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Benjamin Heyne M.D.

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XV. *On the Formation of Sulphur in India.* By BENJAMIN HEYNE, M.D. Botanist and Naturalist to the Hon East India Company, and Surgeon in the Madras Army*.

SULPHUR has been considered to be *indigenous* only where deep seated mines of metals are found, or where volcanoes or earthquakes have ravaged the bowels and surface of a country. Nothing therefore is known of its formation, nor have analytical experiments afforded any other than distant hints, and these so very indistinct that our modern chemists have ranked it among simple substances.

Circumstances requisite for the production of any particular substance sometimes, however, unite at accessible places, and it then becomes possible for an attentive observer to penetrate into such mysteries, and to develop them where or when least expected. I will not say that this is precisely the case here, but I trust that what I have observed on this subject will not be thought altogether unworthy of notice.

I must premise, that I have no where found brimstone on the peninsula of India, though always travelling and inquiring into subjects of natural production and curiosity; nor has it been discovered, as far as I know, by any other person, either in a simple state or in combination. Once indeed I understand, from very respectable authority, that a large lump of very fine brimstone was found at Condapitty in the Masulipatam circar, in the trunk of a Margosa tree, (*Melia azedarachta*) torn up, and (as was supposed) shattered to pieces by lightning; I was therefore not a little astonished when a substance in powder or small pieces evidently brimstone was shown me in the Northern circars, with the intimation that it had been collected on the banks of the Godavery.

The place to which I was directed is not far from Maddepollam and Ammalapore, places situated about half way between Coringa and Masulipatam, and between the branches of the river Godavery, known for the manufacture of fine long cloth, which is carried on to a great extent in this part of the country; but, even there, this circumstance was unknown to all with whom I conversed. My guide however convinced me soon of the truth of this assertion, by conducting me to a small village about twelve miles east of Ammalapore, called Soora-Sauny-Yanam, belonging to the Bommadauram Mootak, one of the Ped-

* Communicated by the author.

datore rajah's districts. Hard by is a lake in which I found the confirmation of my researches. It is a narrow lake extending several miles in the direction from south to north along the village, and seems to be every where very shallow. At its southern extremity it communicates with a branch of the Godavery and a salt-water creek, from which it receives its water in the rainy monsoon.

In the hot season it is nearly dry, and the mud then exposed to the sun exhales a disagreeable smell, which at some places I thought was like that of a sulphuret.

The first excursion I made with my guides was to a place due west of the village, where they went trampling up and down in the water, and at times taking up a handful of mud, which, on examination, certainly had a faint smell of brimstone, but did not at all resemble the substance which had been shown to me some time ago, and which had induced me to make this expensive excursion.

Under the full impression of disappointment, I was sitting after my fruitless return to the village in my palanquin, scarcely observing that it was surrounded by a number of inquisitive visitors, when on a sudden my attention was attracted by the clamorous vociferations of a woman in the pursuit of all my palanquin bearers, who had robbed her little garden of a pumpkin. She appealed to the renter for protection; but he, like many in his situation in absolute power, magnanimously made a present of it to the strangers, who were carrying their booty off in great triumph. Unluckily for them, however, I interfered, and ordered them to restore the stolen goods, which brought on a slight but friendly altercation between me and the renter; and this ended in the payment for the pumpkin, and an offer of all the bystanders to conduct me to the place from which they collected brimstone.

I then followed a man whom they procured, immediately to the northern extremity of the lake, where we found without much searching brimstone in small heaps and in abundance.

I was told that this substance was to be found further north in the same lake, and in small quantities only to the southward, where the lake gets soonest dry. There it is collected in a loose soft form, or in semi-indurated nodules of a grayish yellow colour after it is dry; and never deeper than a foot from the very surface of the ground on which the water stands.

This salt lake, I learnt, was but of recent formation. Only fifty years ago, the spot where it is now found was under

under cultivation. The country for a great number of miles in all directions is quite plain; nay, I may add that not a hillock is to be seen within fifty miles.

Stones of all kinds are nearly as scarce, except some indurated marl which I found in the stratum below the superficial one.

The soil all over this part of the country is either a rich red earth mixed with vegetable mould, which renders it very productive; or it is the black vegetable cotton soil, which is always accompanied with a stratum of marl. This is also the soil which I observed on the spot where the lake is.

Earthquakes are entirely unknown here, and volcanic substances are not to be found.

It might be supposed that the brimstone found here was deposited by the water of the Godavery, as the lake is in conjunction with one of its smaller branches; or that it had been thrown up from the sea, with which it is also connected. Against the former supposition may be adduced, that it is found in none of the manifold beds of that river, or in its vicinity; and against the second, that it is not observed in any other creek or inlet, and here only where it is remotest from the sea.

Against the existence of extinguished volcanoes, or earthquakes, may I think most strongly be urged the confined compass of the spot where this substance is found; besides what has been observed before of the appearance of the country in general, and its minerals. The only way to account for its existence in the humid way therefore is, in my opinion, the supposition of its having been formed here. The substances we have then to consider are sea water, lime, and vegetable mould.

I filled some bottles with the water of this lake, and having carried them along with me for further examination, I found that neither the nitric nor sulphuric acids had any visible effect on it.

Soda precipitated immediately a plentiful white sediment. Oxalic acid produced a copious sediment. Muriate of barytes caused also a plentiful precipitate.

All I wished to ascertain was, whether this water contained alkaline or calcareous sulphurets, or the sulphuric acid in a free state.

From the few experiments above noted, it appears however that it is not impregnated with sulphurets of any description, as these would have been precipitated both by the sulphuric and nitric acids; but that, like most sea waters,

it contains some sulphates; and probably the sulphate of lime, as the latter basis was indicated by the oxalic acid, and the former by the sulphuric acid and the muriate of barytes. I will not enter upon any theoretical disquisitions; but I cannot help observing, that the presence of brimstone in substances which not only can but actually do produce hydrogen gas in such abundance, has suggested to my mind that sulphur itself may be a product of them, and possibly only a modification of hydrogen.

XVI. Of such Portions of a Sphere as have their Attraction expressed by an algebraic Quantity.

(Concluded from vol. xl. p. 329.)

SIR, I ASSIGNED, in a former letter, such cylindric portions as when taken from a sphere, or hemisphere, will leave a remainder having an algebraic quantity for the measure of its attraction. There is yet another problem; viz. to find the nature of the curve bounding the base, when the attraction of the cylindric portion *itself* is an algebraic quantity. It is scarcely necessary to observe that equation (β), which supposes the fluent, with respect to θ , to be taken from $\theta=0$, to $\theta=\frac{\pi}{2}$, is only adapted to particular cases. Let us take the general form:

$$F = \frac{4}{3} \int \left\{ \frac{(2R \cos. \theta)^{\frac{3}{2}}}{(2R \cos. \theta)^{\frac{1}{2}}} - \frac{(2R \cos. \theta - r)^{\frac{3}{2}}}{(2R \cos. \theta)^{\frac{1}{2}}} \right\} \cos. \theta. \dot{\theta} \dots (\gamma);$$

Or,

$$F = \frac{4}{3} R \int \dot{\theta} + \frac{4}{3} R \int \cos. 2\theta. \dot{\theta} - \frac{4}{3} \int \frac{(2R \cos. \theta - r)^{\frac{3}{2}}}{(2R \cos. \theta)^{\frac{1}{2}}} \cos. \theta. \dot{\theta} (\delta).$$

A simple inspection of these forms will point out many ways of effecting what we propose.

Make, in equation (γ), $r = 2R \cos. \theta \{1 - (1 - \cos. {}^n \theta)^{\frac{2}{n}}\}$ and it becomes

$$F = \frac{4}{3} \int \left\{ \frac{(2R \cos. \theta)^{\frac{3}{2}}}{(2R \cos. \theta)^{\frac{1}{2}}} - \frac{(2R \cos. \theta)^{\frac{3}{2}}}{(2R \cos. \theta)^{\frac{1}{2}}} (1 - \cos. {}^n \theta) \right\} \cos. \theta. \dot{\theta} = \frac{8}{3} R \int \cos. {}^{n+2} \theta. \dot{\theta}; \text{ the integral to be taken from } \theta=0, \text{ to}$$

$\theta = \frac{\pi}{2}$. It is evident, that this will be an algebraic quantity, as the problem requires, when n is any odd whole positive number. The curve, moreover, which bounds the base of the cylinder is always algebraic.

Defi-