GENETIC CRITERIA OF DISTINGUISHING LAMPROITES
(on the basis of melt inclusions in minerals)

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1.Great attention in the last decade is paid to the development of principles and criteria for distinguishing lamproites from other rocks of potassium series. The most reliable complex of mineralogical and geochemical features for distinguishing lamproites was suggested by R.H.Mitchell. However, in some cases it appears to be insufficient too: e.g., when the rock does not possess the total set of necessary features or when some of its diagnostic characteristics overlap with the characteristics of other compositionally similar potassium rock. This is especially true in cases when lamproites spatially alternate with other varieties of potassic rocks. Thus, K-basaltoids and their effusive and intrusive derivatives are widespread in the Aldan Shield along with lamproites. Both rocks bear not only their own individual properties, but also features typical of rocks combined with them: lamproites have a low titanium content and most often belong to miaskitic type. Minerals in basaltoids display lack of Al which is, the same as in lamproites, compensated by the presence of Fe^{3+} in the structure of minerals.

2. To solve this kind of problems, we have developed additional genetic criteria of distinguishing lamproites, which allow us to take account of the specific features of physico-chemical conditions of crystallization of rocks. Our work is based on the results of investigation of fluid inclusions of melts (fluids) in lamproitic minerals and compositionally similar basanite-tephrite-phonolites and shoshonites. When analyzing these data all known publications concerning lamproites were considered. These are: 1 -- olivine lamproites and 2 -- fitzroyites of the Ellendale Field *(Sobolev et. al., 1989; Mitchell, 1991; Sharygin, 1991)*, 3 -- cedricites of Mount Cedric *(Sobolev et. al., 1989)*, 4 -- wolgitites of Valgidee Hills *(Sharygin, Vladykin, 1994)*, wyomingites of Leucite Hills *(Sharygin, Bazarova, 1991)*, 6 -- olivine lamproites of Prairie Creek *(Solovova et al., 1988)*, 7 -- jumillites *(Prider, 1982)*, 8 -- verites of Murcia-Almeria *(Solovova et al., 1988)*, 9 -- olivine-leucite hialolamproites of Oscar Plag *(Mitchell, 1991)*. We examined the following rocks from basanite-tephrite-phonolite family: 10 -- leucite tephrites of the Anui River, Siberia *(Panina, 1983, 1993)*, 11 -- phonolites of Eifel *(Sharygin, 1993)* and 12 -- fergusite-porphyries of Pamir *(Panina, 1983)*. Shoshonite group was represented by 14 -- olivine absorakites of Talysh, Azerbaijan *(Panina et al., 1985)*.

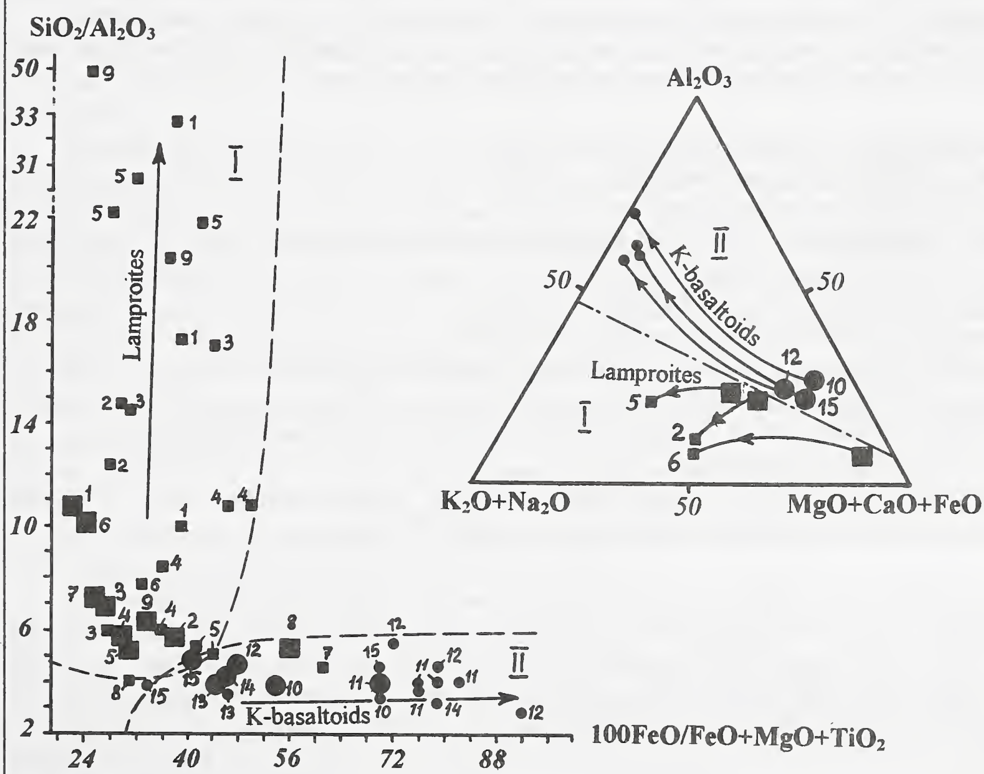
3. The analysis showed that in terms of their crystallization temperatures lamproites do not practically differ from potassic series under discussion: both were formed at high temperatures approximately in the same interval: from 1290 to 1100°C.

1 4. The chemical composition of melts, responsible for the formation of lamproites and rocks of the family of leucite basanites-tephrites-phonolites and family of shoshonites, is essentially different. These differences become distinct during differentiation and fractionation processes which widely occur upon formation of the rocks under discussion.

It is worth to note, that evolution transformation of compositions of initial lamproite, basanite-tephrite-phonolite and shoshonite-potassium melts in general occurs unidirectionally and tends towards an increase in the content of alkalis (with predominance of K over Na), Si, Al, Ti, and Ba in derivative melts and decrease in the amounts of Mg and Ca. Considerable differences are found in the contents and quantitative ratios of petrogenic elements. In lamproite melts even at a significant increase of SiO_2 (to 57-58 %) and alkalis (to 10-12 K_2O and 2.5-3.6 wt % Na_2O), initially low contents of Al_2O_3 (4-9 wt. %) though increase, but negligibly (by 1-2 wt. %), as a result of which the derivative melts always remain low-alumina and agpaitic. The SiO_2/Al_2O_3 ratio in them is never less than 5, typically being within 10-15, sometimes growing up to 30-33 mol. quant. In the melts responsible for the formation of basanite-tephrite-phonolite and shoshonite family, the initially high contents of Al_2O_3 (12-15 wt. %) increase still further (to 22-25 %) and essentially exceed the contents of alkalis (8-10 K_2O and 4-5 % Na_2O). As a result, the melts acquire a distinctly miaskitic character, while the Si_2O/Al_2O_3 ratio does not generally exceed 2.5-3 mol. quant.

During the evolution of initial melts the behavior of femic components is specific. Initially high-magnesian lamproite melts on crystallization still have low *f* ($100FeO/FeO+MgO+TiO_2$ = 28-50 mol. %) both due to preservation of the great importance of magnesium in derivative melt (MgO content is never less that 2-3 wt. %), and due to appreciable increase in TiO_2 content in differentiates (to 5-9 wt. %). In the melts responsible for the formations of rocks of basanite-tephrite-phonolite and shoshonite family, *f* during crystallization increases considerably (from 46

Transformation of the initial melts during formation of lamproites, basanite-tephrite phonolites, and olivine absorakites.



■ ▪ *lamproites and inclusion glasses, respectively.*
● • *high-alumina K-basaltoid rocks and inclusion glasses, respectively.*
The numerals correspond to particular rocks itemized in the text under corresponding number (see item 2). Inclusion glasses are given under the same numbers.

to 79-80 mol. %), the content of MgO most often decreases to a few tenths of per cent, while the concentration of FeO and TiO_2 remaind nearly the same.

In the diagram (K_2O+Na_2O) - Al_2O_3 - (MgO+FeO+CaO), the compositions of lamproites and rocks of basanite-tephrite-phonolite and shoshonite family are situated close to each other and localized in the lower high-magnesian part of the triangle. However, the initial melts during crystallization evolved in different ways: lamproite magmas differentiated towards excess of alkalis over Al (low-alumina agpaitic type), while basanite-phonolite and shoshonite melts -- towards predominance of Al over alkalis (high-alumina miaskitic type). The composition points of the initial melts under study are distinctly arranged in groups in different parts of the diagram and occupy isolated fields between which a separating line can be drawn. The diagram reflecting the ratio 100FeO/FeO+MgO+TiO_2 to SiO_2/Al_2O_3 is extremely revealing as well. Lamproite and high-alumina basaltoid melts with their differentiates also occupy isolated fields (I and II, respectively), and their trends are arranged nearly perpendicular to each other.

5. Conclusions. Al and Mg play the leading role among petrogenic components which govern the difference between lamproite magmas, basanite-phonolite and shoshonite melts. At constant SiO_2 content (i. e., stable degree of differentiation), the behavior of these minerals favors high-magnesian and low-alumina contents (hence, low ratios Al_2O_3/K_2O+Na_2O and SiO_2/Al_2O_3) of lamproites. These features can be used as genetic criteria which may help to ambiguously separate lamproites from high-alumina basanite-phonolite and shoshonite rock groups, and will also help to register possible phenomena of hybridism between them.

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