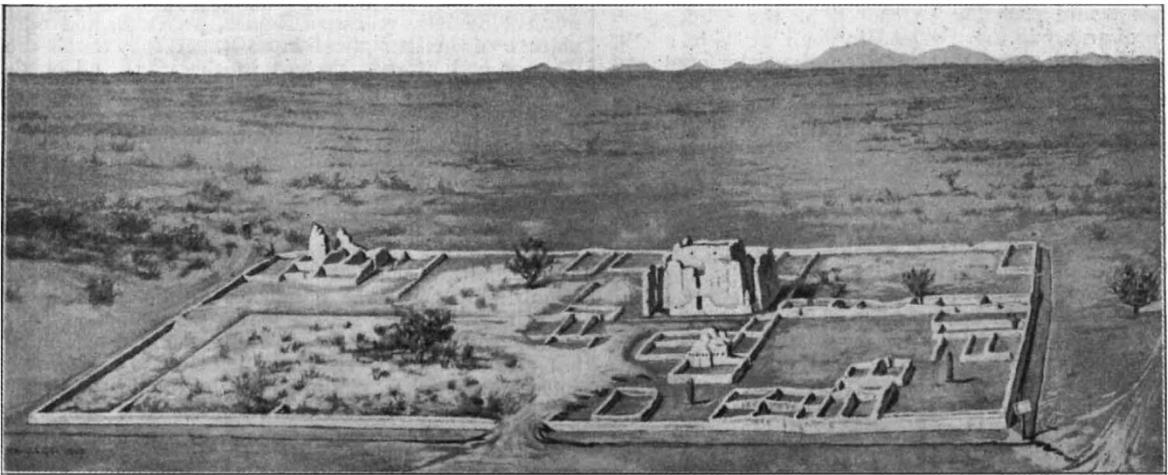


the Zuñi and the Hopi, according to their legends, with whom they still live.

Although Dr. Fewkes refers to the Hohokam as being "homogeneous," the fact that they practised two forms of burial would lead one to suppose a mixture of two cultures. He also points out that whereas the Hohokam dwellings were rectangular, those of the Pima are circular in form, but some of the Pima houses are rectangular; also the Pima do not burn their dead. Dr. Fewkes concludes by saying: "In considering the prehistoric migrations of agricultural peoples in the south-west, especially with respect to changes in culture and to diminution of population, we must not lose sight of the influence of increased salinity due, directly or indirectly, to long-continued prehistoric irrigation. This cause was perhaps more effectual than human enemies or increased aridity [as Ellsworth Huntington claims] in breaking up the prehistoric culture. If barrenness of the soil, due to the

This new base was measured near the town of Lossiemouth, on the southern shore of Moray Firth, and the operations have been described in Professional Paper, No. 1, 1912, where the probable error of the final value is given as 1 in 900,000. The original triangulation was computed in terms of the 10-ft. standard bar of the Ordnance Survey, and a useful chapter of this paper places on record the relations between this bar, the French legal metre, and the international metre of the Bureau International des Poids et Mesures. The three stations—Corrichabbie, Mormon Hill, and Knock of Grange—in the principal triangulation were selected near the Lossiemouth base for the work of verification; but some difficulty was experienced on account of the observation points not having been marked originally in as permanent a manner as is now employed, wooden pickets having been used. All triangulation points that are now being occupied and those of the test triangulation are



Bird's-eye view of Compound A, from the east.

cause mentioned, led to the abandonment of populous aboriginal compounds, this fact has an important bearing on the future of the white farmers in the Gila and Salt River valleys." A. C. HADDON.

THE PRINCIPAL TRIANGULATION OF THE UNITED KINGDOM.¹

THIS publication of the Ordnance Survey deals with a subject of especial interest, since it sets forth the operations which were undertaken in 1910, 1911, and 1912, in order to test the accuracy of a portion of the principal triangulation of the United Kingdom, and discusses the results obtained. This triangulation, which was observed during the seventy-two years, 1783-1855, comprises 552 triangles, and the mean error of an angle as given by Ferrero's formula, $M = \sqrt{\frac{\sum \Delta^2}{3n}}$ is $\pm 1.8''$, a value which is somewhat larger than that of recent first order triangulation. This raised the question whether the triangulation was suitable for incorporation with recent Continental geodetic work. It was therefore decided to measure a new base in a part remote from the principal bases of the triangulation at Lough Foyle and on Salisbury Plain, and to re-observe a portion of the principal triangulation in its neighbourhood.

¹ Ordnance Survey. Professional Papers, new series, 2. "An Investigation into the Accuracy of the Principal Triangulation of the United Kingdom." By Capt. H. St. J. L. Winterbotham. With an Introduction by Col. C. F. Close. Pp. 20+v plates. (London: H. M. Stationery Office; Wyman and Sons, Ltd., 1913.) Price 2s.

marked with bronze bolts set in rock or in a thick foundation of concrete.

The angles were measured with a 12-in. theodolite constructed for this work by Messrs. Watts and Sons, the horizontal circle being read by means of three microscopes. Eight arcs were observed, and the mean error of an angle in the twenty-nine triangles is given as $\pm 0.517''$.

For marking the points to be observed both lamps and heliostats were provided, the pattern being the same as that used in the measurement of the arc of meridian in Uganda; but it was rarely possible to use the heliostats even during the exceptionally fine summer of 1911, and practically all the observations were made on lamps. The theodolite is briefly but not exhaustively described, and a detailed investigation of it would be of much interest. The readings of the horizontal circle are to single seconds, and to tenths of a second by estimation; the vertical circle is only 6 in. in diameter, and is read to one minute of arc, being merely intended for setting to any known angle of elevation.

A special plumbing telescope, which is screwed into the upper horizontal plate, and can be focussed to view marks at from 3-20 ft. distant, provides the means for accurately centring the instrument over the station mark. Concrete observing pillars were used at each station, and were made with a central vertical shaft over the station mark, this being illuminated through horizontal view-holes provided in the base of the pillar.

A large triangulation error which was found in the

base extension is discussed, and the conclusion is reached that it was probably due to lateral refraction caused by a cairn near to which the doubtful ray passed.

The alterations which this check triangulation would produce in the sides which were revised were from 1 in 39,000 to 1 in 94,000, and the angular corrections from 0.989" to 1.066".

Captain H. Winterbotham proceeds to discuss the accord between the bases which have been measured at Salisbury Plain, Lough Foyle, Lossiemouth, and the French base at Paris, calculated through the side Cassel les Harlettes, and investigates the accuracy of the triangulation as shown thereby. Four other bases which were measured with Ramsden's steel chains at the beginning of the eighteenth century are also compared, though they were not used in the reduction of the triangulation, and are in good agreement with the other results.

The general result is to show that the alteration which would probably be caused by the re-measurement of an arc in the United Kingdom would be small, and that the agreement between the calculated and computed lengths of the Salisbury Plain and Lough Foyle bases was not accidental, since the other bases here used indicate an accuracy of triangulation of the same order.

H. G. L.

THE BONAPARTE FUND.

THE Committee appointed by the Paris Academy of Sciences to allocate the amount placed at its disposal by Prince Bonaparte, makes the following proposals for grants during 1914.

2000 francs to Dr. Pierre Breteau, for the continuation of his researches on the use of palladium in analysis and organic chemistry; 2000 francs to M. Chatton, to enable him to continue his researches on the parasite Peridinians; 3000 francs to Dr. Fr. Croze, for the purchase of a concave diffraction grating and a 16 cm. objective, to be used in work on the Zeeman phenomena in line and band spectra; 6000 francs to Dr. Hemsalech, for the purchase of a resonance transformer and battery of condensers, to be used in his spectroscopical researches; 2000 francs to P. Laïs, for assisting the publication of the photographic star map; 2000 francs to M. Pellegrin, to assist him in pursuing his researches and continuing his publications concerning African fishes; 2000 francs to Dr. Troussel, to assist him in his studies of the minor planets; 2000 francs to M. Vigouroux, to enable him to continue his researches on silicon and its different varieties; 3000 francs to M. Ailuaud, to assist the publication (with Dr. R. Jeannel) of the scientific results of three expeditions to eastern and central Africa; 9000 francs divided equally between MM. Pitart, de Gironcourt, and Lecointre, members of the Morocco expedition, for scientific study, organised by the Société de Géographie; 2000 francs to M. Vasseur, for the continuation of his geological excavations in a fossil bearing stratum in Lot-et-Garonne; 3500 francs to Dr. Mauguin, for the continuation of his work on liquid crystals and the remarkable phenomena presented by these bodies when placed in a magnetic field; 2000 francs to Dr. Anthony, to defray the cost of his researches on the determinism of morphological characters and the action of primary factors during evolution; 4000 francs to M. Andoyer, to assist the publication of his new set of trigonometrical tables; 4000 francs to M. Bénard, to enable him to continue, on a larger scale, his researches on experimental hydrodynamics; 2000 francs to Dr. Chauvenet, for the continuation of his researches on

zirconium and the complex combinations of that element; 2000 francs to François Franck, for the chronological study of the development of the embryo, with special examination of the rhythmic function of the heart; 2000 francs to M. Sauvageau, for the pursuit of his studies on the marine algae.

The Committee recommends these eighteen grants after considering close upon sixty applications for assistance. The amount allocated for the year is 54,500 francs.

NAPIER TERCENTENARY CELEBRATION.

THE Tercentenary Celebration of the publication of Napier's Description of the Wonderful Canon of Logarithms opened formally on July 24 under the auspices of the Royal Society of Edinburgh. On Thursday at two o'clock, however, the Committee was able to open to the members of the congress the exhibition of books, calculating machines, mathematical models, relics of Napier, portraits, and other objects of mathematical interest. A fair number of visitors had already arrived in the city, and on the Friday morning the examination room of the University, in which the exhibition was arranged, was a lively scene. The tide-predicting machine under the charge of Mr. Edward Roberts attracted a large amount of attention. Many forms of arithmometers and calculating machines, from the abacus of the East and Napier's "Bones" down to the beautiful instruments of the present day occupied a large part of the hall. Each member received, along with his membership card, the handbook of the exhibition, a large octavo of 340 pages, which contained, not only a descriptive catalogue of what was on exhibition, but also sustained scientific articles on sun-dials, slide rules, integrators, planimeters, harmonic analysers, nomograms, mathematical models, etc., etc. The articles were contributed mainly by members of the mathematical departments of the Universities of Edinburgh and Glasgow, under the editorship of E. M. Horsburgh.

The opening meeting of the congress was held in the debating hall of the University (Students') Union. The Lord Provost of Edinburgh occupied the chair and introduced Lord Moulton in a brief speech, recalling the main facts of Lord Moulton's mathematical career. Among the audience which filled the fine hall may be mentioned Prof. Andoyer, Prof. Bauschinger, Prof. Cajori, Sir William Bilsland, Dr. Dugald Clerk, Prof. Conway, Dr. Glaisher, Dr. J. P. Gram, Prof. Hill, Prof. Hobson, Prof. Macdonald, Major MacMahon, Dr. Conrad Müller, Sir Alexander Napier, Prof. Nielsen, Prof. d'Ocagne, Prof. Putnam, Berkeley, Cal., Dr. Sheppard, Prof. Stekloff, limiting the list to a few of the representative men from a distance.

Lord Moulton, in his inaugural address, endeavoured to trace the origin and growth of the ideas which finally took form in Napier's *Descriptio*. Emphasis was laid upon the fact that Napier's first table is a table of logarithms of *sines*. This seemed to indicate that Napier's intention was to facilitate trigonometrical calculation, although in the *Descriptio* itself this limitation soon disappears from view. Lord Moulton divided what he judged to be the course of discovery into three stages. The first stage was to create tables which would enable numbers to be multiplied together without actually performing the calculation. For this purpose they must proceed in an order resulting from continued multiplication. The word logarithm seems to preserve the trace of this stage, for there can be little doubt that the word means "the number of the ratio." The second stage