

Proto-arc model for ribose and nucleotide genesis: information from Isua Supracrustal Belt

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Proto-arc model has been proposed to explain tectonic evolution of 3.8 to 3.7 Ga Isua Supracrustal Belt, Greenland (ISB; Nutman et al. 2015). Occurrence of tourmaline has been known in ISB (e.g., Appel, 1995, Mishima et al., 2016). Grew et al. (2015) also found tourmaline in various localities in ISB and suggested that the concentration of boron was elevated in a partially isolated basin by hydrothermal processes in proto-arc setting. Initial boron was most likely extracted by deep fluids from TTG and/or accreted sediments. Such deep fluids discharged into oceans as hydrothermal fluids. In addition, Nutman et al. (2016) reported primary evaporite carbonate in ISB. Such carbonate rocks were most likely formed in shallow and partially isolated basin developed in alkaline shallow basin on proto-arc.

I propose that environments created by Hadean proto-arc were ideal not only for TTG genesis but also for prebiotic ribose and nucleotide formations. In isolated and shallow basin on proto-arc, evaporation may have helped to concentrate borate and phosphate, probably precipitating lünebergite. Water in this isolated and shallow basin was alkaline, as indicated by ISB shallow basin. Such alkaline condition is favored to form sugars with the formose reaction. Concentrated borate in such alkaline basin might have helped to form and sequester ribose, selectively. Lünebergite further helps phosphorization of nucleoside (Kim et al., 2016).

Boron-rich (and also phosphate-rich) and alkaline environments also expected locally at around mud volcano on the slope of proto-arc, similar to the model proposed by Holm (2012). Inside of deep marine sediments around the proto-arc would have offered boron and phosphate-rich and alkaline environment (Mishima et al., 2016). Formose reaction could happen not only at evaporite basin but also in deep marine environments around the Hadean proto-arc. As the result, ribose would have been the major aldopentose in Hadean proto-arc environments.

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