TEXTURE OF FELSITE

by

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ABSTRACT

Porphyritic acid to intermediate pyroclastic deposits, flows and hypabyssal intrusions are common in parts of the Eastern Goldfields Province.

Groundmass textures are varied, but abundant micropoikilitic texture and rare relict perlitic texture indicate devitrification and suggest that a substantial part of the felsite suite was emplaced at or near the surface of the ground.

Recrystallization has affected all felsites in the area but ranges in intensity from delicate, with preservation of such details as perlitic cracks, to intense, with development of a secondary coarse mosaic groundmass.

INTRODUCTION

The Geological Survey of Western Australia prepared geological maps of much of the Eastern Goldfields Province of Western Australia between 1963 and 1974. Samples of felsite, as well as other rocks, were collected during this work, and thin sections were prepared. Information from these thin sections has been used in the mapping of individual sheets. The present paper brings together thin-section data on felsites throughout the province. The area of study, geological framework of the Yilgarn Block, and location of map sheets discussed are shown in Figures 1 and 2 of the accompanying paper on granitic rocks of the area (Libby, 1978a).

Textural relations are emphasized because the textural assemblage is rich, and promises to provide clues to the origins of the rock. A textural approach also complements a recent chemical study of the composition of felsites in the northern portion of the Eastern Goldfields Province by Davy (1977).

INTRUSIVE, EXTRUSIVE AND HYPABYSSAL ROCKS

Most accounts of felsites in the Eastern Goldfields Province describe the bodies as large concordant sheets or small, clearly discordant dykes. Neither field relations nor petrography have determined in all cases, whether the sheets are sills or flows. There has even been disagreement as to whether certain sheets are sheared felsite bodies or oligomictic conglomerate. In the face of such uncertainty, attempts to classify felsites on mode of emplacement were abandoned for this report as being more likely to add to confusion than to clarify relationships.

Petrographic criteria have been suggested for distinguishing hypabyssal intrusions from flows. In a section attributed in part to Trendall, Turek (1966, p.A-9) suggested that "... extrusive rocks are characterized by predominance of small corroded quartz phenocrysts and by spherulitic and allied structures of the matrix, while intrusive have larger and more abundant feldspar phenocrysts in an even quartz-feldspar mosaic of the matrix". These tentative criteria could not be checked during the study so were not used.

It seems likely that felsites in the collections represent several types of emplacement: fully intrusive sills and dykes, dykes and less regular intrusive masses associated with vents and/or rifts, lava flows, and, possibly, pyroclastic and sedimentary emplacement.

USE OF TERMS

The rocks studied in this section conform to the definition of "felsite" by Gary and others (1972, p.256). According to this source, a felsite is, "A light-colored, fine-grained extrusive or hypabyssal rock with or without phenocrysts and composed chiefly of quartz and feldspar ..." The term should not be used when a more precise name can be found, but is useful for the varied suite considered here.

The use of "porphyry" follows the recommendations of Trendall (1964, p.46-50), and accordingly, "porphyrite" is not used. Following the argument of Joplin (1964, p.3), the porphyritic aspect of a rock is usually indicated by an adjectival modifier prefixed to the name of the compositionally equivalent even-grained volcanic or plutonic rock. "Porphyry" is used only in reference to other works or where a more precise term would be awkward or misleading.

For a rock to be porphyritic, some single constituent mineral must have at least two distinctly different common sizes; that is, the size distribution of some single mineral must be bimodal. The rock is hiatal (Johannsen, 1939, p.216) in that one or more gaps exist in the size-frequency distribution of grains. In contrast, an inequigranular rock in which the size of grains varies gradually or in a continuous series is seriate (Johannsen, 1939, p.233). "Vitrophyric" is preferred to "porphyritic" where discrete grains are set in a groundmass which is glassy and not devitrified, but "porphyritic" is used for a hiatal rock in which relatively coarse grains are set in a devitrified groundmass.

The grain size of a porphyritic rock, for the purpose of classification, is determined by the coarseness of the groundmass phase, regardless of the proportion of phenocrysts and groundmass. Thus a rock with 90 per cent phenocrysts (of, for example, potassium feldspar and quartz) in an aphanitic matrix is a porphyritic rhyolite, despite the preponderance of coarse grains. However, only igneous textures are considered; a crushed granite is not a rhyolite.

REFERENCE TO SAMPLES

Throughout the text samples are identified by their Geological Survey field sample number followed by the name of the 1:250 000 map sheet covering the area from which they were collected. An exception from Baja California is described in the text. The Australian Transverse Mercator yard grid location for each sample mentioned in the text is listed in the Appendix.

PREVIOUS STUDIES

Felsic volcanic and porphyritic rocks of the Eastern Goldfields Province have been studied in detail by Trendall (1964), O'Beirne (1968), and Davy (1977). In addition to discussion of the propriety of the terms "porphyry" and "porphyrite", Trendall considered problems of alteration of porphyries and their association with conglomerates. The development of oscillatory zoning in plagioclase, and the failure of phenocrysts to straddle the boundary between clasts and matrix suggested that conglomerates are clastic derivatives of associated porphyries, and that porphyries have not been derived from sedimentary rocks by porphyritization. O'Beirne classified the porphyries, determined the physical conditions of their emplacement, found that, in general, they are not directly related to associated granite, and found pseudo-igneous porphyroids at Widgiemooltha, Wongi Dam, and in the Mandilla and Wanda Wanda Beds. Sodic felsic rocks were emplaced over a long period throughout the Kalgoorlie succession; both extrusive and intrusive porphyritic rocks are present, and all the porphyries in the area are older than "internal" granitic rocks, where "internal" granites are discrete granitoid plutons within greenstone belts. Gold appears to O'Beirne to be spatially and genetically related to the porphyritic sodic rhyolite, but details of the relationship remain for further studies.

Trendall (1964) considered the earlier literature on nomenclature, and O'Beirne (1968) reviewed other early literature on porphyritic rocks of the Eastern Goldfields Province.

Davy's study of the bedrock chemistry of the Leonora, Laverton and Archaean portion of the Rason 1:250 000 sheets includes an extended treatment of the chemical aspects of fine-grained felsic rock.

In some areas (Ford Run Plateau, Leonora sheet) Davy found similarities between acid volcanic rocks, hypabyssal intrusives, and nearby "biotite" granite such as to suggest a related origin. Elsewhere (Rutter Soak and Yamarna on the Rason sheet) there is little chemical relation between granitoid rock and nearby volcanic or hypabyssal rock.

In some areas (Rutter Soak) acid volcanic rocks vary widely in composition from ultrapotassic rhyolite to andesite; however, in other areas (Yamarna), the compositional range is small. In general, dacite is the characteristic composition throughout the three sheets.

Wherever enough varied data were available to plot a trend on an AFM diagram the rock suites were found to be calc-alkaline; however, there is a gap due to lack of rocks of intermediate composition.

PETROGRAPHY OF COMMON FELSITES

Three categories of felsite are discussed separately: andesite, alkaline felsite and quartz-bearing felsites without obvious alkaline affinities. For ease of reference the latter are called common felsites. These are the predominant fine-grained felsic rock of the Eastern Goldfields Province, corresponding in large part to the rock called porphyry in this work and the work of various other authors. The andesites are considered later in this report and alkaline felsites are treated together with granitic alkaline rock in a separate report in this publication (Libby, 1978b).

The general petrographic characteristics of the porphyries have been briefly summarized by Trendall (1964, p.48 and 49).

MINERALOGY

Petrographic identification of matrix minerals of small grain size is not reliable and the data of O'Beirne (1968, p.292) suggest that phenocrysts are not a reliable guide to the bulk mineralogical composition of these rocks. Still, recognition of minerals imposes constraints on the bulk composition.

MAJOR FELSIC MINERALS

Quartz

Rounded and embayed quartz phenocrysts (Plates I and III) are common and quartz is also abundant in the matrix of rocks with granular groundmass. It may also be abundant in rocks with micrographophyric texture, but the groundmass grains are commonly too fine for identification in such rocks. Only rarely is feldspar not a phenocryst phase but in samples 38307 (Leonora) and 15504 (Edjudina) quartz is present and feldspar phenocrysts excluded.

Feldspar

Plagioclase phenocrysts (Plates II, III and IV) are prominent in most samples of common felsite. The plagioclase phenocrysts tend to be homogeneous and albitic but there are exceptions. Normative plagioclase up to 30 per cent anorthite was found by O'Beirne (1968) and a-normal extinction angles on plagioclase in a hornblende dacite in the present study suggest zoning up to 25 or 30 per cent anorthite. Oligoclase and andesine commonly have euhedral, oscillatory zoning (sample 32719, Leonora). Zoned plagioclase, that is, plagioclase more calcic than albite, is most commonly associated with primary hornblende, but in samples 20979A and B (Menzies) it is associated with secondary red biotite. Plagioclase is very weakly zoned in a rhyodacite (sample 15501, Edjudina), and, in some samples, zoning appears only in differential concentrations of alteration products (samples 29962, Laverton and 24808, Edjudina; illustrated in Plate IV). Plagioclase commonly is severely altered to sericite or sericite plus saussuritic epidote. Saussuritization indicates that much of the rock which contains albite crystallized with a more calcic plagioclase.

The plagioclase phenocrysts normally are euhedral (Plates II, III and IV) but in a few samples (15514A, Edjudina) phenocrysts are rounded, apparently as a result of resorption in magma or reaction with the matrix. Mechanical rounding of phenocrysts is characteristic of the sheared rocks. In some samples, phenocrysts are glomeroporphyritic (sample 32717, Leonora). Where the matrix is coarsely granular (sample 37803, Laverton) grain margins are irregular in detail but retain their general euhedral shape. Rarely (as in sample 38127, Laverton), plagioclase is surrounded by a granophyric intergrowth of quartz and plagioclase.

Some samples carry phenocrysts of potassium feldspar. In a few of these the phenocrysts have well-developed microcline "M" twinning (samples 17645A, Menzies and 24808, Edjudina) but more commonly twinning is not obvious or is missing (sample 37805, Laverton). Thus potassium feldspar may be present in samples where it was not recognized, especially where alteration has been severe.

In a few samples (9101 and 9102, Kalgoorlie) microcline forms very coarse euhedral phenocrysts, too large for estimation of size in normal thin sections.

Rarely (sample 32717, Leonora), potassium feldspar is associated with zoned plagioclase and hornblende; and, also rarely, plagioclase is intergrown with and surrounded by potassium feldspar (sample 37805, Laverton).

Thus, potassium feldspar, though persistent, seems distinctly subordinate to sodic plagioclase in the phenocryst assemblage of the common felsites. However, as it tends to crystallize late, it may be more abundant in the matrix.

MAJOR MAFIC MINERALS

Biotite

This is the usual mafic mineral in the common felsite but it can only rarely be shown to be primary. In two samples (38308, Leonora and 37820, Laverton) large, euhedral phenocrysts of biotite accompany feldspar phenocrysts. In some samples biotite phenocrysts are chloritized (sample 20926, Kurnalpi) or altered to aggregates of biotite, epidote, and felsics (sample 9102, Kalgoorlie). More commonly, biotite has a clearly hornfelsic habit (sample 24808, Edjudina; illustrated in Plate VIII). Hornfelsic biotite is best developed in rocks with microgranular texture, discussed later. Igneous biotite may be recrystallized even where plagioclase phenocrysts retain their euhedral shape and oscillatory zoning (samples 20979A and B, Menzies).

In rocks showing textural response to stress biotite tends to be reconstituted into multitudinous fine flakes (samples 13143 and 40860, Widgiemooltha and 37810, Laverton). Rarely (sample 37814, Laverton) biotite has been replaced by prehnite as well as chlorite.

The colour of biotite most commonly is medium brown, but grey-brown, dark olive-brown, dusky olive-green and bright fox-red are all developed, probably in secondary biotite.

Amphibole

Amphibole is less abundant in the common felsite than in intermediate porphyries, but euhedral hornblende occurs as a primary phase in several samples, accompanied in sample 32717 (Leonora) by quartz, plagioclase, potassium feldspar and biotite phenocrysts, in sample 32719 (Leonora) by quartz and plagioclase phenocrysts, and in sample 38127 (Laverton) by plagioclase and partly-granophyric quartz. Primary amphibole phenocrysts have been replaced by chlorite in a few samples (9103, Kalgoorlie; 20926, Kurnalpi). Hornblende is seriate in sample 32799 (Leonora). Secondary amphibole and biotite are abundant in a devitrified vitrophyre, sample 8886B (Menzies).

Chlorite

The most common mafic mineral is chlorite which has replaced much of the secondary as well as primary biotite and some hornblende.

Other minerals

Secondary clinopyroxene and garnet along with epidote and prehnite indicate substantial metamorphism of sample 39802 (Leonora).

MINOR AND SECONDARY MINERALS

Colourless mica

Although colourless mica is abundant in many samples there is no evidence for peraluminous magmas. The colourless mica seems entirely secondary. Normally it is concentrated in plagioclase grains. It is invariably associated with chlorite, epidote, carbonate or secondary biotite and in all but one sample (20919, Kurnalpi) the colourless mica is in rocks with a granular groundmass.

In sample 20919 phenocrysts of quartz and feldspar are set in a microsymplectic matrix of incipient spherulites. Here, the coarser muscovite seems to have replaced mafic minerals, possibly biotite; the finer grains range from more-or-less discrete grains to radiating aggregates and irregular, cryptocrystalline wisps. Sericitic alteration of plagioclase is common, but most of the colourless mica is intergranular. Again, none of the colourless mica seems primary.

Carbonate

Secondary carbonate is common in many samples, becoming prominent in some (samples 38659, Kurnalpi and 15522, Edjudina, and the breccia, sample 38660, Kurnalpi). Where carbonate is abundant it forms amoeboid masses replacing parts of both matrix and phenocrysts. Less commonly it occupies veins. Some of the veins seem to be, at least partly, of replacement origin. The veins die out abruptly and irregularly, they may have irregular margins, and include patches of matrix.

Other minerals

Sphene is common in the hornblende-bearing rocks (sample 32717, Leonora). In some samples apatite is coarse enough to be recognized. Magnetite, hematite and ilmenite are common. Fluorite is abundant in a few samples (for example, sample 8887, Menzies).

79306–2

A few common felsites have been metamorphosed at high grade. Sample 17645A (Menzies) contains garnet and sample 39802 (Leonora) contains clinopyroxene and garnet as well as epidote and prehnite. Sample 37814 (Laverton) also has prehnite and contains minor pumpellyite.

TEXTURES

Typical common felsite is a simple porphyry with euhedral or partially absorbed phenocrysts in a groundmass which is granular, patchy or microgranophyric. Examples are shown in Plates I, II, III and IV. However, other textures are common. Many samples are sheared, showing various stages of development of mylonitic texture (Plates V, VI and VII). Some are glomeroporphyritic and some are breccias. A few samples are even grained. Generally, however, a coarse phase and a groundmass phase can be readily distinguished or the rock is seriate, ranging regularly from fine to coarse. In this discussion the terms "matrix" and "groundmass" are used interchangeably.

GROUNDMASS TEXTURES

It seems certain that most or all of the present groundmass texture was developed after the rock cooled below through the solidus temperatures. In some cases the texture has been grossly altered, as in the sheared and metamorphosed samples. More commonly the general texture is one of subsolidus crystallization, that is, devitrification. The term "devitrification" has been used in the literature in various senses. As early as 1903 Sollas criticised the use of "devitrification" by Bonney and Parkinson (1903) for textures which "... might be due to direct crystallization from molten magma". Commonly no critical distinction is made between crystallization at solidus temperatures and early devitrification from a supercooled glass.

After thoughtful consideration of the problem, Lofgren (1971a, p.111) used "devitrification" to describe crystallization below the thermodynamic solidus temperature. Crystallization below the solidus temperature but above the glass transition temperature was included in "devitrification" because of the difficulty in recognizing the glass transition temperature; textures formed above this temperature are similar to those formed below it. The groundmass of most samples can be described under one of five headings: microcrystalline (Plates IX, X and XI), microsymplectic (Plates XII to XX), orb (Plates XXIX and XXX), microgranular (Plates XXI, XXII and XXIII) or microlitic (Plate XXIV). All but the last two textures seem to be associated with devitrification. The three devitrification textures and the microgranular texture seem intergradational.

The devitrification textures seem to be included in the "micropoikilitic" texture of Reed (1895). "Micropoikilitic" has been retained in a restricted sense but was rejected as a general term for the devitrification textures in this work because it does not logically seem to include the vermicular and granophyric intergrowths of microsymplectic texture. Johannsen (1939, p.234) defined "symplectic" as "A texture in which two different minerals are intimately interlaced, embracing thus the pegmatitic, granophyric, poikilitic, ophitic, basiophitic, etc., textures". The microsymplectic textures in the felsites of the Eastern Goldfields Province have the form characteristic of the symplectites of Johannsen, but the diameter of aggregates of intergrown grains is rarely greater than 0.8 mm. Where aggregates are coarser than this the component textures (granophyric, pegmatitic, etc.) are described individually.

Microcrystalline texture

Felsites of the Eastern Goldfields Province commonly have an even groundmass of very fine grain size, about 0.015 mm. This is microcrystalline texture, illustrated in Plates IX and X. Grains are sutured or intertwined in a complex manner. Where intertwining of grains becomes more complex microcrystalline texture grades into microsymplectic texture (Plate XI). If on the other hand, the grain size increases with simplification of grain boundaries, microcrystalline texture approaches microgranular texture. As grain size decreases the texture becomes cryptocrystalline but true cryptocrystalline groundmass texture is rare. Samples 7900 C, K and L (Kalgoorlie), 37805 (Laverton), 17645B (Menzies) and 9102 (Kalgoorlie), among others, have typical microcrystalline groundmass; samples 32719 and 32722 (Leonora) are gradational to microsymplectic texture; and samples 11645A and B (Menzies), and patches in sample 11053

(Kurnalpi) are transitional to microgranular texture.

The origin of microcrystalline texture is not clear. It does not seem to have been found by Lofgren (1971a) among the products of artificially induced devitrification. Probably it is related to the cryptocrystalline texture of various authors (Reed, 1895).

Microsymplectic texture

Very fine aggregates of intergrown felsic minerals are typical of the felsites of the Eastern Goldfields Province. Microsymplectic texture refers to these intergrowths which occur in aggregates seldom more than 0.8 mm in diameter. Microsymplectic texture includes at least three textures which can be more specifically named: "micropoikilitic", "vermicular-granophyric" and "micrographic". All of these textures are "patchy" in that they are difficult to recognize in plain light, but between crossed polarizers elements within aggregates are seen to have either a dominant orientation or a radiating pattern. Most samples with these textures are incipiently spherulitic.

Micropoikilitic (snowflake) texture describes rocks in which individual mineral elements in the microsymplectic aggregates tend to be equidimensional. A texture apparently similar to this was named "snowflake texture" by Snyder (1962). A rounded or irregular single grain, normally quartz, encloses other grains which are effectively equidimensional. There are at least two types of micropoikilitic texture. In the first, enclosed grains, though very small can be easily resolved by a petrographic microscope. The second consists of indistinct quartz patches blurred by inclusions which appear as points under the petrographic microscope. Micropoikilitic texture is illustrated in Plates XII to XV.

Resolvable micropoikilitic texture is normally not well developed and is characteristic of small grain aggregates which are transitional to microgranular texture (see Plate XII).

Fine micropoikilitic texture, or "patchy" texture, refers to dusty patches of quartz, generally smaller than 0.8 mm in diameter. The patches have indistinct margins which, together with dustiness, gives them a blurred appearance between crossed polaroid filters. Unless individual patches are surrounded by material expelled during crystallization (orb texture), adjacent patches are very difficult to distinguish from matrix or from each other under plain light, though the patchiness is evident between crossed polaroids. Fine micropoikilitic texture is illustrated in Plates XIII, XIV and XV.

The mineral of the patches often, possibly invariably, is quartz. Patches of this type are common in descriptions of devitrified natural glass. Reed (1895, p.166-67) described quartz patches in detail in a discussion of micropoikilitic texture. He included with micropoikilitic texture, quartz patches which contain "... cryptocrystalline, or 'dusty' material ...".

Micropoikilitic patches rarely form a continuous pavement in the thin sections studied, but occur individually or in clusters, separated by other textures such as the interstitial microgranular texture in sample 38307 (Leonora) and 15514A and B (Edjudina).

Fine micropoikilitic texture grades into microgranular texture. Some rocks have three-tiered textures with coarse phenocrysts, fine-grained micropoikilitic patches, and interstitial, very minutely granular, almost cryptocrystalline patches (sample 15514A, Edjudina). A small proportion of samples with fine micropoikilitic texture have microlites as well. Probably these rocks have been devitrified from a porphyritic and microlitic vitrophyre.

There are many examples of micropoikilitic texture in the thin sections studied. Fine micropoikilitic texture is represented by sample 32722 (Edjudina). Coarse micropoikilitic texture is developed in sample 9101 (Kalgoorlie), Plate XII. Sample 8885B (Menzies) is similar, but has a microlitic element as well. Micropoikilitic patches are more fully developed in samples 32799 (Leonora), 39018 (Laverton) and 15527 (Edjudina). Resolvable micropoikilitic patches are relatively large (0.75 mm) and unusually well developed in sample 6523 (Widgiemooltha). Scattered resolvable micropoikilitic patches in the microgranular groundmass of sample 37810 (Laverton) seem associated with metamorphic recrystallization.

In sample 9130A (Kalgoorlie) the coarse host to the poikilitic inclusions has a fibrous tendency, transitional to microspherulitic texture.

In sample 9153 (Kalgoorlie) two or more phases are very intimately intergrown so that the distinction between host and inclusions is lost, yet there are elements which retain an approach to parallel extinction. In this sample micropoikilitic texture is much like vermicular-granophyric texture without appreciable elongation of any mineral.

Vermicular-granophyric texture is a form of microsymplectite represented by aggregates of intergrown vermiform grains of felsic minerals, similar to the quartz of myrmekite.

In detail the grains are sinuous, distinguishing the texture from micrographic texture where the grains are rod-like or angular. The vermiform grains appear to pinch and swell, but this may be due to weaving of the "worms" in and out of the plane of the thin section. Bundles of "worms" tend to be roughly parallel, forming groups within single aggregates. Groups of parallel "worms" are joined, forming sectors which give the aggregate an overall radiating appearance. Thus the vermicular-granophyric aggregates in large part probably are incipient spherulites. Sample 32797 (Leonora) is a good example of most of these features. In this and in other samples the "worms" are locally ordered to form micrographic texture. Elsewhere in the sample there are sheaf-like aggregates of the type described by Lofgren (1971a) as incipient spherulites (Plate XVII). Parts of sample 17263 (Menzies), Plate XVI, resemble the spherulitic texture illustrated by Lofgren (1971a) in his Figure 3A.

In sample 15514C (Edjudina) intergrowth is cryptocrystalline and is recognized mainly by radial extinction of very small aggregates. The groundmass of sample 20919 (Kurnalpi) is both microlitic and vermicular-granophyric. The granophyric aggregates are radiating and relatively coarse, about 0.5 mm, but the intergrown rods are very fine. Sample 30800 (Laverton) also has vermicular-granophyric texture superimposed on a microlitic fabric (Plate XVIII).

Micrographic texture is similar to vermicular-granophyric except that the intergrown grains are angular. The two textures are gradational and may be present in the same thin section, for example, samples 32797 (Leonora) and 25033 (Edjudina). Micrographic texture is illustrated in Plates XIX and XX.

Most vermicular-granophyric and micrographic aggregates have an incipient spherulitic form. Some are similar to those illustrated by Lofgren (1971a), Figure 3A. Rarely, as in sample 8889 (Menzies), the margins or resorbed centres of potassium feldspar grains are partly symplectic. In this sample the texture strongly suggests that intergrowth developed subsequent to crystallization as a partial replacement of the phenocrysts rather than as an overgrowth. In other samples, granophyre apparently nucleated on phenocrysts and grew outward. Where the intergrowth has nucleated on a phenocryst or microlite, one phase of the granophyre may be in optical continuity with the host (sample 15532, Edjudina).

Some samples have a three-tiered structure which may consist of phenocrysts, microlites and granophyre; in other samples phenocrysts and granophyre lie in a microcrystalline groundmass.

Vermicular-granophyric and micrographic textures are rare in rocks with appreciable planar cataclasis although vermicular-granophyric texture is weakly developed in at least one sheared sample (38135, Laverton).

Orb texture

Lofgren (1-71a, p.118-19) named and described as orb texture the spheroidal domains relatively devoid of globulites. Globulites, in turn, were defined (Lofgren, 1971a, p.115) as tiny, even-spaced bubbles and crystalline blebs, 0.5 to 5 microns in diameter. The globulites appear as opaque dust particles under transmitted light. They commonly are concentrated at the margins of the globulite-free orbs. Presumably the orbs are free of globulites due to exclusion during devitrification.

Orb-like textures are common in the felsites of the Eastern Goldfields Province; but excluded material coarse enough for rough identification is present as well as globulites. Presumably some of the excluded globulites have recrystallized into coarser grains in response to metamorphism. Orb-like textures are developed in micropoikilitic and microsymplectic rocks (sample 32798, Leonora). Minerals rimming the orbs include chlorite (sample 15514A, Edjudina), sericite (samples 38307 and 32798, Leonora and 25034, Edjudina), biotite (sample 8894, Menzies and 15514C, Edjudina) and biotite plus hornblende (sample 8886B, Menzies). This final sample is unusual, as the orbs are very large, about 4.5 mm in diameter, and enclose relict perlitic cracks and axiolites. Plates XXIX and XXX illustrate orb texture in the Eastern Goldfields Province.

Microgranular texture

This texture refers to a groundmass which is essentially equigranular, and is made up of discrete felsic grains. It is gradational to microcrystalline texture from which it is distinguished by coarser grain size and less interlocking of grains. Although grains may be sutured they are not intimately intergrown. The grain size is coarser than about 0.05 mm. The texture is shown on Plates XXI, XXII and XXIII.

Samples with microgranular texture have a hornfelsic aspect. Felsic minerals, biotite, chlorite, colourless mica and carbonate are common, and amphibole and epidote are less abundant. In rocks lacking strong foliation the mafic minerals and muscovite, especially the micas, tend to be irregular and sutured, with apophyses extending, like the pseudopodia of an amoeba, between grains of felsic minerals. This is a hornfelsic texture suggesting static metamorphic recrystallization. Sample 24808 (Edjudina, Plates XIII and XXI) is microgranular with felsic blebs in the margins of phenocrysts and with hornfelsic, symplectic biotite.

Microgranular texture is typical also of foliated rocks, Plate XXIII. Rarely, microgranular texture is patchy, with areas 1 to 4 mm in diameter which are coarser than surrounding material; these areas seem monomineralic and may be the relicts of recrystallized phenocrysts. Grain shapes and size distribution in a few samples give the rock a clastic appearance; along with phenocrysts, this texture suggests crystal tuff. In a few cases microgranular texture may be due to selective recrystallization of a granitic rock, preserving feldspar grains and giving the rock a pseudoporphyritic texture; however, the great majority of samples seem clearly to be truly porphyritic.

The regular association of microgranular texture with metamorphic mineral assemblages, the association with metamorphic textures in mafic minerals, and the association with deformed rocks suggest that microgranular texture commonly is a result of metamorphic recrystallization.

Microlitic texture

The microlites in felsites of the Eastern Goldfields Province are very small, euhedral feldspar grains commonly, if not always, plagioclase. They are seldom the sole textural element in the groundmass of the rock but commonly are abundant (sample 8885B, Menzies). In some samples (6884 and 20919, Kurnalpi and 32798, Leonora) the microlites are set in a microsymplectic matrix, whereas in others (7900P, Kalgoorlie) they are in a microgranular matrix, or (samples 38647, 11050 and 20926, Kurnalpi) they are in a micropoikilitic matrix. Sample 20919 with a microsymplectic matrix is illustrated in Plate 6D. Samples containing microlites seldom have quartz phenocrysts, although microsymplectite and, rarely, visible quartz in the groundmass show that microlitic rock need not be quartz-free. The best development of microlites is in rocks of intermediate composition. Some care is needed in assigning a rock this texture as lathlike twinning in grains which are in fact irregular can simulate microlitic texture.

The simplest explanation of microlitic texture seems to be that phenocrysts and a few groundmass feldspar grains crystallized before the remainder of the rock was chilled to a glass. After chilling devitrification continued with the formation of micropoikilitic and microsymplectic textures. In some samples microlites are encased in microsymplectite. In others well-formed microlites are crystallographically continuous with pools of feldspar which in turn give way to poorly developed microsymplectite.

GRANOPHYRIC TEXTURE

Granophyric texture, by definition, is coarser than vermicular-granophyric or other microsymplectic textures described above. Well-developed granophyre was found only in one sample (7900E, Kalgoorlie). Somewhat more commonly, granophyre appears as patches enclosed in another texture. In sample 17263 (Menzies) granophyric patches are set in microsymplectite; in sample 38121 (Laverton, Plate XXV) granophyric patches are set in an otherwise coarse-grained adamellite.

SPHERULITIC TEXTURE

A single rock, sample 32793 (Leonora), Plate XXVI, has fully developed, coarse spherulites. The spherulites are of uniform diameter, about 3.5 mm. They consist of radiating, almost submicroscopic, branching and intergrown blades of felsic minerals. Rarely, growth seems to have been periodic forming concentric growth rings, the rhythmic structure described by Mourant (1932, p.232-237). In some places the margins of the spherulites are sharp, against either other spherulites or matrix; elsewhere, adjacent spherulites are intergrown in a complex manner. The matrix is made up of patchy to granular quartz and feldspar, minutely granular, unresolvable material, and very small partially to completely developed spherulites. A few quartz and feldspar phenocrysts are scattered through the rock.

MICROSTRUCTURES

PERLITIC STRUCTURE

At least two samples (8886B, Menzies and 11020, Kurnalpi) have features which can be reasonably interpreted as relict perlitic cracks (Plates XXXI and XXXII). In both cases the felsic groundmass texture associated with the relict perlitic cracks has fine micropoikilitic (patchy) texture. This association probably indicates devitrification from solidified glass. Sample 11020 seems to be a breccia, some fragments of which are microlitic and may have been holocrystalline at the time of emplacement. The groundmass and probably some fragments were glassy. Some of the best perlitic structure seems to be in fragments.

SHARD STRUCTURE

In a few porphyritic rocks (sample 37818, Laverton, Plate XXVII) one can believe that a relict shard structure has been preserved through devitrification and minor metamorphic recrystallization. This rock is established as igneous by euhedral plagioclase, probably combination-twinned (Ross, 1957) in a synneusis relationship (Johannsen, 1939, p.234).

BRECCIA STRUCTURE

Several samples consist of fragments of assorted rock types in a more-or-less uniform matrix. Probably these are flow or intrusive breccias. Those described probably are not tectonic breccias or conglomerates. In sample 32792 (Leonora) fragments of various sizes are set in a heterogeneous matrix. Quartz grains are broken but some feldspar grains are euhedral. The rock probably was a crystal-lithic tuff. Sample 38684B (Laverton) is tightly packed with coarse fragments differing in texture but with a uniform plagioclase-rich, quartz-free aspect. Sample 39029 (Laverton) is also packed with fragments, but they are of medium grain size. The rock is a quartz andesite. Quartz is rare but primary hornblende is common. Sample 9130C (Kalgoorlie) is an oligomictic breccia with plagioclase, including a few relatively coarse microlites, set in a matrix transitional from fine micropoikilitic (patchy) to microgranular and microgranophyric. Fragments and groundmass are difficult to distinguish but the latter may be richer in biotite.

Sample 38660 (Kurnalpi) consists mainly of very coarse, rounded fragments of porphyry in a largely carbonated matrix. Phenocrysts are plagioclase and quartz. In one fragment abundant blocky phenocrysts of a mafic mineral have been pseudomorphed by chlorite. The matrix within fragments normally is granular but in one case there are abundant microlites. A final breccia, sample 11052 (Kurnalpi) probably is a crystal tuff. Many of the coarse grains of feldspar are euhedral, but finer grained quartz and feldspar seem to be fragmental. Other breccias have been described in the section on perlitic structure.

CATACLASTIC FOLIATION

Little evidence was seen suggesting fluxion structure due to flow in a viscous, consolidating magma. Many rocks are foliated, but this foliation seems to be tectonic, superimposed on the rock after cooling. In almost all cases secondary minerals, including mica, amphibole, sericite, and patches of carbonate, have been oriented. In all cases where these minerals, other than sericite, are involved in the foliation the groundmass has a granular texture and quartz phenocrysts have been elongated. The quartz has been either converted into aggregates of sutured or polygonized grains or, at least, severely strained. On the other hand, rocks with sericitic mica tend to have a very fine-grained groundmass, largely of the microgranophyric type, and quartz which is unstrained or weakly strained. Plate V illustrates the sericitized mylonitic rocks and Plates VI, VII and VIII illustrate the more granular type of blastomylonitic porphyry.

In sample 15522 (Edjudina) carbonate occupies the strain-shadow area at the tails of many feldspar phenocrysts; chlorite and quartz occupy the same position adjacent to hematite which probably is pseudomorphous after pyrite.

Although post-crystallization deformation seems responsible for most of the directed fabric in these rocks, textures in many are not clear and flow effects could be present.

PETROGENESIS

Uncertainty concerning physical and chemical conditions within and on the surface of the earth in early Precambrian time as well as the length of time that rocks have been vulnerable to physical and chemical alteration make the interpretation of petrogenesis of Archaean rocks less certain than similar interpretation of more recent rocks. The uncertainty is compounded in volcanic rocks by their susceptibility to textural change and their sensitivity to conditions both within the earth and at the surface. However, bulk changes in chemical composition should be detectable petrographically and many Archaean volcanic rocks have little petrographic evidence of gross metasomatic alteration. Chemical analyses of more than 100 felsites in the Leonora, Laverton and Rason sheet areas by Davy (1977) can be interpreted in the same manner as modern felsites. Anomalies appear only in a few high values for Na and where there is clear petrographic evidence of weathering or silicification.

RECOGNITION OF ACID VOLCANIC ROCKS

Probably the most generally used petrographic criterion for the recognition of a volcanic or shallow hypabyssal origin of an acid rock is a fine-grained, porphyritic texture. Some uncertainty is introduced by similar textures due to marginal chilling of small, shallow stocks and the development of pseudoporphyries by selective tectonic granulation of quartz in a quartz-rich granitic rock. Generally the latter problem is overcome if the samples in question lack planar structure, have phenocrysts of quartz as well as feldspar and if phenocrysts are embayed (samples 9102, Kalgoorlie, Plate III; 41484C, Edjudina; and 37805, Laverton). Well-embayed phenocrysts of quartz from sample 15504 (Edjudina) are shown in Plate I.

Criteria other than porphyritic texture would be more convincing and would be useful if they were recognized often and with confidence. Shard structure and perlitic cracks have been described above but are not common, probably because they are particularly susceptible to destruction during devitrification and later recrystallization. Plate XXVIII illustrates destruction of shard structure during progressive devitrification of a Phanerozoic vitrophyre from Baja California, Mexico.

INTERPRETATION OF GROUNDMASS TEXTURES

Micropoikilitic (or snowflake) texture is generally recognized as a common texture in rocks that have been glassy. However, there are uncertainties as to whether the texture developed directly from glass without an intervening microcrystalline or cryptocrystalline stage, and whether the texture can be relied upon as an indicator of former glassy state.

A sample (133 A-58) from Baja California, Mexico, on loan from the Department of Geology, San Diego State University, seems to establish that micropoikilitic texture can develop from a glassy rock (Plate XXVIII). Patches with micropoikilitic texture, about 1 cm in diameter, constitute about 20 per cent of this Phanerozoic felsic porphyritic tuffaceous rock. The matrix consists of well-developed shards, strongly oriented by flattening and possibly by flow. Everywhere except in the micropoikilitic patches the shards have been devitrified to cryptocrystalline felsic material and opaques which apparently are hydrous iron-oxide. The relict pattern of shards gradually disappears into the centre of micropoikilitic patches. It seems clear, then, that micropoikilitic texture can develop, directly or indirectly, from a felsic glassy rock. Incidentally, these relations show that the development of micropoikilitic texture is effective in obliterating evidence of shards and primary structure, possibly explaining the rarity of these textures in rocks of the Eastern Goldfields.

The glassy origin of a rock with micropoikilitic texture is also demonstrated by a rock from the Eastern Goldfields Province, sample 8886 (Menzies), Plates XV and XXXI. Here a rock with relict perlitic cracks has micropoikilitic texture.

These examples have shown that some rocks which now have micropoikilitic texture were once glassy. Reed (1895, p.167) in a discussion of the rocks around Fishguard, Pembrokeshire, thought that this texture was developed after "normal", even-grained devitrification.

He traced a series of stages from rocks with simple microlitic or cryptocrystalline groundmass to those with a fully developed micropoikilitic mosaic. He thought that introduction of silica in micropoikilitic rocks was suggested by quartz veins, vesicles, etc. He drew an analogy with mosaic textures in slates subject to contact metamorphism and suggested that the degree of development of micropoikilitic texture correlated with the size and nearness of "intrusive masses".

Following this line of argument, micropoikilitic texture should be considered a product of recrystallization rather than devitrification. However, Geijer (1913) thought that approximate eutectic composition of the groundmass in many cases favoured development of micropoikilitic texture by direct crystallization from a melt or, possibly, by devitrification of glass during its original cooling phase either by reheating or by action of volcanic vapours.

Anderson (1969) described further examples of snowflake (micropoikilitic) texture and suggested that the texture may be diagnostic of densely welded ash-flow tuff. However, Green (1970) showed that Keweenawan flows with snowflake texture are massive and uniform with a frothy top "... clearly implying the presence of a fluid lava and not a pyroclastic origin".

Lofgren (1971a) has developed micropoikilitic textures in the laboratory from natural glass fluxed with various alkali salts and hydroxides in runs of a few days duration. He concluded that "... micropoikilitic quartz may be a good indication of a former glassy state". In these runs, even if micropoikilitic texture followed cryptocrystalline devitrification, both processes occurred during the same thermal event. In fact, it seems likely that micropoikilitic texture developed directly from glass. The best micropoikilitic textures generated by Lofgren developed between 400 and 650°C.

Torske (1975) suggested that some, if not all, snowflake texture is generated from quartz-rich and feldspar-rich domains which separated from homogeneous glass by metastable fluid immiscibility below the solidus temperature but prior to crystallization. Subsequent crystallization froze the snowflake pattern in the relation we now see. The "micrograno-phyric" snowflake textures of Torske seem particularly similar to the micropoikilitic texture of the Eastern Goldfields Province.

In summary, micropoikilitic (snowflake) texture clearly can develop from rocks which at some time were glassy. This is the thread of consistency through all of the papers cited. Most of the investigators suggest or assume that the texture forms only in rocks which were glassy. This would be necessary if the metastable exsolved quartz- and feldspar-rich glassy phases described by Torske are prerequisite to the development of snowflakes.

Thus a glassy phase in the history of many of the felsites of the Eastern Goldfields Province seems likely.

Micrographic and vermicular-granophyric textures described in this work seem to be similar to the spherulitic texture of Lofgren (1971a, p.116-117). These textures seem to be incipient forms of the true spherulites of the type sample 32793 (Leonora). Clear sheaf-like forms described by Lofgren as embryonic spherulites are rare in the Eastern Goldfields Province but a few examples were seen (sample 32797, Leonora, Plate XVII). Forms similar to Lofgren's Figure 3a, however, are common (Plates XVI and XXIX). Interfering sheafs of this type were generated by Lofgren (1971b, p.5636) between 400 and 650°C. These results may give some idea of the physical conditions of devitrification in the Eastern Goldfields Province - if the rock types are comparable and the alkali-rich solutions of the experimental runs did not give spurious results.

CHEMISTRY

The chemistry of the felsites has been studied by Davy (1977) in the Leonora, Laverton and Rason sheet areas and by O'Beirne (1968) throughout a broad area around Kalgoorlie. Average composition of three andesites has been reported by Williams and others (1971).

Davy analyzed more than 100 fine-grained felsic rocks, concluding that many, if not all, suites in the area are calc-alkaline, though the composition of individual rocks ranges widely, from ultrapotassic rhyolite to andesite. Some individual suites have a broad compositional range whereas others are compositionally compact. In most areas of felsic rock dacite is characteristic.

Acid and basic rocks from some areas plotted in a continuous series on an AFM diagram, generating chemical trends which seem clearly coherent; though, as usual, rocks of intermediate composition are sparse. Also, in a few areas, spatially associated volcanic rocks, hypabyssal intrusives, and granitic rocks are chemically similar and may be genetically related, but in most areas fine-grained felsic rocks are quite dissimilar to nearby granitoids. Where similarities exist they are usually between rhyolitic porphyries and nearby adamellites.

O'Beirne (1968) found that none of the porphyries which he studied, with the possible exception of minor intrusive porphyritic microcline-albite-quartz rhyolites, were related to the "internal granites" of the Eastern Goldfields Province. "Internal granites" are the discrete granitic plutons within greenstone belts and are contrasted with the seas of granitoid and gneissic rock between greenstone belts which constitute the "external granites" (Sofoulis, 1963, p.10).

Phenocrysts of all porphyries reported by O'Beirne were interpreted to have crystallized between 700 and 900°C. The phenocrysts of the intrusive porphyritic quartz-albite sodic rhyolite were considered to have crystallized between 1 500 and 3 500 kg/cm^2, and those of the intrusive microcline-quartz-albite rhyolites and the extrusive potassic rhyolite, at pressures above 3 500 kg/cm^2.

In general, the proportions of feldspars and quartz in phenocrysts studied by O'Beirne bore little relation to chemical composition, leading to the conclusion that the type and proportion of various minerals in the phenocryst assemblage varied with physical rather than chemical conditions. The composition of the rock apparently can not be estimated from the phenocryst assemblage.

FIELD RELATIONSHIPS

According to Trendall (1964) the porphyries of the Pilbara and Yilgarn Blocks are mainly elongate, planar, concordant bodies, tens of metres thick, which may variously be dykes, sills or flows. Honman (1913) reported that the porphyries of Binduli could be traced for 24 miles (39 km) with little change in thickness.

Gradation of porphyry into granite was reported by Honman (1917) in the Yerilla District and Clarke (1921) at St Ives, but McMath (1950), during the Coolgardie resurvey, considered that the porphyry grading into granite in the Coolgardie area was fundamentally different to the thick porphyry bodies which were continuous for many miles. A tendency for the composition of porphyry at any locality to approach the composition of enclosing rock at that locality was reported by several geologists (Matheson, 1948; McMath, 1950; and Ward, 1951) of the Coolgardie re-survey who considered that the relationship demonstrated assimilation of country rock by porphyry. Clarke (1921), again at St Ives, found "... some remarkable gradations from porphyry to greenstone (probably a result of digestion of the greenstone by the porphyry) ...".

Relations such as the transition from greenstone to porphyry may have led to the theory of "porphyritization" suggested by Sofoulis and Bock (1962, p.11) as an origin for porphyry. Trendall found no petrographic evidence to support porphyritization, but O'Beirne (1968, p.251-271) later interpreted rocks at Widgiemooltha from the Mandilla and Wanda Wanda Beds to be products of porphyritization. "Ghost" pebbles and relict layering in rocks containing megacrysts resembling phenocrysts were cited as evidence of porphyritization. O'Beirne proposed, however, an igneous origin for most of the porphyries which he described.

In 1964 Trendall noted the association of oligomictic conglomerate with porphyry. Horwitz and others (1967) considered this relationship at length, concluding that the oligomictic conglomerates were derived directly from the porphyry. Williams (1970, p.14) is more explicit: "They (oligomictic conglomerates) are thought to be the product of direct deposition of pyroclastic material in water admixed with erosion products derived from the upbuilding acid igneous pile".

Volcanic centres, producing piles of acid rock, have been proposed for parts of the Laverton (Gower, 1974), Kurnalpi (Williams, 1970) and Edjudina (Williams and others, 1971) sheets. Perhaps re-interpretation of sheets mapped earlier would result in the discovery of similar centres of acid volcanic activity in other areas.

SUMMARY OF PETROGENESIS

Porphyritic felsites are common in the Eastern Goldfields Province. Although a few of these rocks may have originated by "porphyritization" of enclosing rocks, the majority are of igneous origin. At least two habits are seen, large concordant or nearly-concordant sheets, and smaller, discordant bosses and dykes. The discordant bodies seem clearly intrusive; some concordant bodies may be sills and some may be flows. Evidence for sills is seen in the slight discordance and bifurcating nature of some "concordant" bodies. Evidence for extrusion includes rare perlitic cracks and shards. Common micropoikilitic and microspherulitic textures probably signify wide development of glassy matrix, suggesting volcanic origin for many more of the felsites. General felsic volcanism is implied by the widespread association of porphyry and oligomictic conglomerate, explained as quasi-contemporaneous erosion of a growing pile of acid rocks. While petrographic criteria alone may not distinguish *in situ* flows from acid volcanic clasts in an agglomerate or conglomerate, the existence of flow-derived rock can be established.

Most major porphyry bodies seem chemically unrelated to adjacent granitoids but there may be a few exceptions. Rarely, in the data from Laverton-Leonora, rhyolitic porphyry is chemically similar to nearby adamellite and, farther south, minor bodies have been reported to grade in field appearance from porphyry to granitoid. However, even these few minor exceptions may be explained differently. Chemical similarities can be fortuitous and, as porphyry bodies pass from one enclosing unit to another, they have been reported to approach the composition of the local host.

This effect has been attributed to assimilation of country rock by the porphyry. If this compositional convergence is extreme it could give the appearance of mechanical gradation into enclosing rock.

The temperature of emplacement is not clear, but O'Beirne (1968) has suggested the phenocrysts crystallized between 700 and 900°C in most types of porphyritic felsites which he studied. Final devitrification may have been near the interval 400 to 650°C within which Lofgren experimentally obtained devitrification textures similar to those in many of the felsites in the Eastern Goldfields Province.

Conditions of emplacement and subsequent alteration of the felsic volcanic and hypabyssal rocks are gradually being clarified but little information is available on the origin of the magma. The origin of this magma is of particular interest in view of the suggestions by Davy (1977) and O'Beirne (1968) that the porphyritic felsites are, at least in large part, not related to spatially-associated granitoidal rock; though other data from Davy suggest that in some areas granitoids, hypabyssal intrusive rocks and extrusives may be related.

ROCKS OF INTERMEDIATE COMPOSITION

Most of the rocks which have been discussed contain quartz phenocrysts. In addition a few without quartz phenocrysts have abundant recognizable quartz in the matrix. These rocks probably range in composition from rhyolite to dacite. In other rocks, not specifically discussed, quartz is absent among the phenocrysts and either absent or not recognizable in the matrix. Where the matrix is coarse effective absence of quartz from the rock can be confirmed.

For this study, rocks in the andesitic compositional field and in the field of dacite near andesite are considered to be of intermediate composition. The original plagioclase composition would be calcic oligoclase to andesine, quartz would be near 20 per cent or less and potassium feldspar would be subordinate to plagioclase.

O'Beirne (1968, p.292) has shown that the phenocryst assemblage cannot be used to estimate the chemical composition of porphyries of the Eastern

Goldfields Province. Thus feldspar porphyries with a matrix in which constituent minerals cannot be identified cannot be classified optically either as acid or intermediate. The criteria for intermediate rocks used here are:

(1) plagioclase is abundant and quartz and potassium feldspar are minor or absent in a rock in which they would be recognized;
(2) hornblende is common; or,
(3) epidote is abundant and apparently is derived from plagioclase in the rock.

In the last two cases, quartz and potassium feldspar must not be obviously abundant, but may be present as obscure phases.

This section does not include the alkaline porphyritic rocks, some of which contain hornblende and little quartz.

Hornblende is the characteristic mafic mineral in these rocks but pyroxene may be the primary mafic mineral in a few. In sample 29987 (Leonora) primary green amphibole along with feldspar phenocrysts are set in a microgranophyric groundmass with fine elongate grains of secondary colourless amphibole and irregular grains of secondary biotite. Three samples from the Laverton sheet area (samples 37821, 37822 and 37823) have altered phenocrysts of amphibole or pyroxene and plagioclase phenocrysts in an extremely fine crystalline matrix. Some samples, as 38123 and 38684B (Laverton), are sufficiently altered that even the presence of original mafic phenocrysts cannot be established. Here heavily saussuritized glomeroporphyritic plagioclase phenocrysts are set in an apparently quartz-free matrix of microlites and poorly developed microgranophyre. Mafic phenocrysts are clearly absent from some rocks, as in the even-grained sample 17262 (Menzies). This sample is an interlocked network of plagioclase microlites, less elongate plagioclase, minor quartz and chlorite, and secondary colourless amphibole, epidote and carbonate. Samples 25080 and 25081 (Edjudina) are hornblende-plagioclase microbreccias with minor quartz in a microlite-rich groundmass. Sample 25076 (Edjudina) has pyroxene overgrown with amphibole and set in plagioclase. The pyroxene may not be primary. Samples 9110, 9112 and 9186 (Kalgoorlie) all contain amphibole. In sample 9110 hornblende is clearly primary and the rock seems to be andesitic.

Although the intermediate rocks have the same general range of textures as the fine-grained acid rocks, there is a tendency towards a higher degree of crystallinity. They tend to have a groundmass which is highly charged with microlites, though these may be set in nearly cryptocrystalline granular or microgranulitic material similar to that in the more acid rocks. Gross textures are variable. Most samples are porphyritic but many are even grained and at least one sample (25087, Edjudina) is seriate, though this may be a breccia or even a little-transported tuffaceous greywacke.

SUMMARY

A wide variety of rocks in the Eastern Goldfields Province is included under the heading "felsite". Of the rocks sampled, most abundant are acid porphyries, including both hypabyssal and flow rocks, and alkaline porphyries, probably mainly hypabyssal. A few are intermediate between acid and basic rocks, characterized by little or no quartz, plagioclase of intermediate composition, a greater abundance of mafic minerals than is common for acid rocks, and a tendency for hornblende rather than biotite to be prominent in the mafic mineral suite.

Chemical evidence suggests that though a few of the common felsites may be genetically related to spatially associated granitoid rocks, most are not.

Many of the groundmass textures in the porphyritic felsites suggest devitrification; that is, crystallization from glass at temperatures below the solidus for the system.

Despite the preservation of devitrification textures, some of which are quite delicate, every sample studied has been affected by secondary crystallization. Such recrystallization in some rocks is limited to sericitization of plagioclase. In others, plagioclase has been albitized, carbonatization is rampant, or secondary colourless mica is abundant. In rocks which have been even more altered the groundmass has been recrystallized to a granular mosaic, and mafic minerals as well as muscovite have developed a hornfelsic texture. Finally, many samples have undergone thorough penetrative deformation with recrystallization of groundmass minerals and breaking, bending, shearing and granulation of phenocrysts.

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APPENDIX

LOCATION OF SAMPLES

Samples are located according to 1:250 000 map sheets and the Australian Transverse Mercator Grid, in yards. The first digit of each coordinate indicates hundreds of thousands of yards. Four-digit coordinates have a precision of 100 yards, three-digit coordinates 1 000 yards. Accuracy is less. Letter suffixes on sample numbers have been omitted.

EDJUDINA	
15501	4721/3803
15504	4568/3916
15514	4545/3897
15522	4682/3868
15527	451-/375-
15532	4722/3795
24808	5029/3159
25033	4570/3913
25034	4582/3897
25080	4841/3963
25081	4841/3963
41484	441-/180-
KALGOORLIE	
7900	435-/204-
9101	Not available
9102	"
9103	"
9110	427-/231-
9112	420-/267-
9130	446-/184-
9153	388-/251-
9186	416-/176-
KURNALPI	
6884	510-/173-
11020	Not available
11050	4586/2360
11052	4600/2315
KURNALPI (CONT.)	
11053	486-/257-
20919	461-/222-
20926	464-/208-
38647	461-/221-
38659	475-/207-
38660	461-/207-
LAVERTON	
20984	5365/4597
29962	4684/4928
29972	4881/4885
30800	558-/432-
37803	5398/4655
37805	5440/4575
37807	5475/4635
37810	5385/4645
37814	5440/4630
37818	5563/4428
37820	5522/4426
37821	4746/4285
37822	4746/4285
37823	4746/4285
38121	534-/525-
38127	540-/522-
38132	543-/526-
38135	545-/522-
38684	474-/428-
39018	4946/4149
39029	4781/4419
LEONORA	
32717	4285/4933
32719	4054/5045
32722	3445/5158
32792	4060/4882
32793	Not available
32797	4069/5031
32798	4085/4885
32799	4140/4918
38307	4125/4855
38308	4230/4930
39802	4530/4580
MENZIES	
8885	433-/366-
8886	450-/372-
8887	450-/378-
8889	449-/378-
8894	442-/394-
17262	4393/3982
17263	4405/3945
17645	3513/2898
20979	4088/3246
WIDGIEMOOLTHA	
6523	4840/1500
13143	4996/0859
40860	499-/092-

P L A T E S

PART I

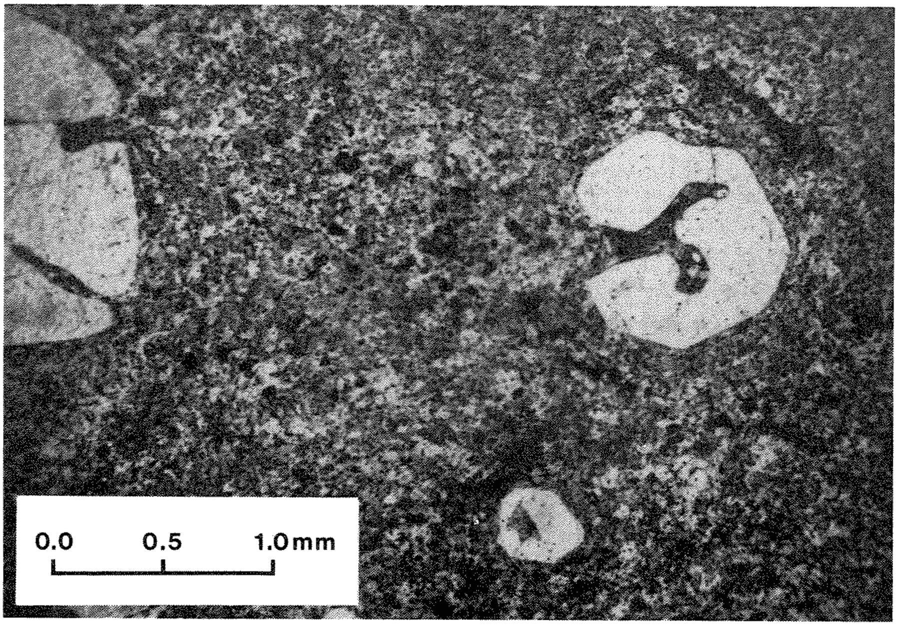

Plate I. Igneous texture: partial resorption of quartz phenocrysts.

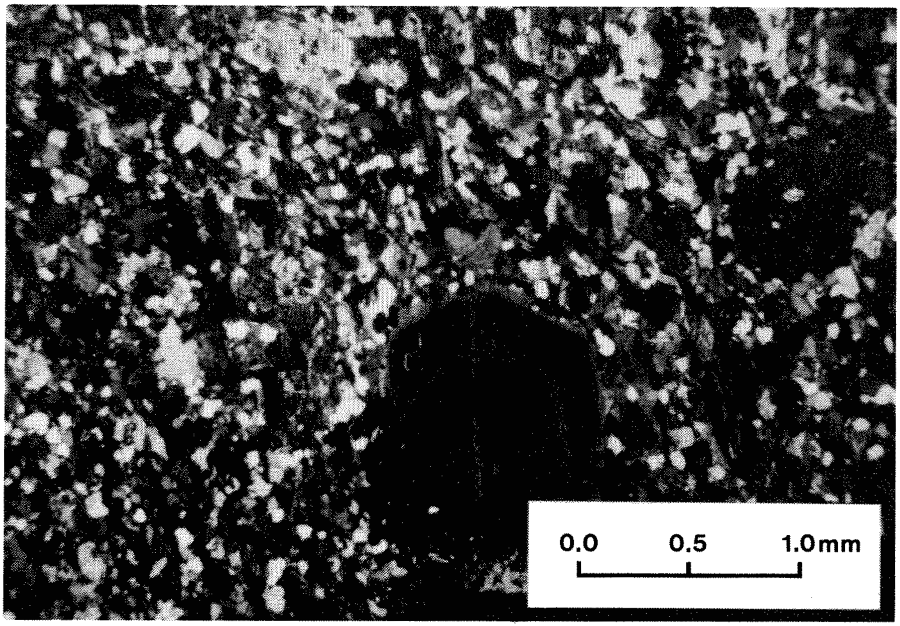

Plate II. Igneous texture: zoned euhedral plagioclase with rounded internal zones.

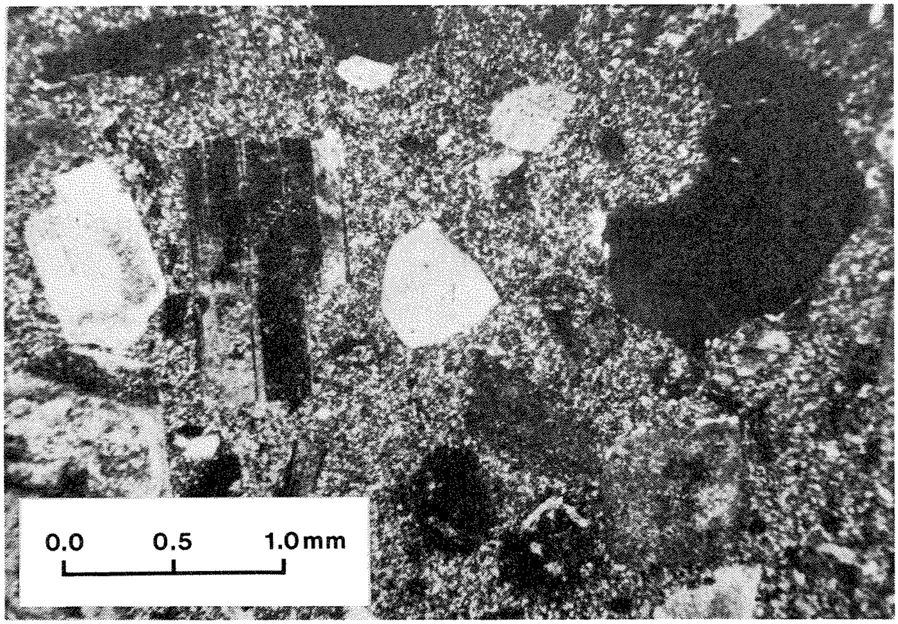

Plate III. Igneous texture: assorted resorbed quartz and euhedral plagioclase phenocrysts.

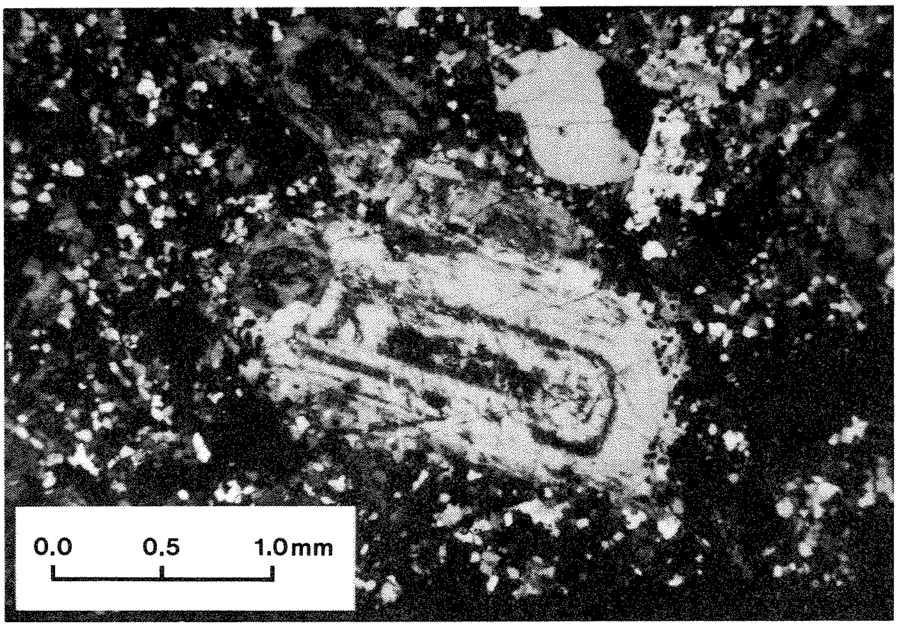

Plate IV. Igneous texture: differential alteration showing relict euhedral oscillatory zoning in plagioclase.

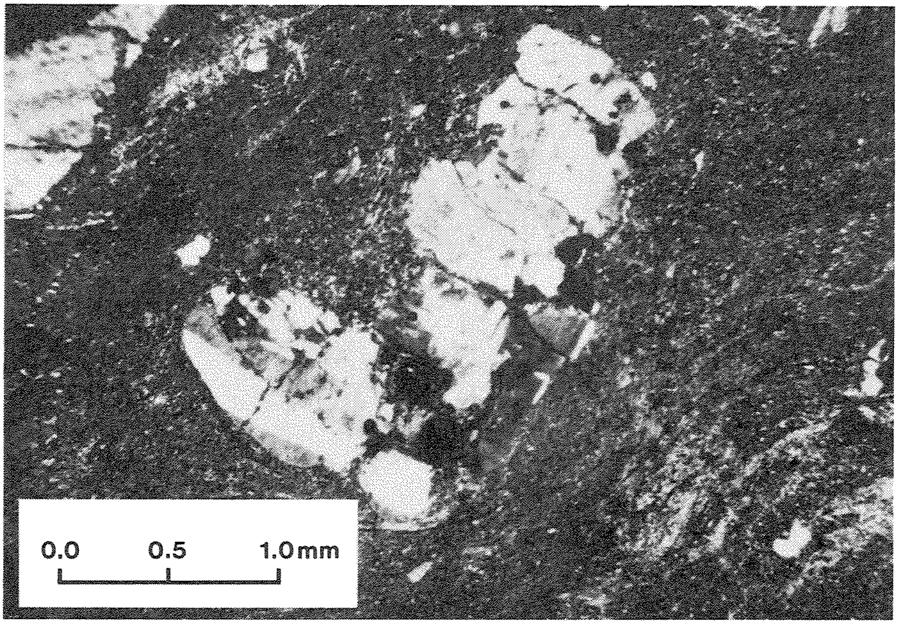

Plate V. Metamorphic fabric: sericitized mylonitic felsite.

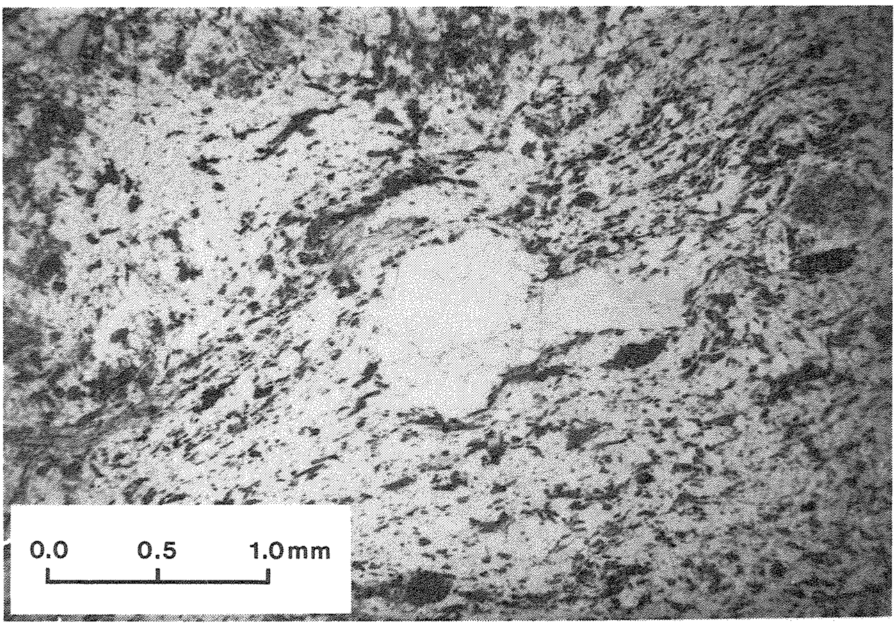

Plate VI. Metamorphic fabric: blastomylonitic felsite.

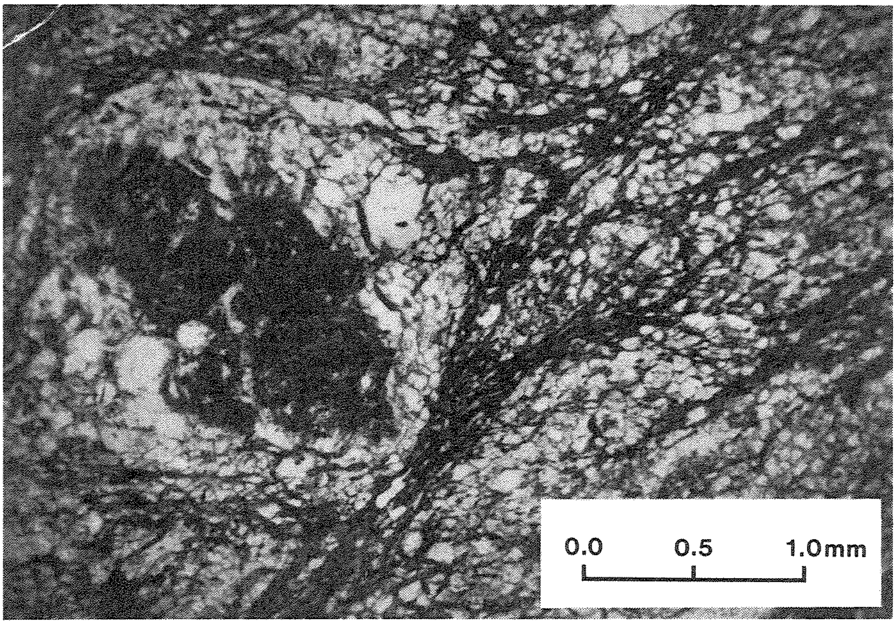

Plate VII. Metamorphic fabric: blastomylonitic felsite.

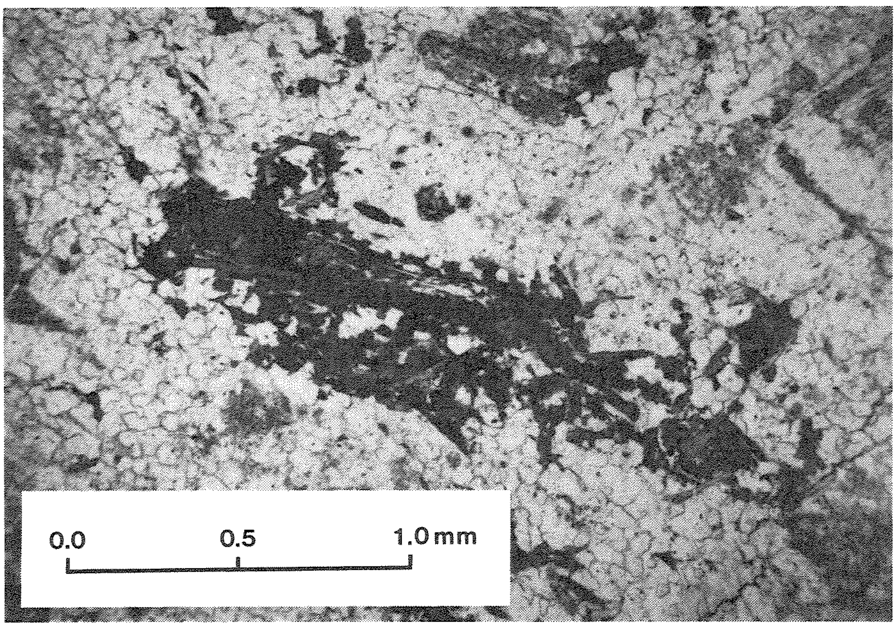

Plate VIII. Metamorphic fabric: hornfelsic biotite in felsite.

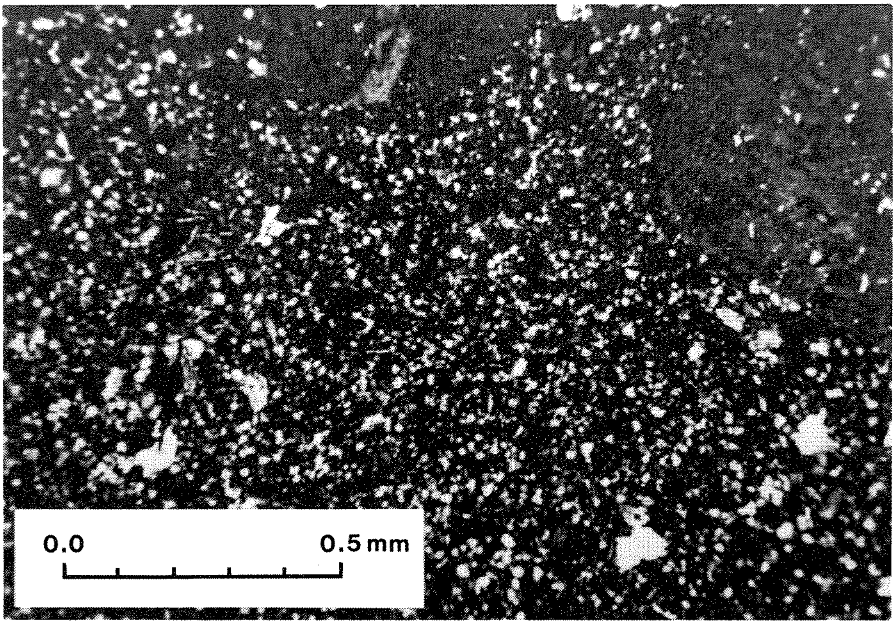

Plate IX. Microcrystalline and micropoikilitic textures: microcrystalline groundmass texture.

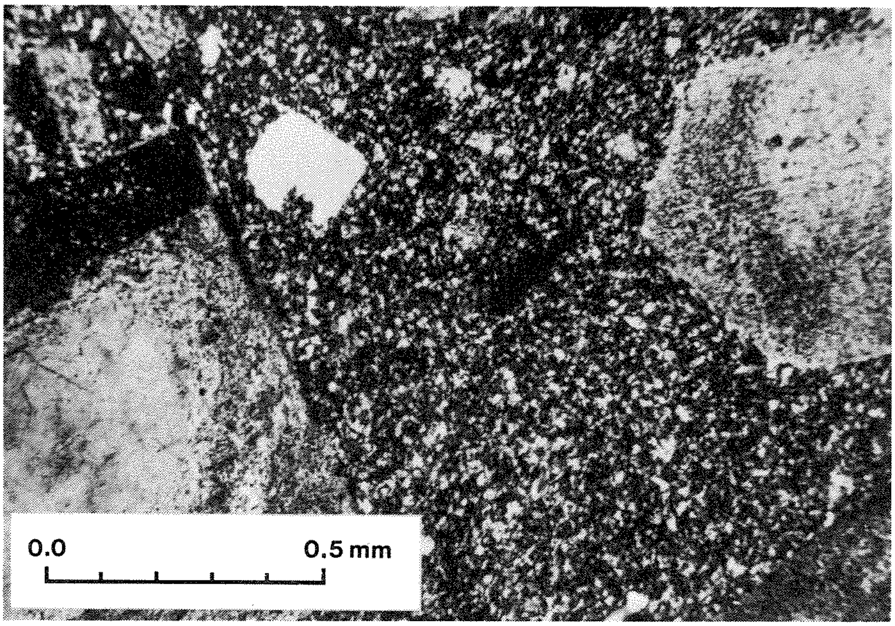

Plate X. Microcrystalline and micropoikilitic textures: microcrystalline groundmass texture.

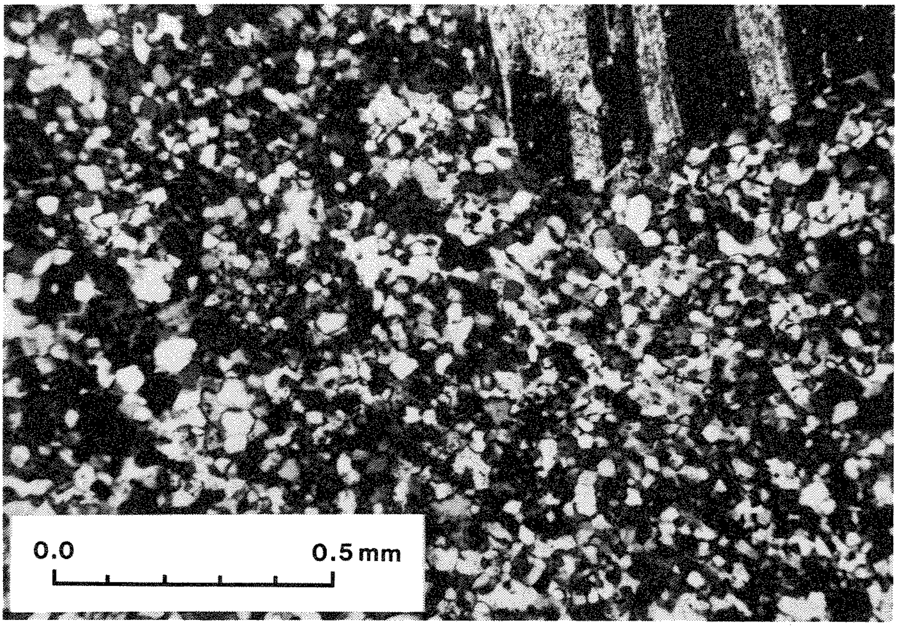

Plate XI. Microcrystalline and micropoikilitic textures: microcrystalline texture transitional to micropoikilitic (coarse) texture.

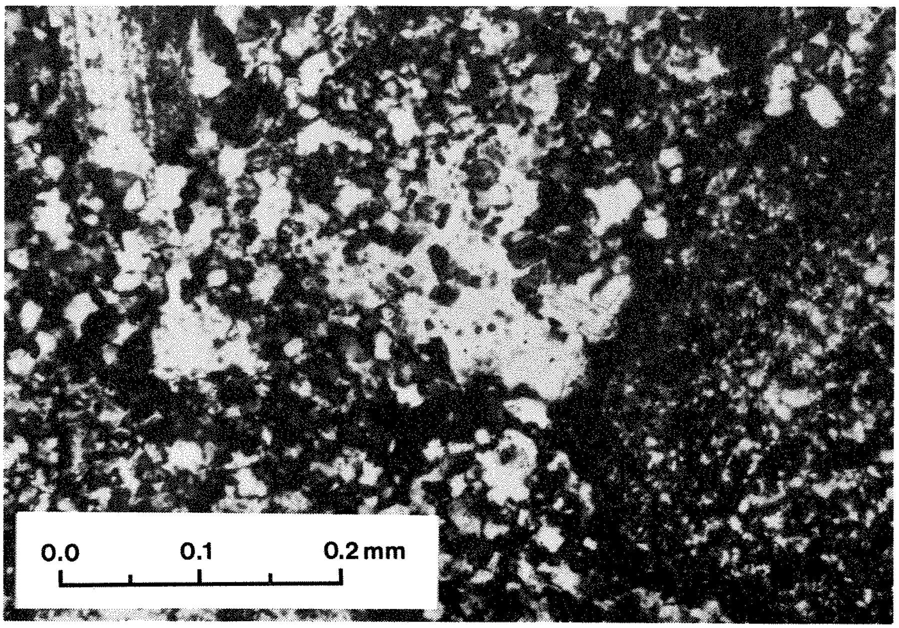

Plate XII. Microcrystalline and micropoikilitic textures: micropoikilitic (coarse) texture.

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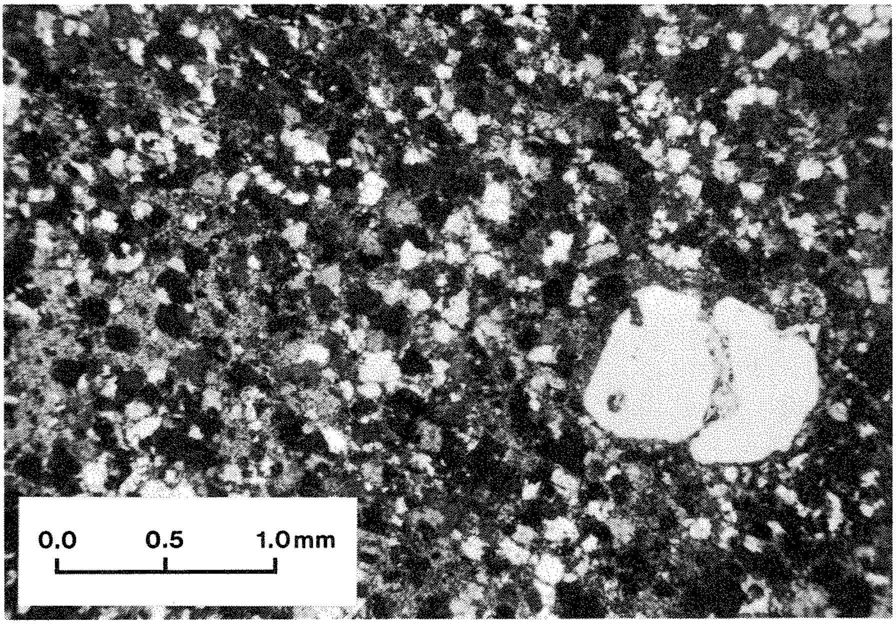

Plate XIII. Microsymplectic textures: micropoikilitic (fine) texture.

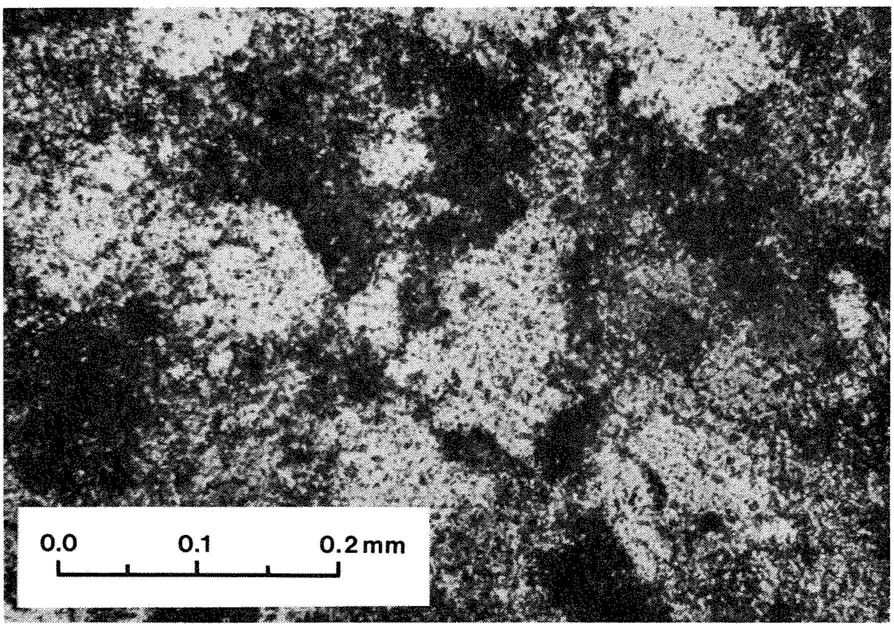

Plate XIV. Microsymplectic textures: micropoikilitic (fine) texture.

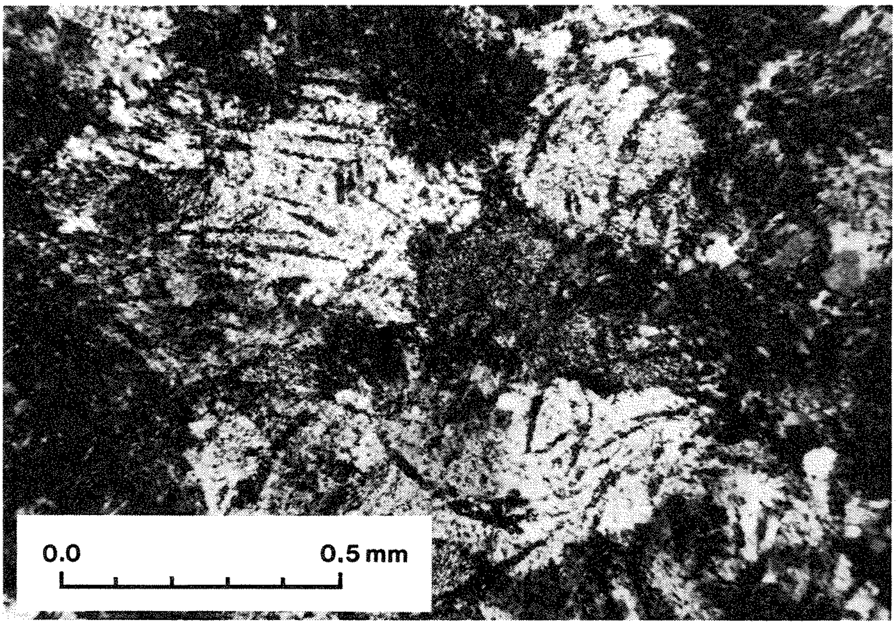

Plate XV. Microsymplectic textures: micropoikilitic texture in rock with relict perlitic cracks.

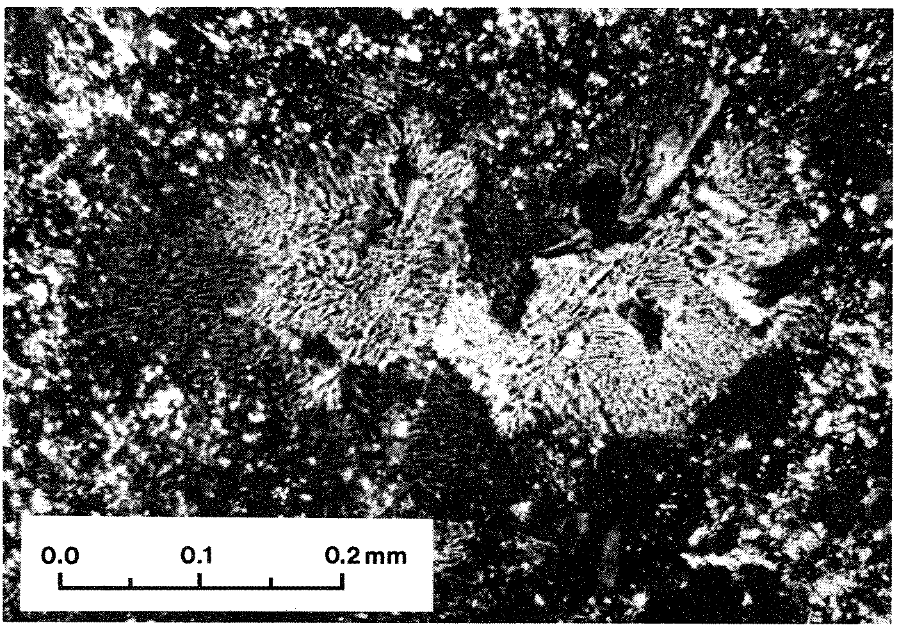

Plate XVI. Microsymplectic textures: vermicular-granophyric texture.

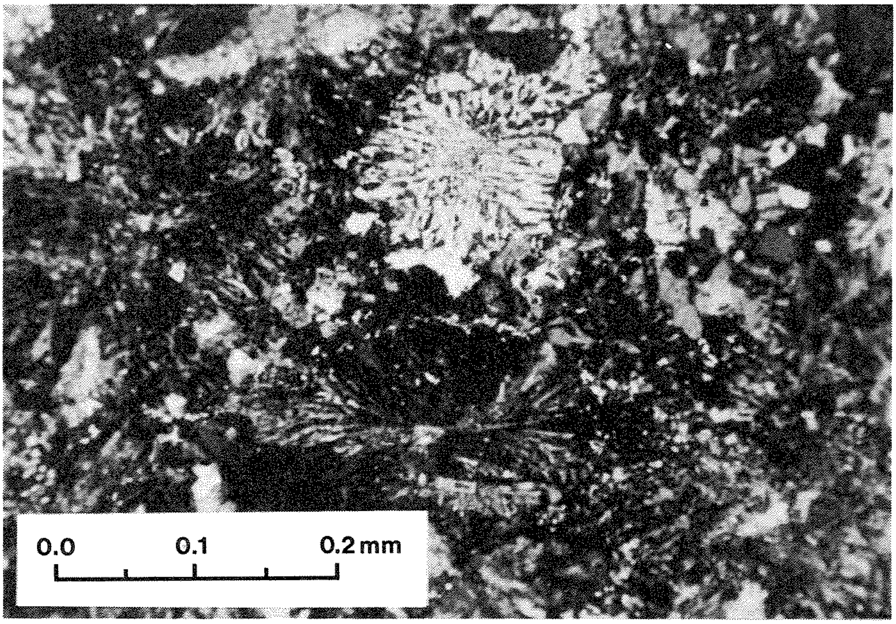

Plate XVII. Microsymplectic textures: sheaf-like and equidimensional forms of vermicular-granophyric texture.

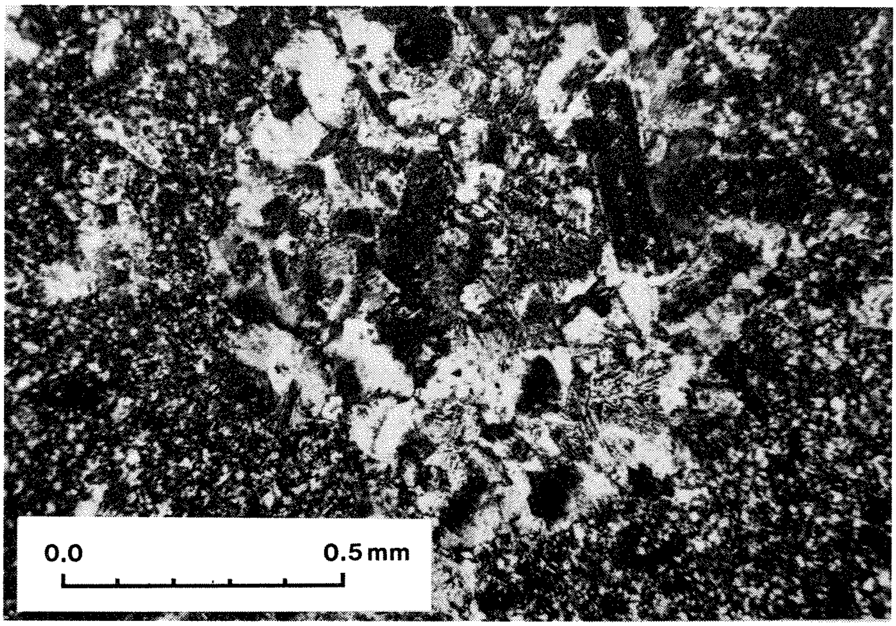

Plate XVIII. Microsymplectic textures: vermicular-granophyric clots in microcrystalline groundmass.

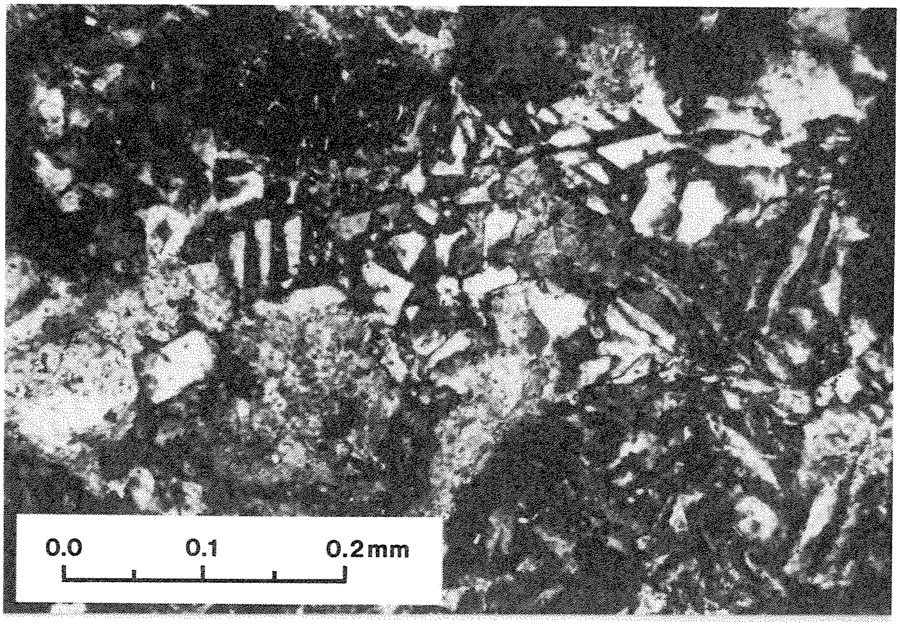

Plate XIX. Microsymplectic textures: micrographic texture.

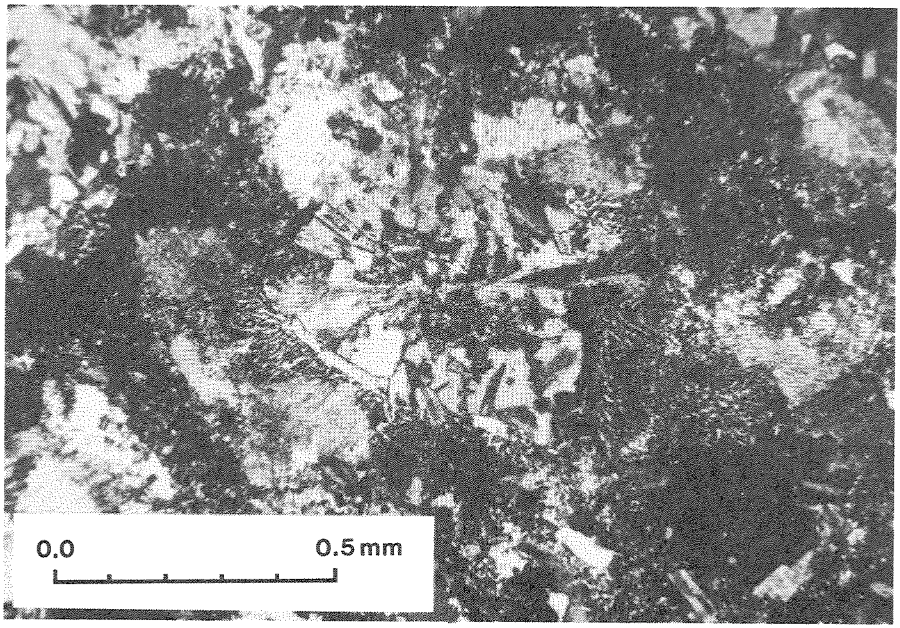

Plate XX. Microsymplectic textures: micrographic cores surrounded by vermicular-granophyric groundmass.

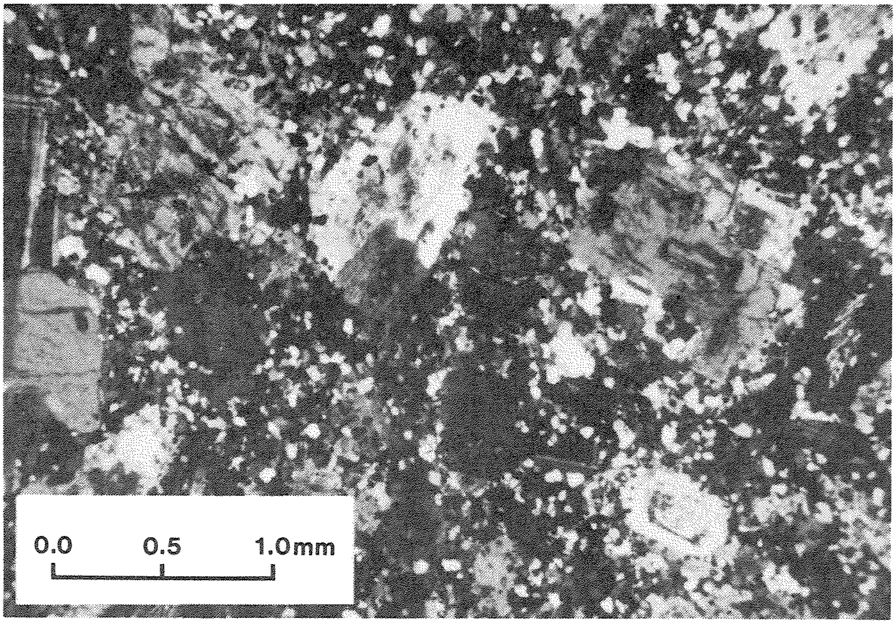

Plate XXI. Microgranular and microlitic texture: microgranular texture.

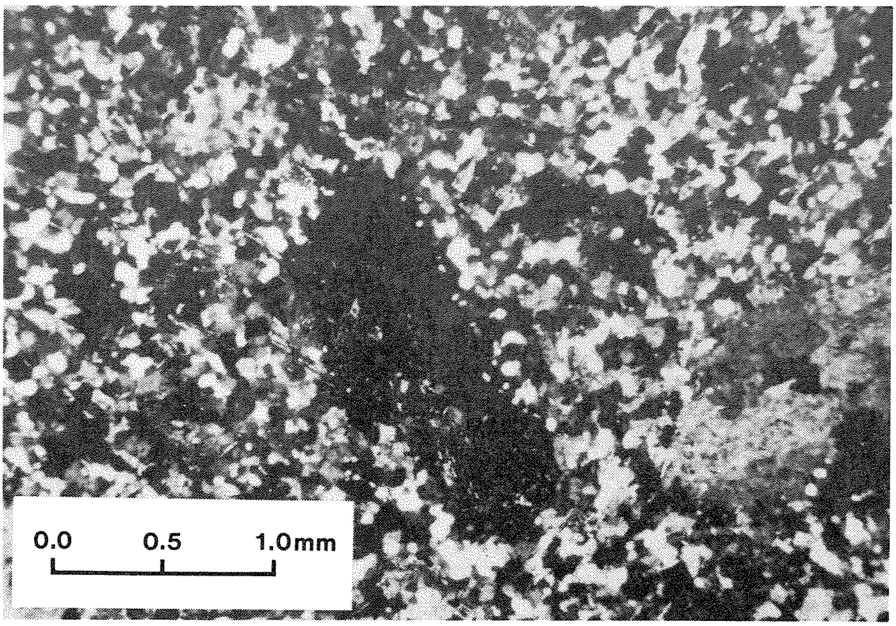

Plate XXII. Microgranular and microlitic texture: microgranular texture.

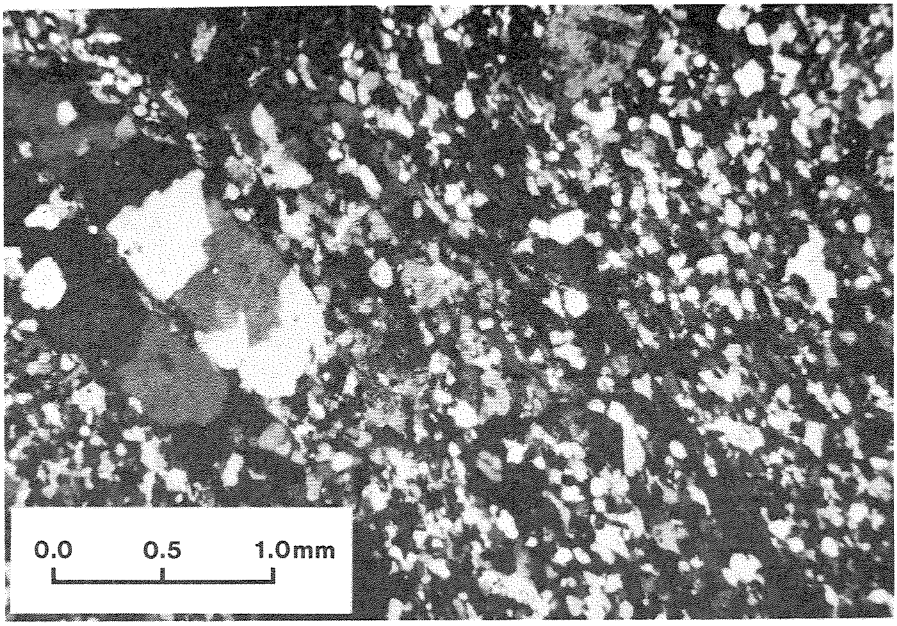

Plate XXIII. Microgranular and microlitic texture: microgranular texture in foliated rock.

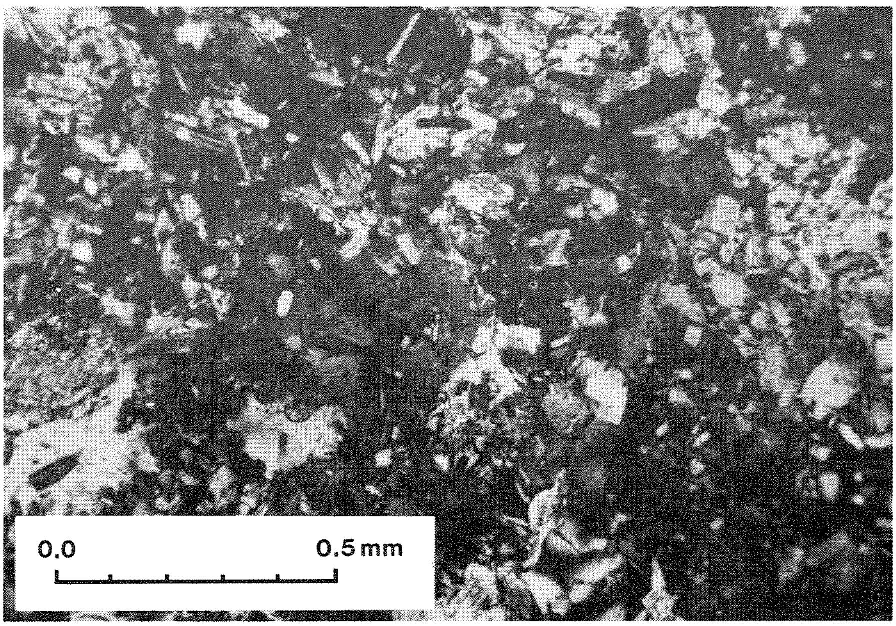

Plate XXIV. Microgranular and microlitic texture: microlitic texture with vermicular-granophyric groundmass.

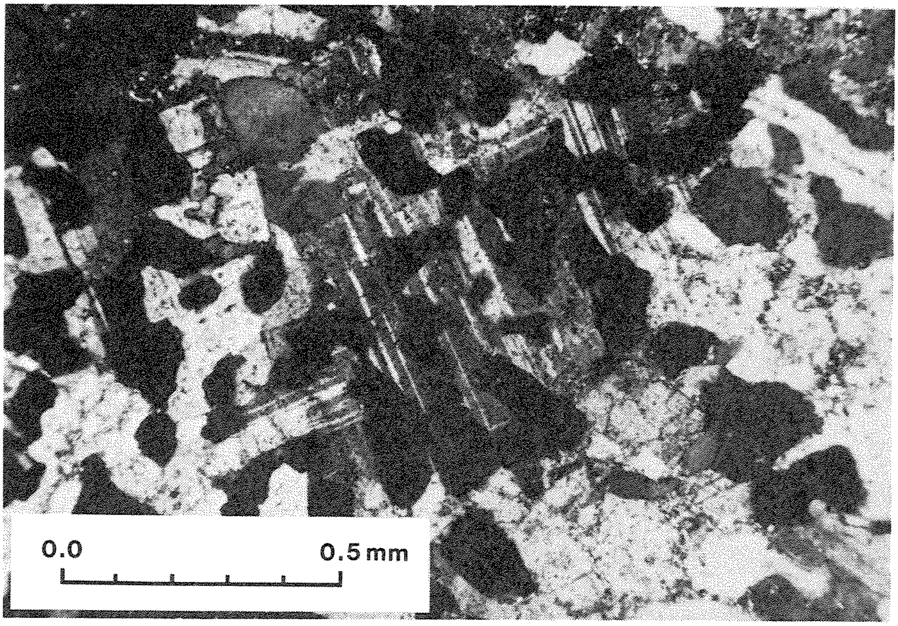

Plate XXV. Various microtextures: granophyric texture.

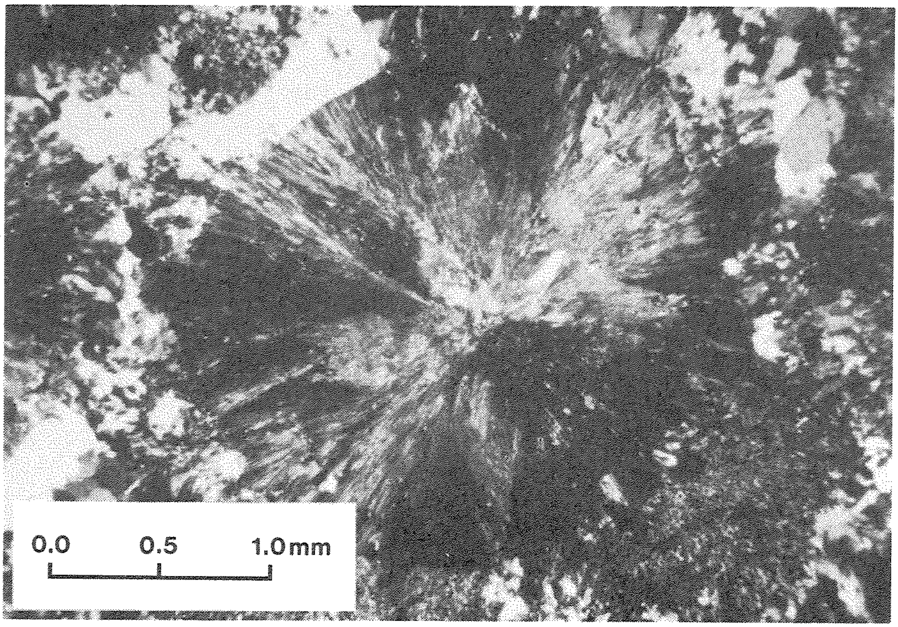

Plate XXVI. Various microtextures: spherulite.

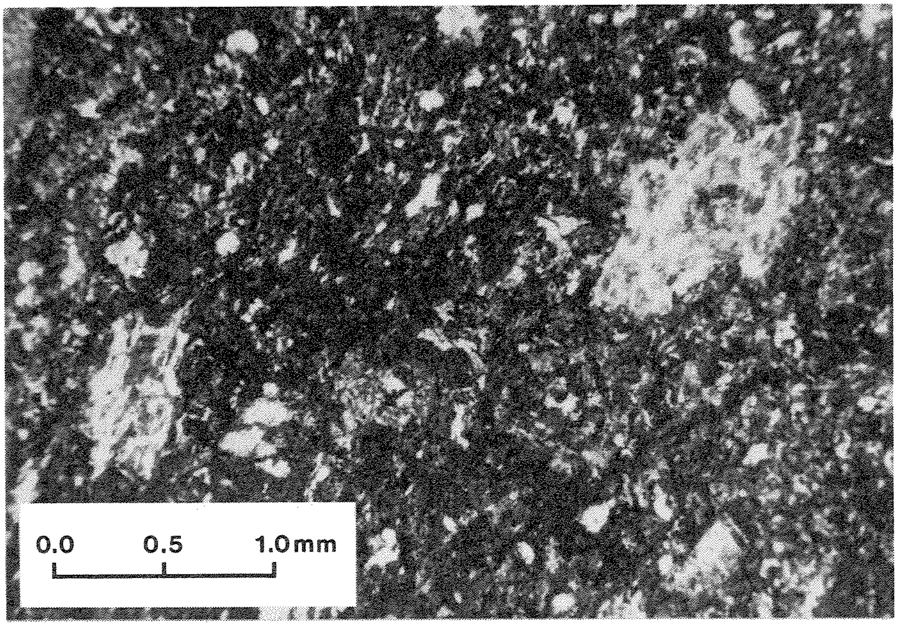

Plate XXVII. Various microtextures: shard(?) structure.

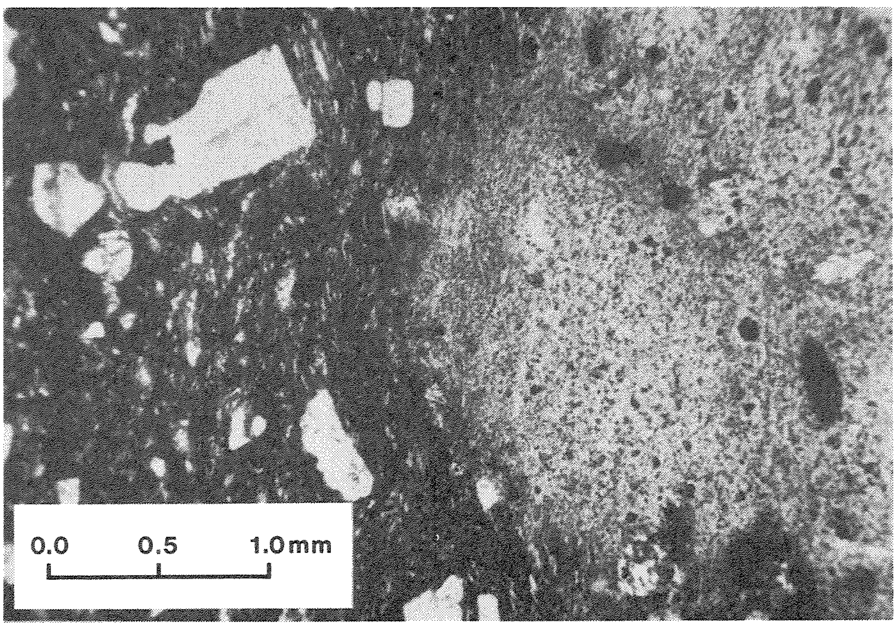

Plate XXVIII. Various microtextures: micropoikilitic patch in a Phanerozoic felsite, Baja California, Mexico.

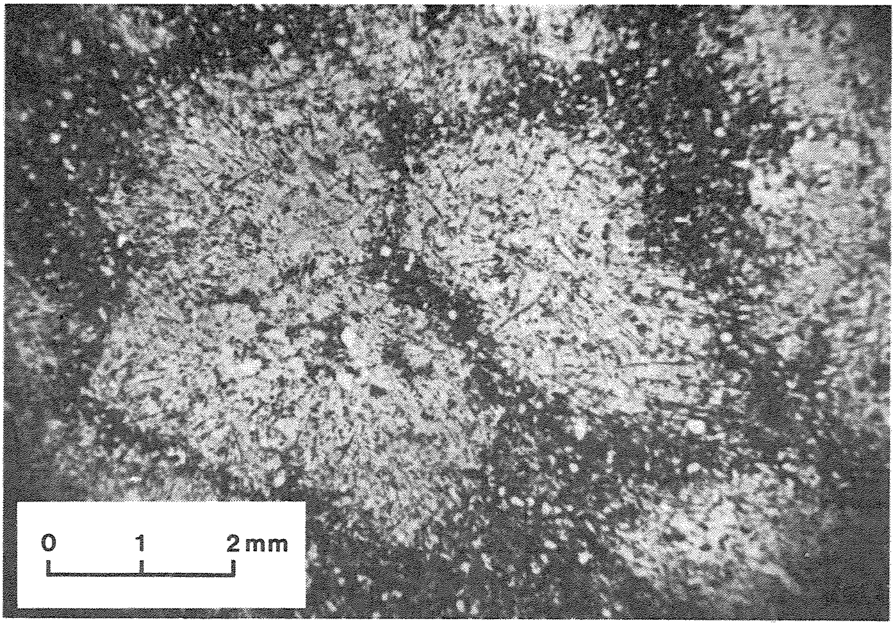

Plate XXIX. Orb and relict perlitic textures: orb texture in recrystallized perlite.

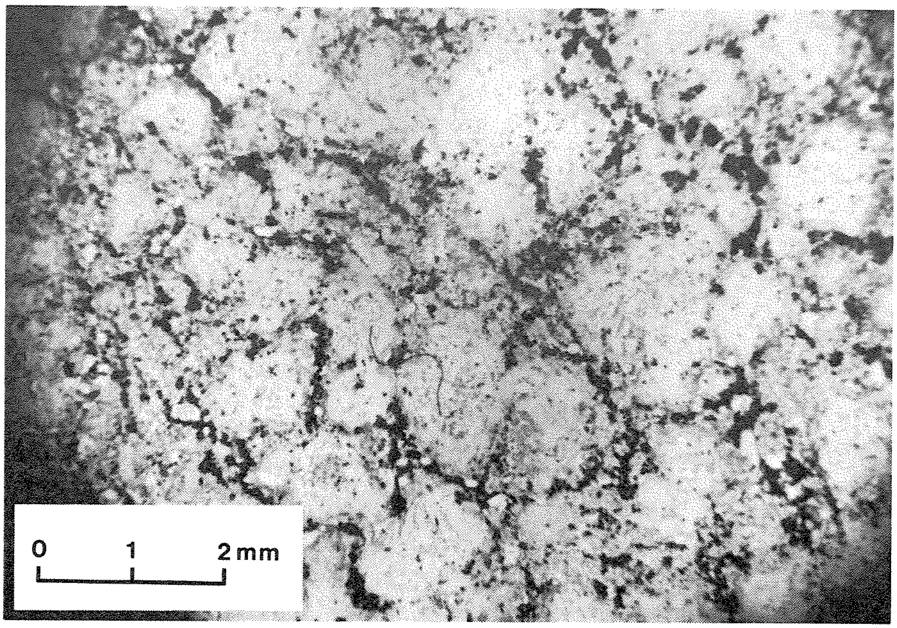

Plate XXX. Orb and relict perlitic textures: orb texture, coarsely recrystallized.

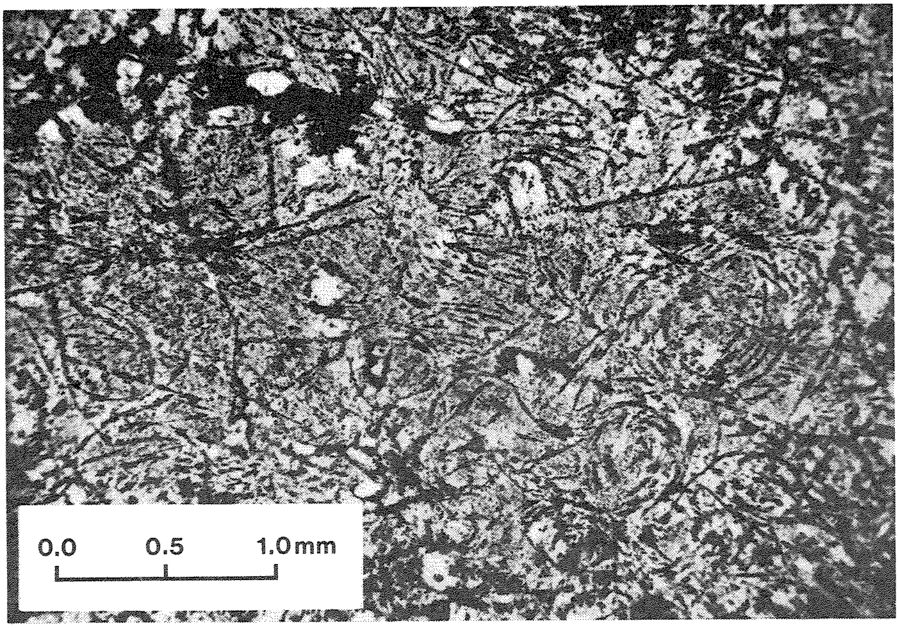

Plate XXXI. Orb and relict perlitic textures: relict perlitic fractures.

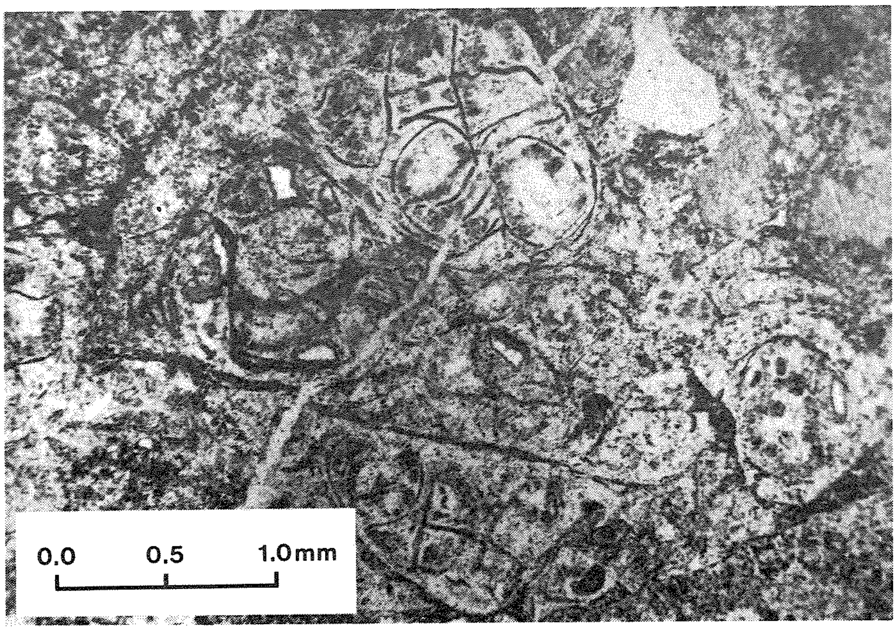

Plate XXXII. Orb and relict perlitic textures: relict perlitic fractures.