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# Carbon isotope compositions of carbonaceous materials and carbonate from Saglek Block (>3.96 Ga), Labrador, Canada

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Elucidation of origin of life is an everlasting challenge but it provides an important constraint on the origin of life to find evidence for early life. So far, the oldest evidences for biogenic carbonaceous materials were reported from the 3.80 Ga Isua supracrustal belt based on carbon isotope ratio (Rosing, 1999) and morphological features (Ohtomo et al., 2013). But, the origin of carbonaceous materials in the 3.83 Ga Akilia Association (Fedo and Whitehouse, 2002) and 3.75 Ga Nuvvuagittuq Supracrustal Belt is still ambiguous (Papineau et al., 2011).

To understand the origin of organic matter in the Eoarchean and find older organic matter, we investigated occurrence and carbon isotope values of carbonaceous material in the >3.95 Ga metasediment rocks from the Saglek Block, northern Labrador, Canada. The metasediment rocks underwent the amphibolite to granulite facies metamorphism, but some avoid pervasive elemental mobility during the metamorphism. We observed thin sections of pelitic rocks (n = 70), conglomerates (n = 14), carbonate rocks (n = 39), cherts (n = 30), and chert nodules in carbonate rocks (n = 3) from over 2000 samples. Among the metasedimentary rocks (n = 156), 54 specimens including the pelitic rocks (n = 21), conglomerates (n = 4), carbonate rocks (n = 26) and chert nodules in carbonate rocks (n = 3) contain carbonaceous materials. Twenty-nine rock samples with the carbonaceous materials were selected for $\delta^{13}C_{org}$ analysis: pelitic rocks (n = 20), conglomerates (n =4), carbonate rocks (n = 3) and chert nodules (n = 2). $\delta^{13}C_{org}$ values of the pelitic rocks range from -27.5 to -11.6 ‰. The $\delta^{13}C_{org}$ value increases as increasing in the metamorphic grade from amphibolite to granulite facies, indicating that the minimum $\delta^{13}C_{org}$ value reflects a primary signature. Raman spectroscopic observation of the carbonaceous materials showed that the matter comprises crystalline graphite, consistent with the intense thermal metamorphism. The $\delta^{13}C_{carb}$ values of carbonate rocks (n = 3) range from -3.8 to -2.6 ‰. Because it is well-known that the $\delta^{13}C_{carb}$ value decreases due to secondary alteration and metamorphism, the primary $\delta^{13}C_{carb}$ value was estimated to be higher than -2.6 ‰.

The minimum fractionation between the $\delta^{13}C_{org}$ and $\delta^{13}C_{carb}$ reaches 25 ‰, indicating biologic origin for the carbonaceous materials. This work presents the organism has already existed ca. 3.95 Ga. The large fractionation up to 25 ‰ implies autotrophs utilizing the reductive acetyl-CoA pathway or Calvin cycle in the Eoarchean.

Keywords: carbonaceous material, carbonate, early life, carbon isotope, Labrador