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Geology 4361
Field Geology of Texas

The Permian, the Delaware Sea, and the Capitan Reef

Between two hundred twenty-five and two hundred eighty million years ago western Texas and southeastern New Mexico were dramatically different places. Today they are stark, seemingly lifeless, deserts. But during the Permian they yielded a different climate. During this time period Pangaea had not yet broken up and Texas and New Mexico occupied the western edge of the super-continent, near the equator. The great Permian Sea surround Pangaea, only a narrow inlet, called the Hovey Channel, connected the vast sea to the Permian Basin. Three arms made up the Permian Basin: the Marfa, Delaware and Midland. The middle arm, the Delaware, will be discussed here.

The Delaware Basin contained the Delaware Sea. This sea was one hundred fifty miles long and seventy five miles wide, and occupied present day Western Texas and Southeastern New Mexico. Late in the Permian Period a reef developed near the borders of the Delaware Sea. This reef, called Capitan Reef, is regarded as one of the premier fossil reefs in the world. This ancient reef is lays best exposed in the Guadalupe Mountains. This massive reef stopped growing near the end of the Permian. The reef ad been expanding and teaming with life for several million years. At the close of the Permian, the environment that led to its success was being altered. The outlet to the Permian ocean soon became inaccessible to the waters of the Basin. The Delaware Sea soon began

evaporating faster than it could replenish. As more water left and less came in, minerals began to precipitate out of the sea and settle on the seafloor, forming bands of sediments. Over a period of thousands of years, more and more minerals were laid in the bands and eventually covered the reef entirely.

About twenty six million years ago uplift of the area, caused by faulting, exposed a long buried portion of Capitan Reef nearly two miles from its original position. This new uplift was now exposed to the elements, and the sediments that were left by the evaporating sea, were slowly washed and/or blown away to reveal the more resistant limestone reef. With the "newly" (relative term) uncovered limestone reef towering over the rest of the country side the national parks service says that it "towers above the desert floor as it once dominated the floor of the Delaware sea 250 million years ago".

Three types of exposure are present in the Guadalupe Mountains National Park. They consist of Reef, Back-Reef, and Fore-reef. The Reef is a submerged resistant mound formed by the accumulation of plant and animal skeletons, and is composed of Capitan Limestone. The massive fine grain Capitan limestone was formed by the growth and accumulation of invertebrate skeletons of algae, sponges, and bryozoans. Encrusting organisms grew over these remains and cemented them into the solid rock reef that we now see.

The back-reef is the area between the reef and the shoreline. Due to its lagoon waters, only fine sediment was carried back into the area. The water was often stagnant, muddy, and had a high salinity. The sediment deposited on this side of the reef contained high amounts of magnesium which combined with the

limestone to form the rock dolomite. Brachiopods, crinoids and fusulinids are common fossils found in the back-reef sediment.

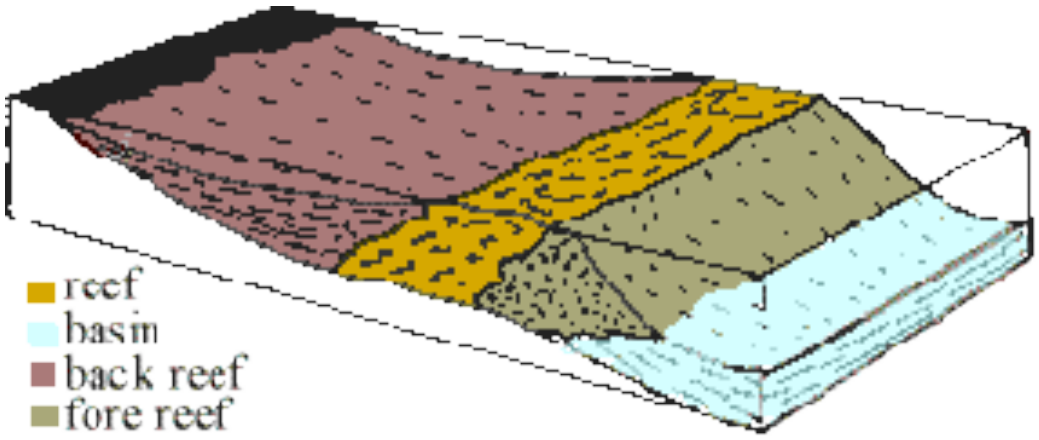
The fore-reef is on what once was the windward side of the reef. Ocean currents and waves continually battered Capitan Reef, causing large pieces to break off and slide down the reef front creating the fore reef. This debris slope extends from the reef wall downward into the basin itself. Trilobites, brachiopods, sea urchins, algae and bryozoans, lime muds, and calcium carbonate are also contained in the fore reef area. This fore reef never became as cemented as the calmer back reef sediment.

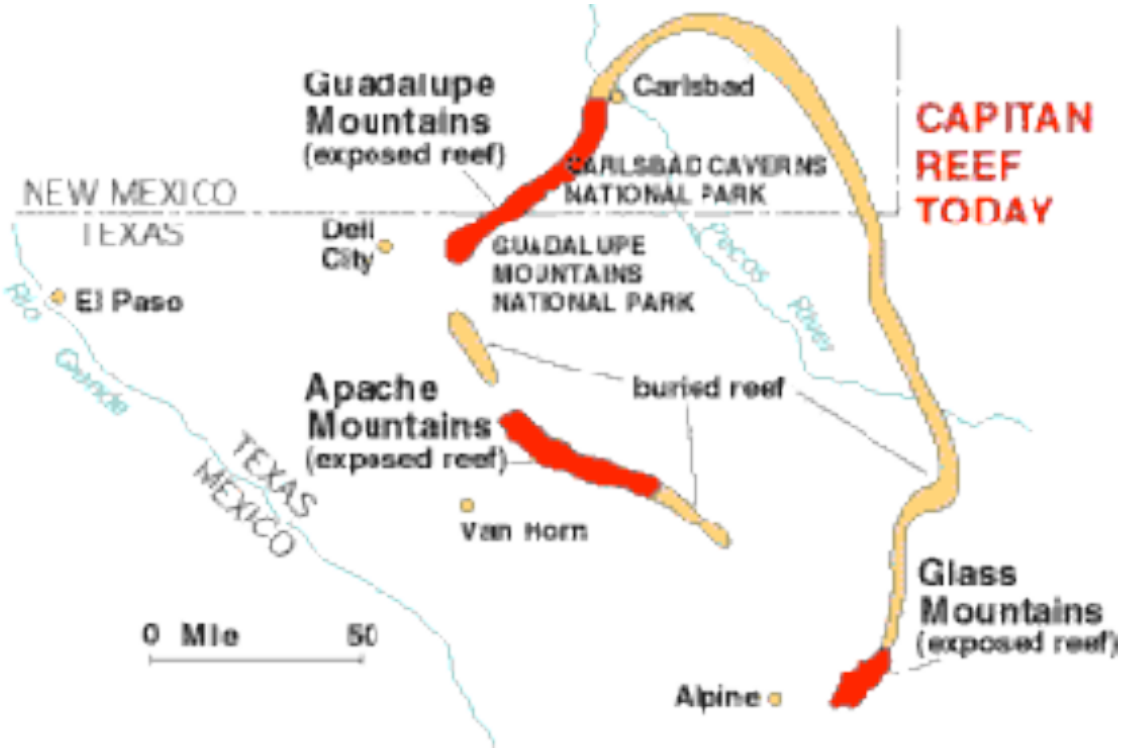
The Basin, located in front of the reef, sloped downward to nearly one-half of a mile deep. The sediments that washed into the basin during the building of Capitan Reef later became thin black limestones separated by thicker beds of fine sandstones and occasional siltstones. This black layer contains organic rich remains of the dead plants and animals that settled to the floor of the basin. Partial decomposition of this organic matter, in the stagnant depths of the basin, used up all the available oxygen. Most of the organics were slowly buried and preserved. During the millions of years since, heat and pressure have changed the organic matter to oil and gas.

When the Permian ended it took with it the lives of nearly every living thing on the planet. The Great Permian Extinction was no less affective on the Delaware Sea. Horn Corals and trilobites became extinct, along with certain groups of brachiopods, crinoids, bryozoans, ammonoids, and nautiloids. Sponges

came near extinction, and many groups of algae died out, including most of the reef builders.

The Western Escarpment has played an important role in revealing the story of the Permian Period in North America. These exposures are one of the finest cross-sections in the world of several transitions from shallow-water deposits to the deep water deposits. One of the most noticeable things in the area approaching the Guadalupe Mountains from the East (if you know what you are looking for) is the large areas of salt flats that formed as the Delaware Sea slowly evaporated itself out of existence.


reef
basin
back reef
fore reef


Guadalupe Mountains (exposed reef)
Carlsbad
CAPITAN REEF TODAY
CARLSBAD CAVERNS NATIONAL PARK
NEW MEXICO
TEXAS
Dell City
GUADALUPE MOUNTAINS NATIONAL PARK
El Paso
Pecos River
Rio Grande
buried reef
Apache Mountains (exposed reef)
TEXAS
MEXICO
Van Horn
0 Mile 50
Glass Mountains (exposed reef)
Alpine