Detection of Subsidences and Landslides in the North-Bohemian Coal Basin by the InSAR Method

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1 GENERAL INFORMATION

This is the first InSAR project processed by the team and also the first project investigating the northern Bohemia brown coal basin. Five ERS-1/2 scenes were selected, all of them acquired in winter season in order to make the coherence as high as possible. Unfortunately, two of them were acquired during the ERS-2 gyroscop problem, causing that they do not generate a coherent interferogram.

Therefore, only two scene pairs were processed with common master: tandem pair acquired on March 7, 1999 (ERS-1) and March 8, 1999 (ERS-2; master); the deformation contains the March 8, 1999 scene (master) and scene acquired on December 28, 1998 (ERS-2). The temporal baseline is 70 days, the perpendicular baseline of the tandem pair is 108 m, the perpendicular baseline of the deformation pair is 98 m. The third pair (with perp. bas. of 16 m), was processed as well, showing no additional information.

2 AREA CHARACTERISTICS

SAR Interferometry is used in this project in order to investigate the Earth-crust deformations caused by mining of coal and other minerals. The area has been exploited since the 15^{th} century using different techniques, of which the oldest ones were the most dangerous, causing squeezes and fires. A large part of the coal basin has been exploited by open mining, but in the central part, where the coal is deposited deeper, there are many deep mines as well.

While we can expect landslides in the reclaimed open-mined areas, which are often covered by vegetation (causing the coherence to be low), the deep mines are often situated in built-up areas, causing smaller subsidences in areas where higher coherence values are expected. In addition, it is much more important to investigate Earth-crust deformations in the built-up areas.

However, we are not able to confirm that the phase change in an area are caused by Earth-crust deformation, considering only one deformation pair available. The phase change may also be caused by soil moisture changes or other seasonal effects. We can therefore only point out some areas suspicious of deformations.

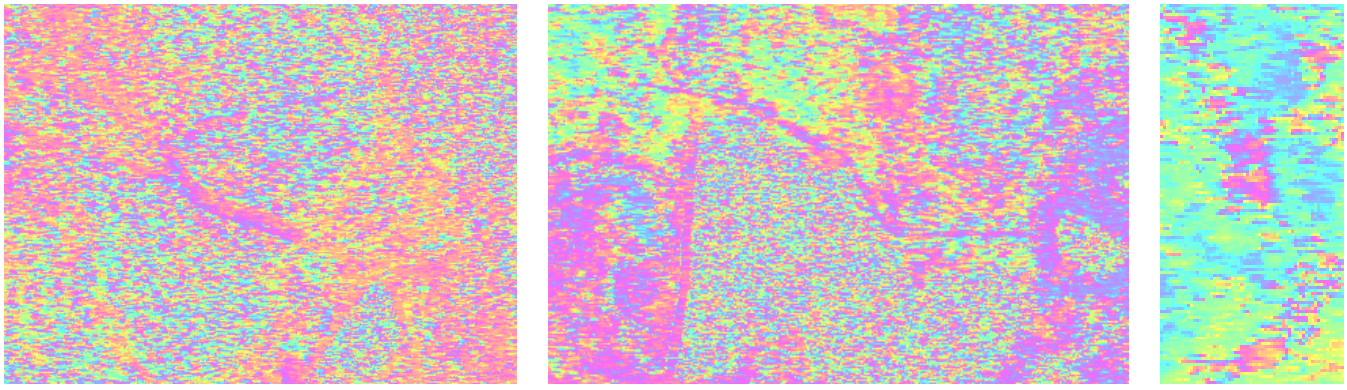
Diploma thesis [1] compares the areas pointed out by radar interferometry with other sources of data: geological maps, mining maps, terrain slope data.

Areas suspicious of deformations (subsidences, landslides) are following:

1. **The Ervěnice corridor, Třebušice village**: the road no. 13/E442 between the Jirkov and Most cities, along with a railroad and a pipeline, is partly situated on the waste mine dump. Here, the deformations are confirmed by an informal conversation with agents of the Mostecká uhelná společnost, although the deformation heaviness was not discussed. We consider the phase change in this area to be really caused by Earth-crust deformations. Near the Třebušice village a geological rupture is situated.
2. **The northern border of the Nechranice dam**: this area is being reclaimed and contains a geological rupture at its border.
3. **The surroundings of the Břvany village**: a geological rupture is situated in this area, a deep mine is situated not far from this area. The area is used for agricultural purposes.
4. **The Tušimice power station**: the area is situated at the border of an open mine and contains ash dump, not far away from the reclaimed area (2).
5. **Several smaller areas south-eastern from the Krupka town, together with the south-eastern part of Krupka**: there are several small deep mines in this area.
6. **The Řehlovice village**: there is a deep mine north of the village.
7. **The Zabrušany village**: there is a small open mine near the village.
8. **Villages Církvice, Libochovany, Řepnice (the right bank of the Labe river)**: geological rupture, Geofond ČR registers landslides in this area.

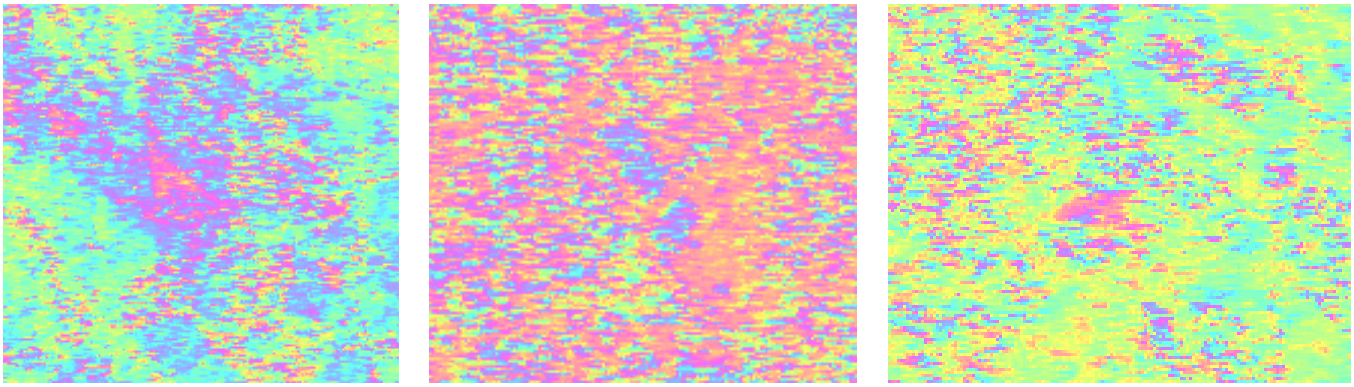
9. **An area east of Bílina town, open mine Maxim Gorkij, waste dump Jirásek**: the area is reclaimed.
10. **North-western border of the Bílina town**: there are open mines and power station in the surroundings.
11. **The Hrobčice village**: Geofond ČR registers landslides in this area.

The interferogram crops of these areas are shown in figures 1 to 3.



Area 1 Areas 2 and 4 Area 7

Figure 1: Interferograms of suspicious areas 1, 2, 4 and 7



Area 3 Area 5 Area 6

Figure 2: Interferograms of suspicious areas 3, 5 and 7

3 TIMING ERRORS OF THE DATA

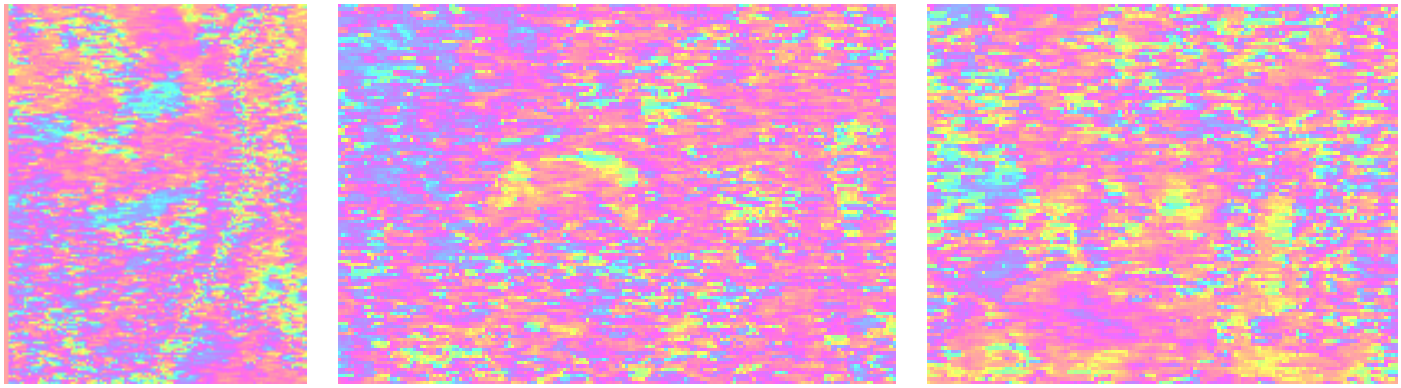
Although the data were processed with DEOS precise orbits, the interferograms originally contained more than two residual fringes after DEM subtraction. In addition, the geocoded scene was shifted with regard to reality by approx. 4 km in the azimuth direction and almost 2 km in the range direction.

Both of these influences were corrected by timing adjustment of the data: the azimuth-timing error was approx. 0.5 s, the range timing error was approx. 4.5 μs.

4 CONCLUSIONS

There are many more areas suspicious of Earth-crust deformation in the northern Bohemia brown coal basin. The deformation can be expected almost everywhere. In addition, it is not possible to judge whether a deformation really occured in a suspicous area from only three SAR scenes. However, some of the suspicious areas correspond to reclaimed areas. Due to a short temporal baseline, we are not able to find out slow subsidences which we can expect in built-up areas, except for the Ervěnice corridor, which is extremely unstable.

The coherence of the interferograms is considered to be high enough.



Area 8 Areas 9 and 10 Area 11

Figure 3: Interferograms of suspicious areas 8 to 11

5 FUTURE WORK

The new project is focused on repeat-pass interferometry, 53 scenes are to be processed from two orbits. The data selection was now performed with the goal to obtain as many scenes as possible, without respect to season or weather. The pairs with longer temporal baseline are hoped to provide some information about subsidences in built-up areas.

6 ACKNOWLEDGEMENT

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References

Michovský, P. : Vyhodnocení území podezřelých z poklesů určených metodou interferometrie, Diploma Thesis, December 2005 (in Czech)