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Investigating the Yahyalı (Kayseri, Türkiye) Pb-Zn deposit by using IP/Resistivity methods

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Abstract

There are significant Pb-Zn mineralizations along the Taurus Orogenic Belt. Various mining operations have operated in these regions from ancient times to the present day. Aladağ-Zamantı province is also one of these major areas. Substantial mining activities are ongoing in several locations in this province. Yahyalı Region is also an area located within this belt. Pb-Zn ore mineralization is observed in Devonian aged carbonates southeast of Yahyalı (Kayseri-Türkiye). Geophysical studies were carried out to determine the ore geometry and potential in this zone. In this region where IP/Resistivity methods were practiced, we have taken several measurements along specific profiles and have evaluated them in combination. As a result of the study, it was concluded that the areas with high chargeability characteristics are rich in sulfide minerals. As a complementary conclusion of the evaluation of both methods, it was realized that the data were in compliance. Therefore, using these geophysical methods in sulfide-rich areas has been deemed to be advantageous in terms of mining activities.

Introduction

Electrical resistivity tomography is widely used for characterizing subsurface structures and overlaying geological settings [1-2]. The induced polarization (IP) can even detect information of small conductive rocks that have been extinct in the subsurface. Resistivity models resulting from both resistivity and IP studies can also identify the presence of sulfur in minerals, mineral deposits and soils [3].

Geological structures where sulfide minerals occur show low resistivity and high chargeability [4-5]. High chargeability and high resistivity anomalies have also been attributed to the presence of disseminated sulfides [6]. Successful applications have been made with these geophysical methods used in mineral exploration. Resistivity and induced polarization applications in lead-zinc exploration have been applied in many studies by various authors [7].

Pb-Zn mining in Turkey extends back to the Roman period [8]. The most important mining sites are observed along the Taurus Orogenic Belt. The Aladağlar-Zamantı province of the Eastern Taurus Mountains has been attracted the interest of many researchers because it is the most prominent carbonated Zn-Pb producing region of Turkey [9-11]. The study area is located in this belt and covers the southeast of Yahyalı region.

In this study, geophysical studies were carried out for the ore potential of the Pb-Zn deposit in the southeast of Yahyalı (Kayseri-Türkiye). Through this study, important data belonging to the region were obtained and provided in the literature.

Material and Method

The IP/Resistivity method is based on the principle that some rocks act like a capacitor and retain some of the current for a certain period of time after the electric current is cut off. The distribution of metallic mineral particles in rocks is the source of IP anomalies. Increasing the concentration of polarizable sulfide minerals increases the chargeability values. In other words, mineralization is directly related to chargeability values.

True chargeability; (M") is the ratio of the voltage after the current is cut off to the voltage measured during the current supply and is defined as mVolt/Volt. It varies between 0-1000 mv/v values.

In resistivity (electrical resistivity) method applications; electric current is sent into the ground through a stainless metal-steel electrode driven into the ground. With the help of two electrodes placed at two other points on the ground, the voltage difference in the ground is measured. The unit of the applied current is recorded in amperes (usually milliamperes) and the unit of the measured voltage in Volts (usually millivolts). Using the measured values and the geometric factor K (array factor) of the electrode array used, the apparent resistivity (in ohm-m) is calculated for this measurement location. The calculated value is assigned below the midpoint of the electrode array system.

In the study area, the AGI brand, 8-channel, 84-electrode resistivity and IP measurement device with 84 electrodes was used.

Dipole-Dipole Gradient method was applied and 19 profiles were made with 20-10-7 meters between the electrodes. This measurement was evaluated in EartImager 2D evaluation program. In this study, the data of 3 profiles are presented.

Mineralization

The study area is located in an area where the fractures and faults of the nap tectonics in the Eastern Taurus Mountains are very intensive. In this region, Aladag and Yahyalı nappes are observed together [8]. Both tectono-stratigraphic units have similar lithological features and host Pb-Zn mineralizations in different locations [8]. This region is also called the "Aladağ-Zamantı Zn-Pb Belt" and has an important place in the Zn-Pb mining of Türkiye. Mineralization is associated with the Devonian-aged carbonates in the Aladag Nappe. In the ore zone, which is in the form of veins and veinlets in E-W direction, smithsonite, anglezite, cerusite and other alteration minerals are observed near the surface. The main ore minerals are galenite and sphalerite respectively [12].

IP-Rezistivity Results

Resistivity and chargeability data were compiled and inverted to obtain a more realistic geologic representation. GPS elevation data of the profiles were used to correct the effects of topography in the inverse analysis. Chargeability and resistivity graphs were prepared for the inverse solutions of the profiles.

In the graphs, warm red-purple colors were used to represent high chargeability and resistivity values and cool colors such as green and blue were used to represent low values. In this study, the important targets are considered to be the areas showing high resistivity (karstic sinkholes).

Normal chargeability values were observed in most of the profiles measured in the field. Probable sulphide ores are thought to be the cause of the high chargeability values obtained.

1. In the 1st profile, high resistivity and high chargeability were observed at the electrode spacing of 20 meters. At the 4th electrode (65 meters) depth, partial correspondence of chargeability and resistivity values indicates the presence of a low grade ore body with small reserves (Figure 1).

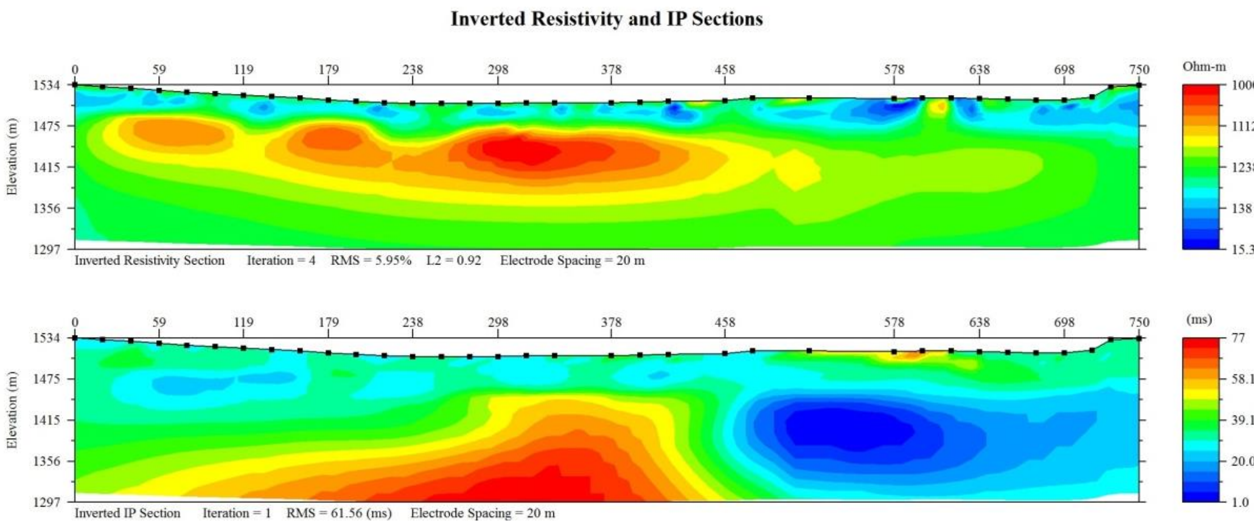

Figure 1. The inverted resistivity and IP sections of the 1st profile.

2. In the 2nd profile, high resistivity and high chargeability were observed at the electrode spacing of 20 meters. At the 4th electrode (65 meters) depth, partial correspondence of chargeability and resistivity values indicates the presence of a low grade ore body with small reserves (Figure 2).

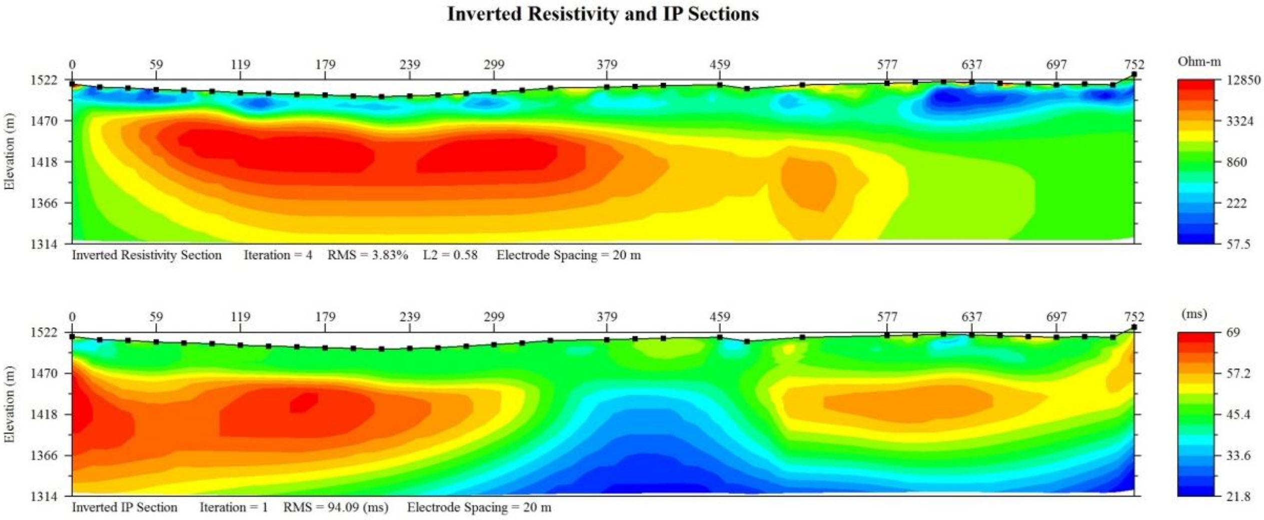

Figure 2. The inverted resistivity and IP sections of the 2nd profile.

3. An anomaly was observed at 336 meters of the profile with an electrode spacing of 10 meters and a depth of 32 meters (Figure 3).

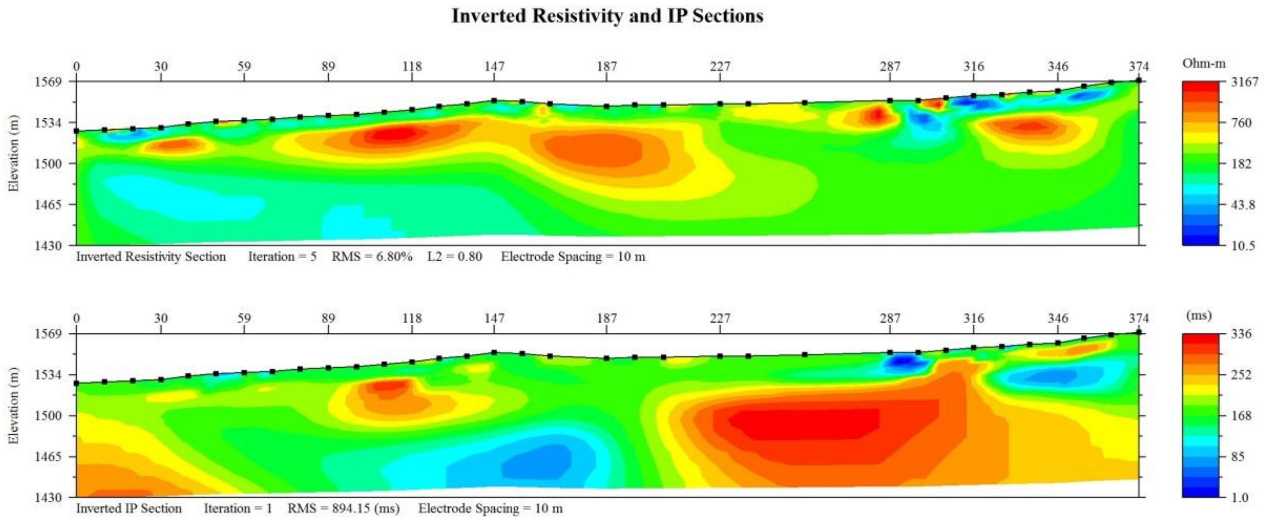

Figure 3. The inverted resistivity and IP sections of the 3rd profile.

Discussion

The induced polarization method improves electrical methods by measuring the chargeability of the soil material [13]. Chargeability provides an opportunity to assess the capacity of soil to store and then restore a current when currents are injected and then interrupted [14-17].

The resistivity tomography examines the horizontal and vertical distributions of the electrical properties of the soil. It quantifies the resistivity of the ground by passing an electric current through the soil through a pair of electrodes and by measuring the resultant potentials via a further pair of electrodes, called potential electrodes [18].

Both methods mentioned above have been implemented in the field. In previous studies, exploration drillings were carried out in two different areas where mineralization was considered and ore was cut in places. When these data were evaluated with the study, the following items were revealed.

1. It was observed that the potential mineralization in the study area is located northeast of the present drilling area.

2. In the study area, it was determined that young sedimentary units and altered sedimentary rocks have lower densities compared to their surroundings.
3. It is concluded that more priority should be given to the areas with Paleozoic-aged carbonate rocks in the study area.
4. Areas with high chargeability characteristics have been identified as potential areas.

Conclusion

There is already an operational mine southeast of Yahyalı where significant Pb-Zn mineralization is observed. Field studies have already been supported by drilling. However, geophysical studies, which provide information about the underground potential and geometry of the ore, contain important clues for the operation. It is understood that IP/Resistivity method can be used successfully in Pb-Zn fields which are sulfide mineralizations.

References

1. Loke, M. H., & Barker, R. D. (1996). Rapid least-squares inversion of apparent resistivity pseudosections using a quasi-Newton method. Geophysical Prospecting, 44, 131-152.
2. Dusabemariya, C., Qian, W., Bagaragaza, R., Faruwa, A., & Ali, M. (2020). Some experiences of resistivity and induced polarization methods on the exploration of sulfide: A Review. Journal of Geosciences and Environment Protection, 8, 68-92.
3. Olowofela, J. A., Ajani, O. O., & Oladunjoye, M. A. (2008). Application of induced polarization method to delineate sulphide ore deposit in Osina Area of Benue State, Nigeria. Ife Journal of Science, 10(1), 137-150.
4. Langore, L., Alikaj, P., & Gjovreku, D. (1989). Achievements in copper sulphide Exploration in Albania with IP and EM Methods. Geophysical Prospecting, 37, 975-991.
5. Yoshioka, K., & Zhdanov, M. S. (2005). Three-dimensional nonlinear regularized inversion of the induced polarization data based on the cole-cole model. Physics of the Earth and Planetary Interiors, 150(1-3), 29-43.
6. Sono, P., Nthaba, B., Shemang, E. M., Kgosidintsi, B., & Seane, T. (2021). An integrated use of induced polarization and electrical resistivity imaging methods to delineate zones of potential gold mineralization in the Phitshane Molopo area, Southeast Botswana. Journal of African Earth Sciences, 174, 104060.
7. Moreira, C. A., Lopes S. M., Schweig C., & Seixas, A. R. (2012). Geoelectrical prospection of disseminated sulfide mineral occurrences in Camaquã Sedimentary Basin, Rio Grande do Sul State, Brazil. Revista Brasileira de Geofísica, 30, 169-179.
8. Hanilçi, N., Öztürk, H., & Kasapçı, C. (2019). Carbonate-hosted Pb-Zn deposits of Turkey. Chapter 10 In: Pirajno, F., Dönmez, C., Şahin, M.B. (Eds.), Mineral Resources of Turkey, Modern Approaches in Solid Earth Sciences. Springer Nature, Switzerland, 497–533.
9. Ayhan, A., & Erbayar, M. (1985). Batı Zamantı (Aladağlar-Yahyalı) karbonatlı pb- zn yataklarının jeokimyasal prospeksiyonu. MTA Dergisi, 105, 75-84.
10. Hanilçi, N., & Öztürk, H. (2003). Aladağlarda Karbonatlar İçindeki pb-zn yataklarında duraylı kükürt izotopu ve mikrotermometrik incelemeler, Doğu Toroslar, Türkiye. 56. Türkiye Jeoloji Kurultayı, Bildiri Özleri Kitabı, Ankara, 112–114.
11. Hanilçi, N., & Öztürk, H. (2005). Mississippi valley type Zn-Pb Deposits in the Aladağlar-Zamantı (Eastern Taurus) Region: Ayraklı and Denizovası Zn-Pb deposits, Turkey. İstanbul Earth Sci Rev. 18(2), 23–43.
12. Hanilçi, N., & Öztürk, H. (2011). Geochemical/isotopic evolution of Pb–Zn deposits in the Central and Eastern Taurides, Turkey. International Geology Review, 53(13), 1478-1507.
13. Burger, R. H., Sheehan, F. A., & Jones, C. H. (2006). Introduction to applied geophysics: exploring the shallow subsurface. Norton & Company, Inc., New York, 265-347.
14. Seguin, M. K. (1974). The use of geophysical methods in permafrost ınvestigation: ıron ore deposits of the Central Part of the Labrador Trough, Northeastern Canada. Geoforum, 5, 55-67.
15. Sumner, J. S. (1976). Principles of ınduced polarization for geophysical exploration. Elsevier, Amsterdam, 227 p.
16. Béhaegel, M., & Gourry, J. C. (2003). Investigation de pollutions organiques par méthodes géophysiques. Rapport BRGM/RP-52642-FR, 89.
17. Gouet, D. H., Ndougsa-Mbarga, T., Meying, A., Assembe, S. P. & Man-Mvele Pepogo, A. D. (2013). gold mineralization channels ıdentification in the Tindikala-Boutou Area (Eastern-Cameroon) Using Geoelectrical (DC& IP) Methods: A Case Study. International Journal of Geosciences, 4, 643-655.
18. Parasnis, D. S. (1997). Principle of Applied Geophysics. Springer Netherlands, p. 429.