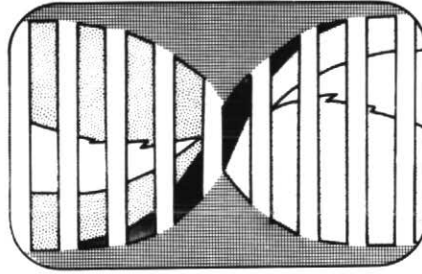


porphyry deposits for potential. Apparently neither the very high salinities nor vapour is evident in specimen from Highland Valley so that plutonic porphyries are in fact probably formed at deeper levels (i.e., base of epizonal to mesozonal). Presumably volcanic porphyry deposits also contain potent fluid inclusions. The syenitic porphyries will be more difficult to examine because of the lack of quartz.

Clearly these two meetings were very different in size, ratio of speakers to listeners, flux of discussion, cost of attending, etc. The large meeting was by most standards very successful. Nevertheless small informal meetings gain currency as large meetings become increasingly ponderous in planning, costly of attendance, and unsatisfactory in mutual exchange of information.

MS received March 8, 1975.



IGCP Project: Precambrian in Mobile Zones – Meetings in 1974

W. D. Brückner and M. M. Anderson
*Department of Geology
Memorial University of Newfoundland
St. John's, Newfoundland A1C 5S7*

Summary

During 1973 an International Union of Geological Sciences (IUGS) correlation project dealing with the Precambrian of mobile zones east and west of the North Atlantic began to operate; excursions were conducted in Morocco (1973) and northwestern France (1974), and a meeting was held in Paris in January 1974 to discuss problems associated with correlating the areas of Precambrian included. In April 1974, it became a key project of the International Geological Correlation Programme (IGCP), and the Board of IGCP suggested that it take in a similar project (Precambrian Stratigraphy) proposed by the Geological Survey of India. At a constitutional meeting in Paris, November 1974, the organization of the modified project and the rules governing it (statutes) were set up, and a limited programme of future activities agreed upon pending the holding of the first plenary session in Moscow in September 1975. This paper is a brief report of the two Paris meetings and of the scope of the project at the present time.

Introduction

Late in 1972, a correlation project, proposed by Dr. G. Choubert and Dr. (Ms.) A. Faure-Muret under the title *Précambrien des Zones Mobiles, Partie II*, was approved by the Coordinating Panel of the IUGS under the code

number PA 71.48. This project was to deal, principally, with the correlation of Precambrian rocks to the east and west of the North Atlantic, thus providing a westward extension to the range of Dr. V. Zoubek's project *Précambrien des Zones Mobiles, Partie I* (Eurasia) which had been approved earlier (PA 70.11).

By early 1973, 26 persons from 10 countries (including six from Canada and three from the U.S.A.) had agreed to participate. This response made it possible for the project to get underway – excursions were organized – and arrangements made for a meeting in Paris in January 1974. The first excursion took place in May 1973 (see report by Church and Young, 1974) enabling the participants to study the rocks and their interrelationships in four of the several Precambrian inliers of the Anti-Atlas in Morocco. The Paris meeting (described more fully below) was concerned with a review of the Precambrian of the countries included in the project, possible correlations between them, and a consideration of the most useful criteria for correlation work. In March 1974, an excursion to the Armorican region in northwestern France was carried out.

During 1973, as a result of the setting up of the IGCP as a joint scientific venture by UNESCO and the IUGS, projects previously accepted by the IUGS Correlation Panel had to be resubmitted and receive the approval of IGCP Scientific Committees before they could be considered for possible acceptance by the IGCP Board, the body responsible for the supervision and implementation of the programme. The correlation project *Précambrien des Zones Mobiles, Partie II* was resubmitted in October 1973, and, after evaluation, it was approved by the IGCP Board in April 1974 (under No. 73/1/2) and rated as a key project, i.e., a well-developed international project of major importance. The Board suggested that it take in a similar project (Precambrian Stratigraphy) submitted by the Geological Survey of India. The continuation of the original project (although enlarged in scope regionally), which became uncertain when it had to be resubmitted to the IGCP Board, was thus assured. The title of the project, however, no longer includes the designation *Partie II*, because *Partie I*, which was also resubmitted to the IGCP Board and approved as a key project

(No. 73/1/22), was renamed *Précambrien des Zones Mobiles Phanérozoïques* at the time of its acceptance by the Board. Nevertheless, the new title is only provisional since the name for each project is the responsibility of the group concerned.

The reasons for the setting up of the IGCP, and details of its major aims and objectives, organization, etc. are to be found in the December 1971 issue of the Unesco publication *Nature and Resources* (v. VII, no. 4, p. 4-9). *Geological Correlation*, issued by Unesco at irregular intervals for the IGCP, is a newsletter covering all aspects of the programme; two numbers have already been published. The newsletter can be obtained from the IGCP Secretariat, Division of Earth Sciences, Unesco, Place de Fontenoy, 75700, Paris, France.

Meeting of January 3-5, 1974 (attended by W. D. B.)

12 participants (including three from Canada) and five guest scientists joined the project proposers/coordinators to listen to accounts of the Precambrian geology of the regions covered by the project at that time, and to discuss possible correlations between them. The presentations given were as follows: Anti-Atlas (A. Boudda), Spain (R. Capdevila, E. den Tex, P. Matte), Brittany (J. Cogné), Normandy (F. Doré), Great Britain and Ireland (W. J. Baker), Appalachian region (W. R. Church, partly on behalf of L. Glover and W. P. Crowley), Newfoundland (W. D. Brückner), and Canadian Shield (G. M. Young). Some aspects of geochronology were also explained (M. Roques, P. Vidal).

To facilitate the discussion of regional correlations, the coordinators, Drs. Choubert and Faure-Muret, had prepared a paper (17 pages, 5 tables) entitled *Essai de corrélation de terrains précambriens et de chaînes précambriennes du Maroc, de la Presqu'île Iberique, du Canada et de l'Armorique*. In addition to the correlations suggested in this paper, G. M. Young, in his contribution, proposed further correlations between Canadian Shield rocks and rocks believed to be of comparable age in Greenland, Scotland, the Fennoscandinavian Shield and elsewhere (see also Church and Young, 1974). It was apparent from the discussion, however, that, apart from

possible correlations between Canada and Morocco, the relationships of the different Precambrian areas to one another are still problematic.

The meeting ended with a debate, led by G. M. Young, on the problems associated with establishing correlations, and the various methods, both tried and untried, that might prove useful in future work of this kind. Although many of the features of regional geology that were considered are potentially important for purposes of correlation, it is not feasible to include comment on all of them in this brief report. The following remarks, however, may be of wider interest.

Precambrian rocks can generally be distinguished from overlying Palaeozoic strata where they are separated by a major unconformity, but in regions without such a significant hiatus the boundary has usually been drawn somewhat arbitrarily. On the basis of results obtained by Russian workers in apparently hiatus-free Siberian sequences, it has, however, become possible in recent years to place that boundary exactly wherever the earliest shelly fossils characteristic of the lowest Cambrian of Siberia make their appearance (Palmer, 1973; Cowie and Rozanov, 1974). So far, work of this kind has been successful in Normandy (F. Doré) and the Anti-Atlas (A. Boudda).

Apart from subtidal columnar stromatolites, useful for correlation purposes in the upper Precambrian of those regions where they are represented (Bertrand-Sarfati, 1972; Walter, 1972; Serebryakov and Semikhatov, 1974), well-preserved fossils are, otherwise, so scarce in the Precambrian that correlations are difficult or impossible to establish on the basis of forms of life. Three main avenues offer themselves instead, although each has its drawbacks.

(1) Radiometric dating.

Geochronologists, conscious of the precision of their measuring techniques, tend to be confident with regard to the dates they obtain, especially when approximately the same results are obtained from several samples of a geological unit, and/or from the use of several methods. Students of regional geology, however, must, for each determination, ask themselves what the radiometric date really represents. Does it actually correspond to the time of

emplacement of an igneous rock, or the end of a metamorphic recrystallization, or could later regional events have reset the radiometric clocks, partly or wholly? The chances of such rejuvenation has probably, if not certainly, occurred extensively on both sides of the North Atlantic (as for example, in the Grenville Province and the Avalon Zone of Canada: for the latter see Anderson, 1972; Brückner, 1974).

(2) Orogenic cycles. It has long been established that three major orogenic cycles took their course during Phanerozoic time, each beginning with a geosynclinal phase, ending with intense deformation accompanied by regional metamorphism and plutonism, and being followed by a major hiatus during which denudation prevailed. Each of these cycles lasted about 200 m.y. Such major orogenic cycles have also been recognized in the Precambrian, but they appear to have lasted progressively longer the earlier they occurred (from 300 to 1000 m.y. according to Church and Young, 1974), although this tentative conclusion may reflect the decreasing availability of reliable data rather than a true fact. If an "accuracy" of \pm a few 100 m.y. is deemed satisfactory, these major Precambrian orogenic cycles would seem to provide acceptable criteria for long-distance correlation. On the basis of experience in Phanerozoic orogenic belts, however, it is uncertain, even improbable in many cases, that discordances of lesser orders of magnitude are valid correlation criteria for distances exceeding the regional or local ranges (despite H. Stille's concept of global contemporaneity of orogenic pulses, which still has followers; see e.g., discussion by Goguel, 1962, chapter 17).

Thus, whereas the rocks of the Avalon Zone in eastern North America, those of the Brioverian in Brittany/Normandy, and those of the Precambrian II-III and III in Morocco may all belong to the same major orogenic cycle, it is doubtful if subordinate unconformities in these three complex geological "provinces" reflect contemporaneous orogenic events.

(3) Facies suites. "Facies" in the widest sense comprises sedimentary as well as igneous and metamorphic lithologies, and even structural styles. It is well

known that certain facies combinations, so-called "facies suites", had a wide regional distribution during specific intervals of geological time (e.g., the facies suite of the Germanic Triassic, or that of the circum-Pacific andesite belt). Comparison of facies suites is hence a valid method of correlation, certainly on the regional scale, but within limits also over larger distances. Of course, one has to be aware that lateral facies changes, which are common, are duly considered and that certain facies types (e.g., red beds) were formed again and again during earth history whereas others apparently developed only during a limited period (e.g., anorthosites). Correlation using facies suites must clearly be done judiciously to avoid the introduction of gross errors.

The results of the efforts made by the project participants during the coming years will reveal in due course what correlations can be established with confidence between the several Precambrian regions concerned.

Constitutional meeting of November 25-27, 1974 (attended by M. M. A.)

The meeting was called, following the approval of the project *Précambrien des Zones Mobiles* as a key one in the IGCP, in order to decide on the organization necessary for fulfilling the aims of the project, establish its regional coverage, and draw up the statutes (which had to be submitted to the IGCP Board by November 30, 1974). In addition to these constitutional matters, the participants at the meeting also had to decide on the programme of activities for the immediate future so that the scientific work of the project could get underway without further delay. 18 participants from seven countries (including M. M. Anderson, K. N. M. Sharma, and G. M. Young from Canada) and three observers were present.

The regional extent of the project at the time of its resubmission to the IGCP Board, i.e., Precambrian mobile zones east and west of the North Atlantic and bordering the Mediterranean, was confirmed, while a planned eastward extension to take in the Arabian Peninsula and Peninsular India, to allow for the inclusion of the Geological Survey of India project (referred to earlier), was held in abeyance as no representatives from these regions were in attendance. Other regions that may be included in future are Greenland and Scandinavia.

The project will be directed by a "Board" made up of representatives of the main organizational units mentioned below, which will meet at least once every year. Day to day activities will, however, be dealt with by a "Permanent Executive" comprising a president (currently G. Choubert), an executive secretary (A. Faure-Muret), and two vice-presidents (E. M. El Shazly, G. M. Young). The members of the Executive are elected or re-elected by the Board for a period of three years. The scientific tasks are to be carried out by five "Thematic Working Groups" (headed by Coordinators elected for two years), each made up of two or more "Thematic sub-groups" (run by Directors) as follows:

Working Group I: *Orogenic cycles* - Sub-groups: 1) Upper Proterozoic and Precambrian/Cambrian boundary; 2) Middle Proterozoic; 3) Lower Proterozoic; 4) Archaean.

Working Group II: *Crustal evolution* - Sub-groups: 1) Geochronology; 2) Tectonic deformation.

Working Group III: *Crustal materials* - Sub-groups: 1) Petrology: plutonism and magmatism; 2) Metamorphic zonation; 3) Metallogeny.

Working Group IV: *Primitive life and palaeogeography* - Sub-groups: 1) Primitive life; 2) Sedimentology and palaeogeography.

Working Group V: *Geophysics* - Sub-groups: 1) Crustal structure (geophysics); 2) Palaeomagnetism.

Participants in the project will thus work as members of thematic sub-groups according to their field(s) of interest. The number of sub-groups is not limited - new sub-groups may be added, or existing ones abolished by the Board. A National Development Committee is also to be formed comprising specialists from the regions in which the project is at an early stage, and liaison maintained with seven related IGCP projects as well as with international commissions and sub-commissions.

The working groups are to meet at least once every year, the sub-groups at least once every two years, and plenary sessions of the project must likewise be held at least once every two years.

Excursions are an integral part of the project, and, hopefully, several (for different sub-groups) will be held each year during the life of the project, which has been set at seven years.

A number of working group coordinators, sub-group directors and liaison men were provisionally designated (among others W. D. Brückner, W. R. Church, K. N. M. Sharma, and G. M. Young from Canada) pending the holding of elections for these positions before the first plenary session.

The first plenary session, coupled with field trips, has been scheduled for September 1975 and will, upon invitation by the U.S.S.R. take place in Moscow. A meeting of the sub-group "Primitive life" is to be held in Great Britain in August 1975, and project members will take part in a field trip to study the Precambrian/Cambrian boundary in Morocco in October 1975. Meetings on the Iberian Peninsula, in Egypt, and in Canada are foreseen for subsequent years.

Although primarily concerned with correlation, it is evident from the range of thematic sub-groups listed above, that, during the course of the project, many other problems associated with Precambrian geology will be investigated. The results of these studies, together with those dealing with correlations, will be summarized in annual reports and in a final report at the end of the project.

At the time of the November meeting in Paris, nine Canadian geologists had expressed an interest in participating. Clearly, this number is inadequate, even to provide for only one Canadian representative in each of the 13 sub-groups, and it is hoped that the information given in this paper will encourage many more geologists to become actively involved in this important IGCP project.

Acknowledgements

The authors are indebted to Drs. G. Choubert and A. Faure-Muret whose official reports of the meetings in Paris have helped greatly in preparing this paper.

References

Anderson, M. M., 1972, A possible time-span for the Late Precambrian of the Avalon Peninsula, southeastern Newfoundland, in the light of worldwide correlation of fossils, tillites, and rock units within the succession: *Can. Jour. Earth Sci.*, v. 9, p. 1710-1726.

Bertrand-Sarfati, J., 1972, Stromatolites colonnaires du Précambrien supérieur du Sahara nord-occidental: *Centre Recherche Zones Arides, sér. géol.*, no. 14, Paris, 245 p.

Brückner, W. D., 1974, Avalon Peninsula geology in the light of trans-Atlantic correlation: *Geol. Assoc. Can./Min. Assoc. Can. Joint Ann. Mtg.*, St. John's, Newfoundland, *Progr. Abstracts*, p. 15.

Church, W. R., and G. M. Young, 1974, L'excursion géologique de l'I.G.C.P. dans l'Anti-Atlas Marocain, mai 1973: *Geosci. Can.*, v. 1, no. 1, p. 48-51.

Cowie, J. W. and A. Yu Rozanov, 1974, I.U.G.S. Precambrian/Cambrian Boundary Working Group in Siberia, 1973: *Geol. Mag.*, v. 111, no. 3, p. 237-252.

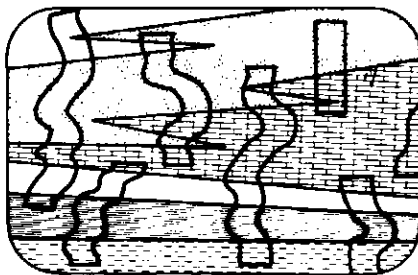
Goguel, J., 1962, *Tectonics: San Francisco and London*, W. H. Freeman and Company, English translation from French edition of 1952, 384 p.

Palmer, A. R., 1973, Lower Cambrian in Siberia: *Geotimes*, v. 18, no. 12, p. 20-21.

Serebryakov, S. N. and M. A. Semikhatov, 1974, Riphean and recent stromatolites: a comparison: *Am. Jour. Sci.*, v. 274, p. 556-574.

Walter, M. R., 1972, Stromatolites and the biostratigraphy of the Australian Precambrian and Cambrian: *Palaeontol. Assoc. London, Spec. Pub.* 11, 189 p.

MS received March 21, 1975.



North American Energy in Perspective

Peter Sonnenfeld
*Department of Geology
University of Windsor
Windsor, Ontario N9B 3P4*

Hard on the heels of the 9th World Energy Conference in Detroit, organized by the Detroit Edison Company, the 16th Canadian-American Seminar convened at the University of Windsor, Windsor, Ontario, on November 14-15, 1974, with the theme "North-American Energy in Perspective". The former was mainly a conference of government delegates who devoted more than half their time to various types of pollution, to the environmental impact of technology used in energy recovery, conversion, transportation and use. In contrast, the seminar proved to be a workshop on the potential future supply and demand of energy in the North-American scene, the source of energy available, the projected demand pattern in the next decade. There were about 500 registrants and 23 panelists.

The first session was devoted to a background discussion, how we had arrived in an energy crisis and how we could get out of it. Lawrence Raicht of the U.S. State Department Office of Energy, Ms. Judy Maxwell, an economist with the C. D. Howe Research Institute and G. N. Patterson, head of aeronautical engineering at the University of Toronto and director of the Science Council Energy Study, gave their projections on the chances for developing autarchy in the energy spectrum. Canada's oil and gas production is expected to decline in the remainder of this decade. Oil and gas exports will soon have to end, electricity and coal will continue to maintain a small

two-way trade. Geothermal and heliothermal plants, nuclear fission, nuclear fusion with and without lasers will not significantly displace fossil fuels and tidal power in the next decade. If the oil exporters' interests demand it, the price of oil from shale or tar sands will always be undercut. Only a high tariff barrier could insure their development and this means continued high domestic price levels.

Then followed a discussion of the feasibility of energy self-sufficiency both in Canada and in the U.S. by D. M. Fraser of the National Energy Board, Patrick McTaggart-Cowan of the Science Council and David Freeman of the Ford Foundation Energy Policy Project, Washington, D.C. The consensus seemed to be that a complete energy self-sufficiency can be achieved either in the U.S. or in Canada in time at a reasonable cost, if planned at a prudent pace. There are, of course, degrees of self-sufficiency, whether to supply all energy requirements from within the country or whether to match imports of one form of energy by exports of another. It might be more economical to trade some western oil south for eastern oil imports or for southern coal to move into eastern Canadian markets. It is, however, foreseen that western coal will start displacing U.S. coal in Ontario by 1977/78. New transport links, developed to deliver western coal to the east, will bring about economically irreversible changes in trade patterns. The overall consumption of energy could be cut drastically by a reduction in waste and by conservation: tax incentives for smaller car engines or for building insulation would be required.

Nuclear power as a major energy source was the topic of a special session. The subject was presented by E. E. Kintner of the U.S. Atomic Energy Commission, Professor David Rose of M.I.T., and A. J. Mooradian of Atomic Energy of Canada. Various nuclear reactor systems were discussed, those actually operating and those still on the drawing boards. To settle for one or the other type of reactor installation represents an enormous investment in the billions of dollars and thus is weighed most carefully against other sources of energy. However, we may not possess the required capital to build a sufficient number of plants, once we spend our money on oil imports. Down-time in nuclear reactor installations of any