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Advanced InSAR techniques for the management and characterization of geothermal resources

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InSAR is a remote sensing tool that has applications in both geothermal exploitation and in the management of producing fields. The technique has developed rapidly in recent years and the most evolved algorithms, now capable of providing precise ground movement measurements with unprecedented spatial density over large areas, allow the monitoring of the effects of fluid injection and extraction on surface deformation and the detection of active faults.
Multi-interferogram approaches have been used at several geothermal sites in different stages of development. SqueeSAR™, which represents the latest breakthrough in InSAR technology, provides a significant increase in the spatial density of measurement points by exploiting signal returns from both point-like and distributed scatterers. Furthermore, recent satellite radar sensors have a higher spatial resolution (down to 1 m), as well as a higher temporal frequency of image acquisitions (down to a few days). The coupling of the new algorithm with this new generation of satellites provides a valuable tool for monitoring the different phases of geothermal production and in support of the decision making process.
Some examples from the US are presented here: the first case study involves the use of InSAR within a suite of tools for exploration of the San Emidio geothermal field in Nevada. This project aimed to develop geophysical techniques to identify and map large aperture fractures for the placement of new production/exploration wells. The second and third examples examine two zones in California: the Salton Sea area, where multi-interferogram InSAR provided an overview of surface deformation at a producing geothermal reservoir. Surface deformation in this area was complex, and the added detail provided insight into the interplay of tectonics and production activities. Additional InSAR studies have also been carried out at the Geysers field in order to evaluate the behavior of an Enhanced Geothermal System (EGS) in response to high rates of water injection, with a strong interest in researching induced seismicity and ground deformation. These studies, along with the continuing developments in radar satellite technology and in the field of InSAR, show considerable promise for the future monitoring of geothermal production facilities.