ABEL Bombardment as the trigger to initiate plate tectonics of Earth: From stagnant lid to plate tectonics

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Here, we address the long-standing question of when and how plate tectonics began on the Earth. Augmented by both the records of Earth-Moon geology and the asteroid belt, we theorize that the onset of plate tectonics was during the Middle Hadean (between 4.37-4.20 Ga) triggered by ABEL Bombardment which delivered oceanic and atmospheric components to a completely dry reductive Earth system (originally comprised of enstatite chondrite-like materials). Through the accretion of volatiles, shock metamorphism proceeded with vaporization of both CI chondrite and supracrustal rocks at the bombardment sites, as well as significant recrystallization under wet conditions, causing considerable eclogitization in the primordial continents; the primordial continents were composed of an upper (~ 21 km thick) anorthosite-enriched, felsic crust, and even thicker (~ 50 km) KREEP lower crust. Eclogitization must have yielded a powerful slab-pull force to initiate plate tectonics in the Middle Hadean. Another important factor is the extent of the bombardment. Through the formation of Pacific-Ocean-size impact craters by 1,000 km-diameter impactors, the operation of rigid-plate (stagnant-lid) tectonics since the Early Hadean was destroyed, and oceanic lithosphere was generated resulting in bi-modal lithosphere on the Earth which drove plate tectonics. Considering the importance of the ABEL Bombardment event which initiated plate tectonics including the appearance of ocean and atmosphere, we propose that the Hadean Eon be subdivided into three periods; (1) Early Hadean (4.57-4.37 Ga), (2) Middle Hadean (4.37-4.20 Ga), and (3) Late Hadean (4.20-4.00 Ga).

Keywords: ABEL Bombardment, secondary accretion of volatiles, initiation of plate tectonics, eclogitization

