Perspective

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Geothermal Hydro Chemistry: Environment and Energy Relevance

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Perspective

Renewable energy sources have become extremely important for the supply of energy for industrial and domestic consumption. In the year 2008, the European commission has proposed a new directive for the adoption and was considered as a replacement for those in the year 2001. It was mentioned that in this new directive each of the new member state are assigned the task of increasing the contribution to renewable energies including that of the solar energy, wind energy or hydroelectric energy. The European Commission has proposed to increase its share up to 20%; geothermal energy is one of the prominent sources of renewable energy in the European Union. In Romania alone several hundreds of wells were drilled up to few thousands of meters to find the geothermal waters having the temperature up to 120°C. The geothermal sources have the potential to produce nearly 500 megawatt of energy.

Hydrochemistry plays an important role in the geothermal exploration, explaining the regional ground water movement, estimation of underground temperatures and mapping extent of geothermal systems. It is also highly relevant for solving the scaling and corrosion problems as well as for safe fluid dispersal and construction designing. The study of the variations in the chemical ratios and the concentration of the stable isotopes define the vertical permeability and potential up-flow zones. On an overall basis the hydro chemical characterization enables prediction of the sustainability and impact of the geothermal energy plant operations. These chemical analyses also include the chemical thermometry and radiocarbon dating.

The geothermal waters mainly contain cations such as sodium, the anion HCO3 and chlorine ions. The meteoric water seep into the ground water even up to a maximum depth of two kilometers that are heated to a high temperature by the granitic body. The water rock interacts with the deep water thus affecting the chemical composition of the geothermal water. Generally, if sea water incursion takes place then it results in the higher sodium and calcium content of the water.

Studies were conducted to analyze the major elemental composition of the geothermal waters from the production wells using ion chromatography methods. However, the heavy metals and the gases that are involved process need to be appropriately disposed to control the adverse environmental effect. A wide range of chemical reactions takes place in the geothermal waters due to the interaction between the water and the rock chambers mostly involving the sulphur or metal cations. Due to high temperatures in the geothermal waters, rocks usually dissolve readily in the geothermal waters. Such prolonged interactions produce clay and dissolved silica. Based on the extent of the temperature the metal ions of calcium potassium and sodium are liberated into the geothermal waters. The silica concentration determines the temperature yield of the geothermal water.

The geothermal waters contain significant quantities of toxic heavy metals such as arsenic and mercury. The residual water from the geothermal field gets discharged into the environment. In order to prevent such contamination such water is re-injected into the by pumping down the well drills at a high temperature to avoid silica formation and also to sustain the field pressure.

The sulphide minerals can liberate the metal cations to the environment When they are exposed to the environment oxidation reactions and the hydrolysis of the metal cations takes place resulting in the acidic metal enriched water that cause environmental pollution. The hydrated ferric oxide can also adsorb other metal cations that are liberated by the oxidation of the sulphide minerals.

The impact of the geothermal waters was investigated on several occasions. In those studies it was found that the thermal waters

were found to cause a drastic rise in the sodium, SO4 ions along with the temperature of the water. Also the concentration of the arsenic, lithium, lead and other heavy metals were found to be increased.

In United States the calcium carbonate scale and the iron related pollution are the most common water problems. These scale formation can reduce the performance of the heat pump. Apart from this the iron precipitation also contributes to the deterioration of the surface water quality. Some studies have reported the estimation of the stable environmental isotopes and the hydrochemistry of Iranian geothermal system. The water samples from the thermal springs were found to be having high electrical conductivity due to chloride water type. The temperature gradient can be as high as 50°C per kilometer of the depth. The stable isotope ratio analysis revealed that the thermal water originate from the rainfall due to depleted oxygen-18 ratios. The mineral saturation indices and the Na-K are useful in estimation of the equilibrium temperatures of the geothermal system.