N89-26359

THE GEOLOGICAL RECORD OF LIFE 3500 Ma AGO: COPING WITH THE RIGORS OF A YOUNG EARTH DURING LATE ACCRETION

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Thin cherty sedimentary layers within the volcanic portions of the 3,500 to 3,300 Ma-old Onverwacht and Fig Tree Groups, Barberton Greenstone belt, South Africa, and Warrawoona Group, eastern Pilbara Block, Western Australia, contain an abundant record of early Archean life. Five principal types of organic and probably biogenic remains and/or structures can be identified (Lowe, 1986): (1) stromatolites, (2) stromatolite detritus, (3) carbonaceous laminite or flat stromatolite, (4) carbonaceous detrital particles, and (5) microfossils.

Early Archean stromatolites have been reported from both the Barberton and eastern Pilbara greenstone belts. Systematic studies are lacking, but two main morphological types of stromatolites appear to be represented by these occurrences. The Barberton stromatolites (Byerly *et al.*, 1986), which are developed in thin cherty units interbedded with komatiitic lavas in the uppermost part of the Onverwacht Group, and stromatolites in the Towers Formation of the Warrawoona Group (Walter *et al.*, 1980) appear to represent the same type of small, low-relief, unbranched stromatolites. In Barberton, this type of stromatolite appears to have developed preferentially on hard substrates along moderate to low energy rocky coasts. Although some stromatolites occur within units containing replaced evaporites, there is no direct interbedding of evaporites and stromatolites. There is no evidence that evaporitive precipitation exerted a significant control on stromatolite morphology although shoreline splash-type wetting and evaporation may have locally contributed to stromatolite build-up and early lithification.

In both Barberton and Pilbara sequences, these stromatolites are associated with distinctive units of stromatolite-chip breccia. These include beds and lenses from a few mm to over 3 m thick composed of sand- and granule-sized, curved, laminated, sometimes carbonaceous stromatolite plates. Similar detritus is also present within cherty sedimentary units throughout the Onverwacht and Warrawoona Groups that are not otherwise known to contain stromatolites. The ubiquitous association of stromatolites and units of rigid stromatolite debris indicates that the stromatolites were partially lithified during growth but still sufficiently fragile to be easily broken up by wave or current activity. The abundance of stromatolite debris suggests that stromatolites were widely developed along wave-agitated rocky shorelines during accumulation of these early Archean greenstone belt volcanic sequences.

A second stromatolite morphology is developed in the Strelley Pool Chert in the upper part of the Warrawoona Group (Lowe, 1980). Small conical stromatolites are interbedded with silicified evaporites over hundreds of square km and show clear evidence that stromatolite growth was strongly influenced if not controlled by precipitative processes.

Carbonaceous laminite, massive black carbonaceous chert, and banded carbonaceous cherts are common within interflow sedimentary layers in these early Archean greenstone belt volcanic sequences. Most of these layers were deposited under quiet, low-energy, subaqueous conditions. In shallow-water sections, they appear to include both *in situ* silicified bacterial mats and detritus eroded from them. Carbonaceous matter in deeper-water deposits consists exclusively of fine-grained pelagic, hemipelagic, or current-deposited detritus.

Preserved early Archean stromatolites and carbonaceous matter appear to reflect communities of photosynthetic cyanobacteria inhabiting shallow, probably marine environments developed over the surfaces of low-relief, rapidly subsiding, simatic volcanic platforms. The overall environmental and tectonic conditions were those that probably prevailed at Earth's surface since the simatic crust and oceans formed sometime before 3,800 Ma. Recent studies also suggest that these early Archean sequences contain layers of debris formed by large-body impacts on early Earth (Lowe and Byerly, 1986, 1988; Lowe *et al.*, 1988). If so, then these early bacterial communities had developed strategies for coping with the disruptive effects of possibly globe-encircling high-temperature impact vapour clouds, dust blankets, and impact-generated tsunamis. It is probable that these early Archean biogenic materials represent organic communities that evolved long before the beginning of the preserved geologic record and were well adapted to the rigors of life on a young, volcanically active Earth during late bombardment. These conditions may have had parallels on Mars during its early evolution.

REFERENCES

Byerly, G. R., Lowe, D. R., and Walsh, M. M. Stromatolites from the 3,300-3,500-Myr Swaziland Supergroup, Barberton Mountain Land, South Africa. *Nature* **319**:489-491, 1986.

Lowe, D. R. Stromatolites 3,400-Myr old from the Archean of Western Australia. *Nature* **284**:441-443, 1980.

Lowe, D. R. Early Archean organisms and paleoenvironments: 5th meeting of the International Soc. for the Study of the Origin of Life, Berkeley, Abstracts, p. 7, 1986.

Lowe, D. R., and Byerly, G. R. Early Archean spherules of probable impact origin, South Africa and Western Australia. *Geology* **14**:83-86, 1986.

Lowe, D. R., and Byerly, G. R. Identification and effects of large, early Archean, terrestrial meteorite impacts: a geological perspective on late accretion. 19th Lunar and Planetary Science Conference, Abstracts, 1988.

Lowe, D. R., Asaro, F., and Byerly, G. R. Iridium anomalies associated with early Archean spherule layers, South Africa and Western Australia. 19th Lunar and Planetary Science Conference, Abstracts, 1988.

Walter, M. R., Buick, R., and Dunlop, J. S. R. Stromatolites 3,400-3,500 Myr old from the North Pole area, Western Australia. *Nature* **284**:443-445, 1980.