

GEODETIC OBSERVATIONS AND TRIANGULATION IN KASHMIR (DE FILIPPI EXPEDITION, 1913-14)

Spedizione Italiana De Filippi nell' Himàlaia, Caracoràm e Turchestàn
Cinese (1913-14).— Series I. Geodesia e Geofisica. Vol. I. Astronomia
Geodetica, Geodesia e Topografia. Alberto Alessio e Giorgio Abetti. Bo-
logna: Nicola Zanichelli. [1925.] 12 × 8½, pp. xxxv. + 415. *Map,*
51 *Plates and Charts.*

THE Introduction to the volumes of Series I., by Dr. De Filippi, gives an admirably concise account of the whole campaign from its first inception. The thorough scientific exploration of the broad zone between the Punjab and Chinese Turkestan (including, therefore, the Western Himalayas, the Upper Indus Valley, the Southern Karakoram, and part of the highest plateau in the world), which was the object of this expedition, might have remained an ambitious dream but for the energy of its authors and the whole-hearted cooperation of His Majesty the King of Italy and of the Italian Government. The scientific branches of the Army, the Navy, and the Universities contributed not only experts but most of the scientific instruments. Financial support came mainly from Italian sources, but also from many foreign scientific societies, including the Royal Geographical Society. Dr. De Filippi writes most warmly of the debt of gratitude which the expedition owes to the Government of India for interesting the Maharajah of Kashmir and his officials in the work, for permitting the close cooperation of the Indian Survey and the Observatories Departments, and for the loan of experienced officers.

The scientific exploration was necessarily divided into two groups: (1) the *instrumental group*, under Captain A. Alessio (lately hydrographer of the Italian Navy), and Prof. G. Abetti, who were in charge of the geodetic, geophysical, and meteorological measurements and observations, the results of which form the subject-matter of the three volumes of Series I. (2) The *exploratory group*, under Prof. G. Dainelli, in charge of the geological, ethnographical, and geographical investigations, the results of which form the matter of the nine volumes of Series II.

The complete instrumental equipment, with the personal effects and camp equipment of the Europeans, weighed 4 tons, and required for their transport alone 60 ponies and 20 porters. The supplies of European food (over 6 tons) necessitated a corresponding additional transport quite apart from the fodder and the food for the natives required during the six months spent in the Upper Indus Valley. It was no light task to organize beforehand this mass of material so that it could be subdivided almost at will and leave individuals free to move in any direction with their proportion of instruments and supplies.

From the arrival of the party at Bombay on 22 August 1913, not a day was wasted. A thorough geological and glaciological examination of the Vale of Kashmir, and the fixing of several geodetic stations between the Zoji-La and Skardo, occupied most of September. The next seven months were spent in strenuous winter work in the Upper Indus.

Meanwhile over 50 tons of food for the caravans and fodder for the horses and yaks had been collected, partly from Kashmir, partly from the Punjab, in the vicinity of Leh, and the whole expedition assembled without a hitch early in June 1914, a few miles south of the Karakoram Pass, on the Depsang Plains (17,590 feet), which had been selected as the headquarters of the expedition during its three months' sojourn in Eastern Kashmir.

Part I. Geodetic Astronomy, pp. 5-230.

Chapter I., by Prof. G. Abetti, gives in detail the various observations by Captain Alessio and himself and the methods adopted in determining eleven principal latitudes. The probable errors varied between $\pm 0''\cdot 16$ and $\pm 0''\cdot 34$, a degree of accuracy which might be expected in major geodetic operations, but unprecedented in the course of an exploring expedition in remote regions and under most unfavourable physical conditions.

Chapter II. is concerned with time determinations, also by Prof. Abetti. Here, as elsewhere, can be seen that remarkable attention to detail which distinguishes the methods of these two observers. The observations were undertaken partly for the determination of the difference in longitude between the various stations of the expedition and Dehra Dun, and partly for finding the rates of the chronometers and especially the rates of the instrument used for timing the pendulums in the gravity observations, the results of which have not yet been published and are awaited with great interest.

Chapter III. Astronomical Determinations of Longitude.—Prof. Abetti opens with a brief historical sketch of experiments in the use of wireless time signals prior to 1913, when radiotelegraphy was still in its infancy. In succeeding paragraphs he describes the apparatus and the methods used in the Italian expedition. At that time there was no great wireless station in India from which controlled time signals could be sent out regularly, but it was arranged that the small wireless station at Lahore should send signals (Plate XVIII.) to be received at Dehra Dun, and in the field. There is a detailed account of the conditions which favoured or prevented the reception of the signals at the various stations, and full particulars of the determination of the exact longitude of the transit instrument at Dehra Dun and of five stations in Kashmir, viz. Skardo, Lamaiuru, Leh, Depsang (connected with India by triangulation), and of three stations in Chinese Turkestan, viz. Sughet Karol (hitherto unfixed), Yarkand, Kashgar.

Chapter IV. Nautical Methods applied to Land Operations.—Captain Alessio discusses in considerable detail the value of the methods employed in the Italian Navy, in view of their comparative simplicity. He puts forward arguments for the exclusion of a Prismatic Astrolabe and for preferring the Zenith telescope and Transit Instrument for accurate determinations, and the use of the sextant for minor stations where portability was of first importance. The rest of the chapter contains minute details of the preliminary tests on the chronometers, and of the watch kept on the rates of each individual instrument; and further, an account of the determination of seven differential longitudes with the sextant and chronometers.

Part II. Geodesy and Topography, pp. 235-415.

Chapter I. The Determination of Station Coordinates.—Captain Alessio gives the details of the methods adopted by Prof. Abetti and himself for determining the coordinates of all the gravity and magnetic stations. In some cases, e.g. Skardo, the work amounted to a triangulation of the whole basin (see Plates II. and III., vol. 8, Series II.), and in this connection a valuable investigation was made (pp. 254-266) on the behaviour of *invar* wire at temperatures below 0° C. The coordinates of twelve stations are printed *in extenso* together with the coordinates and altitudes of all important points visible from the central stations. Among the plates will be found panoramic photographs of all these stations; on each are marked by arrows the exact positions of the instrumental stations and of important peaks. The care taken to secure future identification of the exact sites is characteristic of the attention to detail which is so marked a feature of every part of the work in this expedition.

Chapter II. Barometers and Hypsometers for Altitude Determinations.—Captain Alessio discusses the application of Laplace's formula for deducing the difference of altitude between two stations, and expresses a decided preference for the modification adopted in the International Meteorological Tables of 1890, as compared with that adopted by Angot in the *Instructions Météorologiques* of 1903.

Five mercurial barometers travelled with the expedition, and a sixth was brought out later by Prof. Alessandri, who actually carried it himself during the whole journey! The most elaborate precautions were taken in the packing and transport of these instruments, yet only the sixth actually returned safe to Italy. Two Fuess hypsometers, specially made and rigorously tested, were also included in the equipment, in the first instance merely for the purpose of studying their behaviour under extreme conditions. A most exhaustive series of comparisons between the barometric and the hypsometric results (pp. 362–372), however, greatly impressed Captain Alessio and caused him to set a high value on the hypsometer, especially in view of its portability and the small risk of damage. He therefore formulates certain important conclusions: (1) that the accidental error in reading a hypsometer is negligible as compared with the accidental errors in reading a barometer for determinations of atmospheric pressure; (2) that the correction to a hypsometer is a function of the prevailing low pressure and of the prevailing temperature, and tends to increase *positively* with the diminution of the prevailing pressure and with the increase of the prevailing temperature; (3) that when, and only when, it becomes possible to ascertain the exact effect on the thermometers of these factors (long-continued low pressure and great variations of temperature), then a determination of atmospheric pressure by a fully standardized hypsometer will be of the same order of accuracy as that by a mercurial barometer of the best type, observed under the most favourable conditions.

At the end of the discussion (p. 373), Captain Alessio suggests that some mountain observatory, such as that on Monte Rosa, might usefully undertake the study of hypsometer readings under varying conditions, and he expresses his opinion that this might probably lead to “the triumph of the hypsometer over the barometer”! The attention to detail in the above comparison and in the investigation of the effect of the other variables (temperature and humidity) on the determination of altitude makes the whole inquiry a notable example of physical research, often under almost Arctic conditions.

Chapter III. Geodetic and Topographical Operations.—Signor G. A. Spranger here gives an account of the triangulation carried out by Major H. Wood, R.E., and himself, with the assistance of Jamna Pershad and Shib Lal, two experienced Indian surveyors lent by the Survey Department of India.

Heavy snowstorms in the pass behind Leh and the gorge-like valley of the upper Shyok greatly hampered the plane-table traverse and the recognition of fixed points; and, after arrival on the Depsang Plain, the weather was so bad that it was decided to measure a base and to start an independent triangulation resting on astronomically observed latitudes and azimuths. Fortunately the weather improved shortly afterwards, and it became possible to observe a great many peaks, including K_2 and one of the Teram Kangri peaks and others fixed by the Indian Triangulation. Plate XLIX. shows the chart of the Depsang triangulation: it is the framework for the fine map given in the ‘Storia’ of the De Filippi Expedition. As will be seen, the triangulation is divided into two parts by a west and east line through the Karakoram Pass,

and that therefore the connection between the two parts is rather weak. This weakness, however, was greatly diminished when it became possible to check the whole work by fixing the ultimate station towards the north by means of rays to the Gasherbrum peaks and to 12/52 E. The very unfavourable weather rendered the work extremely difficult, and the fine results achieved reflect great credit on all concerned.

Chapter IV. Photographic Work.—Major C. Antilli, of the Italian Engineers, the official photographer, gives a concise account of the outfit (p. 409). Films and film-packs were used throughout and proved eminently satisfactory, though special precautions were needed during very dry weather owing to the risk of electrification, and also whenever the moon was shining on snow surfaces. Pure water for developing and washing was often a very real difficulty. In addition to a large number of photographs taken by private cameras, 4000 official exposures were made and some 2600 negatives were catalogued, besides several hundred metres of cinematograph films of characteristic scenes and costumes in Baltistan and of the religious masked dances in Ladakh. The splendid plates which adorn this and the other volumes * so far published are in themselves sufficient testimony to the excellence of the photographic work.

B. B. D.

REVIEWS

EUROPE

Majorca.— **Henry C. Shelley.** London: Methuen & Co. 1926. 9 × 5½, pp. xxiii. + 283. *One Map.* 10s. 6d. net.

A PLEASANTLY written book which should be in the hands of every intelligent British and American visitor to this delightful island. The first quarter of the volume gives a good account of the history from the earliest times up to the Catalan revolt of 1640 and the war of the Spanish Succession. Full use has been made of Foster's translation of the original Chronicle of James of Aragon, surnamed the Conqueror, who drove out the Moors in 1229, as well as of the standard works of Piferrer and Quadrado, Maria Bover, and other historians. Then follows an excellent chapter on Palma, the author dwelling lovingly and judiciously on the architectural details and other beauties of that charming old capital, once the pride and glory of merchant princes of the Mediterranean. The mediæval Almudaina, which incorporates much of the earlier palace of the Moorish kings, the magnificent cathedral founded by the first Christian king, and the famous fifteenth-century Lonja, or Exchange, are all well described. Readers of the book will cordially endorse the author's regret that so little use is now made of the third of these noble buildings. A few mediæval retablos and some indifferent modern paintings are practically all that is contained in this so-called "museum." And yet close by, hidden away in an almost inaccessible corner of the Bishop's Palace, "practically unknown to the visitor," is an extensive and rich storehouse of archæological treasures, Iberian, Carthaginian, Greek, Roman, Moorish, and Mediæval, crying out for such a setting as the glorious old Lonja would afford. Also, as

* The following reviews have already appeared in the *Journal*: Series II. vol. 1, 'Storia' or General Report, 66, p. 254; vol. 3, 'Glaciology,' 63, p. 243; vols. 8 and 9, in 68, p. 257. In the footnote to the last on p. 257 the following corrections should be made: line 1, for "fourteen vols." read "thirteen"; line 5, for 43 read 63; line 6, for 46 read 66.