

ART. XIX.—*Proofs that the Holyoke and Deerfield Trap Sheets are Contemporaneous Flows and not later intrusions*; by BEN K. EMERSON.

IN the concluding paragraph of his most interesting article on the Trap Rocks about New Haven,* Professor Dana is inclined to make the results he has reached regarding the traps and sandstones of the New Haven region general for those of the whole Connecticut Valley.

He concludes that these traps are subsequent to and intrusive in the sandstones and not "poured out in one, two or more horizontal sheets, separated, and overlaid horizontally by beds of sandstone." The essential point in this contention, if I understand aright, is that the traps associated with the Triassic sandstones are all newer than these sandstones.

The following is presented as an abstract of the proofs that all the main trap sheets in Massachusetts are contemporaneous flows, and easily distinguished from the smaller intrusive masses.

1. At the upper surface of the Deerfield bed of trap east of the mouth of Fall River opposite to Turner's Falls, a perfect ropy surface of flow is exposed and the soft red shale folds round the curved surfaces and into the deep grooves in a way only possible by a surface flow. The red sand can be picked out of open steam holes on the surface, as the bed is strongly vesicular at surface. At the base it is here aphanitic and the sandstone is baked into a black hornstone-like mass.

2. At the base of the same bed several miles south in the north edge of Greenfield, the cliff has been cleared at the City's Stone Crushing Works and a very remarkable section is exposed (fig. 1). The dip is east, and in the westward facing cliff the heavy trap bed, *T*, rests on soft unbaked sandstone, *S*, and is vesicular and coarsely brecciated for about 12 to 16 feet. The lower portion of this agglomerate, *Ts*, is cemented by a red sand which penetrates the fissures between the breccia blocks for six or eight feet up from the base and is now hardened to red sandstone, which is continuous below with the sandstone on which the trap rests, while an aphanitic non-vesicular trap is continued down between the coarse porous blocks, *Tt*, from the unbrecciated mass above to fill the fissures down to the point reached by the sand.

* This Jour., xlii, p. 110.

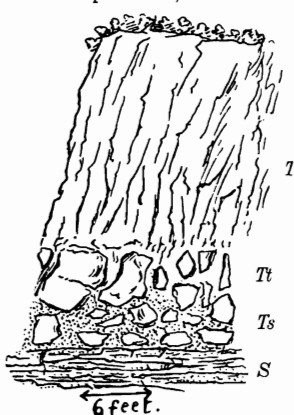
The explanation of this, I believe to be, that like an unrolling carpet the slaggy surface of the flow was underrolled on a submerged or muddy bottom and the mud was forced up into the fissures by the weight of the 200 feet of trap, and met in the cracks by the still liquid trap from above.

3. The Holyoke sheet from its east end to the Connecticut River bakes the sandstone on which it rests and has rarely large long steam pores running up from the base six inches or a foot, caused by the moisture in the subjacent sandstone, and it is highly vesicular and without any trace of baking at its upper surface.

Between the Connecticut and Westfield rivers (fourteen miles), the *base* of the sheet is often very vesicular and kneaded full of dove-colored limestone, as if limestone and trap had been plastic at the same time. In thin sections the fine grained limestone can be seen penetrating the steam holes with a distinct flow structure, but the boundaries are sharp between trap and sandstone. The trap is here perhaps 300 feet thick, but has not baked the subjacent arkose at all. At one place where the railroad between Westfield and Holyoke cuts the south line of the latter place a broad area of the *upper surface* of the sheet is filled in the same way with the same limestone to a depth of 8 or 10 feet. This latter rock is not in place in the rocks cut through by the trap, either at the surface or in the many artesian borings I have studied, down to 3500 feet in depth. I explain the above structure also by the underrolling of the surface of the sheet as above. A limited amount of calcareous mud was washed onto the submerged surface of the advancing sheet (which was superficially solidified) and blended more or less with this surface which by the continued advance of the mass became in part underrolled, thus protecting the sand below from baking, and bringing the highly vesicular trap loaded with limestone to the base of the bed.

4. At the Delaney's Quarry by the railroad on the north line of Holyoke the extremely irregular surface of the trap which rises and falls twenty feet in the quarry and is warty and ropy in the extreme, is closely fitted by the dark mud at first deposited, and the sandy layers immediately above undulate in and

1. Trap Section, Greenfield.



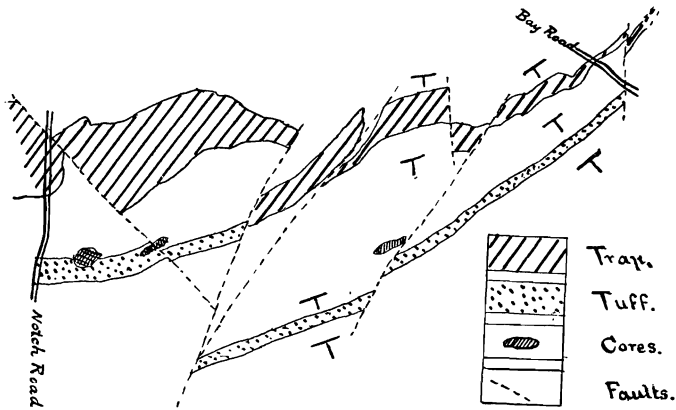
T. Trap: Tt. Trap agglomerate with trap cement: Ts. Trap agglomerate with sand cement: S. Sandstone.

out of the depressions and slowly obliterate them, and all without marked induration. The trap immediately beneath is the finest amygdaloid. This is a portion of the posterior sheet.

5. The Holyoke sheet is covered by arkose and this by a thick bed of trap tuff and agglomerate whose outcrop stretches parallel to, and a mile south of, the main Holyoke sheet from its east end to Holyoke town, about eighteen miles.

I have cut many thin sections from all parts of this bed, and the diabase of which it is composed is not in any way to be distinguished from that of the main trap sheets here discussed. This makes certain the eruption of a great amount of trap during the deposition of the sandstones, and accords with the supposition that the closely associated Holyoke sheet was also contemporaneous with the sandstones. Fig. 2 gives a sketch

2.



of the east end of the Holyoke range and shows that the trap sheet and the tufa bed have been faulted together and that the main trap sheet must have found its present place in the sandstones below the tufa before the epoch of disturbance which caused this faulting, while the latter cores show generally a distinct connection with these faults.

Except the Holyoke and Deerfield beds, and the "posterior" trap sheet running across Holyoke town and Agawam, all the trap given on the small map recently published by me* is intrusive but is in small amount, and is in every way contrasted with the large beds discussed above. The intrusive trap sends out dikes in the sandstone in all ways. The smallest cores or dikes do much more baking than the thick beds because they have passed as hot lava through the sandstone while the beds have run as scoria-encased flows on the sands.

* Bulletin of the Geological Society of America, vol. ii, pp. 451-456, pl. 17.