

advanced I cannot say; but all, I maintain, would be found wanting by a careful and competent judge. If any of your readers can throw light on the subject, it would be interesting to those geologists who happen to have observed the peculiarity to which I refer.

CLEVELAND LODGE, LOWER SYDENHAM.

S. H. WRIGHT.

The nature and origin of these Terraces is, we think, now generally very well understood by geologists.

We recommend to Mr. S. H. Wright's consideration an excellent little article upon them which appeared in the *GEOLOGICAL MAGAZINE* for 1866, Vol. III. p. 293, by the late G. Poulett Scrope, Esq., F.R.S., F.G.S., than whom we could hardly cite a more competent observer or more trustworthy geological guide.—*EDIT. GEOL. MAG.*

THE RIGIDITY (?) OF THE EARTH.

SIR,—It has given me much pleasure to read Mr. Close's remarks referring to my lament over the disagreement between mathematical physicists and geologists touching the condition of the interior of the earth. His letter gives promise that a further discussion of the question with him may serve to elucidate it.

Mr. Close has not, I think, exactly apprehended my meaning. I wrote of the conclusion arrived at by mathematicians, "that the earth is excessively rigid from its centre to its surface." Mr. Close, on the other hand, writes of the disagreement between them and geologists respecting "the rigidity of the body of the earth." It is important to be precise as to what we are discussing. As a physical geologist I seek to explain the phenomena exhibited by the masses which constitute the *surface*; its continents, mountains, plains, valleys, oceans, and volcanos. Still, these phenomena require us to speculate upon the condition of the interior down to a considerable depth; yet not necessarily to a depth which bears any large proportion to the entire radius. In short, I am willing to relegate the "body of the earth" to the physicist pure and simple, as a region beyond my province, and respectfully to accept his conclusion that it is extremely rigid. Possibly this rigidity may be no more than that *viscous* rigidity which Mr. Close so accurately describes, showing in his letter how such a condition of the interior would be capable of explaining many of the facts relied upon to establish rigidity. It certainly also appears to suit, better than absolute rigidity, with one to which he has not alluded; namely, that the *present* ellipticity of the earth agrees so well with the present period of diurnal rotation.

I will now state some objections, which, on geological grounds, I would offer against the contention of Mr. Close, that a general viscous rigidity, such as I understand him to advocate, would meet the requirements of the problem; and I will point out one instance of the neglect of geological phenomena by a mathematician. I maintain that the surface phenomena require that the cooled crust of the earth should be far more rigid than what it rests upon. For instance, they require that the substratum should be sufficiently fluid to admit of the crust being shifted over it towards the mountain ranges; that it should likewise be in a condition to flow upwards into narrow chasms, and form igneous dykes, and to furnish the

ejectamenta of volcanos. These and other phenomena, such as that which I shall shortly mention, have been too much ignored by mathematicians in treating of the subject. To suit the exigencies of the calculus, they assume the earth to be homogeneous throughout, and either fluid, viscous, or elastic, and take no account of any greater rigidity existing in the surface than in the parts beneath it. Mr. Darwin, for example, in his paper on the Stresses of Continents and Mountains, assumes that the earth must be strong enough to bear the stress arising from their weight. But it is a fact well known to geologists that the parts of the earth's surface which have a tendency to sink are not the mountains, but the sedimented areas, the river plains, and the bottoms of shallow seas. The tendency of the mountains, on the other hand, is to rise, so as partially to compensate for what they lose by denudation. In short, the crust of the earth bears a close analogy to a floating field of ice, broken up, crushed together, and refrozen; and no one would argue that there could be no fluid stratum beneath it, because some blocks of ice stood higher than others; for he would know they would receive sufficient support from their under sides sinking deeper into the water.

The above facts show that the substratum must have a less viscosity than the crust. But if the substratum be as rigid as glass or steel, then the crust must be much *more* rigid than glass or steel, which is a *reductio ad absurdum*. For my own part I believe it to be what may without impropriety be called liquid. And if it be asked how it can remain liquid under the pressure of between 20 and 30 miles of superincumbent solid rock, I answer, that recent experiments have tended to show that igneous rocks are denser when melted than when solid at the melting temperature. Consequently we may expect their melting-point to be lowered rather than raised by pressure. If that be the case, solidity would not be induced in such molten rocks by the pressure of the superincumbent crust.

HARLTON, CAMBRIDGE,
5th January.

O. FISHER.

PERMIAN AND TRIAS OF SOUTH-WEST LANCASHIRE.

SIR,—Having read the recent articles on the Permian and Trias by the Rev. A. Irving, F.G.S., and the letters referring to the Permian strata of South-west Lancashire, I beg to offer some further information more recent than that available to Prof. Hull, Mr. De Rance, or Mr. Strahan. During the last week I visited St. Helen's Junction, and in consequence of a fall of *débris* at the side of a pit, found an exposure of ten feet of red marl, containing a layer, a few inches thick, of a greenish colour which effervesces strongly in acid. I and Mr. Strahan saw the sandstone at the base of this section in 1881, but at that time only one foot of the overlying marl was visible. No fossils have been found, or searched for, it being dangerous to approach the spot for fear of falling into the pit. The marl must belong to the beds described in the wells of the brewery many years ago, and most likely represents the Permian.

However, a section of much more importance has just been