Figure 1. Yellow quartz with limonite pseudomorphs, 22 cm; Ziga Mineral specimen.

Re-emerging Treasures: Yellow Quartz from Cabiche

Municipal de Quípama, Boyacá Department, Colombia

All specimen photography by Eddie Rivera

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Figure 2. Site map of Cabiche, in Municipal de Quípama, Boyacá Department, Colombia; prepared by William Besse.

Surrounded by jungle in the mining region of Boyacá, Colombia, amidst mandarin and avocado trees is the small town of Cabiche. Locally recognized for its farming and livestock, Cabiche has recently received recognition on the international mineral-marketplace for a different reason. In late 2017 a prospect in Cabiche produced a superior class of showy quartz specimens with vibrant yellow fibers heavily concentrated in the terminations. Although previously unknown to most of the mineral collecting community, this was actually not the first time such specimens had been found in this area.

History

The discovery of this yellow quartz in Cabiche dates back to the 1980s during the time of Don Víctor Carranza, the "Emerald Czar" of Colombia. Carranza grew up poor and fatherless (*The Economist* 2013). He began to work in emerald mining at an early age and found luck as he rose to the top of the business, controlling nearly half of Colombia's emerald trade. Colombia produces almost 60 percent of the world's emeralds (Schemo 1998). Carranza became one of the country's wealthiest men and largest property owners, and, surely, he possessed a collection of the world's finest emeralds (Cobb 2015).

Situated in the southwestern fringe of the Boyacá mining region, Cabiche was one of the focal points of Carranza's emerald exploitation (fig. 2). During this time the miners in Boyacá were all in strict pursuit of *el sueño verde* (the green dream) and were exclusively interested in emeralds. Other associated minerals were typically discarded, including several species that are highly coveted today. Across the emerald mines of Colombia, euclase specimens, optical-quality quartz, and pink apatites were ordinarily jettisoned as if they were overburden. Only recently have these types of minerals come to be collected and preserved, but an unusual discovery in about the 1980s came as an exception to this old tradition.

Excavation for a road (fig. 3) through Carranza's emerald mining territory connecting Cabiche and Quípama uncovered a quartz deposit with yellow and white inclusions concentrated at the tips of the quartz crystals. In contrast to a long history of emerald fixation, Carranza gave orders for the miners to recover and preserve the yellow quartz for him. White-tipped points were discarded, while the yellows were sent to the Emerald Czar. The vein was mined and yellow quartz extracted until eventually he gave the order for the deposit to be closed off. The area was then covered with a thick slab of concrete to ensure that no one besides Carranza would have even a single point of yellow quartz.

In 1982, under U.S. President Ronald Reagan, the United States declared its war on drugs, and a new U.S.-Colombia extradition treaty came into effect (www.state.gov/s/I/16164.html; accessed January 2019). From 1982 onward, there was a new push to extradite and imprison drug traffickers in the United States. Carranza began to face allegations from American intelligence officials, and in 1998 he was imprisoned for charges involving narcotics trafficking and supporting paramilitary groups (Schemo 1998; Pachico 2012). Some sources say he stood up to drug traffickers wanting to use emerald mining to launder money; others say that he was one of them, but after three years he was absolved of the charges and avoided a criminal conviction. After being released two attempts were made on his life, both of which he survived (Pachico 2012). Ultimately, Carranza died of cancer in April 2013 (*The Economist* 2013). It appears that in the midst of the ongoing legal chaos, assassination attempts, and his overall declining health, the yellow quartz specimens were forgotten (Pachico 2012).

Figure 3. Site of yellow quartz workings in Cabiche; Ziga Mineral archives.

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Figure 4. **Yellow quartz, 9 cm; Ziga Mineral specimen.**

Recent Discoveries

Nearly forty years after Carranza's mining, in the winter of 2017, the yellow quartz deposit was rediscovered. Grandchildren of a local *campesino* (farmer) in Cabiche were hiking the mountain and discovered a hole in the ground following a crack in the bedrock below. Lining the walls of the limestone beneath, washed and glistening from ages of steady jungle rainfall, a spread of yellow quartz clusters waited above the road the Emerald Czar had once claimed (fig. 5).

The *campesinos* began to work the pocket and brought new yellow quartz to light (fig. 6). As is standard practice for today's Colombian quartz miners, the initial production of these specimens from above the road was immediately placed in tubs of acid for cleaning. Unrecognized at the time, these specimens can be extremely sensitive to standard chemical cleaning methods; in a short time it was too late, and most specimens from the pocket were stripped of their color.

However, some pieces from this production were saved from the bath. Speculatively, the ones saved were either too large or too delicate for their washing bins or were already naturally clean, without the typical veneer of iron oxides. The quality of color of the clusters that saw acid was generally diminished, except on specimens where the fibrous inclusions did not breach the surface of the crystals. Where they did, the acid solution would be drawn into the fibers, effectively bleaching the inclusion. Now, with a better understanding of

Figure 5. **Yellow quartz pocket; Ziga Mineral archives.**

the material, more meticulous methods of cleaning are being employed to preserve the quality of the specimens. The pieces that survived the initial recent production came to the American market and immediately attracted interest. With enthusiasm and resources flowing back to Cabiche, further collecting ensued in the area.

Work at this site has been active since this rediscovery (stopping briefly during the 2017 presidential election in Colombia). Specimen extraction is artisanal. Rock is moved with basic hand tools, and, on occasion, the process of removing overburden is aided by the use of a jackhammer or gunpowder. A handful of *campesinos* work on and off, scaling the slopes to mine for specimens.

Figure 6. Campesinos **working to uncover new material at the yellow quartz site; Ziga Mineral archives.**

Figure 7. **Yellow quartz, 16 cm; Ziga Mineral specimen.**

Geology and Formation

Cabiche is situated in the eastern Colombian emerald belt high in the foothills of the Colombian Andes, about 100 miles north of Bogotá, the capital of Colombia. Here, the yellow quartz mineralization occurs in a heavily faulted upper Cretaceous age (66–100.5 million-year-old) limestone. The rocks in which the quartz formed were once deposited in a deep sea between 66 and 145 million years ago as the Nazca tectonic plate collided with the South American plate from the west. Once lithified and emplaced, secondary minerals precipitated from hydrothermal solutions within voids in these limestones. It is estimated that related emerald deposits in the neighboring mining towns of Muzo and Quípama formed over a period of about 33 million years. The quartz deposits in Cabiche may have evolved over a similar time frame, meaning they could have been crystallizing beneath the surface while the dinosaurs went extinct on Earth's surface (www.minemeralds.com/emerald-deposits/; accessed January 2019).

At first, precipitation of what was speculatively dolomite/ankerite (later altered to limonite) coated surfaces of Cabiche's faulted limestones. A following influx of drusy albite covered parts of these dolomites and parts of the limestone host rock. Intermittent late crystallization of quartz and the fibrous phase is suggested by interrupted growth structures on the quartz terminations combined with the absence of these inclusions at the cores of the quartz crystals. Fibers interrupted the quartz growth in some specimens, resulting in stepped terminations, pitted by the inclusions (fig. 10). Tectonic activity during quartz crystallization left deformation features such as broken and recrystallized surfaces, producing "floater"

Figure 8. **Yellow-tipped quartz, 6.5 cm; Ziga Mineral specimen.**

Figure 9. **Included quartz crystals, 12.4 cm; Ziga Mineral specimen.**

Figure 10. **Quartz with termination interrupted by fibrous inclusions, 10.8 cm; Ziga Mineral specimen.**

clusters, allowing for crudely doubly terminated points and the occasional curved crystal.

On some samples, a final influx of iron oxides may have stained fibers, including the quartz crystals, and sometimes left a blackish-orange crust. This stage of rich iron oxide mineralization may have potentially accompanied the alteration of the dolomite/ankerite crystals into a rusty limonite powder. Where the original crystalline surfaces of these pseudomorphs are intact they often show a slight iridescence on the rhombohedral crystal faces. A handful of specimens host globular calcite mineralization, although well-crystallized examples have not been found or saved. Other associated minerals include the emerald variety of beryl, an unidentified brown-black metallic bladed phase, and occasional spots of an unidentified fibrous blue inclusion in the quartz. In addition to the diversity of the inclusions' colors (fig. 11), some crystals boast a satiny chatoyancy from internal parallel fibers; these can be cut into cabochons to show best the cat's-eye effect. The deposit has also produced Japan-law twins with the fibrous yellow inclusions (fig. 12).

Inclusion Analyses

A conclusive identification of the fibrous material included in these quartz specimens has been evasive. We have been working to identify the yellow inclusions, and we first reported them to be humboldtine. We now believe that to be incorrect. Early attempts to isolate yellow fibers or to identify them within the quartz via Raman spectroscopy were unsuccessful. One specimen in our possession had yellow fibrous material exposed at its surface. This was used for powder X-ray diffraction (PXRD) on a Bruker Quest instrument (Mo K-alpha). The data give an excellent match with humboldtine.

Later, fibers from inside a quartz crystal were isolated. These give no discernible X-ray diffraction pattern. Multiple XRD datasets from included material revealed only quartz, which must be admixed with some of the fiber samples. If the fibers are X-ray amorphous, this would explain why the first PXRD data showed only humboldtine. An admixture

Figure 11. **Diversity of inclusion colors from Cabiche, sizes *(from left):* 9.2 cm, 7.2 cm, 7.5 cm, and 6.1 cm; Ziga Mineral specimens.**

Figure 12. **Japan-law quartz twin with inclusions, 13.5 cm; Ziga Mineral specimen.**

of humboldtine with an amorphous material will only yield diffraction peaks for humboldtine.

Another quartz sample exhibited a small area coated with a druse of tiny, sharp, equant yellow crystals. PXRD data from these also matched humboldtine. We speculate that the surface humboldtine taken from the two samples described above is a product of cleaning with oxalic acid. Iron staining (iron oxides) on quartz can be effectively removed by soaking in oxalic acid. This is a common practice in cleaning quartz specimens. Dissolved iron can then combine with oxalic acid $C_2H_2O_4$ to form humboldtine $Fe^{2+}(C_2O_4)\cdot 2H_2O$ if the samples are not adequately rinsed.

A sample of the fibrous inclusions, isolated from within a broken quartz crystal, was mounted on a carbon adhesive disc (Leit tab), without coating, and analyzed on a Zeiss Supra35 variable pressure scanning electron microscope equipped with an EDAX energy dispersive spectroscopy (EDS) detector. Figure 13 shows a backscattered electron image of the fibers. Figure 14 shows an EDS spectra taken from a spot on the fibers. Elements detected from the fiber include oxygen, silica, aluminum, sodium, iron, chromium, and barely detectable calcium (minimum detection limit roughly 0.5 weight percent). The carbon peak is from the mounting tab. These results indicate a silicate mineral chemistry. Multiple analyses from the fibers show a consistent aluminum to silicon ratio (Al/Si) of roughly 3:4 (determined by semiquantitative analysis of the EDS data). Bright spots sparsely intermixed with the fibers, indicated by arrows in figure 13, show

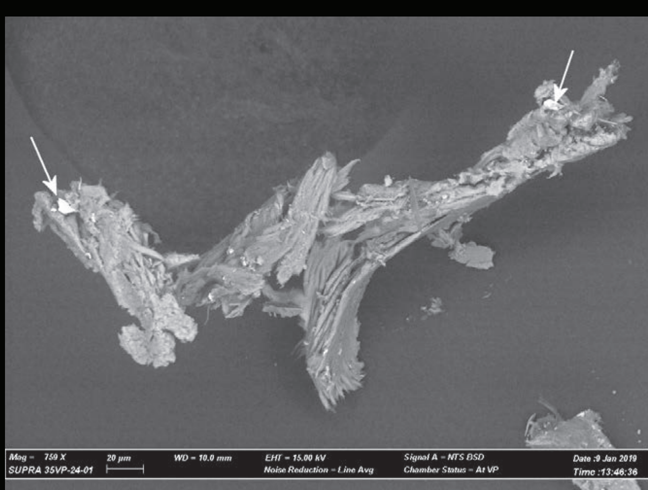

Figure 13. **Backscattered electron image of isolated fibrous inclusions. Arrows point to a second phase with higher mean atomic weight. Chris Emproto photo.**

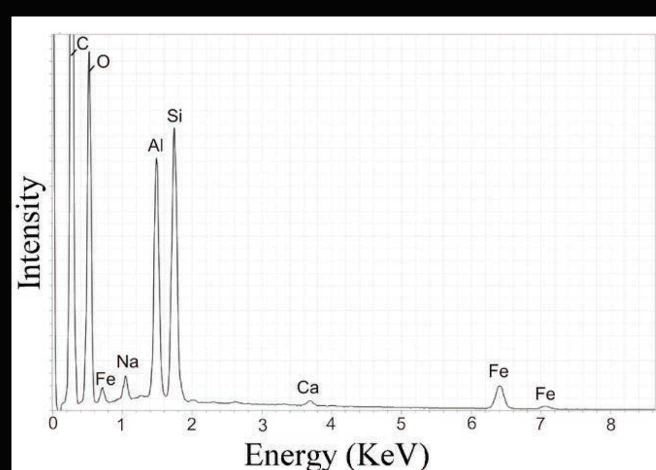

Figure 14. **EDS spectra taken from isolated fibrous inclusion.**

Figure 15. **Quartz with orange-colored inclusions, 12.6 cm; Ziga Mineral specimen.**

Figure 17. **Yellow quartz, 10 cm; Ziga Mineral specimen.**

Figure 16. **Needle quartz with yellow inclusions, 34 cm; Ziga Mineral specimen.**

the presence of significant chromium, iron, and oxygen. The lack of any detectable X-ray diffraction is perplexing. Given this chemistry the volume of material analyzed was more than adequate to detect diffraction. This suggests that the material is amorphous, but that is unexpected for a silicate of this general chemistry. The Al/Si ratio is too high for an amphibole mineral. Although speculative, one possibility is halloysite, which has been shown to become amorphous when exposed to oxalic acid (La Iglesia and Galan 1975). If the fibers breached the surface of the quartz crystal, oxalic acid may have worked its way into the quartz and reacted with the fibers during cleaning. Further study of the yellow fibrous inclusions is ongoing.

Production History

The yellow quartz workings in Cabiche are found close to the surface where tree roots traverse the many fractures in the rock and entangle the clusters of quartz. As interest in the yellow quartz quickly developed and surrounding areas began to be exploited, different styles of quartz points emerged, and the colors of the inclusions changed. The initial production from the pocket above the road had robust, elongated crystals with the inclusions concentrated at the terminations. Unfortunately, most of the specimens uncovered here were affected by early attempts at cleaning.

A later find in the spring of 2018 produced the brightest inclusions; they were orange in color rather than yellow (fig. 15). Here the points and clusters can be included with fibers down to the base of the crystals. This type mainly came from an area immediately above the road and below the rediscovery zone of yellow-tipped quartz. Zones to the left and right of this area have mainly produced white-tipped crystals. As the *campesinos* prospected farther from the source of yellow color, quartz with inclusions of coffee-colored fibers were found below the road, probably tinted by (Fe) oxides. This area continued to produce intermittently. During the summer of 2018 a find of delicate needle quartz, also with bright yellow inclusions concentrated at the tips, came from the yellow-producing area (fig. 16).

The pursuit of yellow quartz in Cabiche is ongoing, but it is uncertain whether more specimens will be found. Patterns of inclusion color localization may define zones in the area and could be an indication that the bright yellow quartz is a unique and isolated deposit. The lateral changes to white or coffee colors may represent a boundary to the area with brightest colored specimens. As for Don Víctor Carranza's yellow quartz specimens, their whereabouts are currently unknown. Perhaps they reside in the Carranza family collection. It could be that they were sold long ago to his prestigious emerald clients or that those pieces have been forever lost.

The future for Colombian mineral-specimen production is bright as minerals in addition to emeralds become appreciated, preserved, and brought to the collectors' market. As long as the *campesinos* continue to prospect we remain in hopeful anticipation of the new, the re-emerging, and the unseen natural treasures of Colombia.

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