Using Thermal Infrared Remote Sensing to Monitor and Explore Geothermal Activity

History of Thermal Infrared in Remote Sensing

The first use of thermal infrared remote sensing was by the Perry 1 glass plate camera in 1899 (Shaw 1942). The first satellite to have a thermal infrared sensor was the Landsat 1 in 1972 (Jensen 2007). Since then, thermal infrared has played a key role in technology, allowing us to monitor, measure, and accommodate this growth. Thermal infrared data has tremendous utility in tracking changes, as it relates to the Earth’s surface and sub-surface. This study uses data from various sources, including airborne and satellite images.

Thermal infrared energy is heat energy emitted from Earth’s surface. This heat is used for various applications, such as detecting surface temperature changes, monitoring geothermal features, and determining potential for electrical power production. This technology allows us to analyze, monitor, and accommodate this growth.

Uses of Thermal Infrared in Remote Sensing

- Monitoring geothermal surface feature temperature changes
- Prediction of future geothermal energy output
- Monitoring geothermal-related minerals for resource exploration
- Monitoring geothermal surface feature spatial extent

Case Study 1 – Remote Sensing of Geothermal-Related Minerals for Resource Exploration in Nevada

This study used primarily Landsat 8 data and radiometric correction to help detect land surface temperatures as shown in Figure 5. The study showed an increase in land surface temperature over the 4-month period of the study, indicating a productive future energy output. This study is an example of the application of thermal infrared remote sensing of mineral deposits.

Different reflectance curves due to properties of the minerals allows researchers to identify between types of minerals present in geothermal features, and therefore determine potential for electrical power production. This is a vital application of thermal infrared to remote sensing as our population is expanding with our primary energy sources all being non-renewable.

Case Study 2 – Identification of Geothermal Features with GIS and Remote Sensing in Delok Marawa, Indonesia

Indonesia is one of the leading countries for production of electrical energy through geothermal energy, which is sustainable, and environmentally friendly (energy intensity 3.7%). Of Indonesia’s national energy production, 3.7% is contributed by geothermal energy, which has become the focus of the study area, in which they used airborne data collection technology to monitor geothermal features, and therefore determine potential for electrical power production.

This study utilized remote sensing, both satellite and airborne data, to characterize mineral and thermal properties of surface geothermal features. The study showed a productive future energy output.

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Case Study 3 – Changes in Aerial Thermal Infrared Signature Over the Rotorua Geothermal Field, New Zealand: 1999-2014

This study examined changes in the thermal infrared surface features of Rotorua, NZ over time. This research was prompted by government induced management after a decline in geothermal output from one of the major commercial geothermal fields in the urban area surrounding the Rotorua Geothermal Field. Through monitoring the thermal infrared signature, we are able to monitor changes in the thermal output of the surface features over a 15 year time span, and not just changes in temperature against a baseline.

This study used an airborne FLIR 162B and 125 TIR cameras attached to a helicopter in 1999 to measure the thermal infrared signature of the geothermal features. The 1999 data was collected from the thermal infrared signature of the geothermal features.

Case Study 4 – Hydrothermal Monitoring in Yellowstone National Park using Airborne Thermal Infrared Remote Sensing

This study was conducted to monitor changes in spatial extent and spatial distribution of two geothermal systems, Mammoth Hot Springs (MH) and Norris Geyser Basin (NGB). One of the main issues that this study aimed to resolve is associated with the focus of the study area, in which they used airborne data collection technology to monitor geothermal features, and therefore determine potential for electrical power production.

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References


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