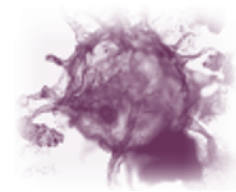


The 'New' EDIACARAN PERIOD



The latest geological time scale includes a newly identified period named after a locality in South Australia.

Kath Grey (Geological Survey of Western Australia), John Laurie (Geoscience Australia) and Jim Gehling (South Australian Museum)

The geological time scale has been developed by geoscientists over the past two centuries to describe and understand the history of the Earth.

Its foundation is an international standardised system of time intervals whose names commonly derive from words associated with the areas where they were first defined.

The Cambrian Period took its name from Cambria, the Roman name for northern Wales, while Jurassic is derived from the Jura region of northern Switzerland. Similarly, the new Ediacaran Period is named after the Ediacara Hills in the northern Flinders Ranges in South Australia.

The Earth thaws

The Ediacaran Period is the first period-level interval of geological time to be created in the Standard Global Chronostratigraphic Scale for well over 100 years. It covers an interval of about 88 million years from the end of the Marinoan glaciation about 630 million years ago to the beginning of the Cambrian Period about 542 million years ago.

As befits a period with such a well-known South Australian name, its base is defined by a Global Stratotype Section and Point (GSSP) at the base of the Nuccaleena Formation, immediately above the Elatina diamictite in the Enorama Creek section of the Flinders Ranges (figure 1). The GSSP was officially unveiled by the South Australian Premier, Mike Rann, on 16 April 2005.

This level in the rock succession marks the termination of the Marinoan glaciation. The Marinoan was the last truly global glaciation of the Neoproterozoic and, at its peak, saw continental glaciers reach sea level in tropical latitudes. It was so severe and widespread that some researchers consider that the entire planet froze (the 'Snowball Earth' hypothesis).

This glaciation, which began near the end of the appropriately named Cryogenian Period, is represented in the Flinders Ranges by the Elatina Formation and correlative units. The subsequent abrupt deglaciation led to the deposition of a peculiar carbonate unit termed a 'cap dolostone' which, in the Flinders Ranges, is found in the base of the Nuccaleena Formation. Cap dolostones like that in the Nuccaleena have been recognised around the globe immediately above the last of the Neoproterozoic glacial deposits.



▲ **Figure 1.** Professor Guy Narbonne (Queen's University, Canada), at left, and Dr Jim Gehling (SA Museum) at the Ediacaran Global Stratotype Section and Point at the base of the Nuccaleena Formation, in Enorama Creek, Flinders Ranges. The toe of Professor Narbonne's left boot is just above the marker denoting the base of the Ediacaran. Dr Gehling is leaning on the explanatory sign.

New life, new system

The Ediacaran is perhaps most famous for its association with the Ediacara biota (figure 2), a peculiar group of organisms, many of which are of uncertain affinity. Although they had previously been found in other places around the world, their significance only began to be understood when they were discovered in the Ediacara Hills by Reg Sprigg in 1946 (Sprigg 1947).

They mark the first appearance of large, architecturally complex organisms in Earth history. Although there has been a great deal of debate about their relationships, current evidence suggests that the Ediacara biota included a mixture of stem- and crown-group radial animals, stem-group bilaterian animals and perhaps representatives of other eukaryotic kingdoms.



Dickinsonia costata



Parvancorina minchami



Tribrachidium heraldicum

▲ **Figure 2.** Representatives of the Ediacara biota.

The Association of Australasian Palaeontologists recently published 'Ediacaran Palynology of Australia' (Grey 2005; figure 3) with support from the Virtual Centre for Economic Micropalaeontology and Palynology and the Geological Survey of Western Australia.

Using a diverse palynoflora, one of us (Grey) has developed the first biostratigraphic scheme for the Ediacaran of Australia. Indeed, it is the first continent-wide biostratigraphic study of such a long interval of Proterozoic time published anywhere in the world.

The scheme of five assemblage zones—based on the ranges of over 60 species of the problematic single-celled organisms called acritarchs (see figure 4)—allows rock successions in the Adelaide Rift Complex and the various remnant basins of the Centralian Superbasin to be correlated more precisely than has previously been possible.

There is much potential for further subdivision and more precise correlation as these acritarch assemblages become better documented. The assemblages also show promise for global correlation because some of the species identified in Australia are also known from coeval successions in China, Siberia and northern Europe.

Ediacaran assemblages in the Centralian Superbasin and Adelaide Rift Complex are taxonomically diverse, with two palynofloras and five assemblage zones recognised (figure 4). The older palynoflora, the Ediacaran Leiosphere-dominated Palynoflora, contains only one assemblage zone. It is succeeded by a younger Ediacaran Complex-Acanthomorph-dominated Palynoflora, which contains four assemblage zones. These zones are demonstrably independent of lithology and can be recognised across the Adelaide Rift Complex and the Officer and Amadeus basins, despite taphonomic and palaeoenvironmental influences.

The large Neoproterozoic acanthomorph acritarchs, which are between 200 and 900 µm in diameter and which form a significant component of these diverse Ediacaran assemblages, are poorly represented in samples prepared using standard palynological preparation techniques. They are particularly vulnerable to fragmentation because of their large size and fragility.

As a consequence, an improved palynological preparation technique—described by Grey (1999)—had to be developed for this study. This produced greatly increased yields of microfossils from horizons that were seemingly barren or had only limited yields using standard techniques. The improved method has increased yields from Ediacaran sediments and allowed the development of this detailed biostratigraphic scheme.

An evolutionary shock?

The marked and rapid increase in abundance, size, morphological complexity and taxonomic diversity of life forms during the Australian Ediacaran shows that it was a period of major evolutionary change. Observed biotic changes are radical, and the position of this important transition matches a short-lived negative $\delta^{13}\text{C}_{\text{org}}$ excursion that approximates to the debris layer from the Acraman impact event. The $\delta^{13}\text{C}_{\text{org}}$ is used as a measurement of the ratio of Carbon isotopes in the organic material in the rock.

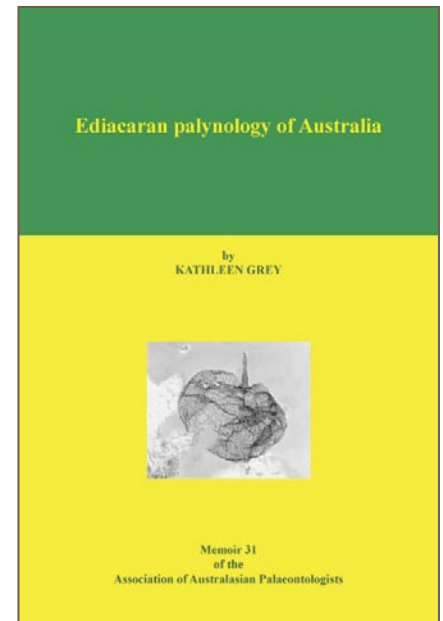
This impact was of a meteorite estimated to be about 4.8 kilometres across, which left a crater about 90 kilometres in diameter centred on Lake Acraman in South Australia. Debris from the impact is spread over a radius of at least 560 kilometres, but it was so large that it would have had a global effect. The following marked positive $\delta^{13}\text{C}_{\text{org}}$ excursion corresponds to the acanthomorph acritarch diversification. The evidence for a relationship between the Acraman impact event and this dramatic diversification is largely circumstantial, and requires further investigation.

References

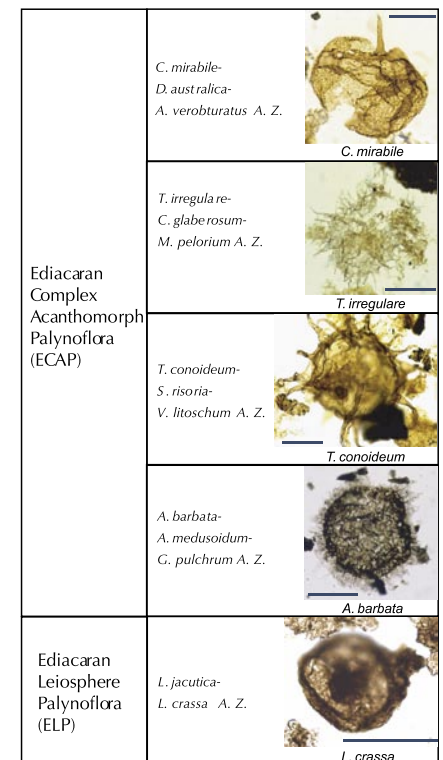
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2. Grey K. 2005. Ediacaran Palynology of Australia. Memoir of the Association of Australasian Palaeontologists 31:1–439.
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Copies of *Ediacaran Palynology of Australia* are available from the Geological Society of Australia (www.gsa.org.au/publications.html)

For more information phone John Laurie on +61 2 6249 9412 (email john.laurie@ga.gov.au)



▲ **Figure 3.** Front cover of 'Ediacaran Palynology of Australia' (Grey 2005).



▲ **Figure 4.** Ediacaran biostratigraphic scheme of assemblage zones (AZ) from Grey (2005), with illustrations of some of the eponymous acritarchs. Scale bars are 100 µm in length.