

N92-13635

EARLY ARCHEAN STROMATOLITES: PALEOENVIRONMENTAL SETTING AND CONTROLS ON FORMATION

D. R. Lowe*

Department of Geology, Stanford University

The earliest record of terrestrial life is contained in thin, silicified sedimentary layers within enormously thick, predominantly volcanic sequences in South Africa and Western Australia. This record includes bacteria-like microfossils, laminated carbonaceous structures resembling flat bacterial mats and stromatolites, and a morphologically diverse assemblage of carbonaceous particles. These structures and particles and their host sediments provide the only direct source of information on the morphology, paleoecology and biogeochemistry of early life; the nature of interactions between organisms and surface systems on the early earth; and possible settings within which life might have evolved.

The three known occurrences of 3.5 to 3.2 billion-year-old stromatolites have been evaluated in terms of depositional setting and biogenicity. All occur within sedimentary units deposited in shallow, probably marine waters on large, low-relief, oceanic volcanic platforms. Hawaii provides perhaps the best modern analog. Evaporitic sediments are common components of these sequences. Associated, off-platform, deep-water deposits commonly contain abundant detrital carbonaceous matter but appear to lack in situ bacterial mats or stromatolites. This environmental specificity of early bacterial communities represents perhaps the most convincing evidence yet reported that they included photosynthetic organisms. The morphology of small conical stromatolites in the Strelley Pool Chert, Western Australia, appears to have been controlled mainly by precipitative processes in hypersaline waters. The well-known stromatolite from the North Pole, Western Australia, consisting of a single specimen that includes one partial stromatolite, probably represents a chunk of flat bacterial mat deformed by soft-sediment movement and the post-depositional growth of evaporitic carbonate or gypsum nodules. Stromatolites in the Barberton Greenstone Belt, South Africa, formed at least in part by inorganic precipitation and resemble siliceous sinter. They apparently developed by silica precipitation in wave- and current-active shallow-water areas fringing the volcanic platforms. Although all of these early Archean stromatolites appear to have been formed at least in part by inorganic, commonly precipitative processes, there is also some evidence that they were covered by active bacterial mats during growth. This may simply reflect passive biological opportunism. It seems plausible, however, that the surficial mats played an important role in controlling local microenvironments and influencing if not mediating precipitation. This could reflect a more active strategy involving the coupling of biological and inorganic processes to produce structures on the shallow sea floor that enhanced community survival.