. Salt-water encroachment can be prevented by regulating the spacing and withdrawal rates of wells (see for example, Todd, 1959).

When potential sources of pollutants are discovered, action should be undertaken to develop monitoring networks that will identify any effective disposal practices that could affect ground-water quality. Vadose-zone sampling equipment should be placed close to waste sites so pollutants can be detected as soon as possible -- preferably before entering the local ground- water system. Once a pollutant reaches the ground water, scientists should be consulted to determine the direction and rate of movement in the subsurface environment (Driscoll, 1986).

After pollution in groundwater occurs, a decision must be made whether to rehabilitate the aquifer or find alternative ground-water resources. However, in many instances, the renovation cost may exceed the community's ability to pay for it, but when new water resources are not available, the costs for restoration become secondary. The decision to attempt restoration of a polluted aquifer is rarely simple or clear-cut. Technical feasibility is only one aspect to consider and is often not the most pressing one. Economics, health, social, political, and other factors must be weighed against one another (Lobel, 1986). But it must not be forgotten that cleanup of polluted aquifers is difficult, time-consuming, expensive, and occasionally dangerous, depending on the fate of pollutants.

CONCLUSIONS

In this review, the hazard of introducing chemicals into an aquatic ecosystem is emphasized. Attention is focussed primarily on carbonate terranes; in areas composed mostly of carbonate rocks there is a high probability for pollution to occur, and the environmental impact of chemicals can be very significant due to physical and chemical parameters of carbonate rocks together with the common practice of using such terranes as waste-disposal sites. It is obvious that wastes must be stored in some way and somewhere, but with greater responsibility and with a completely scientific approach to the problem of finding disposal sites and monitoring effects of disposal upon the environment. The chosen method of disposal must not be the easiest way of disposing of man's undesirable products, but necessarily the safest one. The cost, surely, must be taken into account, but not as the first consideration. Prior to making any decision, the responsibility, not only for ours but of future generations, must be recognized. It depends fully on us what world we are going to leave future generations. Don't let them curse us!

So, as was cited by Fried (1975),

> "Pollution has become the ever-increasing monster that threatens our civilization (what is left of it, at least), the Moloch that will eat us. This is what the information media say, and perhaps they are right; then again, perhaps they are wrong, or at least too pessimistic. We feel that the real danger is not pollution, but the ignorance of pollution problems."

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Hydrology of Limestone Terranes

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   The Gays River deposit consists of stratiform bodies and discordant fault-controlled vein systems within a Mississippian dolomitic reef that overlies unconformably a Lower Paleozoic metasedimentary basement, and is overlain by Mississippian evaporites. Detailed underground mapping and laboratory studies suggest 3 main stages of evolution: 1) pre-ore evaporite deposition, pervasive reef dolomitization and growth of marcasite, 2) precipitation of ore sphalerite, galena, chalcopyrite and calcite, and 3) post-ore deposition of calcite, fluorite, barite, marcasite, pyrite and selenite.

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Strata-bound mineralization occurs in a calcareous belt composed mainly of black limestones, intraformational breccias and calcareous shales, as well as some siliceous layers of Devonian age located in the SW of the Iberian massif, at the boundary between the Eastern Lusitanian-Alcudian and the Ossa Morena zones.

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Radiometric dates from calcite speleothems in Britain indicate deposition before 170,000 yr b.p., during an interglacial period around 90-140,000 yr b.p., an interstadial at 60,000 yr b.p., and in the late Devonian and Holocene. The positions of speleothems within caves allow minimum ages to be estimated for past water tables and associated surface landforms.

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This is the second of three volumes reporting the papers presented at the congress held in Athens, 9-12 October, 1978. Pagination is continuous.

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33. Awramik, S.M. (1976) - Gunflint stromatolites: Microfossil distribution in relation to stromatolite morphology in Walter, M.R., editor, Stromatolites: Amsterdam; Elsevier, p. 311-320.

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Very exact study, based on over 1000 thin-sections and 500 peels, of the formation, genesis, and diagenesis of Upper Muschelkalk (Middle Triassic). Good photographs of thin-sections. Diagenesis of shells is given special attention.

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A geochemical explanation is provided for the extensive dissolution observed along the carbonate coast of the Yucatan Peninsula, Mexico. Mixing of fresh groundwater with subterranean Caribbean seawater generates a highly reactive geochemical zone that enhances aragonite and calcite dissolution and permits geomorphism of aragonite. Enhanced dissolution within the mixing zone not only results in development of porosity and permeability but is also a dominant control on configuration of the coastline. Cave formation is an early phase of the role of groundwater as a geomorphic agent forming the many crescent-shaped beaches that characterize the Yucatan coast. In areas along the coast there are remnants of relict caves whose roofs have collapsed to form coves (incipient lagoons) that later are enlarged by wave action and biological degradation of the limestone. All marine carbonates that are now in a fresh water regime have been subjected to the geochemical reactivity of the mixing zone at least once. Many carbonates have been repeatedly altered as the mixing zone pulsated through the coastal aquifers in response to sea level fluctuations. The mixing zone is a significant site for the development of porosity and permeability that has largely been unrecognized in the geologic record. Further investigation of present day mixing zone environments will provide an evaluation of the hydrogeologic controls on the development and distribution of porosity and diagenetic effects that may be preserved within carbonate aquifers and petroleum reservoirs.

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> The hydrokarstic system which includes the caves Ciur Pono and Ciur Izbuc is discussed with respect to a series of shear and tension cracks. The cracks belong to a system of faults, noticeable at the surface. The morphology of Ciur Ponor is controlled both by the nature of the fracture the water used and by the texture of the limestone hosting the different sections of the cavity. In this respect, there is an obvious difference between the sections situated upstream and downstream of the pseudosump.

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> Due to environmental constraints, water control systems of mines which are subject to water hazards could yield discharges of 80-120 cu m/min and also high amounts of sediment on the order of 6 tons/min for several days. Results of investigations of several types of sediment settlers are reviewed. Settlers considered include those from mining applications and those from surface water treatment. The efficiencies of the simple sump, twin sump, South African vertical settler, two-level settler, vertical-flow settler, radial-flow settler, longitudinal-flow settler, sand trap, and hydrocyclone are compared. Sediment treatment consists of dewatering and transport by belt-conveyor, or hydraulic transport in a slurry form. Since the belt cannot dewater particles <0.2 mm, the hydraulic transport method proved to be the only realistic alternative. A pilot station is being constructed to check different settling system elements in their original size under real sediment conditions.

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> Sparce mineralization and chemical data indicate that the unconformity at the top of the Knox Dolomite is a controlling feature in the up-dip migration of ore-bearing brines into central Kentucky. Mississippi Valley-type veins in the central Kentucky mineral district were deposited from basinal brines transmitted through the Knox Dolomite and emplaced on the Lexington dome along fault zones and fractures no earlier than Alleghenian time. A simple method of determining the source directions of the mineralizing fluids is proposed.

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Chemical analyses of 17 Precambrian phosphorites from seven deposits in Udaipur are presented. Stratigraphic evidence suggests that these phosphorites were deposited in shallow waters where luxuriant growth of stromatolitic algae helped in trapping and precipitating P from the basin waters.

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49. Barnes, H.L. (1983) - Ore-depositing reactions in Mississippi Valley-type deposits in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 77-85.

The characteristics of the depositional environment are best evaluated by evidence from epigenetic, rather than syngenetic, Mississippi Valley-type deposits. Textures of the ores, especially sphalerite stratigraphy, prove that the metals and sulfide are transported together and that deposition is not caused by mixing of these components from separate solutions. Organic complexes of the metals are dominant during transport, possibly also including some thiols, because of the low stability of potential inorganic complexes, the observed solubilities in oil-field brines, and the presence of Ni and V porphyrins.

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At Kamoto and in other Katangan deposits, copper and cobalt occur as sulfides in two stratiform ore bodies. The host rock is dolostone, chert and shale. New evidence is presented to show that this diagenesis took place at first in an environment devoid of copper and cobalt and then proceeded while the metals were brought in from an outside source.

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    Statistical evaluation of the significance of a certain number of oil-forming environments and fundamental research on the genesis of sedimentary rocks are efforts which are entirely justified by their economic importance. Thus, it is safe to say that the beginning of sedimentology, or at least its rapid development during the last 25 years, was mainly invoked by oil research.

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    After a brief review of karst weathering processes, the main rock units formed by intra-karstic sedimentation are considered, i.e. detrital and chemical deposits. The behavior of base metals in trace amounts is then studied with

respect to the evolution of the physicochemical properties of groundwater during its downward course to the water table. Finally, the evolution of both the sulfide deposits and the connate waters during karst fossilization and further burial is discussed.

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90. Biondic, B.; and Goatti, V. (1985) - A complex type of high-capacity intake structure in the Dinaric karst: Yugoslavia; 2:2, Inter. Geol. Congress.

The Yugoslav Adriatic area is primarily built of karstified carbonate rocks pertaining to the Dinaric Mountains. Precipitation in the region is abundant, as much as 3.5 meters a year, of which more than 60 per cent infiltrates. Groundwater runoff variations, however, are high because of the low retention capacity of aquifers.

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A great part of Yugoslavia is composed of karstified carbonate rocks. During the past ten years, great attention has been given to the protection of groundwater because of the possible pollution of sources of potable water. The authors discuss the post city of Rijeka in the Croatian Littoral, a large industrial center, where zones of sanitary-technical protection of groundwaters are determined on the basis of hydrogeologic elements.

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The author discusses shelf, transitional, and basinal environments in the Lower Triassic of Nevada. Good photographs of thin-sections are presented.

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Evolution of karst regions from the Romanian Carpathians is presented based on the analysis of karstic leveling surfaces (karstoplanes); it is concluded that there are three main periods in the formation of the karst relief depending on the periods during which the mountain chain arose.

96. Bleahu, D.M. (1973) - The Underground Halls, 5th Intern. Congr. Speol., Bd.3, p.441-459, 19p., 16 fig., Weinheim (in French).

After a few general considerations on the underground networks, a classification of the underground confluences into three groups is made, as follows: (1)confluences due to the initial intersection of the underground courses, (2)confluences due to the position of the initial waterways and (3)confluences due to hydrodynamic processes. The last category includes a new process, the vacuumatic capture, which is to a large extent responsible for the complex networks.

97. Bleahu, M. (1964) - The Karst of Romania - A Brief Outlook, Lucrurile Institutului de Speologie "Emil Racovita", 4, p.59-73, 6 figures, (in Romanian).

This report is a synthesis study on the karst in Romania. Data are supplied with respect to the age and surface of karstifiable rocks, and the number of caves and their distribution by large geographic units. Assessments are made on the types of karst (plateau, crest and isolated massif karsts), the exo- and endokarstic morphology, and the evolution of karst in Romania.

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Based on some examples from the Bihor Mountains karst (Romanian Carpathians), the way in which the junctions of the groundwaters formed and the constitution of the networks within caves are analyzed. The essential role played by the piracy of surface waters in the underground environment for the karst relief in general is pointed out and some general laws (e.g. the prolongation of the underground course to the detriment of the surface) are enunciated; also, some specific forms (e.g. antithetical karst step) are defined. A classification of captures with respect to genesis is provided, and the way in which water loss takes place from the morphological and hydrographic viewpoints (the constitution of hydrographic basins in karst) is presented.

99. Bleahu, M. (1959) - The Padis-Cetatile Ponorului Endoreic Basin, Proposals for a Future National Park, Protectia Naturii 4: p.89-125, 16 figures (in Romanian).

The Padis-Cetatile Pororului underground drainage basin and surrounding areas which boast outstanding karstic features, such as the sinkholes at Cetatile Ponorului, the Somesul Cald and Valea Galbena gorges, the Padis and Poiana Ponor poljes, as well as intermittent springs, vertical shafts and numerous caves, make one of the most important areas containing natural monuments in Romania. The basin is comprised of a national park, equipped with tourist facilities, as well as of a scientific research laboratory to deal with problems related to this park. Arguments are given in support of the need to conserve the forests in karstic areas and recover the ecology existent prior to timber harvesting operations.

100. Bleahu, M. (1965) -The Underground Junctions: Intern. Journ. Speleology, Vol.I, Part 3, p.441-459, 19p., 16 fig., Weinheim (in French).

After a few general considerations of underground networks, a classification of the underground confluences into three groups is made: (1)confluences due to the initial intersection of the underground courses, (2)confluences due to the position of the initial waterways and (3)confluences due to hydrodynamic processes. The last category includes a new process, the vacuumatic capture, which is to a large extent responsible for the complex networks.

101. Bleahu, M. (1966) - Periglacial Formations in the Bihor Mountains: Revue Roumaine de Geologie, Geophysique, Geographie, Ser. Geogr., T. 10, No.1, p.55-64, 10p., 5 fig., Bucharest (in French).

Based on the general morphology and the morphometric study of the Pleistocene gravel in the Padis zone, the role played by the periglacial formations in the configuration of one of the most typical karst zones from the Romanian Carpathians and in the constitution of closed basins is established.

102. Bleahu, M. (1971) - The Karstic Peneplanes in the Romanian Carpathians and Their Evolution, Studia Geomorphologica Carpatho-Balcanica, vol.V, p.41-46, 7 p. 1 fig., Krakow (in French).

The relationship between the karstoplains and peneplains in the Carpathians is established; the cave formation and underground networks are correlated. Three main speleogenetic periods are considered to have existed: the Miocene, Pliocene and Pleistocene.

103. Bleahu, M. (1974) - Karst Morphology: Geologic and Geographic Conditions of Karstification. 560p., 184 fig., 101 photos: Editura Stiintifica, Bucharest (in Romanian).

This is a treatise of karst morphology, with emphasis on formation processes. After an introduction in which the principles of classical karst are presented, the karstic phenomenon is defined; a short history of karstology and specific features of karstic phenomenon are presented. There follow four parts, each devoted to one of the factors conditioning the karstic process: (1)physico-chemical factors, (2)lithological factors, (3)mechano-tectonic factors and (4)hydrogeological factors. The last factor covers half of the book, comprising the following subchapters: Origin of Water in Karst; Types of Water Drainage through the Limestone Massifs; Mechanism of Formation of Endokarstic Networks; Hydrogeologic Working of the Karstic Systems (with an exhaustive presentation of hydrogeological and speleogenetic models). The book contains a reference list of 1,000 titles grouped on various problems. This is one of the most comprehensive treatises of karstology in the world.

104. Bleahu, M. (1982) - Karst Relief, 296p., 60 fig., Editura Albatros, Bucharest.

This is a complete book on karst and caves emphasizing morphological aspects. The first part of the book reviews karstification processes, while the second part, which is the most important, deals with the endokarst. In addition to the classification of caves and speleogenetic processes, forms of the karstic void are discussed in detail. Cave entrances, passages (horizontal and transverse sections), halls, shafts and complex networks are classified. A complete presentation of corrosion, erosion and imcasion forms is made, followed by speleothem-types, and a presentation of the fillings and breakdowns that lead to the termination of the karst void. The third large section of the book is devoted to exokarst. The negative forms (lapies, sinkholes, uvalas poljes, karst valleys) as well as the positive forms are presented. The karst types (morphological, structural, climatic types) are further presented. One chapter deals with the karst evolution and another one with the non-calcareous karst and the pseudokarst. The book ends with a chapter

referring to the economic importance of karst. On the whole, the book is very concise, presenting all the aspects of the karst relief in a rigorous, genetic classification system. To date, this is the most thorough book on all karst forms that has been published.

105. Bleahu, M. (undated) - Karst of Romania in "Karst - Important Karst Regions of the Northern Hemisphere, Elsevier, M.Herak and V.T. Stringfield (edit.), p.341-353, (in English).

This is a general presentation of the karst of Romania regarding lithostratigraphic and sedimentological problems; the tectonic setting; the phases of karstification and evolution of karst areas; morphological features; and karst developed on salt gypsum and volcanic rocks.

106. Bleahu, M.; and Lascu, C. (1975) - Topolnita Cave, Editura Sport-Turism, Bucuresti, 75p., 80 photographs (in Romanian with German, French and English abstracts).

This is an illustrated album which shows one of the biggest caves in Romania. The text describes the stages of exploration, as well as the wide range of karstic features along the 16 km of passages. The black-and-white and color photographs show characteristic aspects of the cave. A map is also enclosed.

107. Bleahu, M.; and Povara, I. (1976) - A Catalogue of the Caves in Romania, Consiliul National pentru Educatie Fizica si Sport, Bucuresti, 53p.(in Romanian).

Using for the first time the decimal system of classification, applied to the geographic division of the country, this work makes an inventory of the roughly 2,000 karstic cavities known in Romania by 1975.

108. Bleahu, M.; and Rusu, T. (1964) - Proposals for Conventional Signs to be Used in Karstic Areas Cartography - Exokarstic Phaenomena, Studii Tehnice si Economice, Seria F, 5, p.157-178, 142 figures (in Romanian).

This work includes 142 cartographic signs that represent exokarstic forms concerning elements of lithology, hydrology, speleology, tectonics, etc.

109. Bleahu, M.; Decu, A.; and Decu, V. (1963) - The Zaton-Ponoare Hydrological System (Baia de Arama): Revue de Geologie et Geographie, T.VII, No.1, p.147-156, 7 fig., Bucharest (in German).

This is a study of a complex hydrographic system from the South Carpathians with two closed basins which drain underground through a common drain, the Bulba cave. Surface and underground elements are described and the underground drainage system is discussed.

110. Bleahu, M.; Decu, Anca; and Decu, V. (1964) - Topolnita Cave, Ocrotirea Naturii: 8, 1, pp. 73-98; 13 photos. (In Romanian).

The paper presents the Topolnita Cave during the period its galleries were 10,700m long; by that time, it was the longest cave of Romania. Today, its galleries are 20,500m long, thus making it the third longest cave in Romania. The genesis of this cave is very interesting as it has been excavated within a relatively reduced volume of calcareous rock. The authors discuss the location and arrangement of the cave.

111. Bleahu, M.; Decu, V.; Negrea, St.; Plesa, C.; Povara, I.; Viehmann, I.; Diaconu, G.; Constantinescu, T.; Goran, C.; Valenas, I.; Boroneant, V. (1976) - Caves of Romania: Editura Stiintifica si Encyclopedia, Bucurestu, pp. 415; 186 figures representing a map of Romania's

karst; plans of location, plans of caves, 33 drawings of cave animals, 50 photos (In Romanian).

The book includes an introduction and two parts. Part I consists of the history of cave knowledge; the karst geology and geography; palaeozoology and anthropology; living subterranean fauna; caves and their preservation. Part II presents 141 of the most interesting caves (selected according to biospeleological, hydrological and climatic criteria and the beauty of speleothemes), as well as of the karst areas in which these caves are situated. The information given for each cave are historical data, location and access, description, and visiting requirements. An alphabetic index of the caves described or mentioned in the text and selected references end the book.

112. Blessing, H.M. (1976) - Karstmorphologische Studien in den Berner Alpen: Tuebinger Geogr. Stud., No. 65.

113. Boccaletti, M.; Ficcarelli, G.; Manetti, P.; and Turi, A. (1969) Analisi stratigrafiche, sedimentologiche e petrografiche delle formazioni mesozoiche della Val di Lima (Prov. di Lucca): Italy; Mem. Soc. Geol. Ital., Vol. 8, p. 847 - 922.

Passega diagrams are used to interpret the depositional environments of Mesozoic calcarenites.

114. Boegli, A. (1956) - Der Chemismus der Loesungsprozesse und der EinfluB der Gesteinsbeschaffenheit auf die Entstehung des Karstes: Rep. Comm. Karst Phenomena IGU, New York, p. 7-17.

115. Boegli, A. (1956) - Grundformen von Karsthoehlenquerschnitten: Stalactite, Z. Schweiz. Ges. Hoehlenforsch., p. 56-62.

116. Boegli, A. (1960) - Karsthydrographische Untersuchungen im Muotatal: Regio Basiliensis, p. 68-79.

117. Boegli, A. (1963) - Hoehlenkarren: 3. Inter. Kongr. Spelaeol. Wien 1961, p. 25-27.

118. Boegli, A. (1963) - Korrosive Bildungsbedingungen von Hoehlenraeumen: 3. Inter. Kongr. Spelaeol. Wien 1961, p. 29-33.

119. Boegli, A. (1964) - Die Kalkkorrosion, das zentrale Problem der Verkarstung: Steir. Beitr. Hydrogeol. 1963/64, p. 75-90.

120. Boegli, A. (1964) - La corrosion par melange des eaux: Inter. J. Spele. I, p. 61-70.

121. Boegli, A. (1964) - Le Schichttreppenkarst, un exemple de complexe glacio-karstique: Rev. Belg. Geogr. 1:2, p. 64-82.

122. Boegli, A. (1965) - The role of corrosion by mixed water in cave forming in Problems of Speleological Research: Proc. Inter. Spele. Conf., Brno, CSSR, 1964, p. 125-131.

123. Boegli, A. (1968) - Hoehlenniveaus und Hoellochniveaus: 4eme Congr. Inter. Spele., Ljubljana 1965, p. 23-27.

124. Boegli, A. (1969) - Diskussionsbeitrag zu Ek: Abondance du gaz carbonique dans les fissures des grottes: 5 Inter. Kongr. Spelaeol., Stuttgart, p. 14/2.

125. Boegli, A. (1969) - Neue Anschauungen ueber die Rolle von Schichtfugen und Klueften in der karsthydrographischen Entwicklung: Geol. Rundsch. 58,, p. 395-408.

126. Boegli, A. (1969) - Shafts: Actes 3eme Congr. Suisse Spele. 1967, p. 17-18.

127. Boegli, A. (1970) - Le Hoelloch et son karst: Ed. la Baconniere, Neuchatel (Suisse) (French and German version).

128. Boegli, A. (1971) - Karstdenudation - das AusmaB des korrosiven Kalkabtrages: Regio Basiliensis 12:2, p. 352-361.

129. Boegli, A. (1973) - Studie zur Hydrographie der Poljen: Geogr. Z., Beih., p. 84-88.

130. Boegli, A. (1976) - CO_2-Gehalte der Luft und Kalkgehalte von Waessern im unterirdischen Karst: Z. Geomorphol. Suppl. 26, p. 153-162.

131. Bolliger, W.; and Burri, P. (1967) - Versuch einer Zeitkorrelation zwischen Plattformkarbonaten und tiefmarinen Sedimenten mit Hilfe von Quarz-Feldspat-Schuttungen (mittlerer Malm des Schweizer Jura): Basel; Eclogae geol. Helvet. 60:2, p. 491-507, 4 figs.

132. Bonacci, O. (1985) - Hydrological investigations of Dinaric karst at the Krcic catchment and the River Krka Springs (Yugoslavia): Journal of Hydrology, Vol.82, No.3/4, p.317-326.

> The relationship between catchment surface- and groundwater and the spring water of a karst river in Yugoslavia was investigated. Discharge decreases from the spring to the outlet (waterfall at the river's spring). Only in flood situations (some 30-60 days a year) are normal hydrological relations found with discharge increasing towards the outlet. The river dries up regularly every year, with the number of days of zero flow increasing from the spring towards the outlet. A high degree of interdependence between groundwater levels in the catchment and the discharge of the springs has been demonstrated. Analytical expressions for the discharge curves as a function of the groundwater level have been defined. Two zones with turbulent conduit flow have been discovered, one at the surface and the second about 30-100 m under the surface.

133. Bonem, R.M. (1977) - Comparison of cavities and cryptic biota in modern reefs with those developed in Lower Pennsylvanian (Morrowan) bioherms: Proc. Third Inter. Coral Reef Symp., Miami 1, p. 75-80, 4 figs.

134. Boni, M. (1979) - Zur Palaeogeographie, Mineralogie und Lagerstaettenkunde der Palaeokarst-Erze in Sud-West Sardinien (Iglesiente-Sulcis): Dissertation, Univ. Heidelberg, 260 p.

135. Boni, M. (1982) - Paleokarstic ores in SW Sardinia: Some conclusive remarks: Res. Asso. Min. Sarda. 87, p. 91-115.

136. Boni, M. (1984) - Fluid inclusion as a contribution to genetic and paleoenvironmental problems for the post-Hercynian karst ores in Iglesiente-Sulcis: 5th Europ. Reg. Sed. Meeting Marseille, Extended Abstract, p. 66-67.

137. Boni, M. (1984) - Syngenetic and epigenetic ores in SW Sardinia: Examples from the Malacalzetta (Iglesias) mining area in Wauschkuhn, A., Kluth, C., and Zimmermann, R.A., editors, Syngenesis and Epigenesis in the Formation of Mineral Deposits: Germany, F.R., Heidelberg; Springer-Verlag, p. 401-411.

> In the Malacalzetta-S. Benedetto area, Iglesiente, SW Sardinia, there are both "syngenetic" and "epigenetic" ore bodies. The "syngenetic" ores are situated at various levels in the shallow-water carbonates of the Lower Cambrian Gonnesa Formation. "Epigenetic" vein fillings, which probably originated from

further remobilization of the "syngenetic" ores, are related to main tectonic lineaments of the late Hercynian age.

138. Boni, M. (1985) - Les gisements de type Mississippi Valley du Sud-Ouest de la Sardaigne (Italie): Une synthese: Chron. Rech. Min., n. 47, p. 7-34.

139. Boni, M. (1986) - The Permo-Triassic vein and paleokarst ores in southwest Sardinia: Contribution of fluid inclusion studies to their genesis and paleoenvironment: Germany, F.R.; Springer-Verlag, Mineralium Deposita, Vol. 21, p. 3-62.

The author discusses new fluid inclusion data on the temperatures, salinities and composition of mineralizing fluids in gangue and ore minerals in late- and post-Hercynian veins and paleokarsts, both in the Iglesiente and Sulcis areas of southwest Sardinia.

140. Boni, M.; and Amstutz, G.C. (1982) - The Permo-Triassic paleokarst ores of southwest Sardinia (Iglesiente-Sulcis): An attempt at a reconstruction of paleokarst conditions in Amstutz, G.C., El Goresy, A., Frenzel, G., Kluth, C., Moh, G., Wauschkuhn, A., and Zimmermann, R.A., editors, Ore Genesis: The State of the Art: Germany, F.R., Heidelberg; Springer-Verlag, p. 73-82.

The authors present a case study of an area in southern Sardinia where karstification took place at various intervals, producing superimposed karst systems and local sulphide-barite concentrations. Included in the paper are descriptions and genetic discussions of Ba-Pb-Zn-Ag ore bodies in karst cavities, with emphasis on the textural evidence for synchronous karst-age deposition.

141. Boni, M.; and Koeppel, V. (1985) - Ore-lead isotope pattern from the Iglesiente-Sulcis area (SW Sardinia) and the problem of remobilization of metals: Germany, F.R.; Springer-Verlag, Mineralium Deposita, Vol. 20, p. 185-193.

In SW Sardinia, syngenetic to syndiagenetic Pb-Zn ores occur in Cambrian carbonates, along the unconformity between the Cambrian and Ordovician, in Permo-Triassic karsts and in vein-type deposits related to late Hercynian granites, which also contact-metamorphosed some Cambrian deposits. Most of the Cambrian ores contain isotopically similar or identical leads, whereas in the younger deposits the isotope ratios vary and suggest that especially the lead of Permo-Triassic ores may consist to a large extent of remobilized Cambrian, possibly also Ordovician, ore lead plus a Hercynian component.

142. Boni, M.; Cocozza, T.; Gandin, A.; and Perna, G. (1981) - Tettonica, sedimentazione e mineralizzazioni delle brecce al bordo sud-orientale della piattaforma carbonatica cambrica (Sulcis, Sardegna): Mem. Soc. Geol. It. 23, p. 111-122.

143. Bosdoc, T. (1981) - Preliminary observations concerning the drainages in the Northern Poieni Plateau, Carst: 1, p. 5-10, 4 figs., in Romanian.

The discharge of the karstic plateau of Poieni takes place as perched springs at the contact with the underlying crystalline schists. Until now, only short caves, acting as overflow paths have been discovered.

144. Bosdoc, T. (1984) - Genetical observations on some gravitational sliding caves in Metaliferi Mountains: Bulletin Speologic Informative, 8, p. 5-11, 4 figs., in Romanian with English abstract.

The author discusses the genetic and morphological features of gravitational sliding caves. Analysis of the two caves of Metaliferi Mountains, the origin of which may be ascribed to the phenomenon, is presented.

145. Bosdoc, T. (1985) - Considerations on the Syngenetic Waterfall Cavities: Bulletin Speologic Informative, 9, fasc. 1, p. 7-12, 4 figs., in Romanian with English abstract.

The author discusses cavities of reduced dimensions from Metalifieri and Trascau Mountains, occurring under some waterfalls from the karstic areas. Genetic factors mentioned are the frontal and lateral displacements of the waterfall related to the travertine deposition and erosion at the bottom of the waterfall.

146. Bosellini, A.; and Rossi, D. (1974) - Triassic carbonate buildups of the Dolomites, Northern Italy: U.S.; Soc. Econ. Paleont. Min., Spec. Publ. 18, p. 209-233.

147. Bosellini, A.; and Winterer, E.L. (1975) - Pelagic limestone and radiolarite of the Tethyan Mesozoic: A genetic model: Geol. 1975, p. 279-282, 2 figs.

148. Botosaneanu, L.; Decu, V.; and Rusu, T. (1964) - The third international speleological expedition in the People's Republic of Bulgaria: (August 15-27, 1963). Trav. Inst. Speol. "Emil Racovita", Bucharest, III, 4110430, 13 figs., (in Romanian).

Karstic zones and forms in the western part of Stara Planina (Belogradcic-the Magura Plateau, Ciren-Bozijat Most, Vratza-the Ledenika Plateau, Karlukovo-Projofna, the Isker-Lakadnyk pass) are presented and several data are supplied in connection with speleological organization in the People's Republic of Bulgaria.

149. Botoseneanu, L.; Negrea, Alexandrina; Negrea, St.; Decu, Anca; Decu, V.; Bleahu, M.; Balogh, E.; Puscariu, Val.; Rusu, T.; Sencu, V.; Viehmann, I. (1967) - Research of the caves of Banat and Oltenia: (Romania, 1959-1962). Editions du CNRS, Paris, pp. 397; 182 figs., representing: karst distribution maps; plans of location and of caves; 2 tables; 42 photos (Recherces sur les grottes du Banat et d'Oltenie: (Romaine, 1959-1962). (In French).

The authors deal with the exokarst and 173 caves of two of the most speleologically important regions of Romania. Part I presents the exokarst and 73 caves of Banat (Western Carpathians, Banat Mountains) and 12 karst areas; Part II is a treatise of the exokarst and 100 caves of Oltenia (Southern Carpathians, Mehedinti Plateau and Mountains and 9 karst areas; Caves more than 1000m long include Comarnic (4040, today 6201), Buhui (3217/6547), Popovat (1120), Tolosu (1075/1847) and Guru Ponicovei (1666) (Banat); Topolnita (10,700/20,500), Bulba (3240/5160), Lazului (2200/4400), E.A. Martel (2000/4133), din Dealul Curecea (2200/4000), Closani (1100), Vacilor de la Closani (1033). The presentation of each cave includes synonymies, analytic bibliography, exploration data, location and access, description, deposits, genesis, climate, tropic resource, and biospeleology. Besides a general bibliography, each part includes a special bibliography. Moreover, each part ends with a synoptic table and conclusions.

150. Bouladon, J. (1984) - Syngenesis and epigenesis at the Largentiere (Ardeche, France) Pb-Zn-Ag deposit in Wauschkuhn, A., Kluth, C., and Zimmermann, R.A, editors, Syngenesis and Epigenesis in the Formation of Mineral Deposits: Germany, F.R., Heidelberg; Springer-Verlag, p. 422-430.

The Largentiere (Ardeche) Pb-Zn-Ag deposit is made up of a relatively low-grade syngenetic ore, on which the mining started in 1962, and a much richer epigenetic ore, mined along with the former since 1970. The amounts

present of both types are similar. It is likely that the coexisting two types of ore result from several phases of deposition connected with paleogeographical evolution.

151. Bourg, A.C.M. (1983) - Role of fresh water/sea water mixing on trace metals adsorption phenomena in Wong, C.S.; Burton, J.D.; Boyle, E.; and Bruland, K., editors, Trace Metals in Sea Water: United States; Plenum, New York, p.195-208.

152. Bouroullec, J.; and Deloffre, R. (1976) - Relations facies-environment au Cretace moyen en Aquitaine occidentale: France; SNPA 10:2, p. 535-583.

Vraconian, Cenomanien, various environments (supratidal zone, lagoons, deeper marine). Good photographs of thin-sections.

153. Bouroullec, J.; and Deloffre, R. (1977) - Support sedimentologique a l'interpretation diagraphique: Example d'un paleorivage jurassique aquitain (France SW) in Elf-Aquitaine: Essai de caracterisation desimentologique des depots carbonates 2, Elements d'interpretation, p. 151-157, figs. 24-30.

154. Bouroullec, J.; Deloffre, R.; and Rao, C.P. (1978) - Caracterisation statistique des environment et de leur polarite en plate-forme carbonatee application au reservoir albo-aptien de Lacq: Pau; Bull. Cent. Rech. Explor.-Prod. Elf-Aquitaine 2:2, p. 219-336, 11 figs.

155. Bozicevic, S. (1969) - Examples of possibilities to exploit waters from speleologic sites for the water supply in 5 Internationaler Kongress fuer Spelaeologie, Stuttgart, West Germany: Germany, F.R., Munich; Verband der Deutschen Hoehlen- und Karstforscher e.V., p. Hy7/1-Hy7/6.

Dinaric karst covers a large region of Yugoslavia. A permanent supply of potable water in this area is a major concern. Increased attention is being given in Istria, Gorski Kotar, Lika, Dalmatia, Herzegovina, Montenegro, and the Adriatic Islands to the observation and recording of hydrogeological phenomena such as caves, caverns, and sinkholes. During these explorations, possible supplies of subterranean water have been identified.

156. Bozicevic, S. (1980) - Application of radiocarbon dating in chronology of morphologic changes in karstic caves: Yugoslavia; Fizika, 12:S2, 163.

A systematic measurement of speleothems age in the karstic regions would help to establish the geochronology of, as well as climatic changes in, the Dinarides.

157. Bozicevic, S. (1980) - Swallow-hole zones and their natural extensions in limestone deposits: Yugoslavia; Bull. Spele. Soc., "Bosansko-Hercego-Vacki Krs"-Nas Krs, 1:9, p.33-59 (in Srbo-Croatian, with summary in English).

The authors reviews the results of an investigation on the currently active swallow holes which are usually inaccessible in their remote sections due to considerable flood material deposits.

158. Bozicevic, S. (1981) - Morfoloskaa razlika izmedu jame i jamskog sistema te pecine i pecinskog sistema (Morphological difference between a pothole and a pothole system) in Osmi Jugoslovenski Speleoloski Kongres, Beograd, 1981 (8th Yugoslav Congress of Speleology, Belgrade, 1981): Yugoslavia; p. 225-227 [summary in English].

The problems of morphological and geological delimitation of the notions "pothole" and "pothole system" are discussed. Attention is given to the necessity of distinguishing the categories of the spelaeological phenomena.

159. Bozicevic, S. (1982) - The scientific importance of the tourist caves in Croatia: Le Grotte d'Italia, Vol. 4, p.115-119.

> Bone fragments of diluvial cave-bear, lion, and hyena were found in several caves of Croatia, which are today tourist caves (Cerovacke, Veternica, etc.). In addition, several other Croatian tourist caves contain archaeological and biological findings having scientific value (Vranjaca, Sipun, etc.).

160. Bozicevic, S. (1984) - Hydrogeology of the lost River Gacka in the Dinaric karst after completion of hydroelectric power plant Senj: Yugoslavia; Yugoslavije, 11:2,p. 13-70.

> By its hydrologic features, the River Gacka ranks among lost rivers typical of the Dinaric karst. The objective of the present paper has been a comparison between the original state of the lost River Gacka and the present situation in this part of Croatian karst.

161. Bozicevic, S. (1984) - Review of speleological explorations in the area of the Croatian karst in Mais, K., Mrkos, H., and Seemann, R., editors, Akten des Internationalen Symposiums zur Geschichte der Hoehlenforschung Wien 1979: Wien; Herausgegeben vom Landesverein fuer Hoehlenkunde in Wien und Niederoesterreich, Wissenschaftliche Beihefte zur Zeitschrift "Die Hoehle" 31, p. 14-15.

162. Bozicevic, S. (1986) - Pollution of pits and sink-holes in Dinaric karst of Croatia, Yugoslavia in 19th Congress Inter. Asso. Hydrogeologists, Karlovy Vary 8.-15., Symposium on Ground-Water Protection Areas: Czechoslovakia; 7 p.

> The territory of Dinaric karst, with its specific surface and underground features, is referred to as the "locus typicus" of the world's heritage. This paper is the author's contribution to the efforts to prevent pollution of other karst regions of Europe and the rest of the world, such as has happened in some areas of the Dinaric karst in Yugoslavia.

163. Bradner, R.; and Resch, W. (1981) - Reef development in the Middle Triassic (Ladinian and Cordevolian) of the North Limestone Alps near Innsbruck, Austria: Soc. Econ. Paleontol. Min. Spec. Publ. 30, p. 203-231.

164. Braithwaite, C.J.R. (1973) - Settling behavior related to sieve analysis of skeletal sands: U.S.; Sedimentology, Vol. 20, p. 251-262.

165. Brand, U.; and Veizer, J. (1981) - Chemical diagenesis of a multicomponent carbonate system - 2: Stable Isotopes: U.S.; Journ. Sed. Petrol. 51:3, p. 987-997, 7 figs.

166. Brandner, R. (1978) - Tektonisch kontrollierter Sedimentationsablauf im Ladin und Unterkarn der westlichen Noerdlichen Kalkalpen: Innsbruck; Geol. Palaeont. Mitt. Innsbruck, Bd. 8, Festschrift W. Heibel, p. 317-354, 14 Abb., 5 Taf.

167. Brandner, R. (1981) - Unveroeff: Taetigkeitsbericht "Projekt Pb-Zn in den Noerdlichen Kalkalpen": Innsbruck; Geol. -Palaeont. Inst., Univ. Innsbruck.

168. Braun, E.R. (1983) - Ore controls-Middle Tennessee zinc district in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 349-359.

> Geological features associated with mineralization (e.g., alteration, ground preparation, facies, pre-Middle Ordovician structure and post-Middle Ordovician structure) were studied to determine empirical correlations. Zinc-bearing solutions are hypothesized to have moved freely through altered and

karstified limestone beds in the Knox aquifer of middle Tennessee. Hydrocarbons or other reductants accumulated in the aquifer below aquicludes in paleodomes. Sphalerite precipitated where these fluids interacted.

169. Brecke, E.A. (1983) - A supplemental report on the Cave in Rock fluorspar district, Hardin County, Illinois in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 415-423.

    The author describes basic features of the process of ore formation as defined in studies of the Cave in Rock deposits. These features may also be found in other deposits in a carbonate environment.

170. Brennecke, J.C. (1978) - A comparison of the stable oxygen and carbon isotope composition of Early Cretaceous and Late Jurassic carbonates from DSDP Sites 105 and 367: U.S.; Initial Rept. Deep Sea Drilling Project 41, p. 937-955.

171. Breznik, M. (1962) - Akumulacija na cerkniskem in Planinskem Polju: Geologija 7, Geoloski zavod, p. 119-149.

172. Brigo, L.; and Omenetto, P. (1976) - Le mineralizzazioni plombo-zincifere della zona di Raibl: Nuovi aspetti giacimentologici: L'Ind. Min. 27, p. 49-56.

173. Brigo, L.; and Omenetto, P. (1978) - The lead and zinc ores of the Raibl (Cave del Predil) zone in northern Italy; new metallogenetic data in Zapfe, H., editor, Ergebnisse der Oesterreichischen Projekte des Inter. Geol. Korrelationsprogramms (IGCP) bis 1976: Wien; Springer, Oesterr Akad. Wiss. Erdwissenschaftl. Komm.; Schriftenr., Vol. 3, p. 103-110.

174. Brigo, L.; Kostelka, L.; Omenetto, P.; Schneider, H.-J.; Schroll, E.; Schulz, O.; and Strucl, I. (1977) - Comparative reflections on four Alpine Pb-Zn deposits in Klemm, D.D., and Schneider, H.-J., editors, Time- and Strata-Bound Ore Deposits: Berlin-Heidelberg-New York; Springer, p. 273-293.

175. Brinkmann, R.; Fluegel, E.; Jacobshagen, V.; Lechner, H.; Rendel, B.; and Trick, P. (1972) - Trias, Jura and Unterkreide der Halbinsel Karaburun (West-Anatolien): Marburg; Geologica Palaeontologica 6, p. 139-150, 4 figs.

176. Briot, P. (1978) - Phenomenes de concentration de l'uranium dans les environments evaporitiques intracontinentaux: Les calcretes de l'Ylgarn australien: Essai de comparaison avec les calcretes de Mauritanie et de Namibie, These 3eme cycle, Orsay, 167 p., 5 pls., 38 figs.

177. Briot, P. (1983) - Geologie et geochimie des gisements d'uranium lies aux milieux pre-evaporitiques intra-continentaux: Les calcretes uraniferes: These d'etat, Universite Pierre et Marie Curie, Paris VI.

178. Broeker, W.S.; and Olson, E.Z. (1959) - ^{14}C-dating of cave formations: Natl. Spele. Soc. Bull. 21, 43.

179. Brown, J.S. (1970) - Mississippi Valley type lead-zinc ores: Min. Depos., Vol. 5, p. 103-119.

180. Buchbinder, B. (1975) - Lithogenesis of Miocene reef limestones in Israel with particular reference to the significance of the Red Algae: Israel; Geological Survey of Israel, Oil Research Division Report OD/3/75, 173 p.

    This is a report of an investigation of 249 biocalcarenite samples (Upper Miocene) according to the following scheme: visual estimation of the particle

frequency in the thin-section; frequency histograms and calculation of means as well as the standard deviation; subdivision into three frequency classes and processing of the material according to presence/absence; classification of the samples by association analyses and cluster analyses (Q-mode, Jaccard coefficient); check of the relative importance of the groups in each classification (Chi-square test); comparison of the classifications obtained from the various methods: Association analysis permitted detailed grouping and led to more uniform groups than cluster analysis.

181. Buchbinder, B. (1979) - Facies and environments of Miocene reef limestones in Israel: U.S.; Journ. Sed. Petrol. 49:4, p. 1323-1344, 11 figs.

182. Buchbinder, L. G.; and Friedman, G.M. (1980) - Vadose, phreatic and marine diagenesis of Pleistocene-Holocene carbonates in a borehole: Mediterranean coast of Israel: U.S.; Journ. Sed. Petrol. 50:2, p. 395-407, 5 figs.

183. Budinciuc, I. (1985) - Hydrological and speleogenetic observations in Valea Seaca Cave (Poiana Rusca Mountains): Bulletin Speologic Informative, 9, fasc., 1, p. 47-51, 1, fig., in Romanian with English abstract.

Based on two tracing experiments and morphological and sedimentological observations, a tentative evolutionary scheme of the most important cave of Poiana Rusca Mountains is proposed.

184. Buggisch, W. (1980) - Die Geochemie der Kalke in den Trogkofel-Schichten der Karnischen Alpen: Klagenfurt; Carinthia II, Sonderheft 36, p. 101-111, 5 figs.

185. Bulgar, Al.; Diaconu, V.; Cancea, V. (1984) - Modern methods in karst hydrological research: Application to some principal karst system from the Southern Carpathians. Theoretical and Applied Karstology, 1: pp. 215-224, 4 figs.

The high price and technical difficulties related to the use of the direct methods in the karst water circulation study allow for a priority use of indirect methods especially hydrological methods. A case study carried out for two of the main karst zones of the Southern Carpathians points out the possibilities afforded by the hydrological methods.

186. Bulgar, Al.; Povara, I. (1978) - Separation of karstic thermal springs discharge components as based on the analysis of discharge and temperature variations measured at exsurgence. Trav., Inst., Speol. "Emile Racovitza", t. XVII: pp. 209-214, Bucharest.

Determination of the existing relation between deep karstic circulation and infiltration waters taking a more direct and rapid course represents a current concern in karstic hydrology. Karstic spring component separation may be approached as based on correlative analysis of discharge and temperature variations recorded at exsurgence, by reading continuity equations of liquid and caloric discharge. Possibilities and restrictions required in using this method are exemplified in the case of Hercule thermo-mineral spring.

187. Bull, P.A. (1977) - Lamination or waves? Processes and mechanisms of fine-grained sediment deposition in caves: Proc. 7th Inter. Spele. Congr. Sheffield, p. 86-89.

188. Bullock, K.C. (1976) - Fluorite occurrences in Utah: U.S.; Utah Geol. Min. Survey Bull., Vol. 110, 89 p., 33 figs.

Most fluorite production has been from the Spor Mountain district of western Utah, where breccia pipes and veins of uraniferous fluorite occur in dolomite beds of Ordovician and Silurian age.

189. Burns, D.A. (1974) - Changes in the carbonate component of Recent sediments with depth: A guide to paleoenvironmental interpretation: Amsterdam; Marine Geol. 16, p. M13-M19, 2 figs., 1 tbl.

190. Burton, J.D. (1978) - The models of association of trace metals with certain compounds in the sedimentary cycle in Goldberg, E.D., editor, Biogeochemistry of Estuarine Sediments: France; UNESCO, Paris, p.33-41.

191. Button, A. (1976) - Iron-formation as an end member in carbonate sedimentary cycles in the Transvaal Supergroup, South Africa: Econ. Geol., Vol. 71, p. 193-201.

192. Buxton, T.M.; and Sibley, D.F. (1981) - Pressure solution features in a shallow buried limestone: U.S.; Journ. Sed. Petrol. 51:1, p. 19-26, 4 figs.

193. Buyce, M.R.; and Friedman, G.M. (1975) Significance of authigenic K-feldspar in Cambrian-Ordovician carbonate rocks of the Proto-Atlantic shelf in North America: U.S.; Journ. Sed. Petrol. 45, p. 808-821.

194. Caillere, S.; Dietrich, J.E.; Maksimovic, Z.; and Pobeguin, Th. (1978) - Etude mineralogique et geochimique des bauxites a nodules complexes du gisement de Blanquette W, pres le Thoronet (Var.) in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 77-91, 2 figs.

> Bauxites in the south of France are boehmitic bauxites, generally poor in kaolinite, with 10 to 35 percent hematite; diaspore, varying in amount, occurs associated with nodules rich in As, Ni, Co, Cu, and sometimes Zn.

195. Callahan, W.H. (1977) - Some thoughts regarding premises and procedures for prospecting for base metal ores in carbonate rocks in the North American cordillera: U.S.; Econ. Geol. 72, p. 71-81.

196. Campbell, F.A.; and Lerbekmo, J.F. (1965) - Chemical composition of Mississippian carbonate rocks from Throton Creek, Alberta: Calgary; Bull. Canadian Petrol. Geol. 13, p. 229-237.

197. Cannizzaro, C.; Pirri, I. Venerandi; and Zuffardi, P. (1984) - Iron preconcentration in stromatolites/oncolites: An example from the Lower Permian of the central Alps in Wauschkuhn, A., Kluth, C., and Zimmermann, R.A., editors, Syngenesis and Epigenesis in the Formation of Mineral Deposits: Germany, F.R., Heidelberg; Springer-Verlag, p. 342-349.

> The formation of oncolite-bearing beds in the Lower Permian Collio Formation of the central Alps is discussed. The authors propose that the oncolite beds are the result of subaqueous volcanic-exhalative-sedimentary deposition.

198. Carannante, G.; Ferreti, V.; and Simone, L. (1975) - La cavita paleocarsiche cretaciche di Dragoni (Campania): Boll. Soc. Naturalisti Napoli 83, Jg. 1974, p. 1-12, 6 figs.

199. Carlisle, D. (1983) - Concentration of uranium and vanadium in calcretes and gypcretes in Wilson, R.C.L., editor, Residual Deposits: Surface Related Weathering Processes and Materials: U.K., London; Blackwell Scientific, p. 185-195.

> Uranium ore-bearing calcretes (in Western Australia and Namibia) are non-pedogenic. They result from lateral transport rather than vertical redistribution of components and they develop mainly in the capillary fringe along the axes of large stable drainages with low gradients under uniquely arid climates. Distributions of uraniferous pedogenic calcretes are mutually exclusive.

200. Carlson, E.H. (1983) - The occurrence of Mississippi Valley-type mineralization in northwestern Ohio in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 424-435.

> Exposures of Mississippi Valley-type mineralization in northwestern Ohio and parts of adjacent states form a prominent northeasterly trending belt over 200 km long and 75 km wide. This belt of non-economic deposits cuts across the northerly trending Findlay Arch. The structural setting of the district and the presence of favorable host horizons in the subsurface provide an attractive but speculative area for mineral exploration.

201. Carozzi, A.V. (1971) - Geochemical data on back-reef carbonates: Traverse group (Givetian) of the northern part of the Southern Peninsula of Michigan: Pau; Bull. Centre. Rech. Pau, SNPA 5:2, p. 213-222.

202. Carozzi, A.V.; and Textoris, D.A. (1967) - Paleozoic carbonate microfacies of the Eastern stable interior (U.S.A.), Intern. Sed. Petro.y. Ser. 11,: The Netherlands; Brill, 41 p.

> The authors present a geological, stratigraphic survey (Ordovician to Pennsylvanian) according to systems, each with paleogeographic interpretations; photographs are generally good. Fossil identifications are missing or too general (only groups). Environmental interpretation is too general.

203. Carozzi, A.V.; Bourroullec, J.; Deloffre, R.; and Rumeau, J.L. (1972) - Microfacies d'Aquitaine: France; Bull. Centre Rech., CMFA Vol. Spec 1, 594 p.

> Detailed microfacies analyses combined with chemical and sedimentological studies of Jurassic carbonates (Lias to Upper Jurassic) in Aquitaine. The classification of the cores, which was carried out very precisely with the aid of thin-sections, quantitative and qualitative analyses of insoluble residues and trace elements as well as petrophysical data have made possible a reconstruction, based on four theoretical models, of the depositional environment and the paleogeography. Photographs of fossils (primarily only foraminifera and calcareous algae) are very good but not described in any detail.

204. Carozzi, A.V.; Reyes, M.V.; and Ocampo, V.P. (1976) - Microfacies and microfossils of the Miocene reef carbonates of the Philippines: Manila; Philippine Oil Dev. Co. Spec. Publ. 1, 80 p.

205. Carpenter, A.B.; Trout, M.L.; and Pickett, E.E. (1974) - Preliminary report on the origin and chemical evolution of lead- and zinc-rich oil field brines in central Mississippi: U.S.; Econ. Geology, Vol. 69, p. 1191-1206.

206. Carrasco-V. Baldomero (1977) - Albian sedimentation of submarine autochthonous and allochthonous carbonates, east edge of the Valley-San Luis Potosi platform, Mexico: U.S.; Soc. Econ. Paleont. Min. Spec. Publ. 25, p. 263-272, 19 figs.

207. Carss, B.W.; and Carozzi, A.V. (1965) - Petrology of Upper Devonian pelletoidal limestones, Arrow Canyon Range, Clark County, Nevada: The Netherlands; Sedimentology, Vol. 4, p. 197-224.

> The authors discuss a 360 m-thick limestone sequence (Lower Late Devonian); sample interval is 60 cm. A thin-section study includes clasticity indices and frequency indices for all detrital particles and frequency indices of the skeletal grains. On the basis of the arithmetic means of these indices, 10

MF types were distinguished, which could be assigned to different water depths. To check the accuracy with which the samples were assigned to a certain MF type and to determine the reciprocal relations between the MF types, correlation analyses were used.

208. Catalov, G.A. (1972) - An attempt at energy index (EI) analysis of the Upper Anisian, Ladinian and Carnian carbonate rocks in the Teteven Anticlinorium (Bulgaria): Sed. Geol. 8, p. 159-175, 5 figs., 4 pls.

209. Caumartin, V.; and Renault, Ph. (1958) - La corrosion biochimique dans un reseau karstique et la genese du Mondmilch: Notes Biospeleol. 13, p. 87-109.

210. Celet, P. (1962) - Contribution a l'etude geologique du Parnasse-Kiona et d'une partie des regions meridionales de la Grece continentale: Athen; Ann. Geol. Pays Helleniques 13, p. 1-446, 37 pls., 14 figs.

211. Chabert, C. (1977) - Les grandes cavites mondiales: Spelunca 1977/2, Suppl.

212. Chappuis, P.-A.; and Jeannel, R. (1951) - A List of Visited Caves, 1927-1949 (the Eighth Series), Archives of Experimental and General Zoology, 88: 81-230, fig., 1-28 (in French).

The authors discuss geographic location, general description, a list of groups of cave animals, assessments concerning thermohygrometric conditions, and food supplies for 177 caves in Romania, Algeria, Spain, France, Italy, Switzerland and Yugoslavia.

213. Chaudhuri, S.; Clauer, N.; and Ramakrishnan, S. (1983) - Strontium isotopic composition of gangue carbonate minerals in the lead-zinc sulfide deposits at the Brushy Creek mine, Viburnum Trend, southeast Missouri in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 140-144.

Several vug-filling dolomites and calcites and their host Bonneterre dolostones associated with the Pb-Zn sulfide deposits at the Brushy Creek mine in the Viburnum Trend in southeast Missouri were analyzed for their Sr isotopic compositions and selected trace element contents to seek some chemical and isotopic constraints on the possible mode of formation of these ore deposits. The data could best be interpreted in terms of differential alteration of rocks or minerals at the source of the metals for these ore deposits.

214. Chave, K.E. (1960) - Carbonate skeletons to limestone: problems: U.S.; Transactions New York Academy of Science, Vol. 23, p. 14-24.

Recent coastal sands show bimodal distributions. This can be explained by the abrasion of calcareous material which produces finer intermediate sizes.

215. Chave, K.E. (1962) - Factors influencing the mineralogy of carbonate sediments: U.S.; Limn. Oceanography 7:2, p. 218-223, 2 figs., 7 tbls.

216. Chave, K.E. (1967) - Recent carbonate sediments - An unconventional view: U.S.; Journal of Geological Education, XV:5, p. 200-203.

The purpose of this review is to examine the distribution of Recent carbonate sediments, from a geologist's point of view, and perhaps provide a basis for the reexamination of the foundation for some previous paleoenvironmental interpretations.

217. Chen, K.Y.; Lu, J.C.S.; and Sycip, A.Z. (1976) - Mobility of trace metal during open water disposal of dredged material and following resedimentation, Proceedings of Spec. Conference on Dredging and its Environmental Effects, Mobile, Alabama: United States; American Society of Civil Engineers, p.435-454.

218. Chih-Kuei, C.; and Chang-Lin, C. (1984) - Exploitation and control of karst water in coal measures, in Water in Mining and Underground Works (El Argua en la Mineria y Trabajos Subterraneos), Vol.I, p.111-124.

> The occurrence of a thick water-bearing Cambro-Ordovician limestone in Handan and Xingtai district, Hebei Province, China, has presented difficulties for coal and iron ore mining operations. Hydrogeological surveys were carried out over a four-year period to discover how a potential water hazard could be use to benefit the economy of North China where water shortage is a problem. Survey results show that tectonic structures are closely associated with the main course of underground water flow. The district may be divided into four hydrogeological units, namely the Fengfeng Unit in the south, the Xingtai Unit in the center, the Lincheng Unit in the north and the She Hsien Unit in the west. Solution fissures are the predominant form in the karst. Measures adopted to control the karst water underground are to dam water to guard against flooding in the upper reaches, to seal up leakage under the river bed to prevent water infiltration in the middle reaches, and to build water reservoirs for agricultural uses in the lower reaches.

219. Choquette, P.W. (1968) - Marine diagenesis of shallow-marine lime-mud sediments: Insights from O^{18} and C^{13} data: U.S.; Science 161, p. 1130-1132.

220. Chowns, T.M.; and McKinney, F.K. (1980) - Depositional facies in Middle-Upper Ordovician and Silurian rocks of Alabama and Georgia in Frey, R.W., editor, Excursions in Southeastern Geology: U.S.; Geol. Soc. Amer. Annual Meeting, p. 323-348.

221. Churnet, H.G. (1979) - The relationship between dolomitization and sphalerite mineralization in the Lower Ordovician Upper Knox carbonate rocks of the Copper Ridge district, east Tennessee (Ph.D. thesis): U.S.; Univ. Tennessee at Knoxville, 237 p.

222. Churnet, H.G.; and Misra, K.C. (1980) - Zoning in dolomites as indictor of a mixing diagenetic environment involving mixing of fresh and saline waters: U.S.; Geol. Soc. Amer. Abstracts with Programs, Vol. 12, p. 173-174.

223. Churnet, H.G.; and Misra, K.C. (1981) - Genetic implications of the trace element distribution pattern in the Upper Knox carbonate rocks, Copper Ridge district, east Tennessee: U.S.; Sedimentary Geology, Vol. 38, p. 279-300.

224. Churnet, H.G.; and Misra, K.C. (1981) - Genetic implications of the trace element distribution pattern in the Upper Knox carbonate rocks, Copper Ridge District, East Tennessee: Sediment. Geol. 30, p. 173-194.

225. Churnet, H.G.; and Misra, K.C. (1983) - Sphalerite mineralization and its relationship to carbonate facies boundaries, Copper Ridge district, east Tennessee in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 360-372.

> Sphalerite deposits in the Copper Ridge district of east Tennessee occur in the upper part of the Cambro-Ordovician Knox Group. They are largely restricted to brecciated zones which straddle the contact between the Kingsport and Mascot Formations. The original depositional setting of these carbonate sediments was a coastal flat and an adjacent shallow marine environment containing scattered islands. Sphalerite deposits in this district

are located at facies boundaries between sediments that were deposited on topographic highs and those which were deposited in subtidal environments.

226. Churnet, H.G.; Misra, K.C.; and Walker, K.R. (1982) - Deposition and dolomitization of Upper Knox carbonate sediments, Copper Ridge district, east Tennessee: U.S.; Geol. Soc. Amer. Bull. 93, p. 76-86.

227. Cigna, A.A. (1968) - Air circulation in caves: Proc. 4th Inter. Congr. Spele. Ljubljana 1965, p. 43-49.

228. Cigna, A.A. (1975) - Considerazioni sulle teorie speleogenetiche in Le Grotte d'Italia: Riv. Ist. Ital. Spele., p. 391-408.

229. Cigna, A.A.; Cigna, L.; and Vido, L. (1963) - Quelques considerations sur l'effet sel dans la solubilite des calcaires: Ann. Spele. 18, p. 185-191.

230. Cioni, R.; Innocenti, F.; Mazzuoli, R.; and Radicati di Brozole, F. (1973) - Sr-distribution and carbonate mineralogy in the "Calcare Masiccio" formation of non-metamorphic Tuscan series, North of Arno River: Rome; Boll. Soc. Geol. 92, p. 363-389, 13 figs., 2 tbls.

231. Ciry, R. (1959) - Une categorie speciale de cavites souterraines: Les grottes cutanees: Ann. Spele. 14, p. 23-30.

232. Civita, M.; Cocozza, T.; Filippi, L.; Musso, L.; and Perna, G. (1984) - Groundwater problems in the mining district of Iglesiente (Sardinia, Italy) in Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol.I & II, p.1139-1155.

> In Iglesiente, southwest Sardinia, there is an important orebearing district. The ores occur in the carbonate rocks of the Lower Cambrian. The Cambrian sequence was folded and faulted by the Caledonian, Hercynian and Alpine orogenesis, with remobilization of the mineral deposits and the development of various karstic cycles. Large quantities of groundwater posed problems for mining. At present, mining extends to a depth of 300 meters below the land surface. The 1500 liters/second pumped off at present are slightly briny. Research is now underway to allow deepening of the mines and of the water table level.

233. Clarke, O.M., Jr. (1961) - Sink-hole bauxite deposits in northeastern Alabama: U.S.; presented at Alabama Academy Sci., Mobile, Alabama, 7 April 1961, 6 p.

> Bauxite and kaolinite deposits of northeastern Alabama occur in sinkholes in Cambrian and Ordovician carbonate rocks. The Alabama deposits, probably of lower Tertiary age, are very similar in occurrence and origin to the bauxites found in northwestern Georgia, east Tennessee, and western Virginia.

234. Cloud, P.E., Jr. (1962) - Carbonate deposition west of Andros Islands, Bahamas: U.S.; U.S. Geol. Surv. Prof. Paper 350, 138 p.

235. Cocean, P. (1975) - On the Genesis of the Plane-Horizontal Roof of the Pestera cu Apa Cave in Les Valley, Trav. Inst. Speol. "Emil Racovita," Bucharest, 14: 189-196, figs., 1-5 (in French)

> To explain the morphological variety of gours, an analysis is made of the role of 1)the morphology of the initial obstacle; 2)the particularities of the hydrological conditions; 3)the complementary factors; and 4)the stage of evolution of the gours.

236. Cocean, P. (1979) - Plane-Horizontal Roofs and the Karstic Base Level, Trav. Inst. Speal. "Emil Racovita," Bucharest, 18: 219-224, Figs., 1-2 (in French)

The author outlines the particularities of action of the base level in the underground and analysis base level types (gravitational, lithological), as well as the extent to which they influence the genesis of the plane-horizontal roof.

237. Cocean, P. (1979) - The Agricultural Capitalization of the Karstic Relief in the Apuseni Mountains, Studies and Research of Geology, Geophysics and Geology, the Geography Series, 26: 89-96, figs., 1-4 (in Romanian)

Four major zones of agricultural capitalization of karsts are distinguished - karstic depressions, plateaus, valleys, and karstified slopes. The analysis of the salient features of these areas relies on an approach to the physico-geographic causes that emphasize a certain type of agriculture, practiced in the respective areas.

238. Cocean, P. (1980) - Morphogenetic Types and the Distribution of Sinkholes in the Apuseni Mountains Karst, Trav. Inst. Speol. "Emil Racovita," Bucharest, 19: 253-260, figs., 1-4 (in French).

The author analyzes three types of Apuseni Mountains sinkholes (solution, crumbled and complex) and their territorial grouping as alignments or fields of sinkholes.

239. Cocean P. (1981) - Population and Settlements in the Apuseni Mountains Karst, Studies and Research of Geology, Geophysics and Geography, the Geography Series, 28: 57-58, figs., 1-8 (in Romanian).

The distribution of human settlements in the karstic areas of the Apuseni Mountains is of three types: scattered, dispersed and concentrated. The most numerous and characteristic are the scattered settlements. The economic profiles of the settlements lying in karstic areas are confined to farming, forestry and partially industrial occupations. At present, a process of de-population of the karstic areas, entailed by complex causes, is in full progress.

240. Cocean, P. (1984) - Elements of Detailed Morphology of the Ursilor Cave (the Bihor Mountains), Crisia, Oradea, 14: 581-586, figs., 1-6 (in Romanian).

The contribution of gours and of the plane-horizontal roof, which are considered particular elements, to the overall morphology of the cavity is underscored.

241. Cocean, P. (1984) - The Economic Potential of the Karst in the Apuseni Mountains, the Publishing House of the Academy of the Socialist Republic of Romania, Bucharest, 156 pages, figs., 1-38 (in Romanian).

The author presents an original approach to interactions between man and karst. Morphological, hydrographic, climatic and pedological conditionings are highlighted, and emphasis is placed on capitalizing karst (farming, industrial works, forestry, tourism, water supply). Optimal solutions are recommended for efficient exploitation. Finally, the imbalance caused by man's impact upon karst is discussed.

242. Cocean, P. (1984) - The Location of the Caves in the Apuseni Mountains According to Altitude, Studies and Research of Geology, Geophysics and Geography, the Geography Series, 31: 81-84, figs., 1-2 (in Romanian).

Single-floor caves cannot be correlated with erosion platforms. The only possible correlation is between these platforms and the caves that make up the endokarstic systems or galleries that form multifloored caves.

243. Cocean, P.; Rusu, T. (1984) - Genetic Types of Gorges in the Apuseni Mountains Karst, Theoretical and Applied Karstology, Bucharest, 1: 91-98 (in French).

There are four categories of gorges in the Apuseni Mountains karst: (1)epigenetic, (2)underground karstic capture, (3)antecedent and (4)peripheral subsidence. Contributions are also made to the definition of the gorges of underground karstic capture and of peripheral subsidence.

244. Cocean, P.; Rusu, T. (1984) - The Karstic plateaus of the Codru-Moma Mountains, Trav. Inst. Speol. "Emil Racovita," Bucharest, 23: 81-88, figs., 1-2 (in French)

The authors demonstrate that the karstic plateaus of Vascau and Dumbravita de Codru in the Codru-Moma Mountains were remodelled like karstoplains in the Miocene and respectively Pliocene. Emphasis is placed upon the great density and variety of exo- and endokarstic forms which characterize their present morphology

245. Cojocaru, Mircea; Diaconu, G. (1973) - Method of Graphic Interpretation of Data Obtained by Cave Bearing with Theodolite with the Help of Digital Computer, Trav. Inst. Speol. "Emil Racovita," Bucharest, Tome XIII, p. 357-368 (in French).

A method is outlined whereby the bearing of caves is achieved with the help of a digital computer. This method is illustrated in a gallery segment of the Topolnita cave, the Mehedinti Plateau, Romania.

246. Collins, J.A.; and Smith, L. (1976) - Lithostratigraphic controls of some Ordovician sphalerite in Amstutz, G.C., and Bernard, A.J., editors, Ores in Sediments: Germany, F.R., Heidelberg; Springer-Verlag, p. 79-91.

Carbonate lithofacies analysis of sphalerite-hosting strata in the Western Newfoundland Lower Ordovician St. George Formation was used to ascertain why mineralization occurs where it does. The host rock was deposited in two cyclically alternating carbonate bank environments, which produced dolomitic-mottled biointrapelsparite interbedded with dolomite.

247. Collinson, J.D. (1978) - Lakes in Reading, H.G., editor, Sedimentary Environment and Facies: Oxford; Blackwell Science Publ., p. 61-79, 16 figs.

248. Coman, D. (1979) - Essay on the Ecological Interpretation of the origin of Caves, Trav. Inst. Speol. "Emil Racovita," Bucharest, 18: 191-199 (in French).

On the basis of bibliographic studies and individual research work, the author ascribes the origin of the karst and of the caves to a system of ecological relations in which the major part is played by the heterotrophic and chemolithotrophic microflora.

249. Coman, D. (1984) - The Karst - Biogeochemical Aspects, Theoretical and Applied Karstology, Bucharest, 1: 23-28.

The author's arguments support the idea that the process of karst and cave formation is a result of phenomena of biogeochemical alteration of rocks, with the main role played by the heterotrophic and chemolithotrophic micro-flora. Emphasis is placed on biochemical reactions of very rapid oxidation of certain

minerals which lead to the formation of carbonic and sulfuric acid, essential factors in the genesis of karst and caves.

250. Coman, D.; Craciun, V. (1978) - The Vintului Cave, the Sport-Turism Publishing House, Bucharest, 44 pages and 81 photographs (in Romanian with French and German versions).

The authors report the discovery and exploration of the largest cave in Romania (33 km long) and outline, with the help of black-and-white and color photographs, morphological aspects of this cavity which features spectacular labyrinthic meanders that are considered internationally unique.

251. Combes, P.-J. (1978) - Karst precoce et karst secondaire de troisieme horizon de bauxite dans la zone du Parnasse (Grèce) in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 101-113, 6 figs.

Solution structures are described and illustrated.

252. Combes, P.-J. (1978) - Nouvelles donnees sur les relations entre la paleogeographie et la gitologie des bauxites due troisieme horizon dans la zone du Parnasse (Grece) in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 92-100, 5 figs.

Bauxites were deposited in the Middle Cretaceous in a karst developed by the emergence of a Bahamas-type carbonate platform.

253. Conley, C.D.; and Davis, J.C. (1973) - Carbonate petrography by pattern recognition: U.S.; Bull. Amer. Asso. Petrol. Geol. 57:2, p. 399-406, 3 figs.

254. Constantinescu, T. - A Map of Underground Water Circulation in the Piatra Craiului Massif, Trav. Inst. Speol. "Emil Racovita," Tome XXIII, p. 75-79, Bucharest, 1984 (in French).

The major aspects of underground water circulation in the massif (in the Southern Carpathians) are presented. Two hydrogeological basins are shown to exist, as follows: the Prapastiile Zarnestilor basin, in the North, and the Dimbovicioara basin in the South, both extending East of the morphological boundaries of the Piatra Craiului massif. The morphohydrographic map including elements of geology shows inter alia: the major demonstrated and presumed underground drainage directions; the main areas of karstic springs and water losses; the two hydrogeological basins which include four hydrographic basins.

255. Constantinescu, T. - Remarks on the Caves Situated Between the Rivers Susita Verde and Sohodol (the Vulcan - Southern Carpathian Mountains), Trav. Inst. Speol. "Emil Racovita," Bucharest, Tome XIV, p. 169-188, Bucharest, 1975, 7 diagrams and 3 tables (in French).

Thirty caves, the lengths of which vary from 8 to 750 m, are presented and their significance as indices in deciphering the paleogeography of the region is underscored. The author uses tables and maps to show the main karstic springs, water losses, and underground drainage directions.

256. Constantinescu, T. - The Evolution of the Hydrographic Network in the Dimbovicioara Valley. Note 1, Theoretical and Applied Karstology, 2 1986, 3 figures (under print).

This first work highlights the salient geographic and geological features of the Dimbovicioara chute - a highly tectonized karstic area, with altitudes ranging from 700 to 2,230 m. The second part refers to the genesis and evolution of the Dimbovicioara valley, with emphasis on the important role played by

tectonics (in the formation of the Podul Dimbovitei graben in particular) and by karstic processes (underground water circulation) in the evolution of the hydrographic network and in the organization of the hydrographic basin of the Dimbovicioara river.

257. Constantinescu, T. - The Evolution of the Hydrographic Network in the Prapastiile Zarnestilor Karstic Area, Trav. Inst. Speol. "Emil Racovita," Bucharest, Tome XVI, p. 217-228, Bucharest, 1977, 8 figures (in French).

The evolution of the hydrographic network is outlined and three stages of transformations are shown to have occurred in parallel with the major morphological and sculptural stages in the Southern Carpathians. The changes of the last stage, in particular, were obviously facilitated by karstic processes, respectively by underground water circulation. An example is the Prapastiile Zarnestilor gorge. The upper half of the gorge was molded by an epigee stream which gradually infiltrated into limestone forming an underground stream with a cave. Following the destruction of the cave, after the collapse of its roof, the current gorge was formed. The complexity of the respective phenomenon is shown in stages by sketches.

258. Constantinescu, T. - The Karst in the Piatra Craiului. The Particularities of the Genesis and Evolution of the Karst. Note 1. Trav. Inst. Speol. "Emil Racovita," Tome XIX, p. 203-217, Bucharest, 1980, 2 figures and 3 tables (in French).

Considering that the Piatra Craiului Massif (in the Southern Carpathians) contains a karst with a number of particular features, this first note is devoted to aspects specific to the genesis and evolution of the karst, with reference to structural implications, the overall morphology of the massif, and weather conditions. Tectonic activity is shown to be the cause of the respective particularities. The work includes a map showing the distribution of limestone within the massif.

259. Constantinescu, T. - The Karst of Petricica (the Piatra Craiului Massif - the Southern Carpathians), Trav. Inst. Speol. "Emil Racovita," Bucharest, Tome XV, p. 233-245. Bucharest, 1976, 5 figures and 2 tables (in French).

A presentation is made of karst in the Piatra Craiului Massif. Emphasis is placed on the fact that the exokarst is poorly represented (several sinkholes areas, lapies and gorges), while the endokarst (caves and underground circulation) is more interesting. The map of karst is supplied, and synthetic tables are given concerning the fluorescein colorings performed by the author.

260. Constantinescu, T. - The Piatra Craiului Massif. The Genesis and Evolution of the Torrents on the North-Western and Northern Slopes; Pleistocene Glaciation, Theoretical and Applied Karstology, 1, 1984, p. 99-106, 3 figs., (in French).

Torrents on the north-western and northern slopes are shown to be features of relief specific to the massif which have not been mentioned in Romanian geographic literature so far, for which the author suggests the term of "vladusca" ("vladusti", plural) - a torrent formed of limestone with the drainage basin a former cirque and the drainage channel very deep, widely open in the upper part and narrow and vertical in the lower part; polygenetic character (glacial, periglacial, karstic). At the same time, the phenomenon of pleistocene glaciation in the massif is also mentioned for the first time. The work includes maps and sketches for interpretation.

261. Cook, D.J.; Randazzo, A.F.; and Sprinkle, C. (1985) - Authigenic fluorite in dolomitic rocks of the Floridan aquifer: U.S.; Geology, Vol. 13, p. 390-391.

Fluorite in Eocene carbonate mudstone of Florida is reported for the first time. Fluorite occurs within primary gypsum nodules at a depth of 235-240 m below the surface. Water chemistry indicates undersaturation for gypsum and fluorite, and their survival is attributed to a lack of groundwater circulation. Fluorite probably formed penecontemporaneously with gypsum in a sabkha environment from seawater-concentrated brine. An additional source of fluoride may have been fluvial transport of salts weathered from Appalachian volcanic rocks.

262. Cook, P.J.; and McElhinny, M.W. (1979) - A reevaluation of the spatial and temporal distribution of sedimentary phosphate deposits in the light of plate tectonics: U.S.; Economic Geology, Vol. 74, p. 315-330.

A new compilation of paleolatitudes of sedimentary phosphate deposits using worldwide paleomagnetic data confirms the hypothesis that the majority formed at low-latitude locations. It is proposed that there is no direct genetic link between periods of volcanism, orogenesis, formation of evaporites, and episodes of phosphogenesis. Models are developed to explain the different sedimentary sequences that develop in north-south and east-west seaways.

263. Coplen, T.B.; and Schlanger, S.O. (1973) - Oxygen and carbon isotope studies of carbonate sediments from Site 167, Magellan Rise, Leg 17: U.S.; Initial Rept. Deep Sea Drilling Project 17, p. 505-509.

264. Corbel, J. (1959) - Erosion en terrain calcaire: Ann. Geogr. 366, p. 97-120.

265. Corbel, J. (1959) - Vitesse de l'erosion: Z. Geomorphol. p. 1-28.

266. Costantinescu, T. - Geomorphological and Speleological Remarks on the Northern Part of the Piatra Craiului Massif, Trav. Inst. Speol. "Emil Racovita," Bucharest, Tome XII, p.279-302, Bucharest, 1973, 18 figs., and 2 tables (in French).

After a brief geomorphological characterization, 29 small caves situated on the north-western and northern slopes are presented. It is pointed out that the morphological structure did not encourage the formation of large caves. Due to stratification, the position of strata, and marked inclination of the slopes, the waters infiltrated into the mass of limestone and reemerged to the surface after a short underground route.

267. Courbon, P.; and Chabert, C. (1975) - Les grandes cavites mondiales: Spelunca 4, p. 5-8.

268. Courel, L.; Seddoh, K.; and Zoungrana, G. (1977) - Evolution du socle antemesozoique: Place de la carbonatation et des mineralisations siliceuses fluorees et baritees: Cas du Charallais et de Bromais (Massif central francais): Bull. BRGM Sect. II 4, p. 259-264.

269. Cox, F.C. (1978) - An industrial classification of limestone for use in reserve and resource investigation: Abstracts, Tenth Inter. Congr. Sed., Vol. 1, p. 135-136.

270. Cox, F.C.; and Bridge, D.McC. (1977) - The limestone and dolomite resources of the country around Monyash, Derbyshire: Description of 1:25,000 resource sheet SK 16: Institute Geol. Sci., Mineral Assessment Report, No. 26, 137 p., 13 figs., 9 pls., 1:25,000 geol. map.

This report on the Carboniferous limestone of this area of Derbyshire is based on specially collected samples from 23 cored boreholes and 15 major exposures as well as earlier records. The limestones are classified on the basis of their $CaCO_3$ content and the accompanying map shows the distribution of the recognized categories of limestone. The results of

investigations of chemical and mechanical properties are presented, with outline borehole logs and statistical analysis of the data.

271. Craciun, V. (1973) - Granulometric Analyses of the Accretions in Several Caves of the Iad Valley Basin, Trav. Inst. Speol. "Emil Racovita," Bucharest, 12: 349-355, figs., 1-2 (in French). (1975), Granulometric Analyses of the Accretions in Caves in the Iad Valley Basin, Proceedings of the 6th International Congress of Speology, Olomouc, 1: 393-399, one figure (in German).

A brief description is presented of sedimentation conditions and the interpretation of the results of the granulometric analysis of the accretions in four caves in the Iad Valley karst (the Padurea Craiului Mountains).

272. Craciun, V. (1973) - Several Considerations on the Accretions in the caves of the Apuseni Mountains, Livre du cinquantenaire de l'Institut de Speleologie "Emil Racovita," the Publishing House of the Academy of the Socialist Republic of Romania, Bucharest: 643-646, figs. 1-2 (in French).

Granulometric characteristics of accretions in seven caves situated in the Padurea Craiului, Bihor and Rodna Mountains are compared.

273. Craciun, V. (1984) - Phenomena of Endokarstic Condensation in the Eocene Limestone of the Manastireni-Bica Area (Cluj), Theoretical and Applied Karstology, Bucharest, 1: 139-145, one figure (in French).

This is a presentation of the morphological, lithological and structural characteristics of an island of Eocene limestone and the particular features of a karstic spring at its edge, whose source of supply may be endokarstic condensation to a large extent.

274. Craciun, V.; Racovita, G. (1975) - The Pojarul Politei Cave, the Sport-Turism Publishing House, Bucharest, 108 pages and 71 photographs (in Romanian with French and German versions).

This is an album including images from a cave that is a natural monument due to its rich and diversified calcitic crystalizations. Brief reference to the genetic affiliation of the cave to the Scarisoara karstic system (the Bihor Mountains) and a general description of the cavity and of the main types of concretions are made. Emphasis is placed on the need to preserve this important karstic feature.

275. Craig, H. (1953) - The geochemistry of stable carbon isotopes: Oxford; Geochim. Cosmochim. Acta 3, p. 53-92.

276. Crnicki, J. (1978) - Structure controlled bauxite deposits of Dalmatia (Yugoslavia) in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 114-128, 3 figs.

277. Cronan, D.S. (1980) - Underwater minerals: U.K., London; Academic Press, 362 p.

278. Curl, R.L. (1972) - Minimum diameter stalactites: Natl. Spele. Soc. Bull. 34, p. 129-136.

279. Curl, R.L. (1973) - Minimum diameter stalagmites: Natl. Spele. Soc. Bull. 35, p. 1-9.

280. Cussey, R.; Grosdidier, E.; Sulpice, L.; and Umbach, P. (1977) - Un exemple de sedimentation carbonatee de plate-forme: Le sommet du Jurassique moyen du Bassin de Paris in Elf-Aquitaine: Essai de caracterisation sedimentologique des depots carbonates 2, Elements de'interpretation, p. 180-194, figs. 45-51.

281. Cvijic, J. (1893) - Das Karstphaenomen: Geogr. Abh. p. 215-319.

282. Cvijic, J. (1918) - Hydrographie souterraine et evolution morphologique de karst: Rec. Trav. Inst. Geogr. Alpine 6, p. 376-420.

283. Cvijic, J. (1960) - La geographie des terrains calcaires: Acad. Serbe Sci. Arts, Monographies CCCXLI, Beograd.

284. Dandurand, J.L.; Gout, R.; Hoefs, J.; Menschel, G.; Schott, J.; and Usdowski, E. (1982) - Kinetically controlled variations of major components and carbon isotopes in a calcite-precipitating spring: Chem. Geol., Vol. 36, p. 299-315.

285. Dannr, W.R. (1976) - Limestone resources of southwestern British Columbia in 11th Industrial Minerals Forum, Special Publication Montana Bureau Mines Geology, Vol. 74, p. 171-186, 16 figs.

> The largest deposits of limestone in southwestern British Columbia are of Pennsylvanian, Permian, and Late Triassic age. These deposits occur in four, distinct, geological provinces and are thought to have originated in the Pacific Ocean as island arcs or ridges, which moved eastward to become part of the North American continent in mid-Mesozoic time.

286. Davies, D.K. (1968) - Carbonate turbidities, Gulf of Mexico: U.S.; Journ. Sed. Petrol. 38, p. 1100-1109.

287. Davies, G.R. (1970) - Algal laminated sediments, Gladstone Embayment, Shark Bay, Western Australia in Logan, B.W., Davies, G.R., Read, J.F., Cebulski, D.E., editors, Carbonate Sedimentation and Environments, Shark Bay, Western Australia: U.S.; Amer. Asso. Petrol. Geol. Mem. 13, p. 169-205.

288. Davies, G.R. (1979) - Dolomite reservoir rocks: Processes, controls, porosity development in Moore, C., editor, Geology of Carbonate Porosity: U.S.; Amer. Asso. Petrol. Geol. Short Course, p. C1-C17.

289. Davies, G.R.; and Krouse, H.R. (1975) - Carbon and oxygen isotopic composition of late Paleozoic calcitic cements: Canadian arctic archipelago - preliminary results and interpretations: Ottawa; Geol. Survey Canada Paper 75, 1B, p. 215-220.

290. Davies, W.E. (1966) - The earth sciences and speleology: U.S.; National Spele. Soc. Bull. 28, p. 1-14.

291. Davies, W.E.; and Chao, C.C.T. (1959) - Report on sediments in Mammoth Cave, Kentucky: U.S.; U.S. Geol. Survey.

292. Davis, A.O.; and Galloway, N.J. (1981) - Atmospheric lead and zinc deposition into lakes of the Eastern United States in Eisenreich, S.J., editors, Atmospheric pollutants in natural waters: United States; Ann Arbor Science, p.401-408.

293. De Camargo, W.G.R. (1978) - The determination of iron and manganese content of diaspore by x-ray diffraction powder photographs (abstract) in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 129-130.

> It is suggested that diaspore, goethite, and groutite may form an isomorphous series.

294. de Freitas, M.H.; and Wolmarans, J.F. (1984) - Dewatering and settlement in the bank compartment of the Far West Rand, South Africa in Water in Mining and Underground Works (El Agua en la Mineria y Trabajos, Subterraneos), Vol. I, p. 619-635.

> The common form of settlement that accompanied the dewatering of karstic dolomites above the mines in the Bank Compartment is illustrated. Detailed surveys of settlement and water levels have been used to study the time dependency of settlement, illustrations of which are provided. A test embankment, built to load an area where settlement had ceased, produced no further settlement. It is concluded that settlement time curves, when used with a knowledge of basic subsurface conditions, provide a reliable basis from which to assess present day surface stability. Ground above faults and sinkholes requires special assessment.

295. De Voto, R.H. (1983) - Central Colorado karst-controlled lead-zinc-silver deposits (Leadville, Gilman, Aspen, and others), a late Paleozoic Mississippi Valley-type district in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 459-485.

> The Pb-Zn-Ag deposits within the Lower and Middle Paleozoic strata of central Colorado (Leadville, Gilam, Aspen, and others) occur principally in Late Mississippian karst-solution features within dolomites and, to a lesser extent, limestones. Field relationships, mineral assemblages and paragenesis, fluid-inclusion data, and isotope studies suggest that the metals and brines were derived within the Pennsylvanian sedimentary sequence and that the ore minerals were deposited under different temperature conditions and at different depths from deposit to deposit.

296. Dean, W.E. (1981) - Carbonate mineral and organic matter in sediments of modern north temperate hard-water lakes: U.S.; Soc. Econ. Paleon. and Mineralogists, Special Publ. 31, p. 213-231.

297. Deb, M.; Joshi, A.; and Deshmukh, M.G. (1978) - Some observations on the mineralogy, geochemistry and genesis of bauxite deposits on khondalites, Eastern Ghet region, India in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 1008-1033, 17 figs.

298. DeBoer, R.B. (1977) - On the thermodynamics of pressure-solution: Interaction between chemical and mechanical forces: U.K., Oxford; Geochim. Cosmochim. Acta 41, p. 249-256.

299. Degens, E.T.; and Epstein, S. (1964) - Oxygen and carbon isotope ratios in coexisting calcites and dolomites from recent and ancient sediments: Oxford; Geochim. Cosmochim. Acta 28,p. 23-44.

300. Dehm, R.M.; Klemm, D.D.; Mueller, C.; Wagner, J.; and Weber-Diefenbach, K. (1983) - Exploration for antimony deposits in southern Tuscany, Italy: Mineral Deposita 18, p. 423-434.

301. Deike, G.H. (1967) - The development of caverns of the Mammoth Cave region: U.S.; Pennsylvania State University, Thesis.

302. Delfaud, J.; and Gauthier, J. (1968) - Contribution a la connaissance de l'environment de deposits carbonates de plate-forme: Caracteres geochimiques et sedimentologiques du Jurassique Nord-Aquitain: Pau; Bull. Centre. Rech. Pau, SNPA 2:2, p. 347-383, 2 pls., 8 tbls., 7 figs.

303. Delgado, F.; Estevez, A.; Martin, J.M.; and Martin-Algarra, A. (1981) - Observaciones sobre la estratigrafia de la formacion carbonatada de los Mantos Alpujarrides (Cordilleras Beticas): Estudios Geologicos 37, p. 45-47.

304. Demangeot, J. (1968) - Sur une courbe de dissolution des calcaires en montagne mediterraneenne: CNRS, Mem. Doc. 4, p. 185-193.

305. Demovic, R. (1974) - Geochemie der mittel- und obertriassischen Kalke des slowakischen Karstes, der Krizna- und der Choc-Decke: Bratislava; Geol. Zbornik Slov. Akad. Vied. 25:2, p. 335-354.

306. Dennen, W.H.; and Norton, H.A. (1977) - Geology and geochemistry of bauxite deposits in the lower Amazon basin: U.S.; Econ. Geology, Vol. 72, p. 82-89.

307. Deurer, R.; Forstner, U. and Schmoll, G. (1978) - Selective chemical extraction of carbonate-associated trace metals in recent lacustrine sediments: United States; Geochem. Cosmochim. Acta, New York, Vol. 42, p.425-427.

308. Diaconu, G. (1974) - Considerations on the Presence of Anhydride in the Diana Cave, Baile Herculane, Romania, Travaux de l'Institut de Speologie "Emile Racovitza," 13, p. 191-194 (in French).

> By means of infrared analysis, calcium sulfate in the form of both gypsum and anhydride is identified in Diana Cave, Baile Herculane, Romania.

309. Diaconu, G. (1976) - Considerations on the Genesis of Calcitic Mondmilch in Caves, Travaux de l'Institut de Speologie "Emile Racovitza," 15, p. 227-230 (in French).

> Discussing the genesis of mondmilch, the author distinguishes two main types: primary mondmilch, formed directly by the generating solution, and secondary mondmilch, formed by former concretionary crusts or even by the supporting rock, i.e. limestone.

310. Diaconu, G. (1978) - Closani Cave. Genesis and Evolution, Travaux de l'Institut de Speologie "Emile Racovitza," 18, p. 185-191 (in French).

> An interpretation of the genesis and evolution of the cave from Closani is made after complex observations of karstic morphology, hydrography, geology and tectonics.

311. Diaconu, G. (1979) - A classification of Speleothems, Travaux de l'Institut de Speologie "Emile Racovitza," 18, p. 215-218 (in French).

> A classification of speleothems according to a single criterion, their morphology, is given.

312. Diaconu, G. (1980) - Closani Cave. Remarks on the Current Chemism of Infiltration Waters. Its Relationship with local Thermal Values in the Endokarstic Cavity, Travaux de l'Institut de Speologie "Emile Racovitza," 19, p. 219-225 (in French).

> A number of conclusions are proposed concerning the current chemistry of infiltration waters in the passages of Closani Cave from Mehedinti Mountains. Vaterite was identified in the clay of several water influxes.

313. Diaconu, G. (1983) - On the Gypsum-Aragonite Mineralogical Paragenesis in Several Caves from Romania, Travaux de l'Institut de Speologie "Emile Racovitza," 22, p. 81-90 (in French).

The author's viewpoint is presented on the gypsum-aragonite mineralogical paragenesis in several vaces from Romania, with emphasis on the role played by Hydronium (H_3O^+) ions in the genesis of aragonite.

314. Diaconu, G. (1984) - Considerations on the Genesis of the Clays on the Limestones of "Closani Area," Mehedinti Mountains, Theoretical and Applied Karstology, 1, p. 13-22 (in French).

Relying upon chemical and spectral analyses, the hypothesis is proposed that the clays on limestone in the Closani Area are allochthonous. Assessments are made of the role of the "piezoelectric field" in clay fixation on limestone.

315. Diaconu, G. (1984) - Graphic Assessments on the Coordination Polyhedron of the Crystalline Structure of Aragonite, Travaux de l'Institut de Speologie "Emile Racovitza," 23, p. 57-65 (in French).

In his note, the author starts from the values of the x, y and z coordinates of the elements Ca, C and O and makes a graphic representation of the elementary cell of aragonite and the coordination polyhedron CaO_9.

316. Diaconu, G. (1985) - A Graphic Representation of the Elementary Cell of Calcite and of the Coordination Octahedron, Travaux de l'Institut de Speologie, "Emile Racovitza," (in print), (in French).

The authors presents a graphic representation in elevation, profile, plane and space of the elementary cell of calcite. Furthermore, an image is proposed of the coordination octahedron of calcium and oxygen.

317. Diaconu, G. (1985) - The List of Minerals that Form Speleothems, Theoretical and Applied Karstology, 2 (in print), (in French).

The author offers a list of minerals described in natural caves grouped in classes and sub-classes according to their chemical composition. To the list is added a selective bibliography, each mineral being assigned a number (or several numbers) that refers it to pertinent work (or works).

318. Diaconu, G.; Hann, H. P. (1974) - Remarks on Conic Stalactites in the Muierilor Cave, Baia de Fier, Livre du Cinquantenaire de l'Institut de Speologie "Emile Racovitza," Editura Academiei RSR, p. 621-632 (in French).

The structure and the mineralogical composition of several stalactites sampled from Muierilor cave are described. A hypothesis is put forth concerning the genesis of aragonite crystals identified in the channel of stalactites.

319. Diaconu, G.; Medesan, Al. (1973) - On the Presence of Pickeringite in Diana Cave (Baile Herculane, Romania), Travaux de l'Institut de Speologie "Emile Racovitza," 12, p. 303-309 (in French).

By means of X-ray, infrared, differential thermal and chemical analyses pickeringite, a mineral in the hallotrichite-pickeringite series, is detected in a natural cavity for the first time.

320. Diaconu, G.; Medesan, Al. (1975) - Dahllite Speleothems in the Muierilor Cave, Baia de Fier, Romania, Travaux de l'Institut de Speologie "Emile Racovitza," 14, p. 148-156 (in French).

Dahllite, a mineral responsible for the numerous morphologically different speleothems in the Muierilor Cave, Baia de Fier, is identified by means of X-Ray, infrared, differential thermal and chemical analyses.

321. Diaconu, G.; Medesan, Al.; Viehmann, I. (1977) - A New Mineralogical Paragenesis in Fagului Cave, Bihor County (Huntite, Aragonite, Calcite, Travaux de l'Institut de Speologie "Emile Racovitza," 16, p. 203-210 (in French).

A mondmilch sample taken from Fagului Cave, Bihor County, proved to be an interesting mineralogical association of huntite, hydromagnesite, aragonite and calcite determined by means of X-ray and infrared analyses.

322. Diacony, V.; Bulgar, Al.; Oancea, V. (1984) - The use of transfer function in establishing the water circulation characteristics in the karst, Theoretical and Applied Karstology, 1, p. 223-230.

The interpretation of the response of a karst system to an instantaneous tracer release (fluorescein or potassium dichromate) in terms of the transfer function is determined as the Fourier transform of the output tracer concentration variation. This allows the use of the data resulting from tracing operations in determining the attenuation factor and the time lag for transmission of the discharge variation between the input and output points.

323. Dickson, J.A.D.; and Coleman, M.L. (1980) - Changes in carbon and oxygen isotope composition during limestone genesis: Oxford; Sed. 27, p. 107-118, 5 figs.

324. Dietrich, J.E.; and Pinet, M. (1978) - Nouvelles precisions sur les nodules nickeliferes du gisement de Blanquette W pres le Thoronet (Var.) in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 131-143, 5 figs.

The nickeliferous nodules typically consist of three concentric zones: a core of bauxite with boehmite and diaspore is succeeded by a series of concentric layers more or less rich in niccolite (NiAs) and a rim of bauxite with chalcopyrite, sphalerite, and secondary niccolite.

325. Djokic, V.; Kalezic, M.; and Voros, I. (1978) - New aspects of bauxite geology in Montenegro, Yugoslavia in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 144-163, 5 figs.

326. Doebl, F.; Mowahed-Awal, H.; Rothe, P.; Sonne, V.; Tobien, H., Weiler, H.; and Weiler, W. (1972) - Ein "Aquitain" Profil von Mainz-Weisenau (Tertiaer, Mainzer Becken), Mikrofaunistische, sedimentpetrographische und geochemische Untersuchungen zu seiner Gliederung: Germany, F.R.; Geol. Jb. A 5, 141 p.

This is a report on a Late Tertiary limestone-marl sequence.

327. Donath, F.A.; Carozzi, A.V.; Fruth, L.S.; and Rich, D.W. (1980) - Oomoldic porosity experimentally developed in Mississippian oolitic limestones: U.S.; Journ. Sed. Petrol. 50:4, p. 1249-1260, 7 figs.

328. Donavan, R.N. (1975) - Devonian lacustrine limestones at the margin of the Orcadian Basin, Scotland: London; Journ. Geol. Soc. London 131,p. 489-510.

329. Done, A. (1984) - The cave in the Cuciulat Quarry. Buletinul CSER, Bucharest, 8, p. 82-92, 2 maps, 3 pages with photos (In Romanian).

A historical survey of exploration and the description of a 1,707 m cavity which contains the first paleolithic paintings discovered in Romania.

330. Dorhofer, S. (1974) - Mikrofazielle Untersuchunger der Kalksteine des Mundener Mergels von Thuste: West Germany; Unveroeff. Diplomarb. TU Hannover, 40 p.

> Upper Jurassic, Westphalia. Differentiation of microfacies types with factor and cluster analyses (use of distance and correlation coefficients produces similar results). Comparison of groupings based on sedimentary and diagenetic criteria with a method analysis that disregards diagenetic criteria produces a clearer separation into facies units, hence, a clearer interpretation.

331. Doyen, L. (1976) - The manganese ore deposit of Kisenge-Kamata (western Katanga): Mineralogical and sedimentological aspects of the primary ore in Amstutz, G.C., and Bernard, A.J., editors, Ores in Sediments: Germany, F.R., Heidelberg, Springer-Verlag, International Union of Geological Sciences Series A, No. 3, p. 93-100.

> Criteria are offered for a sedimentary origin of the manganese deposit of Kisenge-Kamata. It is of Precambrian age and has undergone a mesozonal metamorphism. The primary ore belongs to two types, a silicate type and a carbonate type, both of which always contain graphitized carbon. The carbonate ore frequently contains stromatolitic structures.

332. Draganescu, A. (1976) - Lower Cretaceous carbonate and carbonate-evaporite-sedimentation in the East-Wallachian Sector of the Moesian Platform (Eastern Romania Plain): Romania; An. Inst. Geol. Geofiz. Vol. 48, p. 5-56.

> Upper Tithonian/Lower Berriasian to the Valanginian. Micritic limestones of the inner shelf. Carbonate-evaporite sequence in tidal zones. Good photographs of thin-sections, particularly of Favreina limestones and pelsparites.

333. Drake, J.J. (1983) - The effects of geomorphology and seasonality on the chemistry of carbonate groundwater: U.S.; Journ. Hydrology 61, p. 223-236.

334. Drake, J.J.; and Wigley, T.M.L. (1975) - The effect of climate on the chemistry of carbonate groundwater: U.S.; Water Resources Res. 11, p. 958-962.

335. Drittenbass, W. (1979) - Sedimentologie und Geochemie von Eisen-Mangan-fuhrenden Knollen und Krusten im Jura der Trento-Zone (ostliche Sudalpen, Norditalien): Eclogae geol. Helvet. 72:2, p. 313-345, 10 figs.

336. Drogue, C.; Daoxiam, Y.; Bidaux, P.; and Zhou, S.Y. (1986) - Structural conditions of the carbonate aquifers in southern China (Guangxi Province, Guilin area): Comptes Rendus de l'Academie des Sciences (Series 2), Vol.302, No.15, p. 975-978.

> The Devonian-Carboniferous limestones and dolomites of the Guangxi area constitute karstic aquifers whose fissural structure originates from three tectonic episodes of the Mesozoic and Cenozoic Ages. The fracture trends which have a probable hydrogeologic role are also identifiable by ERTS. The aquifers are of interest as a potential resource, as well as from the point of view of their origins and hydraulic characteristics.

337. Dubois, P. (1961) - Les circulations souterraines dans les calcaires de la region de Montpellier: Bull. Bur. Rech. Geol. Min., 31.

338. Dubois, P. (1964) - Les circulations souterraines dans les karsts barres de Bas-Languedoc: 3eme Congr. Inter. Spele. 1961, H.2, p. 167-174.

339. Duhovnik, J. (1967) - Facts speaking for and against a syngenetic origin of the stratiform deposits of lead and zinc in Brown, J.S., editor, Genesis of Stratiform Lead-Zinc-Barite-Fluorite Deposits in Carbonate Rocks: U.S.; Economic Geology, p. 108-125.

340. Dunham, K. (1983) - Ore genesis in the English Pennines: A fluoritic subtype in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 86-112.

> A case is made for recognizing as a fluoritic subtype of the Mississippi Valley genus the Illinois-Kentucky, Central Kentucky, Sweetwater and Pennine fields. Unlike the great Pb-Zn producers, all these have major fluorite and are fracture-controlled, and several reveal hot spots, possibly related to deep crustal igneous activity.

341. Dzulynski, S. (1976) - Hydrothermal karst and Zn-Pb sulfide ores: Soc. Geol. Pologne Annales 46, p. 217-230 [English summary].

342. Early, Ch.F.; and Goodell, H.G. (1968) - The sediments of Card Sound, Florida: U.S.; Journal of Sedimentary Petrology, 38:4, p. 985-999.

> The size of carbonate particles decreases towards the sea, but increases near small coral reefs located parallel to the shoreline. Very few carbonates in the inner bay area, but much quartz sand with a wide spectrum of sorting.

343. Ede, D.P. (1975) - Limestone drainage systems: The Netherlands, Amsterdam; Elsevier Scientific, Journ. Hydrology, Vol. 27, p. 297-318.

> This paper describes the form of a number of limestone drainage systems on the Gower Peninsula, South Wales. The effect of system morphology on seasonal variation in flow pattern and solute load at spring sites is examined and the systems ordered according to the degree of development of the conduit flow component and the integration of percolation inputs.

344. Edmunds, W.M.; Owen, M.; and Tate, T.K. (1976) - Estimation of induced recharge of river water into chalk boreholes at Taplow using hydraulic analysis, geophysical logging, and geochemical methods: U.K.; National Environmental Resources Council, Institute of Geological Sciences Report 76/5, 38 p.

> The authors discuss and compare three different techniques used to identify the component of induced recharge entering chalk boreholes from the River Thames.

345. Egemeier, S.J. (1981) - Cavern development by thermal waters: U.S.; NSS Bull., 43:2, p. 31-51.

> Caves containing flowing thermal springs, although rare, are geologically important for a number of reasons. First, the solutional processes now forming thermal spring caves may have played a role in the development of many caves that no longer contain flowing springs. Second, the study of depositional processes in thermal spring caves may provide information on the formation of some ore bodies.

346. Ekdale, A.A.; Ekdale, S.E.; and Wilson; J.L. (1976) - Numerical analysis of carbonate microfacies in the Cupido Limestone (Neocomian-Aptian), Coahuila, Mexico: U.S., Journ. Sedimentary Petrology, 46:2, p. 362-368.

> Samples, evaluated on the basis of 16 thin-section criteria, were subjected to a cluster analysis, where only the presence or absence of criteria were noted. The Q-

mode leads to a differentiation of 15 groups (microfacies). A comparison of sample similarity based on the ordination method indicated the possible original relationships between the MF types.

347. El Aref, M.M. (1984) - Strata-bound and stratiform iron sulfides, sulfur, and galena in the Miocene evaporites, Ranga, Red Sea, Egypt (with special emphasis on their diagenetic crystallization rhythmites) in Wauschkuhn, A., Kluth, C., and Zimmermann, R.A., editors, Syngenesis and Epigenesis in the Formation of Mineral Deposits: Germany, F.R., Heidelberg; Springer-Verlag, p. 458-467.

> The sulfides and sulfur minerals of the Ranga occurrences form three geometric types: (a) stratabound rhythmic type of pyrite/marcasite associated with cryptalgal calcite, barite, and quartz; (b) stratiform to strata-bound rhythmic type of sulfur associated with anhydrite, calcite, and bitumen; and (c) strata-bound authigenic galena growing in karst cement. The systematic investigations lead to conclude that the iron sulfides and sulfur of the rhythmic types are of syndiagenetic origin, deposited with their gangue associations by generations of fractional crystallization in shallow marine environments.

348. El-Naggar, Z.R.; Al-Rifaiy, I.A. (1973) - Stratigraphy and microfacies of the type Maggwa formation of Kuweit, Arabia, Part 2, Mishrif Limestone Member: U.S.; Amer. Asso. Petrol. Geol. Bull. 57:11, p. 2263-2279.

349. Elf-Aquitaine (1975) - Essai de caracterisation sedimentologique des depots carbonates (An attempt at sedimentological characterisation of carbonate deposits) 1.Elements d'analyse (Analytic elements): France; Boussens-Pau: Elf-Aquitaine, 231 p.

> This very well illustrated book, which was originally the working basis for French petroleum geologists, provides a quick introduction into the distinguishing features of carbonate rocks in thin-sections, the possibilities for classification as well as a few characteristics of fabrics.

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351. Ellenor, D.W. (1975) - Sedimentology of the Middle Devonian Timor Limestone, Northeastern New South Wales, Australia: The Netherlands; Sed. Geol., Vol. 13, p. 125-152.

> 14 profiles with a sample interval 1.5 m were taken. 697 thin-sections were analyzed for 13 MF criteria per thin-section and subjected to point-counting analyses. 5 facies types and several subtypes were differentiated by cluster analysis.

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353. Emrich, K.; Ehhalt, D.H.; and Vogel, J.C. (1970) - Carbon isotope fractionation during the precipitation of calcium carbonate: Earth Planet. Sci. Letter 8, p. 363-371.

354. Enos, P. (1977) - Tamabra limestone of the Poza Rica Trend, Cretaceous, Mexico: U.S.; Soc. Econ. Paleont. Min. Spec. Publ. 25, p. 273-314.

355. Epstein, S.; Buchsbaum, R.; Lowenstam, H.; and Urey, H.C. (1953) - Revised carbonate-water isotopic temperature scale: U.S.; Bull. Geol. Soc. Amer. 64, p. 1315-1325.

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> The only known concentration of carbonate complexes in North America is in northern Ontario and western Quebec, in a petrographic province here named the Ontario Carbonate Province. The complex contains a unique, very high grade residual phosphate deposit associated with a well-developed karst topography now buried under glacial lake clays. During karst development, carbonates were dissolved from the carbonatite, and residual minerals, mainly apatite, were concentrated in sink holes and troughs. Sorting and reworking of apatite-rich residuum by surface and subsurface water formed concentrations of nearly pure apatite sand, locally several tens of meters thick.

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> Geochemical studies of subsurface Cambrian strata in the Rolla 1° x 2° quadrangle, Missouri, completed in 1980, and current geochemical studies in the Springfield 1° x 2° quadrangle, Missouri, indicate that insoluble residues are a useful and informative geochemical sample medium in a carbonate environment.

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360. Evans, I.; and Kendall, C.G.St. (1977) - An interpretation of the depositional setting of some deep-water Jurassic carbonates of the Central High Atlas Mountains, Morocco: U.S.; Soc. Econ. Paleont. Min. Spec. Publ. 25, p. 249-261, 15 figs.

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> The author's purpose is to demonstrate that the karst system is an available one and to argue that the petrographic subsystem inside such a karst system plays an important part in the evolution of the latter. We consider that the state of stress and strain of the limestone, especially the strike of the tension joints, determines the development of the cave. Caves from Rodna Mountains and from Apuseni Mountains are cited as examples.

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> A presentation is made of the two types of limestone balls discovered in the Tausoare Cave endokarst: free balls, lying on the cave floor at a depth of 200 m, and balls inlaid in the limestone wall of the cave. The authors conclude that the balls were formed through a process of paleokarstic alteration.

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> A natural Nd-rich hydroxyl-bastnaesite sample from Zagrad (Yugoslavia) was investigated by electron microprobe and X-ray powder diffraction methods. Its

chemical composition is roughly $(Nd,La,Pr)(F,OH)CO_3$. Results of the analyses are listed and compared to earlier data. The reported hexagonal symmetry was confirmed, and reliable cell parameters were calculated from the measured data.

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Upper Jurassic carbonates from shallow water, sills, and basins. 365 samples, 15 criteria; point counting method; cluster analysis (R-Mode) and factor analysis accentuate variable interrelationships and thus permit a better rating of the criteria as facies indicators.

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369. Fenninger, A.; and Holzer, H.L. (1972) - Fazies und Palaeogeographie des ober-ostalpinen Malm: Austria; Mitt. Geol. Ges. Wien 63, p.52-141.

Summary of the studies of the Upper Jurassic facies of the Upper Austro-Alpine unit, with a detailed investigation of microfacies. Deals with all the essential sequences developing in shallow water (e.g., Plassen limestones), on sills (e.g., Steinmuehl limestones), and in basins (e.g., Oberalm beds) as well as sediments from the transitional environments between these depositional areas.

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Hydrogeological investigations carried out along the Dobrogean slope of the Danube led to the statement that two important lines of thermomineral springs with temperatures ranging from 20-26 degrees and 35-50 degrees Celcius are widespread between the Capidava and Vadu Oil localities. Due to the study of their chemical composition, thermal characters and geological conditions, the conclusion was reached that these waters are conditioned by the presence of Jurassic limestones which facilitated the rapid ascension along the vertical line of some hyperthermal waters proceeding from depth, and whose thermal characters could be assigned to the existence in the basement of a region comprising some recent magmatic masses.

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375. Fluegel, E. (1974) - Fazies-Interpretation der Cladocoropsis-Kalke (Malm) auf Karaburun, W-Anatolien: Leoben; Archiv Lagerstaettenforschung in den Ostalpen, Sonderband 2,p. 79-94, 4 pls.

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380. Fluegel, H.W.; and Polsler, P. (1965) - Lithogenetische Analyse der Barmstein-Kalkbank B_2 nordwestlich von St. Koloman bei Hallein (Tithonium, Salzburg): Germany, F.R.; N. Jb. Geol. Palaont., 1965:9, p. 513-527.

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381. Fluegel, H.W.; and Wedepohl, K.H. (1967) - Die Verteilung des Strontiums in oberjurassischen Karbonatgesteinen der Noerdlichen Kalkalpen, Ein Beitrag zur Diagenese von Karbonatgesteinen: Heidelberg; Contr. Min. Petrol. 14, p. 229-249, 6 figs., 7 pls.

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383. Foglierini, F.; Bernard, A.; and Verraes, G. (1980) - Le gisement des Malines (Gard): 26th Inter. Geol. Congress, Paris, Gisements Francais E-4, 55 p.

384. Fold, R.L. (1974) - The natural history of crystalline calcium carbonate: Effect of magnesium content and salinity: U.S.; Journ. Sed. Petrol. 44:1, p. 40-53, 9 figs.

385. Folk, R.L. (1962) - Sorting in some carbonate beaches of Mexico: U.S.; Transactions of the New York Academy of Sci., 25:2, p. 222-224.

The diagram "sorting:mean grain size" produces in terrigenous (siliceous) and calcareous sediments a sinusoidal distribution, which in calcareous sediments

is dependent on the strength of the breakers and on the various degrees of disintegration of organic shells. The latter influences the mean grain size. Surface samples exhibit a standard deviation <0.70; underwater samples a standard deviation >0.90.

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> Investigations of the distribution, composition, grain sizes and grain shapes of a Recent carbonate sand coast. 60% of the coastal sediments of Isla Perez are composed of the remains of Halimeda; 25% of coral fragments; 15% of foraminifera, etc. Six sedimentary populations classified according to origin, grain size, and grain shape as well as topographical position, are present.

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> Geochemical analyses and microscopic observations of sphalerite rhythmites of the Trzebionka mine, in the strata-bound Pb-Zn district of Upper Silesia-Cracow, show that they are very similar to diagenetic crystallization rhythmites of other strata-bound deposits in shallow water carbonate facies. The presence of this type of texture can therefore not be used as an argument for an epigenetic origin of this district; rather, some sort of normal diagenetic evolution must have produced these textures, reflecting a clear diagenetic crystallization differentiation.

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> The process of differentiation by fractional crystallization during diagenesis is exceptionally well recognized in diagenetic crystallization rhythmites (abbreviated as DCRs). DCRs are common textures in certain shallow lithofacies, and specifically in Mississippi Valley type ore deposits. A brief summary of the main characteristics of DCRs based on examples of different ore districts is presented.

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Certain ore occurrences in carbonate rocks have recently been described by different authors. All examples show evidence of fluids migrating through the sediments at different stages of diagenesis, these fluids playing an important role in the formation of ore deposits.

421. Fuchs, Y.; and Touahri, B. (1982) - Dolomitization and ore forming processes at El Abed (Algeria): 11th Inter. Congr. Sedimentology, Hamilton, Ontario, Canada.

422. Fuller, A.O.(1979) - Phosphate occurrences on the western and southern coastal areas and continental shelves of Southern Africa: U.S.; Economic Geology, Vol. 74, p. 221-231.

Several different varieties of sedimentary phosphatic deposits occur in the region. The deposits are of the platform type. No tectonic control of mineralization has been identified, but local topographic features have influenced the distribution of ores. Several modes of origin, including direct precipitation, replacement, diagenesis, allochemical and lithochemical, have been identified.

423. Galasi, G. (1979) - The morphology of Cimpeneasca Cave (Codru Moma Mountains), Nymphaea, 7, p 265-272, 3 figures, 1 plate, in Romanian with French abstract.

The disposition of the cave along the main fractures systems, as well as its evolution for a phreatic to a vadose morphology are examined.

424. Galle, O.K. (1969) - Chemical analysis of some standard carbonate rocks: Amsterdam; Chem. Geol. 5, p. 143-146.

425. Galloway, J.N.; Eisenreich, S.J.; and Scott, B.C. (1980) - Toxic substances in atmospheric deposition: A review and assessment: National Atmospheric Deposition Program, Report NC 141.

426. Galloway, J.N.; Thornton, J.D.; Norton, S.A.; Volchok, H.L.; McLean, R.A.N. (1982) - Trace metals in atmospheric deposition: a review and assessment: Atmos. Environ., Vol. 16, p.1677-1700.

427. Gams, J. (1965) - Types of accelerated karst corrosion: Probl. Spele. Res., Proc. Inter. Spele. Conf. Brno, 1964, p. 133-139.

428. Gams, J. (1973) - Die zweiphasige quaertarzeitliche Flaechenbildung in den Poljen und Blindtalern des nordwestlichen dinarischen Karstes in Ergebnisse der Karstforschung in den Tropen und im Mittelmeerraum: Geogr. Z., Beih. Wiesbaden: Franz Steiner 1973, p. 143-149.

429. Gardner, L.R. (1980) - Mobilization of Al and Ti during weathering-isovolumetric geochemical evidence: Chem. Geol., Vol. 30, p. 151-165.

430. Garrison, R.E. (1967) - Pelagic limestones of the Oberalm Beds (Upper Jurassic -Lower Cretaceous), Austrian Alps: Calgary; Bull. Canadian Petrol. Geol. 15:1, p. 21-49, 8 figs.

431. Garrison, R.E.; and Kennedy, W.J. (1977) - Origin of solution seams and flaser structure in Upper Cretaceous chalks of southern England: The Netherlands, Amsterdam; Sed. Geol. 19:2, p. 107-138, 16 figs.

432. Gaspar, E. (1972) - A quantitative method of hydrological investigation of Karst, Hidrotehnica, 17, 6, 319-327, (In Romanian).

> Complex studies were conducted with the help of radioactive and fluorescent dye tracers to assess the characteristics of underground flow in karstic areas. Five types of karstic networks are analyzed. The methodology provides for an estimation of flow characteristics (laminar or turbulent flow), the existence of stagnant underground water zones, of ranches and underground affluents and defluents on the basis of a quantitative analysis of the meterological data supplied by field experiments.

433. Gaspar, E. (1973) - Method with radioactive tracers and experiments in hydrokarstic structures, Report CSEN-IFA-MR-39, p.25.

> A methodological study of which pinpoints the potentials and limitations of radioactive tracers in karst investigations. Counting frames are supplied to help compute the amount of tracer than can be used in keeping with the sensitivity of the detection devices. The hydrodynamic parameters of the karst, for five types of karstic networks, are determined on the basis of the input and output functions obtained with the help of artificial tracers. Four case studies are reported.

434. Gaspar, E. (1980) - A radiometric projection of radioactive tracer-based investigations in hydrokarstic structures. Studies and research in physics, Bucharest, 32, 9, p. 944-955, (In Romanian).

> The flow pattern for a hydrokarstic structure may be either a conduit or a labyrinth of conduits were in a piston type or a dispersive flow develops. Counting frames are given to project and plallings with radioactive tracers

including the following parameters: activity, volume of labelled water, transit time. The computations were effected for radionuclides T, 24 Na, 82 Br, 131 I, 198 Au.

435. Gaspar, E. (1981) - A critical analysis of radioactive tracer-based research work performed in Karsts, studii si cerecetari de fizica, Bucharest, 33, 3, p. 311-320, (In Romanian).

The way in which a tracer is labelled and measured has a deciding influence on the results on field experiments as the establish the input and output functions. The mode in which the data obtained with the help of tracers are processed in analyzed. Relations are given, which have been set either empirically or through computation, to determine the activity, velocity, transit time and dispersion of a tracer.

436. Gaspar, E. (1986) - New trend in tracer hydrology, CRC-Press, Boca Raton, Florida, USA (in press).

The author refers to the use of natural (isotopic, chemical, polluting) and artificial (chemical, biological, fluorescent dye, activable and radioactive) tracers in hydrology, with special emphasis o karst. Artificial tracer selection criteria, tracer behavior in the underground in interaction with water, rocks and the biological medium, mathematical flow patterns, tracer-bases investigations in wells, the study of hydrokarstic structures and tracer cave hydrology, investigation of geothermal waters also dealt with. The goals of tracing in karsts and numerous case studies listed.

437. Gaspar, E.; and Oraseanu, I. (1986) - Natural and artificial tracers in the study of karst hydrodynamics, in Theoretical and Applied Karstology, 3 (in press).

This is a review paper in which the authors present the use of tracers in karsts and provide a large bibliography on the subject. Usable tracers, labelling methods, methods of in-site measurement, sample taking and the use of ion exchange filters are dealt with. The hydrodynamic parameters of a karst-transit time, turnover time, velocity, dynamic volume - may be obtained by processing the distribution of tracer concentration according to time. Flow patterns applicable to karsts are outlined. The use of artificial and environmental tracers in speleological research, numerous case studies and the prospects of tracing in karsts round off the image of the utilization of karst investigation.

438. Gaspar, E.; and Simion, G. (1982) - Tracer-based research work in the Cerna valley karst to assess the influence of river development operations on thermal waters, hidrotehnica, 27, 8, p. 233-246, (In Romanian).

Labeling with artificial tracers (82 Br, 131 I, 198 Au, fluorescein, dichromate) contributed to the establishment of the origin, genesis and area of supply of the thermal waters in the Cerna valley. The use of radioactive concentrations below the permissible limit in potable water called for the utilization of ion exchangers and low-background spectrometric measurements. The hydrogeological connections and the transit velocities set through labeling with tracers allowed a delimitation of the area of influence of the storage lake.

439. Gaspar, E.; and Simon G. (1986) - Tracer-Based research in the dynamics of the underground waters in the Cerna valley basin, in Theoretical and Applied Karstology, 3 (in press).

This work is a synthesis of all labellings with tracers effected in the Cerna valley karst, which contributed to the elaboration of hydrogeological map. A

series of experimental diagrams are reproduced which have been obtained with the help of a wide range of tracers: T, 82 Br, 131 I, In-EDTA, fluorescein, malachite blue.

440. Gaspar, E.; Farcasiu, O.; Stanescu, P.; Spiridon, S. (1984) - Nuclear methods for karst hydrology investigation, in Proc. Symp. Theoretical and Applied Karstology, 1, 207-214.

Two nuclear methods for the investigation of hydrokarstic structures with the help of tracers are outlined. The first method employs radioactive tracers and allows of the simultaneous labelling of several sinkholes, the tracers being surveyed in one or more sources. Tracers shall be concentrated on ion exchange filters and measurement is to be performed by low-background gamma spectrometry using a Ge(Li) detector. The second method uses Indium, in an In-EDTA complex form, as an activable tracer to study the dynamics of karstic waters. In-concentration in water is determined through bismuth-hydroxide coprecipitation and neutron activation analysis.

441. Gaspar, E.; Stanescu, P.; Oraseanu, I.; Farcasiu, O.; and Spiridon, S. (1986) - The behavior of Indium as a tracer for karst water research, in Theoretical and Applied Karstology 2 (in press).

The experimental results yielded by labellings that used In-EDTA as a tracer in various hydrokarstic structures provided for the establishment of computation formula and the elaboration of a counting frame to assess the amount of tracer needed for one labelling. Tracer extraction and measurement methods are outlined, the minimum concentration that can be currently measured being of 10 -12 g/ml. Tracer retention i the underground medium varied from 0.5 to 33 percent, with the largest loss due to tracer penetration into auxiliary systems. The discharges of the tested springs varied from 50 l/s to 2.75 cu.m/s. The time of transit between injection and the first occurrence of the tracer in the measuring points was of 180 days.

442. Gebelein, C.D. (1977) - Dynamics of recent carbonate sedimentation and ecology, Cape Sable, Florida: Leiden, Brill; Intern. Sed. Petro.y. Ser. 16, 120 p. 52 photos.

443. Gebhardt, J.; and Gordos, P. (1978) - Technical level in Hungarian bauxite mines and possibilities of its rising with particular respect to the diesel-power programme in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 181-203, 6 figs.

444. Geldsetzer, H. (1976) - Syngenetic dolomitization and sulfide mineralization in Amstutz, G.C., and Bernard, A.J., editors, Ores in Sediments: Germany, F.R., Berlin; Springer-Verlag, p. 15-127.

Excellent stratigraphic control and diagenetic changes make it possible to demonstrate the temporal relationship as well as the process of Pb-Zn mineralization in well exposed Precambrian rocks of Helikian age on northern Baffin Island, N.W.T., Canada. Initial deposition of shallow-marine, cratonal sediments was interrupted by regional tilting. Emerging areas were extensively karstified and brecciated, affecting in particular laminated algal carbonates. Excellent permeability, a proper drainage system for a refluxing brine and a continuous supply of evaporating seawater are the essential criteria that account for this Arctic Pb-Zn deposit. The simplicity of this pattern suggests that syngenetic dolomitization and sulfide mineralization are a common geological event and may be responsible for other Pb-Zn occurrence.

445. Gensmer, R.P.; and Weiss, M.P. (1980) - Accuracy of calcite/dolomite ratios by X-ray diffraction and comparison with results from staining techniques: U.S.; Journ. Sed. Petrol. 50:2, p. 626-629, 2 figs.

446. Gerhart, J.M. (1986) - Ground-water recharge and its effects on nitrate concentration beneath a manured field site in Pennsylvania: U.S.; Ground Water, 24:4, p. 483-489.

> Ground-water recharge to a shallow, unconfined, fractured dolomite aquifer underlying agricultural land in Lancaster County, Pennsylvania occurs by two mechanisms. Direct recharge occurs through pathways such as near-surface bedrock fractures and sinkholes, and affects dissolved nitrate concentration of ground water within two to three days; its effects last only about one week. Gradual recharge occurs through small channels and pores in the unsaturated zone and affects dissolved nitrate concentration for several weeks or more after the effects of direct recharge have dissipated.

447. Germann, K. (1966) - Ablauf und Ausmass diagenetischer Veraenderungen im Wettersteinkalk (alpine Mitteltrias): Germany, F.R.; Diss. Univ. Muenchen, 122 p.

> Grain-size curves and parameters of diagenetically changed carbonate rocks provide information about the degree of diagenesis when variations in the grain sizes of the matrix are considered.

448. Germann, K. (1971) - Mangan-Eisen-fuehrende Knollen und Krusten in jurassischen Rotkalken der Noerdlichen Kalkalpen: N. Jb. Geol. Palaeont. Mh. 1971, p. 133-156.

449. Germann, K. (1979) - Deposition of manganese and iron carbonates and silicates in Liassic Marls of the Northern Limestone Alps (Kalkalpen) in Amstutz, G.C., and Bernard, A.J., editors, Ores in Sediments: Germany, F.R., Heidelberg; Springer-Verlag, p. 129-138.

> Considerable manganese occurrences in the Northern Limestone Alps are restricted to lower and middle Jurassic marls, red limestones and radiolarian cherts.. In the red limestones and cherts only minor contents of manganese are concentrated as oxides, forming in the red limestones carbonate-rich manganese nodules, texturally and geochemically comparable to some Recent shallow marine accumulations.

450. Gernandez-Nieto, C.; Fernandez-Rubio, R.; Gutierrez Elorza, M.; and Arrese Serrano, F. (1981) - Papel de la karstificacion en la genesis de los yacimientos de hierro de Sierra Menera (Ternel y Guadalajara): Boletin Geol. Min. 92:2, p. 127-140.

451. Gerstenhauer, A. (1968) - Ein karstmorphologischer Vergleich zwischen Florida und Yucatan: Deutscher Geographentag Bad Godesberg, Wiss. Abh., p. 332-344.

452. Gerstenhauer, A.; and Pfeffer, K.-H. (1966) - Beitraege zur Frage der Loesungsfreudigkeit von Kalkgesteinen: Abh. Karst-Hoehlenkd. A:2.

453. Geze, B.; and Pobequin, Th. (1962) - Contribution a l'etude des concretions carbonatees: 2eme Congr. Inter. Spele. 1958, Bari, Actes I, p. 396-414.

454. Ghita, D.; Naulea, N.; Banu, I. (1979) - A study concerning the pothole from Piciorui Boului - Muchea Coti (Fagaras Mountains), Bulletin Speologie, 1, 2 figures (in Romanian).

> A vadose collapse origin cave, developed in crystalline limestone interbred with amphibolites is described.

455. Ghosh, K.P.; and Dutta, B.C. (1978) - Mineralogy and genesis of Phutkapahar bauxite deposits of eastern Madha Pradesh, India in Augustithis, S.S., editor, 4th International

Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 204-255, 31 figs.

Although previous studies hypothesize the derivation of bauxites of eastern Madha Pradesh, India, from the Deccan lavas, it is now suggested that they were derived from arkosic sandstone/shale of Gondwana age. Model and 18 chemical analyses are given.

456. Gibbins, W.A. (1983) - Mississippi Valley type lead-zinc districts of northern Canada in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 403-414.

Mississippi Valley type (MVT) deposits account for all of the lead, zinc, cadmium and a significant amount of the silver currently produced in northern Canada. This production comes from deposits associated with a Middle Devonian barrier reef complex of the Pine Point district, the Polaris deposit in Ordovician Thumb Mountain Formation in the Cornwallis lead-zinc district and the Nanisivik deposit in Helikian (Proterozoic) Society Cliffs Formation on northwestern Baffin Island. The Cordillera of northern Canada contains important undeveloped MVT deposits in the Robb Lake, Gayna River, Bonnet Plume River and Godlin Lakes districts.

457. Ginsburg, R.N. (1956) - Environmental relationships of grain size and constituent particles on some South Florida carbonate sediments: U.S.; Amer. Asso. Petroleum Geologists Bull., Vol. 40, p. 2384-2427.

Important articles about the grain-size distribution in several traverses which run through a reef area. Various grain-size ranges and mean values in different environments can be seen.

458. Ginsburg, R.N. (1974) - Introduction to comparative sedimentology of carbonates: U.S.; Amer. Asso. Petrol. Geol. Bull. 58:5, p. 781-786.

459. Ginsburg, R.N.; and James, N.P. (1976) - Submarine botryoidal aragonite in Holocene reef limestones: U.S.; Belize. Geol. 4, p. 431-436.

460. Giurgiu, I. (1984) - The Pothole at Dosul Lacorului (the Sebes Mountains). Exploration over 1973-1983, Buletinul CSER, Bucharest, 8, p 197-203, 1 sketch, 2 maps, 1 photo (in Romanian).

Data concerning the history of explorations and items of information in connection with the new discoveries made in a pothole with a level difference of 268 m.

461. Giurgiu, I. (1985) - Caves in Salt in the Vrancea Subcarpathians. Buletinul CSER Bucharest, 9, p 5-35, 28 maps, "sketch, 14 photos (in Romanian)

Comprehensive description of the exo- and endokarst in salt in the Meledic plateau, the Jgheabu Valley, and at Sarile. The author presents information on the largest cavity in salt in the world (cave 6S at Minzalesti, 1,257 m).

462. Giurgiu, I.; Ceara, E.; Roman, C. (1976) - New Discoveries in the Cave at Limanu, (Dobrogea), Buletinul CSER Bucharest, 4, p 170-172, 1 map (in Romanian)

The authors discuss one of the most interesting caves in Romania from an archaeological point of view.

463. Giurgiu, I.; Done, A.; Vadeanu, T.; Roman, C. (1982) - Zalion Minus 226. Buletinul CSER, Bucharest, 7, p 7-22, 2 maps, 1 fig., 4 photos (in Romanian)

A description is presented of a cavity which is 2,121 m long and 226 m deep.

464. Giurgiu, I.; Muraru, A. (1977-1978) - The Frasin pothole (Obcina Mare Mountains). Buletinul CSER, Bucharest, 5, p 26-30, 2 maps (in Romanian)

The authors describe the deepest pothole in sandstone in Romania; the depth is 60 m).

465. Giurgiu, I.; Silvasan, G. (1979) - New Speleological Discoveries in the Rodna Mountains. Buletinul CSER, Bucharest, 6, p 25-52, 10 maps, 1 fig. (in Romanian)

Eight new cavities in the north-western part of the massif are presented. The most important of them is Grota Zinelor (4,269 m long, 110 m deep), which developed in Eocene limestone.

466. Giurgiu, I.; Vadeanu, T.; Done, A.; Negru, M.; Sandeschi, N.; Silvasan, G., Codescu, M.; Ciuculescu, O.; Sfasie, M.; and Cucu, P. (1984) - Speleological Discoveries and Explorations in the Somes Plateau. Buletinul CSER, Bucharest, 8, p 11-81, 53 maps, 4 fig., 2 photo (in Romanian)

This is the first speleological inventory of an area which includes 104 cavities. Noteworthy features are the cave in the Cuciulat quarry (1,707 m) where the first paleolithic paintings in Romania were discovered, the-pothole at Gura Cerului, where a 52-m waterfall was discovered, and the cave at Cetatea Ciceului, the longest cavity in sandstone in Romania (273 m).

467. Giurgiu, Mihaela (1977-1978) - Contributions to the study of cave climate in the Ponorici-Cioclovina cu Apa Cave in view of its therapeutical utilization. Buletinul CSER, Bucharest, 5, p 257-278, 14 tables (in Romanian).

This report is a thesis read at the Medical Institute of Bucharest. The conclusions of the study show that the cave is suitable for the treatment of complaints of the respiratory system.

468. Gnoli, M.; Jaanusson, V.; Leone, F.; and Serpagli, E. (1981) - A Lower Devonian stromatactis-bearing carbonate mound from southern Sardinia: N. Jb. Geol. Palaeont. Mh. 1981/6, p. 339-345, 5 figs.

469. Godney, D.E. (1977) - Non-equilibrium fractionation of the stable isotopes of carbon and oxygen during precipitation of calcium carbonate by marine phytoplankton: U.S.; PhD Thesis, Univ. of Hawaii, 146 p.

470. Godwin, C.I.; Sinclair, A.J.; and Ryan, B.D. (1982) - Lead isotope models for the genesis of carbonate-hosted Zn-Pb, shale-hosted Ba-Zn-Pb, and silver-rich deposits in the northern Canadian Cordillera: U.S.; Econ. Geology, Vol. 77:1, p. 82-94.

471. Gokdag, H. (1974) - Sedimentpetrographische und isotopenchemische (O^{18},C^{13}) Untersuchungen im Dachsteinkalk (Obernor-Rat) der Noerdlichen Kalkalpen: Marburg; Diss. Univ. Marburg, 156 p., 33 pls., 3 encls., 10 diagr.

472. Goldwin, C.I., Sinclair, A.J.; and Ryan, B.D. (1982) - Lead isotope models for the genesis of carbonate hosted Zn-Pb, shale-hosted Ba-Zn-Pb and silver rich deposits in the Northern Canadian Cordillera: U.S.; Econ. Geol. 77, p. 82-94.

473. Goran, C. (1976) - The Evolution of the hydrographic Network in the Topolnita-Epuran Karstic Area (The Mehedinti Plateau), Travaux de l'Institut de Speologie "Emile Racovitza", 15, p 197-206, 6 figures, (in French).

The author presents a regional study of paleogeographic and geomorphological evolution from the moment of limestone emersion until the current configuration of the relief of one of the most interesting and representative underground karstic complexes in Romania.

474. Goran, C. (1978) - The Karst of the Mehedinti Plateau. I. The Northern Part, Travaux de l'Institut de Speologie "Emile Racovitza", 17, p 165-183, 2 figures, 2 plates, (in French).

The author describes one of the most important karstic areas in Romania which analyses with the help of a color 1:20,000 map, the morphology of surface and underground relief in correlation with various drainage directions. A detailed study of the genesis of the Zaton-Bulba karstic complex as found in Romania led to a general model of underground network organization in relation to the morphological evolution of afferent karstic valleys.

475. Goran, C. (1981) - The Karst of the Mehedinti Plateau. II. The Central-Northern Part. Note 1., Travaux de l'Institut de Speologie "Emile Racovitza", 20, p 217-226. (in French).

The author presents morphological and hydrographic aspects of the exokarst in the central-northern part of the Mehedinti Plateau, with emphasis on the conditions of karst formation on the compartmentation and current distribution of karstic forms.

476. Goran, C. (1982) - The systematic catalog of the Romanian caves. Cons. National pt. Ed. Fiz. Sport, Bucharest, 496 p. (in Romanian).

6816 caves included in the catalog of karst in Romania are grouped in three large sections. The author makes an inventory of known caves in each territorial (karstic) unit, according to the decimal system of classification. Thus, a cave is classified according to a catalog number 6 of the unit and to its own number. In the case of caves modelled in "other rocks" a lithological specification is also added. (01-caves in salt, 02-in gypsums, 03-in conglomerates, 04-in grit stones, 05-in volcanic agglomerates, 06-in magmatic rocks, 07-in crystalline schists and 08-in loess). For each cave, the following parameters are outlined within synthetic tables by the order number, field marking of the code number, name and synonyms, location, number of entrances, altitude of the entrance, absolute altitude, relative altitude, mapping situation, hydrological type, length, negative level difference, positive level difference, information source and date, and bibliography. The alphabetical catalog includes all the names of caves and their synonyms with their respective number. Romania's speleogram is an all-country synthesis by geographic units, types of rocks and types of caves of the data registered in the decimal catalogue, followed by their interpretation. The catalog also contains a comprehensive bibliography and abstracts in French and English.

477. Goran, C. (1983) - Types of Karstic Relief in Romania", Travaux de l'Institut de Speologie "Emile Racovitza", 22, p 91-102, 5 figures, (in French).

Deciphering the laws of the present distribution of limestone and dolomite in Romania, the author suggests a new classification of karstic relief on the basis of a genetic-evolutive criterion. As a result of post-sarmatian evolution, nine types of karstic relief with specific features (unitary-perched karstic plateaus, transverse-perched and unitary-lowered plateaus; unitary calcareous bars, both fragmented and levelled; isolated calcareous massifs occurring on

crest, on slope or on valley) were created from the three genetic (plateaus, calcareous bars and isolated massifs).

478. Goran, C. (1984) - The Relationship between the Cave Extent and Vertical Range - A Relevant Speleometric Index, Theoretical and Applied Karstology, 1, p 83-90, 3 figures, (in French).

> The author suggests a new speleometric index - the extent index - and demonstrates its usefulness in classifying caves and in the interpretations of karst geomorphology.

479. Grabowsky, K. (1978) - Economie d'exploitation de bauxite en Yougoslavie en relation avec des possibilites d'abattage dans les mines a ciel ouvert et souterraines in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 256-270, 1 fig.

480. Graf, J.L., Jr. (1983) - Rare earth elements in carbonate rocks and minerals from the Viburnum Trend, southeast Missouri in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 131-139.

> Rare earth element (REE) patterns of carbonate rocks and minerals from four Viburnum Trend deposits show that carbonates precipitated from or recrystallized by the ore solutions are significantly depleted in light REE relative to the host rocks.

481. Grancini, G.; Seivano, B.M.; Giradi, F.; Guzzi, G.; and Pietra R. (1975)- The determination of neutron activation analysis of trace elements in seawater and sediment samples collected in the northern Adriatic Sea: Mem. Biol. Mar. Oceanogr., Vol. 5, p.77-97.

482. Grant, N.K.; and Bliss, M.C. (1983) - Strontium isotope and rare earth element variations in non-sulphide minerals from the Elmwood-Gordonsville mines, central Tennessee in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 206-210.

> Isotope data show the effect of the dissolution of host carbonates during sulphide crystallization, and also the changes in the ore fluid system when the pulse of fluid with elevated $^{87}Sr/^{86}Sr$ ratios ended, and the remaining fluids evolved through local isotopic chemical exchanges with the host carbonates. The evolution of the rare earth element is thought to be largely determined by fractionations occurring during the dissolution, transport, and crystallization processes of mineralization.

483. Grazzini, M. (1978) - Dosage de l'Al au moyen des microanalyseur a rayons X et sa correlation avec la composition et la structure des composes cristallins in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 996-1007, 3 figs.

484. Grieg, J.A.; Baadsgaard, H.; Cumming, G.L.; Folinsbee, R.E.; Krouse, H.R.; Ohmoto, H.; Sasaki, A.; and Smejkal, V. (1971) - Lead and sulphur isotopes of the Irish base metal mines in Carboniferous carbonate host rocks: Soc. Mining Geol. Japan, Spec. Issue 2 , p. 84-892.

485. Griffith, L.S.;, Pitcher, M.G.; Rice, G.W. (1969) - Quantitative environmental analysis of a Lower Cretaceous reef complex: U.S.; Soc. Econ. Paleont. Min. Spec. Paper 14, p. 120-138.

A comparison of the Recent sedimentary conditions off the Florida coast with the Lower Cretaceous El Abra reef in Mexico and the carbonates of the Lower Cretaceous Edward formation in Texas, which is known only from boreholes. The results of factor analyses, which considered all the data available, and factor analyses, which considered only the more important faunal element, were in almost complete agreement.

486. Grogan, R.M.; and Bradbury, J.C. (1967) - Origin of the stratiform fluorite deposits of southern Illinois in Brown, J.S., editor, Genesis of Stratiform Lead-Zinc-Barite-Fluorite Deposits in Carbonate Rocks: U.S.; Economic Geology, p. 40-51.

487. Groom, G.E.; and Williams, V. (1965) - The solution of limestone in South Wales: Geogr. Journ. 131, p. 37-41.

488. Groschopf, P. (1963) - Die geologischen Voraussetzungen fuer die ErschlieBung von Karstwasser im Blautal: Jahresh. Karst-Hoehlenkd., p. 71-79.

489. Gross, M.G. (1964) - Variations in the $^{18}O/^{16}O$ and $^{13}C/^{12}C$ ratios of diagenetically altered limestones in the Bermuda Islands: U.S.; Journ. Geol. 72, p. 170-194.

490. Gross, M.G.; and Tracey, J.I., Jr. (1966) - Oxygen and carbon isotopic composition of limestones and dolomites, Bikini and Eniwetok atolls: U.S.; Science 151, p. 1082-1084.

491. Grotjohann, H. (1978) - Die Korrelation von Geochemie und Faziesdifferenzierung im erzhoeffigen Muschelkalk (Mitteltrias) der Ostalpen: Berlin; Berliner Geowiss. Abh. A, 3, p. 1-70, 5 pls., 34 figs., 10 tbls.

492. Groudev, S.; and Genchev, F. (1978) - Bioleaching of bauxites by wild and laboratory-bred microbial strains in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 271-278.

493. Grundmann, W.H., Jr. (1977) - Geology of the Viburnum No. 27 mine, Viburnum Trend, southeast Missouri: U.S.; Economic Geology, Vol. 72, p. 349-364.

The No. 27 mine lies at the northern end of the Viburnum Trend near a 2.5-mile-long granite formation 3 miles west and basinward of the main ore trend. Mineralization, primarily associated with clastic structures, occurs almost exclusively in the digitate stromatolitic reef horizon of the dolomitic Bonneterre Formation.

494. Gruszczyk, H. (1982) - The genesis of the zinc-lead ore deposits of Upper Silesia, Poland in Amstutz, G.C., El Goresy, A., Frenzel, G., Kluth, C., Moh,, G., Wauschkuhn, A., and Zimmermann, R.A., editors, Ore Genesis: The State of the Art: Germany, F.R., Heidelberg, Springer-Verlag, p. 92-96.

From the evidence accumulated to date, it appears that at least two deposit-forming stages can be distinguished, as follows: stage I in which disseminated ores formed synchronously with dolomites; and stage II in which further concentration of primary ores and secondary alteration of the primary dolomites occurred.

495. Gruszczyk, H.; and Basta-Grzywacz, M. (1984) - The lithology and mineralization of Upper Silesian zinc-lead ore deposits in Wauschkuhn, A., Kluth, C., and Zimmermann, R.A., editors, Syngenesis and Epigenesis in the Formation of Mineral Deposits: Germany, F.R., Heidelberg; Springer-Verlag, p. 431-437.

It has been found that in the Silesian-Cracow ore district mineralization is intimately associated with lithology. Ore bodies occur in zones in which dolomites grade into limestones. Such inferences may prove useful in further prospecting for ores not only in the Silesian-Cracow ore district but also in other areas where carbonate rocks occur and where there is lateral transition between dolomites and limestones. This is also in accord with the hypothesis of syngenetic origin of ore-bearing dolomites and primary ore concentrations.

496. Gruszczyk, H.; and Paulo, A. (1976) - Transitional zone in the carbonate Triassic of the Olkusz area (in Polish): Wrart Geol. 20, p. 737-749.

497. Guillevin, Y.; and Renard, M. (1978) - Apports de la geochimie des elements en traces (Sr, Mg, Na) a l'etude des carbonates recifaux dano-montien du bassin de Paris (Vigny-Montainville): Essai de reconstitution de paleo-environment recifal: Paris; Bull. Inf. Geol. Bassin Paris 15:2, pl. 53-63.

498. Guldali, N. (1975) - Seydisehir and Akseki bauxite deposits and their relation to palaeokarst phenomena in Taurus Mountains in Proceedings Turkish 50th Anniversary Congress Earth Sci., Mineral Resources Explor. Institute, Ankara, p. 392-409, 8 figs., 1 geol. map.

The bauxite deposits of Turkey are mostly found in the western part of the central Taurus Mountains. They occur beneath an unconformity surface, overlain by Maestrichtian limestones and underlain by lower Cretaceous or Cenomanian limestones. Two structural types are distinguished in more than 60 small deposits.

499. Gumiel, P.; Medina, E.; and Santos, J.A. (1978) - Litoestratigrafia y control estructural de la mineralizacion antimonifera de la franja calcarea-devonica de Alburquerque (Badajoz): Bol. Geol. Min. 89:2, p. 146-156.

500. Gumiel, P.; Rey de la Rosa, J.; Sanchez de la Fuente, J.; and Liarte, J. (1982) - Prospeccion de antimonic y otros elementos en la zona calcarea devonica de La Codosera-Alburquerque: Bol. Geol. Min 93:2, p. 146-156.

501. Gunnesch, K.A.; and Baumann, A. (1984) - The Atacocha District, Central Peru: Some metallogenetic aspects in Wauschkuhn, A., Kluth, C., and Zimmermann, editors, Syngenesis and Epigenesis in the Formation of Mineral Deposits: Germany, F.R., Heidelberg; Springer-Verlag, p. 448-456.

The Atacocha District is located in the eastern Cordillera of Central Peru, 20 km north of Cerro de Pasco. Pb-Zn ores of three mines (Machcan, Atacocha, and Milpo) have been investigated. On the basis of geometric criteria, four types of ore can be distinguished: (1) strata-bound ore lenses in carbonate rocks (Pucara); (2) discordant bodies (veins or veinlets) of sphalerite/galena/pyrite; (3) irregular bodies in the contact zone of Tertiary intrusions sedimentary rocks; (4) disseminations of sphalerite, galena, and pyrite in the sandstone of the Goyllarisquizga Group.

502. Gunnesch, M.; and Jaksch, H. (1984) - Fluid inclusion studies in fluorite at Milpo mine (Atacocha district), central Peru in Wauschkuhn, A.; Kluth, C.; and Zimmermann, R.A, editors, Syngenesis and epigenesis in the formation of mineral deposits: Heidelberg, West Germany; Springer-Verlag, p. 328-341.

Fluid inclusions in fluorite from Milpo mine (Atacocha district) central Peru provide interesting observations on the hydrothermal phase in these deposits. Mixing phenomena of fluids with different densities occur.

503. Gurnee, R.H. (1977) - Exploration of the Tanama in Sloane, B., editor, Cavers, Caves, and Caving: U.S.; Rutgers University Press, p. 369-392.

504. Gustafson, L.B.; and Williams, N. (1981) - Sediment-hosted stratiform deposits of copper, lead, and zinc: U.S.; Econ. Geology, 75th Anniversary Vol., p. 139-178.

505. Haditsch, J.G. (1984) - Geology and mineralization of the Ozbak-Kuh Mine and the genesis of the East Iran Pb-Zn deposits in Wauschkuhn, A., Kluth, C., and Zimmermann, R.A., editors, Syngenesis and Epigenesis in the Formation of Mineral Deposits: Germany, F.R., Heidelberg; Springer-Verlag.

> Former investigations in Iranian Pb-Zn and Cu deposits led to the interpretation whereby they formed as products of Mesozoic-Tertiary metallogenetic processes. Recent research work suggests, at least for Pb-Zn deposits of eastern Iran, an origin by Paleozoic sedimentary ore mineral formation.

506. Hadzi-Popvic, S.; and Cicmil, S. (1978) - Les bauxites de region de Niksic (Montenegro), leurs caracteristiques minerogeochimiques et les problemes des roches-meres in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 279-296, 2 figs.

> Contents of trace elements are discussed.

507. Hadzija, O.; Juracic, M.; Luic, M.; Tonkovic, M.; and Jericevic, B. (1985) - The carbohydrates in relation to mineralogic and granulometric compositions of surface sediments in the karst estuary (River Krka estuary, Yugoslavia): Yugoslavia; Estuarine, Coastal and Shelf Science, Vol. 21, p. 701-709.

> The investigation of mineral, granulometric and chemical composition of sediments of the River Krka estuary (Yugoslavia) were performed in order to elucidate the origin of the sediments and the pattern of sedimentation.

508. Hadzisehovic, M.; Komatina, M.; Zupancic, M.; Stamenkovic, V.; Stepic, R.; Bed-Uzarov, D.J. (undated) - Study of the groundwaters using the environmental tritium and hydrochemical data in the Belgrade region: Yugoslavia; "Boris Kidric" Institute, Geozavod, and Belgrade Water Supply, 18 p.

> A study of tritium content and some physico-chemical parameters was performed to investigate the interconnection between surface and atmospheric waters and underground waters in the Belgrade area. Samples of precipitation at Zeleno Brdo-Belgrade meteorological station, water from the Danube and Sava Rivers, and underground water (Ranney walls and piezometers) were analyzed. The ^{3}H content, the content of dissolved ions, total hardness, and electrical conductivity were measured.

509. Hager, J. (1980) - Sorption of manganese and silica by clay and carbonate: Marine Chem., Vol. 9, p. 199-209.

510. Hagni, R.D. (1982) - The influence of original host rock character upon alteration and mineralization in the Tri-State district of Missouri, Kansas, and Oklahoma, U.S.A. in Amstutz, G.C., El Goresy, A., Frenzel, G., Kluth, C., Moh, G., Wauschkuhn, A., and Zimmermann, R.A., editors, Ore Genesis: The State of the Art: Germany, F.R., Heidelberg; Springer-Verlag, p. 97-107.

> Genesis and character of strata-bound ore deposits in the Tri-State district (Missouri, Kansas, and Oklahoma, U.S.A.) depend upon the interrelated

sedimentary, tectonic, karstic, and mineralizing processes that affected the host rocks.

511. Haines, T.A. (1981) - Acidic precipitation and its consequences for aquatic ecosystems: A review: Transactions Am. Fish. Soc., Vol. 110, p.669-707.

512. Haji-Djafari, S.;Antommaria, P.E.; and Crouse, H.L. (1981) - Attenuation of radionuclides and toxic elements by in situ soils at a uranium tailings pond in central Wyoming in Zimmie, T.F., and Riggs, C.O., editors, Permeability and Groundwater Contaminant Transport: U.S.; Amer. Soc. for Testing and Materials Special Technical Publication 746, p. 221-242.

Existing concentrations of radionuclides and arsenic in a uranium tailings pond and groundwater, and hydrogeologic and mass transport parameters were utilized in a Galerkin-based finite element mass transport model to predict future migration potential for discrete chemical species. Field and laboratory data and the results of computer modeling indicate that movement of chemical species of interest at the subject site is mitigated by chemical reaction with in situ soils including precipitation, coprecipitation, and ion exchange.

513. Hakansson, E.; Bromley, R.; and Perch-Nielsen, K. (1974) - Maastrichtian chalk of north-west Europe - a pelagic shelf sediment: Oxford; Inter. Asso. Sed. Spec. Publ. 1, p. 211-234.

514. Halasi, G. (1978) - Contributions to the Knowledge of the Karst of Moneasa Area, Nymphaea, 6, p 373-382, 6 figures, in Romanian with French abstract.

A complex karst area, including classical drainage features, such as poljes, dry perched valleys, the water of which was captured underground by large cave systems, overflow cavities, is described.

515. Halasi, G. (1980) - The Endokarstic System Caprelor Pothole-The Cave from Izbucul Pescariei (Caprioara Limestone Area), Buletin Information, 4, p 66-71, 4 figures, in Romanian.

A little limestone surface hosts a complex karst system, with several springs, the yields of which are discussed correlatively with those of the swallets. In spite of the reduced yields (a few liters per second), a 12 m rise of the water was observed in the pothole leading to the underground stream.

516. Halasi, G. (1981) - Ponor Cave (Drocea Mountains), Buletin Speologic Informative, 5, p 29-34, 2 figures, in Romanian.

The yields variability and the breakthrough times of a karstic drainage system are discussed.

517. Halasi, G. Ponta (1984) - Subterranean drainage in the upper part of the Sighistel Valley (Apuseni Mountains), Theoretical and Applied Karstology, 1,239-242.

The Sighistel karst area is about 15 km and contains several springs and swallets. Maps for more than 6,000 m of caves in Sighistel valley are presented. The drainage network is revealed by a dye tracing experiment, which was used to demonstrate the connection between two caves whose entrances were 410 m apart.

518. Halasi, G.; Enodi, Ioan.; Lascu, Cristian.; Sirbu, Serban (1985) - An Archaeological Discovery in the Izubucul Toplitei Cave Trav. Inst. Speol. "Emil Racovita", Tome XXIV, p 105-110, Bucharest.

A recent discovery beyond a sump of a Bronze Age necropolis containing a variety of cult objects, human skeletons, tools and pottery is under research.

519. Hallam, A. (1967) - Sedimentology and paleogeographic significance of certain red limestones and associated beds in the Lias of the Alpine Region: Liverpool; Scottish Journ. Geol. 3, p. 195-220, pls. 1-2.

520. Halliday, W.R. (1962) - Caves of California: Seattle; Selbstverlag.

521. Ham, W.E. (1952) - Algal origin of the "Birdseyes" limestone in the McLish Formation: U.S.; Oklahoma Acad. Sci., Proc. 33, p. 200-203.

522. Hancock, J.M. (1963) - The hardness of the Irish chalk: Dublin; Irish Natl. Journ. 14, p. 157-164.

523. Hancock, J.M. (1976) - The petrology of the chalk: London; Proc. Geol. Soc. 86, p. 499-535.

524. Hancock, J.M.; and Kennedy, W.J. (1967) - Photographs of hard and soft chalks taken with scanning electron microscope: London; Proc. Geol. Soc. London 1643, p. 249-252.

525. Hancock, J.M.; and Scholle, P.A. (1975) - Chalk of the North Sea in Woodland, A.W., editor, Petroleum and the Continental Shelf of Europe, 1: New York; Wiley, p. 413-425.

526. Hankanson, L. (1980) - An ecological risk index for aquatic pollution control: A sedimentological approach: Water Res., Vol. 14, p.975-1001.

527. Hanor, J.S. (1978) - Precipitation of beach rock cements: Mixing of marine and meteoric waters vs. CO_2 degassing: U.S.; Journ. Sed. Petrol. 48, p. 489-502.

528. Harbaugh, J.; and Demirmen, F. (1964) - Application of Factor Analysis to petrologic variations of Americus limestone (Lower Permian), Kansas and Oklahoma, State Geological Survey of Kansas Special Distribution Publication #15: U.S.; State Geological Survey of Kansas, 52 p.

> 30 cm to 1.5 m thick unit followed over 450 km; 97 samples from 27 localities; pointcounting analyses; check of the variation occurring within and between the samples by factor analyses (Q-mode and R-mode) and trend-surface analyses.

529. Harbaugh, J.W. (1966) - Mathematical simulation of marine sedimentation with IBM 7079/7094 computers: U.S.; Computer Contrib., Vol 1, 52 p.

530. Hardie, L.A., editor (1977) - Sedimentation of the Modern Carbonate Tidal Flats of Northwest Andros Island, Bahamas: U.S.; John Hopkins Univ. Stud. Geol. 22, 202 p., 9 figs.

531. Harmon, R.S.; and Hess, J.W. (1982) - Ground water geochemistry of the Burnsville Cove area, Virginia in White, W.B., editor, Burnsville Cove Symposium: U.S.; National Speleological Society Bull., Vol. 44, No.3, p. 84-89.

> The chemical composition of 56 surface and ground waters from the Burnsville Cove area suggests that solution of carbonate rock in the Sinking Creek drainage basin has largely occurred during sustained contact of the water with a CO_2 reservoir of about $10^{-2.5}$ atm partial pressure.

532. Harmon, R.S.; White, W.B.; Drake, J.J.; and Hess, J.W. (1975) - Regional hydrochemistry of North American carbonate terrains: U.S.; Water Resources Res 11, p. 963-967.

533. Harris, F.W.; and Martin, W.D. (1979) - Benthic community development in limestone beds of the Waynesville (Upper Dillsboro) Formation (Cincinnatian Series, Upper Ordovician) of southeastern Indiana: U.S.; Journal of Sedimentary Petrology, 49:4, p. 1295-1306.

> Vertical and lateral changes in composition within 13 individual limestone beds are investigated using certain variables and discriminant analysis. Differences can be recognized for the tops, bottoms, and centers of the beds indicating changes in community successions.

534. Hart, B.T. (1981) - Trace metal complexing capacity of natural waters: A review: Environ. Tech. Lett., Vol. 2, p.95-110.

535. Hatt, B.L. (1978) - An interpretation of the carbonate geology exposed in the decline at Gays River: Dalhousie Univ., Unpublished M.Sc. Thesis, 134 p.

536. Hattin, D.E.; and Dodd, J.R. (1978) - Holocene cementation of carbonate sediments in the Florida Keys: U.S.; Journ. Sed. Petrol. 48:1, p. 307-312, 5 figs.

537. Hatzigiannelis, G.J. (1978) - Underground mining methods and mechanization in the Otavi-Sila bauxite mines in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 297-311, 9 figs.

538. Hay, R.L.; Pexton, R.E.; Teague, T.T.; and Kyser, T.K. (1986) - Spring-related carbonate rocks, Mg clays, and associated minerals in Pliocene deposits of the Amargosa Desert, Nevada and California: Geological Society of America Bulletin, Vol.97, No.12, p.1488-1503.

> The Amargosa Desert of Nevada-California is a spring-fed structural basin containing large amounts of Pliocene carbonate rocks and Mg clays deposited in playas, marshland, ponds, and flood plains. The nature and environments of chemical sedimentation and diagenesis in the stratigraphic unit containing the large Mg-clay deposits was studied. Pliocene basin-filled deposits dated at 2.4 to 3.2 Ma were subdivided into three lithofacies designated Tpa, Tld, and Tpl. Tpa is chiefly limestone and was deposited in varied environments, including ponds and flood plains. Tpl is almost entirely Mg clays, limestone, and dolomite, which were deposited in playas and associated marshland. The paleohydrology was inferred from the distribution, composition and morphology of chemically deposited sediments. Isotopic data from authentic minerals in the different facies provided a basis for estimating the relative evaporative concentration of water in the different environments.

539. Haynes, S.J.; and Mostaghel, M.A. (1982) - Present-day precipitation of lead and zinc from groundwaters: Min. Depos., Vol. 17, p. 213-228.

540. Heckel, P.H. (1972) - Possible inorganic origin for Stromatactis in calcilutite mounds in the Tully Limestone, Devonian of New York: U.S.; Journ. Sed. Petrol. 42:1,p. 7-18, 6 figs.

541. Heckel, P.H. (1974) - Carbonate buildups in the geologic record: A review: U.S.; Soc. Econ. Paleont. Min. Spec. Publ. 18, p. 90-154, 9 figs.

542. Hem, J.D. (1972) - Chemistry and occurrence of cadmium and zinc in surface water and groundwater: United States; Water Resources Research, Vol. 8, p.661-679.

543. Hemleben, Chr.; and Reuther, C.-D. (1980) - Allodapie limestones of the Barcaliente Formation (Namurian A) between Luna and Cea Rivers (Southern Cantabrian Mountains, Spain): Stuttgart; Neues Jahrbuch Geol. Palaeont. Abhandlungen 159:2, p. 225-255, 20 figs.

544. Herak, M. (1983) - Some ideas and dilemmas concerning the genesis and tectonics of the Adriatic and Peri-Adriatic areas in Babic, L.J., and Jelaska, V., editors, Contributions to Sedimentology of Some Carbonate and Clastic Units of the Coastal Dinarides: Yugoslavia, Zagreb; 4th I.A.S. Regional Meeting, Split 1983, Excursion Guidebook, p. 7-11.

Four major stages of geologic events are distinguished: (1) structural preparation of the basement of the carbonate platform to be developed (Hercynian and Triassic events), (2) persistence of the carbonate platform (Upper Triassic-Upper Paleogene), (3) formation of nappe-systems (Upper Paleogene-Neogene), and (4) post-nappe tectonics (Neogene-Quaternary).

545. Herak, M. (1984) - Geotektonski okvir speleogeneze: Yugoslavia; 9th Yugoslavian Congress of Speleology, Proceedings, p. 111-129.

Determination of the geotectonic nature of speleologic phenomena is proposed in order to anticipate some specific features which are the consequence of formation of different karst types. The tecto-genetic classification in orogenic and epi-orogenic karst types is recommended as suitable for explanation of the diversity of general speleogenetic conditions.

546. Herak, M. (1986) - A new concept of geotectonics of the Dinarides: Yugoslavia; Acta Geologica 16, Prirodoslovna Istrazivanja 53, p. 1-42.

The author proposes that two major geotectonic units, the Outer and Inner Dinarides, are actually four paleoenvironmental and paleodynamics belts extending continuously from the Peloponnesus to the Southern Alps.

547. Herak, M.; Scavnicar, B.; Susnjara, A.; Durdanovic, Z.; Krystyn, L.; and Gruber, B. (1985) - The Lower Triassic of Muc - Proposal for a standard section of the European Upper Scythian: Austria; Sch. Erdwissen. Komm., Band 5, Seiten 93-106.

In the Zmijavac valley (Muc, Mt. Svilaja, Croatia, Yugloslavia) four informal lithostratigraphic units are distinguished. The third unit, being lithologically well defined, without breaks of sedimentation and rich in fossils (ammonoids, pelecypods, gastropods, foraminifers and conodonts) has been studied in detail. Two biostratigraphic zones have been distinguished, characterized by Tirolites cassianus and Tirolites carniolicus, respectively. Due to obvious lithostratigraphic and biostratigraphic features, this unit is proposed as a standard section of the Upper Seythian within the Werfen facies of the Western Tethys area.

548. Herrero, J.M.; Velasco, F.; and Fortune, J.P. (1982) - Estudio preliminar sobre las mineralizaciones de hierro y de plomo-cinc-fluor en ambiente carbonatado del oeste de Vizcaya: Bol. Soc. Espanola Mineralogia 5, p. 183-190.

549. Heyl, A.V. (1983) - Geologic characteristics of three major Mississippi Valley districts in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 27-60.

Three of the most important Mississippi Valley districts are (1) Upper Mississippi Valley, (2) southern Illinois-western Kentucky, and (3) southeast Missouri districts. The three districts are characterized by very large areal extent; very large individual deposits; ore deposition in hard rock; structural and stratigraphic control of most deposits; open-space fillings by most ores, although replacements are important in southeast Missouri, as are veins in Illinois-Kentucky; deposition in certain favorable strata, but ores are not stratabound, nor are they stratiform in detail; subtlely complex mineralogy of the ores, which can no longer be called "unusually simple"; (8)markedly

radiogenic J-type lead in the galenas deposited epigenetically by heated concentrated brines; (9) presence of mantle-derived alkalic igneous rocks in southeast Missouri; similar mantle-derived alkalic plutons are genetically related to the ores in Illinois-Kentucky, but not to those in the Upper Mississippi Valley; (10) dissolution of large volumes of the carbonate country rock by active ore solutions.

550. Heyl, A.V., Jr. (1974) - Some fluorite-barite deposits in the Mississippi Valley in relation to major structures and zonation in Hutcheson, D.W., editor, A Symposium on the Geology of Fluorspar: U.S.; Kentucky Geol. Survey Ser. X. Spec. Publ. 22, p. 55-57.

551. Hidasi, J. (1978) - Oolitic textural elements in Hungarian bauxites in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 312-332, 14 figs.

552. Hill, C.A. (1976) - Cave minerals: U.S.; Natl. Spele. Soc., Huntsville, AL, USA.

553. Hoagland, A.D. (1967) - Interpretations relating to the genesis of east Tennessee zinc deposits: U.S.; Economic Geology, Monograph 3, p. 52-58.

> The most important zinc deposits in Tennessee occur in a narrow stratigraphic zone about 200 feet thick in Lower Ordovician dolomitized limestone and dolomite. The author suggests that genetic theory would be advanced significantly by regional geochemical study.

554. Hoagland, A.D. (1971) - Appalachian strata-bound deposits: Their essential features, genesis and the exploration problem: U.S.; Economic Geology, Vol. 77, p. 805-810.

> Zinc deposits of Appalachian type were formed in nearly horizontal strata and were subsequently folded and faulted by Appalachian orogeny. In their original, nearly horizontal position they closely resemble deposits of the Mississippi Valley with which they are usually classified. With the exception of the Austinville-type deposits, which are not considered herein, the subject deposits are related to a Lower Ordovician paleo-aquifer.

555. Hoagland, A.D. (1976) - Appalachian zinc-lead deposits in Wolf, K.H., editor, Handbook of Strata-Bound and Stratiform Ore Deposits: The Netherlands, Amsterdam; Elsevier Scientific, p. 495-534.

> Appalachian zinc-lead deposits and the classic Mississippi Valley deposits of the mid-continent are similar in many respects. A fresh look at the history of sedimentation, environment, and physiography of the region is generating concepts of the genesis of Appalachian deposits parallel to, and to a considerable extent dependent on, the new ideas related to the character and genesis of the classic Mississippi Valley-type deposits in the mid-continent region.

556. Hodgson, W.A. (1958) - On the origin of calcite-filled cavities in the British Dinantian limestones: Eclogae geol. Helvet. 51, p. 649-656.

557. Holl, R. (1977) - Early Paleozoic ore deposits of the Sb-W-Hg formation in the eastern Alps and their genetic interpretation in Klemm, D.D., and Schneider, H.J., editors, Time- and Strata-Bound Ore Deposits: Germany, F.R., Heidelberg; Springer-Verlag, p. 170-198.

> A widespread, strata- and time-bound metal deposition with W, Sb, and Hg provides an example of metallogeny at a convergent plate margin in the eastern Alps probably from Upper Ordovician to Silurian time.

558. Holter, M.E. (1976) - Limestone resources of Alberta in 11th Industrial Minerals Forum, Special Publication Montana Bureau Mines Geology, Vol. 74, p. 37-50, 10 figs.

Six areas in the Rocky Mountains and foothills of southwestern Alberta contain deposits of high-calcium limestone. The quality and locations of the deposits are discussed.

559. Horton, R.A., Jr.; Geissman, J.W.; and De Voto, R.H. (1983) - Late Paleozoic dolomitization of Leadville limestone and implications for genesis of Pb-Zn-Ag deposits (abs.): U.S.; Amer. Asso. Petrol. Geol. Annual Convention [in press].

560. Hose, H.R. (1978) - Mediterranean karst bauxite genesis and plate tectonics during the Mesozoic in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 333-341.

It is suggested that Mediterranean karst bauxites were formed on island arcs when oceanic microplates were in collision due to the anticlockwise rotation of the African plate toward the European-Asian plate during the Mesozoic.

561. Hoskin, Ch.M. (1968) - Magnesium and strontium in mud fraction of recent carbonate sediment, Alacran Reef, Mexico: U.S.; Bull. Amer. Asso. Petrol. Geol. 52:11, p. 2170-2177, 5 figs.

562. Howard, P.F. (1979) - Phosphate: U.S.; Economic Geology, Vol. 74, p. 192-194.

There are three types of phosphate rock, namely, sedimentary phosphorites of marine origin, apatite-bearing alkaline igneous complexes, and phosphorites of guano origin. Of these, the sedimentary phosphorites have historically dominated the world production scene. Simultaneously, igneous complexes have been gaining and guano-origin deposits have been diminishing in production during the last two decades.

563. Howard, P.F.; and Hough, M.J. (1979) - On the geochemistry and origin of the D Tree, Wonarah, and Sherrin Creek phosphorite deposits of the Georgina Basin, northern Australia: U.S.; Economic Geology, Vol. 74, p. 260-284.

The early Middle Cambrian phosphorites of the Georgina Basin were deposited in shallow nearshore marine environments varying from lagoonal, estuarine, littoral, to intertidal. There are three distinct types of phosphorite: mudstone, replacement, and pelletal. The latter two were formed by diagenetic phosphatization of carbonate skeletal sands, bioclastic and micritic limestones, and dolomites. By comparison, the mudstone phosphorite, which predominates in the three deposits studies, shows little textural evidence of such an origin and has been accepted as an orthochemical sediment. However, this paper proposes a diagenetic origin identical to the other types.

564. Hsu, K.J. (1984) - A nonsteady state model for dolomite, evaporite, and ore genesis in Wauschkuhn, A., Kluth, C., and Zimmermann, R.A, editors, Syngenesis and Epigenesis in the Formation of Mineral Deposits: Germany, F.R., Heidelberg; Springer-Verlag, p. 275-286.

Considerations of the magnitude of the material transport suggest that the solutions transporting ions for dolomite, evaporite, and ore-geneses (Alpine type) must have moved vertically through a sedimentary pile. Laboratory experiments demonstrated ascending ground-water movement induced by evaporite pumping.

565. Hsu, K.J.; and Jenkyns, H.C., editors, (1974) - Pelagic sediments: on land and under sea: England; Spec. Publ. Inter. Asso. Sedimentologists 1, 447 p.

These are the proceedings of an international symposium held in Zurich, Switzerland, in 1973 about Recent and Ancient pelagic sediments, including studies of the genesis of chalk, silicification, and chert formation as well as carbonate solution in the deep sea. Theoretical models are presented of the origin of nodular limestones as well as of the connection between "plate-stratigraphy" and various carbonate solution levels throughout geologic time.

566. Hubbard, D.A., Jr.; Giannini, W.F.; and Lorah, M.M. (1985) - Travertine-marl deposits of the Valley and Ridge province of Virginia - A preliminary report: U.S.; Virginia Minerals, 31:1.

Travertine and marl deposits of Virginia's Valley and Ridge province are the result of precipitation of calcium carbonate from fresh water streams and springs. Travertine is white to light yellowish brown and has a massive or concretionary structure. Buildups of this material tend to form cascades or waterfalls along streams. Marl refers to white to dark yellowish brown, loose, earthy deposits of calcium carbonate. Deposits of these carbonate materials are related and have formed during the Quaternary period. This preliminary report is a compilation of these materials. A depositional model is proposed.

567. Hudson, J.D. (1975) - Carbon isotopes and limestone cements: U.S.; Geol. 3, p. 19-22.

568. Hudson, J.D. (1977) - Stable isotopes and limestone lithification: London, England; Geol. Soc. London Quart. Journ. 133, p. 637-660.

569. Hudson, J.D.; and Jenkyns, H.C. (1969) - Conglomerates in Adnet Limestones of Adnet (Austria) and the origin of the "Scheck": Stuttgart; Neues Jahrbuch Geol. Palaeont. Monatshefte 1969/9, p. 552-558, 2 figs.

570. Hugman, R.H.H.; and Friedman, M. (1979) - Effects of texture and composition on mechanical behavior of experimentally deformed carbonate rocks: U.S.; Amer. Asso. Petrol. Geol. Bull. 63/9, p. 1478-1489, 4 figs., 6 tbls.

571. Hunter, J.C.; and Gutierrez, A.A. (1985) - Exploring for ground water in fractured carbonates: East-central New Mexico in Proceedings of the Association of Ground Water Scientists and Engineers: Western Regional Ground Water Conference, January 15-16, 1985, Reno, Nevada, p.274-280.

Much of the region east of Sandia and Manzano mountains near Albuquerque, New Mexico is underlain by gently-dipping limestones of the Madera Formation (Pennsylvanian). Bulk porosity, storativity and conductivity of these rocks are very low, and many wells in this area produce only 1 gallon per minute or less. A few wells (located in narrow, discrete fracture zones) are considered good producers with specific capacities of 7 - 10 gallons/minute/ft of drawdown. Wells in these fracture zones also have storativities and conductivities several orders of magnitude greater than in the unfractured host rock, and static water levels as much as 100 ft higher than adjacent wells. Pump-test results from wells in fractures show that drawdown in proportional to the square root of pumping time, as predicted by mathematical models. Hydrologically significant fractures lie in an orthogonal pattern (N. 80 W. and N. 30 E.) with a spacing of 1/4 to 1 mile, and are typically 10 - 50 ft. wide. Prospective fracture zones are located by an iterative process which combines data from aerial photograph analysis and field mapping with potentiometric-surface and well productivity surveys. Lineaments mapped on aerial photographs are field-checked, and the productivity of wells located in or near these zones is examined. Lineaments which are associated with highly productive wells become the primary targets for exploratory drilling.

Use of these methods has recently lead to the completion of a successful well (65,000 gallons/day) for a community of 250 in this area.

572. Illing, L.V. (1959)- Deposition and diagenesis of some Upper Paleozoic carbonate sediments in western Canada: 5th World Petrol. Congr. Proc. Paper 2, Sect. I, p. 23-50.

573. Iosof, V.; Coman, D.; Ianc, R. (1974) - Notes on the Presence of Allophane in the Vintului Cave in the Apuseni Mountains, Trav. Inst. Speol. "Emil Racovita", Bucharest, figures 1-5 (in French).

This is the first work to pinpoint the presence of allophane in caves, on the basis of chemical, X-ray, infrared and thermal (DTA, TG, DTG) analyses. The process of formation of this mineral in the Vintului cave, the largest underground cavity in Romania , is explained.

574. Irwin, H.; Curtis, C.; and Coleman, M. (1977) - Isotopic evidence for source of diagenetic carbonates formed during burial of organic-rich sediments: London, England; Nature 269, p. 209-213.

575. Iurkiewicz, A.; Mitgrofan, N. (1984) - On Karstic Cavities Vertical Distribution Regularities in Southern and South-Western Paudures Crainului Mountains, Theoretical and Applied Karstology, 1, 1984, p 77-82, 2 figures, 2 tables, in English with Romanian abstract.

In most cave developments and potholes, vertical extents are determined by local base level. Taking into account some 50 major caves and potholes from southern and south-western Padurea Craiului Mountains, a correlation is proposed between pits bottoms, cave floors and karstic springs elevations on the one hand and the erosional levels derived from surface drainage network evolution on the other hand.

576. Jaanusson, V. (1961) - Discontinuity surfaces in limestones: Uppsala; Bull. Geol. Inst. Univ. Uppsala 40, p. 221-241.

577. Jacka, A.D.; and Brand, J.P. (1977) - Biofacies and development and differential occlusion of porosity in a lower Cretaceous (Edwards) reef: U.S.; Journ. Sed. Petrol. 47:1, p. 366-381, 11 figs.

578. Jadoul, F.; and Omenetto, P. (1980) - Diagenetic evolution of ore-bearing internal sediments in karst cavities: Examples from the Triassic of the Bergamasc Alps (Gorno District, northern Italy): Neues Jahrb Geol. Palaontol. Monatsh 1980, p. 17-32.

579. Jakues, L. (1977) - Genetic types of Hungarian karst: Karst es Berlang [Budapest]: Spec. Issue, p. 3-18.

580. James, J.M. (1981) - The relationship between the availability of organic carbon and cavern development in the phreatic zone: Proc. 8th Inter. Congress Spele. I, p. 237-240.

581. James, W.C. (1980) - Limestone Channel Storm Complex (Lower Cretaceous), Elkhorn Mountains, Montana: U.S.; Journ. Sed. Petrol. 50:2, p. 447-456, 8 figs.

582. Jankovic, S. (1984) - Strata-bound low temperature Pb-Zn-Ba+F deposits in carbonate rocks of western Asia: Geotectonic setting and main metallogenic features in Wauschkuhn, A., Kluth, C., and Zimmermann, R.A, editors, Syngenesis and Epigenesis in the Formation of Mineral Deposits: Germany, F.R., Heidelberg; Springer-Verlag, p. 373-390.

Strata-bound Pb-Zn-Ba+F deposits and their geotectonic setting in western Asia are described. The various zones display common features, including mineral associations, regional structural control, and shape and size of

regional metallogenic units. Zonation of mineral distribution as well as correlation with other regional metallogenic units are considered.

583. Jaquet, J.-M. (1973) - Analyse statistique de la variation verticale des descripteurs dans la formation de Vions (Berriasien superieur, Jura meridional): Switzerland; Arch. Sci. Geneve, 26:1, p. 246-283.

Study of the vertical variations of the carbonate, quartz, and clay content, the mean quartz grain diameter etc., with trend and auto-correlation analyses.

584. Jaquet, J.M. (1973) - Definition de microfacies par classification automatique et comparison des descripteurs: Switzerland; Arch. Sci. Geneve, 26:2, p. 137-171.

Upper Berriasian. Jura mountains/France. 700 samples; 41 non-numerical criteria. Calculation of the similarity coefficients on the basis of presence or absence: dendrograms after Sokal and Sneath; 7 MF types were differentiated. The determination of the variations between the variables of a sample and between the samples themselves permit the differentiation of sensible facies units.

585. Jawad, S.B.; and Hussien, S.B. (1986) - Contribution to the study of temporal variations in the chemistry of spring water in karstified carbonate rocks: Hydrological Sciences Journal, Vol.31, No.4, p.529-541.

The temporal variations of spring water chemistry are used to support observations on the nature of ground water circulation inside a karstified carbonate terrain. Variations in some hydrochemical properties such as the Ca(++) to Mg(++) ratio, the hardness, the electric conductivity, the CO2 partial pressure, and the calcite and dolomite saturation ratios are used to give indications with regard to the nature of the carbonate rock, the groundwater residence time, and the mode of water circulation inside the karstic system. The seasonal variations of these properties during four years of monitoring were determined for six adjacent springs in a karstified carbonate terrain in northwest Iraq. The carbonate terrain, which is known to be mostly limestone with some dolomitic limestone beds, has given an average value of 3.3 for the Ca(++) to Mg(++) ratio. The magnesium and calcium hardness has high values (341-368 ppm) with a coefficient that exceeds 11 percent. The partial pressure of CO2 has a minimum of 10 to minus 2.7 power bar and a maximum of 10 to the minus 1.8 power bar. The values of the calcite and dolomite saturation indices fluctuate about saturation levels despite the presence of an appreciable concentration of NaCl. These results, when combined with other analyses and observations related to the flowrate characteristics of the springs, have revealed that the six springs are fed by a common diffuse type karstic system with a rather high but acceptable coefficient of variation of hardness.

586. Jeannel, R.; Racovita, E. (1929) - A List of Visited Caves, 1918-1927 (the 7th Series), Archives of Experimental and General Zoology, 68(2): 293-608, figures 1-67, diagrams I-II (In French).

Geographic location, a general description and a list of cave animals with thermohygrometric conditions and food supplies are described for 283 caves explored in Romania, Algeria, Spain, France, Madagascar, Portugal, Switzerland, Turkey and Yugoslavia.

587. Jekelius, E. (1964) - Karstic regions between the Dragan and Iad Valleys. Lucr.Inst., de speol. "Emil Racovita", T.III, p 201-213, Bucharest (in Romanian).

Results are outlined of karstic hydrological research work conducted in the basins of the Dragan and Ian valleys to detect and follow underground courses. The author concludes that there is no link between the underground waters of the two basins which developed in two different tectonic units where the recent processes of karst formation were independent from one another.

588. Jenkyns, H.C. (1970) - Growth and disintegration of a carbonate platform: Stuttgart; N. Jb. Geol. Palaeont. Mh. 1970, p. 325-344.

589. Jenne, E.A. (1981) - Speciation of aqueous contaminants - role of the geochemical model in Brinkman, F.E.; Fish, R.H., editors, Environmental Speciation and Monitoring Needs for Trace Metal-Containing Substances from Energy-Related Processes: NBS Spec. Publ., p.39-53.

590. Jimenez, A.N. (1976) - Carso profundisimo de Cuba: Proc. 6th Inter. Congr. Spele., III, Olomouc 1973, p. 225-227.

591. Johansing, R.J. (1982) - Physical-chemical controls of dolomite-hosted Sherman-type mineralization, Lake and Park Counties, Colorado: U.S.; Colorado State Univ., M.S. Thesis, 158 p.

592. Joost, R.E.; Olsen, F.J.; and Jones, J.H. (1987) - Revegetation and minesoil development of coal refuse amended with sewage sludge and limestone: Journal of Environmental Quality, Vol.16, No.1, p.65-68.

A study was conducted at Peabody Coal Company's Will Scarlet Mine in Southern Illinois to evaluate the effectiveness of deep incorporation of dried sewage sludge and/or limestone to ameliorate acid coal refuse (gob) for establishment and survival of three forage grasses. Dried sewage sludge and/or limestone were applied at 10 rates throughout the profile of trenches opened (30 or 60 cm) by a cable trencher. Subplots of reed canarygrass (Phalaris arundinacea L.), tall fescue (Festuca arundinacea Schreb.) and redtop (Agrostis alba L.) were established in September 1980. Analysis of soil chemical and physical changes over time indicated that organic matter applied in the sewage sludge decreased by 35% 2 years after the plots were established, while the proportion of sand-size water-stable aggregates increased over the same period. The proportion of large pores increased in the high rate sewage sludge plots over that of lime-treated plots. Coal refuse pH increased from 2.7 in the unamended gob to 4.4 to 5.2 with all treatments but the two lower lime rates. All treatments maintained grass stands over 4 years with the exception of the 225 Mg sludge/ha plus 45 Mg limestone/ha mixture at 60 cm. Reed canarygrass invaded adjacent plots and was more persistent than the other grasses. Mean herbage yield of the grasses exceeded 4.0 Mg/ha on all treatments. Tissue accumulation of heavy metals was not a problem. Tissue NO_3 levels were considered toxic for ruminants the first 3 years but decreased significantly over time. Coal refuse disposal sites can be revegetated without the use of soil cover by application of sewage sludge or limestone.

593. Juhasz, A. (1978) - Complex development of alumina processing in Hungary in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 343-368, 7 figs.

594. Julia, R. (1983) - Travertines in Scholle, P.A., Bebout, D.G., and Moore, C.H., editors, Carbonate Depositional Environments: U.S.; Amer. Asso. Petroleum Geologists Memoir 33, p. 64-72.

595. Jundrich, Vl. (1969) - Recent carbonate sedimentation by tidal channels in the Lower Florida Keys: U.S.; Journ. Sedimentary Petrology, 39:2, p. 1-533.

Important studies of sediment mixing in a tidal channel in a Recent carbonate sedimentary environment overlying Pleistocene carbonates whose rock fragments are admixed with Recent bioclasts. The channel sediments are characterized by anomalous size/roundness ratios and by negative skewness distributions.

596. Juracic, M.; and Pravdic, V. (1981) - Geochemical and physico-chemical studies on sediments of the Rijeka Bay: The properties of sediments as depositories of pollutants: Yugoslavia; Thalassia Jugoslavica, 17:3/4, p. 339-349.

The sediments of the Rijeka Bay (the Northern Adriatic) were investigated, with regard to their role as a repository of pollutants.

597. Juracic, M.; and Prohic, E. (1986) - Transfer of heavy metals by suspended matter in the Krka River estuary, Yugoslavia: Yugoslavia; Rapp. Comm. Inter. Mer. Medit., 30:2.

The authors describe research in the Krka River estuary in the Yugoslav Eastern Adriatic. Research reported here is part of a modeling exercise, intended to develop environmental management strategies, particularly with respect to pollution from land-based sources.

598. Juracic, M.; Prohic, E.; and Pravdic, V. (1984) - Sediment surface properties and adsorption of heavy metals in a typical karst estuary: Switzerland; VII Journees Etud. Pollutions, C.I.E.S.M., p. 151-157.

The Krka River estuary is located in the typical karst region of the eastern Adriatic. It was chosen as a model for studies of the transfer mechanisms for pollutants from land to sea.

599. Jurcsak, T.; Polis, Rozalia; Ignat Doina; Serban, M.; Popa, Elisabeta (1981) - Data on the Fossil Fauna in the Ursilor Cave, Nymphaea, Folia naturae Bihariae, 8-9: 161-257, Oradea (in Romanian).

The Ursilor Cave in the vicinity of the village of Chiscau (Pietroasa commune, Bihor county) was discovered in 1975 and opened to tourism. As many as 3,744 paleonthologic remains were studied of 39 animal species. Mammals in particular were identified, including Ursus spelaeus, from which the name of the cave originates. Archaeological remains were studied.

600. Jurgan, H. (1960) - Sedimentologie des Lias der Berchtesgadener Kalkalpen: Stuttgart; Geol. Rundschau 58, p. 464-501.

601. Kahle, Ch.F. (1971) - Stratigraphic and environmental significance of sedimentary structures in Cayugan (Silurian) tidal flat carbonates, northwestern Ohio: U.S.; Geol. Soc. Amer. Bull. 82, p. 2071-2098, 15 figs., 5 tbls.

602. Kastning, E.H. (1975) - Cavern development in the Helderberg Plateau, east-central New York: U.S.; New York Cave Surv. Bull. 1.

603. Kastning, E.H. (1978) - Caves and karst hydrogeology of the southeastern Edwards Plateau, central Texas: Guidebook, geology field excursion, National Spele. Soc. annual convention, New Braunfels, Texas, June 18-23, 1978: U.S.; National Spele. Soc. Guide 19A.

604. Kastning, E.H. (1980) - Structural, lithologic, and topographic controls on the origin of Natural Bridge Caverns, Comal County, Texas (abs.): U.S.; National Spele. Soc. Bull. 42, 32 p.

605. Kastning, E.H. (1983) - Relict caves as evidence of landscape and aquifer evolution in a deeply dissected carbonate terrain: Southwest Edwards Plateau, Texas, U.S.A. in Back, W., and LaMoreaux, P.E., guest editors, V.T. Stringfield Symposium: Processes in Karst Hydrology: U.S.; Journ. Hydrology, Vol. 61, p. 89-112.

606. Katz, A.; and Matthews, A. (1977) - The dolomitization of $CaCO_3$: An experimental study at 252-295°C: Oxford; Geochim. Cosmochim. Acta 41, p. 297-308.

607. Katz, A.; Sass, E.; Starinsky, A.; and Holland, H.D. (1972) - Strontium behaviour in the aragonite-calcite transformation: An experimental study at 40-98°C: Oxford; Geochim. Cosmochim. Acta 36, p. 481-496.

608. Kayser, K. (1973) - Bemerkungen Hueber den Pluralismus der Poljenentstehung und die Stellung des Poljes im Rahmen des Karstformenschatzes in Neue Ergebnisse der Karstforschung in den Tropen und im Mittelmeerraum: Wiesbaden: Franz Steiner 1973, p. 75-82.

609. Keith, M.L.; and Weber, J.N. (1964) - Isotopic composition and environmental classification of selected limestones and fossils: Oxford; Geochim. Cosmochim. Acta 28, p. 1787-1816.

610. Keith, M.L.; and Weber, J.N. (1965) - Systematic relationships between carbon and oxygen isotopes in carbonates deposited by modern corals and algae: U.S.; Science 150, p. 498-501.

611. Kelling, G.; and Mullin, P.R. (1975) - Graded limestone and limestone-quartzite couplets: Possible storm-deposits from the Maroccan Carboniferous: Amsterdam; Sed. Geol. 13, p. 161-190.

612. Kendall, C.G.St.; and Schlager, W. (1981) - Carbonates and relative changes on sea level: Amsterdam; Marine Geo. 44 [in print].

613. Kennedy, W.J.; and Garrison, R.E. (1975) - Morphology and genesis of nodular chalks and hardgrounds in the Upper Cretaceous of southern England: Oxford; Sed. 22, p. 311-386.

614. Kerdijk, H.N. (1981) - Groundwater pollution by heavy metals and pesticides from a dredge spoil dump in van Fuyvenboden, W.; Glasbergan, P; and van Lelyveld, H., editors, Quality of groundwater: The Netherlands; Elsevier, Amsterdam, p.279-286.

615. Keskin, C. (1966) - Microfacies study of the Pinarhisar Reef Complex, Istanbul University Fen Fak. Mecmausi, Ser. B: Turkey; 31:3-4, p. 109-146.

> 1000 samples were analyzed by point-counting. Calculation of "reaction groups" were determined for 730 samples by factor analyses. Five facies types were determined (bryozoanalgae F, coral-hydrozoan F, coastal F, mud F with echinoid fragments, and foraminifera facies).

616. Khorosheva, D.P. (1973) - Aluminum oxides in Craboniferous rocks of the junction zone between the Ukrainian shield and the Dnieper-Donets basin: USSR; Dokl. Acad. Sci., Earth Sci. Sec., Vol. 203, p. 120-121, 1 fig. [transl. from Dokl. Akad. Nauk SSSR, 203, p. 443-445, 1972].

> Sparse grains of gibbsite, boehmite, and diaspore occur in argillaceous material in limestone and in kaolin beds. Their presence may be regarded as a possible clue in the search for bauxite deposits.

617. Kinsman, D.H.; and Holland, H.D. (1969) - The co-precipitation of cations with $CaCO_3$ - IV, The co-precipitation of Sr^{2+} with aragonite between 16° and 96°: Oxford; Geochim. Cosmochim. Acta 33, p. 1-17, 1 fig.

618. Kinsman, D.J.J. (1966) - Gypsum and anhydrite of recent age, Trucial Coast, Persian Gulf in Rau, J.L., editor, 2nd Symp. on Salt, Cleveland, Ohio, Northern Ohio Geol. Soc. 1, p. 302-326.

619. Kinsman, D.J.J. (1969) - Interpretation of Sr^{2+} concentration in carbonate minerals and rocks: U.S.; Journ. Sed. Petrol. 39:2, p. 486-508, 4 figs.

620. Kiskyras, D.; Chorianopoulou, P.; and Papazeti, H. (1978) - Some remarks about the mineralogical composition of the Greek bauxites in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 409-433, 12 figs.

> Major element chemical and XRD model analyses are tabulated; some DTA curves are also given.

621. Kiskyras, D.A. (1978) - New data on the Helikon bauxite area in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 434-448, 8 figs.

622. Kiskyras, D.A. (1978) - Quelques reflexions sur la genese des bauxites de la Grece in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 388-408, 5 figs.

> The author hypothesized that Greek bauxites were deposited not in geosynclinal but in geoanticlinal zones. Major element analyses were conducted for 133 bauxites and 11 limestones.

623. Kisvarsanyi, G. (1983) - Multiple source and multiple stage theory of ore genesis in the Southeastern Missouri District in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 486-496.

> The author hypothesized that Southeast Missouri ores formed in four stages. Several pulses of brines may have acquired their metals from different sources: from the Precambrian basement, the arkosic Lamotte, as well as from hydrocarbon-bearing proximal and distant sedimentary basins. The conclusion presented is that there are at least three, genetically different types of ore deposits intermixed in the Southeast Missouri deposits as a result of a fundamental control by structure.

624. Kitano, Y.; Okumura, M.; and Idogaki, M. (1975) - Incorporation of sodium, chloride, and sulfate with calcium carbonate: Geochem. Journ. 9, p. 75-84.

625. Klappa, C.F. (1983) - A process-response model for the formation of pedogenic calcretes in Wilson, R.C.L., editor, Residual Deposits: Surface Related Weathering Processes and Materials: U.K., London; Blackwell Scientific, p. 211-220.

> The compositional and fabric evolution of pedogenic calcretes is viewed as a process-response model involving inorganic and organic soil-forming processes and diagenetic, rock-forming processes. Emphasis is placed on the role of organic activity which determines largely the morphology of pedogenic calcrete profiles and which controls the direction and extent of profile development.

626. Klau, W.; and Mostler, H. (1983) - Alpine Middle and Upper Triassic Pb-Zn deposits in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference

on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 113-128.

> After a brief summary of the depositional environment of the Alpine Triassic, mineralization in the basal continental-detrital sediments is described. The paleotectonic situation of the carbonate-hosted Pb-Zn deposits is discussed, and a new genetic interpretation is presented.

627. Klemm, D.D.; and Neumann, N. (1984) - Ore-controlling factors in the Hg-Sb province of southern Tuscany, Italy in Wauschkuhn, A., Kluth, C., and Zimmermann, R.A, editors, Syngenesis and Epigenesis in the Formation of Mineral Deposits: Germany, F.R., Heidelberg; Springer-Verlag, p. 484-503.

> Various geological parameters which are responsible for the formation of the mercury and antimony deposits in southern Tuscany are studied.

628. Knauth, L.P. (1979) - A model for the origin of chert in limestone: U.S.; Geology 7, p. 274-277.

629. Knox, G.J. (1977) - Caliche profile formation, Saldanha Bay (South Africa: Oxford; Sed. 24, p. 657-674, 9 figs.

630. Kohler, M. (1973) - Mikrofazielle, geochemische und palaeogeographische Untersuchungen des Plattenkalkes und der Koessener Schichten der mittleren Gailtaler Alpen (Kaernten): Innsbruck; Veroeff. Univ. Innsbruck 86, Festschrift Heissel, p. 129-180.

631. Kolmer, H. (1975) - Spurenanalytische Untersuchungen an Karbonatgesteinen des Grazer Palaeozoikums: Mitt. naturwiss. Verein Steiermark 105, p. 53-69, 3 figs., 4 tbls.

632. Komatina, M. (undated) - Hydrogeological approach to investigation in karst for possible modification of groundwater regime and increase of recoverable reserves: Yugoslavia; Geozavod, 7 p.

> An attempt is made in this paper to suggest a variety of solutions for water resource utilization in naked geosynclinal karst and to encourage greater activity in this field.

633. Konikow, L.F. (1985) - Process and rate of dedolomitization: Mass transfer and ^{14}C dating in a regional carbonate aquifer: Extended interpretation and reply: U.S.; Geol. Soc. America Bull., Vol. 96, p. 1096-1099.

> Back and others (1983) used geochemical and isotopic data to estimate flow velocity and hydraulic conductivity for the Madison aquifer system in parts of Wyoming and South Dakota that are downgradient from a major recharge area, the Black Hills. The purpose of this article is to expand upon preliminary hydrologic inferences by Back and others (1983).

634. Kostelka, L.; and Petrascheck, W.E. (1967) - Genesis and classification of Triassic Alpine lead-zinc deposits in the Austrian region in Brown, J.S., editor, Genesis of Stratiform Lead-Zinc-Barite-Fluorite Deposits in Carbonate Rocks: U.S.; Economic Geology, p. 138-146.

635. Koudelin, B.I.; and Karpova, V.P. (1965) - The effect of karst on the regularities of groundwater flow formation: France; UNESCO, International Hydrological Decade, Symposium on Hydrology of Fractured Rocks, Dubrovnik, Yugoslavia, 7-14 October 1965, Paper 67, 6 p.

> Ground-water flow into streams is formed under the influence of three factors: climatic, topographic, and structure-hydrogeologic. Climate influences ground-

water flow distribution features of pronounced latitudinal zonation. Topography influences ground-water flow features of vertical zonation which in turn is related to vertical distribution of precipitation, depending on the elevation. The hydrogeological factor disturbs the smooth zonal character of ground-water flow distribution over the territory.

636. Krajcar-Bronic, I.; Horvatincic, N.; Srdoc, D.; and Obelic, B. (1986) - On the initial ^{14}C activity of karst aquifers with short mean residence time: Yugoslavia; Radiocarbon, 28:2A, p. 436-440.

The ^{14}C activity of total dissolved inorganic carbon (DIC) as well as tritium activity and stable isotope content (^{13}C, ^{2}H, ^{18}O) of spring water were measured for three consecutive years at three karst springs that feed Plitvice Lakes, NW Yugoslavia.

637. Kranz, J.R. (1976) - Strontium - ein Fazies-Diagenese-Indikator im oberen Wettersteinkalk (Mittel-Trias) der Ostalpen: Stuttgart; Geol. Rdsch. 65:2, p. 593-615, 9 figs., 4 tbls.

638. Krebs, W. (1971)- Devonian reef limestones in the eastern Rhenish Schiefergebirge in Mueller, G., Friedman, G.M, editors, Sedimentology of Central Parts of Central Europe, p. 45-81.

639. Krebs, W. (1974) - Devonian carbonate complexes of Central Europe: U.S.; Soc. Econ. Paleont. Min. Spec. Paper 18, p. 155-208, 25 figs.

640. Kresic, N.; and Papic, P. (undated) - Specific chemical composition of karst groundwater in the Ophiolite Belt of the Yugoslav Inner Dinarides: A case for covered karst: Yugoslavia; Belgrade University, 11 p.

Complex hydrogeological research conducted in the last few years have shown that Triassic limestone is widespread and is covered with ophiolites of Jurassic age in the Ophiolite Belt of the Yugoslav Inner Dinarides. The authors' use of hydrochemical analyses established relationships between the main chemical components in groundwaters of the area and allowed conclusions about the origin of karst groundwaters, properties of karst aquifers, and influences of ultramafics on them.

641. Kronberg, B.I.; Couston, J.F.; Filho, B.S.; Fyfe, W.S.; Nash, R.A.; and Sugden, D. (1979) - Minor element geochemistry of the Paragominas bauxite, Brazil: U.S.; Econ. Geology, Vol. 74, p. 1869-1875.

642. Kroopnick, P.M., Margolis, S.V.; and Wong, C.S. (1977) - ^{13}C variations in marine carbonate sediments as indicators of the CO_2 balance between the atmosphere and the oceans in Anderson, N.R., and Malahoff, A., editors, The Fate of Fossil Fuel CO_2 in the Oceans: U.S.; Plenum Press, p. 295-321.

643. Krstulovic, R.; and Peric, J. (1978) - The comparative chemical investigation of bauxite in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 449-466, 2 figs.

Analytical methods for bauxites are discussed.

644. Krule, Z. (1978) - New results and development trends in geophysical prospecting of bauxite deposits in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 467-472.

645. Kubanek, F.; and Parekh, P. (1976) - A study of the trace element distribution in an interlaminated limestone-dolostone: Hannover; Geol. Jahrbuch. D 20, p. 23-39, 1 pl., 8 figs., 9 tbls.

646. Kubat, I. (1973) - Some new facts about the bauxite of eastern Bosnia, with a special review of rare elements: Geol. Glasnik, Vol. 17, p. 261-268, 8 maps and charts [Serbo-Croatian with English summary].

> All bauxite deposits in eastern Bosnia are found in sediments between Upper Cretaceous and Middle Triassic. It seems improbable that all Al originates from limestones and dolomites; other Al-rich rocks may have contributed. The quality of the bauxite ore increases from northwest to southeast. The distribution of trace elements is discussed.

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648. Kukal, Z. (1975) - On the origin of nodular limestone: U.S.; California Min. Geol. 20, p. 359-368.

649. Kunaver, J. (1965) - Guide through the high mountainous karst of the Julian Alps: 4th Inter. Congr. Spele., Ljubljana.

650. Kyle, J.R. (1983) - Temporal and spatial aspects of mineralization in the K57 orebody, Pine Point district, Northwest Territories, Canada in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 338-346.

> The K57 orebody is an excellent example of the nature and controls of mineralization in the upper part of the Middle Devonian Pine Point carbonate barrier complex.

651. Lacey, J.E.; and Carozzi, A.V. (1967) - Crite'res de distinction entre oolithes autochthones et allochthones. Application du calcaires de Saint-Ge'nevie've (Vise'en de l'Ilinois, USA): France; Bull. Centre Rech. Pau SNPA 1,2, p.279-313.

> The authors discuss differentiation of autochthonous and allochthonous ooids with the aid of grain-size distributions (skewness).

652. Lagny, P. (1969) - Mineralisation plombo-zincifere triasique dans un paleokarst (gisement de Salafossa, province de Belluno, Italie): Compt. Rend. Acad. Sci. Paris D268, p. 1178-1181.

653. Lagny, P. (1975) - Le gisement plombo-zincifere de Salafossa (Alpes italiennes orientales): Remplissage d'un paleokarst triasique par des sediments sulfures: Min. Deposita 10, p. 345-361.

654. Lagny, P.H.; and Rouvier, H. (1976) - Les gisements Pb-Zn en roches carbonatees sous inconformite: Gisements paleokarstiques ou gisement dans des paleokarsts?: Mem. Soc. Geol. Fr. 7, p. 57-69.

655. Lambert, I.B. (1976) - The McArthur zinc-lead-silver deposit: Features, metallogenesis and comparisons with some other stratiform ores in Wolfe, K.H., editor, Handbook of Strata-Bound and Stratiform Ore Deposits: The Netherlands, Amsterdam; Elsevier, Vol. 6, p. 535-585.

656. Lambert, I.B. (1982) - Constraints on the genesis of major Australian lead-zinc-silver deposits: From Ramdohr to present in Amstutz, G.C., El Goresy, A., Frenzel, G., Kluth, C., Moh, G., Wauschkuhn, A., and Zimmermann, R.A., editors, Ore Genesis: The State of the Art: Germany, F.R., Heidelberg; Springer-Verlag, p. 625-636.

657. Lamonds, A.G.; and Merritt, M.A. (1976) - Proposed Cross-Florida barge Canal - water-quality aspects: U.S.; U.S. Geol. Survey, Water-Resources Investigation No. 76-23, 189 p.

> Based on the results of this investigation, the authors indicate that the chemical character of both surface and groundwater in the area of the Cross-Florida Barge Canal is strongly influenced by the limestone and dolomite of the Floridan aquifer, the principal source of fresh-water supplies in the area.

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> Connector wells, a mechanism for water management in the Central Florida Phosphate District, have proven to be an effective means of moving good-quality groundwater from one formation downward to another under gravity flow. The results are beneficial recharge to the underlying Floridan Aquifer and a solution to a dewatering problem that enhances the mining of phosphate ore. Three unique recharge systems have been developed in the phosphate district of Florida and are described.

659. Land, L.S. (1970) - Phreatic versus vadose meteoric diagenesis of limestones: Evidence from a fossil water table: The Netherlands, Amsterdam; Sedimentology 14, p. 175-185.

660. Land, L.S. (1980) - The isotopic and trace element geochemistry of dolomite: The state of the art: U.S.; Soc. Econ. Paleont. Min. Spec. Publ. 28, p. 87-110.

661. Land, L.S.; and Hoops, G.K. (1973) - Sodium in carbonate sediments and rocks: A possible index to the salinity of diagenetic solutions: U.S.; Journ. Sed. Petrol. 43, p. 614-617.

662. Langmuir, D. (1971) - The geochemistry of some carbonate ground waters in central Pennsylvania: Geochim. et Cosmochim. Acta 35, p. 1023-1045.

> The field pH and content of Ca^{2+}, Mg^{2+}, HCO_3^-, dissolved oxygen, and other aqueous species were measured in 29 spring waters and 29 well waters in folded and faulted Paleozoic carbonate rocks near State College, Pennsylvania. Most of the springs issue from limestone; most of the well waters are pumped from dolomite. Results of chemical analyses and thermochemical data indicate that 12 well waters and 3 spring waters were saturated with calcite, whereas 7 well waters and 3 spring waters were saturated with dolomite. None of the groundwaters significantly exceeded saturation with respect to either carbonate.

663. Lantzy, R.J.; and MacKenzie, F.T. (1979) - Atmospheric trace metals: Global cycles and assessment of man's impact: United States; Geochim. Cosmochim. Acta, Vol. 43, p.51-525.

664. Laporte, L.F. (1969) - Recognition of a transgressive carbonate sequence within an epeiric sea: Helderberg Group (Lower Devonian) of New York State: U.S.; Soc. Econ. Paleont. Min. Spec. Publ. 14, p. 98-119, 15 figs.

665. Large, D.E. (1980) - Geological parameters associated with sediment-hosted, submarine exhalative Pb-Zn deposits: An empirical model for mineral exploration: Geol. Jahrbuch, Reihe D, Vol. 40, p. 59-130.

666. Larsen, K.G. (1977) - Sedimentology of the Bonneterre Formation, southeast Missouri: U.S.; Economic Geology, Vol. 72, p. 408-419.

The Bonneterre Formation is the host for the lead deposits of southeast Missouri. The sedimentology of the formation strongly influenced the character of individual orebodies.

667. Larter, R.C.L.; Boyce, A.J.; and Russell, M.J. (1981) - Hydrothermal pyrite chimneys from the Ballynoe baryte deposite, Silvermines, County Tipperary, Ireland: Min. Depos., Vol. 16, p. 309-318.

668. Lascu, C.; Bleahu, M. (1985) - The Bulba Cave, The Sport-Turism Publishing House, Bucharest (in Romanian) p 38, 97 photos.

This is an illustrated monograph in which the authors show one of the most representative caves of the karstic area of the Mehedinti Plateau. The authors outline the exceptional geographic location of the 5 km of galleries - the natural bridge at Ponoarele, the lapies field and Lake Zaton. The authors present black-and-white and color photographs of characteristic and original aspects of underground morphology. The highly instructive structural control of the speleothems is used to demonstrate the man-cave relationship.

669. Lascu, C.; Povara, I. (1980) - Notes on the Sapte Isvoare Reci Karstic Emergences (the Cerna Valley). Trav. Inst. Speol. "Emil Racovita", Bucharest, Tome XIX, p 247-251 (in French).

The authors outline the particular hydrology of a group of karstic springs situated in the Cerna valley graben which, although originating from various sources, are related as indicated by analyses of temperature, discharge and chemistry.

670. Lascu, V. (1984) - Ciur Ponor - A cave as yet unconquered, Buletinul CSER, Bucharest, 8, p 125-133, 5 maps. 1 sketch (in Romanian) Pages of delicate exploration in a cavity which is 10,500 m long and has a level difference of 191 m.

671. Laszlo, K. (1978) - System investigations in the aluminum industry in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 1, Bauxites: Athens; Natl. Techn. Univ., p. 369-387, 6 figs.

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674. Laxen, D.P.H.; Harrison, R.M. (1981) - A scheme for the physico-chemical speciation of trace metals in freshwater samples: Sci. Total Environ., Vol. 19, p.59-82.

675. Lea, E.R.; and Dill, D.B., Jr. (1968) - Zinc deposits of the Balmat-Edwards District, New York in Ridge, J.D., editor, Ore Deposits in the United States, 1933-1967: U.S.; Amer. Inst. Mining, Metallurgical, and Petroleum Engineers, Inc., p. 20-48.

Zinc deposits of the Balmat-Edwards Division of the St. Joseph Lead Company in northern New York State provide approximately 10 percent of the domestic zinc mined annually within the United States. These complex ore deposits are contained within marbles of the Precambrian Grenville series, in a repetitive sequence of dolomites and silicated units. Detailed structural and stratigraphic studies indicate the close dependence of the ore deposits on the enveloping structure.

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This is a survey of Recent carbonate sedimentation in the Bahama Banks; early diagenesis and lithification of shallow-water carbonates in Southern Florida; dolomite problems; and Mississippi limestones.

677. Lees, A. (1973) - Les depots carbonates de plate-forme: Pau; Bull. Centre Rech. Pau-SNPA 7:1,p. 177-192, 5 figs.

678. Lees, A. (1975) - Possible influences of salinity and temperature on modern shelf carbonate sedimentation: Amsterdam; Marine Geol. 19, p. 159-198.

679. Lees, A.; and Buller, A.T. (1972) - Modern temperate-water and warm-water shelf carbonate sediments contrasted: Amsterdam; Marine Geol. 13, p. M67-M73, 3 figs.

680. LeGrand, H.E. (1973) - Hydrological and ecological problems of karst regions: U.S.; Science, Vol. 179, p. 859-864.

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681. Lelong, F.; Tardy, Y.; Grandin, G.; Trescases, J.J.; and Boulange, B. (1976) - Pedogenesis, chemical weathering and processes of formation of supergene ore deposits in Wolf, K.H., editor, Handbook of Strata-Bound and Stratiform Ore Deposits, I. Principles and General Studies, Vol. 3, Supergene and Surficial Ore Deposits; Textures and Fabrics: The Netherlands, Elsevier Scientific, p. 93-173.

682. Lesevic, Z.; and Radosevic, B. (1978) - Some aspects of terrigenous sedimentation and karstification of Triassic sediments on Tara Mt. (Yugoslavia) in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 482-492.

683. Lewis, M.S. (1969) - Sedimentary environments and unconsolidated carbonate sediments of the fringing coral reef of Mahe', Seychelles: The Netherlands; Marine Geology, Vol. 1, p. 95-127.

Grain-size parameters (sorting, skewness, etc.) exhibit no clear correlations with certain parts of reefs, but certainly do with the "availability" of the skeletal grains and with different areas of turbulence.

684. Liedtke, H. (1962) - Eisrand und Karstpoljen am Westrand der Lukavicahochflaeche (Westmontenegro): Erdkunde 16:4, p. 289-298.

685. Lindberg, S.E., Harriss, R.C. (1983) - Water and acid soluble trace metals in atmospheric particles: Journal of Geophysical Research, Vol. 88, p.5091-5100.

686. Lindberg, S.E.; Harriss, R.C. (1981) - The role of atmospheric deposition in an eastern US deciduous forest: Water Air Soil Pollut., Vol. 16, p.13-31.

687. Lindberg, S.E.; Harriss, R.C.; and Turner, R.R. (1982) - Atmospheric deposition of metals to forest vegetation: United States; Science, Vol. 215, p.1609-1611.

688. Lindberg, S.E.; Harriss, R.C.; Turner, R.R.; Shriner, D.S.; and Huff, D.D. (1979) - Mechanisms and rates of atmospheric deposition of selected trace elements and sulfate to a

deciduous forest watershed, ORNL TM-6674: United States; Oak Ridge National Laboratory, Oak Ridge, Tennessee, 514 p.

689. Lindberg, S.E.; Maclaughlin, S.B. (1982) - Air pollutant interactions with vegetation: Research needs in data acquisition and interpretation in Krupa, S.V.; and Legge, A.H., editors, Air Pollutants and Their Effects on Terrestrial Ecosystems: United States, Wiley, New York.

690. Lindstrom, M. (1963) - Sedimentary folds and the development of limestone in an Early Ordovician sea: Amsterdam; Sed. 2, p. 243-292.

691. Liszkowski, J. (1975) - Ist die Mischungskorrosion die einzige im phreatischen Bereich der Karstgrundwasserleiter wirksame Korrosionsform?: Proc. 6th Inter. Congr. Spele. III, Olomouc 1973, p. 193-198.

692. Longman, M.W. (1980) - Carbonate diagenetic textures from near-surface diagenetic environments: Amer. Asso. Petrol. Geologists Bull. 64, p. 461-487.

693. Longman, M.W.; and Mench, P.A. (1978) - Diagenesis of Cretaceous limestones in the Edwards aquifer system of south-central Texas: A scanning electron microscope study: Sedimentary Geology, Vol. 21, p. 241-276.

694. Lotze, J. (1978) - Economic evaluation of world bauxite resources in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 493-506.

695. Loucks, R.G. (1977) - Porosity development and distribution in shoal-water carbonate complexes - subsurface Pearsall Formation (Lower Cretaceous), south Texas: U.S.; Texas Univ. Bur. Econ. Geol. Rep. Inv. 89, p. 97-126.

696. Loucks, R.G.; and Anderson, J.H. (1980) - Depositional facies and porosity development in Lower Ordovician Ellenburger Dolomite, Puckett Field, Pecos County, Texas in Halley, R.B. and Loucks, R.G., editors, Carbonate Reservoir Rocks: U.S.; Notes Soc. Econ. Paleont. Min. Workshop 1, p. 1-31.

697. Lucas, G.; Cros, P.; and Lang, J. (1976) - Les roches sedimentaires, 2. Etude microscopique de roches meubles et consolidees: France; Doin, 503 p.

> The authors present a short description of carbonate petrography and an extensive and richly illustrated survey of fossil groups appearing in thin-sections as well as of the diagenesis of carbonates. Instructive photographs of thin-sections are presented, but printing quality leaves much to be desired.

698. Ludvigson, G.A. (1980) - Unusual calcitic alteration of Hopkinton Dolomite (Silurian) in Plum River Fault Zone, eastern Iowa: U.S.; 92nd Session Iowa Academy Sci., Abs. of Papers, p. 15.

699. Ludvigson, G.A.; Bunker, B.J.; Witzke, B.J.; and Garvin, P.L. (1983) - A burial diagenetic model for the emplacement of zinc-lead sulfide ores in the Upper Mississippi Valley, USA in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 497-515.

> The epigenetic sulfide ores of the Upper Mississippi Valley primarily occur in Middle Ordovician carbonate host rocks which display no significant depositional facies variations in the district. A new burial diagenetic model for the Upper Mississippi Valley District is suggested.

700. Lumsden, D.N. (1971) - Facies and bed thickness distributions of limestones: U.S.; Journ. Sed. Petrol. 41:2, p. 593-598, 4 figs.

701. Lumsden, D.N. (1975) - Computer simulation experiments with clastic limestones: U.S.; Journ. Geol, 83:3, p. 375-386.

> In order to explain the development of detrital limestones, the possible relationships between the water energy at the bottom of the sea and five main constituents of limestones (micrite, sparite, skeletal grains, cortoids, ooids) were used for mathematical situations.

702. Lumsden, D.N. (1975) - Markov chain analysis of computer-simulated limestone sequences: U.S.; Geol. Soc. America Bull., Vol. 86, p. 1067-1072.

> No relationships could be found between statistical characteristics and the paleogeographic position of simulated limestone sequences.

703. Luttig, G. (1978) - Die Rolle der oberflaechennahen Rohstoffe in der Oeffentlichkeit und ihre Bedeutung fuer die menschliche Gesellschaft in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 507-525.

704. Lyle, J.R. (1977) - Petrography and carbonate diagenesis of the Bonneterre Formation in the Viburnum Trend area, southeast Missouri: U.S.; Economic Geology, Vol. 7, p. 420-434.

> The Bonneterre Formation in the Viburnum Trend area can be divided into fore reef, reef complex, back reef, and shelf facies. These facies are petrographic units representing different paleoenvironments whose characteristics were developed by sea level fluctuations and the distribution of Precambrian knobs and ridges in a shallow Cambrian sea.

705. Lynts, G.W. (1966) - Relationships of sediment-size distribution to ecologic factors in Buttonwood Sound, Florida Bay: U.S.; Journ. Sedimentary Petrology, 36:1, p. 66-74.

> The factor-vector analysis of ecological factors (water depth, temperature, salinity, pH and Eh) in 74 samples from Buttonwood Bay, which is scarcely 3 m deep, shows that no linear correlation exists between the ecological factors and the grain sizes. The grain size is determined by the distribution of the marine grass Thalassia, which traps fine-grained sediment.

706. M'Rabet, A. (1981) - Differentiation of environments of dolomite formation, Lower Cretaceous of Central Tunisia: Sedimentology 28, p. 331-352.

707. Mac, I.; Leontaris, Nikolaus Sotiris (1981) - The Polje in Skourta (Greece), Trav. Inst. Speol.. "Emil Racovita", Bucarest, XX, p 207-212, Bucharest (in French).

> The Polje in Skourta in the Beotia province, Greece, is a typical example of mixed genesis -- river-karstic and tectonic -- of these features of relief. An important role in the formation of the polje was played by conditions of bigger pluviosity in the Pleistocene. At present, the polje is partially operational, only in the rainy season, when drainage is achieved through lateral swallow holes and central sinkholes.

708. Mack, E.; and Petrascheck, W.E. (1978) - Palaeogeographie, Verteilung und Qualitaet der bauxite in Parnass-Kiona Gebirge in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 526-539, 4 figs.

709. Macquar, J.C.; and Lagny, P. (1981) - Mineralisations Pb-Zn "sous inconformites" des series de plates-formes carbonatees: Exemple du gisement de Treves (Gard, France): Relations entre dolomitisations, dissolutions et mineralisations: Mineralium Deposita, Vol. 16, p. 283-307.

710. MacQueen, R.W.; and Thompson, R.I. (1978) - Carbonate-hosted lead-zinc occurrences in northeastern British Columbia with emphasis on the Robb Lake deposit: Canadian Journ. Earth Sci. 15:11, p. 1737-1762.

711. MacQuown, W.C., Jr.; and Bloxam, T.W. (1972) - Depositional history of Carboniferous (Middle Visean) limestones from Bristol and parts of South Wales: U.S.; Bull. Amer. Asso. Petrol. Geol. 56:12, p. 2392-2414, 1 figs., 7 tbls.

712. Maiklem, W.R. (1968) - Some hydraulic properties of bioclastic carbonate grains: The Netherlands; Sedimentology Vol. 10, p. 101-109.

> Sample and density of bioclastic carbonate grains decisively influence grain-size distribution.

713. Mais, K. (1975) - Vorlaeufige Beobachtungen ueber Kondenswasserkorrosion in der Schlenkendurchgangshoehle (Salzburg): Proc. 6th Inter. Congr. Spele. III, Olomouc 1973, p. 203-208.

714. Maksimov, Z. (1978) - Nickel in karstic environment: In bauxites and in karstic nickel deposits: Bulletin du B.R.G.M., 2° serie, section II, Vol. 3, p. 173-183.

> Development of the Lower Cretaceous and Paleogene weathering crusts in connection with the formation of karstic bauxites and karstic nickel deposits on the Balkan Peninsula is discussed. A genetic relationship between karstic bauxites and karstic nickel deposits is established.

715. Maksimovic, Z. (1977) - Fossil weathering crusts in Yugoslavia and some geological problems: Bulletin de l'Academie Serbe des Sciences et des Artes, LVI, Classe des Sciences naturelles et mathematiques, Sciences naturelles, Vol. 15, p. 119-130.

> The author's purpose was to systematize the present knowledge and add new information on fossil weathering crusts on silicate rocks in Yugoslavia. Based on the evidence of the type and stage of development of weathering crusts on silicate rocks, geological problems such as the genesis of Mediterranean karstic bauxites are discussed.

716. Maksimovic, Z. (1979) - Geochemical study of the Marmara bauxite deposit: Implication for the genesis of brindleyite: Travauz ICSOBA, Vol. 15, p. 121-131.

> The Marmara bauxite deposit is one of the very rare deposits which is transitional between karstic bauxites and karstic nickel deposits. The enrichment "per descensum" of some trace elements (Ni, Cu, REE) has been very pronounced and resulted in the formation of brindleyite, bastnaesite, and malachite. This concentration is considered to be part of the primary syngenetic distribution of trace elements, which took place prior to deposition of the hanging wall limestone.

717. Maksimovic, Z. (1980) - The origin of yttrium and lanthanides in karstic bauxites of the Grebnik Mountain, Yugoslavia: Bulletin de l'Academie serbe des sciences et des arts, LXXII, Classe des sciences naturelles et mathematiques, Sciences naturelles, Vol. 20, p. 1-6.

> Representative samples of ultramafic rock, diabase, shale, and weathered shale were analyzed for rare-earth elements by neutron activation. The

analyses indicate shale and diabase as highly probably sources of yttrium and lanthanides in these bauxites. One part of Y,La-Lu in the shale (16.2% of the total) and in the red, kaolinic clay of the weathered shale (45.7%) occurs in the form of adsorbed ions. This indicates that substantial amounts of yttrium and lanthanides have been transported, in the form of adsorbed ions on clay particles, from the weathering crust on the diabase-chert formation into the adjacent karstic depression.

718. Maksimovic, Z. (1985) - Geochemistry of diaspore and corundum-bearing metabauxites from Naxos, Greece in Feenstra, A., editor, Metamorphism of Bauxites on Naxos, Greece: Utrech; p. 137-206 (Geologica ultraiectina, n. 39).

Part I concerns major and trace element chemistry and geochemical evidence of a Jurassic stratigraphic age (p. 137-173). Part II concerns the existence of premetamorphic trace element pattern in amphibolite facies metabauxite lenses and their use as geochemical top and bottom indicators (p. 175-206).

719. Maksimovic, Z.; and Bish, D.L. (1978) - Brindleyite, a nickel-rich aluminous serpentine mineral analogous to berthierine: Amer. Mineralogist, Vol. 63, p. 484-489.

The nickel-rich aluminous serpentine mineral originally called nimesite has been renamed brindleyite in honor of Professor G.W. Brindley. Brindleyite is a green clay-like mineral occurring adjacent to the footwall limestone at the base of the Marmara karstic bauxite deposit in Greece. Brindleyite is associated with bastnaesite, malachite, and bayerite.

720. Maksimovic, Z.; and de Wiesse, G. (1979) - Geochemical study of an overturned bauxite deposit in Les Codouls (S. France): Travaux ICSOBA, Vol. 15, p. 109-120.

Samples collected from two overturned bauxite layers in Les Codouls were studied using X-ray diffraction, DTA, TGA, chemical, and spectrochemical analysis. In both bauxite layers, the mineralogical composition is the same and an "upward" enrichment of trace elements (Ni, Co, Cu, Mn, Y, La, Pb) is well marked. This pattern of trace element distribution conforms with the reversed position of bauxite layers, which indicates that the present two layers belonged to the same original bauxite layer. Geochemical evidence indicates that for all bauxites formed in situ the primary, syngenetic distribution of trace elements was generally not affected by subsequent geological processes.

721. Maksimovic, Z.; and Panto, G. (1978) - Minerals of the rare-earth elements in karstic bauxites: Synchisite - (Nd), a new mineral from Grebnik deposit: in Augustithis, S.S., editor, 4th Inter. Congress for the Study of Bauxites, Alumina and Aluminum (ICSOBA), Vol. 2: Bauxites, Athens, Greece, Oct. 9-12, 1978: Greece; National Technical University, p. 540-552.

A study using an electron probe of samples with high contents of rare-earth elements revealed the presence of a new mineral of the bastnaesite group, synchysite-(Nd), from a Grebnik bauxite deposit and secondary monazite from a Marmara bauxite deposit.

722. Maksimovic, Z.; and Panto, G. (1980) - Bastnasite-(La) and monazite-(Nd), a new variety of monazite, from the Marmare bauxite deposit (Greece): Bulletin de l'Academie serbe des sciences et des arts, Classe des sciences naturelles et mathematiques, Sciences naturelles, Vol. 20, p. 35-42.

The study of brindleyite by electron probe analysis revealed in all samples the presence of secondary minerals: bastnaesite and monazite. The composition of these minerals is variable, and these differences indicate a strong

separation of individual lanthanides at close distance in the same karstic bauxite deposit.

723. Maksimovic, Z.; and Panto, G. (1981) - Synchisite-(Nd) from Grebnik bauxite deposit (Yugoslavia): Acta Geologica Academiae Scientiarum Hungaricae, Vol. 24 (2-4), p. 217-222.

An electron probe analysis of a bauxite sample with high contents of the rare-earth elements collected at Grebnik Mountain indicated the presence of synchysite-(Nd), a new mineral of the bastnaesite group. The analysis of this mineral is presented and the genesis discussed.

724. Maksimovic, Z.; and Panto, G. (1983) - Mineralogy of yttrium and lanthanide elements in karstic bauxite deposits: Travaux ICSOBA, Vol. 18, p. 191-200.

Authigenic minerals of the rare-earth elements have been found in many karstic bauxite deposits of Cretaceous age (Italy, Hungary, Yugoslavia, Greece). Their highest concentrations have been recently discovered in Jurassic bauxites of Montenegro, Yugoslavia. These minerals normally occur in the lower part of the deposits, in the contact zone with the footwall limestone. The most abundant minerals belong to the bastnaesite group: synchysite-(Nd), bastnaesite-(La), bastnaesite-(Ce), and bastnaesite-(Nd). Bastnaesite-(Nd), discovered in the Jurassic bauxites of Montenegro, represents a new member of this group.

725. Maksimovic, Z.; and Panto, G. (1985) - Hydroxyl-bastnaetie-(Nd), a new mineral from Montenegro, Yugoslavia: Mineralogical Magazine, Vol. 49, p. 717-720.

Hydroxyl-bastnaesite-(Nd), the Nd- and OH-dominant new member of the bastnaesite group, has been found in the red karstic bauxites near Niksic, Montenegro. It occurs as whitish, irregular aggregates of crystals usually 100 to 200 um in diameter. Necessary data on morphology, chemical, physical, and optical properties, X-ray data and infrared spectrum of this mineral are given.

726. Maksimovic, Z.; and Panto, G. (1985) - Neodimian goyazite in the bauxite deposit of Vlasenica (Yugoslavia): TMPM Tschermaks. Mineralogische und Petrographyische Mitteilungen, Vol. 34, p. 159-165.

An electron probe analysis of a bauxite sample with the highest content of the rare-earth elements collected at Nazda in the bauxite-bearing area of Vlasenica revealed the presence of neodimian goyazite, a mineral of the crandalite group. Its composition lies between goyazite, florencite, and crandalite, and can be described as $Cn_{24}Fc_{33}Gz_{43}$. The first analysis of this mineral in bauxites is presented and the genesis is discussed.

727. Maksimovic, Z.; Scavincar, B.; and Dangic, A. (1983) - The origin of karstic bauxites from the Vlasenica area, Yugoslavia: Travaux ICSOBA, Vol. 18, p. 29-38.

The origin of karstic bauxites from a bauxite-bering area in Vlasenica is considered from a study of (a) relics of the Lower Cretaceous weathering crust, (b) trace elements in the deposits, and (c) detrital minerals in the bauxites. The results indicate a complex origin from acid, mafic and ultramafic igneous rocks, as well as metamorphic and older sedimentary rocks. Spatial distribution of detrital minerals and trace element contents suggests not only source rocks but also different source regions.

728. Mamet, B. (1975) - An atlas of microfacies in Carboniferous carbonates of the Canadian Cordillera: Canada; Canada Geol. Survey Bull. 255, 131 p.

An important work dealing with microfacies and microzonation (based on Smaller Foraminifera and algae) of Carboniferous shelf carbonates.

729. Manns, F.T. (1982) - Stratigraphic aspects of the Silurian-Devonian sequence hosting zinc and lead mineralization near Robb Lake, northeastern British Columbia: Univ. Toronto, Ph.D. Thesis.

730. Mansouri, A. (1980) - Gisements de Pb-Zn et karstification en milien continental: Le district minier du Djebel Hallouf-Sidi bou Aouane (Tunisie septentrionale): Unpub. Ph.D. thesis, 3rd cycle. Univ. P. et M. Curie, Lab. Geologie Appl., 257 p.

731. Mansouri, A. (1981) - Le gisement de Pb-Zn du Djebel Hallouf-Sidi bou Aouane: Cong. Natl. Sci. Terre, Tunis, Sept. 1981, Comptes Rendus [in press].

732. Manze, U.; and Richter, D.K. (1979) - Die Veraenderung des C^{13}/C^{12}-Verhaeltnisses in Seeigelcoronen bei der Umwandlung von Mg-Calcit in Calcit unter meteorisch-vadosen Bedingungen: Stuttgart; N. Jb. Geol. Palaeont. Abh. 158:3, p. 334-345, 3 figs.

733. Marin, C. (1979) - Ion Pairs in Karst Waters, Trav. Inst. Speol. "Emile Racovitza", t. XVIII, p 249-2589, 5 fig.

A method of calculating the concentrations and activities of the $CaCO_3$, $CaHCO^{+3}$, $CaSO_4$, $MgCO_3$, $MgHCO^{+3}$, $MgSO_4$, $NaHCO_3$, $NaCO^{-3}$ and $NaSO^{4}$ ion pairs, which are formed in karst waters with ionic strength between 2.5-8.1 x 10^{-3} mole/l and pH between 6.90-8.60 is presented. On this basis it has been observed that in such waters, 3.7%, on an average, from the total concentration of calcium, 3.8% from magnesium, 0.2% from sodium and 14.2% from sulphate are associated in ion pairs. The influence of ionic strength, pH and SO_4^- ion concentration upon the degree of ion association is discussed. The results have been obtained by calculation on 56 water samples from the karst areas situated in the middle basin of the Cerna River (Banat), and the Sevesh Mountains, as well as from the Zaton-Bulba hydrokarstic basin (South Carpathians).

734. Marin, C., (1981) - Chemical Composition of Carbonate Waters in Padurea Craiului, Romania in Trav. Inst. Speol. "Emil Racovitza", p 139-155, 9 fig.

Water samples collected from the karstic area of Padurea Craiului Mountains have been analyzed to detect their main chemical characteristics. Most of them were found to be carbonate water samples, and only the Misid Basin presented sulphate waters. The molar ratio Ca^{++}/Mg^{++} of carbonate waters has different values for those originating in Cretaceous and Jurassic limestones as compared to those from Triassic rocks. Most waters are undersaturated with respect to calcite and dolomite. The degree of saturation, as well as other chemical parameters are different for recharge, cave stream and spring waters.

735. Marin, C. (1984) - Hydrochemical Considerations in the Lower Cerna River Basin in Theoretical and Applied Karstology, (1), p 173-182, 5 fig.

The author discusses data concerning the chemistry of Cerna, karstic waters, and main thermomineral sources from the area of Baile Herculane spa. The Karstic springs are compared with limestone surface steams. pH values are more alkaline as compared to those from other karstic areas. Regarding

thermomineral sources from karstic aquifers, the salt effect is evidence of limestone dissolution. This situation is exemplified at Hercule spring.

736. Marinos, G.P.; Economopoulos, J.N.; and Nicolaou, N.G. (1984) - Problems of water inrush into Greek underground mines with special emphasis to sea water inrush through karstic limestones or impermeable formations in Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol.I, p.463-475.

Since the country of Greece is almost completely surrounded by the sea, Greek mines face the constant threat of seawater inrush. Strong tectonic anomalies usually occur along the coast, and susceptibility to inrush is closely tied to geomorphic conditions prevailing in each area. Impermeable rock formations (marls, clays, schists, etc.) laid below sea level, as well as very permeable ones (karstic limestones and marbles) behave differently towards water inrush into Greek underground mines operating far from or near to the coast line. In the chromite mines of Central Greece, water inrushes are handled by pumping and cement grouting. Lavrion mines near Athens which consists mainly of marble and schist employ grouting of the impermeable schists and skarns to prevent seawater inrushes. The Stratonion and Olympias mines could carry out mining operations even below sea level with seawater inrush. The Aliveri lignite mine which is mainly in Mesozoic limestones is exploited by the sub-level caving method of mining. At 38 m below sea level, a concrete dam was constructed to prevent seawater inrush. This measure, along with pumping and cement grouting, brought seawater inrush under control.

737. Marinos, P.G. (1984) - System of underground water in a karstic country and the tunnels excavated for water transport to Athens (Le Regime Des Eaux Souterraines Dans Un Pays Karstique Et Les Galeries De la Grande Adduction D'Eau D'Athenes) in Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol. I, p. 441-462.

A large part of the aqueduct under construction from Mornos Dam in Central Greece to Athens consists of tunnels through limestone mountains or smaller massifs with important surface karst features. Studies of the geohydrology of the area and observations in the tunnels showed a heterogeneity of the hydrological regime with different hydraulic systems, depending on their altitude, their distance from the relief, the surface discharge points of groundwaters, and the size of the massifs. These factors play an important role in tunnel construction and operation.

738. Markova, O.L. (1965) - The influence of karst on the maximum flow of the rivers of the East European Plains: France; UNESCO, International Hydrological Decade, Symposium on Hydrology of Fractured Rocks, Dubrovnik, Yugoslavia, 7-14 October 1965, Paper 66, 14 p.

The investigation considered in this paper is the first attempt to analyze and generalize data available at present regarding maximum runoff of karstic rivers. Attention is given to the problem of formation of spring runoff (i.e. runoff resulting from snow melt) of karst rivers because of the predominance of maximum discharges of snow-melt floods over rain floods and because of more extensive knowledge of this phase of river regime.

739. Marosi, P. (1959) - Contributions to the question of the salt lakes' genesis in Ocna Mures - Studia Univ.Babes-Bolyai, ser.II. fasc.1, p 81-95, Cluj-Mapoca.

The author analyzes haloexokarst and genesis of salt lakes originating from old salt mines and affected by karst processes with respect to relative freshwater inputs and to erroneous mining operations (in Romanian, Russian and German, 3 figs., 33 ref).

740. Martin, J. (1965) - Quelques types de depressions karstiques du Moyen Atlas central: Rev. Geogr. Maroc. 7, p. 95-106.

741. Martin, J.M. (1978) - Evolucion diagenetica de un sector de los materiales carbonatados de la Unidad Viboras (Mantos Alpujarides, noroeste Sierra Nevada): Bol. Geologico y Minero 89, p. 303-319.

742. Martin, J.M. (1980) - Las dolomias de las Cordilleras Beticas: Tesis Doctoral Univ. Granada, 201 p.

743. Martin, J.M.; and Torres-Ruiz, J. (1982) - Algunas consideraciones sobre la convergencia de medios de las mineralizaciones de hierro y plomo-zinc-fluorita de origen sedimentario, encajadas en rocas triasicas de los Complejos Nevado-filabride y alpujarride del sector central de la Cordillera Betica: Bol. Geologico y Minero 93, p. 314-329.

744. Martin, J.M.; Torres-Ruiz, J.; Velilla, N.; and Hach-Ali, P.F. (1984) - Paleokarstic lead-(zinc)-fluorite deposits in shallowing upward sequences in the Triassic of the Alpujarrides (Beltic Cordillera, southern Spain) in Wauschkuhn, A., Kluth, C., and Zimmermann, R.A, editors, Syngenesis and Epigenesis in the Formation of Mineral Deposits: Germany, F.R., Heidelberg; Springer-Verlag, p. 438-447.

> Paleokarstic deposits have been found in certain zones in the lead-(zinc)-fluorite Triassic deposits of the Alpujarride Complex. The formation of these paleokarstic deposits is contemporaneous with that of the stratiform and/or non-karstic strata-bound deposits widely encountered in the Alpujarrides realm and considered to be of sedimentary/early diagenetic origin. The mineralogical composition and diagenetic evolution of both types are identical.

745. Massacci, P. (1978) - Mining and metallurgical problems related to the exploitation of raw materials substitute of bauxite in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 552-570, 5 figs.

746. Matter, A. (1974) - Burial diagenesis of pelitic and carbonate deep-sea sediments from the Arabian Sea: U.S.; Initial Rept. Deep Sea Drilling Project 23, p. 421-469.

747. Matyasi, S.; Stefan, G.; Csak, T.; Matyasi, L. (1979) - Study of the Topographic and Genetic Aspects of the Multilevelled Cave in the Toplita Valley (Padurea Craiului Mountains), Nymphae, 7, p 273-284, 1 figure, 1 plate, in Romanian, with English abstract.

> An analysis is performed of fracture systems and their control on cavity development. A striking feature of this resurgence cave system is the occurrence of a deep (-62 m) pit, seasonally flooded, in the proximity of the outflow. The phreatic versus tectonic origin of this pit is also discussed.

748. Maurin, V.; and Zoetl, J. (1963) - Karsthydrologische Untersuchungen auf Kephalleni: Atustir, Vienna, Oesterr. Hochschulz. Vol. 15, No. 6.

749. Maurin, V.; and Zoetl, J. (1964) - Karsthydrologische Untersuchungen im Toten Gebirge: Oesterr. Wasserwirtschaft 16, p. 112-123.

750. Maynard, J.B. (1983) - Geochemistry of sedimentary ore deposits: Germany, F.R., Heidelberg; Springer-Verlag, 305 p.

751. Mazurenko, L.V.; Shipilov, A.V.; Anisimov, L.I.; and Gorenko, A.V. (1986) - Restoration of pipe drainage in foundations of hydraulic structures on carbonate rocks: Hydrotechnical Construction, Vol. 20, No.2, p.107-110.

> It is known from the practice of operating dams, navigation locks, and other hydraulic structures what high requirements are imposed on the reliability and service life of drainage systems in their foundations. Nevertheless, it is often necessary to construct these structures on easily and moderately soluble rocks, such as loose limestones, subjected to processes of chemical piping. Thus, the Harlan County (USA), Pontesei and Vaiont (Italy), Kasseb (Tunis), Chirkei and Dubossary (USSR), and other dams are located on carbonate rocks, where the unimpeded development chemical piping can lead, and sometimes does lead, to a marked increase of permeability of the soil, to the formation of concentrated seepage pathways, and also to the loss of stability of the soil. With construction under such conditions, drainage systems under the hydraulic structures, clogging of the drainage by products of disintegration of the foundation and its failure are observed. When designing drained hydraulic structures on carbonate rocks subject to piping processes, it is necessary to provide for the possibility of periodic inspections of the drainage systems, and cleaning in the case of clogging by products of chemical piping. When conducting works on the restoration of drainage in cases where clogging by the disintegration products of carbonate rocks of the foundation, good results are obtained by measures combining dissolution of the mineral deposits by hydrochloric acid with mechanical cleaning of the drains by special jet hose nozzles. When performing restoration works in drainage systems using acid, strict control of the concentration of acid entering the water basin after flushing the drains is imperative.

752. Mazzullo, S.J.; and Cys, J.M. (1977) - Submarine cements in Permian boundstones and reef associated rocks, Guadalupe Mountains, West Texas and Southeastern New Mexico in Field Conf. Guidebook, Permian Basin Sect. Soc. Econ. Paleont. Min. Publ. 77:16, p. 151-200.

753. McClernan, H.G. (1977) - Metallogenesis of mineral deposits in Cambrian carbonate rocks, southwestern Montana: Moscow; Univ. Idaho, Ph.D. Dissertation, 122 p.

754. McClernan, H.G. (1983) - Lead-zinc-silver deposits in carbonate host rocks in Montana--Mississippi Valley-Type? in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J,W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 516-525.

> Recent reexamination of lead-zinc-silver deposits in Cambrian carbonate host rocks in western Montana suggests that some of these deposits may be of the Mississippi Valley type, with all of the attendant genetic implications.

755. McCunn, H.J. (1972) - Calcite and aragonite phenomena precipitated by organic decay in high lime concentrate brines: U.S.; Journ. Sed. Petrol. 42:1, p. 150-154, 8 figs.

756. Mecsnober, M.; Szakaly, A.; and Toth, B. (1978) - Some problems associated with drilling holes for bauxite prospection and large diameter shafts for the hydraulic protection of bauxite mines in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 571-584, 4 figs.

757. Meischner, D. (1962) - Rhenaer Kalk und Posidonienkalk im Kulm des nordoestlichen Rheinischen Schiefergebirges und der Kohlenkalk von Schreufa (Eder): Wiesbaden; Abh. hess. Landesamt Bodenforsch 39, 47 p., 7 pls., 15 figs., 7 tbls.

758. Mendelsohn, F. (1976) - Mineral deposits associated with stromatolites in Walter, M.R., editor, Stromatolites: U.S.; Elsevier Scientific, p. 645-662.

Many mineral deposits are closely associated with stromatolites which occur either as bioherms (reefs), or biostromes that formed as widespread stromatolitic beds or algal mats. In the descriptions that follow, deposits are grouped according to the valuable element(s) they contain.

759. Mendoza, V.; Sifontes, R.S.; and Rodriguez, S.E. (1978) - The Pijigualos bauxite deposits, western Bolivar, Venezuela in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 585-586.

760. Mercado, A.; and Billings, G.K. (1975) - The kinetics of mineral dissolution in carbonate aquifers as a tool for hydrological investigations, I, Concentration-time relationships: U.S.; Journ. Hydrology 34, p. 303-331.

761. Mert Matyasi, J. (1979) - Hydrochemical Observations on the Karst Region Dumbravita de Codru (Mountains Codru Moma), Nymphaea, 7, p 251-264, 9 figures, 1 table, in Romanian with English abstract.

An underground drainage scheme is proposed with respect to the correlation between chemical composition of the water and geological and lithological structure of the region.

762. Metry, A.A. (1981) - Predictive tools for contaminant transport in groundwater in Zimmie, T.F., and Riggs, C.O., editors, Permeability and Groundwater Contaminant Transport: U.S.; Amer. Soc. for Testing and Materials Special Technical Publication 746, p. 197-208.

Understanding mass transport mechanisms that influence migration and attenuation of contaminants is a key element in disposal site selection, and design of monitoring and contaminant migration potential are essential in the evaluation of disposal sites and anticipation of ground-water pollution potential. Among the predictive tools discussed in this paper are mathematical and computer simulation, criteria listing and criteria ranking methods, matrix analysis, and decision tree analysis. An analysis of the advantages, limitations, and applicability of different tools is included.

763. Meyers, W.J. (1978) - Carbonate cements: Their regional distribution and interpretation in Mississippian limestones of southwestern New Mexico: U.K., Oxford; Sed. 25, p. 371-400.

764. Meyers, W.J. (1980) - Compaction in Mississippian skeletal limestones, southwestern New Mexico: U.S.; Journ. Sed. Petrol. 50:2, p. 457-474, 8 figs.

765. Middleton, G.V., editor, (1965) - Primary sedimentary structures and their hydrodynamic interpretation: U.S.; Soc. Econ. Paleont. Min., Spec. Publ. 12, 265 p.

Contains, among other things, extremely important articles about Recent (Bahamas) and Ancient (Jurassic "Korallenoolith", England) sedimentary structures in shallow-water carbonates.

766. Milan, A. (1969) - Faziesverhaeltnisse und Hydrozoenfauna des Malms im Kuestenland des noerdlichen Velebit und Velika Kapela: Zagreb;Geol. Vjesnik 22, p. 135-217, 22 pls.

767. Milanovic, P. (1985) - Hydrogeological and engineering geological problems of hydrotechnical constructions in karst in Karst Water Resources, Proceedings, Ankara - Antalya Symposium, July 1985, Inter. Asso. Hydrological Sci., No. 161, p.151-177.

Successful construction projects in regions which are partially (Tennessee Valley, USA) or completely (a few energy systems in the Dinaric karst,

Yugoslavia) have changed the attitude toward karst as an environment for construction of complex objects and show the importance of knowing geological sites and all specificities of karst for water storage, excavations of underground halls, and constructions of high dams.

768. Milanovic, P. (1986) - Influence of the karst spring submergence on the karst aquifer regime: Journal of Hydrology, Vol.84, No.1/2, p.141-156.

Consequences of the submergence of the flooding of a large and permanent karst spring zone by construction of Grancarevo Dam on the Trebisnjica River, Yugoslavia, are discussed. The construction of the 123-m high dam flooded the spring zone to about 75 m deep. The aquifer zone that discharges through this spring zone formed under complex tectogenetic conditions of the Dinaric karst, of which the most prominent structures are overthrusts and reverse faults. The annual average discharge from the spring zone is 80 cu m/sec. To define the influence on the karst aquifer regime of flooding of springs correlative analysis was conducted between the index of previous precipitation, the water level in the reservoir, the underground water level in the immediate vicinity of the spring and in the distant parts of the aquifer, and the inflow to the reservoir. The multiple correlation coefficients obtained show mutual dependence of most of the parameters analyzed. Flooding of springs has had some influence on the hydrologic conditions of the upstream polje and the surface in the immediate tributary area. Also, there is evidence of formation of an underground reservoir in the karst aquifers; it is connected with the downstream aquifers and has some influence on the layout of natural watersheds. Seismicity in the catchment of the spring was induced by flooding the springs and formation of the reservoir.

769. Milanovic, Petar (1987) - Influence of construction on hydrogeological and environmental conditions in the karst region, eastern Herzegovina, Yugoslavia: U.S.; Environmental Geology and Water Sciences [in press], 16 p.

770. Milliman, J.D. (1967) - Carbonate sedimentation on Hogsty Reef, A Bahamian Atoll: U.S.; Journ. Sed. Petrol. 37:2, p. 658-676, 19 figs.

771. Milliman, J.D. (1974) - Marine carbonates, recent sedimentary carbonates, Part 1: Germany, F.R.; Springer-Verlag, 375 p.

Excellent survey of Recent carbonate sediments and sedimentation as well as the diagenesis of carbonates. Chapters: Mineralogy and chemical composition of carbonates in the ocean; Methods of analysis; Carbonate components (here a very good description of the skeletal mineralogy and microstructures of Recent marine organisms); Shallow-water carbonates in coral reef environments; Sublittoral carbonate sedimentation in shelf environments; Deep-sea carbonates; Carbonate diagenesis.

772. Milliman, J.D.; and Barretto, H.T. (1975) - Relict magnesian calcite oolite and subsidence of the Amazon shelf: U.K., Oxford; Sedimentology 22, p. 137-145, 4 figs.

773. Milliman, J.D.; and Muller, J. (1973) - Precipitation and lithification of magnesian calcite in the deep-sea sediments of the eastern Mediterranean Sea: The Netherlands, Amsterdam; Sed. 20, p. 29-46.

774. Milliman, J.D.; and Muller, J. (1977) - Characteristics and genesis of shallow-water and deep-sea limestones in Andersen, N.R.; and Malahoff, A., editors, The Fate of Fossil Fuel CO_2 in the Oceans: U.S., New York; Plenum Publishing Corporation, p. 655-672.

775. Mimram, Y. (1978) - The Induration of Upper Cretaceous Yorkshire and Irish chalks: Amsterdam; Sed. Geol. 20, p. 141-164, 15 figs.

776. Minatidis, D.G. (1978) - The bauxite deposits as a favorable terrain for gold exploration: A theoretical approach in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 587-598, 1 fig.

777. Minceva-Stefanova, J. (1984) - Electron microprobe investigation of the dolomitization and its relationship with the sulfide mineralizations in the polymetallic deposits confined to the Triassic calcareous sediments in the western Balkans in Wauschkuhn, A., Kluth, C., and Zimmermann, R.A, editors, Syngenesis and Epigenesis in the Formation of Mineral Deposits: Germany, F.R., Heidelberg; Springer-Verlag, p. 317-327.

The studies cover the two types of dolomites in the region of the deposits: the bedded dolomites and the metasomatic dolomites in bodies of irregular and varying shape. The second type of dolomites is characteristic for the ore deposits. They also occur outside the area of the ore deposits at varying distances from them, being always confined to fault dislocations.

778. Mindszenty, A. (1978) - Tentative interpretation of the micromorphology of bauxite laterites in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 599-613, 4 figs.

779. Mirsal, J.A.; and Zankl, H. (1979) - Petrography and geochemistry of carbonate void-filling cements in fossil reefs: Stuttgart; Geol. Rundschau 68:3, p. 920-951.

780. Mitrofan, H. (1978) - Contributions to the Speleological Knowledge of the Ponoare Area (Padurea Craiului Mountains) Based upon the Complex Interpretation of the Geophysical Measurements, Nymphaea, 6, p 251-264, 6 figures, in Romanian, with English abstract.

Water circulating radially through the fissures of the decompressed zone surrounding a cave passage may produce an electric field, giving rise to a detectable anomaly of natural polarization. The potential of a cylindrical anomalous body of this type decreases with the logarithm of the distance to its axis. Such a log-shaped NP signal, recorded in a borehole that had passed through a karstic cavity is discussed. Some other correlated NP, gravity and resistivity anomalies are used to infer the paths of unknown cavities.

781. Mitrofan, H. (1979) - Observations on the Tectonic Conditioning of the Distributon of the Voids of the Ponorici - Ciclovina-cu-Apa Cave System (Sebes Mountains), Travaux de l'Institut de Speologie "Emile Racovitza", 18, p 225-231, 3 figures, in French.

Limestones occurring in a structure consisting of a closely folded syncline with converging plunges and a salient anticline host a cave system with several major strike changes at almost right angles. It is shown that these bends occur where the direction of the compressional stress is supposed to change (for instance where a passage running along the plunge of the fold crosses the neutral surface).

782. Mitrofan, H. (1981) - Current Opinions on Potholes Genesis, Buletin Speologic Informati, 5, p 10-13, in Romanian.

Theories emphasizing vadose, phreatic, or tectonic origin of potholes are reviewed. Difficulties that these theories encounter in explaining some peculiar features of potholes are also addressed.

783. Mitrofan, H. (1982) - Note Concerning Some Morphological Clues to the Genesis of the Vertical Cavities of the Karstic Areas of Romania, Travaux de l'Institut de Speologie "Emil Racovitza", 21, p 77-86.

> Pothole occurrence seems to be controlled by strike-slip fault intersections, their horizontal development by associated extension cracks, their deepening by the successive base-levels. The constitutive pits themselves seem to obey hydrodynamic control, since each of them "ascends" an equal height above its own base level.

784. Mitrofan, H. (1983) - Recent Information Concerning the Hydrogeology of the Area of Techirghiol Lake, Furnished by Electrometric and Thermometric Measurements, Hidrotehnica, 28, 6, p 161-164, 5 figures, 2 tables, in Romanian with English abstract.

> The fresh water - salt water interface in a highly fractured limestone area and the groundwater salinities were established by means of a resistivity survey. They indicate different drainage modalities: between superimposed aquifers, from the shallow aquifer toward the lake, as well as form the lake landward.

785. Mitrofan, H. (1984) - Contributions of a Resistivity Survey to Karstic Aquifers Discontinuity Investigation, Travaux de l'Institut de Speologie "Emil Racovitza", 23, p 67-73, 4 figures, in English.

> The water table of some karstic areas with rough topography was determined by a resistivity survey. Water-table continuity across draining faults is generally not insured, since large permeability contrasts between the faults and rock matrix determine the formation of important seepage facies.

786. Mitrofan, H.; Lascu, V.; Boloveschi, I.; Roman, C.; Andreescu, S. (1984) - Vertical Cavities in South-Eastern Vulcan Mountains (Gorj District) Theoretical and Applied Karstology, 1, p 69-76, 7 figures, in English with Romanian abstract.

> Main cavities in south-eastern Vulcan Mountains are primarily of vertical development. Potholes distribution related to old erosion levels was examined and the depths of the shafts were considered as a function of the surface drainage network frequency.

787. Mochnacka, K.; and Sass-Gustkiewicz, M. (1978) - Metasomatic processes along the contact of the ore-bearing dolomite with limestone (Olkusz mine, Cracow-Silesian Zn-Pb district): Soc. Geol. Pologne Annales 48, p. 183-191.

788. Moller, P.; and Kubanek, F. (1976) - Role of magnesium in nucleation processes of calcite, aragonite and dolomite: Neues Jahrb. Min. Abh. 126, p. 199-220.

789. Monseur, G.; and Pel, J. (1976) - Reef environment and stratiform ore deposits (essay of a synthesis of the relationship between them) in Amstutz, G.C., and Bernard, A.J., editors, Ores in Sediments: Germany, F.R., Heidelberg; Springer-Verlag, International Union of Geological Sciences Series A., No. 3, p. 195-207.

> Comparative analysis of Givetian reef complexes from Belgium and Aptian reef complexes from the Santander province in Spain displays an identical sedimentary rhythm. The study of the stratiform Reocin lead-zinc deposit, located in Aptian dolostones from this Santander province, has disclosed genetic relations between mineralization and location in the reef complex. These relations are dependent on the sedimentary rhythm.

790. Monty, Cl. (1973) - Les nodules de manganese sont des stromatolithes oceaniques: Paris; C.R. Acad. Sci. Paris, Ser. D. 276, p. 2385-2388, 2 pls.

791. Moore, C.H. (1979) - Porosity in carbonate rock sequences in Geology of Carbonate Porosity: U.S.; Amer. Asso. Petrol. Continuing Education Course Notes 11, p. A1-A124.

792. Moore, C.H.; and Druckman, Y. (1981) - Burial diagenesis and porosity evolution, Upper Jurassic Smackover, Arkansas and Louisiana: U.S.; Amer. Asso. Petrol. Geol. Bull. 65, p. 597-628, 13 figs.

793. Moore, C.H.; Smitherman, J.M.; and Allen, S.H. (1972) - Pore system evolution in a carbonate beach sequence: Canada, Montreal; Proceedings of the 24th Inter. Geol. Congress, Section 6, p. 124-136.

794. Moore, C.H.; Smitherman, J.M.; and Allen, S.H. (1979) - Pore system evolution in Cretaceous carbonate beach sequence in Moore, C.H., editor, Geology of Carbonate Rocks: U.S.; p. A11-A23, 6 figs.

795. Moore, G.W. (1970) - Checklist of cave minerals: Natl. Spele. Soc. News 28, p. 9-10, 40 bibliographical entries.

796. Morganti, J.M. (1981) - Ore deposit models-4. Sedimentary-type stratiform ore deposits: Some new models and a new classification: Geoscience Canada, Vol. 8, p. 65-75.

797. Morris, W.G. (1977) - Mineralogy and geochemistry of carbonate lead, zinc, silver mineralization from the Bonaparte Gulf Basin, northwestern Australia: Sydney; Univ. Sydney, Unpublished M.Sc. Thesis, 166 p.

798. Morrow, D.W.; Mayers, I.R. (1978) - Simulation of limestone diagenesis - a model based on strontium depletion: Ottawa; Canadian Journ. Earth Sci. 15, p. 376-396.

799. Moser, R. (1967) - Kalktische im Toten Gebirge und im Dachsteingebiet: Jahrb. Oesterr. Alpenver, p. 75-78.

800. Mosier, E.L.; and Motooka, J.M. (1983) - Induction Coupled Plasma--Atomic Emission Spectrometry: Analysis of subsurface Cambrian carbonate rocks for major, minor, and trace elements in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J,W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 155-165.

> Analytical data on the variation and abundance of 30 elements in subsurface Cambrian rocks demonstrate the usefulness of an Induction Coupled Plasma--Atomic Emission Spectroscopy (ICP-AES) method in geochemical investigations of Mississippi Valley-type deposits. The ICP-AES method provides rapid, simultaneous, quantitative, multielement determinations of many major, minor, and trace elements using a single sample preparation technique. Of particular interest and relevance to this study is the fact that trace elements can be determined at very low concentration levels in a Ca-Mg carbonate matrix without the necessity of time-consuming concentration procedures.

801. Moss, T.A. (1982) - A comparative study of the trace element distribution in limestones, dolostones, and breccias in the Upper Knox Group of the Copper Ridge district, east Tennessee (M.S. thesis): U.S.; Univ. Tennessee at Knoxville, 173 p.

802. Motiu, A.; Viehman, I.; Strusievici, R. (1979) - Discovery of new minerals in the Tausoare Cave (The Rodna Mountains). Trav. Inst. Speol. "Emil Racovitza", Bucharest, XVI, p 211-216, 7 figures, (In French).

The authors refer to the discovery of mirabilite and epsonite in the Tausoare Cave. Results were obtained by optical analyses, X-ray spectroscopy, atomic absorption, infrared absorption, differential thermal analysis, thermogravimetric analysis as well as diffracto-metric analysis.

803. Mouat, M.M.; and Clendenin, C.W. (1977) - Geology of the Ozark Lead Company mine, Viburnum Trend, southeast Missouri: U.S.; Economic Geology, Vol. 72, p. 398-407.

In contrast to most of the other mines in the Viburnum Trend, much of the Ozark Lead Company orebody lies at right angles to the depositional strike of the sediments. A second distinctive feature of the orebody is that ore occurs throughout the vertical range of the Bonneterre Formation at certain horizons. Mineralization is both structurally and stratigraphically controlled.

804. Mountjoy, E.W.; and Jull, R.K. (1978) - Fore-reef carbonate mud bioherms and associated reef-margin, Upper Devonian Ancient Wall Reef complex, Alberta: Ottawa; Canadian Journ. Earth Sci. 15, p. 1304-1325.

805. Mposkos, E. (1978) - Diasporit und Schmirgelvorkommen der Insel Samos (Griechenland) in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 614-631, 19 figs.

806. Mposkos, E.; Tsalikis, D.; and Vgenopoulos, A. (1978) - The use of Greek bauxites as raw material for the refractory industry in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 890-904, 10 figs.

807. Mueller-Jungbluth, W.U.; and Toschek, P.H. (1969) - Karbonatsedimentologische Arbeitsgrundlagen (Begriffe, Erlaeuterungen, Hinweise), 2nd Edition: Austria; Veroeff. Univ. Innsbruck 8, Alpenkundliche Studien 4, 32 p.

Brief description of important criteria found in carbonate rocks, which are useful for facies interpretation in the field and laboratory. Chapter topics include the following: matrix; particles; fabric; open-space structures; recording sedimentogenesis; diagenesis; and documentation. Methods were tested on the analysis of Triassic carbonates from the Northern Alps.

808. Mullins, H.T.; and Neumann, A.C. (1979) - Deep carbonate bank margin structure and sedimentation in the Northern Bahamas: U.S.; Soc. Econ. Paleont. Min. Spec. Publ. 27, p. 165-192, 26 figs.

809. Mullins, H.T.; and Rasch, R. F. (1985) - Sea-floor phosphorites along the central California continental margin: U.S.; Economic Geology, Vol. 80, p. 696-715.

Central California margin phosphorites are a potential natural resource. However, their patchy distribution and occurrence at relatively great water depths make them economically less attractive than well-known, on-land accumulations in central California, as well as submarine deposits off the southern California shore that occur at much more shallow (<330 m) water depths and in higher concentrations.

810. Mullins, H.T.; Neumann, A.C.; Wilber, R.J.; and Boardman, M.R. (1980) - Nodular carbonate sediment on Bahamian slopes: Possible precursors to nodular limestones: U.S.; Journ. Sed. Petrol. 50:1, p. 117-131, 13 figs.

811. Muraru, A. (1983) - Sedimentological Considerations Concerning Cioclovina Cave Deposit, Buletin Speologic Informativ, 7, p 56-68, 2 figures, in Romanian with English abstract.

The deposits of Cioclovina Cave, formerly exploited for phosphates, were studied with respect to sedimentology. The bottom arenitic layer, with cross-deposition, was due to a flow of 1.1 m/sec velocity and a depth of 0.12 m. The subsequent lutitic layer is ascribed to fossilization of the passage when deposited organic matter increased, leading to the formation of the phosphates. The presence of hominids in the cave is testified by local coal fragments.

812. Muraru, A. (1984) - Contributions to the Study of the Karstic System from Luna Hill (Baia, Tulcea District), Buletin Speologic Informativ, 8, p 37-47, 1 figure, in Romanian with English abstract.

Based on an excavation 1.7 m deep in Cave No. 1 from Luna Hill deposits, the author was able to determine three layers. The two lower layers included only blocks of arenitic material, which originated from the host rock, thus indicating that no transport occurred. The third, upper layer, only 10 cm thick, included scarce fragments of the host rock, disseminated in a mass of mostly humic matter. The author inferred from the upward, block dimension reduction that infiltration and gelifraction exerted an influence as the ceiling thinned, while deposition of the shallow layer resulted from collapse pitting of the ceiling.

813. Muraru, A. (1984) - Preliminary Data on the Caves from Luna Hill, Buletin Speologic Informativ, 8, p 19-35, 8 figures, in Romanian with English abstract.

The caves from this area are developed in a single level, along a direction concordant with the local topographic slope. The ceiling of all the cavities, only 1.5-1.2 m thick, is limited to the same highly siliceous limestone bed, while more shaley beds occur in the walls. In spite of passage orientations, the wall directions are structurally controlled. Because no dissolution or calcite deposition traces are found, and the underground deposits do not indicate any transport, the author conclude that the present-day appearance of voids is due exclusively to the rocks' mechanical equilibrium (for instance ceilings passing from a supported plate to a ring structure, by entrance pitting).

814. Murata, K.J.; Friedman, I.; and Madsen, B.M. (1969) - Isotopic composition of diagenetic carbonates in marine Miocene formations of California and Oregon: U.S.; U.S. Geol. Survey Prof. Paper 614-B, p. 1-24.

815. Mylroie, J.E. (1978) - Caves and karst features of western Kentucky as compiled May 1, 1978 in Mylroie, J.E., editor, Western Kentucky Spele. Survey Annual Report, 1978: U.S., Murray; College of Environmental Sci., Murray State Univ., p. 11-55.

816. Nadler, A.; Magaritz, M.; Mazor, E.; and Kafri, U. (1980) - Kinetics of chemical processes in a carbonate aquifer: A case study of water-rock interaction in the aquifer of western and central Galilee (Israel): The Netherlands, Amsterdam; Journ. of Hydrology, Vol. 45, p. 39-56.

The origin of ions in groundwater of the western and central Galilee aquifer is attributed to the dissolution of carbonate rock. Similar chemical compositions have been obtained in laboratory experiments that simulated natural conditions. The field and experimental data indicate the time dependency of ionic composition. A linear correlation was found between the Mg^{2+} concentration and the aquifer decay time. The kinetic factors of the W.C.G. ground water were found to resemble other carbonate-aquifer waters, e.g., in Pennsylvania and Virginia.

817. Nagy, I. (1980) - The Haline Karst of Ocna Mures Exploitation Area, Bul. Club. Speol. "E.Racovita", Bucuresti, 7, p 87-90, 1 plate, in Romanian with French abstract.

> The interaction between the salt exploitation by water injection, followed by the flooding of the mining cavities and the karstic hydrology and morphology is discussed in detail.

818. Narkiewicz, M. (1979) - Telo- and Mesogenetic dolomites in the subsurface Upper Devonian to Lower Carboniferous sequence of southern Poland: Neues Jahrb. Geologie, Palaeontologie Abh. 158, p. 180-208.

819. Negrea, Alexandrina; Negrea, S. (1979) - The caves in the Danube Pass and terrestrial fauna. Speologia, Grupul Portile de Fier", Edit. Acad. RSR, p 30-73, (in Romania).

> Twenty-three caves and potholes in four limestone areas in the pass are discussed with respect to earth fauna. Almost 150 tasconi are determined, including two species that are new in Romania and two species that are international discoveries.

820. Negrea, S.; Negrea, Alexandrina; Sencu, V.; Botosaneanu, L. (1963) - Caves in Banat (Romania) explored in 1963. International Journal of Speleology, volume 1, part 4, p 397-439, (in French).

> Twenty-three caves were studied (mapping, genesis, evolution, speleothems, biospeleology) with respect to limestone lithology and tectonics. Exokarstic forms were also studied.

821. Neugebauer, J. (1973) - The diagenetic problem of chalk - the role of pressure solution and pore fluid: Stuttgart; Neues Jahrbuch Geol. Palaeont. Abhandlungen 143, p. 223-245.

822. Neugebauer, J. (1974) - Some aspects of cementation in chalk: Oxford; Inter. Asso. Sed. Spec. Publ. 1, p. 149-176.

823. Nicod, J. (1967) - Recherches morphologiques en Basse-Provence calcaire: These, Gam, Impr. Louis-Jean.

824. Nicod, J. (1969) - Poljes karstiques de Provence, comparaison avec les poljes dinariques: Etud. Trav. "Mediterranee" 8, Rev. Geogr. Pays Mediterr.

825. Nicod, J. (1970) - Essai sur les facteurs du regime des sources karstiques: Actes 93eme Congr. Natl. Soc. Savantes, Tours, p. 99-119.

826. Nicolaou, N.G.; and Macris, Z.N. (1978) - Restoring works of the basic environmental characteristics at the bauxite surface mines of Parnasse-Ghiona area and their problems in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 632-645, 5 figs.

827. Nikolaou, N.; and Panagopoulos, K. (1978) - Production planning for Greek bauxite deposits in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 646-656, 4 figs.

828. Nobel, J.P.; and Howells, K.D.M. (1974) - Early lithification of the nodular limestones in the Silurian of New Brunswick: Sed. 21, p. 587-609.

829. Nowak, F.J.; and Carozzi, A.V. (1973) - Microfacies of the Upper Bird Spring Group (Pennsylvanian-Permian) Arrow Canyon Range, Clark County, Nevada: Switzerland; Arch. Sci., 25:3, p. 343-382.

The authors discuss a 200 m thick limestone sequence, and 907 samples with a sample interval 22 cm. Other topics include: Thin-sections; frequency and clasticity indices of crinoid fragments, ooids, lithoclasts, and terrigenous quartz as well as frequency indices of bryozoans and brachiopods, agglutinated foraminifera and peloids. A computer printout of data is provided. A comparison of the number of MF types produced by "continuous" sample taking, and sample intervals of about 20 cm produce statistically significant differences.

830. Oancea, V.; Diaconu, V.; Bulgar, Al. (1984) - The application of the numerical filters in the determination of the hydrological parameters of the karst system. Theoretical and Applied Karstology, 1, p 231-234, 1 table.

The transfer function of the karst system can be expressed analytically as a transfer function for a multistage filter. This approach allows the determination of some characteristic parameters of the karst system considered as a sum of subsystems, each of which represents a stage of the filter. Thus, a much more detailed structure of the karst systems can be obtained.

831. Ocean, P. (1985) - The Karstic Level Surfaces of the Apuseni Mountains, Trav. Inst. Speol. "Emil Racovita," Bucharest, 24: 97-104, figs. 1-2 (in French).

From a morphogenetic point of view, the karstic areas in the Apuseni Mountains are grouped into three karstoplains: the Ciumerna-Scarisoara (1,200-1,400 m), of paleogenic age, the Vascau-Zece Hotare (600-800 m), of Miocene age, and the Dumbravita (400-500 m), of pliocene age. They may be correlated with the cave levels of the karstic systems or with the gallery levels in multifloored caves.

832. Ocepek, D.; and Salopek, B. (1978) - Grindability of bauxite ores and some structural properties in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 657-673, 9 figs.

833. Ochsenkuhn, K.M. (1978) - The bivariate correlations Ni/Cr and Ni/Ga of the Kimi bauxites, Greece in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 674-687, 10 figs.

834. Ohle, E.L. (1980) - Some considerations in determining the origin of ore deposits of the Mississippi Valley type-Part II: U.S.; Economic Geology, 75:2, p. 161-172.

Any genetic theory explaining the origin of ore deposits of the Mississippi Valley type must be in accord with all aspects of the geologic setting that existed at the time the deposits were formed. The basinal brine theory is no exception. Unfortunately there is still great disagreement among geologists on most facets of the mechanism, such as the source of the metals, the timing of their release, the origin of the saline solutions, how the metals are carried, the causes of deposition, or why it occurs where it does. The facts and speculations about all of these are discussed, with the conclusion that a great deal of additional research is needed before the hypothesis can be totally accepted.

835. Omenetto, P. (1979) - Significant ore fabric relationships in the lead, zinc, fluorite, and barite deposits of the Triassic province (Italian southern Alps): Ann. Soc. Geol. Belgique 102, p. 512-529.

836. Oraseanu, I. (1986) - Considerations on the hydrogeology of Vascau Plateau. In Theoretical and Applied Karstology, 2 (in press)

Morphological and hydrogeological investigations, results of tracing experiments, hydrologic data and chemical analysis of the karst cold and thermal waters and of the gas outflowing from certain springs are used in drawing a unitary hydrogeological image of the Vascau karstic plateau.

837. Oraseanu, I. (1986) - Partial Captures and Diffluence surfaces: Examples from the Northern Karst Area of Padurea Craiului Mountains in Theoretical and Applied Karstology, 2 (in press).

Starting with examples from the Padurea Craiului Mountains karst, methodological considerations needed for determining the hydrogeological balance of karstic areas led the author to define the concept of karstic basin diffluence and the notion of diffluence surface, with specification of their role and place in the structure of hydrogeological karstic systems.

838. Oraseanu, I.; and Gaspar, E. (1981-1982) - Radioactive tracer-based research concerning the establishment of the area of supply of the underground river in the Vintului Cave (Padurea Craiului Mountains). In Nymphaea, VIII-x, 379-386, (In Romanian).

Research work conducted by using radioactive tracers allowed the authors to determine the hydrological relationship between waters infiltrated through the Recea sinkhole and the active area of the Vintului cave. For the first time, information is provided on the contribution of the subaerial course to the recharge of underground flow that traverses the longest cave in Romania (31.5 km).

839. Oraseanu, I.; Anghel, E.; Gaspar, E.; and Dinescu L. (1978) - Experimental studies by means of radioactive tracers in view to establish more precisely the hydrogeological conditions of the Ghelar and Teliuc ore deposits. In Studii tehnice si economice, IGG, seria E, N 13, 44-52. (In Romanian).

The authors emphasize the efficiency of utilizing radioactive tracers when studying mining hydrogeology. Labelling surface waters with a radioactive tracer allows an analysis of underground waters from a mine. Concomitantly, valuable data regarding the velocity and circulation of water may be obtained.

840. Oraseanu, I.; Bulgar, Al.; Gaspar, E.; Terteleac, N. (1984) - Hydrogeological study of Dimbovicioara Passage in Theoretical and Applied Karstology 1, Bucharest, p.153-164.

A comprehensive, hydrogeological study was performed in a 230 km, essentially carbonatic area of Piatra Craiului Massif. Based upon classical hydrogeologic research, microtectonic observations, radioactive and chemical tracers and hydrometeorological data, surface and groundwater balance is calculated, the hydrogeological basins of the main springs are delimited, the relation between infiltration and runoff is established, and underground water resources are assessed.

841. Oraseanu, I.; Iurkievicz, A. (1982) - Phenomena of karstic capture in the eastern part of the Padurea Craiului Mountains, Trav. Inst. Speol. "Emil Racovitza", T. XXI, p 69-76, 2 maps, 4 fig. (in French).

In this work, which is markedly theoretical in character, the authors start from observations made on karsts in Romania and suggest the introduction of two new concepts: basin karstic diffluence and karstic diffluence area. Furthermore, a new model is proposed concerning the succession of processes that accompany the underground capture phenomenon and which may eventually lead to the formation of karstic capture depressions.

842. Oraseanu, I.; Iurkievicz, A.; Gaspar, E.; Pop, I. (1984) - On the hydrogeological conditions of bauxite accumulations in the Racas-Sclavul Ples karstic plateau (Padurea Craiului Mountains) Theoretical and Applied Karstology, 1, p 147-152, 1 map, 2 fig.

> On the basis of hydrogeological studies, complemented by tracer labellings as well as hydrometeorological observations, the major flow directions of underground waters in the Racas-Sclavul Ples karstic plateau were determined. Furthermore, solutions were suggested for the exploitation of bauxite deposits in the area at a minimum hydrogeological risk.

843. Orban, T.; and Mitrofan, H. (1981) - Possibilities of Identifying the Tectonic Fractures by Means of Resistivity and Seismic Measurements, Studii si Cercetari de Geologie, Geofizica si Geografie, seria Geofizia, 19, p 123-128, with 6 figures, in Romaninan with English abstract.

> The authors make an analogy between geophysical measurement results in a karst area of Aninei Mountains and the experimental photoelastic model of compressional stress variation around a fault, presented by DUDA, 1965 .

844. Orgeval, J.J. (1976) - Les remplissages karstiques mineralises: Example la mine des Malines (Gard, France): Soc. Geol. France Mem., hors serv., Vol. 7, p. 77-83.

845. Orgeval, J.J.; Giot, D.; Sahli, R.; Lenindre, Y.M.; Gharbi, M.; and Monciadini, C. (1981) - Caracterisation des concentrations sulfurees associees aux facies de calcaires du Bahloul (Cenomanien-Turonien inferieur) du secteur du Djebel Bou Grine: Cong. Natl. Sci. Terre, Tunis, Sept. 1981, Comptes Rendus [in press].

846. Orghidan, Tr.; Puscariu, V.; Bleahu, M.; Decu, V.; Rusu, T.; Bunescu, A. (1965) - A Map of Karstic Regions in Romania, Trav. Inst. Speol. "Emil Racovita", Bucarest, IV, 75-104, 5 maps and 6 figures (in Romanian).

> A first map of karstic regions in Romania is presented (scale 1:500,000) which indicates the age of karstifiable forms and the geographic location of the 984 caves and swallow holes known to date, which are included in a list compiled according to geographic units.

847. Osborne, R.H. (1967) - The American Upper Ordovician Standard, VIII. R-mode factor analysis of Cincinnatian limestone: U.S.; Journ. Sedimentary Petrology, 37:2, p. 649-657.

848. Osborne, R.H. (1969) - The American Upper Ordovician Standard, XI. Multivariate classification of typical Cincinnatian calcarenites: U.S.; Journ. Sedimentary Petrology, 39:2, p. 769-776.

849. Osborne, R.H. (1973) - The American Upper Ordovician Standard, XVII. Areal variations of limestone frequencies in the Kope and Fairview Formations, Hamilton County, Ohio: U.S.; Journ. Sedimentary Petrology, 43:1, p. 137-146.

850. Ott, W.F. (1969) - Zur Geologie des Sulzfluh-Kalkes (Malm) in Graubuenden und Vorarlberg: Unpublished Thesis, Technische Hochschule Darmstadt.

851. Ozoray, G. (1976) - The scientific and economic value of karst studies in Alberta: Canada; The Albertan Geographer, No. 12, p. 43-60.

> The main karst areas of Alberta are the deeply buried karst underlying the Athabasca oil sands, about 23,000 km^2 (9,000 sq. mi.); the adjoining drift-covered karst of the Devonian subcrop area, about 26,000 km^2 (10,000 sq. mi) of the 35,000 km^2 (13,500 sq. mi.) subcrop; the mountainous, partly alpine karst of the Cordilleran region, about 17,500 km^2 (6,750 sq. mi.).

852. Paarlberg, N.L.; and Evans, L.L. (1977) - Geology of the Fletcher mine, Viburnum Trend, southeast Missouri: U.S.; Economic Geology, Vol. 72, p. 391-397.

> Fletcher mine is situated on a buried Precambrian ridge that stood as a topographic high during Upper Cambrian Bonneterre deposition. Mineralization occurs mainly as open-space and fracture fillings, with minor replacement of dolomite.

853. Padalino, G.; Pretti, S.; Tamburrini, D.; Tocco, S.; Uras, I.; Violo, M.; and Zuffardi, P. (1976) - Ore deposition in karst formations with examples from Sardinia in Amstutz, G.C., and Bernard, A.J., editors, Ores in Sediments: Germany, F.R., Heidelberg; Springer-Verlag, International Union of Geological Sciences Series A., No. 3, p. 209-220.

> Economic concentrations of bauxite, barite, fluorite and ores of iron, lead, and zinc were investigated in karst formations in Sardinia; they occur in addition to the known strata-bound and vein-type deposits of this major mining region. Three main periods of karst development and karst ore accumulation are recognized: the earliest of Cambro-Ordovician age; a second one of post-Hercynian age; the last of Alpine and post-Alpine age. Reworking of earlier karst ore was observed in different localities and took place during different periods. Hercynian granite intrusion has locally converted some karst fillings into skarn. Details on the ore sedimentation in the karst of different periods and areas are presented on four scales (regional, mine, hand-specimen, and mineral or microscopic).

854. Palciauskas, V.V.; and Domenico, P.A. (1976) - Solution chemistry, mass transfer and the approach to chemical equilibrium in porous carbonate rocks and sediments: U.S.; Geol. Soc. Amer. Bull. 87, p. 207-214.

855. Palmer, A.N.; Palmer, M.V.; and Queen, G.M. (1977) - Speleogenesis in the Guadalupe Mountains, New Mexico; Gypsum replacement of carbonate by brine mixing: Proc. 7th Inter. Spele. Congr. Sheffield, p. 333-336.

856. Palmer, A.N.; Palmer, M.V.; and Queen, J.M. (1977) - Geology and origin of the caves of Bermuda in Proc. 7th Inter. Spele. Congress, Sheffield: British Cave Research Asso., p. 336-339.

857. Palmer, M.V. (1976) - Ground-water flow patterns in limestone solution conduits: U.S.; State Univ. New York, Oneonta, MS thesis.

858. Palmer, R.; and Williams, D. (1984) - Cave development under Andros Island, Bahamas: U.S.; Cave Science 11:1, p. 50-52.

859. Pantic-Prodanovic, S.; and Radosevic, B. (1978) - Geological section of Triassic at Gornje Polje, Crna Gora, Yugoslavia in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 688-703, 2 figs.

860. Parkeh, P.P.; Muller, P.; Dulski, P.; and Bausch, W. (1977) - Distribution of trace elements between carbonate and non-carbonate phases of limestone: Earth Planet. Sci. Letter 34, p. 39-50.

861. Parnell, J. (1983) - Ancient duricrusts and related rocks in perspective: A contribution from the Old Red Sandstone in Wilson, R.C.L., editor, Residual Deposits: Surface Related Weathering Processes and Materials: U.K., London; Blackwell Scientific, p. 197-209.

862. Pascal, A. (1979) - Utilisation des elements traces dans la caracterisation des paleomilieux sedimentaires urgoniens basco-cantabriques (Espagne): Lyon; Geobios. Mem. spec. 3, p. 331-345, 4 figs.

863. Pasini, G. (1973) - Sull'importanza speleogenetica dell'erosione antigravitativa: Le Grotte d'Italia 4, Vol. IV, Bologna.

864. Passaris, E.K.S. (1978) - Finite element analysis applied to rock mechanics problems in underground mining of bauxite in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 704-717, 6 figs.

865. Pavlin, B.; and Fritx, F. (1984) - Protection of the karstic springs system in Golubinka against contamination by the sea water (La protection du systeme des sources karstiques de Golubinka contre la contamination par la mer), in Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol. I, p. 227-235.

Golubinka Karst spring, which is located in the central region of the Yugoslav coastline, has been protected by hydraulic engineering structures against saline water influences, which were notable during the dry summer season when the availability of potable water was particularly important. The engineering solution found for this problem was based on geologic, hydrogeologic and morphogenetic analyses and exploratory works helped by speleologic surveying of the spring branches performed by expert divers.

866. Pedersen, T.F.; and Price, N.B. (1982) - The geochemistry of manganese carbonate in Panama Basin sediment: Oxford; Geochim. Cosmochim. Acta 40, p. 59-68.

867. Pennsylvania Drilling Company (undated) - Hydrogeology in carbonate terranes: U.S.; Pennsylvania Drilling Company, Pittsburgh, 14 p.

The intelligent development of ground-water supplies should be based on sound geological and hydrological studies of an area. Such studies should lead to the selection of well field locations and to an understanding of the hydraulic behavior of often complex geohydrologic systems, and should shed light on the problem of precise well location particularly where joints, fractures, or solution openings are of prime importance.

868. Peppas, Sp.; and Xydous, G. (1978) - Scheduling, planning and organizing in the "A.E.M. Bauxite Parnasse" Company in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 718-733, 8 figs.

869. Persoz, F.; and Remane, J. (1976) - Mineralogie et geochemie des formations a la limite Jurassique-Cretace dans le Jura et le Basin vocontien: Basel; Eclogae. geol. Helvet. 69:1, p. 1-38, 25 figs., 2 tbls.

870. Peryt, T.M. (1978) - Sedimentology and paleoecology of the Zechstein Limestone (Upper Permian) in the Fore-Sudetic area (western Poland): Amsterdam; Sed. Geol. 20, p. 217-243.

871. Pfeffer, K.-H. (1967) - Beitraege zur Geomorphologie der Karstbecken im Bereiche des Monte Velino (Zentralapennin): Frankfurter Geogr. H. 42.

872. Pfeffer, K.-H. (1973) - Flaechenbildung in den Kalkgebieten in Ergebnisse der Karstforschung in den Tropen und im Mittelmeerraum: Geogr. Z., Beih. Wiesbaden: Franz Steiner, p. 111-132.

873. Pfeffer, K.-H. (1976) - Probleme der Genese von Oberflaechenformen auf Kalkgestein: Z. Geomorph. N.F., Suppl. 26, p. 6-34.

874. Pia, J. (1933) - Die rezenten Kalksteine: East Germany; Min. Petro.y. Mitt. N.F., Ergaenzungsband, 420 p.

> The author has presented an extensive description of the genesis of "abiogenous", "physiological" (origin controlled by plants), and "organic" limestones. Of particular interest is the treatment of terrestrial and freshwater carbonates.

875. Picknett, R.G. (1977) - Rejuvenation of aggressiveness in calcium carbonate solutions by means of magnesium carbonate: Proc. 7th Inter. Congr. Spele. Sheffield, p. 346-348.

876. Picknett, R.G.; Bray, L.G.; and Stenner, R.D. (1976) - The chemistry of cave waters in Ford, T.D., and Cullingford, C.H.D., editors, The Science of Speleology: U.K., London; Academic Press.

877. Pigott, C.D. (1965) - The structure of limestone surfaces in Derbyshire: Geogr. Journ.131, p. 41-44.

878. Piller, W. (1981) - The Steinplatte reef complex, part of an Upper Triassic carbonate platform near Salzburg, Austria: U.S.; Soc. Econ. Paleont. Min. Spec. Publ. 30, p. 261-290, 23 figs.

879. Pinchemel, P. (1954) - Les plaines de craie du nordouest de Paris: Paris; Colin.

880. Pingitore, N.E. (1978) - The behavior of Zn^{2+} and Mn^{2+} during carbonate diagenesis: Theory and application: U.S.; Journ. Sed. Petrol. 48:3, p. 799-814, 5 figs.

881. Pinzaru, T.; and Mac, I. (1973) - Morphohydrographic Observations South of Cluj, Bulletin of The Society of Geographic Sciences of the Socialist Republic of Romania, III, p 122-131 (in Romanian).

> A document concerning relief features on the right-hand slope of the Somesul Mic valley, South of the town of Cluj, is presented with respect to micromodelling. Noteworthy features are lacustral folds, which result from clastic-karstic processes that occurred on sands slightly bound with calcium carbonate. Micro-sinkholes are an outcome of the dissolution of gypsum intercalated with Tortonian-Sarmatian depositions.

882. Pisota, I.; Trufas, V.; Ciumplileac, Gh. (1969) - The Lakes form Slanic-Prahova and Telega, Hidrobiologia, 10, p 243-254, 9 figures, in Romanian with English abstract.

> A set of 14 salt lakes situated in the flooded excavations of ancient salt mines are considered with respect to genesis, water budget, salinity, temperature, and hydrooptical properties.

883. Pittman, E.D. (1971) - Microporosity in carbonate rocks: U.S.; Amer. Asso. Petrol. Geol. Bull. 55:10, p. 1873-1881, 9 figs.

884. Playford, P.E. (1980) - Devonian "Great Barrier Reef" of Canning Basin, Western Australia: U.S.; Amer. Asso. Petrol. Geol. Bull. 64:6, p. 814-840, 27 figs.

885. Plesa, C. (1966) - The Crisul Repede Pass - A Guide: The Meridiane Publishing House, Bucharest, 35 pages and 12 figures (in Romanian).

> The author has prepared a complex guide to the Crisul Repede Pass (the Padurea Craiului Mountains) which has been dedicated as a natural

monument. The author describes several caves, the most important among which is the cave at Vadu-Crisului, one of the oldest caves to have been opened to tourism.

886. Plesa, C. (1978) - Original Data on Several Caves in the Padurea Craiului Mountains, Nymphaea, Oradea, VI: 265-278, figures 1-12 (in Romanian).

Six caves are described for the first time and their maps supplied. Furthermore, another cave lying in the Padurea Craiului Mountains, whose map has not been known before is described. All of them are small-size caves. Noteworthy is a cave containing a gallery with a difference of elevation of roughly 4 m below the surface stream bed. The biospeleological importance of the caves is also analyzed.

887. Plesa, C. (1981) - The Cave at Magura, The Sport-Turism Publishing House, Bucharest, 66 pages and black-and-white and color photographs (in Romanian, with English, French and German versions).

The author has prepared an album of and guide to one of the most beautiful caves dedicated as a natural monument in Romania. The work contains a historical survey of the cave, data concerning the inhabitants and the Sighistelului valley, a detailed description of the cave, as well as data on the rich fossil and current terrestrial and aqueous fauna.

888. Pohl, W.; Amouri, M.; Kolli, O.; Scheffer, R.; and Zachmann, D. (1986) - A new genetic model for the North African metasomatic siderite deposits in Mineral Deposits, Vol. 21, p. 228-233.

Based on published accounts of the diagenetic evolution of evaporite diapirs and geological, preliminary geochemical, and fluid inclusion data a new genetic model is presented for the North African metasomatic siderite deposits.

889. Polsak, A. (1981) - Upper Cretaceous biolithitic complexes in a subduction zone: Examples from the inner Dinarides, Yugoslavia: U.S.; Soc. Econ. Paleont. Min. Spec. Publ. 30, p. 447-472, 20 figs.

890. Ponta, G.; Strusievicz, R.; Simon, G. (1984) - Subterranean stream piracy in the Jiul de Vest - Cernisoara karst area-Romania in Theoretical and Applied Karstology, 235-238.

The authors discuss geological and tectonic factors influencing karst hydrogeology of the Jiul de Vest-Cernisoara karst area of the western part of South Carpathians (Retezat, Godeanu and Vulcan Mountains). Labelling with In-EDTA of 13,350 m of limestone is discussed.

891. Pop, E. (1949) - Nitrified Bacteria in the Scarisoara Cave, Scientific Bulletin, Series A, 1(9):899-907, the Academy of the Socialist Republic of Romania, one figure (in Romanian).

Two free stones, one a smooth stone covered with a black film, and the other a cauliflower-shaped, grey stone, inside the "Ghetarul de la Scarisoara" ice, lying in a warm merocliatic area with a constant temperature of 2 degrees celcius, were sampled. The samples were inseminated on two media of Winogradsky culture for nitrosobacteria and nitrobacteria, which entailed a process of nitrification. The Piccini reaction was positive for all four samples and a little more intense for the cultures derived from the black film. The authors' research work attests to the role played by autotrophic bacteria in the formation of the first layer of organic detritus in caves.

892. Pop, E.; and Ciobanu, I. (1950) - Pollen-Analyses in the Ice at Scarisoara, Anals of the Academy of the People's Republic of Romania, the Geology-Geography Series, Technical and Agricultural Sciences, 3(2):23-50, figures 1-4, diagrams I-III (in Romanian).

Pollen analyses were performed on 29 samples taken from the layers of impurities which alternate with ice layers in the descending cave of Scarisoara. The respective analyses showed that the whole ice body, which is more than 18 m thick and has a volume of 40,000 m^3, was deposited in the last post-glacial forestal phase, including the beech-tree, being approximately 3,000 years old. Analysis of five samples taken from the base of ice deposits in Focul Viu cave, Bihor county, show contemporaneity with the lower layers at Scarisoara. There is a historical parallelism between these ice bodies and the oligotrophic sphagnacetes in Romania, which indicates that they were formed in the sub-Atlantic post-glacial period.

893. Pop, G.; and Marza, I. (1977) - The Eocretaceous Paleokarst of Padurea Craiului Mountains (the Socialist Republic of Romania) and its Significance in the Mechanism of Bauxite Genesis, Sci. Geol. Bull., 30(1):51-58, Strasbourg.

A study of the eocretaceous paleokarst of Padurea Craiului and of the textural peculiarities of bauxite ore contained within suggests new elements of interpretation of the indirect genesis and double evolution of these ore deposits. The authors assert that the sinkhole-like cavities are obvious analogies with the forms of the actual tropical karst-plains of Central America, especially the cavities of the "Aston" and "Caguanes" type from Cuba, described by A.N. Jimenex (1967). The authors consider these cavities to be accumulations of traps for allochthonous lateritic products and favorable sites for their bauxitization.

894. Pop, Gh.; and Racovita, Gh. (1973) - Contributions to the Problem of the Genesis of Conic Karsts in Sierra de los Organos (Cuba), Livre du cinquantenaire de l'Institut de Speleologie "Emil Racovita": The Publishing House of the Academy of the Socialist Republic of Romania, Bucharest, 529-549 (in French).

After a critical survey of the theories proposed with respect to the formation of the relief of mogotes characteristics of karst in the western part of Cuba, the authors discuss vertical fragmentation of calcareous massifs through corrosion, a process which implies particular mechanisms and appears to be a morphoclimatic feature specific to tropical karst modelling.

895. Porthault, B. (1979) - Profil geochimique de la plate-forme urgonienne au bassin vocontien (Sud-est de la France): Lyon; Geobios. Mem. spec. 3, p. 347-359, 2 tbls., 5 figs.

896. Pouit, G.; and Bois, J.-P. (1986) - Arrens Zn (Pb), Ba Devonian deposit, Pyrenees, France: An exhalative-sedimentary-type deposit similar to Meggen: Germany, F.R.; Mineralium Deposita, Vol. 21, p. 181-189.

The Arrens deposit outcropping over 5 km on both limbs of a syncline displays specific characteristics: abundant barite with lateral Zn (Pb) zoning, exceptionally thick subreef footwall limestone overlain by black siltstone, abundant Ba silicate, in particular celsianite, locally cymrite, and siliceous, sedimentary-hydrothermal gangue. As all the mineralization of the Pyrenees Paleozoic, the deposit is of the exhalative or hydrothermal sedimentary type and bears some similarities with other exhalative deposits throughout the world.

897. Povara, I. (1973) - Contributions to the Investigation of the Thermomineral Sources of Baile Herculane, Travaux de l'Institut de Speologie "Emile Racovitza", 12, p 337-348, 7 figures, (in French).

Discharge conditions and temperatures are analyzed of seven thermomineral emergences in the northern part of Baile Herculane spa, whose emergences are supplied cold water from a karstic aquifer stored in Jurassic-Cretaceous limestones.

898. Povara, I. (1976) - Notes on the Origin of the Waters of Izvorul Cernei Resurgence, the Sourthern Carpathians, Romania, Travaux de l'Institut de Speologie "Emile Racovitza", 15, p 207-216, 6 figures, (in French).

Through discharge measurements and fluorscein tracing, the author investigated the hydrogeological catchment area of one of the largest karstic emergences in Romania, in the upper basins of the rivers Cerna Jiul de Vest.

899. Povara, I. (1980) - Notes on Underground Water Circulation in the Limestone of the Cerna Basin, Travaux de l'Institut de Speologie "Emile Racovitza", 19, p 237-241 (in French).

A presentation is made of the general features of underground waterflow through limestones from the hydrographic basin of Cerna River located in the south-western part of Romania. Five large structural units, with different hydrogeologic behavior, are distinguished.

900. Povara, I. (1984) - Speleologic Topography and Cartography, in "Elements of Scientific Speleology", 1, 46 p 30 figures, (in Romanian).

Starting from introductory notions of topography and cartography, the author discusses successive stages to be followed in organization, field measurements performing, values processing, and cartographic material for karstic cavities drawing. The measuring instruments, as well as the processing and representation methods described in detail.

901. Povara, I.; and Diaconu, G. (1974) - The Course of the Process of Celifraction in the Underground Media, Travaux de l'Institut de Speologie "Emil Racovitza", 13, p 139-146, (in French).

The authors discuss the effects of gelifraction on the limestone and on speleothems in underground cavities. The genesis of a particular form of stalactite, the "stalactite with facets", as a result of the gelifraction process, is explained.

902. Povara, I.; and Lascu, C. (1978) - Notes on Underground Water Circulation in the Graben of Cerna, Travaux de l'Institut de Speologie "Emil Racovitza", 17, p 193-197, 2 figures, (in French).

A particular type of deep drainage along the faults delimiting the graben of Cerna is presented. There are two karstic aquifers separated by a granitic body: the southern compartment, where a flux of thermomineral water exists (Baile Herculane), is supplied by a northern compartment with predominantly cool waters.

903. Povara, I.; Cosma, R.; Lascu, C.; Bulgareanu, V.-A.C. (1982) - A Particular Case of Karst in Salt Deposits (Slanic-Prahova, Romania), Travaux de l'Institut de Speologie "Emil Racovitza", 21, p 87-93, 3 figures, (in French).

The authors discuss karst and pseudokarst developed on the salt massif at Slanic-Prahova; underground water circulation was determined by means of tracing experiments with fluorescein through salt.

904. Povara, I.; Diaconu, G.; Goran, C. (1972) - Preliminary Remarks on the Caves Influenced by the Thermo-mineral Waters in the Baile Herculane Area, Travaux de l'Institut de Speologie "Emil Racovitza", 11, p 355-365, (in French).

The authors describe several, particular hydrological and mineralogical aspects which were observed in five caves influenced by thermo-mineral waters.

905. Povara, I.; Gutt, W.; Zakarias, A. (1981) - Epuran Cave, Editura Sport Turism, Bucuresti, 24p., 48 black-and-white and 38 color photographs, (in Romanian with English, French and German abstract).

This is an illustrated album which shows one of the most beautiful caves in Romania. In this pictorial collection, the authors emphasize the major stages of exploration and research of the cave which is 4.5 km long.

906. Povara, I.; Marin, C.; (1984) - Hercule Thermo-mineral spring in Hydrogeological and Hydrochemical Considerations, Theoretical and Applied Karstology, 1, p 183-194, 8 figures, (in English with Romanian abstract).

The authors present the variations in temperature, discharge and chemistry of the Hercule Thermomineral spring (Baile Herculane), the main discharge of an extensive synclinal structure developed in Jurassic-Cretaceous limestone. These variations are explained by the mixture of ascendent thermal waters with cold waters from rivers and infiltrations at the level of the natural drain of the aquifer (the Hercule cave, accessible on 94 m). A general scheme is outlined to explain aquifer supply and the mixture of two types of underground waters.

907. Povara, I.; Schmidt, N.; Petcu, A. (1970) - Morphospeleological Observations in an Area Situated Between Oravita and Ciclova Montana (Banat), Livre du Centenaire "Emil G. Racovita", Editura Academiei RSR, Bucuresti, p 621-626, (in French).

The authors present 11 karstic cavities developed in two Jurassic-Cretaceous limestone bars (syncline flanks) in the Banat Mountains. Several morphological and speleogenetic conclusions are presented.

908. Powell, R.L. (1975) - Joints in carbonate rocks in south-central Indiana: U.S.; Proceedings, Indiana Academy of Science, Vol. 84, p. 343-354.

The author presents detailed maps of joints for about 40 sites in carbonate rocks of Mississippian age in south-central Indiana. Joint orientation data, as displayed by conventional rose histograms, are by themselves inadequate for engineering and geologic applications. The maps show joint spacing and other details of pattern and orientation.

909. Pratt, W.P.; Walker, K-M.; Jenson, S.K.; Francica, J.R.; Hastings, D.A.; and Trautwein, C.M. (1983) -Mineral-resource appraisal of the Rolla 1° x 2° quadrangle, Missouri: Manual vs. digital (computer-assisted) synthesis in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 584-595.

The distribution of known occurrences of lead and zinc sulfides in carbonate rocks in the midcontinent suggests that much of this region is conducive to

Mississippi Valley-type deposits. The regional assessment procedure used in the Rolla quadrangle can be used effectively as part of a prospecting strategy for the midcontinent.

910. Pravdic, V.; and Juracic, M. (1986) - The environmental capacity approach to the control of marine pollution from land-based sources: Yugoslavia; Rapp. Comm. Inter. Mer. Medit., 30:2, p.131.

The strategy based on environmental (assimilative, receptive, absorptive) capacity of the marine environment to deal with contaminants is being suggested for use in a sensitive region of the Yugoslav eastern Adriatic, the Krka River estuary.

911. Pray, L.C.; and Murray, R.C., editors, (1965) - Dolomitization and limestone diagenesis - A Symposium: U.S.; Soc. Econ. Paleont. Min., Spec. Publ. 13, 180 p.

The editors present selected articles about the calcite-aragonite problem. Topics include recrystallization and diagenesis of limestones; Recent dolomitization (Bonaire, Persian Gulf, Bahamas); interrelationships between facies, diagenesis and properties of reservoir rocks (Upper Jurassic, NW Germany).

912. Preka, N.; Preka-Lipold, N.; Avdagic, I.; and Kurpjel, B. (1986) - Self-purification capability of karst underground watercourses with respect to the pollution of the Mediterranean Sea: Water Science and Technology, Vol.18, No.9, p.257-265.

The results of the organic self-purification process that occurs in karst underground watercourses are reviewed. Investigations were conducted in two tests between 1974 and 1984. The first test involved the underground section of a river in an area of shallow karst in Slovenia; the second test was in the deep karst area of Eastern Herzegovina. Fundamental studies of the change in BOD loadings resulted in determination of the value of the oxygen consumption rate coefficient in karst groundwaters. To determine the change in loadings, the Upstream-downstream method was applied, while the travel time was defined using a tracer. An identical value of the deoxygenation coefficient was found when observing the changes in the daily loads at the exit profile only. This knowledge enables estimation of the influence of karst springs and coastal sea protection measures.

913. Prohic, E.; (1986) - Heavy metal distribution in recent sediments of the Krka River estuary - an example of sequential extraction analysis of carbonate sediments in Dinaric karst area, Yugoslavia: Yugoslavia; Paper presented at the IX Inter. Symposium, Chemistry of the Mediterranean, 1-7 May 1986, Primosten, Yugoslavia, 24 p.

The sequential extraction procedure is applied to the study of speciation of heavy metals among various phases in recent estuarine sediments of a carbonate drainage area in Dinaric karst of Yugoslavia.

914. Prohic, E.; and Juracic, M. (1985) - Sedimentation pattern and heavy metals distribution in a peculiar karst estuary (eastern Adriatic): Yugoslavia; Rapp. Comm. Inter. Mer. Medit., 29:2, 143 p.

The Krka River estuary is located in a typical karst region (northern Dalmatia) characterized by specific morphology and hydrography. To determine the sedimentation pattern and spatial and temporal distribution of heavy metals, sediment cores along the estuary were investigated.

915. Prohic, E.; and Juracic, M. (1987) - Heavy metals in sediments - problems concerning determination of the anthropogenic influence, study in the Krka River estuary (eastern Adriatic Coast, Yugoslavia): Germany, F.R; Environmental Geology and Water Sciences [in press].

> Factors that govern heavy metal concentration in sediments were examined by a combined analytical, geochemical, and geological approach. Constraints encountered in the determination of the anthropogenic influence are discussed. The region examined was the Krka Rivr estuary located in the typical karst region of the eastern Adriatic, Yugoslavia.

916. Prox, A. (1984) - On the Genesis of the Piatra Craiului Naturwissenchaftliche Forschungen uber Siebenburgen, Volume 2, p 337-354, figures 1-7, Bohlau Verlag Koln Wien (in German).

> For several decades the author has been exploring potholes in the Piatra Craiului massif (Transylvania, Romania) to discover an access route to a hypothetical network of caves that might have been located deep inside the permeable mesocretaceous conglomerates. Contrary to the opionions held by previous investigators, the author discredits the contribution of a major karstic process to the genesis of the potholes, especially of those on the eastern slope of the massif. Strong orogenetic forces produced numerous faults which cross the whole mesocretaceous complex. The swallow holes are determined to be large, deep, and half-open faults.

917. Purdy, E.G. (1963) - Recent calcium carbonate facies of the Great Bahama Bank, 1. Petrography and reaction groups: U.S.; Journ. Geology, 71:3, p.334-355.

> Examinations of 218 Recent sediment samples impregnated and studied in thin-sections, point-counting analyses, and correlation analyses were conducted. As a result, the author identified "reaction groups", defined as groups of sedimentary constituents which react similarly to environmental changes.

918. Purser, B.H., (1980) Sedimentation et diagenese des carbonates neritiques recents, Tome 1: France; Soc. Editions Technip., 366 p.

> The authors deals with sedimentation and diagenesis of Recent neritic platform carbonates. Special attention is given to diagenetic phenomena. Chapters include particles, matrix, and sedimentary textures; structures and sedimentary sequences of the littoral environment; submarine diagenesis of carbonate sediments; diagenesis of carbonate sediments in the continental environment; conclusions and possibilities for the interpretation of Ancient carbonates.

919. Purser, B.H. (1973) - Relations entre les caracteristiques lithologiques et petrophysiques des roches carbonatees: France, Paris; Publ. Inst. Franc. Petrole, No. 21558, 243 p.

920. Purser, B.H., editor, (1973) - The Persian Gulf: Holocene carbonate sedimentation and diagenesis in a shallow epicontinental sea: Germany, F.R.; Springer-Verlag, 471 p.

> The editor presents the results of investigations on Recent and Subrecent carbonate sedimentation in the Persian Gulf.

921. Puscariu, V.; Rusu, T.; Viehjann, I. (1964) - Caves in the Caras Karst, Trav,. Inst. Speol. "Emil Racovita", Bucarest, III, 83-129, 32 figures (in Romanian).

> After a brief historical survey of research work, the authors discuss physico-geographic conditions of the area in which the Cara gorge evolves.

Assessments are made on its genesis and evolution. Exokarstic forms are presented and nine underground cavities are described in detail.

922. Putnam, B.R., III; and Norman, D.I. (1983) - Genetic model for the Hansonburg Mississippi Valley-type mineralization in New Mexico, based upon fluid-inclusion studies and paleotectonic interpretations in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 526-535.

The Hansonburg deposits are located on the easternmost margin of the Rio Grande rift in New Mexico. Field observations of the mineralization indicate ore characteristics which relate to preexisting sedimentary structures within a reef-facies limestone.

923. Quinlan, J.F.; and Ewers, R.O. (1985) - Ground Water Flow in Limestone Terranes: Strategy, rationale, and procedure for reliable, efficient monitoring of ground water quality in karst areas in Proceedings of the Fifth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring, May 21-24, 1985, The Fawcett Center, Columbus, Ohio, p.197-234.

Observation wells drilled to monitor pollutants in most limestone terrains are likely to miss detecting them, and to be a waste of time and money, because it is extremely improbable that such wells will intercept the conduits through which pollutants move. Groundwater flow and pollutant flow in most karst areas is not described by the radially dispersive characteristics of flow in granular or fractured media. Most flow in karst aquifers is turbulent, occurs in discrete conduits that are dendritic or trellised, is analogous to the flow of surface streams, and terminates in springs which have water quality representative of the mean of the groundwater basin. Surface streams are fed by infiltration water stored in interstream areas. Similarly, cave conduits are fed by diffuse Darcian flow through fine fractures. Flow is convergent in the upper and middle reaches of surface stream networks and cave conduit systems. In the lower reaches of both, however, flow is commonly divergent and in distributaries. Waste disposal sites should not be located in karst terrains. But if one is, the design of a groundwater monitoring network for a site in a maturely karstified area should include: (1) locating all springs, streams in sinkhole bottoms, and major streams in caves, (2) dye-tracing to establish connections between the disposal site, springs, and underground streams, (3) monitoring of such connected points, (4) monitoring of at least one spring shown by dye-tracing not to be connected to the site, as a control, and (5) dye-tracing to delineate groundwater basin boundaries.

924. Racovita, E. (1927) - Remarks on the Natural Glacier Called "Ghetarul de la Scarisoara", Bulletin of the Society of Sciences of Cluj, 3:75-108, figures 1-10, diagrams I-IV (in French).

The first monograph of the most important ice cave in Romania. After a brief historical survey, the geographic location is shown and each cavity sector described in detail. Several chapters deal with the morphology of the various types of cave ice and the seasonal variations in their structure, with emphasis on the fossil character of the massive ice deposition conserved in the center of the cave. Reference is made to the thermal particularities of the cave, on cave fauna: furthermore, the special interest aroused by this remarkable karstic feature is highlighted.

925. Racovita, G.; and Craciun, V. (1970) - Considerations on Seasonal Variations in the Ice Formations of the Ghetarul de la Scarisoara" Cave, Livre du centenaire "Emil G. Racovita", the Publishing House of the Academy of the Socialist Republic of Romania, Bucharest, 587-616, figures 1-10 (in French).

A balance-sheet of five annual cycles of monthly measurements of the dynamics of ice stalagmites and a comparison of periodic variations that characterize permanent and seasonal ice formations are presented. Long-term tendencies are evident in the evolution of these two types of formations, and the phase contrast between the dynamics of the stalagmites and the dynamics of the massive ice deposition are highlighted.

926. Racovita, G.; and Craciun, V. (1970) - Notes on Topoclimate in the Vadu-Crisului Cave, Trav.Inst. Speol. "Emil Racovita", Bucharest, 9:61-80, figures 1-10 (in French).

This is a presentation of the annual topoclimatic balance in a cavity with bidirectional aeration established on the basis of a complete series of measurements performed in 24-hour cycles. An approach to daily and seasonal variations in the temperature of the air, relative humidity, aeration velocity and water vapor pressure. The significance of the phenomena at the cave mouth is highlighted.

927. Racovita, Gh. (1967) - New Contributions to the Study of the Topo-climate of the "Ghetarul de la Scarisoara" Cave, Annales de Speleologie, 22(4) 757-786, FIGURES 1-7 (in French).

The author presents the results of a study of the topoclimatic characteristics of the cave, set according to three annual cycles of periodical measurements. An analysis is made of the influence exerted by outside meteorological factors on the underground climate. The author discusses an approach to the major physical phenomena occurring in the underground atmosphere (condensation, evaporation, freezing effect) and their influence on the dynamics of the underground ice deposition.

928. Racovita, Gh. (1972) - On the Correlation Between the Evolution of the Climate and the Dynamics of the Underground Ice Depositions in the Scarisoara Cave, Trav. Inst.Speol. "Emil Racovita", Bucharest, 9:373-392, figures 1-11 (in French).

The author discusses quantitative relationships between the dynamics of the ice formations and the topoclimatic factors of the cave and between the letter and outside meteorological factors. Relationships between weather conditions and the intensity of cave glaciation are also highlighted. Correspondence between microstratigraphic elements of underground ice deposition and climatic fluctuations of the past 250 years are elucidated. This work represents the first attempt to quantitatively interpret the paleoclimatic information contained in the structure of the respective deposition.

929. Racovita, Gh. (1973) - On the Physical Characteristics of the Medium of the Caves in Cuba, Resultats des expeditions biospeleologiques cubano-roumaines a Cuba, the Publishing House of the Academy of the Socialist Republic of Romania, Bucharest, 1:55-68, figures 1-18 (in French).

This report is a brief analysis of topoclimatic factors in correlation with the genetic and morphological elements characteristic of 21 caves explored in Cuba and a presentation of the thermohygrometric measurements performed in the respective caves.

930. Racovita, Gh. (1977) - Climatological Research in the Valea Lesului Cave, Trav. Inst. Speol. "Emil Racovita", Bucharest, 16:183-201, figures 1-13 (in French).

The author discusses the topoclimatic balance of a cavity with unidirectional aeration on the basis of monthly measurements performed for one and one-half years. Mathematical analysis is presented of theoretical curves which

model annual and seasonal thermometric variations. Determination of conditions measured and computation of aeration velocity and evapocondensation are discussed.

931. Racovita, Gh. (1979) - Current Requirements for the Protection of the Apuseni Mountains Caves, Nature and Environmental Protection, 23(2):127-134, figures 1-8 (in Romanian).

This report is a synthesis of the scientific considerations which should underlie the protection of major speleological features in the Apuseni Mountains Caves karst. Hydrogeological, morphological, crystallographic, and biological elements are discussed.

932. Racovita, Gh.; and Craciun, V. (1981) - A Topoclimatic Study of the Fata Apei Cave, Trav. Inst. Speol. "Emil Racovita", Bucharest, 20:157-178, figures 1-4 (in French).

This study is a survey of the results obtained during two annual cycles of measurements of underground topoclimatic factors; mathematical modelling of temperature variations is included.

933. Racovita, Gh.; Rusu, T. (1968) - The Use of the Self-Reducing Tacheometer in Cave Mapping: Trav. Inst. Speol. "Emil Racovita", Bucharest, VII, p 233-242, 5 figures (in Romanian).

The use of this device in underground topography and a new method of graphic representation, specific to the profiles that are obtained, are outlined.

934. Racovita, Gh.; Viehmann, I. (1966) - Observations on the Dynamics of Ice Stalagmites at the "Ghetarul de la Scarisoara - Sala Biserica", Trav. Inst. Speol. "Emil Racovita", Bucharest, 5:43-65, figures 1-15 (in Romanian).

Results are presented of a first series of periodic measurements concerning dynamics of ice stalagmites in the cave at Scarisoara (the Bihor Mountains). The roles of temperature and percolation water discharge in the seasonal evolution of these formations is highlighted. Explanatory considerations are made with respect to several elements of morphodynamics (primary and secondary inclusions in the ice, alveolar structure, and stalagmites with bilateral symmetry).

935. Racovita, Gh.; Viehmann, I. (1984) - On the Role of Underground Condensation in the Genesis of Ice Stalagmites, Trav. Inst. Speol. "Emil Racovita", Bucharest, 23:89-97, figures 1-4 (in French).

An assessment is made of the effect of condensation water in the genesis and dynamics of ice stalagmites in the cave at Scarisoara (Bihor Mountains, Romania). Factors responsible for location of these formations in the glacial zone of the cave are discussed.

936. Radke, B.M. (1976) - Hierarchical classification and vector ordination in the distribution of limestones in the Fairfield Group, Canning Basin, Western Australia: Australia; Journ. Austral. Geology and Geophysics, 1:1, p. 63-76.

Upper Devonian and Lower Carboniferous limestones are differentiated by multivariate analysis of thin-section data and rare elements.

937. Randazzo, A.F.; Stone, G.C.; and Saroop, H.C. (1977) - Diagenesis of middle and upper Eocene carbonate shoreline sequences, central Florida: Amer. Asso. Petrol. Geologists Bull. 61, p. 492-503.

938. Rao, C.P. (1981) - Criteria for recognition of cold-water carbonate sedimentation: Berriedale limestone (Lower Permian), Tasmania, Australia: U.S.; Journ. Sed. Petrol. 51:2, p. 491-506, 10 figs.

939. Rao, C.P.; and Carozzi, A.V. (1971) - Application of computer techniques to the petrographic study of oolithic environments. Ste. Genevieve Limestone (Mississippian), southern Illinois and eastern Missouri: Switzerland; Arch. Sci., 24:1, p. 17-55.

> Frequency and clasticity indices were determined for 800 thin-sections of Mississippian age. The authors differentiated 8 MF types as well as autochthonous and allochthonous ooids. Trend analyses were conducted by the investigators to indicate the relationships between clasticity and frequency indices of ooids and non-ooids.

940. Rao, C.P.; Mann, C.J.; and Carozzi, A.V. (1973) - Factor analysis testing microfacies and interpreted environmental factors: Ste. Genevieve Limestone (Mississippian), Illinois and Missouri: U.S.; Journ. Geology, 81:1, p. 65-80.

> Factor analyses (Q-mode) show that four factors explain approximately 87% of the data appearing in microfacies types and in postulated energy types.

941. Rathjens, C. (1960) - Beobachtungen an hochgelegenen Poljen im suedlichen dinarischen Karst: Z. Geomorphol., p. 141-151.

942. Reddy, M.M. (1977) - Crystallization of calcium carbonate in the presence of trace concentrations of phosphorous-containing anions--I, Inhibition of phosphate and glycerophosphate ions at pH 8.8 and 25°C: U.S.; Journ. Crystal Growth 41,p. 287-295.

943. Reddy, M.M. (1978) - Kinetic inhibition of calcium carbonate formation by wastewater constituents in Rubin, A.J., editor, Chemistry Wastewater Technology: U.S.; Ann Arbor Science, p. 31-56.

944. Renard, M. (1972) - Interpretation des teneurs en strontium des carbonates du Lutetien superieur a Saint-Vaast-les-Melo (Oise): mise en evidence de la valeur de cet element comme indicateur des conditions de diagenese et de sedimentation des carbonates: Paris; Bull. Inf. Asso. Geol. Bassin Paris 34, p. 19-29.

945. Renault, Ph. (1961) - Caractere des vagues d'erosion selon la morphologie des conduits karstiques: 3eme Congr. Inter. Speleol., Vienne, Vol. 2, p. 105-114.

946. Reulet, J. (1977) - Reservoir calcaire de plateforme marine (formation Mishris, Moyen Orient) in Elf-Aquitaine: Essai de caracterisation sedimentologique des depots carbonates: Pau; Elements d'interpretation 2, p. 169-180, figs. 39-44, pl. 17.

947. Rhodri Johns, D. (1978) - Mesozoic carbonate rudites, megabreccias and associated deposits from central Greece: Oxford; Sed. 25, p. 561-573, 6 figs.

948. Riech, V. (1978) - Zur Coelestinbildung im germanischen Muschelkalk Sueddeutschlands: Germany, F.R., Hannover; Geol. Jahrbuch D 29, p. 3-77, 6 pls., 21 figs., 4 tbls.

949. Riggs, S.R. (1979) - Phosphorite sedimentation in Florida-A model phosphogenic system: U.S.; Economic Geology, Vol. 74, p. 285-314.

> Some phosphatic sediments occur in many places in the geologic column and form in many environments on the sea floor in response to "normal" conditions and processes of sedimentation. However, that portion of the Miocene which contains the extensive phosphorites and associated anomalous mineralogies of the Hawthorn Group represents a very "abnormal"

period of sedimentation. This phosphogenic system was characterized by a specific tectonic setting, structural framework, and an abnormal set of environmental conditions; the consequences represent one of the most extensive and important phosphate deposits in the world.

950. Riggs, S.R.; Snyder, S.W.; Hine, A.C.; Snyder, S.W.; Ellington, M.D.; and Mallette, P.M. (1985) - Geologic framework of phosphate resources in Onslow Bay, North Carolina continental shelf: U.S.; Economic Geology, Vol. 80, p. 716-738.

High-resolution Uniboom, sparker, and 3.5 kHz subbottom seismic profiles, in combination with 9-m vibracores from Onslow Bay, delineate a belt of Neogene sediments which crop out on the North Carolina continental shelf around the east flank of the mid-Carolina platform high. The broad, southeast-trending basement high has controlled the general distribution of Cenozoic sediment sequences within the mid-Atlantic continental margin. This newly discovered continental shelf phosphate province could become economically feasible to mine in the near future when rapidly expanding demand for fertilizers and agricultural products, combined with ever-increasing land-use pressures, produces an unacceptable escalation in the cost of mining land-based reserves.

951. Rincon, A.; Lopez de Azcona; and Alvarez, C. (1977) - Estudio geomatematico de las rocas carbonatadas de la provincia de Segovia: Spain; Estudios Geol. Vol. 33, p. 581-587.

The authors report the results of an investigation of the distribution of rare elements in limestones by factor analysis.

952. Ripley, E.M.; Lambert, M.W.; and Berendsen, P. (1980) - Mineralogy and paragenesis of red-bed copper mineralization in the Lower Permian of south central Kansas: U.S.; Econ. Geology, Vol. 75, p. 722-729.

953. Roark, P. (1985) - Development of groundwater in karst zones of Somalia in Symposium on Tropical Hydrology and 2nd Caribbean Islands Water Resources Congress, Proceedings of the International Symposium, May 5-8, San Juan, Puerto Rico, 1985, p.3-6.

The development of groundwater in the karst formations of semitropical Somalia is characterized by generally low yields and water of high mineral content. Well yields vary considerably between sites and surface indicators of karstification and are important factors in locating well sites. Hydrogeologic data is minimal and much of the initial project efforts were devoted to collecting baseline information. In order to reduce the high incidence of inoperable wells which is characteristic of many rural development situations shortly after the technological inputs of well construction are completed, emphasis was placed on increasing local village participation in the design and operations. Local participation integrated with a program of regular maintenance is expected to increase the well life and reduce long-term costs. Costs of groundwater development comparable to the Somalia situation can be expected to be high and primarily reflect high capital outlays for equipment capable of deep drilling in remote areas.

954. Robinson, M.; and Clayton, R.N. (1969) - Carbon-14 fractionation between aragonite and calcite: Oxford; Geochim. Cosmochim. Acta 33, p. 997-1002.

955. Rogers, R.K.; and Davis, J.H. (1977) - Geology of the Buick mine, Viburnum Trend, southeast Missouri: U.S.; Economic Geology, Vol. 72, p. 372-380.

The Buick orebody consists of lead, zinc, and copper sulfides in solution-induced collapse breccias. The breccias occur in dolomitized, shelf-facies

calcarenite of the Upper Cambrian Bonneterre Formation. The shelf facies is underlain by digitate algal stromatolites and overlain by shale of the Davis Formation.

956. Roglic, J. (1960) - Das Verhaeltnis der Fluserosion zum Karstprozes: Z. Geomorphol. 4, p. 116-128.

957. Roglic, J. (1964) - Les Poljes du karst dinarique et les modifications climatiques du quaternaire: Rev. Belg. Geogr., p. 105-125.

958. Rothe, P.; Hoefs, J.; and Sonne, V. (1974) - The isotopic composition of Tertiary carbonates from the Mainz Basin: An example of isotopic fractionation in "closed basin": Oxford; Sed. 21, p. 373-395, 6 figs.

959. Rouvier, H.; Perthuisot, V.; and Mansouri, A. (1985) - Pb-Zn deposits and salt-bearing diapirs in southern Europe and North Africa: U.S.; Economic Geology, Vol. 80, p. 666-687.

Many diapirs with Triassic evaporite successions in southern Europe and North Africa are accompanied by strata-bound Pb-Zn mineral deposits. Study of North African and southern European deposits has led to a genetic model of diapir emplacement and associated Pb-Zn mineralization. The source of these metals is unknown. The transport of the metals is provided or facilitated by the brine from adjacent Triassic evaporites. Deposition of sulfides occurs where the deep fluids meet the upper beds. These deposits can be remobilized with each new phase of diapir growth.

960. Rudnicki, J. (1979) - Role of convection in shaping subterranean karst forms: Kras in Spele. 2:11, p. 92-100.

961. Rudnicki, J. (1980) - Subsurface karst processes in coastal areas: Studia Geologia Polanium, Vol. 65, 60 p.

962. Ruiz, J.; Kelly, W.C.; and Kaiser, C.J. (1985) - Strontium isotopic evidence for the origin of barites and sulfides from the Mississippi Valley-type ore deposits in southeast Missouri-A discussion: U.S.; Economic Geology, Vol. 80, p. 773-778.

963. Rusu, T. (1967) - The Caras Gorge, Nature Protection, 11.1, 37-50, 8 figures (in Romanian).

After a brief physico-geographic characterization of an area in which the gorge evolves, the gorge is described and assessments are made concerning its genesis and evolution and the caves on its slopes.

964. Rusu, T. (1968) - Research of Karstic Morphology and Hydrography in the Upper Basin of Valea Rosia (the Padurea Craiului Mountains), Trav. Inst. Speol. "Emil Racovita", Bucharest, VII, p 11-44, 25 figures (in Romanian).

After a survey of genesis and evolution of the hydrographic network which is effected by karstic captures, 39 caves, swallow holes, potholes, and springs are described, and the results of fluorescein labellings performed by the author are outlined.

965. Rusu, T. (1973) - The Evolution of the Karstic Valleys in the Padurea Craiului Mountains, Trav. Inst. Speol. "Emil Racovita", Bucharest, XXII, p 311-335, 15 figures (in French).

After a survey of several physico-geographic aspects of this natural area, an analysis is made of the factors involved in the general evolution of the valleys in the karst. On the basis of several concrete examples and current morphohydrographic elements, the author concludes that the evolution of

karstic valleys involves four more important stages, as follows: active or primary valleys, temporary active valleys,. dry valleys, and sinkhole-like valleys.

966. Rusu, T. (1973) - The Genesis and Evolution of the Hydrographic Network of the Padurea Craiului Mountains, Livre du cinquantenaire de l'Institut de Speleologie "Emil Racovita", the Publishing House of the Romanian Academy, p 575-589, 3 figures (in French).l

An hypothesis is presented with respect to genesis and evolution of the hydrographic network in that geographic unit, and three more important stages are distinguished, as follows: a primary stage of organization of the hydrographic network, a neogenic stage of bending of the valleys towards peripheral sedimentation basins, and a Pleistocene-Holocene stage of rebending of valleys in the direction of water withdrawal from those basins.

967. Rusu, T. (1975) - The Karstic Capture Depression of Pusta Calatea (the Padurea Craiului Mountains), Trav. Inst. Speol. "Emil Racovita", Bucharest, XIV, p 157-168, 6 figures (in French).

The author asserts that certain karstic depressions are considered poljen and refers to genesis and evolution of the depression at Pusta Calatea, which is a peculiar form created under the impact of an underground-capture stream around the swallet of the Miniera valley. Consequently, the term "karstic capture depression" is suggested to define many features of relief.

968. Rusu, T. (1976) - The Genesis and Evolution of the Karstic Capture Depression at Ponoare (the Padurea Craiului Mountains), Trav. Inst. Speol. "Emil Racovita", Bucharest, XV, p 217-232, 6 figures (in French).

Several physico-geographic aspects are outlined, and an analysis is made of genesis and evolution of the hydrographic network and, implicitly, of the depression at Ponoare. Several more important stages are determined according to paleoclimatic conditions, as follows: ante-Pleistocene, Pleistocene, Holocene, and Recent.

969. Rusu, T. (1977) - The karstic capture depression at Carmazan-Zecehotare (the Padurea Craiului Mountains): Bucharest, Romania; Trav. Inst. Speol. "Emil Racovita", 16, p.229-242.

After a survey of the major physico-geographic aspects, genesis and evolution of this karstic depression are analyzed, the morpho- hydrological sub-units in its composition are described, and karstic forms it includes are described.

970. Rusu, T. (1978) - General considerations on the karstic capture depressions in the Padurea Craiului Mountains: Bucharest, Romania; Trav. Inst. Speol. "Emil Racovita", 17, p. 157-164.

The author surveys karstic capture depressions and underscores differences between poljen and other types of karstic depressions.

971. Rusu, T. (1978) - The genesis and evolution of the depression at Acre (the Padurea Craiului Mountains): Bucharest, Romania; Trav. Inst. Speol. "Emil Racovita", 17, p. 145-156.

Several physico-geographic aspects are surveyed, genesis and evolution of the depression at Acre are analyzed, and main karstic forms in this geographic area are described.

972. Rusu, T. (1979) - The karst in the Padurea Craiului Mountains, abstract of a doctoral thesis: Lithography, the "Babes-Bolyai" University of Cluj-Napoca, 25 p.

On the basis of investigations conducted from 1961 to 1978, the author discusses karst in this geographic unit. The report is organized into the following chapters: A Historical Survey of Research Work, A Physico-Geographic Characterization of the Padurea Craiului Mountains, The Morphohydrography of the Exokarst, The Morphohydrography of the Endokarst, and the Capitalization and Conservation of Karstic Relief. The work is one of the most comprehensive studies on a karstic region in Romania.

973. Rusu, T. (1981) - The underground drainages of the Padurea Craiului Mountains: Bucharest, Romania; Trav. Inst. Speol. "Emil Racovita", 20, p. 1987-205.

The major stages of the evolution of the hydrographic network in the Padurea Craiului Mountains are outlined and general considerations are made on underground water circulation. Forty-four known underground drainages and 49 presumed drainages are analyzed. The work concludes with several considerations on the current stage of the evolution of the hydrographic network and with recommendations on the way to use karstic waters.

974. Rusu, T. (1981) - The Ursilor Cave at Chiscau (the Apuseni Mountains): Romania; Revue Roumaine Geology, geophysique et geographie, Geographie, 25:2, p. 183-204.

The work includes a brief historical survey and refers to morpho-hydrography of the cave. The genesis and evolution of the karstic system to which it belongs are analyzed according to the paleogeography of the region.

975. Rusu, T. (1982) - An introduction to karstology I: Romania; "Karst" Bulletin, the CEPROMIN Club of Amateur Speleologists, Cluj-Napoca, 2, p. 2-19.

This work is intended for amateur speleologists and all those wishing to enrich their knowledge of karstology and speleology. After a brief historical survey of the development of karstology a number of notions are advanced in connection with karstifiable rocks (origin, classification, distribution) and the types of karst in Romania are analyzed. The work ends with a glossary of specialty terms.

976. Rusu, T. (1983) - An introduction to karstology II: Romania; "Karst" Bulletin, the CEPROMIN Club of Amateur Speleologists, Cluj-Napoca, 3, p. 26-46.

Reference is made to karst-formation processes and water circulation in karst. Factors which determine the development of karst are analyzed, and the major exokarstic forms (lapies, sinkholes, uvalas, karstic lakes, potholes, karstic springs, karstic valleys, karstic capture holes and depressions, and poljen) are described. The author concludes with a concise glossary of specialized terms.

977. Rusu, T. (1984) - A study of karstic relief: Romania; The Cave, 1, Bulletin of the "Emil Racovita" Student Speleological Group, Cluj-Napoca, p. 7-13.

This work is intended for amateur speleologists and is a handbook for all those who wish to research karstic regions. The author includes recommendations on collection of information and bibliographic data; extensive research; processing of experimental results; and the proper elaboration of a study.

978. Rusu, T.; and Racovita, Gh. (1971) - The Damis-Ponoras karstic complex (the Padurea Craiului Mountains): Bucharest, Romania; Trav. Inst. Speol. "Emil Racovita", 10, p. 15-42.

The authors analyze genesis and evolution of the hydrographic network, highlight the role of karstic captures, describe the mode of formation of two karstic capture depressions (Damis and Ponoras), and outline the major karstic forms in their respective areas.

979. Rusu, T.; and Racovita, Gh. (1981) - The Ursilor Cave at Chiscau: Nature and Environmental Protection, 2:1, p. 57-71.

A brief description of physico-geographic features and morphology of Ursilor Cave et Chiscau is the basis of an analysis of the major aspects related to the genesis and evolution of this cavity. The topoclimatic, biospeleological, and paleontologic features of this cave are outlined, and emphasis is placed on the need to preserve underground natural feature unaltered by tourist activities.

980. Rusu, T.; Bleahu, M.; Dan, J.; and Mantea, Gh. (1957) - Research of karstic morphology in the "Groapa de la Barsa" (the Bihor Mountains): Romania; Studies and Research, the Geology-Geography Series, 3-4, 8, Cluj, p. 399-419.

On the basis of topographic surveys, the authors discuss exo- and endokarstic forms in this geographic unit and the relationships between them and local tectonics.

981. Rusu, T.; Racovita, Gh.; and Coman, D. (1970) - Contributions to the study of the karstic complex at Scarisoara: Ann de Speol, 25:2, p. 383-408.

On the basis of tacheometric methods in Romanian speleological research, the authors outline evolution of the Ghetar-Ocoale karstic system and define the concepts of "system" and "karstic complex". Emphasis is placed on genesis of the Ghetarul de la Scarisoara Cave with respect to local tectonics and paleoclimatic conditions. Morphometric parameters of underground ice deposition are assessed, and hypotheses are proposed on the conditions in which it was formed.

982. Rusu, T.; Racovita, Gh.; and Craciun, V. (1970) - The Toplita-Ciur-Tinoasa karstic system (the Padurea Craiului Mountains): Romania; Livre de Centenaire "Emil Racovita", The Publishing House of the Academy of the Socialist Republic of Romania, p. 627-650.

The genesis and evolution of the elements that comprise this karstic system are outlined. The Ciur-Izbuc Cave (where several footprints of prehistoric man were discovered) and Ciur-Ponor Cave are described in detail.

983. Rusu, T.; Racovita, Gh.; and Craciun, V. (1974) - The cave at Mezaid, physico-geographic aspects, the genesis and evolution of the cavity: Bucharest, Romania; Trav. Inst. Speol. "Emil Racovita", 13, p. 147-173.

Presentation of physico-geographic aspects is followed by a description of karstic forms in the Mezaid Valley basin and a reconstitution of the genesis and evolution of this important cavity. On the basis of detailed tacheometric surveys, morphohydrography of the cave, topometric parameters, and relationships with exokarstic forms are discussed.

984. Rusu, T.; Racovita, Gh.; and Craciun, V. (1981) - The Meziad Cave: Bucharest, Romania; Sport-Turism Publishing House, 39 p.

This is an album of photographs of one of the best known tourist caves in the Apuseni Mountains. The introduction to this work includes a brief historical survey of research work, a description of the geographic location,

and a presentation of the cave, including elements of genesis and evolution and references to current and fossil fauna.

985. Rusu, T.; Viehmann, I.; Racovita, Gh.; and Craciun, V. (1969) - Footprints of prehistoric man in Romania's caves: Nature Protection, 13:2, 191-200.

The authors discuss morphology of the Toplita-Ciur-Tinoasa karstic system (in the Padurea Craiului Mountains), which includes the Ciur-Izbuc cave, the first underground cavity where footprints of paleolithic man were found (probably dating back to the solutrean), and evidence of activity of the cave bear. The possible use of this cave as a shelter for prehistoric man is suggested.

986. Rutter, E.H.; and Schmid, S.M. (1975) - Experimental study of unconfined flow of Solnhofen limestone at 500°C to 600°C: U.S.; Geol. Soc. America Bull., 86:2, p. 145-152.

Results of 25 uniaxial creep, stress-relaxation, and constant strain-rate tests between 500°C and 600°C on cylinders of Solnhofen limestone are reported. The results of different experimental techniques employed on unconfined rock were found to be consistent and were comparable with data from high-temperature triaxial tests on the same rock.

987. Sagri, M. (1979) - Upper Cretaceous carbonate turbidites of the Alps and Apennines deposited below the calcite compensation level: U.S.; Journ. Sed. Petrol. 49:1, p. 23-28, 3 figs.

988. Sahasrabudhe, Y.S. (1978) - Geochemistry of bauxite profiles on different rock types of central and western India in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Greece, Athens; National Technical University, p. 734-751.

989. Sahli, R.; Giot, D.; Orgeval, J.J.; Lenindre, Y.M.; Sureau, F.; and Snoep, J. (1981) -Schema des principaux evenements diagenetiques affectant les series sulfato-carbonatees associees aux mineralisations plomb-zinc due Jebel Kebbouch, Jebel Lorbeus et Jebel Dogra (Gouvernorat du Kef, Tunis), Essai d'interpretation diagenetique: Cong. Natl. Sci. Terre, Tunis, Sept. 1981, Comptes Rendus [in press].

990. Sakai, H.; and Matsubaya, O. (1971) - Sulfur and oxygen isotopic ratios of gypsum and barite in the black ore deposits of Japan: Soc. Mining Geol. Japan, Spec. Issue 2, p. 80-83.

991. Sakar, S.; Bhattacharyya, A.; and Chanda, S.K. (1980) - Recognition of hardgrounds and emersion surfaces: A new criterion: U.S.; Journ. Sed. Petrol. 50:1, p. 83-89, 7 figs.

992. Salatic, D.; and Deusic, S. (1978) - De la separation de la boehmite d'avec la kaolinite par flottation in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 752-764, 3 figs.

993. Salomons, W.; and Mook, W.G. (1976) - Isotope geochemistry of carbonate dissolution and reprecipitation in soils: Soil Sci. 122, p. 15-24.

994. Samama, C. (1976) - Ore deposits and continental weathering: A contribution to the problem of geochemical inheritance of heavy metal contents of basement areas of sedimentary basins in Amstutz, G.C., and Bernard, A.J., editors, Ores in Sediments: Germany, F.R., Heidelberg, Springer-Verlag, International Union of Geological Sciences Series A, No. 3, p. 247-265.

From the study of recent or old weathering profiles, it appears that each heavy element can either be leached out toward a basin or enriched and provisionally accumulated within weathered covers according to the major weathering process acting upon continents. Based upon geochemical

analysis of three regional examples, the author concludes that only heavy elements accumulated during a weathering period are found in economic deposits in the resulting sandstone formations, and that geochemical evolutions or zonations may derive from climatological evolutions or zonations.

995. Sampo, M. (1969) - Microfacies and microfossils of the Zagros area, Southwestern Iran (from Permian to Miocene), Intern. Sed. Petrogr. Ser. 12: The Netherlands; Brill, 102 p.

The author presents microfacies information based on profile studies of carbonate sequences in the Southwest (Triassic to Pleistocene) and Northeast (Pre-Permian to Pleistocene) Zagros range. A differentiation is made between "faunal zones" according to benthonic and pelagic foraminifera as well as algae, particularly from the Jurassic to the Miocene. Good fossil identifications and detailed photographs of foraminifera in thin-sections are provided.

996. Sangster, D.F. (1976) - Carbonate-hosted lead-zinc deposits in Wolf, K.H., editor, Handbook of Strata-Bound and Stratiform Ore Deposits, Volume 6: The Netherlands, Amsterdam; Elsevier Science Publishing Co., p. 447-456.

997. Sangster, D.F. (1983) - Mississippi Valley-type deposits: A geological melange in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 7-19.

A review of the world's major deposits of the Mississippi Valley type (MVT) and districts of this type reveals a great diversity in their regional and local geology. The author examines six geological features in nine world-class MVT districts and concludes that the differences among these districts are sufficiently significant as to preclude formulation of a unifying descriptive or genetic model. As a result of this analysis, it is proposed that MVT deposits be divided into three sub-types (cratonal, basinal, platforms) based on metal ratios and local geological features.

998. Sarin, A.; and Hrelic, D. (1984) - Vcjena hidrogeoloskih suojstava karbonatnih naslaga na temelju gustode ponikava u niskom: dijelie visokog Krsa Hrvatske: Yugoslavia; Zbor. ref. VIII Jug. Simp. hidnd. inz. geol., Vol. 1, p. 117-125.

The drawing of dolines density maps as a tool in the hydrogeologic cartography of karst terrains has been strongly recommended for the preparation of the Basic Hydrogeologic Map of Yugoslavia, scale 1:100,000, that will be prepared during the next 25 or more years.

999. Sarin, A.; and Urbiha, H. (1977) - Cartographic novelty in a hydrogeologic map of Croatia in Inter. Asso. Hydrogeologists Memoires, Vol. XIII, Part 1: U.K., Birmingham; p. B29-B38.

A Hydrogeologic Map of Croatia, scale 1:200,000, covering an area of 56,538 km^2, is being prepared. A new and important classification of thermomineral waters is applied. Through its use and by means of graphic solutions, thermomineral and other hydrogeochemical characteristics of mapped areas can be determined. The quality of water for domestic use and for irrigation of both ground and surface waters is indicated by various diagrams and symbols.

1000. Sarin, A.; Korolija, B.; and Hrelic, D. (1985) - The most favorable conditions for the ground-water supply on small karst islands: The island of Korcula, Croatia - a case study: Italy; V Inter. Symp. Groundwater, p. 17-21.

The authors deal with a type of island where the conditions for major groundwater occurrences are most favorable.

1001. Sarntheim, M.; and Walger, E. (1973) - Classification of modern marl sediments in the Persian Gulf by factor analysis in Purser, B.H., editor, The Persian Gulf: Germany, F.R.; Springer-Verlag, p. 81-98.

A study of 38 features of 170 bottom samples are studied by factor analysis, using the Q and R modes, leading to a definition of mappable facies units.

1002. Sartoni, S.; and Crescenti, U. (1962) - Recherche biostratigrafiche nel Mesozoico dell'Appennino meridionale: France; Giorn. Geol. 29:2, p. 161-304.

Zonation of the carbonate sequences (Lias to Paleocene) in ten cenozones (fossil assemblage zones) and three subzones is presented. Good paleontological identifications and exact descriptions are provided. Today a "classic", this reference work should be supplemented by Crescenti, 1966, Boll. Soc. Geol. Ital, Vol. 85.

1003. Sarvary, I. (1975) - How can the size of "cavernment" in karstic rocks be estimated?: Proc. 6th Inter. Congr. Spele. III, Olomouc, 1973, p. 267-272.

1004. Sass-Gustkiewicz, M. (1983) - Zinc-lead ore structures from Upper Silesian region in the light of solution transfer in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 20-26.

The strata-bound Zn-Pb sulfide ores from the Upper Silesian district occur in flat-lying Triassic carbonates and were emplaced after sedimentation and lithification of host rocks. Ore bodies show evidence of a prolonged transfer of hot, aggressive, and mineralizing solutions. Two types of transfers are considered: (1) non-integrated flow through inter- and intragranular discontinuities, and (2) integrated circulation through distinct transmissive conduits.

1005. Sass-Gustkiewicz, M.; Dzulynski, S.; and Ridge, J.D. (1982) - The emplacement of zinc-lead sulfide ores in the Upper Silesian district-A contribution to the understanding of Mississippi Valley-type deposits: U.S.; Economic Geology, Vol. 77, p. 392-412.

The authors discuss the manner in which Upper Silesian zinc-lead ores of Mississippi Valley type were introduced into, and deposited within, the ore-bearing dolomite, the host rock of the ores.

1006. Savu, Al. (1967) - The relief in the Cheile Turzii Region and its economic usefulness: Studia Universitatis Babes-Bolyai, the Geologia-Geographia Series, Fasciculum 2, p. 115-119.

Besides economic aspects, the controversial genesis of Turzii Gorge is discussed and new arguments are presented in support of epigenesis and the role played by underground karstic relief.

1007. Savu, Al.; and Haidu, I. (1984) - On the genesis and evolution of limestone klips in the Trascaului Mountains: Studia Universitatis Babes-Bolyai, Geologia-Geographia, p. 30-36.

The authors present a critical approach to the genesis of the alignment of Jurassic, calcareous islands in the mass of Cretaceous flysch. Opinions of their interpretation as remains of overthrust nappe, overthrust folds, and olystolites are invalidated, and the authors suggest that they are klips directly linked to the presence of alignments of ophiolites which serve as supports

and whose eruptions make a bilateral fold in the ocean-type crust of local sialitic blocks. A small number of the more than 50 calcareous islands located along two major directions (alignments) could represent olystolites.

1008. Savu, Al.; and Zagreanu, I. (1976) - Karstic waters and cardiovascular complaints: Romania; Revue Roumaine de Geology, geophysique et geographie (Geographie), Romanian Contributions to the 23rd International Congress of Geography, Moscow, 1976, p. 121-125.

An analysis is made of the calcium content of several Vauclusian-type springs in mesozoic limestone (with insignificant concretions) and values of 65 mg and respectively 160-242 mg/l are assessed. Two groups of apparently healthy individuals who drink calcium-free water and, respectively, water with a high calcium content are investigated. With respect to the latter group, a high incidence of lithiasis and cardiopathy is noted.

1009. Scanlon, B.R.; and Thraikill, J. (1987) - Chemical similarities among physically distinct spring types in a karst terrain: Journal of Hydrology, Vol. 89, No. 3/4, p.259-279.

In karst regions where correlations between physical characteristics of springs and temporal variations in spring water chemistry was used to infer physical attributes of karst systems. Springs were tested in the Inner Bluegrass Karst Region of central Kentucky where previous dye-tracing studies have identified two physically distinct spring types: local high-level springs discharging from shallow flow paths and major low-level springs discharging from a deep integrated conduit system. Representative high-level and major springs were sampled over a 16-month period and analyzed for major dissolved components. Both spring types showed similar variations in temperature, calcium, magnesium, bicarbonate, and hardness. No systematic differences in ironic concentrations or in saturation indices with respect to calcite and dolomite were apparent. Chemical similarities between high-level and major springs during low flow are attributed to recharge of major springs by percolation and by high-level springs and to the occurrence of most chemical reactions near the recharge zone rather than in the deep conduit system. During high discharge, most recharge to the major springs is surface runoff which produces low ionic concentrations. Similarly low ionic concentrations in the high-level springs result from rapid flow through the soil-rock zone and short flow distances. These relationships indicate that spring water chemistry is not only a function of conduit size but also an indicator of recharge type and amount and flow path length. Differing flow path lengths to major and high-level springs counteract the effect of varying conduit size between the two spring types and result in similar ionic concentrations. These data indicate that spring water chemistry cannot be used to predict physical characteristics of karst aquifers in the Inner Bluegrass Region. The physical and chemical attributes of springs in the Inner Bluegrass were compared to those of springs in the Nittany Valley of Pennsylvania. A reported high correlations between physical and chemical characteristics of springs in the Pennsylvania karst system reflects geological and structural controls not present in the Inner Bluegrass Region.

1010. Scavnicar, S. (1978) - New data on the insoluble residuum of limestone in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 765-772.

1011. Schadlun, T.N. (1976) - On the origin of "kies"-ore and Pb-Zn deposits in sediments in Amstutz, G.C., and Bernard, A.J., editors, Ores in Sediments: Germany, F.R., Heidelberg; Springer-Verlag, International Union of Geological Sciences Series A., No. 3, p. 267-273.

A brief summary of the data obtained by numerous investigators on the sulfur isotope deposition from stratiform copper-zinc and lead-zinc deposits from the USSR occurring in sedimentary and volcanogenic-sedimentary rocks is presented in this paper. The problems of the genesis and the source of metals and sulfur are still open to discussion. The comparison of the character of isotope composition variations and certain features of the ore textures and structures suggest that the origin of ores took place during two periods - sedimentary or diagenetic and metasomatic or magmatathermal.

1012. Schafer, P.; and Senowbari-Daryan, B. (1981) - Facies development and paleoecological zonation of four Upper Triassic patch-reefs, Northern Calcareous Alps near Salzburg, Austria: U.S.; Soc. Econ. Paleont. Min. Spec. Publ. 30, p. 241-259, 10 figs.

1013. Schairer, G.; and Lupu, M. (1969) - Mikrofazielle Untersuchungen in untertithonischen, geschichteten Kalken von Kapfelburg bei Kelheim in Bayern: Muenchen; Mitt. Bayer, Staatssammlung Palaeont. hist. Geol. 9, p. 183-199, pls. 11-12, 8 figs.

1014. Schellmann, W. (1978) - Behaviour of nickel, cobalt and chromium in ferruginous lateritic nickel ores: Bull. Bureau Recherches Geologique Minieres, ser. 2, sec. 2,p. 275-282.

1015. Schlager, W. (1980) - Mesozoic calciturbidities in Deep Sea Drilling Project hole 416 A: Recognition of a drowned carbonate platform: U.S.; Initial Rept. Deep Sea Drilling Project 50, p. 733-749, 14 figs.

1016. Schlager, W. (1981) - The paradox of drowned reefs and carbonate platforms: U.S.; Geol. Soc. of Amer. Bull. (in press).

1017. Schlager, W.; and James, N.P. (1978) - Low-magnesian calcite limestones forming at the deep-sea floor, Tongue of the Ocean, Bahamas: The Netherlands, Amsterdam; Bed. 25, p. 675-702, 19 figs.

1018. Schmidt, W.; and Coe, C. (1978) - Regional structure and stratigraphy of the limestone outcrop belt in the Florida Panhandle: U.S.; Florida Bureau Geology, Rept. Inv. 86.

1019. Schmidt, W.; Hoenstine, R.W.; Knapp, M.S.; Lane, E.; Ogden, G.M., Jr.; and Scott, T.M. (1979) - The limestone, dolomite and coquina resources of Florida: U.S.; Florida Department of Natural Resources, Bureau of Geology Report 88, 54 p.

The authors summarize the known data relating to the occurrence of the limestone, dolomite, and coquina resources of the State of Florida and the uses of these commodities. Preparation for this report included geological field reconnaissance, examination of well cuttings and core samples, analysis of data from private industry, and comprehensive literature search by the Florida Bureau of Geology. The study may be considered an up-to-date "state-of-the-art" report including uses and the locations of economic deposits of limestone, dolomite, and coquina in Florida.

1020. Schneider, H.-J.; Moeller, P.; Parekh, P.P.; and Zimmer, E. (1977) - Fluorine contents in carbonate sequences and rare earths distribution in fluorites of Pb-Zn deposits in east-alpine mid-Triassic: Min. Depos. 12, p. 22-36.

1021. Schneidermann, N. (1970) - Genesis of some Cretaceous carbonates in Israel: Jerusalem; Israel Journ. Earth-Sci. 19, p. 97-115, 13 plts., 5 figs.

1022. Schneidermann, N. (1973) - Pelagic limestones of the central Caribbean, Leg 15: U.S.; Initial Rept. Deep Sea Drilling Project 15, p. 773-793, 8 pls.

1023. Schnitzer, W.A.; and Wagner, W. (1969) - Welche Anforderungen muessen Geruchsstoffe fuer Karstwassermarkierungen erfuellen?: Vom Wasser 35, Weinheim, Chemie, 1969, p. 227-236.

1024. Scholle, P.A. (1971) - Diagenesis of deep-water carbonate turbidities, Upper Cretaceous Monte Antola flysch, Northern Apennines, Italy: U.S.; Journ. Sed. Petrol. 41:1, p. 233-250.

1025. Scholle, P.A. (1971) - Sedimentology of fine-grained deep-water carbonate turbidities, Monte Antola flysch (Upper Cretaceous), Northern Apennines, Italy: U.S.; Geol. Soc. Amer. Bull. 82, p. 629-658.

1026. Scholle, P.A. (1974) - Diagenesis of Upper Cretaceous chalks from England, Northern Ireland and the North Sea: U.K., Oxford; Inter. Asso. Sed. Spec. Publ. 1, p. 177-220.

1027. Scholle, P.A. (1977) - Chalk diagenesis and its relation to petroleum exploration: Oil from chalks, a modern miracle?: U.S.; Amer. Asso. Petrol. Geol. Bull. 61, p. 982-1009.

1028. Scholle, P.A. (1977) - Deposition, diagenesis, and hydrocarbon potential of "Deeper-Water" limestones: U.S.; Amer. Asso. Petrol. Geol. Continuing Education Course Notes Ser. 7, 27 p.

1029. Scholle, P.A. (1978) - A color illustrated guide to carbonate rocks constituents, textures, cements, and porosities: U.S.; Memoirs Amer. Asso. Petroleum Geologists, Vol. 27, 241 p.

> A very interesting introduction to thin-section analysis of carbonate rocks. Chapters: Skeletal Grains, Other Carbonate Grains, Other Minerals, Carbonate Cements, Carbonate Textures, Porosity Classification.

1030. Scholle, P.A. (1979) - Porosity prediction in shallow versus deep water limestones -primary porosity preservation under burial conditions: U.S.; Amer. Asso. Petrol. Geol. Course Note Ser. 11, p. D1-D9.

1031. Scholle, P.A.; and Arthur, M.A. (1980) - Carbon isotope fluctuations in Cretaceous pelagic limestones: Potential stratigraphic and petroleum exploration tool: U.S.; Bull. Amer. Asso. Petrol. Geol. 64:1, p. 67-87, 12 figs.

1032. Schroeder, E.R. (1979) - Le calcaire de Caniego: Temoin du'un montee du diapir de Valle de Mena (Province de Burgos Espagne) dans l'Albien superior: Cuademos Geologia Ibernia, Vol. 5, p. 221-225.

1033. Schroeder, J.H.; and Siegel, F.R. (1969) - Experimental dissolution of calcium, magnesium and strontium from Holocene biogenic carbonate: A model of diagenesis: U.S.; Bull. Amer. Asso. Petrol. Geol. 53:3, 740.

1034. Schroeder, J.H.; Miller, D.S.; and Friedman, G. M. (1970) - Uranium distributions in recent skeletal carbonates: U.S.; Journ. Sed. Petrol. 40:2, p. 672-681, 12 figs.

1035. Schroll, E. (1984) - Geochemical indicator parameters of lead-zinc ore deposits in carbonate rocks in Wauschkuhn, A., Kluth, C., and Zimmermann, R.A, editors, Syngenesis and Epigenesis in the Formation of Mineral Deposits: Germany, F.R., Heidelberg; Springer-Verlag, p. 294-305.

> Geochemical characterization results are presented of chemical and isotopic data. Strata-bound lead-zinc deposits hosted in mostly carbonate, sedimentary rocks, can be divided into genetically different groups showing many varieties: sedimentary, Alpine-type, Mississippi Valley-type, volcanogenic sedimentary type, etc. Differences of geochemical parameters between syngenetic and epigenetic ore mineralizations, between Alpine-type (Bleiberg) and Mississippi Valley-type are discussed.

1036. Schulz, O. (1964) - Lead-zinc deposits in the Calcareous Alps as an example of submarine-hydrothermal formation of mineral deposits in Amstutz, G.C., editor, Sedimentology and Ore Genesis: Amsterdam; Elsevier, p. 47-52.

1037. Schulz, O. (1978) - Kolloforme ZnS-Lagengefuege und ihre Genese in Karbonatgesteinen: Oesterr Akad Wiss., Schriftr. Erdwiss. Komiss. 3, p. 159-168.

1038. Schulz, O. (1982) - Karst or thermal mineralizations interpreted in the light of sedimentary ore fabrics in Amstutz, G.C., El Goresy, A., Frenzel, G., Kluth, C., Moh, G., Wauschkuhn, A., and Zimmermann, R.A., editors, Ore Genesis: The State of the Art: Germany, F.R., Heidelberg; Springer-Verlag, p. 108-117.

> In the wake of recently obtained data on Zn-Pb-Fe-Ba-F-enrichments on erosion surfaces and paleokarsts in carbonate rocks, there is a tendency toward unjustified generalization of ideas, beyond immediately straightforward interpretations. Some illustrative examples of features suggesting paleokarst formation are given, and critical statements are presented concerning mineral deposits in Sardinia, Algeria, the Karnian Alps, Gailtal Alps, and Kitzbuehel Alps.

1039. Schulz, O.; and Vavtar, F. (1977) - Sedimentary magnesite fabrics within the sparry magnesite deposit Hochfilzen (Tyrol) in Klemm, D.D.; and Schneider, J.J., editors, Time- and strata-bound ore deposits: Springer-Verlag, p. 260-272.

> In the fine-spathic magnesite deposit of Burglkopf near Hochfilzen (northern zone of greywackes, Tyrol) a matter-concordant, locally limited, apparently lense-shaped intercalated layer of magnesite, hematitie and sericite has been discovered. The findings suggest a generally synsedimentary to diagenetic origin of the magnesite deposit.

1040. Schulze, K.-H. (1975) - Mikrofazielle, geochemische und technologische Eigenschaften von Gesteinen der Oberen Herrsumer Schichten des Korallenoolith (Mittleres bis Oberes Oxfordium, NW-Deutschland) Zwischen Weser und Leine: Germany, F.R.; Geo. Jb., D 11, p. 3-102.

> Semi-quantitative evaluation of more than 1700 thin-sections was performed by comparing geochemical and technological data. The technological properties of rocks, particularly weathering criteria, are correlated with 21 microfacies types.

1041. Schwarz, H.-U. (1975) - Sedimentary structures and facies analysis of shallow marine carbonates: Stuttgart; Contrib. Sed. 3, 100 p., 11 pls., 35 figs.

1042. Schwerd, K. (1977) - Triassische Karbonatgesteine und schichtgebundene Bleiglanz-FluBspat-Lagerstaetten in der westlichen Sierra de Gador (betische Internzone, Provinz Almeria), Spanien: Muenstersche Forsch. Geol. Palaeontol. 43, p. 47-92.

1043. Scoffin, T.P. (1972) - Cavities in the reefs of the Wenlock Limestone (Mid-Silurian) of Shropshire, England: Geol. Rdsch. 61:2, p. 565-578, 12 figs.

1044. Scoffin, T.P.; Alexandersson, E.T.; Bowes, G.E.; Clockie, J.J.; Farrow, G.F.; and Milliman, J. D. (1980) - Recent, temperate, sub-photic carbonate sedimentation, Rockall Bank, Northeast Atlantic: U.S.; Journ. Sed. Petrol 50:2, p. 331-356, 19 figs.

1045. Semeniuk, V. (1971) - Subaerial leaching in the limestones of the Bowan Park Group (Ordovician) of Central Western New South Wales: U.S.; Journ. Sed. Petrol. 41:4, p. 939-950, 9 figs.

1046. Sen, Z.; and alDakheel, A. (1986) - Hydrochemical facies evaluation in Umm Er Radhuma Limestone, Eastern Saudi Arabia: Ground Water GRWAAP, Vol.24, No.5, p. 626-635.

Hydrochemical characteristics of the Umm Er Radhuma (UER) aquifer in the eastern part of Saudi Arabia, were investigated by means of extensive data processing in the form of spatial variations, histograms, equivalents per million percentage histograms, linear relationships between various composite variables and equilibrium studies. Equilibrium studies of groundwater chemistry of the UER aquifer indicate that most waters are of calcium sulfate or sodium chloride types. The aquifer is almost completely oversaturated with calcite but partially undersaturated in the northern part with anhydrite. The graphs developed should prove of use in groundwater studies in other parts of the world.

1047. Sencu, V. (1968) - "Muntele de Sare": Bucharest, Romania; Slanic-Prahova. Ocrot. Nat., 12:2, p. 167-179.

The authors presents a detailed analysis of the karst of the "Muntele de Sare", a natural reserve and part of the salt massif from Slanic-Prahova, and the exokarst located on the insoluble rocks which cover the salt karst.

1048. Sencu, Vasile (1963) - Research in karstic phenomena round the locality of Anina (Banat): Probleme de Geografie, 10, p. 155-180.

Caves and karstic captures are discussed with respect to their genesis and evolution.

1049. Sencu, Vasile (1964) - Research in the karstic phenomena in the southern part of the locality of Anina (Banat): Geology, Geophysics, Geography, the Geography Series, 11, p. 149-162.

Caves and karstic captures are discussed with respect to their genesis and evolution.

1050. Sencu, Vasile (1965) - The karst on halite in Romania: Romania; Romanian Review Geology, Geophysics, Geography, the Geography Series, 9:1, p. 45-58.

The topic addressed by the author include: distribution and shape of salt deposits in Romania; morphology and genesis of karst on salt; a classification of karstic formations in natural karstic forms (lapies, karstic holes, karstic solution and crumbled sinkholes, caves); and anthropic karstic forms (karstic cavities, crumbled salt pits, karstic shafts, karstic galleries, and underground solution basins).

1051. Sencu, Vasile (1966) - Geomorphological remarks on the karst on the Cirsei Hill (Banat): Romania; Geology, Geophysics, Geography, the Geography Series, 13:1, p. 99-106.

Exo- and endokarstic forms are discussed with respect to their genesis and evolution.

1052. Sencu, Vasile (1967) - "Cazanele Dunarii": Romania; Geomorphological remarks, Geology, Geophysics, Geography, the Geography Series, 14:2, p. 161-171.

Exo- and endokarstic forms, karstic captures, and their evolution are studied.

1053. Sencu, Vasile (1967) - Contributions to the study of water supply in the Town of Anina from the neighboring eastern karstic area: Stud. Univ. Babes-Bolyai, Geology-Geography Series, Fascicle 2, Cluj, p. 207-213.

Karstic waters and karstic captures in correlation with exo- and endokarstic forms are studied for water supply.

1054. Sencu, Vasile (1967) - The morphology and formation of Marby Slanic-Prahova: Romania; Romanian Review Geology, Geophysics, Geography, the Geography Series, 11:1, p. 49-65.

The karstic forms situated on the salt mountain proper (the biggest salt mountain in the world), as well as on the insoluble rocks that cover the karstified salt are studied. Rectilinear and dendritic lapies, organ pipes, natural bridges, vertical shafts, crumbled sinkholes, karstic solution valleys, caves, karstic holes and crumbled salt pits are to be found on salt. Karstic collapse sinkholes and karstic subsidence valleys are found on the insoluble rocks with salt in the bedrock.

1055. Sencu, Vasile (1968) - The map of the karst and the clastic karst in Romania: Romania; Romanian Review Geology, Geophysics, Geography, the Geography Series, 12:1-2, p. 35-41.

The authors presents a color map (1:1,000,000) including karstic and clastic-karstic formations (crystal limestone and dolomite, mesozoic limestone and dolomite, neozoic limestone, gypsum, salt, tuff and volcanic agglomerations, sandstone and calcareous conglomerates, loessial depositions with calcium carbonate).

1056. Sencu, Vasile (1970) - Karstic phenomena in tectonic breccia: Romania; Romanian Review Geology, Geophysics, Geography, the Geography Series, 14:2, p. 277-280.

A cave in crystal limestone and a tectonic breccia made of crystal limestone are studied.

1057. Sencu, Vasile (1970) - Valleys of sinkholes in the karst of the Banat Mountains: Romania; Geology, Geophysics, Geography, the Geography Series, 17:2, p. 177-185.

The valleys of sinkholes are formed through the alignment of sinkholes under the impact of the general topography of the relief, through contact between calcareous rocks of various origins, contact between calcareous and non-calcareous rocks, and tectonic lines. The transverse profile acquires various shapes (according to the morphology of the sinkholes) and the longitudinal profile is undulated.

1058. Sencu, Vasile (1971) - The "Ochiul Beu" Lake (the Anina Mountains): Romania; Geology, Geophysics, Geography, the Geography Series, 18, p. 231-237.

A karstic lake consisting of a sinkhole and supplied by an underground karstic spring.

1059. Sencu, Vasile (1972) - The Comarnic and Popovat Caves: the Publishing House of the Academy, 60 p.

Exokarstic forms and their evolution, the genesis, hydrography and evolution of caves, as well as speleothems are approached. Eight figures and a color map (1:25,000) are prepared by the author to indicate karstic phenomena. Abstracts in French and German.

1060. Sencu, Vasile (1972) - The map of the karst in the Lacva Mountains (Banat) according to the international list of conventional signs: Romania; Romanian Review Geology, Geophysics, Geography, the Geography Series, 16:1, p. 41-42.

The author presents a color map (1:50,000) of karst on the basis of international, conventional signs adapted to Romania's territory.

1061. Sencu, Vasile (1972) - The Runcu Gorge: Romania; Geomorphological Remarks, Geology, Geophysics, Geography, the Geography Series, 19:1, p. 81-92.

The author discusses exo- and endokarstic forms and successive captures of the Runcu river favored by the tectonics of calcareous rocks.

1062. Sencu, Vasile (1973) - The karst, scale 1:1,500,000, Nera Gorge, scale 1:50,000, the Vulcan Mountains, scale 1:50,000, and the Loess Sinkholes in the Mostistea Plain, scale 1:100,000: Bucharest, Romania; Atlas of the Socialist Republic of Romania, Sheet III-4, the Karst, the Publishing House of the Academy of the Socialist Republic of Romania.

The color map of the karst in Romania which shows the karstifiable rocks totalling 49,527 sq. km (20.85 percent of the country's area) of which: crystal limestone and dolomite - 4,602 sq. km (1.94 percent of the country's area), salt - 150 sq. km (0.06 percent of the country's area), sandstone and calcareous conglomerates - 975 sq. km (18.44 percent of the country's area). Detailed maps exemplify several types of karst.

1063. Sencu, Vasile (1973) - The karstic waters in the mining area of the Town of Anina (Banat): Livre du cinquantenaire de l'Institut de Speleologie "Emil Racovita", p. 591-604.

Colorings with fluorescein highlight the routes of underground karstic water and their areas of supply.

1064. Sencu, Vasile (1975) - The karst of the Mehedinti Mountains: Romania; Romanian Review Geology, Geophysics, Geography, the Geography Series, 19:1, p. 35-47.

This karst area is situated at an altitude of roughly 1,300 m and is strongly influenced by tectonics. A wide range of forms are displayed (lapies, sinkholes, uvalas, faults, hanging dry karstic valleys, blind valleys, karstic captures). Noteworthy features are Medved and Crovul Mare sinkholes, 1,000 m and 500 m, respectively, in diameter and 170 m and 150 m, respectively, in depth. A color map (1:50,000) is used by the author to indicate karstic forms.

1065. Sencu, Vasile (1977) - Conventional signs for the map of the karst: Actes du 6 Congres International de Speleologie, Olamanc, 7, p. 107-114.

Map legend symbols of karst are adapted to Romania's territory according to international conventional signs for karsts.

1066. Sencu, Vasile (1977) - The karst in the Anina mining field: Romania; Geology, Geophysics, Geography, the Geography Series, 24:2, p. 199-212.

This limestone feature is 1,200 m thick and covers the high-grade coal (pit coal) deposit which is mined at Anina in the Banat Mountains at the deepest mine in Romania and Europe (1,100 m deep). Various karstic forms are discussed and, through wells, karstic holes were identified at a depth of 500 m below sea level. Colorings with fluorescein were used by the author to determine several hydrokarstic blocks. A color map (1:30,000) is presented by the author to indicate all karstic forms.

1067. Sencu, Vasile (1979) - The karst in the Danube Pass: Bucharest, Romania; Speleology, the "Iron Gates" Group, the Publishing House of the Academy, p. 11-28.

The influence of limestone on the Danube river bed, the karstic morphology of the four calcareous areas in the pass, karstic captures and the age of the karst are studied.

1068. Sencu, Vasile (1982) - Remarks on the chemistry of karstic waters in the Anina Mountains: Romania; Geology, Geophysics, Geography, the Geography Series, 24, p. 42-49.

The author studied the calcium carbonate load in waters that flow through limestone, the hardness of water in karstic exurgences, and the aggressiveness of karstic waters in a calcareous area extending 600 sq. km.

1069. Serban, M. (1961) - The Rotunda--A new form of underground water flow, in Die Hohle, 12 (2/3):115 (in German).

Underground meanders are shown to be produced by the same fluid mechanics law that cause the meanders of epigeous streams. The argumentation relies on the poignant geometric similarity between the two types of meanders and on the fact that both surface and underground waters develop only in the stream sections with small slopes. Highly developed are the fixed meanders in the Vintului Cave at Suncuius which conserve all the phases in the historical evolution and represent more complex features of relief; thus, the term rotunda is suggested.

1070. Serban, M. (1970) - Compared morphology of the ice stalagmites in the cave at Scarisoara in Trav. Inst. Speol., "Emil Racoavita," Bucharest, 9:35-60 (In French).

Ice stalagmites are considered to be periglacial formations of cave glaciation which developed at the limit between the cold and warm meroclimate inside the cave. Their morphology differs from one place to the other depending on local microclimate. Bilateral symmetry is determined by air currents while lull zones favor the development of radial-symmetry stalagmites. Low temperatures generate slender columns of white, opaque ice and those close to 0°C create transparent spherical heads. The Scarisoara cave is distinguished by ice monocrystals in the spherical heads of stalagmites.

1071. Serban, M. (1984) - On the meanders in the Vintului Cave (the Padurea Craiului Mountains), Theoretical and Applied Karstology, Vol. I, pp. 107-116 (In French).

Meanders of the fossil karst-formation level corresponding to the first floor of the cave are described. The study of transverse sections highlights an alternation between the elliptical and rectangular form of the pressure major distributor which may be observed in the gallery roof. The alternation indicates a possible existence of an undulation in the vertical plane of the major distributor, which is similar to the model G.H. Deike established concerning Mammoth Cave in 1967.

1072. Serban, M.; Blaga, L.; Blaga, Lucia; Chifu; Alexandra; Ciobotaru, Tamara (1967) - Contributions to the stratigraphy of ice deposits in the Scarisoara ice body.

1073. Serban, M.; Coman, D.; Viehmann, I., (1957) - Speleological Research in the Apuseni Mountains (Romania). Ceskoslovensky Kras, 10(1):11-15, 8 figures (in French).

The introduction to this work contains a brief presentation of the karstic regions in Romania. The case complex is described which was generated by the underground-drainage valley at Ocoale, Alba county, consisting of the caves "Ghetarul de la Scarisoara" and "Pojarul Politei", as a primary stage of karstic evolution and the cave at Sesuri as a secondary phase and current drainage - a cavern in which scallops in the Romanian karst are observed for the first time. A description is also made of the Bihor county sinkholes of

Cetatile Ponorului and the Neagra Cave in the Barsa Hole whose morphological features include the hydrodynamic effects of meanders, erosion levels, and scallops.

1074. Serban, M.; Domsa, M., (1985) - On the Micro-Relief of Corrosion in the Vintului Cave (the Padurea Craiului Mountains, Romania) and the Morphogenesis of the Plane Roof in the Forced Conduits, Theoretical and Applied Karstology, Volume 2, figures 1-9, the "Emil Racovita" Speleological Institute, Bucharest (in French).

Scallops and flutes in the cave were measured to assess flow velocities in fossil conduits. A discharge equation and the width of the conduit, which indicates that the greatest widths are caused by the highest discharges, were established for six transverse sections. Applying assessed velocities to the morphological study of phreatic conduits, the conclusion was drawn that eccentricity of the ellipse-shaped transverse section increases with the rise in kinetic energy of the stream until extremely flat sections, which create the plane roofs of a dynamic nature, are generated.

1075. Serban, M.; Heltmann, H., (1961) - Notes on the Flora in several caves in the Western Carpathians of Romania, Die Hohle, 12 (2/3):87, Wien (in German).

This is an abstract of a paper read at the Third International Congress of Speleology, Vienna, Austria. The microclimatic conditions specific to cave mouths are often expressed by floral features. The entrance sinkhole of the Scarisoara ice cave makes the spring plant Doronicum bloom only in July. At the mouth of the cave at Caput, Bihor county, and of several caves near Garda de Sus, Alba county, Viola biflora was found, which does not grow in surrounding areas. Cortusa matthioli was found at the mouth of "Coiba" cave on the upper Garda valley at an altitude of 900 m, which compares with 1,400 m in open spaces on the Piatra Boghii Mount.

1076. Serban, M.; Viehmann, I., (1961) - Explorations of the caves and the Karst in the Western Carpathians and the Rodna Mountains (Romania) from 1947 to 1960, Die Hochle, 12(2/3):65-66, Wien (in German).

This is an abstract of a paper read at the Third International Congress of Speleology, Vienna, Austria. Reference is made to the following features: (1) the ice cave at Scarisoara and two neighboring caves - Projarul Politei, with exceptional stalagmitic formations; (2) the cave at Sesuri, which is 180 m deep and at the time of its exploration, in 1950, the deepest cave in Romania; (3) the caves at Padis (Bihor, Mountains) at Coiba-Mare on the upper Garda valley; (4) Vintului Cave at Suncuius with fixed meanders; and (5) Izvorul Tausoarelor cave (in the Rodna Mountains) with the greatest depth in Romania of 341 m.

1077. Serban, M.; Viehmann, I., (1961) - The Hology of Underground and Surface Streams, Die Hohle, 12(23/):115, Wien (in German).

This is an abstract of a paper read at the Third International Congress of Speleology, Vienna, Austria. On the basis of studies of several caves in Romania the conclusion is reached that there is a certain parallelism between underground and surface waterflows. The existence of a profile of equilibrium is accepted for underground rivers too. If the morphology of the upper course is dominated by tectonics, the influence of the hydrological factor shows in the lower course of underground drainages. The fixed meanders and the plane-horizontal roofs are salient features of the lower course. The terraces of underground rivers are called karstic terraces. The authors

consider this feature with respect to a particular form of subterranean undercutting.

1078. Serban, M.; Viehmann, I., (1963) - Cxoactbo Mekay O Emh Im Obepxhocth M Pe H M Otokam Obepxhocth M Pe H M Otokam. The similarity between underground and surface streams, novelties in Karstology and Speleology, 3:80-81, The Academy of Sciences of the USSR, Moscow (in Russian).

The authors favor contribution of the hydrodynamic factor to the morphogenesis of underground water drainages. This is based on the development of meanders and erosion levels and on the existence of profiles of equilibrium in caves, thus attesting to a similarity between underground and surface waterflows.

1079. Serban, M.; Viehmann, I., in collaboration with Corman, D.; Pintea, M., and Fronescu, I., (1974) - The Ialomita Cave, results of the Speleological Expedition of December 1953, bulletin of the "Emil Racovita" Circle of Speleology, 3:50-51, with an enclosed map, the University Centre of Bucharest (in Romanian).

A map is supplied of the Ialomita cave which lies in the Carpathians Mountains, the Bucegi massif, and has a total length of 804 m. The cave receives tourist interest as it is located in one of the most frequently visited regions in Romania. It was formed during a diaclase with an inclined position which was highlighted by four successive water losses, all situated on the left-hand side of the primary underground drainage. On the terminal side of the cave, the active stream reaches crystalline shales in the autochthonour of the Bucegi.

1080. Serban, M.; Viehmann, I.; Bals, S.; Bordea, S., (1961) - The Neagra Cave in the Karstic Region of Padis (Romania) and its importance: Die Hohle, 12(23/):66, Wien, (in German).

This is an abstract of a paper read at the Third International Congress of Speleology, Vienna, Austria. The Neagra Cave at Padis, which has a total length of 1,200 m and was explored in 1952 and 1956, contains a stream with three active and one fossil tributaries which feature meanders, erosion levels, and a plane-horizontal roof, all formed under hydraulic action of the stream.

1081. Serban, M.; Viehmann, I.; Coman, D., (1961) - Caves in Romania, the Meridiane Publishing House, Bucharest (in Romanian, with abstracts in French, German, Russian, and Magyar), 33 p., 143 photographs.

This is an album of photographs grouped by the following themes: landscapes from karstic regions, surface karstic formations, underground streams, underground karstic formations, cave exploration, stalagmitic formations, cave ice, aspects of speleological research and various caves in Romania. The photographs are accompanied by a text dedicated to Emil Racovita (1868-1947), the initiator of biospeleology (1904) and the founder of the Speleological Institute of Romania (1920). The authors also outline achievements from Cluj between 1947 and 1960.

1082. Serban, M.; Coman, D.; and Givulescu, R., (1948) - Recent discoveries and observations concerning the Natural Ice Body called "Ghetarul de la Scarisoara", Bulletin de la Societe des Sciences de Cluj, 10:174-210, figures 1-13, diagrams I-IV (in French).

Results are outlined of explorations conducted in 1947 under the aegis of the Speleological Institute in Cluj, which determined the size of the ice body in Chetarul de la Scarisoara Cave which has a volume of 40,000-55,000 cu.m

and extends 5,550 sq. m. The ice body is stratified and includes packs of ice layers alternating with strata of impurities which indicate climatic cycles. The study of the flanks of the ice deposition leads to an understanding of its evolution in time. The case is equally remarkable due to the groups of ice stalagmites with annual evolution.

1083. Shanmugan, G.; and Benedict, G.L. (1978) - Fine-grained carbonate debris flow, Ordovician basin margin, Southern Appalachian: U.S.; Journ. Sed. Petrol. 48:4, p. 1233-1240, 7 figs.

1084. Sharma, T.; and Clayton, R.N. (1965) - Measurements of O^{18}/O^{16} ratios of total oxygen of carbonates: Oxford; Geochim. Cosmochim. Acta 29, p. 1347-1353.

1085. Shaw, R.P. (1983) - Karstic residual fluorite-baryte deposits at two localities in Derbyshire in Wilson, R.C.L., editor, Residual Deposits: Surface Related Weathering Processes and Materials: U.K., London; Blackwell Scientific, p. 245-249.

1086. Shaw, T.R. (1979) - History of cave science: The scientific investigations of limestone caves, to 1900: Crymych; Anne Oldham.

1087. Sherrill, M.G. (1978) - Geology and ground water in Door County, Wisconsin, with emphasis on contamination potential in the Silurian dolomite: U.S.; U.S. Geol. Survey Water-Supply Paper 2047, 38 p.

1088. Shinn, E.A. (1969) - Submarine lithification of Holocene carbonate sediments in the persian Gulf: Amsterdam; Sed. 12, p. 109-144.

1089. Siciu, N. (1983) - Thermic waves propagation through limestones: Buletin Speologic Informativ, 7, p. 21-45.

One of the most important controls of rocks karstification is climate. Temperature is probably the primary, controlling factor, thus, the study of thermic wave propagation through a karstic medium is of prime importance.

1090. Siegel, F.R. (1961) - Variations of Sr/Ca ratios and Mg contents in recent carbonate sediments of the northern Florida Keys area: U.S.; Journ. Sed. Petrol. 31:3.

1091. Siegel, F.R. (1967) - Properties and uses of the carbonates in Chilingar, G.V., Bissell, H.J., and Fairbridge, R.W., editors, Carbonate Rocks: Amsterdam-London-New York; Elsevier, Dev. Sed. 9B, p. 343-393.

1092. Siemag Transplan (1978) - Wear characteristics and flow properties of bauxites in pipelines in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 773-782.

1093. Sijaric, G. (1978) - Mineralogical investigations of the bauxites from Crvene Stijene (Bosnia) in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 783-796, 4 figs.

1094. Silar, J. (1968) - Vliv epeirogenetickych pohybu na vyvoj hydrogeologickych struktur krasu jihovychodne od Banske Bystrice (The influence of epirogenic movements on the development of hydrogeological structures in the karst region SE of Banska Bystrica): Czechoslovakia; Casopis pro Mineralogil a Geologii, r. 13, c. 3, p. 325-332 [summary in English].

Relationships between the geological evolution, origin of karst phenomena, and formation of hydrogeological structures in the basin of Poniky SE of Banska Bystrica (Czechoslovakia) are discussed.

1095. Silar, J. (1969) - Krasove hydrogeologicke struktury a aktualni otazky jejich vyzkumu a vyuziti: Czechoslovakia; Ceskoslovensky Kras, Vol. 21, p. 23-27.

Hydrogeological structures in karst and some topical problems of research and use were investigated.

1096. Silar, J. (1976) - Radiocarbon ground-water dating in Czechoslovakia-first results: Czechoslovakia; Vestnik Ustr. ust. Geologickeho, Vol. 51, p. 209-220.

Carbon-13 values of bicarbonates in water, of travertine and gaseous CO_2, as well as carbon-14 activities of plant samples around CO_2 vents have been determined to be a possible source of contamination of organic matter by non-active carbon near structures bearing CO_2 of deep origin.

1097. Silvestru, E. (1984) - The relationship between tectonics and karstification in the cave from Izvorul Tausoarelor (Rodna Mountains): Theoretical and Applied Karstology, 1, p. 35-42.

The author presents the importance of tectonics in the karstification of the limestone area from Tausoare (Rodna Mountains), using the tectonogram of the limestones and several morphological details. A correlation is attempted between the types of cracks and the role played by each one in developing underground drainage. A possible explanation is proposed for pseudomeanders.

1098. Silvestru, E.; and Viehman, I. (1982) - A study of compared micro-tectonics in the karst of the Rodna Mountains (Romania): Bucharest, Romania; Proceedings of the "Emil Racovitza" Speleological Institute, 21, p. 63-67.

The authors describe techniques used to process data of micro-tectonic measurements conducted in three caves in the Rodna Mountains. The tectonic origin and synchronism of the emergence of fissures that created the karst in local limestone are established.

1099. Simion, G.; Ponta, G.; and Gaspar, E. (1985) - The dynamics of underground waters from Baile Herculane, Cerna Valley (Romania): Annales de la Societe Geologique de Belgique, T. 108, p. 245-249.

Thermomineral water resources of the Cerna Valley come from three different hydrogeological origins: (1) cold waters coming from hydrogeological structures located in the upstream part of the Cerna system; (2) hot waters, coming from the depth and thermalizing cold waters; and (3) mineralized waters coming from a structure probably located outside the Cerna basin, which mineralize warm waters.

1100. Sinkovec, B.; and Sakac, K. (1982) - The Paleogene bauxite of Dalmatia: Yugoslavia, Zagreb; Travaux d'ICSOBA, Vol. 17, p. 293-331.

To determine the genesis of bauxites in Dalmatia, a paleogeographic investigation of accessory minerals, trace elements, and macroelements in bauxites and possible parent rocks was performed. On the basis of data obtained, it was concluded that the most probable parent material for Early Paleogene bauxites originates predominantly from the footwall Cretaceous limestones, while the parent material for Late Paleogene bauxites is diversified and originates from the footwall carbonate rocks and eolian material of volcanic and terrigenous origin.

1101. Sinkovec, B.; and Siftar, D. (1979) - Types and origin of gibbsite in bauxite deposits of Croatia, Yugoslavia: Yugoslavia, Zagreb; Travaux d'ICSOBA, Vol. 15, p. 91-98.

Types of gibbsite among bauxites of Croatia are cryptocrystalline gibbsite; microcrystalline gibbsite derived from the cryptocrysatalline by recrystallization; veinlets of coarse-crystalline authigenic gibbsite; and detrital grains of coarse-crystalline gibbsite. The presence of vein-type gibbsite, particularly detrital grains, indicates conditions favorable for bauxitization.

1102. Sklijarov, R.J. (1978) - The global law-governed nature of the development of bauxite and alumite deposits in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 797-805, 3 figs.

1103. Skow, J. (1986) - Surprising finds from a Florida sinkhole: This Florida spa holds a surprising lode of prehistory: U.S.; Smithsonian, 17:9, p. 72-82.

Underwater archaeologist Wilburn Cockrell keeps bringing up relics of the Pleistocene age from the depths of Warm Mineral Springs. A curiosity of the Springs is that the water contains no dissolved oxygen, except in a layer 15 or 20 feet thick at the surface; thus, organic matter below the surface cannot decay or be disturbed by scavengers.

1104. Slavoaca D.; Oraseanu, I.; Gaspar, E.; and Bulgar, Al. (1986) - Hydrogeological contributions for the existence of the Getic Nappe in Motru Sec-Baia de Arama region: Theoretical and Applied Karstology, 2, (in press).

Tracer investigations proved the continuity of the Danubian Unit under the crystalline schists of the Motru Sec-Baia de Arama zone and hence the existence of the Getic Nappe was established in this area by use of a hydrogeological method.

1105. Sliter, W.V.; Be, W.H.; and Berger, H., editors (1975) - Dissolution of deep-sea carbonates: Lawrence; Spec. Publ. Cushman Foram. Res. 13, 159 p., 20 pls.

1106. Smart, C.C.; and Ford, D.C. (1986) - Structure and function of a conduit aquifer: Canadian journal of Earth Sciences, Vol.23, No.7, p.919-929.

A karst aquifer in the Rocky Mountains of Alberta, Canada was studied to demonstrate how hydrological behavior can reveal physical structure. One perennial and three intermittent karst springs served as outlets to a number of conduits. The oldest and largest of these was possibly choked by sediment and acted as a reservoir rather than a conduit, while others conveyed overflow floods from the upper Saskatchewan Glacier. This karst aquifer is of great antiquity, but it has been disrupted by glaciation. A simplified structural model was presented to provide a framework for future field investigations and simulation modeling of aquifers of this type.

1107. Smith, D.B. (1981) - Bryozoan-algal patch-reefs in the Upper Permian Lower Magnesian Limestone of Yorkshire, Northeast England: U.S.; Soc. Econ. Paleont. Min. Spec. Publ. 30, p. 187-202, 18 figs.

1108. Smith, D.B. (1981) - The Magnesian Limestone (Upper Permian) Reef Complex of northeastern England: U.S.; Soc. Econ. Paleont. Min. Spec. Publ. 30, p. 161-186, 31 figs.

1109. Smith, D.I. (1970) - The residual hypothesis for the formation of Jamaican bauxite-a consideration of the rate of limestone erosion: Geol. Soc. Jamaica Journ., Vol. 11, p. 3-12.

1110. Smith, D.L. (1977) - Transition from deep- to shallow-water carbonates, Paine Member, Lodgepole Formation, Central Montana: U.S.; Soc. Econ. Paleont. Min. Spec. Publ. 25, p. 187-201, 16 figs.

1111. Smith, H.F. (1971) - Subsurface storage and disposal in Illinois: U.S.; Ground Water, 9:6, p. 20-28.

> The storage of both liquids and gases in underground strata has become rather common in Illinois. The problem of disposal of fluid industrial wastes has caused greatest concern. Eight basic design policies have been adopted that must be met before a construction permit will be issued. To date there have been four industrial waste disposal wells in Illinois. Variation in conditions is illustrated by these cases of disposal wells that have been authorized by the State.

1112. Smosna, R.; and Warshauer, S.M. (1979) - A scheme for multivariate analysis in carbonate petrology with an example from the Silurian Tonoloway limestone: U.S.; Journ. Sedimentary Petrology, 49:1, p.257-272.

> Two methods of exploratory data analysis, a numerical classification system applied in conjunction with an ordination technique, were used to facilitate environmental interpretation.

1113. Smosna, R.; and Warshauer, S.M. (1981) - Rank exposure index on a Silurian tidal flat: U.S.; Sed. 28, p. 723-731.

1114. Snipes, D.S.; Manoogian, P.R.; Davis, M.W.; Burnett, L.L.; Wylie, J.A.; and Heaton, S.B. (1986) - Ground-water problems in the Mesozoic Pax Mountain fault zone: U.S.; Ground Water, 24:3, p. 375-381.

> More than 100 steeply dipping or vertical Mesozoic fault zones, which cut across Paleozoic igneous and metamorphic rocks, have been reported in the Piedmont and Appalachians of the Carolinas. The present investigation deals with hydrological problems encountered in exploring for groundwater in the Pax Mountain fault zone.

1115. Song, X. (1984) - Geochemistry of minor elements in host rocks of the Fankou Pb-Zn deposit, south China in Wauschkuhn, A., Kluth, C., and Zimmermann, R.A, editors, Syngenesis and Epigenesis in the Formation of Mineral Deposits: Germany, F.R., Heidelberg; Springer-Verlag, p. 306-316.

> Representative samples of various host rocks of the Fankou deposit are analyzed with respect to minor elements. The author indicates that the average contents of most of the metals, especially Cd, Zn, Cu, Pb, and Hg, in the Fankou limestones are much higher than the Green's abundances of them in carbonate rocks. The concentration coefficients of Cd, Zn, Cu, Pb, and Hg are 391, 7, 6, 3.4, and 2.8, respectively. Correlation matrices of minor elements in the host rocks (limestones) of the Fankou deposit have been tabulated.

1116. Soritau, D.; Nicoara, D.; Silvestru, E.; Demeter, I.; Popa, C.; and Viehman, I. (1984) - The pothole at Stanul Foncii: Buletinul Cercului Studentesc de Speologie "Emil Racovita" din Centrul Universitar Cluj Napoca, supliment al revistei "Napoca universitara", Cluj Napoca, 1, 79-88.

> The authors describe the morphology of the deepest pothole in Romania (-339 m). Several morphological considerations and observations on underground climate are made. Maps of the cave are supplied.

1117. Souilos, G. (1985) - Research on the unity of karstic aquifer systems after examples of Hellenic karst (Recherches sur l'unite des systemes aquiferes karstiques d'apres des exemples du karst Hellenique): Journal of Hydrology, Vol.81, No.3/4, p.333-354.

Current definitions of karstic aquifer systems are discussed and several examples from Greece are described. From these cases, correlations between the outflows of neighboring springs are used to test whether or not they belong to the same hydrological system. Examples are given of two outlets with nearly identical response (Aposkepos-Kephalari), outlets with a low correlation coefficient (semi-independent springs Korisos-Melitsa), and an intermediate case (Xerovouni). The discharges of one spring, classified according to magnitude and plotted on probability paper, produce a simple graph for Korisos, but a more complicated behavior for two springs in Crete (Almyros spring, Aghios Nicolaos and Almyros spring, Iraclio). Breaks in the latter curves are attributed to spilling over of the karst reservoir towards other outlets and to recharge by waters from the surroundings. A comparison of cumulative discharges with cumulative rainfall for the Voula system reveals the influence of human activities (pumping from adjacent alluvium) since 1975.

1118. Spears, D.A. (1983) - Porewater reactions in the unsaturated zone with special reference to groundwater quality in England in Wilson, R.C.L., editor, Residual Deposits: Surface Related Weathering Processes and Materials: U.K., London; Blackwell Scientific, p. 13-18.

Analysis of porewater composition is a sensitive method of monitoring the reactions leading to the formation of residual deposits, and if infiltration has been operative over a sufficient period of time whole rock changes may also be detected. Reactions involving different sedimentary fractions (resistate, hydrolysate and precipitate) are considered with respect to infiltration into the Permo-Triassic sandstones and the Chalk of England.

1119. Spector, A.; and Pichette, R.J. (1983) - Applications of the aeromagnetic method to lead exploration in S.E. Missouri in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 596-603.

The authors describe the techniques by which geochemical information can be obtained from magnetic data and the limitations and resolution capabilities of the magnetic method. Recommendations to optimize aeromagnetic surveys are presented. Existing aeromagnetic coverage of this region is described.

1120. Spencer, E.W. (1964) - Natural Bridge and vicinity: U.S.; Virginia Minerals, 10:2, p. 1-7.

In making interpretations in geology, particularly with reference to the mode of origin of natural features such as Natural Bridge, two factors are of importance. First, an understanding of the function of natural processes is essential. The second consideration is the accumulation of factual information concerning the feature.

1121. Spirakis, C.S. (1983) - A possible precipitation mechanism for sulfide minerals in Mississippi Valley-type lead-zinc deposits in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla; p. 211-215.

Both experimental and geological evidence suggest that partly oxidized sulfur species may exist as long-lived metastable components of the solutions involved in the genesis of Mississippi Valley-type lead-zinc deposits. This concept allows sulfur and metals to be transported to the site of

mineralization together and it provides a source for the partly oxidized sulfur in pyrite without relying on either sulfate reduction, which is kinetically inhibited at these temperatures, or on sulfide oxidation at sites where oxidizing agents do not appear to have been available.

1122. Srdoc, D.; Horvatincic, N.; Obelic, B.; Krajcar, I.; and Sliepcivec, A. (1985) - Procesi talozenja kalcita ukrskim vodama s posebnim osvrtom na plitvicka jezera: Yugoslavia; Krs Jugoslavije, 11:4-6, p. 101-204.

The authors defined physicochemical conditions which favor or inhibit precipitation of calcium carbonate to form tufa or lake sediments in streams and lakes in karst areas of NW Dinarides.

1123. Srdoc, D.; Horvatincic, N.; Obelic, B.; Krajcara-Bronic, I.; and O'Malley, P. (1986) - The effects of contamination of calcareous sediments on their radiocarbon ages: Yugoslavia; Radiocarbon, 28:2A, p. 510-514.

To assess contamination effect, samples of old tufa from the Riss/Wuerm interglacial area were examined.

1124. Srdoc, D.; Obelic, B.; Horvatincic, N.; Krajcara-Bronic, I.; and Marcenko, E. (1986) Radiocarbon dating of lake sediment from two karst lakes in Yugoslavia: Yugoslavia; Radiocarbon, 28:2A, p. 495-502.

Samples of sediment cores from two lakes in the karst areas of northwest Yugoslavia were analyzed. ^{14}C dating, sedimentologic, seismic, and isotopic studies, and distribution of diatoms are presented.

1125. Stanton, R.J., Jr. (1967) - Factors controlling shape and internal facies distribution of organic carbonate buildups: U.S.; Amer. Asso. Petro. Geol. Bull. 51:12, p. 2462-2487, 1 fig.

1126. Steiger, T. (1981) - Kalkturbidite im Oberjura der Noredlichen Kalkalpen (Barmsteinkalke, Salzburg, Oesterreich): Erlangen; Facies 4, p. 215-348, pls. 12-24, 56 figs.

1127. Steiger, T.; and Wurm, D. (1980) - Faziesmuster oberjurassischer Plattform-Karbonate (Plassen-Kalke, Noerdliche Kalkalpen, Steirisches Salzkammergut, Oesterreich): Erlangen; Facies 2, p. 241-284, pls. 25-30, 8 figs.

1128. Steinen, R.P. (1974) - Phreatic and vadose diagenetic modification of Pleistocene limestone: Petrographic observations from subsurface of Barbados, West Indies: U.S.; Amer. Asso. Petrol. Geol. Bull. 58, p. 1008-1024.

1129. Stout, J.L. (1964) - Pore geometry as related to carbonate stratigraphic traps: U.S.; Amer. Asso. Petrol. Geol. Bull. 48, p. 329-337.

1130. Strasser, A. (1979) - Betlis-Kalk und Diphoyides-Kalk (± Valanginian) in der Zentral- und Ost-Schweiz: Switzerland; Mitt. Geol. Inst. ETH Univ. Zuerich. A.F., Vol 225, 209 p.

The author presented results of factor and cluster analyses of more than 800 thin-sections based on 22 microfacies criteria of terrigenous-influenced, platform and deeper, shelf-slope limestones. 12 microfacies types are distinguished.

1131. Stringfield, V.T.; Rapp, J.R.; and Anders, R.B. (1979) - Effects of karst and geologic structure on the circulation of water and permeability in carbonate aquifers in Back, W., and Stephenson, D.A., guest editors, Contemporary Hydrogeology - The George Burke Maxey Memorial Volume, Journ. Hydrogeology, Vol. 43, p. 313-332.

Karstification may have a pronounced effect on topography, hydrology, and the environment, especially where such karst features as sinkholes and vertical solution shafts extend below the land surface and intersect lateral solution passages, cavities, caverns, and other karst features in carbonate rocks. Karst features may be divided into two groups: (1) surficial features that do not extend below the surface; and (2) karst features such as sinkholes that extend below the surface and affect the circulation of water below.

1132. Studencki, W. (1979)- Sedimentation of algal limestones from Busko-Spa environs (Middle Miocene, Central Poland): Amsterdam; Palaeogeography, Palaeoclimatology, Palaeoecology 27, p. 155-165.

1133. Subramanian, K.S. (1978) - Bauxite deposits on high landforms in the southern part of the Indian peninsula in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 806-821, 1 fig.

1134. Susnjara, A.; and Scavnicar, B. (1978) - Heavy minerals as provenance indices of Tertiary bauxites in Dalmatia (Yugoslavia) in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, ICSOBVA Vol. 2, Bauxites: Greece, Athens; National Technical Univ., p. 822-836.

1135. Suszczynski, E.F. (1978) - New bauxite ore deposits in the oriental portion of the Brazilian Shield in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 837-840, 1 fig.

1136. Sverjensky, D.A. (1981) - Isotopic alteration of carbonate host rocks as a function of water to rock ratio - an example from the Upper Mississippi Valley zinc-lead district: U.S.; Econ. Geol., Vol. 76, p. 154-156.

1137. Sverjensky, D.A. (1981) - The origin of a Mississippi Valley-type deposit in the Viburnum Trend, southeast Missouri: U.S.; Econ. Geology, Vol. 76, p. 1848-1872.

1138. Szantner, F.; Knauer, J.; Karoly, G.; Toth, A.; and Nyerges, L. (1978) - Latest results of karst-bauxite-prospecting in Hungary and the geological-geophysical methods applied to prospect different depositional types in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 841-860, 7 figs.

1139. Szczerban, E.; and Urbani, F. (1974) - Formas carsicas en areniscas precambricas del territorio federal Amazonas y Estado Bolivar in Carsos de Venezuela, parte 4, Bol. Soc. Venez. Espeleol. 5, p. 27-54.

1140. Szilagy, A.; Komives, I.; Varga, A.; Kerekes, K. (1979) - The Vintului Cave, Trav. Inst. Speol. "Emil Racovita," Bucharest, 18:259-266.

The authors briefly describe historical surveys of explorations during a ten year period in the largest cave in Romania. A general description of this remarkable karstic feature, including 21,470 m of galleries, is accompanied by a polychrome map.

1141. Szilagyi, G.; Heinemann, Z.; and Bogardi, I. (1984) - Application of a simulation model for a large-scale karstic water aquifer in Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol. II, p.951-964.

Mining activity, water management, and the environment are interrelated in a regional karstic aquifer. A proper operation of existing works and their

optimal development requires the knowledge of water movement. A simulation method is based on a finite difference solution of the two-dimensional, unsteady flow equation. Inputs of the model are rainfall over the area and water intakes at different points. Output yields the piezometric heights in grid points, and system outflow. The simulation model can be connected to a decision model which helps to choose the best alternatives for mine water management, water supply and environmental protection.

1142. Szulczewski, M. (1968) - Slump structures and turbidities in the Upper Devonian limestones of the Holy Cross Mts.: Warsaw; Acta Geol. Polonica 18, p. 303-324.

1143. Talma, A.S.; and Netterberg, F. (1983) - Stable isotope abundances in calcretes in Wilson, R.C.L., editor, Residual Deposits: Surface Related Weathering Processes and Materials: U.K., London; Blackwell Scientific, p. 221-233.

About 300 published and unpublished measurements of carbon and oxygen stable isotope ratios of calcretes are compared in an attempt to define general trends.

1144. Tarutani, T.; Clayton, R.N.; and Mayeda, T.K. (1969) - The effect of polymorphism and magnesium substitution on oxygen isotope formation between calcium carbonate and water: Oxford; Geochim. Cosmochim. Acta 33, p. 987-996.

1145. Taylor, M.; Kelly, W.C.; Kesler, S.E.; McCormick, J.E.; Rasnick, F.D.; and Mellon, W.V. (1983) - Relationship of zinc mineralization in east Tennessee to Appalachian orogenic events in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 271-278.

The authors conclude that deformation twinning in the early and intermediate stages of sphalerite mineralization is an indication of ore deposition that occurred during the Alleghenian orogeny. Basin evolutionary processes that produced the sphalerite and sparry dolomite mineralization were attributed to tectonic events of the Appalachian orogeny. Inherent in the model is the notion that the Appalachian subtype of Mississippi Valley-type deposits are related genetically as well as geographically.

1146. Tenyakov, V.A. (1978) - Genetic classification of bauxite deposits of the world in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 861-871.

1147. Textoris, D.A. (1968) - Petrology of supratidal, intertidal and shallow subtidal carbonates, Black River Group, Middle Ordovician, New York, U.S.A.: Prague; Inter. Geol. Congr. Rept. 23rd Sess., Proc. Sect. 8, p. 227-248, 6 figs.

1148. Thacker, J.L.; and Anderson, K.H. (1977) - The geologic setting of the southeast Missouri lead district - Regional geologic history, structure and stratigraphy: U.S.; Economic Geology, Vol. 72, p. 339-348.

The Viburnum mineralized area lies near the southern edge of the central stable region of the North American craton. Erosion of the Precambrian preceded establishment of basins and uplifts in early Paleozoic time. Shelf deposition prevailed in the Late Cambrian and Early Ordovician, followed by emergence and erosion resulting in the post-Knox unconformity. Silurian and Devonian deposition were followed by severe erosion, and Lower Mississippian strata were laid down on a rough karst surface.

1149. Thacker, J.L.; and Anderson, K.H. (1979) - Preliminary carbonate lithofacies maps of the Cambrian Bonneterre Formation, Rolla 1° x 2° quadrangle, Missouri: U.S.; U.S. Geol. Survey Misc. Field Studies Map MF-1002-C, scale 1:250,000.

1150. Thacker, J.L.; and Anderson, K.H. (1979) - Preliminary isopach maps of the Cambrian Potosi Dolomite and the Cambrian Eminence Dolomite, Rolla 1° x 2° quadrangle, Missouri: U.S.; U.S. Geol. Survey Misc. Field Studies Map MF-1002-G, scale 1:250,000.

1151. Thacker, J.L.; and Anderson, K.H. (1979) - Preliminary isopach maps of the Cambrian Derby-Doerun Dolomite and the Cambrian Elvins Group, Rolla 1° x 2° quadrangle, Missouri: U.S.; U.S. Geol. Survey Misc. Field Studies Map MF-1002-F, scale 1:250,000.

1152. Thomas, F., (1984) - The Topolnite-Epuran Cave System (the Mehedinti Platequ Ramania) Naturwissenschaftliche Forschungen uber Siebenburgen, Volume 2, pp 311-335, figures 1-13, Bohlai Verlag Koln Wien (in German).

> The Mehedinti Plateau in the Southern Carpathians, north of the Danube pass, includes numerous remarkable karstic features, noteworthy among which is the Topolnita-Epuran cave system. The labyrinth with five karst-formation levels and a total length of more than 4,000 m develops inside the arid calcareous massif of "Cornetul Prosacului", which is 3 km long and 1 km wide. The author describes karstic hydrography of the region and monumental speleothemes within the system of caves.

1153. Thomas, F.W., (1984) - The new cave of Risnov, the Valea Fundata Cave (Romania), Naturwissenschaftliche Forschungen uber Siebenburgen, volume 2, pp. 295-310, 7 figures, Bohlau Verlag Koln Wien (in German).

> The first reference to karstic water resurgences in the Postavaru Massif nearby Brasov was made by F. Podek (1911, 1912, 1925) who recalled an eruption in 1903 of the "periodic spring" at Risnov. A similar eruption, which occurred in August 1949, is shown to have opened the mouth of the cave at Valea Fundata, one of the most important karstic features in the massif.

1154. Thomas, G.E.; and Glaister, R.P. (1960) - Facies and porosity relationships in some Mississippian carbonate cycles of western Canada basin: U.S.; Amer. Asso. Petrol. Geol. Bull. 44:5, p. 569-588, 5 pls., 9 figs.

1155. Thompson, A.F.; and Thomasson, M.R. (1969) - Shallow to deep water facies development in the Dimple limestone (Lower Pennsylvanian), Marathon region, Texas in Friedman, G.M., editor, Depositional Environments in the Carbonate Rocks: Menasha; Soc. Econ. Paleont. Min. Spec. Publ. 14, p. 57-78, 32 figs.

1156. Thompson, P.; Schwarcz, H.P.; and Ford, D.C. (1976) - Stable isotope geochemistry, geothermometry, and geochronology of speleothems from West Virginia: U.S.; Geol. Soc. America Bull., Vol. 87, p. 1730-1738.

> Some speleothems (cave-deposited travertine formations) from two caves in West Virginia were formed in isotopic equilibrium with seepage waters from 200,000 B.P. to the present. Curves of relative paleotemperature, based on secular changes in calcite as dated by the $^{230}Th/^{234}U$ method, are presented.

1157. Thrailkill, J.; and Robl, T.L. (1981) - Carbonate geochemistry of vadose water recharging limestone aquifers: U.S.; Journ. Hydrology 54, p. 195-208.

1158. Tocco, S.; Fanfani, L.; Gandin, A.; Garbarino, C.; Grillo, S.M.; Marcello, A.; Mazzella, A.; Salvadori, A.; and Violo, M. (1982) - R and D program on primary raw materials (final rept.

on: The Pb-Zn and Ba Mineralizations in the Carbonate Platform of SW Sardinia, Italy): EEC Contract 091-MPP-I-(S).

1159. Tolic, A.; Vojnovic, M.; Isakovski, S.; Zivanovic, B.; Canic, V.; and Ranogajec, J. (1978) - Adsorptive properties of domestic bauxites used for refining of Trapho Oils by contact and percolation method in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 872-878.

1160. Toomey, D.F. (1966) - Application of factor analysis to a facies study of the Leavenworth Limestone (Pennsylvanian - Virgilian) of Kansas and Environs, Spec. Distrib. Publ. 27: U.S.; Kansas Geol. Survey, 28 p.

1161. Torunski, H. (1979) - Biological erosion and its significance for the morphogenesis of limestone coasts and for nearshore sedimentation (northern Adriatic): Germany, F.R., Frankfurt; Senckenbergiana Maritima 11, p. 193-265, 31 figs., 4 pls., 4 tbls.

1162. Trainer, F.W.; and Heath, R.C. (1976) - Bicarbonate content of groundwater in carbonate rock in eastern North America: U.S.; Journ. Hydrology 31 (1/2), p. 37-55.

1163. Troester, J.W.; and White, W.B. (1984) - Seasonal fluctuations in the carbon dioxide partial pressure in a cave atmosphere: U.S.; Water Resources Res. 20, p. 153-156.

1164. Troester, J.W.; and White, W.B. (1986) - Geochemical investigations of three tropical karst drainage basins in Puerto Rico: U.S.; Ground Water, 24:4, p. 475-482.

> Carbonate chemistry was assessed at various springs and surface stations along three river basins in the northwestern karst belt of Puerto Rico.

1165. Trubelja, F. (1978) - The lateritic crust on the Jablanica gabbro massif and its importance for the genesis of bauxites in the karst of Dinarides in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 879-889, 2 figs.

1166. Trudgill, S.T. (1976) - The marine erosion of limestone on Aldabra Atoll, Indian Ocean: Z. Geomorphol. N.F., Suppl. 26, p. 164-199.

1167. Trudinger, P.A.; and Mendelsohn, F. (1976) - Biological processes and mineral deposition in Walter, M.R., editor, Stromatolites: The Netherlands; Elsevier Scientific, p. 663-672.

> There are two ways by which reefs and biostromes can affect sedimentation: (1) the building of a reef or the creation of an algal mat affects the physical and chemical environment of sedimentation, and (2) organisms can participate directly in chemical processes, either actively or passively.

1168. Trufas, C, (1970) - Dracului Lake and Cave, Terra, 5, p. 43-45, (in Romanian).

> Dracului Lake was formed in the hollow of a "Vaucluse"-type spring and has at present ceased its activity; its flow is being diverted toward a new emergence point. The lake constitutes an underwater entrance toward a probable network of passages and underground streams.

1169. Trufas, C., (1970) - Observations concerning the Karstic Phenomena from Pestera-Pui, Sargetia, 8, Deva, p. 57-60 (In Romanian).

> An approximately 2 km^2 karst area was formed as a consequence of the piercing by a brook of a Jurassic limestone strip, from beneath Mio-Pliocene deposits.

1170. Trufas, V., (1960) - The Lake Invirtita from Mucsoara, Natura, 5, p. 78-81, 4 figures (in Romanian).

> The lake bowl is a depression of suffosion and subsidence in gypsum with interstratified sandstones. Morphometry, temperature, and hydrologic characteristics of this regime are discussed.

1171. Trufas, V., (1966) - Observations of Karstic Morphology in Piatra Lesului area, Lucrarile Institutului de Speologie Emil Racovita, 5, p. 261-273, 9 figures, (in Romanian with English abstract).

> The author discusses the genesis of the gorge, water losses and rises, and a set of caves in the walls of the gorge.

1172. Tsekhovsky, Yu. G. (1978) - Lateritic-soil lithogenesis as a leading process of secondary laterization of bauxites in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 905-918, 2 figs.

1173. Tucker, M.E. (1973) - Sedimentary and diagenesis of Devonian pelagic limestones (Cephalopodenkalk) and associated sediments of the Rhenohercyne Geosyncline, West Germany: Germany, F.R., Stuttgart; N. Jb. Geol. Palaont. Abh. 142, p. 320-350, 24 figs. 1 tbl.

1174. Tucker, M.E. (1974) - Sedimentology of Palaeozoic pelagic limestones: The Devonian Griotte (Southern France) and Cephalopodenkalk (Germany): Oxford; Spec. Publ. Inter. Asso. Sed. 1, p. 71-92.

1175. Tucker, M.E.; and Kendall, A.C. (1973) - The diagenesis and low-grade metamorphism of Devonian styliolinid-rich pelagic carbonates from West Germany: Possible analogs of Recent pteropod oozes: U.S.; Journ. Sed. Petrol. 43, p. 672-687.

1176. Tucker, W.E. (1971) - Subsurface disposal of liquid industrial wastes in Alabama-A current status report: U.S.; Ground Water, 9:6, p. 10-19.

> Four subsurface disposal wells have been drilled and completed in Alabama: Stauffer Chemical Company, Mobile County; Ciba-Geigy, Inc., Washington County; U.S. Steel Corporation, Jefferson County; and Reichold Chemicals, Inc., Tuscaloosa County. A general discussion of the geology, drilling, completion, and testing techniques is presented with respect to the Coastal Plains geological province and Paleozoic sediments of the Warrior Basin.

1177. Tufar, W.; and Strucl, I. (1984) - The Sasa lead-zinc deposit (Macedonia/Yugoslavia) and its position in the Serbian-Macedonian ore province in Wauschkuhn, A., Kluth, C., and Zimmermann, R.A, editors, Syngenesis and Epigenesis in the Formation of Mineral Deposits: Germany, F.R., Heidelberg; Springer-Verlag, p. 412-421.

> Numerous genetically and temporally different lead-zinc deposits occur within the Serbian-Macedonian ore province. These deposits are not related genetically to widespread Tertiary magmatism, but are, in fact, time-bound and strata-bound, stratiform, syngenetic ore mineralizations which have been affected by subsequent regional metamorphism. As a result, the deposits show mineral transformations, redeposition, mobilization, and recrystallization of their primary mineral constituents.

1178. Tulucan, T. (1979) - Martel Cave, Buletin Speologic, 1, 7 figures (In Romanian).

The relationships between a temporarily flooded cave, rainfall, and the drainage system are considered. It appears that only a short segment (approximately 100 m) of the 4 km-long passage effectively drains water, while the rest of it is subject to seasonal water level fluctuation.

1179. Turcanu, N.; and Lascu, C. (1980) - Underground flow through the gneiss of the Iovan foundation barrage (the Cerna Valley) through the method of labeling with dye tracers: Proceedings of the "Emil Racovita", Speleological Institute, XIX, p.243-246 (French).

The authors describe the method used to pinpoint velocity and direction of flow through open fissures in gneiss in the foundation of a barrage resulting from the leviation of altered filling in a tectonized area.

1180. Turnsek, D.; Buser, St.; and Ogorelec, B. (1981) - An Upper Jurassic reef complex from Slovenia, Yugoslavia: U.S.; Soc. Econ. Paleont. Min. Spec. Publ. 30, p. 361-369, 6 figs.

1181. Underhill, H.W. (1969) - Carbonate scale in Roman and modern canals in the Jordan Valley: The Netherlands, Amsterdam; Journ. Hydrology, Vol. 7, p. 389-403.

An outline of the chemistry of carbonates in groundwater is followed by a discussion of chemical analyses of two springs in West Jordan. The relationship between scale precipitation in man-made works and its formation under natural conditions is noted, and the authors conclude the paper with an historical footnote on the probable origin of the scale-filled Roman canal at Ain Feseyl.

1182. United States Geological Survey; and U.S. Bureau of Mines (1968) - Mineral resources of the Appalachian region: U.S.; Geological Survey Professional Paper 580, 492 p.

This report is a compilation of information on the mineral resources, mineral industry, and geology of the Appalachian region, U.S.A.

1183. Urbani, F. (1976) - Polish-Venezuelan Expedition studies Sarisarinama caves: Natl. Spele. Soc. News, USA 34:1, p. 194-195.

1184. V.-A.C. Bulgareanu; V. Feurdean; Al. Gutu; Emilia Olteanu; A. Bogorodita; D. Hannich (1984) - Relations between the fresh- and salt waters circulation and the geodynamics of the Ocna Sugatag karstosaline and anthroposaline lake area (Maramures district): Theoretical and Applied Karstology, 1, p. 165-171, Bucharest.

The authors deal with statistical interpretation of the distribution of natural deuterium contents and propose a circulation pattern of fresh and saline waters (ground-, lake, and surface waters). Statistical analysis is made with respect to terrain sinking rates and a developed gap system, which is flooded and partially endokarstic, belonging to the old salt mines (in English, 4 figs., 1 tab., 10 ref.).

1185. Vadeanu, T. (1981) - Cociului Cave (Padurea Craiului Mountains): Carst, V. 1, p. 11-13 (Romanian).

The author describes a reception cave which is 391.5 m long and has an 86.5 m unevenness.

1186. Vadeanu, T. (1982) - Possibilities of using metric wave communication between the outside and the underground in karstic areas: Buletinul CSER, Bucharest, 7, p. 113-126.

The author discusses experiments with interesting results which show the possibility of communicating through electromagnetic waves.

1187. Valenas, L. (1976) - A general view on the Bihor Mountains Karst: Nymphaea, V. 4, p. 21-58 (Romanian, with French abstract).

Theoretical concepts concerning erosion, corrosion, phreatic and vadose genesis, rates of karstification and karst network organization are illustrated by field examples from the well-developed karst of Bihor Mountains.

1188. Valenas, L. (1977) - Morphology of the karst from Groapa de la Barsa (Bihor Mountains): Travaux de l'Institut de Speologie "Emil Racovitza", V.16, p. 243-257 (French).

This is the first monograph of a karst area from Bihor Mountains, focussing on the closed depression Groapa de la Barsa (2.42 km^2 surface), which at the date of the paper included 16 cavities, with a cumulated length of 14,880 m of passages (the longest of them, Neagra-Zapodie cave system, 10,879 m in 1977). The surface and underground karst are described from an organic viewpoint.

1189. Valenas, L. (1977) - Problems of karstic morphology in Groapa de la Barsa (Bihor Mountains): Nymphaea, V.5, p. 157-199.

A closed karst depression of 2.42 km^2 is drained by 17 epigean watercourses, resulting in a drainage density of 5.34 km/km^2. The underground capture of these courses occurs in a network of caves more than 15 km long, developed mostly along various systems of fractures, under epiphreatic conditions. The structural position of the limestones favors occurrence of a perched aquifer, collecting the waters of the karstic system.

1190. Valenas, L. (1978) - Morphology of the Pothole from Cuciulata (Bihor Mountains): Nymphaea, V.6, p. 363-368 (Romanian, with French abstract.)

The morphology and hydrology of the Pothole from Cuciulata (186 m depth, 925 m length) are discussed. The Cuciulata Pothole is a descending cavity, developed along a lithologic contact between karstifiable and nonkarstifiable rocks. Erosion in the endokarstic environment is considered.

1191. Valenas, L. (1978) - The morphology of the System Coiba Mica-Coiba Mare-Izbucul Tauz (Bihor Mountains): Nymphaea, V.6, p.329-362.

This paper concerns the karst from Casa de Piatra-Tauz (2.9 km extension). Lithologic, structural, hydrogeologic, and morphologic data are furnished. Coiba Mare cave, the most important phreatic network in Romania, is shown to have undergone an evolution analogous to that described by Ford, 1971, for the phreatic caves of Mendip.

1192. Valenas, L. (1979) - A complex study of the area Craiasa Valley-Virtoape Valley, with special regard to Ursilor Cave (Bihor Mountains): Nymphaea, V.7, p.139-176 (Romanian, with French abstract).

This is a report on Ursilor Cave (1500 m development) and on its surrounding area. Lithologic, structural, hydrologic, and geomorphologic relief evolution trends and economic geography data are discussed.

1193. Valenas, L. (1979) - Morphology of the Cave Spiacych Rycerzy Nizna (Western Tatra, Poland): Nymphaea, V.7, p.243-250 (Romanian, with French abstract).

The author includes a series of data concerning the morphology and morphometry of a cave (240 long) from Western Tatra. The cave is

considered to be an old resurgence, fossilized as a consequence of the block uplift of Western Tatra in the upper Pleistocene. It is also estimated that the age of the endokarst of the Polish Tatra is post medium-Pleistocene.

1194. Valenas, L. (1981) - New investigations of physical speleology in Padurea Craiului Mountains: Nymphaea, V.8-9, p.265-316 (Romanian, with French abstract)

34 new cavities are described. Combined with those discoveries published by 1978, these new discoveries result in a length of 17,936 m, which is a quarter of the natural passages know in Padurea Craiului Mountains by 1981. The endokarst is considered to be post medium Pleistocene. External morphological conditions favored the development of kilometric sections, penetrable from the outflows. The Padurea Craiului Mountains are similar to Bihor Mountains with respect to the 1:1 proportion of the active versus fossil passages in a cave more than 1 km in length. The cavities where access was possible only by means of mining galleries are also investigated for the first time, and their origin is considered phreatic.

1195. Valenas, L. (1983) - Preliminary considerations concerning the problems arisen by the active tectonics in the cave from Piriul Hodobanei (Bihor Mountains): Nymphaea, V.10, p.183-194 (French, with Romanian abstract).

1196. Valenas, L. (1984) - Considerations on the chemistry of the karst waters from Dedegol Dag (Western Taurus, Turkey): Crisia, V. 14, p.587-594 (French, with Romanian abstract).

The author discussed problems which have arisen regarding drainages from Dedegol Dag Massif and geochemistry of native karst waters. It is shown that the waters are highly aggressive with respect to both calcium and magnesium. As a consequence, the drainages are considered as vadose, on major fracture lines.

1197. Valenas, L. (1984) - The complex study of the karst from the area Izvorul Ursului-Piriul Sec (Bihor Mountains): Crisia, V.14, p. 559-580 (Romanian, with French abstract).

This is a monograph concerning a karst area; multidisciplinary data, such as lithology, structure, karst water geochemistry, and endokarst morphology, are discussed.

1198. Valenas, L. (1985) - The morphology of the cave from Izvorul Gabor (Padurea Craiului Mountains): Crisia, V.15 (French, with Romanian abstract).

The author discussed the morphologic and hydrogeologic problems concerning the cave from Izvorul Gabor (2707 m length) with regard to its lithological and structural framework. The part played by the cave as a first order drain for the underground capture of an epigean watercourse as it benefits another subaerial stream is outlined. A post-medium Pleistocene age is proposed for the cavity.

1199. Valenas, L.; and Drimba, G.H. (1978) - Physical speleology investigations in Padurea Craiului Mountains: Nymphaea, V.6, p. 279-382 (Romanian, with French abstract).

This is the first report on the endokarst of Padurea Craiului Mountains (1400 km^2) on which the authors present an interpretation of a multidisciplinary approach concerning results obtained by the investigation of 21 representative cavities (12,483 m, combined length). The authors conclude that the endo-karst from Padurea Craiului is of relatively recent age--post medium Pleistocene.

1200. Valenas, L.; and Iurkiewicz, A. (1985) - The morphology of the cave from Hoanca Apei (Bihor Mountains): Crisia, V. 15 (Romanian, with French abstract).

The authors discuss the morphology, morphometry, and hydrogeology of the cave from Hoanca Apei (1839 m long).

1201. Valenas, L.; and Zygmunt, J. (1980) - Contributions to the knowledge of the karst of the Dedegol Dag Massif (Western Taurus, Turkey): Buletin Informativ, V.4, p.7-23 (Romanian, with French abstract).

Morphology and water geochemistry of the karst of Dedegol Dag is discussed. The authors infer from a karst circulation model, based on interpretation of geochemical data, that the karst drainage system is fast, vadose, alpine type.

1202. Valenas, L.; Bleahu, M.; Brijan, P.; and Halasi, G. (1977) - The speleological inventory of Bihor Mountains: Nymphaea, V.5, p. 209-355 (Romanian, with French abstract).

A statistical study of the number of cave entrances, the cave lengths and active versus fossil passages is performed for the karst area of Bihor Mountains. It appears that the descending caves, situated on high plateaus, average three times as long as the ascending caves on valley borders. It also appears that the outflow caves are mostly local and much shorter than active caves from the plateaus.

1203. Valenas, L; and Iurkiewicz, A. (1981) - A complex study of the karst from the Suncuius-Misid Area (Padurea Craiului Mountains): Nymphaea, V. 8-9, p.311-378 (Romanian, with French abstract).

This paper is the first monograph of Suncuius-Misid area (which includes the longest cave from Romania, Wind Cave which was 31,030 m in 1981). Multidisciplinary research was conducted with respect to the following features: lithology, structure, hydrogeology, karst water geochemistry, and exo- and endokarstic morphology. The endokarst of 64 caves was inventoried, and the authors discuss karstic drainages through the liassic impervious rocks. During the geochemical study, the authors discovered the existence of extremely acidic waters, outflowing from pyrite occurrences. The age of the karst as a whole is considered post-medium Pleistocene.

1204. Valenas, L; Halasi, G.; and Czako, L. (1983) - The morphology and the hydrology of the underwater passages from Girda Valley Basin (Bihor Mountains): Nymphaea, V.10, p.195-205 (French, with Romanian abstract).

A series of morphologic and hydrogeologic data concern sumps from Girda Valley. The lithologic-structural framework in which the sumps are located is also discussed. A general drainage model of the karst systems to which the sumps belong is presented. This paper is the first one in Romania in which a debate is presented on the problems related to active tectonics in the endokarst. Seven morphologic forms of active tectonics observed in the cave from Piriul Hodobanei (22,042 m) are described. The observed forms possess active tectonics, subsequent to the organization of the underground network, which are considered to be "active mechanics".

1205. Valeton, I. (1972) - Bauxites: Amsterdam, The Netherlands; Elsevier, 226 p.

1206. Valeton, I. (1983) - Palaeoenvironment of lateritic bauxites with vertical and lateral differentiation in Wilson, R.C.L., editor, Residual Deposits: Surface Related Weathering Processes and Materials: U.K., London; Blackwell Scientific, p. 77-90.

Formation of lateritic bauxites of the type described in this paper occurs worldwide in Cretaceous and Tertiary coastal plains. A model is developed to account for element distributions in lateritic bauxites in terms of ground-water levels and flow. It is shown that many high-level bauxites were formed in coastal plains and were subsequently uplifted to their present altitude.

1207. Vazny, H. (1978) - Trace elements as indices of conditions of sedimentation of carbonate deposits: Poland, Warsaw; Przeglad Geol. 3:299, p. 176-180, 3 figs.

1208. Veevers, J.J. (1969) - Associations of fossils, grain-types, and chemical constituents in the Upper Devonian and Lower Carboniferous limestones of the Bonaparte Gulf Basin, Northwest-Australia: U.S.; Journ. Sed. Petrol. 39:3, p. 1118-1131, 4 figs.

1209. Veihmann, I. (1959) - Contribution to the investigation of stalagmitic formations in caves, Dari de Seama ale Sedintelor Comitetalui, Geologic, V.42, p.579-610 (Romanian).

Twelve types of stalagmitic formations, frequently found in caves, are discussed. Physical, chemical, and crystallographic causes that might explain their genesis are studied. Examples taken from various caves are analyzed.

1210. Veizer, J. (1977) - Geochemistry of lithographic limestones and dark marls from the Jurassic of southern Germany: Germany, F.R., Stuttgart; Neues Jahrbuch Geol. Palaeont. Abhandlungen 153:1, p. 129-140, 6 figs., 1 tbl.

1211. Veizer, J.; and Demovic, R. (1973) - Environmental and climatic controlled fractionation of elements in the Mesozoic carbonate sequences of the western Carpathians: U.S.; Journ. Sed. Petrol. 43:1, p. 258-271, 10 figs.

1212. Veizer, J.; and Demovic, R. (1974) - Strontium as a tool for facies analysis: U.S.; Journ. Sed. Petrol. 44, p. 93-115, 9 figs.

1213. Veizer, J.; and Hoefs, J. (1976) - The nature of $^{18}O/^{16}O$ and $^{13}C/^{12}C$ secular trends in sedimentary carbonate rocks: U.K., Oxford; Geochim. Cosmochcim. Acta 40, p. 1387-1395.

1214. Veizer, J.; Demovic, R.; and Turan, J. (1971) - Possible use of strontium in sedimentary carbonate rocks as a palaeoenvironmental indicator: The Netherlands, Amsterdam; Sed. Geol. 5, p. 5-22, 9 figs.

1215. Verdeil, P. (1961) - Principes generaux de la karstification: Spelunca, Mem. 1, Actes 3e congr. Natl. Spele. Marseille, p. 42-56.

1216. Verdeil, P. (1962) - Les phenomenes d'intermittance dans les reseaux karstiques: 2e Congr. Inter. Spele. Bari 1958, Vol. 1, p. 62-78.

1217. Vgenopoulos, A.G.; and Kanellos, G.K. (1978) - Preliminary study of the bauxite occurrences of Vroderon (Florina), northern Greece in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 919-936, 5 figs.

1218. Videtich, P.E.; and Matthew, R.K. (1980) - Origin of discontinuity surfaces in limestones: Isotopic and petrographic data, Pleistocene of Barbados, West Indies: U.S.; Journ. Sed. Petrol. 50:3, p. 971-980, 4 figs.

1219. Viehmann, I. (1958) - The stalagmitic formations in the caves of the Scarisoara Karstic Complex (Romania): Memoires du Colloquium International de Speleologie de la Federation Speleologique de Belgique, Bruxelles, p.73-80 (French).

Stalagmitic formations in the Ghetarul de la Scarisoara and Pojarul Politei caves and the pothole at Sesuri are described. Concretions are located in passages of the respective caves. Emphasis is placed on rare formations, such as the "flour" of micropearls, cave pearls of various types, eccentric calcite crystals, which are called "cristalictite", and depositions of mondmilch. The "permanent drip" phenomenon, an essential factor in the genesis of eccentric crystals, is described.

1220. Viehmann, I. (1959) - Contributions to the investigation of the genesis of Giant's Cauldrons: Speleologia, Biuletyn Speleoklubu Warszawskiego, Nakladem Speleoklubu Warszawskiego, Warsaw, 1:3, p.145-177 (French).

A brief historical survey is made of research into the morphogenesis of Giant's Cauldrons, which are classified. A series of explanations and hypotheses are supplied concerning the morphogenesis of this type of karstic relief. Several examples from the Apuseni Mountains are presented.

1221. Viehmann, I. (1962) - Cave Pearls in Gehtarul de la Scarisoara, Dari de Sema ale Sedintelor Comitetului Geologic, 41 (In Romanian).

The author presents the morphogenesis of spherical, polyhedric and flat pearls, of micro-pearls, and of pearls with nests. The author refers to the water-freezing phenomenon to explain the presence of a large amount of flour and micro-pearls in the cave.

1222. Viehmann, I. (1962) - Observations on the Morphogenesis of Giant's Cauldrons, Dari de Sema ale Comitetului Geologic, 46,505-521 (In Romanian).

Research work into the morphogenesis of giant's cauldrons is surveyed. Several experiments with dyes and floats, which permit eddy currents to be identified, are described. A number of typical examples of Romanian karst are cited.

1223. Viehmann, I. (1964) - Notes on the genesis of lapis, Dari de Seama ale Comitetului Geologic, 49, pp. 271-288 (In Romanian).

The author analyzes the causes behind genesis of lapis, their evolution and morphology, and their classification. Romanian examples are cited.

1224. Viehmann, I. (1966) - A description of stalagmitic formations in the Ialomita Cave, comunicari de Geologie-Geografie ale societatii Stiinte Naturale si Geografie a RPR, P. 61-66 (In Romanian).

Several particular stalagmitic formations in the Ialomita cave (Bucegi Mountains) were studied, and the causes of certain anomalies in their development were elucidated. Effects of changes in the floor or in supports of stalagmites are described.

1225. Viehmann, I. (1966) - Fluorescein tracing experiments in the investigation of the hydrography of the karst (I), Hidrotehnicall, 1, pp. 37-42 (In Romanian).

Methods of underground water tracing are reviewed, and the fluorescein tracing technique is described in detail. Results of tracing experiments performed in the karst of Romania are discussed.

1226. Viehmann, I. (1967) - Pojarul Politei Cave in Ocrotirea Naturii, 11:1, pp. 61-74 (In Romanian).

The abundance of stalagmitic formations and crystallizations in Pojarul Politei cave is emphasized. A map of this cave is supplied.

1227. Viehmann, I. (1976) - Essay of the classification of underground cave forms, Proceedings of the 6th International Congress of Speleology, Olomouc, Academic Praha, III, pp. 289-293 (In French).

The author classifies the relief of the endokarst in several excavation formations (cave forms and constitutional forms) and filling forms, including fluviatile, ice, clay, biomorphic, and detritic forms and speleotherms.

1228. Viehmann, I. (1976) - Ten years of periodic research in an ice cave, Scarisoara Cave, Romania, Proceedings of the 6th International Congress of Speleology, Olomouc, Academia Praha, pp. 323-327 (In French).

Ghetarul de la Scarisoara Cave was studied eleven months each year over a 10-year period. Observations were made and climate and glaciology recordings performed. Partial and preliminary results are outlined.

1229. Viehmann, I. (1984) - Considerations on the karst of Israel: Theoretical and Applied Karstology, 1, pp. 117-122 (In French).

The author focusses on the Nahal Soreq cave, although the salt caves on the Dead Sea shores as well as the artificial caves (anthropogenic cavities) at Beit Govrin are discussed.

1230. Viehmann, I. (1984) - The Stalagmitic formations in the Ghetarul de la Scarisoara Cave, Pestera, 1, pp. 31-38 (In Romanian).

The author describes the distribution of stalagmitic formations in the chambers of the cave, their composition and classification, and then analyses, crystallizations and concretions in detail.

1231. Viehmann, I.; and Constantinescu, T.; and Diaconu, G. (1970) - Caves, karstic phenomena, and the hydrological situation in the Susita Verde valley, Trav. Inst. Speol. "Emil Racovitza," Bucharest, IX, pp. 9-33 (In French).

Twenty caves located on the slopes of Susita valley in the Vulcan Mountains are described.

1232. Viehmann, I.; Cristea, M.; Serban, M.; and Ghitea, S. (1980) - The morphology of the Cetatile Ponorului Karstic Complex, Apuseni Mountains, Romania, Travaux de l'Institut de Speologie "Emil Racovitza," 19, pp. 261-274 (In French).

The authors describe morphogenesis of two gigantic sinkholes and the catchment vertical shaft at Cetatile Ponorului. Underground hydrography is correlated to surface physiography.

1233. Viehmann, I.; Plesa, C.; and Rusu, T. (1964) - The cave at Vadu-Crisului, Lucrarile Institului de Speologie "Emil Racovita," 3, pp. 49-81 (In Romanian).

A number of physiographic considerations are advanced with respect to karst in the Vad area, where a substantial number of karstic forms and linear, sinkhole depressions are found. The two caves included in karstic systems generated by waters in Pestireu Valley are described in detail.

1234. Viehmann, I.; Racovita, Gh.; and Riscutia, C. (1970) - Traces indicating the presence of the man and of the cave bear in Ciur-Izbuc Cave in Padurea Craiului Mountains, Livre du centenaire "Emil Racovita": Editura Academieii RSR, Bucuresti, pp. 521-527 (In French).

The footprints of paleolithic man and of traces of activity of the cave bear preserved in Ciur-Izbuc Cave are discussed by the authors.

1235. Viehmann, I.; Racovita, Gh.; and Serban, M. (1969) - Chetarul de la Scarisoara, Editura Meridiane, Bucuresti, 79 p. (In Romanian with French and German abstracts).

This is a presentation of major elements characteristic of this glacial cave, which is the most important in Romania and one of the most remarkable in the world with respect to genesis and conservation of underground deposits of perennial ice.

1236. Viehmann, I.; Racovita, Gh.; Serban, M. (1965) - Observations of the microclimate at Ghetarul de la Scarisoara," Lucrarile Institutului de Speologic "Emil Racovita," 4, pp. 105-115 (In Romanian).

Aerodynamic exchanges between the cave and exterior effect physical factors of the underground atmosphere and the extent of the area occupied by the ice deposits in this glacial cavity. The phenomena of ice sublimation and volatilization are demonstrated.

1237. Viehmann, I.; Rusu, T.; Serban, M. (1964) - The Tausoare-Zalion Karstic Complex (Rodna Mountains), Lucrarile Institutuului de Speologic "Emil Racovita," 3, pp. 21-48 (In Romanian).

The cave described is located in Jgheabul lui Zalion and is situated on Izvorul Orbului in Telsicor basin (800 m elevation, 535 m explored length, 130 m depth); resurgence in Izvorul Rece (55 m elevation) belongs to the Izvorul Tausoarelor karstic system.

1238. Viehmann, I.; Silvestru, E; and Fabian, C. (1979) - Iza Cave, Rodna Mountains, Travaux de l'Instiitut de Speologie "Emil Racovitza," 18, pp. 201-207 (In French).

The authors describe the cave at Iza. The geology of this cave is typical of the area. Kaolinitic-type white clay was discovered in the cave and was subjected to a number of chemical analyses.

1239. Viets, J.G.; Mosier, E.L.; and Erickson, M.S. (1983) - Geochemical variations of major, minor, and trace elements in samples of the Bonneterre Formation from drill holes transecting the Viburnum Trend Pb-Zn district of southeast Missouri in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 174-186.

Core samples from six drill holes transecting the Viburnum Trend, from the fore-reef limestone facies to the back-reef white-rock dolomite facies of the Upper Cambrian Bonneterre Formation, were extensively analyzed for major, minor, and trace-element constituents. The objective of the study was to determine the geochemical variations of the Bonneterre relative to the Viburnum Trend.

1240. Viezr, J.; Lemieux, J.; Jones B.; Gibling, M.R.; and Savell, J. (1978) - Paleosalinity and dolomitization of Lower Paleozoic carbonate sequences, Somerset and Prince of Wales, Artic Canada: Can. Journ. Earth Sc. 15, p. 1448-1461.

1241. Villar, E.; Fernandez, P.L.; Quindos, L.S.; and Soto, J. (1985) - Natural temporal evolution of the CO_2 content in the air of the "Paintings Chamber" at Altamira Cave: U.S.; NSS Bull., Vol. 47, p. 12-16.

> The authors infer from results obtained from measurement of CO_2 content in the air of "Paintings Chamber" at Altamira Cave (Santander, Spain) under natural conditions over a period of a year and a half that the content of gas in the air of the chamber is closely linked to thermal conditions inside the cave and shows a well-characterized annual variation, increasing during the spring and autumn months and decreasing during the summer and winter periods.

1242. Villinger, E. (1972) - Seichter Karst und tiefer Karst in der Schwaebischen Alb: Geol. Jahrb. C2, p. 153-188.

1243. Violanti, D.; Premoli Silva, I.; Cita, M.B.; Kersey, D.; and Hsu, K.J. (1979) - Quantitative characterization of carbonate dissolution facies of the Atlantic Tertiary sediments: Italy, Milano; An Attempt. Riv. Ital. Paleont. Strat. 85:2, p. 517-552, 12 figs., 5 tbls.

1244. Vokes, F.M.; and Strand, G.S. (1982) - Atoll texture in minerals of the Cobalite-Gersdorffite Series from the Raipas Mine, Finmark, Norway in Amstutz, G.C., editor, Ore Genesis - The State of the Art: Germany, F.R., Heidelberg; Springer-Verlag, p. 118-130.

> The authors discover examples of "atoll-texture" with respect to Co-Ni-Fe-(Cu) sulpharsenides in specimens from Raipasmine near Alta, Finmark, northern Norway.

1245. Vracar, R.; Tecilazic-Stevanovic, M.; Sinadinovic, D.; and Janackovic, T. (1978) - Kinetics of dehydration processes of hydrargillitic bauxite in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 837-950, 6 figs.

1246. Vujec, S.; Zeljkovic, D.; and Peric, B. (1978) - Method of underground bauxite exploration in Yugoslavia in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 951-964, 4 figs.

1247. Wagner, G.H.; Koenig, R.H.; Smith, D.A.; Stele, K.F.; and Zachry, D.L. (1979) - Geochemistry of Carboniferous limestone units in northwest Arkansas: The Netherlands, Amsterdam; Chem. Geol. 24, p. 293-313, 8 figs., 6 tbls.

1248. Ward, H.J. (1978) - Exploration guides and methods in the discovery of Mt. Saddleback and associated bauxite deposits, southwestern Western Australia in Augustithis, S.S., editor, 4th International Congress for the Study of Bauxites, Alumina and Aluminum, Volume 2, Bauxites: Athens; Natl. Techn. Univ., p. 965-995, 7 figs.

1249. Wardlaw, N.C. (1979) - Pore system in carbonate rocks and their influence in hydrocarbon recovery efficiency: U.S.; Amer. Asso. Petrol. Geol. Course Note Ser. 11, p. E1-E24, 12 figs.

1250. Warwick, G.T. (1962) - Cave formations and deposits in Cullingford, British Caving, 2nd ed., p. 83-119.

1251. Warwick, G.T. (1962) - The origin of limestone caverns in Cullingford, C.H.D., editor, British Caving, 2nd edition: U.K., London; Routledge & Kegan Paul, p. 55-85.

1252. Warwick, G.T. (1964) - Dry valleys of the Southern Pennines: Erdkunde 18:2, p. 116-123.

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1255. Weidenbach, F. (1960) - Trinkwasserversorgung aus Karstwasser in der oestlichen Schwaebischen Alb: Jahrb. Karst-Hoehlenkd., p. 169-192.

1256. Well, St.G.; and Desmarais, D.J. (1973) - The Flint-Mammoth Connection: Natl. Spele. Soc. News 31, p. 18-22.

1257. Wermund, E.G. (1975) - Upper Pennsylvanian limestone banks, North Central Texas: U.S.; Univ. Texas Bur. Econ. Geol. Circ. 75:3, 34 p.

1258. Wermund, E.G.; Cepeda, J.C.; and Luttrell, P.E. (1978) - Regional distribution of fractures in the southern Edwards Plateau and their relationship to tectonics and caves: U.S., Univ. Texas, Austin; Bur. Econ. Geol. Cir. 78-2.

1259. White, A.F. (1978) - Sodium co-precipitation in calcite and dolomite: Chem. Geol. 23, p. 65-72.

1260. White, A.H. (1976) - Genesis of low iron bauxite, northeastern Cape York, Queensland, Australia: U.S.; Econ. Geology, Vol. 71, p. 1526-1532.

1261. White, K.D.; and Tittlebaum, M.E. (1985) - Metal distribution and contamination in sediments: U.S.; Journ. Environmental Engineering, III:2, p. 161-175.

> Heavy metal analysis was performed on sediments from various south Louisiana waterways. Objectives of the study were to determine vertical heavy metal distributions, to evaluate a proposed statistical method used to make qualitative assessments of cultural contamination based on trace metal-conservative metal relationships, and to attempt to determine heavy metal contamination in sampled sediments. Metal contamination was determined by comparing both absolute concentrations and trace metal-conservative metal concentration ratio values to their respective deep core background values.

1262. White, W.B. (1982) - Mineralogy of the Butler Cave-Sinking Creek System in White, W.B., editor, Burnsville Cove Symposium: U.S.; NSS Bull., Vol. 44, No. 3, p. 90-97.

> The Butler Cave-Sinking Creek System is characterized by scattered areas in which flowstone and dripstone occur and by a few more localized areas in which complex erratic speleothems containing aragonite and hydromagnesite occur. The author's purpose is to give an inventory and description of cave minerals, mostly from the Butler Creek-Sinking Creek System.

1263. White, W.B. (1984) - Rate processes: Chemical kinetics and karst landform development in LaFleur, R.G., editor, Groundwater as a geomorphic agent (Binghamton symposium in geomorphology; Inter. Series 13): Boston; Allen and Unwin, Inc., p. 227-248.

1264. White, W.B.; Scheetz, B.E.; Atkinson, S.D.; Ibberson, D.; and Chess, C.A. (1985) - Mineralogy of Rohrer's Cave, Lancaster County, Pennsylvania: U.S.; NSS Bull., Vol. 47, p. 17-27.

> Rohrer's Cave, developed along the contact between Cambrian Vintage Dolomite and Kinzer shaley limestone, was opened by a sinkhole collapse in 1979. The cave's 275 meters of passage are floored in places with brown mud overlying an intricately layered sequence of white, yellow, and gray sediment. In place of the usual calcite speleothems, the cave contains a

bizarre collection of white and black, soft, mushy coatings and hanging forms resembling pinecones. It also contains brown stalactites and stalagmites of hydrated iron oxides. A boxwork-like form occurs as do patches of blue flowstone. All deposits contain large proportions of unbound water which is lost on drying to form loose fine-grained powders or thin flakes.

1265. Whitesides, D.V.; Quinones-Aponte, V.; and Zack, A. (1985) - Estimating the capacity of a salty limestone aquifer in Puerto Rico to receive, store, and release injected freshwater using chloride mass balance in Symposium on Tropical Hydrology and 2nd Caribbean Islands Water Resources Congress, Proceedings of the International Symposium, May 5-8, 1985, San Juan, Puerto Rico, p.50-55.

The feasibility of storing excess streamflow through aritificial recharge in a salty aquifer in north-central Puerto Rico was investigated. Chloride mass balance analyses of the injected and recovered water were used to estimate recovery yields. Injection rates of 600 gal/min were achieved. Recovery rates ranged from 5-26% of the water injected. However, only about 40% of the recovered mix was below a suitability limit of 2,000 microsiemens/cm of specific conductance and 500 mg/L of chloride. The recovered water exceeded the suitability limits after a short residence time in the aquifer.

1266. Wicklein, P.C. (1983) - Characteristics and geologic evaluation of carbonate formations hosting Mississippi Valley-type solution-collapse breccia zinc deposits in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 396-400.

A proper stratigraphic interpretation is the key to understanding and evaluating a formation's potential for hosting solution-collapse breccia zinc ore deposits.

1267. Wigley, P. (1973) - The distribution of strontium in limestones of Barbuda, West Indies: The Netherlands, Amsterdam; Sedimentology 20, p. 295-304.

1268. Wigley, T.M.L. (1975) - Speleogenesis: A fundamental approach: Proc. 6th Inter. Congr. Spele. III, Olomouc, 1973, p. 317-324.

1269. Wigley, T.M.L.; and Brown, M.C. (1976) - The physics of caves in Ford, T.D., and Cullingford, C.H.D., editors, The Science of Speleology: Academic Press, p. 329-358.

1270. Wigley, T.M.L.; and Plummer, L.N. (1976) - Mixing of carbonate waters: Oxford; Geochim. Cosmochim. Acta 40, p. 989-995.

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1272. Wilson, J.L. (1974) - Characteristics of carbonate-platform margins: U.S.; Amer. Asso. Petrol. Geol. 58:4, p. 810-824, 6 figs.

1273. Wilson, J.R. (1977) - Lineations and the origin of caves in the Cumberland Plateau of Alabama: National Spele. Soc. Bull., Vol. 39, p. 9-12.

1274. Winograd, I.J.; and Pearson, F.J., Jr. (1976) - Major carbon-14 anomaly in a regional carbonate aquifer: Possible evidence for megascale channeling, south central Great Basin: U.S.; Water Resources Res. 12:6, p. 1125-1143.

1275. Wittstrom, M.D., Jr. (1979) - Sedimentology of the Leadville Limestone (Mississippian), northeastern Gunnison County, Colorado: U.S.; Colorado School of Mines, M.S. Thesis, 159 p.

1276. Wolf, K.H. (1978) - Limestones in Fairbridge, R.W., and Bourgeois, J., editors, The Encyclopedia of Sedimentology: Germany, F.R., Stroudsburg; Dowden, Hutchinson and Ross, p. 434-446, 14 figs., 3 pls.

1277. Wolff, M.; and Fuchtbauer, H. (1976) - Die karbonatische Randfazies der tertiaeren Suesswasserseen des Noerdlinger Ries und des Steinheimer Beckens: Hannover; Geol. Jahrbuch, D 14, p. 3-53.

1278. Wood, W.W. (1985) - Origin of caves and other solution openings in the unsaturated (vadose) zone of carbonate rocks: A model for CO_2 generation: U.S.; Geology, 13:11, p. 822-824.

> The enigma that caves and other solution openings form in carbonate rocks at great depths below land surface rather than forming from the surface downward can be explained by the generation of CO_2 within the aquifer system.

1279. Woodward, N.B., editor (1985) - Field trips in the southern Appalachians: SE-GSA 1985, Field Trips 1-5, 7: U.S.; Univ. Tennessee, Department Geol. Sciences, Studies in Geology 9.

1280. Wurm, D. (1981) - Gosaukamm, Facies and Paleoecology of the Dachstein Reef Limestones and the Zlambach Limestones in Fluegel, E., editor, Guidebook: Erlangen; Internat. Symposium Triassic Reefs, p. 86-104.

1281. Yaoru, L. (1986) - Some problems of subsurface reservoirs constructed in karst regions of China: The People's Republic of China; Institute of Hydrogeology and Engineering Geology, Ministry of Geology and Mineral Resources, 8 p.

> Surface streams in karst regions are easily sunk underground, particularly in mountain lands, which results in arid conditions. Abundant karst water sources can be accumulated in subsurface karstified rock masses or developed underground rivers. By using suitable methods to exploit water resources from subsurface rivers with adequate flow, the need for a local water supply, either in agriculture or industry, can be satisfied to a certain degree.

1282. Yurewicz, D.A. (1977) - Sedimentology of Mississippian basin-facies carbonates, New Mexico and West Texas - the Rancheria formation: U.S.; Soc. Econ. Paleon. Min. Spec. Publ. 25, p. 203-219, 10 figs.

1283. Zamarreno, I. (1982) - Las litofacies carbonatadas del Cambrico de la zona canatabrica (NW Espana) y su distribucion paleogeografia: Spain; Fac. Ciencias, Univ. Oviedo, Trabajos Geol., Vol. 5, 118 p.

> The author analyzes profiles, paleontological, and sedimentological data as well as numerous thin-sections, of Lower and Middle Cambrian sequence. Photomicrographs are presented.

1284. Zankl, H. (1969) - Der Hohe Goll: Aufbau und Lebensbild eines Dachsteinkalk-Riffes in der Obertrias der Noerdlichen Kalkalpen: Frankfurt; Abhandlungen senckenbergischen naturforsch. Gesellschaft 519, p. 1-123.

1285. Zankl, H. (1971) - Upper Triassic Carbonate Facies in the Northern Limestone Alps in Mueller, G., editor, Sedimentology of Parts of Central Europe, Guide Book: Frankfurt; VIII Inter. Sed. Congr. Heidelberg, p. 147-185, 20 figs.

1286. Ziehr, H.; Matzke K.; Ott, G.; and Vouttsidis, V. (1980) - Ein stratiformes Fluoritvorkommen im Zechsteindolomit bei Eschwege und Sontra in Hessen: Germany, F.R., Stuttgart; Geol. Rundschau 69:2, p. 325-348.

1287. Zimmermann, R.A.; and Amstutz, G.C. (1983) - Barite, its place and role in Mississippi Valley-type deposits in Kisvarsanyi, G., Grant, S.K., Pratt, W.P., and Koenig, J.W., editors, International Conference on Mississippi Valley Type Lead-Zinc Deposits: U.S.; University of Missouri-Rolla, p. 279-285.

> Barite is a ubiquitous mineral, both in sedimentary and hydrothermal environments, and of course also in their metamorphic equivalents. In deposits of the Mississippi Valley-type, barite is a common constituent. This paper is designed to summarize the different types and roles of barite. Specifically, its role in marking the process of, and place in, the diagenetic crystallization process, concluded from different types of textures and facies, is described in detail.

1288. Zimmermann, R.A.; and Spreng, A.C. (1984) - Sedimentary and diagenetic features in the sulfide-bearing sedimentary dikes and strata of Lower Ordovician dolomites, Decaturville, Missouri, U.S.A. in Wauschkuhn, A., Kluth, C., and Zimmermann, R.A, editors, Syngenesis and Epigenesis in the Formation of Mineral Deposits: Germany, F.R., Heidelberg; Springer-Verlag, p. 350-372.

> Additional studies of the Decaturville cryptovolcanic structure in western Missouri, USA, in a new exposure, has revealed additional information on distribution of sulfide minerals and sedimentary features associated with this structure. Formations consist almost entirely of dolomite with some sandstone, shale, and chert. Sulfides occur both as stratiform blebs in a few layers and, more particularly, within the matrix and some breccia clasts in sedimentary dikes which occur in the upper part of the section. It is postulated that sulfides were transported into the dikes as detritals along with detrital sand and clay from source beds which can be defined for most dikes.

1289. Zimmermann, R.K.; and Kesler, S.E. (1981) - Fluid inclusion evidence for solution mixing, Sweetwater (Mississippi Valley-type) district, Tennessee: U.S.; Econ. Geology, Vol. 76, p. 134-142.

1290. Zoetl, J. (1949) - Beitrag zu den Problemen der Karsthydrographie mit besonderer Beruecksichtigung der Frage des Erosionsniveaus: Wien; Mitt. Geogra. Ges. 100, p. 101-130.

1291. Zoetl, J. (1957) - Neue Ergebnisse der Karsthydrologie: Erdkunde 11:2, p. 107-117.

1292. Zuffardi, P. (1976) - Karsts and economic mineral deposits in Wolf, K.H., editor, Handbook of Strata-Bound and Stratiform Ore Deposits, Vol. 3, Supergene and Surficial Ore Deposits; Textures and Fabrics: The Netherlands, Amsterdam; Elsevier Scientific, p. 175-211.

> Many modern authors are giving increasing attention to paleokarsts as favorable environments for ore-mineral deposition. A number of deposits, formerly considered as telethermal by metasomatism in carbonate country rocks, have been reinterpreted and shown to be related to karstic formations.

Secondary and Tertiary Author Index

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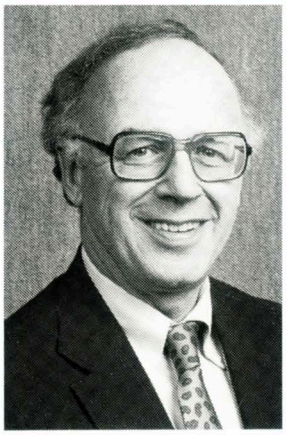

Dr. Philip E. LaMoreaux

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This fourth volume includes references published since 1987 and other works not previously incorporated in Volumes I through III. Volume IV of the Bibliography was compiled by a multidisciplined staff of geologists, hydrologists, geophysicists, and geochemists. The project also benefited from the cooperation of many individual scientists and numerous organizations throughout the world.

Philip E. LaMoreaux
Post Office Box 2310
Tuscaloosa, Alabama 35403

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