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MAGNETIC STUDY OF TOPSOIL POLLUTION IN THE AREA EISENERZ

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Magnetic susceptibility mapping and further investigation of magnetic properties are used since several years to investigate the pollution influx on soils. The advantage of this method is the fast and easy spatial delimitation of heavy metal-polluted sites, due to the correlation of magnetic susceptibility and heavy metal content of soils, found in several studies in recent years. (Bityukova, et.al., 1999)

The area of investigation is a valley in northern Styria, Austria, which is famous for its long history of iron minino and steel production. Over a period of 6 centuries, iron production was big business in this area, starting with small iron production sites in the 13th century and 32 iron foundries in production during the middle of the 19th century. The last iron foundry was closed just after World War II.

The valley was investigated along several profiles with a Bartington MS 2 D Kappameter. The exact measurement points were determined with a Trimble GPS Total Station. In order to get information only about the pollution influx from the industry, the distance to major and minor roads was kept at a minimum of 20 meters. This avoids influence of the vehicle derived magnetic material (Hoffmann, et.al., 1999) The results of the field measurements are plotted in Figure 1.

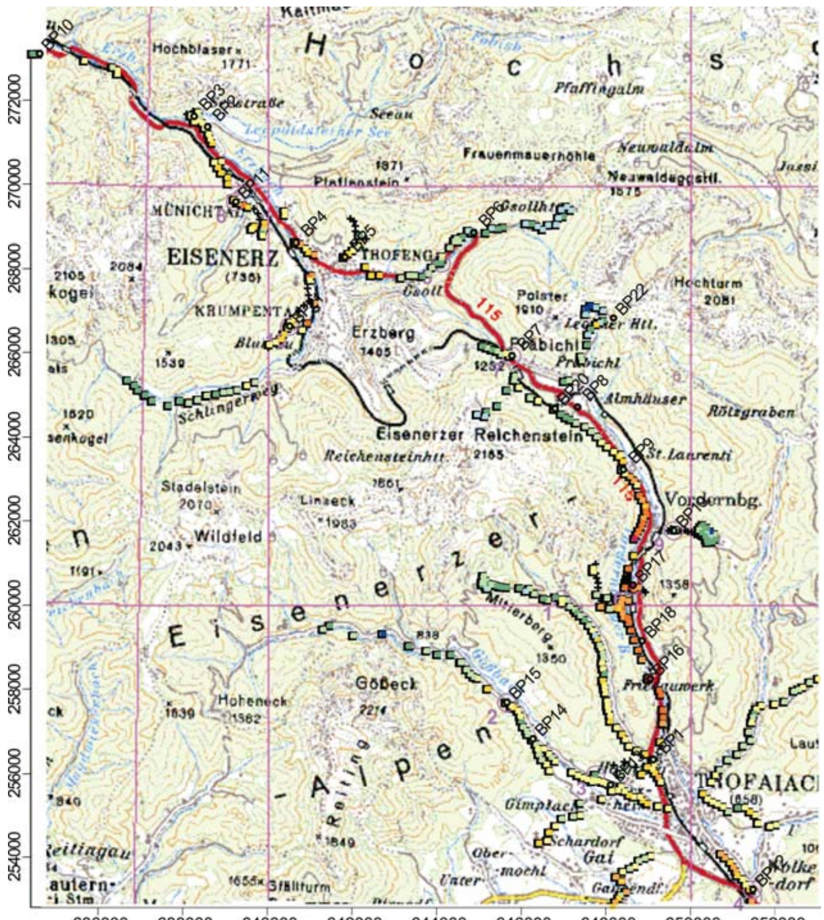

Figure 1: Distribution of surface susceptibility on meadow (boxes) and forest (crosses) soils. Indicators for soil sample and soil profile positions

In order to achieve more information on the origin of the magnetic materials, depth profiles were measured and soil core samples (30 cm length) were obtained. Most of the depth profiles showed enhanced susceptibility values in the topsoil (Figure 2). This is an important feature of anthropogenic influenced soils (Hanesch, et.al., 2002) Only one depth profile (Figure 2: Depth Profile 2) showed a geogenic origin with magnetic susceptibility increasing from top to bottom.

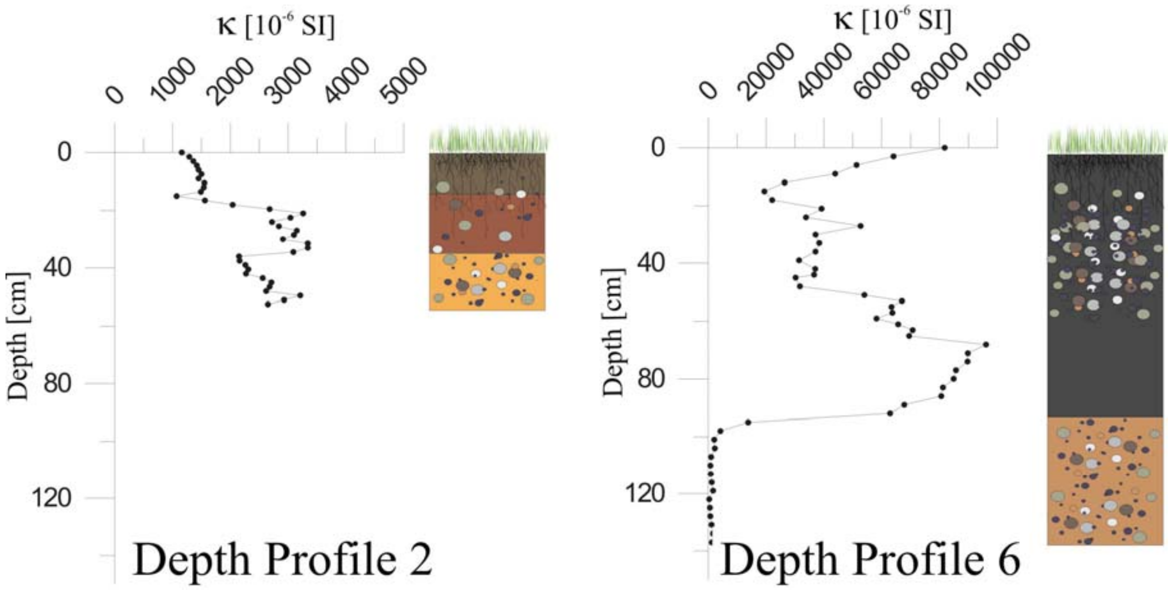

Figure 2: Susceptibility in depth profiles with sketches of soil horizons observed in the field. Profile 6 is in Vordernberg. Profile 2 is from Goessgraben. Please note the different scales of the x-axes.

The susceptibility of the soil in the cores samples was measured with a Bartington MS 2 B Sonde. The measurement built the basis for the sub-sampling for the measurements of further magnetic properties, such as mass-specific susceptibility, the frequency dependence of the susceptibility, the high temperature behaviour (Curie Points) and the isothermal remanent magnetization (IRM) behaviour.

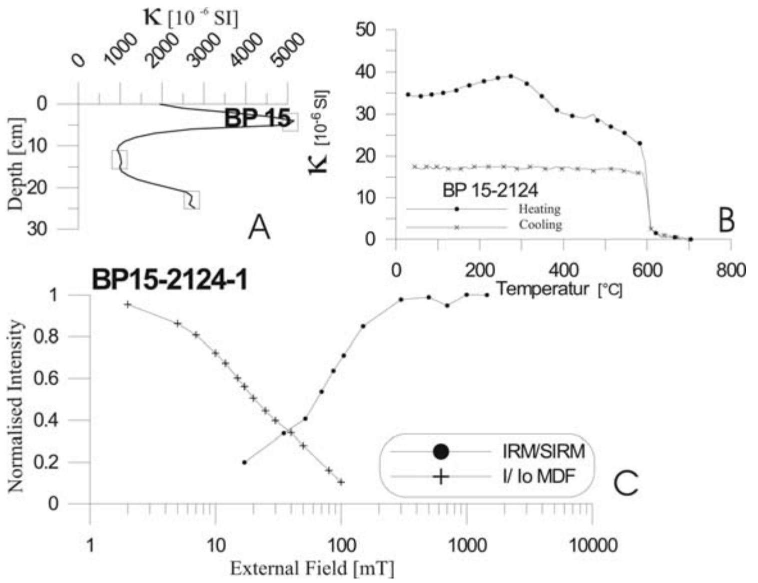

Figure 3: Determination of magnetic parameters. A: Measurement of susceptibility on soil cores, boxes mark the position of sub samples; B: High temperature susceptibility on extracts; C: IRM acquisition and AF demagnetisation of SIRM

It is clearly visible that the magnetic susceptibility of the topsoils in the investigated area is dominated by two big anomalies.

The first anomaly in the village of Vordernberg shows the highest amplitude in magnetic susceptibility. During field work, a layer of very dark material showing extremely high susceptibility values, with thickness ranging from 10 cm up to ~ 1m was found everywhere around this village. In accordance to historical reports this is a layer of ash and soot, a relict from the intensive iron production. All the in-situ and core depth profiles showed anthropogenic pollution characteristics, with the highest susceptibilities in the top soil. This is also confirmed by the results of the detailed magnetic measurements on the subsamples. Curie Temperatures (measured on extracts) range from 580 to 605°C, the IRM Component analysis (Kruiver, et.al., 2001) showed very unstable (low coercive) components, both are indicative for technically derived magnetite-like material.

The second anomaly in the northern part, shows also high susceptibility values, but of less amplitude compared to Vordernberg. This is a result of the broader valley and therefore better wind and distribution conditions. This anomaly is also mainly caused by anthropogenic material, depth profiles showed enhanced topsoil susceptibility and the laboratory measurements indicate technically derived material.

Another anomaly, spatially small and of low amplitude, was found in the “Goessgraben”. For this anomaly the depth profiles showed small enhancement of susceptibility in the top soil, but also increasing values to deeper soil horizons. The influence of the highly magnetic ignimbrites present in this area (Ströbl, 1980) is more indicative in the field measurements. The IRM and Curie temperature characteristics of the geogenic minerals are disguised by the influence of the anthropogenic material, which is also present in the samples. IRM Component analysis gave evidence of two phases ($B_{1/2}$ = 20-25 mT and $B_{1/2}$ = 79-125 mT) with increasing contribution of the higher coercivity component to the subsoil.

The magnetic data was then compared with some geochemical data, but due to a lack of geochemical data it was not possible to find a correlation.

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