Analysis of the thermal anomalies of faults and their relationship with geothermal resources using thermal data from Landsat 8

Case study: Shahdad and Nayband faults

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Date of receive:96.03.14 **Date of accept:96.12.20**

Extended Abstract

Introduction

Faults are fractures in the earth's crust that has the ability to move. Faults are one of the most important geological structures, and since they have paths for emersion of heat from the lower parts of the earth's crust to the surface, can be considered as one of the essential reasons of potential of geothermal energy. Geothermal energy is one of the major sources of renewable energy and compatible with the environment, which if properly utilized and bases on environmental parameters, can play an important role in the energy balance of the country and the goals of sustainable development. There are many methods that can be used to identify potential geothermal, one of which is remote sensing that is part of new technologies, and it is also cost-effective. Among the various methods of remote sensing for exploration of geothermal resources, thermal remote sensing has unique advantages. Thermal infrared remote sensing is an effective method to identify the Earth's surface temperature anomalies whose combination with the analysis of geological and understanding of geothermal mechanism, can be an appropriate approach for exploration of geothermal areas.

Materials and Methods

Data used in this study included images of Landsat-8, geological map of the region and the layer of active faults as well. Images were taken on February 2015, and the reason for selecting this time of year for image processing is to reduce the impacts of solar radiation on the earth's surface temperature and therefore less impact on the heat causes by faults. The study area of this research is the Shahdad county of Kerman city. Two faults of Shahdad and Nayband are in this region. In this research, the method of Single Chanel is used to retrieve the surface temperature. The software used in this study include ENVI5.3, ERDAS Imagine 2014, and ArcGIS 10.3. After the calculation of the Earth's surface temperature by Landsat 8, the thermal behavior of the faults was analyzed.

Results and discussion

In this part of the study, two transversal profiles with an approximate length of 12 km were taken for each one of

the faults, from the surface temperature map of the region. By examining the graphs of the temperature profiles, it was found that temperature changes along the profile increase with the approach to the location of the fault's surface outcrop. The heat accumulation along the Nayband fault corresponds to the closeness to the fault central zone, but this correspondence has been less for the Shahdad fault. Also, by creating a 6 kilometer buffer around the faults, it was observed that the average temperature of the pixels of this buffer is about two degrees higher than the average temperature of pixels of the entire region.

Conclusion

Investigating the possibility of instrumental use of the Landsat-8 satellite's analyzing capability of thermal data to determine the position of the fault based on the thermal anomalies created around the central zone of the faults in the present research showed that LST calculation from the aforementioned data is considered as an appropriate method for extracting the linear anomalies and tracking the possible fault zones. Also, the temperature processing on the areas surrounding the Shahdad fault and the southern part of the Nayband fault and the presence of the thermal aggregates associated with the aforementioned faults are considered as the land index areas. These thermal aggregates in transections created on the faults indicate that the amount of LST increases clearly with approaching the location of the central zone of the above-mentioned faults on the earth's surface. Linear thermal accumulations around the faults are the effects of the superficial and deep causes, so that sometimes the basement faults of the lava exit area have been the constituent of the surface lithology of an area at the time of the formation, which are younger and have less weathering and higher capacity for absorbing the sunlight, while approaching the central zone of the faults as the eruption openings of the volcanic rocks. On the other hand, due to the depth of the faults and their depth's access to the hot material forming the asthenosphere part beneath the earth's crust, the geothermal gradient in the central zones of these fault is higher than the surrounding areas. Considering the lack of introducing the volcanic rocks in the geologic map of the study area, it can be concluded that the linear thermal anomaly around the existing faults in the area is mainly associated with the deep heat sources and it is less likely to be associated with the absorption of the surface heat. Regarding the evident increase in temperature on the isothermal diagrams close to the central zone of the faults in the study area, two areas with the highest slope of increasing temperature along the central zone of the faults were identified and introduced as the possible geothermal potentials for more precise studies and future surveys. These two areas are located 45 kilometers southeast and about 15 kilometers northwest of the town of Shahdad.

Keywords: Thermal remote sensing, LST, Geothermal resource, Thermal anomalies, Shahdad fault, Nayband fault