Application of Electron Paramagnetic Resonance (EPR) Spectroscopy and Geochemistry as Evidence for Hydrothermal Alteration in Carbonates

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SUMMARY

This study attempts to determine whether the combined EPR responses and geochemical characteristics of carbonate rocks, from the Renison mine area of Tasmania, Australia, can be used as an exploration tool. The EPR intensity of dolomite samples were measured based on the peak height of Mn^{2+} sextets. The EPR intensity values are very low (average 5cm) in least-altered samples, while the highest EPR peak height (average 17cm), occur in the highly-altered samples close to the mineralized area. The dolomite samples with more than 10cm EPR intensity, high Mn and Fe concentrations and very light oxygen isotope values are considered to be important for mineral exploration.

Key words: EPR, Geochemistry, Mineral Exploration, Hydrothermal Alteration

INTRODUCTION

Rock powders of dolomite samples from the Renison mine area of Tasmania, were studied to identify alteration related to mineralization. In this study it was found that this integrated method is useful in the search for mineral deposits in carbonate rocks. EPR spectroscopy is a fast technique; the measurement of a spectrum takes only 4 minutes.

METHOD AND RESULTS

Rock powders of 46 dolomite samples were used for chemical analysis by AAS and Mass Spectrometer at the University of Tasmania. A measure of the paramagnetism of dolomite powders was obtained by using an analogue JEOL JES FE3X EPR Spectrometer. EPR is based on the property of electrons and the resonance of unpaired electrons in a sample. The EPR intensity of dolomite samples were measured based on the peak height of Mn^{2+} sextets in centimetres. In carbonate rocks, particularly dolomites, there are several substitution elements such as Mn and Fe which are paramagnetic. Although the EPR signature of quartz has been extensively studied by many authors, this is a preliminary study to examine whether the EPR response of carbonate rocks along with elemental and isotopic compositions are useful in the search for alteration related to mineralization.

The well developed Mn^{2+} sextets are common in most dolomite samples of the study area. The highly altered samples close to the mineralized area are characterized by strong EPR intensities of Mn^{2+} sextets observed at magnetic flux density sweeps over 326.3 ± 2500 mT and 326.3 ± 1000 mT. The EPR intensity and the Mn and Fe content increase while the oxygen isotope values decrease towards the ore body. The EPR intensity values are very low (average 5cm) in least-altered samples, while the highest EPR peak height (average 17cm), occur in highly-altered samples close to the mineralized area. Low average Mn (680ppm) and Fe (7400ppm) concentration are in samples away from mineralized area, in contrast, the very high Mn (average 3000ppm) and Fe (21500ppm) contents are present in samples close to the ore body. Oxygen isotope values are more enriched (average, -2.9‰) in least-altered samples, while the oxygen isotope values decrease (average -7.8‰) in samples close to the ore body.

CONCLUSIONS

The results of the EPR study in the dolomite samples support an application of the combined EPR and geochemical methods for mineral exploration. The highly altered samples close to the mineralized area are characterized by strong EPR intensities of (more than 10cm), which correspond to the higher Mn and Fe and lighter oxygen isotope values. The highly altered dolomite samples are considered to be related to wall rock hydrothermal alteration and tin mineralization.