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VI.—The Age of the Earth and the Sodium of the Sea.[1]

By Arthur R. Hunt, M.A., F.G.S.

PROFESSOR J. JOLY, in his interesting paper estimating the geological age of the earth from the amount of sodium contained in the sea,[1] mentions in an appendix seven possible errors which may render his estimate a minimum, and seven others which may render it a maximum. Neither among the former errors

[1] Trans. Roy. Dublin Soc., vol. vii (1899), p. 23.

guarded against in the appendix, nor in the body of the paper, does there appear any reference to the possibility of sea-water being absorbed by the surface rocks of the globe, either by capillary attraction, as maintained by Daubrée, or by means of fissures, as contended by De la Beche.

The possibility—nay, the probability—of sea-water obtaining access to the deep-seated and heated regions of the globe was admitted by Lyell, De la Beche, and Daubrée, and by other eminent geologists; and although to a large extent neglected at the present time, the arguments in favour of the hypothesis seem worth considering.

My own attention was attracted to the subject as follows:—From 1879 to 1889 inclusive, I wrote seven papers on the detached blocks which lie strewn on the bottom of the English Channel. The primary object of the enquiry was to ascertain whether the blocks represented a prolongation of the Dartmoor granite, as commonly supposed, and whether they were in any way related to the metamorphic rocks of the neighbouring headlands of the Start, the Prawle, and the Bolt.

I commenced the investigation in the full expectation that the connection with Dartmoor would be proved at once.

I secured thirty-four crystalline rocks from the Channel, and a large collection from Dartmoor. Not a single speck of tourmaline or crystal of chloride of sodium did I detect in the twenty granites and gneisses from the Channel; while not a single slice from Dartmoor failed to indicate chlorides, and very few of the Dartmoor rocks from which they were cut (if any) were without tourmaline. The fluid inclusions in the Channel rocks were of a different type from those in the Dartmoor rocks. The two series of rocks seemed absolutely distinct.

This most unexpected result greatly excited my curiosity, and I sought to find some explanation. Finally, in 1889, I hazarded the suggestion that sea-water had gained access to the Dartmoor granite in Carboniferous times; and in 1892, after an examination of the South Devon schists, I, for entirely different reasons, threw out the suggestion that they also had been influenced by the presence of sea-water during their metamorphosis.

These suggestions were not only almost universally rejected by geologists, but they caused considerable umbrage, so I discontinued the enquiry, and put away my microscope.

However, before bringing my own work to a conclusion, I examined the older authorities, and found that both Lyell and De la Beche maintained the hypothesis that sea-water reached the heated rocks, and that subsequently the late Mr. J. A. Phillips and M. Daubrée were of the same opinion; and, strange to say, they all had different reasons for their belief. My own conclusions were also based on entirely independent evidence; and, indeed, so far as appears from the records, all the observers thought out the problem independently from different points of view. Lyell relied on the steam emitted by volcanoes, De la Beche appealed to his mineral

veins, Phillips pointed to hot salt-springs transforming the rocks at considerable though accessible depths, Daubrée relied on experiment, while I have been impressed by the characteristics of the vein rocks of Dartmoor with their abundant sodium (as chloride and silicate), and with the chlorite, amphibole, and albite of the green schists.

The conclusions of De la Beche seem the most noteworthy, seeing that he was necessarily ignorant of the fact that the vein rocks of Devon and Cornwall are charged with salt and brine. In 1839 that acute observer wrote—"There is, therefore, nothing unreasonable in supposing that a large proportion of the Cornish and Devon fissures, now wholly or in part filled up, were opened either beneath the sea or in such situations that portions of them were so placed that it entered freely into them" (Report on Geology of Cornwall and Devon, p. 378). Subsequently De la Beche cites an instance of water filtrating through hard basalt, filling its internal cavities with liquid, and setting up crystallization of 'mesotype' (loc. cit., p. 392). In 1851 De la Beche touches on the chemical combinations of the chlorides in the fissures (Geol. Observer, p. 770).

In January, 1873, the late Mr. J. A. Phillips read a most interesting paper to the Royal Society, which was subsequently communicated to the *Philosophical Magazine*. In it the author discusses the composition and origin of the waters of a salt-spring at Huel Seton mine, with a chemical and microscopical examination of certain rocks in its vicinity. The water is shown to be derived from the sea, and to enter into chemical combination with the minerals of the rocks through which it passes, producing brown hornblende, pale-green actinolite, and chlorite. Another salt-spring, in the now abandoned Huel Clifford mine, was 1,320 feet below the sea, and issued at a temperature of 125° F. As Mr. Phillips does not refer to De la Beche, he seems to have overlooked De la Beche's views, just as I unfortunately overlooked at first both De la Beche and Phillips. The result, however, is that all three identical conclusions were arrived at independently, and all on different grounds. Had De la Beche lived to learn that the quartz in his fissures actually contained brine and crystals of salt, and that the felspar of his veins, instead of being the orthoclase of the main mass, was triclinic, and more or less a soda-felspar, he would have realized with what unerring sagacity he had hit his mark.

In 1880 Daubrée published his invaluable "Géologie Expérimentale," of which work the third chapter is headed—"Expériences sur la possibilité d'une enfiltration capillaire au travers des matières poreuses."

Daubrée shows experimentally that bottom heat greatly accelerates the passage of water through rocks in the face of a strong counter-pressure of steam. He incidentally admits that such water may be salt water, and that it would be capable of producing great mechanical and chemical effects. But this is incidental; his object is to explain the origin of volcanic steam, not to follow up the new combinations of the sodium which the steam leaves behind in the bowels of the earth.

Lord Kelvin [1] and Professor Joly agree in assuming that because melted basalt is lighter than consolidated basalt the chilled surface of a lava ocean would sink: Lord Kelvin further assumes that all minerals crystallizing out of a melted basalt would also sink: I would, however, venture to submit that the gases imprisoned in the chilled surface layers would buoy them up, and that a good many minerals, lighter than the magma, on rising to the surface would form a scum or slag which, by blanketing the glowing lava, would thereby check radiation. I have no especial interest in the controversy as to the age of the Earth, and go no further than to suggest that these points should be allowed their due weight in the argument.

The application of the above sea-water hypothesis to the cases of Dartmoor and the schists is a somewhat intricate question, and not worth discussing so long as the main principle is rejected.

VII.—Notes on Literature bearing upon the Geology of the Malay Peninsula; with an account of a Neolithic Implement from that country.

By R. Bullen Newton, F.G.S., of the British Museum (Natural History).

In view of the interest lately shown by geologists and others engaged in the Malay Peninsula through Mr. H. F. Bellamy's discovery of Triassic Lamellibranchs in that area, a brief account of the principal works on the geology of that portion of South-Eastern Asia may prove of service. More particular reference will be made to the sedimentary rocks, purely mineral papers being excluded from consideration.

One of the earliest records on this subject is by William Jack,[2] who in 1822 observed a red sandstone at Singapore which he regarded as "the chief secondary rock" of the district. He further mentioned that the Island of Penang was entirely of granitic structure. Somewhat later the following remarks were made by J. Crawford:[3] "At Singapore a secondary formation is discoverable, and varieties of sandstone and shale form the principal rocks, together with conglomerate, argillaceous sandstone and gray limestone."

In 1847 Colonel James Low,[4] speaking of the same rock at Singapore, stated that "the sandstone lies immediately under the Oolitic beds, and would be therefore New Red Sandstone." The discovery of a bituminous coal on the southern coasts of the Island of Junk-Ceylon off the Malay Peninsula was reported by J. R. Logan [5]

[1] Trans. Victoria Inst., vol. xxxi, p. 24.

[2] W. Jack, "Notice respecting the Rocks of the Islands of Penang and Singapore": Trans. Geol. Soc. London, ser. II, vol. i, pt. 1 (1822), p. 165.

[3] J. Crawford, "Geological Observations made on a Voyage from Bengal to Siam and Cochin China": Trans. Geol. Soc. London, ser. II, vol. i, pt. 2 (1824), p. 406.

[4] Col. Jas. Low, "Notes on the Geological Features of Singapore": Journ. Indian Archipelago, vol. i (1847), p. 83.

[5] J. R. Logan, "Notice of the Discovery of Coal on one of the Islands on the Coast of the Malay Peninsula": Quart. Journ. Geol. Soc., vol. iv (1848), pp. 1, 2. "On the Local and Relative Geology of Singapore, etc.": Journ. Asiatic Soc. Bengal, vol. xvi (1847), pp. 519–557, 667–684. "Sketch of the Physical