**Arrojadite-(KFe)**  
KNaFe\(^{2+}\)(CaNa2)Fe\(^{2+}\)\(_{13}\)Al(PO\(_4\))\(_{11}\)(PO\(_3\)OH)(OH)\(_2\)

**Crystal Data:** Monoclinic.  
**Point Group:** \(m\).  
As cleavable masses to 15 cm.

**Physical Properties:** Cleavage: On \{001\}.  
Tenacity: Brittle.  
Fracture: Uneven.  
Hardness = 5  
\(D(\text{meas.}) = 3.527\)  
\(D(\text{calc.}) = 3.586\)  
Nonfluorescent.

**Optical Properties:** Transparent.  
**Color:** Dark yellowish green.  
**Streak:** White.  
**Luster:** Vitreous.  
**Optical Class:** Biaxial (-).  
\(\alpha = 1.662-1.664\)  
\(\beta = 1.668-1.670\)  
\(\gamma = 1.672-1.675\)  
2V(meas.) = 80°-86°  
**Pleochroism:** \(X = \) colorless;  
\(Y = \) colorless to pale green;  
\(Z = \) pale yellow-green.  
**Orientation:** \(X = b;\)  
\(Y \wedge c = 18°-21.5°\).  
**Dispersion:** \(r < v\), strong.

**Cell Data:**  
**Space Group:** Cc.  
\(a = 16.453(2)\)  
\(b = 10.031(2)\)  
\(c = 24.692(4)\)  
\(\beta = 105.72(9)°\)  
\(Z = 4\)

**X-Ray Diffraction Pattern:** South Dakota, USA. (ICDD 34-149)  
3.042 (100), 2.714 (85), 3.222 (45), 2.774 (30), 2.852 (25), 2.751 (25), 2.550 (25)

**Chemistry:**

<table>
<thead>
<tr>
<th>Formula</th>
<th>(1)</th>
<th>(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P(_2)O(_5)</td>
<td>[40.70]</td>
<td>CaO</td>
</tr>
<tr>
<td>Al(_2)O(_3)</td>
<td>2.42</td>
<td>SrO</td>
</tr>
<tr>
<td>FeO</td>
<td>28.48</td>
<td>BaO</td>
</tr>
<tr>
<td>MnO</td>
<td>14.56</td>
<td>PbO</td>
</tr>
<tr>
<td>ZnO</td>
<td>0.40</td>
<td>F</td>
</tr>
<tr>
<td>MgO</td>
<td>1.37</td>
<td>H(_2)O</td>
</tr>
<tr>
<td>Li(<em>2)O(</em>{1.06\text{AM}})</td>
<td>0.26</td>
<td>(-O = F) 0.32</td>
</tr>
<tr>
<td>Na(_2)O</td>
<td>6.16</td>
<td>Total 100.40</td>
</tr>
<tr>
<td>K(_2)O</td>
<td>1.71</td>
<td></td>
</tr>
</tbody>
</table>

(1) Nickel Plate mine, South Dakota, USA; average electron microprobe analysis, H\(_2\)O and P\(_2\)O\(_5\) calculated, total includes SiO\(_2\) = 0.03, TiO\(_2\) = 0.05; corresponds to K\(_{0.76}\)Na\(_{4.15}\)(Ca\(_{0.93}\)Ba\(_{0.07}\))Fe\(_{13}\)O\(_{11}\)(PO\(_3\)OH)(OH)\(_2\) \((\text{ICDD 34-149})\).

**Polymorphism & Series:** Forms a series with dickinsonite.

**Mineral Group:** Arrojadite group.  
A\(_2\)B\(_2\)CaNa\(_{2+x}\)M\(_{13}\)Al(PO\(_4\))\(_{11}\)(PO\(_3\)OH\(_{1-x}\))W\(_2\).

**Occurrence:** A high-temperature (≈ 800 °C) primary mineral in granite pegmatites.

**Association:** Graffonite, cassiterite, spodumene, beryl, muscovite (Nickel Plate mine).

**Distribution:** From the Nickel Plate mine, near Keystone, Pennington Co., South Dakota, USA [TL]. Chemically similar material from the Smith mine, Newport, and the Palermo No. 1 and Nancy mines, North Groton, New Hampshire, USA.

**Name:** *Arrojadite* indicates a member of the group with Fe\(^{2+}\) dominant at the \(M\) site; two suffixes indicate the dominant cation of the dominant valence state at the \(A\) and \(B\) sites. Honors Miguel Arrojado Ribeiro Lisbôa (1872-1932), Brazilian geologist. Formerly ‘arrojadite’.

**Type Material:** Mineral Museum, School of Mines, Paris, France (38431).

**References:**  