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Earth's earliest chemofossils? The importance of getting the geology and geochronology right!

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Four decades have now passed since Schidlowski et al. [1] proposed that a light carbon isotope signature in metasedimentary rocks, as found in the 3.7 Ga Isua Greenstone Belt (IGB) of southwest Greenland, might be used to indicate the presence of life in some of the earliest preserved geology. Isotopic evidence was relied upon because the host rocks have been metamorphosed and deformed to a degree that precludes preservation of unambiguous biomorphic features, such as those seen in the ca. 3.4 Ga algal mats at Strelley Pool, Western Australia [2]. Since Schidlowski et al.'s seminal work, a number of claims have been made for low δ13C indicating life in the Eoarchean, including those from Isua [3] and Akilia [4] in west Greenland, and the Nuvvuagittuq Greenstone Belt [5] and Saglek region, Labrador [6] in northern Canada. Such cases, often hailed at the time of publication as evidence for 'the Earth's oldest life', attract great publicity and debate, and are remarkable not least because of the overlap with a time when the rate of meteorite bombardment was considerably greater [7], with a concomitantly increased "impact frustration" to the establishment of terrestrial life [8].
A number of key criteria, required for the credibility of claims for early life, were proposed in a review paper by Whitehouse and Fedo (2007) [9] and have recently been reiterated by Whitehouse et al. [10]. Along with the veracity of the carbon isotopic evidence itself, upon which most Eoarchean life claims rely, these criteria include (1) the suitability of host rocks as possible environments in which life might have developed and (2) temporal constraints provided either directly by the isotopic dating of the host rock or through field relationships with well-dated lithologies. Using the case studies cited above, this presentation will stress the important of both unambiguous geological relationships and geochronology in the quest for finding evidence of Earth's earliest biogenicity, and will review the status of such claims. It is noteworthy that the preservation of fossil evidence in all claims prior to the Paleoarchean is severely limited by the effects of tectonism and metamorphism, and sole reliance on chemical or isotopic evidence cannot provide an unambiguous basis for biogenicity.

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