**SOME MICRO SPECIES FOUND IN THE AUTUMN OF 2021 AT HURRICANE MTN, NORTH CONWAY, NH: AN ALKALI-RICH PEGMATITE LOCALITY**

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The Hurricane Mtn. trail is not as well travelled by collectors today as it probably was two or three decades ago. At that time macro specimen collectors were still quite active excavating arfvedsonite, smoky and amethystine quartz specimens. What collectors think of as the "Hurricane trail" is not a biking or hiking trail at all. It's simply a remnant logging trail that has been used, and apparently even driven on once upon a time by collectors.

The "trail" is accessed from the Black Cap parking lot on North Conway's Hurricane Mountain Rd. Although Black Cap is in the White Mountain National Forest, most of the Hurricane Mtn. collecting area is on New Hampshire state land. And, whereas the Black Cap trail heading south from the parking lot is obvious, signed, and heavily used by hikers and trail bikers, the entrance to the trail at roadside up to the Hurricane mineral collecting area is not so easy to find. In recent years this "trail" entrance on the north side of Hurricane Mountain Road has become obscured by downed trees, brush and regrowth. To find it, you need to walk down the opposite side of Hurricane Mtn. Road a couple hundred feet or so and strike directly into the woods. Once in 25 to 50 feet walking parallel to the road keeping an eye out for the trail is the best way to find it. At this brief stage it is bushwhacking. Once found however, the trail is more like an old cart path and is very easy to follow up the mountain. Eventually it dog-legs to the right and will ascend up and over a couple of granite outcrops. As you explore this area above these slabs you will start to come across past collector excavations. You are on the western side of the collecting area.

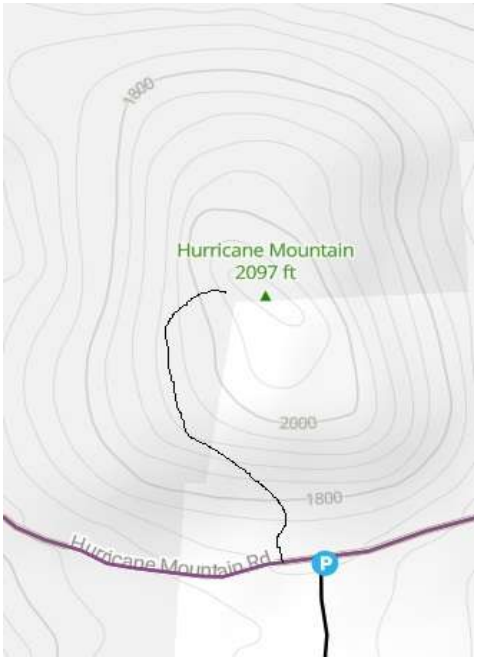



**Figure 1 An approximation of the trail to the Hurricane collecting area.**

Overall, the hike is not particularly strenuous. The grade gets moderately steep for only short segments of the hike. As long as you take it slowly, it's just good exercise. The granite slabs may for some be a bit challenging especially if the surfaces with mosses, lichens and algae are damp.

An area of extensive excavation commonly referred to as "Peter's Quarry" is on the eastern side of the mountain. Peter Samuelson worked this area for several years decades ago. Without providing GPS coordinates I would not hazard giving instructions to this area. Although the trail from the previously-mentioned area continues for some distance towards it, it then dies out and you are left to bushwhack in an uncertain direction.

Figure 2: A 0.5mm composite hematite crystal

Depending upon what you consider worthy of collecting as micro minerals, there are a few very nicely crystallized species at Hurricane such as hematite, arfvedsonite, and zircon. Hematite forms nice black hexagonal plates. Arfvedsonite is shot through the pegmatite everywhere, but you need to find some very fine-grained vuggy material for complete crystalline micro specimens.

Figure 2: A 1.5 mm arfvedsonite crystal

Zircons are prolific at Hurricane. They range from "industrial," opaque embedded ones to a rare gemmy-grade specimen such as the one Scott Whittemore has posted a photo of on Mindat.org. The ones I have chosen to photograph are very small, but more likely than not, they are sharper and cleaner than most of the larger ones I found. The prismatic crystal form shown in one specimen photo (fig. 5) does not seem particularly common.

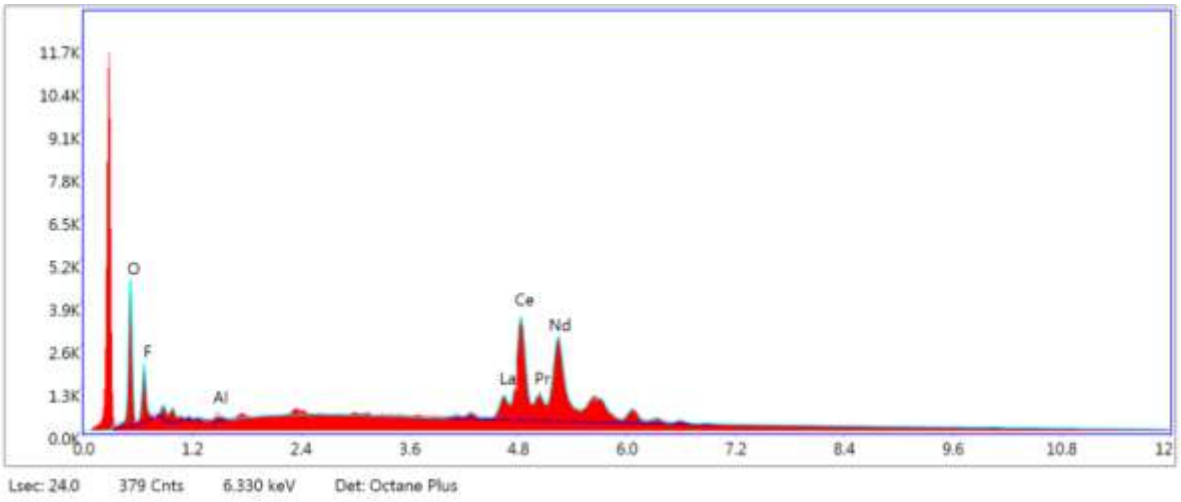
Figure 4: A 0.3 mm zircon crystal

Figure 5: A group of minute prismatic zircons; a 1.6 mm field of view

Unreported on Mindat.org, bastnaesite-Ce turned up on both of my trips to Hurricane with Gordon Jackson in 2021; once from a western location dig and once from a “Peter’s Quarry” dig. At first, I was uncertain as to whether these tiny reddish crystals were bastnaesite or monazite. EDS proved them to be bastnaesite-Ce. In many cases these crystals were partially or totally etched away leaving orange granules in vacant vugs. As a carbonate, bastnaesite would be vulnerable to acidic fluids percolating through the granite.

Figure 6: A 0.5 mm compound bastnaesite crystal on albite.

Figure 7: A 0.5 mm bastnaesite-Ce crystal with hematite.




| Element | Weight % | Atomic % | Net Int. | Error % | Kratio | Z | A | F |
|---|---|---|---|---|---|---|---|---|
| O K | 7.36 | 37.87 | 952.24 | 7.78 | 0.0535 | 1.5222 | 0.4779 | 1.0000 |
| F K | 1.71 | 7.43 | 276.78 | 10.35 | 0.0117 | 1.4147 | 0.4838 | 1.0000 |
| AlK | 0.67 | 2.03 | 77.35 | 13.97 | 0.0030 | 1.3577 | 0.3315 | 1.0033 |
| LaL | 9.99 | 5.92 | 370.34 | 8.74 | 0.0956 | 0.9384 | 1.0061 | 1.0137 |
| CeL | 50.50 | 29.67 | 1741.35 | 3.14 | 0.4811 | 0.9433 | 1.0073 | 1.0026 |
| PrL | 6.22 | 3.64 | 201.45 | 17.06 | 0.0593 | 0.9508 | 1.0006 | 1.0015 |
| NdL | 23.55 | 13.44 | 697.37 | 6.31 | 0.2209 | 0.9410 | 0.9992 | 0.9977 |

The bastnaesite-Ce EDS result, or $Ce(CO_3)F$, is shown to have the required fluorine, cerium and other lesser rare earth substitutions for cerium, in this case neodymium, lanthanum and praseodymium.

Upon examining material from my two 2021 Hurricane trips, I noticed on numerous occasions an amphibole-like species that was dark green and that had a compact rigid fibrous nature. It looked much like arfvedsonite (fig. 9). There were also brittle green "splinters" at the core of or intergrown with arfvedsonite crystals. Rarely the mineral appeared as coarse vitreous shards or crystal segments. It was this vitreous matter that was submitted for EDS testing. The sample was taken from a specimen with mostly

poorly-formed but discreet, stubby green crystals as shown in the associated photo (fig. 8).

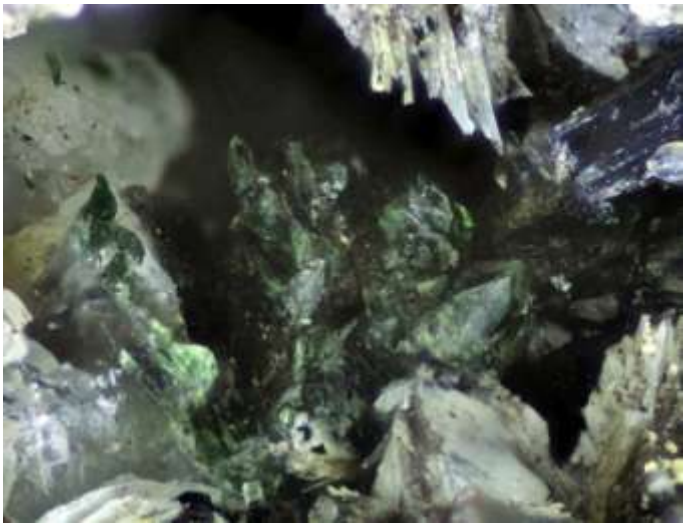
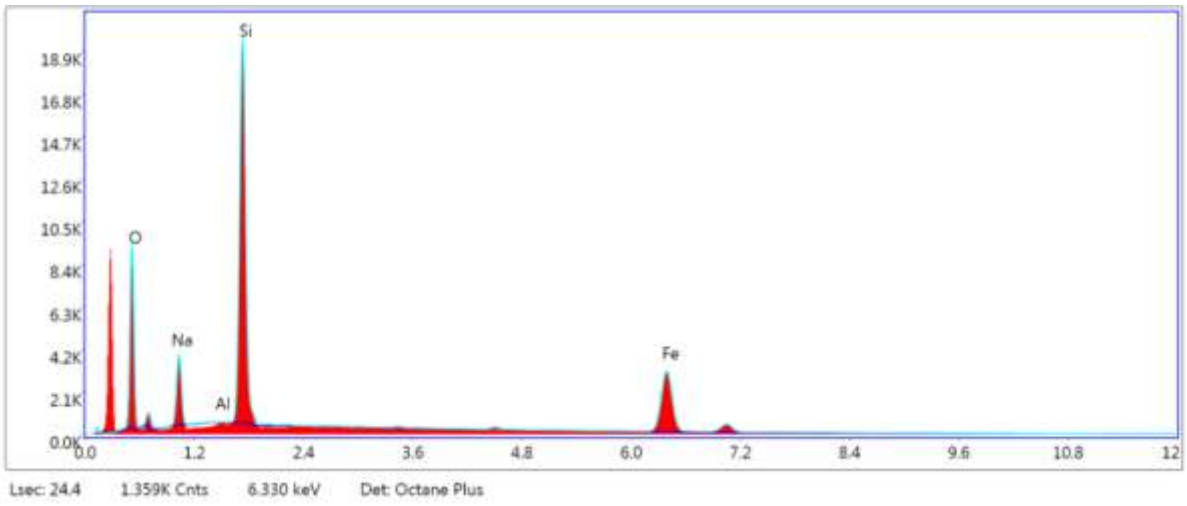


**Figure 8: A 2.4 mm view of an aegirine crystal group.**

Aegirine and The Red Hill Ring Dike Complex

One of the most authoritative references on the Red Hill ring complex *in Mineralogy and Petrology of the Red Hill Alkaline Igneous Complex* by Henderson, Pendlebury and Foland, suggested a trend toward aegirine-augite in the outer core syenite (OCS) intrusion of the ring complex. This had been first referred to in Chapman and Williams' "Evolution of The White Mountain Magma Series" *American Mineralogist* article in 1935 later to be cited in Stewart's The Geology of New Hampshire. Note: Numerous attempts by Tom Mortimer to find aegirine here have to date not been successful.




| Element | Weight % | Atomic % | Net Int. | Error % | Kratio | Z | A | F |
|---|---|---|---|---|---|---|---|---|
| O K | 17.57 | 32.70 | 1866.14 | 7.13 | 0.0951 | 1.1571 | 0.4681 | 1.0000 |
| NaK | 9.65 | 12.49 | 877.45 | 8.76 | 0.0366 | 1.0489 | 0.3614 | 1.0008 |
| AlK | 0.01 | 0.01 | 2.17 | 98.52 | 0.0001 | 1.0262 | 0.5986 | 1.0030 |
| SiK | 30.35 | 32.17 | 6132.99 | 4.49 | 0.2282 | 1.0482 | 0.7163 | 1.0017 |
| FeK | 42.42 | 22.62 | 1738.34 | 3.01 | 0.3743 | 0.8743 | 0.9997 | 1.0097 |

With the standard aegirine formula of $NaFe^{3+}Si_2O_6$, an atoms-per-formula-unit (APFU) calculation for the EDS resulted with the empirical formula $Na_{0.95}Fe_{0.71}^{3+}Si_{2.0}O_{3.57}$. This is not "perfection," but it is closer to aegirine than any other possible amphibole option. This result definitively and officially settled the existence of aegirine as a Hurricane Mountain species but also as a New Hampshire species.

The question remains however, is the compact fibrous dark green amphibole (fig. 9) also aegirine? It remains to be proven. There *are* other possible amphiboles. Actinolite is one of them included on the Mindat.org species list for Hurricane Mountain. But this is probably as a result of a couple of references found in Stewart and Meyers' *The Geology of New Hampshire*. One was an anecdotal personal communication by Millard Chandler saying he found crocidolite associated with actinolite "near the top of Hurricane." And, the other was the Marland P. Billings report that actinolite occurs *regionally* in his "Regional Metamorphism of the Littleton-Moosilauke Area." But, I have yet to find any valid identification of it with testing specifically for Hurricane Mountain.

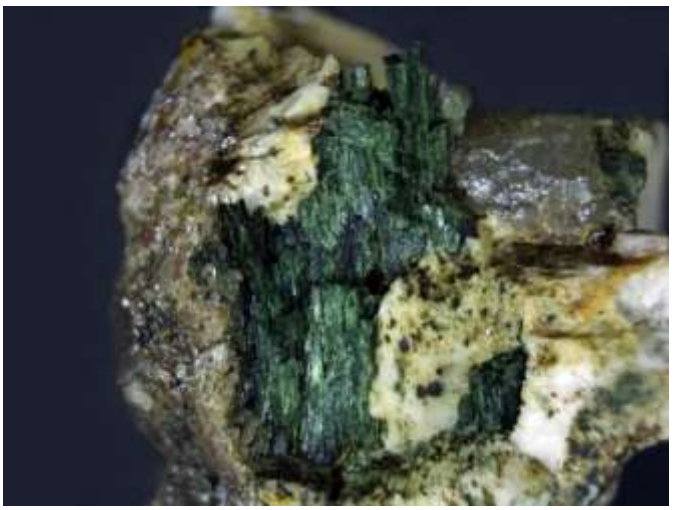


Figure 9: A 1.8 cm tall still untested amphibole.

Riebeckite var. crocidolite is best known from Hurricane as blue-gray or brown fibrous masses. This variety of riebeckite is sometimes referred to as riebeckite asbestos. It is more sodium and iron-rich than aegirine and is typically found as hair-like masses. It is considered a respirable carcinogen. Yet, not all riebeckite is of this loose fibrous crocidolite variety. The species can be much more rigid and well crystallized as a result of igneous origin. This can vary from blue, black to dark green.

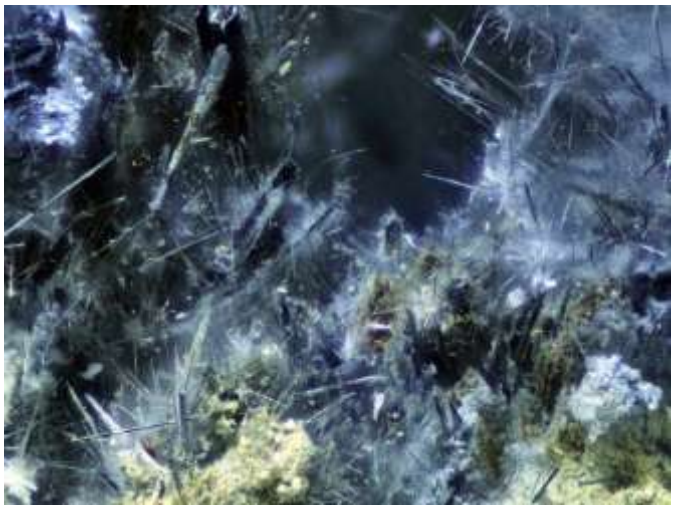


Figure 10:Riebeckite var. crocidolite. A 1.8 mm field of view

Astrophyllite can also be found at Hurricane. It consists mostly of embedded, elongate dark brown crystals that may span small voids in the sampled rock.

Figure 11: A 1.7 mm (center) astrophyllite crystal.

Figure 12: A 5.5 mm long astrophyllite crystal (center).

Crystals rarely show a defined termination. Mostly they tend to be helter-skelter assemblages of needle to lath-like growths. In some instances, they are included within quartz crystals so as to look much like rutilated quartz. A Cliff Treblecock specimen on Mindat.org is a fine micro example astrophyllite. Tom Mortimer's MindatNH.org also has some fine examples of larger than micro examples.

Other more common species not represented by photos here are siderite, goethite, smoky quartz, albite, microcline as well as both biotite and muscovite micas. I generally attempt to keep at least one example of such basic species depending upon quality. A void-filling, green clay-mica mineral, glauconite, is also an interesting and worthy species to keep. It certainly gets your attention when you find it in moist rock because of the vibrant green color. When processed in quantity commercially, this material is marketed as "greensand" for use as a soil conditioner.

Will other mineral species be found at Hurricane? In the course of writing this, web searches for information about the mineralogy of Hurricane Mountain brought to light a 2011 thesis by Kristen

Camp, a University of New Orleans graduate student: *Mineralogy and Geochemistry of Anorogenic Granitic Miarolitic Pegmatite Associated with the White Mountain Intrusive Suite, New Hampshire*. The author records several other species found in the course of her investigation. Due to hematite's crystal form similarity to that of ilmenite, I had considered it as an additional possible species. And, Camp provides electron microprobe presence of "minerals of the Ilmenite/Pyrophanite series" at East Hurricane. Although she states monazite exists "as an abundant accessory mineral in some of the miarolitic pegmatite locations including… West Hurricane….," in this case there is no testing evidence given of a specific sample from any Hurricane location. However, allanite from West Hurricane *is* confirmed by an SEM analysis. Fluorite is also cited for both East and West Hurricane, but with no analyses of specific subjects. This would likely be an easy sight identification. In an affirmation of my own finds, it is satisfying to note that the author records SEM evidence of bastnaesite from *both* East and West Hurricane.

In closing my recommendation would be pretty obvious to most field collectors. And, that is not to take Mindat.org's list as gospel for Hurricane; or perhaps for any location. Many of these listings have been gleaned by scouring literature…recent or maybe from a century ago. Nevertheless, it's still helpful as a starting point. Many species are easy to sight ID while others are not. At MMNE we are in a unique situation having access to SEM analysis and, hopefully, soon to a more expanded Raman ID analysis.

Acknowledgement: I gratefully thank Boston College for the use of its SEM laboratory.

References:

*Camp, Kristen F. "*Mineralogy and Geochemistry of Anorogenic Granitic Miarolitic Pegmatite Associated with the White Mountain Intrusive Suite, New Hampshire." Master thesis, University of New Orleans, 2011. https://scholarworks.uno.edu › cgi › viewcontent.cgi?article=2400&context=td

Chapman, Randolph W. and Charles R. Williams. "Evolution of The White Mountain Magma Series." *American Mineralogist* Vol 20 no.7, pp.502–530. AM20_502.pdf (minsocam.org)

"Greensand/glauconite." Mindat.org, 13 May 2022. https://www.mindat.org/min-53714.html

Henderson, C. M. B., et al. "Mineralogy and Petrology of the Red Hill Alkaline Igneous Complex, New Hampshire, U.S.A." *Journal of Petrology* Vol 30, No 7, pp627-666. https://doi.org/10.1093/petrology/30.3.627

"Hurricane Mountain Localities, North Conway, Conway, Carroll County, New Hampshire USA," Mindat.org 13 May 2022. Hurricane Mountain localities, North Conway, Conway, Carroll County, New Hampshire, USA (mindat.org)

Meyers T., and Glenn W. Stewart. *The Geology of New Hampshire Part III Minerals and Mines*. The State of New Hampshire Department of Resources and Economic Development, 1977.

"The Mineral Riebeckite." Minerals.net: The Minerals and Gemstone Kingdom, 13 May 2022. https://www.minerals.net/mineral/riebeckite.aspx