First results and problems of interferometric processing

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The main purpose of this project is testing the conventional radar interferometry in an area of nothern Bohemia. Very strict criteria were applied to data selection, therefore only two deformation pairs are available. One of them is from a different track, so it is incompatible with the other deformation pair and tandem pair, which serves for deriving topografic information. As mentioned in previous reports, data were originally available in "raw format". There is no information about magnitude and phase of scatterer in this format but only information about intensity and phase of the pulses received by radar antenna with regard to the position on satellite orbit. Transformation from this kind of data to slant range complex format requires signal processing provided by SAR processor. There is no SAR processor publicly available, and data were converted to SLC format with the use of a package by Evely J. Price, installed at TU Delft.

All datasets were transformed to the SLC format and two interferograms and maps of coherence were generated. From the tandem pair (dated March 7-8, 1999), the digital elevation model was generated, too. Our area of interest shows quite good conditions in coherence point of view, and also generated digital elevation model looks good in general. Elevation models generated with this method are unfortunately influenced by errors and gaps caused by shadows, foreshortening and decorrelation. Other problems of this model are propagated orbit errors and also signal noise. For example, these inaccuracies cause the digital elevation model to fall approx. 300 m below sea level in our area of interest. Before using this model for a different purpose than interferometric processing, it needs to be adjusted according to external information, filtered and smoothed. Figures 1 and 2 show the fringes on the tandem interferogram and perspective view of area of interest: abandoned open brown coal mine Chabařovice.

The other interferogram was generated from the scenes of March 8, 1999 (master) and December 28, 1998 (slave). Coherence is worse here, caused by temporal decorrelation. Differential interferogram was also generated (with the use of previously noted tandem interferogram) and is shown in figure 3. After subtracting the phase of the tandem interferogram, phase contains only deformations (landslides) and errors (unwrapping errors, athmospheric influence, orbit errors etc.). Even though the area is largely covered with vegetation and conventional interferometry often fails in such conditions, in our results about 50% of the cropped area shows at least some coherence. However, interpretation of the results is difficult. Unfortunately, our area of interest is almost fully decorrelated in this interferogram (although the correlation is quite good in the tandem interferogram) and our attempts to improve the correlation in this area at the cost of decorrelation in other areas were unsuccessful. One of the possible reasons is the direction of the land-

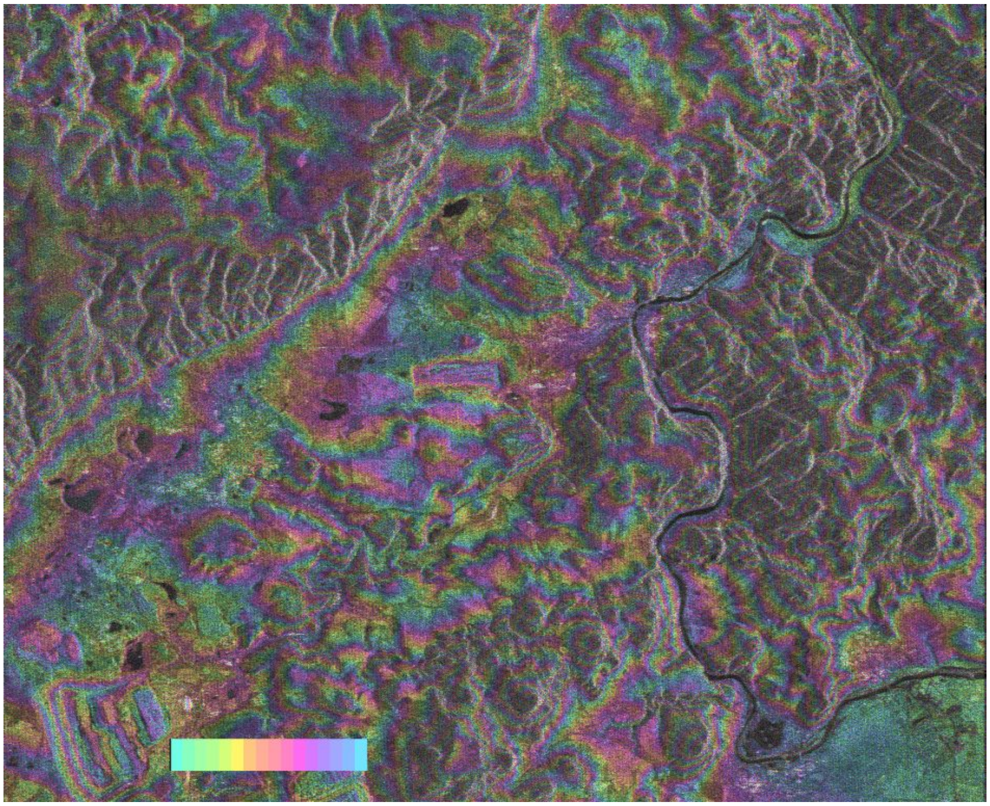

Figure 1: Tandem interferogram with the flat earth phase subtracted (phase mixed with magnitude)

slide; the slope is approximately parallel to the satellite track, i.e. the projection of the landslides to the slant range are minor. We are now waiting for the data measured by other methods to validate it.

In figure 3, there are also other areas suspected of deformation (in the ”right” direction) but these areas cannot be validated by other methods.

We also tried to generate an interferogram from the last two datasets, dated November 13, 2002, and February 26, 2003. Our attempts were unsuccessful so far, probably due to the fine coregistration algorithm. In the future work, we'd like to perform a radiometric correction before processing and thorougly review correlation vectors.

Subsequent work shall focus on improving results using different algorithms. First, instead of the tandem interferogram, external DEM (SRTM-3) will be used. We will also try to perform some adjustment of observations based on ground control points (GCPs).

Also, in cooperation with Delft Institute for Earth-Oriented Space Research in TU Delft, a new algorithm for fine coregistration is being developed. This algorithm uses a DEM for estimating fine coregistration vectors changes from satellite configuration. First results of vector changes can be seen in Figure 4. It is just a 2D profile corresponding approximately to one master line. But, there are still many approximations there. But at the time when all problems are fixed, and results show a relevant influence, it can be implemented into the fine coregistration algorithm.

Tandem pair configuration is described in table 1, the other pair configuration is described in Table 2.

We can see that in our conditions with quite small baseline the influence of DEM on the deformations is minor (y-axis is the vector length in pixels). But when we use the permanent scatterers technique or high correlated areas, and also in the case of larger baselines and in more mountainous areas, the influence is more significant. Fine coregis-

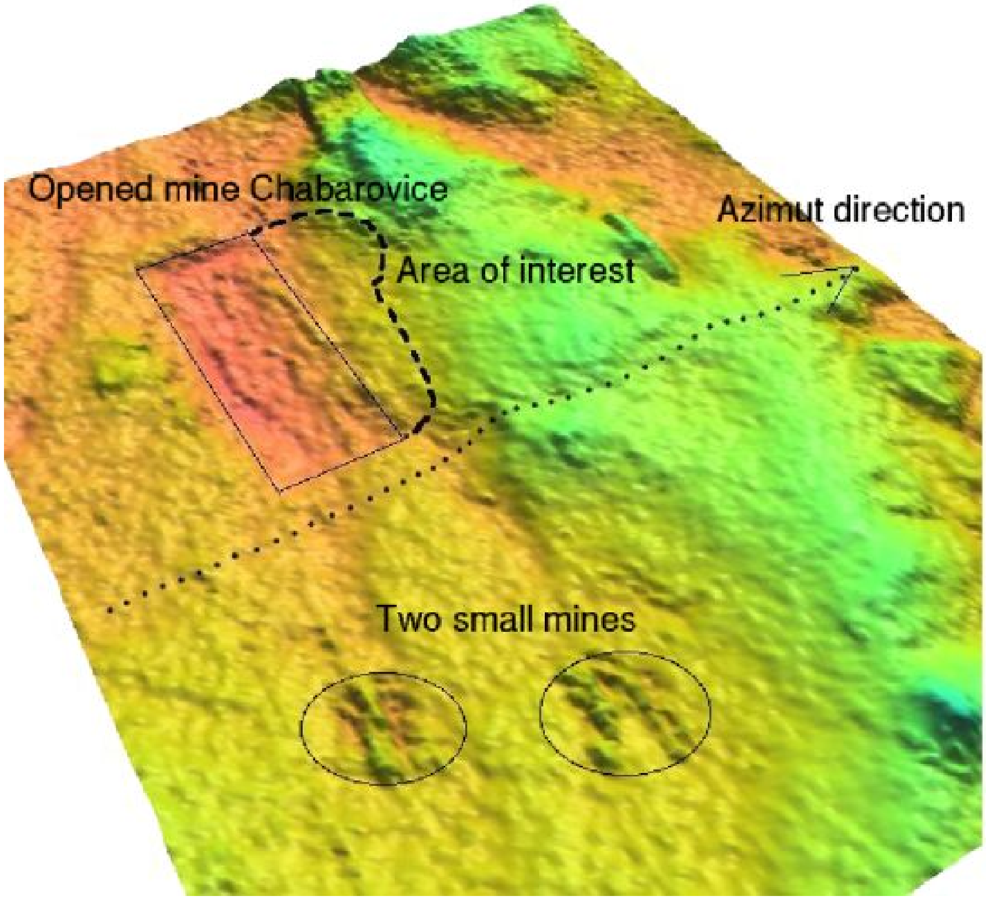

Figure 2: A perspective view of the coal mine and surrounding area (DEM generated using the tandem interferogram, interpolated to 1m resolution)

tration should reach the precision of 1/10 pixel.

Software used:

DORIS - Delft Object Oriented Radar Interferometric Software
SAR processor created by Evely J.Price, Scripps Institution of Oceanography
ERS baseline - David T. Sandwell
Getorb - program for reading Orbit Data Records developed in DUT/DEOS
SNAPHU - Statistical-Cost, Network-Flow Algorithm for Phase Unwrapping

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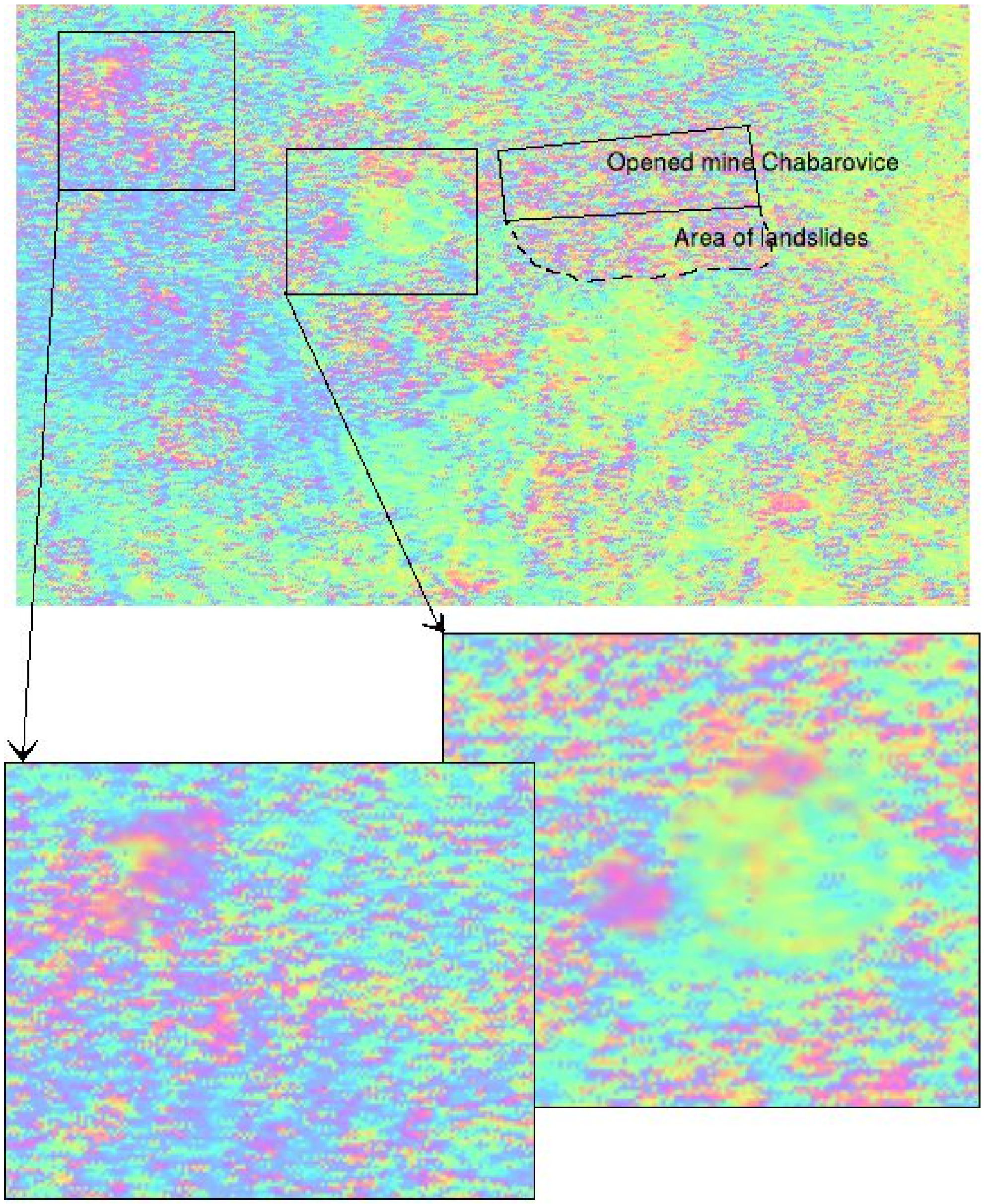

Figure 3: The differential interferogram of the area. The area of interest is almost fully decorrelated, some other areas suspected of landslides are shown in detail.

B_{perp}	$[m]$	-110	perpendicular baseline
B_{par}	$[m]$	-48.6	parallel baseline
B_h	$[m]$	-119.7	horizontal baseline
B_v	$[m]$	11.4	vertical baseline
B	$[m]$	120.3	baseline
α	$[deg]$	174.5	baseline orientation
θ	$[deg]$	18.4	look angle
θ_{inc}	$[deg]$	20.8	incidence angle

Table 1: Tandem pair configuration. Parameters obtained from DEOS, small inaccuracies are possible.

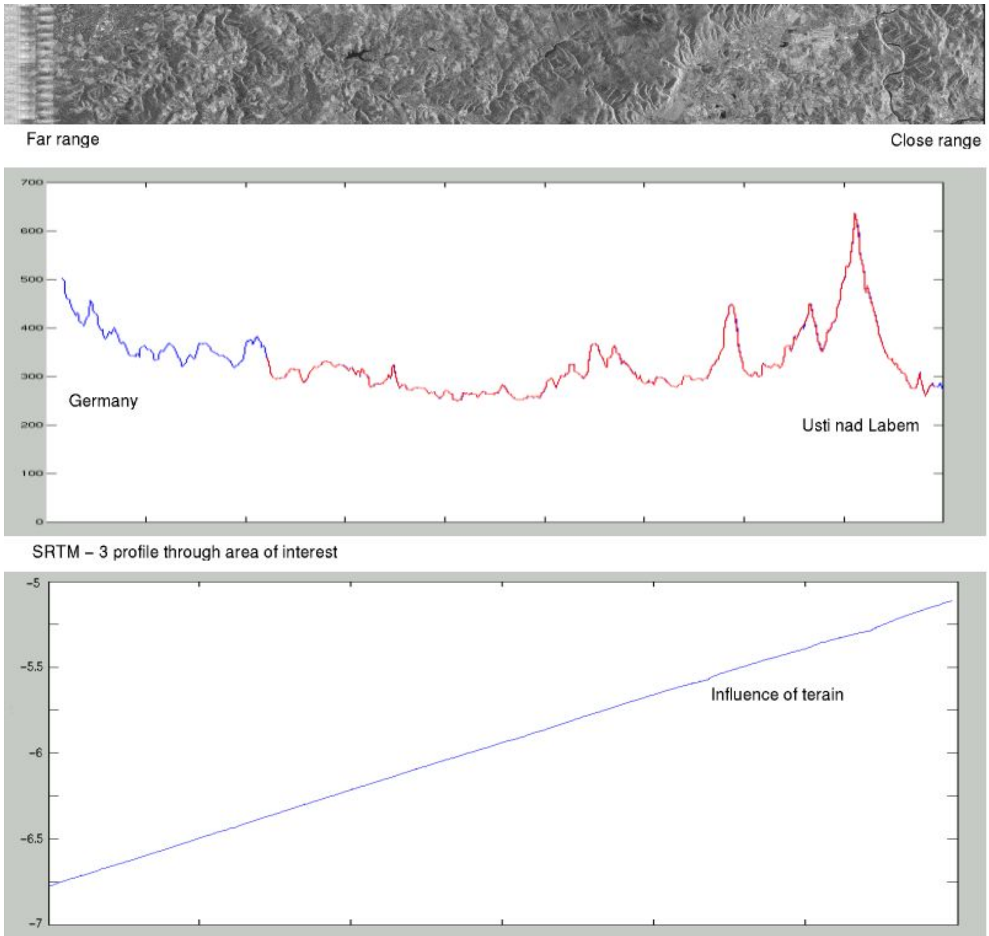

Figure 4: Part of the master image (the profile acquired in it), profile itself (the influence of the DEM on the deformations is computed in the red part (range length of 3000 pixels), the influence of the DEM on deformations.

B_{perp}	$[m]$	98.3	perpendicular baseline
B_{par}	$[m]$	9.3	parallel baseline
B_h	$[m]$	96.1	horizontal baseline
B_v	$[m]$	22.5	vertical baseline
B	$[m]$	98.7	baseline
α	$[deg]$	13.2	baseline orientation
θ	$[deg]$	18.6	look angle
θ_{inc}	$[deg]$	21.0	incidence angle

Table 2: Interferogram of Dec 1998 and March 1999 configuration. Parameters obtained from DEOS, small inaccuracies are possible.