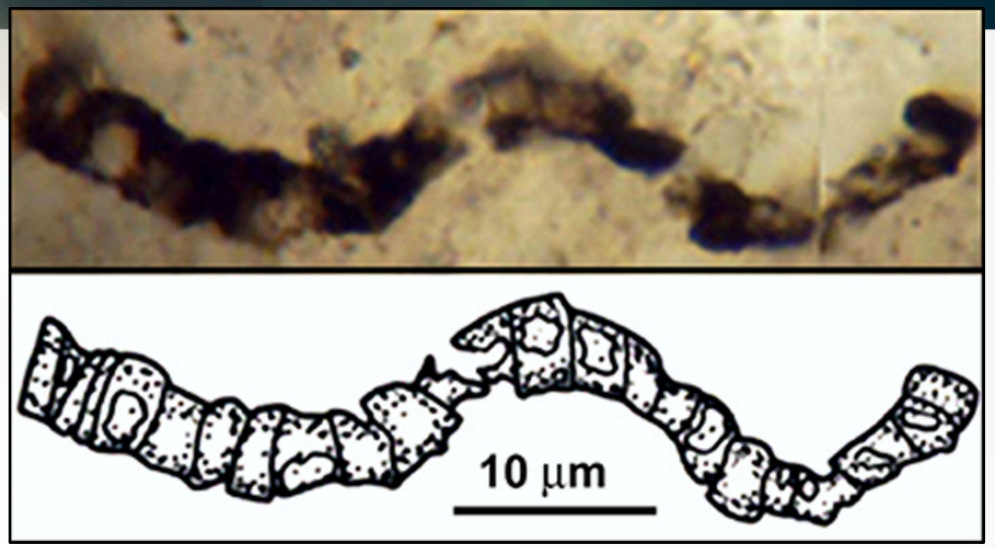
Earth's Oldest Fossils Show Life Evolved Early, Far and Fast

BACKGROUND: Eleven species of microscopic fossils were first reported in 1993 from the 3,465-million-year-old Apex chert of Western Australia. Follow-up studies documented their coal-like carbonaceous composition and the box-like cells of their thread-like filaments. Their relations to modern microbes and how they lived remained unknown.



***Primaevifilum amoenum*, Apex chert, interpreted to be a methane-consuming γ-Proteobacterium. CREDIT: J.W. Schopf, UCLA.**

RESEARCH AND RESULTS: Using SIMS (secondary ion mass spectrometry), measurements of the ratio of carbon isotopes in 11 specimens of five species of the Apex fossils show them to be notably diverse in their metabolism and role in Earth's ecology. Two of the fossil species are primitive non-oxygen-producing photosynthetic bacteria, evolutionary precursors of the O_2-generating plants that drive today's ecosystem; one is a member of the Archaea, an early-evolved group that produces methane; and the other two are methane-consumers. Coupled with this same team's report in September of 2017 of sulfate-reducing bacteria only 65 million years younger than the Apex fossils, this new finding documents the diversity of early life on Earth.

SIGNIFICANCE OF THIS WORK: Microbial photosynthesizers, sulfate-reducers, and methane-producing and -consuming microorganisms existed more than 3,400 million years ago, only a billion years after Earth's formation. All of these groups live today and all have complex cells. Life must have originated much earlier – perhaps 4,000 million years ago –and rapidly than had been imagined.

J. William Schopf, Kouki Kitajima, Michael J. Spicuzza, Anatoliy B. Kudryavtsev, John W. Valley. SIMS analyses of the oldest known assemblage of microfossils document their taxon-correlated carbon isotope compositions. *PNAS*. doi: 10.1073/pnas.1718063115