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Geochronology of the Chuktukon carbonatite massif, Chadobets uplift (*Krasnoyarsk Territory*)

D.A. Chebotarev [a,*], A.G. Doroshkevich [a,b], V.V. Sharygin [a,c], D.S. Yudin [a,c], A.V. Ponomarchuk [a], S.A. Sergeev [d]

[a] *V.S. Sobolev Institute of Geology and Mineralogy, Siberian Branch of the Russian Academy of Sciences, pr. Akademika Koptyuga 3, Novosibirsk, 630090, Russia*

[b] *Geological Institute, Siberian Branch of the Russian Academy of Sciences, ul. Sakh'yanovoi 6a, Ulan-Ude, 640047, Russia*

[c] *A.P. Karpinsky Russian Geological Research Institute, Srednii pr. 74, St. Petersburg, 199106, Russia*

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Abstract

We present results of U–Pb (SHRIMP II) and Ar–Ar geochronological study of the rocks of the Chuktukon massif, which is part of the Chadobets alkaline-carbonatite complex, and of the weathering crust developed after them. Perovskite from picrites and monazite from the weathering crust were dated by the U–Pb (SHRIMP II) method, and rippite from carbonatites, by the Ar–Ar method. Rippite has first been used as a geochronometer. The estimated ages (252 ± 12 and 231 ± 2.7 Ma) testify to two magmatism pulses close in time (within the estimation error) to the stages of alkaline magmatism in the Siberian Platform (250–245 and 238–234 Ma). These pulses characterize, most likely, the processes accompanying and completing the activity of the mantle superplume that formed the Siberian Igneous Province at 250–248 Ma. The monazite-estimated age (102.6 ± 2.9 Ma) reflects the time of formation of the ore-bearing weathering crust on the massif rocks.

Keywords: geochronology; alkaline magmatism; carbonatite; weathering crust; perovskite; monazite; rippite; Chuktukon massif; Chadobets uplift

Introduction

Mantle plume activity is usually accompanied by areas of alkaline magmatism and the formation of large igneous provinces with large mineral deposits (Sobolev et al., 2011). One of the largest igneous provinces is the Siberian trap province of the East Siberian Platform (Dobretsov et al., 2003, 2010; Reichow et al., 2008). The Chadobets uplift, including the Terina and Chuktukon massifs, is located on the northwestern margin of the Siberian Platform and the trap province. It is one of the regions of alkaline ultrabasic platform rocks: picrites, carbonatites, and kimberlites. Dating of the alkaline rocks of the Chadobets complex is of great importance for reconstructing the evolution of the Siberian trap province. Note, however, that the earlier dates for the rocks of the Chadobets complex vary over a wide range of values and do not ensure an unambiguous conclusion about their age and the magmatism stage of their formation. Available K–Ar geochronological data show the age of these rocks from 299 to 183 Ma. For example, picrites of the first stage of magmatism were dated at 299–252 Ma (Zabirov et al., 1967), and carbonatites of the second stage, at 260–183 Ma. The age of kimberlite pipes formed at the third stage of magmatism is 219–200 Ma. The upper age boundary of the Chadobets complex was determined by the spore–pollen method as the Paleogene, based on the time of formation of weathering crust on its igneous rocks and of associated bauxite-bearing strata (Kirichenko et al., 2012).

In this work we report the first, more precise U–Pb and Ar–Ar geochronological studies of the Chadobets complex, namely, the rocks of the Chuktukon massif, including the weathering crust. Dating was made for minerals formed directly from silicate and carbonate melts and in the weathering crust (perovskite from alkali picrites; rippite from calcite carbonatites; and monazite from the weathering crust formed on the carbonatites). We have first used rippite $K_2(Nb, Ti)_2(Si_4O_{12})O(O, F)$, a recently registered new mineral (Doroshkevich et al., 2016; Sharygin et al., 2016a), as a geochronometer. This is one of the major Nb-minerals in the carbonatites of the Chuktukon massif. The rippite-based date, together with the date obtained for monazite from the weathering crust

* Corresponding author.
E-mail address: chebotarev@igm.nsc.ru (D.A. Chebotarev)

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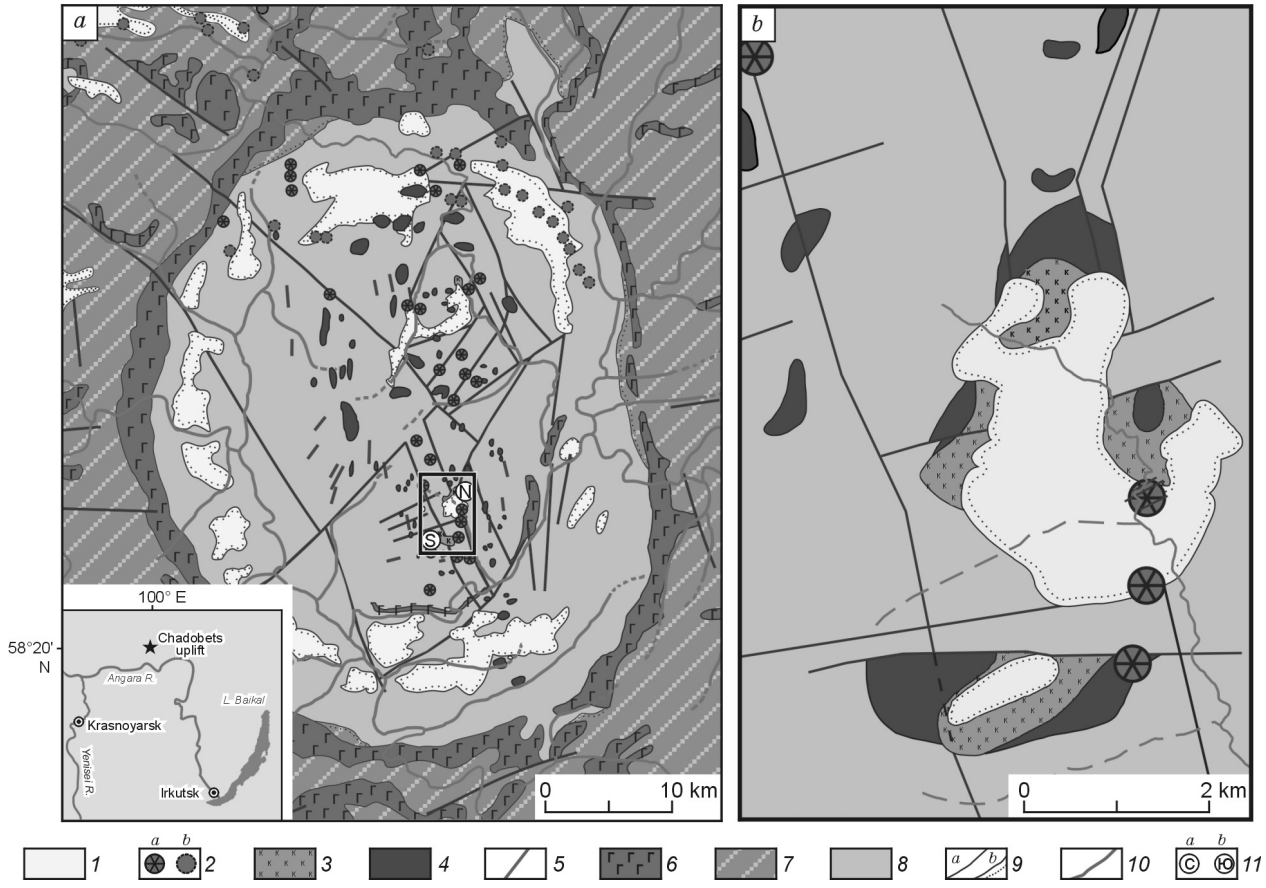

Fig. 1. Geological schemes of the Chadobets uplift (*a*) and Chuktukon massif (*b*), after Kirichenko et al. (2012). *1*, Upper Mesozoic–Cenozoic deposits: clays with sand intercalates, weathering crust (bauxites); *2*, off-scale: *a*, kimberlite pipes (third phase of the Chadobets complex); *b*, pipe-type magnetic and aeromagnetic anomalies (Mkrtych'yan, 2005); *3*, carbonatites of the second phase; *4*, ultrabasic intrusions of the first phase; *5*, dikes composed of rocks of the first phase; *6*, Permo–Triassic dolerite and gabbro–dolerite intrusions; *7*, Upper Paleozoic–Lower Mesozoic deposits: sandstones, siltstones, mudstones, siderites, conglomerates, coals, pebbles, tuffstones, tuffaceous siltstones, and tuffs; *8*, Middle Riphean–Cambrian deposits: argillaceous and siltstone-argillaceous shales, sandstones, limestones, dolomites, and siltstones; *9*, geologic boundaries between heterochronous deposits: *a*, concordant; *b*, discordant; *10*, faults; *11*, largest carbonatite massifs: *a*, Northern, *b*, Southern.

developed after carbonatites, made it possible to estimate the age and stages of ore genesis within the Chadobets uplift.

Geologic description of the Chadobets uplift

The uplift is an ellipse in shape, with 45 and 35 km long axes (Fig. 1). The uplift core forming two salients, northern (Terina massif) and southern (Chuktukon massif), is composed of Middle Riphean–Cambrian carbonate-terrigenous sediments: argillaceous and siltstone-argillaceous shales, sandstones, limestones and their dolomitic varieties, dolomites, siderite lenses, shingles, siltstones, and coal interlayers. The outer framing of the uplift is formed by fields of dolerite and gabbro–dolerite traps in subhorizontal Permo–Carbonaceous terrigenous deposits and Permo–Triassic tuffs (Kirichenko et al., 2012; Sklyarov, 1971).

Three phases of intrusion of igneous rocks are recognized in the Chadobets igneous complex: (1) alkaline ultrabasic rocks, (2) carbonatites, and (3) kimberlites (Kirichenko et al., 2012; Sklyarov, 1971) (Fig. 2).

The alkaline ultrabasic rocks are predominant picrites and alkaline picrites and subordinate phlogopite-containing micaceous peridotites and melilite and nepheline–melilite rocks. The rocks of this phase form an almost continuous sill–vein complex around the Terina and Chuktukon salients (Kirichenko et al., 2012; Kovrigina, 1984; Sklyarov, 1971). The sills and dike bodies are usually several tens of meters in thickness. In the cores of arched structures, alkaline ultrabasic rocks compose mainly stock-like and irregular-shaped intrusions 50×80 to 1300×1500 m in size (Kirichenko et al., 2012; Sklyarov, 1971).

Carbonatites form stock-like massifs in the cores of arched structures (100×50 and 200×250 m in size in the Terina salient and 2.3×1.4 and 1.9×0.9 km in the Chuktukon salient) as well as irregular-shaped bodies and dikes and veins cutting the ultrabasic rocks of the first phase (Kirichenko et al., 2012).

Kimberlites form volcanic pipes (diatremes) and vein-shaped bodies. Diatremes are 30–700 m in size, pipe-like, with sharp cutting contacts (Kirichenko et al., 2012). The bodies stretch along the uplift core from north to south and are also