Esperanzaite  

\[ \text{NaCa}_2\text{Al}_2(\text{AsO}_4)_2\text{F}_4(\text{OH})\cdot 2\text{H}_2\text{O} \]

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**Crystal Data:** Monoclinic.  
**Point Group:** 2/m.  
As radiating crystals, in spherulites, to 1.5 mm, which may form botryoidal aggregates.

**Physical Properties:**  
**Cleavage:** One, perfect, || [001].  
**Tenacity:** Brittle.  
**Hardness =** 4.5  
D(meas.) = 3.24  
D(calc.) = 3.36(3)

**Optical Properties:**  
**Transparent to translucent.**  
**Color:** Pale blue-green; colorless in transmitted light.  
**Streak:** White.  
**Luster:** Vitreous.  
**Optical Class:** Biaxial (−).  
**Orientation:** Y = b; X \(\cap\) c = 35°; Z \(\cap\) a = 50.5°.  
**Dispersion:** \(r < v\), medium.  
\(\alpha = 1.580(1)\)  
\(\beta = 1.588(1)\)  
\(\gamma = 1.593(1)\)  
\(2V(\text{meas.}) = 74(1)^\circ\)  
\(2V(\text{calc.}) = 76.3^\circ\)

**Cell Data:**  
**Space Group:** \(P2_1/m\).  
\(a = 9.687(5)\)  
\(b = 10.7379(6)\)  
\(c = 5.5523(7)\)  
\(\beta = 105.32(1)^\circ\)  
\(Z = 2\)

**X-ray Powder Pattern:** La Esperanza mine, Mexico.  
2.966 (100), 3.527 (90), 2.700 (90b), 5.364 (80), 4.796 (80), 3.801 (80), 2.246 (60)

**Chemistry:**

<table>
<thead>
<tr>
<th>Element</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>As(_2)O(_5)</td>
<td>40.67</td>
<td>40.75</td>
</tr>
<tr>
<td>Al(_2)O(_3)</td>
<td>19.20</td>
<td>18.08</td>
</tr>
<tr>
<td>ZnO</td>
<td>0.87</td>
<td></td>
</tr>
<tr>
<td>CaO</td>
<td>20.75</td>
<td>19.89</td>
</tr>
<tr>
<td>Na(_2)O</td>
<td>3.86</td>
<td>5.49</td>
</tr>
<tr>
<td>F</td>
<td>13.9</td>
<td>13.47</td>
</tr>
<tr>
<td>H(_2)O</td>
<td>8.65</td>
<td>7.99</td>
</tr>
<tr>
<td>(-\text{O} = \text{F}_2)</td>
<td>5.83</td>
<td>5.67</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>102.07</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

(1) La Esperanza mine, Mexico; by electron microprobe, average of three analyses on two grains; H\(_2\)O by Karl Fischer coulometric titration; (AsO\(_4\))\(^3−\), (OH)\(^1−\), H\(_2\)O confirmed by IR; calculated from an original analysis As 26.50%, Al 10.16%, Zn 0.70%, Ca 14.83%, Na 2.86%, F 13.9%, H\(_2\)O 8.65%, O 24.45% calculated for charge balance, total 102.15%; corresponds to Na\(_{0.68}\)Ca\(_{2.03}\)Zn\(_{0.07}\)Al\(_{2.06}(\text{AsO}_{4.97}\text{O}_{4.94})_2\text{F}_{4.00}(\text{OH})\cdot 2.13\text{H}_2\text{O}.\) (2) Na\(_{2}\)Ca\(_2\)Al\(_2\)(As\(^{3+}\)O\(_4\))\(_2\)F\(_4\)(OH)\cdot 2\text{H}_2\text{O}.

**Occurrence:** Very rare from a tin-bearing rhyolite.

**Association:** Hematite, cassiterite, quartz, tridymite, cristobalite, “opal”, calcite, zeolites, mimetite, clay minerals.

**Distribution:** From the La Esperanza mine, 3.7 km southeast of Madero, Zaragosa district, Durango, Mexico.

**Name:** For the La Esperanza mine, Mexico, from which the mineral was collected.

**Type Material:** National Museum of Natural History, Washington, D.C., USA, 171530.