POSTGLACIAL SUBMERGENCE
SOUTH TEXAS COAST
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ABSTRACT

New radiocarbon dates on algal mats and authigenic carbonate sediments from the supra-tidal flats of the south Texas coast in conjunction with previously published dates generate an accurate record of the submergence of the Texas coast for the past 7000 years. The resulting sea level rise curve for south Texas is closely similar to that of both south Florida and for islands in Micronesia. All three of these areas have been considered to be relatively stable with regard to postglacial isostatic adjustments and the resulting geoid changes. It may be possible to use the Texas data in conjunction with that from south Florida and Micronesia to approximate the eustatic sea level rise for the past 7000 years.

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INTRODUCTION

Although there are numerous postglacial sea level rise curves which are applicable to the Texas coast, there is a paucity of data for samples with radiocarbon dates more recent than 3000 YBP (years before present). As a result, many workers have assumed sea level reached its present stand about 3000 years ago (Curray, 1961). Since sea level 4000 YBP was only 4 ft. (1.2m) below present sea level, an accurate curve for the final rise must be based on biological samples which have an accurately determined elevation and a very narrow range of elevations relative to sea level within which they can sustain life. Furthermore, it is desirable that those samples can be shown to be in situ. Two sediment types which fulfill these requirements are peat deposited and laminated blue green algal mat deposits.

On the Texas coast, algal mat deposits form from sea level to less than 1 meter above sea level (Brown, Fisher, Erxleben, and McGowen, 1971). If continuously submerged in water connected with a lagoon of normal to moderately high salinity, algal mats are either consumed by grazing cerithid gastropods or replaced by other organisms better suited to the environment (Friedman, Amiel, Braun, and Miller, 1973). Therefore, a curve drawn just below the lowest of the dated algal mat samples for any age should be close to sea level for that time.

METHODS

The new data presented in this study are based on the age dating of algal mat deposits with accurately known elevations. Additional new age dates with accurately known elevations are dates on carbonate muds which have formed in association with the algal mats. All of the new age dates reported in this study were measured by Geochron Laboratories of Cambridge, Massachusetts, based on a Libby half-life of 5570 years for ^{14}C using 95% of the activity of N.B.S. Oxalic Acid as a standard. The reference year for the new data and all other data presented is 1950. Elevations were determined by Bill Lothrop, Registered Public Surveyor. The majority of the algal mat and carbonate samples were obtained by James A. Miller (Union Oil Company of California) and dated by the Radiocarbon Laboratory of the University of Texas at Austin (Valastro, Davis, and Varela, 1972; Miller, 1975). Accurate positions for those samples are not published and were obtained in a personal communication with Miller (1988). Elevations for the topes of the cores obtained by Miller were determined by plotting their locations on a topographic map of the study area produced by Humble Oil and Refining Co. (Fisk, 1949). The Fisk topographic map is contoured on an interval of 0.2 ft. (6.1 cm). Erosion in a few of the locations in the interval between Fisk's 1949 survey and survey work by Lothrop in 1988 required an adjustment to arrive at the probable elevation for the top of some of miller's cores, collected in 1969.

All of the algal mat and carbonate samples dated in this study and by Miller were located on the supratidal flats of Kenedy County along Laguna Madre, Texas (Fig. 1).

Additional data points for the supratidal flats, Laguna Madre, and Padre Island are from Fisk (1959); for Baffin Bay from Behrens (1974) and Andrews (1964), reported in Pierson, Davis, Tamers, and Johnstone (1965); for Harbor Island, Tx. from Amdurer, Munson, and Valastro (1979); for Lavaca Bay from Wilkinson and Byrne (1977); and for San Antonio Bay from Shepard (1956). All of these dated samples are plotted together for the first time and define a sea level rise curve for the past 7000 years on the South Texas coast.

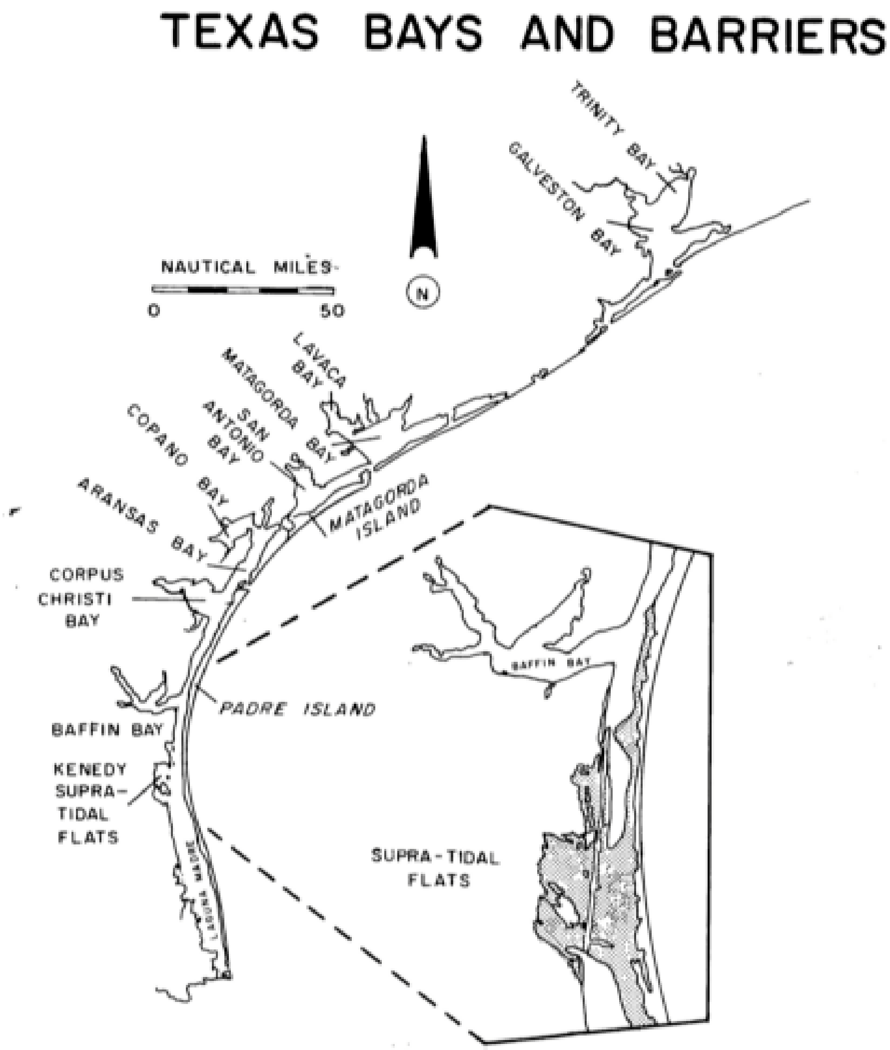

Figure 1. Location map of the Texas Coast.

RESULTS

Figure 2 presents all applicable age dates plotted against their elevation above or below sea level. The plotted sea level curve falls just below the algal mat samples and above the subtidal samples with a few exceptions. Two of Behrens' diverse (low salinity) shell assemblages fall above the curve at 5600 YBP and at 6000 YBP. These are probably bad dates, or perhaps the curve should be a bit higher to accommodate the sample at 5600 YBP.

There are two Anomalocardia sp. samples at 2700 YBP and at 1950 YBP. These hypersaline lagoon molluscs were probably washed up onto supratidal flats during a storm and thus are not in situ. The group of carbonate samples (within the circle on Figure 2) between 3900 YBP and 4700 YBP at near sea level elevation were associated with younger algal mat samples and are probably contaminated with older carbonate material. All other samples properly fall above or below the curve in consideration of their environment of deposition. Only 8 (7.4%) of a total of 108 samples fall on the wrong side of the sea level rise curve. The elevation of the samples above or below sea level at the time of their formation is consistent with what we know of their present day environments.

The sea level curve, as drawn from the present to 5000 YBP is identical with that of Scholl, Craighead, and Stuiver (1969) for south Florida, based on peat and shallow marine sediments. I chose to use the Scholl et. al. curve for zero to 5000 YBP because it fits the data as well as any that could be chosen. South Florida is believed to be very stable tectonically, with little subsidence or uplift (Scholl, et. al., 1969; Redfield, 1967). From 5000 YBP to 7000 YBP the curve is based on the plotted data for Texas. This suggests that south Texas has been stable with regard to subsidence and uplift for the past 5000 years.

It has recently been recognized that the search for a stable region of the earth to measure the postglacial eustatic rise in sea level may well be futile. Isostatic adjustments to accommodate glacial unloading of the glaciated continents and loading of the ocean basins with meltwater are accompanied by slow non-elastic fluid displacements of the earth, resulting in geoid shape changes (Walcott, 1972; Clark, Farrell and Peltier, 1978). These authors demonstrate there is a zone of relative stability between the subsiding ocean basin and the adjacent rising deglaciated landmass. They further suggest this zone is present in south Florida and Texas near the Texas-Mexico border. Morton and Price (1987) further suggest post Wisconsonian sea level for the Texas shelf curves should be reliable, because the gulf of Mexico lies within the zone of postglacial geoid adjustment separating regions of emergence from regions of submergence.

Bloom (1970) proposed steep sided oceanic islands be used as the reference to measure eustatic changes in sea level. The sea level rise curve measured in the Caroline Islands of Micronesia is presented on Figure 2. Note the sea level rise recorded in Micronesia is very similar to that measured in both south Florida and south Texas. Perhaps these three locations represent minimal postglacial geoid adjustment and therefore our best estimates of eustatic rise in sea level.

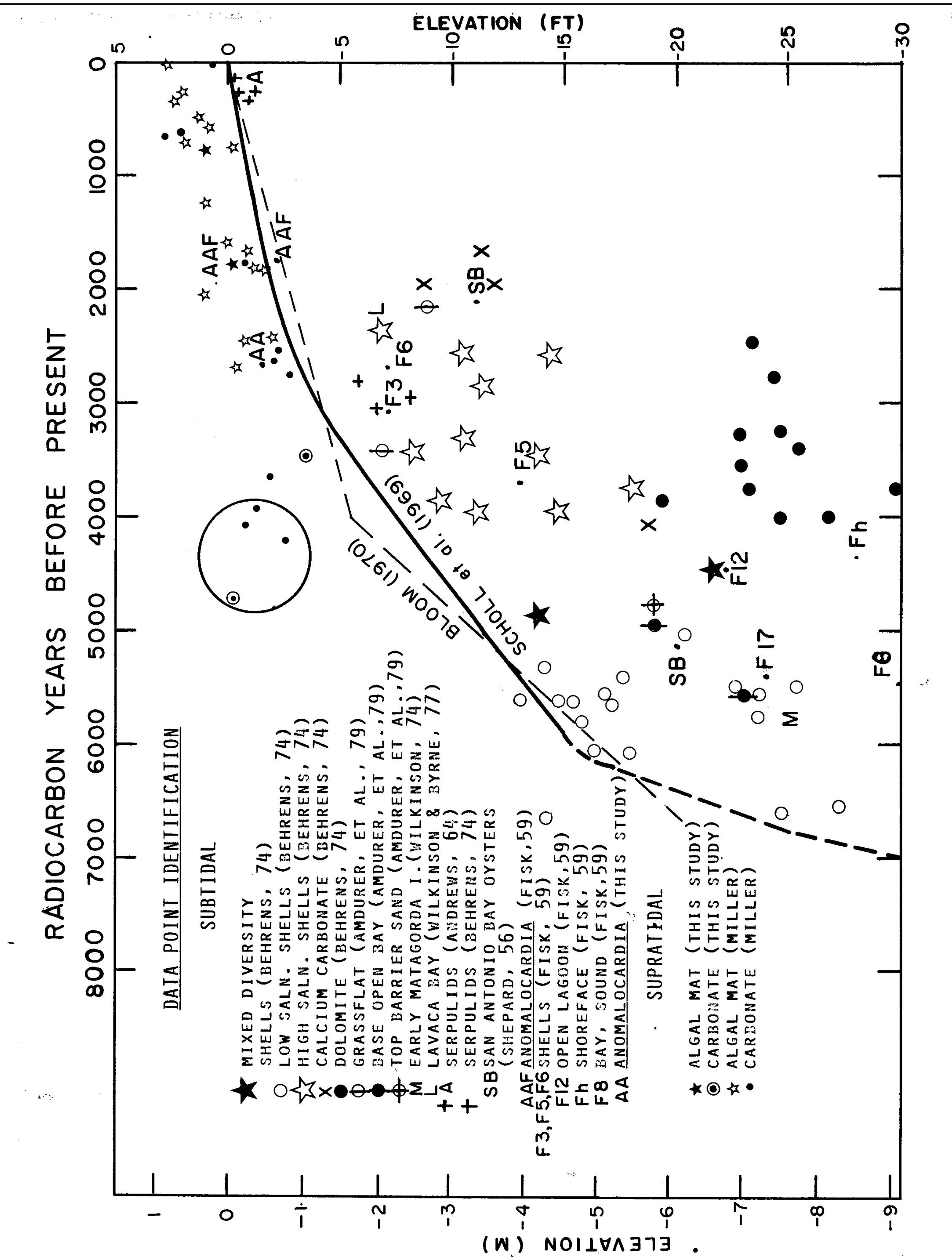

Figure 2. Radio Carbon Age Dates in the Laguna Madre

Seven submergence curves for the gulf of Mexico, South Atlantic States and Bermuda are compared in Figure 3. The curve presented by Milliman and Emery (1968) is based on samples from the continental shelf and has no control near sea level for the past 3 or 4 thousand years. Curray (1961) drew his curve to reach present sea level about 3000 YBP based on data for Louisiana in Gould and McFarlan (1959). There was no data near sea level for the last 3000 years and the curve was extrapolated to reach the surface at 3000 YBP. All of the samples from near current sea level reported by Nelson and Bray (1970) are shallow marine or brackish water shells. Either minor transport or the existence of brackish water swamps at a very shallow depth below sea level could contribute to an interpretation of the sea level reaching its present position 3000 years ago. The curves from both Redfield (1967) and Neumann (1971) fall well below the curve presented in this paper and by Scholl et. al. (1969). Neumann states that while Bermuda is emergent with regard to some areas, it is submergent with regard to others.

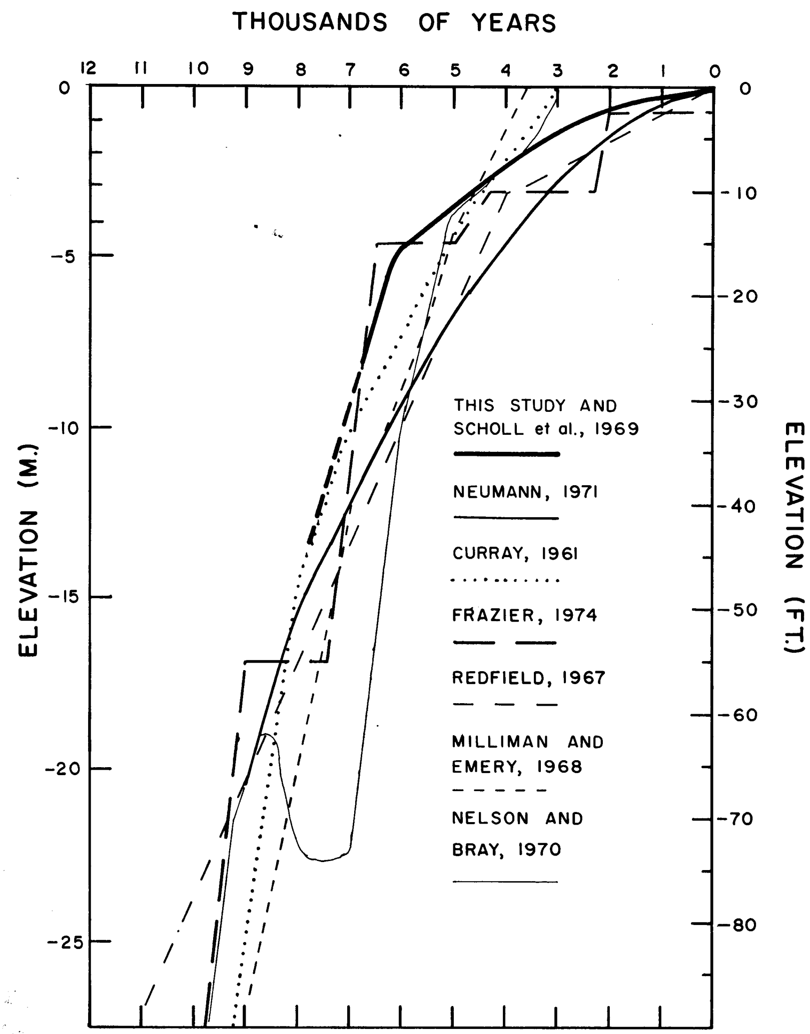

Figure 3. Sea Level Rise on the Texas coast for 10,000 years.

CONCLUSIONS

It is suggested the curve for the submergence of the south Texas coast presented here may be the most accurate because it is supported by a large number of age dates on environmentally depth sensitive organisms with good surveying control of the core elevations. It appears for ages older than 7000 YBP the submergence curve for the south Texas coast could logically fall anywhere in the region defined by Milliman and Emery (1968) or by Curray (1961).

The present data also reveals the rate of submergence has decreased several times in the time span covered by the data of this study. From 7000 YBP to 6000 YBP the submergence rate was 1.45 ft./100y. (44.2 cm/100y.); from 6000 YBP to 3000 YBP, 0.38 ft/100y. (11.59 cm/100y.); from 3000 YBP to 1000 YBP, 0.11 ft./100y. (3.4 cm/100y); and from 1000 YBP to the present, 0.09 ft./100y. (2.75 cm/100y.).

The common assumption that sea level reached its present position 3 to 4 thousand years ago has served well in interpreting the geologic history of the major elements of the Texas coast, such as the time of formation of barrier islands and lagoons and maximum submergence of bays. However, this more accurate estimate of the time of the final three feet of submergence will prove to be very useful in interpreting the geologic history of elevation sensitive environments, such as supratidal flats and salt and fresh water marshes.

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