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Formation mechanism and mixing behavior of Nanyang thermal spring, Xingshan County of Hubei Province, central China

Na Li (1), Hong Zhou (2), and Zhang Wen (1)

(1) School of Environmental Studies, China University of Geosciences, Wuhan, China, (2) Geological Survey, China University of Geosciences, Wuhan ,China

Low-medium temperature geothermal systems have enormous potential for generating energy in light of the increasing shortage of traditional energy resources. This paper elucidated the hydrochemical characteristics and formation mechanisms of the Nanyang thermal spring situated in a typical low-medium temperature geothermal field. Based on the isotopic, hydrochemistry analysis, thermal groundwater was originated from precipitation in the Shennongjia group of mountains. Hydrochemical features of thermal groundwater derived from the regional flow system was generally of Cl-Na type, and were very different from that of cold shallow water, with higher TDS values and minor elements (such as Sr, F) content. Most cold shallow groundwater belonged to the local flow system was HCO_3-Ca type. With pumping, the thermal groundwater of Cl-Na type transformed to HCO_3-Cl-Na type with low TDS values due to mixing with local shallow groundwater, confirmed by the Na-K-Mg geothermometer. Reservoir temperature was evaluated by cation and silica geothermometry, and the results indicated quartz geothermometers can provided a reliable reservoir temperature of about 141.3 °, combing with the silica-enthalpy mixing model. Meanwhile, the actual proportion of the shallow groundwater in the mixture was about 84.9% in this geothermal area. Finally, a conceptual model of the formation holding the thermal spring was established: the thermal groundwater was driven by a long distance recharge via deep-seated fault and fracture zone (mainly Jiuchong Fault) from the Shennongjia Mountains precipitation, and then upwards to the surface accompanied by the mixing with the cold shallow groundwater when encountering the impermeable Shale. This research was significant for the development of improved protection mechanism for sustainable utilization of geothermal resources especially in low-medium temperature geothermal fields.