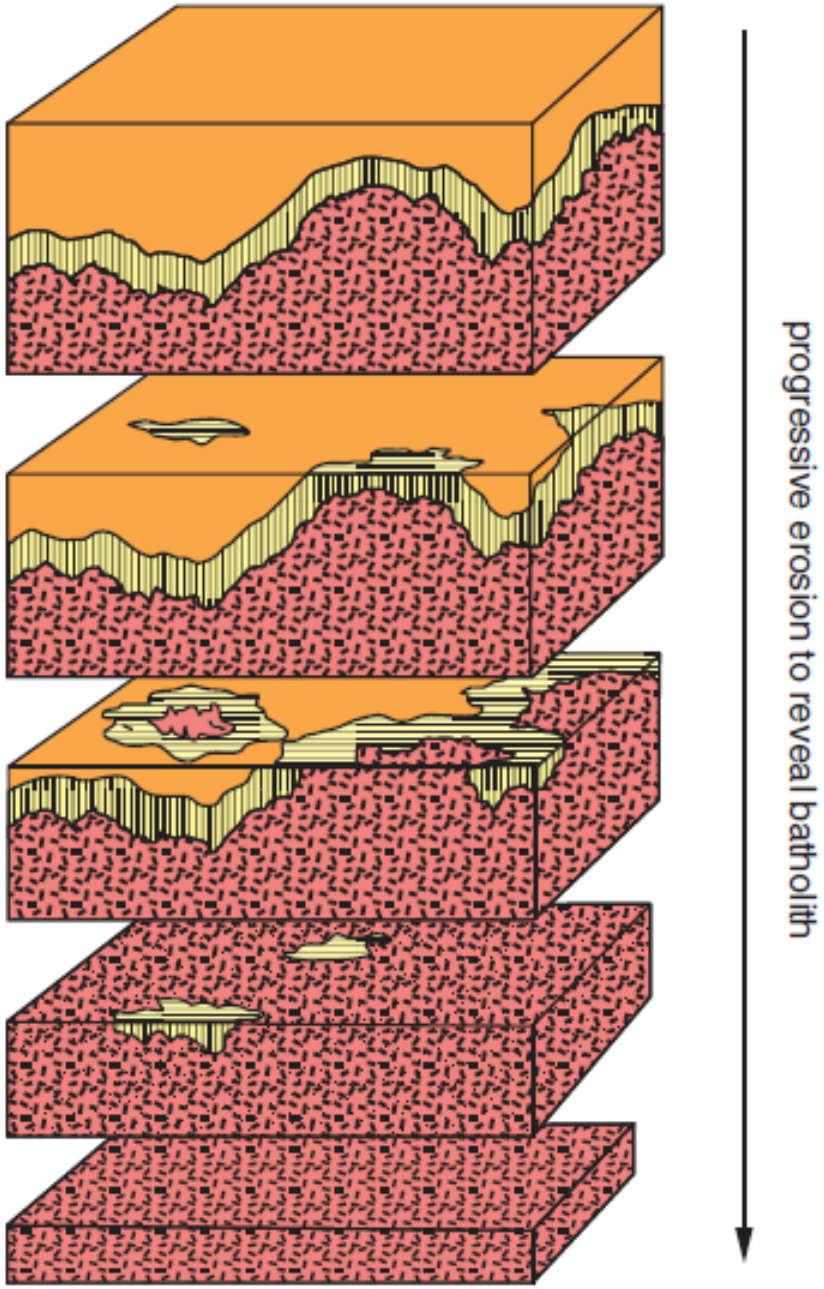
GRANITIC COMPLEXES



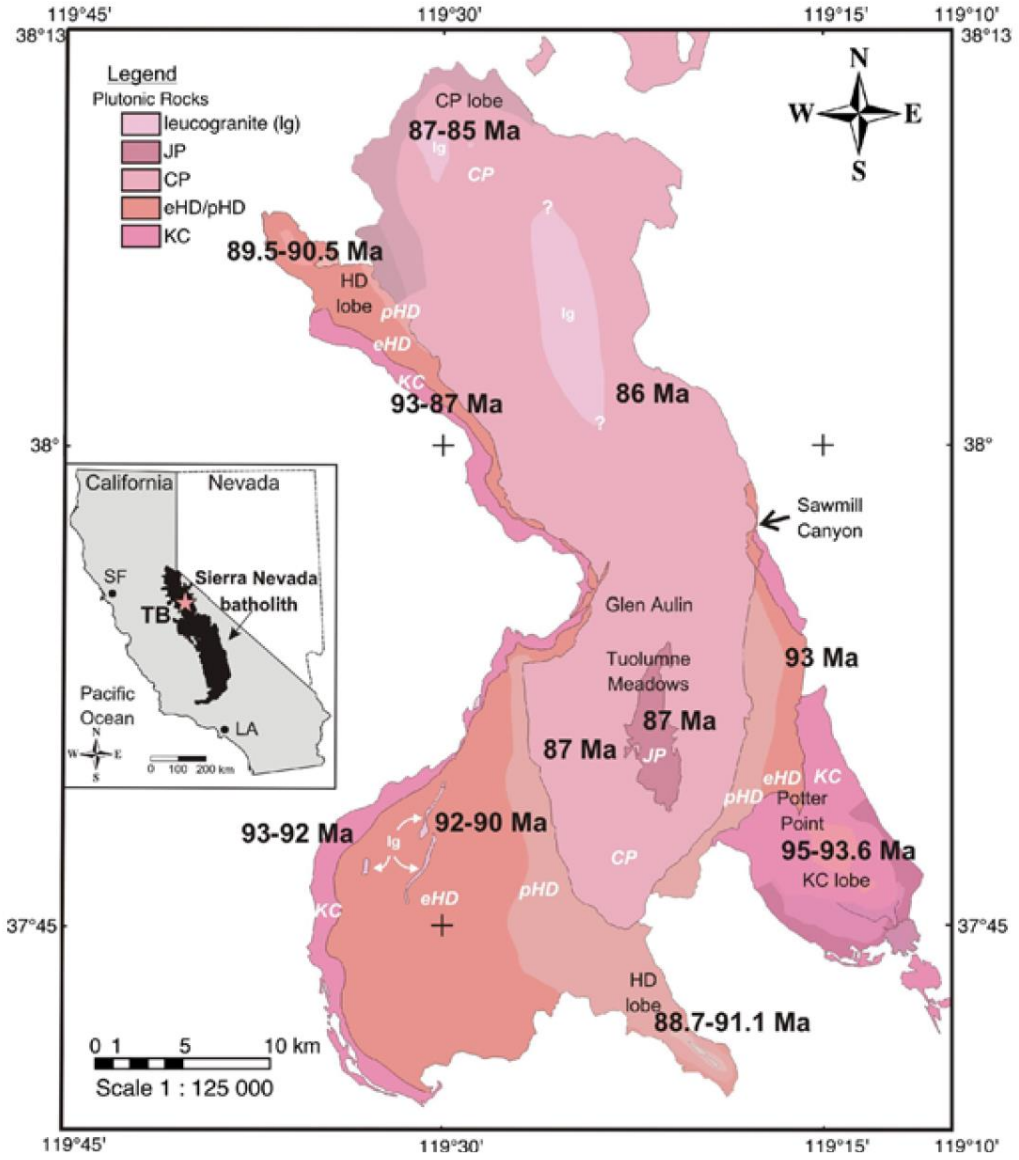
Successive stages in the exposure of batholith rocks

Table 7.1 General characteristics and possible origin of I-S-A-TTG-type granitoids.

Classification	I-type	A-type	TTG	S-type
Overall petrology	Part of a broad spectrum from diorite or tonalite through granodiorite to granite	Spectrum including peralkaline granites, alkali syenites and fayalite granites	Trondhjemite-Tonalite-Granodiorite (Dacite as volcanic equivalent)	Restricted to leucocratic granites
Distinctive minerals/ chemistry	Hornblende, biotite, magnetite, sphene	Alkali feldspar dominant, riebeckite, fayalite, rapakivi structure, fluorine-rich	Amphibole, plagioclase, high Na, high ratios of Sr/Y, La/Yb, low Y	Muscovite, biotite, cordierite, monazite, garnet, ilmenite
Enclaves	Mainly magmatic enclaves	May contain all enclave types	Mafic enclaves rare in trondhjemites	Mainly metasedimentary xenoliths
Associated metalliferous mineral deposits (see Chapter 10)	Porphyry copper and molybdenite deposits; lead-zinc deposits at lower temperatures	None distinctive	'Adakite' plutons world class porphyry copper; gold	Tin-tungsten deposits
Origin	Produced by partial melting of igneous material	Partial melting of mafic underplate or product of extreme differentiation	Partial melting of deep mafic protolith with garnet or amphibole stable, plagioclase absent	Produced by partial melting of meta-sedimentary material
Tectonic setting	Island arcs and continental margin subduction-related batholiths	Anorogenic/post orogenic setting (cratonic), continental rift zones	Early Archean crust, phanerozoic subduction zones	Continental collision zones with overthrust terrain

- *General characteristics and possible origin of I-S-A-TTG-type granitoids*

Zoned Plutons

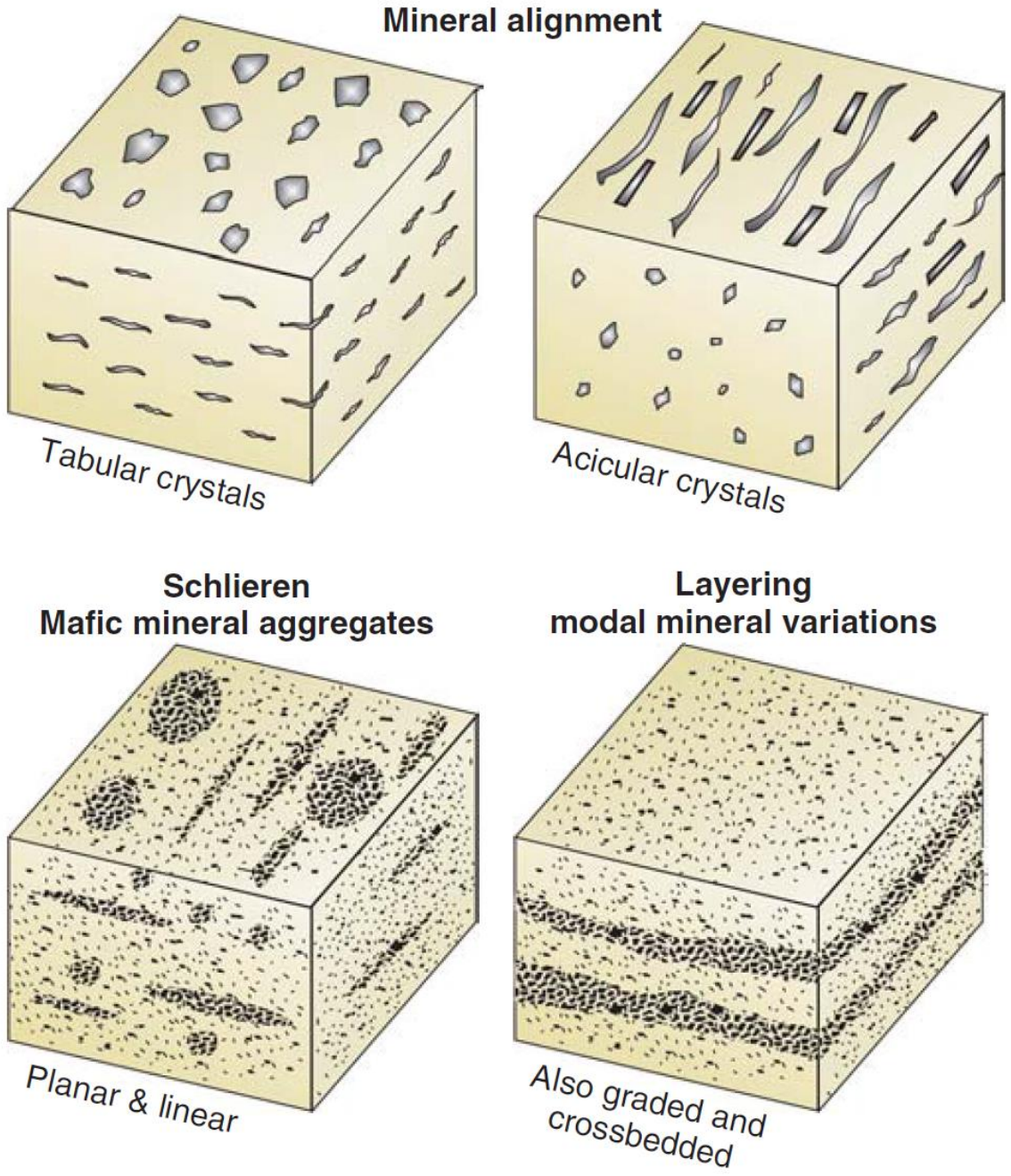


- *the normally zoned Tuolumne Batholith, Sierra Nevada*

Internal Structures and Textures

1. Magmatic planar fabrics:

Rotation and translation of crystals in cooling magma during emplacement either by local flow or regional deformation can lead to the development of a *magmatic planar* fabric.

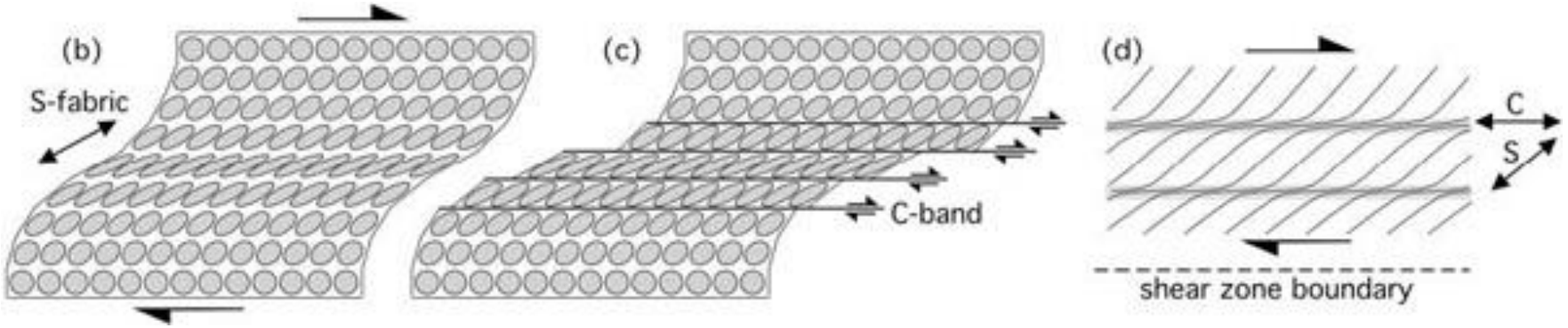

Mineral alignment
Tabular crystals
Acicular crystals
Schlieren
Mafic mineral aggregates
Planar & linear
Layering
modal mineral variations
Also graded and
crossbedded

2. Crystal plastic strain fabrics

- planar fabrics can also be developed when plutonic rocks are subjected to regional deformation after the magma has crystallised (but not necessarily cooled to ambient temperatures).

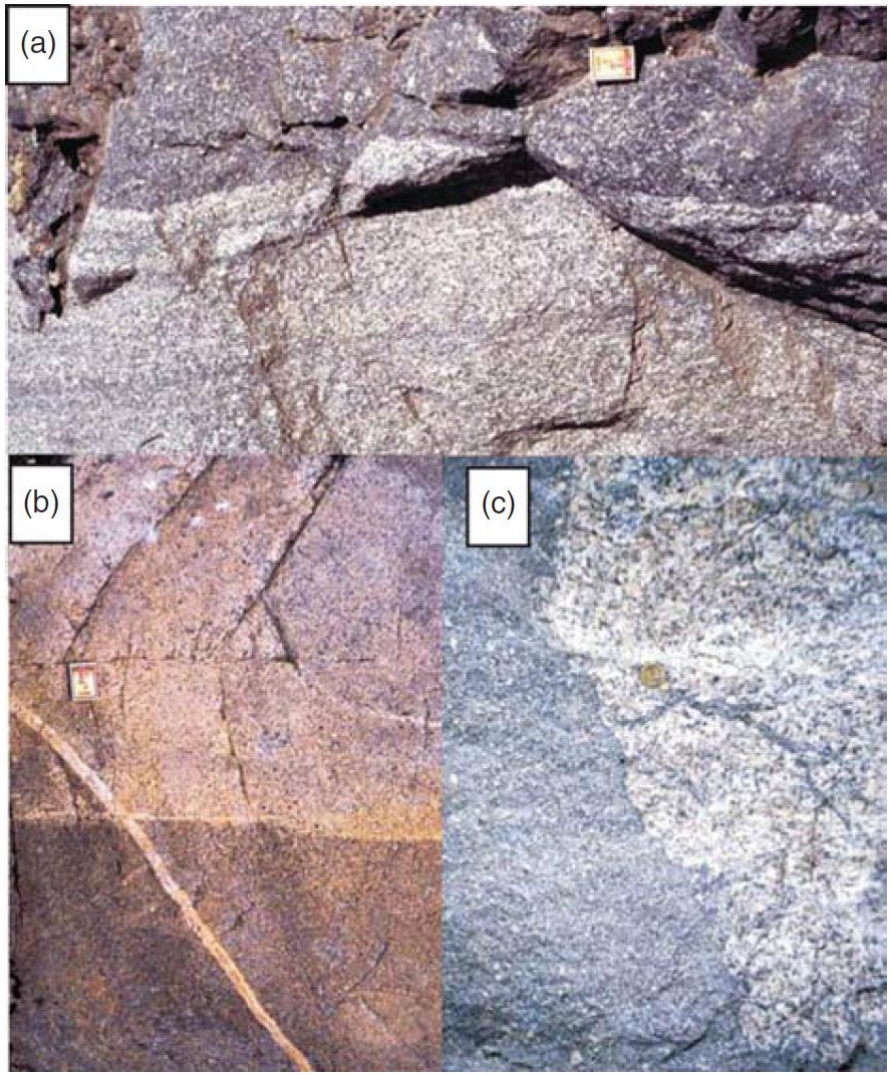
An S-C fabric

- An S-C fabric is a metamorphic fabric formed by the intersection of shear surfaces within rocks affected by dynamic metamorphism. C-surfaces are parallel to the margin of the shear surface, whilst S-surfaces are oblique to the surface. They produce a fabric that can appear similar to crenulation cleavages.



S-C fabric

Contacts

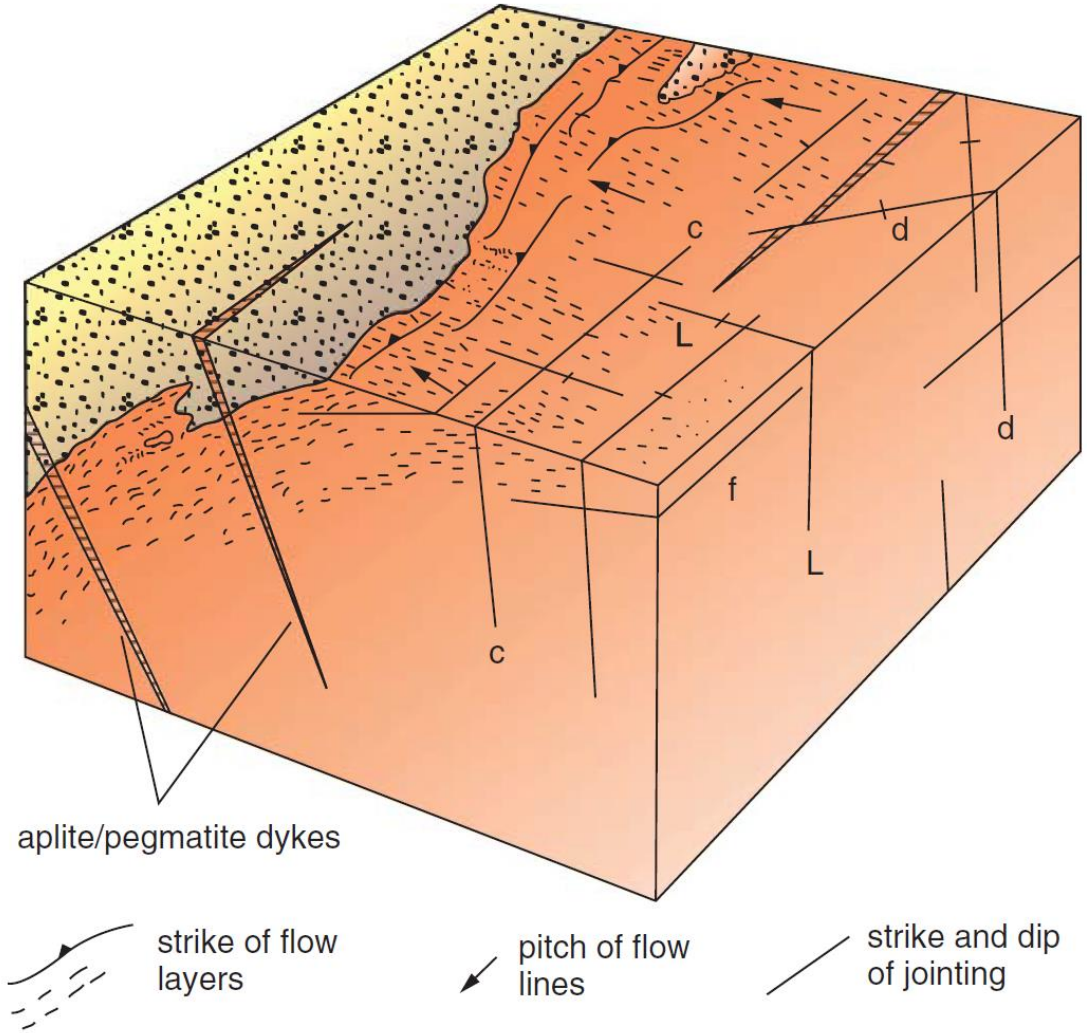


a) subhorizontal contact between tonalite and diorite, contact sharp and sinuous (b) Horizontal contact between granite and diorite. Contact marked by narrow aplite band and cut subsequently by diagonal aplite vein. Contact sharp, straight. (c) vertical contact between granodiorite and diorite. Note apophyisis of dark diorite cutting granodiorite gives timing relationship, contact sharp and sinuous

Jointing

- All plutonic rocks contain fairly regular sets of joints. ***Primary joints*** are related to cooling of the intrusion.
- ***Secondary joints*** form during subsequent phases of crustal-scale tectonic deformation or uplift and unroofing

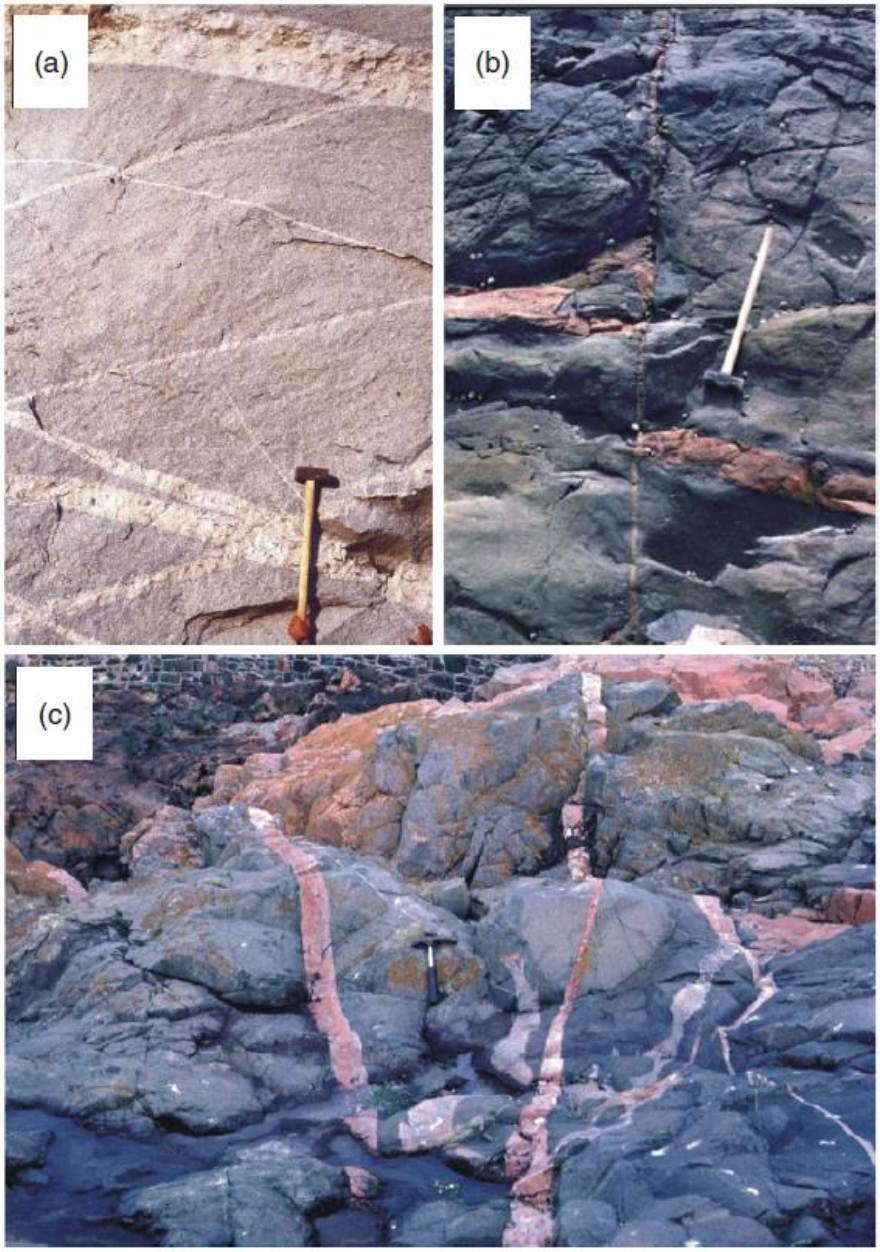
Two joint sets are visible, flat-lying
sheet joints generally parallel to the surface and vertical cross joints



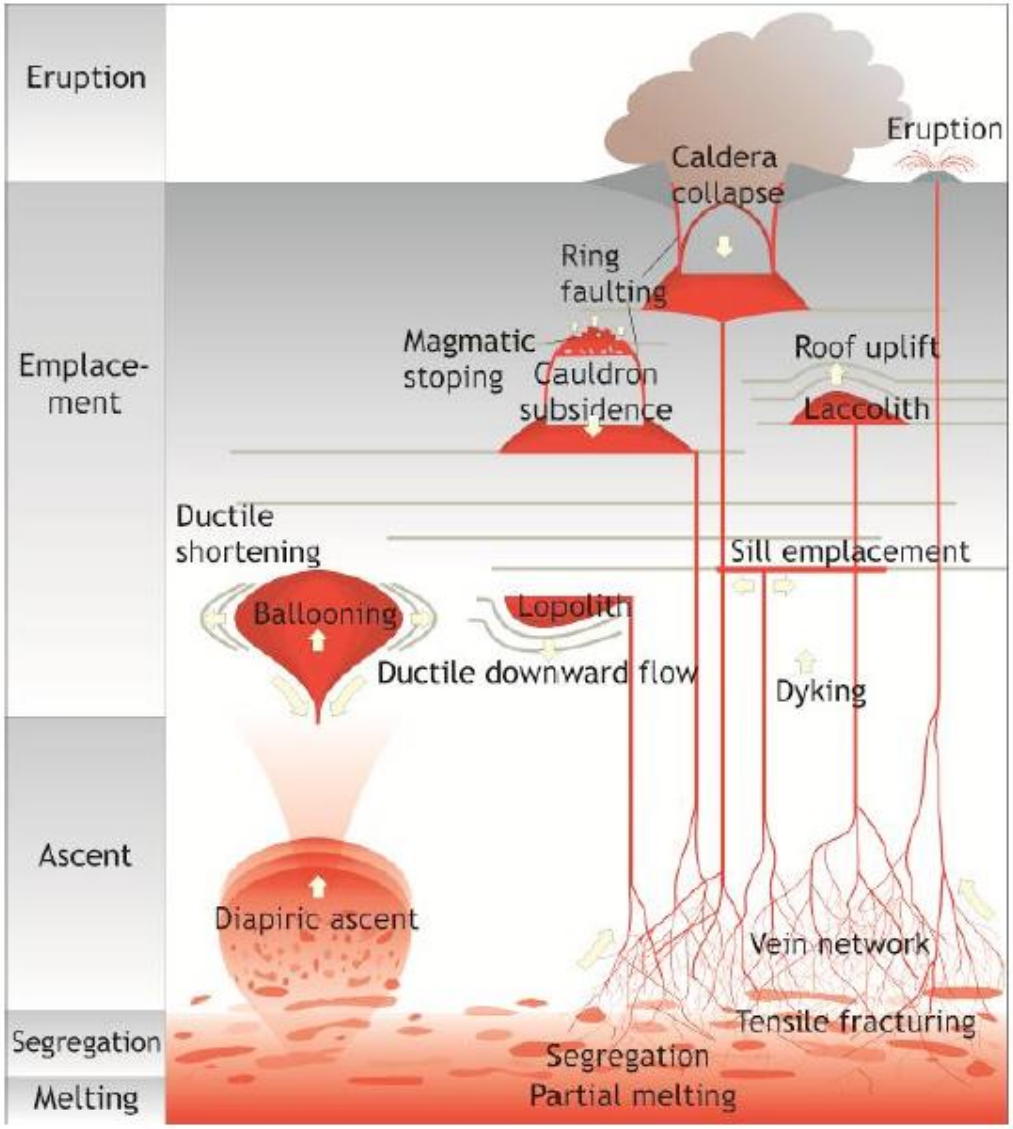
Block diagram showing the relationship between flow structures and joint systems in an intrusive mass. c, Cross joints; d, diagonal joints; f, flat-lying joints; l, longitudinal joints.

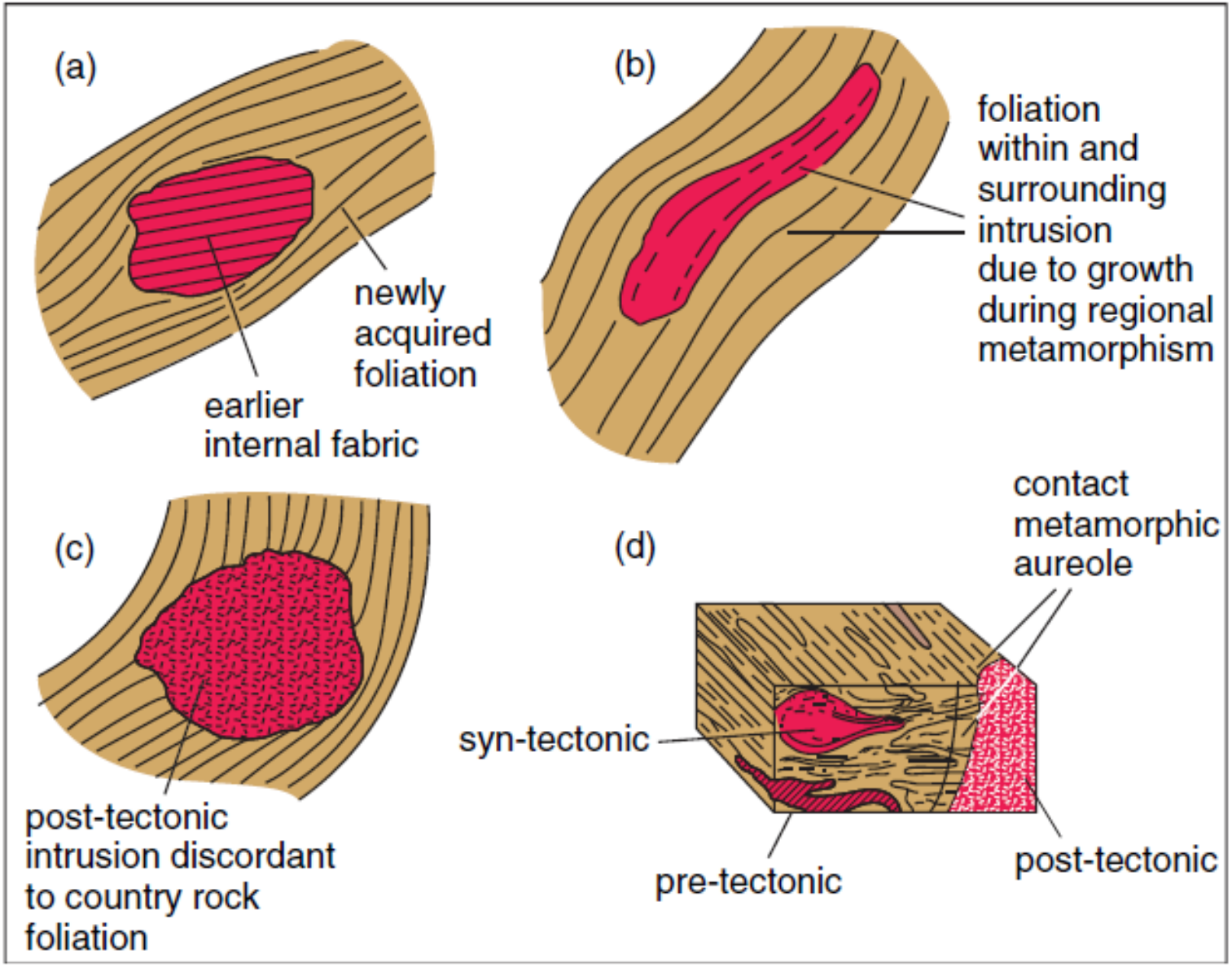
Aplites and pegmatites

- Aplites and pegmatites are veins comprised mainly of quartz and alkali feldspar with subordinate muscovite and occasional garnet that form during **the final stages of cooling and crystallisation.**


(a)
(b)
(c)

Emplacement Timing




(a)
newly acquired foliation
earlier internal fabric
(b)
foliation within and surrounding intrusion due to growth during regional metamorphism
(c)
post-tectonic intrusion discordant to country rock foliation
(d)
contact metamorphic aureole
syn-tectonic
pre-tectonic
post-tectonic

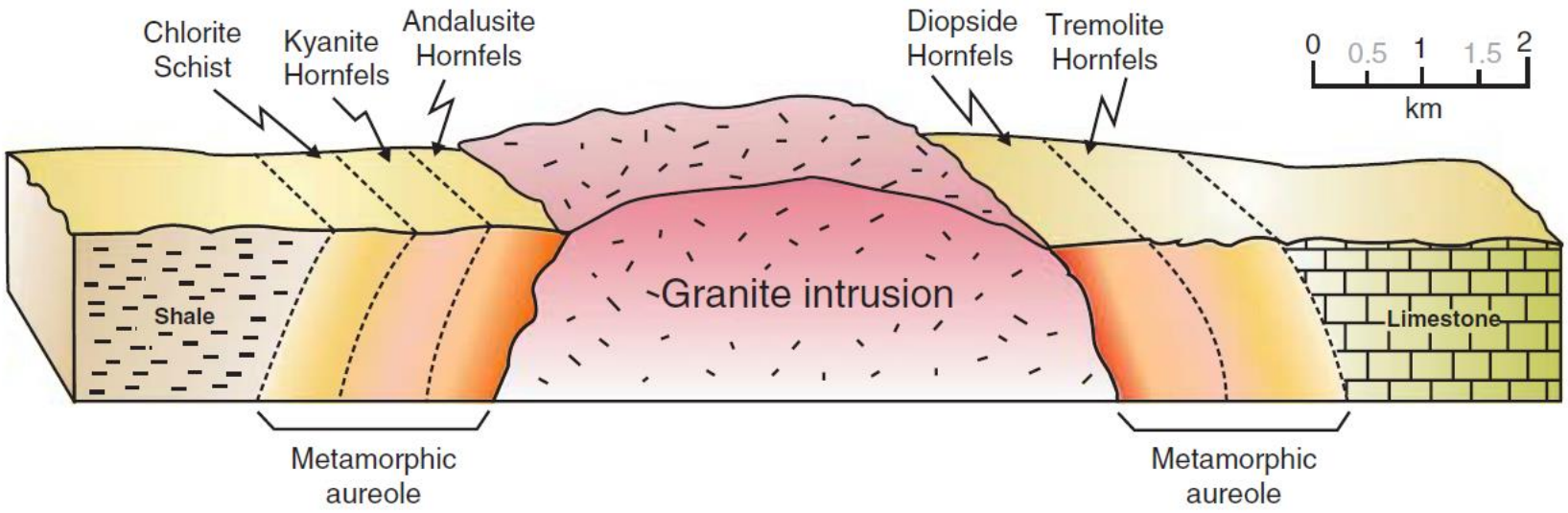
Distinctive Granitoid Textures

- **Porphyies:** These rocks are recognised by their highly porphyritic nature, with large, mainly euhedral phenocrysts embedded in a fine (quenched) groundmass.
- ***Graphic granite*** refers to an inter-growth texture which develops in some quartz-alkali feldspar pegmatites.

- ***Rapakivi granite*** contains large phenocrysts (several centimetres long) of alkali feldspar, often salmon pink or flesh-coloured, mantled by a rim (1–2mm thick) of white plagioclase feldspar.

Metamorphic Aureoles

aureoles are best developed around granitoid (granodiorite and granite) intrusions emplaced within a few kilometres of the Earth's surface,


Chlorite Schist
Kyanite Hornfels
Andalusite Hornfels
Diopside Hornfels
Tremolite Hornfels
0 0.5 1 1.5 2
km
Shale
Granite intrusion
Limestone
Metamorphic aureole
Metamorphic aureole