

Preservation of Baleen Whales in Southern Peru

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From time to time there are news reports of a whale found stranded on a beach. Rescue workers and volunteers rush to the area and endeavor to return the whale back to the water so it might yet have a chance for survival. Each occurrence generates much interest and curiosity in whales and their behavior.

Over the past four years, I have focused my research on a phenomenon much more astonishing. A joint team of paleontologists and geologists from the Geoscience Research Institute in Loma Linda, Loma Linda University, Southwestern Adventist University in Texas, the Universidad Peruana Union, and the National History Museum in Peru, have documented over 1,500 specimens of well-preserved, fossilized baleen whales at four localities in western Peru. These are not isolated, beached whales. Whale bones in a single deposit known as the Pisco Formation have been found across several hundred square kilometers of a dry desert over 20 km from the Pacific Ocean.

Preservation

The preservation of the whales is remarkable since most of them are nearly complete (over 72% of the whales have connected vertebrae) while some have partially disconnected skeletons. They have not been markedly altered by mineralization. All of the bones are surprisingly light weight, porous and must be handled carefully to prevent breakage. Degree of preservation and coloration is uniform in all of the specimens. The bones bear no evidence of having been abraded, scraped, nicked or scratched during their deposition and invertebrate organisms have not bored or colonized the bones. This is curious because in the modern seas whale carcasses are bored, colonized, and destroyed by a variety of invertebrate animals that feed and dwell on them for many years after the skeletons reach the sea floor. Baleen whales are an excellent source of food for many marine animals--especially scavengers--not only because of the large amount of flesh available but also because of the high content of fat stored within the bones, which provides enough nutrients for an invertebrate community for many years. In addition, there is no evidence that the bones have partially dissolved during long exposure in the ocean. One very interesting aspect of the skeletons is the occurrence of shark teeth with many of the specimens. However no shark tooth marks have been found on the bones, which would be the normal case if sharks were attacking the whales. Moreover, delicate parts like flippers are in many cases entirely preserved and articulated, which suggests that sharks were not feeding on the whales. The reason for the association of shark teeth with the carcasses remains undetermined. In some cases the baleen plates are preserved, even within the mouth, in life position. This is remarkable because baleen is made of protein keratin and tends to disarticulate and decay more quickly than bone, namely in a matter of hours. Several levels of fish fossils (scales and bones) indicate multiple mass mortalities of fish. The high quality of the bone preservation, the large number of articulated whales and the preservation of the baleen suggests that the whales were buried quickly after their death.

Sediments and Paleoenvironment

As mentioned, the whales occur in sediments called the Pisco Formation. These deposits are dominated by diatoms, volcanic ash, and clays. There does not appear to be any evidence of burrowing in the diatomaceous sediments. Burrowing is expected to occur in shallow waters, especially in sediments associated with decaying carcasses because of the abundance of invertebrates living in and around the bones.

Random orientation of the whale carcasses suggests their deposition was undisturbed by strong currents. A bay could provide a somewhat sheltered environment of deposition. Paleogeographic studies suggest that this area was sheltered by a number of islands a few kilometers offshore, creating an environment where diatoms would thrive and whales would find abundant food. The quality of preservation suggests a rapid burial over a period of a few weeks or perhaps months.

Time Implications

The Pisco Formation has been dated as Middle Miocene to Early Pliocene according to the standard geologic chronology, based on radiometric dating of several volcanic ash layers that occur throughout the basin. Accordingly, the whales would have lived and been deposited during a span of time of about 13 million years. During that time, slow deposition of sand, silt, diatoms, and volcanic ash would bury decaying whale carcasses at a rate of 10-75 cm/kyr. That means that a 40-cm thick whale skeleton might have taken one to two thousand years to be entirely covered and preserved. It is easy to imagine that before a few years had passed by the whole skeleton would have been disarticulated and destroyed by scavengers and physical agents. That's what happens in modern times with whale carcasses that are found on the sea floor. Therefore, in order to completely preserve a whale skeleton, with the bones in articulation and its baleen plates in life position, the carcass must have been buried very rapidly, in a matter of a few days to a few months, but not decades or hundreds of years.

This conclusion is in clear contradiction to the rates of deposition inferred from the radiometric dates obtained from the encasing layers of sediment. This issue is becoming common in many geologic and paleontologic studies, which yield long time and slow processes using radiometric techniques, but much shorter spans of time and faster processes based on the study of the fossils therein. More research needs to be done before elucidating the reasons for this apparent contradiction.

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