OCTOBER 2021

DIARY			
October	*2*	*10:00–14:00*	***Open to the Public Day** – Rocks, gems, jewellery, mineral specimens to look at, chat about, or buy. NO MASK, NO ENTRY. All Covid-19 protocols still in force. STAY SAFE – GET VACCINATED.*

Namibian cubes meet Canadian cubes
What's the significance? See below.

Blue chalcedony pseudomorphs from Ysterputs, southern Namibia

By Jo Wicht and Duncan Miller

Introduction

Recently, the blue chalcedony pseudomorphs from Ysterputs in southern Namibia have become better known, but their origin has remained a bit of a mineralogical mystery. In this article we describe and illustrate examples in some detail, and compare them with similar chalcedony pseudomorphs from Trestia in Romania, California in the USA, and Alberta in Canada. We consider three possible precursor minerals for the pseudomorphs from Ysterputs—fluorite, halite, and melanophlogite. The prevailing consensus is that the cubic chalcedony pseudomorphs from Romania, California and Canada are after melanophlogite, a rather rare silica clathrate. Substantial similarities in appearance and geological environment between these and the Namibian examples leads us to conclude that the Ysterputs examples are also after melanophlogite.

Figure 1. A typical plate of Ysterputs blue chalcedony pseudomorphs.
JW040 specimen, 70 × 55 × 40 mm. Photo DM.

Local and regional geology

The cubic chalcedony pseudomorphs from Ysterputs **(Figure 1)** originate in the same near vertical, brecciated shear zone in dolerite as the Blue Lace Agate Mine on the farm Ysterputs 254 (28°12′07.48″S 17°56′27.63″E), about 80 km north of the South African border on the Orange River. The mine is a narrow trench about a kilometre long and about 50 m deep. It exploits the NNE/SSW trending linear fracture zone, with several prospecting pits and small excavations to the north and south for several kilometres (Wicht & Miller 2020).

The shear zone is in the extensive Jurassic Tandjiesberg dolerite sill, up to 100 m thick, which intruded Permian marine deposits of the older Karoo-age sediments of the Whitehill Formation of the Ecca Group (Werner 2006; Miller 2008). The Whitehill Formation is a carbonaceous, gypsiferous and pyritic shale (Miller 2008). The dolerite intrusion produced regional low-grade metamorphism (Smithard et al. 2015) but at the base of the dolerite sill temperatures were high enough to cause partial melting of the Whitehill shales (Werner 2006). Presumably, this was the source of a hydrothermal system that transported saline brine and other volatile components upwards from the Karoo sediments into the shear zone fractures in the dolerite sill.

These hydrothermal fluids, on cooling or boiling due to drop in pressure, deposited first dolomite lining the walls of the fractures and then a rhythmic succession of chalcedony and quartz to form blue lace agate. This is a typical hydrothermal vein agate (Götze et al. 2020), and for the past 50 years the target of mining for lapidary raw material (see Wicht & Miller 2020 for numerous images).

The Ysterputs cubic chalcedony pseudomorphs

The chalcedony pseudomorphs from Ysterputs are not plentiful, but are quite widely known https://www.mindat.org/gallery.php?loc=159631&min=960, accessed June 2021). Until now, because of their morphology, they have been assumed to be after fluorite (Zzyzx 2011). The blue cubic pseudomorphs are reported to have originated from two different locations at Ysterputs. The relatively few specimens with smaller cubes, up to about 3 mm in size, came from clay-filled pockets in the main mine excavation. The more numerous specimens with the larger cubes, up to 9 mm in size, came from a large pocket further south, along the same strike of the shear zone, in the area associated with so-called 'crazy lace' (Wicht & Miller 2020).

Figure 2. A cluster of small cubes found in the main part of the mine.
JW086 specimen, width of field of view 22 mm. Photo DM.

Figure 3. Weathered small cubes found on the surface nearer the 'crazy lace' area. JW089 specimen, width of field of view 20 mm. Photo JW.

Figure 4. A typical plate of larger cubes from the 'crazy lace' area. DM specimen, 80 × 75 × 40 mm. Photo DM.

Figure 5. Ysterputs 'crazy lace' area looking north west. Photo JW.

These plates of larger cubes are on a matrix of finely laminated alternations of chalcedony and carbonate, mostly calcite **(Figures 1 & 6)**. This is similar to the wall-coating matrix of the blue lace agate but without the thick layer of coarse dolomite crystals immediately underlying the blue lace agate (Wicht & Miller 2020). In some cases this laminated matrix was etched deliberately with acid, perhaps in an unsuccessful attempt to remove the original white coating of opal **(Figure 7)**. In most cases the variably thick, brittle coating has been removed by hand to expose, either partially or entirely, the underlying cubic chalcedony pseudomorphs.

Figure 6. Specimen with etched matrix and opal crust removed. JW075 specimen, 80 × 60 × 30 mm. Photo JW.

Figure 7. A partially cleaned specimen with some adhering coating.
JW039 specimen, width of view 40 mm. Photo JW.

The visual appearance of the cube 'faces' of specimens of both the smaller and larger cubes is similar. Each face is slightly concave, with an irregular surface producing a 'tiled' appearance **(Figure 8)**.

Figure 8. Macrophoto of large cube faces showing characteristic 'tiled' appearance.
DM specimen, width of field of view 22 mm. Photo DM.

A petrographic thin section viewed under the microscope showed the cubes to consist of randomly orientated tufts of chalcedony, with no regular relationship to the original faces of the precursor mineral. Viewed in crossed-polarized light with a 1 λ (first-order red) wave plate inserted the chalcedony fibres are length-slow, with the optic axis of crystallites parallel to the fibre elongation. Fibrous chalcedony found in agates is more commonly length-fast (Kerr 1959; Kile 2005; Merino 2005; French et al. 2013). Length-slow chalcedony, or 'quartzine' (Cady et al. 1998), typically forms under saline conditions and in sulphate evaporites (Folk & Pittman 1971; Heaney & Post 1992; Heaney 1993). The presence of length-slow chalcedony in the Ysterputs pseudomorphs and also the blue lace agate (Wicht & Miller 2020) probably is due to hypersaline conditions in the Ysterputs hydrothermal system. The source of saline hydrothermal fluid probably was the marine Whitehill Formation sediments intruded by the dolerite sill.

The overall blue colour of the agate is due to the Tyndall effect—Rayleigh scattering of light by micro-particles or voids (Hoskin 2005; Götze et al. 2020). In transmitted light the cubic pseudomorphs are yellowish-grey, which is typical for blue chalcedony. None of the Ysterputs chalcedony pseudomorphs appear to fluoresce under ultraviolet light, although parts of the opal coating do **(Figure 9)**. The green fluorescence under short wave ultraviolet light is due the presence of uranyl ions (Michalski & Foord 2005; Modreski 2005), if only in trace amounts (Götze et al. 2020).

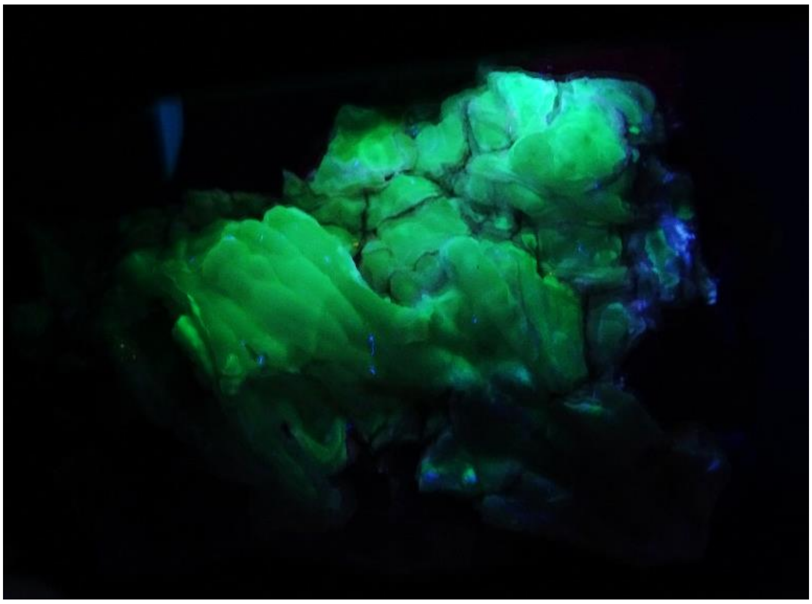

Figure 9. Fluorescence shown by crust in SW ultraviolet light. JW046 specimen, 120 × 70 × 65 mm. Photo JW.

Comparison with the chalcedony pseudomorphs from Trestia, Romania

The plates of larger cubic pseudomorphs from Ysterputs are visually very similar to illustrated examples from Trestia in Romania, known since at least the 18th century (Ilinca 1989; Ilinca et al. 2009; Ilinca et al. 2013; Popescu et al. 2013, p. 95). The Trestia pseudomorphs are claimed to be associated with Neogene andesitic pyroclastites and up to 30 mm in size (Ilinca et al. 2013, p. 95); although all the online and published photographs show them to be far smaller. Both the Ysterputs and illustrated Trestia specimens have individual cubes up to 12 mm in size **(Figure 10)**. The Trestia specimens were all recovered loose in overburden, so they lack any matrix. Most of the published examples appear to be a bit weathered, so the edges of the cubes are somewhat rounded and no detailed texture of individual faces is visible (https://www.mindat.org/gl/108365, accessed June 2021). However, Ilinca et al. (2009) described examples with a characteristically 'stepped' surface appearance and interpreted these as residual signs of cubic (not octahedral) cleavage, and hence concluded the precursor could not be fluorite. But fluorite cubes can show similar cubic growth steps (for examples, see Simmons 2020, pp. 425–428).

The origin of the Trestia pseudomorphs has been the subject of speculation for a long time (Ilinca 1989). 'Celebrated occurrence of the blue chalcedony, known since the 18th century. The sky-blue fragments (5–15 cm in size) are scattered in soil or alluvial material, being formed by solidification of some silica gel originating in hot springs. Sinter-like reniform masses, thin radial-fibrous or parallel banded structures, surfaces imprinted by irregular reliefs or plates and druses inlaid with cubic crystals. Though considered to represent quartz-chalcedony pseudomorphs after fluorite … it is more likely that the blue cubes are quartz-chalcedony paramorphs after melanophlogite.' (Udubaşa et al. 1992, p. 40). Ilinca (1989) reported weak X-ray diffraction peaks characteristic of melanophlogite in a powdered sample of Trestia chalcedony. This is direct evidence that the Trestia cubic chalcedony pseudomorphs could be after the silica clathrate melanophlogite—nominally $46SiO_2 \cdot 6(N_2, CO_2) \cdot (CH_4, N_2)$, with a stabilised, pseudo-cubic tetragonal structure (Skinner & Appleman 1963).

Figure 10. A chalcedony pseudomorph from Trestia, Maramures, Romania. 75 × 57 × 26 mm. The largest individual pseudomorph is 12 mm on edge. This photo is © Rob Lavinsky & MineralAuctions.com Photo ID: 847523 on mindat.org and is reproduced with permission.

Comparison with cubic chalcedony pseudomorphs from California, USA

The smaller cubic pseudomorphs in vugs from the Blue Lace Agate Mine are visually similar to published examples from various localities in California (Murdoch 1936; Dunning & Cooper 2002; Housley 2013; Chorazewicz 2014). The illustrated examples generally are small, under 1 mm in size, but examples up to 6 mm have been reported (Chorazewicz 2014). These all display stepped cube faces, with a typically 'tiled' appearance, and often are concave. These were first reported by Murdoch (1936) and assumed to be after fluorite. Petrographic thin sections showed that they consisted of '"feathery" and jasperoid chalcedony', with the 'outline of the cubes themselves…clear-cut' (Murdoch 1936, p. 22). The Californian pseudomorphs are identical in visual appearance to local examples of melanophlogite, and reportedly some cubic pseudomorphs from San Benito County actually are a mixture of chalcedony and melanophlogite (Dunning & Cooper 2002).

Comparison with cubic chalcedony pseudomorphs from Alberta, Canada

The smaller cubic pseudomorphs from Ysterputs are visually identical to those from various locations in the Alberta Badlands of Canada. The slightly concave cube faces, with a stepped growth producing a tiled appearance is identical to the surface texture of illustrated examples of the chalcedony pseudomorph cubes from Canada (Menzies & Frazier 2012). The published specimens of cubic pseudomorphs from the Alberta Badlands in Canada originate from the Horseshoe Canyon Formation of the Upper Cretaceous Edmonton Group in the Drumheller area. These are locally fossiliferous '…flat-lying, interbedded sandstones, siltstones, mudstones or claystones, and shales, with variable concentrations of coal, coaly shale, bentonite, and ironstones' (Menzies & Frazier 2012, p. 514). The specimens from Drumheller are mostly only a few millimetres across individual faces, although some are reported to occur up to 10 mm in size. They form clusters and rarely isolated cubes on an ironstone matrix and in cavities in fossilised wood. These chalcedony pseudomorphs were initially believed to be after α-cristobalite (Morton & Smith 1987), but more recently considered to be after pseudocubic melanophlogite (Menzies 2005; Menzies & Frazier 2012).

For this study, Canadian collector Jon Kinch provided several specimens of cubic chalcedony pseudomorphs on a thin basal layer of chalcedony on ironstone and fossilised wood. They were from a different, private-collecting, Alberta Badlands location with geology similar to Drumheller (Jon Kinch personal communication to J. Wicht, February 2020). Photographs from Jon showed fossilised wood **(Figure 11)**, ironstone **(Figure 12)** and an associated halite crystal **(Figure 13)**. Petrographic thin sections of two of these Canadian chalcedony pseudomorphs show they are internally similar to those from Ysterputs, consisting mainly of random clusters of length-slow chalcedony, although one example had an area of larger plumes of length-fast fibres.

Figure 11. Blue chalcedony cubes on fossilised wood specimen from the Alberta Badlands, Canada. The piece is 3.8 mm long and 12.7 mm wide. The biggest cube is 0.5 mm. Photos Jon Kinch.

Figure 12 left. White chalcedony cubes on ironstone from the Alberta Badlands, Canada. Photo Jon Kinch. The cubes he has seen all range from 0.5 mm to one centimetre. Photo Jon Kinch.
Figure 13 right. Halite cube (25.4 mm) found by Jon Kinch in the Alberta Badlands, Canada. Photo Jon Kinch.

Discussion and conclusion

The origin of the cubic blue chalcedony pseudomorphs from Ysterputs has been contentious—halite, fluorite, and melanophlogite are considered as possibilities here. The association of Jon Kinch's specimens with halite crystals is suggestive that halite may be the precursor mineral to the Alberta Badlands and Ysterputs pseudomorphs. The hydrothermal fluids distilled from the dolerite-intruded Whitehill Formation marine sediments have been shown to be saline. The Ysterputs pseudomorphs may be void-filling casts after halite crusts. Silicified halite casts can form plates of cubic pseudomorphs in quartz and chalcedony (e.g. Pope & Grotzinger 2003, pp. 282–283). The opal layers coating the Ysterputs pseudomorphs may represent part of the mould, but it is relatively thin and brittle, and has the appearance of subsequent deposition. The Ysterputs pseudomorphs also may be replacement after fluorite, as suggested by Zzyzx (2011), based on the visual similarity with an apparently cubic precursor. As far as we know, no residual fluorite has been found at Ysterputs, either in association with the pseudomorphs or elsewhere in the deposit. This is also true of melanophlogite at Ysterputs, so identification of the precursor here cannot be based on finding local residues of a likely candidate.

The prevailing consensus is that the cubic chalcedony pseudomorphs from Trestia (Ilinca 1989), the various Californian localities (Dunning & Cooper 2002), and the Alberta Badlands (Menzies & Frazier 2012) were originally melanophlogite. It has a stabilised, pseudo-cubic tetragonal structure with the nominal formula $46SiO_2 \cdot 6(N_2, CO_2) \cdot (CH_4, N_2)$ (Skinner & Appleman 1963). With the loss of the stabilising hydrocarbons it collapses to a more dense silica structure like quartz or chalcedony (Dunning & Cooper 2002). The structure and chemistry are described in detail by Dunning and Cooper (2002), with examples of partial inversion from melanophlogite to quartz and chalcedony. The visual similarity between specimens from Trestia, California and Alberta is strong, if indirect, evidence that the Ysterputs chalcedony pseudomorphs are indeed after melanophlogite. (A possible counter-argument is that none of the numerous published photographs of primary melanophlogite (see https://www.mindat.org/gm/2630, accessed June 2021) show flat plates of large crystals resembling those of the Trestia and Ysterputs pseudomorphs.

What is geologically common between the North American, Namibian and Romanian localities? According to Housley (2013) the Californian ones have '…one unifying feature. The Conejo Volcanics, which occur throughout the area, were all erupted onto, or intruded into a thick sequence of marine sediments…. Bitumen is widespread in the veins of secondary minerals throughout both the volcanics and the sedimentary rocks. In fact there are active hydrocarbon seeps out of the volcanics in several places.' The Canadian examples originate in sedimentary rocks, rich in hydrocarbon species. Menzies & Frazier (2012, p. 520) state 'In the Alberta Upper Cretaceous environment, such guest molecule species [to form melanophlogite] should have been available in abundance from breakdown of the plant material that created the coal seams and petrified wood.' The Trestia material is also found in close association with pieces of fossilised wood, perhaps in association with hydrothermal deposits related to local extrusive rocks (Ilinca 1989).

At Ysterputs, the Tandjiesberg dolerite sill intruded the black, organic carbon-rich shales of the Whitehill Formation (Werner 2006), which could have been the source of the hydrocarbons necessary for melanophlogite formation. The published record shows that the cubic chalcedony pseudomorphs after melanophlogite considered here all occur in close geological proximity to potential sources of the necessary hydrocarbons, in the form of organic-rich sedimentary rocks in association with igneous intrusives or extrusives. By comparison of the visual appearance and geological setting of the Ysterputs blue chalcedony pseudomorphs with similar material from Romania, the USA and Canada, we conclude that the Ysterputs pseudomorphs are not after fluorite, as widely believed, but more probably after melanophlogite.

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We wish to thank Lionel Swanson for providing access to the Ysterputs Blue Lace Agate mine and also the former mine manager Muller Roux and his wife Susan for helpful discussions. The Blue Lace Agate Mine currently is dormant, and no private visits or collecting are allowed. Hayley Cawthra (Council for Geoscience, RSA) is thanked for petrographic thin sections for this study. Jon Kinch (North Edmonton, Canada) generously provided photographs and several samples of the Canadian blue chalcedony pseudomorphs on matrix. Gregor Borg and Martin Scheuplein (Martin-Luther-University, Halle-Wittenberg) are thanked for their assistance in locating several Trestia references. Rob Lavinsky and MineralAuctions.com are thanked for permission to reproduce the photograph of Trestia chalcedony pseudomorphs.

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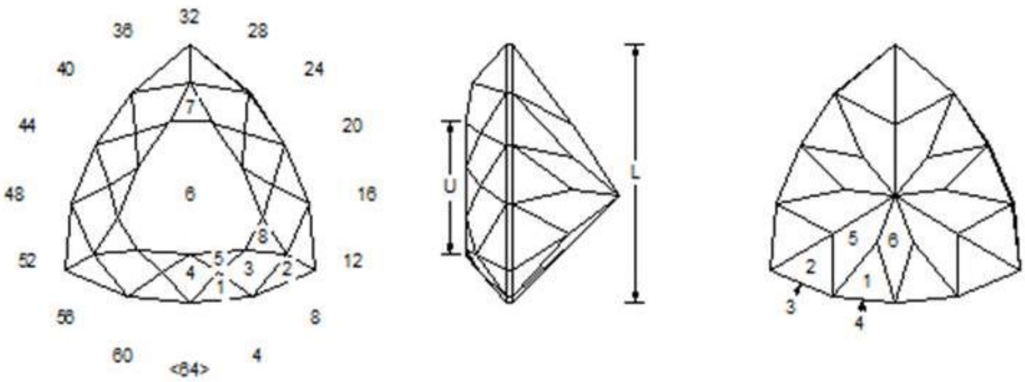
From the Cabinet of Curiosities

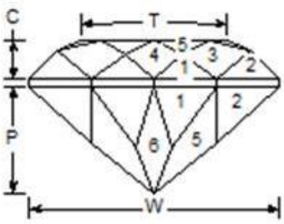
Good enough to eat…?

The first curiosity is a slice of lemon curd tart; with lemon curd topping (otherwise known as yellow smithsonite, with a pinch of cadmium) on meringue (otherwise known as white smithsonite) on pastry (otherwise known as matrix). From Wenshan, Yunnan Province, China. Looks pretty edible? **PR**

FACETIPS

If you are looking for a trilliant design for a 64 Index, try this….





Trilliant for 64 index

By Duncan Miller
9 March 2009
Angles for R.I. = 1.540
52 + 12 girdles = 64 facets
1-fold, mirror-image symmetry
64 index
L/W = 1.033 T/W = 0.585 U/W = 0.536
P/W = 0.427 C/W = 0.159
Vol./W³ = 0.200

PAVILION

1	46.00°	01-20-22-42-44-63	cut to TCP
2	44.00°	04-17-25-39-47-60	cut to TCP
3	90.00°	04-17-25-39-47-60	cut to size
4	90.00°	01-20-22-42-44-63	level girdle
5	43.00°	03-18-24-40-46-61	meet 1,2,3,4,culet
6	45.00°	64-21-43	meet 1,4,culet

CROWN

1	43.00°	01-20-22-42-44-63	set girdle thickness
2	48.00°	04-17-25-39-47-60	level girdle
3	40.00°	02-19-23-41-45-62	meet 1,2
4	40.00°	64-21-43	meet 1, girdle
5	36.00°	01-20-22-42-44-63	meet 1,3,4
6	0.00°	Table	table, meet 4,5
7	10.00°	32	fit to meets
8	14.41°	10.5-53.5	fit to meet 2,3; 3,5,6

Many older faceting machines came standard with 64 index wheels and finding 96 wheels for them can be difficult. You cannot cut regular triangular stones on a 64 index, because it is not evenly divisible by three. Few people will notice that this does not have strict 3-fold symmetry. (You have to cheat the stars into place.)
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