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THERMOCHRONOLOGY OF THE ANGARA-VITIM GRANITOID BATHOLITH AS A PROXY INDICATOR OF PLUME EVENTS?

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Introduction

In comparison with others the Phanerozoic granitoids of the Angara-Vitim batholith (AVB) are characterized by the formation of huge volumes ($S \geq 150\ 000\ km^2$, $V \sim 10^6\ km^3$) of granite magma in a short period of time - 30 Ma (U/Pb, zircon) (Tsygankov et al. 2017). Magmatism in Transbaikalia has been explained by several models which invoke (i) suprasubduction magma generation (Donskaya et al. 2013; Jahn et al. 2009), (ii) slab detachment or crust delamination in the collision zone and asthenospheric diapirism (Khain et al. 1986), (iii) activity of an independent mantle superplume (a mantle hot field) (Yarmolyuk et al. 1997), water rich mantle plume at the final stage of Hercynian orogeny (Tsygankov et al. 2017).

Detailed field mapping, geochronology, thermochronology, and thermal modeling can be used to test competing hypotheses for batholith formation processes and the link with the geodynamic settings.

On the basis of the gravity data obtained (Turutanov, 2011), most of large plutons and some small bodies of AVB coalesce at depth into a single sheet, the area of which exceeds 100 000 km^2. Its average thickness is 5-7 km, reaching locally 10-30 km. The deep geometry of the AVB can be comparable with the giant plate is constructed with an uneven base and a flat eroded top.

We have carried out thermochronological reconstruction for samples of the Barguzin (S-type granites) and Chivyrkui (I/H-type granites) complexes of AVB using U/Pb and $^{40}Ar/^{39}Ar$ dating on primary magmatic minerals.

$^{40}Ar/^{39}Ar$ dates obtained by step heating (Travin, 2016), on the basis of a Plateau. U/Pb Dating on zircon obtained by LA-ICPMC (Tsygankov et al. 2017).

Results

The U/Pb zircon dates, which is an estimate of consolidation of granite melt, fall in a range of 320-290 Ma (Figure), with two prominent peaks at 318±1 Ma and 293±1 Ma. The thermal history of the AVB included three events at 245±1, 212±1, 156±1 Ma marked by clusters of U/Pb and $^{40}Ar/^{39}Ar$ Ages for samples from different parts of the batholith (Figure). They could be accompanied by a short-term, local increase in temperature and, then, rapid cooling. The explanation of these pulses may be related to the pulsating nature of the manifestation of intraplate mantle magmatism within the Siberian platform and its folded frame. Thus, pulses with the age of 245±1, 212±1 Ma are correlated, respectively, with the formation of the Khangai (255±10 Ma), Khentei (220±15) zonal magmatic areas with homonymous batholith nuclei (Kuzmin et al. 2010). Tectono-thermal activity could be transferred to the geological time scale almost instantly (several Ma) on the mechanism of the structural deformation of solid lithoplates. Probably, the impulse with the age of 245±1 Ma was a response to the formation of a large igneous province under the influence of the Siberian superplume, the maximum activity time of which is T=250±1 Ma (Al'mukhamedov et al. 2004, Reichow et al. 2009).

Such a long history of closure of isotope systems for samples corresponding to the modern erosion level imposes strict restrictions on the history of consolidation and cooling for granites corresponding to the deep (> 20 km) levels of the magmatic chamber. It was modelled using a mathematical algorithm describing the dynamics of heat and mass transfer in a magmatic chamber (Murzintsev et al. 2019) corresponding to the size of the AVB. The results of numerical calculations show (Figure) that after the formation of the magma chamber consolidation with the formation of the solid crust begins at the roof of the batholith. Gradually, the volume of the chamber is consolidated from top to bottom, and the lifetime of the residual melt at the deep levels of the chamber can reach 100 Ma or more.

After a period of relative calm in Central Asia 150-160 Ma ago there was a resumption of magmatic activity, expressed in the formation of the West Trans-Baikal, South-Khangai, East Mongolian rift zones (Kuzmin et al. 2010). Apparently, these events are associated with the activation of the processes of the collapse of the Hercynian orogen in Transbaikalia, recorded by isotopic systems of AVB granites, and dating Intrusive rocks associated with the metamorphic core complexes of Western Transbaikalia (Figure, Donskaya et al. 2016).

Thus, thermochronological approach to the study of the Angara-Vitim batholith allows us to record the responses of the isotopic systems of granitoids on the pulse of the manifestations of intraplate mantle magmatism within the Siberian platform and its folded framing in the age range from early Triassic to early Cretaceous, inclusive.

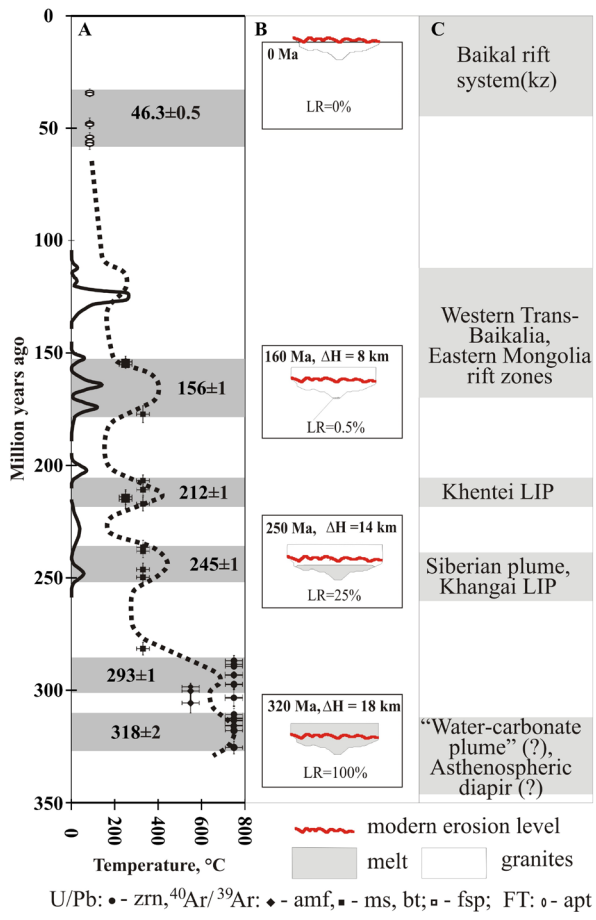

Figure. Termochronology of AVB.

A. History of closing of isotope systems of minerals of AVB granitoids. The solid line shows the probability density based on the dating of the dating of the metamorphic core complexes of Transbaikalia (Donskaya et al. 2016).

B. Results of numerical modelling of cooling and consolidation of granite magma chamber. LR(%) is the percentage of melt remaining in the magma chamber.

C. Main events of intraplate magmatism in the Siberian platform and surrounding areas (Kuzmin et al. 2010).

Conclusions

320-290 Ma ago in the section of the Earth's crust of Transbaikalia was the formation of molten granitic layer (the underlying granitoid batholith), and the existence and evolution of the melt continued for another 100 Ma.

Tectonic-thermal events with age 245 ± 1, 212 ± 1, 156 ± 1, 125 ± 2 Ma reflect the gradual transformation of the "semi-frozen granite layer" and the discrete nature of its tectonic exposure to the upper level of the earth's crust as part of the Trans-Baikal terrain under the influence of tangential elastic deformations caused by the pulsating manifestation of intra-plate mantle magmatism within the Siberian platform and its folded frame.

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