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Deciphering Hydrochemistry and Fluid-Mineral Equilibria from Characteristic Low-Enthalpy Geothermal Waters of Himalaya and Eastern India

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Abstract

Geothermal energy, with associated low-carbon emissions compared to conventional fossil fuels, is presently one of the potential renewable energy sources. The decryption of the chemistry of thermal manifestations of geothermal systems, in terms of relative abundances of various chemical facies, is mandatory before launching systematic geothermal exploration in a given area as it provides valuable information on the basic characteristics of the geothermal reservoir. For the present study, three clusters of hot springs have been selected -1) Shyok-Nubra valleys geothermal prospect in NW Himalaya, 2) Subansiri valley geothermal areas in NE Himalaya and 3) the hot spring system occurring along Munger-Saharsa Ridge Fault Zone (MSRF) in the Eastern part of India. The study of these geothermal systems with low to moderately high temperatures of 35−75°C, has been carried out with two main objectives. The first objective is to estimate reservoir temperature and other characteristics in the three above-mentioned hot spring groups using conventional chemical geothermometry techniques for the first-hand assessment of the quality of the geothermal resource and postulating its possible application. The second objective of the study is to understand the distribution of stable isotopes (δ^2H and $\delta^{18}O$) in the studied geothermal systems to reveal reservoir-related hydrological aspects of the geothermal system.

The three groups of hot springs show large variations in total dissolved solids (TDS) from <150 to about 1800 mg/L. Enigmatic and inexplicably low TDS values of 126 to 150 mg/L are reported from the three Bhimband hot springs along MSRF Zone. These springs discharge $Ca-Mg-HCO_3$ type water. The dearth of dissolved ionic species in these springs indicates lack of water-rock interaction in Bhimband area. Silica is the most abundant solute species and corresponds to a reservoir temperature of about 75°C. It may be inferred that relatively inert lithology in the reservoir and very high water-to-rock ratio might have rendered the observed chemical signatures to Bhimband hot springs. Shyok-Nubra springs at Changlung and Panamik are predominantly $Na-HCO_3$ type with TDS values of about 1700 and 550 mg/L, respectively. These hot springs give an indication of water-rock interaction in different types of lithology at temperatures of 120 to >150°C resulting in the observed chemical differences between the two. Thermal water at Taksing in NE Himalaya is also $Na-HCO_3$ type. Chetu hot spring with TDS of >1100 mg/L is anomalous in two ways. First, it has a very high SO_4 content of 358 mg/L and second, it has the lowest silica value. There is a possibility that the Chetu hot spring has its chemistry influenced by the dissolution of sulfates of Ca and Na. Preliminary stable isotope study indicates that the geothermal fluid is derived from meteoric sources. The lack of any indication for positive $\delta^{18}O$-shift suggests that reservoir temperatures of the springs are generally low.

Keywords: Thermal Waters, Hydrogeochemistry, Reservoir Temperature, Stable Isotopes, Himalayas, Bihar

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