

The Magma Engine and the Driving Force of Plate Tectonics

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50 years after the Plate tectonics has been proposed, its driving force remains obscure. Slab pull is popularly taken as the dominant driving force, followed by ridge push and mantle convection. From the energy perspective, the dissipation of heat from the Earth's interior is the main source of power that maintains plate tectonics. Given that well organized release of heat is essential to transform the static energy into kinetic energy. A Magma Engine model has been proposed^[1,2]. Heat produces potential energy through magmatism, and consequently drives plate tectonics through gravity. The newly formed oceanic crust is lighter and thinner, whereas older ones are thicker and denser, such that the oceanic plate is tilted, lying on a big slope, with a height difference of 80 kilometers. This produces a huge plate sliding force and is the primary driving force of plate tectonics. Mantle plume is another type of Magma Engine that may have initiated plate tectonics in the early history of the Earth. Under the current plate tectonic regime, plume head is an "igniter" of mid-ocean type of Magma Engines. Subduction initiation is more difficult than spreading. It is therefore critical to understand how subduction started. According to the Magma Engine model, subduction is initiated by the gravity force of tilted plates. For an individual plate, the subduction may be initiated by itself (so called spontaneous) or by other plates (induced). Spontaneous subduction initiation usually occurs in old ocean basins, forming double-track subductions on either side of the ocean basin. In contrast, induced subduction initiation usually occurs in young ocean basins, forming single-track subduction. The closures of Neotethys Oceans were likely associated with induced subduction initiation, which always forms northward subductions^[1,2].

1. W Sun, Magma Engine and the driving force of plate tectonics Chinese Science Bulletin, in review
2. W Sun et al. The golden transformation of