Fluorowardite \( \text{NaAl}_3(\text{PO}_4)_2(\text{OH})_2\text{F}_2\cdot2\text{H}_2\text{O} \)

**Crystal Data:** Tetragonal.  *Point Group:* 422.  As tetragonal bipyramidal crystals, to 0.1 mm, displaying \{001\} (prominent and lustrous), \{011\} and/or \{012\} (prominent, irregular, and striated parallel to \{100\}), and \{100\} (common, irregular, and striated parallel to \{100\}).

**Physical Properties:**  
*Cleavage:* Perfect on \{001\}.  
*Fracture:* Irregular.  
*Tenacity:* Brittle.  
*Hardness = 5*  
*D(meas.) = n.d.*  
*D(calc.) = 2.706*

**Optical Properties:**  
*Cleavage:* Perfect on \{001\}.  
*Fracture:* Irregular.  
*Tenacity:* Brittle.  
*Hardness = 5*  
*D(meas.) = n.d.*  
*D(calc.) = 2.706*

**Cell Data:**  
*Space Group:* P4\(_1\)2\(_1\)2\(_1\)2.  
*a = 7.077(2)*  
*c = 19.227(3)\*  
*Z = 4*

**Chemistry:**

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na(_2)O</td>
<td>6.27</td>
<td>7.71</td>
</tr>
<tr>
<td>CaO</td>
<td>1.74</td>
<td></td>
</tr>
<tr>
<td>MgO</td>
<td>0.42</td>
<td></td>
</tr>
<tr>
<td>Al(_2)O(_3)</td>
<td>35.21</td>
<td>38.05</td>
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<tr>
<td>Fe(_2)O(_3)</td>
<td>0.72</td>
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<tr>
<td>P(_2)O(_5)</td>
<td>32.49</td>
<td>35.32</td>
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<tr>
<td>AsO(_5)</td>
<td>0.64</td>
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<tr>
<td>F</td>
<td>6.76</td>
<td>9.45</td>
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<tr>
<td>-O = F(_2)</td>
<td>2.85</td>
<td>3.98</td>
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<tr>
<td>H(_2)O</td>
<td>[13.35]</td>
<td>13.45</td>
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<tr>
<td>total</td>
<td>94.74</td>
<td>100.00</td>
</tr>
</tbody>
</table>

(1) Silver Coin mine, Valmy, Humboldt County, Nevada, USA; average of 8 electron microprobe analyses supplemented by FTIR and Raman spectroscopy, H\(_2\)O calculated from the structure; corresponds to (Na\(_0.87Ca_{0.13}Mg_{0.04}\))\(_{\Sigma=1.04}\)(Al\(_{2.96Fe^{3+}0.04}\))\(_{\Sigma=3.00}\)(P\(_{1.96As_{0.03}\})\_\Sigma=1.99\)(OH)\(_{2.33}\)F\(_{1.53}\)2H\(_2\)O.  
(2) NaAl\(_3\)(PO\(_4\))\(_2\)(OH)\(_2\)F\(_2\)·2H\(_2\)O.

**Occurrence:** A secondary phase, in a F-rich secondary phosphate assemblage.

**Association:** Alunite, barite, cacoxenite, chlorargyrite, fluorapatite, goethite, gorceixite (F-rich), iangreyite, iodargyrite, jarosite, kidwellite, kintoreite/plumbogummite, krásnoite, leucophosphite, lipscombite/zinc lipscombite, meurigite-Na, metavariscite, millisite (F-rich), morinite, quartz, rockbridgeite, strengite/variscite, turquoise/chalcosiderite. Minerals separated by slashes exhibit variations in chemistry between the two species.

**Distribution:** From the phosphate stope, Silver Coin mine, Valmy, Iron Point district, Humboldt County, Nevada, USA.

**Name:** The fluorine analog of wardite; with the prefix “fluoro-” rather than “fluor-” to make pronunciation more straightforward.

**Type Material:** Mineral Sciences Department, Natural History Museum of Los Angeles County, Los Angeles, California, USA (57659 and 63810).

**References:**  
Fluorowardite, NaAl\(_3\)(PO\(_4\))\(_2\)(OH)\(_2\)F\(_2\)·2H\(_2\)O, the fluorine analog of wardite from the Silver Coin mine, Valmy, Nevada.  
*Amer. Mineral.*, 99, 804-810.