Trace and minor elements in sphalerite: an assessment of distributions in metamorphosed deposits.

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TRACE AND MINOR ELEMENTS IN SPHALERITE: AN ASSESSMENT OF DISTRIBUTIONS IN METAMORPHOSED DEPOSITS:

ABSTRACT:

Sphalerite is a common sulphide mineral and occurs in ore deposits of various types. It is the major ore mineral in the majority of Zn-Pb sulphide deposits. The emergence of precise, high-resolution microanalytical methods, such as Laser-Ablation Inductively-Coupled-Plasma Mass-Spectrometry (LA-ICP-MS) has allowed for greater precision in the analysis of the minor and trace elemental characteristics of sulphides, including sphalerite. These methods have evolved to become valuable petrogenetic tools over the past decade. In this study Laser-Ablation Inductively-Coupled-Plasma Mass-Spectrometry (LA-ICP-MS) has been used to analyse 19 sulphide samples from metamorphosed sphalerite-bearing deposits in Norway and Australia. The distributions of Mn, Fe, Co, Cu, Ga, Se, Ag, Cd, In, Sn, Sb, Hg, Tl, Pb and Bi have been investigated with particular attention to how concentrations of these elements vary with metamorphic grade and the extend of sulphide recrystallisation and syn-metamorphic deformation. The study has also attempted to address any possible correlations among the different elements. The results were found to indicate that trace elements which are believed to exist as micro- to nano-scale inclusions in sphalerite (such as Cu, Pb and Bi) are reduced in abundance with increasing metamorphic grade. This is due to recrystallisation resulting in these small scale inclusions being removed from the sphalerite and remobilised to form discrete minerals elsewhere. The distributions of lattice-bound elements (Mn, Fe, Cd, In, Hg) show few trends, suggesting that source and physico-chemical conditions of primary crystallisation are dominant in defining the concentrations of these elements. A moderately strong positive correlation between copper and indium concentrations was also identified, confirming previously published data.

KEY WORDS

Sphalerite, metamorphism, trace, elements, distribution, mass spectrometry, laser ablation
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Figure 8: Back-scatter electron (BSE) images of sphalerite from the 6 deposits. (A) is a picture of a sample from Mt Isa. (B) is a picture of a sample from Røros. (C) is a picture of a sample from Mofjellet. (D) is a picture of a sample from Sulitjelma. (E) is a picture of a sample from Bleikvassli. (F) is a picture of a sample from Broken Hill. In all pictures the lightest grey (not white) is sphalerite.

Table 2: Summary of LA-ICP-MS minor and trace element data for each sample (means and standard deviations for each element), bdl is listed where majority of ablation spots gave results below minimum detection limits.

Figure 9: Graphical representations of the mean abundance of Mn, Fe, Co, Cu, Ga, Ag, Cd, In, Sn, Sb, Hg, Tl, Pb and Bi within each sample in ppm on a logarithmic scale. Where the elemental abundances were mostly below detection limits no mark is displayed. The rock samples 5984A, 5984B are from the Mt Isa ore deposit, STO-175-04, STO-175-05 and STO-175-06 are from the Røros ore deposit, NC5835, NC6005, Sulis 1b, Sulis 2a and Sulis 2b are from the Sulitjelma ore deposit, Mo2, Mo5 and Mo10 are from the Mofjellet ore deposit, Bv1, V59.197, V60.446 and V61.538 are from the Bleikvassli ore deposit, and BH218 and BH221 are from the Broken Hill ore deposit.

Figure 10: Graphical comparisons of the abundance in ppm of some elements of interest compared to Cu and Pb, which are considered to exist mostly in inclusions in sphalerite. Data points from all samples shown. The two axes display the abundance of different elements logarithmically so that they can be compared easily. Note that a moderately strong positive correlation between In and Cu and between Ag and Cu, and a quite strong positive correlation between Ag and Pb is observable.

Figure 11: Binary element plots demonstrating how common minor elements in sphalerite compare to each other in each of the deposits types. Note that there does not appear to be any consistent trends present which link these elements. The data from some samples from the same deposit cluster together, such as those from Røros, while data from Sulitjelma is more spread out.