

memory to bear testimony to the soundness of his judgment.

EDWARD HULL

Geological Survey Office, Dublin, September 27

ROBERT HARKNESS, F.R.S.

ANOTHER of the captains in the phalanx of British geologists has dropped from the ranks. Robert Harkness died suddenly in Dublin on Saturday last. He had been ailing for some time, and the disease from which he suffered—an affection of the heart—had gained ground so much this year that he lately felt himself compelled to resign the chair of geology at Cork. It was the expectation of his friends that, released from duties which he had so long conscientiously performed, he might yet enjoy some years of comparative health in the quiet retirement of his Cumberland home, to which he used to return with such pleasure every summer. But this was not to be. He has fallen just as he had himself brought the public labours of his life to a close.

It is now some five-and-thirty years since the name of this able geologist first appeared as a writer on his favourite science. During this long period he had explored, on foot, the geology of large districts in the north of England, in Scotland, and in various parts of Ireland. The reports of the British Association and the *Quarterly Journal* of the Geological Society bear witness to his industry and to the painstaking minuteness of his method of investigation. To him we owe our earliest exact information regarding the correlatives of the reptiliferous sandstones of Dumfriesshire and Cumberland. It was his patient labours continued year after year over ground most difficult to unravel, that led the way to the working out of the structure of the silurian uplands of the south of Scotland. To his research, too, is due the identification of the metamorphic rocks of the north-west of Ireland with those of the west of Scotland. To the elucidation of every one of the palæozoic systems of deposits he contributed something of value.

But important as was his scientific work, it had not a wider and more hearty recognition among his brother geologists than his own admirable qualities of head and heart. Who that has been privileged with his friendship will not cherish the memory of his earnestness over even the driest of details, his quiet enthusiasm, his generous admiration for the work of others, his unflinching cheerfulness? Who will forget that beaming ruddy face, never absent from the platform of Section C at the British Association meetings, always ready to rise among the speakers there and to reappear at the festive gatherings in the evening? There have been men who have graven their names more deeply on the registers of scientific thought and progress, but there have been few whose sunny nature has more endeared them in the recollection of their friends than Robert Harkness.

A. G.

MANGANESE NODULES IN LOCH FYNE

ON September 21, this year, I anchored the steam yacht *Mallard* near the mouth of Loch Fyne, in 104 fathoms, for the purpose of making physical and chemical observations on the water of this, the deepest part of the Firth of Clyde. When the anchor was got up a large mass of clay and shells was found sticking to one of the flukes. It was gently dried, and on examining it I observed a number of nodular concretions, which, on being freed from the surrounding clay, presented a finely mammillated black surface, were easily cut with a knife, giving a brownish-black powder, which liberated chlorine from strong hydrochloric acid, and possessed all the properties of peroxide of manganese; in short, they were identical with the manganese nodules which we found in the *Challenger* to form so important a constituent of the sea-bottom in the greatest depths.

One half of the dried mud was carefully broken up and searched through, the nodules being collected by themselves and also the shells. It was thus separated into three portions, which were weighed, with the following results:—

Manganese nodules ...	142·7 grammes.	...	30	per cent.
Shells ...	35·0	"	7·5	"
Sandy clay ...	289·0	"	62·5	"
Total ...	466·7		100·0	

The manganese nodules, therefore, made up thirty per cent. of the weight of the mud. Compared with those frequently met with on board the *Challenger*, the nodules were small. In the sample examined there were eighty-three nodules weighing 142·7 grammes, hence the average weight was 1·7 grammes. Their volume was found to be 58 c.c., so that the average volume was 0·7 c.c., and the specific gravity 2·46. Their form was roughly spherical, the largest, which was somewhat elongated, measured 13 × 9 × 6 millimetres, the average diameter of them all being 11·4 millimetres.

Of the eighty-three nodules so obtained I have split twenty-two. When subjected to this treatment they are found to differ in constitution from the majority of those obtained on board the *Challenger*. Although they had not been exposed to any heat they were hard and sandy to the knife, and when treated with strong hydrochloric acid, they left a large amount of mineral (chiefly quartz) sand. This difference, however, is explained by the different kind of bottom from which they were obtained. In dissolving up nodules which had come from "red clay" in 2,500 or 3,000 fathoms I always found the same mineral sand left as on treating the clay in the same way. But the amount of sand was always quite insignificant, as compared with the clay; hence the nodules were easily cut with the knife. They, however, got harder on keeping. In Loch Fyne the bulk of the mud consists of quartz sand, giving the nodules the appearance of sandstone, whose binding material is made up to a great extent of peroxide of manganese, and hence the gritty feeling to the edge of the knife.

Where a hard nucleus has been found it has always been a piece of rock from the neighbouring shore, but in most instances (in sixteen out of twenty-two examined) the ordinary arrangement has been reversed, the nodule consisting of a soft rich nucleus of peroxide of manganese, surrounded by a black sandy rind, the whole enveloped in the characteristically mammillated black skin.

I hope very shortly to be able to report more fully on them; in the meantime, I have only been able to verify their nature by finding abundance of a higher oxide of manganese, easily recognisable quantities of cobalt, and the presence of water, which, on being expelled by heat, has an alkaline reaction and an empyreumatic odour, properties in which they agree with those which I had occasion to test on board the *Challenger*.

Their position in the mud, with dead shells above, below, and on all sides of them, will, when carefully studied, no doubt throw much light on their age and method of formation. I have observed two nodules firmly attached to the interior of shells, one having evidently been directed in its growth by the shape of the shell.

In endeavouring to procure a further supply I dropped anchor in about the same depth, but about a hundred yards further down the loch, and I obtained about the same amount of mud, but it contained very much more shell and no nodules. Also in Kilbrennan Sound, between Arran and Cantyre, in a depth of eighty-five fathoms, there was much shell and pebble, but no nodules. So far, therefore, this occurrence appears to be very local.

J. Y. BUCHANAN