

Model calculations of scale forming minerals of high enthalpy geothermal waters in Turkey

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Located on the active Alpine-Himalayan Orogenic Belt, Turkey's geological and neo-tectonic evolution had been dominated with active faults and volcanisms which are the leading causes of substantial geothermal resources. Such resources are widespread throughout the country and are identified with three distinctive geothermal regions based on their tectonic settings. Of which, high enthalpy resources, suitable for geothermal power production, are mainly located in the western part of the country along the major graben and associated fault systems. These include Denizli-Kızıldere (242°C), Aydın-Germencik (232°C), Manisa-Kavaklıdere (213°C), Aydın-Pamukören (187°C), Canakkale-Tuzla (175°C), Aydın-Salvatlı (171°C) and Kütahya-Simav (162°C) [1]. Low and moderate enthalpy sources exist in the Middle and Eastern Turkey along North Anatolian Fault Zone because of volcanism and fault formations.

The total geothermal potential in Turkey is estimated to be about 31,500 MWt. Most of the geothermal development in Turkey has been initiated by MTA (General Directorate of Mineral Research and Exploration of) since 1962. A law allowing geothermal sources discovered by the MTA to be used by commercial organizations was introduced in 2007. Moreover, legislation concerning renewable energy was brought in at the end of 2010. These new laws have led to increased efforts to explore profitable geothermal electricity and to use the heat directly.

In this study, geochemistry of the medium to high enthalpy geothermal waters suitable for electrical energy production has been critically reviewed and the solubilities of potential scale-forming minerals including silica polymorphs and carbonates at various temperatures have been calculated by using EQ3/6, for determining the optimum operation conditions in power generation.

[1] Mertoglu O. *et al.* (2010). *Proceedings World Geothermal Congress*. Bali, Indonesia, 25-29 April 2010.

Geochemical tracing of water-rock interactions in the Ringelbach granitic research catchment (Vosges, France)

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For constraining the nature of water-rock interactions occurring within granitic watersheds a geochemical and isotopic (Sr, U) study of all springs within the Ringelbach granitic research catchment (Vosges, France) has been undertaken, following the approach classically developed in the Lab [1]. This study also includes the analysis of water samples collected in two 150-m deep boreholes, which permit the evaluation of (a) water flux and composition in the deeper part of the watershed and (b) deep weathering processes within the granitic bedrock. At the scale of a single spring, important geochemical variations are observed over the year. Such variations cannot be accounted for by a simple mixing scenario of rainwater contributing in variable quantities to the chemical composition of these waters. For each considered spring, the geochemical variations have to be interpreted as the contribution of two different weathering fluxes with changing intensities over the hydrological cycle. At the scale of a same slope a systematic geochemical variation of the spring waters is observed according to their emergence altitude along this slope. These chemical changes affect both the elementary and U activity ratios but not the Sr isotope ratios. This indicates that geochemical variations are not simply controlled by mixing processes between waters having interacted with different lithologies. Furthermore, geochemical variations observed in subsurface waters (springs) cannot be explained by a contribution of deep waters (boreholes). All together these data suggest that the main parameter explaining geochemical variations of water samples collected within the Ringelbach catchment is the water pathway of the waters within the watershed. Modeling approaches confirm and constrain the importance of this parameter in the control of geochemical characteristics of surface waters (Schaffhauser *et al.*, this issue).

[1] S. Durand, F. Chabaux, S. Rihs, P. Düringer, P. Elsass (2005), *Chem. Geol.*, **220**, 1-19; [2] M.L. Bagard, F. Chabaux, Oleg S. Pokrovsky, J. Viers, Anatoly S. Prokushkin, P. Stille, S. Rihs, A.D. Schmitt, B. Dupré (2011) *GCA*, DOI: 10.1016/j.gca.2011.03.04.