Magma evolution and redox conditions of Sangilo igneous rocks, Philippines: Insights from zircon U-Pb age, Hf isotopes, and trace elements

*Ylam Shalev Matba[1], Mayuko Fukuyama[1]

1. Graduate School of Engineering Science, Akita University, Japan

The Baguio Mineral District is one of the most productive gold and copper provinces in the Philippines. This study investigates the magmatic evolution and oxidation state of the igneous rocks in the Sangilo deposit using U-Pb dating, Lu-Hf isotopes, and trace element composition of zircon from the igneous rocks. The $^{206}Pb/^{238}U$ ages of zircon revealed three distinct magmatic pulses: Early Miocene quartz diorite and gabbro (22.84 to 20.89 Ma), Middle Miocene granodiorite (16.32 ±0.34 Ma), and Pliocene basaltic trachyandesite (3.23 ±0.23 Ma). In-situ Hf isotope analysis of zircon shows ε Hf(t) values ranging from +9.5 to +18.2 across all rocks. These results indicate significant juvenile crustal growth derived from a depleted mantle source, typical of island-arc settings with minimal continental crustal contamination. Zircon trace element compositions exhibit relatively reduced signatures for the Early Miocene units (ΔFMQ_{avg} = −0.4). Conversely, the Middle Miocene and Pliocene igneous rocks yielded more consistent oxidized conditions (ΔFMQ_{avg} = +0.3) which are characteristic of fertile magmas capable of transporting chalcophile elements. While zircon trace element composition in the Early Miocene gabbro and Middle Miocene granodiorite suggests fertile porphyry potential (e.g., elevated Dy/Db, P (μg/g), Eu/Eu*), the reduced state of the Early Miocene magmas likely constrained porphyry formation during that period. The integration of high ε Hf(t) and ΔFMQ values underscores the role of oxidized juvenile magmatism in the formation of the Sangilo system. This study demonstrates that trace element composition of zircon provides critical constraints for assessing the mineral potential of arc-related magmatic systems.

Keywords: Baguio Mineral District, Zircon U-Pb age, in situ Hf isotopes, Oxygen fugacity, Porphyry potential

