

ART. XXXVIII.—*The Earthquakes in Spain*; by C. G. ROCKWOOD, JR.

THE series of earthquakes which has recently devastated the southern part of Spain, began with a disastrous shock at 8^h 53^m P. M., on December 25, 1884.

It had been preceded by a light, but somewhat widely extended shock in the early morning of December 22, which was felt on the northwest coast of Spain and in Portugal, and reached so far under the Atlantic Ocean as to affect Madeira and the Azores. The shock of December 25, has also been followed by a long series of oscillations, repeated at first several times a day, during the rest of December, and with gradually diminishing frequency through the months of January and February, 1885.

The shock on the evening of Christmas day, much the most violent of the series, caused great loss of life and destruction of property. Its influence was plainly felt as far north as Madrid, where bells were rung and clocks stopped, and very slightly also in England; but it was in the southern provinces of Spain, bordering on the Mediterranean Sea, that the greatest damage occurred. In Cadiz, Seville, Cordova, Jaen, and Almeria it was strongly felt, although causing no very serious damage in these places; but within the area defined by this chain of cities and the Mediterranean Sea, many towns and villages were left in a more or less ruined condition. In Granada, of the 10,000 houses composing the city, at least 7,000 will need repairs. The façade of the cathedral was injured. The inhabitants left their homes by thousands, and either camped for days in the open fields or emigrated from the city entirely. The famous Alhambra fortunately escaped injury. The villages of Arenas del Rey, Albuñuelas, Santa Cruz, Zaffaraya, and Albama were destroyed. The latter place was built partly upon and partly at the foot of a bluff, and the upper town was shaken down upon the lower, overwhelming 1000 houses and 350 of the inhabitants. Here also the hot springs ceased to flow, and after two days began again with increased quantity and augmented temperature, the waters also having acquired a sulphurous character which they had not before possessed.

In Malaga all the public buildings were more or less injured. At Estepona a church and buildings were thrown down. At Torrox twenty-six shocks occurred between 8^h 50^m P. M. of the 25th and 11^h A. M. of the 26th, completely destroying the town. At Nerja the first shocks were followed by a hurricane which

blew down many of the already weakened houses. At Almuñecar twelve shocks occurred in fifteen minutes. At Periana, a landslip overwhelmed a large part of the town, destroying a church and 750 houses. At Guevejar, a great semi-circular crevasse has surrounded the town on its upper side and the village, which rests on clay strata, is slowly sliding downward to the bed of the river Cogollos, some of the houses having already moved 27 meters up to January 16.

The provinces of Granada and Malaga have thus been the scene of the greatest destruction. Official reports up to January 14, state the number of persons injured in Granada as 695 killed and 1480 wounded. Other accounts estimate the entire loss of life as upwards of 2000. Thirty-five villages are named where a greater or less number of victims were taken from the ruins.

As bearing on the possible connection of earthquakes with atmospheric phenomena it is noted that an unusually high atmospheric pressure prevailed over the Spanish peninsula during the first-half of December, while on December 20, a heavy storm, attended by unusual depression of the barometer, struck the northern coast, and passing southward, reached the Mediterranean Sea on December 22, just previous to the great earthquake.

The geological relations of this earthquake may be seen from the following extract from remarks of Mr. J. MacPherson to the Spanish Natural History Society, reported in *Nature* (vol. xxxi, p. 278).

“A study of the Mediterranean watershed of Andalusia will show the existence of two great mountain masses, chiefly formed of archaic deposits. One of these is known by the name of the Serrania de Ronda, and the other by that of the Sierra Nevada. Both run in a series of folds and faults from southwest to northeast, and between them there lies an interval filled up with palæozoic, secondary and tertiary deposits. Toward the middle of this interval there rises up like an island in the midst of these later deposits, a series of ridges running from northwest to southeast, and formed of archaic rocks. They are known by names of the Sierra Tejea and Sierra Almjara, and the folds of these ranges, as in the case of the other archaic formations, run from southwest to northeast. It is clear, therefore, that this intermediary mountain mass is a segment of a more considerable archaic formation, separated from adjacent rocks through the subsidence of the ground on both sides. Owing to constant oscillations, this detached portion has been covered with the thick mantle of sediment which now overlies it, and its structure is easily accounted for as the result of that great fracture which crosses the peninsula from northwest to southeast, and in the prolongation of which lies the region now described.

“ . . . The most violent shocks of the earthquake of December 25, were experienced in the region intervening between the Sierra Nevada and the Serrania de Ronda, and precisely on the very belt which enclosed the archaic mass of the Sierras Tejea and Almajara. That part of Andalusia, broken and torn by the secular disturbances of our globe, has proved naturally the weakest, and has, therefore, been the most exposed to the shocks from which Andalusia has so terribly suffered.”

The Spanish government has appointed a commission, under the presidency of Sr. D. Manuel Fernandez de Castro, to study the phenomena of this series of earthquakes; and the Paris Academy of Sciences has also sent out a commission on a similar errand, under the lead of M. Fouqué, Professor of Geology in the Collège de France. The former has already issued an exhaustive list of questions, and most interesting and valuable results may be expected from the labors of these commissions.

Princeton, N. J., March 6, 1885.