

The Complexity of Agardite

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In BMS NL 117 (October 2022) I wrote a little bit about the four varieties of agardite. Now I want to look at agardite in a bit more detail – but be aware that for us as micromineral hobbyists, decent recognition, let alone proper identification, is becoming more and more “a bridge too far”.

Agardites are a group of arsenates that contain rare earth elements (REE). All agardites belong to the mixite group. The general agardite formula is $(\text{REE})\text{Cu}_6(\text{AsO}_4)_3(\text{OH})_6 \cdot 3\text{H}_2\text{O}$, with a hexagonal crystal structure. The first photo below clearly shows this, as you can see by the hexagonal end faces.



Agardite-(Ce)

Clara Mine, Wolfach, Germany

FOV Imm

Mostly however the habit of agardite is spiky, needle like, or even hairy as can be seen in the images below. There are four distinct varieties within the group, the REE being cerium (Ce), lanthanum (La), neodymium (Nd) and/or yttrium (Y). Minerals of the agardite group are widespread all over the world, but the Hilarion Mine in Kamariza near Lavrion in Greece is something special in that respect: in a very small area in the mine, on level 4, all four varieties occurred next to each other. When you look closely at the photos below of the four, you notice that there are slight colour differences between them. Those might give you a first clue if your eye is trained enough - but of course the colour is not decisive - far from it.



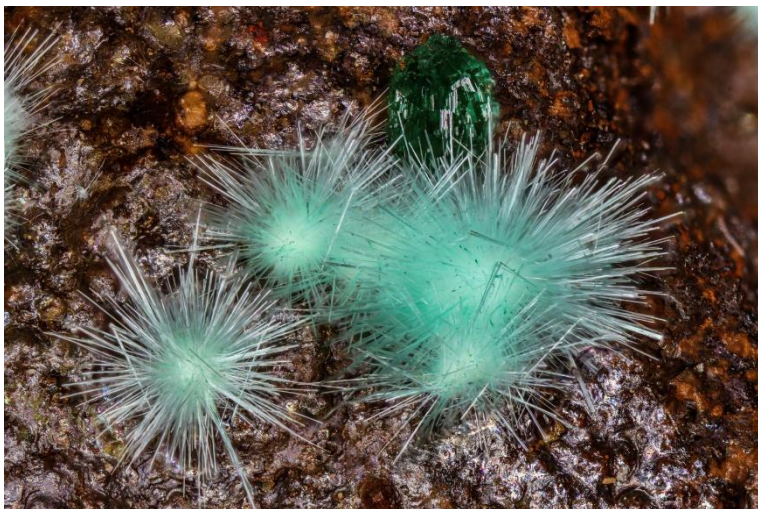
Agardite group Hilarion Mine, Kamariza, Greece

spray 0.5mm



Agardite-(Ce) Clara Mine, Wolfach, Germany

FOV 4mm



Agardite-(Nd) Hilarion Mine, Kamariza, Greece FOV 2mm



Agardite-(La_Nd) Hilarion Mine, Kamariza, Greece FOV 6mm

Without full analysis the varieties are impossible to tell apart. If a specimen is not fully analysed we can only refer to it as “agardite group”. And beyond that, as usual, reality is more harsh: ongoing extensive research shows that there are hardly any pure agardites with only one REE - practically all are to some extent mixtures. Luckily all the specimens in the images shown, except for one, have been analysed.



Agardite-(Y) Hilarion Mine, Kamariza, Greece FOV 2mm

But as usual in the mineral world, things are even more complicated. Besides the agardites the mixite group contains three other arsenates, which look exactly the same. Zalséiite has calcium (Ca) instead of REE, mixite has bismuth (Bi) instead of REE, while goudeyite contains aluminium (Al) instead of REE. All of which might make you wonder why they have separate names instead of agardite-(Ca), agardite-(Bi), agardite-(Al)...? Oh, and there is also plumboagardite...



Zalséiite on malachite Gold Hill Mine, Tooele Co, Utah USA 0.5mm



Mixite Clara Mine, Wolfach, Germany FOV 3mm

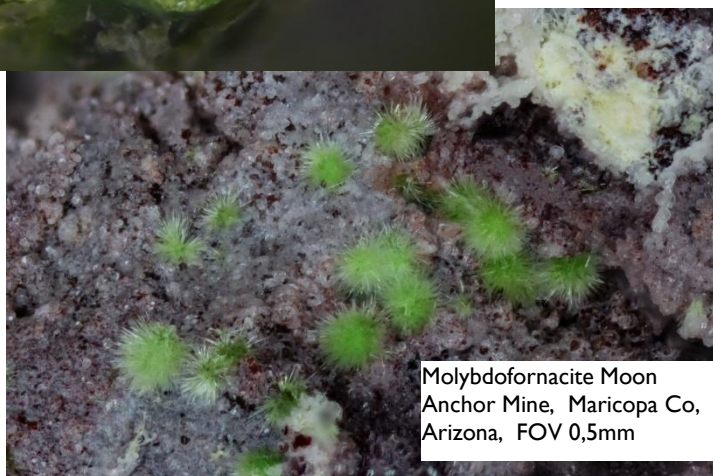


Goudeyite Clara Mine, Wolfach, Germany FOV 1mm

And that's not all. There is the phosphate analogue within the mixite group, that also looks exactly like agardite: petersite, which comes in four varieties, three of which involve REE's (Ce, La and Y), and the fourth being calciopetersite. Alas I don't have any of those.

And finally, not within the mixite group, but visually often very similar to agardite are minerals such as the lead copper iron silicate creaseyite, the copper iron arsenate arthurite, and molybdoformacite $\text{Pb}_2\text{Cu}(\text{MoO}_4, \text{CrO}_4)(\text{AsO}_4, \text{PO}_4)(\text{OH})\dots$

Are you still there ?



All in all, these are minerals that can produce fantastic crystals, but you have to be very cautious about the labels!

All the above photographs by Henk Smeets.