

of the International Exhibition of London, and a similar one at the Exposition Universelle of Paris in 1867. In the latter year, also, he was presented with the silver medal of the Natural History Society of Montreal as a mark of its appreciation of his "long-continued and successful labours in Canadian Science."

As a diversion from his almost unremitting palæontological researches, Mr. Billings, at different periods of his life, occupied himself with the study of mineralogy and entomology. Among insects, his favourite group was the Coleoptera, and he made quite an extensive collection of Canadian beetles, which a few years since he deposited in the Museum of the Natural History Society of Montreal.

Like many other original thinkers, Mr. Billings was entirely self-taught, so far as science was concerned, and those who were best qualified to form an opinion on both points knew not which to admire most, the untiring industry of the man, or the conscientious thoroughness of his work. To show that he spared no pains to increase his knowledge of the science which he made peculiarly his own, it may be mentioned that he learned to translate with ease, palæontological essays, written not only in the French and German, but also in the Norwegian, Swedish, and Danish languages.

J. F. WHITEAVES.

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DAVID FORBES, F.R.S., SEC. G.S., F.C.S., ETC.

BORN 6 SEPT. 1828. DIED 5 DEC. 1876. AGED 48 YEARS.

For many years past the names of its oldest and most eminent members have one by one been removed from the list of the Geological Society, and we have looked around, almost in despair, for men to fill the front benches, once distinguished by the presence of a Murchison, a Lyell, a Scrope, a Sedgwick, or a Phillips. Now, alas! we have to record with sorrow the loss of one of those younger members from whom we had fondly looked for some ten years at least of active scientific work.

The name of Forbes had already become well-known and honoured in association with the Geological and other learned Societies by the scientific labours of the late Prof. Edward Forbes, brother of the subject of our present memoir; and when David Forbes returned to England after nearly twenty years of his life had been spent abroad in Norway and South America, he was cordially welcomed as a fellow-worker by his brother Geologists and speedily took an honoured place among them.

Born in the Isle of Man in 1828, he was partly educated there and subsequently at Brentwood in Essex. His school-days over, he was removed to the University of Edinburgh, where, in Dr. Wilson's laboratory, he laid the foundation for those chemical and physical studies which so distinguished his later years.

An early opportunity was afforded him of turning this chemical and scientific training to good account, and before he was 20 he ac-

accompanied Mr. Brooke Evans to explore the mineral resources and afterwards to superintend extensive mining and metallurgical works at Espedal in Norway, a post which he held for about 12 years. During this period he travelled much, and lost no opportunity of increasing his store of scientific knowledge, as his writings testify. David Forbes was a man of resolute and determined courage, and when in Norway, in 1848, and a revolutionary movement threatened the country, he armed 400 of his men to aid the Government. For this service the King sent for Forbes, and thanked him personally, and ever afterwards remained his friend.

During this time he became a partner in the well-known firm of Evans and Askin, Nickel-smelters, Birmingham, and it was in connexion with them that he visited Chile, Peru and Bolivia, in search of Nickel and Cobalt. His investigations into the mineral resources of these countries extended over six years. During the years 1857–60, he made a special geological exploration of certain districts in South America, the result of which, entitled "On the Geology of Bolivia and Southern Peru," was communicated to the Geological Society in 1860.

The paper is full of interesting details, and although many points may appear to have been neglected, this is not the result of oversight, but, as the author truly observes, is "due to the great difficulties and frequently severe privations encountered in exploring a country in many parts entirely uninhabited, or to a great extent in a savage condition, and, further, by having been limited both as to time and pecuniary resources, and hampered by other occupations and by the political state of the country."

A second communication was to have embodied the Geology and Mineralogy of the neighbouring Republic of Chile and the Argentine Provinces, which would have strengthened his previous conclusions, especially as several of the geological formations not well developed or studied in the districts described in his first paper, were seen by Forbes much better and more characteristically exhibited further south. From South America he made an expedition to the South Sea Islands, and spent some time in studying their volcanic formations and minerals.

During four years he traversed Chile in all directions from considerably south of Santiago northwards, up to the frontiers of Bolivia in the Desert of Atacama.

He inspected all the principal and some of the lesser mining districts along the range of the Cordilleras; from these he collected a valuable and extensive series of minerals, including about 190 species, of which he published a list (much more copious than that given in the second edition of Domeyko's Mineralogy), together with a classification, according to the mode of their geological occurrence, in his paper "On the Mineralogy of Chile" (see *Phil. Mag.*, 1865).

It was with the same view that during his long residence in Norway Forbes studied the Mineralogy of the several districts in that country, viz. with especial reference to the circumstances under which each mineral occurred and the causes which led to its ap-

pearance. (See the *Edinb. Phil. Journ.*, 1856–57, and *Quart. Journ. Geol. Soc. Lond.*, 1855.)

His cabinets are replete with abundant and carefully selected rocks and minerals, all intended to illustrate the association, paragenesis and mode of occurrence of minerals in connexion with the origin and formation of the rock-masses or mineral veins in which they are found imbedded.

On his return from Bolivia in 1860, he was requested, previous to his departure, by a Committee representing the chief commercial and mining interests of that country, to address a letter to Lord John Russell urging the re-appointment of a representative of the British Government to protect British interests. This letter was accompanied by a memorandum on the resources of the Republic. Although the official appointment was not then deemed necessary, it must have been some satisfaction to Mr. David Forbes to know that a number of influential persons connected with mining enterprises requested Sir Roderick Murchison to use his influence to secure the appointment of Mr. David Forbes to the vacant post in that country.

Igneous and Metamorphic phenomena and the resulting changes in rock-formations were among David Forbes's especial and favourite studies, and he lost no opportunity, during his extensive travels in Europe and Africa, but especially in Mexico and South America, of observing the effects of modern volcanic action, and their relation to similar phenomena in past time.

Having ample opportunities in Norway, in connexion with metallurgical operations, he was enabled to submit various rocks to very high temperatures and pressures for longer or shorter periods, and thus imitate metamorphic action in the production of various forms of rock-structures. The results of these experiments were partly embodied in his paper to the Geological Society in 1855, "On the Causes producing Foliation in Rocks." Bearing also on this subject are his papers "On the Chemical Composition of some Minerals from the South of Norway" (*Brit. Assoc. Rep.*, 1854, *Edinb. New Phil. Journ.*, 1855–57), "On the Igneous Rocks of Staffordshire" (*GEOL. MAG.* Vol. III. p. 23) and "On the Contraction of Igneous Rocks in Cooling" (*GEOL. MAG.* Vol. VII. p. 1).

Mr. Forbes was a Fellow of the Royal, the Chemical, and the Geological Societies. Of the latter he had been the active Honorary Secretary for some years past. As Foreign Secretary of the Iron and Steel Institute, he has prepared for six years (1871–76) careful and elaborate details of the progress of the iron and steel industries in foreign countries, in which his knowledge of languages materially assisted him. Nor did geological science and mineralogy alone interest him, for as a member of the Ethnological Society he contributed an interesting and elaborate paper "On the Aymara Indians of Bolivia and Peru."

Upwards of fifty papers have been communicated by Mr. David Forbes to the Scientific Societies and Journals, besides a long series of articles in the "Chemical News," the Transactions of the "Iron and Steel Institute." Sixteen of Mr. Forbes's articles and letters

have appeared in the GEOLOGICAL MAGAZINE from 1866—1872. They all indicate the tendency of his mind to study the bearings of chemistry on igneous and cosmical phenomena. Forbes felt that whilst in other departments of Geology, Great Britain was foremost, she was far behind in the study of Chemical Geology, and he hoped that others might be induced to devote themselves to this most interesting and prolific branch of scientific inquiry. His views were expressed in his paper on "Chemical Geology" (*Chemical News*, 1867 and 1868; *Popular Science Review*, 1868; *GEOL. MAG.*, 1868, Vol. V. p. 366, and in his Lecture to the Chemical Society, 1868), and also in his paper on the "Chemistry of the Primeval Earth," (*GEOL. MAG.*, 1867, Vol. IV. p. 433; and 1868, Vol. V., p. 105), in which he criticized certain opinions of Dr. Sterry Hunt published in his lecture at the Royal Institution (1867) on the same subject (*GEOL. MAG.*, 1867, Vol. IV. p. 357).

His most important papers are *already quoted* in the body of this memoir, to which may be added the following:—

- "On the Relation of the Silurian and Metamorphic Rocks of the South of Norway." *Edinb. New Phil. Journ.* 1856, iii. p. 79.
- "On the Causes producing Foliation in Rocks." *Quart. Journ. Geol. Soc.* 1855, xl. p. 166.
- "On the So-called Primitive Formation of the South Coast of Norway." *Quart. Journ. Geol. Soc.*, 1858, xiv.
- "On the Geology of South America." *Quart. Journ. Geol. Soc.* 1860.
- "On the application of the Blowpipe to the Quantitative Determination of certain Minerals"—a series of papers in the "*Chemical News*."
- "Researches in British Mineralogy." *Phil. Mag.*, 1867 and 1868.

Mr. Forbes devoted himself almost entirely to his professional and literary pursuits, and took but little physical exercise, and it is to be feared that his too sedentary habits, together with the sad domestic loss he had recently suffered, depressed his spirits and broke up a constitution already to some extent enfeebled by recurrent fever caught in South America, and so accelerated his end.

His loss is keenly felt by those friends who really knew his genial and social character; whilst his scientific associates, who had hoped for the further prosecution and publication of his researches and observations on rocks and minerals will all regret his vacant place in their midst.

Removed from us at so early a period in his career, when his future promised a devotion to his favourite studies and the arrangement of the scientific notes he had so earnestly collected, some of which it is hoped may still be rendered available, although we fear, with regard to a large proportion, the mind of the master whose hand penned them could alone render them useful for scientific purposes. Endowed with great mental activity, although partly impaired of late by the state of his health, he seems to have acted on the motto of the great Swedish naturalist—

"NULLA DIES SINE LINEA."

J. M.