10. Miss M. Workman: The Permian Rocks of Skillaw Clough.
11. Professor G. Hickling: The Tectonics of the Lancashire Coalfield.
12. Mr. G. Slater: Observations on the Nordenskiöld and neighbouring Glaciers of Spitsbergen, 1921.
13. Mr. K. W. Earle: Preliminary Report on the Geology of the Windward and Leeward Islands.
14. Mr. C. P. Chatwin: A new Gastropod Fauna from the Chalk.
15. Discussion on Metamorphism; opened by Dr. J. S. Flett, F.R.S.

Papers on Cognate Subjects read in other Sections.

Section E.—Geography.

Mr. W. Hewitt: The Physiographical Features of the Region around the Mersey and Dee Estuaries.
Professor J. W. Gregory, F.R.S.: To the Alps of Chinese Tibet.
Mr. R. R. Walls: The High Plateau of Brazil.
Mr. J. A. Steers: Orfordness.

Section H.—Anthropology.

Professor W. J. Sollas, F.R.S.: Miocene Man.

Section B.—Chemistry.

Professor W. Vernadsky: Alumosilicates.

CORRESPONDENCE.

A CRITICISM OF MR. S. H. WARREN'S VIEWS ON SUBSOIL PRESSURE-FLAKING OF FLINTS.

Sir,—We have already had occasion to expose to the archæological world[1] the gross errors underlying the work of Mr. S. H. Warren in connexion with the subject of the fracture of flint. We have shown that he employed entirely wrong units in which to express many of his measurements; that he is guilty of grave errors in his use of elementary mathematics and mechanics; and that his experiments were conducted under conditions which rendered the results of no scientific value.

We regret to find that he is continuing to promulgate some of these errors and misstatements in a paper on "Subsoil Pressure Flaking", published recently as a Presidential Address to the Geologists' Association.[2] It becomes necessary, therefore, for us to direct the attention of geologists to some of the errors underlying the work of this author, and again to express our determination to expose such errors whenever they are brought to our notice.

[1] *Man*, vol. xxiii, April, 1923, No. 32; June, 1923, No. 51; August, 1923, No. 74.
[2] *Proc. Geol. Assoc.*, vol. xxxiv, 1923, pt. iii.

We will first examine the foundations upon which Mr. Warren bases his work.

On the first page of his Presidential Address, he states that his "first principles" are (1) the planes of least resistance and (2) chip and slide.

In dealing with the planes of least resistance, Mr. Warren claims that a piece of flint of plano-convex form, provided it be of reasonably good quality and not flawed, gives us four planes of progressive resistance to flaking, as illustrated in his diagram fig. 19 (p. 154 loc. cit.). We desire to point out that, for any given specimen, the number of planes revealing a progressive increase in resistance to fracture, so far from being restricted to four, is *infinite*. Further, Mr. Warren attempts, in a single diagram (fig. 19 loc. cit.), to specify the position of "four planes of progressive resistance to flaking", designated α, β, γ, and δ, in relation to a specimen of flint of plano-convex form. This, as anyone possessing an elementary knowledge of solid geometry knows, is a physical impossibility, and the directions of all the lines shown in Mr. Warren's diagram are indeterminate. In fact, an infinite number of planes may be drawn, each containing one of the lines shown in Mr. Warren's diagram, and it cannot be said that any one of the lines in question represents any one of these planes rather than another. The whole conception is chaotic, indeterminate, and scientifically valueless, but it is presented by Mr. Warren to the members of the Geologists' Association as one of his "first principles", of which he says "it is not going too far to say that no real understanding of mechanical flint flaking is possible until its bearing has been properly grasped".

Mr. Warren's second "principle" is "chip and slide".

This concept, the absurdity of which has been exposed by one of us in the *Proceedings of the Prehistoric Society of East Anglia* (vol. iii, pt. iii), relates, we are informed, "to the comparative degree of stability of contact between any two stones in different relative positions." We may point out, however, that this depends upon the nature and stability of the matrix surrounding the stones in question, a factor which Mr. Warren does not take into account.

It is not to be wondered at that the application of these so-called first principles leads to a number of errors, some of which are amusing in their singularity. For example, we may consider briefly the "coefficient of resistance to flaking" dealt with by Mr. Warren in all seriousness on pp. 157–8 (loc. cit.). He states that, as the results of his experiments, he feels assured "that the coefficient of resistance to flaking (dealing with α flaking only) is not less than the square of the increase of thickness of the flint". In physical science a "coefficient" expresses the relationship of one quantity to a like quantity, and is, therefore, a "pure number"; in mathematics it is also a "pure number". An increase in thickness is, of course, a length, and the square of this is, necessarily,

an area. That is to say, in Mr. Warren's statement the pure number is equated to the area, which we need hardly point out is an absurdity.

In addition to errors due to lack of knowledge, Mr. Warren's paper contains a large number of statements which are not true. For instance, he states on p. 172, with reference to the sub-Crag flints found in the brickfield of Messrs. A. Bolton & Co., Ltd., Ipswich, that " marine organisms are attached to the flaked surfaces, showing that the flints were exposed to drifting on the bed of the Crag Sea ". In regard to this we may say that not a single specimen bearing marine organisms has been found in this pit, and we fail to comprehend why the presence of such organisms upon any flints indicates that such specimens have been " drifted " by the sea.

It is abundantly clear that Mr. Warren's knowledge is negligible regarding the sub-Crag flints, about which, however, he continues to write with dogmatic assurance. In the interests of British archæology we hope that further publication of the kind of errors we have indicated will cease.

A. S. Barnes.
J. Reid Moir.