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Magnetic picroilmenites from Guinean (Africa) and Yakutian kimberlites

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Picroilmenites from kimberlites of different regions of the World are well studied. Nevertheless, very unusual zonal picroilmenites were found in recently discovered Massadou kimberlite field (Republic of Guinea).

Massadou field disposes within the Man Shield, as a fragment of Archean West African craton (Fig. 1) Clifford (1966). Kimberlites of the Man Shield are of Jurassic age (140-150 Ma) Skinner et al. (2004). According to Haggerty (1992) kimberlites emplacement is connected with opening of the Atlantic rift in Mesozoic time. The system of transform faults (K-4) interfaced to a rift zone has latitude orientation and supervises kimberlites.

Two types of picroilmenites – ferromagnetic and paramagnetic were determined in Massadou field kimberlite dikes. Ferromagnetic picroilmenites have well developed rims, with different thickness for each kimberlite body.

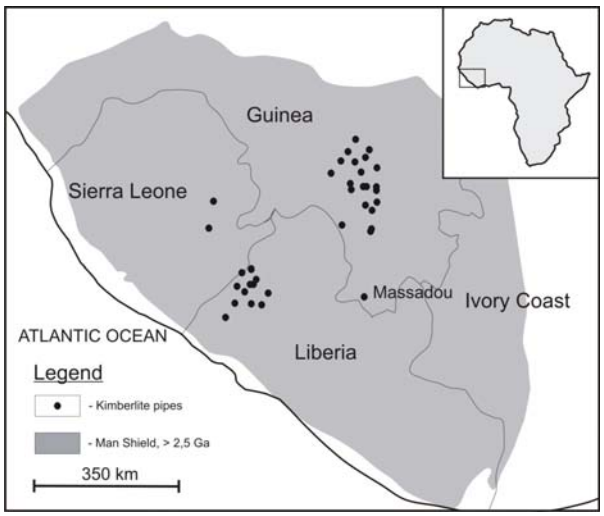

Fig. 1. Location of Massadou field, Man Shield territory.

Surface and outer part of such picroilmenites have layer-like or ribbed structure (Fig. 2). The rims structure development is not limited only by outer parts of picroilmenite grains, but distinctly surrounds a large cracks inside the grains (Fig. 3).

The results of picroilmenite from Yakutian kimberlites (Malo-Botuobinsky region, pipe Dachnaya) study show up that ferromagnetic picroilmenites also frequently have zonality similar in outward view as well as in chemical composition to picroilmenites zonality of the most of Massadou kimberlite dikes (Fig. 2).

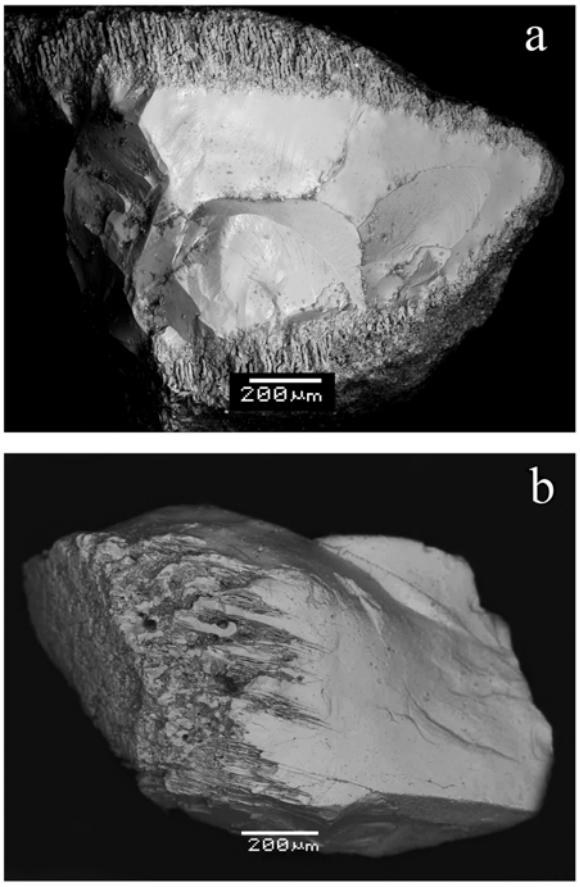

Fig. 2. Massadou field zonal picroilmenite - a; Dachnaya pipe zonal picroilmenite - b.

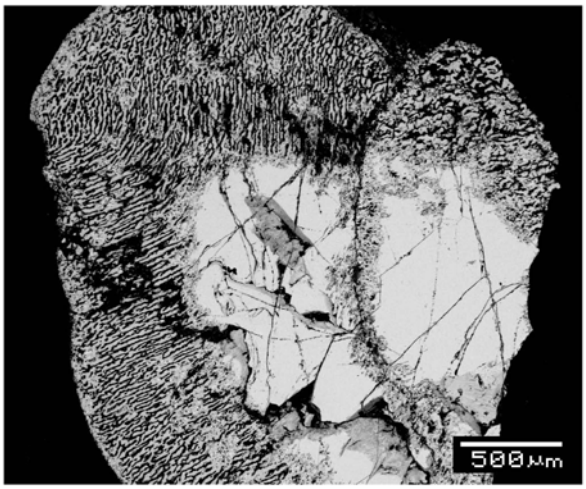

Fig. 3. Crack in grain of picroilmenite.

Paramagnetic picroilmenites from African and Yakutian kimberlites are homogenous in chemical composition.

Zonal and homogeneous picroilmenites from Massadou kimberlite field and Malo-Botuobinsky region have been studied using electron scanning microscope (JEOL 6380 LA) and microprobe (JEOL JXA-8100). The mechanisms of the chemical composition change from rim to core of African and of Yakutian ferromagnetic picroilmenites are completely equal. TiO_2, Cr_2O_3, MnO, MgO contents increase in the outer parts of zonal ferromagnetic picroilmenites, and content of Al_2O_3, FeO also decrease twice.

Distribution of composition points on the diagram in coordinates MgO - TiO_2 for zonal picroilmenites represents a trend consisting of two areas.

№	1c	1r	2c	2r	3c	3r	4c	4r
MgO	2,9	9,4	8,6	2,7	3,9	12,9	4,0	12,7
Cr_2O_3	1,61	2,42	2,40	1,48	2,60	4,04	3,69	5,04
MnO	0,18	0,41	0,36	0,19	0,15	0,47	0,14	0,30
Al_2O_3	0,34	0,08	0,01	0,34	0,80	0,33	0,77	0,27
FeO	61,3	39,4	39,1	61,7	57,3	32,8	56,5	32,0
TiO_2	30,1	45,5	47,6	30,1	32,7	48,5	32,5	48,7
NiO	0,03	0,14	0,13	0,03	0,12	0,09	0,11	0,14
Nb_2O_5	0,49	0,57	0,68	0,59	0,26	0,03	0,29	0,15
V_2O_3	0,51	0,42	0,17	0,52	0,27	0,38	0,11	0,21
ZrO_2	0,14	0,07	0,12	0,11	0,21	0,10	0,16	0,03
Total	97,6	98,4	99,2	97,7	98,3	99,6	98,3	99,6

Table 1. Composition of zonal picroilmenites: c - core, r - rim; 1, 2 - dike №5 (Africa), 3, 4 - Dachnaya pipe (Yakutiya).

The bottom field is characterized by dense distribution of points, and is located in an interval 2-5 wt. % on MgO and 27-34 wt. % on TiO_2. The top field borrows a greater area on the diagram and is located in an interval 7-17 wt. % on MgO 40-55 wt. % on TiO_2 (Fig. 4).

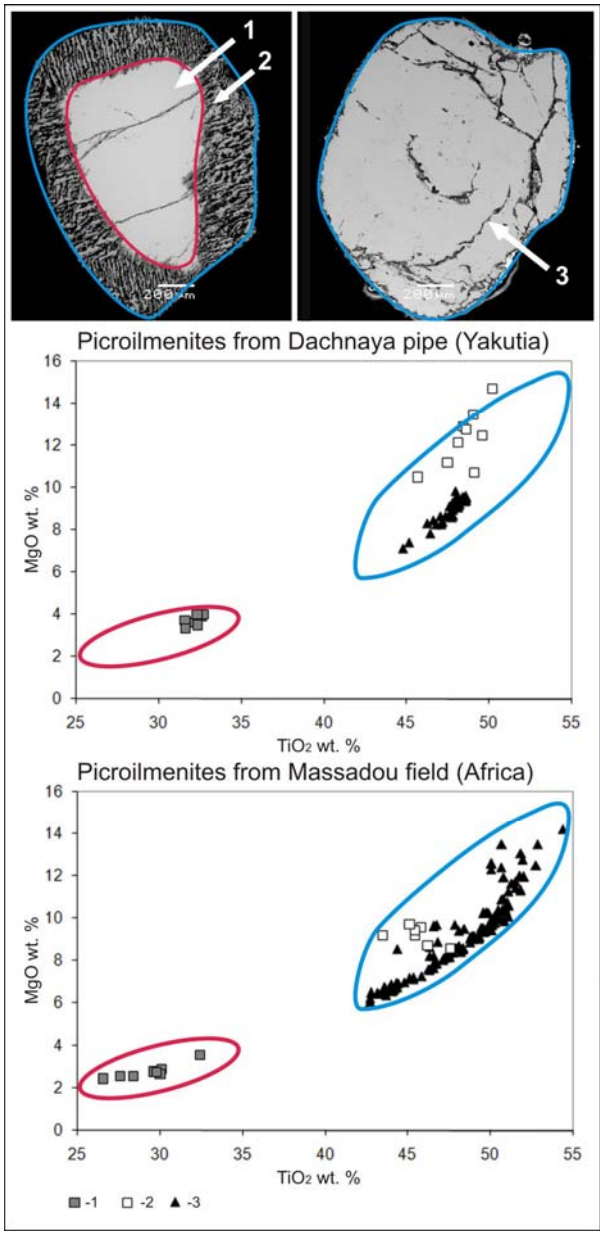

Fig. 4. Weight percent MgO-TiO_2 variations in African and Yakutian picroilmenites: 1-core of zonal grains; 2-rim of zonal grains; 3-not zonal picroilmenites.

Not zonal grains are characterized by the curved trend typical of kimberlitic picroilmenites. Distribution of composition points in coordinates MgO-TiO_2 is very dense and located in a field of 20-15 % of

maintenance Fe_2O_3 in picroilmenites structure. Maintenance MgO exceeds 6 wt. %, up to 14 wt. %, at maintenance TiO_2 more than 42-43 wt. % (Fig. 4).

The comparison of microprobe analysis data for ferromagnetic and paramagnetic picroilmenites from Massadou field and Dachnaya kimberlite pipe makes it clear that TiO_2, MgO, FeO, NiO content in homogenous picroilmenites corresponds to the content of that elements in the rims of zonal picroilmenites. Inner parts of zonal grains correspond in chemical composition to the group of low-Ti and low-Mg ferromagnetic picroilmenites, rim zones correspond to Ti-rich and Mg-rich paramagnetic picroilmenites, which are typical for all kimberlite rocks.

Results of this study give grounds to suggest that chemical composition change of the picroilmenites rim zones occurred with addition of some elements and removal of others. Presence of zonality proves that the process of chemical composition change is not finished. That's why homogenous (paramagnetic) picroilmenites can be interpreted as a result of chemical composition change finished process or as a crystallization result from new system which is also responsible for picroilmenites rims appearance. The chemical system responsible for picroilmenite composition and structure change could be magnesium-rich kimberlite melt that have altered picroilmenites during the kimberlite process development.

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