402 SHORTER COMMUNICATIONS


GEOCHEMISTRY OF SPHALERITE FROM INGALDHAL MINE
CHITRADURGA DISTRICT, MYSORE STATE

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Introduction: The Ingaldhal sulphide mine is situated about 8 km SE of Chitradurga in Mysore State. Mineralogical and minor element studies reveal that the ore mineral assemblage, occurring mainly in schistosed chloritic rocks (meta volcanics), represents a typical hydrothermal deposit. The purpose of this paper is to present quantitative estimates and discuss the distribution of Fe, Mn and Cd, the most important elements that substitute for Zn in sphalerite (ZnS). Eleven core samples from seven bore holes have been selected for analysis such that 5 of them represent the vertical variation in the minor element concentration, if any, and the other the lateral variation.

Analytical method: The selected sphalerite samples were analysed for zinc, sulphur, iron, manganese and cadmium by electron probe micro-analysis. Under the analytical conditions employed, detection limits were 0.01% Fe and Mn and 0.008% Cd. In each of the samples 12 to 16 grains were probed at random choosing inclusion-free areas and the average estimates, are listed in Table 1.

The distribution and correlation of minor elements are given below:

Manganese: There is a general agreement that the manganese content of sphalerite varies with iron content and that it is highest in samples from high temperature deposits. The results of Kullerud (1953) agree with this in general but with many exceptions. Rose (1967) found no correlation between Mn and Fe for the samples from Bingham district. In fact, he observed highest manganese concentrations in sphalerite of very low iron content. Hughes (unpublished) considers the Mn content to be both temperature and pH dependent.

Mn is found in all the analysed sphalerite samples from Ingaldhal mine and ranges between 0.01 wt. % and 0.074 wt. %. The data (sample Nos: 7C/102 to 7C/182 given in Table 1) show increases and decreases in the Mn content with depth. The Mn values are plotted against the corresponding Fe values and no systematic variation is observed (Fig. 1).
**Cadmium:** It was established that the variation of cadmium concentrations in sphalerite does not depend on the time of its formation, but is related to the quantitative relationships of zinc, iron and manganese (Vlasov, 1966). He considers that

**Table 1**

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Wt. % Fe</th>
<th>Wt. % Zn</th>
<th>Wt. % Mn</th>
<th>Wt. % Cd</th>
</tr>
</thead>
<tbody>
<tr>
<td>2C/355</td>
<td>7.06</td>
<td>59.10</td>
<td>0.01</td>
<td>0.33</td>
</tr>
<tr>
<td>3C/287</td>
<td>7.73</td>
<td>58.54</td>
<td>0.04</td>
<td>0.20</td>
</tr>
<tr>
<td>5C/289</td>
<td>5.77</td>
<td>62.00</td>
<td>0.023</td>
<td>0.175</td>
</tr>
<tr>
<td>6C/354</td>
<td>7.47</td>
<td>58.71</td>
<td>0.01</td>
<td>0.18</td>
</tr>
<tr>
<td>7C/102</td>
<td>5.77</td>
<td>61.80</td>
<td>0.054</td>
<td>0.157</td>
</tr>
<tr>
<td>7C/208</td>
<td>6.20</td>
<td>69.0</td>
<td>0.041</td>
<td>0.251</td>
</tr>
<tr>
<td>7C/247</td>
<td>6.40</td>
<td>68.9</td>
<td>0.074</td>
<td>0.188</td>
</tr>
<tr>
<td>7C/319</td>
<td>6.50</td>
<td>58.5</td>
<td>0.026</td>
<td>0.096</td>
</tr>
<tr>
<td>7C/382</td>
<td>6.72</td>
<td>59.5</td>
<td>0.057</td>
<td>0.089</td>
</tr>
<tr>
<td>10C/312</td>
<td>5.16</td>
<td>60.89</td>
<td>0.06</td>
<td>0.160</td>
</tr>
<tr>
<td>12C/311</td>
<td>6.23</td>
<td>60.05</td>
<td>0.05</td>
<td>0.130</td>
</tr>
</tbody>
</table>

![Figure 1. Correlation between minor elements in sphalerite.](image-url)
the cadmium content increases with increasing zinc content, and decreases with increasing iron and manganese contents. Statistical analysis of Fe and Cd in sphalerite from Selon, Holst and Zgid deposits of USSR has revealed an inverse relationship between this pair (Borreswara Rao, 1961). However, the individual results do not precisely indicate this relationship. On the other hand, Edwards (1955) showed that the concentrations of cadmium in sphalerite from Broken Hill decreases with decreasing iron content.

Kullerud (1953) maintains that the solubility of CdS in ZnS is a function of temperature. Edwards (op. cit.) found that the cadmium content decreases with decreasing temperature of formation. Muta (1958) and others have argued that the distribution of cadmium is independent of temperature. Mookerjee (1962) indicates that attempts to correlate experimentally the cadmium content of sphalerite and the temperature of its formation yielded contradictory results.

![Figure 2. Correlation of Fe content in sphalerite with depth.](image)

There are no distinct regularities in the behaviour of cadmium as a function of time of formation and nature of the ore processes in the Karamazar deposits. In view of this, conclusions to the effect that cadmium content of sphalerite increases with decreasing temperature of formation and that the maximum amounts of this element are confined to the latest stages of sphalerite, require additional verification. According to some, the variations in the cadmium content of sphalerites from various deposits are not related to the specific conditions of their formation. The cadmium content of sphalerites belonging to the more iron bearing early, and less iron bearing late generations is constant. Thus, there seems to be no universal criterion by which the cadmium content of sphalerite may be evaluated.

In sphalerites from Ingaldhal mine the cadmium content ranges between 0.089 and 0.33% (Table I). The Cd values are plotted against Zn, Fe, and Mn and no specific correlation with any of these elements is observed. Consideration of the relationships between Mn-Fe, Mn-Cd, Cd-Fe, and Zn-Cd from several large districts and recent studies of Rose (1967) indicate that there is no consistent relationship between any of these pairs.
Thus, the cadmium content seems to be independent of the conditions of formation or the quantities of zinc, iron, or manganese. An extrapolation of this conclusion leads us to believe that temperature has probably had little effect on the distribution of cadmium in the sphalerites of Ingaldhal deposit. Since the concentration of cadmium in sphalerite is almost invariably much lower than the theoretical isomorphous capacity of this element, it may be concluded that the cadmium content depends on the concentration of the element in the solution and on the chemistry of the mineralizing solutions rather than the pressure and temperature.

Iron: That Fe substitutes for Zn in ZnS (sphalerite) is clear by the general increase of iron with decreasing zinc content (Fig. 1). The iron content in sphalerites analysed ranges between 5.16 to 7.75 wt.% Fe and steadily increases from higher to lower levels of Ingaldhal lode (sample Nos: 7C102 - 7C582 plotted in Fig. 2). This indicates that iron in sphalerite increases with the general temperature gradient which increases with depth. In other words there exists a sympathetic variation between the iron content in sphalerite and the temperature of its formation. Recent work on natural sphalerites also is in favour of Kullerud's (1953) observation that the concentration of Fe in sphalerite increases with increasing temperature.

Conclusions: The iron content in Ingaldhal sphalerite may be used to indicate relative temperatures of its formation. The minor elements Mn and Cd can not be indicators of formation temperature. Various ratio calculations show that there is no correlation between Mn-Fe, Cd-Zn, Cd-Fe or Cd-Mn.

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References


