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Geoelectrical Survey at Historic Silver Mine Area, Suggental 2025-27

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Description

Together with Dr. Bock, the head of the Mining Association, geologist Peter Geerdts, and the local miners, the EG Geosciences team conducts ongoing geoelectrical investigations.

Objectives:

1. Prospection of undiscovered ore veins
2. Search for historical features such as tunnel sections, buildings, or athropogenic deposits

Mining site website [translation]:

"In recent years, various geophysical methods have been tested for their applicability in relation to historic mining and the exploration of hydrothermal barite veins—as in this specific case.

Methods used included geomagnetics, geoelectrics, seismic refraction, and gamma spectroscopy.

The results of the geoelectrical survey proved particularly convincing.

This measurement campaign was conducted in cooperation with EG Geosciences of the Einstein-Gymnasium Kehl. - Our sincere thanks and *Glück Auf!*"

https://www.silberbergwerk-suggental.com/silberbergwerk-suggental/silberbergwerk-geologie-2/

History

Mining in the Suggental probably began as early as Roman times, reached its peak in the 13th century, and ended in 1288 due to a catastrophe. Afterwards, the mine was repeatedly reopened, especially during the 18th century; mining operations have been dormant since 1938.

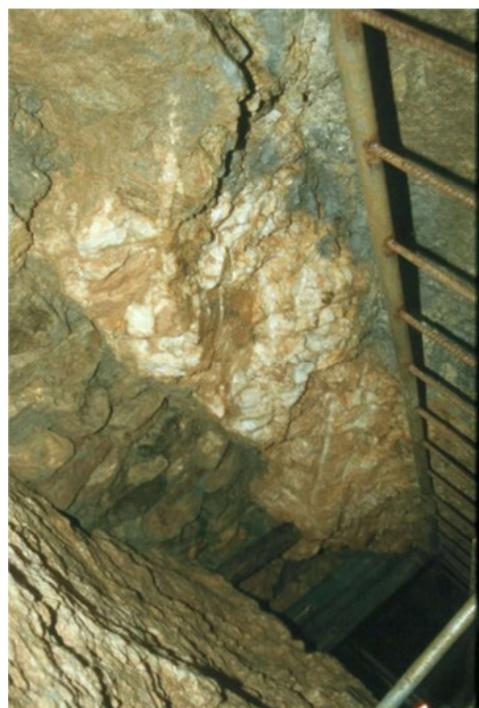Miners at Tunnel II 1937, Foto Kury Family, https://www.silberbergwerk-suggental.com/
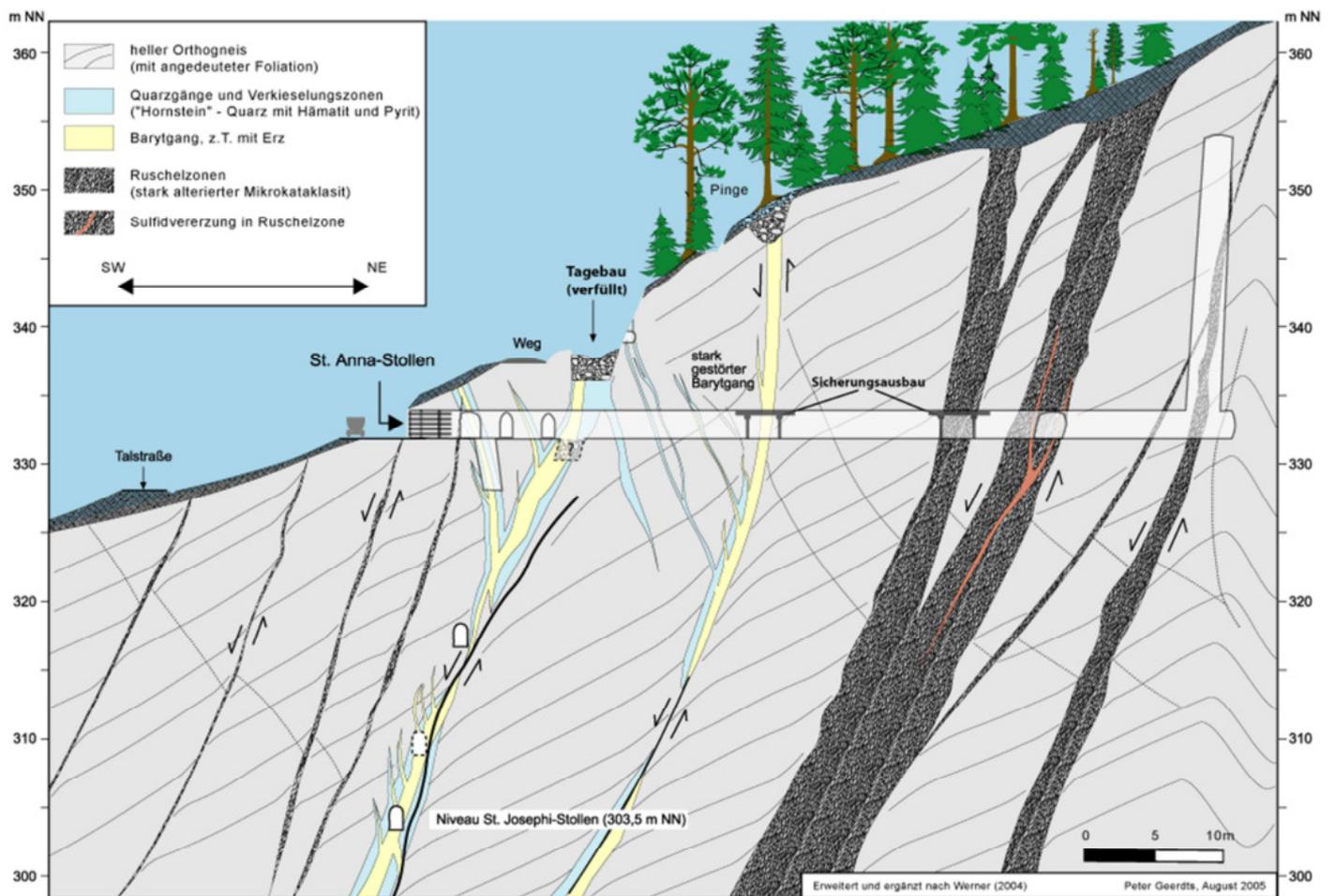
Local Geology

The Suggental is located within the Central Black Forest gneiss massif, with paragneiss and orthogneiss as the surrounding rocks.

Along a major tectonic fault, a hydrothermal vein deposit was formed. The ore vein consists mainly of quartz and barite, containing embedded sulfides such as galena, tetrahedrite, pyrite, and chalcopyrite, which were mined as silver-bearing minerals.

Several phases of mineralization indicate complex formation processes at temperatures below 200 °C from highly saline solutions.

Source: https://www.silberbergwerk-suggental.com/silberbergwerk-suggental/silberbergwerk-geologie-2/

Legend (inset, top left):

- heller Orthogneis (mit angedeuteter Foliation)
- Quarzgänge und Verkieselungszonen ("Hornstein" - Quarz mit Hämatit und Pyrit)
- Barytgang, z.T. mit Erz
- Ruschelzonen (stark alterierter Mikrokataklasit)
- Sulfidvererzung in Ruschelzone

SW ⟷ NE

Labels on section: Pinge, Tagebau (verfüllt), Weg, St. Anna-Stollen, stark gestörter Barytgang, Sicherungsausbau, Talstraße, Niveau St. Josephi-Stollen (303,5 m NN)

Scale: 0 5 10 m

Erweitert und ergänzt nach Werner (2004)   Peter Geerdts, August 2005

Green Vault: Secondary copper minerals (malachite, brochantite, chrysocolla) formed by the oxidation of copper ores in the quartz veins of the Suggental silver mine (mine website)
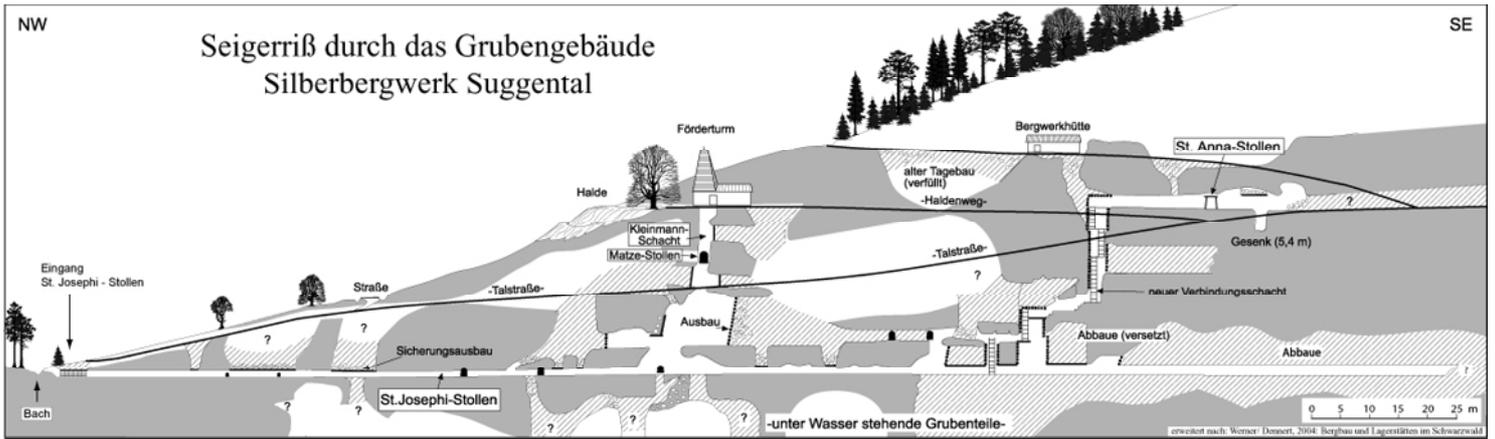
Quartz vein with a sulfide ore seam (probably galena or tetrahedrite) from the Suggental silver mine (mine website)

Quartz-sulfide ore from the Suggental silver mine – quartz with pyrite and chalcopyrite (mine website)

Currently accessible sections of the mine

Seigerriß durch das Grubengebäude
Silberbergwerk Suggental

580 meters of tunnels are currently accessible, with a maximum elevation difference of 50 meters
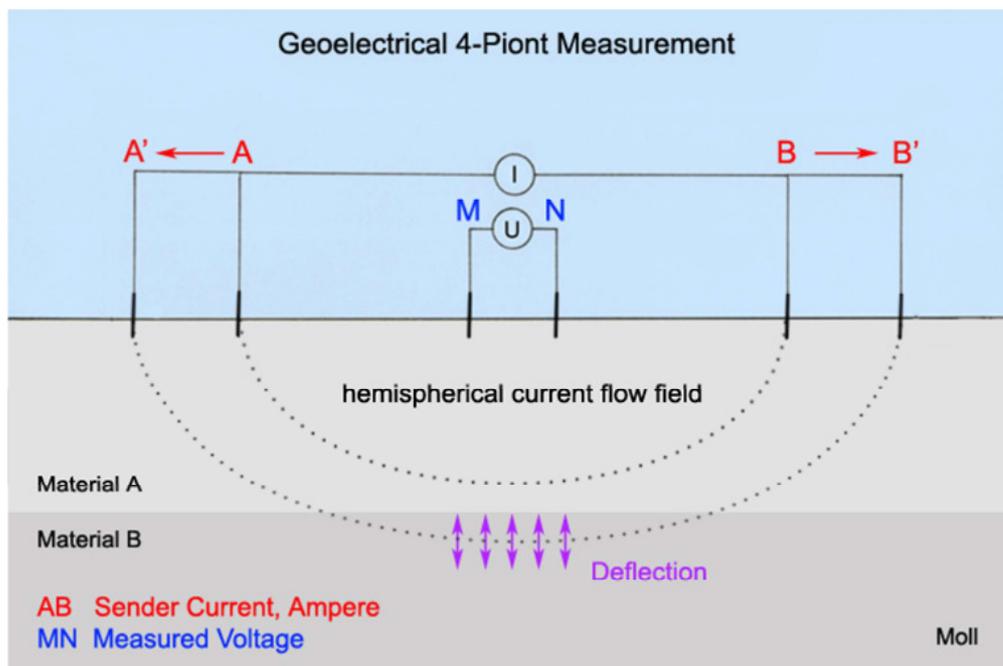
Geoelectrics

Methods Used

Electrical Resistivity Tomography (ERT):
ERT determines the spatial distribution of electrical resistivity in the subsurface by injecting current and measuring the resulting voltage response. Differences in resistivity allow conclusions to be drawn about lithology, porosity, water content, and structural disturbances of the Earth's crust.
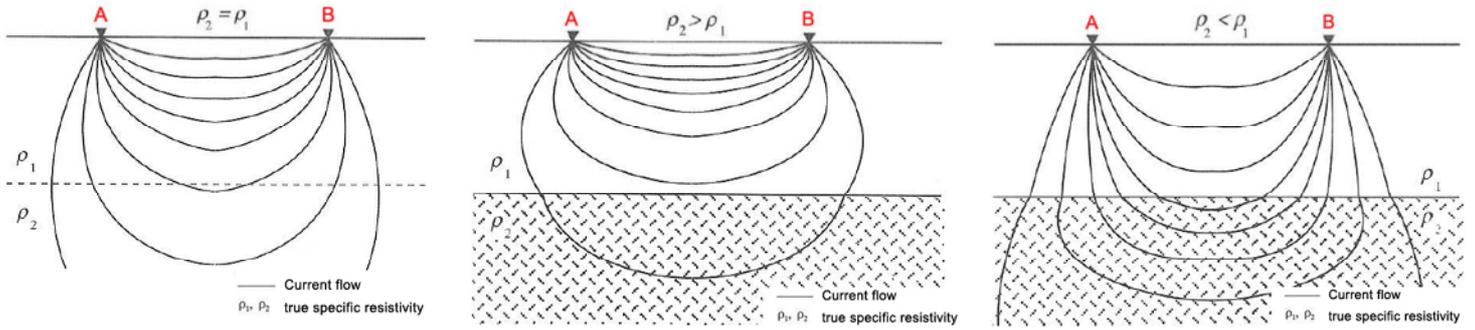
Induced Polarization (IP):
IP measures the delayed decay of the electric field, capturing the ability of rocks to store electrical charges. This behavior is typical of clay-rich or sulfide-bearing zones and is specifically used for mineral exploration and the characterization of fine structural features.

Both methods are measured **simultaneously** and provide a complementary electrogeophysical model of the subsurface.

Geoelectrical 4-Piont Measurement

hemispherical current flow field

Material A

Material B

Deflection

AB   Sender Current, Ampere
MN   Measured Voltage

Moll

Deformation of Geo-Electrical Current Fields depending on Changes in Ground Conductivity:[1]


2-dimensional Resistivity Measurement:
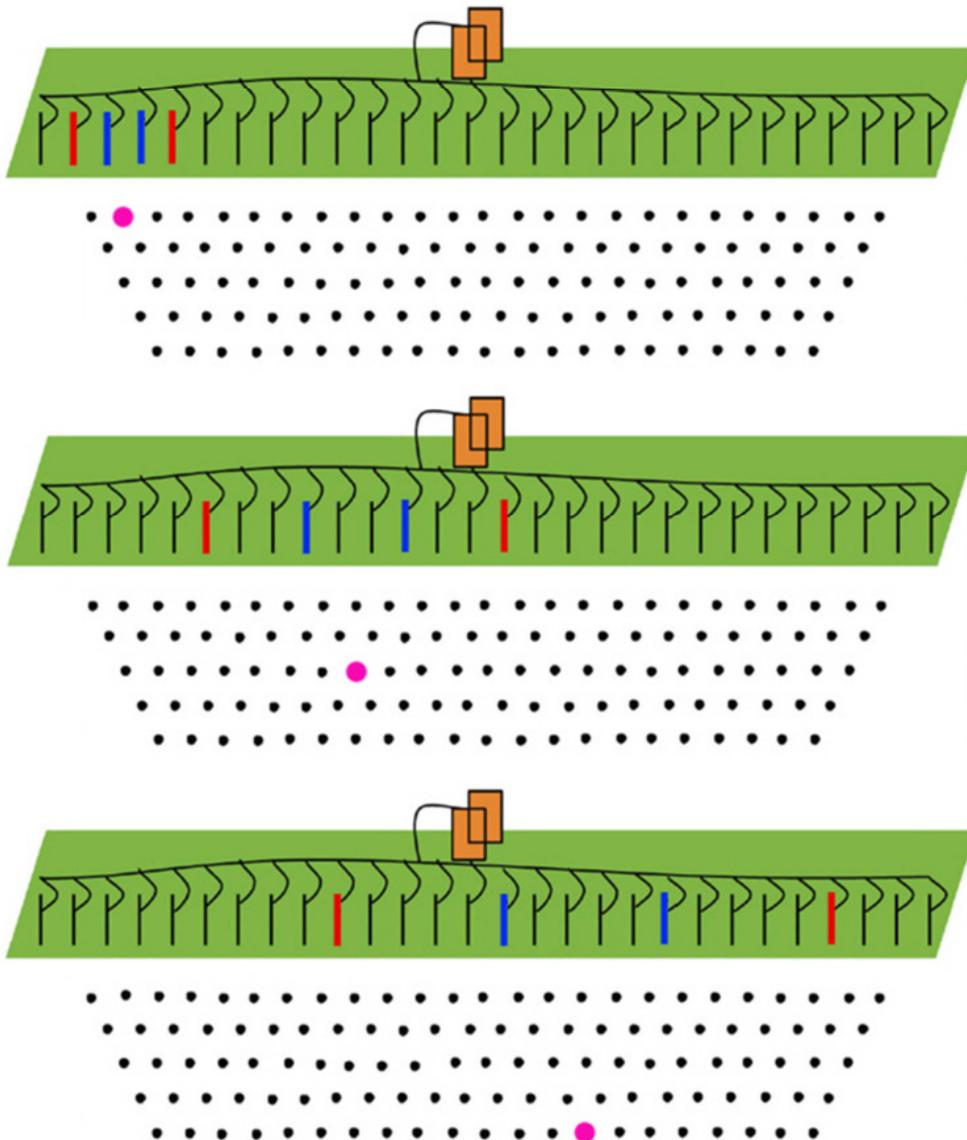
[1] Script "Geophysik", Prof. Dr. A.Henk,

Electrical resistivity measurement: For each four-point measurement (see above)—consisting of injecting a defined current through electrodes A and B and recording the resulting voltage between electrodes M and N—the apparent specific electrical resistivity of a particular hemispherical subsurface volume can be calculated according to Ohm's law. By systematically accumulating a large number of individual measurements that differ in position and electrode spacing, a two-dimensional data space filled with resistivity values is created (see image above). Specialized software then computes a 2D subsurface profile in which zones of differing electrical conductivity or electrical resistivity are displayed using a color scale. Such a model must ultimately be interpreted in the context of the local geological conditions.

Using a custom-built patch box, the required electrodes (A, M, N, B) are addressed along the survey line. Hundreds of four-point measurements are carried out, with the banana plugs being repositioned for each individual measurement. In this way, the team is able to generate within six hours a dataset comparable to that of an automated geoelectrical tomography system. The data quality is comparable, as the manually operated single-channel instrument delivers highly precise measurements.

The hemispherical current flow fields are simultaneously used to carry out an induced polarization (IP) measurement. In IP surveying, after the subsurface has been electrically charged, the time-delayed voltage decay following shutdown of the current source is recorded. The resulting phase shift is measured in milliradians and subsequently visualized in a 2D model.

In geoelectrical surveys, different electrode configurations (arrays) are used in order to optimally image different types of subsurface structures.
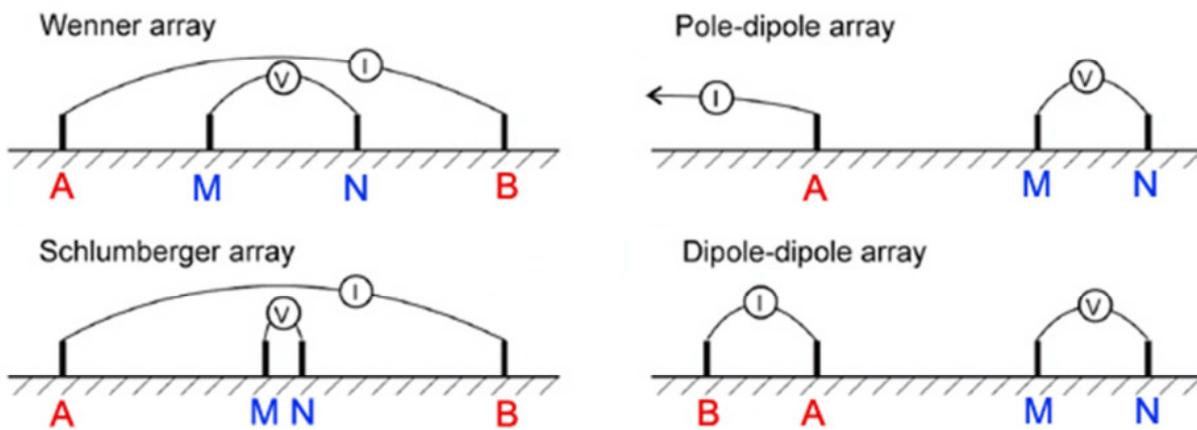
The **Wenner array** provides stable, high-quality data and is used for a general overview of the subsurface.

The **pole–dipole array** enables the detection of broad horizontal structures at greater distances.

The **Schlumberger array** allows for detailed depth exploration and offers good resolution of horizontal layering through localized current loops.
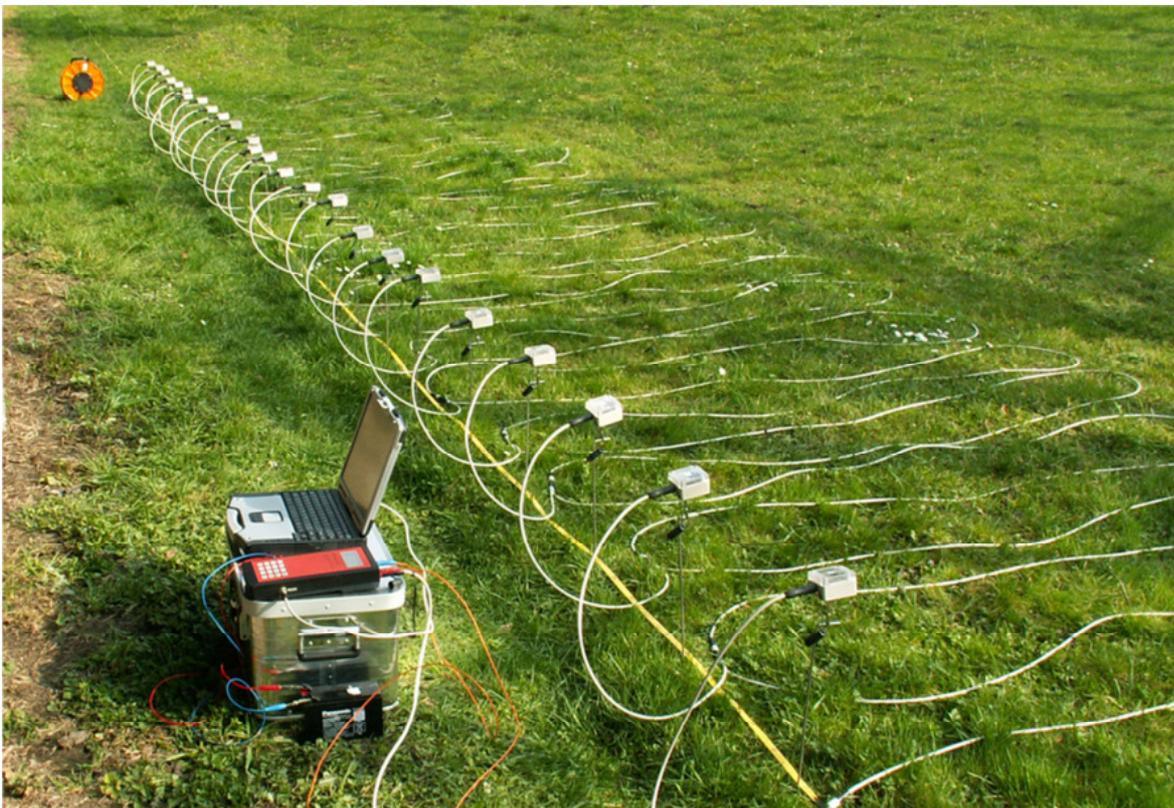
The **dipole–dipole array** provides high sensitivity to vertical resistivity alteration and delivers fine resolution of vertical structural changes.

Manual Measuring Equipment:
Student-built system: 370 m serial cable, 75 stainless steel electrodes, connection box.
Loan from Lippmann company: 4-Point Light measuring device, maximum sender current 50 mA (Moll)

Automatic Measuring System: Loan from Lippmann company – active electrodes with **4-Point Light** measuring device, maximum output current 100 mA; (Moll)