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Evolution Mechanism and Energy Potential of the Low to Medium Enthalpy Non-Volcanic Hot Springs of Odisha, India

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The non-renewable fuel resources are rapidly depleting with time, besides rising prices and uncertainty at a global scale. Therefore, sustainable energy resources such as Geothermal energy which is green, clean, and pollution free need to be explored. India has huge potential for geothermal energy such as those of Odisha thermal province, which is less explored compared to other thermal provinces of India. The current research is focused on understanding the origin, reservoir depth, temperature, and energy potential by using the integrated methods of geochemical, geophysical, and MCDM techniques.

Analysis of geochemical analysis of water samples indicates that the thermal water types are mostly Na-Cl, $NaHCO_3$, and Ca-HCO_3 of a short residence time as per studies. The mixing, weathering, or dissolution of rock is a dominant mechanism that influences the subsurface basement rock composition. The average reservoir temperature is found to be around 110±5°C, at depths of 1.37±0.32km, and fluid circulation depth of 1.41±0.32km. The geothermal water is heated due to radiogenic heat production by minerals such as U, Th, and K at basement depths, and water circulating through deep faults, and fractures present in the region. The Very low frequency (VLF-EM) geophysical data have been used to identify shallow subsurface faults and fractures through which water circulation takes place. A combination of subjective and objective multi-criteria decision models (MCDM) have been used, such as the Analytical Hierarchy Process (AHP), and Entropy methods for estimating the geothermal potential in the region. The eight major geothermal thematic parameters e.g. Heat Flow, Thermal Gradient, Curie Point Depth, Sediment Thickness, Crustal Thickness, Fault Density, Earthquake Density, and Lithology have been used to identify the geothermal potential in the region. As per our analysis, 40% of the study area shows high geothermal prospects. The results were validated using the receiver operating characteristic (ROC) curve, which demonstrates a favourable outcome evident by the area under the curve (AUC) of 0.682. The findings of this study could aid government agencies working in the renewable energy sector in harnessing potential alternative energy resources in the study area.