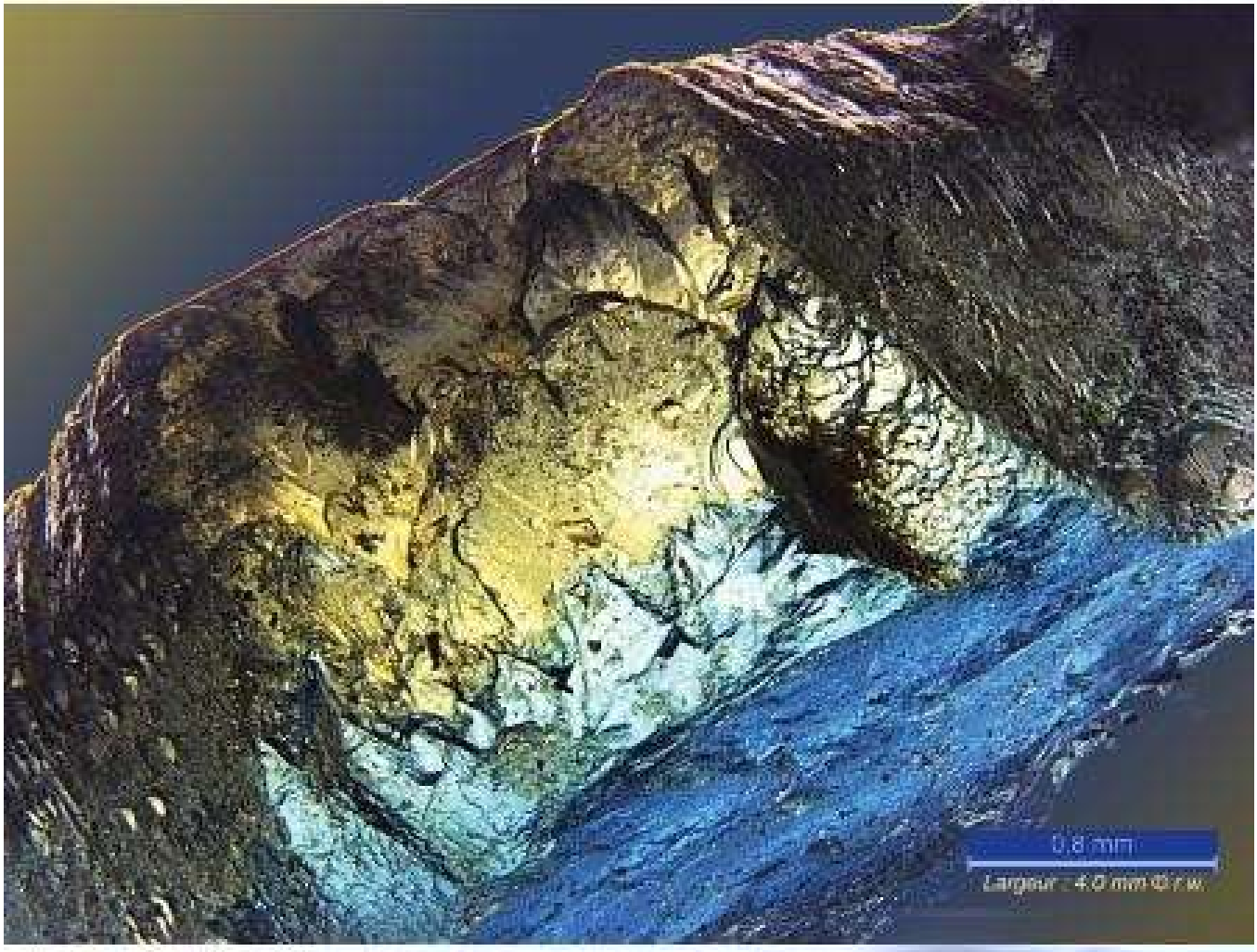
Laurentthomasite

A.G.A.B. MINI BUL

Association des Géologues Amateurs de Belgique A.S.B.L.

Siège social : Rue de la Casmatrie, 31
4050 Chaudfontaine



PERIODIQUE MENSUEL
(sauf Juillet-Août)
Juin 2026 59e année - N° 6

Focus stack of approximately 100 images obtained under combined transmitted and reflected light using a Leica stereomicroscope equipped with fluorite optics (base illumination)

LAURENTTHOMASITE

PRELUDE

The island of Madagascar is truly a unique island, a one-of-a-kind relic of the past. To think of it as an island is misleading given its size: 1,580 km long and 580 km wide, with roads that are mostly just paths—it's huge! However, it's worth noting that it's an island "like no other" when it comes to its wildlife and geology, which are always surprising.

Fig. 1 – Laurentthomasite, a prismatic {10$\bar{1}$0} single crystal on a {0001} base, covered with disoriented microcrystals of the same species. The dichroism of this microcrystalline coating alters the base color. Coll. & © 2026 R. Warin.

The lithosphere is not a homogeneous medium. A series of crystallization events has led to variations in rock composition. Thus, the granitic massifs crystallize first, consisting of more than 65% quartz, feldspars, and micas. This initial deposit expels incompatible polar compounds, which accumulate as outcrops on the granitic massifs, forming secondary magma chambers known as **pegmatites** and other associated structures. A large amount of water is added to this. Originally, the **water was in a so-called supercritical state**, bearing no resemblance to our solvent. It is a fluid medium in which atoms circulate freely, as in a gas. While, generally speaking, a granite massif cools very slowly, producing a mixture of crystals measuring centimeters or less, pegmatite is characterized by a more rapid drop in temperature, favoring the growth of large crystals, sometimes measuring meters.

Madagascan pegmatites are diverse. By chance—or rather, thanks to the courage of

Madagascan miners—it was possible to discover these remote corners of pegmatite chambers, where many cations had not yet found a site within a crystal lattice. Nature thus gave birth to novel and surprising molecules. The temperature there was relatively low, around 200°C.

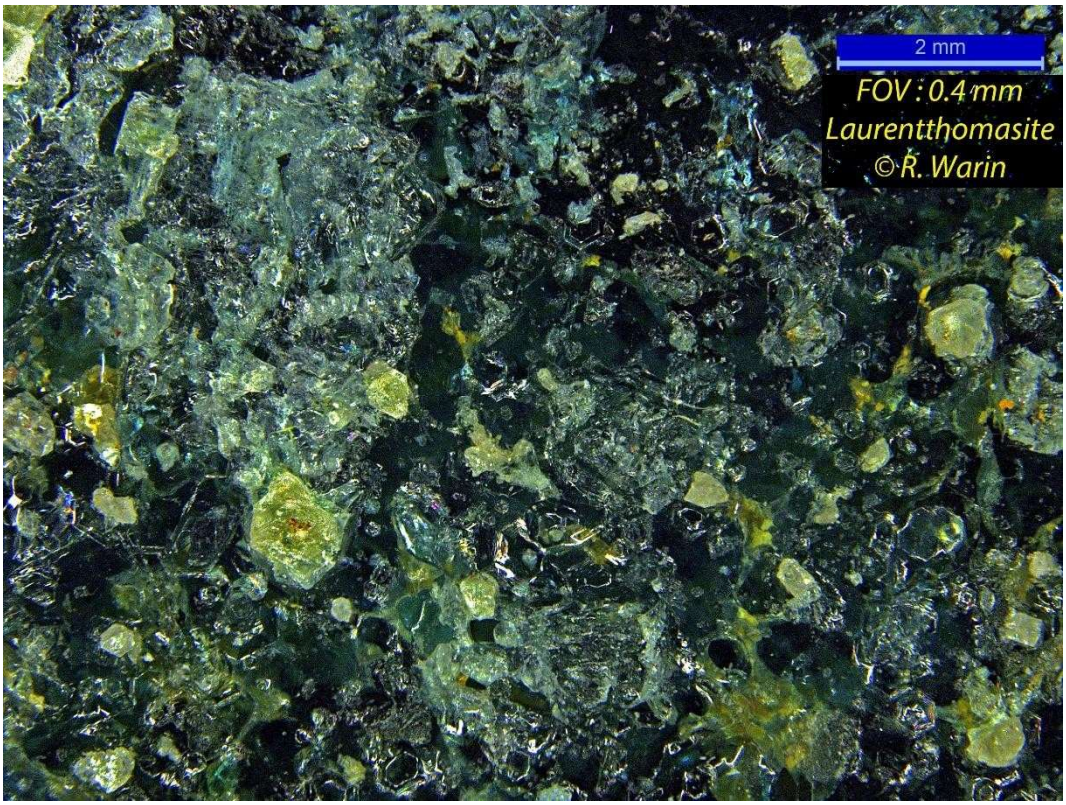


Fig. 2 – Laurentthomasite – (0001) face, covered with disoriented microcrystals of the same type, which already reveals dichroism. FOV : 0.4 mm. Coll. & © 2026 R. Warin.

In Ambatovita, Mandrosonoro, Ambatofinandrahana District, Madagascar, Pezzottaite was discovered in the Sakavalana mine, and Laurentthomasite was recently discovered (2019) in the Ihorombe region (Madagascar).

We owe this “almost fantastical” discovery to Laurent Thomas, a geologist and prospector, and his small teams of Malagasy miners and prospectors. The discovery was officially confirmed in 2019, although Pezzottaite had already been found in the same region of Mount Ibity, at Ambatovita, by miners searching for tourmalines in November 2002.

SCIENTIFIC RIGOR AND POPULARIZATION

At the “end of life” of the pegmatite chambers’ extremities, the environment became heavily enriched with various cations that had not yet been able to integrate into a crystal lattice. In Madagascar, nature has “invented” new mineral species on a macroscopic scale. Pezzottaite and Laurentthomasite are among them. Furthermore, superb, large, idiomorphic single crystals of sapphirine have also been discovered there by Laurent Thomas.
Laurentthomasite is particularly complex, to the point that it is still not included in the

"American Mineralogist Crystal Structure Database – RRUFF." However, thanks to the high quality of its structural determination by the team at the National Museum of Natural History, Laurentthomasite has been approved by the IMA.

What can an amateur do in this situation? Without the CIF master file containing the pedigree of the unit cell, it becomes more difficult to use the VESTA program, which generates spatial representations of the single unit—and possibly extends them to neighboring units. While it is more tedious to use VESTA without the CIF data, it is of course possible to run the program by entering the basic parameters manually. However, given the complexity (variability in composition) of the Laurentthomasite unit, I had to accept the following compromise.

Fig. 3 - Island of Madagascar. Credit: Mindat. Adaptation: R. Warin.

Certain concepts have therefore been deliberately simplified for practical (or educational) purposes, while maintaining sufficient scientific rigor to ensure a correct understanding of the subject. Consequently, despite the presence of two crystallographically distinct (yet similar) [SiO_4] sites for these tetrahedra (which are nevertheless considered nondeformable) in the structure of Laurentthomasite, they will be treated here as a single tetrahedron for the sake of clarity. The Si-O bond possesses a significant covalent character, but also a substantial ionic character. Si-Si bonds are less favored compared to the Si-O bond, whereas in carbon chemistry, its lower homologue, C-C bonds are common. For this reason, silicon could never have served as a basis for life.

CRYSTALLOGRAPHY[i]

Type Locality: In the Ihorombe region, Fianarantsoa Province, Madagascar
Laurentthomasite is a hexagonal holocrystal. It belongs to the Milarite Group $(K,Na)Ca_2AlBe_2Si_{12}O_{30}\cdot H_2O$, sometimes referred to as the Osumilite Group.

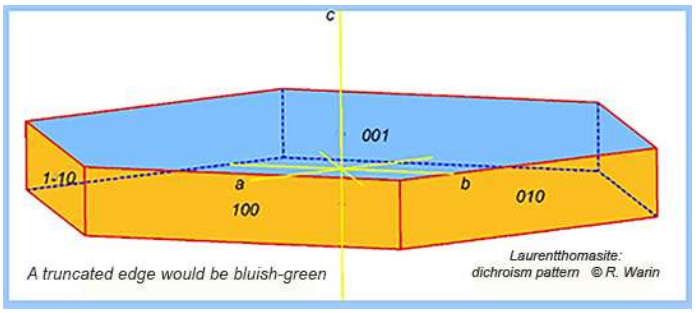


Fig.4 - Laurentthomasite pattern related to dichroism.

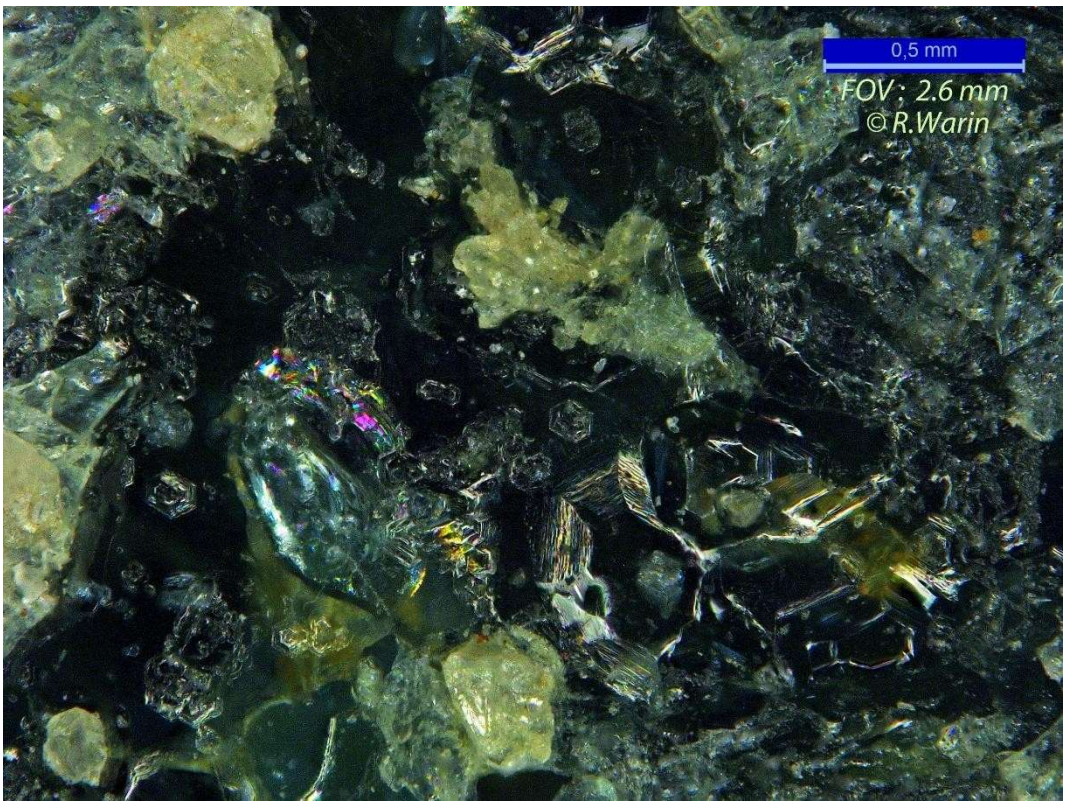


Fig. 5 – Laurentthomasite (at a very close-up view -FOV = 2.6 mm), in the center one can see the apex of a parallel (hexagonal) growth of the same mineral, still exhibiting the same hesitation in the prism's termination often observed in this type of crystal, where lateral cohesion is stronger than that of elongation along the c-axis. Dichroism is evident on crystals not aligned along the c-axis. Coll. & © 2026 R. Warin.

The simplified formula is **$(Mg, Sc)_2(K, Na)[(Be, Al, Mg)_3(Si, Al)_{12}O_{30}$**.
Note the possible presence of **scandium**.
Space group P6/mcc (No. 192), with a=9.95343(6) Å, c=14.15583(8) Å, V=1214.54(1) Å3, and Z=2. Point group 6/mmm (Hermann-Mauguin). Hexagonal holoedric system.

Density: 2.67 g/cm³, relatively low since there are few heavy atoms as impurities.
It is transparent, with a vitreous luster.
Its color ranges from cobalt blue to a yellowish green.
Laurentthomasite is strongly dichroic.
Streak: the powder of this mineral is blue. Hardness (Mohs): 6. Tenacity: like beryls, Laurentthomasite is brittle. Poor cleavage, rather indistinct on the {0001} plane. Fracture: irregular and conchoidal, a first resemblance to tectosilicates. Simple morphology: the {0001} base and the {10$\bar{1}$0}. No twinning. (Fig. 4).
General appearance: small idiomorphic crystals not exceeding 15 mm in width and 5 mm in thickness.

Fig. 6– The cobalt-blue color of the Laurentthomasite viewed in transmitted light along the c-axis. High magnification is required to observe this feature, as a late-stage crystallization event has altered the coplanarity of the base (Fig. 1). Coll. & © R. Warin.
Figure (6) should be viewed in conjunction with Figure (7).

OPTICAL DATA: DICHROISM

In the absence of specific lighting, the crystal is a slightly bluish green (Fig. 2 & 3).
Since the Laurentthomasite crystal is uniaxial (+), strong dichroism is observed.
It is one of the most intense known in the gem world.
The colors observed along the [0001] direction of the c-axis, are cobalt blue, and the colors observed along [1000] are yellow-green. The photo even shows a greater difference, resulting in a brass-like hue (beam path ≈ 13 mm).

In Laurentthomasite, the origin of the dichroism is indeed attributed to an intervalence charge transfer $Fe^{2+} \leftrightarrow Fe^{3+}$ (or the acronym IVCT), but with significant structural precision regarding the nature of the sites occupied by the cations:

$$F\,e^{2+} + F\,e^{3+} \longrightarrow F\,e^{3+} + F\,e^{2+}$$

The two ions virtually exchange their oxidation states.
Despite surface imperfections, we can assume that this crystal (Fig. 5) is a gemstone.

Sites of ferrous and ferric ions

- Fe^{2+} primarily occupies the octahedral A sites of the lattice.
- Fe^{3+} is located in the tetrahedral T(2) sites.

The ionic radius of iron (Fe^{2+}) is 0.076 nm, while the ionic radius of iron (Fe^{3+}) is 0.067 nm.
In the case of Laurentthomasite, when a photon strikes the crystal, an electron is temporarily transferred from Fe^{2+} to the neighboring Fe^{3+}.

Light can reveal the anisotropy of Laurentthomasite:

- If the direction of observation is parallel to the c-axis or [0001], a broad absorption band is observed between 600 and 1400 nm, which yields the complementary color, cobalt blue.
- If the direction of observation is perpendicular to the c-axis, a narrow absorption band in the blue/violet region is observed instead, which transmits a yellow-green color.

This transition is **much more intense** than a simple d–d transition observed, for example, in the well-known case of Cordierite, or iolite as it is called in gemology. The latter effect is significantly less intense, as it is due to more conventional, less energy-intensive internal electronic transitions of Fe^{2+} involving the $d \rightarrow d$ orbitals.
To put it another way, in the case of the d–d transition, the electron remains on the same Fe^{2+} ion, whereas in the case of an intervalent transfer (IVCT), the electron moves from one Fe^{2+} ion to another Fe^{3+} ion. This **charge transfer** is more difficult because the Fe–Fe coupling is weaker and the Fe–Fe distance is greater. Furthermore, the polyhedra are very different, with the ferrous ion occupying an octahedral site and the ferric ion a tetrahedral site:

$$Fe_{oct}^{2+} \rightarrow Fe_{tet}^{3+}$$

This site asymmetry hinders charge transfer. The spectroscopic consequence of this higher energy requirement is that the IVCT bands are much more intense, often broader, and thus result in more saturated (or darker) colors. This is what is observed in Laurentthomasite. The two ions effectively exchange their oxidation states.

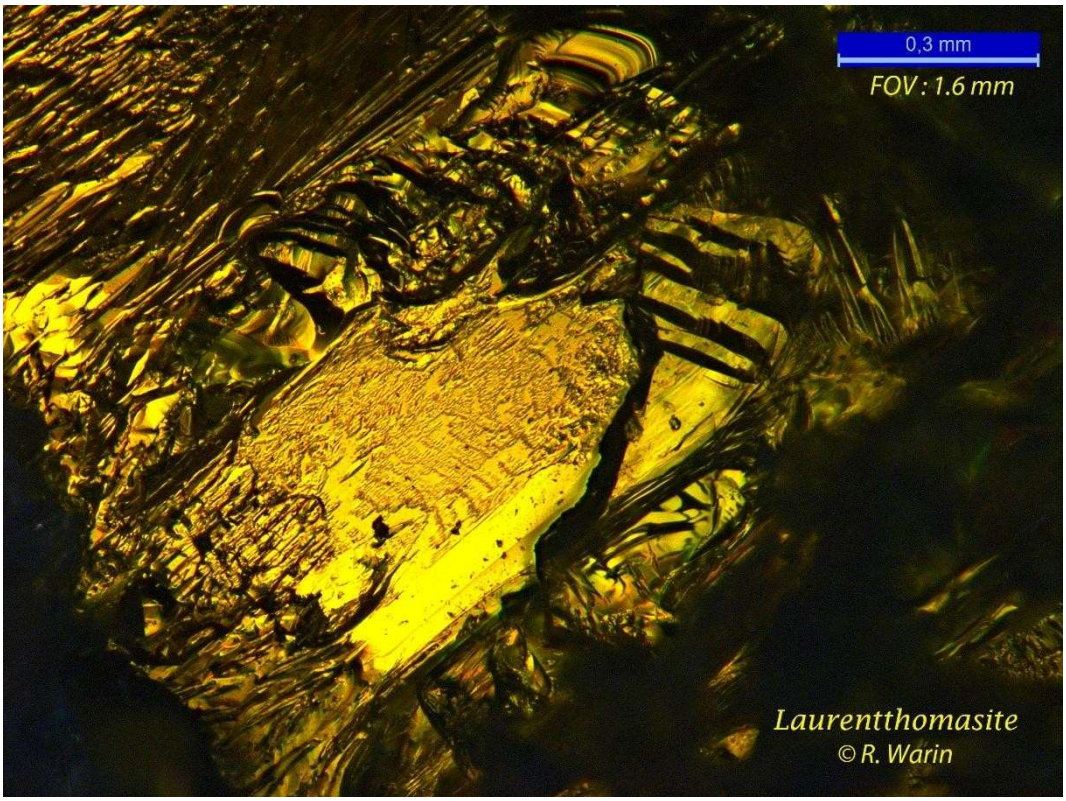


Fig.7 – Laurentthomasite – Crystal (Fig. 1) placed on its {10$\bar{1}$0} prismatic face.
Viewed in transmitted light (≈ 13 mm), the light ray is perpendicular to the c-axis, illustrated in the photo by minute growth figures, roughly inclined along the diagonal. Coll. & © 2026 R Warin.

An analogy may help clarify this: the use of filters in photography that block a narrow or wide range of wavelengths. Depending on the absorbed frequencies, the color will vary. There are many other examples of this type of dichroism. For instance, magnetite undergoes this transfer, but the crystal is black. Oxidized vivianite also exhibits a partial transfer; the crystal is blue-green. As for almandine garnet, it ranges from deep red to black (the melanite variety) due to the absorption of yellow and orange light with $Fe^{2+} \rightarrow Ti^{4+}$
Here we can recall a story of folklore: according to legend, Viking sailors used Cordierite to help them navigate at sea. Due to its strong pleochroism, it was believed to indicate the position of the sun, even on cloudy days.
Iolite is the gem-quality variety of the mineral Cordierite.

STRUCTURAL CHEMISTRY

These concepts in chemistry serve to clarify the role of each atom or group of atoms present in the molecule, known in mineralogy as the formula unit. The most important anionic group is the **double cyclosilicate ring**. Before discussing this point, it is important to consider the unit cell, that is, the pattern that repeats in three dimensions.
In the case of Laurentthomasite, this unit cell contains two formula units (Z = 2). The formula unit here is $Mg_2KBe_2Al(Si_{12}O_{30})$. The formula unit contains 48 atoms and, consequently, the

unit cell contains 96 atoms. The K site may in fact be a vacancy, or another substitution such as Na or an H_2O molecule.

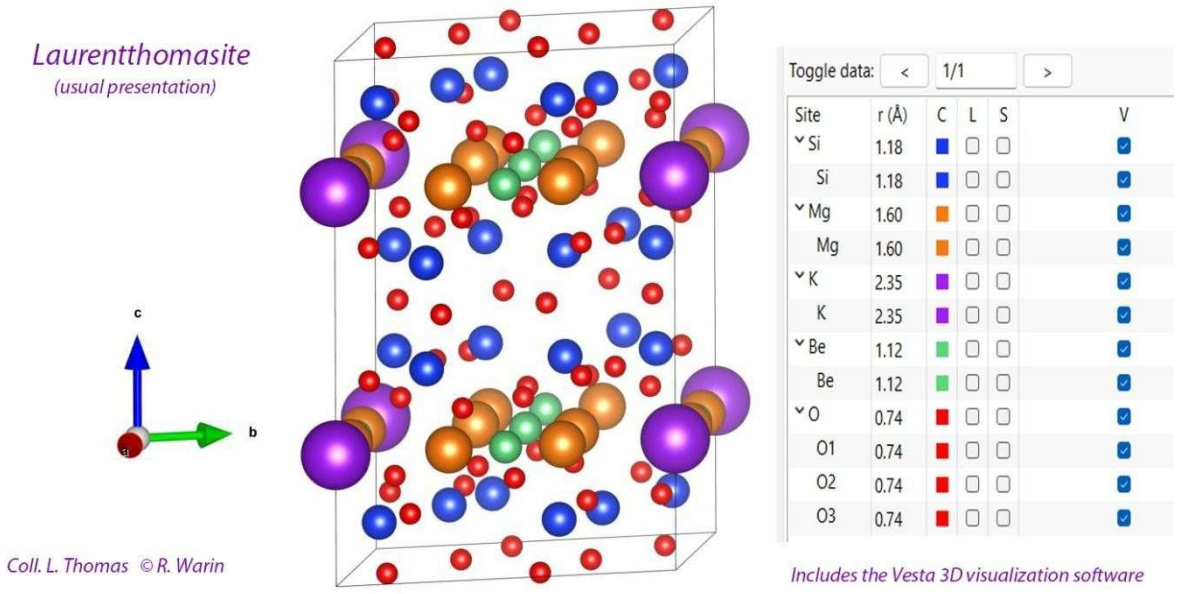


Fig. 8 – Unit cell of Laurentthomasite. Al is treated as Be, at the same site. © r.w.

To highlight the mineral's properties, these models must be "manipulated," and to identify the key anionic unit that forms the basis of this structure, additional units must be added and certain other atoms must even be hidden to allow for the subsequent reconstruction of the lattice.
Laurentthomasite is a cyclosilicate. To highlight the cycles, the [SiO_4] tetrahedra must be emphasized, by positioning the model in the correct orientation, the c axis is represented by a blue dot of the compass (Fig. 9).

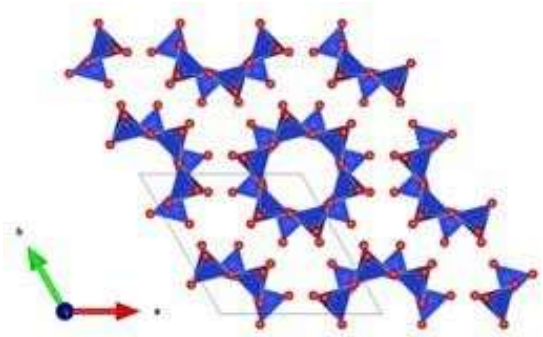


Fig.9 – Front view (along axis c) of the [$Si_{12}O_{30}$] anionic double ring. © R.W.

This profile (Fig. 9) gives the illusion of a tubular channel, which is not the case. It is a cross section of a cavity that will accommodate K (or remain vacant, depending on the presence of H_2O, Na, or other less likely elements).

The [$Si_{12}O_{30}$] ring, the anionic group, is the actual skeleton of Laurentthomasite. It consists of 12 slightly distorted T1-type [SiO_4] tetrahedra that have joined to form a 12-membered ring, with the various vertices of the shared tetrahedra arranged alternately (Fig.10).

The median plane of this [$Si_{12}O_{30}$] ring is parallel to the (0001) base and perpendicular to the vertical c-axis. The crystal grows by stacking these large anionic rings along the c-axis (Fig.11).

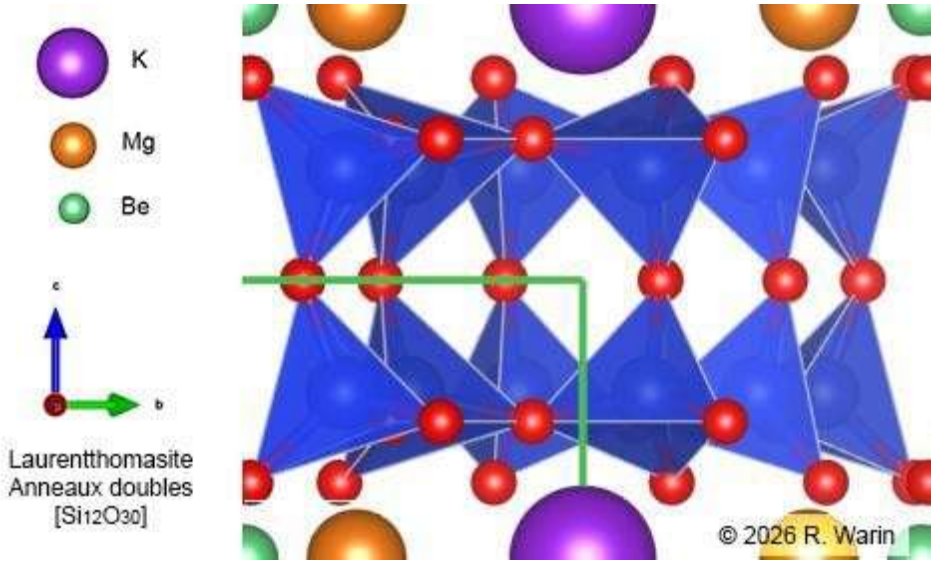


Fig. 10 – Anionic double ring [$Si_{12}O_{30}$] composed of tetrahedra (T1) [SiO_4] – The green line delineates the unit cell, since the anionic double ring does not fit within a single unit cell. © R. Warin.

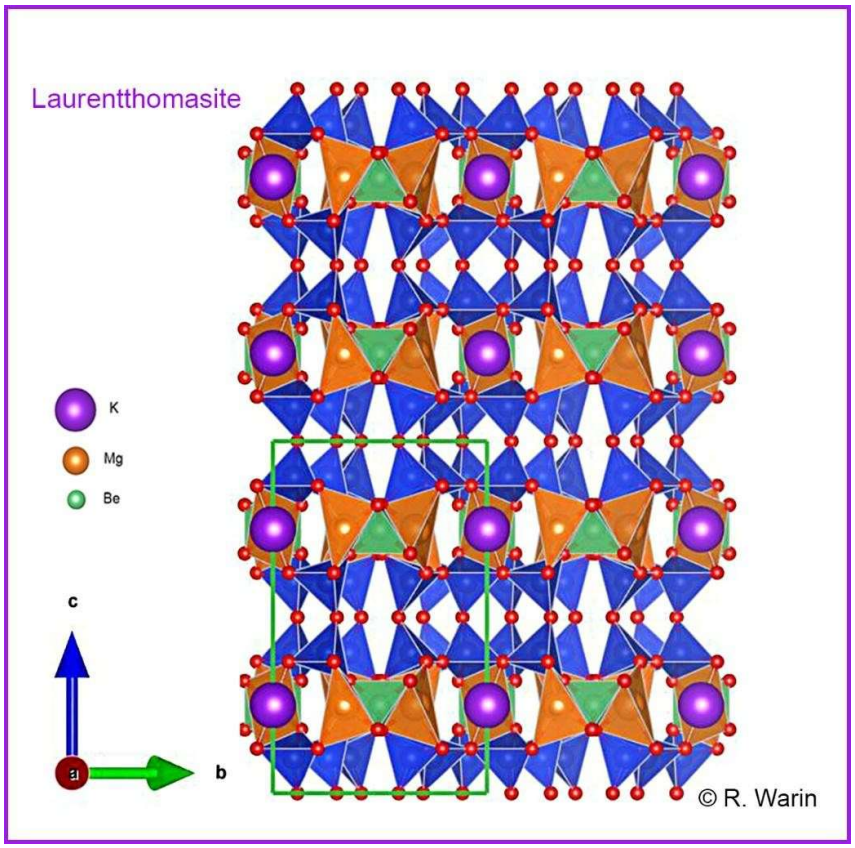


Fig. 11 - Set of 4 unit cells showing, in particular, the absence of a channel blocked by the [$Si_{12}O_{30}$] anion ring. © R. Warin.

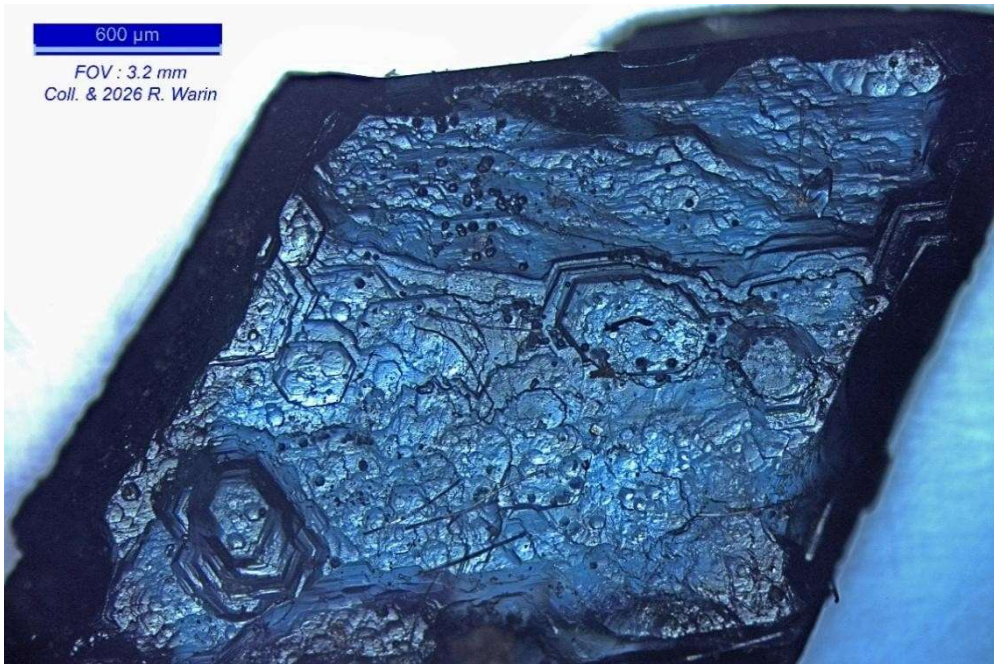


Fig. 12 – Laurentthomasite. (0001) face. FOV = 3.2 mm. © R. Warin.
It is viewed in transmitted light along the c-axis. This tiny specimen is the ideal Laurentthomasite crystal. Yet, strangely enough, it does not appear to have holohedral hexagonal symmetry!

NOTE

At this point in the description of Laurentthomasite, numerous observations raise a question: although it has a hexagonal holocentric structure (group 192), no photograph of a small, perfect crystal—nor, for that matter, a morphological drawing—can be found in the literature. The age of machines has stripped science of its grace, of its contact with matter. It is true that the morphology is simple, consisting of a hexagonal prism terminated by a pinacoid (Fig. 4). Rather than speculating that the rounded appearance of the crystal (Fig. 1) is due to other truncations, it seems preferable to attribute this characteristic to the discontinuous nature of conditions at the end of growth. The random asymmetry of the deposit allowed one face of the prism to emerge. It is this facet that produces the yellow window resulting from yellow dichroism (Fig.16).

OTHER CYCLOSILICATES

There are several types of cyclosilicates:

- 3-tetrahedron rings: $[Si_3O_9]_6$- such as Benitoite.
- 4-tetrahedron rings: $[Si_4O_{12}]_8$- such as Axinite.
- 6-tetrahedron rings: $[Si_6O_{18}]_{12}$- such as Beryl and Tourmaline.
  This means that the structure of Laurentthomasite is quite exceptional, often overlooked in textbooks.
- 12-tetrahedron rings: $[Si_{12}O_{30}]_{12}$- such as milarite $K(\square H_2O)Ca_2(Be_2Al)$ $[Si_{12}O_{30}]$. The [SiO4] tetrahedra are very rigid (in this article, we have assumed them to be constant; they are called T1). However, in Laurentthomasite, there is a very slight difference between two subtypes of [SiO4].

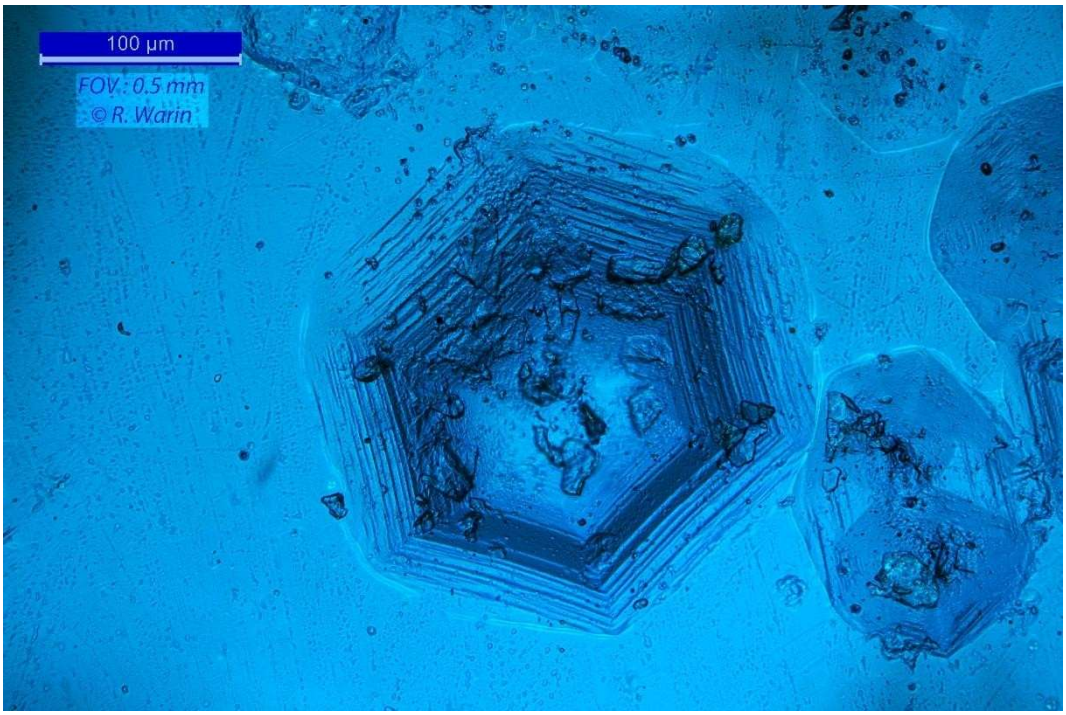


Fig. 13 – Laurentthomasite – Enlarged view (FOV : 0.5 mm) of a growth termination consisting of short pseudohexagonal pyramids (width ≈ 250 µm). Backlit view along the c-axis (= blue cobalt). © R. Warin.

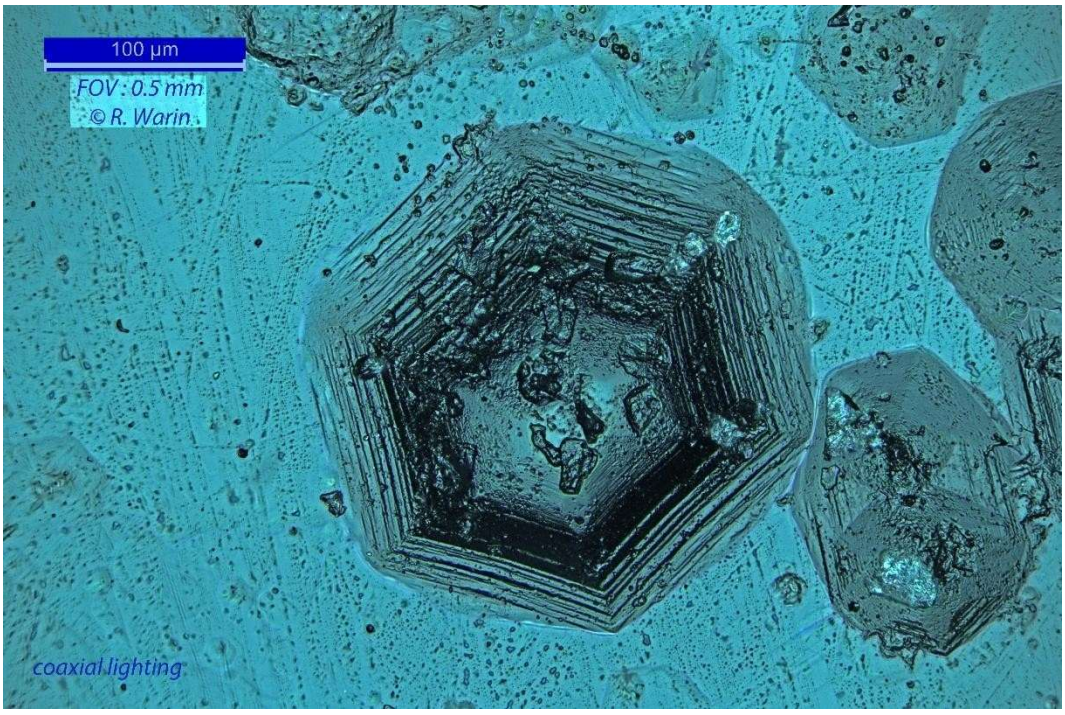


Fig. 14 – Laurentthomasite – Same photo as Fig. 13, except for the coaxial reflected lighting.
The crystal's surface reflects imperfections in the crystal that are invisible when viewed through the crystal.
The black area corresponds to internal reflections that trap the light captured in the photograph.
(200 x magnification). Coll. & © R. Warin.

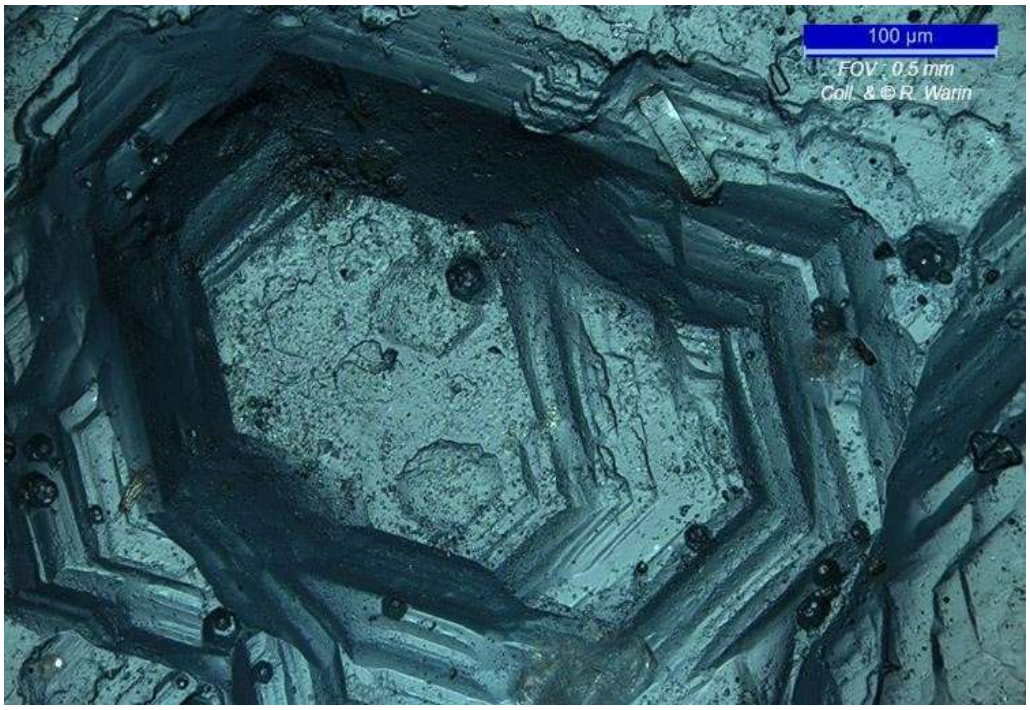


Fig. 15 – Laurentthomasite; another view of this face shows the end of the crystal's growth.
In this close-up of the same crystal, one can see the delicate, pseudo-hexagonal multiple terminations. The only crystalline impurities are very small secondary crystallizations of Laurentthomasite, resembling tiny black grains. In addition, a colorless prismatic crystal (presumably a plagioclase) is visible in the photo.

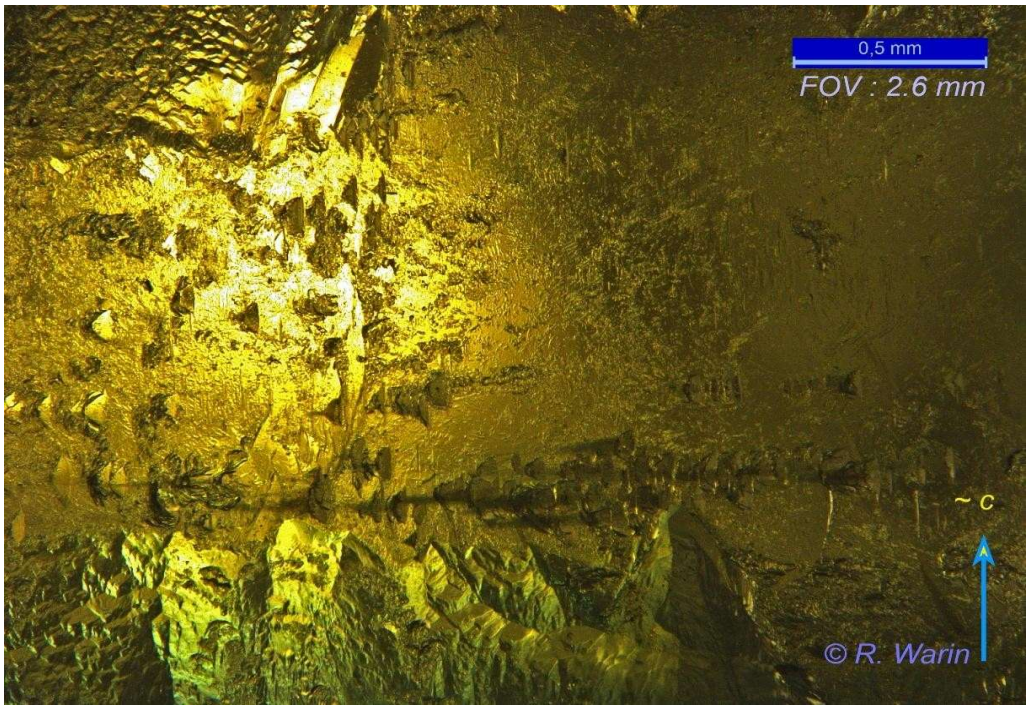


Fig. 16 – Laurentthomasite. Strong dichroism gives the crystal, viewed on a cross-section, a brass-yellow color. Since the lower zone is not coplanar (captured by stacking), it appears khaki.
The surface growth features visible on the yellow face mark the direction of the c axis, along which the intense cobalt-blue color is observed in transmission. © R. Warin.

The [SiO_4] tetrahedra bond alternately, thereby creating a central cavity. It should be noted, however, that these channels are not tubes, as some structural diagrams might suggest. Thus, they do not form channels as certain perpendicular sections of the structure might imply.
The T2 tetrahedral sites are occupied by Be and Al. The [$Si_{12}O_{30}$] cycles retain free O atoms (protruding from the ring, which allows them to connect to the T2 tetrahedral sites). The centers of the large anions form a series aligned along the c-axis, creating large cavities that accommodate K (or a vacancy, or H2O).

EPILOGUE ON THE GROWTH OF LAURENTTHOMASITE CRYSTALS:
KINETIC ASPECTS - MORPHOLOGICAL APPROACH

Before concluding, let us highlight an observation made in Madagascar that demonstrates **the importance of kinetics in crystal growth**. Axial growth may be significantly less favored than lateral growth. This is the case for morganite, but also for minerals with lower symmetry than beryl, such as Pezzottaite. Because of this differentiation, the surface of the basal pinacoid is not perfectly flat, as it is intersected by vertical growth patterns.
Collectors should therefore not overlook microsamples whose crystallization is still in its early stages. A series of photos of Laurentthomasite illustrates this point, while also highlighting its famous dichroism.

This tiny crystal (Fig. 12) remains a true “treasure” to me! Its size (3.2 mm) and thinness allowed for a photograph taken at 200x magnification (with bottom lighting). Subtle details emerge under the microscope’s lens. This tiny crystal is, in a sense, a stillborn child, having escaped the vicissitudes of a complex, evolving environment. As **explorers of invisible crystalline landscapes**, we were naturally led to reflect on this.. The very first moments of a crystal’s existence reveal its morphological symmetry. This symmetry results from a framework of elementary units that is governed by crystallization kinetics rarely discussed. The crystal’s morphology can be directly affected by this, to the point that a *quick glance* might have led one to classify it as monoclinic, whereas Laurentthomasite is a hexagonal holohedron.

1. The hexagonal terraces are most likely growth stages.
The concentric patterns are therefore strongly reminiscent of *growth mounds* or successive growth terraces, layer by layer.

2. A pseudo-asymmetry is evident.
Thus, the large local hexagonal overgrowth exhibits edges that are either:
thick, dark (internal reflections), and strongly developed, whereas if thermodynamic equilibrium had been perfectly achieved, the six equivalent sectors would have exhibited a very regular morphology, close to a hexagon. We can therefore conclude that the Malagasy pegmatite in the Ihorombe region exhibited a heterogeneous state during the crystallization of the various minerals. It is important to note that **crystallographically equivalent directions were not chemically equivalent in this particular environment.**

3. Possibility of a spiral growth mechanism.

Continuing this somewhat abstract exploration, an examination of the second enlarged view (Fig.15) might perhaps lead us to suggest crystal growth partially fueled by screw dislocations. But let us remain cautious. The terraces are not perfectly concentric and appear slightly offset in places. This idea seems to me compatible with repeated nucleation whose supply of material was intermittent. This resulted in crystalline defects. It is undoubtedly this aspect that determined the somewhat irregular morphology of single crystals exceeding 1 cm in size. This appears to be confirmed by the observation of numerous growths on all faces of secondary Laurentthomasite grains, whether oriented or not. Hydrothermal crystals often exhibit this on a small scale.

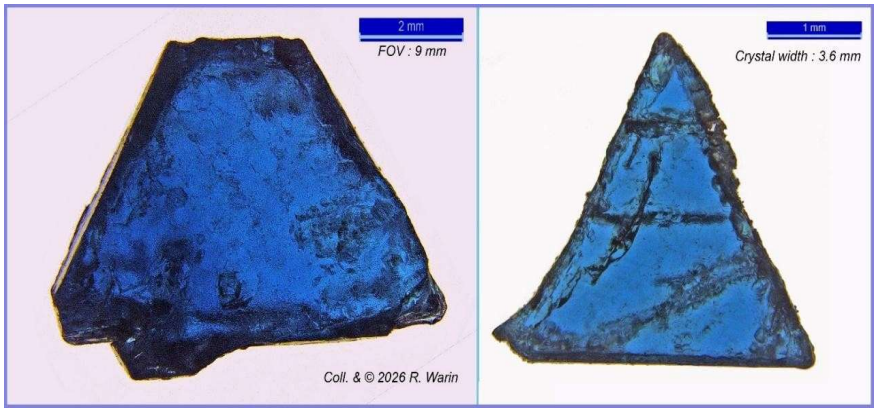


Fig. 17 – Laurentthomasite – 2 tiny crystals, resembling thin natural blades. © R. Warin.

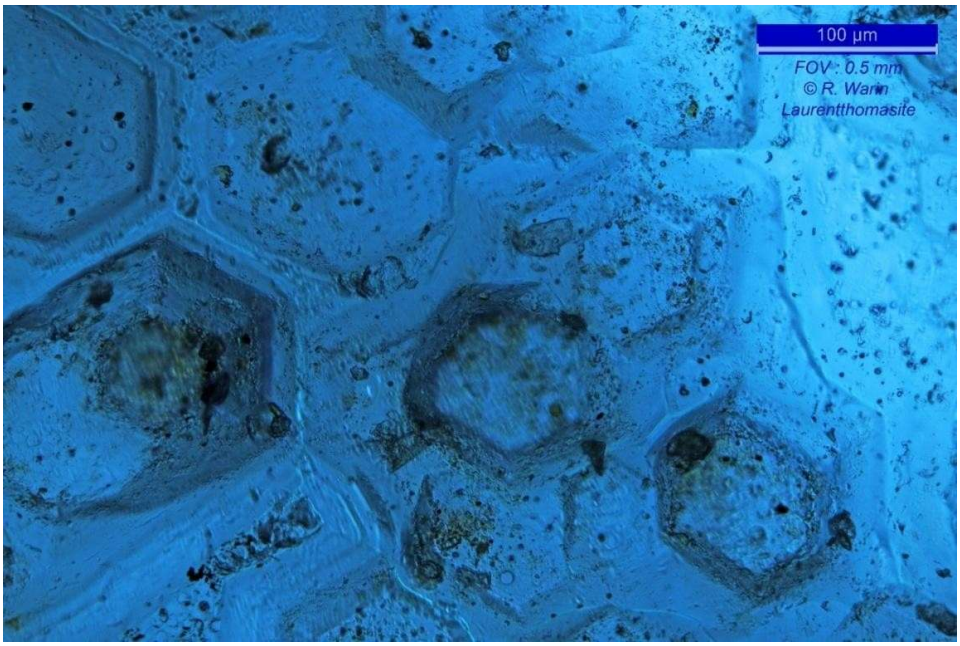


Fig. 18 – Laurentthomasite, embryo. Detail of the 3-mm specimen.
General trigonal habit. Hexagonal honeycomb texture extending to the walls of the often-rounded prism, whose faces are never sharp. Coll. & © R. Warin.

Another specimen (3.6 mm) provides a detailed view of the lateral faces (Fig. 17) of this highly flattened prism (~1 mm). This photograph reveals a honeycomb-like texture formed by the main pinacoid (see below).

TERMINAL BASE (0001) 6/mmm (H-M)

Hexagonal symmetry was already visible on the main crystal (Fig. 13). Examination of these small crystals, whose growth was halted immediately upon formation, reveals remarkable and reproducible findings: they suggest that **the crystal growth fronts** did not advance at a constant rate. This results in a "terraced field" appearance, similar to those found in Provence (F):

- on the one hand, the remarkable preservation of the hexagonal geometry,
- followed by the "interlocking" appearance of the growth steps,
- and above all, the local irregularity in their width, even on the smallest formations. Successive adjustments to the lens, resulting in the series of images, show that the small central base is located at the summit. The structure resembles the Pyramid of Djoser, built in 2770 B.C.

SIDE FACES

As usual, the side faces exhibit dichroism. Examination of the 3.2-mm embryo revealed its texture (Fig. 18). Only crystalline embryos allow for identification. The photographs allow us to propose a crystallographic pattern of the Laurentthomasite crystal (Fig. 19).

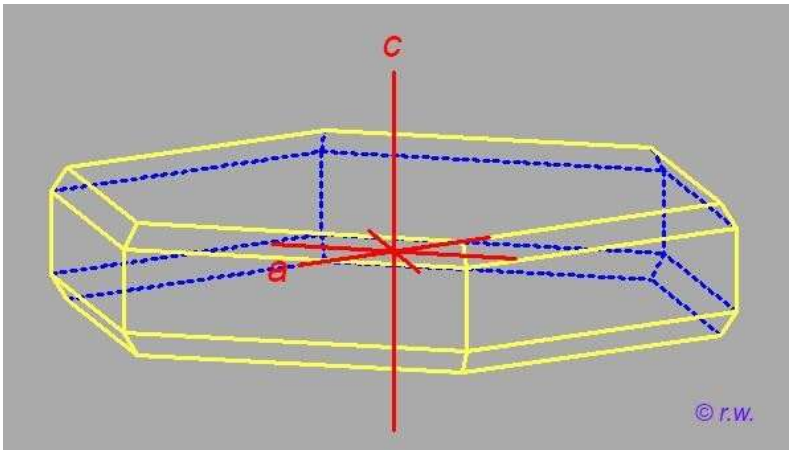


Fig. 19 – Proposed crystal pattern for Laurentthomasite:
pinacoid {00.1}, prism {10.0}, and pyramid (truncated along an edge) {11.1}. © R. Warin.

Figure 20 shows the fluted appearance of one face of the {10.0} prism. This texture appears to be related to the honeycomb growth of Laurentthomasite (Fig. 18). The large cyclosilicate anion appears to be the cause of this phenomenon. Consequently, it seems unlikely that a euhedral crystal of Laurentthomasite will ever be discovered. The deformation of the macrocrystal leads to its rounding (Fig.1).

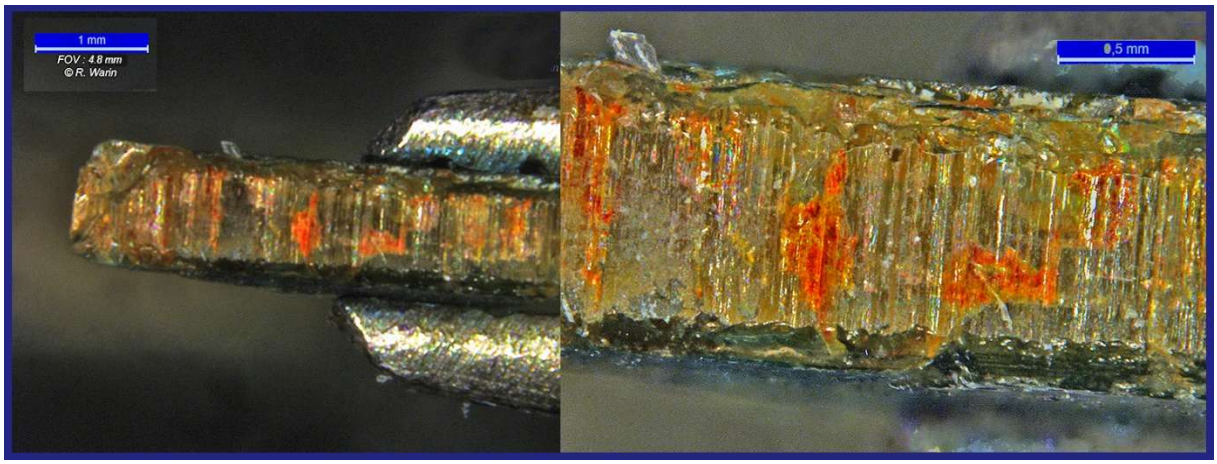


Fig. 20 – Fluted lateral view of a Laurentthomasite crystal (thickness ~1 mm) correlated with the pattern. © R. Warin.

CONCLUSION

Upon examining the structure of Laurentthomasite, we observe that the "flagship" ring [$Si_{12}O_{30}$] cannot complete the crystal at the (0001) base. We can also see its importance in connecting all the substructures to one another. Secondary cages appear, binding other cations. Similarly, the large anionic ring [$Si_{12}O_{30}$] cannot fit into a single unit cell (which is merely a spatial repetition unit of the various atoms).

Using the VESTA software, we realize that, before being a cyclosilicate, Laurentthomasite **reveals the structure of a tectosilicate featuring modules** in the form of truly exceptional rings, typical of the Milarite group.
When admiring the qualities of this "cobalt blue" gem and its surprising optical properties—which even reach a peak in terms of dichroism—one can't help but exclaim: Thank you, MADAGASCAR!!

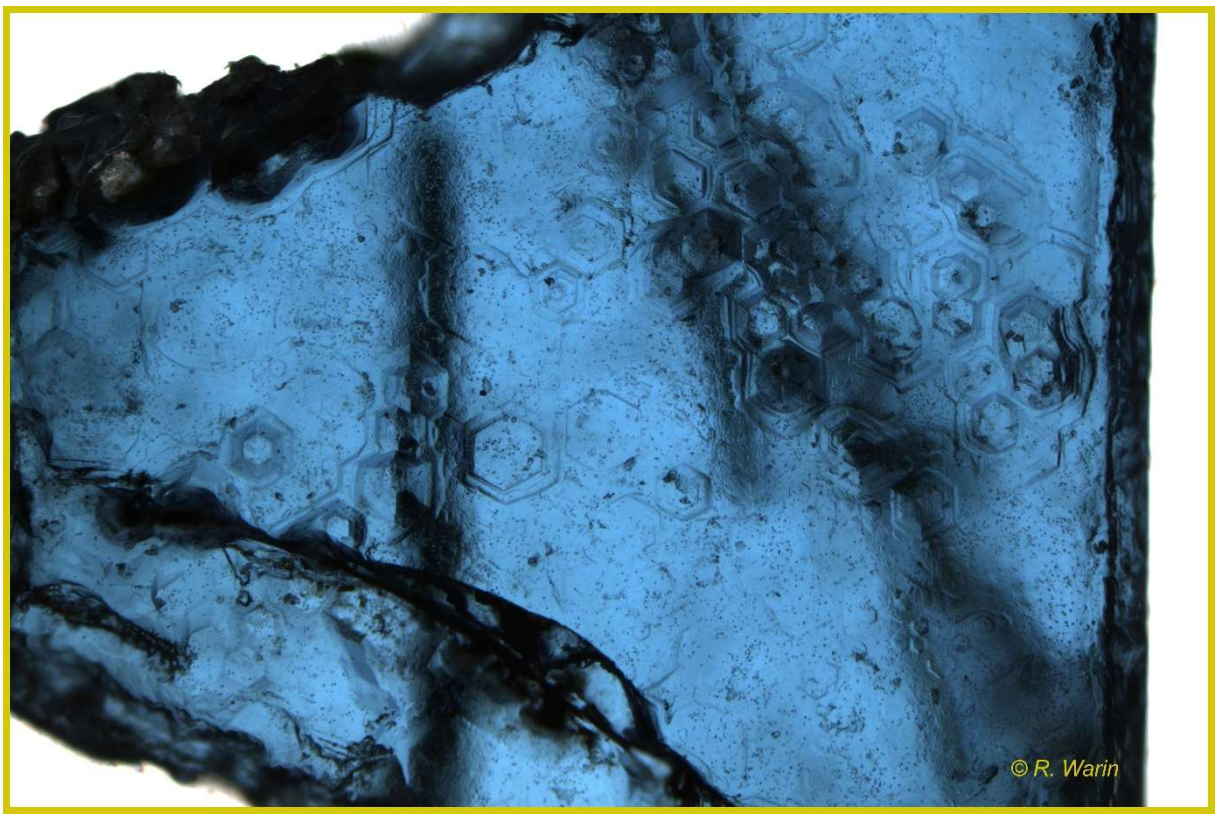
This article was written with the aim of reaching a broad audience of mineralogy enthusiasts—people with a general scientific background but who are not mineralogists—to demonstrate how Nature can solve the grand problem of energy stabilization, taking into account the many constraints of its environment. Although this may seem like a challenge, it is infinitesimal compared to our understanding of life and the sciences related to it. To paraphrase Jacques Monod, M.D., Ph.D., Nobel Prize laureate (1965), I will conclude by saying that **chance and necessity create beauty.**

My task was made easier by the rigor, technical expertise, and pedagogical skill of the authors who collaborated under the direction of C. Ferraris (National Museum of Natural History – Paris) to develop the framework and provide an explanation for the mystery of Laurentthomasite… a product of the weathering of a Malagasy pegmatite, which, after its temperature dropped to approximately 200 °C, underwent irregular infusions.

Acknowledgments

Laurent THOMAS is responsible for the discovery of new mineral species and exceptionally well-crystallized specimens, thanks to his keen eye as a geologist and field researcher. I am honored by his friendship. It has allowed me to explore the previously unknown world of various small mines in Madagascar. My contribution to Laurent Thomas's research was, in fact, limited to photography and a few reflections on the chemistry of certain minerals.
I extend my warmest thanks to him.

Roger Warin, Chem. PhD.



[i] Cristiano Ferraris, Isabella Pignatelli, Fernando Cámara, Giancarlo Parodi, Sylvain Pont, Martin Schreyer, and Fengxia Wei. EJM, 32, 355–365, 2020 (*European Journal of Mineralogy*).