

## MINING AND GEOLOGY

### GEOPHYSICS IN MINING

Geophysical surveys for many years have been used in issues related to the exploration and exploitation of mineral deposits, both on the surface and underground.







*Seismic survey to assess the risk of rockburst in hardcoal mine (top).*

*Georadar profiling method for the determination of shear planes in the ground in the former hardcoal mine area (left).*



*Microgravimetric survey to locate the waste-ring voids being the result of shallow mining.*

Most commonly used methods:










-  seismic method
-  microgravimetric method
-  DC electrical resistivity method
-  georadar method (GPR)



*Engineering seismic surveys to determine the thickness of the weathered layer in sandstone quarry.*



Geophysical surveys are used to identification and determination of:

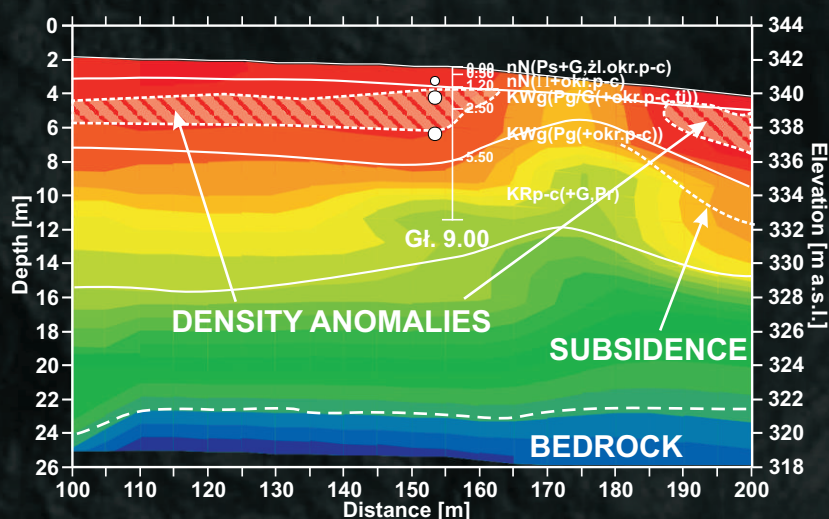
-  thickness of overburden and to bedrock determination for the exploitation of near-surface deposits
-  continuity and disturbance of the structure in seams with cracks and fractures
-  contact zones between e.g. salts and anhydrites
-  spatial geological structure of overlying layers and deposits - deposit contouring
-  prospective zones for optimal exploitation of the mineral resources
-  rockburst risk
-  underground „migrating voids” in post mining areas
-  undocumented and unliquidated excavations
-  loosened ground and „weak zones”



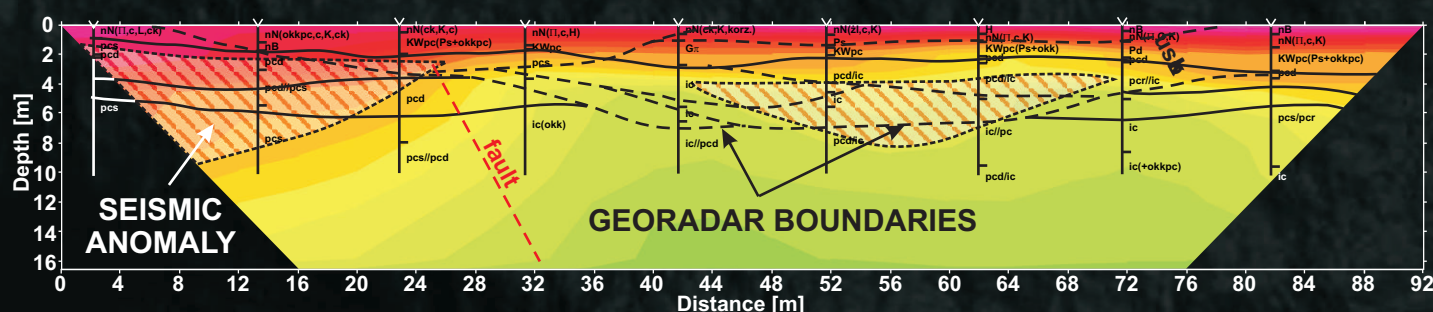
MASW seismic survey to detect cracks and loosened zones in post-mining area.

## SEISMIC SURVEYS

Seismic surveys base on the variation of density and elastic properties of tested ground. In the mining and geology this method is appropriate for voids and cracks zones location in the ground and effectiveness of backfill in shallow mining areas. It is commonly used to determine the depth and continuity of solid bedrock, to estimate cracks anisotropy, rock rippability for exploitation and also for calculations of dynamic elastic modules and preliminary assessment of geomechanical classes.



Results of MASW 2D surveys carried out for detecting and contouring voids, loosened zones, cracks and subsidences under the road surface.

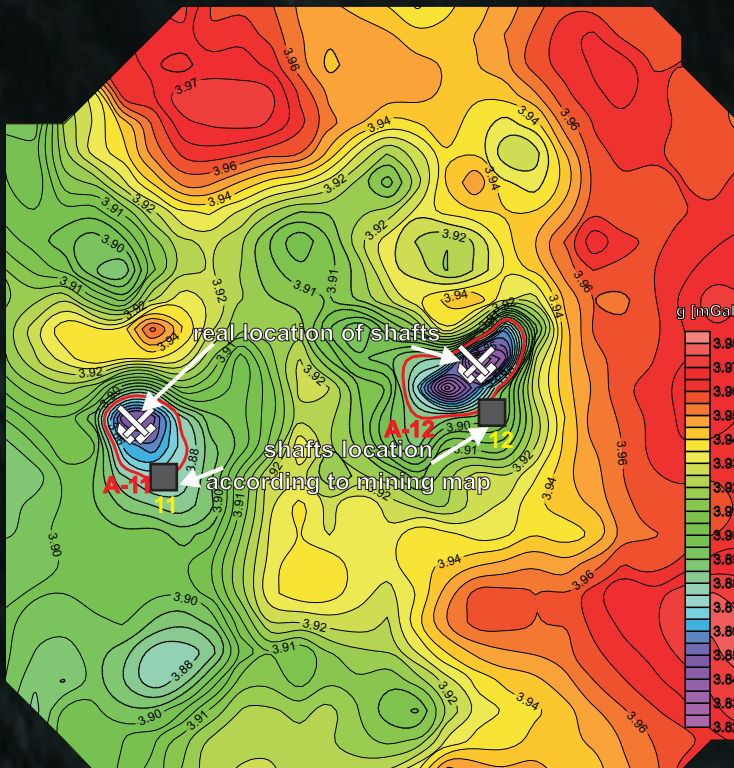


P-wave velocity field as a result of seismic surveys done by refraction tomography method to determine the loosened zones and cracks. Ranges of landslide risk areas are marked basing on georadar boundaries. Indicated probable fault zone was confirmed by geotechnical surveys.



## GRAVIMETRIC SURVEYS

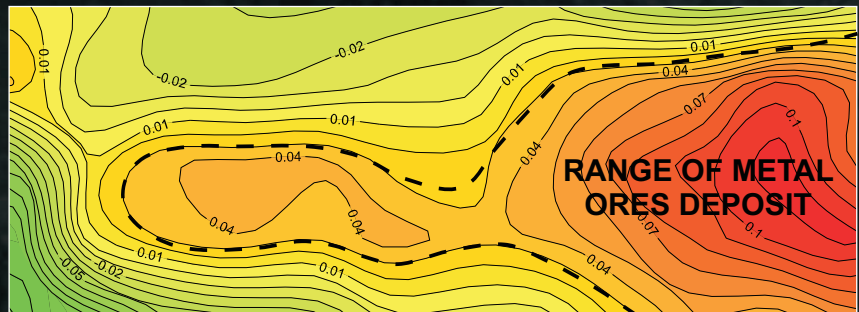
Geophysical gravimetric method bases on the variation of gravitational field of the Earth. Application of engineering version called microgravimetry gives particularly good results in the location of mining excavations occurring in the subsurface along with forecasting their expansion towards the surface. These objects can generate discontinuous deformation of surface creating shell-pits and sinkholes. The areas of occurrence of such voids, cracks and loosened zones generate relative negative gravity anomalies. Microgravimetric observations are carried out using gravimeters. The results of the surveys are presented as maps of the distribution of gravity anomalies.



Map of gravity anomalies based on microgravimetric surveys.

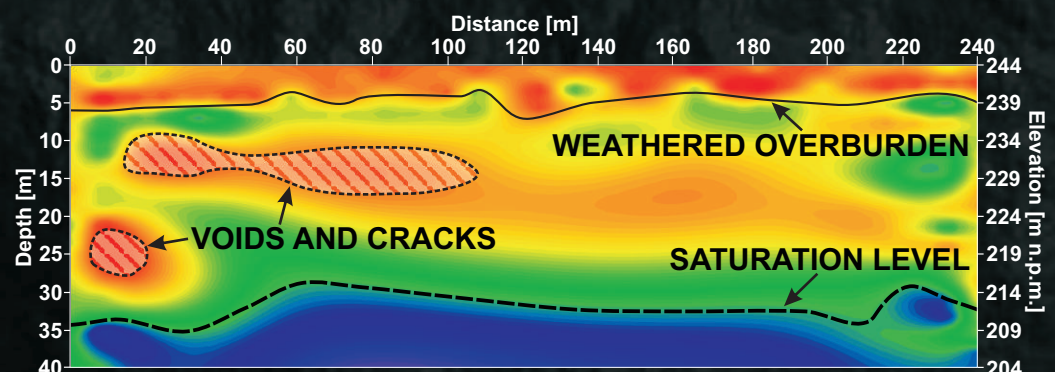
Regional surface gravimetric image for exploration of raw materials deposits.

Gravimetric surveys are also carried out in regional scale to locate the energy raw materials and mineral deposits. These surveys give possibility to determine structural oil and gas traps, salt domes and surface range of deposits.



## DC ELECTRICAL RESISTIVITY SURVEYS

Geophysical surveys using the electrical method is based on the flow of electric current through the geological center. This method allows the separation of zones with different electrical properties. The method can be used to separate soil and rock layers, determine aquifers, zones of voids, cracks and loosening, as well as the location of mine workings.

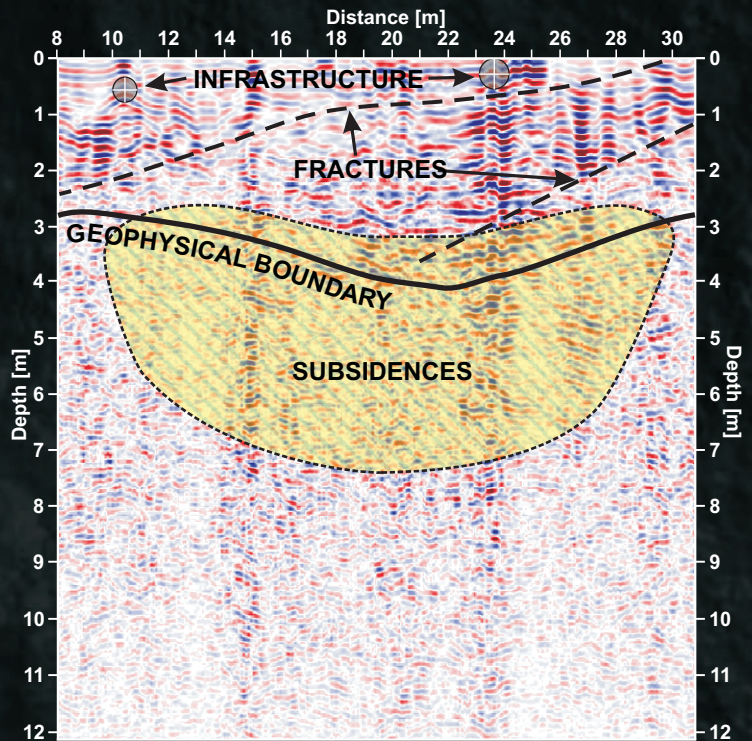


Results of electrical resistivity tomography ERT in the area of historical hardcoal mining.

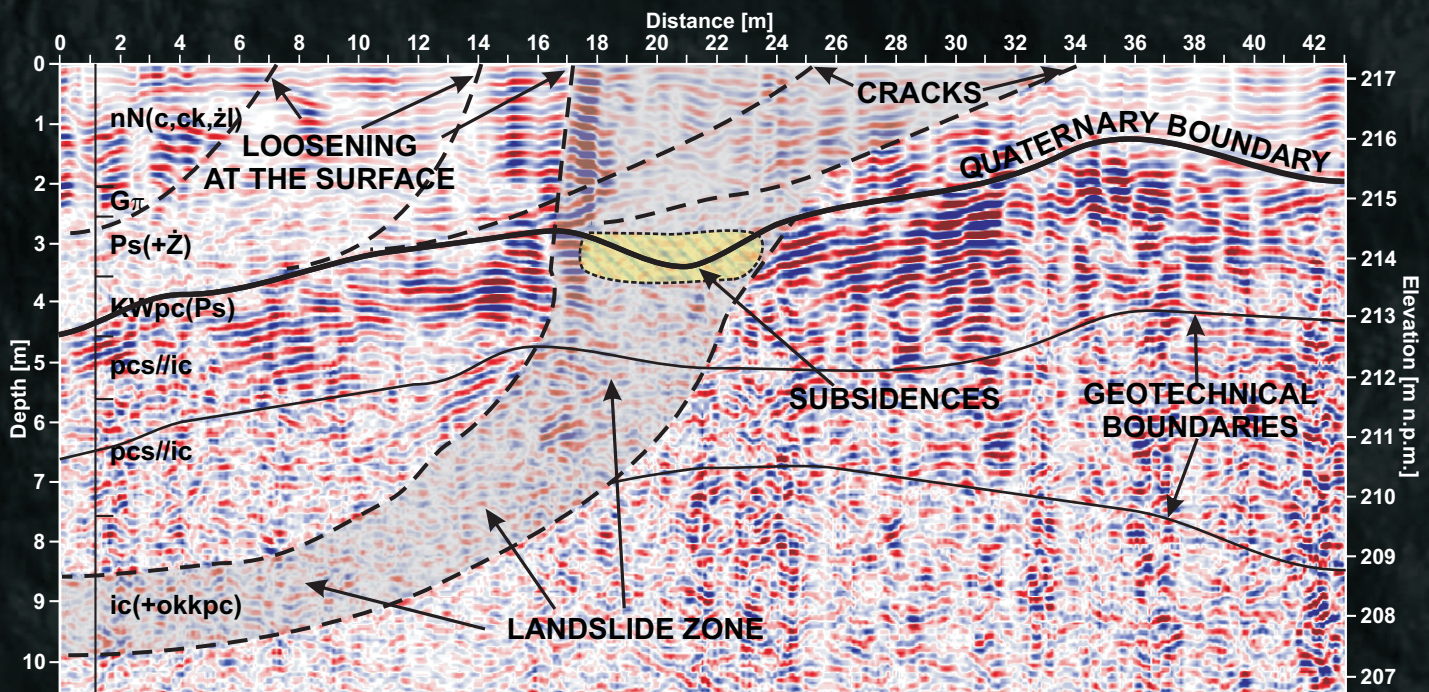


## GEORADAR SURVEYS

Application of georadar method (GPR) in the open pit and underground mines areas helps in determination of structure of the investigated ground or rock massif. Typical GPR applications are: determination of fracture zones, delineating geophysical boundaries which after correlations with geotechnical boreholes allow to detect discontinuities in the structure and lithology. Additional effect of georadar surveys, where high vertical resolution antennas are used is detection and location near-surface infrastructure of the mine. By using a dense grid of transverse and longitudinal acquisition profiles, it is possible to contour spatial anomalies.



GPR cross-section to determine subsidence areas in the ground as a result of improper liquidation of the mine shaft. Larger fracture planes formed by subsidence and bending of the plastic layers can also be observed.



Depth GPR cross-section on the edge of the slope of an open pit coal mine, for determining the range of landslide zone. There was also detected rupture of soil-rock massif in places where loosening and cracks on the surface were observed.