

Garnet from the Orford nickel mine, Saint-Denis-de-Brompton, Quebec, Canada. D. Dallaire

Garnet family minerals from Orford nickel mine have been sight identified as ei ther uvarovite $[\text{Ca}_3\text{Cr}_2(\text{SiO}_4)_3]$, andradite $[\text{Ca}_3\text{Fe}_2\text{SiO}_4)_3]$, grossular $[\text{Ca}_2\text{Al}_2(\text{SiO}_4)_3]$ or some other garnet family member. This brief paper was written to reach some conclusions on the identity of the garnet family minerals found there.

The Orford nickel mine (ONM) is known primarily for its abundance of large (up to 32 cm. in diameter), well formed crystals of diopside. It also is known for groups of small (1mm) green grossular garnets which were erroneously thought to be uvarovite in the past. During the past 10 years some other garnets were found and labeled grossular or andradite depending upon their color. This paper will give a brief overview of the locality, the minerals found there and an analysis of the various garnets to determine their composition. For a more detailed history, geology and mineralogy refer to the Mineralogical Record volume 25 #5 (Sept-Oct 1994) to an article on page 327 titled *Famous Mineral Localities: The Orford nickel mine, Quebec, Canada* by P. Tarassoff & R. A. Gault.

It is not clear when the ONM was discovered but it was likely the result of a search for copper between 1840 – 1860. The first date of the existence of this deposit comes from 1863 and is likely the result of the increased demand for copper caused by the American Civil War. The green garnets were thought to be colored by copper. ONM did not develop into a metal mine since the "ore" that was smelted did not produce any metal at first. Finally a process was develop that worked to some degree but made the product too expensive. Mining ceased in 1879. Diamond drill exploration between 1950 and 1960 showed no profitable ore. Although the mining history was uneventful and unprofitable, ONM has had a long history of providing mineral specimens to collectors and museums.

The ONM is in the same belt of rocks that hosts the major asbestos producing mines in North America. This belt includes the VAG Asbestos Quarry in Vermont; the Jeffrey Mine in Asbestos, Quebec and the asbestos mines at Black Lake and Thetford Mines, Quebec. The ONM is in a fault zone and was worked to 45 meters underground by two shafts. The shafts have been buried for many years for safety so collecting is done on the mine dumps which over time have become relatively shallow but occasional good specimens are still found. It is a fee collecting locality and any collector needs to contact the owner who resides at the house on the property for access and cost.

The minerals listed as commonly collected at the site over the years are **diopside** from micro to cabinet size, **calcite** as massive chunks up to 12 cm, **grossular** from micro to thumbnail size, **andradite** from micro to thumbnail size and **millerite** in crystals generally less than 5mm. **Pyrite** was imported to ONM to act as a flux in the smelting process and samples are occasionally found. There are several other minerals present which occur only in micro specimens. The most comprehensive list presented below comes from the article in the Mineralogical Record previously referred to.

Table 1. Minerals of the Orford nickel mine from Tarassoff & Gault

<i>Sulfides</i>	<i>Phosphates and Arsenates</i>
Arsenopyrite	Annabergite
Godlevskite	Apatite Group
Maucherite	
Millerite	<i>Silicates</i>
Pentandlite	Albite
	Allenite (Ce)
<i>Oxides</i>	Andradite
Chromite	Clinocllore
Magnetite	Diopside
	Epidote
<i>Carbonates</i>	Grossular
Calcite	Microcline
Dolomite	Pecoraite
	Prehnite
	Tremolite

The author's first trip to the ONM was on September 26, 2000. After spending a few unsuccessful days of collecting at Percy Peak in Stratford, NH with Vincent Valade it was decided to try some different preferably collecting at a site with easier access. Vince had been to ONM before and suggested that we collect there. On that day several small, but terminated Diopside crystals were found and the author came up with a garnet specimen of thumbnail size. The garnets were brown, lustrous and up to 5mm. They almost completely covered a small Diopside crystal 16 x 7 x 1.5mm. Vincent said that this was an andradite garnet and that he had not found any of that size before.



Figure 1: Specimen collected in September 2000 originally sight identified as andradite

On October 12, 2003 at the Capital Mineral Club Mineral Show at Sunapee, NH, John McCrory exhibited a cabinet specimen of garnet on Diopside that was quite spectacular. He had collected this specimen along with several others from thumbnail to miniature size. He was offering specimens for sale and the writer bought the lot for his collection. These garnets were a bit redder in color than the specimen collected in 2000 but John labeled his find as Grossular. At the show several members got together for a field trip to ONM in late October. The group consisted of Bill Brown, Don Dallaire, John McCrory and Vincent Valade. On October 30th at the collecting site the group dug on the side of the dump nearest the path to the owner's house. Several specimens were found but this time the garnets were a light yellow - green color up to 12mm on Diopside crystals and massive Diopside. It was decided by observation (inaccurate analysis) that these were also grossular.

The author was not content to label these specimens on observation and sent samples of each color to the University of New Orleans for analysis. Unfortunately these specimens were in New Orleans when hurricane Katrina hit. Although not damaged or lost the analysis was put off for a while since rebuilding and dealing with the effects of Katrina were paramount. Al Falster at UNO was able to do the analysis in early 2008 using an AMRAY Scanning Electron Microscope equipped with an energy dispersive X-ray detector. and the following observations were made:



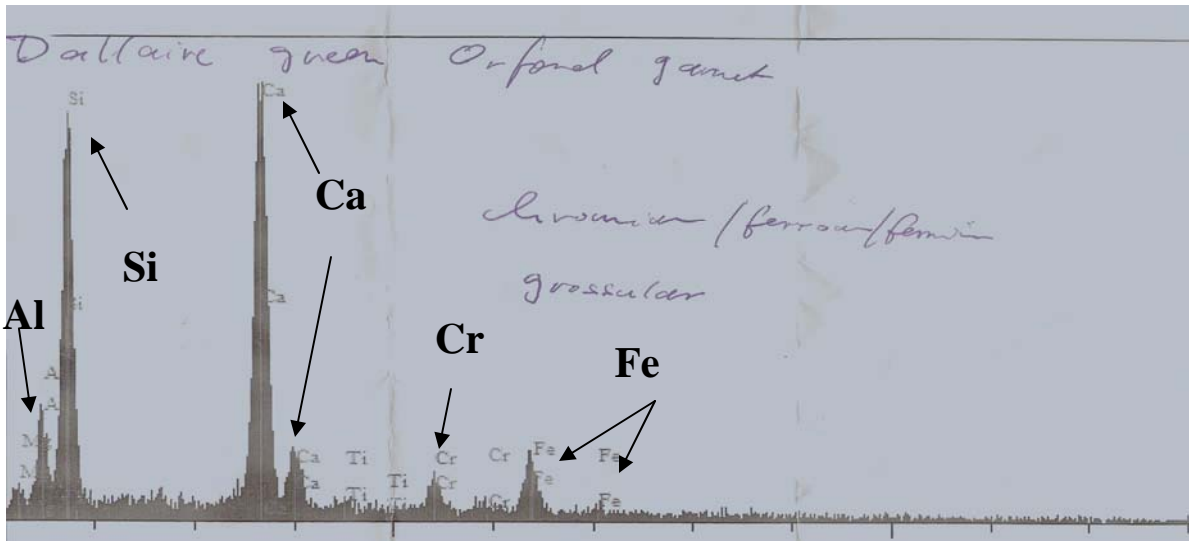
Figure 2. Andradite/Grossular solid solution garnet similar to analysis specimen #2. Miniature specimen with garnet 6mm Collected by John McCrory, D. Dallaire collection.

Analysis specimen #1

Bright green garnets up to .5mm from 2000 find

Showed dominant calcium (Ca) with minor chromium (Cr) and a small amount of iron (Fe). This shows that the green garnet is actually Grossular var: Chromian Grossular since the amount of chromium is not sufficient for uvarovite. Ideal endmember uvarovite is essentially aluminum free! This is consistent with results of an analysis done by Pete Dunn referred to in the Mineralogical Record article.

Analysis #1



Analysis specimen #2

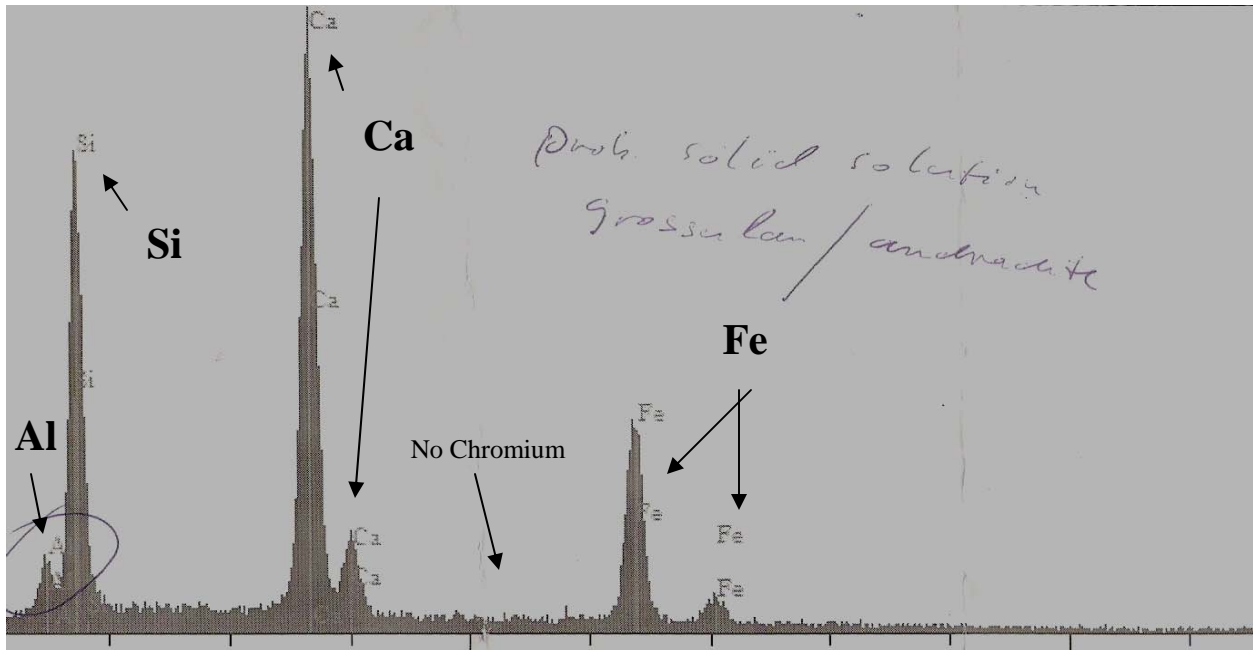
Reddish brown garnet from McCrory find

Showed dominant calcium (Ca) but a much higher peak of iron (Fe) and no chromium (Cr). This specimen appears to be a solid solution of Andradite and Grossular. Endmember andradite does not contain any aluminum whereas grossular 2 Al in the Y-site. On the energy dispersive spectrum, the approximate relationship of aluminum and silicon can be estimated from the peak height. A ratio of about 2:3 should be seen for pure grossular. Fe^{3+} substitutes for Al and thus the Al:Si ratio will decrease accordingly. If Fe^{2+} only is present, it will end up in the X-site, substituting for Ca and there will be no effect on the Al:Si ratio.



Figure 3. Andradite/Grossular solid solution garnet similar to analysis specimen #2. Miniature specimen with garnet 6mm. Collected by John McCrory. D. Dallaire collection.

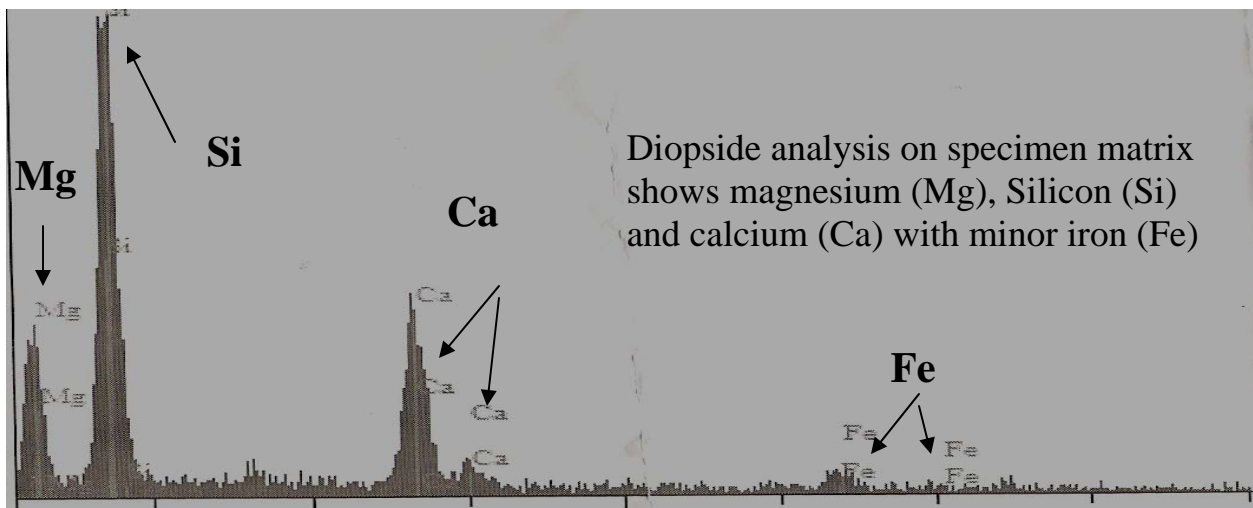
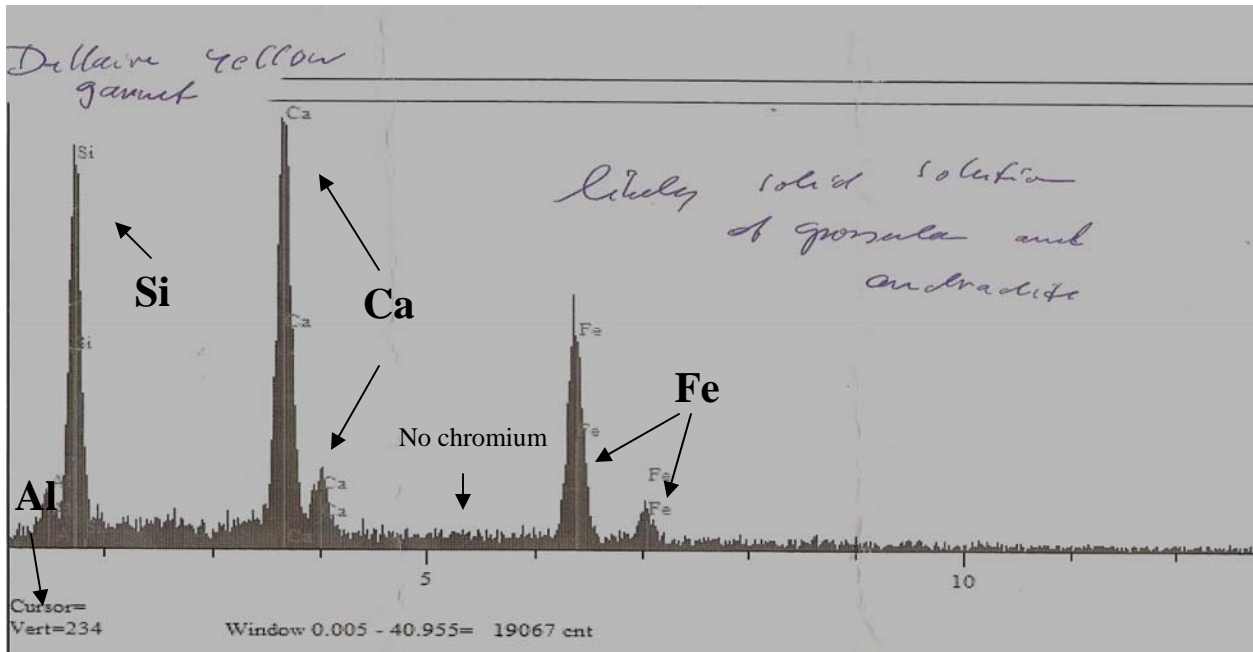
Analysis #2



Analysis specimen #3
Yellow – green garnet from
October 30 find
This specimen also showed a
high Calcium (Ca) peak as
well as a high Iron (Fe) peak.
The iron in this sample was
somewhat higher than
sample #2.
This garnet is also appears to
be a solid solution of Andra-
dite and Grossular.

Figure 4. Andradite/Grossular solid solution garnet similar to analysis specimen #3. Collected by B. Brown, D. Dallaire, J. McCrory and V. Valade. D. Dallaire collection.

Analysis #3



Conclusion:

Garnets from the Orford Nickel Mine that are bright green in color are chromium rich grossular while the other garnet family members of other colors are a solid solution of andradite and grossular with the composition varying across the sample.

I would like to thank Al Falster for the analysis and review of the paper as well as thanking the collecting partners that helped in collecting and acquiring these specimens.