**Ludlamite**

\[(\text{Fe}^{2+}, \text{Mg}, \text{Mn}^{2+})_3(\text{PO}_4)_2 \cdot 4\text{H}_2\text{O}\]

**Crystal Data:** Monoclinic. Point Group: 2/m. As crystals, usually tabular \(\{001\}\), showing \(\{100\}\), \(\{110\}\), \(\{001\}\), \(\{\bar{1}1\}\), others, to 9 cm, may be in parallel groups; granular, massive.

**Physical Properties:** Cleavage: \(\{001\}\), perfect; \(\{100\}\), indistinct. Hardness = 3.5

\(D(\text{meas.}) = 3.12-3.19\)  \(D(\text{calc.}) = 3.176\)


**Cell Data:** Space Group: \(P2_1/\alpha\).

\[
\begin{align*}
\alpha &= 10.541(5) \\
\beta &= 4.646(4) \\
\gamma &= 9.324(5) \\
\beta &= 100^\circ 25.8(1.0)'
\end{align*}
\]

\(Z = 2\)


3.96 (100), 2.765 (100), 2.543 (100), 4.91 (75), 2.990 (60), 3.74 (50), 2.387 (40)

**Chemistry:**

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\text{P}_2\text{O}_5)</td>
<td>32.95</td>
<td>33.04</td>
</tr>
<tr>
<td>(\text{FeO})</td>
<td>49.22</td>
<td>50.18</td>
</tr>
<tr>
<td>(\text{MgO})</td>
<td>0.96</td>
<td></td>
</tr>
<tr>
<td>(\text{H}_2\text{O})</td>
<td>16.12</td>
<td>16.78</td>
</tr>
<tr>
<td>insol</td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>99.82</td>
<td>100.00</td>
</tr>
</tbody>
</table>

(1) Palermo #1 mine, New Hampshire, USA. (2) \(\text{Fe}_3(\text{PO}_4)_2 \cdot 4\text{H}_2\text{O}\).

**Occurrence:** In complex granite pegmatites, a common hydrothermal alteration product of earlier phosphates, formed under reducing conditions.

**Association:** Phosphoferrite, triploidite, triplite, triphylite, apatite (Hagendorf, Germany); fairfieldite, vivianite, siderite, whitlockite (Palermo #1 mine, New Hampshire, USA).

**Distribution:** Some localities for fine crystals or large masses include: from Wheal Jane, Kea, Cornwall, England. At Hagendorf, Bavaria, Germany. From the Stari Trg mine (Trepča), Kosovo, Serbia. In the USA, at the Palermo #1 mine, North Groton, Grafton Co., New Hampshire; large crystals from the Blackbird mine, Lemhi Co., Idaho; at the Dan Patch, Ferguson, Big Chief, and other pegmatites, near Keystone, Pennington Co., South Dakota. From the Rapid Creek district, Yukon Territory, Canada. Large crystals from the San Antonio mine, Santa Eulalia district, Chihuahua, Mexico. In the Ênío pegmatite mine, northeast of Galliĉia, Minas Gerais, Brazil. Fine crystals from Morococala and Huanuni, Oruro, Bolivia. In the Ashio mine, Tochigi Prefecture, Japan. A number of other localities are known.

**Name:** To honor Henry Ludlam (1824–1880), English mineral collector, London, England.

**Type Material:** The Natural History Museum, London, England, 44187.

**References:**
2. Abrahams, S.C. and J.L. Bernstein (1966) Crystal structure of paramagnetic ludlamite, \(\text{Fe}_3(\text{PO}_4)_2 \cdot 4\text{H}_2\text{O}\), at 298°K. J. Chemical Physics, 44(6), 2223–2229.