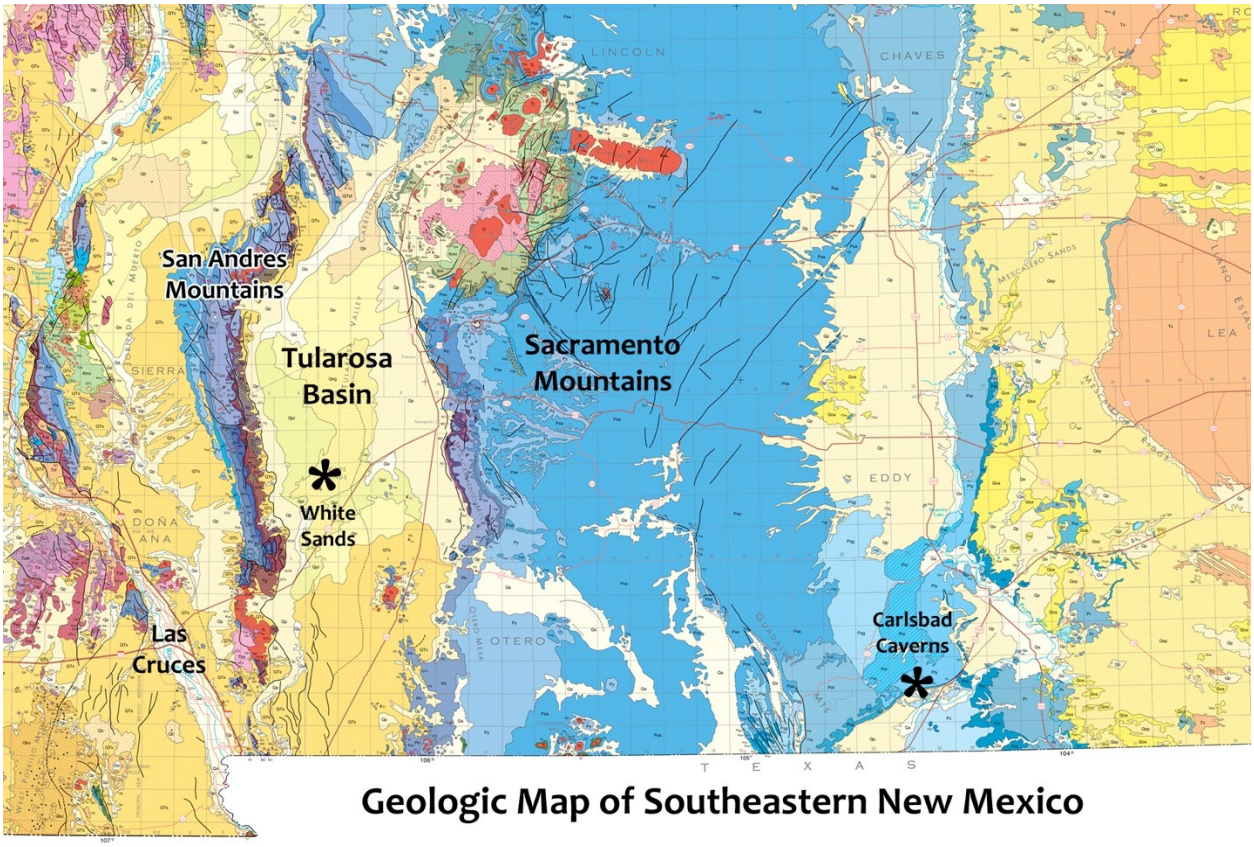
Geology of Western National Parks: Carlsbad Caverns and White Sands

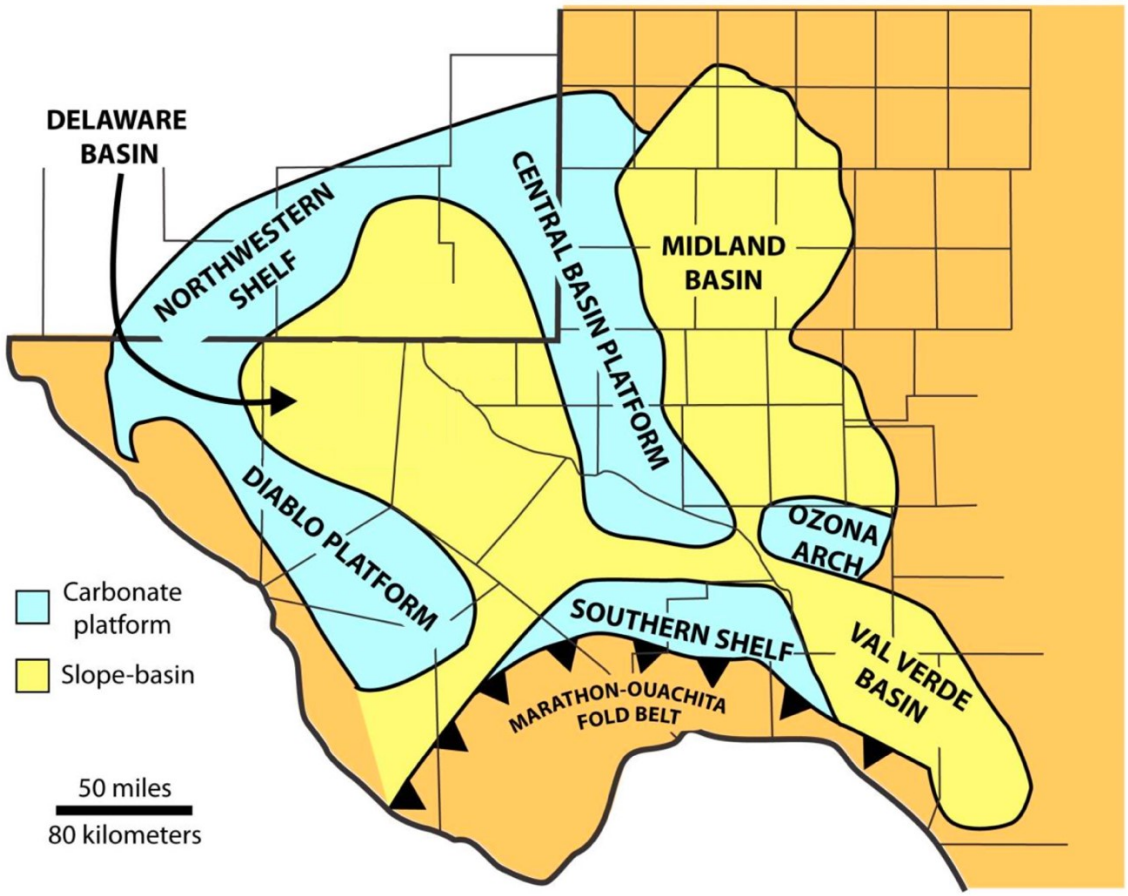
with Kirt Kempter • kempter@newmexico.com

Greetings! I look forward to seeing everyone on Zoom this Monday, and have created a 3.5-minute Google Earth flyover of both parks which you can watch on YouTube by clicking **here.** This will help give you a geographic perspective of the two parks.

You can also see the geologic connection between these parks by observing the New Mexico state geologic map, showing mountain ranges in southern New Mexico that are composed of limestone and other ocean deposits from the Late Paleozoic (mostly Permian), when equatorial seas covered much of southern New Mexico. These ocean sediments include shallow and deep water carbonate rocks, evaporites, and a great barrier reef that paralleled the coast for a few hundred kilometers. Today's oil and gas deposits in southeastern New Mexico and west Texas are also tied to these Permian (and older) ocean deposits. On the next page is a map showing the paleogeographic highs (blue) and lows (yellow) of the Permian Basin ocean deposits. As sea level rose and fell through the Permian, many inlets of the sea became stranded and hypersaline, leading to the precipitation of gypsum and a wide variety of salt minerals. The modern gypsum sand dunes at White Sands National Park owe their origin to gypsum-bearing strata in the adjacent San Andres and Sacramento Mountains.

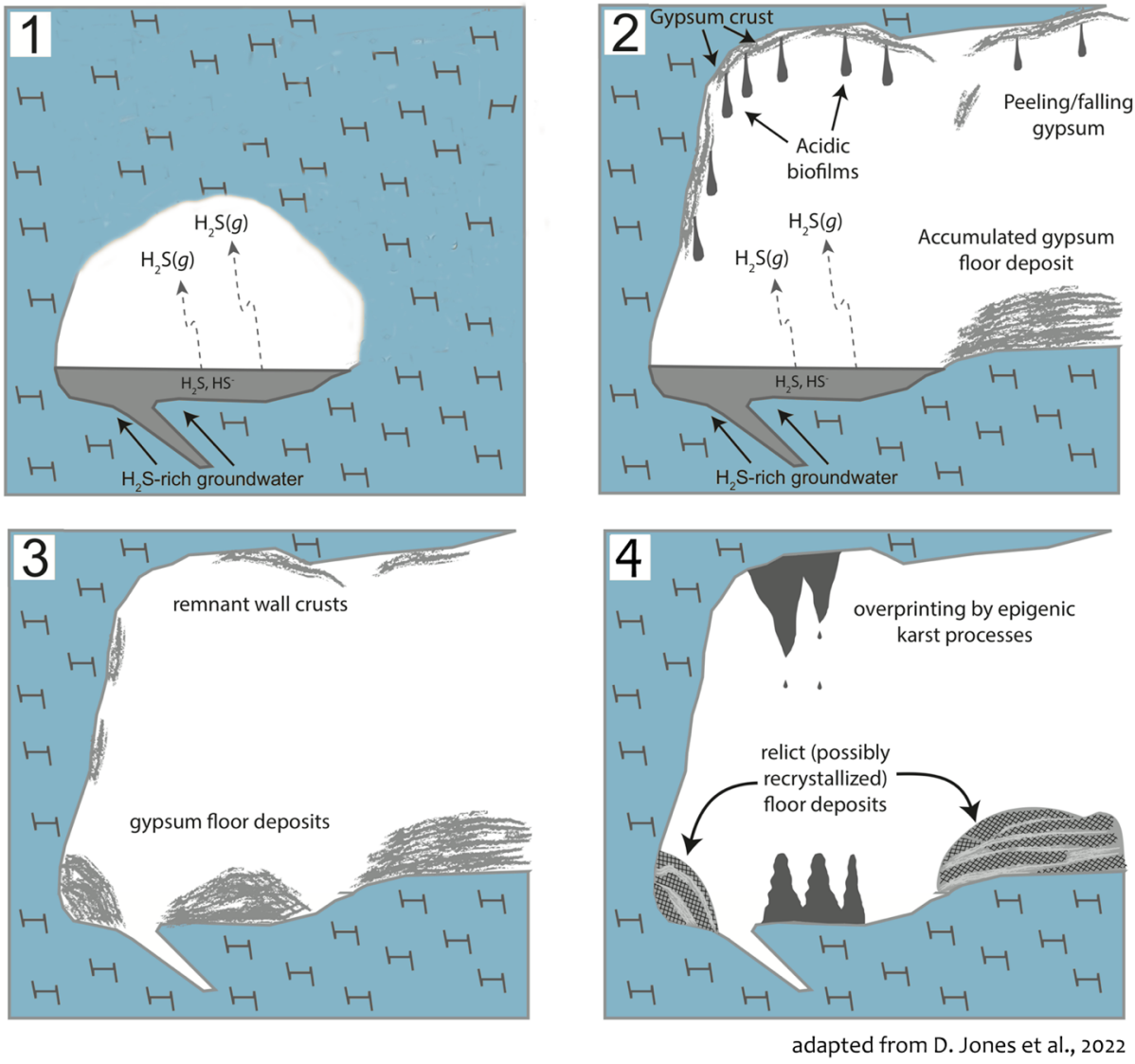


Geologic Map of Southeastern New Mexico



Permian Basin geography reflecting shallow (blue) and deep (yellow) ocean deposits during the Late Permian. The Great Permian Reef ringed the Delaware Basin, with shallow carbonate platforms (or shelfs) on all sides.

Carlsbad caverns, and other caves in the Guadalupe Mountains, are unusual in that they originally formed by dissolution from sulfuric-acid waters. Most caves in limestone deposits worldwide form by dissolution from weaker carbonic acid, originating from surface waters. In the Permian Basin, however, H_2S related to subsurface hydrocarbon production, rose into the carbonate rocks, forming sulfuric acid that was much more effective at dissolving the limestone. Extremophile microbes in these growing caves consumed sulfur and produced more sulfuric acid, facilitating more limestone dissolution. A diagram on the next page shows cave evolution by this process.



adapted from D. Jones et al., 2022

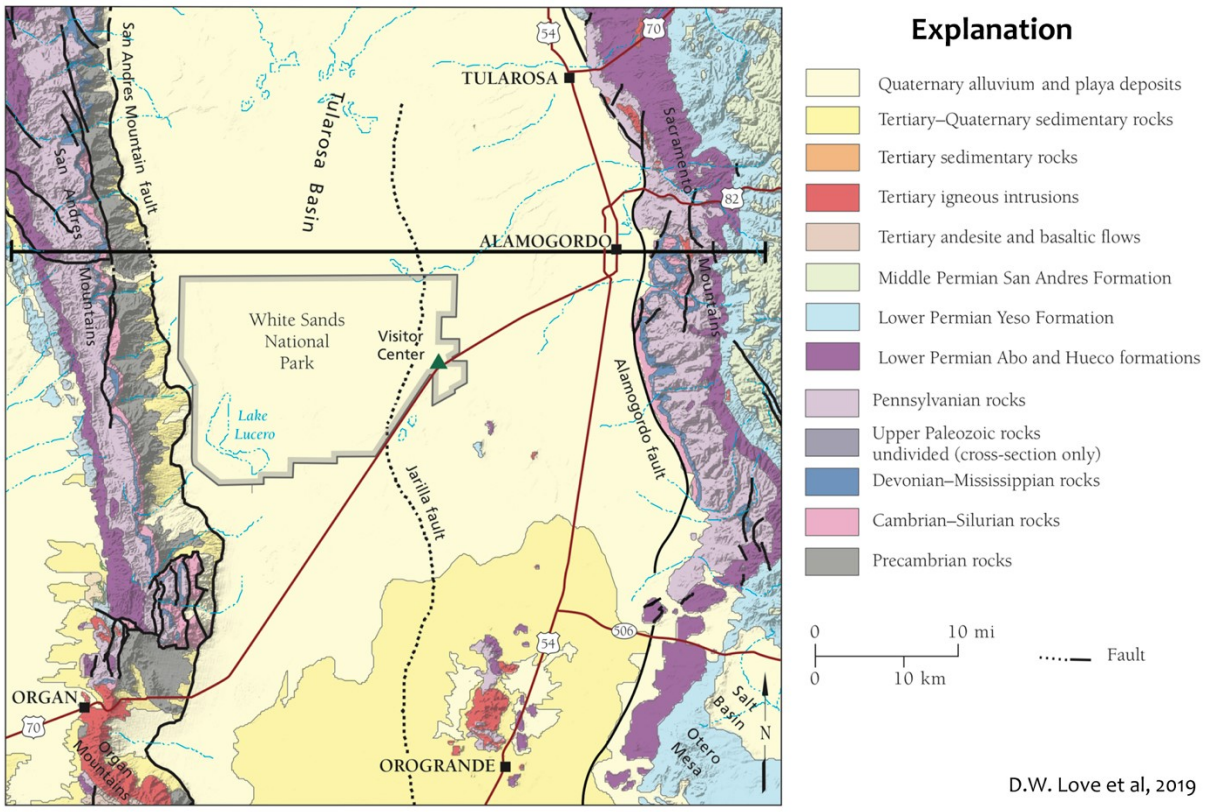
There are many great references on the geology of Carlsbad Caverns and White Sands National Parks. Below are links to a few that I recommend – mostly in pdf format and "free"!

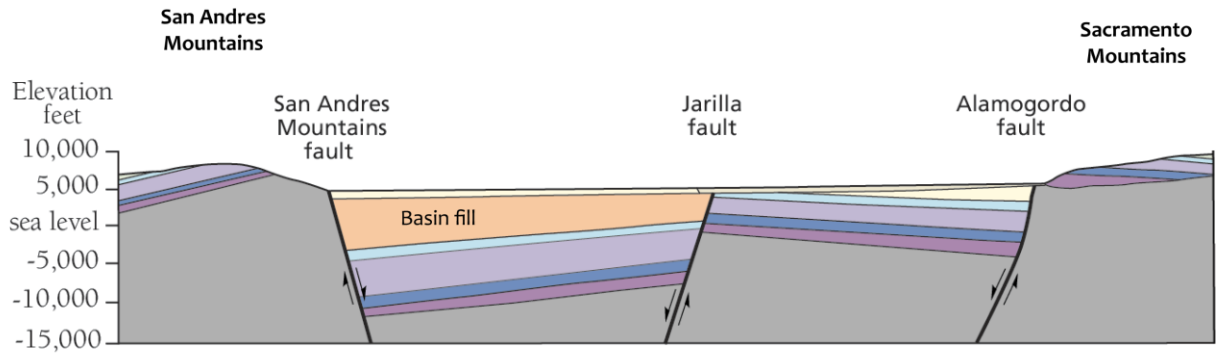
Geology of White Sands National Park

New Mexico's Sulfuric Acid Caves

Carlsbad Caverns Cave Geology

Lecture on the Amazing Ice-Age Footprints at White Sands





Geologic map and cross-section of the southern Tularosa Basin, including White Sands National Park. The basin is part of the Rio Grande rift, a major tear in the crust of New Mexico that has been forming in the past 30 million years, related to the development of the San Andreas fault. Extension of the crust facilitates blocks dropping down (basins), along with magma from the mantle finding pathways through the crust to form intrusive and extrusive igneous rocks.