Meetings

South Pole Reaches the Sahara

Paleomagneticists have been steadily accumulating data that lead them to conclude that the poles of instantaneous rotation (the "geographic poles") in the past can be established on the basis of a reasonably large number of determinations of a paleomagnetic pole for a given period. This paleomagnetic pole in turn is calculated on the basis of rock magnetism "frozen" into a given rock at the instant of time corresponding to its final lithification. Progressively the poles have been traced backward through time. The shift has not been random, but rather in a series of migrations in the same general direction or in spiralling motion. We use the expression "polar migration" as one of convenience, for it is assumed that the axis of spin remains more or less constant in terms of celestial mechanics, while it is the earth's lithosphere that has shifted with respect to the core.

This tracing of former pole positions has taken the locus of the South Pole from south of Australia about 100 to 200 million years ago, to Africa 300 million years ago, to somewhere near Morocco about 400 to 500 million years ago. Because the "South Pole" would no longer be in that hemisphere it has been suggested that this "southern" pole, that spent most of its time wandering around the old "Gondwanaland" continents, should be called the "Gondwana Pole." Correspondingly, the "northern" one should be called the "Pacific Pole" (Fairbridge, 1969).

If the Gondwana Pole was situated in northwest Africa in the Ordovician time and that region had a cratonic (that is, continental) crust since Precambrian time, surely there should be some traces of glaciation still visible there today? Over the last few years scattered reports from oil geologists indicated there were indeed glacial striations there in rocks of about this age. Since the main reservoir horizons of the Hassi Messaoud oilfield are Ordovician sandstones, there has been an "official" interest in the nature of these rocks. Accordingly, in January 1970, an international mission of sedimentologists was invited by the Institut Algerien du Pétrole to carry out an expedition into the Central Sahara to confirm or deny these reports. After covering nearly 10,000 kilometers by charter aircraft, Land-Rover, and on foot, the group reassembled in Algiers, 25–27 January 1970, for a symposium on the Saharan Orovician Ice Age.

After general discussions on 25 January, the sedimentology group, together with geologists of the Institut Algerien du Pétrole, the Geological Survey of Algeria, and the University of Algiers, gathered for formal papers in three sessions—glacial evidence, geomorphic evidence, and platform sedimentation.

Glaciated surfaces and glacial tectonics were discussed by Stefan Rozycki (Poland), who pointed out the adherence of the ice flow directions (always from south to north) to structural lines dictated by the Precambrian grain and pre-Ordovician faulting. It was a strictly polar type of glaciation, and not a mountain glaciation of temperate latitudes. Bijou-Duval (Paris) stressed the very gentle topography of the craton. Nils Spjeldnaes (Aarhus, Denmark) summarized the glacial sedimentary features, both marine and continental, stressing the paleogeography of the Ordovician Tethys and the European evidence of cooling toward the south. Anders Rapp (Uppsala, Sweden) talked about the channels, subglacial and outwash, and the eskers. The periglacial areas were examined also by Anders Rapp, Jean Dresch, and Percy Allen (Reading, England). Rhodes Fairbridge then spoke about the interactions of eustasy and isostasy. In view of the dissection of the flat cratonic area to over 300 meters, involving an interfingering with marine facies, it was evident that we were dealing with a very large body of continental ice. Its physical dimensions in North Africa extend over 4000 kilometers, from Morocco, through Mauretania, Algeria, Niger to Libya and Tchad. Several speakers (notably Bigarella) pointed out evidences of possible Ordovician ice extending all the way to Brazil and South Africa.

The general paleogeography was discussed further by Spjeldnaes, Fairbridge, and Rapp. Of outstanding, and perhaps unique importance, is the strictly cratonic nature of the region. The continental glaciers probably had extensive ice shelves and there is much evidence of ice grounding in fossiliferous marine sediments. Eustatic and isostatic oscillations repeatedly exposed this shelf region to an alternation between ice advances and retreat stages with vast outwash sheets. The proglacial outwash channels are so perfectly preserved that their courses and meanders can now be observed from the air.

Jean Dresch (Sorbonne, Paris) examined the "surface infratassilienne" (the sub-Tassili erosion surface). "Tassili" is a Tuareg word meaning plateau, but specifically we apply it to the flat-lying Paleozoic rocks overlapping the Precambrian core of the Hoggar (Ahaggar). The erosion surface concerned is quite flat and clearly a pediplain or a peneplain (depending on which school you come from). Dresch prefers the former, and pointed out the importance of various periglacial indicators: pingos and palsas, permafrost (cryoturbation, "grès cloisonnés"), and ice wedges. Fairbridge submitted that the so-called ice wedges were, in fact, sandstone dikes radiating from sand volcanoes (sand springs), which may well have been related to the nearby ice loading. Percy Allen (United Kingdom) pointed out the evidence of very-high-velocity currents in producing sand waves, of wavelengths exceeding 2 meters and amplitude over 50 centimeters, suggesting Froude numbers in excess of 1.5. They have the "ripple drift" form described by Sorby. Fairbridge suggested a catastrophic decanting of meltwaters during isostatic readjustment resulting in torrential streams always directed toward the north. The possibility of giant tides, associated with the postulated proximity of the Earth-Moon pair in early Paleozoic time, was raised, but regarded as doubtful in view of the continuous, uninterrupted sequences of the sand waves (10- to 20-meter units and extending laterally for hundreds of kilometers). A vast supply of relatively "clean" sand was also involved. The niveolian hypothesis was rejected.

Dresch raised the question of the Silurian transgression. The Ordovician

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glacial sequence is covered disconformably by a widespread Silurian transgression, shales with graptolites. This involves a curious contradiction to traditional ideas of the meaning of graptolitic shales, usually taken to be a deep-water facies with a pelagic fauna. Fairbridge pointed out that there were two sorts of transgression (apart from those involving crustal movement): eustatic and geoidal. A glacio-eustatic rise would only be expected to replace the water glacially removed from the ocean, but an important polar shift would call for a readjustment of the geoid, that would be instantaneous in the case of the ocean, while the crustal adjustment would be quite slow. The Silurian transgression seemed to be one of the second type. As observed in the field, the sub-Tassili (that is, pre-Ordovician) erosion surface lacks major conglomerates, but is marked by small quartz gravels, often "eolized," even with some small "dreikanters." The underlying Precambrian is chemically weathered and leached to a depth of 3 to 4 meters and is capped by a residual hematitic crust or paleosol. Bogdanov pointed out that the age of the last major folding in the shield hereabout was 1.5 to 1.6×10^9 years, but there were some dates indicating 4 to 5×10^8 years. The latter were clearly incompatible with the fossil and structural evidence of unwarped Ordovician.

It is interesting that there is widespread evidence of eolian conditions just prior to the Ordovician in north Africa [a subpolar(?) desert, for example, Gobi], and there is also a widespread Eocambrian glaciation. It seems likely that the hematitic crust (residual lateritic paleosol) and bleaching are relics of seasonably warm wet weathering conditions from well back in the Precambrian. In this environment a semiarid pedimentational history could well have been the last important event before the arid conditions descended. Percy Allen pointed out that wherever we saw the contact there were no fragments of the underlying basement in the transgressive Ordovician pebble conglomerate, which suggested a long intervening period of subaerial history associated with a great climate change. De Charpal noted that the kaolinitic weathering observed by us east of Hoggar became gradually replaced by illite farther to the northwest; this might suggest a late Precambrian pole position still farther to the northwest.

Paul Potter (University of Indiana) presented a clear analysis of the geometry of the sand bodies, emphasizing the distinction between the piedmont fan type that thins distally and paralic type that thins landward. Jean-Philippe Mangin (University of Nice) stressed the unusual relationship in the Ordovician glacials where both the underlying beds were sandstones and so were the tillites. Indeed it seems clear that often the only major difference in lithology was that the underlying sands were frozen, and therefore temporarily "lithified" by permafrost, while the overlying tills were mostly laid down during retreat stages; then, after total deglaciation, the slight differences between "bedrock" and "drift" require very close inspection. Fairbridge questioned the "fluviatile" interpretation of some of the "bedrock" (Ordovician) sands. It was not enough to find them unfossiliferous (actually, they are not), but the structure, granulometry, and gross distribution must be considered. Mixture with both eolian and marine conditions must be regarded as normal. Statistically the chances for continental preservation are always less than for marine. In desert regions such as eastern Saudi Arabia, the desert dune sands (that started as fluvial sands) are regularly dumped onto the beach by the westerly winds and then they are redistributed as offshore bars. Many of the so-called "eolian" sandstones of the American West are regarded by Fairbridge as marine, although the grains may well be "eolized." In the case of the Saharan Ordovician the near-parallel division of most of the cross-bedded units (and the less-than-25-degree dips) speak for a marine setting. The current is systematically north to northwest, which seems to be general paleoslope of the craton, followed later by the ice, and later still by the outwash sandurs. Jão José Bigarella (University of Paraná, Brazil) confirmed that the structural form of most of the cross-bedding (except in the glacial outwash) was marine.

Adolf Seilacher (University of Tübingen, Germany) demonstrated how he found fossils or tracks of trilobites and traces of other marine life systematically almost through the entire mid-Saharan Ordovician section. The fossils suggest that the glaciation was in or immediately followed the Upper Caradocian. These observations offered further confirmation that the cross-bedding was marine and that the continental glaciers came down to form ice shelves comparable, say, with those of the Ross Sea and the Weddell Sea today.

The last session was devoted to talks

about platform sedimentation in other regions and the drawing of analogies with the mid-Saharan situation. Bigarella presented a fine series of slides of the South American and South African Carboniferous and earlier Paleozoic glacial records, and demonstrated definitive methods for recognizing the various environments of cross-bedding by the geometry of the fine structure. Bogdanov spoke on the Russian craton. And André Vatan (France) spoke on Iran. The Permian glaciation of Australia, traces of which occur in every state of the Commonwealth, was summarized by Fairbridge. Tasmania was possibly unique in having Precambrian, Permian, and Pleistocene glacials (and incidentally separated by periods of subtropical climate). Polar shift should never be regarded as a "one-shot" affair. Fairbridge spoke also on the origin of ice ages. He supports the old Lyell-Ramsay relief theory which argues that when the global paleogeography leads to a blocking of oceanographic circulation (as in the blocked radiator of a car) the heat balance becomes upset; when poles coincide with open seas there is no ice age, but when wide continental and mountainous areas come to coincide with poles, the snows of winter do not melt and the Kukla albedo theory takes over. Cyclism of 25,000 to 90,000 years is introduced by celestial mechanics (the Milankovitch theory) and short-term modulations are superimposed by solar variations of the ultraviolet transmission (and thereby the ozone density in the stratospheric "greenhouse").

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Courses

Basic Processes in Neuronal Networks, Avalon, Calif., 22 June–25 July. This course will be devoted to the study of basic neuronal mechanisms operating at the cellular and small network level. Emphasis will be placed on direct experimental demonstration of the properties of membranes and synapses, receptors and receptor networks, networks for control of motor function, pattern generation in networks, and learning in simple networks. (Dr. Russell L. Zimmer, Resident Director, Santa Catalina Marine Biological Laboratory, P.O. Box 398, Avalon, Calif. 90704)

X-ray Spectrometry, Albany, N.Y., 8–19 June (two sessions). This is an integrated course in the fundamentals, applications, and advanced techniques of x-ray spectrometry, including computer automation methods. The course covers the complete range of x-ray spectrometric techniques and theory from beginning elementary principles to the most advanced methods and latest developments. Is intended for those who are working or intend to work in x-ray spectrometric analysis. The course was established to meet the increasing demands of the x-ray spectroscopist who requires an introduction and thorough grounding in basics and for the spectroscopist who wants to expand his capabilities. Persons may register for individual sessions or for the entire 2-week course. Session 1 (8–12 June) will cover fundamentals, experimental techniques and procedures of x-ray spectrometry. No previous knowledge or experience is required or assumed. Session 2 is a continuation of fundamentals, advanced methods, and recent developments. A background equal to Session 1 is assumed. *Tuition*: $250 per session; $450 for both sessions. (Physics Department, State University of New York at Albany, Albany 12203)

Wear in Theory and in Practice, Cambridge, Mass., 22–27 June. This course will deal with wear—a description of the various forms of wear, an evaluation of the equations for analyzing wear quantitatively, and a discussion of methods available for minimizing the amount of wear and the size of wear debris. Related topics like friction, sliding temperatures, and lubrication will be covered. Experimental techniques will be demonstrated and their application to solving industrial problems will be stressed. (Director of the Summer Session, Room E19-356, Massachusetts Institute of Technology, Cambridge 02139)

Odor Perception: Multidisciplinary Research Methods, Utrecht, Netherlands, 23 August–5 September. The physicochemical, biological, physiological, and psychological methods in olfactory research will be demonstrated and discussed. It will be organized in the form of a large experiment in which all these methods will be applied to a central problem—odor mixing. The course is open to chemists, biologists, physiologists, and food technologists with an active interest in the fundamental problems of olfaction. [Dr. J. Wiederhold, Course Registrar, Netherlands Universities Foundation for International Co-Operation (NUFFIC), 27 Molenstraat, The Hague, Netherlands]

Design and Analysis of Scientific Experiments, Cambridge, Mass., 6–17 July. This course will focus on factorial designs with each factor at two or at three levels. Applications will be taken from the physical, chemical, biological, and medical sciences, as well as from engineering and development. (Director of the Summer Session, Room E19-356, Massachusetts Institute of Technology, Cambridge 02139)

Laser Raman Spectroscopy, College Park, Md., 8–12 June. Is intended for participants from industrial, government, and academic laboratories. Topics include the theory of Raman spectroscopy, applications to studies of molecular structure and dynamics in single crystals, polycrystalline and amorphous materials, liquids and gases, correlation with infrared spectra, and recent advances in instrumentation and microsampling techniques. Stress is placed on developing an understanding of fundamentals. (Prof. Ellis R. Lippincott, Center of Materials Research, University of Maryland, College Park 20742)

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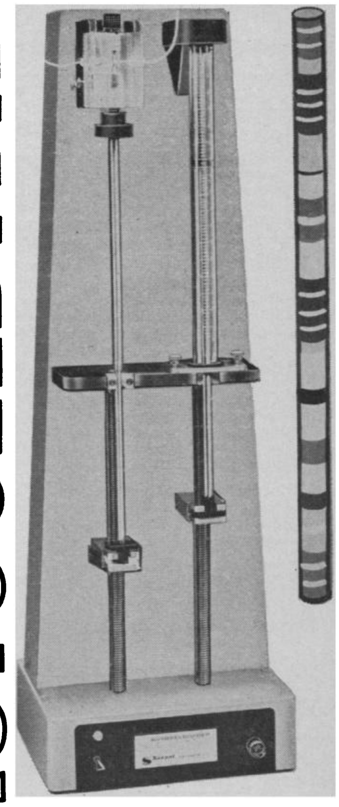

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