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# *EARTH SCIENCES*

1980-1994

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***EARTH  
SCIENCES***

*Uranium Geology,  
Exploration and Mining  
Hydrology*

***1980–1994***

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## **EARTH SCIENCES**

### ***Uranium Geology, Exploration and Mining***

#### **AGE, SEDIMENTARY ENVIRONMENTS, AND OTHER ASPECTS OF SANDSTONE AND RELATED HOST ROCKS FOR URANIUM DEPOSITS**

**Technical Reports Series No. 231**

Despite the fact that about 40% of the world's uranium resources are contained in sandstone-type deposits, which has led to extensive research and many publications on the subject, a need has remained for additional information on the various aspects of the geology and the factors controlling the formation of sandstone-type uranium deposits. The project described in this book identifies and considers a number of topics and unsettled questions requiring further investigation.

*Contents:* Introduction; Age of host rocks; Partitioning of uranium between continental and marine sediments; Latitude limitation on sandstone uranium deposits; Effect of rock formation dip on sandstone ores; Usefulness of stable isotope and fluid inclusion studies; References.

STI/DOC/10/231 (63 pp., 4 figures; 1983)

ISBN 92-0-145383-3

Price: 220 Austrian Schillings

#### **AIRBORNE GAMMA RAY SPECTROMETER SURVEYING**

**Technical Reports Series No. 323**

This report examines the use of gamma ray spectrometer surveying for environmental monitoring as well as for nuclear emergency response requirements. It provides an up-to-date review of airborne gamma ray spectrometry (AGRS) instrumentation and practice conducted by government geological surveys, exploration and mining organizations, environmental organizations and those concerned with radiation protection field measurements.

*Contents:* 1. Introduction; 2. Principles of airborne gamma ray spectrometry; 3. Survey methodology; 4. Calibrations for natural radioelement mapping; 5. Quality control; 6. Processing data for natural radioelement mapping; 7. Products in natural radioelement mapping; 8. Environmental monitoring; 9. Searching for radioactive objectives; Appendix: Airborne gamma ray spectrometric survey sample specifications.

STI/DOC/10/323 (98 pp., 18 figures; 1991)

ISBN 92-0-125291-9

Price: 340 Austrian Schillings

# **ANALYTICAL TECHNIQUES IN URANIUM EXPLORATION AND ORE PROCESSING**

**Technical Reports Series No. 341**

The purpose of this manual is to assist in the establishment of an analytical laboratory able to perform all the basic chemical and instrumental analyses commonly used in conjunction with uranium exploration and mining and ore processing activities, including the development of hydrometallurgical processes. It is intended for chemists with a general background in analytical chemistry, but with limited experience in the analytical chemistry of uranium and of related elements.

*Contents:* Introduction; Part I. General aspects of laboratory operation; Chapter 1. Uranium exploration; Chapter 2. Analytical requirements in uranium ore processing and process development; Chapter 3. Analytical chemistry of uranium; Chapter 4. The uranium analytical laboratory; Chapter 5. Sample preparation; Chapter 6. Calibration methods and quality control in the uranium analytical laboratory; Chapter 7. Statistical techniques for chemical analysis and process control; References; Part II. Analytical methods: Method 1. Analytical procedures for fluorometric determination of labile uranium; Method 2. Determination of uranium in water using a scintrex UA-3 uranium analyser; Method 3. Determination of uranium in geological materials by fluorometry; Method 4. Determination of uranium, thorium and potassium by gamma ray spectrometry; Method 5. Uranium determination by the fission track method; Method 6. Determination of uranium by delayed neutron counting (DNC); Method 7. Determination of uranium in ores, rocks and mineral processing solutions by XRF analysis; Method 8. Determination of uranium in ores and other samples by UV/VIS spectrophotometry; Method 9. Determination of uranium ( $U_3O_8$ ) in uranium mill products and ores by the lead reduction method; Method 10. Atomic emission spectroscopy methods for measurement of impurities in uranium; Method 11. Determination of molybdenum in ore samples and uranium mill products; Method 12. Determination of titanium ( $TiO_2$ ) by UV/VIS spectrometry; Method 13. Determination of vanadium in uranium ores and uranium mill products by volumetric titration; Method 14. Ammonia determination in uranium process solutions; Method 15. Analysis of mill process solutions for the ferrous/ferric iron ratio, silicon and phosphorus by various analytical techniques; Method 16. Nitrate and sulphate determinations in uranium process solutions by ion chromatography; Method 17. Determination of radium-226 in solid and liquid samples by alpha spectrometry; Appendix 1: Techniques used for uranium determination and those used for determinations other than uranium; Appendix 2: Laboratory safety.

STI/DOC/10/341 (187 pp., 14 figures; 1992)

ISBN 92-0-103792-9

Price: 600 Austrian Schillings

**BOREHOLE LOGGING FOR URANIUM EXPLORATION —  
A Manual  
Technical Reports Series No. 212**

Borehole logging is one of the most effective ways of estimating uranium resources and is one of the most powerful and efficacious methods of measuring, directly or indirectly, uranium at depth. It provides most of the sub-surface information needed by the exploration geologist, including in-situ analysis, lithological identification, stratigraphic correlation, and information on density and moisture. Logging is equally important in mine development and grade control, in mining operations and in production. The present text takes into account the requirements of both developing countries, which might be at an incipient stage of uranium exploration, and industrialized countries, where more advanced exploration and resource evaluation techniques are commonly in use.

*Contents:* Introduction; The borehole: its characteristics and effects; Logging technique; Instrumentation; Field procedures; Interpretation; Selected references; Appendices A–D.

STI/DOC/10/212 (279 pp., 155 figures: 1982)

ISBN 92–0–145082–6

Price: 570 Austrian Schillings

**CONSTRUCTION AND USE OF CALIBRATION FACILITIES  
FOR RADIOMETRIC FIELD EQUIPMENT  
Technical Reports Series No. 309**

This report describes facilities primarily designed for uranium exploration instruments, but also discusses the use of these facilities for the calibration of radiation protection instruments.

*Contents:* 1. Introduction; 2. Basic radiation geophysics; 3. Instruments used in radiation surveys; 4. Quantities and units; 5. Relations between instrument readings and the corresponding field assay values; 6. Calibration systems; 7. Design considerations for calibration pads; 8. Construction of calibration pads; 9. Calibration.

STI/DOC/10/309 (87 pp., 15 figures; 1989)

ISBN 92–0–145189–X

Price: 290 Austrian Schillings

**CORRELATION OF URANIUM GEOLOGY BETWEEN  
SOUTH AMERICA AND AFRICA  
Technical Reports Series No. 270**

This publication is the result of recognition of the great potential for discovery of additional uranium resources in Africa and

South America and the long common geological history of the two continents. The document provides a summary of the regional geology and tectonics as a basis for correlation of the geodynamic settings of the uranium occurrences. Studies and new satellite imagery interpretation of West-Central Africa are the basis for much of the new information included. The document reviews the occurrences of uranium and the implications for exploration. This compilation of geological information provides an excellent summary of current knowledge on the geology of the two continents that should provide new insights into the exploration for uranium and other commodities. Four coloured maps at a scale of one to ten million were assembled in the project and show: (1) Precambrian cratonic areas, mobile belts and sedimentary covers; (2) Palaeozoic and Gondwana sequences; (3) Post-Gondwana sequences; (4) Alkaline complexes and kimberlites.

The maps can also be purchased separately at 740 Austrian Schillings.

*Contents:* Preface; Chapter 1. General introduction to uranium correlation between South America and Africa; Chapter 2. Precambrian cratons; Chapter 3. Late Precambrian belts; Chapter 4. Precambrian sedimentary covers; Chapter 5. Lower Palaeozoic and Gondwana sequences; Chapter 6. Post-Gondwana sequences; Chapter 7. Alkaline rocks and carbonite; Chapter 8. Significance for uranium exploration; Appendix: Index of uranium deposits and occurrences.

STI/DOC/10/270 (475 pp., 60 figures and 4 maps; 1986)

ISBN 92-0-145286-1

Price: 1940 Austrian Schillings

## **GEOCHEMICAL EXPLORATION FOR URANIUM**

### **Technical Reports Series No. 284**

The intention has been to introduce the concepts and methods of *uranium exploration geochemistry in sufficient detail* so that the user may make effective use of the techniques.

*Contents:* Chapter 1. Geochemical exploration for uranium; Chapter 2. General chemistry and geochemistry of uranium; Chapter 3. Exploration strategy; Chapter 4. Sample media and sampling techniques; Chapter 5. Sample preparation and storage; Chapter 6. Geochemical analysis for uranium; Chapter 7. Data and map preparation; Chapter 8. Interpretation of geochemical surveys; Annex I. Data recording instructions; Annex II. Analytical procedures for fluorimetric determination of labile uranium.

STI/DOC/10/284 (96 pp., 11 figures; 1988)

ISBN 92-0-145088-5

Price: 310 Austrian Schillings

**GEOLOGY AND METALLOGENESIS OF  
URANIUM DEPOSITS OF SOUTH AMERICA**  
Panel Proceedings Series

Proceedings of a working group, San Luis, Argentina, 21–23 September 1981. The book contains nine papers on regional or national uranium resources, one of which discusses the possible existence of carbonite bodies around the southern and western borders of the South American proterozoic shield. In addition, an introductory paper reviews the geological favourability for uranium in South America.

STI/PUB/641 (275 pp., 79 figures; 1984)

ISBN 92-0-041084-7

Price: 660 Austrian Schillings

**HANDBOOK ON NUCLEAR DATA FOR  
BOREHOLE LOGGING AND MINERAL  
ANALYSIS**

**\*NEW**

Technical Reports Series No. 357

This Handbook is a compendium of nuclear data to be used for neutron borehole logging and neutron activation analysis of mineral samples, meeting the major requirements of the nuclear geophysics community for microscopic cross-section and decay data.

*Contents:* Chapter 1. Introduction; Chapter 2. Table of nuclides; Chapter 3. Prompt gamma rays from thermal neutron capture — Extracted from the database; Chapter 4. Nuclear decay gamma rays with intensities higher than 5% — An extract from the ENSDF radioactivity database; Chapter 5. Spectra of neutron sources; Chapter 6. Neutron induced reaction cross-section data for nuclides required for borehole logging and mineral analysis; Chapter 7. Neutron source averaged cross-sections.

STI/DOC/10/357 (231 pp. + 1 diskette containing approx.

100 pp., 78 figures; 1993)

ISBN 92-0-102393-6

Price: 1000 Austrian Schillings

**MANUAL ON THE PROJECTION OF URANIUM  
PRODUCTION CAPABILITY: General Guidelines**  
Technical Reports Series No. 238

A continuous supply of uranium is of vital concern to governments and to the nuclear industry. There are countries where exploration for and production of uranium is an important part of the national economy and where developing and maintaining



a healthy uranium mining industry and a participation in a reliable world uranium market are national priorities.

*Contents:* Introduction; Purpose and scope; Resource estimates versus production capability projections; Appendix 1. Historical summary of relevant activities; Appendix 2. Procedures in Canada, France, the Republic of South Africa and the USA; Appendix 3. Definitions; Appendix 4. Lead time experience.

STI/DOC/10/238 (37 pp., 10 figures; 1984)

ISBN 92-0-145084-2

Price: 160 Austrian Schillings

## **METALLOGENESIS OF URANIUM DEPOSITS Panel Proceedings Series**

Proceedings of a Technical Committee meeting, Vienna, 9-12 March 1987. This volume brings together current knowledge on the processes involved in the formation of the various types of uranium deposits and helps to clarify the underlying common factors and principles involved. In addition, it includes reports on studies done on various deposit types in different countries. There are panel discussions on three specific topics: the formation of uranium deposits, the use of metallogenic concepts in uranium exploration, and deposit classification schemes and models.

STI/PUB/775 (490 pp., 177 figures; 1989)

ISBN 92-0-141289-4

Price: 1200 Austrian Schillings

## **METHODS FOR THE ESTIMATION AND ECONOMIC EVALUATION OF UNDISCOVERED URANIUM ENDOWMENT AND RESOURCES — An Instruction Manual Technical Reports Series No. 344**

The present manual is part of the IAEA's programme on guides on uranium resource assessment and supply. Its purpose is to describe methods of making numerical estimates of undiscovered uranium endowment and of the economic potential of the uranium resources. It provides guidance on choosing the method(s) most applicable to a given situation.

*Contents:* 1. Introduction; 2. Geological analogy principles; 3. Control areas; 4. Approaches to estimation of endowment; 5. Probability considerations; 6. Limited information and subjective probability; 7. Deposit density methods; 8. Mineralized rock density methods; 9. Crustal abundance methods; 10. Economic potential evaluation; 11. Criteria for method selection; 12. Utili-

zation of resource estimates; Appendix I: Glossary; Appendix II: Selected control area descriptions and grade-tonnage curves; Appendix III: Case studies.

STI/DOC/10/344 (145 pp., 24 figures; 1992)

ISBN 92-0-104092-X

Price: 480 Austrian Schillings

**METHODS FOR THE ESTIMATION OF URANIUM ORE RESERVES: An Instruction Manual**  
**Technical Reports Series No. 255**

The present manual is designed mainly to provide assistance in uranium ore reserve estimation methods to mining engineers and geologists with limited experience in estimating reserves, especially to those working in developing countries. The methods presented have been generally accepted in the international uranium industry. The methods described do not require the use of computers. A brief section on statistical and geostatistical methods has been included, together with a bibliography.

*Contents:* Introduction; Sampling; Treatment of assay results; Cut-off grade and thickness; Calculation of volume, tonnage, average grade and uranium content of ore blocks; Ore reserve estimation methods; Overview of statistical and geostatistical methods; Recovery factors; Appendix I: Definitions of resource categories; Appendix II: Gamma ray log evaluation; Appendix III: Areas of influence in different sandstone uranium deposits; References; Bibliography.

STI/DOC/10/255 (92 pp., 47 figures; 1985)

ISBN 92-0-145085-0

Price: 280 Austrian Schillings

**NUCLEAR TECHNIQUES IN THE EXPLORATION AND EXPLOITATION OF ENERGY AND MINERAL RESOURCES**  
**Proceedings Series**

Proceedings of a symposium, Vienna, 5-8 June 1990. Over the last few decades, many nuclear techniques have been developed and used on an industrial scale for the exploration and exploitation of energy and mineral resources, resulting in great technical and economic benefits. The major nuclear techniques which are currently employed on a large scale include nucleonics control and on-stream analysis, nuclear well logging and tracer investigations. The advantages of nuclear techniques include rapidity, relative simplicity of use and, in some cases, the possibility of use in hostile environments where no other methods can be used. Furthermore, nuclear measure-

ments and nucleonics control can be made by non-contact processes. The purpose of the symposium was to review the latest concepts and developments and to foster an exchange of information leading to technology transfer from developed to developing countries.

*Contents:* Nucleonics control systems and on-stream analysers in the coal industry; On-line nuclear and nuclear related analytical techniques in the mineral industry; Nucleonics control systems and on-stream mineral analysers; Nuclear borehole logging applications; Nuclear borehole logging instrumentation, data processing and interpretation; Tracer techniques and radiometric methods in the mineral industry; Off-line nuclear activation analysis in the mineral industry; Summary of the panel discussion: nuclear and nuclear related techniques in the mineral industry — trends and future perspectives.

STI/PUB/841 (627 pp., 207 figures; 1991)

ISBN 92-0-060091-3

Price: 1660 Austrian Schillings

### **PRACTICAL BOREHOLE LOGGING PROCEDURES FOR MINERAL EXPLORATION, WITH EMPHASIS ON URANIUM** **Technical Reports Series No. 259**

Borehole logging is a basic tool in the exploration for and delineation of uranium deposits. The radioactivity associated with the uranium can be used for the quantitative evaluation of the uranium content of rocks intercepted by the borehole. This manual is designed to provide an explanation of such procedures in a clear and straightforward manner so as to meet the needs of field practitioners.

*Contents:* Introduction; The borehole: Its characteristics and effects; Gross count gamma ray logging; Resistance, resistivity and conductivity; Spontaneous potential; Density logging; Neutron logging; Field procedures; Logging examples; Appendix 1: Calibration procedure for gross count gamma ray logging; Appendix 2: Correlation factors for gross count gamma ray logging; Appendix 3: Glossary and reference data.

STI/DOC/10/259 (44 pp., 21 figures; 1986)

ISBN 92-0-145086-9

Price: 180 Austrian Schillings

### **RECOGNITION OF URANIUM PROVINCES** **Panel Proceedings Series**

Proceedings of a Technical Committee meeting, London, 18-20 September 1985. The aim of the project reported in this

book was to cover three principal areas of interest: The general nature of uranium provinces and their formation; the characteristics of known uranium provinces; and implications for resource evaluation and exploration. The papers presented provide an excellent coverage of this topic. In addition to the papers, three panels were organized to cover the three basic themes of the meeting, formation of provinces, characteristics of provinces and exploration.

*Contents:* The general nature of uranium provinces and their formation; Major uranium deposits and their characteristics; Uranium exploration; Panel discussions.

STI/PUB/736 (459 pp., 126 figures; 1988)

ISBN 92-0-141088-3

Price: 1130 Austrian Schillings

## **REMOTE SENSING IN URANIUM EXPLORATION:**

### **Basic Guidance**

#### **Technical Reports Series No. 208**

This report describes the various techniques for remote sensing in uranium exploration, specific applications in view of exploration strategy and a selection of appropriate techniques, their availability and costs.

*Contents:* Introduction; Physical phenomena and measurement techniques; Applications of remote-sensing techniques; Economic considerations; Summary and conclusions; Bibliography.

STI/DOC/10/208 (50 pp., 2 figures; 1981)

ISBN 92-0-145181-4

Price: 160 Austrian Schillings

## **SIGNIFICANCE OF MINERALOGY IN THE DEVELOPMENT OF FLOWSHEETS FOR PROCESSING URANIUM ORES**

### **Technical Reports Series No. 196**

This report, in the form of a guide for planning and developing treatment flowsheets for uranium ore processing, has been prepared from material developed at a consultants' meeting in Vienna in January 1978. Ore mineralogy, analysed, described and interpreted in ways most meaningful to the metallurgist, is essential as this information forms the basis of planning a programme of investigation into the extraction of uranium ores. This topic, here termed metallurgical mineralogy, is therefore a major theme of this publication.

*Contents:* Part I: Principles and practice of uranium mineralogy and ore-processing metallurgy; Part II: Selected examples of

specific uranium deposits and operations; Part III: Summary tables on specific uranium deposits and processing plants.

STI/DOC/10/196 (276 pp., 23 figures; 1980)

ISBN 92-0-145080-X

Price: 570 Austrian Schillings

**URANIUM DEPOSITS IN ASIA AND THE PACIFIC:  
GEOLOGY AND EXPLORATION  
Panel Proceedings Series**

Proceedings of a Technical Committee meeting, Jakarta, Indonesia, 16-19 December 1985. One in a series of publications dealing with regional studies being carried out on the uranium geology and resources of the world. It provides a review of the specific exploration techniques that are appropriate for the geological and climatic conditions in Asia. The deposits, promising prospects and exploration activities in Bangladesh, China, the Indian subcontinent, Indonesia, Japan, the Republic of Korea, Malaysia, the Philippines, Sri Lanka and Thailand are described. The proceedings also include the findings of two Working Groups on Uranium Provinces and Criteria for Favourability and on Exploration Techniques.

*Contents:* Review papers on uranium deposits and provinces on regional and national scales; Methods and levels of exploration in the different countries of the region; Working Group reports.

STI/PUB/756 (341 pp., 137 figures; 1988)

ISBN 92-0-141188-X

Price: 840 Austrian Schillings

**URANIUM DEPOSITS IN LATIN AMERICA:  
GEOLOGY AND EXPLORATION  
Panel Proceedings Series**

Proceedings of a regional Advisory Group meeting, Lima, Peru, 4-8 December 1978. The South American Continent, containing extensive, favourable lithologic and tectonic environments for uranium mineralization, is one of the world's most interesting areas for uranium exploration, and has a speculative potential of 0.7 to 1.9 million tonnes of uranium. Presenting a wide range of aspects of the uranium geology and exploration of the Continent, these proceedings include a great wealth of new geological models, favourability studies and information on uranium resources.

*Contents:* I. Geochronological and tectonic evolution of the South American Continent and its uranium potential; II. Exploration techniques applicable to the South American environ-

ments; III. Preliminary reconnaissance and regional favourability studies; IV. Uraniferous mineralizations; Geology and mine development; V. Recovery of uranium as by-product of other mining operations; Reports of the Working Groups.

STI/PUB/505 (625 pp., 155 figures; 1981)

ISBN 92-0-041081-2

Price: 1150 Austrian Schillings

## **URANIUM DEPOSITS IN MAGMATIC AND METAMORPHIC ROCKS**

### **Panel Proceedings Series**

Proceedings of a Technical Committee meeting, Salamanca, Spain, 29 September to 3 October 1986. Magmatic and metamorphic rocks continue to be important sources of uranium despite the fact that in recent years interest in them has been eclipsed by the discovery of larger, lower cost deposits in other geological environments. However, many developing countries have geological environments consisting of magmatic and metamorphic rocks favouring these types of uranium deposits. Individual deposits can be quite large and economically competitive and constitute worthwhile exploration targets.

*Contents:* General characteristics and genesis of uranium deposits in magmatic and metamorphic rocks in Europe, North America, Asia and Africa; Panel discussions.

STI/PUB/767 (253 pp., 89 figures; 1989)

ISBN 92-0-141089-1

Price: 640 Austrian Schillings

## **URANIUM DEPOSITS IN VOLCANIC ROCKS**

### **Panel Proceedings Series**

Proceedings of a Technical Committee meeting, University of Texas at El Paso, Texas, 2-6 April 1984. Occurrences of uranium mineralization in rocks of volcanic origin have been known for many years. These proceedings summarize the current knowledge of uranium deposits in volcanic rocks and provide new information on many of the important deposits, particularly in North and South America.

*Contents:* The metallogenesis, geology and characteristics of deposits in Argentina, Bolivia, Canada, France, Italy, Mexico, Peru and the United States of America; Classification; Deposit models; Geochemistry; Exploration practices; Panels: 1. Genesis of volcanogenic uranium deposits; 2. Recognition criteria

and deposit characterization; 3. Exploration for uranium ore deposits in volcanic environments.

STI/PUB/690 (468 pp., 151 figures; 1985)

ISBN 92-0-041085-5

Price: 1100 Austrian Schillings

## **URANIUM EVALUATION AND MINING TECHNIQUES** **Proceedings Series**

Proceedings of a symposium organized with the co-operation of the OECD/NEA, Buenos Aires, 1-4 October 1979. The skilled evaluation of uranium resources, their eventual exploitation and the mining methods used are of vital importance. Many countries have embarked on national programmes either to determine their uranium potential or to explore for uranium deposits. An accurate, comprehensive and clear appraisal of the world's undiscovered uranium resources is essential for making qualified decisions in relation to the future supply of nuclear fuel. This publication is particularly valuable for information on the latest evaluation and mining techniques presented by experts from a number of countries.

*Contents:* Introductory papers; Physical exploration and estimation of ore reserves; Mining and other uranium recovery methods; Estimation of undiscovered uranium resources.

STI/PUB/524 (551 pp., 147 figures; 1980)

ISBN 92-0-040280-1

Price: 1030 Austrian Schillings

## **URANIUM EXPLORATION CASE HISTORIES** **Panel Proceedings Series**

Results of an Advisory Group meeting, Vienna, 26-29 November 1979, as part of a programme to improve the rate of uranium discovery by collecting and systematically analysing information about the general practice of uranium exploration. The purpose of the meeting was to describe the methods used in the exploration of major and new-type uranium deposits during the past three decades and to recount the history of the discovery of these deposits. The cases represented at the meeting show a wide spectrum of exploration methods applied in varying geological, topographic and climatic conditions from the more important or promising uraniferous areas of Argentina, Australia,

lia, Brazil, Canada, Czechoslovakia, Greenland, France, South Africa, Sweden, the USA and Zambia.

*Contents:* Case histories; Working Group Report.

STI/PUB/584 (407 pp., 150 figures; 1981)

ISBN 92-0-141081-6

Price: 760 Austrian Schillings

## **URANIUM EXPLORATION IN WET TROPICAL ENVIRONMENTS**

### **Panel Proceedings Series**

Proceedings of an Advisory Group meeting, Vienna, 16-19 November 1982. A large body of experience was gathered from worldwide uranium exploration in moderate, dry and cold climates. For this work, many diverse exploration techniques employing a wide range of sophisticated instruments have been developed. In contrast, very little is known in the public domain about uranium exploration in wet tropical environments and the performance and effectiveness of techniques and instruments used. Papers were presented and two ad hoc Working Groups prepared reports with recommendations.

STI/PUB/642 (162 pp., 60 figures; 1983)

ISBN 92-0-141183-9

Price: 380 Austrian Schillings

## **URANIUM EXTRACTION TECHNOLOGY**

**\*NEW**

### **Technical Reports Series No. 359**

The purpose of this publication is to update and expand the first edition, which was published in 1983, and to report on advances in uranium ore processing which have taken place since. It includes background information about the principles of the unit operations used in uranium ore processing and summarizes the current state of the art. It also seeks to preserve the technology and the operating 'know-how' developed over the past ten years. Extensive references provide sources for specific technological details.

*Contents:* Introduction; Part I. Uranium resources and mining technology; Chapter 1. Uranium resources; Chapter 2. Mining technology; Part II. Processing technology; Chapter 3. Processing concepts; Chapter 4. Ore preparation; Chapter 5. Leaching; Chapter 6. Solid-liquid separation; Chapter 7. Solution purifica-



tion; Chapter 8. Product recovery; Chapter 9. By-products; Part III. Waste management and the environment; Chapter 10. Tailings management technology; Part IV. Flow sheet examples; Chapter 11. Olympic Dam; Chapter 12. Key Lake; Chapter 13. Rabbit Lake; Chapter 14. Lodève; Chapter 15. Rossing; Chapter 16. Cominak; Chapter 17. White Mesa; Chapter 18. Rosita (in situ leaching).

STI/DOC/10/359 (358 pp., 77 figures; 1993)

ISBN 92-0-103593-4

Price: 1100 Austrian Schillings

### **URANIUM IN THE PINE CREEK GEOSYNCLINE Proceedings Series**

Proceedings of a symposium, Sydney, Australia, 4-8 June 1979. Latest exploration activities prove that the resources of the Geosyncline are approximately 289 000 tonnes  $U_3O_8$ , more than 15 per cent of the Western World's uranium resources. Regional and detailed aspects of exploration, geophysics, stratigraphy, geochemistry and petrology form part of the discussions. In addition to the coverage of many aspects of uranium distribution and mineralization within the Pine Creek Geosyncline, vein-type uranium deposits in Lower Proterozoic rocks in other countries are discussed and compared with the Australian deposits. Particular emphasis is given to the Athabasca margin deposits in Canada. Attached to the publication are three analyses on microfiche and four maps on the solid geology, the gravity, the magnetics and the radiometrics of the Pine Creek Geosyncline.

*Contents:* Pine Creek Geosyncline; Regional studies; District studies; Detailed studies; Models for uranium mineralization; Canadian deposits; Other deposits; General; Retrospect and Prospect; Author Index; Text Appendices (3 analyses on microfiche and 4 maps).

STI/PUB/555 (762 pp., 341 figures; 1980)

ISBN 92-0-140080-2

Price: 1390 Austrian Schillings

### **VEIN-TYPE AND SIMILAR URANIUM DEPOSITS IN ROCKS YOUNGER THAN PROTEROZOIC Panel Proceedings Series**

Proceedings of a Technical Committee meeting, Lisbon, Portugal, 24-28 September 1979. Vein-type and similar uranium deposits made the main contribution to world production of uranium in the early days of the development of the nuclear power era up to the time when the production of uranium

coming from sandstone deposits and Proterozoic quartz-pebble conglomerates played a dominant role. However, ores from vein-type deposits have always maintained a significant contribution.

*Contents:* General; European deposits; World vein and similar deposits; Portuguese deposits; Working Group IV Report.

STI/PUB/600 (395 pp; 1982)  
ISBN 92-0-041082-0  
Price: 780 Austrian Schillings

## ***Hydrology***

### **ARID-ZONE HYDROLOGY: INVESTIGATIONS WITH ISOTOPE TECHNIQUES Panel Proceedings Series**

The publication includes the papers presented at an Advisory Group meeting, Vienna, 6-9 November 1978. It gives a complete and current account of the progress made by environmental isotope techniques in arid-zone hydrology, as well as of the problems which still remain open and demand further thought and data.

*Contents:* Groundwater recharge studies; Field investigations on groundwater origin and flow patterns.

STI/PUB/547 (265 pp.; 108 figures; 1980)  
ISBN 92-0-141180-4  
Price: 500 Austrian Schillings

### **ENVIRONMENTAL ISOTOPE DATA No. 1: WORLD SURVEY OF ISOTOPE CONCENTRATION IN PRECIPITATION (1953-1963) Technical Reports Series No. 96**

This is a series of reports from a network organized by the IAEA in co-operation with WHO and seven national co-operating laboratories.

*Contents:* Introduction; Data printouts; Numerical station index; Alphabetical station index; Appendix: Tritium laboratory code numbers.

STI/DOC/10/96 (421 pp., 1969)  
ISBN 92-0-145069-9  
Price: 360 Austrian Schillings

**ENVIRONMENTAL ISOTOPE DATA No. 2:  
WORLD SURVEY OF ISOTOPE CONCENTRATION IN  
PRECIPITATION (1964-1965)  
Technical Reports Series No. 117**

*Contents:* Introduction; Data printouts; Numerical station index; Alphabetical station index; Tritium laboratory code numbers; Deuterium oxygen-18 laboratory code numbers.

STI/DOC/10/117 (404 pp., 4 figures; 1970)

ISBN 92-0-145070-2

Price: 360 Austrian Schillings

**ENVIRONMENTAL ISOTOPE DATA No. 3:  
WORLD SURVEY OF ISOTOPE CONCENTRATION IN  
PRECIPITATION (1966-1967)  
Technical Reports Series No. 129**

*Contents:* Introduction; Data printouts; Numerical station index; Alphabetical station index; Tritium laboratory code numbers; Deuterium and oxygen-18 laboratory code numbers.

STI/DOC/10/129 (402 pp., 4 figures; 1971)

ISBN 92-0-145271-3

Price: 390 Austrian Schillings

**ENVIRONMENTAL ISOTOPE DATA No. 4:  
WORLD SURVEY OF ISOTOPE CONCENTRATION IN  
PRECIPITATION (1968-1969)  
Technical Reports Series No. 147**

*Contents:* Introduction; Data printouts; Numerical station index; Alphabetical station index; Tritium laboratory code numbers; Deuterium and oxygen-18 laboratory code numbers.

STI/DOC/10/147 (434 pp., 2 figures; 1973)

ISBN 92-0-145173-3

Price: 410 Austrian Schillings

**ENVIRONMENTAL ISOTOPE DATA No. 5:  
WORLD SURVEY OF ISOTOPE CONCENTRATION IN  
PRECIPITATION (1970-1971)  
Technical Reports Series No. 165**

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*Contents:* Introduction; Data printouts; Numerical station index; Alphabetical station index; Appendix 1: Laboratories which have co-operated or are co-operating in the IAEA/WMO network; Tritium laboratories; Stable isotopes laboratories.

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tems. The application of isotope techniques in waste isolation technology can be especially valuable when used in connection with other hydrological and geochemical methods.

*Contents:* Introduction; General scope of the report; Water and tracer movement in the aquifer; Chemical evolution along groundwater flow-paths; Description of isotope techniques; Stable isotopes of hydrogen and oxygen; Tritium; Isotope evolution of aqueous systems; Isotope evolution of dissolved noble gases; Other radioisotopes of cosmic origin; Uranium series nuclides; Radioisotope tracers and other nuclear methods; Conclusions; Appendix 1: Relevant IAEA publications.

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*Contents:* Isotopes in atmospheric studies; Isotopes in the soil-plants-atmosphere system; Degradation of water resources; Palaeohydrology and palaeowaters; Isotope indicators of climatic changes; Poster presentations.

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*Contents:* Introduction; Statistical data; Data summary; Numerical station index; Alphabetical station index; Laboratories which have co-operated or are co-operating in the IAEA/WMO network.

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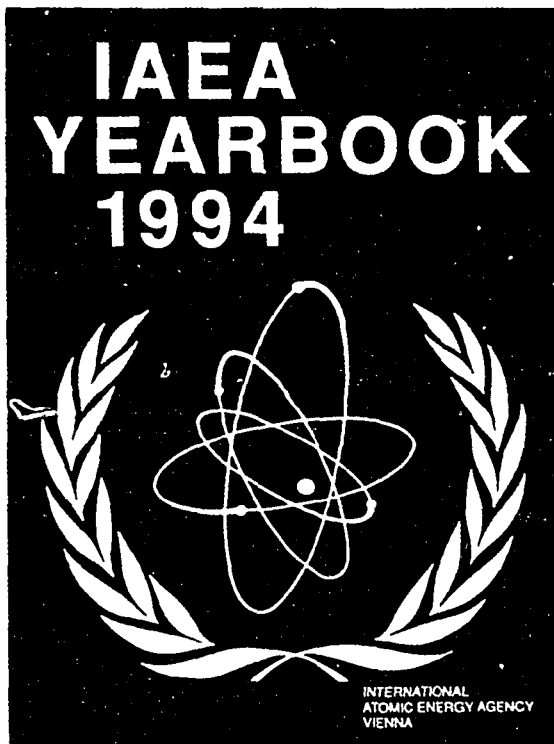
Proceedings of an Advisory Group meeting, Vienna, 17-20 June 1985. The variations of sulphur isotopes in natural compounds (and of oxygen isotopes in sulphates) provide a powerful method of investigation in various fields of earth sciences such as hydrology, geochemistry, geothermal exploration, volcanology, oceanography, sedimentology, ore formation and environmental sciences.

*Contents:* Summary; Isotopic composition of dissolved oceanic sulphate; Sulphur isotopes in the water of Lake Neusiedl, Austria; Relationships between the sulphur and oxygen isotope composition of dissolved sulphate; Sulphur and sulphate-oxygen isotopes in New Zealand geothermal systems and volcanic discharges; Isotopic composition and origin of sulphur compounds in groundwaters and brines in the Po Valley (northern Italy); Two case studies on the origin of aqueous sulphate in deep crystalline rocks; Sulphur and oxygen isotopic compositions of groundwater — and sabkha — sulphate in the Middle East; Radiolytic oxidation of sulphides and geochemical behaviour of sulphur isotopes in uranium deposits; On bias in  $^{34}\text{S}/^{32}\text{S}$  data obtained in  $\text{SO}_2$  gas in mass spectrometry; Sulphur isotope analyses of trace sulphide and sulphate in various materials using Kiba reagent.

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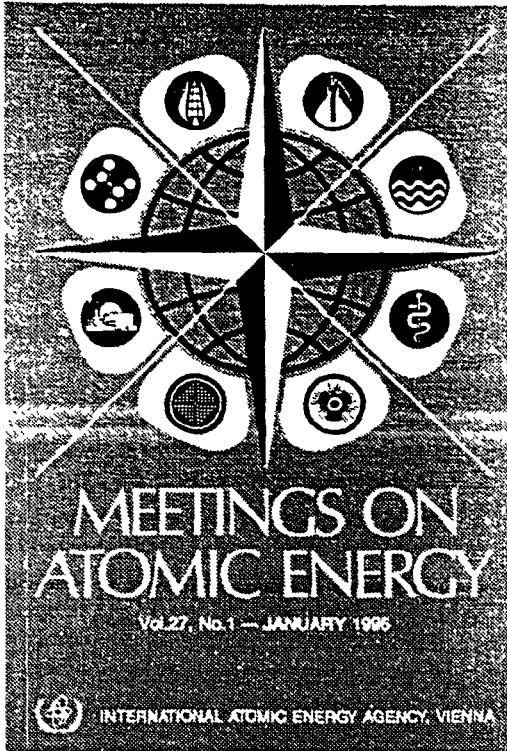
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