CORRELATION AND CLASSIFICATION OF KIMBERLITE INDICATOR PROPERTIES

Tsyganov Vladimir A.

Almazy Rossii-Sakha Co. Ltd. 7, Chernyshevsky Shosse (road), Mirny, Republic Sakha (Yakutia), 678170, Russia.

The problem of prospecting low magnetic kimberlite pipes, as well as diatremes, locating in unfavourable prospecting situations for heavy-concentrate mineralogical method, accelerates application of non-traditional methods of exploration in the practice of diamond prospecting works. These methods are based on specific properties of kimberlites allowing to reveal them on the background of country rocks. New prospecting methods are also used when classifying magnetic anomalies according to the degree of perspectivity, as well as for localization of pipes in the contours of the revealed heavy concentrate-mineralogical haloes. While doing this, as a rule, the character of correlation relationship between the contrast of occurrence of various indicator properties in pipes is not taken into consideration. These noted circumstances create real possibilities of missing the targets. In order to increase geological effectiveness and to cut expenses for geological works there has been made an attempt to determine correlation relationship between various indicator properties of kimberlites on three main diamondiferous fields of Yakutian Province (Mirninskoye, Alakhit-Markhinskoye, Daldynskoye).

On the materials of I.P.Ilupin, D.I.Savrasov and A.T. Bondarenko there has been compiled a data base for about 100 pipes of the noted territory with inclusion in it for each pipe of the following features: size, chemical composition, content of microelements, content of pyropes, picroilmenite and other indicator minerals, content of country rock xenoliths, thickness of kelyphytic edging on pyrope, petrophysical properties, diamondiferous and some other properties. Correlation relationships between the properties were investigated with the help of the method of factor analysis, couple and rank correlation.

In the result of the performed investigation there have been revealed three main factors, the changeability of which practically completely explains all variations of main rockforming components of the material composition of kimberlites in the region (table N 1). Further on the correlation of indicator properties was investigated in regard to these factors.There have been revealed three types of properties, all in all, which, depending on the strength of correlation with the main factors, were called: **properties of the entailed type** (when correlating with the factors close to linear dependence), **properties of the entailed-autonomous type** (when correlation has the level of significance in the interval of 0,001 to 0,05), **properties of autonomous type** (with the level of significance worse than 0,05). The properties of the first two types then were devided into classes, depending on which of the main factors the most strong correlating relationships are noted for them with. The results of the described approach to classifying indicator properties are given in Table N 2.

Table N 1

N of a factor	Main chemical components and the sign of correlation with a factor
1	+ MgO, SiO_2, H_2O
	− CaO, CO_2
2	+ FeO, Fe_2O, TiO_2
3	+ K_2O, Na_2O

Analysis of Table N 2 gives an opportunity to make several important conclusions in regard to practice.

1. Changeability of the chemical composition of kimberlites, which is described by variations of the first factor, practically completely controls changeability of main geoelectrical features: electrical resistivities on AC and dielectric permeability. This relationship may be conditioned by the influence on the noted properties of general porosity, which itself is the consequence of correlation in rock of ser-

pentine and carbonate components. The levels of concentration in pipes, and hence in-the secondary geochemical halo of dispersion, of chemical elements (B, Zn, Cr, Ni, Ba) make it possible to forecast the significance of the first factor for undiscovered pipes and accordingly forecast the significance of geoelectric parameters for kimberlite rocks composing these targets. The latter, in comparison with analogous parameters of country rocks, allow to make a decision about the expediency of using and modification of electric prospecting method during localization of kimberlite pipes.

2. The changeability of the chemical composition of rocks, described by variations of the second factor, considerably regulates main indicator properties of kimberlites, petromagnetic parameters, density (gravity), content of picroilmenite, chromespinel and in smaller degree of chromediopside. And in this case the specific nature of secondary geochemical haloes, at first, and then specific features of mineralogical halo, make it possible to forecast petromagnetic and gravity properties of undisco-vered pipes and according to it determine the expediency and the way of applying geophysical methods.

Table N 2.

N of a factor	Sign of correlation with a factor	Groups of indicator properties		
		Levels of chemical elements concentration	Content of minerals and other components of rock	Petrophysical features
Properties of the entailed type - C				
1	+	B, Zn, Cr, Ni	-	Electrical resistivity on AC
	−	Li, Ba	-	Effective porosity, Dielectric permeability
2	+	Cu, Ta, Sc, Co, V, Sn, Nb, Ga, Mn	Picroilmenite	Magnetic susceptibility, Factor Q, Density
	−	-	Chromespinel	-
3	+	Sr, Hf, Rb	-	-
Properties of entailed-autonomous type - CA				
1	+	-	Pseudomorphs on olivine	-
1,2	−	Zr	Chromediopside, Xenoliths of country rocks	-
3	+	Mo	Thickness of kelyphytic edging on pyrope	
Properties of autonomous type - A				
Form associations	A_1	+ P_2O_5 Th, U, La, Y / − Size of pipe		
	A_2	+ S, Content of diamonds		
	A_3	+ Content in picroilmenite (Fe, Cr, Co, Sc, Hf, Ta)		
Completely autonomous		• Content of pyrope • Content of Al_2O_3 • Electrical resistivity on DC.		

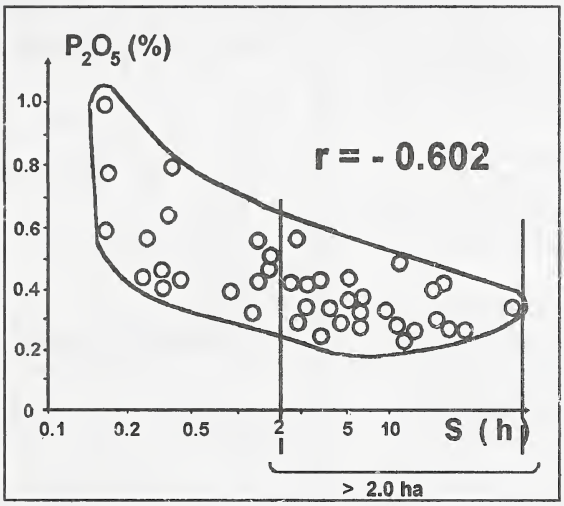
3, Changeability of general alkaline nature of kimberlite rocks finds direct reflection in containing Sr, Hf, Rb, Mo in pipes and in the thickness of kelyphytic edgings on pyrope. Consequently, corresponding specific feature of the secondary geochemical halo (low concentrations of the mentioned elements) allows to consider with more optimism the haloes of pyropes having no reactionary edgings, and on the other hand not to exclude possibility of complete substitution of pyropes by secondary minerals.

4. Indicator properties of autonomous type of association A1 establish distinct reverse correlation between the sizes of kimberlite bodies and the content of phosphorus, thorium, uranium, lanthanum and yttrium in them (Fig.N 1.) The noted fact testifies about an opportunity to use gamma-spectrometry method for prospecting of small in size pipes.

5. Indicator properties of autonomous type of association A2 closely connect together the content of diamonds in pipes and the content of sulphur in the same pipes (Fig. N2). This circumstance does not contradict to the existing data on the inclusions of sulphides in diamonds, data about the steady character of diamonds in the system "sulphur - oxygen", with evident predominance of the first chemical element. Considerable difference in the

meanings for sulphur in the left part of the scheme, that is if the diamondiferous property of the pipes is poor, may be connected with two sources of sulphur in kimberlites: hypogenic and hypergenic. It is evident that during application of data on isotopy of sulphur hypogenic dependence sulphur - diamondiferous property can manifest with more contrast. The noted data testify possible efficiency of electroprospecting search of diamondiferous kimberlites by the method of Induced Polarization (IP). At this, the available data on mineralogical forms of sulphur in kimberlites and the data on mineralogy of sulphides of different genesis (on the materials of N.N.Zinchuk) make it possible to suggest the reality of separation of anomalies of induced polarization, connected with hypogenic sulphides from hypergenic analogies.

Fig. N 1.



This classification of indicator properties of kimberlites, based on correlation relationship between their material and indicator characteristic features, on one hand allowed to make several, in regard to practice, conclusions, but on the other hand it is based on the limited actual material. This last circumstance means that it is necessary to involve into such processing the data on a greater number of pipes, located in different diamondiferous provinces of the world. At the same time, the available average characteristic features on some kimberlite fields and provinces demonstrate reliability of the described main tendencies of relationship between material and indicator characteristic features of kimberlites.

In application to the task of kimberlite prospecting the above described mainly allows to formulate a special problem about forecasting indicator properties of undiscovered pipes, clusters of kimberlite bodies, separate kimberlite bodies. Such a forecast of properties can be based, on one hand, on the specific features of secondary mineralogical and geochemical haloes, which had formed during the destruction of diatremes in near surface conditions, and, on the other hand, quite probable, on tectonic attribution of definite diamond-perspective territories. As a consequence of such forecasting there will be the development of forecasting-prospecting combination of methods, adapted to a definite region or plot, that is more efficient and reasonable.

Fig. 2.