The Dawn of Animal Life

Boston, Massachusetts, U.S.A., 15 February 1988

In February 1988, specialists from four continents met to discuss the systematics, taphonomy and paleoecology of the Ediacaran fauna, an assemblage of soft-bodied fossil organisms up to 1 m in length, occurring with trace fossils in Late Proterozoic sediments. The Ediacaran fossils are a key to our understanding of the emergence of animals because they are the earliest body fossils of organisms at the "animal" grade of evolution.

The most pressing question of the conference was: What are these creatures? The traditional view is that the fauna is a polyphyletic group of animals, and that most members are either cnidarians, annelids, or arthropods. This view was challenged in 1983 by A. Seilacher (West Germany) when his analysis of the fossils' constructional morphology suggested that they bear no close relationships to living groups. Seilacher referred to body-fossil members of the Ediacaran fauna as "Vendozoans," and he characterized them as an evolutionary lineage distinct from modern metazoan phyla.

The main difference between the traditional and 'vendozoan' views of the Ediacaran fauna was not resolved at this conference, despite the fact that new data were presented. R.J.F. Jenkins (Australia) reported the occurrence of arthropod trace fossils from South Australian strata that also contain Ediacaran body fossils. These traces indicate the presence within the Ediacaran biota of soft-shelled arthropods similar to trilobites, a finding that confirms the traditional claim that arthropods were part of the Ediacaran fauna.

There was consensus in Boston that deposit-feeding metazoans were present in the Ediacaran fauna because of the presence of subhorizontal trace fossils formed by peristaltically burrowing animals. M.A. Fedonkin (U.S.S.R.) confirmed the presence of deep (>1 cm) vertical burrows in Proterozoic rocks by showing photographs of the inclined tubular trace fossil *Skolithos declinatus* from the Vendian of the White Sea Region, U.S.S.R.

The ecologic roles and trophic strategies of the Ediacaran body fossils came under scrutiny during the conference. The standard view, presented by Jenkins, is that the Ediacaran body fossils represent filter-feeding and deposit-feeding metazoans, together with predatory jellyfish. However, Jenkins' interpretation of the Ediacaran body fossil *Kimberella* as a cubozoan (a fast-swimming predatory jellyfish) was challenged by Seilacher on the grounds that *Kimberella* probably had a three-fold not four-fold radial symmetry required by the cubozoan interpretation.

McMenamin presented an alternative view of Ediacaran paleoecology, in which the larger members of the Ediacaran fauna are seen as having employed photoautotrophic or chemoautotrophic feeding strategies in a largely predator-free "Garden of Ediacara" (McMenamin, in *Palaios*, v. 1, 1986, p. 178-182). In addition to explaining the unusual, high surface-area body plans of the Ediacaran fossils, the "Garden of Ediacara" hypothesis also offers an explanation for why these organisms became extinct when they did. The soft-bodied and possibly autotrophic members of the Ediacaran fauna apparently died out during an episode of pronounced Late Proterozoic marine eutrophication, and areas

of high marine nutrient flux are known to favour heterotrophic animals at the expense of autotrophic ones with photosymbionts.

S.M. Rowland (U.S.A.) made the provocative suggestion that the Cambrian Archaeocyatha were skeletonized relicts of an Ediacaran ecosystem. He presented evidence suggesting that archaeocyaths were photo-symbiotic and argued that they were able to survive the terminal Proterozoic eutrophication event by living in skeletal reefs first formed by archaeocyaths early in the Cambrian. Rowland showed that Phanerozoic reef environments are comparatively oligotrophic and implied that reef waters are analogous to Late Proterozoic marine waters, at least in terms of dissolved nutrient content. The first reefs may thus have acted as refugia for organisms that required oligotrophic conditions to thrive.

Figure 1: An Ediacaran soft-bodied fossil, perhaps belonging to the genus *Pteridinium*, from the Carolina Slate Belt (U.S.A.). Scale bar in centimetres. Specimen from collection of G.G. Gibson.

Taphonomic and ontogenetic conditions that led to the preservation of soft-bodied Ediacaran fossils were also discussed. G.M. Narbonne and H.J. Hofmann (both from Canada) displayed their new discoveries of the globular to bag-shaped organism *Beltanelliformis*, one of the most common Ediacaran fossils known. *Beltanelliformis* specimens are frequently found clustered together on a single bedding plane, and Narbonne and Hofmann have found (*Palaeontology*, 1987, v. 30, p. 647-676) that the size distributions on individual bedding planes is strongly

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unimodal, suggesting that each bedding plane sample represents a population of individuals at the same stage of growth.

There is now much more information about the Ediacaran fauna than in the 1960s when much of the seminal taxonomic work was done in Australia by M.F. Glaessner and M. Wade. Nevertheless, it is not yet possible to choose between competing hypotheses such as Seilacher's vendozoa concept, or Fedonkin's version of the traditional view, in which he sees the radially symmetric Ediacaran body fossils as ancestral to bilaterally symmetric animals of the Cambrian and later.

A combination of several approaches may ultimately prove most fruitful; for instance, many experts now agree that *Tribrachidium* (a triradiate Ediacaran body fossil) belongs to

an extinct phylum, even though it had been earlier argued that *Tribrachidium* was allied to the edrio-asteroid echinoderms. Interestingly, a pentamerally symmetric soft-bodied Ediacaran fossil has been recently described by J.G. Gehling (Australia) as a true edrioasteroid (Alcheringa, 1987, v. 11, p. 337-345). Considering their importance for our understanding of early animal evolution, the unresolved systematic questions will continue to dominate discussion of the Ediacaran fossils.

M.A.S. McMenamin

Department of Geology and Geography
Mount Holyoke College, South Hadley,
Massachusetts 01075-1484, U.S.A.

IGCP 156 Reviews Phosphorites in Jordan

Amman, Jordan, 3 - 8 April 1988

The 11th international IGCP 156 symposium and field workshop was held recently to discuss Late Cretaceous-Tertiary Tethyan phosphorites. The meeting was held jointly with the 3rd Jordanian Geological Conference and was sponsored by the Jordanian Geologists Association (JGA), the Iraq Geological Union (IGU) and Working Group 4 of the IGCP Project 156 - Phosphorites.

Figure 1: IGCP 156 field trip participants at Petra.

Some 50 papers presented in the three-day symposium dealt with the causes of periodicity in the accumulation of phosphorites, microbial processes in the genesis of phosphorites, hard grounds, and Middle East deposits, especially those of Jordan, Syria, Iraq, Saudi Arabia, Egypt and North Africa.

One important issue considered during the symposium and the field trip that followed concerned the presence of high amounts of silica (as chert, tripoli and porcellanite) that is associated rhythmically with the phosphorites. Chert predominates over phosphorite in the shallower parts of the basins (the highs), whereas phosphorites become more friable (less chert) and dominant in the deeper parts of the basins.

Attention was also concentrated on the role of oyster reefs and banks in the accumulation of phosphorites in central Jordan. Isolated oyster reefs (up to 40 m thick) were widespread on the Mujib High in central Jordan during latest Cretaceous time. They created small basins several kilometres across within the shallow epicontinental sea, producing about 30 isolated ore bodies, and more may remain undiscovered. Some of these basins contain vast amounts of oil shales, with up to 25% organic matter, deposited above the phosphorites. For example, there are over 1.4 billion tonnes of oil shales in the the Lajjun deposit of central Jordan.

The three-day field trip visited the deposits of northwest Jordan, Ruseifa, Central Jordan (El Abiad and El Hasa mines) and Esh Shidiya in the southeastern part of the country. Visits were also made to the ruins (Roman) at Jarash in north Jordan and those of the spectacular Nabatian Arab city of Petra carved into the massive Cambrian and Ordovician sandstones in south Jordan (Fig. 1). Proceedings will be published by JGA and IGU.

Abdulkader M. Abed

Department of Geology and Mineralogy
The University of Jordan
Amman, Jordan

LATE NEWS:

Wang Sijing, Director of the Institute of Geology, Academia Sinica, Beijing, is the new President of AGID, the Association of Geoscientists for International Development. He was elected by the Council of AGID, which met in late September at the Geosciences in Development conference at Nottingham, England. New Vice-Presidents are Sandra Barr (Acadia University, Canada), Victor Ricaldi (State Development Corporation, Cochabamba, Bolivia), B.B.S. Singhal (University of Roorkee, India), Isabelle Sy-Nyang (Université de Dakar, Senegal), and Anthony Muze (Ministry of Minerals, Tanzania). Jon Rau (ESCAP, Bangkok) is the new Secretary-Treasurer and Dorrik Stow (University of Nottingham) the new Editor.

VISOS Debates the Ordovician

St. John's, Newfoundland, Canada, 8 - 12 August 1988

The IUGS Subcommittee on Ordovician Stratigraphy played host to over 130 specialists in early August at Memorial University of Newfoundland for the International Symposium on the Ordovician System (VISOS), the fifth since 1974. Over 120 papers were given by specialists from more than a dozen countries on a wide spectrum of themes from global aspects of chronostratigraphy, paleoceanography, geochronology, magnetostratigraphy, and geochemistry, to regional stratigraphy and tectonics, paleontology, and hydrocarbon resources. In recognition of the cosponsorship by IGCP 216 (Global Bioevents), several formal papers addressed Ordovician bioevents, particularly the basal radiation and the terminal extinction events.

After the last symposium in 1982 in Oslo, the Subcommittee on Ordovician Stratigraphy established several regional chronostratigraphy working groups. At St. John's it was agreed to focus future work on zonal levels that represent significant bioevents and/or excellent correlation potential. Some of these levels are considered appropriate for the definition of a revised series classification for the System. One possibility is that the *Cordylodus lindstromi* conodont Zone be used to redefine the base of the Tremadoc (and Ibexian) Series. The level of the base of the *Tetragraptus approximatus* graptolite Zone is close to the base of the *Paroistodus proteus* conodont Zone, marking a level of significant graptolite evolution (bi-theical development) that has been traditionally accepted as the base of the Arenig Series.

Figure 1: Proposed Cambrian-Ordovician boundary stratotype, Green Point, western Newfoundland. The strata are here overturned; the boundary level is marked by an arrow.

Important zonal levels within the interval of the Arenig Series include *Oepikodus communis* conodont Zone with, slightly higher the *Orthidiella* brachiopod Zone and the *Tripodus laevis* conodont Zone marking the base of the Whiterock Series. Arguments were advanced to recognize a significant level just below the traditional base of the Llanvirn Series at the level of the *Undulograptus austro-orientatus* graptolite Zone (initiation of biserial graptolites), which is close to the base of the *Eoplacognathus? variabilis* conodont Zone.

For many decades one of the most widely correlatable horizons has been the base of the *Nemagraptus gracilis* graptolite Zone (close to the base of the *Pygodus anserinus* conodont Zone), which lies within the Llandeilo Series. Slightly higher, near the base of the Caradoc Series are the useful zonal levels of the *Diplograptus multidens* graptolite Zone and the *Prioniodus gerdæi* conodont Zone. The important glacial events near the end of the Ordovician lie principally within the Ashgill Series. Increasing faunal provincialism reduces effective correlation but the zonal levels of the *Climacograptus complanatus* graptolite Zone and the *Amorphograthus ordovicicus* conodont Zone are possible candidates to define the base of the terminal series for the System. However, there is no agreement that the historical British Series will necessarily be those finally recommended.

The Subcommittee, in collaboration with other specialists, will now consider these proposals for potential Series revision and for their definition and correlation with potential biohorizons and magnetostratigraphic events. Final draft decisions will be debated at the next International Symposium on the Ordovician System (possibly in Australia in 3-5 years' time), prior to submission and ratification by the Commission on Stratigraphy.

One workshop proved to be the most controversial: the Cambrian-Ordovician boundary, following the publication in July 1988, of a special issue of the *Geological Magazine* devoted to this topic. After fourteen years of investigation the Group has condensed the selection of a boundary stratotype to two sections: at Green Point in western Newfoundland and near Dayangcha, northeast China. In both the level is to be defined on conodonts just below the first appearance of nematophorous graptolites.

After debating the latest data, there were straw votes by both members of the Working Group present and by the workshop attendees as a whole. Both sets of votes preferred that the boundary stratotype be selected from the two final candidates, that Green Point, be favoured over Dayangcha, and that the boundary level of the base of *Cordylodus lindstromi* conodont Zone be favoured over the *C. intermedius* (no support) and *C. proavus* zones. A strong final recommendation of the workshop was that the Working Group arrange for a final mail ballot within the near future to arrive at a recommendation to the Commission on Stratigraphy.

A selection of the VISOS papers will be published by the Geological Survey of Canada. Further details on the Symposium and subsequent activities will be reported in *Ordovician News* produced by Barry Webby (Editor and Subcommittee Secretary, University of Sydney, Sydney, NSW 2601 Australia) to which Ordoviciophiles may subscribe.

C.R. Barnes
Geological Survey of Canada
580 Booth Street
Ottawa, Ontario K1A 0E4

Reuniting Gondwanaland

São Paulo, Brazil, 17 - 22 July 1988

Some 200 geoscientists from 22 countries met recently in São Paulo, at the 7th International Gondwana Symposium to discuss progress in understanding the geology of the supercontinent that was fragmented during Mesozoic time. The dismembered and far-travelled pieces are now spread into all continents, so that investigations of what the supercontinent was like, and of its ancient geologic history, involve many nations, languages, and methods of study.

New sea-floor data on magnetic stripes and recent isotopic dating reviewed in São Paulo add confidence to reconstructions of Gondwana in pre-fragmentation time. Pieces of the supercontinent in Tibet, where they have become involved in Himalayan deformations, are now documented. However, problems remain, especially in restoring fits between greater India and northwestern Australia, and in the way that slices of Gondwanan strata are distributed in southeast Asia. Paleomagnetic data from tectonic blocks now incorporated into continents have revised the fit, especially around Antarctica.

The now-dispersed Gondwana stratigraphic sections have a commonality between them, and several sessions concentrated on paleontologic and stratigraphic data and on interpretations of Gondwanan paleogeography in and around

small pieces that are now parts of Asia, Europe, and North America. One of the sponsoring organizations of the symposium is the IUGS Subcommission on Gondwana Stratigraphy, and at the final session, A.C. Rocha-Campos, organizer of the Symposium, was elected its new chairman, replacing J.M. Dickens of Australia.

One important topic in São Paulo was the history of the tectonic assembly of the Gondwana supercontinent prior to the early Paleozoic. For example, the Pan-African fold belt, which crosses through Africa and South America, is now much better mapped and its history can be interpreted through the prudent comparison of plate-tectonic concepts with data from the rocks within the fold belt and within the cratons to either side. Much interest during the meetings was, therefore, drawn to the paleogeography and tectonics of the Earth before the supercontinent came into existence. Over the 21 years that these symposia have been held, there has been a gradual swing of interest from details of the Paleozoic and early Mesozoic history to the long history of the regions upon which Gondwana sequences lie.

The proceedings of Gondwana VII will be published by the Brazilian Departamento Nacional da Produção Mineral, and the abstract volume and excursions guidebooks can be ordered from Paulo R. dos Santos, DPE, Instituto de Geociências, Universidade de São Paulo, C.P. 20899, CEP-01498 São Paulo, SP, Brazil. Negotiations are now underway to hold the next Gondwana Symposium in 1991 in southeast Asia.

John C. Crowell
University of California
Santa Barbara, CA 93106
U.S.A.

Figure 1: Metre-sized dropstone in thin-bedded glacial sequence (subaqueous), of the Carboniferous-Permian Tubarão Group, of eastern Paraná Basin.

basins originally confined within the supercontinent. The symposium was especially useful in that paleontologists, stratigraphers, coal geologists, paleoclimatologists, and others could compare notes on similarities and differences between such bedded sequences in India, Australia, Africa, South America, and Antarctica, as well as the relatively

LIST OF ABBREVIATIONS: Others are identified in the text or in the Directory of IUGS Bodies.

AGID	Association of Geoscientists for International Development
CGMW	Commission for the Geological Map of the World
GSA	Geological Society of Africa
IAEG	International Association of Engineering Geology
IAGC	International Association of Geochemistry and Cosmochemistry
IAGOD	International Association on the Genesis of Ore Deposits
IAH	International Association of Hydrogeologists
IAMG	International Association for Mathematical Geology
IAP	International Association of Planetology
ICL	Inter-Union Commission on the Lithosphere
IGC	International Geological Congress
IGCP	International Geological Correlation Programme
IGU	Iraq Geological Union
IMA	International Mineralogical Association
INQUA	International Union for Quaternary Research
IPA	International Palaeontological Association
JGA	Jordanian Geologists Association
SGA	Society for Geology Applied to Mineral Deposits
Unesco	United Nations Educational, Scientific and Cultural Organization