Review of

Water and moganite participation in agates from Bou Hamza (Morocco)

Tomasz Powolny, Magdalena Dumańska-Słowik, Magdalena Szczerbowska-Boruchowska & Maciej Woszczyna, in www.nature.com/scientificreports (2024), 21pp.

Review by Donald Kasper, 11/06/2025

The authors took 8 or so agate fragments from the Aouli Mountains of Morocco to study. This area was discovered a decade ago by German collectors, who descended on it and hit it hard for specimens, so these authors should have selected quality specimens at rock and gem shows. They subjected the specimens to Raman study, Infrared spectroscopy for water, and used cathodoluminescence to see structures. Interestingly, they did not do any microscopy study or at least did not include that in their paper.

- Pg 2, they talk about the ratio of infrared 5200 cm-1 to 4500 cm-1 water, noting that a 4350 cm-1 band exists. This ratio of 5200/4500 for water content is typical in the literature. Its only problem is that a rolling 4500 is part of a doublet, the other being at 4000 cm-1 which forms a carbonate doublet. Only carbonate does this doublet in this region so far by the author's study of minerals over 15 years in infrared (Figure 1). Since they don't know this, they show part of the 4000 cm-1 peak but not the whole thing. Sharp troughs in reflectance infrared the author uses indicated mineral carbonate in crystalline form, and it is likely the weak rolls are from caliche, which is a mixture of carbonate and silica. The authors are identifying caliche from weathering. 4350 cm-1 is part of a doublet that indicates clay water. On to pg 14, figure 10 then show this as a weak doublet because they did not set up their spectrometer to hunt for clay water properly. It requires the right beam splitters and light setup.
- Pg 2, they mention 3585 cm-1 and 3745 cm-1 water from the literature and then only studied water down to 4000 cm-1, so these bands that come from very high temperature exposure are removed from their study as they go on to discussions about how all agates form from weathering and silica solutions that only apparently invade lava voids, and no other kind of rock on earth. For example, there is no agate on earth found in granite, schist, shale, or marble bodies of the world so apparently there is some really weird weathering going on only for lava voids or, as the author has written about extensively, agates are silica exsolution structures where the silica comes out of the melt and forms spheroids due to surface tension. Large scale silica migration or magma intrusions create agate veins that these authors, like so many others, don't seem to be able to collect and study. That is why a large group, but not all agates, are found in lavas. The others are found in volcanic ash and its alteration products. The former is a high temperature group, and the latter is a low temperature group. High and low meaning formed in supercritical conditions (over 374 C), or subcritical (under 374C) is the distinction. Note they find celadonite in their agates, a mineral that cannot and does not form from weathering, and is the transitional mineral between agates and the host lava melt that sometimes forms tubes and other structures in the agates.
- Pg 2, they state the host lavas for their site agates are 200 million years old. This is how old their agates are and how long they have subsequently been exposed to weathering. Agates just don't decompose because quartz is indestructible without heat, and if moganite is still around after this long, their proposition the moganite is a precursor has problems because it needs to be 100% quartz by this time. It is fair to claim that if a chemical reaction has not occurred in 50 million years, it never will.

- Pg 4, they talk here and further on several times about carbonaceous matter found in agates as proof of solution intrusion with dissolved organic matter but don't discuss weathering in tropical climates for 100 million years doing that--for example, the brown Brazilian agates found at the surface and the clear ones found at depth. Another example is the "smoky quartz" crystals in Lake Superior agates that is actually brown humic acid inbetween the quartz points within their agates. The Moroccan agates have minor humic acid staining, so this does not mean tropical exposure, just a wetter regime when the Atlas Mountains formed these agates.
- Pg 4, they discuss the "osculum" structures, they describe as agate tubes variously infiltration channel or fluid escape tubes. This misnomer is consistent in the literature because serial sections of agates are not done, but if they bother at least some the author has sliced show that these "tubes" of a central agate cuts continue up and down the agate and are seen as actually being folds. A point of silica entry might be a tube, but a fold is not. Many of their specimens has matrix, so if a tube is a point of entry, the host rock must have a silica tube as well, and alteration of the host rock around the tube. This is never found which is uniformly ignored in these research efforts. The quartz does not materialize from nowhere, it has to accumulate and migrate to voids, and all that has wall lining deposition. Without that evidence, there was no large scale migration, it has to be local diffusion/exsolution accumulation.
- Pg 10 and elsewhere, they report moganite content values based on a calibration curve of the Raman 501 to quartz 464 peak ratios. Raman reports a hit count, so you take their hit counts to get a ratio, then that actual ratio is wiped out with an exponential function calibration curve which greatly exaggerates the amount of moganite. If I recall correctly, some X-Ray obsessed professor tried to calibrate Raman to X-ray data, the normal standard for mineral identification to get this garbage, but moganite is defined by Raman, so is unique in mineralogy. X-ray spectroscopy has a valuable role except for much regarding agates full of man opaline, amorphous, glass relict and other largely disorganized silica forms that leaves X-ray spectroscopy blind. X-rays bounce off crystal structures nicely and scatter all of in glassy materials of any mineral type. This is why infrared spectroscopy of the entire spectrum, not just water is key to studying agates, which the authors don't do.
- Pg 13 and elsewhere they discuss feather agates and on this page state it may be related to hydrothermal activity. Actually, it is clear proof of hydrothermal intrusion of silica. The famous Brazilian feather agates show this in spectacular fashion with feather structures torn from the side walls and swung into the agate interiors, itself quite clear evidence of a gel state precursor to catch all these overprinted structures. Weathering cannot do that. What they don't see since they reported no microscopy work is that the formation of those quartz points successively have generational banding just like nearby fibrous banded agates does, and the two can intermix so they missed feather quartz banding as a quartz texture in their work. They also ignore that as the quartz fibers twist to the agate center they hit an light extinction point successively in polarizing microscopy that has nothing to do with where visible quartz bands occur. The quartz fibers twist right on through these bands.

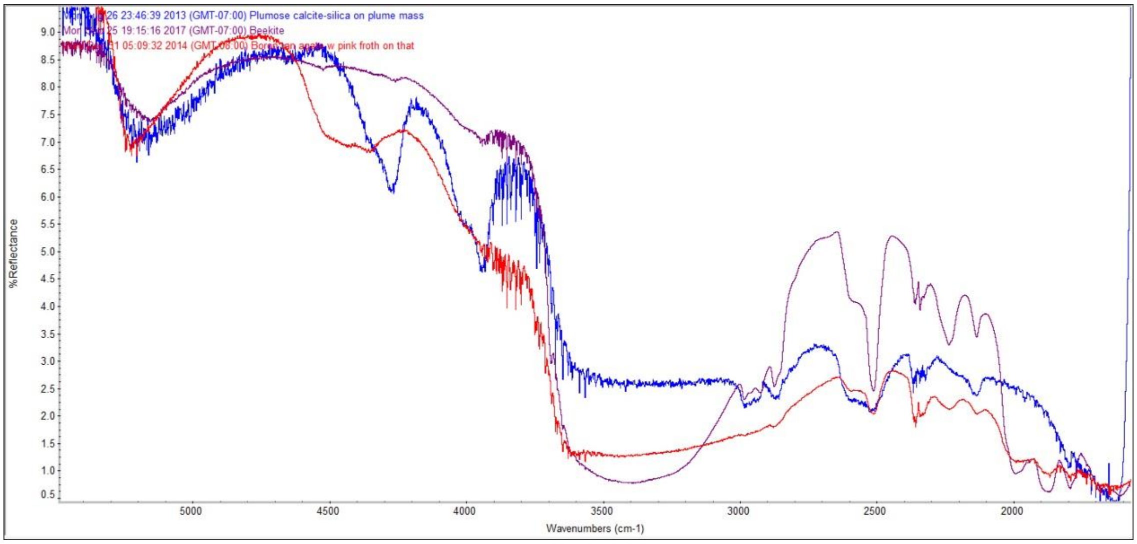

Figure 1. Calcite bands as troughs in reflectance infrared are sharp in the 4000 cm-1 region (blue spectrum) forming a distinct doublet. Beekite, a concentric structure on some carbonate fossils (magenta spectrum) and Boron, CA (CA High Desert) agate crust (red spectrum) show the double shifted to higher wavenumbers and broadened.

Conclusions: The most interesting outcome of this paper is the Raman microscopy identification of carbon inclusions. With reflectance infrared the author uses, carbon is really hard to identify as it acts like a metal so just reflects and does not absorb in infrared to show up well, but the author has come back to 1800 to 1400 cm-1 water bands again, and if they are carbon matter related (and there is good evidence they could be) then there are some agate groups of the world with carbon in them such as the Chinese Gobi agates, but far from all agates have these bands. Usually more porous and fine grained (micron sized particles) silica rocks like opals and chrysoprase have them.

The error repeatedly in this type of geologic research is that “gee, agates are boring, it is all some quartz, maybe some moganite, so let us look as a few to document the agates of the whole world”. The author complains this is egregiously ignorant, inciting overly broad generalizations like in this paper where they show one quartzine, one twisted fibers, one zebraic fibers, one mosaic quartz, one feather quartz, and man, that Raman spectrum for each sample settles it.

Yeah, except when they get microscopes they will see the moganite platelets perched on banding planes making shadow agates, and start to explore a microuniverse of diversity of structures and inclusions in agates they just barely start to grasp here, treating them as post-genesis curiosities instead of minerals defining and constraining the actual conditions of agate formation, for example, the lab data showing celadonite formed in supercritical fluids. Some day when X-Ray spectroscopy can distinguish alpha-moganite from beta-moganite from quartzine and sees all the admixtures like alpha-beta-moganite, which Raman also cannot but the author claims infrared spectroscopy can, then beta-moganite forms at 354C for a reason called the 354-374C supercritical fluid transition, and then suddenly all those shadow agates have beta-moganite in infrared.

We get it, the universe formed at 30 C and so did our rocks and oxygen isotope data proves it as the authors claim, except that is all oxygen isotope data ever shows and when fluid inclusion data shows huge divergence, well, we can ignore fluid inclusion data because, you know, diffusion contamination, so it must be wrong getting values of 200 C and higher consistently in solid quartz crystal points in agates, but we won’t talk about that in proper research papers.