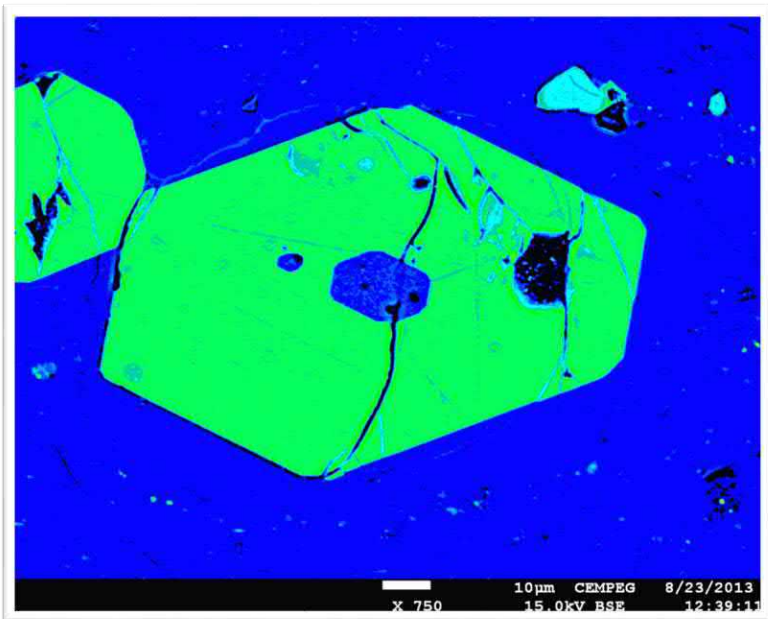
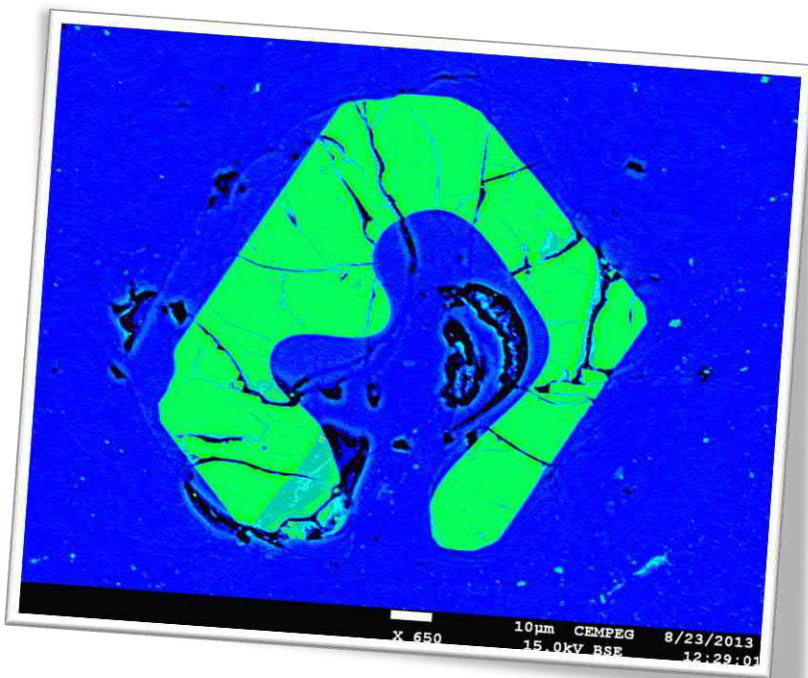


GET TO KNOW YOUR MINERALS

By Professor V.R. Troll



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” I came to realise, more and more so, that the use of simple but fundamental approaches and methods, such as polarizing microscopy which learn by studying mineralogy, have led me to some of the most important insights that others tried to solve with elaborate and expensive methods ”.

*Johannes Georg Bednorz, Nobel Prize for Physics 1987
for discovering supra-conduction in ceramics*

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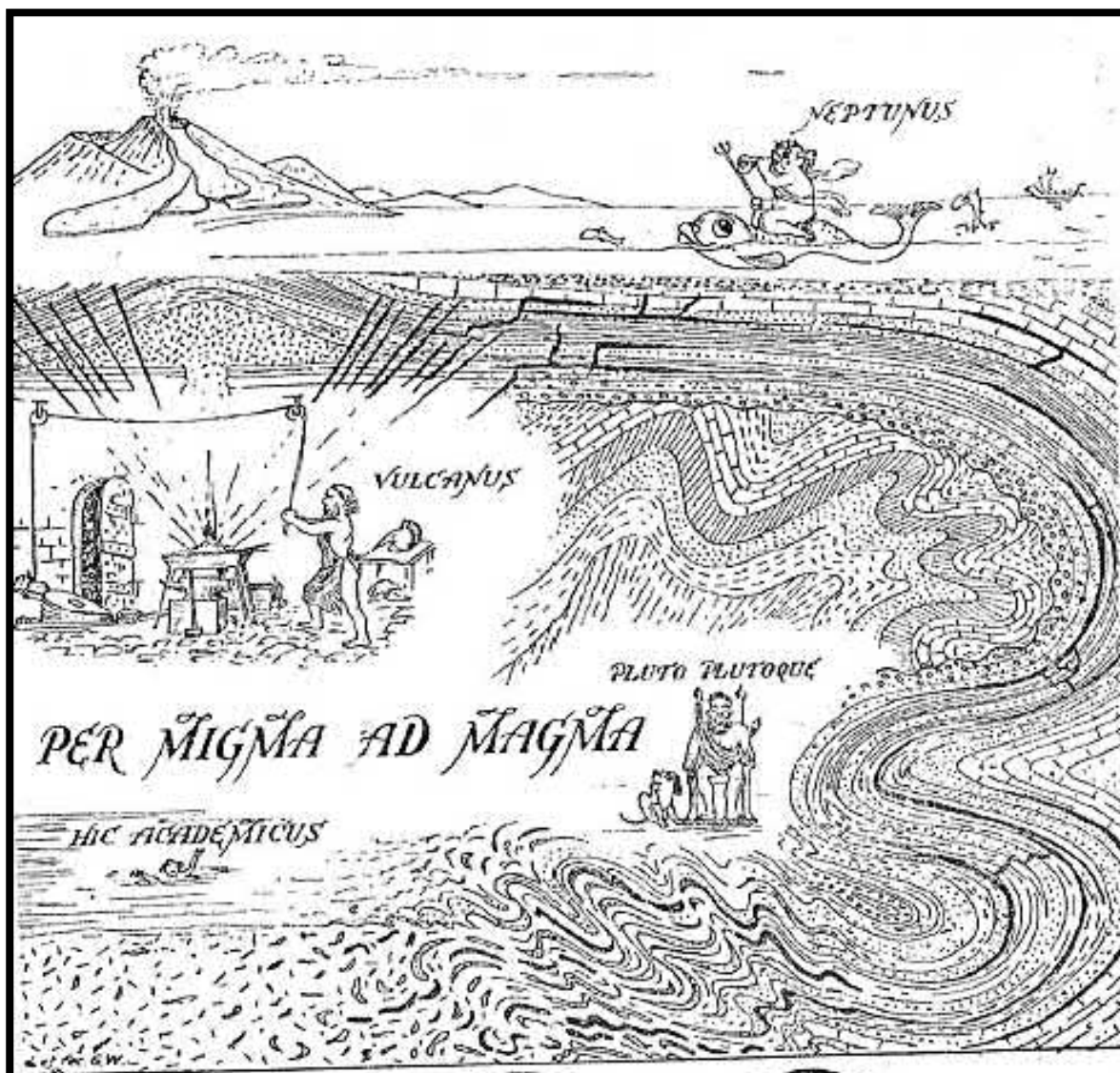
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The Rocks Display'd



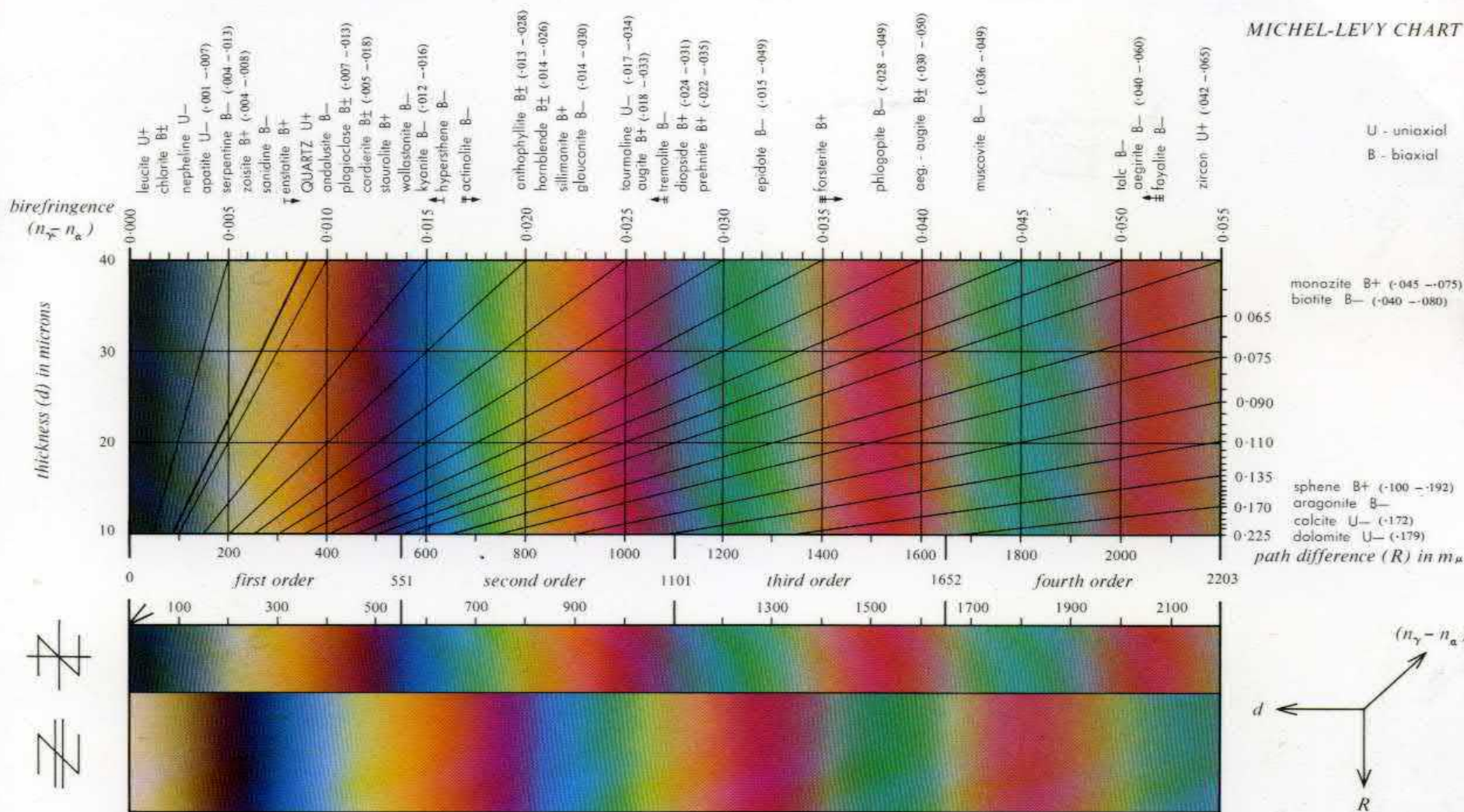
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Michel-Levy Table



MICHEL-LEVY CHART

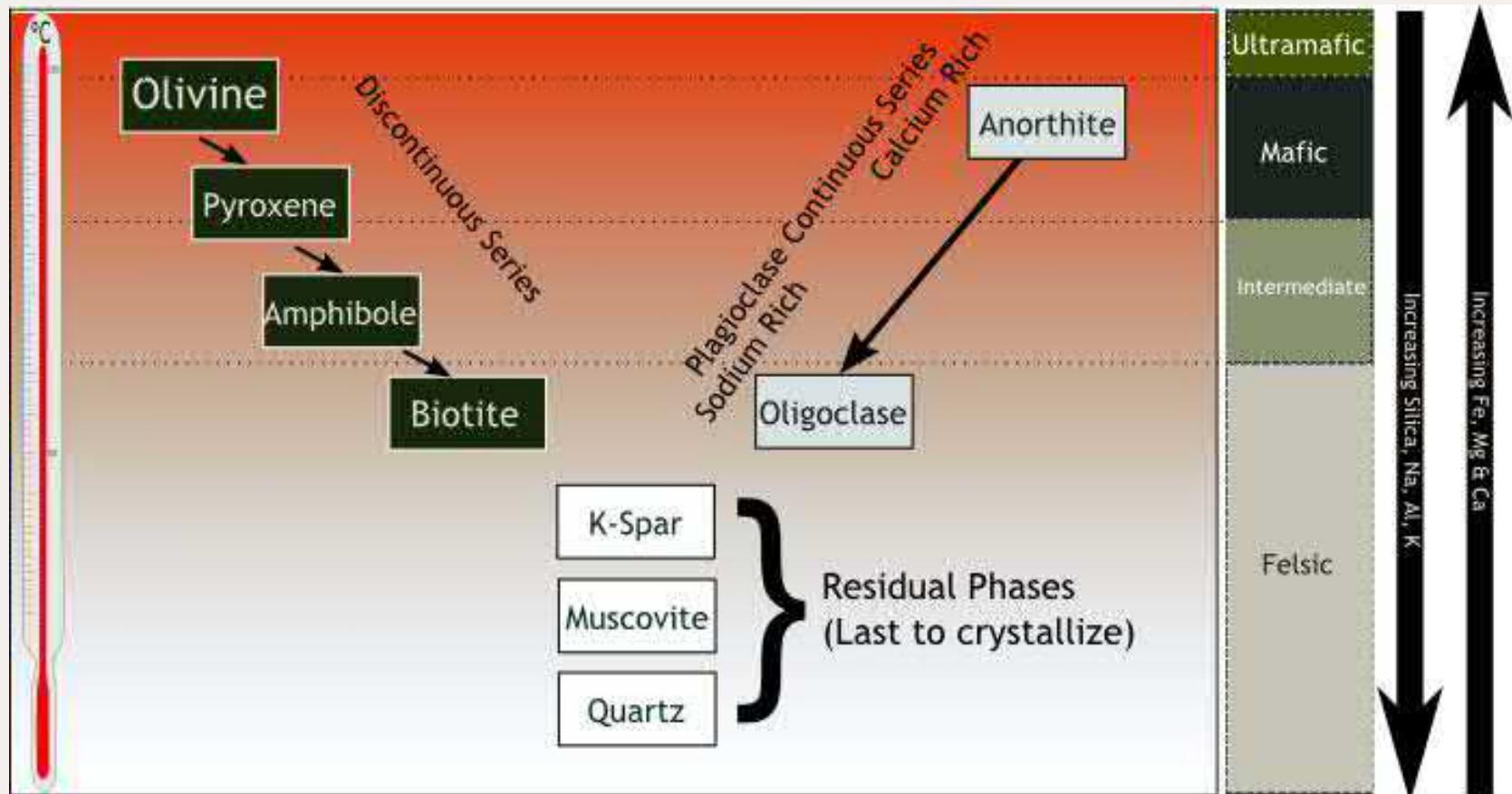
U - uniaxial
B - biaxial





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Igneous minerals

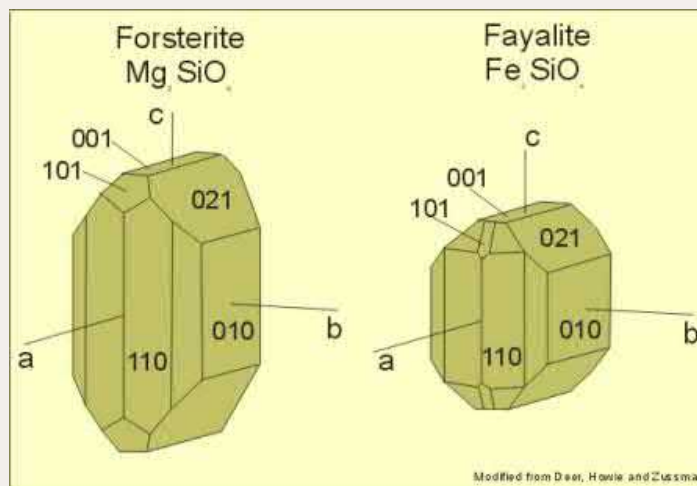




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Olivine

$(\text{Mg,Fe})_2\text{SiO}_4$





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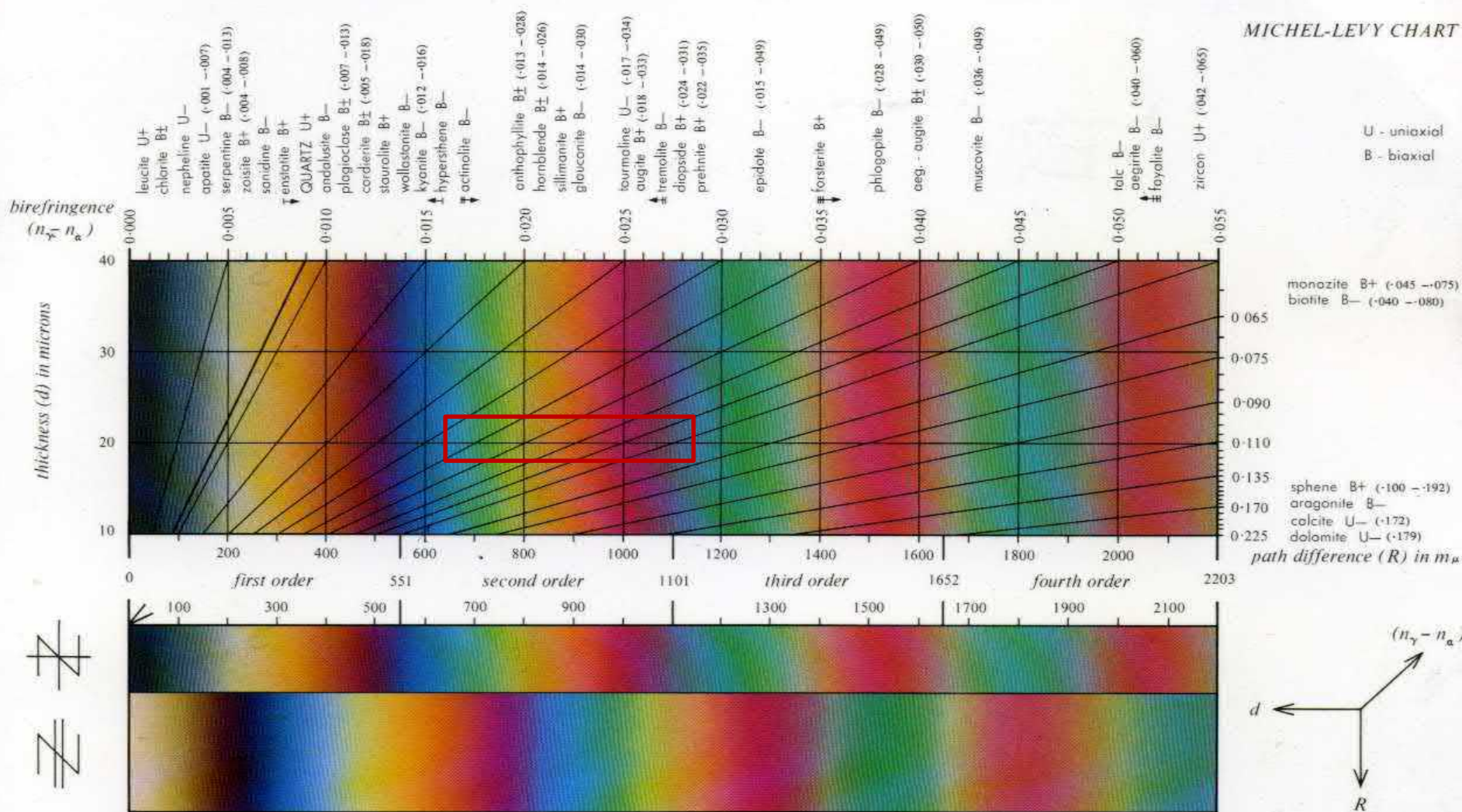
Olivine

Second order



MICHEL-LEVY CHART

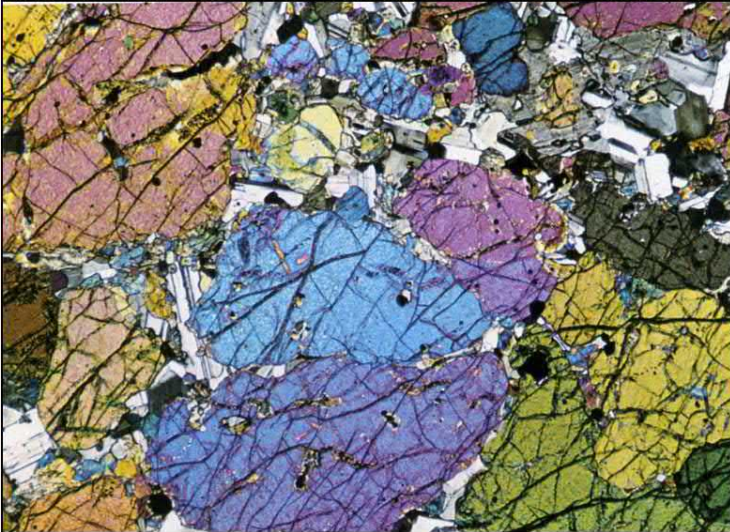
U - uniaxial
B - biaxial



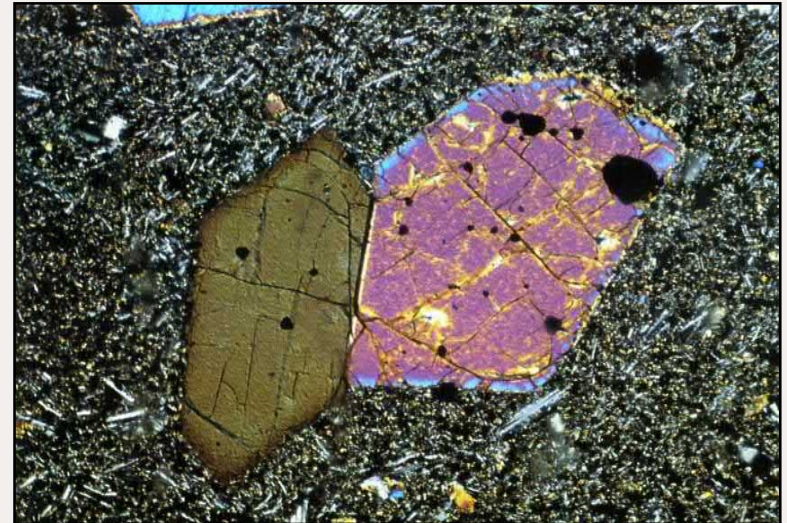


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Olivine



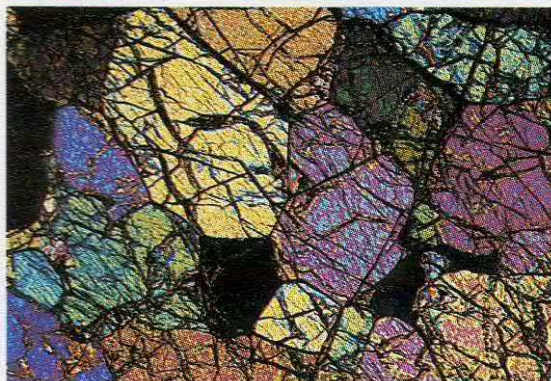
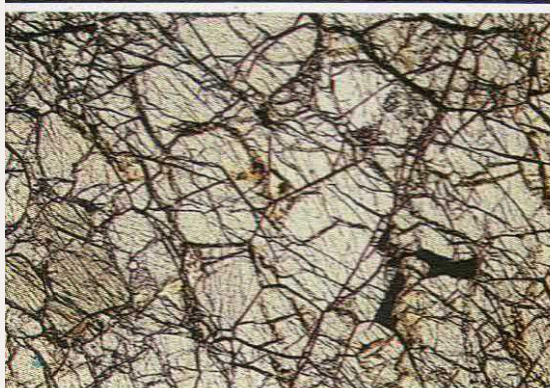
Specimen from gabbro picrite, Border Group, Skaergaard intrusion, East Greenland; magnification x23



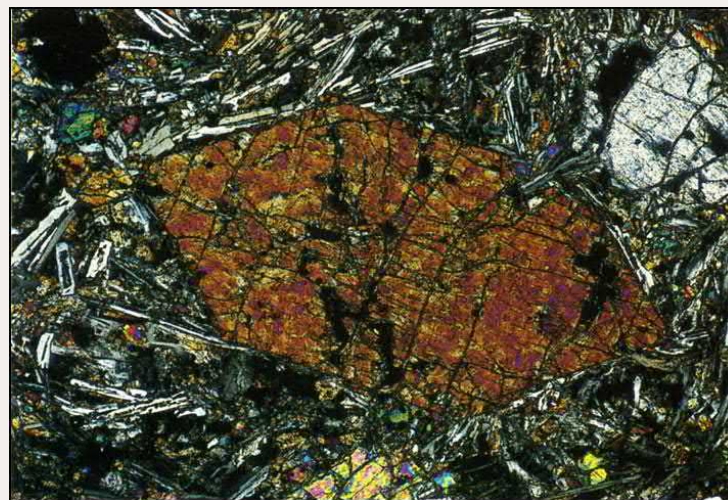
Specimen from ankaramite, Mauna Kea, Hawaii, magnification x43



Olivine



OLIVINE $(\text{Mg,Fe})_2\text{SiO}_4$
colorless, rarely pale yellow-green
m-vh 3 orth bi+/bi-
 $2V_x = 98-46^\circ$ w:r $\geq$ v par poor cl.+
(010) poor, fractures Z simp, rare
eu-subhedral, rounded, alters to
serpentine, chlorite, Fe-oxides; Mg-
rich memb. $2V > 72^\circ$; endmembers
forsterite (Mg) + fayalite (Fe) (X17)



Olivine basalt from Ubekendt Ejland, West Greenland;
magnification x40, XPL



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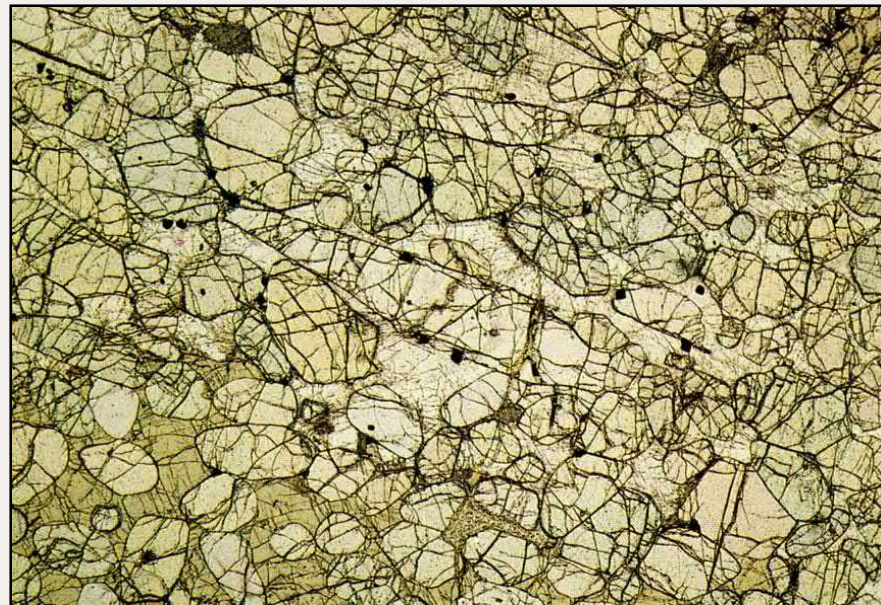
Peridotite





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Peridotite



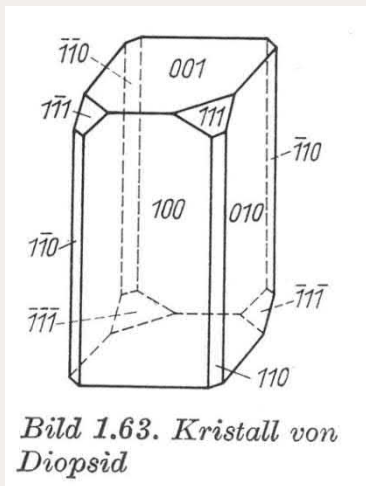
Peridotite from Rhum, Scotland; magnification x12, PPL and XPL



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Diopside

$\text{MgCaSi}_2\text{O}_6$





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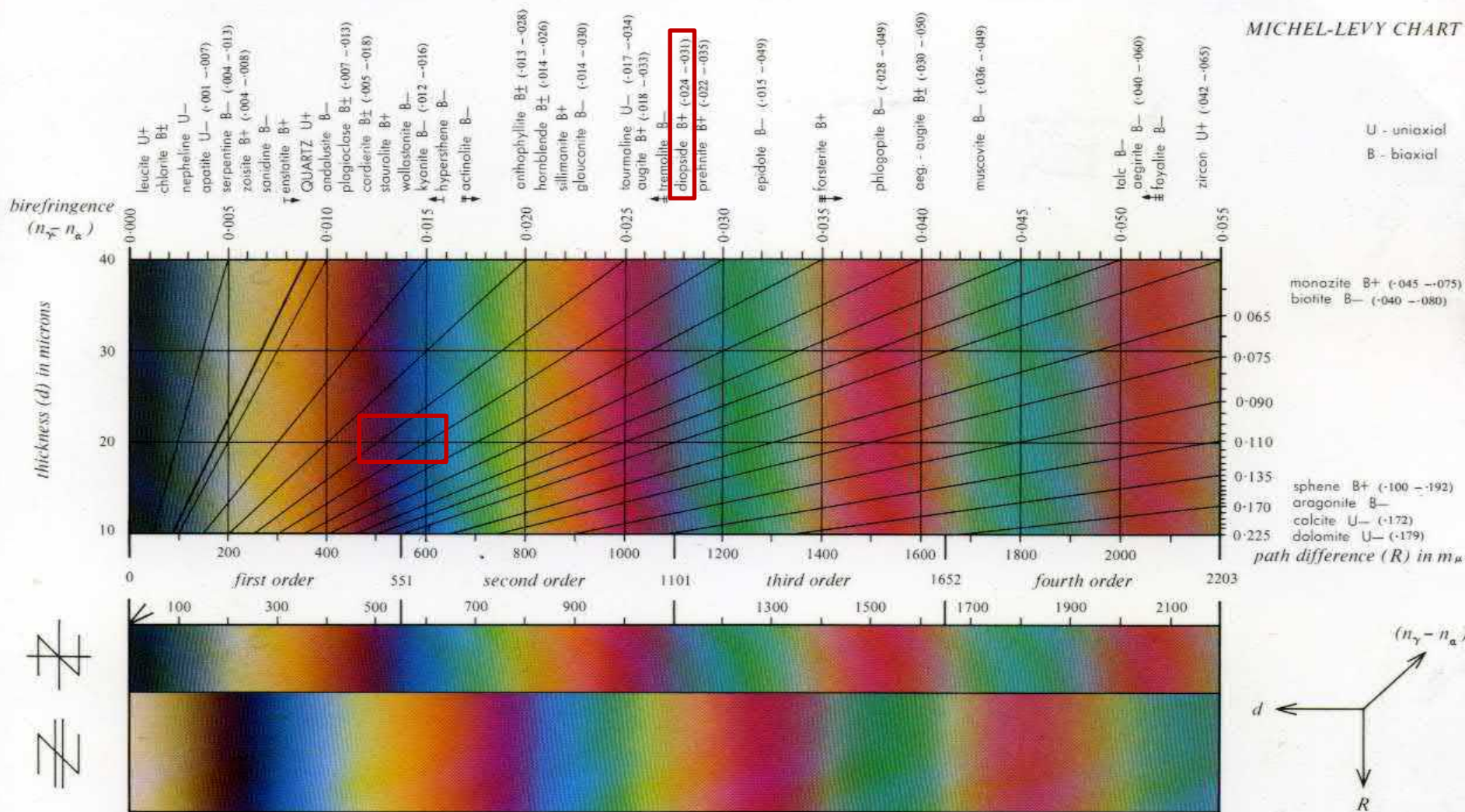
Diopside

First – second order



MICHEL-LEVY CHART

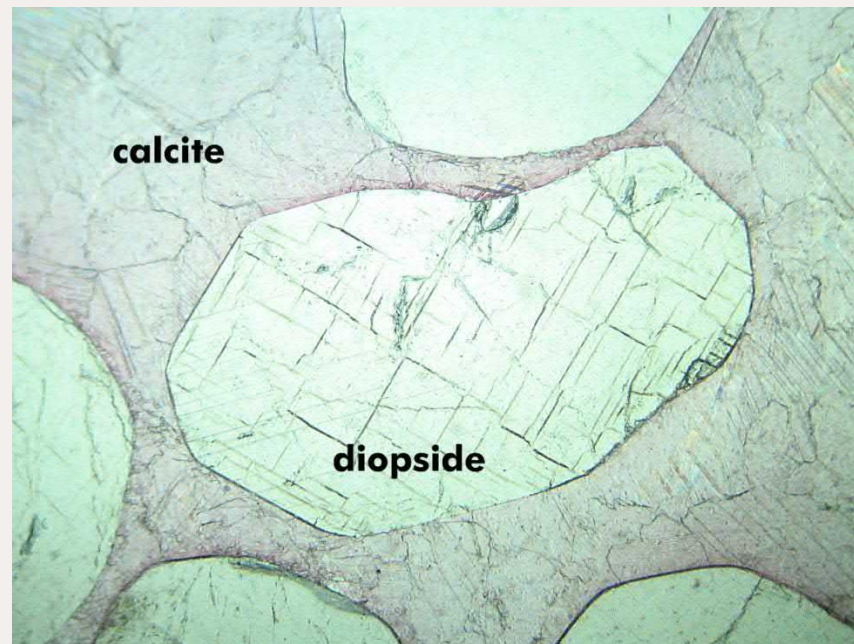
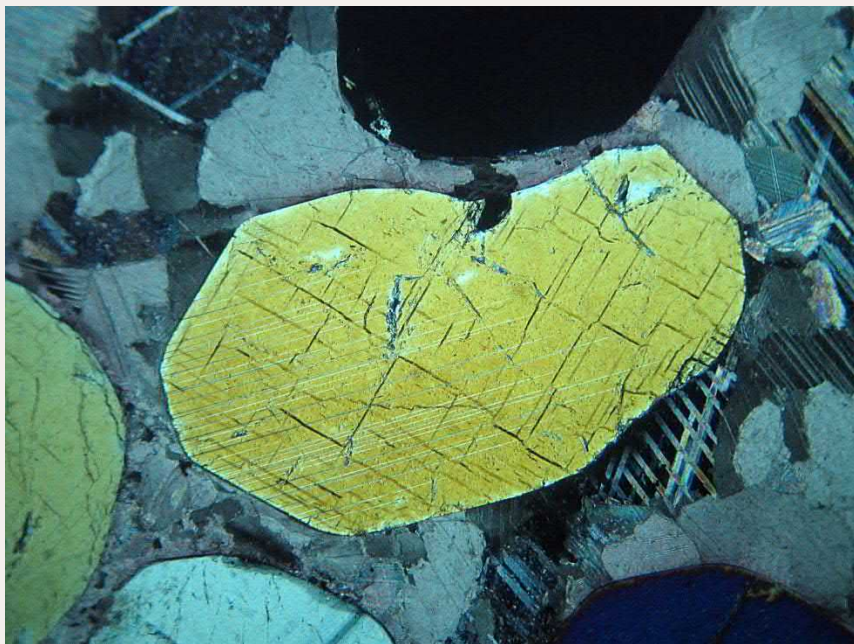
U - uniaxial
B - biaxial





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Diopside

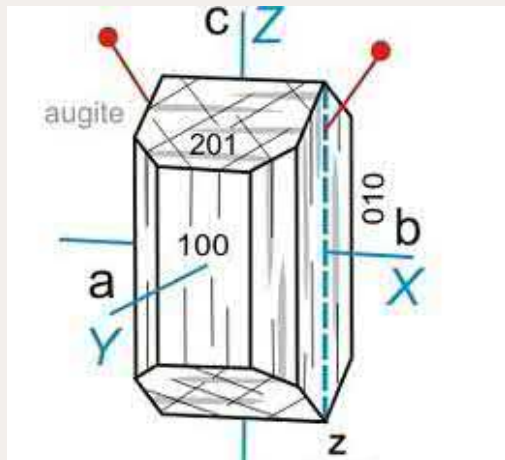


Diopside in a marble, Adirondack Mountains, New York



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Augite





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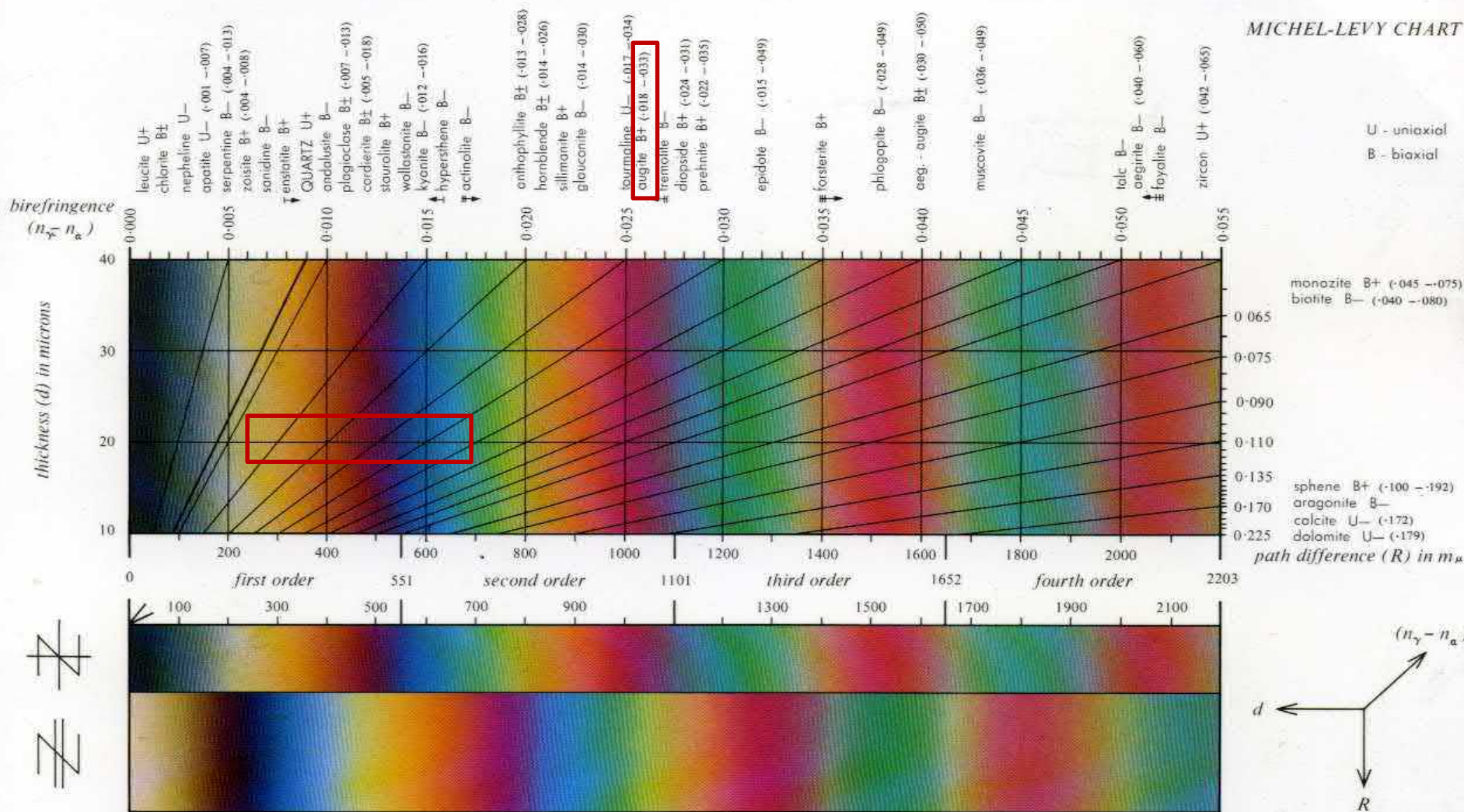
Augite

First – second order



MICHEL-LEVY CHART

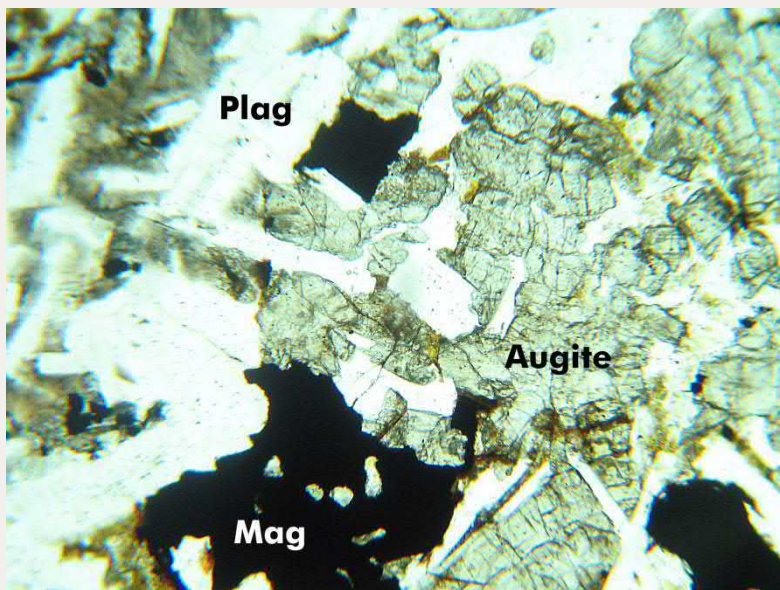
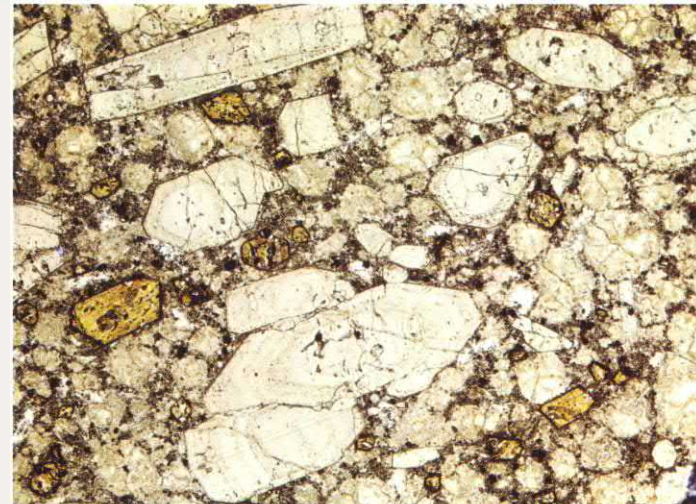
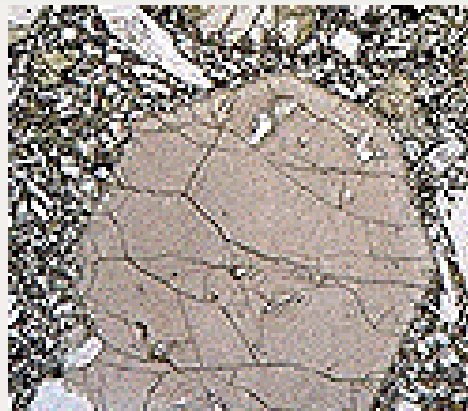
U - uniaxial
B - biaxial





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Augite





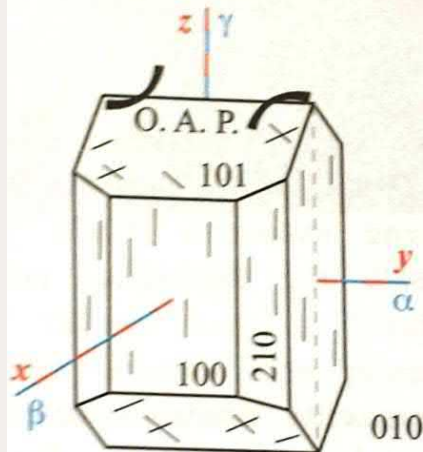
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Enstatite

MgSiO_3



Enstatite (+)



Enstatite
Burma



Enstatite Crystal





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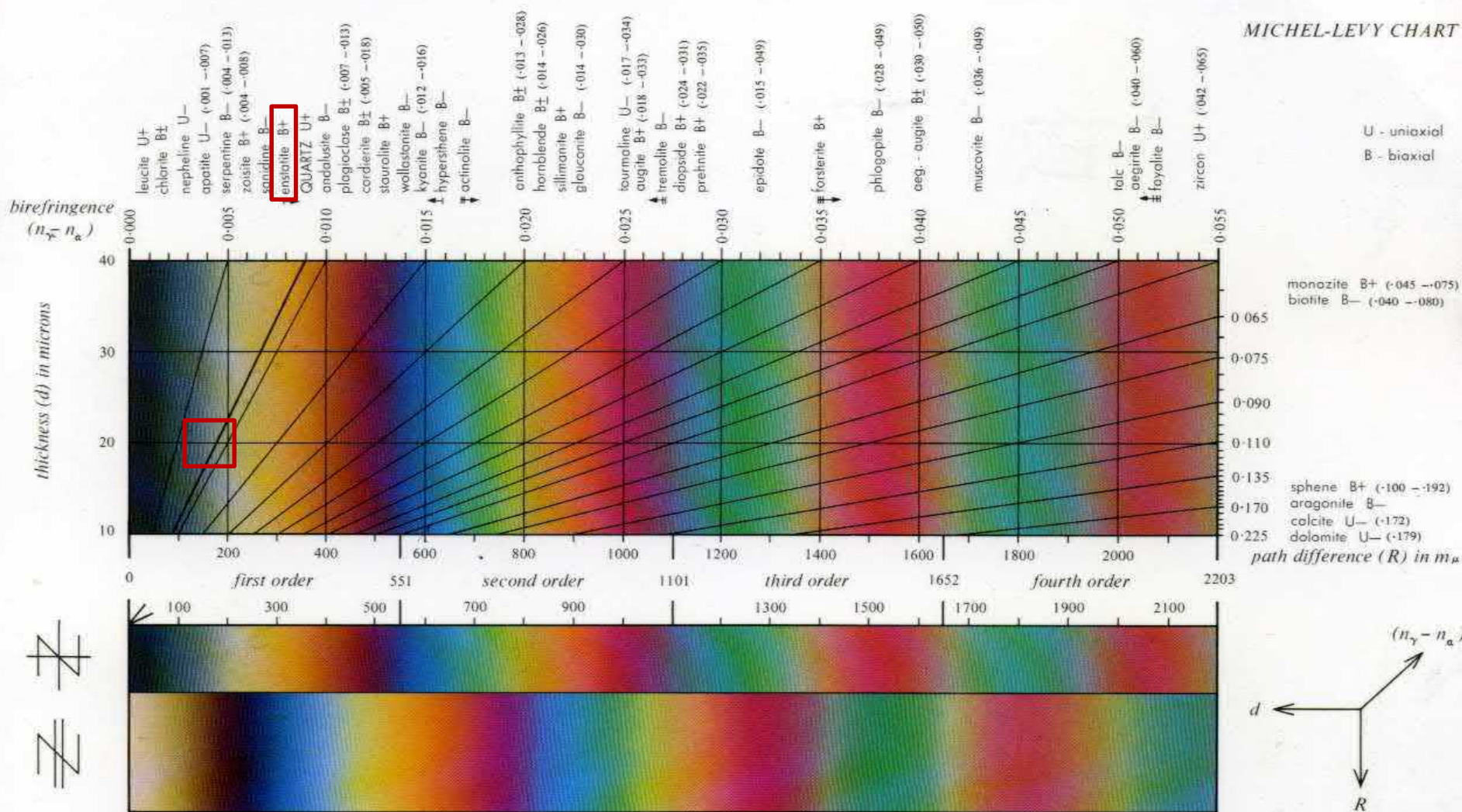
Enstatite

First order



MICHEL-LEVY CHART

U - uniaxial
B - biaxial





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Enstatite



Specimen from chondritic meteorite, near Fort Dauphin, Madagascar;
magnification x20





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Ferrosilite

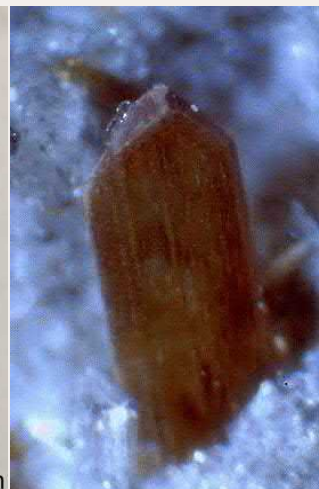
FeSiO_3



R070386



5 mm



R070386

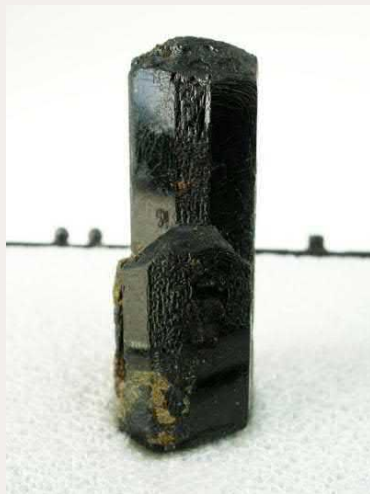
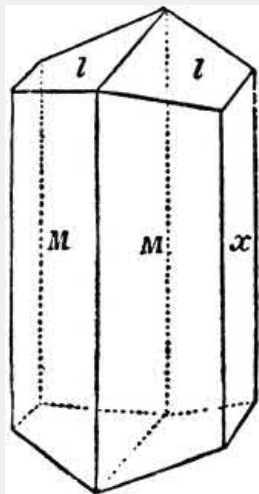
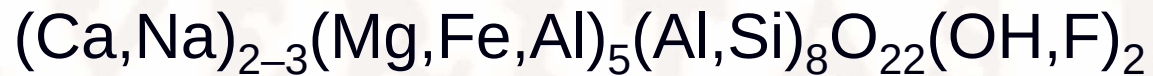
1 mm

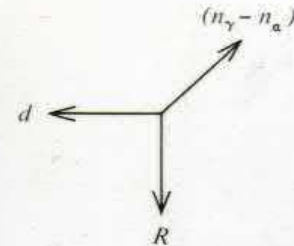
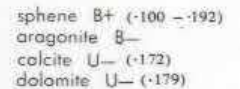
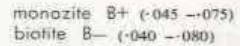
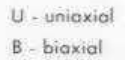




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Hornblende

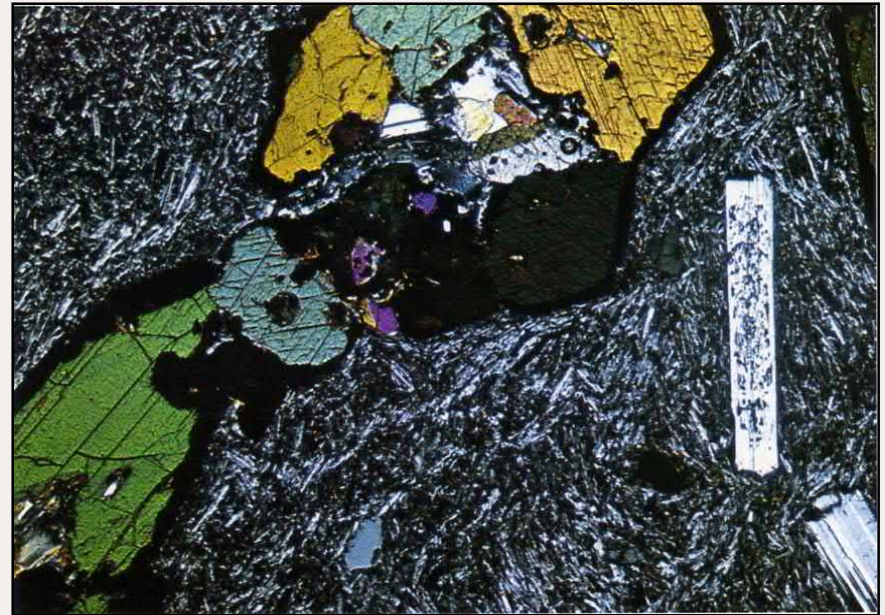
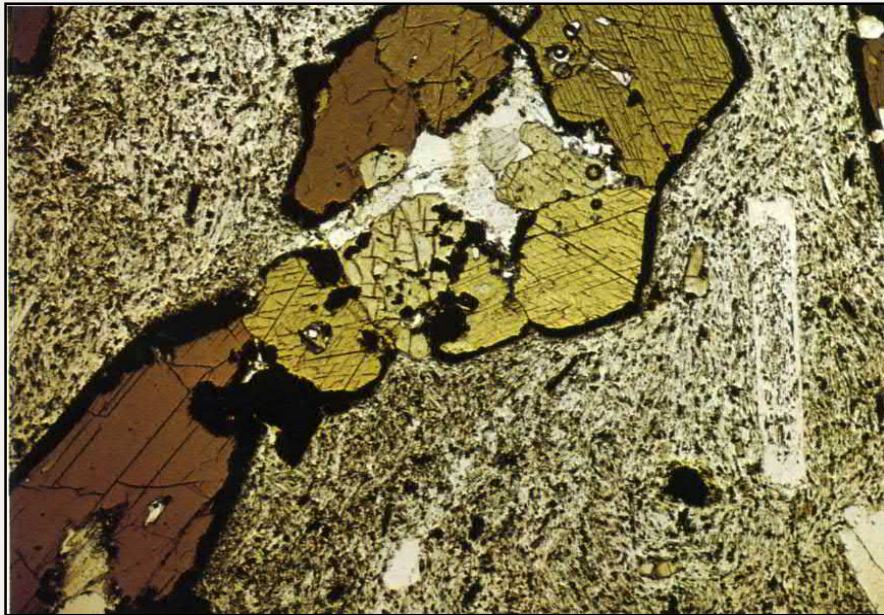




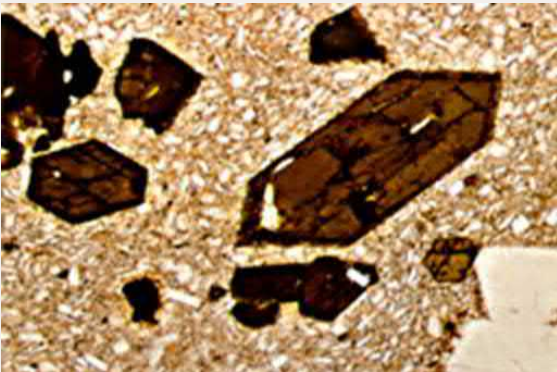


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Hornblende



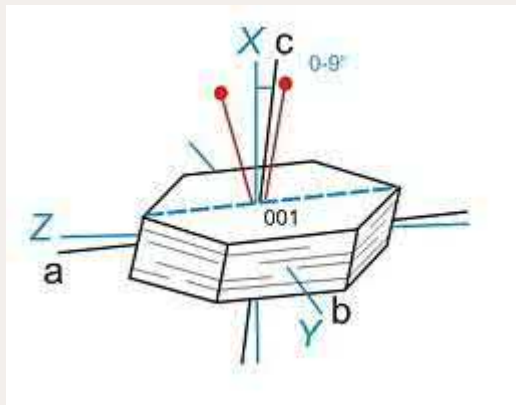
Specimen from tachryte, Lacqueille, Mt. Dore region, France;
magnification x32





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Biotite





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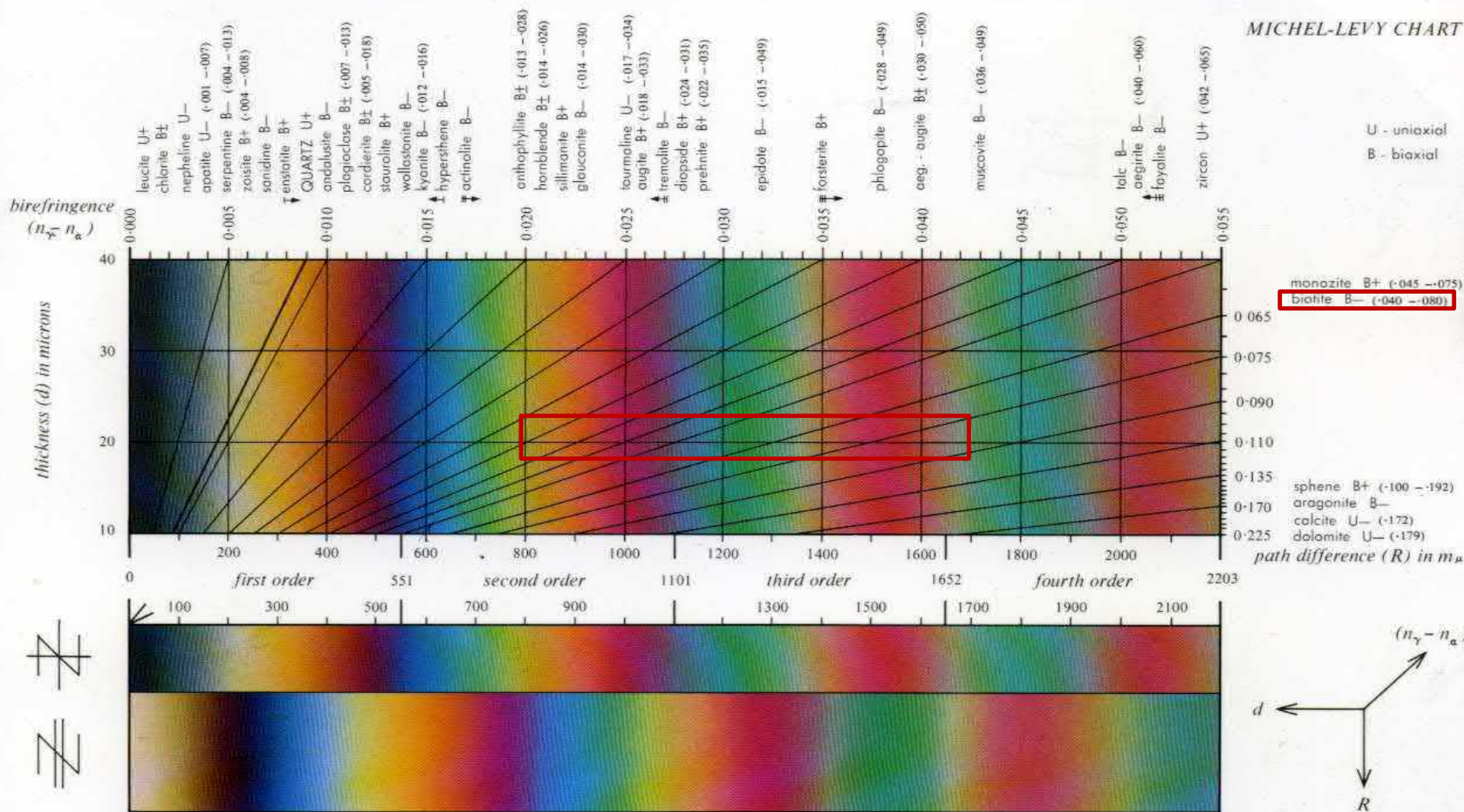
Biotite

Second to third order (4th)



MICHEL-LEVY CHART

U - uniaxial
B - biaxial





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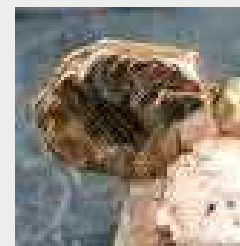
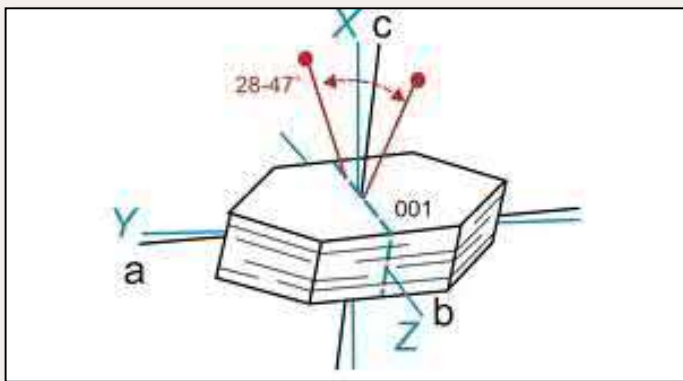
Biotite





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Muscovite

$$\text{KAl}_2(\text{AlSi}_3\text{O}_{10})(\text{OH})_2$$




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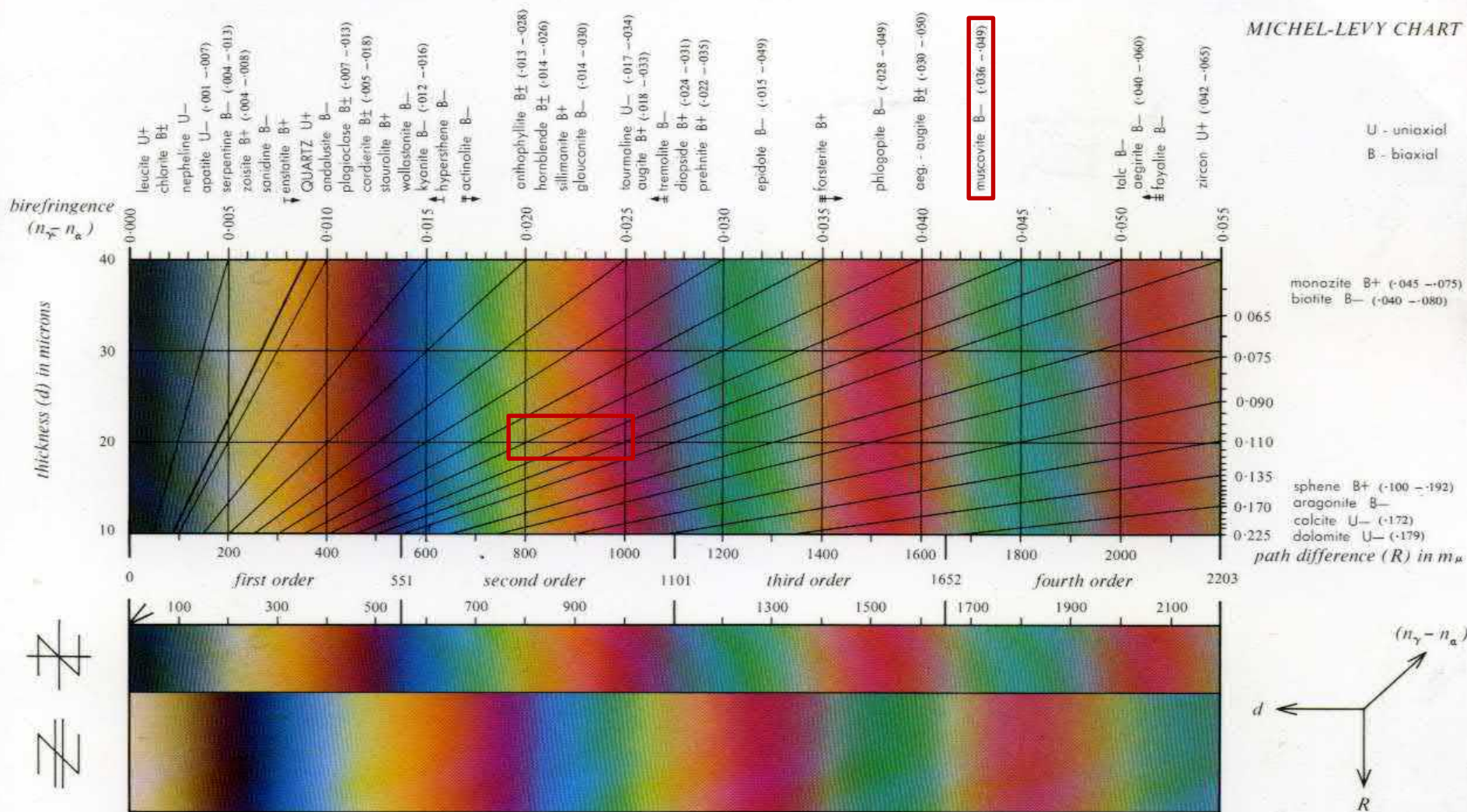
Muscovite

Second order



MICHEL-LEVY CHART

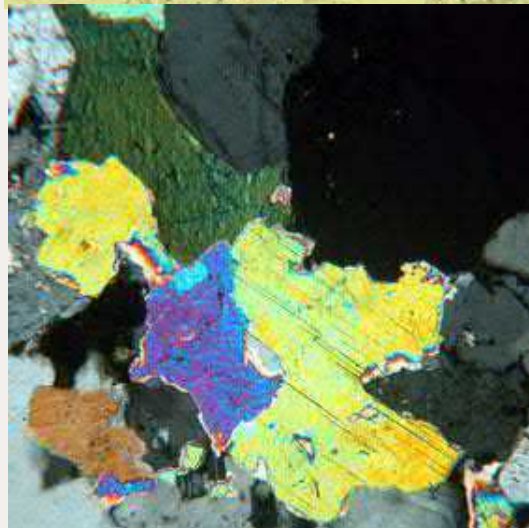
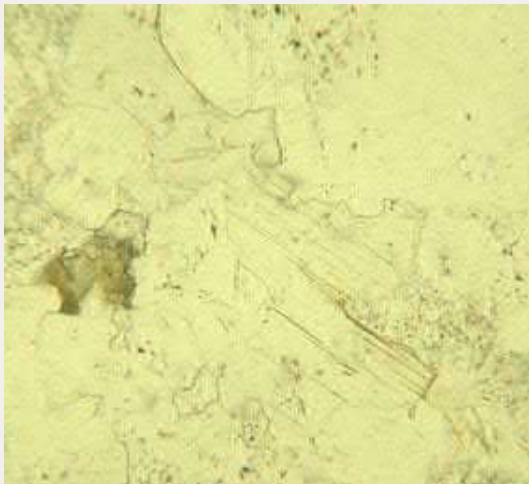
U - uniaxial
B - biaxial



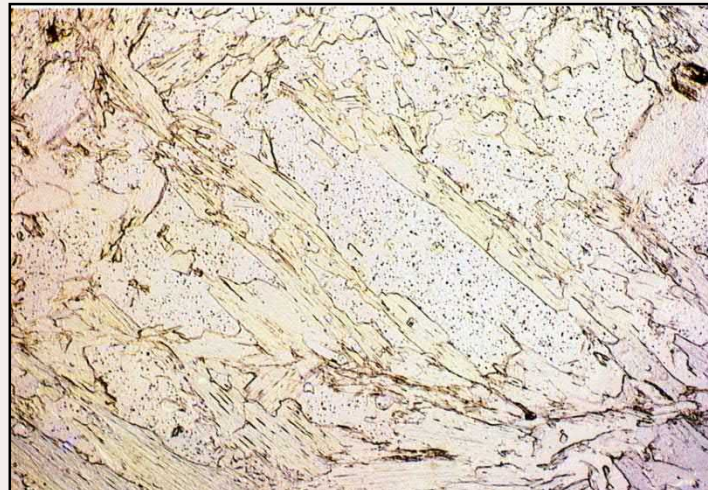


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Muscovite



Granite, Megilligar Rocks,
Cornwall, England



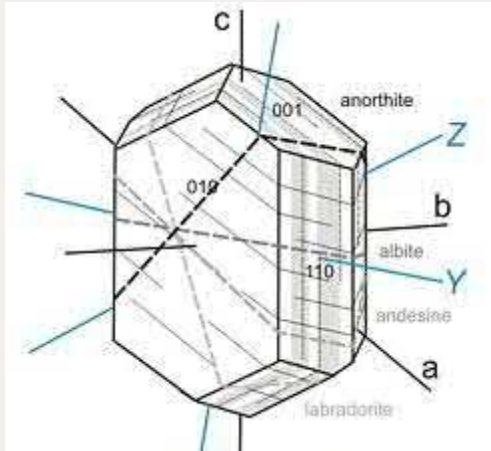
Specimen from kyanite schist, Hamma of Snarravae,
Unst, Shetland, Scotland



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Plagioclase

$\text{NaAlSi}_3\text{O}_8 - \text{CaAl}_2\text{Si}_2\text{O}_8$





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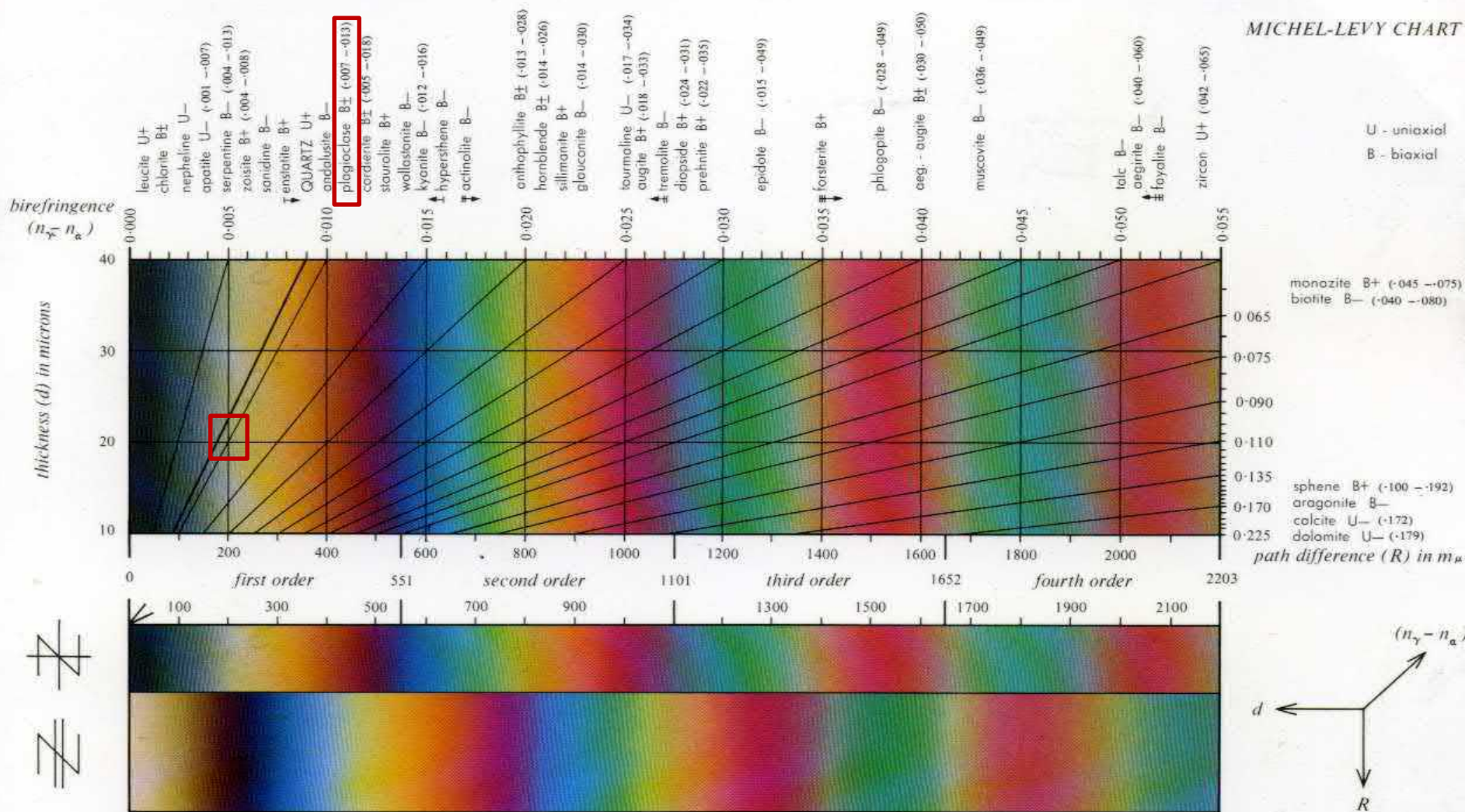
Plagioclase

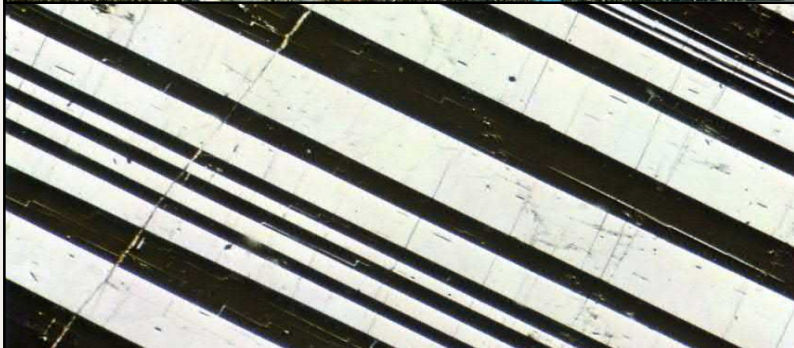
Gray to yellow - First order



MICHEL-LEVY CHART

U - uniaxial
B - biaxial



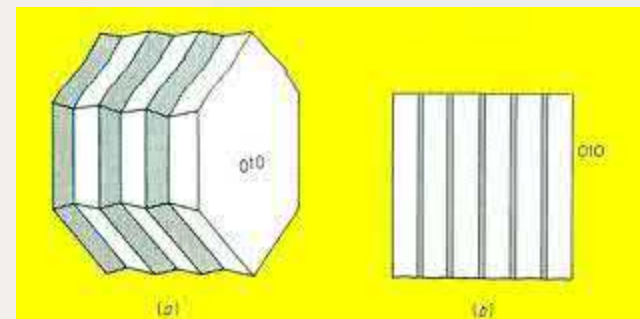
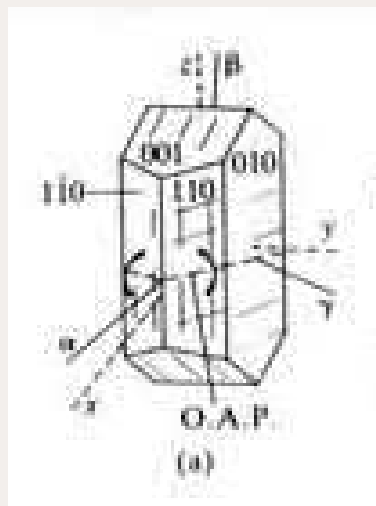




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Albite

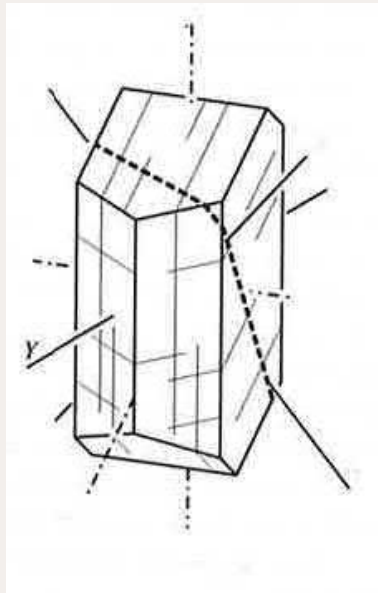
$\text{Na}(\text{AlSi}_3\text{O}_8)$





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Anorthite

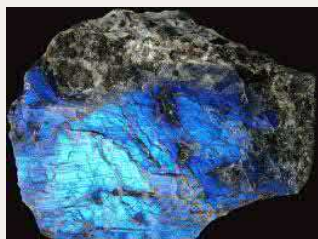
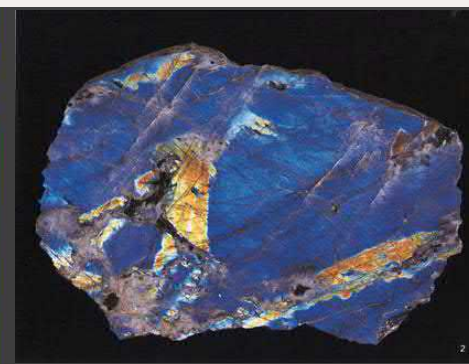
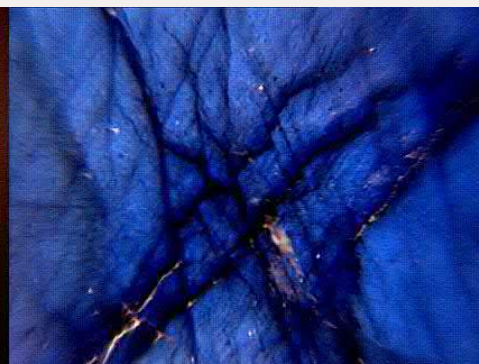
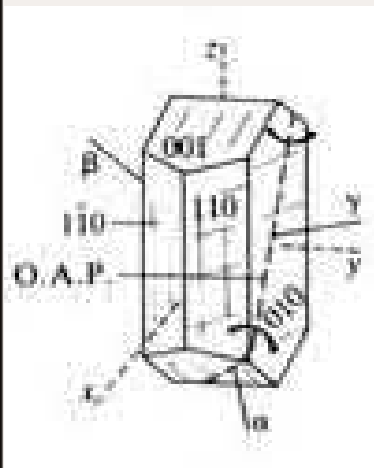
$$\text{CaAl}_2\text{Si}_2\text{O}_8$$




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Labradorite

$(\text{Na}, \text{Ca}) [\text{Al}_{1-2}\text{Si}_{3-2}\text{O}_8]$

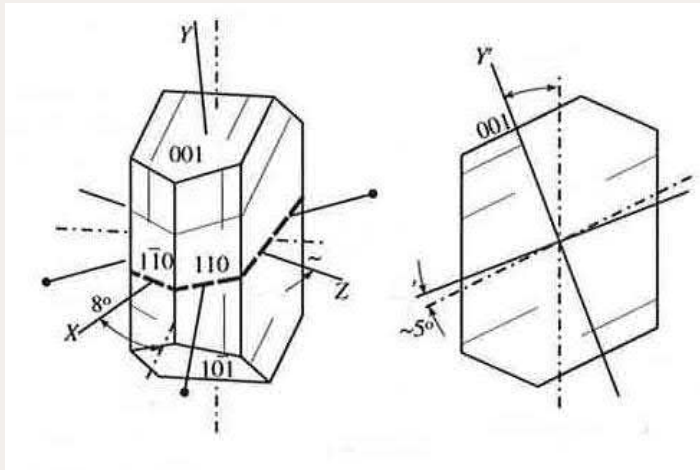




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Microcline

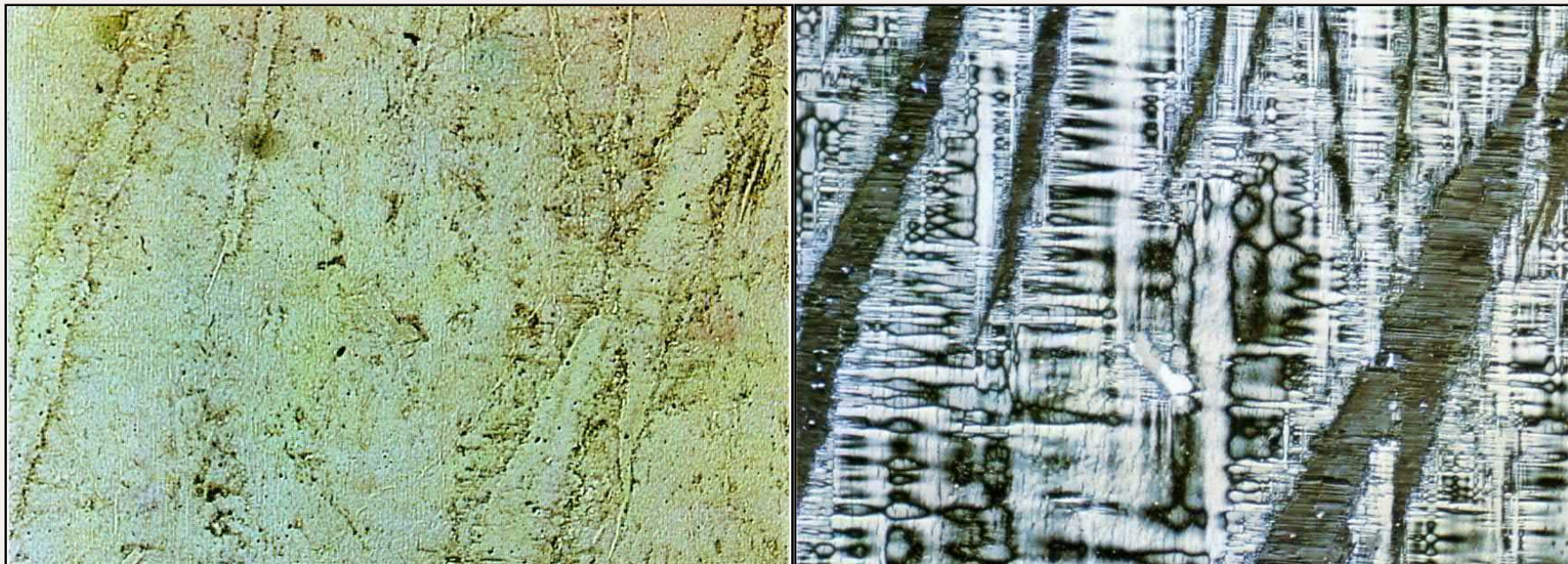
KAlSi_3O_8





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Microcline



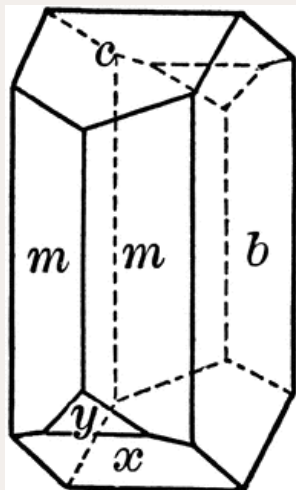
Specimen from pegmatite, Diamond Mine, Topsham,
Maine, USA, magnification x43



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Orthoclase

KAlSi_3O_8





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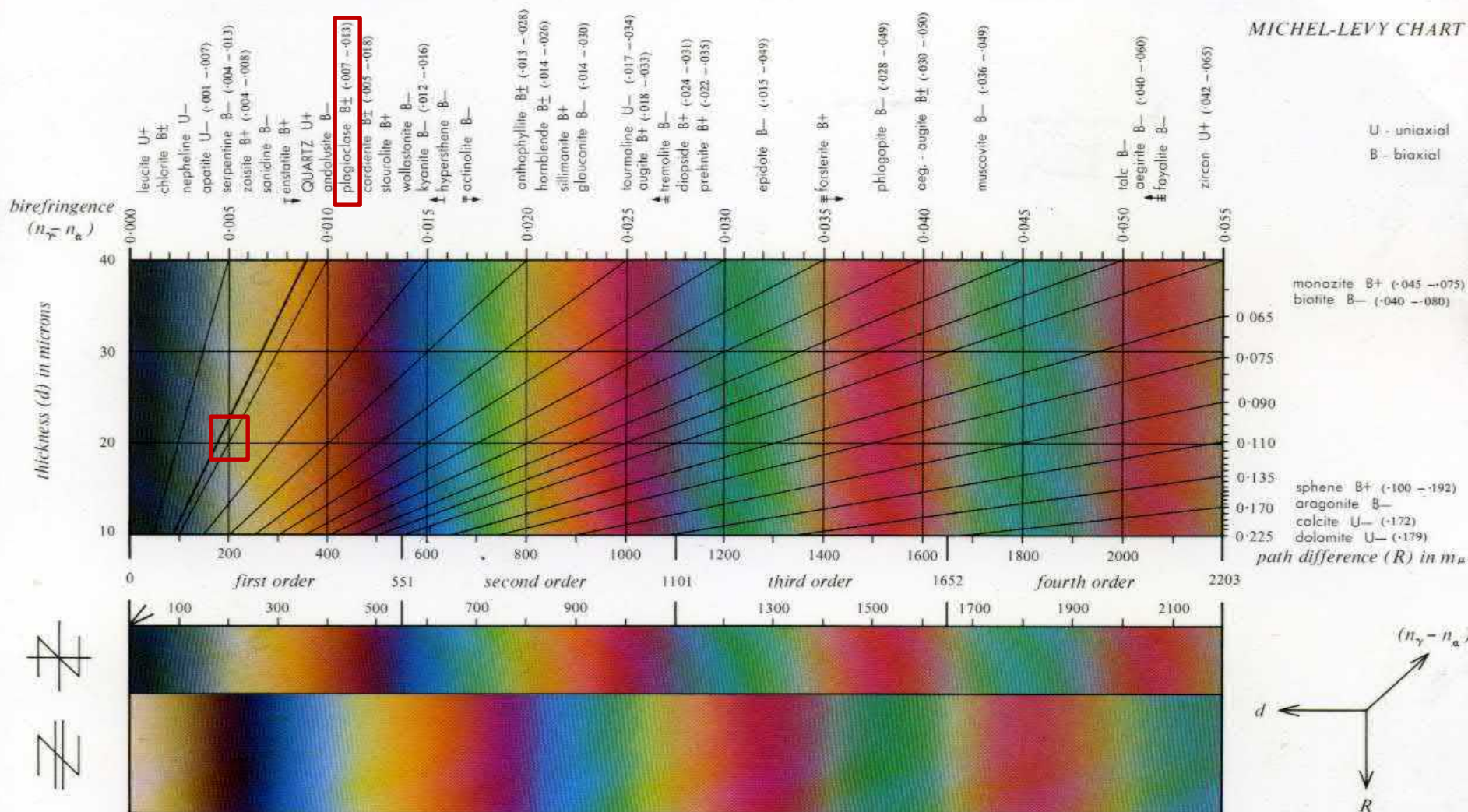
Orthoclase

Gray to yellow - First order



MICHEL-LEVY CHART

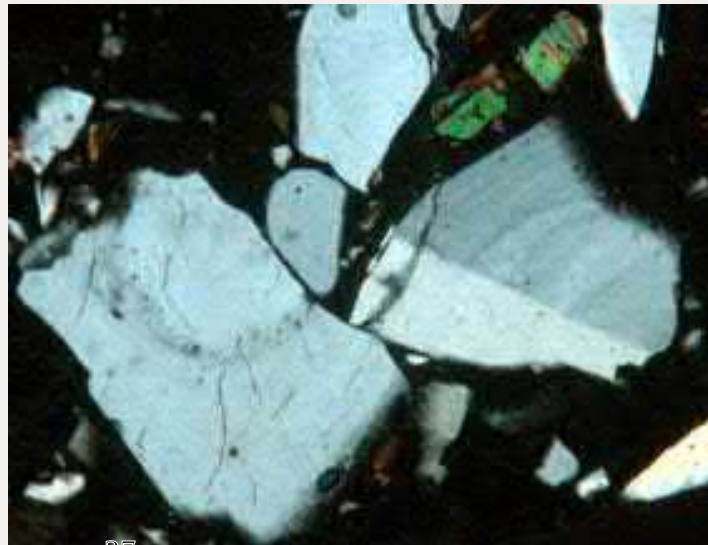
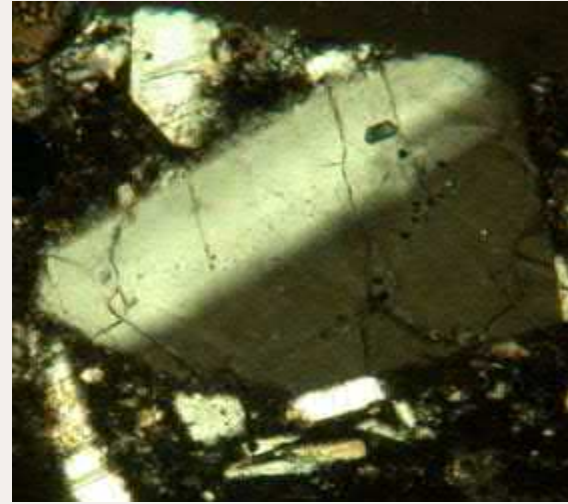
U - uniaxial
B - biaxial





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Orthoclase

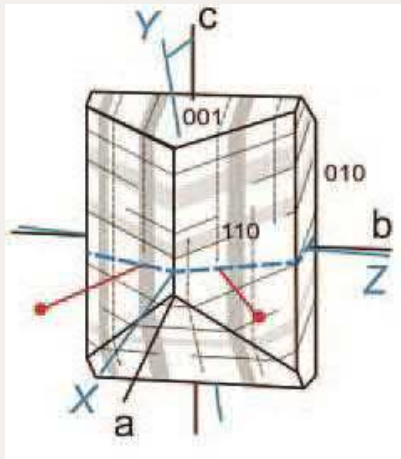




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Anorthoclase

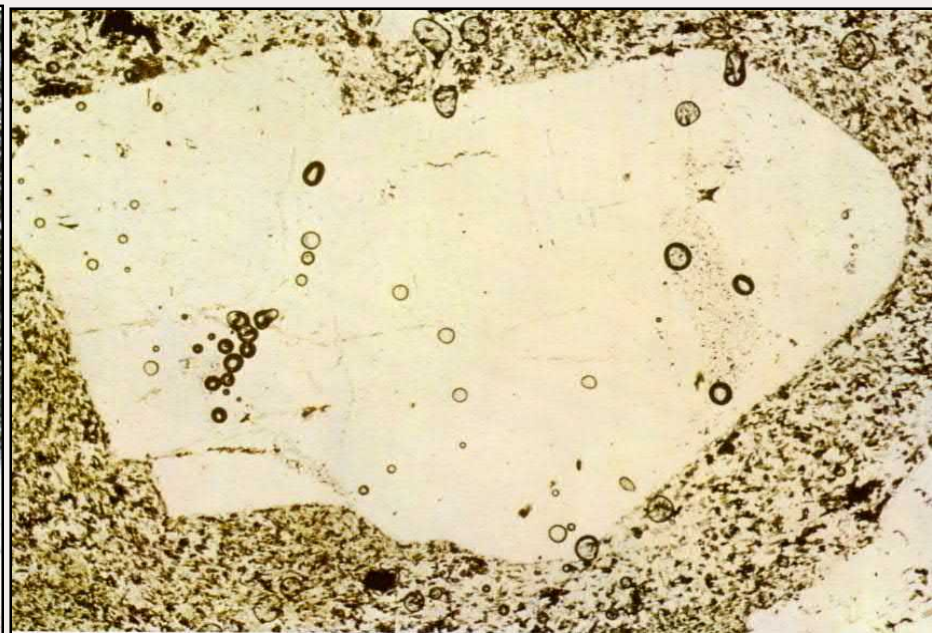
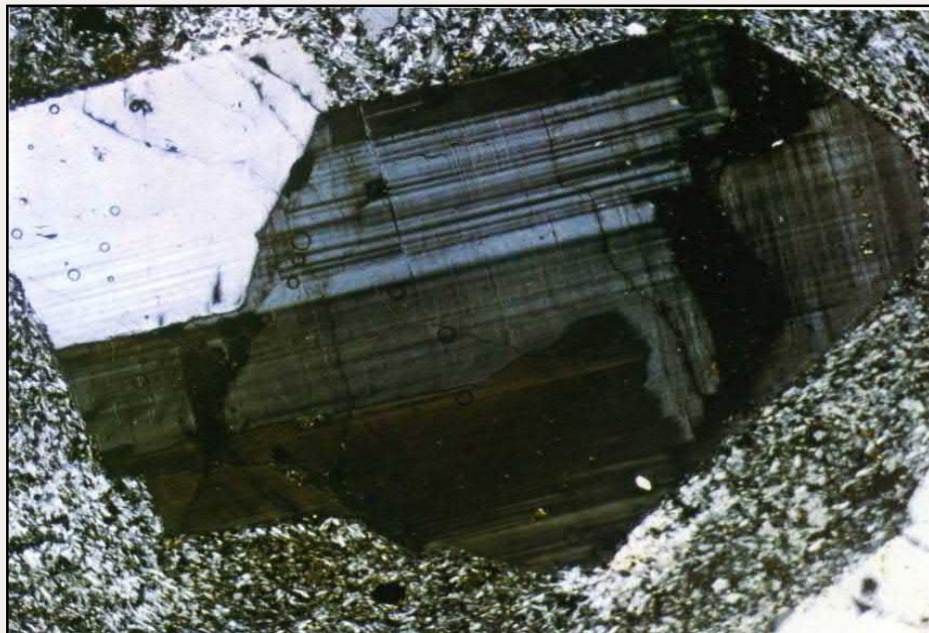
$(K,Na)AlSi_3O_8$





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Anorthoclase



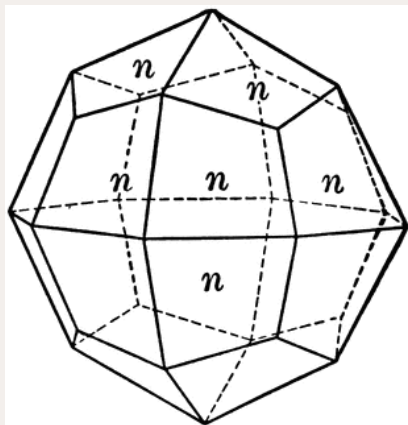
Specimen from pantellerite, Pantelleria, Italy; magnification x37



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Leucite

KAlSi_2O_6





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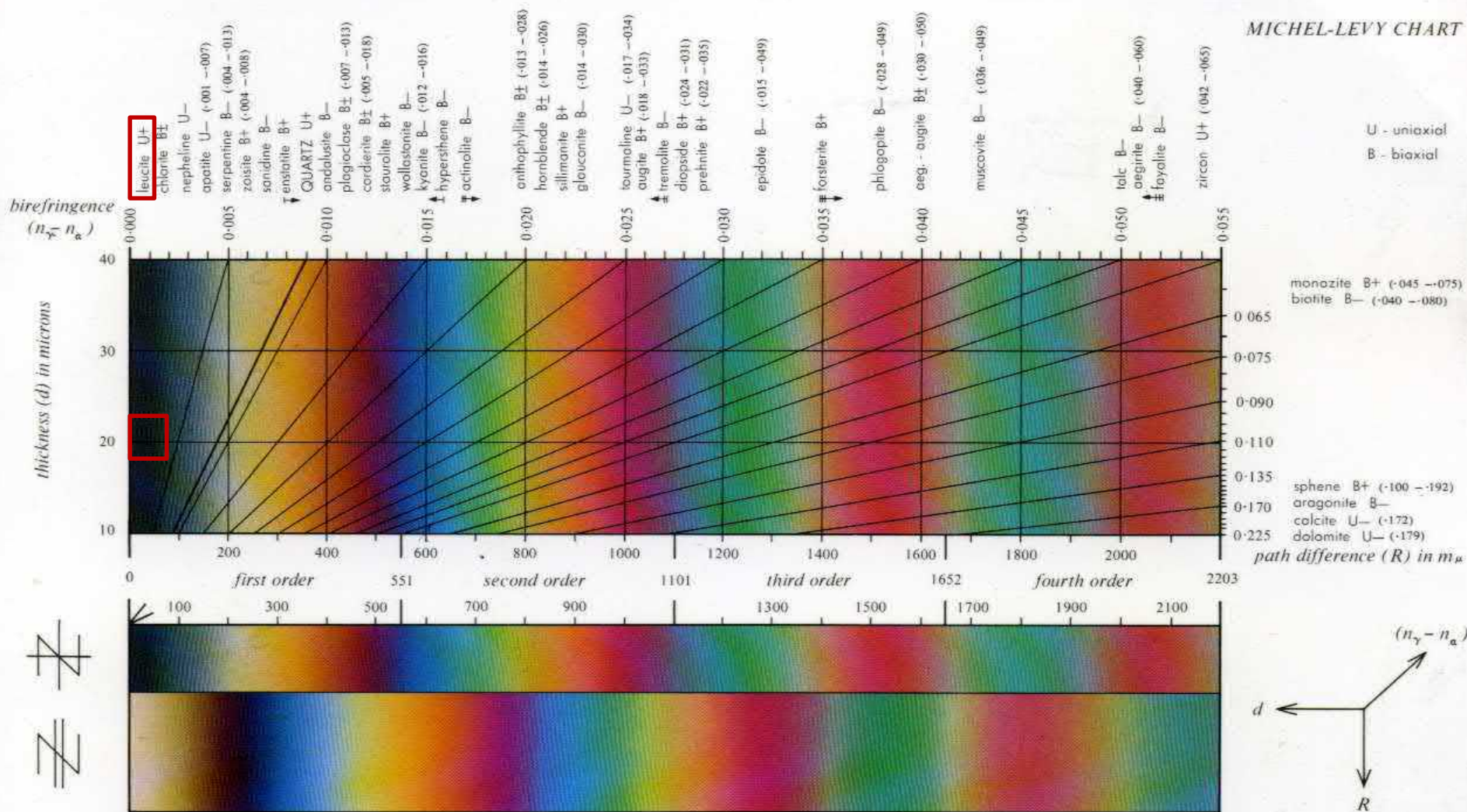
Leucite

Grey to black - First order



MICHEL-LEVY CHART

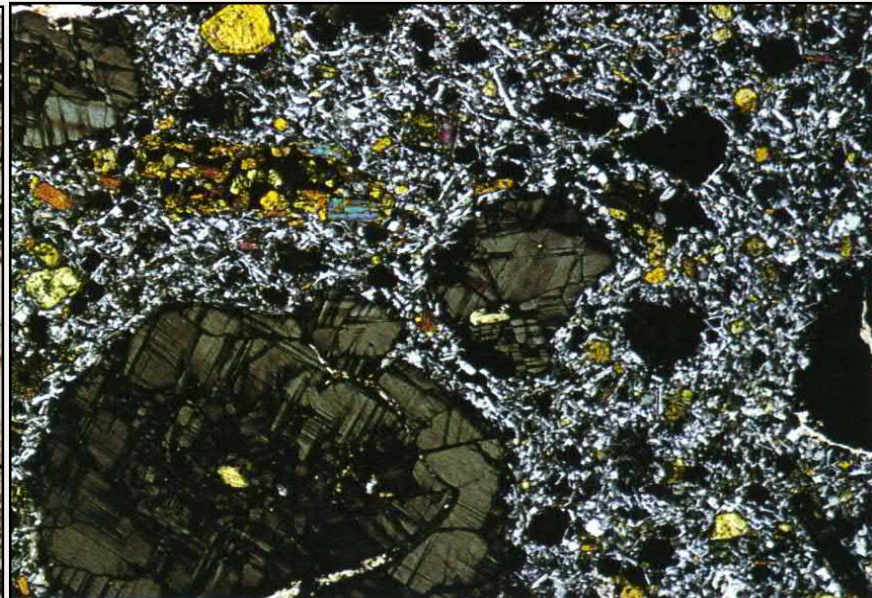
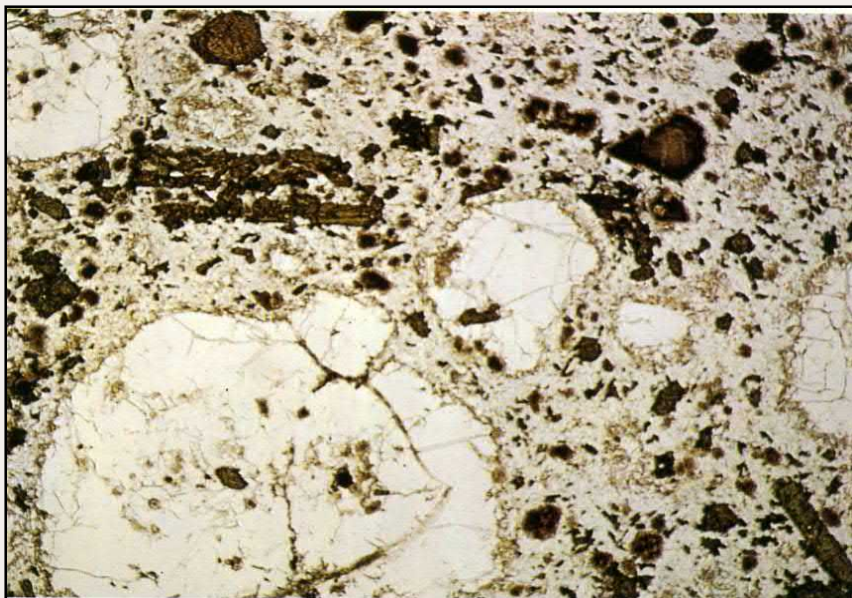
U - uniaxial
B - biaxial





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Leucite

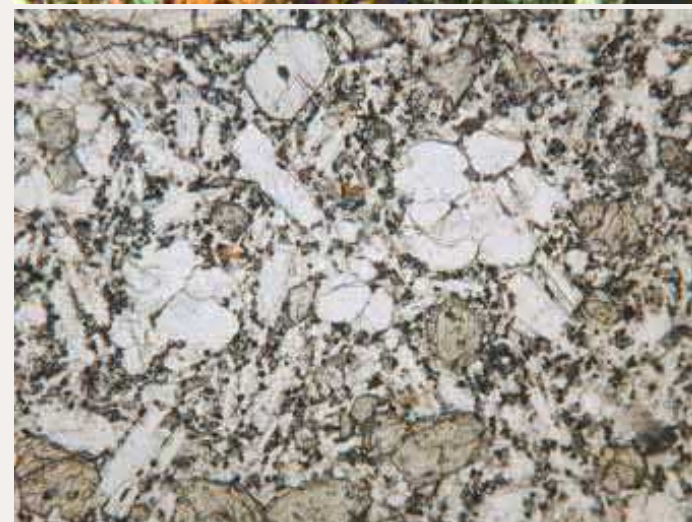
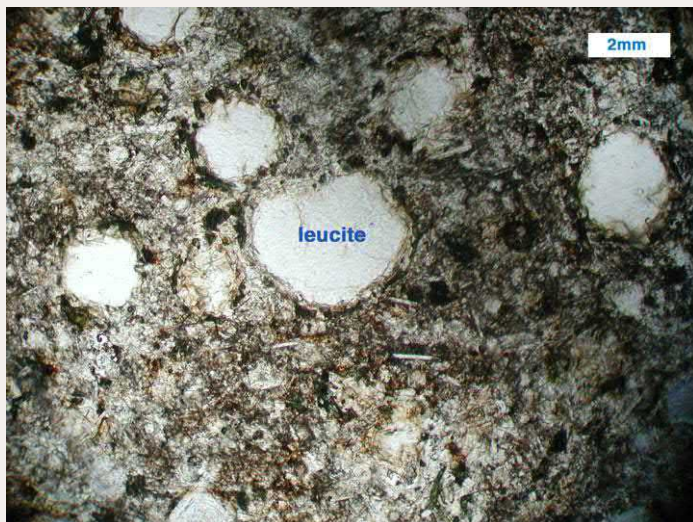
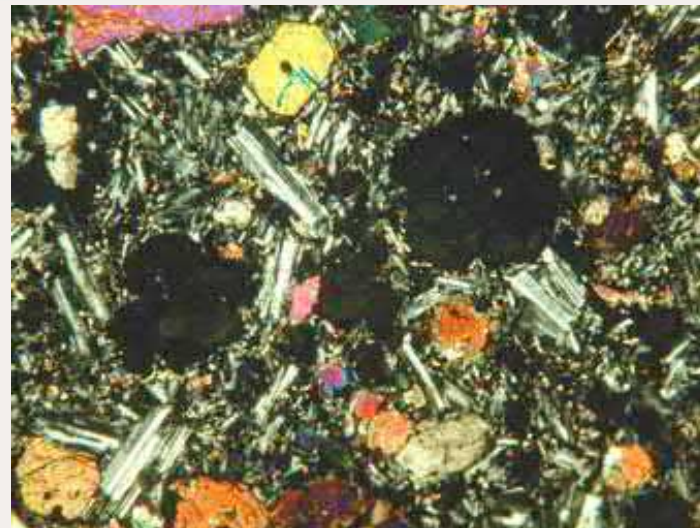
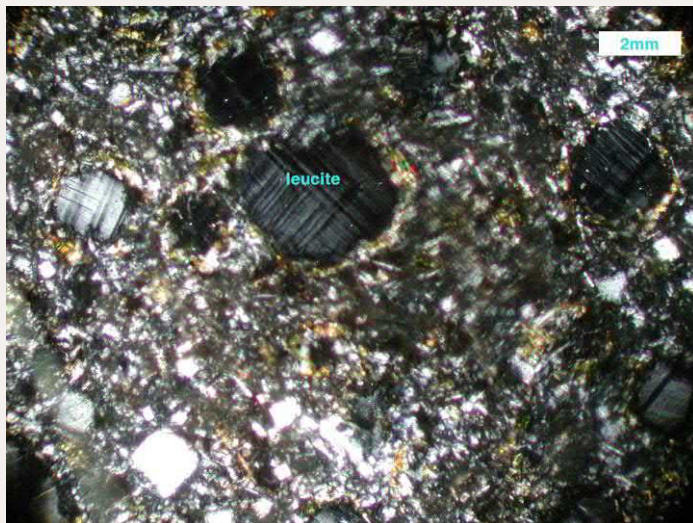


Specimen from leucitophyre, Reiden, Eifel, Germany;
magnification x20



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Leucite

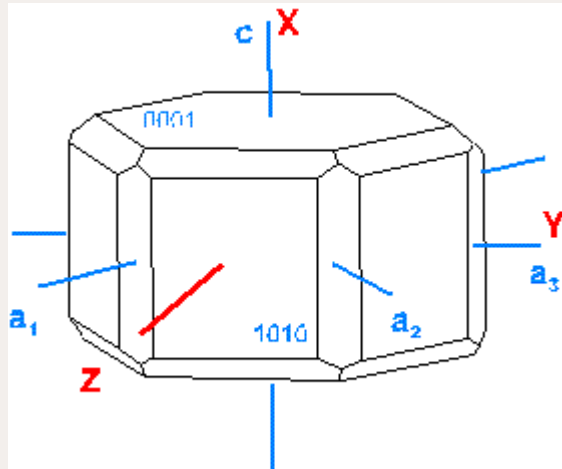




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Nepheline

$(\text{Na,K})\text{AlSiO}_4$





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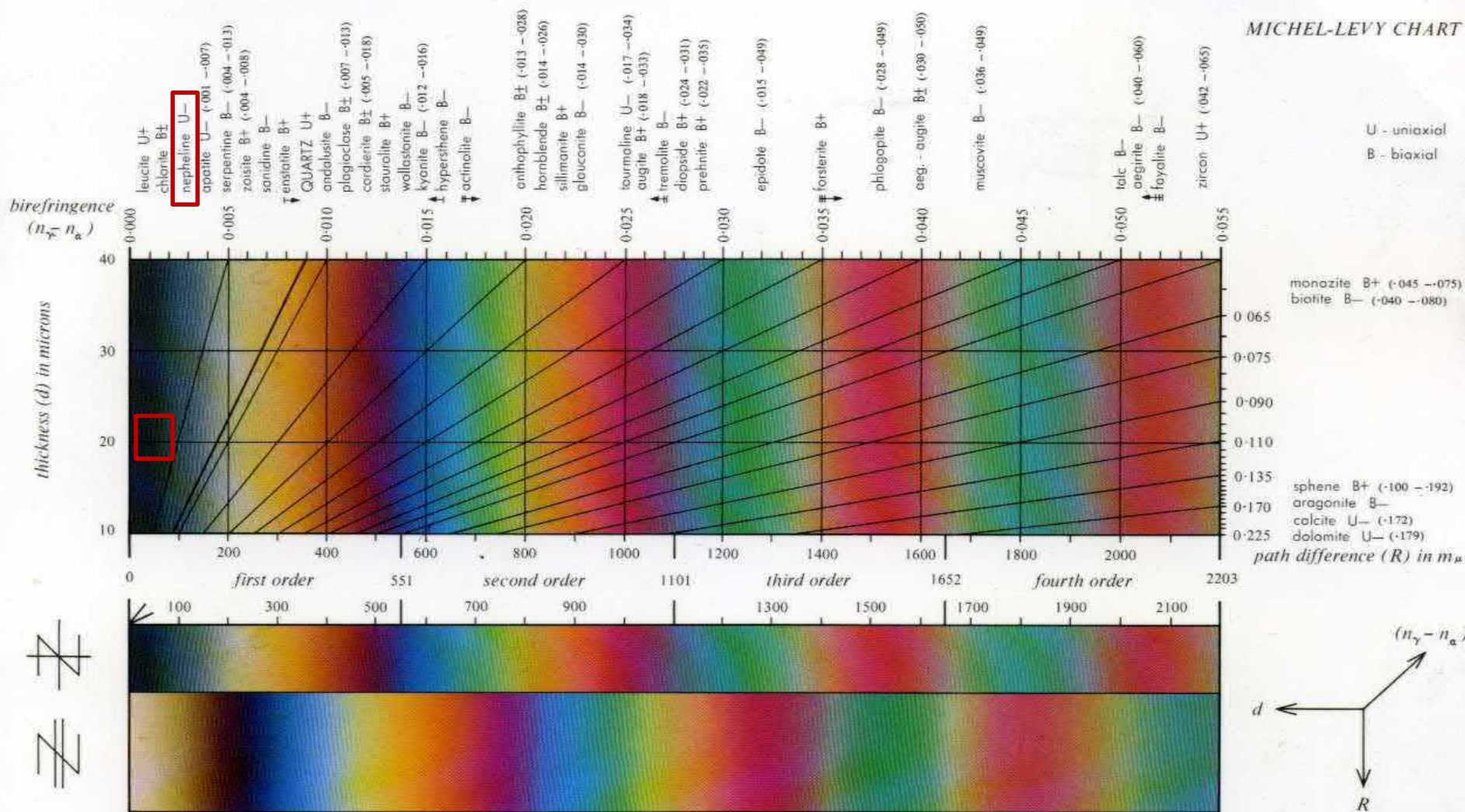
Nepheline

First order



MICHEL-LEVY CHART

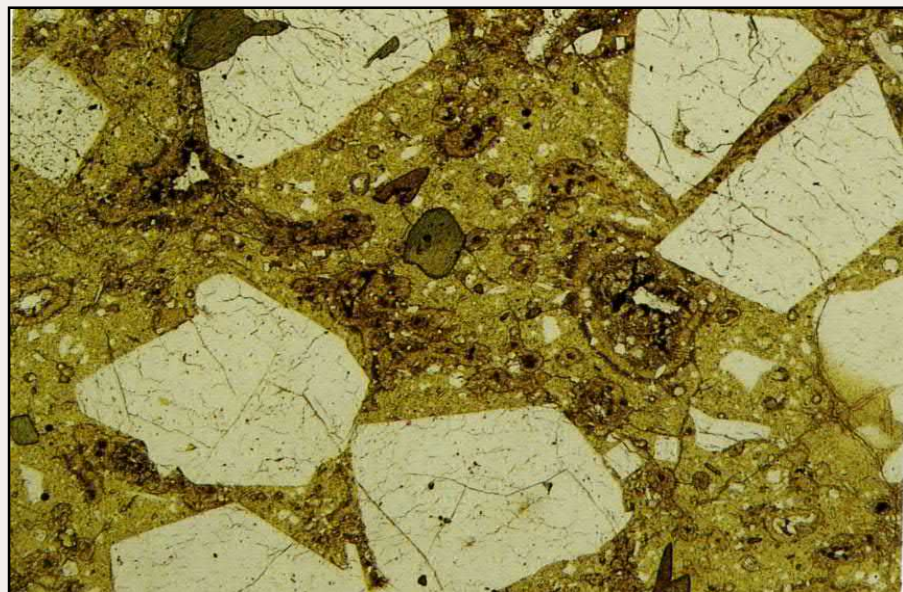
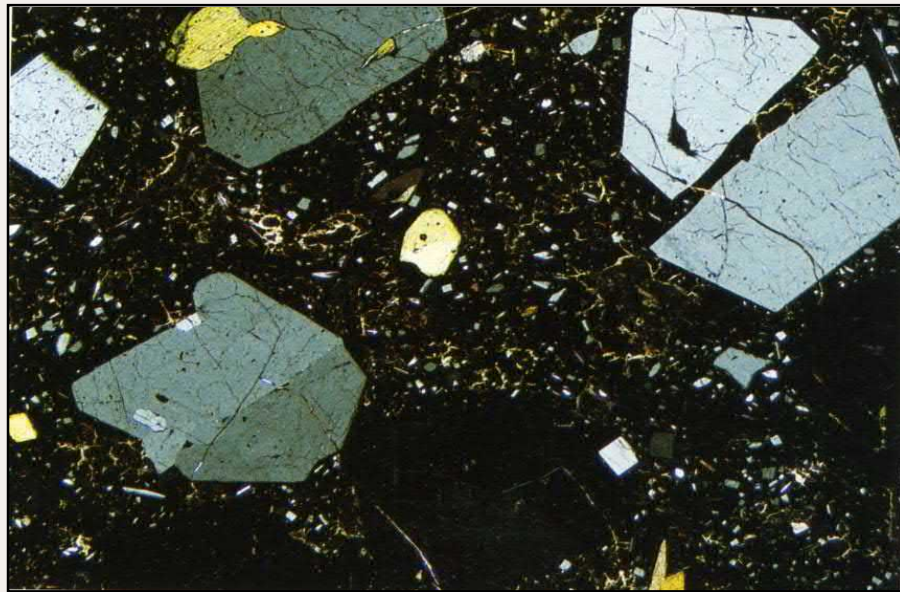
U - uniaxial
B - biaxial





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Nepheline



Specimen from phonolite, ejected block, Oldoinyo Lengai,
Tanzania; magnification x20





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Quartz

SiO_2

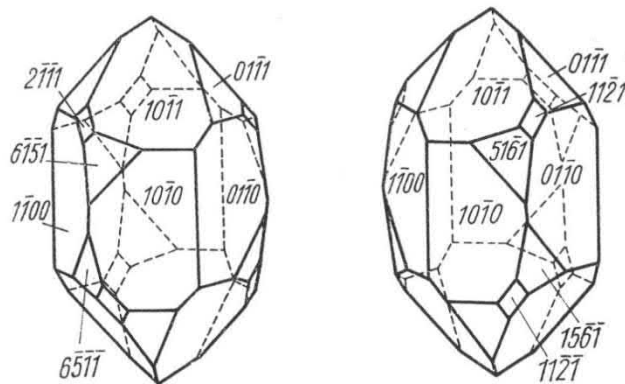


Bild 1.90. Kristall von Quarz (Tiefquarz)
Links- und Rechtsform





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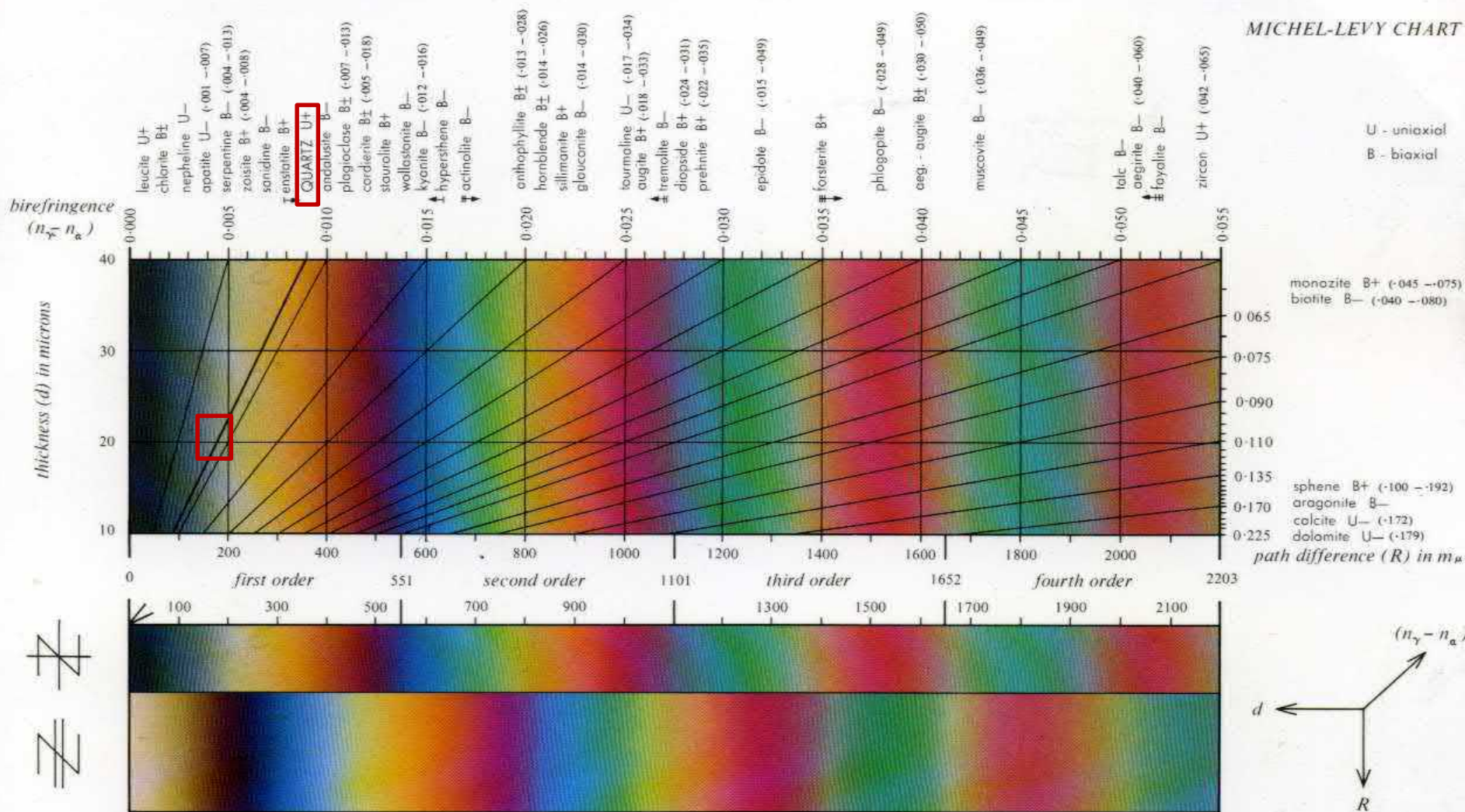
Quartz

Gray – first order



MICHEL-LEVY CHART

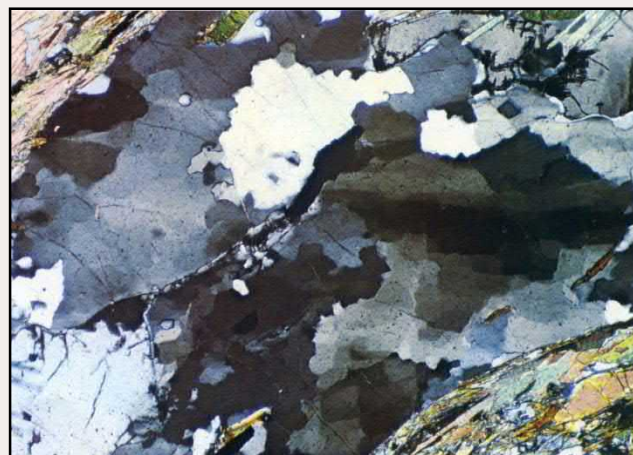
U - uniaxial
B - biaxial





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Quartz



Specimen from quartz porphyry, Dundubh,
Isle of Arran, Scotland, magnification x21

Specimen from cordierite-sillimanite gneiss, 11 km south of Ihosy,
Madagascar, magnification x43



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Obsidian

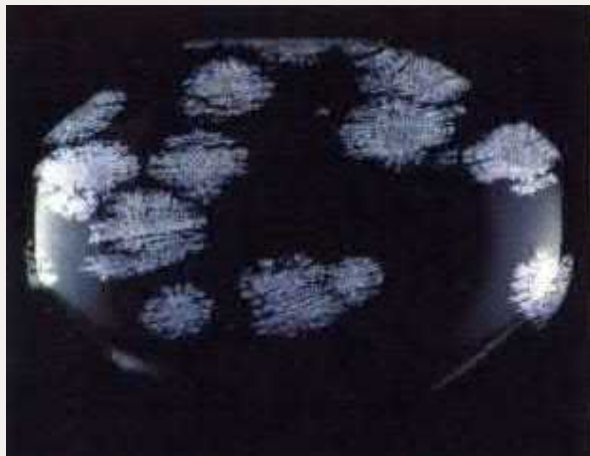
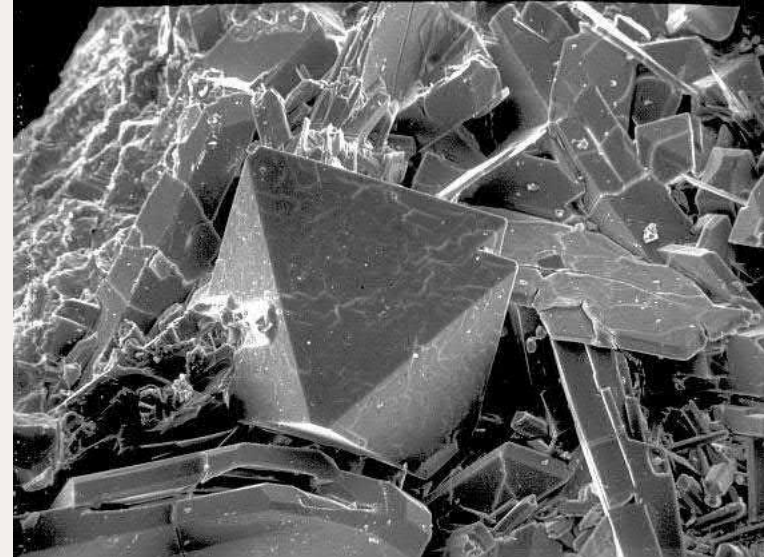
70 – 75 % SiO_2 + MgO , Fe_3O_4





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Snowflake obsidian (Obsidian + Cristobalite)





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Beryl

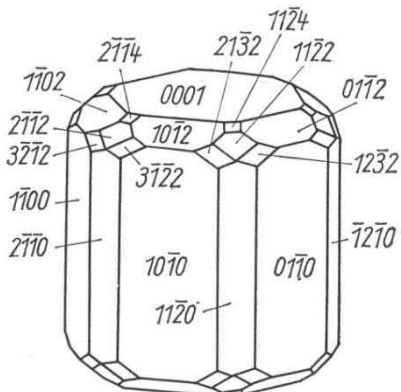
$$\text{Be}_3\text{Al}_2(\text{SiO}_3)_6$$


Bild 1.106. Kristall von Beryll



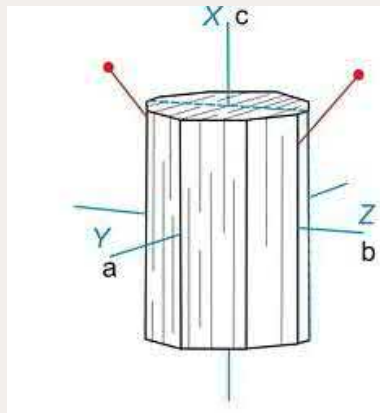
Morganite, Aquamarine and
Heliodor (3 varieties)



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Cordierite

$(\text{Mg,Fe})_2\text{Al}_4\text{Si}_5\text{O}_{18}$





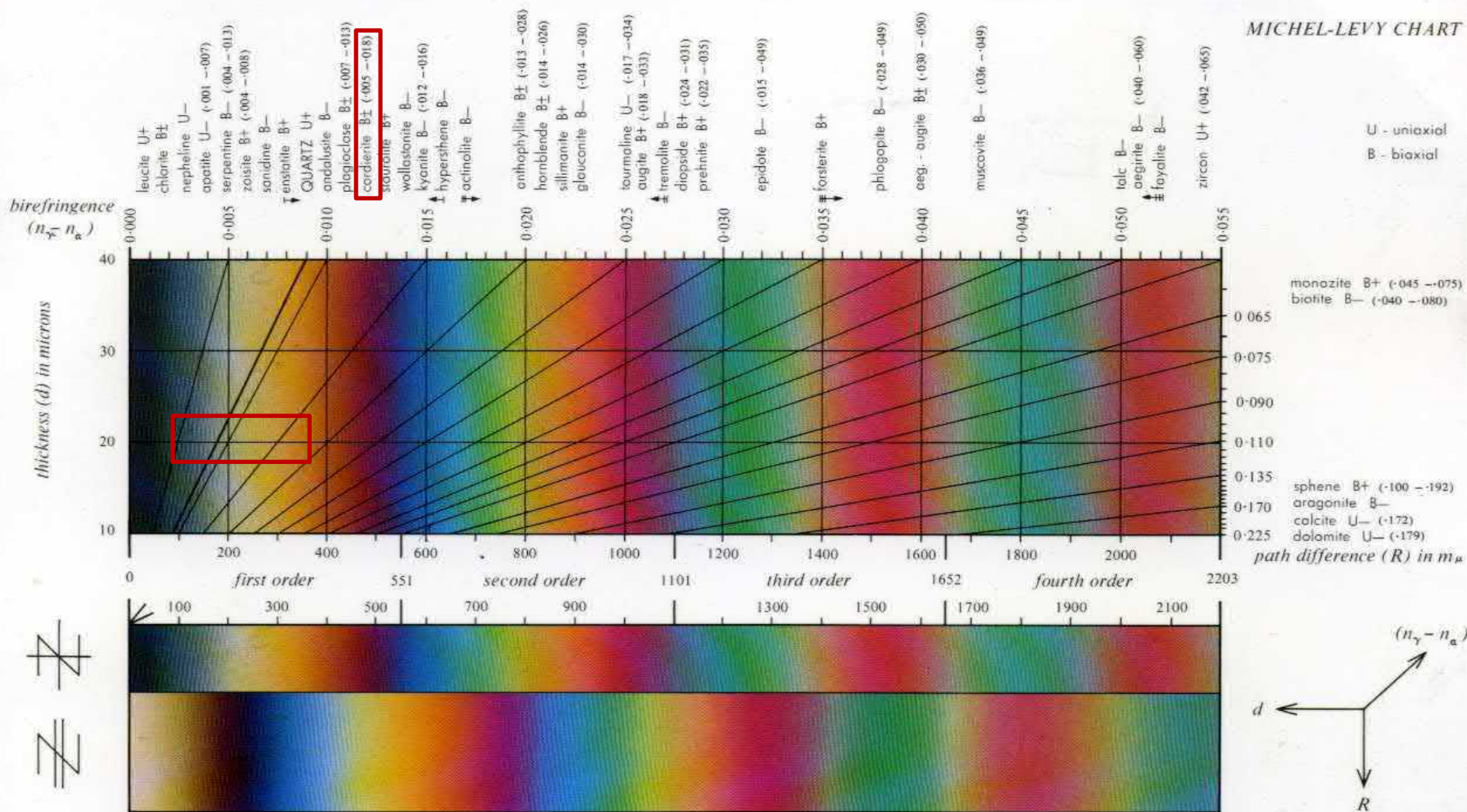
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Cordierite First order



MICHEL-LEVY CHART

U - uniaxial
B - biaxial





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Cordierite

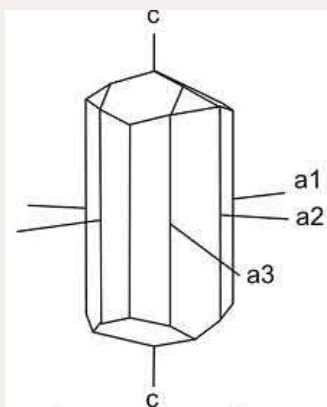


Silimanite-cordierite gneiss, Fort Dauphin, Madagascar, magnification x20



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Tourmaline





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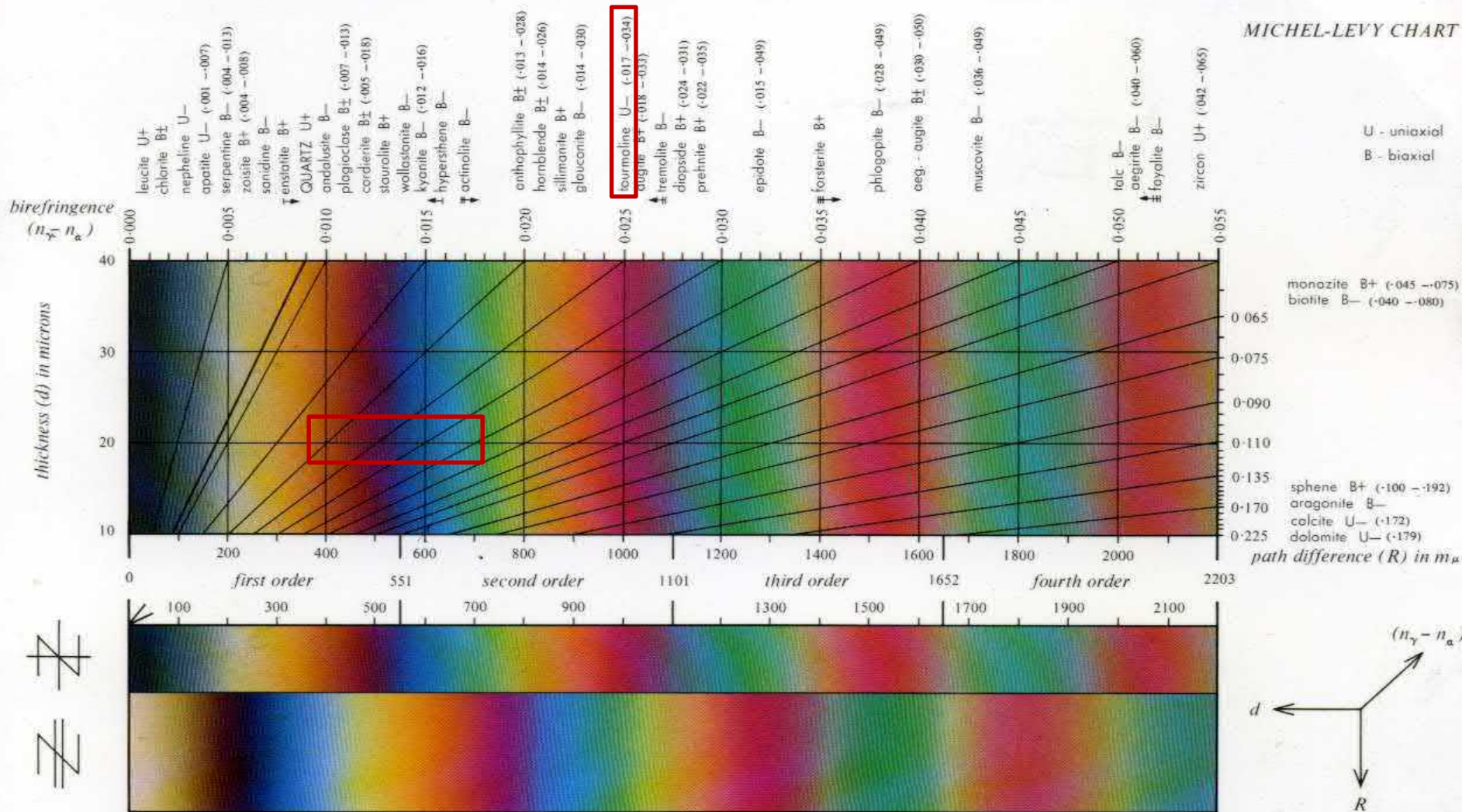
Tourmaline

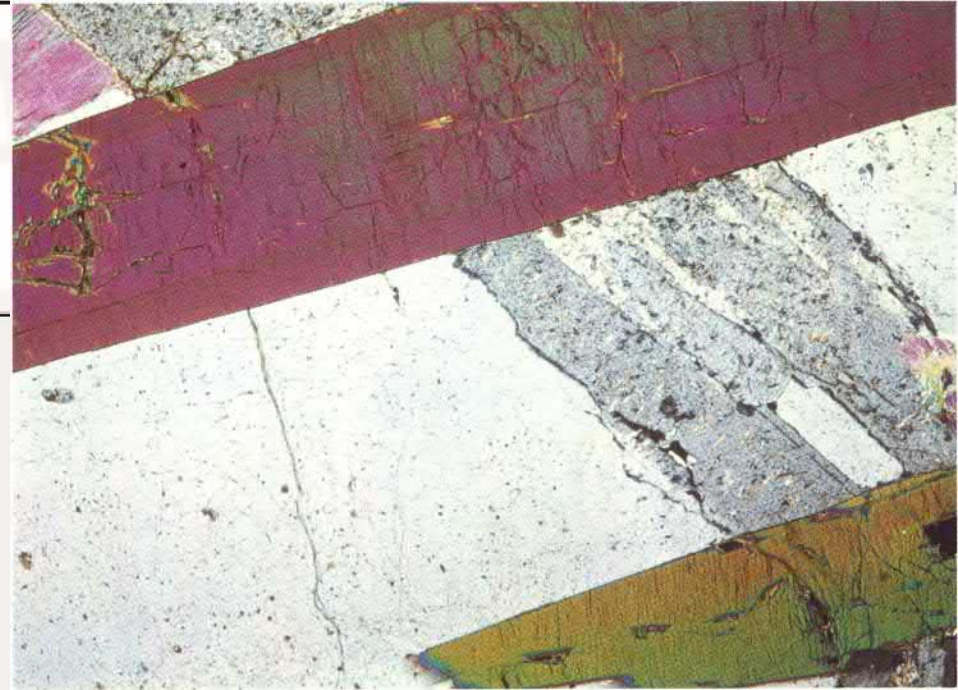
First-second order



MICHEL-LEVY CHART

U - uniaxial
B - biaxial





Topaze-tourmaline-quartz rock, Blackpool Clay Pit,
Cornwall, England, magnification x20





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Tourmaline

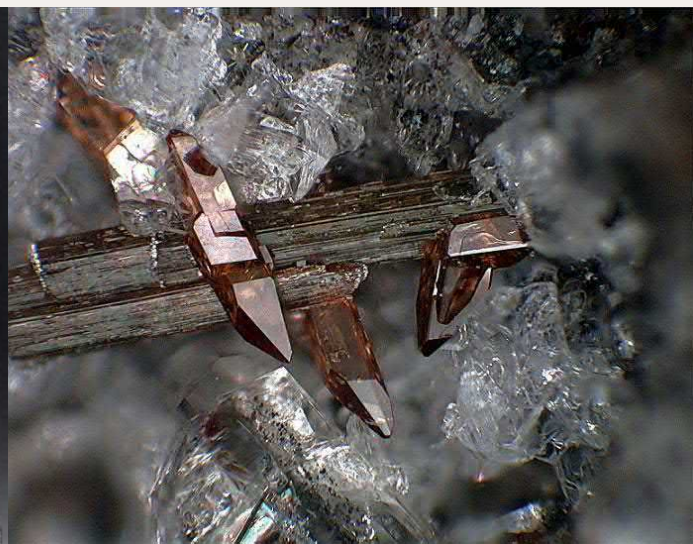
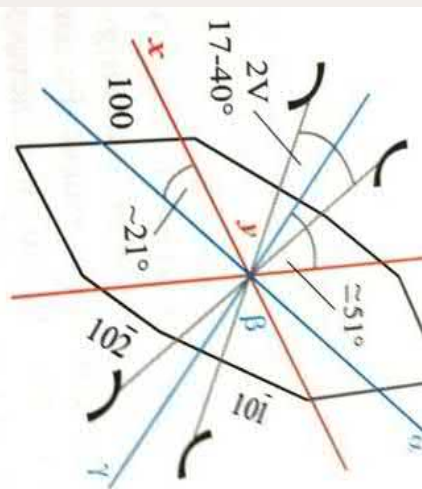




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Titanite

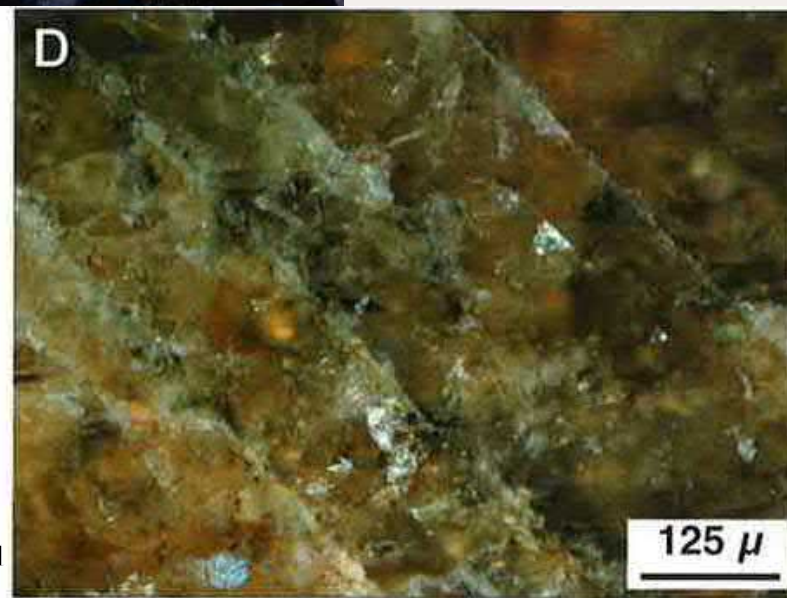
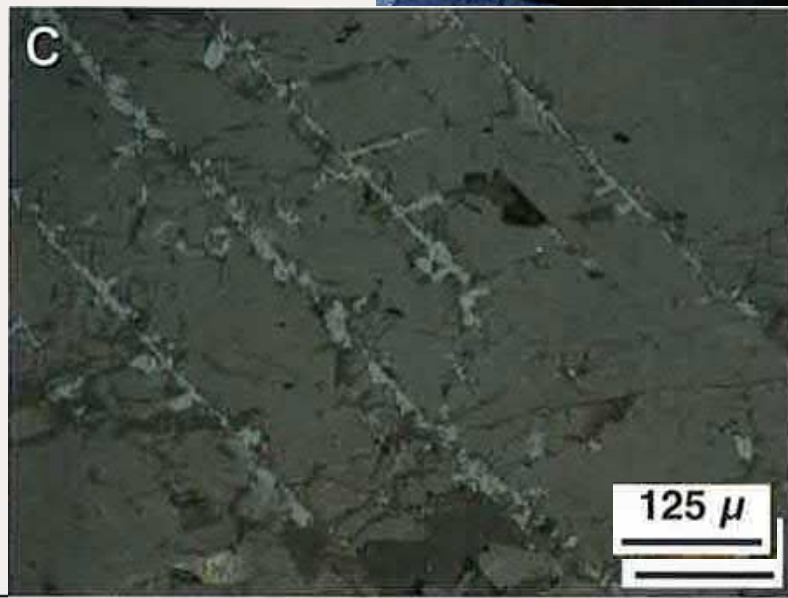
CaTiSiO_5





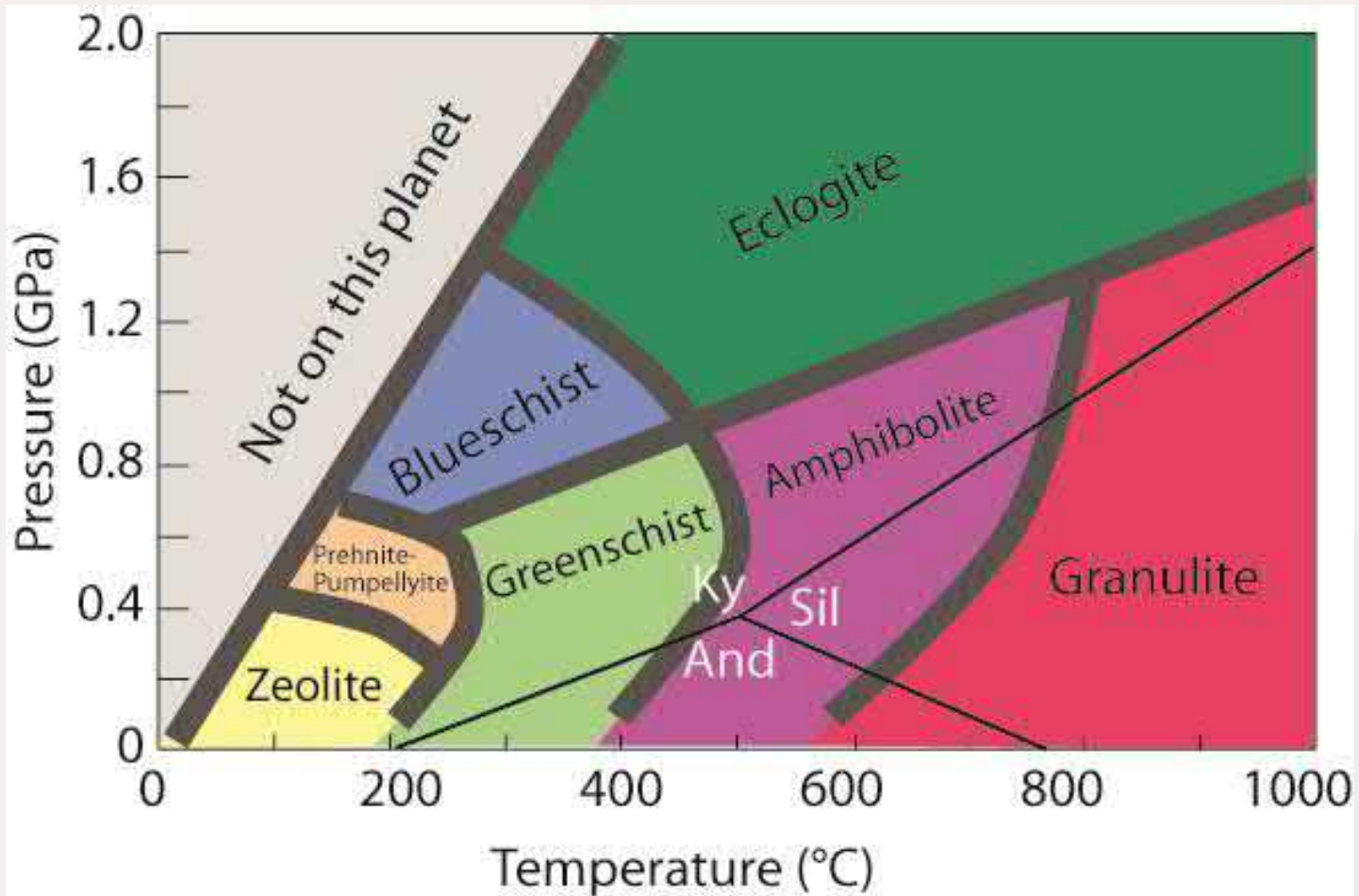
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Titanite





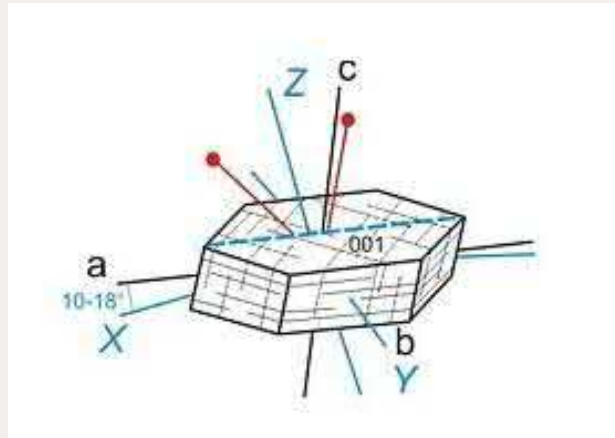
Metamorphic minerals





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Chloritoid



(c) Thomas Witzke + Abraxas Verlag



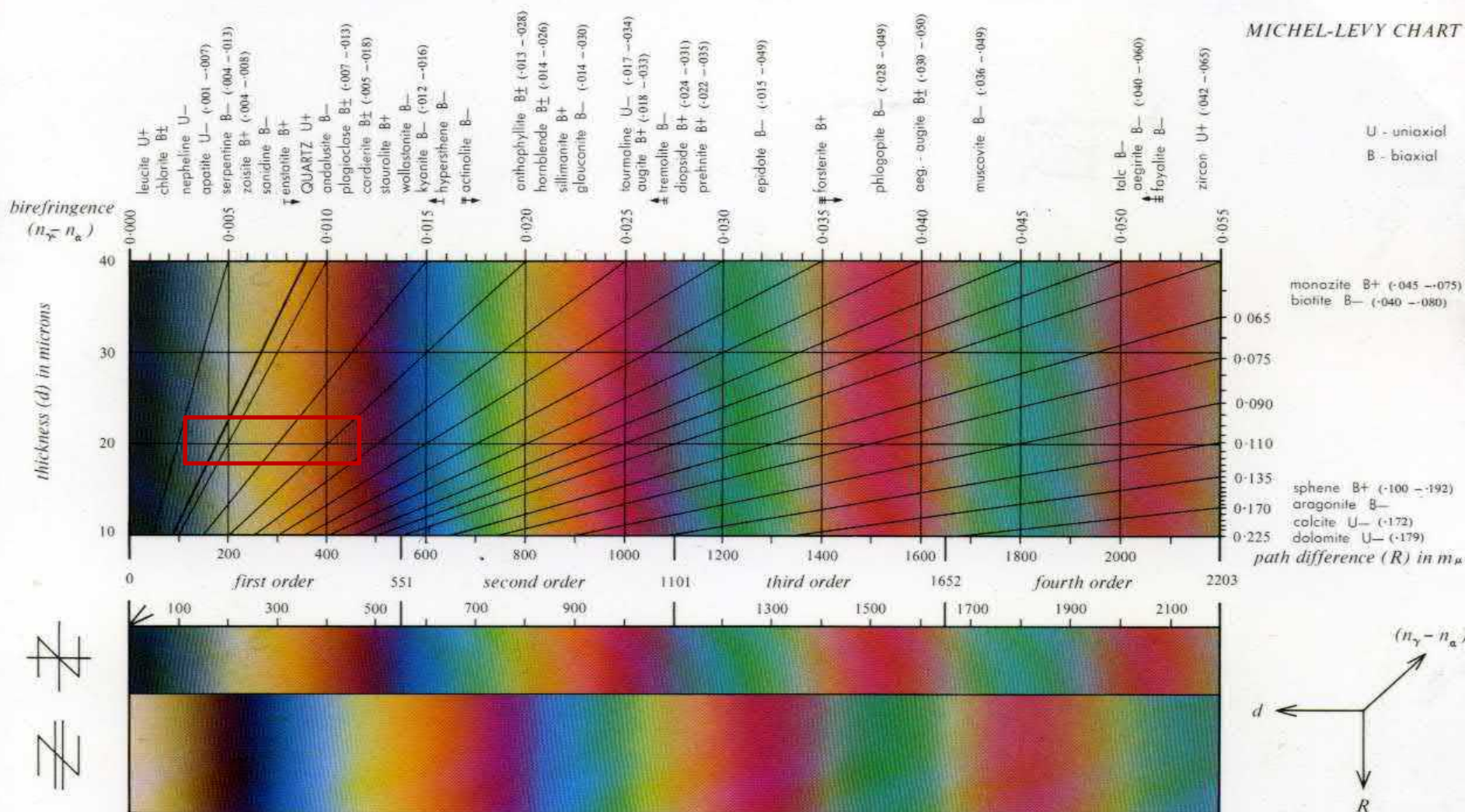
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Chloritoid First order



MICHEL-LEVY CHART

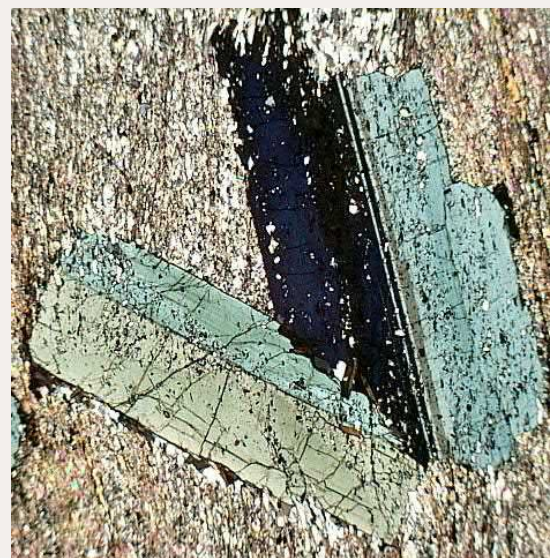
U - uniaxial
B - biaxial





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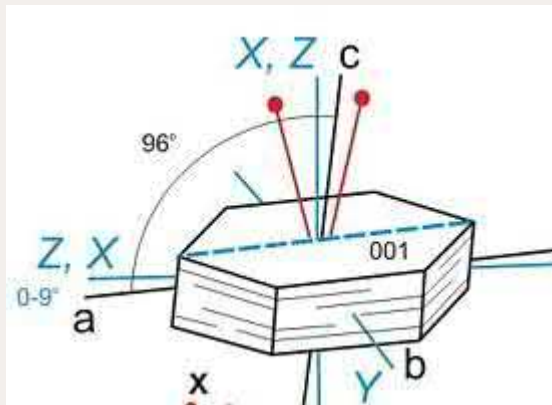
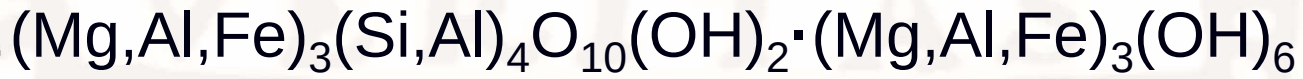
Chloritoid





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Chlorite





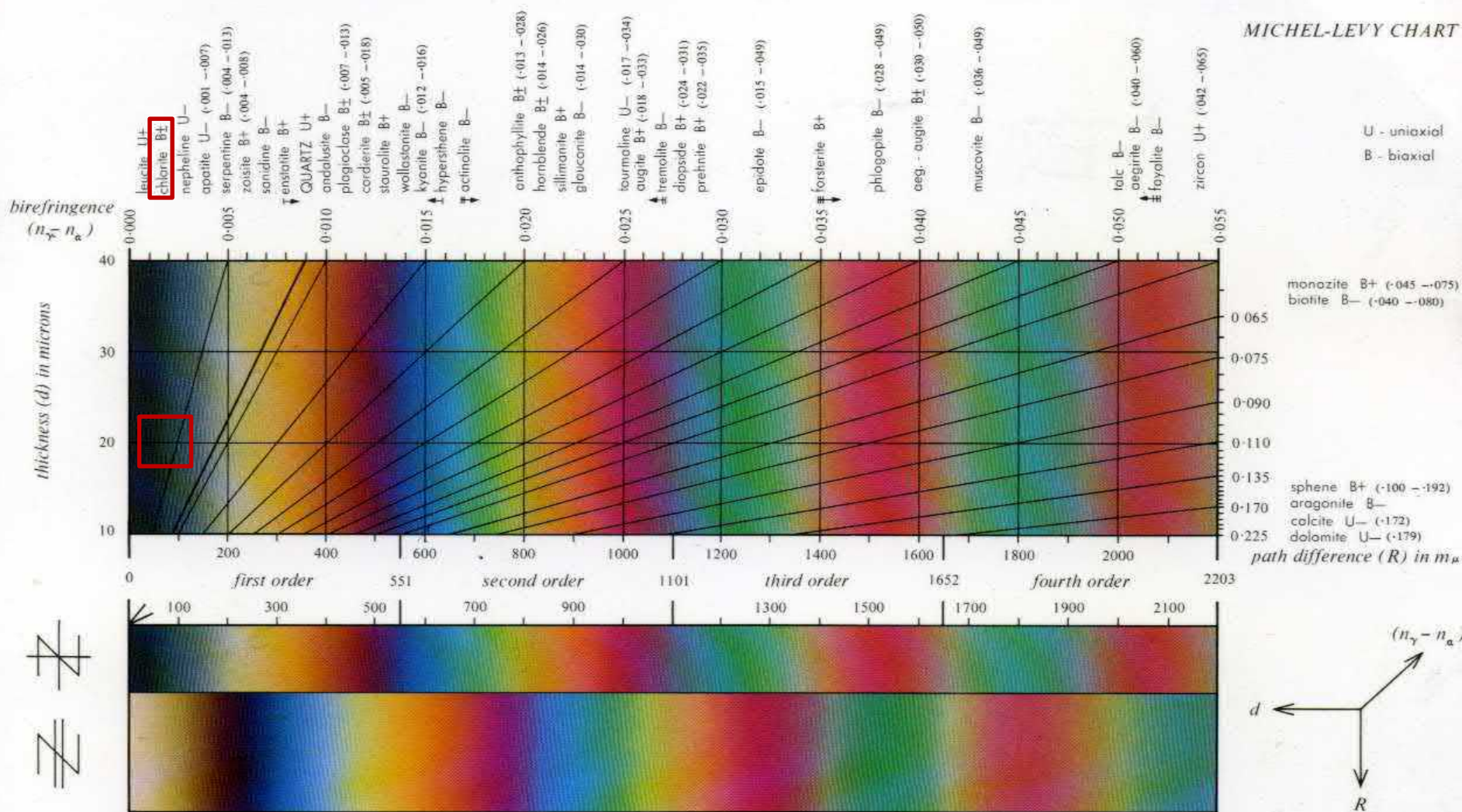
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Chlorite First order



MICHEL-LEVY CHART

U - uniaxial
B - biaxial





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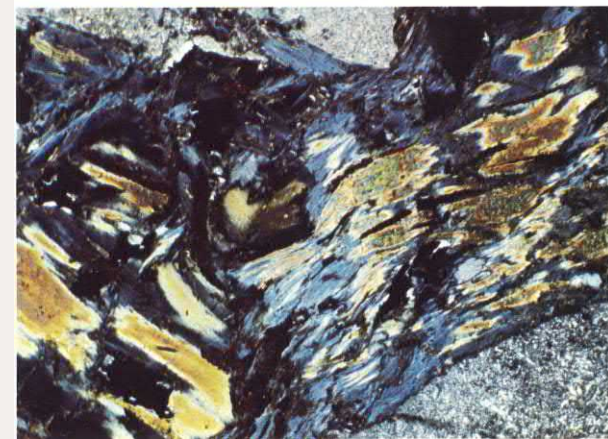
Chlorite



DC120-F11, May 7, 1999 4:06:41 PM Exposure: 0.0000 sec Zoom Factor: 2.3



DC120-F11, May 7, 1999 4:21:38 PM Exposure: 0.0000 sec Zoom Factor: 2.3



Adularia-quartz vien, St. Gottard, Switzerland,
magnification x27

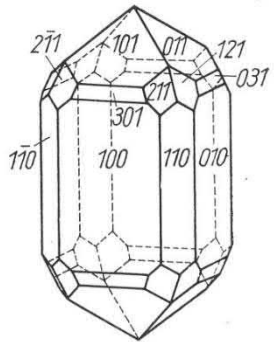
Mica-diorite, Glen Loy, Scotland, magnification
x58



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Zircon

ZrSiO_4



*Bild 1.85. Kristall
von Zirkon*



www.dk.com



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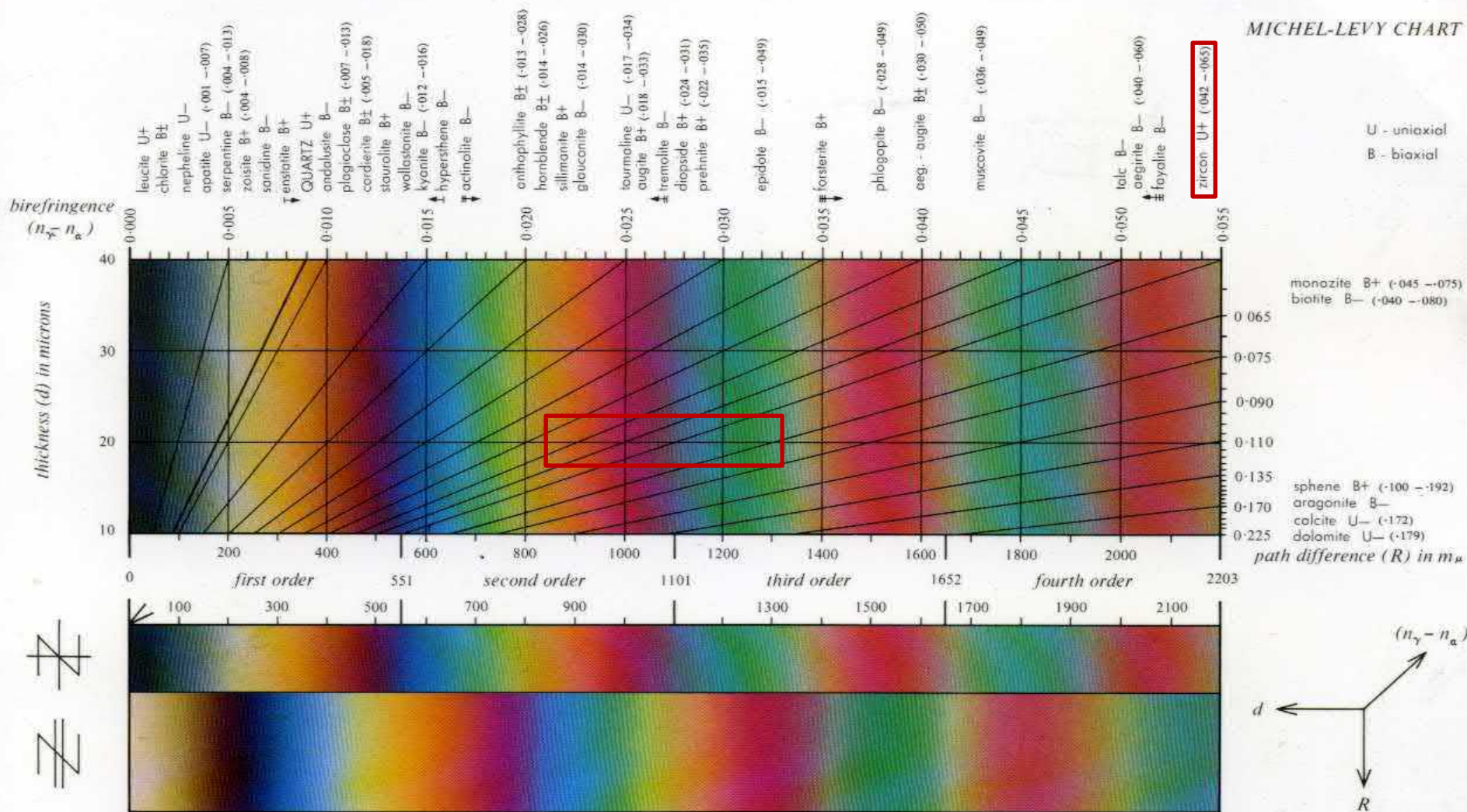
Zircon

Second-third order



MICHEL-LEVY CHART

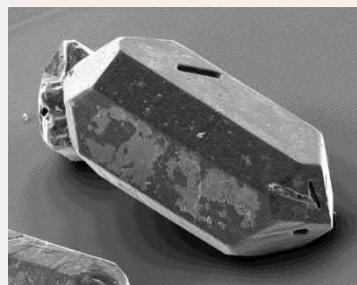
U - uniaxial
B - biaxial





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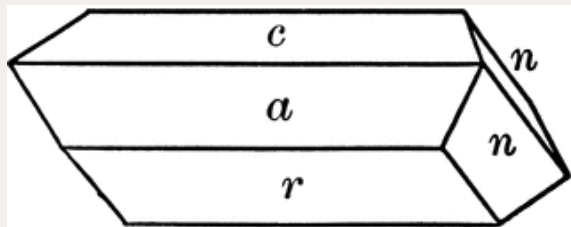
Zircon





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Epidote





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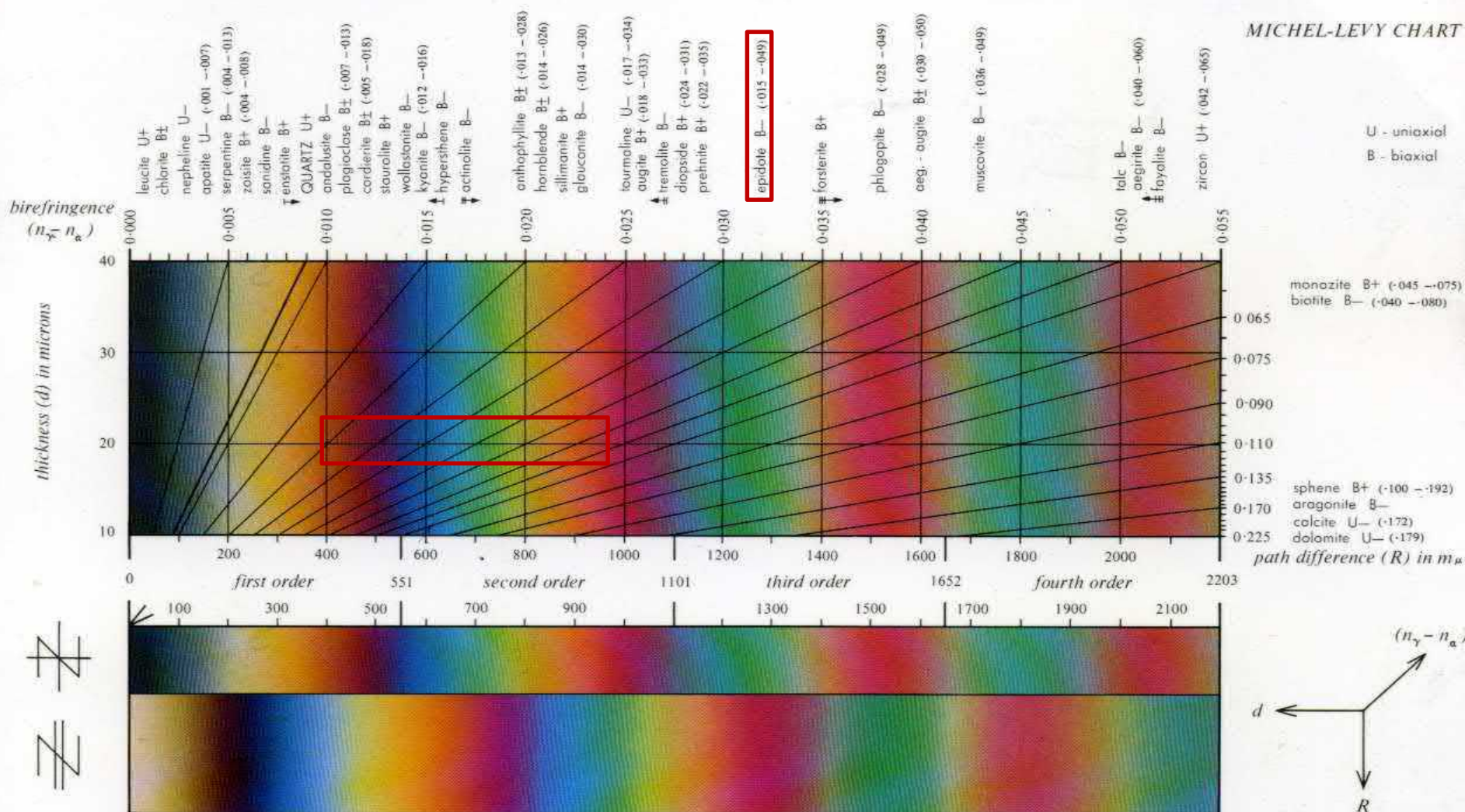
Epidote

First – second order



MICHEL-LEVY CHART

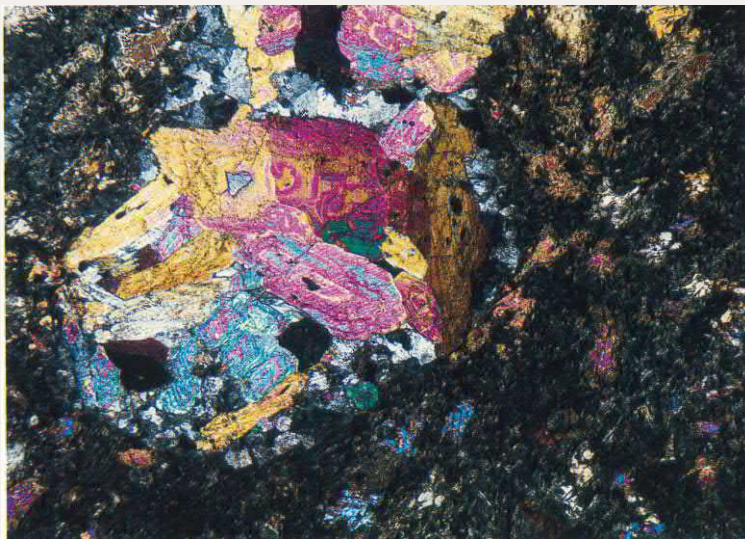
U - uniaxial
B - biaxial



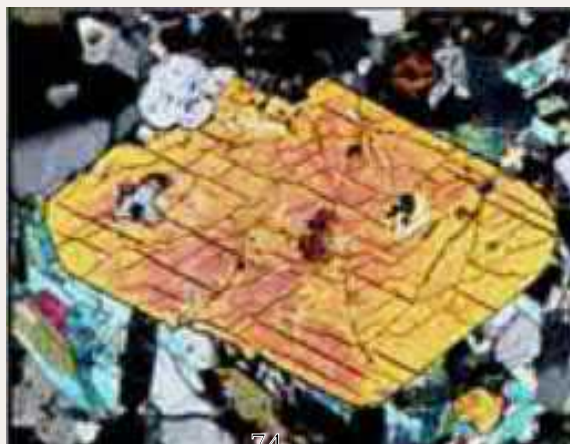


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Epidote



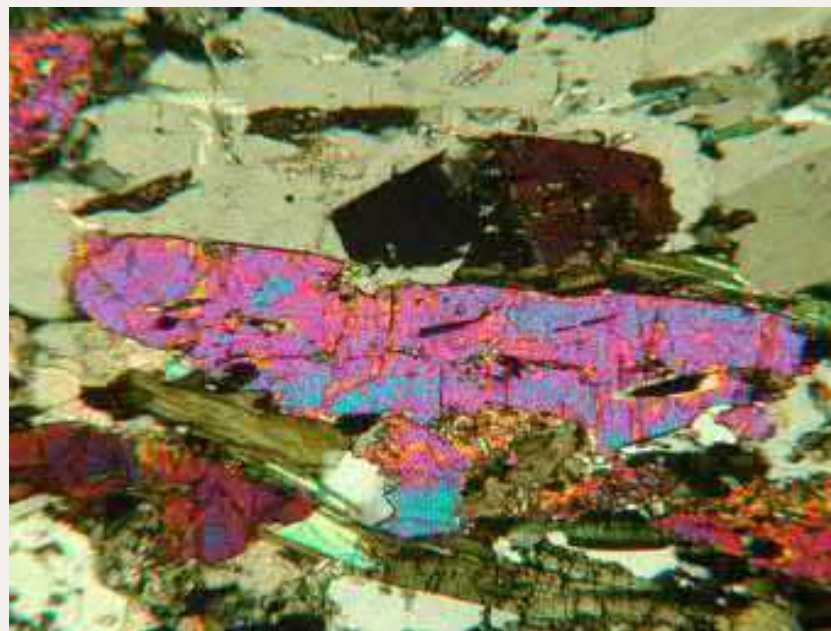
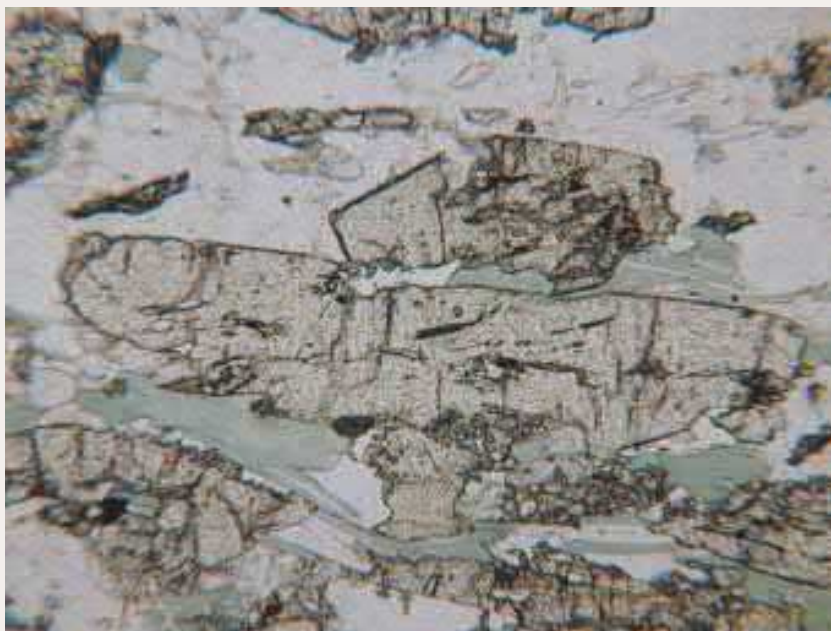
Epidotized basalt, Michigan, USA, magnification x32





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Epidote

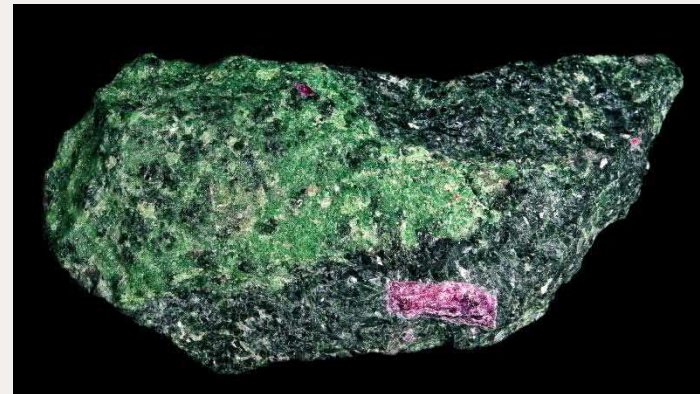
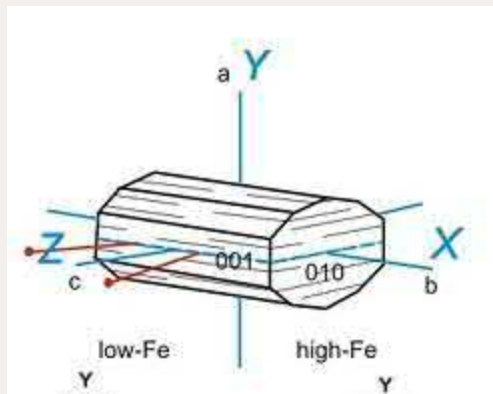
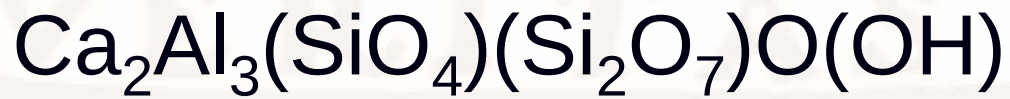


Greenschist, Siphnos, Greece



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Zoisite





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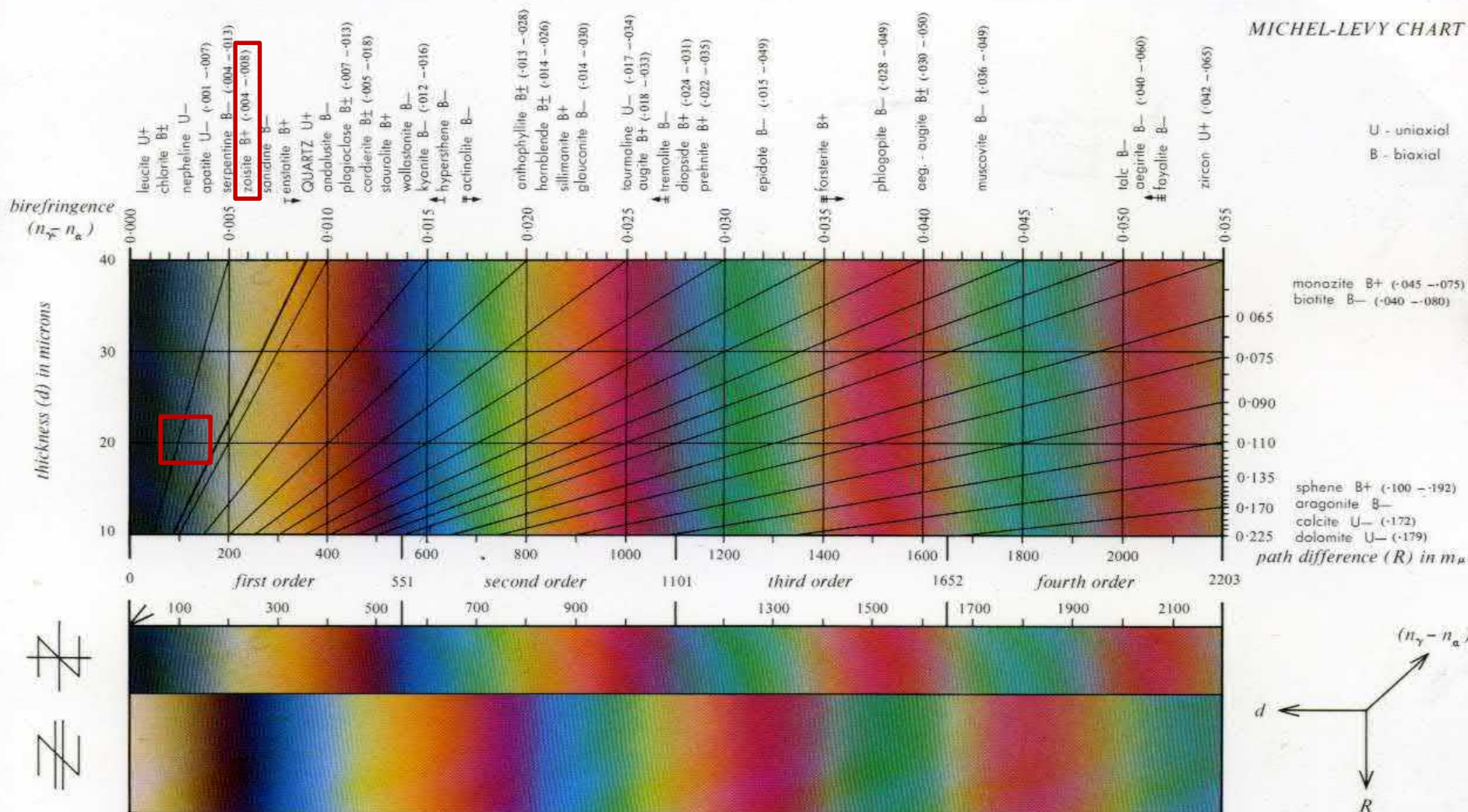
Zoisite

First order



MICHEL-LEVY CHART

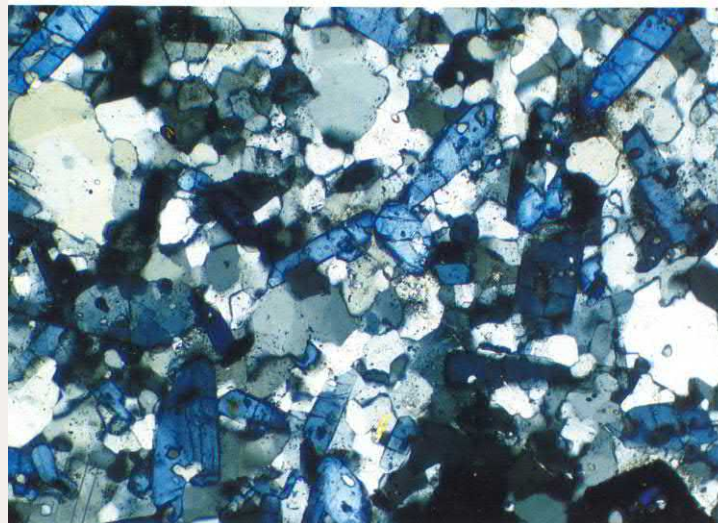
U - uniaxial
B - biaxial





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Zoisite



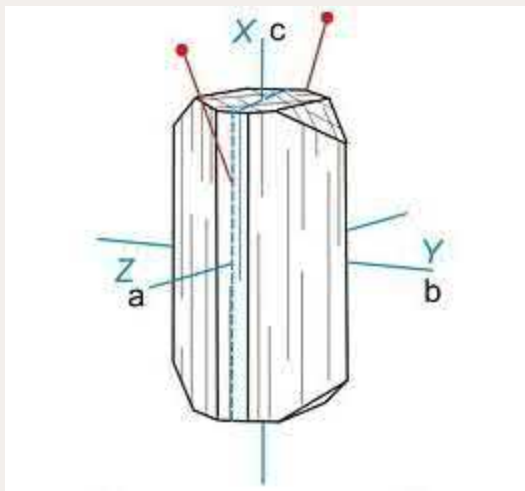
78
Zoisite schist, Glen Roy, Scotland, magnification x60



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Andalusite

Al_2SiO_5





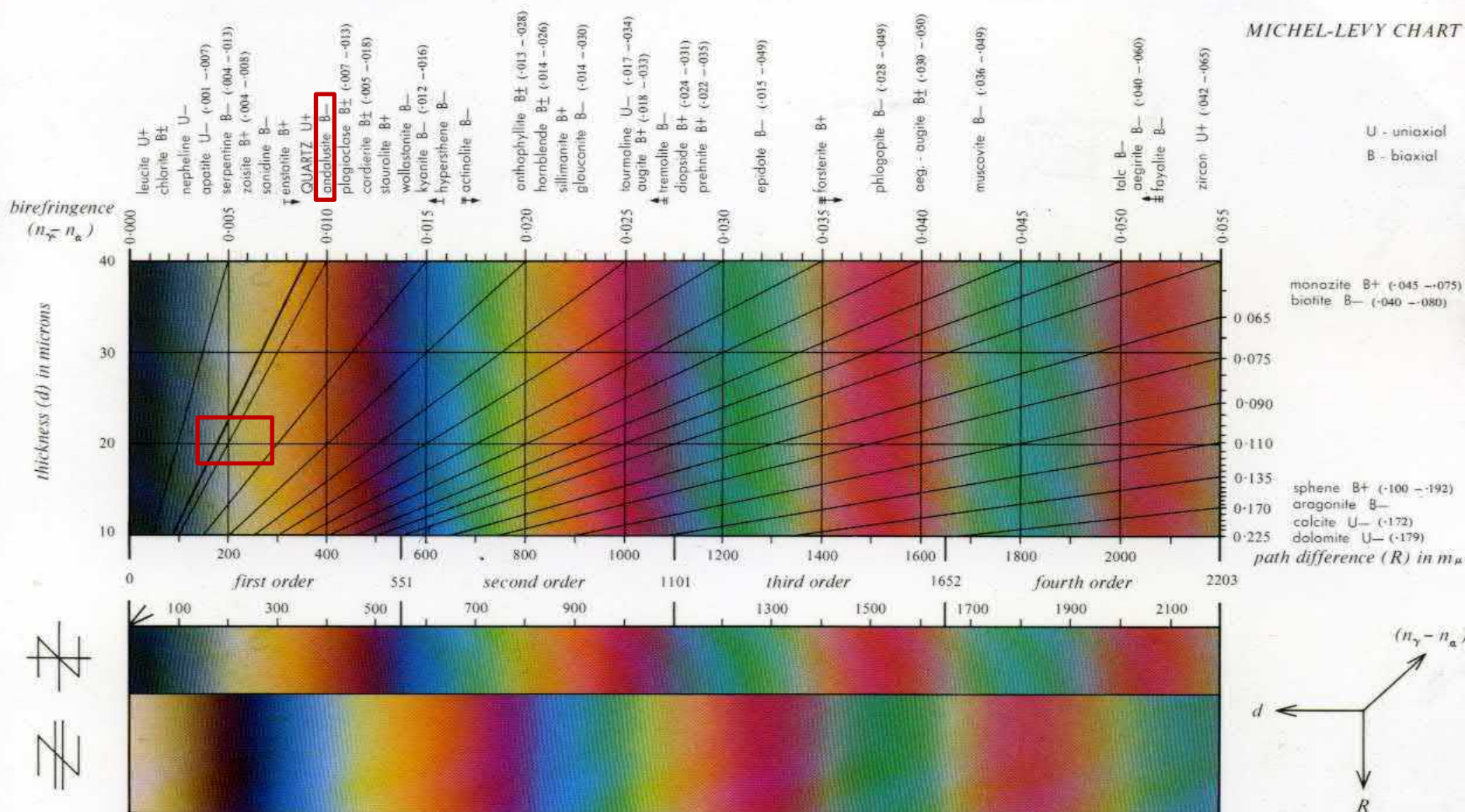
UPPSALA
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Andalusite First order



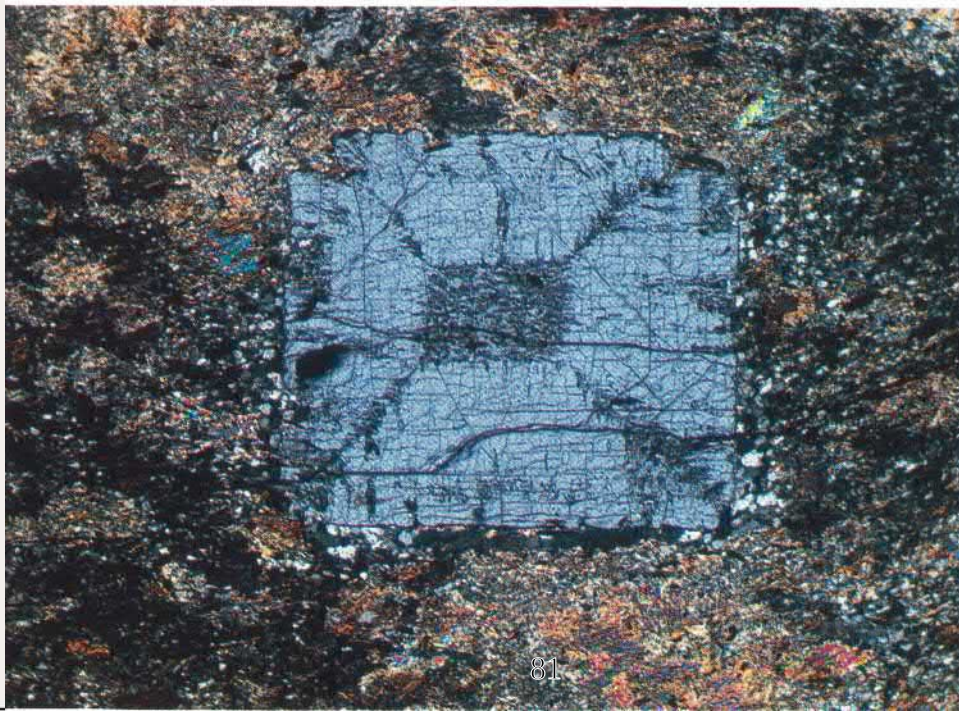
MICHEL-LEVY CHART

U - uniaxial
B - biaxial





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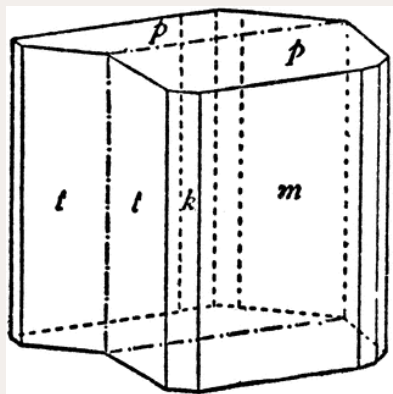




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Kyanite

Al_2SiO_5





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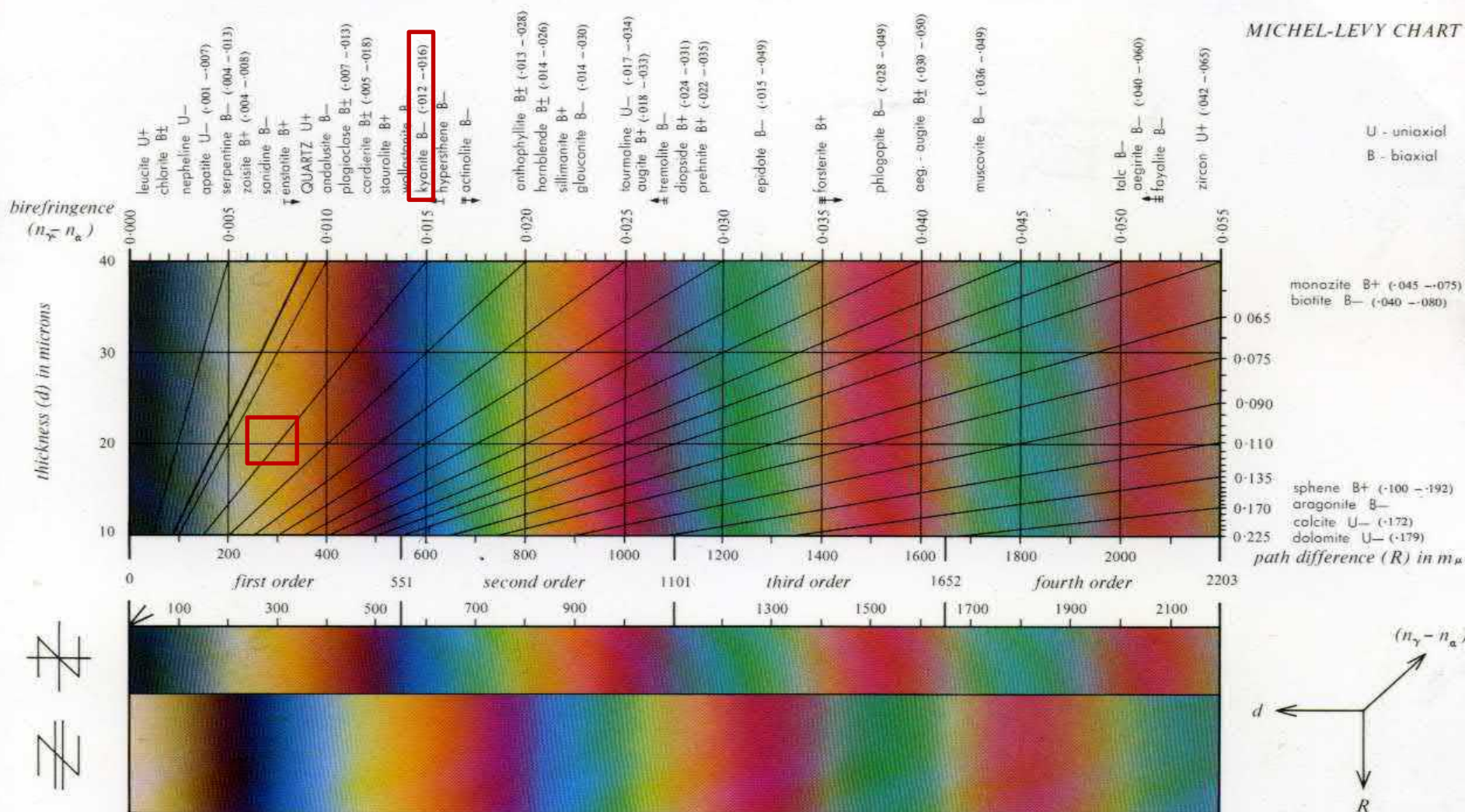
Kyanite

First order



MICHEL-LEVY CHART

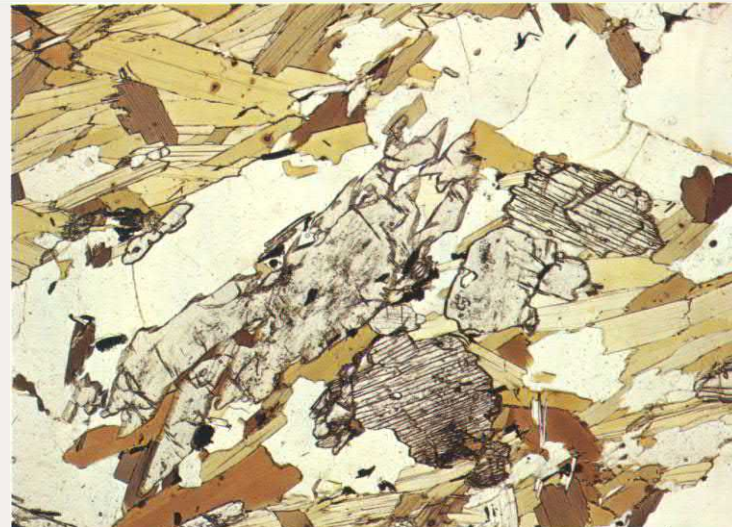
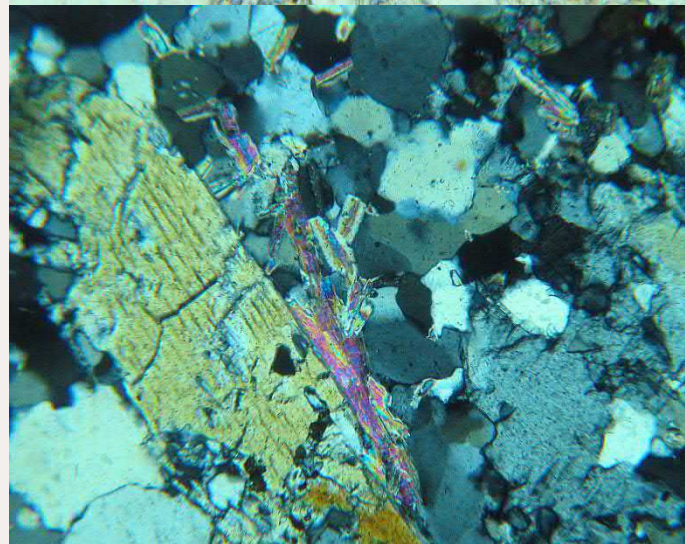
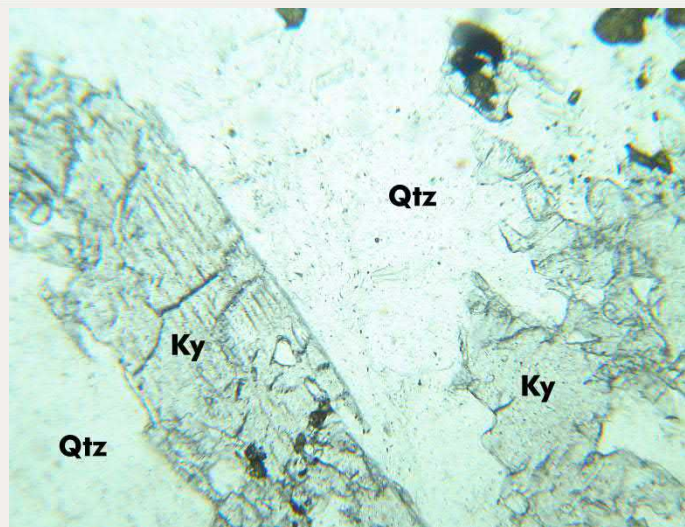
U - uniaxial
B - biaxial





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Kyanite

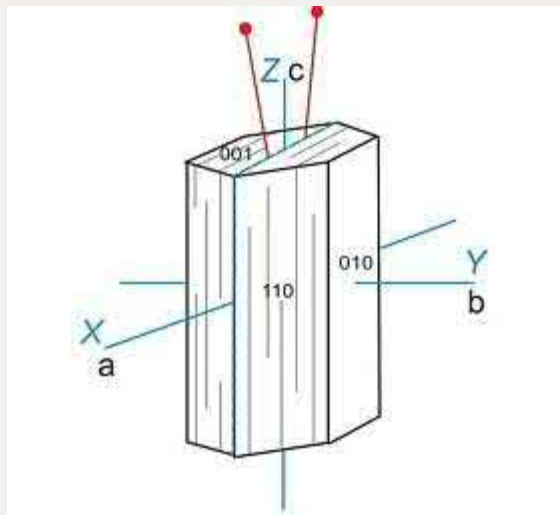




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Sillimanite

Al_2SiO_5





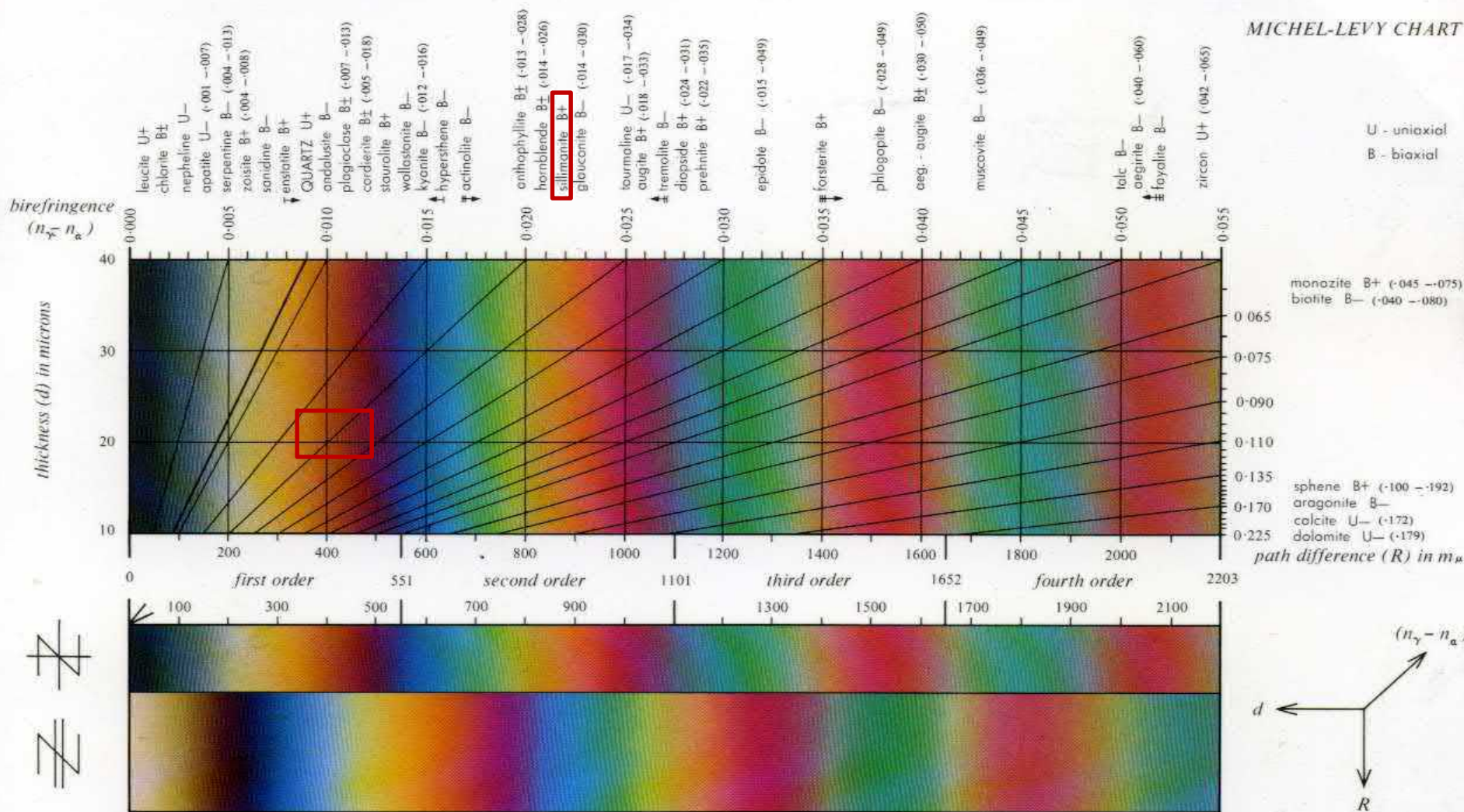
UPPSALA
UNIVERSITET

Sillimanite First order



MICHEL-LEVY CHART

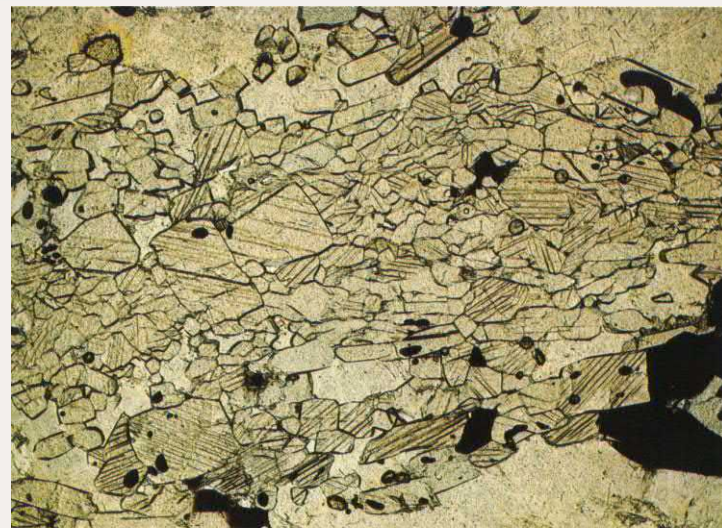
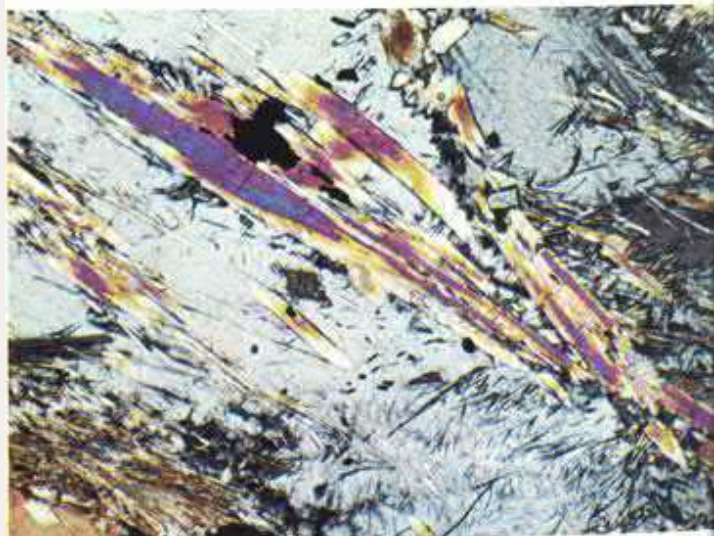
U - uniaxial
B - biaxial





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Sillimanite



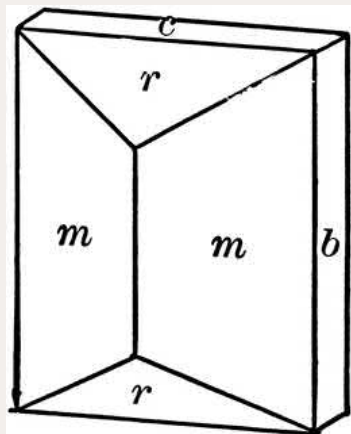
88
Cordierite-sillimanite gneiss, 11km south of Ihosy, Madagascar, magnification x68

Garnet-cordierite-sillimanite gneiss, Ihosy, Madagascar, magnification x40



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Staurolite





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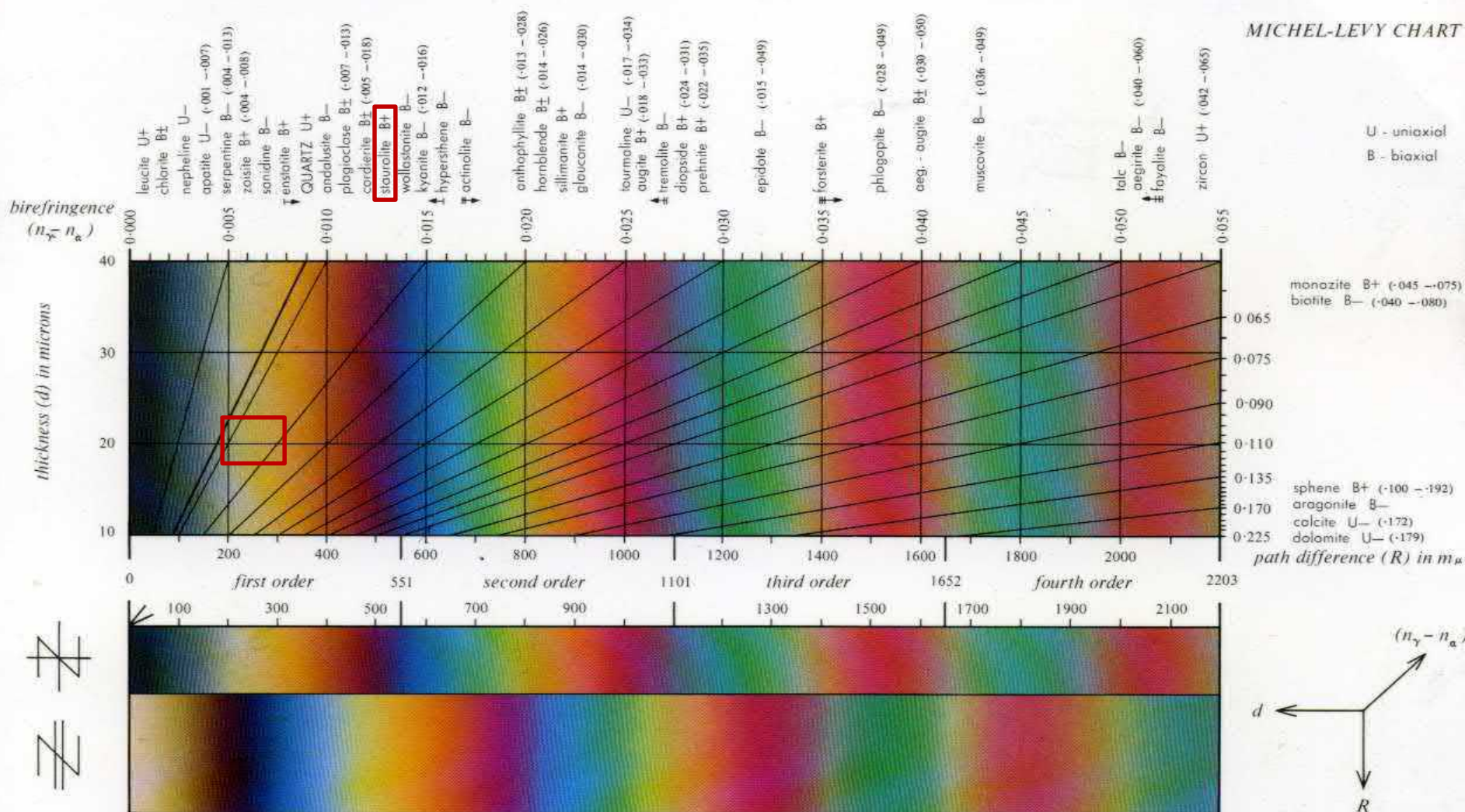
Staurolite

Yellow - First order



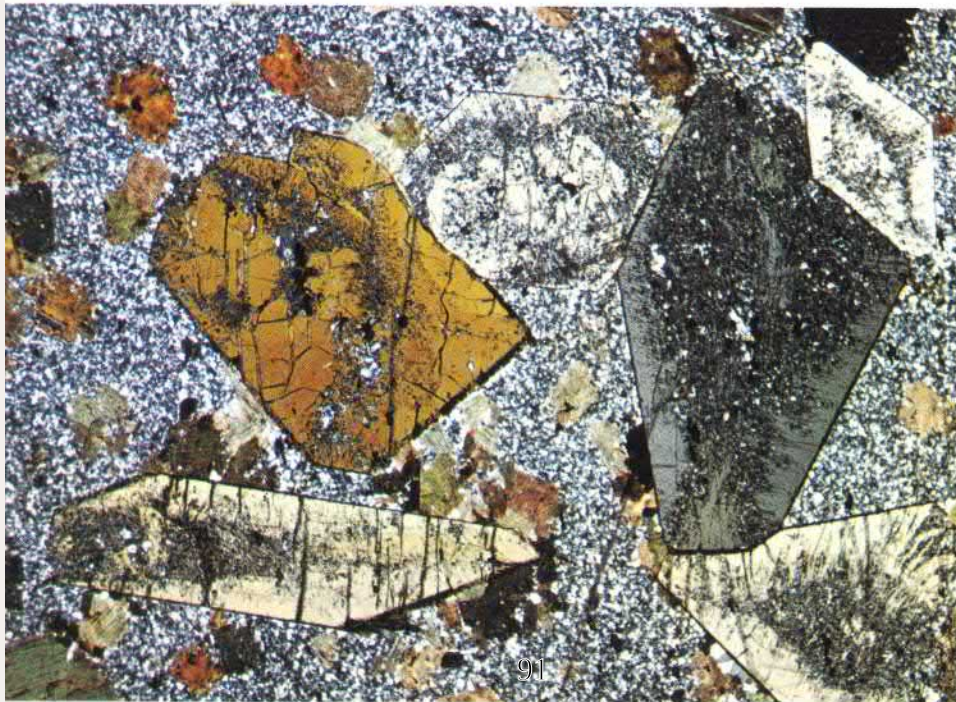
MICHEL-LEVY CHART

U - uniaxial
B - biaxial





UPPSALA
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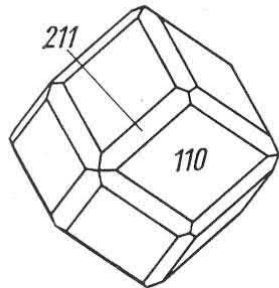


Staurolite schist, Waddy Lake,
Saskatchewan, Canada, magnification x20

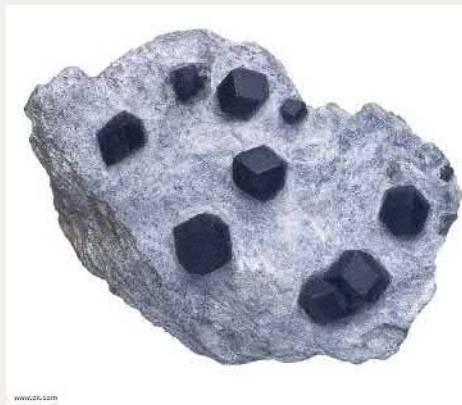


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Garnet

$$X_3Y_2(SiO_4)_3$$


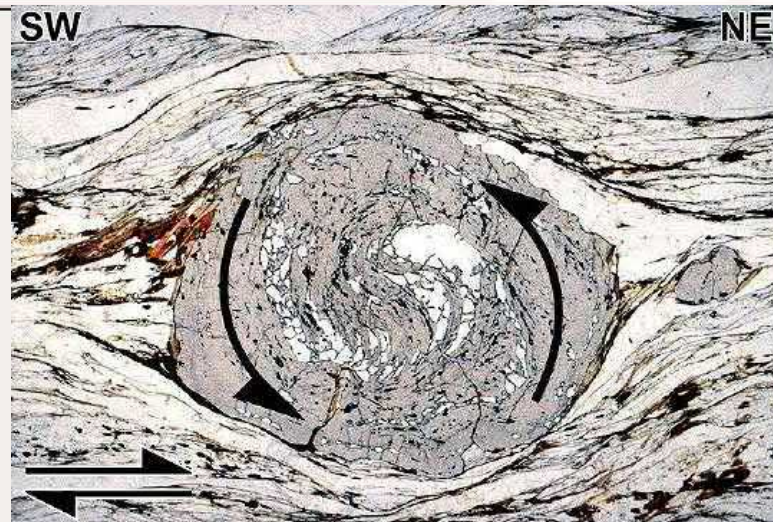
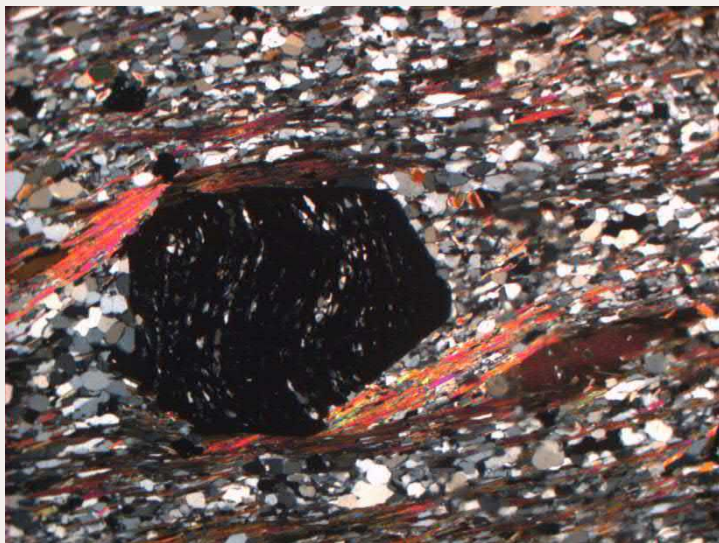
*Bild 1.115. Kristall von
Granat*





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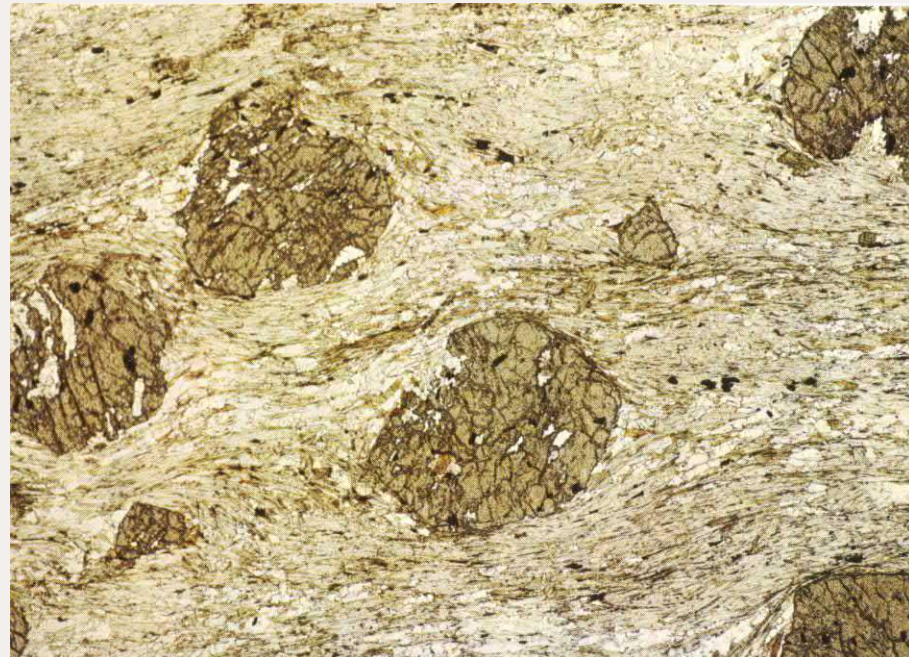
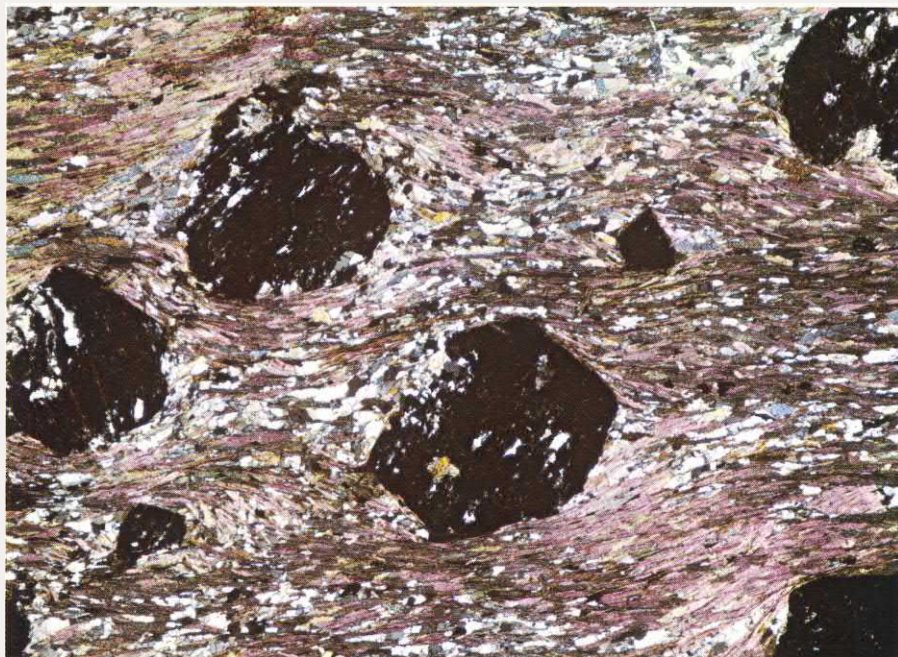
Garnet





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Garnet



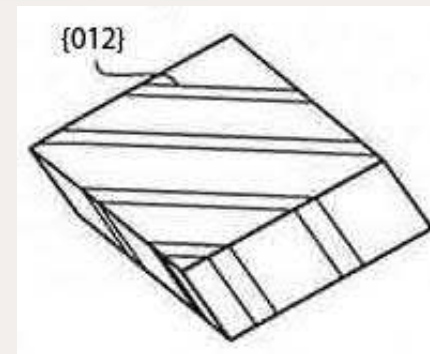
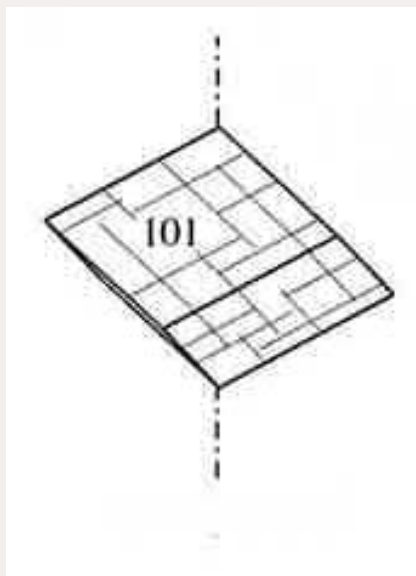
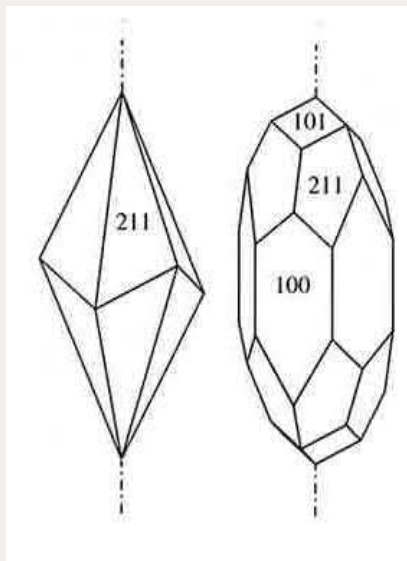
Garnet-mica schist, Pitlochry, Scotland, magnification x11



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Calcite

CaCO_3





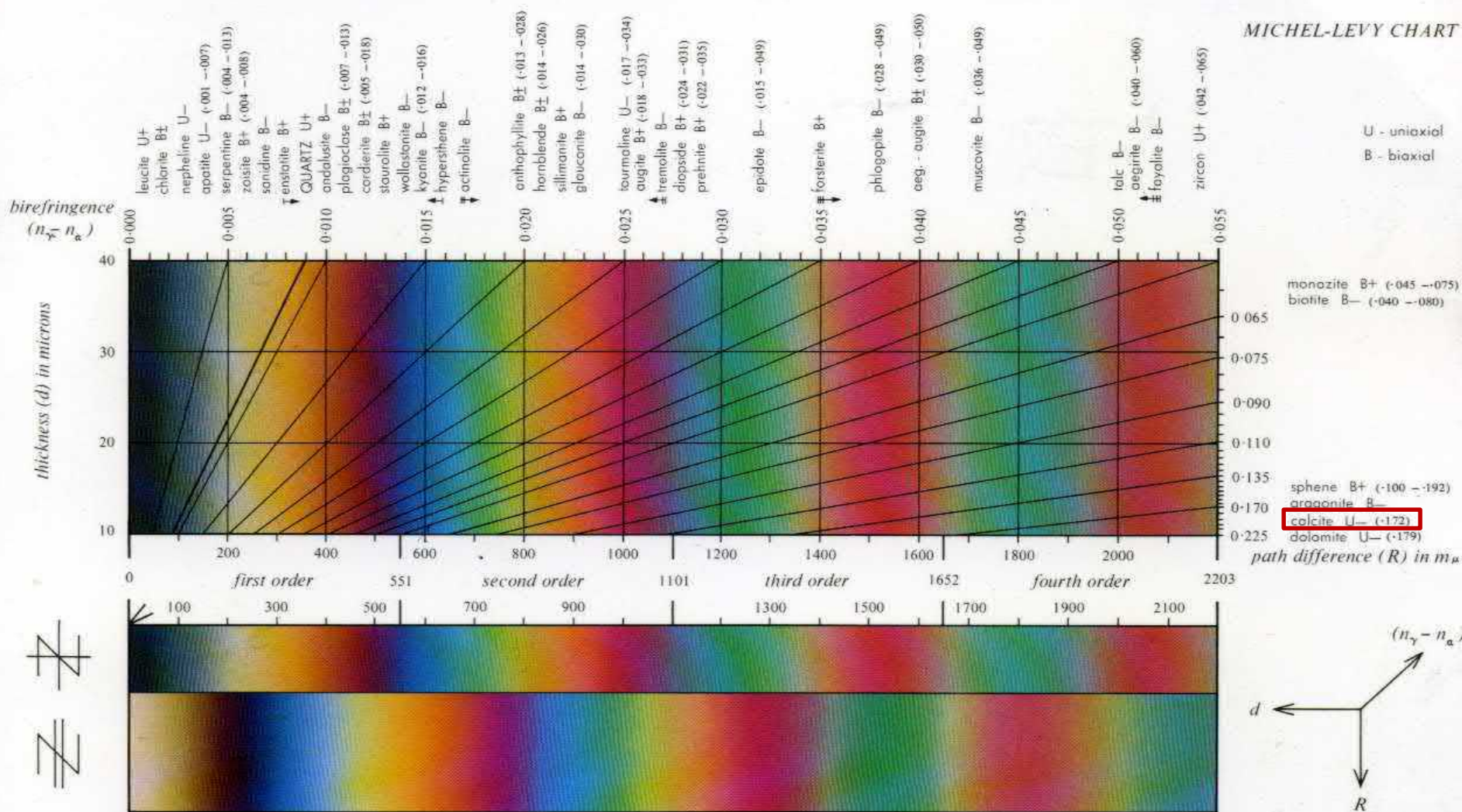
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Calcite High order



MICHEL-LEVY CHART

U - uniaxial
B - biaxial





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Calcite



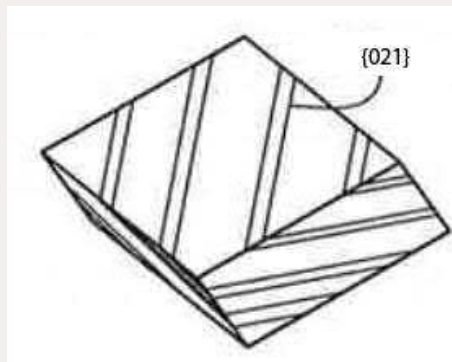
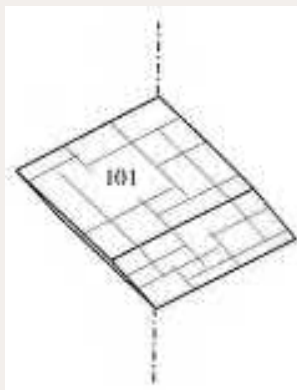
Diopside-forsterite marble, Loch Duich, Scotland, magnification x44



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Dolomite

$(\text{CaMg})(\text{CO}_3)_2$





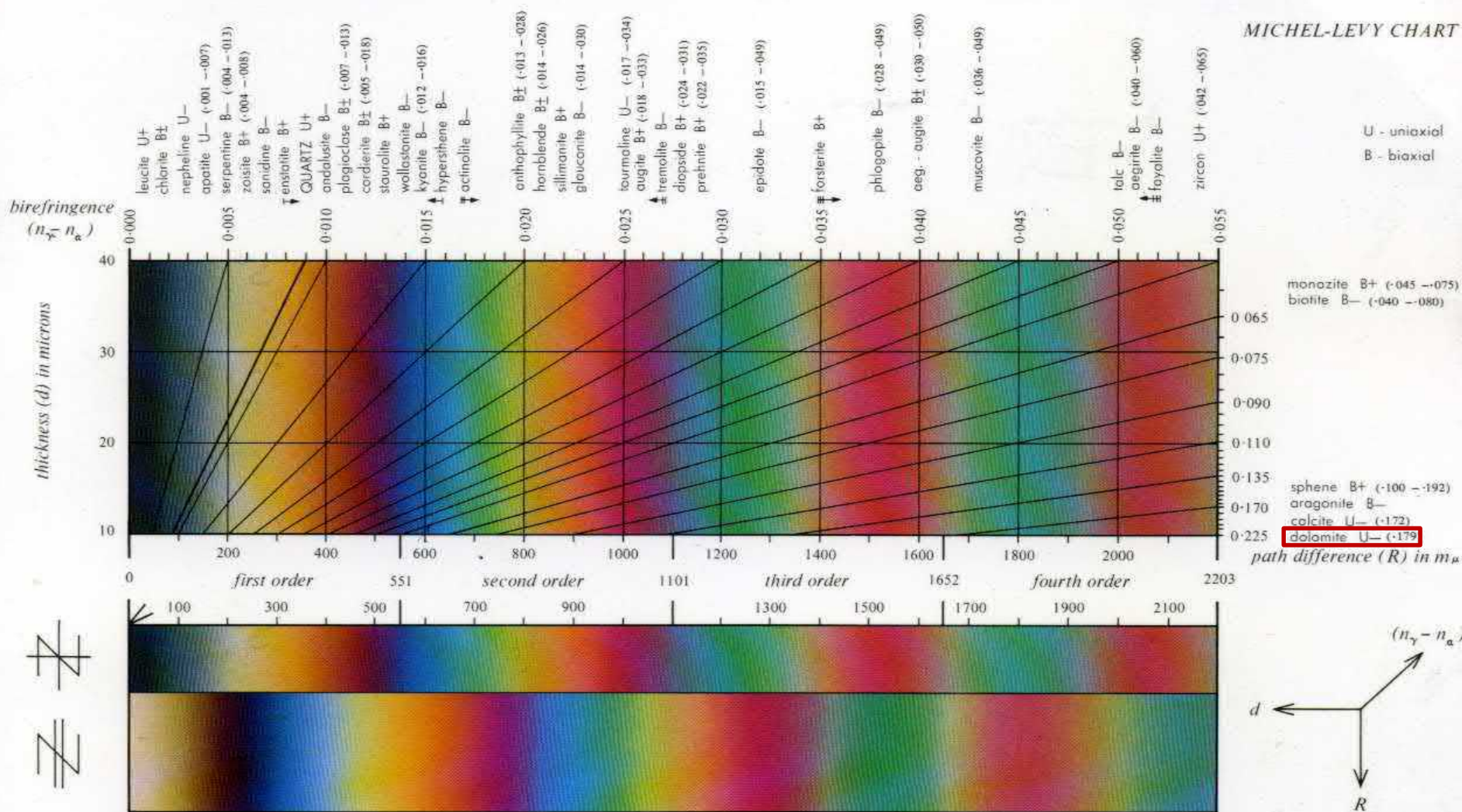
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Dolomite High order



MICHEL-LEVY CHART

U - uniaxial
B - biaxial





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Dolomite



100

Forserite marble, Sri Lanka, magnification x 43



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Ore minerals

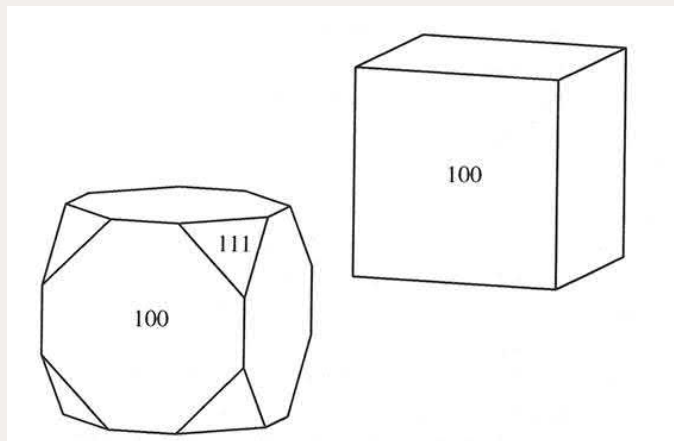




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Galena

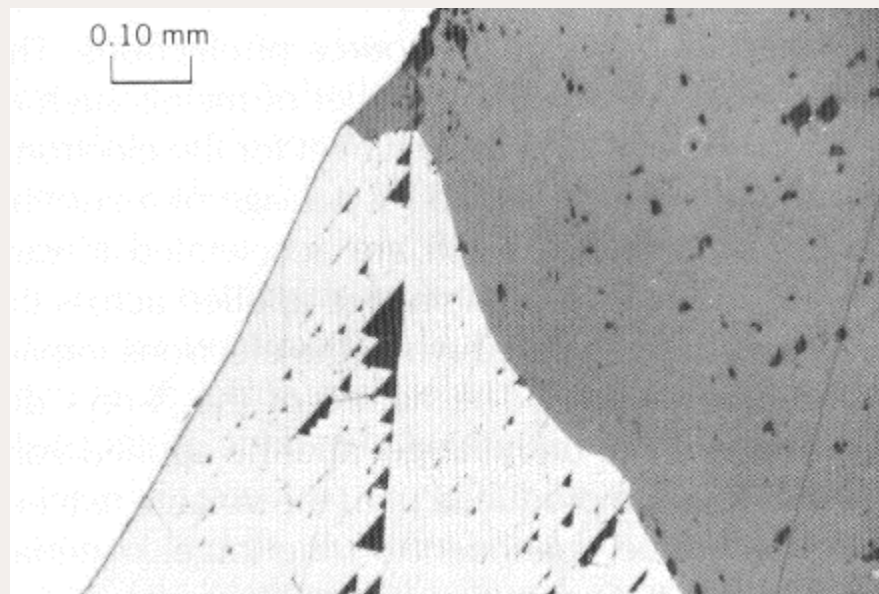
PbS





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Galena

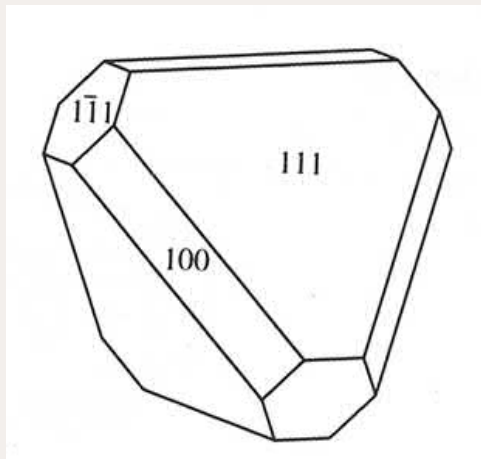




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Sphalerite

$(\text{Zn,Fe})\text{S}$

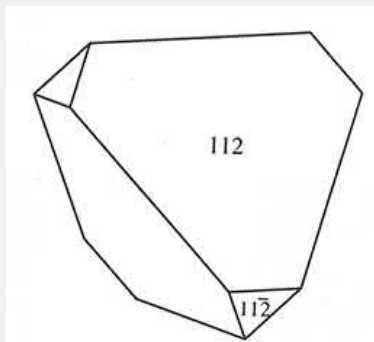




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Chalcopyrite

CuFeS_2

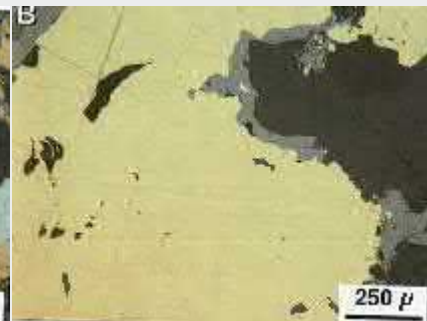
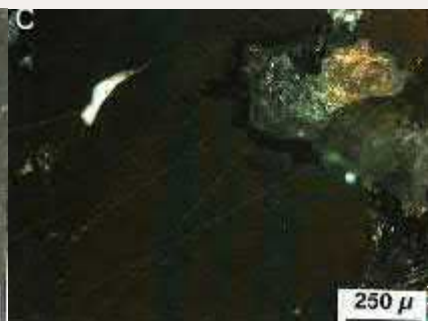
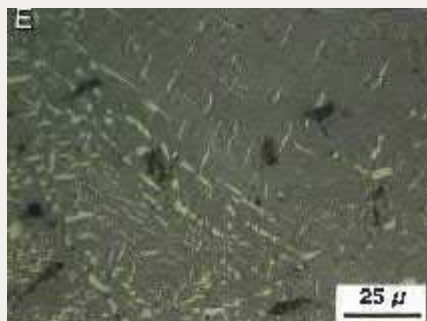
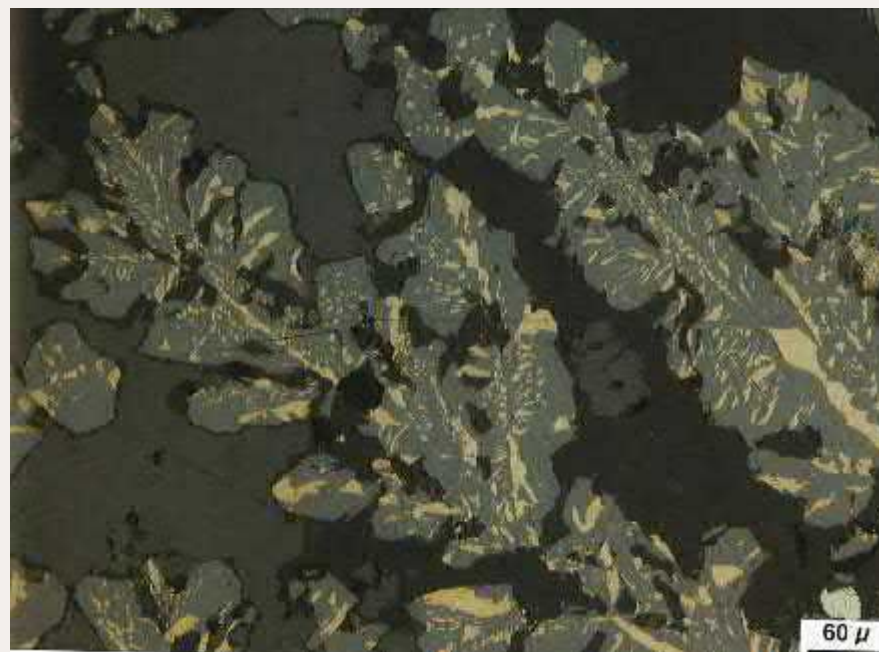




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Chalcopyrite

CuFeS_2





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Molybdenite

MoS_2

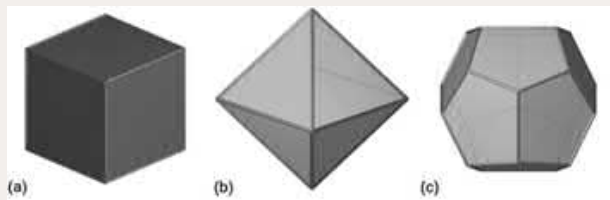




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Pyrite

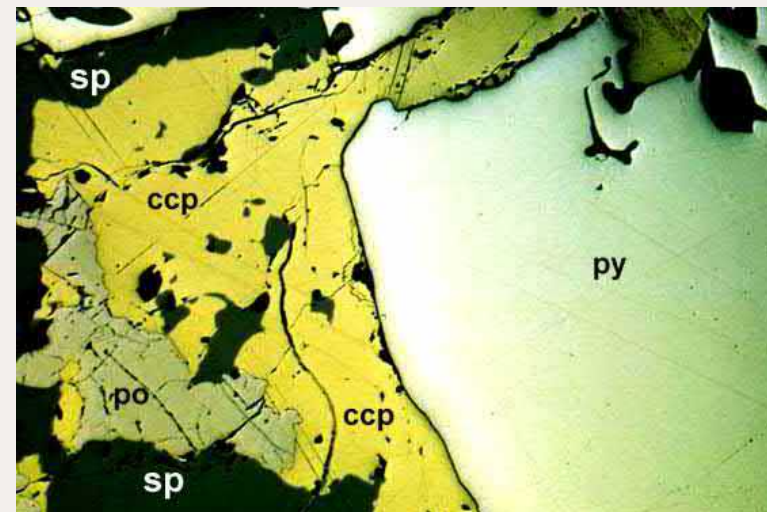
FeS_2





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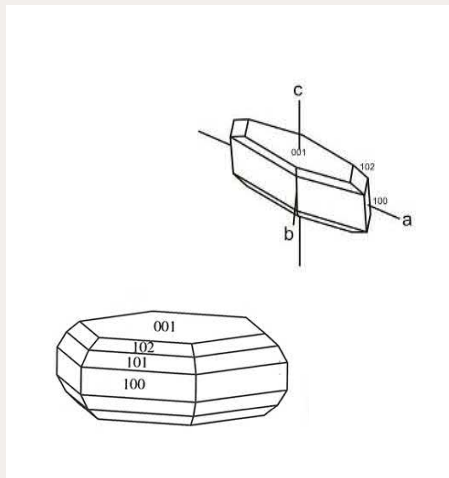
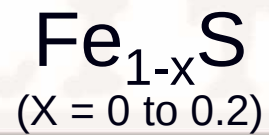
Pyrite





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Pyrrhotite





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Pyrrhotite

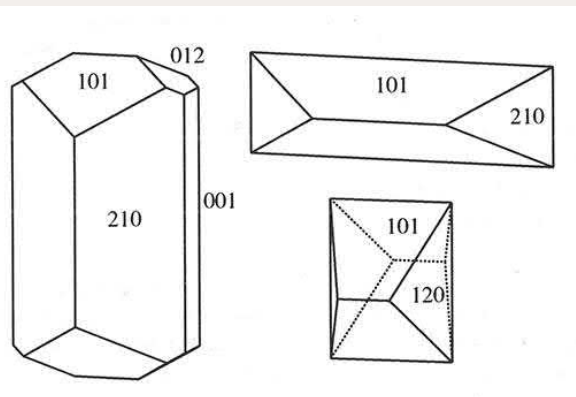




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Arsenopyrite

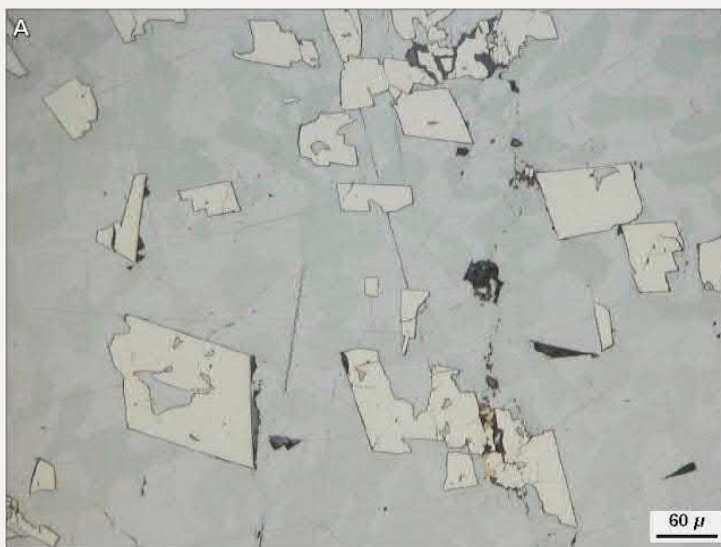
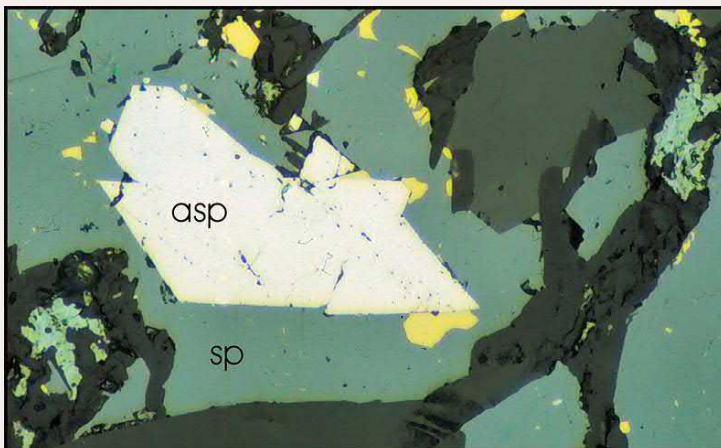
FeAsS





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Arsenopyrite

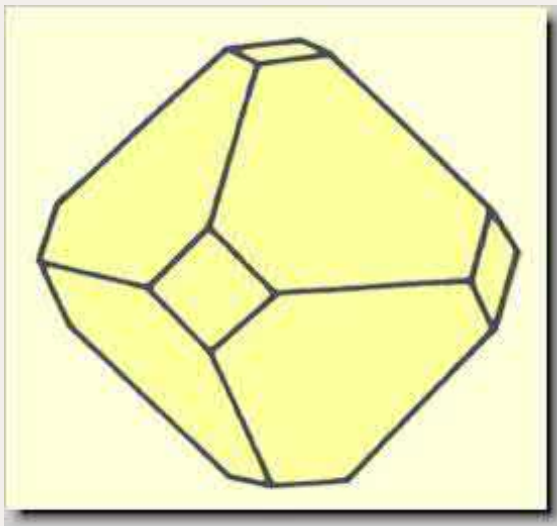




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Bornite

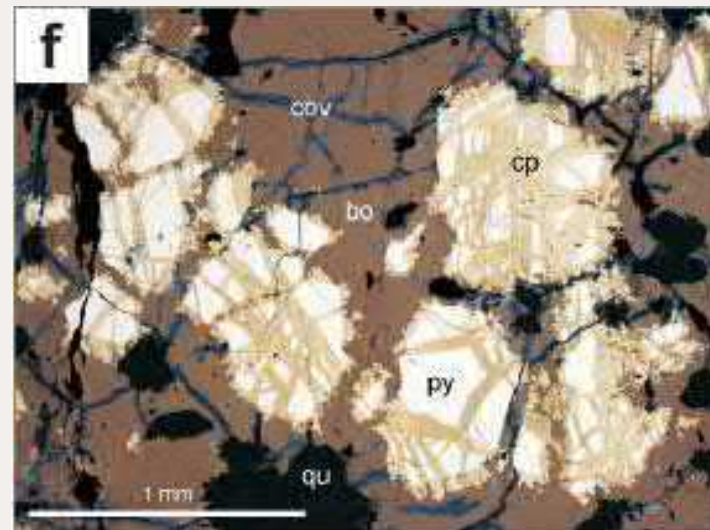
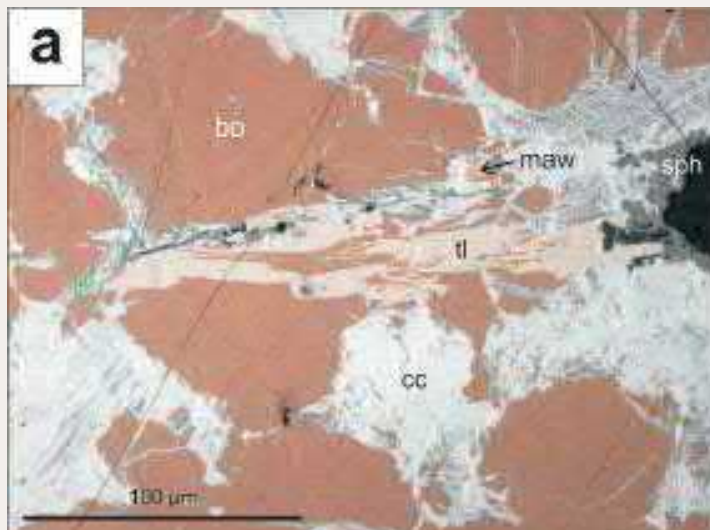
Cu_5FeS_4





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Bornite

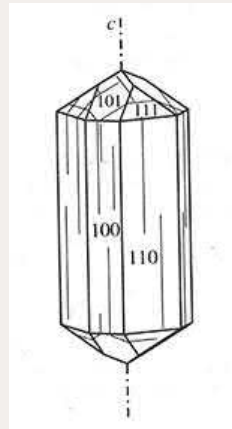




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Rutile

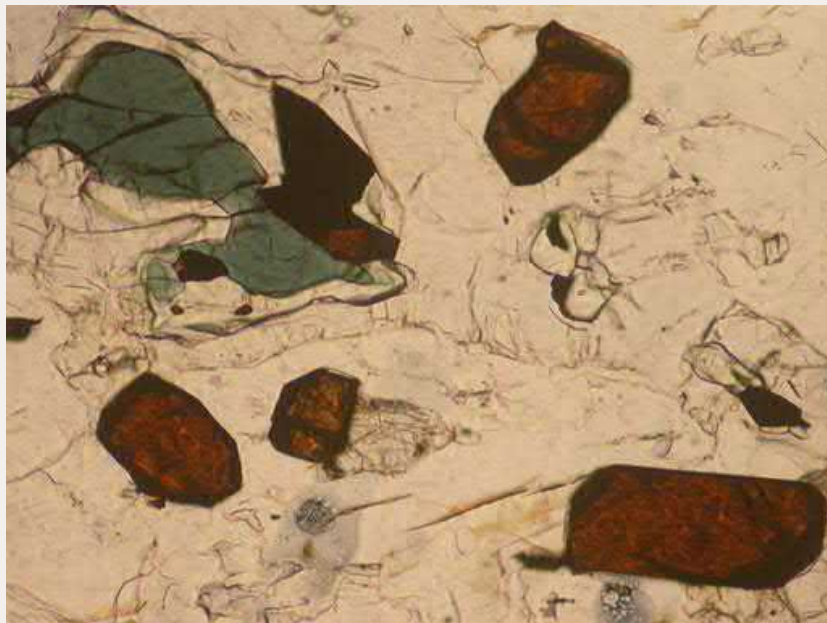
TiO_2





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Rutile

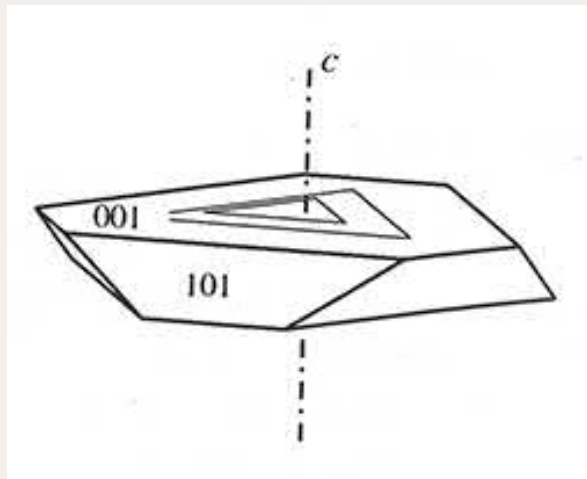




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Hematite

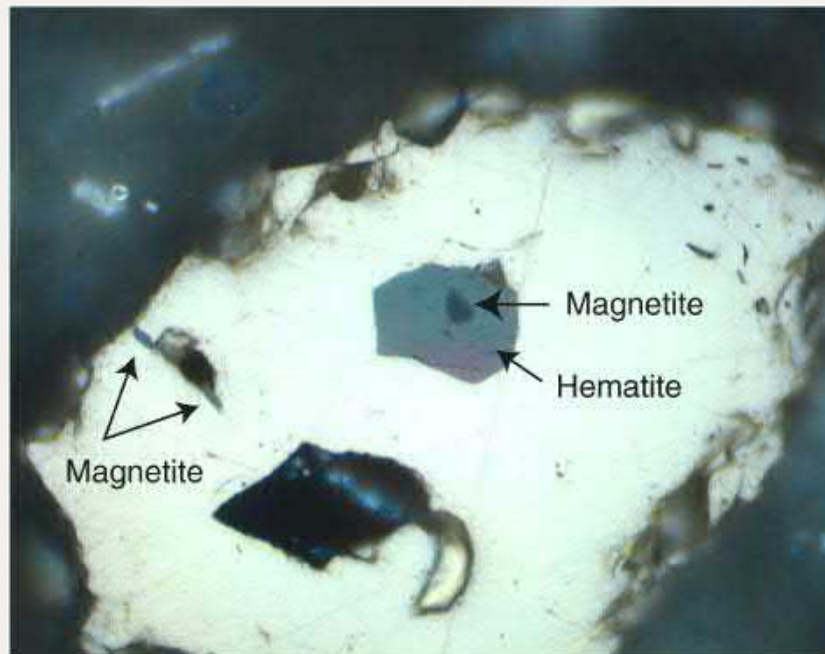
Fe_2O_3





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Hematite

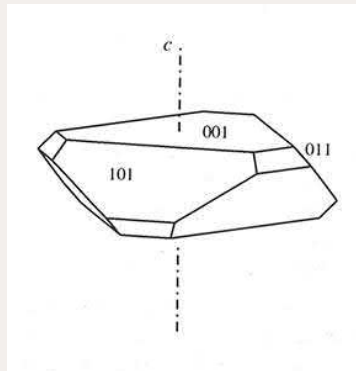




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Ilmenite

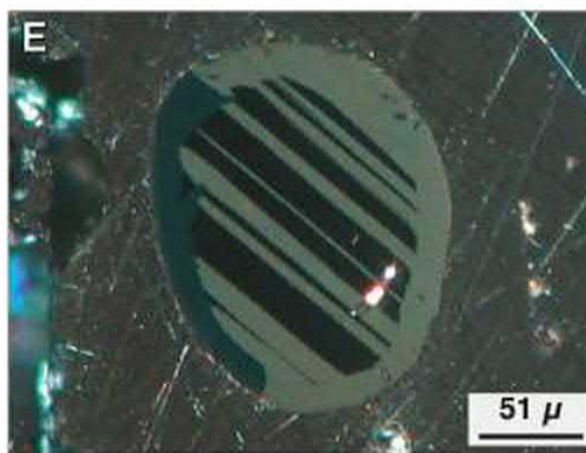
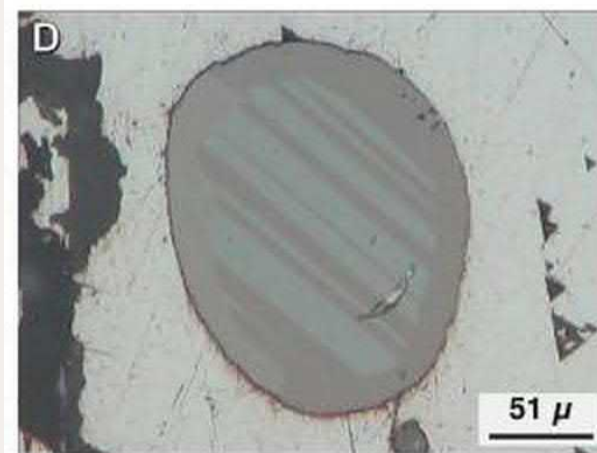
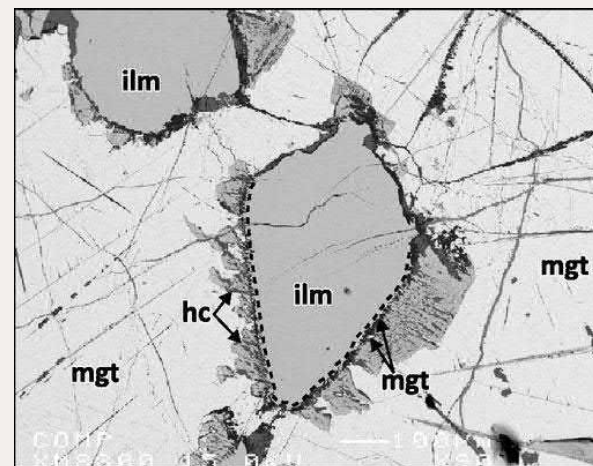
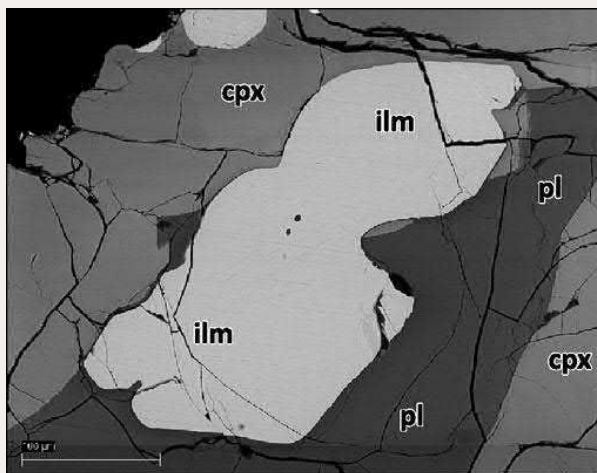
FeTiO_3





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Ilmenite

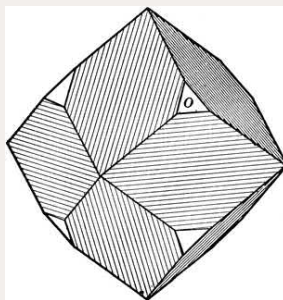
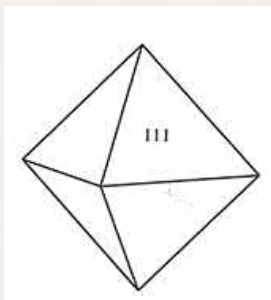




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Magnetite

Fe_3O_4





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Magnetite

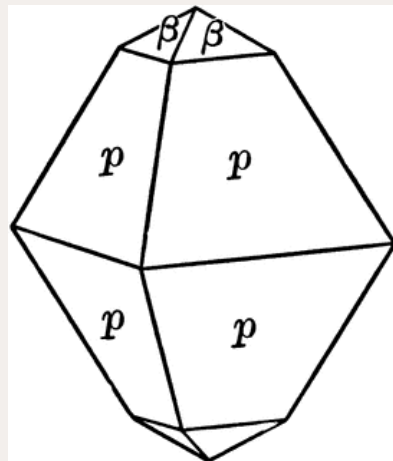




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Scheelite

$\text{Ca}(\text{WO}_4)$





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Scheelite

