Transport and Reaction Behavior of Supercritical Geofluid Revealed by Porphyry Copper Deposit

*Geri Agroli[1], Noriyoshi Tsuchiya[1]

1. Tohoku University

Supercritical geothermal reservoir (SCGR) is a novel system in the geothermal field. Recently this geothermal system got a lot of attention from scholar since the successful of IDDP that encountered the supercritical fluid in Reykjanes and Krafla geothermal field. SCGR is promising exploited geothermal resource in the near future with several benefits in the economic and technical aspect. However the limited access to geological properties of SCGR system to optimize the potential of the system as well as to address the issue of the system lead us to investigate the natural analog that suitable with this system, Instead of we spend huge money for drilling activity. Porphyry copper deposit is a suitable candidate for SCGR analog where magma ascent from deep mantle and fluid infiltrate a ductile rock mass at ~600˚C, and stock work fracture as an important fluid pathway developed intensively.

The research was conducted on the largest porphyry copper deposit in northern Mongolia called Erdenet deposit. We used 700m depth drill core samples from an open pit. Based on texture and mineralogy, lithology of Erdenet comprises of quartz porphyry and granodiorite porphyry at shallow and deep level consecutively. Mineral assemblages of Quartz porphyry are qtz-ser-py-cp±cal and chl-plg-qtz±kfs for Granodiorite porphyry. Stockwork vein system can be well observed on certain samples and Er-22 (569.9m) reveal distinct vein generation process and evolution based on cross-cutting relationship. Qtz-Mo vein precipitated at the beginning of the process followed by the formation qtz-py±cp vein and those 2 vein type cut by qtz±cal vein. Fluid activity was investigated by several analytical techniques to measure mineral composition to further obtain thermodynamics properties (P-T conditions). Host rock crystallize at temperature 389-861˚C (measurement point from core to rim) using Ti-in-Quartz geothermometer under lithostatic pressure derived from a cotectic line in the Qz-Ab-Or ternary diagram. The similar methods perform to obtain quartz precipitation temperature of qtz-mo vein and the result show vein was precipitated at 323-678˚C (measurement point from core to rim). Fluid inclusion is a useful technique to determine the precipitation of the other two vein type. Qtz-py±cp vein homogenizes at temperature 147.8-358.9˚C with median 251.9˚C but the pressure regime and salinity of fluid are difficult to measure due to most of the inclusion size is less than 5 μm. The last fluid activity marked by the presence of qtz±cal that cut all of the previous veins. The homogenization temperature is less than 200˚C.

The distribution of vein in the granodiorite porphyry system in Erdenet revealed the evolution of fluid in order to understand the geological properties of a supercritical geothermal reservoir. The emplacement of granodiorite at >600˚C followed by formation of qtz-mo vein that interpreted to have formed in the supercritical regime at 500-600˚C under lithostatic pressure and subsequent pressure drop to hydrostatic condition induce qtz-py±cp vein formation due to drop of silica solubility. Lithostatic to hydrostatic pressure shifting indicate by the presence of pervasive sericite alteration imply meteoric water had circulated into the system. The temperature of the system keeps decrease and precipitation of qtz±cal occurred as the last product on this system. Erdenet Cu-Mo provides a lesson regarding on fluid process and development of supercritical geothermal activity and strong candidate as a natural analog for advanced scientific studied in the future.

Keywords: supercritical geothermal reservoir, erdenet, porphyry deposit, fluid inclusion

