Bertrandite in Emeralds

Shane F. McClure
Global director of colored stone services
Gemological Institute of America, Carlsbad, CA, USA, smcclure@gia.edu

Over the past few years we have been seeing more and more lower quality stones in the lab. The reasons for this may be related to lack of supply of finer goods, rising prices, the global pandemic or others. Among these lower quality stones have been large numbers of heavily included emeralds (Figure 1).

We began to notice that a number of these emeralds were highly fractured with the fractures being very low relief. They appeared to be filled with a clarity enhancing substance and for a while were treated as such. However, we noticed that there were differences between these fractures and ones we knew to be filled with polymers to enhance the clarity of emeralds.

When testing for clarity enhancement, we look for certain clues. These include flash effect, high relief unfilled areas, gas bubbles, UV fluorescence, sweating of filler out of the fractures, polymers in the FTIR spectra and more. We use these indications to support the conclusion that there is a filler present and it is affecting the appearance of the stone. However, it is possible that many of these things may not be present in a given stone. So the lack of these indications in suspicious looking fractures can make it challenging to decide if a stone is clarity enhanced or not.

For the emeralds in question what looked like a filler in many of them did not show bubbles or unfilled areas, did not have a flash effect or UV fluorescence of any indication of polymer int the FTIR. The fractures sometimes appeared brownish when viewed down the length of the fracture (Figure 2) and also sometimes showed interference colors when viewed under crossed polaroids. Sometimes there was an irregular structure within the fractures that resembled a roiled effect.

Many of these fractures are very narrow but some get wide enough that the material in them can be seen at the surface. The luster of this material is somewhat different than the host emerald and often slightly undercut, indicating that it is softer than the emerald (Figure 3). Raman analysis came up with a match for two minerals – some phlogopite but mostly a beryllium mineral called bertrandite.

Figure 1: An example of a heavily included emerald that contains bertrandite filled fractures. 1.82 carats.

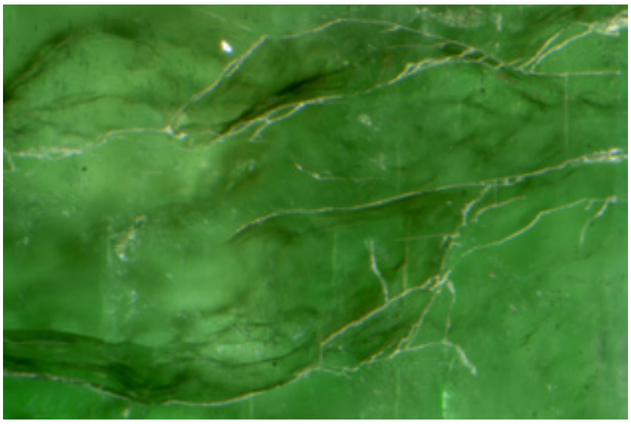

Figure 2: Fractures filled with bertrandite sometimes look brownish when viewed down the length of the fractures. Photomicrograph by Chandler Powers, field of view 1.83 mm

Phlogopite is fairly common in emeralds from a number of localities but typically as an inclusion, not as a filler in fractures. Bertrandite, while commonly associated with beryl in some environments, has been mentioned a few times as an inclusion in emerald, but we could only find one reference of it filling fractures.

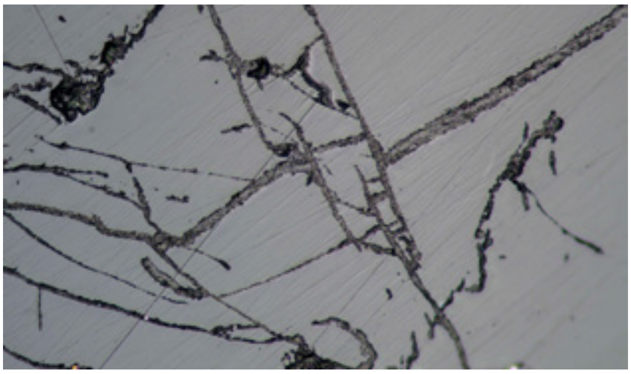

Figure 3: Extensive fracture system with bertrandite showing different surface luster and slight undercutting. Photomicrograph by Nathan Renfro, field of view 0.72mm

A search of the literature revealed a note by Zellagui (2022). In this article he documented an instance where they identified a wide fracture system in an emerald with bertrandite and phlogopite filling it. He showed the bertrandite along the edges of the fractures with the phlogopite filling the middle.

In our experience we have not yet seen an example where there was a clear difference in surface luster in a single fracture which might indicate both minerals being present. This could possibly be attributed to the width of the fractures we have observed being narrower than the example mentioned in the note.

In an attempt to see if we could identify the presence of bertrandite in these fractures in the FTIR spectra we found that in some cases the two strongest peaks in the FTIR spectrum of bertrandite showed up as tiny broad peaks at approximately 6981 and 6930 cm^{-1} within the emerald spectrum (Figure 4). Unfortunately these peaks are often too weak to be visible even though spectra were run in multiple directions.

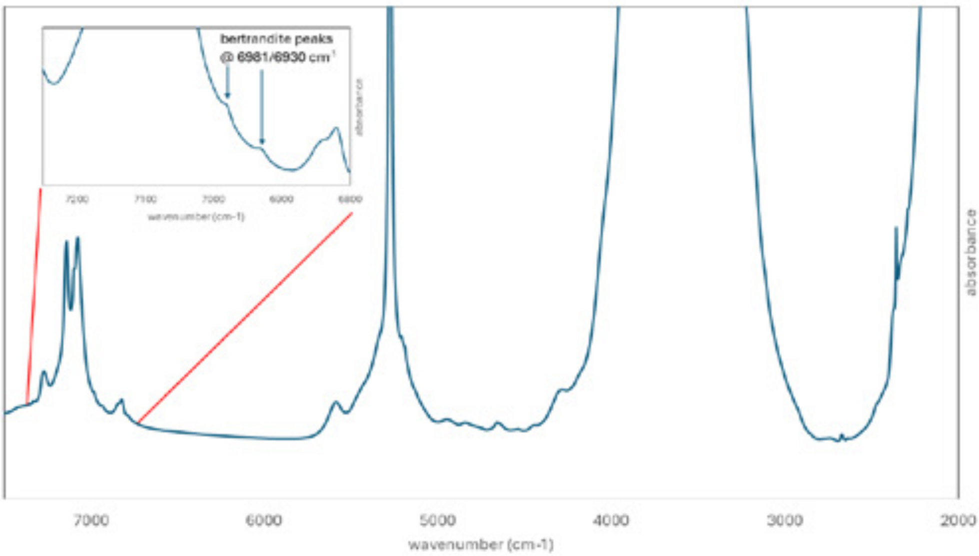

Figure 4: FTIR spectrum of an emerald showing two small bands at 6981 and 6930 cm^{-1} indicating the presence of bertrandite in this stone.

Bertrandite is a beryllium silicate - $Be_4(Si_2O_7)(OH)_2$ - that Mindat.org describes as "a common hydrothermal alteration product of beryl". It has an R.I. of approximately 1.59 – 1.61, which explains why fractures filled with it in high iron emeralds have such low relief. It is said to commonly replace beryl, often with a sheet silicate such as mica taking up the aluminum content of the beryl (Barton 1986). This could explain the detection of phlogopite in association with the bertrandite in fractures.

Most references discuss the formation of bertrandite in pegmatites, although there is some mention of it forming in non-pegmatitic environments (Barton,and Young, 2002). It is one of the last minerals to form in such pegmatites and requires water vapor to be present to form (Jacobson, 1988). Theoretically this could explain how bertrandite could form in the open fractures of a beryl crystal.

So, if all the fractures present in an emerald are filled with another mineral, then the stone has not been clarity enhanced and we have seen quite a few stones where this was the case. However, we also have seen quite a few where some fractures were not filled with a mineral and these fractures were usually filled with a polymer. We have seen both oil and artificial resin that exhibited the properties we would expect from such fillers, such as flash effect with the artificial resin. These fractures fluoresce weakly while all the other fractures filled with bertrandite do not fluoresce at all. The polymers show up in the FTIR. The challenge then becomes trying to separate which fractures are filled with what and how much that is affecting the appearance of a stone.

At this point in time, the origin of these stones is still unclear. The people submitting the stones to the lab say they do not know the origin. In comparing the chemical plots against known samples from the GIA reference collection, some of these stones are similar to samples originating in Russia, while others are similar to Zambia. However, all of the stones containing bertrandite look very similar to one another, so we are convinced that they are coming from the same locality.

References:

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