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The magmatic evolution leading to porphyry Cu-Mo mineralization at the Shand porphyry deposit, Northern Mongolia

GANBAT BAYARAA[1], ODGEREL DASHDORJGOCHOO[2], XIAOYONG YANG[3], SANCHIR DORJGOCHOO[4], MUNKHTUR ENKHTUR[5] AND TUNGALAG NAIDANSUREN[2]

[1]Oyu Tolgoi LLC
[2]Institute of Geology, Mongolian Academy of Sciences
[3]University of Science and Technology of China
[4]Institute of Geology and Geophysics, Chinese Academy of Sciences
[5]Oyu-Tolgoi LLC

Presenting Author: ganbat_b@mas.ac.mn

The Shand Cu-Mo deposit, located in the Erdenet ore district, Northern Mongolia, is closely associated with the Erdenet porphyry association and Selenge complex. The magmatic process leading to porphyry Cu-Mo mineralization at Shand deposit are reconstructed on the basis of petrogenesis and corresponding mineralization significance, a detailed study in new geochronology, geochemistry, and mineral chemistry was performed for the host Selenge complex (ore barren intrusive) and Erdenet porphyry association (mineralized intrusive) in the Shand Cu-Mo deposit, Erdenet ore district, Northern Mongolia.

Zircon LA-ICP-MS U-Pb dating suggests emplacement ages of 240.1 Ma for granodiorite porphyry, Erdenet complex (mineralized intrusive porphyry). They both belong to normal to fractionated I-type granite and are divided into two intrusive complexes based on geochemical differences. Mineralized intrusions have relatively high SiO_2 (66.82–66.04 wt%), a high Sr/Y ratio (385.25–118 wt%), and enriched Eu anomalies. Rocks from the Selenge complex have relatively low SiO_2 (67.78–61.7%), a low Sr/Y ratio (35.5–14.7%), and depleted Eu anomalies. In addition, mineralized intrusions show a more adakite signature than ore barren intrusions.

The biotite phenocrysts of the samples are eastonite, and slightly siderphyllite, whose compositions indicate a fO_2 lower than the HM buffer line. The determination of the chemical composition of biotite plays an important role in both magmatic activity and the ore forming process. Most magmatic and hydrothermal biotites are Mg-rich, plotted in the phlogopite and Mg-biotite compositional fields. The biotite from mineralized intrusive rocks and barren intrusive rocks yielded Ti in biotite crystallization temperature of 685–775% ˚C (average of 815% ˚C) and 575.92–812.12% ˚C (av. of 689.7% ˚C). Chlorite geothermometers show that the formation temperature of chlorite from mineralized and barren intrusive rock samples ranges from 179 to 269 ˚C (av. 235 ˚C), 145 to 235 ˚C (av. 188 ˚C), respectively, indicating the temperature of hydrothermal alteration.

The magmatic process of the Orkhon-Selenge belt in Northern Mongolia at different depths led to variable elemental compositions of magma in the ore barren and mineralized intrusive rocks. Middle Triassic intrusions with high oxygen fugacity, initial Cu content, and adakite signatures are the key factors in forming the Shand Cu-Mo deposit, Orkhon-Selenge belt.