MINERALOGICAL MAPPING OF THE NORTH-EAST SECTION OF THE YAKUTIAN KIMBERLITE PROVINCE AND ITS MAIN RESULTS.

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It is widely known that the biggest diamond deposits of Siberia and South Africa were discovered using mineralogical methods. However, since the late 1950's, it became clear that high concentrations of indicator minerals, including Cr-pyropes, occur in both high-diamond-grade and barren kimberlites. Results of the first studies of crystalline inclusionsins in natural diamonds (Meyer, 1968; Sobolev et al., 1969), as well as of minerals in diamondiferous xenoliths (V.Sobolev et al. 1969; Sobolev 1971; Sobolev & Lavrent'ev 1971) were used as basis for mineralogical criteria applied to the estimation of diamond grade of kimberlites (Sobolev 1971). It was shown that subcalcic Cr-pyropes and chromites with maximally enriched Cr contents (>62 wt.% Cr_2O_3) and low Ti and Fe3+, interpreted as originating from cpx-free harzburgite-dunite paragenesis (Sobolev et al. 1969, 1973), are the main important indicators of potential diamond grade of Siberian kimberlites.

On the basis of analyses of >500 Cr-pyropes and nearly 600 chromites included in diamonds, as well as of the compositions of representative numbers of pyropes and chromites (usually >200 grains of each mineral) from kimberlite concentrates of more than 100 pipes with wide variations in diamond grade, we have established the following compositional ranges of indicator minerals, which we use for estimation of potential diamond grade of kimberlites:

1) Pyropes: CaO<1.6 + 0.38 Cr_2O_3 wt.%, with the condition that Cr_2O_3 >5 wt.%.

2) Chromites>71-1.637 Al_2O_3 wt.%, with the conditions that Cr_2O_3>62 wt.%; Al_2O_3<7.5 wt.%; TiO_2<0.7 wt.%.

Spesial significance was given to the P-T boundary of the graphite-diamond transition (Sobolev 1977), reflected in the composition of coexisting pyropes and chromites in the harzburgite paragenesis (Pokhilenko et al., 1991; 1993). This factor was very important in increasing the reliability of the estimations of potential diamond grade of kimberlites. We have found that there is a large possibility of very significant errors in such estimation where Cr-pyropes containing > 15-17% of the knorringite molecule are absent from a kimberlite pipe. This is because pyropes of such composition were only formed in the diamond stability field (Pokhilenko et al., 1991; 1993).

The work of the mineralogical mapping of the North-East part of the Yakutian kimbrlite province was undertaken by us in close cooperation with the Amakinskaya prospecting expedition (group of the late Yu.P.Belyk) since 1974. The territory studied covered approximately 60,000 km^2, was delimited to the East by the Lena River and included the lower part of the Olenek River basin. The main part of this territory is characterized by relatively simple prospecting conditions (open sedimentary host rocks of Cambrian age), but very complicated geological and prospecting conditions occur in its eastern part, where host rocks for potentially diamondiferous kimberlites are covered by younger sediments and even traps.

Mineralogical mapping of this territory was based on detailed studies of specific peculiarities of composition of Cr-pyropes and chromites (minerals bearing information about the potential diamond grade of their primary sources) from the modern alluvials,from secondary collectors of different ages and from the kimberlite pipes

known in that territory. Peculiarities of composition of Cr-pyropes of over 200 representative sampes (100 grains or more) and 70 samles of chromites were studied using the electron microprobe. The total number of indicator grains was over 60,000.

Analysis of data obtained produced the following results and conclusions:

1. High concentrations of subcalcic Cr-pyropes (up to 10%; Sobolev et al., 1981), as well as the presence of significant numbers of diamonds, were established for gravelites and conglomerates of Lower Carboniferous age of the Kyutyungde River basin and for Permian-age sediments of terrigenous origin in the South-West part of this locality.

2. High concentrations of subcalcic Cr-pyropes (up to 38%), sometimes together with significant numbers of "diamond-association" chromites (up to 10%), as well as diamonds, themselves were found in alluvial deposits of several rivers of this locality (the same river basin). Significant variations in the distribution of compositions of pyropes and chromites in different samples of this locality, both in modern alluvials and in secondary collectors of different origin and ages support that: a) there are several undiscovered kimberlite pipes of Paleozoic age (older than Lower Carboniferous). This conclusion was supported by the discovery of the Ivushka kimberlite pipe which was covered by Permian sediments. b) There are some high-grade pipes among them. The total scheme of mineralogical mapping of this territory is presented in Fig.1; two examples of differences in distribution of compositions of Cr-pyropes in different samples of this region are shown in fig.2.

3. Analysis of the results of compositional studies of pyropes and chromites from 25 kimberlite pipes of Mesosoic age (J_3) of this region shows practically a complete absence of minerals derived from diamondiferous harzburgites and dunites, and the absence of signs of the presence of diamonds in these pipes. These facts, together with reliable data about the presence of high, and sometimes very high, concentrations of the disaggregation products of diamondiferous harzburgites in the kimberlites of Paleozoic age (before C_1) existing in this locality, can be explained by the availability of processes of erosion and transformation of the deepest levels of the lithosphere in this region, accompanied by intensive basic magmatism, at the time of tectono-magmatic activation at the boundary between Permian and Triassic periods. Active interaction between melts of probable asthenospheric origin, very enriched in Si, Ti, Al, Fe, Ca, Na, K and HREE and having high fO_2 compared with depleted harzburgites and dunites was a reason for partial erosion of the keel parts of the lithosphere, transformation of dunites and harzburgites into lherzolites and oxidation of diamonds.

References

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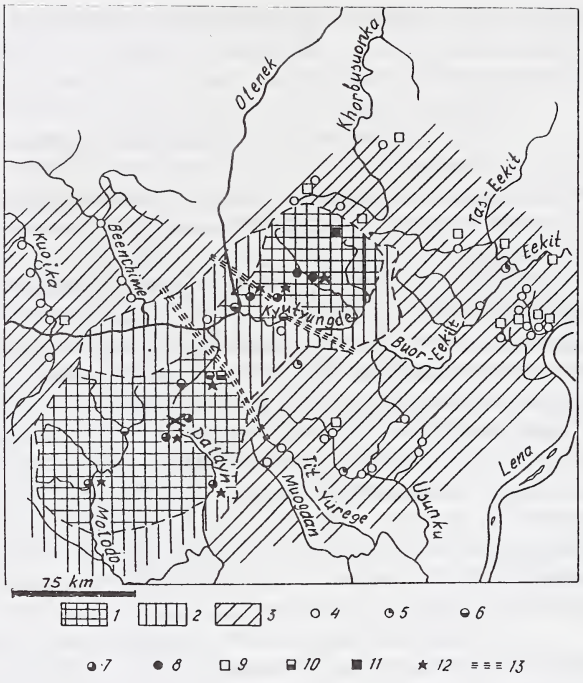
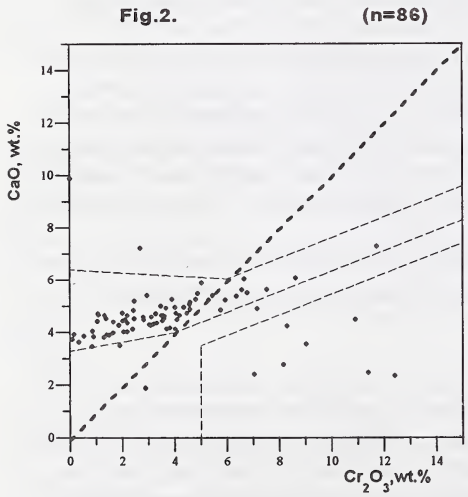
Fig.1 Scheme of mine-ralogical mapping of the Kyu-tyungde graben and its bordering territiries: 1 - the most promising fields; 2 - fields of second turn; 3 - fields without of perspectives. Contents of subcalcic Cr-pyropes in samples: 4 - <0.1%; 5- 0.1÷2%; 6 - 2÷-5%; 7 - 5÷10%; 8 - >10%.
Contents of chromites of the "diamond"association: 9 - <0.1%; 10 - 0.1-5%; 11 - 5÷ 10%; 12 - mass finds of diamonds of the Kyutyungde type; 13 - fault zones of the Kyutyungde graben.





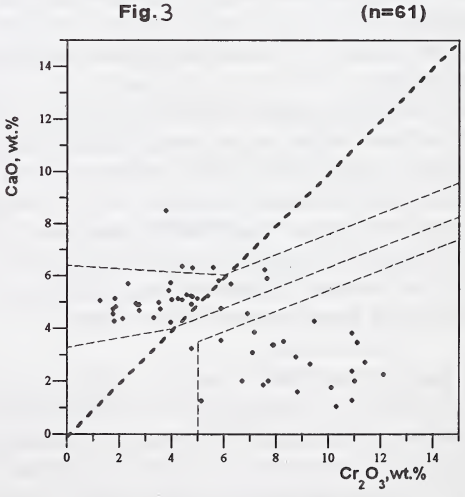


Fig. 2-3. Plots of CaO against Cr_2O_3 for Cr-pyropes from alluvials of the South-West and the North-East promising fields of locality (see Fig.1).