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When did the plate tectonics start on the Earth?

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Initiation of plate tectonics on the Earth is a key to make life-sustaining rocky planet Earth, because primordial ocean was highly toxic and primordial atmosphere had high XCO2. Transportation of huge amounts of CO2 into mantle by plate subduction depends on pH of seawater and composition of oceanic slab.

Plate tectonics has been proposed from the data set of the ocean-floor, firstly by ocean-floor spreading theory followed by rigid lithosphere. Yet, the oldest lithosphere goes back to only 200Ma, hence demonstration of plate tectonics on the Earth is restricted to the Earth after 200Ma.

Hence, we need to make logical framework of pre-200Ma plate tectonics of the Earth. The principle of Accretionary Complex Geology (ACG) is an only key issue which is centered by Ocean Plate Stratigraphy (OPS). ACG is a technology which separates the subducted oceanic slab from trench turbidites, and offers the MORB, OIB, pelagic sediments, and subduction zone magmatic rocks from the mixture of rock units formed at trench.

Application of this technology to 3.8Ga Isua ACs clarified Early Archean plate tectonics which had different aspects of plate tectonics from the modern plate tectonics, e.g., thickness and composition of lithosphere (Komiya et al., 1999). Specifically, thickness of MORB was 20km which seems to be buoyant to prohibit subduction (e.g., Davies, 1992). But if slab-melting is common, the buoyancy turns to be negative to cause more rigorous slab-pull force at subduction zone (Komiya et al., 2002).

For the Hadean Earth, there are no geologic units remained on the modern Earth, except for zircons with back to 4.4 Ga. Mineral inclusions within the Hadean zircons suggest the host melt with granitic magma. Formation of granitic melts could be most probable for the operation of plate tectonics. But this is logically imperfect, because small amounts of granitic melts can be formed and actually present on the Moon. Conversely, the forward modelling of planetary tectonics could be more important than zirconology. Formation of primordial ocean causes the formation of rigid lithosphere, and hydrous minerals on the slab surface would act as liberated lubricants along Benioff plane. This is plate tectonics and plays even in the state of magma pods remains in the asthenospheric mantle (Sleep et al., 2011). If so, initiation of plate tectonics on the Earth could be back to Hadean Earth, presumably back to 4.4Ga.