The Sennar Dam and the Gezira Irrigation Project.

IN the Sudan, immediately south of Khartum, lies an extensive plain, known as the Gezira Plain, constituting the triangular tract of land enclosed between the two branches of the Nile—the White Nile and the Blue Nile, which unite at Khartum. Some fifteen or twenty years ago this area, comprising considerably more than 3,000,000 acres, was a barren waste. To-day, a substantial part of it is under cultivation and covered with crops.

It was Sir William Garstin who, in recent years, first envisaged the idea of rendering this sterile tract cultivable. He put forward the suggestion at the beginning of the present century, and the possibilities of a system of artificial irrigation attracted favourable attention. After due consideration, the project ultimately materialised in accordance with plans prepared by Sir Murdoch Macdonald.

The scheme provided, in the first instance, for the construction of a dam across the Blue Nile at Makwar, a little village a few miles south of the more important town of Sennar. It was not, however, until 1913 that the necessary financial arrangements were completed, enabling the work to be begun in 1914. Suspended more or less during the War, operations were actively resumed thereafter, and the dam, as announced in NATURE of January 30, p. 167, was officially opened by Lord Lloyd on January 21, although the constructional work was actually completed last June, and the irrigation scheme has been in operation since the autumn.

FIG. 1.—Sennar Dam. General view of the works taken from the downstream of the Dam on the west bank on May 1, 1925.

Broadly speaking, it may be said that the area which has been canalised and rendered cultivable is equal to the county of Bedfordshire. The total length of main canals is about one thousand miles, and the length of the subsidiary canals is considerably greater. The surface soil is loess (black cotton soil), and the excavation was carried out by drag-line excavators.

The dam itself is an immense structure 3025 metres (nearly two miles) in length, built of granite rubble masonry, which has been founded on an outcrop of gabbro. It is substantially built and contains 422,440 cubic metres of stone and cement. The maximum height of the dam is 39·5 metres and the foundations are carried 10 or 12 metres down below the river bed. The central portion of the dam across the river channel, 1800 metres in length, is pierced by 80 sluices, each 8·4 metres high and 2 metres wide. Above this are 72 small spillways, 2 metres high and 3 metres wide, while at each end of the sluice dam there are 20 large spillways, 5 metres wide and 2 metres high. The main canal head regulator, on the western bank, consists of fourteen sluices, 3 metres wide and 5 metres high. The Sudan Government Railway is laid across the dam, and is to be extended at a later date so as to connect up with the existing line at Kassala and so to communicate with Port Sudan.

FIG. 2.—Gezira canalisation, March 10, 1925. View of main canal at Kilometre 80 from the Dam, showing a branch canal on the left, and on the right an area already developed and under cotton, and watered by pumps on the river.

The reservoir formed by the dam is capable of containing 636 million cubic metres of water, or, after allowing for evaporation, 485 million cubic metres. In the cycle of seasonal flow, the reservoir will be filled during November, when the river is free from silt, and the impounding water will be used for irrigation from the middle of January to the middle of April. This reservoir will enable the whole of the natural supply of the upper Nile to be transmitted into Egyptian territory, only that portion of the water being retained in the Sudan for irrigation purposes which would otherwise pass off during flood into the Mediterranean. The present cultivable area lies at a distance of 57 kilometres from the dam and is served by a main canal, 114 kilometres in length. In the process of cultivation, crops will be grown in rotation. Of the 300,000 acres now irrigated, one-third will be assigned to cotton cultivation each year, and 100,000 acres to other crops, of which one-half will be maize, the staple food of the cultivator, and one-half lubia, a leguminous bean suitable for cattle fodder. The remaining 100,000 acres will lie fallow.

The full development of the scheme for the irrigation of the Gezira Plain involves the construction of another dam across the White Nile at Gebel Aulia, about thirty miles south of Khartum. The object of this dam, the construction of which is not yet commenced, is to ensure the summer water supply of Egypt.

The whole project is a remarkable manifestation of the benefits to be derived from the regularisation of forces of Nature, which in their unrestrained condition cause barrenness and waste, but when skilfully controlled add immeasurably to the resources at the disposal of mankind and bring comfort and prosperity in their train.

The consulting engineers for the scheme during the last two years have been Messrs. Coode, Fitzmaurice, Wilson, and Mitchell, who have courteously supplied the photographs reproduced herewith. The contractors were Messrs. S. Pearson and Son, Ltd., represented by Sir Frederick Hopkinson. The chief resident engineer for the Sudan Government was Mr. O. L. Prowde. The cost of the dam structure has been about 5,600,000*l.*, or, including the canalisation works, 8,500,000*l.*, but with preliminary expenses and other outlays the total cost of the project, so far, to the Sudan Government is in the neighbourhood of 13,000,000*l.*

Smokes as Aerial Colloids.

By Prof. R. WHYTLAW-GRAY.

CONSIDERING the rapid growth of colloid chemistry, it is remarkable that systems of finely divided matter suspended in gases have attracted so little attention from workers in pure science. This is all the more surprising because, on first consideration, such systems appear to be the simplest of all forms of disperse material, and it might be contended that just as the principles of the older chemistry originated from a study of gases, the investigation of aerial suspensions might throw a new light on the many complexities of the colloid state.

Apart from researches in physics which deal with the motions of individual particles mainly of microscopic dimensions, and centre around the question of unit electronic charge, much of the literature in this field is of an applied character, such as, for example, the cause and prevention of dust explosions in coal mines and factories, electrical precipitation, filtration, and settling, and the pathological effects of silicious and other dusts. Information on the stability of smokes, their electrical character and constitution, the size and nature of the aggregates formed on flocculation, is inadequate and meagre, so that the inquirer, unless he is prepared to make experiments himself, is perforce compelled to deduce the properties of these systems from first principles. This is the method followed by Dr. W. E. Gibbs in the very interesting survey of the subject delivered before the Chemical Engineering Group of the Society of Chemical Industry on October 9, and entitled "Aerosols in Industry."

From the literature available, Dr. Gibbs concludes that a close parallelism exists between these systems and the better known hydrosols. Thus smokes in general should owe their stability to the particles all carrying a charge of the same sign, and loss of charge should bring about flocculation or coagulation. The existence of an iso-electric point is assumed, and this it is stated can be reached by adsorption either of gaseous ions or of smoke particles of opposite electric sign. Stability is believed to be enhanced by adsorption from the medium of a protective gas sheath which diminishes the chance of adhesion or coalescence of the smoke particles on collision. It must be confessed that this is an attractive working hypothesis which is supported by the work of Rudge on the charges carried by dusts and also by many observations which have been recorded in the literature.

It seems but a step to go from aerosols to aerogels, and from protection to peptisation, and to assume, as the present writer did some years ago, that the counterpart of all the main characteristics of suspensoid colloids can be discovered in these aerial systems. This, indeed, may prove ultimately to be the case, but in the present state of our knowledge, more is to be gained from a study of the differences than by the pursuit of an analogy which is based on scanty experimental evidence.

Before this view can be tested, it is essential to be able to determine the degree of dispersion in aerosols and to trace how this varies under different experimental conditions. In the case of dusts, many methods are available for estimating the total weight of suspended matter and the number of particles in a given volume, but with the more highly disperse systems consisting mainly of units near the limit of the microscope, to which alone the term aerosol is really applicable, recourse must be had to the ultra-microscope and to special methods of filtration. An attempt along these lines has been made by the present writer and his colleagues. During the last few years a number of fine oxide smokes, composed of non-volatile materials, have been examined in some detail, and it has been shown conclusively that these differ sharply from hydrosols in two fundamental points at least.