The Cretaceous rocks include the only known occurrence *in situ* of Upper Cretaceous rocks in Scotland. In the White Sandstone, which lies below the Chalk, the "millet-seed" character of some of the sands is regarded as evidence of desert conditions on the shores of the Cretaceous sea.

The final chapter on the economic geology includes an account of the building stone quarried in the very decorative Ross of Mull granite, and a record of a good glass-sand at Loch Aline, on the mainland.

Chemical Problems of Soil Fertility.

Base Exchange in Soils: a General Discussion held by the Faraday Society, December 1924. Pp. 547-617. (London: The Faraday Society, 1925.) 5s. net.

ONE of the directions in which little real progress has been made in agricultural science, in spite of an immense amount of careful work, is in the exact specification of soil fertility by means of chemical analyses. Such analyses have, in general, only qualitative significance, and their main purpose is to serve as a check to the direct field observations. In recent years considerable progress has been made, however, especially by American workers, who have paid especial attention to the concentration of radicles in the so-called "soil-solution." Progress in such a complex problem as the fertility of a normal soil is most likely to be made if extreme cases are taken, such as alkali and acid soils, where certain factors are thrown into high relief. The work of Kelly and others in California, on alkali soils, and of Bradfield in Missouri on acid colloidal clay, are good illustrations of the method. More recently Dr. Hissink and his collaborators at Groningen, Holland, have effectively used the well-known electrical double layer hypothesis as the basis of a reasonably complete theory of base exchange that can be applied to a wide range of soil conditions: the exchangeable bases are held on the surface of the clay particles by chemical attraction between them and the clay and humus acids. In a suspension of soil in water, some of the surface molecules are ionised, and an electrical double layer is formed containing anions of soil acids inside, and outside the cations H^+ , Mg^{++} , Ca^{++} , K^+ , Na^+ . Students of soil science will recognise in this hypothesis a restatement in modern terminology of the essential features of Way's classic investigations of 1850.

Dr. Hissink, in his introductory paper, considers both the degree of saturation of the soil (which is the ratio of the quantity of adsorbed bases actually present, to the total amount the soil could hold) and the relative proportions of exchangeable bivalent and univalent bases. The relation of these factors to soil properties such as physical condition and pH value is discussed

in detail, and with special reference to Dutch land-reclamation problems. Messrs. Page and Williams present some important studies of base exchange in the classical Broadbalk permanent wheat and Park grass plots at Rothamsted. The long-continued treatment of these plots with various artificial manures would be expected to accentuate many of the base exchange processes, and thus to provide yet another illustration of the incomparable value to agricultural science of long-time experiments. The results show that on the acid soil of the grass plots from which chalk is absent, the amount of exchangeable calcium is correlated with the pH of the soil. On Broadbalk, where considerable quantities of chalk still remain, the relative proportions of the different bases vary consistently with the manuring, and there is some evidence of a gradual conversion of exchangeable potash to a non-exchangeable form or vice versa depending on whether potash manures are used or not.

The value of the base exchange theory in suggesting not only new view-points of known facts, but also fresh lines of work, is well shown by the remaining papers. Prof. Comber reviews earlier work based on the physical adsorption hypothesis and has some cogent observations to make on the part played by electro-negative ions. Messrs. Robinson and Williams, of Bangor, in a study of some Welsh soils subject to high rainfall, show that their lack of response to liming, although they appear "acid" by lime requirement tests, is due to the presence of considerable proportions of exchangeable calcium as determined by Dr. Hissink's method. These soils are "acid" in the chemical sense but not "sour" in the agricultural sense. Mr. E. A. Fisher contributes two suggestive papers on the relation of base exchange to adsorption phenomena, and the swelling of soil colloids. Mr. Saint, working in Prof. Comber's laboratory, shows that there is no consistent relation between the pH value, the "lime-requirement" and the Comber thiocyanate test of acidity for soils of different types.

The verbatim report of the discussion is at least as interesting as the papers, and there is much healthy criticism of both methods and results. Attention should be directed to Dr. T. P. Hilditch's discussion of industrial developments of synthetic aluminosilicates for water-softening purposes and the close relation of this to base exchange in soils.

This is the third general discussion on agricultural problems that the Faraday Society has held since 1920. The value of these discussions and the demand for the reports is shown by the fact that the accounts of the first two meetings are now out of print. The high level of the present discussion and its modest price will certainly ensure an equally gratifying demand for copies.

B. A. KEEN.