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# Transition in the style of volcanism by secular change of mantle dynamics in Mars

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## 1. Change in the style of volcanism

Martian volcanism has been characterized by formation of large volcanic edifice such as Olympos Mons and Tharsis Montes localized in a few restricted areas. This means magmatic sources ware active for long time in the scale of $10^9$ years while their spatial distribution was localized. By the recent detailed analysis of the crater chronology for identification of volcanic activity the peak for large-edifice building stage was late Noachian to Hesperian and the activity clearly declined in Amazonian[1].This is consistent with the predictions by numerical simulations on thermal evolution[2][9]. Recent high resolution imaging has revealed existence of different style of volcanism from the large-edifice-building volcanism. A good example can be seen in the extensive lava flow formation at Central Elysium Planitia[3]. Plenty of rootless cones indicate the formation is composed of relatively thin lava flows[4]. Spreading flat planes indicates low viscosity nature of the lava. The activity does not seem to continue for long time. The overall nature resembles to the terrestrial flood basalt activity. The age is estimated at late Amazonian. Similar style of volcanism has been identified at several areas. Figure 1 shows the locations of this flood type lava flows where rootless cones are identified[5]. They seem to exist in the vicinity of crustal dichotomy boundary in the latitudinal position while they spread in the longitudinal position.
Occurrence of flood type volcanism at Amazonian indicates predominant style of volcanism changed from large-edifice-building type to flood type. The former one is considered to be controlled by plume activities in the martian mantle[2]. What controls/drives the flood type volcanism is a challenge in understanding martian mantle dynamics.

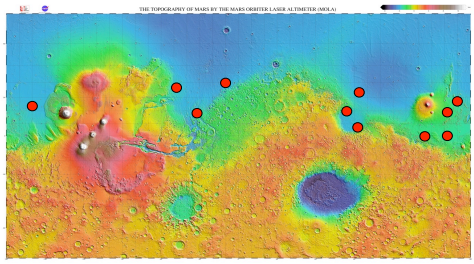

**Figure 1.** locations of lava flows with rootless cones

## 2. Basalt-Eclogite Transition

The chemical composition of the martian crust is estimated from various sources such as martian meteorites, APX on rovers and remote sensing spectrum analysis from orbit. All these indicate iron-rich basaltic composition, which is also supported by high density obtained by gravity measurements. Babeyko and Zharkov[5] analysed possible mineralogical assemblage of this composition in the martian interior and suggested basalt-eclogite transition is plausible. Recently Ohmori[6] estimated equilibrium composition of minerals based on thermodynamical data for various compositions of model crust of Mars. He clarified density crossover would occur between martian mantle and transformed eclogite in the lower crustal pressure regime. Figure 2. shows density variation associated with basalt-eclogite transition. Contrasting to the case of terrestrial basalt(MORB for example) the density increase becomes evident at relatively shallower depth.

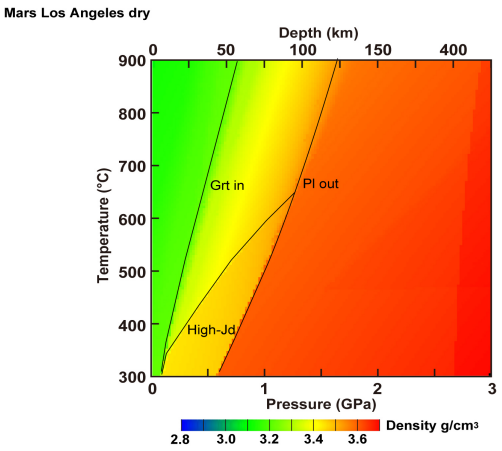


Figure 2: Density variation associated with transformation of constituent minerals. The chemical composition is a Shargottite.

## 3. Possible link between eclogite-induced delamination and flood type volcanism

Material scientific investigation suggests transformed eclogite becomes denser than the mantle at the base of the crust. The possibility of delamination of eclogite crust and subsequent overturn is estimated by Ferrachat et al[7]. Once this overturn occurs the mantle material should be displaced to the shallower position. If mantle geotherm was close to the solidus, which is suggested by high dissipation of tidal energy[8] and also thermochemical simulation on the thermal history[9] , decompressional melting should be induced. Since there exist significant difference in the thermal gradient between solidus and mantle adiabat at low pressure regime decompressional melting generates higher degree of melting. We consider this process is responsible for the formation of flood style volcanism. The preferential localization to the dichotomy boundary is also consistent with the delamination.

## References

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