floor, partly by means of the bottom-sampler, partly by dredging and trawling.

Å. V. TÅNING
CARLSBERG LABORATORIUM,
COPENHAGEN

REPORTS

BATHYGENETIC AND OROGENETIC MOVEMENTS

PROFESSOR ALBRECHT PENCK, of the University of Berlin, addressed the Boston Geological Society in the North Hall of Walker Memorial at the Massachusetts Institute of Technology on Friday evening, September 28, 1928.

That a period of mountain making generally follows the formation of geosynclines, in which a great thickness of rocks was deposited in a gradually sinking basin, was an old idea originated by James Hall and further advanced by the studies in the Appalachian region. In the Bavarian Alps a limestone formation occurs, known as the Wettersteinkalk. It is of Lower Triassic age, and although it has a thickness of five thousand feet, it shows no important change from bottom to top. It represents deposition in a shallow sea, the bottom of which was slowly subsiding. The Wettersteinkalk is covered by the Raibl shales, which are in turn overlain by the Upper Triassic Haupt Dolomite, a formation also about five thousand feet thick. The thickest part of the Haupt Dolomite is offset geographically from the thickest part of the Wettersteinkalk, so that the great limestone masses form overlapping lenses. The whole thickness of the Haupt Dolomite also consists of deposits formed in shallow water, thus implying continuous subsidence. This type of progressive subsidence Penck called "Bathygenetic movements."

Walcott found evidence of similar movements in the northwestern part of the United States during his study of the Cambrian rocks. These rocks were formed in separate basins that continuously sank during the period of deposition. When bathygenetic movements occur successively at different times and the area of maximum depression shifts or migrates from one locality to another, the large lenses of sediments will be found either with overlapping edges or in separate basins.

An important observation in the Bavarian Alps is that the Raibl strata contain pebbles of Wettersteinkalk, indicating that sufficient elevation followed the sinking of the geosyncline to allow a conglomerate to form. The structure of the Wettersteinkalk is complex, but since the Raibl beds are horizontal, a compression must have followed closely upon the bathygenetic movements.

Professor Penck had just come east from a summer at the University of California where he had become familiar with the geology around Berkeley. There the Orinda formation of the Coast Range has a thickness of about five thousand feet, but its geographical extension is a very narrow one, being only ten to fifteen miles wide. The formation, which consists of clay, conglomerate and sands that were deposited in very shallow water, is of Upper Miocene and early Pliocene age. In the vicinity of Berkeley there are some other more recent formations also of narrow width and of great thickness. West of Berkeley, however, the Jurassic Franciscan formation is found, and no more Pliocene rocks are met until San Francisco is reached. There seem to have been two blocks, separated by north-south faults; the western one, containing the Franciscan rocks, was being elevated while the eastern one was sinking. Into the basin so formed, the material derived from the erosion of the elevated western block was deposited. Thus the Orinda formation was made.

The manner of deposition of the Orinda differs from that in geosynclines, which are structures of wide extent, and indicates the sinking to very considerable depths of very narrow belts. As to the cause of such sinking there are varying opinions. One view is that the basin is of synclinal form, while another is that the sinking block is bounded by faults and represents a graben. Professor Penck believes that the block was not pushed down by the sediments as they were deposited, but that the sinking took place by the movement of the underlying block, and into the trench so made the detritus was deposited. Another observation bearing on this same problem was made by Walcott, who noted that each sinking basin has its own individual succession of strata.

In no place are the Orinda beds horizontal, and all have been considerably disturbed. This disturbance followed closely on the deposition, as in the case of the Wettersteinkalk in the Bavarian Alps.

Returning to a discussion of the European locality Professor Penck noted that the chain of the Alps is bounded by the Alpine foreland, in which there is a great thickness of Miocene formations, several thousand feet in total, although elsewhere the deposits are not thick. Fifty years ago he made a study of this Alpine foreland, and found that although the lower strata could not be followed, one upper layer was sufficiently unique to trace, which he did with Franz Edward Suess. This layer, although somewhat tilted, is nearly horizontal. During the World War some drilling for coal and oil gave the opportunity to study the underlying strata. Bore holes, one of which was four thousand feet in depth, showed that all the underlying strata are inclined about 20 degrees. This indicates that the lower part was disturbed while the upper was not, and proves that the crustal movements went on during the deposition of the series. This is evidence that folding goes on in depth.

The formation of a geosyncline goes on together with considerable compression. Thus one can understand how the narrow troughs in California, like that in which the Orinda was deposited, have been so greatly compressed. If a layer is compressed, it must lose in width what it gains in thickness. As a consequence, although not a necessary one, the deposit may be pressed up and elevated. Thus as a result of the compression the block containing the Orinda beds was elevated, and now after erosion it forms the Berkeley Hills.

During this erosion a number of terraces were cut, a fact which indicates that several periods of uplift had occurred, causing a corresponding number of erosion cycles.

Professor Penck expressed the view that sinking, compression and elevation have gone on very slowly. There was first the formation of a very gentle anticline, a mere swell, and this was eroded to give an initial peneplain. Continued elevation during erosion produced several phases of leveling. This idea of the sequence of events was advanced by his son, the late Walter Penck.

During the formation of the Berkeley Hills there must have been other vertical movements, since there is a fine development of longitudinal valleys resulting from faults and flexures.

The sequence of orogenetic movements following bathygenetic is proven also in the Alps. Many years before, Professor Penck had made a study of the glacial deposits there. Although he then had an idea that the mountains were formed by folding (he would now say thrusting) he realized that there was another movement, since the Pliocene strata gave evidence of a vertical movement following the period of folding. He now believes that there was a gentle, though not uniform, movement in the Alps at a late period, a movement which is still going on. The elevation began before erosion had done much work in the Alps, so that the topography so formed is not of striking appearance. As elevation continued, however, and the valleys were cut deeper into the Alpine overthrust mass, a very rugged topography resulted.

In conclusion, Professor Penck emphasized that this sequence of sinking, deposition, compression and folding with uplift is not shown by every orogenetic province, such as the Cordillera of the Colorado region.

During the discussion following the formal address the evidence of recent and continued movement in the Alps was further brought out by Professors Collet and Penck. There was at least one post-glacial volcanic eruption in the Alps, and even in the last few years earthquakes have been reported.

Professor Daly suggested as a cause of the uplift in the Alps the melting of the deep rocks with consequent increase in volume by as much as 10 per cent.

Joseph L. Gillson,
Secretary, Boston Geological Society

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A LOCATION FINDER FOR MICROSCOPES

Every one who has wasted precious time—and who has not?—in trying to find a particular portion of a microscope slide will be interested in a new device for accurately and readily locating on a slide any region of special interest.

The common practice of "ringing" such special regions (by India ink, wax and glass-cutting pencils) is crude at best, and under certain conditions difficult or even impossible (*e.g.*, with immersion oil on the slide, unremovable condensers). This device consists of (1) a lined chart (Figure 1) to be applied to the

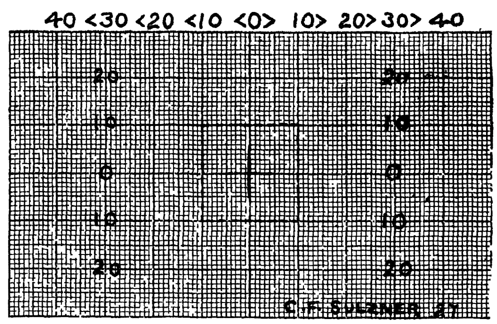

Fig. 1

ordinary stage, and (2) an inexpensive aluminum stage square to keep the microscope slide parallel to the stage chart lines and to control further the slide position, as described later.

When the stage of the microscope is thus marked or divided into millimeter spaces, as shown in Figure 1, locating any desired region on a microscope slide is greatly facilitated. To this end, the millimeter-spaced chart is first "centered" with a low-power objective, so that the intersection of the vertical zero and the horizontal zero lies in the optical axis. The chart having thus been centered, it is then held firmly in place, while corner after corner is carefully lifted, moistened on the under side with rubber cement, and pressed down on the stage. After verifying the optical-center-position of the chart, the glue or cement may be allowed to "set" and the detachable center removed, thus leaving a hole in the chart two centimeters square, which is larger than the original stage opening, and, therefore, prevents the chart from interfering with the passage of light or with the use of the condenser or immersion oil. (If the chart extends