REPORT FOR PERMIT 80/06/01/012/52 MICROMORPHOLOGY SAMPLES FROM PINNACLE POINT, MOSSEL BAY

In addition to stratigraphic analyses and granulometric studies of sands from archaeological sites at Pinnacle Point (PP), Mossel Bay, we wish to enhance our understanding of site formation processes by conducting micromorphology studies to include biogenic and anthropogenic influences on the archaeological deposits and history of their deposition. Soil micromorphology "is the study of resin-impregnated, undisturbed blocks of sediment and petrographic thin sections" (Goldberg 2000, 43). See the Goldberg (2000) article for more details on sampling techniques and results of the study conducted on deposits from Die Kelders Cave 1. In sum, the latter study revealed that habitation horizons can be resolved into more ephemeral events such as fires, that preservation of the same deposit varies across different areas of the cave and therefore, that excavation of cave deposits should not be conducted only in one localized area within a cave.

Micromorphological analysis was carried out on samples from all stratigraphic units in 13B. Samples were collected as in tact blocks using different techniques depending on the consistency and degree of induration of the sediment. For firm material, particularly those from the north and south sections where the LC-MSA deposits occurred, blocks were cut out of the profile and wrapped securely with tissue paper and packaging tape. For loose and friable samples, such as those in the western section at the rear of the cave, and in the central area near the entrance, plaster jackets were used to secure undisturbed samples.

The samples were oven-dried for several days at 60° C and then impregnated with unpromoted polyester resin diluted with styrene at a ratio of 7 parts resin to 3 parts styrene; MEKP was the catalyst. After the resin had achieved a hardened gel-like consistency they were placed in the oven 60° C overnight for final curing. The hardened blocks were then cut into cm-thick slabs, which were processed into 50x75 mm petrographic thin sections by Spectrum Petrographics (Vancouver, WA) or Quality Thin Sections (Tucson, AZ). Thin sections were observed in plane-polarized and cross-polarized light (PPL, and XPL, respectively) at magnifications ranging from 15x to 400x. The text below integrates our micromorphological observations with field observations of the stratigraphy. It is a draft of a paper that is currently in preparation on the material.

In the text below, the reader will find codes that refer to the following:
MB-03-07 – any code beginning with an "MB" is a Goldberg sample number.
OYG-013 - any code beginning with an OYG is a slide code.

Stratigraphy and Sedimentology

The stratigraphic sequence at Cave 13B is revealed in two principal areas, either as a result of excavation or because of natural exposures. In the rear of the cave sections were created as a result of excavations in the area of N97, 98 and E96, 97. In the front of the cave just inside of the entrance, on the other hand, both natural and excavated exposures occur. Natural exposures revealed generally cemented deposits (LC-MSA)

along the north and south walls of the cave, whereas both cemented and softer sediments were exposed in the excavated central part of the cave (sq. N91-94?; E106-110?)

Rear/Western Area – In the rear part of the cave, excavations revealed the earliest deposits in the cave sequence. These are composed of a beach boulder formation at the base, overlain by a sequence of silty and sandy sediments with intercalated organic bands that shows local gullying and erosional features, along with exposed surfaces. These are geogenic at the base and become increasingly anthropogenic upward in the section.

The stratigraphically lowermost deposits consist of large rounded boulders at the base of the sediments exposed in N97E97 NW, SW, and SE. The interstitial finer sediment is composed of silty sand that occurred as a thin rind on the rocks. Some of the large open spaces around the rocks were partially filled with some roof spall. The deposits were sterile.

Overlying deposits are largely finer grained and are well exposed in N98, 97E 97). They can be described as follows from bottom to top:

Unit 1 (laminated facies): This occurs throughout the western area and directly overlies the Boulder Beach deposits. This is a predominantly sterile zone of yellowish gray, to gray laminated sands and silt that become less well bedded upward; this upper part also contains scatters of angular quartzite fragments [e.g., W4CB]. Furthermore it contains yellow phosphatic (apatite) lumps and stringers, as well as small pieces of fossil mammal bone that exhibit polished surfaces. The contact with overlying unit is sharp and dips to SE. In southern part of this western profile in N97E97, the unit appears to interfinger with overlying looser, angular debris of Unit 2 that fills a gully; ends against wall.

Unit 2: (LB Silt through to LBG Sand 3 and 2 and DB Sand 4a, b, c) This~15-20 cm thick unit fills a gulley in the area of the subsidence in the area of N97.5E97) but then extends throughout the excavated area is is called LB Silt) is a gully fill generally inclined to SE and truncates unit 2. Within the unit are several ~1 cm thick attenuated and inclined organic dark stringers (DB Sand 4a, 4b, and 4c) that thicken and thin, and locally pinch out across profile [photo DSCN 1754.jpg]; they are more continuous along the northern face of N97E 96,97. Unit 2 consists of a jumbled, heterogeneous mixture of angular stones (flat and equant) within a brownish sandy and silty matrix, which is more laminated and yellowish green in color toward the base. Also occurring within the deposit are attenuated, mm thin, brownish stringers of apatite as well as dark brown organic anthropogenic horizons.

Unit 3: (LBG Sand 1) Firm, light gray brown, massive silts with some quartzitic rock fragments and lumps of apatite and some bone that rest on dark layer (W4BR). The deposit overall slopes to SE and to the SW, it is more heterogeneous and cm size burrows in increase; on the N profile, the unit is more uniform and less disturbed. It is ca. 20 cm thick on west profile, and about 12-15 cm on N profile.

Unit 4: (DB Sand 3 and 2) Similar to unit 3 but darker color, sandier, and less disturbed. Many rounded cm-size yellow lumps of apatite. Some layer ~ 10 cm angular roof spall at top. Gradual contact with (3). Truncated above and locally grades upward into

Unit 5: ~7-10 cm (DB Sand 3 to LB Sand 1) dark brown, organic, crudely bedded, sandy gritty pebbly layer with fine platy granules and roof spall; some bird gastroliths. Dips to SE. 1 m to W, this unit sharply truncates underlying sediments in second gully.

This unit seems to represent a change in type of sedimentation from silty to more flat stony deposits.

Unit 6: (Surface sediments) Fine angular roof spall in a loose, yellow, sandy matrix that thickens to the west. Ca 5 cm thick.

Micromorphology

The above field observations were supplemented with micromorphological analysis.

Unit 1 [sample MB-04-45e]: The basal laminated sand and silt deposits of Unit 1 consist of rounded to subangular grains of quartz (with undulose extinction) with some minor quantity of feldspars, which are partly altered to sericite. Grains occurring in trace amounts include blocky phytoliths, a weathered diatom, and isotropic, hollow, needle-like objects (sponge spicules). The fine silty-clay is pale greenish gray and almost isotropic phosphate (apatite). The silty and sand lenses are accompanied by apatitic material (confirmed by FTIR) mostly in the form of fragments of yellowish isotropic masses that frequently contain bone fragments; scattered yellowish bone fragments and solid yellow grains are also observed, probably belonging to the remains of disintegrated carnivore coprolites. Furthermore, the apatite clasts conform to the wavy form of the sandy and silty matrix, and in certain cases, the apatite appears to be precipitated within the silty clastic material; apatite authigenic nodules were observed in sample 11A.

Although the coarse material (i.e., sand) is embedded in silt, the silt rarely constitutes distinct lenses. In these latter cases there is no grading of coarse to finer material; the boundaries of the silt and sand increments are rather sharp.

Comments: the wavy and bedded structure of the silt/sand, the general paucity of silt lenses, and the washed (i.e., fine-depleted/elutriated) aspect of some of the coarse beds are clearly due to low energy water flow, such as that which might occur in a setting with a spring seep or surge emanating from the back of the cave, to the west of this location (N97E97). The angular sand and silt are mostly breakdown products of the bedrock rather than resulting from inputs of aeolian or marine sand, which are distinctly better rounded, and calcareous (see discussion below). On the other hand, trace amounts of rounded sand (<1%) do occur and they become more distinctive as a whole within the rear profile.

The distinctness of the bedding in the lower part of unit 1 also suggests that the substrate was rather moist for much of the accumulation of the lower part of these silts and sands. However, as one proceeds upward in unit 1, the less distinct nature of the bedding suggests that the damp conditions were less prominent and that the sediments were drying out and becoming less coherent and possibly subjected to minor reworking by the wind.

The thin lenses of apatite, consisting of bone and amorphous apatite, likely represent bird and possibly bat guano. This material seems to have accumulated during short periods when the silty and sandy substrate was exposed as an ephemeral surface.

Unit 2 [sample MB-04-45d, c, b, LB Silt through to LBG Sand 3 and 2 and DB Sand 4a, b, c]: Unit 2 consists of more poorly sorted silty sand that is enriched in some roof spall. Apatite occurs as below, as yellow nodules and crust-like pieces (coprolite fragments?), but here also as isotropic colorless material that surrounds clastic grains.

Comments: The erosional contact which slopes to the SE, clearly shows that unit 2 infills a gully caused by subsisdence that is eroded into Unit 1. Moreover, the attenuated and discontinuous nature of the organic stringers shows that this sediment must have also gradually slumped along the direction of the gully. In addition, the sediment must have been at least seasonally wetted in order to maintain the cohesion of the observed bedding and stringers. Furthermore, the slightly chaotic nature of the sediment and its poor sorting would substantiate this interpretation. Nevertheless, toward the top of the unit we see evidence for periods of stabilization, in which organic matter accumulated on exposed surfaces and was oxidized. Throughout the infilling of the gully, however, phosphatic guano continued to accumulate and be incorporated and reworked into the gully deposits. The latter is shown by the presence of vertically oriented apatitic crusts and pieces of guano.

Units 3 and 4 : (LBG Sand 1, DB Sand 3 and 2, LB Sand 1) [sample MB-04-45b, a; sample MB-04-44e, d, c, b]:

The situation in Unit 3 notably different from the underlying sediments and we note the presence of calcareous elements in the form of bioclastic sand (shell fragments, frustules), along with bone and organic matter. Enterolithic apatite also occurs along with lozenge-shaped crystals of anhydrite that appear to have replaced gypsum. A stringer of charcoal and burnt bone marks the first occupation observed in the rear part of the cave.

Comments: the presence of the bioclastic remains in the unit show that sedimentation is increasingly terrestrial with inputs of wind blown sand derived ultimately from the beach zone. This aeolian activity is possibly linked to drier conditions than those that existed during the formation of the bedded sands and silt of Unit 2 for example. The dryness is also supported by the presence of gypsum crystals and later replacement by anhydrite. The gypsum precipitation is tied to the presence of guano (Shahack-Gross et al.) accumulating on the surface. Associated with the gypsum formation and organic matter accumulation is the dissolution of the calcareous bioclasts which are unstable and eventually would disappear under these conditions.

Unit 5 DB Sand 3 to LB Sand 1) [samples MB-03-04/65] a dark organic horizon in the field is totally decalcified, and contains a thin horizon of burned bones and charred material that delineates the top of the layer. Some areas show less bioturbation and have a yellow-orange appearance, along with some features that suggest the precipitation of apatite; moreover, some bones appear to be dissolving into an apatite mass.

Comments: the brownish color of the sediment in the field appears to be tied to the increase in charcoal and organic matter, burnt bone as seen in thin section. Although the top of unit 5 in N97E97 is similar to the dark layer, these two profiles are not physically correlated so at this point it is not clear whether they are the same deposit or represent two different episodes of burning. Nevertheless, either or both possibilities indicate that unit 5 is strongly influenced by human inputs.

Unit 6 Surface sediments) [samples MB-03-04/65] is widespread surface cover. It is comprised of roof spall fragments (mostly sand and granule sizes) embedded in a spongy, loose matrix consisting of finely comminuted faecal material and a high number

of black particles mixed with calcareous elements, such as shell, tiny gastropods, echinoderms, calcareous sandstone, which are now dissolving. In addition, it contains shreds of fine organic matter and charcoal, brown material (insect parts?), burnt shell, and fluffy micro aggregates of interstitial material, particularly at the top. Although the chips of roof spall are flat lying, bones are commonly vertical.

Comments: This layer appears to represent recently reworked deposit as shown by the loose nature, content (shells, charcoal, burnt bones), but includes bioturbated material reworked from the underlying sediments. The fact that the calcitic shells and aggregates are dissolving indicated that the process of apatitization is still active.

Entrance (Eastern) Section

In the eastern part of the cave, near the entrance, deposits rich in anthropogenic inputs and features occur along the northern and southern walls of the cave and in the central part. Those along the walls are cemented to well indurated with carbonate, plastered against the bedrock walls, and perched on isolated steps of bedrock. Those in the center of the cave include both indurated and softer sediment .

1) Southern Part

The deposits in the south section of the cave are generally similar to those on the northern side. They are ~1m thick and overall are composed of angular, sharp, cm to dm-size clasts, some mixed with ash and darker brown organic matter-rich ash. The deposits can be divided into three generalized subunits:

a) The lowest ~25 cm consist of angular flattish stones in a darker reddish brown matrix with bands of charcoal/organic matter and what appeared to be altered ashes. It pinches out to the east.

b) The middle part, ~30-45 cm thick, also thins to east (thickest along E106 squares). It is much lighter color, due to its carbonate content; well-preserved shells occur, as well as some charcoal.

c) The upper part is partly eroded, especially in the east. It is the most cemented unit of the south section, and like on the northern side the upper part grades into tufa-like carbonate.

Comment – the southern and northern (LC-MSA) deposits do differ in some important ways. In the south, lithics are larger, roof fall is larger and very blocky, the shellfish are also larger and include very large patella. In the north, there are no to few shellfish in the LC-MSA Middle and Lower, and the shellfish in the thin lense in the LC-MSA Upper are sand mussel

2) Northern Part

Deposits n the north section are comprised of distinct layers and stringers of lighter and darker blackish brown greasy OM/charcoal-rich sediment, in some cases underlying whitish ashy lenses; also many angular and worked pieces of reddish quartzite occur. The northern deposits appear more matrix-supported and less clast supported than on the south side. The upper part of these marine mollusk shell-rich, largely anthropogenic deposits, is capped by a massive, hard, whitish sandy, calcareous crust, which drapes over the underlying, subhorizontal deposits (photo of N breccia section with white cap]. This crust in turn is overlain by white, carbonate-impregnated, sandy

aeolian deposits, which are steeply inclined toward the rear of the cave; based on their inclination, they extended back only to about E106-107. In any case, both calcareous layers are penetrated by large root fillings (1 to 5 cm in diameter) composed of calcium carbonate. They are in turn capped by a distinctive, clear, cm-thick flowstone, which occurs only on the north side of the cave.

3) Central part

Between these two profiles, in the central part of the cave along the main axis, are pockets of sediment that are bounded on both sides by the bedrock steps mentioned above. These deposits are thus not physically connected to the south and north brecciated sediments, although they do rest directly on bedrock. They are described below from bottom to top:

1) Loose stony layer made of angular bedrock fragments, mostly clast-supported; it rests upon a flaked bedrock.
2) Strongly indurated whitish layer, mostly homogeneous but locally containing yellowish spots and becoming grayish. Large vughs are observed. Towards the back of the cave it gradually becomes a loose stony layer not much different from layer 1.
3) Moderate indurated layer with yellowish spots. It also becomes a loose sandy to stony layer towards the back of the cave. A few dark to black stringers of probably burnt remains were identified.
4) A dark almost black thin layer which probably represents burnt remains.
5) Gravelly sands, slightly cemented in places.
6) Alternating gray, black and white lenses representing a hearth.
7) Recent reddish aeolian sand cover.

Excavations in 2004 took place along the square 92 rows, revealing deposits that appeared to be stratigraphically above those described. Here, at the base, at least two multicolored blackish lenses, likely representing combustion features occurred in a gray granular matrix with some dispersed fragments of roof spall. These were overlain with a sharp, undulating contact by a loose, crudely stratified stony sandy deposit, rich in roof spall and shell fragments. Moreover, both shell and rock fragments tended to be steeply dipping and oriented overall to the SE; they appeared to fill in the underlying erosional surface; the lithology and internal organization of this upper layer along with its sharp, erosional basal contact gave the impression of its being a debris flow.

Micromorphology

1) South Profile

Samples MB-03-07 and 20/21/22; Thin sections OYG-013 and 29/30/31/32/33/34/35/36

Upper part

From the top OYG-029 down to the middle part of section OYG-033 the coarse component is composed of mainly rounded sand-sized quartz and sericitized grains, with some rounded shell fragments and a few scattered roof spall fragments. This upper part of the sequence contains a few dispersed pieces of charcoal and one or two very thin horizons rich in charred material, along with some burnt bones; some of these dark bands do not appear to be part of combustion features, but possibly represent humified organic

matter, with elongated structure but which could possibly have functioned as other purposes, such as matting? The cementing matrix of the entire breccia is almost pure calcite, which appears as a networked alveolar structure formed mostly by needle-shaped calcite (lublinite: photo OYG29 x50a xp). Sometimes, islands of a first generation of micritic cement can be recognized but which is rarely recrystallized to sparite. Squiggly masses of apatite looking like ribbons of toothpaste occur, along with localized isotropic domains representing apatitic replacements from guano. In any case, the secondary calcification and rooting has disturbed much of the original internal structure of the deposits, making it difficult to reconstitute the intact nature of the combustion features. Question – does the southern cemented deposits have the large root castes evident in the northern cemented section?

Middle Part

In the middle of the section (e.g., MB-03-21; OYG-033) there are more shells than above, as shown by a pocket of shell fragments (photo OYG33 x50). Locally the matrix is somewhat more porous than above, with many rounded sand-size aggregates of what was once the original material of micrite (ash?). In addition, the charcoal is dispersed as fine comminuted splinters, likely due to the growth of carbonate, which has disrupted the originally larger pieces.

Basal Part

The upper part of the basal sediments of the profile, which tend to be much softer, darker, and more organic rich (charcoal and organic matter) than above, is similar to the overlying deposits. Below this, however, the deposits become more massive, and voids and hypocoatings are more individualized and less spongy. Nevertheless, both organic matter and charcoal are disrupted by voids and growth of secondary carbonate.

North Profile

The deposits in the northern profile – which were excavated only to a limited extent – were studied within a section of indurated anthropogenic deposits of the north breccia, as well as a number of isolated samples collected from various localities, which were stratigraphically above this, also along the north wall.

North breccia [Samples MB-03-18; thin sections OYG-024/25/26/27]

From top to bottom we observed the following:

18A: OYG-024 – (Upper LC-MSA) Massive deposit with scatters of quartz sand, bone and burnt bone, shells (many burnt), egg shell, and shreds of charcoal; rounded sand-sized grains occur but not in large amounts as in the south breccia. In section OYG-024 some kind of stratification and elongated vesicular structure is visible in the anthropogenic material. This suggests that it has been moved from its original location of combustion, either by water or by dumping, although typically lamination from water might be better expressed. All of the above has been cemented by micritic calcite that results in the formation of a continuous mass with some polyconcave vughs; some of the voids have lublinite fillings. Recrystallization of calcite has produced patches of coarser crystals (photo OYG24 x50 xp). Finally, some circular, very localized domains of phosphate were observed.

18B: OYG-025 – (Middle LC-MSA) This exhibits in situ burned zones, including a thin undisturbed feature in the upper part, and a larger one at the bottom, which contains a large bone fragment. In the upper part, there is a pocket full of fragments of shells, some of which are very well rounded (photo OYG25 x50). Organic matter is reddish brown in color, and it is not clear if it is actually burned or just decayed. In addition, fine sand sized alveolar carbonate cementation mirrors that observed on the south profile. This results in the production of fine shreds of organic matter that appear to be floating within the mass of carbonate.

18C: OYG-026 (transition from Middle to Lower LC-MSA)– Below (as was with the south breccia) the sediment changes to an overlapping sequence of layers rich in charred material, charcoal fragments, burnt bones, which appear to represent several bands of in situ fires. Yet, some charcoal and bone material in the lower left hand corner are on end and seem to be disturbed, possibly by bioturbation or trampling. There seems to be another small increment of sand that looks water lain. In between the charcoal-rich layers the calcitic cement has the form of alveolar structures (hypocoatings), and in some zones, apatite is replaced by the calcitic cement (photo OYG26 x50, OYG26 x50 xp).

18D: OYG-027 (Lower LC-MSA) – The basal sediment appears to be better bedded than the layers above, with thinner stringers of ash and organic matter. Noteworthy at the top is a large fragment of bone that is crushed in place with no redistribution of the fragments, thus suggesting trampling. As above, secondary calcite cementation is represented by a felt-like mass of interwoven fine crystals. Although a pocket of bioturbated material is visible in the lower left hand corner, most of the sediment seems to represent a sequence of very fine in situ fires, with some hearth cleanout separating them. In this slide, at least 4 or 5 intact fires could be observed.

Comments: In general both here and in the south profile the breccias are very rich in burnt remains, although the southern one has a more clearly preserved upper sandier layer that is of aeolian origin; the anthropogenic component there is very scant.

Miscellaneous Samples from Northern Wall of Cave

Sample 27 [MAP# 46546] comes from N95.91E109.29 – this is north of the northernmost excavated profile, near the osl sample 20720 that yielded 132 ka. It is ca. 15 cm thick, and from top to bottom consists of:

1. ~1 cm of flowstone;
2. ~4 cm cemented dark brown with charcoal band at base ca. 5 mm thick; some reddened stone chips;
3. ~4-6 cm beige sand with massive chalky impregnations; osl sample includes this one and 4. below
4. ~1.5 cm dark brown cemented sand with chalky impregnations along rootlets. Laterally this layer contains numerous burnt mollusks and to the West appears to overtop the bedrock.

In thin section we observed in the upper part (top 2 units), a clear travertine crust (flowstone) developed on top of sand (probably the material found in sample 4-4C), which rests upon sparitic root fills that penetrate into the brown organic mat. In the lower two units, sand is scattered throughout although it is locally concentrated into broad bands. The deposits have a spongier microstructure than those above, with more typical-looking, individualized, and less massive carbonate hypocoatings. This perhaps relates to

the fact that they are further below the flowstone capping with less supply of carbonate. There is not much evidence for human activity in this sample, except for a rounded mm-size piece of charcoal.

Comments: *Thus seem to have increasingly wet conditions with first formation of root/organic mat, then calcification along roots of organic material and then finally swamping of surface with active speleothem layer of dense calcite.*

Sample MB-4-32 [MAP# 46551; RYW-44] comes from the cave entrance, where ~ 3 cm thick cemented sand is draped against wall at 65° dipping to S. It is very fresh and hard, with numerous shells and lithics. In thin section, it consists of a dense packing of fresh bone, ash, and shell. Locally, the charcoal is perforated by roots, with hypocoatings and fillings of sparite.

One can see that this is a continuation of the Upper LC-MSA projecting out to the mouth of the cave, and further suggests that the LC-MSA at one time projected well out beyond the current cave mouth onto a sediment plane that abutted the cliff face

Comments: The sample represents essentially cemented sand and hearth material that was possibly blown around or moved by humans as hearth rake-out, for example.

Sample MB-4-33 (RYW-10, 11; MAP# 46552, note that this is quite close to 46557 and likely is from the same layer remnant adhering to the north wall of the cave)(photo of sample from field??) is from the north side, in the highest occupation layers (by elevation) in cave. It consists of a series of partly cemented burned layers about 1 cm thick, composed of black organic bands separated by white layers about 1 cm thick; it is capped by 2-3 cm thick hard, well-cemented ash with a stringer of darker color in the center. Underlying the lower black layer is ~5mm thick rubefied zone. Laterally, are mm-size coalescing white splotches of what appeared to be gypsum.

In thin section the upper part is composed of a mat of large interlocking gypsum crystals with interstitial hematite, which appear to have re-crystallized from smaller ones and 'exploded' the matrix, which contains some shell and bone fragments. (The fine size of the gypsum suggests that no soil water was present, as gypsum would have dissolved completely and not recrystallized. As such, recrystallization would have occurred under just a moist atmosphere only; and the deposit was never wetted.) In places it seems that there are remnants of organic aggregates, that are being oxidized and probably related to the formation of the hematite. Notable is a band of spherulitic calcite that post-dates the gypsum. This calcite is spherical, often of uniform size, and some possess a radial structure but without a cross. In one area very close to the top, there is some spicule-like object. The interstitial hematite is accompanied by some calcite.

The lower part of the sample is similar, with secondary spherulites formation that post-dates the gypsum. The lowermost part is comprised of massive calcite that impregnates charcoal and organic matter, thin weathered shell fragment remains, bone fragments, and crust/enterolithic-type guano pieces. The contact between the upper part and the lower massive micritic calcite is abrupt and sharp. Moreover, the micrite is recrystallizing to sparite. There are a few features that look like roots but not so many. The structure becomes vughy in the lower part.

Comments: Seems to be cap of tufa developed on top of a previously existing surface that was comprised of sediment and likely human occupation material, such as

charcoal/organic matter and bone. The sharp contact between this and overlying gypsum appears to be due to the gypsum 'attacking the basal carbonate zone.

Sample MB-4-38 [RYW-12; MAP# 46557,] . It consists of 1 cm of ash at the base, ~1cm of charcoal with bone, overlain by 2-3 cm of ash. The entire sequence is well indurated.

In thin section, calcite is replacing gypsum which itself is replacing a dark brown organic, phosphate rich horizon.

It is unclear what this relates to stratigrpahically, but it is a remnant of some MSA depsoits, and that remnant is present in several areas along the northern profile

MAP 46446 – similar to 46447, clear cap of calcareous casts roots, corresponds to an osl. This is from just near where the steeply sloping dune surface contacts and levels out with the flowstone

MAP# 46447 – pure aeolianite, with vados micritic cementation and fine root marks, correspondes directly to an osl sample, this is out near front of cave opening, this one connects directly to the LC-MSA Upper, and is stratigraphically below 46446

Central Part of Cave Eastern Area

Samples come from various portions of the excavated area in the central part of the cave. These excavations revealed deposits resting on bedrock up to a thickness of ____ cm.

Front middle area

Samples MB-03-05/6/14/23/24/25; Thin sections OYG-010/11/12/21/37/38/39/40/41

The upper part of the sequence (i.e. layers EC and ED) consists of roof spall embedded in a matrix of highly comminuted gray dirty, dissolving calcitic aggregates. Diamond-shaped gypsum crystals, anhydride aggregated (identified by FTIR), and cubic halite crystals locally cement the material. There are also shell fragments with etched edges, an abundance of burnt and unburnt bone, and charcoal fragments. In thin section OYG-040, there is a horizon rich in charcoal fragments probably representing in situ burnt remains. Recent roots are also visible in this top layer. In general, the layer resembles the top layer in the back of the cave.

Oyg-010-011 is from 20232 (N91.5E107.9)

Oyg-012 is from 20233 (N91.7E107.9)

Both are from the sothern area where the sediments are thin, and much of the MSA been stripped off

Below the top layer there is an apatitized zone that in some areas is quite thick (e.g., lower parts of sections OYG-010 and OYG-012, and section OYG-011); in some other areas it is more diffuse and thinner (lower part of section OYG-040). Clearly identifiable precipitated apatite nodules (photo OYG10 x100) (some of the bone is losing its interior structure due to recrystallization) can be recognized together with stringers of charcoal-rich material and burnt bones (OYG10 x50, OYG10 x50 xp), as well as some iron staining. The lens-like domains, rich in finely comminuted charcoal, as well as sand-size bone, appear to be the remains of combustion features. However, here they are

not strictly in place, but have been moved somewhat; a brown/black zone in middle appears to be more strictly in tact.
Oyg-040-41 is 20256 at (N91.8E109),

Below this apatite-rich layer there is a lower calcified layer with polyconcave vughs. In some thin sections, (e.g., OYG-040) the calcified layer is replaced gradually by overlying apatite and may also be mixed with the top layer. Gypsum crystals were identified in the intermediate zone. [Note that in this intermediate zone (section OYG-040) there are very few remnants of a low relief, low-to moderate birefringence mineral aggregate (magnesite?) (photo OYG40 x200c cp) that resembles those commonly found in the side breccia of the cave.]
Oyg-038 is 20255 at N92 E108.5

The calcitic cement of the lower layer is mostly sparitic with equant- or sometimes diamond-shaped crystals (photo OYG38 x50a, OYG38 x50a xp), which probably represent pseudomorphs after gypsum (photo OYG37 x100a xp). Clearly the calcite cement engulfs and replaces yellowish apatite nodules (photos OYG41 x100, OYG41 x100 cp, OYG38 x50a and OYG38 x50a xp). In thin section OYG-41, the entire upper part of the section is capped by a marked flowstone, including some cells of calcified rootlets that resemble those found in the north and south profiles. Locally, in between the sparitic calcite, there are areas with micritic calcite, which in most cases contain high amounts of microfragments of charred material (photo OYG41 x200). In one case there is a discrete horizon with a high amount of charred material that is less cemented than the surrounding area and contains some gypsum crystals. Calcitic shells and burnt bone fragments are frequently found. In the lower part of thin section OYG-021 the micritic calcite looks like ash.
Question – is oyg-041 above or below 40

Comments. It seems that the material has gone through a sequence of events that most likely started with a moderate apatitization period that did not affect the calcitic shells. It was followed by a stage of calcification that cemented all the material. After that it seems that the sequence was exposed during which the flowstone formed, which afterwards was subjected to renewed apatitization at the surface. At the same time, recent human activities introduced some calcitic material in the system (ash, shells) that is currently undergoing dissolution. If the above interpretation is the correct, then the calcification event took place during the formation (burial) of the sequence whereas the second apatitization event during the erosion and exposure of the sequence. It also seems that the prevailing process today in this area of the cave is decalcification and apatitization.

Front northern area in the center of the cave (eastern excavations)

Sample MB-4-4 (N92E108.3, this is in the N92 Line section) and exhibits loose, pale yellow sandy material at the top sharply overlying bedded anthropogenic deposits and combustion features.

In thin section the uppermost zone [*MB-4-4A; RYC-04]* consists clasts of tufa and phosphatized tufa, roof spall, and apatite nodules within a fluffy loose matrix rich in organic matter. Bone appears to be burnt in places. Shell fragments and other calcite are being dissolved. As elsewhere close to the surface, calcite is dissolving. [*Seems to be*

modern, redeposited trampled cultural material which has been imbedded with guano and in process of being dissolved.] This is the Truncated Fill of Marean

This overlies with a sharp contact a layer of more compact and organic-rich material *[MB-4-4B; RYC-05]* (corresponding to dark zone in the field) that contains digested and burned bones. Locally, at the base of 4-4B, bone is crushed and broken down in place as a result of trampling rather than transport, indicating that the combustion feature is essentially in tact. The presence of a reddened soil aggregate, which is likely rubefied by heating, suggests the proximity of soil material. *In all, it seems that this central zone represents trampled bone and organic-rich occupation horizon. This is the Upper Roof Spall of Marean*

At the very base [MB-4-4C; RYC-06] the sediments are overall similar to those of the middle part but with a less well-pronounced organic-rich zone. Thin stringers of charcoal occur that suggest in tact remnants of fire, although some seem to be trampled. In addition, remnants of phosphatic-crust-type and nodular apatite occur along with some bone. Charcoal is found with ash inside pores and voids, but it is more dispersed within the roof spall. A fragment of aeolian sandstone or perhaps breccia/tufa/calcrete looking material was observed. This is the Lower Roof Spall of Marean
Question – are those thin stringers of charcoal anthropogenic, or are they natural? WE found very few artifacts in these lenses.