A COMPARISON OF GALKHAITE FROM NEVADA AND FROM THE TYPE LOCALITY, KHAYDARKAN, KIRGIZIA, U.S.S.R.

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ABSTRACT

Galkhaite from one of the type localities, Khaydarkan, Kirgizia, U.S.S.R., has been compared with galkhaite from the Getchell mine, Humboldt County, Nevada, U.S.A. The average composition of the Khaydarkan material is (Hg0.40Cu0.60Zn0.42)2.78 Tl0.01Cs0.44(As0.32Sb0.44)2.76S12. There are minor compositional differences from the Getchell mine material, and these account for an increase in the unit-cell parameter from 10.365(3) Å [Getchell] to 10.393(2) Å [Khaydarkan]. Essentially, there is no significant difference between the minerals, apart from a lower (Cs + Tl) content in the Khaydarkan material. Their powder-line intensities are indistinguishable.

Keywords: galkhaite, type locality, Khaydarkan, Getchell mine (Nevada), microprobe analyses.

INTRODUCTION

In a previous paper, the authors reported that galkhaite from the Getchell mine, Humboldt County, Nevada, contains more Cs than Tl, and has a composition equivalent to (Hg, Cu, Zn, Tl, □)4(Cs, Tl, □)(As, Sb)6S16. It was shown that Tl is distributed between the 12d sites (with Hg, etc.) and the 2a sites (with Cs), and that neither site was fully occupied. The cell edge a of the mineral is 10.365(3) Å and the space group is I43m (Chen & Szymanski 1981). No material from either of the type localities (Gal Khaya in Yakutia or Khaydarkan in Kirgizia, U.S.S.R.) was available at the time for a comparative analysis. The type material was reported to have a composition (Hg, Cu, Zn, Tl)(As, Sb)6S16 and a cell edge 10.41(1) Å (Gruzdev et al. 1972). Cs was not reported in the type material from either locality, and this leads to the question of whether the minerals from the Getchell mine and the two type-localities are actually the same. As the X-ray powder patterns of the type materials and the Nevada material are very similar, it is also possible that the Nevada material is a cesium analogue of galkhaite.

Recently, Roy Kristiansen of Torp, Norway, kindly provided us with a specimen of galkhaite from Khaydarkan, Kirgizia, U.S.S.R. This type-locality material was compared with the Getchell mine material; the results are presented in this paper.

CHEMICAL COMPOSITION

Galkhaite from Khaydarkan was first examined using an SEM equipped with an energy-dispersion analyzer, and subsequently analyzed using an electron microprobe. The analytical conditions of the microprobe analyses were: accelerating voltage 20 kV, and the following emission lines and standards: SKα and CuKα enargite, HgMα cinnabar, FeKα argentopyrite, CsLα CsCl, TIα TlCl and AsLα lorandite, ZnKα ZnS, and SbLα chalcostibite. The data were processed using a modified EMPADR VII computer program of Rucklidge & Gasparetti (1969). The reasons for choosing these emission lines and standards have been explained in Chen & Szymanski (1981). A crystal from the Getchell mine was analyzed at the same time for direct comparison (No. 4, Table 1). Table 1 shows that the compositions of galkhaite from Khaydarkan are fairly consistent, the average
corresponding to \((Hg_{4.48}Cu_{0.99}Zn_{0.99})_{22.75}Na_{0.7}Cso_{0.69}(As_{2.85}Sb_{0.44})_{22.75}S_{32}\). In general, the composition is within the range of the compositions of galkhaite from the Getchell mine. Hg and Sb appear to be somewhat higher than the average Getchell composition, whereas As, Cs, and Tl appear to be low. The most significant difference appears to be in the proportion of (Cs+Tl). For the Getchell material, a linear antipathetic compositional relationship between Cs and Tl was found, with the slope of the relative proportions being \(3\)Cs:2Tl (Chen & Szymański 1981). The Khaydarkan material has \((Cs+Tl) = 0.5\) atoms; this is much lower than any Getchell composition, whereas As, Cs, and Tl appear to be somewhat higher than the average Getchell composition. Although first indications appeared to show the presence of Rb, it was found that, after background correction, the intensity initially attributed to Rb (RbL\(\alpha\), 1.693 keV) was in fact due to the HgM\(\alpha\), \(\xi\) lines (1.714, 1.710 keV). No Rb peaks were found.

X-RAY DATA

X-ray powder-diffraction patterns were obtained using CoK\(\alpha\) radiation and a 114.6 mm Debye-Scherrer camera for the Getchell mine and Khaydarkan samples of galkhaite. They are indistinguishable, except for a slight difference in cell edge: 10.365(3) Å for the Getchell mine, 10.392(2) Å for Khaydarkan. The latter is very close to the value of 10.41(1) Å reported by Gruzdev et al. (1972) for material from the same source. The values of 10.365(3) Å (Chen & Szymański 1981) was found for material of composition \((Hg_{4.29}Cu_{0.6}Zn_{0.33}Fe_{0.6}S_{22.5})_{23.0}Tl_{0.3}\) Cso_{0.26}(As_{8.44}Sb_{0.6})_{22.48}S_{32}. The powder pattern of galkhaite from the Getchell mine reported by Botinelly et al. (1973) is in excellent agreement with the one obtained here, even to the value given for the cell edge (10.36 Å).

It appears that there is a small but consistent difference between the cell edge of galkhaite from the two localities, and this appears to be related to the minor compositional differences. The cell-edge difference can be explained by two factors. Firstly, owing to the differences in the covalent radii of the atoms in the 12\(d\) position -Hg\(^{+2}\), Cu\(^{+2}\) and Zn\(^{+2}\), 1.10, 0.71 and 0.74 Å, respectively; Shannon (1976), an increase in the proportion of Hg relative to Cu+Zn will result in an increased cell-edge. Secondly, a less-occupied atomic position gives rise to increased interatomic distances (Shannon 1976). In the present case, the Khaydarkan material has both a higher mercury content (first point) and a lower \((Cs+Tl)\) content, which results in a lower occupancy of the 2\(a\) sites (second point) the result is a longer cell edge. The same explanation can be advanced to account for the difference between our value (10.365(3) Å) and that found by Divjaković & Nowacki (1975), 10.379 (4) Å, for their Getchell mine galkhaite of composition \(Hg_{4.66}[Cu, Zn]_{1.44}^{+}Tl_{0.48}As_{0.8}S_{32}\). It should be noted that the galkhaite from the Getchell mine does show large compositional variations.

CONCLUSIONS

1. Galkhaite from the Getchell mine, Nevada, is essentially identical to the galkhaite from the type locality, Khaydarkan, Kirgizia, U.S.S.R.
2. The compositions of Khaydarkan galkhaite, \((Hg_{4.48}Cu_{0.6}Zn_{0.42})_{22.75}Tl_{0.65}Cso_{0.42}(As_{8.32}Sb_{0.44})_{22.75}S_{32}\) and that of the Getchell mine galkhaite, \((Hg_{4.48}Cu_{0.88}Zn_{0.42})_{22.75}Tl_{0.47}Cso_{0.47}(As_{8.45}Sb_{0.64})_{22.80}S_{32}\), are similar, although minor variations occur in Hg, As, Sb, Cs, and Tl. The \((Cs+Tl)\) content in the Khaydarkan galkhaite is very low, approximately 0.5 atom per formula unit; however, with always more Cs than Tl, the majority in the 2\(a\) sites is filled with Cs.
3. The cell edge of the Khaydarkan galkhaite is 10.393(2) Å, and that of the analyzed specimen from the Getchell mine is 10.365(3) Å. The larger cell of the Khaydarkan material can be explained by a greater proportion of Hg in the 12\(d\) sites and of vacancies in the 2\(a\) (Cs, Tl) sites in the structure.

### TABLE 1. ELECTRON MICROPROBE ANALYSES OF GALKHAITE

<table>
<thead>
<tr>
<th></th>
<th>Khaydarkan, Kirgizia</th>
<th>Getchell Mine, Nevada</th>
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<td>U.S.A.</td>
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<tr>
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<tr>
<td>Total</td>
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<td>100.6</td>
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</tbody>
</table>

* Average and range of 47 crystals (Chen & Szymański 1981).
** Crystal No. 2, Table I of Chen & Szymański (1981) re-analyzed. nd = not detectable.
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