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Discussion

Reply to comment "Validity of sea-level indicators" by E.G. Otvos

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Otvos (in press) has raised a number of interesting comments concerning our interpretation of the origin of the buried, Holocene New Orleans Barrier. These comments address (1) the proposed disconformable rather than gradational/conformable relationship between the Barrier Complex and the underlying Nearshore Shelf Deposit, (2) the significance of onshore sediment transport rather than longshore transport, and (3) the nature of the Holocene sea-level curve for the northern Gulf of Mexico: a Shepard (1963, 1964)-type that describes a continually, but not uniformly, rising, non-fluctuating, sea-level that asymptotically approaches the present-day position versus a Fairbridge (1961, 1976)-type that describes a series of fluctuations, which have exceeded present-day level by perhaps up to several meters, and that decrease in both amplitude and duration toward the present-day position.

Proposed disconformity at the base of the Barrier Complex.

We disagree with Otvos (in press) and maintain that the Lake Carmel pit "firmground", no matter of its limited geographic extent nor its minimal thickness, is of paramount importance to the interpretation of the stratigraphic relationship between the Nearshore Shelf Deposit and the Barrier Complex. Furthermore, Miller (1983, Fig. 2 and Table 1) identified only one "firmground" layer at the Lake Carmel pit and placed it at the contact between the Barrier Complex and his underlying Michoud Formation (Nearshore Shelf Deposit of Stapor and Stone, 2004). Because this pit is no longer accessible, Miller (1983) must be considered the definitive stratigraphic description.

The proposed disconformable relationship between the Barrier Complex and the underlying Nearshore Shelf Deposit is not based on the amount of erosional relief present at this critical interface. We agree with Otvos (in press) that this interface shows little, if any, evidence of pronounced scour and hence missing section. It does indeed appear to be conformable in both the Morrison Road and Bullard Road pits. However, unconformities are surfaces defined on the basis of missing record, commonly but incorrectly referred to as missing 'time', which may or may not have a geometry of erosional relief.

The "firmground" of Miller (1983) present in the Lake Carmel pit provides the only material evidence to suggest that the Nearshore Shelf Deposit and Barrier Complex are separated by an interval of essentially zero net deposition. The 800-year age range of articulated marine pelecypods in the upper 20 cm of the Nearshore Shelf Deposit in the Bullard Road pit likewise indicates an interval of low net deposition, 0.025 cm/year. The entire 35-km-long Barrier Complex had to have been deposited over a

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200–300 year interval, based on the 4270 BP age of the youngest articulated *Mercenaria campechiensis* at the top of the Nearshore Shelf Deposit and the 4000 BP age of the Linsley midden located seaward of the Barrier Complex. Thus at the Bullard Road pit the Barrier Complex had a minimum net deposition rate of 1.5 cm/year. These dramatically different net deposition rates argue that the Barrier Complex and the Nearshore Shelf Deposit do not have a gradational facies relationship resulting from progradation and/or aggradation, but rather are actually disconformable.

One possible explanation for the disconformable positioning of the shallower-water Barrier Complex facies on top of the deeper-water Nearshore Shelf Deposit is indeed the Saucier (1963) and Otvos (1978) model of a spit-like, lateral progradation from a more eastern headland. This intuitively attractive model can be evaluated by estimating the minimum net longshore transport rate necessary to prograde the Barrier Complex from its eastern terminus and comparing this rate with existing rates in the northern Gulf of Mexico. Otvos confuses the term "Littoral transport" with "Longshore transport" where the latter, used by us, is a partial component of the former, the other component being cross-shore flux. The Barrier Complex was constructed over 200–300 years, and contains approximately 7×10^8 m^3 of sand. If the dominant mechanism for forming the island was longshore transport as suggested by Otvos (in press), then the net drift rate required would be 3×10^6 m^3 per year. Transport rates of this magnitude are extremely unlikely given the limited fetch and subsequent low, modal wave energy conditions along the northern Gulf of Mexico. (We make the assumption that the modern wave climate in the Gulf is a reasonable proxy for conditions during the formation of the Barrier Complex.) Longshore transport rates of this magnitude have to our knowledge, never been reported in the literature (see review in Komar, 1998). Transport rates along the modern northern Gulf of Mexico do not typically exceed 125,000 m^3 per year (Stone et al., 1992; Stone and Stapor, 1996; Cipriania and Stone, 2000; Stone and Zhang, in press). We disagree with Otvos (in press) that this volume estimate is "…vaguely delineated…" given the 826 drill points (provided by Roger Saucier, written communication) on which Fig. 4 of Stapor and Stone (2004) is based. Finally, Otvos (in press) cites a study by Jaffe et al. (1997) conducted on the shoreface off south-central Louisiana as evidence of large volumes of sediment flux. We disagree that this study sheds light on the formation and sediment source for the New Orleans Barrier Complex as discussed by us. Jaffe et al. (1997) focus on quantifying sediment flux (not littoral flux) on the lower shoreface and sediment bypassing a wide and complex tidal inlet. It is important to note that Jaffe et al. (1997) focus on possible mechanisms describing inlet bypassing and subsequent reductions in down-drift barrier island erosion; these data were not used to evoke a depositional model for barriers as implied by Otvos (in press). Because of this longshore transport rate problem as well as the presence of obviously reworked, large shells within the Barrier Complex, we were forced to consider both an alternate sand source and transport path.

It is beyond the scope of this reply to respond to Otvos' (in press) critique of higher-than-present sea-level indicators from the northeast and eastern Gulf of Mexico. We concur with Blum and Carter (2000) and Blum et al. (2001) that there well may be a set of methodological biases between subsurface and surface studies. The vast majority of subsurface studies have concluded a Shepard-type curve in which mean sea-level asymptotically approaches present-day with no interpreted fluctuations. In contrast, surface studies involving beach-ridge plains, archeological sites, and scarps/terraces have concluded that fluctuations, some above present-day mean sea-level, characterize the middle and late Holocene sea-level rise, a Fairbridge-type curve. Stapor and Stone (2004) is perhaps the first study in the northern Gulf of Mexico to interpret a sea-level fluctuation based on subsurface data. We suggest that stratal geometries are not effectively sampled by centimeter-wide cores and hence this technique is incapable of identifying critical bounding surfaces that are so important to modern stratigraphy. Furthermore, centimeter-wide cores do not sample enough mass to permit the identification of reworked material. The borrow pits examined by Otvos (1978), Miller (1983), and Stapor and Stone (2004) were of sufficient size that both stratal geometries and reworked materials could be identified. An integration of northern Gulf of Mexico subsurface and surface sea-level data is a critical priority.

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