REVIEWS.

I.—The San Francisco Earthquake.

The California Earthquake of April 18, 1906: Report of the State Earthquake Investigation Committee. By Andrew C. Lawson, in collaboration with G. K. Gilbert, H. F. Reid, and others. Carnegie Institution of Washington.

THREE days after the earthquake which destroyed so large a part of San Francisco in 1906, a committee was appointed by the Governor of California for the purpose of investigating the different phenomena, both transitory and permanent. The committee included Professor A. C. Lawson as chairman and several well-known men of science. Working in conjunction with them were also many other observers, who investigated various details and examined the whole of the ground traversed by the great fault, and photographed and measured the displacements of the surface-beds. By the end of the year the materials were nearly all collected, and the results of the discussion when completed will fill two quarto volumes and a folio of maps and plates. Of these the first volume and the atlas are already published. The former contains the record of the facts observed, the detailed account of the fault and of the movements along it which caused the earthquake, the description of the secondary phenomena and of the variations of intensity throughout the disturbed area. The second volume will be occupied by an investigation of the seismographic records of the earthquake obtained at observatories in all parts of the world. The theory of the seismograph will also be considered in some detail. In the atlas the course of the fault is clearly traced, the variations of intensity in the shock are depicted, especially within the city of San Francisco, and the seismograms from nearly seventy observatories are reproduced. In addition to the forty plates in the atlas there are more than three times that number in the first volume, chiefly reproductions of photographs. The report is published by the Carnegie Institution of Washington, and it is evident that no expense and no trouble on their part have been spared to make it the most complete account ever furnished of any scientific phenomenon. Nor have Professor Lawson and his colleagues failed in any way to take advantage of so unique an opportunity. Their work has been admirably done. The immense mass of detail is carefully collated. Whenever possible the editor has allowed the observers to speak for themselves in short notes and papers, which are so neatly inserted that in reading the text there seems to be no breach of continuity.

The advantages of this mode of collaboration are nowhere better illustrated than in the description of the remarkable fault which occupies so large a part of the first volume. The fault was traced by different observers for a distance of at least 190 miles, except for a few short interruptions in which its course is submarine, and there can be little doubt that it reappears after a somewhat longer break still farther to the north, so that the total length of the line is about 270 miles. On the whole, the path of the fault is a slightly curved line running in a general north-west and south-east direction, and, to the north of San Francisco, keeping close to the Californian coast. Its

mere length is not, however, its most remarkable feature. Throughout its whole extent there was a sudden displacement of the crust, the ground on the south-west side to a great but unknown depth being shifted to the north-west, and that on the north-east side to the south-east. The amount of the horizontal displacement varies considerably. As a rule it lies between 8 and 15 feet, and in no place exceeds 21 feet. All structures which crossed the line of the fault were severed. Roads and paths were displaced, sometimes by as much as their own width or more, fences were snapped across and their ends separated, piers were broken and shifted, and water-mains ruptured and telescoped. These and other effects are fully illustrated by numerous photographs. In other earthquakes there have been more pronounced changes of elevation along the fault, but in no other known case have the horizontal movements been so persistent over so vast an area. In none, certainly, have the fault-movements been so carefully studied or the investigations of the geologist been aided so effectively by the researches of the biologist and the measurements of the surveyor.

Among the minor sections of the report one of the most useful is that which deals with the relations between the nature of the ground and the intensity of the shock. The distribution of the damage in San Francisco affords decisive evidence on this point. Though the area covered by the city lies only a few miles from the fault, the intensity of the shock was governed more by the nature of the underlying rock or soil than by proximity to the fault. In houses built on rocky ground, especially on the summits of hills, many chimneys remained unshattered; on thick deposits of sand or earth, brick walls were badly cracked and chimneys were generally destroyed; on 'made' land, and most of all on that which occupies the sites of recently filled creeks and marshes, ordinary buildings collapsed and even the best masonry was seriously injured. The lesson conveyed could not be more clearly enforced; yet it is one to which the rebuilders of San Francisco are not paying all the attention which it claims.

The only omission of any consequence in the book is the absence of comparisons drawn between the phenomena of this and other great earthquakes. If the San Francisco earthquake were the only shock known to mankind, the attention paid to it could hardly have been more exclusive. The examination of the points in which the Californian fault resembles, or differs from, those of other earthquakes might with advantage have been more detailed. The scantily observed sound is described, but no surprise is expressed at its general inaudibility. The valuable discussion on the distribution of damage in San Francisco would have received ampler illustration if it had been pointed out that similar relations between the amount of damage and the nature of the ground have been noticed in many other earthquakes. But comparisons such as these would have increased the size of volumes already large enough and have delayed their publication. They can be suggested by other writers, and there can be little doubt that in this report there are facts described and photographs reproduced that will form a veritable mine for workers in nearly every branch of seismology.

C. Davison.