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Isuasphaera isua (Pflug) revisited

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Abstract

Spherical objects, identified as microfossils and named *Isuasphaera isua* (Pflug), were reported in 1978 from a chert in the 3.7–3.8 Ga Isua Greenstone Belt (IGB). Soon afterwards the biological nature of these objects was questioned on a number of grounds by several authors.

Following renewed, recent claims for biogenicity, the locality has been revisited and the host-rock (metamorphosed chert) to the putative microfossils re-examined. Extreme stretching deformation of the metachert cannot possibly have preserved syn-depositional spherical objects. We conclude that the objects (whether biological or not) are entirely post-tectonic and probably result from pre-Quaternary weathering.

Keywords: Microfossils; *Isuasphaera isua*; Isua Greenstone Belt

1. Introduction

Since the discovery of the antiquity (3.7–3.8 Ga) of the Isua Greenstone Belt (IGB) (Moorbath et al., 1973), intensive research has been carried out on various rock types for geochemical tracers of life (Schidlowski et al., 1979; Monster et al., 1979; Rosing, 1999). Attempts to find fossils have also been made. In 1978 and 1979, H.D. Pflug claimed to have found microfossils in a sample of metachert from the banded iron formation in the IGB (Pflug, 1978; Pflug and Jaeschke-Boyer, 1979). The fossil was named "*Isuasphaera isua* sp." (Pflug) and occurred as small black spherical objects in quartz grains. Pflug's interpretation was seriously challenged by Bridgwater et al. (1981) and by Roedder (1981). The former claimed that the putative microfossils are indistinguishable from limonite-stained fluid inclusions of inorganic and post-depositional origin. Roedder (1981) claimed that Pflug's microfossils are limonite-stained cavities, which result from dissolution of dolomite grains. Recently Pflug (2001) published another account of his discovery, but without even discussing the arguments raised by Bridgwater et al. (1981) and by Roedder (1981).

2. Geologic setting

One of the problems which both Pflug and his critics faced was that they did not know from which part of the IGB the sample with the putative microfossils was collected. The IGB has suffered several phases of deformation and has been repeatedly metamorphosed (Nutman, 1986; Myers, 2001). In large parts of the

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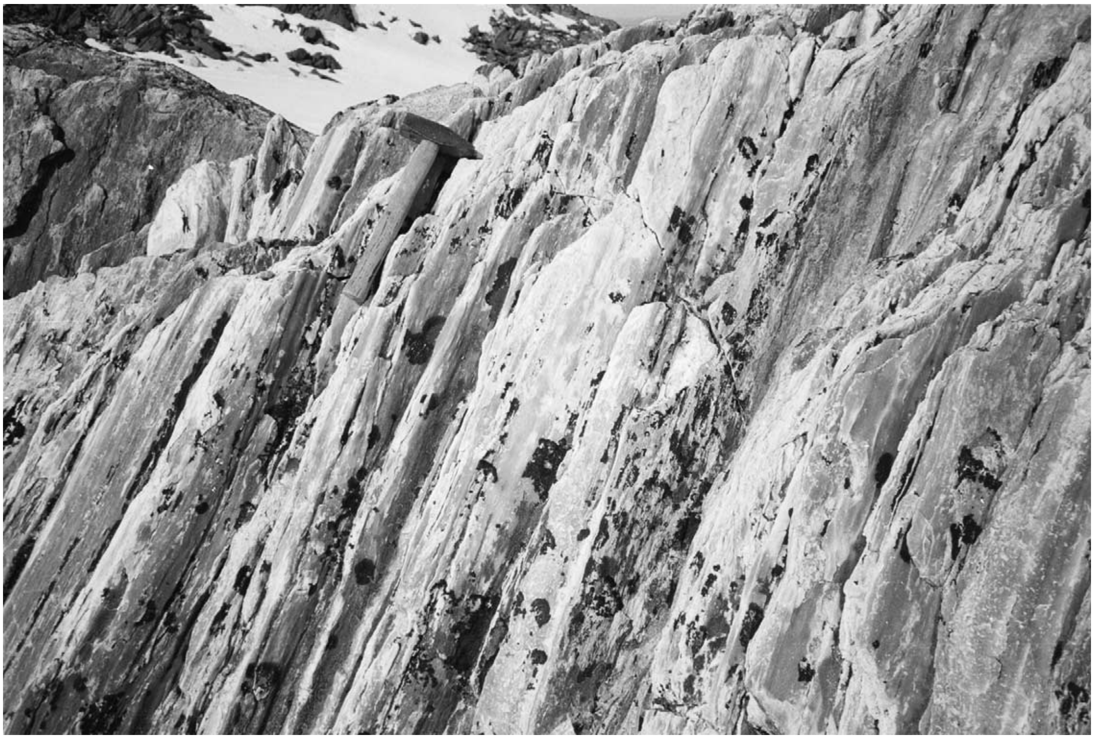

Fig. 1. The sample of metachert in which Pflug claimed to have found the microfossil *Isuasphaera isua* (Pflug) is from this outcrop. The rocks are strongly rodded (parallel to the hammer handle) and show extreme stretching parallel to the plunge of a large synform. The rocks are furthermore strongly affected by surface weathering and were patchily granulated during weathering processes. Hammer is 75 cm long.

IGB the rocks are intensely deformed, whereas in other parts there are relative low strain zones in which a multitude of primary structures can be seen (Appel et al., 1998).

The sample in which Pflug found Isuasphaera was collected from an outcrop by one of us (PWUA) in 1976 (Fig. 1). The outcrop is situated in the easternmost part of the IGB at an altitude of 1150 m and location 65°12.67′N and 49°45.02′W. During the field season of 2001 we revisited the outcrop, which is situated in a high-strain zone close to the core of a regional scale synform (Fig. 2 in Myers, 2001). In this vicinity, the layers of banded iron formation are folded into small-scale folds related to this regional fold structure. These folds refold previously deformed layering that had been segmented into boudins (Fig. 8 in Myers, 2001). The folding was accompanied by extreme stretching parallel to the steeply plunging fold axes. This stretching resulted in a pronounced lineation that dominates the existing rock fabric. On a regional scale, the steeply plunging lineation is most intensely developed in the vicinity of the core of the regional scale fold where the sample described by Pflug originated.

The dominant fabric in the vicinity of the regional fold-core is a stretching lineation in which all the structural components of the rock were very strongly extended. The amount of extension is too great to quantify precisely, but is at least >10:1 and could be an order of magnitude greater. The rock outcrops from which the sample was obtained (Fig. 1) are dominated by rods of quartz that can be seen to extend for several metres across the whole length of the outcrop. The rods are tens of metres long and individually centimetres wide.

Thin-section examination shows that the rock (Fig. 1) is completely recrystallised, with a fine-grained, granular quartz texture. Quartz is shot through with fine actinolite needles and patches of light mica grains in random orientation. Metamorphic mineralogy and texture post-date rock deformation. Quartz grains contain numerous small, round inclusions of carbonate. Where these inclusions are cut by later cracks the carbonate has been dissolved and removed, leaving round, limonite-stained cavities as described by Roedder (1981). This process could be due to strong surficial weathering. Rock outcrops in this part of Greenland are as a rule very fresh, and weathering rarely extends to depths of more than a few millimetres because of Quaternary to Recent glacial erosion. However, this particular mountain peak was close to the pre-Quaternary peneplain. Here the rocks have been exposed to a long period of weathering, indicated by the local abundance of silcrete in the adjacent moraine and by the hematitic alteration of the adjacent banded iron formation deposit. The original purpose of collecting the sample that was later described by Pflug was to investigate the extent of this surficial weathering. Thus Pflug chose one of the worst possible samples from the IGB for microfossil work.

3. Discussion

One of the key arguments for a biological origin of the black objects named *Isuasphaera isua* is their spherical shape (Pflug, 1978; Pflug and Jaeschke-Boyer, 1979). However, we claim that if these spherical black objects were present prior to deformation, their original shape cannot have been remotely spherical.

All rock components were strongly deformed, so that any originally spherical grains would have been transformed into ellipsoidal-to-rodded shapes with large length-to-width ratios. The objects described by Pflug as indigenous spherical microfossils "*Isuasphaera isua* sp." must also have been through the deformation. Either they were originally extremely elongated and were intensely deformed to become spherical, or they are younger features formed after intense deformation of the host-rock. The first possibility is unlikely, as any originally elongated objects would most likely have been folded before being stretched, and would have become ellipsoidal or rod-like rather than spherical. Therefore, as previously concluded by Bridgwater et al. (1981) and Roedder (1981), the black spherical objects cannot be primary features. These spherical objects clearly formed by post-tectonic processes, probably pre-Quaternary weathering.

This is in broad agreement with high resolution SEM data by Westall (2000) on samples of nearby Isua cherts and banded iron formation. The latter contains abundant remains of fossilised endolithic cyanobacteria, fungi and spores between grains and on fracture surfaces, regarded as <8000 years old because the area was until recently covered by ice. Cherts, however, contain irregular carbonaceous particles and graphite crystals (<2 μm) embedded within individual quartz crystals, which could be contemporaneous with formation of the sediment, but bear no morphological resemblance to organisms.

Thus the only remaining known occurrence in the IGB relevant to the debate on early life is that described by Rosing (1999), where fine-grained, layered rocks of supposed metasedimentary origin contain abundant graphite microparticles with isotopically light C ($\delta^{13}C \approx -19‰$), which he interprets as biogenic.

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