A Proterozoic Pangaea?

from D.H. Tarling

In a recent review of palaeomagnetic data (*Earth planet. Sci. Lett.* **59**, 61; 1982), Piper concludes that a single huge continent, Pangaea, existed throughout the Proterozoic period of the Earth's history (2,600–570 Myr ago). Such a conclusion is consistent with many geological features that indicate extensive continental stability during this period, yet Piper's analyses also require that this Pangaean supercontinent was in motion relative to the Earth's axis of rotation. Such motion must, presumably, be associated with the same mantle convective motion that currently results in continental splitting and ocean-floor spreading. Piper's conclusions are thus of fundamental importance in testing some of the basic assumptions in both palaeomagnetism and plate tectonics.

Palaeomagnetic studies allow the determination of the palaeolatitude and orientation (relative to the palaeomagnetic pole) of the sampled area. Where sufficient data are available, they can be used to construct a palaeomagnetic polar wandering curve, indicating the changing position of the pole relative to the stable tectonic block from which the samples were obtained. Such curves do not, in fact, mean that the pole is moving, as this is fixed relative to the ecliptic, but results from a movement of the sampled region relative to the pole. The fact that polar wandering curves exist for the Proterozoic is thus of the utmost importance as it clearly indicates that the continent, or continents, were in motion and were presumably driven by mantle convection.

If polar wandering paths for the same period of time can be matched between different tectonic units, then the relative positions of these tectonic units can be precisely defined. Thus the palaeomagnetic data from the different cratonic blocks of the world can be used to determine the existence, or not, of one or more continental units during the Proterozoic. Piper finds that he can define Pangaea throughout the Proterozoic as a cigar-shaped continent comprising Australia, China, India and Antarctica backing onto western South America–Africa, with Kazakhstan–Siberia against North Africa and bordering onto western Laurentia (North America, Greenland and Europe). Piper finds that such a continent is not only required by the palaeomagnetic data but is also consistent with the available geological evidence.

It is only too easy to be sceptical about the data base on which any such model is erected. Even with a single craton, the radiometric dating of any intrusive event is uncertain within 100–200 Myr, even ignoring problems of open chemical systems, during which time major continental motions could have occurred. It is also worrying that much Precambrian data are based on alternating magnetic field demagnetizations — a technique that is 'noisier' then thermal demagnetization — yet thermal demagnetization is often apparently ineffective in determining discrete components of remanence. Even when such components can be isolated, there is doubt about their age. There is a tendency to assume that the component with the highest stability is, in fact, the oldest — yet this may simply reflect the presence of haematite that may have formed very much later than the rock itself. Even when such components have been isolated and dated, it is rare for there to be adequate tectonic control of subsequent movements, although the Proterozoic crust appears to have been little deformed as the overlying sediments tend to have only shallow dips. The uncertainties involved are thus immense and require subjective evaluation. Unfortunately, this can lead to the syndrome in which scattered data are examined and the odd points that are near to previous observations are accepted for publication and the remainder appear, if at all, in the inaccessible appendix of a thesis. Despite Piper's attempts to be objective, therefore, the data may well already have been subjectively selected to conform to previous data or models. However, the only way in which such problems can be resolved is by the erection of specific models which can then be tested by a variety of methods and by new data.

This is not Piper's first model and it seems unlikely to be his last. However, the fact that he can make a very plausible case for support of his model is, in itself, of great importance. It demonstrates, for example, that continental motions occurred, thus indicating the action of mantle convection currents. This is no great surprise in view of the much higher radiogenic heat production in the past, but raises the problem of why such motions did not cause continental splitting, as they do now and also did in pre-Proterozoic times. The implication is that the continental lithosphere, in Proterozoic times, was too strong or too thick to be split by such motions. But how did such a thickness develop suddenly at the end of Archaean times and what caused the change to present-day continental splitting? □

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The sunflower seed protection business

from Peter D. Moore

The consumption of the seeds of plants by invertebrate and vertebrate predators is a serious problem for the agronomist, and much effort has been devoted to finding ways of limiting the predators' numbers. There is, however, a quite different way of tackling the problem. In a recent paper[1], field trials are reported of attempts to protect economically important seeds by buying off the predators with an abundant supply of another seed.

In many North American forests, small mammals have often been found responsible for seed predation and depression of woodland regeneration, in particular the douglas fir (*Pseudotsuga menziesii*) has been much studied. That seed predators may limit the regeneration of plant species has been known for some time. As long ago as 1919 Watt's[1] records of the fate of acorns in oakwoods showed that high mortality of acorns in oakwoods could be largely put down to predation by birds and mammals. He also found that in the case of beech[2], invertebrates were involved and concluded that the low level of regeneration found in British woodland was a consequence of seed predation. The high population density of mice and voles, regarded by him as major culprits, could in turn be related to rearing of game birds and consequent destruction of predators, a view supported and popularized by Tansley[3].

The possibility that the problem might be overcome through providing an alternative food source was first approached experimentally by Sullivan[4] who supplied deer mice (*Peromyscus manlculatus*, a major seed predator of douglas fir) with sunflower seed in order to distract it from the conifer seed. He found that very large quantities of sunflower seed had to be provided (seven sunflower seeds for every douglas fir seed) in oraer to reduce predation significantly.

Sullivan and Sullivan[5] have now repeated these experiments with lodgepole pine (*Pine contorta*) in an area of British Columbia from which the pine had been

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