

THE SONORA EARTHQUAKE OF MAY 3, 1887.

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On the afternoon of May 3, 1887, at 2.12 Pacific time (=120 W. of Greenwich), the first of a series of earthquake movements was felt in the State of Sonora and the adjacent parts of Mexico and the United States, over an area extending from El Paso in Texas on the east, to the river Colorado and the Gulf of California on the west, and from the State of Sonora on the south, as far north as Albuquerque in New Mexico, the extremes in both directions being over 500 miles. It was the fortune of the writers to be at the time at the great copper mining camp of Bisbee in Arizona, in a narrow gorge of the Mule Pass Mountains, about 5,300 feet above the sea, and near the border of Sonora. A violent tremor of the earth, including two sharp shocks, and lasting over ninety seconds, was succeeded at frequent intervals by many lesser movements in the next three days, and less frequently at least up to May 29. In this part of Arizona solid house-walls, of adobe or unburned brick, were cracked or overturned, while huge rocks in the steep mountain gorges rolled down, causing much damage. Fires, perhaps kindled by these in their course, appeared immediately afterwards in various wooded regions in Sonora and Arizona, giving rise to many false rumours of volcanic eruptions. The movement here seemed from south to north; the railroad track in one place near the frontier, running east and west, was displaced three inches to the north, while a chimney shaft, without being overturned, was turned violently around upon its base. The small town of Bavispe in the Sierra Madre in Sonora, was nearly destroyed, many people being wounded and forty-two killed. Oporto suf-

ferred in a similar way, and Fronteras to a less extent. The district chiefly affected by the earthquake is, however, for the most part a desert, with some cattle ranches and mining stations.

Interesting studies were made by the authors in the valleys, or *mesas*, between the parallel mountain ridges in this region, both in San Pedro and Sulphur Spring Valleys. The latter, to the east of Bisbee, and stretching north and south about one hundred miles, is often eight or ten miles wide, and has its lower portion in Sonora. Though without a visible watercourse, water is there generally found at depths of from ten to forty feet in the numerous wells sunk at intervals to supply the needs of large herds of cattle. As described by many observers, the surface of this plain was visibly agitated by the first earthquake shock, so that persons were in some places thrown down by the heaving of the soil, which burst open with discharges of water, while the wells overflowed and were partially filled with sand. In the southern part of this valley, for about seven miles south from the Mexican frontier, the authors found the result of the undulatory movement of the soil apparent in great numbers of cracks and dislocations. For distances of several hundred feet, along some lines with a generally north and south course, vertical downthrows on one side of from one foot to two feet and more were seen, the depressed portion rising either gradually or by a vertical step to the original level. Branching, and in some cases intersecting, cracks were observed. These depressions were evidently connected with outbursts of sand and water, which, along cracks—marked by depressions on both sides, sometimes covered areas of many hundred square feet with layers a foot or more in depth, marked here and there by craters two feet or more in diameter, through which water had risen during the outburst of these mud volcanoes. The authors examined many of these phenomena in northern Sonora, and took photographs which were exhibited. They note that while the earthquake movements in the adjacent hills of Palæozoic strata had left no marks, the dislocation over many square miles in the valley would have sufficed to throw down buildings and to cause

great loss of life in an inhabited region. There are believed to be no evidences of previous earthquake disturbances in this region since its discovery by the Spaniards centuries ago.

From the published reports of commissioners named by the State of Sonora, it appears that the regions injured by the earthquake are in two nearly parallel north and south valleys in the district of Moctezuma, along the river Bavispe, a tributary of the Yaqui. The town of Bavispe itself, 1,500 souls, lies about seventy miles south of the American frontier and 110 miles south-east of Bisbee, Arizona, its elevation being 3,073 feet above the sea. Here forty-two persons were killed and twenty-five wounded. Bacerao, twenty miles farther south, also suffered much damage, and the estimate for property destroyed in this valley was 218,199 dollars. Opoto, Guasalas, Granados, Bacudebachio, and Nacovi lie in a lower valley about thirty miles west of the last, the elevation of Guasalas being only 1,720 feet above the sea. The loss of life was here confined to Opoto, where nine were killed and six wounded. The injury done to property in this valley was estimated at 78,151 dollars. In both regions are noticed the opening, in the arable lands, of numerous fissures, generally north or north-east in direction, from many of which water flowed abundantly. The river, thus supplied in a time of excessive drought, swelled to the volume usual in the rainy season of summer, a condition which lasted up the time of the report of Senor Liborio Vasquez, dated at Bavispe, May 29, 1887. The fields had become green and the river moist with prevailing fogs. A report concerning the region of Opoto mentions not less than seven volcanoes in the vicinity, which were seen burning for two days, but without any flow of lava, while that for the Bavispe region declares that no volcano had there been discovered. The authors incline to the belief that, as was the case in the San Jose mountains, and others examined by them along the borders of Arizona, the appearances of volcanoes near Opoto were due to forest fires.