New Occurrences of Diamond Indicator Minerals and Alkaline-Ultramafic Rocks from the Eastern Border of the Hanka Massif, Primorje, the Far East, Russia

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The Hanka Middle Massif is in the Primorje Territory of the Far East of Russia. There are different views on the age of the basement complex of the Hanka ancient massif which many researchers consider as one of the uplifted projections of the Chinese Platform subjected in MZ and KZ to major tectonic modification. Some geologists believe it to be PR while others date it as 3800 My. Recent finds of kimberlite indicator minerals and occasional diamonds in the area along the eastern border of the Hanka massif attest to the second point of view, that is these allow to assign the massif to the ancient cratons with the basement complex of the AR age. Within the area of these finds named as Nezametninskaya Diamond Area a suite of alkaline-ultramafic intrusives (aillikites, nephelinites, aluminat-calcium breccias) which had not been described before was also discovered, though not kimberlites yet.

The Nezametninskaya Diamond Area is traversed by the Dal'nerechensky sublatitudinal lineament and by the NE Arsen'evsky deep-seated fault, the latter being the easternmost seam of the Hanka-Corean rift zone that in turn is the eastern branch of the Eastern Chinese rift system. Such tectonic setting of the area is favourable for location of kimberlites since the kimberlites of the North-Cninese Platform are known to be sited in the areas of intersections of basement's uplifts by sublatitudinal lineaments and deep-seated faults of the N.-NE rift system.

In the central part of the area is the Marjevskaya Depression infilled with continental molasse with beds of brown coal intruded by alkaline olivine basalts of the N.-Quaternary age. The Marjevskaya Depression is a young Neogene rift with 500-1000m subsidence of the Hanka massif's basement. The Kedrovka river valley where dispersion halos of diamonds, pyropes, kimberlite-type chromites as well as multiple magnetic "pipe-type" anomalies have been found lies along the eastern shoulder of this young rift. The locality is underlain by the PZ-MZ clayey-siliceous assemblage that represents marine sediments of the Main Sikhote-Alin' Synclinorium thrust on the ancient massif's margin. Conjectural age of the diamondiferous magmatism is Paleogene-Neogene and presumably this preceded alkaline-basaltic volcanism.

9 diamonds in all were found in the Kedrovka river basin in 1996-2001. The largest one (Fig.1) was found by the author when sampling alluvium of Zveriny Creek-a right tributary of river Kedrovka. The crystal dimensions are 2.1x2.1x2.4mm. It is transparent, light-yellow with a light greenish shade, and contains graphite inclusions. The form is rounded dodecahedron. When irradiated by U-V light the crystal shows intense yellow-green luminescence.

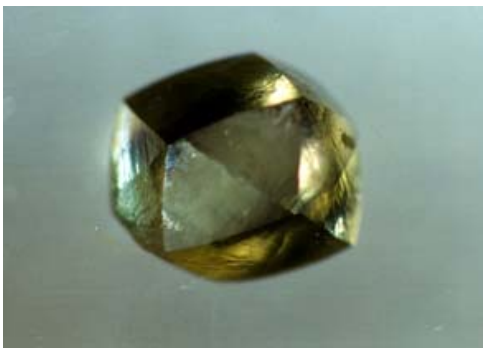

Fig.1 Zveriny Creek diamond

In the year 2001 a sample collected from tailings of former gold-digging operations on Zveriny Creek revealed 6 smaller diamonds, 2 of them are with largest dimensions slightly over 1mm and remaining 4 in the 0.2-0.6 range. Grains are broken octahedrons or formless fragments, transparent and colourless, one grain bears on the surface remnants of a fine film of the Pd-Au alloy.

Two small (0.25mm) diamond crystal fragments were found in samples collected from alluvium of Peschany Creek- another tributary of river Kedrovka. Both samples were enriched in serpentine grains and chromites with host rock adhesions. About 20% of chromite grains belong to the diamond inclusion type. One of these samples was located in the very center of a magnetic anomaly.

Before the author's exploration work in the area one colourless diamond in the form of rombic dodecahedron 1x1x1.5mm was found together with 19 pyropes in a minibulk alluvial sample collected in the Kedrovka river basin in 1990. All grains are unweared, pyropes are red-purple, purple and orange-red coloured with the Cr2O3 content from 2 to 8.5%.

On the whole pyropes are rare in alluvium samples of the Kedrovka river area. These are fractured grains and mostly fragments of grains 0.3-1.2mm of orange-red, pale-purple and crimson colour. Some of them have a preserved kelyphytic mantle. Microprobe study of 4 grains has shown variations of Cr2O3 from1.8 to 6.5% (Fig.2)

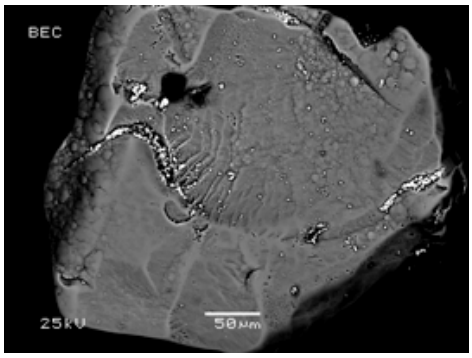

Fig.2 Purple pyrope with a pristine magmatic surface from river Kedrovka

Chromites dominate in all samples in the size range 0.3-1.5mm. The most of them judging by their morphology and chemical compositions are from various ultrabasic non-kimberlitic rock sources. However a number of grains correspond to kimberlitic morphology. They are octahedrons with vicinal faces, complex polyhedra, rounded grains without evident crystal forms, blocky grains, all with an irregular corrosion relief spread over their entire surface or part of it.

These types of chromite grains were picked in samples collected from tributaries of river Marjevka- Panov Creek, Solnechny, tributaries of Chernaya river, and from Zveriny Creek and river Kedrovka (Fig.3)

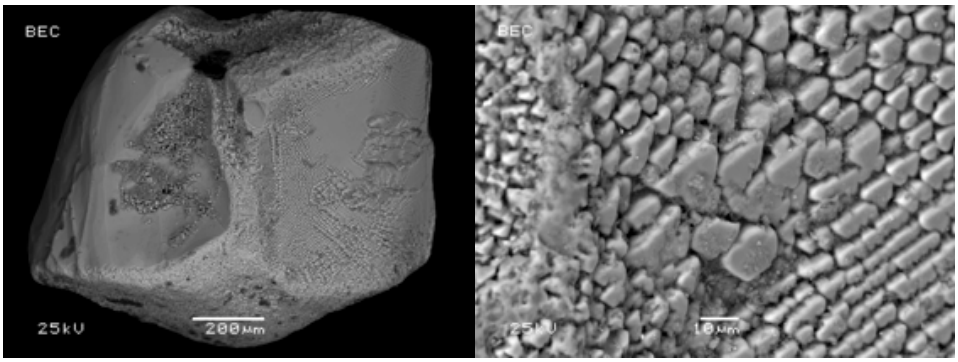

Fig.3 Chromite grain from Zveriny Creek with a typical corrosion relief
Detail of the corrosion relief

It is significant that most of these distinctive grains were picked in samples from Zveriny Creek and river Kedrovka where diamonds, pyropes and multiple serpentine fragments were found which suggests common rock sources for these indicators. Compositions of chromites from the Kedrovka river area show on the major oxide distribution plot a typical spread for mantle chromites of kimberlitic affinity (Fig.4)

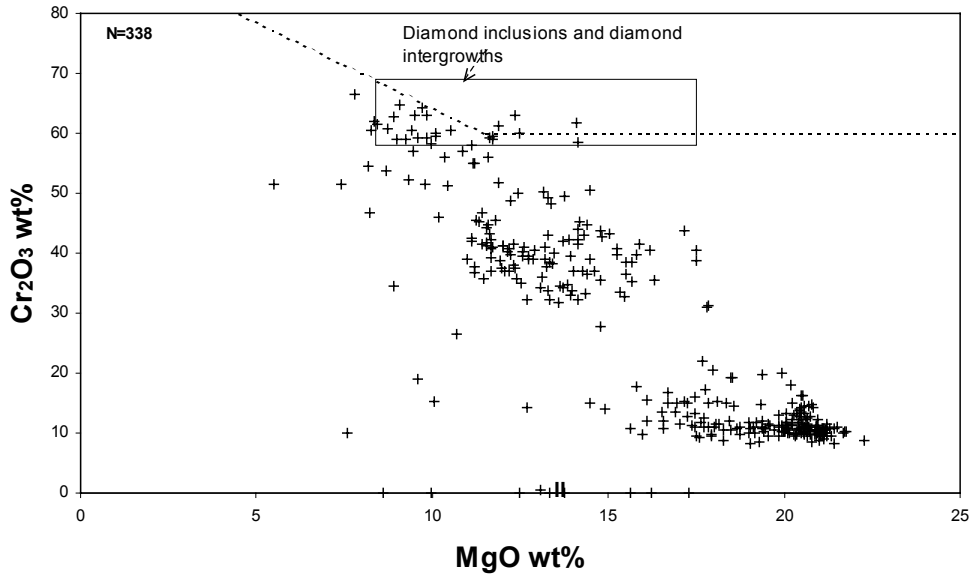

Fig.4 Kedrovka river chromites composition

Ilmenites of the Kedrovka river area are unabraded or slightly weared pitch-black blocky grains and fragments 0.5-3mm with dirty-yellowish leucoxene coating. Coarsely pitted primary surfaces are typical for kimberlitic ilmenites. Composition is characterized by 2 to 11% of MgO and 0.05 to 0.5%, occasionally to 1% of Cr2O3. This kind of composition is not peculiar for kimberlitic ilmenites but their universal presence in the Kedrovka river alluvium together with diamonds, pyropes, kimberlitic chromites may indicate the same magmatic source for them. At the same time the possibility of them to be shed into alluvium from other types of alkaline-ultramafic rocks of the Kedrovka river valley, aillikites for example, cannot be excluded.

Equant emerald-green chrome-diopside grains were encountered in a majority of samples, however elevated content in them of Al2O3-4-8% with Cr2O3 1-2% and NaO 1-2% are not consistent with the diamond bearing source which makes them related more probably to alkaline basalts or pyroxenites.

Besides above-described indicator minerals, pink and yellowish “pipe-type” zircon, moissanite, forsterite, blue and green sapphires are quite common in alluvial samples.

The alkaline-ultramafic rocks- aillikites, nephelinites with xenolithes of spinel lherzolites, meimechites, aluminat-calcium breccias of the eastern border of the Hanka massif are related to the later remobilization in KZ. This magmatism was probably active from Paleogene till Quaternary being closely connected with the post-subduction rifting of the area. Aillikites were discovered as boulders in the alluvium of river Kedrovka and as pipes and dikes near Ariadnoe village 80km to the south of river Kedrovka. Aillikites are characterized by the uniform-segregational structure and composed of altered olivine, phlogopite (up to 70%), diopside, magmatic calcite (Fig.5). The rock is enriched in K,Ti,Zr,Nb,REE and represent a product of the potassium-ultramafic melt.

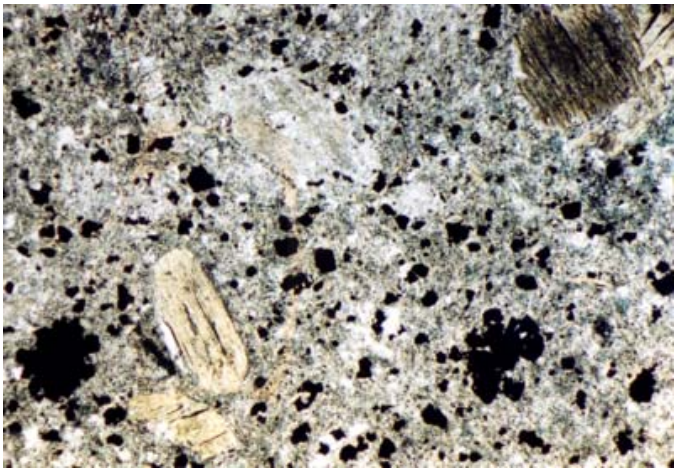

Fig.5 Aillikite composed of phlogopite macrocrysts, carbonate pseudomorphoses after olivine, ore minerals and carbonate matrix.

A unique aluminat-calcium breccia comprises fine fresh olivine, fresh periclase set in the Fe-Ca hydroaluminate (hibschite) matrix, abundant Ca hydrosilicates and Fe-Ca aluminate hydrosilicates (Fig.6). Realationships of minerals in the rock matrix indicate its primary magmatic nature. The rock is strongly enriched in CaO (22wt%), slightly enriched in K2O and depleted in MgO (2.5%) which clearly differ from a typical kimberlite chemistry. Nevertheless high NiO (0.15-0.3) and high CaO (0.6-1.0wt%) in olivine (Fo 86-91) and matrix periclase indicate high MgO and extremely high CaO nature of the primary melt forming this unique rock which we propose to name as ussurite (Fig.7).
Slight enrichment in Cs,Ba,Sr,LREE and slight depletion in Ti,Nb of the rock indicate that the primary ussurite melt was derived from the collision affected mantle source that probably comprised mantle eclogites.

Fig.6 Alluminat-calcium breccia of Nezametny Creek. Dark fragments are Neogene liparites

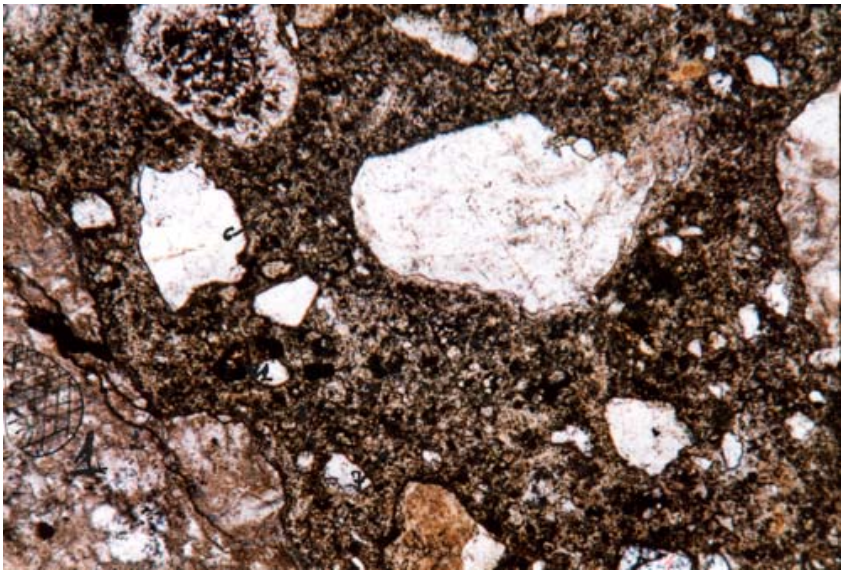

Fig.7 Grains of quartz, feldspar and fragments of felsic rocks in a volcanic matrix with multiple forsterite grains (as small black grains within brownish matrix)

The main importance of these discoveries is that they are a manifestation of a new large province of the alkaline-ultramafic magmatism and judging by the preliminary results it should warrant further investigation.