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ORIGINAL ARTICLES.

I.—ON THE GEOLOGICAL EPOCHS AT WHICH GOLD HAS MADE ITS
APPEARANCE IN THE CRUST OF THE EARTH.

By DAVID FORBES, F.R.S., F.G.S., etc.

IN the GEOLOGICAL MAGAZINE, 1865, Vol. II., p. 308, reference is made to the recent discoveries of Whitney as to the occurrence of Gold in the rocks of California even of an age as recent as Cretaceous. These discoveries fully confirm my previous results in South America,¹ yet the examination of a series of specimens recently sent me from California makes me communicate these few observations upon the relations of the gold-bearing rocks in question and some remarks on the views which I have expressed² with reference to the geological periods at which gold has made its appearance in the crust of our globe.

When Mr. Whitney speaks of auriferous Triassic and Jurassic strata, the impression left upon the mind of the reader seems to me to be, that the strata pertaining to these formations contain sedimentary beds having gold disseminated in them.

Not having been able to obtain as yet the original reports of Mr. Whitney, I cannot judge conclusively whether this is his exact meaning or not; but the examination of the rocks and other specimens sent me from California makes me believe that such impression is decidedly not the reality of the case, but that the mineral deposits of California are precisely identical with those which I have met with in Chile, Peru, and Bolivia, and in part described.

In South America I do not state that the Upper Oolitic strata, etc., are auriferous; but I report that the presence of gold in such strata is due to the eruption of Dioritic rocks of still younger age, which carry up the gold into the neighbouring rock in the form of veins, or metallic impregnation, extending a greater or less distance into the sedimentary strata, which are more or less altered by contact with the eruptive rock. Where we have no Diorite in the neigh-

¹ Geol. Soc., Nov., 1860. Quart. Journ. Geol. Soc., vol. xvii.

² *Vide* abstract, GEOLOGICAL MAGAZINE, January, 1866, p. 23.

bourhood, or have no reason to suppose the existence of Dioritic rocks which may not come quite to the surface, there we find no gold.

The specimens from California which I have alluded to, fully confirm these views—and specimens of Diorite are mineralogically and chemically the same as those of similar age from Chile, Peru, and Bolivia—whilst the microscopical examination of their sections gives strikingly identical results.

With regard to the time of introduction of gold, or rather auriferous eruptive rocks, into the crust of the earth, a continued study of the subject, and the collection of more data from other parts of the world, not only confirms me in the views expressed in a communication to the British Association, in 1865 (a short abstract of which is given in the *GEOLOGICAL MAGAZINE*, for January, 1866, p. 23) but makes me further believe the views therein expounded to be of universal application, and—

§ bearing in mind that any bed of sedimentary origin may contain fragmentary débris of any auriferous eruptive rock or vein substance which was of previous geological age—

I am of the opinion that gold is not in itself characteristic of any sedimentary stratum or formation, and when found in such beds, introduced otherwise than stated in the proviso §, that its presence there is due to subsequent intrusive causes.

My researches have led me to conclude that, universally, gold has been introduced into the crust of the earth at two¹ very distinct geological epochs, and that in both these cases it has been carried up in direct consequence of, and in conjunction with, the outbursts of distinct and characteristic plutonic rocks.

These two epochs of auriferous impregnation I designate respectively as—1. The older or auriferous granite outburst. 2. The younger or auriferous diorite outburst.

(1). The older, or auriferous, granite intrusion appears to have occurred at some time between the Silurian and Carboniferous period; certainly not older than the Upper Silurian, or younger than the Carboniferous strata; probably not younger than the deposition of the first members of the latter formation.

Gold formations, belonging to this period, present themselves in Australia,* Bohemia, Bolivia,* Brazil, Buenos Ayres, Chile,* Cornwall, Ecuador, Hungary, Mexico,* New Granada, Norway, Peru,* Sweden, Ural,* Wicklow.

To this period and cause I also attribute most of such deposits of gold as are found intruded as quartz nodules and veins in many places, as if interstratified in the Cambrian and Silurian (and probably also Laurentian and Devonian) systems, which I believe to

¹ Although subsequent researches may render it necessary to modify these conclusions, at present I am not inclined to admit that gold has appeared at other than these two epochs.

* These so marked, as well, I believe, as California and many others, have gold deposits of both ages.

have arisen and been rendered auriferous solely from their proximity to invisible or now superficial granites.¹

(2). The newer, or Dioritic, outburst I have called Post-oolitic as the veins containing gold, and which proceed from its centres, cut through strata containing fossils of decided Post-oolitic forms, and possibly may be as late as early Cretaceous. These strata are frequently much altered and metamorphosed by the contact of the igneous Diorite, and, at such points, often become auriferous, or are cut by auriferous veins proceeding from the Diorite head mass. Although the results of an extended examination of these deposits in Chile, Bolivia, and Peru, occupying me from 1857 to 1863, are extremely interesting, I have only had time to publish comparatively few of the observations made. Since my return to Europe, however, I have been able to collect sufficient data to show me that this occurrence of gold is not at all confined to South America, as I had at first imagined, but appears also to be common to all the other quarters of the world. I have seen auriferous Diorites from Italy, and some auriferous rocks of this class are known to occur in the Ural; and, as before-mentioned, I have specimens from California, and I some time back received very similar specimens, through Lieutenant Aytoun, from the gold districts of India; and, lastly, within a few days, I have had the opportunity of examining a fine series sent over to the Jermyn Street Museum by Mr. Aveline, the head of the Geological Survey in Victoria, which are all strikingly similar to those examined by myself in various parts of South America.

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II.—RESULTS OF OBSERVATIONS ON THE CLIFFS, GORGES, AND VALLEYS OF WALES.

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[PLATE XV.]

THIS article will be devoted to the consideration of the indications of marine and fluviatile denudation furnished by the cliffs, gorges, valleys, and other phenomena, of some parts of Central and North Wales. With the view of collecting facts, the author, during April and May of the present year, resided successively at Bwlth, Rhayader, Aberystwyth, Dolgelley, Newtown, and Llangollen, so as to have opportunities for repeated observations; and the following notes refer chiefly to the neighbourhood of these towns and the intervening districts.

Abereddw Cliffs.—On entering the narrow part of the valley of the Wye beyond Three Cocks Junction, I began to be struck with the dim outlines of terraces at a considerable elevation above the river, until the romantic tiers of cliffs near Abereddw suddenly came into sight. They are the culminating point of what, in their absence,

¹ See Forbes on Peru and Bolivia, *Quart. Journ. Geol. Soc.*, vol. xvii.