ISSN 1028-334X, Doklady Earth Sciences, 2007, Vol. 414, No. 4, pp. 515–518. © Pleiades Publishing, Ltd., 2007.
Original Russian Text © S.M. Katkov, A. Strickland, E.L. Miller, J. Toro, 2007, published in Doklady Akademii Nauk, 2007, Vol. 414, No. 2, pp. 219–222.

GEOLOGY

Age of Granite Batholiths in the Anyui–Chukotka Foldbelt

S. M. Katkov[a], A. Strickland[b], E. L. Miller[b], and J. Toro[c]

Presented by Academician Yu.M. Pushcharovsky June 16, 2006

Received July 5, 2006

DOI: 10.1134/S1028334X07040058

The Alyarmaut Uplift, which hosts the studied granite intrusions, is located in the western Anyui–Chukotka foldbelt that represents the western framing of the South Anyui lineament (Fig. 1). The latter is typically considered a suture formed during Late Cretaceous collision between Eurasia and the Chukotka microcontinent [1, 3, 5, 6, 8].

The time of collision termination is controversial. The age of undeformed granitoids, which intrude the collisional structure, can serve as an indicator. We studied the internal structure of six granitoid massifs and their relations with host rocks and took samples for geochronological dating. Four massifs are situated in the Alyarmaut Uplift, while the Pyrkanai and Kelil'vun massifs are located to the south and east of the uplift (Fig. 1).

The Alyarmaut Uplift includes variably metamorphosed Paleozoic (Upper Devonian–Lower Carboniferous) and Mesozoic (Triassic and Lower Cretaceous) rocks. Devonian–Carboniferous terrigenous–carbonate rocks of the epidote–amphibolite facies and granitoid intrusions are exposed in the internal sector of the uplift [4]. The periphery is composed of weakly metamorphosed and intricately deformed Triassic terrigenous rocks. The Triassic rocks are overlain by undeformed Cretaceous volcanogenic–terrigenous rocks.

The oldest rocks in the area are Devonian metamorphosed quartz–feldspathic sandstones with interlayers of massive quartzites. The Lower Carboniferous rocks are composed of crystalline schists, quartzites, and marmorized limestones. Fossil corals attest to the Tournaisian–Visean age of the rocks [4]. The carbonate rocks are overlain by shales with interlayers of sandstones and siltstones and calcareous nodules, which are typically ascribed to the Lower Triassic. The Lower Triassic rocks are overlain by Upper Triassic (Carnian) phyllites with interlayers of siltstones and sandstones with *Monotis ochotica* (Keys.) and other typical species. The contact between limestones and overlying schists is unclear. Our observations point to the tectonic contact between the Paleozoic and Mesozoic complexes. The Triassic intricately folded rocks are stratigraphically overlain by Lower Cretaceous (Valanginian) dense arkosic sandstones. They are discordantly overlain by Cretaceous andesites, rhyolites, tuffs, and tuffoconglomerates. The youngest rocks of the area are ignimbrites with a K–Ar age of 94 ± 6 Ma and rhyolites dated at 94, 107, 112, and 114 Ma (Aptian–Cenomanian) [4].

The intrusive rocks of the Alyarmaut Uplift are represented by granites and granodiorites [2, 4], which intrude the Devonian crystalline schists and the intricately deformed Triassic phyllites. The outer contact zone with andalusite extends over a few hundreds of meters from the massif. The K–Ar dating of plutonic rocks was carried out during geological mapping (scale 1 : 200 000) in the 1970s [4]. According to these data, the oldest moderately alkaline rocks have an age of 123 Ma. The late magmatic phases form granitic sheets and laccoliths with an age of 100 Ma, while postgranite pegmatites are dated at 90 Ma. The contact between granites and granodiorites represents a mingling zone.

Granites of the Pyrkanai and Kelil'vun massifs intrude the Upper Triassic rocks and the Lower Cretaceous sedimentary complex, respectively. In terms of geological positions, they can be younger than the Alyarmaut granites.

Zircons for the U–Pb (SHRIMP) isotopic dating were separated at Stanford University (United States) using the conventional heavy-liquid (lithium tungstate) technique. The isotope measurements were carried out on a SHRIMP-RG high-resolution ion microprobe at the SHRIMP-USGS Microanalytical Center (A. Strick-

[a] *Geological Institute, Russian Academy of Sciences, Pyzhevskii per. 7, Moscow, 119017 Russia; e-mail: sergkat@yandex.ru*
[b] *Stanford University, Stanford, California 94305, USA*
[c] *West Virginia University, Morgantown, West Virginia 26505-6300, USA*

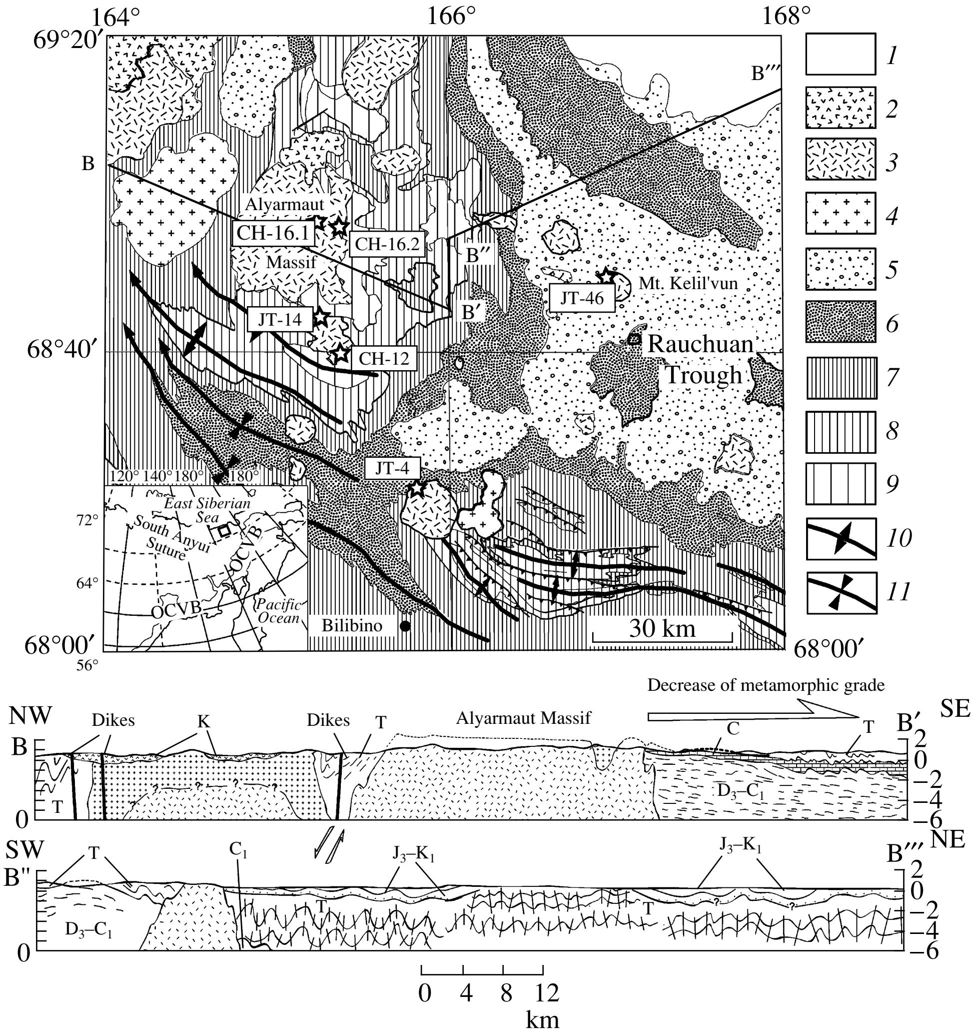

Fig. 1. Geological map of the Alyarmaut structure and adjacent areas, based on GGK-200 materials: A.I. Sadovskii and M.L. Gel'man (1964); M.D. Chasovitin and A.P. Shpetnyi (1961); G.M. Sosunov and S.M. Til'man (1959); G.Ya. Belik and G.M. Sosunov (1966). (*1*) Quaternary sediments; (*2*) volcanogenic rocks (Cretaceous); (*3*) granitoids (Cretaceous); (*4*) diorites and gabbroids (Cretaceous); (*5*) massive sandstones (Upper Jurassic–Lower Cretaceous); (*6*) phyllitic shales (Upper Triassic); (*7*) siltstones with sandstone interlayers (Middle Triassic); (*8*) siltstones and sandstones (Lower Triassic); (*9*) mica schists and limestones (Upper Devonian–Lower Carboniferous?); (*10*) axes of regional-scale antiforms; (*11*) axis of regional-scale synforms.

land and S.M. Katkov, analysts) using a standard technique [8].

The U–Pb isotopic system in zircons is resistant to thermal resetting because of the high closure temperature (>900°C). The age of magmatic zircon defines the crystallization age.

Zircons from sample CH-16.1 (granodiorite phase of the Alyarmaut batholith) are represented by transparent prismatic crystals. The U concentration in them varies from 398 to 3202 ppm. The weighted mean age of ten zircons is 115.7 ± 1.7 Ma. Among ten dates, nine values are concordant within the analytical error limit (MSWD = 0.48).

Zircon grains taken from the granite phase of the Alyarmaut Uplift (sample CH-16.2) are elongated and thin (Fig. 2a). The U concentration in them varies within 1398–5068 ppm. Based on 13 grains among 16 analyzed grains, the weighted mean value is 112 ± 1.3 Ma, with the scatter of $^{206}Pb/^{238}U$ dates ranging from 106.2 to 119.7 Ma (MSWD = 2.13). The variations obtained can be ascribed to analytical errors.

Sample CH-12 was taken from a leucogranite body intruding the aforementioned granites at the southern edge of the Alyarmaut Uplift. Foliation observed in the sample can be interpreted as deformation texture. Zircons occur as weakly elongated short-prismatic crystals. Their cathodoluminescence images (CI) distinctly demonstrate zoned cores a the U-depleted margin and a relatively U-enriched rim. In total, we analyzed 16 grains, including three core/rim pairs. Most of them are discordant, attesting to the loss of Pb. Eight concordant dates define a weighted mean age of 112.8 ± 1.3 Ma

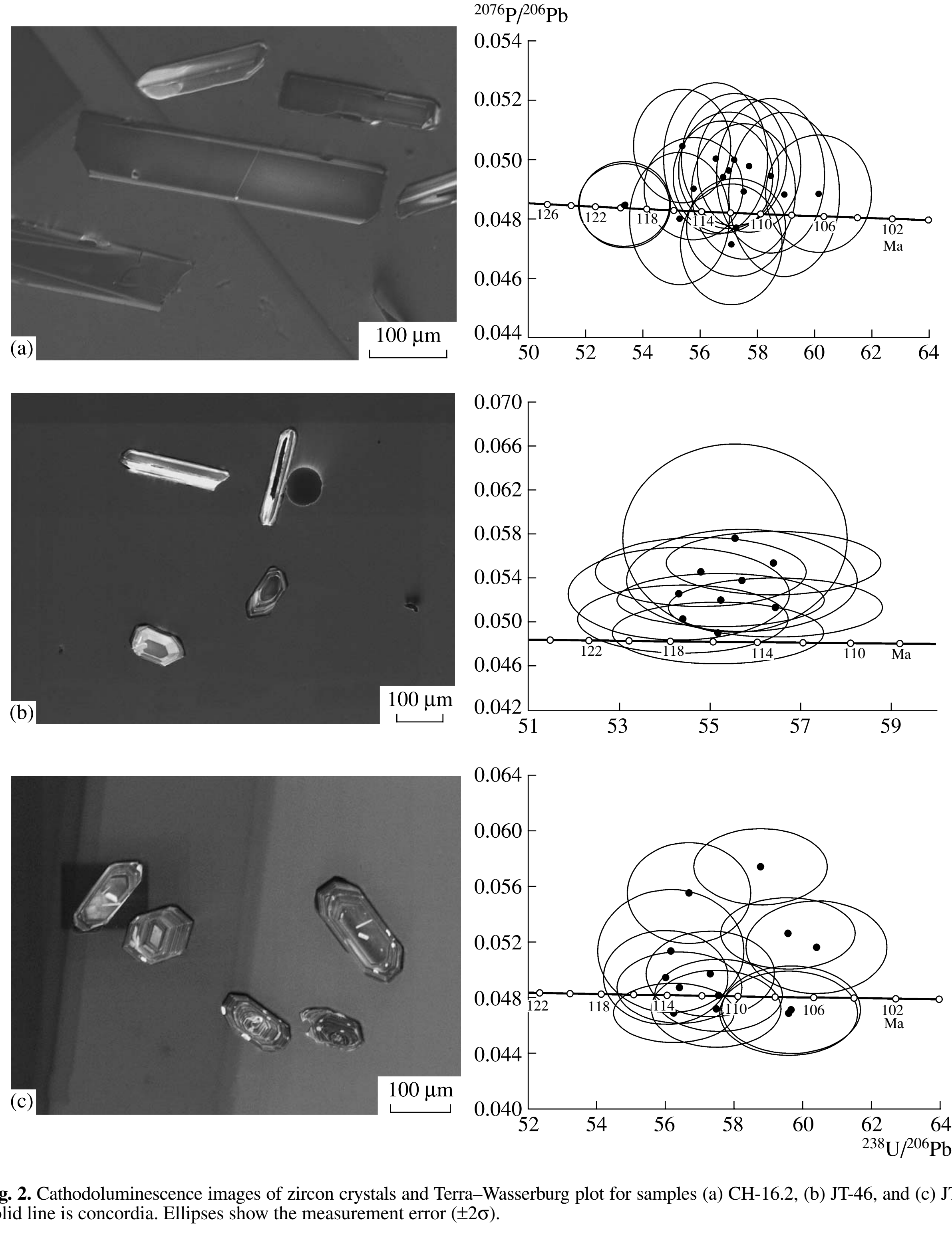

Fig. 2. Cathodoluminescence images of zircon crystals and Terra–Wasserburg plot for samples (a) CH-16.2, (b) JT-46, and (c) JT-4. Solid line is concordia. Ellipses show the measurement error (±2σ).

(MSWD = 1.17), which is interpreted as the crystallization age. Analysis of cores revealed the Precambrian age of the protolith (717, 1070.4, and 1581.5 Ma).

Sample JT-14 was taken from a large medium-grained homogenous granite pluton in the southern part of the Alyarmaut Uplift. Prismatic zircons have complex two- to three-stage internal zoning with distinct cores. The rim of crystals is typically dark and azonal, suggesting a high U concentration (up to 7638 ppm). The U content in the cores is 782–5907 ppm. The age of the analyzed cores varies from Middle Triassic to Early Jurassic ($^{206}Pb/^{238}U$ age within 191.6–232.9 Ma).

Six analyses of rims yielded an age of 117.1 ± 1.9 Ma (MSWD = 1.4). Both clusters are plotted above concordia, suggesting partial loss of Pb. These data attest to the Early Cretaceous crystallization age, with inclusions of older grains.

Sample JT-46 was taken from medium-grained homogenous granites of the Kelil'vun Massif east of the Alyarmaut Uplift. In the cathodoluminescence images, the crystals demonstrate distinct zoning and well-expressed cores (Fig. 2b). The U concentration varies from 344 to 1287 ppm. Nine of eleven analyses are concordant or near-concordant within the analytical error limit and have an age of 114.7 ± 1.3 Ma (MSWD = 0.75), which corresponds to the crystallization age.

Sample JT-4 was taken from the granite porphyry of the Pyrkanai Massif located north of the town of Bilibino. The analyzed zircons are short-prismatic crystals. The cathodoluminescence images exhibit weak zoning with almost indiscernible cores (Fig. 2c). The U concentration is within 563–2082 ppm. Eight of thirteen analyses yielded the weighted mean age of 112.4 ± 1.1 Ma (MSWD = 0.66), which is interpreted as the crystallization age. The remaining five analyses related to zircons of the younger subgeneration yielded values ranging from 105.2 to 107.7 Ma, which can be interpreted as indicator of a secondary loss of Pb or the age of a younger magmatic phase.

CONCLUSIONS

The U–Pb (SHRIMP) zircon dating of granitoids of the Alyarmaut Uplift and the Pyrkanai and Kelil'vun massifs yielded values ranging from 117.1 ± 1.9 to 112 ± 1.3 Ma, which correspond to the Aptian. Zircons from granites in the southern Alyarmaut Uplift have cores of Precambrian and Triassic–Early Jurassic ages. Some zircon grains from the Kelil'vun Massif also contain Triassic cores.

The dating of undeformed granitoid intrusions in the Paleozoic–Mesozoic folded complex allowed us to establish the termination of the collision between Eurasia and the North American Plate, which allegedly included the Chukotka microcontinent [3, 5, 6, 9, and others]. New geochronological data based on modern geochronologiocal methods not only support the concept of the pre-Aptian collision between the North Asian continent and the Chukotka microcontinent [2, 5, 6, 9], but also define the termination of collision at 117.1 ± 1.9 Ma.

ACKNOWLEDGMENTS

We are grateful to S.D. Sokolov for the review and V.V. Anikin for comments during manuscript preparation. We also thank collaborators of the Laboratory of Structural Geology (Stanford University) and the SHRIMP-USGS Microanalytical Center for help in analytical studies.

This work was supported by the Russian Foundation for Basic Research (project nos. 05-05-65052 and 04-05-65132), the Federal Program for the Support of Leading Scientific Schools (project no. NSh-9664.2006.5), and the Division of Earth Sciences of the Russian Academy of Sciences.

REFERENCES

1. N. A. Bogdanov and S. M. Til'man, *Tectonics and Geodynamics of Northeastern Asia: Explanatory Note to Tectonic Map* (Moscow, 1992) [in Russian].
2. G. E. Bondarenko and M. V. Luchitskaya, Byull. Mosk. O–va Ispyt. Prir., Otd. Geol. **78** (3), 25 (2003).
3. L. M. Parfenov, *Continental Margins and Island Arcs in the Mesozoides of Northeastern Asia* (Nauka, Novosibirsk, 1984) [in Russian].
4. A. I. Sadovskii and M. L. Gel'man, *Geological Map of the USSR. Scale 1 : 200000* (Leningrad, 1970), Ser. Anyui–Chaun. Sheet R-58-XXVII, XXVIII: Explanatory Notes [in Russian].
5. K. B. Seslavinskii, Dokl. Akad. Nauk SSSR **249**, 1181 (1979).
6. S. D. Sokolov, G. E. Bondarenko, O. L. Morozov, et al., Dokl. Earth Sci. **376**, 7 (2001) [Dokl. Akad. Nauk **376**, 80 (2001)].
7. S. M. Til'man, *Tectonics of Continental Margins of the Northwestern Pacific* (Mir, Moscow, 1980) [in Russian].
8. R. J. Muir, T. R. Ireland, S. D. Weaver, et al., Chem. Geol. **127**, 191 (1996).
9. B. A. Natal'in, J. M. Amato, J. Toro, et al., Tectonics **18**, 977 (1999).
10. I. S. Williams, Rev. Econ. Geol. **7**, 1 (1998).