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MAJOR STAGES OF RIFTING EVOLUTION IN THE EARTH'S HISTORY

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The Earth's history can be subdivided into a number of epochs marked by activization of the uppermost mantle heating (up to its partial or complete melting), horizontal extension of the entire crust or its large parts and origination and rapid development of linear tensional rift-like or rift structures. The concept of the pulsating Earth on the background of its general and irregular expansion seem to explain these epochs' existence most naturally (Milanovsky, 1980). Five major epochs of rifting activization and crustal extention can be distinguished, and among them three epochs with relatively most intensive global extension. They are: Archean, Late Proterozoic and Mesozoic-Cenozoic. Extention zones originated in each of these epochs differ greatly in geometry, morphology, paragenesis of tectonic features, rock formations, thermal regime, also in accompanying magmatism and metamorphism. They also vary in the following geological evolution, in particular, in later deformations occurred in these zones. These differences of the consequent rift-like and rift structure generations testify the irreversible evolution of the Earth and as a part of its changes in the structure and properties of the crust which underwent tension and destruction in various periods of its history.

1. Linear structures of the most ancient Archean epoch of rifting originated on the relatively thin mobile protocontinental crust and combined features of both rift and geosynclinal zones of the following geological time. They were set under conditions of the heat increase, magmatic permeability, destruction and horizontal extension of the most ancient crust; their further development, however, was accompanied by the alternation of regimes from tension to compression (or numerous such alternations) and considerable changes of thermal regime. Probably the earliest of these mobile ancient zones and nevertheless of great "vitality", are zones presented in the recent Earth's structure as charnockite-granulite belts forming a rather large net within ancient platforms of all continents. Further on, these zones underwent numerous tectonic and magmatic regeneration and, in fact, predetermined the localization of late Proterozoic and Phanerozoic rift zones of continents, and the outlines of margins of "secondary" (Mesozoic-Cenozoic) oceanic basins. During periods of more intensive but more local horizontal extension and heating, the Archean protocontinental crust in many places was cut by quite dense net of more narrow and short extention zones presented in the recent tectonic pattern as greenstone belts. These zones filled with thick early and late Archean volcanic and sedimentary materials were recorded as zones of subsequent compression and granitoid

plutonism. Some scientists consider these zones (greenstone belts) analogue to later eugeosynclinal troughs or island arcs, other-analogue to rift zones. In fact, these belts (like charockite-granulite belts) combined in themselves features of both rift and geosynclinal epochs.

2. Protorift zones of early Proterozoic epoch were set in the result of a partial destruction of a relatively more rigid and mature crust, compared to Archean epoch. They seemed to be related to protogeosynclinal troughs of the same age but differ in scale and role of the following compression deformations (aulacogeosynclinals of the Pechenega-Varzuga-zone type in the northeastern part of the Baltic shield), or sometimes should almost complete absence of any compression manifestations (i.e., Great dyke in Rhodesia). Generation of these protorift structures on the whole is yet poorely revealed and analysed.

3. Sharp intensification of a rifting process is dated back to late Proterozoic (Riphean, especially middle) when numerous continental rift zones-aulacogenes-originated on the ancient, mainly, Laurasian platforms and also on the Australian platform (Amadeus, etc.) (Milanovsky, 1981). By structure and genesis aulacogens related close to the geosynclinal belts of Neogeicums set at the same time, and separated ancient platforms. In the majority of cases aulacogens were branches of these belts penetrating far into the platform bodies or cutting off separate their peripheral segments. In such cases, there originated especially large and deep aulacogens (aulacogeosynclinals) evolution of which was completed by tectonic inversion and folding. In late Proterozoic, a complicated system of aulacogeosynclinal zones originated and evolved within a number of present platforms of the Gondwanaland group (South American, African).

4. Partial regeneration of geosynclinal belts in early and middle Paleozoic was accompanied by regeneration of a number of Riphean aulacogens in the regions of ancient platforms adjacent to these active belts. New aulacogens within the platforms did not seem to originate. By the end of Paleozoic, tension and subsidence in the regenerated aulacogens and in Paleozoic geosynclinal belts ceased and in many of them changed to compression. In some aulacogens it repeated periodically during Mesozoic.

Synchronically with the development of the epiplatform rift zones, in early and middle Paleozoic, in Baikalian and Caledonian folding systems, correspondingly there generated for the first time most early epiorogenic rift zones. They originated in the result of horizontal extension during the Cambrian and, mainly, Devonian time.

First manifestations of the general (Mesozoic) breakup of the Gondwanaland super-continent (super-platform?) can be dated back to late Paleozoic when this process started at its certain

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5. Rifting and accompanied non-geosynclinal magmatic activity reached their gigantic scale during the last Mesozoic-Cenozoic epoch of the Earth's evolution. Rifting of the epoch contrast to Proterozoic and Paleozoic one and with rare exception was not connected directly with the evolution of geosynclinal zones and belts and was not subordinated to it as an associated process within the platforms framing them. On the contrary, it presented the extention and destruction of the crust mainly spatially and genetically connected with the formation of "secondary" oceanic basins. In their peripheral parts along the continental boundaries, perioceanic rift zones and systems were set in Mesozoic, while in their inner parts, intraoceanic rift belts originated since middle Mesozoic. In the latter, horizontal tension and formation of oceanic crust (spreading) reached great scale. Similar belts originated and envolved synchronously within the ancient, though tectonically and magmatically rejuvenated in Mesozoic, Pacific basin. Late Mesozoic rift zones and systems of residual Gondwanaland continents and also Cenozoic rift zones and systems of Africa, North America and Eurasia are of much less scale than intraoceanic and intracontinental rift zones, presenting however, blind branches of these large rift zones, or evolving parallel to them. Contrast to the Pre-Mesozoic rift zones, there is no evidence of the following tectonic inversion and compression in the majority of Mesozoic-Cenozoic continental and oceanic rift zones; in same cases though present they are not distinct and are too local. Mesozoic-Cenozoic rifting is not subordinated to the geosynclinal belts evolution; on the contrary, by its kinematic tendencies it is an "antagonistic" process. These two processes have very complicated relations in space and time and in global scale they balance each other: in time periods of rifting activization alternate with the compression paroxysms in geosynclinal regions during which tension in the rift zones stops or reduces its rate; that leads to the reorganization of their kinematic pattern (Milanovsky, 1980, Schwan, 1980). On the whole, Mesozoic-Cenozoic epoch is marked by predominance of global horizontal extension (in particular, as rifting) over compression regime.

In the Earth's history, thus, rifting as a geological process undergoes complicated evolution. In Archean, development of linear tectonic zones combined features typical of the rifting and geosynclinal processes of the following epochs; during Proterozoic and great part of Paleozoic, the continental rifting was related and subordinated to geosynclinal process, while during the last Mesozoic-Cenozoic epoch, it acquired great independent significance as one of the principal destruction forms, break up and "creeping apart" of continental massives and sea floor spreading in the course of the general activized expansion of the Earth.

Distribution of various types of rift zones and other tectonic regions during the Earth's history is shown on the diagram.

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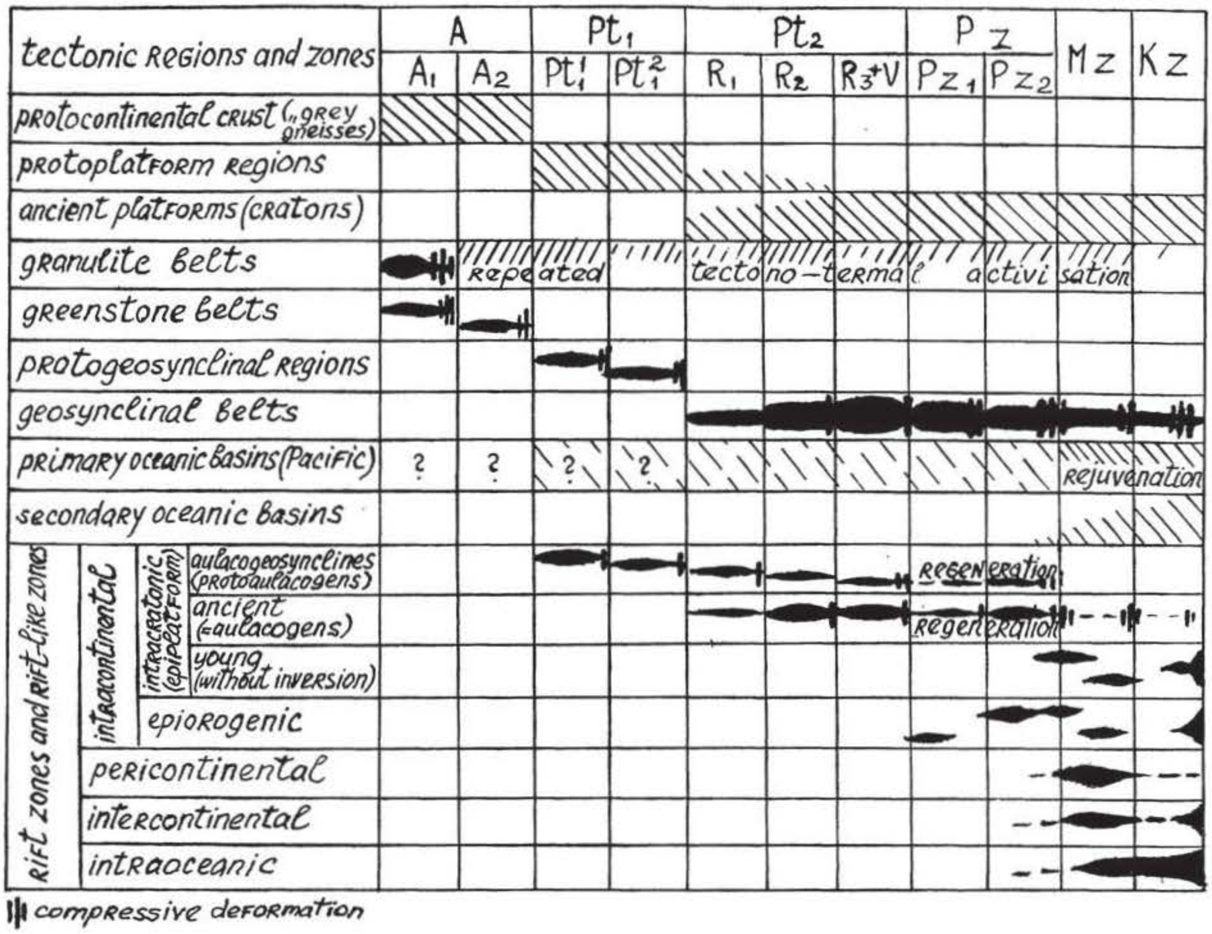

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