

*The History and Cause of the Subsidence at Northwich and its Neighbourhood, in the Salt District of Cheshire*, by Thos. Ward.—The frequent occurrence of subsidence in the neighbourhood of Northwich makes it desirable to learn their history and cause. Northwich overlies extensive beds of salt. These occupy about three square miles. The first, or "top" rock-salt, lies at a depth of about 50 yards from the surface, and is covered by Keuper marls, and these by the drift-sands and marls. Between the two beds of salt there are 30 feet of indurated Keuper marl. The second, or "bottom" rock-salt, is over 30 yards in thickness. The subsidence which are so destructive in the town of Northwich and the neighbourhood are entirely caused by the pumping of brine for the manufacture of white salt. It was only about 1770, or shortly afterwards, that the first sinking was noticed; since that date, subsidence has gone on very rapidly, and much destruction of property has resulted. Large lakes or "flashes," one of more than 100 acres in area, and of all depths up to 45 feet, have been and are being formed. This peculiar phenomenon of subsidence in the salt-districts is worthy of more consideration than it has hitherto received from scientific men.

*The Sonora Earthquake of May 3, 1887*, by Dr. T. Sterry Hunt, F.R.S., and James Douglas.—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 5300 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 minor 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 small town of Bavispe in the Sierra Madre in Sonora was nearly destroyed, many people being wounded and forty-two killed. Opoto suffered 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 the San Pedro and Sulphur Spring Valleys. The latter, to the east of Bisbee, and stretching north and south about 100 miles, is often 8 or 10 miles wide, and has its lower portion in Sonora. Though without a visible watercourse, water is there generally found at depths of from 10 to 40 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 7 miles south from the Mexican frontier, the authors found the results 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 1 foot to 2 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 2 feet or more in diameter, through which water had risen during the outburst of these mud volcanoes. While the earthquake movements in the adjacent hills of Palæozoic strata had left no marks, the dislocations 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. 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 to the time of the report of Señor Liborio Vasquez, dated at Bavispe, May 29, 1887. The fields had become green and the air mist 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 José Mountains, and others examined by them along the borders of Arizona, the appearances of volcanoes near Opoto were due to forest fires.

*The Disaster at Zug on July 5, 1887*, by the Rev. E. Hill.—On July 5, 1887, at the town of Zug, in Switzerland, a portion of the shore gave way and sank into the lake. About three hours later another much larger adjacent area also suddenly subsided, so that in all an area considerably over two acres, with half of one of the principal streets, was submerged to a depth of about 20 feet. It can be seen that the subsoil consists of coarse gravel and sand, followed after a few feet by soft wet sand and fine mud. According to Prof. Heim, this fine mud or sludge reaches to a depth of nearly 200 feet, and the disaster is shown to be due to a flowing out into the lake of this mobile sludge from under the superincumbent weight of buildings and firmer ground. The buildings collapsed as they sank. The catastrophe must have been long impending; the exact cause which precipitated it is indeterminate, but a low level of the lake and tremors from pile-driving for new quays are suggested as contributory. On the English coast the incessant changes of pressure from tides probably render impossible such instability of equilibrium.

*The Triassic Rocks of West Somerset*, by W. A. E. Ussher.—This paper is the result of investigations made in the years 1878 and 1879. The constitution, extent, and general relations of the Lower, Middle, and Upper Triassic rocks of the area are briefly described, with the following general results:—The Lower Trias consists of breccia and breccio-conglomerate upon sands and brecciated sand and loam; it is faulted against Keuper basement beds, and is conformably overlapped by Middle Trias marls upon the margin of the older rocks. The Middle Trias consists of marls with sandstones in places at their base; it is faulted against the successive divisions of the Keuper on the east, and terminates northward in the angle made by converging faults at Bicknoller. The Middle Trias marls rest on the older rocks near Yellow Wood Farm, and finally disappear near Orchard Wyndham, south of Williton, under Keuper breccias. The Keuper beds consist of marls, sandstones, and a locally varying series of conglomerates, gravels, and breccia in descending sequence. The sandstones are very calcareous south of Crowcombe; they form marginal deposits in places near Dunster. The coarser beds of the Keuper develop at the expense of the sandstones in the area west of Williton. It is very probable that the Keuper basement beds of the Porlock valley may be marginal deposits formed during a progressive subsidence, and therefore may belong to a higher horizon than the Lower Keuper beds south of Williton.

*The Devonian Rocks of West Somerset on the Borders of the Trias*, by W. A. E. Ussher.—The composition of the Quantocks is first briefly described, and the faulted relations of Middle Devonian grits, slates, and limestones of which they consist alluded to. From the constitution of the Palæozoic districts on the east and west of the Triassic rocks of Crowcombe and Stogumber, the author considered the beds eroded in the intervening valley would amply account for the variability of the Triassic strata derived from them. From Withycombe to Porlock the faulted relations of the Middle and Lower Devonian grits are then briefly described. The author considered that the elevation of the Quantocks, the Brendon, and the Dunkery ranges was pr