

## 6.7.12

**Do early Archean Isua and Akilia rocks contain traces of life?**

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The oldest known supracrustal rocks on Earth from the Isua belt and the Akilia association in Greenland have gathered wide publicity as proposed hosts of the earliest traces of life [1, 2, 3]. Recent studies [4, 5, 6] have, however, shown inconsistencies in these interpretations. Carbonate-rich Isua rocks (metacarbonates) that were originally thought to be metamorphosed sediments containing organic remains, have been shown to have a deep-seated metasomatic origin, unsuitable for hosting traces of early Archean life.

The applicability of elemental carbon and its isotopic composition as a biomarker in high-grade early Archean supracrustal rocks has been placed in further doubt by our recent ion microprobe measurements of individual carbon particles. Abiogenic carbon in Isua metacarbonates, formed upon abiogenic Fe(II)-carbonate disproportionation, is isotopically heterogeneous with variation of  $\delta^{13}\text{C}$  values among individual particles exceeding 20‰ in cm-scale sample areas. Some graphitic particles in metacarbonates have  $\delta^{13}\text{C}$  values within the nominal biogenic carbon field. Similar isotopic heterogeneity was also found among individual particles in a sample from the Bouma sequence type graded beds [3], regarded as the most promising Isua rocks to host early Archean biogenic carbon. However, isotopic heterogeneity and the occurrence of graphitic particles with heavy  $\delta^{13}\text{C}$  values, far from the nominal biogenic carbon field, draw the biogenic origin of graded bed particles into question. Our ion data thus highlight the need for careful assessment of processes, both biogenic and inorganic, responsible for observed isotopic heterogeneities.

The biologic significance of carbon particles included in Akilia and Isua apatite [2] is not supported by our findings. Detailed studies of numerous apatite crystals from Akilia quartzite have failed to show any such association. In fact we have not found any graphitic carbon (> 2  $\mu\text{m}$ ) at all in 15 different Akilia samples including the actual sample used by [2]. In Isua rocks, carbon inclusions in apatite have only been found in biologically irrelevant metasomatic veins [5].

**References**

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## 6.7.13

**A new concept for controlled fluid-inclusion extraction**

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Fluid inclusions in rocks and minerals may hold valuable information about the temperature and composition of the fluids in which the minerals precipitated. Low temperature mineralizations in fluids containing organic phases should be of special interest for astrobiologists since they may act as sealed containers of non-contaminated organic matter with a defined minimum age.

Most techniques concerning the study of these inclusions are indirect, and involve methods such as freezing and heating the sample (in order to study homogenization temperatures and composition of the fluid), Raman analysis of solid phases, and fluorescence spectroscopy of organic phases. To perform (often needed) direct analysis of the fluid content, it has been necessary either to crush the sample or to heat it, with subsequent decrepitation of the inclusions, in order to extract the fluids. However, a disadvantage with crushing or heating is that a mean composition of all fluid inclusions in the sample is analyzed, and no distinction is made between primary and secondary inclusions. The only way so far to open fluid inclusions in a controlled manner has been laser ablation, but due to the extreme temperatures involved, it is not well suited for extraction of organic matter.

Here I present a novel concept to extract selected fluid inclusions, without ablating the sample. The method is based on the illumination of selected fluid inclusions with a laser of a wavelength that is absorbed by water and organic material, but not the minerals encapsulating the fluid. Thus, when the inclusion is illuminated by the laser, the fluid expands and the inclusion decrepitates. Since the sample is placed in a vacuum chamber, the fluid evaporates, and may subsequently either be collected in a cooling trap, or transported by a carrier gas directly for analysis.

An additional advantage with the method is the potential to avoid contamination of the analyzed hydrocarbons. Since fluid inclusions act as sealed vessels, the chemical composition of the fluid stays intact until the vessel has been opened. The sample can thus be handled and prepared in any desired way (often as doubly polished thin sections) without contaminating the fluid before the extraction takes place.