The Globigerina Limestone might be an indurated chalk of Barbadian type, but it can also be compared with the Globigerina marls recently described by Mr. Lechmere Guppy,[1] and its association with a rock containing shallow-water forms, such as *Amphistegina* and *Nummulites* is a fact which specially recalls the San Fernando section, where a certain band of limestone is said to consist chiefly of *Amphistegina* and *Nummulites*, *Rotularia clymenioides* and Nullipores.[2]

The San Fernando beds are considered to be of Eocene age by Mr. Guppy, and if Eocene is used in its older Lyellian sense as including all that is older than Miocene, he may be right; but the classification of the Tertiary deposits of the West Indies is at present in a very unsatisfactory state. It is at any rate interesting to find in this small patch of limestone on Canouan what seems to be evidence of the northerly extension of the sea in which the Foraminiferal deposits of Trinidad were accumulated.

IX.—Note on the Tuscan Archipelago.

By C. S. Du Riche Preller, M.A., Ph.D., M.I.E.E., A.M.I.C.E., F.C.S., F.G.S.

In the course of a recent prolonged residence in Tuscany and the Carrara Marble District, I had occasion to become well-acquainted with the Maremma hills and the islands composing the Tuscan Archipelago; and as I propose to revisit those islands at an early date with a view to more closely examine certain phenomena relating to the eruptive and metamorphic series more especially of Elba, it may not be out of place if, in the meantime, I give a rapid preliminary sketch of the leading geological and petrological features of that archipelago as a whole.

As is well-known, the exceedingly interesting but also extremely complex phenomena which are met with more especially in Elba have, apart from the mineral wealth of that island, for many years attracted the attention not only of Italian, but also of other geologists such as Vom Rath, Rayer, Dalmer, Nessig, and others. In not a few cases, however, the more or less cursory inspection on the spot by some, and the one-sided microscopical examination of a few isolated and hence not representative specimens by others, have led to a variety of conflicting and not infrequently erroneous views. The recent survey of the island, made on behalf of the Italian Government by Signor Lotti and his coadjutors, is therefore the more welcome, as at any rate a modern and adequate geological map of that classic locality is now available as a basis and starting-point for further research.

It need hardly be pointed out that the Tuscan Archipelago not only constitutes the connecting link between the mainland of the Italian peninsula and Corsica and Sardinia, but also forms part of the chain of islands which fringe the whole length of the peninsula as far as Sicily, and whose eruptive phenomena in more ancient as well as in

[1] Quart. Journ. Geol. Soc. vol. xlviii. p. 519.
[2] *Op. cit.* p. 523.

recent geological epochs have been both the cause and the effect of great changes no less on the mainland of the peninsula than in the Mediterranean itself.

The islands composing the Tuscan Archipelago, and situated, roughly speaking, at about thirty miles from each other, are Gorgona, Capraja, Elba, Pianosa, Montecristo, Giglio, and the promontory, practically also an island, of Argentario.

The most ancient rocks of the Tuscan Archipelago are the pre-Silurian schists and serpentines of Gorgona, Giglio, Argentario and the eastern part of Elba, bearing analogy not only with the same series of Sardinia and the north-eastern part of Corsica, but also generally with the Archean and Cambrian series of the Alps. In the eastern part of Elba, these schists and serpentines underlie the Upper Silurian fossiliferous schists, and although Dieulefait refers the Corsican serpentines to Trias, or at all events declines to accord them a greater age than Permian, their analogy with the Elban rocks stamps them as undoubtedly pre-Silurian.

The rocks overlying the Upper Silurian strata in the islands of Giglio, Argentario, and also in the Maremma hills, have been referred to Permian from their analogy with the schists of Monte Pisano, the highest peak of the Carrara mountains where Permian fossils have been found.

Of the secondary formation, Trias is conspicuous by its absence in the whole of the Archipelago, and Infralias, which is also represented in the Maremma hills and in Corsica, rests directly not only

on the Permian, but also on the Silurian and pre-Silurian rocks. The Lias series is represented in Elba but not in the other islands, and gives evidence of another remarkable break, inasmuch as it overlies directly the Permian and even the pre-Silurian strata. The Upper Lias comprises the metamorphic rocks, felsitic schists, and compact and crystalline limestone with garnet and Wollastonite, which are met with on the summit of Monte Cappane, the highest point of Elba, where they overlie the granite. Upon the Upper Lias strata follow immediately the Eocene rocks, thus marking another characteristic gap which is also conspicuous in Corsica as well as in the Maremma hills. Indeed in Elba, the Eocene strata rest not only on the Lias, but also direct on the pre-Silurian formation. They comprise in upward series, nummulitic schists, red, green, and grey limestone, followed again by nummulitic limestone, limestone, schists and sandstone, with numerous and extensive dykes of serpentine, gabbro, and diabase. The Eocene serpentine frequently appears in close proximity to the ancient serpentine, from which it is easily distinguished alike by its different texture and location. It is a characteristic feature that the Eocene serpentine, gabbro, and diabase of undoubtedly igneous origin always occur together in the same superposition. The Upper Eocene strata are traversed by great viens of porphyritic granite, and the fact of these strata having been proved to be nummulitic and hence Eocene proves the further important fact that the intrusive Elban granite, which has been so fruitful a source of controversy, is neither trachyte, nor liparite, nor felsitic porphyry as it has been called by some petrologists, but is a true tourmaline-bearing porphyritic granite of Tertiary age. Moreover, the same intrusive granite occurs under analogous conditions in the islands of Montecristo and Giglio, as well as on the mainland in the Maremma hills.

Of the metalliferous deposits of Elba, some are found in the pre-Silurian, others between the Permian and the Liassic, others again between the Permian and Infralias strata, while the workable deposits of oxide of iron and the limestone and siliceous rocks with which they are associated, are younger than the Eocene sedimentary and intrusive rocks already referred to. The Miocene and Pliocene strata are absent in the Archipelago with the exception of Pianosa, where they bear close resemblance to the Corsican rocks of the same age. The post-Tertiary formation is represented in Elba, Giglio, and Pianosa by a coarse calcareous sandstone and a conglomerate with marine-shells, which in part edge the coast and in places reach a depth of over 600 feet above sea level. The andesites of Capraja probably erupted during the same period.

It is thus seen (1) that the islands of the Tuscan Archipelago are, geologically and petrologically, closely connected, not only with each other, but with the Maremma hills on the one hand, and with Corsica and Sardinia, as well as with the Ligurian Alps on the other; (2) that, therefore, they probably constitute part of a former Tyrrhenian continent; and (3) that as a whole, and with a few significant exceptions, they are representative of every geological

formation from the pre-Silurian downwards, irrespective of the exceedingly interesting eruptive series, which it is not the purpose of this preliminary notice to discuss.

X.—Was the Deposit of Flint and Chalk Contemporaneous?

By G. Abbott, M.R.C.S.

MANY difficulties remain to be solved and much work to be done before we rest satisfied that we can understand how flint took the peculiar shapes and position in which we find it in the Cretaceous strata.

Most geologists will now agree with me that we must look to the action of segregation for the explanation. The older theory of colloid silica, as well as that of the chemical replacement of the organic matter in the sarcode of sponges by silica, long held sway, and even yet their influence is to be traced in the most recent literature on the subject.

To advance our knowledge and to obtain a working hypothesis at once accurate and comprehensive, ought we not to commence by trying to find out *when* the silica was deposited? Did it take place before or after the Chalk was raised above the sea-level?

Many writers imply, if they do not state, that the formation of flint took place contemporaneously with the deposit of the chalk strata. With this I disagree; anyway it seems of the utmost importance that this point should be inquired into, for manifestly the influences at work to effect the chemical changes would be quite different in the two cases.

The *tabular* flint of the Upper Chalk appears to give us some valuable data with regard to this point.

During the last twelve months I have examined all the specimens I could find, many *in situ*, and they all showed signs of having "grown" in faults.[1] Besides being found in the position where one would expect to find such fissures, they show innumerable traces of having been formed of two plates originally distinct, but which by the gradual addition of silica have approached each other and united into one thick tabular mass. Few specimens fail to show where this junction took place, whilst here and there irregular cavities remain, due, I presume, to the process in that portion being incomplete when segregation ceased.

The thickness of these tabular flints varies considerably—ranging from $\frac{1}{4}''$ to 6″ or more, sometimes almost reaching these extremes within the space of a foot, but more often lying for long distances between fairly parallel walls. The external surfaces correspond to those of the broken chalk, having here and there excrescences which indicate the growth of flint in cavities on the walls of the fissure, the surfaces in some specimens being so angularly rugged that the Chalk must have been dry and hard when the fissure occurred.

I have looked for, but hitherto have failed to find, any other satisfactory explanation of these remarkable dyke-like deposits.

[1] This can hardly apply to the continuous *horizontal* layer of flint which occurs in the Chalk from Thanet to Dover.—Edit. Geol. Mag.