# WINTER AND TROPICAL STORM EVENT IDENTIFICATION BASED ON LATE HOLOCENE SHELL BEDS, TEN THOUSAND ISLANDS, S.W. FLORIDA

**RAMON J. LOPEZ JR**
Department of Geology, Vassar College
Sponsor: Friedrich Pflueger, Ph.D.

## INTRODUCTION

Determination of storm frequency through tempestite identification over the past 5, 000 years is key to understanding how coastal geomorphology of southwestern Florida will be affected in the future (emphasis mine). Arguably, a global warming trend is likely to produce more hurricanes of increased intensity. Higher occurrences of Hurricane Andrew-type storms (Category IV) will drastically affect mangrove island health and thus have serious implications for property values and human development in and around one of the fastest growing areas of the United States.

Research indicates that mangrove islands are responsible for shoreline stabilization and progradation. Since mangrove roots are known to trap sediment, they slowly prograde seawards as new seedlings take root. Parkinson (1991) reports mangroves have kept pace with Holocene sea level rise and are thus responsible for an apparent late Holocene sea level regression. Parkinson (1987) states numerous studies on the Ten Thousand Island conclude hurricane landfall is the major control mechanism for sedimentation and thus geomorphology.

The identification of storm events based on shell deposits in the stratographic is the focus of this study. Several observable differences between winter and tropical storm generated shell beds should be evident. This hypothesis is based on the assumption winter storms carry significantly less energy than larger tropical storms. A winter storm would produce relatively smaller shell bed with shells having relatively better taphonomic condition as opposed to those generated by hurricanes. Understanding the difference(s) between tropical and winter storm deposits allows for a better understanding late Holocene climate and how storms will affect southwest Florida in the future.

## METHODOLOGY AND STUDY SITES

A model describing two types of shell beds was developed for this study. *Type I* shell beds are those occurring within a “parent” facies or geologic unit. *Type II* shell beds are found on a facies contact and are indicative of a change in paleoenvironment (i.e. increased wave energy associated with rising sea level, or amalgamated storm deposits). The depositional mechanism responsible for the shell bed is a separate matter; this is based on the organization of material within the bed. A generic storm generated shell bed would show a fining upwards grain size trend with articulated, imbricated shells in hydraulically stable positions in the lower zone of the bed. Shells of poor taphonomic condition are expected to be deposited in the upper zone of the bed, as they are less dense than articulate ones.

## Coring Program

A series of two transects— three cores from Barfield Bay and two from Blackwater River— were hand cored in areas where tempestites preservation is most likely, that is, a waterway of constricted flow opening into a relatively larger area. (Parkinson, 1989 and Purlmutter, 1982). Strain on program resources and the risk of attracting large predators were the main reasons for not using a vibracore.

## Barfield Bay, and Blackwater River

Barfield Bay is mostly likely a non-carbonate inter-island bay (IIB) within the TTI mangrove island complex (MIC) coastal zone (Parkinson, 1991). Known sediment types for chain-of-bays, and inter-island bay systems are: (1) soft organic-rich shelly quartz mudstone, (2) mollouscan quartz packstone, (3) shelly quartz packstone, and (4) oyster rudstone and bindstone (Parkinson, 1987). A transect of three cores was taken down the middle of a smaller, submerged flood delta in Barfield Bay. The study site is located on a sand bar in the seaward most area of the mainland shore (MS) coastal zone (Parkinson, 1991). The predominant sediment within this area is red mangrove peat, quartz, and occasionally calicitic muds. The mineralogy of the Blackwater River study area is predominately quartz in nature.

# RESULTS

The Blackwater transect, consisting of two cores (cores BW-1 and BW-2, figure 1) were interpreted to have five distinct sedimentary units: (1) mottled organic rich quartz packstone, (2) red mangrove peat, (3)shelly marine quartz packstone or muddy oyster bindstone, (4) very shelly quartz rudstone, and (5) quartz grainstone with shelly debris.

The Barfield Bay transect exhibits two major geologic units in cores BB-2 and BB-3 with a third distinct unit in core BB-1 (figure 1). Several subunits are also described within these cores; classification of a subunit is based on the amount of shell material. The preliminary facies analysis (based on observation) is: (1) slightly shelly to shelly quartz packstone, (2) quartz wackestone with shell debris, and (3) slightly shelly quartz grainstone (core BB-1 only).

These cores are associated with open marine sequences. Sufficient material for absolute age dating is not available for any cores within this study.

# Discussion

Two occurrences of sea-level change, the Lower Holocene transgressive and Upper Holocene “regressive” sequences (Parkinson, 1991), have been identified within the Blackwater River transect. The Lower Holocene transgressive sequence is identified by the first four facies in cores BW-1 and BW-2 (figure 1). The following paleoenvironment reconstruction of the facies is based on sedimentary evidence: (1) sub-aerial (mottled, organic rich quartz packstone), (2) red mangroves (peat), (3) shallow marine (shelly quartz packstone, or muddy oyster bindstone), and (4) high energy marine (shelly quartz rudstone).

The Upper Holocene “regressive” (or rather shoreline progradation) sequence is identified by the fifth facies, quartz grainstone. The moment in geologic history where mangrove progradation begins to match the rate of sea level rise is difficult to determine from this data. The quartz grainstone unit, although an open marine sequence is part of the Upper Holocene regression as a red mangrove forest surrounds the study site—this indicates a return to more shallow marine conditions.

The shelly quartz rudstone unit exhibits several interesting features making an interpretation of the depositional mechanism problematic. The sharp basal, non-bioturbated contact with the underlying shelly quartz packstone lends evidence of rapid erosion and re-deposition. The lower zone of the rudstone facies also contains a higher concentration of broken shells while the upper zone has an increased concentration of articulated specimens—this suggests a coarsening upwards sequence of shell material.

Based on the shell bed model developed for this study, the shelly quartz rudstone unit of the Blackwater transect partially fits the criteria of a *Type II* shell bed generated by storm activity since it occurs on a facies boundry. It is unlikely this unit represents a singular storm deposition event but rather an amalgamation of tropical storm layers

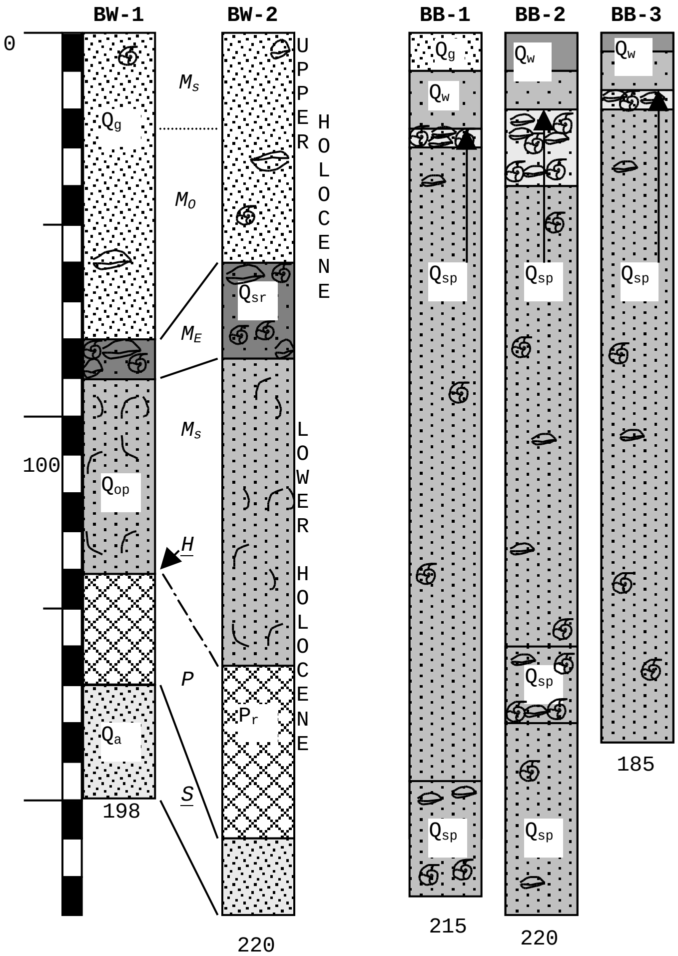
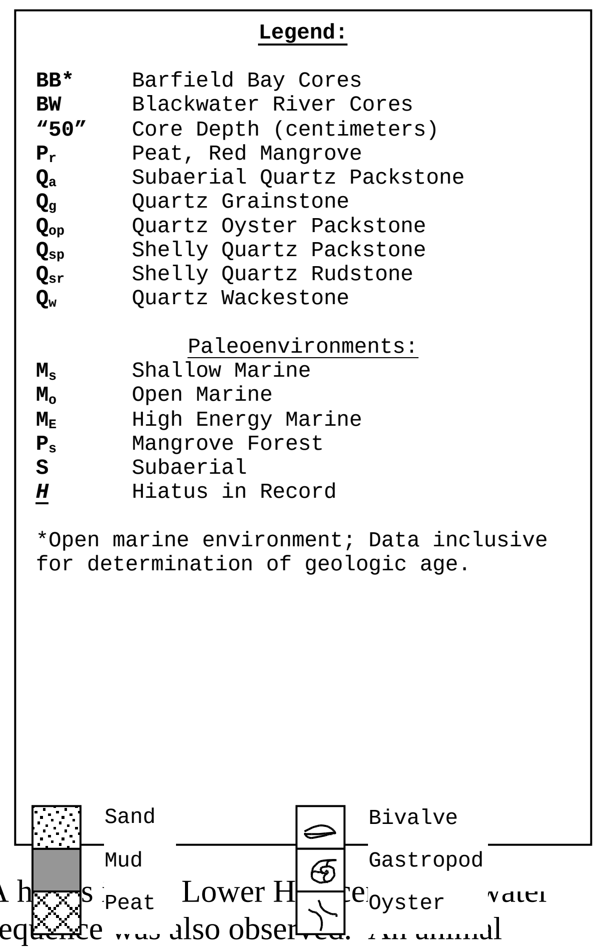



***Figure 1*. Core data, geologic time scale, paleoenvironment. Scale in cm.**




energy wave action is a certainly a plausible explanation for the poor taphonomic condition of bivalves, gastropods, and oysters. In either case, these interpretations support a sea level transgression described by Parkinson (1991). Rising sea level would result in increased wave action thus exposure to larger waves is expected.

reworked during a period of rising sea level or rapidly changing climate. (It does not seem likely winter storms carry enough energy to amalgamate large amounts of sediment and shell material.) The poor taphonomic condition of shells within this layer (high degree of fragmentation and numerous bore holes) indicates the material was subjected to predation (i.e. parasites, worms, other mollusks) followed by exposure to high energy conditions before incorporation into the facies. This lends evidence of a climatic change that may have proved catastrophic for oyster reefs within the Ten Thousands Islands. An alternative interpretation of this shell bed—a high energy oyster reef—is also a consideration. Repeated exposure to high

A h[illegible] Lower H[illegible] water sequence was also observed. An animal burrow embedded in red mangrove peat infilled with clean quartz packstone, is found within core BW-2. Clean quartz packstone was not found within any of the Blackwater cores. Quartz packstone and grainstone are indicators of high energy conditions. Rising sea level would deposit quartz sand top of the red mangroves. A large errosional event then occurred infilling the animal burrow and erasing a portion of the geologic record. As sea level continued to rise and oyster colonization began, tidal currents may have eroded any record of such a storm. Storm activity is a plausible explanation, as this is the only mechanism capable of eroding large amounts of sediment in the Ten Thousand Islands. This is strong evidence rising sea level causing a catastrophic change to the Ten Thousand Islands during the late Holocene.

The Barfield cores are too ambiguous to determine the nature of the depositional system, although they are associated with open marine sequences. Barfield Bay may have always been the regional seaward-most extent of the Ten Thousand Islands.

# CONCLUSIONS

Clear evidence for the generation of shell beds by tropical or winter storms have not been identified by this study. Shelly tempestites showing singular depositional events were also not observed. The geomorphology of the study sites may not allow for preservation of singular storm tempestites. However, there is evidence indicating at least two occurrences of rapid sea level rise and/or periods of high tropical storm activity affected the late Holocene ecosystem of the Ten Thousands Islands. The first episode possibly killed off the mangrove forests, and the second lead to the demise of oyster reefs. Further analysis and coring is required to gain higher resolution of any trends in storm activity over the late Holocene.

# REFERENCES CITED


Carter, M. R., Burns, L.A., Cavinder, T.R., Dugger, K. R., Fore, D. B., Revells, H. L., and Schmidt, T. W., 1973. Ecosystems analysis of the Big Cypress Swapm and esturaries: U. S. Environmental Protection Agency Region IV, Atlanta, Georgia.

Duever, M.J., Meeder, J. F., Meeder, L. C., and McCollom, J. M., 1994. The climate of south Florida and its role in shaping the Everglades ecosystem: The Everglades Ecosystem and Its Restoration, Davis, S. M. and Ogden, J. C. (eds), St. Lucie Press, Delray Beach, Florida.

Dunnam, R. J., 1962. Classification of carbonate rocks according to depositional textures, in Ham, W. E., ed., Classification of carbonate rocks. American Association of Petroleum Geologist, Mem. 1: 117, Table 1.

Embry E. F., III and Klovan, J. E., 1972. Absolute water depth limits of late Devonian paleoecological zones: Geology Rundschau, 61: 676, Figure 5.

Gesanliter, S., 1996. Holocene stratigraphy of the Chatham River region, southwest Florida; with a reevaluation of the late Holocene sea level curve: Master of Science Thesis, University of Miami, Coral Gables, Florida.

Kemp, A. E. S. (ed.), 1996. Palaeoclimatology and Palaeoceanopgraphy from Laminated Sediments. Geological Society Special Publication, No. 116: vii-xii.

Parkinson, R. W., 1987. Holocene sedimentation and coastal response to rising sea level along a subtropical low energy coast, Ten Thousand Islands, southwest Florida: Ph.D. Dissertation, University of Miami, Coral Gables, Florida.

Parkinson, R. W., 1989. Decelerating Holocene sea-level rise and its influence on Southwest Florida coastal evolution: a transgressive/regressive stratigraphy: Journal of Sedimentary Petrology, 59(6): 960-72.

Parkinson, R. W., 1991. Geologic evidence of net onshore sand transport thoughout the Holocene marine transgression, southwest Florida: Marine Geology, 96(3-4): 269-77.

Perlmutter, M. A. 1982. The recognition and reconstruction of storm sedimentation in the nearshore, southwest Florida: Ph.D. Dissertation, University of Miami, Coral Gables, Florida.

Sexton, W. J., 1995. The post-storm Hurricane Hugo recovery of the undeveloped beaches along the South Carolina coast, “Capers Island to the Santee Delta:” Journal of Coastal Research, 11(4): 1020-5.

Sheridan, P. F., 1992. Comparative habitat untilization by esturine macrofauna within the mangrove ecosystem of Rookery Bay, Florida: Bulletin of Marine Science, v. 50(1): p. 21-39.

Tedesco, L.P. Wanless, H.R., Scusa, L.A., Risi, J.A., and Gelsanliter, S., 1995. Impact of Hurricane Andrew on South Florida's sand coastlines: Journal of Coastal Research, Special Issue 21, p. 59-82.

Twilley, R. P., 1985. The exchange of organic carbon in basin mangrove forest in a southwest Florida estuary: Estuarine Coastal and Shelf Science, 20: 543-57.

Wanless, H.R., 1981. Fining-upwards sedimentary sequences generated in seagrass beds: Journal of Sedimentary Petrology, 51(2): 445-54.

Yokel, B. J., 1975 B. Esturine biology: Rookery Bay Land Use Studies, Study No. 5. The Conservation Foundation, Washington, D.C.