CHEMISTRY AND CRYSTALLOGRAPHY

MINERAL NAME: PEZZOTTAITE
CHEMICAL FORMULA: 
Cs(Be₂Li)Al₂Si₆O₁₈
CRYSTAL SYSTEM: rhombohedral
SPACE GROUP: R₃c

a = 15.946(2) Å  b =15.946(2) Å  c = 27.803(8) Å
(α, β, γ = angles of the unit-cell)

V = 6122(2) Å³
(V = Volume of unit cell, Å = Ångstrom, 1cm = 100 000 000 Å)

Z = 18
(Z is number of formula units per unit-cell)

Lithium (Li)  Caesium (Cs)
Beryllium (Be)
Silicon (Si)
Aluminium (Al)
Oxygen (O)

Caesium position inside channel
Lithium position inside oxygen tetrahedra
Superstructure unit-cell

THE CHALLENGE OF THE IDENTIFICATION OF A NEW GEMSTONE
About 4000 mineral species are known and about 20 to 30 new species are discovered each year. The majority of the new species occurs as very small crystals and is only detected with the help of very sophisticated optical and spectroscopic instrumentation available today. The discovery of a new mineral forming large crystal is thus exceptional. Such a rare and spectacular discovery of a new mineral with gem quality was made in Madagascar. “Pezzottaite”, named after the Italian mineralogist Pezzotta, is a mineral belonging to the “beryl group”. The appearance of this beryl-like mineral on diverse Mineral shows (Tucson) attracted various research groups worldwide and two groups identified almost simultaneously the material as a new mineral. The acceptance of a mineral as a new species requires the determination of a number of physical and chemical properties (optical character, hardness, chemical composition, crystal structure etc.). This “finger-print” has to be presented to the Commission on New Mineral and Mineral Names (CNMMN), a body of the International Mineralogical Association (IMA), which has to approve this new mineral and its name.

This special “new gem mineral edition” of Contribution to Gemology No.3 gives an inside into the details of the physical and chemical analyses that were undertaken for the identification of the new gem mineral “Pezzottaite” and the preparation of a successful IMA application.

Adolf Peretti
What's inside?

- Identifying a new gem mineral
- Analyzing the crystal structure

The superstructure: The difference between the two minerals
- “BERYL” and "PEZZOTTAITE"

Materials
- The application to the Commission on New Minerals and Mineral Names (CNMMN IMA)

Rotating pezzottaite crystal model
- BOX 1 Chemistry and crystallography

Pezzottaite rough, cut and in matrix

BOX 2 Origin and mineralogy

BOX 3 Physical and optical properties
- Chemistry of pezzottaite

BOX 4A Electron microprobe analysis (EMPA)
- BOX 4B Laser ablation mass spectroscopy analysis (LA-ICP-MS)

BOX 5A Crystallography of pezzottaite
- Single crystal X-ray diffraction analysis
- X-ray powder diffraction analysis

BOX 5B Relations to other mineral species

BOX 6 Miscellaneous

Inclusion features, literature and acknowledgments

Appendix Pezzottaite gemstone examples
THE CHALLENGE OF THE IDENTIFICATION OF A NEW MINERAL SPECIES: EXAMPLE "PEZZOTTAITE"

Adolf Peretti (1), Thomas Armbruster (2), Detlef Günther (3), Bernard Grobéty (4), Frank C. Hawthorne (5), Mark A. Cooper (5), William B. Simmons (6), Alexander U. Falster (6), George R. Rossman (7), Brendan M. Laurs (8)

(1) GRS Gemresearch Swisslab AG, Hirschmattstr. 6, P.O. Box 4028, CH-6003 Lucerne, Switzerland
(2) Chem. Miner. Kristallogr., University of Berne, Freiestr. 3, CH-3012 Berne, Switzerland
(3) Laboratory of Inorganic Chemistry, ETH Hönggerberg, HCI, G113, CH-8093 Zurich, Switzerland
(4) Department of Geosciences, University of Fribourg, Pérolles, CH-1700 Fribourg, Switzerland
(5) Geological Sciences, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2
(6) Geology & Geophysics, University of New Orleans, New Orleans, Louisiana, LA 70148, USA
(7) Division of Geological & Planetary Sciences, California Institute of Technology, Pasadena, CA 91125, USA
(8) Gemological Institute of America, Carlsbad, CA 92008, USA

(Authors (1)-(4) are referred in this article as the “Swiss research team” and authors (5)-(8) are referred in this article as the “US-Canadian research team”)

IDENTIFYING A NEW GEM MINERAL

In 2002, a new gem mineral of commercial importance was discovered. In accordance with the need for all new mineral discoveries to be scientifically characterized (see Nickel and Grice, 1998), the gemological community anxiously awaited the results of tests to positively identify the new mineral (Hawthorne et al., 2003, Hawthorne et al., submitted and Laurs et al., 2003). This period of analysis brought into play the question: Exactly what procedures are necessary for the positive characterization of a new mineral?

These principal steps of identification are illustrated in the following case study for identifying a new mineral of the beryl group - pezzottaite.

The identification of this new mineral provided two major challenges: first, the determination of the exact chemical composition, and secondly, the identification of its crystallographic structure (the geometrical arrangement of the atoms in three dimensions (see Box 1, Figs. P2 and P6). From special technique of analysis (Boxes 4 and 5A), the exact stoichiometric chemical formula, and the space group of this new mineral, have to be determined (Box 1). As soon as the mineral was characterized (Boxes 1-6), the differences between already existing minerals had also to be investigated (see Nickel and Grice, 1998 and Box 5B) and a decision had to be made regarding whether a new mineral had been found, and, if so, what would be its new name? (Hawthorne et al., 2003 and Box 6). In the case of pezzottaite, these analysis provided major challenges. As pezzottaite contains light elements - such as hydrogen, lithium, and beryllium, which cannot be directly analyzed by quantitative methods commonly used for mineral analysis such as electron microprobe (EMPA) or XRF analysis - direct measurement by Laser Ablation Mass Spectroscopy was also used (see Box 4B and Fig. P16), as well as conventional methods used for chemical analysis (Box 4A). In addition to challenges in the analysis of chemical composition, determination of different atomic positions in the crystal structure was not trivial. A combination of various analytical techniques was necessary (Figs. P3 and P17) to finally elaborate the structural differences to beryl (Figs. P1 and P2 and Box 5B). It was discovered that the unit-cell of pezzottaite had unusually large dimensions, which is best described as a superstructure of conventional beryl (Figs. P1, P2 and P6). Also, the number of atoms necessary to define the crystal structure turned out to be unusually high in comparison with other beryl- group minerals (Boxes 1 and 5).

ANALYZING THE CRYSTAL STRUCTURE

The secrets of the nature of a new mineral are so small we cannot even identify them with the help of microscopic magnification. One way to explore this atomic world is with X-rays (Figs. P3 and P17).

X-rays have a very short wavelength (with dimensions similar to atoms), allowing them to penetrate and interact with atoms in a mineral structure. As atoms group together at very short distances, X-rays are diffracted when passing through a crystal and change their direction when they interact with them. Furthermore, diffracted X-rays interfere with each other, just like water waves emerging from two ships. The interaction between atoms and X-rays depends, among other factors, on the geometrical arrangement of the atoms and can be interpreted with X-ray diffraction diagrams, and computer calculations. A
**THE SUPERSTRUCTURE: THE DIFFERENCE BETWEEN THE TWO MINERALS "BERYL" AND "PEZZOTTALITE"**

**Fig. P1-2** Ball-and-stick models of beryl (Fig. P1) and pezzottaite (Fig. P2). A projection of the crystal structure in the direction of the c-axis is shown in order to explain some details of the ring systems in these two minerals. The size and position of the unit-cell (as seen perpendicular to the c-axis) is also shown. **Green balls = aluminium cations (Al), blue = beryllium (Be), yellow = lithium (Li), red = caesium (Cs), grey = oxygen (O), black = silicon (Si).** The structure of beryl is characterized by six-membered rings of SiO₄ tetrahedra alternating along the c-axis with twelve-membered rings composed of alternating BeO₄ and AlO₆ polyhedra. In the mineral pezzottaite, an arrangement of beryl-like rings is found, but there are two different types of twelve-membered rings: (1) Those identical to the corresponding rings in beryl, and (2) those assembled of LiO₄, BeO₄ and AlO₆ polyhedra. To allow for the ordered (Be, Li) distribution in the structure of pezzottaite, the unit-cell had to be enlarged relative to beryl (compare P1 and P2). Both models are represented in hexagonal settings for better comparison. It must be remembered, however, that pezzottaite has a rhombohedral crystal lattice and beryl has a hexagonal lattice. In trigonal/rhombohedral symmetry, the highest symmetry element is a three-fold rotation axis, whereas in hexagonal symmetry a six-fold rotation axis is required.

**Fig. P3** Single crystal X-ray diffractometer

One of the instruments used for the analysis of the crystal structure of the new mineral pezzottaite. Critical parts of the instrument include an X-ray generator (1), a multichannel X-ray detector (2), and utilizing the latest computer software for visualization and analyzing signals (not shown). X-ray can be used to compute the geometrical arrangement of atoms (Figs. P1, 2 and P6) in a mineral. The result leads to the determination of crystal structure details (Box 5A).

The interaction between atoms and X-rays depends, among other factors, on the geometrical arrangement of the atoms and can be interpreted with X-ray diffraction diagrams, and computer calculations. A comparison with other beryl-group minerals (Boxes 1 and Box 6) is necessary for the positive identification of tests to positively identify the new mineral. The result leads to the determination of crystal structure details (Box 5A).
MATERIALS

The new gem material was first introduced to the international mineralogical community at the Tucson show in February 2003, where it was recognized as a mineral of unusual gemological properties not referenced in world literature (see Laurs et al., 2003). For details on materials tested, see Hawthorne et al. (submitted) and Laurs et al. (2003). Three of the totally tested samples are officially registered reference materials (Box 6). They are deposited in the USA, Canada and in Switzerland.

The samples analyzed by the Swiss team are shown in Figs. P4-P5, P7-8, P12-13 and Box 7. Three samples were investigated by chemical and crystallographic investigation. These include 0.5cm-sized samples obtained from the large mother piece (Fig. P5). One of the small fragments entered the collection as a type locality specimen (Box 6).

THE APPLICATION TO THE COMMISSION ON NEW MINERALS AND MINERAL NAMES

The Swiss research group (authors 1-4) filed an application to the Commission on New Minerals and Mineral Names of the International Mineralogical Association (CNMMN, http://www.geo.vu.nl/users/ima-cnmmn/), stating that they had characterized a new mineral. The chairman of CNMMN informed the Swiss team that he had just received a proposal for the same mineral from a different research group (US-Canadian, authors 5-8). He further stated that both proposals were complementary to each other. An agreement was established that both groups’ information and data should be merged and a new joint proposal should be submitted. Subsequently, CNMMN members decided unanimously that the new mineral should be accepted with the name ‘pezzottaite’.

Box 1 to 6 summarized original data of the merged IMA application submitted by:


Fig. P4 A reference set of pezzottaite including a faceted sample of 4.85 ct, 2 pezzottaite cat’s eyes, 2 tabular rough crystals (35.38ct, 29.41ct), 1 large crystal fragment with matrix (35.22 ct), 2 tabular pezzottaite crystals with host rock, and one with tourmaline intergrowth (27.51 ct). On public display at the Natural History Museum of the University of Fribourg (Switzerland), GRS collection.

Fig. P5 Pezzottaite tabular crystal of 29.41ct and a broken part of it (lower right), which served as the sample used for the Swiss team’s detailed chemical and crystallographic investigations. The lower right piece parted in 3 different fragments which are currently at the University of Berne (see Box 6), the University of Fribourg, and the SFIT (Switzerland). The remaining motherpiece of 29.41 ct is in the GRS collection.
New Gem Mineral Species Pezzottaite: Crystallographic Model

**ROTATING PEZZOTTAITE CRYSTAL MODEL**

Fig. P6a-c
NEW RHOMBOHEDRAL SUPERSTRUCTURE OF PEZZOTTAITE.

Crystal structure model with oxygen polyhedra surrounding a cat ion in the centre. Yellow oxygen tetrahedra: containing lithium (Li), blue tetrahedra with beryllium (Be), red tetrahedra with silicon (Si), green octahedra with aluminium (Al), and red spheres indicating caesium (Cs) positions. Solid outlines mark the superstructure cell. Substitutions in tetrahedral and octahedral positions by other elements such as Ti, Ca, Mn, Fe, Na, K, Rb and Sc see Laurs et al. (2003) and Box 4B.

Rotating the crystal model of pezzottaite (P6a-c) shows the arrangement of caesium (Cs) in the direction of the c-axis within the channels. The Cs atoms are surrounded by six-membered rings involving Si, and 2 different types of twelve-membered rings. One ring is composed of Be and Al and the second composed of Be, Al and Li. With further rotation of the unit-cell, the complexity of the pezzottaite crystal structure becomes more clearly visible and the third dimension of the complicated crystal structure is more exposed (Fig. P6b). In a view perpendicular to the c-axis (Fig. P6c), the arrangement of Cs in the channels in the direction of the c-axis become visible. In the case of beryl, channels may be partially occupied by H₂O, while in pezzottaite, the corresponding position is mainly occupied by Cs.

**BOX 1**
CHEMISTRY AND CRYSTALLOGRAPHY
(IMA Application)

MINERAL NAME: PEZZOTTAITE
CHEMICAL FORMULA: Cs(Be₂Li)Al₂Si₆O₁₈
CRYSTAL SYSTEM: rhombohedral
SPACE GROUP: R₃c
a = 15.946(2) Å  b = 15.946(2) Å  c = 27.803(8) Å  (a, b, c = unit-cell dimensions)
α = 90°  β = 90°  γ = 120°  (α, β, γ = angles of the unit-cell)
V = 6122(2) Å³  (V = Volume of unit-cell, Å = in Angstrom, 10⁻⁸ cm = 1Å)
Z = 18  (Z is number of formula units per unit-cell)
New Gem Mineral Species Pezzottaite: Occurrence and Mineralogy

PEZZOTTAITE ROUGH, CUT AND IN MATRIX

Fig. P7 A rough pezzottaite crystal of over 80ct and its final product after cutting reveals a gem quality cabochon of 59.98ct. Rough and cut stone courtesy of MJ3 Inc. (NY, USA), cut by G.E.O. LTD (Bangkok, Thailand).

Fig. P8 Mineral specimen of pezzottaite in matrix. Length of pezzottaite 10 mm. Collection GRS.

BOX 2 ORIGIN AND MINERALOGY (IMA)

ORIGIN
The mine deposit is located in central Madagascar, about 140 km southwest of Antsirabe (Coordinates 20° 44.78' S and 46° 04.45' E and at an elevation of 920m (3020 feet). The route to the mine leads to Ambatofinandrahana and passes through Amborompotsy and Mandrosonoro.

ASSOCIATED MINERALS
Boron-bearing minerals: tourmaline, danburite.
Lithium-bearing minerals: lepidolite and spodumene (kunzite)
Other silicates or oxides: quartz, K-feldspar (amazonite), albite (clevelandite)

OCCURRENCE OF PEZZOTTAITE
Pezzottaite occurs in a miarolitic cavity in a mixed-feature granitic pegmatite (such pegmatites are fairly common in this region (Pezzotta 2001)). Pezzottaite crystallized from fluids in the cavity over a relatively large time-span forms both relatively early and late-stage crystals, the latter having (in some cases) Cs-enriched margins.

Fig. P9 The position of the Pezzottaite mine within Central Madagascar

Fig. P10 Occurrence of pezzottaite in Li, Be, B and Cs-bearing pegmatites. The pockets containing pezzottaite are excavated in small shafts and tunnels. (Picture P10 and P11 as of spring 2003, courtesy of MJ3 Inc., New York)

Fig. P11 The mining camp and a view of the topography next to the mining site where the new gem mineral pezzottaite was found.
New Gem Mineral Species Pezzottaite: Physical and Optical Properties

**COLOUR** (megascopic) raspberry pink to red
Moderate dichroism is present:
- orange-pink (red);
- purplish pink (red) to purple

**STREAK** colorless to white

**LUSTRE** vitreous

**TRANSPARENT** to **TRANSLUCENT**

**FLUORESCENCE** inert to long- and short-wave UV radiation

**HARDNESS:** Mohs’: 8

**RADIOACTIVITY:** None

**CLEAVAGE** (001) imperfect

**PARTING** none observed

**TENACITY** brittle

**FRACTURE** irregular and conchoidal

**DENSITY (meas.)** 3.09 - 3.11 g/cm³

**DENSITY (calc.)** 3.06 g/cm³ (using unit-cell)

**OPTICAL PROPERTIES**

**WAVELENGTH = Na light**

**UNIAXIAL (B)**
- $\omega$: 1.615-1.619
- $\epsilon$: 1.607-1.610

**BIREFRINGENCE** 0.008 - 0.009 (negative)

**PLEOCHROISM**
- strong ($\epsilon$): orange pink (red)
- ($\omega$): purple

---

**Fig. P12** Natural cat’s eye pezzottaite
Cutting of pezzottaite as a cabochon intersecting the direction of the growth tubes produces a so-called cat’s eye effect (see white line produced by a directed light source perpendicular to the direction of the c-axis).

**Fig. P13** Pezzottaite rough of 29.41ct (see also Fig. P5) is shown as seen through crossed polarizers. A projection sphere is introduced to show the uniaxial property of “pezzottaite” (Cross pattern if viewed in the direction of the c-axis).

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**BOX 3 PHYSICAL AND OPTICAL PROPERTIES (IMA)**

**APPEARANCE AND PHYSICAL PROPERTIES**

Pezzottaite occurs as usually isolated crystals that range in color from whitish pink to a deep raspberry red. There are three distinct types of crystals: (1) Irregularly-shaped flat masses (up to 8 cm in diameter) that fill cavities between clevelandite, quartz and tourmaline; (2) subhedral-to-euhedral hexagonal tabular crystals (up to 7 cm in diameter); (3) small (< 0.5 cm in diameter) euhedral flat-to-elongated crystals attached to faces of large tourmaline crystals.

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**Fig. P14a:** Polarized UV-VIS-NIR spectra on a 6 mm thick slice of pezzottaite which was used for chemical and crystal structure analysis. Note: Absorption bands at 494 and 563 (polarized perpendicular to the c-axis) and 572 nm (polarized parallel to the c-axis).

**Fig. P14b:** Pleochroism of pezzottaite with orange-red to purple is shown which is distinctively different from other minerals of the beryl group, such as pink beryl "morganite" (see Laurs et al., 2003).
New Gem Mineral Species Pezzottaite: Chemical Analysis

**BOX 4A EMPA ELECTRON MICROPROBE ANALYSIS (IMA Application)**

![Example of an Electron Microprobe. University of New Orleans, USA (A.U. Falster).](image)

**Explanation of method.** The method is used to analyze the chemical composition. For analytical purposes, the analyzed mineral must be coated with an electron-conducting layer and positioned in a highly evacuated vacuum chamber (1). The mineral is bombarded by electrons, which have previously been produced and accelerated in an electron gun (2). The different atoms in the mineral react to the impacting electrons by creating signals. These signals include X-rays, which can be detected by various kinds of detectors, such as WDS (3). From the responding signals, the chemical composition can be determined, providing standard materials (materials of known composition or “Probe Standards”) are analyzed for comparison. Light elements such as beryllium or lithium are determined by other methods.

**ELECTRON MICROPROBE WDS**  
20 kV  10 nA  beam: 5 Fm  

**NOTE:** H₂O was determined by LOI and a value of 1.72 wt.% was obtained. However, the crystals are riddled with tubules that are occupied by a fluid; the paragenesis (granitic pegmatite) indicates that the fluid will be an aqueous fluid which will therefore result in an anomalously high value of H₂O. The crystal-structure refinement gives the total scattering within the channel, and this value minus the scattering from the channel constituents determined by EMPA gives the amount of (H₂O) in the channel: ~0.1 apfu, 0.28 wt.% H₂O. Li by ICP.

**ANALYTICAL RESULTS:** Number of analyses: 8

<table>
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<th>Constituent</th>
<th>Wt.%</th>
<th>Range</th>
<th>Standard Deviation</th>
<th>Probe Standard</th>
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<tr>
<td>SiO₂</td>
<td>56.52</td>
<td>55.8 - 57.2</td>
<td>0.59</td>
<td>Spessartine</td>
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<tr>
<td>Al₂O₃</td>
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<td>14.9 - 17.0</td>
<td>0.65</td>
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<td>Li₂O</td>
<td>2.16</td>
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<tr>
<td>BeO</td>
<td>8.05</td>
<td>-</td>
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<tr>
<td><strong>Total</strong></td>
<td>97.46</td>
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* The BeO content was calculated from the relation Be = 3 - Li.

**EMPIRICAL FORMULA**  
\[(Cs_{0.62} Rb_{0.05} K_{0.02} Na_{0.11})_{S=0.80} (Be_{2.07} Li_{0.93})_{S=3} (Al_{1.97} Mn_{0.01})_{S=1.98} Si_{6.05} O_{18}\]

**BASIS OF CALCULATION** 18 O-atoms

**SIMPLIFIED FORMULA**  
\[(Cs,□)_{(Be, Li)} Al_{2} Si_{6} O_{18}\]
**New Gem Mineral Species Pezzottaite: Chemical Analysis**

**EMPIRICAL FORMULA**

\[
(\text{Cs}_{0.833} \text{Rb}_{0.030} \text{K}_{0.019} \text{Na}_{0.095}) (\text{Be}_{2.098} \text{Li}_{0.917}) \text{Al}_{2.000} \text{Si}_{5.860} \text{Al}_{0.135} \text{O}_{18}
\]

**SIMPLIFIED FORMULA**

\[
\text{Cs Be}_2 \text{ Li}_2 \text{ Al}_2 \text{ Si}_6 \text{ O}_{18}
\]

**IONS PER 18 OXYGENS, ANHYDROUS BASIS**

\[
\begin{array}{c|c|c|c|c|c|c|c|c|c|c|c}
\text{Si} & 5.860 & \text{Ti} & 0.001 & \text{Al} & 0.139 & \Sigma_{\text{tetrahedral}} & 6.000 & \text{Na} & 0.095 & \text{K} & 0.019 \\
\text{Be} & 2.098 & \text{Li} & 0.917 & \Sigma_{\text{Be+Li}} & 3.016 & \text{Al} & 1.996 & \text{Ca}^* & 0.025 & \text{Sc} & \text{nd} \\
\text{Rb} & 0.030 & \text{Mn} & 0.002 & \text{Fe}^{2+} & 0.001 & \Sigma_{\text{channel}} & 0.977 & \Sigma_{\text{octahedral}} & 2.024
\end{array}
\]

*Ca is assumed present at the octahedral site, but it may occur elsewhere in the pezzottaite structure.* n.d. = not determined

---

**Explanation of method**

The laser ablation technique (LA) uses a 193 nm excimer laser (1) which is focused onto the sample surface via microscope lenses (2). The laser is ablating (carrying away) the material (crater diameter 4 to 80 microns) (3). The mobilized material is suspended in a carrier gas (4) and transported via transport tube into an Inductively Coupled Plasma Mass Spectrometer (ICP-MS) (5). The material/elements (except those that cannot be ionized, such as gases and fluorine) are vaporized, atomized and ionized within the ICP. The created ions are then transferred to the mass spectrometer and separated by their mass divided by charge (5). The detector allows measuring major, minor and trace elements within a single analysis. Very light elements, such as boron, lithium or beryllium, can be detected, along with a large series of other elements at concentrations of less then 1 ppm. The quantification at low concentrations is possible by LA-ICP-MS due to a matrix-independent calibration, e.g. glass standard was used for quantification of pezzottaite including special computer analysis and specific software (6). The use of complementary solid-analysis methods (such as EMPA and XRF) for comparison and validation purposes (e.g. for quantitative measurement of silicon and aluminium) must be applied (see Box 4A).
BOX 5A CRYSTALLOGRAPHIC ANALYSIS (IMA)

SINGLE-CRYSTAL STUDY

METHOD 4-circle
CRYSTAL SYSTEM rhombohedral (hexagonal setting)
SPACE GROUP R3c
CELL PARAMETERS a 15.946(2) Å  α  90°
b 15.946(2) Å  β  90°
c 27.803(8) Å  γ  120°
V 6122(2) Å³  Z = 18

POWDER DATA CuKα
Diffractometer
CELL PARAMETERS REFINED FROM POWDER DATA
CRYSTAL SYSTEM rhombohedral (hexagonal setting)
SPACE GROUP R3c
a 15.973(4) Å  α  90°
b 15.973(4) Å  β  90°
c 27.850(11) Å  γ  120°
V 6153(3) Å³  Z = 18

See Table 1 for X-ray Powder-Diffraction Data

CRystal STRUCTURE
R = 2.9%

MORPHOLOGY
Habit tabular
forms (001) dominant, {100}, {110}
Twinning none observed
c:a 1 : 1.7436
(from unit-cell parameters)

TABLE 1. X-RAY POWDER-DIFFRACTION DATA FOR PEZZOTTAITE

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<th>d measured</th>
<th>d calculated</th>
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</table>
Pezzottaite is related to the beryl group (see table 2), but differs in having a superstructure involving ordering of Be and Li in tetrahedral coordination (see Fig. P1, P2 and P6).

**TABLE 2. THE MINERALS OF THE BERYL GROUP: (2a) Be₃Al₂Si₆O₁₈(H₂O)<₁

<table>
<thead>
<tr>
<th>Mineral</th>
<th>a (Å)</th>
<th>c (Å)</th>
<th>V (Å³)</th>
<th>ω (°)</th>
<th>D (g/cm³)</th>
<th>Z</th>
<th>2a</th>
<th>Be</th>
<th>Al</th>
<th>(Al₂Si)²</th>
<th>Mg₂</th>
<th>Be₂Li</th>
<th>Cs</th>
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<td>Al₂</td>
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<td>Bazzite</td>
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<td>719.5</td>
<td>1.602</td>
<td>2.77</td>
<td>2</td>
<td>-</td>
<td>Be₃</td>
<td>Sc₂</td>
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<td>Stoppaniite</td>
<td>9.397</td>
<td>9.202</td>
<td>703.7</td>
<td>1.619</td>
<td>2.79</td>
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<td>Fe²⁺</td>
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<td>Be₂Li</td>
<td>Cs</td>
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</table>

1 Aurisicchio et al. (1988); 2 Armbruster et al. (1995); 3 Della Ventura et al. (2000), Ferraris et al. (1998); 4 Meagher & Gibbs (1977); 5 Hawthorne et al.(submitted).

**End-member formulae**

- **Beryl:** Be₃Al₂Si₆O₁₈
- **Bazzite:** Be₃Sc₂Si₆O₁₈
- **Stoppaniite:** Be₃Fe²⁺Si₆O₁₈
- **Indialite:** (Al₂Si)²Mg₂(Al₂Si₄)²O₁₈
- **Pezzottaite:** Cs(Be₂Li)Al₃SiO₁₈


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**NAME**

Named after Federico Pezzotta, Museo Civico, Milano, Italy; born 1967. Dr. Pezzotta has played a major role in characterizing the granitic pegmatites of Madagascar and their constituent minerals. He has made major contributions to our knowledge of the paragenesis of tourmaline-group minerals, particularly in Elba, Italy.


**TYPE MATERIAL**

Smithsonian Institution

Canadian Museum of Nature, PO Box 3443, Station D, Ottawa, Ontario, Canada

Natural History Museum Bern, Bern, Switzerland
New Gem Mineral Species Pezzottaite: Inclusion Features, Literature and Acknowledgments

Fig. P18a/b Microfeatures observed in pezzottaite. Negative crystal in connection with growth tubes (P18a) and growth tubes of various length parallel to the c-axis (P18b). Images taken at 40-60x microscopic magnification (microphotographs A. Peretti).

About the authors

Dr. Peretti is Director of the GRS Gemresearch Swisslab Ltd., Lucerne, Switzerland
Adolf@Peretti.ch

Dr. Armbruster is Professor of Mineralogical Crystallography at the University of Berne, Switzerland
thomas.armbruster@krist.unibe.ch

Dr. Günther is Professor for Trace Elements and Microanalysis at the Laboratory for Inorganic Chemistry, ETH Zurich, Switzerland
guenter@inorg.chem.ethz.ch

Dr. Grobéty is Professor of Mineralogy at the University of Fribourg, Switzerland
Bernard.Grobety@unifr.ch

Dr. Hawthorne is Professor of Mineralogy and Mr. Cooper Laboratory technician, at the University of Manitoba, Winnipeg, Canada
frank_hawthorne@umanitoba.ca
mark_cooper@umanitoba.ca

Dr. Simmons is Professor of Mineralogy and University Research Professor and Mr. Falster is Senior Research Technologist, at the University of New Orleans, Louisiana, USA
wsimmons@uno.edu
afalster@uno.edu

Dr. Rossman is Professor of Mineralogy at the California Institute of Technology, Pasadena, USA
grr@gps.caltech.edu

Mr. Laurs is Editor of Gems & Gemology at GIA in Carlsbad, California, USA
blaurs@gia.edu

Acknowledgements

The authors are grateful to all research scientists of different Institutions for their contributions and to the experts of the IMA Commission. Special thanks to gem dealers who supported this research with samples. The senior author would like to thank Steve Jaquith and Marc Jobin MJ3 Inc. (NY, USA), G.E.O. International Co., LTD (Bangkok, Thailand) and Papas Gem Co., LTD for supply of samples. This report was prepared with the help of Anong Imaging (Bangkok), Mr. Sumet Tanthadilok, IMAGIMAX Animation & Design Studio (Bangkok, Thailand) and Mr. Saleem Michael.
## BOX 7 PEZZOTTAITE GEMSTONE EXAMPLES

<table>
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<tr>
<th>Gemstone Type</th>
<th>Weight (ct)</th>
<th>Dimensions</th>
<th>Cut</th>
<th>Shape</th>
<th>Color</th>
<th>RI</th>
<th>SG</th>
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<td>13.65 x 8.3 x 9.05 mm</td>
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### Selected Literature


