The sand beaches on North Carolina's barrier islands are composed mainly of quartz sand, with varying amounts of abraded shell material and local areas with minor concentrations of black heavy mineral sand and river gravel (figure 1-20). The quartz sand and associated black sand and river gravel were derived from eons of erosion in the Piedmont and Appalachian provinces. Subsequently, through time, rivers along the Atlantic margin transported these eroded sediments into the coastal region and deposited them as riverine channel fills and delta deposits. With fluctuating sea level, these old riverine deposits have been eroded and reworked many times into various coastal deposits and, finally, into the present barrier islands. The shell component consists only partly of modern shells of organisms presently living within the surf zone and associated continental shelf environments. Most of the shells on the North Carolina beaches are fossils that range in age from thousands to hundreds of thousands of years old.

The most abundant shells on many beaches are the gray to black-stained oysters (Ostrea virginica) (figure 1-20D), which live only in the estuaries behind the barriers. They lived, died, and were deposited in the mud and peat sediments that form in the back-barrier marshes. In response to ongoing sea-level rise, the barrier islands migrate upward and landward over the back-barrier marsh deposits. With time, these marsh deposits, along with the included oysters, crop out in the surf zone, erode during storms, and are supplied back to the beach as blocks of peat and fossil oysters. This represents an important source of "new" sediment that continues to feed the beach through time. The oysters generally date from a few hundred to several thousands of years in age.

The orange iron-stained shells on the beach (figure 1-20D) often range from tens to hundreds of thousands of years old. Many of these shells were on the surface of the continental shelf during the last glacial episode (20,000 to 14,000 years ago). During this time period, the North Carolina shoreline was below the outer continental shelf, about 425 feet below present sea level, and between fifteen and sixty miles offshore of the modern shoreline. During this period, the continental shelf was part of the Coastal Plain, and these shells occurred within the soil profile that developed on the exposed surface of the continental shelf and became iron stained by the soil that developed on the sediment surface.

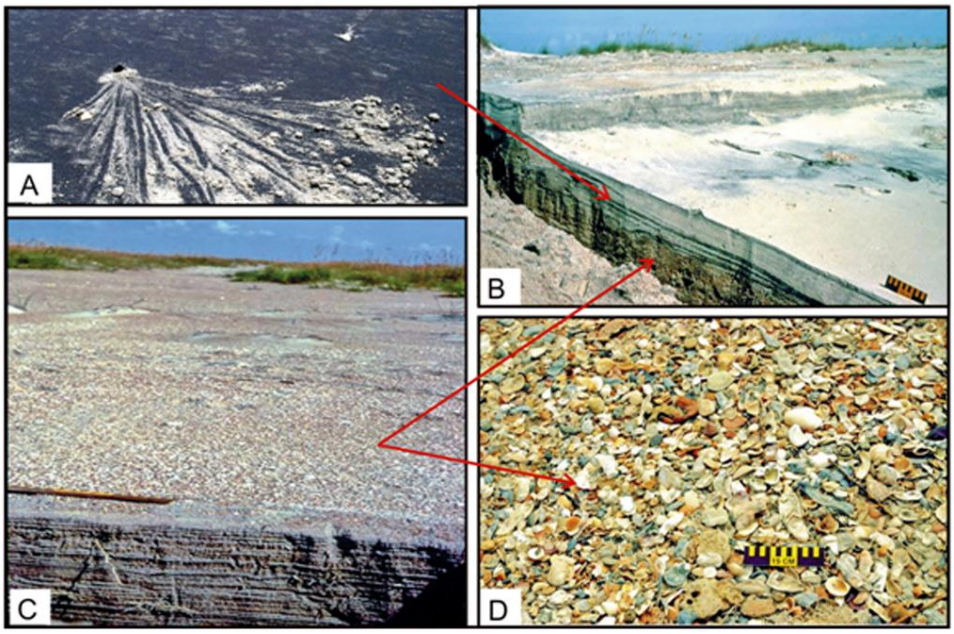

Figure 1-20. Sand beaches on North Carolina's barrier islands are composed mainly of quartz sand with varying amounts of abraded shell material and local areas with concentrations of black heavy mineral sand and river gravel. Panel A. White quartz sand is covered by a thin layer of black heavy mineral sand. The underlying white sand is exposed on the surface by a burrowing ghost crab. Panels B and C. Photographs of two beaches that consist of alternating beds of white quartz sand and shell gravel as exposed in the trenches dug across the beaches. In Panel B the white sand is on the surface. In Panel C the shell gravel is on the surface. These alternating beds are deposited by changing water levels in response to either astronomical tidal or storm tide cycles. Panel D. A close up photograph shows the abundant orange and gray stained shell gravel that commonly occurs on the ocean beaches. Photographs are by S. Riggs.

Among the largest shells found on the beach are the quahogs or cherrystone clams (*Mercenaria mercenaria*). Some of these shells that contain the beautiful purple coloration on the inside of the clam shell are modern in age. These clams live on the adjacent sand flats within inlet ebb and flood-tide deltas. However, most of these shells range from bleached white to dark amber brown and are often tens to hundreds of thousands of years old. These older *Mercenaria* shells are being eroded out of older layers formed during the Pleistocene era and crop out on the shore face and inner continental shelf during storms. Notice that many of these shells, once they are on the beach, eventually break down in the "ball mill" of the high-energy surf zone into smaller-sized particles – severely abraded gravels and much finer-grained, flat, and rounded shell sand grains. It is fine gravel and course sand shell material that gives the beaches their variable orange colorations as you look across the beach. Most medium and fine-grained sand beaches are gray colored due to the dominance of quartz sand with a total lack of shell particles among this grain size fraction.

The black heavy mineral sands (figure 1-20A) are composed of various types of very hard and chemically stable heavy materials. The dominant black minerals (illmenite and magnetite) include lesser abundant red minerals (garnet and rutile) and the rare pale green and blue minerals (tourmaline, zircon, apatite, etc.). Because these minerals are much heavier and denser than quartz and calcite, they tend to be fine to very find sand size grains and occur with courser-grained fractions of quartz and calcite sand. Consequently, the heavy mineral sands tend to occur in the upper portions of the storm beach and are particularly concentrated around inlets and capes.