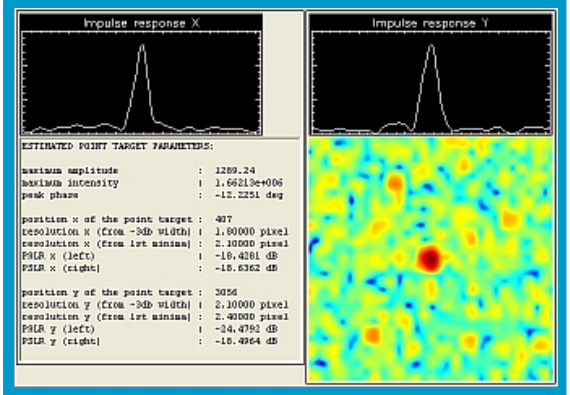
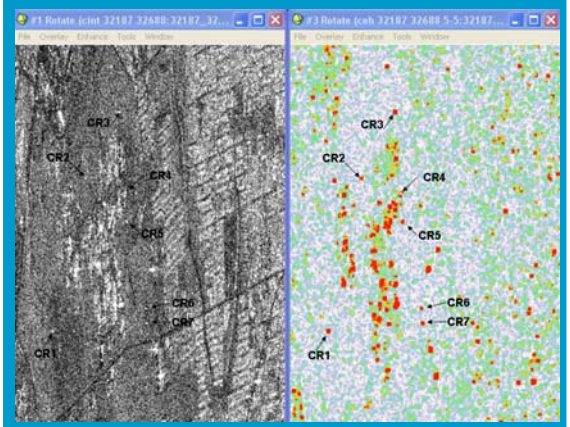
High-Resolution Synthetic Aperture Radar Interferometry Validation Using Corner Reflectors (CRInSAR)

Project Number:	20-R9791
Sponsor:	SwRI
Principal Investigators:	M. Necsoiu and M. Pilcher
Inclusive Dates:	2/2008 to 6/2008

Trihedral CR



Point target analysis—trihedral CR



CR positions identified on the magnitude channel of an interferogram (left) and coherence product (right)

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Project Brief

Statement of Problem: This project explored the possibility of developing a radar interferometry (InSAR) method using artificial permanent scatterers (i.e., corner reflectors or CR) that can measure ground displacement with a resolution less than 1 cm.

Approach and Accomplishments: Several CRs, in two different geometries, were designed and placed at locations on the SwRI campus, an ideal environment for such tests due to small to no rate of ground movement, existing infrastructures to mount the CR for easy access, and a vegetated environment. Controlled vertical movement was induced on two of them by raising the structures using 3/8-inch (0.9-cm)-thick aluminum plates.

ENVISAT ASAR C-Band satellite data were used in the InSAR analysis. The analysis of SAR imagery included (1) detection of CR response on SAR amplitude channel and (2) line-of-sight (LOS) displacement extraction from a radar interferogram produced by a pair of SAR images. Method validation was performed per interferogram by intercomparison of satellite-based measurements of "fixed" CRs as well as calculating displacement for those CRs that were raised a controlled distance.

Tested CRs enabled the phase changes caused by the artificial "ground motion" to be quantified. Their strong reflection suggested that displacements down to a few millimeters could be detected over short (and possibly long) time intervals. Regarding the design geometry, trihedral structures performed better than dihedral structures due to an increased mechanical stability and easier positional adjustment in the field.

The displacement measured via InSAR showed good agreement with field data, proving the potential of this method to provide very accurate measurements of ground movement.

Client Benefits: The results of this project can be applied to a variety of issues including detection and assessment of ground movements due to faults, landslides, and subsidence. It broadens SwRI expertise in the field of radar interferometry applied to natural hazards assessment and mitigation. If enough satellite data are available over areas where CRs are to be installed, persistent scatterer interferometry applications based on PSInSAR®, Interferometric Point Target Analysis (IPTA), Coherent Target Monitoring (CTM), or Stable Point Network (SPN) could be developed, which would increase long-term measurement accuracies to a few cm/year.