screen being required to shut the blue part of the purple out! Yet this lens gives particularly sharp images, and is a very strong diatom resolver. Now, however, Herr Winkel has revived the American red corrections with Jena glasses. The result is excellent, for brighter, sharper, or, for their apertures, stronger resolving object-glasses will not be found. This red correction is peculiarly suitable, because a peacock-green glass screen turns red into black, and so makes a strongly contrasted image. When the *Podura* was first examined with the 1/7 of 0·85 N.A., for the moment it was difficult to exclude the idea that one of the American red objectives was not on the nose-piece."

The outstanding colour in the fluorite objectives is of the same red tint. In these, of course, the outstanding colour is less, and their definition leaves nothing to be desired.

"Complanat" is a new word coined by Winkel for a new set of Huyghenian eye-pieces which are strictly achromatic and have a perfectly flat field.

Messrs. Angus have also sent us Winkel's new form of screw micrometer. This is based on a suggestion of Koch's. A combination of scale and screw replaces the combination of screw and thread, giving a ready means of obtaining the exact measurement of objects subtending a number of divisions of the scale, the fractional part only of an interval having to be determined by means of the screw. In the instrument real or lateral displacement is measured to 1/500 mm., one turn of the screw travelling over two divisions of the scale, an arrangement which we think will be found inconvenient.

The microscope stand is a beautifully finished specimen of the Continental model; an extension of the horseshoe backwards would make it more stable. The graduation of the scales in the attachable mechanical stage, and its general finish, leave nothing to be desired; the old reputation of the firm for fine metalwork is still kept up.

We have also received from Messrs. Angus a microscope and objectives representing the latest productions of the eminent firm of Reichert, of Vienna, together with a catalogue. As was to be expected, both the optical and mechanical parts are of the highest excellence. In the catalogue the number of fluorite lenses employed in each apochromatic objective is stated. The apochromatic of N.A. 1·30 sent us is a magnificent lens with little trace of colour, and its definition does not break down under a power of 3000.

THE FLORA OF FORMOSA.

PREVIOUS to the acquisition of Formosa by Japan, in 1895, little was known of the vegetation of the mountains of the interior. Many European collectors had visited the island, but none had been able to penetrate the central range, on account of the hostility of the natives. The Japanese soon organised a Botanical Survey, and several botanists have been engaged in the investigation of the flora, the results of their labours having been published from time to time, mostly in English, with Latin descriptions of the novelties, and figures of some of the most remarkable plants. The forerunner was the "Enumeratio Plantarum Formosanarum," by J. Matsumura and B. Hayata, which appeared in 1906. This was followed in 1908 by Hayata's "Flora Montana Formosæ"; and the same author has now issued a bulky and important supplement.[2] As is stated on the title-page, Dr. Hayata worked out his collections at Kew, where he had the opportunity of studying numerous types of genera and species of Eastern plants first described by the Kew botanists.

This work and its predecessors are mainly statistical, descriptive, and pictorial, though publications on the economic botany of the island are not wanting. However, it is possible to extract much that is interesting in the composition of the flora. Taking Dr. Hayata's own figures, the "Enumeratio" comprises 1999 species, belonging to 701 genera and 153 families; and the present supplement brings the numbers up to 2660, 836, and 156 respectively. It should be explained that these figures relate to the flowering plants and ferns and their allies only. In nearly all its features and generic elements the flora of Formosa is essentially Chinese, with a very large number of peculiar species. In all probability the number of species existing is far from exhausted; but the very small generic endemic element is not likely to be much increased by future explorations. Excluding ferns, Forbes and Hemsley's "Enumeration of Chinese Plants" includes representatives of 159 families, so that there are nearly as many in the smaller area as in the large. The same fact comes out in comparing a county flora with that of the whole of England, for example. Although the mountains rise to upwards of 13,000 feet, there is no real alpine flora in Formosa, though many genera are represented that are common to temperate and alpine zones.

Of the Cupuliferæ, the genera Fagus, Alnus, Carpinus, Castanea, Castanopsis, and Quercus are represented, the last-named by thirty-two species. Salix is represented by several species; Populus absent. About five and twenty Coniferæ are recorded, including *Chamaecyparis formosensis*, *Cunninghamia Konishii*, *Juniperus morrisonicola*, *J. formosana*, *Picea morrisonicola*, *Pinus formosana*, *P. taiwanensis*, *Tsuga formosana*, and *Taiwania cryptomerioides*, all of which are supposed to be peculiar to the island. The last is a monotypic genus endemic in Formosa. Nepenthes is not known to occur, nor Pedicularis, whereas in China there are about 150 species of the latter.

Vascular cryptogams are evidently strongly represented, as already there are on record upwards of 300 species of ferns, about twelve species each of Lycopodium and Selaginella, and two species of Equisetum. Orchids number about sixty species, mostly small-flowered and inconspicuous. The foregoing totals are partly compiled from Takiya Kawakami's "A List of Plants of Formosa," published in 1910.

W. BOTTING HEMSLEY.

THE INDIAN SALTPETRE INDUSTRY.[1]

THE production of potassium nitrate in India is probably a very ancient industry, and at the present time, in spite of German competition, the export still amounts to about 20,000 tons per annum. As is well known, the potassium nitrate is extracted by natives from soil collected in the villages, where in all probability it has been formed by bacterial decomposition of the organic matter, with production first of ammonia and subsequently of nitrates. The chemical and bacteriological changes have not yet been studied, but the actual methods of extraction have recently been described by Dr. Leather and Mr. Mukerji in a well-illustrated bulletin issued by the Pusa Research Station.

The soil from which the crude saltpetre is extracted usually contains about 3 to 5 per cent. of pure potassium nitrate, although there may be as little as 1 per cent. or as much as 29 per cent.; chlorides and sulphates are invariably present as well. The soil is scraped together in small quantities and collected by a very low caste called "Nuniah" or "Lunia," who also carry out the extraction process. An earthen chamber, called the "Kuria" or "Kothi," is first made of wet mud and then allowed to dry; the floor of this slopes somewhat from back to front, where a hole is made at the lowest point for the escape of the nitrate liquor. Raised a few inches above the floor, and supported by a few loose bricks, is a false bottom made of bamboos and matting, on which the saltpetre earth is laid with the greatest care and so trodden in that no crevices shall exist. As a rule wood ashes are mixed with the earth beforehand. The filling-in process is stopped when the layer of soil is about 6 to 8 inches in thickness; a small piece of matting is then laid on the top, and water is poured in until about one inch lies on the surface of the soil. Several hours elapse before the water has percolated and begun to flow out from the hole. It usually emerges as a fairly concentrated clear solution, coloured brown by

[1] A delicate test for colour is the raphæ of a Cherryfield Rhomboides, when mounted in balsam, quinidine, or styrax.

[2] Materials for a Flora of Formosa. Supplementary Notes to the Enumeratio Plantarum Formosanarum and Flora Montana Formosæ, based on a Study of the Collections of the Botanical Surveys of the Government of Formosa, principally made at the Herbarium of the Royal Gardens, Kew. Journal of the College of Science, Imperial University of Tokyo, vol. xxx., 1911, pp. 471.

[1] "The Indian Saltpetre Industry." By J. W. Leather and Jatindra Nath Mukerji. Agricultural Research Institute, Pusa. Bulletin No. 24, 1911.

organic matter. The first runnings are put into a pan and further concentrated by exposure to the sun, or by boiling over a fire until a mixture of sodium chloride and potassium nitrate, with varying quantities of sodium sulphate and magnesium nitrates, separates out. This is sold to the refiner as crude saltpetre. The mother liquor is thrown on to the heap of saltpetre earth, the so-called factory, to which are also added the wet soil from the "Kuria" and the weaker solution of nitrates coming out in the later stages of the percolation, and requiring too much fuel to make further concentration worth while. After a time the heap can again be extracted, and so the process goes on perpetually. Fresh village earth is constantly being added, but no special additions of organic matter seem to be made.

At the refinery the crude saltpetre, the impurities of which are soil, sodium sulphate, sodium chloride, and magnesium nitrate, is added to a boiling mother liquor from a previous operation. This liquor, being already saturated with sodium chloride and sodium sulphate, only dissolves the nitrate. When the insoluble matter has subsided, the clear liquor is run into wooden vats, and on cooling deposits a good deal of potassium nitrate, that only requires to be drained and slightly washed to be ready for market. The insoluble material still contains some potassium nitrate, and is thrown out on to the factory heap of nitre earth, from which more nitrate is subsequently again extracted as before. The mother liquor cannot be used indefinitely for the purification of the crude saltpetre, but it is not wasted. When it becomes too impure for further use, it is concentrated to deposit some of the sodium chloride, and the final liquor is simply thrown on to the factory heap again. Whilst the extraction process is remarkably efficient, considering that it has been evolved by the natives themselves without outside help, the refinery process is admittedly wasteful, and various improvements are suggested by Messrs. Leather and Mukerji.

GEOPHYSICAL RESEARCH.[1]

TO write the history of the earth is a very different undertaking from writing the history of a people. In the latter case, a diligent seeker can usually find some ancient monastery where far-sighted historians of an earlier generation have collected the more important records which he requires, and placed them within reach of his hand. With the earth's history, which is the province of geology, it is another matter. The great globe has been millions of years in the making, and, except for a mere fragment of its most recent history, it has had neither a historian nor an observer. Its formation has not only extended over an almost incomprehensible interval of time, but we have no parallel in our limited experience to help us to understand its complicated development, and no system of classification adequate to the task, even of grouping in an orderly way all the observed rock and mineral formations with reference to the forces which moulded them. And even if we could correctly interpret all the visible rock records, we are still quite helpless to comprehend all those earlier activities of the formation period, the record of which is now obliterated.

To the student of the earth's history, therefore, the problem of gathering and ordering such a widely scattered and heterogeneous collection of effects and causes is one of somewhat overwhelming scope and complication. In the industrial world, a situation of this kind soon results in replacing individual effort with collective effort, in the organisation of a system of a scope more appropriate to the magnitude of the task. We are familiar with industrial organisation and the wonderful progress in the development of American industries which has everywhere followed it. We are also familiar with organised geological surveys and the success which has attended them in geological and topographical classification. But the idea of organising research to meet a scientific situation of extraordinary scope and complexity is still comparatively new. The very words science and research are still regarded as referring to something out of the ordinary, something to be withheld from the common gaze, to be kept hidden in a special niche, behind a mysterious curtain and served by priests of peculiar temperament and unpractical ideals. This is both disparaging to our good sense and prejudicial to the progress of knowledge. Scientific research is not a luxury; it is a fundamental necessity. It is not a European fad, but is the very essence of the tremendous technologic and industrial success of the last twenty years, in which we have shared.

Prof. Nichols, of Cornell, as retiring president of the American Association for the Advancement of Science, put the case in this way: "The main product of science (research) . . . is knowledge. Among its by-products are the technologic arts, including invention, engineering in all its branches, and modern industry." The idea of scientific research is therefore not less tangible than industrial development, or less practical; it is merely one step more fundamental; it is concerned with the discovery of principles and underlying relations rather than their application. This being true, research should profit as much from efficient organisation as industrial development has done, or even more.

Although this conclusion is making its way but slowly in American science, in geological research, where material must be gathered from the utmost ends of the earth and even from within it, and where nearly every known branch of scientific activity finds some application, there is a peculiarly favourable opportunity for organised effort which is already coming to be recognised. "So long as geology remained a descriptive science," says President Van Hise, of Wisconsin, "it had little need of chemistry and physics; but the time has now come when geologists are not satisfied with mere description. They desire to interpret the phenomena they see in reference to their causes—in other words, under the principles of physics and chemistry. . . . This involves cooperation between physicists, chemists, and geologists."

In a general way, physics, chemistry, and biology have already supplied working hypotheses which have been used by students of geology to help in the examination, classification, and mapping of the most conspicuous features of the exposed portion of the earth. The geologist has gone abroad and has studied the distribution of land and water, the mountain ranges, the erosive action of ice and of surface water and the resulting sedimentary deposits, the distribution of volcanic activity and of its products, the igneous rocks; or more in detail he has studied the appearance of fossils in certain strata, and has inferred the sequence of geologic time. The distribution of particular minerals and of ore deposits has been carefully mapped. Regions which offer evidence of extraordinary upheaval through the exercise of physical forces have been painstakingly examined, and so on through the great range of geologic activity. In a word, the field has been given a thorough general examination; but the manifold problems which this examination has developed, although early recognised, and often the subject of philosophical speculation and discussion, still await an opportunity for quantitative study. They are often problems for the laboratory and not for the field, problems for exact measurement rather than for inference, problems for the physicist and chemist rather than for the geologist. This is not a result of oversight; it is a stage in the development of the science—first the location and classification of the material, then the laboratory study of why and how much.

Certain indications have led us to believe, for example, that the earth was once completely gaseous and in appearance much like our sun. Indeed, it possibly formed a part of the sun, but through some instability in the system became split off—a great gaseous ball which has cooled to its present condition. The cooling probably went on rapidly at first until a protecting crust formed about the ball, then more and more slowly, until now, when our loss of heat by radiation into space is more than compensated by heat received from the sun. Obviously, the earliest portions of this history are, and must remain, dependent upon inference, but the formation of a solid crust cannot advance far before portions of it become fixed in a form such that further disturbance does not destroy

[1] Presidential address delivered at the 700th meeting of the Philosophical Society of Washington, November 25, 1911, by Dr. Arthur L. Day. Reprinted from the Journal of the Washington Academy of Sciences, December 4, 1911.