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Oldest Convincing Evidence for Life on Earth Discovered in Archaean Subaerial Hot Springs: Implications for an Origin of Life on Land

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Introduction: New discoveries in the Dresser Formation in the Pilbara of Western Australia reveal that the surrounding North Pole Dome area is not a marine coastline as previously thought but is an ancient volcanic water-filled caldera ringed with hot springs. These rocks have been dated to 3.48Ga making this the oldest pristine piece of the Earth's Paleoarchean crust. Adding to the recently published discovery of Dresser Formation geyserite [1] bedded with well preserved stromatolites (rock textures preserving evidence of microbial activity) the morphologies at the newly discovered "Southern Locality" represent a diverse range of microbial communities thriving within subaerial fresh water hot springs, streams and pools. Preservation visible in the figure below includes: microbial communities within flowing hot water rich in silica; microbial mats ripped up and folded at a shoreline by a storm event; and domical stromatolites buried and preserved by a volcanic ash deposit. Such a robust presence of life on land in the earliest fossil record suggests that life may have originated in or around such hot spring pools. A consensus is building that the chemistry of life favors its origin on land, not in a deep or shallow marine environment [2]. These discoveries add to the weight of evidence in support of a terrestrial origin of life, in which in-falling organic compounds can both be concentrated in pools for reactions to occur and also subject to nonenzymatic polymerization through wet-dry cycling from the hydrothermal system. Polymer-encapsulating protocells cycling through three phases provide a kinetic trap mechanism [3,4] for the chemical evolution of a Woese progenote [5], its evolution into cellular life and a downhill adaptation pathway of early life to the shallow marine setting. The diversity of morphologies observed in Southern Locality rocks suggest that hot springs were dynamic and powerful drivers for life to first arise and then adapt to niches on land and in the sea.

References:

[1] Djokic T et al. (2017). *Nature Comunications*. (in press). [2] Deamer DW and Georgiou C (2015) *Astrobiology* 15(12): 1091-1095. [3] Damer BF and Deamer DW (2015) *Life* 5(1) 872-887. [4] Damer BF (2016) *Life* 6(2) 21. [5] Woese C and Fox G (1977) *Proceedings of the National Academy of Sciences* 74:5088–5090

Figure 1 – Left, stromatolite laminates (red) bedded within barite-length 6cm; Center, edgewise conglomerates produced by rmicrobial mat ripped up by a storm event and; Right,domical stromatolites preserved in volcanic ash.