Marking the progress of remote sensing

Workshop Report

Andreas Laake, Michele Vellico, and Fabio Rocca report on EAGE Vienna Workshop 7 on 'High Resolution Remote Sensing Observations: Radar, Lidar, and Multispectral Techniques'.

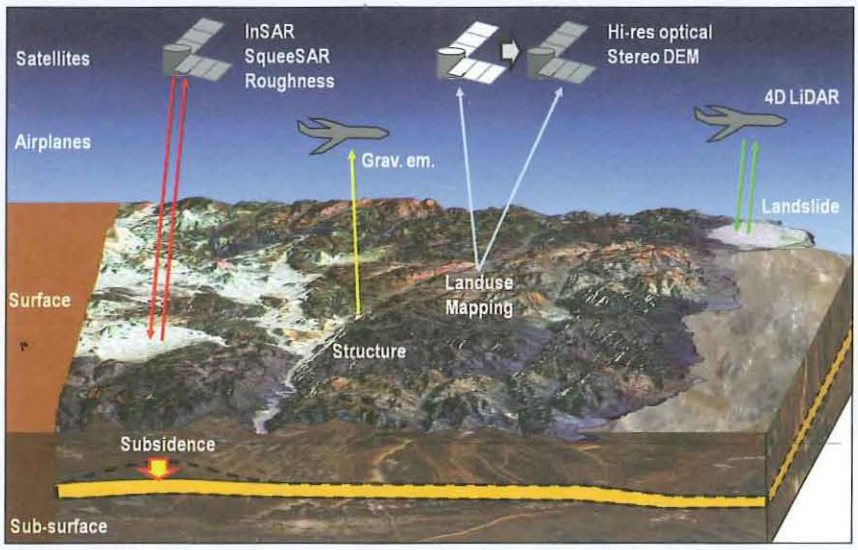

Figure 1 Overview of technology covered by the workshop.

The last EAGE workshop dedicated to remote sensing was held in Rome in 2008. Since then, the rapid development in satellite imaging and airborne laser and imaging sensors has broadened the possibilities for applications in the oil and gas industry. New technologies using widely available high resolution images both in the optical and the radar domain have been developed. In addition, highly detailed digital terrain models are being made available by the use of the new LiDAR sensors. New ways of calibrating remote sensing data with the scope of generating real geological and structural models are possible. Multi-temporal images allow the generation of time-lapse images, which provide information about the dynamic behaviour of the surface and subsurface. The scope has also broadened from dry arid deserts, which were the prime topic in the first workshop, to global challenges in arctic or humid climatic zones.

Satellites

A short overview of the status of available satellite imagery is shown in Table 1.

Surface morphology and geological structure

Digital elevation models computed from high resolution stereo optical satellite imagery now achieve 50 cm vertical and lateral resolution. This improvement was made possible by improved processing of the imagery data using an adaptation of seismic processing. Present work horses for this application are the WorldView and GeoEye satellites. Radar data also provide measurements of the surface roughness or rugosity. Macro-scale rugosity maps average slope for logistic applications and organization strength for lithological applications. Micro-rugosity mapping is applied in road characterization.

Multi-temporal radar and LiDAR

Multi-temporal synthetic aperture radar (SAR) has further penetrated the hydrocarbon sector. Most frequently used satellites are the TerraSAR-X and COSMO-SkyMed satellite constellations as well as ENVISAT. Examples of reservoir monitoring for shallow heavy oil in Canada and CH4 and CO2 monitoring in Algeria have been completed successfully. The use of permanent scatterers improves the vertical accuracy of subsidence measurements. A new method SqueeSAR was presented

Satellite	Type of data	Status	Data
New satellites:			
Landsat	Multi-spectral optical	2012 next launch	Archive available for free
WorldView-2	Visible optical	active	50 cm DEM and imagery
GeoEye-1	Visible optical	active	50 cm DEM and imagery
TerraSAR-X	X-band radar	tandem active	1 m res., 11 days revisit
RADARSAT-2	C-band radar	active	3 m res.
COSMO-SkyMed	X-band radar	active (x4)	Focus on Mediterranean Sea
Sentinel	C-band radar	2013 launch	
Retired satellites:			
ALOS Palsar	L-band radar	retired	Worldwide archive available
Envisat	C-band radar	retired	Worldwide archive available

Table 1 Status of satellites since last workshop.

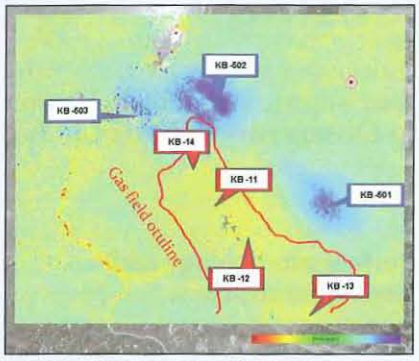

Figure 2 Example for subsidence map produced from SqueeSAR.

which employs a multi-interferometric approach using time series of deformations rather than interferograms of image pairs as previously done.

Multi-temporal LiDAR has advanced through the combination of airborne LiDAR and ground-based wireless sensors to assist landslide monitoring. Base maps of rugged terrain with high terrain stress and high tendency to movement are prepared to identify high risk areas. The maps are calibrated with airborne hyperspectral data.

Integration and cross-validation

Airborne gravity gradiometry provides a technique which reduces the impact of the platform movement and accelerations on the gravity data. The gradient of the gravity field is measured as a 3D field tensor. The BlueCube concept was presented. This is a database comprising gravity gradiometry and magnetic field data combined with LiDAR elevation measurements. The integration of interpreted satellite imagery with surface seismic data allows the geological mapping of the shallow subsurface for lithological boundaries and fracture zones. The interpretation of satellite imagery also allows the generation of feature templates from braided rivers which are used for the detection of geobodies in subsurface seismic data.

Summary of workshop

Altogether 11 papers covered the following aspects of remote sensing:

- Developments in the fields of activity covered in the first workshop to provide an update in the established techniques like mapping of geology and structure for infrastructure and logistic planning.
- High resolution mapping from satellite radar and multispectral data as well as airborne hyperspectral, radar and LiDAR for high resolution geological and structural mapping
- Multi-temporal radar and LiDAR mapping for dynamic mapping of the earth surface with applications in geotechnical and hydrocarbon projects
- Integration with gravity data derived from satellite imagery for basin mapping in exploration concessions
- Cross-validation and integration with ground based geophysical data for propagation of geological and structural delineation from the surface into the subsurface

The workshop was attended by 30 participants from the oil companies and contractors, satellite data and service providers as well as from academia.

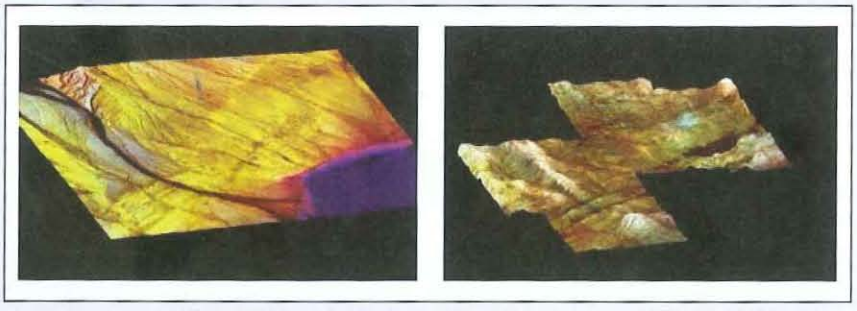

Figure 3 Integration of interpreted satellite imagery (left) with ground base seismic data (right).