

aerial with that of marine denudation. Before positive estimates were made in regard to the two rates, no one ever imagined that marine denudation was so trifling in comparison to sub-aerial. Is the amount of materials deposited in the submarine volcanoes equal to that derived from marine denudation? The sea is continually at work, but volcanoes are only now and again in eruption. If the materials supplied by submarine volcanoes be not greater than that by marine denudation, all the three sources which we have been considering put together, must fall far short of supplying an amount of material equal to that supplied by sub-aerial denudation. There is this, however, to be said of volcanoes, viz., the materials which they do produce—lava and trap-rock—resist denudation, and are consequently better preserved than rocks formed out of materials derived from sub-aerial and marine denudation. This, no doubt, is the reason why, in rock sections the traps bear so large a proportion to the sandstones, shales, and other softer rocks. Still further, were it not for the protection afforded by cappings of trap, the sedimentary rocks would be much thinner than they actually are.

EDINBURGH.

JAMES CROLL.

## THE CRUST OF THE EARTH.

SIR,—With your permission I should like to ask a question or two suggested by one part of Mr. Forbes's very instructive paper in the April number of your *MAGAZINE*.

Is not the comparison there drawn between the crust of the earth and the shell of an egg likely to produce a somewhat inaccurate impression, which it is as well to avoid, and especially so when, as in the present instance, the illustration to some extent does duty as an argument? In the case of an eggshell, the vault consists of a single piece, so that the form is largely aided by the force of cohesion in supporting a load. The weight is equally distributed by the former, but transverse fracture, crushing of the material and the shearing, or sliding of particle on particle, are, up to a certain extent, prevented by the latter. It is, however, improbable that in the crust of the earth no joints or fissures exist reaching continuously or interruptedly from the top to the bottom. The igneous rocks, as we know them, are so fractured that it is hard to find a mass of many yards in length free from cracks and flaws. Does not the presence of these destroy the analogy between the crust of the earth and an *unbroken* eggshell? and every one can see how deft a hand would be required to build up the fragments of a *broken* one, so that it should bear even its own weight. Is it not more correct to liken the crust of the earth to a heavy, but unloaded arch, whose voussoirs are constantly sliding on one another, in consequence of the ever-varying strain thrown upon the different parts, and the necessity of preserving equilibrium? Considerable up-and-down movement would thus be allowed, evidence of which may be seen in the enormous throws sometimes shown by faults. Cavities, too, might exist underneath the vault without endangering its stability, their size being limited by the ability of the material to resist crushing.

Again, does not a fallacy lurk under the inference that the crust of the earth is stronger than the shell of an egg because it is proportionally somewhat thicker, the former being the 158th and the latter the 200th part of the diameter. This seems to involve the assumption that the strength of a structure increases with its size, whereas, on the contrary, size is an element of weakness. The model is always stronger in proportion than the machine or the building, because the weight increases so much faster than the power to support it. The conclusion seems unavoidable, that while an egg-shell will bear its own weight, and even a large additional load, without giving way, the crust of the earth could not maintain itself in position unless its pieces rested everywhere, or nearly everywhere, on the liquid central mass, and, as it were, partially floated upon it.

E. W. C., B.A., B.Sc.

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#### OBITUARY.

SIR J. F. W. HERSCHEL, BART.—This great philosopher died on the 11th ult., at the advanced age of 79, in the full possession of all his mental faculties. Though he devoted most of his time to astronomy, natural philosophy, chemistry, meteorology, physical geography, etc., geology did not altogether escape his attention. Among his suggestive contributions to this science may be mentioned the following:—1. On Changes of Climate arising from the varying excentricity of the earth's orbit (*Geol. Trans.*, 2nd series, vol. iii., referred to in *Lyell's Principles* as early as 1837). 2. On the effect of the Removal of Matter from above to below the Sea, producing "a mechanical subversion of the equilibrium of pressure and temperature;" On Subsidence and Elevation; The Influence of Subterranean Steam; The results of the Expansion of Rocks by Heat; The Fusion and Metamorphism of Sedimentary Rocks, etc. (letters written in 1836, and published in 1838, at the close of *Babbage's Ninth Bridgewater Treatise*). In one of these letters the following remarkable passage occurs:—"We are led by analogy to suppose that He (the Creator) operates through a series of intermediate causes, and that in consequence the origination of fresh species, could it ever come under our cognizance, would be found to be a natural, in contradistinction to a miraculous, process." 3. Remarks on Denudation, etc., in his article on Physical Geography in the *Encyclopædia Britannica*, since published separately. 4. Various important allusions to geology in articles lately published in *Good Words*, etc. In private life Sir John was characterized by a rare combination of candour and unaffected humility, and he was never known to write discourteously in his replies to the most discourteous opponents. His remains were interred in Westminster Abbey on Friday, May 19th, beside those of Sir Isaac Newton. A more appropriate place could not have been selected; for, though the fame of Herschel will not rival that of Newton, he was as industrious, skilful, and devoted a labourer in the same field, and contributed to extend the boundaries of that science which was alike dear to both.