a physicist before he became actively engaged in X-ray crystal analysis. His son, Professor W. L. Bragg, also had a thorough training in physics. It is natural, therefore, that each of them should see the subject through the eyes of a physicist rather than of a crystallographer. To them it is of interest how a physical agent like X-rays can give us knowledge of the arrangement of atoms in crystals, and how the arrangement, so determined, is consistent with the external symmetry. This takes up, altogether, eleven chapters (diffraction, production and absorption of X-rays, the intensity of diffracted X-ray beams, X-ray spectra and the spectrometer, crystal structure, methods of crystal analysis and crystal symmetry). There is an excellent chapter on atomic forces as determined from crystal structure data, and another on the structure of organic compounds.

The whole book is written in the clear and delightful style which characterizes the lectures of the authors. This is not to be wondered at, for both the Braggs are excellent teachers as well as renowned physicists. The result is a book of fifteen chapters which should be read by every physicist, chemist and crystallographer. They will all find it "a faithful sketch of the subject as it stands to-day."

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SPECIAL ARTICLES

PLEISTOCENE FEATURES OF SOUTHERN NEW ENGLAND

AN article in this journal, of date October 2, by Robert W. Sayles, entitled, "Superficial Factors in Earthquakes," contains the following statement that invites correction and comment.

". . . in southern New England the ice pressure is supposed to have uplifted the land near the terminal moraine instead of depressing it, . . . Thus Long Island, Block Island and the Cape Cod region were higher than now at the close of the Glacial period. . . . Since the ice left New England, about 30,000 years ago, the more northern part has been uplifted and the southern part has been depressed. There has been a kind of tilt, the northern part going up and the southern part going down."

As to the coast and the belt of terminal moraine the statement is incorrect both in fact and philosophy. The coastal region participated in the Glacial depression and in the Postglacial elevation of all the glaciated territory. The evidence is very abundant and not inconspicuous.

Under the generally accepted theory of isostatic equilibrium in the earth's crust it is thought that the depression of the ice-weighted area should have been, at least partially, balanced or compensated by uplift of neighboring territory. While the location and character of a zone of uplift, or "peripheral bulge," is not determined, it yet appears quite certain that it would lie beyond the weighted territory, and in this case outside the New England coast. In so far as the downthrow of the glaciated area was due to elastic compression of the earth's crust it appears by mathematical analysis that the depression would extend far beyond the weighted area. Under the theory of isostasy, the subsidence beneath the glacier load was chiefly effected by plastic deformation, the forced migration or flow of deep-seated magma out from beneath the weighted area into the surrounding unweighted territory. The considerable depth at which pressure and heat would produce the required plasticity implies a thickness of the supercrust too great to permit of abrupt and sharp folding, or of a high and narrow bulge. At whatever radial distance any bulging occurred it must have been a wide zone of low elevation.

According to Mr. Sayles's conception the axis of oscillation, or hinge-line, was inland from the moraine and within the ice-weighted area. But it should be noted that the moraine belt was part of the loaded area, carrying beside the marginal ice the considerable load of drift deposit. Conceding that any hypothetic bulge would largely have sunk, in response to the Postglacial rise of the deglaciated area, the fact that no clear proof of such bulging has been found on our land territory argues for a wide uplift of small relief.

This complex and difficult subject in geophysics is discussed in an interesting article by Professor R. A. Daly in the October issue of the *American Journal of Science.* He there suggests that the downthrow of the glaciated area might, possibly, have been produced by a down-punching of the area, with surrounding faulting.

So much for the theoretic, and now for some facts. In southern New England we find many plains of sand and silt of wide extent and high above the sea, which are positive effects of standing water. Some of these water-laid deposits face the sea, and some occur in the terminal moraine. Some geologists formerly thought that these evidences of submergence belonged to an episode of glaciation antedating the latest, or Quebec glacier. Waiving the strong argument against multiple glaciation of New York and New England, the fact remains that these water-produced features are superficial, and the very latest geologic record of the region. They have not been overriden by any subsequent ice sheet. Any later ice sheet must have been restricted in its field, and should have left a conspicuous terminal moraine somewhere inland.

Another explanation credited the sandplains to glacial waters. The new romance of glacial geology and the recognition of glacial lakes caused some students to give ice-impounded waters undue credit. "Glacial lakes" were named in eastern Massachusetts without any proof of ice barriers or evidence of damming, or of shorelines, or of definite outlets. The only well-attested glacial water of the region lay in the Nashua Valley, as described by W. O. Crosby. But here we find a capacious valley declining (northward) toward the receding glacier front, the only proper relation for ice-dammed waters. Only by violent imagination could any long-lived and effective water-body be conceived as hemmed in, on the sea-facing slopes, by some queer behavior of the thinning ice sheet.

As an example of the high sandplains we may take the "Sharon Plains," in the southern part of Norfolk County, some thirty miles south of Boston. These handsome and extensive plains are on high ground with free drainage in different directions seaward. Between Sharon Heights and Foxbury the unbroken gravel plain extends two and one half miles, with altitude of 285 to 290 feet. The limit of water-work is clear at three hundred feet, which is the determined marine level in the district. If this occurrence were unique it might more reasonably be attributed to some capricious behavior of the ice sheet. But it is only one of scores of plains, of gravel, sand or silt, all the highest ones having harmonious and consistent relation in altitude to the upraised marine level.

There is no conflict nor difficulty whatever if the geologic features are accepted at their face value. And the New England features must be considered in their origin, character and altitude in correlation with similar phenomena in the wider adjacent territory.

In a series of published papers[1] the writer has recorded the results of long and careful study of the recent submergence phenomena of northeastern America, and has described them with a minimum of theory. The latest paper in the list covers the area now under discussion.

No geologist now ventures to deny considerable uplift for northern New England, the maritime provinces, the St. Lawrence Valley and even of the Hudson Valley. But precisely the same kind and quality of evidence applies to all the glaciated territory. For the reader to whom the geologic literature is not available a brief mention of some of the evidence may be given. (1) On the lower ground are wide areas of water-laid material, usually fine materials, which were laid in deeper water, following the ice removal. (2) Elevated, stratified deposits occur facing the sea. Examples at Gay Head, Sankaty Head, Manomet Hill (east of Plymouth and Highland Light at North Truro. (3) Considerable water-laid and well-stratified beds are found in the terminal moraine. (4) Marine fossils are found in uplifted strata. (5) Perfect horizontality of extensive surfaces, and of conspicuous level skylines, represent wave-work of standing water. (6) Many higher plains, of glacial outwash, mark the summit-level of the invading sea when it laved the ice margin. The Sharon plains are an illustration. (7) Massive river deltas occur in all the valleys declining seaward from the highlands. The summit deltas record the sea-level at the time of their building. These are the most useful criteria for the summit marine level, because they carry that level far inland. Fifteen such summit deltas are located in the paper on southern New England.

The summit features 6 and 7 have remarkable consistency in elevation, rising steadily to over one thousand feet in southern Quebec. They have been the

[1] "Pleistocene Marine Submergence of the Connecticut and Hudson Valleys," *Geol. Soc. Amer.*, Bull. Vol. XXV, pp. 219–242, June 29, 1914.

"Pleistocene Features in the Schenectady-Saratoga-Glens Falls Section of the Hudson Valley (abstract)," *Geol. Soc. Amer.*, Bull. Vol. XXVII, pp. 65–66, 1916.

"Pleistocene Uplift of New York and Adjacent Territory," *Geol. Soc. Amer.*, Bull. Vol. XXVII, pp. 66, 235–262, June, 1916.

"Post-Glacial Marine Waters in Vermont," Report of the Vermont State Geologist for 1915–1916, pp. 1–41, 1917.

"Post-Glacial Features of the Upper Hudson Valley," *N. Y. State Museum*, Bull. 195, 1917.

"Post-Glacial Marine Submergence of Long Island," *Geol. Soc. Amer.*, Bull. Vol. XXVIII, pp. 279–308, June, 1917.

"Post-Glacial Continental Uplift," SCIENCE, Vol. XLVII, pp. 615–617, June 21, 1918.

"Glacial Depression and Post-Glacial Uplift of Northeastern America," *Nat. Acad. Sci.*, Proceedings Vol. 4, No. 8, pp. 229–232, August, 1918.

"Post-Glacial Uplift of Northeastern America," *Geol. Soc. Amer.*, Bull. Vol. XXIX, pp. 187–238, 1918.

"Post-Glacial Sea-level Waters in Eastern Vermont," Report of the Vermont State Geologist for 1917–1918, pp. 52–75, June, 1919.

"Pleistocene Marine Submergence of the Hudson, Champlain and St. Lawrence Valleys," *N. Y. State Museum, Bulletin*, 209, 210 (May-June, 1918), April, 1920.

"Post-Glacial Uplift of Southern New England," *Geological Society of America*, Bull., Vol. XXX, pp. 597–636 (December, 1919), May, 1920.

chief reliance in determining the slope of the upraised land surface over New York, New England and eastern Canada.

Probably the chief reason why the New England men have underestimated the marine submergence (or the subsequent uplift) is because they have relied on the highest evidence of standing-water work in a limited area. And such features may be far inferior to the glacial sealevel. Absence of phenomena in a single district, or even over considerable territorry, is never conclusive. Only by examination of great areas and the correlation of summit phenomena is the true summit level determined.

The present elevation over ocean of the glacial-time sealevel features in the ice-covered territory is the net result of plus and minus movements of both sea and land since the Quebec glacier melted. The ocean surface was considerably lower when the great volume of water had been withdrawn for storage in the Pleistocene ice caps. Hence the present height of the upraised marine features in the coastal region quite certainly does not indicate the total rise. And it appears probable that recent growth of polar and mountain ice fields has again somewhat reduced the ocean level. This matter is also discussed, with up-to-date data, by Professor Daly in his article noted above.

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LIGHT LOCALIZATION IN CTENOPHORES

ONLY living ctenophores or parts of them are photogenic. Peters (1905) states that "phosphorescence appears along the rows of paddle plates and no phosphorescence was obtained from jelly free from paddle plates." Although the luminescence of ctenophores seems to relate closely to the paddle plates, a question is still open as to whether or not any necessary connection exists between the paddle plates and the light production. Peters has already mentioned that the movement of the paddle plates is generally not accompanied by luminescence. It was shown in *Mnemiopsis leidyi,* a ctenophore found at Woods Hole, that *the smallest piece from which light was obtained must contain four consecutive paddle plates,* and that a piece with a lesser number of them could not produce light. Peters' experiments show evidently that the light production by ctenophores depends upon the minimal number of the paddle plates.

Ocyropsis fusca is a very active ctenophore found at Misaki, Japan, in the spring. This species is strongly compressed in the direction of the tentacular axis and possesses well-developed lappets, larger than one and a half times the height of the body. The meridional canals in the lappets are not accompanied with paddle plates. The meridional canals are provided with lateral branches carrying the gonads. The lateral branches of the subpharyngeal canals in the parts not covered by the paddle plates are much better developed than those situated aborally in the body proper and covered by the paddle plates. The former branches are very conspicuous on account of their milky white color. The luminescence of *Ocyropsis* is especially bright in the sub-pharyngeal meridional canals located in the lappets. The canals in the lappets, as just described, are not covered by the paddle plates. Several pieces of varying sizes were excised from the lappets and observed in a dark room. Luminescence came from all pieces containing any small amount of the lateral branches of the meridional canals, but not from those pieces of jelly which were so excised as to be entirely without branches. Such pieces of jelly were, however, alive, for when they were touched with a needle-end they showed muscular contraction.

From the foregoing description the light localization of ctenophores may be summarized as follows: *the luminescence is localized in the eight meridional canals and is strictly limited to the region where the sexual cells are found,* but the phenomenon has little relation to the paddle plates. The photogenic substance appears to be of fine granules which can be set free from the cells by crushing.

Not only the adult but also the embryo and even the egg of ctenophores produce light. The light emission of ctenophore eggs has been known as far back as 1862 (Allman), and the phenomenon has been described by several authors such as Agassiz, A. (1874), Chun (1880), Peters (1905) and Yatsu (1912). According to Peters "no phosphorescence can be obtained from the eggs of *Mnemiopsis* before segmentation," but Yatsu observed at Naples that the egg of *Beroë,* when stimulated with a weak electric current, emits "a beautifully greenish light." The luminescence is said to be produced by the ectoplasm alone and with the development of the egg this property is strictly confined to this layer.

A ctenophore egg consists of three layers, an extremely thin homogenous envelope, ectoplasm and endoplasm. The ectoplasm, in which the luminescence takes place, contains no visible morphological signs of light production. In this case no granules, which are characteristic of the photogenic cells, were found. Nevertheless light is emitted by the ctenophore egg. The formation of the photogenic material seems to be possible only in darkness, and upon a very slight stimulation the formed substance is broken down very quickly, the katabolic phase being accompanied by luminescence.

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