SAMPLE NO. **6160576**

Thin Section Description:

Partially Silicified, Micritic Phosphorite.

- Sparsely distributed phosphatic peloids in a matrix of micrite and silica.

Composition:

Cement Mineralogy:

- Megaquartz ~35% (NB: quartz relative abundance contradicts geochemical data)
- Micrite (carbonate mud) ~30%
- Microquartz ~10%
- Cryptocrystalline apatite (collophane mudstone) <2%

Framework Grain Mineralogy:

- Apatitic peloids ~15% - 20% (relative abundance varies between laminae)
- Apatitic bioclasts ~2%
- Very fine grained detrital quartz grain <1%
- Fe-oxides – minor

NB: Note that % refers to relative abundance

Texture:

Fine-grained, matrix supported, phosphatic peloids within a partially silicified micritic cement.

Cement:

- Peloids typically cemented by micrite.
- Finely crystalline microquartz encloses and truncates the micritic matrix and represents silicified micrite.
- Drusy megaquartz mosaic occurs interstitial to the micrite/peloid lattice.
- Collophane mudstone occurs rarely within the sample as very thin (0.2 mm) laminae.

Framework grains:

- Peloids – ovule, cryptocrystalline apatite – up to 0.1mm. Relatively well sorted.
- Minor Fe-oxide staining of the peloids.

Bioclasts:

- Apatitic brachiopod and trilobite fragments. Brachiopod bioclasts larger and less fragmented than trilobite debris.

Porosity:

- Vugs, partially - wholly infilled with coarser megaquartz crystals.

Interpretation:

Originally a vuggy, micritic, phosphatic limestone partially silicified. Diagenetic alteration of limestone to chert.
Evidence for silicification:

- The zone between the "host rock" and the altered rock is preserved within this sample and the original textural character of the micrite is being retained as microquartz truncates and intrudes upon the microquartz.
- Silica infill of vugs, suggestive of the presence of a siliceous fluid.

Basic Paragenesis:

- Phosphatic peloids and bioclasts cemented by carbonate mud and possible sparry calcite. Fragmented bioclasts suggestive of transportation of framework grains prior to deposition.
- Sparry calcite matrix silicified preferentially to micrite (assuming silicification was texturally retentive), therefore only partial replacement of micrite.

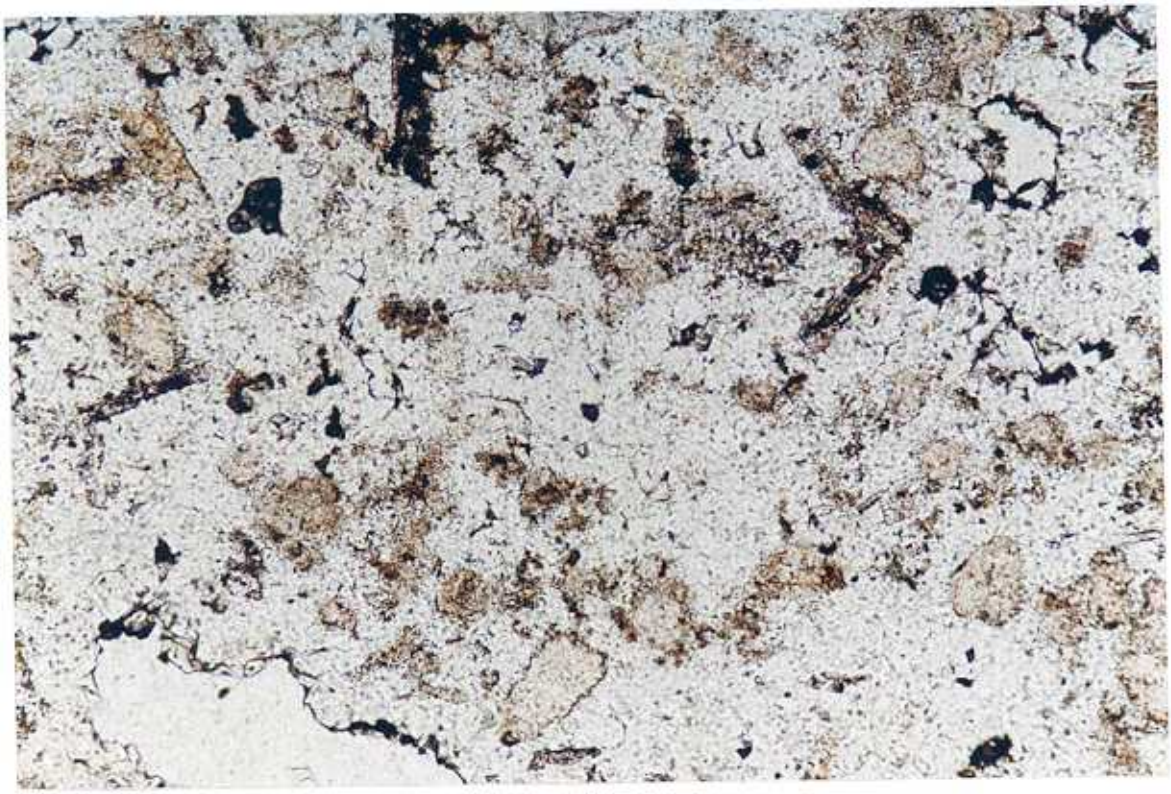

Figure 576.1 x 10; PPL. Dusty green/brown remnant micrite areas can be recognised within the predominantly clear microquartz matrix. Sparsely distributed apatitic peloids can be noted throughout. (Sample 6160576)

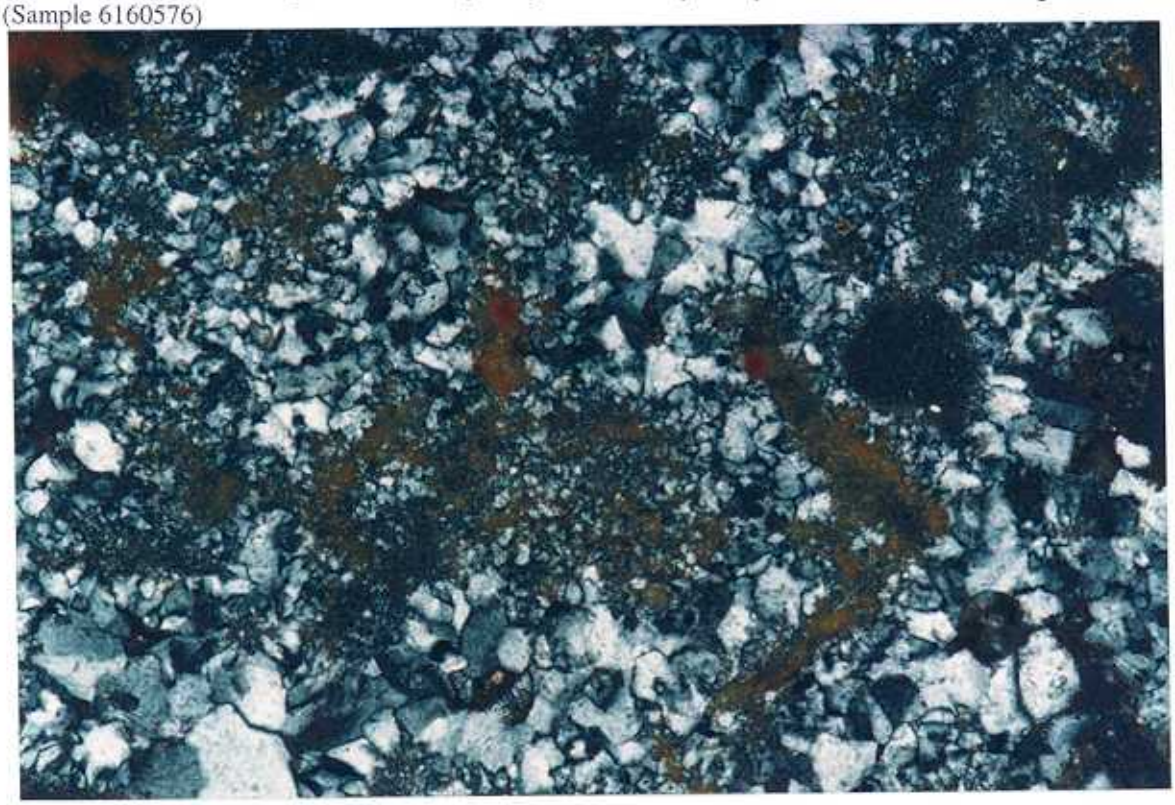

Figure 576.2 x 20; XPL. Finely crystalline microquartz encloses and truncates Fe-stained micritic matrix. Drusy megaquartz mosaic occurs interstitial to the micrite/peloid lattice. (Sample 6160576)

SAMPLE NO.	6160575

Thin Section Description:

Finely Laminated Phosphatic Chert.
Phosphatic peloids within a chert matrix of microquartz with a small proportion of remnant micrite patches throughout.

Composition:

Cement Mineralogy:

- Microquartz ~30%
- Megaquartz (slightly coarser than microquartz) ~20%
- Micrite ~15%
- Chalcedonic quartz <5%

Framework Grain Mineralogy:

- Apatitic peloids ~25%
- Apatitic bioclasts <5%
- Calcareous bioclasts <1%
- Detrital quartz – minor

NB: Note that % refers to relative abundance

Texture:

Faint, thin laminations of fine grained, clast-supported peloidal phosphorite within a microquartz/micrite cement, occur interstitial to laminations of matrix-supported microquartz/drusy megaquartz crystalline mosaic with sparsely distributed peloids (micrite absent).

Cement:

- Very fine crystalline mosaic of microquartz and its occurrence in and around patches of micrite is suggestive of a texturally retentive, replacement texture.
- Megaquartz occurs as a veinlet and vug infill and is incorporated with microquartz as a cement in some areas of the matrix-supported laminae. Therefore occurs as infill and replacement.
- Chalcedonic quartz exhibits angular, intercystalline boundaries and is therefore also an infill.

Framework grains:

- % framework grains varies from 25% in clast-supported laminae, to 5-10% in matrix-supported laminae.
- Peloids – ovule to irregular spherical form, up to 0.2mm in diameter. Relatively well sorted.
- A minor proportion of the peloids are in variable stages of deferrification, i.e. some have a general Fe-rich (goethite) staining, whilst others posess an Fe-rich rim.

Bioclasts:

- Bioclasts, predominantly trilobite fragments, are poorly sorted and localised to particular laminae.
- Minor calcareous bioclasts are those of brachiopods.

Porosity:

- Original vugs may have been infilled with drusy megaquartz, whilst secondary pore space has been infilled by chalcedonic quartz.

Interpretation:

Prior to diagenesis this sample would have originally been a micritic, apatetic peloidal limestone. Diagenetic replacement of micrite and possibly calcite spar by silica. Preferential silicification would appear to have been a function of the original texture of the limestone, i.e. silicification has been more prominent in matrix-supported laminae.

Basic paragenesis:

- Apatitic framework grains cemented by micrite and some possible, minor calcite spar.
- Micrite matrix partially to fully replaced by silica.
- Chalcedonic quartz infill of minor vugs.
- Secondary megaquartz infill of fractures and remnant pore space.

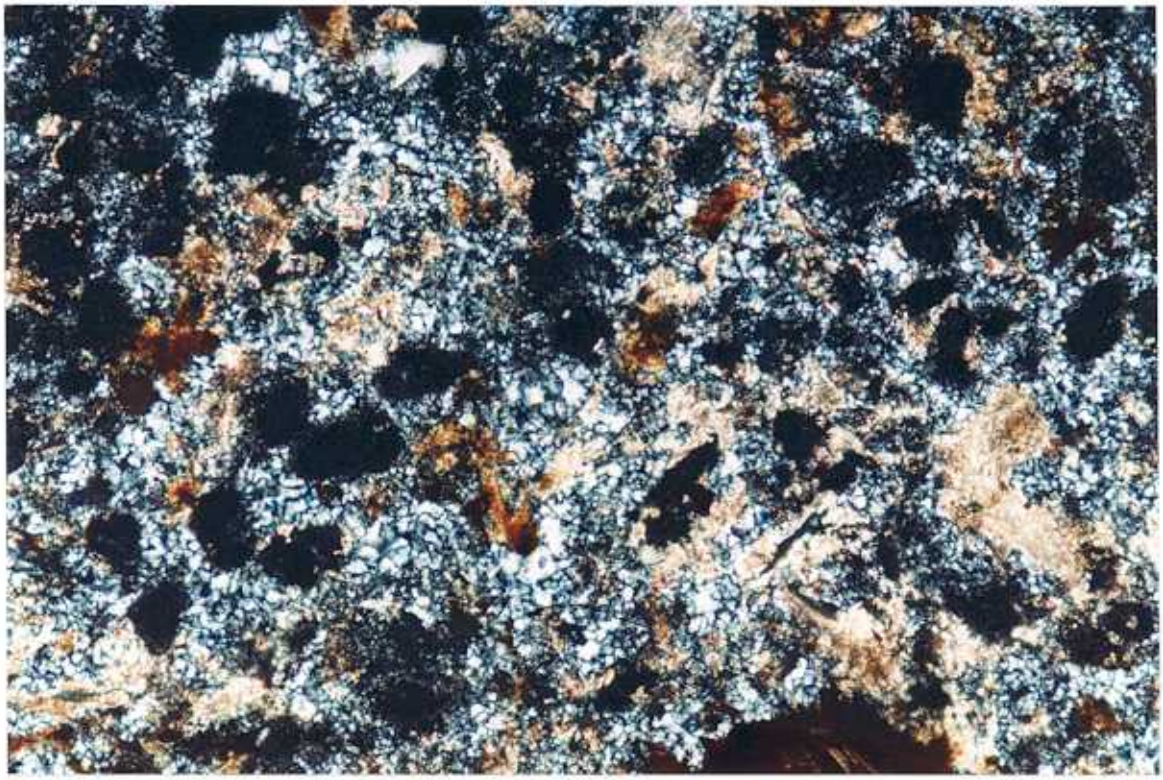

Figure 575.1 x 10; XPL. Microquartz/megaquartz partially replacing micrite. Opaque peloids of cryptocrystalline apatite. (Sample 6160575)

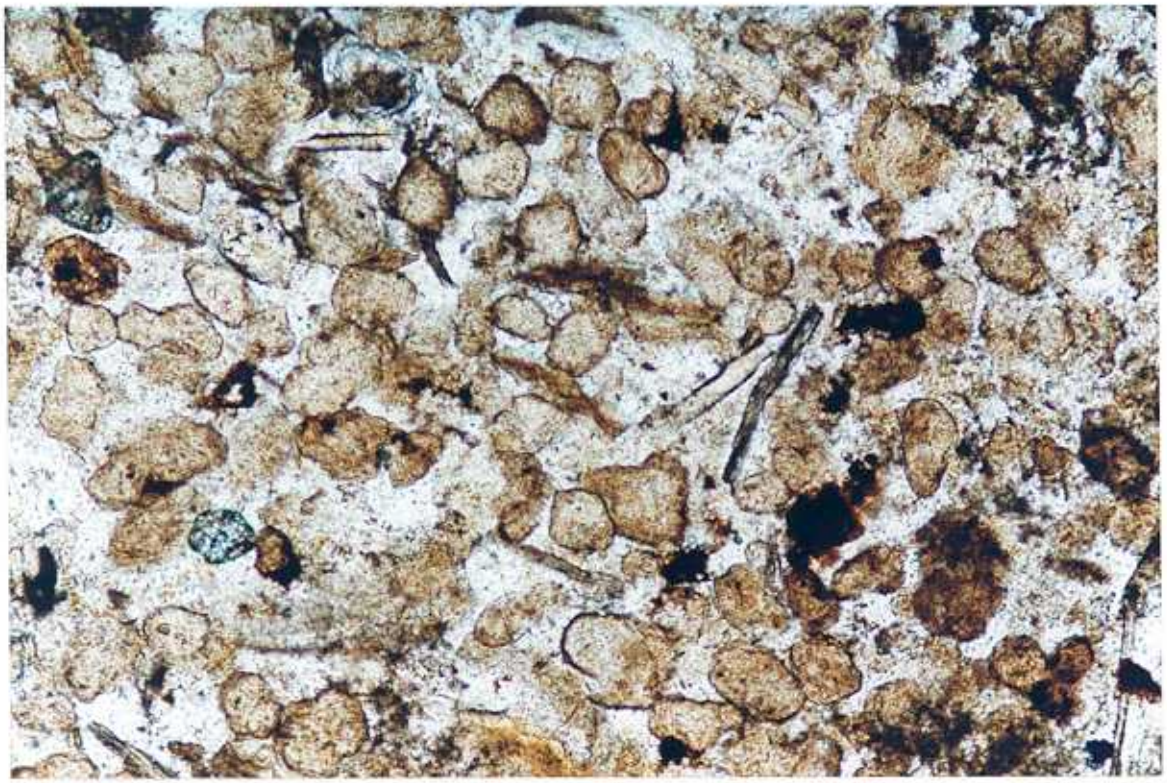

Figure 575.2 x 10; PPL. Fine grained, clast-supported peloidal phosphorite within a microquartz/micrite cement. (Sample 6160575)

SAMPLE NO. **6160574**

Thin Section Description:

Limonitic/Phosphatic Breccia

- Brecciated phosphorite clasts in a limonitic matrix. Substantial secondary aluminophosphatic and siliceous infill of pore space between fragments.

Composition:

Matrix Mineralogy:

- Poorly crystallised reddish-brown limonite.
- Detrital apatitic peloids and bioclasts.
- Detrital quartz

Fragment Mineralogy:

- Small fragments (<3 mm)
  - Very fine-grained peloidal phosphorite cemented by cryptocrystalline apatite.
  - Dolomitised limestone fragments (P-free)
- Large fragments (>3 mm)
  - Phosphatic chert – very fine-grained peloids within microquartz. Some remnant micrite present.
  - Fine-grained peloidal phosphorite and very fine-grained detrital quartz in a limonite altered matrix.

NB: Note that % refers to relative abundance

Texture:

Matrix-supported breccia with randomly oriented, angular clasts.

Matrix:

- Strongly altered, limonitic matrix containing zones that comprise detrital apatitic peloids and bioclasts and quartz grains. Therefore the matrix varies from crystalline to very fine-grained (ie. where detrital clasts are included).

Fragments:

- Size range ~2 mm diameter up to ~25 mm.
- Angular fragments, mixed composition although dominated by peloidal phosphorite.
- Fractured fragments subject to some limonite alteration, and all fragments subject to infill of vugs and fractures by various minerals (see porosity).

Phosphate Form:

- Apatite occurs as (1)'primary' cryptocrystalline peloids within brecciated fragments and also as a detrital component within limonite matrix and (2) as a secondary aluminophosphatic infill mineral – wavellite.

Porosity:

- The majority of the pore space has been infilled.
- Pore infill has affected both the matrix and the fragments.
- Wavellite occurs within large pore space as a subhedral-euhedral, fibrous aggregates.
- Silica infill of pore space created within breccia matrix.
- Some minor secondary calcite within matrix pore space also. Silicification after calcite as noted by the small-scale intercrystalline textures.

Interpretation:

Angular fragments and the occurrence of detrital apatitic and quartz clasts within the matrix, suggestive of a collapse breccia. (Only a equivocal interpretation, based on thin section textures.)

Basic paragenesis:

- Brecciation of variable lithologies (4 noted in thin section)
- Limonitic alteration of matrix and some consequent alteration of brecciated clasts.
- Pore infill
  - alumino phosphate – wavellite
  - minor calcite
  - silica

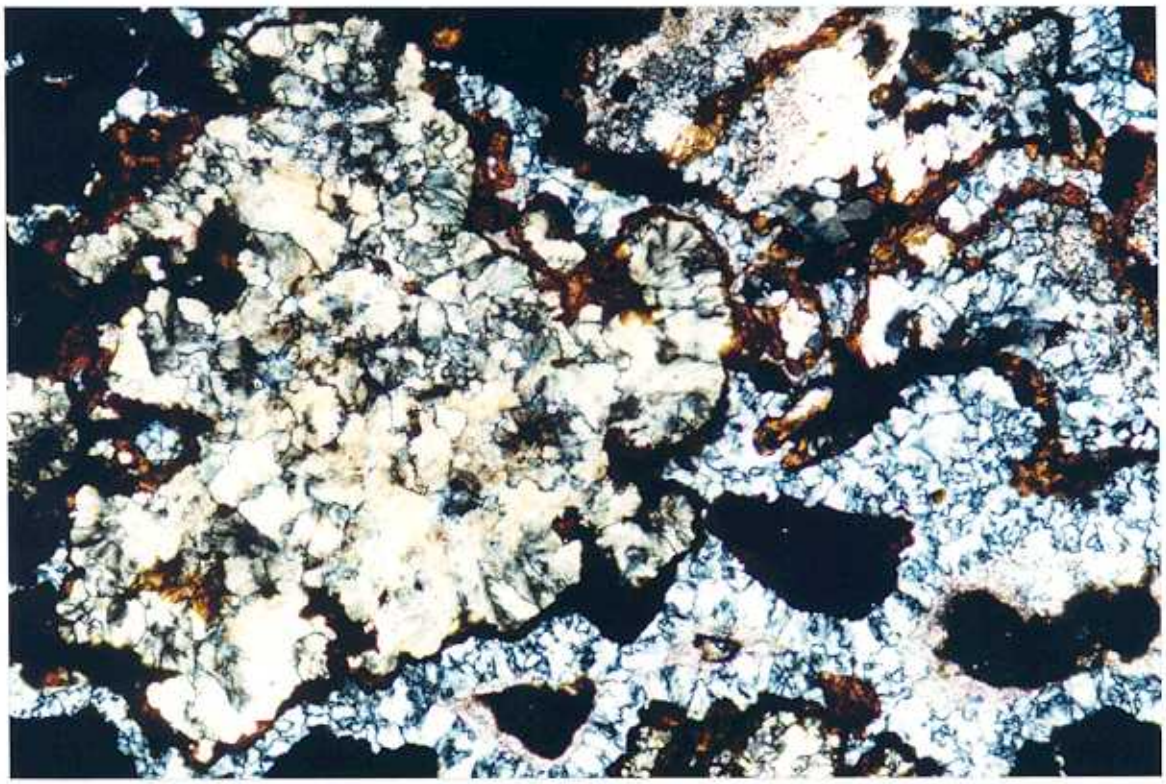

Figure 574.1 x 10; XPL. Chalcedonic quartz (and possible wavellite) infill within the limonitic matrix.

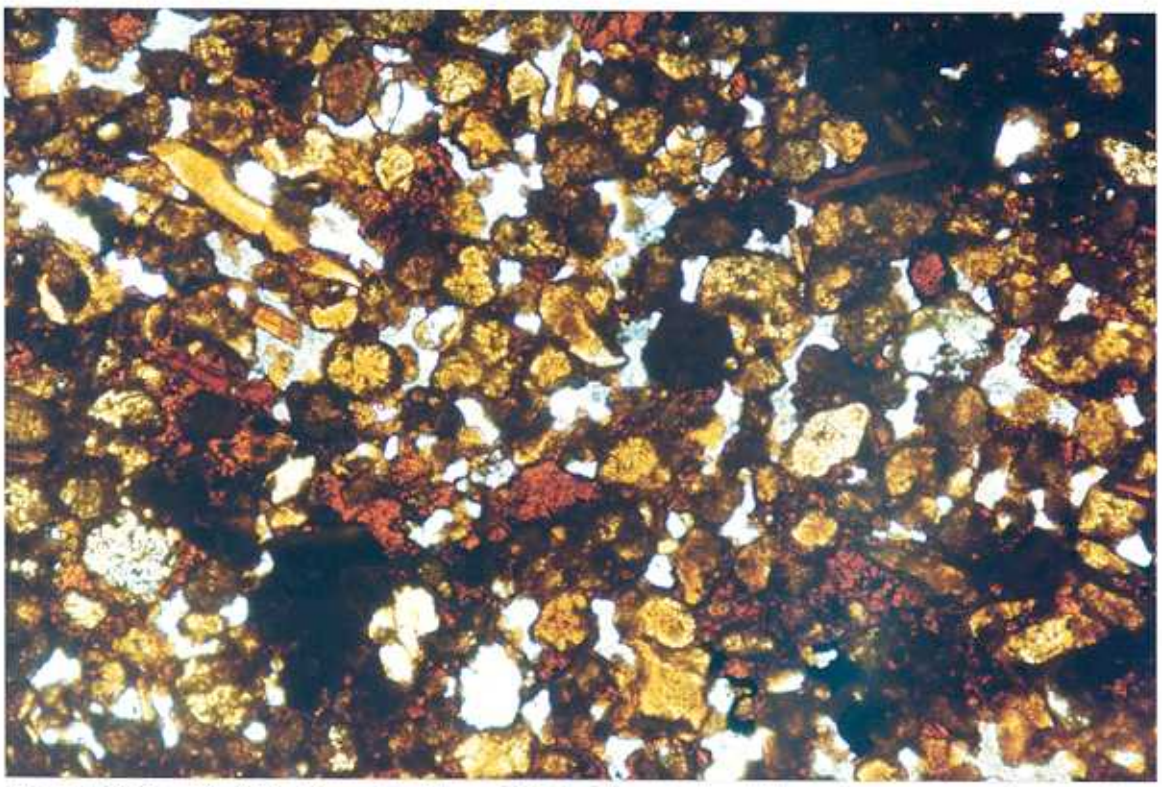

Figure 574.2 x 10; XPL. Brecciated clast – Peloidal phosphorite within a microquartz matrix. Partial limonitic alteration within the matrix. (Sample 6160574)

SAMPLE NO. **6160573**

Thin Section Description:

Partially Silicified, Micritic Phosphorite

- Fine sand grain sized, goethite stained apatitic peloids and bioclasts within a micrite and microquartz cement. (Very similar to 6160576, except that peloid density is much greater in this sample and peloids are extensively goethite stained.)

Composition:

Cement Mineralogy:

- Micrite ~ 20%
- Microquartz ~30%

Framework Grain Mineralogy:

- Apatitic peloids ~45%
- Apatitic bioclasts ~5%
- Detrital quartz – minor

NB: Note that % refers to relative abundance

Texture:

Two texturally different lithologies noted: (1) Clast-supported Fe-stained peloids in a matrix of microquartz and (2) matrix-supported, peloidal, micrite dominated laminations.

Cement:

- Microquartz more prominent in vuggy zones.
- In vuggy, laminations, microquartz encloses apatitic peloids – almost occurs as a fringe-like cement, whilst micrite occurs interstitial to the quartz.
- Where pore space is decreased, micrite is the predominant cement with a more patchy distribution of quartz.

Framework grains:

- Cryptocrystalline apatite peloids ~0.25 mm. Variable Fe-stained.
- All peloidal, no oolitic structures noted.

Bioclasts:

- Bioclasts, predominantly trilobite fragments, up to 0.4mm in length.
- Brachiopods up to 0.7mm in length.

Other framework grains:

- Angular quartz grains. Fine sand grain size.

Porosity:

- Vuggy. Most vugs only partially infilled with slightly coarser megaquartz crystals. Some vugs infilled with chalcedony.

Interpretation:

Similar interpretation as 6160576.
Prior to diagenesis this sample would have originally been a micritic, apatetic peloidal limestone. Diagenetic replacement of micrite and possibly calcite spar by silica. However, selective silicification of vuggy, clast-supported laminae, rather than matrix-supported carbonate mud lithology.
Basic paragenesis:

- Apatitic framework grains cemented by micrite and some possible, minor calcite spar.
- Micrite matrix partially to fully replaced by silica.
- Secondary megaquartz infill of fractures and remnant pore space.
- Chalcedonic quartz infill of minor vugs.

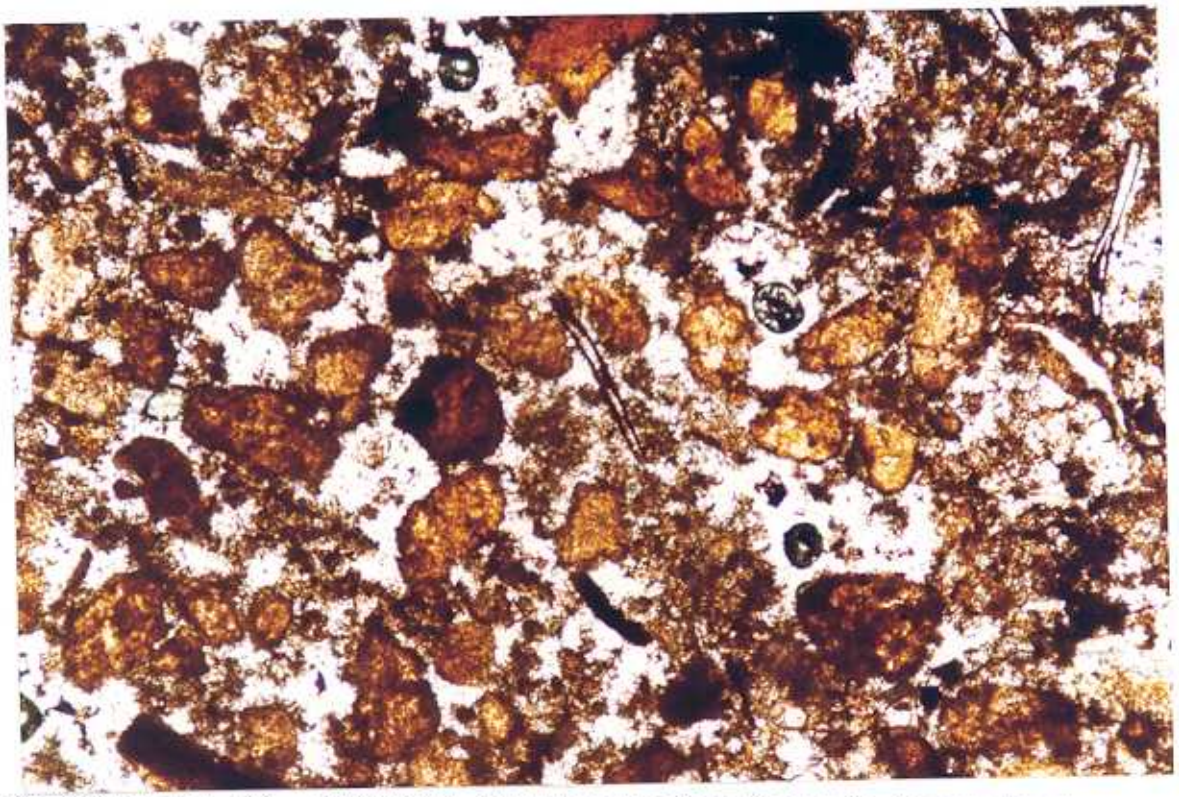

Figure 573.1 x 10; PPL. Lithology (1). Clast-supported peloidal phosphorite. Fe-oxide stained cryptocrystalline apatite peloids and bioclasts within a matrix of microquartz. (Sample 6160573)

Figure 573.2 x 10; PPL. Lithology (2). Matrix-supported peloidal phosphorite. The green/brown dusty micrite has been partially replaced by microquartz. Note that the peloids do not exhibit Fe-oxide staining, as is characteristic of lithology 1 in this sample. (Sample 6160573)

SAMPLE NO.	6160572

Thin Section Description:

Micrite/Sparite Dolomitic Limestone.

- Patchy, coarsely crystalline spar and micrite cement.

Composition:

Cement Mineralogy:

- Dolomite and/or calcite ~ 50% (Unable to distinguish between the two – staining required.)
- Micrite ~50%

* NB: Despite geochemical results of 50% SiO_2 – no quartz was observed in this thin section.

Framework Grain Mineralogy:

N/A

NB: Note that % refers to relative abundance

Texture:

- Alternating micritic layers and lenses and patchy – lensoidal sparite.
- Crystal size and shape vary irregularly throughout the mosaic which is characteristic of neomorphic spar.
- Neomorphic fabric – often see gradational boundaries between micrite and spar, but more commonly see irregular or curved intercrystalline boundaries, i.e. embayments within spar.

Spar:

- Dolomite/calcite spar forms a coarsely crystalline, euhedral mosaic. Coarse, equant grains.
- Euhedral rhombs suggestive of recrystallisation.
- Crystal size = centimicron – millimetre size.
- Zoned rhombs.

Framework grains:

- No apatite observed in thin section.

Bioclasts:

- Rare – absent.

Porosity:

- Pore space not evident. Although it is a possibility that the lenses of spar may have infilled fenestral moulds in a fenestral micritic limestone. However a neomorphic origin is favoured.

Interpretation:

Most likely that this was originally a carbonate mud.

Neomorphism may have resulted in the micritic material of this limestone being dolomitised or recrystallised to coarser, calcite spar (or both).

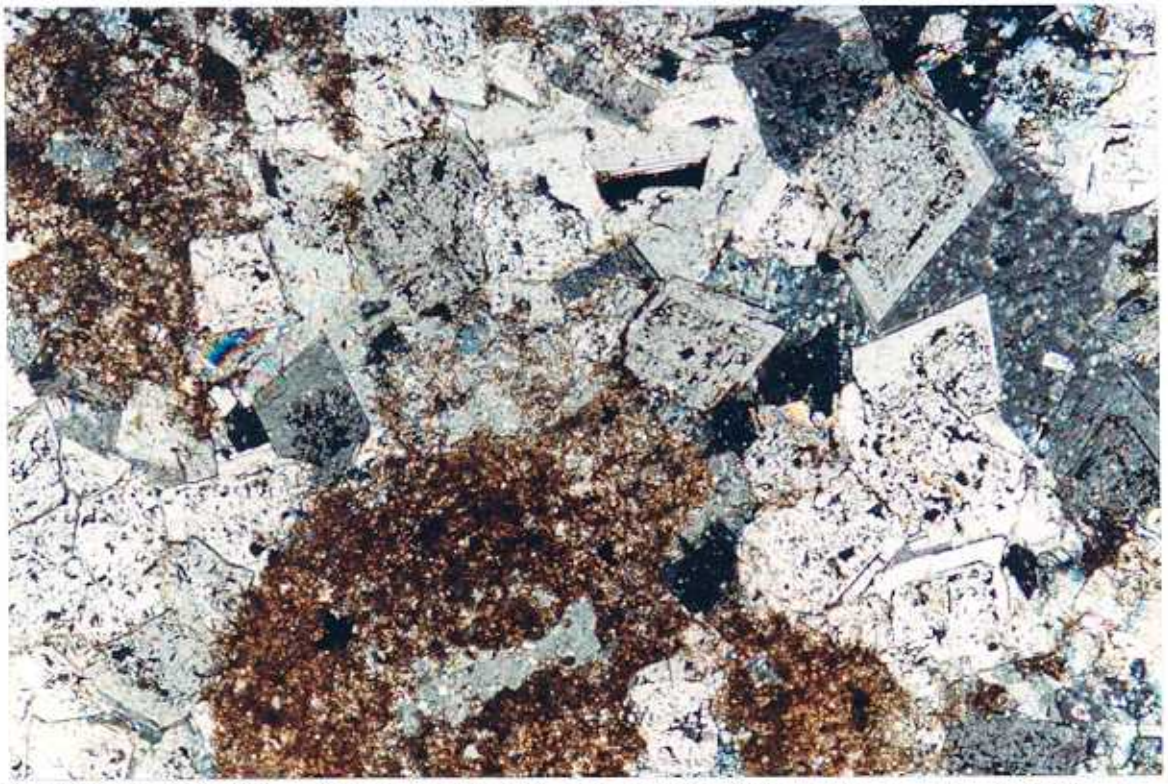

Figure 572.1 x 10; XPL. Patchy, coarsely crystalline spar and micrite cement. Zoned, euhedral rhombs common. (Sample 6160572)

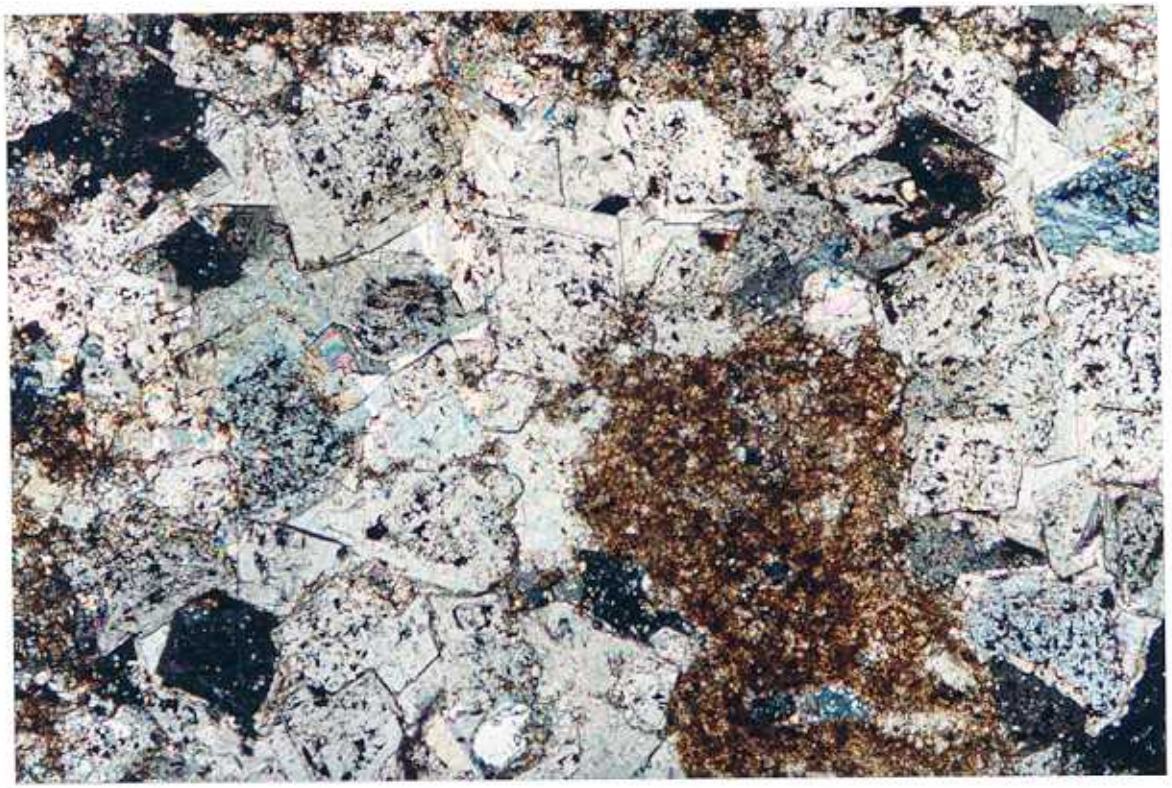

Figure 572.2 x 10; XPL. Neomorphic fabric – gradational boundaries between micrite and spar. Irregular or curved intercrystalline boundaries, i.e. embayments within spar. (Sample 6160572)

SAMPLE NO.	6160540

Thin Section Description:

Recrystallised Phosphatic Chert

- Cryptocrystalline/microcrystalline apatite/silica mosaic.

Composition:

Cement Mineralogy:

- Cryptocrystalline apatite ~50%
- Microquartz ~40%
- Limonite and/or goethite ~10%

NB: Note that % refers to relative abundance

Texture:

- Structureless, irregular crystalline masses of apatite occurring as a mosaic with microcrystalline quartz.
- Differs from other cherts observed in thin section, in that lamination and compositional layering or segregation does not exist.
- High amount of iron oxide inclusions within the crystalline mosaic, suggestive of recrystallisation.
- Some faint apatitic peloidal structures can be recognised in certain areas of the slide by a thin organic staining that outlines the peloid shape. Recrystallisation of apatite is evident in these areas as the apatite has 'overgrown' the peloid boundaries.

Interpretation:

- Phosphatic chert that has been subject to recrystallisation.
- Evidence to say that at least some of the apatite was peloidal in morphology prior to recrystallisation.

Figure 540.1 x 10; PPL. Structureless, irregular crystalline mass of apatite occurring as a mosaic with microcrystalline quartz. Some peloids can be recognised in this view but are more obvious in Figure 540.2.

Figure 540.2 x 10; XPL. Same view as Figure 540.1 except in cross polarised light. The very dark view is due to cryptocrystalline, isotropic apatite. (Sample 6160540)

SAMPLE NO.	6160539

Thin Section Description:

- Microcrystalline wavellite/apatite mosaic.

Composition:

Cement Mineralogy:

- Microcrystalline wavellite ~60%
- Cryptocrystalline apatite ~30%
- Microquartz ~5%
- Detrital quartz ~5%

NB: Note that % refers to relative abundance

Texture:

Microcrystalline apatite and wavellite mosaic.

- Apatite can be distinguished from wavellite by the pin-point extinction, in comparison to wavellite extinction which is fibrous.
- Partial replacement of wavellite by microquartz.
- Microquartz intrudes upon microcrystalline wavellite, leaving remnant patches of wavellite in and around the microquartz mosaic.
- Silica would appear to be preferentially replacing microcrystalline wavellite.
- Silt-sized detrital quartz grains occur within the cryptocrystalline apatite.

Porosity:

- Pore space comprises an ~25% proportion of this sample. Recrystallisation has been prominent around pore space, with the formation of tabular, euhedral crystals that protrude into the pore space.

Interpretation:

- Collophane mudstone variably recrystallised to microcrystalline wavellite, particularly around pore space.
- Minor silicification of wavellite

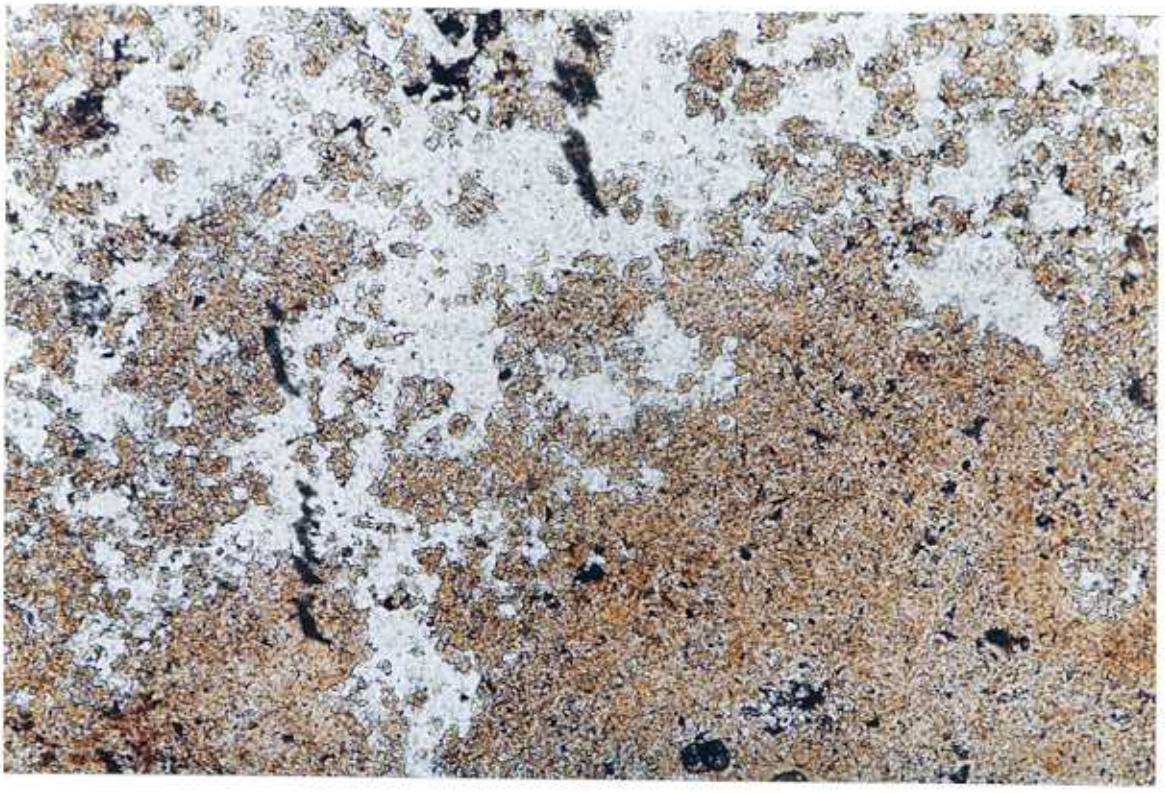

Figure 539.1 x10; PPL. Microcrystalline wavellite (?) partially replaced by silica. (Sample 6160539)

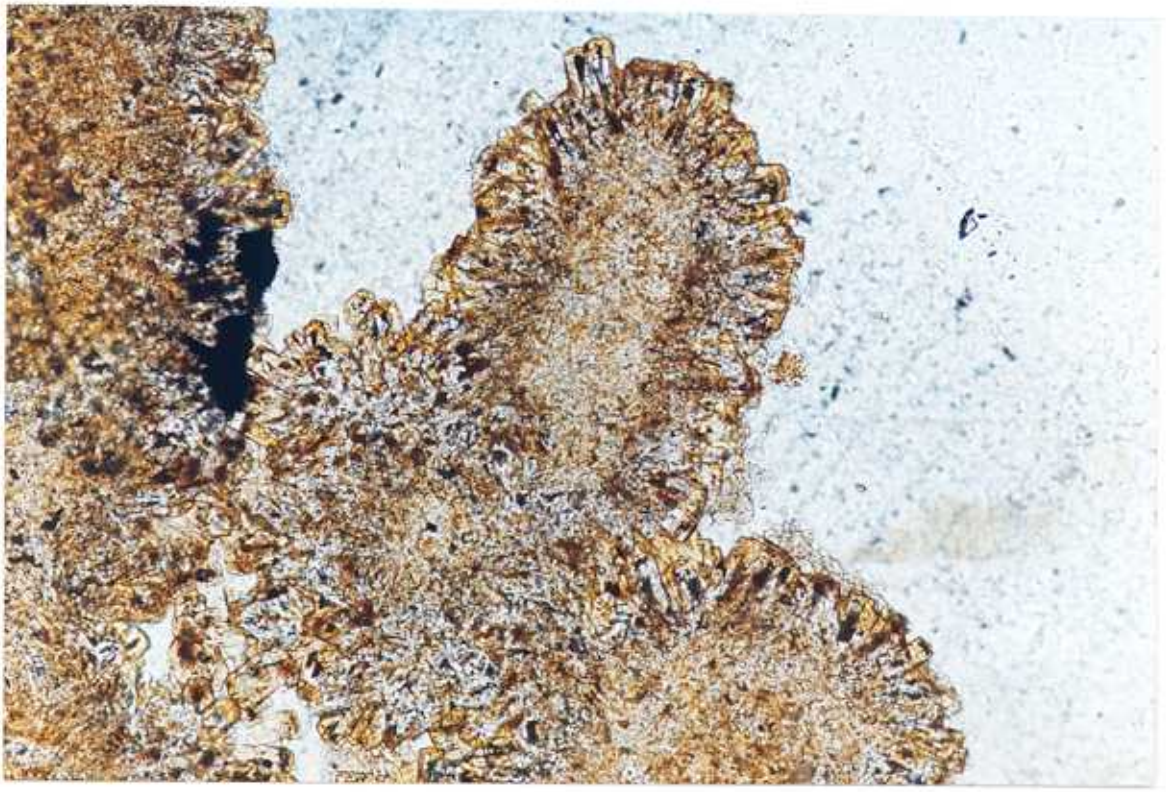

Figure 539.2 x 20; PPL. Recrystallisation has been prominent around pore space, with the formation of tabular, euhedral crystals that protrude into the pore space. (Sample 6160539)

SAMPLE NO.	6160538

Thin Section Description:

Limonitic Phosphatic Mudstone

- Laminated Fe-oxide stained, cryptocrystalline matrix comprised of silt-sized quartz grains and clay laths.

Composition:

Cement Mineralogy:

* Due to the microcrystalline nature of this sample, mineral identification was not always possible.
  - Fe-oxidised cryptocrystalline apatite or aluminophosphate ~ 75%
  - Microcrystalline quartz (uncertain of this identification however as the 'quartz' exhibits a metallic sheen to it in PPL) ~ 10%
  - Detrital silt-sized quartz ~10%
  - Phosphatic bioclasts ~ 5%

NB: Note that % refers to relative abundance

Texture:

- Cryptocrystalline mudstone interlaminated with detrital, silt-sized quartz grains in a mudstone matrix.
- This section contains what look to be clasts of microcrystalline quartz in XPL (unsure of correct identification as in PPL this material has a 'metallic' sheen to it), however these 'clasts' have a triangular, intercrystalline texture relationship with the mudstone. Therefore suggesting an infill origin.
- This infill texture is worth noting as in sample 6160537, material of this same composition occurs as distinct angular, clasts, i.e. sample 6160537 appears to contain brecciated clasts.

Bioclasts:

- ~5% bioclasts – relatively unfragmented.
- Contains a large trilobite fragment ~ 1cm long

Interpretation:

- Weathered bioclastic apatitic mudstone.
- Infill of pore space with possible microquartz.

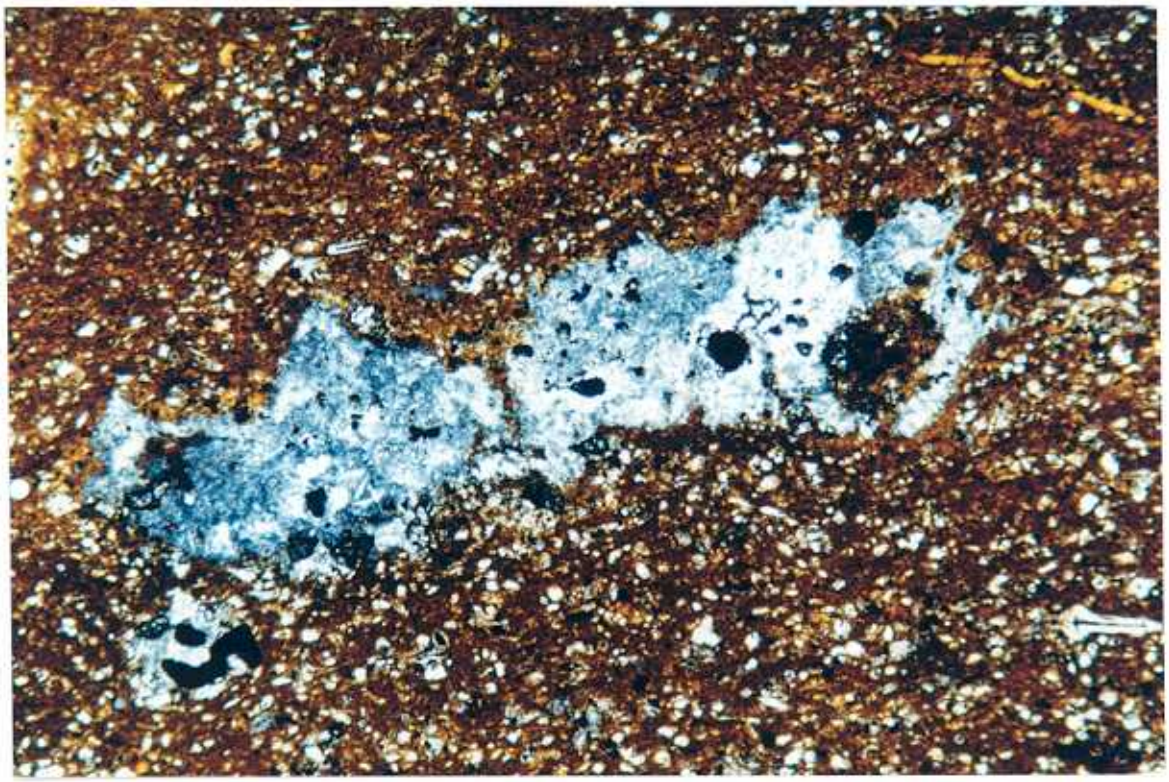

Figure 538.1 x 5; PPL. Detrital silt-sized quartz rich limonitic matrix with a chalcedonic quartz infill (?) (Sample 6160538)

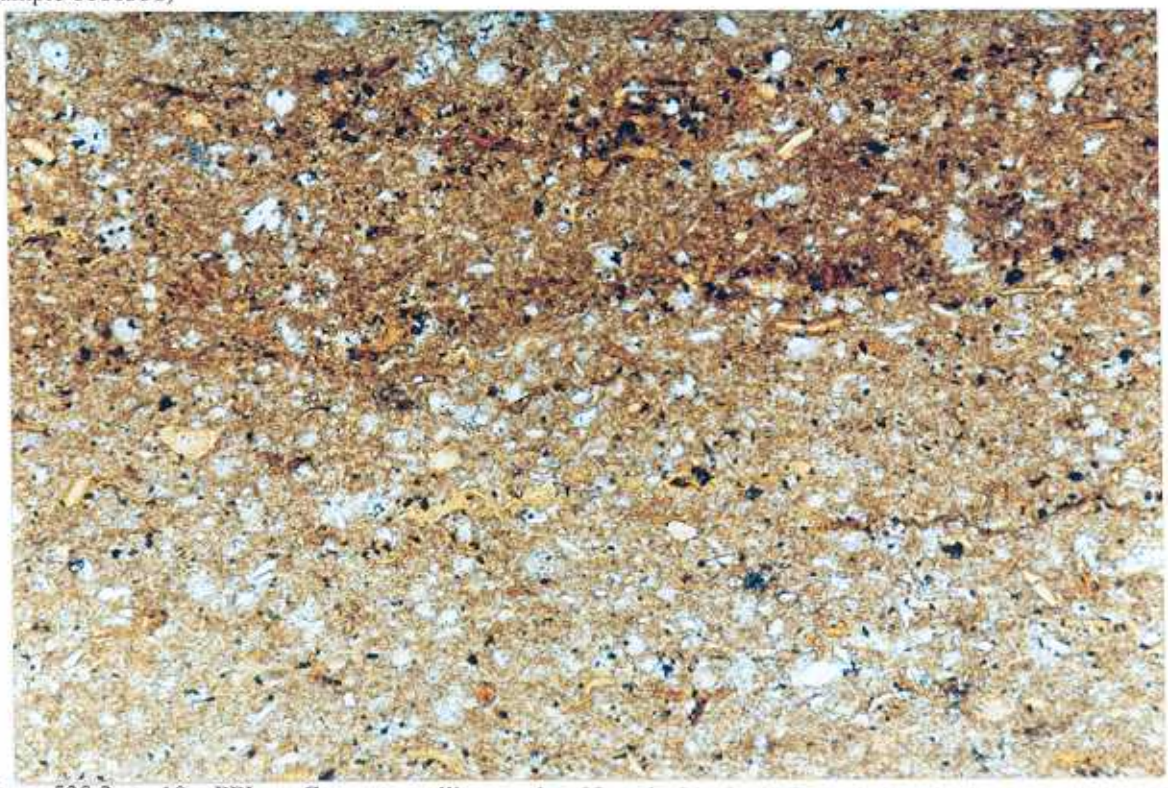

Figure 538.2 x 10; PPL. Cryptocrystalline apatite. Note the bioclastic fragments with long axis aligned parallel to lamination and the limonitic laminae at the bottom of the photo. (Sample 6160538)

SAMPLE NO.	6160537

Thin Section Description:

Limonitic/Phosphatic Mudstone with silicified carbonate clasts.

- Laminated Fe-oxide stained, cryptocrystalline matrix comprised of silt-sized quartz grains and clay laths. The matrix is interrupted by large (1.5 cm) clasts of silicified carbonate.

Composition:

Cement Mineralogy:

* Due to the microcrystalline nature of this sample, mineral identification was not always possible.
  - Fe-oxidised cryptocrystalline apatite or aluminophosphate ~ 55%
  - Microcrystalline quartz (uncertain of this identification however as the 'quartz' exhibits a metallic sheen to it in PPL) ~ 30%
  - Detrital silt-sized quartz ~10%
  - Phosphatic bioclasts ~ 5%

NB: Note that % refers to relative abundance

Texture:

- In hand sample, this sample appears to be a breccia, however the would be matrix material is laminated and has a cryptocrystalline mudstone mosaic with bioclasts displaying a preferential alignment of long axis along a lamination plane.
- Finely laminated limonitic collophane mudstone fabric is interrupted by large clasts of microquartz.
- The microquartz clasts included within this matrix however, are angular and definitely do not appear to be areas of altered matrix or infill (as in sample 6160538).
- The clasts contain black relict carbonate rhombs (figure 537.2).

Bioclasts:

- Variably fragmented trilobite clasts.

Interpretation:

- Oxidised, laminated, bioclastic mudstone containing clasts of silicified carbonate.
- The silicified carbonate clasts would not appear to have been emplaced by brecciation.
- The angular clasts have not been transported far and emplacement within the mudstone matrix did not involve any notable force as the mudstone lamination has not been disrupted or warped.

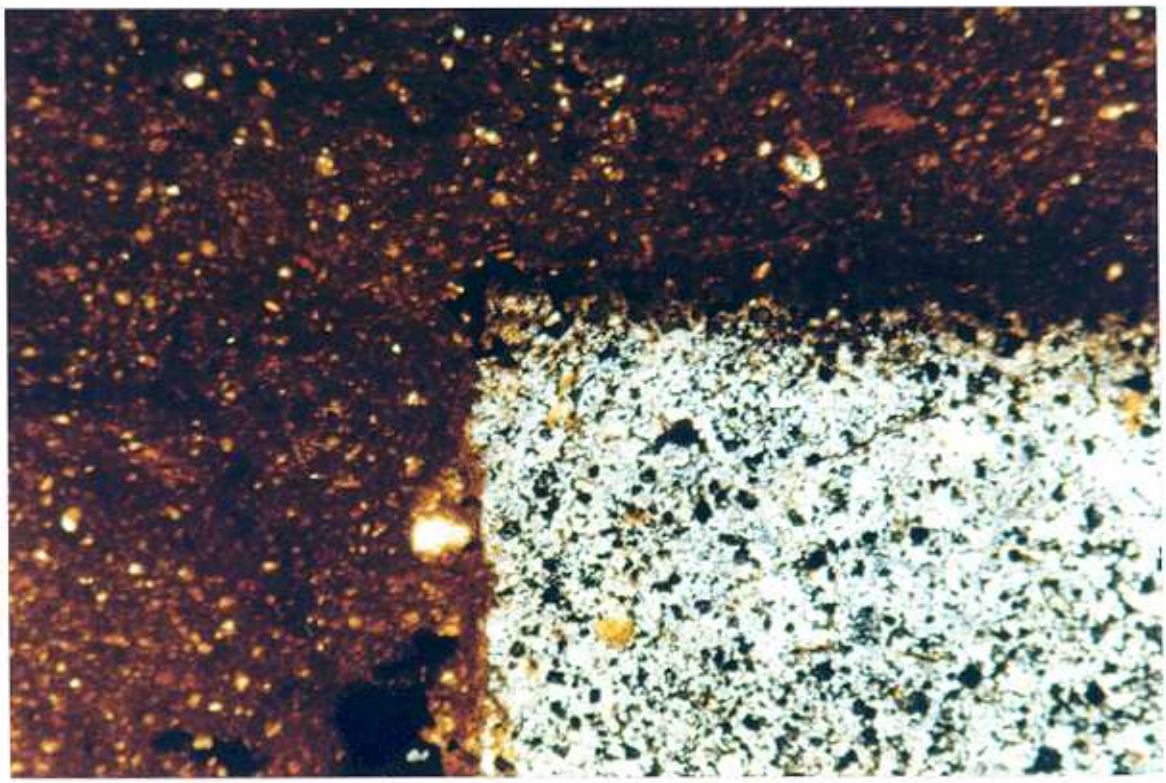

Figure 537.1 x 5; PPL. Angular, silicified carbonate clast within limonitic mudstone matrix. Note that the silicified carbonate clast has been subject to Fe-oxidation around the edge also.

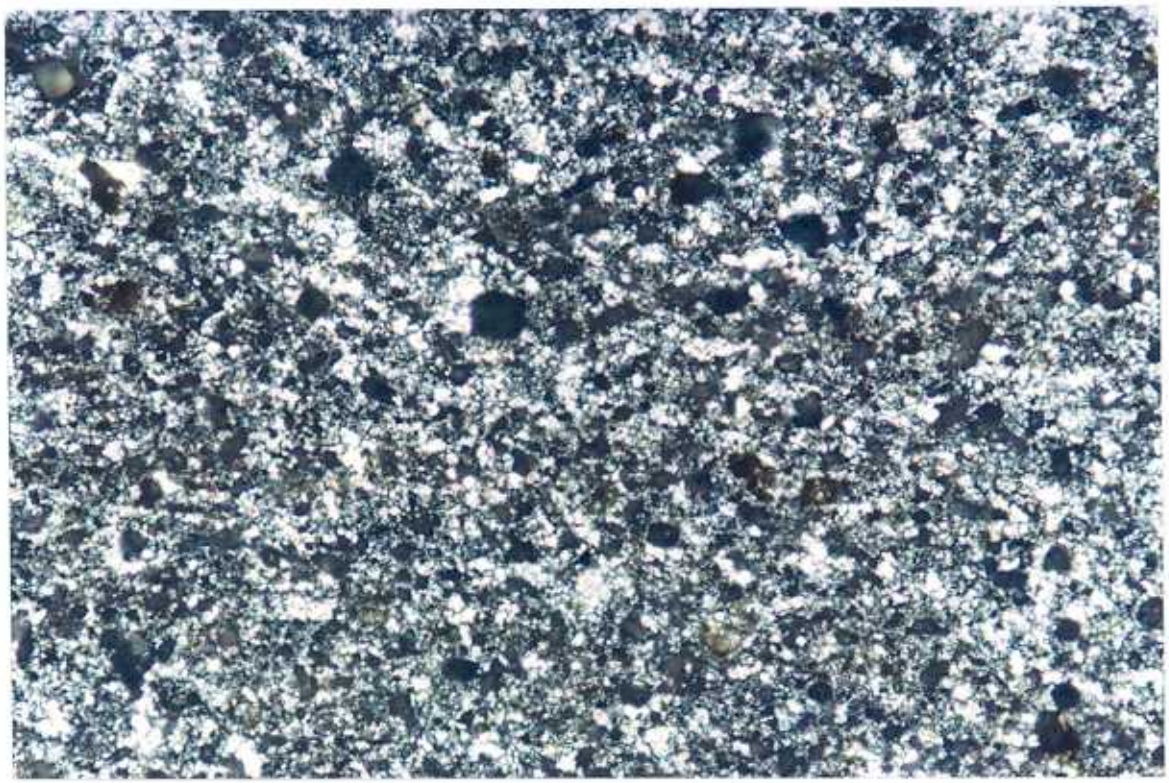

Figure 537.2 x 10; XPL. Silicified carbonate clast displaying small-scale, black relict carbonate rhombs and possibly an isotropic microcrystalline phosphatic mineral occurring in the microquartz mosaic.

Sample location and description

Sample#	DPO#	AMG_E	AMG_N	Notes	Brief_description
6160537	200867	652009.2	7786981.4	Core sample 6156365 from WON00DD58 39.1 m	Chert breccia phosphorite
6160538	200867	652009.2	7786981.4	Core sample 6156365 from WON00DD58 39.1 m	Chert breccia phosphorite
6160539	200867	654536.7	7787005.7	Core sample 6156263 from WON00DD47 51.2 m	Transitional phosphorite; replacive
6160540	200867	656999.8	7789506	Core sample 6156211 from WON00DD35 46.8 m	Mudstone phosphorite
6160572	200867	641614	7776700	Rock chip sample 6160519	Phosphatic dolostone
6160573	200867	641227	7775590	Rock chip sample 6160504	Porcellinous mudstone phosphorite
6160574	200867	640943	7775805	Rock chip sample 6160516	Fe chert breccia phosphorite
6160575	200867	641162	7775430	Rock chip sample 6160505	Porcellinous mudstone phosphorite
6160576	200867	640936	7775109	Rock chip sample 6160506	Porcellinous mudstone phosphorite

Indicative assay values

Petrology sample #	Assay sample #	DPO #	Datum	Zone	Type	P205 wt%	Fe2O3 wt%	Al2O3 wt%	CaO wt%	K2O wt%	MgO wt%	MnO wt%	Na2O wt%	SiO2 wt%	TiO2 wt%
6160537	6156365	89437	AGD66	53	PQ drill core	7.98	3.51	5.48	10.60	0.39	0.15	0.02	0.10	68.50	0.18
6160538	6156365	89437	AGD66	53	PQ drill core	7.98	3.51	5.48	10.60	0.39	0.15	0.02	0.10	68.50	0.18
6160539	6156263	89433	AGD66	53	PQ drill core	20.00	0.72	2.13	27.20	0.20	0.13	0.12	0.05	46.00	0.125
6160540	6156211	89432	AGD66	53	PQ drill core	39.20	0.69	0.67	51.80	0.04	0.03	0.07	0.01	3.79	0.025
6160572	6160519	200865	AGD66	53	Outcrop grab	0.34	1.30	0.22	18.00	0.01	7.45	0.11	0.02	50.30	0.01
6160573	6160504	200865	AGD66	53	Outcrop grab	34.40	2.50	0.23	47.90	0.02	0.08	0.08	0.06	11.10	0.01
6160574	6160516	200865	AGD66	53	Outcrop chip	6.78	33.30	2.50	10.90	0.30	0.46	0.13	0.06	34.80	0.12
6160575	6160505	200865	AGD66	53	Outcrop chip	30.80	1.27	0.35	44.30	0.04	0.33	0.16	0.12	17.80	0.02
6160576	6160506	200865	AGD66	53	Outcrop panel	35.30	1.17	0.42	49.80	0.03	0.14	0.03	0.08	8.96	0.01