Conference Reports

Geodynamics Problems — Outlook to the 80's

IUGS Symposium
Zurich, Switzerland
February 5-6, 1979

A new international interdisciplinary research project being planned by the International Union of Geological Sciences and the International Union of Geodesy and Geophysics (IUGG) will build upon the scientific achievements and the spirit of cooperation between geologists and geophysicists fostered by the international Geodynamics Project (see EPISODES, 1978, III, p. 3-4). The latter is scheduled to end with the presentation of final reports at the ICG Bureau and Commission Meeting in Sydney, Australia in December, 1979. Planning for the new project reached a turning point at an intellectually stimulating and fruitful conference entitled "Geodynamics Problems -- Outlook to the 80's", convened and organized by **Prof. R. Trümpy**, President of IUGS, with the assistance of **Dr. W.W. Hutchison**, Secretary General, and their associates. It involved about 65 invited participants representing IUGS scientific bodies, affiliations and national adhering organizations, as well as representatives of IUGG and national committees for the Geodynamics Project; at least one hundred other interested observers attended the sessions held at the Swiss Federal Institute of Technology in Zurich. The draft report of the IUGG/IUGS joint task force looking into the need for the new program (see EPISODES, 1978, III, p. 7-8) and headed by **Prof. C. Kisslinger** (IUGG) and **Prof. H. Illies** (IUGS), provided a focus for the discussions.

To set the stage for a series of personal assessments of the main problems requiring a concerted international effort, **Prof. C. Drake**, first President of the Inter-Union Commission on Geodynamics (ICG), and **Miss F. Delany**, its first Secretary General, provided brief reviews of some of the principal contributions of the Geodynamics Project, both to progress in the earth sciences and to the establishment of effective cooperation among different national groups and disciplines. The exciting scientific developments of the 70's that have so profoundly changed our understanding of how the earth works can be credited, in no small measure, to the links in cooperative international, interdisciplinary research forged during the Geodynamics Project, and it is this particular success that has provided much of the incentive for establishing a new international project involving the two unions. Both Prof. Drake and Miss Delany emphasized the importance of not letting the glow of success obscure the fact that many challenges still remain: the difficulties in achieving the same degree of elegant simplicity in applying the plate tectonics model to the interpretation of continental areas as to the interpretation of oceanic areas; the need to utilize, effectively, the potential contributions of the "grass roots" field geologists who prepare the geological maps upon which much of our progress in understanding continental geology is ultimately based, and many others.

The concept of an almost "unlimited memory" in continental rocks, which bear the physical and chemical imprint of most of the important processes that have controlled their evolution during their comparatively longer time of residence in the earth's crust, was introduced by Prof. Illies. He discussed the importance of research on in situ stress and strain determinations and this became a recurring theme in subsequent presentations. For example, **Prof. J. Ramsay** (Switzerland) elaborated on it and on the concept that surface exposures provide access to the record of deformational and metamorphic processes that operate several tens of kms below the earth's surface; he showed how careful perceptive field and laboratory studies can provide important clues about the rheology of rocks at depth, and about the nature and magnitudes of strains associated with the deformation of the crust. U.K. Professors **B. Windley** and **J. Sutton**, in their review of recent advances in research on the evolution of Precambrian crust, also discussed the importance of this kind of work, and stressed its interdependence with geophysical and geochemical investigations of Precambrian lithosphere. They pointed out that although important similarities have been established between parts of the record of evolution of Precambrian and Phanerozoic continental crust, many fundamental questions concerning the Precambrian record have emerged or have acquired a new urgency during the Geodynamics Project, specifically:

(1) To what extent and over what time span can the plate tectonic models that have been so successful in elucidating Phanerozoic crustal evolution, be adapted to Precambrian crustal evolution?

(2) What is the real significance of the greenstone belts and associated tonalitic "granitic" belts that are so characteristic of older Precambrian terranes?

(3) What are the implications of the widespread Precambrian basic dike swarms?

(4) How can models for the thermal evolution of the earth be integrated with the Precambrian geological record?

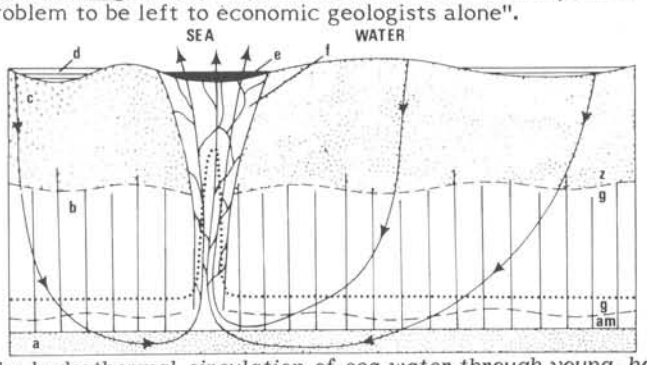
(5) How can the recent discoveries about the evolution of the moon and planets be integrated with the geological record of the Precambrian evolution of the earth's crust?

A field trip through the spectacular Glarus Alps in Switzerland, led by Professor R. Trümpy, President of IUGS (centre foreground), preceded the IUGS Symposium.

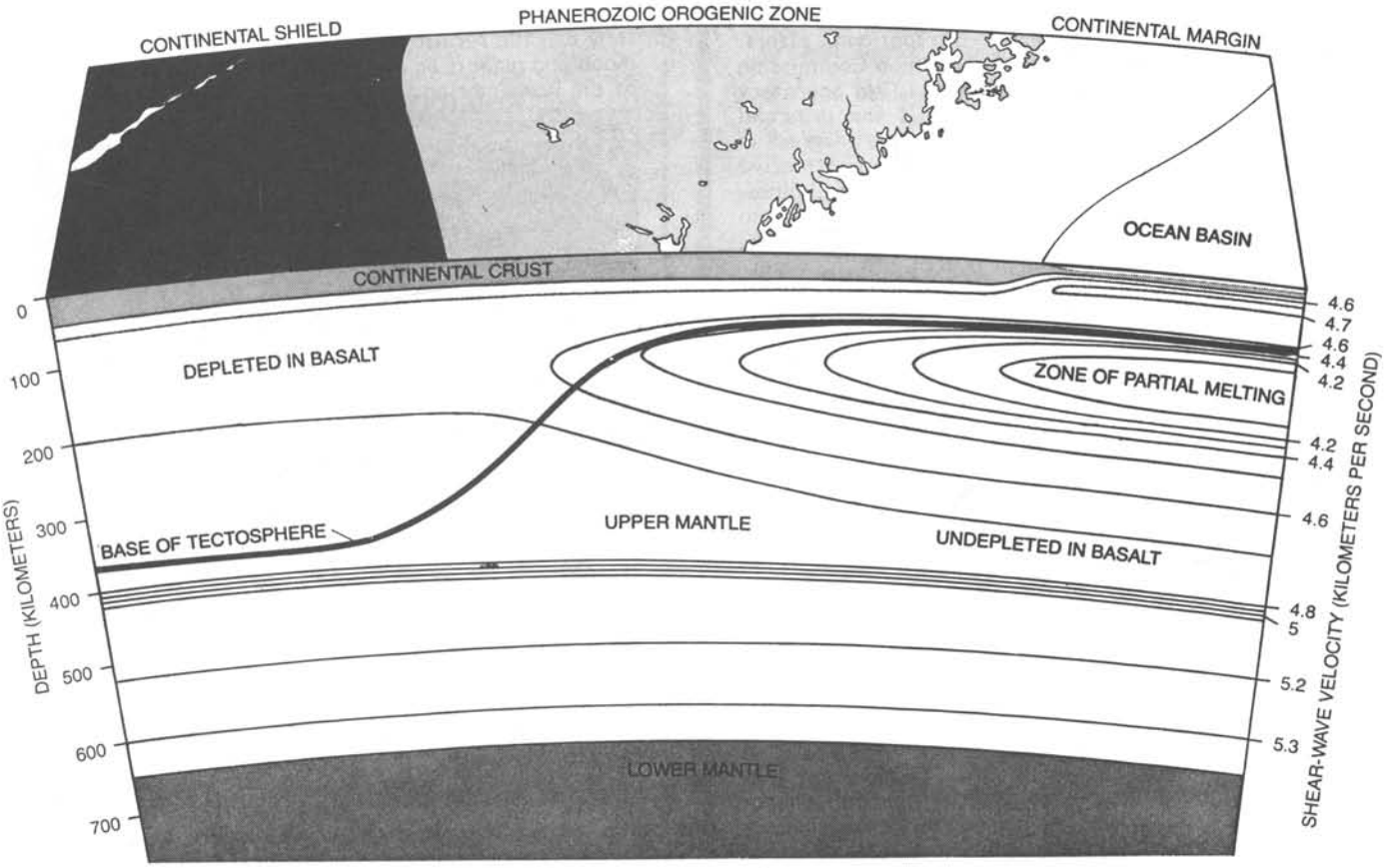
There is need to integrate careful field investigations, involving the application of new concepts and techniques in structural analysis, petrology, sedimentology and stratigraphy, with petrochemical, paleomagnetic, and geochronologic studies, and with seismic, gravity, magnetic and electromagnetic studies of the crust and upper mantle in the same areas. There is also the promise of improved genetic models of ore genesis that can guide the exploration for new mineral deposits in Precambrian terranes.

Dr. D. Ajakaiye (Nigeria) addressed the need for opportunities, such as this possible new project, wherein effective participation by scientists in less developed countries (LDCs) would be encouraged, and suggested that geotraverses could be developed that would involve the cooperative participation of earth scientists from several countries. Turning to the impact of fundamental research in the earth sciences in LDCs, Dr. Ajakaiye outlined the economic, social and logistical difficulties that impede the expansion of research in developing countries, if it is not focussed on a specific practical result. She also used the example of how the initial curiosity-motivated discoveries in the field of electricity and magnetism led to the technology upon which resistivity surveys for groundwater resources in developing countries are now based, to demonstrate that basic and applied research are inherently inseparable. The surprising new results from seismology and seismic refraction and reflection experiments outlined by **Dr. T. Jordan** (U.S.A.) and **Prof. S. Muller** (Switzerland) indicate that it will be possible to achieve a close integration between studies of the evolution of the crust and upper mantle based on the investigation of surface exposures, and the fine structure of the crust and upper mantle and the contrasts in the upper mantle beneath different kinds of crust outlined by geophysical investigations.

The fruitful cross fertilizations associated with recent advances in the study of mid-ocean ridges, involving seismic refraction and reflection and magnetic surveys, direct observations and sampling from submersibles and deep drilling, petrographic and petrochemical investigations, heat flow measurements and hydrodynamic modelling of the geothermal system, and the development of better models of the genesis of sulphide ore deposits described by **Prof. G. Anderson** (Canada) of the International Association for Geochemistry and Cosmochemistry, underscored the importance of this kind of interplay among earth science disciplines. He concluded that the study of ore deposits is inherently an interdisciplinary problem requiring a joint attack by geology, geophysics and geochemistry, or, in short, "it is too important a problem to be left to economic geologists alone".



The hydrothermal circulation of sea water through young, hot oceanic lithosphere provides a ready explanation for the origin of an important group of metallic mineral deposits (Diagram from Parmentier and Spooner, Earth Planet. Sci. Lett., V. 40, 1978, Fig. 1)



The Continential tectosphere indicates that continental crust has deep geochemical and geophysical "roots" in the upper mantle and that studies of crustal evolution require interactive collaboration among geophysicists, geochemists and geologists. (From "Deep Structure of the Continents" by T.H. Jordan. Copyright © 1978 by Scientific American Inc. All rights reserved. Scientific American, January, 1979, p. 93)

A review by **Prof. C. Nishiwaki** (Japan) of detailed correlations between recent mineral deposits and the location and configuration of active subduction zones, one of which was illustrated in startling three-dimensional detail with a pair of stereographic diagrams of earthquake hypocentres under Japan, demonstrated convincingly how the results of studies of seismicity can help to develop better models of the origin of ore deposits.

The discussion by **Prof. P. Wyllie** (U.S.A.) of igneous processes in continental and oceanic environments stressed recent advances in understanding the role of volatiles, particularly water and carbon-dioxide, in the processes of magma generation that have controlled the chemical differentiation of the earth and evolution of the continental and oceanic crust. He provided a lucid demonstration of the importance of both experimental petrology and geophysical studies of the crust and mantle to the determination of where and when a critical isotherm may intersect the mantle solidus, and what kind of crust and upper mantle may form. Because igneous petrology is rooted in geophysical processes, and because it results in differentiation that is controlled by geochemical processes but influences geophysical parameters, progress in all three fields requires intimate collaboration on a global scale. His list of high priority requirements for more data included:

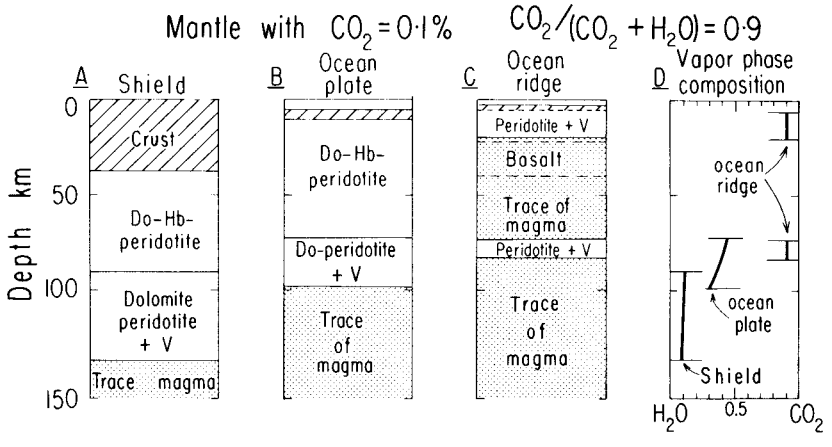
- Complete phase diagrams for all major magma types;
- The magma compositions produced from various source materials, and how are they influenced by pressure, temperature and various combinations of volatiles;
- The temperature distributions in various tectonic environments;
- The nature of the flow patterns in the mantle;
- The fluid dynamics of magmas;
- Basic information on composition, distribution, volume, and time relationships of plutonic and volcanic rock associations;
- Geochemical models of source materials and magmatic processes based on trace elements and stable isotopes;
- The circulation of volatiles (H_2O, CO_2, S and Cl) among the mantle, magmas, the hydrosphere and the atmosphere;
- Variation in oxygen fugacity as a function of depth in the crust and mantle;
- The origin of the quartz-rich tonalites that occur in early Precambrian terranes and young batholiths.

The plate tectonic concepts which assumed a dominant role in research in solid-earth science during the Geodynamics Project quite naturally formed a dominant theme at the symposium. **Prof. K. Hsü** (Switzerland), referring to the hypothesis that science leaps ahead in distinct increments associated with the emergence of a new ruling paradigm, identified the major conceptual advance in sedimentology and stratigraphy in the 1970's with a "bloodless revolution" in which the long-reigning geosynclinal model was overthrown in favour of the plate tectonics paradigm. His predictions for areas of major scientific progress in sedimentary geology in the 1980's included paleo-oceanography and paleoclimatology, which have made major gains in the wake of plate tectonics and the Deep Sea Drilling Project, and the hydrodynamics of flow of fluids in rocks, with all its many applications, ranging from sedimentary diagenesis through hydrogeology and hydrocarbon migration to geothermics and the formation of mineral deposits.

The plate tectonic model was also the dominant theme in: (1) an elegant geotectonic synthesis by **Prof. J. Aubouin** (France), linking the evolution of the Mediterranean area, the Atlantic basin, the Caribbean and the Cordillera of South and North America, (2) a comprehensive review by **Dr. L. Montadert** (France) of recent progress and current problems in analyzing the geodynamic evolution of the Mediterranean basin, (3) and in a carefully documented review by **Dr. J.C. Moore** (U.S.A), of recent results of seismic reflection, deep-drilling and on-land geological studies of the deformation in accretionary prisms above active Beneoff zones.

This general enthusiasm for simple plate tectonic models was tempered by some of the other presentations. **Sir Peter Kent** (U.K.) showed how, throughout a large area stretching from the North Sea, down eastern North America to the Gulf of Mexico, and perhaps including northern Alaska and parts of Australia and the southwest Pacific as well, a similar record of intermittent rifting, spanning an interval from Late Paleozoic to Cretaceous time, and involving modest horizontal extension, is followed by widespread simple progradation of continental margins -- a pattern that seems difficult to reconcile with currently popular simple models for the plate tectonic evolution of these continental margins.

Dr. A. Bally (U.S.A.) regaled the meeting with his humorously clever discussion "On margins and mountains, or the iconography of crustal transmutation", in which he showed how simplistic plate tectonic models can become rigid symbols and objects of worship that are confused with reality and inhibit the search for alternate explanations and real truth.



Temperature distribution, dissolved volatiles and partial melting in the mantle control geophysical properties of the lithosphere and variations in compositions of magmas (Diagram from Wyllie, Am. Mineral., V. 64, 1979, Fig. 10). Cross-sections through the mantle in three different tectonic environments are based on differences in geotherms and on phase relations discussed by Wyllie (1979) for the volatile contents shown at the top of the diagram. In Diagrams A, B and C, for each layer that contains a vapor phase, the composition or the vapor is given in diagram D.

Prof. V. Beloussov (U.S.S.R.), not constrained by this form of iconography, presented a carefully developed alternative interpretation involving thermal perturbations of deep-seated origin which induce crustal subsidence and geosynclinal sedimentation, inversion, and orogenic deformation, without any overall lateral displacement between the margins of orogenic belts.

All of these state-of-the-art reviews and appraisals set the stage for general discussions which provided an opportunity for all participants to contribute their suggestions concerning the nature and scope of the proposed new project. Virtually all of the individual research subjects suggested during these discussions were mentioned somewhere in the Kisslinger-Illies draft report. One issue that generated particular discussion concerned the ways in which the new project could and should respond to the particular problems of discovering future mineral and energy resources, in both the developed and less developed parts of the world. The broad spectrum of opinions expressed on this point were noted by those who now face the important task of preparing the draft proposal for a new program.

Raymond A. Price
Chairman, Canadian
Geodynamics Committee

EDITOR'S NOTE: Following the IUGS Symposium, three working groups formed to summarize the views expressed and to report to the IUGS Executive Committee, holding its XXth Meeting in Zurich. Their resolutions and reports, as well as the revised document "The Lithosphere: Frontier for the 1980's" (edited by C. Kisslinger and H. Illies) are now being circulated to all IUGS scientific bodies, affiliates and member countries for comment; they are available, on request, from the IUGS Secretariat. The following timetable on anticipated progress in planning a future program might be of general interest:

Feb. 1979:	IUGG is informed of IUGS Executive Committee agreement on program proposal.
Feb. 1979:	IUGS national and scientific bodies and ICG are informed also and their further input is sought by Sept. 1979.
Apr. 1979:	Agreement of IUGG Executive Committee is sought by correspondence.
July 1979:	Submission of proposal to ICSU General Committee
Fall 1979:	Input from IUGS bodies is evaluated and/or incorporated.
Dec. 1979:	Proposal submitted to IUGG Council
July 1980:	Proposal submitted to IUGS Council New program launched at IGC, Paris
Sept. 1980:	Formal presentation of final documents to ICSU

Scenes from the IUGS Symposium "Geodynamics Problems - Outlook to the 80's" which attracted interdisciplinary expertise from all over the world.

Left to right: Dr. G. Kautsky (Sweden; national delegate) and Dr. G.M. Anderson (Canada; representing IAGC).

Left to right: Dr. C. Kisslinger (U.S.A., Chairman, IUGG Task Group) and Dr. P.J. Hart (U.S.A., Geophysics Research Board, NAS).

Left to right: Dr. T. Kukkamäki (Finland; President of IAG) and Prof. V.V. Beloussov (U.S.S.R.; President, Soviet Geophysical Committee)

Left to right: Prof. R. Trümpy (Switzerland; President of IUGS), IUGS Executive Committee members Prof. P.F. Howard (Australia) and Prof. I.E. Altinli (Turkey), Dr. J.A. Comba (Spain; national delegate) and Prof. J. Aubouin (France; IUGS Executive Committee member).

Left to right: Prof. C.L. Drake (U.S.A.; Past President of ICG) and Dr.A.W. Bally (U.S.A., Shell Oil Company)

Left to right: Prof. J.G. Ramsay (Switzerland; Federal Institute of Technology) and Prof. J. Sutton (U.K., ICG Board member).

Singapore Symposium Analyzes Science and Technology for Development

At a symposium organized in Singapore January 21-26, representatives of some 19 Non-Governmental Organizations were given an opportunity to influence the proceedings of the forthcoming United Nations Conference on Science and Technology for Development (UNCSTD), to be held in Vienna in August, 1979. Specifically, they addressed the following objectives:

- to explore ways of enhancing the contributions of Science and Technology (S&T) to a higher and sustainable level of world development;
- to explore the various mechanisms which would facilitate a continuing interaction between the world scientific and technological communities;
- to examine the existing methods of national funding by independent organizations in developed countries, and
- to plan how to accomplish these objectives through the concept of partnership and cooperation rather than the former concepts of "donor-recipient" and "assistance".

Topics for discussion were wide-ranging and included

(1) Development of indigenous S & T competence,

(2) Sectoral demonstration of S & T contributions to development: food, population and employment,

(3) The role of scientists and technologists in the development process, and

(4) Social, political, economic, cultural and other contexts of development and the linkages among these elements.

The principal areas of concern that were identified in the debates pertained largely to the educational problems of lesser developed countries (LDCs). In particular, the "brain drain" which generally followed specialized training and the subsequent lack of facilities and remuneration for citizens on return to their home country, was identified as a critical problem. It was felt that this could be overcome by training scientists and technologists from LDCs in, say, South America, Africa and Asia, rather than in universities and institutions in North America and Europe.

It was noted also that there was a serious lack of S & T communication, or access to S & T data and new development for the LDCs which had to be overcome. The problem was not only a question of S & T availability, but also the will and determination of the S & T communities, political authorities and politicians themselves to make the system work more satisfactorily.

The Symposium produced a general declaration directed toward the scientific and technological communities of the world to conscientiously work towards a cooperative solution to the problems, and to get involved in "selling" S & T for development to politicians and those in a position of influence. Specific recommendations to UNCSTD were as follows:

I For the immediate future,

(i) A large number of technical colleges should be opened in the LDCs (over the next five years) to train technicians, craftsmen and other skilled workers required to support programs for the provision of shelter, food, transportation, and medical care. A few of these colleges should also train "trainers" so that the program could become self-sustaining.

(ii) Equipment and construction sets should be provided in large numbers to schools to help generate the basic technical skills.

(iii) Every year, thousands of university and technical college teachers from the developed countries should spend about a year working on projects in one of the LDCs.

(iv) A large number of technicians from the LDCs should each year participate in actual production work in the developed countries, including apprenticeships with multi-national corporations.

(v) Special attention must be paid to the education and training of women under each of the above categories.

(vi) There must be vigorous international campaigning among the international S & T and social science community to make it aware of the magnitude of the problem.

II Each of the LDCs should be urged to develop and strengthen its own scientific and technological capability in order to enable it to improve on its indigenous technology, make a rational choice of foreign technology, effectively absorb imported technology and create new technology to suit its circumstances. In tackling world-wide problems, such as depletion of energy resources, desertification and other environmental consequences of human activity, international collaboration must be encouraged. In some areas, such as tropical diseases, active regional centres in the tropics should be stimulated, as such problems are unlikely to receive adequate attention elsewhere. International centres for advanced research should be set up in the LDCs and strengthened to reduce the "brain drain".

Each of the LDCs should establish institutional structures for S & T for development, delineating the domain of activities within the total S & T system. The system should coordinate S & T policies and activities, devise appropriate policy instruments to help realize S & T policy objectives, create and manage demand for S & T, mobilize the S & T community for critical and global problems for which concerted international action is necessary, and incorporate a strategy for attaining basic human needs.

III There should be a network of national or regional agencies in the LDCs which should be encouraged to exchange ideas and experiences and possibly evolve principles of wide applicability in the use of S & T for development.

IV Member nations in the developed world should be urged to emulate the excellent examples of countries such as Canada, Norway, Sweden, Netherlands, which have set up distinct, and in some cases autonomous, funding organizations outside their aid agencies (IDRC, IFS, SAREC and NUFFIC) for the specific purpose of supporting S & T in the LDCs. There should be a coordinated network of such donor organizations to exchange ideas and experiences in such a way as to preserve their individual strengths and promote their common interest.

V Non-Governmental Organizations should make positive efforts to include scientists and technologists from the LDCs among their membership and to give them sufficient professional support in building up the capabilities of their countries. They should also mobilize their members in the developed countries to tackle some of the problems of the LDCs.

VI The specialized agencies of the UN should follow the lead of UNESCO in facilitating effective partnership between NGOs and these agencies, and the work of the United Nations University should receive adequate support from all countries.

These recommendations were provisional, pending possible revisions by the Steering Committee following comments from delegates.

One noticeable gap in the discussions was the lack of mention of non-renewable resoures and their importance in terms of the rapid attainment of a favourable balance of payments and cash flow in helping LDCs to help themselves in the critical areas of basic human needs. The important topic of energy and mineral resources in general as a key foundation to development in LDCs should not be overlooked in Vienna. It is also the area where IUGS could offer considerable support, particularly in enumerating the geological aspects of man's environment and their optimum exploitation/conservation, or in the compiling of earth science parameters in map form which could guide planned development.

Peter F. Howard
Vice President, IUGS

Focus on Small Scale Mining

Small scale mining is as important to developing countries as it is to industrialized ones - this was the general conclusion arrived at by representatives of some 70 countries attending the First International Conference on Small Scale Mining held in Jurico, Queretaro, Mexico from November 26 to December 5, 1978. Most of the 62 papers presented stressed the need to enhance small scale mining operations because they

- diversify mining production
- require low level capital investment and high level employment
- can create a cash-flow almost immediately
- promote much infrastructure in a wide geographical expanse.

Another common denominator in the papers was the fact that the small scale operator is not a subject-of-credit, and banks do not readily accept the concession, or blocked-out ore, as collatoral to finance these operations. It was generally felt that government and international fund financing is required to stimulate small scale mining operations.

Of special interest were the papers presented by Latin American countries such as Mexico, Peru, Argentina and others, regarding the legal structure of the codes of law and regulations specially designed to rule and regulate small scale mining operations. Included here were observations on the fiscal law practices both in Mexico and Peru, where thousands of small scale mining operations thrive and are being enhanced by modern legal and fiscal legislation. In Mexico, 20% of the total mining production comes from small scale operations.

A number of technical papers concentrated on the technology, previously used only for large scale mining, that was now being revamped to be applied to small scale mining operations. Leaching of waste dumps and/or production at small scale operations, especially where low grade ore was being produced, was shown to be economical and simple to apply. Leaching can be applied to rich ore as well and sometimes with advantages.

In general, the Conference called upon governments and international organizations to support the promotion, improvement, and expansion of small scale mining, particularly in developing countries where it is of utmost importance. Such support, it was concluded, could lead to increased utilization of mineral resources, provide increased and meaningful employment, and contribute to economic development.

The Conference furthermore recommended to interested Governments the following proposals to assure maximum use of small deposits:

1. Design funding mechanisms specifically to assist in the exploration for new mineral deposits and the development of small mines.
2. Provide technical assistance to small mining as follows:
   a) Make available geotechnical information and provide related assistance;
   b) Provide laboratory and metallurgical analyses and assay services;
   c) Provide equipment pools or other means for making the most suitable equipment available;
   d) Support custom concentration plants and/or portable mills.
3. Arrange for additional financial support:
   a) Establish special development funds for small scale mining;
   b) Have tax incentives to encourage development of small deposits;
   c) Assist in marketing.
4. Provide necessary infrastructure where justified so that the small scale mining industry receives the benefits of access roads, water and power supply, and medical services.
5. Provide special training facilities for the small scale miner.
6. Promote safe working conditions.
7. Educate small scale miners on preservation of the environment.

In addition, the Conference called upon the United Nations system to support small scale mining. Organized by the United Nations through UNITAR, in collaboration with the Mexican Consejo de Recursos Minerales, the U.S. Geological Survey and several co-sponsoring organizations, the Conference was deemed successsful enough to merit becoming a permanent bi-annual affair.

Guillermo P. Salas
Vice President, IUGS

Regional Influences on Geological Theories

INHIGEO Symposium
Münster, F.R.G.
September 12-24, 1978

The history of geology gives rise not only to a re-evaluation of ancient theories but also to a critical evaluation of contemporary geology. In comparing the personal observations and interpretations of present-day field geologists with those of our predecessors once confronted with the same phenomena, one also develops a deeper insight into the processes of theory-building.

All this was convincingly demonstrated at a Symposium last fall held under the auspices of the IUGS Committee on the History of Geological Sciences (INHIGEO) and organized with the help of the Geological Institute, University of Münster. Participants from 17 countries listened to a variety of short papers addressing the general theme of "Regional influences on the origin and development of geological theories". F.E. Ellenberger pointed out that in 18th century France, for example, geologists working in the Paris Basin, arrived at geodynamical theories (on fluviatile erosion in particular) that differed considerably from those of the geologists of Southern France. A.M. Ospovat argued that the current opinion on Werner's neptunism being wholly determined by the geological environment in which he worked, should be revised.

Several speakers noted how a certain landscape and its geological interpretation became the model for similar phenomena in other regions; for example, Tübingen is the type-locality of the scarped landscape (H. Hölder), whereas the Russian platform became the "prototype of analagous tectonic units of all the continents" (V.V. Tikhomirov). E.E. Milanovsky, on the other hand, cautioned against making certain regional formations into universal models, for history has shown that this may lead to an oversimplification in geological classification.

Guided by Professors Langer and Hölder, participants also took part in some excellent excursions to nearby regions and also in visits to several palaeontological museums. INHIGEO business meetings reviewed the plans for participation in the "History of Geology" Section of the 26th International Geological Congress in 1980, and those for future INHIGEO symposia: on "basalt" in 1981 (probably in Dublin), on geological cartography (in Hungary) and on the history of mineralogy in 1984 in the U.S.S.R.

R. Hooykaas
Chairman, INHIGEO

Indo-Austrian Expedition into the Himalayas

Under IGCP Project No. 4 (Triassic of the Tethys Realm), an Indo-Austrian expedition into the Spiti area of the Himalayas was organized from July through September 1978 aimed at investigating the important Triassic sections biostratigraphically and mapping the geology of the area. After the field work was concluded, a field-meeting was held in Guling (altitude 3640m) in the Pin River Valley, Spiti district. A.P. Tewari, a Director of the Geological Survey of India, presided over the meeting, the agenda of which included:

- reports on the general development of the Project, the activities of the Indian National Working Group, and the future plans for activities in the Indian Triassic;
- a report on the investigations in Spiti carried out by the Indo-Austrian expedition;
- comparison of these results with the investigations in the Triassic of Kashmir.

With regard to the studies of the Triassic sequence of Spiti, the problem was tackled in two ways: through regional mapping of the area, and through detailed stratigraphical study of selected Triassic sections. All of the important stratigraphic sections investigated occur in the Pin Valley; the rock sequence, therefore, in both the Pin Valley and its side valleys (Kukoli Gad and Parahio), were mapped. Mostly Triassic and older rocks are exposed south of the Spiti Valley. Throughout the area the strike of the rocks is NW-SE, and the structural style resembles the Dolpo region in northern Nepal.

Detailed measurement of all the Triassic formations was carried out, the total thickness of the Triassic rocks being 1200 m. The sections studied are located in the middle (Kuling and Sagnam) and in the upper course (Muth and Tilling) of the Pin Valley, about 30 km south of the Spiti Valley. Around Muth several continuous sections, ranging from Lower Triassic to the Kioto Limestone (Triassic-Jurassic transition) were studied, and extensive fossil collections were made from the Lower Triassic and Muschelkalk. The classical localities near Kagha, Parahio Valley were visited but not studied in detail because of their faunistic and lithological similarities to the Muth section.

In the Lower Pin Valley north of Kuling, two other sections through the Lower and Middle Triassic (which resemble the Muth section) were measured, and a very interesting ammonoid fauna of the lowermost Keyserlingites beds, with certain Anisian affinities, was collected.

Another important result was the discovery of an ammonoid-rich transition zone from Upper Anisian to Lower Ladinian within one of the sections near Kuling. In the Daonella (Halobia) Limestone, situated NE of Kuling, near the village of Shilling, the diagnostic Lower Carnian ammonite Trachyceras aonoides was found.

Starting from the Grey Beds, the Upper Triassic formations proved to be of shallow water origin and poor in diagnostic fossils (ammonoids, for example). A short survey of the Kuling Shales (Upper Permian) lead to the discovery of two finds favouring the presence of a hiatus between Permian and Triassic in the Spiti area: a) Cyclolobus ranges almost up to the top of the Kuling Shale, and b) the uppermost 10 cm of the Kuling Shale consist of a brown to yellowish marl bed, rich in oxidized pyrite and re-worked pebbles of Kuling Shale.

To summarize then, the scientific work carried out by the Indo-Austrian Expedition showed that: the Spiti area is likely to become very important for Lower and Middle Triassic subdivisions of the Tethys Realm (Mid-Scythian, boundary between Scythian and Anisian, and between Anisian and Ladinian). On the other hand, the Upper Triassic of Spiti is poor in fossils and is not very valuable for time-stratigraphic purposes. For the Upper Triassic subdivisions of the Himalayas, future work should be limited to the Byans area of Kumaun.

The expedition was extremely well organized by the Geological Survey of India. The Indian participants included three geologists from the Survey - D.K. Bhatt, K.C. Prashra and R.K. Arora. Austrian members of the expedition were: G. Fuchs (Geological Survey of Austria, Vienna), L. Krystyn and R. Golebiowski (Palaeontological Institute, University of Vienna). During September, the following people joined the field-party: A.P. Tewari (Director of the G.S.I., Chandigarh), H.M. Kapoor, (Senior Geologist of the G.S.I., Lucknow, and Convenor of the Indian Working Group of IGCP Project No. 4) and H. Zapfe, (Palaeontological Institute, University of Vienna).

H. Zapfe
Project Leader
IGCP Project No.4

IGCP Project No. 4 ("Triassic of the Tethys Region") holds a field meeting in the Spiti region of the Himalayas (altitude 3640m) in September, 1978. Left to right: R.K. Arora, G. Fuchs, D.K. Bhatt, H. Zapfe, A.P. Tewari, H.M. Kapoor, and K.C. Prashra.

Second Workshop Appraises SEATAR Progress

The second SEATAR (Study of East Asia Tectonics and Resources) Workshop convened in Bandung, Indonesia from 17-21 October, 1978 to review the progress made by the SEATAR program and to propose short-term and long-term studies that would respectively bring to a conclusion the International Decade of Ocean Exploration (IDOE) and outline research for a subsequent period. The SEATAR program, in spite of a complicated genealogy (see EPISODES, Vol. 1978, No. 3, pp. 9-11), has been enthusiastically and generously supported by the member and participating countries of CCOP (Committee for Coordination of Joint Prospecting for Mineral Resources in Asian Offshore Areas). It has provided a framework for stepped-up bilateral assistance in both regional (geological, geochemical, geophysical) surveys and in laboratory methods (palaeomagnetics, isotope analyses, geochronology, Landsat interpretation). It provoked an era of intense oceanographic survey work, including magnetic, gravity and seismic surveys and deep-sea drilling.

The interdisciplinary work under SEATAR has focussed on six transects, covering critical strips of land and sea. A review of each transect was prepared by two consultants to CCOP (Drs. A.J. Barker and D. Jongsman) and presented at the Workshop. Participants were further provided with copies of pertinent recent publications.

The marine surveys were illustrated by a series of six maps constituting a Geophysical Atlas of East and South Eastern Asian Seas, 1:6 000 000, published in 1978 by the Geological Society of America as M.C.25. These maps complement "Bathymetry of the East Asian Seas", to the same scale, edited by J. Mammericx et al. at Scripps Institution of Oceanography, U.S.A. and published by the Geological Society of America in 1976 (M.C.17). The Atlas sheets (Mercator projection, 90^{o}-150^{o}E; 45^{o}N-15^{o}S) illustrate heat flow, thermal conductivity, thermal gradient, free-air gravity field, magnetic anomalies, crustal structure, sediment isopachs and tectonics. The review and the maps are a major contribution to our knowledge of the area and of the problems that need to be solved.

Looking to the future, the Workshop proposed that radio-isotope, geochronological and palaeomagnetic studies be intensified. Upgrading of the network of seismic stations in eastern Indonesia to cover satisfactorily events in the Banda Arc was stressed. Study of ophiolites, and of the calc-alkaline intrusives and extrusives, locally mineralized and locally sterile, were proposed. The Workshop found that insufficient attention had been paid to some facets of the investigations: for instance, the relations between tectonics and mineralization, and deposition of organic matter and its maturation.

To an outsider attending the SEATAR Workshop and CCOP meetings for the first time, the lack of information on parallel international research projects, and the potential advantages of integrating proposed SEATAR research into these projects, appeared as an unfortunate lack of communication. This integration may be all the more essential when plans for the period following the decade of ocean exploration are crystallized.

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