Geophysical Research Abstracts
Vol. 16, EGU2014-5942, 2014
EGU General Assembly 2014

Remote Sensing Techniques as a Tool for Geothermal Exploration: the Case Study of Blawan Ijen, East Java

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The use of remote sensing techniques in the initial phase of geothermal surveys represents a very cost-effective tool, which can contribute to a successful exploration program. Remote sensing allows the analysis of large surfaces and can lead to a significant improvement of the identification of surface thermal anomalies, through the use of thermal infra red data (TIR), as well as of zones of widespread and recent faulting, which can reflect larger permeability of geological formations. Generally, the fractures analysis from remote sensing can be fundamental to clarify the structural setting of an area. In a regional volcanic framework, it can also help in defining the spatial and time evolution of the different volcanic apparatuses. This paper describes the main results of a remote sensing study, conducted in the Blawan-Ijen volcanic area (East Java), which is at present subject of geothermal exploration. This area is characterized by the presence of a 15 km wide caldera originated by a collapsed strato volcano. This event was followed by the emplacement of several peri-calderic and intra-calderic volcanoes, among which G. Raung, as testified by the frequent occurrence of shallow earthquakes and by H2S emission and sulfur deposition, and G. Kawah Ijen, occurring at the eastern rim of the caldera, are still active. The summit of G. Kawah Ijen volcano consists of two interlocking craters forming an E-W elongated depression filled up by a hyperacidic lake. Along the southern shore of the lake, a small rhyolitic dome occurs, which exhibits strong fumarolic activity with temperature of as much as 600 °C. We performed an analysis based on the combined interpretation of Landsat ETM+7, Aster and Synthetic Aperture Radar (SAR) images, focused on the identification of subsurface high permeability zones. The main trends of the linear features as derived from the fractures analysis, as well as their relation with the distribution of volcanic centres, were identified, singling out the variations of these trends as a function of the geographic location and age of volcanism. Moreover, the density of weighted linear features and nodal points were elaborated, in order to locate the zones where the effects of the fractures crossing could be more important. Two major belts of anomalously high density of linear fractures were identified: the first running E-W along the neo-volcanic axis and the second N-S in correspondence of the main structural features. The findings of this study, combined with the field observations about the position of thermal springs, allowed us to outline a zone that could be characterized by larger permeability and consequently could have hydrogeological and structural conditions suitable for the formation of an exploitable geothermal system.