EARLY ARCHEAN (~3.4 Ga) PROKARYOTIC FILAMENTS FROM
CHERTS OF THE APEX BASALT, WESTERN AUSTRALIA:
THE OLDEST CELLULARLY PRESERVED MICROFOSSILS NOW KNOWN

J. W. Schopf*

Department of Earth and Space Sciences, Institute of Geophysics and Planetary
Physics, Center for the Study of Evolution and the Origin of Life
University of California

In comparison with that known from later geologic time, the Archean fossil record is
miniscule: although literally hundreds of Proterozoic formations, containing more than
2800 occurrences of bona fide microfossils, are now known, fewer than 30 units,
containing some 43 categories of putative microfossils (the vast majority of which are
of questionable authenticity), have been reported from the Archean. Among the oldest
fossils now known are Early Archean filaments reported from cherts of the Towers
Formation (Awramik et al., 1983) and the Apex Basalt (Schopf and Packer, 1987) of
the 3.3-3.6 Ga-old Warrawoona Group of Western Australia. The paleobiologic
significance of the Towers Formation microstructures is open to question: thin
aggregated filaments described by Awramik et al. are properly regarded as
"dubiomorphicossils" -- perhaps biogenic, but perhaps not -- and they therefore cannot
be regarded as firm evidence of Archean life. And although authentic, filamentous
microfossils were reported by Awramik et al. from a second Towers Formation locality,
because the "precise layer" containing the fossiliferous cherts "has not been relocated"
(Awramik et al., 1983, 1988), this discovery can neither be reconfirmed by the original
collector nor confirmed independently by other investigators.

Discovery of microfossils in bedded cherts of the Apex Basalt (Schopf and Packer,
1987), the stratigraphic unit immediately overlying the Towers Formation, obviates the
difficulties noted above. The cellularly preserved filaments of the Apex Basalt meet all
of the criteria required of bona fide Archean microfossils: (i) they occur in rocks of
unquestionably Archean age; (ii) they are demonstrably indigenous to these Archean
sediments; (iii) they occur in lithic clasts that are assuredly syngenetic with deposition
of this sedimentary unit (with the fossils themselves pre-dating deposition of the
bedded cherts in which the clasts occur); (iv) they are certainly biogenic; and (v) as
demonstrated by replicate sampling of the fossiliferous outcrop, the provenance of
these microfossils is known with certainty. Recent studies indicate that the Apex
assemblage includes at least six morphotypes of uniseriate filaments, composed of
barrel-shaped, discoidal, or quadrate cells and exhibiting rounded or conical terminal
cells and medial bifurcated and paired half-cells that reflect the occurrence of
prokaryotic binary cell division. Interestingly, the majority of these morphotypes are
morphologically more similar to extant cyanobacteria than to modern filamentous
bacteria. Prokaryotes seem clearly to have been "hypobradytelic," exhibiting
exceptionally slow rates of morphological evolutionary change, and the evidence
suggests (but does not prove) that physiologically advanced oxygen-producing
photosynthesizers may have been represented in the Early Archean biota.