representing the three main branches of the human species—a black, a white and a yellow man. In alcoves around the hall are displayed racial types geographically arranged by continent.

On entering the hall from the west, one meets, on the right hand, natives of Africa. A Bushman of the Kalahari Desert, in characteristic posture, is about to release an arrow from his bow, while his wife squats beside him, her small baby strapped to her back. In contrast to these diminutive people, a tall and lithe young girl of the Sara tribe is poised to begin a dance, incomparable grace in her slender limbs and a vivacious smile upon her face. Near her, a Senegalese drummer beats upon his tom-tom, his head thrown back in a rapt and dreamy expression. A Batwa boy from the Belgian Congo grins mischievously, showing his filed teeth. From East Africa an extremely tall young Shilluk warrior of serious mien stands on one leg in the peculiar stork-like posture characteristic of his tribe. Numerous other figures portray the divergent racial types of the African continent.

On the left-hand side, races of the many islands of Oceania and of Australia are shown. A full-length figure of an Australian mother and son and of an Australian man reveal not only the bodily form, but the undeveloped intellect of that primitive race. A muscular Solomon Islander, of fierce expression, is climbing a cocoanut palm. The Polynesian race is represented by a Hawaiian skimming toward the beach on his surf board, every muscle of his fine body tense with life.

In the central section of the hall, European types are represented on the right hand: among them, a Sicilian fisherman of Mediterranean type; the full-length figure of a Nordic man; a woman from Brittany wearing her quaint bonnet. On the left-hand side are American Indians and Eskimo types from the American continent. A prominent place is given to the full-length figure of a rugged middle-aged Ainu, a member of that ancient and fast-disappearing race now confined to the islands of northern Japan.

The east end of the hall is devoted to the many and varying Asiatic types. The remarkably slender figure of a Vedda from Ceylon is portrayed in the full-length figure of a young man, his long bow in his hand. A Kashmiri sits in the characteristic attitude of meditation. The delicate face of a woman from Jaipur, India, carved in stone, contrasts markedly with the wrinkled countenance of a Rajput woman of the "untouchable" class. Chinese and Mongol types are well represented; and an old Tibetan merchant from Lhasa sits cross-legged on a rug. There is a young Japanese woman with elaborate hair dress, and a fine head of a Japanese man of the upper class.

Only a few of Field Museum's great assemblage of races have been mentioned. Many of the types here represented will probably be extinct within a few decades, but their faces and forms are nowhere as well preserved for posterity as in the Hall of Races of Mankind.

A section at the east end of the hall will be devoted to physical anthropology. The exhibits will include anthropometric instruments with an explanation of the methods employed; growth changes; stature in various races; the use of the hand and foot; hair samples; charts showing variations in eye color; the shape of the nose, the mouth and the ear. The range of variation in skin color will be shown by means of colored transparencies arranged by continent. A section will be devoted to demography, wherein vital statistics, multiple births, growth of populations, racial problems in the United States, immigration questions and longevity in races will be illustrated. There will be an exhibit showing the effects of epidemics and disease on populations. The racial characteristics of the skeleton will be shown, together with a type series of skulls to show racial variations. Skull deformation with appliances and distribution maps showing ancient and modern practises of this custom, as well as examples of trepanning and trephining, will be included. Finally, there will be an exhibit of comparative osteological material showing typical adult male skeletons of man and the anthropoids.

HENRY FIELD
FIELD MUSEUM OF NATURAL HISTORY

REPORTS

THE LONG BEACH EARTHQUAKE[1]

THE first motion recorded at the Seismological Laboratory in Pasadena from the Long Beach earthquake was at 5h. 54m. 19.3s., P. M., on March 10, 1933, with a possible error of one or two tenths of a second; it was also recorded at various times less than 45s. later, at our six other stations in southern California. Thus guided, the origin of the shock was determined to be a point in the ocean about 17 miles to the southeast of Long Beach and 3 miles to the west of Newport at 33° 34½′ north latitude, 117° 59′ west longitude, with an error of probably not larger than 5 km., perhaps not larger than 2 km. Hundreds and hundreds of after-shocks were also recorded; they

[1] Abstract of reports made to the Los Angeles Section of the American Society of Mechanical Engineers on April 12, 1933.

do not all seem to come from the same point of origin, although none come from far away. It is not impossible that, as the shock is believed to have been due to movement on a fault trending northwest, the after-shocks were developed more to the northwest than the main or first shock This, however, is not very probable.

The varying measures of damage may be explained from my experience in the San Francisco earthquake of April, 1906, where I spent 2½ months on the ground studying its effects. The underground structures varied greatly in that district; and it was found that the destructive effects over most of the shaken area varied more with the nature of the underground and with the strength of building construction than with distance from the earthquake center, the destruction being greater on alluvium than on rock. In the Long Beach district the ground conditions vary from graded and filled ground through wet natural alluvium to firm hilly ground.

The fall of buildings and chimneys at Long Beach was predominantly to the north and slightly to the east. The amount of movement there has not yet been determined; but at Pasadena the shock began with small, rapid-motion waves which lasted for 5 or 6 seconds; and these were soon followed by slower waves causing a recorded amplitude of slightly over 3 inches with a period of 8 or 10 seconds.

Earthquakes may be classed both as to their magnitude and as to their intensity. In magnitude the Long Beach earthquake was not a great shock, but a moderately strong, local shock. In intensity it reached VIII (possibly IX) on the Modified Mercalli Scale of 1931, which specifies twelve grades. It was of about the same energy as the Santa Barbara earthquake of 1925. On the other hand, the energy of the San Francisco earthquake of 1906 was more than a thousand times greater than either of these southern shocks, and its shaking continued longer. Had the buildings in San Francisco been of the same defective quality as those at Long Beach, the damage there in 1906 would have been much greater than it was.

Earthquake prediction is at present impossible, but from the experience of southern California for the past century, it appears that the earth's crust here is in a serious state of strain and that we may expect such moderate shocks as we have lately had until a stronger shock brings relief to the whole area.

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WHAT HAPPENED GEOLOGICALLY

California lies in a zone of active mountain-making; and our earthquakes are merely the growing pains of our mountains. Our scenic topography is largely the direct result of geologically recent displacements on faults, many of which are still active and of so recent a date that erosion has not yet effaced their scarps. The movement on the fault which caused the Long Beach earthquake took place under the ocean about 3 miles off shore, and hence the fault can not be examined directly; but it is traceable in its extension northwestward through the Los Angeles district, where it is known as the Inglewood fault, which was active in that suburb in the earthquake of 1920. Its length is moderate; much less than that of the great San Andreas fault, movement on which caused the San Francisco shock of 1906 and which has been traced from hundreds of miles north of the Golden Gate far southward nearly to and perhaps into Mexico.

The fault system of southern California includes six or seven main fractures, trending northwest-southeast. Nearest the coast is the Inglewood fault, above mentioned; next inland comes the Elsinore or Whittier fault, which starts in the Gulf of California, comes up through the Peninsular mountains, and appears to die out east of Los Angeles. Third is the San Jacinto fault, which also comes from the Gulf of California, runs through San Jacinto and the Cajon Pass, beyond which it joins the above-mentioned San Andreas fault, the fifth and greatest member of the system. These faults divide southern California into a series of great slices or blocks, a few miles wide and a few tens or a few hundreds of miles long. Their geological structure shows that they have acted rather independently. They have been in movement for millions of years. It is little slips in their movement which cause our earthquakes.

It appears that the adjoining part of the Pacific basin is slowly moving northwestward with respect to the continent and that the movement is distributed on our fault system. Of two adjoining fault slices, the southwestern one always, as far as our experience goes, moves northwestward with respect to the northeastern one. The slices are believed to be moving at a very slow but constant rate. Where they are in contact they tend to stick together and a condition of strain is there built up by friction of slice on slice. When the movement of the slices has gone far enough, friction is overcome by the strain and a slip occurs, not because of any sudden movement in the entire slice, but only for the relief of the strained margins of the two slices. The Long Beach earthquake is believed to have been caused in this way, even though the part of the fault on which its slip occurred is below the sea. The slip is measured in feet or tens of feet in strong earthquakes; it may last for a fraction of a minute in small earthquakes, it may continue one or two minutes in great earthquakes. To build up marginal strain sufficient to produce a slip and thus cause an earthquake may require slice movement during a decade or a century, but not until man has lived in California one or two thousand years can accurate judgments be made of that matter.

When a slip takes place, the adjoining fault surfaces move with a grating effect because they are not smooth. Waves of several kinds and of unlike velocities, thus set up, are propagated through the earth; and when they reach the surface, an earthquake is there experienced. Its destructive effect is greater if it emerges through alluvium than through solid rock. Just as a shock causes jelly in a dish to quiver more than the dish, so alluvium quivers more than the bed rock on which it lies. For that reason the damage in the recent earthquake was greater at Long Beach and Compton, which are built on an alluvial plain on the coast twenty miles north of the earthquake origin, than at Laguna, which is built on a rocky coast only twelve miles southeast of the origin.

We must recognize that southern California will continue to have earthquakes, not periodically, not regularly, but at unknown intervals; and we should therefore build for safety against them. We must demand earthquake-resistant construction for safety of life and property.

J. P. BUWALDA

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ENGINEERING LESSONS OF THE QUAKE

Civil engineering has been defined as the science of building things that stand up and mechanical engineering as the science of building things that move. During an earthquake things move, but they are also expected to stand up. This may be the reason for having a civil engineer speak at a meeting under the auspices of mechanical engineers. The destruction by an earthquake is the result of inertia, not only of buildings and other structures, but to perhaps a greater degree of human inertia. Engineers can deal tolerably well with the inertia of inanimate things, but feel much more helpless in overcoming the inertia of human nature.

The vertical component of an earthquake motion is generally of less amplitude than the horizontal, and it is customarily disregarded in discussions of engineering design because the factor of safety provided for static vertical force is ample to take care of added stresses produced by the vertical component of earthquake motion. There is quite general agreement that earthquake damage to buildings is due principally to horizontal forces. Building regulations in Japan, Italy and New Zealand, representing the consensus of opinion of engineers who have considered the problem, require that designs shall provide for an arbitrary horizontal acceleration of the order of 1/10 gravity. This is the most reasonable and expedient method at present available to minimize earthquake hazard to life and damage to property. The approximate additional cost of incorporating this resistance to horizontal forces in a building of Class "A" is from 5 to 7 per cent. of its total cost. This should not be misinterpreted to mean that a Class "C" building can be converted to an earthquake-resistant Class "A" structure for an additional cost of 5 to 7 per cent.

The earthquake of March 10 was discriminating. The buildings that it singled out for destruction were the worst of design, material and workmanship. It emphasized, what every one now accepts, that the function of mortar is to hold bricks together, not to keep them apart. The desirability of using cement mortar and wet brick is not a new discovery. It was advised after the San Francisco fire of 1906 and after every subsequent earthquake. But why repeat what has been said so often. Existing publicly owned buildings, such as schools, can be remodeled to reduce the menace to the lives of the children. Each building should be studied by a structural engineer as thoroughly as he would a limit-height office building. Even though the existing schoolhouses can not be made as earthquake resistant as new structures specially designed with this end in view, the danger to life can be reduced greatly.

With privately owned, Class "C" buildings, such as stores, the problem of finance is greater than that of design. Building codes can not be made retroactive. Whatever method of bringing about the betterment of these buildings is used, the job is not exclusively for the engineer. Perhaps the biggest contribution he can make is to keep the interest in earthquake-resistant construction from waning, as it has too consistently after all past earthquakes; then we may hope to have buildings so safe that we may adopt as a slogan: "Come to California and enjoy the earthquakes."

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD OF MOUNTING MAPS

MOUNTED maps are more durable and do away with the possibility of being torn during classroom or field use. In universities there often arises the need for mounted maps and the facilities for mounting are lacking. At Syracuse, in the geology and geography