



**UNIVERSITY OF ZAMBIA
SCHOOL OF MINES
DEPARTMENT OF GEOLOGY**

GG 4070

IGNEOUS PETROLOGY

LECTURE NOTES TEXTURES OF IGNEOUS ROCKS

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TEXTURES OF IGNEOUS ROCKS

Compulsory Reading: Ehlers and Blatt (1982) pp. 44-47, 166-144; Best (1982) pp. 62-70. Additional Reading: Williams, Turner and Gilbert (1982), pp. 53-67.

INTRODUCTION

The term texture is essentially meant to describe the interrelationships between the various minerals in a rock. It includes the size and shape of the different minerals, the way in which they are distributed through a rock, and their relation to each other. The texture reveals much about the origin and the crystallization history of the magma from which the rock was derived, for instance, the rate of cooling and the sequence in which minerals were formed. Therefore, a discussion of the texture forms an essential part of a rock description.

This chapter aims at a complete as possible overview of all existing textures of igneous rocks, although it would be quite an achievement of the fourth year petrology student to know them all by heart. An attempt has been made not only to describe the various textures, but also to explain them.

GRAIN SIZE

The grain size of minerals in igneous rocks varies greatly from very fine grained to very coarse. In **aphanitic** rocks the minerals are so fine grained that they cannot be observed with naked eye. In phaneritic rocks the minerals can be observed without optical aid. This category is roughly subdivided according to grain size into fine grained, medium grained and coarse grained in the following way:

Diameter 5mm or more	:	Coarse grained phaneritic
Diameter 1 to 5mm large	:	Medium grained phaneritic
Diameter up to 1mm	:	Fine grained phaneritic
Too fine to see with unaided eye	:	Aphanitic

As was already observed while discussing the classification of igneous rocks, the plutonic rocks are typically phaneritic, whereas the matrix of volcanic lavas is either glassy or aphanitic. The coarseness of the crystals in intrusive rocks reflects the slow cooling history of the magma. This is in sharp contrast with the high cooling rate of a lava. The crystallization of an intrusive basic magma may take 1000's to millions of years, whereas a acid lava can solidify in one year or less! Hypabyssal rocks occupy an intermediate position between the plutonic and volcanic rocks: they crystallize below the surface of the earth, but at shallow depth, usually in dykes or veins, or in relatively thin sills. Cooling rates are therefore high and consequently the resulting rock is fine grained.



Fig. 1a-Coarse-grained

1b-Medium-grained

1c-Fine-grained

GRAIN SHAPE

Shapes of crystals are characterized by the degree of development of crystal faces. In igneous rocks the grain shape often reflects the sequence of crystallization: if a mineral is among the first to crystallize from a melt it has the space and time to develop its proper habit. Hence these minerals tend to develop their ideal crystal shape. Later formed minerals can grow only in spaces left between the earlier crystals. They tend to have an irregular shape. Commonly used terms for grain shapes are as follows:

Euhedral (idiomorphic) : Well-developed crystal faces, grains show perfect or nearly perfect shape.

Subhedral (hypidiomorphic: Partly developed crystal faces, grains show an imperfect but still recognizable crystal shape.

Anhedral (xenomorphic) : No crystal faces developed, grains show no regular shape.

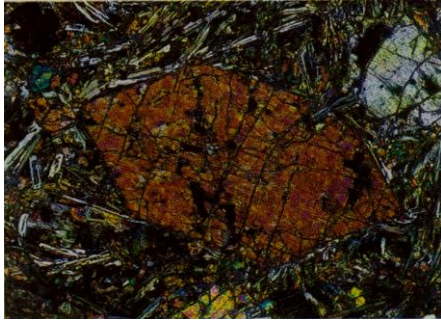


Fig. 2a-Euhedral olivine in olivine basalt

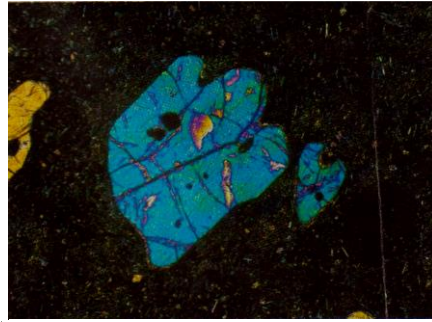
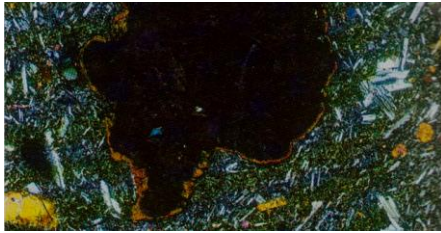


Fig. 2b-subhedral olivine in picritic basalt

Fig. 2- Anhedral olivine phenocryst in basalt



Common examples of euhedral minerals in igneous rocks are phenocrysts of plagioclase or mafic minerals in basalts or andesites. Granites consist of predominantly subhedral quartz and feldspar crystals. In gabbros you can usually establish easily the order of crystallization from grain shapes (See Figure 6-1) and sometimes also from reaction rims (See Figure 3).

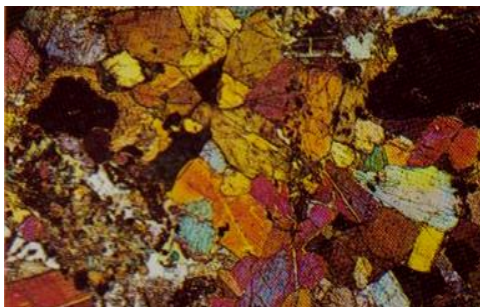


Fig. 3a-Euhedral granular hornblendite

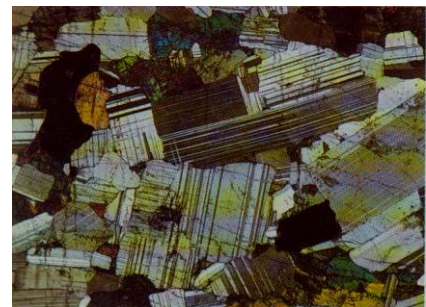
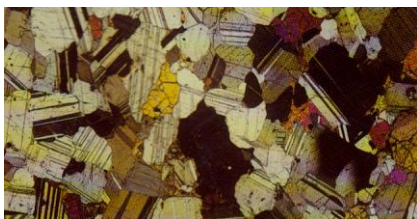


Fig. 3b-Subhedral granular gabbro

Fig. 3c-Anhedral granular troctolite



Many igneous rocks consist largely of equal-sized, anhedral or subhedral grains. This rock texture is referred to as **equigranular**. If the grains are not equal in size the terms to be used is **inequigranular**. If a mineral species is conspicuously larger than others in an igneous rock, the texture of the rock is called **porphyritic**.

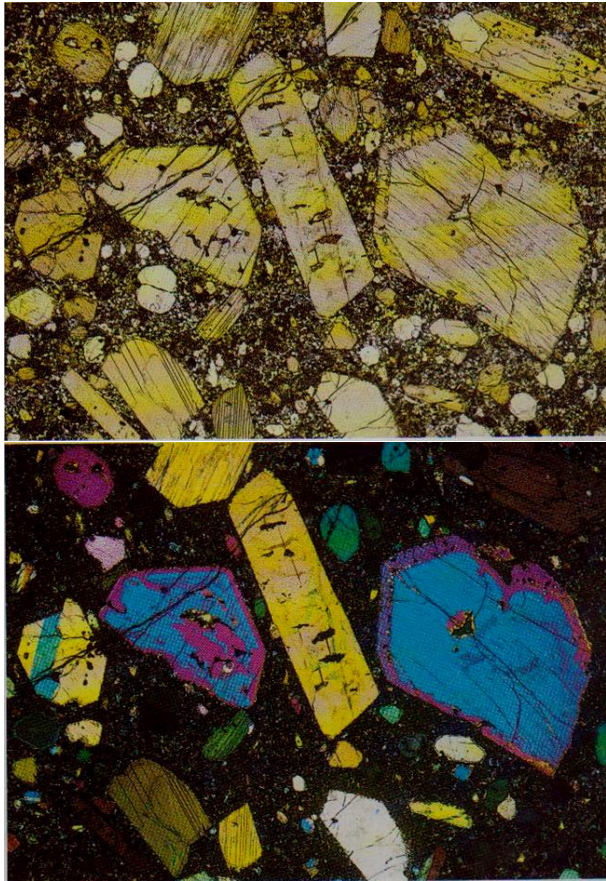


Fig. 4 Porphyritic texture

The larger minerals are called porphyries or **phenocrysts**, the latter term is especially used when describing porphyries in volcanic rocks. The porphyritic minerals are the first minerals to crystallize from the magma, which explains their larger size and the fact that they are usually euhedral in shape. Porphyries that contain inclusions of other minerals are said to be **poikilitic**.

PORPHYRITIC TEXTURES

In basic igneous rocks four different types of porphyritic texture can develop, involving the textural relation between plagioclase and pyroxene crystals. These are (See Illustrations in Figure 6-2).

- (i) **Ophitic textures.** Laths of fine grained, euhedral plagioclase crystals are enclosed by a large pyroxene crystal. The texture is common in basic intrusive rocks, as is the related texture (ii).



Fig. 5 Ophitic-textured alkali olivine dolerite

- (ii) **Subophitic texture**. Similar to (i), but the plagioclase laths lie partly inside, partly outside the pyroxene porphyry.

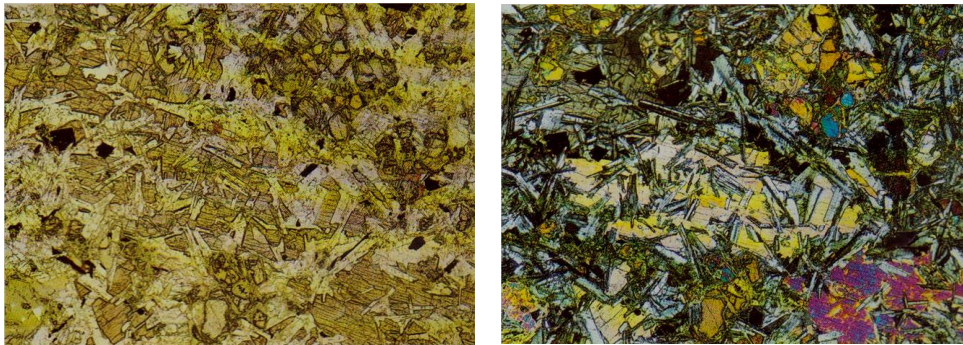


Fig. 6 Subophitic texture in olivine dolerite

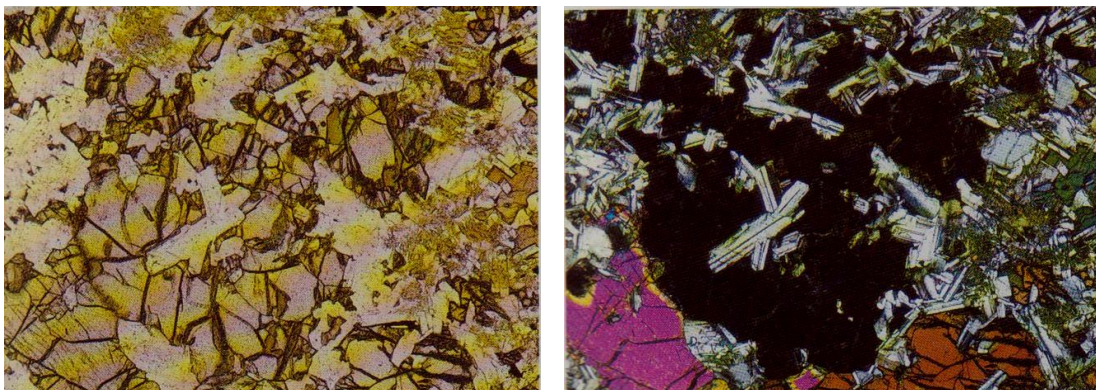


Fig. 7 Subophitic alkali olivine dolerite

- (iii) **intergranular textures**. Crisscross orientated plagioclase laths, the interstitial spaces filled by finer grained pyroxene crystals. This is the typical texture of dolerite dykes, but may also occur in basalts.

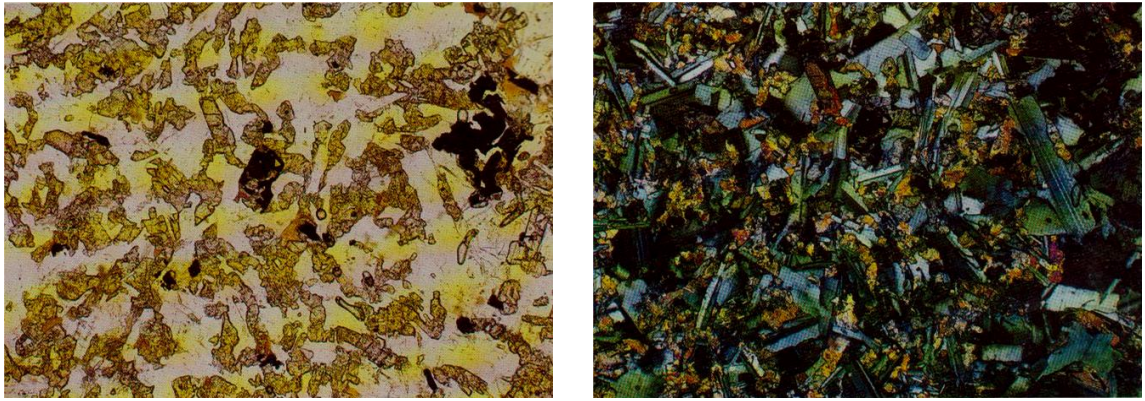


Fig. 8 Intergranular dolerite

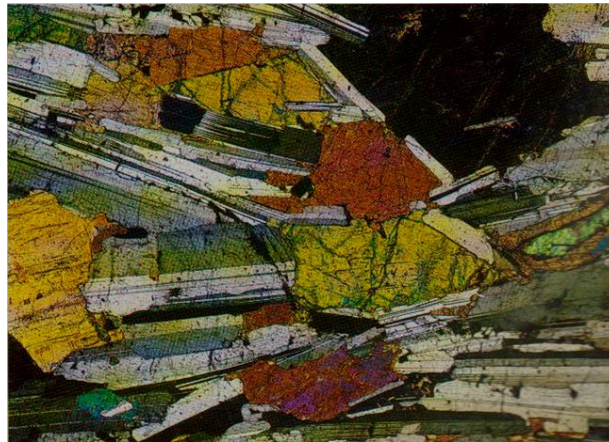


Fig. 9 Intergranular olivine gabbro

- (iv) **Intersertal textures.** Similar to (iii), but the interstitial spaces between the plagioclase laths are filled with basaltic glass. This texture only occurs in basic volcanic rocks.

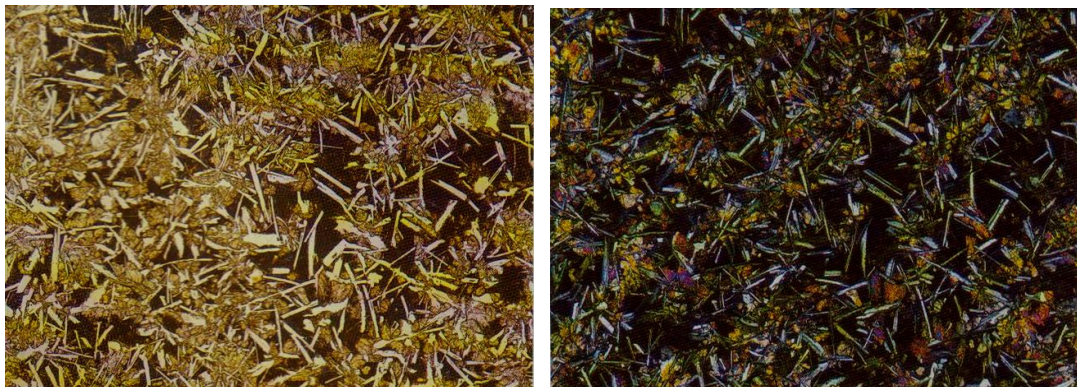
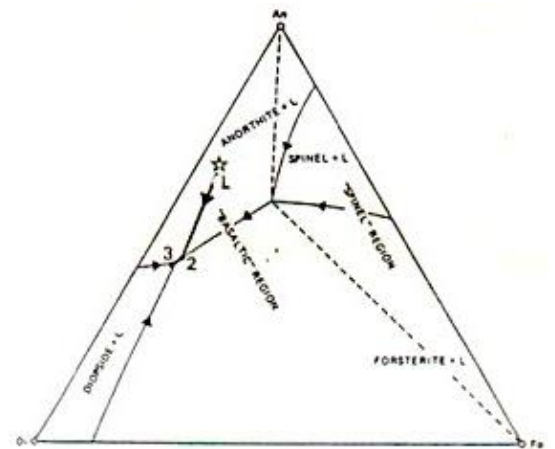
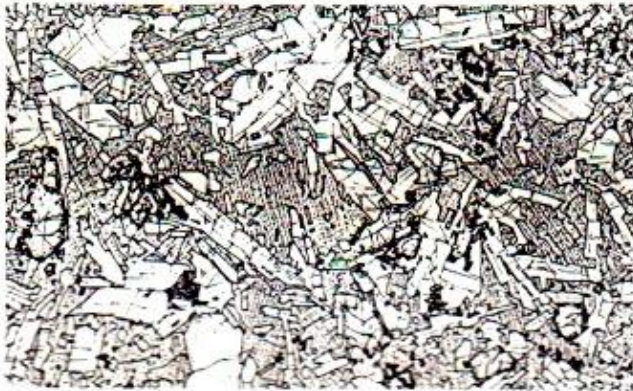


Fig. 10 Intersertal, intergranular and subophitic textures in dolerite

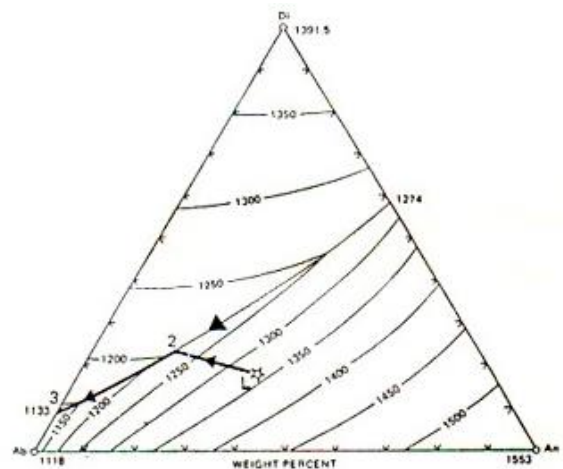
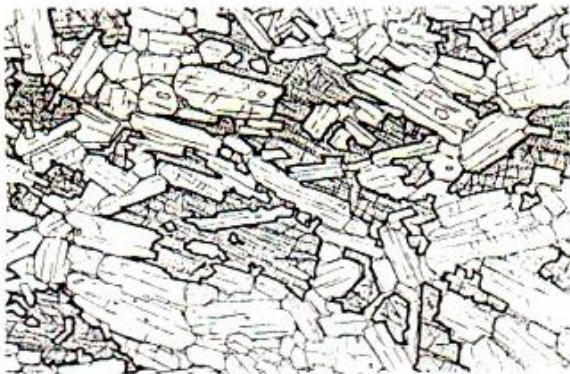
The intergranular texture can be explained with the aid of the ternary system Anorthite-Diopside-Forsterite. It is produced by the crystallization of a melt with a composition such as L in Figure 6-3a, which starts with formation of primary plagioclase crystals, followed by minor olivine, and finally by pyroxene. Ophitic texture also is produced by primary crystallization of plagioclase laths, followed by

simultaneous crystallization of plagioclase and pyroxene during which pyroxene forms poikilitic grains surrounding the plagioclase laths. This is illustrated with the aid of the ternary system Diopside-Albite-Anorthite (See Figure 6-3b).



A

Fig. 11 (a) Origin of intergranular texture explained by crystallization path of a liquid L in the system an Di Fo.



B

Fig. 11(b) Ophitic texture explained with the aid of the system Di-Ab-An (after Bard, 1986).

Porphyritic textures are also very common in granitic and syenitic rocks. It is either alkali feldspar (orthoclase or microcline) or plagioclase that develops porphyritic dimensions (See Figure 6-6). A special type of porphyritic granite texture is the **Rapakivi texture**, which is characterized by very large, pink alkali feldspar porphyries that are rimmed by bluish plagioclase. Granites showing this texture are called Rapakivi granites after the type locality in Finland. The origin of the texture is as yet not well understood.

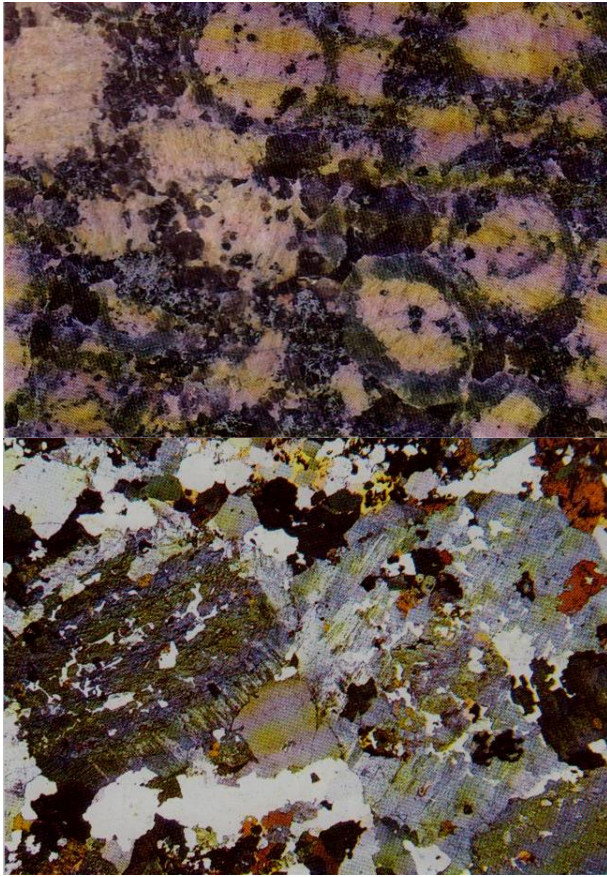


Fig. 12 Rapikivi texture

6.5 TEXTURES TYPICAL OF PLUTONIC ROCKS

6.5.1 Cumulate textures

Rocks with a **cumulus fabric** are the result of gravitational differentiation in basic intrusions. The so-called **cumulate rocks** are formed from the accumulation of crystals that have sunk to the bottom of a magma chamber under the influence of gravity. The crystals that settle in melt and build up these cumulates are called **cumulus minerals**. The liquid that surrounds the cumulus minerals is the **intercumulus liquid**, which will eventually crystallize into the **postcumulus minerals**. Various types of cumulate rocks and their nomenclature are shown in Figure 6-4.

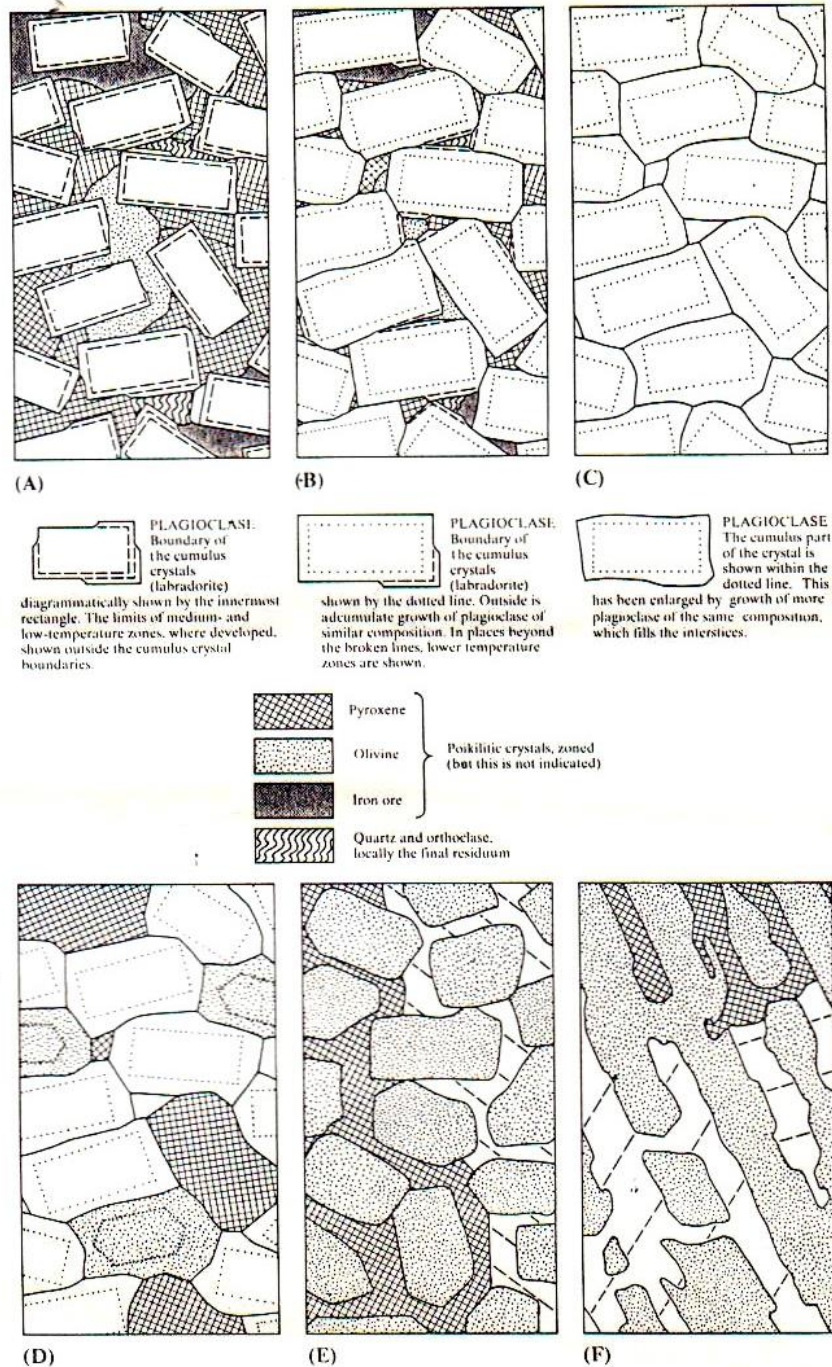


Fig. 13 Cumulate textures. (A) Plagioclase orthocumulate. Early-formed euhedral plagioclase is originally surrounded by a melt of different composition. The melt crystallized to anhedral postcumulus minerals while a rim grew around the plagioclase crystals. **(B) Mesocumulate,** intermediate between ortho- and adcumulate. **(C) Plagioclase adcumulate.** Cumulate rock in which the intercumulus phase is almost, or totally, absent. **(D) Polymineralic adcumulate.** **(E) Olivine heteradcumulate.** The cumulus olivine grains show no evidence of postcumulus growth; the surrounding melt formed large poikilitic pyroxene and plagioclase. **(F) Olivine crescumulate.** Cumulate olivine has grown upward into the liquid above, preserving its optical continuity.

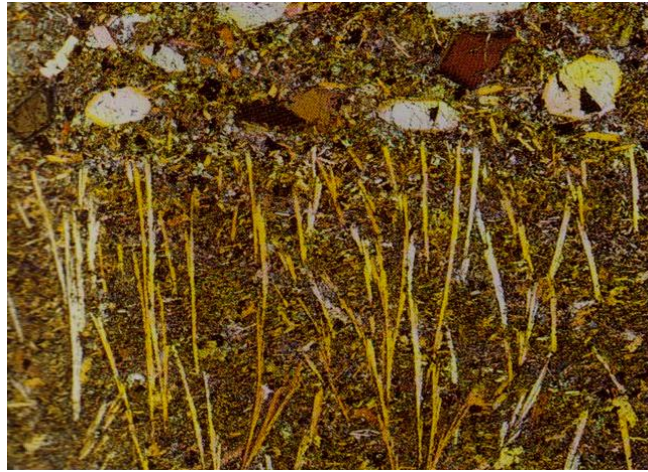


Fig. 14 Pyroxene comb layer in a thin lamprophyre (fourchite) dyke

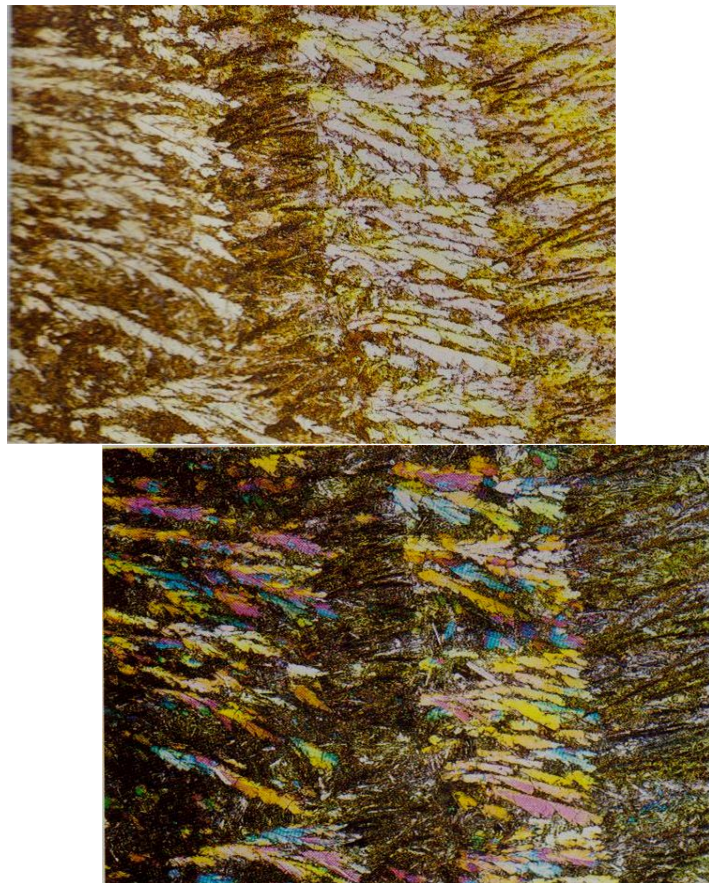


Fig. 15 Comb layers in dolerite dyke

Examples of cumulates are found in basic layered intrusions, which will be further discussed in Chapter 10. The most common cumulus minerals include chromite, olivine, pyroxene, and plagioclase. Intercumulus minerals may include any of these and most of the minor late-stage minerals (magnetite, apatite, sometimes amphibole and so on). The cumulate rocks can be either classified with the aid of the gabbro classification triangle or the peridotite

classification triangle, depending on the amount of mafic minerals and plagioclase.

Cumulates often show **preferred orientation** of the cumulus minerals as a result of magma flow along the floor of the magma chamber.