Aijala mine tailings area as an example of a source of secondary raw materials

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In this article we describe the Aijala tailings ponds' potential to be a source of secondary raw minerals. The tailings pond was targeted as a study site because the mines, Aijala and Metsämonttu, from which the tailings are from, have been shut several decades ago, and therefore the tailings might contain significant amounts of minerals which could be utilised with the modern processes. The amount of Cu, Zn, Ag and Pb has been estimated within the tailings layers. Aijala tailings pond is one of the Finnish pilot areas of EU funded SMART GROUND project.

Keywords: secondary raw materials, mine tailings, Aijala, Finland, SMART GROUND

1. Smart ground project

Raw material are becoming a more important for the EU economy. The recycling and recovery of these materials becomes more relevant as they become scarser and their prices raise. According to an estimation, there are in the EU area between 150 000 and 500 000 highly variable landfills, and they could contain a significant potential of secondary raw materials. However, there is no standardised inventory available of the secondary raw materials in these landfills, nor are the present reporting standards sufficient.

The SMART GROUND project funded by the EU's Horizon 2020 program intends to improve availability and accessibility of information of the secondary raw material in the EU. The consortium will create a single EU database (SmartGround database) that integrates all the data from existing sources and new information retrieved with time progress. Such database will enable the exchange of contacts and information among the relevant stakeholders (e.g. companies), which are interested in providing or obtaining secondary raw materials. The project produces detailed information of secondary raw materials from three pilot landfills of each partner countries. Aijala tailings pond is one of the Finnish pilots.

2. Aijala tailings pond

The Aijala copper mine was active in the community of Kisko, which is part of Salo today, in years 1945 – 1958. The enrichment plant worked in Ailaja till 1974, as the ore was brought from the nearby Metsämonttu Zn-Pb mine between years 1952 – 1958 and 1964 – 1974. Also ore from Telkkälä Ni-Cu mine was enriched in Aijala in 1970. (Sipilä, 1994)

The composition of Aijala tailings pond has been studied already in 1982 by Kokkola. The Aijala tailings pond contains around 2 million tons of waste which average metal content is as follows: 0.12 % copper, 0.5 % lead, 0.11 % silver and 0.69 ppm gold. Thickness of the tailings layer is on average 8.7 m and the deepest part is 12 m thick. (Sipilä, 1994, Kokkola, 1982)

3. Soil drilling and geochemistry

In summer 2016 Geological Survey of Finland took additional samples of the Aijala tailings pond. Five additional drill holes were made and the tailings samples were analysed in 1 m intervals, 48 samples in total. A vast geochemical analysis was carried out, but in this article only copper, zinc, lead and silver are referred to.

Even if the tailings material looked the same from top to bottom, the geochemical assays of the samples taken from the drill holes revealed the interface of the tailings material from Metsämonttu and Aijala mines. The top part which contained tailings from Metsämonttu mine was rich in lead and the bottom part containing tailings from Aijala, was rich in copper (Figure 1).

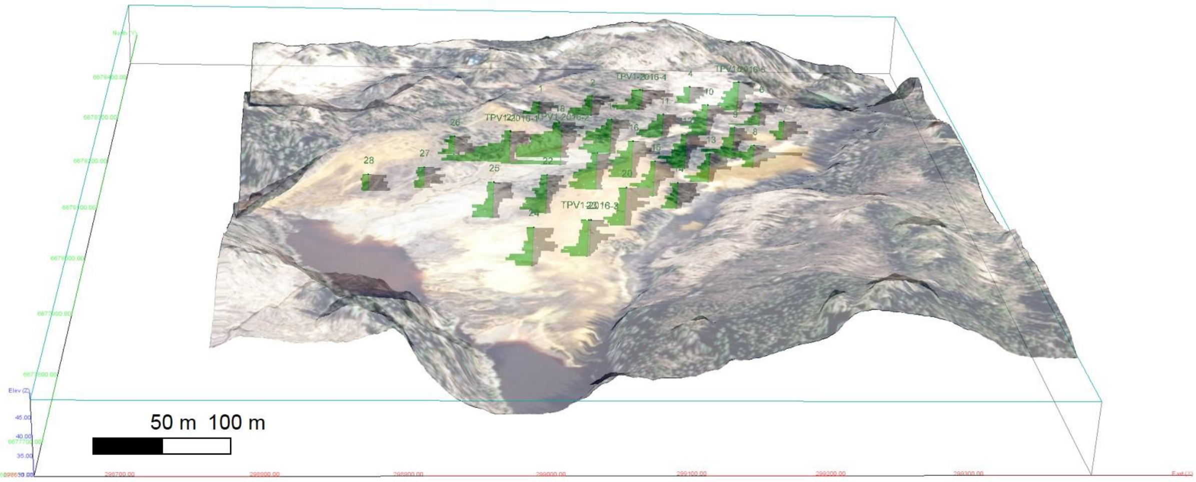

Figure 1. Topography of the Aijala tailings pond with an aerial photo draped onto the surface. The copper and lead content in the tailings are marked with green and grey bars next to the old and new drill holes.

4. Geophysical studies

Geophysics was utilised to study the inner structure and dimensions of the tailings pond. Gravimetric, magnetic and electromagnetic GEM-2, and electrical resistivity tomography (ERT) surveys were carried out. Results of the gravimetric survey were used to interpret the thickness of the tailings pond and depth of the bedrock surface. The drill holes were used as reference points in the interpretations, as they were drilled to the hard soil material underneath the tailings pond. Magnetic survey gave a general picture of the iron content in different parts of the tailings pond. GEM-2 method was utilised to map electrical conductivity of the tailings ponds surface layers from 1 up to 10 m depth. Electrical resistivity tomography was used to study changes in the electrical conductivity of the tailings material up to 30 meters depth. The results of the geophysical interpretations helped in defining the inner structures of the pond and they also gave more information of the variation of the tailings ponds bottom and bedrock surface. The results were utilised in 3D modelling of the structure of the tailings pond (Figure 2).

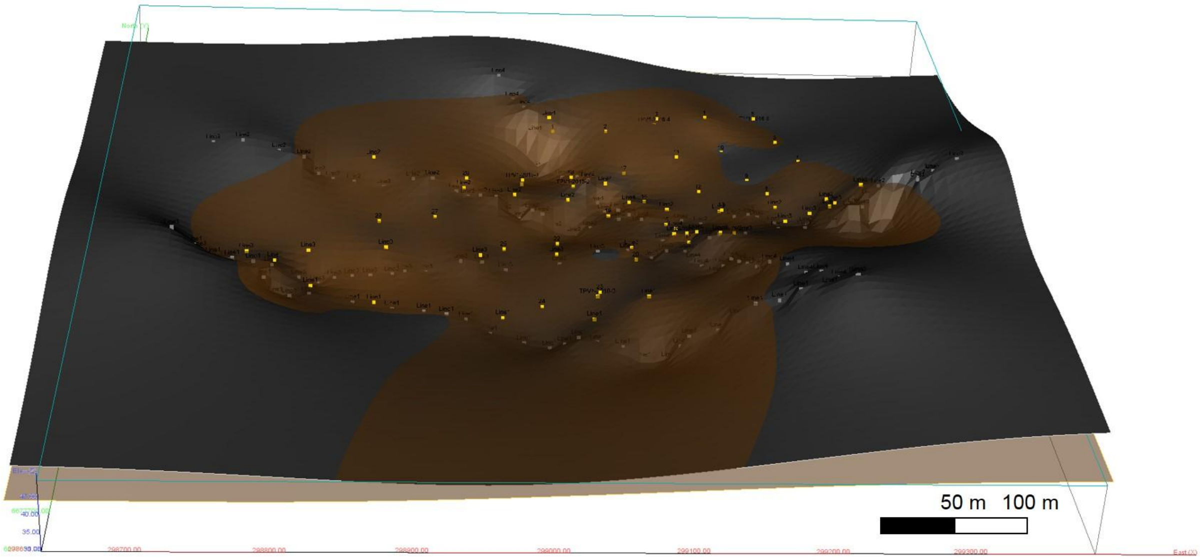

Figure 2. Bedrock (grey) and tailings bottom (brown) layers were generated according to the gravity interpolations of the bedrock depth (grey points) and tailings bottom (yellow points).

5. Mineral resources estimation

The mineral resources in the Aijala tailings pond were estimated by interpolating the metal contents in the old and new drill cores into a 1 m^3 resolution block model. Because the geochemical composition of the tailings pond is not continuous, the interpolation was carried out separately to the Metsämonttu mine tailings layer and the Aijala mine tailings layer.

The blocks belonging to the different layers were determined by the layers generated according to the gravimetric interpretations of the bedrock surface and the tailings bottom (Figure 2). The blocks belonging to the two different tailings layers were separated by a layer generated to the approximate middle of the change in geochemical content seen in the drill cores (Figure 1).

We used Kriging method to interpolate the metals contents in the block model. The used search ellipsoid was horizontal and 200 m in length and in width and 2 m in depth. This is because the metal content of the layers is assumed to be rather continuous in horizontal direction, and the changes in metal content are more likely to be in vertical direction.

Figure 3 shows as an example the interpolated copper content in the Metsämonttu mine tailings layers. The total volume of the layer is 852 399 m^3, and it contains approximately 678 tons of copper.

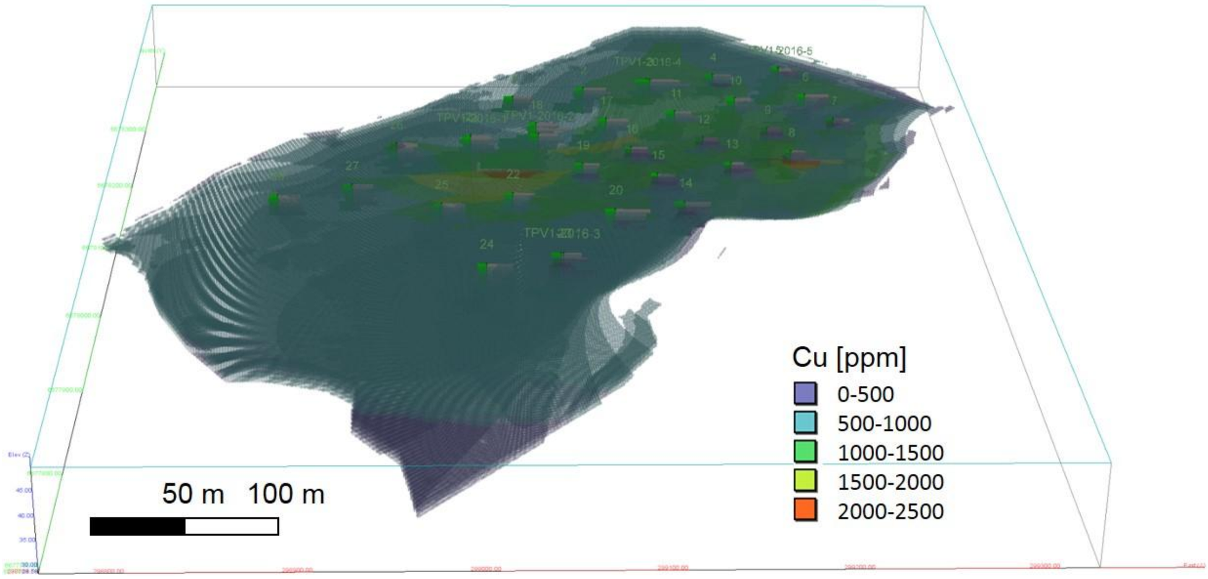

Figure 3. Block model showing the interpolated copper content in Metsämonttu mine tailings layer. The drill holes show copper (green) and lead (grey) contents in the analyzed samples.

6. Conclusions

The Aijala tailings pond example of a landfill as a source of secondary raw materials in EU is a detailed study with 3D model of the structure of the landfill. The information concerning the landfill can be found later in the standardised EU landfill database, and it can be utilised by the possible re-user of the raw material to make feasibility study and planning the operations.

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