

Proto-arc model for chemical evolution: Constraints from geological information of Isua Supracrustal Belt

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Proto-arc model has been proposed to explain tectonic evolution of Isua Supracrustal Belt (ISB) (1). Tourmaline has been discovered from various locations in ISB, suggesting local enrichment of boron (2, 3). Deep fluids from proto-arc most likely made the semi-closed ocean water highly alkaline and B-, CO₂-, NH₃-rich. A part of tourmaline in ISB is found to be associated with reduced carbon. This finding suggests that >3.7 Ga semi-closed ocean water was rich in borate and organic matter. In particular B-rich environment is essential to generate and stabilize ribose, followed by formation of nucleotide (4, 5). Such geological environments associated with proto-arc could happen on the Hadean Earth.

Oligomerization experiments of individual amino acids by our group suggest that diagenetic P-T conditions are suitable to form various prebiotic peptides (5, 6). Those results further suggest that Hadean clay-rich sediments, which deposited in open ocean environments, could accumulate and convert amino acids into peptides. Further tectonics made “open-ocean” peptides encounter to “semi-closed ocean” nucleotide, storing in proto-cell. It is suggested that many experimental data for chemical evolution are concordant with environments by proto-arc tectonics.

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