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Evolution of thermal springs in the West Coast geothermal province, India: evidence from hydrogeochemical and stable isotope studies

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India is home to numerous thermal springs (~340) confined within ten geothermal provinces. The occurrence of so many thermal springs is associated with the unique geotectonic evolutionary history of the Indian plate, making the Indian lithosphere considerably hotter, thinner, and more buoyant than the other shields. The present work deals with one of such low-enthalpy geothermal systems located along the western continental margin of India−the West Coast Geothermal Province (WCGP), which is located in Maharashtra and is comprised of nearly 60 thermal springs with a discharge temperature ranging from 39°C to 70°C. The springs mostly emerge from the contact between dykes and the Deccan Flood Basalt (DFB) that overlies the Precambrian basement.

A new survey was conducted around the thermal springs adopting a detailed geochemical and isotopic approach to provide an improved understanding of the functioning of the geothermal reservoir, the source of water, the reservoir temperature, the residence time, and the nature of the exchange and mixing of the fluid endmembers in the WCGP. The major ion chemistry indicated the involvement of seawater in the discharge of geothermal fluid. The seawater fraction in the thermal waters was estimated using a binary mixing model based on Cl and Br as two conservative tracers and an inverse modelling using PHREEQC code which indicated that the seawater fraction ranges from 1.7 to 14% and increases from south to north of the study area. The trace alkali (Li and Rb) and alkaline earth (Ba and Sr) contents indicated that the dissolution of Precambrian basement rocks underlying the Deccan basalt controls the geochemistry of the geothermal waters. The isotope-elevation relationship was investigated using $\delta^{18}O$ measurements, indicating that the geothermal system is fed by meteoric water at an elevation ranging from 200 to 550 m above mean sea level. The silica-based geothermometers predicted that the reservoir temperatures could be around 85-125°C. Finally, the ^{14}C activities in the thermal waters were also measured to estimate the residence time of geothermal, which is crucial for geothermal reservoir management and sustainable usage of this green energy resource.