Multi-temporal SAR Monitoring: exploiting both amplitude and phase information

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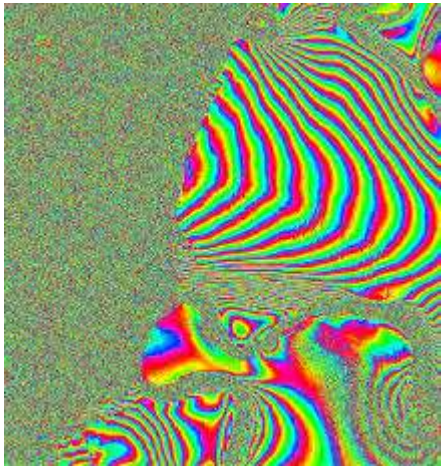
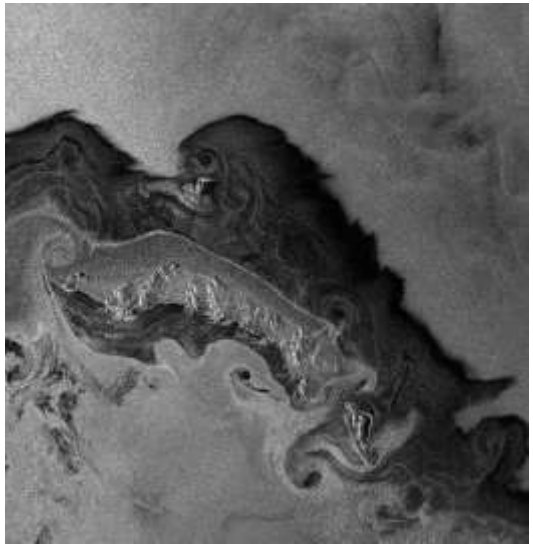
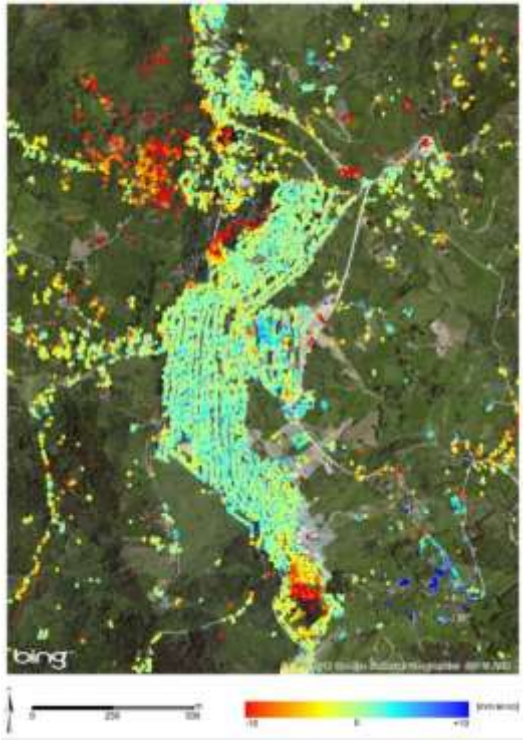
Outline

- SAR images: phase and amplitude data applications
- Importance of a joint analysis of amplitude and phase information for challenging areas
- Application on real case scenarios
- Conclusions



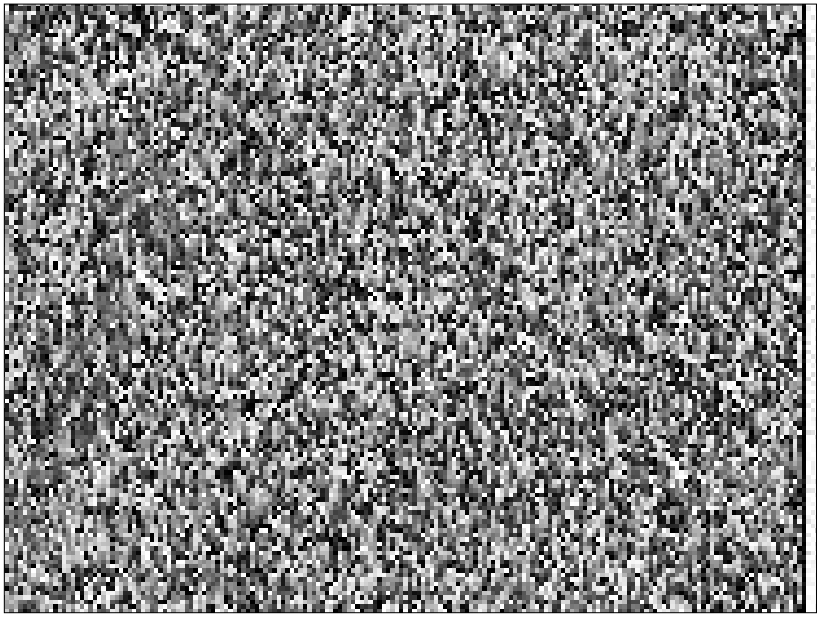




SAR data

A SAR image is a set of pixels characterized by amplitude and phase values, both contain information about sensor-targets distance

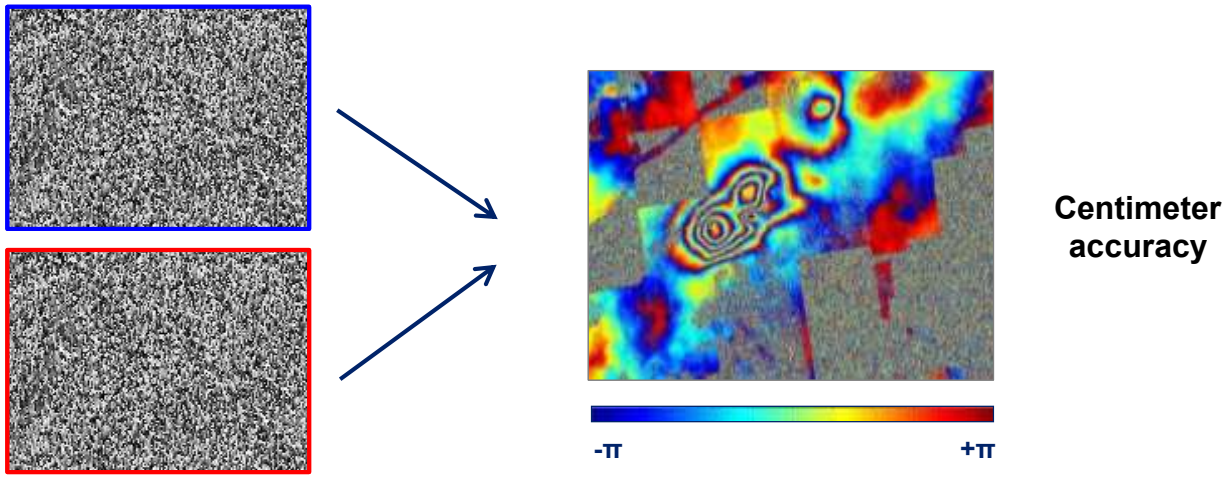
Amplitude



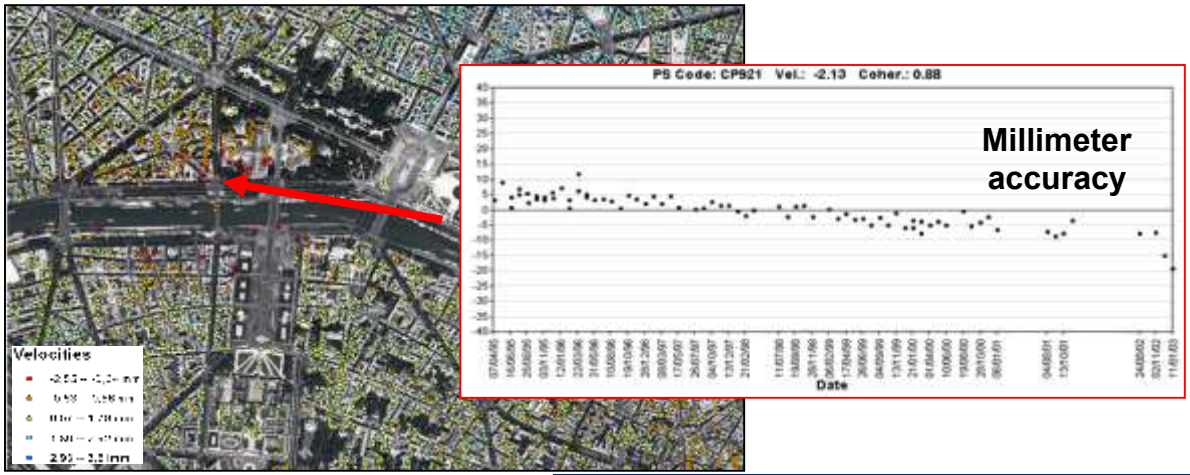
Phase (known modulo 2π)

Use of phase information

- In order to retrieve information from the phase signal of SAR images it is necessary to compare couples of images ⇨ interferogram

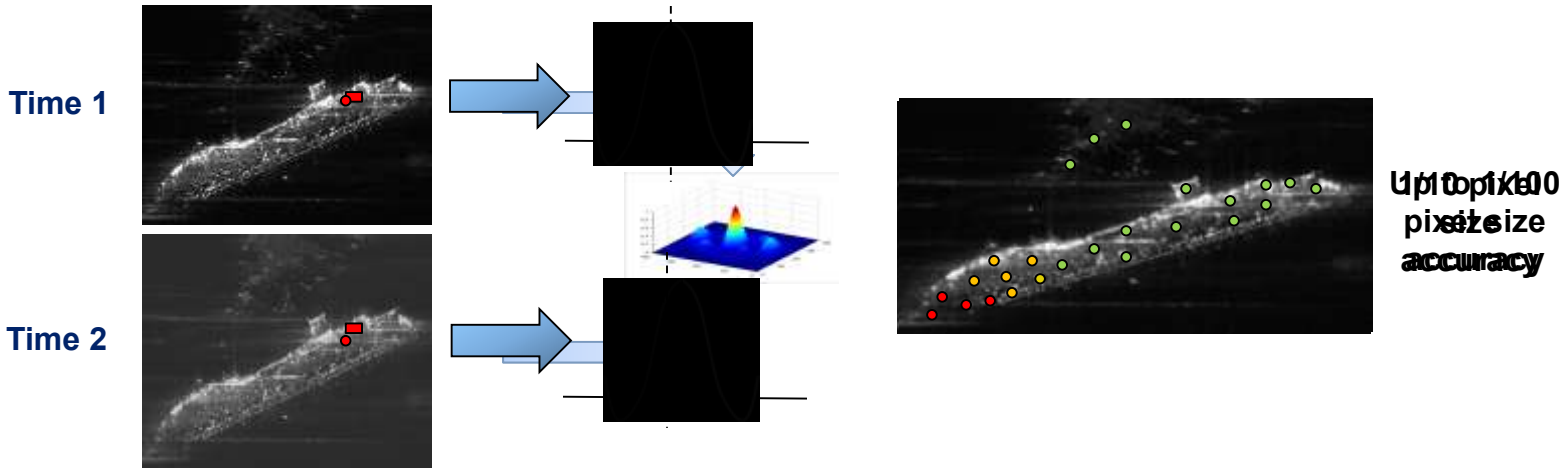


- When a data-stack of SAR images is available it is possible to perform PSI analysis

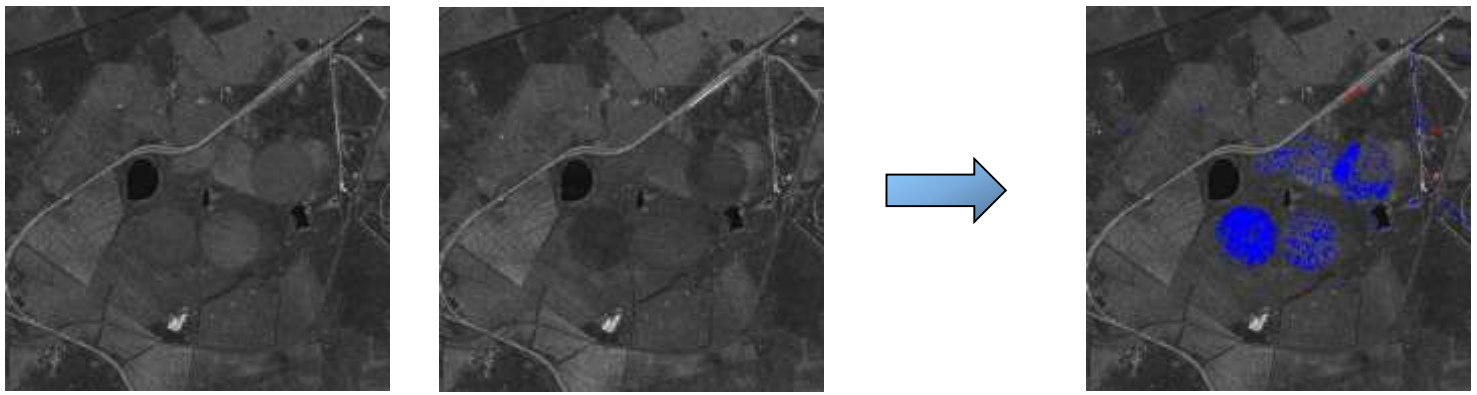


Use of amplitude information

- Speckle tracking techniques can be used to monitor high rate of deformation



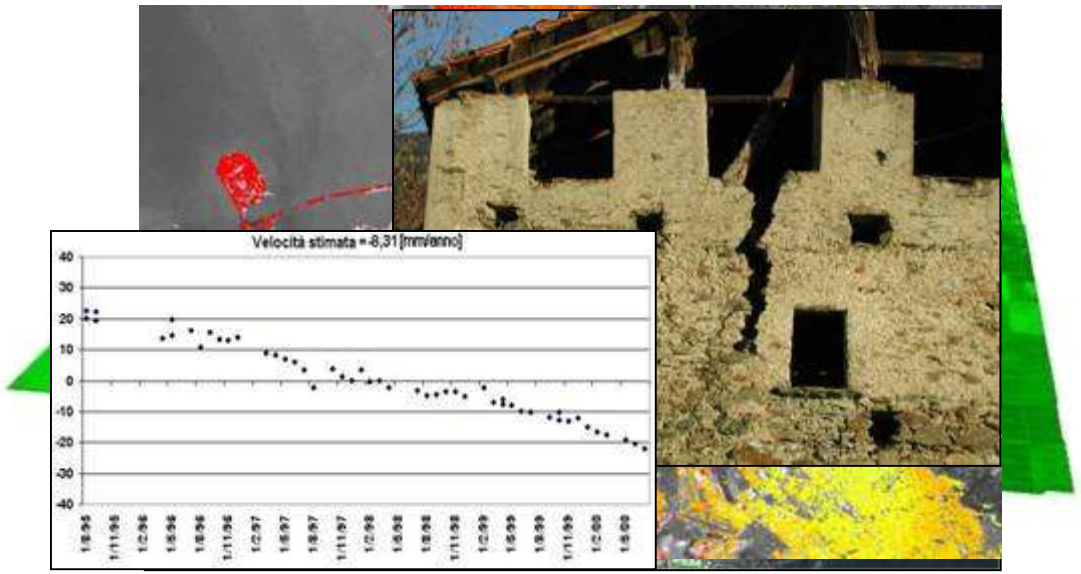
- Comparison of amplitude data for change detection applications



Phase vs Amplitude

Phase	Amplitude
• Higher accuracy, proportional to wavelength	• Lower accuracy, proportional to pixel size
• Phase unwrapping errors	• No need for phase unwrapping
• Suitable for slow rate of deformation	• Suitable for high rate of deformation
• More sensitive to tmeporal decorrelation	• Less sensitive to temporal decorrelation

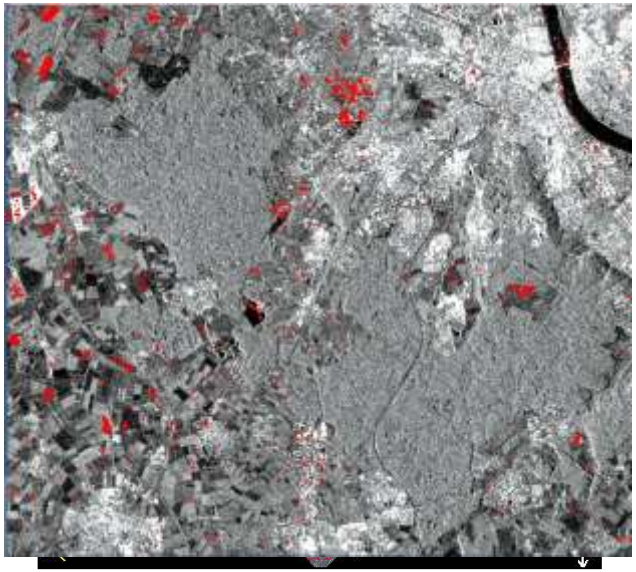
SqueeSAR™: applications



SqueeSAR™ applications

Subsidence **Landslides** **Seismic faults** **Single building**

SAR amplitude data applications



SAR amplitude applications

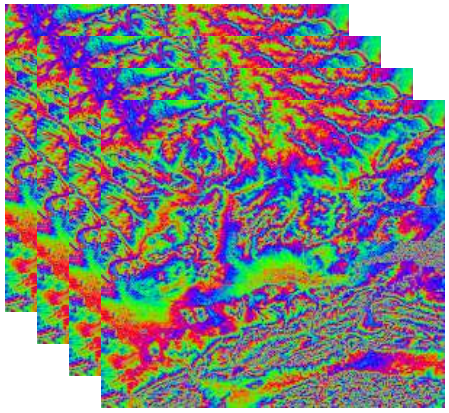
Earthquake **Glacier motion** **Change detection**

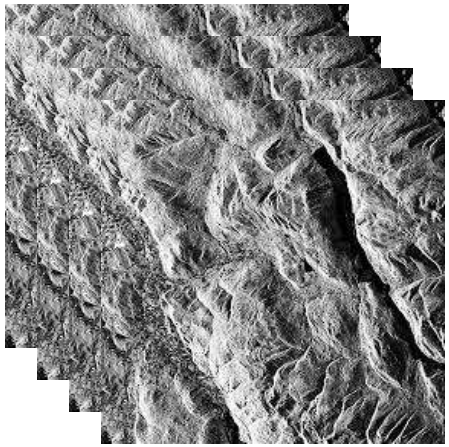
Phase + Amplitude

Phase	Amplitude
• Higher accuracy, proportional to wavelength	• Lower accuracy, proportional to pixel size
• Phase unwrapping errors	• No need for phase unwrapping
• Suitable for slow rate of deformation	• Suitable for high rate of deformation
• More sensitive to tmeporal decorrelation	• Less sensitive to temporal decorrelation

Monitoring challenging areas

- High resolution SAR satellites make possible to use speckle tracking to monitor deformation phenomena with centimetric accuracy
- In challenging areas both phase and amplitude data should be exploited to monitor both low and high rate deformation phenomena





SqueeSAR analysis

Time-lapse analysis to monitor low rate deformation areas

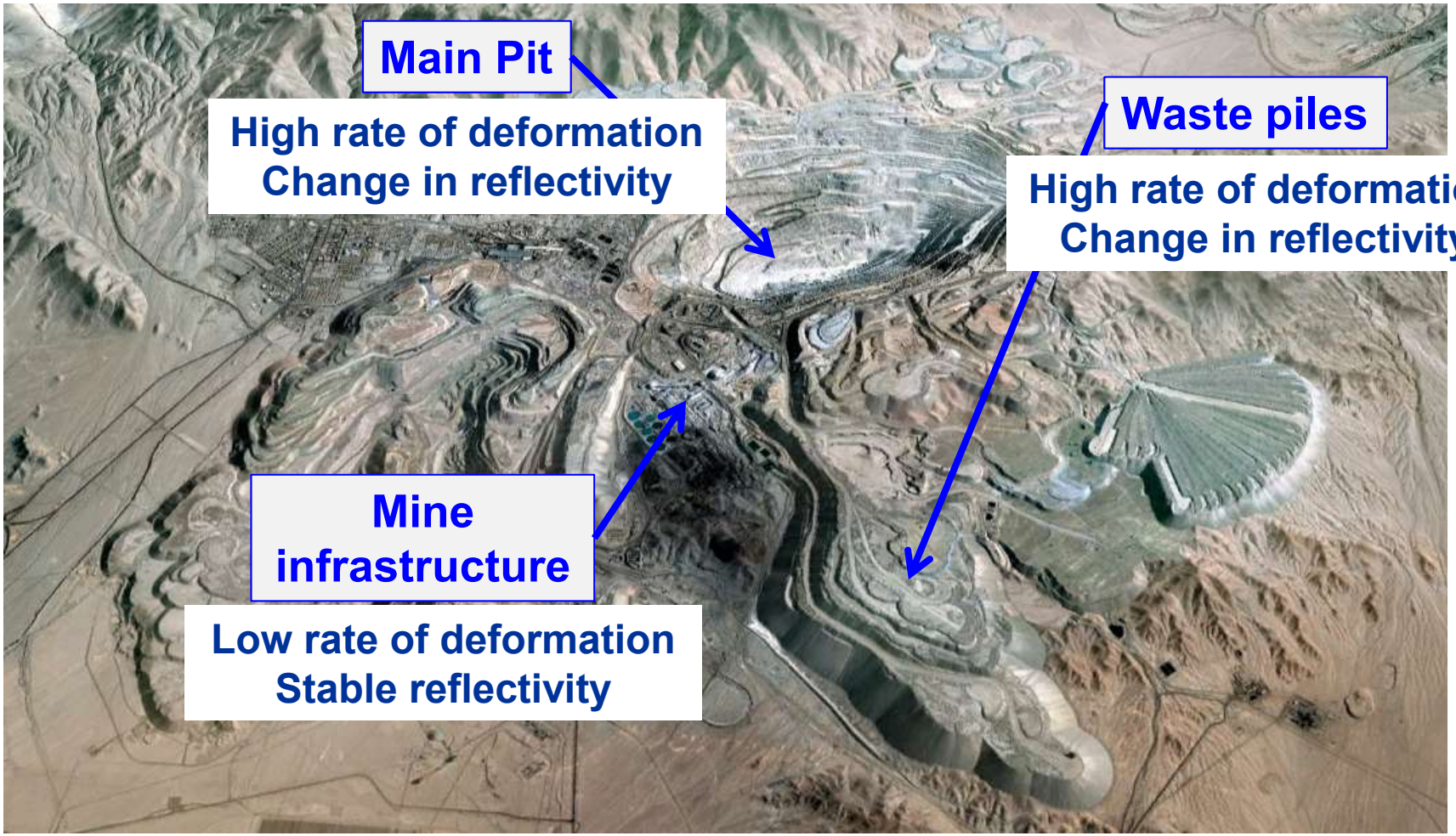
Speckle tracking analysis

Time-lapse analysis to monitor high rate deformation areas
2D deformation field

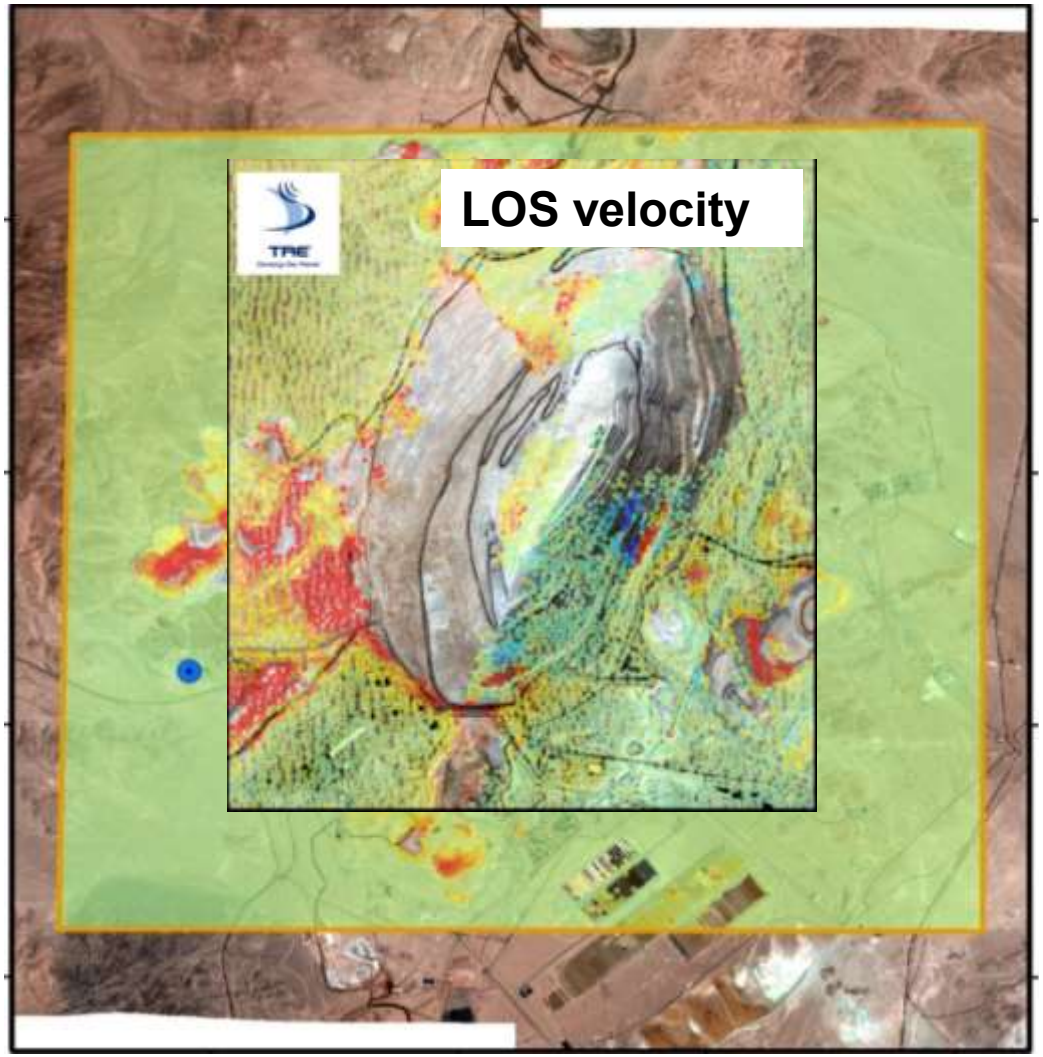
Change detection maps

to identify areas which change in reflectivity and can not be monitored through time

Mining areas

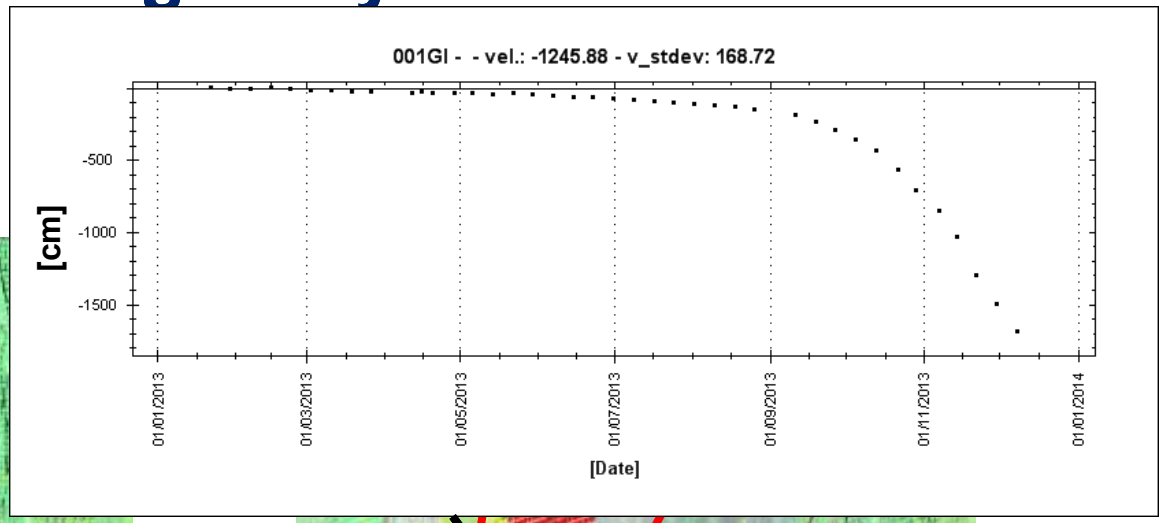


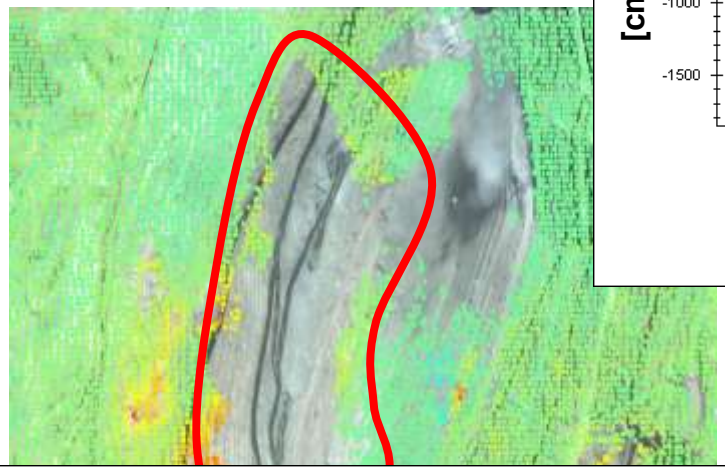
First test case

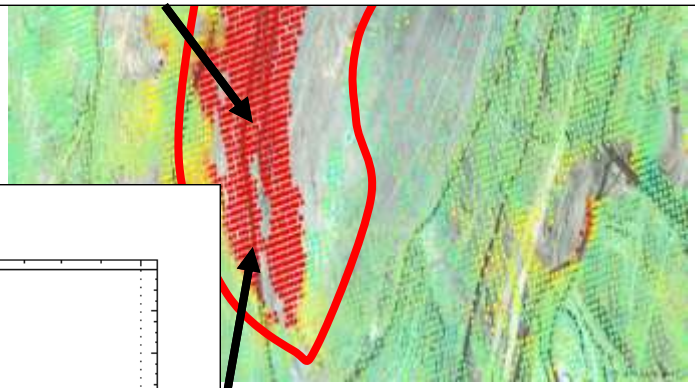


Speckle tracking analysis

SqueeSAR







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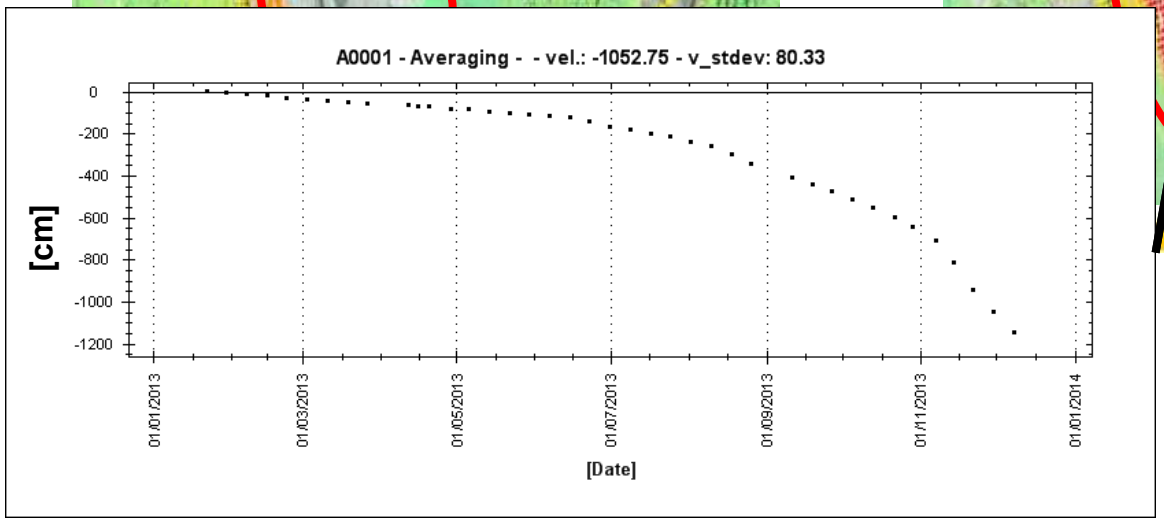
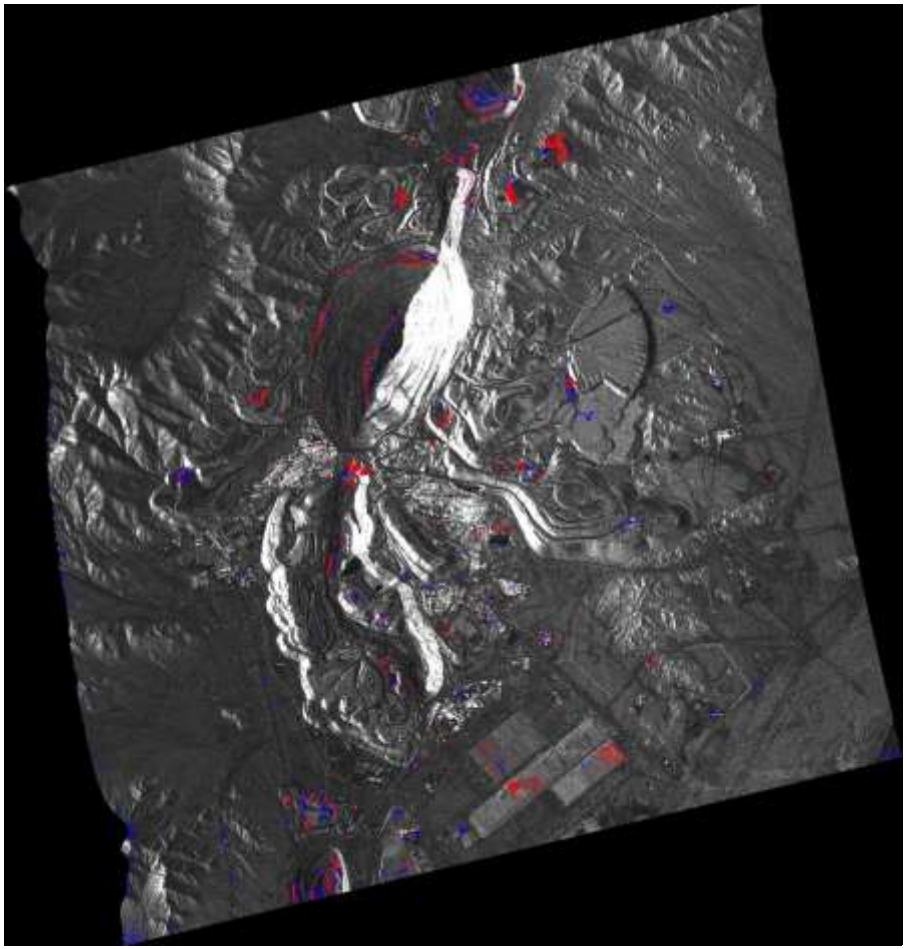


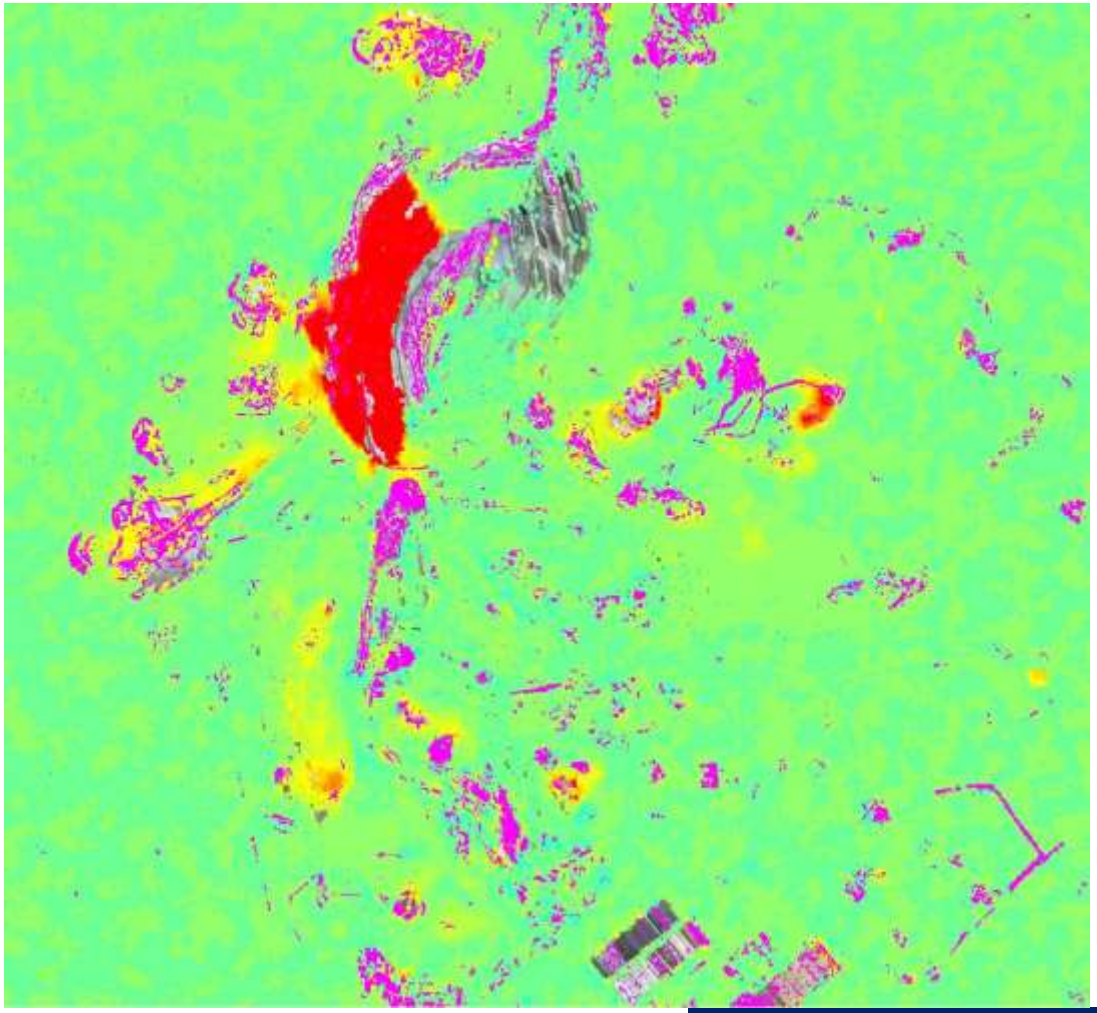
Change detection analysis

- Amplitude data can also provide information about the areas which have been operated during two consecutive acquisitions



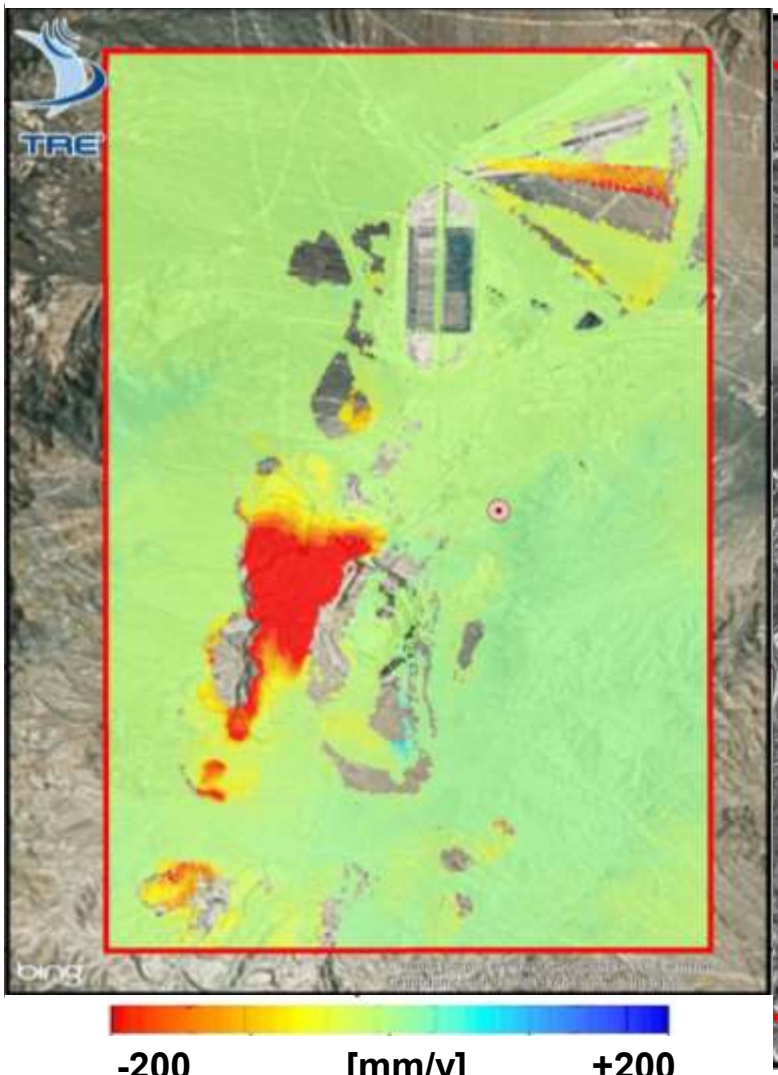
Analysis Overview

- A joint exploitation of all these techiniques helps to get a comprehensive analysis of the area of interest

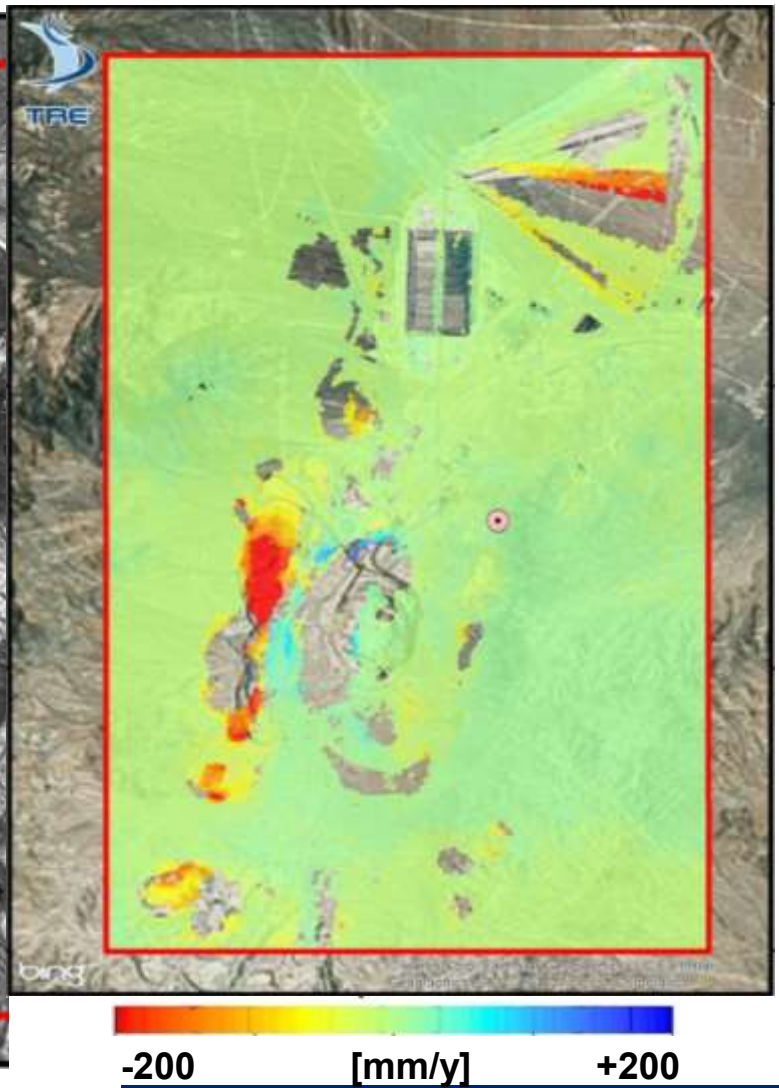


Second case study

CSK - Ascending

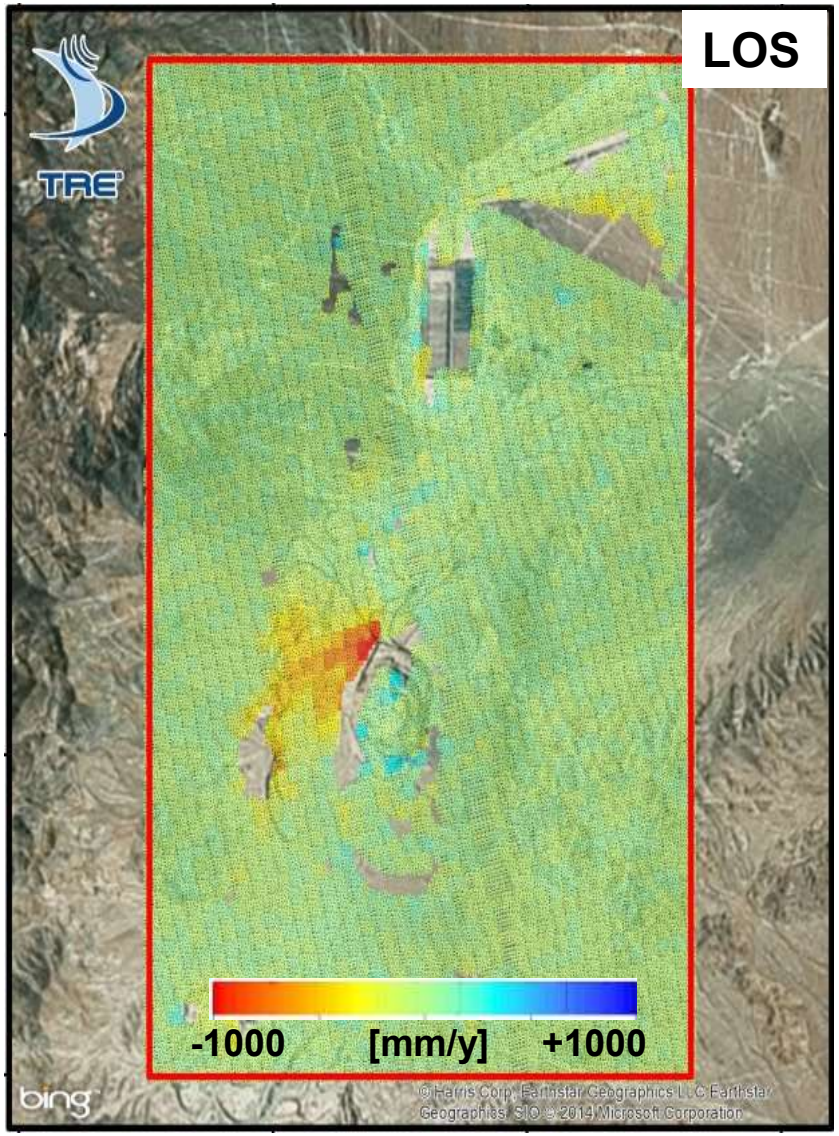


TSX - Descending



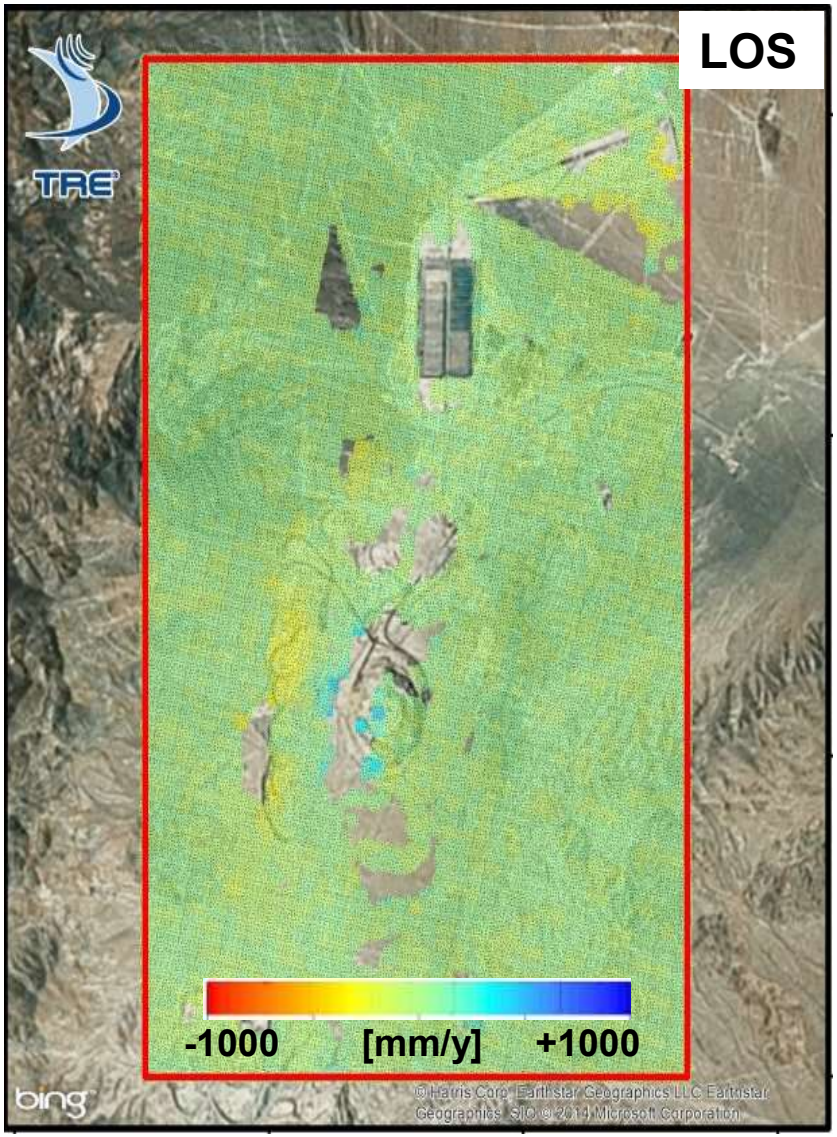
Speckle tracking analysis

CSK - Ascending



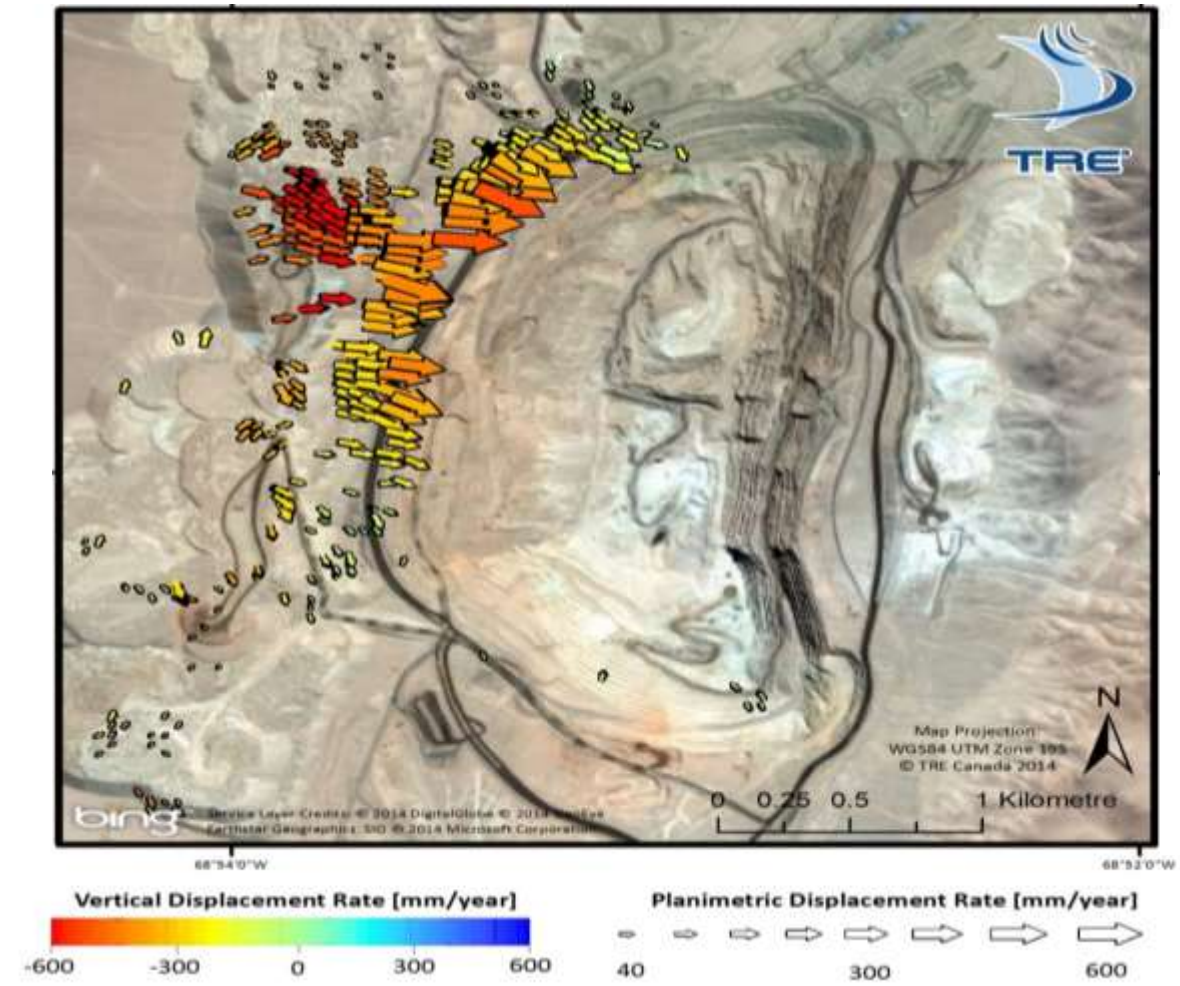
Speckle tracking analysis

TSX - Descending



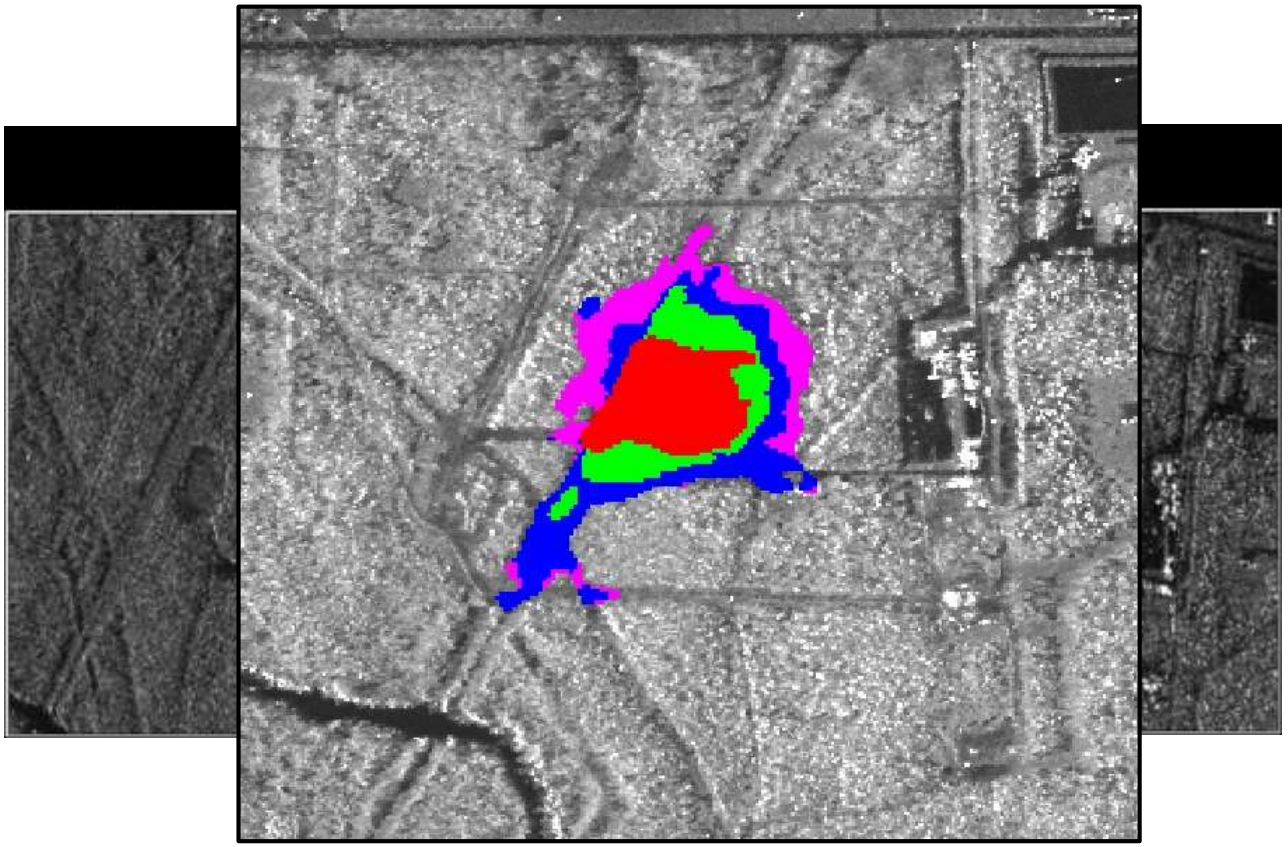
3D displacement field

- Combining the results of the SqueeSAR and speckle tracking analysis it is possible to retrieve the full 3D displacement field



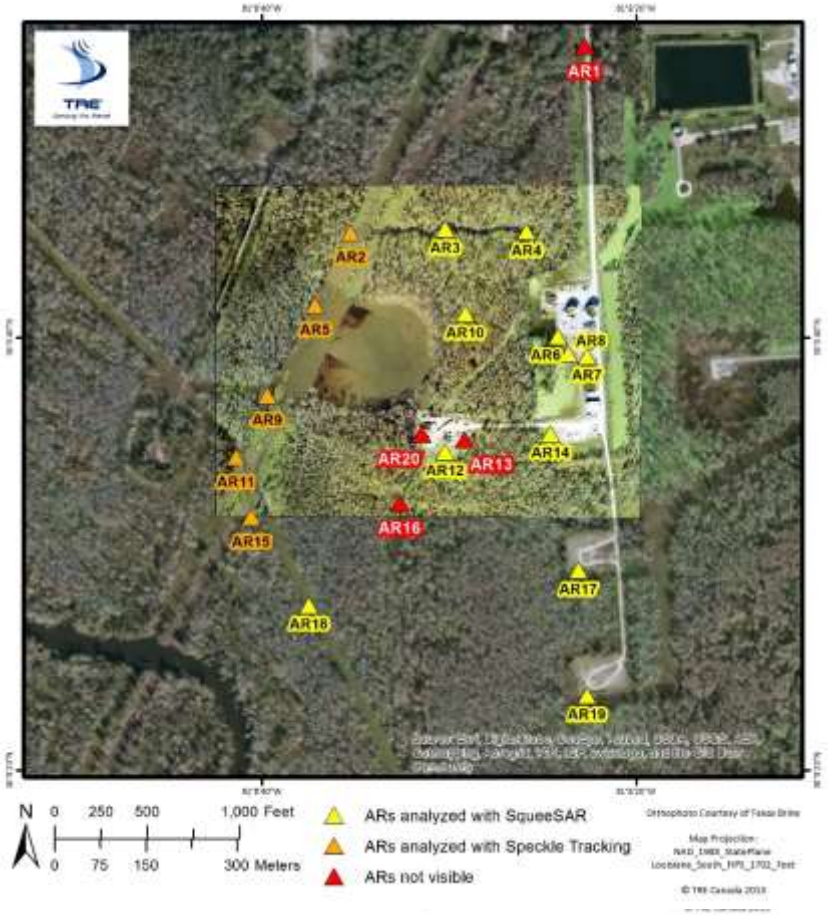
Salt dome for brine production

- The monitoring started in August 2012, shortly after a sinkhole of about 150 meters wide
- 20 AR were installed in that specific area of interest



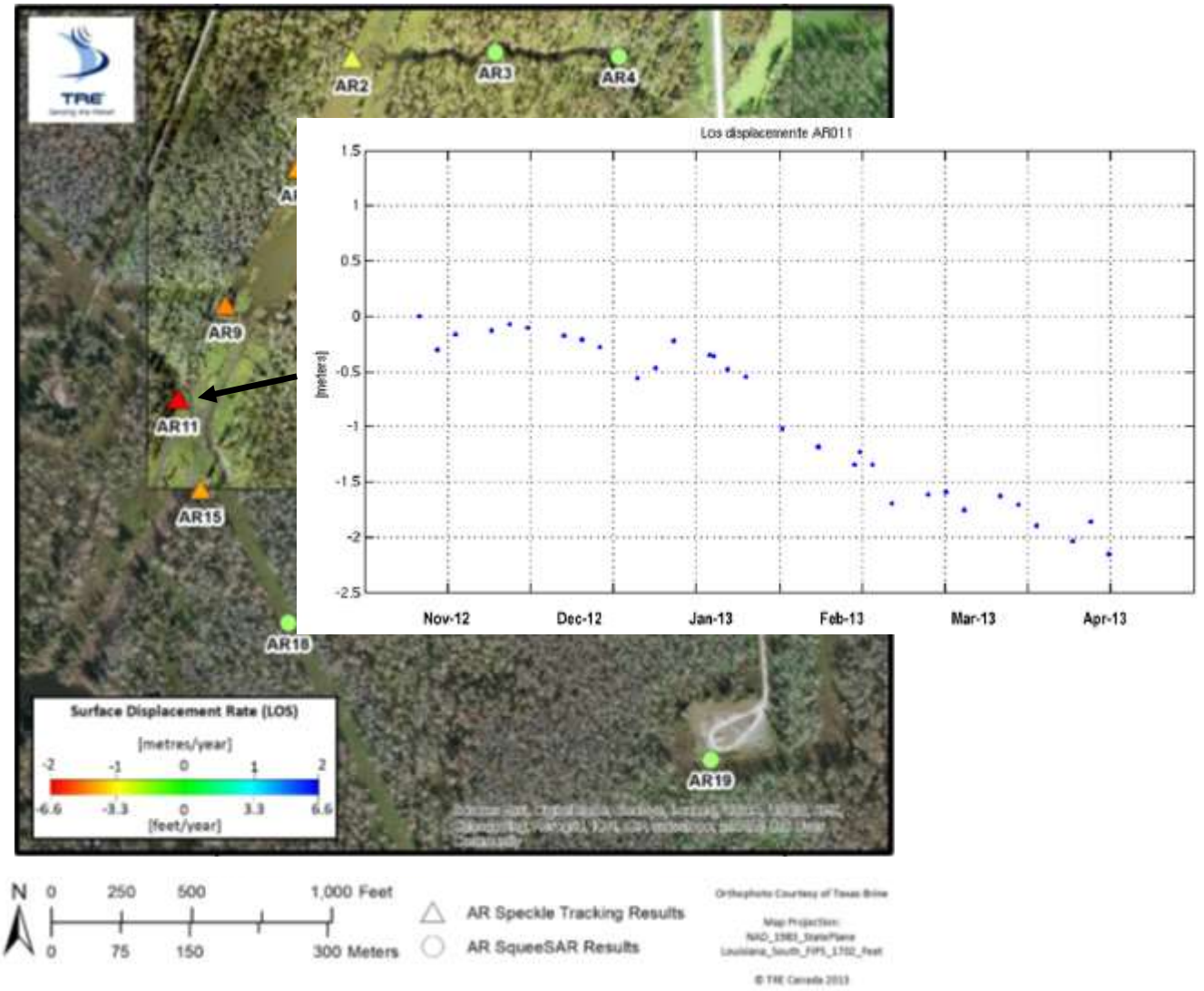
SqueeSAR analysis

- Infrastructures can be monitored by interferometry



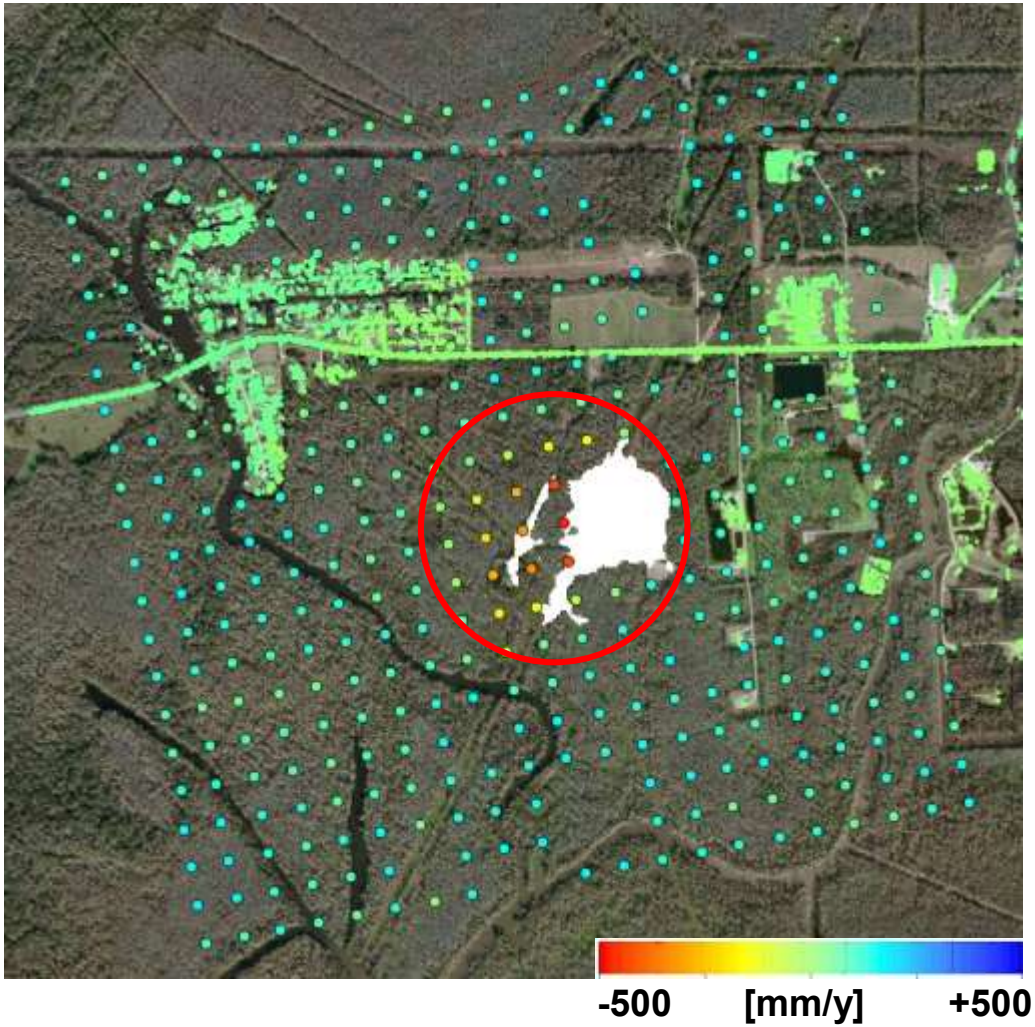
AR analysis

- To monitor the Ars it is necessary to combine interferometry and speckle traking



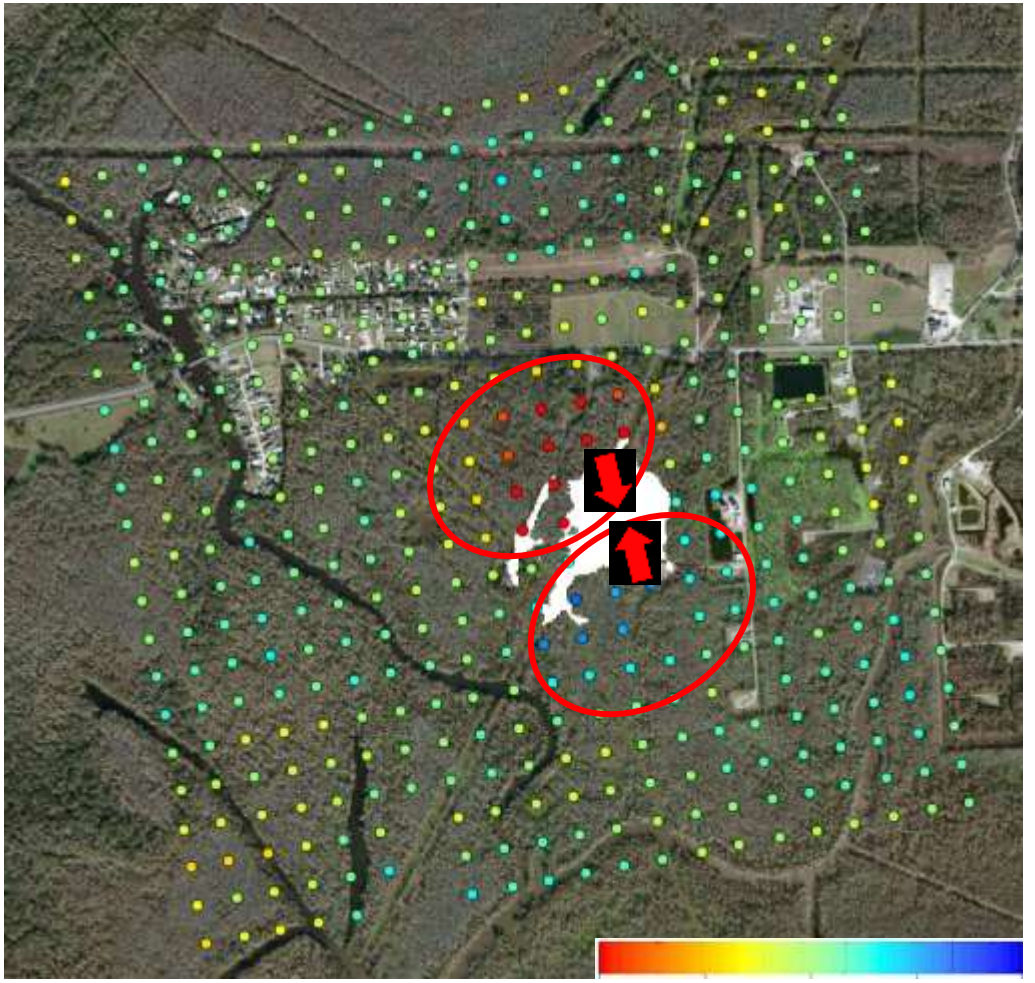
Range component – joint analysis

- To provide a comprehensive analysis of the range component also the speckle-tracking analysis has been performed



Azimuth component

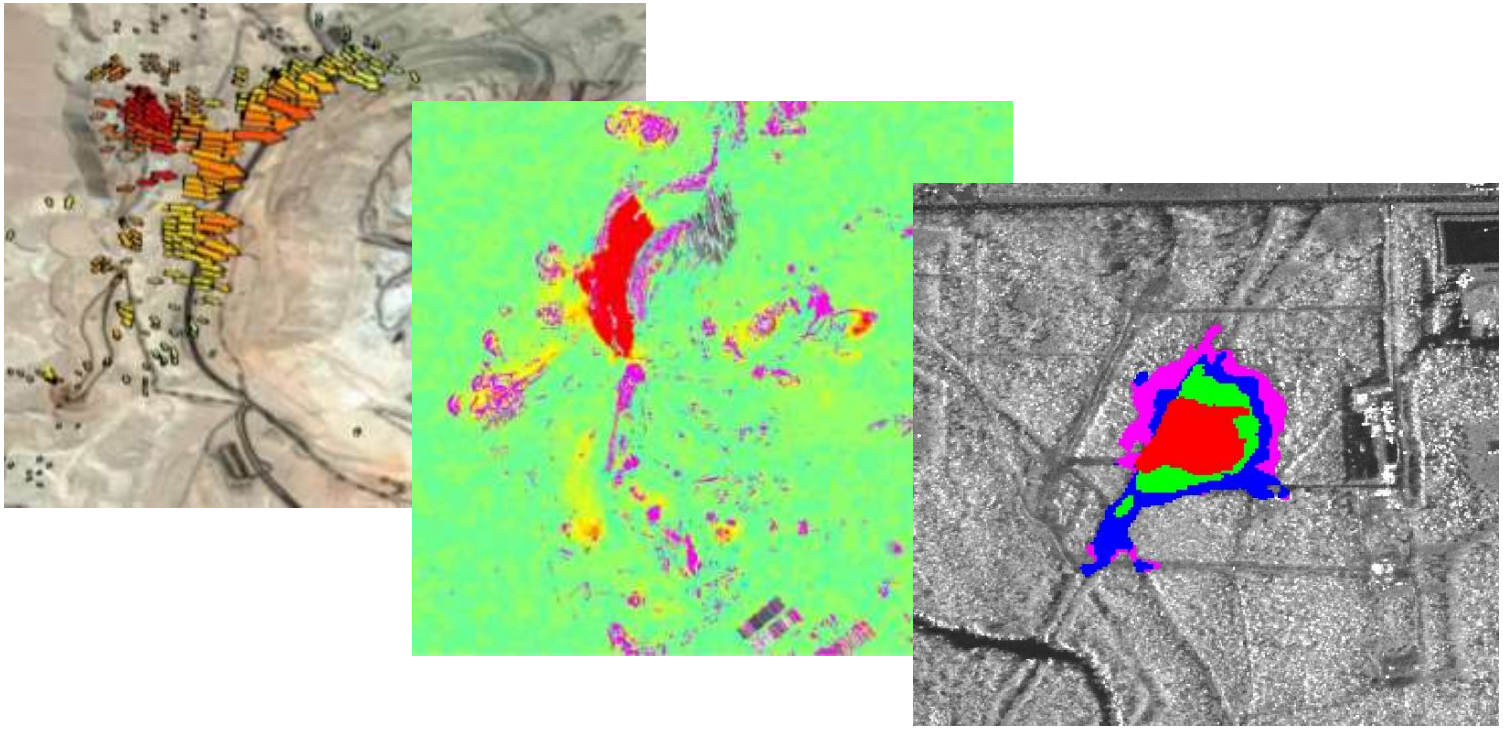
- Analysis provided by the speckle-tracking solely



Conclusions

- High resolution images increases the range of applicability of SAR amplitude information

- Deformation time-lapse monitoring should always exploit both phase and amplitude information for a better characterization of the area under study.



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