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The existence of a compressed structure round the cavities clearly proves that the diamond has been in a soft state; but it may be shown, from various considerations, that this softness was not the softness produced by igneous fusion, and that it is likely to have been the softness of a semi-indurated gum. I have already stated that no such cavities exist in minerals of igneous origin; a fact which entitles us to separate the diamond from that class of crystals; and it is equally important to observe that its polarizing structure, which I have studied with peculiar care in a great variety of specimens, connects it closely with amber and indurated gum. From such substances, indeed, it differs in having a distinct crystalline form; but in the mineral resin called mellite we have an equally distinct crystalline form, though there can be little doubt, both from its composition and its locality, that it derives its origin from the vegetable kingdom.

XXX. *On the Ancient and Modern Formation of Deltas in the Persian Gulf by the Euphrates and Tigris, in answer to Mr. Beke. By W. G. CARTER, Esq.*

[Continued from p. 202, and concluded.]

SINCE writing the foregoing remarks, I have seen Mr. Beke's paper on what is termed the geological evidence of the advance of the land at the head of the Persian Gulf, which commences by bringing again into notice the single passage of the historical, in which Pliny, after mentioning three different admeasurements from the gulf to Charax, a port lying near the course by the Euphrates, to Babylon,—the 1st, and shortest, made in the time of Alexander the Great; the 2nd, and longer, furnished by Juba; and the 3rd, and longest, being of Pliny's time,—the historian, very remarkably, goes on to account, as it seems, for these varying estimates by saying that the silt of the rivers had made additions to the land*. The peculiarity is, that in the preceding chapter he had given measurements of the whole distance from the gulf past Charax up to Babylon, which presented a totally different result. For the first there, is the longest, and is also made in the time of Alexander, and the second is shorter, and yet also is furnished by Juba; and the inference there is the very natural one, that the account being thus discordant, he had not been able to determine the distance†.

* Pliny, *Hist. Nat.*, lib. vi. cap. 27.

† Errata in former part, last Number:—p. 200, *note*, for "Bosra, 12 miles below Khorna," read 42; p. 198, *note*, for "35 miles" read 37; and p. 199, for have read has.

I have before noticed, that to make the theory of the great delta and its increase of 245 miles since 325 B. C., at all coincide with the entire relation given by Pliny, we must admit the extravagant hypothesis, that the rivers had since Pliny's time separated, and then again united, and added a territory of some 200 miles to its length; or if we are not to suppose these mighty changes, but (dismissing the great delta to the winds) an increase of 70 or 35 miles only is to be inferred from the measurements to Charax, even that increase, so deduced, is negatived by the fact that these distances to Charax would actually make many more miles of country at the head of the gulf than are to be found there even at the present day*. It is, then, manifest that no dependence can be placed on them. It is the more evident that Pliny could have arrived at no greater certainty in respect of them than of the further distance on to Babylon, and that his inference from the former, that the rivers had added to the land, must, if indeed authentic, be taken subject to all the uncertainty he complains of in his data for the latter. This inference, however, with the expression of great surprise which follows it that the tide did not carry away what the rivers had brought down, is again adduced as a highly important authority in the last paper, and one is astonished at the amount of evidence which this single expression is supposed to concentrate. We are told that "it proves more evidently, that the subject of the growth of land at the mouths of rivers was entirely familiar with the natural historian, who was a native of Verona," (which remains a question,) "a city at a short distance only from the shores of the Adriatic," (it is about 60 miles distant,) "... and it further demonstrates that special attention had been devoted by him to the particular changes at the head of the Persian Gulf, since he pointedly contrasts what he conceives ought to have been the effect of the tide there, with the consequence of the absence of tides within the Mediterranean."

Now, as Pliny appears in the questionable passage here referred to, to express much surprise that the tide did not carry away whatever the rivers had deposited, in fact, that any ad-

* There is a strong mark in this locality, which I should before have named. Pliny (lib. vi. cap. 28.) notices a place where once was the mouth of the Euphrates, plainly pointing to that singular inlet of the sea at the south-west of the Mesopotamian delta now called the Khore Abdallah, which seems to have been one of its ancient branch streams (still, says Dr. Vincent, called in the country its mouth,) now stopped up, at its head. Here, then, is another of those nice points of identity which we are to imagine the rivers in their vagrant transmutations to have accurately replaced since he wrote.

vance had been made by the land upon the sea, the inquiry naturally arises, what "evidence," what "demonstration" did this afford, on the principles of the reply, of Pliny's deep consideration of the topic, seeing that he thus drew, on its theory, a totally wrong conclusion? But passing that, we come to the assertion that Pliny pointedly contrasts the effect of tide in the Persian Gulf with that of the want of it in the Mediterranean. On this I have merely to observe, that neither in the context of this passage, where from the terms employed we ought to find it, nor I believe elsewhere, will Pliny be found to have made any such remark, nor even any allusion to the topic of this "pointed contrast". If it be intended only as the construction put by the writer on the above passage about the Persian Gulf, combined with the opinion that Pliny was born so near the sea as the inland town of Verona, it should, under favour, so have been given. As it is, it comes with the authority and effect of the undoubted act of that great author.

And then, rather unfavourably for this evidence of Pliny's early familiarity with the rapid formations by the Po and Adige, he has, in the former part of his work, spoken particularly of the Po, and the phenomena of its embouchure in the Adriatic. He there tells us, that from the accessions obtained by its waters, it runs over, and *most persons say*, thus forms a triangular figure between the Alps and the sea, as the Nile in Egypt makes what they call Delta*. Thus, so far from stating that he had long been "entirely familiar" with the locality, and had been watching these great alluvial changes, he is quite silent on the topic, and as to the course which the channels of the river here took, does not profess even to have seen it, but observes simply, "most persons say so".

From the conjoint tenor of these two papers, I am not very certain, however, what the amount of alluvial formation at the head of the Persian Gulf may be, which is by this time contended for. Indeed, we also seem to be thrown by the reply into much the same perplexity which bewildered Pliny. In the former paper we had a construction of Nearchus's esti-

* "His se Padus miscet, ac per hæc effunditur plerisque, ut in Egypto Nilus, quod vocant Delta triquetram figuram inter Alpes atque oram maris facere proditus stad. duum M. circuitu." (Pliny, *Hist. Nat.*, lib. iii. cap. 16.) See the whole chapter on this topic. Whether we are to read with Dr. Holland a space of 2000 paces, or with others 2000 stadia, is a point not necessary here to decide. It will, I presume, scarcely be said that Pliny, in using the word Delta, did so in the modern geological sense of an area of alluvial land. He simply thus describes the figure formed by the divided streams of the river.

mate which made the distance to Babylon 206 miles, and thus the addition to the delta since Alexander the Great 245, combined with the "assuming a construction" (of the distance to Charax) "to be more correct," which, without all those metamorphoses, would bring it to worse than nothing; and now, "if we attach no importance to Pliny's express reference to the extraordinarily rapid growth of the land in the Persian Gulf," we may, from the formation of new land within the Adriatic, "at all events be permitted to calculate" this growth in the Persian Gulf to be at least from 2 to 20 miles in 2000 years, that is, at the utmost, about 24 for the same period!

The whole geological evidence now offered, reduced to a plainer form, amounts to little more than the latter inference. Mr. Beke, however, supposes the claims of the Euphrates and Tigris to a large delta to be stronger than that of the Italian rivers, from the far greater extent of country through which the former and their tributaries sweep. But any such rule must, I apprehend, be received with very large qualifications. In the instance cited, certainly the fact lies exactly the other way. The great source of the silt of rivers is the high grounds, from which the looser matters, set free by rivulets and other causes, descend to the lowlands—the higher of course the greater the quantity,—and that again increased by the momentum it gains in its headlong passage to the plains. But what lowlands can be placed more favourably for an increase to their level by such an agency, than those about the shallow head of the almost tideless Adriatic, little removed from the end of a declivity from such a storehouse of detritus as the Alps?

The source whence the evidence is taken, and the authority adduced, is the able work of Mr. Lyell. But we are immediately there taught the utter unfitness of the comparison. "The Adriatic," (says Mr. Lyell,) "presents a great combination of circumstances favourable to the rapid formation of deltas*;" and yet the 20 miles at Adria, the maximum of this increase, is in great measure attributable, not to geological causes, but to mere human labour, for again we find "that since the system of embankment became general, the rate of encroachment of the new land on the Adriatic is said to have been greatly accelerated." M. Prony†, whose investigations seem to have led to this knowledge, says that in the 12th century, before, by the same ordinary means, a passage had been opened at the north bank of the Po, Adria was distant from the sea but 9000 or 10,000 metres, in 1600 its distance was

* Lyell's *Geology*, first edit., vol. i. p. 235.

† De la Beche's *Geological Manual*, third edit., p. 70.

18,500, and now it is 32,000 or 33,000. In this way it has more than tripled in four centuries: and this is the spot which is to form a rule for that before us*.

Then, again, the Mesopotamian rivers bend their course through a locality widely different from the Italian, the Euphrates more particularly. It passes for 700 or 800 miles over a level with much sandy desert, and carries its lingering stream at a rate which will often glide over mud without disturbing it†,

* Going back to a much earlier period, we shall, perhaps, find still less reason to view either Adria or Spina as any sure landmarks for these great fluvial encroachments. Strabo (lib. v. 214.), Livy (lib. v. cap. 33.), Justin, (xx. 1.), and all the best authorities state, that the Adriatic took its name from Adria. But the gulf bore that title at a period of from 500 to 600 years B.C., for Scylax mentions the sea of Adria, if not the city. The latter was probably of a date very ancient even to him. Yet we find from Justin, about seven centuries later, that it was still "mari proxima". (*Ibid.*) The unaided labours of the river had thus made no appreciable progress with its delta, in a period probably very far more than that in which we have seen that it has since tripled it. Ravenna, Strabo (*ibid.*) understood, was built by the Thessalians in the marshes. So Zosimus (lib. v. cap. 27). It is supposed by Rubeus (*Raven. Hist. incip.*), Amati (*Dissert. Rubic.*) and other learned Italians, to be one of their settlements noticed by Halicarnassus (lib. i. cap. 16.) as made in this part long before the Trojan war. From what Jornandes about A.D. 552 (*De Reb. Get. Linden.*, p. 109,) adds to his account from Dion, it seems to have been as little in the waters then, as any visitor to the spot will now find it. Bernard Justinian (*De Orig. Urb. Venet.*, lib. i. cap. 6.), a learned Venetian of the 15th century, tells us it was then more than three miles, about its present distance, from the sea, and that the efforts of five Roman emperors had been employed to accomplish the filling up of its canals and marsh. The sea, except by the labours of man, has surely been little intruded on here. Yet Butrium, a very ancient, and supposed by Cellarius, Spretus, Amati, and others to be also a Thessalian town, seems, from what Strabo says of it, to have been founded by the people of Ravenna, yet in the time of Pliny (iii. 15.) it was "nec procul a mari". Of Spina we hear much, Strabo stating *φασί* it was once situated on the coast, but was then 90 stadia inland. But "*φασί* (says Cellarius) dicunt homines non probunt documentis". Halicarnassus (i. 16.) says only that a city was built at the Spinetic mouth of the Padus. Taking this to be Spina, he probably means no more than the site mentioned by Scylax, who notices the distance across Italy from sea to sea, from city to city, and that the Greek city on the river was 20 stad. from the Adriatic. That this was the original site of Spina seems far from improbable, and Cluverius, Vossius, Gronovius seem all to agree that it was the city, Scylax thus notices. Filiasi, Amati, Frissi, and other Italian writers are much divided about its site. Now, bearing in mind that Ravenna, Butrium, and Spina were probably all of nearly the same high antiquity, and, with Adria, near to each other, and more or less subject to the operation of the same causes of change, and connecting with this, and with what we have learned from M. Prony, the great extent of marshy debateable ground between land and water formerly existing in this part, and which might be reckoned as either, we may, perhaps, view the storied amount of geological change here as much more imposing than the true.

† De la Beche, Geol. Manual, p. 112.

making no large gatherings of buoyant matter to mingle with its waters like the fertilizing Nile*, but whenever its current is strong enough to lift earthy substances from its channel, it rather takes up comminuted granite†, or other heavy debris, which sinks when the impetus that upheld it fails‡. If to this we add, that in ancient times it became at length an extremely slender stream at its termination§, we may conclude the Euphrates to have had, within the historic era, a very moderate share in the uprearing of any delta.

In this reference to Mr. Lyell's work for the aids of analogy it was surely overlooked, that the whole joint delta formed by the mighty rivers whose waters are set free at the mouths of the Ganges and Burrampooter, is there said|| to be of the length of 200 miles only, yet "so great is the quantity of mud and sand poured by the Ganges into the sea, in the flood season, that the sea only recovers its transparency at the distance of 60 miles from the coast, and even islands are formed in its channel in a period far short of a man's life, many miles long; some of the islands there rivalling in size the Isle of Wight." What proportion of this 200 (or 220 miles) in any fair judgement on the two localities, can we be required to add to the 50 miles of admitted delta at the head of the Persian Gulf?

But from the infinite varieties of level, soil and other local causes operating to produce and transmit the matter abraded, from the higher to the lower lands, over thousands of square miles of country, it is manifest that no such criterion applies, and I reluctantly turn from the plainer facts adduced in proof of this theory being unfounded, to deal with topics in their nature and application of a less determinate character.

I must, however, notice that "it is beyond the scope of the present paper to institute an inquiry into what may have been the direction of the coast line, when the voyage of Nearchus was undertaken." Yet it determines again that the Euphrates and Tigris had once separate outlets, and proceeds to a lengthened enumeration of investigations impliedly necessary to the present discussion¶. But it was surely forgotten, that if not within the scope of that paper, both the inquiry and the decision were within the scope of the last, for there we find "the distance from Babylon to the sea, by following the

* Pliny, *Hist. Nat.*, lib. xviii. cap. 17.

† Col. Chesney's Evidence in Report.

‡ Buckingham's Travels in Mesopotamia, ch. ii.

§ Arrian, *Exped. Alex.*, lib. vii. cap. 7.

|| Lyell's Geology, p. 243.

¶ In the last paper we read "of a portion of the Euphrates finding a partial course through the less obstructed channels of the Tigris, and of the consequently easier and more rapid victory," &c. But it is forgotten

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course of the Euphrates in that navigator's (Nearchus's) time, was only $206\frac{1}{2}$ miles, whilst in the present day it is as great as about 400, it seems to me we have no alternative but to attribute the difference between these two measurements to the gain of the land upon the sea during the intervening period of 2160 years." Surely $206\frac{1}{2}$ miles from a town on any road or river is plain enough. Nearchus then sailed on the gulf up to about the present town of Simauvu, where he found Diridotis, and about the present town of Duffas on the Tigris*, Alexander the Great entered its mouths. We have now merely to explain his sailing down the Euleus from Susa, the navigation across the canal, and the localities of these narrations. Though, indeed, our labours do not even terminate here, for "the possibility has been hinted to Col. Chesney, that the actual site of Babylon may be some 30 or 40 miles north-west of Hillah," a discovery which would of course require the shifting about and readjustment (if indeed the matter has been thought of) of the historical corresponding landmarks. But it is now, I believe, becoming evident, that the incongruity of all this with the plain facts of history, is beginning to be felt. Such a theory may appear feasible enough while kept within a circle of eloquent generalities; drawn thence for a closer view and application to circumstances, we find it not formed for the occasion.

Temple Chambers, July 22, 1835.

W. G. CARTER.

XXXI. *Proposed Method for inferring the Dew-point from the Indications of the Wet-bulb Hygrometer.* By HENRY HUDSON, M.D., M.R.I.A.†

AS the expansion of air by heat is uniform, and equal to $\frac{1}{480}$ th of its volume (at 32°) for each degree above that temperature, the relative volumes at different temperatures will (*ceteris paribus*) be proportional to $448 + t$, and, of course, the relative *densities* will be inversely as $448 + t$: hence putting f' for the elastic force of (or pressure on) air, and t' for any temperature, we have density at 212° (under 30 pressure): density at 212° under $f' :: 30 : f'$; also density at 212°

that the channels of the Tigris are clearer on account of the greater rapidity of their current down the declivity towards the Euphrates, whose waters could not run in such channels without running up a slope. I have before pointed out, that this declivity distinctly negatives the joint delta of two long separated streams.

* See Col. Chesney's Map in Report.

† Communicated by the Author.