Guidebook for field excursion of the 2-nd International Geological Conference «Granites and Earth's evolution»

Granite quarries of Novosibirsk Priobie

16-20
August
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2014

GRANITES AND EARTH'S EVOLUTION
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ПУТЕВОДИТЕЛЬ ЭКСКУРСИИ

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of the 2nd International Geological Conference
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Introduction

Descriptions of three largest stone quarries (Novobibeevo, Mochishche and Borok) in which industrial production of granites is conducted are provided in the guidebook. Visiting of these quarries is carried out within the 2nd International Geological Conference "Granites and Earth evolution: Granites and Continental Crust" (on August 17-20, 2014, Novosibirsk, Russia). Mochishche and Borok quarries (in 35 and 20 km from the Academgorodok) are located in city boundaries of Novosibirsk (the central part of Novosibirsk Priob′e), and Novobibeevo – in northwest part of Novosibirsk Priob′e (150 km from the Academgorodok). Arrival of participants to routes and departure after their finishing is carried out by motor transport. Excursion participants will be able to get to know different phases of Priob′e and Barlak granitoid complexes rocks and will be able to observe there contact interrelations on multilevel horizons of quarries. It is possible to select a representative collection. Excursion is developed by employees of IGM SB RAS, SNIIGGiMS and NSU.

The conference organizing committee is grateful the management of LLC «Mining Company», of Novobibeevo, Mochishche and Borok quarries for the given opportunity of studying of a geological structure within the divisions entrusted to them. We are grateful to the deputy director of Novobibeevo quarry Gennady N. Kovalyov, to surveyors of Mochishche quarry Sergey A. Kudryavtsev and Aleksandra S. Kudryavtseva, to surveyor of Borok quarry Vladimir V. Lapushenko for the help in development of schemes of routes and the indication of the most interesting objects.

Novosibirsk Priobie granitoid massifs are located in central part of northwest front of Kolyvan-Tomsk fold zone (KTFZ). The last in one's turn is northwest edge of Altay-Sayan accretion area and tectonically represents difficult constructed shingle-block structure [Distanov et al., 2006]. Middle devonian-early carbonic intensively undulose volcanic, terrigenous and carbonate deposits participate in a geological structure of KTFZ: Bugotaksky, Toguchinsky, Pachinsky, Yurginsky suites and Insky series. From the west Siberian Plate (WSP) the zone is overlied by a Mesozoic-Cenozoic cover, and in the east it abuts on Kuznetsk Alatau, Kuznetsk and Gorlovsky deflections. The last separates from KTFZ the Doroninsky depression and Salair with Prisalairsky (Khmelevsky) deflection (fig. 1).

Novosibirsk is among those few cities of Russia which were laid on granites. As building material granites played an important role in the course of transformation of Novonikolaevsk – settlements for temporary residence of railway builders (1893) in modern industrial and scientific center of federal value. Building materials for the foundation of houses, a paving of streets, building of support for bridges, etc. were necessary to promptly developing settlement. The first quarries were laid near places of their mass application and so up to now, naturally, didn't remain. So, the quarry in the lower current of Kamenka river was one of the first. It served later not only the new bed of the river, but also a place of a location of the concrete bridge which was filled up further. The same fate has comprehended several quarries, and some of them were simply flooded (Vertkovsky, Krivoshchekovsky, the 8th Kamensky). Nevertheless, some large granites quarries continue to function in the territory of the city and in its immediate environment. Three of these quarries are studying subjects in the this excursion – Novobibeevo, Borok and Mochishche.

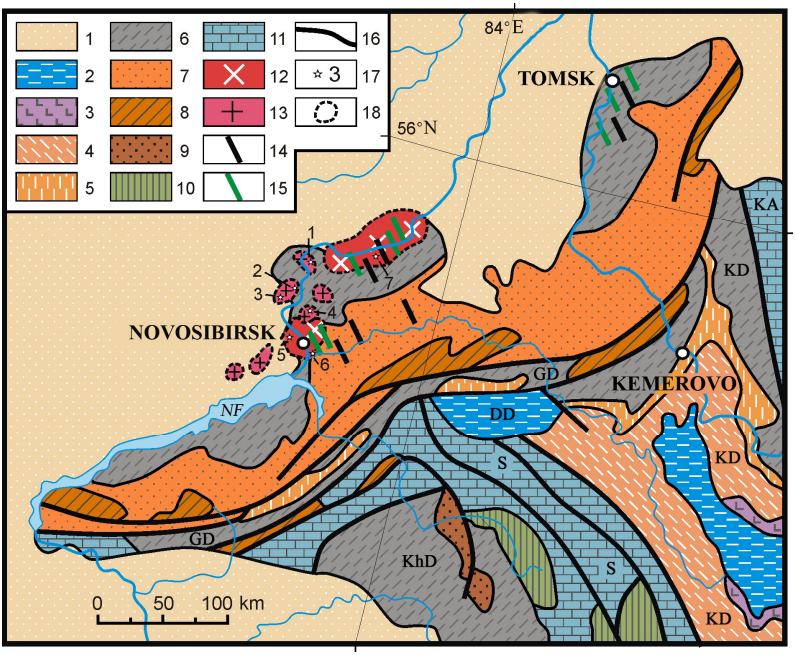

Fig. 1. Large granite quarries distribution scheme in Novosibirsk and its immediate environment.

1 – sandshale sediment, $N - \cancel{P}$; 2 – sandshale deposit with brown coal, J; 3 –basalts and dolerites of saltymaksky complex, T; 4 – carbonate-terrigenous deposit with coal, P_2; 5 – carboniferous terrigenous deposit, P_1; 6 – fine terrigenous-carbonate deposit, D_3–C_1; 7 – terrigenous deposit with different composition volcanites (depression), D_3; 8 – carbonate-terrigenous deposit with mixed composition lavas and tufas (highland), D_2; 9 – terrigenous-carbonate deposit, D_{1-2}; 10 – carbonate-schistose-psammitic deposit, O–S; 11 – schistose-rudaceous and carbonate-psammitic deposit, containing different composition effusive rocks, $\in$; 12 – priobsky complex (granodiorites, granosyenites, granites), P_2–T_1; 13 – barlak complex (leucogranites), 14 – abinsky dike complex (olivine gabbro, dolerites), P; 15 – priobsky complex dikes, III phase; 16 – tectonic disturbance; 17 – quarries: 1 – Barlak, 2 – Skala, 3 – Kolyvan, 4 – Mochishche, 5 – Vertkovsky, 6 – Borok, 7 – Novobibeevo; 18 – conventional boundaries of massifs with enclosing rocks and/or with overlying incoherent sediment. Deflection: GD – Gorlovsky, KhD – Khmelevsky, KD – Kuznetsky; mountain systems: S – Salair, KA – Kuznetsk Alatau; DD – Doroninskaya depression. NF – Novosibirsk floodwater.

The first information about Novosibirsk Priobie granites and their presumable age, relating to the end of XIX century, is contained in A.N. Derzhavin, I.D. Chersky, G.G. Petts, A.A. Inostrantsev's works [Kuzmin, Parshin, 1976]. In 30th years of the last century M.K. Belshterli [1933] and A.I. Gusev [1934] have been studied the magmatic formation. The following stage of their studying falls on 60-70 years [Moiseenko et al., 1966; Nuvaryeva, 1968; Matveevskaya, 1969; Kozlov, 1971]. Detailed petrogeochemical and geochronological researches of magmatic rocks were conducted by employees of IGM SB RAS, TSU and SNIIGGiMS recently [Sotnikov et al., 1999; Vladimirov et al., 2001; Fedoseev et al., 2001; Nebera, 2010; Babin et al., 2014]. It should be noted that given poor natural outcropping of the region some researchers believe that on study degree magmatic associations of Novosibirsk Priobie yet didn't reach the validity status in volume of recommendations of the Petrographic code. Nevertheless, in 2003 the first standard of a gabbro-granitoid complex on one of early versions of the scheme of magmatism of KTFZ [Khomichev et al., 2003] was developed.

At the initial stages of studying Novosibirsk Priobie granitoids were considered as a part of the uniform (Obsky) complex corresponding to the traditional gomodromny scheme of evolution of the uniform basite pocket. Along with this view, divided by some researchers currently [Khomichev et al., 2003; Nebera, 2010], there is also the alternative point of view according to which two granitoid complexes which rationale of independence is based not on genetic model, but on petrological-geochemical and isotope and geochronological features are marked out. The material collected as a result of thematic and geological survey by employees of two research institutes – IGG SB RAS (1997-1999) and SNIIGGiMS (2012-2014) formed a factual basis for this concept. Two granitoid complexes – priobsky (three-phase) and barlak (two-phase) are

marked out and detailed characterized [Sotnikov et al., 1999; Babin et al., 2014]. Obskoy and Novosibirsky massifs are a part of the first complex; Barlaksky, Kolyvansky, Senchansky, etc. massifs – structure of the second.

Granitoids of these complexes quite confidently already with traditional geological studies – mineral composition, structural-textural and geochemical features (fig. 2). The first have granite-granodiorit-granosiyenite composition, directive textures, a wide variety of structures, variability of material composition, an intensive hornfelsing of the enclosing rocks, poorly expressed deficiency of europium. The second are characterized monotonous granite-leycogranite composition, massive textures, continuous presence of fluorite and a serious europium minimum.

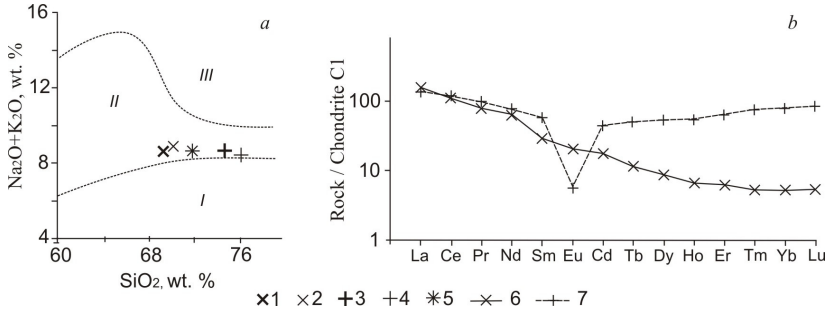

Fig. 2. Novosibirsk Priobie granites petrochemical features: *a* – position of Priobsky and Barlak complexes rocks in the diagram SiO_2 – (Na_2O+K_2O) and *b* – corresponding average ranges of REE.

To *(a)*: 1–2 – priobsky complex: 1 – II (major) phase (14), 2 – III (dike load) phase (13); 3-4 – barlak complex: 3 – I (major) phase (12), 4 – II (dike load) phase (8); 5 – Mochishche stock (5). Plots are constructed by average values, in parentheses indicate the number of measurements.

To *(b)*: 6–7 – major phases rocks of complexes: 6 – Priobsky, 7 – Barlak.

Significant distinctions of trace element composition of two complexes rocks are observed by contents of cesium, hafnium and thallium, by an uranium and thorium ratio, by

different concentration of heavy lanthanides, by iron index and a fluorine index of biotites, and by metallogenic specialization [Sotnikov et al., 2000].

Multiphase ***priobsky complex*** has relatively simple rock composition. Diorites, quartz diorites and their gently alkaline analogs are composed the first phase and have limited development. The major phase is presented by granosyenites and gently alkaline biotite-hornblende granites with directive textures. Microgranites, monzoleucogranites, quartz monzodiorite porphyres, spessartite, aplites and pegmatites are composed a dike load phase. Intensely altered (shadow) rocks xenoliths of the first phase occur in marginal parts of massifs. A petrochemical variety gently alkaline, less potassium, complex rocks is explained by the contamination phenomena. The configuration of REE spectra practically doesn't depend on material composition of rocks.

The Barlak complex is characterized by monotonous composition. It is represented gray two feldspars mediumgrained biotite leucogranites and granite porphyries in which coloration inside the undulose zones by alteration there are yellowish and reddish shades. Point impregnations sulphides and cassiterite occur in quartz veins, and beryl and topaz - in pegmatites. Ultrafelsic granites belong to the gently alkaline potassium one. REE spectra are characterized by sharply expressed evropium minimum, the low La/Lu ratio and an anomalistic concentration of heavy lanthanides (fig. 2, *b*). Priobsky and barlak granitoids differ in trends of U, Th and heavy lanthanides, and also in biotites composition. The molybdenite and pyrrhotite mineralization is associated with the first complex, with the second – sulphide cassiterite mineralization. Greisenization, albitization, sericitization and feldspatization sections and zones are noted in Mochishche stock. In some zones of crushing it is found a polymetallic mineralization [Osintsev, 1988].

The retrospective analysis of granitoids age geological estimates shows that they fit into a very wide range – from Archaean to Jurassic. K-Ar dating also gave considerable age dispersion the bulk of which corresponded to the late Paleozoic. Nunerous $^{40}Ar/^{39}Ar$ datings by monomineralic (biotite, a hornblende, pyroxene, plagioclase) for the first time showed bimodal distribution (251,5±2,4 – 243,7±2,1 and 235,9±2,6 – 233,0±1,8 Ma) that served as one of basic criteria for division of the Ob granitoid complex into two – priobsky and barlak [Sotnikov et al., 1999, 2000]. In 2014 the SRIGGMR employees, carrying out charting on the page N-44, formation time of the allocated complexes main phases was significantly refined by zircon U-Pb method (10 samples, about 100 dot determination): 260,7±3,2÷255,8±2,7 Ma and 249,7±1,4÷242±2 Ma for priobsky (P_3-T_1) and barlak (T_{1-2}) complexes respectively.

It should be noted that despite the many granite quarries in Novosibirsk Priobie no one in which reliable representatives of both allocated complexes would be at the same time uncovered. Therefore for acquaintance to them it is necessary to study some quarries. The conference program provided for visiting of three quarries for two hiking trails. The first day Novobibeevo (150 km from the Academgorodok) and Mochishche (on the way back) quarries are studied, and in the second – Borok quarry (20 km from the Academgorodok). Novobibeevo and Borok quarries uncovered priobsky complex. Barlak granites quarries (Barlak, Kolyvan, White Stone) are less available to free attendance. Therefore it is expected to visit Mochishche quarry uncovering the stock of the same name which reference to a concrete complex is discussed now in view of polysemantic petrogeochemical specificity.

Route № 1. Novobibeevo quarry (*16th August 2014*)

Functioning Novobibeevo quarry is at distance of 150 km from the Academgorodok in northwest part of NSO. Leaving from Novosibirsk to the track "Baikal" and passing the settlements Sokur and Moshkovo, it is necessary to reach to a stele with the turn index on the v. Baikal and turn left off the track. Next on the old asphalt road to follow to settlement Novobibeevo, turn left again and go to the quarry (Fig. 3, *a*).

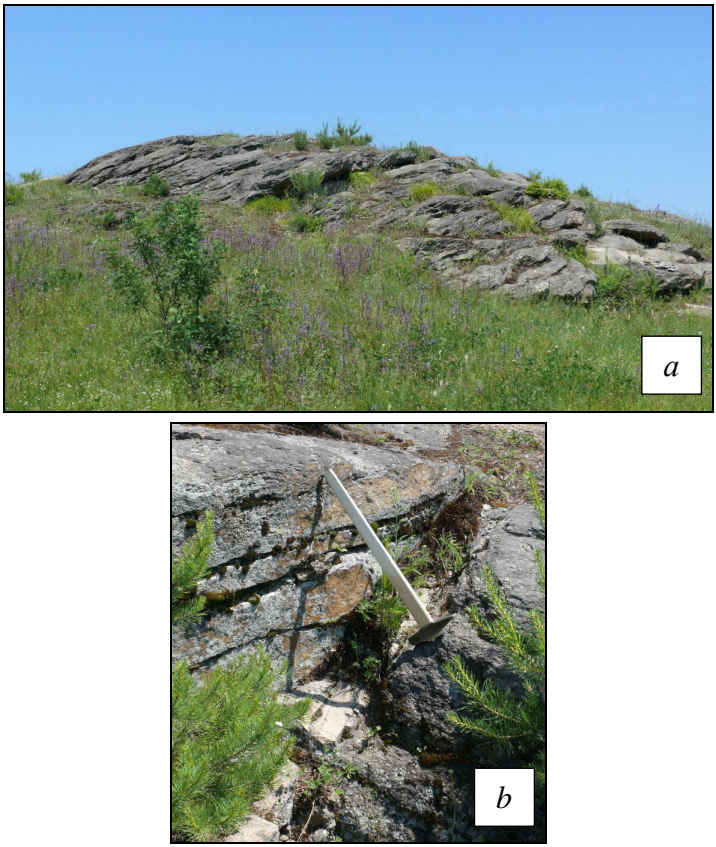

Fig. 3. Erosion granite dome in front of the entrance to the Novobibeevo quarry.

a – south slope of dome (*photo by A. Lesnikh*);

b – leucogranite dike in porphyritic granosyenites.

The route will pass on the third horizon. The visit purposes are establishment of indicative signs of tectonic-magmatic interaction at granitoids emplacement, observation textural-structural variety of the granitoid rocks and familiarization with the dike complex composition, including porphyritic and aphyric dolerite, varigraned granosyenites, aplites and pegmatites.

Stop 1 is located on the way to a quarry and is a dome-shaped outcrops of porphyritic granites (Fig. 3, *a*). It is smoothed erosional remnant of about 200 m with a well defined pillow clevage. Fresh rock sample selection is quite problematic due to the fact that rocks are altered. Nevertheless, trachytoid, large phenocrysts of K-Na feldspars and leucogranite dike capacity of about 10 cm are well visible (Fig. 3, *b*).

Stop 2. It will be shown areas for detailed examination and identified areas (St 2 – St 6) with the most interesting phase and facial interrelations of priobsky complex granitoid rocks on the makeshift lookout St1, located on the second quarry horizon (Fig. 4).

Stop 3. A series of mafic dikes in the north-western and north-eastern walls of the quarry will be observed (Fig. 5 and 6). Getting acquainted them will begin with outcrops of porphyritic dolerite dykes 1, which has a capacity of about 4-5 meters. On the first level, reveals ancient weathering crust, desquamation process, accompanied by the formation of spherical relics is widely developed (see Fig. 6, *c*). This process gradually fades with the depth, quite crusts exogenous transformation, that different from fresh differences tan color, are left.

Stop 4. The small dike 2 aphyric dolerite is traced on the third and second horizons. There are traces of later tectonic

deformations in dike and granitoids enclosing it (glide planes with poorly expressed subvertical striation).

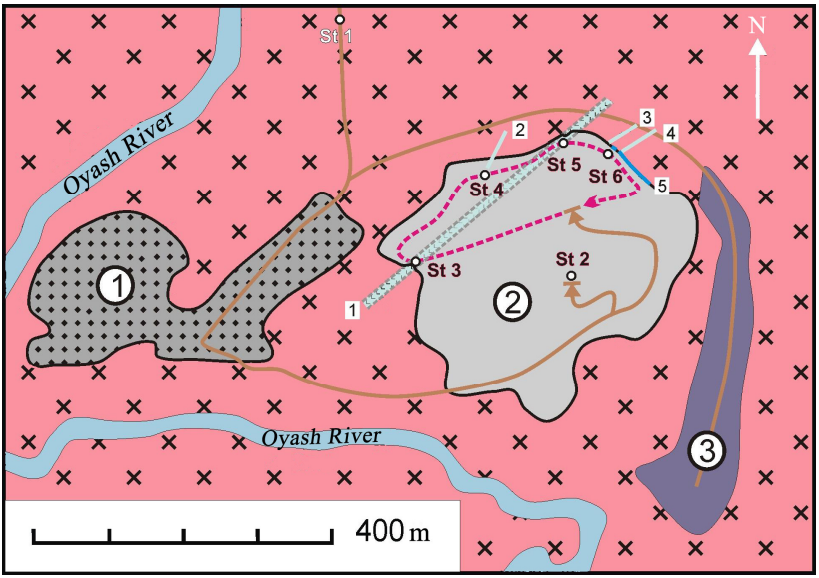

Fig. 4. The route scheme in Novobibeevo quarry.

St 1–St 6 – points of detailed studying and survey. By figures in circles are designated: 1 – industrial site, 2 – quarry and 3 – mullock (as of July 23, 2014), figures on a white background – numbers of dikes. Red dotted line – the route line.

Stop 5. The second porphyritic dolerite dike outcrop is located on the opposite side quarry. It will not be possible to trace it at the quarry bottom, so that petrographic features comparison of dike rocks sampled at two points will be produced.

Stop 6. In the north-east wall of the quarry on two horizons granitoids with different textures are exposed. Granites are crossed by mafic dikes series with clear contact, and stable chilling signs.

Fig. 5. The eastern side of Novobibeevo quarry.

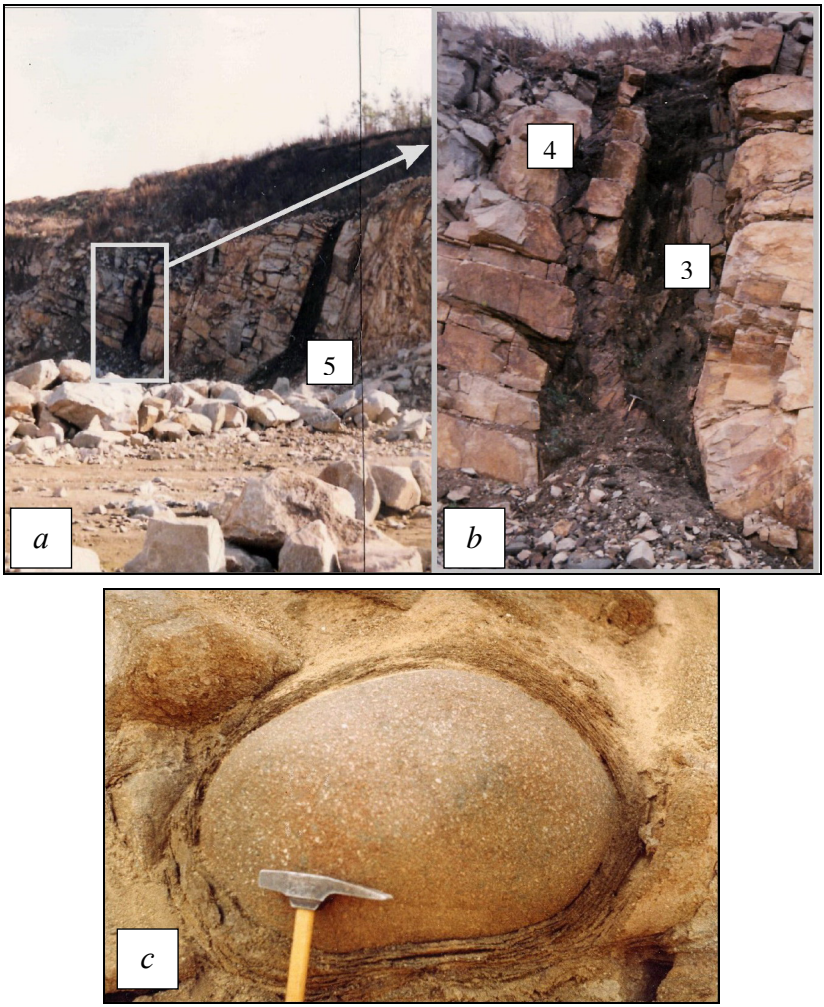

Fig. 6. Dolerite dikes in north-eastern side quarry, 2 horizon (as of August 1998).

a, b – the dikes intersection 3 and 4; *c* – dolerite relic ellipsoid is the result of desquamation in the dike 1, horizon 1.

At earlier visits quarry it was possible to observe the intersection (Fig. 6, *a*, *b*) two dikes on the second horizon, and in close proximity to the right – another dike (Fig. 6, *a*).

Currently quarry is expanded and quarry wall shifted to 40 m in the north-east. At that on the third horizon, these dikes appeared almost side by side, and the direction of the transversal dikes changed from sublatitudinal on north-west.

The enclosing granitoids are represented by three main differences. *The first difference* is medium-grained amphibole (±biotite) quartz porphyry monzodiorites composing inclusion and xenoblocks in later granitoids. *The second difference* is medium-grained amphibole-biotite porphyry granosyenites forming the bulk of the massif. *The third difference* is represented by fine-grained biotite granite, forming a dike- and stock-shaped body of granosyenites. All these varieties of rocks are crosscut by dikes of aplite granites, aplitse and aplite-pegmatites.

Porphyry shape rocks is determined by the presence of K-feldspar phenocrysts, ranging from few percent to 20 % of the rock volume. Phenocrysts size in quartz monzodiorite reaches 3-5 cm, in granosyenites – to 1,5 cm. For all varieties of rocks gneissic texture are typical, which are shown in regular orientation of feldspar and dark-colored minerals crystals. Interrelation of gneissic banding direction in different phases rocks and its orientation with respect to contacts indicate that the emplacement of the melt later portion was occurred against the background of tectonic deformation. These superimposed processes resulte in also tectonic deformation and minerals recrystallization in earlier rocks. This process is most clearly manifested in first phase quartz monzodiorite. There are clearly defined two types of K-feldspar grains. The first type is represented by well-faceted crystals, they often don't shown regular orientation and present in the rock regardless of its gneissic banding degree. Phenocrysts of this type are magmatic. The second type is present only in gneissic banding rocks and is represented

significantly worse-faceted (often oval) grains with a regular orientation and conformal total gneissic texture rocks.

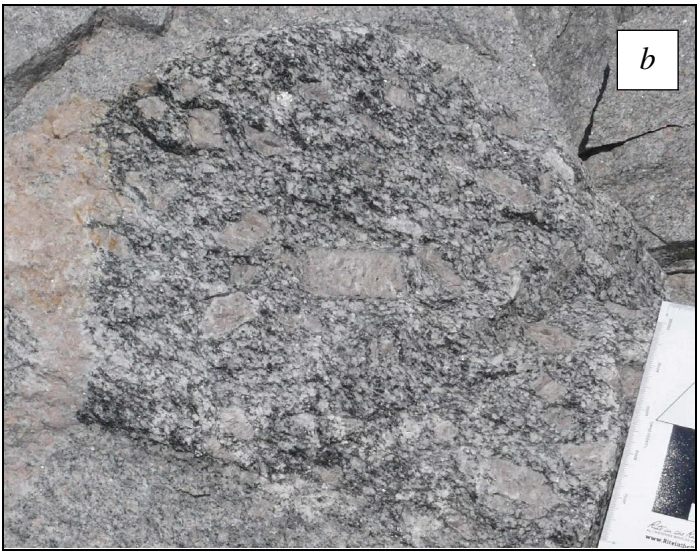

Fig. 7. Large K-Na feldspars crystals types:

a – metasomatic, *b* – magmatic.

These grains are likely to represent late phenocrysts formed during the tectonic-metamorphic transformations. Wide development of this process is verified a growth virtually perfect porphyrocrysts in the border zone with fine-grained granosyenites dikes, as well as within the latter (Fig. 7, *a*). A more complex interrelation (intersection of contact magnophyric and fine-grained granosyenites with aplite-pegmatite dike containing fine-grained granosyenite xenolith) are depicted in Fig. 7, *b*.

All along the hiking trail in the wreckage and oversized lumps of granite and granosyenites aplite-pegmatite occurrence are found, sporadic small biotite and feldspar-biotite (Fig. 8, *a*) schlieren and heavily altered "shadow" xenoliths (Fig. 8, *b*).

Fig. 8. Xenogenous inclusion in porphyric granosyenites:
a – feldspar-biotite schlieren; *b* – "shadow" xenoliths.

Route № 2. Mochische quarry (*16th August 2014)*

Functioning quarry Mochische located in Novosibirsk. Purpose of visit is definition of component rocks and dikes specificity, as well as exposure of postmagmatic transformations and ore mineralization features (Fig. 9).

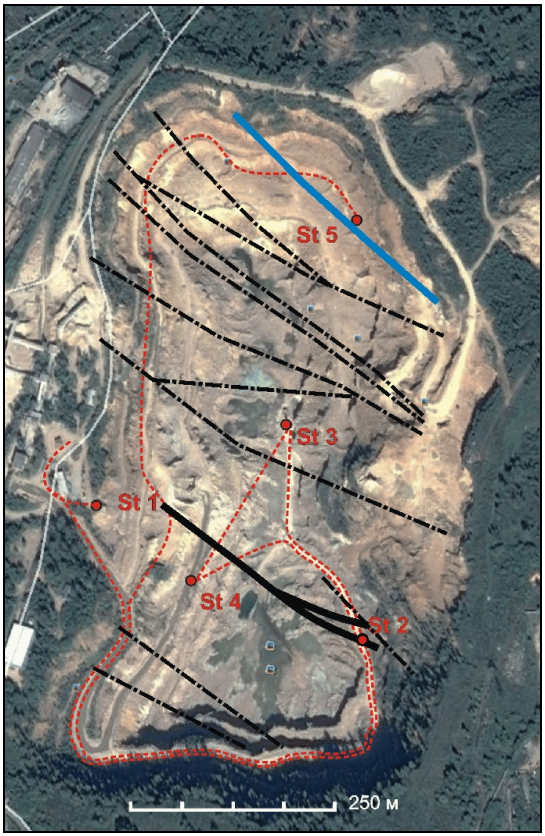

Fig. 9. Route scheme on Google Earth photo of Mochische quarry.

Dash-dotted lines are tectonic zones, bold black line is basalt-dolerite dike, blue line is porphyrite diorite dike. Red dotted line – the route line.

Stripping of granite products is carried out in five horizons. It should be noted four features of the geological structure of the site: a) amazing the primary granite composition monotony, broken only by the varying degrees of hydrothermal-metasomatic alteration; b) the abundance of subparallel tectonic zones in a northwest direction; c) the association of polymetallic mineralization to some of these zones was first discovered in 1985 [Osintsev, 1988]; d) extreme dikes poverty and xenoliths lack in the rocks of the major phase.

Stop 1. In this point conference participations receive a general idea about location of observation objects (see fig. 9). It is shown dikes location particularly (Fig. 10).

Fig. 10. The northern side of Mochische quarry (as of 27th june 2014).

In the background walls of three upper horizons diorite porphyrite dike is visible (Stop 5). It traced in the northwest direction and exposed in ledge of second horizon (marked by white cross).

Stop 2. It is located in south-east quarry side. Two parallel basalt dolerite dikes are visible in quarry wall, however they are branches of unified dike. In last years investigations are shown that this dike split in central part (fig. 11).

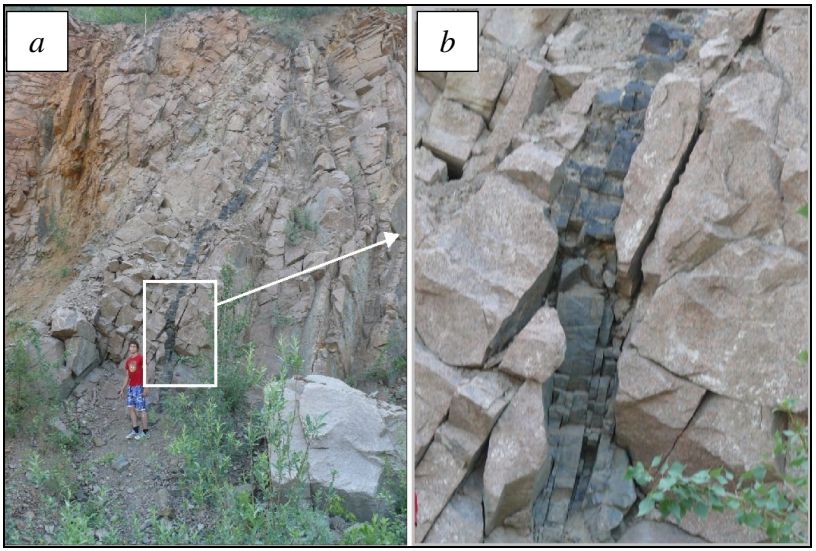

Fig. 11. Right branch of basalt dolerite dike in the eastern side of Mochishche quarry (St 2).

a – general view, *b* – fragment.

Stop 3. The scree will be examined to search of sulfide mineralization signs. There is an opportunity to take specimen samples of different stages of hydrothermal metosomatic altered granite. The coloring of the freshest granite differences is pinkish, altered granites is grey, and heavily altered granites are greenish.

Stop 4. In the southern part of the western side leucogranites sericitization zones near tectonic dislocation. Here basalt dolerite dike continuation observed earlier on the fifth horizon is traced (fig. 12, *a*).

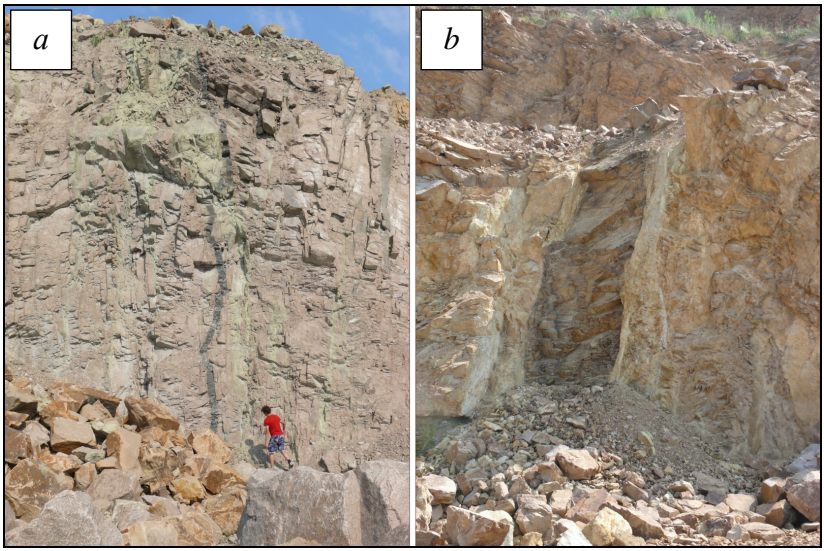

Fig. 12. Dikes in Mochishche quarry.

a – basalt dolerite dike in west side of quarry (St 4);
b – diorite porphyrite dike in north side of quarry (St 5).

Stop 5. Diorite porphyrite dike will be examined on third horizon (fig. 12, *b*; see fig. 10).

Route № 3. Borok quarry *(20th August 2014)*

Borok quarry is located on the southern suburb of Novosibirsk, on the left to the Berdsk highway. The purpose of visiting is familiarization with composition specification, contact alteration and dikes.

Stop 1. This stop is on the right side of Berdsk highway, 1200 m before entrance in Borok quarry. It is original cropping in the form of dome 15 m height. In the geological sense this crop is interesting for metamorphosed carbonaceous siltstone schists of inskaya series (D_3-C_1). This schists are crosscut by Novosibirsk granite massif, which is uncovered by Borok quarry. The ensemble became Novosibirsk sight after installation of the Poklonny Cross on the top of the dome in 2003 (Fig. 13).

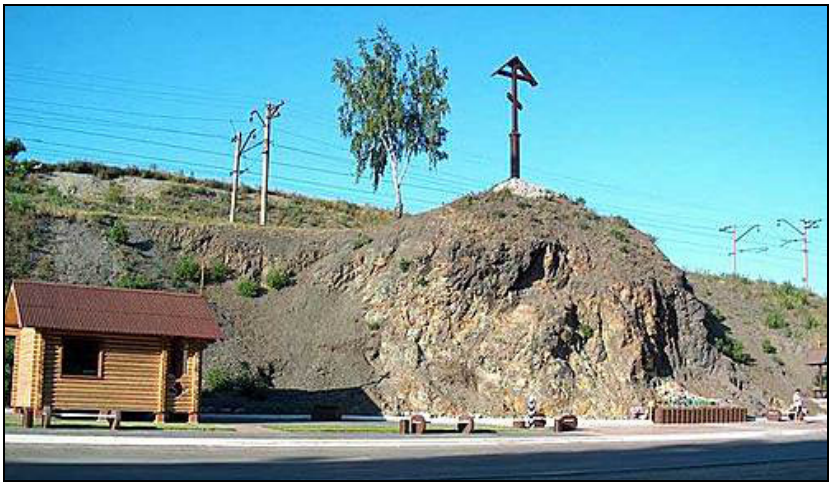

Fig. 13. The crop of Inskaya series schists
(Photo from Google Earth).

Stop 2. The visiting of one of long living quarries (this year it celebrates 106th birthday) starts from temporary viewpoint on industrial area edge.

Mostly new part of the quarry is visible from this point. Old part of the quarry located on the left behind bourock is halfly flooded and mostly filled-in by oversized blocks. The old quarry was located on the right bank of Inya river, which bed was blocked and directed to the channel of Ob river. Currently, the location of the old bed is marked by two waterfalls. The route movement is in counterclockwise direction along border of new quarry (fig. 14).

Fig. 14. The location of Borok quarry viewpoints by space photo (as of 15th may 2014, *photo: Google Earth*).

Fig. 15. The view of south-eastern quarry side.

The waterfall of old Inya river bed is marked by rectangle (see fig. 16, *b*)

Stop 3. Monzodiorite dikes series visiting (fig. 16).

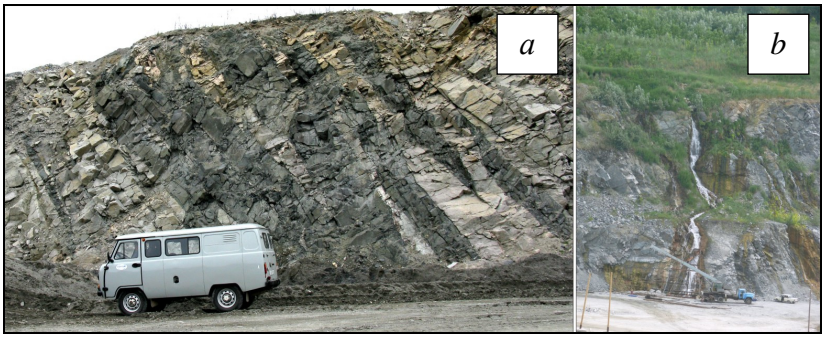

Fig. 16. Monzodiorite dikes series (*a)* in northern quarry wall (*photo by I. Loskutov*) and waterfall (*b).*

Stop 4. The contact of Novosibirsk massif with Inskaya series hornfels and metasomatized rocks (fig. 17).

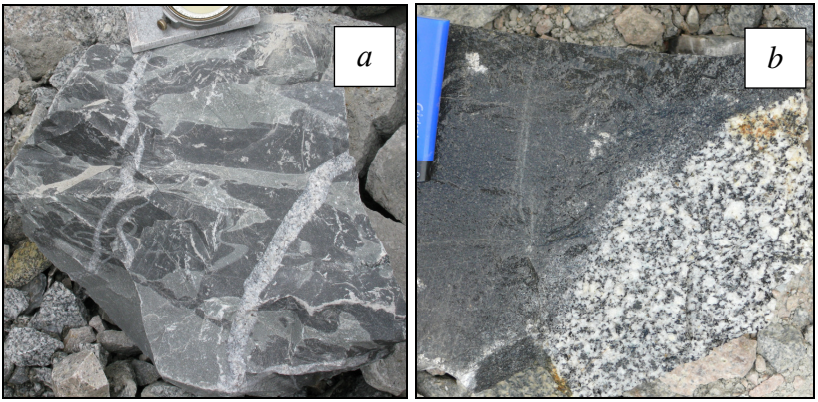

Fig. 17. The influence of granitoids on enclosing rocks.

a – metasomatized hornfels, crosscut by granodiorites folium (*photo by I. Loskutov*); *b* – the impact of granodiorite on enclosing rocks (initial stage).

Syenite porphyry and dolerite dikes are located in this quarry side. The course of this dikes is different from that of basite dikes on St 3. In some blocks, plentiful and alterated in

different degrees xenoliths of enclosing rocks may be visible. This xenoliths is sometimes mistakenly determined as diorite and alterated gabbroids xenoliths (fig. 18).

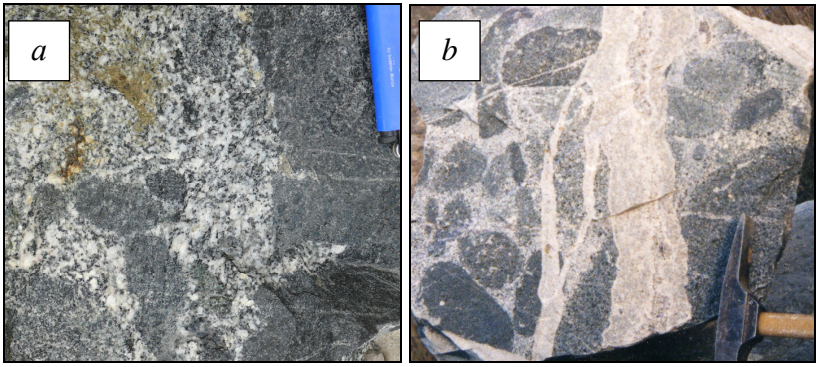

Fig. 18. Xenoliths plentiful in granodiorites (*a*) and granosyenites (*b*) at near contact zones of Novosibirsk massif.

It should be noted that in this part of the quarry quite complex phase relations can be observed in rock spalls and some oversized blocks (fig. 19, 20).

Stop 4–5. Visual observation of quarry wall with numerous apo-dolerites dikes in hornfels and metasomatizied schists. In **Stop 5** the first waterfall is located, its location mark old bed Inya river.

Stop 6. Lamprophyres dike (fine-grained weakly porphyry spessartite) had been found in 2001. It is sublatitudinal trend.

Stop 7. The old burrow of oversized blocks will be survey to sample representative collection of rock differences and its phase-facies relations.

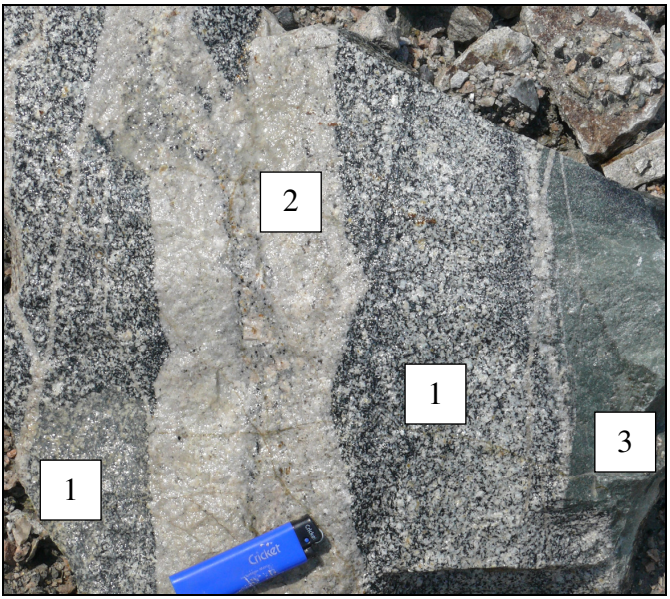

Fig. 19. Consecutive granodiorite emplacement (1) and aplite granite (2) in enclosing rocks (3).

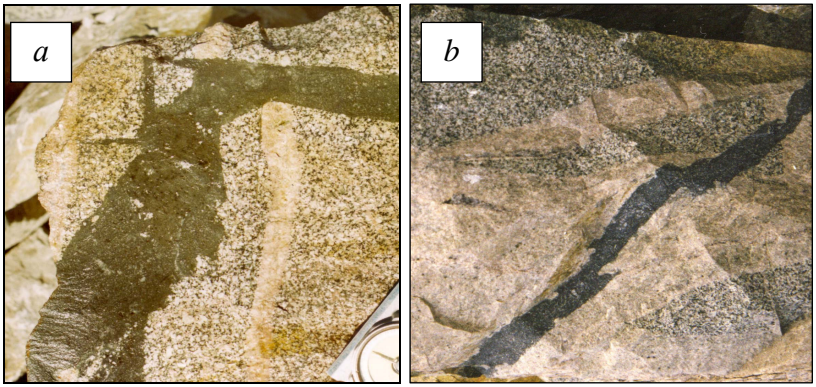

Fig. 20. Abinsky complex mafic dikes in granosyenites, crosscut aplite dike (*a*) and aplite granite (*b*).

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Field excursion guide of the 2nd International Geological Conference «Granites and Earth's evolution: granites and continental crust» (2014, August, 17-20, Novosibirsk, Russia)

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