Ophirite

\[ \text{Ca}_2\text{Mg}_4[\text{Zn}_2\text{Mn}^{3+}_2(\text{H}_2\text{O})_2(\text{Fe}^{3+}\text{W}_9\text{O}_{34})_2]\cdot46\text{H}_2\text{O} \]

Crystal Data: Triclinic.  
Point Group: \( \bar{1} \).  
Crystals are tabular, to 1 mm, displaying \{100\} and \{110\}.

Physical Properties:  
Cleavage: None.  
Fracture: Irregular.  
Tenacity: Brittle.  
Hardness = \( \sim 2 \)

\( D(\text{meas.}) = \text{n.d.} \)  
\( D(\text{calc.}) = 4.060 \)

Optical Properties: 
Transparent.  
Color: Orange-brown.  
Streak: Pale orange.  
Luster: Vitreous.  
Optical Class: Biaxial (+).  
\( \alpha = 1.730(3) \)  
\( \beta = 1.735(3) \)  
\( \gamma = 1.770(3) \)  
\( 2\nu(\text{meas.}) = 43(2)^\circ \)

\( 2\nu(\text{calc.}) = 42.1^\circ \)

Orientation: \( Y \wedge b = 9^\circ \), one optic axis \( \sim \{001\} \).  
Dispersion: \( r > v \), strong.

Absorption: \( X < Y << Z \).  
Pleochroism: \( X = \) light orange-brown, \( Y = \) light orange-brown, \( Z = \) orange-brown.

Cell Data:  
Space Group: \( \overline{\text{P}}1 \).  
\( a = 11.9860(2) \)  
\( b = 13.2073(2) \)  
\( c = 17.689(1) \)

\( a = 69.690(5)^\circ \)  
\( \beta = 85.364(6)^\circ \)  
\( \gamma = 64.875(5)^\circ \)  
\( Z = 1 \)

X-ray Powder Pattern: Ophir Hill Consolidated mine, Ophir district, Tooele County, Utah, USA.

10.169 (100), 11.33 (91), 2.992 (75), 8.27 (55), 2.760 (55), 16.72 (38), 5.44 (33)

Chemistry:

<table>
<thead>
<tr>
<th>Element</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CaO</td>
<td>1.68</td>
<td>1.94</td>
</tr>
<tr>
<td>MgO</td>
<td>2.79</td>
<td>2.78</td>
</tr>
<tr>
<td>ZnO</td>
<td>2.86</td>
<td>2.81</td>
</tr>
<tr>
<td>MnO₃</td>
<td>2.50</td>
<td>2.73</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>3.25</td>
<td>2.76</td>
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<tr>
<td>Sb₂O₅</td>
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<td>WO₃</td>
<td>71.94</td>
<td>72.06</td>
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<tr>
<td>H₂O</td>
<td>[15.24]</td>
<td>14.92</td>
</tr>
<tr>
<td>Total</td>
<td>100.87</td>
<td>100.00</td>
</tr>
</tbody>
</table>

(1) Ophir Hill Consolidated mine, Ophir district, Oquirrh Mountains, Tooele County, Utah, USA; average of 14 electron microprobe analyses supplemented by Raman spectroscopy, \( \text{H}_2\text{O} \) calculated from structure; corresponds to \( \text{Ca}_1.46\text{Mg}_{0.50}\text{Zn}_{0.04}\text{Fe}_{2.00}[(\text{Mg}_{0.30}\text{Zn}_{0.70})_{0.04}]_{2.00}[(\text{Zn}_{1.16}\text{Fe}^{3+}_{0.86}\text{Ca}_{0.14}\text{Mn}^{3+}\text{Sb}^{2+}_{0.02}]_{2.00}[(\text{Mn}^{3+}_{1.42}\text{Sb}^{2+}_{0.20}\text{Fe}^{3+}_{0.24}\text{W}_{0.02}]_{2.00}[(\text{H}_2\text{O})_2[(\text{Fe}^{3+}_{0.80}\text{Sb}^{5+}_{0.10}\text{Mn}^{3+}_{0.10}\text{Ca}_{0.07}\text{Mn}_{1.00}]_{2.00}[(\text{W}_{0.71}\text{Mn}^{3+}_{0.29}]_{2.00})_2]\cdot46\text{H}_2\text{O} \)

(2) \( \text{Ca}_2\text{Mg}_{4}[\text{Zn}_2\text{Mn}^{3+}_2(\text{H}_2\text{O})_2(\text{Fe}^{3+}\text{W}_9\text{O}_{34})_2]\cdot46\text{H}_2\text{O} \)

Occurrence: Produced by late acidic and oxidizing hydrothermal solutions reacting with dolomite and scheelite, in the presence of pyrite and calcium-rich hornfels.

Association: Scheelite, pyrite, dolomite, sericite, apatite, bournonite, galena, sphalerite, fluorite, sulfur.

Distribution: From the Ophir Hill Consolidated mine, Ophir district, Oquirrh Mountains, Tooele County, Utah, USA.

Name: For the mine that produced the first specimens.

Type Material: Natural History Museum of Los Angeles County, Los Angeles, California, USA (64029 and 64030).

References: (1) Kampf, A.R., J.M. Hughes, B.P. Nash, S.E. Wright, G.R. Rossman, and J. Marty (2014) Ophirite, \( \text{Ca}_2\text{Mg}_4[\text{Zn}_2\text{Mn}^{3+}_2(\text{H}_2\text{O})_2(\text{Fe}^{3+}\text{W}_9\text{O}_{34})_2]\cdot46\text{H}_2\text{O} \), a new mineral with a heteropolytungstate tri-lacunary Keggin anion.  