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[Continued from No. 10.]

3. *On the Neighbourhood of BOMBAY, and certain beds containing Fossil Frogs.* By G. T. CLARK, Esq., C.E. *Communicated by the Very Rev. the Dean of Westminster.*

THE island of Bombay is composed of five or six bands of trap rock, chiefly greenstone and amygdaloid, conformable, and dipping west at about 10° or 15° , and separated by beds that have every appearance of being of sedimentary origin, though there is no actual proof of the fact. The highest and most western of these beds have been laid open in some engineering operations, and in these the fossils sent to the Society have been found.

The batrachian beds are a mass of blue rock, weathering into a shale not unlike ordinary coal shale, and containing what I have no doubt will turn out to be vegetable impressions. The upper beds are interstratified with thin seams of sandstone and argillaceous rock, and over the whole is a mantle of basalt which cannot have been less than 70 feet thick. This basalt has in parts caused imperfect fusion of the fossil beds, obliterating their stratification and superimposing something of its own columnar, or at least prismatic structure.

These fossils were discovered, a few days ago, by Dr. Leith of the Bombay Service, and as he is an acute and diligent observer and well-acquainted with his subject, I think, before very long, these beds will be thoroughly investigated.

I am preparing an account of the geology of the island, but it is so closely connected with that of the main land, that I am loath to say much upon the one until I am better acquainted with the details of the other.

I have however succeeded, in the course of the past year, in establishing some rather interesting facts relating to the trap district, and a sketch of these I propose, at the risk of becoming very tedious, to relate.

From this section it appears that the Ghauts are a step or scarp, rather than a regular mountain range. Upon the scarp, however, are many hills, commonly the abrupt ends of long ranges which traverse the Deccan E. and W. for from 50 to 300 miles. (B) is such a mountain.

The Deccan rocks are traps, chiefly greenstone and amygdaloid, capped with basalt. Their dip is very slight, and not discernible upon distances of less than a mile or two. It is however easterly, and this is shown by the occurrence of a peculiar bed near the top of the Ghaut mountains, and low down on the outlying mountain (C) above Poonah. After extending from two to three hundred miles eastward or inland, the trap is found to overlie gneiss and other metamorphic, as well as some later rocks.

The rocks of Bombay and the western margin of the Konkun, all dip west and at a much higher angle. This led me to suppose that their origin would be in the centre of the anticlinal, and to seek it, not as some have done in the interior of the peninsula, but in the middle of the Konkun; and here, at (A), I found a broad band of very well-marked craters, extending nearly N. and S., parallel therefore to the Ghauts, and (which is important to any general theory of India) ranging with the Laccadive and Maldive band of islands.

Lateral bands of volcanos seem to have been here and there given off for short distances, producing bays in the general outline of the Ghauts, of which the most remarkable is that nearly E. of Bombay, towards Jooneer. Basaltic dykes are numerous, parallel both to the main and subordinate bands.

The aspect of these volcanos shows that they have been submarine, and have been covered up by other igneous rocks; in fact, that they were the nuclei of more lofty volcanos, now in great part removed.

It would be tedious to enumerate the evidences, but the history of the matter seems to be as follows :—The original peninsula was metamorphic, raised and supported by granites of various ages, and covered up partially by the diamond sandstones and argillaceous limestones, the whole being traversed by greenstone dykes.

Next, the whole mass being still below the sea, a line of volcanic vents seems to have burst forth along the western coast ; all the eastern ejections from these rolled, at a very moderate dip, over the older rocks, while the western ejections descended at once into the deep sea.

As the accumulation proceeded the volcanic region gained elevation, and finally reached a height of at least 5000 feet above the present sea-level, or perhaps it would be more correct to say above the beds now forming the sea-shore. The later eruptive period produced basalt, beds of which mantle the western coast and cap the Ghauts. This basalt seems to have flowed out rather in long coulées than in sheets, and to have formed the mountain ridges which run eastwards from the crest of the Ghauts.

After this came a period of basaltic dykes. These seem to have closed the scene, for they traverse the craters as well as the adjacent rocks, and though confined for the most part to the crater region, they lie along and parallel to it, and seem to have been injected, not from the individual craters, but from some deeper-seated action affecting the whole.

Many of these dykes are above fifty feet thick, are highly columnar, and extend for many miles ; they are seldom found east of the Ghauts, but they cleave the highest mountains upon them.

Denuding forces seem next to have come into action. The whole surface of the Deccan presents evidences of the action, I think the gradual action, of water. The rocks being undisturbed the water cut its way slowly, but it did *cut* its way, cutting through rather than lifting up the beds. All the Deccan valleys are valleys of excavation, and I have seen no trace of any thing like an extensive fault ; in fact I do not think I have seen a fault at all.

In the volcanic region the case is wholly different. The water was admitted, through the craters and the dykes, which are fissured and everywhere loose, at once into the interior of the mass, and the result has been the removal, with some exceptions (which remain as evidences), of the whole of the upper 5000 or 6000 feet of volcanic matter. The waters have not *cut* the rocks as in the Deccan, but have *dissected them out* neatly ; and the valleys, except near the sea, are not water-worn, but are evidently formed by the meeting of lava streams, often actually meeting at a sharp angle, and sometimes such valleys are partially filled up by a third stream. The rocks are commonly hard, and the water-flow has often been unable even to efface the sort of ripple-mark that is so common in lava streams.

I believe the distinction between the Konkun and the Deccan (and therefore the Ghauts) to be due entirely to the loose structure of the former and the dense undisturbed structure of the latter, and, in the absence of anything like a great line of fault, it is difficult to account for the Ghauts in any other manner. The Konkun is in fact

a great valley of elevation, the line of the volcanos being its anticlinal line.

Mr. Malcolmson and others have established the age of certain beds connected with the eastern margin of the trap. Dr. Leith's discovery bids fair to determine the age, on the western margin, of the beds above the regular trap and below the basalt capping.

Professor Orlebar is of opinion that he has discovered a sort of intercalary volcano, below this basalt, in Salsette.

I have collected a great number of specimens, and I hope, during the next eight months, when I shall be under canvas, to add to them, and so far to arrange them as to render them worth the acceptance of the Society, when perhaps some competent geologist may be induced to take the matter up.

4. *On the BATRACHOLITES, indicative of a small species of FROG* (*Rana pusilla*, Ow.). *Addendum to the Communication from G. T. Clark, Esq., Bombay.* By Professor OWEN, F.G.S.

THE portions of shale transmitted by Mr. Clark contain delicate, but for the most part distinct, traces of the, generally, entire skeleton of small anourous *Batrachia*; the osseous substance is black, as if charred.

The number of vertebræ, atlas and sacrum inclusive, is nine: the caudal vertebræ are fused into a long, slender cylindrical style, as in most anourous *Batrachia*.

Fig. 1.

Fig. 2.

In the specimen (fig. 1) which lies on its back, the posterior convexity of the vertebral bodies is shown.

The short, subcylindrical and very slightly expanded lateral or transverse processes of the sacrum, and the absence of ribs or their rudiments in the dorsal vertebræ, with the proportional expanse of the skull and length of the hind-legs, show the specimens to belong to the family of Frogs (*Ranidæ*).

There are seven abdominal vertebræ, with long and subequal transverse processes, that of the second (third vertebra including the atlas) being the longest. The humerus is cylindrical, not expanded as in