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Heaps of Information – Exploratory Data Analysis of Geophysical and Borehole Data for the Investigation of Tailings at an Abandoned Mining Site using "R" and a 3D-Geodatabase.

Heinz Reitner [1,*], Christian Benold [1], Adrian Flores-Orozco [2], Jakob Gallistl [2], Alexander Römer [1], Albert Schedl [1]

(1) Geological Survey of Austria, Neulinggasse 38, 1030 Wien, *heinz.reitner@geologie.ac.at

(2) Technische Universität Wien, Research Group Geophysics

Investigation of Tailings at an Abandoned Mining Site

The authors investigated tailing heaps at an abandoned mining site by means of geo-electrical profiles and geochemical analyses of borehole samples to study the extent, structure, material properties and metal content of the heaps. Datasets of mine waste sites, boreholes, electrical resistivity, induced polarization and geochemical content were 3D-georeferenced for import into a 3D-geodatabase of a Geographic Information System (GIS).

Study Area: Schwaz (Tirol, Austria)

Our study took place in the Falkenstein mining district near the city of Schwaz in the lower Inn valley (Figure 1). Schwaz has been one of the most prominent Tirolean mining areas, where activities of mining of copper and silver in fahlores peaked in the 16th century. The book „Schwazer Bergbuch", year of publication is 1556, is testimony of this time (Figure 2). To the present a large number of mining adits, shafts and mining waste sites remained. These are registered in the „Nationwide Inventory of Mining and Waste Sites" of the Geological Survey of Austria. We selected one of the mine waste sites for examination in our study (Figure 3).

Fig. 1: Location of Schwaz mining area, Tirol, Austria.

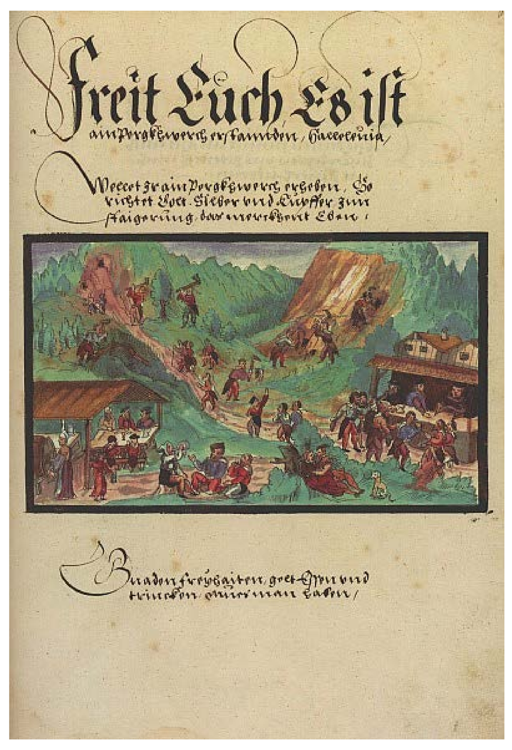

Fig. 2: The Schwazer Bergbuch, 1556. © Austrian National Library

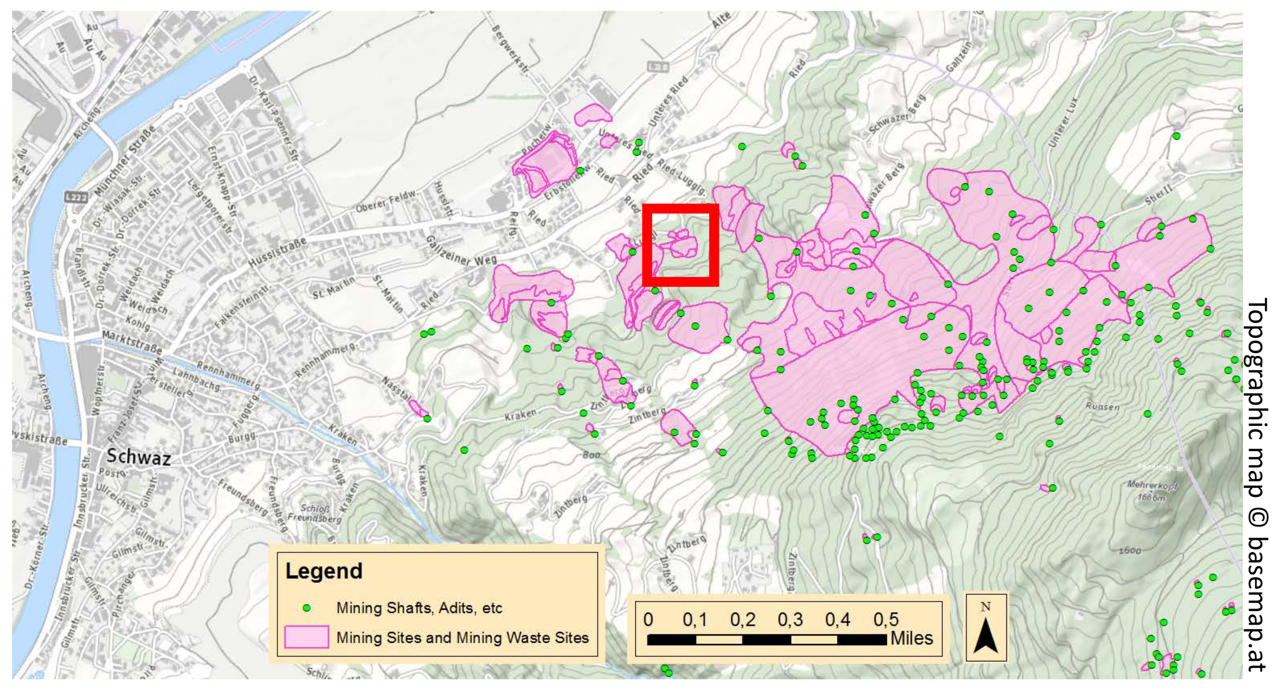

Fig. 3: Nationwide Inventory of Mining Sites and Mine Waste Sites of the Geological Survey of Austria. Map detail of Schwaz mining area (study area outlined in red).

Field Work and Laboratory Analysis

Geophysical measurements were accompanied by drilling of boreholes. Core samples were analyzed for metal content on site by using a handheld XRF device (Figure 4).

The results of the extensive geophysical measurement campaign enabled detailed mapping of a former unkown, coarse grained part of the waste site (Figure 5, top row).

Additional geochemical and grainsize analyses of the samples were made in the laboratory, supplemented by microscopical and micro-chemical analyses. These revealed low metal content and the occurrence of secondary mineral phases due to weathering (Figure 5, bottom row).

Fig. 4: Field work included geophysical measurements, drillings and handheld XRF.

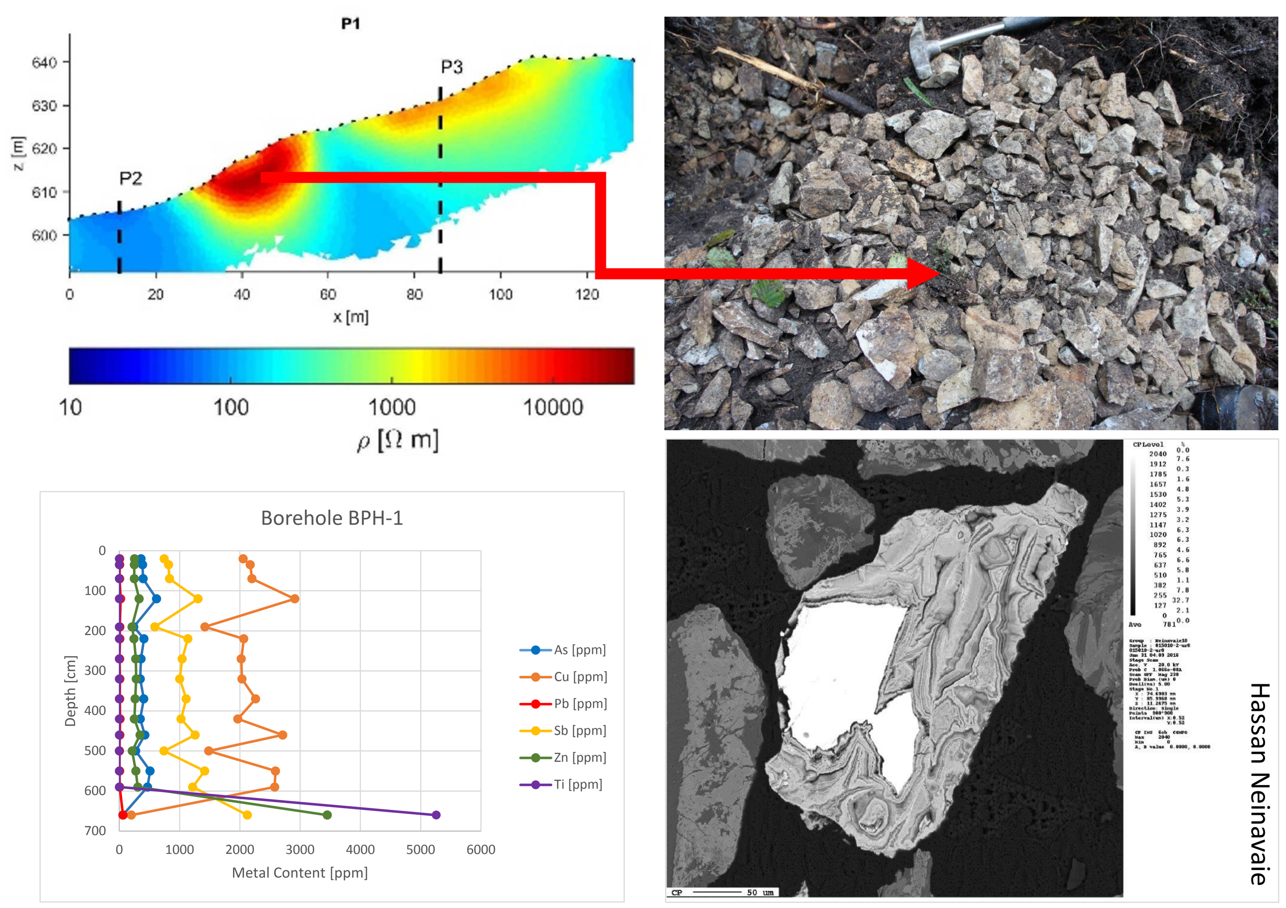

Fig. 5: Discovery of coarse-grained waste site (top row) and detection of low metal content and secondary mineral phases (bottom row).

3D Geodatabase and Geographic Information System (GIS)

Using the 3D-geodatabase, a simultaneous display of the datasets on-screen enabled quality checks of location and values of the measurements as well as the detection of trends and structures in the data. The local government of Tirol in Austria provided a detailed digital terrain model (DTM) of our study area, generated by light detection and ranging (LIDAR) data. The revised waste site map was draped on the DTM according to the results of the field work (Figure 6).

Additionally different 3D-georeferenced datasets of borehole lines, location of samples and geochemical and geophysical measurement data were added (Figures 7 to 9). The software products ArcCatalog® and ArcScene® of Environmental Systems Research Institute (ESRI®) were used for data storage and visualization.

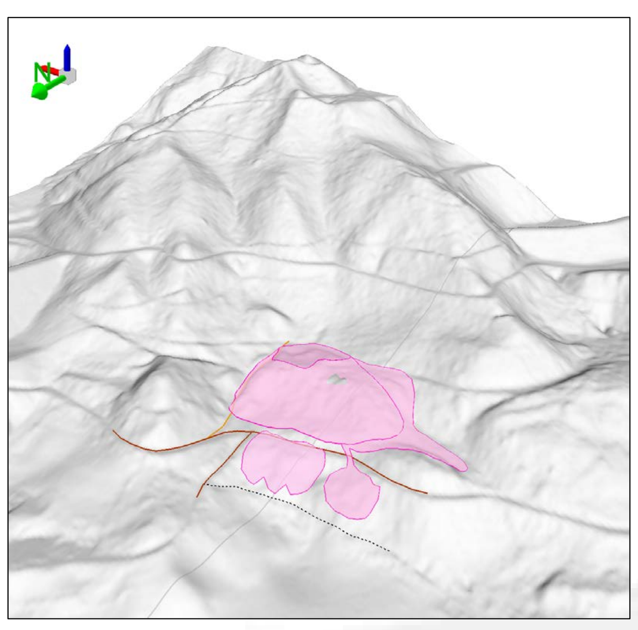

Fig. 6: Revised waste site map draped on DTM (LIDAR data).

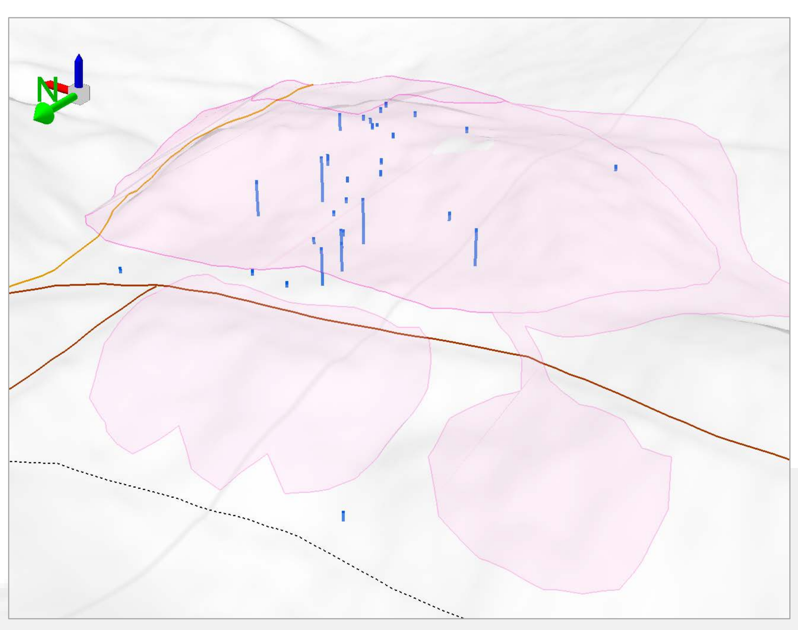

Fig. 7: 3D datasets of borehole lines and sample pits added.

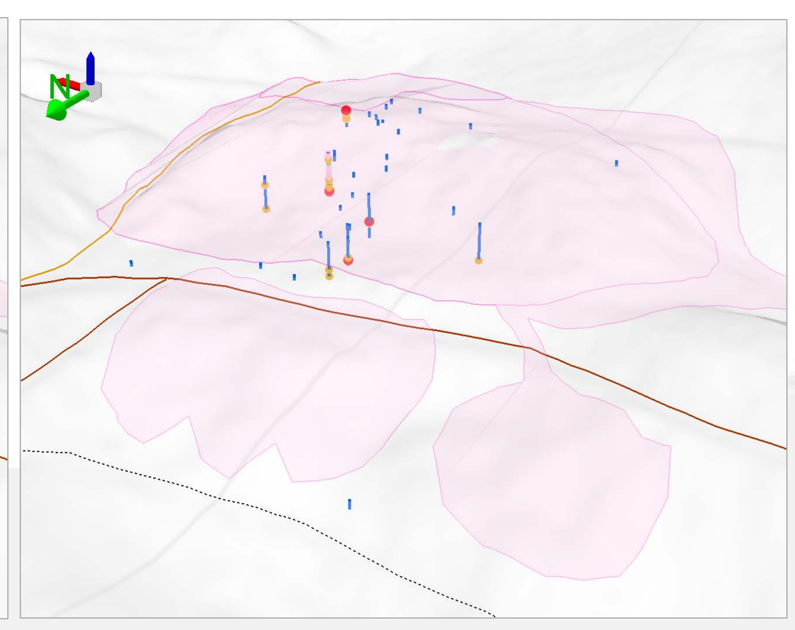

Fig. 8: 3D location of samples, symbols according to metal content.

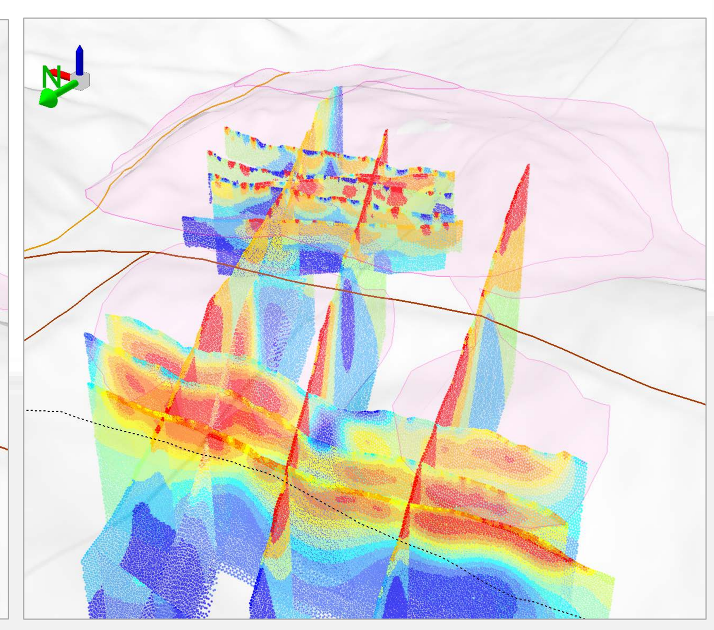

Fig. 9: 3D data of geophysical resistivity measurements.

Exploratory data analysis using „R"

The free software for statistical computing "R" (R Core Team, 2017) was used to retrieve and process data from the 3D-geodatabase using the R-library "RODBC" (Ripley, 2017). Exploratory data analysis (EDA) tools of the R-library "StatDA" (Filzmoser, 2015) were applied to investigate and interpret the data. The use of the EDA-tools enabled the detection of subgroups and patterns in the data structure (Figure 10).

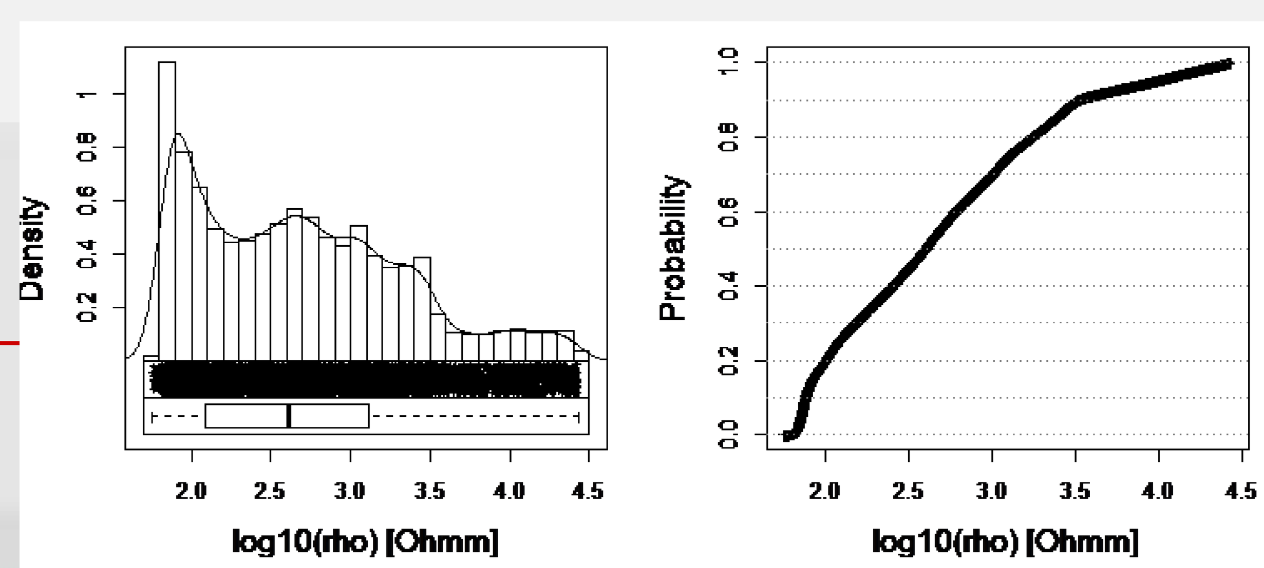

Fig. 10: Exploratory data analysis of datasets, i.e. geophysical resistivity measurements (for comparison see Figure 5, top row).

References: Filzmoser, P. (2015). StatDA: Statistical Analysis for Environmental Data, R-Package.
Ripley, B. (2017). RODBC: R-Package.
R Core Team (2017) R: A Language and Environment for Statistical Computing. https://www.R-project.org/

Bundesministerium Bildung, Wissenschaft und Forschung

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