Detecting and Monitoring Geologic Hazards Using Remote Sensing Methods

Southwest Research Institute® (SwRI®) is developing and applying techniques using satellite radar and optical imagery to detect and monitor ground movements related to geologic hazards ranging from earthquakes to landslides. Recently developed interferometric synthetic aperture radar (InSAR) and multispectral data displacement analysis (MDDA) provide a fundamentally new method to study changes of the earth's surface.

InSAR Techniques

Conventional InSAR, differential interferometry (DInSAR), corner reflector InSAR (CRInSAR), and persistent scatterer interferometry (PSI) are different implementations of InSAR, each being useful in detecting, monitoring, and evaluating various geologic hazards.

Conventional InSAR and DInSAR techniques process the phase differences between image pairs for all backscattered signal data. PSI uses data only from high-reflectance objects (e.g., persistent scatterers) of dams, pipelines, buildings, highways, and exposed rocks.

CRInSAR complements DInSAR and PSI in situations where neither coherent natural targets nor persistent scatterers are available. The CRInSAR technique uses coherent radar targets such as rocks, man-made metal objects, or fabricated corner reflectors.

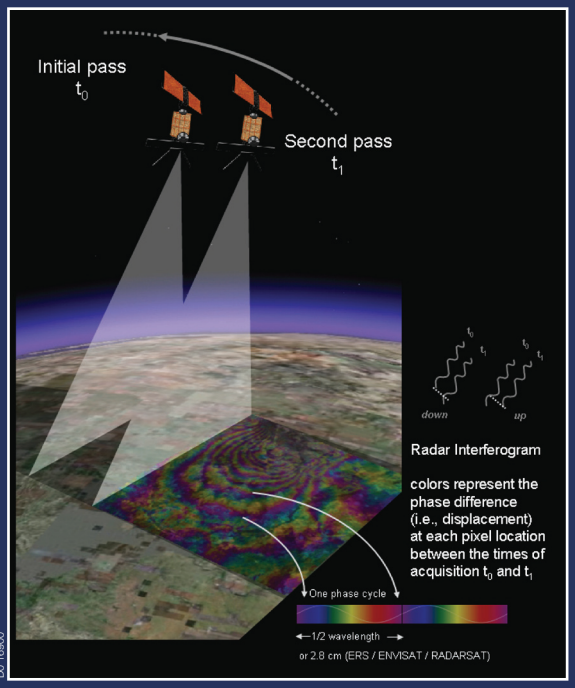
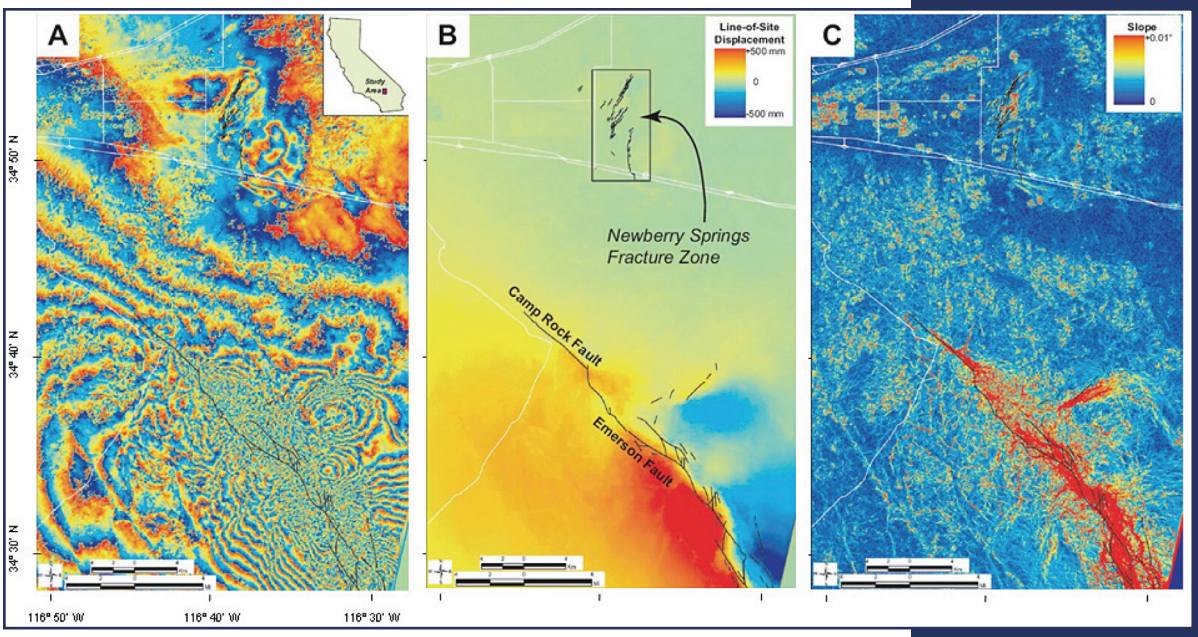
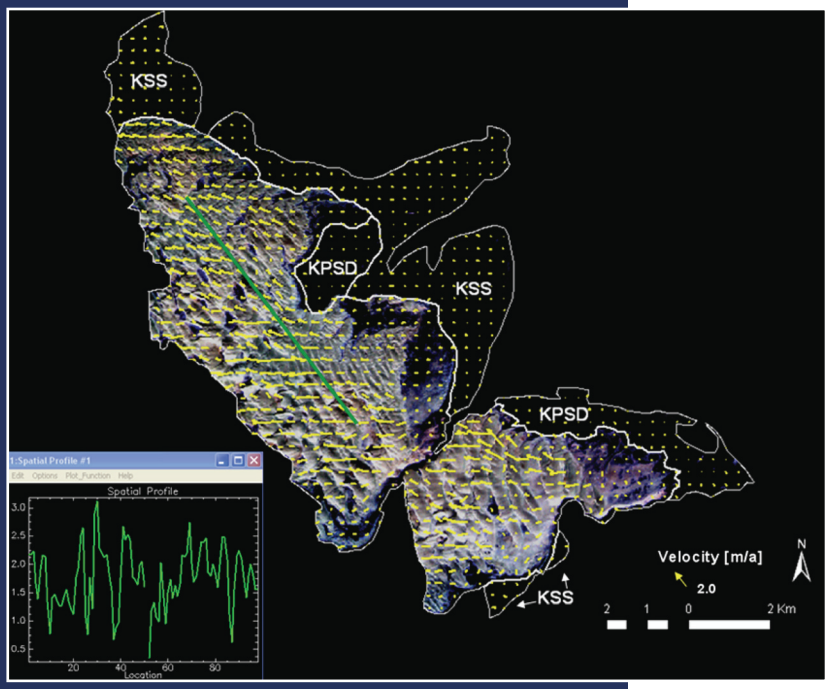


Illustration of concepts for detecting ground movements based on satellite interferometry.

Trihedral corner reflector.



Changes in land surface elevation after an earthquake detected with DInSAR. (a) Coseismic radar interferogram; (b) displacement map; (c) displacement gradient map for identification of fault ruptures.



Sand dune migration rates (vectors) superimposed on color composite image. Insert shows migration rate along green transect line averaging about 2 m/yr.

MDDA Technique

SwRI has developed methods for improving the detection of lateral movements of landscape features such as landslides, sand dunes, and glaciers by using precise orthorectification and correlation of optical aerial and satellite imagery. MDDA can detect lateral displacements as small as 0.5 m (1.6 ft) in landscape features represented by persistent patterns in optical and near-infrared satellite images.

Because MDDA reveals displacements in persistent optical patterns, it can detect and monitor landscape changes resulting from ground movements, as well as vegetation and land use changes.

Southwest Research Institute is an independent, nonprofit, applied engineering and physical sciences research and development organization using multidisciplinary approaches to problem solving. The Institute occupies 1,200 acres in San Antonio, Texas, and provides more than 2 million square feet of laboratories, test facilities, workshops and offices for more than 3,300 employees who perform contract work for industry and government clients.

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