IMA Elects New Council

1986 was a year of much activity for the International Mineralogical Association (IMA), culminating in the 14th General Meeting held in July at Stanford, California, and attended by nearly 600 registrants.

A new Working Group on Organic Minerals was created with L. Saskevitch (U.S.S.R.) as Chairman. The IMA Commission on Applied Mineralogy was brought into full operation with the election of A.J. Naldrett (Canada) as Chairman. In 1986, the Commission on Ore Microscopy substituted Mineralogy for the last word in its title, and it also published a Quantitative Data File on Ore Minerals, through the British Museum of Natural History in London.

During the Stanford Meeting elections for a new council were held with the following results:

President:	P. Wyllie (U.S.A.)
First Vice President:	Huang Yun Hui (China)
Second Vice President:	W.S. McKenzie (U.K.)
Secretary:	S.S. Hafner (F.R.G.)
Treasurer:	P. Zwaan (The Netherlands)
Members:	D.G.W. Smith (Canada)
M. Lagache (France)	O. Pedersen (Denmark)
N. Sobolev (U.S.S.R.)	I. Sunagawa (Japan)

The 15th General Meeting of IMA will be held in Beijing in July 1990, and the IMA will sponsor a variety of symposia and a short course on diamonds during the 1989 International Geological Congress in Washington, U.S.A. □

D.G.W. Smith, Edmonton, Canada

IUGS and COSPAR — A Valedictory Message

COSPAR is the Committee on Space Research, one of the most active members of ICSU, the International Council of Scientific Unions. IUGS was represented on COSPAR from 1973 to 1986 by W.D. Carter, a leader in encouraging the application of remote sensing to the geological sciences and now succeeded in COSPAR by G.L. Raines (U.S.A.). The following is taken from Dr. Carter's review of his 13 years with the ICSU committee. (Ed.)

COSPAR is a fine, international collection of dedicated space scientists with whom it has been an honour and a pleasure to be associated. If there is ever to be peace on our Earth or for that matter, in our Galaxy, it will be through the friendly interchange and understandings that have been typical of COSPAR where scientists representing all political persuasions meet but where politics are rarely discussed.

In 1973, I presented the first scientific paper on the uses in geology and geophysics of the ERTS-1 system (now Landsat), at the COSPAR meeting in Constance, F.R.G. At this time I began my activities as first IUGS Representative to COSPAR. I met many young earth scientists from many lands with whom in 1975 I organized, with Larry Rowan IGCP Project 143 "Remote Sensing and Mineral Exploration." By its end, in 1982, over 300 scientists from 80 different countries had participated in one way or another in the project, and we had assembled a bibliography of over 2,000 titles dealing with remote sensing, mineral exploration and related subjects.

Most of our activities were interwoven with and furthered by participation in COSPAR. For example, through COSPAR in 1979 we held a workshop in Bangalore, India, on remote sensing and mineral exploration. There were more than 100 participants and the proceedings were published the following year in *Advances in Space Research*, the COSPAR series now published by Pergamon. Under IGCP we held another workshop that year in La Paz, Bolivia, which attracted 30 geologists from 10 Latin American nations. The following year, an IGCP workshop was held in

Nairobi, Kenya, for about 25 African scientists, and in 1982 a COSPAR workshop in Budapest, Hungary brought together some 70 geoscientists.

In March 1982 I was invited by the United Nations to lecture to some 50 participants on the use of computers in the processing and analysis of Landsat imagery at the Center for Geological Remote Sensing in Beijing. This was followed that June in Ottawa, Canada, by a COSPAR workshop on remote sensing and mineral exploration, which marked the conclusion of IGCP Project 143.

As IUGS/COSPAR representative, I was later invited to serve on the program committee for Remote Sensing Sessions of the International Geological Congress held in Moscow in 1984. During the last two COSPAR meetings (Graz, Austria 1984 and Toulouse, France - 1986) I was asked to organize workshops aimed at remote sensing applications in developing countries. These were only partly successful, because the high travel costs and limited Unesco funding reduced drastically the number of representatives from developing nations. Mexico and Kenya did join the list

Figure 1: At a 1982 COSPAR meeting: L-R: W.D. Carter, A. Parker (U.S.A.), B. Koscec (Yugoslavia) and F. Ahmed (Sudan).

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of COSPAR participating nations during my tenure as IUGS Representative, but there are still many nations of Africa, South and Central America, and Asia that could benefit by active participation in COSPAR activities.

During these 13 years five Landsats were launched, and SPOT Image is now a reality. This French-Swedish-Belgian system went into orbit in early 1986 and is now producing outstanding images with a resolution of 20 m in multi-spectral and 10 m in panchromatic formats. A large number of geologists throughout the world have begun to use satellite imagery, and several new, significant ore deposits have been discovered as a result. Man has landed on and sampled the surface of the Moon. Unmanned satellites have observed, measured and sampled the distant planets of Mars and Venus and its moons. Soyuz cosmonauts have established new endurance records for continuous spaceflight encouraging the development of permanent space habitats to be developed in the next decade.

From atmosphere-free space stations, continuous observations of the stars, planets and Earth can now be made. We can watch the world turning in its cloudy atmosphere and

observe subtle changes of sun on vegetation, storm development and, perhaps, find new ways to improve weather prediction. The greatest improvement in our powers of observation may come in the field of oceanography, as we observe and map the most dynamic surface of the Earth.

International cooperation in space may be the only way to afford the high costs of space travel. Multinational manned trips to Mars and other planets, planetary habitats and other developments not dreamed of before are now more than a remote possibility. As earth scientists we should prepare ourselves to influence and design new scientific experiments and make the most of new observational capabilities as they become available. Historically, COSPAR has been led and dominated by astronomers and meteorologists with earth and planetary scientists in secondary roles. Perhaps it is time to rethink our objectives and seek a greater leadership role in COSPAR. □

A Visit to the Soviet Arctic

In 1984, Canada and the U.S.S.R. entered into an Arctic Science Exchange agreement, an important theme of which is the comparison of the geological evolution of the Arctic regions of both countries. One of the major products of this cooperative program will be a set of Quaternary and pre-Quaternary geological maps as well as tectonic maps and cross-sections, all of which will use the same sets of basic geological concepts, standards and terms. Another output will be a paper comparing and contrasting key geological provinces around the Amerasian Basin.

One of the more popular theories concerning the opening of the Canada Basin is that Alaska together with the Chukchi Sea-East Siberian Sea continental shelf (CS-ESS-CS) and adjacent Chukotka Peninsula rotated away from the Canadian Arctic islands around a pivot point in the northern Yukon, sometime during the middle Mesozoic. One objective of the exchange is to test this and other hypotheses concerning the formation of the Canada Basin.

In 1985, two Soviet geologists, B.G. Lopatin and M.K. Kos'ko, visited Melville Island in the Canadian Arctic with geologists from the Geological Survey of Canada to review its stratigraphy and structure. In return, the authors, both GSC geologists spent two weeks in mid-1986 with a Soviet geological team on Wrangel Island, located in the middle of the Chukchi Sea continental shelf, 140 km off northeastern U.S.S.R.

Wrangel Island, nearby Herald Island, and the New Siberian Islands, 1000 km to the west, are the only surface exposures of lower Paleozoic strata on the entire CS-ESS-CS. This shelf area is about 700 km wide, and Wrangel Island is located close to its geographic center. Wrangel itself is 70 by 140 km and features from coast to coast an east-west range of low-relief mountains 30 to 40 km wide. North and south of these mountains are broad coastal plains underlain by Quaternary deposits.

At least three northwards directed, east-west trending thrust sheets can be recognized. The lowest and northernmost sheet lies on Carboniferous rocks and comprises dominantly Precambrian(?) strata unconformably overlain along

the southern margin by a thin succession of Carboniferous limestone. The latter is overthrust in turn by Precambrian(?) sedimentary, volcanic and minor intrusive rocks at the base of the second thrust sheet, which contains the most complete stratigraphic succession observed on Wrangel. These Precambrian(?) rocks are overlain unconformably by 200-300 m of Cambrian(?) elastics, and in succession by a similar thickness of Devonian-Mississippian elastics, gypsum and limestone, 800-1000 m of crinoidal Carboniferous limestone and shale, 100-200 m of Carboniferous to Permian argillite and at the top 100-200 m of Permian to Triassic black shale. The latter are overlain structurally by Devonian(?) dolostone, sandstone and argillite of the third and southernmost thrust sheet. This third sheet carries rocks as young as Late Triassic, the youngest pre-Quaternary strata known on the island.

Figure 1: Looking east from central Wrangel Island along the second thrust sheet.

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An interesting feature of the island is that, despite the structural elevation by post-Triassic thrusting of the Precambrian(?) core, stratigraphic data indicate that these rocks had high relief during deposition of most Paleozoic strata. Moreover, Paleozoic erosional unconformities converge toward Precambrian(?) exposures, and there are notable facies changes in most successions away from them. The omission of a Permian section in this thrust sheet, we believe, is due to pre-Late Triassic erosion, though it could also be structural.

With few exceptions all strata dip moderately to steeply south. All folds, including those in the Triassic, verge northwards. The youngest structures (post-Late Triassic) observed are a closely spaced (kilometre scale) set of northwest-trending, steep, right-lateral faults each of which offsets all stratigraphic units a hundred metres or more.

The Precambrian(?) core of the island is metamorphosed to greenschist and locally to amphibolite facies. Whether there is an abrupt change in grade at the Precambrian(?) - Cambrian(?) contact or a continuous decrease in grade across this boundary and up through the section has yet to be determined.

Readers familiar with Arctic geology will immediately recognize the comparisons between Wrangel Island and Alaska (e.g. the Doonerak "High" of the Brooks Range), but they will see minimal comparisons with any part of the Canadian Arctic. However, Wrangel Island lies inshore of the geographic center of a huge continental shelf, and even if this shelf is restored to a position alongside the Canada Arctic islands, it is not surprising that the two regions are not comparable in geology. What we are actually looking for, on either side of the Canada Basin, are different parts of a single late Paleozoic or older orogenic belt; parts that have some key elements of their history in common and that when considered as a single entity, will compliment each other. However, there are many problems to be addressed before significant comparisons can be made. For instance, the ages of the Precambrian(?) complex and other stratigraphic successions on Wrangel are not clearly established.

Figure 2: Soviet and Canadian geologists on Wrangel Island. Looking north, with Carboniferous strata in the middle ground and Precambrian rocks in the background.

Existing radiometric data from this core complex give early Paleozoic and Mesozoic ages, whereas microfauna identifications suggest they are Precambrian.

This exchange is really just the beginning of a long and difficult process involving not only additional visits to other parts of the CS-ESS-CS and the Canadian Arctic but also additional field work on both sides to resolve problems with the data already gathered. The exposed geology will also have to be extrapolated into the subsurface of both the CS-ESS-CS and continental shelf of the Canadian Arctic using geophysical data. □

M.P. Cecile and J.C. Harrison,
Calgary, Canada

(Geological Survey of Canada Contribution 37586)

Super-Mobility of the Indian Sub-Continent

It is generally accepted now that Gondwanaland, consisting of Antarctica, Africa, Australia, India and South America, broke apart nearly 150 million years ago due to thermal convection currents. Subsequently, the Indian subcontinent drifted from the Central Indian Ocean ridge near Antarctica to the Tethys trench in the north for nearly 9000 km and experienced an anti-clockwise rotation of 60° before colliding with Eurasia nearly 40 Ma ago.

Calculating the rate of drift from marine magnetic anomalies, it appears that India "crawled" relative to Antarctica at less than 3 to 5 cm/year for the first phase of its 70 Ma journey, speeding up to 15-20 cm/year around 80 Ma ago and continuing this pace until it collided with the Eurasian plate. On average, the subcontinent has shown a mobility much higher than any other continent. The contrast is especially marked with the African plate, which remained more or less fixed during the same period.

The great mobility, both translational and rotational, of the Indian subcontinent has long been a major puzzle for theorists of plate tectonics. A new study by J.G. Negi, O.P. Pandey and P.K. Agrawal (National Geophysical Research

Institute, Hyderabad, India) has recently been published in *Tectonophysics* (vol. 131, p. 147-156, November 1986) on the "super-mobility of hot Indian lithosphere," based on analysis of global heat-flow data and estimated temperature-depth profiles. They show that the Indian lithosphere does not have the characteristics of a typical shield today. Thus, the thickness of a mobile African shield (such as beneath Niger) is approximately 400 km, whereas the Precambrian of Antarctica, South America, Greenland, Ukraine and Canada show an approximate lithospheric thickness of 300 km. In contrast, more mobile continents like Australia and India have reduced lithospheric thicknesses of the order of 200 and 110 km respectively.

The detailed analysis of temperature-depth profiles reveal that the Indian shield has a mean thickness of 60 km in Central India, 90 km in the Aravallis, and 130 km in southern Peninsular India. It is estimated that at the time of break up of Gondwanaland, the average lithospheric thickness was around 300 km. The Indian lithosphere has thus lost nearly 150-200 km during its long journey, amounting to an erosion of its base at an average rate of about 1mm/year during last 100 Ma.

The regional negative gravity anomalies of India also reflect mass deficiency. The authors' estimates of high sub-crustal temperatures (350–860°C at the Moho, 40 km deep), low viscosity (10^{19} poises) and reduced thickness of the lithosphere here clearly explain the super-mobility of the Indian plate compared to the slow and thick African plate. The rapid movement of India must have produced substantial amounts of additional heat due to friction at the base of the lithosphere and a corresponding melt-down of its foundations. The Deccan volcanism around 65 Ma also corresponds to the time when India exhibited its highest drift rates of 18 cm/year. In contrast, the African shield must have thickened because of secular cooling and radio-active decay.

Knowledge about the rate of thinning of the lithospheric base and prevailing hotter upper-mantle conditions below India will provide important constraints for dynamic modelling of evolution of the Indian lithosphere. There are implications also for the geochemical interpretation of the lithosphere–asthenosphere boundary beneath India and for the understanding of the folding and crustal shortening of the lithosphere beneath the Himalayas and Central India. □

J.G.Negi
Hyderabad, India

New Proposal to Deal with Volcanic Hazards

For more than ten years now volcanologists have been seeking ways to improve training opportunities for colleagues in developing countries so as to improve their ability to avert volcanic disasters and to minimize the resultant economic and social disruptions. Some of these efforts have paid off. Geologists in Indonesia and the Philippines dealt well with serious threats from Merapi and Mayon volcanoes in 1984. However, disasters in Mexico, Colombia and elsewhere remind us that we are still poorly prepared to deal with most volcanic crises.

A report on this topic was presented recently to IUGS by the Working Group for the Mitigation of Volcanic Disasters of IAVCEI (the International Association for Volcanology and Chemistry of the Earth's Interior) and the Ad Hoc Working Group for the Mitigation of Volcanic Hazards set up by the Circum-Pacific Council on Energy and Mineral Resources (CPCEMR; see Souther et al., in *Episodes* December 1984, p. 10–18). These groups acknowledge that Unesco and UNDRO, the United Nations Disaster Relief Organization, together with various bilateral assistance programs, have provided a modest level of support for training and field work, but they have barely scratched the surface in most areas.

The report to IUGS states that the only realistic and appropriate way to gather the needed baseline data on high-risk volcanoes is to help national scientists to study their own volcanoes. Assistance should start with training and relatively inexpensive field studies and monitoring, and expand as funding permits. Simultaneously, these national scientists must begin educating civil authorities and the public about volcanic hazards and mitigation measures. Responses to volcanic crises can be much better if there exist adequate base-line data, a group of well-trained volcanologists, and volcano-educated public officials.

The IAVCEI and CPCEMR groups now propose the creation of a Circum-Pacific Volcanological Institute, to be set up within existing university

departments and to be the focal point for thesis projects to gather the required base-line data on high risk volcanoes. This is a combination of training and research, at both topical and geographic frontiers of volcanology. Specialised studies might be taken from the following list prepared for another purpose by IAVCEI:

- Preliminary identification of the world's high-risk volcanoes using available geologic, demographic, and social economic data and criteria.
- Acquisition of additional data for volcanoes in densely populated regions for which existing information is insufficient or too poor to make adequate assessments of their eruption potential and hazards.
- Preparation or refinement of hazard zonation maps for the high-risk volcano.
- Establishment of even crude monitoring networks on presently quiet but potentially dangerous volcanoes in order to begin the acquisition of base-line measurements that will demonstrate the normal variation in their seismic, geodetic and volcanic behaviour.
- Development of simple, rugged, reliable and easy-to-maintain volcano monitoring instruments.
- Development of new and improved experimental monitoring techniques (gas emission, geomagnetic, geoelectric, etc).
- Increased understanding of the causes, mechanism, distribution in space and time, and possible precursors of caldera-forming events.
- Investigations of the origins, processes, and effects of primary and secondary volcanic hazards. The former include pyroclastic flows and surges, tephra falls, lateral blasts, lava flows, and poisonous gases. The latter results from hot volcanic ejecta interacting with water, snow and ice to form, e.g. debris avalanches, lahars, mud-flows, stream-channel modification, and reduced channel flow.

Figure 1: Event stratigraphy at Armero, Colombia. Hammer points to a lahar deposit dating from around 1200 AD and overlain by a succession of lahars at 1595 AD, 1845 AD and at the top the 1985 flow, each separated by paleosols. Photo by C. Pride.

Figure 2: Armero lies buried beneath the November 1985 lahar from Ruiz volcano. Crosses commemorate some of the 25,000 people killed. Photo by C. Pride.

The report states that perhaps the single most cost-effective measure would be the preparation of video source tapes on volcanic hazards. The people of Armero in Colombia did not really understand lahars, and might well have responded differently had they seen a dramatic video of lahars before that eruption. □

- after report by C. Newhall
USGS, Vancouver, Washington

Recent Proposals for Subdivision of the Precambrian

The IUGS Subcommittee on Precambrian Stratigraphy (SPS) has long addressed the problem of an internationally agreed subdivision of Precambrian time. In a proposal developed sequentially over several years the Subcommittee has argued for a purely chronometric subdivision of Precambrian time (Table 1). Time-unit boundaries have been selected so as to enclose or delimit principal cycles of sedimentation, orogeny and magmatism, but the boundaries are defined in years, without specific reference to any bodies of rock. The

provisional proposal, its background, and the database from which it has been derived, have been comprehensively summarised by Plumb and James ("Subdivision of Precambrian time: recommendations and suggestions by the Subcommittee on Precambrian Stratigraphy," *Precambrian Research*, v. 32, p. 65-92, 1986).

The proposal satisfies the requirements of classification and standardization of boundaries, but a suitable nomenclature remains to be developed (see Plumb and Gee, *Precambrian Research*, in press). It has been agreed to retain the Eon terms - *Archaean* and *Proterozoic*. Preferences for Era names are rather evenly split between formalizing the informal terms *Early*, *Middle*, and *Later Proterozoic*, with their attendant difficulties, and developing new terms based on the Greek language, such as *Proteran*, *Deuteran*, and *Triteran* (meaning, loosely, "First Era", "Second Era", and "Third Era"). There is as yet no favoured nomenclature for the Periods.

Further development of a proposal for subdivision and nomenclature of the Precambrian, to the stage that it may be formally submitted to IUGS, is dependent on response to these provisional proposals from the geological community at large. Widespread expressions of both support or constructive criticism are essential. We draw your attention to the discussions cited above and invite your comments. □

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R.D. Gee
Secretary SPS
Geological Survey of Western Australia
Mineral House, 66 Adelaide Terrace
Perth, W.A. 6000, Australia

TABLE 1

Present Proposal for Subdivision of Precambrian Time

EON	ERA	PERIOD	Ma
	(Base of Cambrian)		570*
PROTEROZOIC	PROTEROZOIC I	(H)	700
		(G)	900
		(F)	1200
	PROTEROZOIC II	(E)	1400
		(D)	1600
		(C)	1800
		(B)	2100
	PROTEROZOIC III	(A)	2500
ARCHAEAN			

* According to Plumb and James (1986).

First Circular Released for 1989 IGC

The First Circular for the 28th International Geological Congress is being mailed in January 1987 to some 100,000 individuals and organizations around the world. This impressive document outlines the technical and non-technical activities being planned.

The extensive scientific program is being organized on the assumption that the geological sciences increasingly need interdisciplinary approaches. Fifteen broad topics have been chosen ranging from The Sedimentary Crust in Space and Time, Tectonic Processes, Comparative Planetology, to Surface and Near-surface Processes. These will attract interdisciplinary participation and will emphasize the importance of the geological sciences in addressing societal problems. From more than 350 proposals submitted for symposia topics, the Program Committee has chosen 180 titles for inclusion in the First Circular. These will include both invited and volunteered contributions, and there will also be many poster sessions.

One feature new to the Congress will be the presentation of short courses and workshops just prior to the opening session and on the free weekend during the IGC period. Thirty-four short courses ranging from Quaternary Dating Methods to Metamorphic Pressure-Temperature-Time Paths are listed, together with 19 workshops in which new research results will be shared.

There is a very rich offering of some 150 field trips. These will cover virtually every geological province of the United States and adjoining parts of Canada and Mexico, including Alaska and Hawaii. Also planned are excursions to the Caribbean and even one to the Scotia Arc in the South Atlantic.

Prior to the Congress, abstracts up to two pages long, including graphics will be issued. These will be printed at the last possible moment, using electronic techniques, so as to maintain the maximum flexibility in scheduling presentations. The Congress organizers are strongly encouraging the convenors of individual symposia to arrange for publication of their proceedings.

The Congress will be held in the Washington Convention Center in the downtown part of the city. It is being co-hosted by the United States Geological Survey and the National Academy of Sciences in cooperation with many national societies and industry organizations involved in the earth sciences. Many social activities will also be held for both professional registrants and their accompanying members.

The First Circular contains a preliminary questionnaire to be returned by May 15, 1987. If you have not received a copy of the circular by the end of February, notify the IGC Secretary General, Dr. B.B. Hanshaw, P.O. Box 1001, Herndon, VA 22070-1001, U.S.A., to whom all other enquiries should also be addressed. □

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