

The chemical and isotope characteristics of geothermal fluids in Shandong, China

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Utilization of low and medium temperature geothermal fluids is an alternative energy source to fossil fuels and play an increasingly important role in space heating in Northern China. The distribution of the geothermal activity, the fluid chemistry and origin and reservoir temperatures are, however, still largely unexplored.

In order to trace the processes controlling the fluid composition, fluid mixing, fluid origin and reservoir temperatures, major, trace and water isotope analysis were performed for groundwaters (boreholes and springs) in the Shandong area, China. 16 hot springs were sampled, with the geothermal fluid temperatures ranging from 28 to 81°C, pH from 6.95 to 8.44, Cl from 58 to 5316 ppm, SiO₂ from 61 to 137 ppm, B from 0.21 to 0.91 ppm, HCO₃ from 60 to 573 ppm, δD from -72.0 to -48.0‰ and δ¹⁸O from -9.8 to -6.6‰. About 50 chemistry data of geothermal waters associated with sandstone reservoirs were collected, with the temperatures ranging from 37 to 86 °C, pH from 7.08 to 8.60, Cl from 809 to 13234 ppm, SiO₂ from 9.5 to 43 ppm, B from 1.12 to 6.43 ppm, HCO₃ from 76 to 655 ppm, δD from -75.1 to -54.8‰ and δ¹⁸O from -10.0 to -5.8‰.

Based on geochemical relations and modeling, the water composition is controlled mainly by two processes: (1) water-rocks interaction and formation of secondary minerals; (2) variable source waters and mixing between them.

Geothermal waters associated with sandstone reservoirs are mainly ancient water, with limited recharges from modern atmospheric precipitation. In contrast, geothermal water associated with intrusive rock are mainly recharged by modern atmospheric precipitation mixed with seawater or shallow groundwater with the hydrology controlled by deep faults with NNE strike.