Geothermics 72 (2018) 145–155

Contents lists available at ScienceDirect

Geothermics

journal homepage: www.elsevier.com/locate/geothermics

Application of lineament density extracted from dual orbit of synthetic aperture radar (SAR) images to detecting fluids paths in the Wayang Windu geothermal field (West Java, Indonesia)

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ARTICLE INFO

Keywords:
Lineament
ALOS PALSAR image
Modified segment tracing algorithm
Ordinary kriging
Wayang Windu

ABSTRACT

Lineaments appearing on satellite images were used to characterize a regional fracture system. Manual extraction of lineaments is subjective and difficult to extend to a wide area because smaller lineaments may be overlooked. To increase the extraction accuracy of fracture-related lineaments and specify fractures that act as geothermal fluid paths with high permeability, this study adopts Synthetic Aperture Radar (SAR) data because the backscattering intensities of SAR images can enhance small topographical reliefs relevant to fractures by using oblique microwave irradiation. We used two Phased Array type L-band SAR (PALSAR) images from the Advanced Land Observing Satellite with opposing irradiation directions to reduce the effect of topographic distortion caused by the oblique irradiation. Lineaments are extracted using the modified Segment Tracing Algorithm filtered by the Laplacian of Gaussian for linear features enhancement and noise removal. Surface geothermal features at the Wayang Windu geothermal field, West Java, Indonesia, were confirmed by comparing with soil pH, magnetic susceptibility, and surface roughness measurements. The calculated lineament distribution was spatially characterized by the intersection, occurrence frequency, and length densities of the lineaments. An ordinary kriging map of the lineament length density using 1 × 1-km cells showed good agreement with the geothermal surface features (hydrothermally altered zones, mud pools, and hot springs), which were probably formed by highly permeable fractures and fluid ascent. The high-anomaly zones of length density overlapped two fluid ascent sites and three water recharge sites in the water- and steam-dominated geothermal systems, respectively.