Discovery of possible microfossils from c. 3.4 Ga Strelley Pool Chert, Pilbara Craton: evidence for antiquity of biotic diversity?

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The Pilbara Craton, Western Australia contains one of the best-preserved Archean volcano-sedimentary successions in the world and gives us the chance to search for the oldest evidence of life on Earth, although the origin of biogenic structures in the Archean is currently a highly controversial topic. Recently, possible biogenic microstructures were discovered by K.S. in black chert of the c. 3.4Ga Strelley Pool Chert (SPC) at Mt. Goldsworthy and Mt. Grant in the northeastern Pilbara Craton. The morphologically diverse, abundant microstructures are identified in thin sections. They are surprisingly well preserved and may provide evidence for antiquity of life and biotic diversity. We are now collaborating with Australian Centre for Astrobiology (M.R. Walter, A. Allwood & C.P. Marshall) and Geological Survey of Western Austrlia (M. Van Kranendonk & K. Grey), in order to reveal the whole picture of the microstructure of possoble biogenic origin.

The Archean sedimentary succession at the Mt. Goldsworthy-Mt. Grant region is composed of 50m thick quartz-rich clastic rocks and overlying laminated to banded chert up to hundreds meters thick. Black chert containing possible microfossils occurs at the uppermost portion of the clastic rock unit. The black chert is composed dominantly of microcrystalline quartz and is locally characterized by agate-like or stalactitic texture, possibly originated from dissolution cavities, and partially displays microscopic fenestra-like structure. A few layers of black chert less than 20cm thick are inter-bedded with fine- to coarse-grained clastic rocks and evaporite; this association totals less than 5m thick and extends laterally 1km along strike at Mt. Grant. The black chert is evidently sedimentary in origin and is assumed to have deposited in the shallow to sub-aerial depositional environment at a coastal setting. Four major morphological types of carbonaceous microstructures are preliminarily identified, including filamentous, film-like, spherical and lenticular to spindle-like structures. Biogenicity is inferred from their carbonaceous composition, narrow size distribution, inferred physical properties (flexible but breakable), colony-like occurrence, hollow interiors, and/or resemblance to modern bacteria. Bulk isotopic composition also supports a biogenic origin of the component carbonaceous matter.

Many of spherical and lenticular to spindle-like structures are larger than 20 microns, up to 80 microns in diameter or length. The size is comparative to that of modern eukaryote, although they could be outer sheath of colony or spore of prokaryote. Alternatively, they may have been kinds of big bacteria, like some species of sulfur bacteria. The possible presence of photosynthetic microbes is also suggested from assumed shallow to sub-aerial depositional environment for the host chert. The microstructures discovered from SPC at Mt. Goldsworthy and Mt. Grant, Pilbara Craton suggest the early development of a microbial community in the shallow euphotic zone.