Early Life on Earth and the Search for Extraterrestrial Biosignatures

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An understanding of earliest terrestrial life is of astrobiological importance, as knowledge of early evolutionary processes on Earth could provide insight to development of life on other planets. Yet, the nature of early life on Earth is difficult to assess because the oldest potential biosignatures are commonly poorly preserved.

Johnson Space Center has been using the relatively new technique of nanometer-scale, secondary ion mass spectrometry (NanoSIMS) to evaluate ancient microorganisms preserved on Earth. Results from well-preserved and non-controversial microfossils have provided new criteria for assessing the origin of poorly preserved organic materials. These criteria were applied to controversial organic microstructures from a 3-billion-year-old sedimentary rock in Australia. Results suggest that the organic structures are biogenic and the same age as the rock. More importantly, results from NanoSIMS add to a growing body of data suggesting that by 3 billion years ago, life on Earth was multifaceted and diverse. This view of early terrestrial evolution may increase the likelihood that primitive life on other planets could survive and adapt to adverse or unusual conditions by ready development of diversity in form and biochemistry (figures 1 and 2).

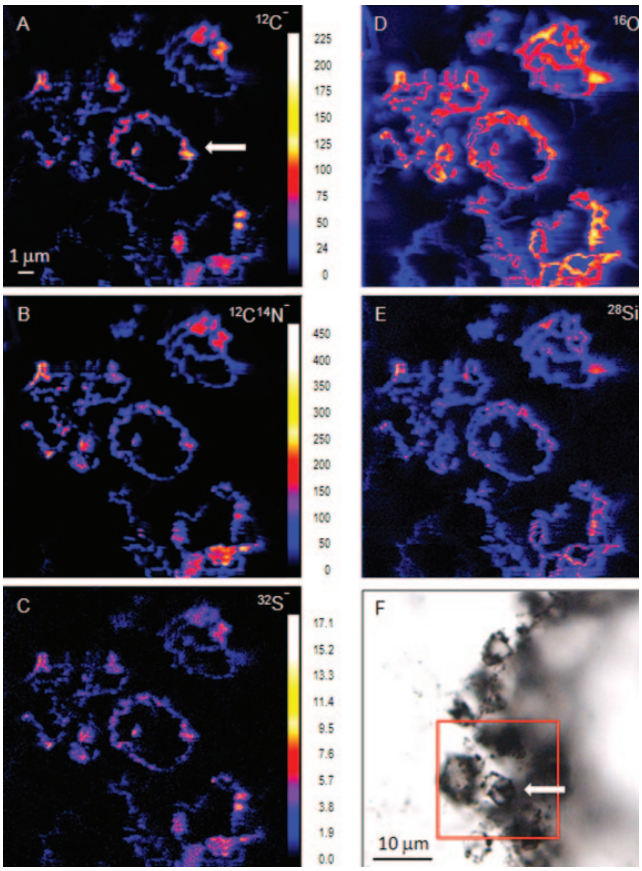

Fig. 2. *Controversial, organic microstructures in a 3-billion-year-old rock from the Pilbara of Australia: (a-e) nanometer-scale, secondary ion mass spectrometry element maps of the spheroidal structures within the red rectangle of (f); (f) optical photomicrograph in transmitted light of a thin section.*

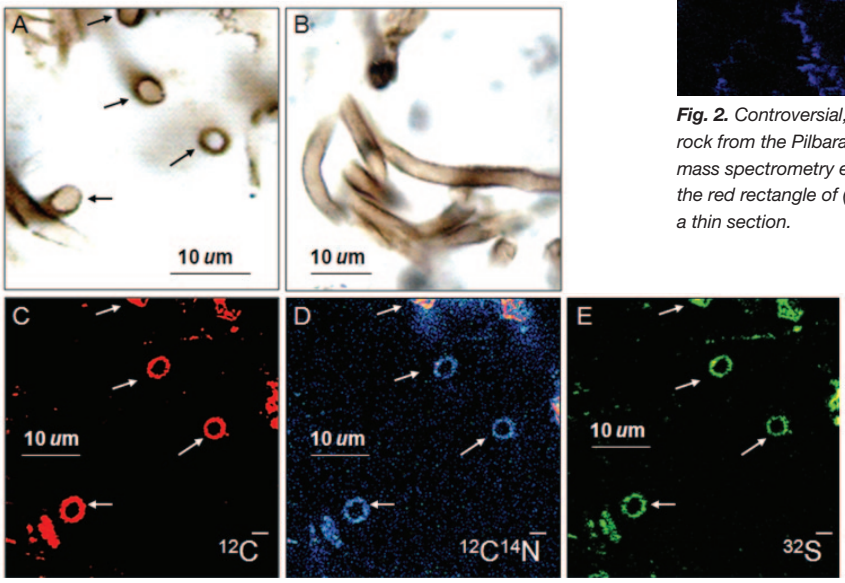

Fig. 1. *Well-preserved, 1-billion-year-old organic microfossils, Bitter Springs Formation, Australia: (a-b) optical photomicrographs in transmitted light of filamentous microfossils in a thin section; (c-e) nanometer-scale, secondary ion mass spectrometry element maps of the three filaments imaged in cross-section of (a).*