The Organ Mountains originated about 32 million years ago in the middle of the Tertiary Period. At that time, magma began to ooze from great depths, pushing up the overlying layers of rock. Some of the magma was forced to the surface ejecting vast quantities of ash, rock, and lava over an area of 100 square miles. The result of this volcanic activity can be seen today as the dark red rocks of the Organ caldera that forms the southern portion of the range. The magma that did not reach the surface cooled slowly to form the Organ batholiths. The pinnacles of the northern Organs are remnants of this slowly cooled magma. This craggy, light gray rock of granite composition can be easily recognized in the northern section of the range.

Along the western side of the pinnacles, the remnant of the sedimentary layers can be seen forced into nearly vertical bedded layers. The interface between the sedimentary rock and batholiths is the location of several historic mines.

Scientists currently document the birth of the Earth at 4.6 billion years ago. The oldest rocks in New Mexico are around 2 billion years old and were formed during the Pre-Cambrian Era of the Earth's history. This was a time of mountain building, turbulent seas, and volcanic activity of the former mountains. The rocks were then covered by masses of magma from the Earth's core that slowly cooled into beds of pinkish granite crossed by coarse pegmatite veins. Again, these mountains wore down and southern New Mexico lay featureless for millions of years.

At the dawn of the Paleozoic Era (old life) 570 million years ago, the "Age of Fishes", the land was low. The Rio Grande did not exist and shallow warm seas covered the area that is now Las Cruces and the Organ Mountains. Sedimentary rocks such as limestone and dolomite were formed under the invading seas.

The Mesozoic Era (middle life), the "Age of Reptiles", began about 245 million years ago. The Las Cruces area was gently uplifted and then eroded away. Near the end of the Era, the shallow seas returned depositing sandstone, shale, and conglomerate rock thousands of feet thick.

Geological forces changed abruptly about 60 million years ago with the start of the Cenozoic Era (recent life), the "Age of Mammals", and its Tertiary Period. The land rose under tremendous pressures causing overriding cracks or faults in the Earth's crust. Massive blocks of older rock were forced up and over other blocks, forming mountain ranges and basins or valleys. Once again the mountains eroded and by 45 million years ago, the land was again flat.