Geophysical Research Abstracts,
Vol. 10, EGU2008-A-05786, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-05786
EGU General Assembly 2008

Conjugate Holmes-Houtermans and Concordia-Discordia model for common lead: Constraints for geological history of terrains with ore deposits in East Asia

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All radiogenic ore leads of the Earth used to be constituents of closed U-Pb systems. Various models were used to discriminate two stages of lead evolution in terms of values t_1, t_2, μ_1 and μ_2. A strict solution of common lead evolution gives however only the Holmes-Houtermans model suggesting an age of the Earth 4.56×10^9 years and an isotopic composition of lead similar to that of the Canyon Diablo troilite. The model presumes evolution of lead isotopes in a closed system. In processes of gravitational acceleration of the Earth, a radioactive transforming of short- and long-living nuclides as well as a bombardment of the Earth by space bodies during the first 500 million years of its existence, considerable amounts of energy were given off, sufficient for a total melting. The widespread melting of the mantle had suggested the existence of a time interval of an open isotopic system. Hence the Holmes-Houtermans model is not valid for a system totally closed since the formation of the Earth and a modification of approach to the isotopic evolution of leads is required accounting for an open isotopic system with an age younger than the age of the Earth.

Formally, the process of separation and segregation of leads was described by the diffusion Concordia-Discordia model. We found a connection between this model and the Holmes-Houtermans one. Calculations showed that the diffusion model gave after

separation anomalous leads only, but leads could be as normal, as well as anomalous depending on the instance of a system closing ***T*** and the instance of lead separation ***t***.

The conjugate model was applied for study of ore deposits in East Asia in respect of geological settings. In terms of the suggested systematics of ore deposits, East Asia was divided into several regions. On the one hand, some regions showed different ages (different ***T***) of protoliths formed in the early stage of the Earth evolution. On the other hand, spatially separated terrains demonstrated common early geological history (identical ***T***) but different timing of lead separation (t_1 and t_2). The latter parameters were found to be consistent with local tectonic events. The Gargan cratonic block yielded, for example, normal leads with ***T***=4.5 Byr, t_1=1.8 Byr, t_2=1.05 Byr, and μ=8.9, but the adjacent Siberian craton margin revealed anomalous leads of the J-type with ***T***=3.2 Byr, t_1=2.2 Byr, t_2=1.6 Byr, and μ=50.

We use varied isotopic compositions of common leads determined in ore deposits of different terrains to constrain timing of transition from open to closed U-Pb system occurred during the early stage of the Earth evolution. Extent of temporal delay of this transition depends on concentration of incompatible elements (U etc.) in convecting domains which should be traced in cratonic blocks since the primarily melted Earth until 3.2 Byr.