GEOS 254 Lecture 2: FELDSPARS

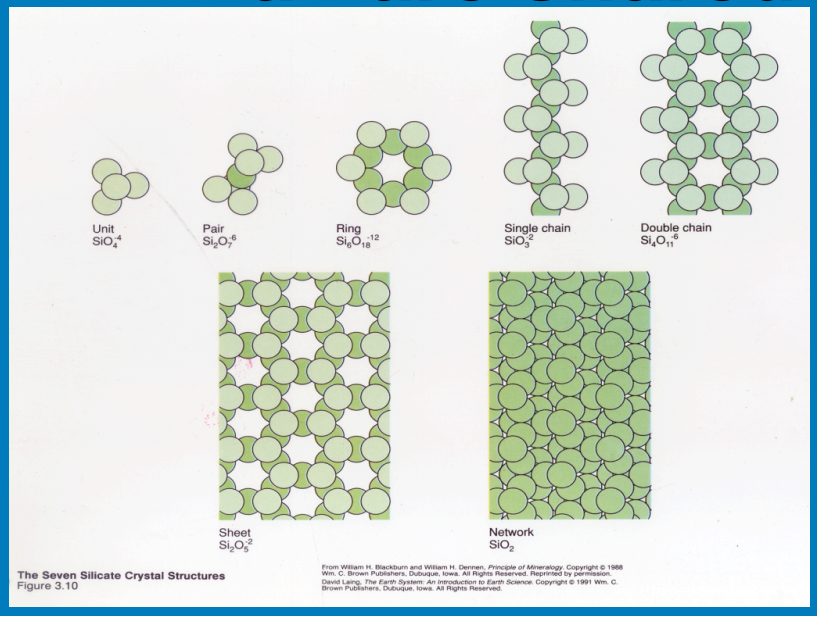
- Feldspars are the most abundant minerals in the crust (very minor in the mantle).
- Three main end members:
  - Albite *Ab* $NaAlSi_3O_8$
  - Anorthite *An* $CaAl_2Si_2O_8$
  - Orthoclase *Or* $KAlSi_3O_8$

  The plagioclase feldspars are solid solutions of **albite** and **anorthite**. Na^+ Si^{4+} is replaced by Ca^{2+} Al^{3+}

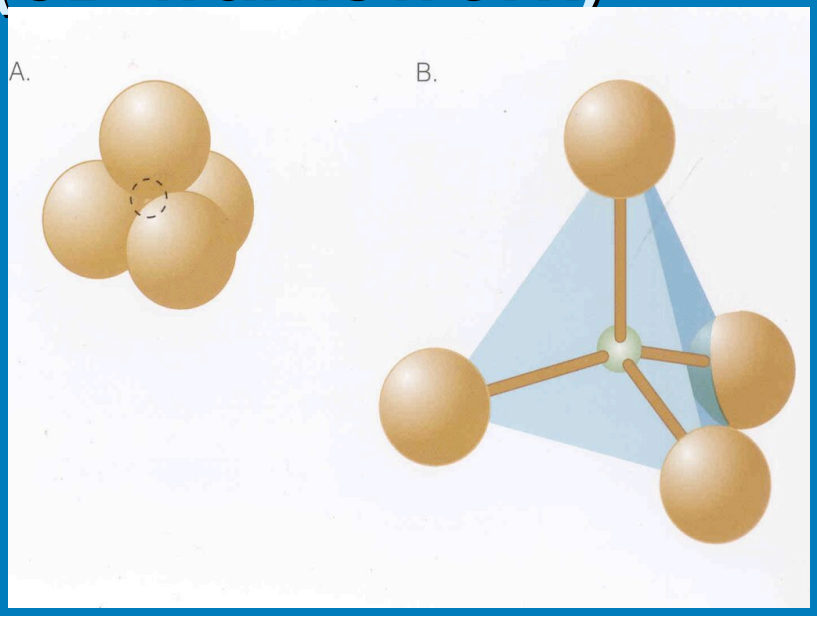
  The alkali feldspars are solid solutions of **albite** and **orthoclase**. Na is replaced by K

  There is virtually no solid solution between An and Or.

Silicate minerals have silicon tetrahedra that are variably interconnected. In olivine they are isolated (none of the four oxygens are shared with the adjacent tetrahedra). In pyroxenes one oxygen is shared (chains). In amphiboles two are shared (double chain). In micas three are shared (sheets) and in quartz & feldspar all are shared (3D framework)



The Seven Silicate Crystal Structures
Figure 3.10



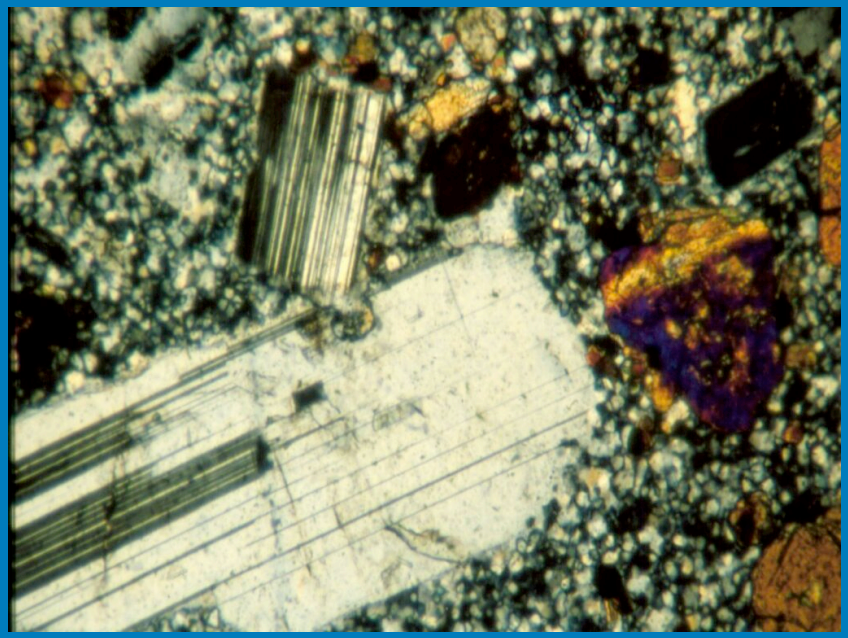
Plagioclase Feldspars

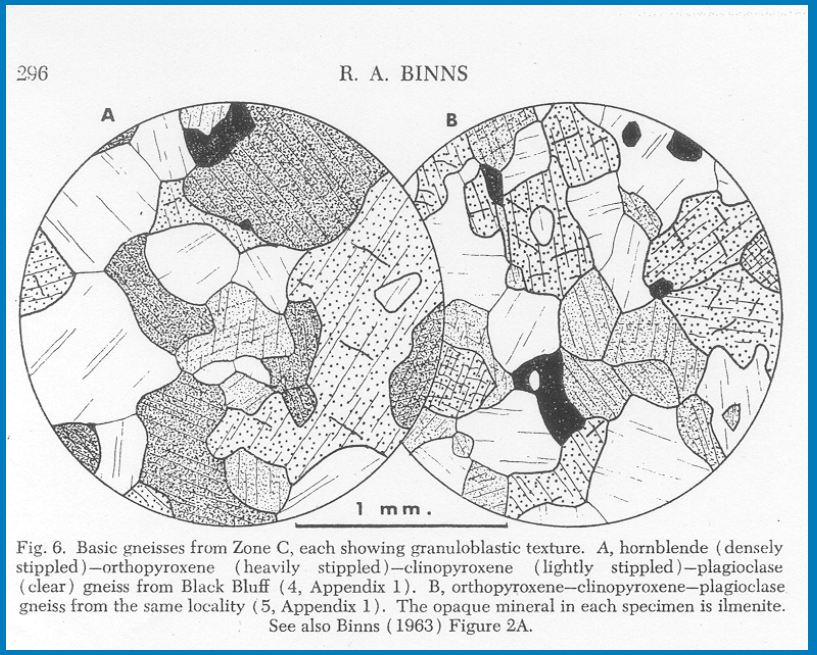
- Are “triclinic” (no axes at 90^{o})
- Have multiple twinning (albite) & can also have pericline twinning (multiple) forming a coarse grid twinning.
- In igneous rocks form rectangular crystals (more elongate in many volcanic rocks) & commonly have intricate zoning (oscillatory) and many twins.
- In metamorphic rocks form polygonal grains with little zoning and sparse growth twinning.
- Deformation twins can occur in both rock types.

K-feldspar

- K-feldspar has three different structural states: K-feldspar formed at high temperature and cooled quickly is **sanidine**. If formed at high temperature and cooled slowly (plutonic) or formed at moderate temperatures are **orthoclase.** If formed at low temperature are **microcline**. Sanidine and orthoclase are monoclinic and have no multiple twinning. Microcline is triclinic and has fine grid or tartan twinning.

Feldspars are rectangular in igneous rocks and polygonal in mm





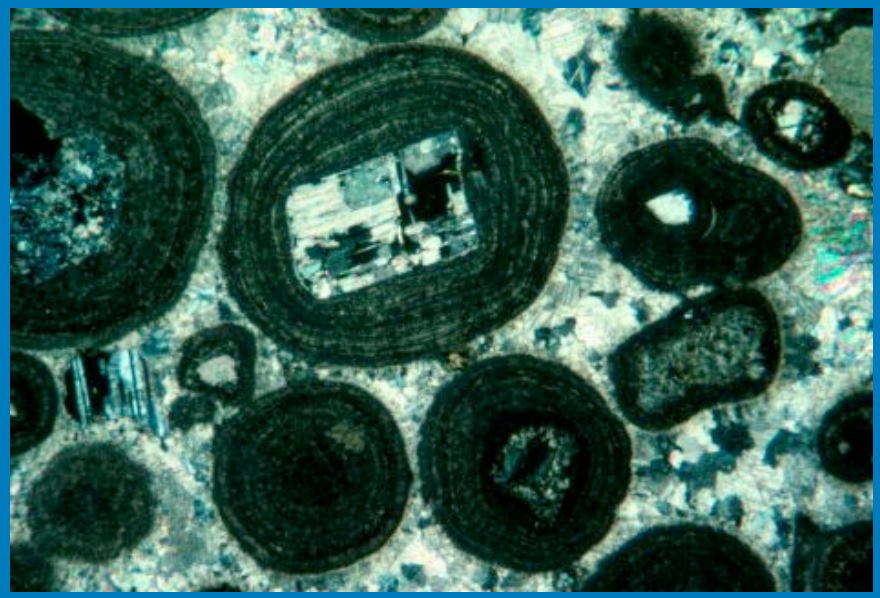
296 R. A. BINNS

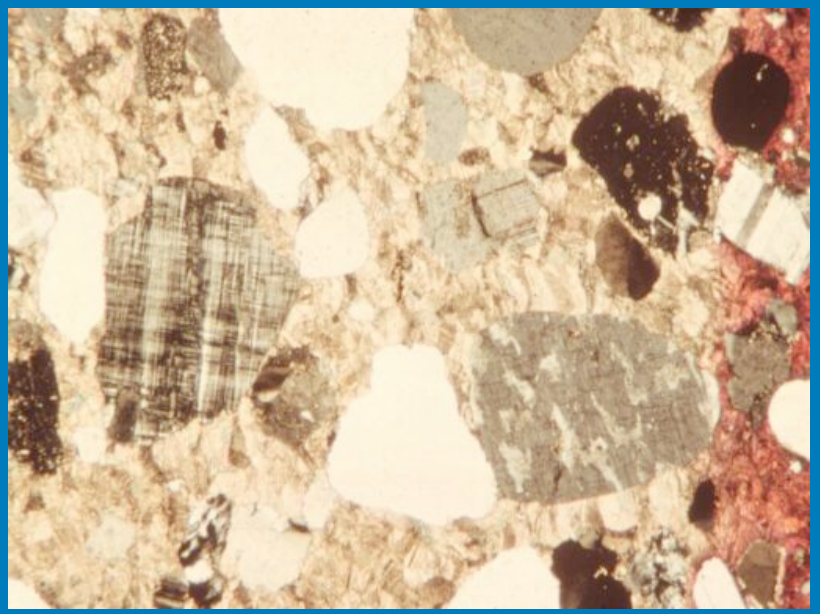
Fig. 6. Basic gneisses from Zone C, each showing granuloblastic texture. *A*, hornblende (densely stippled)—orthopyroxene (heavily stippled)—clinopyroxene (lightly stippled)—plagioclase (clear) gneiss from Black Bluff (4, Appendix 1). B, orthopyroxene—clinopyroxene—plagioclase gneiss from the same locality (5, Appendix 1). The opaque mineral in each specimen is ilmenite. See also Binns (1963) Figure 2A.

- Complex zoning common in igneous not in mm.
- Growth twins common in igneous, sparse in mm.

Feldspar in sedimentary rocks

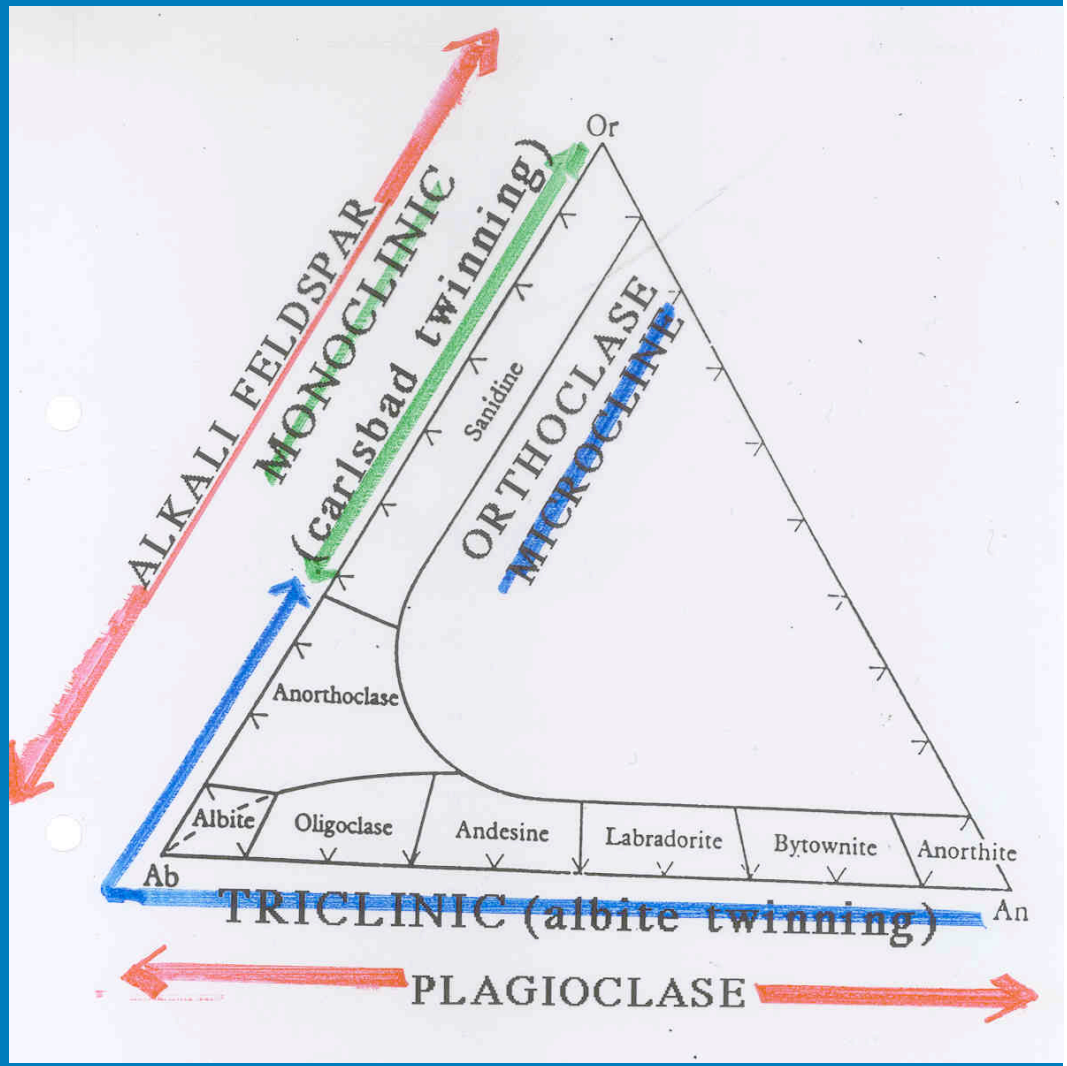
- A: Rectangular plagioclase (volcanic ash) forming nucleus for oolite in limestone at Keepit.
- B: Microcline and perthite grains in sandstone. Pink colour on right is a stain that shows the carbonate cement is calcite (not dolomite).





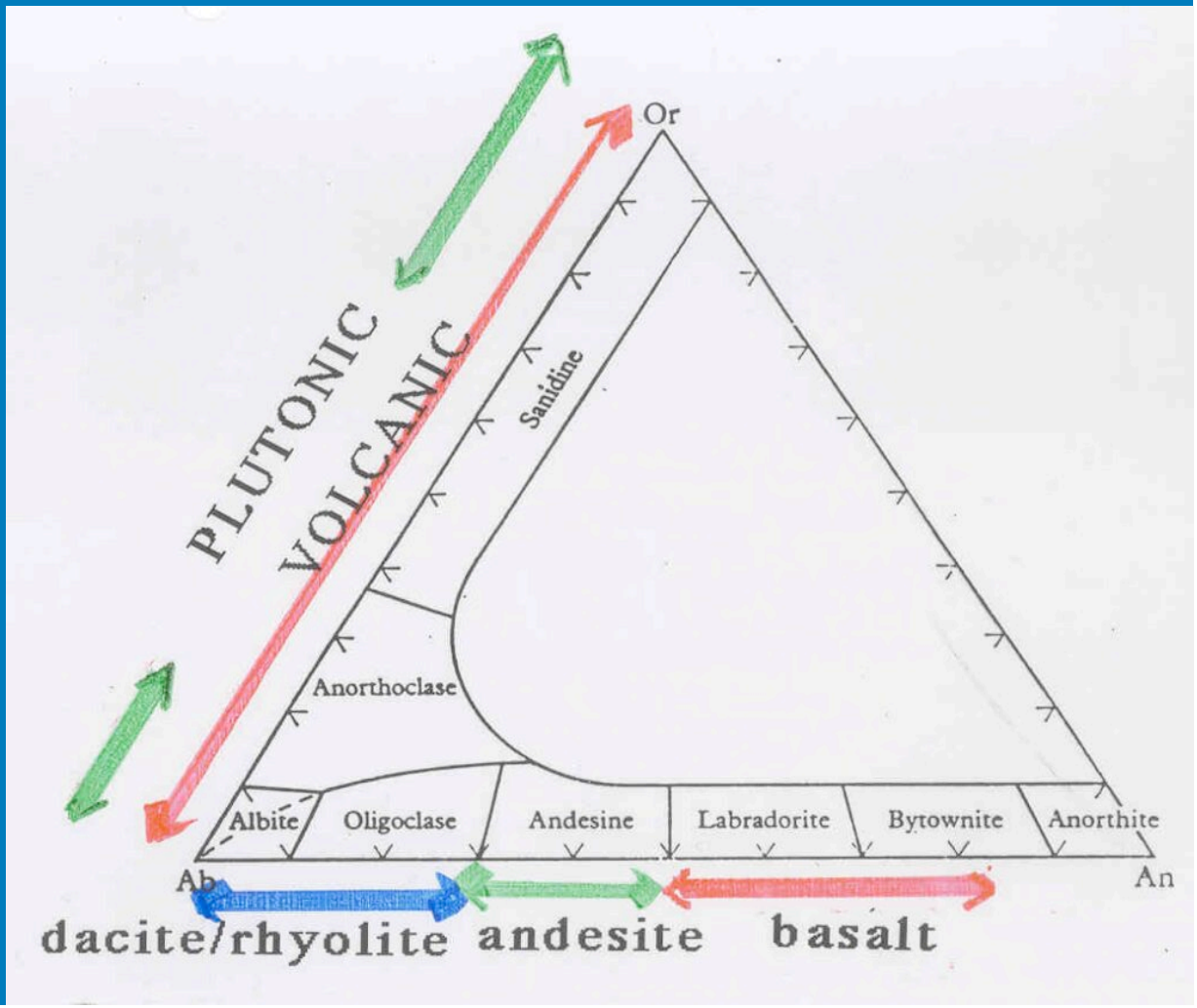
3 main feldspar end-members (Ab, An, Or)

- 2 series (red arrows), plagioclase and alkali feldspar.
- Plagioclase, anorthoclase & microcline are triclinic (blue arrows) and have multiple twinning.
- Orthoclase & sanidine are monoclinic (green arrows) and only have simple twins.



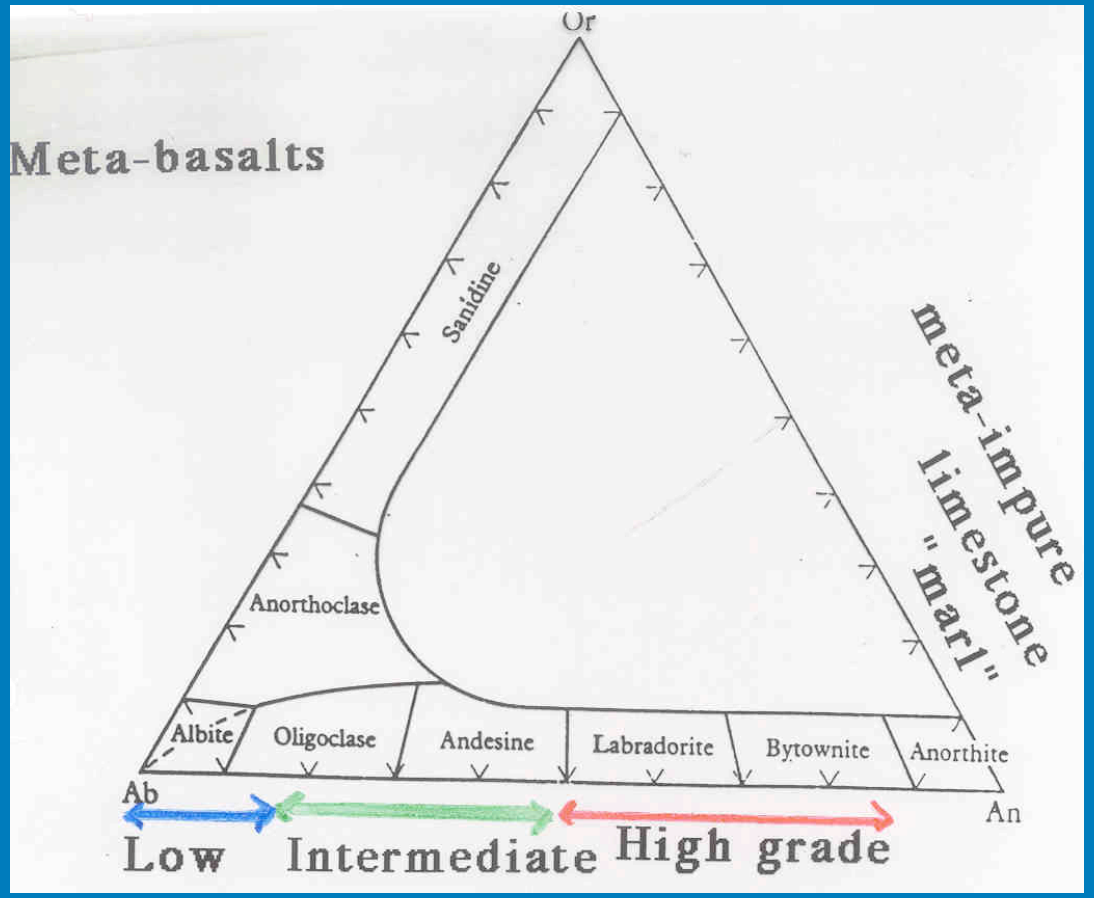
Feldspars in igneous rocks.

- Basalt An> 50; andesite An 30 –50; dacite & rhyolite An< 30.
- High temperature volcanic alkali-feldspars from Ab to Or (sanidine or anorthoclase).
- Plutonic: K-rich or Na-rich.



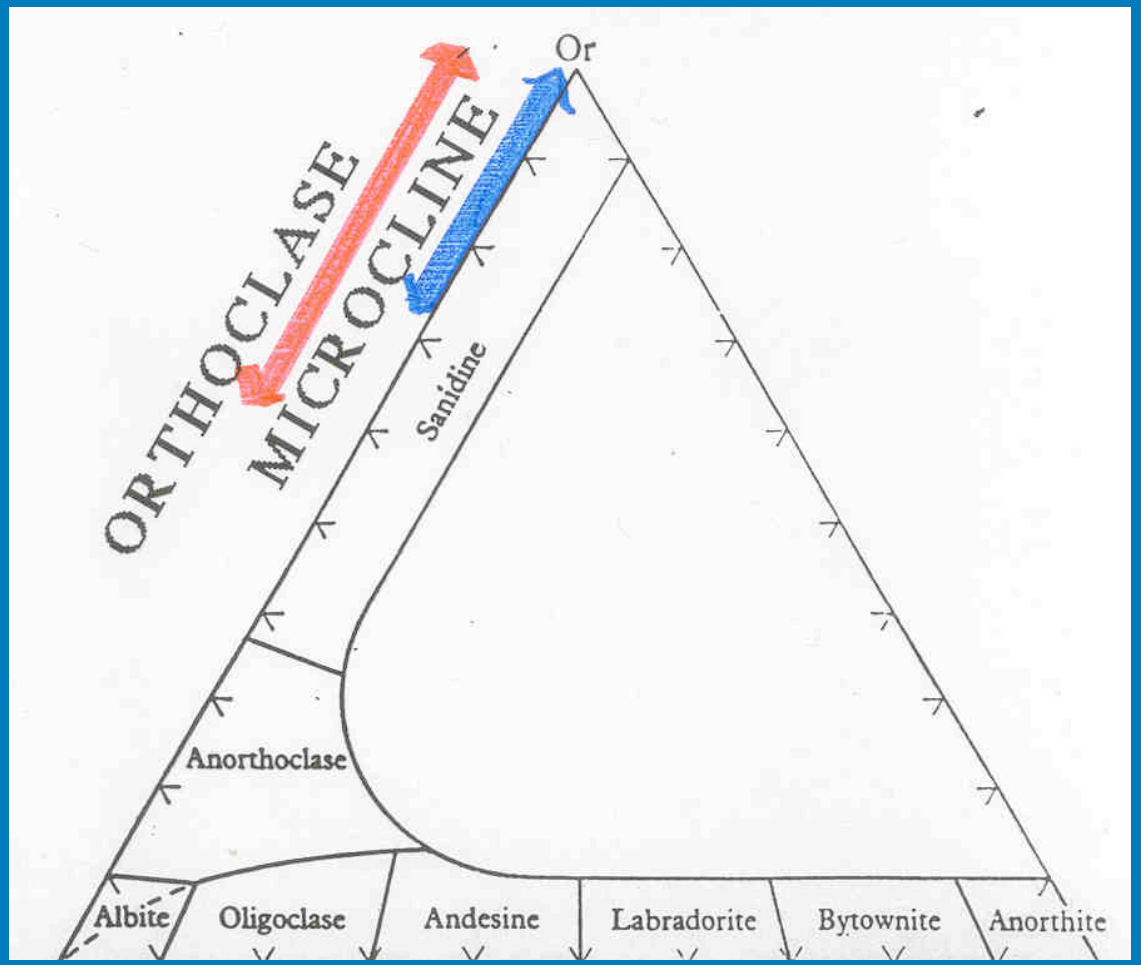
Plagioclase in meta basalt.

- Basalts & high-grade meta-basalts have An>50
- Low grade metabasalts have An<10 (albite). The Ca & Al is in epidote and hornblende.
- Meta-limestones (marl with clay minerals for Al) have pure anorthite



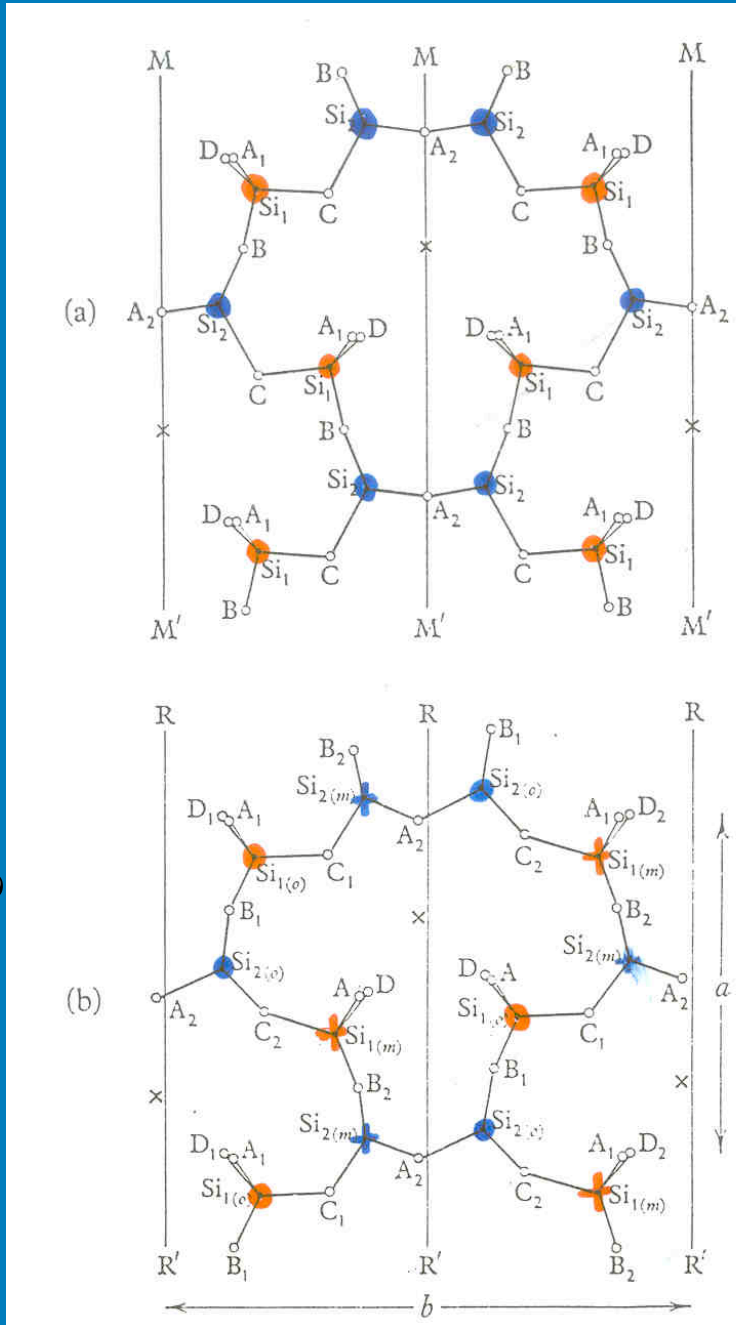
K-feldspar in metamorphic rocks

- Sanidine only in rare ultra high temp contact mm.
- Orthoclase in moderate and high temp mm
- Microcline in low temp. mm rocks.
- Deformation promotes change from meta-stable orthoclase to microcline.

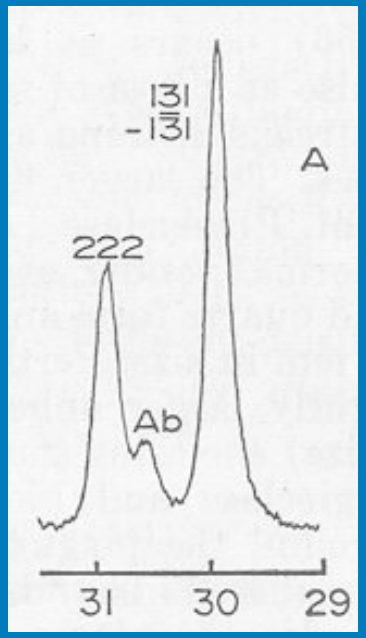


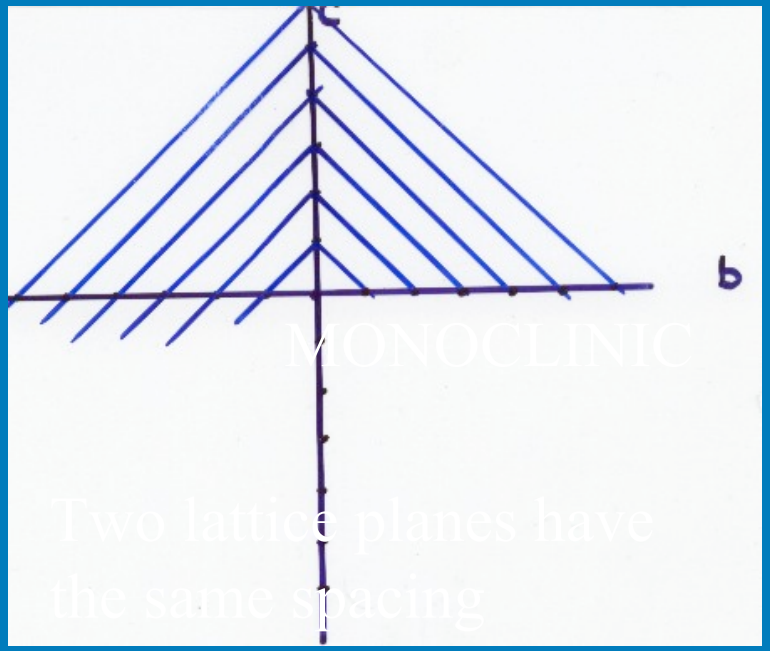
Order/disorder in K-feldspars.

- Sanidine and orthoclase (monoclinic) have 2 different sites for Si and Al.
- Sanidine has no preference with 25% Al & 75% Si in both.
- In orthoclase the red site takes 30% Al and the blue only 20%
- Microcline (triclinic) has four sites. Red dots have 56% Al, blue dots 7%, red + 25%, blue + 8%.



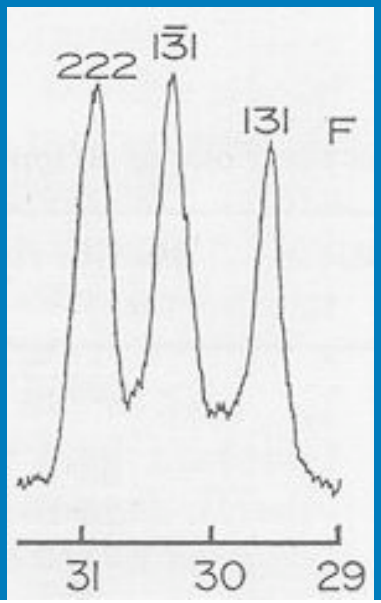
How the change from monoclinic to triclinic is detected by X-ray diffraction

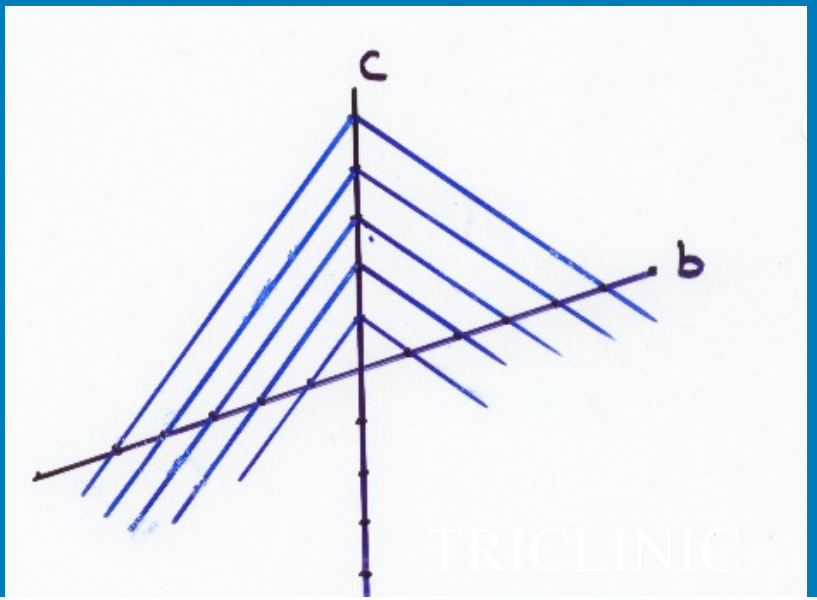




- X-rays are "reflected" by each lattice plane when the angle of incidence is correct.
- n_ = 2D Sin_

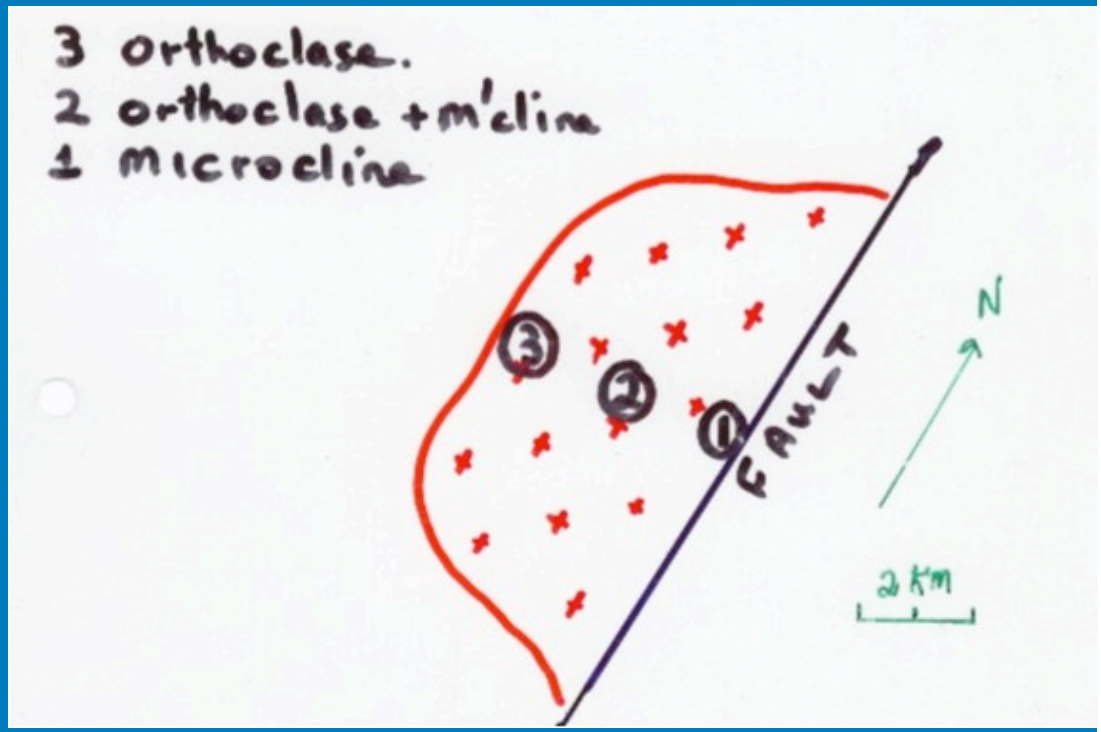
Two lattice planes have different spacing





Orthoclase/microcline

- Deformation of a granite near the fault has allowed the meta-stable orthoclase to transform to microcline.
- What is the cause of the microcline in slide 14 at Bathurst? Is there a hidden fault?



3 metamorphic zones at Broken Hill

- Grade increases to the SE.
- Granitic gneisses in Zone 1 (lowest grade) contain microcline as the K-feldspar.
- Granitic gneisses in Zone 2 (intermediate) and Zone 3 (high grade) contain orthoclase.

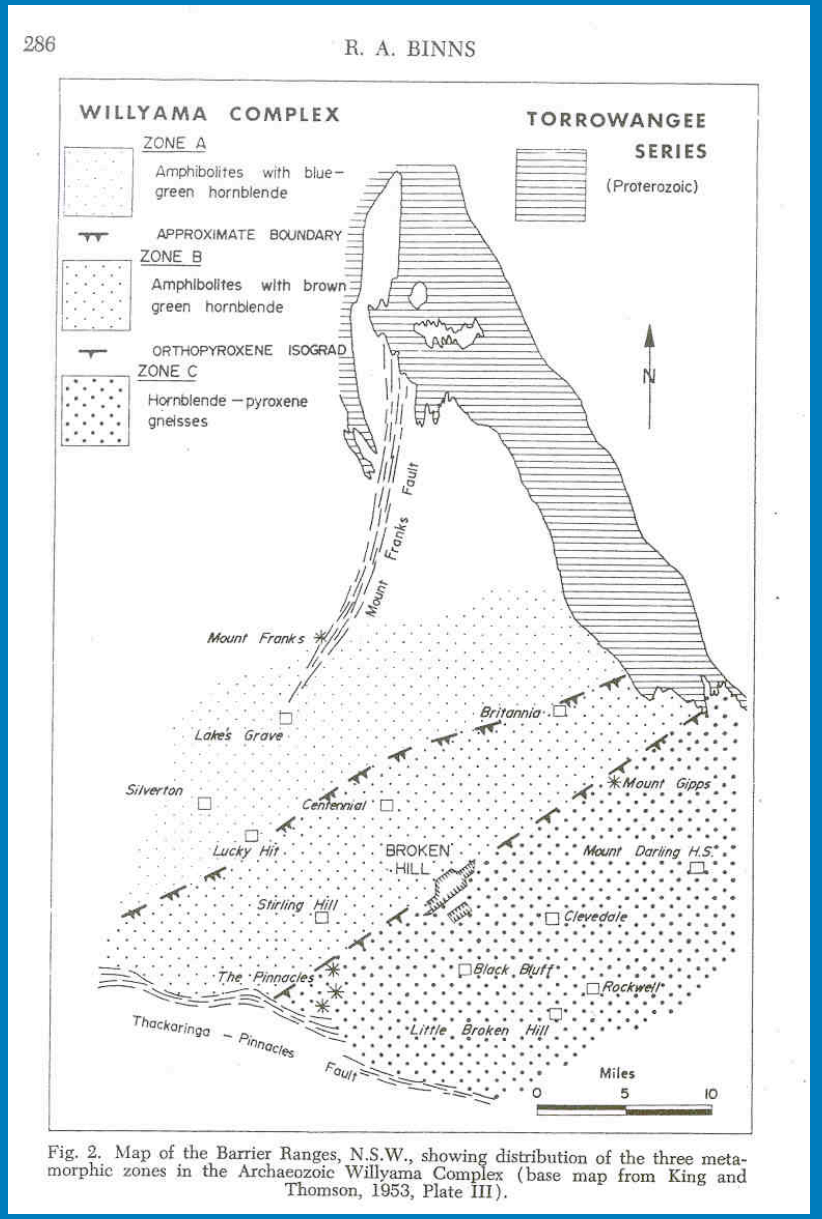


Fig. 2. Map of the Barrier Ranges, N.S.W., showing distribution of the three metamorphic zones in the Archaeozoic Willyama Complex (base map from King and Thomson, 1953, Plate III).

Orthoclase/microcline

- Contact metamorphism of one granite by another later granite.
- In the outer aureole microcline forms.
- In the inner it is disordered to orthoclase.
- Allows the relative age of granites that are close together to be determined.