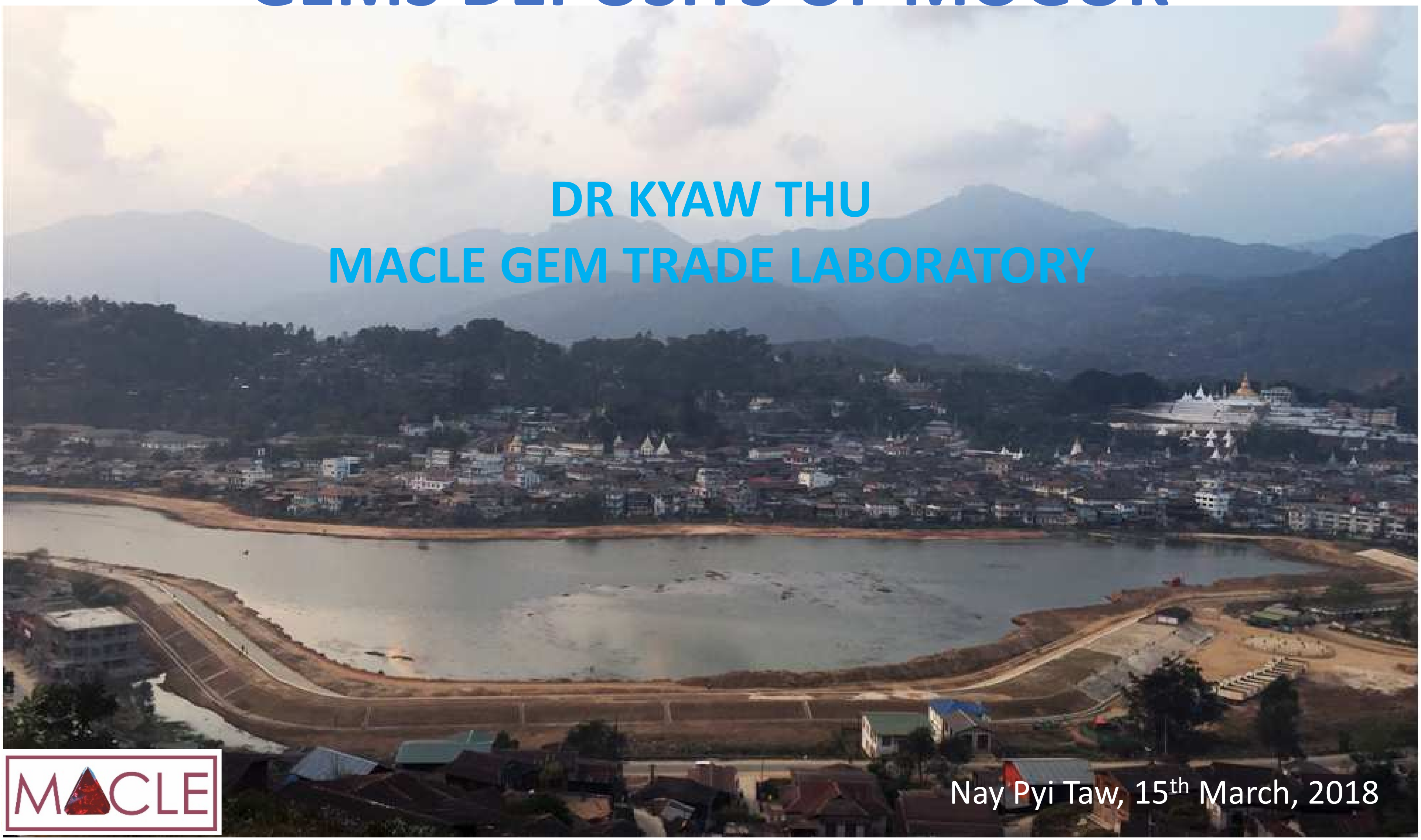
GEMS DEPOSITS OF MOGOK

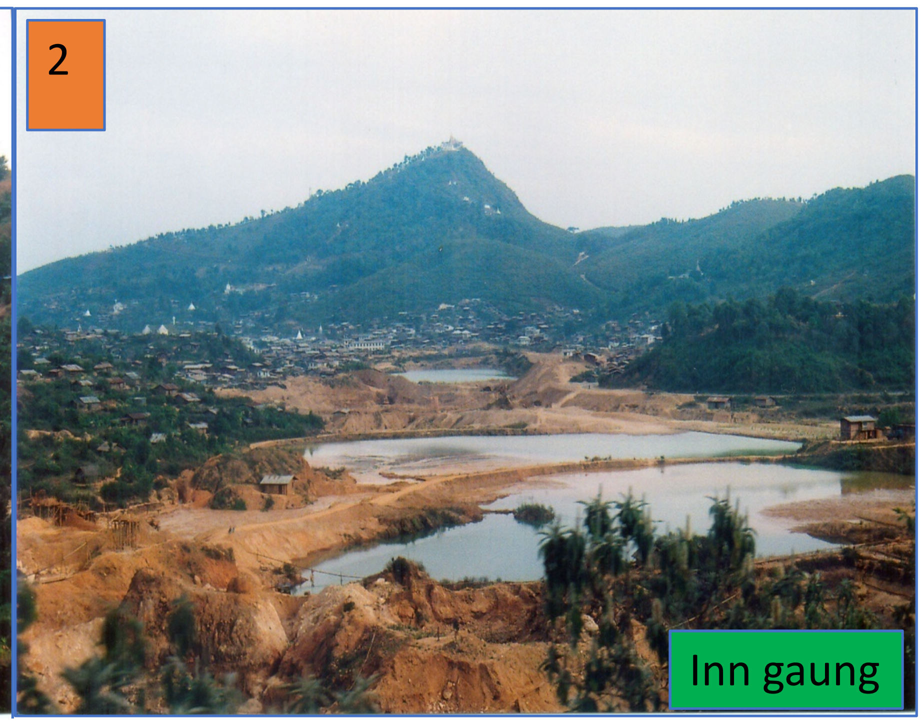


DR KYAW THU
MACLE GEM TRADE LABORATORY

Nay Pyi Taw, 15th March, 2018

Gems deposits in Mogok can be classified into:

(1) Primary and (2) Secondary



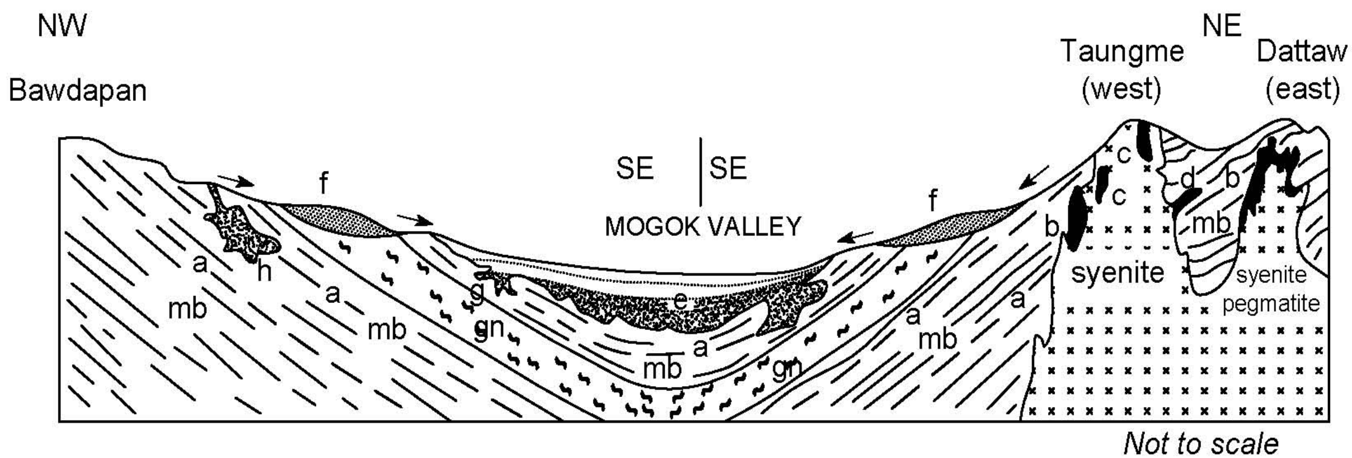


Figure Schematic cross-sectional diagram showing the various modes of occurrence of precious gemstones in the Mogok-Kyatpyin area. . a - primary band (*ge gyaw*); b - skarn; c - mgamatic segregation; d - hydrothermal vein; e - alluvial placers; g - fissure-filled deposits (*let-kyar byon*); h - cavern-filled deposits (*lu*).

From Dr U Thein, 2007

1) Ruby-bearing bands parallel to foliation, in the marble locally named “Ge Gyaw”.
2) Skarn; with a range of gem minerals in the contact zones between the marbles and the syenite, nepheline syenite, urtite or leucogranite, locally named “Kyauk Oh”.
3) Sapphire segregation within syenite, nepheline syenite, and syenite pegmatite
4) Veins (hydrothermally altered and bearing sapphire) extending from some syenite pegmatite.
5) Peridot segregation within dunite and peridotite.
6) Pegmatite dykes or veins (bearing topaz, aquamarine, tourmaline, etc. and some rare gemstones) intruding metasedimentary rocks and granitoids.




A member of Hematite Group of minerals

- ❖ Corundum Al_2O3
- ❖ Eskolaite Cr_2O3
- ❖ Hematite α-Fe_2O3
- ❖ Karelianite V_2O3

Other "rhombohedral oxides"

- ➢ Ecandrewsite (Zn, Fe^{2+}, Mn^{2+})TiO3
- ➢ Geikielite MgTiO3
- ➢ Ilmenite Fe^{2+}TiO3
- ➢ Pyrophanite Mn^{2+}TiO3

All of the listed elements participate in solid solution

Al	Ti	Cr	Ga	V	Fe^{3+}	Mn^{3+}	Mg	Zn	Fe^{2+}	Mn^{2+}
0.53Å	0.605	0.615	0.62	0.64	0.645	0.65	0.725	0.74	0.77	0.82

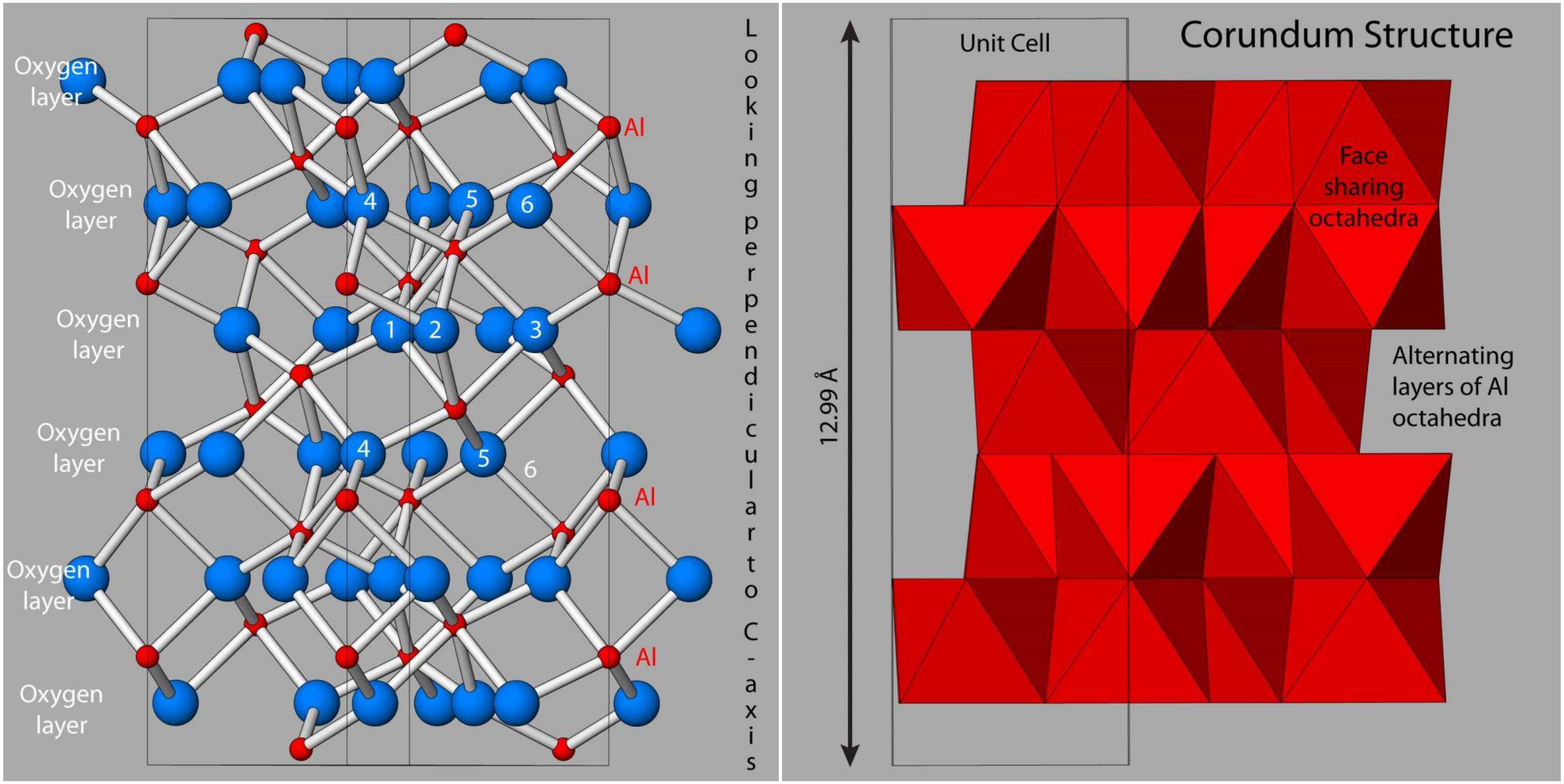
Important Properties

Mineral	H	d	R.I.
❖Corundum Al_2O_3	9	3.97	1.76-1.77
❖Eskolaite Cr_2O_3	8-8.5	5.18	opaque
❖Hematite α-Fe_2O_3	5-6	5.26	2.94-3.22
❖Karelianite V_2O_3	8-9	4.87	

Important Properties

❖ Fluorescence: Strong Cr emission when Fe content is LOW

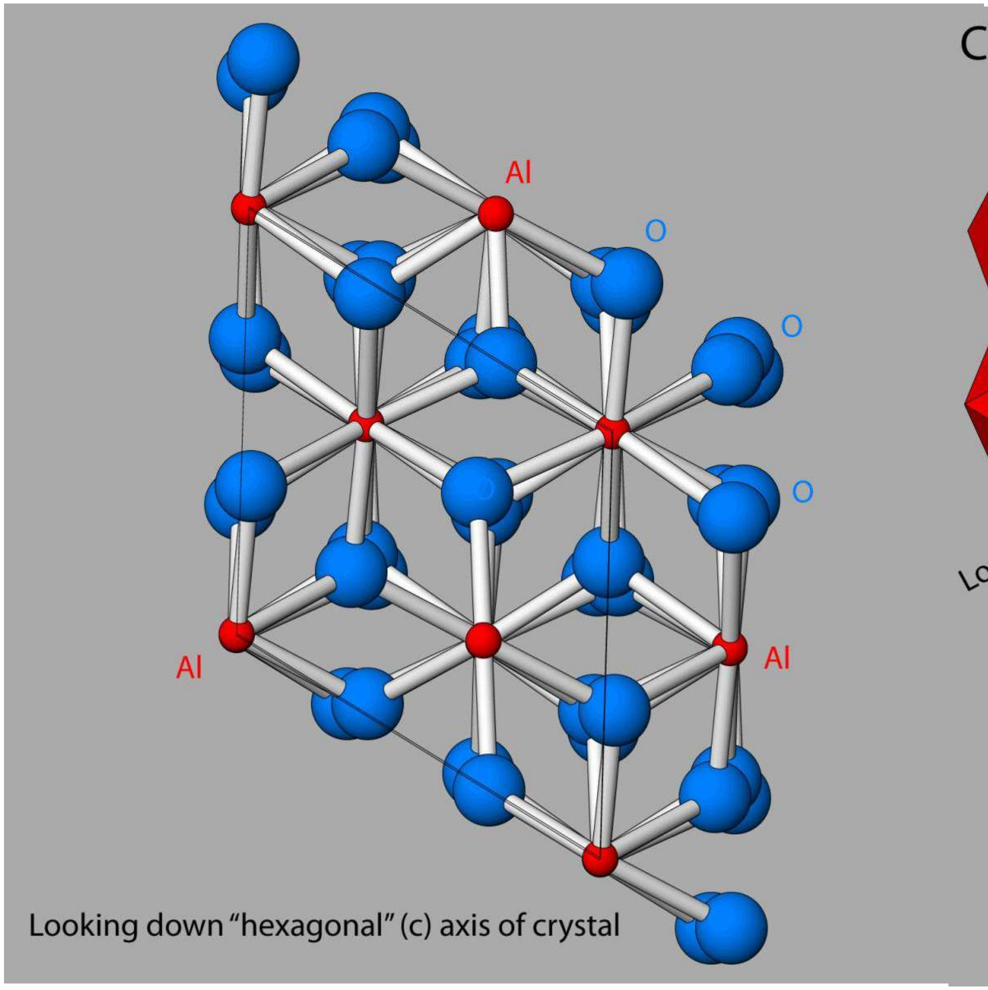
Crystal Structure

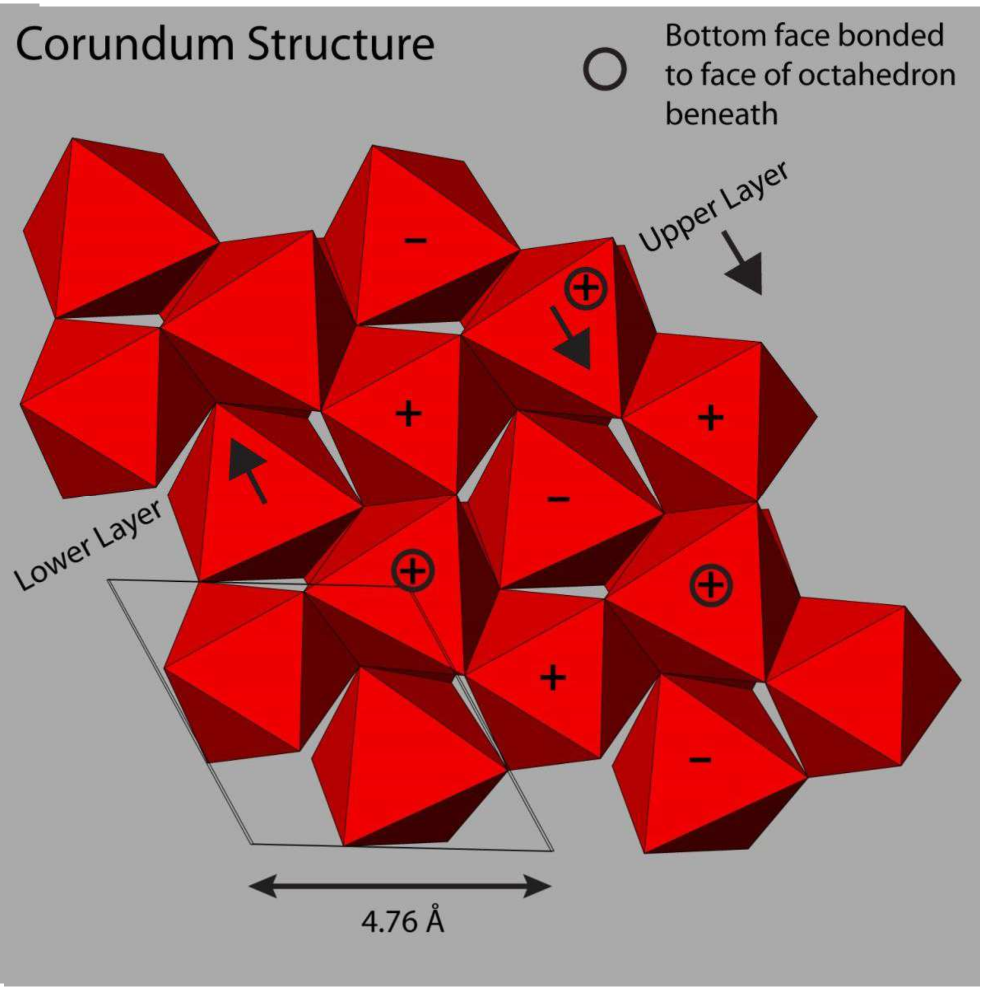


Crystallography: Hexagonal/rhombohedral

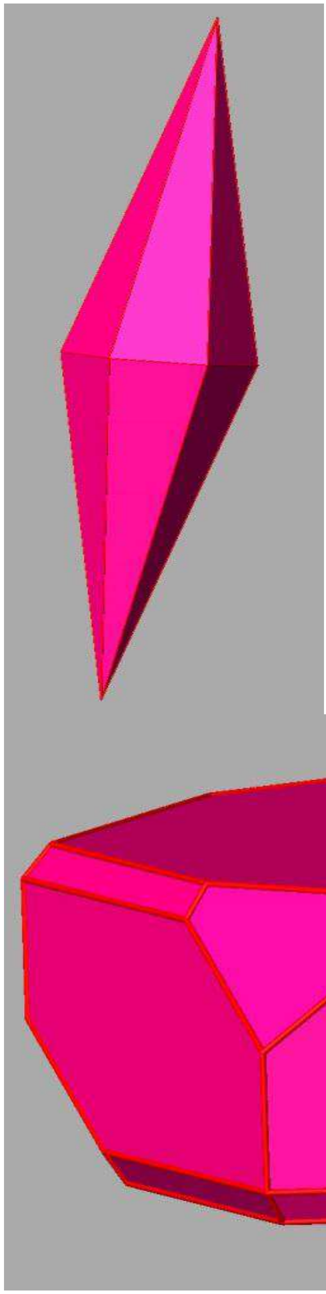
Space group: R-3c

Crystal Structure

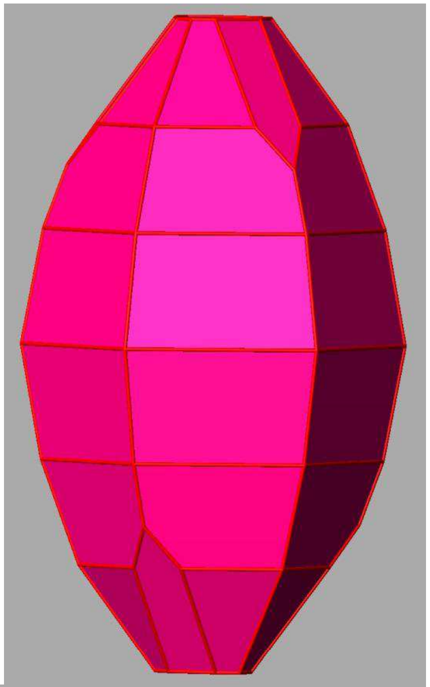


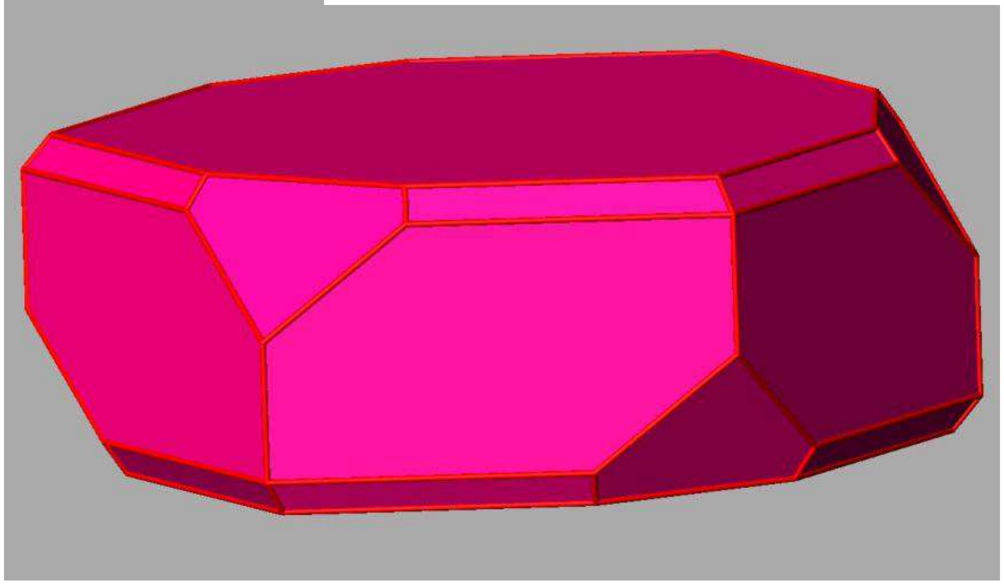


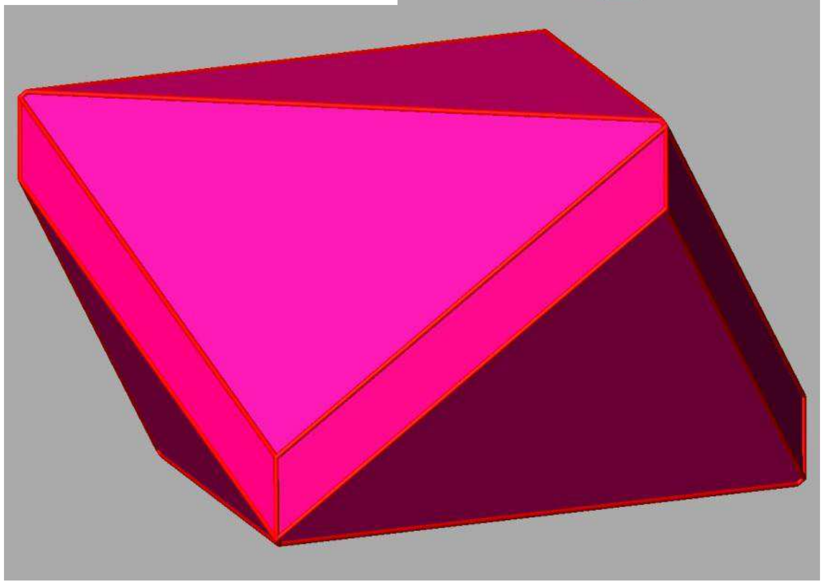
Common Crystal Habits



- Long tapered hexagonal prisms
- Hexagonal plates
- Modified rhombohedra












Occurrences

- Silica deficient rocks (Al typically combines with Si to form silicates):
  - Igneous: syenites
  - Metamorphic: metasediments, particularly meta-bauxite (emery)
  - Marbles
  - Contact metasomatites and skarns

Geology

- Mogok Belt: marbles and schists
  - Proterozoic-Cambrian sediments (>750 – 500 MYa) with younger carbonates (Permian-Triassic, ~250 – 200 MYa)

  - Metamorphism in Cretaceous time (~150 MYa) by collision of Burma Block with Shan plateau

  - Further metamorphism and granite intrusions from Indian Block collision in Eocene time (~50 MYa to <20 MYa)

Mogok Belt – ruby host

Radiometric dating of magmatic and metamorphic rocks along the Mogok belt[11] includes an Ar–Ar biotite age of 15.8 Ma for the Kabaing granitoid and Ar–Ar biotite ages of three nearby metamorphic rocks ranging from 16.5 to 19.5 Ma[18].

These dates, along with Ar–Ar phlogopite ages for a ruby-bearing marble of 18.7 Ma and for two ruby-free marbles of 17.1 and 17.9 Ma[19], all appear to be resetting ages as U–Pb dating of zircon inclusions in a Mogok ruby gave 31 to 32 Ma age[16].

[11]Kyaw Thu (2007), [18]Bertrand et al. (2001), [19]Garnier et al.(2006), [16]Khin Zaw et al. (2010)

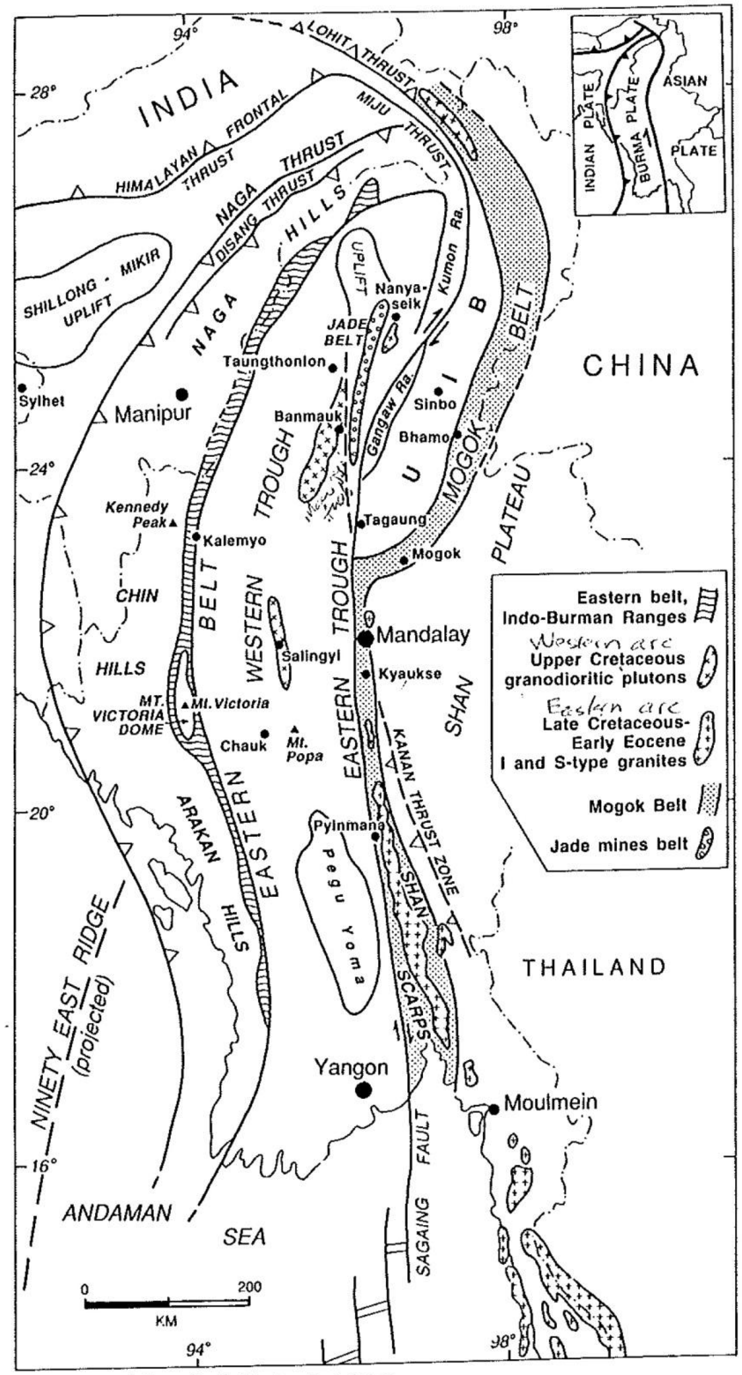
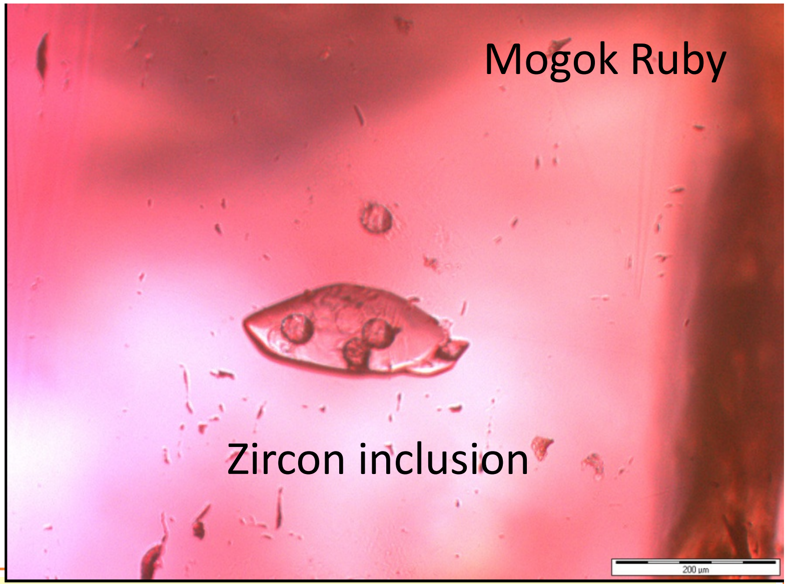
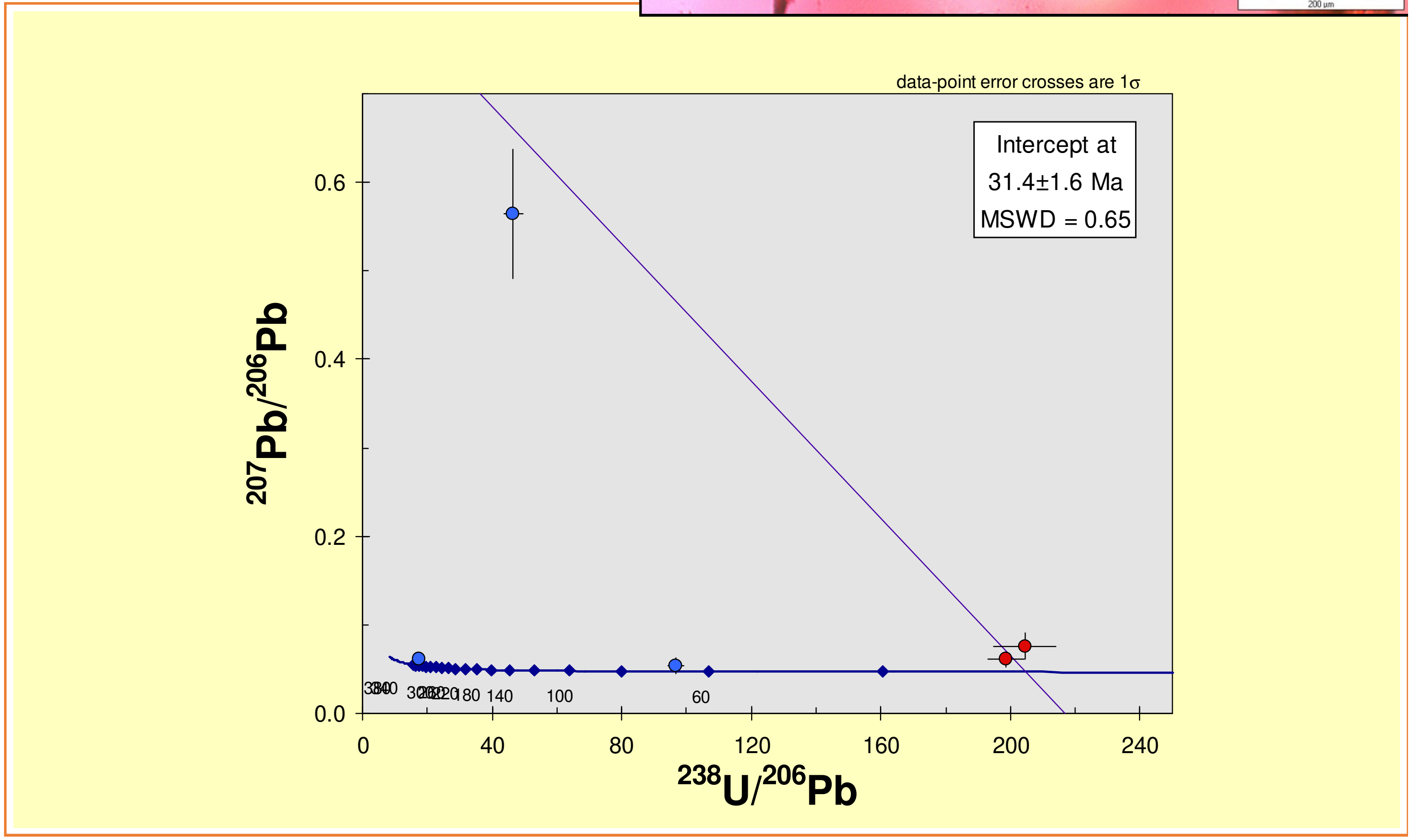


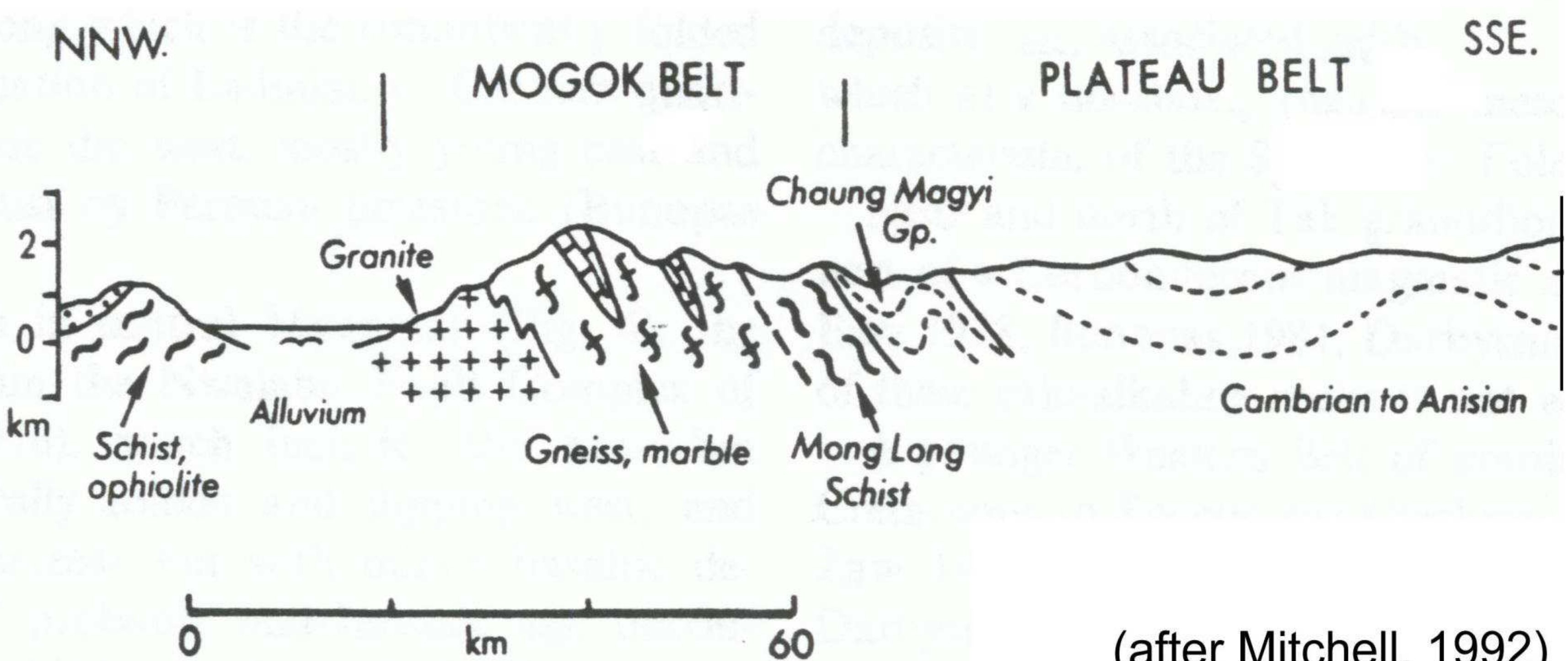
Fig. 1, Mitchell 1993

Photomicrograph showing zircon Inclusion in Mogok ruby

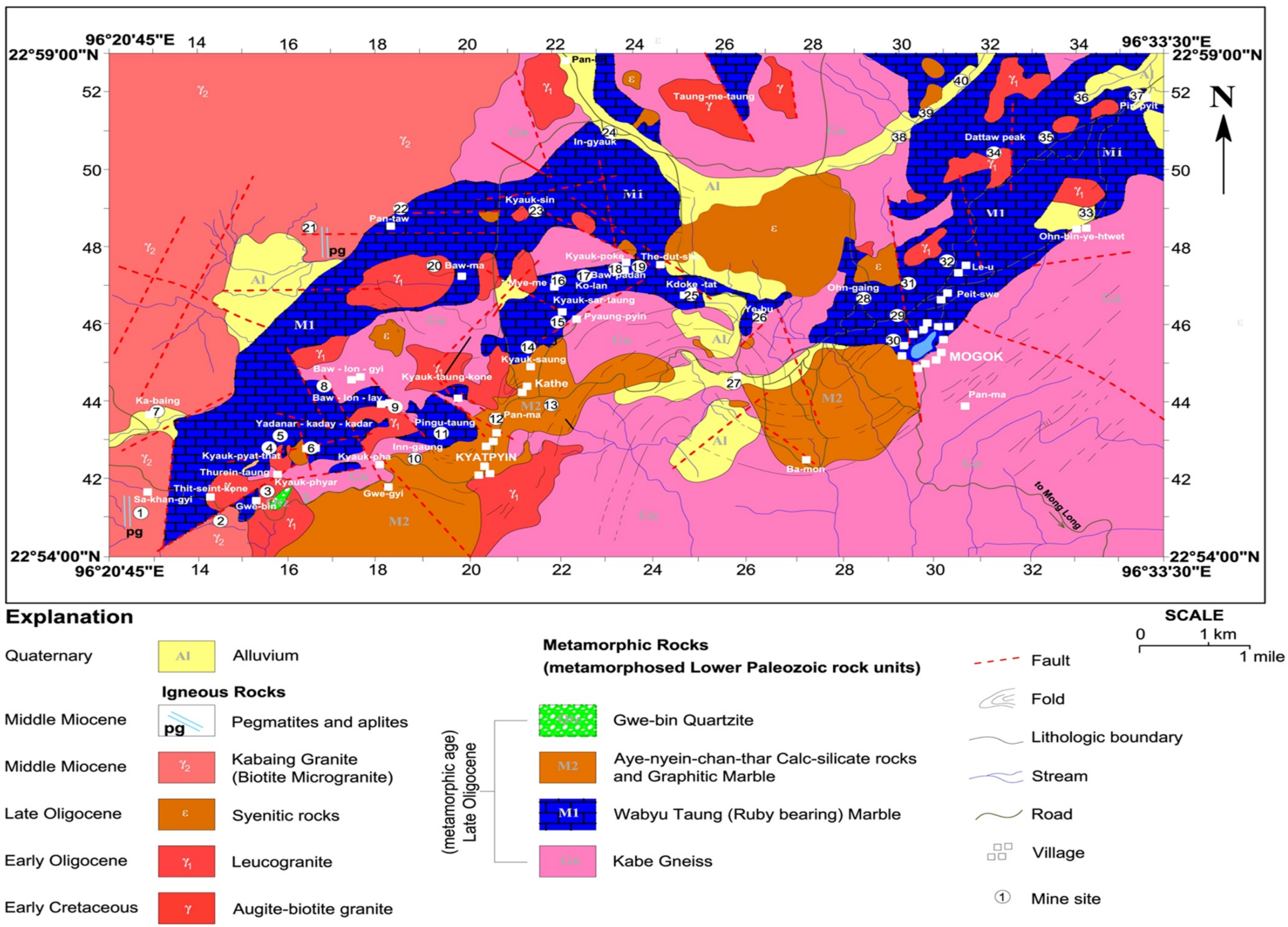


Concordia plot of LA-ICP-MS U-Pb Zircon age (31-32 Ma) of the zircon inclusion in the ruby





(after Mitchell, 1992)



96°20'45"E
96°33'30"E
22°59'00"N
22°54'00"N
N
MOGOK
KYATPYIN
Kathe
Dattaw peak
Taung-me-taung
In-gyauk
Kyauk-sin
Pan-taw
Baw-ma
Kyauk-poke
The-dut-shi
Baw-padan
Ko-lan
Mye-me
Kdoke -tat
Kyauk-sar-taung
Pyaung-pyin
Ye-bu
Kyauk-saung
Kyauk-taung-kone
Baw - lon - gyi
Baw - lon - lay
Yadanar - kaday - kadar
Pingu-taung
Pan-ma
Inn-gaung
Kyauk-pha
Kyauk-pyat-that
Thurein-taung
Thit-seint-kone
Kyauk-phyar
Gwe-bin
Gwe-gyi
Sa-khan-gyi
Ka-baing
Ohn-gaing
Le-u
Peit-swe
Ohn-bin-ye-htwet
Ba-mon
to Mong Long
Explanation
Quaternary
Alluvium
Igneous Rocks
Middle Miocene
Pegmatites and aplites
Middle Miocene
Kabaing Granite
(Biotite Microgranite)
Late Oligocene
Syenitic rocks
Early Oligocene
Leucogranite
Early Cretaceous
Augite-biotite granite
Metamorphic Rocks
(metamorphosed Lower Paleozoic rock units)
(metamorphic age)
Late Oligocene
Gwe-bin Quartzite
Aye-nyein-chan-thar Calc-silicate rocks
and Graphitic Marble
Wabyu Taung (Ruby bearing) Marble
Kabe Gneiss
SCALE
0
1 km
1 mile
Fault
Fold
Lithologic boundary
Stream
Road
Village
Mine site

Geology (continued)

Intrusions include:

❖Nepheline syenites transformed to Ijolite (>75% nepheline + cpx + zircon + other) bearing sapphire (e.g., Thuyin-taung).

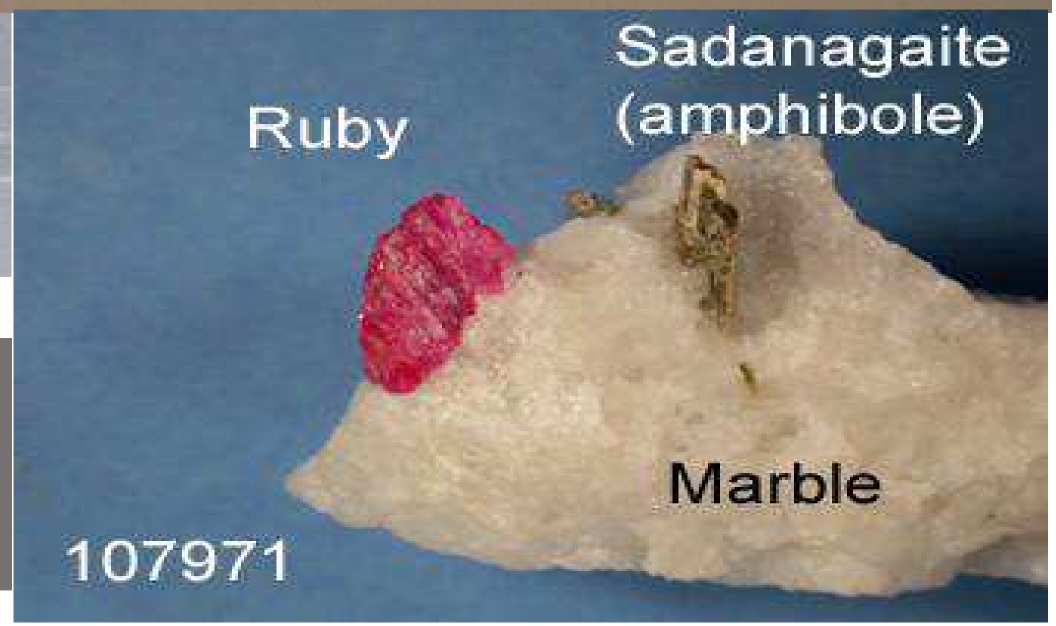
❖Complex granite pegmatite bearing tourmaline, topaz, aquamarine, gem sanidine, etc. at various places in the Tract (e.g., Sakangyi, Dattaw, Ohn-gaing, etc.).

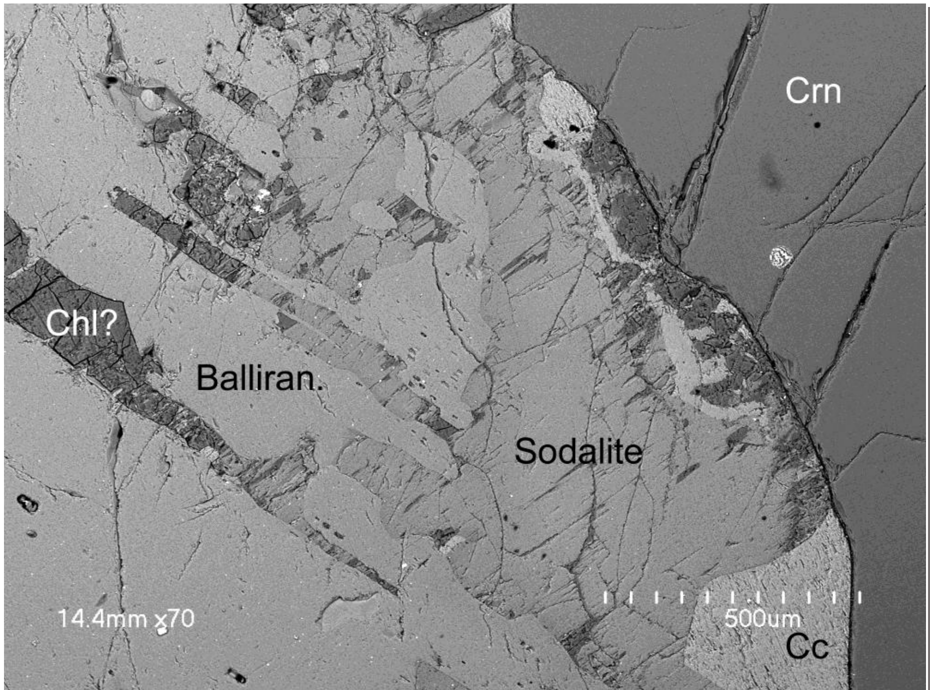
Ruby Assemblages:

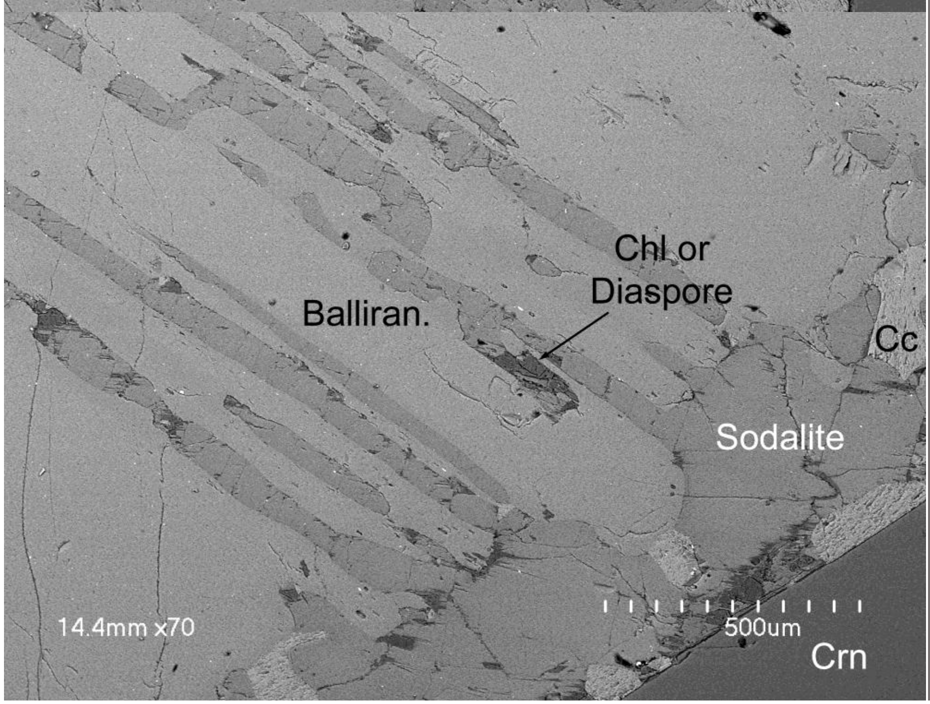
Large rubies in calcite/marble often intersected by veins bearing:

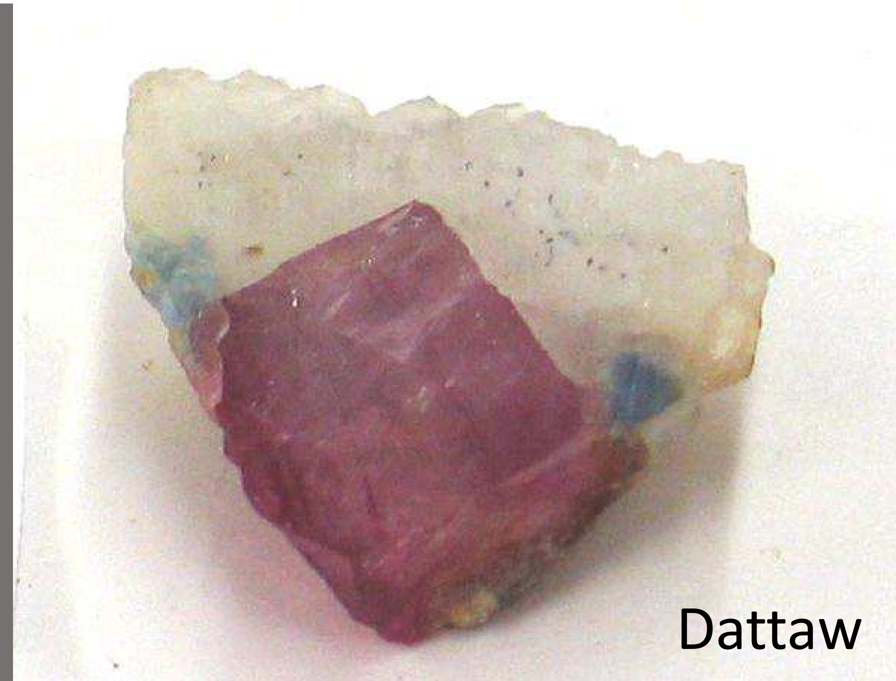
- ❖Blue dichroic balliranoite [(Na,K)6Ca2(Si6Al6O24)Cl2(CO3)]
- ❖Colorless sodalite [Na8Al6Si6O24Cl2]
- ❖Nubbly scapolite (mizzonite) [Na4Al3Si9O24Cl – Ca4Al6Si6O24 (CO3)]
- ❖Sometimes nepheline, pargasite, pyrite, phlogopite, and sanidine.

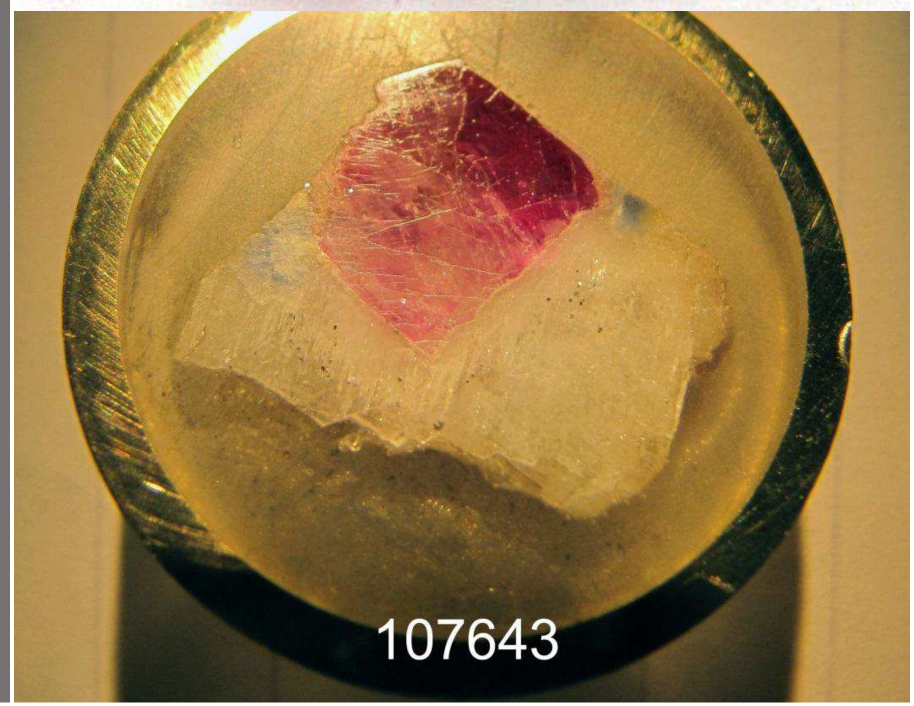
Ruby on scapolite, Dattaw




Crn
Chl?
Balliran.
Sodalite
14.4mm x70
500um
Cc


Chl or
Diaspore
Balliran.
Cc
Sodalite
14.4mm x70
500um
Crn


Dattaw

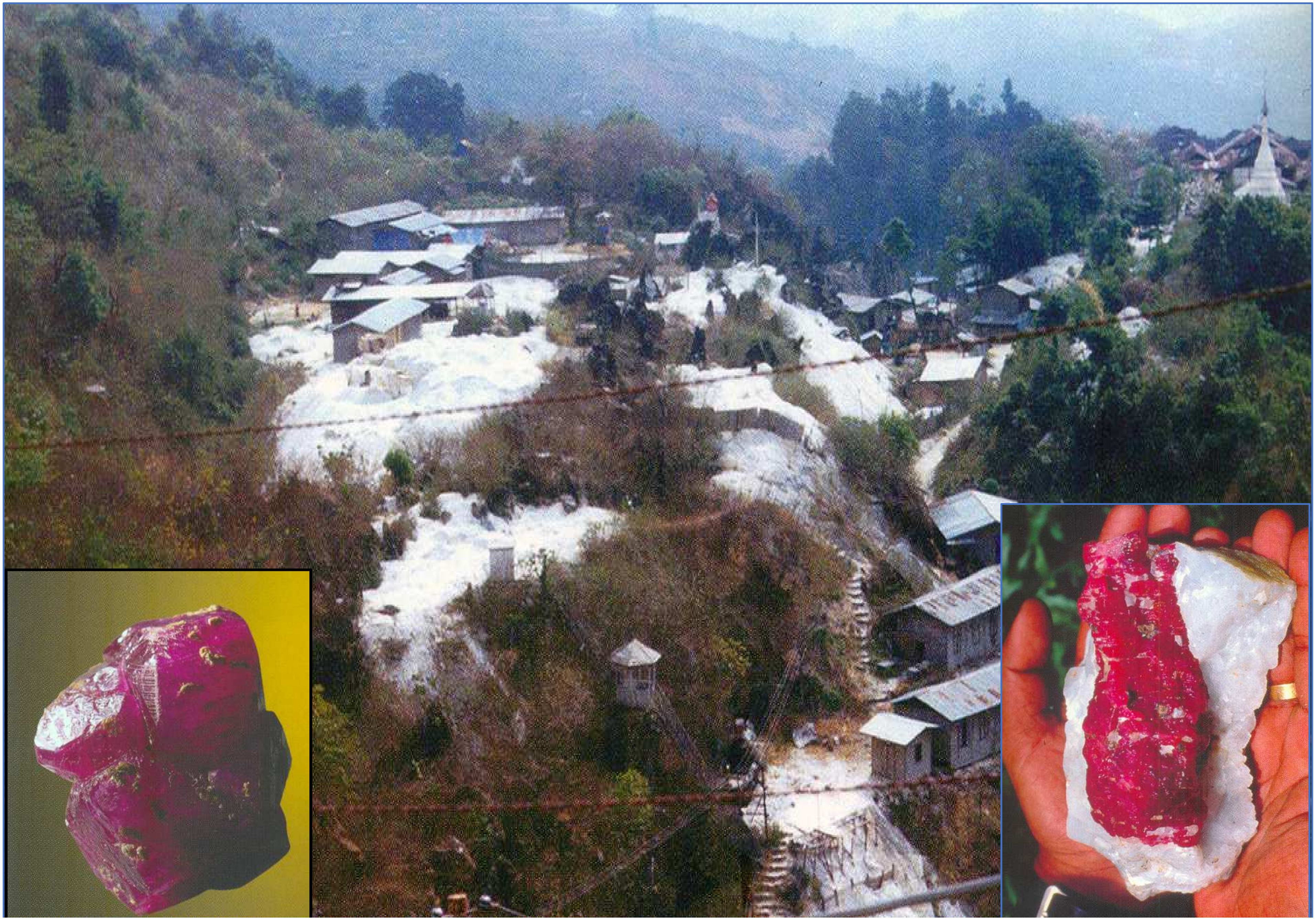

107643

Ruby on Painite $CaZrAl_9O_{15}[BO_3]$

Painite ($CaZrAl_9O_{15}[BO_3]$), from Wet Loo area in **skarn formed between leucogranite and marble – assemblage includes margarite, tourmaline (mostly foitite), zircon, baddeleyite and rutile. Ruby appears as overgrowths but also as inclusions in painite.**

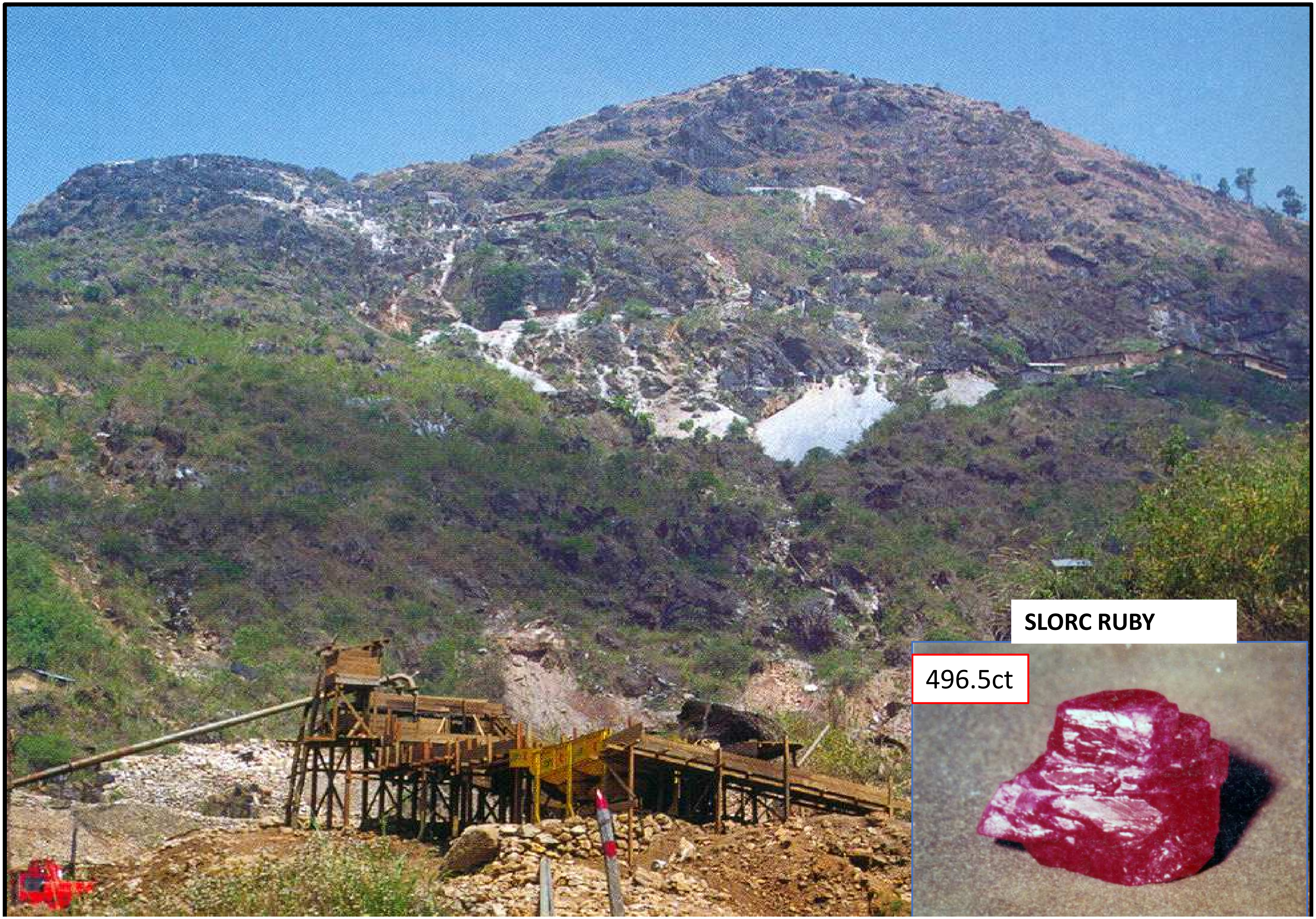
Primary Ruby Mine ; Baw Padan

Primary Ruby Mine; Kyauk Saung



Primary Ruby Mine; Kyauk Poke

Primary Ruby Mine; Dattaw

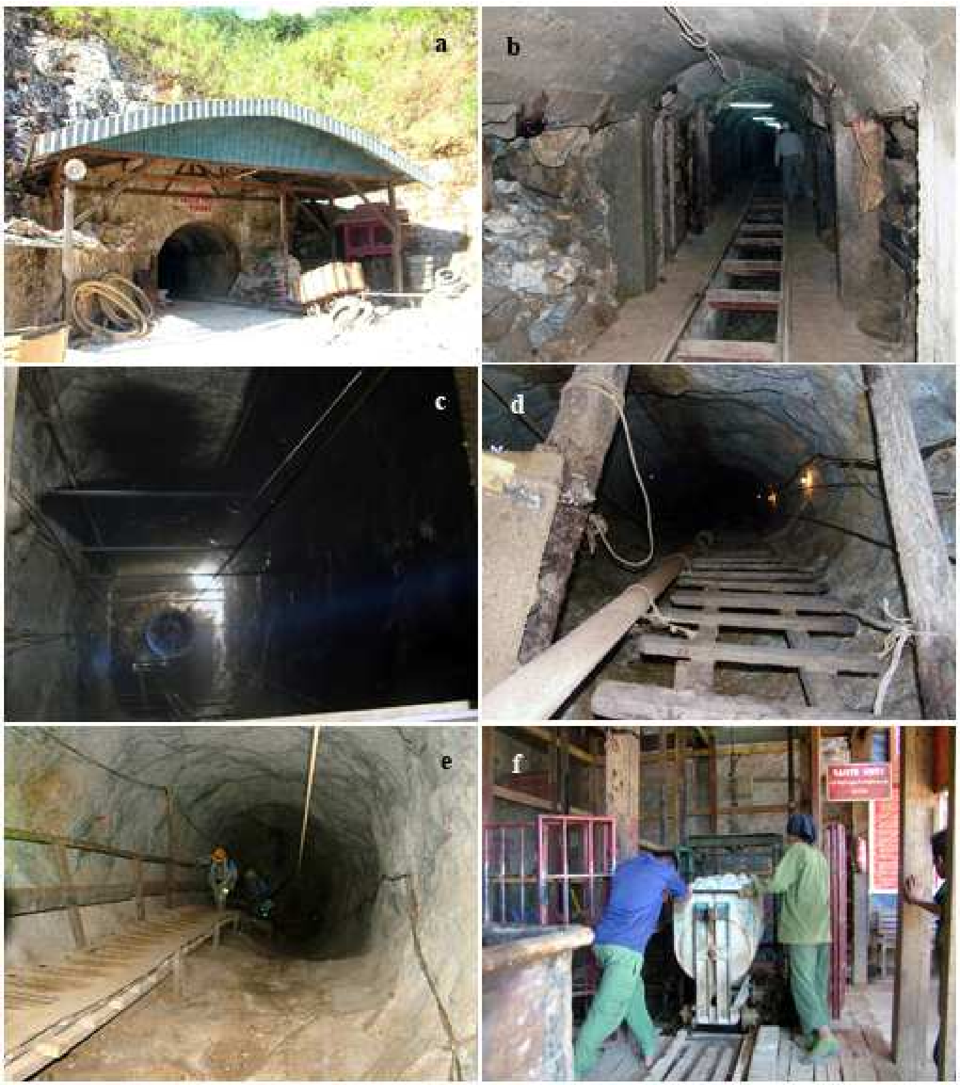


Mining in Primary Ruby Deposits

DRILLING – MAKING THE DYNAMITE STICK- BLASTING

Aditting, Blasting & Trimming

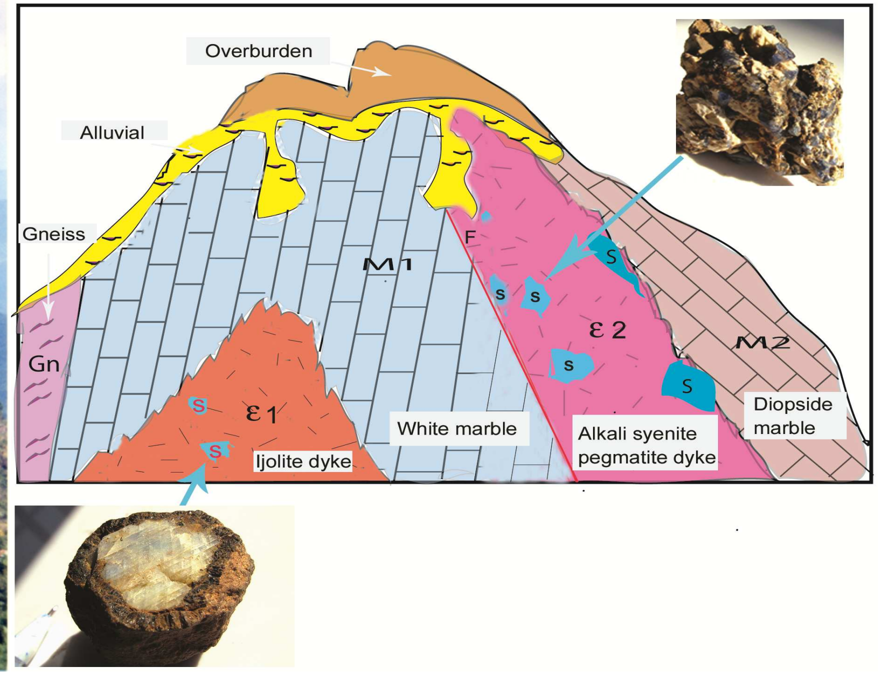
Systematic Mining in Primary Ruby Deposit



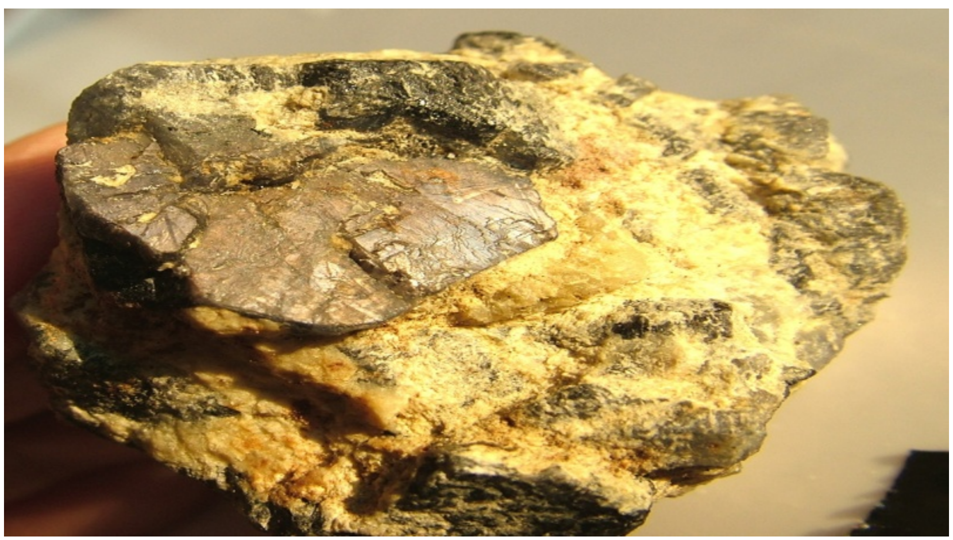
Sapphires in Syenite Pegmatite

The miners digging the sapphire from syenite pegmatite dyke in Buga mine, On-dan, 22° 59’ 7" N, 96° 12’ 51" E

Sapphires in Syenite Pegmatite and Ijolite



Geological sketch model of Thurein Taung

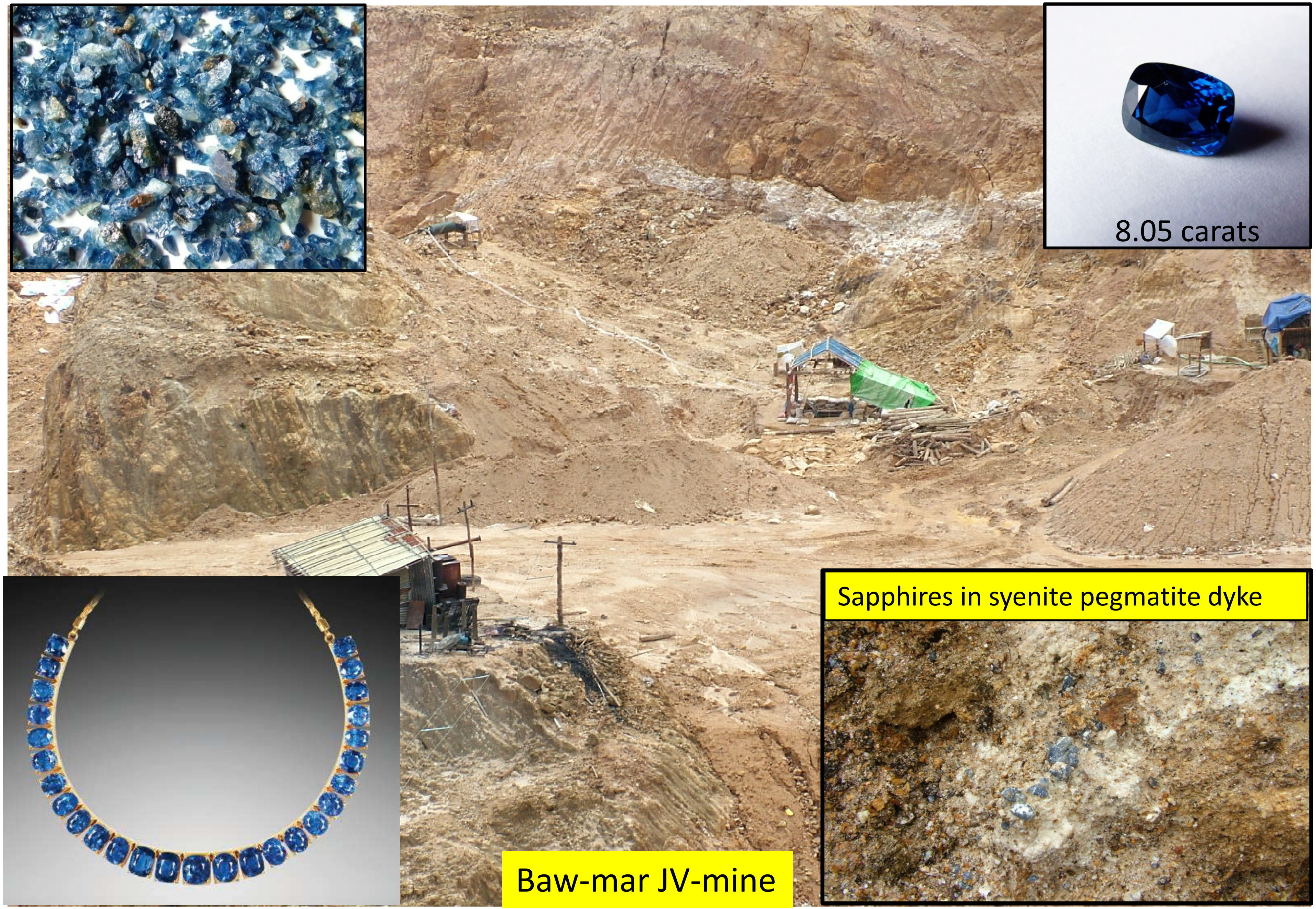


Sapphire crystal with “black silk” in feldspar ground mass of nepheline syenite, On-dan

Sapphires in Syenite Pegmatite

Alkali syenite pegmatite dykes intruded in calc-silicate rocks and local miners digging sapphires from highly weathered syenite pegmatite, JV mine of Lay-thar, 23° 00’ 26.3" N, 96° 30’ 19.5" E

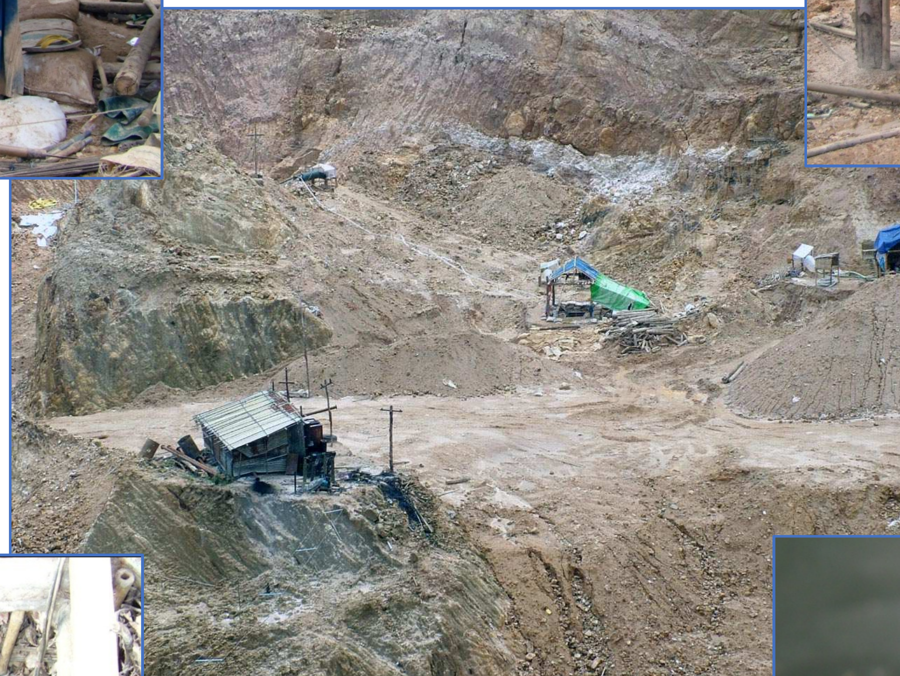
Sapphire in Syenite Pegmatite and Skarn



Primary Sapphires Deposit from Contact Metasomatism; Htayan Sho

Mining in Primary Sapphire Deposits

Air pump

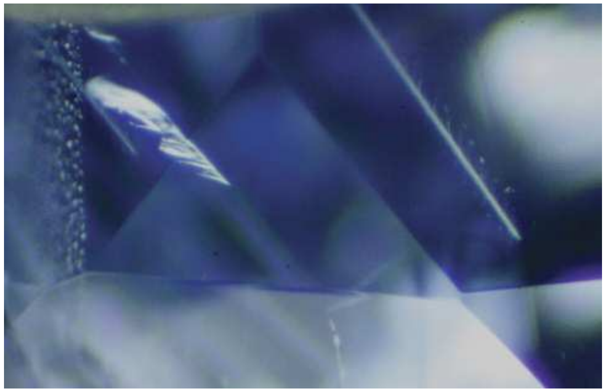


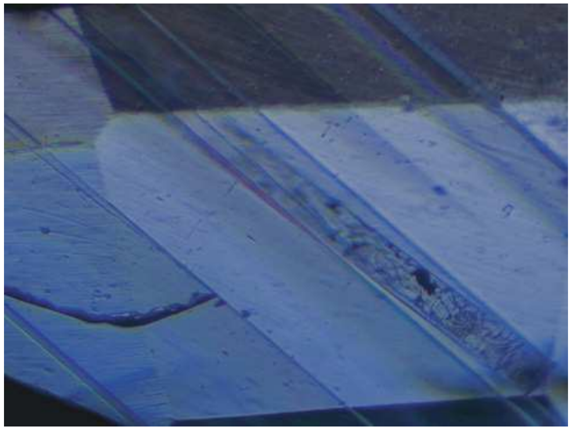
Adit

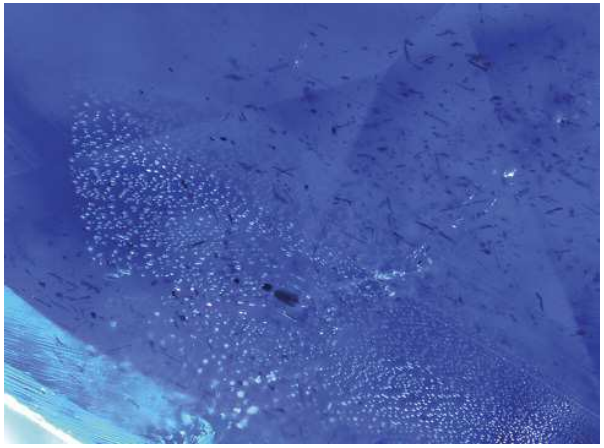
Baw-mar JV-mine

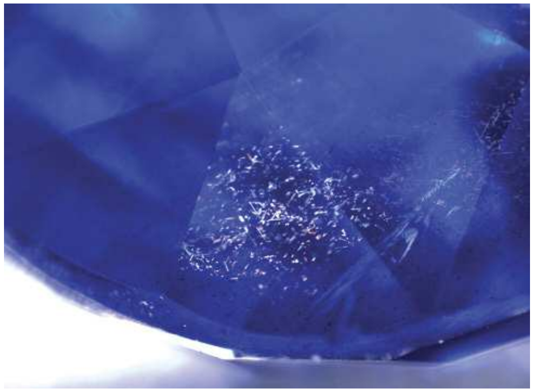
Sapphires in syenite pegmatite

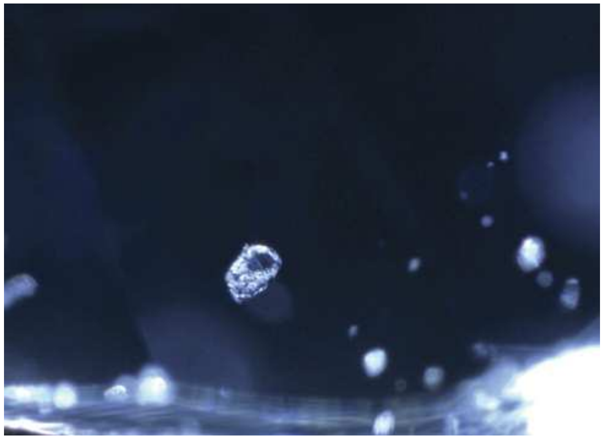
Inclusion in Baw Mar Sappphires

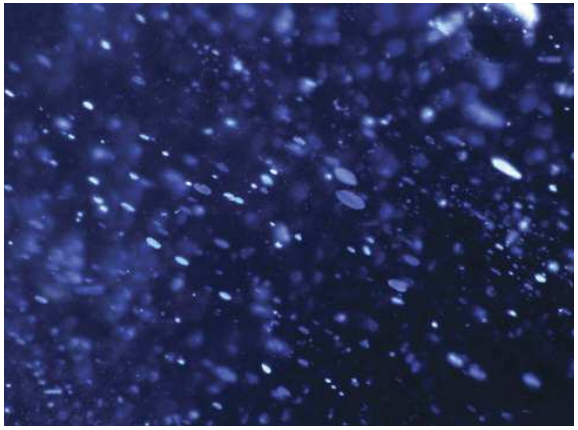




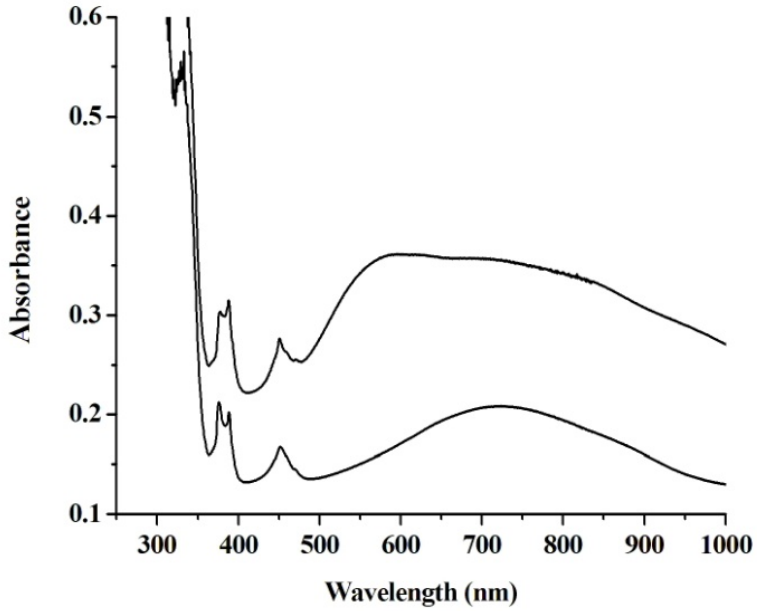


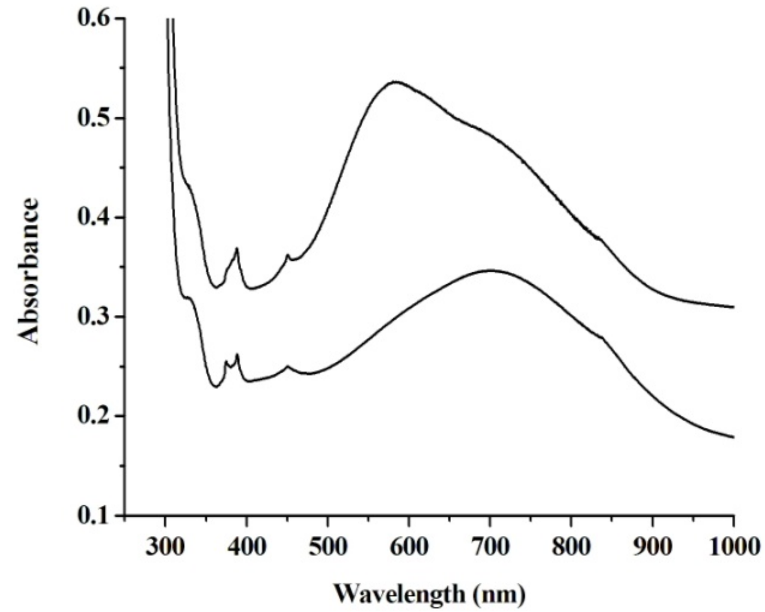






UV-VIS-NIR Spectra of Baw Mar Sapphire & Classic Mogok Sapphire





The polarized UV-Vis-NIR spectra from 250 to 1000 nm of sample SABUM282 show pronounced bands related to iron.

The polarized UV-Vis-NIR spectra from 250 to 1000 nm of a “classic” Burmese blue sapphire are different from those of Baw Mar blue sapphire.

Spinel in Marble

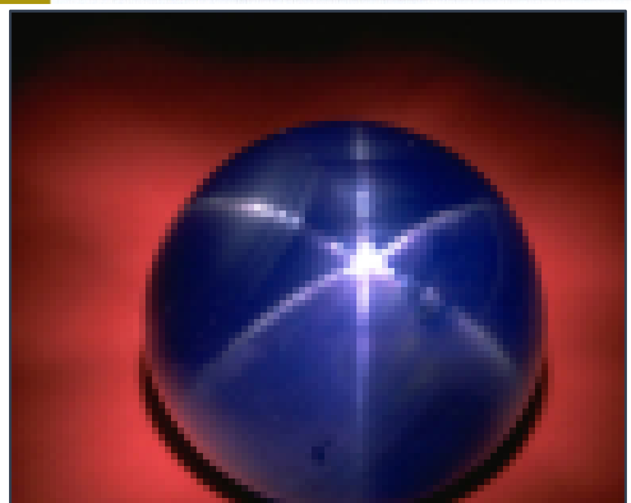
Anyant Taung (Spinel Hill), Pein-pyit mine

PROMINENT RUBIES & SAPPHIRES OF MOGOK

Natural Rubies (Mogok) and Diamonds Jewels

Bismark Sapphire 98.6 ct
NMNH, Smithsonian

Carmen Lucia Ruby 23.10ct
NMNH, Smithsonian



Star of Asia 329.7 ct
NMNH, Smithsonian

Analysis

- X-ray Diffraction for phase verification

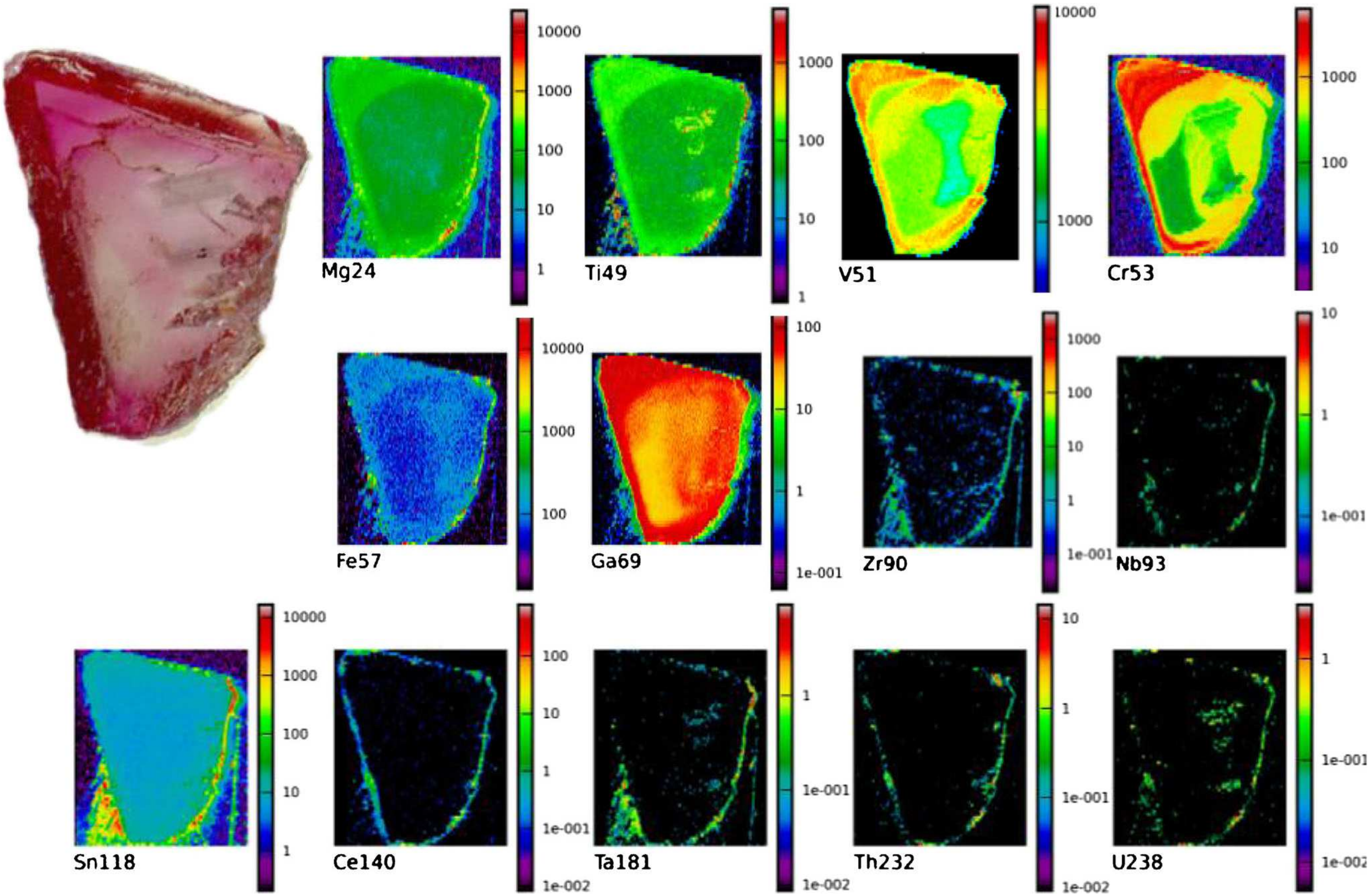
- BSE imaging and EDS/EPMA for inclusions

- Laser-Ablation Inductively-Coupled Plasma Mass Spectroscopy for trace-elements:
  7Li, 9Be, 11B, 24Mg, 27Al (internal standard), 29Si, 43Ca, 44Ca, 47Ti, 51V, 52Cr, 55Mn, 57Fe, 65Cu, 66Zn, 69Ga, 90Zr, 93Nb, 118Sn, 120Sn(Te), 138Ba, and 181Ta

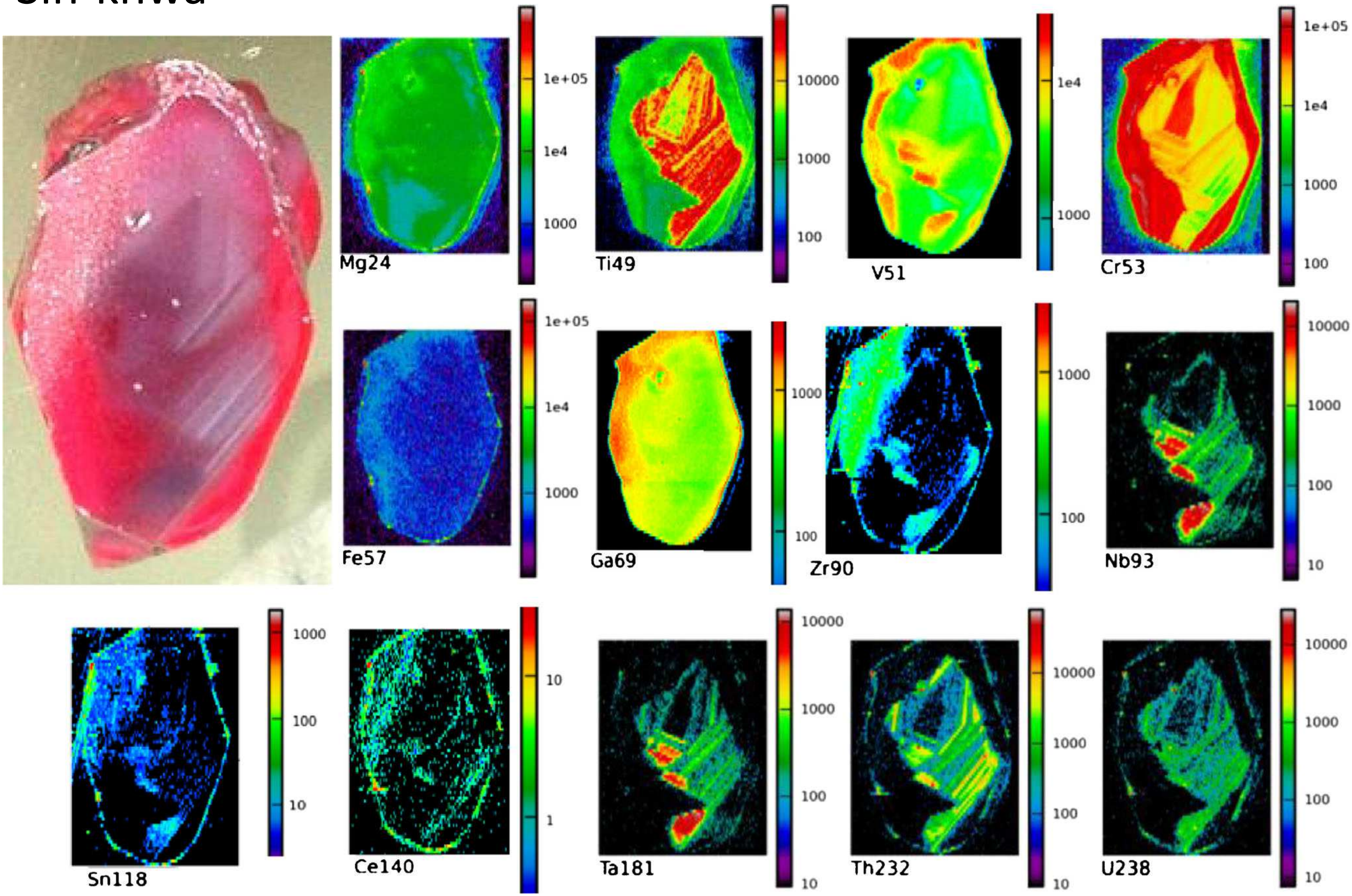
- Electron Probe Micro-Analysis (EPMA) for minor elements:
  Si, Ti, V, Cr, Ga, Mg, Mn, Fe, Zn, Ca, Na

- Oxygen isotope composition

LA-ICP-MS trace element images of a ruby Pingu-taung



LA-ICP-MS trace element images of a ruby Sin-khwa



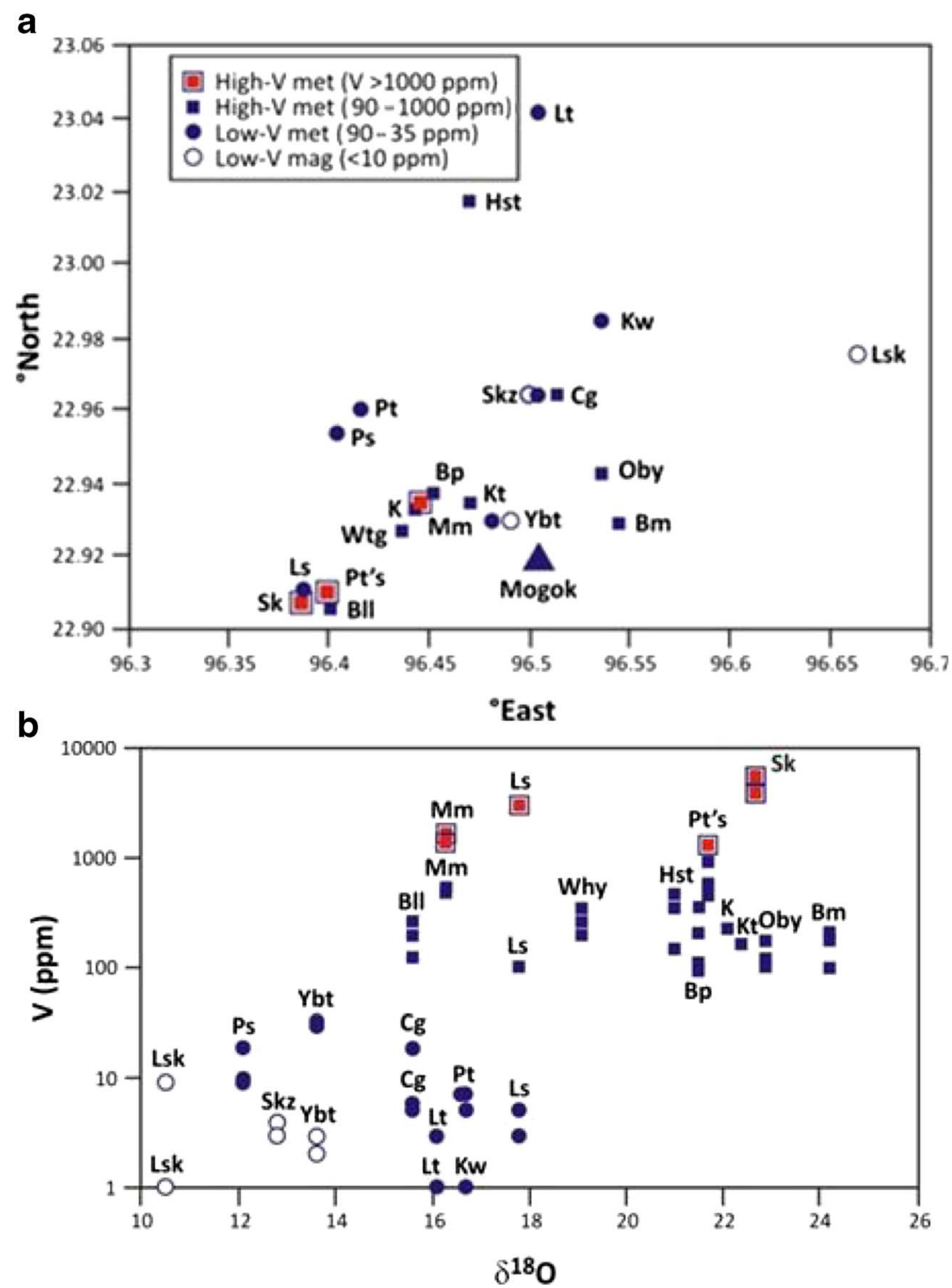
(a) Lat/Long plot of V-levels of ruby and sapphire

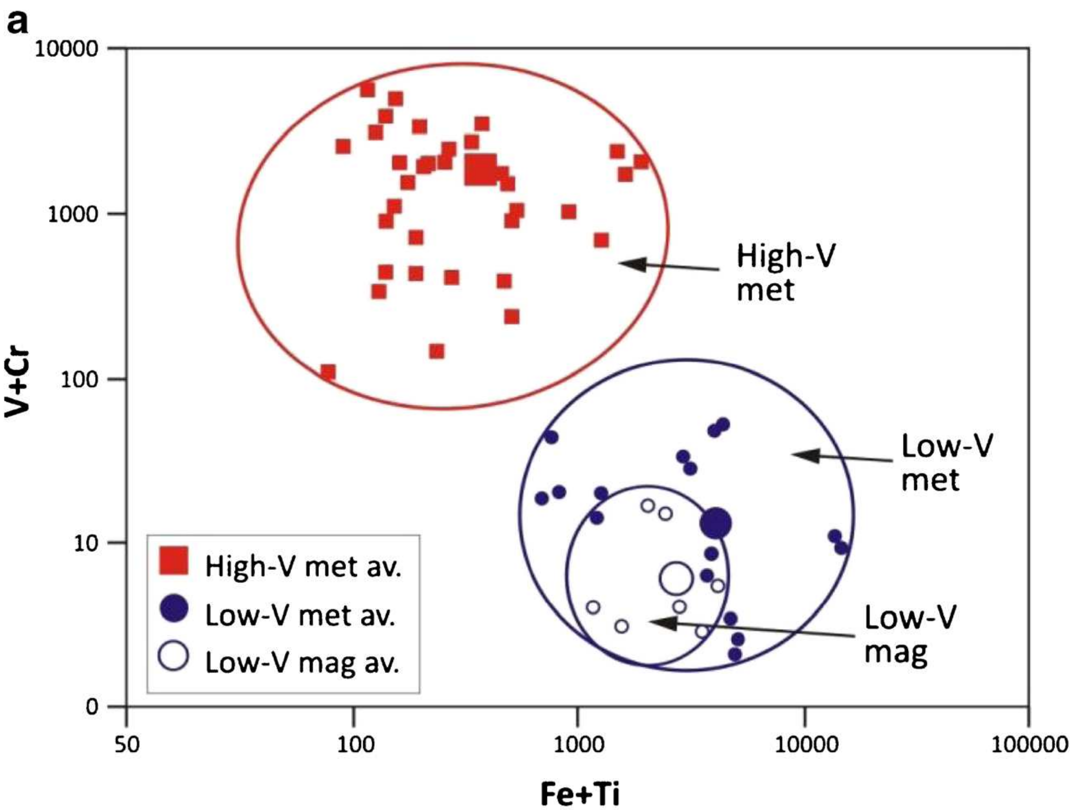
^{18}O composition

Ruby -15.6 to 24.2%

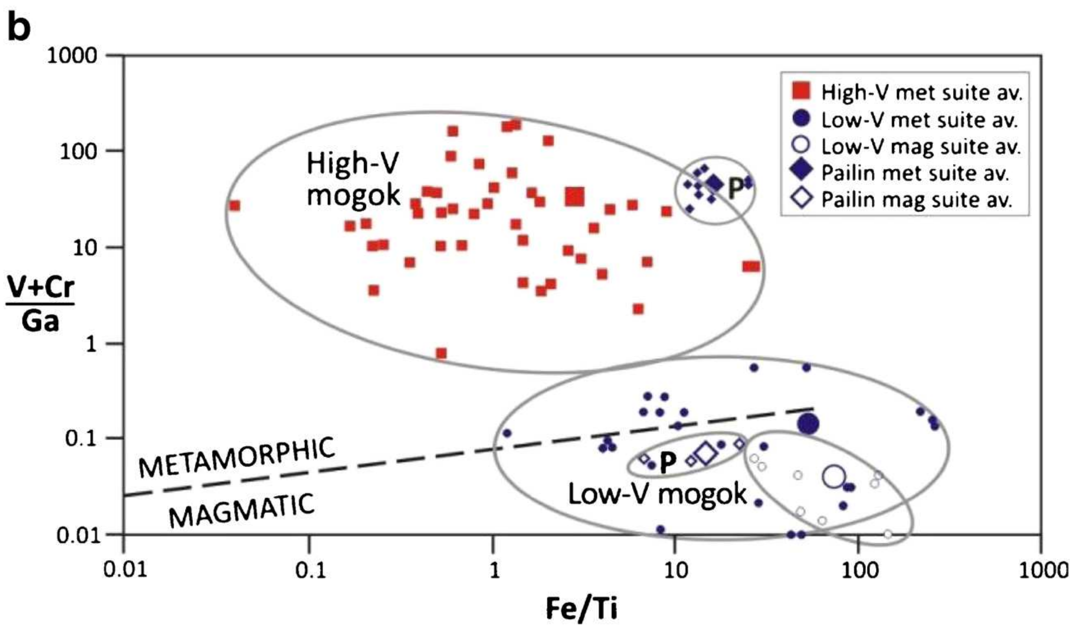
Sapphire – 10.6 to 22.7%

(b) V ppm Vs ^{18}O of ruby and sapphire



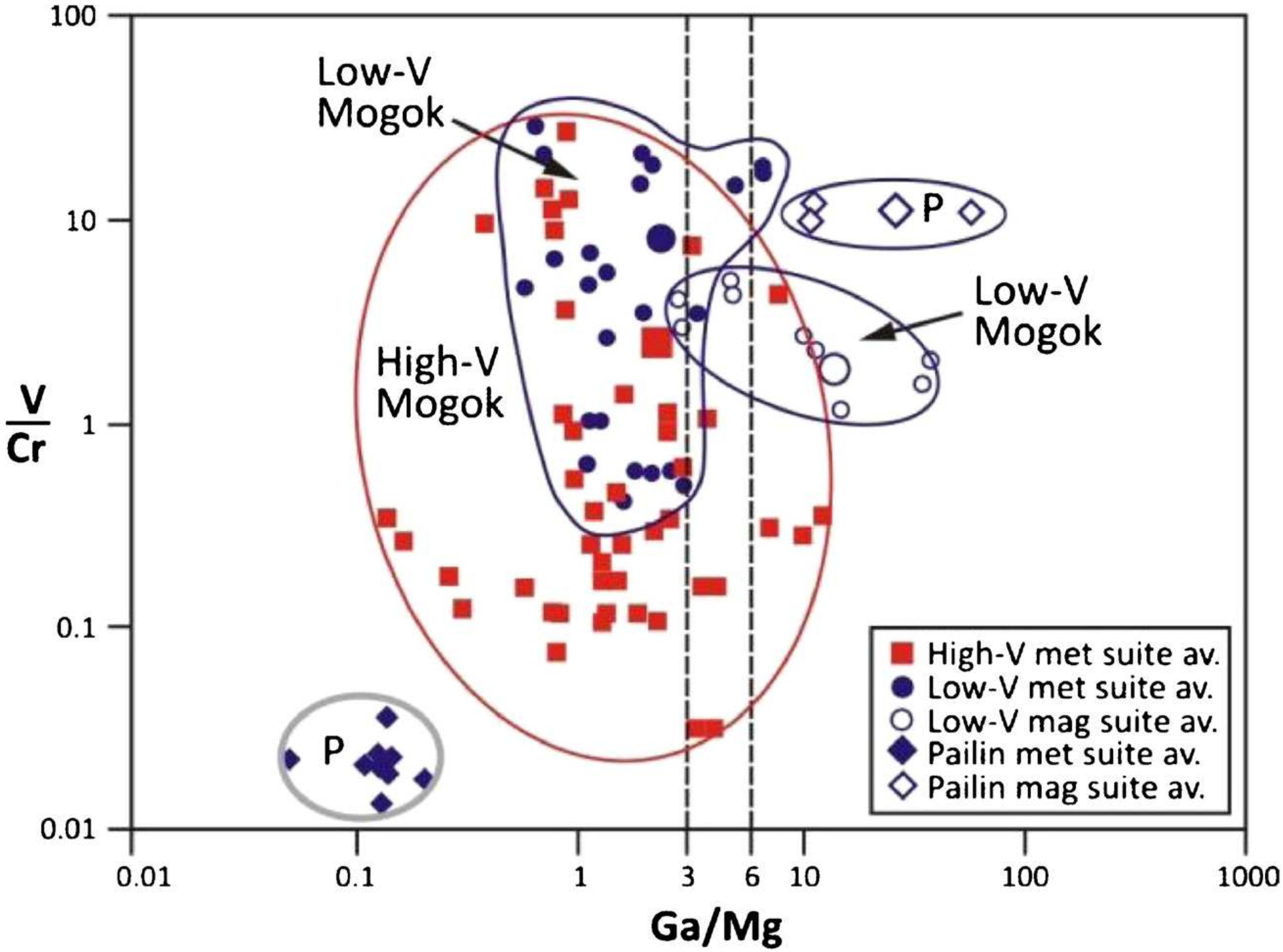


(a) V+Cr Vs Fe+Ti plot



(b) V+Cr/Ga Vs Fe/Ti plot

V/Cr Vs Ga/Mg plot of ruby and sapphire



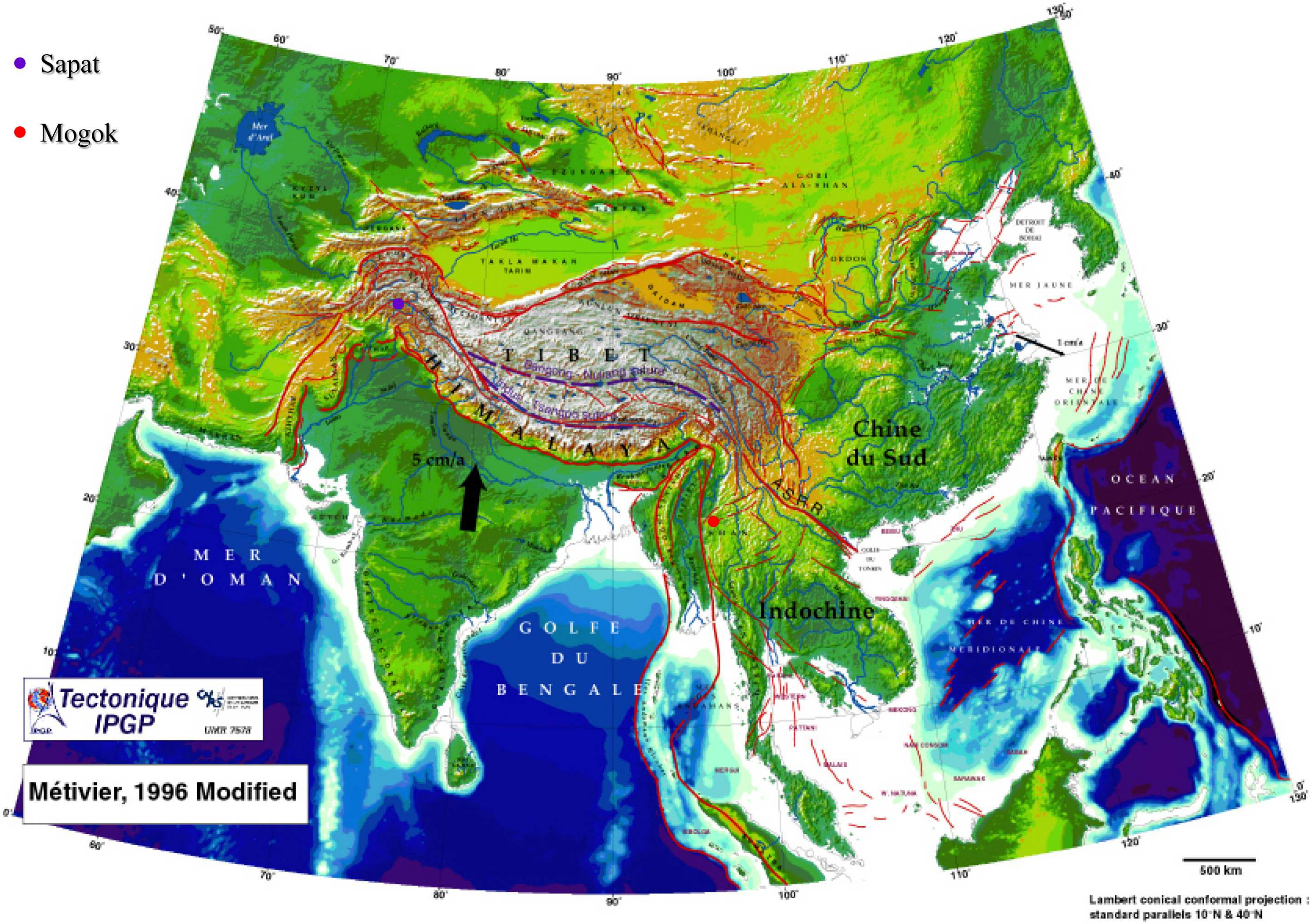
Mogok Ruby Interpretations

- ❖Iyer (1953) did the most detailed field study and found ruby was associated with pneumatolytic veins from igneous intrusions.
- ❖Gubelin (1960s?) suggested melt hybridization in reaction of granites with marble to crystallize ruby, diopside, and olivine.
- ❖Garnier et al. (2008): a closed-system metamorphic origin for many of the marble-hosted ruby sources from platform carbonate containing evaporite/organic-rich shale units.
- ❖Harlow (2013): Test hypothesis that skarn origin should affect corundum trace-element composition, particularly B and Zr (in painite) or other pegmatite/granite abundant elements (Li, Be, etc.)

Peridot from Pyaung-Gaung

Introduction: ***Peridot***

- Gem variety of forsteritic olivine.
- Small stones (~<5 carats) mostly from dunites.
- Large stones and well-formed crystals are from only 3 deposits: Zabargad Island, Egypt; Pyaung-Gaung, Myanmar; and Sapat, Kohistan, Pakistan.
- Sapat and Zabargad peridots form in pockets in tectonized dunite with evidence for (re)crystallization from a hydrous fluid.

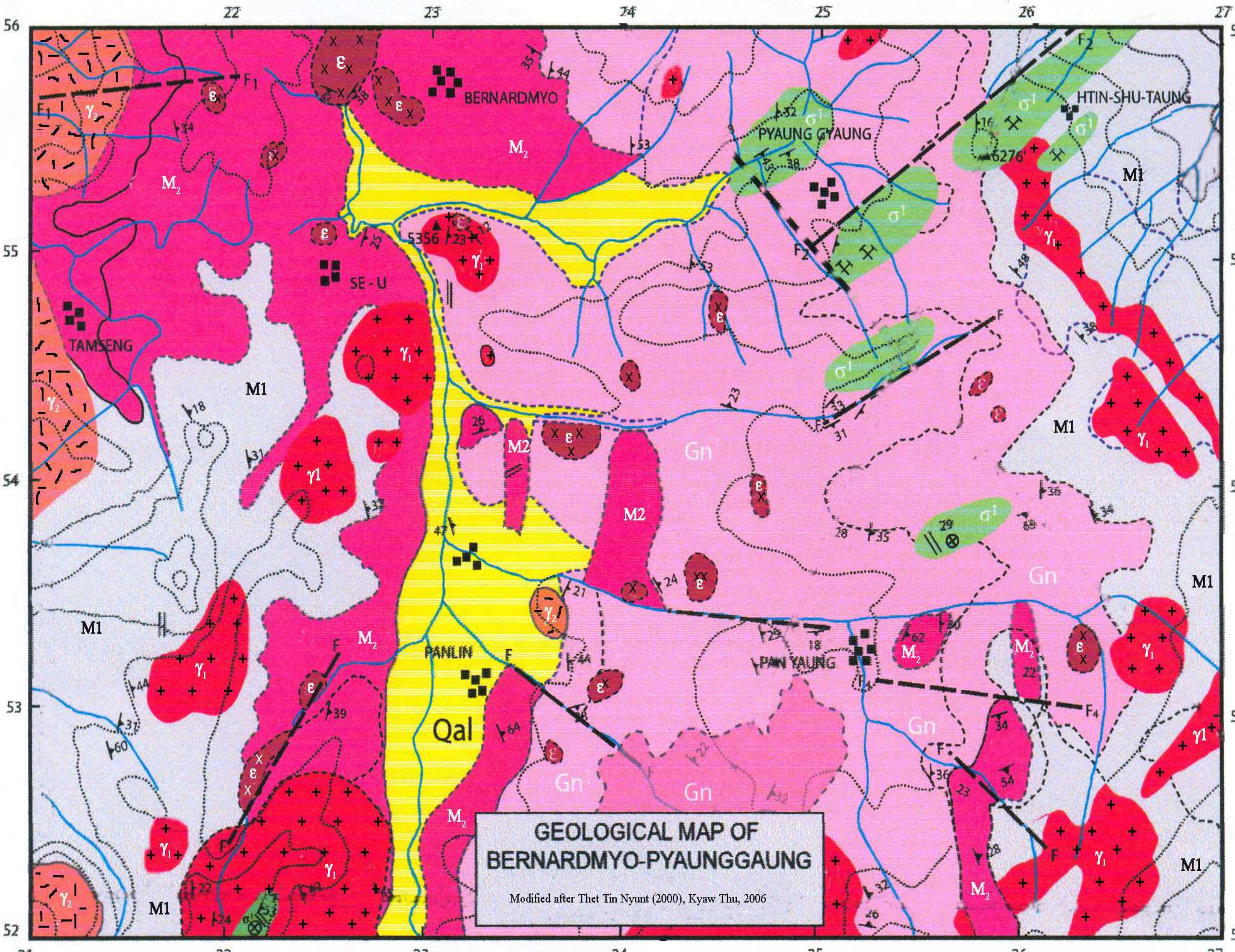


Sapat
Mogok
TIBET
HIMALAYA
5 cm/a
Bangong - Nujiang suture
Indus - Tsangpo suture
TAKLA MAKAN
TARIM
QAIDAM
DZUNGAR
GOBI
ALA-SHAN
ORDOS
MER JAUNE
MER DE CHINE ORIENTALE
Chine
du Sud
ASRR
Indochine
OCEAN
PACIFIQUE
MER DE CHINE MERIDIONALE
GOLFE
DU
BENGALE
MER
D'OMAN
Mer d'Aral
500 km
Lambert conical conformal projection :
standard parallels 10°N & 40°N
Tectonique IPGP
Métivier, 1996 Modified

4.8 cm Pyaung-Gaung Peridot

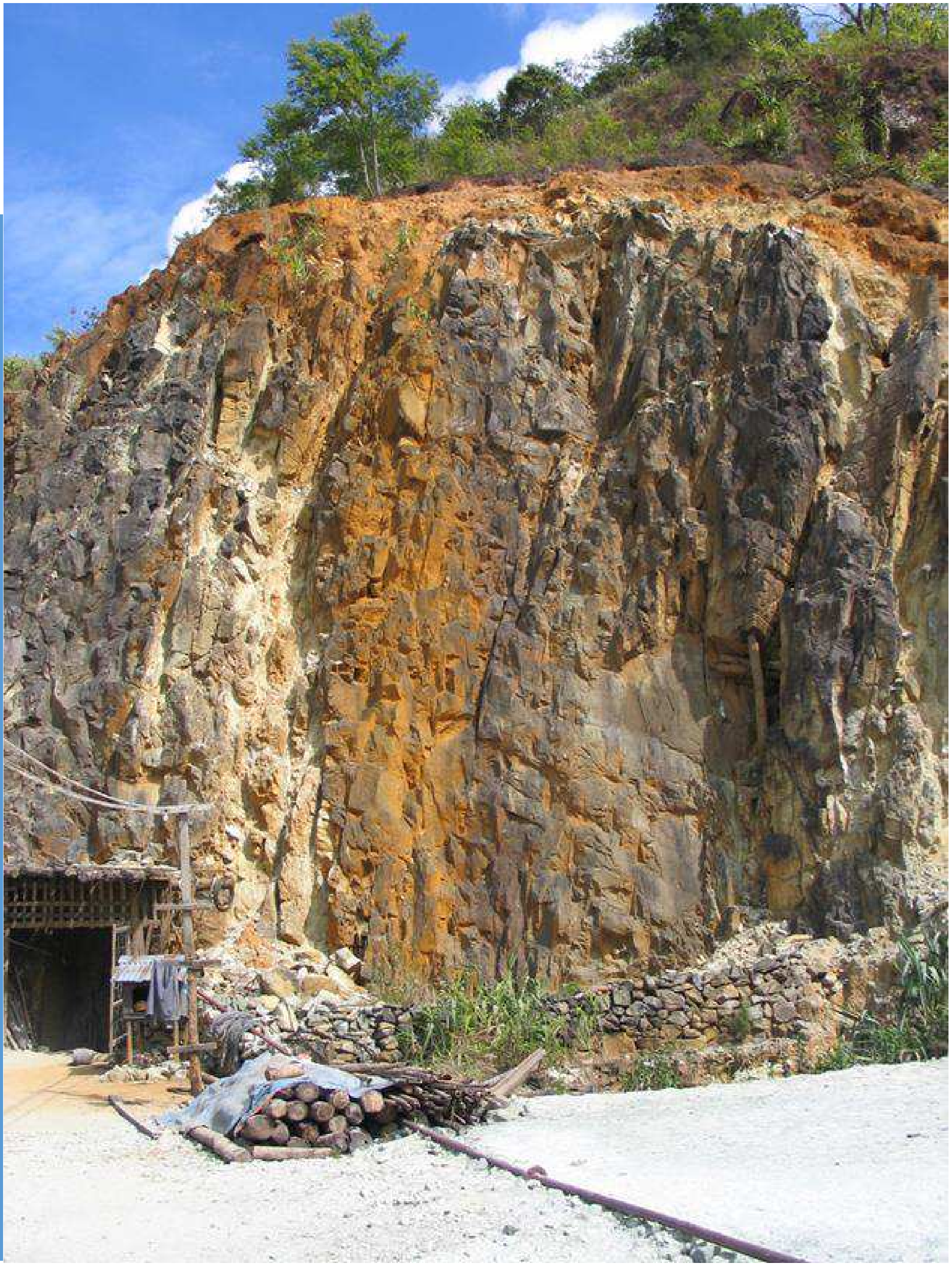
Geology

- ❖Mogok Belt: marbles and schists.
  - ❖Sediments as old as Proterozoic (>750 Ma) but mostly Paleozoic (650 – 300 Ma).
  - ❖Multiple early metamorphic events—Jurassic (185 Ma) & Cretaceous (~150 Ma), last by collision of Burma Block with Shan plateau. Boundary along which ultramafics and **peridot is associated, however no dating.**
  - ❖More extensive metamorphism and granite intrusions from Indian Block collision as recently as Miocene (26 – 15 Ma). Probable latest event affecting **peridot.**
  - ❖Ruby and spinel are marble-hosted; sapphire in syenitic dikes; and tourmaline, topaz, etc. in granitic pegmatites; peridot in uplifted ultramafic.
  - ❖**Lots of evidence for involvement of fluids.**

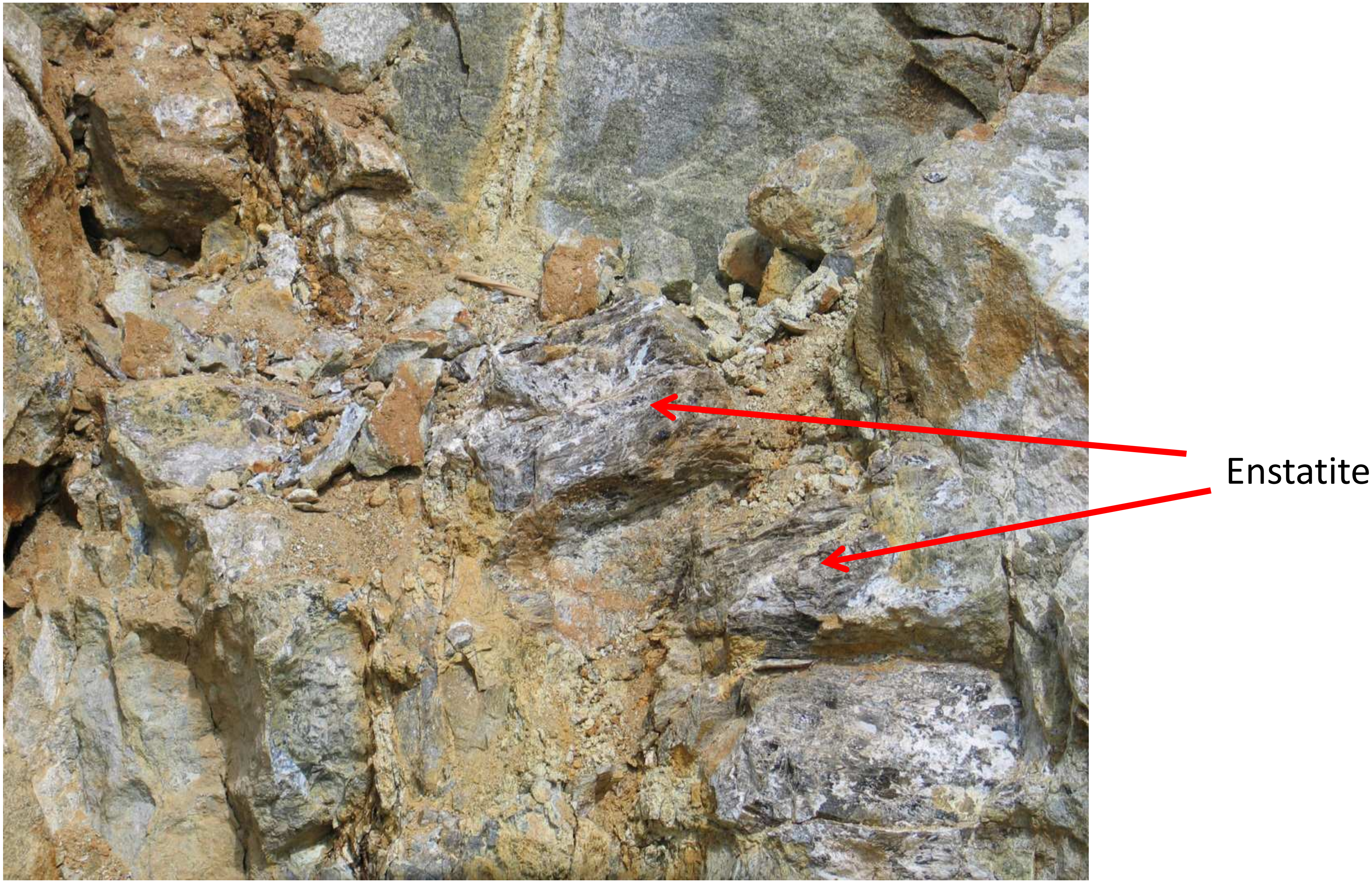


GEOLOGICAL MAP OF
BERNARDMYO-PYAUNGGAUNG
Modified after Thet Tin Nyunt (2000), Kyaw Thu, 2006
BERNARDMYO
PYAUNG GYAUNG
HTIN-SHU-TAUNG
SE - U
TAMSENG
PANLIN
PAN YAUNG
Qal
Gn
M1
M2
F1
F2
F4
5356
6276
21
22
23
24
25
26
27
52
53
54
55
56

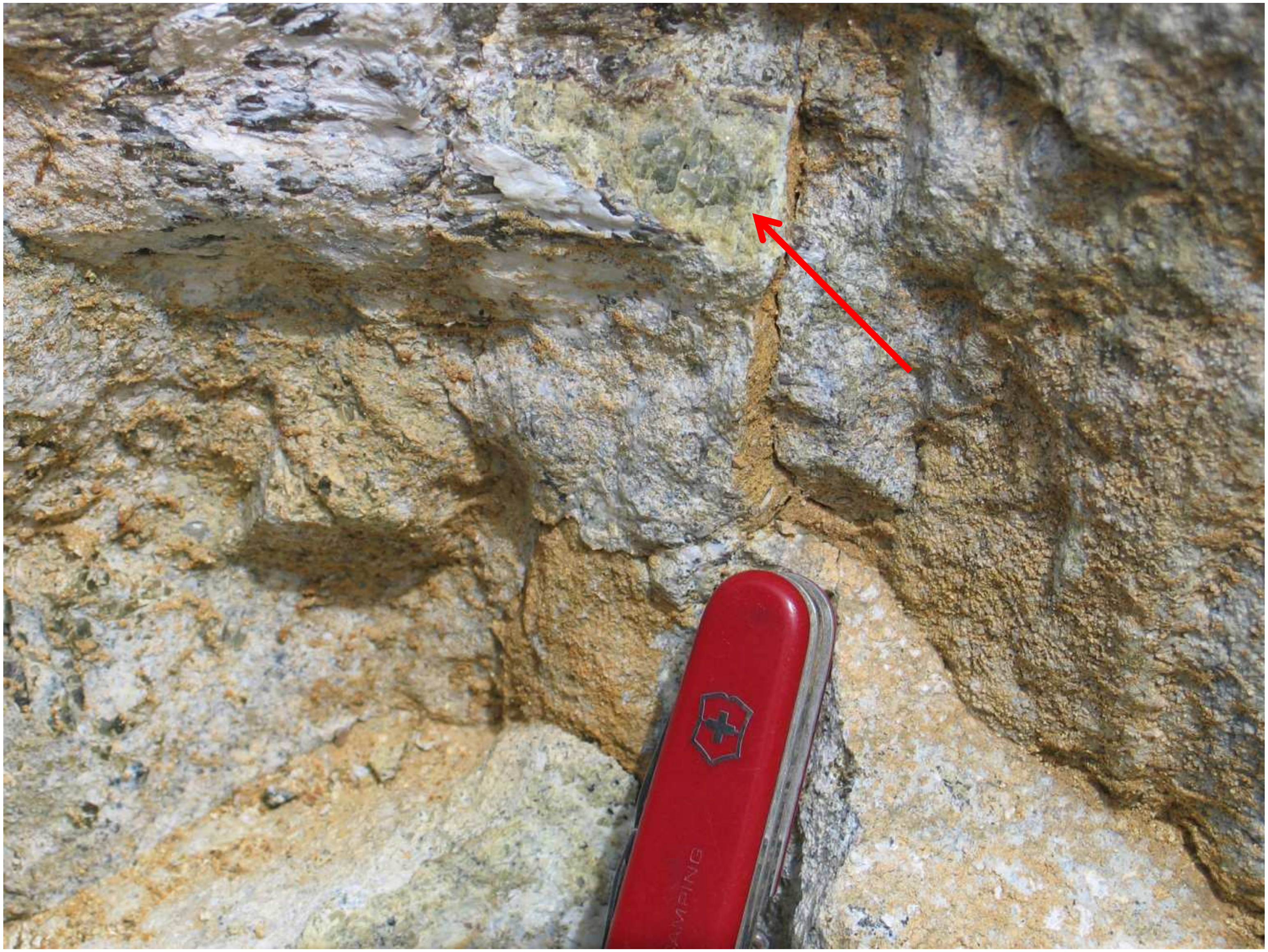
Entrance to underground Mya-sein-taung mine at Pyaung-gaung with adjacent weathered outcrop of partially serpentinized peridotite. Rustiness indicates that there is still olivine in the peridotite that has not been reacted to become serpentinite.



Partially serpentinized, tectonized peridotite (yellow-green) outcrop showing the subhorizontal planar shear feature (decorated with Mgt) cut by fractures exposing surfaces partially coated with a mixture of talc and serpentine (white & brown).



Close up of outcrop exposing a large vein of brown enstatite (coated by talc and carbonate), running upper left to lower right through the chaotic exposure. The image is about a meter across.



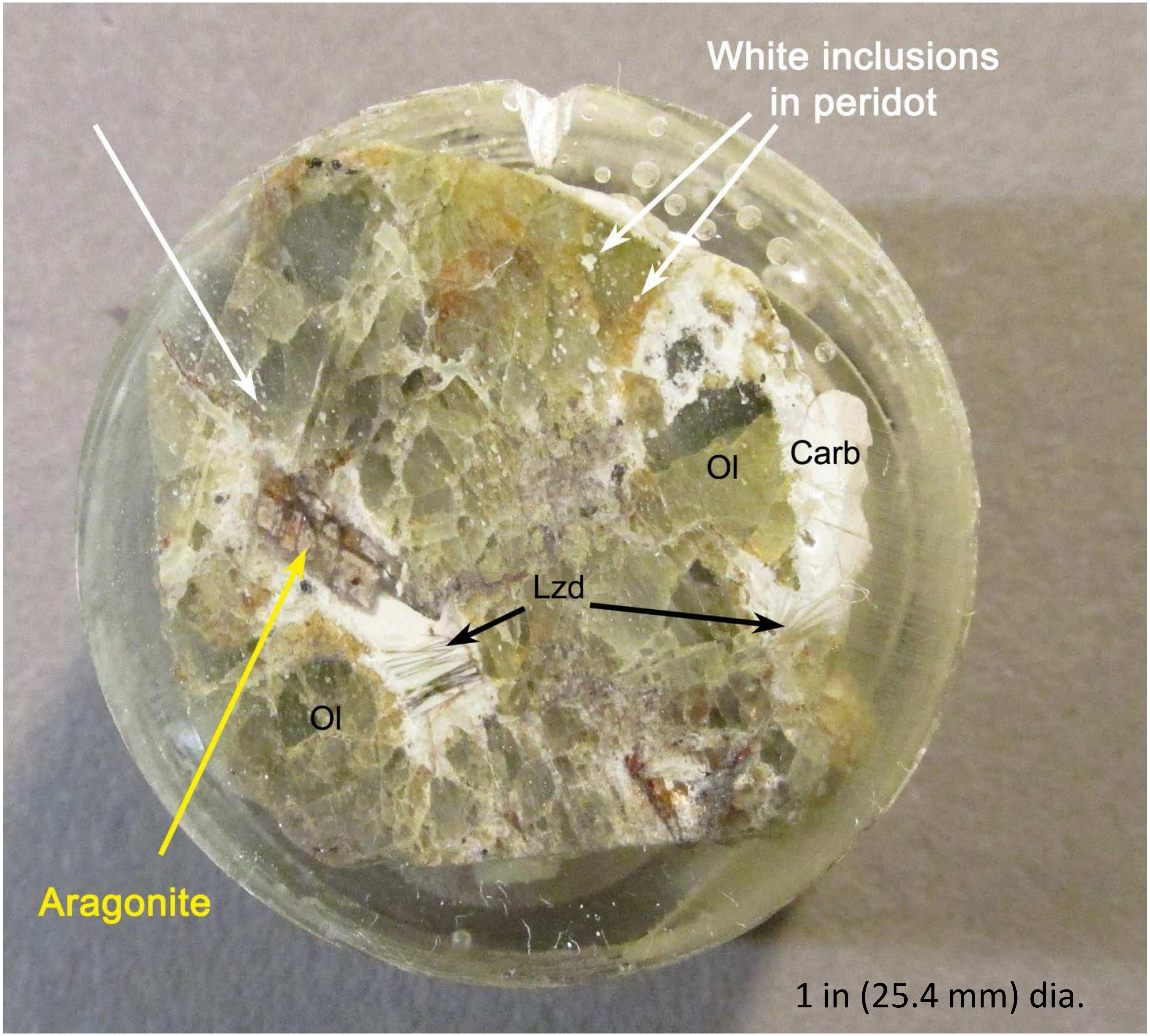
Close up of a small area of pocket peridot, surrounded by talc + carbonate (white) and interspersed enstatite exposed in a fragmented rusty peridotite.

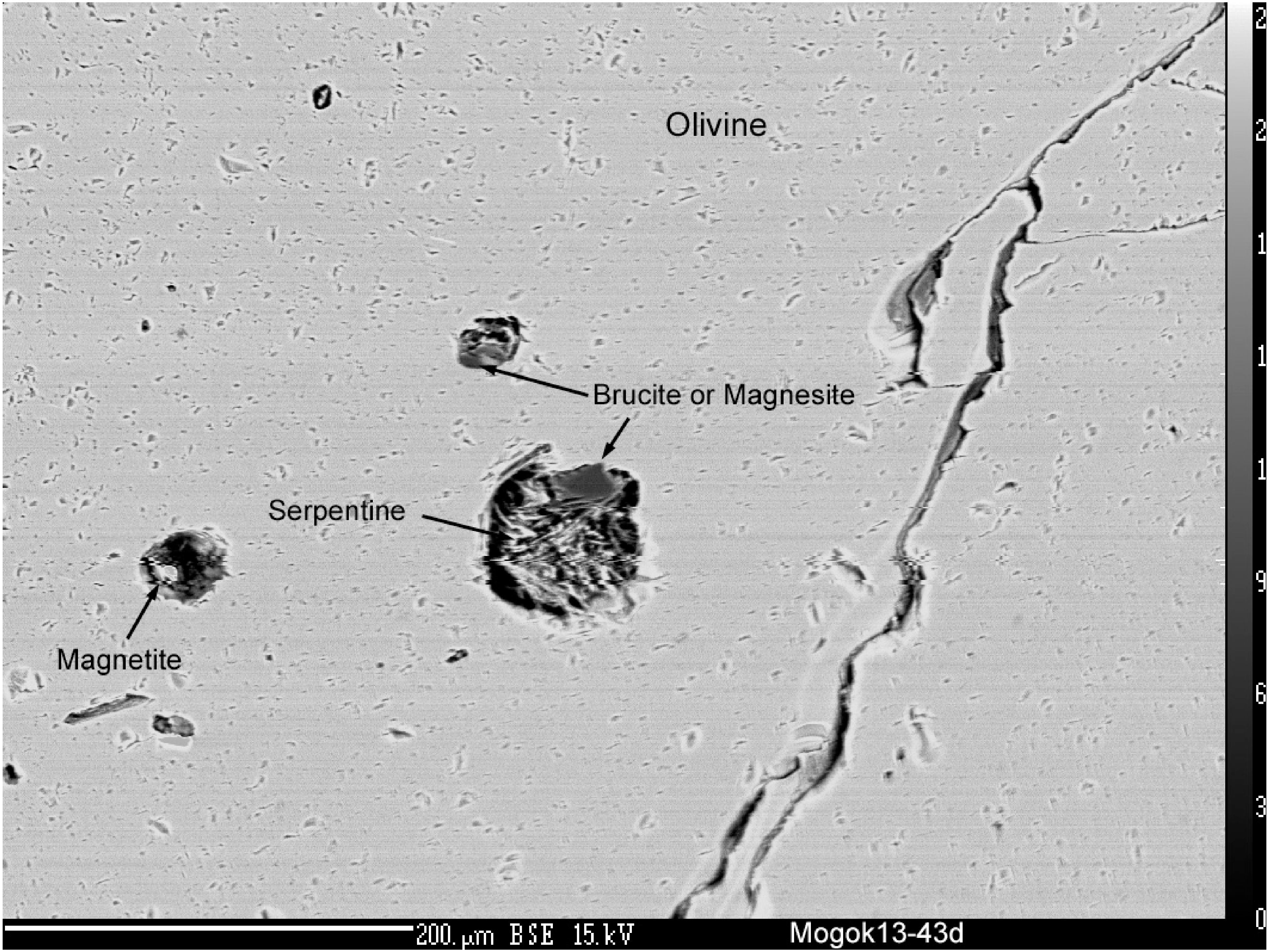
Two samples of a portion of pockets showing peridot crystals (green), white pocket filling (microcrystalline calcite, pyroaurite(?)
$Mg_6(Fe^{3+})_2CO_3(OH)_{16}.4H_2O$), talc, and lizardite serpentine) and grayish serpentinized pocket host rock

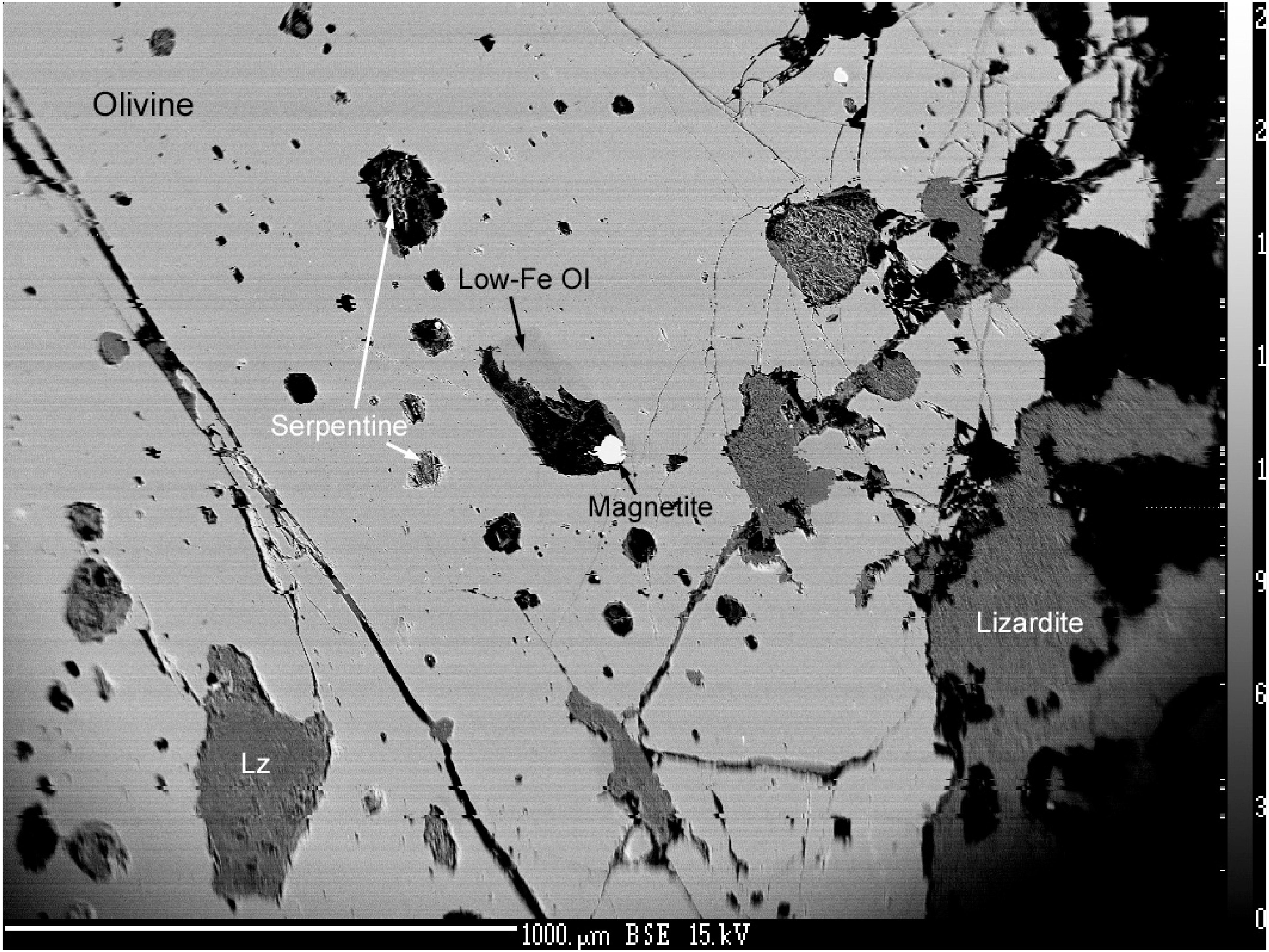
- Harzburgite (rare):
  - olivine (Fo92-93), NiO = 0.4-0.5 wt%
  - brown orthopyroxene (En92-93CaTs2)
  - chromian magnetite (Mgt61Pcm18Cm10Sp9)

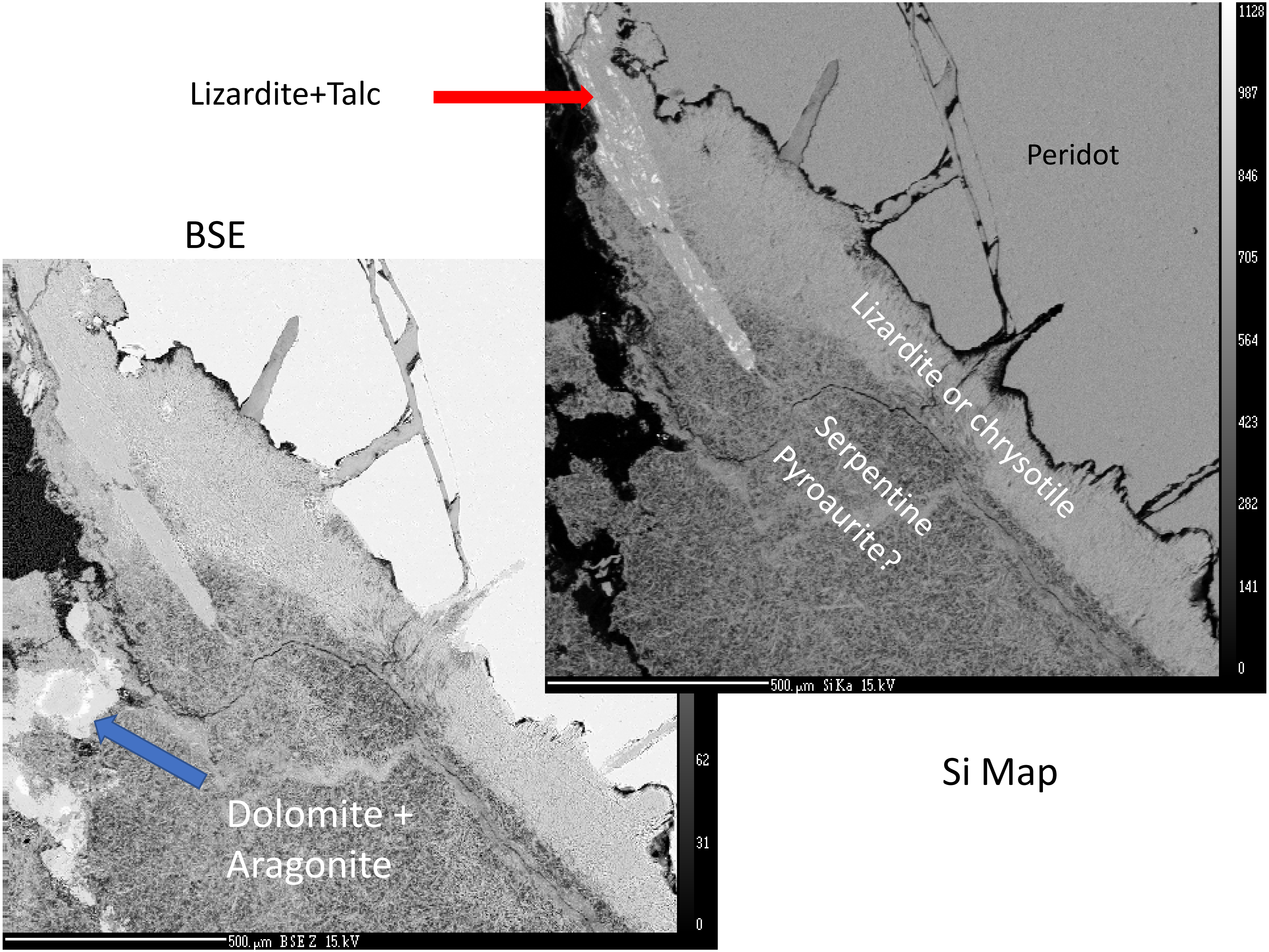
- Dunite
  - olivine (Fo92-93), NiO = 0.4-0.5 wt%
  - magnetite (Mgt65-70Cm20-22Pcm8Sp4)

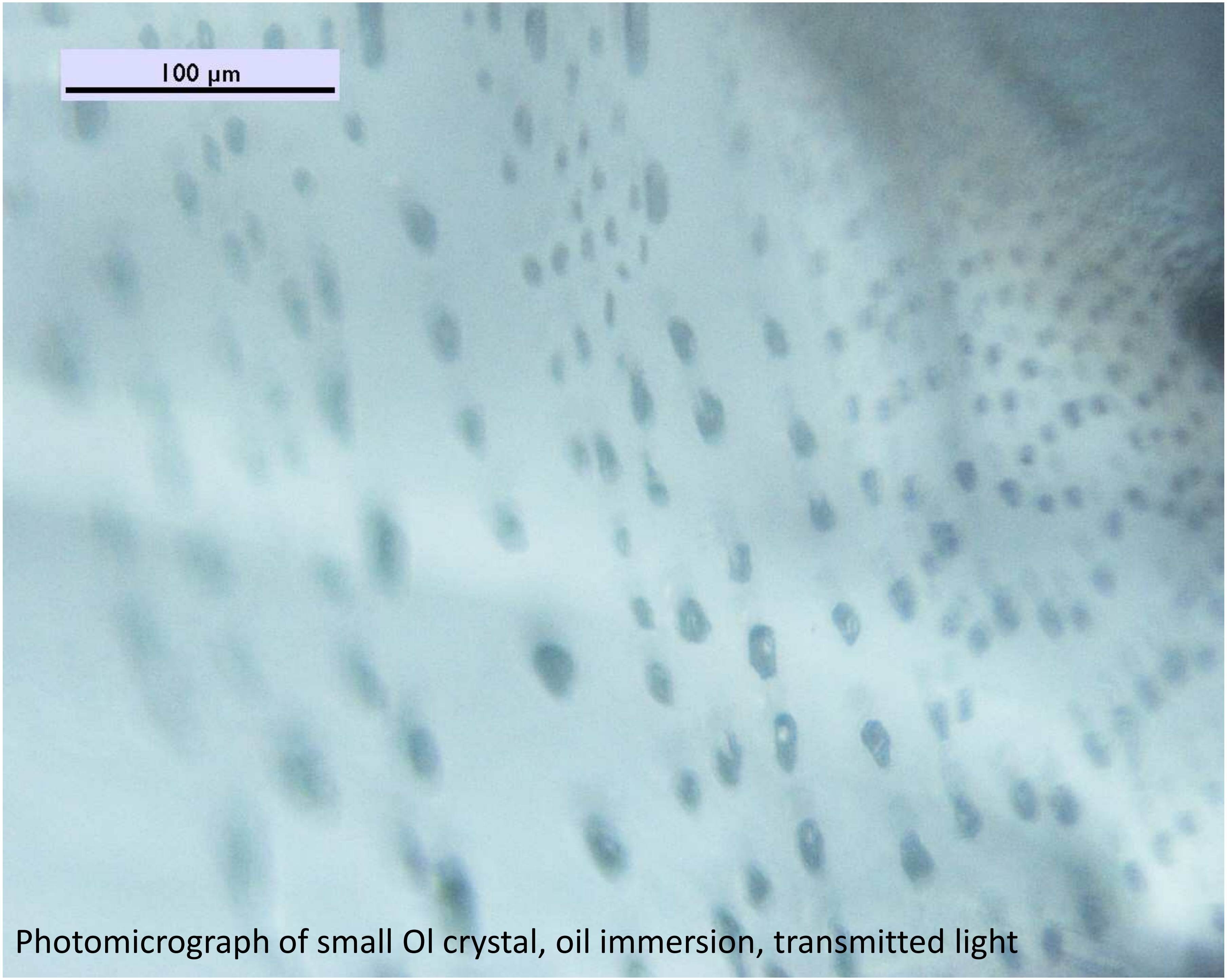
- Peridot composition:
  - Fo92-93, NiO = 0.4-0.5 wt%
  - Very homogeneous


White inclusions
in peridot
Carb
Ol
Lzd
Ol
Aragonite
1 in (25.4 mm) dia.


Olivine
Brucite or Magnesite
Serpentine
Magnetite
200.µm BSE 15.kV
Mogok13-43d


Olivine
Low-Fe Ol
Serpentine
Magnetite
Lizardite
Lz
1000. µm BSE 15.kV


Lizardite+Talc
Peridot
BSE
Lizardite or chrysotile
Serpentine
Pyroaurite?
Dolomite +
Aragonite
Si Map
500.μm BSE Z 15.kV
500.μm SiKa 15.kV
1128
987
846
705
564
423
282
141
0
62
31
0



Photomicrograph of small Ol crystal, oil immersion, transmitted light

The white inclusions in peridot can be interpreted as the result of the reaction:

Forsterite + H_2O = Antigorite + Brucite

or if silica activity were greater, constrained by:

Forsterite + Talc + H_2O = Antigorite.

Thermobarometry – sort of

- Ol-Opx-Spinel thermometry:
  - 730 °C ± 100
- Original fluid inclusions
  - T > 400 ºC @ 5 kbar for Fo + H_2O
  - T > 540 ºC @ 5 kbar for Fo + Tc + H_2O
- Aragonite (hmmm??)
  - 11 kbar @ 400 ºC

Other occurrences:

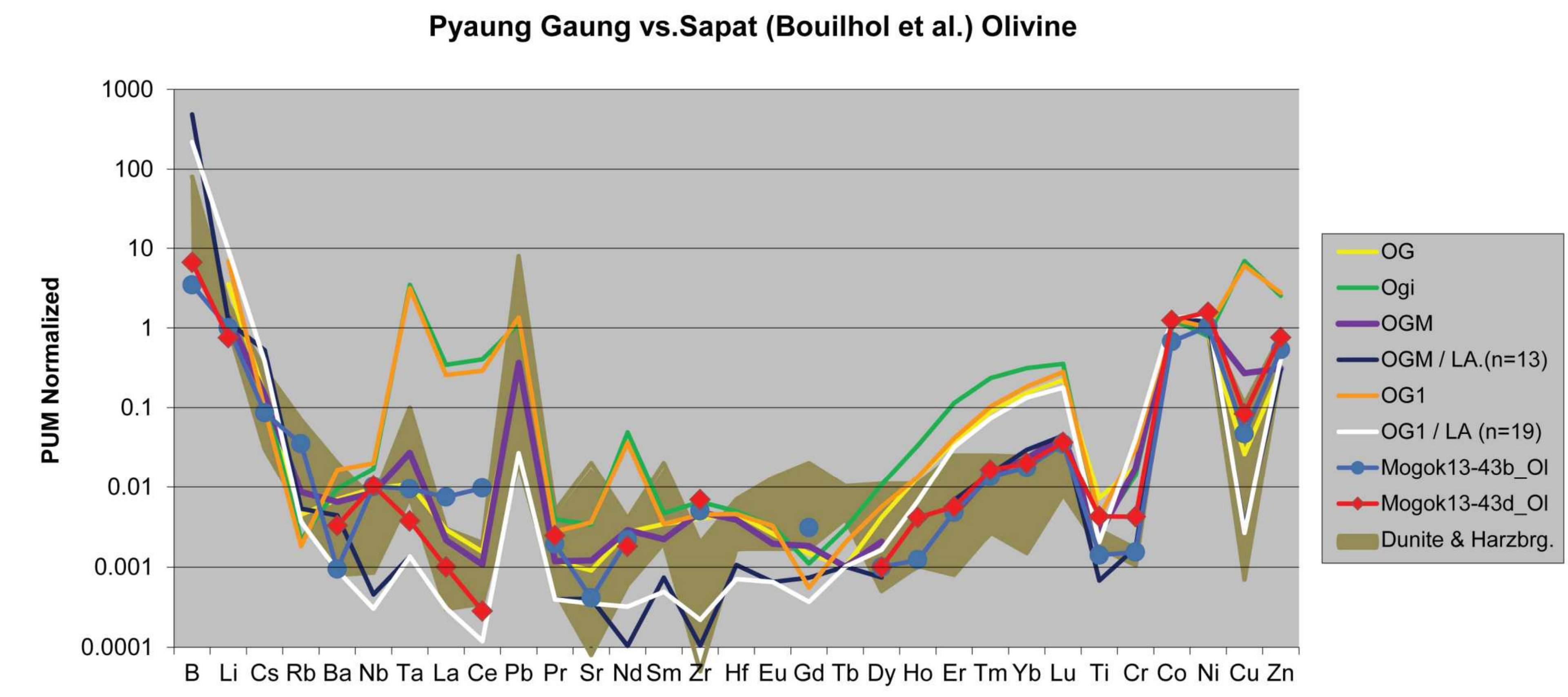
- Sapat: Bouilhol et al. (2012) found carbonate, Fe-Mg borate (ludwigite-vonsenite), and fluid inclusions in gem olivine, interpreted as subduction dewatering that recrystallized olivine in tension gashes in tectonized dunite.

- Zabargad: Kurat et al. (1993) found halite, carbonates, and CO2 in gem olivine from “olivinite” veins, interpreted as relics of hypersaline fluids of the latest metasomatism.

Boron in Peridot

- Bouilhol et al. (2012) reported from 54 to 121 µg/g B in gem olivine from Sapat.
- This study has measured 2 (±0.4) µg/g B by LA-ICPMS and δ11B of -14 to -9‰ (2σ < 3‰) by SIMS in peridot from Pyaung-Gaung.
- Although B data on dunite olivine is minimal, Sapat is clearly B-rich, but P-G may not be. However, P-G δ11B values are lower than primitive mantle (~-7: Marschall personal commun.) and more like negative values associated with either an evolved igneous source or subduction-zone-related metasomatism (Martin et al. 2014).

Peridot/olivine trace elements



OG- OG1 = gem olivine from Sapat (Bouilhol et al. 2012, Can Min; Mogok 13-43 = Pyaung-Gaung pocket olivine; Dunite and Harzburgite from crust-mantle transition zone at Sapat (ibid)

Pyaung-Gaung Interpretation

- Tectonic emplacement with recrystallization of dunite and harzburgite (T = 700±100°C) in the presence of H2O-CO2 fluid; peridot crystallized from fluid in tension gashes followed by carbonate, talc and serpentine infilling.

- Too what degree are dunites, in general, modified by hydrothermal fluids?

Gemstones Deposits in Granite Pegmatite

Prominent pegmatitic gemstones deposits in Mogok;

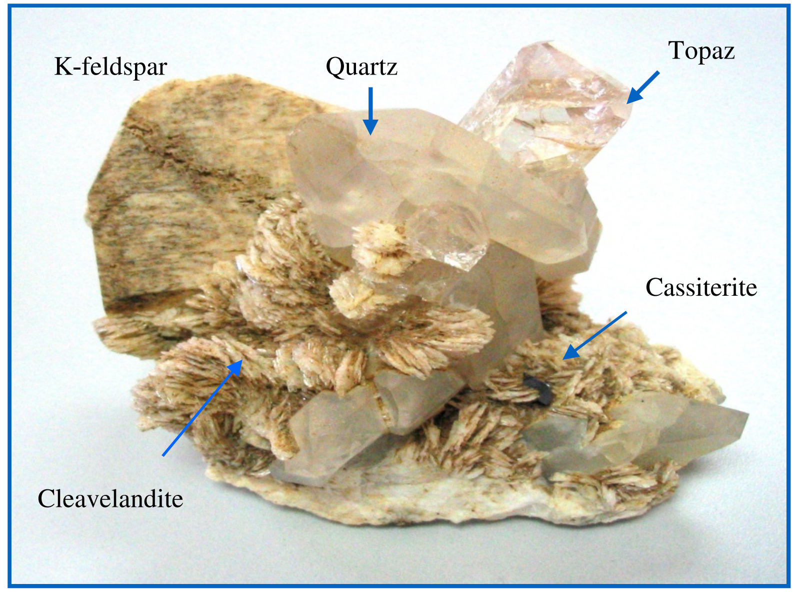
- Sakhangyi pegmatite & Pan Taw pegmatite

  - 16 km west of Mogok and 14.4 km NW of Mogok
  - More than 100 years (Sakhangyi)
  - Feldspar, quartz, muscovite, topaz, aquamarine, herderite, cassiterite, csheelite, columbite-tantalite, lepidolite, rhodochrosite, etc.
  - Pegmatite dated (16 Ma) intruded into Kabaing granite
  - Complex, rare element class, beryl type (LCT & NYF)

GEMS IN PEGMATITE

Highly weathered pegmatite dyke exposure in Sakhan-gyi, 22° 54’ 1.2" N, 96° 20’ 56.1" E

GEMS IN PEGMATITE



Lay-bin-dwin (adit) in pegmatite deposit, Sakhan-gyi, Mogok.
22° 54’ 02.1" N, 96° 20’ 51" E

GEMS IN PEGMATITE

Pegmatite dyke at Pan-taw area, entrance of adit in pegmatite body and drilling in Kabaing Granite for blasting processes (in-sets), 22° 57’ 47.3" N, 96° 24’ 15.6" E

GEMS IN PEGMATITE

Pegmatite pocket with quartz, topaz, feldspar and mica at Sakhan-gyi JV-mine

GEMS IN PEGMATITE

Topaz in matrix

Goshenite

Large aquamarine crystal (21 cm in length) Sakhan-gyi

Topaz crystals

Topaz and quartz crystals

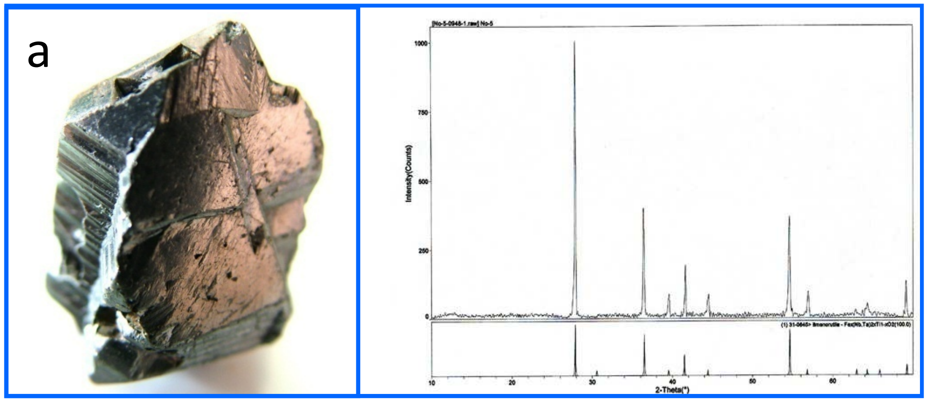
GEMS IN PEGMATITE

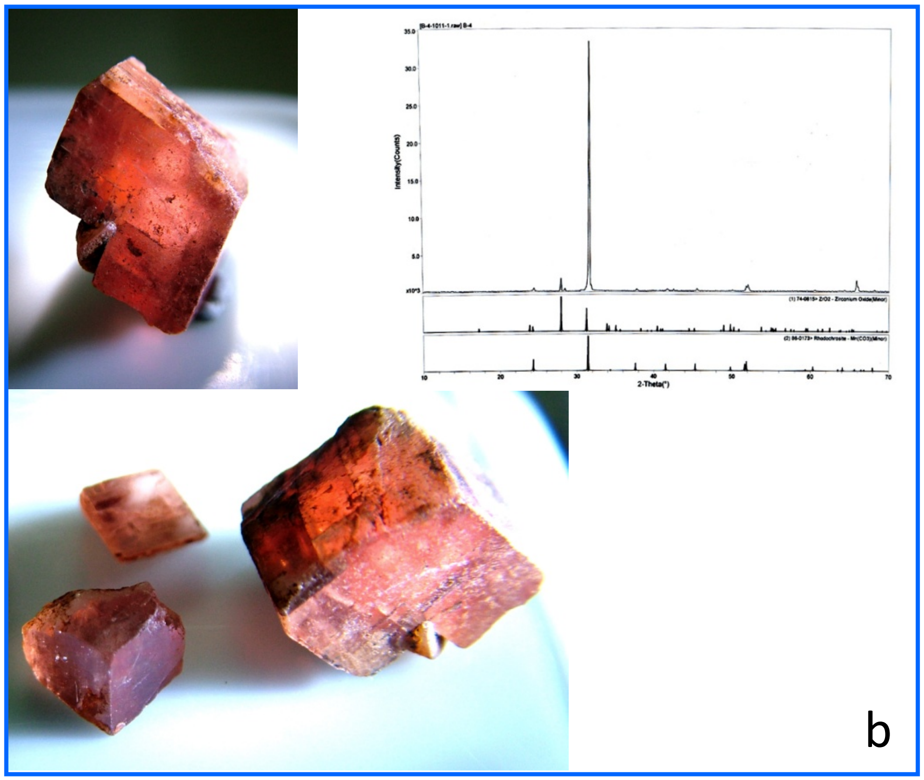



Gem quality rough and faceted scheelite, sherry topaz, aquamarine cat’s eye


Cassiterite, k-feldspar, muscovite and amazonite in pegmatite

GEMS IN PEGMATITE



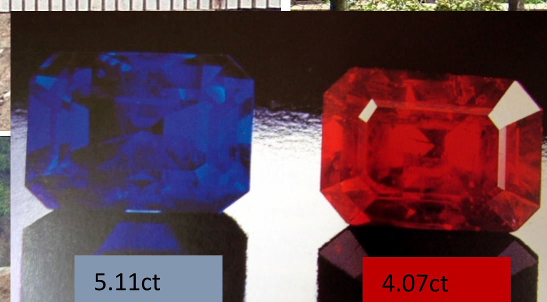


(a) Ilmeno-rutile crystal and its X-RD spectrum, (b)rhodochrosite crystals and its X-RD Spectrum,(c) colour changed fluorite, (d) rough and faceted monazite from pegmatite deposit

Secondary Deposits

-The gemstones eroded from the primary deposits and transported by rivers, streams and transported in sedimentary placer basins at variable extensions.
-Secondary deposits gems and minerals are ruby, sapphire, spinel, peridot, zircon, etc. and some rare gemstones.

Alluvial Deposits



5.11ct

4.07ct

In-gaung mine

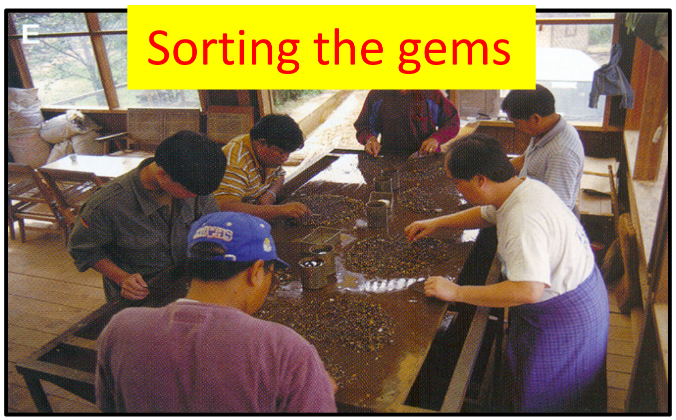
Shwe-pyi-aye mine

Elluvial Deposits (on slope)

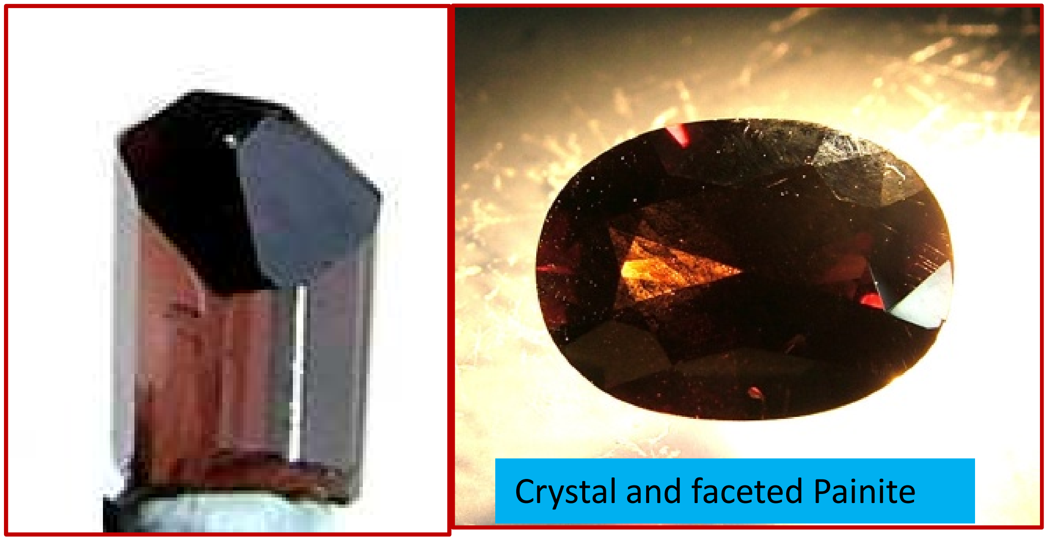
View of the mid-Dattaw Taung JV-mines

Sinkhole and Fissure Filled Deposits (Lu & Let Kya)

ALLUVIAL MINING PROCESS (SHWE PYI AYE MINE)



RARE GEMSTONES OF MOGOK



Crystal and faceted Painite

Crystal and faceted Johachidolite

Hibonite crystals

Faceted Dumortierite and Dumortierite cat's eye

RARE GEMSTONES OF MYANMAR (MOGOK)

Crystal and faceted Taaffeite

Musgravite Crystals

Hackmanite Cabochon

Crystal and faceted Poudretteite

Faceted Sinhalite

Crystal and faceted Jeremejevite

Anatase

Crystal and faceted Serendebite

Rough Scheelite

Baddeleyite crystal

RARE GEMSTONES OF MYANMAR (MOGOK)

Kyawthuite, $Bi^{3+}Sb^{5+}O_4$, a new gem mineral from Mogok

Faceted kyawthuite gem; 1.61 carats; 5.80 mm × 4.58 mm × 3.00 mm.

A series of en echelon hollow tube inclusions near the girdle of the kyawthuite gem. The field of view is 2 mm across.

CONCLUSION

- Myanmar has unique gem and gem deposits in the world

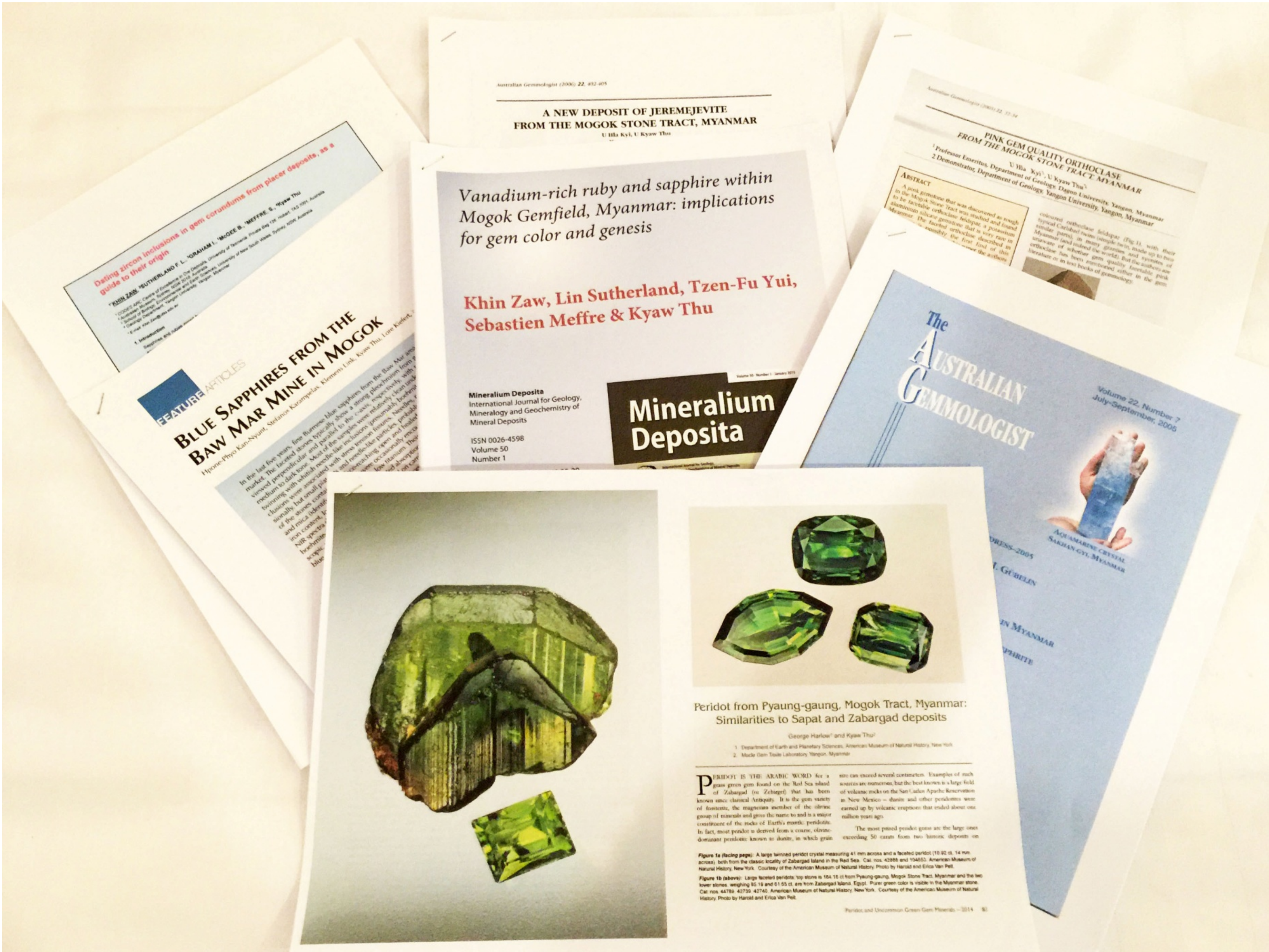
- The Myanmar pigeon's blood coloured Mogok rubies are the finest in the world and the best blue sapphires

- A variety of other gem minerals such as spinel, peridot, topaz, aquamarine, tourmaline and rare gemstones, etc. are also encountered in Mogok.

- Most of secondary placer gems deposits are depleted. But, primary ruby and sapphire deposits are still producing in Mogok.

- Mogok belt have a Tertiary ages but more work in progress with Prof Khin Zaw.

References


A NEW DEPOSIT OF JEREMEJEVITE FROM THE MOGOK STONE TRACT, MYANMAR
Vanadium-rich ruby and sapphire within Mogok Gemfield, Myanmar: implications for gem color and genesis
Khin Zaw, Lin Sutherland, Tzen-Fu Yui, Sebastien Meffre & Kyaw Thu
Mineralium Deposita
International Journal for Geology, Mineralogy and Geochemistry of Mineral Deposits
ISSN 0026-4598
Volume 50
Number 1
Mineralium Deposita
Dating zircon inclusions in gem corundums from placer deposits, as a guide to their origin
FEATURE ARTICLES
Blue Sapphires from the Baw Mar Mine in Mogok
PINK GEM QUALITY ORTHOCLASE FROM THE MOGOK STONE TRACT, MYANMAR
The Australian Gemmologist
Volume 22, Number 7
July–September, 2005
Peridot from Pyaung-gaung, Mogok Tract, Myanmar: Similarities to Sapat and Zabargad deposits
George Harlow and Kyaw Thu


THANKS YOU