

Geothermal Potential Identification Based on Remote Sensing and Fault Fracture Density (FFD) Techniques, Western Arabian Plate (Al-Lith, Saudi Arabia)

Jawad Rafiq, Israa Abu-Mahfouz, Pantelis Soupios, Mohammed Idrees Farooqui

King Fahd University of Petroleum and Minerals (KFUPM)

Abstract

Along the Saudi Arabian coastal plains, the Al-Lith region is situated around 250 kilometers southeast of Jeddah. The research area has a 620 m elevation, lies on a tectonic plate border, and is severely dissected by wadis that flow into the Red Sea. The rugged mountains of the Arabian Shield surround the northern region, which is made up of mafic dikes, Tertiary sedimentary rocks, and Precambrian crystalline rocks. The area's southern half is primarily covered by a variety of Quaternary deposits. Wadi Al-Lith is one of Saudi Arabia's most attractive geothermal prospects for the development of renewable energy due to its proximity to various hot springs (Ain Al-Harrah hot spring is the nearest), volcanoes, and hot spots along this coastal region. However, due to the sparsity of recent surface geology and structural mapping and geophysical research, the structural and tectonic framework of the Al-Lith region remains little known. Therefore, by utilizing the latest remote sensing and GIS mapping techniques and software, this project aims to map fractures and lineaments and provide a Fault Fracture Density map displaying the surficial structural, geological features, and zones with high fault/fracture densities. Digital elevation models and Landsat-8 imagery were used to perform both automated and manual lineament analysis. The extracted lineaments density and orientation analysis were evaluated using a lineament density map and a rose diagram. Ten high-density zones were identified using fault fracture density (FFD) analysis, with the northernmost zone having the highest fault fracture density. The results also show a positive correlation between the dominant orientations of the extracted major lineament and the structural elements (faults, fractures, and folds). The resultant dataset will facilitate the understanding of the region's structural style, which ultimately allows future exploitation of particular resources, such as geothermal and mineral resources. Moreover, the fault fracture density data integrated with other geophysical measurements can be used as input data for estimating the expected permeability of the investigated geothermal field and its performance.