Gobi Agate Water Study Indicating Brucite and Possible Cerussite, Witherite

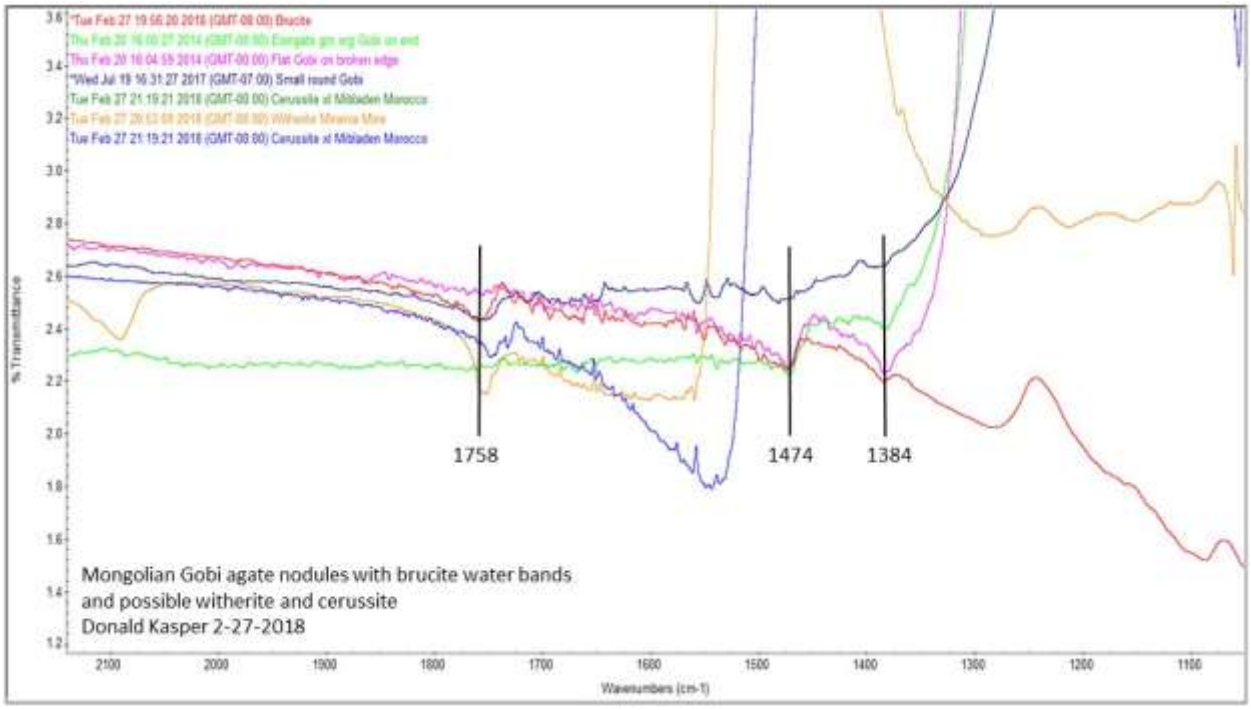
Donald Kasper 2-27-2018

It has been a mystery to me for two years how the Mongolian Gobi agates formed. Sometimes this is from a lack of information. At other times, it means the science is insufficiently advanced to explain what that data is showing. Infrared spectroscopy is one of these particularly prone to neglect because what it reports is a complex suite of optical behaviors. If you don't understand this, you basically go mad.

I have studied the infrared spectrum in range groups of similar behavior, and lastly over the winter tackled the 2300-1300 cm-1 region. This has been a complex problem, and it does not help there is no literature to guide me on what is going on. If someone does publish on this, it is not that you want to read it because they get into organic compounds and start labelling bands after carbon molecular groups. This band is methyl, and that one is an alkane, and on and on it goes. Yet, after 7 years study of minerals, my count on carbon compounds in them stands at zero. One by one, I have disproven them all to my satisfaction. This is the last group being called, let me see, oh, a bunch of humic or fluvic acid bands. The literature is so trashed with this talk, that is why I saved this problem to dead last. 7 years studying other spectral regions in infrared.

A variety of water bands live here, and in the study of Gobis I am on the hunt for water. The compositional bands report quartz and moganite. Okay, this is not very helpful. I have labelled three mystery water bands based on my work. They are 1758, 1474, and 1384 cm-1. I have overlaid three minerals. How did I pick these? The Gobis have no attachment points and so they formed in soft sediments. The candidates for silica replacement are sulfates and carbonates. Otherwise they had to form in basalt as amygdules, but the surface crumple texture does not match any known basalt textures for amygdules. Further, we do know the Chinese screen them out of volcanic ash and posted pictures of them doing so. So, playa lake evaporites of some type is the target.

Each carbonate and sulfate usually have one very distinct vibrational water band in this region. Calcite is at 1800 cm-1, for example, and barite is at 1961 cm-1. These are the most common around agates and they are out because they are in the wrong spectral location, and they lack the other two bands (although we could have a replacement of two minerals or something in the middle of a compositional series).



Cerussite is very exciting as it has known dendrite crystal structure with all the branching and star-shapes that cover the Gobis. Its band position is off by 10 cm-1, but the data zoomed in is noisy. This is lead carbonate, will be insoluble in water, so when silica solution appears from the ash burial, this is a good choice as it will stay around to be replaced, and not just dissolved out.

Witherite is an exact band match, but it doesn't have the crystal structure types seen on the surfaces of Gobis. This is barium carbonate. The barium should make this also quite insoluble.

I have long predicted that brucite should be around agates, but have hunted for it in poppy jaspers. I bought some brucite specimens to compare to poppy jaspers, not Gobis. When I didn't find any brucite in poppies, I lost interest and archived the brucite data. Yet, all 3 bands of the Gobis are an exact match to brucite. Brucite has been found with cerussite, so this looks pretty good. One matches our bands, and the other has the texture we need, so unique to the Gobis. Brucite is a magnesium hydroxide. I have not looked up the solubility for brucite again, but hydroxides are generally quite soluble, and thus we see our candidate in one of the driest deserts of the world, the Gobi desert. Well, this makes sense.

Two months study of other carbonates, sulfates, silica minerals, and some silicates reveals nothing else with these three bands, or combination. Some specimens have just the 1474 cm-1 band identifiable.

Agates form in a restricted range of geochemistry, don't form from weathering, and as such, we cannot pick just anything we want. It has to be a mineral that can form in the alkaline conditions agates form in. Note that the precursor brucite-cerussite nodules can form from weathering, but the silica came in from an ash event very suddenly, and replaced them with silica. This would be essentially hydrothermal water, that is temperatures above 10 C surface temperatures, but the Gobi desert can get hot, yet not hot enough to have waterline structures (supercritical, 374 C). They could form over a longer geologic period, as reactions run slower at lower temperatures in the 50 C to 150 C range. Cerussite mixed with brucite would dramatically lower the nodules solubility, but not enough to prevent silica replacement. This is similar to Keokuk sedimentary geodes of anhydrite gypsum replaced with silica. The shallow sea and evaporite conditions with tidal wetting allowed radiolarians into the tidal flats, and so Keokuks contain them in their structures. The Gobis do not. Nor do they have fresh water diatoms. Just quartz and moganite and non-silica water.

At this point, we have a structural match to cerussite, and a water match to brucite, cerussite, and witherite. The last two are similar, and in the aragonite mineral group.

The Gobi water bands sit directly on top of the most noisy atmospheric water bands that occur, so study is difficult as our specimens are exposed to the atmosphere is small amounts with the laser. These machines run by doing an atmosphere scan, saving that, then the spectrometer subtracts the atmosphere water from the scan. Tiny shifts in water content over a few hours adds up, and you have to do another background scan. Yet, zoomed in to see trace water in parts-per-million noise spikes occur from that water interference. Despite these technical problems, I do have a mineral match to pursue further. The Gobis do have a geochemical precursor history captured in their residual mineral water.

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