Heavy Mineral Analysis

Learning objectives

1. Know what heavy minerals are;
2. How they may be isolated and prepared to complement an investigation;
3. How they may be used to characterize sediment and sedimentary environments

Heavy Minerals

- Have a density > than 2.8 g/cm^3
- Usually volumetrically insignificant, but they can tell important stories about the geologic history of specific areas (if present)
- Studied in sands and sandstones

Heavy Minerals cont.

- A great tool for investigating, Provenance
  - Garnet, Staurolite, Kyanite common in Metamorphic rocks
  - Augite, Magnetite, Olivine common in Igneous rocks
- May be problematic, but still a useful data
  - Weathering (chemical and mechanical)
  - Burial diagenesis
  - Preferential sorting

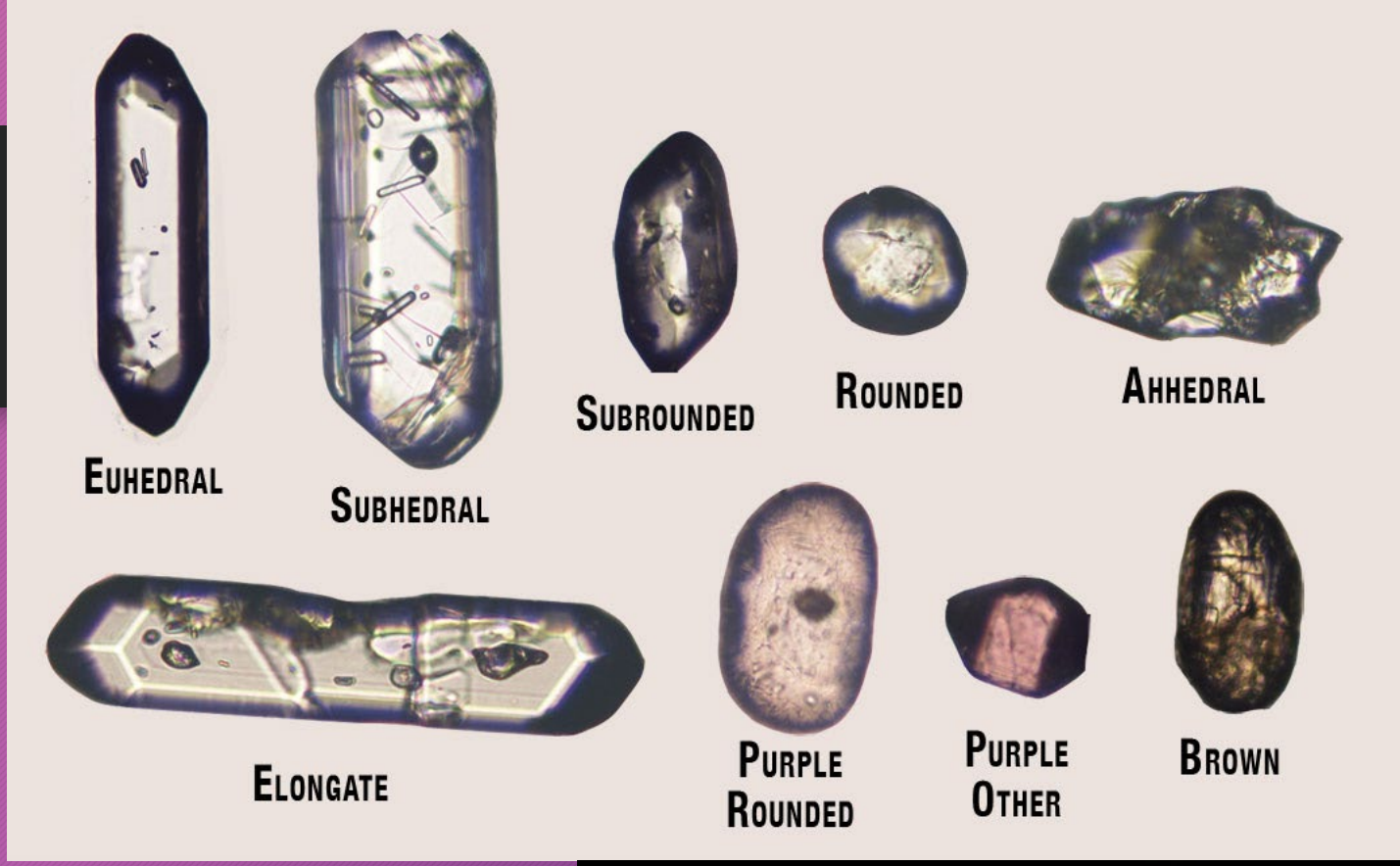
Common heavy minerals

Zircon $ZrSiO_4$

- Color – many
- ID – Extreme relief

Crystalline vs rounded

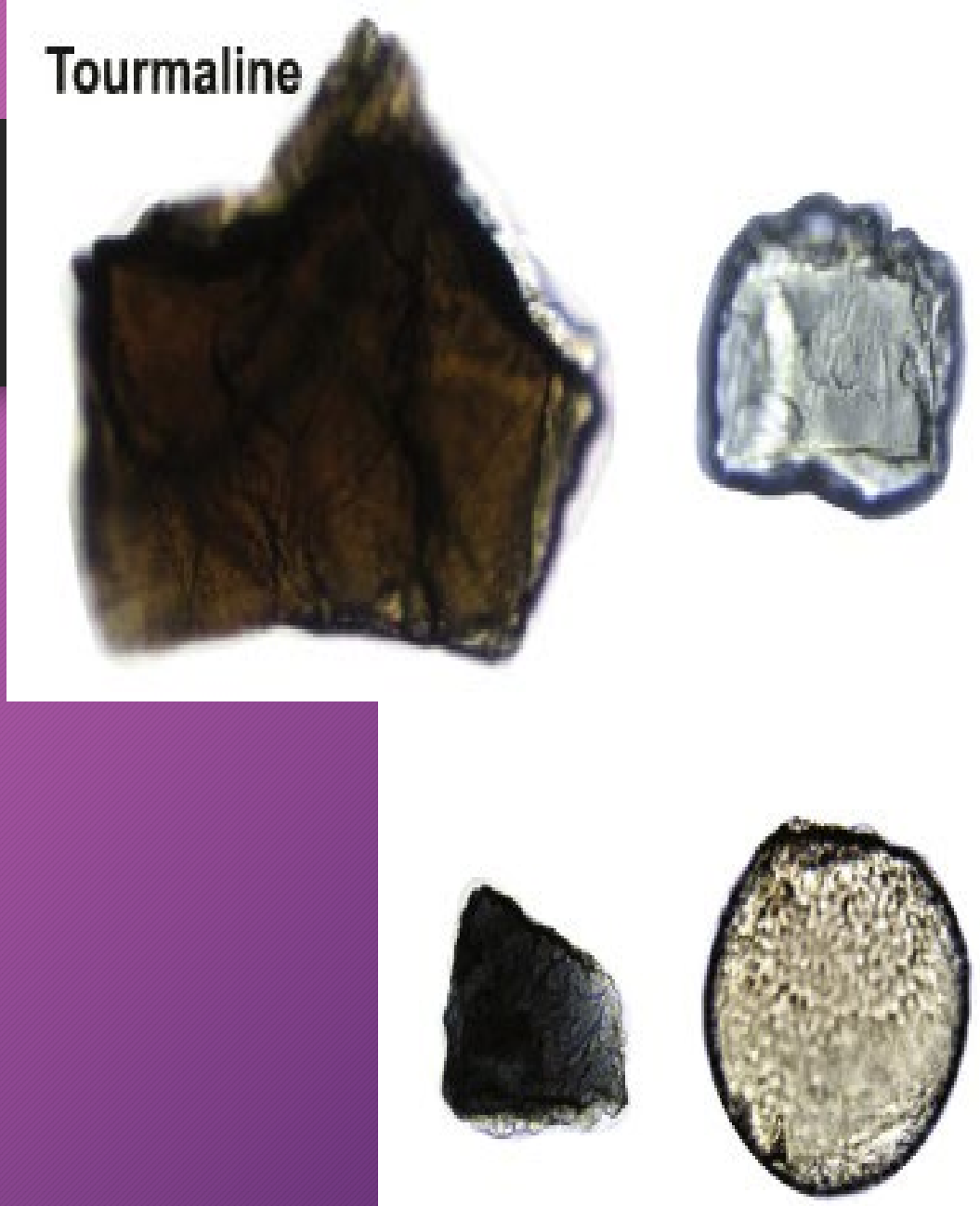
- Occurrence – Igneous intrusive



Tourmaline

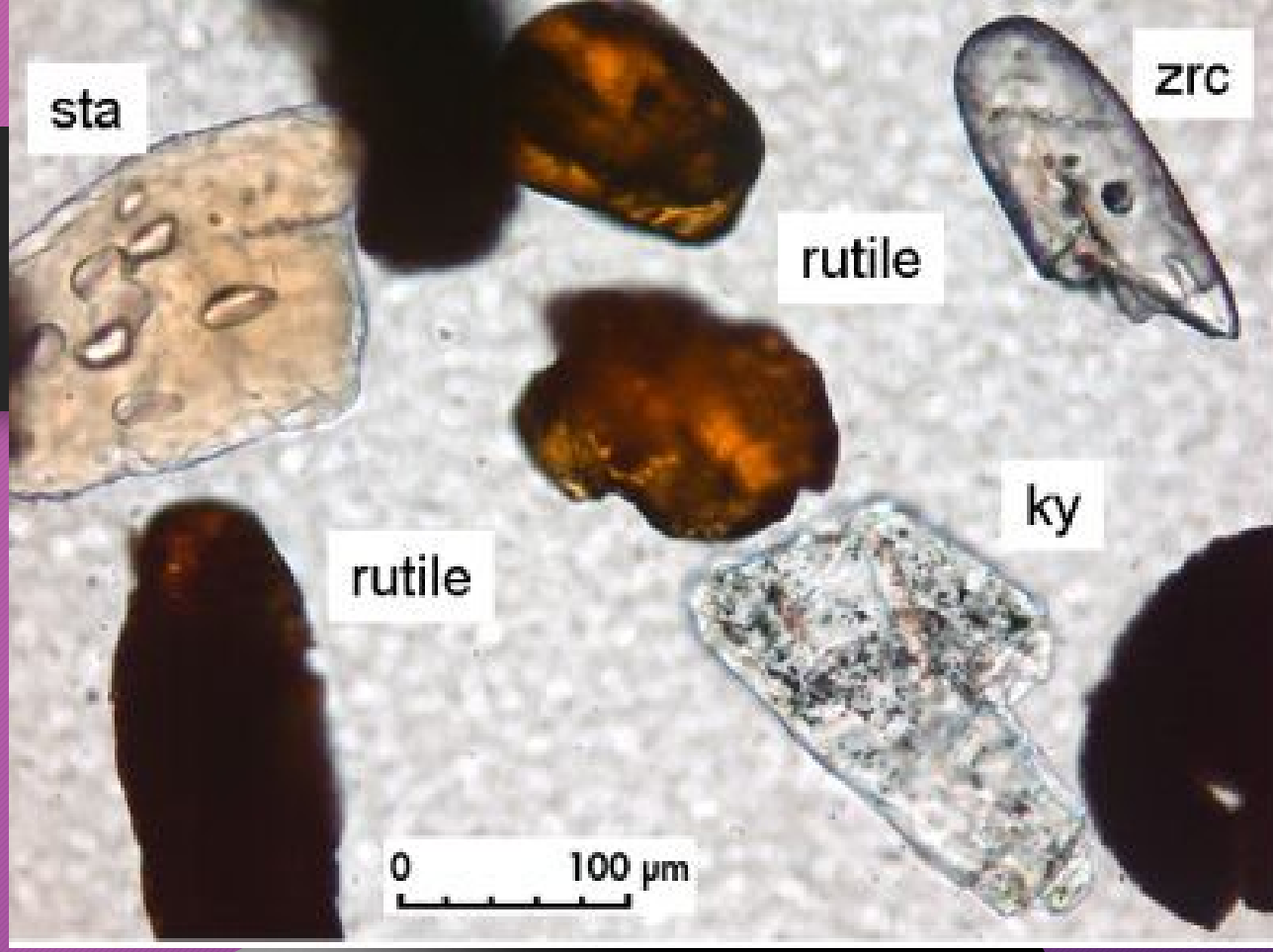
$(Ca,K,Na)(Al,Fe,Li,Mg,Mn)_3\ (Al,Cr,Fe,V)_6\ (BO_3)_3(Si,Al,B)_6O_{18}(OH,F)$

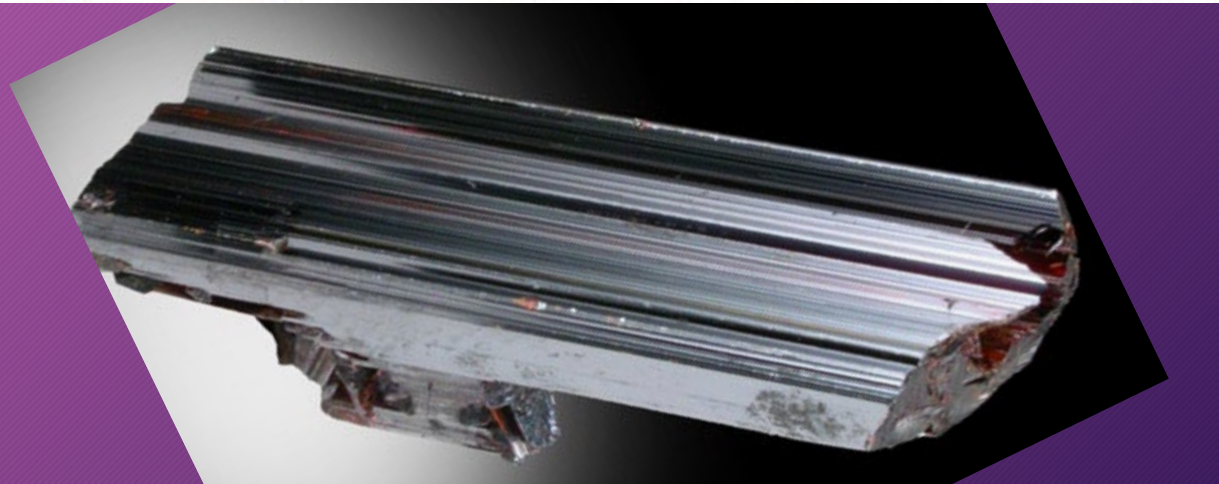
- Color – many
- ID – Strong birefringence, high order interference tints, moderate relief
- Occurrence – Igneous intrusive and metamorphic



Rutile, TiO2

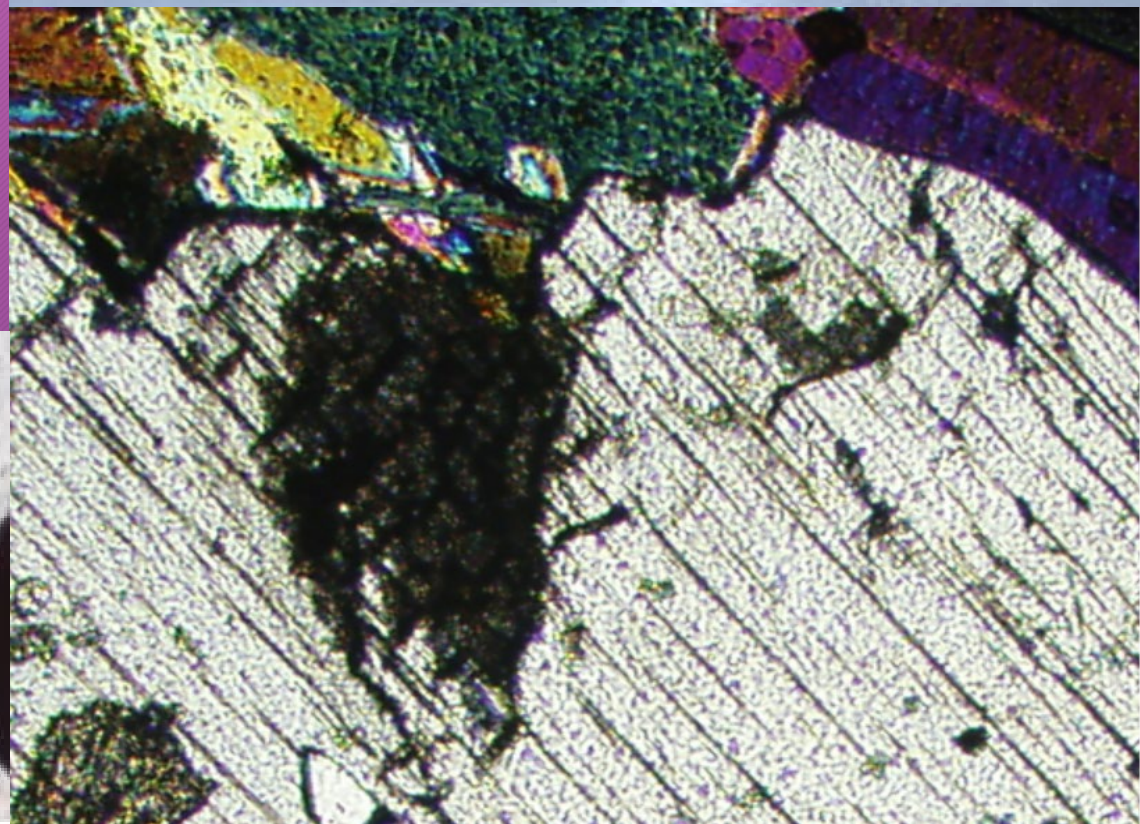
- Color – Shades of red
- ID – High relief, deep (reddish) color
- Occurrence – Common in metamorphic (e.g. schists)

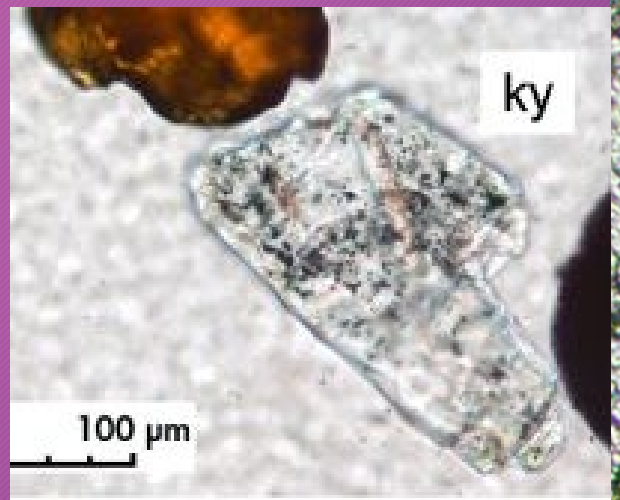




Kyanite, Al_2SiO_5

- Color – colorless to blue (rare)
- ID – perfect cleavage, parting, good interference
- Occurrence – common in gneiss, schists (metamorphic terranes)





Magnetite, Fe_3O_4

Color - Black, gray brownish tint

ID – Opaque in thin section

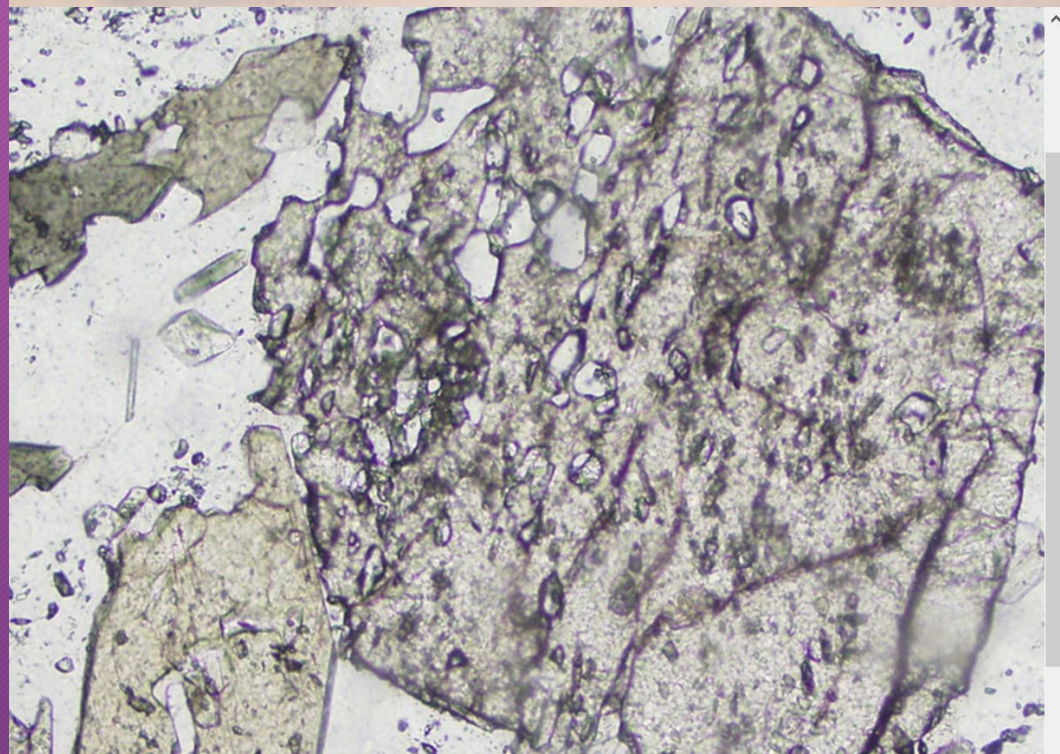
Source -

Galena, PbS

- Color – Metallic ‘silver’
- ID - Opaque – Still metallic
- Source - Ig./Met. and
- Carbonate secondary

Garnet, $Fe_3Al_2Si_3O_{12}$ **Almandine**

- Color – colorless, light pink, pale red
- Id. – High relief,
- Occurrence – common in metamorphic terrane and some igneous intrusive settings

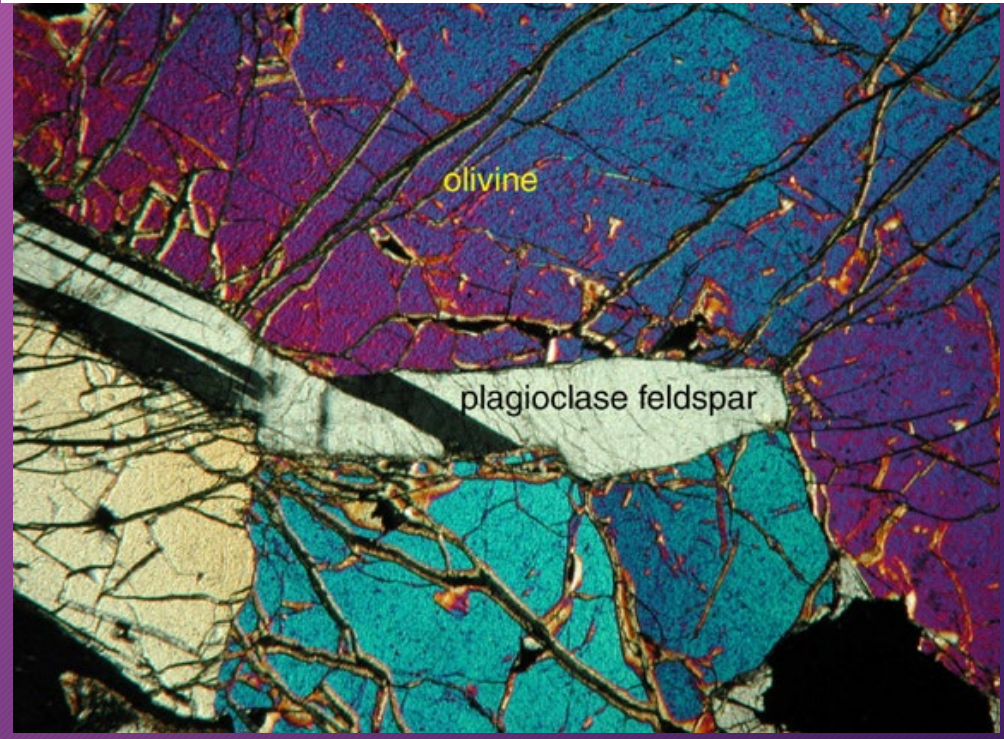


Olivine, (Mg,Fe)2SiO4

Color – colorless or pale green

ID – High relief, vivid interference colors

Occurrences - Basic igneous rocks, ultra mafic / dense terranes



Apatite, $Ca_5(PO_4)$

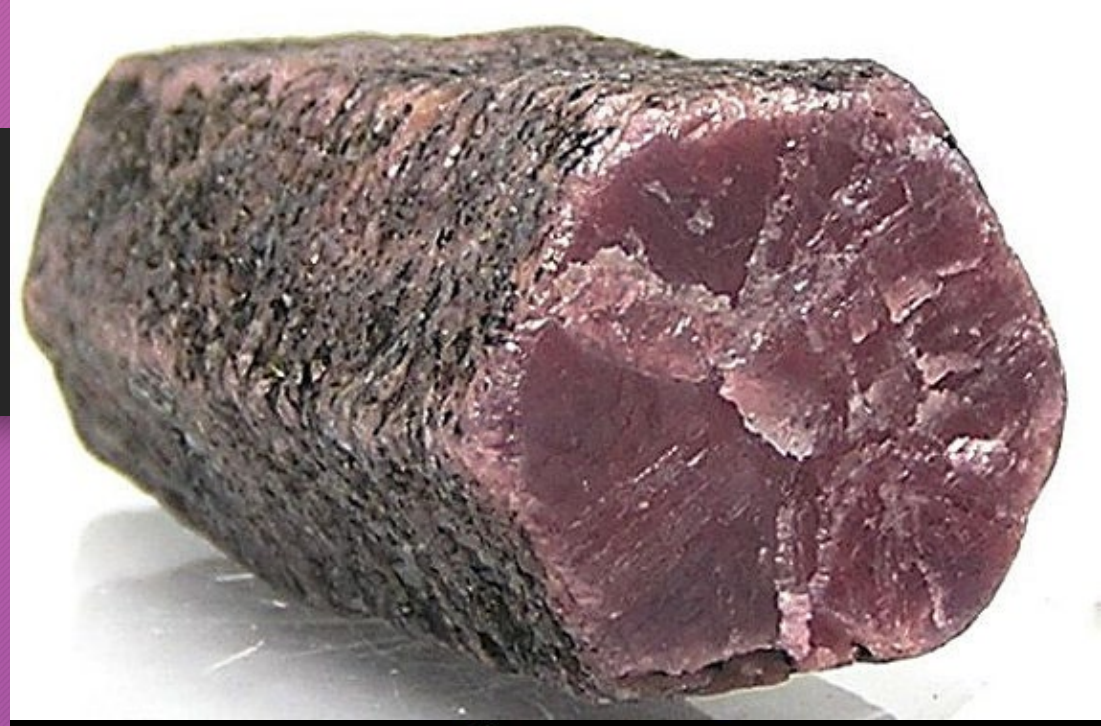
Color – colorless, to weak reddish tint

Id- Moderate relief, weak birefringence

Occurrence – common accessory mineral in igneous rocks

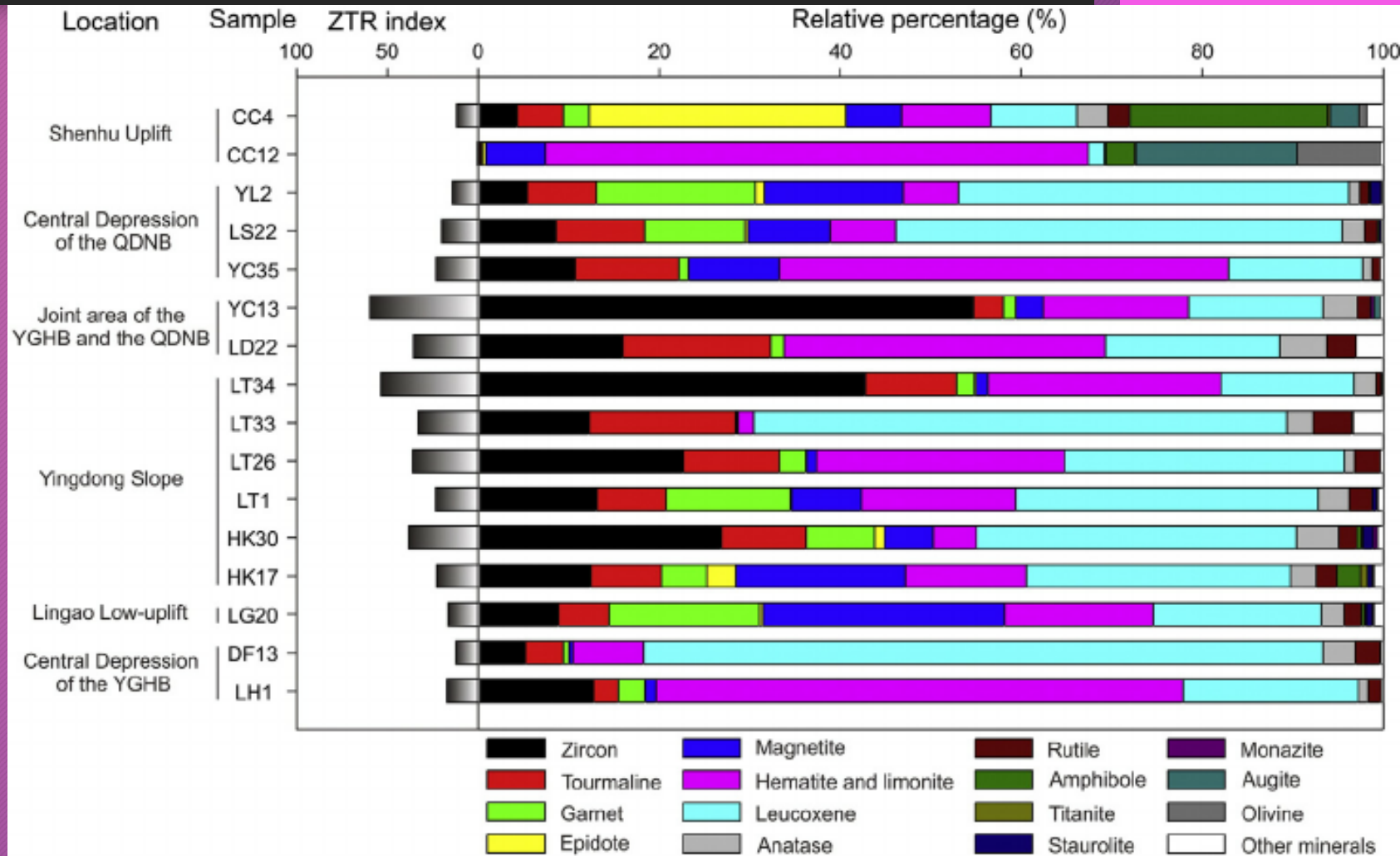
Corundum, Al_2O_3

- Color Clear, blue, red, pink, yellow, grey, golden-brown
- ID – Density 3.98 to 4.02,
- Occurrence – Silica poor igneous rocks, hornfels. Carbonate metamorphic rocks

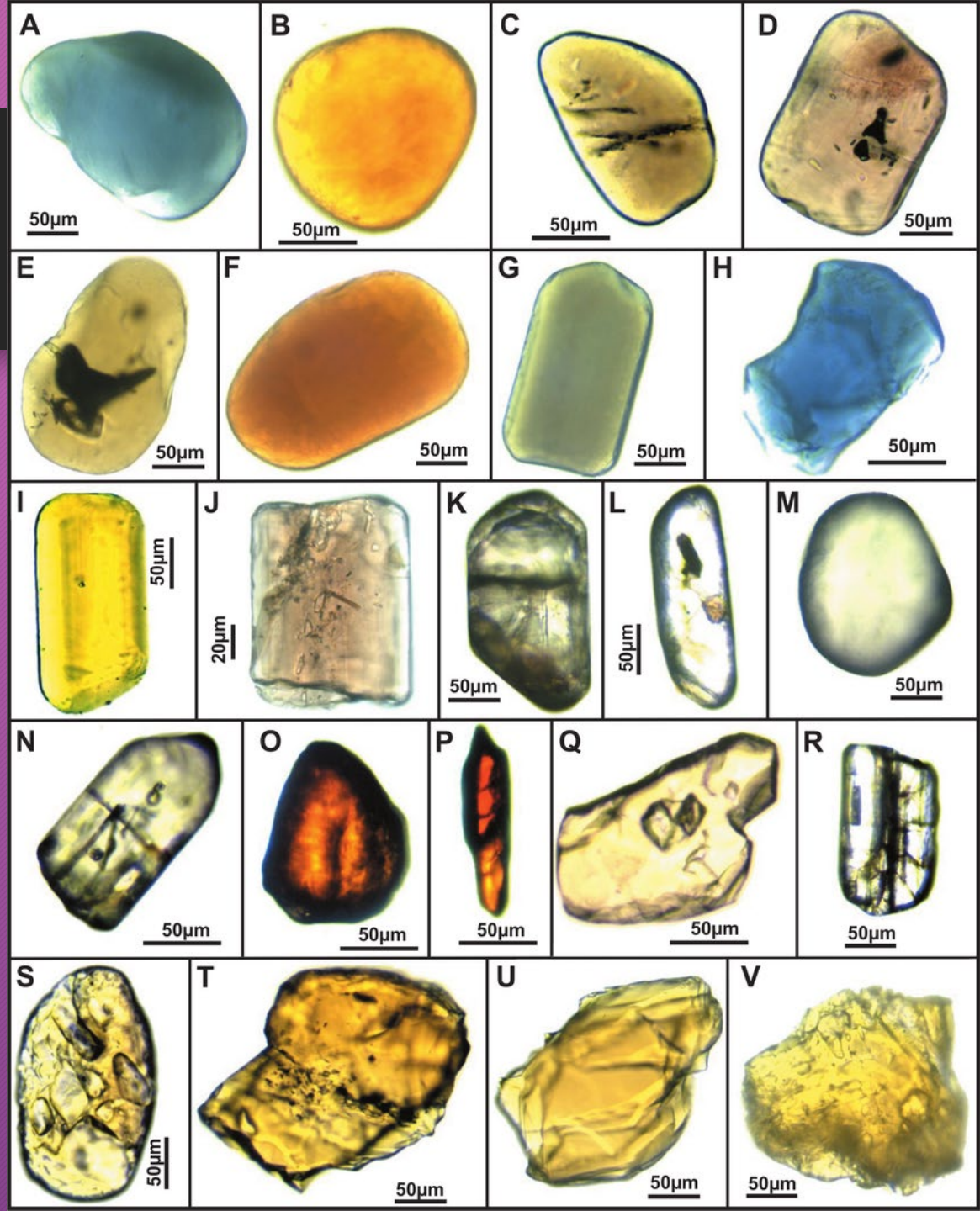


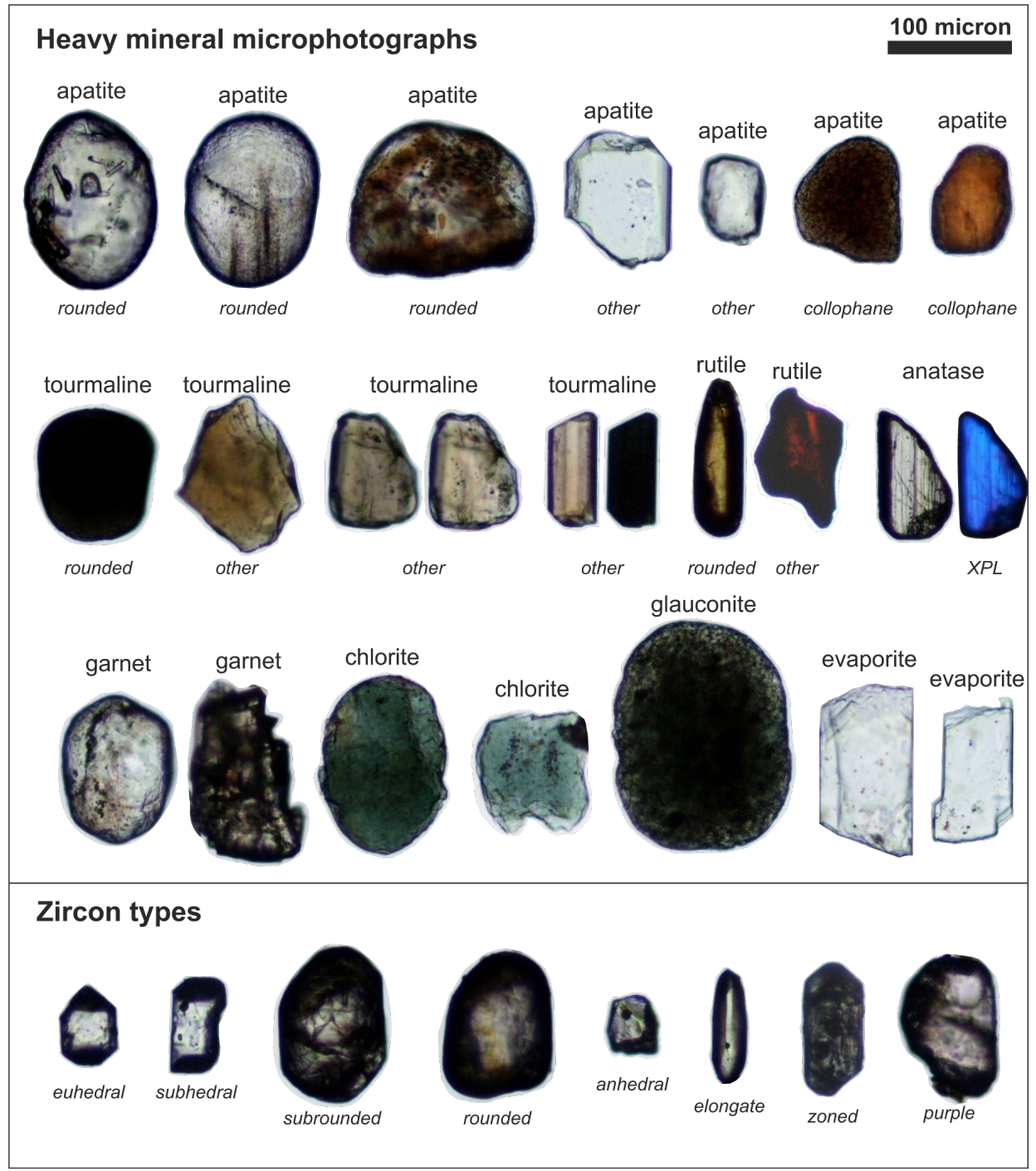
Zircon-Tourmaline-rutile (Z-T-R) Index

- Weathering profiles



- Figure 7 -Photomicrographs of non-micaceous transparent heavy minerals from fine-and very fine-grained sands of colluvial deposits (1) and from the Bauru Group (2). Tourmalines: well-rounded (1A and 1B), with prismatic inclusions (1C), rounded-edge (1D, 2E, 2F and 2G), irregular blue (2H), with little rounded euhedral terminations (1I), prismatic pink with euhedral terminations and inclusions (2J); Zircon: prismatic colorless with zoning (1K), with little rounded-edges (1L) and spheric and well-rounded 1(M) and with inclusions (2N); Rutile: prismatic red with subrounded edges (1O) and prismatic forms suggestive of pyramidal terminations with striations (2P); Garnet: pink to colorless with inclusions (2Q); Kyanite: prismatic colorless (1R); Staurolite: prismatic with rounded edges and inclusions (1S) and irregular yellow with zigzag saw-like edges (1T, 2U and 2V).




Heavy mineral microphotographs
100 micron
apatite
rounded
apatite
rounded
apatite
rounded
apatite
other
apatite
other
apatite
collophane
apatite
collophane
tourmaline
rounded
tourmaline
other
tourmaline
other
tourmaline
other
rutile
rounded
rutile
other
anatase
XPL
garnet
garnet
chlorite
chlorite
glauconite
evaporite
evaporite
Zircon types
euhedral
subhedral
subrounded
rounded
anhedral
elongate
zoned
purple

Franz Magnetic Separator