



Archean-palaeoproterozoic graphic discs extracted from highly metamorphosed rocks in north china

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The discovery of Precambrian microfossils from relatively unmetamorphosed cherts and shales has served as a taphonomic guide for Precambrian paleontologists over the past 50 years. However, most Precambrian—particularly Archean and early Paleoproterozoic rocks are highly metamorphosed. Was evidence for biological activities, if any, completely erased from these highly metamorphosed rocks? Geochemists have ventured to address this question by studying carbon isotopic ratios of possible biological origin in amphibolite-grade Archean rocks, but ambiguous results have not been able to provide a convincing answer.

Recent years, abundant graphite discs occur in phyllite of the early Paleoproterozoic Hutuo Group and amphibolite-grade quartzite of the Archean-Paleoproterozoic Wutai Metamorphic Complex in the Wutaishan area of North China. Scanning and transmission electron microscopy revealed that graphite discs from both the Hutuo Group and the Wutai Metamorphic Complex are characterized by a circular morphology, distinct marginal concentric folds, surficial wrinkles, and complex nanostructures. These characters represent that graphite discs should be deflated, compressed, and subsequently graphitized organic-walled vesicles. Laser Raman spectroscopic analysis of extracted graphite discs from the Wutai Metamorphic Complex indicated that they experienced a maximum metamorphic temperature of $513 \pm 50^\circ\text{C}$. Therefore, some conclusions could be summarized as (1) Graphite discs extracted from the Hutuo Group and the Wutai Metamorphic Complex were organic-walled vesicles. (2) Highly metamorphosed rocks could retain highly altered but morphologically and geochemically recognizable signs of life. (3) It is not possible to delimit the biostratigraphic boundary

between the Hutuo Group and the the Wutai Metamorphic Complex, based on present biological evidence displaying as graphite discs.