Supplemental Digital Material
Chapter 3
Geomorphic Trench and Locality Descriptions

By

David B. Madsen, Charles G. Oviatt, D. Craig Young, and David Page

Here we provide trench and locality descriptions for geomorphological sample sites in both the proximal and distal sections of the Old River Bed delta. The proximal and distal sections are arbitrarily defined by the boundary between lands managed U.S. Air Force, Hill Air Force Base and U.S. Army, Dugway Proving Ground (for the location of this boundary see Fig. 1.2, Chapter 1, "The Paleoarchaic of the Old River Bed Delta" by David B. Madsen, Dave N. Schmitt, and David Page). Information on radiocarbon dates associated with these trenches can be found in Table 3.2, in Chapter 3 of that same monograph.

Sampling in the Proximal Old River Bed Delta

DPGNW-1 (UTM 309803 m E, 4457312 m N)

The Light Blue channel was trenched at the southern margin of the mudflats directly north of the ridge of eolian dunes separating the exposed and unexposed channel sections of the ORB delta (Fig. 1). Six trenches, each about 3 m long and 1.5 m deep, were dug about 6 m apart along a line perpendicular to the sand channel. The low-energy channel is clearly visible on the mudflat surface, where it is marked by a smoothly curved channel-shaped depression. Figure 2 illustrates the relationships exposed in one of the short trenches near the eastern margin of the low-energy channel. At the eastern end of the trench, marl deposited in the deep water of Lake Bonneville is exposed beneath the coarse sand, and north of the channel the marl is overlain by less than 0.5 m of mud on the mudflat surface. A radiocarbon age of ~9700 ^{14}C BP on snail shells (*Stagnicola* sp.) from the coarse sand is within the range of other ^{14}C age estimates from the Light Blue channel and may represent a relatively accurate age for deposition of the coarse gravel in the channel fill.

DPGNW-5 (UTM 312665 m E, 4456464 m N)

A series of trenches were dug at DPGNW-5 (Figs. 1 & 3). DPGNW-5(1) consisted of a 10-m trench that started on the flank of a high-energy Black channel, and which was parallel to with a series of short, shallow trenches across a low-energy channel that is probably part of the Light Blue channel system. DPGNW-5(2) was dug parallel to DPGNW-5(1) about 6 m to the east, and showed the stratigraphic relationships between the two channels. Trench DPGNW-5(3) was dug on the opposite (north) side of the Black channel at the same locality where no low-energy channel was present. Bonneville marl is overlain in these trenches by silt and fine sand. In DPGNW-5(1) and DPGNW-5(2), however, the silty sediments directly above the marl are highly disrupted – the bedding is broken and discontinuous, and layers can be traced no farther than about a meter. Isolated bodies of fine sand or silt contain contorted bedding. Except for the deformed bedding, the lithology is identical to the lacustrine fines in other exposures, so we interpret the disrupted sediments as slumped lacustrine fines. A sample of charcoal from the disrupted lacustrine fines yielded a radiocarbon age of ~14,100 ^{14}C BP. At 14,100 ^{14}C BP Lake Bonneville was occupying the Provo shoreline (~1480 m in this area), indicating that the charcoal sample at DPGNW-5(2) was reworked from older deposits. The age, however, provides a

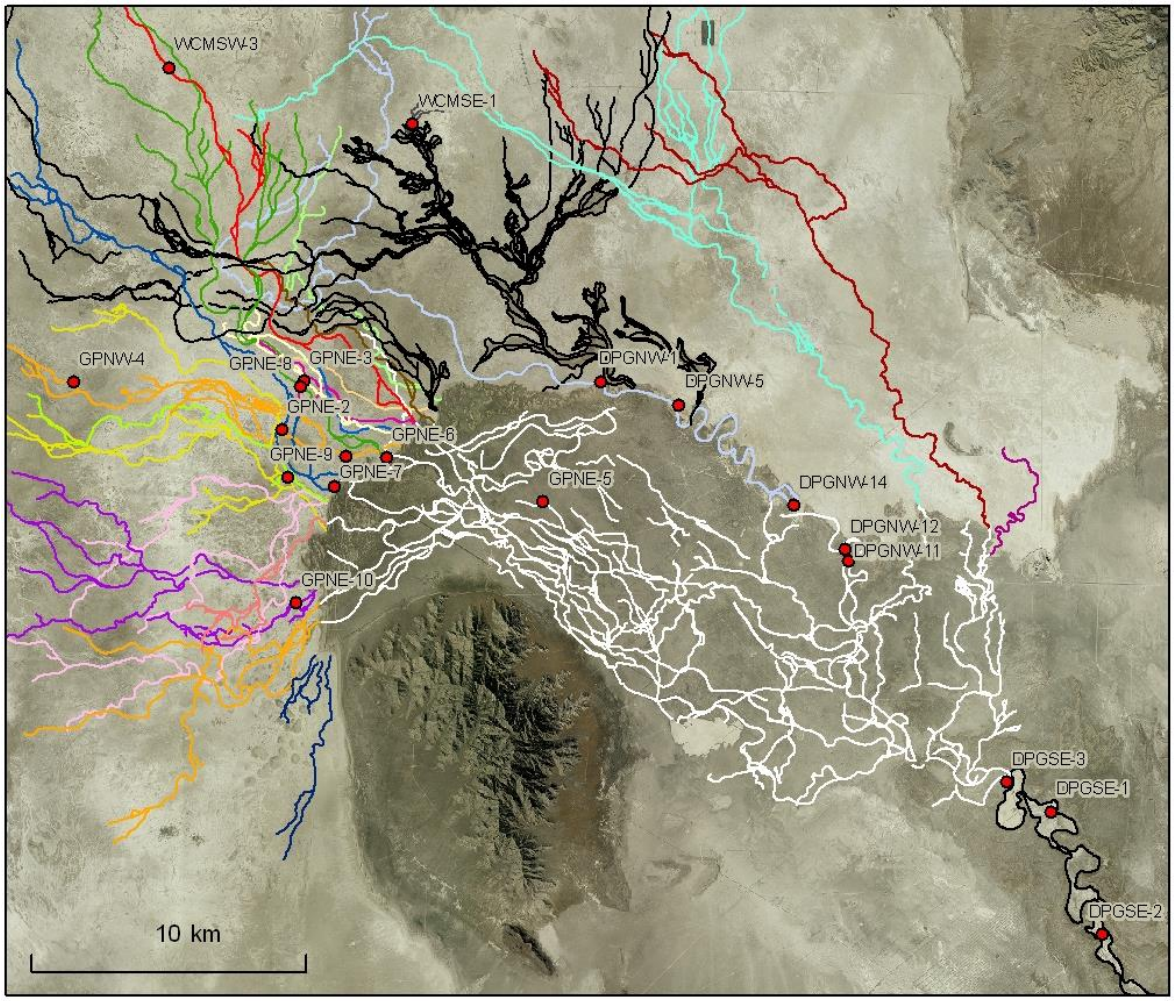

Figure 1 - Selected trench and surface sampling locations in the proximal ORB delta.

maximum-limiting age for the lacustrine fines on both sides of the Black channel, the Bonneville marl and the lacustrine silt and fine sand are unconformably overlain by coarse sand and gravel of the Black channel. In addition, the Light Blue channel deposits unconformably overlie the Bonneville deposits (in this case, the Light Blue channel does not cut laterally into the Black channel, but cuts into the lacustrine fines that underlie the Black channel). Black mat deposits, which we tentatively think are associated with the Light Blue channel deposits, were identified imm ediately south and west of the trench area. These organic deposits contain the remains of Utah Chub (*Gila atraria*). A bulk organic sediment sample from this black mat dates to ~9850 ^{14}C BP (DPGNW-5c). Four additional dates directly on organic material (seeds and plant remains) from the same exposure average ~9400 ^{14}C BP.

DPGNW-11 (UTM 318818 m E, 4450769 m N)

An old gravel pit just south of the dune covered margin between the exposed and unexposed channel sections of the ORB delta (Fig. 1) reveals sand and gravel overlain by organic-rich mud. We initially obtained two radiocarbon ages of 11,440 ± 50 (DPGNW-11D) and 9660 ± 50 (DPGNW-11C) ^{14}C BP from bulk organic samples collected from the mud in two hand dug trenches along the old exposures. In order to test these ages, which appear to place a minimum limit on the age of gravel associated with early high-energy Black channels, we dug four backhoe trenches along the margins of the gravel pit. The

trenches expose the stratigraphic relationships between the fill of the high-energy channel and the fine-grained channel fill of a low-energy channel adjacent to it.

The fine-grained channel fill stratigraphically overlies the gravel, and was deposited after the gravel was laid down in a braided river system. We obtained new radiocarbon ages on organic black mats in the fine-grained channel fill of the low-energy channel (Fig. 4). Because we were working with a small hand-dug exposure when the initial radiocarbon samples were collected, it is not clear which, if any, of the black mats illustrated in Figure 4 yielded the ages of 11,440 and 9660 ^{14}C BP. The average of all five ages, however, is ~10,300 ^{14}C BP, and this can be regarded as a reasonable minimum-limiting age for the underlying gravel of the high-energy channel. Other than the 11,440 ^{14}C BP age, the oldest ages from fluvial deposits in the proximal ORB delta are ~11,100-11,000 ^{14}C BP. We are therefore cautious about using the 11,440 ^{14}C BP age. It is, however, within the age range we estimate for initial ORB delta formation based on a constant regression rate from the Provo level of Lake Bonneville to near modern levels preceding the Gilbert episode.

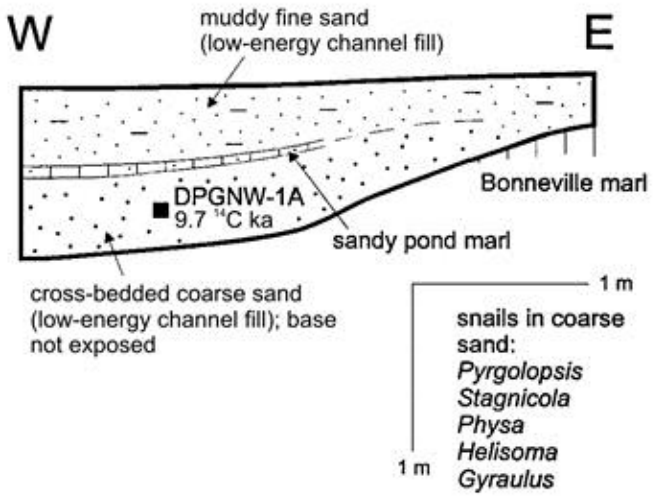

Figure 2 - Schematic diagram of one of the short backhoe trenches at DPGNW-l, through the Light Blue channel.

Figure 3 - View of hand-excavated trench at site 42To1000 with a partially exposed black mat dating to ~9800 ^{14}C BP underlying channel sands of the Light Blue channel.

Trough cross-stratification in the gravel is similar to that in other exposures of gravel associated with the Black channels in the exposed channel section of the ORB delta. The cross-stratification, the lack of fines, and the overall form of the high-energy channels all suggest deposition in a braided river system (compare with descriptions in Prothero 1990, p. 52-55).

DPGNW-12 (UTM 308687 m E, 4451198 m N)

A long trench at site DPGNW-12 (Fig. 1) revealed cross-bedded and foreset gravel at the distal end of an early high-energy Black channel in the unexposed channel section of the ORB delta. Muddy channel-fill sediments associated with a low-energy channel overlie the gravel. There is a radiocarbon age of ~9920 ^{14}C BP on a black mat in the muddy channel-fill sediments. The Black channel gravel is cross-bedded throughout, and long foresets are evident in the gravel at its northern end, where the gravel dips down slope and under the channel-fill mud. This lobe of the Black channels is part of the gravel deposit that is exposed in the gravel pit several hundred meters to the south. We interpret this gravel as part of a high-energy Black channel that was deposited as stream power dropped.

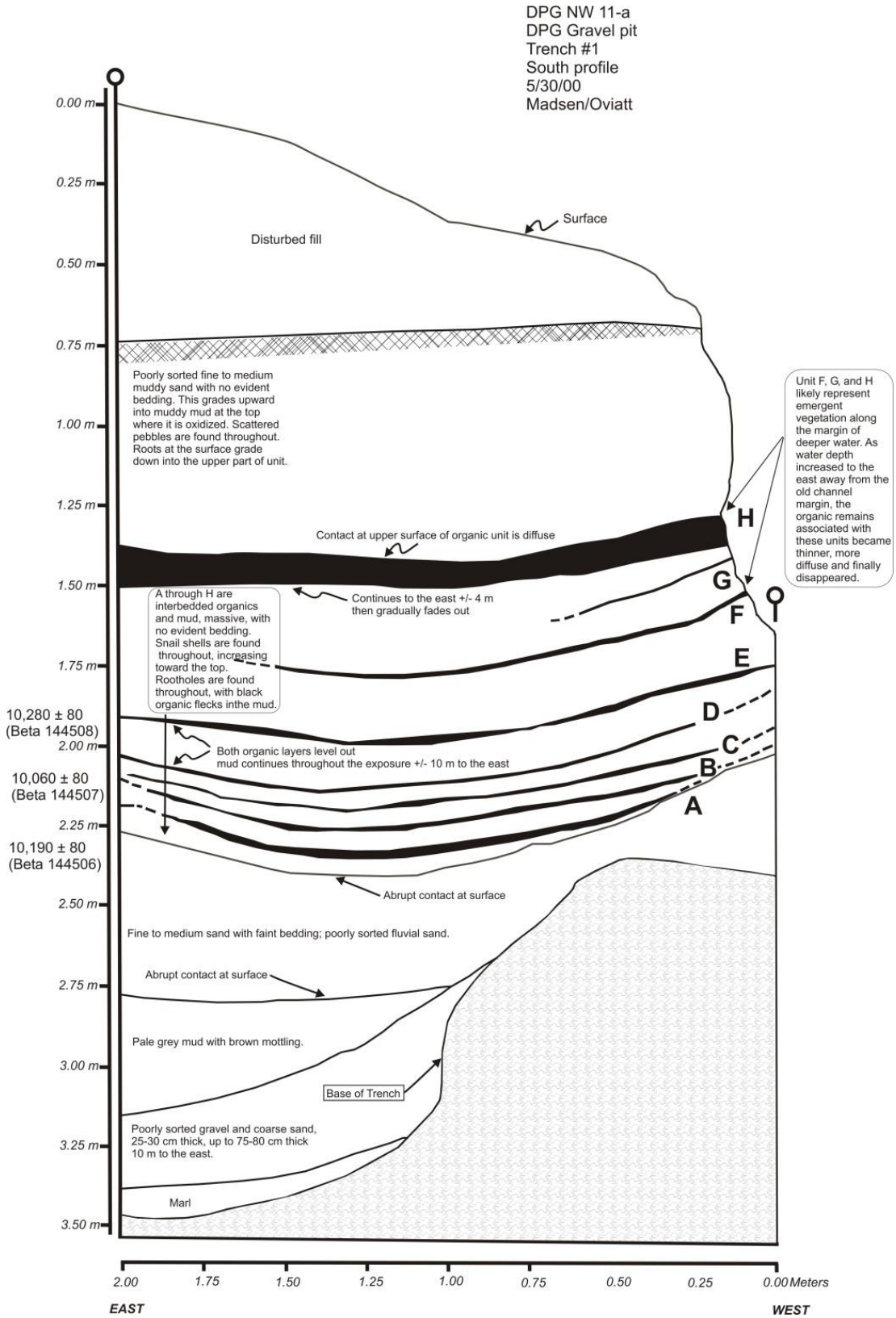

Figure 4 - Measured profile of radiocarbon sample locations at DPGNW-11A (DPGGPIT) showing relative position of black mats in channel fill. These postdate river flow which deposited the underlying gravels. Trench 11a is the northern-most east-west trench in a series of four.

DPGNW-14 (UTM 316823 m E, 4452807 m N)

A site designated as 42TO1161 yielded a radiocarbon age of ~8800 ^{14}C BP from a low- energy channel (Fig. 1). The sample was collected from a natural black mat exposure containing abundant shells of fresh-water clams (*Anodonta* sp.), and no backhoe trench was dug here. Aerial photographs indicate that the low-energy channel at this location is part of the same Light Blue channel system as at DPGNW-11, DPGNW-9, DPGNW-5, DPGNW-7, and DPGNW-1.

DPGSE-1 (UTM 326196 m E, 4441641 m N)

A backhoe trench within the entrenched ORB valley was dug to search for evidence of the last flow through the Old River Bed (Fig. 1). At this locality, the uppermost 3 m consists of poorly sorted sandy silt, which we interpret as alluvium (Fig. 5). It overlies about 0.5 m of thinly bedded sandy silt, containing four thin layers of black organic debris, and coarse fluvial gravel at the base of the trench. We obtained radiocarbon ages for six samples from DPGSE-1 (Table 3.2). Most are in stratigraphic order except for DPGSE-1E. This sample consisted of small flecks of charcoal dispersed in cross-laminated sand. The age of ~25,000 ^{14}C BP is anomalously old, and we interpret the charcoal as reworked from older deposits. The other ages range from about 11,000 to 9400 ^{14}C BP, and suggest that the ORB valley was wet and supporting marsh/wetland vegetation for this entire period. It is still unclear how old the basal fluvial gravel in DPGSE-1 is, but the lowest age in the sequence (~11,000 ^{14}C BP) indicates Lake Bonneville had regressed to below ~1330 m before this time.

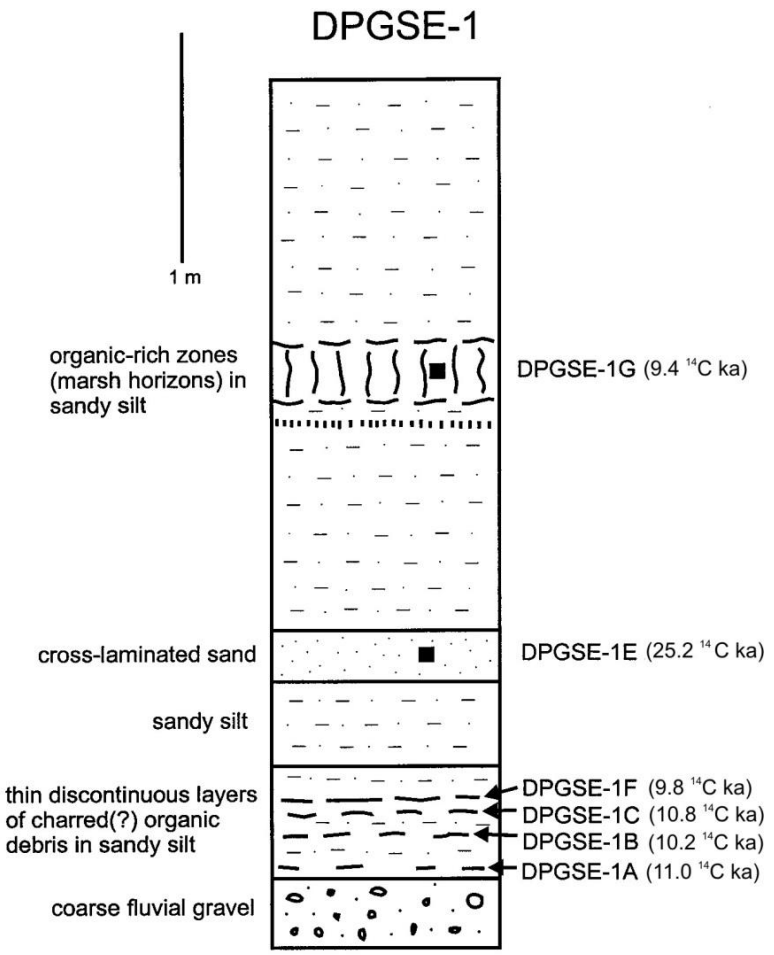

Figure 5 – Stratigraphic section at DPGSE-1 showing relationship of dated samples.

DPGSE-2 (UTM 328059 m E, 4437155 m N)

This trench was dug on the floor of the entrenched ORB valley (Fig. 1), about 4 km upstream along the Old River Bed from DPGSE-1. The stratigraphic sequence at DPGSE-2 is very similar to that at DPGSE-1. Fluvial coarse sand and gravel at the base of the pit is overlain by sandy mud and poorly sorted sand that contains thin beds of black organic material (which appears to consist of charred plant stems and leaves). Diffuse organic matter in poorly sorted sand just above an unconformity ~3 m above the base of the trench dates to ~9000 ^{14}C BP suggesting the deposits were laid down relatively late in the ORB sequence. One of the thin beds of charred organic material from low in the trench yielded a radiocarbon ag e of ~9880 ^{14}C BP, which is consistent with the ages of similar organic units near the base of trench DPGSE-1.

DPGSE-3 (UTM 324603 m E, 4442724 m N)

This backhoe trench was dug in the northern end of the well-defined ORB valley (Fig. 1). The overall sedimentology and stratigraphy in this trench are similar to those in DPGSE-1 and DPGSE-2, but DPGSE-3 shows some interesting differences. At DPGSE-3 coarse sand and gravel at the base is overlain by silty sand, which is overlain by reddish and brown silty clay that contains organic material (Fig. 6). There are three radiocarbon ages from the reddish silty clay. One on plant material of ~8850 ^{14}C BP likely provides a reliable age for deposition of the clay. The two other age estimates of ~9330^{14}C BP and ~9950 ^{14}C BP are on *Anodonta* sp. shell and may be contaminated by older carbon. The major difference between DPGSE-3 and DPGSE-1 and 2 is the presence of about 2 m of cross-laminated and cross-bedded, well-sorted sand overlying the silty clay (Fig. 1). This sand is interpreted as fluvial in origin based on the trough cross laminations and the presence of aquatic snails (*Stagnicola* sp.).

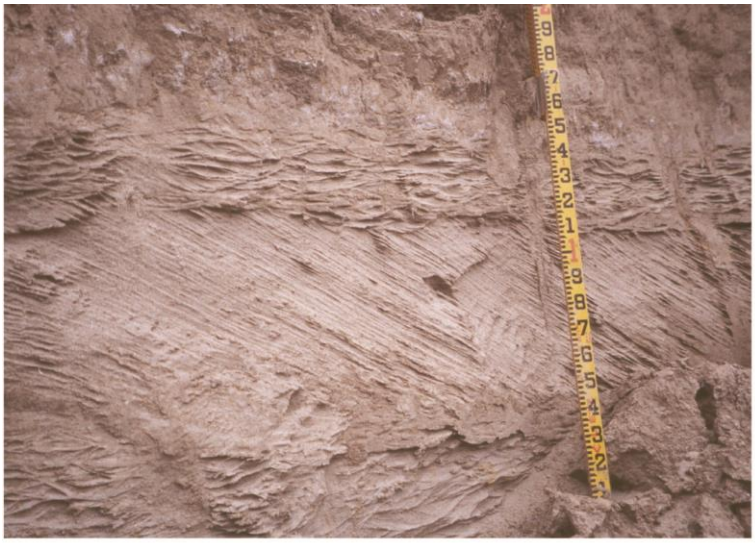

Figure 6 - Ripple-laminated and cross-bedded sand in the upper part of the section at DPGSE-3. The trough-shaped ripple laminae suggest fluvial deposition. Scale is in feet and tenths of feet.

GPNE-2 **(**UTM 298209 m E, 4455569 m N)

This 12-m-long trench runs east from the margin of a dune covering the Blue channel to the exposed mudflats along the edge of the channel (Fig. 1). At the deepest end of the trench towards the center of the channel and the center of the dunes the stratigraphic section is as follows: surface-88 cm – aeolian silty sand; 88-113 cm – weakly formed soil on the surface of fluvial sediments, slight reddening, gypsum crystals and granules at surface; 113-228 cm – fluvial cross-bedded fine to medium sand and mud (Fig. 7). The surface of the mudflats east of the channel is 40 cm below the top of the buried soil, suggesting there has been that degree of mudflat deflation since dune building began on the channel surface. The top of the dune west of the trench is 3 m higher than the surface on the west end of the section described above and 5 m higher than the east end.

GPNE-3 (UTM 299004 m E, 4457321 m N)

An 8-m-long N-S trench was excavated across the Buff channel where it is inset into the margin of the older Fuchsia channel, exposing a series of higher and lower energy stream flows characterized by sands and gravels in the former and clays and silty clays in the latter (Fig. 1). The Fuchsia channel deposits consist of rippled laminated to cross-bedded medium fluvial sands at the surface. A series of muddy clay beds forms the fill of the inset Buff channel (Fig. 8, A & B). Four of these muddy clay deposits consist of thin ~5 cm thick units of reddish-brown to salmon-colored clay sediments that may ultimately have derived from the Arapien Shale far upstream along the Sevier River. If so, that implies the Buff channel was created by overflow over the ORBT threshold from the Sevier basin, at least episodically, rather than by groundwater. Alternatively, the red muds could be the result of the reworking of older, upstream sediments during extreme storm events, although the extremely clean and uniform nature of the sediments argues against this explanation. Intervening clay deposits consist of olive to gray muds containing plant macrofossils, a variety of gastropods, and *Anodonta* sp. shell. This series of muddy clay beds overlies coarse sand and pea gravel that appear to be related to the initial formation of

the Buff channel. A sample of plant macrofossils (unidentified sedge or grass) collected from a depth of 120 cm below the surface from muds immediately overlying these basal sands and gravels dates to ~9200 ^{14}C BP. The age estimated provides a closely limiting date on the age of initial channel formation. A companion sample of gastropods from this unit was also collected but not dated.

GPNE-5 (UTM 307710 m E, 4452944 m N)

An existing pit in the unexposed channel section of the ORB delta north of Granite Peak reveals about 1.5 m of silt, clay, and fine sand overlying an organic-rich wetland deposit (Fig. 1). From the limited exposure it is difficult to tell if the black mat is associated with channel fill or is part of an overbank wetland deposition. The black mat dates to ~9500 ^{14}C BP.

GPNE-6 (UTM 301998 m E, 4454537 m N)

This is a short, 3 m long, E-W trench excavated to explore the sediments below a black mat on the Green channel fill previously dated to ~9300 ^{14}C BP (Fig. 1). The black mat dips to the east 50 cm within the length of the trench, and it, and the sediment package around it, appears to fill a channel running north-south. Lightly banded thin silty clay laminae fill this basin (Fig. 9). This is almost

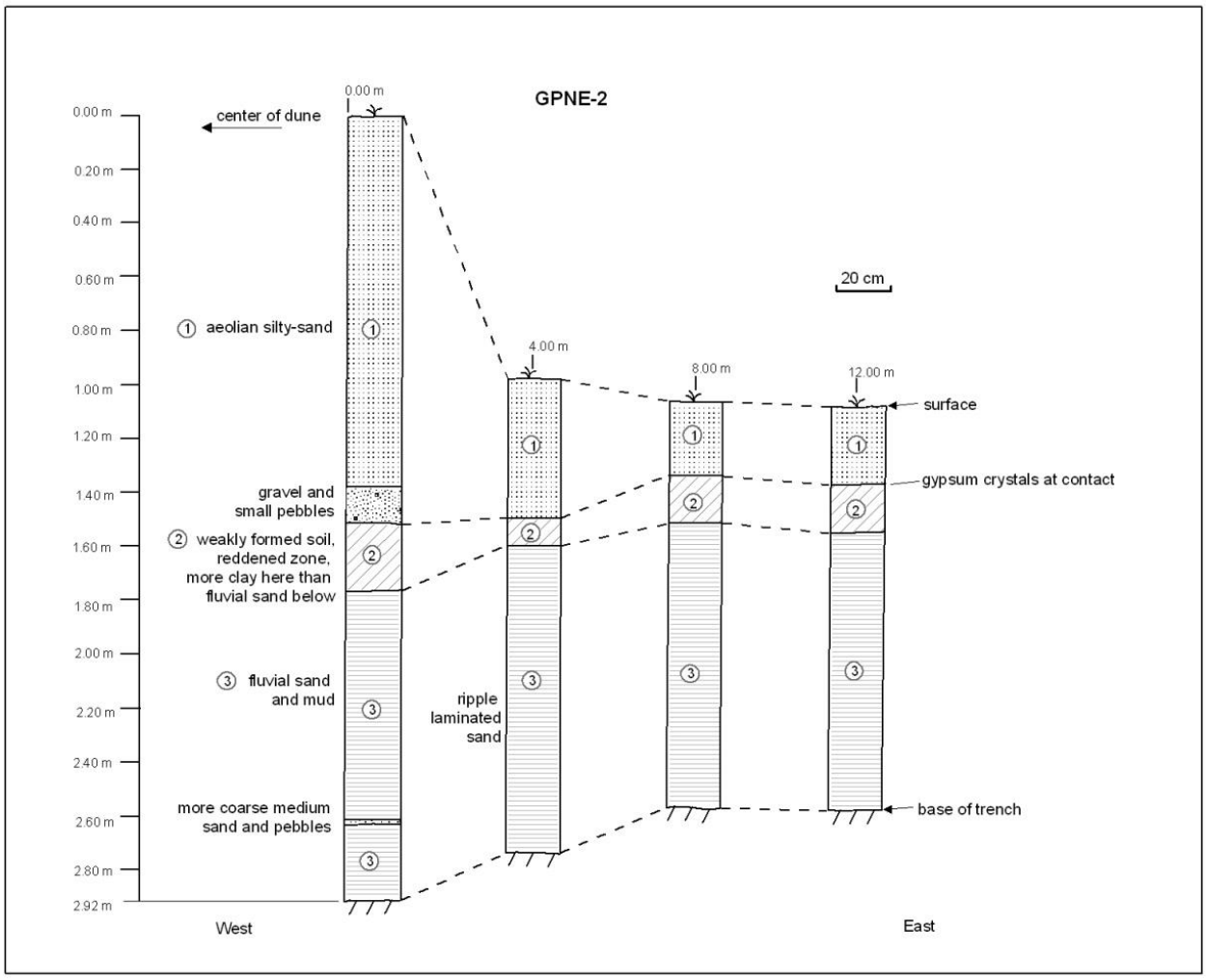

Figure 7 - Cross-section drawing of Blue channel sediments in the GPNE-2 trench profile. Sand and gravel lenses in the deepest part of the trench are not visible throughout the section

perpendicular to the direction the Green channel appears to flow in air photos, and it may be that these deposits and the date are from a later crosscutting channel and not the Green channel at all. The black mat deposit is ~10 cm thick and is composed of an upper and lower unit, each 3-4 cm thick, sandwiching an orange-stained silty clay layer. Overall trench depth is 80 cm.

GPNE-7 (UTM 299326 m E, 4453728 m N)

A hand-dug trench in a channel meander that is part of several within the Blue braided channel system was excavated to a depth of 1.25 m and revealed 70-100 thin organic lenses alternating with muddy silt (Fig. 1). These alternating organic and silt lenses overlie a 1-3 cm thick layer of reddish clay possibly derived the Sevier basin and basal sands and gravels likely related to initial flow in the channel (Fig. 10, A & B). The upper units appear to represent groundwater flow in the channel supporting marsh/wetland vegetation that dried at times and was buried by eolian silts. The uppermost organic lens dates to ~9450 ^{14}C BP and one at a depth of 96 cm dates to ~9530 ^{14}C BP. A third radiocarbon sample from a black mat collected at the surface of another meander within the Blue channel system 830 m east of the trench locality dates to ~9750 ^{14}C BP, suggesting the Blue channel distributary system initially formed sometime prior to ~9800 ^{14}C BP.

GPNE-8 (UTM 298869 m E, 4457120 m N)

We sampled a black mat on the surface of a Green channel distributary for radiocarbon dating. The sample location is on the margin of an interior channel bend (Fig. 1). The black mat consists of two ~5 cm thick lenses of organic stained soil, plant parts and a hash of a wide variety of snail shells. *Anodonta* sp. shells and fish bones, probably Utah chub (*Gila atraria*), were also present. The lower organic unit dates to ~10,000 ^{14}C BP and the upper unit dates to ~10,300 ^{14}C BP. While the dates are stratigraphically inverted, they overlap extensively when converted to calibrated years, and the entire sequence was probably laid down very rapidly. The combination of aquatic snails, *Anodonta*, and fish bones suggests flowing water in a channel formed at the end of the Green channel sequence.

GPNE-9 (UTM 298426 m E, 4453818 m N)

A 5-10-cm-thick black mat on the surface of the Yellow channel was sampled for radiocarbon dating. The black mat is on the margin of a broad braided channel section and represents either a late meander or a groundwater-supported wetland after active stream flow ceased (Fig. 1). Unidentified plant parts produced an age estimate of ~10,130 ^{14}C BP.

GPNE-10 (UTM 298712 m E, 4449251 m N)

A radiocarbon sample was collected from a black mat on the surface of the Lavender channel where it is covered by a small dune (Fig. 1). The dune appears to have protected the black mat from deflation and the black mat is only visible along the margins of the dune. At present, the 5 cm thick black mat is only present on the Lavender channel surface, but it may have originally extended out across the surrounding mudflats as part of an extensive overbank marsh/wetland. Regardless, an age estimate of ~9010 ^{14}C BP on identified plant material from the black mat provides a limiting date for the initial formation of the Lavender channel. The black mat appears to be directly associated with site 42To2948 and the date provides an approximate age estimate for when the site was occupied.

GPNE-11 (UTM 300509 m E, 4454589 m N)

Two short, shallow trenches were excavated to explore the deposits below a black mat covering the Gold channel fill at this location (Fig. 1). The black mat is ~5 cm thick at the surface and overlies what appears to be massive regressive Bonneville Lake clays. A ^{14}C sample of the black mat was collected southwest of these trenches. At the sample location, the black mat is 3-4 cm thick and underlies a 3-5 cm thick clay surface deposit. The top of this upper unit is oxidized. The black mat in turn overlies

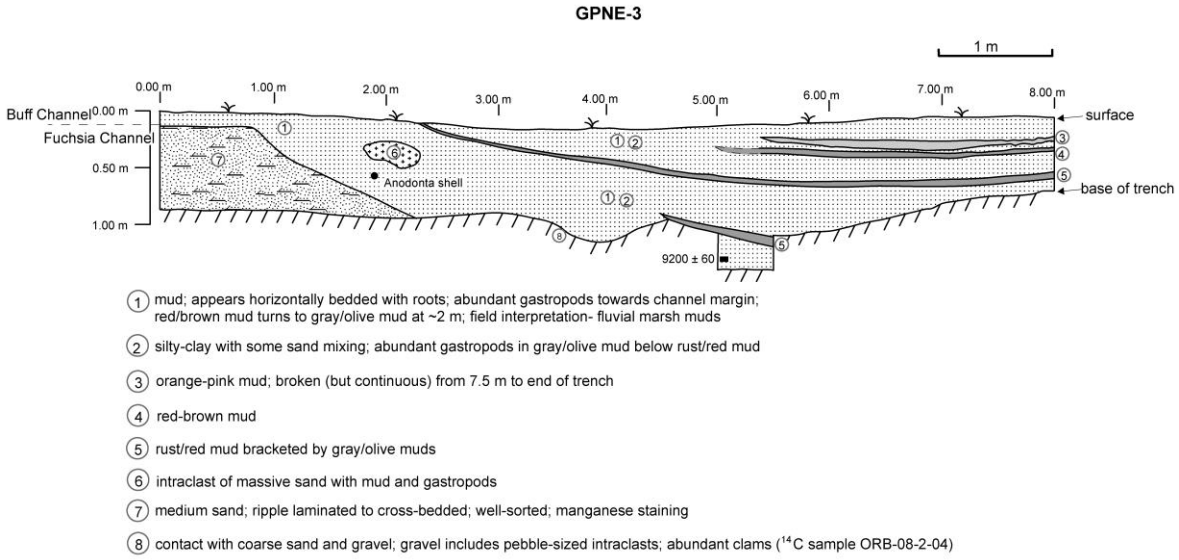

Figure 8 – (A) Photo of Buff channel profile in the GPNE-3 trench. (B) Cross-section drawing of the Buff channel profile in the GPNE-3 trench.

a 3-4 cm layer that appears to represent shallow pond deposits. All of this overlies the massive lake clays. The whole black mat sequence extends across the surface of the Gold channel onto both sides of the surrounding mudflats. It appears to significantly post-date Gold channel flow, but does provide a limiting age for channel flow. What appears to be leaves of a sedge (*Schoenoplectus* sp.), but which could be a grass, were dated to ~9250 ^{14}C BP. A variety of gastropods, *Anodonta* sp. shells, and fish bones, likely Utah Chub (*Gila atraria*), were observed in the black mat.

GPNW-4 (UTM 290623 m E, 4457285 m N)

This is a surface black mat sample associated with a Gold channel distributary (Fig. 1). Both plant macrofossils and a gastropod shell "hash" are present and samples were collected for radiocarbon dating. The location is at 1294 m on the mudflats. Without trenching the locality it is difficult to tell whether the black mat is directly associated with Gold channel flow, represents a groundwater fed marsh/wetland within the channel, or represents overbank wetland deposits. *Phragmites* sp. leaves in the black mat date to ~10,460 ^{14}C BP (GPNW-4a), so the channel must have formed sometime prior that time. A paired date on gastropod shells (*Gyraulus* sp.) from the snail "hash" dates to ~10,720 ^{14}C BP (GPNW-4b).

WCMSW-3 (UTM 294082 m E, 4468753 m N)

A black mat radiocarbon sample was collected from the mudflat surface immediately east of a topographically inverted gravel armored channel "island" on the proximal end of the ORB delta (Fig. 1). This is an area where the Red channel runs parallel to, and occasionally meanders back-and-forth across, the Green channel and it is difficult to tell with which channel the black mat is associated. Although the black mat appears to be associated with the higher-energy channel, it appears to post-date initial flow in the channel and may represent groundwater flow supplying a marsh/wetland covering the surrounding

Figure 9 - Photo of Green channel sediments in the GPNE- 6 trench profile.

mudflat surface, or flow in a younger, parallel, channel. A backhoe trench would be required to resolve this issue. Regardless, the age estimate provides a minimum limiting date for initial Green channel flow. Unidentified plant remains in the sample date to ~9800 ^{14}C BP.

WCMSE-1 (UTM 302960 m E, 4466682 m N)

Two radiocarbon samples were collected from a black mat exposed in shallow hand-dug pits along the edge of a digitate end of the northernmost end of Black Channel A (Fig 1). Hand-dug trenches at the center of the channel indicate the black mat extends completely under the Black Channel A gravels and also indicate there was no channel incision in this area. This suggests the channel gravels were deposited over an older black mat after rising lake waters had flooded the locality.

Sample WCMSE-1b was collected from the west side of the channel (UTM 302464 e, 4466094 n) at a depth of 25 cm below surface (Fig.11). The 1 cm thick black mat is overlain by 20 cm of reworked silty sand with some armoring gravels apparently derived from slope wash from the adjacent topographically inverted Black Channel A sediment, and by 4-5 cm of clay. The black mat sits atop fine cross-bedded sands from earlier fluvial deposits, but also extends across the regressive Bonneville muds of the adjacent mudflats. The surface on which the black mat rests is relatively level, but its depth below surface increases towards the Black Channel A center due to the slope angle of the channel margin. The age of the sample is ~11,020±60 ^{14}C BP.

Sample WCMSE-1c was collected from a similar situation on the east side of the same Black Channel A

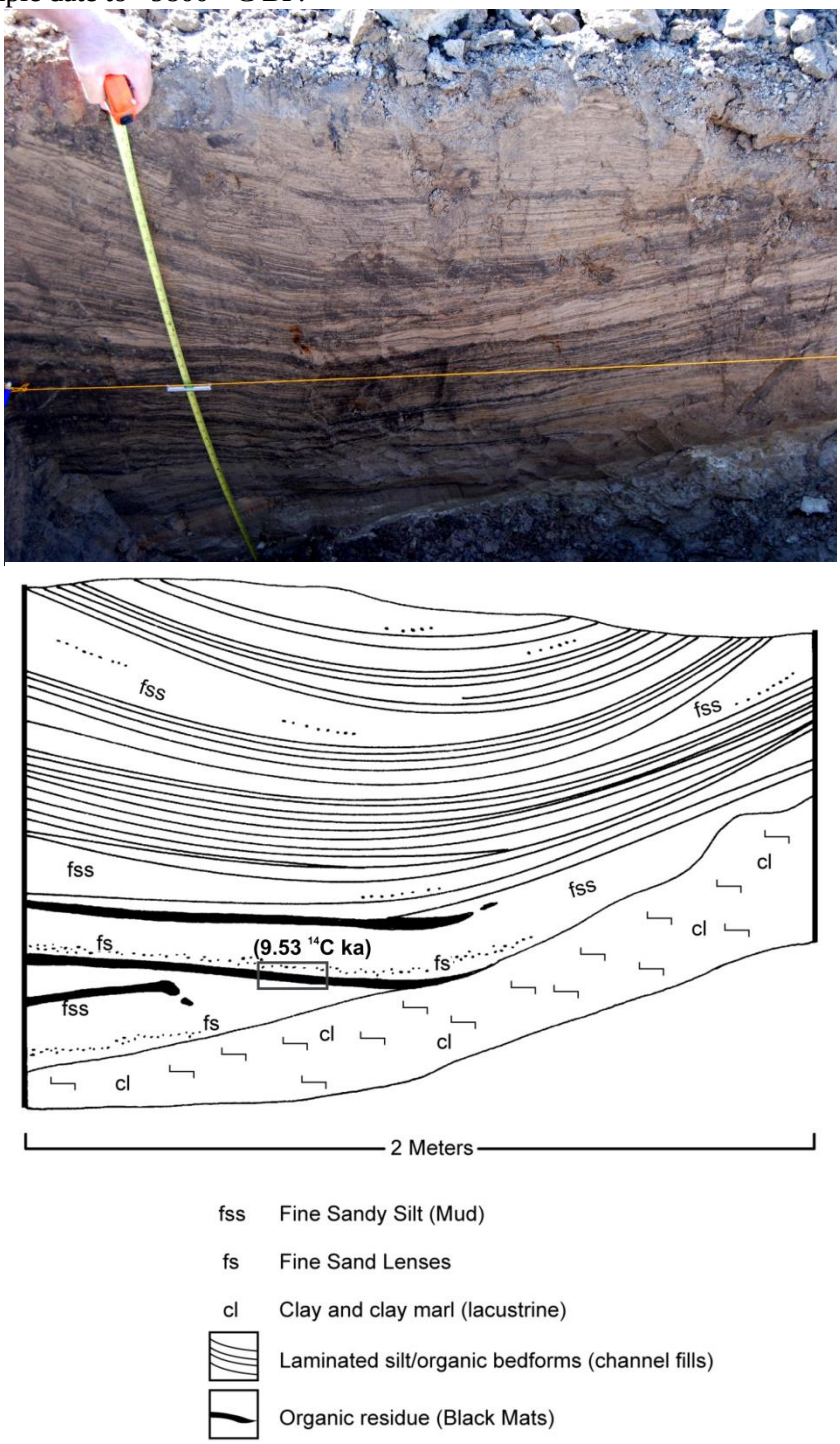

Figure 10 – (A) Photo of Blue channel sediments in the GPNE-7 trench profile. (B) Cross-section drawing of Blue channel sediments in the GPNE-7 trench. Loqwee aands and gravels are not visible in either image.

distributary in what we have informally called "Lake Itssospecial" (UTM 303026 e, 4466269 n). This is a small area of denuded mudflats completely surrounded by the topographically inverted channel (Fig 12). At the sample locality the 1 cm thick black mat is 45 cm below the surface. The surface unit consists of reworked silty sand armored by gravel that appears to be material moved by slope washed from the adjacent black channel. No overlying clay deposit is present at this location. Below the black mat the sediments consist of fine cross-bedded sand extending beyond a depth of at least 60 cm below the surface. The age estimate of 11,050±60 ^{14}C BP on this sample is statistically indistinguishable from the age estimate for the other black mat sample and helps confirm the geomorphological assessment that the black mats are all a product of the same event, an event that predates formation of Black Channel A.

The two black mat samples are related to a sample of gastropod shells collected in a Limestone channel distributary that cuts across the digitate end of the Black Channel A distributary (UTM 302960 m E, 4466682 m N). Shells of the fresh water clam *Sphaerium* sp. from the Limestone channel yielded an age estimate of ~10,590 ^{14}C BP (WCMSE-1a). If valid, the date would mean Black Channel A formed between ~11,000-10,600 ^{14}C BP. However, the date is on shell, and is likely older than its true age (see Oviatt et al. 2005).

Figure 11 - View of a buried black mat dating to ~11,040 ^{14}C BP. along the fringe of the northernmost Black channel at WCMSE-1b. The black mat is below what would have been the ground surface when the gravels of the Black channel were laid down, and, thus, likely pre-dates formation of the Black channel.

DPGNW-T9 (UTM 316747 m E, 4444762 m N)

A shallow trench was excavated through a buried channel (Fig. 1) adjacent site 42To3834 to test for the possibility of buried cultural features. No such features were encountered, but the upper portion of a channel cut-and-fill sequence was revealed. The upper 38 cm of fill is composed of aeolian silts. These overlie a sequence of cross-bedded medium sand (38-76 cm below surface), a massive reddish clay layer (76-79 cm), horizontally bedded silt (79-101 cm), a dark organic band (101-103 cm), and massive fine sand (103-150 cm). The base of the channel was not encountered. Unidentified plant parts collected from the organic band produced an age estimate of 9080±50 ^{14}C BP. The overlying red mud that post-dates this age estimate may, like other red mud deposits in the ORB delta, be derived from the Arapien Shale far upstream along the Sevier River, and may have been deposited either during an episodic period of overflow or following reworking of upstream deposits.

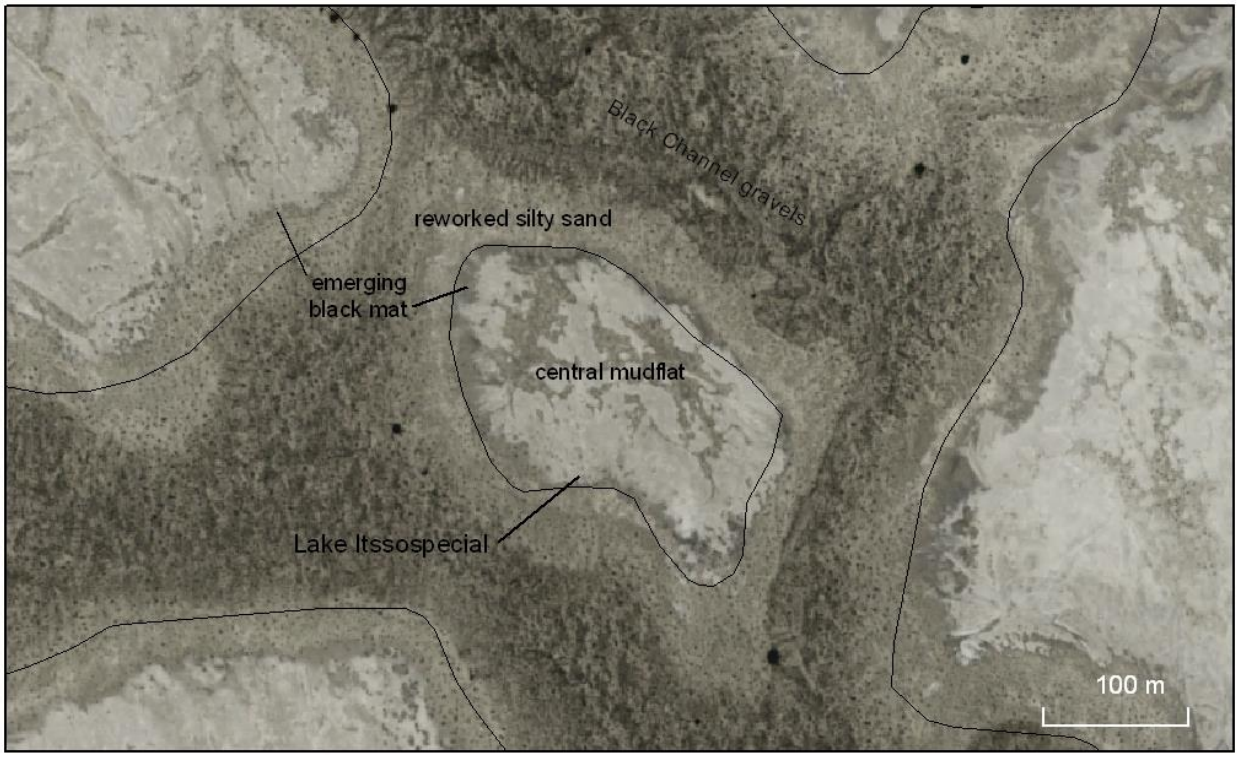

Figure 12 - Aerial photo of "Lake Itssospecial" showing central mudflat, emerging black mat, reworked silty sand, and Black channel gravels.

DPGNE-T21 (UTM 319386 m E, 4448189 m N)

Like the T9 trench, this trench was excavated to test for subsurface cultural deposits adjacent site 42To3946. The trench was excavated through what would have been a point bar in a channel oxbow. No cultural materials were encountered, but the trench revealed a channel fill sequence much like that at trench T9. The upper 85 cm is composed of aeolian silt. The channel fill sequence below these wind-blown deposits consists of muddy clay (85-142 cm), mud with dispersed organic lenses (142-160 cm), fine sand with little cross-bedding and red mud (200-215 cm). Scattered plant parts from this red mud produced an age estimate of 8790±40 ^{14}C BP and may represent the youngest period of overflow from the Sevier Basin, although this requires confirmation.

Sampling in the Distal Old River Bed Delta

Locality 2

Along the northern arm of the Wild Isle Dune, variations in surface texture mark subtle traces of the distal delta. Discovered early in our investigations at Wild Isle, the channel at Locality 2 (Fig. 13) was documented using an auger transect which exposed a well-defined sand-filled channel approximately 20 meters wide and almost a meter deep (Fig. 14). The channel is cut into silty fine sands that rest on lacustrine clays of former Lake Bonneville highstands. A nearby terrace of silty fine sands is capped by a thin black mat. This mat was sampled during archaeological excavations at 42To1046. Stratigraphically below the local archaeological assemblage, the organic sediments provide a limiting date on both the flake stone assemblage and local black mat deposition at ~8900 ^{14}C BP.

Locality 10

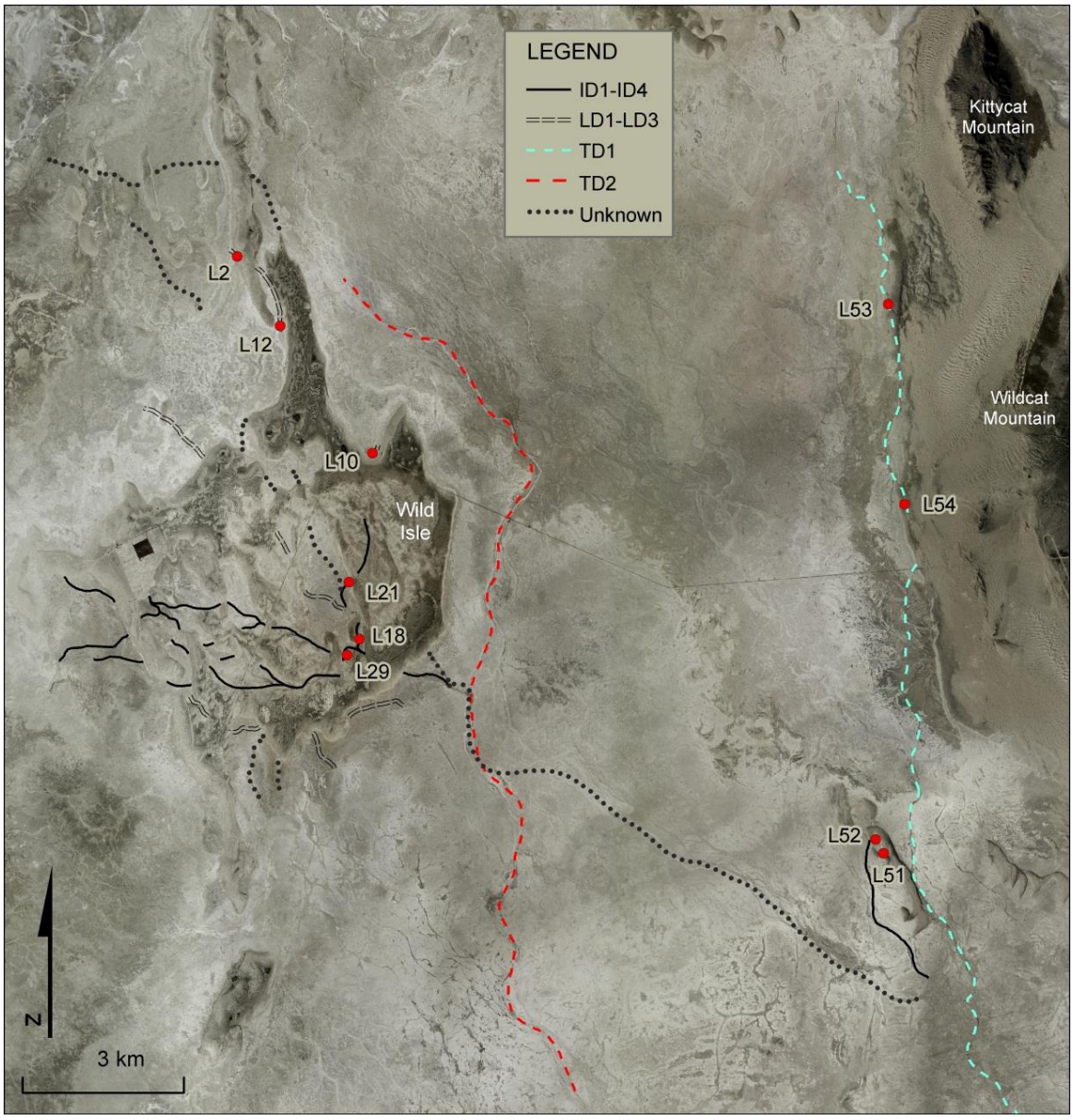

Figure 13 - Distal ORB overview with place names, study localities, and channel groups.

Archaeological investigations at 42To1016 on the northern margin of Wild Isle, including two back-hoe trenches, revealed an artifact assemblage in a terrace position marked by a prominent black mat (Fig. 13). The channels associated with the terrace at Locality 10 extend only a short distance from the base of the north-trending arm of the Wild Isle Dune. The channel is cut into red-hued fine to coarse sands intercalated with thin fine sand and silt beds whereas the terrace is a generally massive fine silty sand capped by an organic black mat. Flotation failed to recover plant macrofossils, but the organic sediments provided a limiting date of ~8800 ^{14}C BP for local organic deposition and relative terrace stability (Terrestrial snail shells from this locality are dated to ~10,600 ^{14}C BP; the date may reflect a local carbonate reservoir.). An older channel cut deeply into the lacustrine facies underlying the red-hued sands is also present in the western area of Locality 10. The levees or margins of this western channel show complex cross- and scalloped-bedding, features that may actually be bed- or channel-forms of an earlier Locality 10 channel.

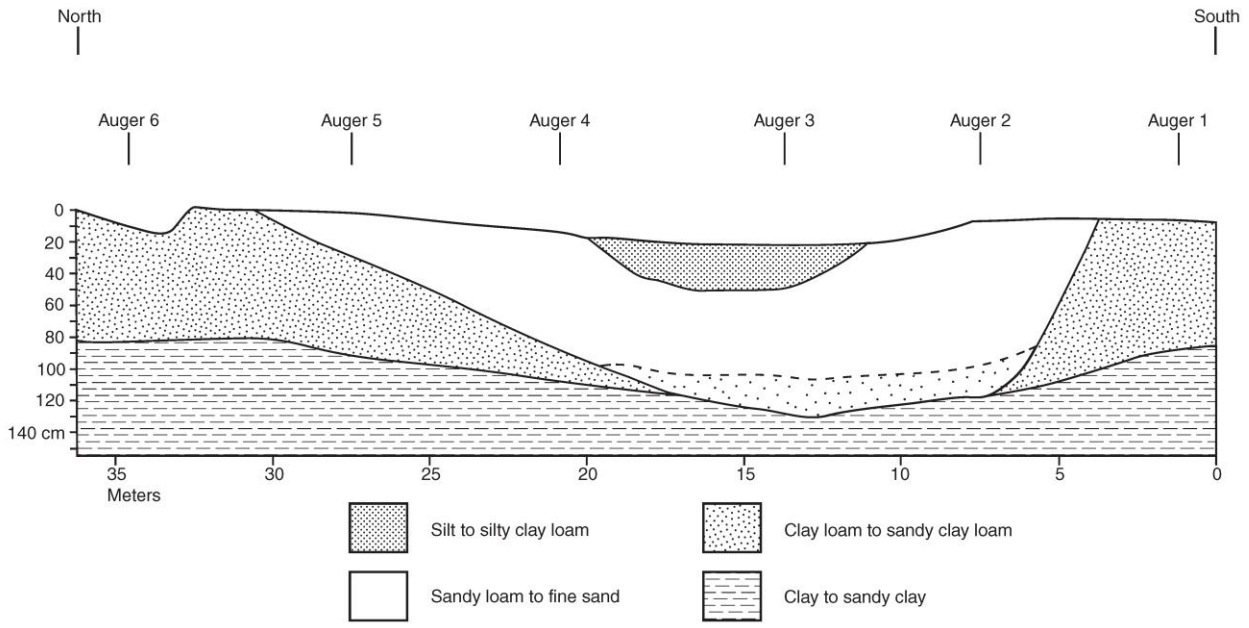

Figure 14 - Locality 2 auger transect.

Locality 18

Large blowouts or inter-dune areas are common in the central portion of Wild Isle (Fig. 13). Well-preserved channel sequences are often exposed in these areas and these exposures provide windows into the pedestal preserved beneath the larger dune.

Locality 18 (L18) contains a complex of overlapping channels where avulsions or stream captures are preserved. Over the course of several years eight trenches and a variety of archaeological excavations have been opened in and around the locality. These have revealed a series of aggrading terrace deposits with at least two stratigraphically distinct black mats. Archaeological sites (42To1021 and 42To3817) occupy terraces on both sides of the prominent L18 channel. The channel profiles at L18 are typically over two meters deep and tens of meters wide. Although terrace surfaces and risers have been truncated locally by erosion, as seen in the profiles of Trench L18-1 (Fig. 15), the relationships between the channel and terrace is well-preserved at Trench L18-2. The upper terrace is formed on inter-bedded silts and red-hued fine sands resting abruptly on green-hued, lacustrine silty clays. Thin black mats in the upper terrace deposit, exposed in Trench L18-1, L18-3, and in the terrace remnant (sub-dune pedestal) adjacent to Trench L18-2 date from ~9900 ^{14}C ka to ~10,300 ^{14}C BP. Buried deeply below the dune on the west side of L18 (Trench L18-8), organic sediments in a black mat preserved on green-hued lacustrine clay provide the earliest date, ~11,600 ^{14}C BP, on a terrace cut into a drying lakebed. The gap in the L18 series of dates may reflect dating of distinct channel sequences. Channel patterning, visible in aerial imagery, suggests that the early date is associated with an east-to-west channel (exposed at Locality 29) in the early or initial delta/wetland sequence, while the later dates are associated with a slightly later channel pattern oriented south-to-north. The later wetland terrace formed on top of sediment deposited as the overall wetland began to dry.

Locality 21

Located at the eastern margin of an expansive interdune basin, Locality 21 (L21) provided our first clear view of the dune-channel relationship at Wild Isle (Fig.13). Here, a prominent channel can be traced almost perpendicular to, and across, both sides of a semi-stabilized to active dune front. The channel cuts deeply into green-hued and marled lacustrine silty clay, but its margins are formed in a silt and fine sand sequence. A cross-channel trench (L21-1) clearly showed the channel form and its

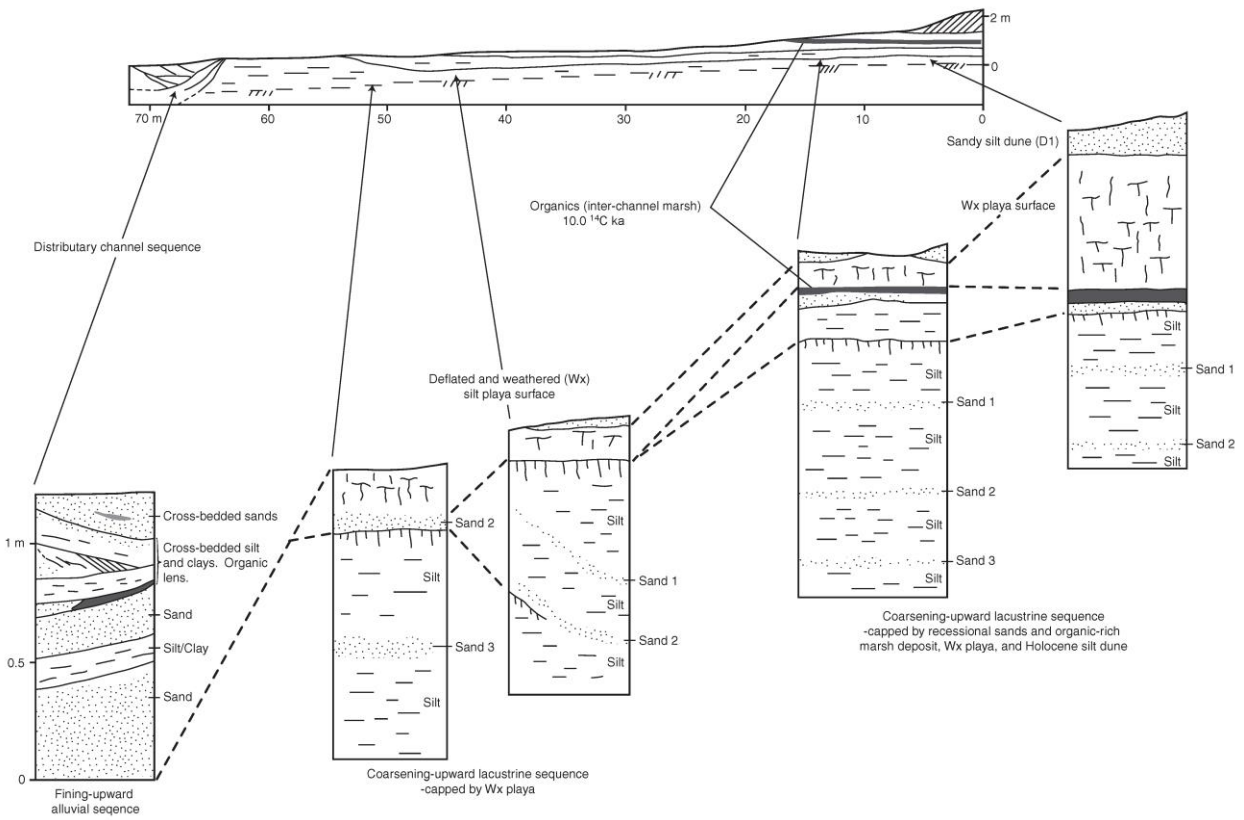

Figure 15 - Generalized profile of Trench L18-1; north view.

depositional sequence but lacked dateable material. Trench L21-2, however, excavated parallel to the channel and perpendicular to the dune-front captured the upper terrace sequence of interbedded silts and fine sands capped by a very thin organic bed. This organic deposit is different than the typical soil-like development documented on terraces elsewhere – it is a discrete bed (~4 millimeters thick) clearly lacking horizonation or other pedogenic structure. The organics are likely a pond lining (algal mat?) deposited on the terrace in an overbank event. The thin bed is dated at ~10,100 ^{14}C BP, which matches the the age of the top of the interbedded terrace observed at several localities. There is a stratigraphically inverted very old date, ~13,500 ^{14}C BP, on a massive clay stratum above this thin organic bed. This could be lacustrine mud reworked into a terrace pond, but this flat-lying clay bed is locally anomalous.

Locality 29

Situated in an deflation basin adjacent to L18, Locality 29 presents an overlapping channel sequence showing two distinct cycles of delta progradation (Fig. 13). The eastern exposure of Trench L29-1 shows overlapping, upwardly fining, cross-beds of active sets of braided channels (Fig. 16). Unusual for most of the channels at Wild Isle, this braided stream transported fine gravels to the distal reaches of the ORB. This early channel is cut into the underlying lacustrine clays, but unfortunately the profile lacks dateable organic residues or plant macro-fossils (a date of ~12,900 ^{14}C BP on organics of the lacustrine terrace exposed in Trench L29-2 nearby is too old; the profile contained obvious secondary carbonates). A pair of dates on *Helisoma* and *Lymaea* shells, however, provides a temporal range consistent with the early down-cutting sequence and terrace organics observed at Locality 18. The freshwater shells, sampled from a lower set of coarse sand cross-beds, provide dates of ~11,000 and ~11,100 ^{14}C BP respectively. Elsewhere in the distal ORB, freshwater shell samples from sandy cross-bedded bedforms (i.e., active flowing water) have returned dates similar to organic sediments from similar stratigraphic context.

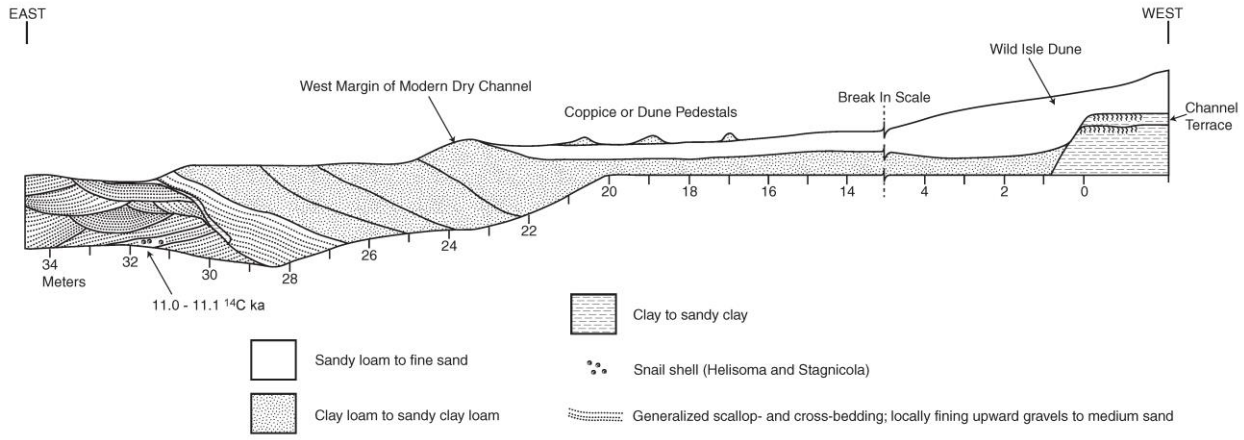

Figure 16 - Stratigraphic profile of Trench L29-1; south view.

The coarse grained cross-bedded channel is cut by a sequence of clay-lined, fine sand to silt channels (Fig. 17). The complete upper channel is preserved across a space almost 30 meters wide. It appears that at least a dozen upwardly fining sets are preserved within this slightly younger channel. Each pulse of channel activity was followed by relative stagnation resulting in the silty clay or clay bed that marks each set. In places, the laminated clay beds are steeply inclined at channel margins which may indicate that anchoring plants were present, but evidence of organic deposition, root casts, or similar material is absent. The channel sequence rests against a western terrace of horizontally bedded silt and fine sand sets. Capped by red-hued fine sands, this is the same late terrace sequence observed elsewhere at Wild Isle.

The Wild Isle Dune buries the western portion of the channel sequence and differential erosion placed the upper channel in a topographically higher position than the earlier, lower channel. In fact, bedforms of the upper channel form levees that appear as margins of the final down-cutting sequence within L29. Much of the upper profile of the lower channel and a portion of cross-cutting upper channel have been removed by erosion, forming the undulating topography of the deflation basin. Minor flecks of what appeared to be charred material from just above the Wild Isle dune contact were too small (and possibly not organic) to provide a relevant date (the lab reported the date [~12,100 ^{14}C BP] as unreliable).

An archaeological assemblage at 42To1032 is located adjacent to the dune front on the east side (point bar?) of the L29 channel set. The dune front at the western margin of L29 lacks an archaeological assemblage, though sites are present further north in proximity to this channel, especially where it bends and is exposed within L18. However, the L29 western dune front rests mid-channel where sites are not expected.

Locality 51

East of Wild Isle, a linear dune rises from the playa (Fig. 13). Lone Dune lacks a sub-dune pedestal similar to Wild Isle, but it does cap and preserve a terrace sequence that may be paired with channel traces to the west of the dune front. Black mats formed on lacustrine, red-banded clays on top of a massive green-hued clay sequence have been dated to ~10,000 ^{14}C BP in Trench L51-1 and ~10,200 ^{14}C ka in similar stratigraphic position in Trench L51-2 (Fig. 18). This lower black mat is disturbed by root traces or filled burrows of small fossorial animals, evidence that this local surface was stable and certainly dry for a period of time. It is overlain by silty clays interbedded with silts and fine sands. Terrestrial shells (cf. *Helisoma*) increase upward through about 20 centimeters below an upper black mat, thinner and less organic rich than the lower black mat, is exposed just below an unconformable contact with the lower sands of the capping dune. Organic sediments from the upper black mat dated to ~9300 ^{14}C ka.

Figure 17 - View of clay-lined channel forms at Locality 29 (image spans the 31-36 m area in the stratigraphic profile shown in Figure 16).

Locality 52

A second series of trenches north of L51 exposed a channel profile beneath an eroded remnant of the slowly migrating Lone Dune at Locality 52 (Fig. 13). Trenches L52-1 and L52-2 exposed a mid-channel sequence of fining-upward beds each approximately 12 to 15 centimeters thick and capped by an organic-rich clay or silt-clay stratum. The uppermost organic deposit is formed on an upwardly convex bedform, possibly a mid-channel bar or splay isolated by subsequent channel shifts and drying. A date of ~9700 ^{14}C BP was obtained on the organic sediments of the bar, which was soon buried by the encroaching dune. The deepest interbedded channel rests on a weathered massive green-hued, lacustrine clays. The contact between the lacustrine clay and the channel sequence is abrupt; it is likely that the black mat observed on this same stratigraphic unit nearby at L51 has been truncated between the two localities. A date of ~12,400 ^{14}C BP on the weak organic horizon reveals that these organics formed in a lacustrine environment (i.e., this deposit is neither visually nor structurally similar to the "black mats" documented throughout the distal delta).

Locality 53

The Seafoam channel is a relatively late feature extending from the proximal delta and running parallel to the dune-front of the expansive Wildcat Dune (Fig. 13). Trenching investigations near the northern extent of this channel revealed a deeply incised cut and fill sequence associated with Seafoam's past and present course. Trench L53-1 cut perpendicular to and immediately east of modern Seafoam exposed a now-buried channel sequence cut into green-hued, lacustrine clays of the channel's terrace margin. A thick black mat on the lacustrine terrace dated to ~10,600 ^{14}C BP, similar to early channel

terraces to the west at Wild Isle. However, within the fill sequence of the channel a black mat that formed on a muddy mid-channel bar dated to ~8700 ^{14}C BP. Late in the sequence a black mat, which appears to represent ponding associated with the current position of Seafoam, provided a date of ~8300 ^{14}C BP; this is the youngest black mat encountered on the distal delta so far.

Locality 54

A deflation basin along the Seafoam channel contains the Cache Site (42To2622) where archaeological investigations provided a trench exposure (L54-1) cutting across a sequence of channels showing that Seafoam has shifted to the west (a similar relationship is revealed at L53 downstream) (Fig. 13). The channels are stratigraphically below Seafoam and mark the former position of active stream flow (Fig. 19). Four channels are preserved in the profile of the Cache Site trench. Channels 1 – 3 form stacked mud-filled channel remnants that record cycling from active stream flow to ponds and bogs occupying abandoned or otherwise inactive channels. Each channel retains a prominent scour followed by vegetation colonization (preserved as organic black mats). The vegetation was eventually capped by dense sandy silts as the local channel was subjected to seasonal desiccation. Occasional flows filled the generally drying channel with silty sandy mud. Channels 2 and 3 may have followed in relatively quick succession repeating the scour to vegetation to mud cycles. The uppermost (youngest) preserved channel (Channel 4) appears to have resulted from a relatively rapid channel shift and moderate energy flow; this

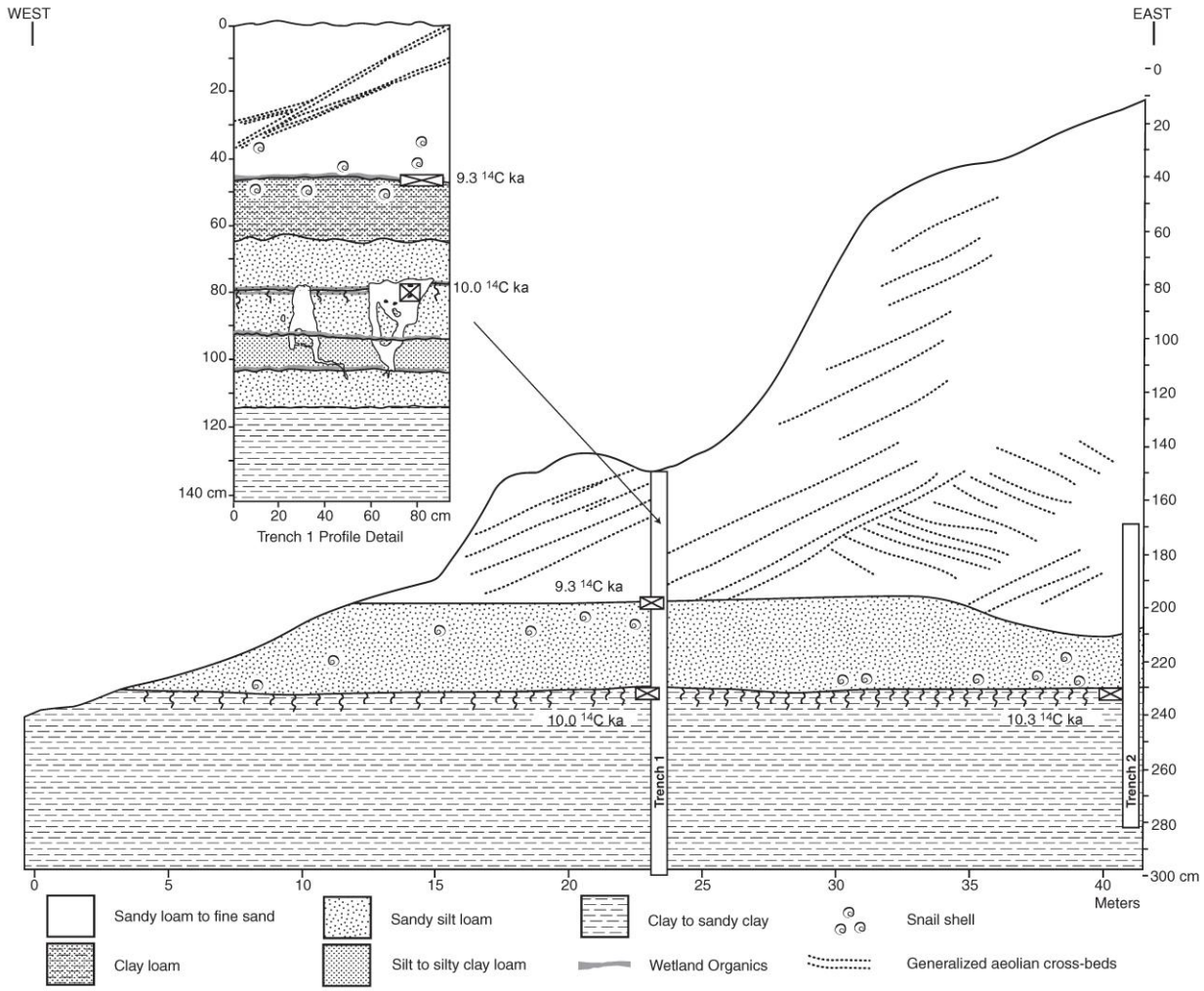

Figure 18 - Composite profile of Lone Dune and Locality 51 distal ORB channels.

channel is much sandier than earlier, underlying sets. The channels appear to be stratigraphically above the "red sands" deposit, but are also cut directly into lacustrine clays and marls on their eastern margins (there are no black mats on the upper contacts of the lacustrine facies).

The profile reveals that the channels supported the formation of a local terrace and overbank sequence where channel-margin wetlands and interfluves supported vegetation communities and human habitation. The artifact assemblage of the Cache Site is contained in the terrace deposits of the local overbank wetland. Recent dunes drape the remnants of the channel system.

Radiocarbon dates from the channel sequence at the Cache Site (L54) exposure are roughly contemporaneous with channel-margin black mats preserved at Wild Isle. Although a few dates are stratigraphically inconsistent, the dates provide a very clear picture of sequential channel and landform evolution. Dates on organics from the wetland terrace begin at ~9200 ^{14}C BP; Channel 1 remains undated but Channel 2 organics, immediately above, have been dated at ~9100 ^{14}C BP. It seems the terrace may have sustained some type of vegetation community for the duration of channel activity. Channel 3 organics provided a date of ~8900 ^{14}C BP. The organic remnants preserved in Channel 4, the latest of the local sequence, are dated at ~9000 ^{14}C BP. These dates are slightly earlier than the late dates from Wild Isle, but within the margin of error. Shell dates on *Physa* and *Stagnicola* from the channels are similar to the organic dates, but are typically slight older; shells of both genera from the active channels (~8900 ^{14}C BP in Channel 3 and ~8900 ^{14}C BP in Channel 4) are close to their organic pairs. The shell dates from the stagnant overbank marsh or wetland terrace tend to be older than their organic pairs (~9800 and ~10,000 ^{14}C BP). The recent course of the Seafoam channel cuts into the buried channels at the Cache Site and is certainly the latest expression of channel shifting along the margin of Wildcat Dune.

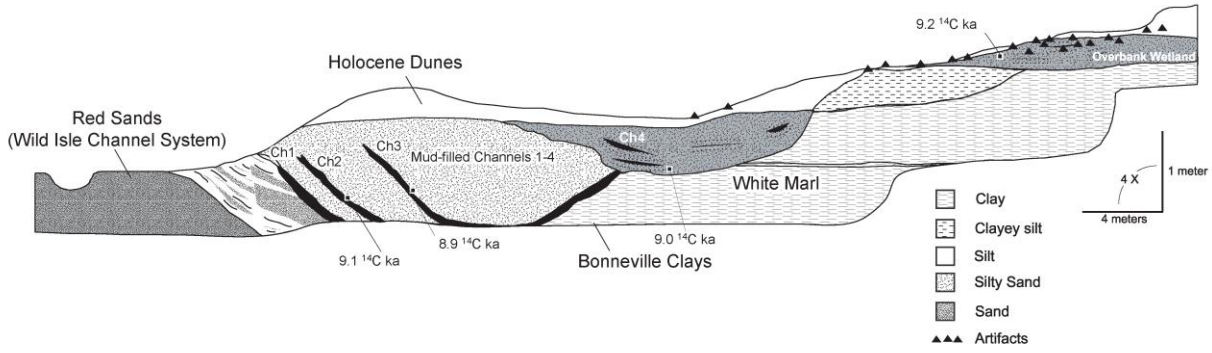

Figure 19 – Locality 54 (Cache Site-42To2622) trench exposure and channel sequence.