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Hydrogeochemistry and genesis analysis of the geothermal springs in Arxan, Northeast China

Xiaomin Gu, Jingli Shao, Yali Cui, Qiulan Zhang

School of Water Resources and Environment, China University of Geosciences, Beijing 100083, China

Abstract : In this work, the origins and the genesis of Arxan springs are discussed, which are well known for the occurring of both cold and thermal springs. The hydrogeochemistry and environmental isotope data are utilized to understand characteristics and origins of the springs, the reservoir temperature is calculated using mineral saturation indices and geothermometers methods.

Arxan geothermal system involves 24 springs with outlet temperature ranging from 13.3°C to 41°C, which can be classified into two groups based on Piper diagram. The main water type of Group I is mostly HCO₃-Na-Ca, with outlet water temperature between 7.9 °C and 18.4 °C and was classified as cold springs. The main water type of Group II is HCO₃-Na. The temperature is between 19.5 °C and 41 °C, they are mixed type of cold and thermal springs.

Based on the isotopic analysis, the δ¹⁸O and δ²H data points of the Arxan springs are near the global meteoric water line, implying that the spring water is of meteoric origin. The aquifer where the samples of Group I occurring is the shallow cold aquifer of Jurassic system related to local groundwater with groundwater age younger than 10 years, and the springs rise from the weathering crust and fissure. While the samples of Group II occurs in a deep low-medium temperature geothermal system recharged by deeply circulating meteoric water. The springs rise from the deep basement faults in the form of hot fluid with the groundwater age about 80 years.

Various outlet temperature of Group II is mainly caused by the different mixture ratio of shallow cold water, the proportion is estimated to range from 55% to 89% in the Arxan thermal springs calculated by mass conservation of enthalpy and silica dioxide concentration. The circulation depth of the meteoric water is about 1440m. The estimated thermal reservoir temperature is between 50~70°C according to calculations using chalcedony geothermometers and computation of saturation indices for different solid phases. According to the hydrogeochemical results and hydrogeological features of the study area, a conceptual flow model for circulation of meteoric water is given to describe the low-medium temperature geothermal system of the Arxan springs.

Key words: Springs, Thermal groundwater, Hydrogeochemistry, Isotopes, Arxan

