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LARGE IGNEOUS PROVINCES, MANTLE PLUMES AND METALLOGENY IN THE EARTH'S HISTORY

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The proceeding will be interesting for geologists dealing with mafic/felsic igneous complexes and their metallogenic specialization.

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EVOLUTION OF HIGH-ALUMINA ALKALINE MAGMATISM IN THE CENTRAL ASIAN FOLDED BELT

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One of important specific features of alkaline magmatism in structures of the Central Asian Folded Belt (CAFB) is its high content of alumina. Unlike alkaline-ultrabasite complexes of central type, which have been developed within ancient cratons or in consolidated blocks of their boundaries, these rock associations always have in their composition petrographic varieties enriched with feldspathoids, in particular with nepheline or leucite (ijolites and urtites, feldspathic ijolites and urtites, as well as leocotefrites (bereshites, juvites and leucite-rich syenites). An important petrochemical parameter for these rocks is that they belong to a miaskite series, which composition does not include alkaline dark-color minerals, as well as any signs of obvious enrichment in the most active volatile F- or Cl components. This can be observed in the Khibinsky, Lovozersk, or Ilimussaksk massifs. As a rule, these associations show in whole-rock composition high content of CO_2 that defines fassaitic type of clinopyroxenes and manifestation of interstitial carbonate. One of the proves for such a conclusion is presence of magmatic carbonatites as late "segregates" at the latest formation stages of alkaline-gabbroic plutons in Kuznetsk Alatau and Western Tuva.

Formation of alkaline complexes of miaskite series in folded structures usually takes quite long time and is assumed to undergo multiple impacts of one or several stages of plume activity onto centers of magma generation. Let us analyze this on the example of alkaline-basite complexes of the Western sector of CAFB (Kuznetsk Alatau, Gorny Altay, Tuva, and Northern Mongolia). Based on the results of our isotope studying of alkaline and middle alkaline basites from Kuznetsk Alatau and Gorny Altay, we determined a polychronous nature for formation of rocks with similar petrographic and geochemical composition (Vrublevsky et al., 2003; Krupchatnikov et al., 2012; Vrublevskii et al., 2014a). In both Kuznetsk Alatau and Gorny Altay, there were found complexes of at least three different ages: 1) Late Cambrian – Ordovician (Verkhnepetropalovsk Massif, complex "Edelveis", Kokhtag complex); 2) Early Devonian (Kiya-Shaltyr, Dedovogorsk, Belogorsk, and Kurgusul Massifs); 3) Late Permian – Early Triassic (Goryachegorsk Massif and Chuysk lamprophyric complex). U-Pb isotopic dating (using SHRIMP method) of juvites from Northern Mongolia (Overmaargolsk Massif) yielded a Silurian age of 426.5±3.5 Ma (Vrublevskii et al., 2014b), mean while similar rocks from Western Tuva (Dahunur, Bayankol, Kharlin, and other massifs) are assumed to be formed in Upper Carbon – Early Permian (330-300 Ma) (Vrublevskii et al., 2014c).

An important element in forming high-aluminous rocks of alkaline series/sequence is processes of fraction crystallization and possible accumulation of an early subliquid phase of feldspathoids, in particular nepheline. However, there is a certain limitation. Real compositions of alkaline magmatic melts generated by mantle plumes correspond to subsolidus ratios of nepheline, pyroxene, and feldspars. In this case, a mechanism of crystallization differentiation would not allow accumulating early crystal phase of a feldspathoid, because this phase was not this one. In order for initial magmatic melt to "get into" a field of a primary nepheline crystallization, additional reactions are required that will provide accumulation of Al_2O_3 in residual melt. The most possible mechanism for such enrichment is interaction between silica melt and carbonate substrate. One of the first supporter of this hypothesis was R.A. Deli, who proved that nepheline syenites are formed in places of granites contacting with limestones. Practical application of this scheme is a technological process of agglomeration of nepheline ores with calcium carbonate implemented in the Achinsk factory in order to obtain free alumina. In 1960s, it has already been proven using simple thermodynamic calculations that neither “granite” magma nor basalt one has real temperature reserve sufficient for assimilation of a certain amount of calcic substrate so high-aluminous magmas can be obtained. However, a new concept suggesting active impact of mantle plumes on lithosphere lets us go back to those ideas them. Plume has much bigger energy reserve that allows eroding not only lithosphere mantle but also crust fragments including its carbonate component.

If we analyze lateral and temporal zoning of alkaline magmatism in Kuznetsk Alatau, Gorn Altay, Tuva, and Northern Mongolia, we can note following patterns. The most Western part of the region represented by Cambrian-Ordovician complexes is described by melanocratic profile and signs of metasomatism shown. Starting with Silurian manifestations, we can see obviously participation of high-aluminous varieties of juvites, feldspathic urtites (Mongolia), feldspath less urtites and juvites in Devonian (Kunetsk Alatau, Kiya-Shaltyr deposit, and Kurgusulsk Massif), then feldspathic ijolite-urtites and juvites in Carbon and Permian (Kharlinsk Massif in Tuva, Goryachegorsk Massif in Kuznetsk Alatau). Taking into account that the most high-alumina rocks localize among carbonate rocks or go through carbonate base of Cambrian folded substrate, we can assume that there was an active interaction between silica magmas and a certain crust component under impact of mantle plumes.

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