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New data about age and geodynamic nature of Hamsara terrane

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On the basis of isotopic-geochemical studies and analysis of geological evidences heterogeneity of Hamsara terrane has been determined. Formation of stationed metamorphosed layers underlying the Hamsara formation occurred not earlier than 630 Ma, probably in the oceanic island arc system. Acidic effusive rocks of Hamsara formation were formed in intraplate condition in the range of 462–464 Ma. Sediments of Hamsara formation couldn't be the part of island arc system and belong to completely other period of geological region development. This is the time of completion of accretion-collision events in the northern part of Altai-Sayan fragment of CAFB adjacent to the Siberian platform.

Kuznetsk-Tuva island arc system existed in Paleoasian ocean during Vend-Cambrian time [*Berzin, Kungurtsev, 1996; and others*]. Tannu-Ola-Hamsara segment can be distinguished in the range of this system which in its turn can be divided into Hamsara and Tannuol zones classified as terranes or subterranes [*Berzin, Kungurtsev, 1996; Kuzmichev, 2004; Mongush et al., 2011*]. In the eastern part of Hamsara terranes its northern border is Main Sayan fault, separating the terrane itself from the south border ledge of Siberian platform basement; on the south this terrane is bound to Tuva-Mongolia massive along the Azassk-Jombola fault and also along the fault with Eastern-Tuva back arc terrane. The western border is less defined. In the scheme [*Mongush et al., 2011*] on the west from Hamsara terrane there is Sistighem terrane (Fig. 1).

Hamsara terrane is filled with granite intrusions. Structure of its layered sediments has been reconstructed by xenoliths and huge blocks in granite. In the

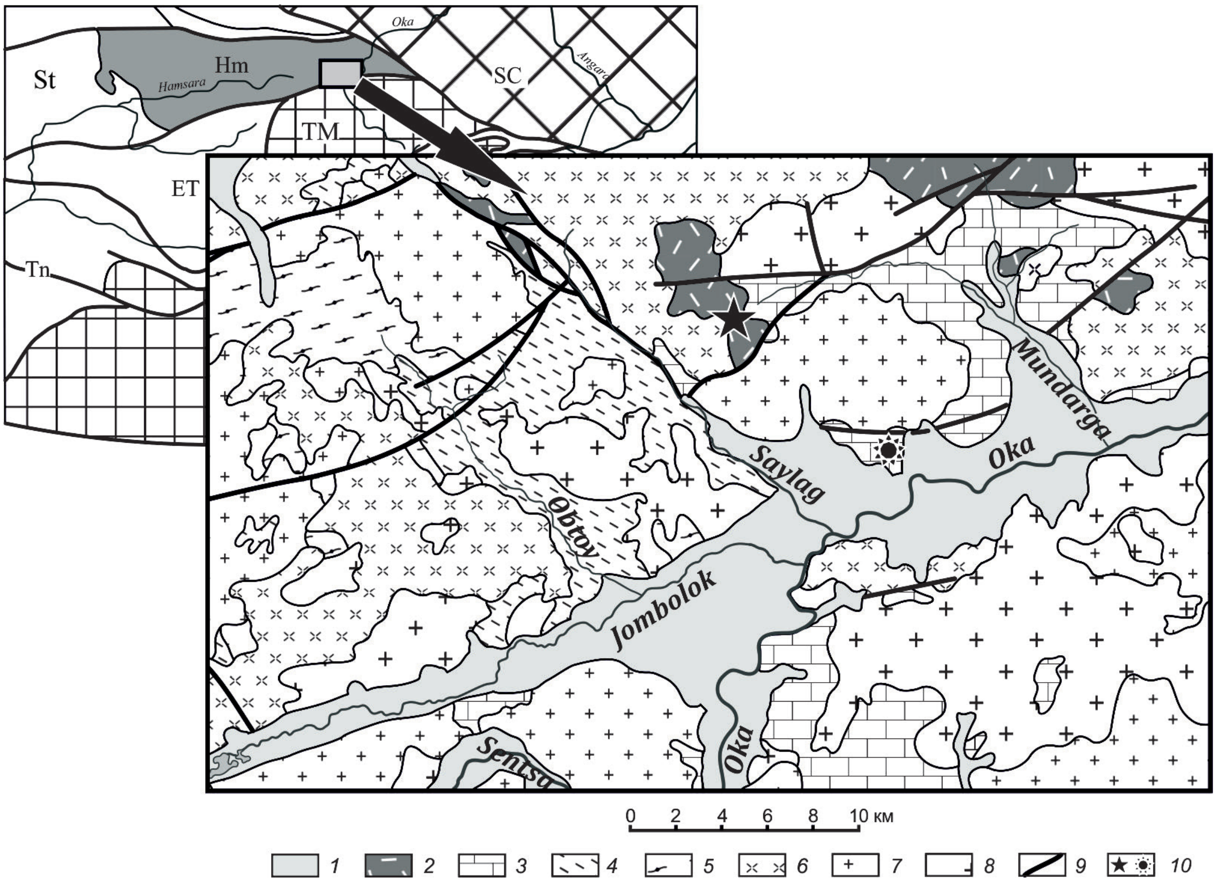

Fig. 1. Modified from the terrane map of *Kuzmichev* [*2004*] and *Mongush et al.* [*2011*] and simplified geological map of Oka and Jombolok rivers (on the basis map 1:200000).

TM – Tuva-Mongolian microcontinent, SC – Siberian platform and Hm – Hamsara, Tn – Tannu-Ola, ET – Eastern-Tuva, St – Sistighema terranes. *1* – cenosoic rocks; *2* – Hamsara formation; *3* – Mongosha formation; *4* – Baliktighemsk formation; *5* – Shuthulay formation; *6* – Ognite granitoids; *7* – Tannu-Ola granitoids; *8* – Proterozoic granitoids; *9* – faults; *10* – sample locations.

structure of layers a set of presumably Precambrian formations can be distinguished (Shuthulay, Baliktighemsk, Mongosha, Dibinsk) composed by metamorphosed in various degrees para- and orto-rocks. Amphibole-biotite and biotite gneisses and crystalline slates, green slates, metacarbonate rocks are among them. They are overlaid with unconformity by volcanogenic almost non metamorphosed rocks of Hamsara formation [*Mongush et al., 2011*], with Cambrian age determined by archaeocyathids from organogenous carbonates met in one of xenoliths. Rocks of Hamsara formation are broken by granitoids, belonging mostly to Ognit and Tannu-Ola complexes.

Isotopic geochemical data for Tannuol-Hamsara segment from Central-Asian fold belt are scanty. Age of 578.1±5.6 Ma has been determined with $^{40}Ar/^{39}Ar$ method in amphiboles for gabbroids In Tannu-Ola terrane which are considered as a part of ophiolite complex in initial development system stage [*Mongush et al., 2011*]. The stages are estimated as time intervals of 560–570 and 540–520 Ma as the result of isotopic age determinations of island arc granitoids and gabbroids in general for island arc system [*Rudnev, 2013*]. Sedimentation age interval for layers of Hamsara terrane as well as their geodynamical nature up to present time remains uncertain.

Researches were made near the south-eastern border of Hamsara terrane along the inflows of river Oka – rivers Saylag and Mundarga (Fig. 1). This part of the terrane is represented by thin spike between Siberian platform and Tuva-Mongolian block limited by Main Sayan and Azassk-Jombolok faults. Abundant here sediments of Mongosha formation are represented by marbled limestones with horizons of biotite and amphibole-biotite slates. For isotopic dating with LA-ICP-MS method a sample of biotite slate was separated (N 52°47'51.2"; E 99°47'34.4") composed mostly by quartz, biotite and plagioclase. Tentative sample preparation and separation of accessory zircon was made in IEC SB RAS, Irkutsk using the standard methodic. U-Pb geochronological dating of zircons from slates of Mongosha formation was done in the Institute of Geochemistry and Analytical Chemistry of RAS in the laboratory of isotopic geochronology with laser ablation me-

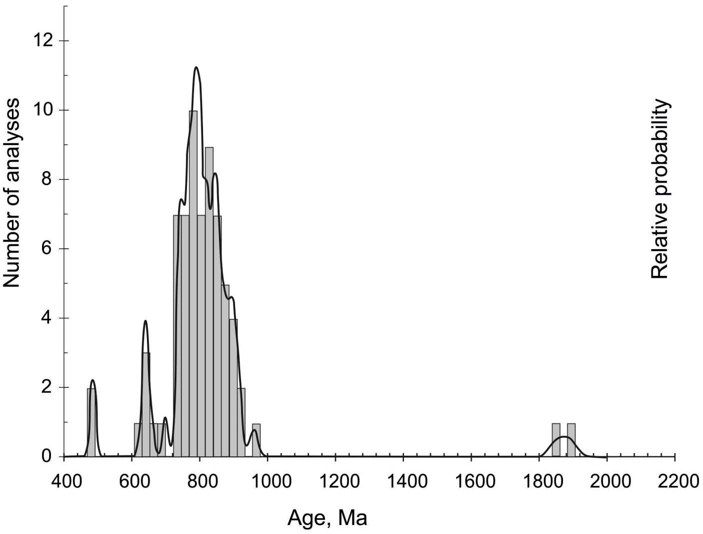

Fig. 2. Histogram and the relative age probability curve for detrital zircons from metaterrigenous rocks of the Mongosha formation.

thod (laser UP-213) on the mass-spectrometer of high resolution Element-XR with ionization in inductively coupled plasma LA-ICP-MS.

60 of the 92 analyzed zircon grains (65 %) showed concordant age values (discordance ±5 %) which were used during the creation of age histograms and probability density plots (Fig. 2). The diagram reveals two contiguous zircon groups with Neoproterozoic age. Concordant ages for the youngest zircon group vary from 630 to 690 Ma with maximum of 640 Ma. Main zircon group forms a huge cluster in the range of 730–920 Ma with strong maximum at 786 Ma. Besides this, for separate zircon grains age determinations were received in the intervals of 480–490 Ma and 1800–1900 Ma, but because these data are not statistically approved they cannot be used for the interpretation of the results. Also earlier we received with U-Pb (SIMS) method the age of acid effusive rocks from Hamsara formation [*Shkolnik et al., 2017a*]. Points of isotopic zircon composition from two analyzed samples on U-Pb diagram with Concordia form concordant clusters with the age of 463.9±2.8 and 461.7±3.1 Ma (Fig. 3). Received values corresponding to the crystallization time of acid effusive rocks of Hamsara formation slightly vary from those received earlier by Rb-Sr isotopic method from the rocks in general – younger age 402.1±11.1 Ma [*Vorontsov, Sandimirov, 2010*]. Volcanites of Hamsara formation which were not exposed to structural-metamorphic alterations overlay with unconformity metamorphosed sediments of other formations, including Mongoshinsk one, and are typical in their geochemical features for intraplate formations [*Shkolnik et al., 2017a*]. Type of the section and absence in Mongoshinsk formation source area rocks of zircons with old age determinations let us consider that they were formed far from continental blocks and only due to the destruction of island arc Neoproteozoic complexes. In the range of studied CAFB segment igneous events of early Neoproterozoic time (900–720 Ma) are quite abundant [*Kuzmichev et al., 2005; Kuzmichev, Larionov, 2011; and others*]. Detrital zircons of this time interval are also typical for the most of CAFB terrigenous layers [*Kozakov et al., 2005; Rojas-Agramonte et al., 2011;Kovach et al., 2013; Reznitsky et al., 2015; and others*], while the zircons of late Neoproterozoic age on the present day are found only in metaterrigenous

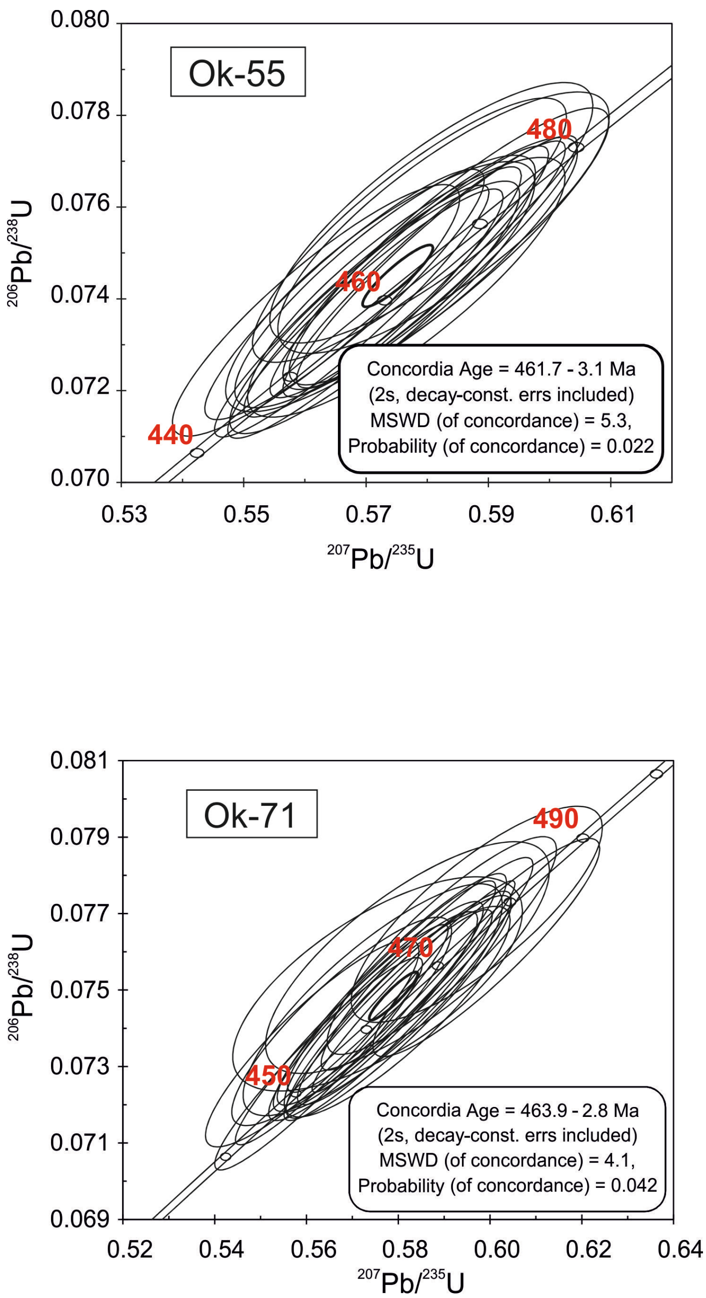

Fig. 3. Concordia diagram showing zircon ages for rhyolite (OK-55 и OK-71) of Hamsara formation.

rocks of Dzida and Ikat terrains, where also early Cambrian archeocyathids were found and in the Shubuta formation ending the section of Hamardaban terrane [*Shkolnik et al., 2016; 2017b*]. Old source areas, probably from craton, are of most importance in all of the studied layers. Those zircons haven't been found in the sediments of Hamsara terrane and this is connected from our point of view with the isolation of the structure – that is with its formation in intraoceanic environment.

Received isotopic-geochronological data together with analysis of geological facts show that sediments of Hamsara terrane were heterogenous. Deployed metamorphosed layers underlying the Hamsara formation were formed in the interval of 630–460 Ma. Taking into account the archeocyathid findings and obvious time gap between Hamsara formation and underlying it sediments exposed by folding and metamorphic alterations the most possible age interval of sedimentation for these sediments is upper Neoproterozoic to lower Cambrian, apparently in the intraoceanic environments of island arc.

Main material sources for metasedimentary rocks were, apparently, island arc igneous rocks. Hamsara formation couldn't be the part of island arc system – its sedimentation in the intraplate environment belong to the principally various time period of geological region development. This period is usually considered as the time of completion of accretion-collision events in the northern part of Altai-Sayan fragment of CAFB adjacent to the Siberian platform.

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