TU Clausthal
Clausthal University of Technology

Michael Schäfer, Diana Walter, and Wolfgang Busch
Institute of Geotechnical Engineering and Mine Surveying

DInSAR Ground Movement Monitoring in the Rural Environment of an Open Pit Mining Area

Area of investigation

The area of interest is situated in Germany, south the city of Leipzig. In this area active and decommissioned lignite open pit mining sites lie in a spatially close neighbourhood. This can cause uplifts and subsidence due to ground water level changes.

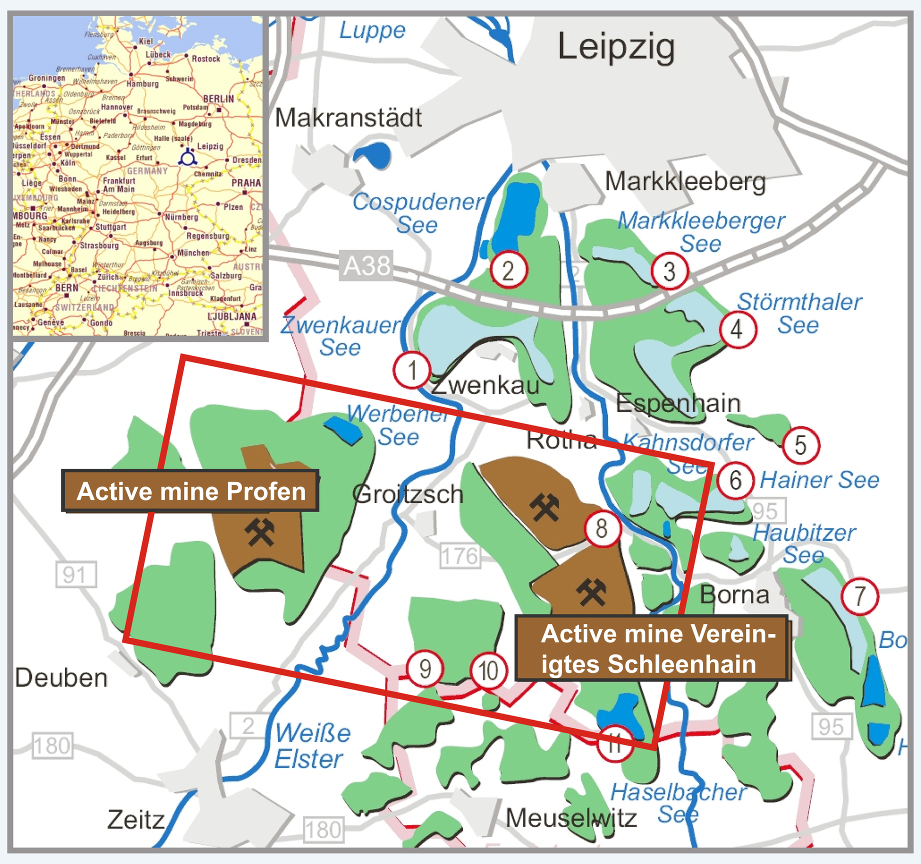

Fig. 1: Area of interest with active (brown) and decommissioned mining sites (green). Red box shows extent of Fig. 4. Source: www.lmbv.de

Corner Reflectors

In the area of interest twelve Corner Reflectors (CR) have been installed for deformation measurments and georeferencing of the SAR data. These Reflectors were built by IGMC using an optimum pentagonal panel design described by SARABANDI & CHIU (1996).

Fig. 2: Pentagonal Corner Reflector made of aluminium at the edge of an open pit mine.

This CR design was preferred because it offers a lighter construction with 33% smaller panels while giving the same intensity response (RCS) as a normal trihedral CR. Additional it causes less interaction with reflected waves by the surrounding terrain.

Data processing

Currently the processing is restrained to DInSAR processing using Software by Gamma Remote Sensing. Use of a Persistant Scatterer approach (IPTA module) is planned for the near future.

Correction for unwanted phase contributions

Main problems for an automated interferometric analysis of ground deformation are phase offsets due to small orbit errors or mainly due to atmospheric path delays.

Orbit errors can be strongly reduced by using precise state vectors from TU Delft instead of DORIS data.

For atmospheric phase contributions an IDL program has been developed which computes an average phase value within a big sized circle shaped moving window (ca. 10 km diameter). Fig. 3 shows an example for this phase correction.

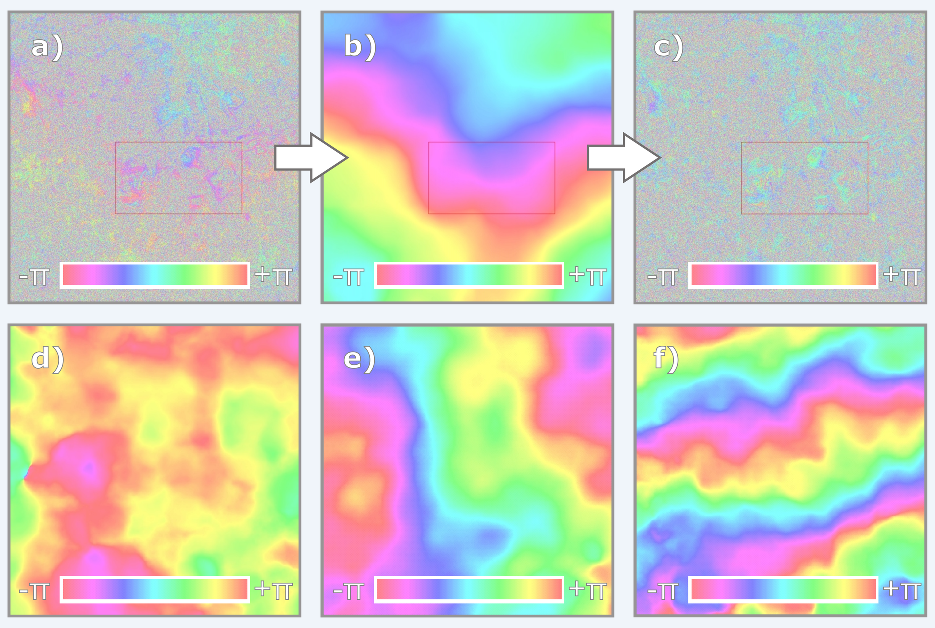

Fig. 3: The result of the computation (b) is subtracted from the original phase (a), resulting in the corrected phase image (c) in which phase values of zero (colour cyan) show areas of no deformation. Additional images (d) to (f) show examples of phase correction images for three different interferograms (all 100 x 100 km^2).

The correction images (Fig. 3 b & d-f) possess high analogy with atmospheric phenomenons. Also residual orbit trends can occur. The corrected phase images allow direct comparison and combination of divers interferograms. One residual problem is that spatially large surface deformations (extent over 10 km) can't be differentiated between atmospheric effects at the moment. This could be solved by stacking of interferograms in future.

Preliminary results

The area of interest shows quite good interferometric coherence in respect of vegetation conditions in Central Europe, particulary in open pit mine areas. However many planes used for agriculture and forestry most times show no coherence (cf. Fig. 4).

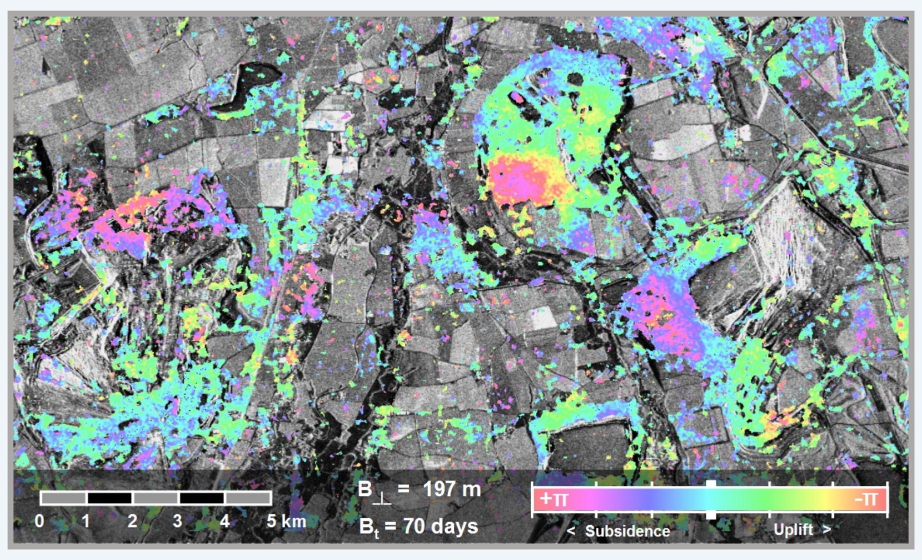

Fig. 4: Interferogram (corrected) with temporal Baseline of 70 days, masked for regions with coherence > 0.35 % (one colour cycle = 3 cm).

The observed deformation rates are very small and most likely for seasonal reasons. The comparison with reference data measured every two years is a difficult task. Fig. 5 shows some example charts obtained directly from differential interferograms.

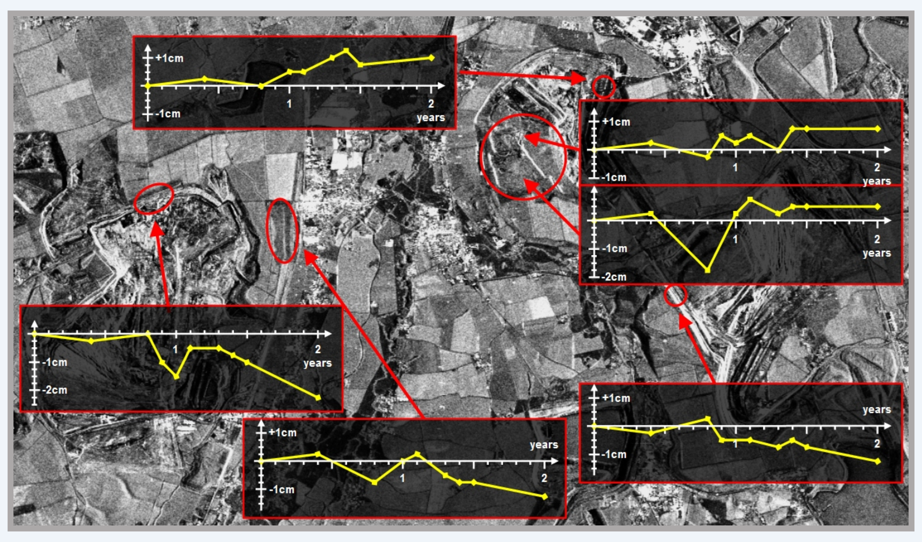

Fig. 5: Deformation charts for selected areas.

Acknowledgment

This research project is financed by AiF/German Federal Ministry of Economics and Technology.

The used SAR data was partially provided by the European Space Agency through Cat-1 P 3085.

References

SARABANDI, K. & CHIU, T.-C. (1996): Optimum Corner Reflectors Design. – Proc. IEEE National Radar Conference, Ann Arbor.

Contact address:
Dipl.-Geol. Michael Schäfer
michael.schaefer@tu-clausthal.de

Institute of Geotechnical Eng.
and Mine Surveying (IGMC),
Clausthal University of Technology
Erzstrasse 18
D-38678 Clausthal-Z., Germany

More information: http://www.igmc.tu-clausthal.de/sar