Geochemical Modeling of Water-Rock Interaction in the Biliran Geothermal Project, Biliran Island, Philippines

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On the basis of fluid and gas chemistry obtained from the Biliran exploratory wells combined with alteration mineralogy studies, the current hydrogeologic model of the Biliran geothermal field suggests that the neutral chloride fluids result from the neutralization of acidic fluids due to intensive water-rock interaction. This study in particular, aims to model the water-rock interaction of the Biliran geothermal system using fluid chemistry data by predicting the alteration mineral assemblage that may form at various water-rock ratio. Results of the study may be useful in identifying potential problems during the exploitation of the system in terms of changes in fluid chemistry, well casing corrosion, and/or precipitation of scale minerals possibly causing blockages.

Numerical calculations was performed using the FORTRAN program CHIM-XPT by Reed along with plotting tool MINTAB. Water-rock interaction was simulated by incrementally titrating the andesitic wall rock into the 1 kg of the theoretical acidic reservoir water at the reservoir temperature (350°C). Results of the modeling showed a drastic change in pH from 1.5 to 5.6. Rutile initially forms followed by alunite and quartz with very small pH change. The most drastic increase in pH happens when alunite forms along with anhydrite and andalusite at around 20-100 grams of rock reacted. Beyond this, several minerals (mostly silicates along with some sulfides, phosphates, and sulfates) form. pH change would be stable for a certain w/r ratio range due to the occurrence of mineral buffers (i.e. andalusite-margarite at 200 grams and muscovite-microcline pair (at 400 grams). At the largest water-rock ratio, the alteration assemblage consists of quartz, plagioclase, wairakite, epidote, clinozoisite, chlorite end members, sphene, amphibole, apatite, pyrrothite and fluoroapatite. Hydrothermal alteration mineral assemblage in the Biliran exploration wells has a close similarity to the end assemblage of the model having quartz, chlorites, epidote and amphiboles as the most common minerals in these neutral-Cl wells while acidic assemblage including alunite, quartz, anhydrite were typically observed in narrow faulted zones along the wells.

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