The Infrared Spectroscopy Identification of Nevada White Buffalo, a Material Sold as Turquoise

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A cabochon of White Buffalo, purchased from Charles Valdez, La Jara, CO. This material originally came from the White Buffalo claims of the Otteson family, Tonopah, NV. The texture is slightly oolitic in this specimen with a common two-tone white, and black matrix. The purpose of this investigation is to study the White Buffalo material with infrared spectroscopy to determine if it is indeed a white turquoise, else one of many claimed alternative minerals that have been proposed over the years.

Abstract

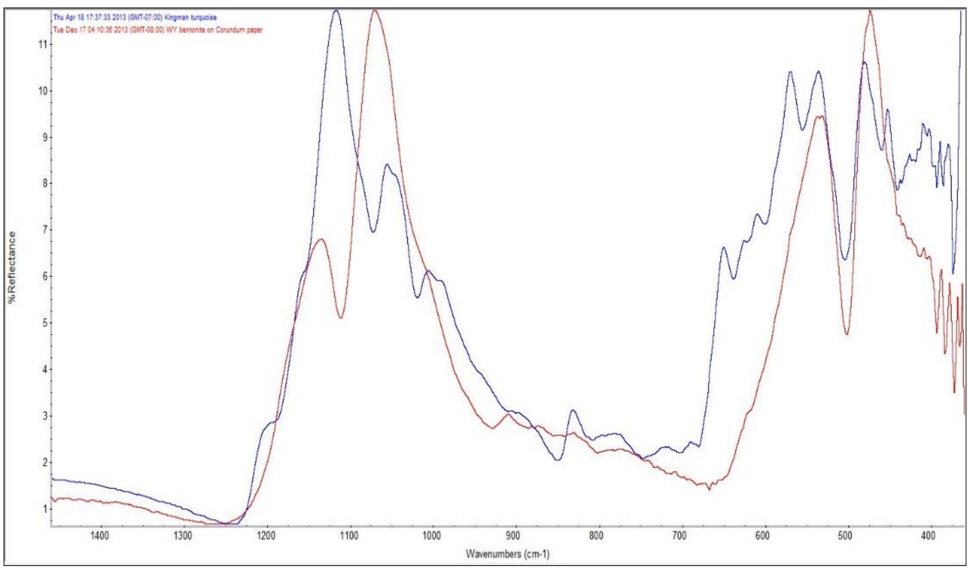
The author sampled two purchased sets of material branded as Otteson White Buffalo from dealers, a material sold as turquoise. Both samples are shown to be aragonite and dolomite using infrared spectroscopy. The samples do not contain copper or phosphate.

Introduction

For at least a decade, there has been mystery and controversy about the White Buffalo material dug from the Otteson Family claim, Dry Creek area, Battle Mountain, Nevada. There are various reports attributing it to calcite, a mix of calcite and opal, a turquoise but lacking copper as a colorant, howlite (a borosilicate), magnesite (a magnesium carbonate), and planerite (a turquoise mineral). Essentially, at one time or other, many white minerals have been proposed. A sample graph of turquoise plotted using infrared spectroscopy is shown in Figure 1.

Figure 1. An Arizona turquoise graphed with infrared spectroscopy (Reflectance Infrared).

The peaks and troughs can be identified by their wavenumber to identify unknown minerals encountered. Of all the Western turquoises, they all graph roughly the same, and not that different from related minerals such as variscite (blue graph). The sharp 501 cm^{-1} trough, for example, is present in all turquoise (red graph). Also, the triplet of peaks from 1100 to 1000 cm^{-1} with the tallest peak at 1100 cm^{-1} is typical of all turquoises the author has studied. For variscite, the main peak shifts to 1050 cm^{-1}.



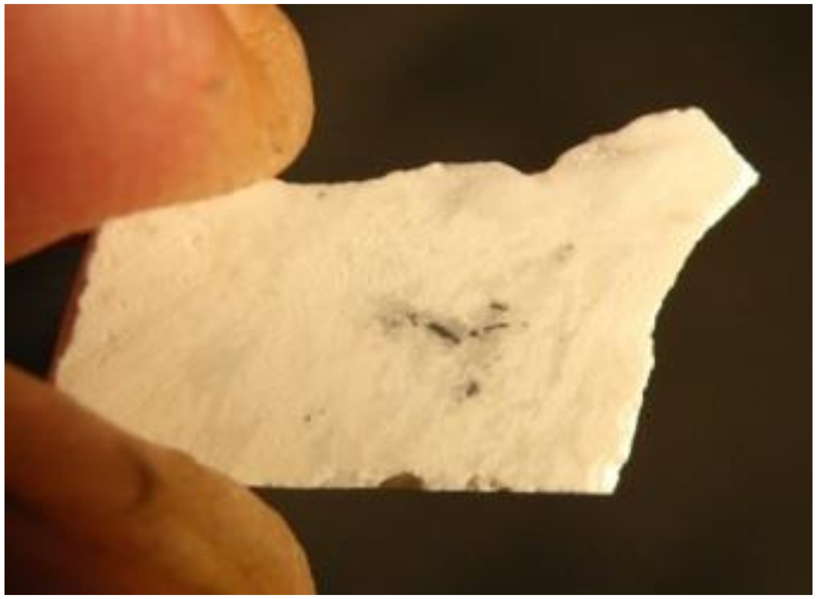
Background

Many years ago, in about 2004, the author and rockhound friend were traveling through the Tonopah region and decided to stop off at the Otteson store. The Ottesons are famous for their series of turquoise mines operated in Nevada for over 60 years. The key question on my mind at the time that I asked Ms. Otteson was, “Is White Buffalo turquoise?” Her answer was clear, “No.” After almost a decade, I cannot recall the long list of minerals reported to occur in the material, and so will not speculate here unless I find some old travel log notes with the answer, but the identification of not being turquoise was clear (Photo 1).

Current Status

At the Otteson web site (http://tonopahmuckers.webs.com/whitebuffalo.htm), their assessment of the material has changed since the author visited the Otteson store. “’Until someone can prove differently, we’re going to call it white turquoise from the White Buffalo mine,’ Otteson says”, is quoted at that web site.

Photo 1. This is one of the six White Buffalo pieces the author obtained originally from SunWest Silver through a colleague, and is the only one with a hint of matrix. The chip is ½ by ¼ inch in size. Note the two-tone white matrix. Purer samples that are all white were studied, but an all-white chip is not interesting to photograph. The others have the same white matrix. The purest white specimens were obtained since the matrix was unimportant to this study. The left side of this specimen was assayed along with the other chips.



Bureau of Land Management Legal Status

The Bureau of Land Management (BLM) holds the public, legal, official record of all mine claims in the U.S. It is available for anyone to use, as is available online at blm.gov/lr2000. The system takes a bit of learning and is somewhat cumbersome to use. Danny Otteson reports on his web site he owns the White Buffalo claims. BLM records shows he currently owns White Buffalo #4 through #8 claims along with Tommy Otteson. Dean Otteson owns White Buffalo #1 through #3 claims. I just searched under the Otteson name, so there may be other mining partners. There are no Dry Creek claims under the Otteson name for Nevada. Since these claims would likely all be adjacent to each other, I searched details for claim #4. It is in fact reported in the Battle Mountain District, Esmeralda County, Nevada. These claims are all reported as active. BLM only handles claims on public lands, so it is unclear why statements continue to circulate that these claims reside on Shoshone Indian Reservation lands. That would be handled by private contracts, so these claims are on BLM lands.

An Age of Infrared Spectroscopy

The principle of infrared spectroscopy is simple. There are about a dozen types of infrared techniques, each producing slightly different results. Regardless of the method, the goal is to aim an infrared beam that is oscillating over a range of wavelength at a specimen. This will excite the atomic components in the specimen and start them to vibrate, wobble, or stretch more than their normal state. This energy excitation will in turn, alter the laser signal. A detector can then read that final signal. We put in known reference standards to get graphs of how the signal varied with the wavelength of the infrared. We can then put in unknown specimens to compare. Scientists in their original assessments of minerals also combine many assay methods to correlate, and have done so with infrared. So in the literature, we will see comparisons to x-ray spectroscopy, and Raman spectroscopy (a very different type of infrared), chemical assays, and Fourier transform infrared, all compared. Each technique has its own strengths and specific variations in experiment setup for each to get the best results of identification.

In the original spectrometers, the specimens were ground to a powder, and mixed with potassium bromide, a salt that is transparent to infrared (most salts are). The powder would be pressed into a pellet and put in the laser path. The latest technology allows for nondestructive sampling of materials. The author uses one of these called reflectance infrared Fourier transform. Fourier transform just reminds the scientist of the method of generating the infrared beam. In one pulse, all wavelengths are added up to contact the sample. This saves an enormous amount of time over the original method of generating one wavelength at a time, and so dominates all infrared equipment today.

Method of Sample Study

The author uses a Nicolet 560 and 570 Fourier transform infrared spectrometers. Thermo-Nicolet is one of the largest manufacturers of infrared equipment. Within the sample bay, a Harrick Corporation reflectance detector setup was used. This was purchased separate from the Nicolet. Many types of detectors can be installed in these spectrometers, depending on what the scientist is studying. All it takes for infrared reflectance is placing the sample over the laser pinhole and pressing the scan option in the computer software running the spectrometer to get a graph. This save an enormous amount of time compared to making powder samples with the old approach, and your specimen is unharmed, allowing the graphing (assaying) of valuable samples.

This instrument scans from 7500 to 350 inverse centimeters (cm^{-1}) infrared, which is mid-infrared. Generally, the higher wavenumbers have a lot of noise, as does the very low end at the limit of the machine, so a typical scan for the author is 6500 to 360 cm^{-1}.

The author studies agates and their inclusions, which involves many other minerals. Over time, the author has amassed a large database of graphs of many rocks and minerals. These are identified by comparison to scientifically published archives for minerals, of which there are many online sites, including two sites at Arizona State University, and one site each at Caltech, the Jet Propulsion Laboratory in Pasadena, CA, and the U.S. Geological Survey. Online research papers individually can provide other graph samples, as samples can vary by locality somewhat.

The author obtained a number of thin slice chip samples of White Buffalo from the SunWest Silver Company, purchased from them originally by a colleague at the rock and gem show held annually in Quartzite, Arizona. Several small pure white slices were placed in the reflectance infrared unit for assay. To reduce noise, 50 data scans were run. These scans are added together, the idea being that noise is random, so summing many scans removes much of the background noise. Sampling can be done down to 0.125 cm resolution with the Nicolet, but for a general assay scan, the default of 4 cm was used.

This discussion does not include all the details of how these spectrometers are calibrated, how the samples are prepared, and discussions of experimental setups the author has developed. All these techniques though, are intended with the primary goal of producing quality graphs with low noise (choppiness), and repeatable results. Reflectance infrared, diffuse infrared, etc. and its companion methods are a major leap forward in terms of repeatability over the powder sample method, and will likely dominate mineral assay work in the future.

Identification

How does the author identify carbonates? Based on a huge archive of specimens, and review of the literature, the author has a master classification key for carbonates based on the position of the 700 cm^{-1} region band which uniquely identifies each carbonate mineral. The carbonates all have different 700 cm^{-1} positions. The cations in the carbonates cause the peaks in many band positions to shift, but that is the easiest to read. This key is published in the author's book on semi-precious gems, along with many other keys. There are keys for silica minerals, for opals, and for the feldspars, for example. This type of identification does not exist in the science literature. Most science papers are the study of a few specimens, not an archive of 35,000 mineral graphs. So the author has more data, and the time to develop these mineral ID keys. They are not keys found to work some of the time. They are not published until they work all of the time, match the literature, and match what are documented from specimens purchased from very well established sites.

This original report was done with 4 cm resolution. All work subsequent to that is done with 2 cm resolution for all work including identification of the 700 cm^{-1} band. Key identification at commonly published resolution of 8 cm is not sufficient to identify the carbonates.

Results

The specimens obtained plot as aragonite-dolomite. Some specimens are very pure aragonite, and others grade into dolomite. No other mineralization could be detected, but the material does contain a significant water signature common for aragonite and dolomite. The samples have no phosphate to relate the material to turquoise, nor any copper mineralization. A sample graph is shown in Figure 2 with the White Buffalo overlaid with an aragonite reference of the author. Many other graph overlays were performed for comparison purposes, but are not included here as there were no other matches.

If this material is representative of the White Buffalo material, there is no basis to call this material turquoise. Some have argued that turquoise can be white, and does not have to have copper. The author would disagree, in that look and composition are both important in gem naming, but regardless, there is no detectable phosphate in the specimens studied.

The gray matrix was not studied. One chip had some, but not enough to pick up a good signal. In addition, what the host rock is composed of, is not relevant other than the statements of the material being hardness 6 could only be from specimens dominated by a silica rich matrix rock of some type (hardness 5.5 to 7.5 is reported at the Otteson site mentioned above). Carbonates commonly have a 1600-1400 cm^{-1} peak cutoff as a flat top, and have a peak at about 700 cm^{-1}. The two peaks at 700 cm^{-1} in Figure 2 is the standard used to identify aragonite, along with the other peaks shared with dolomite.

Backup Results

Based on this mineral determination, a second sample as a cabochon was purchased from Charles Valdez, La Jara, CO (the specimen is on the cover photo). Mr. Valdez confirmed that he purchases his White Buffalo directly from the Ottesons. This cabochon has a slightly oolitic texture, which means tiny, cemented orbicular structures occur in the specimen. This cabochon graphs as dolomite, a close relative to the aragonite in the other set of samples (Figure 3).

Figure 2. An infrared spectroscopy (reflectance infrared) graph comparing a purchased aragonite crystal reference (red graph) to White Buffalo sample (violet graph).

Comparison is done by matching peaks and troughs and the character of curves. At the far right, the upslope in the aragonite crystal reference indicates purer occurrence, while the Otteson sample has mixed dolomite and aragonite. Also, infrared reports crystallography, so the comparison of a crystal to an amorphous specimen mix will be somewhat different.

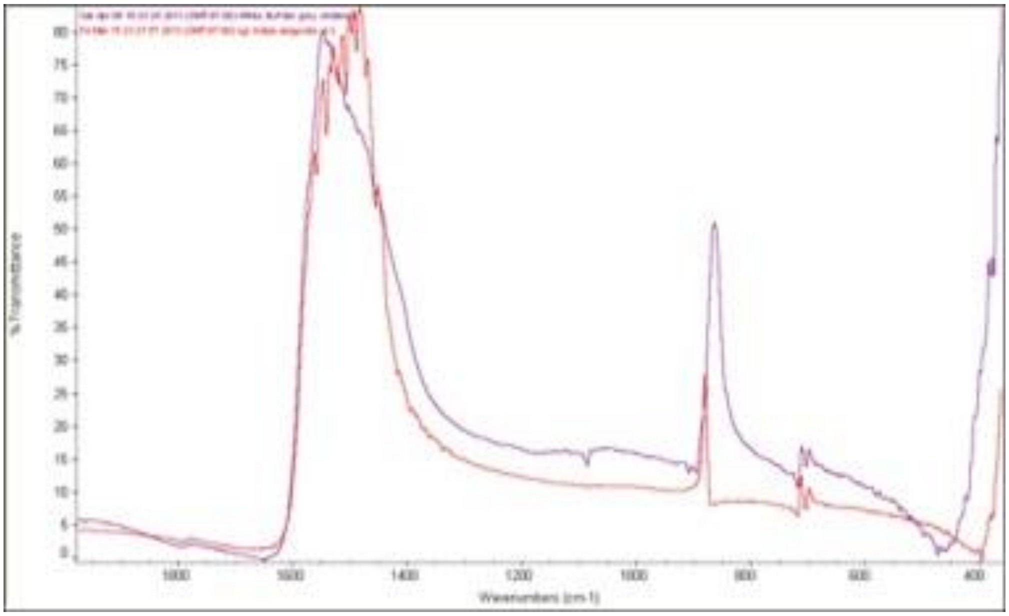
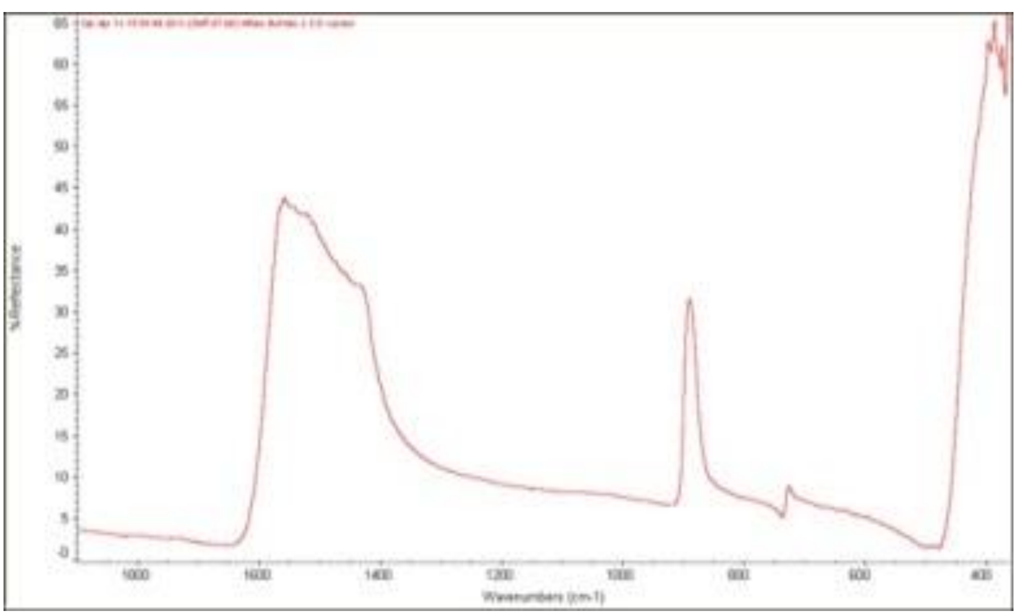


Figure 3. White Buffalo cabochon infrared spectroscopy (reflectance infrared) graph from Charles Valdez, an EBay retailer of this material.

The peak at 1600-1400 cm^{-1} in carbonate is always a cut-off using reflectance. This assay was done to confirm from a second source the identity of the Otteson White Buffalo material.



Challenges to Identification

For anyone with a challenge to this identification, the author will make his spectrometer equipment available for other specimens to assay, or to re-run these specimens now on file, but a lab fee will be expected for the author's time and use of equipment.

The Otteson's were directly contacted for samples to be assayed at no charge, and were asked for any assay data they have. The offer was made that infrared graphs would be sent regarding the material for them to review for themselves or by their own contracted geologists. They did not follow-up on an initial expression of interest. A follow-up contact by the author was not productive. In terms of professionalism, when a miner is selling material for $300 a pound in the rough and $3 a gram cut (about $1360 per pound), it is the responsibility of the miner to provide assay information transparently, and post that information on the Internet web site, or in literature they provide, particularly when the material is reported as something new. This is simply good business practice, and mitigates market confusion over the material identification.

Statements are have been made on Internet forums that have circulated over the years that those assaying calcite or other minerals have confused the White Buffalo Otteson material with material from other claims. For this reason, two major retailers who both obtain their material directly from the Ottesons were selected. Those stating further mistakes have been made would have to prove up their statement with specimens that graph in infrared as phosphate mineralization, which to-date the author has not seen.

For any mining interest where fake material or other similar appearing material may circulate, it is the responsibility of the miner to provide a list of qualified and certified retailers who are authorized to handle the material, provide that list of contact information with their mining literature, and on their Internet web site. It is not the responsibility of anyone else to guess who a qualified retailer is. Until such time as other samples are provided, the provenance of the handling of these specimens is excellent, and the assays are unambiguous--White Buffalo is a combination of dolomite and aragonite.

Conclusions

With finer resolution infrared the author changes the previous identification of calcite to dolomite. The identification of aragonite is unchanged. Nevada White Buffalo has no copper or phosphate to be called turquoise. It graphs as a mix of oolitic aragonite, and dolomite. The black veining was not identified.

Acknowledgements

The author thanks Donald Kasper, Sr. for his help in acquiring several pieces of equipment used in this project, and his encouragement to pursue study of the agates, jaspers, opals, and other Western U.S. minerals. Special thanks to all the numerous rock and gem collecting (rockhound) friends the author has met along the way.

Author's Background

The author has an undergraduate in Earth Science, and Master's in Computer Science. This led the author to work at companies like Union Oil in oil exploration, Simulation Sciences for oil refining, and aerospace companies working on Earth Science research projects, and at JPL/NASA in Pasadena, CA. The author currently writes books on agate genesis including "A Southwestern Field Guide to the Agates, Jaspers, and Opals", 465 pages, 2013. See donaldkasper.com for details.