PERHAMITE – Palermo Mine
N. Groton, NH
2017

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SEM-EDS mineral analysis at the Boston College laboratory.

- Sponsored by the Micromounters of New England for its members.
- Standardless quantitative analysis with excellent light element detection.
- Epoxy embedded, polished grain, sample preparation.

Energy Dispersive Spectroscopy
Typical polished grain epoxy block, 20 mm x 16 mm
A recent finding was the identification of perhamite specimens from the Palermo mine, N. Groton, NH

0.3 mm “crandallite” balls on a quartz crystal. Palermo Mine, N. Groton, NH.

Collected by and gift from Janet & Steve Cares.
My first effort to confirm this crandallite was at a Micromounters sponsored EDS session at Microvision Laboratories, Chelmsford, MA.

However there are no minerals with only Aluminum, Strontium, Phosphorus and Calcium.
A follow-on EDS analysis of this “crandallite” indicated a chemistry of approximately $\text{CaAl}_3\text{SiP}_{1.8}\text{O}_{13.6}$ [Normalized for one Ca]

Crandallite chemistry is $\text{CaAl}_3(\text{PO}_4)(\text{PO}_3\text{OH})(\text{OH})_6$
or grouping elements and eliminating hydrogen $\text{CaAl}_3\text{P}_2\text{O}_{14}$.
The Micromounters of NE acquired the bulk, unmounted, micro-mineral material from the estate of Gene Bearss.
Egg cartons of Gene’s micros frequently appear the Micromounters give-away table.

This one contained many dime to nickel sized specimens similar my Cares specimen.
Example specimen from the Bearss egg carton

1.7 cm specimen

3 mm field of view

These specimens provided ample material for additional testing.
The results of three probings of a polished grain (BC121) from one of these specimens (plus the earlier BC63 analysis) are tabulated below.

The atoms per unit formula were calculated from the EDS Atomic %’s
** Hydrogen atomic % of 2.76 % was added to EDS result.
The APFU’s have been normalized for three (Ca + Sr).

(Mineralogical Magazine v. 70.)

<table>
<thead>
<tr>
<th>Analysis run</th>
<th>Ca*</th>
<th>P</th>
<th>Sr</th>
<th>Al</th>
<th>Si</th>
<th>O</th>
<th>H**</th>
<th>Implied formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC121</td>
<td>2.85</td>
<td>4.7</td>
<td>0.15</td>
<td>8.4</td>
<td>2.4</td>
<td>32.5</td>
<td>30.9</td>
<td>((\text{Ca}<em>{2.85}\text{Sr}</em>{0.15})\text{Al}<em>{8.4}\text{Si}</em>{2.4}\text{P}<em>{4.7}\text{O}</em>{32.5}\text{H}_{30.9})</td>
</tr>
<tr>
<td>BC121a</td>
<td>2.86</td>
<td>4.5</td>
<td>0.14</td>
<td>8.3</td>
<td>2.0</td>
<td>37.4</td>
<td>32.5</td>
<td>((\text{Ca}<em>{2.86}\text{Sr}</em>{0.14})\text{Al}<em>{8.3}\text{Si}</em>{2.0}\text{P}<em>{4.5}\text{O}</em>{37.4}\text{H}_{32.5})</td>
</tr>
<tr>
<td>BC121c</td>
<td>2.78</td>
<td>4.4</td>
<td>0.22</td>
<td>10.2</td>
<td>3.4</td>
<td>70.5</td>
<td>50.1</td>
<td>((\text{Ca}<em>{2.78}\text{Sr}</em>{0.22})\text{Al}<em>{10.2}\text{Si}</em>{3.4}\text{P}<em>{4.4}\text{O}</em>{70.5}\text{H}_{50.1})</td>
</tr>
<tr>
<td>BC63</td>
<td>3.0</td>
<td>5.3</td>
<td>-</td>
<td>8.9</td>
<td>2.9</td>
<td>41.5</td>
<td>36.0</td>
<td>(\text{Ca}<em>{3}\text{Al}</em>{8.9}\text{Si}<em>{2.9}\text{P}</em>{5.3}\text{O}<em>{41.5}\text{H}</em>{36.0})</td>
</tr>
</tbody>
</table>
All four analyses consistently showed a presence of two to three silicon atoms per formula unit (APFU).

There is only ONE mineral that contains only Ca, Al, P, Si, O: **Perhamite**!

Perhamite chemistry is: \( \text{Ca}_3\text{Al}_{7.7}\text{Si}_3\text{P}_4\text{O}_{23.5}(\text{OH})_{14.1} \cdot 8\text{H}_2\text{O} \)
Since a claim of perhamite occurrence at the Palermo Mine is somewhat extraordinary, I felt further evidence was required. A sample from the egg-carton was sent to John Attard, San Diego, CA for XRD analysis.
So why did I see a big strontium peak in my initial Microvision Lab analysis?

Mouse click on spectral line for KeV value and element
Use d key to erase last cursor
Use z key to show 4x horiz. zoom view
Use e key to mark specified element lines (mouse click on list below)
Use escape key then click to exit: r key to refresh the spectrum
So why did I see a big strontium peak in my initial Microvision Lab analysis?
0.7 mm perhamite cluster on albite. Emmons Quarry, Greenwood, ME

1.2 mm perhamite cluster on quartz. Palermo Mine, N. Groton, NH
Habit variations in another Palermo aluminum phosphate: GOYAZITE
Closing thoughts:

- Literature tells us perhamite is “structurally related” to crandallite.
- Goyazite is the strontium analog of goyazite.

How did the Cares make the crandallite determination?

Crandallite had been known since 1917, but perhamite was first described in 1977. The Cares “crandallites” were collected in 1976 according to the micro-box label added by Gene Bearss.

- Janet Cares was a very accomplished chemist, and was responsible for identifying many Palermo minerals for her collection.
- Janet likely used wet chemistry techniques to determine these were a calcium-aluminum-phosphate.
- The morphology and Palermo environment strongly suggested the species to be crandallite.
- Particularly since perhamite was very likely not yet defined at the time of her analysis.
Closing thoughts – continued:

• What level of analysis is sufficient to identify (and label) with confidence a particular specimen?

• The labeling on my specimen #u1884 shows the importance of preserving the history of the specimen. The original collector (Cares) and date (1976) make the crandallite identification understandable.

• This is an example of an investigation made possible by the EDS analysis program financed and sponsored by the Micromounters of New England.