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Preface

Earliest evidence of life on earth

On 20 June 2006 a symposium on the paleobiology of the early Earth was held during the 2nd International Palaeontological Congress at Beijing University. This volume is derived from presentations at that symposium.

The hunt for evidence of Archean life has a history that spans more than a century. Finding definitive evidence of such ancient microbes can be challenging, though by the onset of the Proterozoic the established record is overwhelming. In the late Archean, abundant well-preserved and diverse stromatolites, hydrocarbon biomarkers, carbon and sulfur isotope signals and, less commonly, microfossils, attest to flourishing microbial life inhabiting broad marine platforms as well as widespread greenstone-dominated settings. Until recently, however, the evidence from Archean successions older than 3 Ga has been less convincing. The oldest recognizable sedimentary rocks are ∼3.8 Ga, of which those in southwestern Greenland are best known. All such very old rocks have been strongly tectonized, and many have been metamorphosed to amphibolite grade. Despite the concerted efforts of numerous researchers, definitive evidence of life has yet to be discovered in these especially ancient terrains, though the abundance and isotopic composition of the graphitic matter preserved in some of the surviving metasediments is suggestive.

For the last 40 years the search for early life has focused on the relatively well-preserved 3.2–3.5 Ga rock successions of the Barberton Mountainland in South Africa and the Pilbara Craton of Western Australia (e.g., Barghoorn and Schopf, 1966; Pflug, 1967; Engel et al., 1968; Nagy and Nagy, 1969; Oehler et al., 1972; Walter, 1976; Knoll and Barghoorn, 1977; Dunlop et al., 1978; Lowe, 1980; Walter et al., 1980; Buick et al., 1981; Awramik et al., 1983; Schopf, 1983, 1993, 2006; Walsh and Lowe, 1985; Byerly et al., 1986; Schopf and Klein, 1992; Grotzinger and Knoll, 1999; Hofmann et al., 1999; Hofmann, 2000; Ueno et al., 2001; Schopf et al., 2002; Tice and Lowe, 2004; Allwood et al., 2006; Westall and Southam, 2006). At first, the known record was confined to very rare microfossils, sparse stromatolites, and isotopically light kerogen. Only the kerogen record escaped vigorous dispute, though even that has been questioned. In recent years, however, stromatolites have been shown to be widespread and diverse in these terrains, and there are now many reports of microfossils. Nonetheless, a few workers still dispute such ancient evidence for life.

Even more recently, discoveries of zircon grains as old as 4.4 Ga and studies of their geochemistry have yielded remarkable insights into the tectonics and even the surface environments of the very ancient Earth, and models of the composition of the early atmosphere and of the chemistry and structure of the hydrosphere are becoming more and more refined. In addition, as the exploration of the Solar System gathers pace, comparative planetology is stimulating new conjectures about the first billion years of Earth's history, just as new knowledge of Earth's earliest biosphere is informing the search for life on other planets.

In this volume much new evidence is presented and some previous work is reviewed and evaluated. Lowe and Tice discuss the known Archean rock record. Sugitani and his colleagues describe new finds of Archean microfossils. Furnes et al. report microbial borings in Archean pillow lavas. Schopf et al. review the Archean stromatolite and microfossil records and present new data on the reported fossils of ∼3465 Ma Apex Basalt chert; and Allwood and her colleagues summarize their recent in-depth studies of the stratigraphic setting and morphology, paleoecology, and biogenicity of ∼3400 Ma stromatolites.

It was apparent during the symposium that the discussion has now shifted from whether life actually existed at 3.4–3.5 Ga to the nature of that life and the composition of the biosphere. Early evolved ecosystems are being identified, mapped and interpreted. Specific kinds of microbial populations are being postulated. Hints of a deep history for the Eucarya are being uncovered. The discovery of particularly well-preserved ancient rock

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units and the application of new and improved analytical techniques are yielding a wealth of new information. One thing is clear: there will be an explosion of research and new findings in the coming decade that will greatly improve our understanding of early life on Earth.

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