

Determination of Absolute Displacements of Tishinsky Opencast Mine Sides Based on Sentinel-1 Data

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Russia, 614990, Perm, Komsomolsky prospect, 29.

Our experience



From 2008 to 2010,
ENVISAT data:

- Berezniki;
- Orenburg;
- Perm;
- Astrakhan gas condensate field;
- Nov. Urengoy;
- Northern Buzachi (Kazakhstan);
- Zhirnovsk;
- Nefteyugansk;
- Solikamsk;
- Samara.

From 2011 to 2018,
TerraSAR-X data:

- Tuapse;
- Naryan-Mar;
- Astrakhan gas condensate field;
- Solikamsk;
- Kuleshovskoye field;

- Vankor field;
- Zapolyarnoye field;
- Kogalym.
- Fields of the Chamber of Commerce and Industry of RITEKBeloyarskneft

2014-present COSMO-SkyMed data:

- Kogalym;
- Karaganda (Kazakhstan);
- Nefteyugansk;
- Berezniki;
- Solikamsk;
- Ridder (Kazakhstan);
- Zhezkazgan (Kazakhstan).

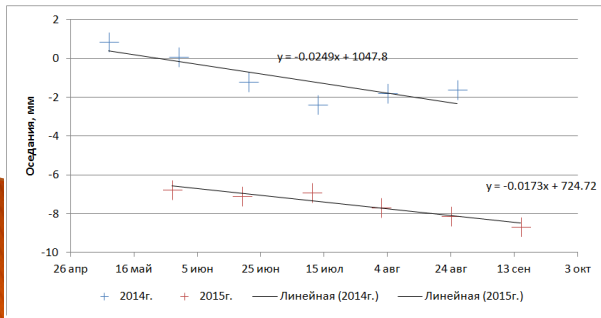
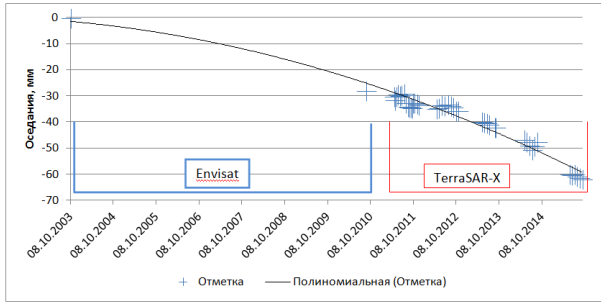
From 2016 to the present,
Sentinel -1a,- 1b data:

- Astrakhan Gas Station;
- Berezniki;
- Solikamsk;
- Ridder (Kazakhstan);
- Zhezkazgan (Kazakhstan).

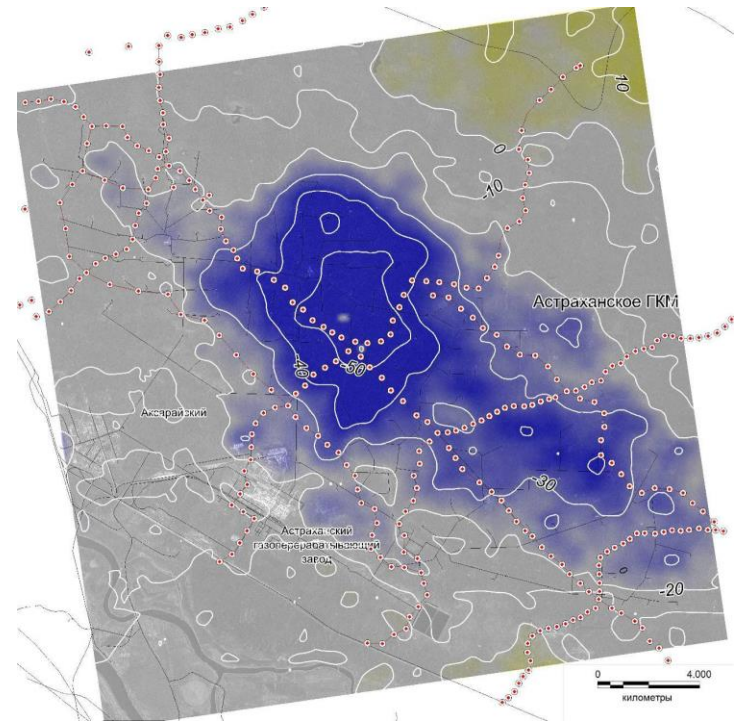
Monitoring data from 2003 to the present day; The number of initial survey cycles from 10 to 66; The values of detected subsidence—from the first millimeters to 1–1.5 m / year; Survey conditions – built-up areas, taiga, steppe, desert, tundra, swampy area, mountainous area, arable land.

Astrakhan gas condensate field

Chart of point subsidence during the monitoring period from 08.10.2003 to 15.09.2015 (top) and from 08.05.2014 to 15.09.2015 (bottom)

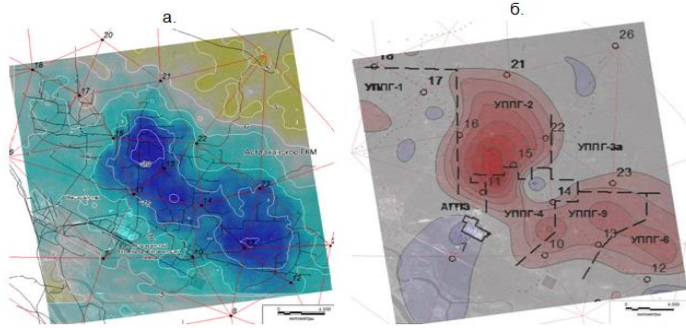


Map of accumulated subsidence of the Earth's surface for the period from 2003 to 2015 based on the results of interferometric processing of ENVISAT and TerraSAR-X radar data

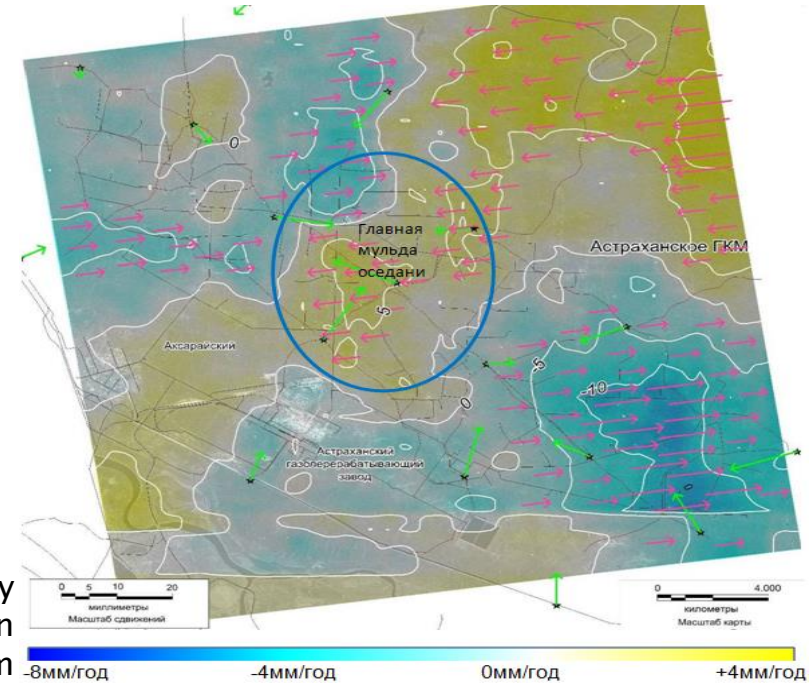


Astrakhan gas condensate field

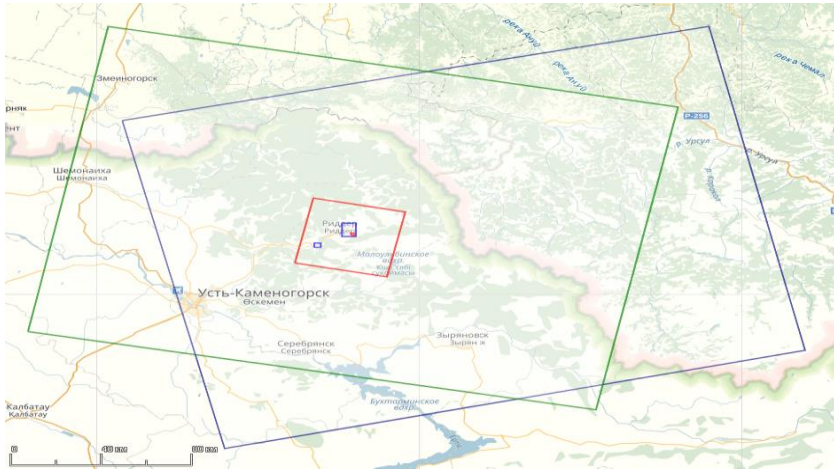
Map of the earth's surface subsidence for the period from 2011 to 2015 based on the results of interferometric processing of the TerraSAR-X radar data. b–Map of the Earth's surface deformations for the period from 2005 to 2015 based on the results of GNSS survey



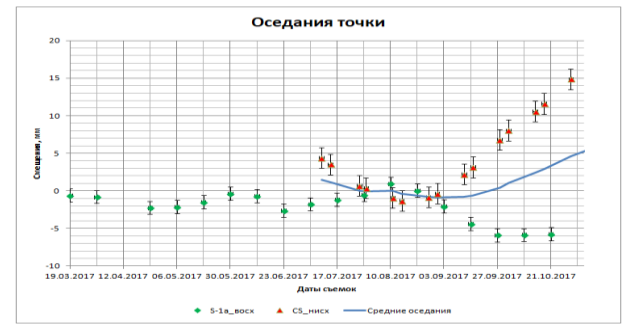
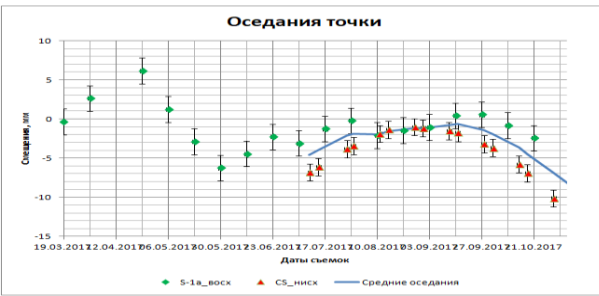
Map of horizontal shifts according to radar interferometry data for 2011–2015. (The isolines show numerical shifts in the sensing direction. Use the red arrows to visualize them on a larger scale. Green arrows – horizontal movements based on geodetic observations for the same period at the same scale)



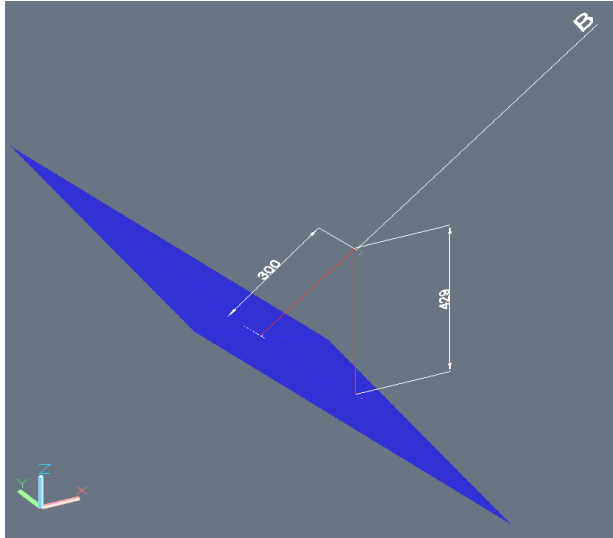
Tishinsky opencast mine



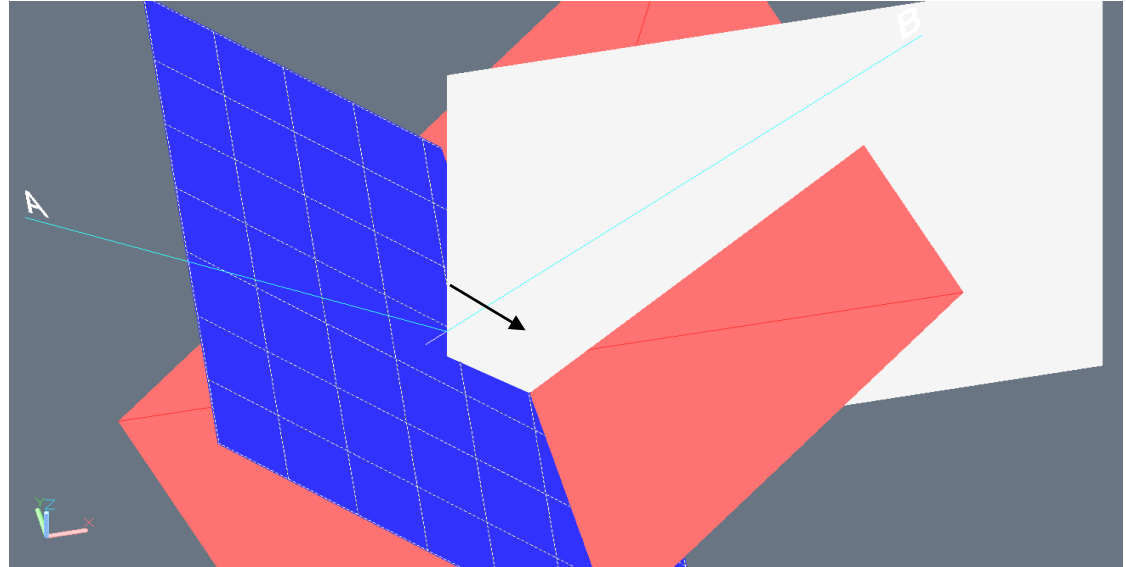
The scheme of covering the work area with scenes:
 red-COSMO-SkyMed-1,2,3,4;
 blue-Sentinel-1a;
 green-Sentinel-1b



Tishinsky opencast mine

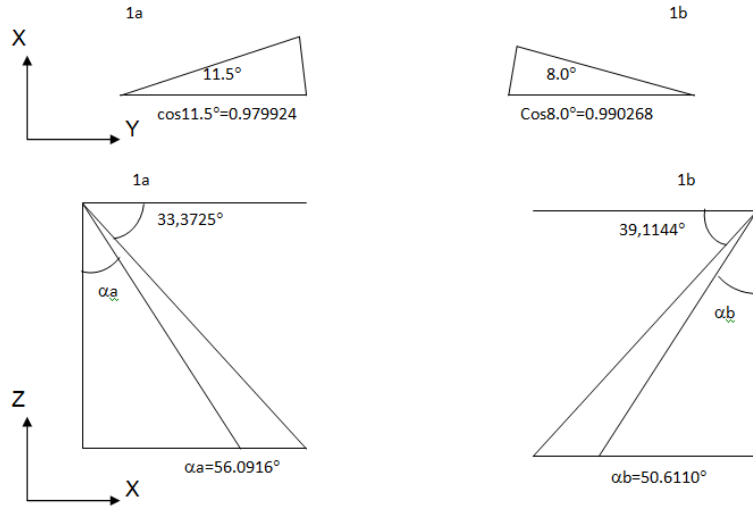


The traditional scheme for determining subsidence from radar interferometry data on the example of vector elongation by 300 mm

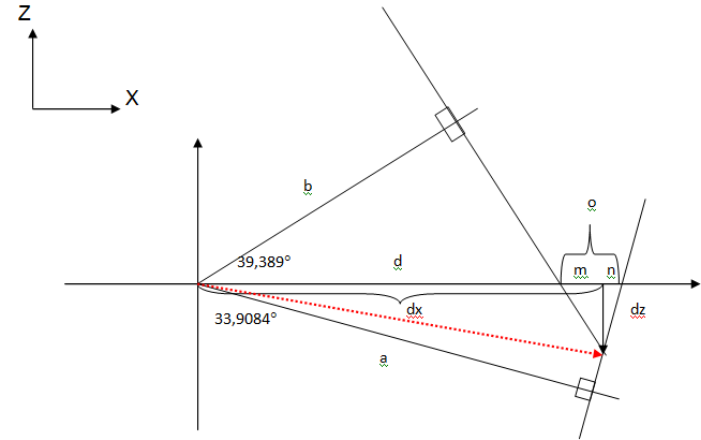


Vector of absolute displacement in space, including horizontal displacement and subsidence

Tishinsky opencast mine



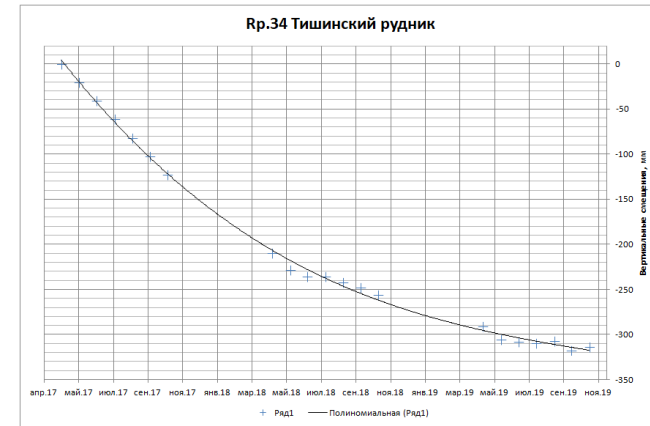
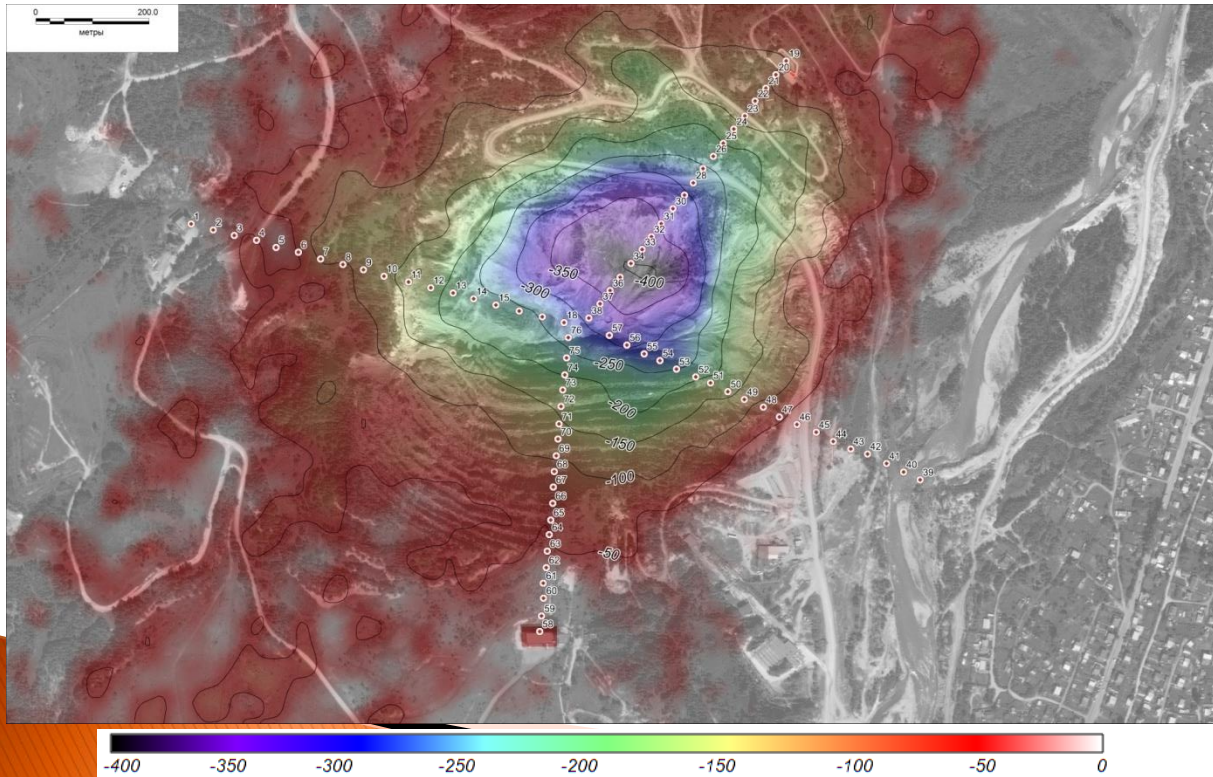
Scheme for finding projections of inclined angles on the Z-X plane



A special schematic case of finding displacement vectors in the Z-X plane. a and b are increments of the probing vectors

Tishinsky opencast mine

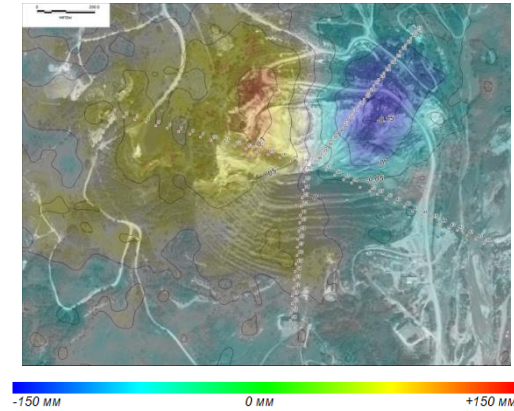
Map of accumulated sedimentation over 3 years in the territory of the Tishinsky quarry based on the results of radar monitoring Sentinel-1a and Sentinel-1b 2017–2019.



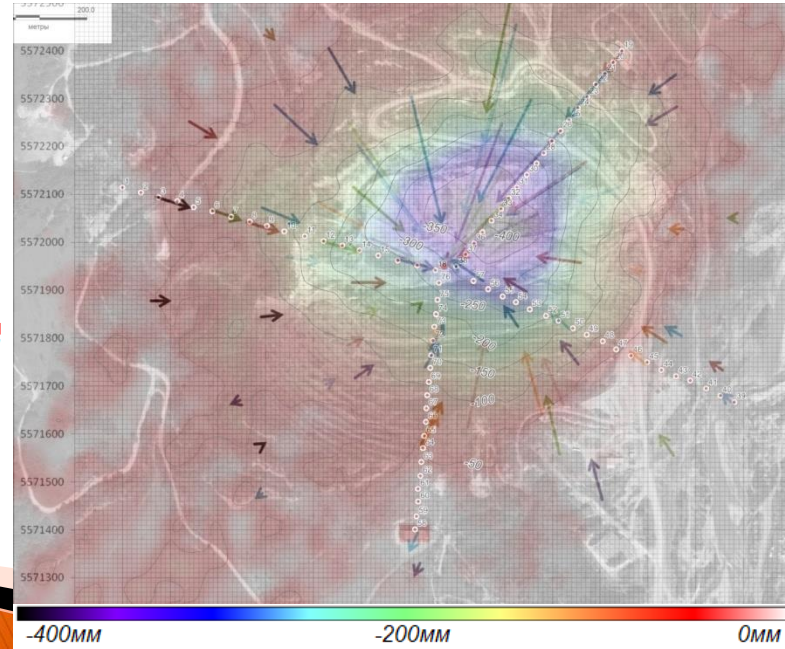
Graph of the history of subsidence Rp34 of the conditional profile lines of the Tishinsky mine for the period 2017–2019.

Tishinsky opencast mine

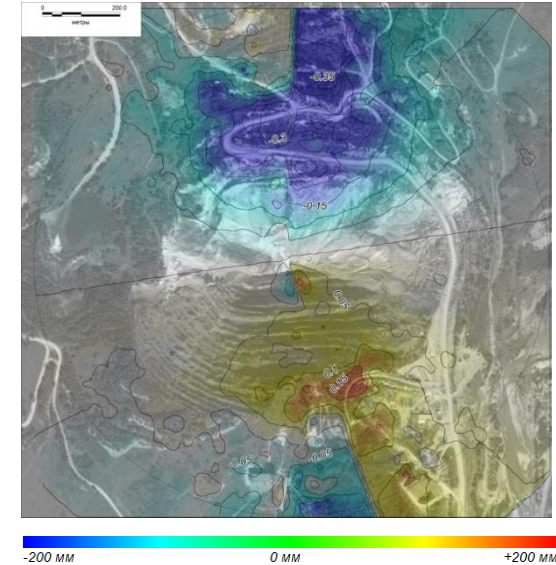
Horizontal displacements at the Tishinsky quarry on the X-axis for 3 years from 2017 to 2019 (the displacement isolines are indicated in meters)



The combined plan of shifts at the Tishinsky quarry for three years from 2017 to 2019. The isolines show the subsidence (mm). The arrows show the vectors of horizontal movements

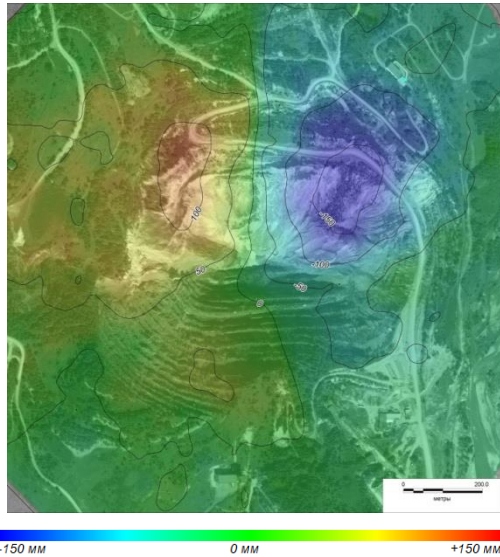


Horizontal displacements at the Tishinsky quarry along the Y-axis for 3 years from 2017 to 2019 (the displacement isolines are indicated in meters)

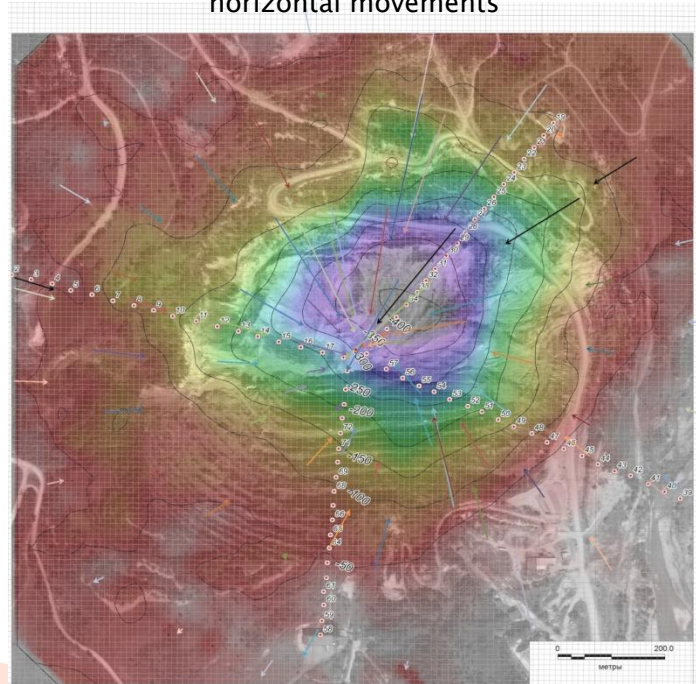


Tishinsky opencast mine

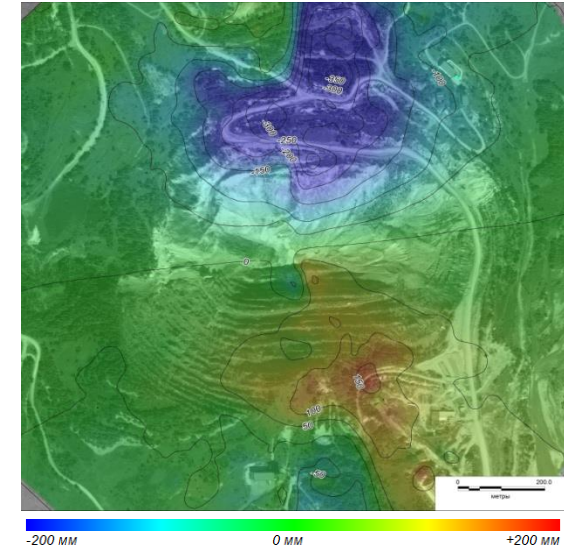
Horizontal displacements at the Tishinsky quarry on the X-axis for 3 years from 2017 to 2020 (the displacement isolines are indicated in meters)



The combined plan of shifts at the Tishinsky quarry for three years from 2017 to 2020. The isolines show the subsidence (mm). The arrows show the vectors of horizontal movements



Horizontal displacements at the Tishinsky quarry along the Y-axis for 3 years from 2017 to 2020 (the displacement isolines are indicated in meters)



-400mm -200mm 0mm

Thanks for your attention



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