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Boron as a biomarker? : Report from ca. 3.8 Ga Isua Supracrustal Belt, Greenland

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Debates are going as to if microbial life was already active in 3.8 Ga oceans. Finding 12C-enriched graphite in Isua rocks is currently a strong but only tool to answer the above question. Additional ambiguity often comes from metamorphosed rocks because of difficulty to identify if graphite-bearing metamorphic rocks (or graphite themselves) were sedimentary or igneous in origin. It is, therefore, necessary to cross-check if information from graphite and metamorphic rocks is consistent. Garnet-biotite schists were collected from ca. 3.8 Ga Isua Supracrustal Belt in Greenland. Garnet was almandine (Fe-rich) in compositions. Geothermometer using compositions of garnet and biotite suggests the metamorphic temperature was up to ca. 590C. This garnet-biotite schist was often associated with 12C-enriched graphite-bearing units. Surprisingly tourmaline crystals were included in almandine, suggesting that garnet-biotite schist was sedimentary in origin and borate minerals (most likely tourmalne) were formed during diagenesis. Borate from continental weathering is the largest borate flux into modern oceans. Such boron was taken into deep marine sediments by incorporated into organic matter or adsorption by clays. Finding of sedimentary tourmaline in examined samples indicates that (1) 3.8 Ga oceans were already borate (B(OH)3) rich and (2) clay or organic matter was functioning to remove borate into sediments from ocean water. In general, continental weathering was considered to be less during 3.8 Ga. This further posts the large possibility that borates were fixed into sediments through microbial activities because of bio-essential characteristics of boron. Borate was most likely supplied into 3.8 Ga oceans by alkaline submarine hydrothermal processes, making difference from modern boron cycle.

Keywords: boron, Isua, tourmaline, garnet