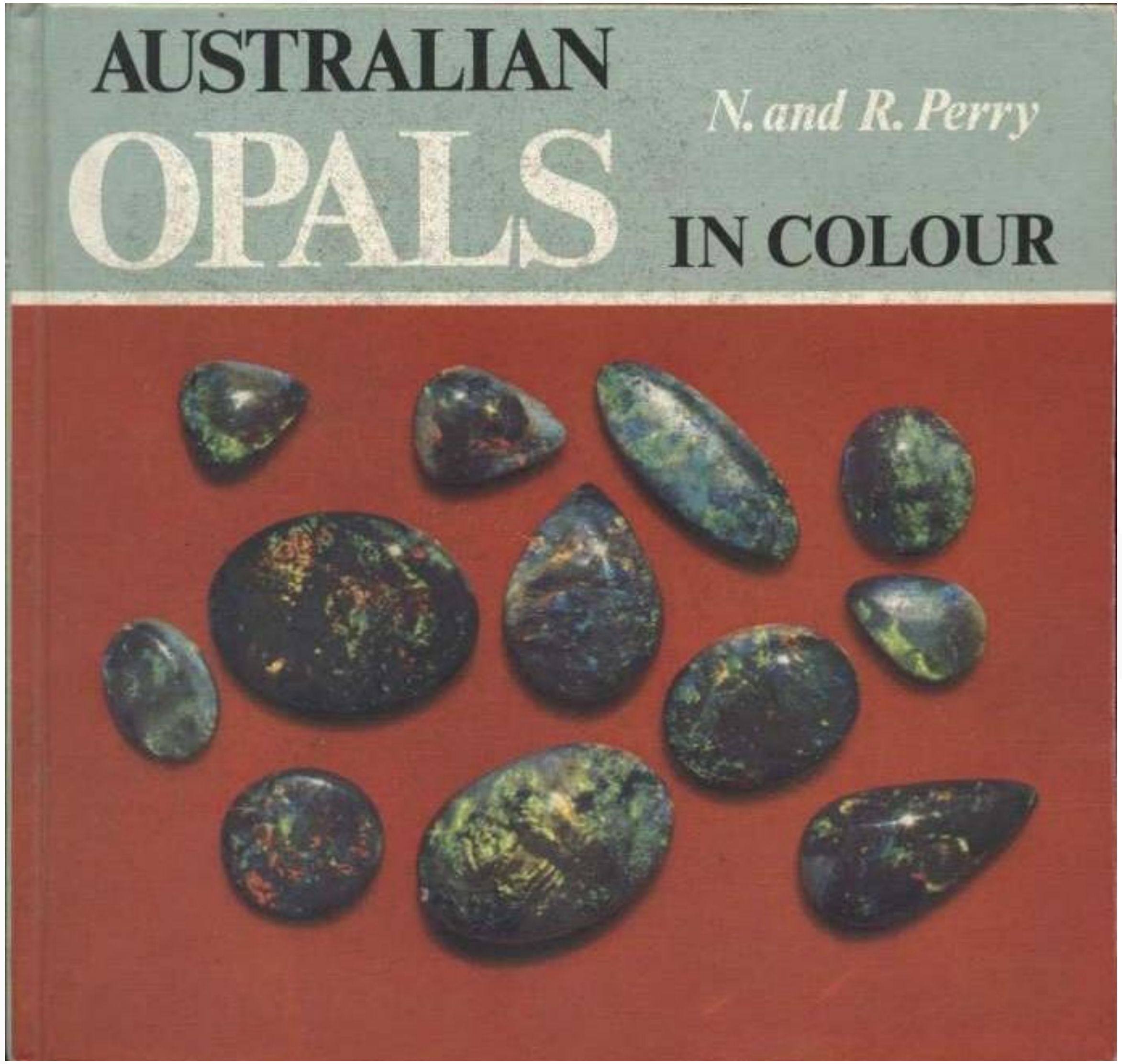
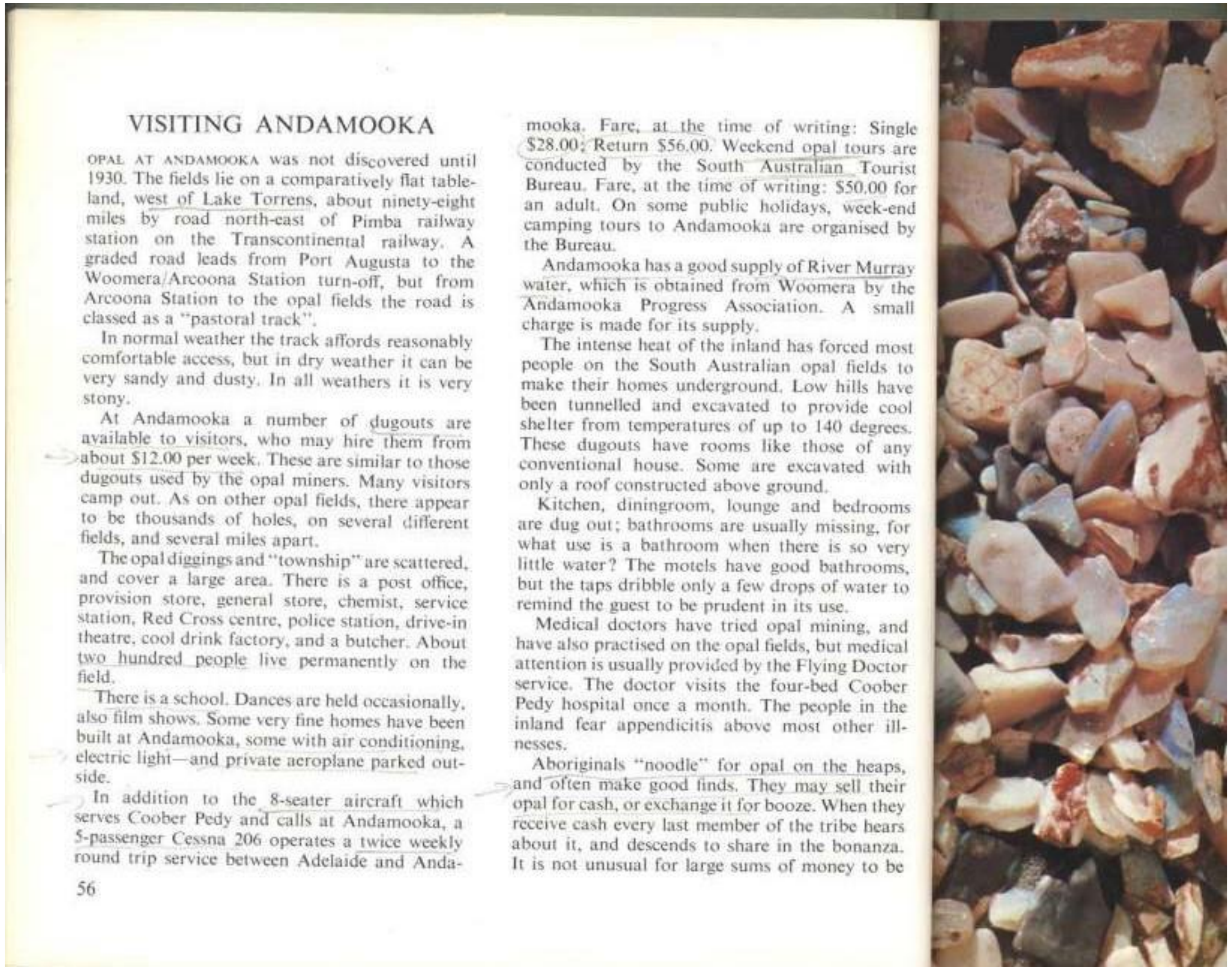
MKA
veiling 2024

deel 1

1 Australian Opals in Colour 3,00 €





VISITING ANDAMOOKA

OPAL AT ANDAMOOKA was not discovered until 1930. The fields lie on a comparatively flat tableland, west of Lake Torrens, about ninety-eight miles by road north-east of Pimba railway station on the Transcontinental railway. A graded road leads from Port Augusta to the Woomera/Arcoona Station turn-off, but from Arcoona Station to the opal fields the road is classed as a "pastoral track".

In normal weather the track affords reasonably comfortable access, but in dry weather it can be very sandy and dusty. In all weathers it is very stony.

At Andamooka a number of dugouts are available to visitors, who may hire them from about $12.00 per week. These are similar to those dugouts used by the opal miners. Many visitors camp out. As on other opal fields, there appear to be thousands of holes, on several different fields, and several miles apart.

The opal diggings and "township" are scattered, and cover a large area. There is a post office, provision store, general store, chemist, service station, Red Cross centre, police station, drive-in theatre, cool drink factory, and a butcher. About two hundred people live permanently on the field.

There is a school. Dances are held occasionally, also film shows. Some very fine homes have been built at Andamooka, some with air conditioning, electric light—and private aeroplane parked outside.

In addition to the 8-seater aircraft which serves Coober Pedy and calls at Andamooka, a 5-passenger Cessna 206 operates a twice weekly round trip service between Adelaide and Andamooka. Fare, at the time of writing: Single $28.00; Return $56.00. Weekend opal tours are conducted by the South Australian Tourist Bureau. Fare, at the time of writing: $50.00 for an adult. On some public holidays, week-end camping tours to Andamooka are organised by the Bureau.

Andamooka has a good supply of River Murray water, which is obtained from Woomera by the Andamooka Progress Association. A small charge is made for its supply.

The intense heat of the inland has forced most people on the South Australian opal fields to make their homes underground. Low hills have been tunnelled and excavated to provide cool shelter from temperatures of up to 140 degrees. These dugouts have rooms like those of any conventional house. Some are excavated with only a roof constructed above ground.

Kitchen, diningroom, lounge and bedrooms are dug out; bathrooms are usually missing, for what use is a bathroom when there is so very little water? The motels have good bathrooms, but the taps dribble only a few drops of water to remind the guest to be prudent in its use.

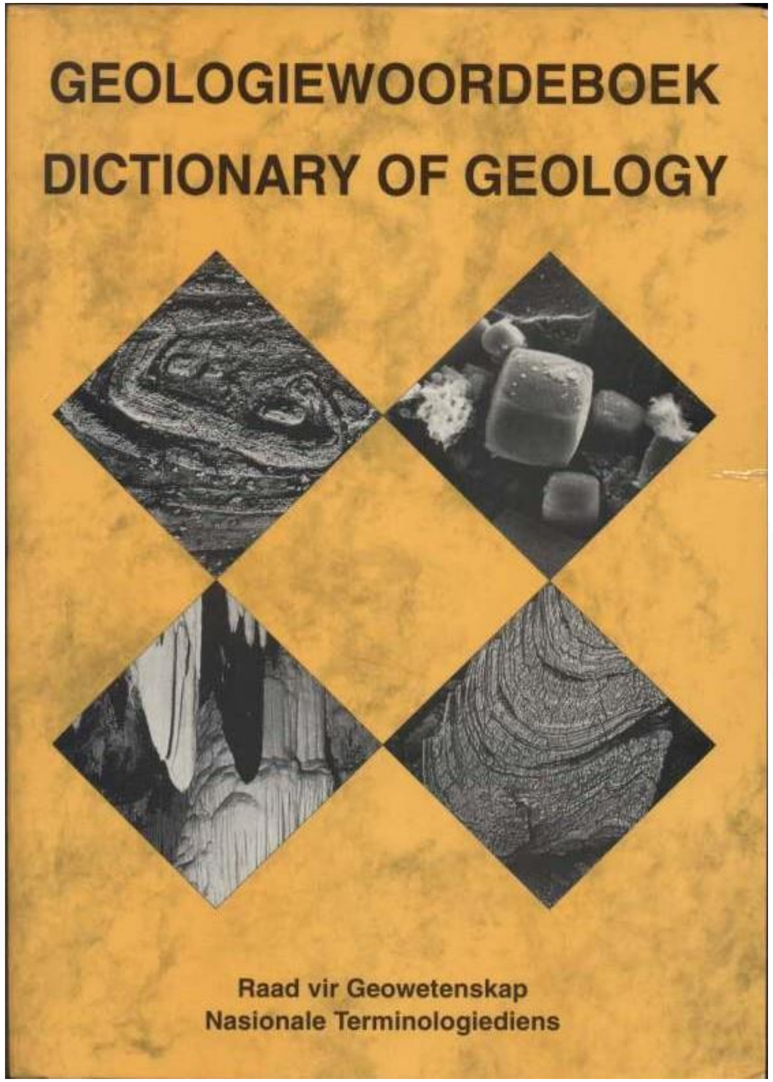
Medical doctors have tried opal mining, and have also practised on the opal fields, but medical attention is usually provided by the Flying Doctor service. The doctor visits the four-bed Coober Pedy hospital once a month. The people in the inland fear appendicitis above most other illnesses.

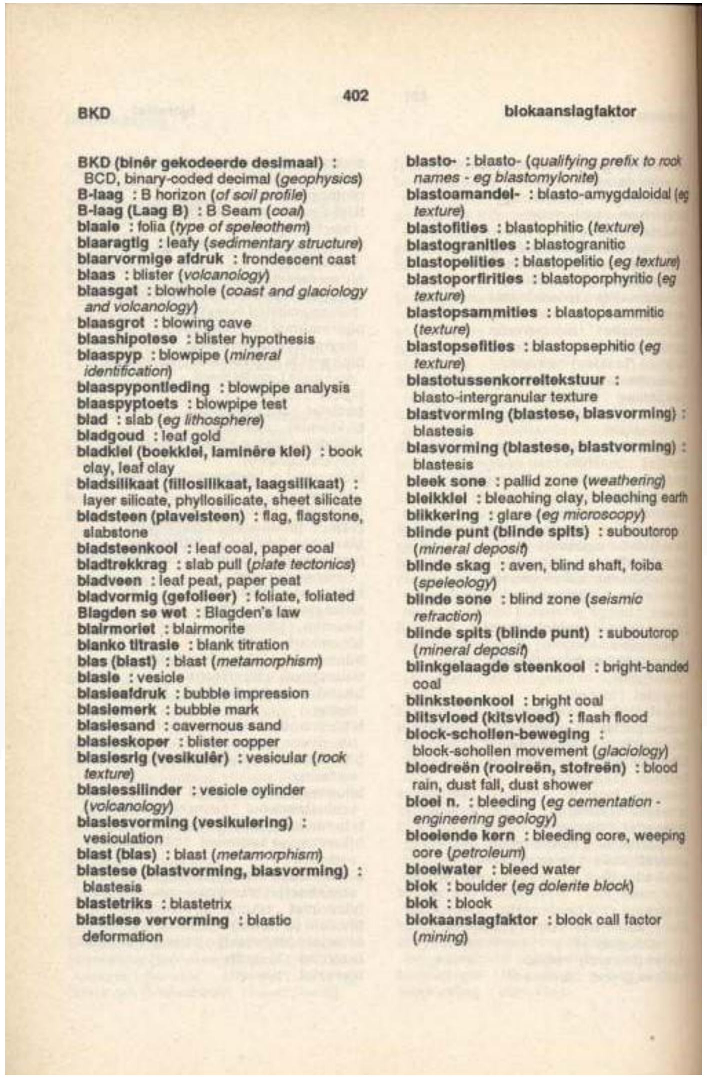
Aboriginals "noodle" for opal on the heaps, and often make good finds. They may sell their opal for cash, or exchange it for booze. When they receive cash every last member of the tribe hears about it, and descends to share in the bonanza. It is not unusual for large sums of money to be

56

2 Geologiewoordeboek – Dictionary of Geology

3,00 €





BKD (binêr gekodeerde desimaal) : BCD, binary-coded decimal (*geophysics*)
B-laag : B horizon (*of soil profile*)
B-laag (Laag B) : B Seam (*coal*)
blaaie : folia (*type of speleothem*)
blaaragtig : leafy (*sedimentary structure*)
blaarvormige afdruk : frondescent cast
blaas : blister (*volcanology*)
blaasgat : blowhole (*coast and glaciology and volcanology*)
blaasgrot : blowing cave
blaashipotese : blister hypothesis
blaaspyp : blowpipe (*mineral identification*)
blaaspypontleding : blowpipe analysis
blaaspyptoets : blowpipe test
blad : slab (*eg lithosphere*)
bladgoud : leaf gold
bladklei (boekklei, laminêre klei) : book clay, leaf clay
bladsilikaat (fillosilikaat, laagsilikaat) : layer silicate, phyllosilicate, sheet silicate
bladsteen (plaveisteen) : flag, flagstone, slabstone
bladsteenkool : leaf coal, paper coal
bladtrekkrag : slab pull (*plate tectonics*)
bladveen : leaf peat, paper peat
bladvormig (gefolieer) : foliate, foliated
Blagden se wet : Blagden's law
blairmoriet : blairmorite
blanko titrasie : blank titration
blas (blast) : blast (*metamorphism*)
blasie : vesicle
blasieafdruk : bubble impression
blasiemerk : bubble mark
blasiesand : cavernous sand
blasieskoper : blister copper
blasiesrig (vesikulêr) : vesicular (*rock texture*)
blasiessilinder : vesicle cylinder (*volcanology*)
blasiesvorming (vesikulering) : vesiculation
blast (blas) : blast (*metamorphism*)
blastese (blastvorming, blasvorming) : blastesis
blastetriks : blastetrix
blastiese vervorming : blastic deformation
blasto- : blasto- (*qualifying prefix to rock names - eg blastomylonite*)
blastoamandel- : blasto-amygdaloidal (*eg texture*)
blastofities : blastophitic (*texture*)
blastogranities : blastogranitic
blastopelities : blastopelitic (*eg texture*)
blastoporfirities : blastoporphyritic (*eg texture*)
blastopsammities : blastopsammitic (*texture*)
blastopsefities : blastopsephitic (*eg texture*)
blastotussenkorreltekstuur : blasto-intergranular texture
blastvorming (blastese, blasvorming) : blastesis
blasvorming (blastese, blastvorming) : blastesis
bleek sone : pallid zone (*weathering*)
bleikklei : bleaching clay, bleaching earth
blikkering : glare (*eg microscopy*)
blinde punt (blinde spits) : suboutcrop (*mineral deposit*)
blinde skag : aven, blind shaft, foiba (*speleology*)
blinde sone : blind zone (*seismic refraction*)
blinde spits (blinde punt) : suboutcrop (*mineral deposit*)
blinkgelaagde steenkool : bright-banded coal
blinksteenkool : bright coal
blitsvloed (kitsvloed) : flash flood
block-schollen-beweging : block-schollen movement (*glaciology*)
bloedreën (rooireën, stofreën) : blood rain, dust fall, dust shower
bloei n. : bleeding (*eg cementation - engineering geology*)
bloeiende kern : bleeding core, weeping core (*petroleum*)
bloeiwater : bleed water
blok : boulder (*eg dolerite block*)
blok : block
blokaanslagfaktor : block call factor (*mining*)

3

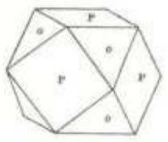
Manual of the Mineralogy of Great-Britain & Ireland

3,00 €

Manual of the
MINERALOGY
of
Great Britain & Ireland
by
Greg & Lettsom
1858

A facsimile reprint
with
Supplementary Lists of British Minerals
by
L. J. Spencer, F.R.S.
and
a Fourth Supplementary List
(1977) together with a foreword
by
Peter G. Embrey

LAPIDARY PUBLICATIONS
Broadstairs · Kent · England



P P 90° 00′
P o 125 15
o o 109 28

Combinations: P; P o.

AgCl	Silver	75·34
	Chlorine	24·66
		100·00

Has been found crystallized, massive, and investing other minerals at some of the Cornish mines and at a few other localities, but it is a rare British mineral. It occurred crystallized in small cubes, and in cubic dodecahedrons, in brown gossan at Wheal Duchy in Phillack, and associated with native silver at Wheal St. Vincent, both near Calstock; also at Huel Mexico in Perranzabuloe, crystallized and massive. At Silver Valley and Wheal Brothers.

At the Sark silver-mine it formerly occurred massive, and disseminated in gossan in considerable quantities.

In Ireland it is reported as accompanying native silver, at Ballycorus, Co. Dublin.

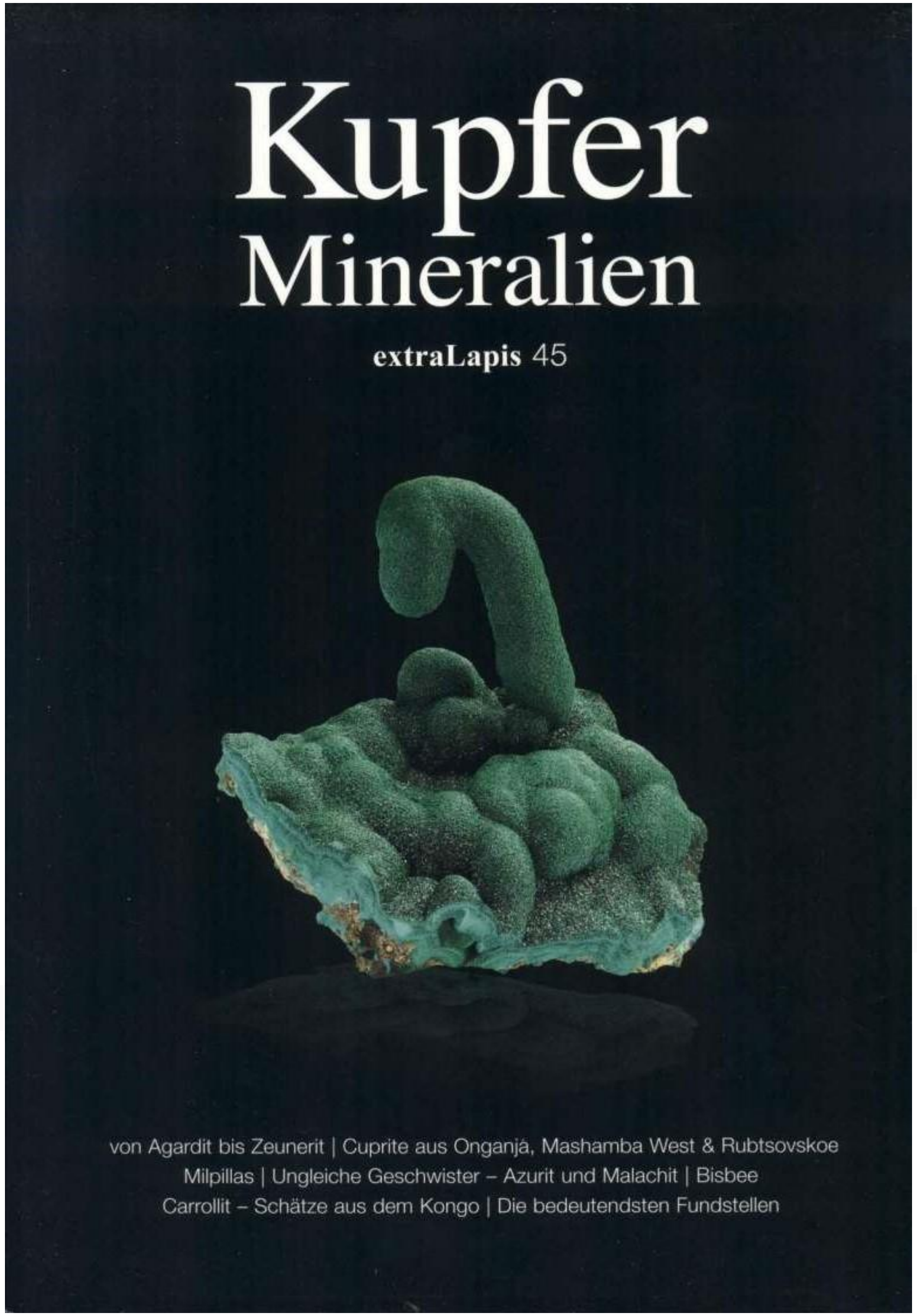
Order III. PLATINUM.

121. PLATINUM.—Native Platina.

Cubic. Primary form the cube. No cleavage. Fracture hackly. Opaque. Lustre metallic. Steel-grey, streak the same, shining. Ductile and malleable. H. 4·5; Gr. 17·5 to 19·0.

Frequently magnetic. Before the blowpipe, alone or with fluxes, unchangeable. Soluble only in nitromuriatic acid. The solution yields a yellow precipitate on the addition of a salt of potash. Platinum, as it occurs in nature, always contains from 14 to 26 per cent. of other metals, iron being always one, and

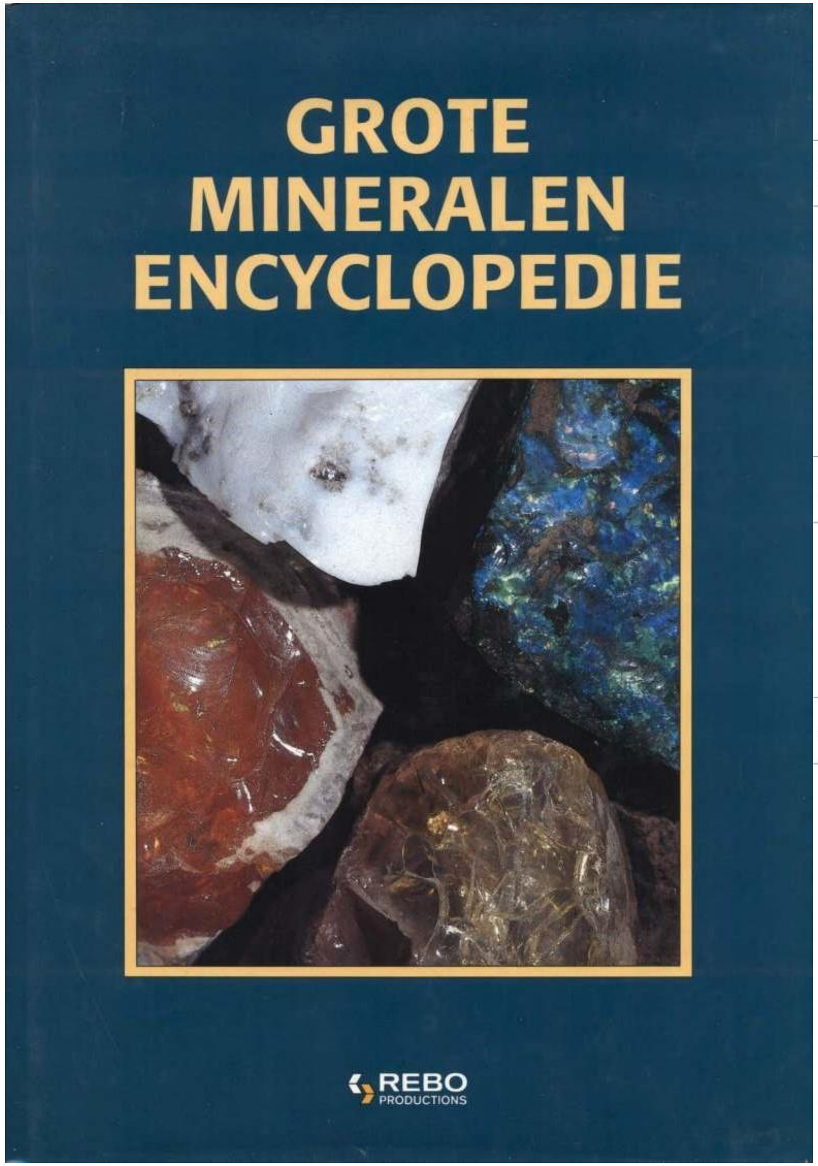
4 Kupfer Mineralien

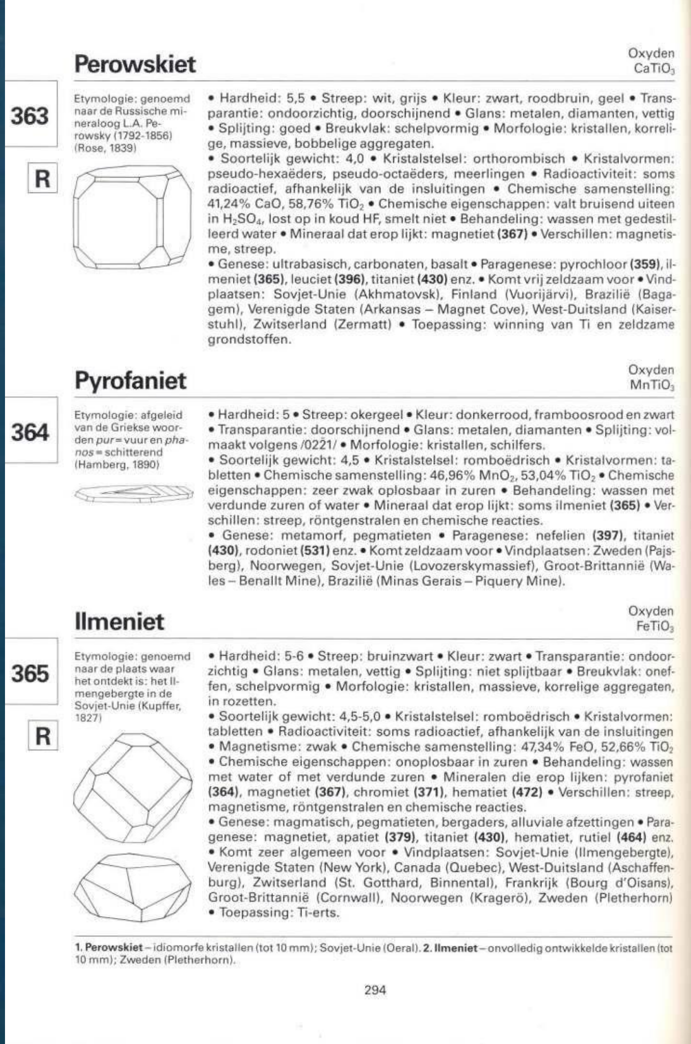


5,00 €

5 Grote mineralen encyclopedie

5,00 €





Perowskiet

Oxyden
$CaTiO_3$

363

R

Etymologie: genoemd naar de Russische mineraloog L.A. Perowsky (1792-1856) (Rose, 1839)

• Hardheid: 5,5 • Streep: wit, grijs • Kleur: zwart, roodbruin, geel • Transparantie: ondoorzichtig, doorschijnend • Glans: metalen, diamanten, vettig • Splijting: goed • Breukvlak: schelpvormig • Morfologie: kristallen, korrelige, massieve, bobbelige aggregaten.
• Soortelijk gewicht: 4,0 • Kristalstelsel: orthorombisch • Kristalvormen: pseudo-hexaëders, pseudo-octaëders, meerlingen • Radioactiviteit: soms radioactief, afhankelijk van de insluitingen • Chemische samenstelling: 41,24% CaO, 58,76% TiO_2 • Chemische eigenschappen: valt bruisend uiteen in H_2SO_4, lost op in koud HF, smelt niet • Behandeling: wassen met gedestilleerd water • Mineraal dat erop lijkt: magnetiet **(367)** • Verschillen: magnetisme, streep.
• Genese: ultrabasisch, carbonaten, basalt • Paragenese: pyrochloor **(359)**, ilmeniet **(365)**, leuciet **(396)**, titaniet **(430)** enz. • Komt vrij zeldzaam voor • Vindplaatsen: Sovjet-Unie (Akhmatovsk), Finland (Vuorijärvi), Brazilië (Bagagem), Verenigde Staten (Arkansas – Magnet Cove), West-Duitsland (Kaiserstuhl), Zwitserland (Zermatt) • Toepassing: winning van Ti en zeldzame grondstoffen.

Pyrofaniet

Oxyden
$MnTiO_3$

364

Etymologie: afgeleid van de Griekse woorden *pur* = vuur en *phanos* = schitterend (Hamberg, 1890)

• Hardheid: 5 • Streep: okergeel • Kleur: donkerrood, framboosrood en zwart • Transparantie: doorschijnend • Glans: metalen, diamanten • Splijting: volmaakt volgens /02$\bar{2}$1/ • Morfologie: kristallen, schilfers.
• Soortelijk gewicht: 4,5 • Kristalstelsel: romboëdrisch • Kristalvormen: tabletten • Chemische samenstelling: 46,96% MnO_2, 53,04% TiO_2 • Chemische eigenschappen: zeer zwak oplosbaar in zuren • Behandeling: wassen met verdunde zuren of water • Mineraal dat erop lijkt: soms ilmeniet **(365)** • Verschillen: streep, röntgenstralen en chemische reacties.
• Genese: metamorf, pegmatieten • Paragenese: nefelien **(397)**, titaniet **(430)**, rodoniet **(531)** enz. • Komt zeldzaam voor • Vindplaatsen: Zweden (Pajsberg), Noorwegen, Sovjet-Unie (Lovozerskymassief), Groot-Brittannië (Wales – Benallt Mine), Brazilië (Minas Gerais – Piquery Mine).

Ilmeniet

Oxyden
$FeTiO_3$

365

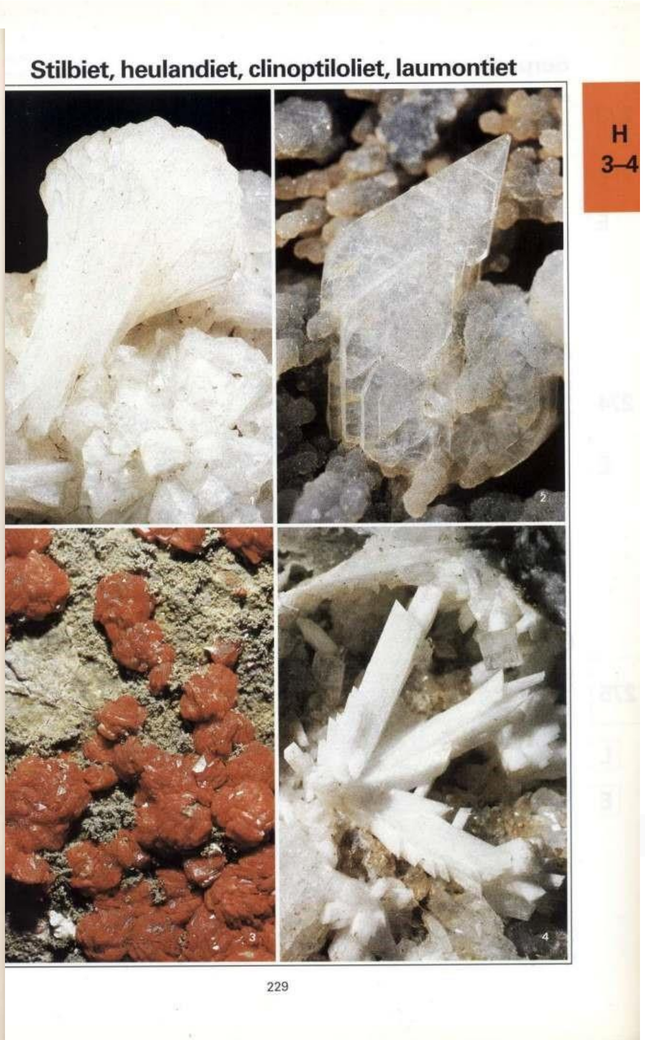
R

Etymologie: genoemd naar de plaats waar het ontdekt is: het Ilmengebergte in de Sovjet-Unie (Kupffer, 1827)

• Hardheid: 5-6 • Streep: bruinzwart • Kleur: zwart • Transparantie: ondoorzichtig • Glans: metalen, vettig • Splijting: niet splijtbaar • Breukvlak: oneffen, schelpvormig • Morfologie: kristallen, massieve, korrelige aggregaten, in rozetten.
• Soortelijk gewicht: 4,5-5,0 • Kristalstelsel: romboëdrisch • Kristalvormen: tabletten • Radioactiviteit: soms radioactief, afhankelijk van de insluitingen • Magnetisme: zwak • Chemische samenstelling: 47,34% FeO, 52,66% TiO_2 • Chemische eigenschappen: onoplosbaar in zuren • Behandeling: wassen met water of met verdunde zuren • Mineralen die erop lijken: pyrofaniet **(364)**, magnetiet **(367)**, chromiet **(371)**, hematiet **(472)** • Verschillen: streep, magnetisme, röntgenstralen en chemische reacties.
• Genese: magmatisch, pegmatieten, bergaders, alluviale afzettingen • Paragenese: magnetiet, apatiet **(379)**, titaniet **(430)**, hematiet, rutiel **(464)** enz. • Komt zeer algemeen voor • Vindplaatsen: Sovjet-Unie (Ilmengebergte), Verenigde Staten (New York), Canada (Quebec), West-Duitsland (Aschaffenburg), Zwitserland (St. Gotthard, Binnental), Frankrijk (Bourg d'Oisans), Groot-Brittannië (Cornwall), Noorwegen (Kragerö), Zweden (Pletherhorn) • Toepassing: Ti-erts.

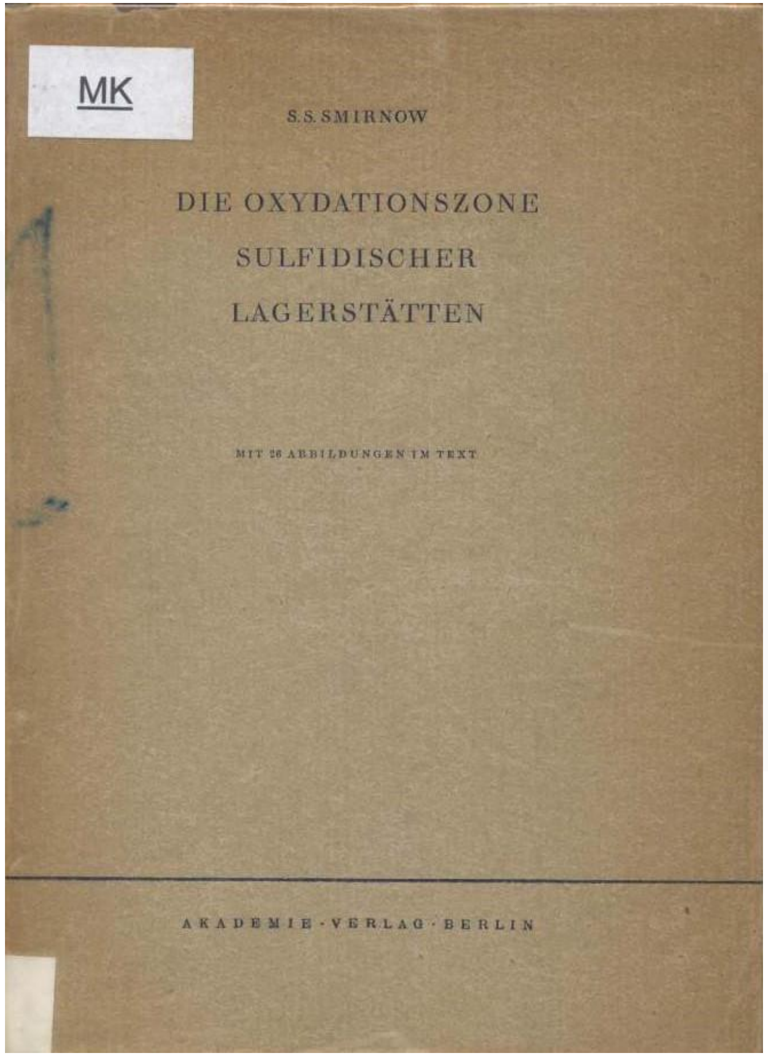
1. Perowskiet – idiomorfe kristallen (tot 10 mm); Sovjet-Unie (Oeral). **2. Ilmeniet** – onvolledig ontwikkelde kristallen (tot 10 mm); Zweden (Pletherhorn).

294



6 Die Oxydationszone sulfidischer Lagerstätten

3,00 €



Als Beispiel kann man die Lagerstätte von Potschekuewsk (Transbalkalien) anführen, in dessen einzelnen Partien Adamin in größeren Mengen vorkommt. Adamin entwickelt sich in Hohlräumen im Limonit, der bei der Oxydation und Auslaugung monheimitischer Erze entstanden ist.

Vanadate

Descloizit .... $4(Pb, Zn)O \cdot V_2O_5 \cdot H_2O$
Hügelit .... *ein wasserhaltiges Pb- und Zn-Vanadat*

Hier kann man all das wiederholen, was bei der Charakteristik der Bleivanadate angeführt wurde.

Silikate

Willemit .... $2ZnO \cdot SiO_2$
CALAMIN .... $2ZnO \cdot SiO_2 \cdot H_2O$
Alumosilikate des Zinkes[1] $1ZnO \cdot m Al_2O_3 \cdot n SiO_2 \cdot p H_2O$

Nach den Karbonaten sind die Silikate die häufigsten Zinkverbindungen der Oxydationszone.

Vorherrschend tritt Calamin auf, der in wechselnden Mengen fast stets in oxydischen Zinkerzen vorkommt und der in einigen Fällen sogar das Hauptmineral bildet.

Die Untersuchung seiner paragenetischen Verhältnisse führt für gewöhnlich zur Folgerung, daß er in seiner Hauptmasse bei der Umarbeitung karbonatischer Erze durch Wässer entsteht, die CO_2 und SiO_2 führen. Hierbei kann man nur selten eine unmittelbare Ersetzung des Zinkspates durch Calamin beobachten, da letzterer meist aus Lösungen abgesetzt wird und Hohlräume ausfüllt. Im besonderen ist seine Bildung in Hohlräumen oxydierter Monheimiterze außerordentlich typisch, offensichtlich durch Umsetzung von kieselsäurehaltigen Wässern mit eisenfreiem Zinkspat, der beim Zerfall von Monheimit in Limonit und reinem Zinkspat entstand.

Versuche zur künstlichen Herstellung von Calamin, die von Wang und L. E. Rotman unternommen wurden, führten zu keinen Ergebnissen.

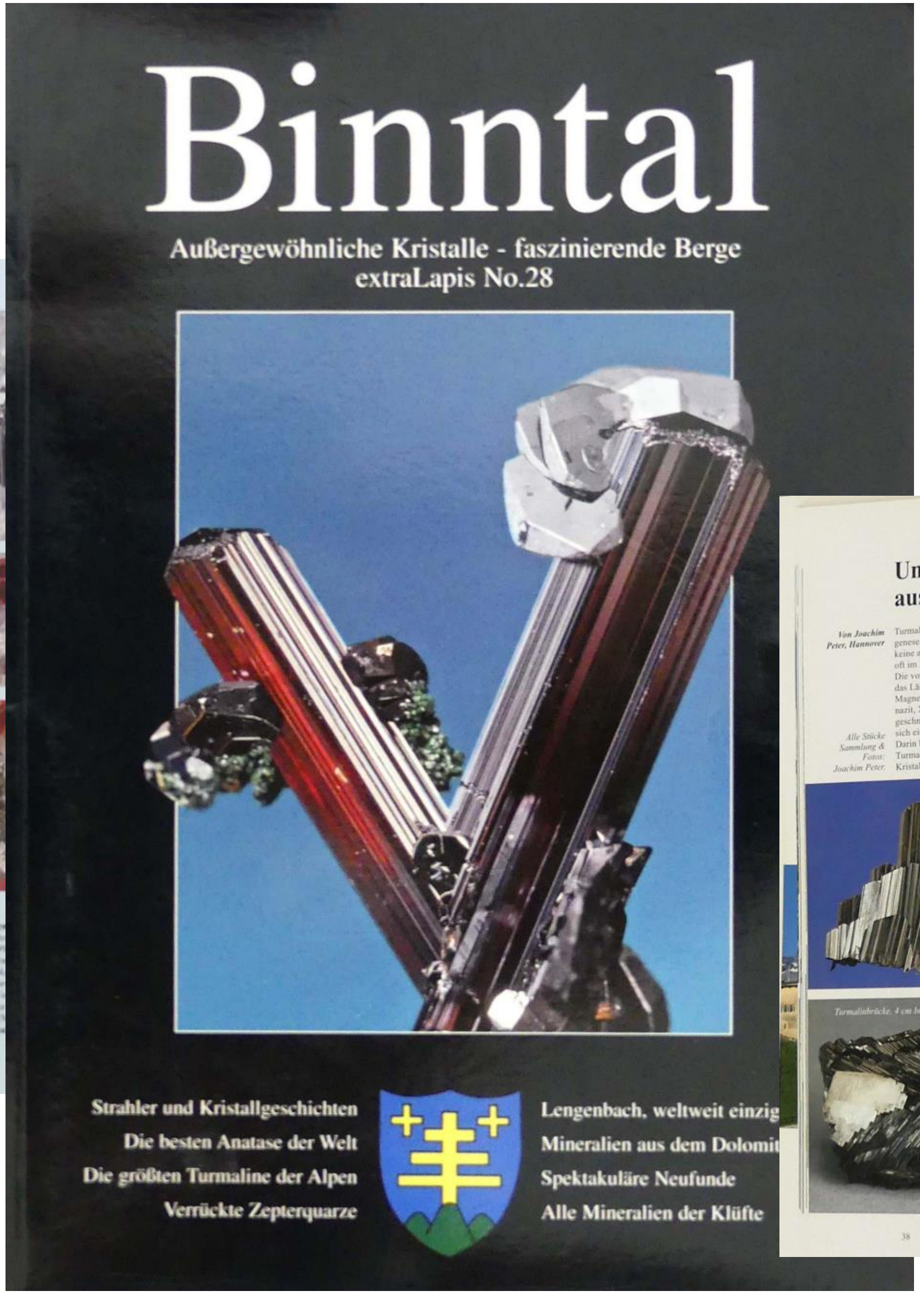
So gelang es z. B. Wang, nur amorphes $ZnSiO_3$ bei Einwirkung von Natriummetasilikat (Na_2SiO_3) auf eine Zinkhydrogenkarbonatlösung zu erhalten. Ein seiner Zusammensetzung nach dem Calamin ähnlicher Niederschlag wurde nur bei der Einwirkung von NaOH und Na_2SiO_3 auf $ZnSO_4$ erhalten. Rotman, der das System ZnO-Na_2O-SiO_2 und ZnO-Na_2O-SiO_2-SO_3 untersuchte, erhielt ebenfalls nur amorphes $ZnSiO_3$ und Zn_2SiO_4.

Daher haben wir bisher noch keine exakten Angaben zur Frage der Bildung des Calamines unter Bedingung der Oxydationszone, und man kann lediglich hervorheben, daß alle Angaben zugunsten seiner vorzugsweisen Bildung bei der Wechselwirkung von hydrogen-karbonatischen und nicht sulfatischen Lösungen von Zink mit SiO_2-führenden Wässern sprechen.

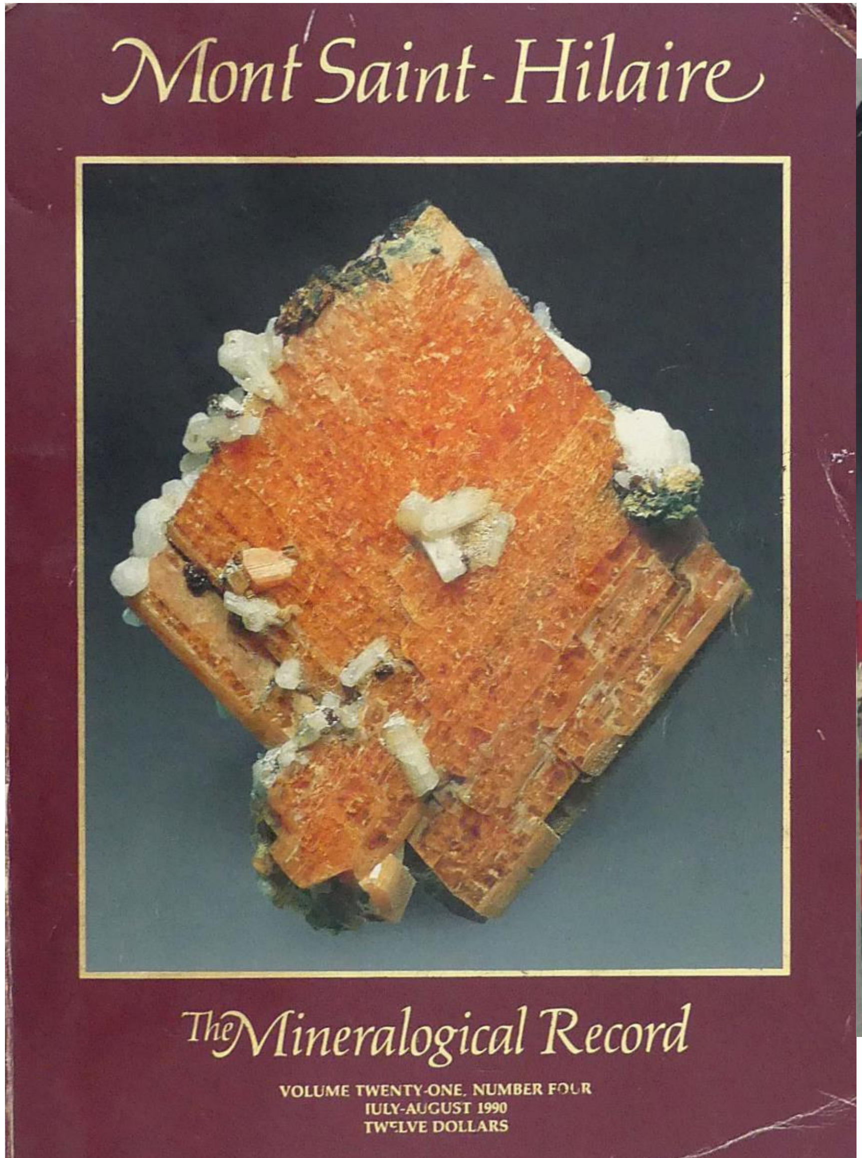
[1] Hierher gehören: Moresnetit, Vanuxemit, Fraipontit, zinkhaltige Tone und Kaoline usw.

7 Binntal

10,00 €



8 Mont Saint Hilaire 3,00 €



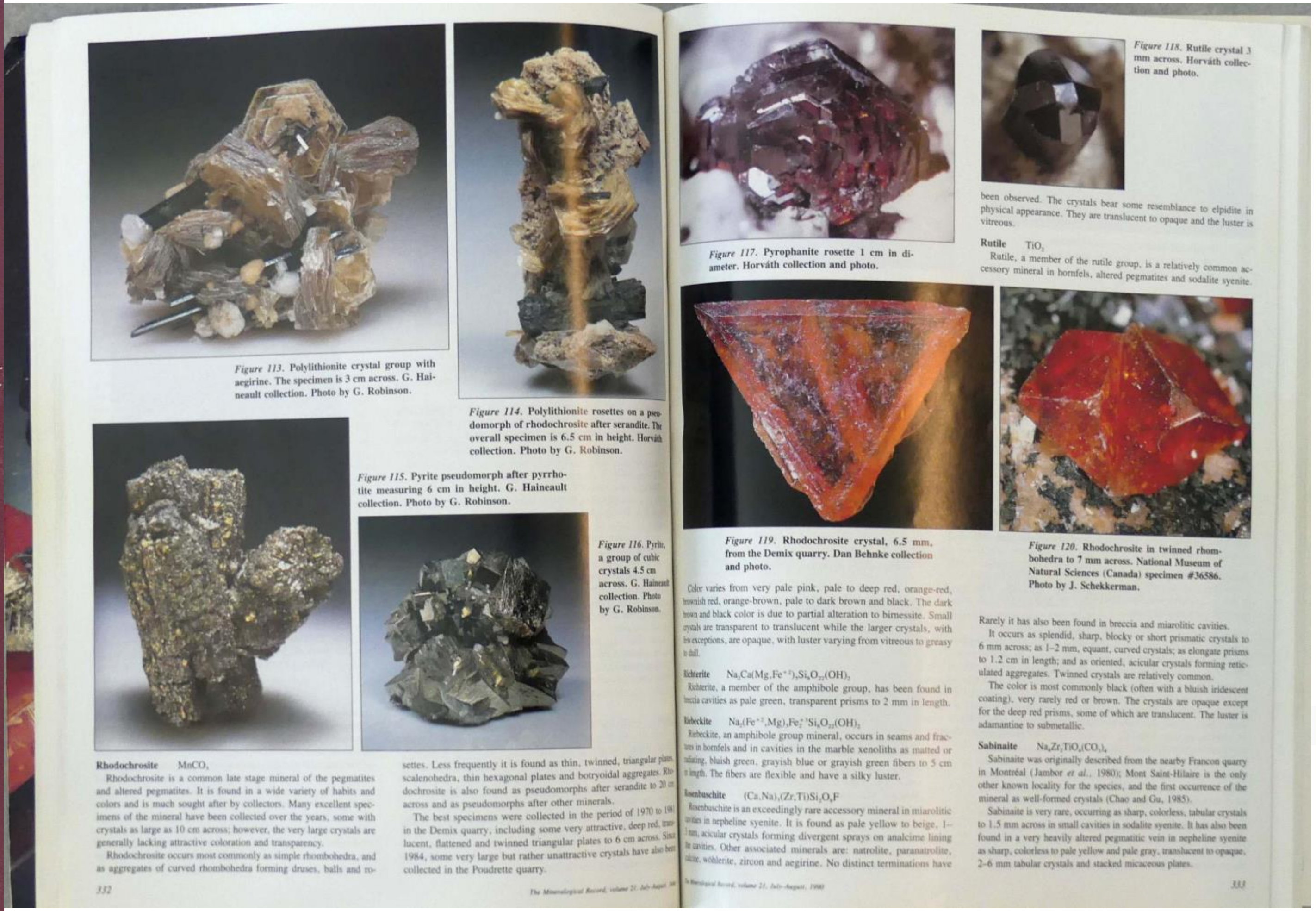


Figure 113. Polylithionite crystal group with aegirine. The specimen is 3 cm across. G. Haineault collection. Photo by G. Robinson.

Figure 114. Polylithionite rosettes on a pseudomorph of rhodochrosite after serandite. The overall specimen is 6.5 cm in height. Horváth collection. Photo by G. Robinson.

Figure 115. Pyrite pseudomorph after pyrrhotite measuring 6 cm in height. G. Haineault collection. Photo by G. Robinson.

Figure 116. Pyrite, a group of cubic crystals 4.5 cm across. G. Haineault collection. Photo by G. Robinson.

Rhodochrosite $MnCO_3$

Rhodochrosite is a common late stage mineral of the pegmatites and altered pegmatites. It is found in a wide variety of habits and colors and is much sought after by collectors. Many excellent specimens of the mineral have been collected over the years, some with crystals as large as 10 cm across; however, the very large crystals are generally lacking attractive coloration and transparency.

Rhodochrosite occurs most commonly as simple rhombohedra, and as aggregates of curved rhombohedra forming druses, balls and rosettes. Less frequently it is found as thin, twinned, triangular plates, scalenohedra, thin hexagonal plates and botryoidal aggregates. Rhodochrosite is also found as pseudomorphs after serandite to 20 cm across and as pseudomorphs after other minerals.

The best specimens were collected in the period of 1970 to 1981 in the Demix quarry, including some very attractive, deep red, translucent, flattened and twinned triangular plates to 6 cm across. Since 1984, some very large but rather unattractive crystals have also been collected in the Poudrette quarry.

332 The Mineralogical Record, volume 21, July-August 1990

Figure 117. Pyrophanite rosette 1 cm in diameter. Horváth collection and photo.

Figure 118. Rutile crystal 3 mm across. Horváth collection and photo.

been observed. The crystals bear some resemblance to elpidite in physical appearance. They are translucent to opaque and the luster is vitreous.

Rutile TiO_2

Rutile, a member of the rutile group, is a relatively common accessory mineral in hornfels, altered pegmatites and sodalite syenite.

Figure 119. Rhodochrosite crystal, 6.5 mm, from the Demix quarry. Dan Behnke collection and photo.

Figure 120. Rhodochrosite in twinned rhombohedra to 7 mm across. National Museum of Natural Sciences (Canada) specimen #36586. Photo by J. Schekkerman.

Color varies from very pale pink, pale to deep red, orange-red, brownish red, orange-brown, pale to dark brown and black. The dark brown and black color is due to partial alteration to birnessite. Small crystals are transparent to translucent while the larger crystals, with few exceptions, are opaque, with luster varying from vitreous to greasy to dull.

Richterite $Na_2Ca(Mg,Fe^{+2})_5Si_8O_{22}(OH)_2$

Richterite, a member of the amphibole group, has been found in breccia cavities as pale green, transparent prisms to 2 mm in length.

Riebeckite $Na_2(Fe^{+2},Mg)_3Fe_2^{+3}Si_8O_{22}(OH)_2$

Riebeckite, an amphibole group mineral, occurs in seams and fractures in hornfels and in cavities in the marble xenoliths as matted or radiating, bluish green, grayish blue or grayish green fibers to 5 cm in length. The fibers are flexible and have a silky luster.

Rosenbuschite $(Ca,Na)_3(Zr,Ti)Si_2O_8F$

Rosenbuschite is an exceedingly rare accessory mineral in miarolitic cavities in nepheline syenite. It is found as pale yellow to beige, 1–3 mm, acicular crystals forming divergent sprays on analcime lining the cavities. Other associated minerals are: natrolite, paranatrolite, calcite, wöhlerite, zircon and aegirine. No distinct terminations have

Rarely it has also been found in breccia and miarolitic cavities.

It occurs as splendid, sharp, blocky or short prismatic crystals to 6 mm across; as 1–2 mm, equant, curved crystals; as elongate prisms to 1.2 cm in length; and as oriented, acicular crystals forming reticulated aggregates. Twinned crystals are relatively common.

The color is most commonly black (often with a bluish iridescent coating), very rarely red or brown. The crystals are opaque except for the deep red prisms, some of which are translucent. The luster is adamantine to submetallic.

Sabinaite $Na_4Zr_2TiO_4(CO_3)_4$

Sabinaite was originally described from the nearby Francon quarry in Montréal (Jambor *et al.*, 1980); Mont Saint-Hilaire is the only other known locality for the species, and the first occurrence of the mineral as well-formed crystals (Chao and Gu, 1985).

Sabinaite is very rare, occurring as sharp, colorless, tabular crystals to 1.5 mm across in small cavities in sodalite syenite. It has also been found in a very heavily altered pegmatitic vein in nepheline syenite as sharp, colorless to pale yellow and pale gray, translucent to opaque, 2-6 mm tabular crystals and stacked micaceous plates.

The Mineralogical Record, volume 21, July-August, 1990 333

9 Die Grube Clara

5,00 €

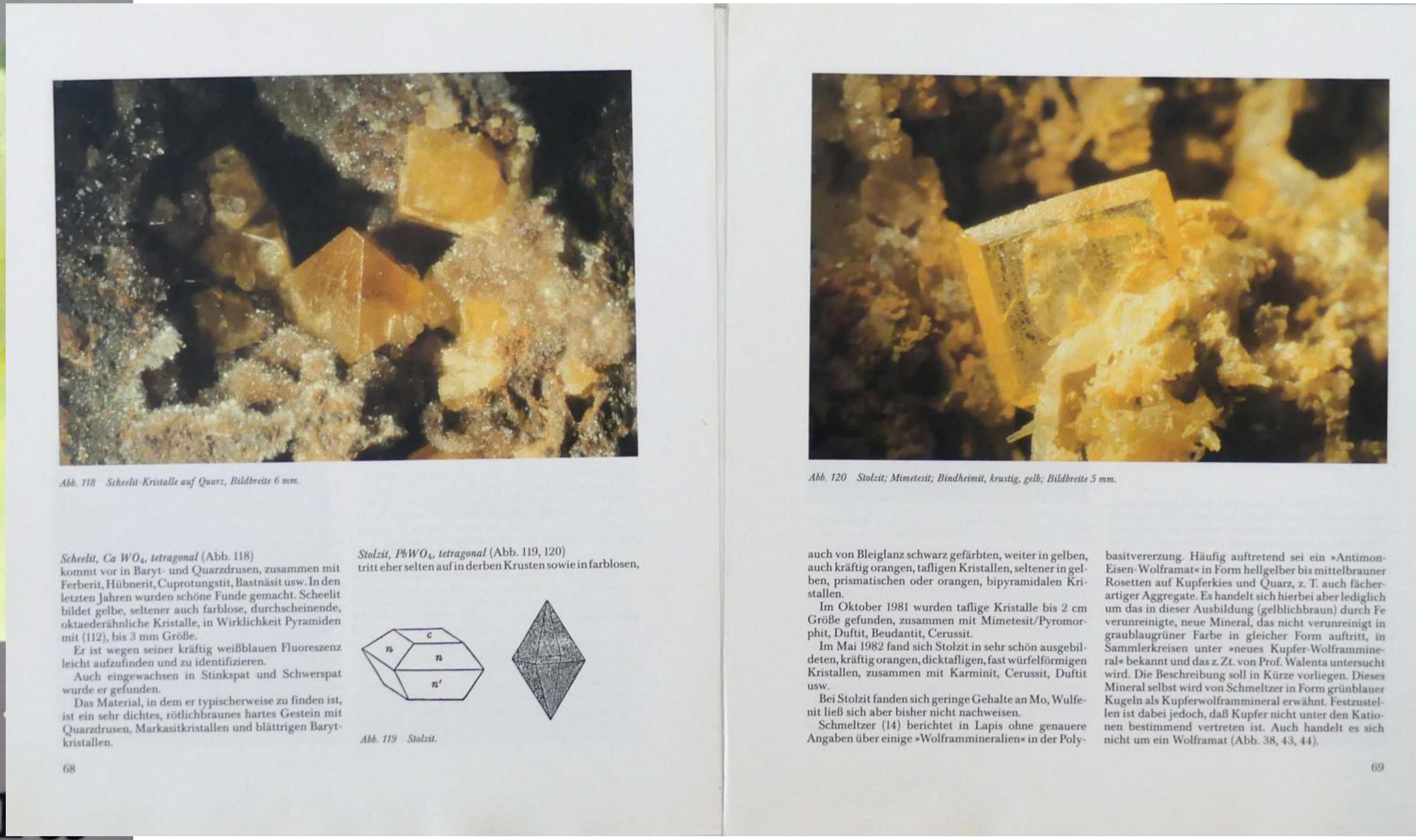


Abb. 118 Scheelit-Kristalle auf Quarz, Bildbreite 6 mm.

Scheelit, Ca WO_4, tetragonal (Abb. 118)
kommt vor in Baryt- und Quarzdrusen, zusammen mit Ferberit, Hübnerit, Cuprotungstit, Bastnäsit usw. In den letzten Jahren wurden schöne Funde gemacht. Scheelit bildet gelbe, seltener auch farblose, durchscheinende, oktaederähnliche Kristalle, in Wirklichkeit Pyramiden mit (112), bis 3 mm Größe.

Er ist wegen seiner kräftig weißblauen Fluoreszenz leicht aufzufinden und zu identifizieren.

Auch eingewachsen in Stinkspat und Schwerspat wurde er gefunden.

Das Material, in dem er typischerweise zu finden ist, ist ein sehr dichtes, rötlichbraunes hartes Gestein mit Quarzdrusen, Markasitkristallen und blättrigen Barytkristallen.

Stolzit, $PbWO_4$, tetragonal (Abb. 119, 120)
tritt eher selten auf in derben Krusten sowie in farblosen,

Abb. 119 Stolzit.

68

Abb. 120 Stolzit; Mimetesit; Bindheimit, krustig, gelb; Bildbreite 5 mm.

auch von Bleiglanz schwarz gefärbten, weiter in gelben, auch kräftig orangen, tafligen Kristallen, seltener in gelben, prismatischen oder orangen, bipyramidalen Kristallen.

Im Oktober 1981 wurden taflige Kristalle bis 2 cm Größe gefunden, zusammen mit Mimetesit/Pyromorphit, Duftit, Beudantit, Cerussit.

Im Mai 1982 fand sich Stolzit in sehr schön ausgebildeten, kräftig orangen, dicktafligen, fast würfelförmigen Kristallen, zusammen mit Karminit, Cerussit, Duftit usw.

Bei Stolzit fanden sich geringe Gehalte an Mo, Wulfenit ließ sich aber bisher nicht nachweisen.

Schmeltzer (14) berichtet in Lapis ohne genauere Angaben über einige »Wolframmineralien« in der Polybasitvererzung. Häufig auftretend sei ein »Antimon-Eisen-Wolframat« in Form hellgelber bis mittelbrauner Rosetten auf Kupferkies und Quarz, z. T. auch fächerartiger Aggregate. Es handelt sich hierbei aber lediglich um das in dieser Ausbildung (gelblichbraun) durch Fe verunreinigte, neue Mineral, das nicht verunreinigt in graublaugrüner Farbe in gleicher Form auftritt, in Sammlerkreisen unter »neues Kupfer-Wolframmineral« bekannt und das z. Zt. von Prof. Walenta untersucht wird. Die Beschreibung soll in Kürze vorliegen. Dieses Mineral selbst wird von Schmeltzer in Form grünblauer Kugeln als Kupferwolframmineral erwähnt. Festzustellen ist dabei jedoch, daß Kupfer nicht unter den Kationen bestimmend vertreten ist. Auch handelt es sich nicht um ein Wolframat (Abb. 38, 43, 44).

69

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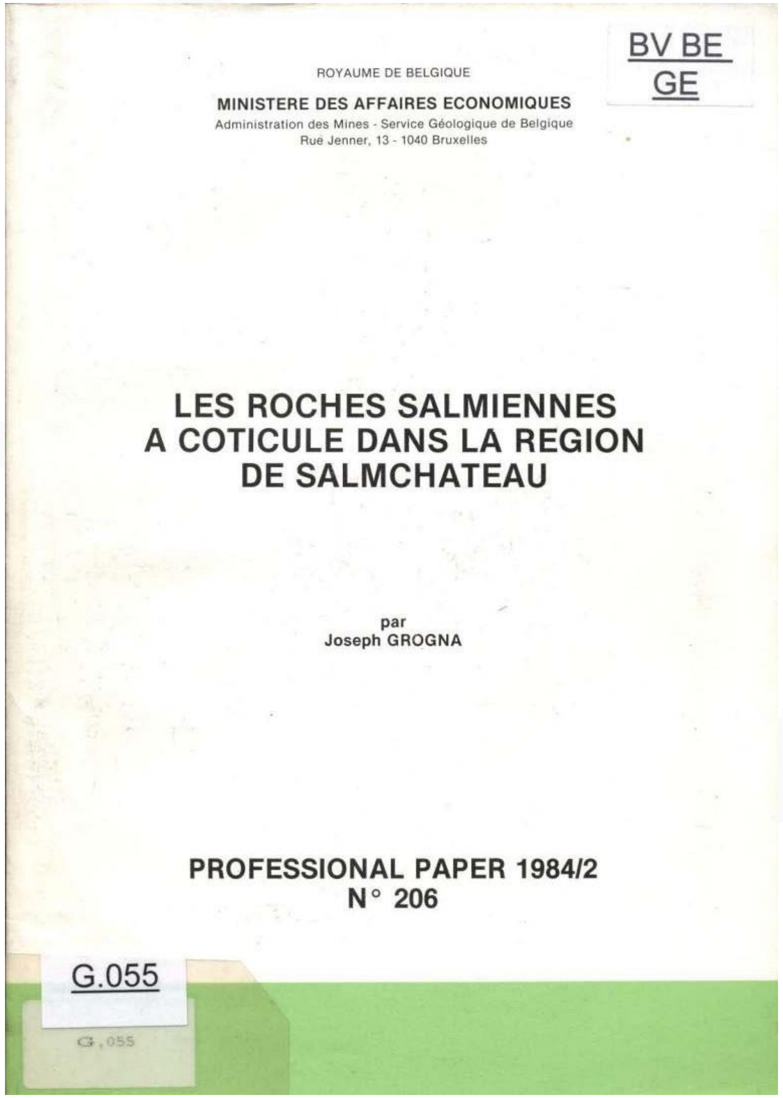
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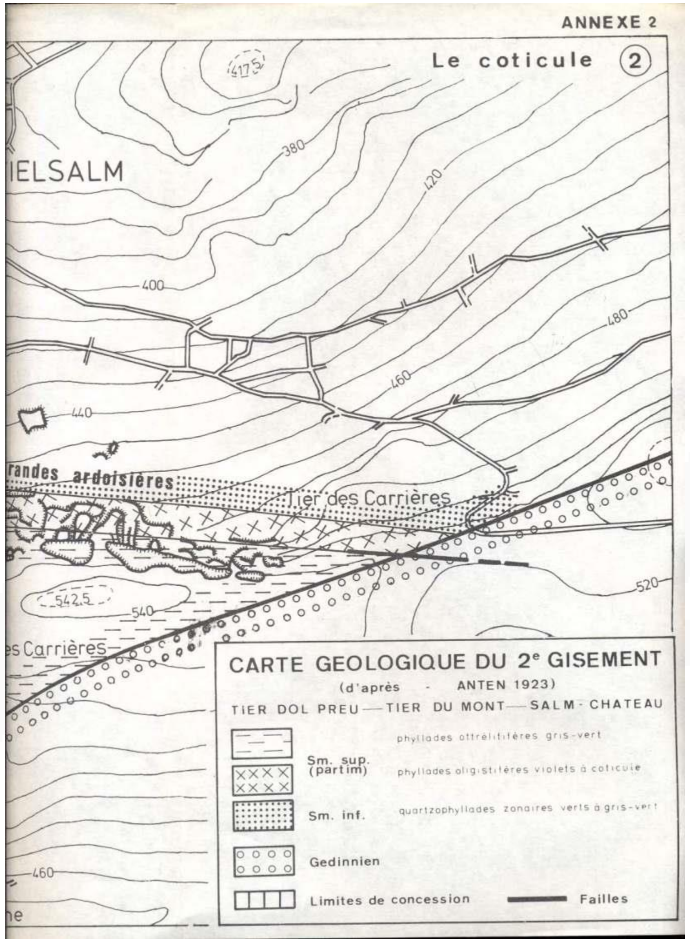
LES ROCHES SALMIENNES A COTICULE DANS LA REGION DE SALMCHATEAU

par

Joseph GROGNA

PROFESSIONAL PAPER 1984/2

N° 206



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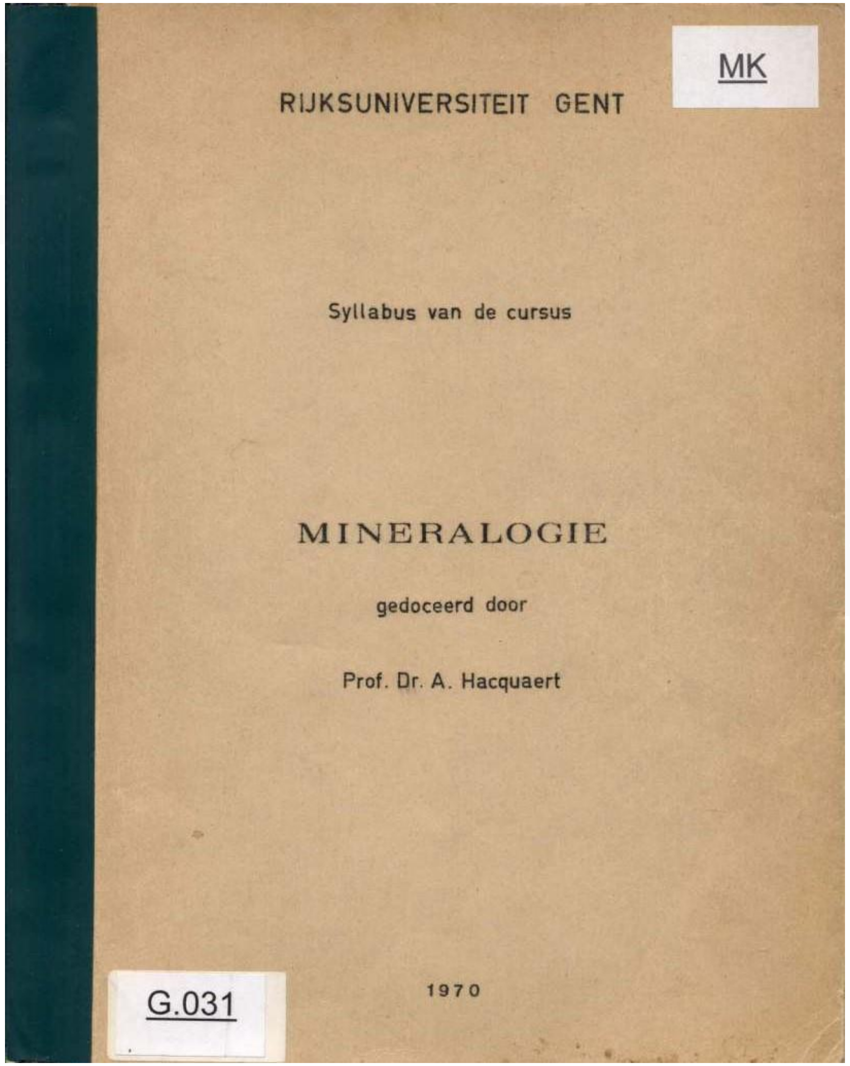

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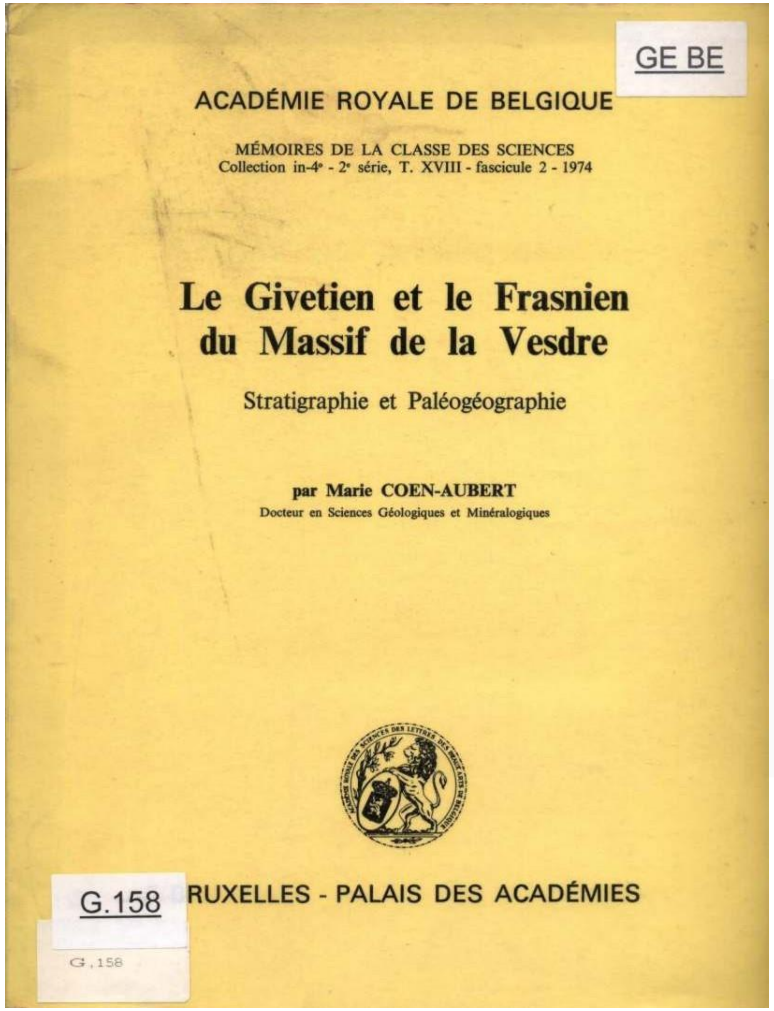

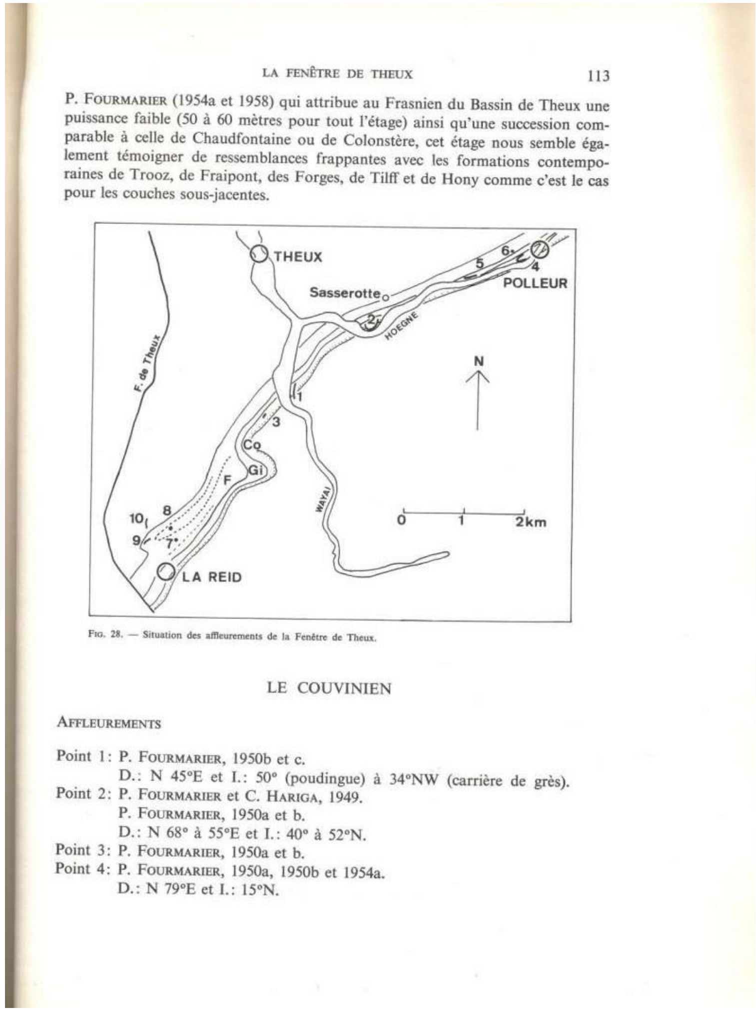

LA FENÊTRE DE THEUX 113

P. FOURMARIER (1954a et 1958) qui attribue au Frasnien du Bassin de Theux une puissance faible (50 à 60 mètres pour tout l'étage) ainsi qu'une succession comparable à celle de Chaudfontaine ou de Colonstère, cet étage nous semble également témoigner de ressemblances frappantes avec les formations contemporaines de Trooz, de Fraipont, des Forges, de Tilff et de Hony comme c'est le cas pour les couches sous-jacentes.

THEUX, Sasserotte, POLLEUR, HOEGNE, F. de Theux, N, WAYAI, Co, Gi, F, 0, 1, 2km, LA REID, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

FIG. 28. — Situation des affleurements de la Fenêtre de Theux.

LE COUVINIEN

AFFLEUREMENTS

Point 1: P. FOURMARIER, 1950b et c.
D.: N 45°E et I.: 50° (poudingue) à 34°NW (carrière de grès).
Point 2: P. FOURMARIER et C. HARIGA, 1949.
P. FOURMARIER, 1950a et b.
D.: N 68° à 55°E et I.: 40° à 52°N.
Point 3: P. FOURMARIER, 1950a et b.
Point 4: P. FOURMARIER, 1950a, 1950b et 1954a.
D.: N 79°E et I.: 15°N.

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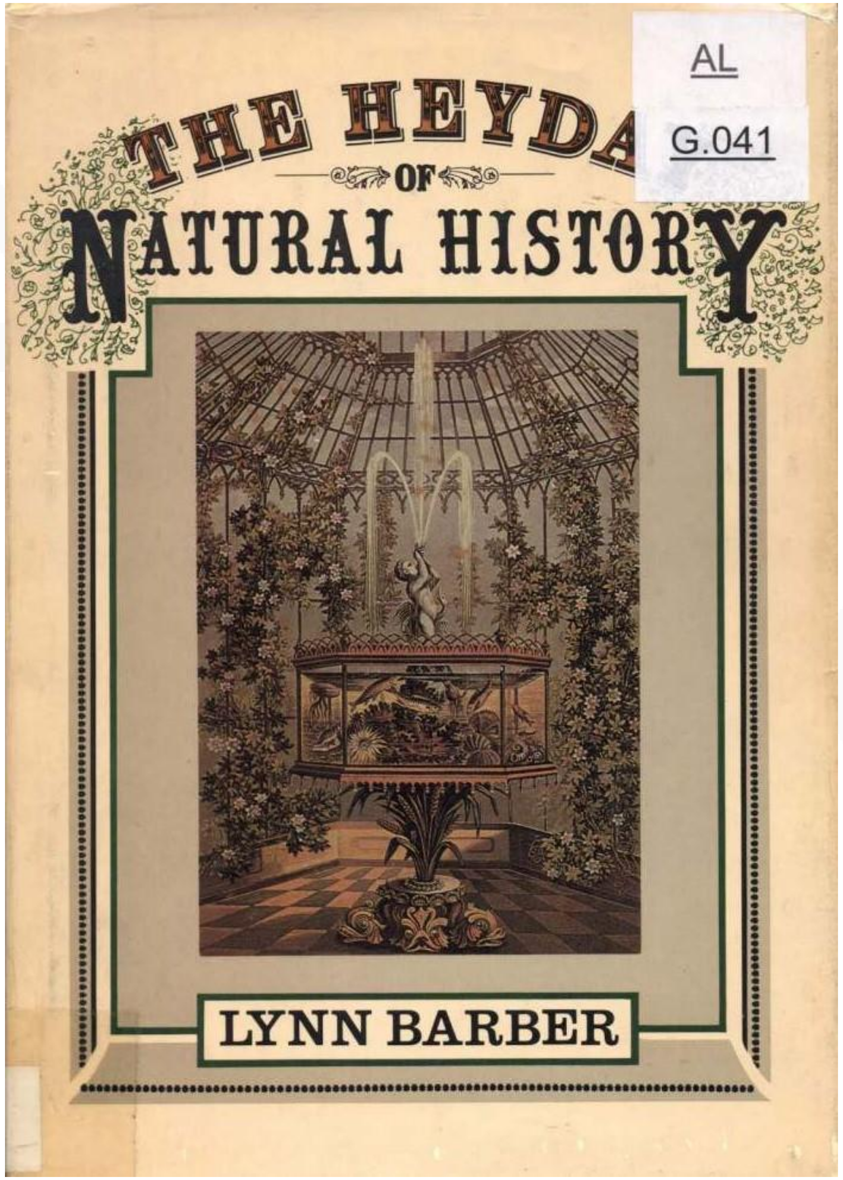

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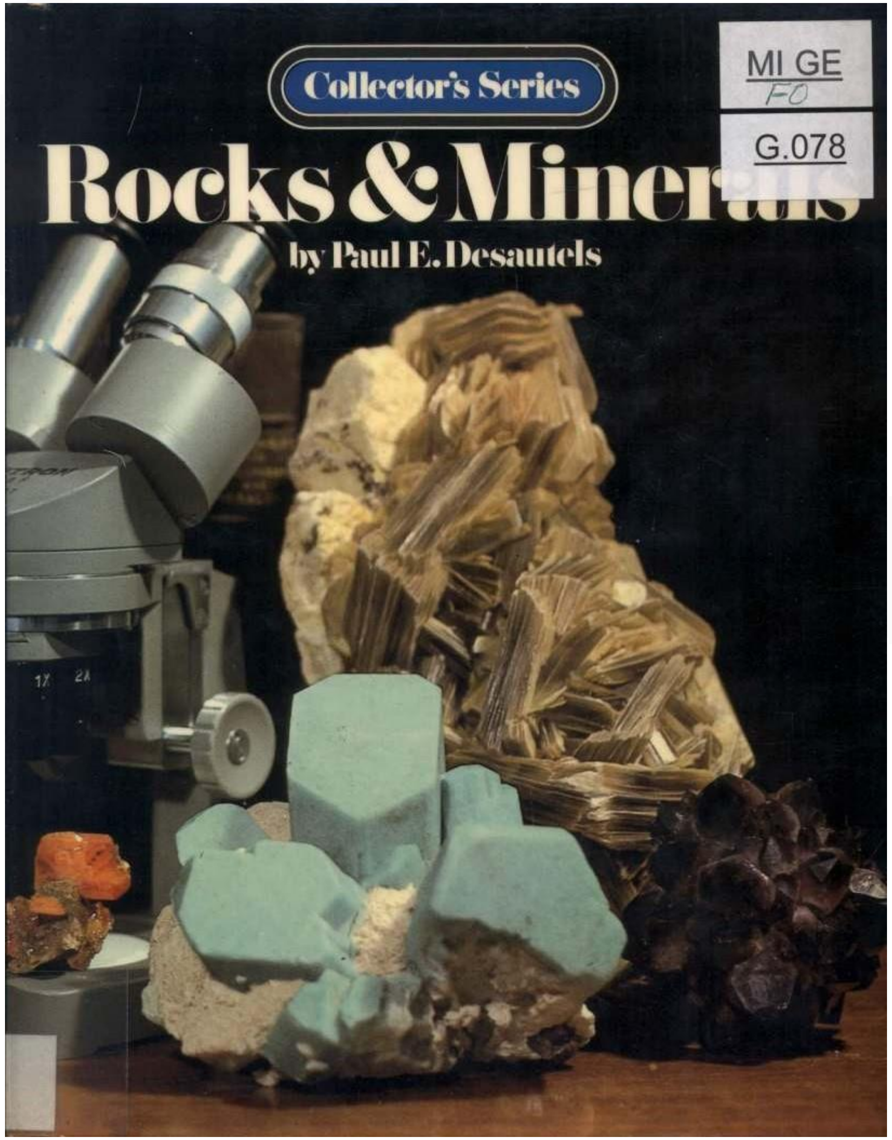

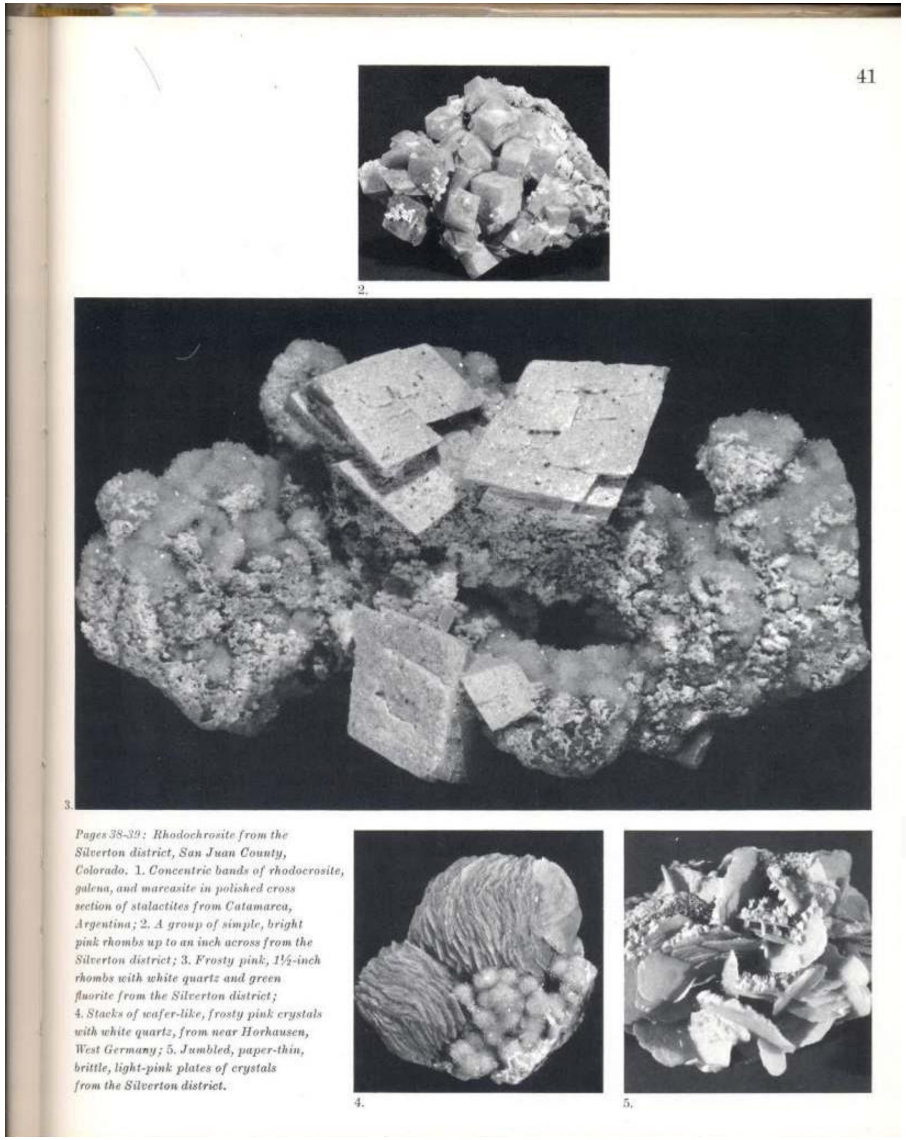
41

2.

3.

Pages 38-39: Rhodochrosite from the Silverton district, San Juan County, Colorado. 1. *Concentric bands of rhodocrosite, galena, and marcasite in polished cross section of stalactites from Catamarca, Argentina;* 2. *A group of simple, bright pink rhombs up to an inch across from the Silverton district;* 3. *Frosty pink, 1½-inch rhombs with white quartz and green fluorite from the Silverton district;* 4. *Stacks of wafer-like, frosty pink crystals with white quartz, from near Horhausen, West Germany;* 5. *Jumbled, paper-thin, brittle, light-pink plates of crystals from the Silverton district.*

4.

5.

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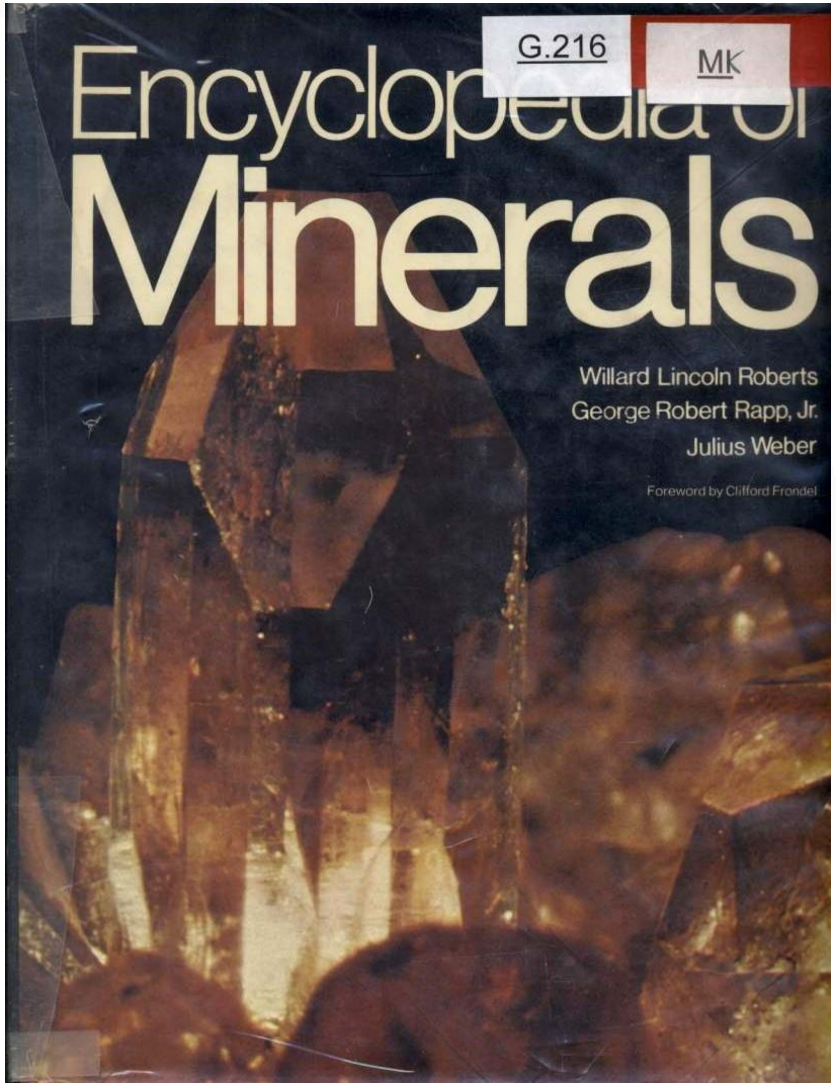

COLOR-LUSTER: Orange.

MODE OF OCCURRENCE: Occurs at Alcaparossa and Chuquicamata, Chile, as an alteration product of hohmannite.

BEST REF. IN ENGLISH: Palache, et al., "Dana's System of Mineralogy," 7th Ed., v. II, p. 608, New York, Wiley, 1951.

METAKAHLERITE

$Fe(UO_2)_2(AsO_4)_2 \cdot 8H_2O$

CRYSTAL SYSTEM: Tetragonal
Z: 1
LATTICE CONSTANTS:
$a = 7.18$
$c = 8.58$
3 STRONGEST DIFFRACTION LINES:

(Sophia Shaft)	(synthetic)
3.59 (100)	8.86 (100)
8.55 (90)	3.59 (100)
4.29 (60)	1.608 (70)

OPTICAL CONSTANTS:
$\omega = 1.642$
$\epsilon = 1.608$
Uniaxial to biaxial, negative, with 2V up to 22°.
HARDNESS: Not determined
DENSITY: 3.84 (Calc.)
CLEAVAGE: {001} excellent
{100} good
HABIT: As scaly aggregates.
COLOR-LUSTER: Sulfur yellow; pearly on {001}.

MODE OF OCCURRENCE: Occurs in the Sophia Shaft, Wittichen, Baden, Germany.

BEST REF. IN ENGLISH: Walenta, Kurt, *Am. Min.*, **45**: 254 (1960).

METAKIRCHHEIMERITE

$Co(UO_2)_2(AsO_4)_2 \cdot 8H_2O$

CRYSTAL SYSTEM: Tetragonal
LATTICE CONSTANTS: Cell probably similar to metakahlerite.
3 STRONGEST DIFFRACTION LINES:
8.55 (100)
3.56 (100)
5.07 (60)
OPTICAL CONSTANTS:
$\omega = 1.644$
$\epsilon = 1.617$
Uniaxial to biaxial (−) with 2V = 0°–20°
HARDNESS: 2–2½
DENSITY: < 3.33
CLEAVAGE: {001} excellent
HABIT: As tabular crystals, and crusts.
COLOR-LUSTER: Pale rose; pearly on cleavage.

MODE OF OCCURRENCE: Occurs associated with metakahlerite, novacekite, meta-heinrichite, and erythrite in the Sophia shaft, Wittichen, Baden, Germany.

BEST REF. IN ENGLISH: Walenta, K., *Am. Min.*, **44**: 466 (1959).

METANOVACEKITE

$Mg(UO_2)_2(AsO_4)_2 \cdot 4\text{-}8H_2O$
Autunite Group

CRYSTAL SYSTEM: Tetragonal
CLASS: 4/m
SPACE GROUP: P4/n
Z: 1
LATTICE CONSTANTS:
$a = 7.16$
$c = 8.58$
3 STRONGEST DIFFRACTION LINES:
8.52 (100)
3.57 (90)
2.14 (60)
OPTICAL CONSTANTS:
$\omega = 1.632$
$\epsilon = 1.595$
(−)
HARDNESS: 2½
DENSITY: 3.51 (Meas.)
3.716 (Calc.)
CLEAVAGE: {001} perfect
{010} indistinct
{110} indistinct

HABIT: Crystals rectangular plates flattened on {001}. As crusts or porous interlocking aggregates of thin plates and scales; also as lamellar aggregates.

COLOR-LUSTER: Dull pale yellow, yellow. Nearly opaque. Fluoresces dull green in ultraviolet light.

MODE OF OCCURRENCE: Occurs at the Anton mine, Black Forest, Germany.

BEST REF. IN ENGLISH: Walenta, Kurt, *J. Geol. Landes. Baden-Wurtemburg*, **3**: 17 (1958). Walenta, Kurt, *Tscherm. min. pet. Mitt.*, **9**: 111–174 (1964).

METAROSSITE

$CaV_2O_6 \cdot 2H_2O$

CRYSTAL SYSTEM: Triclinic
Z: 2
LATTICE CONSTANTS:

$a = 7.065$	$\alpha = 96°39'$
$b = 7.769$	$\beta = 105°47'$
$c = 6.215$	$\gamma = 92°58'$

OPTICAL CONSTANTS:
$\alpha = 1.840$
$\beta > 1.85$
$\gamma > 1.85$
(+)2V = large
HARDNESS: Not determined. Soft.
DENSITY: 2.45 (Meas.)
CLEAVAGE: Not determined. Friable.

HABIT: As platy to flaky masses and veinlets. Twinned on $(0\bar{1}1)$.

COLOR-LUSTER: Light yellow. Pearly to dull.

Soluble in water.

MODE OF OCCURRENCE: Occurs as a dehydration product of rossite in carnotite-bearing sandstone in Bull Pen Canyon, and in ore from the Buckhorn claim, Slick Rock district, San Miguel County, Colorado.

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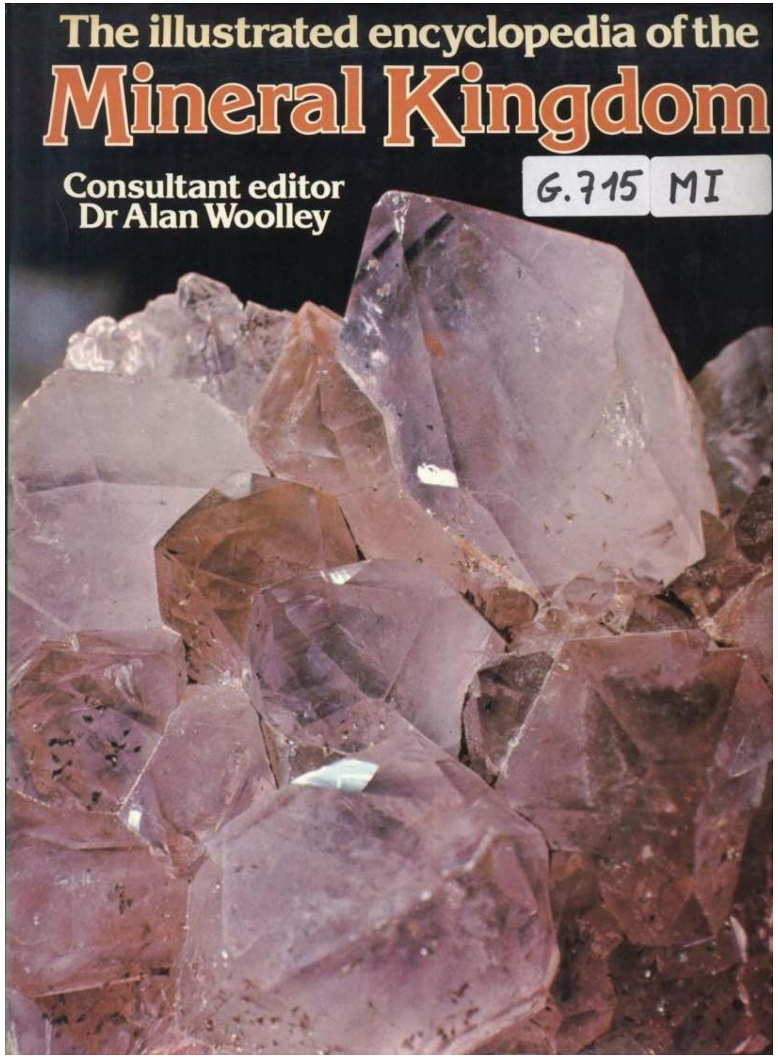
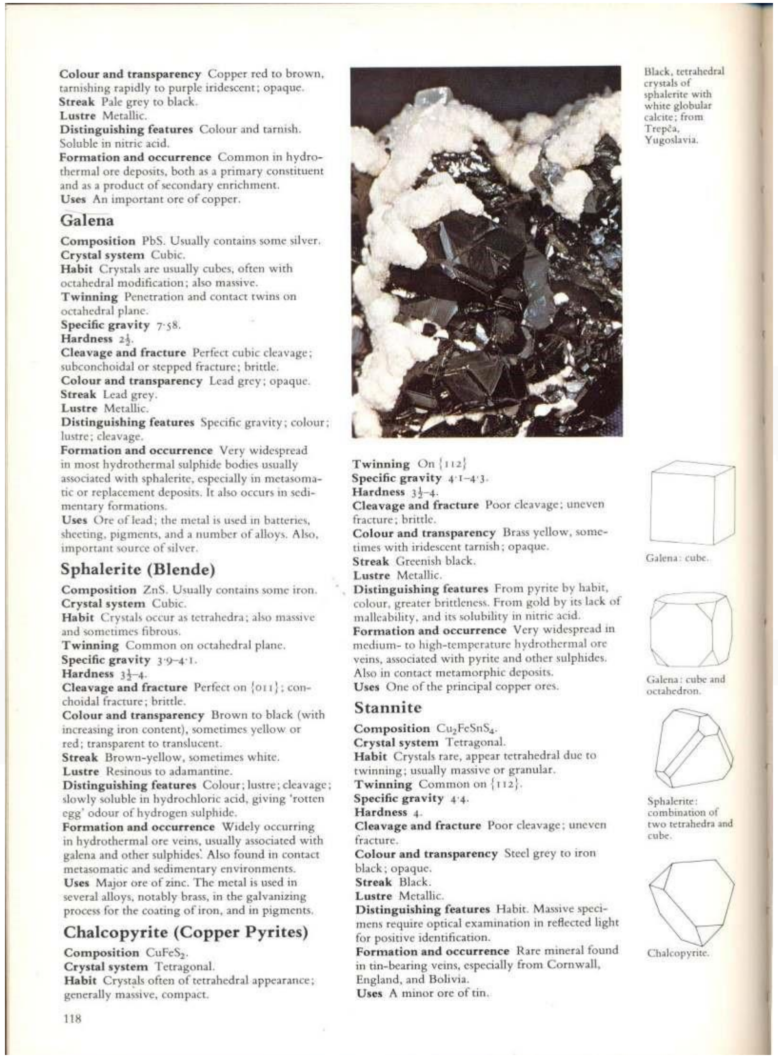




Colour and transparency Copper red to brown, tarnishing rapidly to purple iridescent; opaque.
Streak Pale grey to black.
Lustre Metallic.
Distinguishing features Colour and tarnish. Soluble in nitric acid.
Formation and occurrence Common in hydrothermal ore deposits, both as a primary constituent and as a product of secondary enrichment.
Uses An important ore of copper.

Galena

Composition PbS. Usually contains some silver.
Crystal system Cubic.
Habit Crystals are usually cubes, often with octahedral modification; also massive.
Twinning Penetration and contact twins on octahedral plane.
Specific gravity 7·58.
Hardness 2½.
Cleavage and fracture Perfect cubic cleavage; subconchoidal or stepped fracture; brittle.
Colour and transparency Lead grey; opaque.
Streak Lead grey.
Lustre Metallic.
Distinguishing features Specific gravity; colour; lustre; cleavage.
Formation and occurrence Very widespread in most hydrothermal sulphide bodies usually associated with sphalerite, especially in metasomatic or replacement deposits. It also occurs in sedimentary formations.
Uses Ore of lead; the metal is used in batteries, sheeting, pigments, and a number of alloys. Also, important source of silver.

Sphalerite (Blende)

Composition ZnS. Usually contains some iron.
Crystal system Cubic.
Habit Crystals occur as tetrahedra; also massive and sometimes fibrous.
Twinning Common on octahedral plane.
Specific gravity 3·9–4·1.
Hardness 3½–4.
Cleavage and fracture Perfect on {011}; conchoidal fracture; brittle.
Colour and transparency Brown to black (with increasing iron content), sometimes yellow or red; transparent to translucent.
Streak Brown-yellow, sometimes white.
Lustre Resinous to adamantine.
Distinguishing features Colour; lustre; cleavage; slowly soluble in hydrochloric acid, giving 'rotten egg' odour of hydrogen sulphide.
Formation and occurrence Widely occurring in hydrothermal ore veins, usually associated with galena and other sulphides. Also found in contact metasomatic and sedimentary environments.
Uses Major ore of zinc. The metal is used in several alloys, notably brass, in the galvanizing process for the coating of iron, and in pigments.

Chalcopyrite (Copper Pyrites)

Composition $CuFeS_2$.
Crystal system Tetragonal.
Habit Crystals often of tetrahedral appearance; generally massive, compact.

Black, tetrahedral crystals of sphalerite with white globular calcite; from Trepča, Yugoslavia.

Twinning On {112}
Specific gravity 4·1–4·3.
Hardness 3½–4.
Cleavage and fracture Poor cleavage; uneven fracture; brittle.
Colour and transparency Brass yellow, sometimes with iridescent tarnish; opaque.
Streak Greenish black.
Lustre Metallic.
Distinguishing features From pyrite by habit, colour, greater brittleness. From gold by its lack of malleability, and its solubility in nitric acid.
Formation and occurrence Very widespread in medium- to high-temperature hydrothermal ore veins, associated with pyrite and other sulphides. Also in contact metamorphic deposits.
Uses One of the principal copper ores.

Stannite

Composition Cu_2FeSnS_4.
Crystal system Tetragonal.
Habit Crystals rare, appear tetrahedral due to twinning; usually massive or granular.
Twinning Common on {112}.
Specific gravity 4·4.
Hardness 4.
Cleavage and fracture Poor cleavage; uneven fracture.
Colour and transparency Steel grey to iron black; opaque.
Streak Black.
Lustre Metallic.
Distinguishing features Habit. Massive specimens require optical examination in reflected light for positive identification.
Formation and occurrence Rare mineral found in tin-bearing veins, especially from Cornwall, England, and Bolivia.
Uses A minor ore of tin.

Galena: cube.

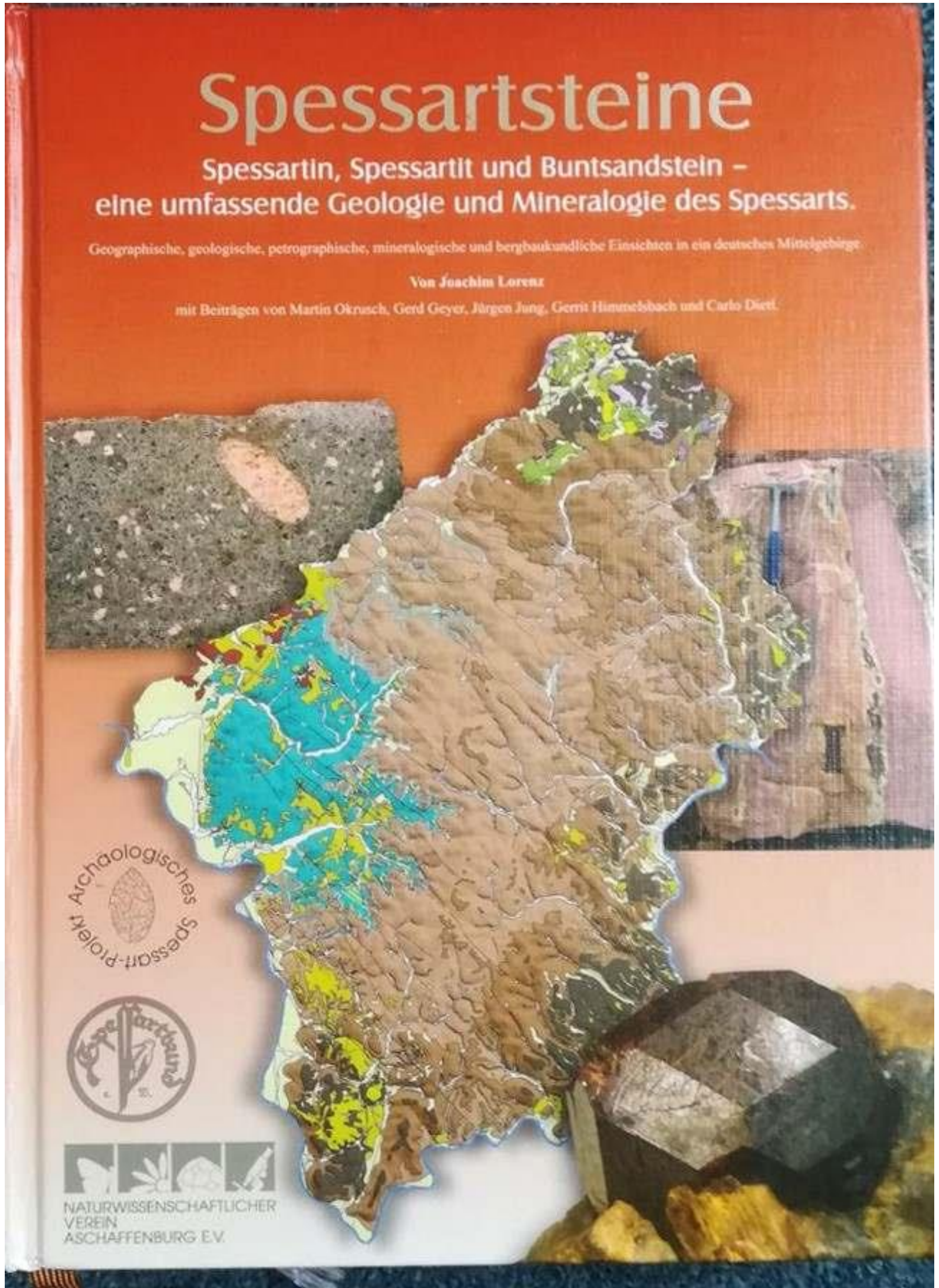
Galena: cube and octahedron.

Sphalerite: combination of two tetrahedra and cube.

Chalcopyrite.

118

17 Spessartsteine



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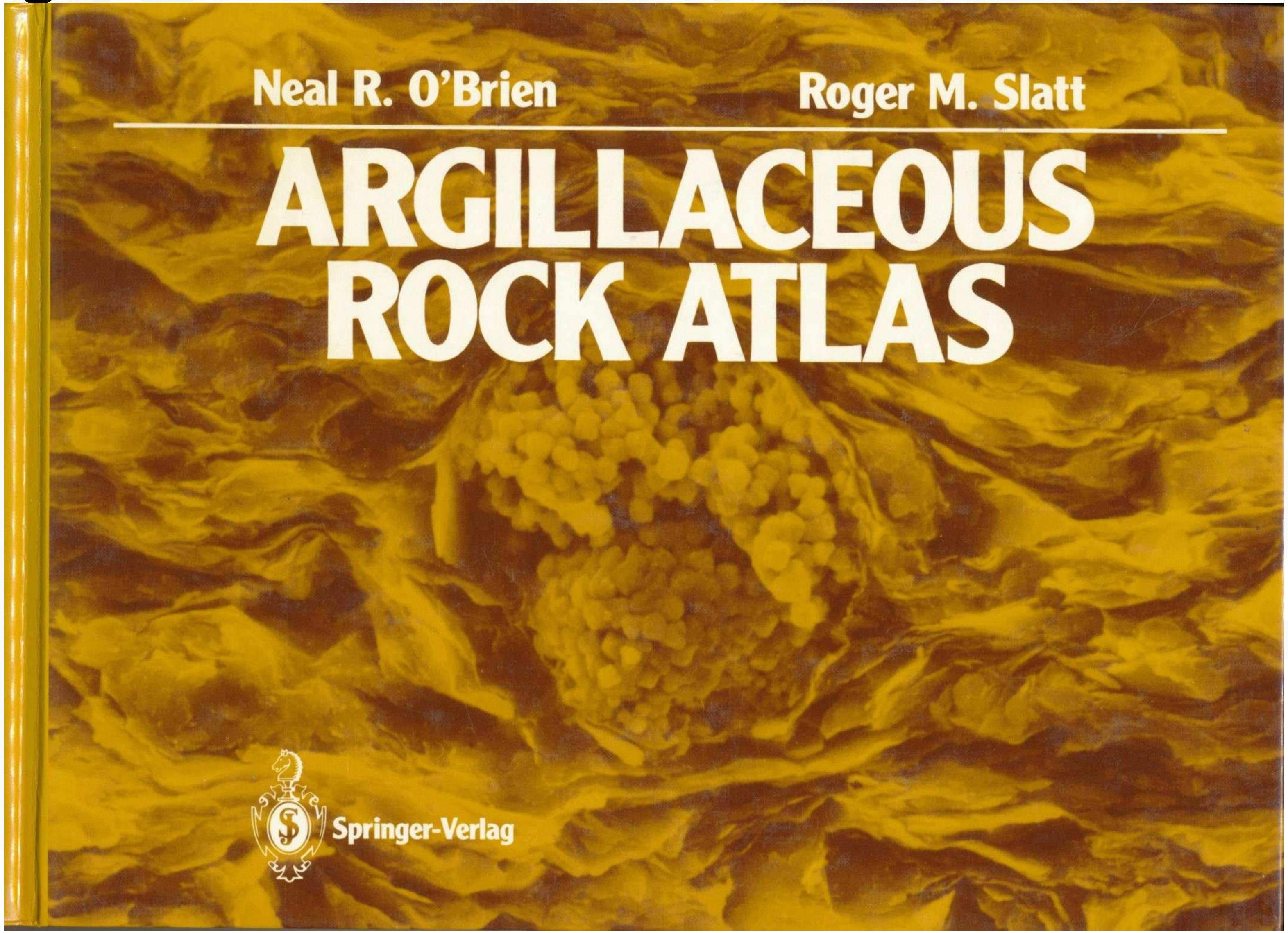

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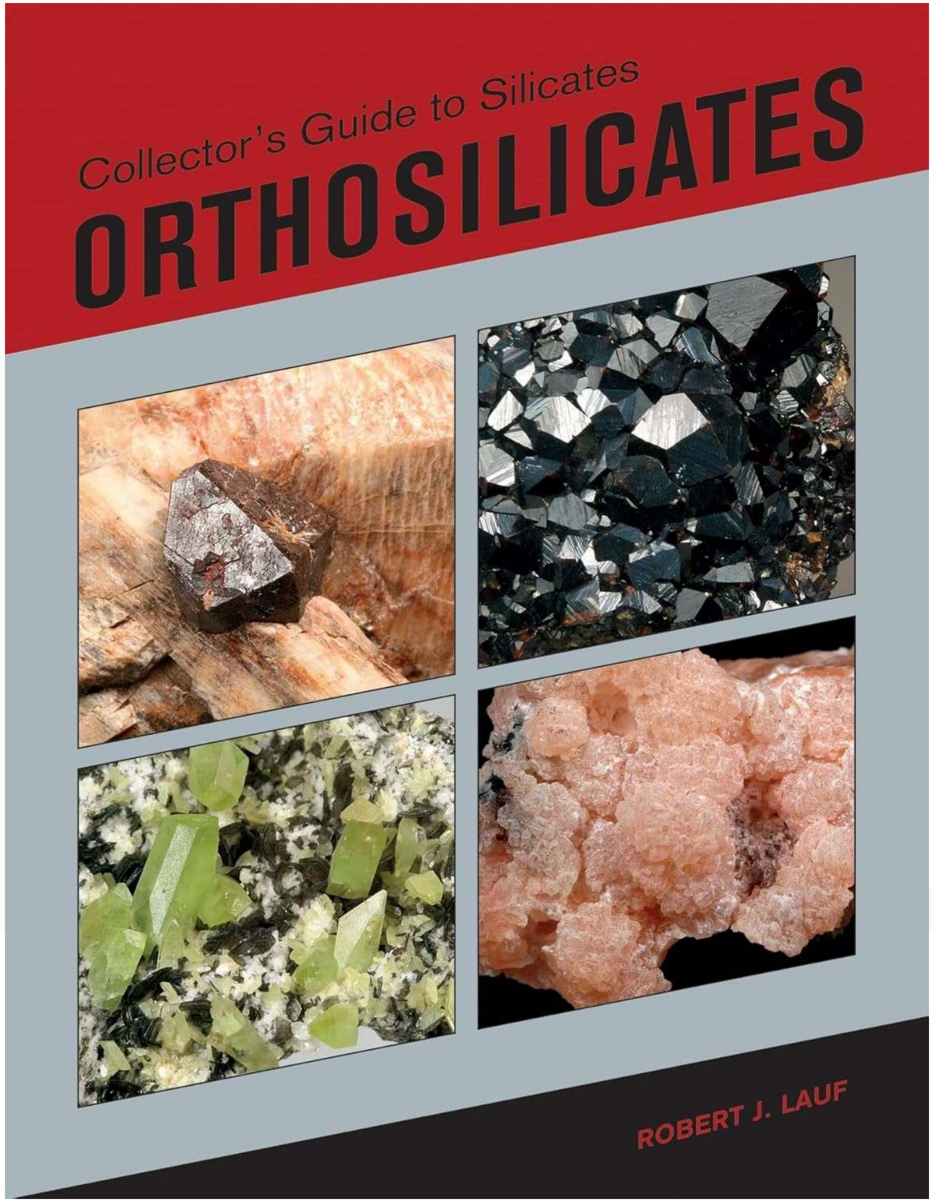

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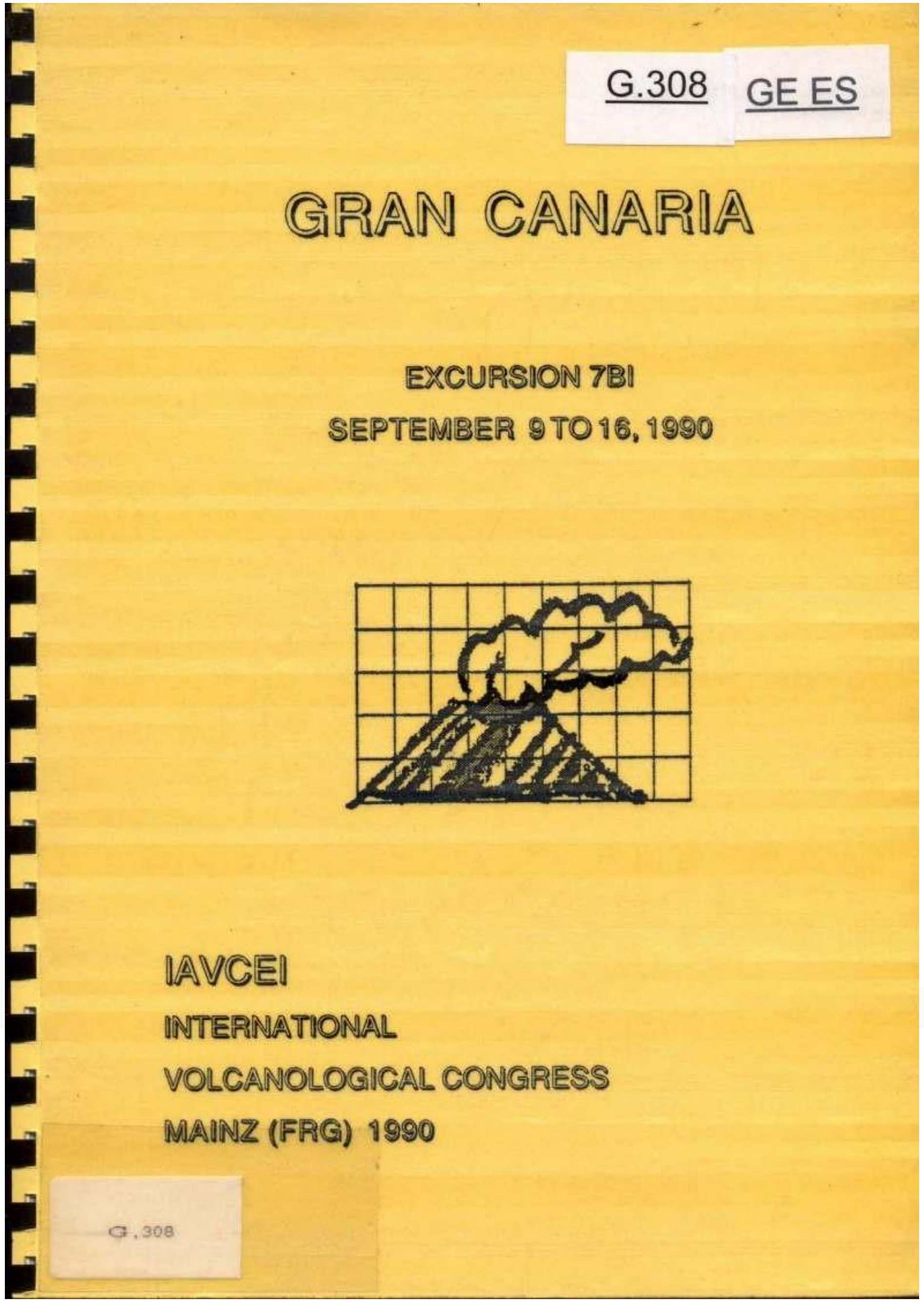

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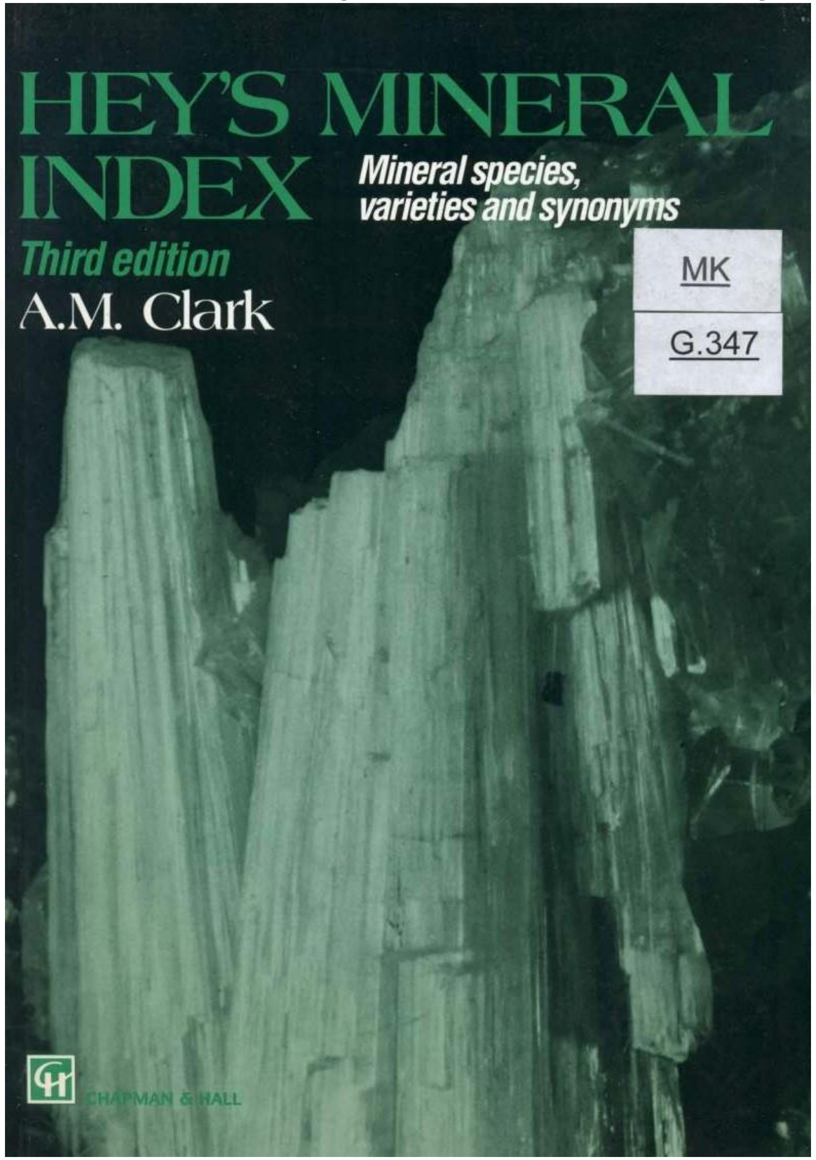

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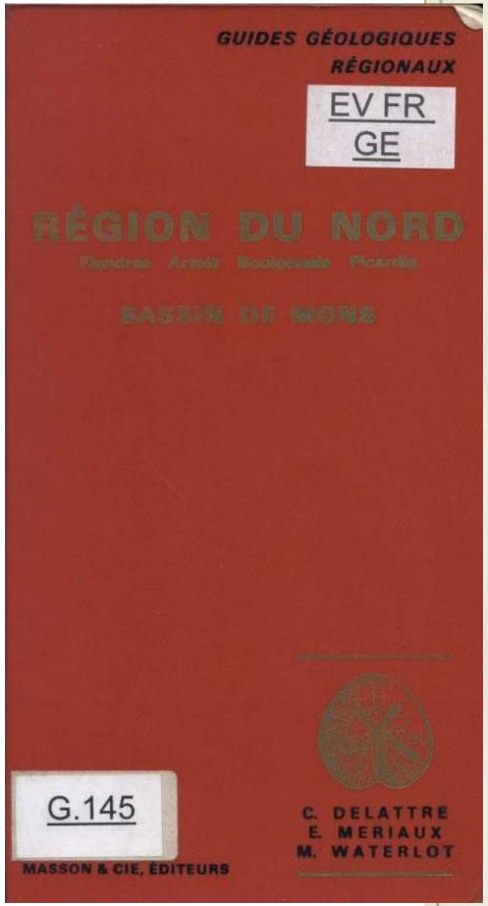

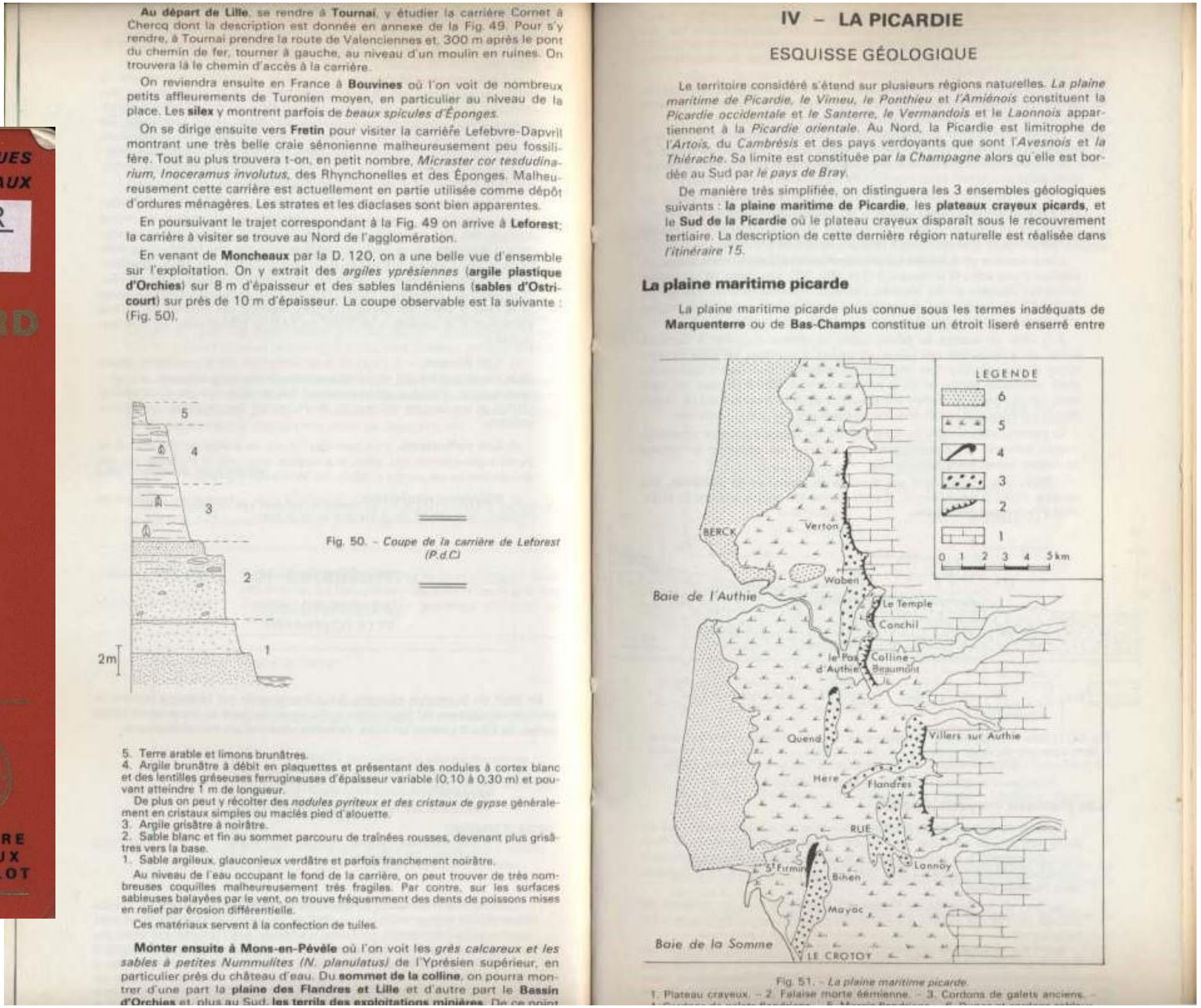

Au départ de Lille, se rendre à **Tournai**, y étudier la carrière Cornet à Chercq dont la description est donnée en annexe de la Fig. 49. Pour s'y rendre, à Tournai prendre la route de Valenciennes et, 300 m après le pont du chemin de fer, tourner à gauche, au niveau d'un moulin en ruines. On trouvera là le chemin d'accès à la carrière.

On reviendra ensuite en France à **Bouvines** où l'on voit de nombreux petits affleurements de Turonien moyen, en particulier au niveau de la place. Les **silex** y montrent parfois de *beaux spicules d'Éponges*.

On se dirige ensuite vers **Fretin** pour visiter la carrière Lefebvre-Dapvril montrant une très belle craie sénonienne malheureusement peu fossilifère. Tout au plus trouvera t-on, en petit nombre, *Micraster cor tesdudinarium, Inoceramus involutus*, des Rhynchonelles et des Éponges. Malheureusement cette carrière est actuellement en partie utilisée comme dépôt d'ordures ménagères. Les strates et les diaclases sont bien apparentes.

En poursuivant le trajet correspondant à la Fig. 49 on arrive à **Leforest**; la carrière à visiter se trouve au Nord de l'agglomération.

En venant de **Moncheaux** par la D. 120, on a une belle vue d'ensemble sur l'exploitation. On y extrait des *argiles yprésiennes* (**argile plastique d'Orchies**) sur 8 m d'épaisseur et des sables landéniens (**sables d'Ostricourt**) sur près de 10 m d'épaisseur. La coupe observable est la suivante : (Fig. 50).

5 4 3 2 1 2m

Fig. 50. – *Coupe de la carrière de Leforest (P.d.C)*

5. Terre arable et limons brunâtres.
4. Argile brunâtre à débit en plaquettes et présentant des nodules à cortex blanc et des lentilles gréseuses ferrugineuses d'épaisseur variable (0.10 à 0.30 m) et pouvant atteindre 1 m de longueur.
   De plus on peut y récolter des *nodules pyriteux et des cristaux de gypse* généralement en cristaux simples ou maclés pied d'alouette.
3. Argile grisâtre à noirâtre.
2. Sable blanc et fin au sommet parcouru de traînées rousses, devenant plus grisâtres vers la base.
1. Sable argileux, glauconieux verdâtre et parfois franchement noirâtre.

Au niveau de l'eau occupant le fond de la carrière, on peut trouver de très nombreuses coquilles malheureusement très fragiles. Par contre, sur les surfaces sableuses balayées par le vent, on trouve fréquemment des dents de poissons mises en relief par érosion différentielle.

Ces matériaux servent à la confection de tuiles.

Monter ensuite à Mons-en-Pévèle où l'on voit les *grès calcareux et les sables à petites Nummulites (N. planulatus)* de l'Yprésien supérieur, en particulier près du château d'eau. Du **sommet de la colline**, on pourra montrer d'une part la **plaine des Flandres et Lille** et d'autre part le **Bassin d'Orchies** et, plus au Sud, **les terrils des exploitations minières**. De ce point

IV – LA PICARDIE

ESQUISSE GÉOLOGIQUE

Le territoire considéré s'étend sur plusieurs régions naturelles. *La plaine maritime de Picardie, le Vimeu, le Ponthieu* et *l'Amiénois* constituent la *Picardie occidentale* et *le Santerre, le Vermandois* et le *Laonnois* appartiennent à la *Picardie orientale*. Au Nord, la Picardie est limitrophe de l'*Artois*, du *Cambrésis* et des pays verdoyants que sont l'*Avesnois* et *la Thiérache*. Sa limite est constituée par *la Champagne* alors qu'elle est bordée au Sud par *le pays de Bray*.

De manière très simplifiée, on distinguera les 3 ensembles géologiques suivants : **la plaine maritime de Picardie**, les **plateaux crayeux picards**, et le **Sud de la Picardie** où le plateau crayeux disparaît sous le recouvrement tertiaire. La description de cette dernière région naturelle est réalisée dans *l'itinéraire 15*.

La plaine maritime picarde

La plaine maritime picarde plus connue sous les termes inadéquats de **Marquenterre** ou de **Bas-Champs** constitue un étroit liseré enserré entre

LEGENDE 6 5 4 3 2 1
0 1 2 3 4 5km
BERCK Verton Waben Baie de l'Authie Le Temple Conchil le Pas d'Authie Colline Beaumont Quend Villers sur Authie Hère Flandres RUE St Firmin Bihen Lannoy Mayoc Baie de la Somme LE CROTOY

Fig. 51. – *La plaine maritime picarde.*
1. Plateau crayeux. – 2. Falaise morte flandrienne. – 3. Cordons de galets anciens. –

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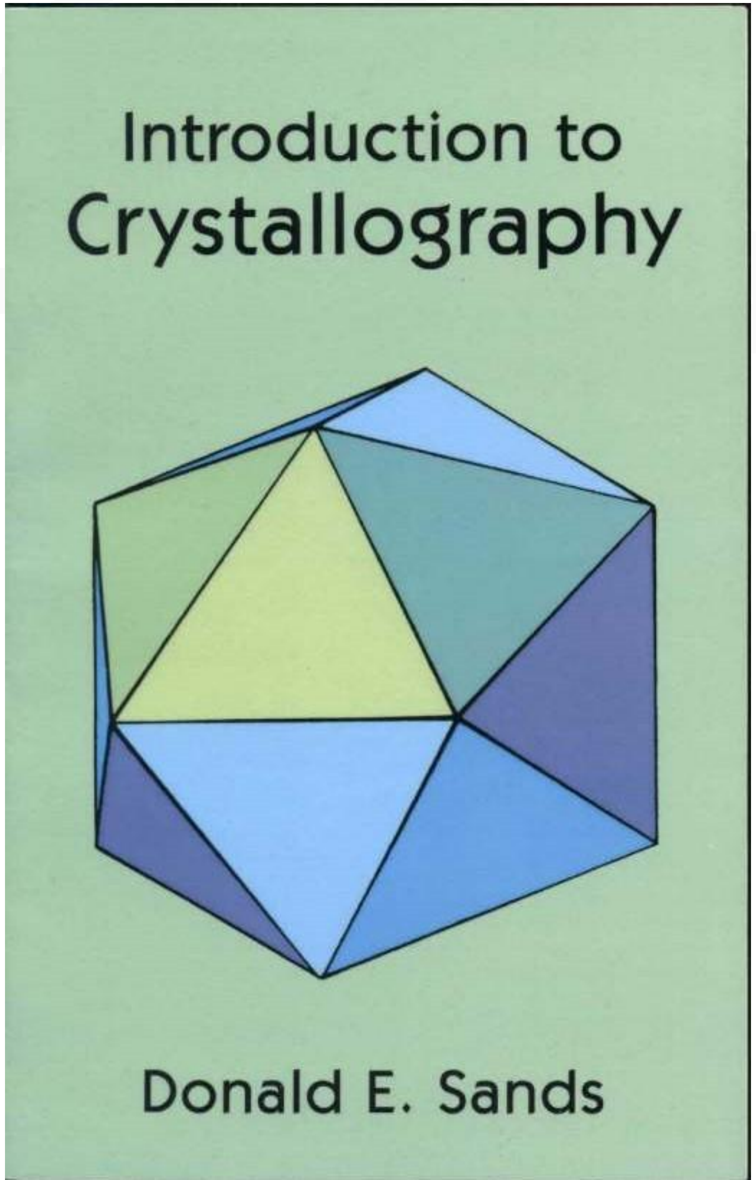

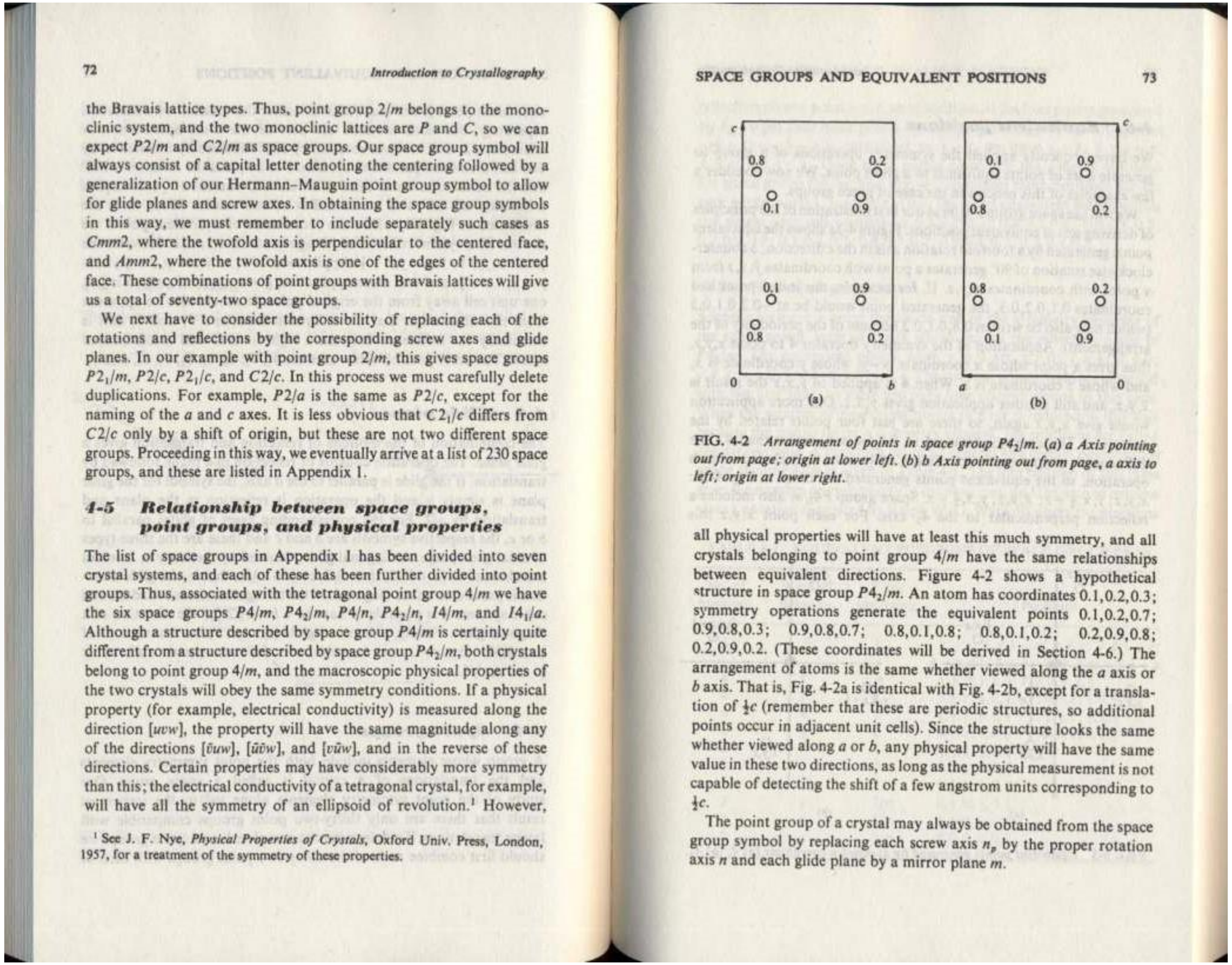

the Bravais lattice types. Thus, point group $2/m$ belongs to the monoclinic system, and the two monoclinic lattices are P and C, so we can expect $P2/m$ and $C2/m$ as space groups. Our space group symbol will always consist of a capital letter denoting the centering followed by a generalization of our Hermann–Mauguin point group symbol to allow for glide planes and screw axes. In obtaining the space group symbols in this way, we must remember to include separately such cases as $Cmm2$, where the twofold axis is perpendicular to the centered face, and $Amm2$, where the twofold axis is one of the edges of the centered face. These combinations of point groups with Bravais lattices will give us a total of seventy-two space groups.

We next have to consider the possibility of replacing each of the rotations and reflections by the corresponding screw axes and glide planes. In our example with point group $2/m$, this gives space groups $P2_1/m$, $P2/c$, $P2_1/c$, and $C2/c$. In this process we must carefully delete duplications. For example, $P2/a$ is the same as $P2/c$, except for the naming of the a and c axes. It is less obvious that $C2_1/c$ differs from $C2/c$ only by a shift of origin, but these are not two different space groups. Proceeding in this way, we eventually arrive at a list of 230 space groups, and these are listed in Appendix 1.

4-5 Relationship between space groups, point groups, and physical properties

The list of space groups in Appendix 1 has been divided into seven crystal systems, and each of these has been further divided into point groups. Thus, associated with the tetragonal point group $4/m$ we have the six space groups $P4/m$, $P4_2/m$, $P4/n$, $P4_2/n$, $I4/m$, and $I4_1/a$. Although a structure described by space group $P4/m$ is certainly quite different from a structure described by space group $P4_2/m$, both crystals belong to point group $4/m$, and the macroscopic physical properties of the two crystals will obey the same symmetry conditions. If a physical property (for example, electrical conductivity) is measured along the direction $[uvw]$, the property will have the same magnitude along any of the directions $[\bar{v}uw]$, $[\bar{u}\bar{v}w]$, and $[v\bar{u}w]$, and in the reverse of these directions. Certain properties may have considerably more symmetry than this; the electrical conductivity of a tetragonal crystal, for example, will have all the symmetry of an ellipsoid of revolution.[1] However,

[1] See J. F. Nye, *Physical Properties of Crystals*, Oxford Univ. Press, London, 1957, for a treatment of the symmetry of these properties.

FIG. 4-2 *Arrangement of points in space group $P4_2/m$. (a) a Axis pointing out from page; origin at lower left. (b) b Axis pointing out from page, a axis to left; origin at lower right.*

all physical properties will have at least this much symmetry, and all crystals belonging to point group $4/m$ have the same relationships between equivalent directions. Figure 4-2 shows a hypothetical structure in space group $P4_2/m$. An atom has coordinates 0.1,0.2,0.3; symmetry operations generate the equivalent points 0.1,0.2,0.7; 0.9,0.8,0.3; 0.9,0.8,0.7; 0.8,0.1,0.8; 0.8,0.1,0.2; 0.2,0.9,0.8; 0.2,0.9,0.2. (These coordinates will be derived in Section 4-6.) The arrangement of atoms is the same whether viewed along the a axis or b axis. That is, Fig. 4-2a is identical with Fig. 4-2b, except for a translation of $\frac{1}{2}c$ (remember that these are periodic structures, so additional points occur in adjacent unit cells). Since the structure looks the same whether viewed along a or b, any physical property will have the same value in these two directions, as long as the physical measurement is not capable of detecting the shift of a few angstrom units corresponding to $\frac{1}{2}c$.

The point group of a crystal may always be obtained from the space group symbol by replacing each screw axis n_p by the proper rotation axis n and each glide plane by a mirror plane m.

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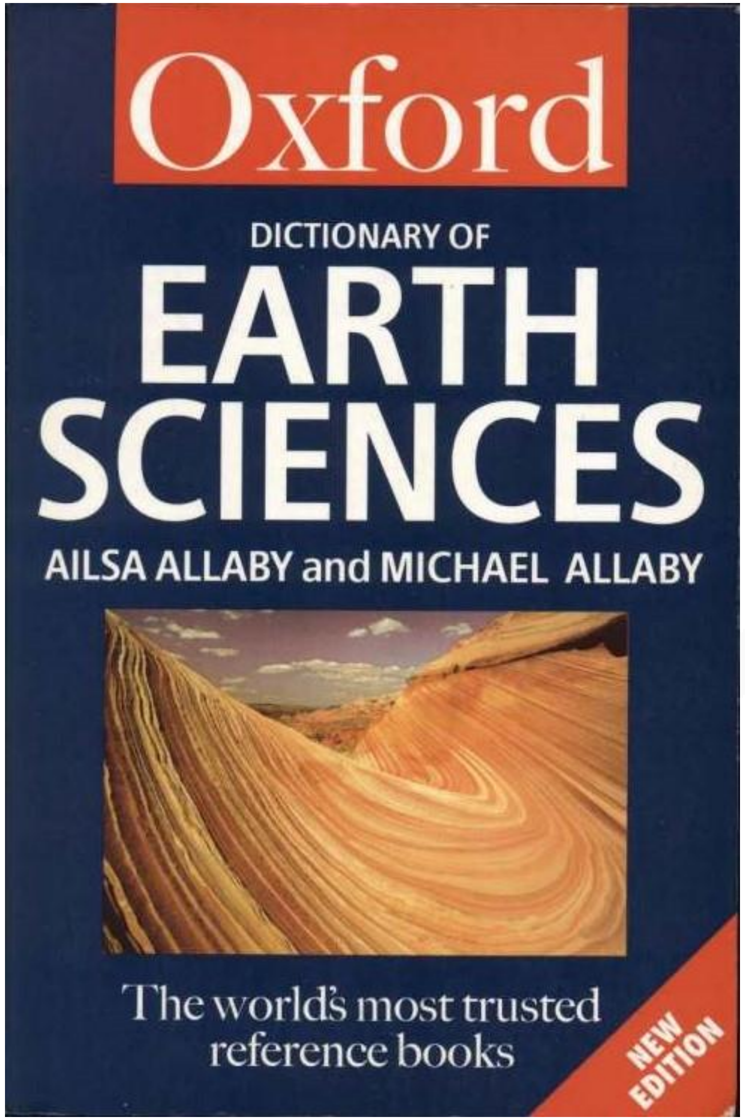

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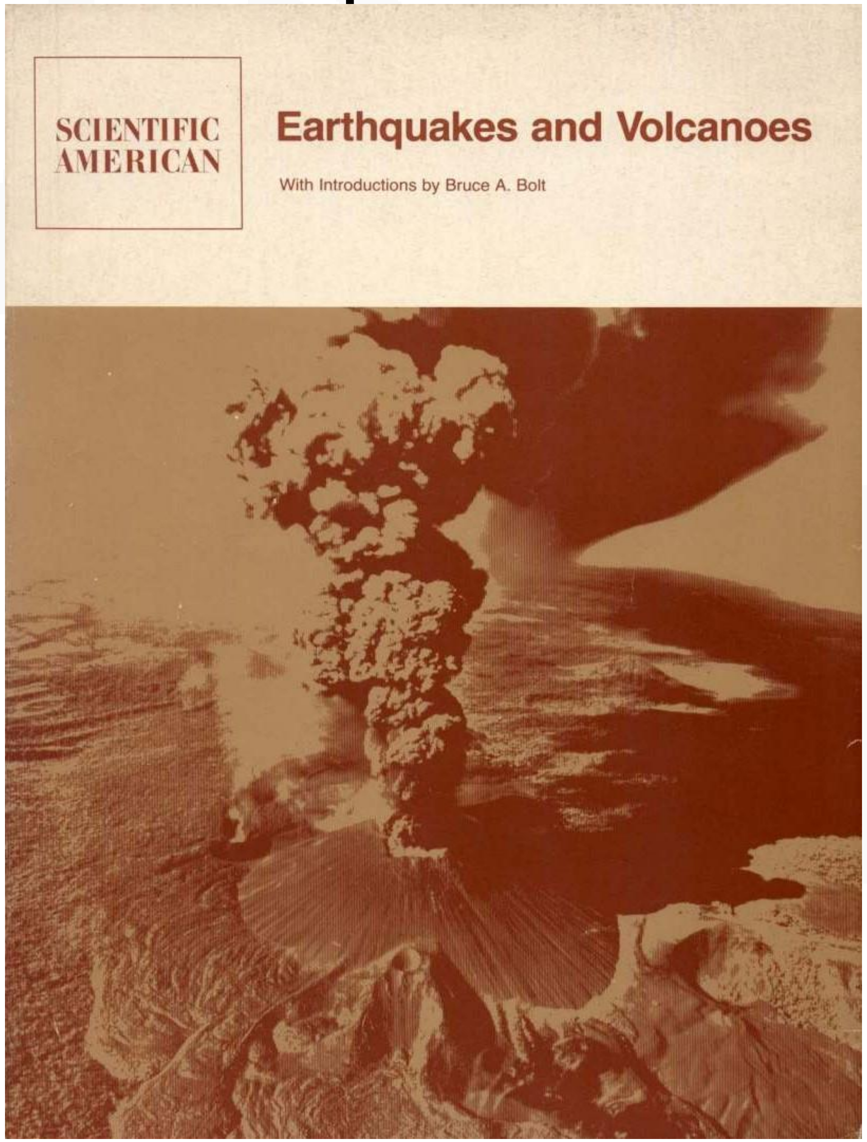

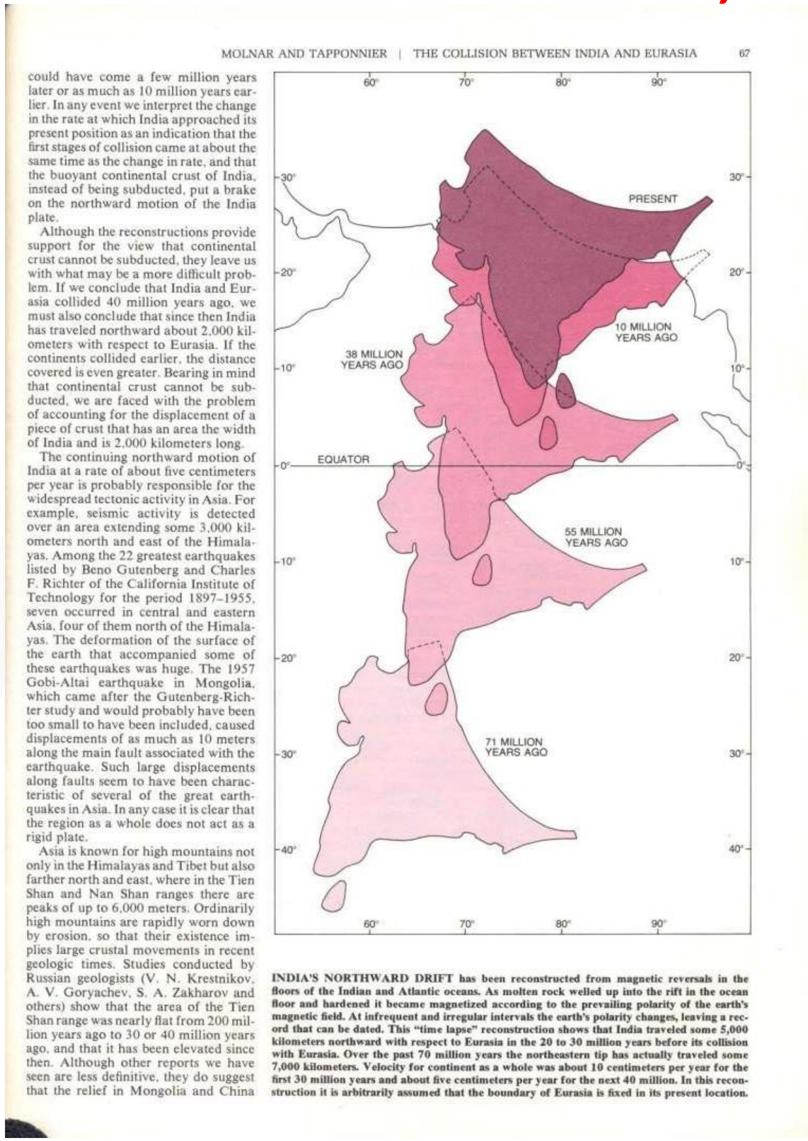

could have come a few million years later or as much as 10 million years earlier. In any event we interpret the change in the rate at which India approached its present position as an indication that the first stages of collision came at about the same time as the change in rate, and that the buoyant continental crust of India, instead of being subducted, put a brake on the northward motion of the India plate.

Although the reconstructions provide support for the view that continental crust cannot be subducted, they leave us with what may be a more difficult problem. If we conclude that India and Eurasia collided 40 million years ago, we must also conclude that since then India has traveled northward about 2,000 kilometers with respect to Eurasia. If the continents collided earlier, the distance covered is even greater. Bearing in mind that continental crust cannot be subducted, we are faced with the problem of accounting for the displacement of a piece of crust that has an area the width of India and is 2,000 kilometers long.

The continuing northward motion of India at a rate of about five centimeters per year is probably responsible for the widespread tectonic activity in Asia. For example, seismic activity is detected over an area extending some 3,000 kilometers north and east of the Himalayas. Among the 22 greatest earthquakes listed by Beno Gutenberg and Charles F. Richter of the California Institute of Technology for the period 1897–1955, seven occurred in central and eastern Asia, four of them north of the Himalayas. The deformation of the surface of the earth that accompanied some of these earthquakes was huge. The 1957 Gobi-Altai earthquake in Mongolia, which came after the Gutenberg-Richter study and would probably have been too small to have been included, caused displacements of as much as 10 meters along the main fault associated with the earthquake. Such large displacements along faults seem to have been characteristic of several of the great earthquakes in Asia. In any case it is clear that the region as a whole does not act as a rigid plate.

Asia is known for high mountains not only in the Himalayas and Tibet but also farther north and east, where in the Tien Shan and Nan Shan ranges there are peaks of up to 6,000 meters. Ordinarily high mountains are rapidly worn down by erosion, so that their existence implies large crustal movements in recent geologic times. Studies conducted by Russian geologists (V. N. Krestnikov, A. V. Goryachev, S. A. Zakharov and others) show that the area of the Tien Shan range was nearly flat from 200 million years ago to 30 or 40 million years ago, and that it has been elevated since then. Although other reports we have seen are less definitive, they do suggest that the relief in Mongolia and China

INDIA'S NORTHWARD DRIFT has been reconstructed from magnetic reversals in the floors of the Indian and Atlantic oceans. As molten rock welled up into the rift in the ocean floor and hardened it became magnetized according to the prevailing polarity of the earth's magnetic field. At infrequent and irregular intervals the earth's polarity changes, leaving a record that can be dated. This "time lapse" reconstruction shows that India traveled some 5,000 kilometers northward with respect to Eurasia in the 20 to 30 million years before its collision with Eurasia. Over the past 70 million years the northeastern tip has actually traveled some 7,000 kilometers. Velocity for continent as a whole was about 10 centimeters per year for the first 30 million years and about five centimeters per year for the next 40 million. In this reconstruction it is arbitrarily assumed that the boundary of Eurasia is fixed in its present location.

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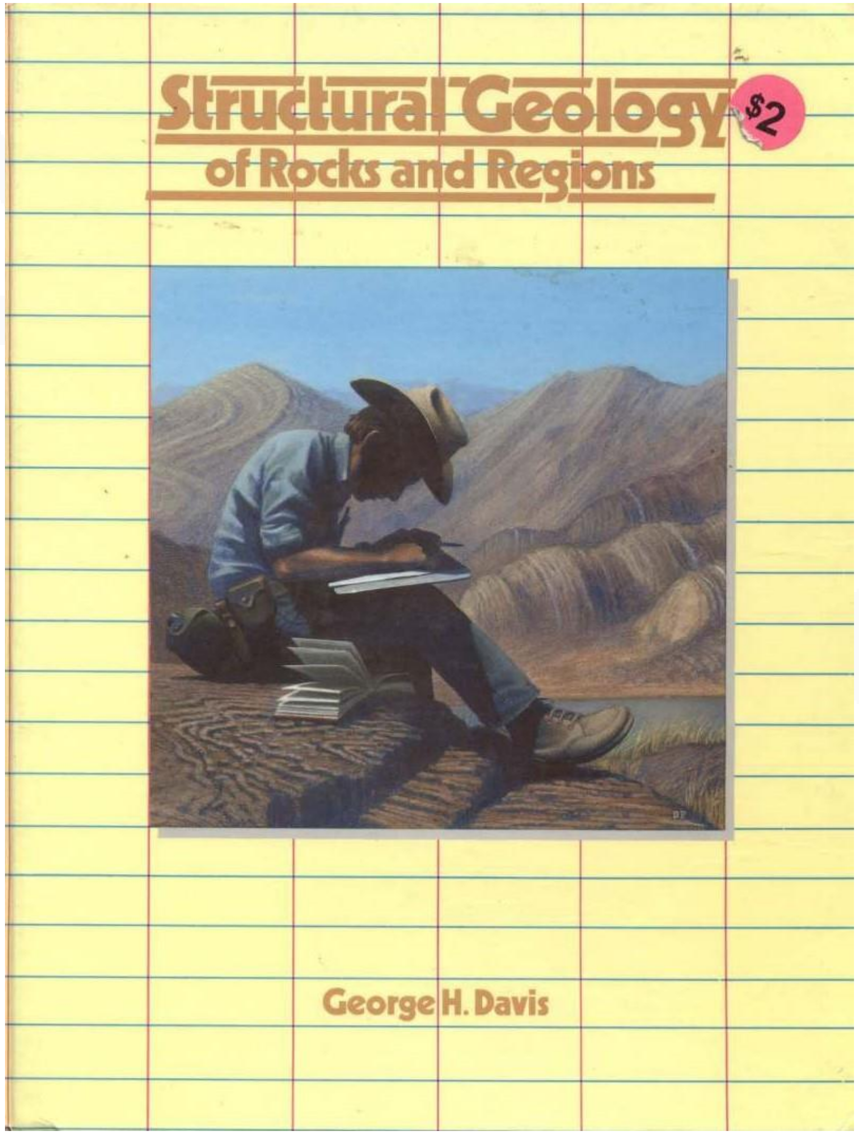

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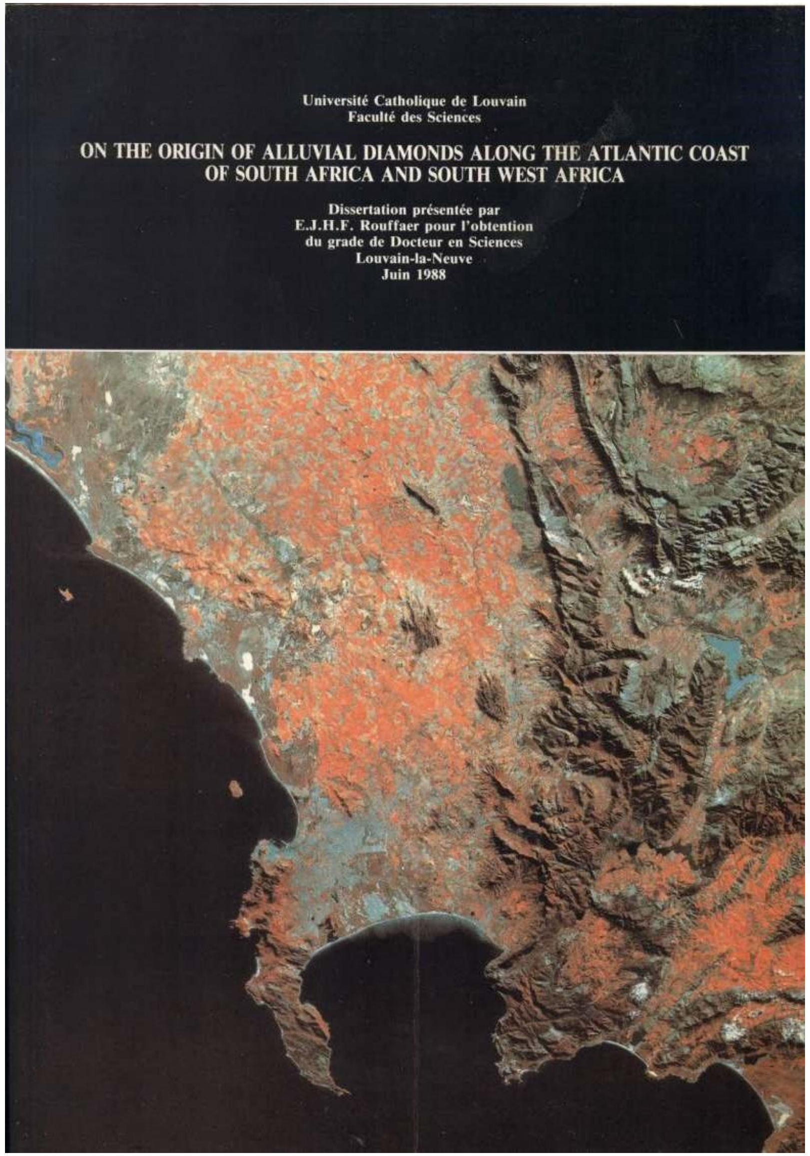

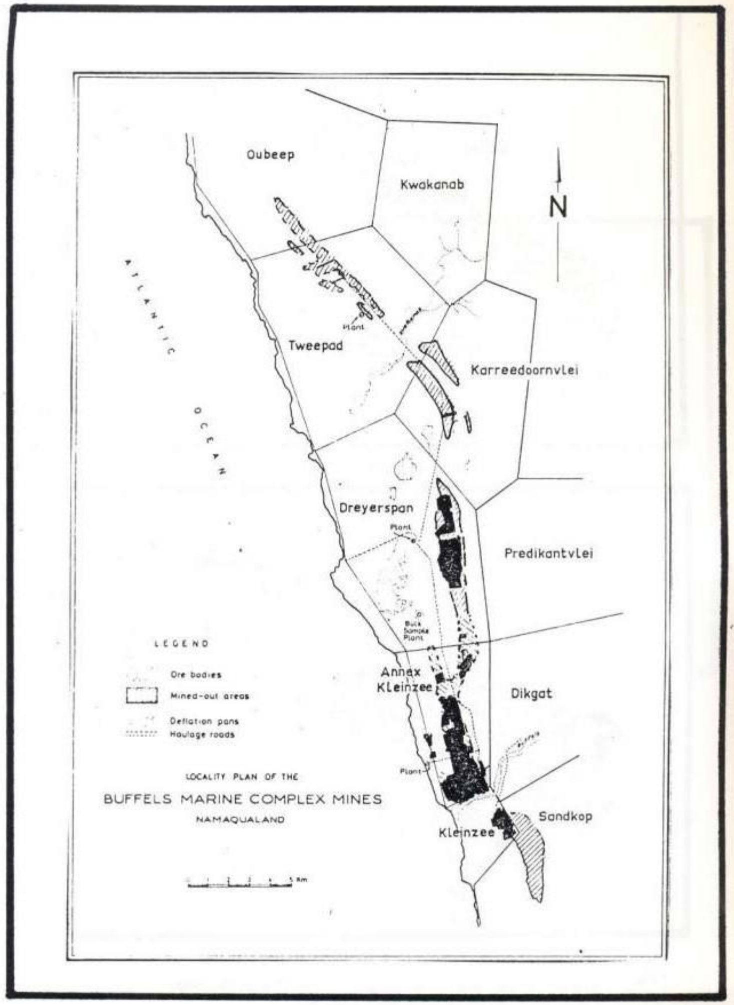

Fig. 8 (After De Beers)

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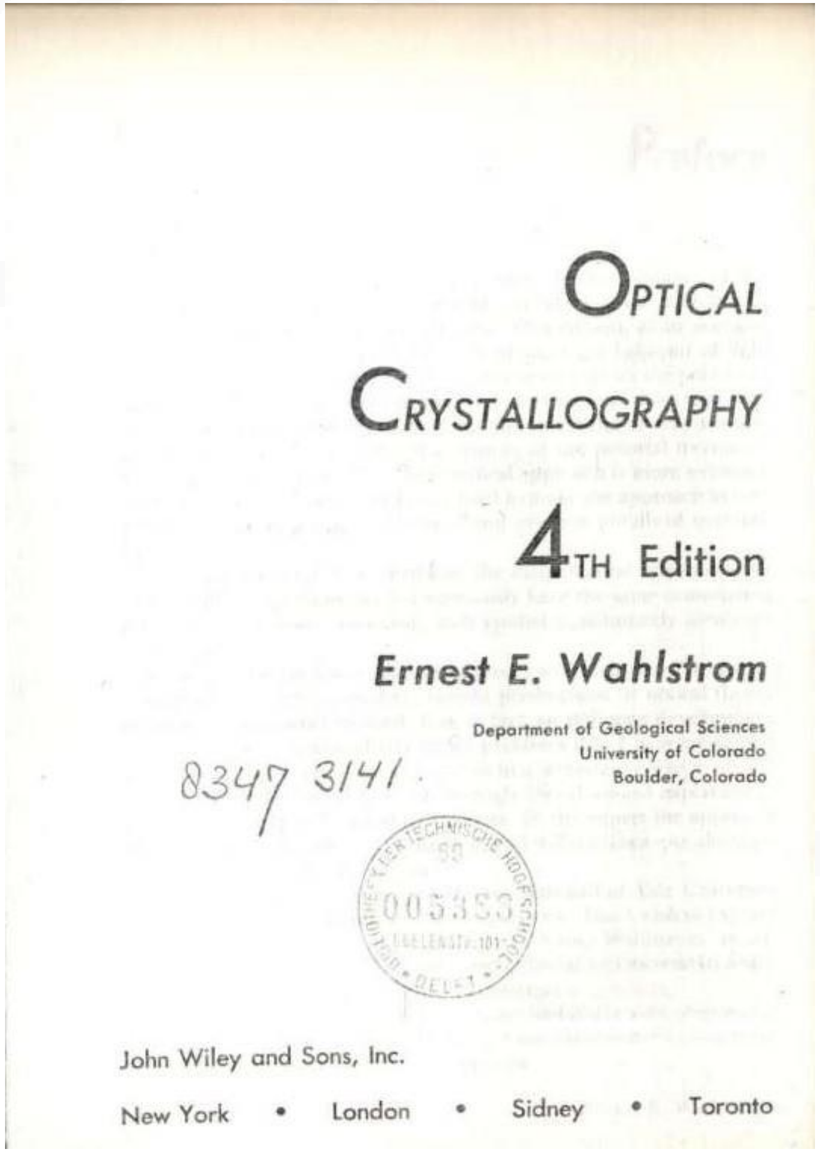

OPTICAL CRYSTALLOGRAPHY

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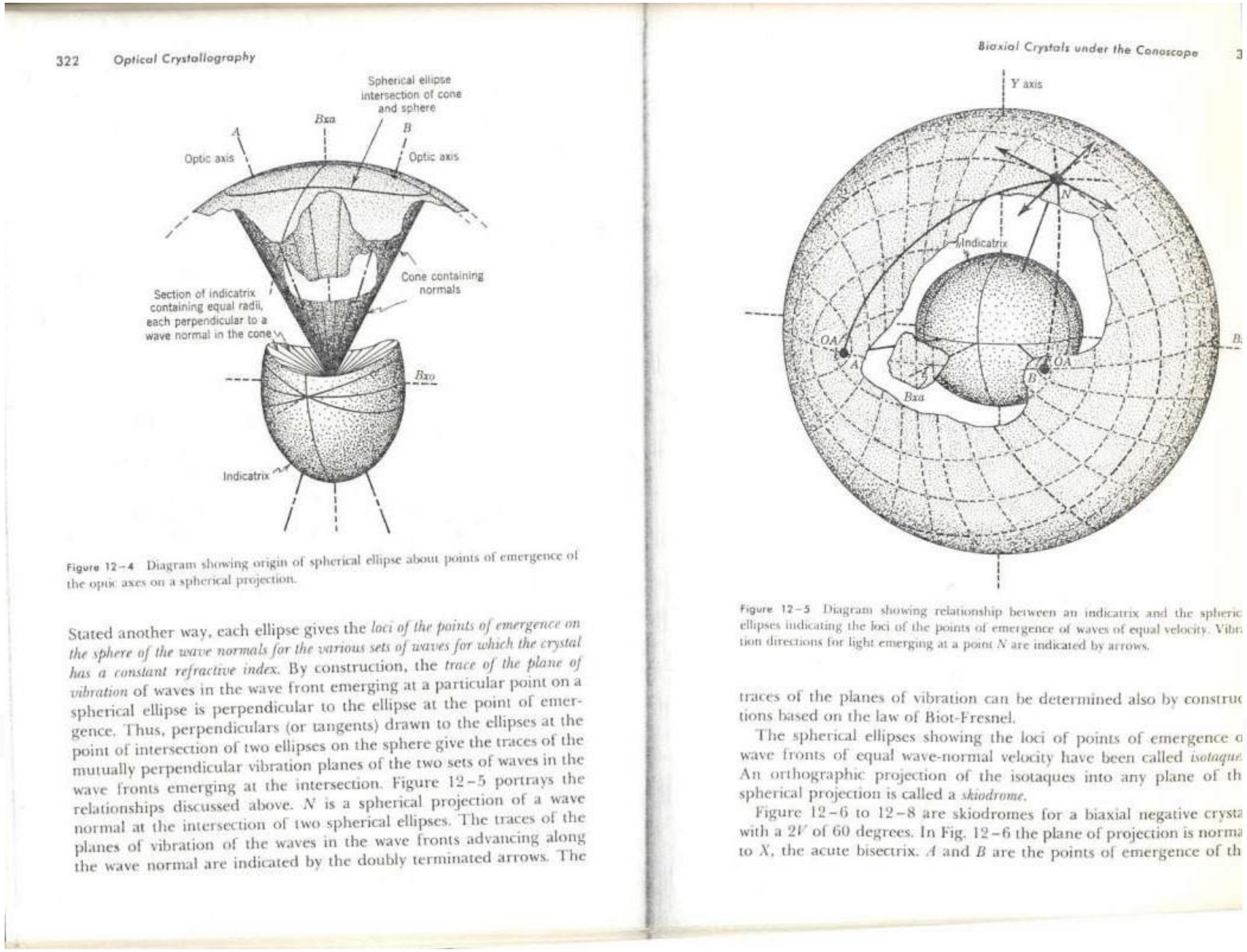

Figure 12–4 Diagram showing origin of spherical ellipse about points of emergence of the optic axes on a spherical projection.

Stated another way, each ellipse gives the *loci of the points of emergence on the sphere of the wave normals for the various sets of waves for which the crystal has a constant refractive index.* By construction, the *trace of the plane of vibration* of waves in the wave front emerging at a particular point on a spherical ellipse is perpendicular to the ellipse at the point of emergence. Thus, perpendiculars (or tangents) drawn to the ellipses at the point of intersection of two ellipses on the sphere give the traces of the mutually perpendicular vibration planes of the two sets of waves in the wave fronts emerging at the intersection. Figure 12–5 portrays the relationships discussed above. N is a spherical projection of a wave normal at the intersection of two spherical ellipses. The traces of the planes of vibration of the waves in the wave fronts advancing along the wave normal are indicated by the doubly terminated arrows. The

Figure 12–5 Diagram showing relationship between an indicatrix and the spheric ellipses indicating the loci of the points of emergence of waves of equal velocity. Vibr tion directions for light emerging at a point N are indicated by arrows.

traces of the planes of vibration can be determined also by construc tions based on the law of Biot-Fresnel.

The spherical ellipses showing the loci of points of emergence o wave fronts of equal wave-normal velocity have been called *isotaque* An orthographic projection of the isotaques into any plane of th spherical projection is called a *skiodrome.*

Figure 12–6 to 12–8 are skiodromes for a biaxial negative crysta with a $2V$ of 60 degrees. In Fig. 12–6 the plane of projection is norma to X, the acute bisectrix. A and B are the points of emergence of th

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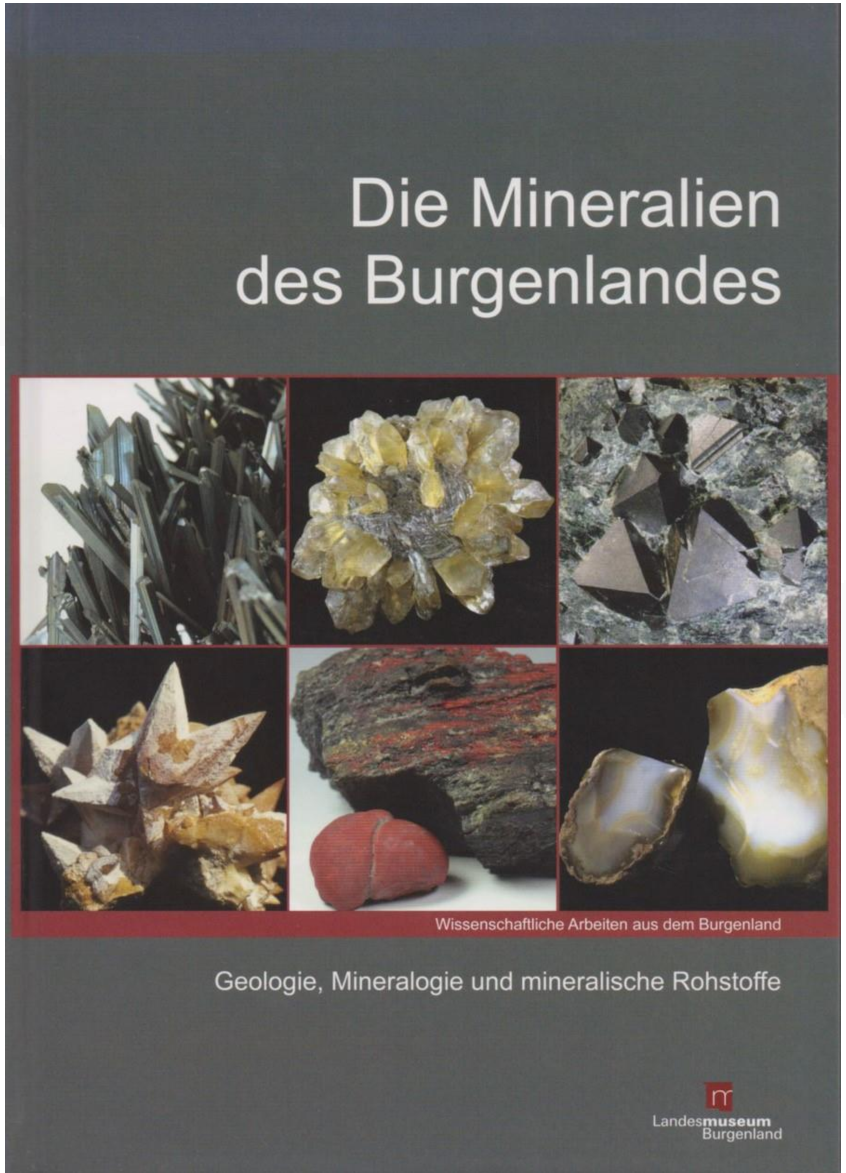

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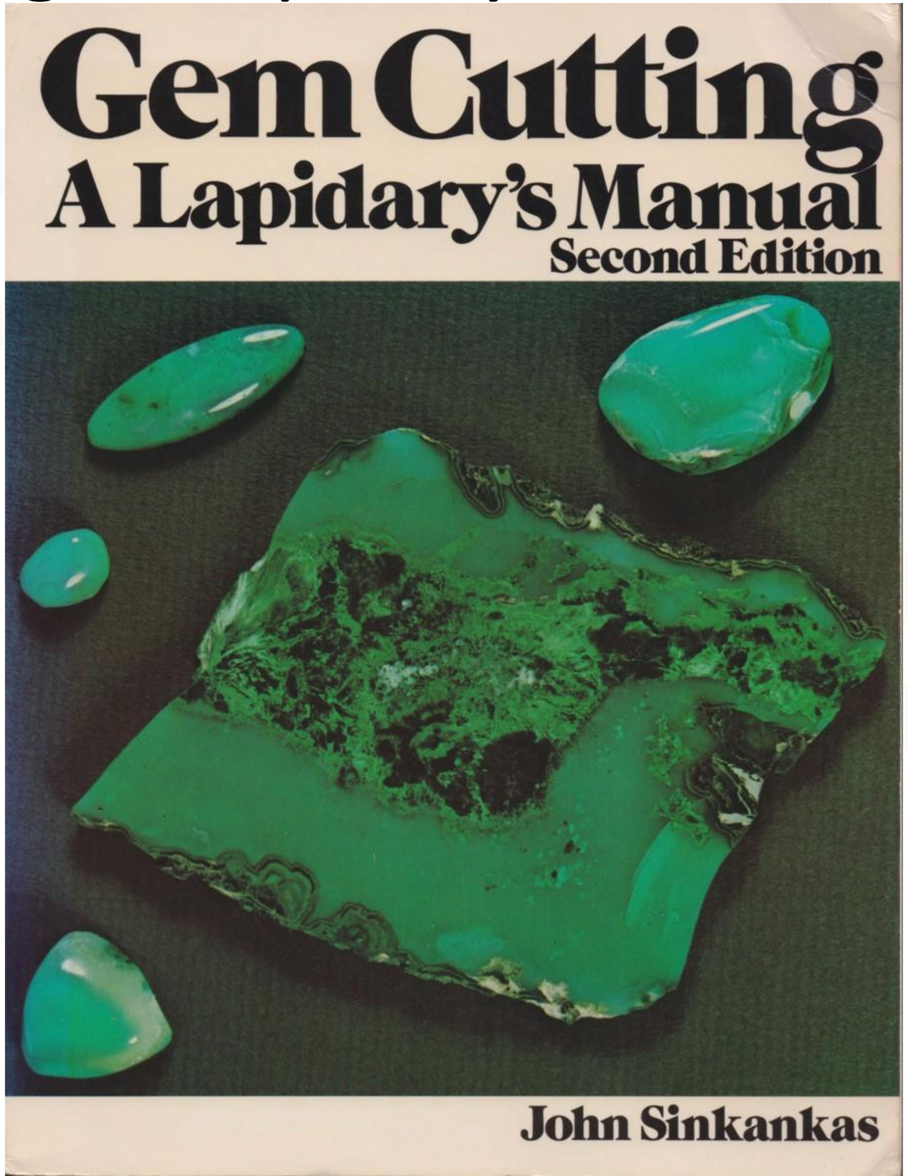

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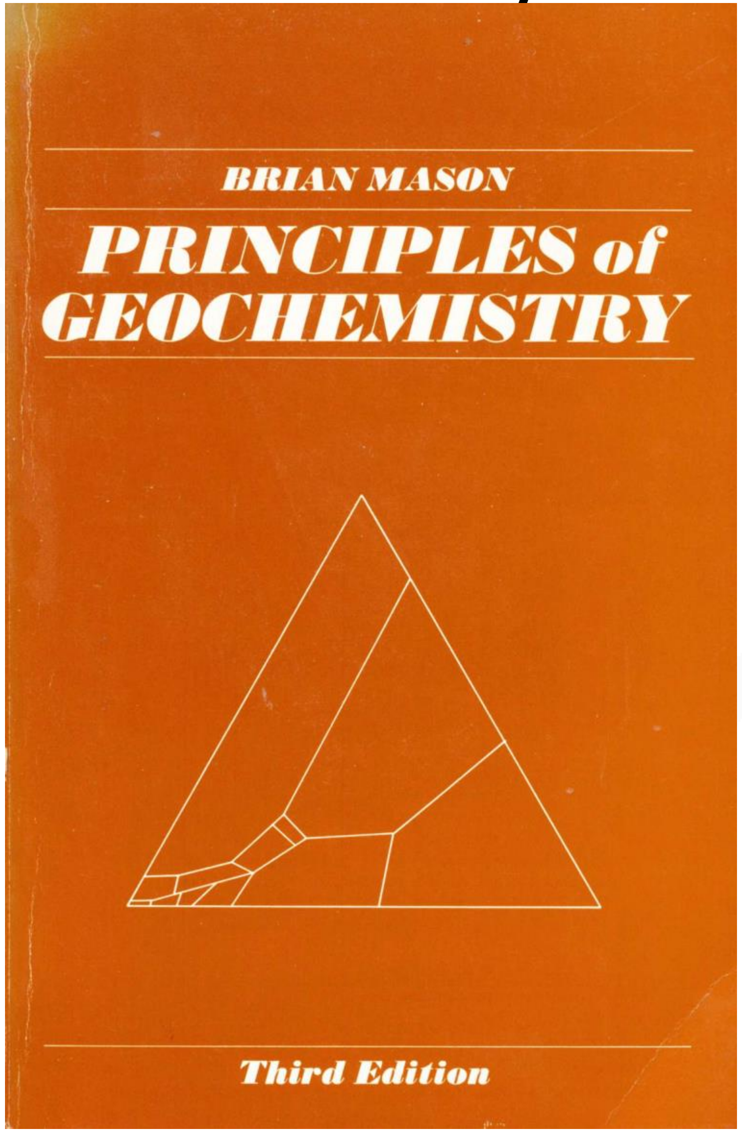

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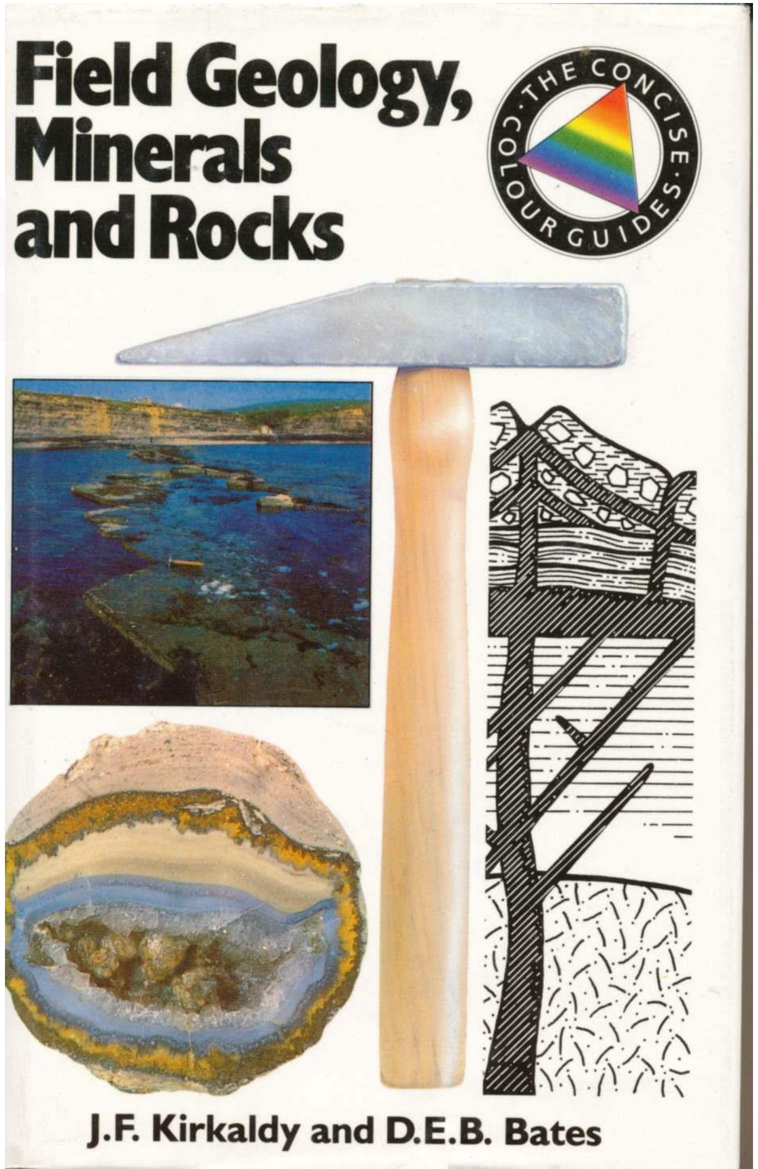

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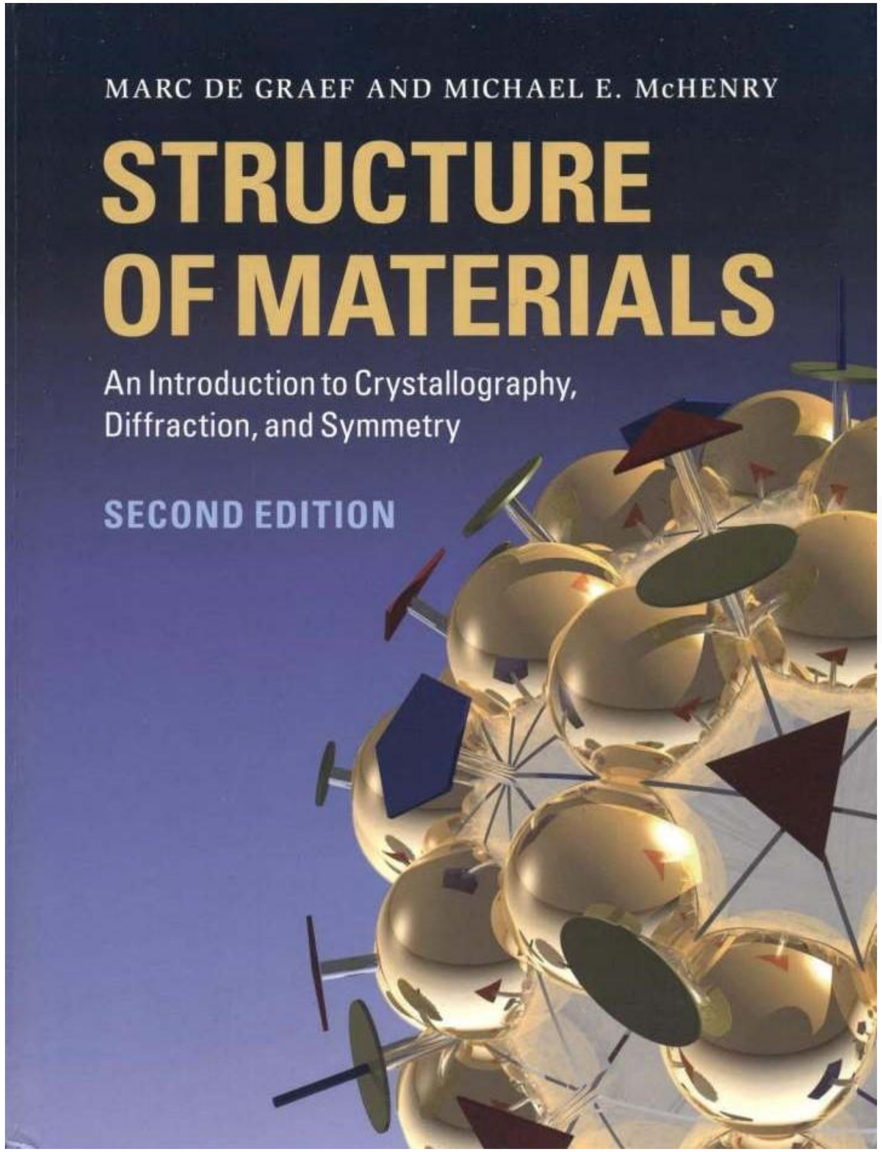

independent of the lattice parameters. Note that this is the case because of the particular definition we use for the reciprocal lattice vectors. In the following subsections, we will look at the four possible types of centering (P, C, I, and F) and determine the extinctions for each of them.

12.2.1.1 Primitive lattice A primitive lattice is characterized by the absence of any centering vectors. This means that for the most general atom position $\mathbf{r} = (x, y, z)$ (general in the sense that the atom does not lie on a symmetry element of the structure) *there is no equivalent atom located at any of the positions* $\mathbf{r} + \mathbf{A}$, $\mathbf{r} + \mathbf{B}$, $\mathbf{r} + \mathbf{C}$, or $\mathbf{r} + \mathbf{I}$ (using the notation from Chapter 3). For a primitive structure with only one atom in the unit cell, say at $\mathbf{r} = (0, 0, 0)$, we find:

$$F_{hkl} = \sum_{j=1}^{1} f_j e^{2\pi i(h0+k0+l0)} = f,$$

and, therefore, the diffracted intensity is proportional to $I_{hkl} = f^2$. Remember that the value of f does depend on the particular lattice plane (hkl). In other words, for a primitive lattice there are no extinctions; all lattice planes give rise to a diffracted beam.

12.2.1.2 C-centered lattice A C-centered lattice is characterized by the fact that, for every atom at position $\mathbf{r}$, there is an *identical* atom at position $\mathbf{r} + \mathbf{C}$. The structure factor for this situation (for $\mathbf{r} = (0, 0, 0)$) is given by

$$F_{hkl} = \sum_{j=1}^{2} f_j e^{2\pi i(hx_j+ky_j+lz_j)} = f(1 + e^{\pi i(h+k)}).$$

Using the properties of exponentials and Euler's formula we can rewrite this as

$$\begin{aligned} F_{hkl} &= f e^{\frac{\pi}{2} i(h+k)} \left(e^{-\frac{\pi}{2} i(h+k)} + e^{\frac{\pi}{2} i(h+k)} \right) \\ &= 2f e^{\frac{\pi}{2} i(h+k)} \cos \frac{\pi}{2}(h+k). \end{aligned}$$

The intensity in the diffracted beams is then proportional to

$$\begin{aligned} |F_{hkl}|^2 &= \left(2f e^{\frac{\pi}{2} i(h+k)} \cos \frac{\pi}{2}(h+k) \right) \left(2f e^{-\frac{\pi}{2} i(h+k)} \cos \frac{\pi}{2}(h+k) \right) \\ &= 4f^2 \cos^2 \frac{\pi}{2}(h+k). \end{aligned} \qquad (12.8)$$

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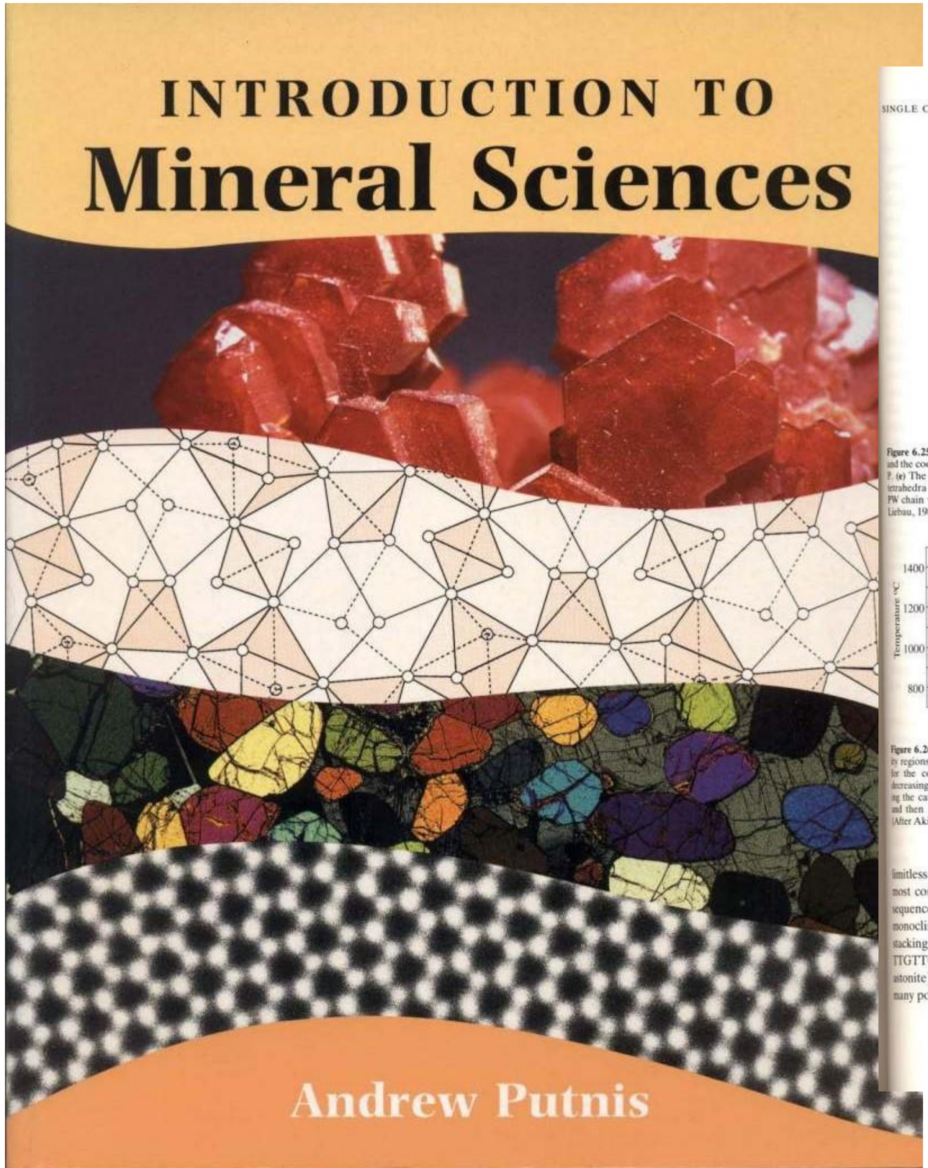

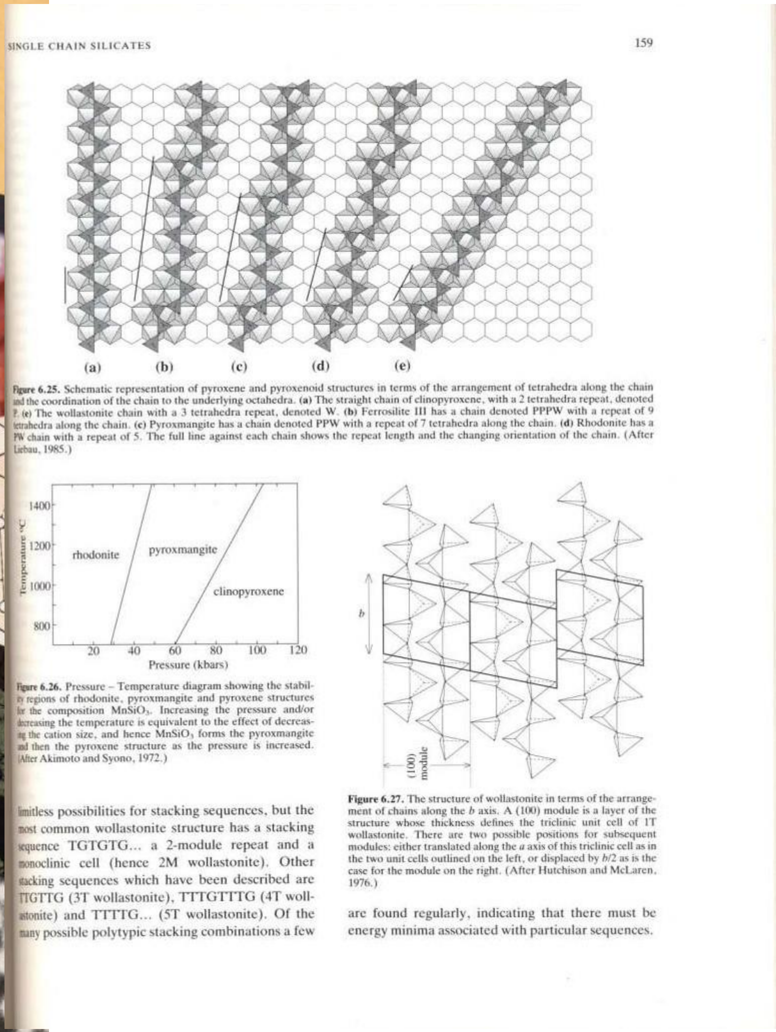

(a) (b) (c) (d) (e)

Figure 6.25. Schematic representation of pyroxene and pyroxenoid structures in terms of the arrangement of tetrahedra along the chain and the coordination of the chain to the underlying octahedra. **(a)** The straight chain of clinopyroxene, with a 2 tetrahedra repeat, denoted P. **(e)** The wollastonite chain with a 3 tetrahedra repeat, denoted W. **(b)** Ferrosilite III has a chain denoted PPPW with a repeat of 9 tetrahedra along the chain. **(c)** Pyroxmangite has a chain denoted PPW with a repeat of 7 tetrahedra along the chain. **(d)** Rhodonite has a PW chain with a repeat of 5. The full line against each chain shows the repeat length and the changing orientation of the chain. (After Liebau, 1985.)

Temperature °C: 1400, 1200, 1000, 800
rhodonite
pyroxmangite
clinopyroxene
20 40 60 80 100 120
Pressure (kbars)

Figure 6.26. Pressure – Temperature diagram showing the stability regions of rhodonite, pyroxmangite and pyroxene structures for the composition $MnSiO_3$. Increasing the pressure and/or decreasing the temperature is equivalent to the effect of decreasing the cation size, and hence $MnSiO_3$ forms the pyroxmangite and then the pyroxene structure as the pressure is increased. (After Akimoto and Syono, 1972.)

b
(100) module

Figure 6.27. The structure of wollastonite in terms of the arrangement of chains along the *b* axis. A (100) module is a layer of the structure whose thickness defines the triclinic unit cell of 1T wollastonite. There are two possible positions for subsequent modules: either translated along the *a* axis of this triclinic cell as in the two unit cells outlined on the left, or displaced by *b*/2 as is the case for the module on the right. (After Hutchison and McLaren, 1976.)

limitless possibilities for stacking sequences, but the most common wollastonite structure has a stacking sequence TGTGTG... a 2-module repeat and a monoclinic cell (hence 2M wollastonite). Other stacking sequences which have been described are TTGTTG (3T wollastonite), TTTGTTTG (4T wollastonite) and TTTTG... (5T wollastonite). Of the many possible polytypic stacking combinations a few are found regularly, indicating that there must be energy minima associated with particular sequences.

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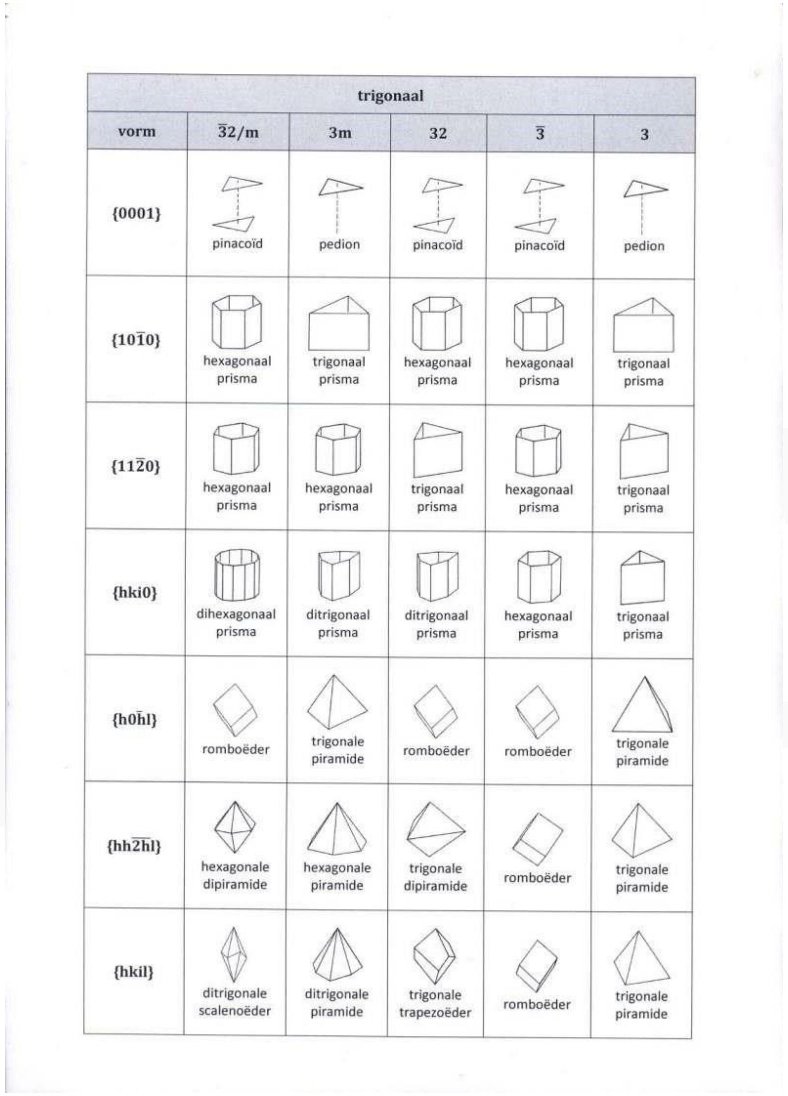

	trigonaal				
vorm	$\bar{3}2/m$	3m	32	$\bar{3}$	3
{0001}	pinacoïd	pedion	pinacoïd	pinacoïd	pedion
{$10\bar{1}0$}	hexagonaal prisma	trigonaal prisma	hexagonaal prisma	hexagonaal prisma	trigonaal prisma
{$11\bar{2}0$}	hexagonaal prisma	hexagonaal prisma	trigonaal prisma	hexagonaal prisma	trigonaal prisma
{hki0}	dihexagonaal prisma	ditrigonaal prisma	ditrigonaal prisma	hexagonaal prisma	trigonaal prisma
{$h0\bar{h}l$}	romboëder	trigonale piramide	romboëder	romboëder	trigonale piramide
{$hh\overline{2h}l$}	hexagonale dipiramide	hexagonale piramide	trigonale dipiramide	romboëder	trigonale piramide
{hkil}	ditrigonale scalenoëder	ditrigonale piramide	trigonale trapezoëder	romboëder	trigonale piramide

37 Gemmology

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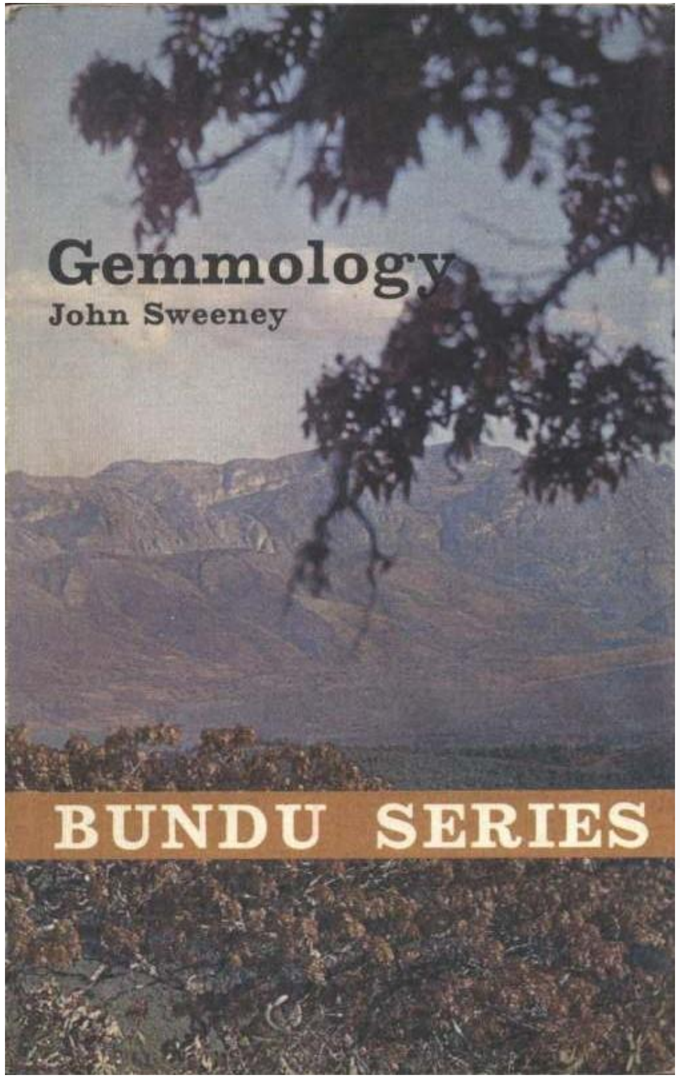

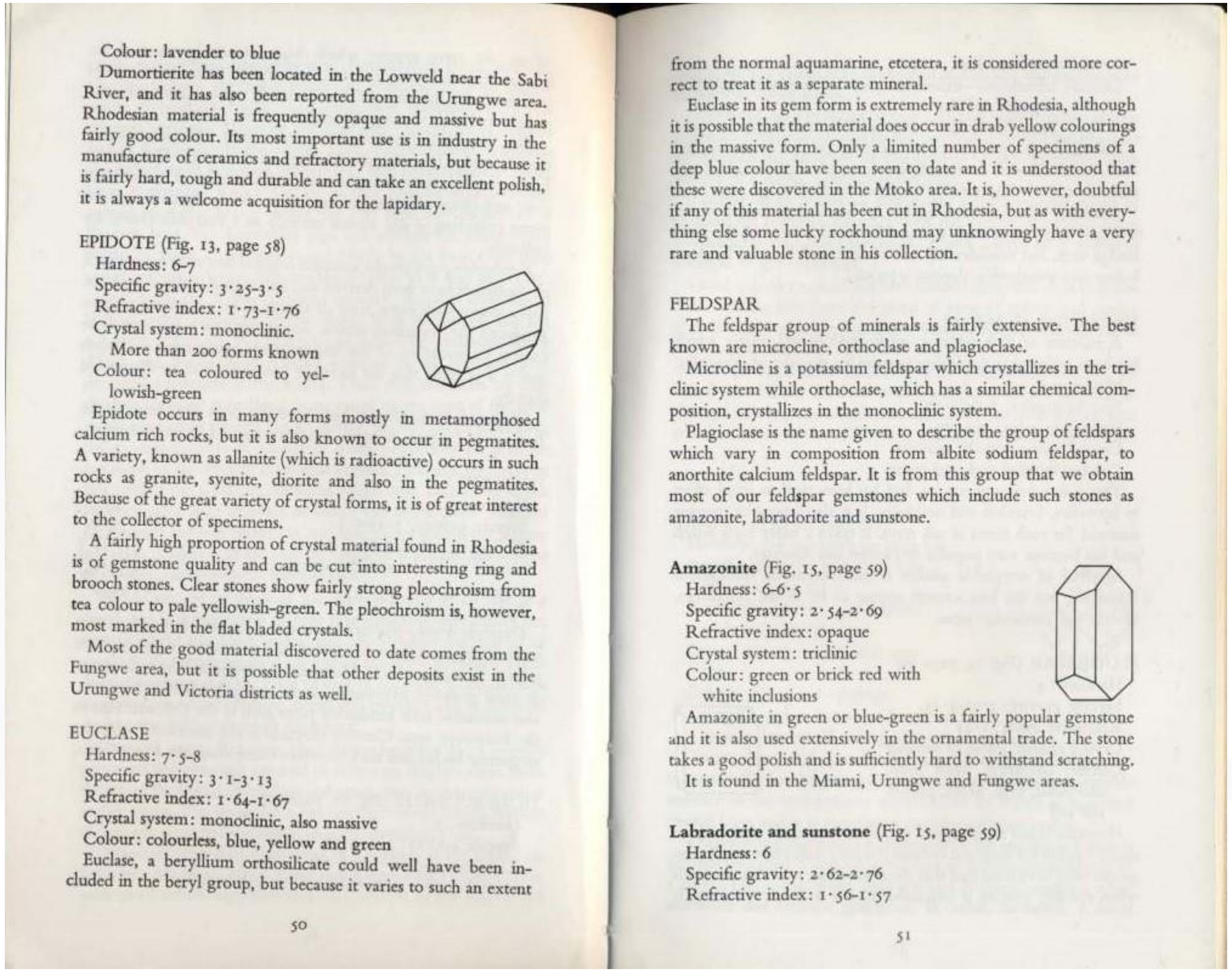

Colour: lavender to blue

Dumortierite has been located in the Lowveld near the Sabi River, and it has also been reported from the Urungwe area. Rhodesian material is frequently opaque and massive but has fairly good colour. Its most important use is in industry in the manufacture of ceramics and refractory materials, but because it is fairly hard, tough and durable and can take an excellent polish, it is always a welcome acquisition for the lapidary.

EPIDOTE (Fig. 13, page 58)

Hardness: 6–7
Specific gravity: 3·25–3·5
Refractive index: 1·73–1·76
Crystal system: monoclinic. More than 200 forms known
Colour: tea coloured to yellowish-green

Epidote occurs in many forms mostly in metamorphosed calcium rich rocks, but it is also known to occur in pegmatites. A variety, known as allanite (which is radioactive) occurs in such rocks as granite, syenite, diorite and also in the pegmatites. Because of the great variety of crystal forms, it is of great interest to the collector of specimens.

A fairly high proportion of crystal material found in Rhodesia is of gemstone quality and can be cut into interesting ring and brooch stones. Clear stones show fairly strong pleochroism from tea colour to pale yellowish-green. The pleochroism is, however, most marked in the flat bladed crystals.

Most of the good material discovered to date comes from the Fungwe area, but it is possible that other deposits exist in the Urungwe and Victoria districts as well.

EUCLASE

Hardness: 7·5–8
Specific gravity: 3·1–3·13
Refractive index: 1·64–1·67
Crystal system: monoclinic, also massive
Colour: colourless, blue, yellow and green

Euclase, a beryllium orthosilicate could well have been included in the beryl group, but because it varies to such an extent

from the normal aquamarine, etcetera, it is considered more correct to treat it as a separate mineral.

Euclase in its gem form is extremely rare in Rhodesia, although it is possible that the material does occur in drab yellow colourings in the massive form. Only a limited number of specimens of a deep blue colour have been seen to date and it is understood that these were discovered in the Mtoko area. It is, however, doubtful if any of this material has been cut in Rhodesia, but as with everything else some lucky rockhound may unknowingly have a very rare and valuable stone in his collection.

FELDSPAR

The feldspar group of minerals is fairly extensive. The best known are microcline, orthoclase and plagioclase.

Microcline is a potassium feldspar which crystallizes in the triclinic system while orthoclase, which has a similar chemical composition, crystallizes in the monoclinic system.

Plagioclase is the name given to describe the group of feldspars which vary in composition from albite sodium feldspar, to anorthite calcium feldspar. It is from this group that we obtain most of our feldspar gemstones which include such stones as amazonite, labradorite and sunstone.

Amazonite (Fig. 15, page 59)

Hardness: 6–6·5
Specific gravity: 2·54–2·69
Refractive index: opaque
Crystal system: triclinic
Colour: green or brick red with white inclusions

Amazonite in green or blue-green is a fairly popular gemstone and it is also used extensively in the ornamental trade. The stone takes a good polish and is sufficiently hard to withstand scratching. It is found in the Miami, Urungwe and Fungwe areas.

Labradorite and sunstone (Fig. 15, page 59)

Hardness: 6
Specific gravity: 2·62–2·76
Refractive index: 1·56–1·57

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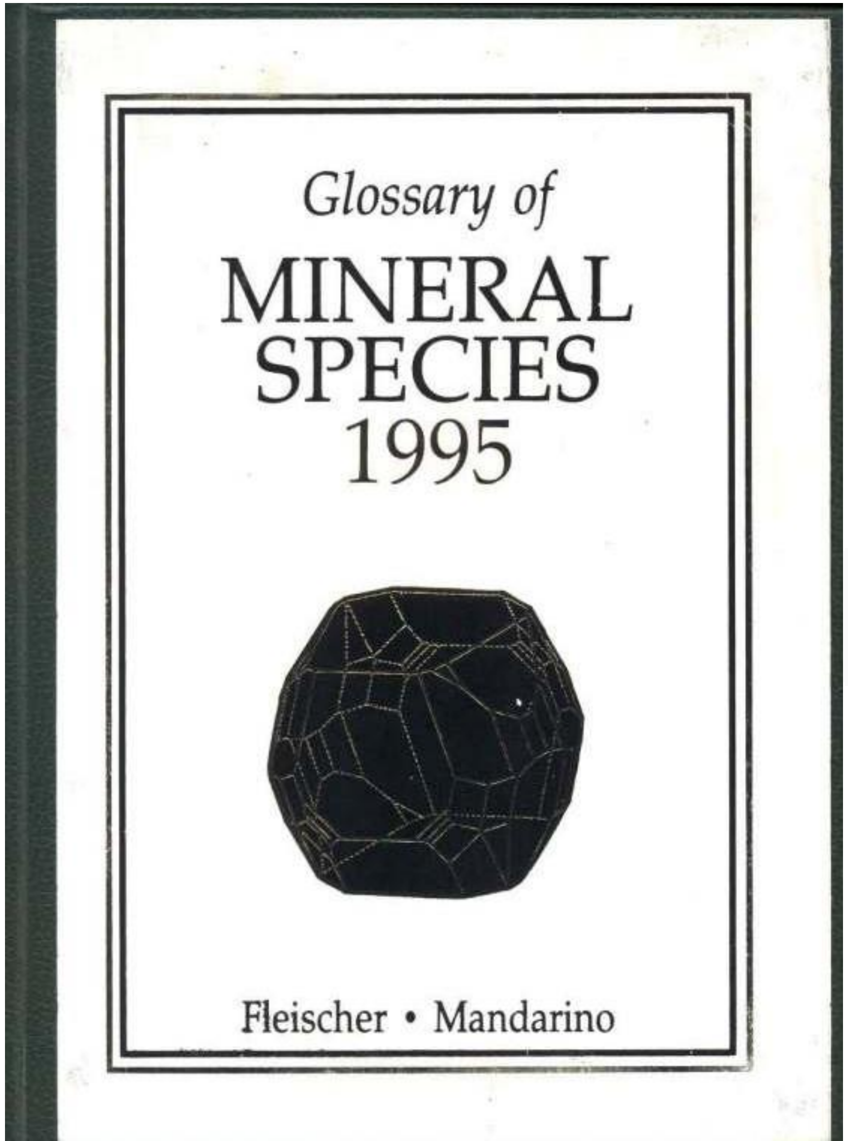

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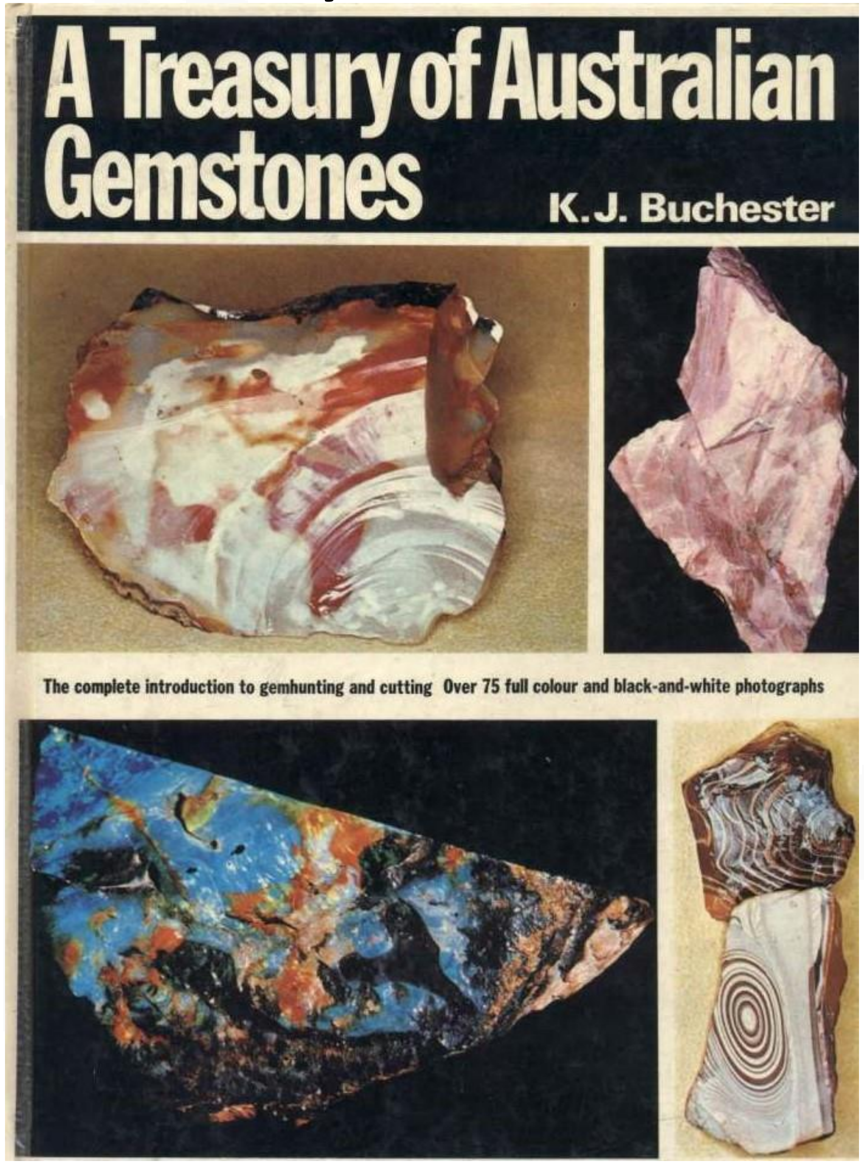

Diamonds in Australia

To those who are under the impression that diamonds are found only in Africa it may come as a surprise to learn that the king of gems occurs in every State of Australia. From Cape York to Tasmania and from eastern New South Wales across to Western Australia, diamonds have made their appearance, often in the most unexpected spots. Although Nature seems to have scattered them round wildly in most of the States in an effort to confuse us, she has been a little kinder in eastern Australia, by concentrating some of the supply, so as not to discourage the gemhunter completely. These concentrations are in the northern part of New South Wales.

Here, especially at Copeton and Bingara, there were flourishing diamond centres where many thousands of carats of gems were mined and sold at the turn of the century, when market prices were comparatively low. In the peak year (1899) the production from these northern New South Wales fields reached over 25,000 carats, whilst the total recorded production from Bingara and Copeton alone amounted to almost 250,000 carats. Some very fine gems were recovered from these fields and exported to markets overseas. As any gemstone may quickly become anonymous after being handled and cut, there are undoubtedly many Australian diamonds distributed throughout the world, unidentified as such and probably now quite honestly regarded as being African or Brazilian stones.

All of the diamonds found in Australia have been recovered from alluvial deposits as fragments, crystals or water-

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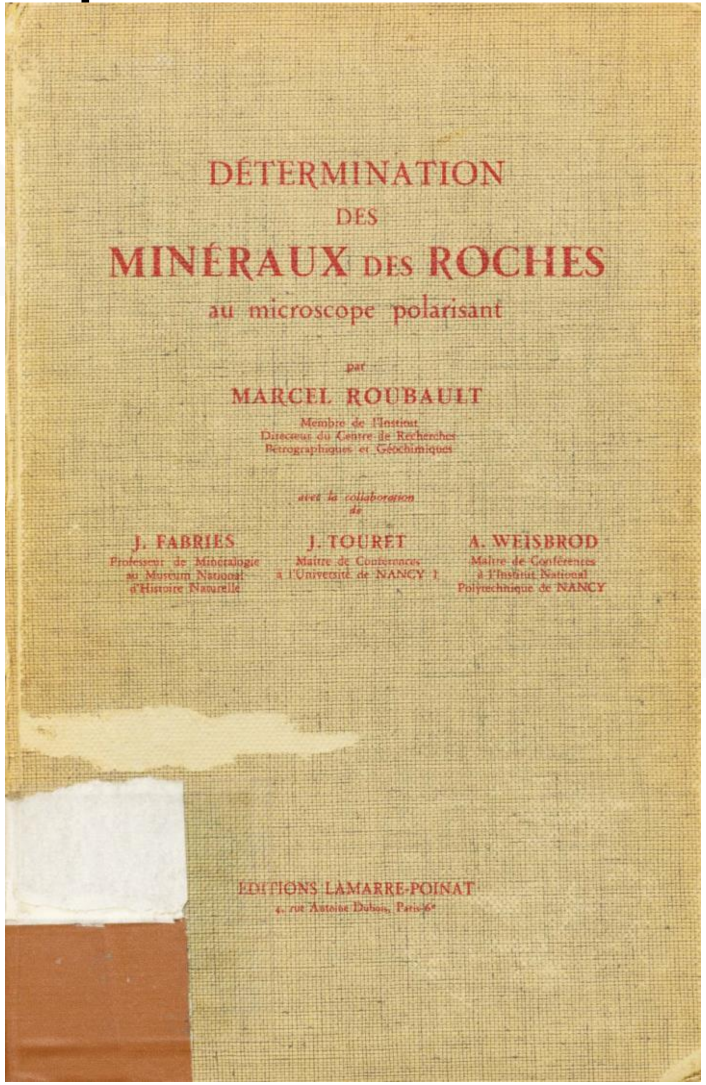

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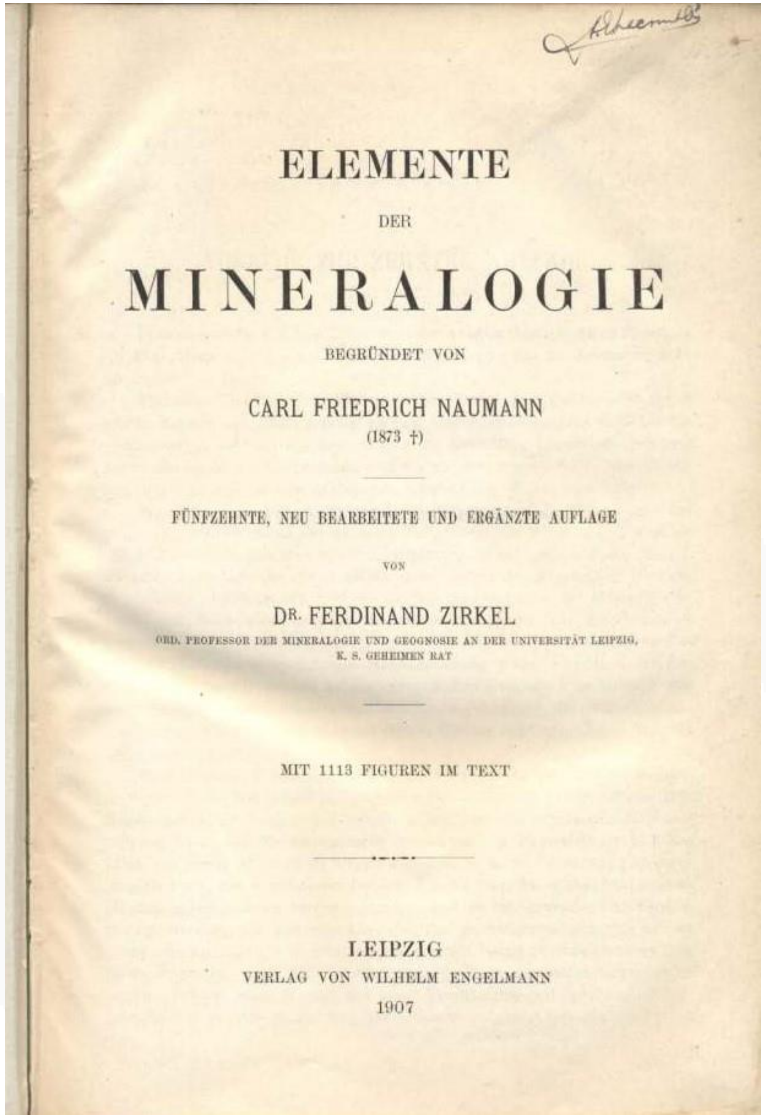

ELEMENTE

DER

MINERALOGIE

BEGRÜNDET VON

CARL FRIEDRICH NAUMANN

(1873 †)

FÜNFZEHNTE, NEU BEARBEITETE UND ERGÄNZTE AUFLAGE

VON

DR. FERDINAND ZIRKEL

ORD. PROFESSOR DER MINERALOGIE UND GEOGNOSIE AN DER UNIVERSITÄT LEIPZIG, K. S. GEHEIMEN RAT

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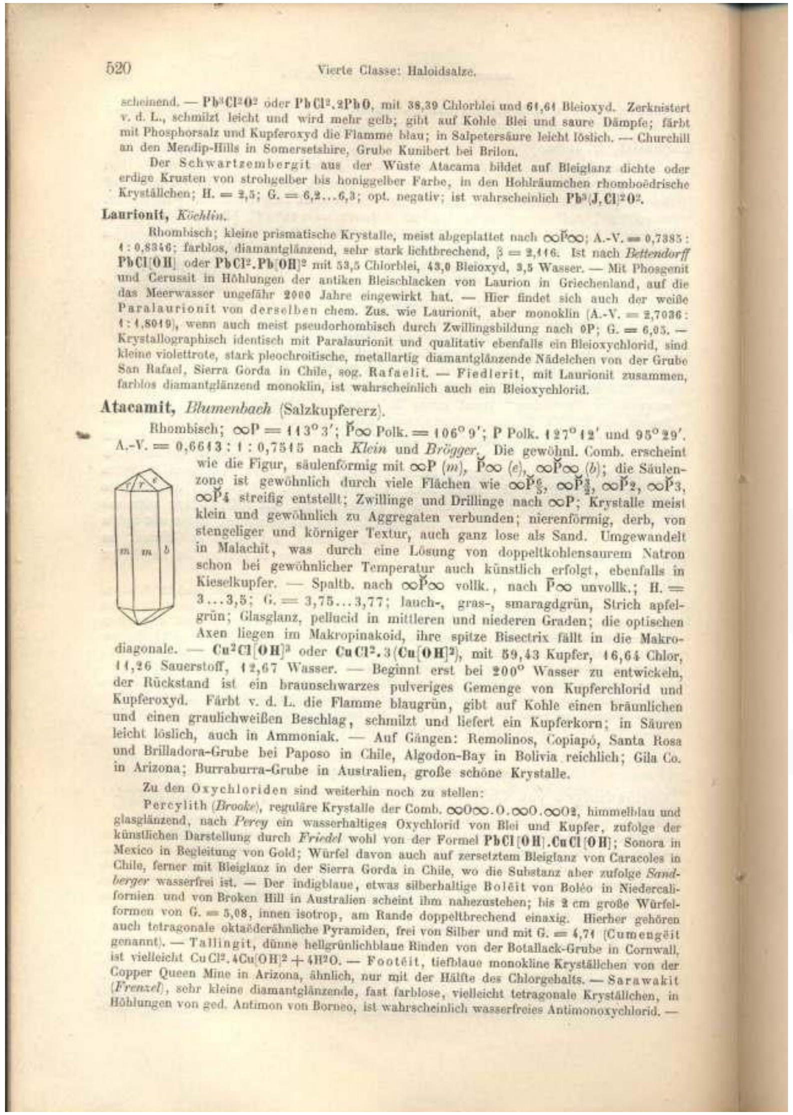

520 Vierte Classe: Haloidsalze.

scheinend. — $Pb^3Cl^2O^2$ oder $PbCl^2.2PbO$, mit 38,39 Chlorblei und 61,61 Bleioxyd. Zerknistert v. d. L., schmilzt leicht und wird mehr gelb; gibt auf Kohle Blei und saure Dämpfe; färbt mit Phosphorsalz und Kupferoxyd die Flamme blau; in Salpetersäure leicht löslich. — Churchill an den Mendip-Hills in Somersetshire, Grube Kunibert bei Brilon.

Der Schwartzembergit aus der Wüste Atacama bildet auf Bleiglanz dichte oder erdige Krusten von strohgelber bis honiggelber Farbe, in den Hohlräumchen rhomboëdrische Kryställchen; H. = 2,5; G. = 6,2...6,3; opt. negativ; ist wahrscheinlich $Pb^3(J,Cl)^2O^2$.

Laurionit, *Köchlin.*

Rhombisch; kleine prismatische Krystalle, meist abgeplattet nach ∞P̆∞; A.-V. = 0,7385 : 1 : 0,8346; farblos, diamantglänzend, sehr stark lichtbrechend, β = 2,116. Ist nach *Bettendorff* $PbCl[OH]$ oder $PbCl^2.Pb[OH]^2$ mit 53,5 Chlorblei, 43,0 Bleioxyd, 3,5 Wasser. — Mit Phosgenit und Cerussit in Höhlungen der antiken Bleischlacken von Laurion in Griechenland, auf die das Meerwasser ungefähr 2000 Jahre eingewirkt hat. — Hier findet sich auch der weiße Paralaurionit von derselben chem. Zus. wie Laurionit, aber monoklin (A.-V. = 2,7036 : 1 : 1,8019), wenn auch meist pseudorhombisch durch Zwillingsbildung nach 0P; G. = 6,05. — Krystallographisch identisch mit Paralaurionit und qualitativ ebenfalls ein Bleioxychlorid, sind kleine violettrote, stark pleochroitische, metallartig diamantglänzende Nädelchen von der Grube San Rafael, Sierra Gorda in Chile, sog. Rafaelit. — Fiedlerit, mit Laurionit zusammen, farblos diamantglänzend monoklin, ist wahrscheinlich auch ein Bleioxychlorid.

Atacamit, *Blumenbach* (Salzkupfererz).

Rhombisch; ∞P = 113° 3′; P̆∞ Polk. = 106° 9′; P Polk. 127° 12′ und 95° 29′. A.-V. = 0,6613 : 1 : 0,7515 nach *Klein* und *Brögger*. Die gewöhnl. Comb. erscheint wie die Figur, säulenförmig mit ∞P (*m*), P̆∞ (*e*), ∞P̆∞ (*b*); die Säulenzone ist gewöhnlich durch viele Flächen wie ∞P̆$\frac{6}{5}$, ∞P̆$\frac{3}{2}$, ∞P̆2, ∞P̆3, ∞P̆4 streifig entstellt; Zwillinge und Drillinge nach ∞P; Krystalle meist klein und gewöhnlich zu Aggregaten verbunden; nierenförmig, derb, von stengeliger und körniger Textur, auch ganz lose als Sand. Umgewandelt in Malachit, was durch eine Lösung von doppeltkohlensaurem Natron schon bei gewöhnlicher Temperatur auch künstlich erfolgt, ebenfalls in Kieselkupfer. — Spaltb. nach ∞P̆∞ vollk., nach P̄∞ unvollk.; H. = 3...3,5; G. = 3,75...3,77; lauch-, gras-, smaragdgrün, Strich apfelgrün; Glasglanz, pellucid in mittleren und niederen Graden; die optischen Axen liegen im Makropinakoid, ihre spitze Bisectrix fällt in die Makrodiagonale. — $Cu^2Cl[OH]^3$ oder $CuCl^2.3(Cu[OH]^2)$, mit 59,43 Kupfer, 16,64 Chlor, 11,26 Sauerstoff, 12,67 Wasser. — Beginnt erst bei 200° Wasser zu entwickeln, der Rückstand ist ein braunschwarzes pulveriges Gemenge von Kupferchlorid und Kupferoxyd. Färbt v. d. L. die Flamme blaugrün, gibt auf Kohle einen bräunlichen und einen graulichweißen Beschlag, schmilzt und liefert ein Kupferkorn; in Säuren leicht löslich, auch in Ammoniak. — Auf Gängen: Remolinos, Copiapó, Santa Rosa und Brilladora-Grube bei Paposo in Chile, Algodon-Bay in Bolivia reichlich; Gila Co. in Arizona; Burraburra-Grube in Australien, große schöne Krystalle.

Zu den Oxychloriden sind weiterhin noch zu stellen:

Percylith (*Brooke*), reguläre Krystalle der Comb. ∞O∞.O.∞O.∞O2, himmelblau und glasglänzend, nach *Percy* ein wasserhaltiges Oxychlorid von Blei und Kupfer, zufolge der künstlichen Darstellung durch *Friedel* wohl von der Formel $PbCl[OH].CuCl[OH]$; Sonora in Mexico in Begleitung von Gold; Würfel davon auch auf zersetztem Bleiglanz von Caracoles in Chile, ferner mit Bleiglanz in der Sierra Gorda in Chile, wo die Substanz aber zufolge *Sandberger* wasserfrei ist. — Der indigblaue, etwas silberhaltige Boléit von Boléo in Niedercalifornien und von Broken Hill in Australien scheint ihm nahezustehen; bis 2 cm große Würfelformen von G. = 5,08, innen isotrop, am Rande doppeltbrechend einaxig. Hierher gehören auch tetragonale oktaëderähnliche Pyramiden, frei von Silber und mit G. = 4,71 (Cumengëit genannt). — Tallingit, dünne hellgrünlichblaue Rinden von der Botallack-Grube in Cornwall, ist vielleicht $CuCl^2.4Cu[OH]^2 + 4H^2O$. — Footëit, tiefblaue monokline Kryställchen von der Copper Queen Mine in Arizona, ähnlich, nur mit der Hälfte des Chlorgehalts. — Sarawakit (*Frenzel*), sehr kleine diamantglänzende, fast farblose, vielleicht tetragonale Kryställchen, in Höhlungen von ged. Antimon von Borneo, ist wahrscheinlich wasserfreies Antimonoxychlorid. —

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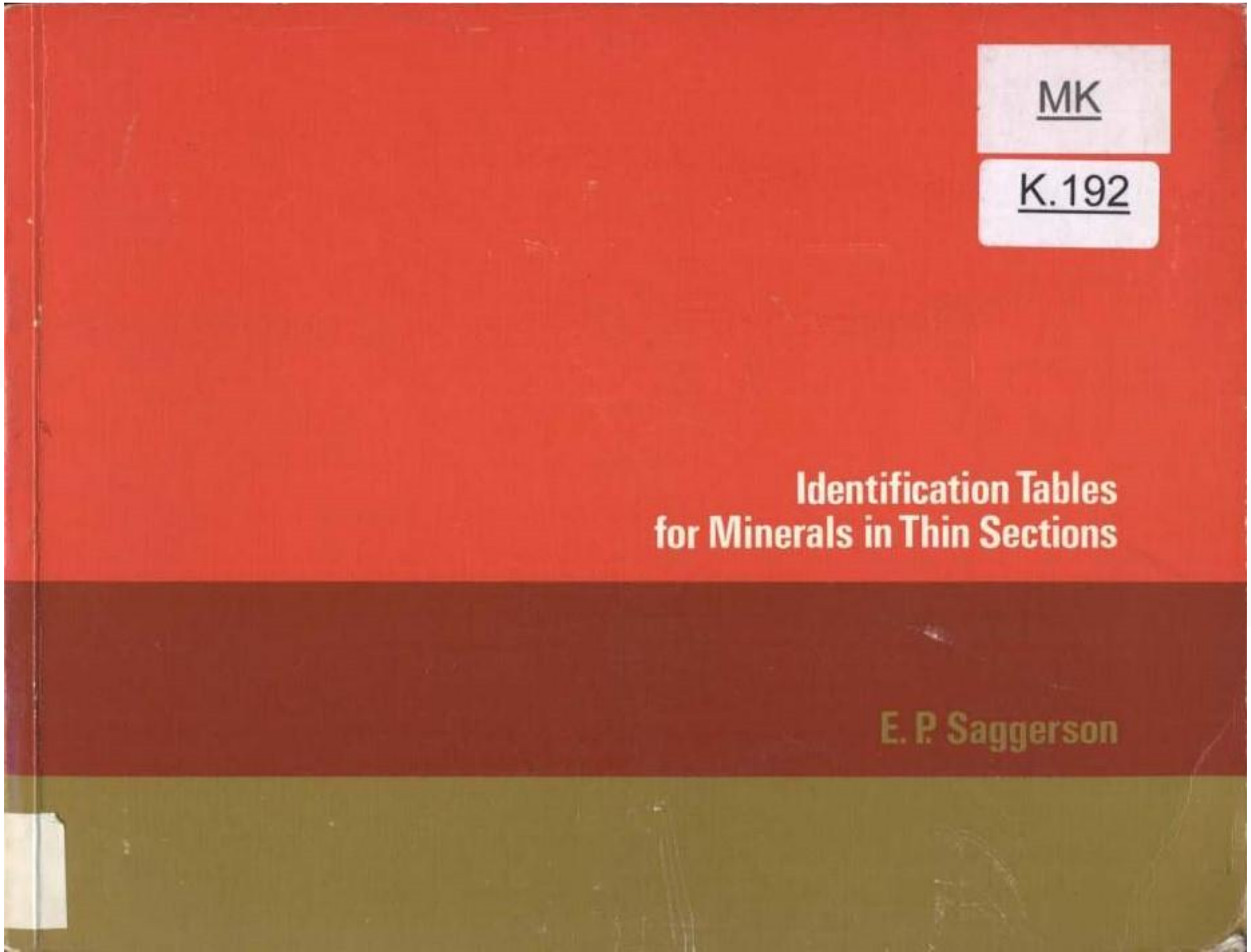

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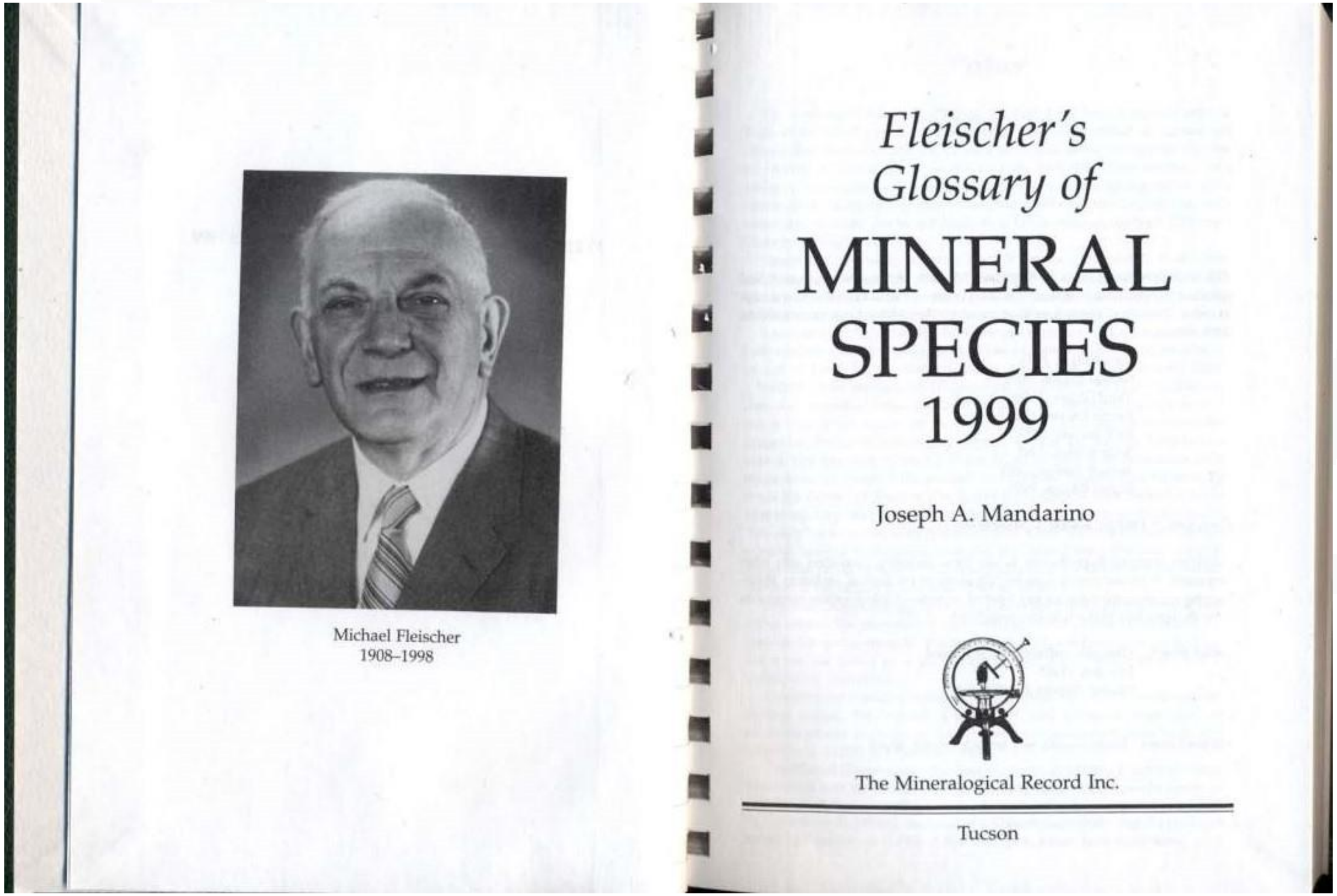

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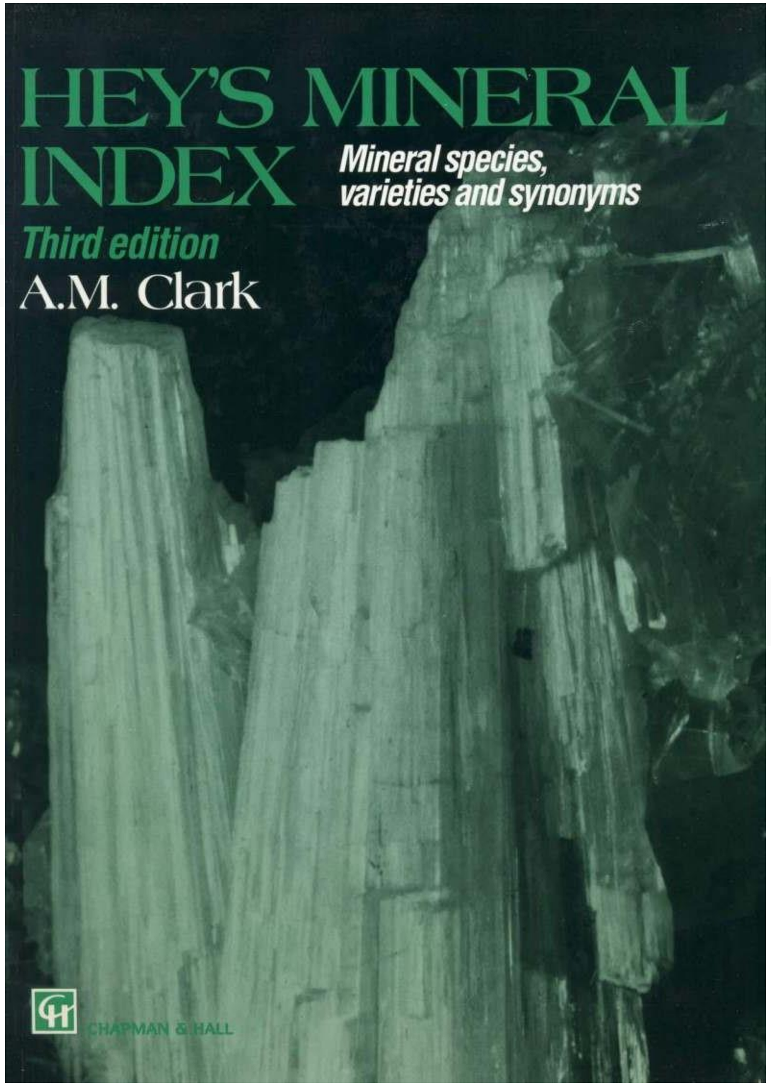

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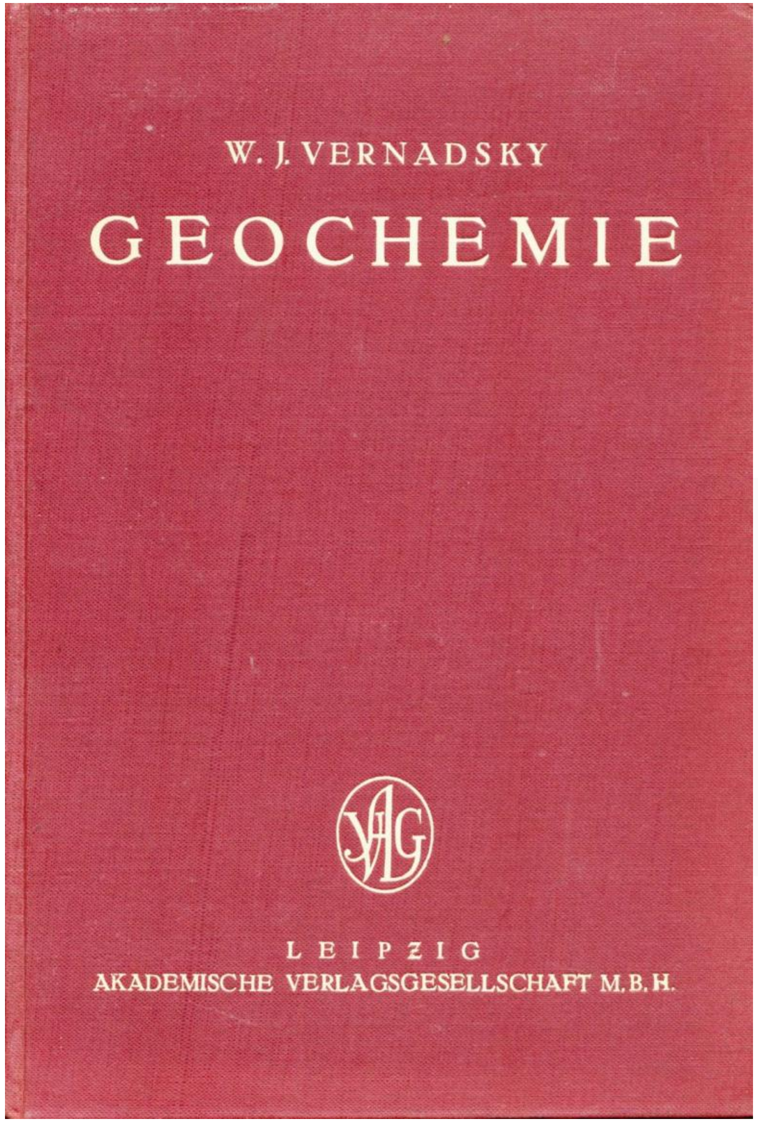


GEOCHEMIE

IN AUSGEWÄHLTEN KAPITELN

VON

W. J. VERNADSKY

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AUTORISIERTE ÜBERSETZUNG
AUS DEM RUSSISCHEN

VON

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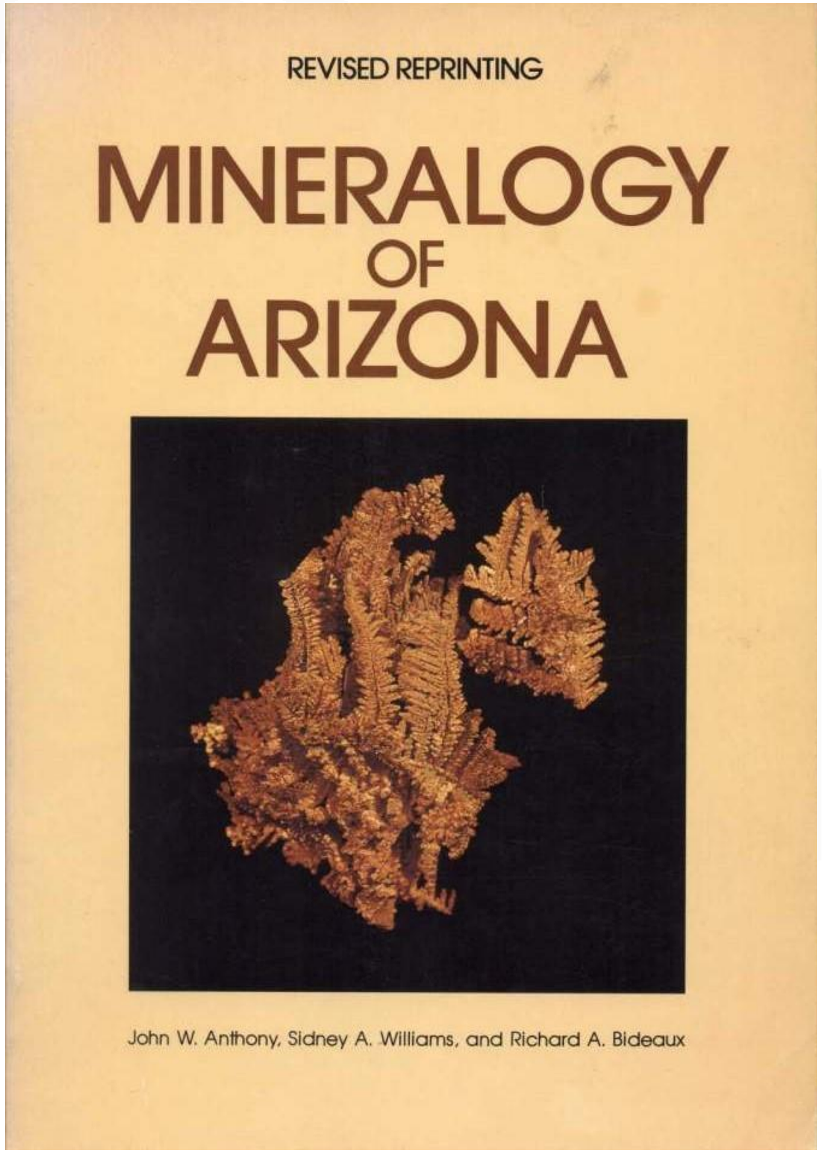

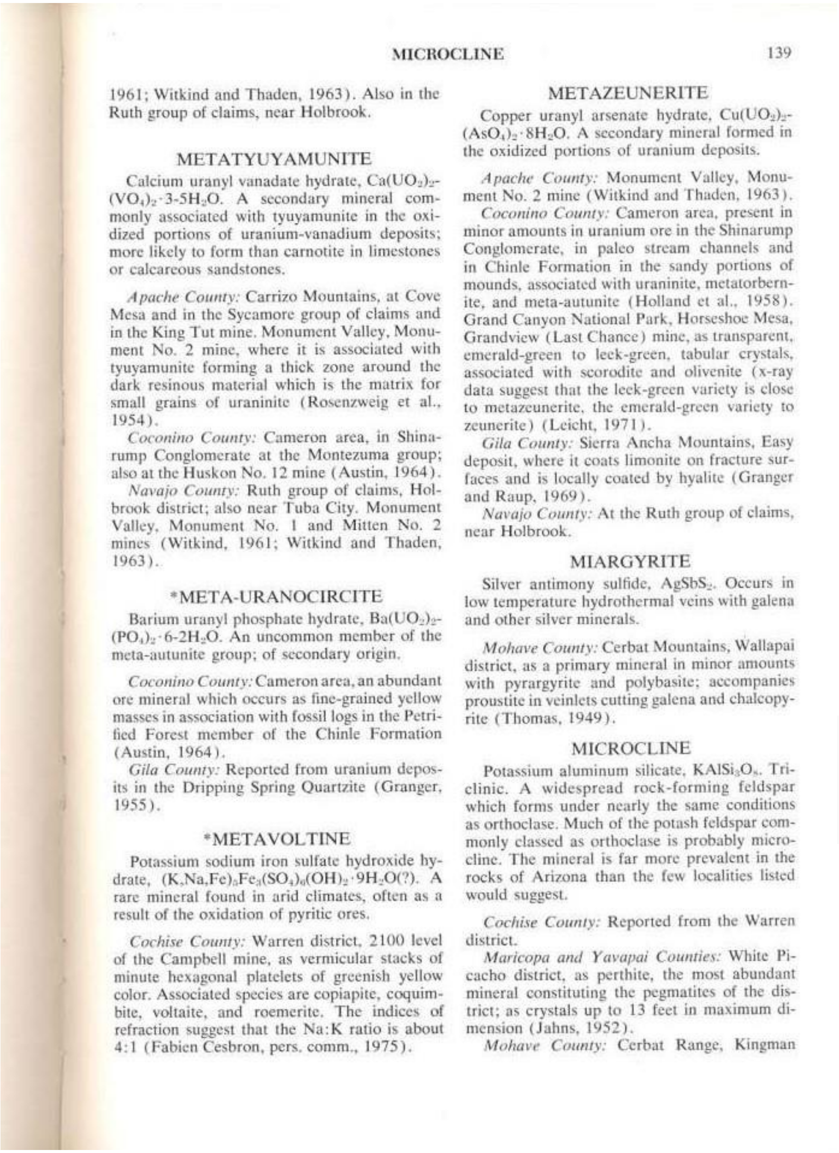

1961; Witkind and Thaden, 1963). Also in the Ruth group of claims, near Holbrook.

METATYUYAMUNITE

Calcium uranyl vanadate hydrate, $Ca(UO_2)_2(VO_4)_2 \cdot 3\text{-}5H_2O$. A secondary mineral commonly associated with tyuyamunite in the oxidized portions of uranium-vanadium deposits; more likely to form than carnotite in limestones or calcareous sandstones.

Apache County: Carrizo Mountains, at Cove Mesa and in the Sycamore group of claims and in the King Tut mine. Monument Valley, Monument No. 2 mine, where it is associated with tyuyamunite forming a thick zone around the dark resinous material which is the matrix for small grains of uraninite (Rosenzweig et al., 1954).

Coconino County: Cameron area, in Shinarump Conglomerate at the Montezuma group; also at the Huskon No. 12 mine (Austin, 1964).

Navajo County: Ruth group of claims, Holbrook district; also near Tuba City. Monument Valley, Monument No. 1 and Mitten No. 2 mines (Witkind, 1961; Witkind and Thaden, 1963).

*META-URANOCIRCITE

Barium uranyl phosphate hydrate, $Ba(UO_2)_2(PO_4)_2 \cdot 6\text{-}2H_2O$. An uncommon member of the meta-autunite group; of secondary origin.

Coconino County: Cameron area, an abundant ore mineral which occurs as fine-grained yellow masses in association with fossil logs in the Petrified Forest member of the Chinle Formation (Austin, 1964).

Gila County: Reported from uranium deposits in the Dripping Spring Quartzite (Granger, 1955).

*METAVOLTINE

Potassium sodium iron sulfate hydroxide hydrate, $(K,Na,Fe)_5Fe_3(SO_4)_6(OH)_2 \cdot 9H_2O$(?). A rare mineral found in arid climates, often as a result of the oxidation of pyritic ores.

Cochise County: Warren district, 2100 level of the Campbell mine, as vermicular stacks of minute hexagonal platelets of greenish yellow color. Associated species are copiapite, coquimbite, voltaite, and roemerite. The indices of refraction suggest that the Na:K ratio is about 4:1 (Fabien Cesbron, pers. comm., 1975).

METAZEUNERITE

Copper uranyl arsenate hydrate, $Cu(UO_2)_2(AsO_4)_2 \cdot 8H_2O$. A secondary mineral formed in the oxidized portions of uranium deposits.

Apache County: Monument Valley, Monument No. 2 mine (Witkind and Thaden, 1963).

Coconino County: Cameron area, present in minor amounts in uranium ore in the Shinarump Conglomerate, in paleo stream channels and in Chinle Formation in the sandy portions of mounds, associated with uraninite, metatorbernite, and meta-autunite (Holland et al., 1958). Grand Canyon National Park, Horseshoe Mesa, Grandview (Last Chance) mine, as transparent, emerald-green to leek-green, tabular crystals, associated with scorodite and olivenite (x-ray data suggest that the leek-green variety is close to metazeunerite, the emerald-green variety to zeunerite) (Leicht, 1971).

Gila County: Sierra Ancha Mountains, Easy deposit, where it coats limonite on fracture surfaces and is locally coated by hyalite (Granger and Raup, 1969).

Navajo County: At the Ruth group of claims, near Holbrook.

MIARGYRITE

Silver antimony sulfide, $AgSbS_2$. Occurs in low temperature hydrothermal veins with galena and other silver minerals.

Mohave County: Cerbat Mountains, Wallapai district, as a primary mineral in minor amounts with pyrargyrite and polybasite; accompanies proustite in veinlets cutting galena and chalcopyrite (Thomas, 1949).

MICROCLINE

Potassium aluminum silicate, $KAlSi_3O_8$. Triclinic. A widespread rock-forming feldspar which forms under nearly the same conditions as orthoclase. Much of the potash feldspar commonly classed as orthoclase is probably microcline. The mineral is far more prevalent in the rocks of Arizona than the few localities listed would suggest.

Cochise County: Reported from the Warren district.

Maricopa and Yavapai Counties: White Picacho district, as perthite, the most abundant mineral constituting the pegmatites of the district; as crystals up to 13 feet in maximum dimension (Jahns, 1952).

Mohave County: Cerbat Range, Kingman

48 Mineralien reinigen und aufbewahren 5,00 €

canthiol bei der Passivierung von Silber und Kupfer (**Kap. 4.5**), sowie zur Naßreinigung von wasserlöslichen oder haarförmigen Mineralien verwendet (**Kap. 2.1.3** und **Kap. 3.9**).

Petroläther (Reinbenzin), $C_nH_{(2n+2)}$, Gemisch niedermolekularer gesättigter Kohlenwasserstoffe Δ!

Siedepunkt: 35-80°C; Dichte: 0.63-0.68 g/mL; Flammpunkt: - 20°C; Zündtemperatur: 280°C; Explosionsgrenzen: 1.2-7.5 Vol%; nicht wasserlöslich.

Petroläther ist ein Gemisch von verschiedenen gesättigten Kohlenwasserstoffen. Es sind verschiedene Fraktionen mit unterschiedlichen Siedepunktsgrenzen im Handel. Ähnliche Produkte sind Reinbenzin und Wundbenzin. Es handelt sich um leichtflüchtige, **extrem feuergefährliche** Flüssigkeiten mit großem **Explosionspotential** (siehe **Organische Lösungsmittel** für Gesundheitsschutz). Petroläther muß zur Entsorgung an eine Sammelstelle gebracht werden. Dieses extrem apolare Lösungsmittel eignet sich zum **Entfetten** von Stufen, welche z.B. aus ungeeignetem Kitt Öle aufgesogen haben. Im Gemisch mit andern polareren Lösungsmitteln wird Petroläther zum Verdünnen von organischen Lacken verwendet (**Kap. 4.4**). Er eignet sich auch zum Reinigen von haarförmigen Mineralien (**Kap. 2.1.3** und **Kap. 3.9**).

2-Propanol (Isopropanol), $(CH_3)_2CHOH$ / C_3H_8O) Δ!

Siedepunkt: 82.4°C; Dichte: 0.783 g/mL; Flammpunkt: 12°C; Zündtemperatur: 425°C; Explosionsgrenzen: 2-12 Vol%; wasserlöslich.

Leichflüchtige, leichtentzündliche Flüssigkeit mit angenehmem Geruch. Explosionsgefahr, siehe auch **Organische Lösungsmittel**. Isopropanol wirkt lokal reizend; auch dieser Alkohol ist ein schwaches Zellgift und die Dämpfe haben eine narkotisierende Wirkung, wobei die allgemeinen Effekte mit Äthanol zu vergleichen sind. Kleinere Mengen 2-Propanol können mit viel Wasser in den Ausguß gespült werden. Isopropanol dient zum Verdünnen von Lacken (**Kap. 4.5**), sowie zur Reinigung von wasserlöslichen oder haarförmigen Mineralien (**Kap. 2.1.3** und **Kap. 3.9**).

Phosphorpentoxid (Phosphorsäureanhydrid), P_2O_5 Δ!

Weißes, extrem stark Feuchtigkeit ziehendes Pulver. **Reagiert äußerst heftig mit Wasser**, die Behälter sind stets gut zu verschließen. Phosphorpentoxid wirkt stark ätzend und verursacht schlecht heilende Wunden. Der Staub darf nicht eingeatmet werden und jeder Kontakt mit der Haut und den Augen ist zu vermeiden. Spritzer sind sofort und mit viel Wasser abzuspülen. Kleine Mengen können mit viel Wasser in den Ausguß gespült werden. Größere Mengen werden in einem Glasgefäß sorgfältig hydrolysiert; wegen der heftigen Reaktion mit Wasser werden dazu mit einem Spatel oder Löffel nur kleine Portionen (etwa 0.5 g) in viel Wasser eingetragen, wobei Phosphorsäure entsteht. Zur Entsorgung müssen größere Mengen einer amtlichen Sammelstelle übergeben werden. Besonders heimtückisch ist die Zerstörung von gebrauchtem P_2O_5, welches mit einer zähen Schicht Polyphosphorsäure überdeckt ist. Diese muß zuerst mit einem Spatel vorsichtig abgehoben und in ein Becken mit viel Wasser gegeben werden, wo sie sich langsam auf-

49 Kristallformen von Fluorit (...)

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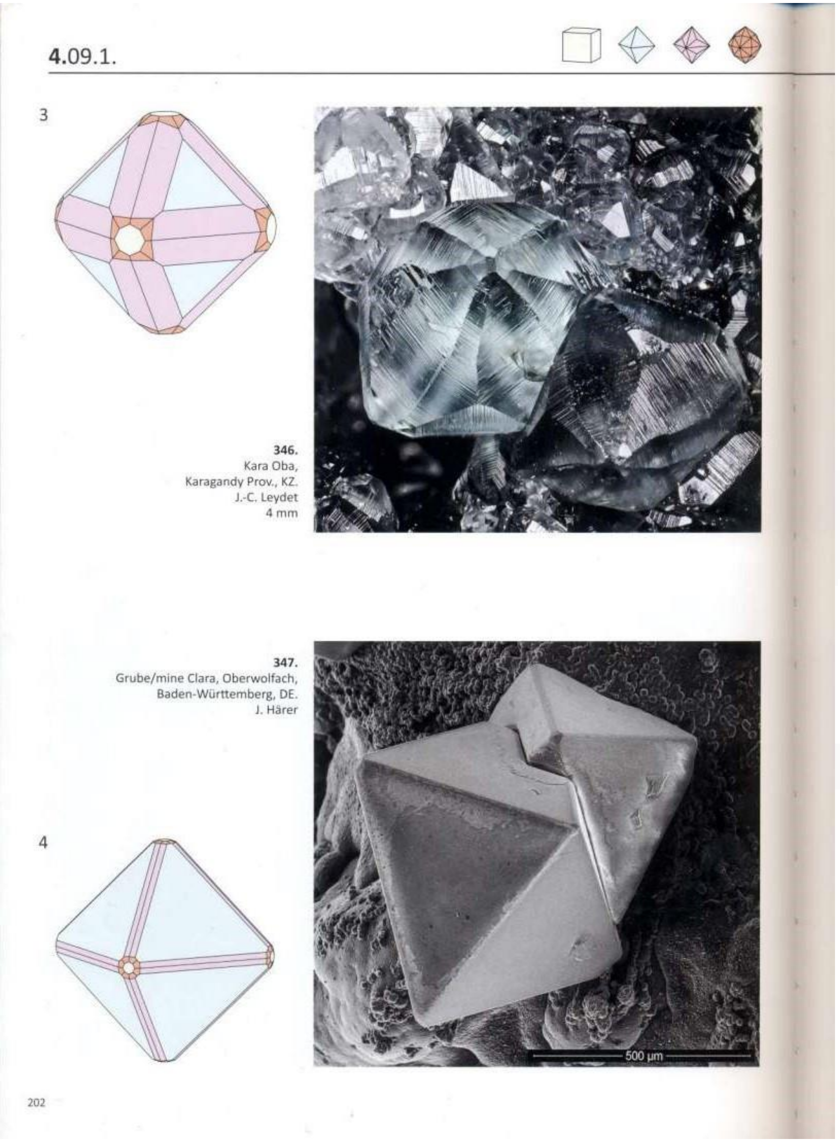

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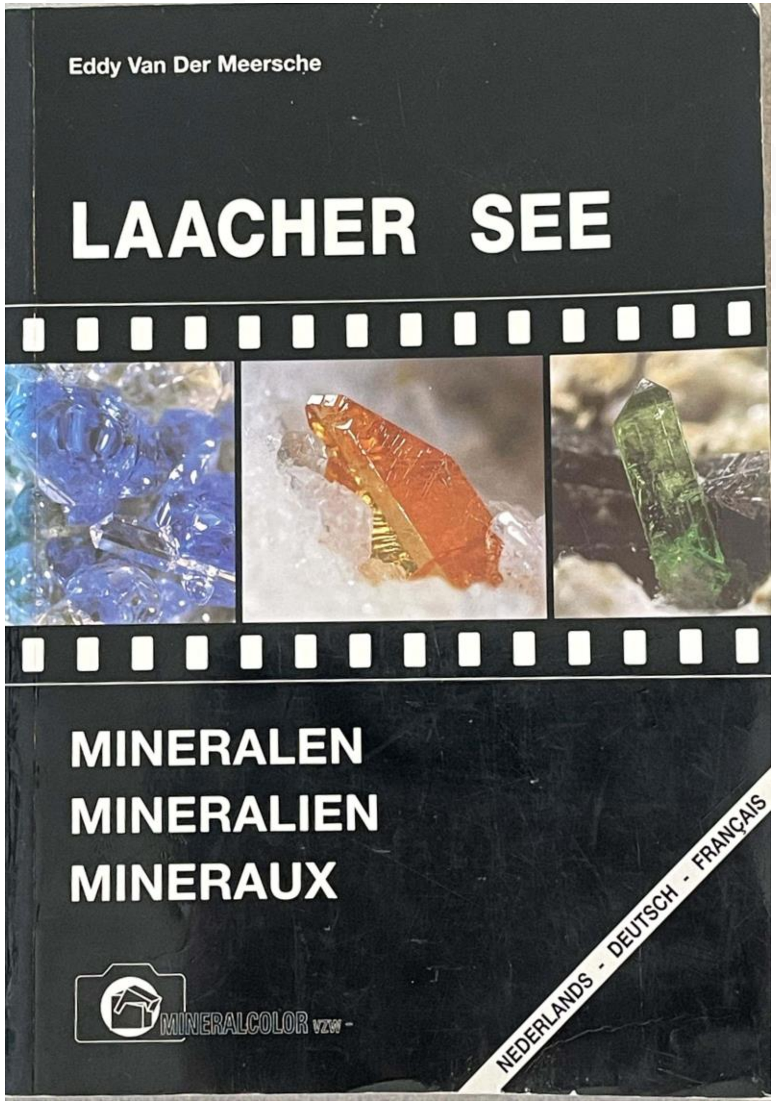

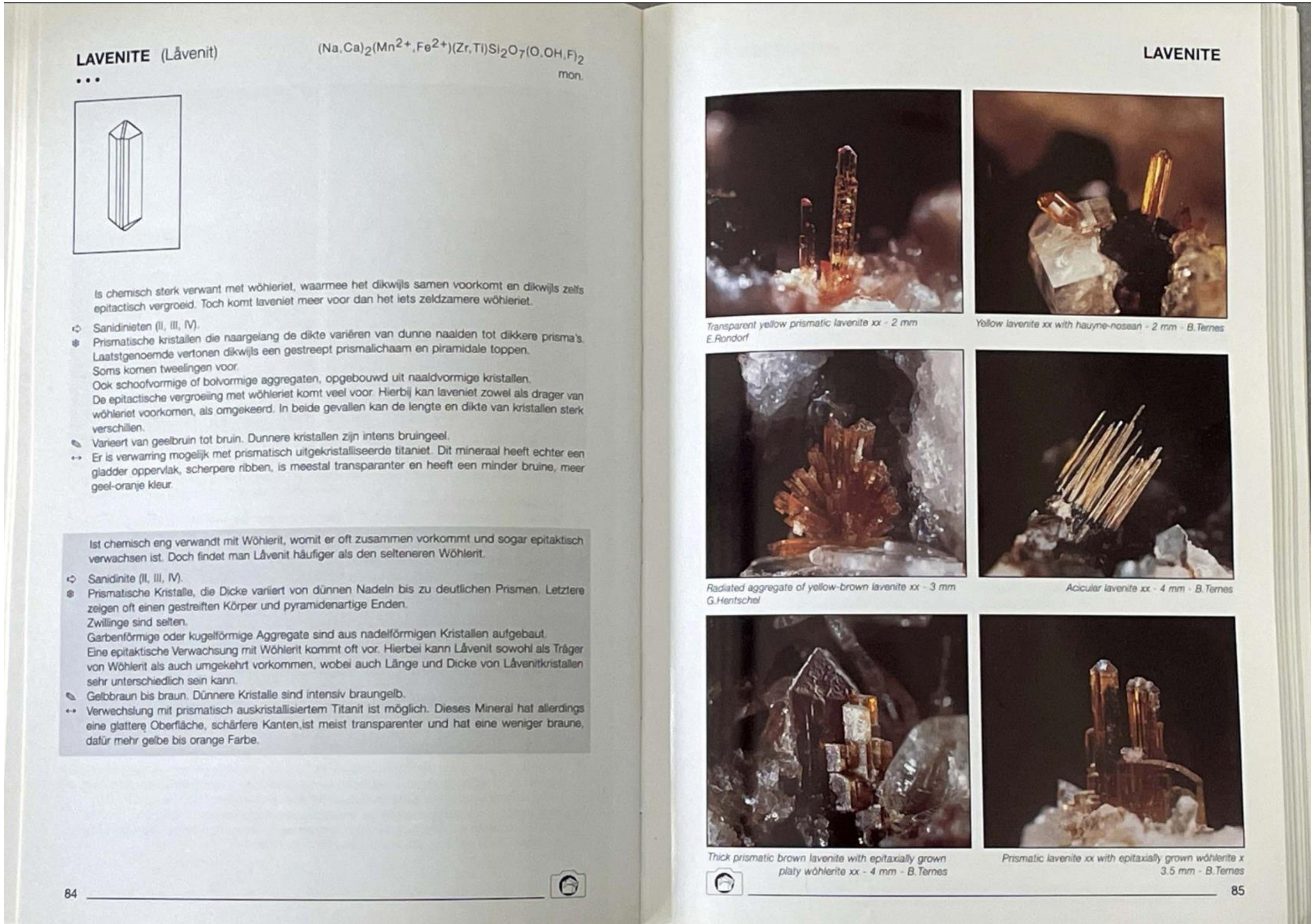

LAVENITE (Låvenit) $(Na,Ca)_2(Mn^{2+},Fe^{2+})(Zr,Ti)Si_2O_7(O,OH,F)_2$

• • • mon.

Is chemisch sterk verwant met wöhleriet, waarmee het dikwijls samen voorkomt en dikwijls zelfs epitactisch vergroeid. Toch komt laveniet meer voor dan het iets zeldzamere wöhleriet.

- Sanidinieten (II, III, IV).
- Prismatische kristallen die naargelang de dikte variëren van dunne naalden tot dikkere prisma's. Laatstgenoemde vertonen dikwijls een gestreept prismalichaam en piramidale toppen.
  Soms komen tweelingen voor.
  Ook schoofvormige of bolvormige aggregaten, opgebouwd uit naaldvormige kristallen.
  De epitactische vergroeiing met wöhleriet komt veel voor. Hierbij kan laveniet zowel als drager van wöhleriet voorkomen, als omgekeerd. In beide gevallen kan de lengte en dikte van kristallen sterk verschillen.
- Varieert van geelbruin tot bruin. Dunnere kristallen zijn intens bruingeel.
- Er is verwarring mogelijk met prismatisch uitgekristalliseerde titaniet. Dit mineraal heeft echter een gladder oppervlak, scherpere ribben, is meestal transparanter en heeft een minder bruine, meer geel-oranje kleur.

Ist chemisch eng verwandt mit Wöhlerit, womit er oft zusammen vorkommt und sogar epitaktisch verwachsen ist. Doch findet man Låvenit häufiger als den selteneren Wöhlerit.

- Sanidinite (II, III, IV).
- Prismatische Kristalle, die Dicke variiert von dünnen Nadeln bis zu deutlichen Prismen. Letztere zeigen oft einen gestreiften Körper und pyramidenartige Enden.
  Zwillinge sind selten.
  Garbenförmige oder kugelförmige Aggregate sind aus nadelförmigen Kristallen aufgebaut.
  Eine epitaktische Verwachsung mit Wöhlerit kommt oft vor. Hierbei kann Låvenit sowohl als Träger von Wöhlerit als auch umgekehrt vorkommen, wobei auch Länge und Dicke von Låvenitkristallen sehr unterschiedlich sein kann.
- Gelbbraun bis braun. Dünnere Kristalle sind intensiv braungelb.
- Verwechslung mit prismatisch auskristallisiertem Titanit ist möglich. Dieses Mineral hat allerdings eine glattere Oberfläche, schärfere Kanten, ist meist transparenter und hat eine weniger braune, dafür mehr gelbe bis orange Farbe.

84

LAVENITE

Transparent yellow prismatic lavenite xx - 2 mm E.Rondorf

Yellow lavenite xx with hauyne-nosean - 2 mm - B.Ternes

Radiated aggregate of yellow-brown lavenite xx - 3 mm G.Hentschel

Acicular lavenite xx - 4 mm - B.Ternes

Thick prismatic brown lavenite with epitaxially grown platy wöhlerite xx - 4 mm - B.Ternes

Prismatic lavenite xx with epitaxially grown wöhlerite x 3.5 mm - B.Ternes

85

51 Simon & Schuster's Guide to Rocks and Minerals

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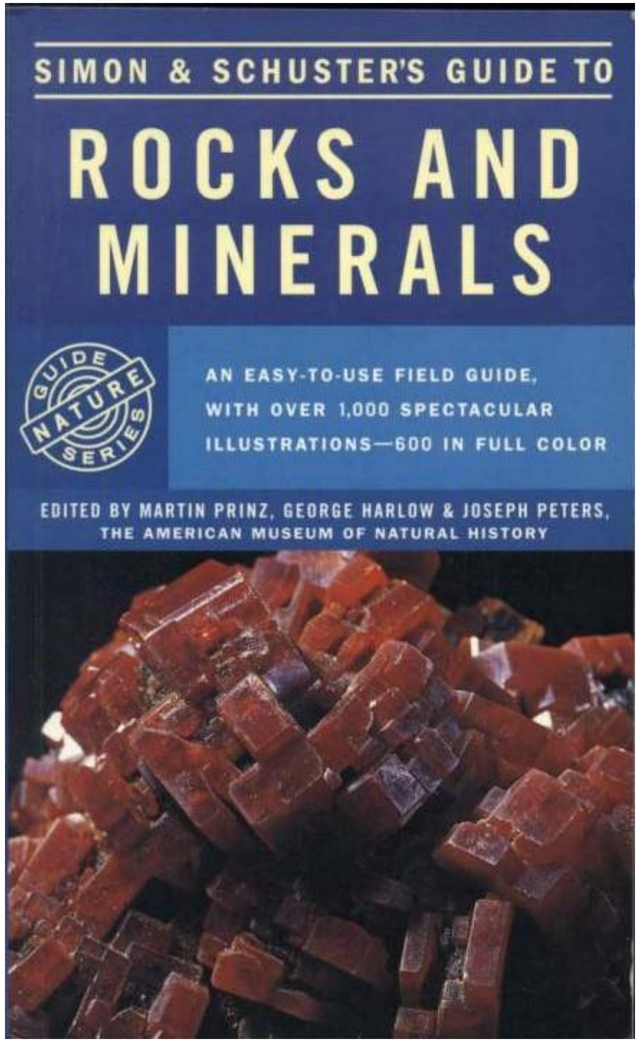

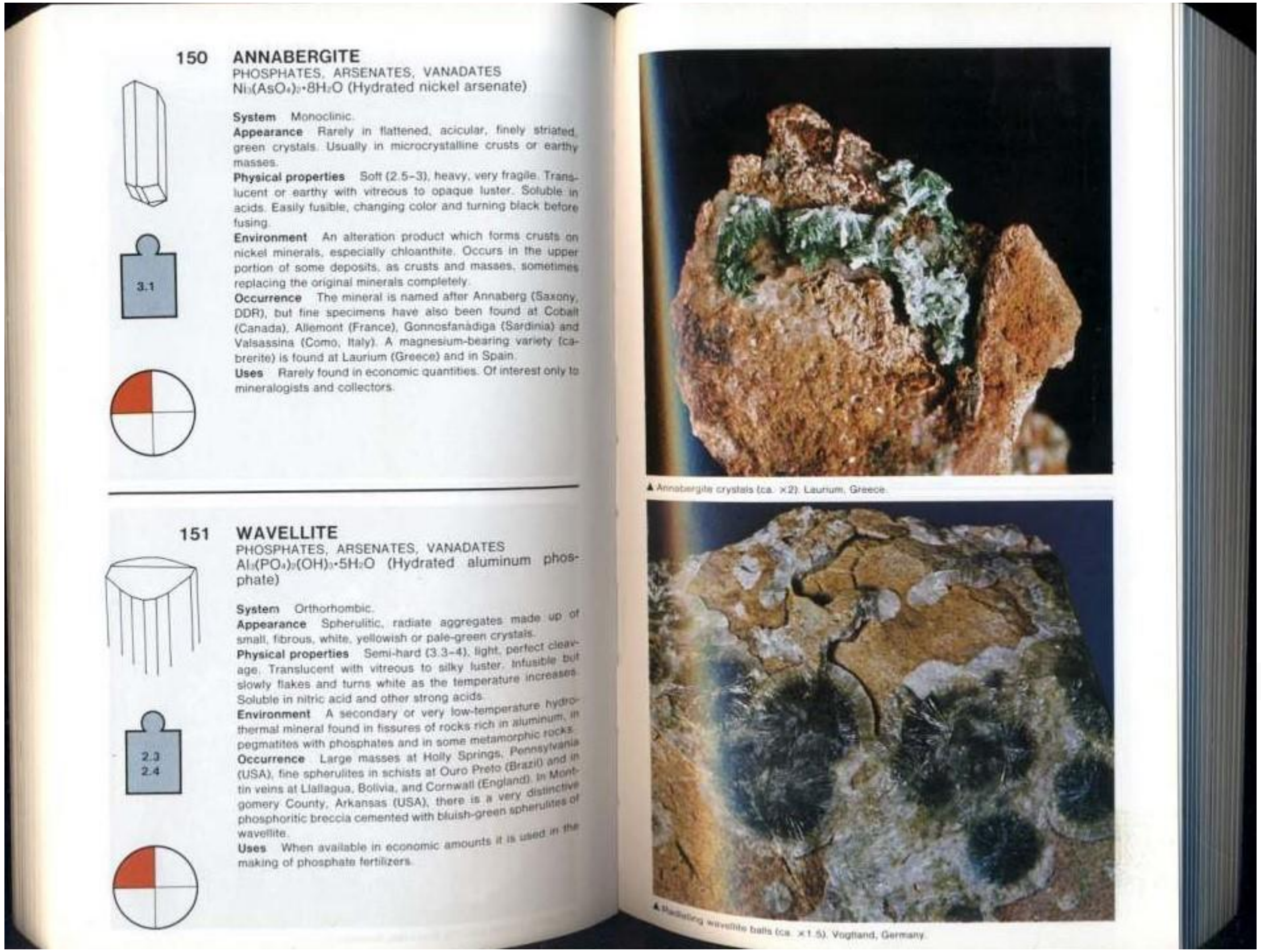

150 **ANNABERGITE**
PHOSPHATES, ARSENATES, VANADATES
$Ni_3(AsO_4)_2 \cdot 8H_2O$ (Hydrated nickel arsenate)

System Monoclinic.
Appearance Rarely in flattened, acicular, finely striated green crystals. Usually in microcrystalline crusts or earthy masses.
Physical properties Soft (2.5–3), heavy, very fragile. Translucent or earthy with vitreous to opaque luster. Soluble in acids. Easily fusible, changing color and turning black before fusing.
Environment An alteration product which forms crusts on nickel minerals, especially chloanthite. Occurs in the upper portion of some deposits, as crusts and masses, sometimes replacing the original minerals completely.
Occurrence The mineral is named after Annaberg (Saxony, DDR), but fine specimens have also been found at Cobalt (Canada), Allemont (France), Gonnosfanàdiga (Sardinia) and Valsassina (Como, Italy). A magnesium-bearing variety (cabrerite) is found at Laurium (Greece) and in Spain.
Uses Rarely found in economic quantities. Of interest only to mineralogists and collectors.

151 **WAVELLITE**
PHOSPHATES, ARSENATES, VANADATES
$Al_3(PO_4)_2(OH)_3 \cdot 5H_2O$ (Hydrated aluminum phosphate)

System Orthorhombic.
Appearance Spherulitic, radiate aggregates made up of small, fibrous, white, yellowish or pale-green crystals.
Physical properties Semi-hard (3.3–4), light, perfect cleavage. Translucent with vitreous to silky luster. Infusible but slowly flakes and turns white as the temperature increases. Soluble in nitric acid and other strong acids.
Environment A secondary or very low-temperature hydrothermal mineral found in fissures of rocks rich in aluminum, in pegmatites with phosphates and in some metamorphic rocks.
Occurrence Large masses at Holly Springs, Pennsylvania (USA), fine spherulites in schists at Ouro Preto (Brazil) and in tin veins at Llallagua, Bolivia, and Cornwall (England). In Montgomery County, Arkansas (USA), there is a very distinctive phosphoritic breccia cemented with bluish-green spherulites of wavellite.
Uses When available in economic amounts it is used in the making of phosphate fertilizers.

▲ Annabergite crystals (ca. ×2). Laurium, Greece.

▲ Radiating wavellite balls (ca. ×1.5). Vogtland, Germany.

52 Evolution of Chromium Ore Fields

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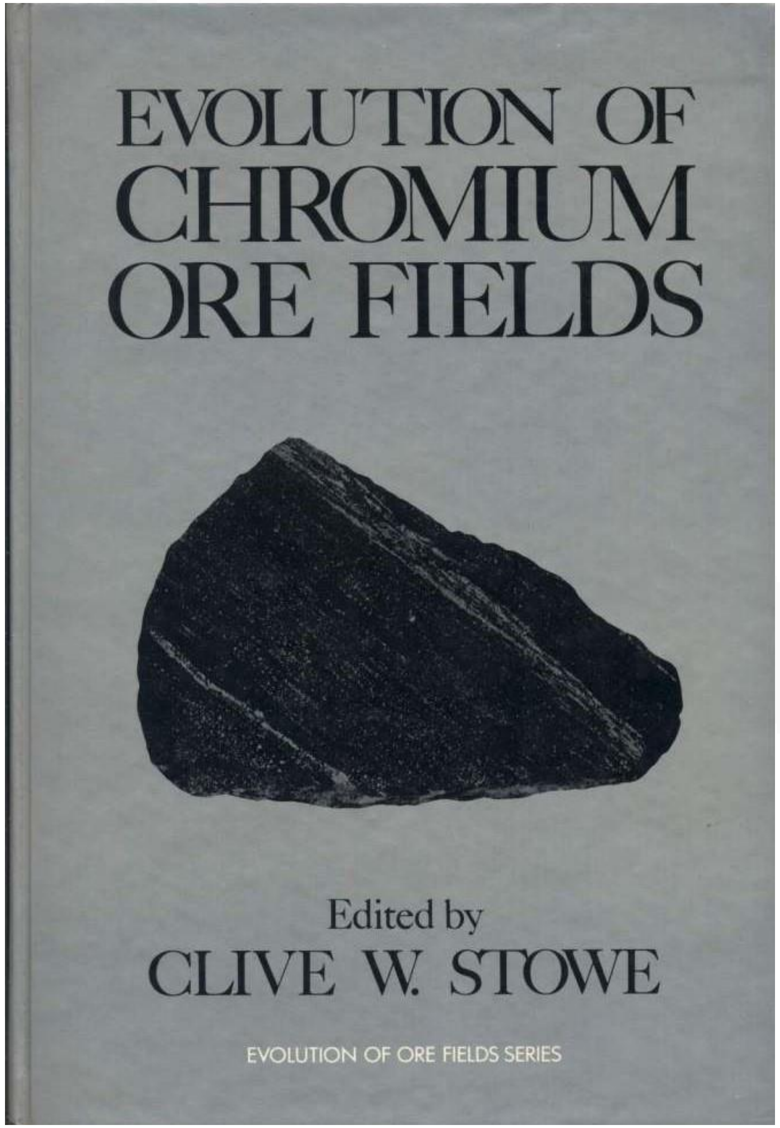

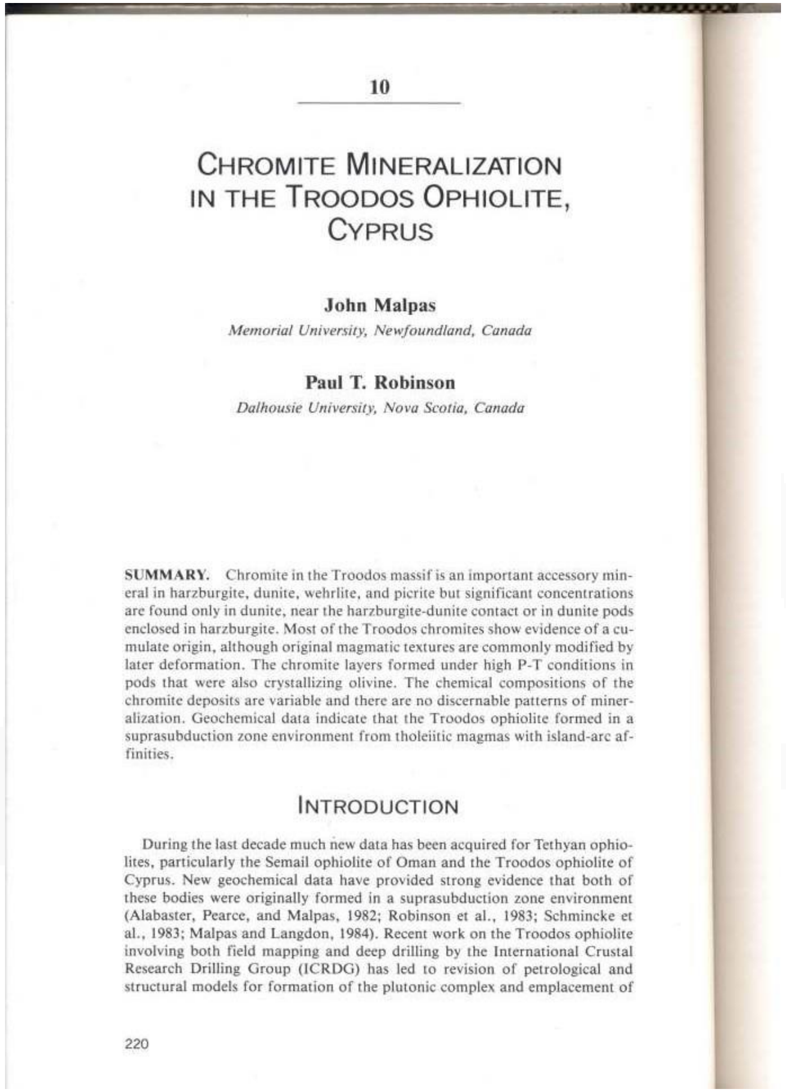

10

Chromite Mineralization in the Troodos Ophiolite, Cyprus

John Malpas
Memorial University, Newfoundland, Canada

Paul T. Robinson
Dalhousie University, Nova Scotia, Canada

SUMMARY. Chromite in the Troodos massif is an important accessory mineral in harzburgite, dunite, wehrlite, and picrite but significant concentrations are found only in dunite, near the harzburgite-dunite contact or in dunite pods enclosed in harzburgite. Most of the Troodos chromites show evidence of a cumulate origin, although original magmatic textures are commonly modified by later deformation. The chromite layers formed under high P-T conditions in pods that were also crystallizing olivine. The chemical compositions of the chromite deposits are variable and there are no discernable patterns of mineralization. Geochemical data indicate that the Troodos ophiolite formed in a suprasubduction zone environment from tholeiitic magmas with island-arc affinities.

Introduction

During the last decade much new data has been acquired for Tethyan ophiolites, particularly the Semail ophiolite of Oman and the Troodos ophiolite of Cyprus. New geochemical data have provided strong evidence that both of these bodies were originally formed in a suprasubduction zone environment (Alabaster, Pearce, and Malpas, 1982; Robinson et al., 1983; Schmincke et al., 1983; Malpas and Langdon, 1984). Recent work on the Troodos ophiolite involving both field mapping and deep drilling by the International Crustal Research Drilling Group (ICRDG) has led to revision of petrological and structural models for formation of the plutonic complex and emplacement of

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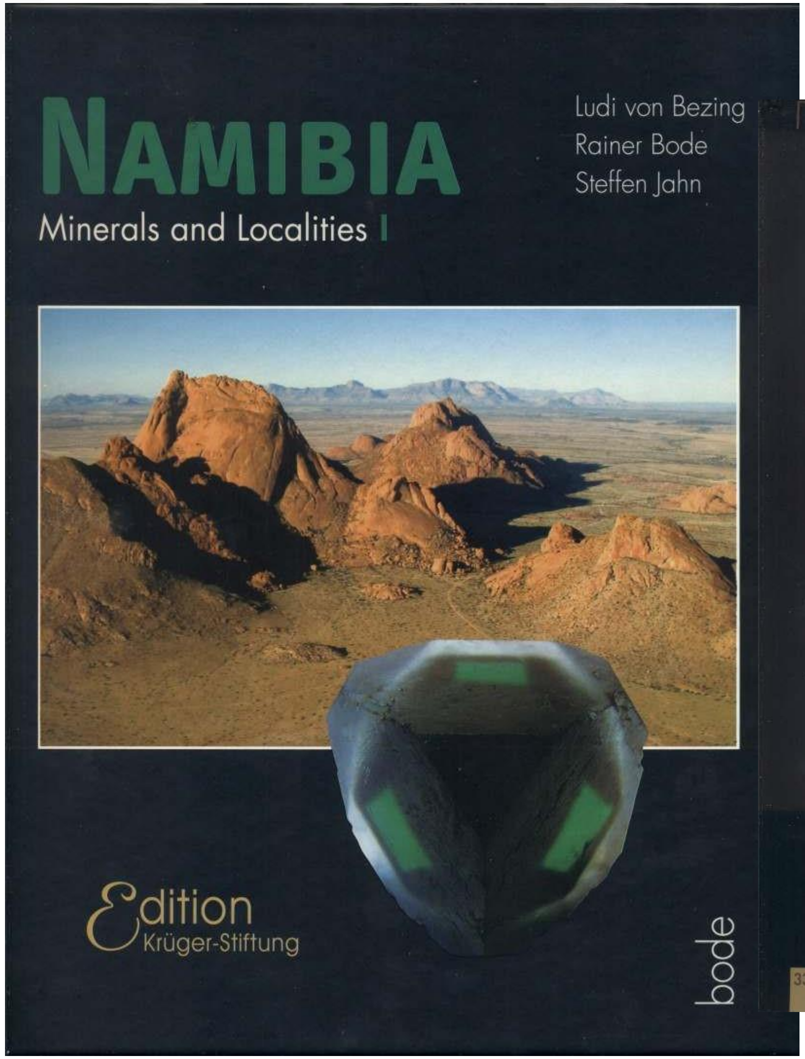

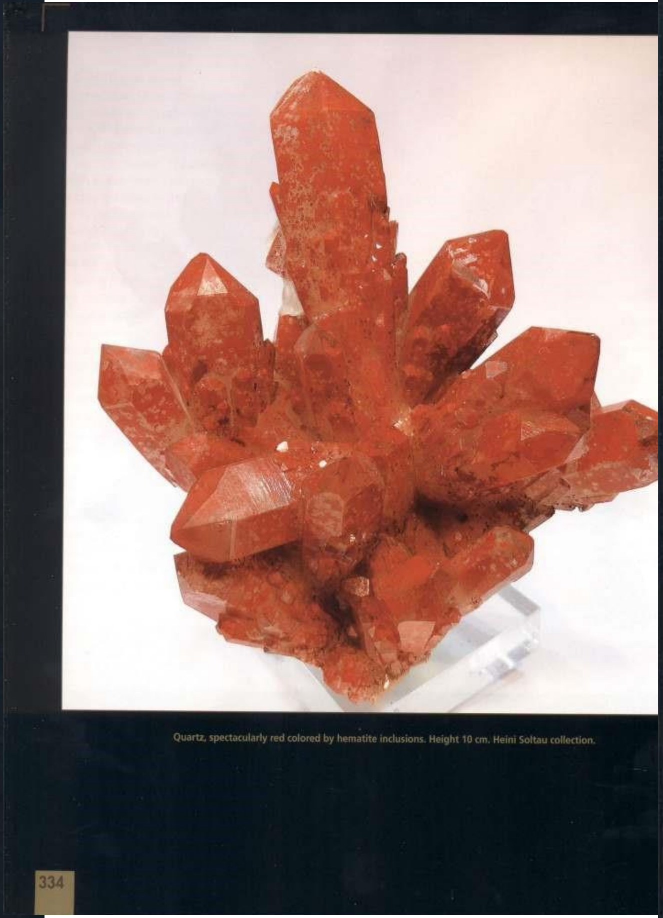

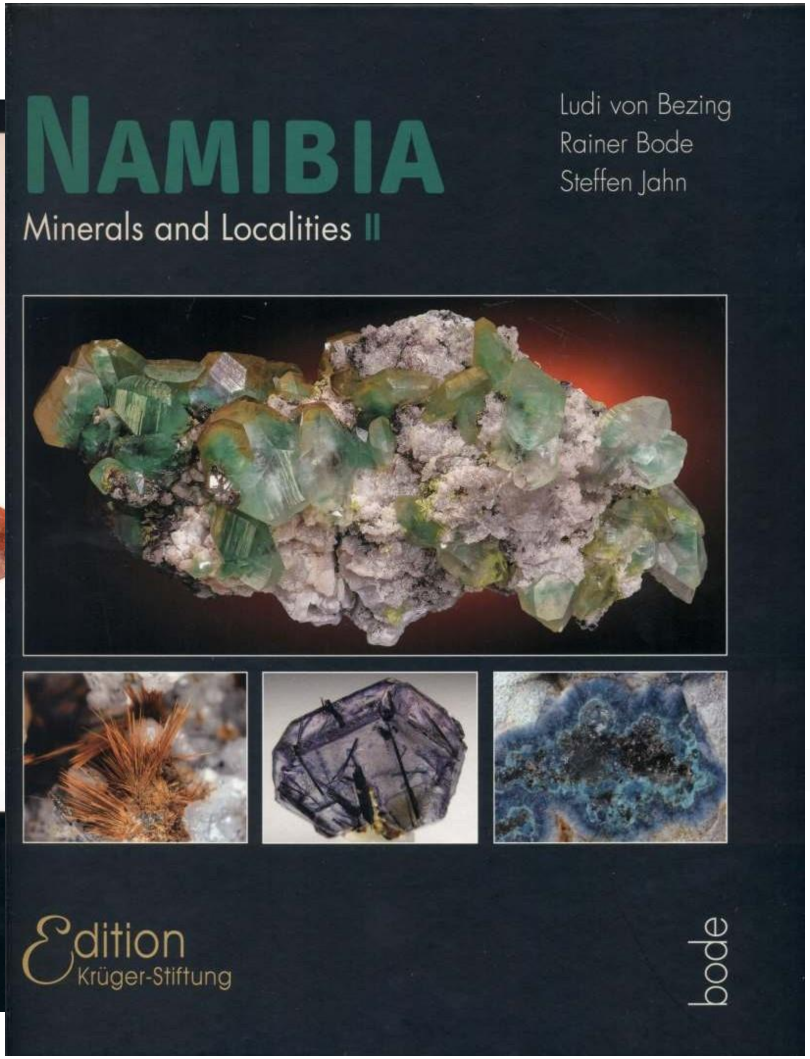

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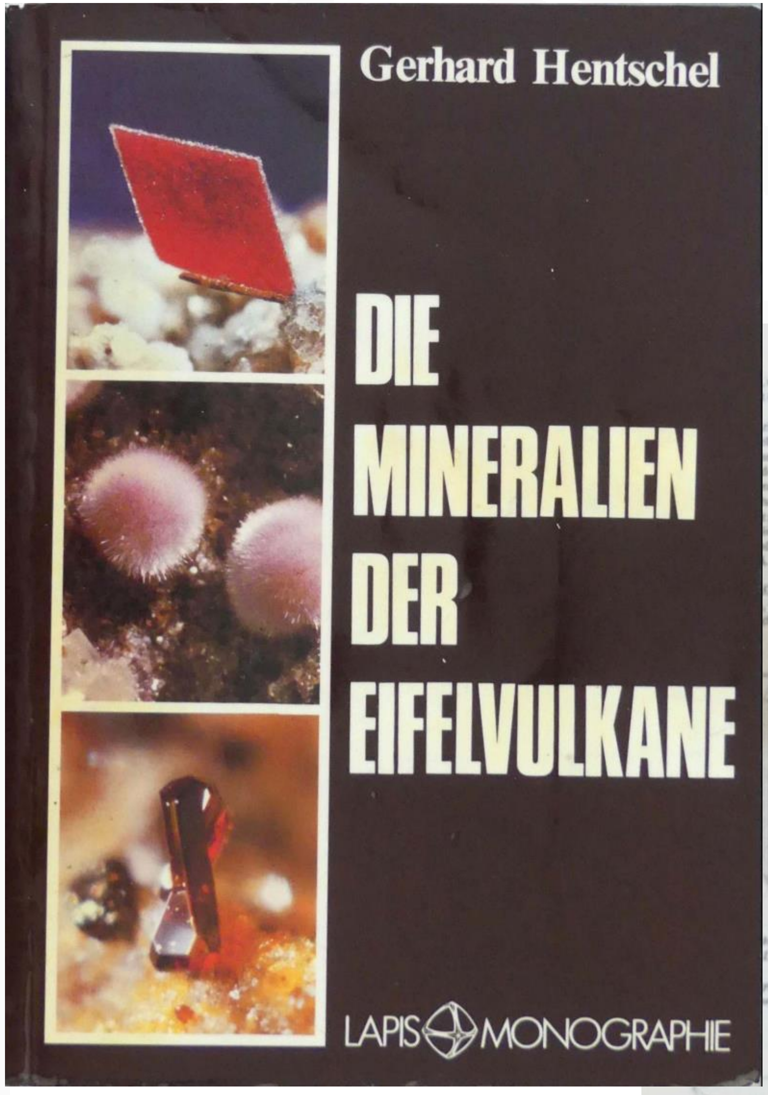

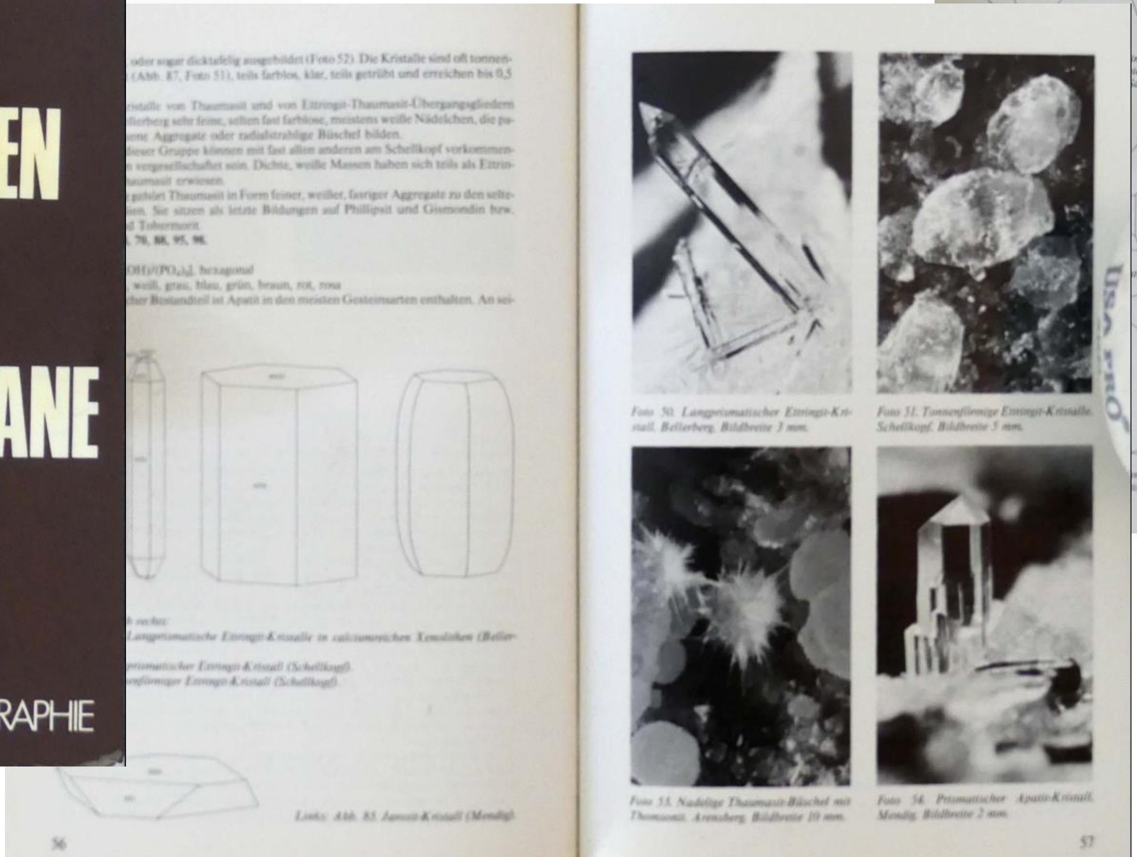

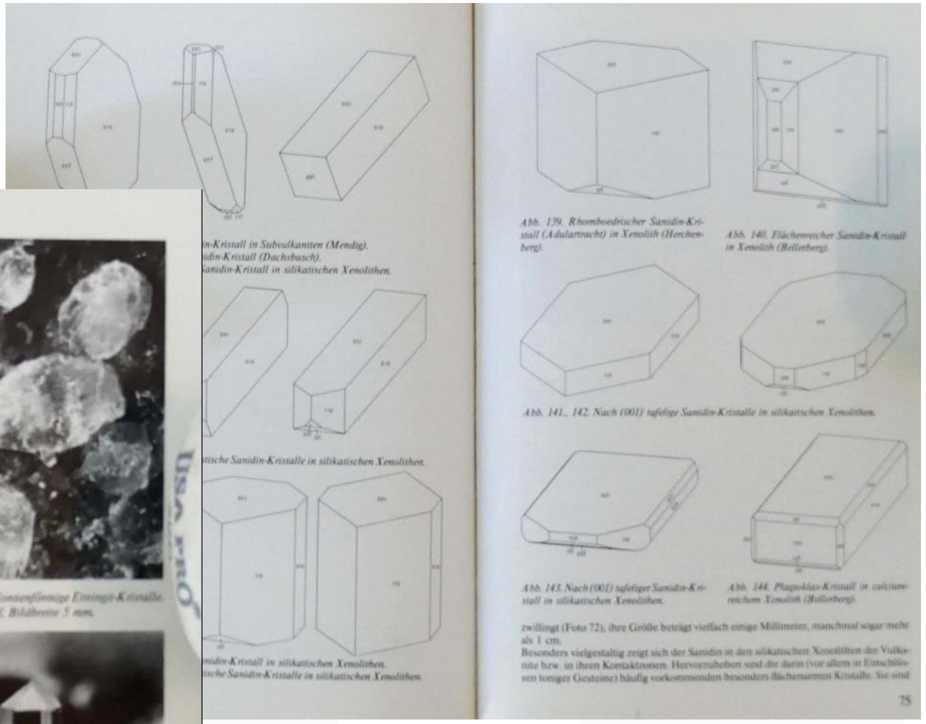

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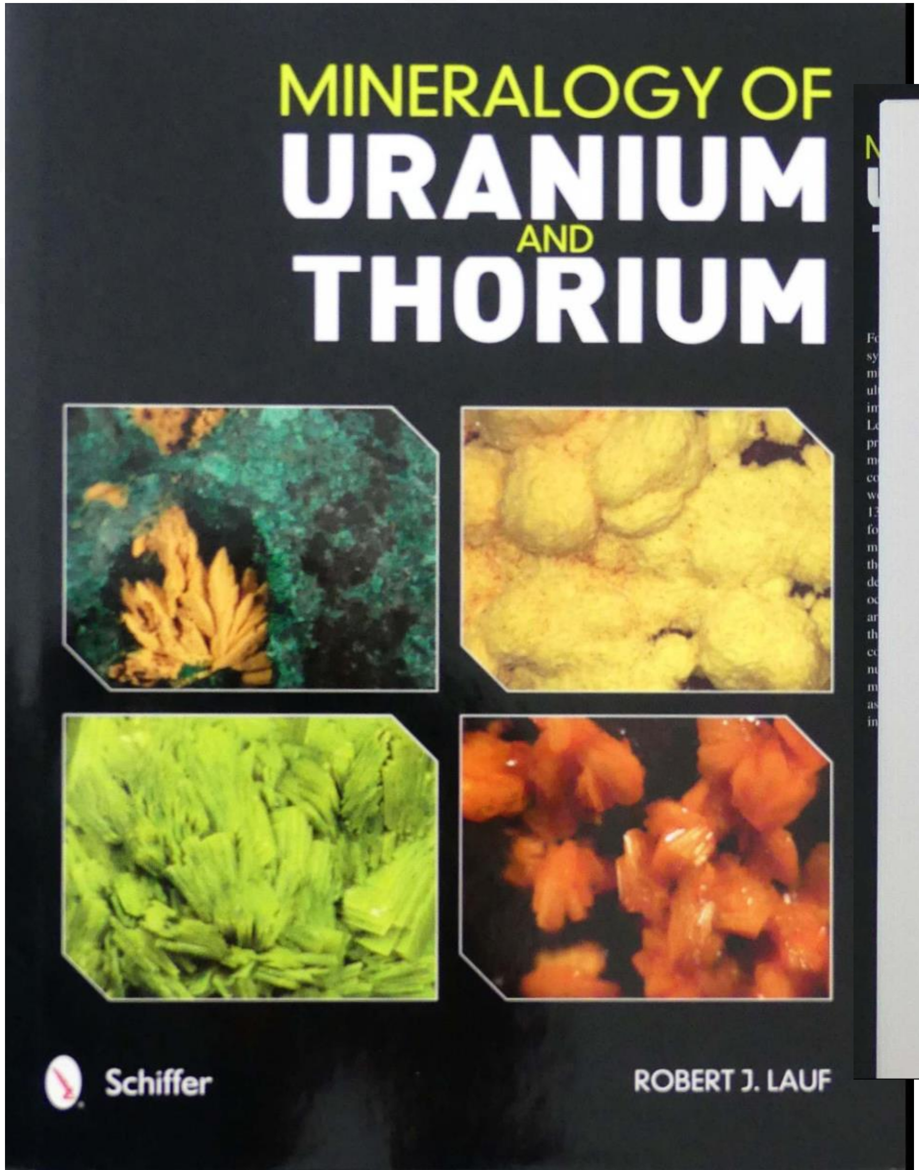

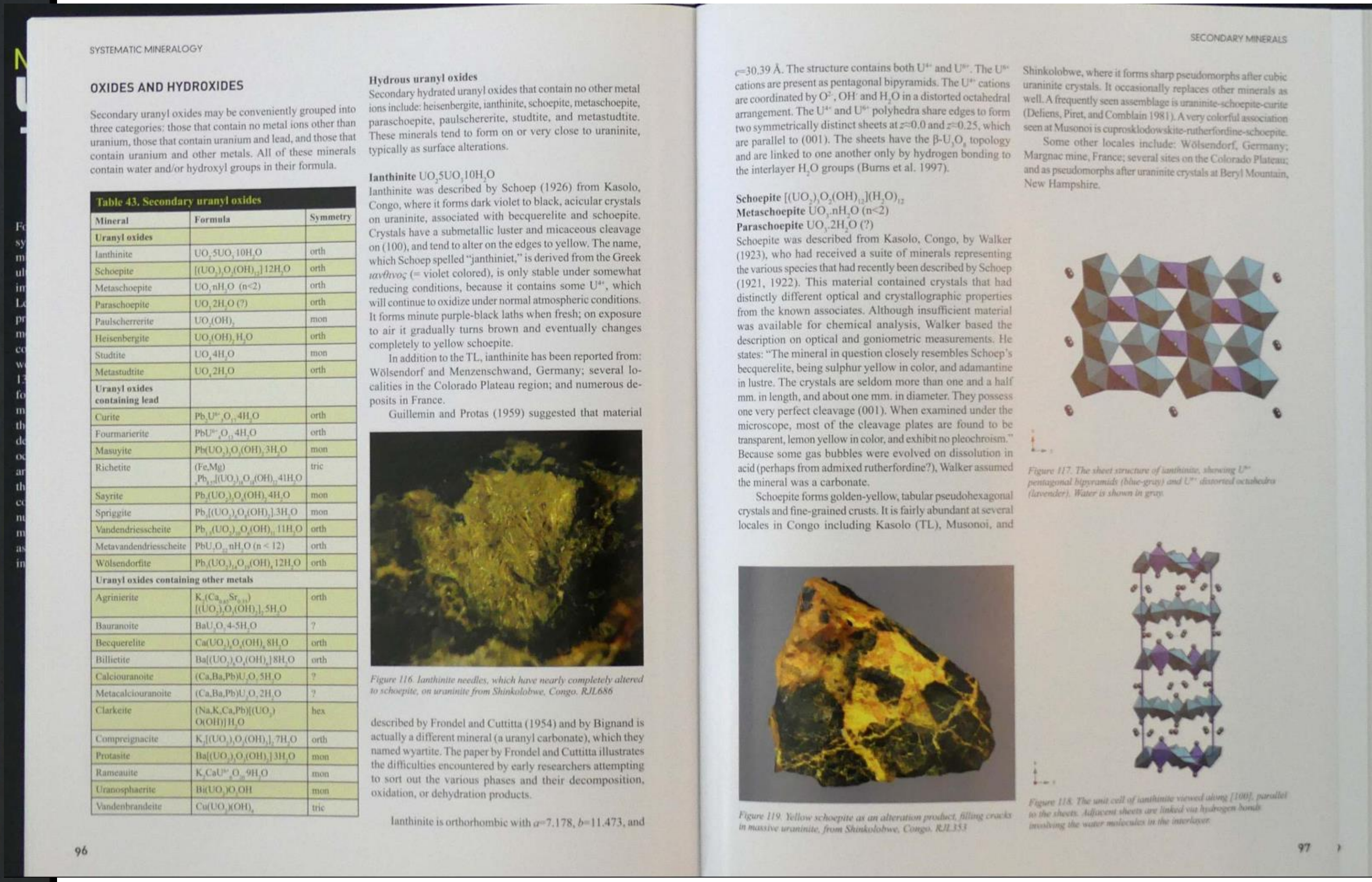

OXIDES AND HYDROXIDES

Secondary uranyl oxides may be conveniently grouped into three categories: those that contain no metal ions other than uranium, those that contain uranium and lead, and those that contain uranium and other metals. All of these minerals contain water and/or hydroxyl groups in their formula.

Table 43. Secondary uranyl oxides

Mineral	Formula	Symmetry
Uranyl oxides		
Ianthinite	$UO_2 5UO_3 10H_2O$	orth
Schoepite	$[(UO_2)_8O_2(OH)_{12}]12H_2O$	orth
Metaschoepite	$UO_3 nH_2O$ (n<2)	orth
Paraschoepite	$UO_3 2H_2O$ (?)	orth
Paulscherrerite	$UO_2(OH)_2$	mon
Heisenbergite	$UO_2(OH)_2H_2O$	orth
Studtite	$UO_4 4H_2O$	mon
Metastudtite	$UO_4 2H_2O$	orth
Uranyl oxides containing lead		
Curite	$Pb_3U^{6+}{}_8O_{27} 4H_2O$	orth
Fourmarierite	$PbU^{6+}{}_4O_{13} 4H_2O$	orth
Masuyite	$Pb(UO_2)_3O_3(OH)_2 3H_2O$	mon
Richetite	(Fe,Mg) $Pb_{8.57}[(UO_2)_{18}O_{18}(OH)_{12}]_2 41H_2O$	tric
Sayrite	$Pb_2(UO_2)_5O_6(OH)_2 4H_2O$	mon
Spriggite	$Pb_3[(UO_2)_6O_8(OH)_2]3H_2O$	mon
Vandendriesscheite	$Pb_{1.5}(UO_2)_{10}O_6(OH)_{11} 11H_2O$	orth
Metavandendriesscheite	$PbU_7O_{22} nH_2O$ (n < 12)	orth
Wölsendorfite	$Pb_7(UO_2)_{14}O_{19}(OH)_4 12H_2O$	orth
Uranyl oxides containing other metals		
Agrinierite	$K_2(Ca_{0.65}Sr_{0.35})[(UO_2)_3O_3(OH)_2]_2 5H_2O$	orth
Bauranoite	$BaU_2O_7 4\text{-}5H_2O$	?
Becquerelite	$Ca(UO_2)_6O_4(OH)_6 8H_2O$	orth
Billietite	$Ba[(UO_2)_6O_4(OH)_6]8H_2O$	orth
Calciouranoite	$(Ca,Ba,Pb)U_2O_7 5H_2O$	?
Metacalciouranoite	$(Ca,Ba,Pb)U_2O_7 2H_2O$	?
Clarkeite	$(Na,K,Ca,Pb)[(UO_2)O(OH)]H_2O$	hex
Compreignacite	$K_2[(UO_2)_3O_2(OH)_3]_2 7H_2O$	orth
Protasite	$Ba[(UO_2)_3O_3(OH)_2]3H_2O$	mon
Rameauite	$K_2CaU^{6+}{}_6O_{20} 9H_2O$	mon
Uranosphaerite	$Bi(UO_2)O_2OH$	mon
Vandenbrandeite	$Cu(UO_2)(OH)_4$	tric

Hydrous uranyl oxides
Secondary hydrated uranyl oxides that contain no other metal ions include: heisenbergite, ianthinite, schoepite, metaschoepite, paraschoepite, paulschererite, studtite, and metastudtite. These minerals tend to form on or very close to uraninite, typically as surface alterations.

Ianthinite $UO_2 5UO_3 10H_2O$
Ianthinite was described by Schoep (1926) from Kasolo, Congo, where it forms dark violet to black, acicular crystals on uraninite, associated with becquerelite and schoepite. Crystals have a submetallic luster and micaceous cleavage on (100), and tend to alter on the edges to yellow. The name, which Schoep spelled "janthiniet," is derived from the Greek *ιανθινος* (= violet colored), is only stable under somewhat reducing conditions, because it contains some U^{4+}, which will continue to oxidize under normal atmospheric conditions. It forms minute purple-black laths when fresh; on exposure to air it gradually turns brown and eventually changes completely to yellow schoepite.

In addition to the TL, ianthinite has been reported from: Wölsendorf and Menzenschwand, Germany; several localities in the Colorado Plateau region; and numerous deposits in France.

Guillemin and Protas (1959) suggested that material

Figure 116. Ianthinite needles, which have nearly completely altered to schoepite, on uraninite from Shinkolobwe, Congo. RJL686

described by Frondel and Cuttitta (1954) and by Bignand is actually a different mineral (a uranyl carbonate), which they named wyartite. The paper by Frondel and Cuttitta illustrates the difficulties encountered by early researchers attempting to sort out the various phases and their decomposition, oxidation, or dehydration products.

Ianthinite is orthorhombic with a=7.178, b=11.473, and

c=30.39 Å. The structure contains both U^{4+} and U^{6+}. The U^{6+} cations are present as pentagonal bipyramids. The U^{4+} cations are coordinated by O^{2-}, OH^- and H_2O in a distorted octahedral arrangement. The U^{4+} and U^{6+} polyhedra share edges to form two symmetrically distinct sheets at z≈0.0 and z≈0.25, which are parallel to (001). The sheets have the β-U_3O_8 topology and are linked to one another only by hydrogen bonding to the interlayer H_2O groups (Burns et al. 1997).

Schoepite $[(UO_2)_8O_2(OH)_{12}](H_2O)_{12}$
Metaschoepite $UO_3.nH_2O$ (n<2)
Paraschoepite $UO_3.2H_2O$ (?)
Schoepite was described from Kasolo, Congo, by Walker (1923), who had received a suite of minerals representing the various species that had recently been described by Schoep (1921, 1922). This material contained crystals that had distinctly different optical and crystallographic properties from the known associates. Although insufficient material was available for chemical analysis, Walker based the description on optical and goniometric measurements. He states: "The mineral in question closely resembles Schoep's becquerelite, being sulphur yellow in color, and adamantine in lustre. The crystals are seldom more than one and a half mm. in length, and about one mm. in diameter. They possess one very perfect cleavage (001). When examined under the microscope, most of the cleavage plates are found to be transparent, lemon yellow in color, and exhibit no pleochroism." Because some gas bubbles were evolved on dissolution in acid (perhaps from admixed rutherfordine?), Walker assumed the mineral was a carbonate.

Schoepite forms golden-yellow, tabular pseudohexagonal crystals and fine-grained crusts. It is fairly abundant at several locales in Congo including Kasolo (TL), Musonoi, and Shinkolobwe, where it forms sharp pseudomorphs after cubic uraninite crystals. It occasionally replaces other minerals as well. A frequently seen assemblage is uraninite-schoepite-curite (Deliens, Piret, and Comblain 1981). A very colorful association seen at Musonoi is cuprosklodowskite-rutherfordine-schoepite.

Some other locales include: Wölsendorf, Germany; Margnac mine, France; several sites on the Colorado Plateau; and as pseudomorphs after uraninite crystals at Beryl Mountain, New Hampshire.

Figure 117. The sheet structure of ianthinite, showing U^{6+} pentagonal bipyramids (blue-gray) and U^{4+} distorted octahedra (lavender). Water is shown in gray.

Figure 119. Yellow schoepite as an alteration product, filling cracks in massive uraninite, from Shinkolobwe, Congo. RJL353

Figure 118. The unit cell of ianthinite viewed along [100], parallel to the sheets. Adjacent sheets are linked via hydrogen bonds involving the water molecules in the interlayer.