ACS
LABORATORIES
PTY LTD

PETROLOGY

of

SUNFISH-1

for

ESSO AUSTRALIA PTY LTD

by

ACS LABORATORIES PTY LTD

17 September, 2002

Esso Australia Pty Ltd
12 Riverside Quay
SOUTHBANK VIC 3006

Attention: Georgina Vlassco

FINAL REPORT: 0451-01 – SUNFISH-1

CLIENT REFERENCE: Service Order Contract No. 382048

MATERIAL: Six cuttings samples

LOCALITY: Sunfish-1

WORK REQUIRED: Petrology

Please direct technical enquiries regarding this work to the signatory below under whose supervision the work was carried out.

KEVIN H. FLYNN
Operations Manager

PETROLOGY

of

SUNFISH-1 CUTTINGS SAMPLES

A report prepared for

ESSO AUSTRALIA PTY LTD

by

JULIAN C. BAKER Ph.D.

September 2002

C O N T E N T S

1. INTRODUCTION

A petrological study was carried out on six cuttings samples from between 6840' (2085m) and 7350' (2240m) (Intervals 1-3) in Sunfish-1, Gippsland Basin. Prime aims of the study were to describe the volcanics that occur within Interval 3 and to determine whether volcanics are included within Intervals 1 and 2. Sample depths are listed in Table 1.

2. ANALYTICAL PROGRAM

Composite samples were prepared by mixing splits from several closely-spaced cuttings samples from each of the six depth intervals shown in Table 1. Thin-sections were cut in kerosene and impregnated with blue dyed epoxy resin to assist in porosity recognition. Each thin-section includes at least 200 randomly-selected cuttings. Mineral composition of several dolomite-cemented sandstone cuttings in the top sample was determined by a brief count of 250 points, and mean grain size and sorting of the sandstones were estimated in thin-section with the aid of an eyepiece graticule. Photomicrographs were taken to illustrate features such as lithology, texture, composition, diagenetic effects and porosity.

Scanning electron microscopy (SEM) and energy-dispersive spectroscopy (EDS) were used to determine the elemental composition of feldspar in volcanic cuttings from 7280'-7350' and carbonate cement in sandstone cuttings from 6840'-6890'.

TABLE 1. SAMPLE DEPTHS AND LITHOLOGY

Interval	Depth (ft)	Depth (m)	Main lithology
1	6840 - 6890	2085 - 2100	Dolomitised sands
1	6890 - 6960	2100 - 2121	Dolomitised sands
2	7020 - 7080	2140 - 2158	Dolomitised sands
2	7080 - 7140	2158 - 2176	Dolomitised sands
3	7200 - 7280	2195 - 2219	Volcanics
3	7280 - 7350	2219 - 2240	Volcanics

3. THIN-SECTION DESCRIPTIONS

There is little variation in cuttings composition between Intervals 1 and 2 samples and between Interval 3 samples. Accordingly, samples are described as two groups. Annotated photomicrographs are presented in Appendix 1.

Intervals 1 & 2 (6840'-7140') (4 samples) Plates 1 - 4

Cuttings are mainly dolomite-cemented sandstones, marls, mudrocks and argillaceous/carbonaceous siltstones and also include pyrite-cemented sandstones, macroporous quartzose sandstones, argillaceous sandstones, limestones, organic fragments, pyrite cement fragments, quartz grains, quartzose metamorphic rock fragments and chert grains. Volcanic cuttings are absent. Only the dolomite-cemented sandstones are described below.

Dolomite-cemented sandstones are cement/grain-supported sublitharenites and subarkoses that range from being well sorted and fine grained to moderately sorted and coarse grained. A point count analysis of several dolomite-cemented sandstone cuttings from 6840'-6890' indicates the following composition; quartz (55.7%), K-feldspar (3.7%), metasedimentary rock fragments (4.8%), chert (0.4%), dolomite (35.4%) ($Q_{87}F_6R_7$). Quartz is mainly monocrystalline and also includes polycrystalline quartz of metamorphic and granitic origin. Quartz grains locally have oriented phyllosilicate inclusions and K-feldspar intergrowths that are indicative of a metamorphic and granitic origin, respectively. Most quartz grains are angular to subrounded. Feldspar is fresh to slightly altered, locally corroded granitic orthoclase, microperthite and microcline. Lithic grains are mainly low-grade metasedimentary rock fragments (metasiltstone, quartz/muscovite schist, phyllite, mica/illite-bearing quartzite, quartzose metasandstone). Other framework grains include rare cherty felsic volcanic rock fragments, quartzofeldspathic granitic rock fragments, argillaceous sedimentary rock fragments, muscovite, organic fragments and accessory heavy minerals (tourmaline, zircon). The provenance was dominated by granitic and low-grade metasedimentary rocks.

Most dolomite-cemented sandstone fragments lack detrital and authigenic clay.

Dolomite forms a pervasive, coarsely-crystalline/poikilotopic cement that tightly fills intergranular spaces and partly replaces some micaceous rock fragments and feldspar grains. Dolomite-cemented framework grains are generally loosely packed, but the dolomite formed at depth rather than near the depositional surface because it encapsulates compacted micaceous rock fragments as well as quartz grains that locally have long and slightly embayed grain contacts that are the result of minor grain contact dissolution (Plates 1, 3, 4). EDS analyses show that the dolomite is a non-ferroan variety.

Other cements besides dolomite include minor pyrite, siderite and, where dolomite is absent, thinly-developed quartz overgrowths.

In nearly all dolomite-cemented sandstones, intergranular porosity is absent due to dolomite cementation. Trace secondary porosity is the result of partial dissolution of K-feldspar grains. The high frequency of dolomite-cemented sandstone cuttings indicates that most sandstones between 6840' and 7140' are tight due to extensive dolomitisation.

Interval 3 (7200'-7350') (2 samples) Plates 5 - 11

Cuttings are mainly fresh and variably altered intermediate volcanics (andesites) and also include marls, mudrocks, dolomite-cemented sandstones, argillaceous siltstones, siderite (totally siderite-replaced volcanics), organic fragments, quartz grains and ankerite fragments. Only the volcanics are described below.

Fresh volcanics are holocrystalline (i.e. non-glassy) and are composed largely of intergrown, pilotaxitically*[1]-arranged, 0.10-0.35mm long plagioclase (andesine) microlites (Plates 5, 6, 8). Interstices between plagioclase microlites are filled by Fe-oxides/Fe-Ti-oxides and, particularly at 7280'-7350', secondary microcrystalline quartz (Plates 8, 11). Mafic minerals are absent.

In the altered volcanics, plagioclase microlites have partly to completely altered to clay (smectite or mixed-layer illite/smectite), and mesostasis has altered to brown clay and rare vermicular kaolinite that fills interstitial areas between altered plagioclase microlites (Plates 7, 9). Some highly altered volcanics are compactionally deformed, and a few volcanic cuttings are largely or completely silicified. There is complete gradation between fresh and highly altered volcanic cuttings.

Most volcanic cuttings contain at least 5-10% carbonate replacement. Volcanics with greater than 15% carbonate replacement (e.g., Plate 10) are particularly common at 7280'-7350'. Carbonate is mainly siderite that forms coarse, concentrically-zoned spherulitic crystals, finely to coarsely-crystalline patches and disseminated fine rhombic crystals (Plates 5, 6, 8). A few volcanic cuttings are completely replaced by siderite. Replacement carbonate also includes patchy, medium- to coarsely-crystalline ankerite and subordinate coarsely-crystalline dolomite (Plate 10). Fractures are healed by sparry ankerite (Plate 11).

Altered volcanic cuttings are locally partly replaced by iron sulphide.

EDS analyses of numerous plagioclase microlites in several cuttings indicate that the ratio of sodium to calcium is consistent with the plagioclase being andesine and possibly high-sodium labradorite. Most clays that are associated with altered plagioclase have a morphology and elemental composition that is consistent with the clay being either smectite or mixed-layer illite/smectite.

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[1] *Pilotaxitic - said of the texture of the groundmass of a holocrystalline igneous rock in which lath-shaped microlites (typically plagioclase) are arranged in a glass-free mesostasis and are generally interwoven in irregular unoriented fashion.*

4. SUMMARY AND CONCLUSIONS

- Most sandstone cuttings from Intervals 1 and 2 (6840'-7140') in Sunfish-1 are clean, fine to coarse grained sublitharenites and subarkoses that are tightly cemented by coarsely-crystalline/poikilotopic dolomite.

- Intervals 1 and 2 lack volcanics.

- Volcanic cuttings from Interval 3 (7200'-7350') are andesites that are composed largely of pilotaxitically-arranged plagioclase (andesine) microlites and interstitial Fe-oxides/Fe-Ti-oxides and secondary microcrystalline quartz. Mafic minerals are absent.

- There is complete gradation between fresh and highly altered volcanic cuttings. In the altered volcanics, plagioclase microlites have partly to completely altered to clay (smectite or mixed-layer illite/smectite), and mesostasis has altered to brown clay and rare vermicular kaolinite. A few volcanic cuttings are largely or completely silicified.

- Volcanic cuttings are commonly partly to completely replaced by ferroan carbonate and dolomite and are locally cut by ankerite-healed fractures.

APPENDIX 1

PHOTOMICROGRAPHS

PLATE 1 6840' – 6890' (Interval 1 – dolomitised sands)

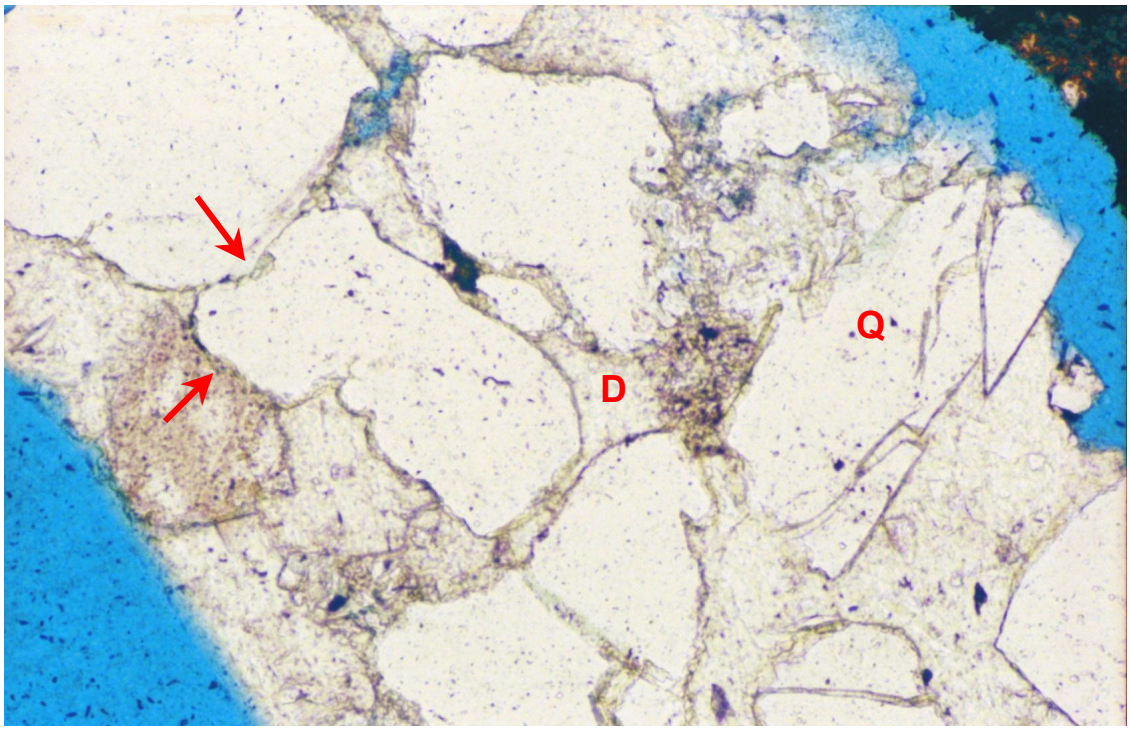
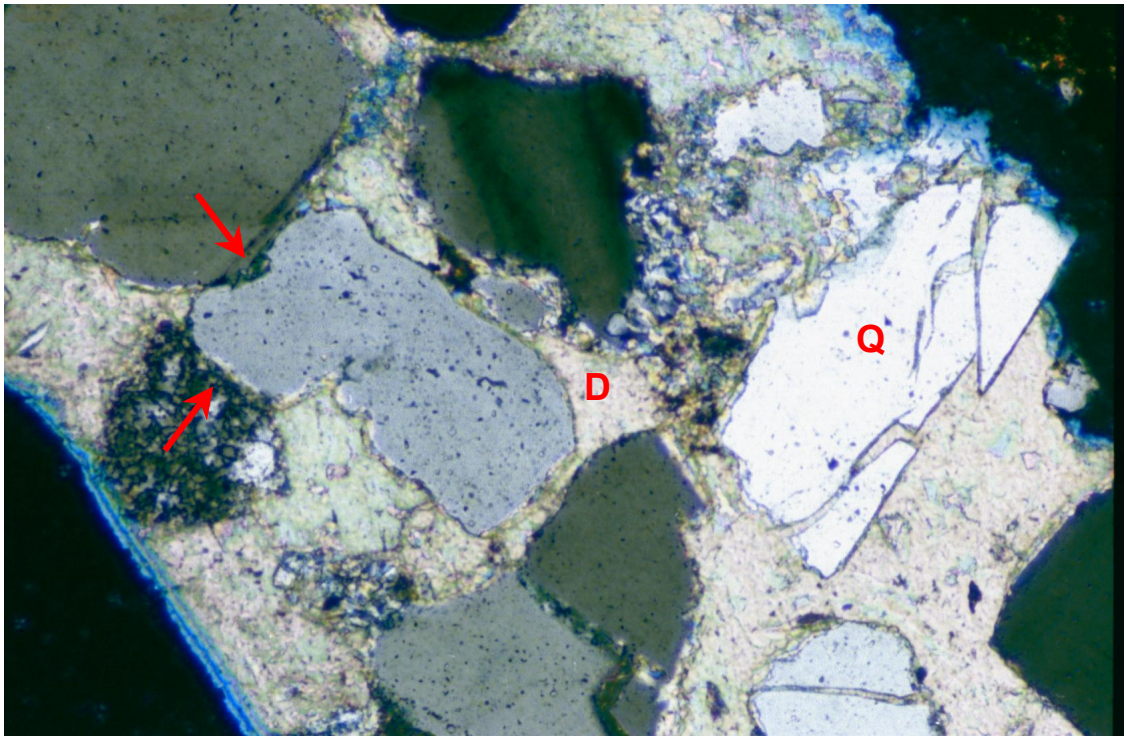


FIGURE 1 Plane polarised light

FIGURE 2 Crossed polarisers

0.2 mm



Sandstone cutting in which intergranular spaces are filled by poikilotopic dolomite (D). Dolomite encapsulates framework grains with long and slightly embayed grain contacts (arrows), indicating that dolomite formed after some compaction. One quartz grain (Q) is fractured as a result of dolomite precipitation.

PLATE 2 6890' – 6960' (Interval 1 – dolomitised sands)

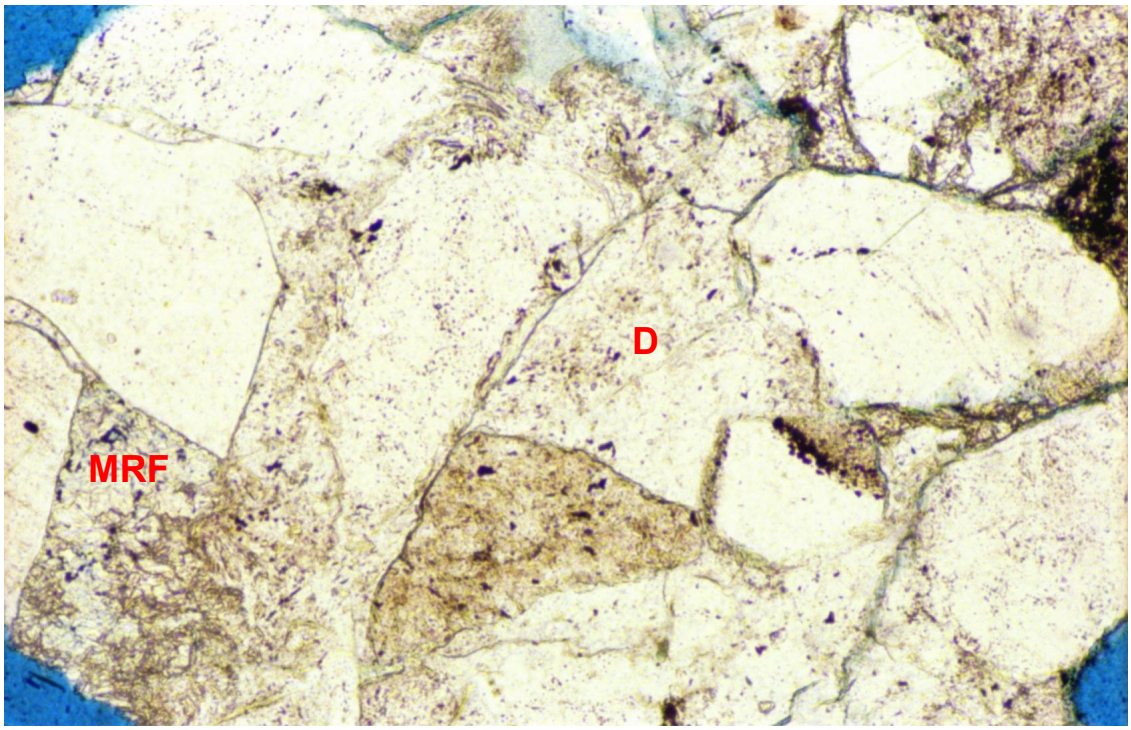
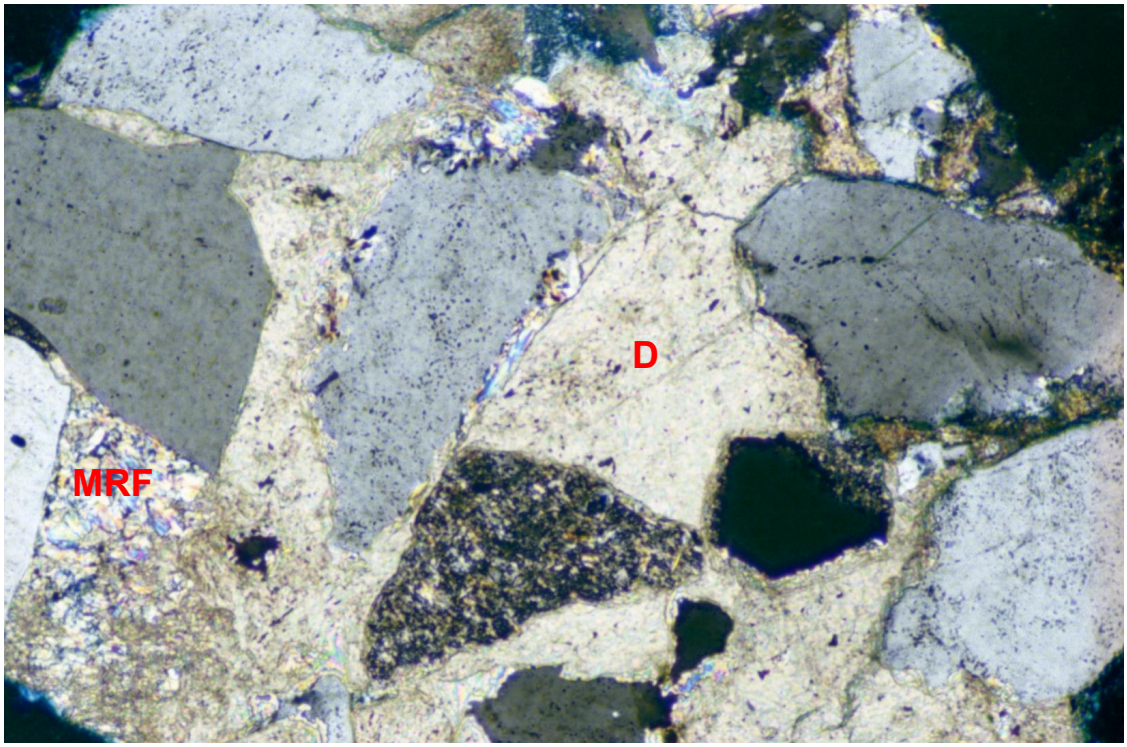


FIGURE 1 Plane polarised light
FIGURE 2 Crossed polarisers

0.2 mm



Sandstone cutting in which poikilotopic dolomite (D) tightly fills all intergranular spaces and partly replaces a micaceous metamorphic rock fragment (MRF).

PLATE 3 7020' – 7080' (Interval 2 – dolomitised sands)

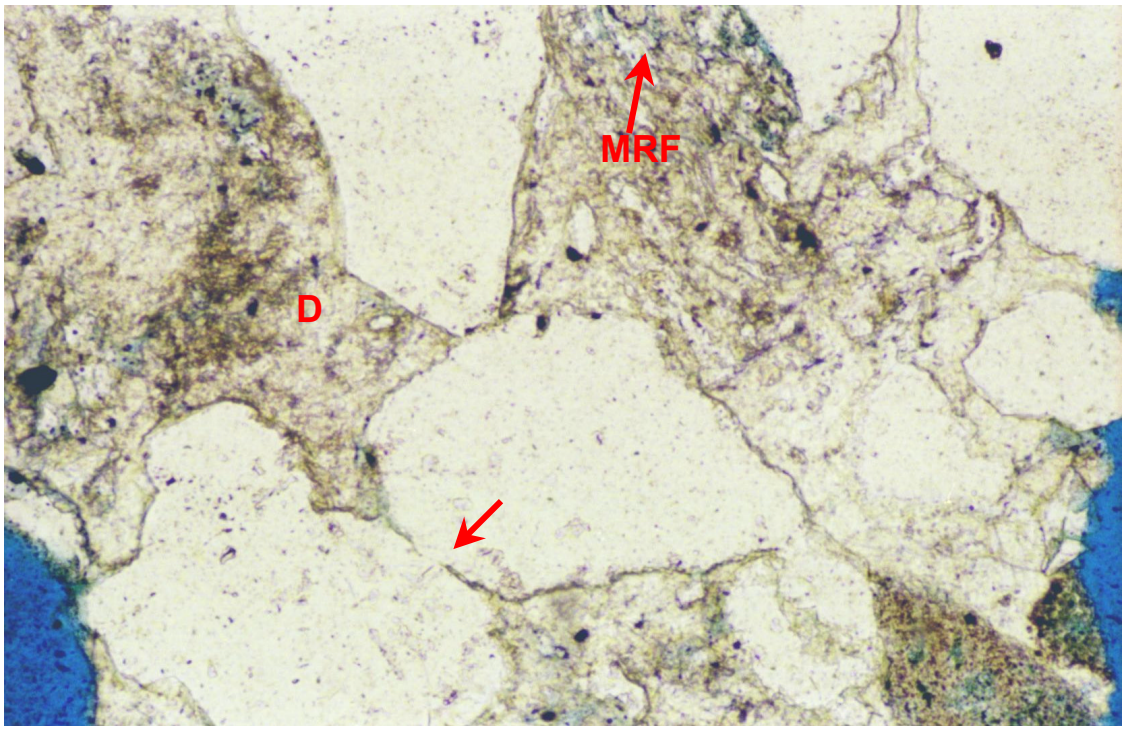
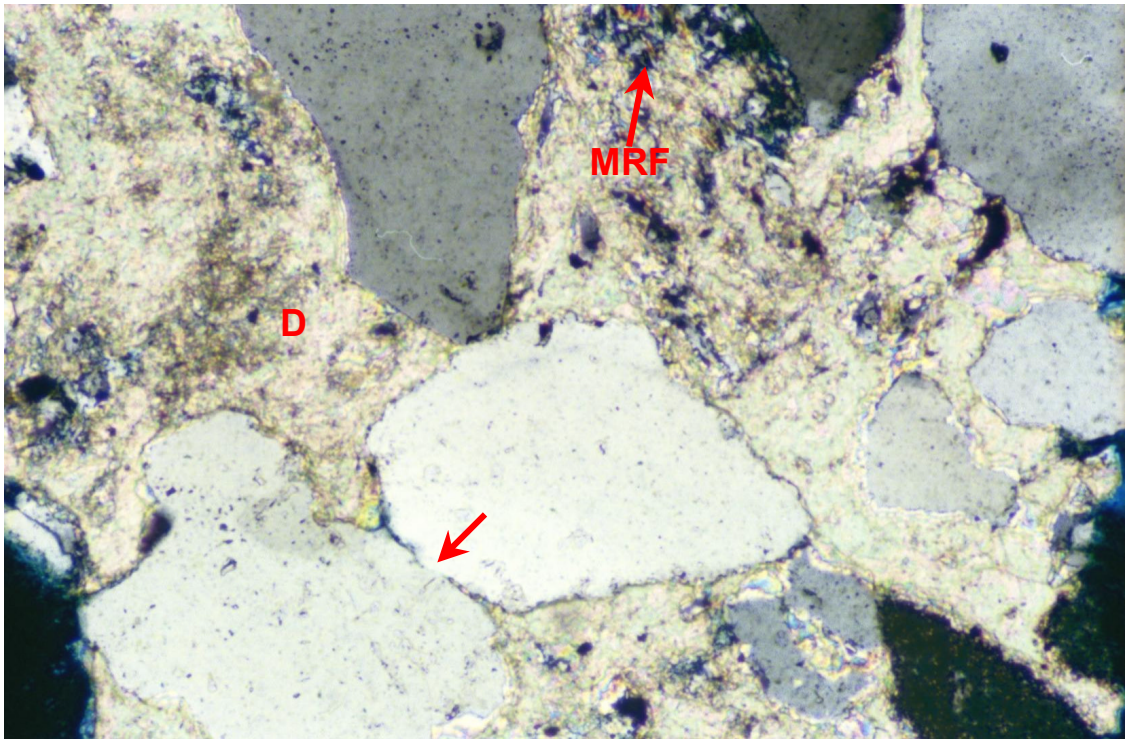


FIGURE 1 Plane polarised light
FIGURE 2 Crossed polarisers

0.2 mm



Poikilotopic dolomite (D) encapsulates quartz grains with slightly welded grain contacts (arrow) and largely replaces a micaceous metamorphic rock fragment (MRF).

PLATE 4 7080' – 7140' (Interval 2 – dolomitised sands)

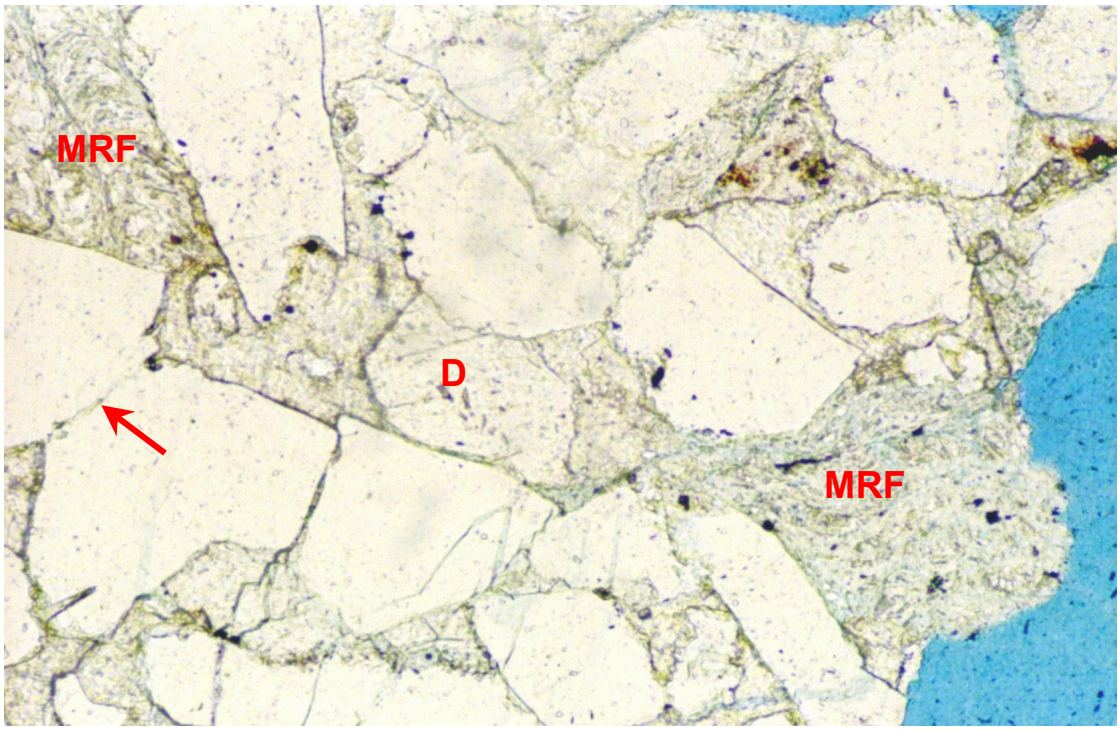
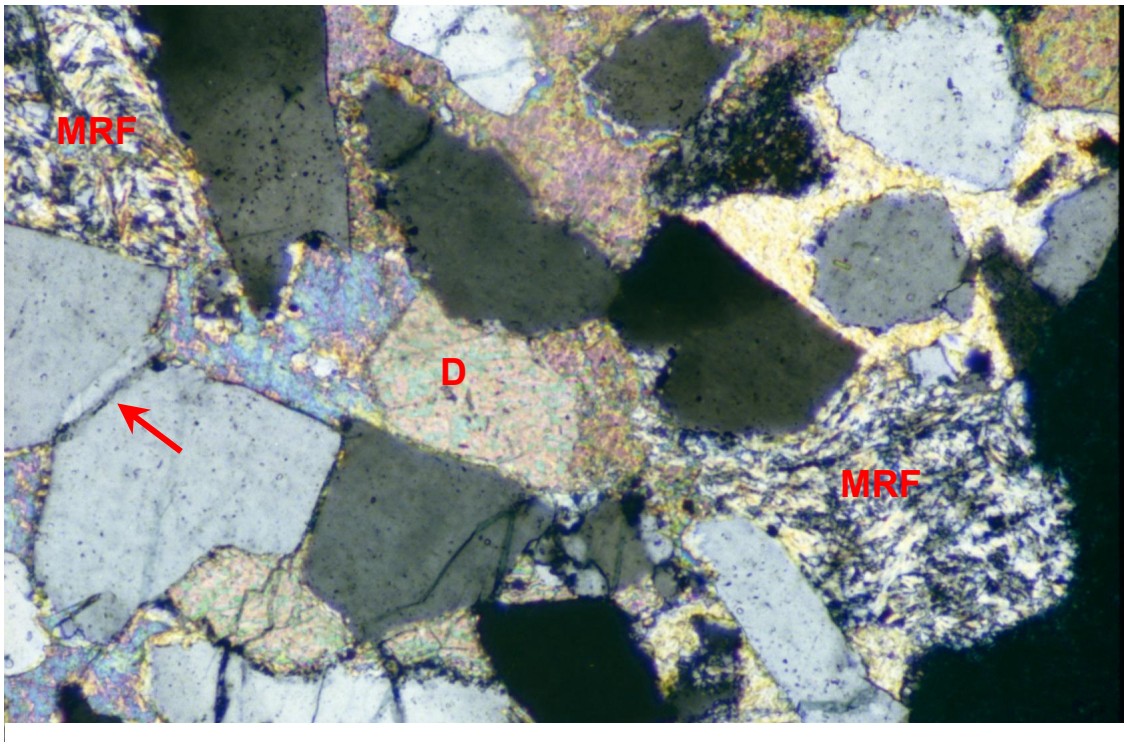


FIGURE 1 Plane polarised light

FIGURE 2 Crossed polarisers

0.2 mm



Framework grains are loosely packed, but the presence of compacted micaceous metamorphic rock fragments (MRF) and quartz grains with welded grain contacts (arrow) within tightly dolomite (D)-cemented sandstone indicates that dolomite formed after some compaction rather than near the depositional surface.

PLATE 5 7200' – 7280' (Interval 3 – volcanics)

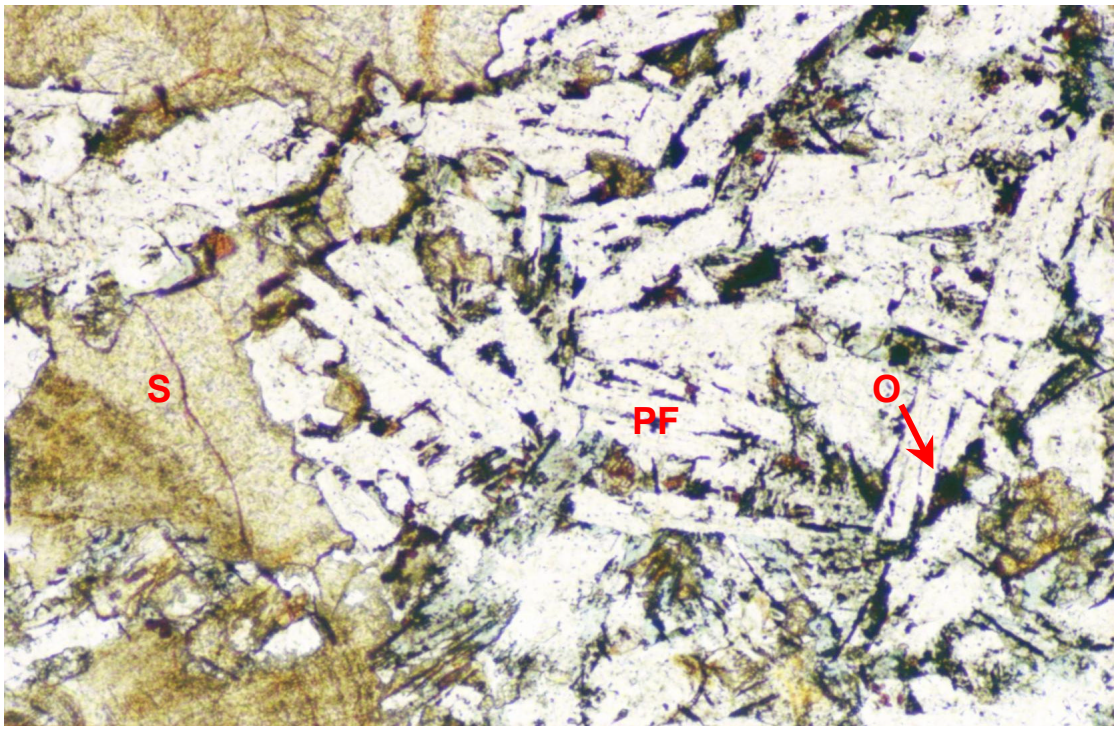
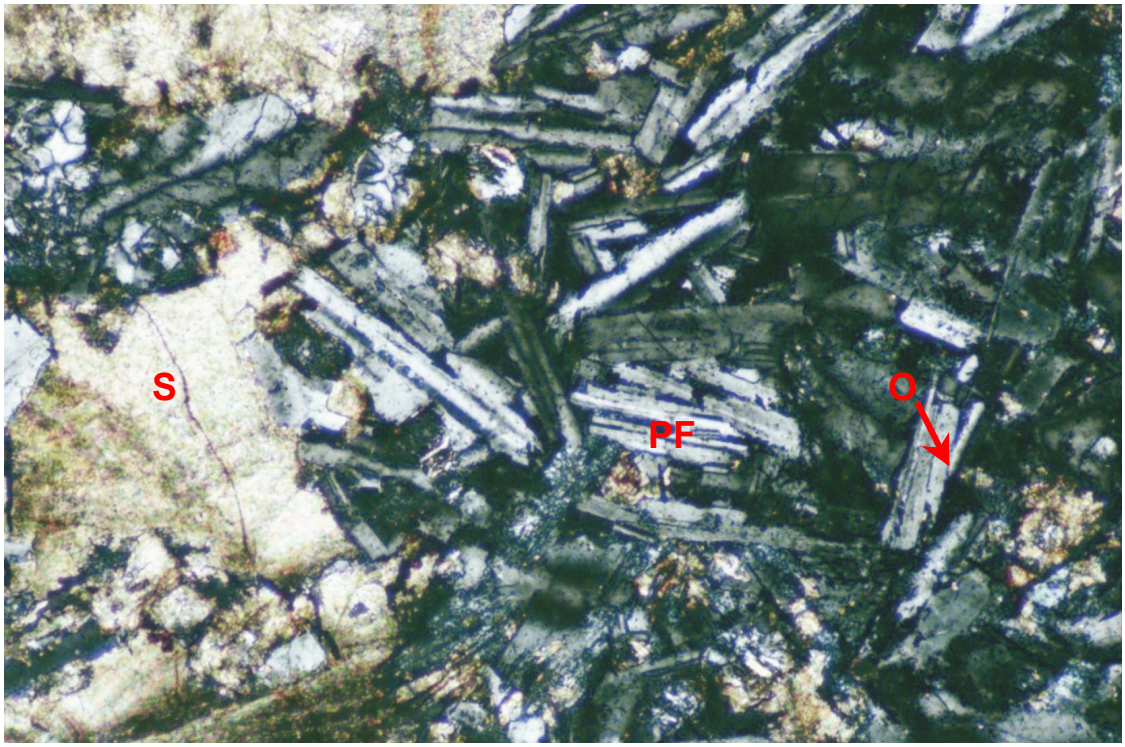


FIGURE 1 Plane polarised light
FIGURE 2 Crossed polarisers

0.2 mm



Fresh intermediate volcanic composed of pilotaxitically-arranged plagioclase microlites (PF), interstitial fine Fe-oxides/Fe-Ti oxides (O) and patchy spherulitic secondary siderite (S).

PLATE 6 7200' – 7280' (Interval 3 – volcanics) cont.

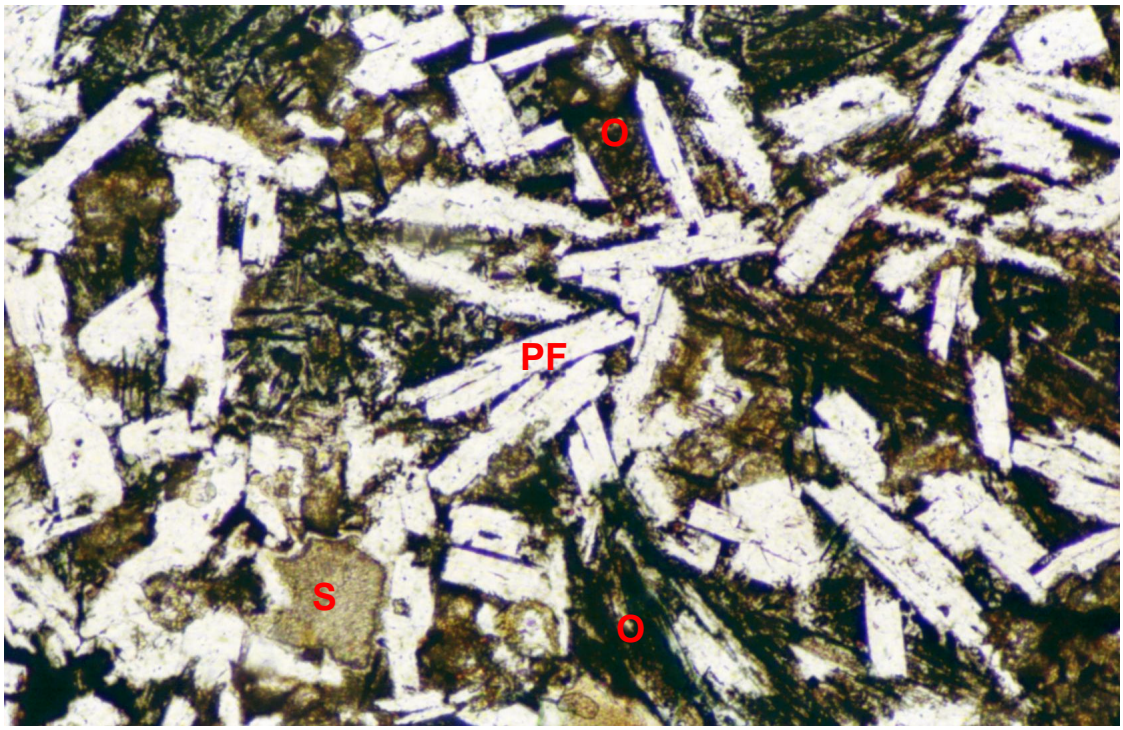
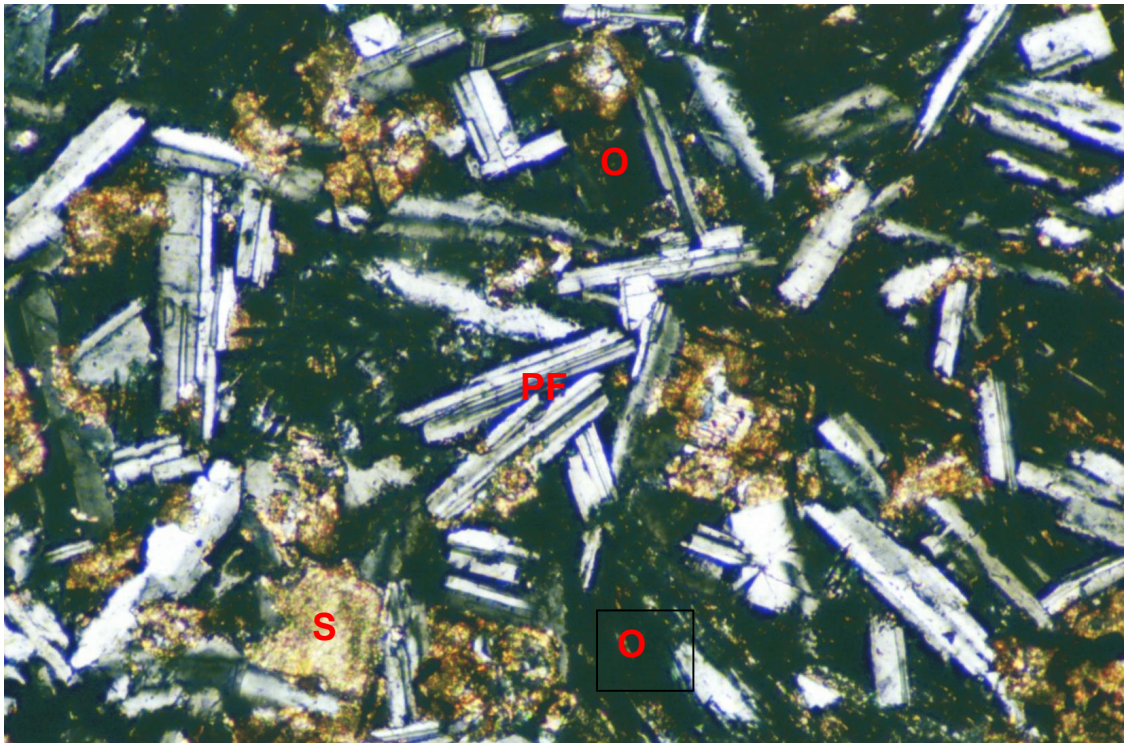


FIGURE 1 Plane polarised light

FIGURE 2 Crossed polarisers

0.2 mm



Disseminated secondary siderite (S) replaces fresh plagioclase laths (PF) and interstitial Fe-oxides/Fe-Ti oxides (O).

PLATE 7 7200' – 7280' (Interval 3 – volcanics) cont.

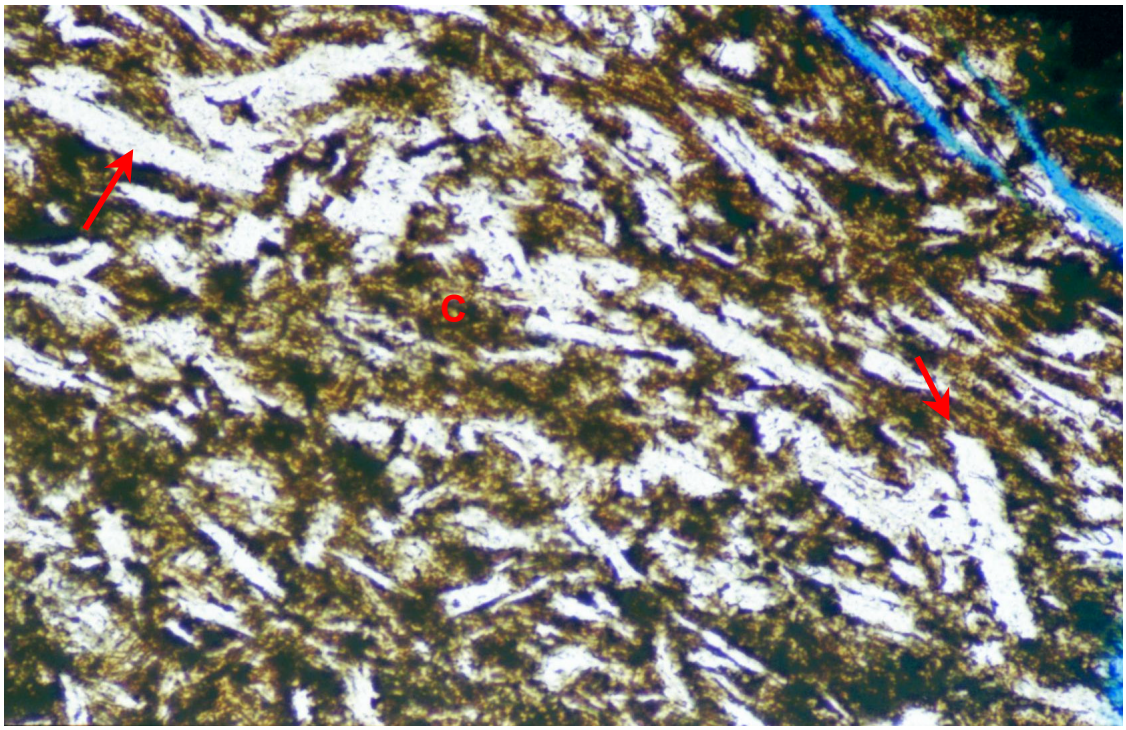
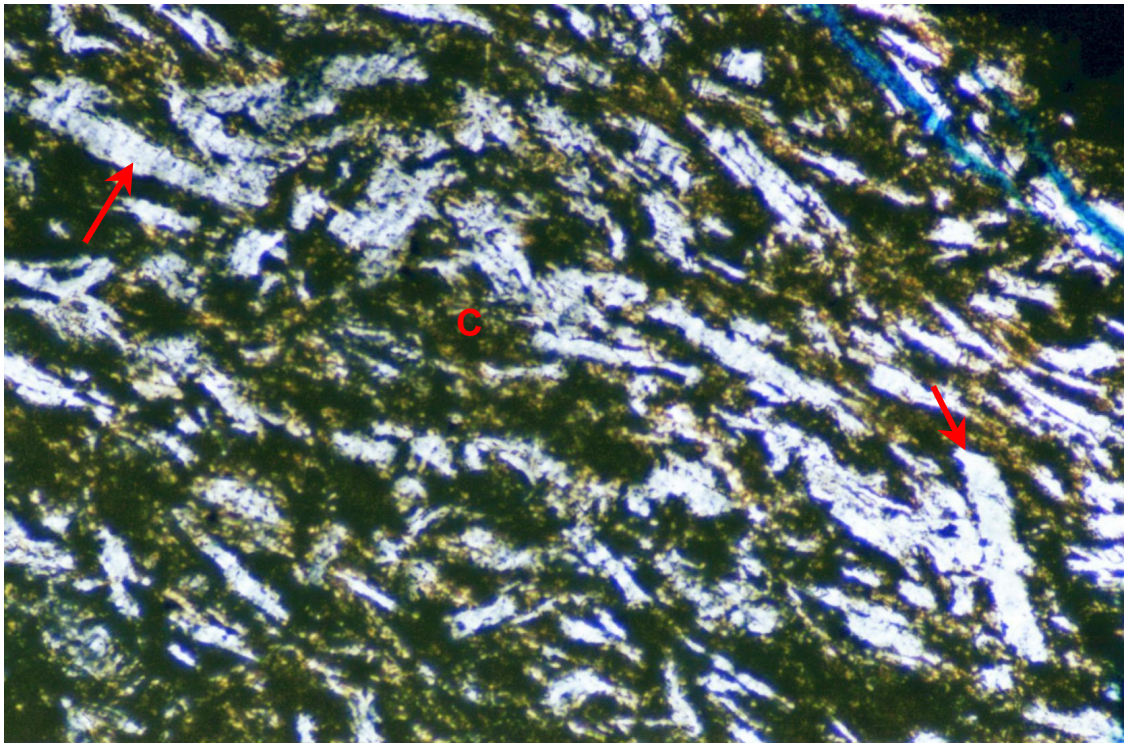


FIGURE 1 Plane polarised light

FIGURE 2 Crossed polarisers

0.2 mm



Highly altered intermediate volcanic in which plagioclase microlites are totally replaced by clay (probably smectite or illite/smectite) (arrows). Brown clay (C) and fine opaques occupy areas between altered plagioclase microlites.

PLATE 8 7280' – 7350' (Interval 3 – volcanics)

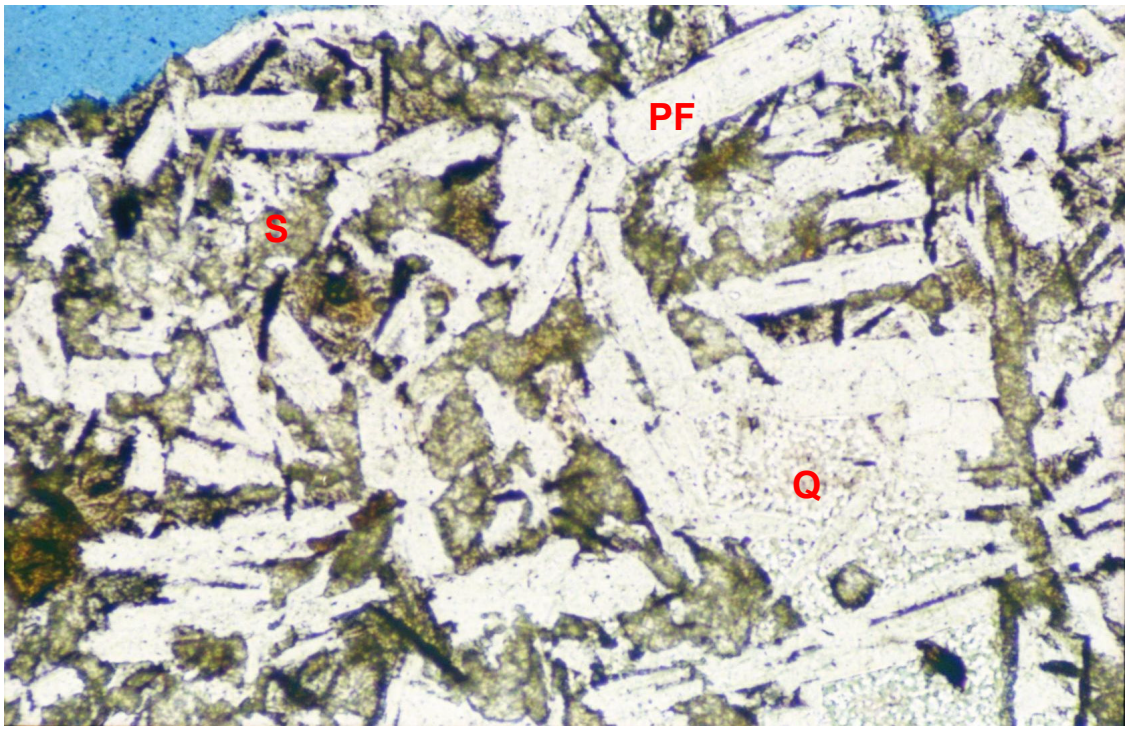
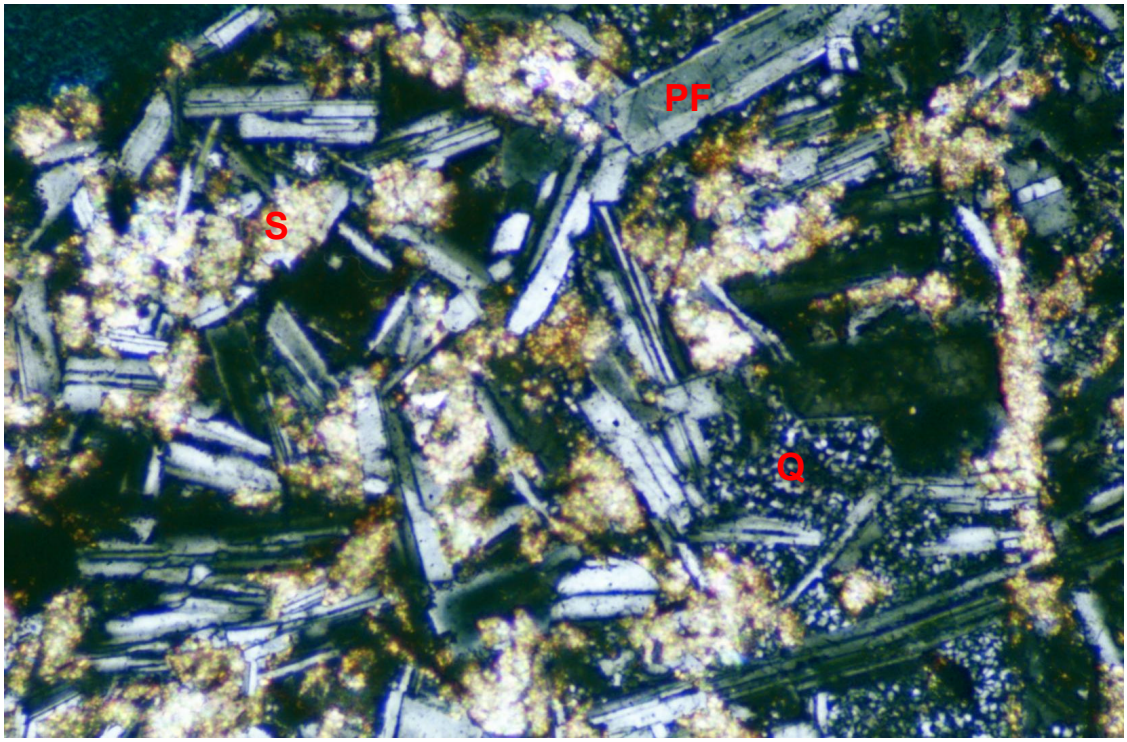


FIGURE 1 Plane polarised light
FIGURE 2 Crossed polarisers

0.2 mm



Fresh intermediate volcanic composed of pilotaxitically-arranged plagioclase microlites (PF), interstitial secondary microcrystalline quartz (Q) and disseminated secondary siderite replacement (S).

PLATE 9 7280' – 7350' (Interval 3 – volcanics) cont.

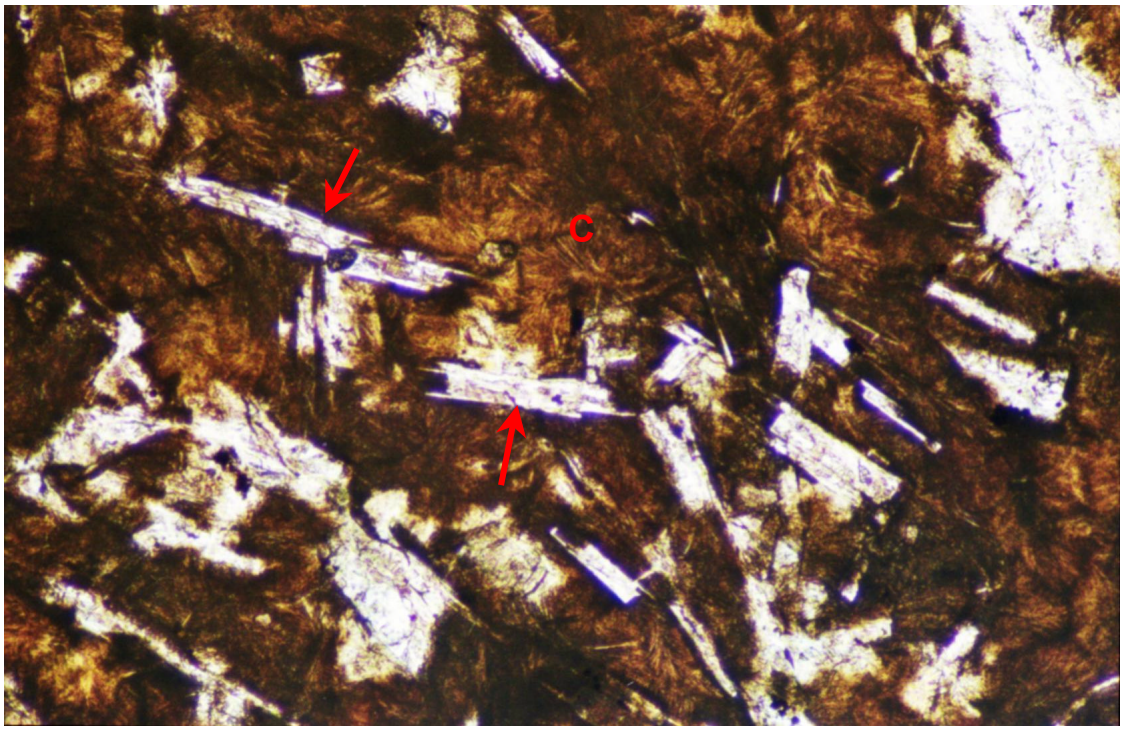
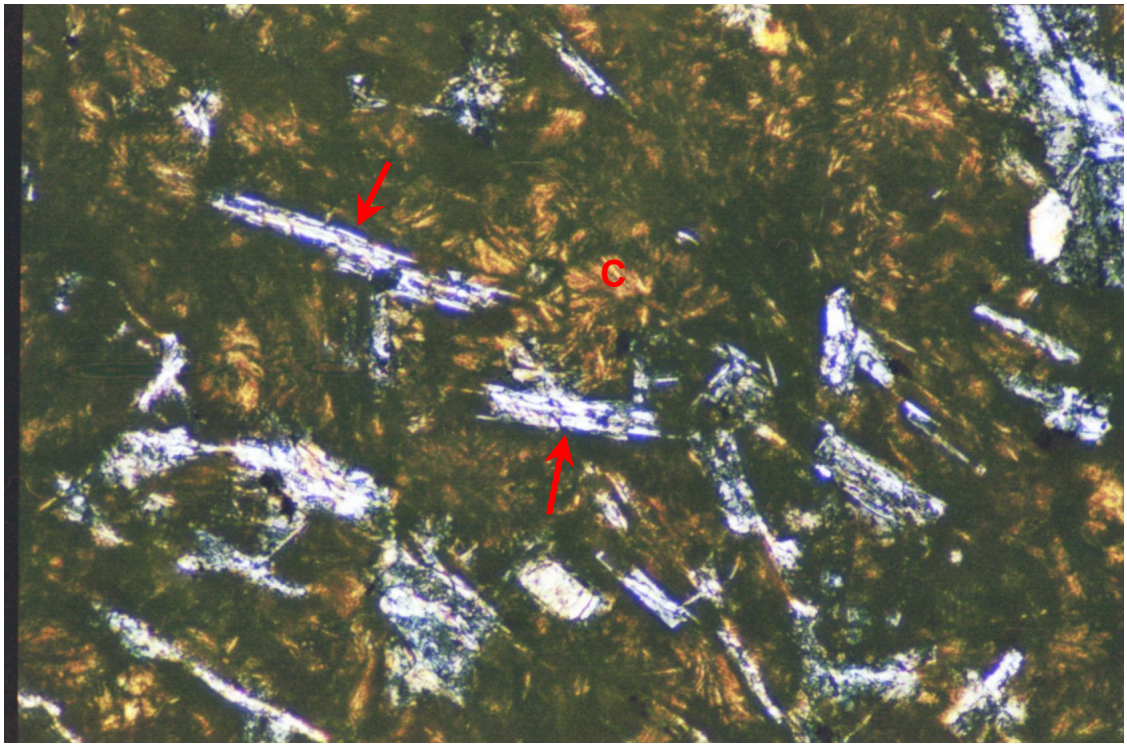


FIGURE 1 Plane polarised light

FIGURE 2 Crossed polarisers

0.2 mm



Highly altered intermediate volcanic in which plagioclase microlites are largely replaced by clay (probably smectite or illite/smectite) (arrows). Mesostasis has totally altered to brown clay (C).

PLATE 10 7280' – 7350' (Interval 3 – volcanics) cont.

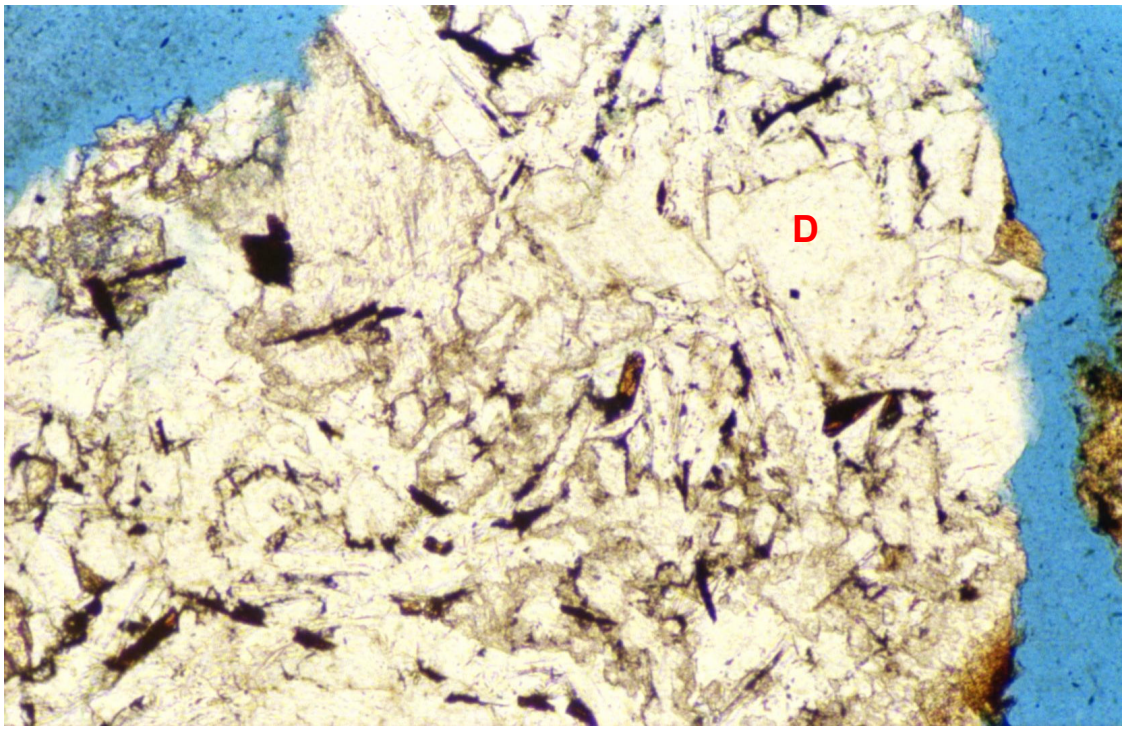


FIGURE 1 Plane polarised light

FIGURE 2 Crossed polarisers

0.2 mm

A fresh volcanic cutting is largely replaced by dolomite (D).

PLATE 11 7280' – 7350' (Interval 3 – volcanics) cont.

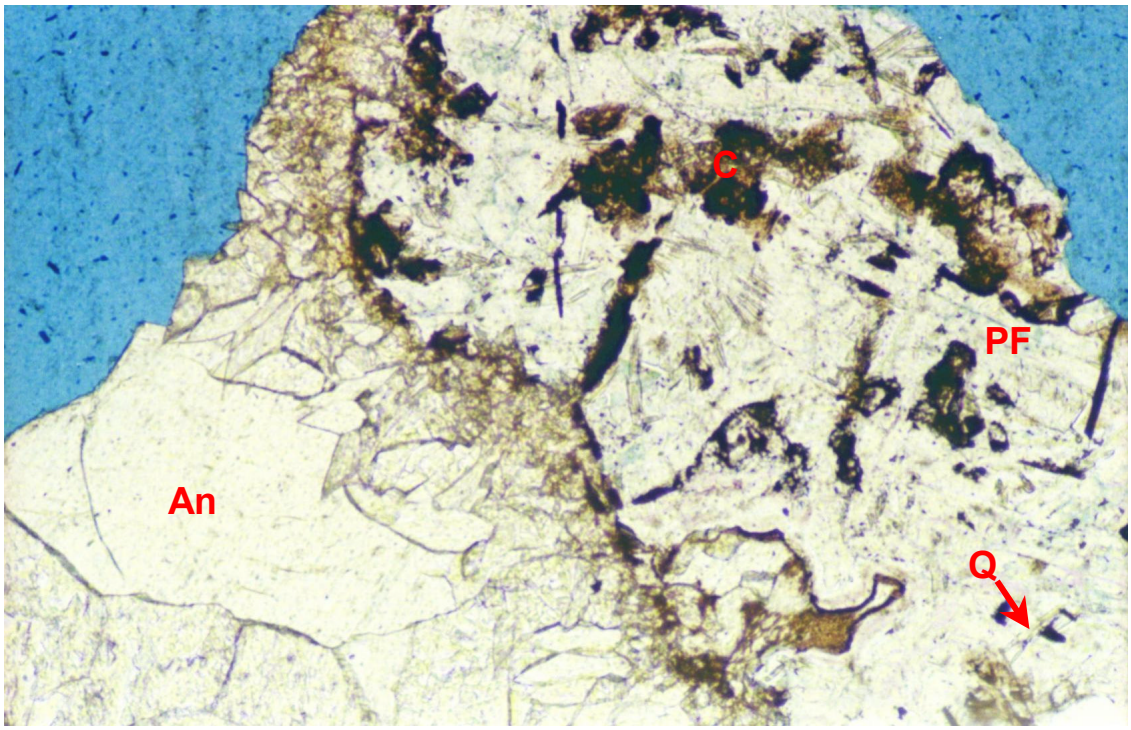
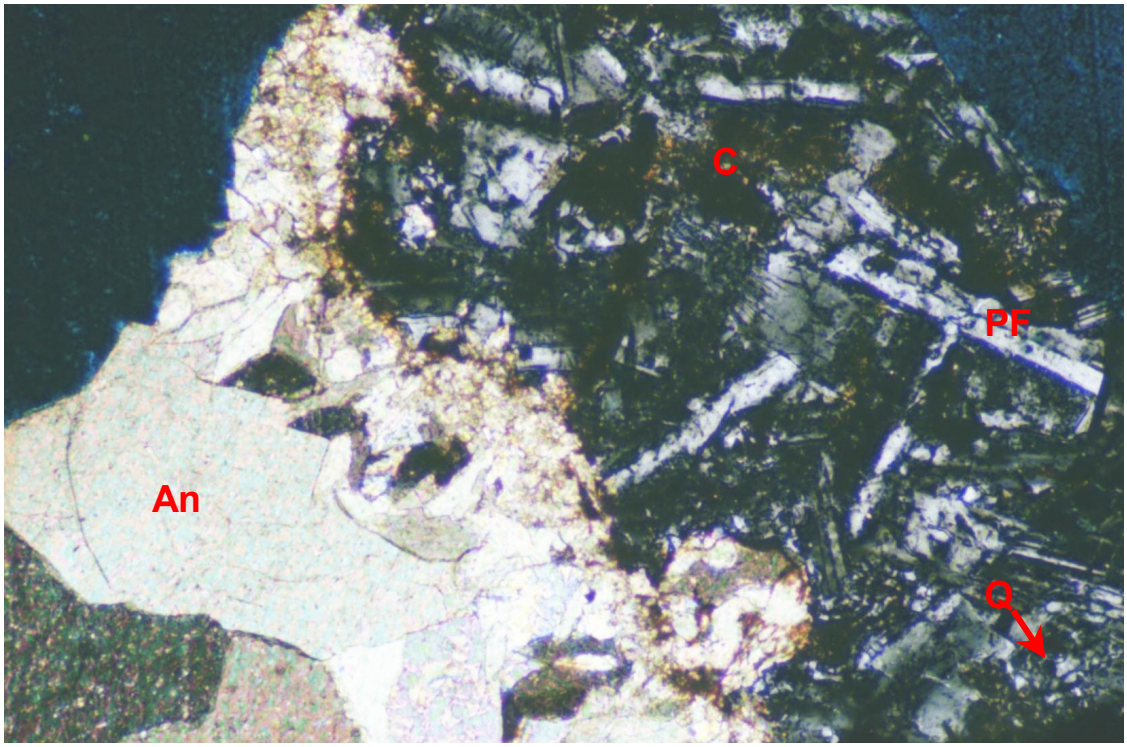


FIGURE 1 Plane polarised light

FIGURE 2 Crossed polarisers

0.2 mm



In this cutting, sparry ankerite (An) heals a fracture within an intermediate volcanic that is composed of plagioclase laths (PF), interstitial microcrystalline quartz (Q) and patchy clay (C).