ISSN 1028-334X, Doklady Earth Sciences, 2006, Vol. 407, No. 2, pp. 179–183. © Pleiades Publishing, Inc., 2006.
Original Russian Text © A.M. Mazukabzov, T.V. Donskaya, D.P. Gladkochub, E.V. Sklyarov, V.A. Ponomarchuk, E.B. Sal'nikova, 2006, published in Doklady Akademii Nauk, 2006, Vol. 406, No. 6, pp. 788–792.

GEOLOGY

Structure and Age of the Metamorphic Core Complex of the Burgutui Ridge (Southwestern Transbaikal Region)

A. M. Mazukabzov[1], T. V. Donskaya[1], D. P. Gladkochub[1], Corresponding Member of the RAS E. V. Sklyarov[1], V. A. Ponomarchuk[2], and E. B. Sal'nikova[3]

Received October 13, 2005

DOI: 10.1134/S1028334X06020048

In the 1990s, peculiar Late Mesozoic structures of intracontinental extension, the so-called metamorphic core complexes (MCC), previously considered inliers of the Early Precambrian basement [1], were defined in the Transbaikal region (Fig. 1). Geochronological substantiation of these structures was, however, insufficient, except for the Zagan core complex. Special geostructural investigations of the Burgutui metamorphic core make it possible to fill this gap.

The lithostructural paragenesis of the Burgutui Ridge MCC is developed in the area of ~1200 km^2 in the Selenga–Chikoi interfluve. The MCC represents probably an autonomous structure, although one cannot rule out that this structure can be an element of the larger Butuliin–Nur MCC defined in Mongolia. Its discrimination was substantiated by both published and unpublished geological data [1].

In the present-day structure of the southwestern Transbaikal region, the Burgutui MCC is characterized by a vague northeastern strike and ensuing tectonostratigraphic succession (Fig. 2).

The basal section corresponds to the Kyakhta Group (various gneisses with stratiform bodies of quartz–sillimanite schists and interbeds of quartzites and amphibolites). The thickness of the Kyakhta Group is unclear (presumably, several hundreds of meters). The section is intruded by leucocratic gneissose granites and granodiorites. In general, these rocks constitute the MCC zone. The age of the Kyakhta Group is still debatable, and is estimated by different researchers in the time interval spanning from the Paleoproterozoic to the Late Riphean–Early Paleozoic.

Structurally high in the section, one can see tectonites developed after rocks of the Kyakhta Group, gneissose granites, and siliceous–volcanogenic rocks of the Kataevo Formation, which were subjected to dynamometamorphism during the formation of the detachment zone (marker of the detachment zone).

The Kataevo Formation consists of tectonites developed after basic, intermediate, and acid volcanics that enclosed stratiform bodies of metaconglomerates, metasiltstones, and metatuffites. The tectonites also include lenticular bodies of diabases (with signs of dynamometamorphism), gabbrodiabases, granitoids, and pegmatites that are almost conformable with the mylonite bedding and schistosity. By their petrochemical properties, mafic tectonites and diabases correspond to calc-alkaline basalts and andesites; tectonites developed after intermediate volcanics, to the andesite–dacite group; and tectonites developed after acidic volcanics, to the rhyodacite–rhyolite group. Direct datings of the Kataevo Formation are lacking. According to geological data, its age ranges from the Vendian to Permian. We consider the Kataevo Formation as a Permian–Early Triassic formation, because dynamometamorphosed rocks of the Kataevo Formation grade into the Permian–Lower Triassic volcanogenic–siliceous sequences in several outcrops on the right side of the Selenga River below the settlement of Ust'-Kyakhta. In the detachment zone, the rocks are subjected to different degrees of mylonitization, blastic metamorphism, and plastic flow. Transitions from the overlying and underlying rocks to mylonitized varieties are gradual. Therefore, boundaries between them are arbitrary.

Toward the top of the section, Upper Mesozoic rocks without signs of metamorphism fill up depressions that border the ridge in the northwest and southeast.

Planar elements (banding and schistosity) in the MCC show significant variations. In general, they outline a dome-shaped structure with a NW-dipping trend (Fig. 3). The tensile linearity recorded at planar sur-

[1] *Institute of the Earth's Crust, Siberian Division, Russian Academy of Sciences, ul. Lermontova 128, Irkutsk, 664033 Russia; e-mail: mazuk@crust.irk.ru*

[2] *United Institute of Geology, Geophysics, and Mineralogy, Siberian Division, Russian Academy of Sciences, ul. Akademika Koptyuga 3, Novosibirsk, 630090 Russia; e-mail: ponomar@uiggm.nsc.ru*

[3] *Institute of Precambrian Geology and Geochronology, Russian Academy of Sciences, nab. Makarova 2, St. Petersburg, 199034 Russia; e-mail: kate@es7880.spb.edu*

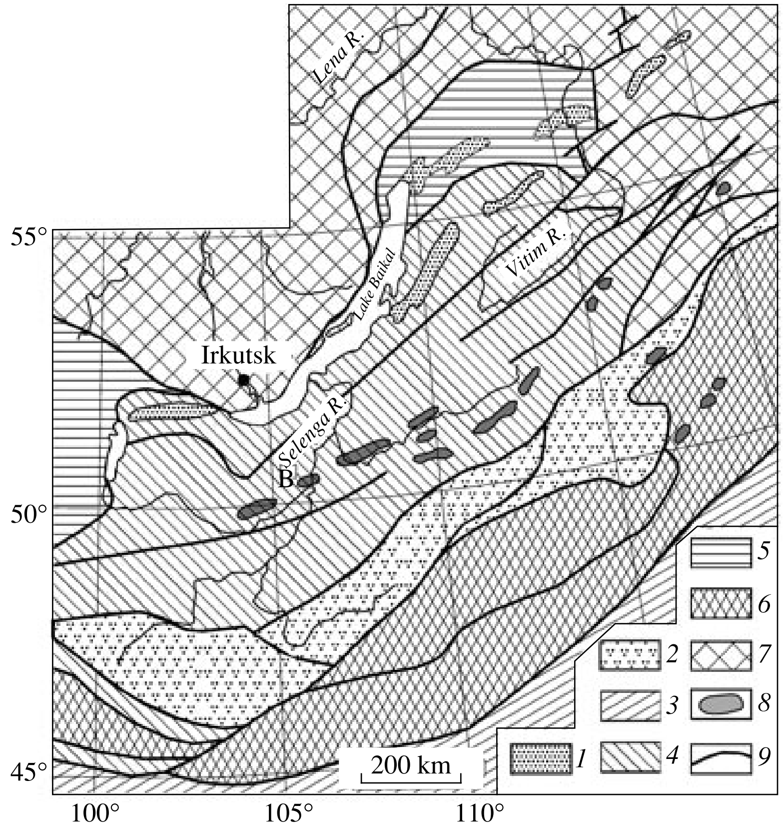

Fig. 1. Schematic tectonic structure of the Mongol–Transbaikal segment of the Central Asian Foldbelt and position of the metamorphic core complex (MCC). Compiled using data from [1, 2], as well as (Parfenov et al., 2003). (*1*) Cenozoic rift basins; (*2)* Middle Paleozoic–Early Mesozoic Mongol–Okhotsk Foldbelt; (*3*) Middle Paleozoic foldbelt; (*4*) microcontinent with the Precambrian basement; (*5*) rocks of the Riphean foldbelt altered in the Early Paleozoic; (*6*) microcontinent with the Precambrian basement; (*7*) Siberian Craton; (*8*) metamorphic core complexes; (*9*) major faults; (B) Burgutui Complex.

faces is characterized by a well-sustained strike along 140°–320°.

Based on gneissosity and banding in rocks of the Kyakhta Group, one can reconstruct in the core zone fragments of hinges of low-angle folds with NW-oriented axes. The linear elements of minerals (amphibole and sillimanite) and their aggregates are oriented in the same direction. In outcrops along the Selenga River bank, one can observe fragments of hinges of similar relatively large narrow and isoclinal folds with axial surfaces gently dipping to the southeast. Orientation of their hinges changes from northeastern to almost meridional. This phenomenon is related to the superposition of open NW-oriented folds (with subvertical axial surfaces) onto older NE-oriented folds. In addition, older schistosity is locally truncated by younger schistosity, with similar mineral species. These data indicate two stages of deformation and metamorphism. The first stage reflects events that predated the MCC formation, whereas the second stage is coeval to the MCC formation. Based on the empiric amphibole geothermobarometer, biotite–amphibole gneisses and amphibolites of the Kyakhta Group underwent deformations and metamorphism of the second stage at T = 590–640°C, P = 3.2–4.6 kbar [3].

The MCC is intruded by granites and small pegmatite bodies. The granites are exposed along the left and right banks of the Selenga River near the settlement of Naushki. By their petrochemical parameters, they correspond to alkaline granites and syenites with irregular gneissose structure. The pegmatites are younger, because they intrude the granites and usually follow the orientation of gneissosity in granites and host rocks of the core.

The detachment zone borders the core as a band up to 3.5 km wide and comprises mylonites developed after gneissose granites of the core, in addition to the aforementioned tectonites developed after Upper Paleozoic volcanics. By their appearance, the mylonites are similar to leucocratic gneisses with the fine-grained texture and parallel structure. The mylonites have typical mylonitic and blastomylonitic textures with local signs of cementation and cataclastic deformation. Fold deformations in this zone are rare and represented by symmetrical flow folds with the morphology varying from flexural bends to isoclines along the rise of the curvilinear axial surface. In the limit variant, surfaces

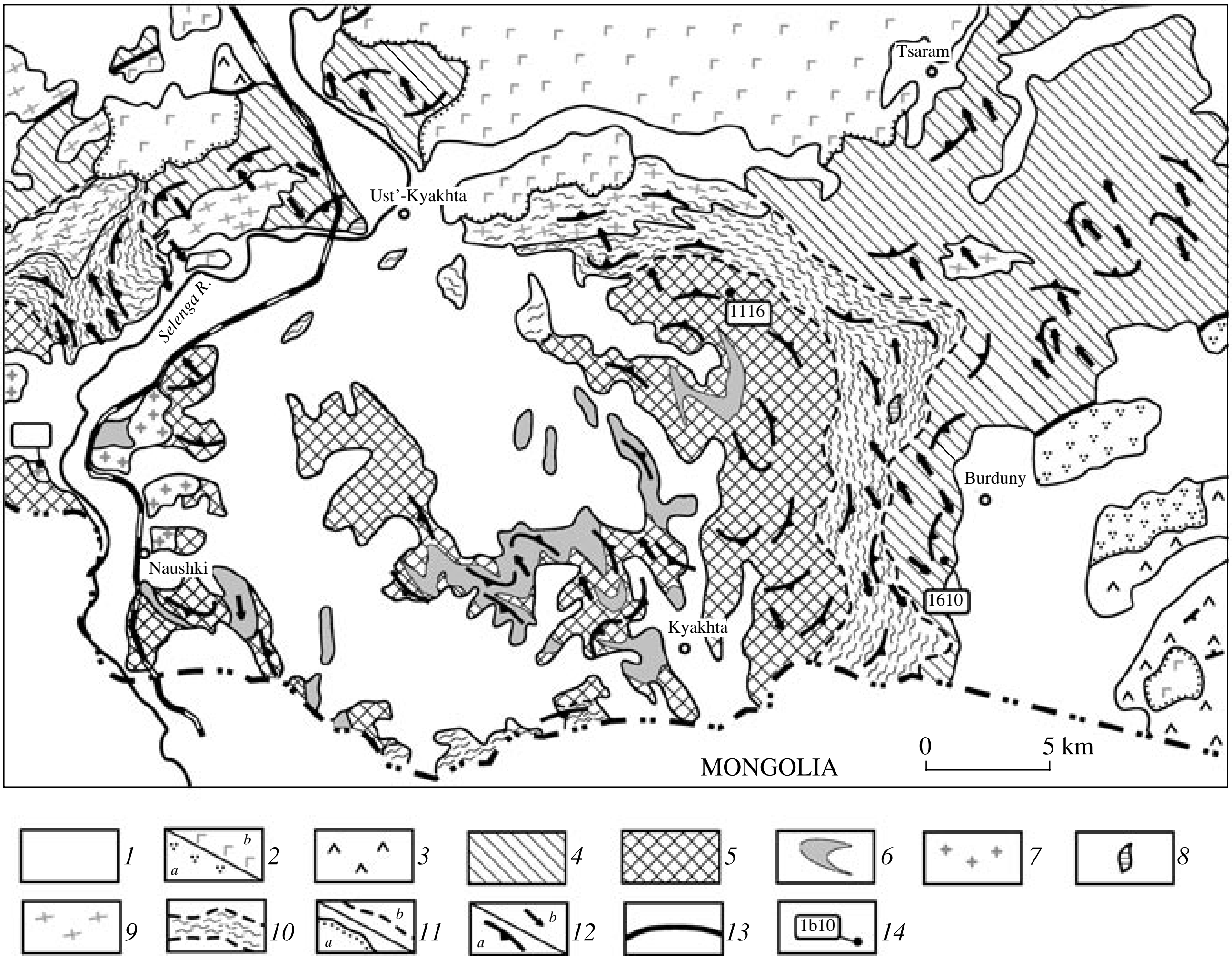

Fig. 2. Schematic geological structure of the Burgutui MCC. (*1*) Quaternary alluvial and eolian sediments; (*2*) Lower Cretaceous rocks: (*a*) sedimentary, (*b*) basic volcanics; (*3*) Permian–Triassic volcanosedimentary rocks; (*4*) dynamometamorphosed volcanosedimentary rocks (Kataevo Formation); (*5*) gneissose granites; (*6*) schists and gneisses (Kyakhta Group); (*7*) Middle Jurassic granitoids; (*8*) tectonized gabbro diabases; (*9*) presumably Middle Jurassic gneissose granitoids; (*10*) mylonitization and plastic flow zone (detachment zone); (*11*) geological boundaries: (*a*) unconformable, (*b*) assumed; (*12*) generalized orientation of (*a*) planar and (*b*) linear elements; (*13*) normal faults; (*14*) sampling sites with sample numbers.

of such folds are subparallel to mylonitic banding and schistosity. Morphologic–kinematic properties of folds suggest their formation in the shear zone of a low-angle viscous fault, where upper structural elements were displaced to the southeast (relative to lower ones). One can outline two extreme (NE and NW) orientations for hinges of these folds. Such a behavior of hinges implies changes in their trajectory in the course of prograde flow deformation during one deformation stage. The linear tension-related arrangement of minerals and furrows in the detachment zone demonstrate sustained NW–SE orientation. The plunge of linearity varies from subhorizontal to 30° with both NW- and SE-oriented dips.

In the development area of the Kataevo Formation, extensional linearity is mainly oriented from northwest to southeast. Among all varieties of rocks of this formation, metamorphosed polymictic conglomerates are most appropriate for the study of kinematics. Pebbles in conglomerates are compressed and elongated. Their elongation degree varies from 5 : 1 to 7 : 1, and relative elongation calculated for granite pebbles is as high as 230–320%. Deformation of pebbles is accompanied by pressure shadows, boudinage, and *C–S* and *C* textures. In some places, the metamorphosed matrix of pebbles contains microfolds with axes corresponding to extensional linearity and with axial surfaces subparallel to schistosity. By their morphology, such structures are similar to sheath folds. Typical sheath folds are observed in outcrops north of the settlement of Ust'-Kyakhta. The NE-striking and NW-dipping kink bands (a few centimeters to 1.5 m wide) represent the youngest deformations in the zone under consideration. They deform the dynamometamorphic banding and linearity.

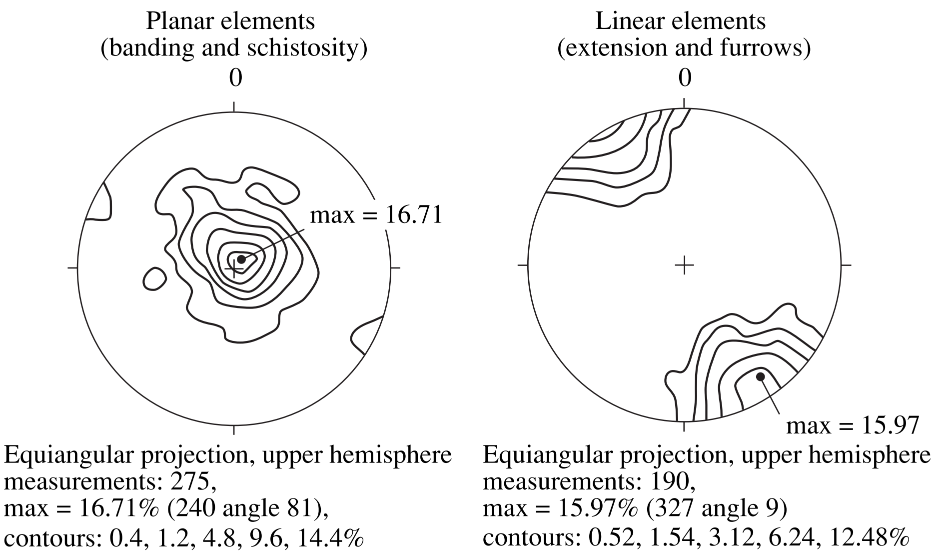

Fig. 3. Spherograms of (πS) planar and (L) linear elements in the Burgutui MCC.

The appearance of kink bands in the zone reflects the change in *PT* conditions and transition from plastic to brittle-plastic deformations. The study of kinematics of different-scale structural elements (folds, linearity, boudinage, kink bands, and *C–S* and *C* structures) shows that the rocks were deformed under conditions of simple shear with their SE transport. Such a rock transport trend is reconstructed for the northwestern, central, and southeastern parts of the structure.

Thus, structural observations show that textures in rocks from different zones of the Burgutui MCC reflect kinematics of the core formation.

In order to substantiate chronology of stages in the Burgutui MCC evolution, we carried out dating of different minerals in the following types of rocks from the core and detachment zone: (1) the U–Pb dating of zircons from slightly gneissose syenites (Sample A-1) that intruded rocks of the Kyakhta Group in the core and were not subjected to deformations of the first stage; (2) the Ar–Ar dating of amphiboles and biotites from biotite–amphibole gneisses of the Kyakhta Group in the core (Sample 1116); and (3) the Ar–Ar dating of biotites from a tectonized gabbro diabase body occurring conformably with the banding of tectonites developed after rocks of the Kataevo Formation in the detachment zone (Sample 1610). The choice of objects for dating was based on their structural–metamorphic features to characterize all stages of the MCC formation.

By their petrochemical and geochemical properties, alkaline granite–syenites from the studied massif (Sample A-1) are close to *A*-type granites. In particular, these rocks are characterized by high contents of alkali metals, Zr, Y, and Nb, but low Sr concentrations. Accessory zircon extracted from the sample was dated at the Institute of Precambrian Geology and Geochronology (St. Petersburg). Taking into consideration morphological features of zircon that indicate its magmatic origin, the estimated age of 178 ± 3 Ma corresponds to melt crystallization [4] at the middle crustal level of the orogenic structure.

The Ar–Ar dating was performed at the United Institute of Geology, Geophysics, and Mineralogy (Novosibirsk). The spectrum obtained for hornblende from biotite–amphibole gneiss from the core zone (Sample 1116) demonstrates a distinct plateau with the age of 134 ± 1 Ma. Biotite from the same sample shows a three-step plateau with the age of 126 ± 1 Ma. Biotite from tectonized gabbro diabase (Sample 1610) yielded the Ar–Ar age of 123 ± 1 Ma.

Data on the Burgutui MCC, combined with information on the Zagan Complex [1] and closure time of the Mongol–Okhotsk Ocean [5], make it possible to refine the model of development of MCCs for the Transbaikal segment of the Central Asian Foldbelt. Data on the age of plagiogranites (207 Ma [5]) formed in subduction settings during the closure of the Dzhargalantuin Trough of the Mongol–Okhotsk Ocean suggest that the Transbaikalian MCC formed in the environment of postcollisional extension. This is evident from the intrusion of igneous rocks into the lower and middle levels of the consolidated crust at the stage of collapse of the collision system that appeared after the closure of the Mongol–Okhotsk Ocean. The intrusions are represented by alkaline granite–syenites (178 ± 3 Ma) in the core zone of the Burgutui Complex, as well as granites and granosyenites (153 ± 1 and 160.1 ± 1.2 Ma, respectively [1]) in the core of the Zagan complex. Precisely these values mark the origination of the Burgutui and Zagan MCCs. Intrusion of these rocks during the collapse of the thick continental crust against the background of regional extension provoked the development of the low-angle detachment zone in the middle crust. Subsequently, the deep-seated rocks were exhumed along the detachment zone. The structural–

kinematic data indicate that the structure of dynamometamorphosed rocks of MCCs formed in common tectonic settings of a simple shear along the detachment zone. Moreover, MCCs overlying the detachment zone had a tendency for the southeastward shift. This stimulated extension, thinning of the middle crust, isostatic compensation, and consequent exhumation of metamorphic complexes. This stage is registered by biotite in dated rocks of the Burgutui (this work) and Zagan [1] Complexes. The Zagan MCC was exhumed 10–15 Ma after the Burgutui MCC [1]. This conclusion is consistent with the concept of the scissor-type closure mechanism of the Mongol–Okhotsk Ocean [6]. Such a mechanism was responsible for earlier closure of the ocean in the western part of the Transbaikal region as compared with its eastern part. Therefore, it is logical to assume that the western Transbaikal region can incorporate the oldest MCCs (e.g., the Burgutui MCC).

ACKNOWLEDGMENTS

This work was supported by the Russian Foundation for Basic Research, projects nos. 04-05-64148, 04-05-64412, and 05-05-64016.

REFERENCES

1. E. B. Sklyarov, A. M. Mazukabzov, and A. I. Mel'nikov, *Metamorphic Core Complexes of the Cordilleran Type* (Sib. Otd. Ross. Akad. Nauk NITs OIGGM, Novosibirsk, 1997) [in Russian].

2. Yu. A. Zorin, V. G. Belichenko, E. Kh. Turutanov, et al., Int Geol. Rev. **37**, 154 (1995).

3. T. V. Gerya, L. L. Perchuk, C. Triboulet, *et al.*, Petrologiya **5**, 563 (1997) [Petrology Int. **5**, 503 (1997)].

4. T. V. Donskaya, D. P. Glabkochub, A. M. Mazukabzov, *et al.,* in *Isotopic Geochronology in the Solution of Problems of Geodynamics and Ore Genesis: Materials of the 2nd Russian Conference on Isotopic Geochronology* (TsIK, St. Petersburg, 2003), pp. 153–156 [in Russian].

5. V. V. Yarmolyuk, V. I. Kovalenko, E. B. Sal'nikova, et al., Geotektonika **36** (4), 42 (2002) [Geotectonics **36**, 293 (2002)].

6. L. P. Zonenshain, M. I. Kuz'min, and L. M. Natapov, *Lithospheric Plate Tectonics of the USSR* (Nedra, Moscow, 1990), Book 1 [in Russian].