AlOS-PalSAR data for Geological Mapping and Landslide Monitoring

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ABSTRACT

Our investigation demonstrates the capabilities ALOS PALSAR images for geological mapping and landslide monitoring. In this paper we report on preliminary results of two test sites where current EO mapping and monitoring programs exist. Our results show that in vegetated mineral belts in Canada the ALOS images are providing the same information on litho-structural mapping as RADARSAT-1 images. ALOS PALSAR InSAR results show that we can observe deformation on both vegetated and exposed rock areas on the Frank Slide. This was not observed on RADARSAT InSAR results over the same time period.

Keywords: Geological mapping *InSAR,* rock avalanche.

1. GEOLOGICAL MAPPING

This investigation explores the utility of ALOS-PALSAR for geological mapping, in support of mineral exploration programs, in the Canadian Shield. Our test site focuses on the **Sudbury Basin,** a world class mineral belt of economic importance. The Sudbury Basin (250 km diameter) is centered on the Sudbury Igneous Complex, a tectonically-deformed Proterozoic impact structure with economic deposits of nickel, copper and gold. The basin is the result of a 10 km meteorite impact that occurred 1.85 billion years ago. The region has been used as a remote sensing super site for several years in joint Canadian-American investigations, and for a Lithroprobe transect. Data from these investigations, in combination with those from many geophysical and geological studies, provide an excellent example of the application of remote sensing to litho-structural mapping. The regional structure of the Sudbury area is described by Lowman (1994) and Singhroy et al. (1993, 1995, 1996), and only its main characteristics need be covered here. The exceptionally good structural rendition is due to several factors. The look direction is at a high angle to both the long axis of the Sudbury structure and the folds of the Southern Province to the south. Current SAR image shows not only structures such as dikes and faults but also topographically expressed lithology such as the Sudbury Igneous Complex.

Several publications by Singhroy 1996, Singhroy et al 1993, 1996, 2004, and Rivard at al 1994 and Lowman 1994 describe the use of SAR/Magnetics fusion techniques for geological mapping. Our current research in this mineral belt has shown that C-HV image provides the most information on the fracture systems. Given the positive early results of SAR polarimetric composites for geological mapping, an evaluation of the enhanced vegetation penetration capabilities of ALOS L band for improved litho-structural mapping in glaciated vegetated terrains in mineral belts is necessary.

Figure 1 shows a high resolution vertical gradient magnetic image fused with RADARSAT and ALOS PALSAR data of small portion of the Sudbury Basin. A detailed geological map published by Ames at al (2006) is included for interpretation. The associated rose diagrams show the distribution and orientation of the exposed structures, identified from both RADARSAT and ALOS images, respectively. Our results show that there is no significant difference between RADARSAT and ALOS PALSAR images for the identification of exposed geological structures and dykes, as well as lithological contacts and units in these vegetated mineral belts. The vegetation penetration capability of the ALOS L band did not add any new litho-structural information, not seen by RADARSAT.

2.LANDSLIDE MONITORING

Landslides have significant bearing on economic, engineering, environmental and land use projects. In Canada and the United States the direct and indirect cost of the damages caused by landslides is about US 2.2 billion dollars a year. Developing new remote sensing techniques to identify, characterize and monitor landslides motion will assist in current national landslide mitigation practices.

The **Frank Slide,** a 30 x 10^6 m^3 rockslide-avalanche of Paleozoic limestone, occurred in April 1903 on the east face of Turtle Mountain of southern Alberta, Canada. Seventy fatalities were recorded. This slide is still active. Several investigations have focused on monitoring and understanding post failure mechanism and mobility (Mei et al, 2007, Singhroy et al, 1998, 2004). Factors contributing to the slide have been identified as the geological structure of the mountain, subsidence from coal mining at the toe of the mountain, blast induced seismicity, above-average precipitation in years prior to the slide, and freeze-thaw cycles. In 2001, 6,000 tons of rock fell from the north slope of the Frank Slide which led to our InSAR investigation. The Government of Alberta has installed GPS stations and several in-situ instruments to monitor post-slide activity at specific locations. In this study, we

compare differential InSAR results from RADARSAT and ALOS PALSAR images over the near same time period during summer 2006. Our InSAR results for ALOS (July 12-Aug 27th/06) and for RADARSAT (June 15th- Aug 2nd /06) show that ALOS interferograms show more deformation on the upper rocky and vegetated slopes than RADARSAT. The RADARSAT InSAR results show that the slide is relatively stable except for a small area on the North Slope. The ALOS data show a larger area of rock deformation. This result is still being verified with in-situ monitoring networks from the Alberta Geological Survey. This preliminary findings that ALOS PALSAR data show deformation not only on the exposed rocky surfaces but also on the vegetated South Peak. This is particularly interesting since the South Peak is extensively monitored and does show gradual motion. Another possible explanation is that the deformation seen on ALOS interferofram (Figure2) occurs after the RADARSAT acquisition(i.e. Aug 3rd- 27th/06). In addition, both RADARSAT and ALOS InSAR results show opposite deformation on the northern area of the slide. This is not clearly understood at this time.

3.CONCLUSION

Our results show that in vegetated mineral belts in Canada the ALOS (L-HH) images are providing the same litho-structural information as RADARSAT-1 (C-HH) images. The ALOS PALSAR InSAR results show deformation on rock and vegetated slopes on the Frank Slide. This was not observed on RADARSAT InSAR results over the same time period. The accuracy of these findings are currently being investigated

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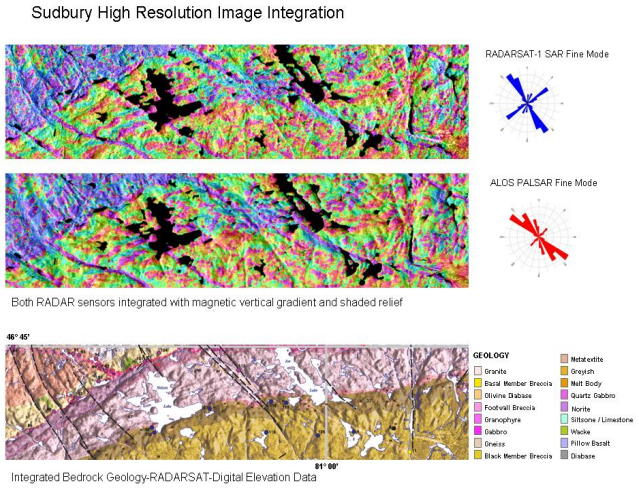

Figure 1:

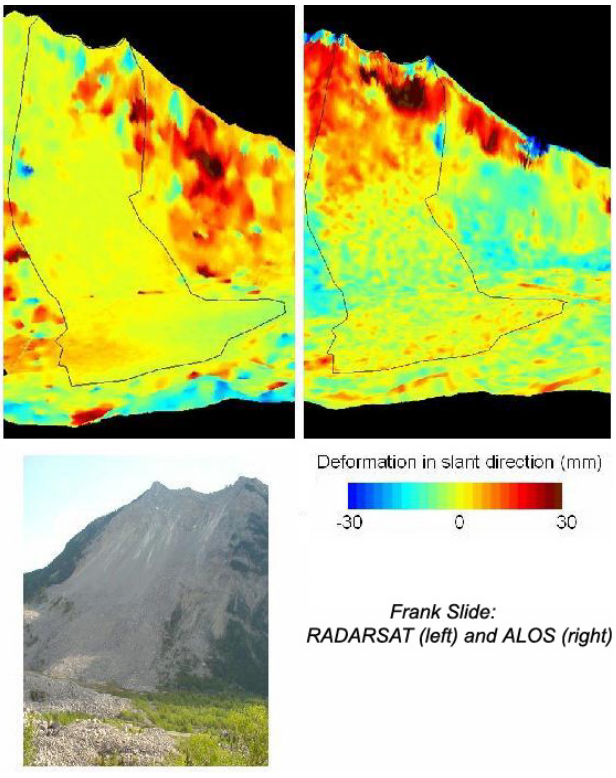

Figure 2: