Geochemical and geochronological study on granitoids in west-central Mongolia:Petrogenesis and tectonic implications

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https://hdl.handle.net/2324/5068287

出版情報：Kyushu University, 2022, 博士（理学）, 課程博士
バージョン：

（様式３）

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論 文 名　：Geochemical and geochronological study on granitoids in west-central Mongolia: Petrogenesis and tectonic implications（西～中央モンゴルに分布する花崗岩類の地球化学的・年代学的研究：成因とテクトニックな意義）

区　　分　：甲

論 文 内 容 の 要 旨

Granitoid magmatism is widespread in territory of Mongolia, and it provides critical information to understand the crustal formation, evolution, and growth of the Central Asian Orogenic Belt that is the longest-lived and the largest orogenic belt in the Earth history. This study constrains the timing of magmatism, petrogenesis, and tectonic setting of the Mongolian Altai granitoids and Khangai granitoids based on geochronological and geochemical data set.

Petrological and geochronological results allow the Mongolian Altai granitoids can be divided into seven groups. Geochemically, group-I (Leucogranite), -IV (hornblende–biotite granite), -VI (K-feldspar porphyritic biotite granite) have calc-alkaline to high-K calc-alkaline and metaluminous affinity, whereas group-II (biotite–muscovite granite), -III (cordierite–biotite granite), -VII (Ms granite) have high-K calc-alkaline and peraluminous affinity. Group-V (biotite quartz syenite) has shoshonitic and peralkaline affinity.

The zircon U–Pb dating constraints the Middle Ordovician (*c.* 460 Ma) magmatic age for group-I granites, Devonian magmatic ages of 387–361 Ma for group-II, 369–353 Ma for group-III, and 366–356 Ma for group-IV granites, whereas *c.* 315 Ma for group-V quartz syenite and 208–200 Ma for group-VI and -VII granitoids. Group-I granites have continental crust-like signature formed in a volcanic arc setting which suggest presence of magmatic arc at *c.* 460 Ma. Groups-II and -III peraluminous granites have high-Th/Nb, and low-Ba/Th reflecting sources might be derived from sedimentary rocks. On the other hand, group-IV metaluminous granite has low-Th/Nb and high-Ba/Th reflecting source might be derived from mafic crustal material.

Based on our geological, geochemical and geochronological data combined with recent published data, group-II, -III, and -IV are most likely formed by ridge subduction. Group-V quartz syenite has a with-plate magmatism signature and formed at *c.* 315 Ma demonstrating crustal extension related to the ridge subduction and formation of slab window. Group-VI and -VII granitoids have I- and S-type affinity and they were formed in post collision environment at *c.* 208–200 Ma, which are good agreement with timing of collision related metamorphism at *c.* 260 Ma.

The Khangai batholith consists of mainly hornblende–biotite granodiorite associated with the mafic magmatic enclave and biotite granite which are formed at *c.* 260 Ma and subordinated pegmatitic granite was emplaced at *c.* 237 Ma in central Mongolia. Petrographic and geochemical features suggest that the hornblende–biotite granodiorite is typical I-type, while the biotite granite and pegmatitic granites are hornblende free fractionated I-type granites. Based on petrography and whole-rock chemistry, mafic magmatic enclave was in equilibrium with hornblende–biotite granodiorite and both magmas were formed from dehydration melting of the amphibolite-dominant source. Whole-rock Sr–Nd isotopic compositions of hornblende–biotite granodiorite associated mafic magmatic enclave and biotite granite suggest that they may have been derived from dehydration melting of the amphibolite-dominant juvenile crust subsequently involved assimilation fractional crystallization processes. On the other hand, subordinated pegmatitic granite show highly differentiated affinity, and their Sr–Nd isotopic compositions are different from other rock types and probably derived from the partial melting of hornblende bearing juvenile lower crust subsequently involved assimilation fractional crystallization processes.

Based on our data and integrating with published data allows for the following tectonic evolution in west-central Mongolia:

1) Subduction initiation was started in *c.* 560–530 Ma that segment of Paleo- Asian oceanic plate beneath under microcontinent that existed in the Central Asian Orogenic Belt, possibly the Tuva-Mongolian–Zavkhan–Baidrag microcontinent regarding

volcano-sedimentary sequences and ophiolitic remnants with supra-subduction zone affinities followed by arc-related magmatism

2) The oceanic plate has continued subduction beneath the microcontinent and form arc-related group-I granites at *c.* 460 Ma.

3) During the *c.* 390–350 Ma period, ridge subduction occurred in the Mongolian Altai and formation of slab window has provided a heat source for partial melting of the mafic lower crust and middle crust (dominated by metasedimentary rocks), which provided voluminous peraluminous S-type granite (group-II and -III) with a minor amount of I-type granite (group-IV).

4) The ridge subduction and slab window-related crustal extension cause within-plate basaltic magma which is precursor magma of quartz syenite at *c.* 315 Ma.

5) The Paleo-Asian Ocean was closed at *c.* 260 Ma by subsequent collision and led to the complete formation of the Mongolian Altai mountains in western Mongolia.

6) At the similar period of *c.* 260–240 Ma, continental arc-related voluminous I-type Khangai granitoids were formed in central Mongolia, which are caused by subduction of the Mongol-Okhotsk paleo-oceanic plate beneath the south-eastern margin of the Siberian craton (Tuva-Mongolian–Zavkhan–Tarvagatai and Transbaikalia) and led to the formation of huge Khangai mountain range.

7) In western Mongolia, post-orogenic group-VI and -VII granitoids were formed due to the slab break-off and asthenosphere upwelling at *c.* 208–200 Ma.

Above seven events in between microcontinental block, Paleo-Asian Ocean and Mongol-Okhotsk Ocean have produced present subduction–accretion–collision orogeny during the Cambrian to Triassic period.