

GEOLOGICAL-MINERALOGICAL SYSTEM OF SEARCHING FOR DIAMOND DEPOSITS

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Searching for diamond deposits with indicator minerals is based on the ability of these minerals to remain in exogenic structures and to form vast haloes around the sources. However, their stability is not absolute and each mineral is subjected to some degree of alteration during halo generation. The degree and the way minerals alter depends on their geological environment.

Peculiarities of the minerals' alteration allow us to reconstruct the geological environment, to trace the history of mineral and halo generation. This is the basis for the geological-mineralogical system of searching for diamond deposits.

Searching raises two main problems: 1) halo identification, i.e. source determination (known or unknown; diamond-bearing or without diamond); 2) localization of the minerals' source if it is an unknown kimberlite or lamproite body.

Identification can be complicated due to three groups of factors: 1) physico-chemical and mechanical alteration of minerals in the process of halo generation causing significant changes in mineral habits and composition of mineral associations; 2) polygenic character of the haloes, i.e. a possibility of remixing of minerals from various sources; 3) heterogeneous and heterochronous character of haloes, i.e. their generation due to redeposition of indicator minerals from more ancient haloes of different lithodynamical type and age. Besides, localization depends, which on the degree of kimberlite erosion which determines the halos' sizes.

Maximum information on the sources and environment of halo generation is revealed through morphology of minerals since physico-chemical and mechanical alterations are reflected in morphology first of all. To determine correctly the degree and process of secondary alterations it is necessary to be well-acquainted with the primary morphology of minerals. The morphology is "primary" only for the searching, in reality it is a result of continuous deep-seated mineral development including periods of their presence in the mantle substrate, kimberlite melt and post-magmatic environment. Each stage of the deep-seated morphogenesis is fixed in the minerals by specific morphological peculiarities.

In an exogenic environment at the generation of halos the indicator minerals are subjected first to mechanical wearing. We have shown that the wearing degree depends more on environment of the halo generation than the distance of transportation. Hydraulic sorting by granulometry and density of minerals and distribution of their concentrations relativ to the kimberlite body (for aluvial) is described by the following formula:

$$P(x) = P_0 e^{-bx},$$

where x - distance of transportation; P_0 - mineral concentration in the source; $P(x)$ - mineral concentration at distance x ; b - inertial coefficient dependent on the size and density of the mineral. Physico-chemical alteration of minerals is performed after the halo generation. Major types of alteration are hypergenic in the weathering crust of kimberlites and sedimentary collectors, diagenetic, referring to metagenesis in the folded regions, referring to metasomatoses at exocontacts of intrusions (f.ex. differentiated trappes). The hypergenic alterations are spread most widely.

Halos of the indicator minerals are generated in various environments and change in geological history. However, three major lithodynamical types may be distinguished: the continental (aluvial) type along the river valleys; the coastal-alluvial type in zones of the coastal alluvial depressions; the coastal-marine type in zone of the wave activity. Each halo type has its own typical features. Their major difference is a degree of the minerals wearing; aluvial halos are characterized by a minimum degree of mineral wearing; coastal-aluvial haloes - by average degree; coastal-marine - by maximum. For the searching of kimberlite bodies the aluvial haloes are most perspective. Coastal-marine haloes do not allow the searching of kimberlites but are favourable for placers generation. Coastal-aluvial haloes are not favourable neither for searching of kimberlites nor for the placers generation.

However, these types of haloes are rare, more often these are haloes of the coastal marine type. Due to cyclicity of the sedimentogenesis processes the sedimentary thicknesses with haloes of indicator minerals are eroded and indicator minerals are transported to younger deposits. Simultaneously kimberlite bodies may erode. Thus, in the new halo there is a remixing of minerals redeposited from an ancient halo and minerals from a kimberlite, i.e. the heterochronous halo takes place comprising indicator minerals of different stages of erosion of the same kimberlite bodies. During redeposition minerals from different lithodynamic types of the haloes may mix and cause the appearance of heterogeneous haloes. The heterogeneous and heterochronous character of modern as well as of ancient haloes is common for all the diamond provinces. It raises serious problems in searching since re-deposited minerals lack the relation to a primary source and the kimberlite body is may be found only by those minerals which directly get from the kimberlite. There is a complex of signs which allow us to distinguish the re-deposited minerals and the minerals which get to the halo only from kimberlites.

Due to differences in the geological structure and the evolution of the diamondiferous area, character and development of indicator minerals each region will be distinguished by its own conditions of the searching work. However, four major types of geological-mineralogical searching setting may be distinguished:

Type I is kimberlite bodies are exposed at the surface; ancient collectors of indicator minerals were absent. In haloes the re-deposited indicator minerals are absent and haloes are generated only due to minerals being obtained only from kimberlites. The simplest searching scheme is realized - through the "trace" of indicator minerals.

Type II is kimberlite bodies are exposed at the surface and the ancient collectors were present which are weathered almost up to the present. The haloes comprise

indicator minerals re-deposited from ancient collectors and minerals obtained only from kimberlites. In this setting it is necessary to separate re-deposited minerals and to perform the searching through the "trace" of minerals obtained only from kimberlites.

Type III is kimberlite bodies are buried under younger deposits representing collectors of indicator minerals. This type is the most complicated since the sampling of the collector has to be done "blindly" by drilling, the sampling volumes are insignificant. Besides, as investigations of the Yakutian ancient collectors have shown, they contain the indicator minerals re-deposited from ancient collectors.

Type IV is wide distribution of ancient coastal-marine deposits which are the primary or re-deposited to younger (up to Quaternary aluvial period) deposits. These haloes are characterized by more expressed alteration of minerals and by absence of relation to the sources. However, they have the potentia to contain diamond placers, since during sea coast processes diamond concentration takes place and also removal of small particles due to differences in hydraulic features.

Type I has a restricted distribution. The other three types are spread most widely. The most accessible is Type II. Type IV takes place in all diamond regions. However, coastal-marine haloes only indicate the presence of sources and it is not possible to localize them. At early stages of searching the first findings of diamonds are mostly related to coastal-marine haloes, but the meaning of such findings should not be over-estimated. There are methods which allow to determine the origin of diamonds from such haloes even if they do not reveal signs of mechanical wearing.

There are other types of searching settings: glacial, eolian, etc. which have not been sufficiently studied. Each type has its own potentials and restrictions on geological-mineralogical searching. Study and correct determination of the type of searching setting in each case will allow us to estimate the tactics for the searching process.