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Hydrogeological environments and radon activities of saline geothermal hot spring sites located along eastern and western coastlines of southern Thailand

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ABSTRACT

Hydrogeological settings and natural radionuclides of saline geothermal fields along the coastlines of the Gulf of Thailand and Andaman Sea in Southern Thailand are currently not fully understood. Six saline geothermal springs have been discovered in Surat Thani Province (Southern Thailand's east coast); SR2, SR3, and SR7 sites; Krabi Province (Southern Thailand's west coast); KB2, KB3, and KB4 sites. Based on total dissolved solid contents, we divided the saline geothermal springs into three categories: a) slightly saline geothermal spring had only SR7 (1828 mg/L), b) moderately saline geothermal spring consisted of SR2 (10,196 mg/L) and KB3 (3448 mg/L), and c) very saline geothermal spring comprised SR3 (11,856 mg/L), KB2 (17,014 mg/L) and KB4 (18,070 mg/L). The major ions in the saline geothermal groundwater represent decreasing trends with the distance from the coastline. Stable isotope signatures ($\delta^{18}O$ and $\delta^{2}H$) relative to the VSMOW plotted in comparison with the global meteoric water line and local meteoric water line are presumably of meteoric origin and influenced by seawater/brackish water. However, the SR7 and KB3 sites indicated that the isotopic signatures were mainly recharged by rainwater. Significantly, the Na-K-Ca-Mg geothermometer can reasonably estimate the reservoir temperatures for the five saline geothermal springs to be in the range of 120 °C (KB3) to 169 °C (SR2). While the SR7, the silica-quartz geothermometer is proposed of approximately 115 °C. However, the silica-chalcedony and other cation geothermometers fail to estimate suitable reservoir temperatures. On the other hand, the radon concentrations in the saline geothermal groundwater along the Gulf of Thailand and Andaman Sea were assessed by RAD7-H_2O, which varied from 18.64 ± 0.96 kBq/m^3 (KB2; Andaman Sea side) to 8507.48 ± 1.06 kBq/m^3 (SR7; Gulf of Thailand side). A comparison of radon activity with the saltwater intrusion showed that the saline geothermal groundwater on the Gulf of Thailand side had higher levels than that at the Andaman Sea side. The deposition of Quaternary sediments combined with significant saltwater inflow enriched with radon resulted from the decay of uranium from both non-marine and coastal deposits related to granitic mountain weathering along the Gulf of Thailand. Radon concentrations in the geothermal groundwater were highly influenced by the local geological environment and coastal sediments.

1. Introduction

High-salinity geothermal springs are widely distributed in many coastal areas of the world's seas, such as, Holts Landing State Park (Delaware, USA), Sperchios basin (central Greece), and Wenquanzhen in the eastern Sichuan Basin, southwest China (Andrés et al., 2010; Duque et al., 2019; Duriez et al., 2008; Guo et al., 2018). In addition to beautiful beaches and islands, Thailand's southern region also has many popular tourist destinations, e.g., mountain ranges, mangrove forests, and natural hot springs. At least six saline geothermal spring attractions were discovered on the coastlands of the Gulf of Thailand and Andaman Sea, and at least two saline geothermal springs are the most visited in

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