PREDICTION OF DISTRIBUTION AND DIAMOND POTENTIAL OF KIMBERLITE PROVINCES, FIELDS AND DIATREMES

V.A.Milashev

All-Russia Research Institute for Geology and Mineral Resources of the World Ocean (VNIIOkeangeologiya), 1, Angliysky Prospect, 190121, St.Petersburg, Russia

1. Prediction of kimberlite provinces is based on known regularities in their distribution and structure, such as restriction to ancient platforms, position relative to boundaries of Gondwana and Laurasia supercontinents, and internal zonation. The latter is demonstrated in the presence in central parts of the provinces of the highest pressure kimberlites of diamond subfacies and surrounding volcanic and plutonic formations of ultrabasic and alkaline-ultrabasic picrite-facies rocks, whereas less barophilic kimberlites of pyrope subfacies are found along the margins of provinces. Such zoning is explained by formation of ultrabasic and carbonatite magma at final stages of mantle processes whose early and middle stages generated kimberlite magmas. Distribution and age of new kimberlite provinces in a region can be predicted with sufficient degree of reliability from spacing and geological datings of picrite-facies magmatic complexes and intermediate collectors of kimberlite-type diamonds. Based on these conclusions, we have foreseen the location, diamond potential and ages of ten kimberlite provinces in different parts of the world, and three of these provinces - Central Brazilian, Russian and Australian - have already been discovered in 1976, 1977 and 1978, respectively.

2. Boundaries of kimberlite fields have commonly been arbitrarily drawn at some distance outside the limit of distribution of the most remote of known diatremes. Such boundaries only register size and configuration of the areas with discovered kimberlites but provide no independent geological information relevant for defining the natural contours of kimberlite fields, structural boundaries in the first place. A more efficient approach applies structural zoning of kimberlite provinces based on data on megafracturing. It is established that manifestations of kimberlite magmatism are associated almost exclusively with crustal blocks showing isotropic orientation of fracturing. Therefore analysis of megafracturing allows to structurally outline the kimberlite fields regardless of the amount and the position of discovered diatremes. When defined for all the fields of the Yakutsk and Russian provinces, such boundaries appear to encompass 96% of pipes and dikes, with only 4% of the bodies located outside these boundaries at distances not exceeding 2.0 km. Because the blocks with isotropic fracturing which are really prospective for discovery of new kimberlite fields usually occupy no more than 10%, rarely up to 30% of the total investigated area, implementation of remote technologies for defining such blocks allows to significantly reduce the costs and improve the efficiency of prospecting.

3. The method of reconstruction of kimberlite-controlling structural dislocations is used to predict the occurrence of yet undetected bodies. It allows to define the sites which are most likely to contain new diatremes within the limits 1.5 x 1.5 km, with total area of such sites in each field not exceeding few percent of its territory.

4. In any kimberlite field, the costs of discovery of every new pipe steadily increase, and the feasibility of further prospecting becomes questionable. The solution may be provided by comparison of amount of kimberlite pipes already discovered with the minimum number of diatremes calculated for this field by the proposed method.

5. Upon discovery of a kimberlite pipe, the content, quality and reserves of diamonds are usually estimated by conventional means, which include extracting extremely voluminous (tens of tons) rock specimens, their enrichment and subsequent examination of the concentrate. Due to high consumption of investment and labour, these methods are in most cases not cost-effective because only 2% of diatremes contain commercial concentrations of diamonds. Indirect method of evaluation of diamond potential of a kimberlite pipe is economically more attractive since it allows to predict, from the results of chemical analyses and dimensions of a diatreme at the surface, the reserves of diamonds it contains (in carats) and their gross value (in rubles or dollars), and ultimately to assess, with sufficient confidence, the feasibility of large-scale sampling needed for final determination of the content, quality and amount of reserves of diamonds in the deposit. With this method, about 90% of kimberlite bodies appear unworthy for commercial exploration, and verification of the procedure in hundreds of kimberlite pipes proved its 100% reliability.

6. The initial stage of prospecting for diamond fields in the frontier regions commonly involves sampling of alluvial deposits, and only after some diamonds have been detected the search for bedrock sources begins. As a rule, diamond-bearing kimberlite bodies would, indeed, be discovered somewhere in respective drainage systems, but none of them with concentration of diamonds sufficient to justify the prospecting costs. We have developed the method allowing to evaluate the diamond potential of kimberlite-type sources by photoluminiscent features, morphology and average weight of placer diamonds. Therefore it is possible to predict the maximum diamond concentrations expected in yet undetected bedrock kimberlites in the source area, and to assess feasibility of their prospecting.