

Activity of the ancient deep continental biosphere revealed by uranium isotopes in reduction spheroids

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Life on Earth extends several kilometres down from the surface into porous subterranean and subseafloor rocks and sediments. The "deep biosphere" contains a large biomass (>20% of Earth's total) of metabolically active and diverse microbial populations, and is likely to have played critical roles over geological time in the evolution of microbial diversity, diagenetic processes, and biogeochemical cycles. However, very little is known about deep life in deep time, in part because of a paucity of fossil and geochemical evidence. Here, we apply the recently developed uranium-isotope proxy for biological uranium reduction to reduction spheroids (bleached spots) in continental rocks (red beds) ranging from Mesoproterozoic to Permo-Triassic in age. Although these common palaeo-redox features have previously been suggested to reflect deep bacterial activity, unequivocal evidence for biogenicity has been lacking. Our analyses show a clear fingerprint of metal reducing bacteria in all samples, revealing a compelling new record of Earth's deep biosphere.