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Investigating Environmental Change on the Coastal Plain of South Carolina

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During the Pleistocene, which began about two million years ago, massive glaciers advanced and retreated in four great episodes. The latest of these retreats ushered in our own era of geologic time, the Holocene.

Although the continental glaciers never extended into South Carolina, they profoundly affected the climate and landscape here. Palaeoenvironmental records from Carolina bays and other wetlands provide clues to understanding how the Coastal Plain responded to global climate. Because the region has been well-populated with humans since at least 13,000 years before present, near the end of the Pleistocene, these changes are important to understanding human palaeoecology.

Palaeoenvironmental records of the Coastal Plain take diverse forms. From wetland basins, organic carbon, particularly charcoal, can yield radiocarbon dates useful for dating sediments up to 30,000-40,000 years in age. Pollen is perhaps the best-known of the fossil materials in wetland sediments, but other plant remains and animal remains can also be found. Frustules of diatoms, a group of algae, are often preserved in wetlands. The frustule (Figure 1) is an ornamented shell-like structure, composed of a matrix of silica, that contains the diatom cell. Because many diatom species have narrow tolerances for chemical or physical conditions, the species composition of fossil diatoms can be used to infer characteristics of the environment. Remains of freshwater sponges are also useful. Sponges are common but inconspicuous, often growing as thin crusts on submerged wood. They are not rich in species, but their spicules, needle-like skeletal structures composed of silica, are robust, often lingering in the sediments after more delicate materials, such as frustules of diatoms, have decomposed. Spicules indicate that sediments were deposited under aquatic, rather than terrestrial, conditions. Terrestrial habitats adjacent to the wetlands often provide additional records. Archaeological sites can document shifts in the type and intensity of human activity, which may reflect changes in the local environment. Archaeological sites can also provide dates for geologic events. The time of burial for wind-deposited sands can be estimated using optically stimulated luminescence (OSL), a relatively new method that dates time since last exposure to sunlight. This method is a valuable complement to radiocarbon dating, extending the range by about 80,000 years. Further, datable material can be obtained from features of the uplands where old organic carbon is seldom preserved.
Our current studies focus on three times of change: episodes of climate resulting in development of Carolina bays during the late Pleistocene; a hydrologic threshold during the mid-Holocene; and a possible moister episode beginning in late prehistoric times. The research is a cross-disciplinary effort. Current and recent collaborators include: Dr. Christopher Clement, South Carolina Institute of Archaeology and Anthropology; Dr. Evelyn Gaiser, Florida International University; Dr. Robert Gardner, University of South Carolina; Dr. Andrew Ivester, West Georgia State University; Mr. Peter Stone, South Carolina Department of Health and Environmental Control; and Dr. Eric Wright, Coastal Carolina University. The research has been sponsored by the United States Department of Energy (Savannah River Site—SRS), by the natural and cultural resource management program at Shaw Air Force Base (Big Bay), and by the South Carolina National Guard (Fort Jackson).

Sand dominates the sediments of the Coastal Plain in South Carolina. Some climatic regimes have resulted in wind-driven formation of localized dune fields, ridges, and other features, including the oval, northwest-southeast oriented depressions known as Carolina bays. At Flamingo Bay (Figure 2), a small (0.7 km length) Carolina bay on the SRS, OSL dates from the base of the sand rim indicate that deposition began around 110,000 years ago, probably near the beginning of the last glacial period. Dates of 40,000 years (OSL) and 10,000 years and later (temporally diagnostic artifacts) from overlying strata show that episodes of deposition occurred later in the Pleistocene and into the Holocene. The sand rim of Bay 40, another Carolina bay on the SRS, yielded a date of 75,000 years ago. These dates establish that Carolina bays are old features of the landscape and indicate that modification of the rims occurs in episodes. Correspondences between the dates and global climate records from Arctic ice cores suggest that the earlier episodes of bay formation and development occurred during intervals of milder climate. Because the margin of error is large on the earliest OSL dates, however, additional evidence will be required to establish a pattern that we can interpret with full confidence.

Big Bay, a much larger (5 km length) Carolina bay on the Poinsett Electronic Combat Range of Shaw Air Force in Sumter County, South Carolina, may provide further resolution on the timing of these episodes. Big Bay contains a series of well-separated concentric ridges that represent former shorelines of the bay. The interior forest of the bay burned in spring of 2001, facilitating access to these features, and we are presently dating a series of OSL samples from the innermost to the outermost ridges.

More recent OSL dates from interior river dunes, clustering in the range of 40,000 to 30,000 years ago in South Carolina and 30,000 to 15,000 years ago in Georgia, suggest that these features were most active during the colder conditions before and during the last glacial maximum. Active movement of these sands would have required locally sparse vegetation, and the dates thus imply times of drier, as well as colder, conditions.

Organic sediments from the wetlands within Carolina bays typically yield basal dates much younger than the known ages of the bays. Most of them probably reflect transitions to moister climate, resulting in development of wetlands and accumulation of organic materials in the basins. Accumulated organic material would oxidize.
During periods of prolonged desiccation under drier climates, so that only material from the most recent moist episodes should be preserved.

Evidence from two basins on the SRS suggests transitions to moister conditions during the mid-Holocene and, unexpectedly, during late prehistoric times. At Flamingo Bay on the SRS, the evidence comes mainly from radiocarbon dates. The oldest preserved organic material from the deepest part of the basin was deposited 4,500 years ago. Although diatoms and pollen have not been preserved, sponge spicules indicate the presence of standing water, at least seasonally. The oldest organic material from shallower portions of the basin was deposited much more recently. On a shallow ridge (surfaces 80-90 cm above the deepest point) in the interior of the basin, organic materials began to accumulate only 300 years ago.

Extensive modern records from several Carolina bays indicate that inundation for more than 50% of the year is required for preservation of datable organic material. We used a 14-year record of water depth at Flamingo Bay and corresponding weather records from Blackville, South Carolina, to estimate precipitation thresholds for preservation at different elevations within the basin. Modern precipitation averages 120 cm annually. The analyses suggest that a prolonged episode of about 100 cm annual precipitation occurred prior to 300 years ago. The record of fossil diatoms from Peat Bay, another wetland on the SRS, corroborates this inference and suggests further that this threshold was reached by progressive, rather than abrupt, increases in precipitation beginning about 1,600 years ago. Conditions before 4,500 years ago, the oldest date from the deepest part of Flamingo Bay, were likely somewhat drier (perhaps less than 80 cm annual precipitation).

These changes inferred from palaeoenvironmental records correspond roughly to times of substantial change in prehistoric cultures. Mid-Holocene increases in moisture may have facilitated the transition to the more settled economies of the Late Archaic, Woodland, and Mississippian cultures. As David Anderson has suggested, fluctuations in moisture could have influenced agricultural production and political stability of the Mississippian cultures. Both of these hypothesized palaeoenvironmental changes require further study. We have found a well-preserved, potentially informative sequence of pollen-bearing sediments dating from late Pleistocene to modern times at a wetland on Fort Jackson, and we continue to seek additional sites.

This research contributes pieces to the pictures of changing prehistoric climate and landscape. Prehistoric processes shaped the modern landscape. Knowledge of this history can help us to understand these processes and to anticipate directions of future change.