Petrochemistry of Igneous Rocks in Area of the Erdenetiin Ovoo Porphyry Cu-Mo Mineralized District, Northern Mongolia

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Abstract. Petrochemical data for the igneous rocks in and around the Erdenetiin Ovoo Porphyry Cu-Mo deposit, Orkhon Selenge trough (part of the Mongol Okhotsk Fold Belt) are re-examined. Magmatic activity of the trough started by Permian bimodal volcanism formed in extensional regime changed in early Mesozoic by compressional regime by intrusion of calc-alkaline gabbro-granodiorite-granite of the Selenge Intrusive Complex with subsequent intrusion of Porphyry Association followed by trachybasalt-trachyandesite alkaline series volcanics of the Mogod Formation. Permian volcanics exhibits typical continental arc characteristics, the Selenge Complex intrusion and Porphyry Association are related to calc-alkaline, I-type, magnetite series, medium and high K rock, and enriched in LIL, depleted in Nb, Ta, Ti and P that typical for continental arc environment. The Mogod Formation is characterized by variation in K, enrichment in Al and LIL, depletion in Nb, Ta and Ti, showing magmas derived from a sub-arc mantle source. Petrochemistry and low initial 87Sr/86Sr isotope ratio of intrusive rocks are corresponding to the adakitic nature and consisting with arc condition.

Keywords: Magmatism, Selenge Intrusive Complex, Erdenet Porphyry Association
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INTRODUCTION

The Erdenetiin Ovoo deposit occurs within the Orkhon-Selenge trough, a part of large Mongol-Okhotsk Fold Belt. The most large porphyry Cu-(Mo-Au) deposits in the worldwide are formed in association with subduction-related magmas and occur sporadically in magmatic arc. In northern Mongolia late Paleozoic magmatism, which indicates coeval subduction, started in early Permian with maximum of activity in the late Permian-Triassic, corresponding to the closure of the Mongol-Okhotsk Ocean [1].

This paper reviews possible preexisting petrochemical data for the igneous rocks distributed in the Orkhon Selenge trough.

MAGMATISM

Geological Situation

The Erdenet area with 20-25 km length is located in the center of the narrow dome structure, which is mainly occupied by Permian Khanui Group volcanic and the Selenge Intrusive Complex rocks (Fig. 1).

The earliest magmatic activity in the area is represented by widely distributed Permian Khanui Group volcanics, which is composed of four conformable formations: (1) mafic and intermediate volcanics; (2) felsic volcanics; (3) volcanoclastics; and (4) mafic volcanics. It was followed by Late Permian Selenge Intrusive Complex (including Erdenet Pluton), which occupies an area of around 2800 km^2 [2] with multiple, mainly hypabyssal and shallow intrusions showing 40Ar/39Ar age of 258.6±3.3 and 247±3.7 Ma [3]. Three phases are noticed: (1) gabbro, gabbro-diorite, diorite, monzonite and rare monzodiorite; (2) subalkaline granite, granodiorite, granosyenite, syenite

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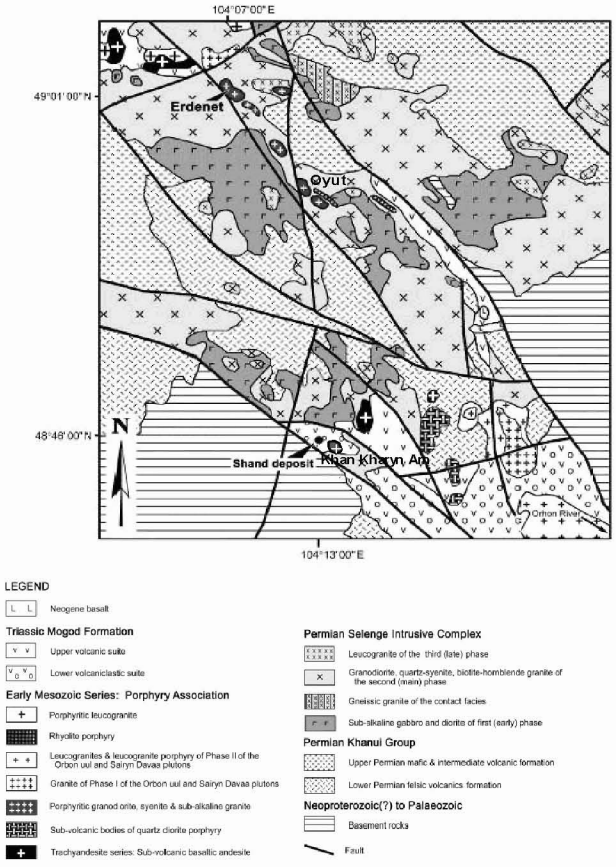

FIGURE 1. Geological map of the Erdenet area (Koval et al., 1985).

and quartz-syenite; (3) dykes and stocks of leucogranites and granites.

A series of mineralization related dykes and plugs are widespread in the Erdenet area distinguished as the "Porphyry Association" [2].

Erdenet Porphyry Association is intruded into the Selenge Intrusive Complex.

It consists mainly of diorite and granodiorite porphyry showing 40Ar/39Ar age of 234.6±1.7 Ma (I stage) and 225.3±1.0-220.3±5.8 Ma (II stage) with initial Sr ratio of 0.70393-0.70437 [3].

Mid- to upper Triassic and Jurassic volcanics of Mogod Formation are widespread occurring the tectonic grabens and overlapping onto upper Paleozoic sequences.

Petrochemistry

Khanui Group Volcanic Rocks

The Khanui Group rocks show subalkalic features with compositional ranges from basalt, basaltic andesite, andesite, to rhyolite and rhyodacite, with rare dacite. Due to K2O vs. SiO2 classification, they plot mostly on medium potassic field. Basalts and basaltic andesites in the MgO-FeO (tot)-Al_2O_3 diagram, though not shown here, basalts are plotted in the field of MORB, and basaltic andesites in the field of volcanic arc. In the AFM diagram the Khanui group rocks are calc-alkaline, but some basalts fall in the tholeiitic field.

Selenge Intrusive Complex

The rocks of the Selenge Intrusive Complex show compositional range from gabbro, syenodiorite to granite and calc-alkaline and include medium to high potassic members in terms of K_2O vs. SiO_2 classification.

Granitoids are metaluminous, I-type and magnetite series, enriched in LIL-group elements and depleted in Sr, Nb, Ti and P (Fig. 2).

Rocks show comparatively enriched in LREE, less fractionated (La/Yb 5.4-15.6) with flat HREE pattern (Fig. 3).

The Erdenet Pluton granitoids have more enriched, but similar trace element characteristics to the Selenge Complex and also show low fractionated, and comparatively lower REE content without negative Eu anomaly.

Porphyry Association

The Porphyry Associations in the area belong to alkaline and subalkaline series, with medium to high potassic characteristic. Porphyry Association samples show depletion in Ti, Sr and P, enrichment in Ba, Rb and K (Fig. 2). They have similar content of LREE and barren Porphyry Association (Khan Kharyn Am) shows higher content in HREE (Fig. 3).

In terms of tectonic discrimination diagram of Rb vs. (Y+Nb) [4], the granitoid rocks belong to Volcanic Arc Granite (VAG) field (Fig. 4).

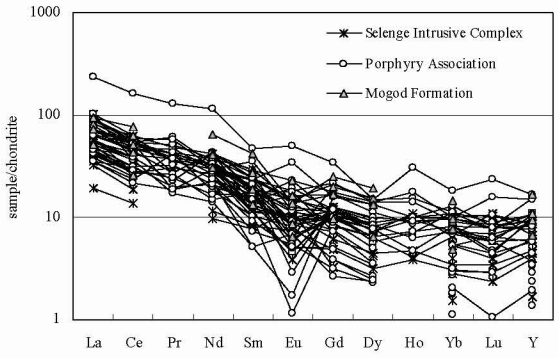

FIGURE 2. Trace element spider diagram of igneous rocks in Erdenet area.

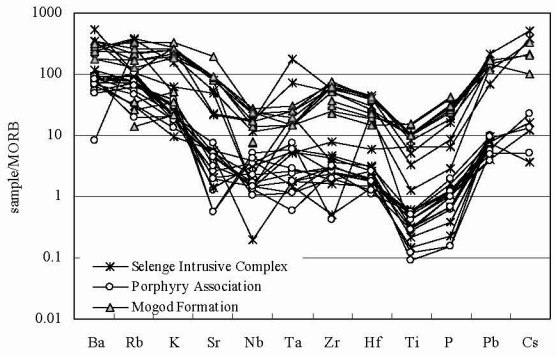

FIGURE 3. REE pattern of the igneous rocks.

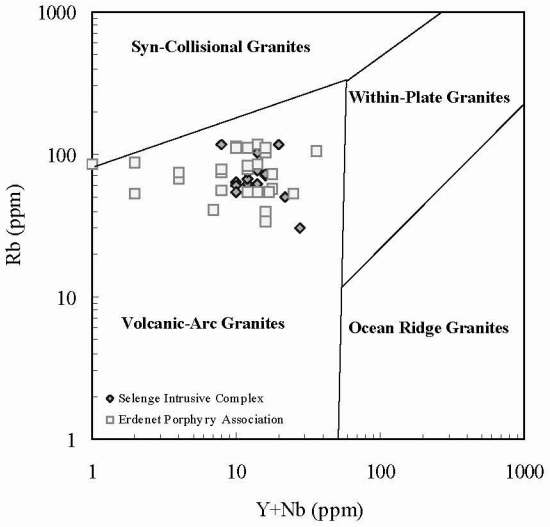

FIGURE 4. Tectonic discrimination diagram for the Selenge Intrusive Complex and Erdenet Porphyry Association.

Mogod Formation

The Mogod Formation rocks belong to alkaline series and show compositional range from basalt, trachybasalt, basaltic trachyandesite, trachyandesite and trachydacite. In expression of K_2O vs. SiO_2 diagram, the rocks show variable composition from medium to high K and shoshonite series. The rocks are enriched in LIL elements and depleted in Nb, Ta and Ti, which is common geochemical characteristic of the arc magmatism (Fig. 2). They show less fractionated REE pattern (Fig. 3).

DISCUSSION AND CONCLUSION

The history of igneous activity at the Erdenet area within the Orkhon Selenge trough could be summarized as follows:

Magmatism has started by bimodal volcanism of the Early Permian Khanui Group. Few major element analyses follow to conclude that these rocks formed in the extensional regime. The Group is characterized by a subalkalic composition with elevated potassium alkalinity, mostly calc-alkaline, but some have tholeiitic characteristics.

This volcanism is followed by intrusive magmatism of Late Permian-early Triassic Selenge Complex, which is characterized by calc-alkaline, medium to high potassic, I-type and magnetite series rocks. Major and trace element distribution, LREE enrichment, with moderately and low fractionated HREE, and negative Nb anomalies are typical of magmas formed above a subduction zone in active continental margin. Ore-bearing porphyritic intrusions including Erdenet Porphyry Association are also characterized by calc-alkaline, I-type, magnetite series and medium to high potassic features. Major, trace and RE Element chemistry and low initial $^{87}Sr/^{86}Sr$ isotope ratio of intrusive rocks are corresponding to the adakitic nature [5] and consisting with arc condition. Previous researchers described that the Erdenetiin Ovoo deposit formed in intracontinental environment, but petrochemical data are more consistent with arc conditions. Late Mesozoic Mogod Formation rocks show similar petrochemical characteristics to those intrusive rocks of the Porphyry Association.

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