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Tectonomagmatic evolution of the terrestrial planets: importance for understanding of processes of their formation and subsequent development

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Our knowledge about formation and evolution of the terrestrial planets (the Earth, Venus, Mars, Mercury and, possibly, the Moon) based on different physical and geochemical speculations and models. The main disadvantage of such hypotheses is their abstract character and ignoring any data on tectonomagmatic evolution of those planets. At the same time, just this type of data provide an important information, which is necessary for elaborating of a present-day theory of their formation and evolution. The Earth has been much better studied compared to the other planets, therefore we will discuss the main questions of planetary tectonomagmatic evolution using the Earth as example plus involve other data on the Moon and the terrestrial planets.

Two dominating hypotheses about composition of the primordial Earth's crust exist now: (1) traditional implies that the primordial crust had basic composition, whereas the sialic crust resulted from a geosyncline process or, in modern terms, from processes at convergent plate margins, and (2) primordial crust was sialic; the plate tectonic mechanisms started in the Middle Paleoproterozoic and resulted in oceanic spreading and formation of the secondary oceanic crust. Both models require a global melting of a primary chondritic material to form the primordial crust. The final result depends on the degree of melt differentiation during solidification of a magmatic ocean. Such a solidification, due to differences between adiabatic and melting-points gradients had to proceed in bottom-top direction (Jeffries, 1929) and resulted in accumulation of low-temperature derivates in the primordial crust. Geological data, namely granite-dominated Archean crust, and results of studying of detrital zircon from Australia supports the primordial-sialic crust hypothesis. The Moon which is four times smaller than Earth has a basic primordial crust. Such a difference can be explained by different depths of their magmatic oceans.

The Early Precambrian (Archean, Early Paleoproterozoic) tectonomagmatic activity on the Earth was rather different from the Phanerozoic: the major features then were huge granite-greenstone terranes (GGTs) and their separating granulite belts; mantle melts were derived from a depleted source. The GGTs consisting of greenstone belts with komatiite-basaltic magmatism in Archean, "submerged" in granite gneiss matrix, probably, strong reworked primordial sialic crust, and by siliceous high-Mg series (SHMS) in early Paleoproterozoic. GGTs were areas of extension, uplifting and denudation, whereas the granulite belts were dominated by compression, sinking and sedimentation. Generally, the Early Precambrian geological pattern was rather different from the modern plate tectonics and can be described in plumetectonics terms.

A drastic change of the tectonomagamtic and ecology processes on it's surface occurred at ca. 2.3-2.0 Ga: instead of high-Mg magmas appeared geochemical enriched Fe-Ti pucrites and basalts, and the plume tectonic was changed by plate tectonics, which is still active now, as well as ecologic situation on the surface. Since that time the primordial sialic continental crust has been gradually replaced by the secondary basaltic oceanic crust. Systematic consumption of the ancient crust in subduction zones obviously started at $\tilde{2}$ Ga and led to gradually replacing it by the secondary mafic (oceanic) crust. The crustal materials has stored in the "slab cemeteries", revealed in the mantle by seismic tomography.

Tectonomagmatic evolution of the Moon began4.4-4.0 Ga in lunar highlands with low-Ti magnesium suite, analogous to the terrestrial Paleoproterozoic SHMS. Cardinal change of tectonomagmatic processes, close to that on the Earth, happed on the Moon $\tilde{3}$.9 Ga to form large depressions of lunar maria with thinned crust and vast basaltic volcanism with signatures of plume magmatism (high-Ti basalts). The lunar maria were, probably, specific analogues of Earth's oceans.

On Venus and Mars also two main types of morphostructures, which are vast fields of basalts, and older lightweight uplifted segments with a complicated topography (tesseras on the Venus and terras on the Mars) occur. So, it possible suggest two-stage evolution of these planets. During the first stage the primordial lithospheres formed due to solidification of global magmatic oceans. During the second stage the secondary basaltic crust formed due to ascent of thermochemical plumes from the their CMBs. Smaller Mercury is less studied, however, its relief also contains morhostructures resembling lunar highlands and maria.

The established succession of events on the Earth was not link with external actions and could be provided by combination of two independent factors: (1) Earth originally was heterogeneous and (2) the downward heating of Earth was followed by cooling of its outer shells. As a result, the primary core material was long time remained untouched. The most probable cause of the centripetal heating of the Earth was a zone/wave of heat-generating deformation directed inside them. We suggest, that those zone of deformation appeared after the planet's was formed (accretion finished) and its rotation around axis accelerated due to law of conservation of momentum as a result of materials compaction and shortening their radii. That wave could reach the Earth's interiors thus heating deep mantle material and generating first superplumes. Finally, it reached the metallic core, melted it and produced secondary thermochemical plumes, which are still active.

Because tectonomagmatic evolution of other terrestrial planets (Moon, Venus, Mars, and Mercury) developed at the close scenario, it suggests that the same progression of events occurred in other solid planets. Available data suggest that terrestrial planets are self-developed systems, whose evolution was associated with irreversible changes in tectonomagmatic processes. The development of all of them, except the Earth, is completed and they are "dead" bodies now.