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LETTER TO THE EDITOR

Discussion of "Prehistoric Landfall Frequencies of Catastrophic Hurricanes..." (Liu and Fearn, 2000)

Correct identification of storm deposits could aid in prehistoric climate reconstructions and in assessing coastal hazards. Otvos and Price (2001) recognized that as recently as the middle Holocene, climate conditions on the northern Gulf were periodically drier than at present. Such shifts may have triggered changes in the intensity and frequency of tropical cyclone activity (Forman *et al*., 1995). Liu and Fearn (1993, 2000) inferred a late Holocene period of 12 "catastrophic," Category 4 and 5, hurricanes. This stormy interval was bracketed by relatively calmer climate phases in the Gulf of Mexico. The evidence comes from cores from two lakes currently separated from the Gulf by sand barriers: Shelby Lake, Alabama and Western Lake, Florida (Fig. 1; Liu and Fearn, 1993, 2000). In the mud beneath each lake they found sand layers, and they interpreted many of these layers as evidence for hurricane storm surges that washed across the adjoining sand barrier.

Before any hurricane history can be extracted from such evidence, competing explanations for the sand layers need to be demonstrated as being unlikely. For Shelby Lake, I recently showed (Otvos, 1999) that nearly all the sand layers accumulated in a valley-filled estuary, much narrower and quite unlike the present lake. Shelby Lake formed during a subsequent coastal development phase, in the center of a large triangular cuspate spit (Fig. 2). I also suggested that many of the layers resulted not from storm-surge overwash but from a variety of processes involving ordinary estuarine sedimentation, as well as

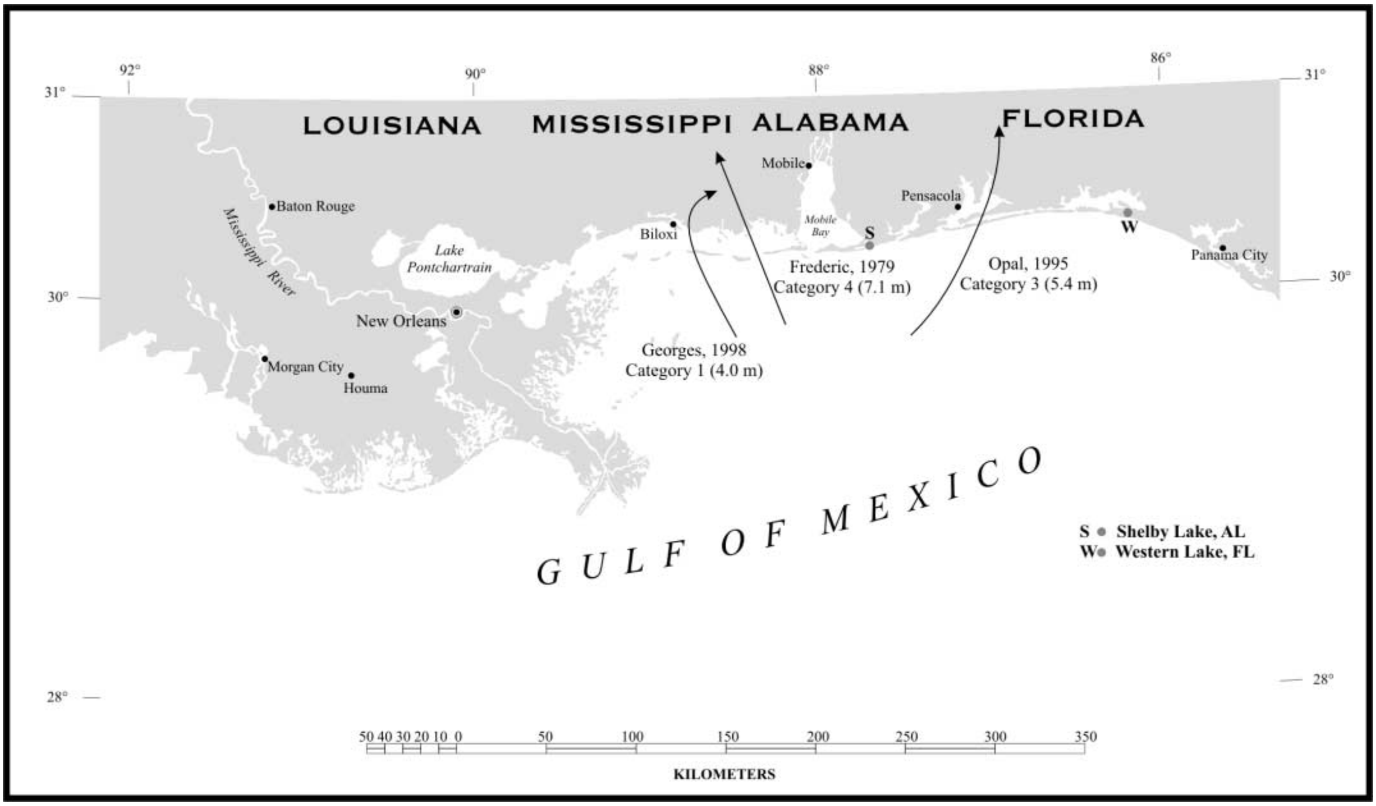

FIG. 1. Map of the north central Gulf of Mexico showing locations of Shelby and Western Lakes and tracks of the three cited Gulf hurricanes at landfall. Maximum reported storm surge and wave runup elevations in general hurricane coastal impact area, are based on U.S. Army (1981, 1998) and Maxfield (1995).

sand redeposition from sand dunes that form the lake and inlet shores. The hurricane history inferred from Western Lake raises similar questions about paleogeography and sedimentology:

1. Where was the sand barrier beside Western Lake during the late Holocene? In a conceptual diagram Liu and Fearn (2000, Fig. 2) treated the barrier as fixed. Under this assumption, storm overwash may influence the presence or absence and the landward extent of sand layers in the lake. However, between 1868 and 1935 the Walton County shoreline retreated, at an average rate of about 0.5–1.0 m/yr (U.S. Army, 1971, p. d140). If a similar rate of shore retreat prevailed in the late Holocene, it steadily changed the conditions for recording the size and frequency of storms that may have overwashed the barrier. Shore retreat has been accompanied by bluff erosion and landward shift of large individual barren sand dunes that advance landward in front of the continuous transgressive dune barrier. As the individual dunes and the shore barrier moved

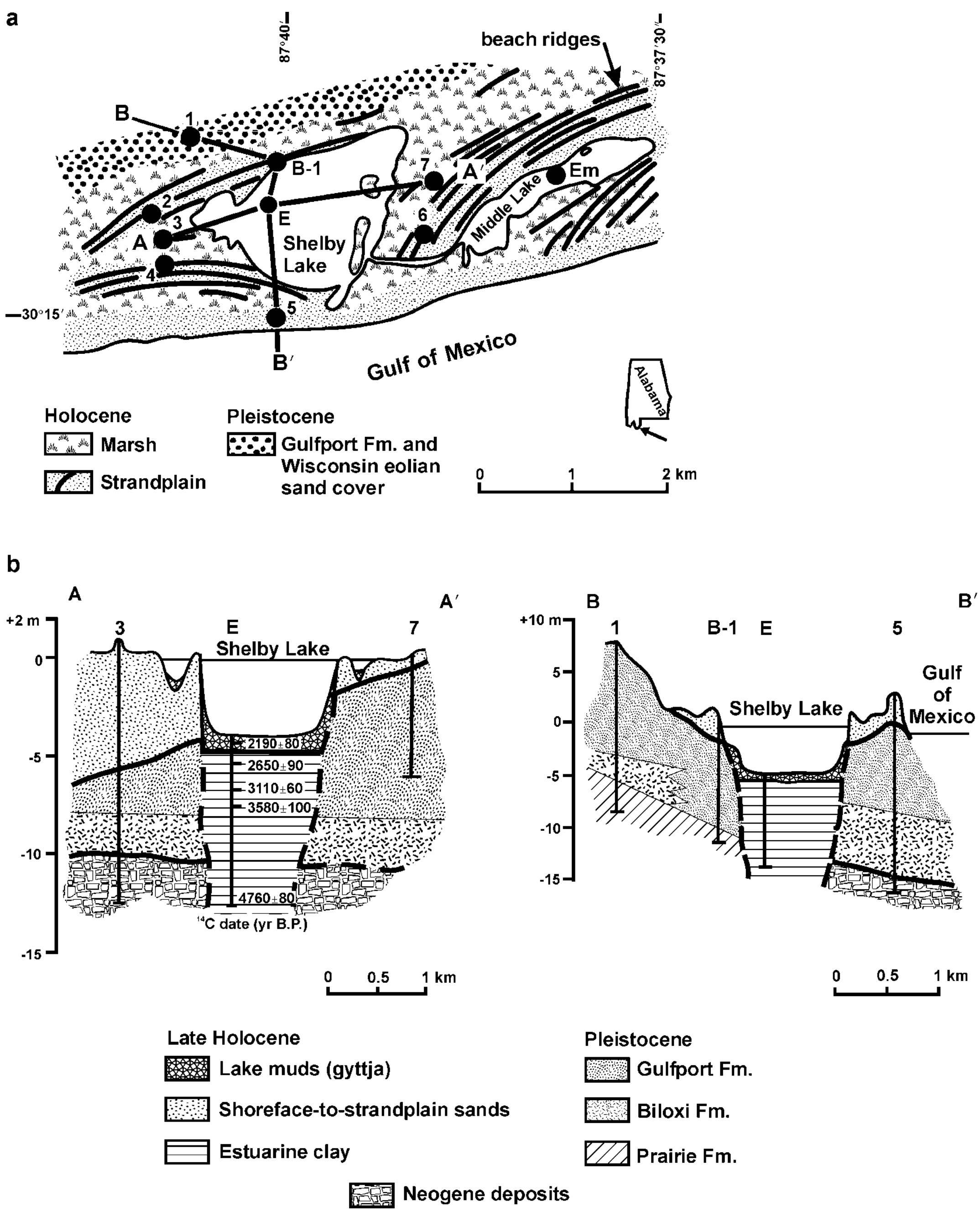

FIG. 2. (a) Shelby Lake, southeastern Alabama. Geologic units and drillhole locations are from Otvos (1999). (b) Geologic cross sections across Shelby Lake. Core E, with radiocarbon dates and general geology during Hurricane Opal are reproduced from Liu and Fearn (1993) and Otvos (1999).

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closer to previously untouched muddy lake floor areas, these started to receive overwashed sand from minor storms and sand reworked from transgressing dune shores by lake waves and currents.

2. To support their case, Liu and Fearn (2000) should provide guidelines to distinguish between overwash by minor storms across low pathways gap and that produced by high-category hurricanes across high barrier sectors. In a pertinent publication on hurricane deposits in Gulf nearshore and estuarine settings, Davis *et al.* (1989, p. 1055) could not distinguish even between tidal delta and storm washover facies in Florida bays "with any degree of certainty."

Overwash is favored by low sectors along the crest of the barrier ridge, including inlet entrances. The highly variable crest elevations, already open inlets, and those reopened by storms provide ready overwash pathways, as illustrated by the coastal topography around Western Lake. Low barrier dune sectors and gaps in them between sea level and 4 m altitude are common (Fig. 3). Low lake shore sectors would easily channel 2- to 4-m-high surge and even higher wave runup generated by a minor hurricane, such as the Category 1 Hurricane Georges in 1998 (U.S. Army, 1999). Minor Gulf hurricanes and lower-than-catastrophic wind velocities at significant distances from the center of major hurricanes still produce significant surge elevations with potentially substantial overwash processes (Fig. 1). The coastal topography in the Western Lake area and comparisons with 18 adjacent and analogous Walton County estuarine lakes and their inlets point to the existence of a previously active Gulf inlet, now buried beneath the transgressive barrier dune ridge (Fig. 3). When open in the past, this inlet would have provided a ready conduit for sand from the Gulf to Western Lake.

3. The authors report little about the Holocene history of Western Lake's dune barrier. Their conceptual chart treats the barrier and Western Lake as having been stable since 5000 ^{14}C yr. B.P. However, the main core diagram (Liu and Fearn, 2000, Fig. 6) does not show clearly the presence or absence of any sand layer older than 3400 ^{14}C yr B.P. (their Fig. 6).

4. Liu and Fearn (2000) provide no basis for comparing "prehistoric" sand layers in the lake muds with any historically documented storm overwash-related sand layers. The authors interpreted sand at a high level in their Core 11 as having been transported into Western Lake during Opal, a noncatastrophic hurricane, and not by overwash, which was absent, but by sand transport through a tidal channel. They need to explain why there are no equivalent sand layers in nearby core sites 8, 9, 12, and 13 and why simple mualacustire sand redeposition from sandy lake bottoms adjacent to the southern dune barrier shore may not have been responsible. They also need to show why the sand layer in Core 11 must date from Opal, or from any hurricane at all.

5. As indicated, being dependent on sand availability, the connection between the size of sand bodies produced by overwash and the hurricane stage is rather tenuous. Relating the size and frequency of estuarine sand layers to the size and energy levels of prehistoric hurricanes is a difficult proposition. For instance, while Hurricane Frederic, a 1979 Category 4 hurricane, formed an extensive set of 400-m-long and 100-m-wide (maximum) washover fans off Dauphin Island, Alabama (Nummedal and Otvos, 1985), its impact through washover deposition in nearby Lake Shelby was minimal (Liu and Fearn, 1993).

6. Details of coastal geologic history and a variety of processes must be carefully weighed before reaching conclusions on the frequency and intensity of prehistoric tropical cyclones.

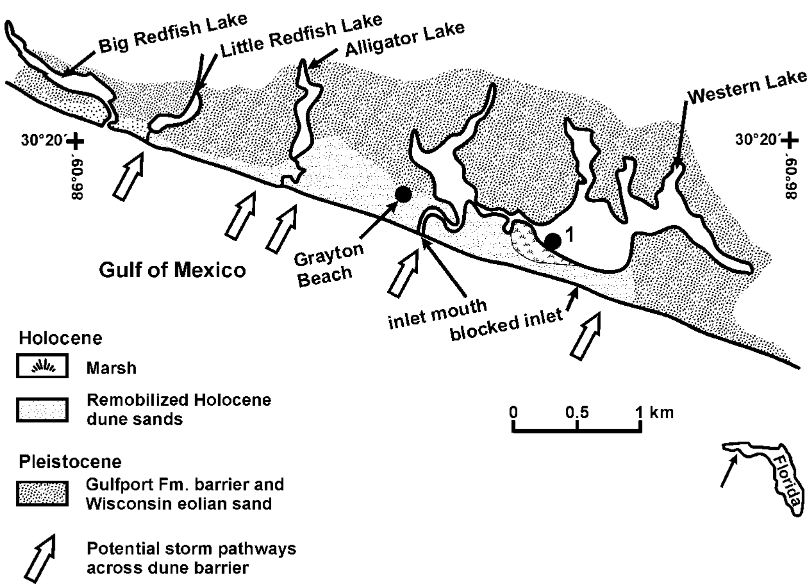

FIG. 3. Map showing geologic setting of Western Lake, northwestern Florida and Core 1 location (Liu and Fearn, 1993; Otvos, 1999). Potential storm overwash pathways (arrows) through inlets and across transgressive dune-barrier in Western Lake area, Walton County, Florida. U.S.G.S. Grayton Beach Quadrangle.

On the everyday level, such conclusions may influence the insurance industry, which, based on the long-term geological record, is attempting to predict storm risk in coastal areas.

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