RECENT GEOLOGICAL DISCOVERIES IN THE NEIGHBOURHOOD OF PLYMOUTH.

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I PURPOSE in this paper simply to put upon record in a general way a few facts of interest in connection with the Geology of the neighbourhood of Plymouth, which have come under my notice within the past eighteen months, and which have been followed up to the present time.

My notes relate to two topics:—(1) The character of the rocks of the Eddystone reef, as revealed by the operations for the construction of a new lighthouse, and the proofs which I have been fortunate enough to discover of the wide extent of the formation to which they belong; and (2) the progress of research in connection with the ossiferous fissures of the limestone of Plymouth and its vicinity.

Recent operations at the Eddystone have shown how careful an observer the late Mr. Prideaux, the first systematic writer upon the geology of Plymouth, was. He describes the Eddystone reef in the following terms:—"Southward, no further distant than the Eddystone, we again find the granite . . . one rock, on which stands the lighthouse, and that one only, is of gneiss." Elsewhere he speaks of the "house-rock" as a "single rock, probably 200 feet square," and the three specimens from the Eddystone which he deposited in the museum of the Plymouth Institution,* consisted of an example of this house-rock gneiss—"2 ditto, passing into granite, 3 granite"—his note on the latter being, "The rocks nearest the gneiss contain the largest amount of felspar, and have the most laminar texture." †

* They are not there now.

† "Geology of the Country near Plymouth." *Plym. Inst. Trans.*, 1830, pp. 40 and 44.

The new lighthouse is being erected on a rock to the south of the "house-rock," and a considerable portion of this has been removed in levelling for the foundations of the new building. Although the area is small it has afforded examples in every stage of gradation, from what we may regard as the typical gneiss of the "house-rock" to pieces which in hand-specimens cannot be distinguished from the common red granitic veins of Dartmoor, the felspar and the quartz largely predominating. A thin vein of compact glassy quartz also traverses the rock immediately beneath the centre of the new tower. Probably none of the Eddystone rocks can be regarded as in the ordinary sense typical gneiss or typical granite, but they partake of the characteristics of both in a very curious and ofttimes puzzling way.

Mr. Prideaux was, I believe, the first who identified the gneissic character of the Eddystone rocks, as he was also the first to indicate their granitic features. He believed the gneiss of the Eddystone to be "the only gneiss in England";* and it has generally been regarded as at least the only instance of the occurrence of this rock in the West of England. Some twelve years since, however, an isolated fort was erected immediately within the Plymouth Breakwater, on the Shovel Rock, and in the course of the works portions of that rock were removed. Some of them were preserved, and a few months since passed into my possession, when I was astonished to find that they were as distinctly gneissic in character as the most gneissic of the Eddystone examples.

Prior to the erection of the Breakwater the Shovel Rocks were a formidable impediment to the navigation of the Sound, entirely closing against large ships a considerable part of the middle entrance; extending about 1,200 yards from east to west, and having an average breadth from north to south approaching 500—the depth of water at low tides ranging from under three fathoms to five. The fort is built towards their western extremity, where the water is the shallowest. These rocks thus form, it will be seen, no unimportant item in the submarine geology of Plymouth Sound, and the probability is that the whole of the reef is of gneissic character. No such rocks occur on either shore of the Sound, but the strata there are such as to lead to the conclusion that they ha e been subjected to great disturbance.

The "cont rtions and displacements" of the rocks on each side of the Sound, have indeed been noticed by every geologist who has written upon the district, from the time of

* *Op. cit.*, p. 44.

Mr. Prideaux's paper downward. Sir Henry de la Beche, writing on these beds, says that "they are much twisted, the contortions being probably due to the causes which produced the intrusion of a porphyritic rock that occurs in mass on the north of Cawsand." * Professor Phillips, describing the beds on the east of the Sound, by Staddon on to Bovisand, speaks of the contortions as "amazing." † The late Professor Jukes grounded upon the contortions and inversions which he observed in the same locality one of his strongest arguments for the inferiority of the Bovisand sandstone and associated rocks to the limestone. ‡

We can hardly, I think, now fail to recognise it as at least highly probable that these inversions and contortions are due to the upheaval of the rocks of the Shovel Reef. But whether we accept that speculation or not, the discovery of the true character of these rocks is an important element in our local geology. Until a few months since, the Eddystone offered the only direct and unquestioned evidence of the existence of a granitic Channel outlier. Last year, however, the occurrence of blocks of granite on the Salcombe fishing grounds, added considerably to the weight of "the hypothesis of a submarine granitoid formation" of considerable extent, off the southern coasts of Devon and Cornwall. § And the discovery of the gneissic character of the Shovel Rocks conclusively proves that the Eddystone Reef is no isolated phenomenon, but part of an extended granitoid formation, which occupies the entire area between Plymouth Breakwater and the Eddystone, a distance of 11 miles from N.N.E. to S.S.W., and in all probability skirts the coasts of Devon and Cornwall, and stretches into the Channel, for a much greater distance. The existence of a submarine granitic area, probably comparable in extent with Dartmoor and the other well-known granitic districts of this western peninsula is, therefore, no longer an hypothesis, but an established fact. The Shovel Rocks are about six miles to the north of the line of strike of the metamorphosed rocks of the Bolt Head district.

My remaining notes are but brief, and refer merely to the recent occurrence of ossiferous fissures in the neighbourhood of Plymouth, with which I hope to deal more at length on a future occasion. Last year, a cavern at Yealm Bridge, which was stated by old workmen to be a branch of that explored

* *Report Dev. Cor., and W. Somerset*, p. 65.
† *Palæozoic Fossils*, pp. 201-202.
‡ *Notes on Parts of S. Dev. and Cornwall*, pp. 18-22.
§ *Vide* papers by A. R. Hunt, F.G.S., and W. Pengelly, F.R.S., F.G.S. *Trans. Dev. Association*, vol. xi., pp. 311-342.

by Mr. Bellamy, yielded a small quantity of bones, including remains of the hyæna and bear. Of the latter there was a fine ramus of the lower jaw (left) with the canine and three molars. Teeth which by the description were horse were also found. The fissure was near the top of the quarry; and the bones were discovered next the rock on one side in clay.

Other fissures, in the Plymouth limestone, have yielded during the past twelve months, but in small quantity, bones and teeth of rhinoceros (tichorinus), bear, hyæna, wolf, aurochs, ox (primigenius and longifrons), horse (fossil), ass, sheep, hare, red-deer, reindeer, pig, fox, and a small rodent, &c. Of these the reindeer has never been recorded in the Plymouth district before; and is now for the first time definitely added to its cave fauna. Most of the bones were found in clay; some in apparently surface earth; a few were encrusted in stalagmite. Associated with them were a few flakes and chippings of flint—patinated—some unmistakeably worked, and worn by use.