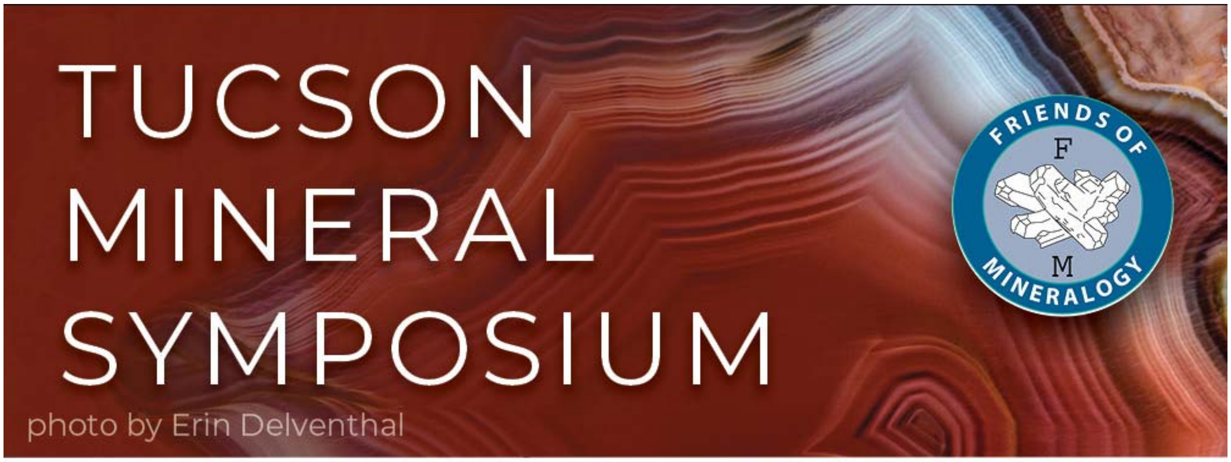

In conjunction with the Mineralogical Society of America and the Tucson Gem & Mineral Society, Friends of Mineralogy is pleased to announce the **41st Annual Tucson Mineral Symposium.**

SILICA MINERALS –

QUARTZ, AGATE, OPAL, TRIDYMITE, AND CRISTOBALITE

SATURDAY, FEBRUARY 11, 2023

Acknowledgments

The Friends of Mineralogy executive board, Erin Delventhal, Linda Vanegas-Smith, and Bruce Bridenbecker, has been very supportive of proceeding with this symposium as well as our co-sponsors, the Mineralogical Society of America represented by J. Alex Speer and Ann Benbow, and the Tucson Gem and Mineral Society, represented by Pat McClain. *Mineral News*, managed by Tony Nikischer, *Rocks & Minerals*, managed by Marie Huizing, and the *Mineralogical Record*, managed by Wendell Wilson all helped with providing publicity for the symposium. Erin Delventhal and Matt McGill are appreciated with creating the magazine publicity notices.

The 41th FM-TGMS-MSA Tucson Mineral Symposium

The 41th FM-TGMS-MSA Tucson Mineral Symposium, Theme " Silica minerals – quartz, agate, opal, tridymite, and cristobalite and other silicates" Saturday, February 11, 2022, Tucson Convention Center, Tucson, AZ

10:00 AM	Opening of symposium
10:00-10:05 AM	Introduction by symposium chair, **Mark Jacobson**
10:05-10:15 AM	Introduction by symposium MC, **Dale Gann**
10:15 – 10:45 AM	**David London, Feldspars Tell the Tale of Pegmatites**
10:45 - 10:55 AM	break
10:55 - 11:25 AM	**Brad Cross** , **Dazzling Silica Minerals: The Agates and Geodes of Northern Chihuahua, Mexico.**
11:25- 11:35 AM	break
11:35 – 12:05 AM	**Dale Gann, Overview of the thundereggs of North America**
12:05 - 1:30 PM	**Lunch**
1:30 – 2:00 PM	**Peter Heaney, The Many Colors of Agate: A Comparison of Pigmented and Iris Banding**
2:00 - 2:10 PM	break
2:10 - 2:40 PM	**Amir C. Akhavan (remote speaker, Europe), A superficial look at quartz crystal faces - reviving an old technique to determine handedness and position**
2:40 - 2:50 PM	break
2:50 – 3:20 PM	**William Stephens, New sites and crystal habits of quartz in the Herkimer area, New York**
3:20 – 3:40 PM	extended break
3:40 – 4:10 PM	**Parker Chang, Blue "cubic" Trestia (Maramures, Romania) chalcedony: pseudomorph after what?**
4:10 – 4:20 PM	break
4:20 – 4:50 PM	**Nathan Renfro, The Micro-world of Chalcedony and other Silica Gems**
4:50 – 5:00 PM	break
5:00 – 5:30 PM	**H. Peter Knudsen, quartz twins from the PC mine, Jefferson County, Montana**
5:30 PM	**close of symposium**

Quartz and Feldspars Tell the Tale of Pegmatites

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Quartz and feldspars comprise more than 80% by volume or composition of granitic pegmatites, even the most chemically evolved and mineralogically complex ones. Pegmatites are the sole source of the ultra-high purity silica from which microprocessors are fabricated. Pegmatitic quartz and feldspars are the principal ingredients of manufactured glasses and ceramics. Despite their abundance and industrial value, quartz and feldspars in pegmatites have received far less scientific scrutiny than have the rare and exotic minerals.

Quartz. All quartz is nearly pure SiO_2, but pegmatitic quartz achieves extraordinarily low levels of total impurities. After beneficiation, clear pegmatitic quartz contains ~ 50-100 ppm (parts per million by weight) of elemental contaminants. Opaque white (a.k.a. milky or bull) granular quartz contains < 10 ppm of impurities after processing. The quartz is white due to fluid inclusions that have been trapped during a low-temperature interval of recrystallization. With that recrystallization, elemental impurities in the quartz are moved to minute minerals along grain boundaries, where they can be removed by grinding.

The habits of most pegmatitic quartz are anhedral and interstitial. Anhedral means that the shapes of quartz crystals are not those forms that are intrinsic to its crystal structure. Interstitial means that the quartz normally precipitates between other minerals, and hence it assumes the shapes of the spaces between them. Highly structured intergrowths of quartz with other minerals, however, are common in pegmatites. One, graphic granite, is the skeletal intergrowth of quartz and potassium feldspar (Kfs, $KAlSi_3O_8$) to which the term *pegmatite* alludes, and it is the only texture that is unique to pegmatites. In that case, quartz fills interstices between maze-like raised surfaces of Kfs crystals. In association with sodic feldspars of the plagioclase series, quartz forms skeletal branching hexagonal crystals, sometimes meters in scale, in which the plagioclase is interstitial. The massive pure quartz of pegmatite cores has posed a scientific enigma to all who have studied these rocks, but recent experiments indicate that the pure quartz bodies can form through solely igneous processes without the involvement of an aqueous solution.

Feldspars. Granitic pegmatites normally contain two coexisting feldspars – sodic plagioclase and K-feldspar, termed the alkali feldspar series – from start to finish. Plagioclase begins with the composition of oligoclase (~ 85-90% $NaAlSi_3O_8$, or Ab_{85-90}) at the pegmatite margin that evolves inwardly to nearly pure albite (Ab_{99}). The composition of Kfs ranges between 88-98% of the potassium component. Kfs in the outer zones possesses the partially disordered structure of orthoclase, which progresses inwardly to the fully ordered structure of microcline. The ordering of the feldspar structure coincides with the development of perthite, in which the albite component of the feldspar has exsolved as crystalline lamellae in the host microcline.

Coexisting alkali feldspars provide the most reliable means of establishing the temperatures of crystallization in pegmatites. Those temperatures are in the range of 400°C, rising to ~ 450°C at dike centers. In miarolitic cavities, the primary stage of gem mineral growth occurs between 450°C and 350°C over the duration of months. These temperatures are well below the theoretical values at which crystallization of a granitic melt should commence. All of the textural and compositional attributes of pegmatites can be ascribed to the consequences of the crystallization of a granitic melt at a highly undercooled state.

Figure 1. Graphic granite, a skeletal intergrowth of feldspar and quartz, was the original defining texture of pegmatites. It is the only texture found in pegmatites that is unique to them. The process by which graphic granite forms reflects the environment of crystallization that leads to the generation of pegmatitic textures.

David London obtained his B.A. in geology (1975) at Wesleyan University, Connecticut, after which he mapped for the U.S. Geological Survey (1975-1976) in the high-grade metamorphic terrane of eastern Connecticut, USA. He continued annual summer field mapping in metamorphic rocks of central Connecticut through 1988. London received his M.S. (1979) and Ph.D. (1981) in geology from Arizona State University. His graduate studies included investigations of pegmatites in the White Picacho district, Arizona, and he began laboratory research for his Ph.D. in Washington, D.C., at the Geophysical Laboratory, the U.S. Geological Survey, and the Smithsonian Institution. He returned to the Geophysical Laboratory as a postdoctoral research fellow (1981-1982). London joined the faculty of the School of Geology and Geophysics at the University of Oklahoma (1983-2020), where he held several professorships and a chaired position. He established and directed the University's electron microprobe lab. London is the managing editor of the Pegmatite Interest Group of the Mineralogical Society of America (http://www.minsocam.org/msa/special/pig/). His book *Pegmatites* (Canadian Mineralogist, 2008, Special Publication **10)** is the only authoritative monograph on the subject. Londonite, isometric $CsAl_4Be_4[B_{11}Be]O_{28}$ (Can. Mineral. **39**: 747-755), was named for him in 1999. London has published 144 research articles and has received \$4.4M in funding through 31 grants from the U.S. National Science Foundation and the U.S. Department of Energy.

Dazzling Silica Minerals: The Agates and Geodes of Northern Chihuahua, Mexico

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Since the mid-1940's, Mexico has gifted collectors with a wide variety of colorful, complex, and intriguing agates, geodes, and thundereggs. The occurrences are found as isolated deposits, most within andesites, rhyolites, and ash flow tuffs that range in age from 38 to 44 million years old. Rare exceptions, such as Crazy Lace Agate, do occur and can be found in Cretaceous (90 to 65 million years) limestone.

The occurrences are all found in association with past tectonic activity with regional trends of deposits easily recognized. Traveling south of El Paso, Texas along Mexican Highway 45, the first commercial quartz geode deposit is found near Villa Ahumada, Chih., approximately 83 miles south of the border. Intermittent deposits of colorful agate nodules and quartz geodes can be traced in a southerly direction into the state of Durango, a distance of at least 450 miles.

A vast majority of the more popular agates (e.g., Laguna Agate, Coyamito Agate, "Coconut" geodes, etc.) are concentrated mid-way between El Paso and Chihuahua City in the Sierra Gallego region. A second trend or belt of occurrences continues off to the northwest some 125 miles to the city of Nuevo Casas Grandes, then 100 miles north up to Palomas on the U.S. – Mexico border and finally back southeast to our starting point, Villa Ahumada.

Each variety of agate is named after a nearby ranch or railroad station and all are found on private land, usually large cattle ranches. Although quality material could be easily collected from the land surface in the 1940's and 1950's, surface material quickly disappeared and hard rock mining was initiated. Today, mechanized mining replaces the surface collecting, hand-dug tunnels or pits and constitutes a multi-million-dollar business.

Although there are many varieties of Mexican agate, each has a unique set of characteristics such as specific color ranges, fineness of banding, nodule size and shape, as well as external pitting and color that help provide clues in identifying the exact location. A few of the more popular varieties that will be included in Brad's presentation are described below.

Laguna Agate

This nodular agate is perhaps one of the most popular varieties of agate in the world, recognized by its colorful, distinct, ornate, fluted, and holly leaf-like fortifications. The brighter color combinations are many times found in the central portion of the nodule where clear chalcedony tends to alternate with opaque bands. There are several colors found in Laguna that seem to be particularly typical. Raspberry red, shades of orchid, pleasing soft yellows, orange, and gray bands are especially common. The most prized specimens have contrasting combinations of color such as purple, red, and orange.

Nodules, ranging in size from a hen egg up to a large cantaloupe, are mined immediately east of Estación Ojo Laguna in the Sierra El Oso, located approximately 170 miles south of El Paso.

Figure 1. A Laguna agate, Brad Cross photo.

Coyamito Agate

Rare color combinations of purple and yellow, rose and white, as well as various shades of red, orange and mustard are found in this Chihuahuan gem. Unlike the Laguna Agates, most of the brighter colors typically occur in the outer perimeter. The clash colors, coupled with ghostly pseudomorphs of evaporitic minerals, make this agate one of Chihuahua's most prized gems.

Found on Rancho Coyamito Norte, or about 30 miles north of the Laguna Agate deposit, several primary deposits are identified on the ranch. The *Los Alamos* area is the most southerly productive region on the ranch and characteristically contains muted or dark shades of lavender and yellow bands commonly encasing pseudomorphs of past mineralization. These agates are particularly large and can reach upwards of a foot or more in diameter.

Some 500 yards to the north of Los Alamos is *La Sonoreña,* a grouping of small and isolated concentrations of agate. Here, over 20 small pits are found on the slopes of the volcanic hills where each pit tends to produce a unique type of agate. Few agates offer the variety and appeal as those from this ranch.

Moctezuma Agate

Pastel shades of salmon, pink, yellow, tan, and white readily identify a Mexican agate locality as Rancho El Barreal. Found east of Estación Moctezuma, these nodules are located within the mining concession Laguna Verde. The surface nodules typically have a siliceous and sometimes chalky white banana peel-like rind. Chromatography, a separation of coloring agents by semi-permeable bands, are many times found in Moctezuma Agate and provide abrupt and dramatic color changes.

Apache Agate

Unlike the common fortification pattern found in other nodular agates, Apache agate has bright red, vivid orange, and dark yellow splashes of color seemingly suspended as draped folds and swirling veils in colorless to deep blue chalcedony. Located on Rancho La Viñata, most of the host andesite has succumbed to the attacks of mother nature, leaving the irregular-shaped nodules to prominently stand out in a beige clay-like soil.

Agua Nueva Agate

Occurring in both nodule and vein form, the trademark characteristic for Agua Nueva Agate are remarkable straw-like tubes. Vein agate, reaching over 14 inches in thickness, occurs on Rancho Los Nogales as a golden brown to red moss agate with individual pockets of purple, white, and pink tube agate. The individual tubes average three-quarters of an inch in diameter, many times being completely encased by euhedral quartz. Found within the same mining concession, *Mi Sueño*, nodular banded agates can be found and occur in shades of lavender, purple, gold, and yellow.

A second area of the ranch, claimed under the name *Agua Nueva*, produces nodular agates with a flat base and somewhat domed top. These nodules characteristically contain an outer perimeter of dark yellow to light orange moss agate. The central portion of the nodules typically contain rosy violet hues and sharply contrast with an outer band of bright yellow, dark green, black, or white.

Crazy Lace Agate

Towering above the desert floor to an elevation of 6,200 feet, the Sierra Santa Lucia hosts numerous agate mining concessions and diggings. Primarily occurring as a vein agate, irregular curved and twisted bands in shapes of zig-zags, scallops, bouquets, sunbursts, and eyes compose this agate. The peculiar structures are many times grouped together in a larger spherical complex. While individual bands of red, yellow, orange, or brown occur, the vast majority of the material is gray or white. However, widespread staining is primarily responsible for much of the color.

Unlike all other Mexican Agate, Crazy Lace Agate occurs as a vein deposit and is mined from a highly siliceous, dark gray limestone of Cretaceous age; however, agate emplacement likely didn't occur until rhyolitic domes intruded the area some 40 to 50 million years ago during Tertiary time.

"Coconut" Geodes

The popular Mexican "coconut" geodes occur within an ash-flow tuff at Las Choyas, a remote geographic point approximately 22 miles northeast of Ojo Laguna, Chih. These quartz geodes are mined from a two square-mile area with most mines reaching depths of over 150 feet deep. Geodes from this location are easily identified by their near-perfect spherical shape. They occur in a 44-million-year-old ash flow tuff and the geodes, when brought to the surface, appear white from the clinging fragments of the volcanic ash in which they were imbedded. Roughly three-foot diameter shafts are dug through tenacious, welded ash flow tuff to reach the producing unit. Once the geode-producing unit is reached, tunnels are constructed in the highly altered tuff, following the pay zone.

Only 20 percent of the geodes are hollow and those that are, usually have an outer wall of variable thickness consisting of blue-gray banded agate. However, the walls of some coconuts consist of siderite and are commonly termed "brown rimmed coconuts." Regardless of the rim mineralogy, the walls grade inward into well-defined crystalline quartz of colorless, smoky, and amethystine varieties. Finally, there is a complex of late-stage sequence of minerals, including carbonates, manganese oxides, and iron oxides and hydroxides, in the centers of many of the geodes.

Conclusion

Mexican agates and geodes are ranked among the very finest varieties of cryptocrystalline quartz. Occurring in both nodular and vein forms, a wide-array of types are found including moss, bands, eyes, and tubes. Although occurrences number in the hundreds, much of the Mexican republic remains relatively unexplored and new varieties will certainly be discovered in the future.

Brad L. Cross, is a renowned authority on Mexican agates and geodes and author of “The Agates of Northern Mexico,” “Gem Trails of Texas,” “Gem Trails of New Mexico,” and “Geodes: Nature’s Treasures.” His latest book, “Mexican Agates: Majestic Treasures” is anticipated to be published in the near future. Brad has been a collector of museum quality agates for over 50 years. He has travelled extensively throughout northern Mexico and has conducted geologic mapping at a number of the agate beds throughout Chihuahua. He has also visited southern Brazil, evaluating the agate and geode deposits of the extensive Parana flood basalts in the state of Rio Grande do Sul. He is a professional hydrogeologist and is currently employed with a consulting firm in Round Rock, Texas.

Thundereggs of North America

Dale Gann

Commonly known as thundereggs, the geologic word for the name of this species of nodule is lithophysae (Greek for "rock bubbles"). This species of nodule only occurs in rhyolite-perlite lava flows and ash flow tuffs. Lithophysae are spherulites that happened to develop gas cavities wherever the external pressure was low enough to allow dissolved gas to expand a cavity. Spherulites (solid rhyolite nodules) are considered duds by miners and collectors and are discarded.

There is a common error of terms among collectors and rockhounds. Somehow, thundereggs became a word that meant solid nodule. Although geode does mean a hollow nodule, thundereggs can be either solid or hollow and if they are hollow, then they can correctly be called geodes.

Thunderegg is a Native American name. They believed that these nodules were missiles cast by the Thunder Gods living in the volcanoes of the Cascade Mountains in Oregon.

This presentation will look a selection of Thunderegg locals from Canada through Mexico.

Thunderegg from black Rock Desert, Wyoming, Dale Gann specimen and photo.

Dale Gann is an environmental engineer and has been accused of trying to impersonate a geologist. Growing up in Miami, FL there were very few opportunities to enjoy rock hounding. That changed one year when Dale and his parents went to Franklin, NC and visited one of the local gem mines. That sparked an interest in rocks that did not blossom until Dale and his family moved to Denver, CO and he attended his first gem and mineral show. Dale attended the 2005 Symposium on Agate and Cryptocrystalline Quartz and that sparked his continuing interest in agates. Dale has collected agates and thundereggs in 12 western states and has assembled a large collection of agates, geodes and thundereggs. Dale was the Master of Ceremonies and speaker at the 2016 Agate Expo and Master of Ceremonies at the 2019 International Exposition of Agates.

The Many Colors of Agate: A Comparison of Pigmented and Iris Banding

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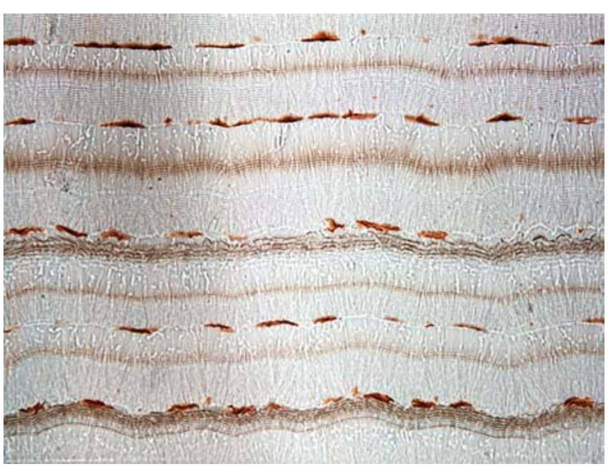
Agates are renowned for their extraordinary variety of natural colors, typically occurring within concentric bands that can exhibit surprising shifts in hue along a traverse from the exterior to the center of the specimen. Scientists have identified a wide array of mineral inclusions responsible for agate coloration, most commonly Fe and Mn (hydr)oxides that impart shades of red, yellow, brown and black. Often, the geometric intricacy of this polychromatic layering will enable an experienced collector to identify an agate with its locality. Not all agates are pigmented, and the absence of impurity minerals in many agates suggests that these compounds do not play an essential role in agate formation. Light microscopic examination of thin sections of pigmented agates reveals that the pigmenting oxides often are concentrated between fiber growth sectors, suggestive of crystallite bulldozing by agate fiber fronts followed by periods of stasis.

Superimposed upon these pigmented bands, however, is a zonation associated with the microstructure of the fibrous chalcedony. In both colored and transparent agates, a repetitive fabric at the micron scale can be discerned with respect to the fibrous quartz crystals that compose the chalcedony. Although this silica texture is less well-known than the coloration imparted by metal oxide inclusions, it gives rise to the diffraction effects responsible for the rainbows of iris agate. A study of iris banding by transmission electron microscopy reveals that the modularity can be ascribed in the simplest terms to oscillations in grain size with a wavelength of ~1 micron. A crystallographic analysis reveals that the alternation between fine and coarse grains is associated with variations in the concentrations of Brazil twins – defects that separate right- and left-handed quartz. In some agates, this texture occurs as a hierarchical fabric characterized by the fractal qualities of a so-called Cantor dust. This presentation will describe the curious nature of the Brazil twins that populate agates as oscillatory waves at length scales of nanometers, microns, tenths of millimeters, and centimeters.



Microscopic image in plane light of an Brazilian agate thin section showing the concentration of hematite nanoparticles between chalcedony fiber growth fronts. Iris banding is faintly visible as repetitive striations parallel to the hematite bands.

Peter J. Heaney has served as a professor of mineralogy in the Department of Geosciences at Penn State University since 1998. As an environmental mineralogist, he has investigated the ability of soil minerals to remove toxic metals from surface and ground waters, using a range of X-ray and electron probes that offer crystallographic insights into metal sequestration. In addition, Heaney has published papers on unusual optical effects in gem materials, such as chatoyancy in tiger's-eye and iridescence in agate, rock crystal, hematite, and goethite. He was the president of the Mineralogical Society of America (MSA) in 2008 and is a fellow of MSA and the Geological Society of America.

A superficial look at quartz crystal faces - reviving an old method to determine handedness and position

Amir C. Akhavan

Every mineralogy textbook shows an idealized figure of how the handedness of quartz crystals is expressed in the positions of certain crystal faces. The "x-face", a positive trigonal trapezohedron, can be used to reliably determine the handedness, the position of the rhombohedra r and z, and the position of the axes. Unfortunately, going by this and other simple rules often does not work for the not-so-ideal real-life crystals. Not only are x-faces often missing, but some of the crystallographic forms on quartz also occur as left, right, positive, or negative variants – defined by their position relative to the positive rhombohedron r. To further complicate the matter, contrary to popular belief, there can be left-handed forms on right-handed quartz crystals and vice versa. To avoid confusing such rare faces with the more common variants, misjudging the handedness, or observing twinning when there is none, one needs to determine r and z and the handedness independently from trapezohedra. Some sophisticated, but unfortunately destructive techniques were developed in the 1940s when natural crystals were still the raw material for oscillator plates, but collectors will prefer less expensive and non-destructive methods.

One method available to everyone with a stereo microscope is studying the surface features of crystal faces, particularly their growth hillocks. These usually form by a mechanism called spiral growth and are found in many minerals. In a surprisingly large number of cases, one can determine *r*, *z*, and handedness from their geometry. In the early 1930s, long before a mechanism of their formation was suggested, Georg Kalb described certain quartz growth hillocks in detail, used them to identify *r* and *z* and twin domains, and also tried to correlate their shapes with different growth conditions.

Figure 1. Ideally developed triangular growth hillocks on the rhombohedral faces of a quartz crystal from Jenipapo, Minas Gerais, Brazil. Height 15 mm.

One only needs to compare the growth hillocks on a few dozen quartz crystals to notice that i) the same shapes are found at many localities, ii) there are only a handful of different types of growth hillocks, and iii) certain types on *r*-faces are always associated with certain other types on *z*-faces. The last point means that one can often directly recognize *r* and *z*. Slightly distorted or rounded triangular shapes are common, and these are skewed in opposite directions on *r* and *z*, indicating the handedness. Some growth hillocks do not help in face discrimination. They are usually of a more irregular shape, radially or concentrically gooved, and often seen on milky, stubby quartz crystals with a simple face development.

Surface features on the prism faces are more difficult to interpret. The striation is usually caused by elongated growth hillocks, but only two types of them directly indicate handedness and the position of r and z. The prism faces may also be covered by small steps of rhombohedral faces, and if stepped prism faces alternate with smooth or striated ones, the stepped faces apparently only occur below z.

The method is not foolproof, and some of the difficulties caused by interfering surface features will also be presented in this talk.

References

Akhavan, A. (2021) Die Flächen der Quarzkristalle. Teil 2: Rhomboeder, oberflächlich betrachtet. Mineralien-Welt, 32(5), 42-62.

Kalb, G. (1933) Beiträge zur Kristallmorphologie des Quarzes. I. Die Vizinalerscheinungen des Quarzes und ihre Bedeutung für die Erkennung der Zwillingsdurchwachsungen nach dem Dauphinéer und Brasilianer Gesetz. Zeitschrift für Kristallographie 86, 439-452.

Amir C. Akhavan, an independent scientist living in Hamburg, Germany. He started his mineralogical career at an age of 7 in the Peine iron mining district at an unnamed anthropogenic gravel pile outside a construction site by trying to predict the sparkliness of the interior of pebbles from their surface patterns. After a brief stint in optical mineralogy and the corresponding discovery that milky pebbles look more translucent when put into water, he gravitated towards chemistry, then geology, and then biology, in which he got his Ph.D. for something that really has nothing to do with minerals. His involvement with quartz is purely accidental: cheap and easy to get, it just kept piling up, until his mineral collection had turned into a quartz collection - now what to do with it? Around 2005 he realized that information about quartz on the Internet is patchy and outdated and created the website www.quartzpage.de. In addition to reporting what others have discovered, he recently started doing his own research on all sorts of silicious subjects.

Blue ”cubic” Trestia (Maramureş, Romania) chalcedony: pseudomorph after what?

Parker Chang*, and Stefan Nicolescu

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* speaker

Blue, pseudo-cubic cryptocrystalline quartz (aka chalcedony) from Trestia (Maramureş county), Romania is a long-standing riddle when it comes to explaining both its morphology and its color.

Regarding morphology, there are several views regarding the potential precursor of pseudo-cubic Trestia chalcedony. The common denominator for these is that obviously its precursor was a cubic mineral. At various points in time, it was suggested that the morphology is the result of pseudomorph after pyrite (FeS_2), fluorite (CaF_2) or melanophlogite (a relatively rare SiO_2-clathrate with the general formula $46SiO_2 \bullet 6M^{14} \bullet 2M^{12}$ ($M^{14} = N_2, CO_2$; $M^{12} = CH_4, N_2$)). Below 40 °C melanophlogite is tetragonal/pseudo-cubic; above 40 °C it has cubic symmetry.

As for the color, until now the dominant hypothesis was that it is caused by microscopic halide (sylvite or fluorite) inclusions.

In an attempt to find answers to both issues, a range of analytical techniques were used in the present study on a suite of Trestia chalcedony specimens from the mineralogy collection of the Yale University Peabody Museum of Natural History: optical- and scanning electron microscopy (SEM), X-ray fluorescence (XRF), and electron microprobe analysis (EMPA). For comparison, regular (non-“cubic”) blue chalcedony from Trestia, as well as blue chalcedony from Guerrero (Mexico), and a blue quartz sandstone from Brazil (probably from Serra de Macaúbas) were also investigated. In addition, synthetic quartz, natural colorless quartz (Hot Springs, AR), and melanophlogite (Mt. Hamilton, CA) were also analyzed.

Although relatively recent (2017) literature still posits that fluorite was pseudomorphosed by the Trestia chalcedony, no chemical evidence for its existence has been revealed during the investigation. The same lack of chemical evidence disqualifies pyrite as a possible progenitor of its morphology.

Besides typical microcrystalline quartz, Trestia “cubes” also contain larger idiomorphic quartz phenocrysts. Faint features in some of them, illustrated in the picture below, are reminiscent of melanophlogite banding generated by thin films of most likely carbon.

Combined with SEM imaging revealing the same feature and with the absence of any other element except Si, these results point to melanophlogite as the most likely precursor pseudomorphosed by chalcedony at Trestia. Lighter melanophlogite constituent elements (H, C, O) cannot be detected by the analytical methods used in this work.

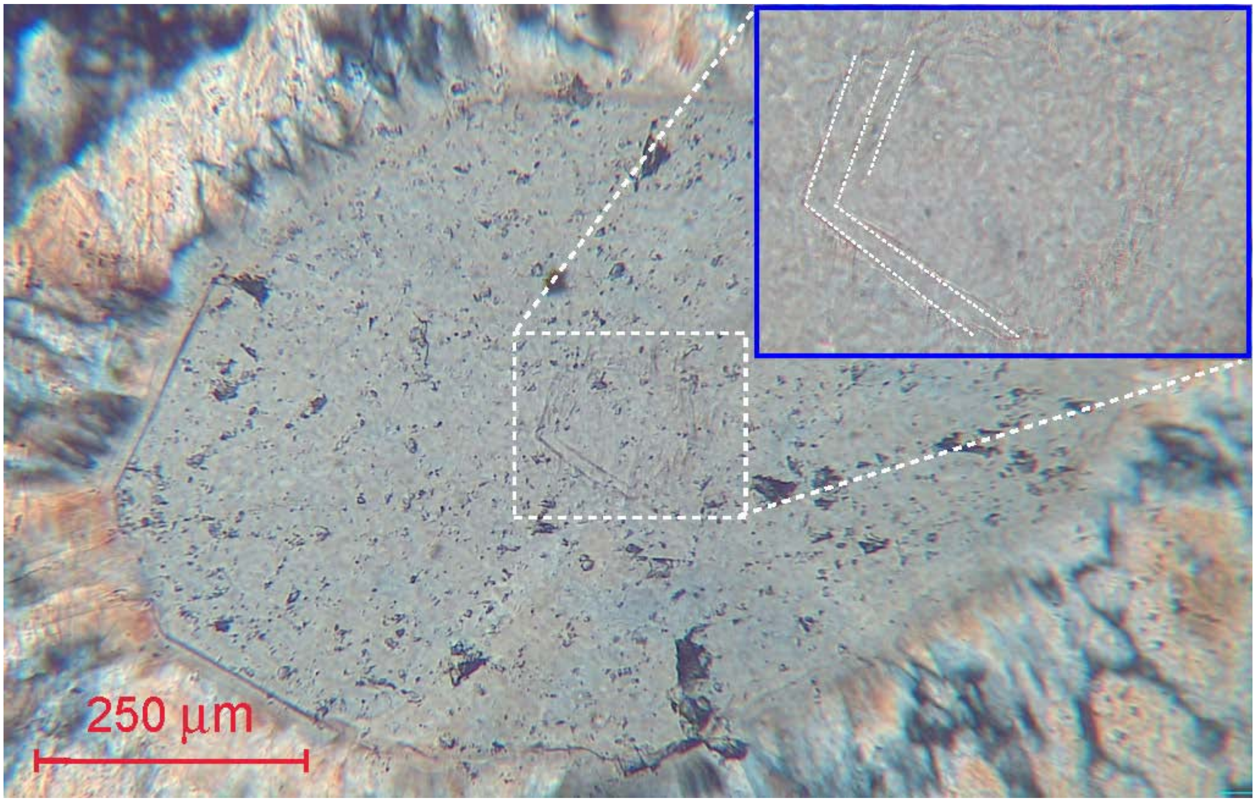

Figure 1. Faint banding in quartz phenocryst in pseudo-cubic Trestia blue chalcedony attributed to melanophlogite. (specimen YPM MIN.015296; crossed polars image)

Although the investigated Brazilian quartz was found through EMPA to be colored blue by dumortierite inclusions, no color-imparting inclusions have been detected in Trestia or Guerrero chalcedony. The most likely explanation for their blue color (and the blue color of many chalcedony specimens from around the world) is Rayleigh scattering. What makes Earth's sky blue also makes Trestia chalcedony blue.

Parker Chang is a second-year student at Yale University. He is pursuing a Bachelor of Science degree in Environmental Studies. Parker is originally from Honolulu, HI. He is currently working as the Sustainability Liaison for the Trumbull Residential College at Yale. Parker spent the 2021 fall semester working at the Yale University Peabody Museum of Natural History with Dr. Stefan Nicolescu on a project investigating the morphology of pseudo-cubic blue chalcedony from Trestia (Maramureş, Romania), gaining experience with research in the fields of mineralogy and earth science.

New sites and crystal habits of quartz in the Herkimer area, New York

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"Herkimer Diamonds" have been known and reported from the Little Falls Dolostone of Herkimer, Montgomery, and Fulton Counties of New York State since the 1820's. Most collectors are familiar with the Herkimer Diamond Mine and Ace of Diamonds well known for small to walnut size "gemmies" or "water clears" and the occasional larger crystals found in large pockets, mainly in commercial mining zones; gorgeous "perchers" on clear to black drusy quartz-lined vugs at Crystal Grove. Semi-private sites including Diamond Acres are well known for producing large crystals known as "Fonda footballs" as well as gemmy crystals, drusy matrix specimens and less common skeletal habit crystals

Several successful and productive new mining ventures have sprung up in and near the classic "Herkimer District" as it is known in the literature. Buoyed by effective marketing through social media, names like "Soul Family Farm," "Diamond Mountain", "Mohawk Valley Mineral Mining" and "Area 52" along with branded entity names like "The Elusive Herkimer Diamond", "Dirty Diamond Diggers" and "Area 51 Miners" are becoming household names.The growth and success of these new ventures can be attributed not only to successful marketing and business models, but also to unusual size and habits of Quartz crystals they produce. Compared to the classic localities at localities such as Mohawk Valley Mineral Mining (MVMM), produce fist-sized "palmers" and softball or larger sized "goonies" or "Mohawk Monsters" on a daily basis both from topsoil below the pocket layer and from pockets in the solid dolostone ledge. Disarticulated clusters more than 20-lbs have been found. Other sites such as Area 52, a private quartz collecting locality, produces stunning skeletal, mud-included fenster crystals up to 10-lbs. Other sites produce quartz scepters with anthraxolite rod cores.

Figure 1. Three-pound crystal after removal, pocket on the primary pocket ledge, MVMM, Sprakers, NY, Labor Day Weekend, 2022 by Bill Stephens.

This presentation will focus on some remarkable crystals recently recovered and extraction videos from Area 52, a "top-down" surface mine and MVMM, a steeply sloping ledge mine. Preliminary mapping of these sites has been completed, including a survey and drone map for each of these sites. The general geology of the occurrence, recent studies pertaining to the source, mode and paragenesis of crystallization and implications for future development will be covered.

Figure 2. Large smoky, skeletal, mud & fluid-included complex crystal with fensters recovered by Shane Moore at his Area 52 Mine, Montgomery County, NY

Bill Stephens is a licensed Professional Geologist, Current President of FM-PA Chapter and President of Stephens Environmental Consulting, Inc., a full-service environmental consulting, engineering and surveying company serving in the Mid-Atlantic Region since 1995 and President of the Eastern Federation of Mineralogical and Lapidary Societies. Bill is also a past VP of Programs for the Delaware Mineralogical Society. Bill started collecting about age 11, after being inspired by a National Geographic article on gems of the Eastern Appalachians. Family and later college buddy collecting trips focused on collecting mainly in North Carolina, with incidental trips to southeastern PA locations including Phoenixville. More recently Bill has developed a passion for “machine digs”, including Diamond Hill and Hogg Mines machine digs from which real knowledge of these deposits can be obtained. Bill uses his resources, including geological knowledge, GIS skills and drones to develop programs designed to inspire others and help provide them more tools to be more successful in their collecting adventures.

The Micro-world of Chalcedony and other Silica Gems

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Abstract

Chalcedony as a gem offers a wide range of interesting micro-features. This is in part related to the various mineral inclusions that may be present during formation and subsequently incorporated into the gem. Chalcedony's interesting micro-features also are the result of structural patterns that occur during formation. The sedimentary processes which produce chalcedony often leave a banded or layered pattern, which add to the interesting observations possible in the microscope. Mineral inclusions such as azurite, copper, malachite, realgar, hematite, goethite are often observed as foreign minerals are dispersed throughout the gem imparting a wide variety of colors. This presentation will cover a wide variety of microscopic features within chalcedony gems.

Figure 1. This fossil dinosaur bone from Colorado, U.S.A. resembles a red tire track across black pavement. Field of View 24.00mm Copyright GIA. Stone Courtesy of the John Koivula Inclusion Collection.

Figure 2. This iris agate gives the viewer a scenescape reminiscent of an Aurora event over a frozen lake among a forest. Field of View: 5.28mm

Figure 3. Goethite sheaves resemble a field of wheat in this chalcedony. Field of View 10.28mm

Nathan Renfro, a native of western North Carolina, developed an interest in minerals during his late teens, which was sparked by his grandfather's rock collection. In 2006 he completed his undergraduate studies in geology and then went on to enroll at GIA for the resident Graduate Gemologist (GG) program as a recipient of the William Goldberg Diamond Corporation scholarship. After finishing the Graduate Gemologist program at GIA, he was hired by the GIA laboratory as a diamond grader and soon transferred to the Gem Identification department in 2008. Since then, Mr. Renfro has authored or co-authored more than one hundred gemological articles and lectured to several gem and mineral groups throughout the Unites States. His primary areas of gemological interest are photomicrography and identification of inclusions, gemstone cutting and defect chemistry of corundum. Mr. Renfro is currently the Senior Manager of the Colored Stone department in Carlsbad, CA and New York, NY. He is also a microscopist in the Inclusion Research Department. Mr. Renfro is the editor of G&G's Microworld quarterly column which is published in the journal Gems and Gemology, where he is also a member of the editorial review board. Mr. Renfro also completed his FGA in 2014.

Quartz Twins from the PC Mine, Jefferson County, Montana

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The PC mine is about seven miles north of Basin, Montana, and is best known for its Japan law twins. The mine also produced many tons of single and groups of quartz crystals. Other collectible species include pyrite, galena, and sphalerite. The mine exploits a hydrothermal breccia deposit hosted in the Late Cretaceous Elkhorn Mountain Volcanics. The deposit contained numerous pockets or vugs containing excellent euhedral quartz crystals.

Much of the quartz contains fluid inclusion. Dr. Gammons at Montana Tech studied these and based on the phase relationships concluded that the deposit was formed at a depth of 3.5 km. This is similar to other deposits in the Boulder Batholith.

Figure 1. A quartz twin from the PC Mine.

Quartz occurs as single crystals, groups, and Japan Law Twins. Most of the quartz is colorless but rarely smoky quartz was found. Individual crystals up to 30 centimeters and groups up to 76 centimeters were found. No records of twin production were kept, but I believe I mined about 4000 specimens of Japan Law Twins.

A twin is symmetrical intergrowth of two crystals. A Japan-law twin is a contact twin, with the c-axes inclined (to each other) at the angle of 84.55degrees. Ichiro Sunagawa (2004, page 210) describes three forms of Japan law twins. Sunagawa's type A is open at the top. His type B twin is almost closed and fan shaped. His type C twin is a closed twin and has parallel sides.

At the PC mine many of the twins initially grew as closed twins (Type C) and as they grew larger they grew into Type B twins and then to Type A. The phantom inside the Type A twin shows that initially it was a type C twin. Three examples of this twinning are shown in Figure 2. Figure 3 shows a type B twin that grew from a type C twin.

Figure 2. Three quartz twins illustrating Type A, B and C twins.

In addition to Japan Law Twins a small number of Reichenstein-Grieserntal Twins were found.

One interesting side bar is that a number of fine specimens of quartz showed excellent phantoms. Dr. Eugene Foord of the USGS identified the inclusions as sericite.

Figure 3. A twinned quartz cluster

Figure 4. A quartz crystal group with phantoms.

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Pete Knudsen obtained his BS in Geological Engineering from Montana Tech in 1968. He worked for the Atomic Energy Commission until going to Naval Officer Candidate School in 1969 graduating as an Ensign. He was Officer in Charge of Beachmaster Team Alfa in 1971 on its tour to the Western Pacific. He left active duty in 1972 and returned to the AEC. In the fall of 1973 he enrolled at the University of Arizona to study geostatistics and complete his MS and Ph.D. in Mining Engineering.

Dr. Knudsen taught at the University of Arizona for four years and then returned to his Alma Mater where he taught for 37 years. He was Department Head of the Mining Engineering Department and then Dean the School of Mines and Engineering from 1996 to 2017. Dr. Knudsen is a registered Professional Engineer and Legion of Honor member of SME. The American Federation of Mineral Societies Scholarship Foundation gave Dr. Knudsen an Honorary Award in 2001 for distinguished achievement in the field of earth sciences. In 2011, SME recognized Dr. Knudsen with the Ivan B. Rahn Education Award for distinguished contributions to the educational activities within SME. The Underground Mine Research Center at Montana Tech is credited to Dr. Knudsen's foresight, fund raising and drive to provide the only on-campus underground lab for mining engineering schools in the USA.

In addition to his academic experience, he has been employed by the Atomic Energy Commission, the Anaconda Copper Company, and was a partner in the Gleason Heights Mining Company. Pete is married to Renee Sanchez and together they have four daughters (one recently deceased), two sons, and seven grandchildren.

Pete's mineral collecting specialties are field collected minerals, minerals from Butte and thumbnail specimens. Pete was the co-author of "Butte Silver Bow County, Montana" in "American Mineral Treasures", the author of "The Silver Bill Mine, Gleeson, Arizona", *Mineralogical Record,* Vol. 14, no. 2 and author of "Minerals from the PC Mine, Jefferson County, Montana", *Rocks and Minerals* Vol. 96, no. 6.