

307001

**Yolla-1 Service Report.
Petrography, XRD, SEM and Geochronology.**

AMDEL, Amoco Australia Petroleum Company

OR_0313



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F 6274

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Attention: S.C. Bane

REPORT F 6274

YOUR REFERENCE: Local Purchase Order 475

MATERIAL: Core chips

LOCALITY: YOLLA-1

WORK REQUIRED: Petrography, XRD, SEM, geochronology

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1. INTRODUCTION

During the last 2 weeks both reservoir samples and igneous rocks from Yolla-1 have been examined. Summaries of results have been telexed to the client and this formal report gives complete results.

A letter (MISC-AUP-316-L-340-GMK) refers to work on the sedimentary rocks and quotes Local Purchase Order 475. Telexes of 12 and 15 August refer to work to be carried out on the igneous rocks.

2. SEDIMENTARY ROCKS

Seven core chip samples were received from the reservoir section of Yolla-1. The depths are as follows:

(m)	(ft)	(m)	(ft)
1845.7	6055.5	1846.2	6057
1846.5	6058	1846.8	6059
1847.1	6060	1847.4	6061
1848.0	6063		

Thin sections (TSC 45540-45546) were cut from each sample. Brief examination of the section showed that the rocks are essentially the same and hence one overall description is given supplemented by photomicrographs.

The section represents a remarkably well-sorted siltstone in which the average grain size is 0.05-0.07 mm and detrital grains in this size range comprise about 75% of the volume of the rock. Quartz is by far the most abundant detrital mineral and there is less than 5% (altogether) of lithic fragments, mica and heavy minerals. Feldspar is absent. Grains of quartz are angular (mostly) to subangular in shape and they fit closely together. Contacts are, however, mainly of the tangential type, rarely long and curved; hence the angularity is an integral feature of the detritus and not a result of diagenetic modifications. There are no quartz overgrowths. As far as can be determined, the quartz is of the common or plutonic variety, although the sorting suggests an immediate sedimentary provenance.

Small (~ 0.05 mm) patches of birefringent, heterogeneous clay are relics of lithic fragments deposited with the quartz. The rocks contain about 1% of clean detrital muscovite. Most of the flakes are distorted (due to compaction effects) and are not more than 0.1 mm in length.

Finally, the samples contain traces of tourmaline. As far as can be determined from the thin sections this mineral is decidedly rare at 1845.7 m (6055.5 ft) but somewhat more abundant, for example at 1847.4 m (6061 ft). Tourmaline grains are subangular in shape and similar in size to adjacent quartz grains. Most show pale straw to yellow colours with a few also with pale green tints. Zircon and opaques were occasionally noted among the terrigenous component.

The two other main components of these rocks are clay and carbonate and these, together comprise about 20% of the samples. 'Carbonate' is most abundant by far at 1845.7 m (6055.5 ft) (15% carbonate) and 1846.8 m (6059 ft) (7-10% carbonate); there are traces at 1847.1 m (6060 ft) and none in the other sections. Brown clay represents 15-20% of all the thin sections.

At 1845.7 m (6055.5 ft) the carbonate is siderite and it occurs about equally as widely disseminated crystals up to 0.1 mm in size and as large, monomineralic aggregates up to 0.5 mm in size. The disseminated material is patently authigenic, has partly replaced quartz and, in some instances, forms subidiomorphic crystals. In the large aggregates, the siderite has a notably granular texture and small individual crystals often have a dark core. This appears most likely to be siderite derived from alteration of original pyrite concentrations. At 1846.8 m (6059 ft) most of the carbonate occurs in equant to lensoid concentrations similar to those at 1845.7 m (6055.5 ft).

The photomicrographs show the pervasive brown colour of the matrix clay. This is generally homogeneous and hence is derived from an original muddy matrix. The material is dark between crossed Nicols and commonly more or less obscured by ferruginous staining.

Pores are coloured blue in the photomicrographs. Given that core analysis shows a high porosity for this part of the geological section, it is thought likely that the pores seen in thin section are an integral part of the rocks (and not the result of the preparation of the sections). In general, porosity has a patchy distribution and is inversely related to the clay matrix. It appears that the pores are either primary (original intergranular space never filled with matrix) or are derived from the selective, patchy dissolution of some of the clay matrix. It is likely that at least some of the pores are secondary in origin; especially the somewhat larger ones. In general, the pores are less than 0.05 mm in size and are probably interconnected via narrow channelways restricted by the clay matrix.

Figure 1 shows photomicrographs in plane polarised light and crossed Nicols of the same field at 1845.7 m (6055.5 ft) (long dimension approximately 1 mm). The highly birefringent material (dark grey patch in centre) is siderite and this mineral occupies about 25% of this field-of-view. Blue material in plane polarised light shots is porosity and the white material is quartz. Clay matrix is pale brown.

Figures 2, 3 and 4 are at 1846.2 m (6057 ft), 1847.1 m (6060 ft) and 1847.4 m (6061 ft) and all are in plane polarised light and the long axis is approximately 2.5 mm. They all show typical fields in these rocks. Porosity is abundant at 1846.2 m (6057 ft) and 1847.1 m (6060 ft) though somewhat occluded at 1847.4 m (6061 ft) where there is more opaque iron oxide/hydroxide material. In the last-named, there is a thin bed of iron-rich material in the thin section; otherwise the rock is similar to those at 1846.2 m (6057 ft) and 1847.1 m (6060 ft).

SEM photographs are given as Plates 1-9, with captions included.

Two of the samples were examined by X-ray diffraction analysis on both the bulk material [in the case of that from 1846.8 m (6059 ft)] and the -2 μ m sedimented portion. The results are as follows:

X-ray diffraction analyses:

		1846.8 m (6059 ft)		1845.7 m (6055.5 ft)	
Bulk	Quartz		D		
Mineralogy	Siderite		A-SD		
	Kaolinite		A		
	Halite		Tr		
	Pyrite		Tr		
		%	B		6
-2 μ m fraction	Kaolinite	D		Kaolinite	D
	Quartz	A		Quartz	A
	Mica/			Mica/	
	Illite	Tr-A		Illite	Tr-A
	Smectite	Tr		Smectite	Tr

The kaolinite is very well crystallised.

3. IGNEOUS ROCKS

3.1 Introduction

Four samples of drilling cuttings from Yolla No. 1 were received for evaluation of suitability for isotopic dating and any suitable material was to be dated urgently under Code M1.4.

3.2 Procedures

The samples were washed to remove drilling mud and wet screened on 200 BS mesh (75 micron aperture). Thin sections were prepared from composite grain mounts of the dried samples.

In response to a telephone call from John Taylor of AMOCO, the samples from 3034-3043 m, 3061-3070 m and 3142-3151 m were riffled into 2 portions, one portion of each being returned urgently to Sydney via Skyroads. The bulk magnetic susceptibilities of the remaining portions were determined and reported by telephone to John Taylor on 14 August 1985.

The thin sections were examined but only one sample (from 2612-2621 m) was found to contain material suitable for dating. This sample was crushed and a biotite concentrate prepared for K and Ar analysis.

3.3 Petrographic Details

2612-2621 m

The rock is a medium to fine grained gabbro, with a grain size ranging from 3 to 0.3 mm. The primary mineral components, in decreasing order of abundance, are clinopyroxene, plagioclase, hornblende, biotite, magnetite and apatite.

Plagioclase occurs as generally tabular grains and is extensively altered to sericite, zoisite/epidote, calcite and chlorite. Faint albite twinning can still be distinguished and occasional marginal zones or rims of slightly different composition can be seen.

The ferromagnesian minerals are generally fresh. The amphibole, a dark red-brown variety, appears in places to be replacing pyroxene but elsewhere, occurs as discrete grains with euhedral shape and well developed twinning.

Biotite is also a reddish-brown variety and is generally unaltered. Both biotite and hornblende could be used for K-Ar dating but the biotite may prove easier to concentrate.

Patches of a fibrous, colourless ?zeolite mineral are also present.

Apart from the alteration of the plagioclase, the rock is fresh and shows no sign of strain. A K-Ar date on biotite or hornblende should give the age of crystallisation of this gabbro.

3034-3043 m

The drilling cutting in this sample, and in the following two samples, are much finer than those from 2612-2621 m. Many particles are monomineralic.

Carbonate particles are abundant and, as they do not stain with Alizarin Red-S, are probably dolomitic. Fine to medium grained olivine gabbro particles are common. The distinctive red-brown amphibole and biotite noted in 2612-2621 m are present but the plagioclase is remarkably fresh and olivine was not noted in the higher sample.

Fine grained micaceous siltstone chips (some with carbonate), coal fragments and occasional quartzite are also present.

There is no material in this sample that could be used from isotopic dating.

3061-3070 m

Many fragments in this sample are monomineralic. Carbonate (mainly dolomite but also some calcite) is common, both as single particles and within fragments of basalt. Coarser grained gabbroic material (described above) is present and quartz is much more abundant.

The major new lithology present is basalt. One slightly coarser grained and plagioclase-rich fragment was noted but most chips contain plagioclase laths smaller than 300 x 30 microns with fine, intergranular pyroxene ~30 microns in size and abundant opaque granules. Chlorite is a common interstitial replacement mineral and also occurs as patches which may represent small (100 microns) altered phenocrysts. Irregularly shaped patches of dolomite are common in the basalt. The alteration products and the presences of carbonate make the basaltic phase unsuitable for dating.

3142-3151 m

These chips are predominantly fine grained, plagioclase-rich basalt. Plagioclase laths, generally less than 100 microns in length and small pyroxene grains up to 40 microns in size are set in a feldspathic matrix. Chlorite is common throughout the rock and perhaps also as a replacement of phenocrysts. Small opaque Fe oxide granules are common.

Calcite occurs both as veins and associated with chlorite as a phenocryst replacement.

The sample is too altered to be used for dating.

3.4 Bulk Magnetic Susceptibility

The bulk susceptibility of the three samples between 3034 and 3151 m are given in Table 1.

TABLE 1: BULK MAGNETIC SUSCEPTIBILITY

Sample	Bulk Magnetic Susceptibility (S.I. Units)
3034-3043 m	700×10^{-5}
3061-3070 m	1200×10^{-5}
3142-3151 m	2000×10^{-5}

3.5 Geochronology

The K and Ar analyses and calculated K-Ar age for biotite from 2612-2621 m are given in Table 2. The age of 23.8 Ma falls on the Oligocene-Miocene boundary and was reported by telex on 16 August 1985.

TABLE 2: POTASSIUM-ARGON RESULTS

Sample	%K	$^{40}\text{Ar}^*$ ($\times 10^{-10}$ moles/g)	$^{40}\text{Ar}^*/^{40}\text{Ar}_{\text{Total}}$	Age [†]
Biotite	6.37	2.6508	0.823	23.8 \pm 0.2
2612-2621 m	6.38			

*Denotes radiogenic ^{40}Ar .

[†]Age in Ma with error limits given for the analytical uncertainty at one standard deviation.

Constants:

$$^{40}\text{K} = 0.01167 \text{ atom } \%$$

$$\beta = 4.962 \times 10^{-10} \text{ y}^{-1}$$

$$\epsilon = 0.581 \times 10^{-10} \text{ y}^{-1}$$

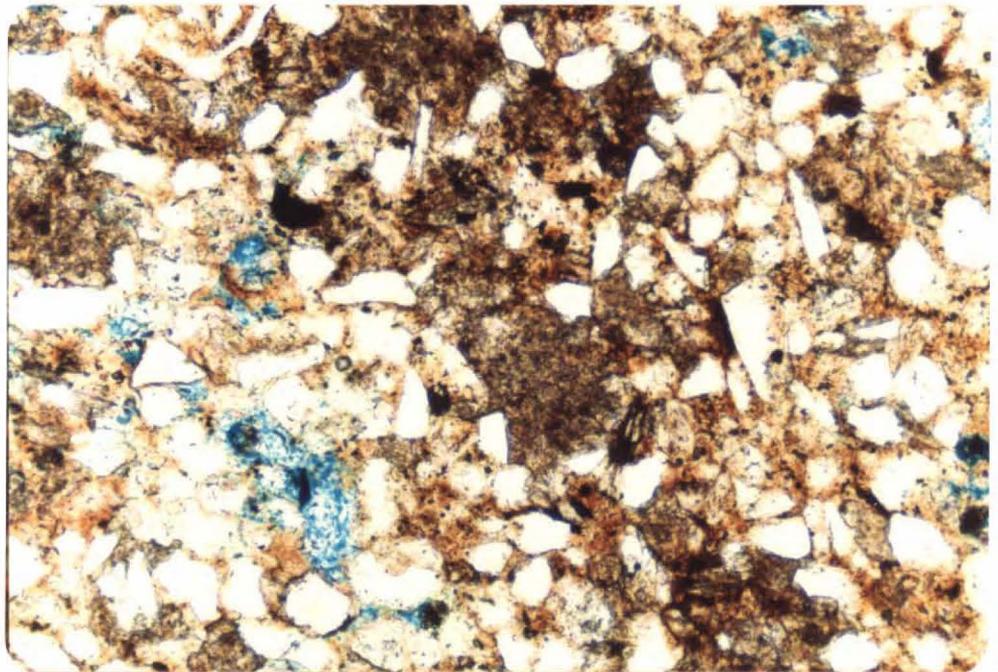


FIGURE 1a: 1845.7 m (6055.5 ft) Plane Polarised Light
Scale = 0.1 mm 

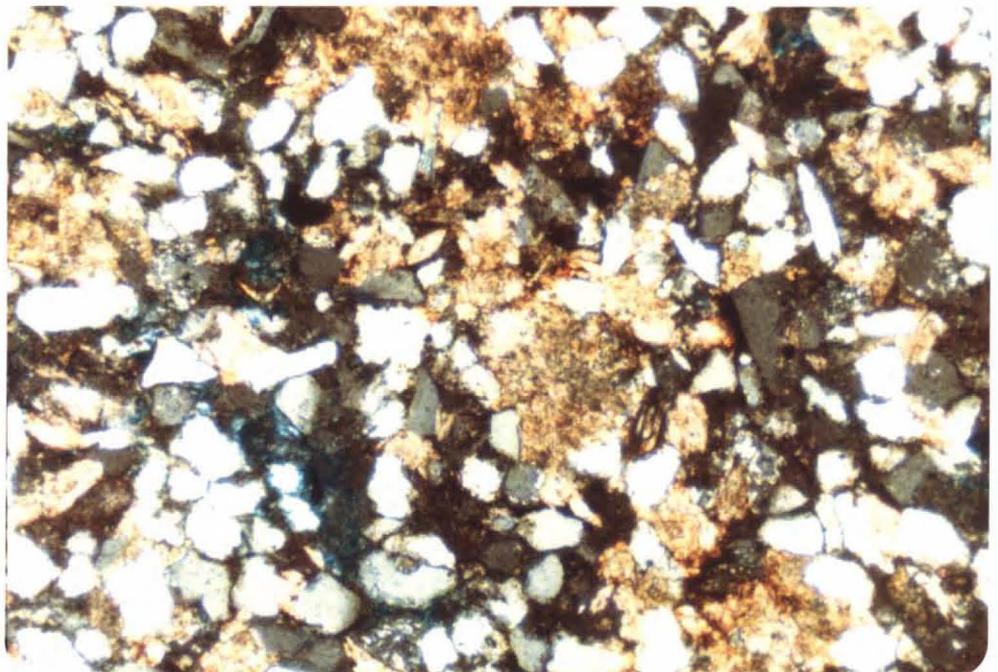
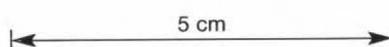


FIGURE 1b: 1845.7 m (6055.5 ft) Crossed Nicols

 5 cm

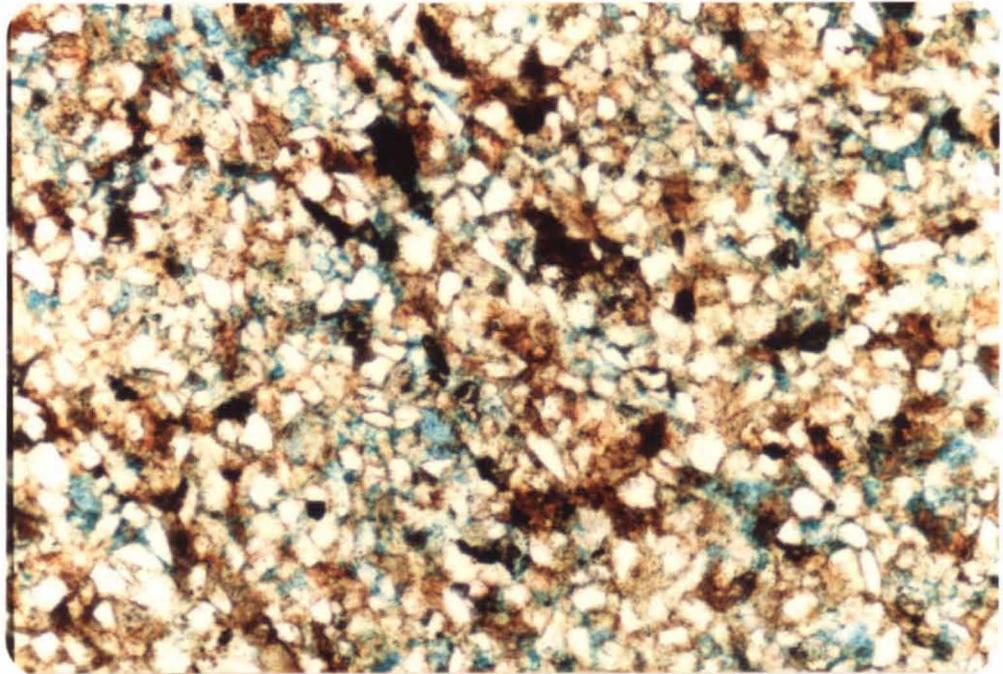
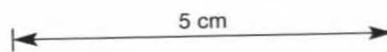


FIGURE 2: 1846.2 m (6057 ft)
Scale = 0.2 mm 

Plane Polarised Light



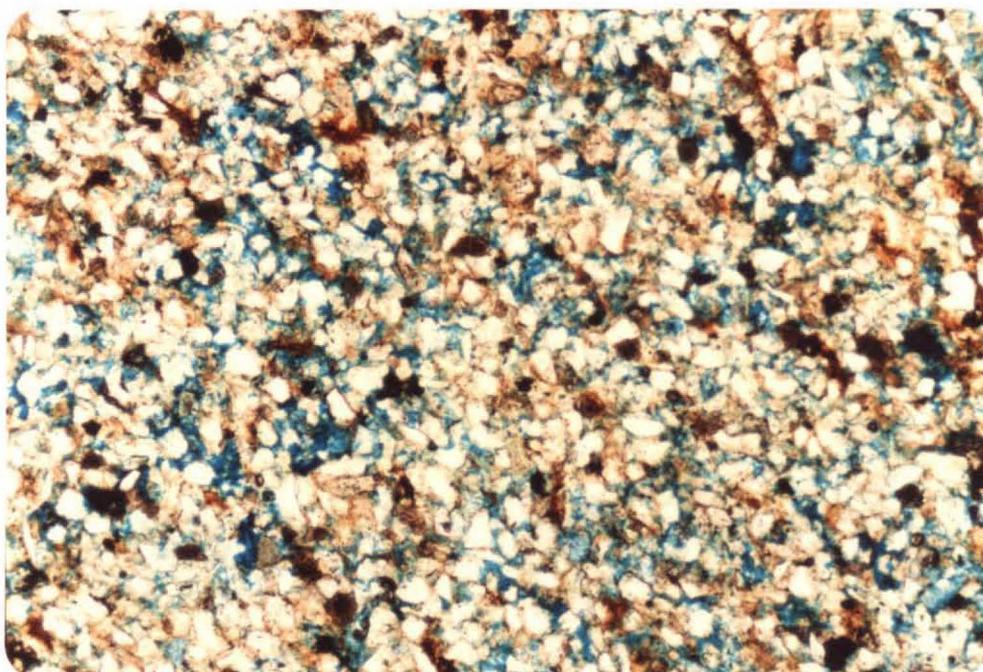
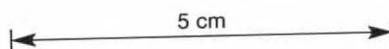


FIGURE 3: 1847.1 m (6060 ft)
Scale = 0.2 mm 

Plane Polarised Light



307013

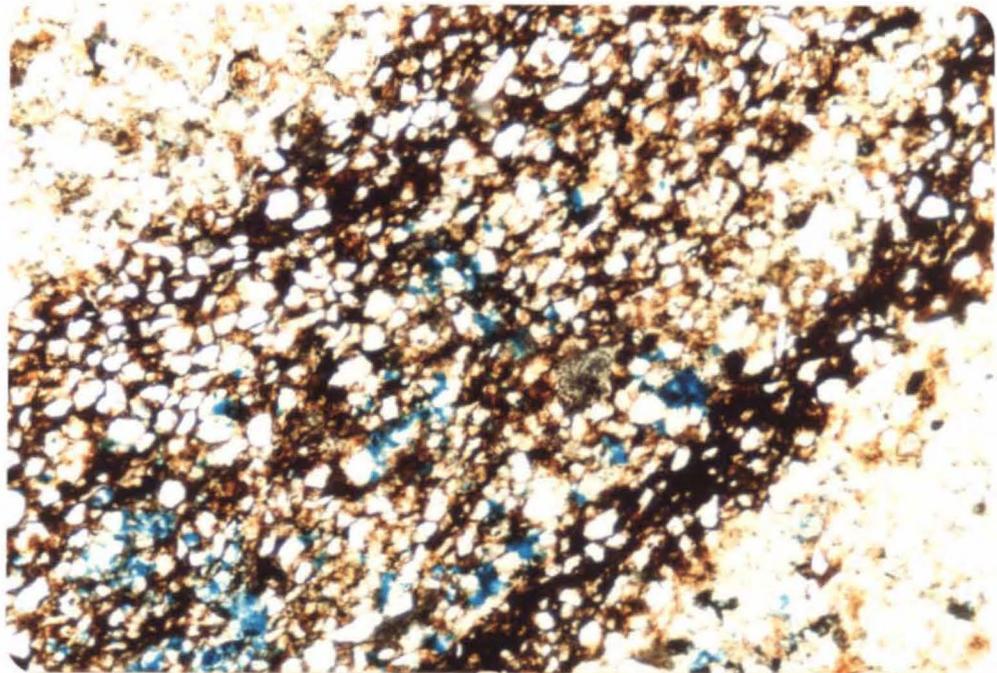


FIGURE 4: 1847.4 m (6061 ft)

Plane Polarised Light

Scale = 0.2 mm 

 5 cm

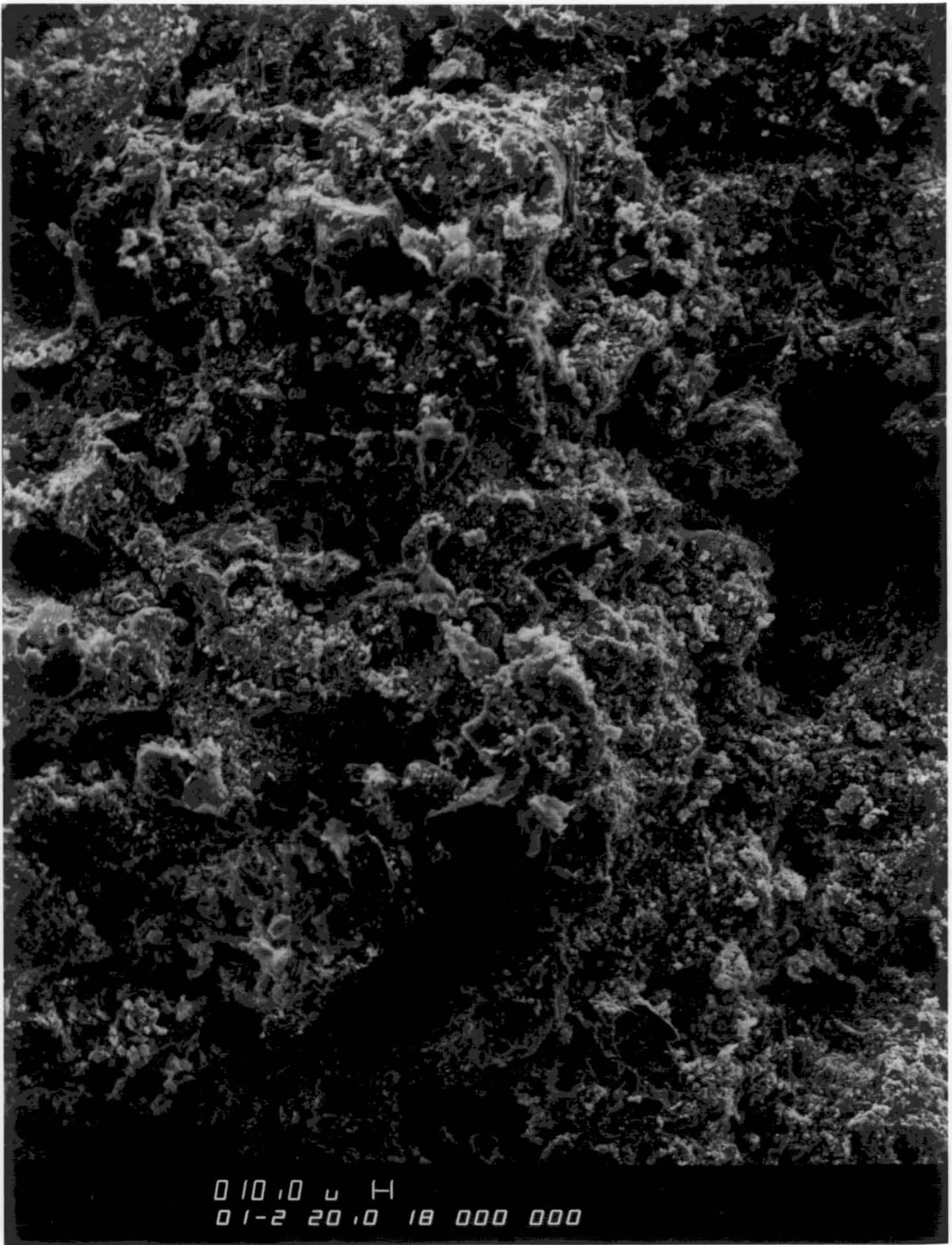


PLATE 1: 000 - 1845.7 m (6055.5 ft)
Low magnification shot showing a Typical
Field of View (TFOV). Note large and
small pore spaces between mineral grains.
Many pores are filled with clays.

307014

5 cm

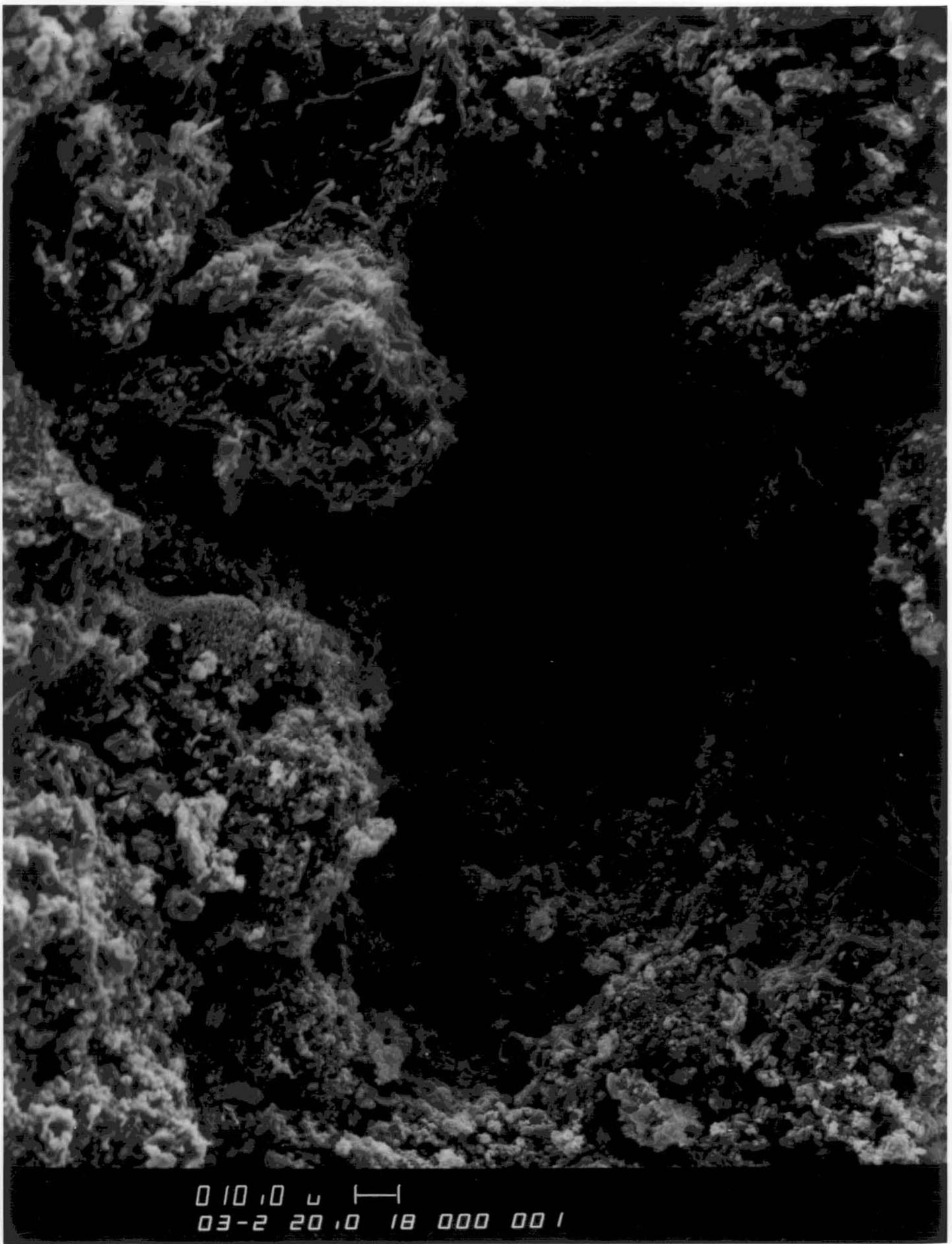


PLATE 2: 001 - 1845.7 m (6055.5 ft)
Close up of a large pore - it does not
appear to be interconnected in this
plate.

307015



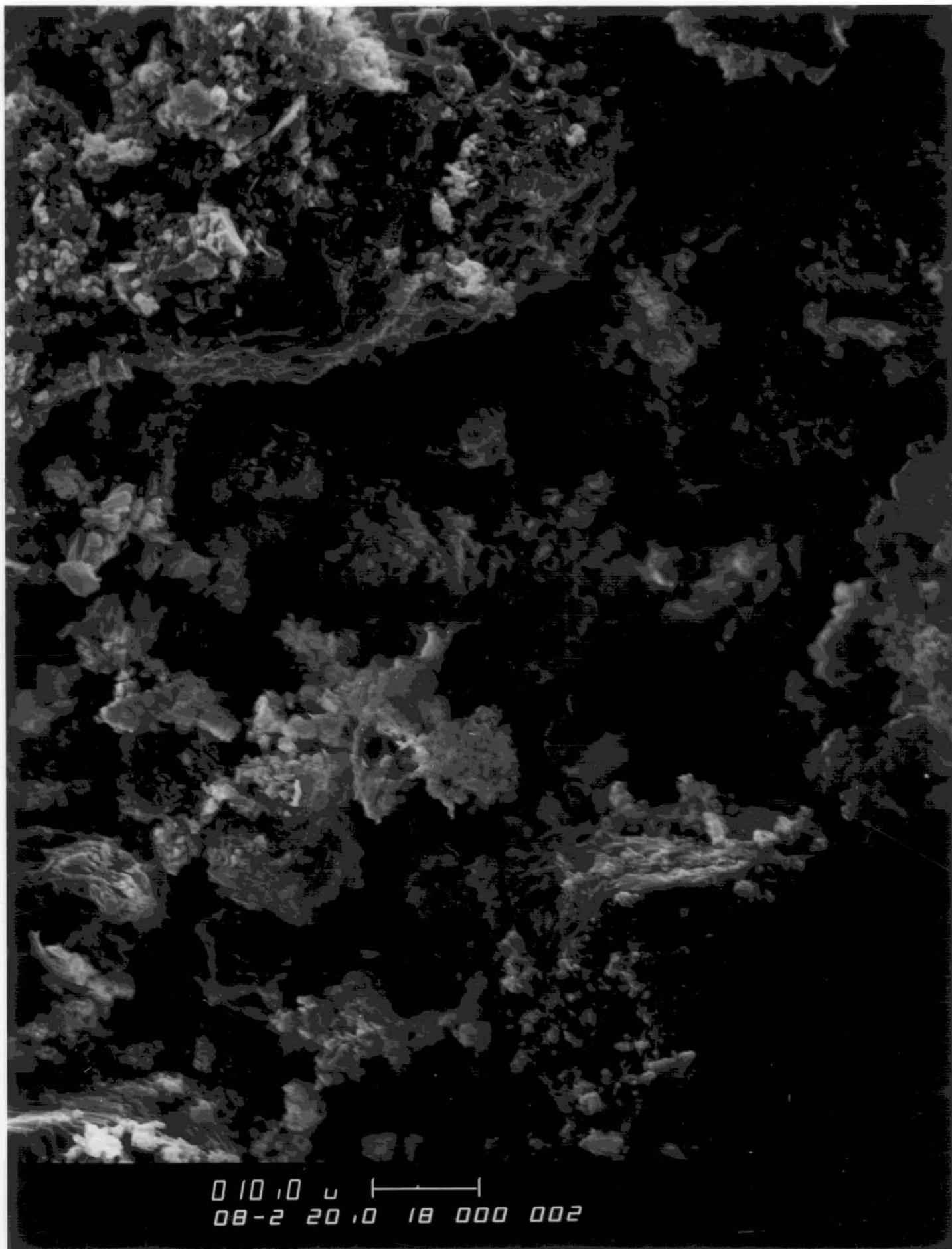


PLATE 3: 002 - 1845.7 m (6055.5 ft)
High magnification shot showing a small
pore space; notesiderite (block, bottom
right) and authigenic clays (kaolinite)
lining the pore space and coating the
smaller mineral grains.

307016

5 cm

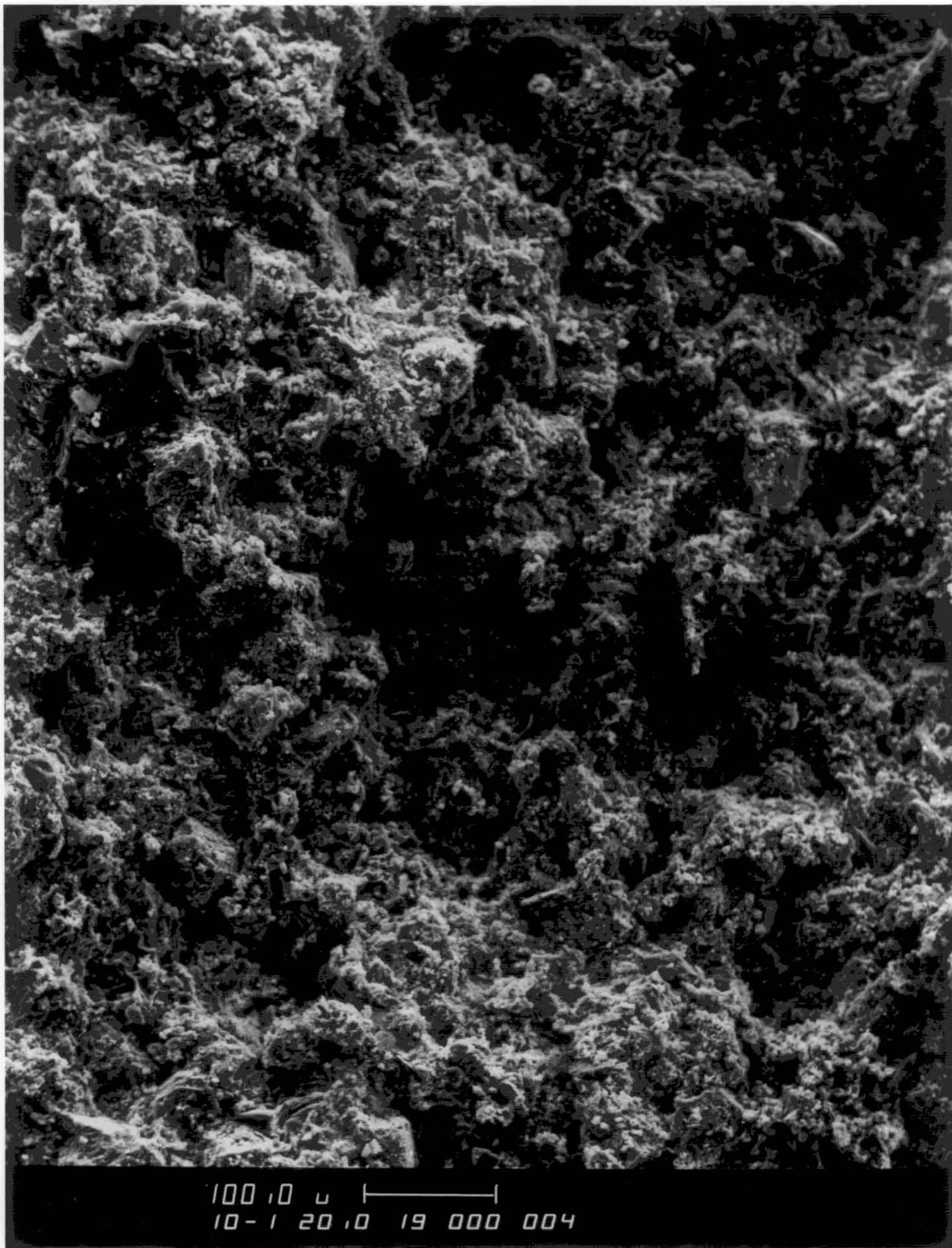


PLATE 4: 004 - 1846.8 m (6059 ft)
Low magnification TFOV - ?high porosity

5 cm

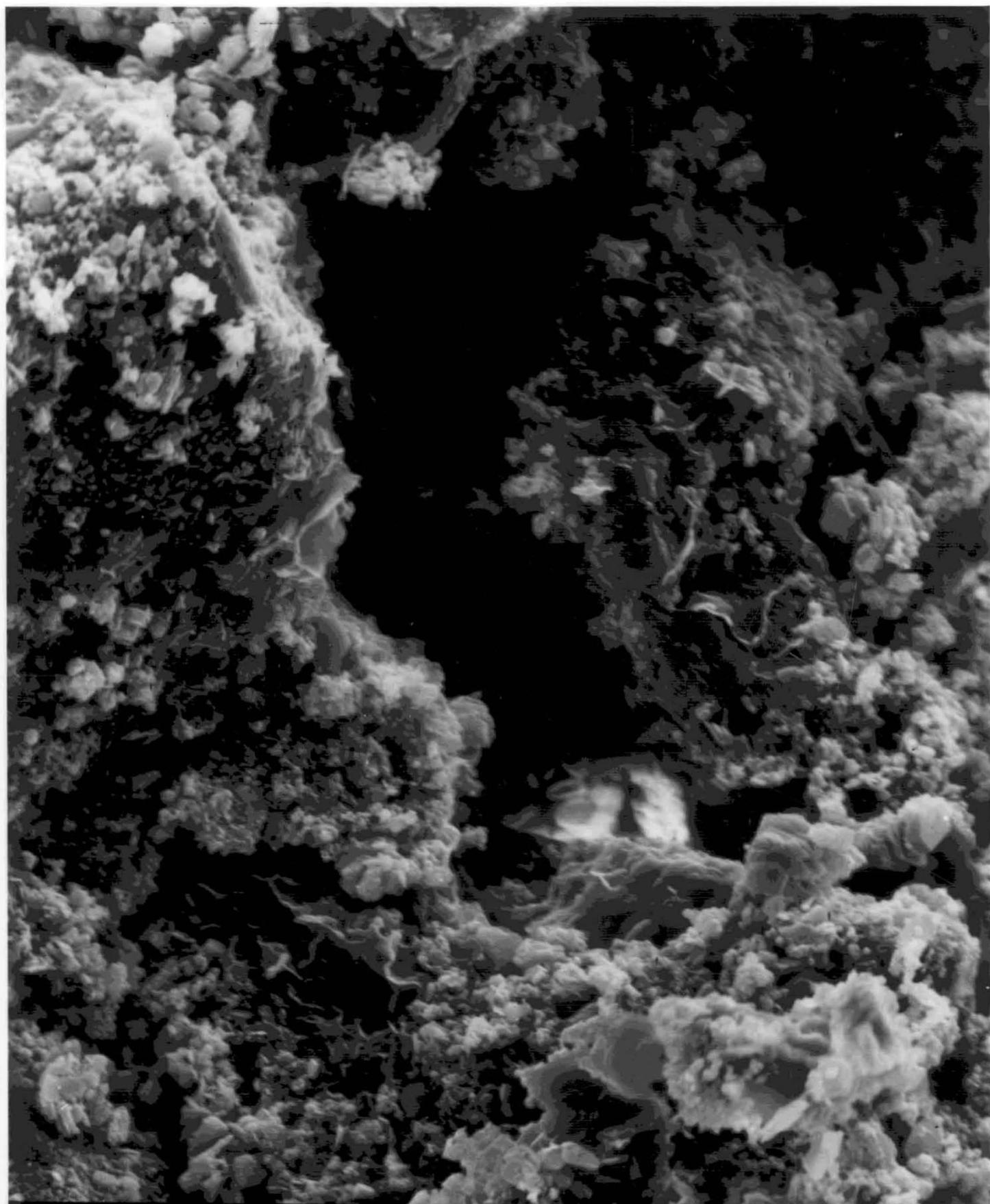
307017



PLATE 5: 005 - 1846.8 m (6059 ft)
Closer shot showing kaolinite lining
pore space (centre right). Note siderite
cementing quartz grain (top centre) and
minor authigenic quartz (to the right
of the siderite).

307018

5 cm



0 10 10 μ |—————|
10-2 20 10 19 000 006

PLATE 6: 006 - 1846.8 m (6059 ft)
High magnification shot of a pore space
(from Plate 5) lined with authigenic
kaolinite. Note minor ?chlorite (bottom
left).

←————— 5 cm —————→

307019

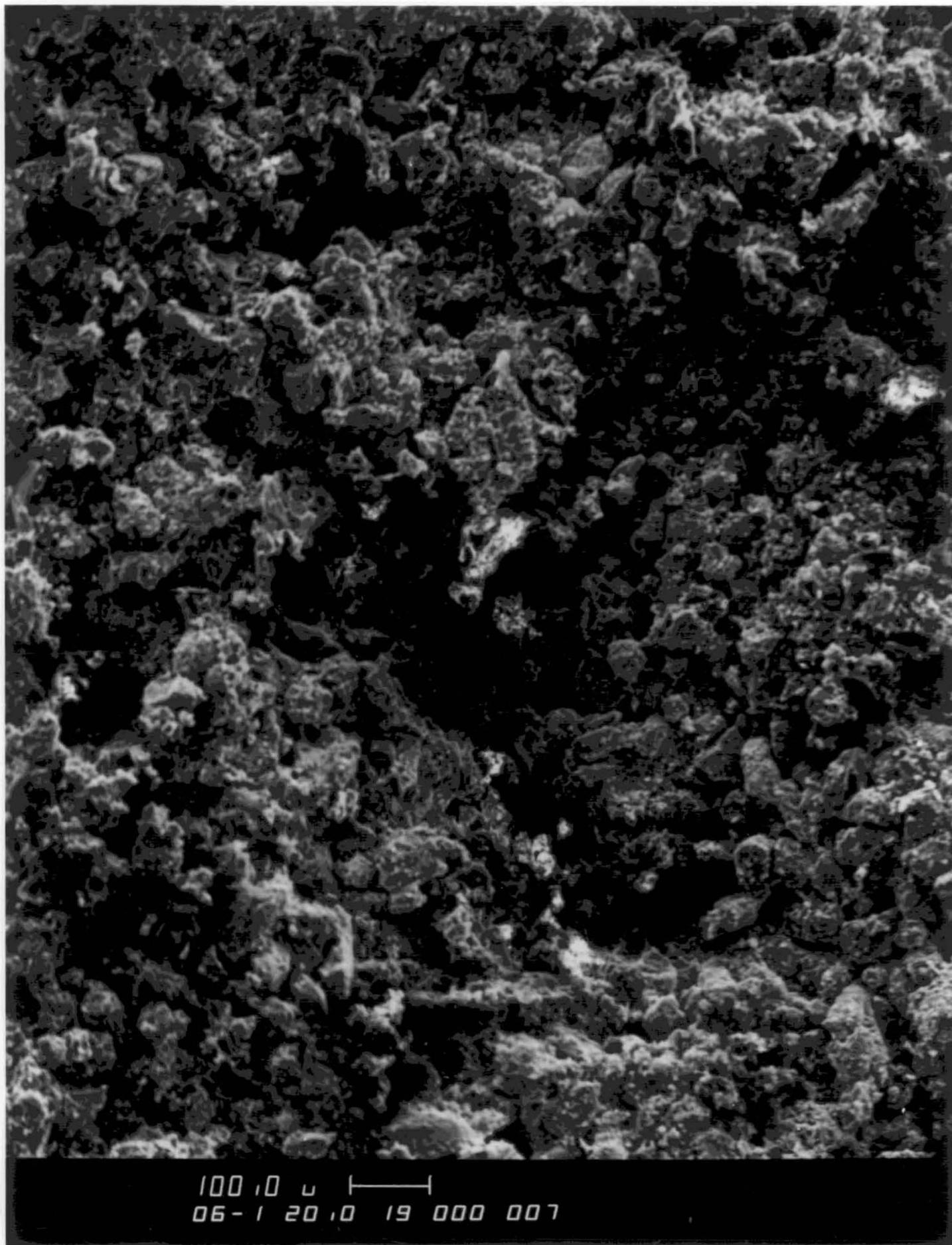


PLATE 7: 007 - 1847.1 m (6060 ft)
Low magnification TFOV. Note porosity
higher, siderite and clays much less
abundant than previous two samples.
Angularity of the quartz grains is
clear.

307020



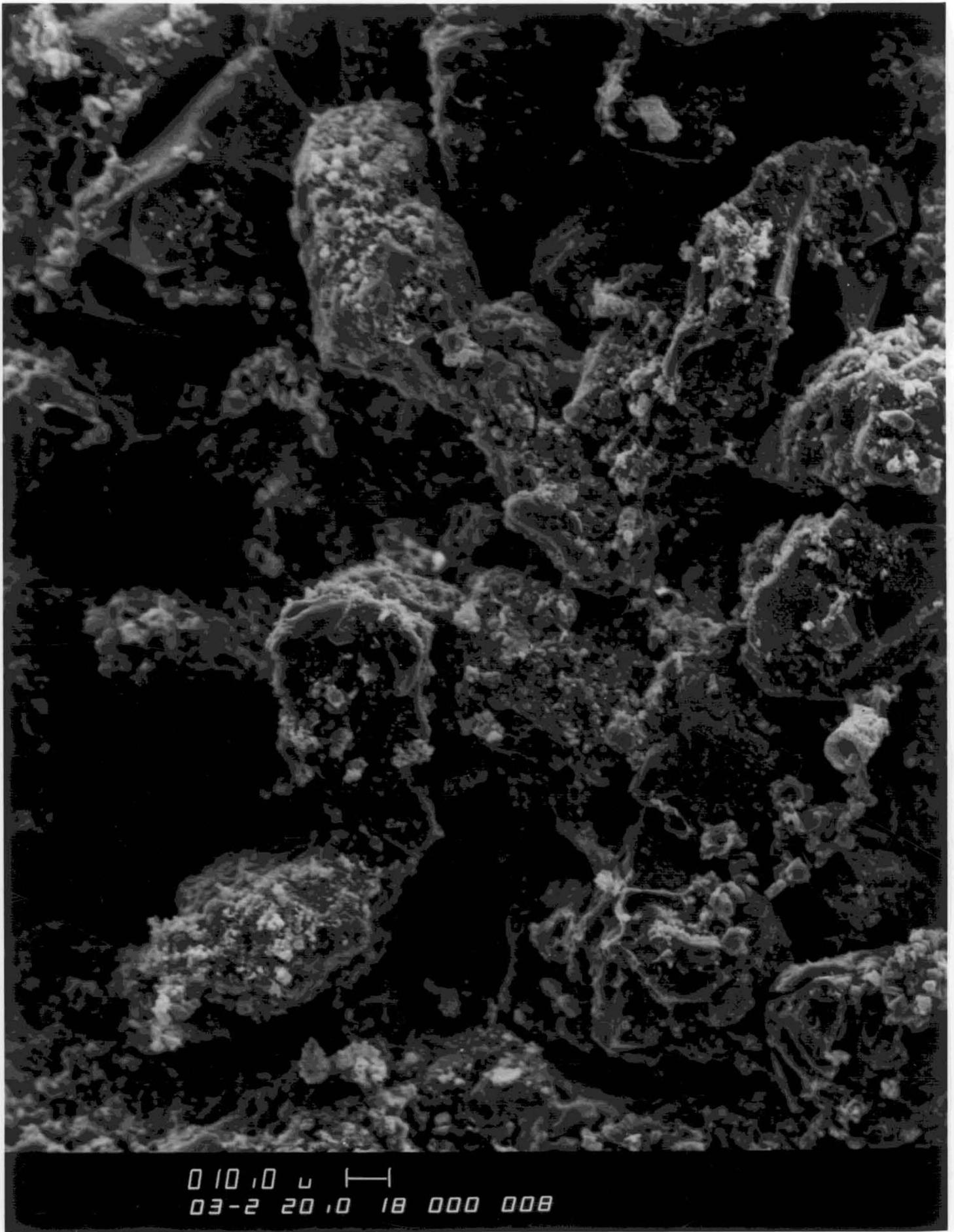
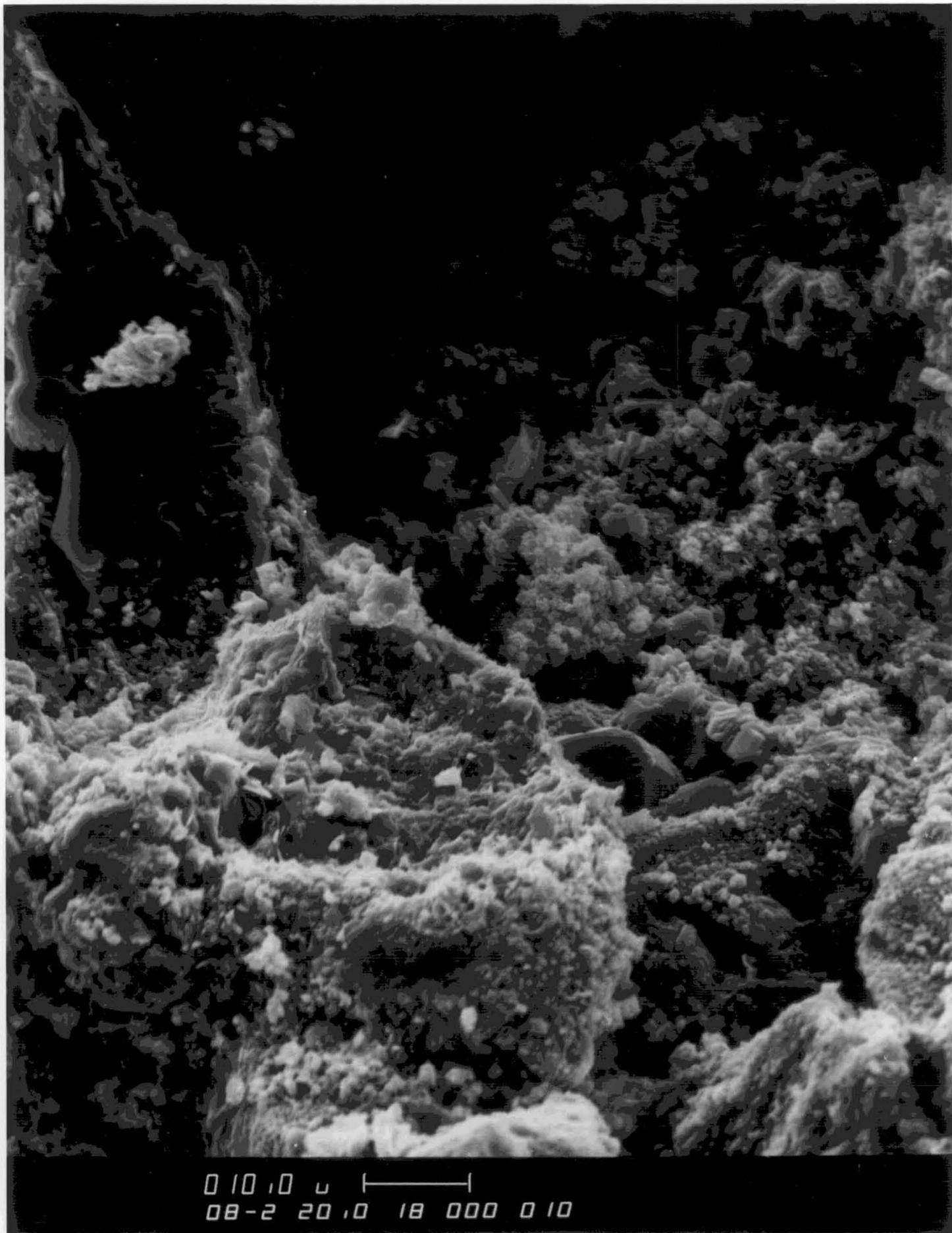


PLATE 8: 008 - 1847.1 m (6060 ft)
TFOV - some occurrences of minor quartz
overgrowths. Impression of better
interconnection between the pores.

307021





0 10 10 u |-----|
08-2 20 10 18 000 0 10

PLATE 9: 010 - 1847.1 m (6060 ft)
Typical clayey area. The plates show the
pervasive nature of fine-grained,
moderately well crystallised clays
which line much of the porosity.

←-----→ 5 cm

307022