PALEOMAGNETISM AND THE AGES OF KIMBERLITES EXEMPLIFIED BY THE FOUR PIPES OF YAKUTIA

Zhitkov[1] A.N., Savrasov[2] D.I.

(1) VostSibNIIGGiMS, Geological Committee of Russia, Irkutsk, Russia; (2) Botuobinsky expedition, Mirny city, Russia

The oriented samples were collected in four Middle Paleozoic economic diamond-bearing bodies of Malya Botuoba (Sputnik, named after 23rd Congress) and Alakit-Markhinsky (Sytykanovsky, Yubileiny) regions. The collections represent all main varieties of kimberlites of every pipe (661 samples). The magnetometric measurements were made by highprecision spin-magnetometer JR-4 and kappabridge KLY-2. Experiments on thermal demagnetization and demagnetization by alternating magnetic field were conducted in the facility of magnetic vacuum with a precision of the field compensation + 10 nT. A step of scalariform demagnetization was 25-50o C and 20-40 kA/m, accordingly. The diagnostics of the magnetism bearers was carried out on the curves of normal

Table 1
Magnetic properties of kimberlites in natural occurrence

	M	б	Ml	ε	J	D	K	A_{95}	ρ_{39}
			Pip "After 23rd Congress", N-138						
I	465	95	225	1.11	-31.4	5.7	1.9	12	42
In	578	92	293	1.12	-71.2	22.4	3.9	7	29
æ	377	28	241	1.10	-	-	-	-	-
Q	2.7	0.2	2.4	1.07	-	-	-	-	-
			Pipe "Sputnik", N=138						
I	401	60	78	1.15	51.8	354.6	3.1	7	33
In	396	64	36	1.22	3.9	347.5	1.8	12	44
æ	280	33	74	1.14	-	-	-	-	-
Q	1.9	0.2	0.8	1.12	-	-	-	-	-
			Pipe "Sytykansky", N=244						
I	2092	184	786	1.11	66	344	3	6	34
In	781	86	285	1.12	50	340	2	10	44
æ	2465	205	871	1.11	-	-	-	-	-
Q	1.42	0.17	0.54	1.09	-	-	-	-	-
			Pipe "Jubileiny", N=141						
I	2582	88	2297	1.05	80	1	137	1	5
In	618	48	372	1.10	70	11	3	8	31
æ	3337	82	3084	1.04	-	-	-	-	-
Q	0.27	0.02	0.20	1.08	-	-	-	-	-

I - *ummary magnetization*, In - *natural residual magnetization*, æ - *magnetic susceptibility*, Q - *Kenigsberger coefficient*, M - *average arithmetic*, Ml - *average geometric*, б - *standard deviation*, ε - *standard multiplier of lognormal distribution*, J(D) - *inclination (declination) of the single vector resultant*, K - *clustering*, A_{95} - *radius of confidence circle for 95% probability (after R.Fischer, 1957)*, ρ_{39} - *radius of a single circle of dispersion (spherical standard)*. *Values* I, In *are given in mA/m*, æ - *in* 10^{-5} *CI units*; J, D, A_{95}, ρ_{39} - *degrees*; Q, ε, K - *dimensionless*.

magnetization in the fields up to 600 kA/m. Quantitative paleomagnetic dating was preformed via comparison with the trajectory of apparent migration of the Siberian platform.

A complete spectrum of magnetic parameters was obtained and statistically processed. The values and dispersion of magnetic properties of kimberlite in the natural occurrence are provided in Table 1. All studied bodies were found to contain the rock varieties retaining primary natural residual magnetization which can be easily interpreted. An instance of thermal demagnetization of kimberlite with a dominant primary component of natural remanent magnetization is given in the Figure.

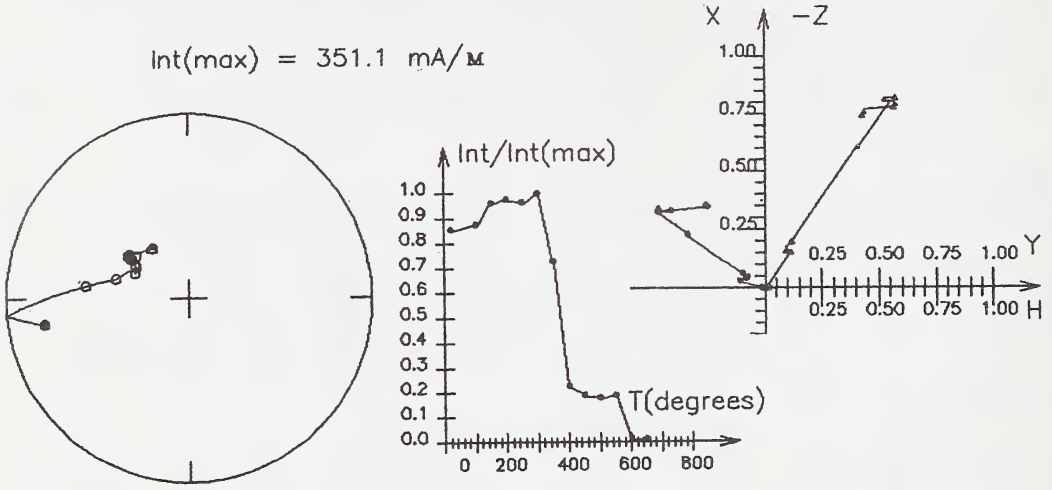

Figure. Results of thermal demagnetization. The porphyry kimberlite of endocontact zone of "Sytykan" pipe.

A particular feature of the kimberlites studied is a wide spectrum of limiting temperatures and Curie points bearing natural remanent magnetization (from 250 to 650o C). This indicates presence in source rocks of hypogenous magnetic minerals of different age (magnetite, hemoilmenites with different ratios of Fe-Ti components).

The results of paleomagnetic studies and quantitative polar paleomagnetic dates are listed in Table 2. The conditional paleomagnetic directions and poles were obtained for four pipes. The primary origin of natural residual magnetization is substantiated by a set of criteria including the most reliable method of comparison of paleomagnetic directions obtained for kimberlites and host sedimentary rocks in the contact zone (test of burning). It was revealed that remagnetization of hosting rocks by kimberlite occurs only in the vicinity from the contact (the first centimeters). A significant and unexpected result was inverse polarity and the primary natural residual magnetization of all studied varieties of the Middle Paleozoic kimberlites of the two separated kimberlite fields. There is every ground to believe that this feature can be bound or dominant in other

bodies of the same or close age. A stable inverse polarity of geomagnetic field contributes to origination of the Middle Paleozoic kimberlites.

Table 2
Paleomagnetic directions, poles and dates of Yakutian kimberlites

	N/n	Paleomagnetic directions J	D	k	α_{95}	Region φ	λ	Paleomagnetic poles Φ	Λ	A_1	A_2	T mln. yrs.
	Malaya Botuoba region											
1.	16/49	-70	318	121.1	3.2	62.5	113.5	32	141	5.5	4.8	345±*9*
2.	15/45	-66	326	39.5	5.8	62.5	113.5	24	138	9.4	7.6	348±*11*
	Alakit-Markhinsky region											
3.	14/60	-64	322	42.0	5.8	66.1	111.8	25	140	9.2	7.3	346±11
4.	11/37	-63	324	100.2	4.2	66.0	111.7	24	139	6.4	5.0	344±10
5.	4/191	-	-	-	-	-	-	27	139	3.3	3.3	347±8

1 - "*Named after 23rd Congress*", 2 - "*Sputnik*", 3 - "Sytykan", 4 - "*Yubileiny*", 5 - *summary determination for 4 pipes. Number of vectors involved in statistics*: N - *lumps of ore*, n - *samples*. J, D - *inclination and declination of the average direction of primary magnetization*; k - *clustering* ; α_{95} - radius of confidence circle for 95% probability; φ,λ - *coordinates of sampling site*; Φ,Λ - *geographic latitude and longitude of the average paleomagnetic pole*; A_1, A_2 - *semiaxes of ellipses of confidence for 95% probability*, T.- *paleomagnetic date*.

The data were obtained on paleomagnetic poles of every pipe and general determination. According to paleomagnetic data the age of kimberlites is estimated as the Upper Devonian-Early Carboniferous, most probably Early Turnean (347+8 Ma), which agrees well with determinations by F.F.Brachfogel (1984, 1992) from a complex of radiological and other kimberlite dating evidence and is their independent confirmation and specification. Regarding the Khramov's magnetostratigraphic scale (1982), the dates obtained correspond to the middle part of the Tikhvinsk superzone of the Donetsk hyperzone characterized by a steble inverse polarity of geomagnetic field. The scatter of estimates for every pipe and the summary pole fall in a very narrow time span (3 Ma).

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