

generally discredited, though he claimed native sources for them; and it is fair to add that we have no positive certainty how great the value of the mnemonic system of the Quichuas, their knotted and colored cords, the *quipus*, may have been. It has also been more than once argued that there must have occurred important modifications in climate since the great temples and cities on the cold plateaus were built, and harbored the large populations which must have dwelt in them. This would require a long period.

As Dr. Dorsey speaks from personal observations and extensive archæological explorations in Peru, his opinion, however at variance with that usually entertained, merits careful consideration.

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CURRENT NOTES ON PHYSIOGRAPHY (IX.)

THE GLACIAL ORIGIN OF LAKE BASINS.

AS LONG as lakes are regarded simply as locally deepened valleys, their explanation by glacial erosion may be fairly maintained; for when the problem is thus vaguely stated, the requirements to be met by the theory are so simple that the hypothesis of glacial erosion finds perhaps better reasons for acceptance than any other hypothesis. But as the facts to be explained are more carefully observed, they generally become more highly specialized and more peculiarly correlated; and their glacial origin may then be either confirmed or excluded. The peculiar association of features described by Lincoln (*Amer. Jour. Sci.*, xliv., 1892, 290) and by Tarr (*Bull. Geol. Soc. Amer.*, v., 1894, 339), regarding Cayuga Lake, seems on the one hand to demonstrate the glacial excavation of this basin; but, on the other hand, the extraordinary correlation of facts determined by various observers around Lake Zurich does not seem to be within reach of explanation by so simple a process

as glacial erosion. In spite of so good a general argument for the competence of ice action as has been presented by Bohm (*Verein zur Verbreit. Naturw. Kenntnisse in Wien*, xxxi., 1891, 477), and in spite of the emphatic disapproval by J. Geikie of various other processes that have been suggested for the production of Alpine lakes (*Great Ice Age*, 3d ed., ch. xix.), the origin of Lake Zurich is certainly not to be accounted for by generalizations at a distance, but only by a special process that will fit all the facts found on the ground. Evidence tending to this end has gradually been accumulating for a number of years; but at an accelerated rate since Heim and Bodmer interpreted the meaning of the rock terraces on the valley sides, and since Penck, DuPasquier and others deciphered the records of the several glacial epochs on the north slope of the Alps.

THE ORIGIN OF LAKE ZURICH.

THE problem of Lake Zurich is presented in a masterful manner by Aeppli in the thirty-fourth number of the *Beiträge zur Geologischen Karte der Schweiz*, in brief as follows: The valley of the Limmat, in which the lake lies, was eroded in broad upland over which the *Deckenschotter* of the first glacial epoch had been previously spread. That the erosion of the valley was performed in the normal fashion by weather and water, and not by ice, is shown by the graded terraces or rock benches, traceable more or less continuously along its sides; these terraces being independent of rock structure, and associated with similar terraces in other valleys, all leading agreeably to the conclusion that after the first glacial epoch the region was generally elevated and the streams thereby given increased power of erosion. The *Deckenschotter*, where preserved on the ridges between the adjacent valleys, together with the terraces on the valley slopes, are bent backwards across a belt six

or eight kilometers broad, so as to slope *towards* instead of *from* the Alps; and the deformation of the *Deckenschotter* and of the earlier higher terraces is greater than that of the lower and younger terraces, thus proving the progressive action of the deforming forces. Associated with this change, there was a general depression of the *Molasse* belt, between the Jura and the Alps, and in the depressed part of the valley of the Limmat, thus generally outlined by the latter process and locally deepened by the former process, the lake had its birth. The belt in which the terraces are deformed crosses the valley somewhat obliquely, but runs parallel to the strike of the general Alpine deformations of the region. Into the lake thus formed, the glaciers of the second and third epochs advanced; but they exercised so little destructive power that they did not obliterate the terraces on the valley sides. The lateral moraines of the last epoch are distinctly discordant with the terraces; the moraines reaching successively higher and higher terraces up-stream, and crossing the belt of deformation without indication of disturbance. Outside of the several terminal moraines, the former lower end of the lake received the valley gravels that were washed from the ice. Hence while the later glaciers may have acted to some degree in altering the form of the lake, their chief effect was to diminish its size by supplying plentiful gravels from the inner Alps, with which a part of the lake basin that they entered was filled.

TARNS OF THE ENGLISH LAKE DISTRICT.

J. E. MARR has examined the tarns or smaller lakes of the mountainous district of northwest England, and finds that their reputed dependence on rock basins is not justified by local study. They appear to result from drift obstructions, by which their outlets have been turned to one side of the former valley troughs and detained in dis-

charging the lakes by settling on rock ledges. In many cases lakes of similar origin have been converted into meadows when their outlets did not depart greatly from the former valley line, and hence encountered only drift in trenching new discharging channels (Quart. Jour. [London] Geol. Soc., li., 1895, 35-48). This does not bear so much on the general question of glacial erosion as on the particular question of the ability of glaciers to form basins by local erosion in excess of their general action along their floor.

THE REGION ABOUT MUNICH.

IN celebration of its twenty-fifth anniversary, the Geographical Society of Munich has issued a handsome volume of 440 pages, containing a number of essays by Günther, Ratzel, Penck and others. Ratzel makes the coast line of Maine 4,300 miles in actual length; though a direct line from Eastport to Kittery measures only about 200 miles. The essay most likely to interest American readers is on the geology of the region about Munich by Ammon, illustrated with a geological map, plate and cuts. It may serve as a guide to excursions from this attractive center; from few other points can so many phases of piedmont glacial geology and geography be seen to so good advantage. Würm and Ammer lakes lie twenty odd miles to the southwest, enclosed by the younger morainic belt. Older moraines stretch farther out from on the plain, especially to the east of the city; and beyond them are spread the flat confluent gravel fans that are associated with various epochs of ice advance. On the sloping plain stands Munich, and across it the Isar and the Amper have trenched their new valleys. The illustrations of morainic topography are very characteristic. A good bibliography accompanies the article; while on an earlier page, Simonsfeld contributes a thirty-page *Bibliotheca geographica bavariae*.

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