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Heavy metal contamination around the As-Pb-Zn-Au-mine at Astano (Malcantone, Ticino)

Extended abstract

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1. Introduction

In the Malcantone area 15 km W of Lugano in the southern part of Switzerland (Fig. 1), several small sulfide ore deposits rich in As, Pb, Zn, Fe and Au occur. These were mined for gold from the middle of the 19th century to about 1950. Between 1984 and 1989 a Canadian mining company made a new exploration campaign for gold (Schneiderfranken 1943, Köppel 1966, Hansen & Köppel 1985, Laureri 1985, Bazzurri 1989, Gex 1990). The country rock of these ore deposits are K-feldspar- and plagioclase- gneisses and minor amphibolites and schists of the Strona-Ceneri Zone of the Southern Alps. One of the larger ore bodies is situated between the villages of Astano and Sessa, close to Italian border (cf. Fig. 1). A sulfide-vein system, between 50 and 150 cm thick, outcrops on an east-west orientated hill over a total length of about 1,200 m. It contains pyrite, arsenopyrite, sphalerite, gold and galena.

Between 1855 and 1950, three systems of adits were built with a mean length of 300 m (mines of Costa, Bolle and Perla) and at least 2,000 tons of ore containing between 6 and 36 g/ton gold were mined. At the eastern end of the ore zone close to the road Sessa-Astano near the village of Beredino a concentration plant based on flotation was built (destroyed around 1970) and the concentrated ore was sent to Belgium for further treatment. The non-productive rocks have been dumped on the vineyards and grasslands below the mine entrances. These and considerable quantities of highly concentrated ores close to the former concentration plant are the subject of this pollution study, involving soils and dump material analyses.

2. Methods

Around forty soil samples at different places and depths around the former mining area on the Scree hill side have been taken, half of which following the procedures foreseen

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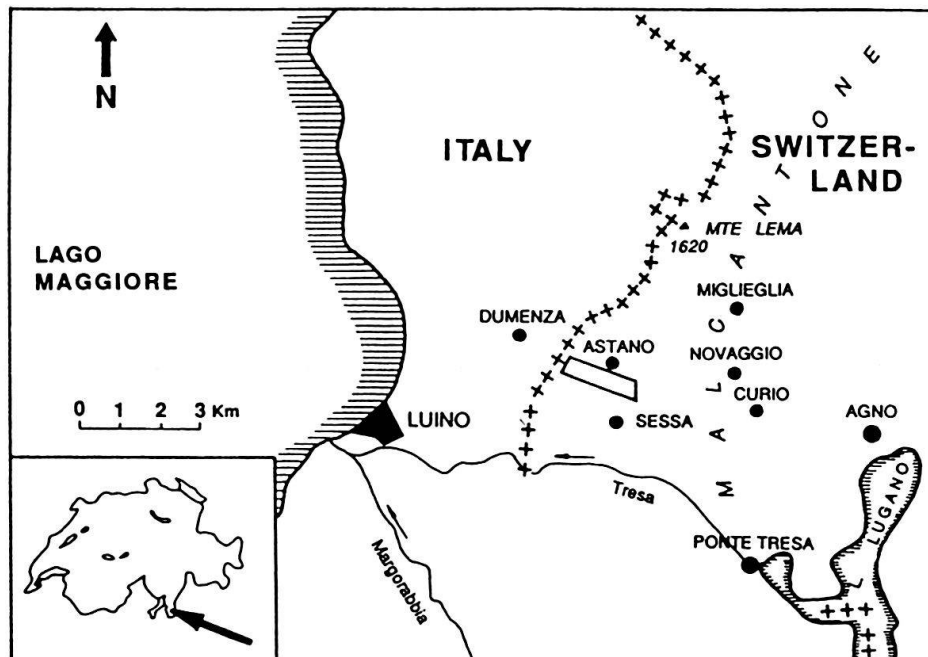


Fig. 1. Location of the study area (emphasized by a rectangle). Adapted from Gex (1990).

by the Swiss Law on soil protection (VSBo 1987), i.e. a representative sample of the top-soil (first 20 cm) and the deeper soil (50 to 80 cm). The other samples were collected as single soil horizons. The 0-2 mm fraction of most samples was then analysed by three different methods: (1) extractable heavy metal contents contained in solutions extracted with nitric acid (Cd, Co, Ni, Cu, Pb, Cr, Zn, Hg, Sb, Sn, Ag, As), (2) extracted with NaNO_3 (Cd, Ni, Cu, Pb, Zn) according to the Swiss Law (cf. VSBo 1987) and (3) total heavy metal and sulfur contents determined with X-ray fluorescence (As, Pb, Zn, Cd). The results for the latter four elements with method (1) and (3) are often similar, whereas NaNO_3 -extractable contents are usually 10 to 20 times lower (Gini 1992). Therefore only the XRF-results are presented.

3. Results

In the field, four different soil materials were recognized (Fig. 2): (1) a sandy yellow-red-dish layer with abundant angular rock fragments, usually sitting directly on the bedrock. It looks like a till-deposit, but could also be dip-debris or a mixture of both. (2) On grassland, in areas of forest (often former vineyards), apparently not influenced by the mining activity, an organic-rich brown-black layer of up to 40 cm occurs. Material type (3) is a brown-black mixture of steril rock, ore fragments of all sizes below 20 cm and some humus material. Material type (4) is found around the former treatment plant and consists of concentrated, in part highly weathered, sulfide-rich ore mixed with local colluvial soil. Figure 3 shows the typical heavy metal concentrations of these four materials.

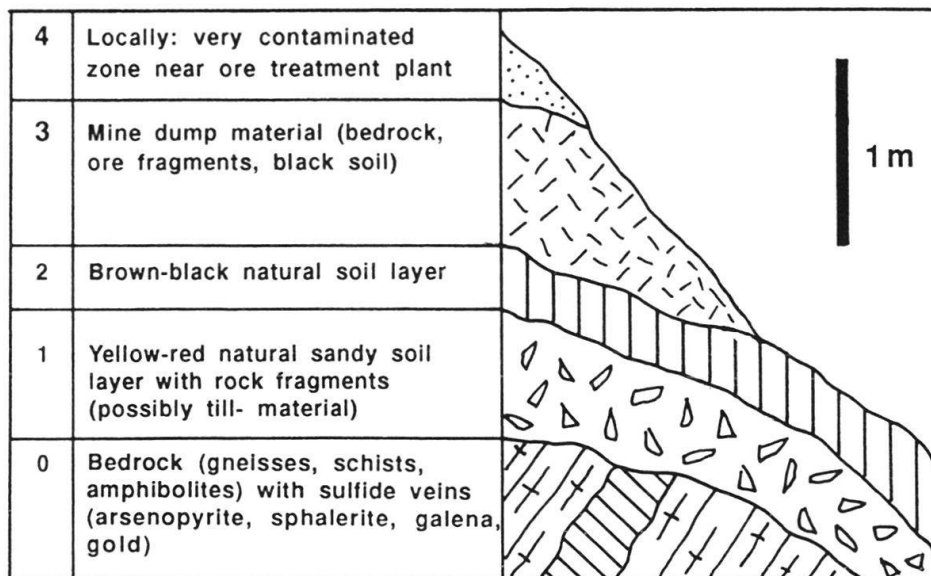


Fig. 2. Schematic cross section through the different soil layers of the Astano mining area.

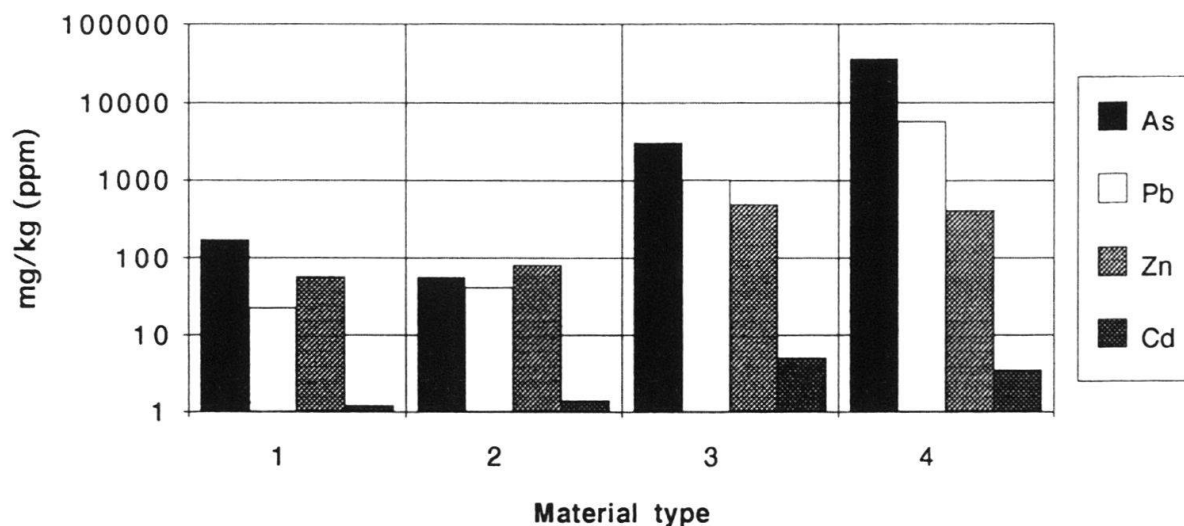


Fig. 3. Bar diagram showing some total heavy metal contents analysed by X-ray fluorescence of the different soil materials of the Astano area (for material definition cf. Fig. 2). Analysts: C. Schlegel, D. Rey, J.-C. Lavanchy.

4. Discussion

As it was expected, total heavy metal contents are highest in the vicinity of the former treatment plant (material type 4: several weight % As, up to 0.6 wt % Pb, up to 500 ppm Zn and between 2 and 20 ppm Cd). The contents in the dump material (material type 3) are slightly lower, but still in the range of several hundreds to more than a thousand ppm for As, Pb, Zn and Cd is often even higher than in material type 4. The natural soils of the area (material type 1 and 2) are almost similar, i.e. between 20 and 170 ppm of As, Pb and Zn and max. 2 ppm Cd, but their heavy metal contents are astonishingly high for natu-

ral soils! This is probably due to natural weathering processes of the many sulfide veins in the area.

It is clear, that the concentrations of all heavy metals are, even in the least contaminated, natural samples, either close to or beyond the guide levels recommended by the Swiss Law. For example for As, the law contains no guide level, however, normal soils around the world contain between 0.2 and 40 ppm As with a mean at 7 ppm. Here we found mean values close to 100 ppm outside the dump zones! Additional results on the exact extent of the contamination, the water and plant composition and possible contaminant transport by creek and river sediments in the whole area will allow to outline the potential danger for land users in the surroundings of the Astano mine area.

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