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TEM observation and possible graphite genesis in 3.8 Ga rocks in Isua Supracrustal Belt, West Greenland

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Graphite, reported from meta-sedimentary rocks at the 3.8Ga Isua Spracrustal Belt (ISB), West Greenland, was interpreted as the oldest remnant of life, although graphite-bearing metasomatic rocks are located at several spots in the ISB. These reports have confused reconstruction of early earth's biosphere. Here we investigate graphite crystal structure indicating different carbon stable isotope values by TEM and estimate their genesis and precursor.
Graphite-bearing rocks are collected from whole Isua area. Concentration and carbon stable isotope compositions of graphite were determined on 70 samples. New outcrops of the graphitic schists found in this study, containing graphite up to 8.8 wt %, were interbedded with banded iron formation and extended for approximately ca. 250m from NW to SE. The graphitic schists preserved fine laminated alternate layers of quartz-rich zone and graphite-rich zone and consist of chlorite, cummingtonite, quartz, graphite and ilmenite as major constituent minerals. Carbon stable isotope compositions of graphite range from ?23.8 per mil to ?12.5 per mil. Graphite indicating lightest carbon stable isotope composition in the most northern area was observed by Transmission Electron Microscope (TEM). Some of graphite crystals were intercalated in chlorite in a few hundred nm scales, whose orientations were roughly uniformed. On the other hand, aggregates of graphite grains were also observed. Each grain constituting aggregates took random orientations. Lattice image observation of graphite shows lattice fringes are subparallel and frequently bend over. Sometimes graphite consists of a few nm domains uniformed orientation. Abiogenic graphite (-12.0 per mil) from metasomatic rocks was also observed, representing straight, parallel fringe.
These results indicate that even under metamorphism graphite from graphitic schists remains low crystallinity presumably due to impurity-rich precursor, thus organic matter, while abiogenic graphite show high crystallinity. Considering those all geological, geochemical and mineralogical data, graphite of graphitic schists give another evidence of 3.8Ga marine biota.