Art. XXXIV.—*On the Aeration of the Auckland Lava-beds.*

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About forty years ago the writer had the honour of reading before this Institute a paper describing certain lava caves at Three Kings, near Auckland.* In that paper, *inter alia*, reference was made to the fact that in the main pair of caves, upper and lower, currents of air were at all times observed blowing inwards from the outer air, and on one occasion, when a stiff breeze was blowing outside, the draughts were so strong in the more contracted places that the candles used for marking the main points of the traverse lines guttered and wasted away in a very short time. These currents were observed through the whole ramifications of the caves, and even at the extreme ends or in side chambers the flame of a candle showed decided draughts into the more open beds of the lava. Only in one place—viz., where the innermost end of one cave was found to overlap the position of another—was any outward draught observed. As the entrance to the main pair of caves at Three Kings is of considerable area—about 80 square feet, in fact—the velocity indicated that a very large volume of air passed inwards; and, although to the writer and his friend the late Mr. T. Kirk, F.L.S., who was one of the exploring party, the phenomenon was unexpected, no great importance was attached to it, as it was natural to suppose that the circulation would be quite local, and quickly diffused upwards through the more open patches of the rocky crust.

Two years ago, however, the significance of this terrestrial circulation of air was very forcibly called to the writer's notice. In the work of drainage of the Epsom depot of the Auckland Electric Tramways, situated 265 ft. above sea-level, he had occasion to extend the depth of a drainage-pit, sunk some years previously after consultation with the then Health Officer of the district. It was found, however, to be better to construct a new pit alongside the first one, which terminated in rock not sufficiently fissured to carry off the greatly increased amount of drainage from the septic tanks, &c., of the depot and adjacent show-grounds. The new pit passed through 19 ft. of rich volcanic soil, then through 7 ft. of slightly fissured but very hard bluestone lava. At the depth of 26 ft. a very open stratum of yellowish-brown scoria gravel of large size was struck, and opened out for about 2 ft. in depth. From this gravel a strong draught of pure fresh air was blowing into the pit. So strong was the current that a match could not be struck and lighted in it, and the workmen stated that a candle could not be kept alight in the strongest part of the draught. The indraught, as observed and noted by the writer, was strongest from the south-west, or from the direction of the Three Kings Hills, about a mile distant, but it extended with varying force more or less round fully one-half of the circumference of the pit. This inblast of air steadily continued until the pit was finished and put into use.

As these drainage-pits have become very common of late years in the scoria lands, the writer set about inquiries as to whether or not such an

* Trans. N.Z. Inst., vol. ii, p. 162.

indraught had been observed before. He found that it had, especially in the Mount Eden district, and that sometimes the current was reversed, or from the pit into the scoria, the smoke from the blasting-powder clearing out of the pit with a downdraught. In a drainage-pit which has lately been sunk in the Township of Grand Park, a mile south-east from the Epsom depot, a band of loose rock was passed through, from which a decided draught of air came into the pit, but in volume not to be compared with that experienced at the Epsom depot.

The facts as above stated seem sufficient to warrant the conclusion that all the permeable mass of the volcanic formation in the County of Eden is subject to constant aeration. From a sanitary point of view, the significance of this fact cannot be overrated. It seems to afford a satisfactory reason to account for the continued purity of the western and Onehunga springs, notwithstanding the fact that Onehunga has been settled for about sixty-two years, and Mount Eden district for about forty-five years. The population of the volcanic lands of Onehunga, Epsom, Mount Eden, and One Tree Hill at last census was 14,970, settled on an area in which there is not a yard of surface stream in the ordinary sense of the term, and up to the present no system of drainage excepting that of natural or artificial drainage-pits. On these volcanic lands at least three-fourths of the rainfall sinks into the ground, and certainly one-half passes into the vast mineral sponge, which term correctly describes the volcanic formation of the isthmus. The rainfall carries with it all sewage and liquid waste, and, if no purifying reaction existed, the effluent at the springs would long ere now have been quite unfit for domestic use. Without going into the records of chemical and bacterial testing, the particulars of which are not at the writer's command, it is sufficient to observe that the water yielded by the Onehunga springs maintains in all essential points the same high standard as from the first.

It must not, however, be deduced from this that it would be wise to trust to a continuance of the purity of the springs, without a regular system of drainage, at Onehunga, where a very considerable area of the crust is comparatively shallow, and where an accidental exposure of any of the larger fissures or cavities in the rock might lead to direct and rapid pollution. It must have been from some such cause that nearly fifty years ago the writer saw the main spring in Onehunga discharging in full volume red muddy water. But so long as the aeration as observed in the higher parts of the isthmus continues, the many millions of cubic yards of permeable strata which form the gathering-ground of the springs can be considered as nothing less than a gigantic aerobic filter, in which the soakage from such as the Epsom depot anaerobic tanks cannot flow more than a few hundred yards before it is thoroughly oxidized and rendered fit to mingle with, and be carried by, the discharge of that vast mineral sponge at the two great main springs and the numerous smaller ones that flow from the lava-beds which border high water on both shores of the isthmus.