EARLY METAL AGE POTTERY FROM FATU AKI ANIK KNUA, TIMOR-LESTE AND THE APPEARANCE OF CERAMICS IN THE WALLACEAN ISLANDS

SUPPLEMENTARY FILE 5: FAAK THIN SECTIONS CATALOGUE

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This catalogue presents a record of the preliminary petrographic analysis of 21 thin section samples from the Faak Cave and Faak Open Site. It also includes an unpublished report by Dickinson (2011) that has been referred to in the main text: Summary Petrographic Evaluation of Temper Sands in Protohistoric Sherds from East Timor.

The visual qualitative assessment of the thin sections aimed to identify the range of fabric types based on inclusions and to establish groups and characteristics as appropriate. It also aimed to test the presence of applied surface color layers. With reference to the descriptive methodology provided by Quinn (2013:80), standardized terminology outlined by Josephs (2005) and description evaluation reference charts, the following details were recorded and assessed:

- photomicrographs—in Plane Polarizing Light (PPL) and Crossed Polarizing Light (XPL), views of specific area or features of the sample
- sorted—very poorly, poorly, moderate, well, very well
- density—very few <5%, few 5–15%, frequent 15–30%, common 30–50%, dominant 50–70%, very dominant >70%
- angularity—round, subrounded, subangular, angular
- inclusions—possible inclusion type: calcareous, limestone, polycrystalline quartz, plagioclase, sedimentary rock fragment, volcanic rock fragment, clay pellet, iron oxides, ferruginous nodules, etc.
  – other descriptions as appropriate: unknown inclusions, changes in appearance from PPL to XPL, colors, shape, etc.
- matrix—color, consistency, density, naturally occurring inclusions
- voids—channels, planer, vughs, rents, tears
- observations—bimodal/unimodal distribution, remarks on distinctive features, overall appearance.

Thin sections were observed using an Olympus CX31 polarizing microscope. Photomicrographs were imaged with an Olympus CS30 3MP color camera and processed using Olympus Stream V1.9.1 imaging software.

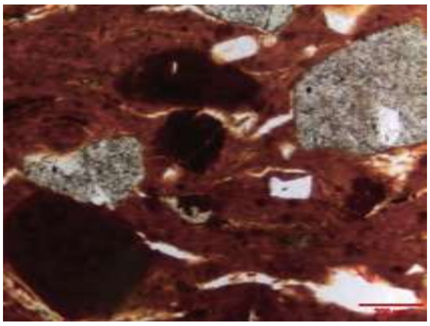
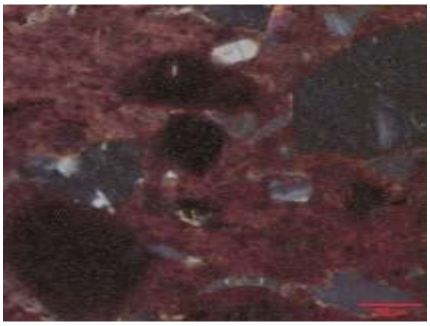
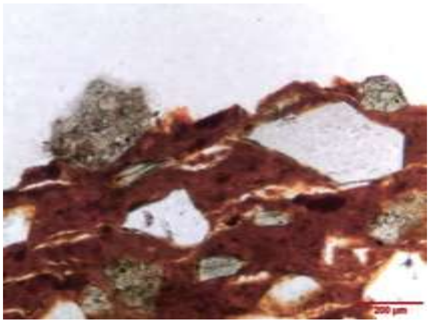
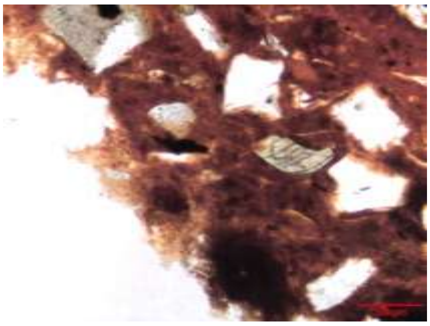
REFERENCES

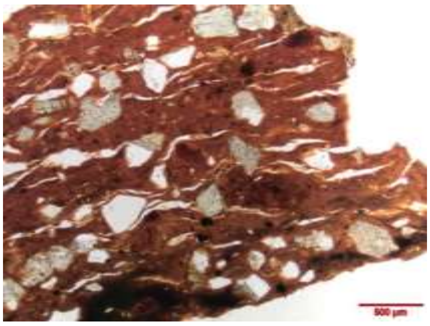
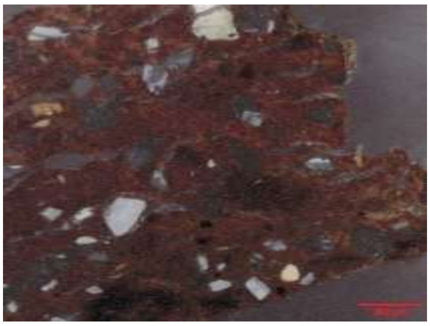
Dickinson, W.R. 2011. Summary Petrographic Evaluation of Temper Sands in Protohistoric Sherds from East Timor. *Petrographic Report WRD-295*.

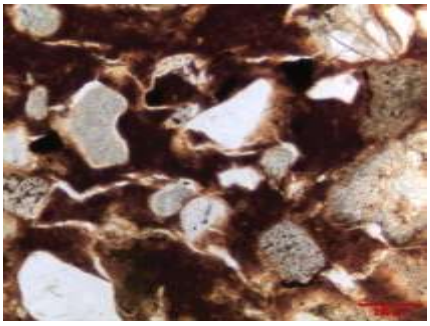
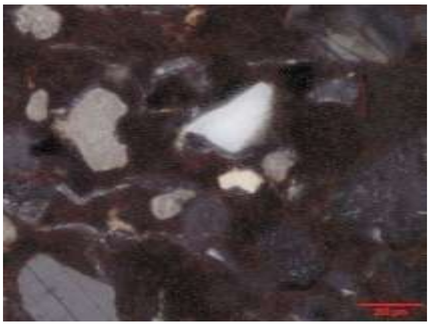
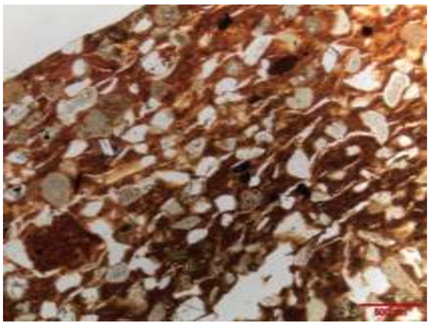
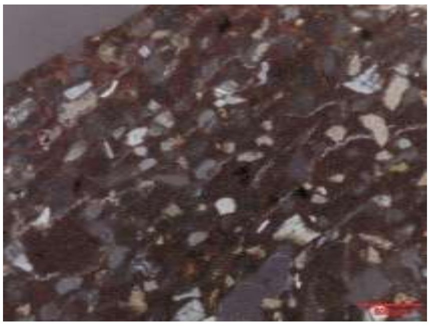
Josephs, R.L. 2005. Short contribution: Applying micromorphological terminology to ceramic petrography. *Geoarchaeology: An International Journal* 20(8):861–865.

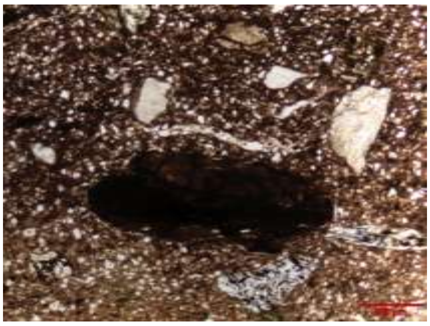
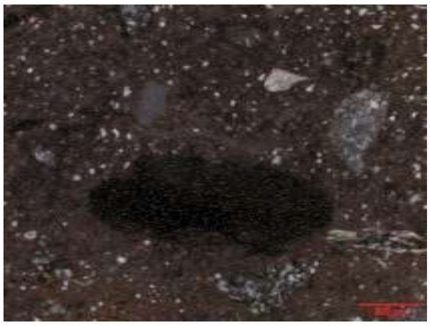
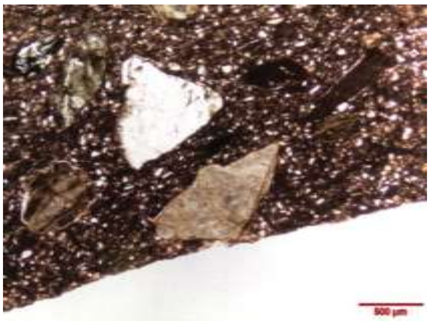
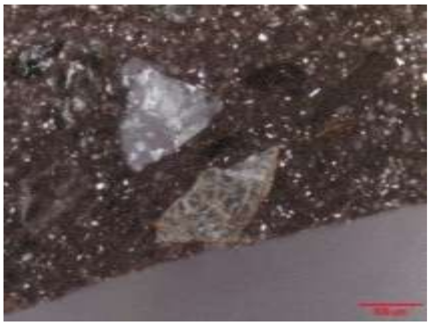
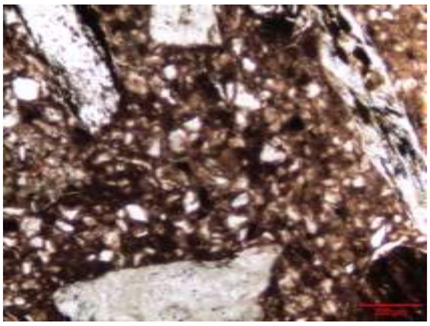
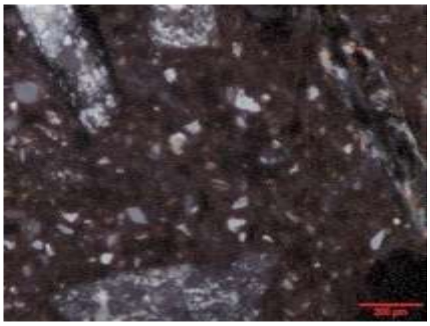
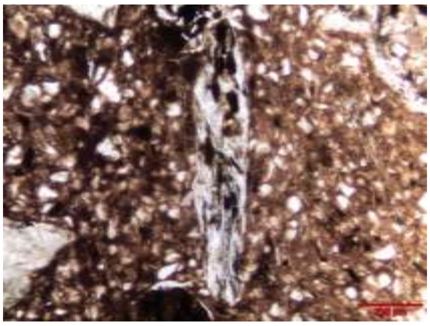
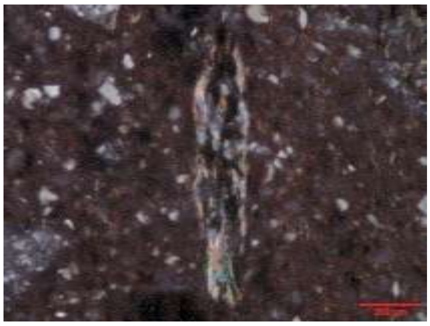
Quinn, P.S. 2013. *Ceramic Petrography: The Interpretation of Archaeological Pottery and Related Artefacts in this Section*. Oxford: Archaeopress.

<u>Faak Cave</u>

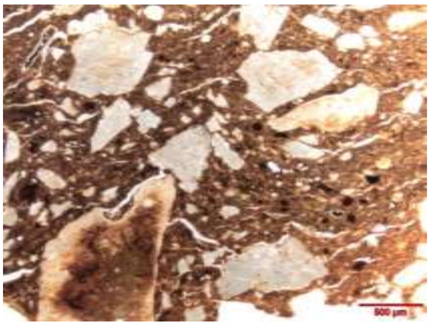
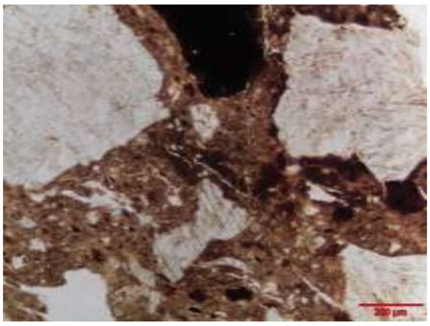
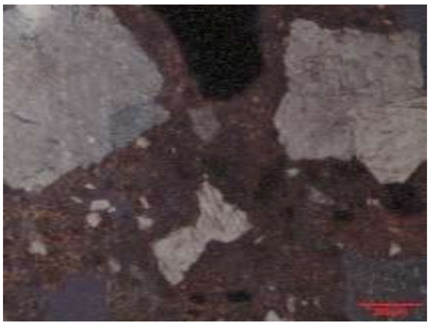
References	Shard	Thin Section Slide
<u>Slide 1 Sample A</u> **SQC-S4-A** **Cave** **Square C Spit 4** **Surface color**		
	Plane Polarizing Light - PPL	**Crossed Polarizing Light - XPL**
1-A-01		
1-A-02		
1-A-03		

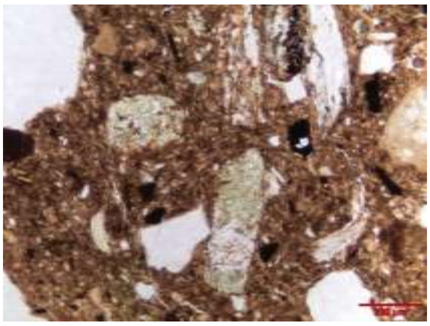
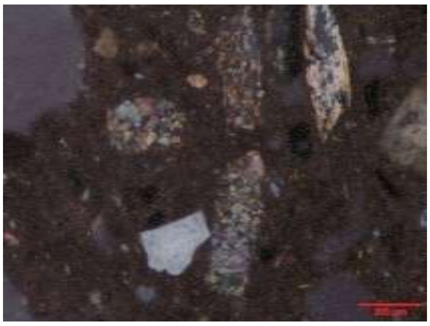
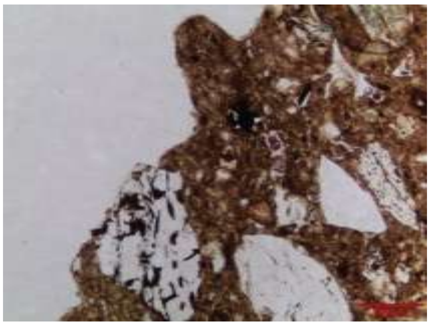
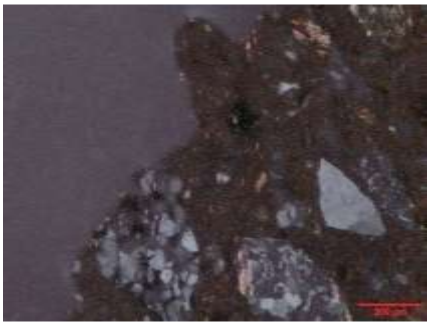
1-A-04		
Sorted	very poorly	
Density/ Angularity	large inclusions—frequent 20%; angular–subangular small inclusions—few 5%; subrounded	
Inclusions	plagioclase; white-ivory, large, angular, twinning volcanic-granitic rock fragments; gray mottled/speckled few diffuse plastic inclusions	
Matrix	red-brown, dense, consistent and dominates fabric (50%)	
Voids	Elongated, narrow channels running parallel to edges/surfaces.	
Observations	Few inclusions tending to unimodal. Apparent surface color (SC) as seen by naked eye but no discernible applied SC layer in thin section. Surface appears rough, torn possibly indicating SC damage/loss during section cutting/preparation. Veins of black on lower surface. Probably burnt carbon. Clay pellets, brown-red rounded lumps.	

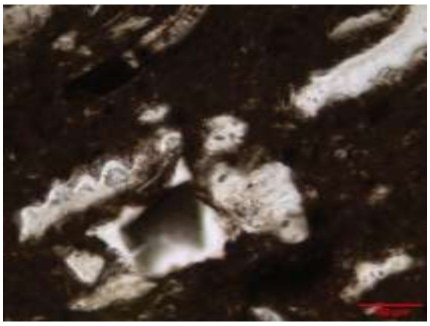
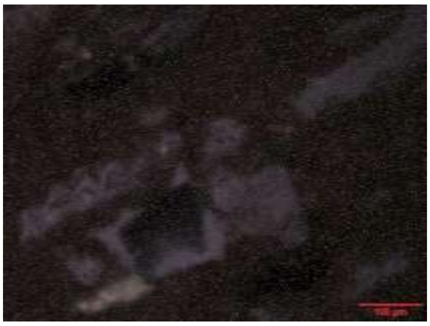
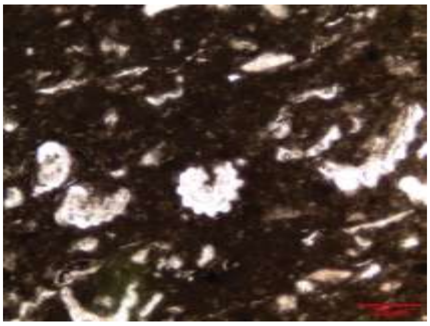
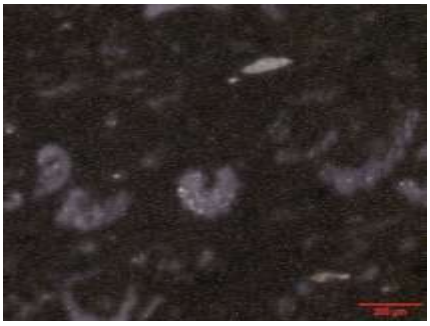
<u>Slide 1 Sample B</u> **SQC-S5-B** **Cave** **Square C Spit 5** **Surface color**		
1-B-01		
1-B-02		
Sorted	moderate	
Density/ Angularity	large inclusions—common 30%; subrounded medium inclusions—common 40%; angular	
Inclusions	calcareous; color change gray to tan at XPL (1-B-01), some approaching crescent shapes plagioclase volcanic-granitic rock fragments clay pellets	
Matrix	brown to red color change, densely packed	
Voids	Snaking, elongated channels and planer voids abundant.	
Observations	Abundant bimodal inclusions No sense of clear surface layer. Deep band and change of color across half of the section, likely firing outcome/oxidization. May account for apparent SC.	

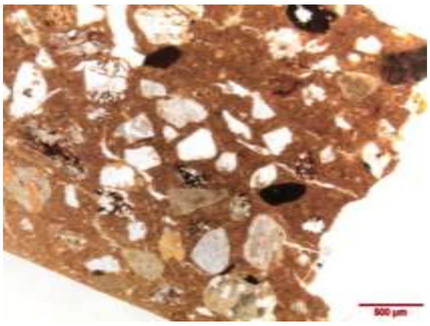
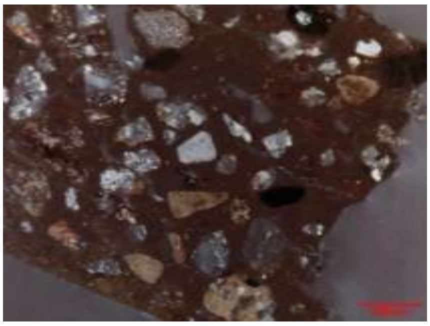
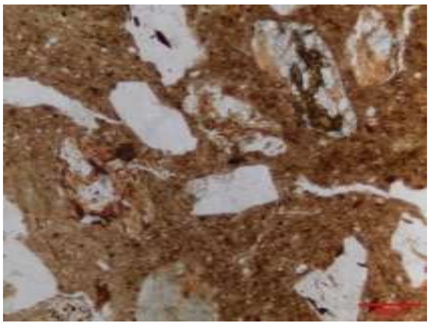
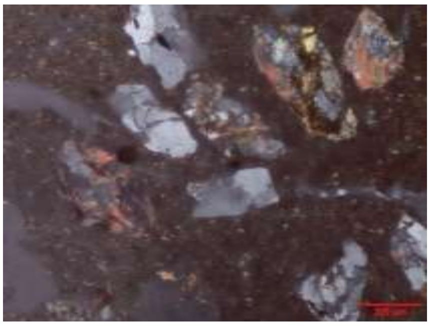
<u>Slide 2 Sample A</u> **SQC-S1-A** **Cave** **Square C Spit 1** **Body**		
2-A-01		
2-A-02		
2-A-03		
2-A-04		
Sorted	very poorly	
Density/ Angularity	large inclusions—frequent 20% and various; angular–subrounded small inclusions—dominant 60%; subangular	

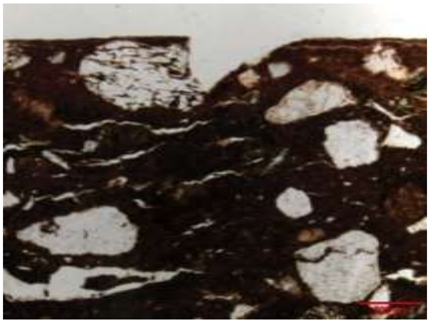
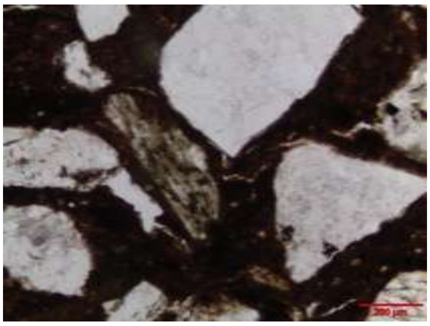
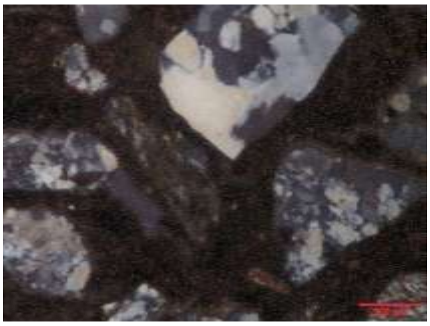
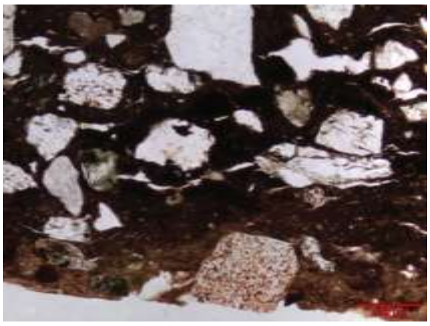
Inclusions	dominant small, white and angular inclusions throughout matrix polycrystalline quartz; mottled white to black plates at XPL argillaceous clay pellets (2-A-01)
Matrix	brown-gray heterogeneity, closed and densely packed with small white grains (naturally occurring in clay?)
Voids	Very few, small and elongated.
Observations	Strong bimodal distribution. One surface exhibiting lighter layer, probably firing outcome. Dense with small and notable variety of larger inclusions.

<u>Slide 2 Sample B</u> **SQC-S5-B** **Cave** **Square C Spit 5** **Body**		
2-B-01		
2-B-02		
Sorted	very poorly	
Density/ Angularity	large inclusions—frequent 30%; angular medium–small inclusions—frequent 20%; subangular–subrounded	
Inclusions	limeclast calcareous type; large white-gray plates, parallel striations, un-changed at XPL red-brown, irregular, unchanged at XPL	
Matrix	brown, fine, closed and consistent; moderate number of small grains	
Voids	Moderate number of medium elongated channels and voids running mostly parallel to surfaces.	
Observations	Bimodal distribution. Large white speckled appearance.	

<u>Slide 2 Sample C</u> **SQC-S5-C** **Cave** **Square C Spit 5** **Body**		
2-C-01		
2-C-02		
Sorted	moderately	
Density/ Angularity	large inclusions—frequent 30% and various; angular–subrounded	
Inclusions	polycrystalline quartz platey surface white and yellowish, multicolored at XPL (2-C-01); metamorphosed quartz? iron oxides; dark brown, medium and angular	
Matrix	tight and even but changes in color indicative of uneven firing	
Voids	Generally lacking. Occasional but large voids where inclusion has been dislodged or dissolved.	
Observations	Unimodal distribution. Inclusions prominent, notable diversity by size, shape and apparent type.	

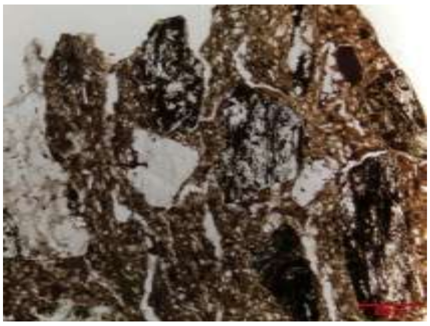
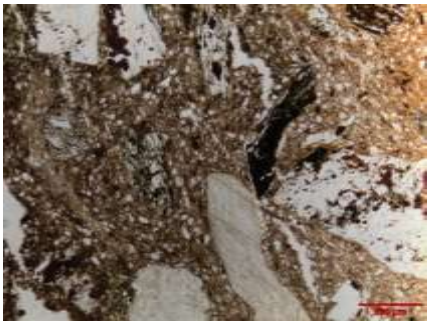
<u>Slide 3 Sample A</u> **SCF-S1-A** **Cave** **Square F Spit 1** **Surface color**		
3-A-01		
3-A-02		
3-A-03		
Sorted	moderately	
Density/ Angularity	large inclusions—frequent 15% medium–small inclusions—few 10%	
Inclusions	calcareous (forminiferal); probable limestone derivation other inclusions scarce	
Matrix	dark gray-brown, dense/consistent, changing in color brown-red	
Voids	Elongate, relatively broad void/rents and smaller crescent shape irregular pores, difficult to distinguish from inclusions. Resulting from dissolution of inclusions. Long very fine lines running parallel various points in body.	
Observations	Essential bimodal distribution of related inclusions. Fine surface line or layer, more apparent at XPL – possible SC (3-A-01). Perpendicular-45O lines (3) in fabric, one end. Most visible PPL. Likely saw/sectioning or polishing marks?	

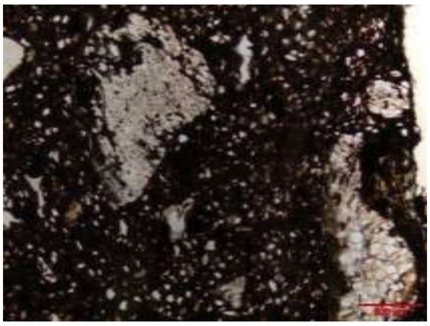
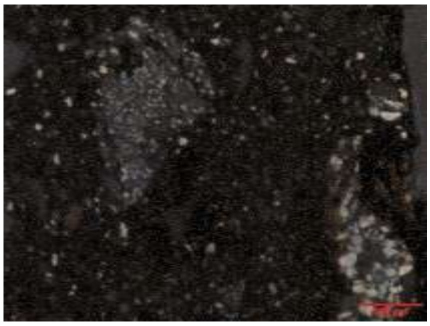
<u>Slide 3 Sample B</u> **SCF-S1-B** **Cave** **Square F Spit 1** **Surface color**		
3-B-01		
3-B-02		
Sorted	well	
Density/ Angularity	large–medium inclusions—common 40%; subangular–subrounded	
Inclusions	polycrystalline quartz platey, mottled surface, multicolored at XPL; metamorphosed quartz?	
Matrix	light-brown, dense, heavy and consistent; lacking in grains	
Voids	Some snaking channels, with occasional bigger, rounder voids where inclusion has been likely dislodged.	
Observations	Unimodal distribution, prominent and various larger inclusions. Absence of small inclusions. No apparent SC layer.	

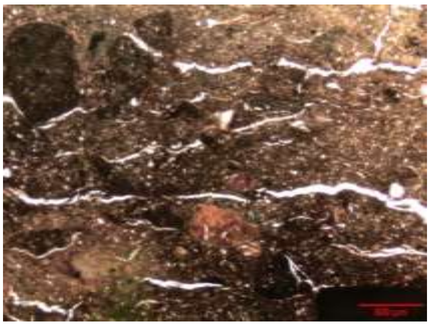
<u>Slide 3 Sample C</u> **SCF-S4-C** **Cave** **Square F Spit 4** **Surface color**		
3-C-01		
3-C-02		
3-C-03		
Sorted	moderately	
Density/ Angularity	Large–medium inclusions—common 40%; subangular–subrounded	
Inclusions	polycrystalline quartz plagioclase sedimentary rock fragment; shale? (3-C-03)	
Matrix	dark brown, dense and closed	
Voids	Snaking channels generally parallel to surfaces but throughout body.	
Observations	Unimodal distribution, prominent quartz inclusions. No clearly differentiated surface layer color at either edge. Fine channel running along surface that may indicate a laminating surface layer.	

<table>
<tr><td><u>Slide 4 Sample A</u>

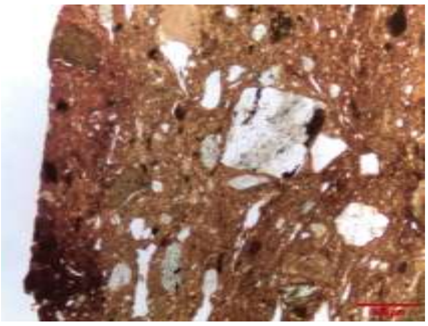
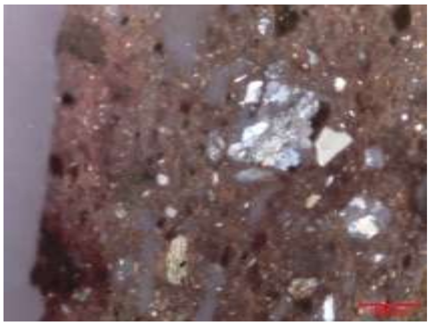
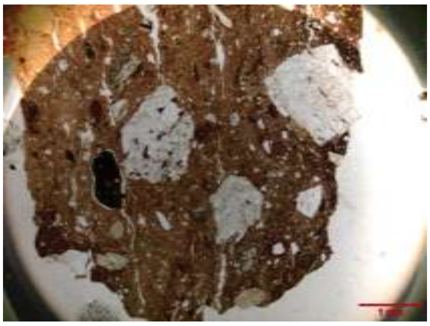
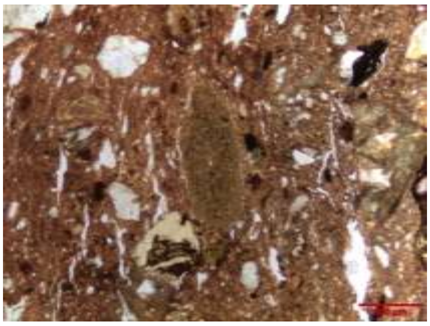
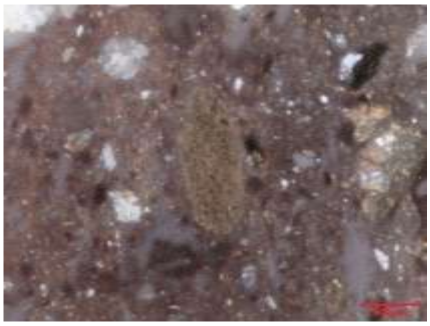
SCF-S1-A

Cave
Square F Spit 1
Body</td><td></td><td></td></tr>
<tr><td>4-A-01</td><td></td><td></td></tr>
<tr><td>4-A-02</td><td></td><td></td></tr>
<tr><td>Sorted</td><td colspan="2">very poorly</td></tr>
<tr><td>Density/
Angularity</td><td colspan="2">large inclusions—common 40%; angular
small inclusions—dominant 70%; angular</td></tr>
<tr><td>Inclusions</td><td colspan="2">polycrystalline quartz
sedimentary derived (4-A-02)?; light gray, with fine striations, unchanging at XPL; possible limestone clasts</td></tr>
<tr><td>Matrix</td><td colspan="2">dirty looking, and heavily packed with small fragments (likely to be naturally occurring in the clay); color varies from light brown to dull gray-brown</td></tr>
<tr><td>Voids</td><td colspan="2">Major channels, voids, rents, tears largely parallel to surface but also elsewhere.</td></tr>
<tr><td>Observations</td><td colspan="2">Bimodal distribution. A dominant dense bed of small grains with large inclusions throughout. Voids are a feature.</td></tr>
</table>

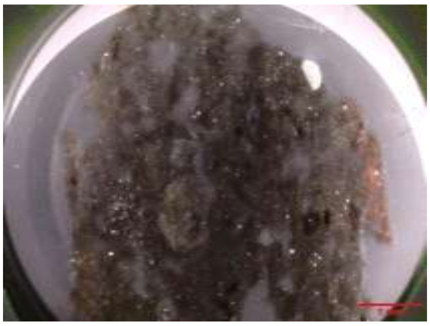
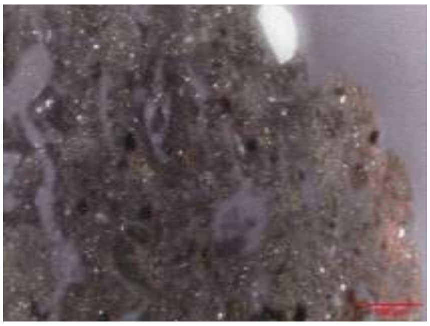
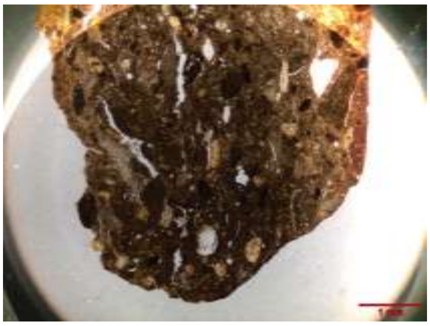
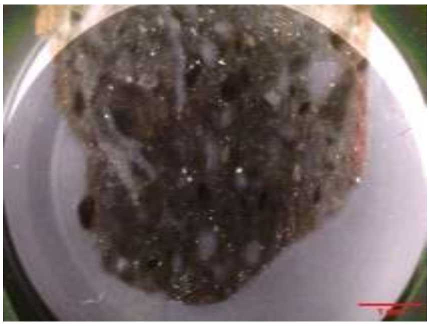
<u>Slide 4 Sample B</u> **SCF-S1-B** **Cave** **Square F Spit 1** **Body**		
4-B-01		
Sorted	poorly	
Density/ Angularity	large inclusions—frequent 20%; angular small inclusions—common 50%; subrounded	
Inclusions	polycrystalline quartz	
Matrix	dark, closed and packed with small grains (likely to be naturally occurring in clay)	
Voids	Largely absent. Few small snaking channels, occasional bigger elongate voids.	
Observations	Clear bimodal distribution. Dense fabric with small grains with some prominent large inclusions.	

<u>Slide 4 Sample C</u> **SCF-S4-C** **Cave** **Square F Spit 4** **Body**		
4-C-01		
Sorted	very poorly	
Density/ Angularity	large inclusions—frequent 20%; angular small inclusions—common 30%; subrounded	
Inclusions	rock fragments plastic inclusions (red clay pellets) (no apparent quartz)	
Matrix	irregular and open, dirty looking matrix which may contain organic matter fine grains occurring naturally in clay	
Voids	Rents, voids, elongate tears of varying size and direction (although mostly parallel to surface) are common.	
Observations	Voids are a distinguishing feature. Varying small inclusions and few large inclusions but also of various types. Many inclusions difficult to discern in dirty looking matrix. Irregular, heterogeneous and jumbled appearance overall.	

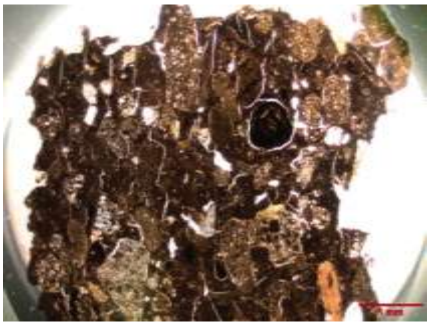
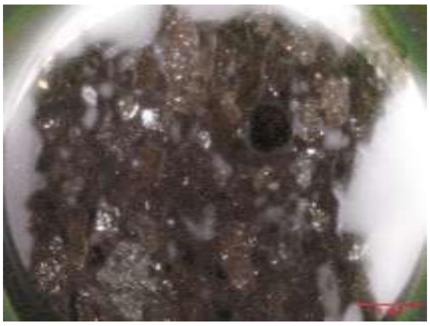
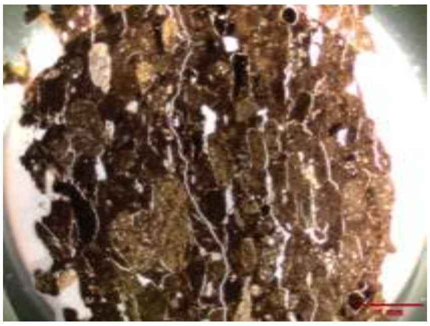
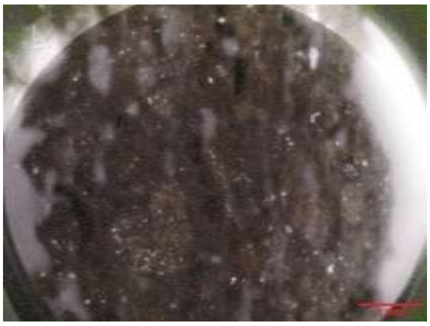
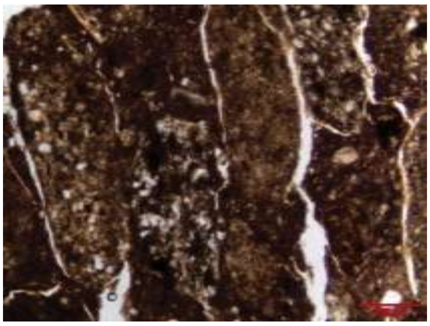
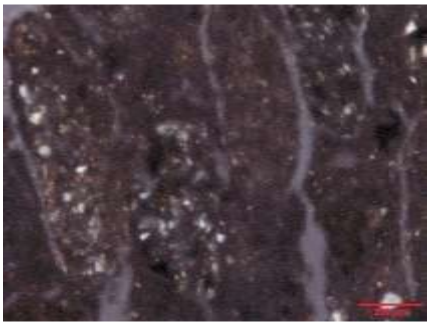
<u>Faak Open Site</u>

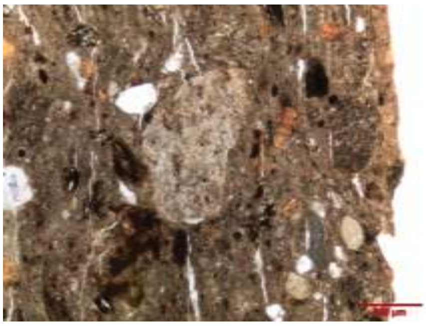
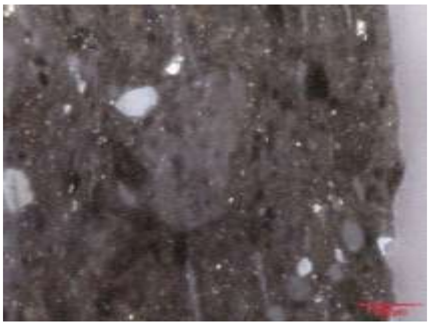
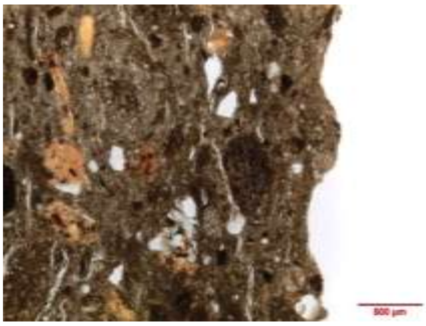
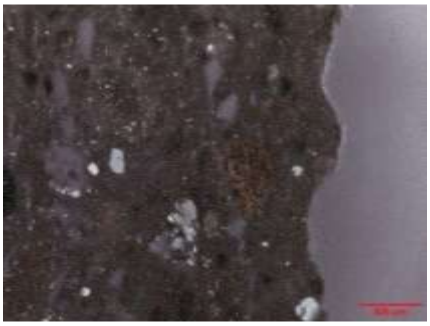
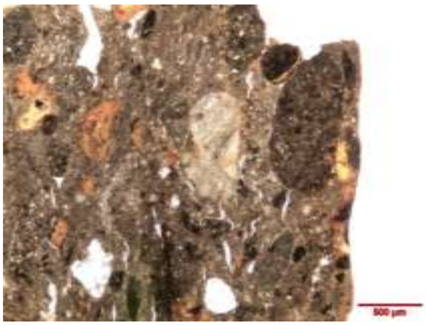
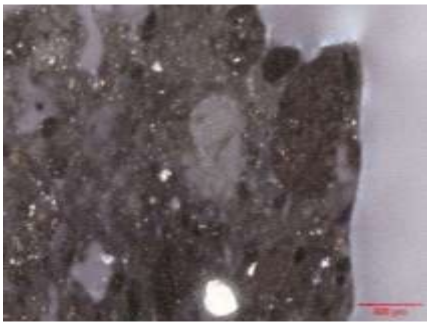
References	Shard	Thin Section Slide
<u>Slide 5 Sample A</u> **SH-S2-A** **Open Site** **Spit 2** **Surface color**		
	Plane Polarizing Light - PPL	**Crossed Polarizing Light - XPL**
5-A-01		
5-A-02		
5-A-03		
Sorted	very poorly	
Density/ Angularity	large inclusions—few 10%; angular–subrounded small inclusions—frequent 15%; angular–subrounded	

Inclusions	polycrystalline quartz beige isotropic grains anistropic rounded inclusion; possible altered mineral (5-A-03) dark brown, irregular, unchanged at XPL; possible organic (5-A-02)
Matrix	open in places with dirt-like appearance and tiny spot particles; few small inclusions appear as separate to clay generally
Voids	Abundant voids around large inclusions and elsewhere indicating where matrix has shrunk during drying, firing. Snaking channels and wider voids mostly parallel to surface edges but some more perpendicular.
Observations	Relatively wide red color band at one surface, probable thick SC layer. Diverse large inclusions but not densely concentrated. Fewer small inclusions. Strongly bimodal distribution.

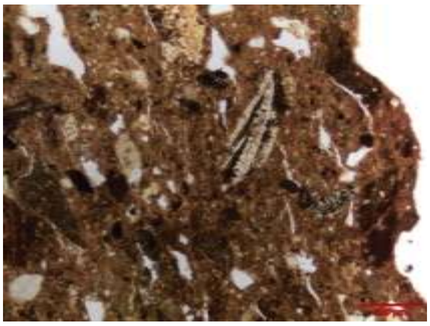
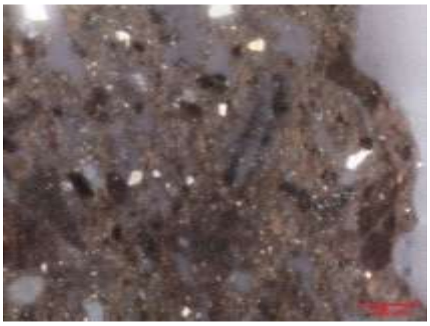
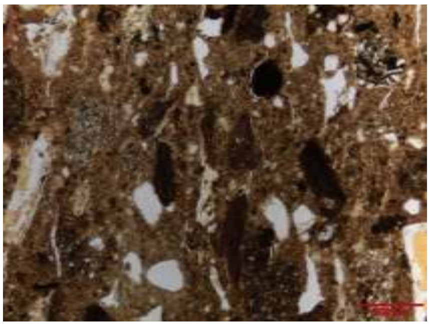
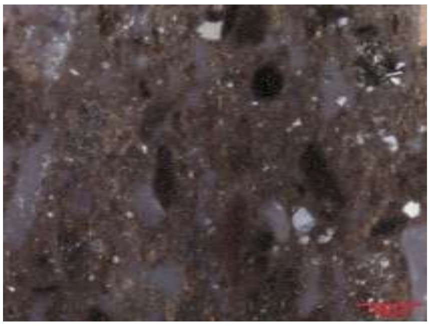
<u>Slide 5 Sample B</u> **SH-S2-B** **Open Site** **Spit 2** **Surface color**		
5-B-01		
5-B-02		
5-B-03		
Sorted	very poorly	
Density/ Angularity	large inclusions—frequent 25%; subrounded–rounded small inclusions—few 5%; angular–subangular	
Inclusions	large rock fragments (with visible inclusions) large beige sub-rounded, no change at XPL (5-B-01) prominent white pearly, lucent, subrounded, bright at XPL (5-B-02) (no quartz)	

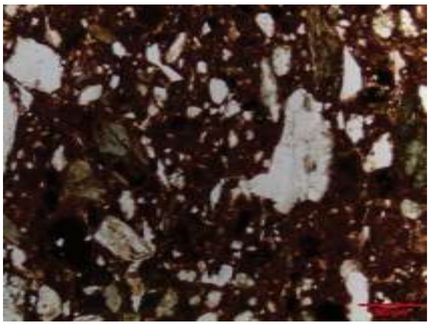
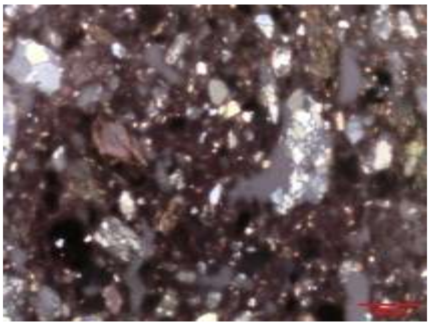
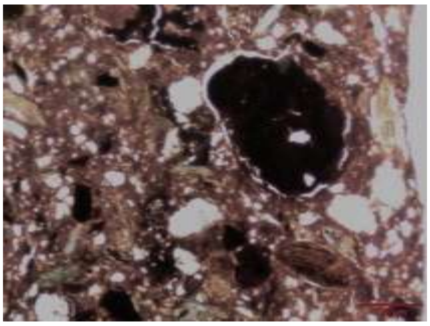
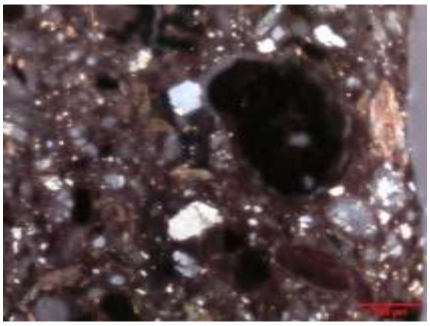
Matrix	Dirty looking, inconsistent matrix.
Voids	Numerous snaking channels of varying width, largely parallel to surfaces. Voids around many inclusions where matrix has apparently shrunk.
Observations	Bimodal distribution. SC layer but discontinuous at one surface in all micrographs (possibly torn when sectioned). Various large inclusions, some hard to differentiate from matrix, fewer small inclusions.

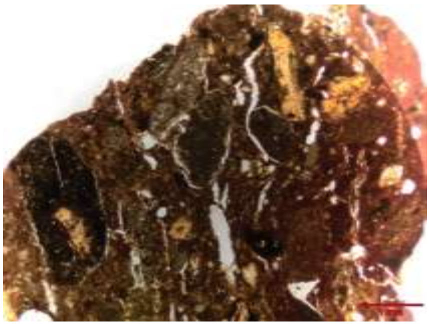
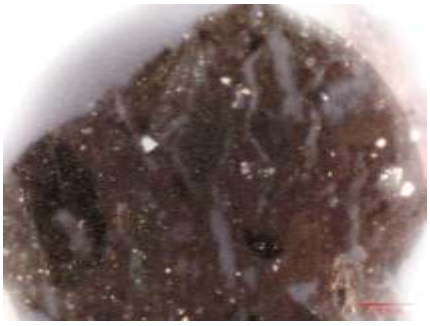
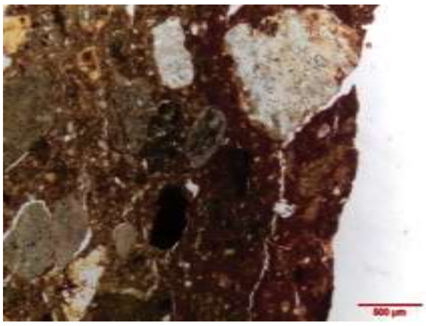
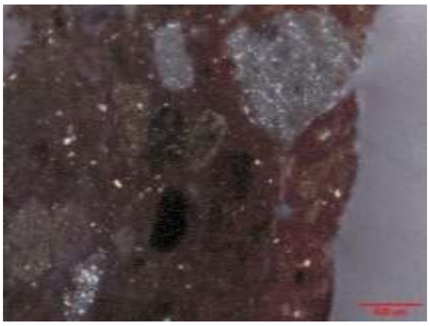
<u>Slide 6 Sample A</u> **SH-S2-A** **Open Site** **Spit 2** **Body**		
6-A-01		
6-A-02		
6-A-03		
Sorted	very poorly	
Density/ Angularity	large inclusions—common 30%; subrounded–rounded small inclusions—subangular	
Inclusions	elongate rock fragments large ferruginous nodules; probable natural occurrence in clay	
Matrix	clay matrix appears grainy, dirty and inconsistent	
Voids	Abundant running channels/voids/rents throughout. Circular, curving rents/voids where clay shrunk. Many voids where minerals dislodged or dissolved.	
Observations	Densely packed, many inclusions difficult to distinguish in matrix. Elongate rock fragments aligned parallel to margins. Edges uneven, torn.	

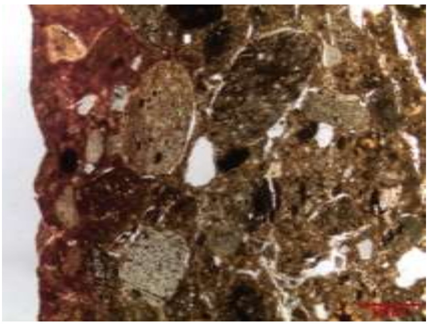
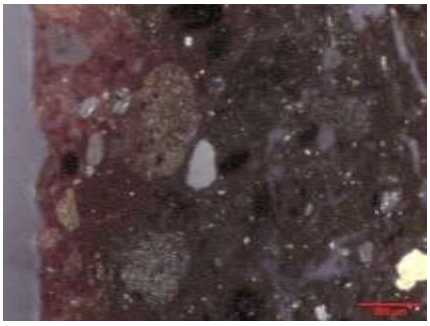
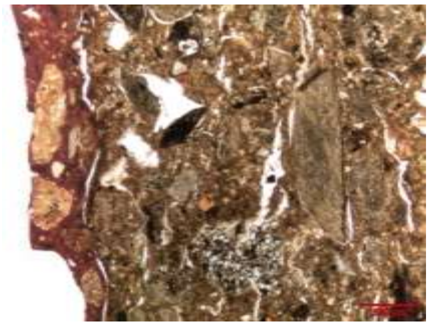
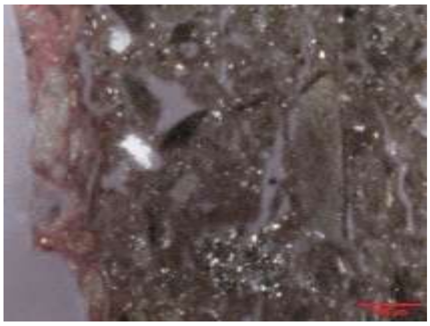
<u>Slide 6 Sample B</u> **SH-S2-B** **Open Site** **Spit 2** **Body**		
6-B-01		
6-B-02		
6-B-03		
Sorted	poorly	
Density/ Angularity	large inclusions—frequent 25%; subrounded small inclusions—few 10%; subangular	
Inclusions	orange isotropic grains feature white, subangular, anisotropic rock fragments, mottled and with visible inclusions dark subrounded elongate	

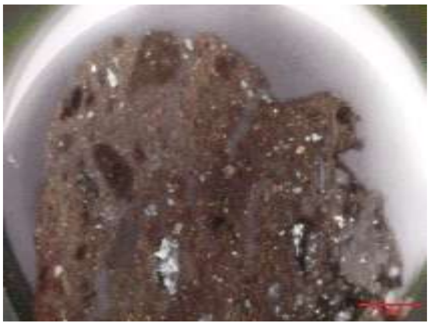
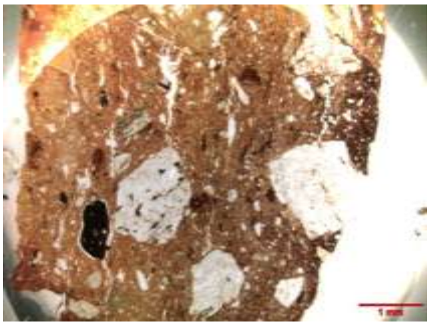
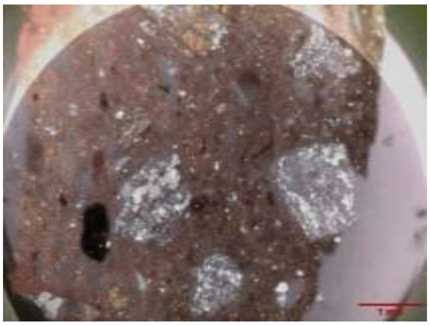
Matrix	appears consistent, lightly grainy only
Voids	Snaking channels/veins/voids, larger voids where mineral dislodged, mostly parallel with surface.
Observations	Many different large inclusions, small inclusions not prominent. Several inclusions difficult to distinguish from clay matrix.

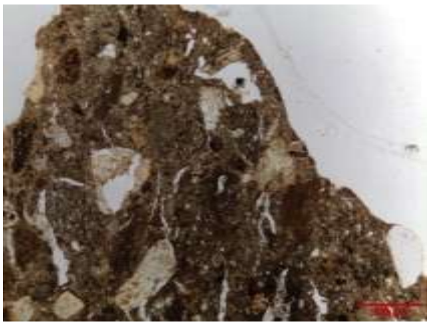
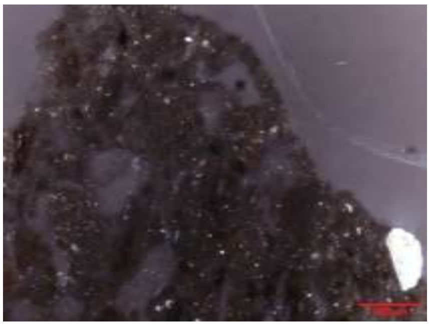
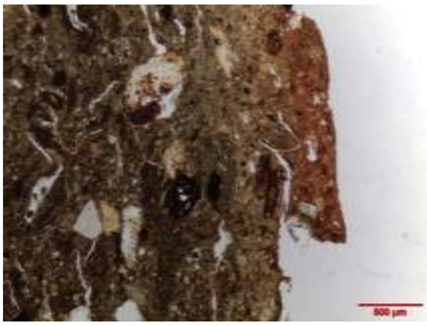
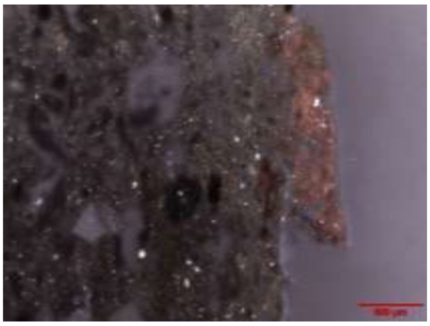
<u>Slide 6 Sample C</u> **SH-S2-C** **Open Site** **Spit 2** **Body**		
6-C-01		
6-C-02		
Sorted	poorly	
Density/ Angularity	medium inclusions—common 40%; subangular–subrounded small inclusions—few 10%; angular–subangular	
Inclusions	rock fragments of various types carbonate? fragments, irregularly shaped, isotropic (no polycrystalline quartz)	
Matrix	consistent appearance, only lightly grained, changing to red color at margins	
Voids	Featuring several dislodged/dissolved inclusion voids (apparent at XPL).	
Observations	Small inclusions generally lacking. Unimodal.	

<u>Slide 7 Sample A</u> **SH-S5-A** **Open Site** **Spit 5** **Surface color**		
7-A-01		
7-A-02		
Sorted	moderately	
Density/ Angularity	medium inclusions—common 40%; angular–subrounded small inclusions—common 40%; angular–subangular	
Inclusions	polycrystalline quartz plastic iron-rich beige-gray anisotropic gray-green grains PPL (7-A-01)	
Matrix	red and seemingly heavy, even clay with few grains	
Voids	Voids are few, some voids where inclusion apparently dislodged but very few. Circular voids around large inclusions where clay has shrunk.	
Observations	No apparent SC layers but darker fabric at edges apparent. Dense and bimodal concentrations of inclusions. Many inclusions elongated. Small inclusions are prominent.	

<u>Slide 7 Sample B</u> **SH-S5-B** **Open Site** **Spit 5** **Surface color**		
7-B-01		
7-B-02		
Sorted	poorly	
Density/ Angularity	large inclusions—common 40%; subangular–subrounded small inclusions—few 10%; subangular	
Inclusions	polycrystalline quartz beige-gray-yellow isotropic rock fragment various types; blackish mottled with inclusions, white and microgranular in XPL; beige-gray	
Matrix	moderately grainy appearance with dark iron oxides and rock fragments	
Voids	Few snaking channels/rents and voids but not prominent	
Observations	Deep red fabric at edges with SC layer (quite thick) at one surface just slightly possible (7-B-02).	

<u>Slide 7 Sample C</u> **SH-S5-C** **Open Site** **Spit 5** **Surface color**		
7-C-01		
7-C-02		
Sorted	poorly	
Density/ Angularity	large inclusions—dominant 50%; subrounded–rounded small inclusions—few 10%; angular–subrounded	
Inclusions	granitic rock fragments beige-gray elongate subrounded	
Matrix	even khaki clay contrasting strongly with red margins	
Voids	Snaking channels, voids, rents, parallel to surface but also other orientations. More sizeable voids and holes where inclusions have probably been dislodged/dissolved.	
Observations	Shard shows both red and yellow (featured above) faces. Distinct red layer one surface, full of inclusions. (Appears as an applied surface paint, as some inclusions seem covered and some with margins covered and rest not. Some inclusions untouched though.) Red layer separating (laminating) along its length by long vein/void. Other surface also has distinct red-brown layer but not as wide or red. Many large and otherwise inclusions hard to discern from background.	

<u>Slide 8 Sample A</u> **SH-S5-A** **Open Site** **Spit 5** **Body**		
8-A-01		
8-A-02		
Sorted	poorly	
Density/ Angularity	large inclusions—frequent 20%; subangular–subrounded small inclusions—few 10%; subangular–subrounded	
Inclusions	polycrystalline quartz beige-gray smaller rock fragments dark brown, irregular, unchanged at XPL; possibly organic	
Matrix	light brown compact fabric darker/burnt at one end; many small inclusions likely to occur naturally in clay	
Voids	Many channels, tears, snaking rents generally in an aligned orientation parallel with margins but some random.	
Observations	Inclusions generally not abundant. Medium–large inclusions more evident within bimodal distribution.	

<u>Slide 8 Sample B</u> **SH-S5-B** **Open Site** **Spit 5** **Body**		
8-B-01		
8-B-02		
Sorted	very poorly	
Density/ Angularity	large inclusions—frequent 25%; angular–subangular small inclusions—few 10%; subrounded	
Inclusions	rock fragments various types; beige-gray prominent white lucent inclusion at surface 8-B-01 (compare with 5-B-02—same shape)	
Matrix	consistent and darker khaki fabric, looks dirty; minor grains	
Voids	Moderate snaking channels/voids and bigger voids where inclusion has likely been dislodged/dissolved.	
Observations	Red surface layer apparent in places (probably firing outcome). Torn, ripped fabric at one end. Bimodal distribution.	

PETROGRAPHIC REPORT WRD-295 (10 JUNE 2011)

SUMMARY PETROGRAPHIC EVALUATION OF TEMPER SANDS IN PROTOHISTORIC SHERDS FROM EAST TIMOR

While examining in thin section eight additional sherds from Macapainara, eleven supplemental sherds from Vasino, and raw temper from Raca sent by Sue O'Connor, opportunity was taken to evaluate anew all the modern and protohistoric ceramic materials received from East Timor in the past, as detailed in the following previous petrographic reports:

WRD-240 (July 2004 for Matthew Spriggs): five sherds from Telepunu
WRD-288 (November 2010 for Sue O'Connor): seven sherds from Macapainara
WRD-291 (February 2011 for Peter Lape): four sherds from Ira Ara
WRD-292 (March 2011 for Peter Lape): a modern sherd from Raca

The additional Macapainara-Vasino-Raca samples treated for the first time in this report more than double the available thin sections of sherds and temper from East Timor (to a total of 35 plus the modern Raca temper and Raca sherd). Of the 37 total, 16 or 43% derive from the non-fortified Telepunu and Vasino sites, 19 or 51% derive from the fortified Macapainara and Ira Ara sites, and two or 6% derive from the modern potterymaking site at Raca.

RACA TEMPER (FROM RACA VILLAGE WHICH IS A CURRENT POTTERY PRODUCTION VILLAGE IN TIMOR LESTE)

The modern Raca sherd (a fragment broken from a contemporary ceramic vessel) and the Raca temper source (taken from a temper collecting pit) display wholly calcareous sand composed of globular foraminiferal tests. The only discernible difference between the two materials is that fired clay occupies the areas between temper grains in the sherd, whereas the foraminiferal tests in the raw temper are set in a matrix of calcitic microspar (diagenetic carbonate). To my eye, the foraminiferal temper is indistinguishable from the Ouh temper of Maluku Tengah also collected from Neogene limestone, but sherds from East Timor containing foraminiferal calcareous sand as temper surely must derive from local temper sources in East Timor, either at or resembling the Raca temper source, rather than from Maluku Tengah. The congruence of Raca and Ouh tempers can be ascribed to regional similarity of Neogene foraminiferal limestones throughout the Banda arc. Foraminiferal calcareous sand tempers of East Timor sherds can conveniently be termed the Raca-type temper (Table 295-1).

TELEPUNU TEMPER (TIMOR LESTE)

The temper in all five Telepunu sherds is hybrid sand composed predominantly (80%–90%) of calcareous limeclasts made of diagenetic microspar, with which subordinate terrigenous grains of quartz and feldspar are admixed. The limeclasts include abraded skeletal grains and reworked biomicrite, but none appear to be modern reef detritus. The temper sand was evidently derived from the erosion of indurated limestone on Timor, and is presumed to be local temper collected at or near Telepunu. The non-foraminiferal hybrid temper sands of East Timor sherds dominated by detrital limeclasts can conveniently be termed the Telepunu-type temper (Table 295-1).

IRA ARA SHERDS (TIMOR LESTE)

Of the four sherds studied from Ira Ara (Table 295-1), two contain foraminiferal calcareous temper indistinguishable from the Raca-type temper, one contains non-foraminiferal hybrid but predominantly calcareous temper resembling the Telepunu-type temper, and one contains hybrid temper rich in metamorphic rock fragments similar to the Buru-type temper in Macapainara sherds (see below). Only the sherd with Buru-like temper could potentially derive from wares exotic to East Timor.

VASINO SHERDS (TIMOR LESTE)

Of the 11 Vasino sherds studied in thin section (Table 295-1), two contain Raca-type temper (foraminiferal calcareous grains), three contain Telepunu-type temper (limeclast calcareous grains), and one contains “mixed” Raca-Telepunu temper (both foraminiferal and limeclast calcareous grains). These calcareous tempers in Vasino sherds reinforce the interpretation that Raca-type and Telepunu-type tempers derive from indigenous sands available for collection in East Timor, and the “mixed” Raca-Telepunu temper in one Vasino sherd indicates that Raca and Telepunu tempers are just different variants of a related East Timor calcareous temper spectrum, probably because Neogene foraminiferal and non-foraminiferal limestones are interbedded in local sedimentary successions.

The temper sand in the other five Vasino sherds is heterogeneous hybrid sand in which lithic terrigenous detritus is admixed in variable proportions with calcareous grains that include both massive grains and foraminiferal tests (Table 295-2 top), although the latter are subordinate. This temper can conveniently be termed the Vasino-type temper. The lithic fragments of sedimentary rock and other grain types in Vasino-type temper are appropriate for derivation from bedrock exposed on Timor, suggesting that Vasino-type temper is yet another indigenous sand of an East Timor temper spectrum. The presence of minor foraminiferal calcareous grains analogous to those in Raca-type temper reinforces that interpretation. Vasino-type and Buru-type tempers (see below) are petrologically distinctive, and readily distinguished from one another at a glance in thin section. The lithic fragments in Vasino-type temper are dominantly murky argillite (or shale or mudstone) as opposed to the foliated metamorphic grains characteristic of the Buru-type temper. Provided Vasino-type temper is representative of indigenous lithic tempers of East Timor, as seems to be the case, then the Buru-type temper in Macapainara and Ira Ara sherds is anomalous.

Being unaware of the internal layout of the Vasino site, or of the location of Vasino relative to Raca or Telepunu, I am unable to evaluate the detailed provenience of the Vasino sherds with different temper types, or to suggest where the source of Vasino temper might be located with respect to the sources of Raca and Telepunu tempers, but a source nearby is indicated.

MACAPAINARA SHERDS (TIMOR LESTE)

Five of the first seven Macapainara sherds studied in thin section (denoted by prefix M of Table 295-1) contain Raca-type (Ouh-like) foraminiferal temper that can be viewed with confidence as an indigenous East Timor temper type, with the Buru-type temper in the other two suggestive provisionally of ceramic transfer from Buru in Maluku Tengah. Only one of the eight additional Macapainara sherds examined contains Raca-type temper and none contains Buru-type temper, but three contain Telepunu-type temper and three contain Vasino-type temper (Table 295-2 bottom), both of which are indicative of local ceramic origin (see above). Vasino-type tempers in Macapainara sherds are somewhat different from Vasino-type tempers in Vasino sherds (Table 295-2): more volcanic rock fragments, fewer argillite grains, a lower quartz/feldspar ratio, and more calcareous grains (one-half versus one-third), but with fewer foraminiferal tests among the calcareous grains. These differences imply that the Vasino-type tempers in the two sherd subsets were not collected at exactly the same place, but the generic similarities lead me to regard the two related tempers as variants of the same broad temper type. The fifteenth Macapainara sherd, however, contains a volcanic sand temper wholly unlike any East Timor or Maluku Tengah tempers, and indicative of ceramic transfer from Banda (see below).

BURU TEMPER (BURU ISLAND MALUKU TENGAH)

Two sherds from Macapainara and one from Ira Ara contain similar hybrid sands in which the terrigenous grains are exclusively metamorphic detritus of the type expected from basement rock of Buru in Maluku Tengah but not from any of the metamorphic assemblages of Timor. Table 295-3 indicates the severe compositional contrasts between Vasino-type temper interpreted as indigenous to Timor and the Buru-type temper. Several grain types present in each are wholly absent from the other. Only percentages of quartz mineral grains and opaque iron oxide grains, neither diagnostic of origin, are comparable for Vasino-type and Buru-type tempers. Recognition that the foraminiferal Raca-type temper was derived from local sources on East Timor rather than from Ouh in Maluku Tengah weakens the argument for exotic sherds from Buru in the Macapainara collection. The occurrence, however, of a sherd unmistakably from Banda (see below) serves to rejuvenate the interpretation that wares from well north of Timor were used at Macapainara, and thereby strengthens the case for bonafide Buru sherds at Macapainara.

BANDA TEMPER

One Macapainara sherd (Table 295-1) contains plagioclase-rich volcanic sand temper for which derivation from Timor does not seem feasible. The composition of the temper closely matches indigenous temper in sherds from Banda (Table 295-4). Frequency percentages of grain types overlap at one standard deviation for all grain types except opaque iron oxides, which are susceptible to irregular fluctuations in abundance from sorting effects because of their high specific gravity, and overlap in any case at two standard deviations (95% confidence level). The volcanic lithic fragments in both the indigenous Banda sherds and the exotic Macapainara sherd are pumiceous vitric fragments of volcanic glass with internal vesicular porosity. Comparison of the indigenous and exotic Banda sherds side-by-side on the microscope stage shows that their tempers are texturally as well as compositionally indistinguishable.

The temper match is enhanced by the nature of the clay pastes. In Banda sherds, volcanic sand was added manually to ash-rich clay bodies, and volcanic glass shards of vitroclastic texture are embedded in the fired clay pastes (Dickinson, 2005; Dickinson, 2006: 50, 109-110). Ash-rich clay paste has not been observed in any other sherds from Pacific Oceania, apart from one sherd collected in Halmahera. Derivation of the Macapainara sherd from Banda thus seems assured. With a sherd from Banda present at Macapainara, the presence of other sherds from Buru seems plausible. It is well to note that prehistoric Banda sherds have been documented on Seram and Gorom in Maluku Tengah to the north, as well as in the Aru Islands to the east.

SUMMARY OF TEMPER RELATIONS

From comparison with Raca, Telepunu,and Vasino tempers assumed to be indigenous to East Timor, ~80% of Macapainara and Ira Ara tempers are also indigenous to East Timor (Table 295-1), but the other 20% of sherds at the prehistoric fortified sites of East Timor probably document ceramic transfer from Banda and Buru to the north. There may be a means to test this proposition using U-Pb ages of detrital zircons from suspected exotic sherds at Macapainara and Ira Ara. We are in process of using U-Pb ages of detrital zircons extracted from potsherds to document the origin of exotic temper sand in late Lapita sherds from Roviana Lagoon in the Solomon Islands, and I will soon outline for you the possible application of U-Pb technology to the Buru-type tempers in sherds from Macapainara and Ira Ara (just as soon as our abstract for the national meeting of the Geological Society of America late this year is approved by all co-authors).

REFERENCES

Dickinson, W.R., 2005, Petrography of temper sands in prehistoric potsherds from the Aru Islands, south of West Irian near the shelf edge of the Arafura Sea [Appendix 6.1], in O'Connor, S., Spriggs, M., and Veth, P., The archaeology of the Aru Islands, eastern Indonesia [Terra Australis 22], Canberra, Pandanus Books, p. 115–124.

Dickinson, W.R., 2006, Temper sands in prehistoric Oceanian pottery: Geotectonics, sedimentology, petrography, provenance: Boulder, Colorado, Geological Society of America Special Paper 406, 164 pp.

Table 295-1: Distribution of temper types in potsherds and raw temper from sites in East Timor.

Temper type	Telepunu	Vasino	Raca	Ira Ara	Macapainara
Raca: foraminiferal calcareous grains	—	VA-A1-23 VA-C3-195	temper sand sherd temper	ET0	M822, M882, M899, M930, M942 MA-A2-6
"Mixed" Raca-Telepunu (both limeclast and foraminiferal calcareous grains)	—	VA-A1-24	—	—	—
Telepunu: limeclast calcareous grains	TTP2-1, 2, 3, 4, 5	VA-A2-41 VA-C1-69 VA-E2-251	—	ET3 ET4	MA-A3-160[1] MA-A3-229 MA-D12-1567
Vasino: hybrid lithic Timor sands	—	VA-A4-57 VA-C2-97 VA-C2-124 VA-E2-252 VA-E3-284	—	—	MA-C7-1062 MA-D12-1566 MA-D12-1568
Buru (or Buru-like) hybrid coastal sand (metamorphic terrigenous detritus)	—	—	—	ET5	M64, M858
Banda volcanic sand	—	—	—	—	MA-A9-1069

[1]Calcareous grains removed by post-depositional dissolution to leave sand-sized vacuoles in the sherd

Table 295-2: Frequency percentages of 400 sand grains of Vasino-type temper in Vasino (VA at top) and Macapainara (MA at bottom) sherds.

Grain type	VA-A4-57	VA-C2-97	VA-C2-124	VA-E2-252	VA-E3-284	Mean (±SD)
Quartz	25	24	18	12	19	20±5
Feldspar	4	4	7	3	6	5±1.5
Clinopyroxene	1	1	1	1	—	~1
Opaque Fe Ox	2	4	1	3	2	~2.5
Biotite (mica)	trace	trace	trace	trace	—	trace
Chert	2	3	4	2	4	3±1
VRF[1]	5	6	7	6	7	6±1
Siltstone[2]	4	1	2	5	2	3±1.5
Argillite[3]	28	43	26	30	30	31±6
Tectonite[4]	2	trace	trace	1	—	1±1
Calcareous[5]	27	14	34	37	30	28±8[7]
(foraminiferal)[6]	*3*	*1*	*2*	*3*	*3*	*~2.5*

Grain type	MA-C7-1062	MA-D12-1566	MA-D12-1568	Mean (±SD)
Quartz	30	7	8	15±11
Feldspar	8	6	4	6±2
Clinopyroxene	tr	3	5	3±2
Opaque Fe Ox	3	1	tr	1±1
Biotite (mica)	tr	—	—	—
Chert	4	3	2	3±1
VRF[1]	6	19	9	11±6
Siltstone[2]	tr	1	5	2±2
Argillite[3]	24	16	10	17±6
Tectonite[4]	1	tr	1	~0.5
Calcareous[5]	24	44	56	41±13[7]
(foraminiferal)[6]	*trace*	*trace*	—	*trace*

[1]Volcanic rock fragments
[2]Microgranular sedimentary rock fragments
[3]Includes shale displaying mass extinction
[4]Metasedimentary quartz-mica slate or phyllite
[5]Total calcareous grains
[6]Globular foraminiferal tests
[7]Mean =32±2 (~one-third) for four of five samples of Vasino-type temper in Vasino sherds, and mean=50±6 (~one-half) for two of three samples of Vasino-type temper in Macapainara sherds

Table 295-3: Contrasts in terrigenous grains in hybrid Buru-type and Vasino-type tempers in Macapainara and Vasino sherds.

(*frequency percentages ± CE*[1] *or ± SD*[2] *for grain types in temper sands recalculated free of calcareous grains*)

Grain Type	**Buru-type tempers**		**Vasino-type tempers**	
	Indigenous Buru sherd (BX46)	Macapainara sherds (M858 and M1064)	Macapainara sherds (Table 295-2)	Vasino sherds (Table 295-2)
Monocrystalline quartz	21±6	16±2	23±12	27±5
Monocrystalline feldspar	0	0	10±1	7±2
Clinopyroxene mineral grains	0	0	5±4	1±1
Opaque iron oxide particles	0	3±1	2±2	4±1
Microcrystalline chert	0	0	5±0	4±2
Polycrystalline quartz	21±6	13±1	0	0
Foliated polycrystalline quartz	13±5	18±2	0	0
Volcanic rock fragments	0	0	21±11	9±2
Microgranular siltstone grains	0	0	4±5	4±2
Murky argillite grains	0	0	28±4	44±5
Unfoliated quartz-mica grains	6±4	10±4	0	0
Foliated quartz-mica tectonite	36±7	36±2	1±1	1±1
Foliated micaceous aggregates	3±3	8±0	0	0

[1]CE (counting error) for indigenous Buru sherd given by the expression [p(100–p)/n]½ where p is percentage of a given grain type and n is the total number of points counted.
[2]SD (standard deviation) for Macapainara and Vasino sherds calculated from the multiple counts of Table 295-2.

Table 295-4: Composition of volcanic sand tempers in four sherds from Banda and an exotic Banda sherd (MA-A9-1069) from Macapainara.

Grain Type	**Indigenous Banda sherds**[1]	**Exotic Macapainara sherd**[2]
plagioclase feldspar	35 ± 5 (29–43)	42 ± 4
augite clinopyroxene	4 ± 1 (2–6)	2 ± 1
opaque iron oxides	7 ± 2 (5–9)	2 ± 1
vitric lithic fragments	52 ± 6 (42–59)	51 ± 4
microlitic lithic fragments	2 ± 1 (1–3)	3 ± 1

[1]Mean and standard deviation (±) of grain frequency counts (percentages) of 180-235 temper sand grains in each of four indigenous Banda sherds with ranges of percentage in parentheses (after Dickinson, 2006: Table 26 on p. 110).
2Mean and standard deviation of counting error (±) for a grain frequency count (percentages) of 190 temper grains in an exotic sherd from Banda found at Macapainara where ± is given by the expression [p(100–p)/n]½, where p=percentage of grain type and n=total grains counted.