

MAGNETIC PROPERTIES OF Cu (Fe) MINERALIZED ZONES OF CAROLINA DE MICHILLA DISTRICT (NORTHERN CHILE): AEROMAGNETIC EXPLORATION APPLICATION

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INTRODUCCION

District and local scale characterization of the variations of the magnetic properties at Carolina de Michilla copper district are reported. This district is located in the Coastal Cordillera metallogenic belt of northern Chile that is formed by a thick basaltic-andesitic volcanic pile intruded by Upper Jurassic batholiths of dioritic to granodioritic composition. These rocks are interpreted as the Jurassic magmatic arc developed on the active continental margin of South America. The main mineral deposits of the Coastal Cordillera are manto-type or stratabound Cu deposits hosted by the Jurassic lava flows of La Negra Formation that are the second source of copper production in Chile (after younger porphyry copper production). Therefore has been a great deal of exploration work done along this belt including high-resolution aeromagnetic surveys. However the interpretation and modeling of magnetic anomalies have been done without knowing the actual magnetic properties of the underlying rocks. The aim of the present study is to characterize the magnetic properties of La Negra volcanics at zones that are affected by hydrothermal alteration and mineralized and to compare these results with regional values of the barren Jurassic lava flows. The second objective is to use paleomagnetism in mineralized rocks to provide additional insights on the mineralization processes, especially about relative chronology of ore formation, tectonic and intrusive events, and the behavior of magnetic minerals upon increasing degrees of mineralization.



SAMPLING AND RESULTS

The Carolina de Michilla copper mining district was characterized by 9 sites, mainly drilled in plutonic rocks that intrude the volcanic sequence, and others in lava flows affected by hydrothermal alteration and Cu-oxides mineralization. In addition we have taken 400 samples in 5 drill cores that cut orthogonally the mineralized lava flows and show a complete characterization of the metric scale magnetic properties variations. Michilla topographic position, suggest that this levels are in the upper zone of La Negra sequence. The ore bodies present a vertical zonation with chalcopryrite-pyrite-magnetite at deeper zones and chalcocite-covellite-hematite closer to the surface with increasing quantities of Cu-oxides. Magnetic susceptibility of the lava flows (barren and mineralized) range from 0.02 to 0.04 (IS), whereas intrusive bodies show slightly lower values between 0.01 to 0.03 (IS). Some mineralized lava flows with chalcocite-covellite-hematite presents very low susceptibilities (< 0.001 SI). The intensity of magnetic remanence in the lava flows show variations between 0.1 and 0.4 A/m, values slightly larger than those of the intrusive bodies. Both normal and reverse polarities have been observed.

Barren lava flows were characterized by 40 sites drilled at the base and central portions of La Negra sequence at Tocopilla, Antofagasta and Paposos areas of the Coastal Cordillera (22° - 25° Lat.S). The three areas show evidence of very low-grade metamorphism characterized by the epidote-clorite-calcite-chalcedony-zeolites-prehnite-pumpellyite assemblage, particularly in the brecciated levels of the lava flows. Magnetic susceptibility of the lava flows for these areas is usually high, ranging from 0.02 to 0.07 (S.I. units). The highest values are found near Tocopilla, a feature that correlates with a lower degree of low-grade metamorphism. Our limited sampling of intrusive rocks seems to indicate a lower range of susceptibility values between 0.01 and 0.03 (IS). Intensities of magnetic remanence are distributed between 0.2 to 0.5 A/m.

DISCUSSION OF RESULTS

The above results indicate that there are no significant difference of magnetic response between barren areas and values of the Carolina de Michilla copper district. Unfortunately copper mineralization processes does not produce relevant changes in magnetic properties of the Jurassic volcanic rocks of La Negra Formation that would be useful as prospective tool in regional scale magnetic surveys. At Michilla there is complete destruction of primary mineralogy only at metric scales and replacement by the chalcocite-covellite-hematite assemblage with a very low magnetic susceptibility. Outside of these zones the magnetic properties are mostly relicts from primary characteristics (magnetite) and/ or secondary ones related to very low-grade metamorphic event (maghemite replacement).

CONCLUSIONS

Magnetic properties of La Negra Formation are characterized by high magnetic susceptibility and relatively low magnetic remanence, product of the relict primary mineralogy and secondary effects related to very low-grade metamorphism. These characteristics appear not to be affected at district to regional scales by the mineralization processes related to Cu stratabound deposit formation. At these scales there is no contrast in terms of magnetic susceptibility between mineralized and non-mineralized zones that could generate a significant magnetic anomaly. Only at local (metric) scales and with very high-resolution magnetic survey some anomalies related to intrusive bodies with low total magnetization and mineralized bodies with very low susceptibility linked to the chalcosite-covellite-hematite assemblage would be detected.

INTRODUCTION

Barite is one of the most widespread minerals in the Earth's crust. It occurs in barite and complex (barite-iron sulphides, barite-base metallic and fluorite-barite-base metallic) endogenic and exogenic mineralisations of different size or is present as an accompanying mineral in the ores of almost all other genetic and compositional types of mineralisations including the gold-bearing deposits. The latter fact represents the guideline for a more systematic research on the gold content and distribution in barite with the aim to look for some additional indications for the gold prospects of newly found barite-containing ore mineralisations as well as of already but still not studied in that aspect mineralisations.

MATERIALS AND METHOD OF STUDY

The gold content in monomineral samples of barites has been determined by neutron-activation analysis with detection limit of the method of 0.0001 ppm (or 0.1 ppb) and precision of +/- 25% (analyst R. Jankova). The results are shown in table 1.

The investigation included barites from ores with and without gold mineralisation in Bulgaria (except for Madneuli deposit in Georgia). The first type of ores was presented by the Alpine epithermal high sulphidation (copper-pyritic ores of Chelopech, Baryta and Madneuli deposits) and low sulphidation (gold-polymetallic ores of Madzharovo deposit) gold mineralisations and the Hercynian mesothermal quartz-gold-sulphide (quartz-gold ores of Govezhda deposit) and barite-gold-polymetallic (barite-gold-polymetallic ores of Kashana deposit) vein mineralisations. The second studied type of ores covered the mineralisations of the Alpine (Martinovo and Mihalkovo deposits) and Hercynian (Tran and Seslavtsi deposits) barite, fluorite and barite-fluorite vein mineralisations as well as

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