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PALEOSEISMOLOGICAL STUDIES IN THE CHARLESTON, SOUTH CAROLINA REGION

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Abstract

The seismicity in the Middleton Place Summerville Seismic Zone, the source of the Charleston earthquake of 1886 occurs on a network of faults of which the Sawmill Branch fault zone is the most active and the Ashley River fault aseismic. Macroseismic data following the 1886 earthquake suggested the presence of a buried fault on the grounds of Fort Dorchester in SSE Summerville, SC. A shallow trench encountered a prehistoric sand blow along the inferred fault, suggesting that this fault had been active in the past. Geological and geotechnical investigations revealed the soil profile and the location of the source sands, at a depth of 10-14 ft below the surface.

Resistivity surveys in the Magnolia Plantation were used to seek a near surface manifestation of the Ashley River fault. Anomalies on these profiles collinear with a ruptured tomb outlined the strike of the ARF. The results of the resistivity survey show that it is possible to map near surface manifestations of these buried faults.

NON TECHNICAL SUMMARY

The project was aimed at digging long, shallow trenches across anticipated near surface manifestations of earthquake prone faults in the Charleston region with the anticipation of studying them. Before the trench locations are decided, geophysical surveys were carried out to determine the optimum locations for digging. In the Colonial Fort Dorchester State Park in Summerville, S.C. a shallow trench was dug across a line joining the crack which displaced the north and south walls of a historic fort. In this trench a prehistoric seismically induced sand blow was discovered attesting to the occurrence of prehistoric earthquakes on this fault.

In Magnolia Plantation, a family tomb was cracked during the 1886 Charleston earthquake. The crack on opposite side of the tomb walls suggested that the associated Ashley River fault trended NW-SE. This fault was detected on two suitable located resistivity profiles, suggesting that ARF is oriented N55°W-S55°E along the Ashley River between Magnolia Plantation and Middleton Place. The exercise also revealed that it may be possible to detect the location of seismogenic faults by shallow geophysical techniques.

II. TRENCHING IN COLONIAL DORCHESTER STATE PARK

1. Introduction

In this report we describe the results of trenching operations at Fort Dorchester near Summerville, South Carolina and resistivity studies in Magnolia Plantation near Charleston, South Carolina. The former were associated with the recently discovered Sawmill Branch fault zone (Dura-Gomez, 2004; Dura-Gomez and Talwani, 2008) and the latter with the Ashley River fault. The results of the trenching operations led to the discovery of a shallow prehistoric sand blow. Additional geotechnical investigations were carried out to reveal the geologic profile and the thickness and depth of the source sand. The resistivity surveys delineated the geometry of the Ashley River fault in the Magnolia Plantation and also showed the efficacy of using shallow geophysical techniques in search of surface manifestations of buried faults. In this report we first provide some background information and then the field observations and results of our investigations.

2. Middleton Place Summerville Seismic Zone

The destructive Charleston earthquake of 1886, and the current seismicity near Summerville, South Carolina are associated with the Middleton Place Summerville Seismic Zone (MPSSZ) (Tarr et al., 1981). The MPSSZ was discovered after the deployment of the South Carolina seismic network in 1973, and is the most active seismic zone in South Carolina. The instrumentally located seismicity occurs below a depth of ~3km, and there are no surface expressions of causative faults (Figure 1). However, continued seismicity on these faults has breached the overlying basalt flows (on unknown thickness and lying below ~750m of Coastal Plain sediments) in the epicentral area. This activity has also caused warping, liquefaction features and uplift in shallow sediments –features which are evidence of ongoing neotectonic activity, and the target of the investigations described in this report. The seismicity is associated with multiple faults in response to a maximum horizontal stress, S_{Hmax}, oriented N60°W – S60°E.

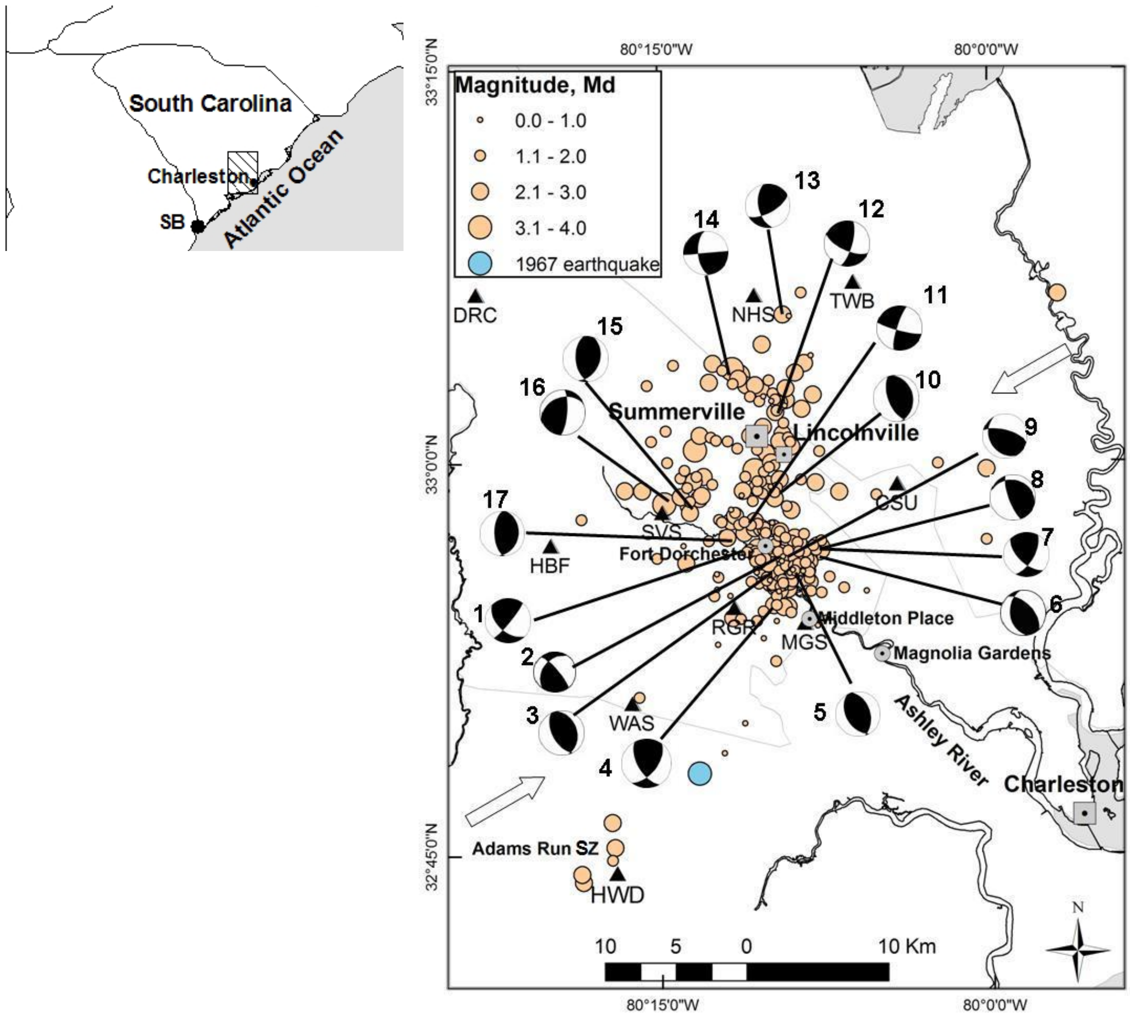

Figure 1: Instrumentally located seismicity (1974-2004) in the Middleton Place Summerville Seismic Zone. Various focal mechanisms attest to the presence of multiple faults. Seismicity occurs in response to a maximum horizontal stress field (open arrows) oriented N60°W-S60°E.

3. Seismotectonic Framework

By a reanalysis of seismicity data and with constraints from geomorphological, geophysical and geologic data, Dura-Gomez and Talwani (2008) revised our understanding of the nature of the causative faults associated with the seismicity in the MPSSZ. The revised tectonic framework (Figure 2) is composed of the NE-SW trending Woodstock fault (WF) and a NW trending fault system, which consists of the Sawmill Branch fault zone and the Ashley River, Lincolnville and Charleston faults (SBFZ, ARF, LF and CF, respectively in Figure 2).

The ~N30ºE oriented, Woodstock fault is associated with oblique right-lateral strike-slip motion. The fault has a ~6 km long compressional anti-dilatational left step near Middleton Place that divides it into North and South Woodstock faults (WF(N) and WF(S)), both of which dip steeply (≥50º) to the NW.

The N30ºW to N40ºW striking Sawmill Branch fault zone and the Lincolnville and Charleston faults are located within the left step and are associated with oblique left-lateral strike-slip and reverse faulting. The ~3 to 4 km wide N30ºW Sawmill Branch fault zone (SBFZ) is the most active of them. It extends from Middleton Place to about 3.5 km northwest of Fort Dorchester. The ~N65ºW-striking ARF is located between Middleton Place and the Magnolia Plantation. The N40ºW-striking Lincolnville fault (LF) is located about 5 km northeast of SBFZ, near the towns of Lincolnville and Summerville, and dips steeply to the NE. The dip of the N30ºW-striking Charleston fault (CF) located about 18 km to the northeast of SBF is not constrained by the seismicity data. A dip about 40º to the SW was inferred from the presence of Oligocene age Mt. Holly dome.

The tectonic deformation in the MPSSZ occurs in response to an in situ stress field with the direction of the maximum horizontal stress oriented ~N 60º E (Talwani, 1982).

The SBFZ consists of 3 or more NE dipping faults, which display a mixture of reverse and left lateral strike slip motion. The main segment of SBF lies along the N30°W trending segment of the Ashley River and its extension along Dorchester Creek (Figure 3). About 500 m to the west of SBF lies Fort Dorchester.

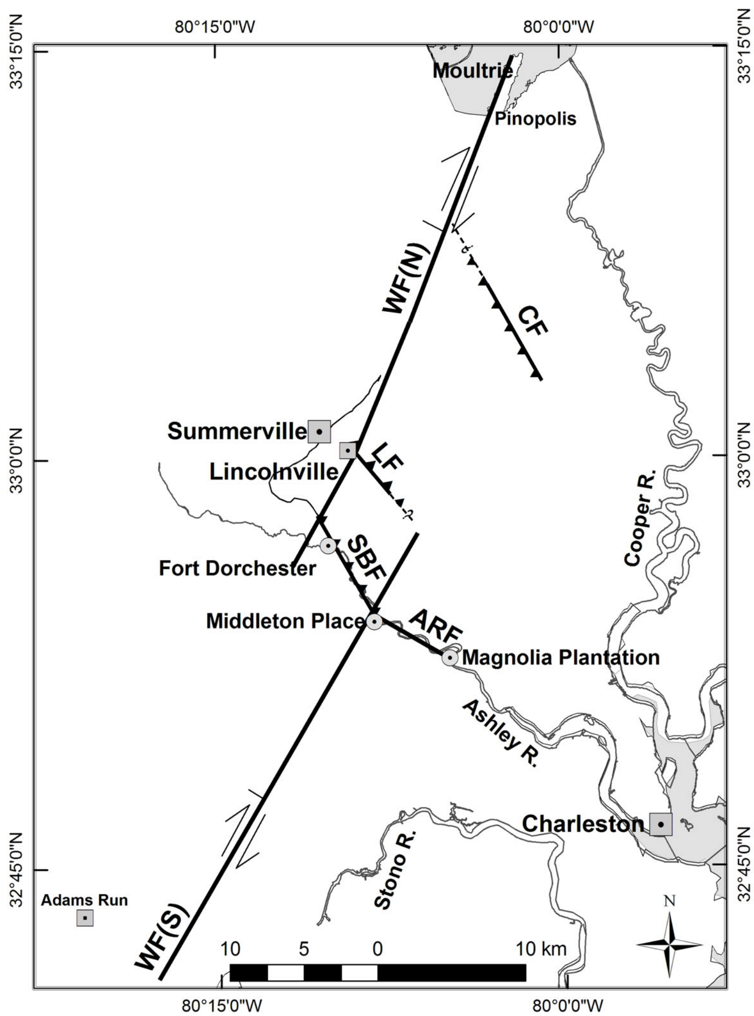

Figure 2: Revised seismotectonic framework for the MPSSZ (from Dura-Gomez and Talwani, 2008).

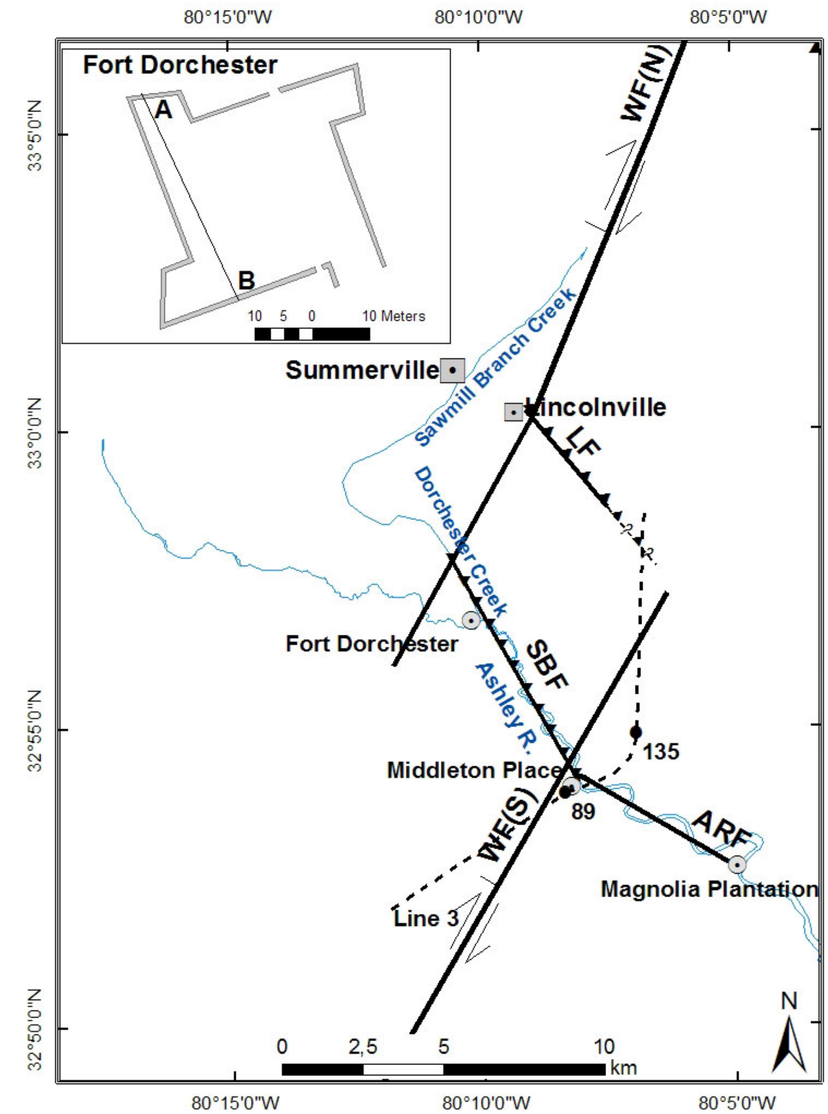

Figure 3: The main segment of the SBF lies along the Ashley River and Dorchester Creek N30°W of Middleton Place. A parallel strand associated with left-lateral strike slip motion lies below Fort Dorchester, which during the 1886 earthquake offset the northern and southern walls by 7cm and 10cm respectively (at A and B in inset).

4. Fort Dorchester

The Old Dorchester State Park, on S.C.642 near Summerville, contains the abandoned town of Dorchester, a damaged church and an ancient fort on the banks of the Ashley River. The fort was built on the north bank of the river using tabby (roasted oyster shells) as mortar in 1775. The town of Dorchester was torn down brick by brick and moved to Summerville. An old church was badly damaged by the earthquake but is still standing. (Please see Appendix I for a description of Fort Dorchester).

The first settlement was established there in 1697 and abandoned in the late 18th century. For a historical account of Fort Dorchester (now named Colonial Dorchester

State Historical Park) taken from Henry Smith's Cities and Towns of Early South Carolina, see Appendix I.

The 1886 Charleston earthquake caused the southern and northern walls of Fort Dorchester (Figure 3) to shear. On the long southern wall of the fort, there is a remarkable crack ~47 feet (14.3 m) from the east end of the wall. This crack has cut the 2.5 feet thick, 7 feet high tabby wall and moved it in a left-lateral sense by ~10 cm (point B in Figure 3, inset). A similar left-lateral displacement is seen in the northern wall, about 9.5 feet (2.9 m) from the northwest corner of the fort. (The southwest wall shows evidence of slumping into the river and was restored in the 1980s). The two cracks in the northern and southern walls of the fort exhibit left lateral displacement of ~10 cm along ~N20°W (Figure 3, inset, and Figure 4a,b). Other cracks in the eastern and western walls do not show any lateral displacement or a systematic pattern of deformation. In the description from Dutton's account of the Charleston earthquake (pages 297-298), Dutton describes the damage to the fort *"especially at the northeast corner"*. This description is based on Sloan's account. However perusal of Sloan's account [see Peters and Hermann (editors) p.59] shows that Dutton had misquoted Sloan. According to Sloan's account *"Old Fort walls of shell concrete 8ft high with thickness battered from 3ft at base to 2 ft at top cracked through E wall at SE corner also badly cracked in two places at* **N.W.** *corner (emphasis added)"*. From these data Sloan inferred a N20°W trend –similar to our interpretation (Figure 3). The displacement is interpreted as being caused by left-lateral offset on a splay of the Sawmill Branch fault.

Between the fort and the river, Dutton (1889) reported that there were *"several wide cracks in the ground parallel to the river"*. These cracks were likely associated with slumping of the ground.

Our interpretation of left-lateral strike slip on a splay of the Sawmill Branch fault is also supported by various focal mechanisms (Figure 1).

Figure 4a: Left lateral displacement of 7 cm of the northern wall of Fort Dorchester (location A in Figure 3, inset).

Figure 4b: A left-lateral displacement of 10 cm of the southern wall of Fort Dorchester (Location B in Figure 3, inset).

5. Ground Penetration Radar Surveys

The coseismic displacements of the northern and southern walls of the fort suggested a strike of ~N20°W for the causative fault. To see if the fault had any surface manifestations we decided to cut trenches to the north and south of the fort, sited in a way to intercept the fault. However, Colonial Dorchester had been declared a protected archeological location and we were denied permission to do so until the completion of archeological investigations on the grounds of Colonial Dorchester Park.

Consequently, in the summer of 2005 we carried out near site geophysical investigations. These consisted of 22 profiles using a Ground Penetration Radar (GPR) (Appendix II). Of the 18 ~10 to 30m in length profiles, cutting the N20°W trend of the inferred splay of the Sawmill Branch fault, 10, 1, and 7 were located to the north, within and south of the fort respectively. An additional 2 profiles were run along the fault trend and 2 were ‘sounding’ to get the electrical properties using a common middle point. The antenna setting for the various profiles varied between 50mHz, 100mHz and 200mH (Appendix II). Due to the presence of several trees the data were very noisy. However, some anomalous diffraction patterns and reflections were identified on the different profiles. These are shown on Figure 5. The anomalous features on the different GPR profiles describe a broad anomalous NW trend –roughly parallel to the inferred strike of the splay of the SBF. They were used to site the location of the trench dig for paleseismological investigations.

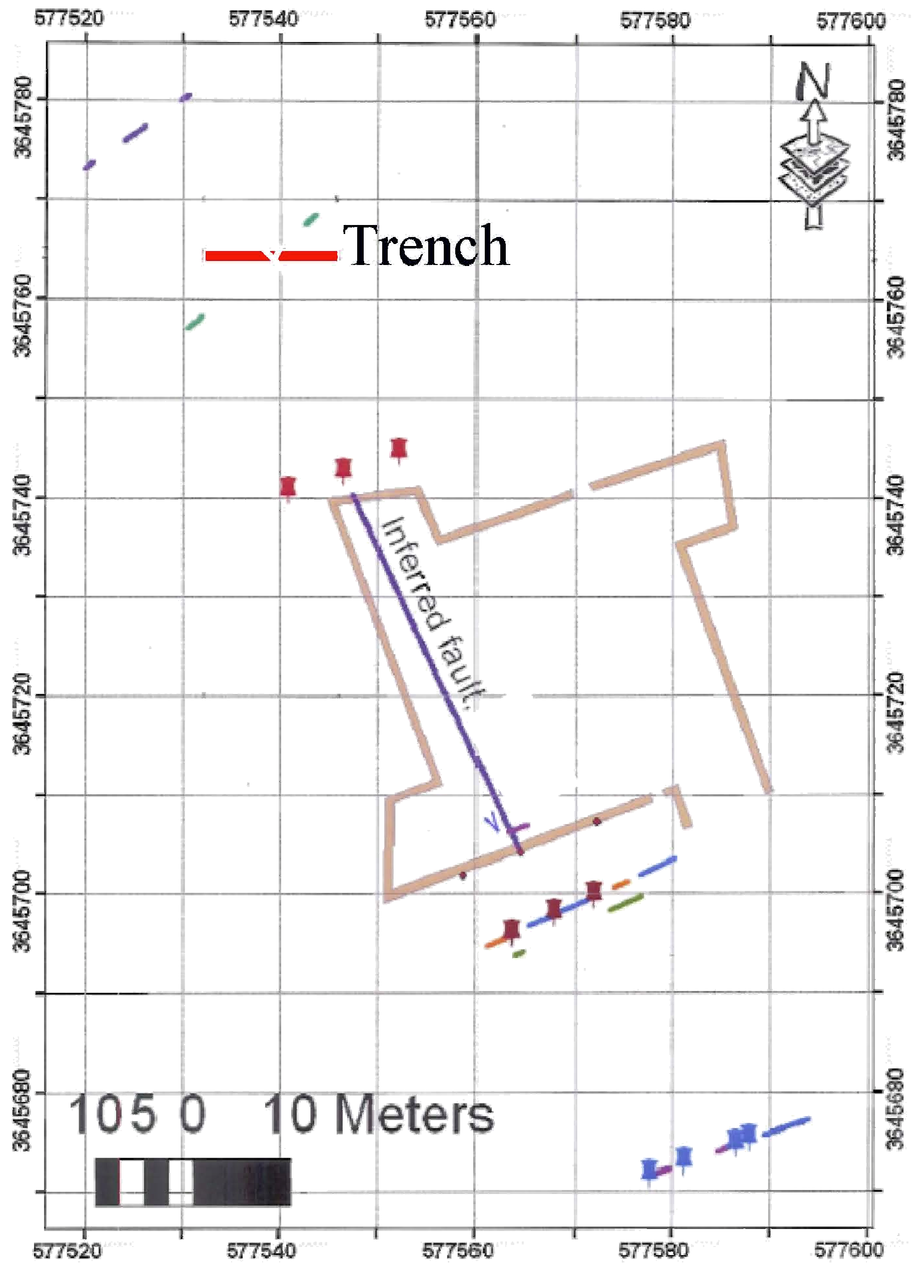

Figure 5: Showing the inferred fault based on displaced walls of the Fort Dorchester. Anomalies encountered along the various GPR profiles are shown by dashes in different colors and by the thumb-tacks. Figure also shows the location of the trench dug for paleoseismological investigations.

6. Paleoseismological investigations in a trench

In the summer of 2007, we were given permission to dig a trench in Colonial Dorchester State Historical Park, in Fort Dorchester, South Carolina. The Fort Dorchester site is located to the SSE of Summerville, just south of SC Highway 642 and overlooks the Ashley River to its south. The Fort is situated on flat ground, and slopes to the west and south towards the Ashley River. The foundation of the fort is about 5.5m higher than the Ashley River. It is underlain by the Ten Mile Hill beds that were deposited during the early to middle Pleistocene as fluvial/ lagoonal and possibly beach deposits (Hasek et al., 2008).

The trench is located ~25m north of the north wall of the fort (Figure 5). The location had been chosen by us, but we had to wait for the completion of archeological investigations in the top 20cm by the state archeologists. The ~SW corner of the 15m long, 1m wide and ~1m deep trench, labeled ‘O’, is located at (UTM coordinates) 3,645,764m Northing and 577,532m Easting, with the NE corner at 3,645,765m Northing and 577,547m Easting (Figure 6). The surface adjacent to the south wall was flagged at 1m intervals. UTM coordinate system was chosen for convenience and the coordinates were determined by Total Station operated by Ashley Chapman, of the Colonial Dorchester Park. A trench log along the southern wall, working from west to east, is given in Appendix IV.

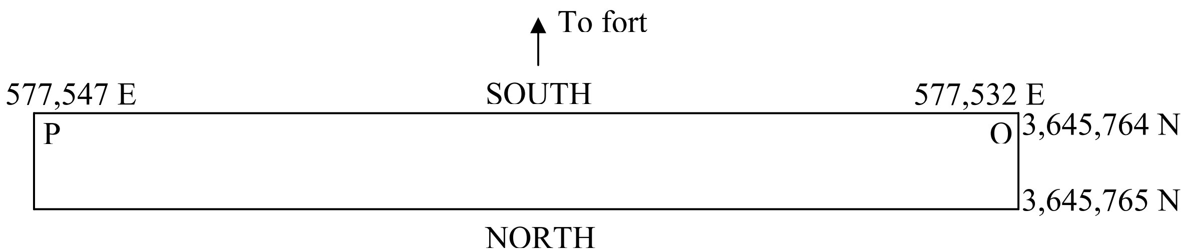

Figure 6: Plan of the trench

The soil profile in the trench to ~1m depth consists of light brown colored clayey sand at the top of variable thickness. It overlies a clay-rich layer of sand. A sand blow was discovered between ~577,539 N and 577,540 E or 539 and 540 for short. The bowl-like feature is centered at ~539.5 m and lies below the line AL (Figures 7 and 8). The sand above AL is light brown, and does not contain any mottled clay within it. However, below AL the clay content increases as you go towards Q. It is still sand but with more clay, whereas above AL it is more sandy. In either case, it is distinct from the underlying layer which is more of a sandy clay. This bath-tub like structure, full of mottled rich sand is clearly anomalous and was interpreted to be a seismically generated sand blow. In order to seek the source of the sand in the feature we cleaned the floor of the trench in front of Q and discovered the presence of the anomalous molted sand (Figures 7 and 8). A small 30cm deep trench was excavated in the floor of the main trench. It showed that the anomalous sand could be traced to the bottom and within the smaller trench (Figure 9). In subsequent investigations, the smaller trench was broadened to its south and north sides, all the way to the south and north walls of the trench. On the southern wall, the anomalous sand contact with the underlying clay layer was lower, suggesting that our trench had not encountered the source vent. To seek the source sand we obtained the soil profile in the trench and at nearby locations. Some roots were collected from within the bowl of anomalous sand, i.e. below AL and above Q for dating (Figure 7 and 8).

Figure 7: A slant view of the south face of the trench between 577,539 and 577,540 Easting shows the sand blow. The sand below AL contains mottled clay, whereas the sand above it does not. The wooden scale below Q is 50cm long. A small trench was cut in the floor in front of Q. The floor between this trench and the south wall also contains the mottled sand.

Figure 8: (top) Front view of the sand blow. (bottom) The anomalous mottled source sand can be seen on the floor of the trench.

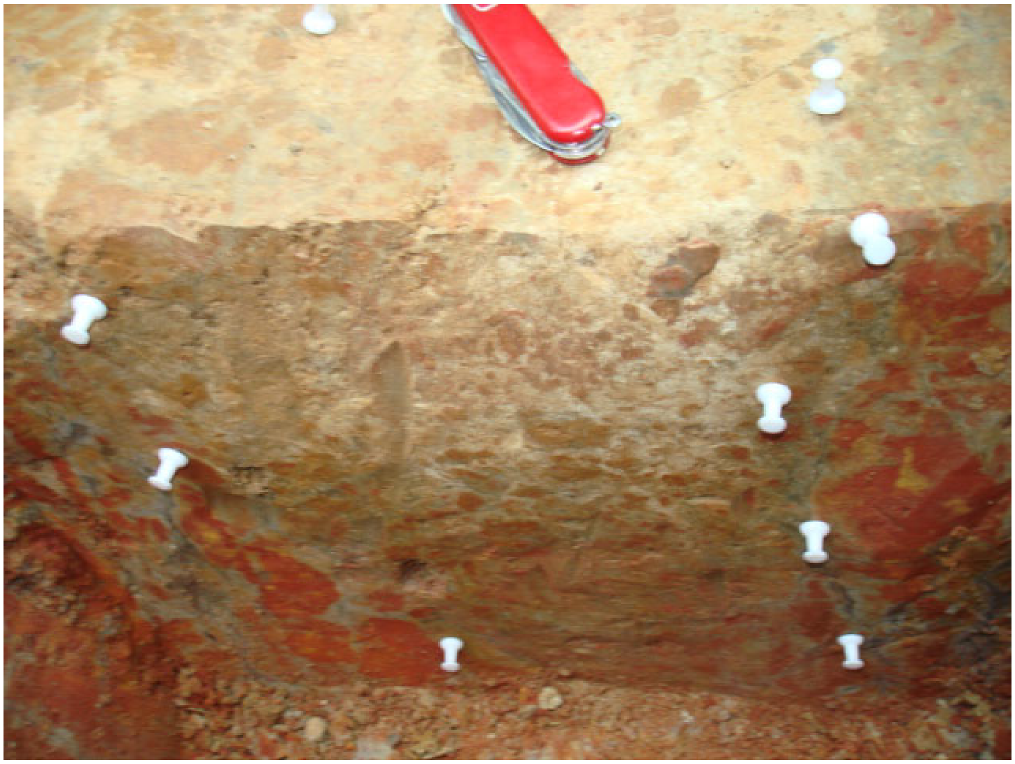

Figure 9: (top) The anomalous mottled sand continues on the wall of the smaller trench. Its location is outlined by the white thumbtacks. (Bottom) A view of the trench from the top showing that the anomalous sand is also seen on the northern face (bottom of the picture). The wooden scale is 50cm long.

7. Geological Investigations

Figure 10 shows the locations from where vibracores were collected by Will Doar III of the S.C. Geological Survey (VC1 to VC3). They showed that the soil profile overlying the Ashley formation consist of sands with varying amounts of clay. The well sorted quartz sands, encountered at a depth of 10 to 14 feet were inferred to be the source sands encountered in the sand blow (Figure 11).

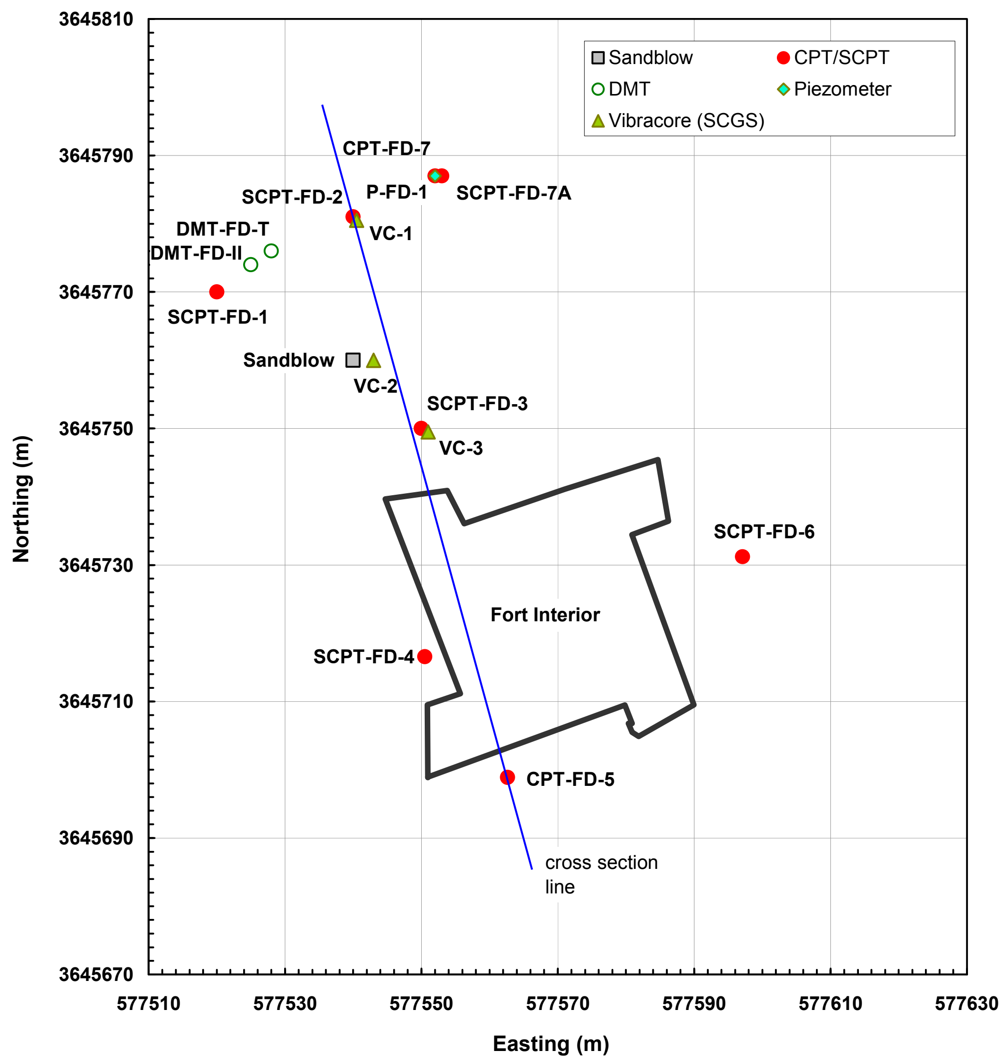

Figure 10: Showing the locations of geological and geotechnical investigations. Vibracores to a depth of 20ft were collected at three locations (triangles). The locations of geotechnical investigations (see text) are also given.

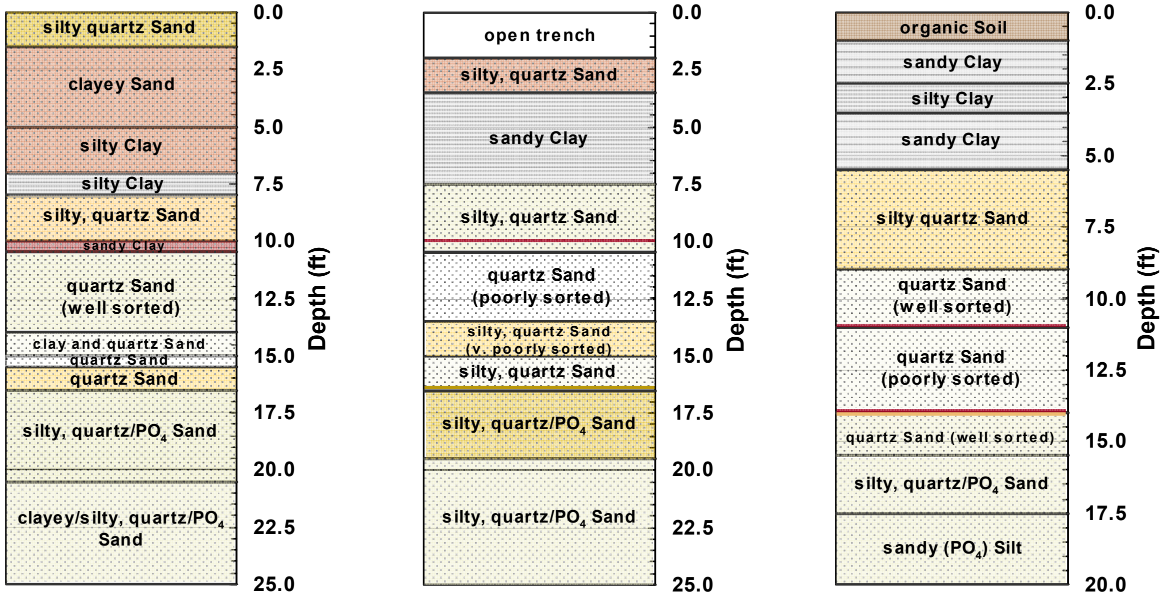

Figure 11: Soil profiles inferred from Vibracores VC1 to VC3 (left to right). The source sand was inferred to lie between ~10 and 14ft below the surface. The vibracores bottomed out in the clay-rich –sands of the Ashley formation (at a depth of ~17ft). This layer is overlain by fluvial, coarsening downward, quartz sands (Courtesy Will Doar III J., 2007).

8. Geotechnical Investigations

As a part of an NSF funded project (Dr. Andrus, PI, Drs. Sarah Gassman, Pradeep Talwani and W. Camp (Co PIs)) aimed at characterizing the liquefaction resistance of aged soils, geotechnical properties in the vicinity of the trench were collected in July and December, 2007 (Hasek et al., 2008). These included seven cone penetrometer tests (CPT) with pore pressure measurements (six with seismic) (CPT/SCPT-FD-1 to 7) (Hasek et al., 2008). (See Figure 10 for locations). The results, taken from Hasek et al. (2008) are as follows.

"An example of the CPT results at SCPT-FD-3 is shown in Figure 12 along with the field log from the nearest vibracore VC-3. The CPT profile is characterized as a 5 ft (1.5 m) thick silty to sandy clay layer near the surface, overlaying a 12 ft (3.4 m) thick sand layer, underlain by a silty sand which corresponds to the Ashley Formation. Cooper Marl would be encountered directly below the final depths of the CPT soundings. The groundwater table is encountered at a depth of 17 ft (5.2 m) below ground surface (bgs). Soils with a tip stress less than 160 tsf (Youd and Idriss, 1997) are generally considered to be potentially liquefiable. Within the 12 ft (3.4 m) thick sand layer, the upper 7 ft (2.1 m) has an average tip stress, q_t, of 150 tsf and the lower 5 ft (1.5 m) has a an average tip stress, q_t, of 50 tsf . Furthermore, the sand found at a depth of about 12.5 ft (3.8 m) (see the Vibracore Field Log VC-3 in Figure 10) is a fine, quartz sand that is poorly sorted (clean with no fines) and corresponds to the lower 5 ft (1.5 m) of the sand layer. Given the low tip resistance of this layer and the clean, uniform nature of the sand, this layer is most probably the source of the sand found in the sandblow (i.e "source sand"). The source sand is about 200,000 years old (McCartan et al., 1984; Weems and Lemon, 1984) and is part of the Ten Mile Hill beds that were deposited during the early to middle Pleistocene as fluvial/lagoonal and possibly beach deposits.

The general soil layers observed at SCPT-FD-3 are observed to extend across the Fort Dorchester site as shown in the cross section of bearing NNW presented in Figure 13. This cross-section was developed using the four CPT profiles (SCPT-FD-2, 3 ,4 &5) along the NNW bearing shown in Figure 10. The potentially liquefiable source sand occurs at a depth of about 12 to 16 ft (3.4 to 4.3 m) bgs north of the fort and at a depth of 5 to 7 ft (1.5 to 2.1 m) bgs south and down-elevation of the fort. Generally, the soils overlaying the liquefiable source sand consist of silty and clayey, fine sands. Soil strata defined by the cone penetration tests correlate well with the three field logs from the vibracores shown in Figure 11. VC-1 is in the vicinity of SCPT-FD-2, VC-3 is in the vicinity of SCPT-FD-3 and VC-2 is in between the two CPT soundings. Index tests will be performed on the vibracore samples to further correlate the CPT signatures with the soil types and assess the liquefaction susceptibility."

These data will be used to back-calculate the magnitude of the prehistoric earthquake associated with this sand blow.

9. Age of the Prehistoric earthquake

Based on the morphology observed in the trench, the sand blow is associated with a pre-1886 earthquake. Fine roots were collected from within the mottled zone (below AL and above Q in Figure 8) and the corresponding mottled zone on the northern wall. Unfortunately these roots were associated with modern ages and did not represent the timing of the earthquake (Appendix III).

10. Conclusions

The sand blow discovered in the Colonial Dorchester State Historical Park lies along the strike of a splay of the Sawmill Brach fault zone. The middle of the sand blow encountered in the trench at 3,645,764 Northing and 577,539.5 Easting are collinear with the crack encountered on the northern and southern walls of the fort i.e. lie along a strike of ~N20°W. The age of this event could not be determined, but from its geomorphological profile and setting within the sand blow, it was associated with a pre-1886 earthquake.

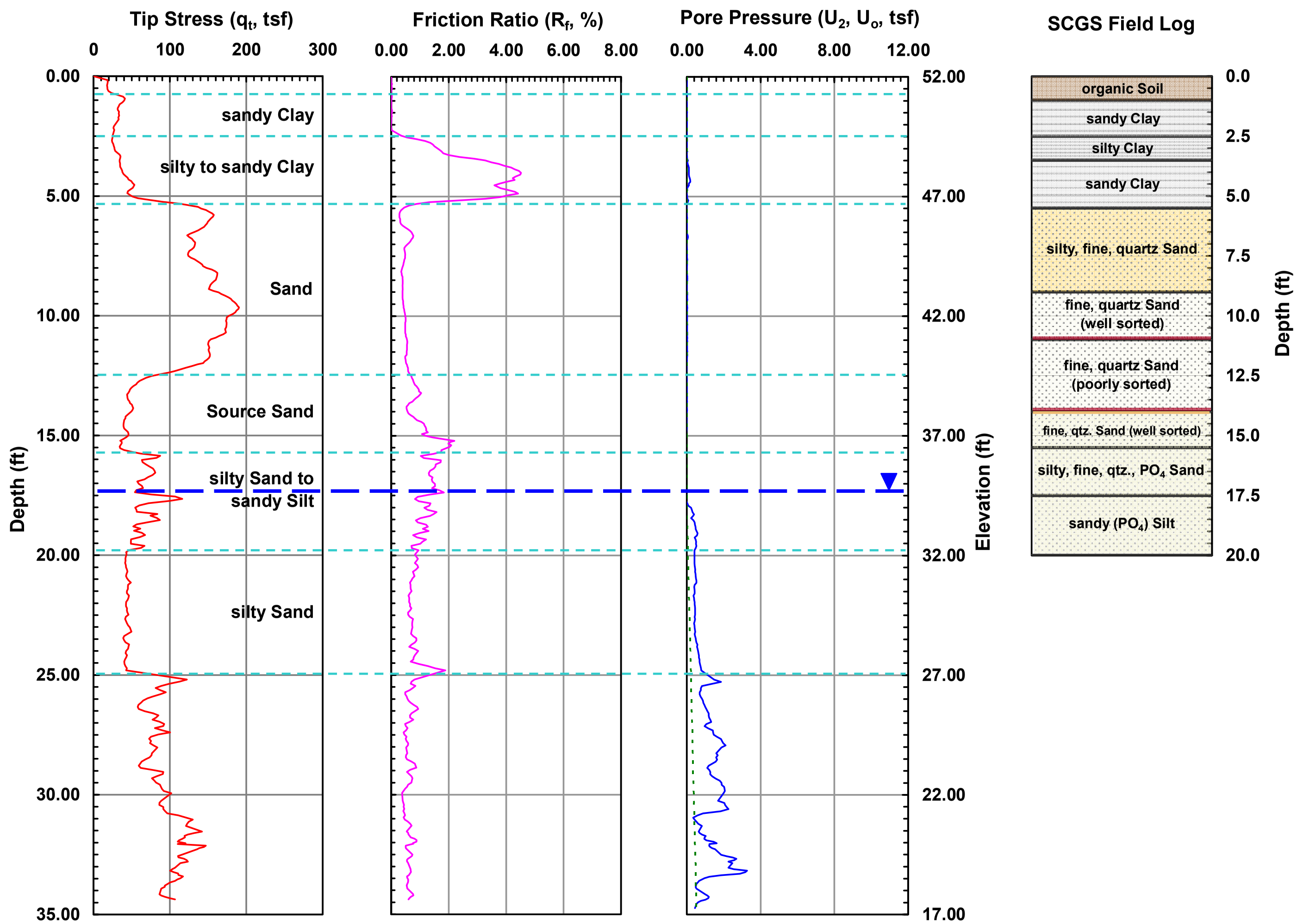

Figure 12: Cone Penetration Test Results at SC PT-FD-3 showing the source sand interval and Vibracore results at VC3 (from Hasek et al., 2008).

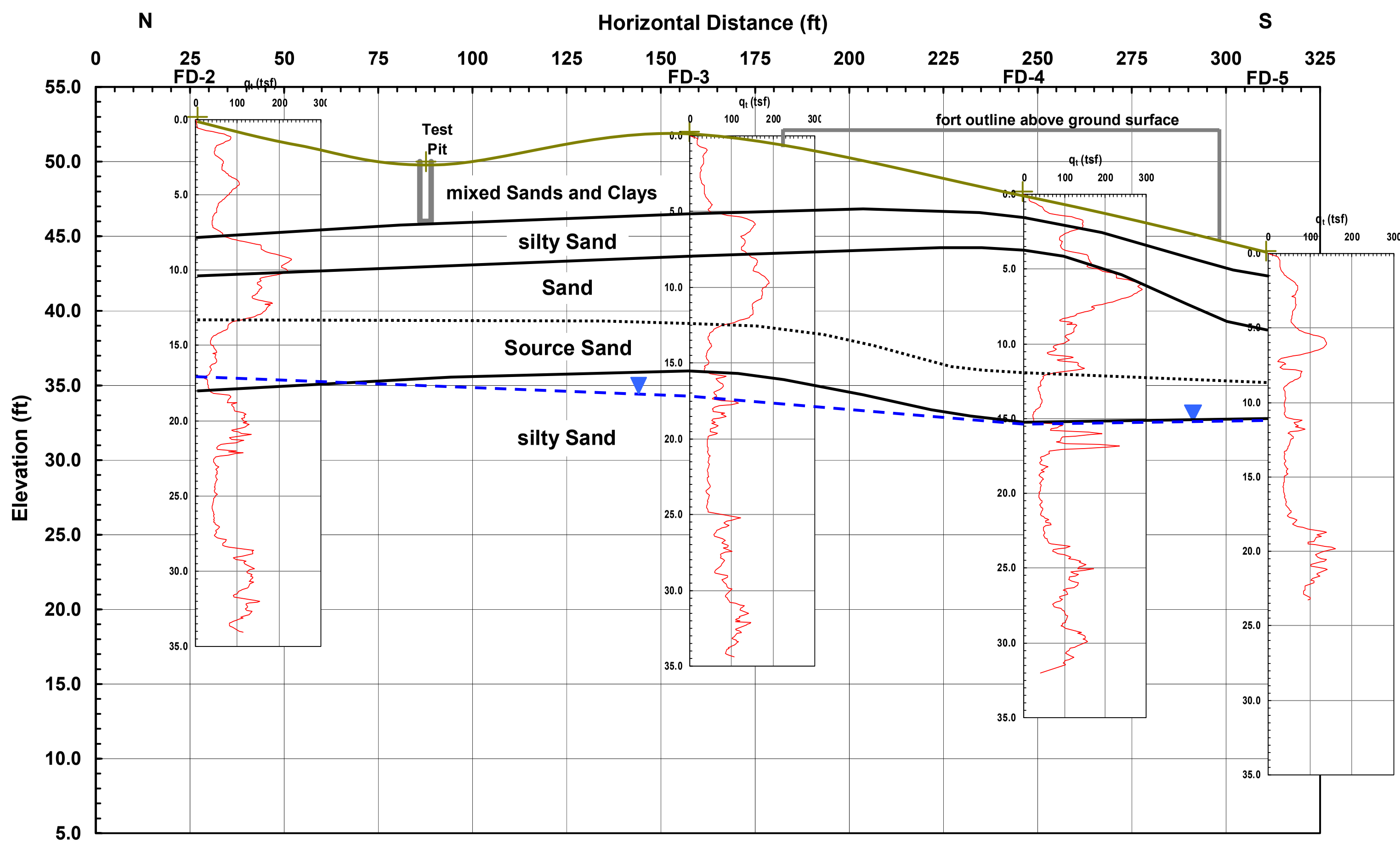

Figure 13: General stratigraphy along cross section bearing NNW shown in Figure 10.

II. SEARCH FOR ASHLEY RIVER FAULT IN MAGNOLIA PLANTATION

1. Background

The Ashley River fault (ARF) was originally defined by the instrumental seismicity and focal mechanisms, to extend from near Summerville ~545°E along the Ashley River (Talwani, 1982). The 1886 Charleston earthquake caused cracks in the northern and southern side of the Drayton tomb located on the south bank of the Ashley River in the Magnolia plantation. The crack lay along a ~NW-SE orientation and led Talwani (2000) to suggest that the ARF extended SE from Summerville to Magnolia Plantation. A reevaluation of the instrumental seismicity in MPSSZ, led Dura-Gomez (2004) to reevaluate the orientation and nature of ARF. She divided it into two faults, the seismic Sawmill Branch fault zone, extending ~N30°W from Middleton Place to Summerville, and the aseismic Ashley River fault, extending ~S60°E from Middleton Place towards Magnolia Plantation. This orientation was inferred from the trend of the Ashley River between these two old plantations. Evidence of a fault SE of Middleton Place had been noted in the COCORP seismic reflection line 3 by Schilt et al. (1983) (Figure 3). There was a gap in the reflection data where the reflection line crossed the Ashley River. Schilt et al. (1983) inferred the presence of a fault based on the sense of the basement relief there (higher on the southwest side of the gap). Such a configuration –a northwest-trending reverse fault would be consistent with our interpretation of SBF, although the SW dip direction postulated by Schilt et al. (1983) differs from the inferred NE dip for SBF. However, if the inferred fault is the ARF, its dip could be different.

2. Resistivity Survey in Fall 2003

Based on a NW trend of a fault between the Tomb on Magnolia Plantation (T in Figure 13), in Fall 2003 we carried out a resistivity survey along a small road in the Plantation (PQ in Figure 14). Using a Wenner configuration, resistivity surveys were conducted along a road in Magnolia Gardens located about 250m northwest of the Drayton family tomb which was cracked by the 1886 Charleston earthquake. The 600ft profile, using different station spacings, was oriented S50°W –N50°E (Figure 15). Two anomalous resistivity highs were encountered with a 10ft spacing (green curve). A short profile (#2) with 20ft spacing did not pick up the high. Resistivity soundings at A and B confirmed the resistivity values obtained on the profile. The location of ARF could not be unambiguously determined on this profile alone. The two highs are shown as H1 and H2 in Figure 14.

3. Resistivity Survey in Summer of 2008

With a borrowed 56 channel Automated Resistivity System, we carried out resistivity surveys along two other lines (BA and BC in Figure 14) on the grounds of the Magnolia Plantation. This system has 56 electrodes in a spread and the electrode separation can be varied. The instrument can be programmed to obtain resistivity profiles in both the Wenner and dipole-dipole configurations. The instrument comes with software to invert the data and present them in the form of a resistivity vs. depth section.

ARF was identified on line AB (at H3 in Figure 14). Figure 16 shows both the Wenner and dipole-dipole inverted resistivity sections along the SE-NE line from B to A (Figure 14). Distance (in m) are from the point B. In both cross-sections we notice that at about 168 m from B, there is a marked contact in resistivity values, higher towards A. We interpret this change in resistivity as being associated with a steeply dipping ARF. This location is marked as H3 on the map of Magnolia Plantation (Figure 14). On the N-S line BC (Figure 17) we do not see any anomaly. We pick up a continuous layer at about 5m.

We interpret the anomalous high resistivity on these profiles to mark the edge of the ARF. In Figure 14 we have connected the resistivity highs on lines PQ and BA with the location of the tomb (T) to infer a ~N55°W orientation for ARF. Further geophysical surveys are planned in the Magnolia Plantation.

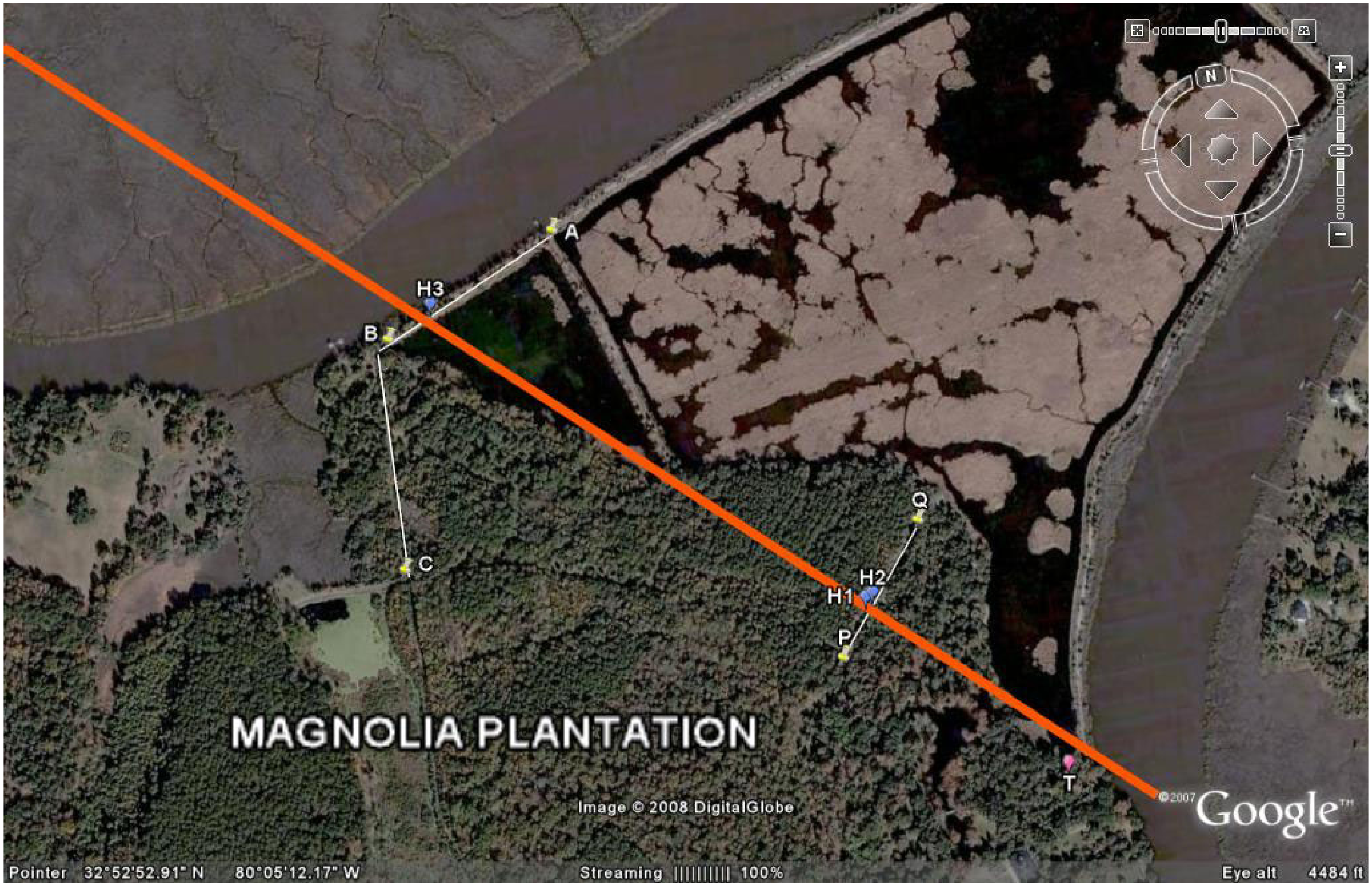

Figure 14: Shows location of Drayton family tomb (T) on the banks of the Ashley River. Also shows the location of resistivity profiles PQ, BA and BC. The orange line shows the inferred location of the Ashley River fault.

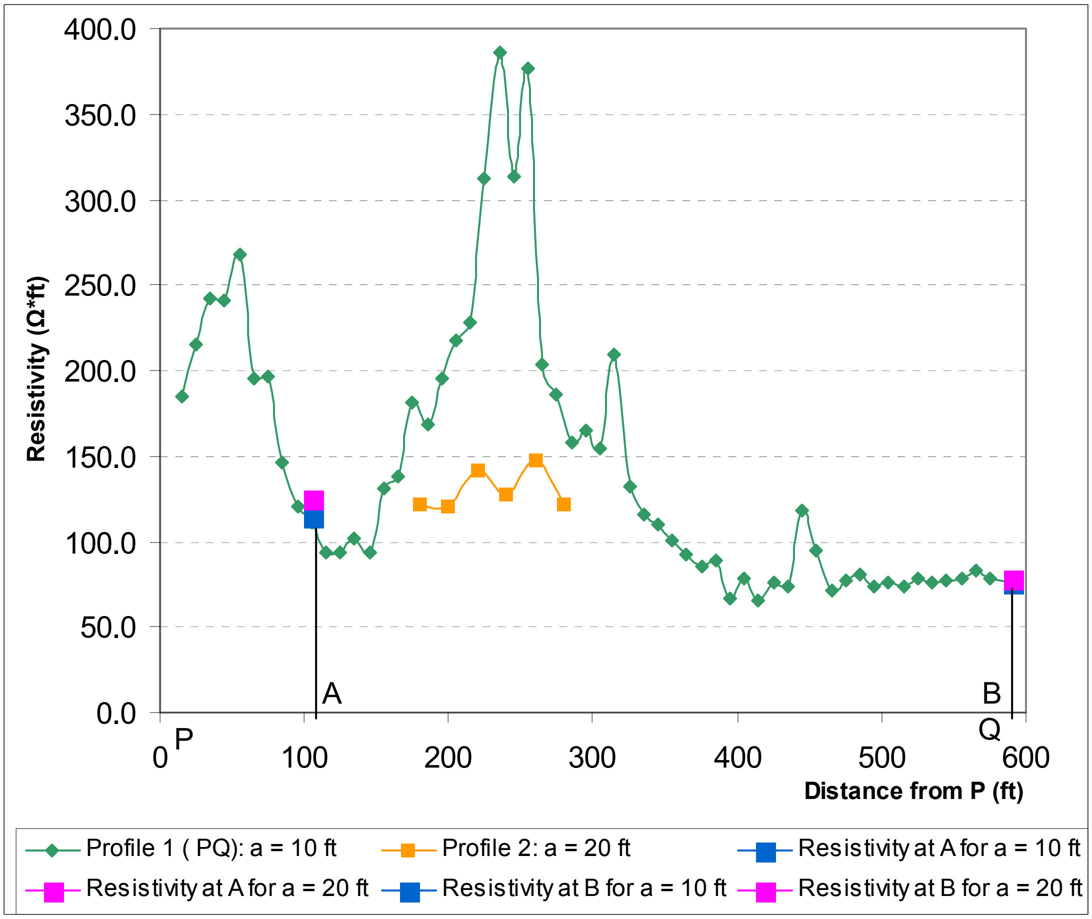

Figure 15: Resistivity profile from P in a N50°E direction to Q. PQ is located about 250m NW of Drayton family tomb in the Magnolia Gardens. Resistivity profile with 10ft spacing is associated with two highs. For one of them between 200 and 300 ft from P the high is not observed on the resistivity profile with 20ft spacing indicating a shallow source.

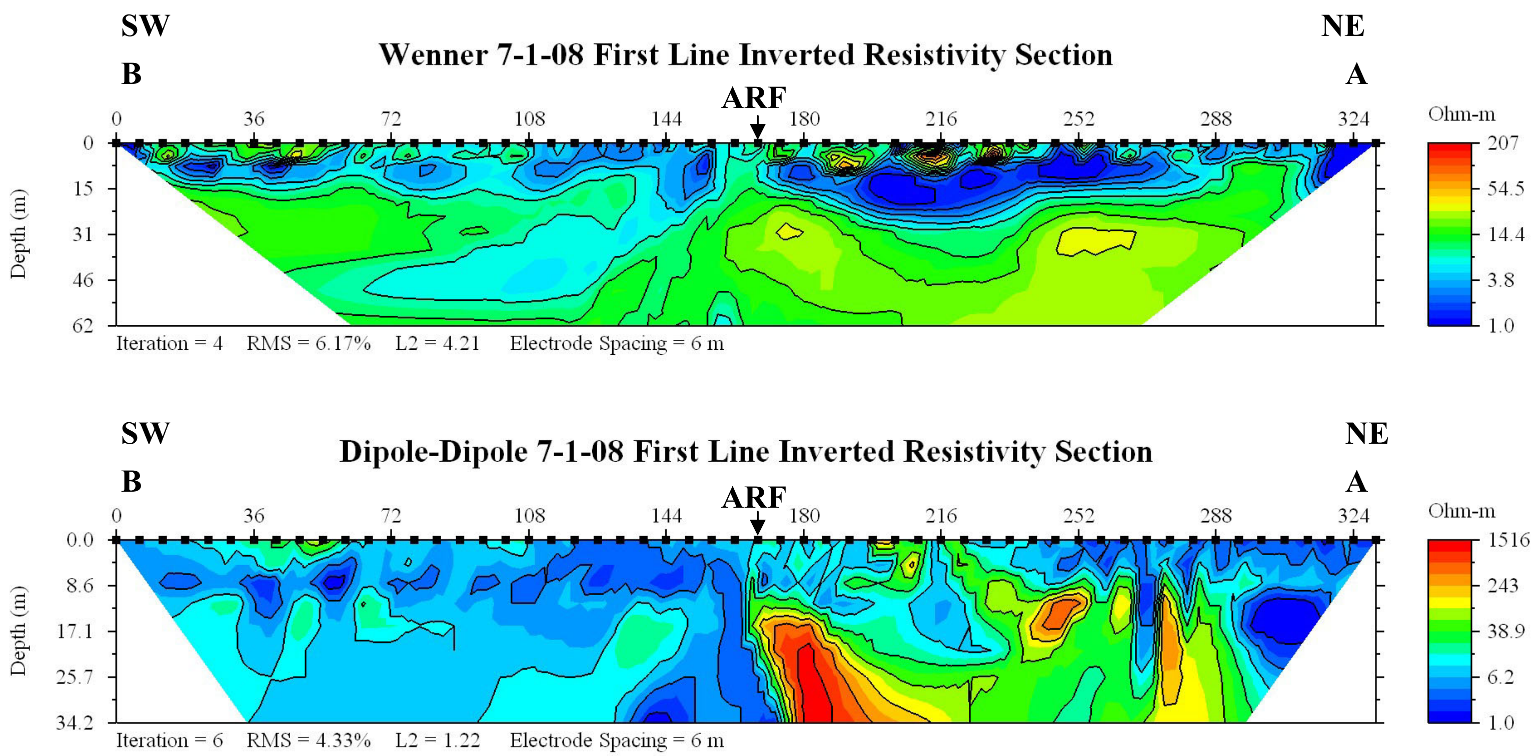

Figure 16: Inverted resistivity section along SW-NE profile along a dike in Magnolia Plantation. ARF is interpreted at 168m from B. (Courtesy Mike Waddell)

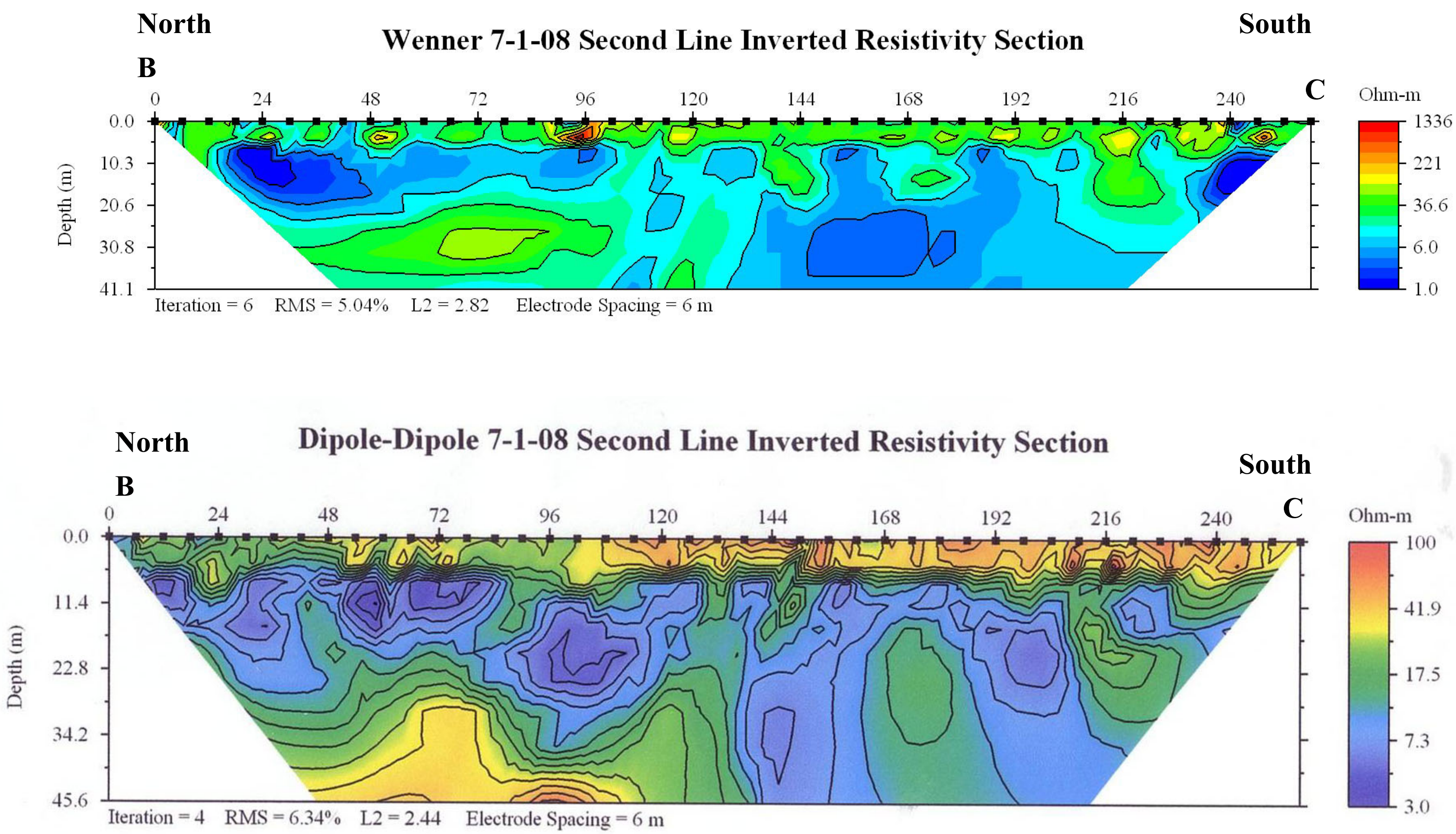

Figure 17: Inverted resistivity section along N-S profile in Magnolia Plantation. No evidence of faulting was found on this profile.

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APPENDIX I: The Old Fort

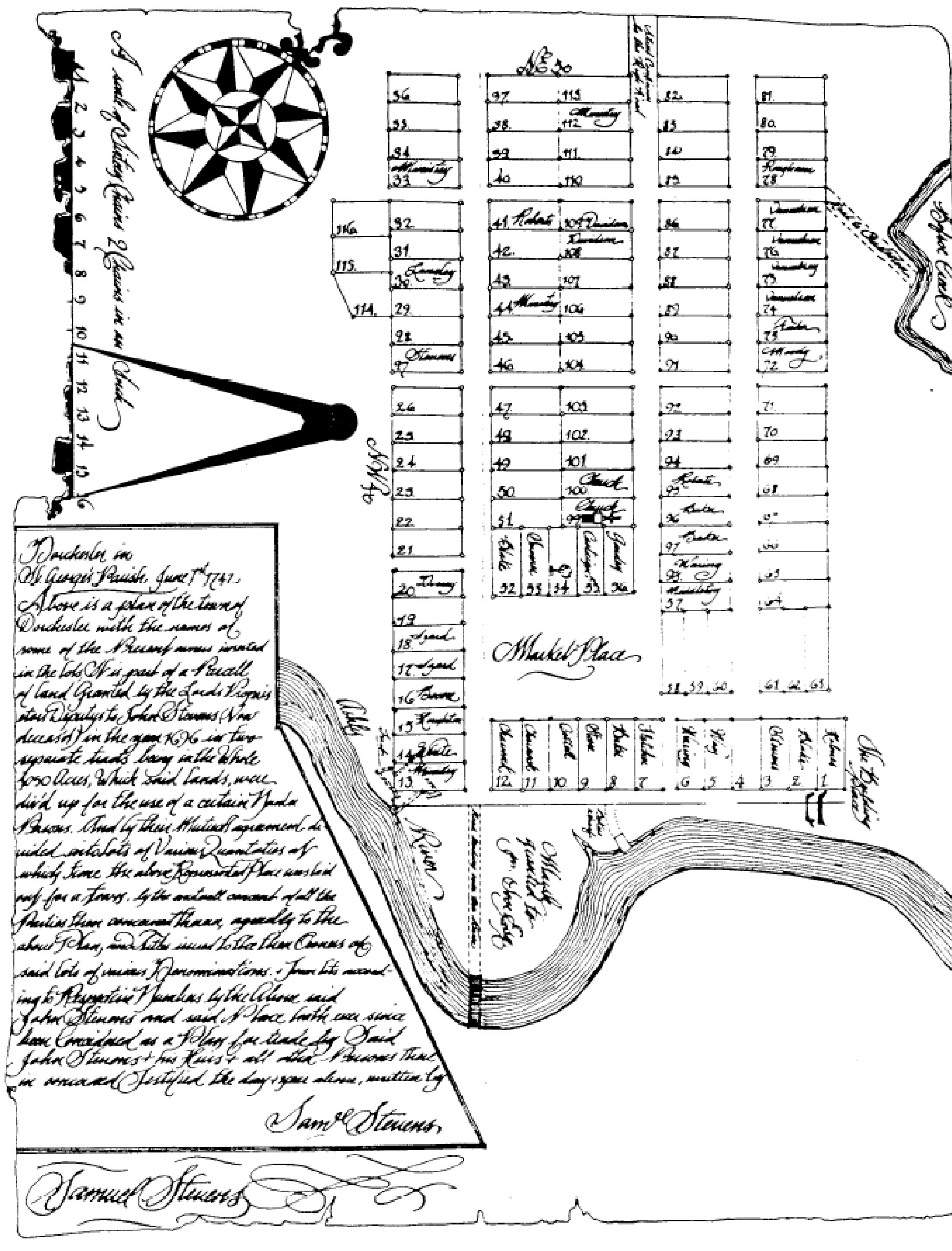
The old fort that faces the old church stands on the top of the rise of bluff of the river bank where it commanded the bridge across the river and the approach to it. It is located partly on lot 13 in the plan of the old village and partly on the street leading to the bridge head. It is the most perfect example remaining in the State of a fort of the period. It is constructed of the material called “tapia”, or more commonly “tabby”. This is composed of oyster shells embedded in a bond r matrix of burut shell lime, and forms a most durable and lasting composition. The exact date of its construction is unknown. The material of its construction gives no certain indication as “tabby” was used for such purposes from early date in the history of the Province down to as late as 1812.

There is a tradition that the fort was coeval with the settlement of Dorchester, and was relied on as a defense against the Indian enemies of the Province. No record support of this exits, although it is plausible and likely. On the plan of the village as originally laid out in 1697, as afterwards, in 1742, recorded in the office of the Secretary of State, no fort is set down, although the site of the parish church, constructed in 1719, is mentioned. There are a number of appropriations for fortifications in the tax Acts passed by the Assembly from 1740 on, but in none of such ass are published in the Statutes at Large is any specific mention made of the fort at Dorchester.

In 1775 the Council of Safety of the Province directed Dorchester to the fortified, and in December, 1775, they directed Fort Lyllelton, near Beaufort, to be repaired with “tappy”. Commissioners of fortifications for Dorchester were appointed by the Council of Safety, and in December, 1775, urgency was recommended to them in the erection of barracks, a guard room, and a place for confinement of prisoners; and on January 31, 1776, the Council of Safety authorized the payment of £760.10.07 on account of the fortification of Dorchester, and in February the military stores were placed in the fort and magazine at Dorchester, with a further payment of £271.10.00 on February, 6, 1776, for hire of negroes on the works at Dorchester.

Whatever fort or strong-work may have existed prior to 1775 it is safe to infer that the present fort represents the fortification constructed in that year by order of the Council of Safety.

From: Smith, Henry A.M., Cities and Towns of Early South Carolina, Vol.2, and Spartanburg, SC: The Reprint Company, Publishers, 1988.



Dorchester in
St. George's Parish, June 1st 1741.
Above is a plan of the town of
Dorchester with the names of
Market Place
Sam^l Stevens
Samuel Stevens

APPENDIX II: Particulars of GPR surveys in Colonial Dorchester Park collected in the summer of 2005.

II.1. Particulars of GPR lines

June 8, 2005	Line No.	Location	Antenna (mHz)	Length (m)	Remarks
	1	A to B	50	30	South of fort
	2	B to A	50	30	
	3	C to D	50	30	Parallel to AB and offset 2m to the south
	4	E to F	50	31	
	5	F to E	100	31.5	
	6	A to B	100	31	
	7	B to A	200	31	
	8	I to H	200	10	Inside fort; 1.5m north of south wall; centered around the main crack.

July 8, 2005	Line No.	Location	Antenna (mHz)	Length (m)	Remarks
	9	K to L	100	20.5	North of fort
	10	M to N	100	25.5	Between row of trees
	11	O to P	100	29.5	
	12	O to P	200	29.5	
	13	M to N’	200	25.65	
	14	K to L’	200	20	
	15	K to L’	200		CMP for velocity model; centered at 17.5 m on Line 14; moved 0.5 m on each side.

August 9, 2005	Line No.	Location	Antenna (mHz)	Length (m)	Remarks
	16	Q to R	100	17	Stopped at 17m then continued as Line 17
	17	Q to R	100	15	To 32m from Q
	20	Q to R	100		CMP
	21	Q to U	200	11	
	22	U to R	200	21	To 32m from Q
	18	S to S’	100	26.75	North-south profile
	19	T’ to T	100	22.25	North-south profile (T’ at 25m from S; T at 49m from S)

II.2. Surveyed (Total Station Locations)

	Northing (m)	Easting (m)	Elevation (m)
	3,645,	577,	
A	704.673	582.8063	6.36
B	691.780	554.495	6.01
C	679.537	600.7318	2.50
D	699.018	569.8043	1.72
K	769.695	514.936	9.01
L	781.043	531.396	9.42
M	753.408	526.218	8.60
N	769.765	545.102	9.14
O	738.494	534.805	8.12
P	747.961	562.208	8.09
Cracks in South Wall			
Main Crack	704.157	564.536	7.06
Crack to E of Main Crack	707.239	572.3372	6.99
Crack to W of Main Crack	701.812	558.7428	7.02
Main Crack in North Wall			
Y: Crack in NW corner of wall	740.403	547.463	846
Z: NW corner of fort	739.890	544.241	844
Location of sand blow center on south wall of trench	764.00	539.5	

APPENDIX III

BETA ANALYTIC INC.

DR. M.A. TAMERS and MR. D.G. HOOD

UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964
E-MAIL: beta@radiocarbon.com

REPORT OF RADIOCARBON DATING ANALYSES

Dr. Pradeep Talwani — Report Date: 2/12/2008

University of South Carolina — Material Received: 1/14/2008

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 239781	104.9 +/- 0.5 pMC	-25.9 o/oo	105.1 +/- 0.5 pMC

SAMPLE : DORC5
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (plant material): acid/alkali/acid
COMMENT: reported result indicates an age of post 0 BP and has been reported as a % of the modern reference standard, indicating the material was living within the last 50 years.

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 239784	108.1 +/- 0.5 pMC	-28.2 o/oo	108.8 +/- 0.5 pMC

SAMPLE : DORC11
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (plant material): acid/alkali/acid
COMMENT: reported result indicates an age of post 0 BP and has been reported as a % of the modern reference standard, indicating the material was living within the last 50 years.

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 239785	114.7 +/- 0.5 pMC	-27.9 o/oo	115.4 +/- 0.5 pMC

SAMPLE : DORC12
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (plant material): acid/alkali/acid
COMMENT: reported result indicates an age of post 0 BP and has been reported as a % of the modern reference standard, indicating the material was living within the last 50 years.

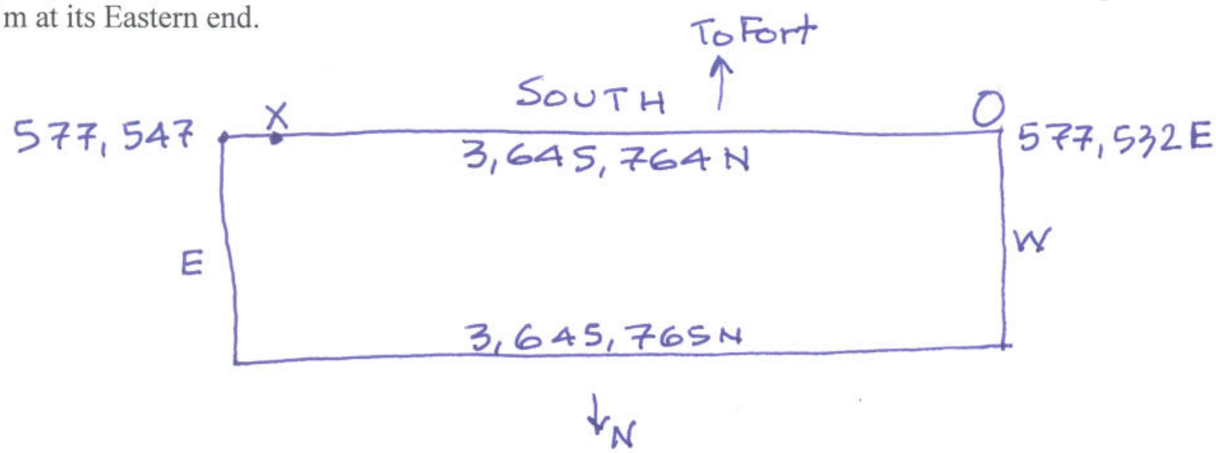
Dates are reported as RCYBP (raduicarbon years before present, "present" = 1950A.D.). By International convention, the modern reference standard was 95% of the C14 content of the National Bureau of Standards' Oxalic Acid & calculated using the Libby C14 half life (5568 years). Quoted errors represent 1 standard deviation statistics (68% probability) & are based on combined measurements of the sample, background, and modern reference standards.

Measured C13/C12 ratios were calculated relative to the PDB-1 international standard and the RCYBP ages were normalized to -25 per mil. If the ratio and age are accompanied by an (*), then the C13/C12 value was estimated, based on values typical of the material type. The quoted results are NOT calibrated to calendar years. Calibration to calendar years should be calculated using the Conventional C14 age.

TRENCH LOG APPENDIX IV (Unedited field notes)

June 6, 2007.

Cut an E-W trench ~25m north of the north wall of Fort Dorchester. The trench is about 15m long, 1m wide and 1m +/- 10cm deep. The trench was not excavated all the way to a depth of 1m at its Eastern end.



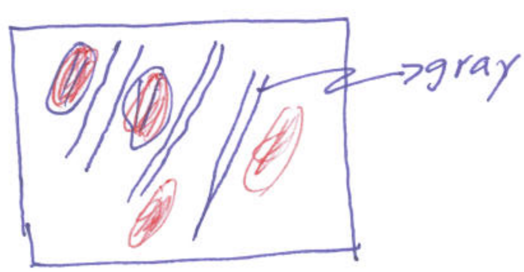
Point X is ~1m from the Eastern end and its coordinates are N 3,645,764, E577,546.. The coordinates of O are N 3,645,764, E577,532. The northern wall is along N 3,645,765.

For mapping, worked on the south wall, going from East to West.

O. Easting 577,532 to 577, 533.

Marked by lots of roots in the western wall all the way to the bottom of the trench.

All across the trench we have ~< 20cm of disturbed soil where the Colonial artifacts were found. Below that the soil is sandy- the top horizons being more sandy w/ some clay. The bottom was thick clay with sand. The gray stringers in this bottom layer were of almost pure clay, the "red" area is also clay, but with more sand.



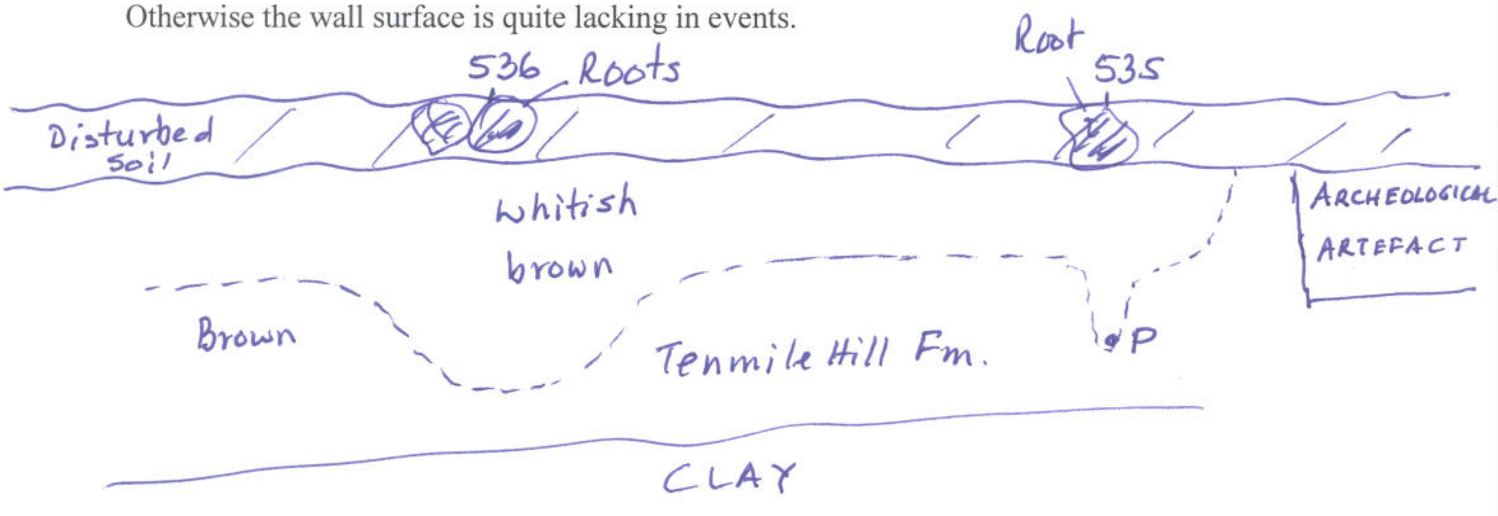
About 25 cm from O, and about 25 cm into the trench, the soil was wet. Not clear if the roots of the tree that had been cut contributed to the water. Two days later, this wet spot had dried. The color of the 'sand' is distinctly brown, and different from what you find in the rest of the trench. However, the clay later (red and gray) appears to be uniform all thru the length of the trench. The width of the sand layer fluctuates, and so does its color, but the underlying clay layer appears to be uniform all thru. However, the density of the underlying clay and its moisture content does seem to vary- as evidenced by the feel when digging and also by touch. It is clayey , i.e., it will roll in fingers, but is not exactly the same all the way thru. The overlying seems to vary-it is friable at some locations, and clayey at others., has a sharp boundary w/ the underlying clay at some places an gradational boundary at others,- the color of the sand also varies considerably—from brown and moist near O, to faintly whitish brown 6m from O. In some places it is devoid of mottled material and shows possible fluvial structure, and at others it is filled with mottled clay-rich clayey material.

577,533 E
About 1.55m from O, and 0.5 m from the South wall, Will Doar III of the South Carolina Geological Survey put in a 0.86m deep hole in the bottom of the trench. The hole was completely in clay.

577,534 E

Marker 534 sits on an archeological site, described by Ashley Chapman (Archeologist at Fort Dorchester) as 2007-7. It marks the location of a post put in by the colonials in the 1700s.

577,535 E
Otherwise the wall surface is quite lacking in events.

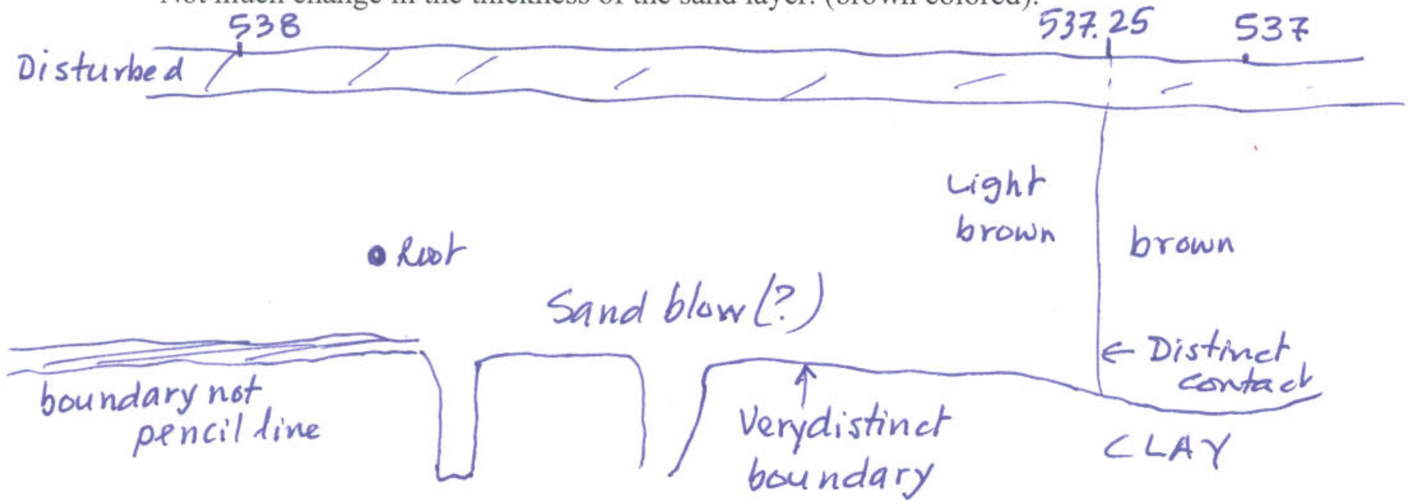


Just past the 535 marker, there is a anomalous thin sandy protrusion in clay (P in the figure).

577,536 E
At 536 there is a root. The lighter brown, friable sand (near the root) seems to thicken. Past 536, the sand seems to thin and lose its whitish hue, turning into brown about 40cm past 536. However, the sand clay boundary continues at about the same depth. So it seems possible that this lighter brown sand could be related to the roots (chemical reaction).

577,536-537 E

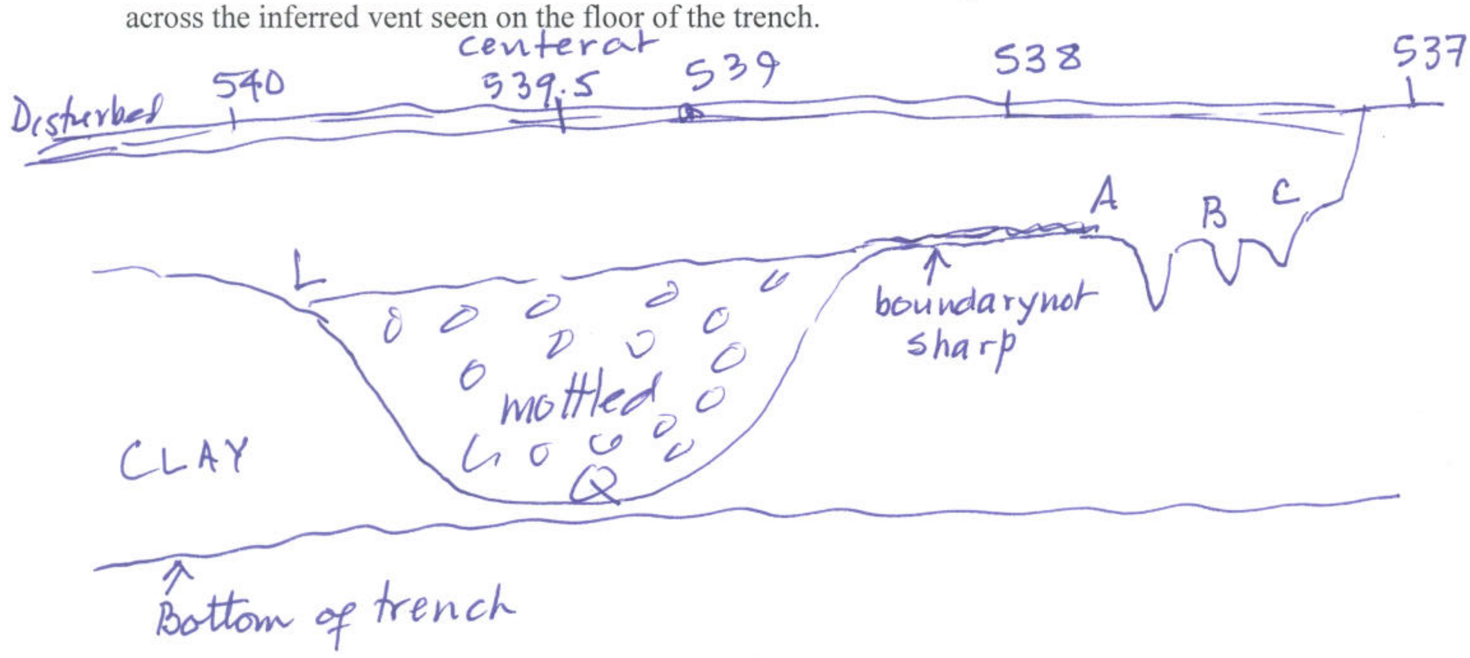
Not much change in the thickness of the sand layer. (brown colored).



We find a main feature between 537.25 and 539/40 E.

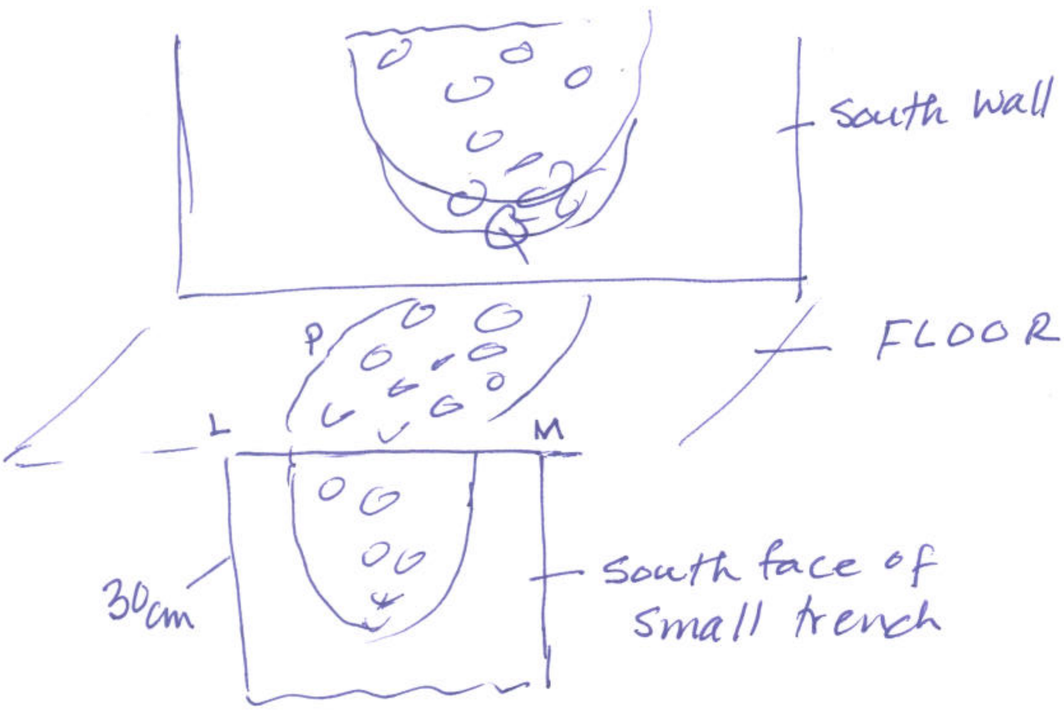
At A,B, and C there appear to be fluvial patterns in the sand, just above the contact with clay. The sand above AL is light gray without the mottled clay. As you go towards Q, the clay content increases. It is still sand w/ more clay, whereas above AL it is more sandy. In either case, it is distinct from the clay below.

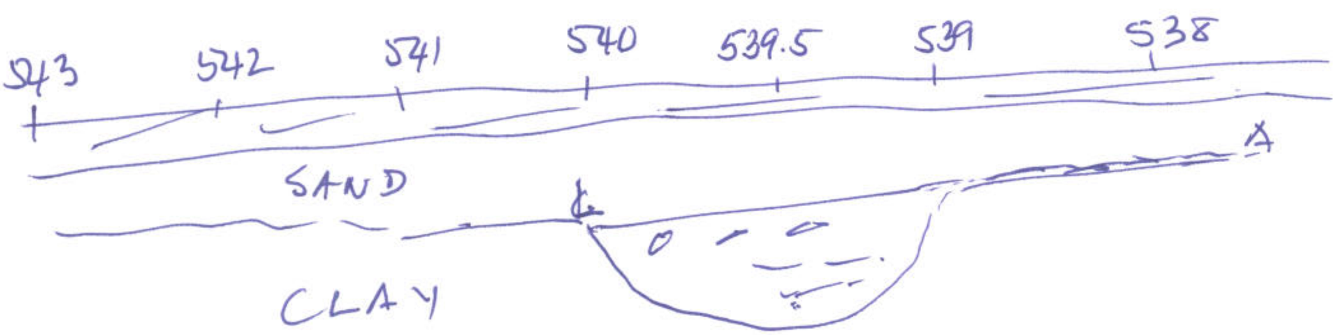
We cut a small rectangular hole in front of Q. The anomalous mottled layer that we found above Q, was also present in front of Q on the floor of the trench. The small hole was cut thru it. We interpret the mottled clay at P on the floor of the trench to be a conduit or vent. It is about 9" wide.. To see if this is a conduit, cut a 1 ft deep hole where LM cut across the inferred vent seen on the floor of the trench.



We see that the vent continues in the hole cut in the trench floor, (hand dug about 30cm). On the southern wall of this small trench, we see the same mottled surface, Vent (?) about 20cm(+/-) wide.

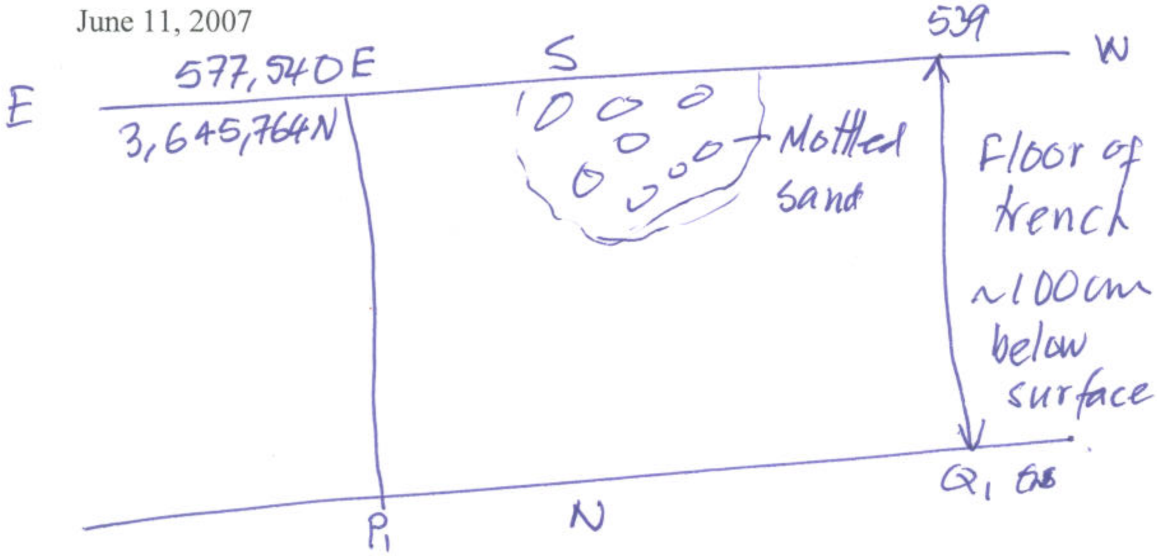
577,539-577,543 E

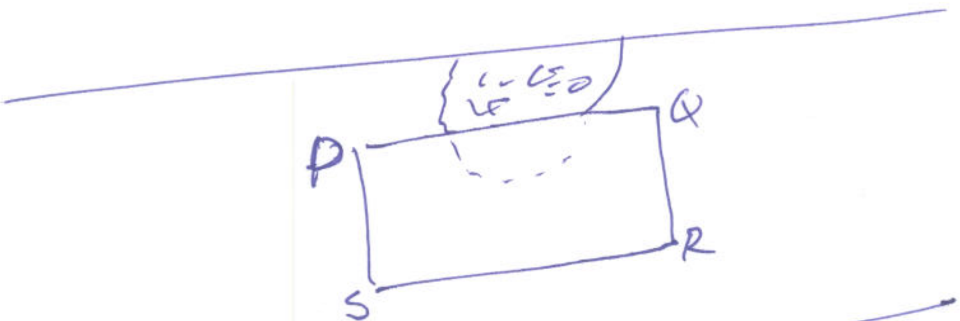


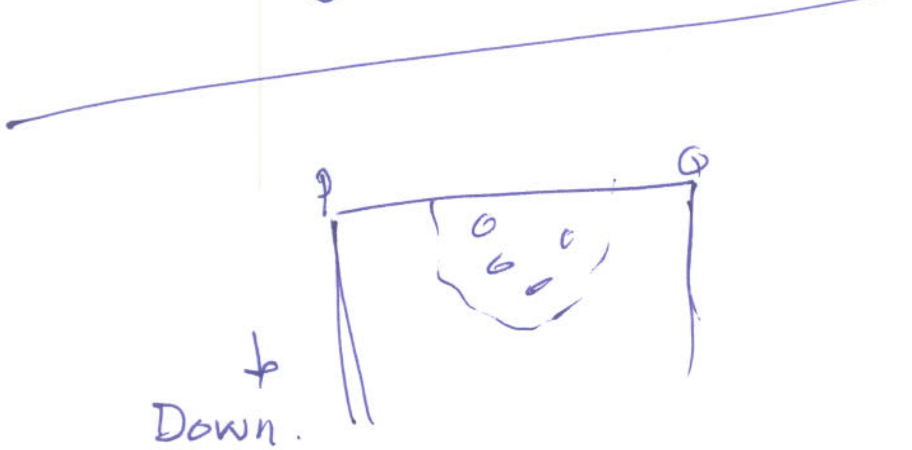


MAP VIEW

June 11, 2007







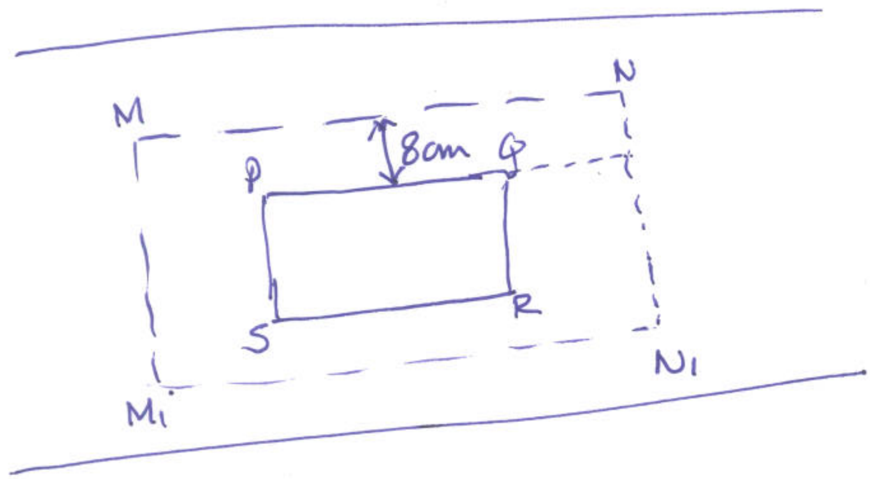
Cut a 30cm deep hole to see the mottled sand in cross section. Along PQ , we see mottled sand that is connected with the sand seen on the floor (middle).

See light brown sand underlain by what appears to be older, mottled, more clay rich than the un-deformed and un-layered sand that overlies it.

Intriguingly, across the trench on the north wall we also see mottled sand ,which would suggest that the mottled sand seen on the north and south faces and that seen on the floor are a part of the same sand blow. This suggests that the narrowing that we see in the small trench made on the floor of the trench could be the conduit. Mapped it and marked it with pins, all this on June 8/08.

See the feature on the northern wall.

On Monday June 11th, widened the floor trench in an E_W direction, and then cut 8cm more towards the south face to see the body of the sand blow, and also deepened it to a depth of 38cm.



Samples 2 and 3 have a number of fresh looking roots Not clear if they are recent which have grown into the linear clay lenses that they appear in, or they are older.(WERE NOT USED). Near S1 hit a modern looking root ~1/2 " in diameter which broke with abrittle , crackling sound.
Also, on the face MNN1M1 we note that the mottled sand is broader and we can track it all the way to the floor, although the clay content increases.