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Regional structures influencing the groundwater geochemistry around geothermal springs: A case study from Padiyathalawa, Sri Lanka

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Hydro-geochemistry of groundwater plays an important role in understanding the characteristics of a geothermal system. Mixing zones of geothermal deep waters and shallow groundwater can be identified through chemical distribution maps and help identify geothermal flow paths. The flow paths can be used to calculate the chemical values of the geothermal water leading to a characterization of the heat source. In combination with knowledge about regional structures, the geochemical distribution can further reveal unknown geothermal zones.

In the present study, the geochemical distribution of the groundwater is studied from samples collected from shallow and deep wells, with special reference to the regional structures present in the terrain. The study area was selected as a 20 • 20 km area centered around the Padiyathalawa hot spring field in Sri Lanka. From the results, two main geochemical anomalous zones are identified, especially with the increased values of electrical conductivity (EC), total dissolved solids (TDS), and Sulphate distribution maps. Those two zones include the hot spring itself as well as an area in ~10 km distance in the NE direction from the hot spring. Both zones are characterized by crosscutting structures of dolerite dykes and shear zones. Due to the shear zones, there are deep-seated fractures facilitating water flow from deeper layers towards the surface. This uprising water mixes with the shallow groundwater, affecting the general geochemical values of the shallow groundwater system.

Common minerals in Dolerite in Sri Lanka are Pyroxenes, Feldspar, Ilmenite, Magnetite, and Pyrite with minor amounts of other minerals. The increased EC values in both before mentioned zones relate with higher amounts of iron due to dissolution and mixing processes in regions with fractured Dolerite. Similarly, the increased concentration of Sulphates in the groundwater can be related to Pyrite from the fractured Dolerite, as microbial oxidization of Pyrite leads to origin of Sulphates. The increase of TDS can be interpreted as shallow water mixing with deep geothermal water, which contains a higher amount of minerals from the fractured dolerites.

The similar geochemical anomalies in those two zones can be associated with cross-cutting Dolerite dikes and existing faults in the shear zones at greater depth, subsequently mixing uprising deep geothermal water with shallow groundwater. A similar geochemistry and tectonic setting suggest similar flow paths from the underground and therefore also similar geothermal conditions at both spots. However, due to the rural and remote region, only one of the two before mentioned areas is known as a hot spring field. Thermal signatures dissipate much more quickly in the shallow groundwater than the mineral composition and might not be significant for measurement. Geochemical signatures of groundwater can therefore be a substantial help to locate geothermal springs, identify source mechanisms and characterize fluid flow paths.