Pacific Science Review, vol.14, no.1, 2012, pp. 103~107

About Possible Influence of Deep-Seated Geodynamics on Localization of Ring Platinum-Bearing Plutons of the Southeastern Part of Aldan Shield (Russia)

Vadim G. Khomich[*] and Natalia G. Boriskina[**]

Abstract: *In the south-east part of Aldan Shield several ring basite-ultrabasite plutons have been recognized, with which the commercial placers of platinoids associate. Several versions are available by now revealing the specific features of spatial localization of platinum-bearing massifs. The authors focus attention on possible influence of the deep-seated geodynamics processes on the regularities of their localization. Analysis of the known geodynamic models of the region formation and materials of seismic tomography showed that the subduction processes, that actively manifested themselves in the Asia-Pacific convergence zone in Mesozoic, were responsible for initiation of the stagnated oceanic slab. Its NE and SW boundaries appear to coincide with the transform faults. Projection of the transform fault, bordering the above mentioned slab in the NEN, coincides with the Konder-Feklistovsky metallogenic belt distinguished earlier and its Aldan (Inaglinsky) member. Higher platinum content of ring massifs of the belt is controlled by the influence of the lower mantle derivatives on the ascending upper mantle plumes.*
Keywords: *South-East of Aldan Shield, Mantle plumes, platinum-bearing ring massifs, transform faults.*

INTRODUCTION

In the southeast part of Aldan Shield , on the Central-Aldan and Omninsk-Batomsky rises there are several platinum-bearing basite-ultrabasite plutons, among which most known are Inaglinsky, Kondersky, and Chadsky ones (Fig. 1). They have dunite cores surrounded by pyroxenites, gabbroids, and more acid varieties of rocks of higher alkalinity [1-10]. So they are often called heterogenous, zoned, and ring. Commercial placers of the platinum group minerals (PGM) and sometimes gold associate with them. Another zoned massif – Feklistovsky – with concentrate aureoles and PGM and Au placers has been revealed in the Shantar Archipelago (the Okhotsk Sea) among the terrigenous-siliceous rocks of the Middle Paleozoic [9]. The formation of corresponding plutons is related with the processes of underthrust of the Kula oceanic plate. Petrochemical characteristics and mineral composition to be similar to those been studied in detail at the Inagli and Konder deposits [4, 5, 8]. The availability of a group of the same-type massifs provides the basis for distinguishing the Konder-Feklistovsky Middle Jurassic-Early Cretaceous (173-136 m.y.) metallogenic belt [4, Fig. 8.7]. On the area of the latter, several Ti-Fe(+V) deposits of impregnated and massive ores have been discovered in gabbro and pyroxenites.

GENERAL INFORMATION

By now the physicochemical conditions of the heterogenous massif formation and their evolution direction and geochronology of the emplacement in them of different magmatic associations have been studied in the main, the typomorphic features of accessory and ore minerals from placers and lode occurrences of precious metals have been investigated, and probable sources of ore-forming matters, possible levels of the protomagmatic centers' location, and many other characteristics of the study platinum-bearing ore-magmatic systems have been determined. At the same time, another important problem of the determination of geological and geodynamic regularities of distribution of the zoned mafite-ultramafite plutons has been solved incompletely. Publications on this problem present significant diversity of opinions: the inheritance of the pluton formation (under the action of the processes of autonomous activization of the local Archean-Proterozoic dome and dome-like structures) and restriction to the intersections of differently oriented deep-seated faults; the location in the extended suprasubduction tectonic, magmatic, and metallogenic belts; the relation with the local intraplate plumes of the upper- and lower-mantle location. So in the authors' opinion the recognition of the factors responsible for the

[*] *DSc, Professor, Chief of Laboratory, Far East Geological Institute, FEB RAS, Russia*
E-mail: khomich79@mail.ru
[**] *PhD, Senior Researcher, Far East Geological Institute, FEB RAS, Russia*
E-mail:boriskina2000@mail.ru

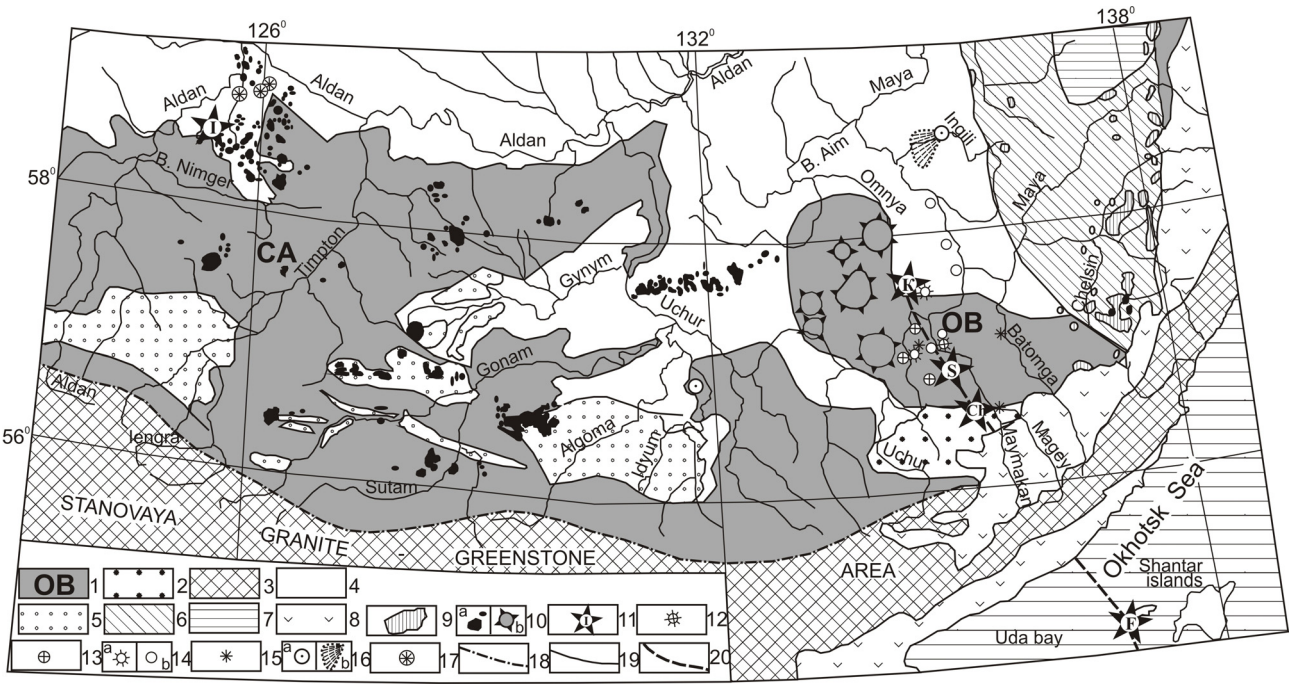

Fig. 1. Scheme of tectonic districting of the southeast flange of the North-Asian craton. After [3, 5] with some changes. 1 – Aldan granulite-gneiss area. CA – Central-Aldan and OB – Omninsky-Batomsky rises; 2 – Ulkansky intracraton trough; 3 – Stanovaya granite-greenstone area; 4 – Proterozoic and Cambrian deposits of the platform cover; 5 – deposits of Mesozoic superposed basins; 6-7 – cover-folded structures of the South-Verkhoyansky orogenic belt: 6 – Yudomo-Maisky marginal rise, 7 – Allakh-Yun'sky synclinorium; 8 – Okhotsky and Udsky members of the Okhotsky-Chukotsky and Udsky-Murgal'sky volcanic belts; 9 – Jurassic-Cretaceous granitoids of the OChVB peripheral zone. Dzhugdzhur complex; 10 – Jurassic-Cretaceous alkaline, subalkaline, and alkaline-earth magmatic formations (laccoliths, stocks, sills) (a) and local tectono-magmatic rises (b); 11 – large concentrically zoned (heterogenic) massifs with a dunite core (I – Inagli, K – Konder, S – Sybakh, Ch – Chad, F – Feklistov); 12 -13 – intrusions of ultrabasites: 12 – having concentrically zoned structure according to electromagnetic data, 13 – other bodies; 14 – not eroded massifs of the central type distinguished by aeromagnetic data: a – verified by boreholes, b – not verified; 15 – small bodies of ultramafites; 16 – carbonatite massifs (a) and fields of dikes and pipes of kimberlite-like rocks (b); 17 – large kimberlite pipes; 18-19 – faults: 18 – deep-seated, 19 – abyssal occurrence; 20 – axial zone of the Konder-Feklistovsky metallogenic belt.

distribution of ore-bearing (chrome-PGE) plutons is a prior direction of the specialized metallogenic investigations.

Petrological-geochemical and geological data on the hearth magmatism of the Central-Aldan and Omninsky-Batomsky rises indicate that on their area, in addition to large ring plutons there were found a considerable amount of small bodies of ultrabasites containing chromite, chrome-diopside, and high contents of Cr [3, 5]. On these rises, widespread are the areals of magmatites of the alkaline-earth row that occur as volcano-plutons of the central type and simpler intrusive subvolcanic bodies, dikes, and volcanic pipes. Some of the Late Cretaceous kimberlite pipes of the Tobuka-Khatystyra interfluve (Aldan district) were assigned to a pyrope subfacies of the picrite facies [7].

Remarkable is the occurrence of the platinum-bearing alkali-ultrabasic massifs near the boundaries of the rises (from the Archean metamorphic complexes) with troughs filled with the Proterozoic and Cambrian sedimentary masses. On both rises, especially clear on the Omninsky-Batomsky one, there are the signs of a zonal distribution of all Late Mesozoic magmatic formations. Relative to the "mafite" zone (NW strike), where large heterogene eroded to a various degree massifs (Konder, Sybakh, Chad) and small bodies of ultramafites occur, there are other two zones. In the zone localized to the WSW of the "mafite" one, several local isometric rises were revealed, in which the magmatic formations of the alkaline-earth row are grouped (Fig. 1).

According to the air-magnetic data [5], in another zone located to the ENE of the "mafite" one, other not

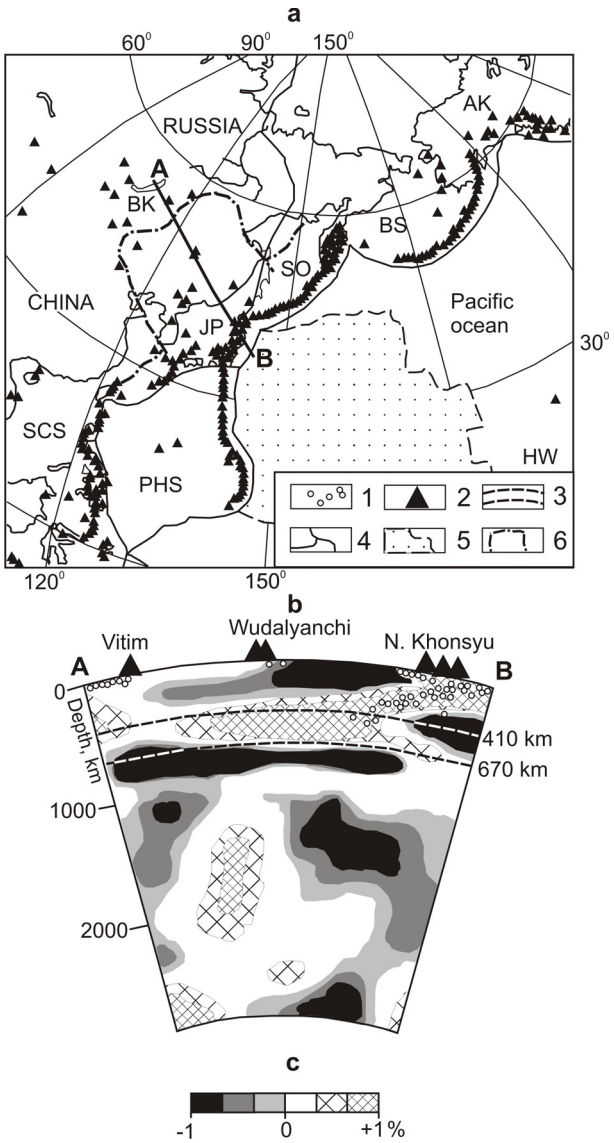

Fig. 2. Scheme of the Asia-Pacific megazone of convergence (a), section of mantle along AB profile (b), and scale of propagation rates of longitudinal seismic waves (c) in the form of tomograms. After [13, 15] with some changes and additions. Black, grey, and light-grey colors and hatching of different density - low and high rates of the seismic wave propagation, correspondingly. Other conventional symbols: 1 – hypercenters of earthquakes (in zone of ± 100 km from profile); 2 – active volcanoes; 3 – interval of spasmodic change of seismic features at a depth of 410 and 670 km (transition zone); 4 – plate boundaries; 5 – ancient part of oceanic plate (age of > 95 m.y.) (Dobretsov et al., 2001); 6 – contours of the stagnated Primorsky slab at a depth of 550 km [13, 15]. Latin letters: AK – Alaska, BK – Baikal Lake, BS – Bering Sea, JP – Japan Sea, PHS – Philippine Sea, SCS – South-China Sea, SO – Okhotsk Sea; HW – Hawaiian islands.

eroded ring massifs are suggested to occur under the cover sedimentary deposits. A total extension of the "mafite" zone (on the Omninsky-Batomsky Rise and Shantar Archipelago), distinguished earlier as the Konder-Feklistovsky metallogenic belt [4], exceeds 350 km. Taking into account the availability of the platinum-metal-magmatic systems in the Uchur-Maisky interfluve [11] a total length of the belt is more than 400 km.

On the Central-Aldan Rise there are also present the evidence of a zonal distribution of the Late Mesozoic magmatic formations relative to the Inaglinsky heterogenic massif and kimberlite pipes of the Tobuka-Khatystyra interfluve. To the SSE of the local "mafite" zone, dominating are the alkaline-earth magmatic formations of the Aldan complex, including large volcano-plutons of the Central type [3, 6], and to the NNW the sedimentary masses of the Siberian platform cover dominate, under which the presence of the hidden heterogenic massifs is possible.

The availability of the implicit signs of a zonal distribution of the Late Mesozoic intraplate magmatites on both rises suggests that the origination of rises and occurrence of the platinum-bearing massifs on their area are governed by the influence of the one-type processes and their possible belonging to a single structure. To obtain an answer to this supposition we have analyzed the known geodynamic models of the region formation and published materials of the seismic tomography [13, 14, 15]. Information from both sources indicates that since the Late Mesozoic in the Asia-Pacific megazone of convergence there developed the processes of subduction of the Pacific Ocean megaplate (PMP) beneath the Eurasian continent overlapping it where by that time the North-Asian and Sino-Korean cratons and enclosed between them Amurskaya lithospheric plate occurred [14, 15]. Kula and Izanagi plates and the Japanese member of the PMP subducted under them [4]. Gently submerging into the mantle in the transition zone of the latter (at a depth of 410-670 km) they turned into a slab stagnated on depth that preserved the relation with the today zone of subduction (Fig. 2). The seismic tomography methods document a steep dip of the subduction zones on the neighbor (Okhotsky and Filippinsky) areas of convergence of the PMP and Eurasian continent. The modern frontal (western) boundary of the slab (we call it Primorsky) is projected on the Aldan River left bank (from nearly latitude 59° North), the Olekma River valley to its upper reaches, North and East Transbaikal, East Mongolia, and North China. The north-east-north and south-south-west borders of the slab appear to coincide with the transform faults of the sublatitudinal and north-west orientation extending under the continent.

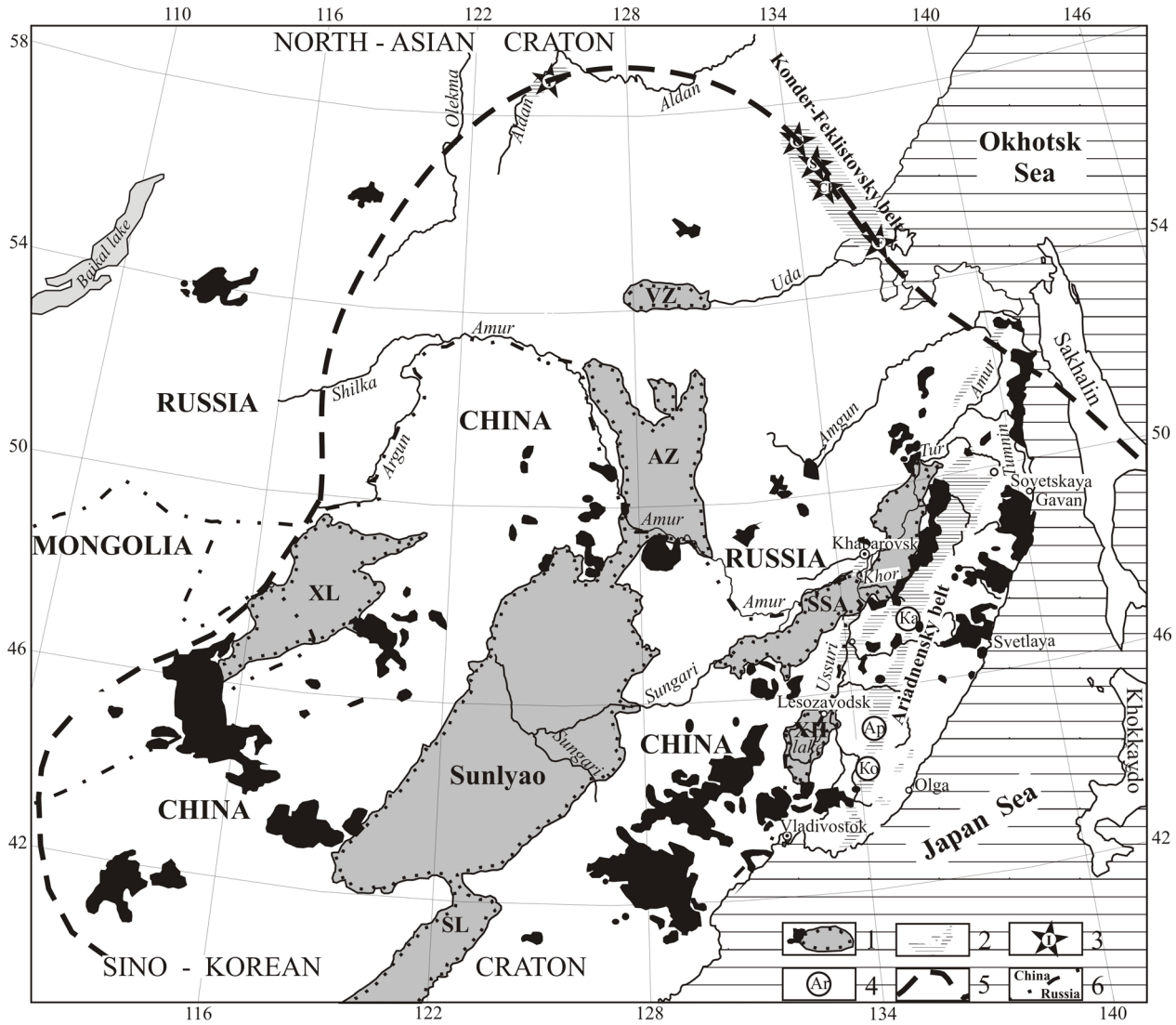

Fig. 3. Scheme of location Inagli-Konder-Feklistovsky (South-East Russia). 1 – Late Mesozoic-Cenozoic epirifting basins, depressions, troughs and large lava fields of the basalts: AZ – Amur-Zeiskaya, VZ – Verkhnezeiskaya, SSA – Santzyang-Sredneamurskaya, SL – Silyaokhe, XL – Tamtsag-Khailarskaya, XH – Khankaiskaya; 2 – contours of metallogenic belts; 3 – known zonal platinum-bearing massifs: I – Inaglinsky, K – Kondersky, S – Sybakhsky, F – Feklistovsky; 4 – known Ti-Fe (+V) deposits of the Ariadnensky metallogenic belt: Ar – Ariadnoe, Ka – Katenskoe, Ko – Koksharovskoe; 5 – projection of boundaries of the stagnated oceanic slab; 6 – state boundaries.

Above the slab there is a low-rate anomaly that L.P. Zonenshine and Kuz'min [14] called "a hot field of the mantle", D. Zhao [13] – "a large mantle wedge" (LMW), and V.V. Yarmolyuk with co-authors [12] – "North-Asian superplume". It is remarkable that immediately under the slab in the lower mantle a low-rate anomaly is fixed also.

The projection of the transform fault, bordering in the NEN the stagnated on depth Primorsky slab, matches with the Konder-Feklistovsky metallogenic belt and its Aldansky (Inaglinsky) member (Fig. 3).

The today models of the "hot field of the mantle" and LMW [13,14] suggest that the deep-seated dehydration of the oceanic slab in the mantle transition zone could cause upwelling of the hot asthenospheric material. The upwelling resulted in deformations of the lithosphere (on the earlier emplaced tectonic zones), reactivation of the continent marginal parts, formation of sedimentary basins (Sunlyao, Santsyan-Middle-Amur, and other types), development of magmatism, ore-forming processes, and origination of the deposits of useful minerals.

It is rather important to underline that according to the model of the LMW [13] near the NE and SW borders of the slab (corresponding, probably, to the transform faults) recurrent flows could exist, in which the hot mantle material from the lower mantle (!) reached the upper one and they together were involved into further transformations. The reality of such interaction can be judged from the interpretation of petrogeochemical data on not only mafite-ultramafite but on alkaline-earth complexes also demonstrating the evidence of "hybridization" and genetic relation with the latite geochemical type of magmatic formations [4]. This type is known to be assigned to the intraplate ones, characteristic of the stable zones with the continental crust, as a "suprasubduction" differentiate of the mantle basaltic and alkaline-basaltic magmas of supraplume nature [4].

CONCLUSIONS

In the light of the foregoing the earlier assumed influence of the ascending mantle plumes on the breakage of the North-Asian craton margin and formation of the ring intrusions is supported convincingly by the materials of interpretation of the seismic tomography data. Thus, the fact that the ultramafites of the Inagli-Konder-Feklistovsky belt are saturated with platinoids is possible to explain by participation of the low mantle matter. This is the case also for the restriction of ring plutons to the transform fault separating the stagnated Primorsky slab from Okhotsk-Kamchatka fragment of the Pacific plate.

REFERENCE

[1] Dobretsov, N.L., Kirdyashkin, A.G., Kirdyashkin A.A. *Deep-Seated Geodynamics*. 2nd ed., Novosibirsk, Siberian Branch of RAS, Department of "GEO", 2001 (in Russian).

[2] Dodin D.A., et al. "Platinoid deposits of North-Asian craton and its surrounding: metallogeny and geodynamics". *Geologiya i geofizika (Geology and Geophysics*), 40(11):1619-1634, 1999. (in Russian).

[3] El'yanov A.A., and Andreev G.V. *Magmatism and Metallogeny of Platform Areas of Many-Stage Activization*. Novosibirsk, Nauka, 1991. (in Russian).

[4] Khanchuk, A.I., ed., *Geodynamics, Magmatism, and Metallogeny of East Russia (in 2 books)*. Vladivostok, Dalnauka, 2006 (in Russian).

[5] Gurovich, V.G., et al. *Geology, Petrology, and Ore Content of Konder Massif*. Moscow, Nauka, 1994. (in Russian).

[6] Korchagin, A.M. *Inaglinsky Pluton and Its Useful Minerals*. Moscow, Nedra, 1996. (in Russian)

[7] Maksimov, E.P. "Experience of formation analysis of Mesozoic magmatic formations of Aldan Shield". *Izvestiya AN SSSR (Proceedings of the USSR Acad. Sci.). Geol. Series*, (4): 16-32, 1975. (in Russian).

[8] Nekrasov, I.Ya. et. al., *Petrology and Platinum Content of Ring Alkaline-Ultrabasic Complexes*. Moscow, Nauka, 1994. (in Russian).

[9] Ostapchuk, V.I. "About platinum-bearing massif of Far East". *Tikhookeanskaya Geologiya (Pacific Geology)*, (2):113-119, 1989 (in Russian).

[10] Simonov, V.A., Prikhod'ko, V.S., and Kovyazin, S.V. "Formation conditions of platinum-bearing ultrabasic massifs of the South-East Siberian platform," *Petrologiya (Petrology),* 19(6): 579-598, 2011. (in Russian).

[11] Yalynychev, E.V., and Mirzekhanov, G.S. "Magmatism of ring structures of southeast part of Siberian platform (on the example of Uchur-Maisky interfluves)," *Tikhookeanskaya geologiya (Pacific Geology)*, (3): 84-87, 1983. (in Russian).

[12] Yarmolyuk, V.V., Kovalenko, V.I., and Kuz'min, M.I. "North-Asian superplume in Phanerozoic time: magmatism and abyssal geodynamics," *Geotektonika (Geotectonics)*, (5): 3-29, 2000. (in Russian).

[13] Zhao Dapeng, Piraino Franko, Liu Lyusi. "Structure and dynamics of mantle under East Russia and adjacent regions". *Geologiya i geofizika (Geology and Geophysics)*, 51(9):1188-1203, 2010. (in Russian).

[14] Zonenshine, L.P., Kuz'min, M.I. *Paleogeodynamics*. Moscow, Nauka, 1993. (in Russian).

[15] Zorin, Yu.A., et. al., "About nature of Cenozoic upper-mantle plumes in East Siberia (Russia) and Central Mongolia," *Geologiya i geofizika (Geology and Geophysics)*, 47(10): 1060-1074, 2006. (in Russian).