GEOPHSICAL INVESTIGATION OF THE Pb-Zn DEPOSIT OF LONTZEN, BELGIUM

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Abstract

The new ore deposits discoveries are more and more complex: lower grades, smaller size, higher depth, complex mineralogy and geometry… Geophysical prospecting methods should be adapted and improved in order to respond to the current needs of the mining industry. The Pb-Zn deposit of Lontzen (Eastern Belgium) has produced more than120kt of Pb-Zn concentrate during the beginning of the 20th century and was one of the biggest mine of Belgium. The mine has ceased its activities since 1934, but some unexploited ore are still present under old mining works. The deposit of Lontzen is classified as a Mississippi Valley type deposits and it consists mainly of Pb-Zn-Fe sulphides and oxides veins/lodes hosted in sandstones, shales and limestone (Dejonghe et al., 1993). Three geophysical techniques are used to inspect the MVT ore deposits: electrical, gravimetric and magnetometric techniques. The data obtained will then be combined using innovative inversion techniques and constrained with drill-hole information allowing better detection and targeting the Pb-Zn deposits.

Keywords. Geophysics, MVT deposit, 3D modelling, Lontzen.

1 Introduction

The deposit of Lontzen is a MVT ore deposit located in Eastern Belgium near the German and Dutch borders (Fig.1). This deposit was already extracted during the beginning of the 20th century, but Pb-Zn mineralization is still hosted in the basement, as reveal by a hole-drilling campaign in the 80's. A 3D modelling of the Pb-Zn mineralization has been achieved in order to target the deposit and to better understand its genesis. This step enables to target the deposit using geophysical investigation techniques (electrical, magnetic and gravity methods). The geophysical 3D model will further be used to build a geologically-constrained multi-geophysics inversion model.

2 Geological Context

The Pb-Zn deposit of Lontzen is located in the mining district of the Verviers synclinorium. This mining district is the most important of Belgium and has produced the overwhelming majority of the Belgium Pb-Zn concentrates (2Mt) from historical time until the beginning of the 20th century (Fig.1) (Dejonghe et al 1993).

Figure 1: Location of the Pb-Zn deposits in Belgium (Dejonghe et al., 1985b)

The deposit of Lontzen is very complex and the ore is present in various environments: filling of Visean karst, at the contact between visean limestone and Namurian shales and as vein in transverse fault crosscutting the Famennian sandstones and Tournaisian dolostones. The mineralizing process is similar for all the MVT deposits of the district of the Verviers synclinorium: the mineralizing fluids-originated from seawater evaporation during Givetian to Carboniferous era and percolated to the Cambro-Silurian basement causing a dolomitization of the crossed limestones (Dewaele et al. 2004). Mineralized dense brines were then expulsed during the Jurassic via transverse faults generated by the Rhine graben extension (Muchez et al. 2000). The fluids have then precipitated in Pb-Zn sulphides mainly within the carbonated formations (Fig. 2) (Dejonghe et al. 1993, Dewaele et al. 2004). The Pb-Zn mineralization is mainly composed of sphalerite and galena but calcite, pyrite, marcasite, chalcopyrite and Zn and Pb oxides are also present.

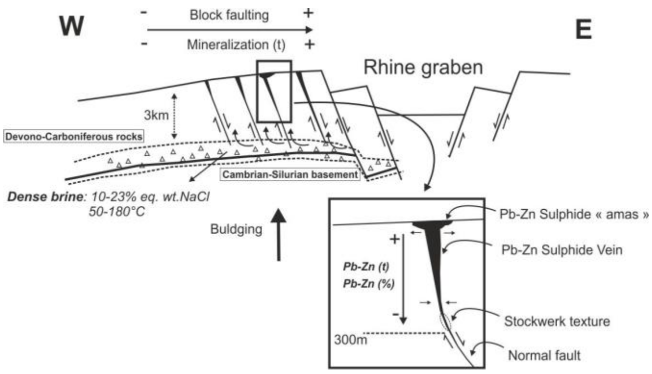

Figure 2: Genesis of the Belgian MVT deposits (mineralization zone is not at scale)

3 Methods and results

3.1 3D geological modelling

During the 80's a drill hole campaign has been led in Lontzen to explore the root of the Pb-Zn mineralization under the old mining works and to explore if the extensional faults are also mineralized. The purpose of this campaign was to evaluate its potential resources. Three (non-connected) ore bodies have been evidenced: Lontzen, Poppelsberg East and Poppelsberg West. The drillings have crosscut Pb-Zn mineralization at depth between 5 and 110m according to the places (Fig. 3).

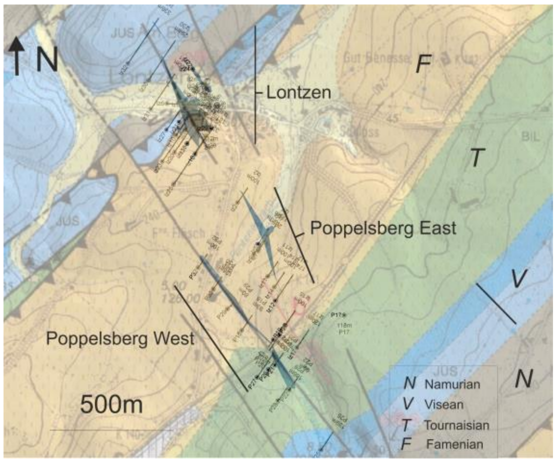

Figure 3. Modelling of the Pb-Zn deposits of Lontzen

A 3D modelling has been achieved with Micromine using the data of the 55 drillholes (Fig.3). The geometry of the orebody has been drawn manually through connection of the drillholes.

This geological model provides information about the deposit: size, length, depth, width, shape of the mineralization and a better understanding of the genesis. The extensional faults generated by the Rhine graben extension are clearly visible in the core rocks and its role in the mineralization process is evidenced in the core..

3.2 Geophysical survey

Three geophysical techniques are used in this project to inspect this MVT ore deposits: electrical, gravimetric and magnetometric methods. Only the veins of Poppelsberg E and W can be explored using geophysics because the deposit of Lontzen is located under the homonym village.

Thirteen electrical profiles of 300m length have been achieved to target the Pb-Zn vein of Poppelsberg East and West. This campaign give excellent results: the Pb-Zn veins are clearly identified in the majority of the 2D sections. The correlation between the low resistivity area (resistivity profiles) and the high chargeable area (chargeability profiles) correspond to the mineralized Pb-Zn vein. These signatures are particularly clear in the northern part of Poppelsberg E vein and the whole Poppelsberg W vein.

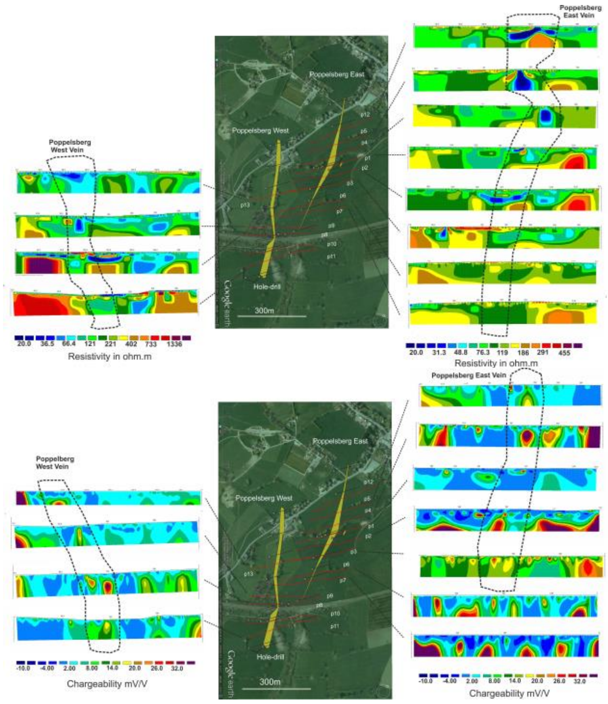

Figure 4: Electrical tomography: resistivity (on the top) and chargeability profiles (on the bottom)

A gravity campaign has also been achieved using the Scintrex CG-5 AUTOGRAV gravimeter. Height gravimetric profiles have been made to investigate the Poppelsberg East and West vein (Fig. 5).

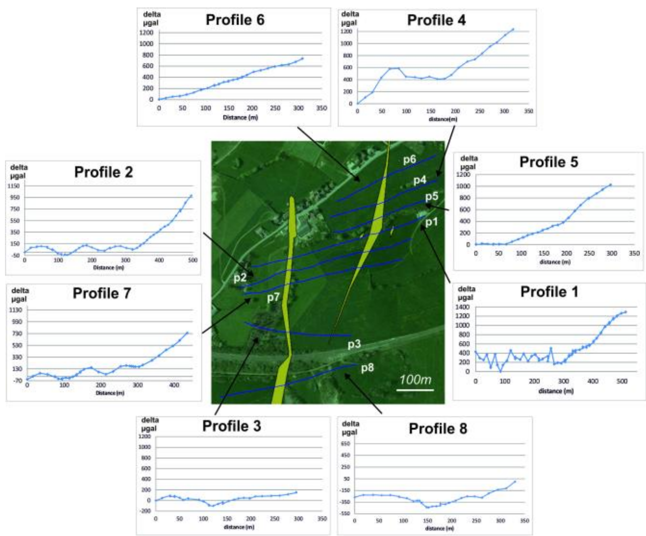

Figure 5: Electrical profile. The resistivity profile (top) and chargeability profile (bottom)

The gravity profiles give some unexpected results. Indeed, instead of having a positive anomaly due to the excess of the dense Pb-Zn mineralization, we rather observe a negative trend of 0.8-1.4 milligal from East to West for the profiles 1,2, 4, 5, 6 and 7. Profiles 3 and 8 are more flat and are not affected by the previous anomaly.

Magnetic survey has been made on the field using the Overhauser magnetometer GSM-19 of GEM. The goal was to target the Pb-Zn veins and the faults using the magnetic susceptibility of pyrrhotite and iron oxides (if present). The results weren't as good as expected. No anomalies corresponding to the Pb-Zn vein have been detected probably due to the non-presence of the tracked minerals but also to the magnetic disturbance caused by electric wire, buildings and the railway (Fig. 6).

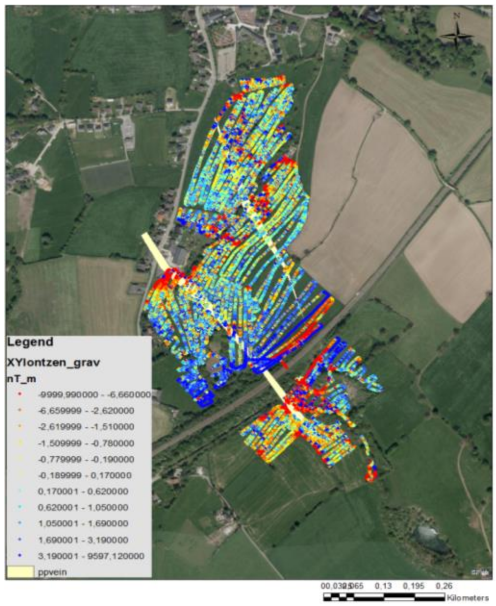

Figure 6 : Magnetic map of the Lontzen deposit

4. Discussion

The electrical and gravity survey give the most interesting results to target the Pb-Zn deposit of Lontzen. The electrical survey gives precious 2D information about the mineralization (on the opposite of the hole drill giving only 1D information). Indeed, the electrical survey give information about the minimal and maximal depth of the mineralization, the lateral extension of the vein between the hole drill, the resistivity/ chargeability of the host rocks, presence of faults and undiscovered mineralization..

MVT deposits are amongst the most difficult ore deposits to detect using geophysics. Indeed, the mineralogy, the texture and shape of the ore is very variable from place to place even within a deposit (Leach et al., 1993). Some Zn deposits are by this fact non-chargeable, non-conductive, nonmagnetic and giving no gravity anomaly. The only information we have about the mineralogy of the Pb-Zn vein of Poppelsberg is the Zn, Pb and silver content. Galena and native silver are excellent conductive mineral which help to detect the Zn-bearing minerals (Bishop and Emerson 1999). In our case the correlation between the geophysical signal and the Pb/Ag content is evidenced on the Poppelsberg W vein but not in Poppelsberg E vein where the Pb and Ag silver are very low. The geophysical signature of this vein should be due to the presence of pyrite/marcasite (especially in the Northern part where the signal is very intense). The gravity results are not directly linked to Pb-Zn mineralization but more to the density of the host rocks. Indeed, the local geology presents a lot of faults -which have locally weathered the host rocks- changing by the way their density, and so their local gravity response. The gravity profile can be linked with the electrical resistivity profile where the non-weathered rocks are clearly visible on the 2D cross sections. These huge mass of healthy rocks play probably a role in the gravity responses.

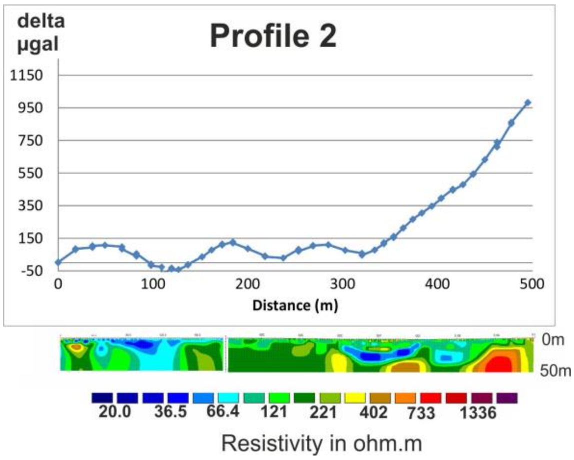

Figure 7 : Comparison between gravity and resistivity profile

On figure 7, a correlation can be made between the high resistive rocks (presenting a higher density) and the positive gravity anomalies. In our case the density of the Pb-Zn mineralization is probably too low, and so "hide" by the high amount of non-fractured dense host rocks . This explanation can be applied for the other profiles and especially for the 1, 2, 4, 5, 6 and 7.

The magnetic survey gives no information, certainly due to the absence of magnetic minerals in the ore.

5. Conclusion

The deposit of Lontzen has been target using three different geophysical methods: electrical tomography (resistivity and IP), gravity and magnetometry. The electrical survey seems to be the best technique to target the Pb-Zn ore deposit of Poppelsberg E and W; giving precious information about the size and depth of the ore veins. The gravity technique isn't able to target the Pb-Zn veins in our case due to the presence of large amount of dense non fractured sedimentary rocks hiding the gravity signal of the sulphides. The magnetometric survey provides no useful information due to the non-presence of magnetic minerals in the ore.

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