Geoelektrical Survey

Calibration Measurement in the Josephi Tunnel

This test measurement using resistivity tomography and IP in the tunnel was intended to determine whether, and under what data conditions, barite veins in the Suggental mine can be detected.

Drill holes for current electrodes; Jonathan (Moll)

Installation of the electrode line; optimization of current injection into the tunnel wall using a contact medium; Jonathan, Sophie, Stefan (Moll)

Kalibration Measurement

2D Resistivity/IP, Schlumberger-Array
25 Electrodes, Spacing 0,075m
EG Geosciences, 11th March 2011
Team: Philipp Moll (Survey Leader),
Sophie Mätz, Stefan Beck, Jonathan Armas

EG Geosciences
Geologie • Geophysik • Archäologie
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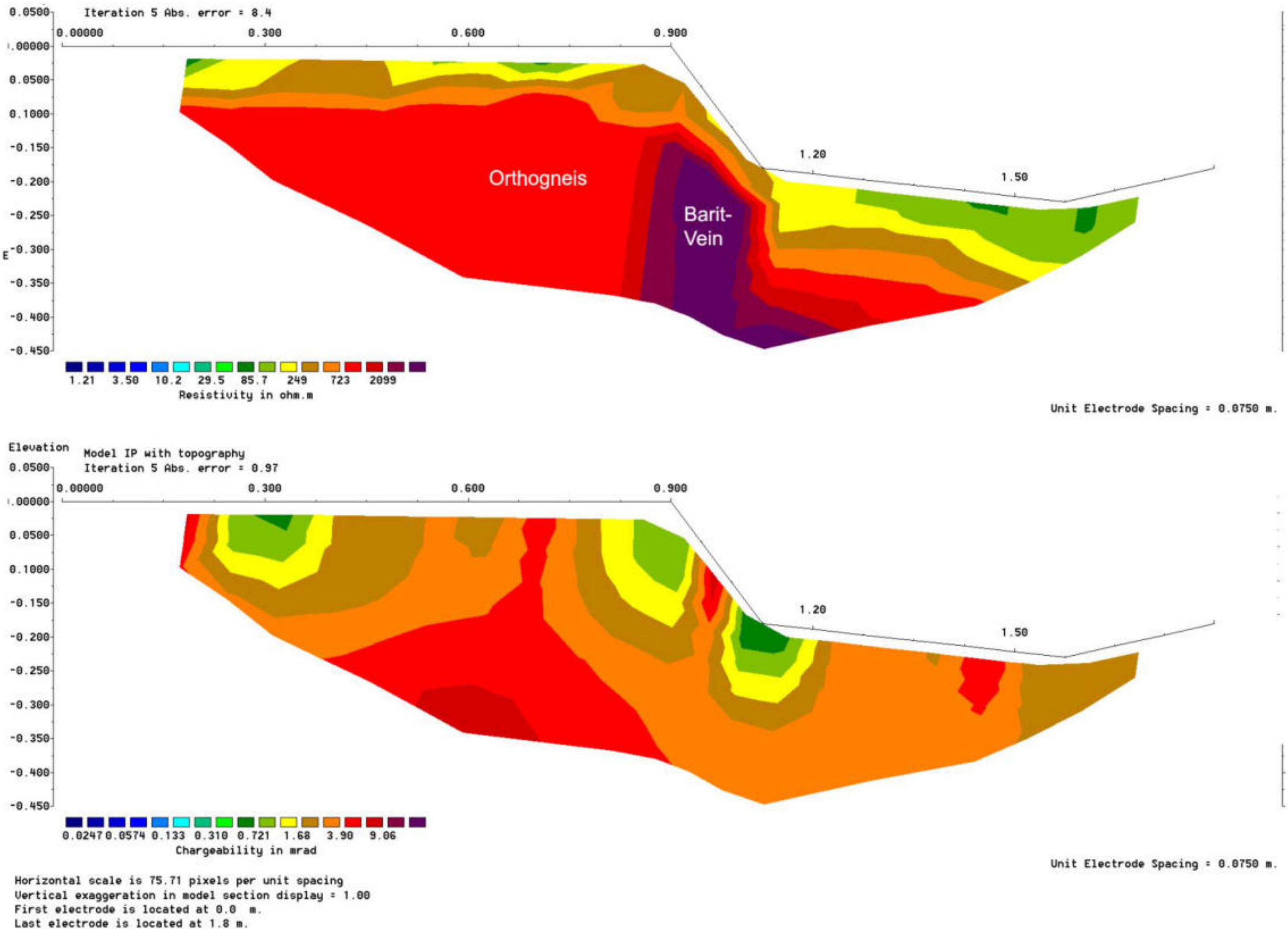


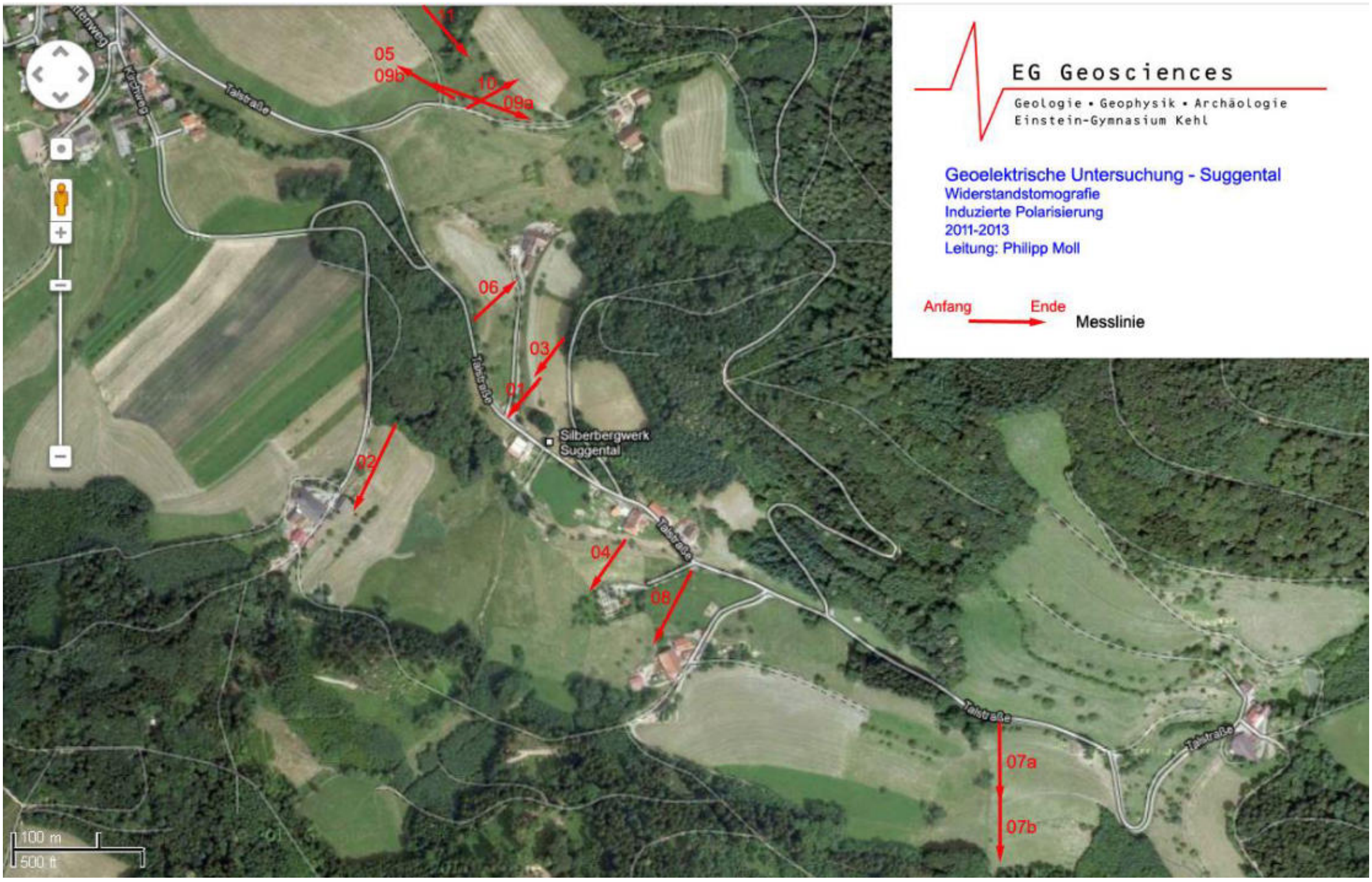
Explanation

The barite vein (baryte) was clearly identified by means of resistivity measurements. The electrical conductivity of barite is lower than that of gneiss. Similarly low conductivity would also be expected for a quartz vein.

In the area of the barite vein, chargeability (IP) is only slightly elevated near the surface. Therefore, the concentration of sulfide minerals—and thus the ore metal content—is likely to be low.

The higher electrical conductivity observed at the surface is probably due to moisture from the contact medium as well as water-filled microfractures (erosion features) in the near-surface rock.

Line Map

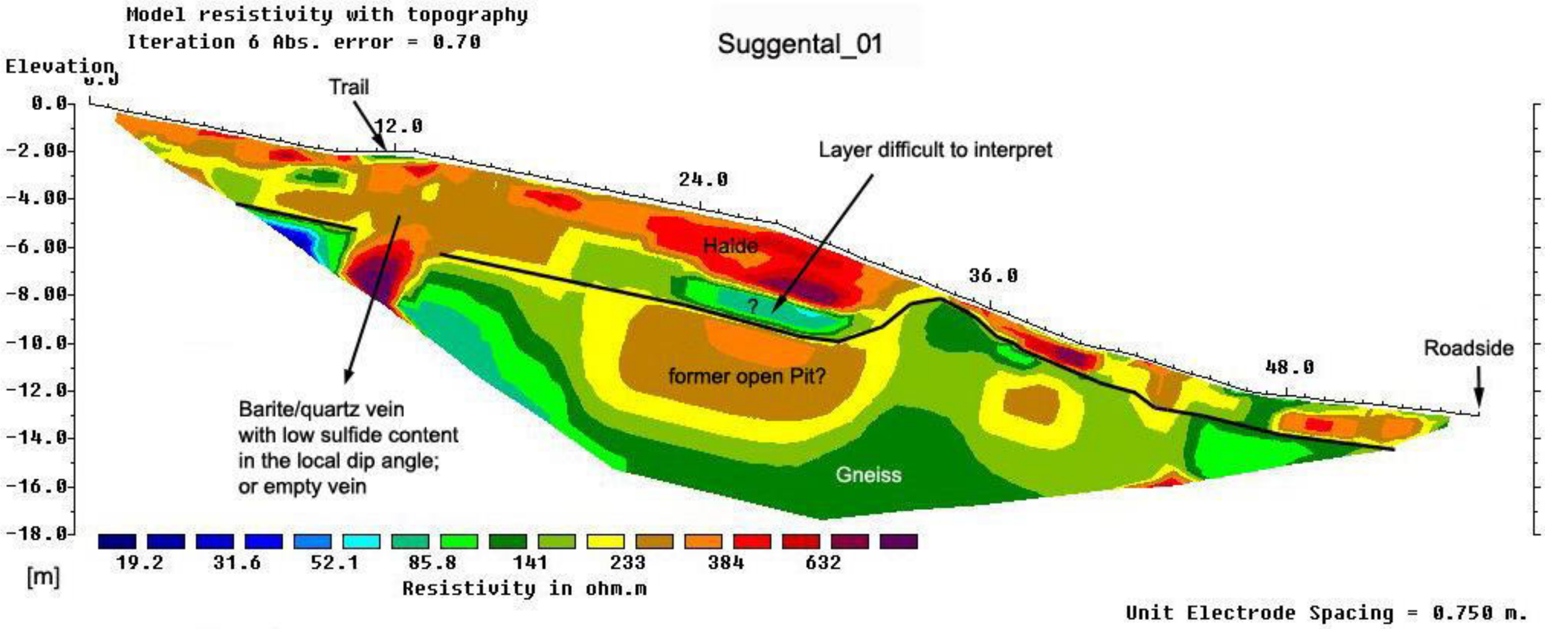


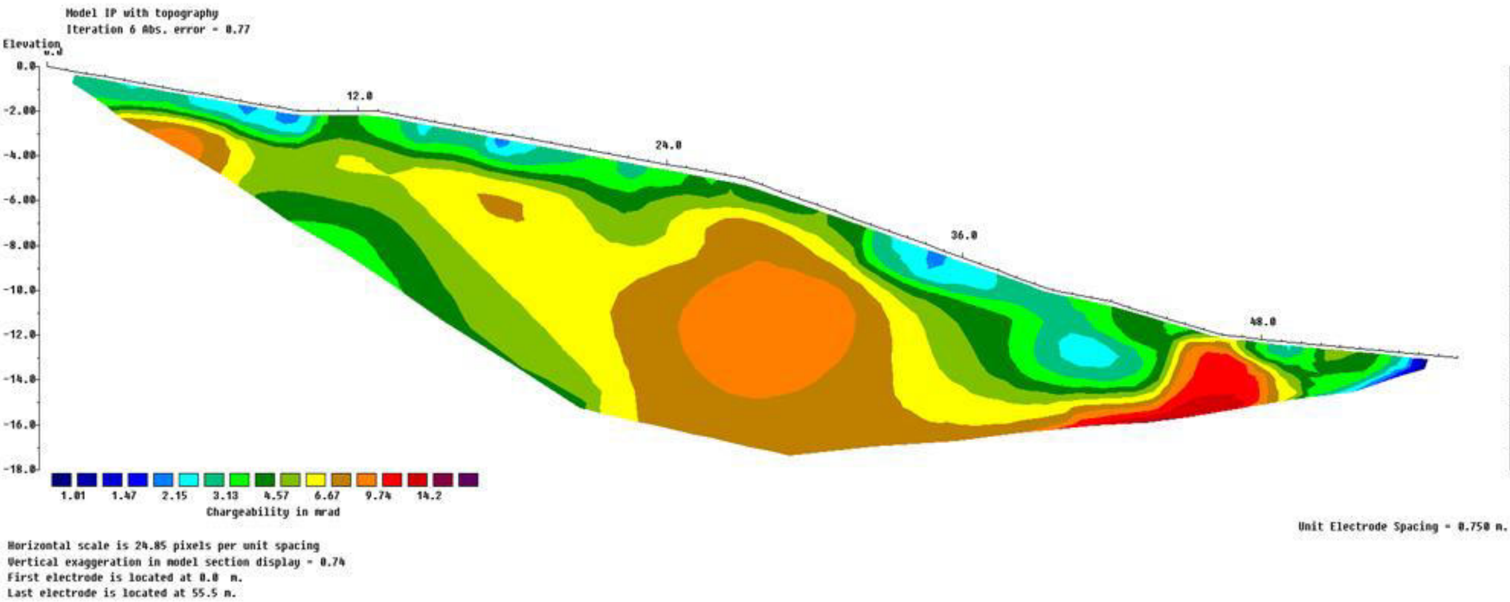
Line_01

Measurement Team: Jonathan, Sophie, Stefan; (Moll)

Line_01: Electrode Line (Moll)

Line_01
2D Resistivity/IP, Schlumberger-Array
75 Electodes, Spacing 0,75m
EG Geosciences, 12nd March 2011
Team: Philipp Moll (Survey Leader),
Sophie Mätz, Stefan Beck, Jonathan Armas





Interpretation

The upper layer appears to be characteristically rich in spoil material and therefore poorly conductive, due to its high rock content and possible cavities. Slope water likely leaches minerals from the matrix of the fractured rock, further reducing conductivity. The lower layer shows resistivity values typical of gneiss. The varying data are explained by differences in fracturing, weathering, and metamorphic mineralization.

At 12–16 m along the profile, the adjacent rock may contain cavities as a result of past mining activity. Alternatively, a barite or quartz vein may dip downward at this point, though it would be low in sulfides since the IP profile does not show increased values there. However, the elevated chargeability just to the left could be distorted by an edge effect, possibly still indicating vein-related sulfides. Another possibility is the presence of a shear zone in that area, which could also explain the higher IP values.[1]

Between 20 and 30 m, both profiles show clearly elevated readings. The width of this roughly 10 m zone most likely indicates the main shear zone. Fractured material shows increased electrical resistance due to largely stagnant water enriched with dissolved minerals. The higher chargeability can be explained by the effect of increased interfacial areas between electrically contrasting materials (see last footnote).

At around 45 m, the IP profile shows moderately elevated data near the surface, which could indicate the beginning of an ore-bearing zone. The good conductivity in this area could accordingly be caused by local soil moisture within eroded rock.

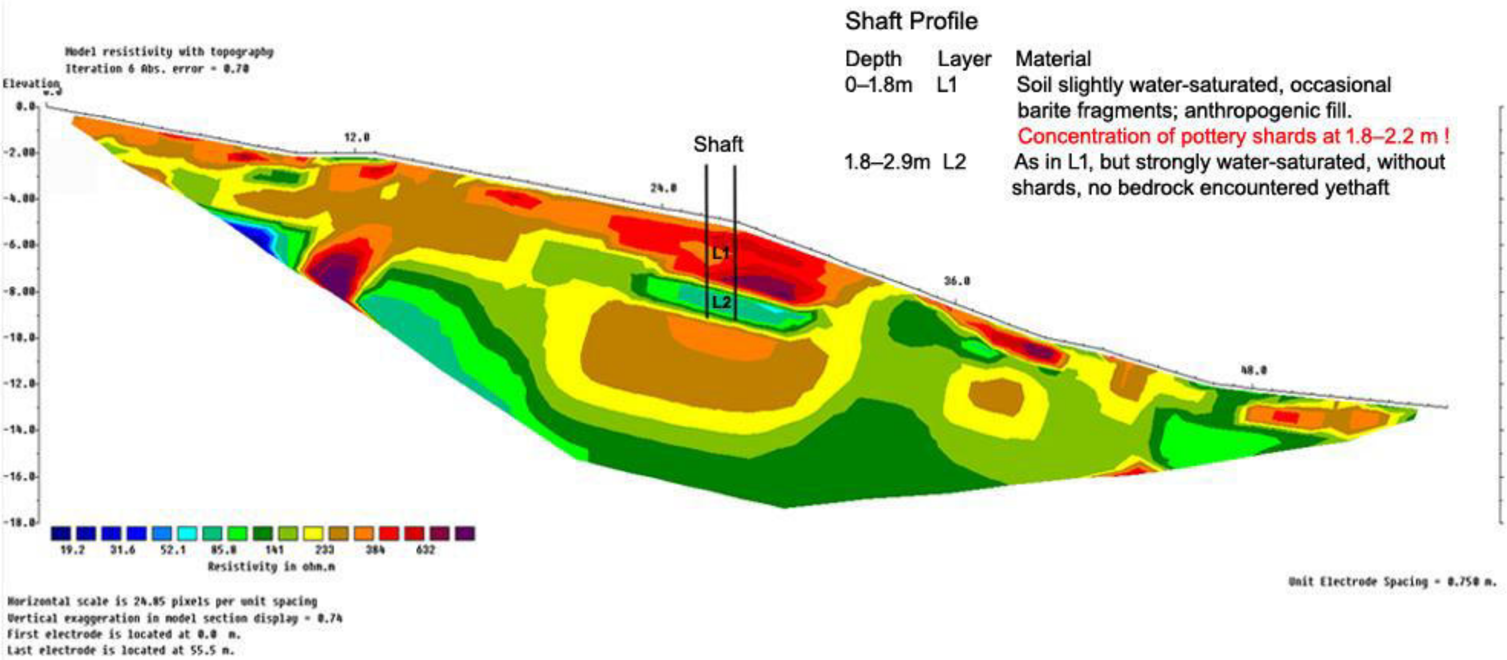
Between 20 and 30 m, there is a relatively well-conductive intermediate layer that does not fit the usual two-layer pattern (gravel above, rock below). This layer is more difficult to interpret; it might consist of material saturated with slope water that cannot drain because of a possible rock bulge below. However, it could also represent something new and unexpected. We therefore decided to conduct a test pit in the middle of this unexplained layer.

Test Pit: Jonathan, Alper, Jérome; (Moll)

[1] An increase in chargeability within a weathered or transition zone is caused by enhanced electrochemical polarization resulting from contrasts in polarizable materials. In these zones, conductive pore fluids and ion-bearing clays come into contact with less conductive but polarizable mineral grains (e.g., sulfides, oxides, or graphite). As a result, the electrical current density becomes unevenly distributed, leading to local ion rearrangement at the grain boundaries. This delayed discharge after the current is switched off manifests as increased apparent chargeability in the IP profile.

Sieving of excavated material from 180 m depth; Alper, Jonathan; (Moll)

Test Pit: Jonathan, Alper, Jérome; (Moll)



Explanation

The more conductive layer beneath is more strongly saturated with water, explaining the marked change in resistivity data. The slope-water hypothesis is thus verified.

At a depth of 1.80m, medieval pottery shards were discovered—completely unexpectedly! This leads to the strong hypothesis that the terraced topography in the area around the silver mine is not solely related to mining activities.

Apparently, as early as the Late Middle Ages, and later as well, slope terraces were constructed for agricultural purposes. This new interpretation was developed by the EG Geosciences team in collaboration with the miners, expanding the scientific understanding of the site’s history, particularly as researched by the University of Freiburg.

Line_02

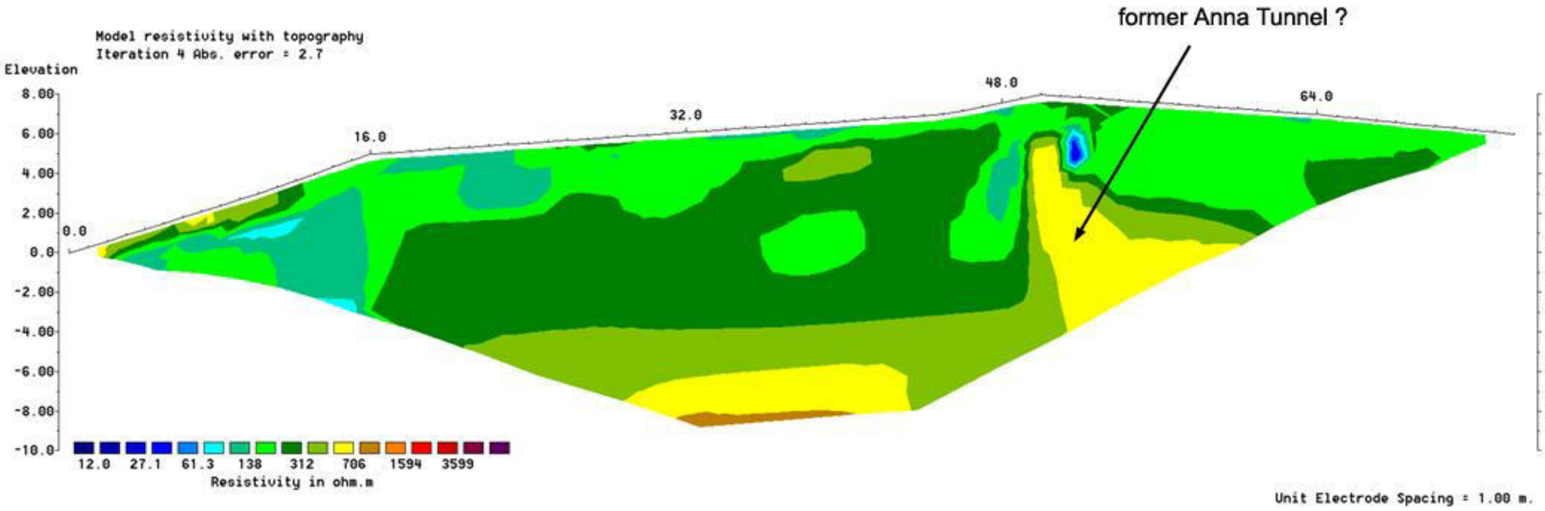
The local orientation of this survey was based on assumptions by current miners that the old Anna Vein might be located in this section. This vein is mentioned in historical records but has not yet been found. The present measurement was therefore conducted to search for this historic vein.

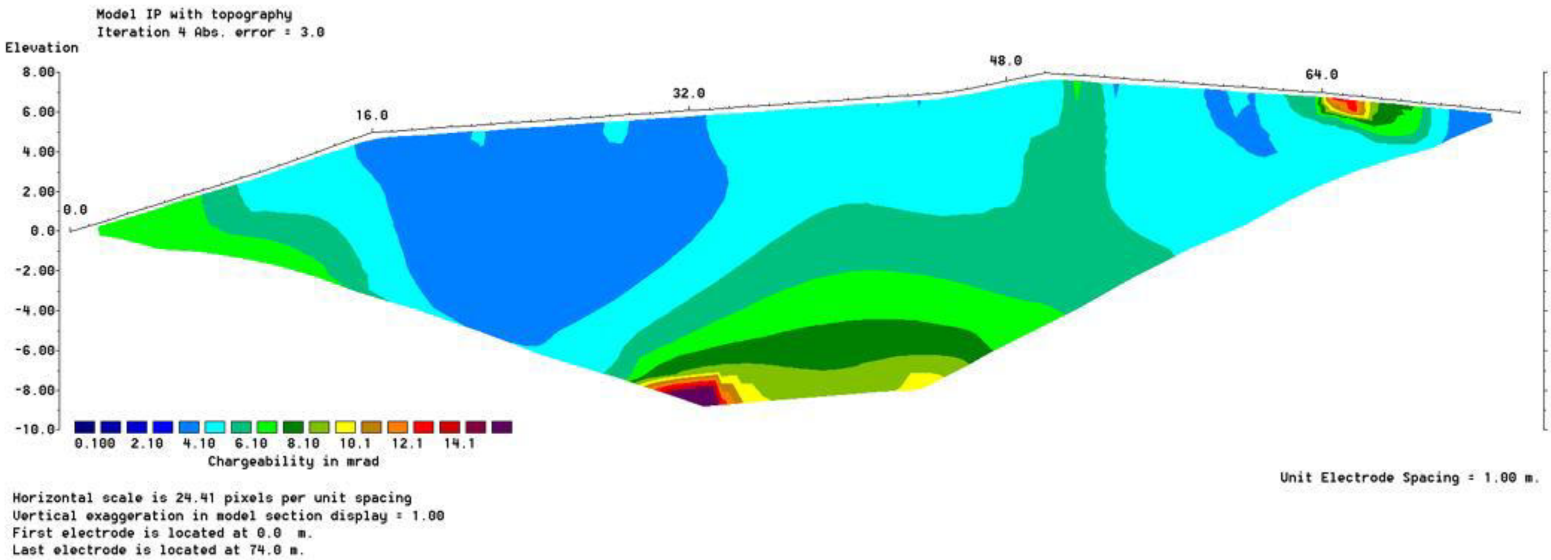
(Moll)

Line02: Electrode Line (Moll)

Line_02

2D Resistivity/IP, Schlumberger-Array
75 Electrodes, Spacing 0,75m
EG Geosciences, 13th March 2011
Team: Philipp Moll (Survey Leader),
Sophie Mätz, Stefan Beck, Jonathan Armas





Interpretation

The yellow zone visible in the profile at around 600 ohm-meters may indicate the presence of an underground cavity. However, the probability remains moderate, as the resistivity values are relatively low for an open void. The surrounding material, however, shows good electrical conductivity, which would cause the current to flow preferentially around a potential cavity. This, in turn, increases the likelihood of a vein.

The IP profile provides no reliable evidence for further probability assessment; the data high at the bottom of the profile is an artifact.

Overall, the data in this profile appear significantly more homogeneous. The measurement was taken on the opposite slope, west of the main mining area. Here, mining activity seems to have been minimal, and the geological fault zone associated with the mine does not appear to have any major effects in this area.

Profiles_03_01

2D Resistivity/IP, Schlumberger-Array
75 Electrodes, Spacing 0,75m
EG Geosciences, 14th March 2011
Team: Philipp Moll (Survey Leader),
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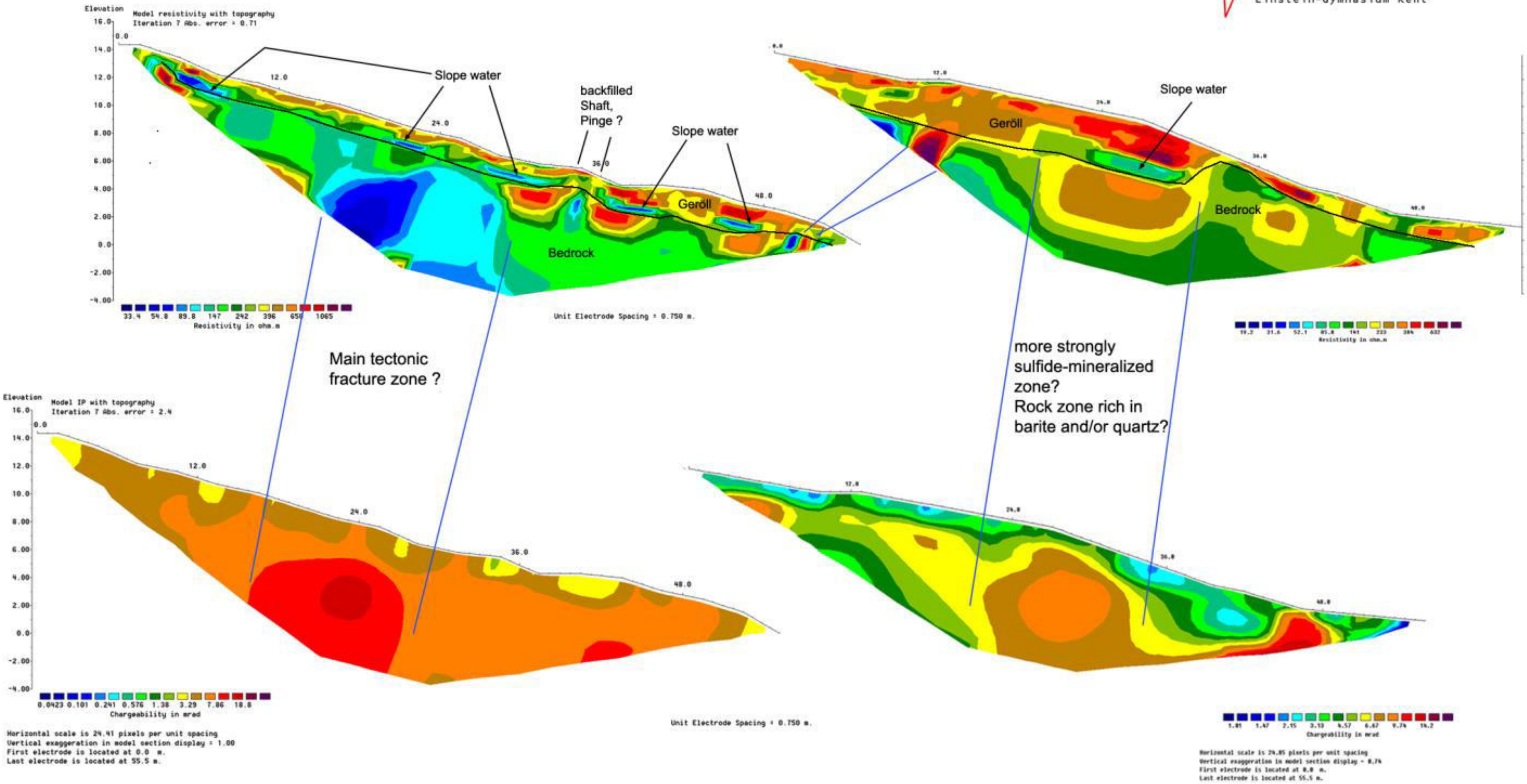
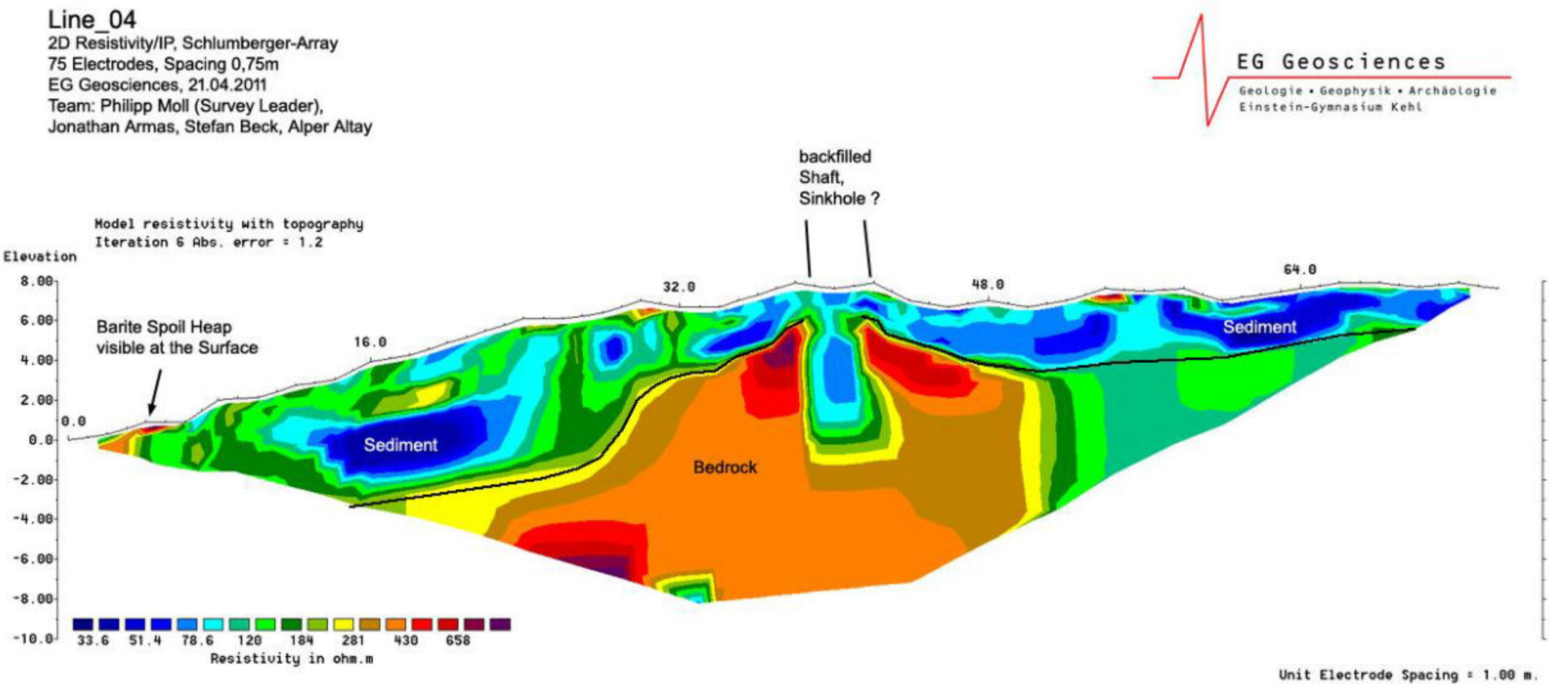


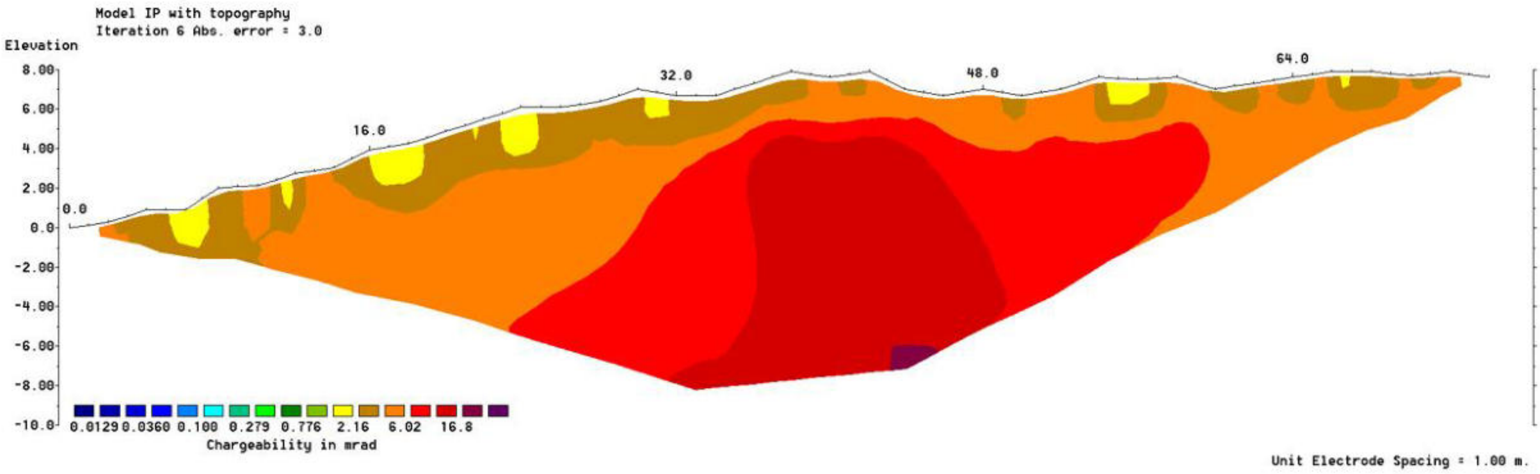
Interpretation

Profile_03 is an extension of Profile_01, overlapping by approximately 8 meters and shifted about 5m northward (see measurement map). The hypothesis—verified by the test pit in Profile_01—of slope terraces covered by saturated loose sediments, as well as the data anomaly at 12m in Profile_01, can most likely be traced further in Profile_03.

The slope terraces interpreted in Profile_03 exhibit the same internal structure as those in Profile_01, with generally similar data characteristics. The hypothetical vein observed at 12m in Profile_01 appears again—narrowed—at the end of Profile_03.

Roughly in the middle of Profile_03, the **main tectonic fracture zone** seems to have been detected—an approximately 10-meter-wide shear zone in which the material has been strongly fractured due to deformation and is permeated by water, much of which is likely stagnant or only slowly moving. This results in very high electrical conductivity as well as distinctly increased chargeability, the latter again being explained by interfacial effects between electrically contrasting materials.





Interpretation

Profile_04 appears to reflect a strongly anthropogenically modified topography of the surrounding rock. On both sides, the rock seems to have been removed through open-pit excavation.

At 16m along the profile, a less conductive intermediate layer is visible, the lower boundary of which likely indicates the onset of slope or groundwater.

In the center, there is a conspicuous depression with a strong data contrast. The highly conductive material in this central zone may represent the fill of a shaft that possibly connects laterally to a vein, as the lower boundary of the anomaly displays a tapered, plume-like shape.

Line_05
2D Resistivity/IP, Schlumberger-Array
75 Electrodes, Spacing 0,75m
EG Geosciences, 22nd March 2011
Team: Philipp Moll (Survey Leader),
Jonathan Armas, Stefan Beck, Alper Altay

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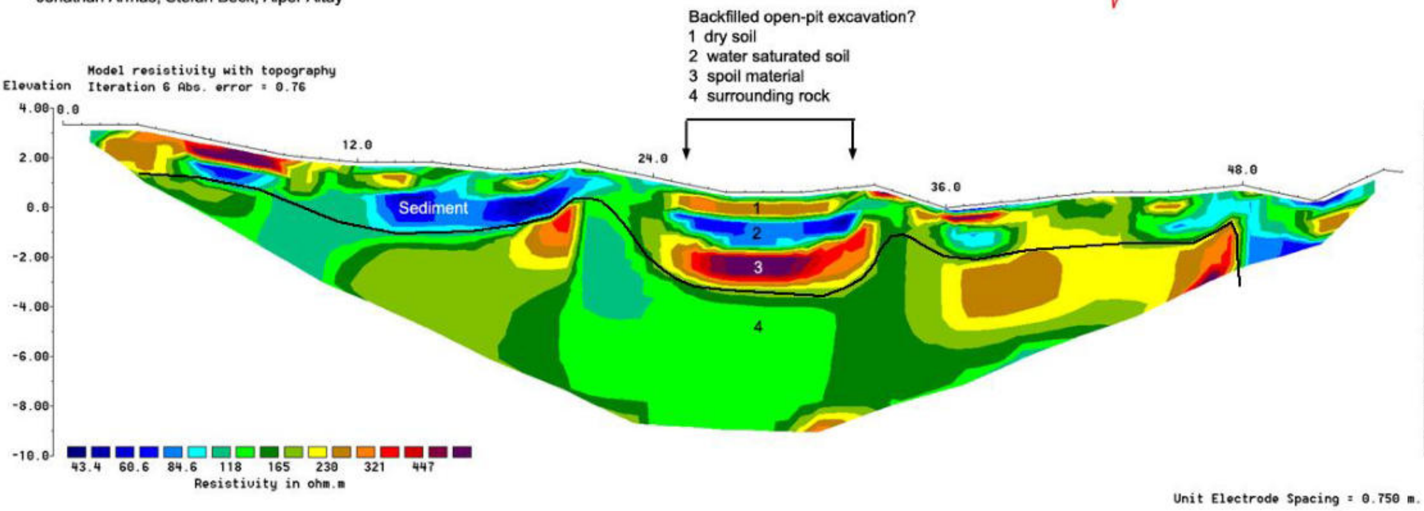
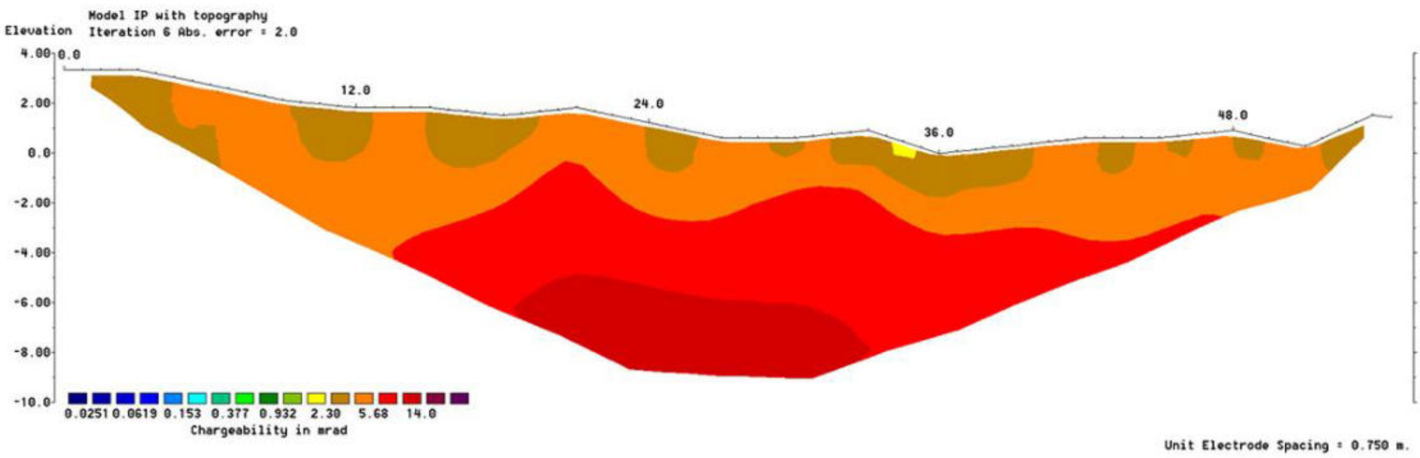
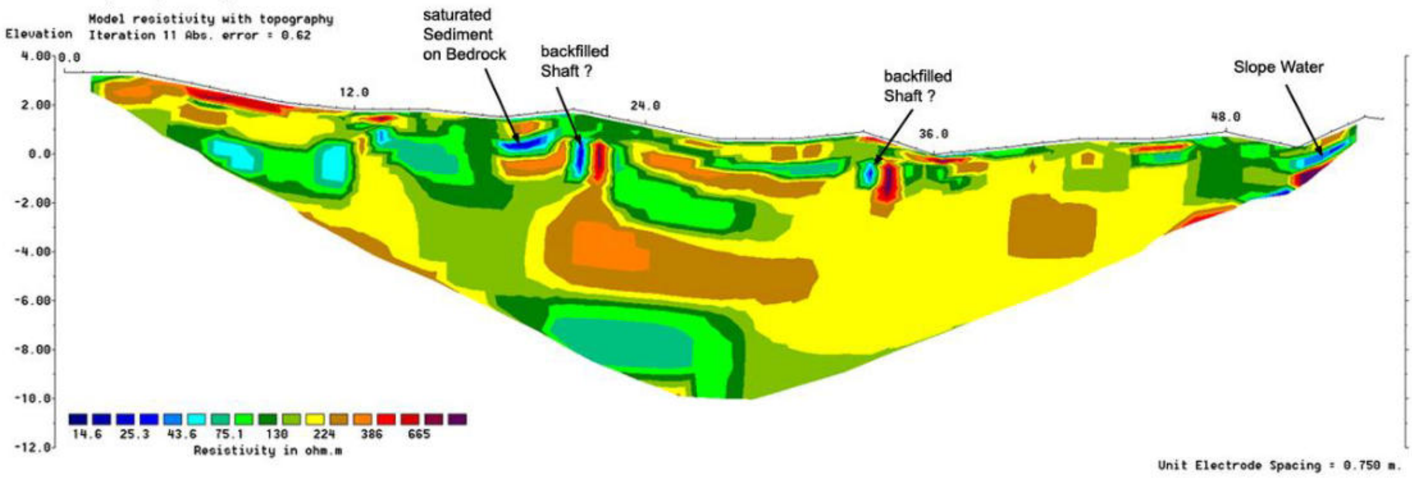
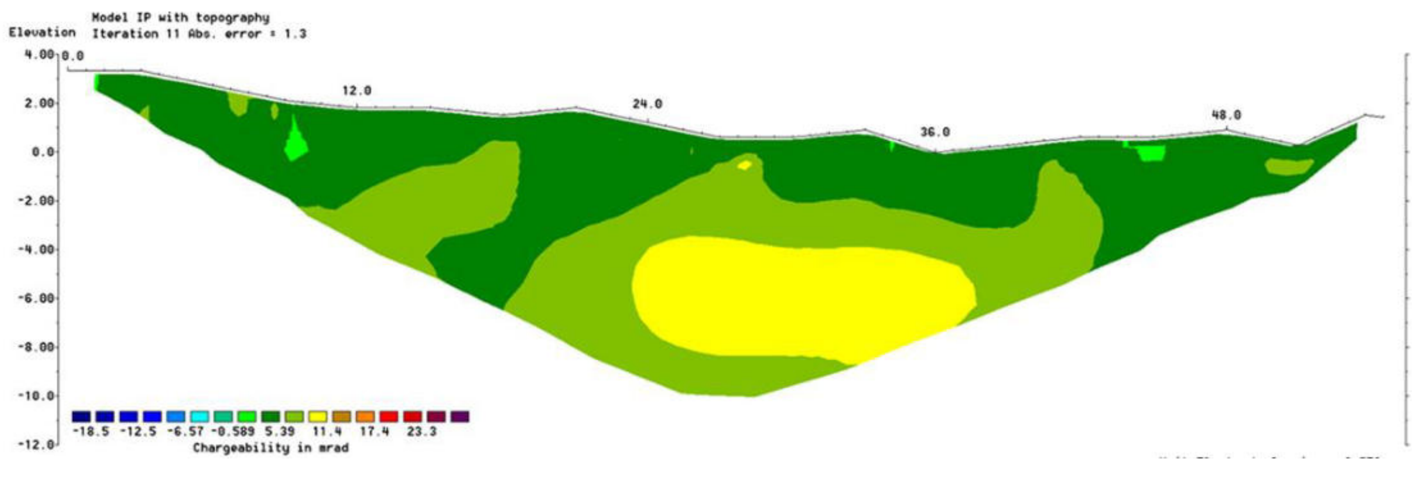




Dipole-Dipole Array





Interpretation

<u>Schlumberger Profile</u>
In the area of Profile_05, the topography of the surrounding rock also appears to have been shaped by mining activity.

In the center, a distinct stratification can be observed, most likely indicating a historical open-pit excavation. The uppermost layer is very likely dry soil; the second layer represents the groundwater zone; the third layer could consist of spoil material that has become sealed toward the surface over time; and the lowest layer is, in all likelihood, the underlying bedrock.

On the right side, around 48 meters, an interesting alteration is visible. Although the feature lies at the edge of the profile and is only partially recorded, it very likely marks the beginning of a zone influenced by mining processes.

<u>Dipole–Dipole Profile</u>
The electrode line was also used with a dipole–dipole configuration for data acquisition. As theoretically expected, the dipole–dipole profile provides enhanced insight into structures with vertical resistivity transitions.

At about 20m, the model reveals a precisely defined fine structure. This internal pattern may indicate a small shaft filled with highly conductive material. Alternatively, the adjacent high-resistivity vertical structure could represent a cavity or the onset of a barite or quartz vein. With increasing depth, this high-resistivity zone continues downward, suggesting the possible presence of a more extensive tunnel system.

Line_05 (Moll)

EG-Geosciences-Team

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