Paleoseismological Studies in the Charleston, South Carolina Region

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INVESTIGATIONS UNDERTAKEN

Introduction

Results of earlier paleoseismological investigations (Talwani and Schaeffer, 2001) suggested two scenarios for the location of major earthquakes – one, there had been at least six M~7.0 earthquakes in the past 6000 years, all centered at Charleston, and two, some of these events were smaller and centered ~100 km to the NE and SW of Charleston. Also macroseismic reports of the 1886 Charleston earthquake suggested that it might be possible to study the causative Ashley River fault (ARF) in shallow trenches located in Magnolia Gardens and at Fort Dorchester. Fort Dorchester is a State Historical Site and the State Parks Service insisted on the need of an archeological survey of the proposed trench sites before they would allow us to dig trenches. Unfortunately, the requested funding for the archeological survey was not approved. So following negotiations with the State Park Service it was decided we would carry out GPR and resistivity surveys so as to limit the length of the trenches. At the proposed locations for trenching in the Magnolia Gardens we found that it had been the location of phosphate mining. Near surface phosphate nodules had been mined in the last century. Consequently we decided to carry out geophysical surveys there, in the hope of detecting ARF below the nodules, before commencing to trench. The inferred orientation of ARF, N45ºW did not agree with the macroscopic observation at Fort Dorchester, where the inferred orientation of the fault was ~N20ºW. Also there was lack of seismicity between the Middleton Place and Magnolia Gardens. So it was decided to review a variety of geological and geophysical data to come up with a revised seismotectonic framework which would then dictate trenching locations.

RESULTS

(a) Revised Seismotectonic Framework

Figure 1 shows the locations of earthquakes in the Middleton Place Summerville Seismic Zone (MPSSZ) between 1977 and 2003. It also shows the tectonic framework due to Garner (1998). It shows the Ashley River fault extending N45°W from Magnolia Gardens through Fort Dorchester. ARF forms the step-over between two legs of the NNE trending Woodstock fault. The revised seismotectonic framework (Dura-Gomez, 2004) is shown in Figure 2. The ARF is split into two parts, the seismogenic Sawmill Branch fault (SBF) striking N30°W with ~67°SW dip and the ARF which dips to the SW and is associated with reverse faulting. The exact strike of ARF could not be determined. The two legs of the Woodstock fault dip steeply to the northwest and are associated with right-lateral oblique faulting.

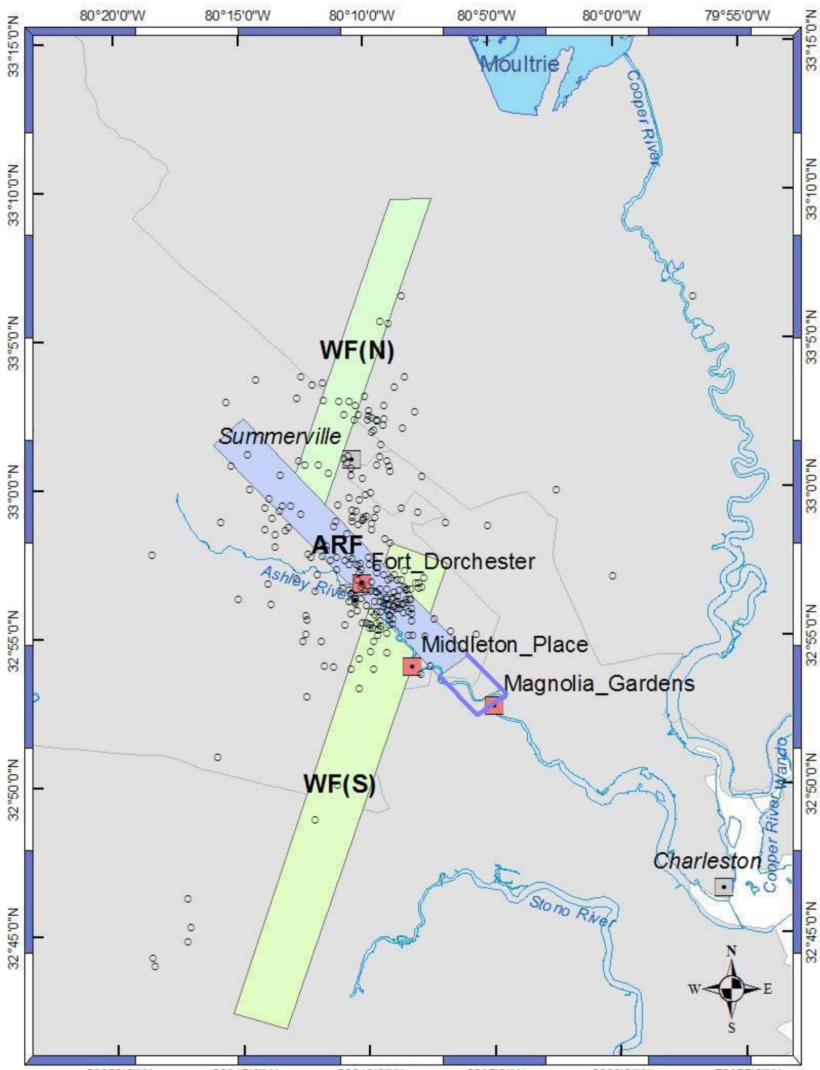

Figure 1: Instrumentally located seismicity (1974-2003) and inferred faults (Garner, 1998). The Woodstock fault (WF) is associated with right-lateral oblique slip and is broken and offset by the northwest trending Ashley River fault (ARF). A broken tomb at Magnolia Gardens was used to infer the SE extent of ARF.

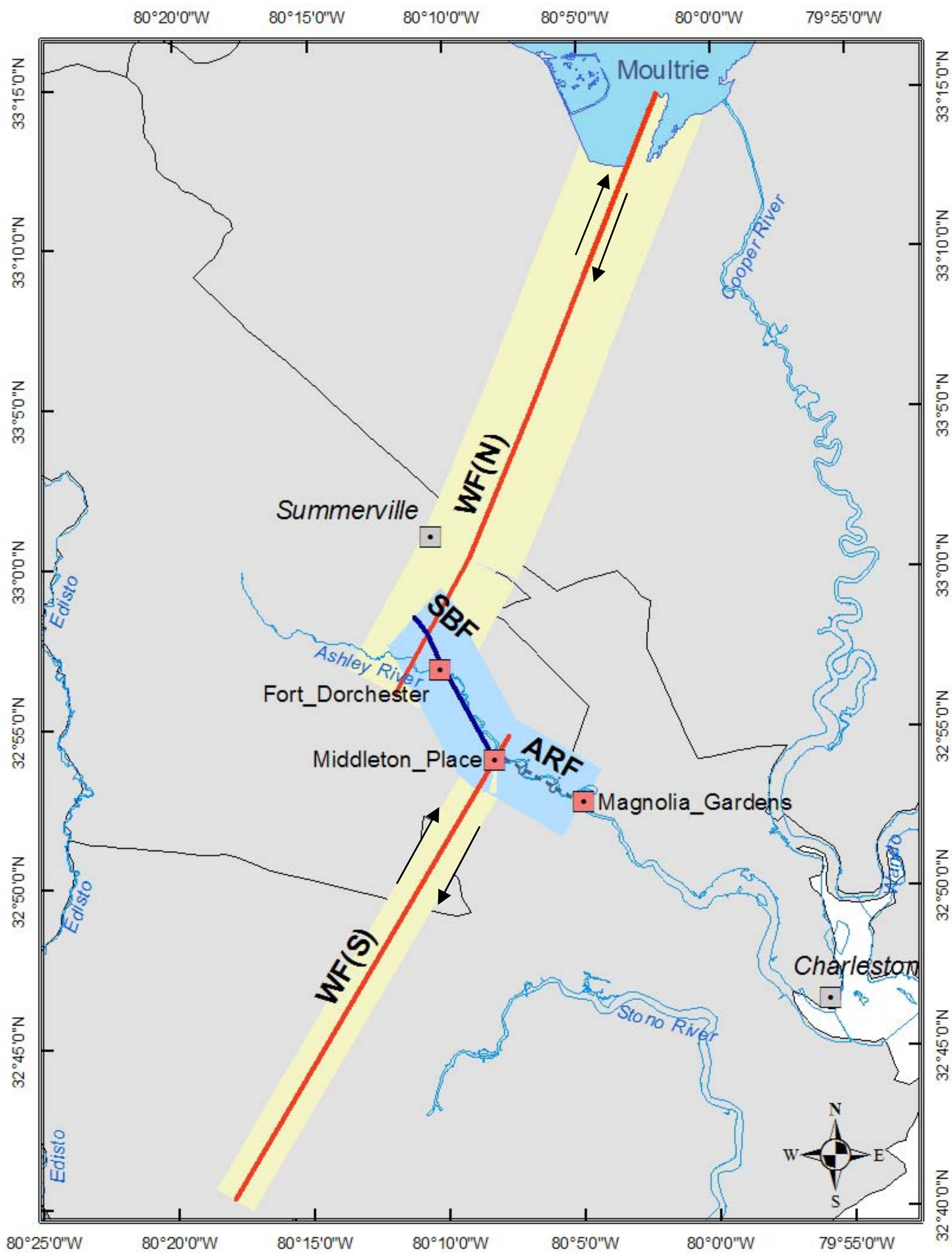

Figure 2: Revised seismotectonic framework (Dura-Gomez, 2004). The Sawmill Branch fault – Ashley River Fault system has been redefined. Trenching and geophysical investigations are planned for sites at Magnolia Gardens and Fort Dorchester.

(b) Geophysical Investigation

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 3). Two anomalous resistivity highs were encountered with a 10ft spacing (green curve). These appear to be associated with shallow phosphate deposits. A short profile (#2) with 20ft spacing did not pick up the high suggesting that the phosphate deposits are relatively thin. Resistivity soundings at A and B confirmed the resistivity values obtained on the profile. The location of ARF could not be unambiguously determined.

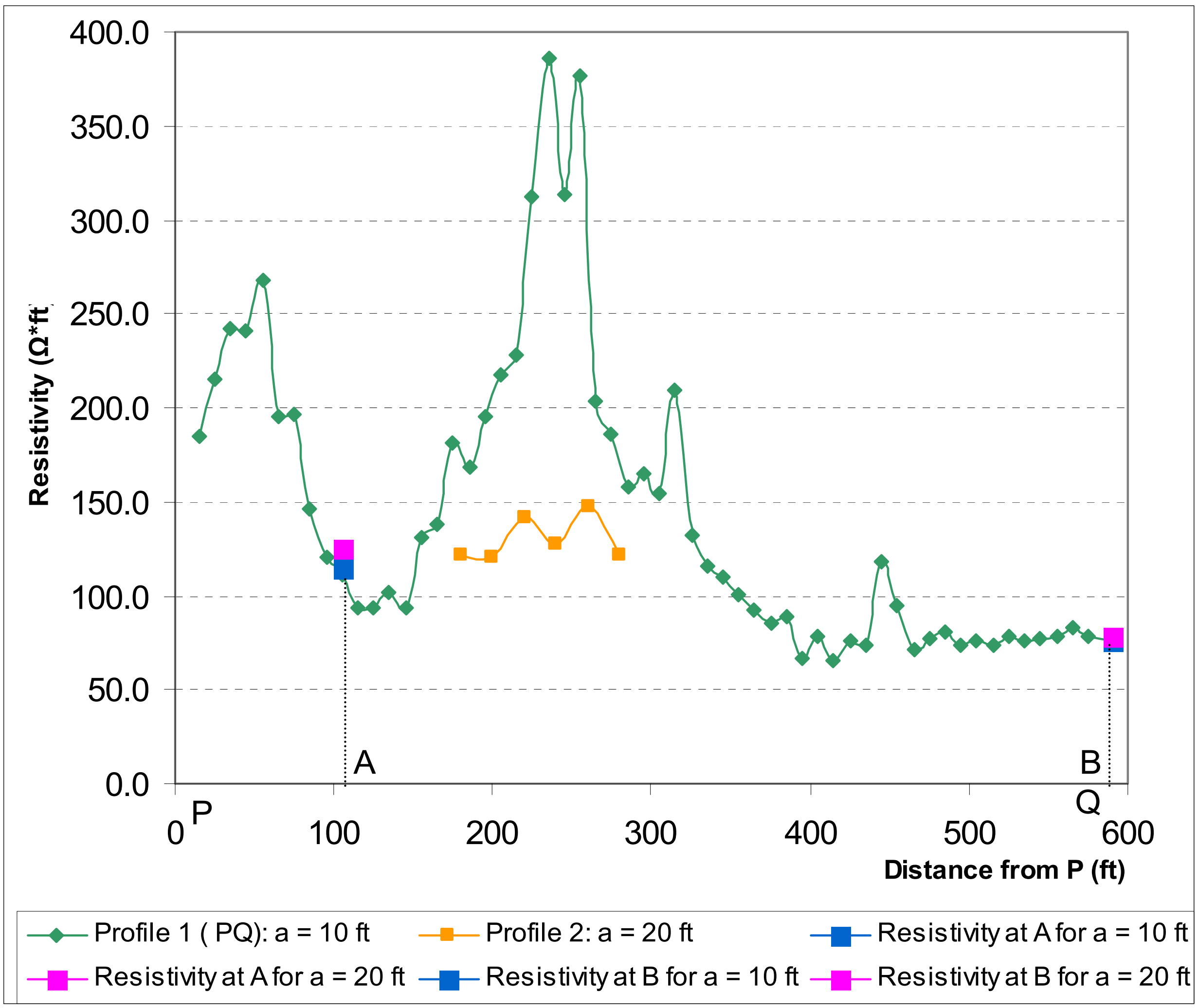

Figure 3: Resistivity profile from P in a N50°E direction to Q. PQ is located about 250m NW of Drayton family tomb in the Magnolia Gardens. Resistivity profile with 10ft spacing is associated with two highs. For one of them between 200 and 300 ft from P the high is not observed on the resistivity profile with 20ft spacing indicating a shallow source.

FUTURE INVESTIGATIONS

We plan further electrical resistivity surveys in Magnolia Gardens along two profiles using multiple station spacings and targeted resistivity soundings. Limited resistivity surveys are also planned for Fort Dorchester. We have recently acquired a Ground Penetrating Radar (GPR) and plan to run profiles along the lines chosen for resistivity investigations. We anticipate completing these investigations by Spring 2005 and anticipate zeroing in on the locations of the Sawmill Branch fault in Fort Dorchester and the ARF in Magnolia Gardens. Trenching operations will be carried out in May – July 2005.

REPORTS PUBLISHED

Dura-Gomez, I., (2004). Seismotectonic Framework of Middleton Place Summerville Seismic Zone, Charleston, South Carolina. M.S. Thesis, University of South Carolina, pp 180.

Dura-Gomez, I., Talwani, P., (2004). Seismotectonic Features of Charleston Earthquakes. Talk presented at the Eastern Section-Seismological Society of America Conference, 2004 in Virginia Tech, Blacksburg, VA.

REFERENCES

Dura-Gomez, I., (2004). Seismotectonic Framework of Middleton Place Summerville Seismic Zone, Charleston, South Carolina. *M.S. Thesis*, University of South Carolina, pp 180.

Garner, J. T., (1998). Re-evaluation of the Seismotectonics of the Charleston, South Carolina Area, *M.S. Thesis*, University of South Carolina, pp 250.

Talwani, P. and Schaeffer, W. T., (2001). Recurrence rates of large earthquakes in the South Carolina Coastal Plain based on paleoliquefaction data, *J. Geophys. Res.*, **106**, 6,621 – 6,642.

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. The catch is in determining the exact spot to trench. Two sites were chosen for these investigations – Fort Dorchester and Magnolia Gardens near Charleston, South Carolina. However, at Fort Dorchester, a SC Historical Site, there are several archeological artifacts. At Magnolia Gardens we discovered large scale distribution of shallow phosphate nodules, which had been mined in the last century. Their presence made it difficult to determine the precise fault location to trench. So it was decided to try and better define the seismotectonic framework. So the major emphasis during the reporting period was on developing a seismotectonic framework. A seismotectonic framework describes the location and configuration of faults on which the seismicity is being observed. Using a GIS database and seismological data, a revised tectonic framework was obtained (Figure 2). This will be used to guide further geophysical and trenching investigations.