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michael (*Quibda*), Niebuhr (*Kowäbde*), Capper (*Cœbda*), Taylor (*Qebda*). Plaisted and Taylor saw only a ruined village and a fort—Capper said it had been ruined by the Persians—but in the days of Della Valle it was "a town." It seems to have been the usual "rendezvous" for outgoing caravans. Della Valle records that "an Arabian Sceich" resided there, "who receives a Gabel (*i.e.* backseesh) of the Caravans and Burdens that pass that way." Another two or three hours led the travellers into Zubair,* where they were generally met by their friends, and escorted onwards to Basra.

Niebuhr records the stages on another route still further out in the desert, which the caravans took when the usual track was not safe. At Hammam or Abu el Fiad it bifurcated to the south-west, passing through *Bir Kdäm* (Bischoff's *Gübb Kedem*, Musil's *al Ḳdejm;* Suchne (Sukhne); Saraim (Irwin's *Jebel Serhim ?*) ; *Souàb* (Wadi Suab); *El Ghara* (El Gara, the depression containing the famous wells of Mulusa, or Er Rah); *Hödsjere*, his Arabic gives Hajrah; *Mhavis*, or, according to his Arabic, Mahewiz (Muhaiwir, a Kasr on the banks of the Wadi Hauran at the point where the Hit–Damascus track crosses it); *El biddi*, ? *Kteri*, ? *El adtle*, or, according to the Arabic, El Athlah (*Âthelahât*, Huber—a station on Darb Zubaida); *Salmàn* (Selman, a watering on the Darb Selman, recorded by Huber as the third stage southwards from Semawa, but by Raunkiaer as two days south of Semawa, and three days north of Leina), *El Kosar* (El Kuseir), where it joined with the usual route.

THE IDENTIFICATION OF PEAKS IN THE HIMALAYA

HAVING occasion to examine the numbering of peaks on the late Captain Grant Peterkin's map, made to illustrate the work of the Bullock Workman expedition on the Siachen Glacier, we found ourselves unable to discover in the Library or Map Room of the Society any means of identifying a northern frontier peak bearing such a number as Pk. 24/52 C: a system of numbering which was adopted by the Survey of India about 1909. The well-known work by Burrard and Hayden, 'A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet, 1907–8,' contains in Part 3, "On the Names of Certain Peaks," a very valuable guide to the variety of names and numbers given at different times by the Survey and by individual observers to the principal peaks, with an explanation of the systems adopted in the past. "Astronomers," wrote Colonel Burrard, "do not name the stars; in olden times they grouped them in constellations, and they now number them according to

* Zubair appears as Issabier, Zebar, Zebeer, Xebire. It is the mediæval Basra; a still older site, according to Teixeira, was Jebel Sinam or Sanam, 20 miles to the south. "It has many waters," and is tbe first stage for Mecca-bound caravans.

right ascension. Colonel Montgomerie endeavoured to introduce for peaks a method resembling that of constellations, and he named the whole Karakoram region K, and its peaks K^1, K^2, K^3, etc. . . . The nomenclature of a mountain region should not be forced; it should grow spontaneously, and we should never invent a name until its absence has become inconvenient. We cannot do better for Tibet and Turkestan than extend the simple system introduced by Montgomerie for the Karakoram; his method of constellations is more suitable for the peaks of Asia than a long series of successive numbers from west to east would be. We need not design constellations to include one whole range, and we need not follow the astronomical plan of drawing animals and heroes; we can have rectangular constellations enclosed by meridians and parallels."

This last sentence supplies the key to the principle upon which the latest system of numbering peaks is based. They are given numbers on the degree sheets, each sheet being treated as a separate "constellation." Very few of the new degree sheets, however, are as yet published, and it seemed that we had no means of identifying a peak on the north-west frontier mentioned only by its new survey number.

The Survey of India, having allowed one personal name, Mount Everest, to stand, for reasons convincingly set out by Sir Sidney Burrard on page 21 of the 'Sketch,' have set their faces sternly against any extension of the practice of giving personal or fanciful names to peaks which have no native names, although only nineteen out of the seventy-five peaks above 24,000 feet have ascertained native names. They refuse to accept the name Godwin-Austen for peak K^2, believing that "The permanent adoption of the symbol K^2 will serve to record the interesting facts that a mountain exceeding 28,000 feet in height had not been deemed worthy of a name by the people living under its shadow, and that its pre-eminent altitude was unsuspected until it was brought to light by trigonometrical observations."

Those who travel in and write about this mountain country are therefore faced with a double difficulty: the most glowing description of scenery is damped by a strict attention to the official nomenclature of mountains. The name K^2 itself does not adorn a descriptive passage; but its modern equivalent $\frac{\text{Pk. } 13}{52 \text{ A}}$ would wreck the finest language. Moreover, there are of course thousands of peaks that have never been intersected and have no survey numbers. They may be unimportant in the general mass of the range; but from particular points of view they may be the chief features, and for them no method of naming or numbering is officially supplied. Hence we sympathize with the contention of explorers that they must be allowed to use descriptive or fanciful names for such peaks as they refer to frequently; and a few of these may stick; but, in accordance with the long-standing rule of the Society, we would avoid as strictly as do the Survey of India the allocation of personal names.

To obtain the latest information on the Indian official system, and especially to clear up the difficulty that the Society seemed to possess no key to peak numbers on many degree sheets, which have been allotted in some cases several years ago, we addressed a letter in November last to the Surveyor-General, from which it is necessary to print extracts only because Sir Sidney Burrard's reply refers directly to it :—

"About 1913 you started a new system of numbers relating to degree sheets, thus $\frac{\text{Pk. 15}}{\text{52 B}}$, and this appears to be the present system. It has, at any rate for the time being, the disadvantage that the degree sheets are not published for the more mountainous regions, so that, unless all references to the peaks are accompanied by their latitude and longitude, we may be unable to identify the peak mentioned only by its new survey number."

"A good many of the peaks of lesser importance have been given fancy names by Sir Martin Conway, Mrs. Bullock Workman, and others ; and although these names are not accepted by the Survey of India, it is very difficult to know how to refer to the peaks except by these names, since they either have no survey-numbers or we cannot discover them.

"The present survey system is difficult to print in the form in which you print it, as it occupies more than a line in depth, and involves justification of the type. It would be easier to print if you allow Pk. 15/52 B, which can be done in a line. It has, however, still the disadvantage that it is difficult to remember, and that until the whole of the degree sheets are published it remains impossible to discover where the peaks may be of which we know nothing but the official number. I do not know whether you have thought of publishing a sort of synoptical index to all triangulated peaks with their new system of numbering, in advance of the publication of the degree sheets ; it would be very helpful.

"I do not feel certain myself that the solution adopted in 1913 is the best. The problem is, as you say, very much like the problem of cataloguing stars or nebulæ. It is more closely allied to the nebula catalogue because, whereas stars are distributed more uniformly all over the sphere, the nebulæ, like mountains, occur in bunches. The problem is simpler in one respect than that of the nebulæ because one has not to deal with precession. The nebulæ of course can be identified by their places, though they are in practice mostly referred to by their number in the New General Catalogue, Dreyer. This makes a fair working system, but of course has all the disadvantages that when one is dealing with many individuals it becomes difficult to remember the numbers. I am not sure that there would not be advantages both for nebulæ and for mountains in making the number give the degrees and minutes of latitude and longitude ; Peak 15/42 K is almost as hard to remember as 3734.7449, which are its degrees and minutes of latitude and longitude, but the latter plan has the advantage of giving you the position. It would also have the advantage of enabling one to interpolate into the series at any time. I do not think it is a satisfactory solution of the problem at all, but I suppose nothing but a name is really much good. We do, however, want something which enables us to identify a peak when it is mentioned, and that the present system does not do."

In reply Sir Sidney Burrard has very kindly sent us this interesting Memorandum on the numbering and naming of Himalayan peaks ; with specimens of maps and charts which may be seen in the Map Room. The letter is unofficial and not written for publication with the note; but its interest to the Society will, we hope, justify our taking leave to prefix it.

Surveyor-General's Office,
Dated Simla, 29 May 1918.

Your letter about the numbering of Himalayan peaks reached me when I was moving about. I must apologize for the delay. I had to write to Dehra Dun to get certain statements verified. My reply to you is an explanation of the system now adopted, and as it is too lengthy for a letter, I have embodied it in a note. Please make what use you like of this note; there is nothing confidential in it.

Years ago I followed the controversy over the name Mount Everest. Although I was averse to ousting this name after it had been accepted in geography for fifty years, I was much impressed by Freshfield's arguments against the introduction of English names into Himalayan geography. I adopted Freshfield's views and have acted upon them. It has frequently been my job to refuse English names (please see my note). A political officer gave the name Dufferin to the peak Mustagh Ata; and this name gained admittance to maps, but it has been deleted. Lord Minto named a range after Sven Hedin, but the latter's attitude in the war has justified the deletion of his name from all our maps. The name Godwin Austen has been pressed on us for peak K^2, and I have been asked recently again to introduce it; but I have refused. As far as Southern Tibet, the Himalayas, and Hindu Kush are concerned, Mount Everest is the only English name hitherto accepted. Nothing would be easier for the Survey of India than to sprinkle the map with names of English governors, members of council, generals, etc.; if once the Survey of India relaxes its rigidity, English names will flood the maps. The geography of Northern Tibet has been marred by names such as Humboldt, Prjevalsky, Nicholas, Richthofen, King Oscar. That Southern Tibet has been saved from this fate was largely due to the R.G.S., for it was the controversy over the name Mount Everest that hardened the heart of the Survey of India. I hope that the R.G.S. will maintain the same watchful attitude in the future, and will refuse to support the English names given to peaks by travellers.

S. BURRARD.

ON THE NUMBERING AND NAMING OF HIMALAYAN PEAKS.

The following maps and charts are attached to illustrate this note:

A. Index to Sheets, scale $\frac{1}{1000000}$.
B. Index to Degree Sheets.
C. Index to Triangulation Charts.
Bound together { D. Pamphlet appertaining to Degree Sheet 42 L.
E. Triangulation Degree Chart 42 L. }
F. Chart of Triangulation 52 A.

[These are placed in the Map Room.]

1. *Systems adopted* 1830–1900.—In the early days of the Trigonometrical Survey the Himalayan area was dealt with in parts and not as one whole. Many different systems of numbering peaks were introduced. In 1852 a list of seventy-nine great peaks was compiled, and these were numbered from east to west, Roman numerals being employed; Chumalhari was I., Mount Everest

was XV., Nanda Devi was LVIII. This system was soon found to be defective, for when new peaks came to be observed, they could not be allotted a suitable number. In 1856 Montgomerie introduced the system of numbering the Karakoram peaks K^1, K^2, K^3, etc., and the peaks of Nepal were numbered N^1, N^2, etc. In 1880 Tanner adopted the plan of designating each peak by the initial letter of the observer's name (*vide* page 15, 'Sketch of Himalayan Geography'). In Synoptical Volume **7**, G.T. Survey of India, the peaks of the Punjab Himalaya were classified and numbered by watersheds (page 269, 'Sketch of Himalayan Geography'). In 1885 the peaks in Gilgit were designated by letters after the initial letters of the stations of observation D.S. b. or D.S. e.c. Peaks were never numbered by Atlas sheets.

2. *The Present System.*—When Synoptical Volume **35**, G.T. Survey of India, which is a catalogue of peaks in the Kumaun and Nepal Himalaya, was being compiled in 1903–1909, the confusion arising from different systems became intolerable, and a new system was introduced which is applicable to the southern half of Asia. South Asia is now divided into areas, each of which is 1° in latitude by 1° in longitude. In each of these areas the peaks are numbered serially 1, 2, 3. . . . The method by which the several areas of one degree have been designated will be readily understood by any one who will study our index maps. The primary division of the continent is by sheets, each of which is 4° in latitude and 4° in longitude (*vide* attached Index Map, marked A), and each of which is given a simple number, 1, 2, 3, etc. The Baghdad 4° sheet is No. 2 ; the Delhi sheet is No. 53 ; the Lhasa sheet is 77. These 4° sheets are then subdivided into 16 "degree" sheets, 1° in latitude by 1° in longitude, each of which is designated by a letter A, B, C, up to P. (*vide* Index to degree sheets attached and marked B. Each of these "degree" sheets covers an area of about 69 miles by about 60 miles. The Kandahar "degree" sheet is 34 E, the Delhi "degree" sheet is 53 H, the Mandalay "degree" sheet is 93 C. Thus we have our whole continental area divided into degree sheets, 69 miles by 60 miles, each of which has a distinguishing number and letter. This system is as simple as that adopted for the International Map of the World. In degree sheets which embrace mountain areas the peaks of each sheet are numbered serially 1, 2, 3, . . . ; thus Mount Everest is 72 I/37 ; 72 being the primary number for the 4° sheet, the letter I being the designation of the interior degree sheet, 37 being the peak number. A preliminary sketch of this system was published on page 15, 'General Report, Survey of India,' 1907–08, and a definite description of it was given in the preface (page viii.), Synoptical Volume **35**, G.T. Survey of India, 1909.

3. *Publication of Degree Charts.*—As far as surveyors are concerned the new system has worked well. But Mr. Hinks has offered some criticisms from the point of view of the public, and these I will endeavour to meet. It is stated that the degree sheets are not published ; this is true of the topographical detail, but for each degree sheet a degree chart *has been* published (or is under publication ; *vide* Index to triangulation charts attached and marked C), and these charts show the numbers of all observed peaks (*vide* pamphlet attached to degree chart 42 L and marked D). Any one who will devote five minutes to the study of a triangulation chart will understand the system of numbering peaks. For example, on the chart 42 L (marked E) to which pamphlet 42 L is attached, all triangulation points are numbered. These triangulation points are not necessarily all peaks ; in some charts of mountain areas the triangulation points may be mostly peaks, but in other charts they may be mostly signals erected by surveyors on ranges or hillsides,

whilst in charts of flat country there are no peaks. The number of every peak is given in the pamphlet attached to the chart; the chart 42 L, for example, shows a triangulation point No. 57 (lat. 36° 24′, long. 74° 57′), and on page 10 of the pamphlet point No. 57 is shown to be peak 39 of 42 L.

It will be noticed from the list of points on pages 9 to 11 of the pamphlet that the peaks are not numbered consecutively; this is due to the fact that charts have to be constantly revised, and newly observed peaks inserted in the former lists. The new peaks when inserted are given new numbers, and the old numbers are not disturbed. The pamphlets are the latest method adopted for publication. In 1909 the charts and their data were published on sheets and not in pamphlets (*vide* sheet 52 A attached and marked F). Chart 52 A is now under recompilation in pamphlet form. This pamphlet will contain the peaks fixed by the Bullock-Workman survey (Siachen Glacier). The fact that the co-ordinates of these peaks have been taken from Peterkin's triangulation will be mentioned, but the names given to them will not be accepted for reasons explained hereafter.

4. *Other Systems of Numbering.*—All institutions who have to deal with thousands of units forsake names for numbers. The army identifies its men by numbers, astronomers catalogue stars by numbers. Human powers of memory are incapable of grasping thousands of unconnected names.

I will compare our system of numbering with the system of latitudes and longitudes suggested by Mr. Hinks. In a degree chart, 69 by 60 miles, the peaks will be numbered under our system—

31 H/17 31 H/21 31 H/44

Peaks in contiguous degree charts will be numbered as 31 E/14 or 31 G/25; the changes are simple, and no strain on the memory is imposed. If we numbered these by latitudes and longitudes, the several peaks would be (3314, 8625), (3328, 8617), (3352, 8603). This system is more complex.

Occasionally two prominent peaks exist within the same square mile; their numbers by our system would be simple, but under the Latitude-Longitude system, seconds would have to be introduced, and the two Masherbrum peaks, for example, would have to be numbered (353836, 761831), and (353829, 761823).

Moreover a surveyor has opportunities of entering such a number as 31 H/47 in his angle book when he is actually observing the peak, but the numbers obtained from the Latitude-Longitude system would only be available after final computation.

In numbering their peaks the Survey of India has been led to adopt a system very similar to that adopted by the G.P.O., London, for houses:

Himalayan system	31 H/43
G.P.O. system	43, Montague Street, S.W. 4

When a new house is built in a suburb, the owner asks the G.P.O. to give it a street number; similarly when an explorer wishes to have a number officially allotted to a peak, he should apply to the Survey of India, who would number it. In giving a number to a new house, the G.P.O. first ascertains its situation, and if an explorer asks for a new peak to be numbered, he should produce evidence of its position.

I agree with Mr. Hinks that it would be better in referring to peak symbols to write them in one line, such as 31 H/47 instead of $\frac{47}{31\ \mathrm{H}}$; the letter used should be a capital.

5. *Names of Himalayan Peaks.*—Very few of the higher Himalayan peaks are known to the natives by native names (*vide* 'Sketch of Himalayan Geography and Geology,' p. 15). Where native names have been given they are as a rule striking and impressive (Tirich Mir, Badrinath, Dhaulagiri); they harmonize with their surroundings and they are worthy designations for the Earth's highest points. They have indeed set such a high standard of nomenclature that difficulties have been found in inventing new names that will harmonize with the old. The native names of Himalayan hill stations, Dharmsala, Kasauli, Simla, Chakrata, Mussooree, are distinctive and characteristic; but one unconsciously feels that the two British names which have been given to hill stations, Dalhousie and Lansdowne, are out of geographical harmony. The R.G.S. is interested in books of travel in which certain Himalayan peaks have been given fancy names by the authors. But the Survey of India receives numerous suggestions of fancy names, names of men, names of women, poetic names, descriptive names. All these names appear suitable if one regards them locally, but they become unsuitable if regarded continentally.

A peak of 24,000 feet height is not an uncommon feature in Asia; to name such a peak "King George Peak" may appear suitable to those encamping at its foot, but to the geographer the name is incongruous. When a feature is unique, such as the Falls of the Zambezi, I think it right to call them the Victoria Falls, but I do not think it suitable to attach the British sovereign's name to a feature of no particular prominence. When therefore the Survey declines to adopt the names given to peaks by an enterprising traveller-author, the reason for the disagreement is simply this: the traveller is describing in his book a particular locality, and he invents names suitable for that locality and for his book; the Survey, while recognizing their local suitability, finds them unsuitable for the geography of Asia.

6. A house-owner in Maidstone may name his house Victoria Villa, and an Indian pensioner in Cheltenham may name his residence Curzon Cottage. These names do not appear incongruous to the local residents, but they would be out of place on an Ordnance Survey Map of the British Isles.

Travellers and authors give names to peaks such as "Broad Peak," "Silver Throne," "Cathedral Peak," "Pyramid Peak," but the frequent recurrence of these same names in the Records of the Survey show how limited the human imagination is. We have several so-called "Silver Thrones," we have many so-called "Cathedral Peaks," whilst such names as "Broad Peak" and "Sharp Peak" abound. It would be impracticable to accept such names for geographical maps.

7. I make the two following proposals for consideration:

(*a*) To give a name to each degree chart.

(*b*) To prepare a Himalayan peak catalogue.

The International Map Committee give a name to each international sheet *in addition* to its number. Similarly we could give a name to each degree chart, the name being taken from some prominent feature of the chart. Thus the degree chart 52 H, for example, could be named Chandra, and the chart could be designated 52 H (Chandra). Then peak 21 of this chart would have for its official designation peak 52 H/21; but it could also be known as peak Chandra 21. The name of a well-known glacier, such as Siachen, could thu be attached to a degree chart.

As to my proposal to compile a catalogue of Himalayan peaks, I am not sure if this would be useful. It would be merely a compilation of peak-designations, names, numbers, co-ordinates and heights abstracted from degree charts and collected into one pamphlet.

S. BURRARD.

29 May 1918.

Thanks to the kindness of the Surveyor-General in sending us this memorandum and its accompanying documents, we are now able to put together the following notes which may be useful to those who have occasion to identify peaks by the aid of the material in the Society's collection. For the north-west Himalaya series, Synoptical Volume VII. contains a set of degree sheets on the old system of numbering, now abolished : thus degree sheet 21 covers the same area as 52 A sent with the Surveyor-General's letter. The numbers of the peaks are entirely changed : thus Karakuram No. 2 of Sheet 21 (which is not K2) bears on the triangulation chart of 52 A the number 46, and in the corresponding table reference Pk. 38/52 A. The old degree sheet chart showed in outline the principal rivers and glaciers; the new chart shows nothing but numbers and the rays of the triangulation, which is decidedly less convenient in identification of peaks.

The charts and numbers of Synoptical Volume VII. are consequently abolished, and we have not in the collection the new charts, either in sheet or pamphlet form, which replace them. Reference to correspondence of some two years ago shows that this series has been promised to us by the Survey of India, but that its despatch has been delayed by war conditions. The Synoptical Volume XXXV., published in 1909, covers Series I. of the north-east quadrilateral. It contains the tables of stations and peaks on each degree-sheet in the new notation, and the accompanying volume of triangulation charts is in the same general form as the chart for degree sheet 52 A accompanying the Surveyor-General's note. There is, however, a little difference. The triangulation charts of this series contain the reference number of the peak, *e.g.* Pk. 8, on the face of the chart, and have not a separate and apparently somewhat unnecessary number on the chart by which reference is made to the real new number of the peak in the accompanying table. It would, we think, have added to the convenience of the new charts for the north-west series if the same principle had been followed upon them.

The necessity for this revision of nomenclature is well illustrated by the following list of synonyms. The peak K^2, engraved as K2 on the Indian Atlas, Sheet 44^A N.W., is Karakuram No. 13 of Sheet 21 Synoptical Volume VII., which becomes No. 21 on the triangulation chart of degree sheet 52 A, and Pk. 13/52 A in the attached table, with alternative K2, but without reference to the fact that this is "Mount Godwin Austen." Snowy Peak No. 13 of Atlas 44^A S.W. is Braldo-Shigar watershed peak of Vol. VII.; we have not yet its designation in the new system. Snowy Peak B^{18} of Atlas Sheet 44^A S.W. becomes No. 2 peak Sheok-Braldo watershed of Sheet 21, Vol. VII., No. 1 of the triangulation chart

52 A, and Pk. 1/52 A of the list. It will be noted that while K^2 of the atlas numbering becomes Karakuram No. 13 of Vol. VII., K^8, K^7, and K^{13} become respectively Karakuram No. 6, No. 7, and No. 2; while a peak lettered K without index number becomes Karakuram No. 9.

On some of the Atlas sheets there are peaks referred to as, *e.g.*, Snowy Peak No. 13, and it is not clear to what series these numbers refer, as the Surveyor-General says above that peaks were never numbered by the Indian Atlas sheets.

In regard to the general questions raised by Sir Sidney Burrard, we think that the proposal to give a name to each degree chart is probably good. Experience of the sheets of the International Map of the world shows that in practice they are rarely, if ever, referred to by their sheet numbers, but always by their names. Such a nomenclature as Pk. 28 Siachen would have the considerable advantage over Pk. 28/52 A that it would give immediately some idea of its position to those who were unable to bear in mind the complicated relation of degree sheet numbers to the country, a relation made more difficult by the fact that there is no very obvious continuity in the numbering of adjacent sheets. Thus, Sheet 52 D is surrounded in the following order by these eight sheets, beginning from the north and going clockwise: 52 C, 52 G, 52 H, 53 E, 53 A, 44 M, 43 P, 43 O. The selection of an appropriate name would doubtless be difficult, since names that would go well with peak numbers should perhaps be restricted as far as possible to names of mountain groups and glaciers. And this suggests that the analogy of the degree sheet with the constellation is not very close, since constellations may be large or small, regular or irregular in shape according to the grouping of the conspicuous stars, whereas the hard and fast geometrical boundaries of a degree sheet in many cases divide the most obviously natural groups, and apportion them to separate " constellations."

The suggestion to prepare a Himalayan-peak catalogue would, we think, be useful if it were a double catalogue; that is to say, if it contained first the latitude and longitude and the designations upon older systems of the peaks as numbered in series for each degree sheet, while its second part contained the same information arranged in order of longitude of the peaks, just as the stars in a star-catalogue are arranged in order of right ascension, divided often in an extensive catalogue into zones of latitude. With such a double catalogue we should be able very conveniently to discover the position of a peak from its serial number, or alternatively whether a peak of a given position had had a serial number attached; and to have the whole in one volume would be a great convenience for many purposes.

The suggestion made in our letter to the Surveyor-General that an 8-figure number composed of the latitude and longitude might be an appropriate designation, would not, of course, provide any convenient method of referring to the peak in ordinary descriptive language; but then neither, we think, does the present official designation. It has of course a close analogy to the method of designating points on the battle front by their co-ordinates upon the grid; but we believe that the experience of the front shows that these numbers are naturally soon replaced in common use by names appropriate or inappropriate added by the temporary inhabitants of the locality to the sparse official names of the neighbourhood. In fact, the needs of the soldier and of the traveller minutely interested in a particular region are in this respect identical.

The whole question is as complicated as it is interesting, and we shall be glad to publish comments or suggestions from travellers whose experience of the detailed geography of the Himalaya has led them to any mature conclusions. A. R. H.

REVIEWS

EUROPE

Macedonia.— T. R. Georgevitch, D.Phil. London: George Allen & Unwin Ltd. 1918. Pp. xvi. and 284. 7*s*. 6*d*. *net*.

THIS book, which is in many respects painful reading, is definitely a piece of propaganda. The author's object is to show that the Macedonians are Serbs in origin, history, language, traditions, national character and customs no less than in national sentiment. The treatment is almost wholly historical, the numerous geographical problems connected with the subject not being discussed.

The author adopts the Bulgarian conception of the term Macedonia, as including the territory extending from the frontiers of Bulgaria to the Shar Mountains, to the river Drin, to the Gulf of Salonika and the river Mesta, but maintains that this is historically incorrect, and that strictly speaking the name should be used to include mainly the middle and lower reaches of the Vardar, the regions round the great lakes in the west, with an eastward extension to the Struma, and in places as far as the Mesta. His treatment includes an historical discussion of the larger Macedonia, and of the relation of Bulgaria and the Bulgars to it. Some of the historical chapters are of much interest. Other chapters and sections are purely propagandist, and there are a number of appendices dealing with Bulgarian atrocities, one giving a list of Serbs murdered in Macedonia by Bulgars or their agents during the period between 1881 and 1909. Throughout the author speaks with a bitterness which, though natural, is to be deprecated; for one cannot forget that, whatever changes of frontiers may occur in the Balkan Peninsula at the peace, the Serbs and Bulgars must continue to be neighbours, and there seems little hope for the future save in a reconciliation of their differences.

The relations between Bulgaria and Pre-revolutionary Russia are discussed with some fullness. In his first chapter Dr. Georgevitch ascribes Russian sympathy with the Bulgars to political motives, that is to the desire of the former country to strengthen her hold in the Balkan Peninsula through and by means of Bulgaria. In a later chapter, however, he states that in 1878 Russian public opinion was stronger than the Government, and led to the creation of the Greater Bulgaria of San Stefano which has had so much influence in Bulgaria. In this chapter he states that the enthusiasm for the Bulgarian cause in Russia was due to the fact that while refugees from Serbian subject of first-rate importance. It has come out very markedly in help he has more recently given me for the 1/5M map of Asia, a much more difficult question. I should like to emphasize my appreciation of the very great services Mr. Young has rendered. Mr. McCaw's question, whether volcanic change could have affected the source of the Kagera, I am unable to answer. I am not sure whether any competent geologist has been to the source of the Kagera; it is rather east of the parts affected by the great volcanic outburst in the western rift. However, if it is true that Lake Kivu used to be in the Nile system, then clearly the volcanic outburst has affected the source of the Nile very materially, although not at the particular point Mr. McCaw mentioned. In closing, I should like to express my thanks to those who have spoken all too appreciatively of the work we have been trying to do here, and also to call attention to the fact that we are for the first time making a serious attempt to produce a layer-coloured map of Africa upon an adequate scale. We cannot expect to get contours at close intervals because the parts sufficiently well surveyed are very slight; but we have tried to make contours at intervals of 500 metres, and when they are layer-coloured you do get a representation that is beginning to be satisfactory of what is, I think, the most interesting country in the whole world, the lake region and the two rift valleys of Central Africa.

GEOLOGICAL INTERPRETATIONS OF GEODETIC RESULTS: A CRITICAL EXAMINATION OF MR. R. D. OLDHAM'S RECENT TREATISE ON HIMALAYAN STRUCTURE

Sir Sidney Burrard, F.R.S., Surveyor-General of India

THE alluvial plains of the Ganges conceal from our view a deep "trough" that has been formed in the Earth's crust. The "trough" is bounded on the north by the Himalayan Mountains and on the south by an ancient tableland. This "trough" was called by Suess the Himalayan Foredeep; its origin and its relationship to the mountains are among the unsolved problems of geology and geophysics.

For many years the Trigonometrical Survey of India has been taking geodetic observations over both hills and plains: it has determined the direction and the intensity of gravity at numerous places. During its operations its chiefs have frequently had the benefit of consultation with foreign delegates at International Geodetic Conferences, and with successive directors of the Geological Survey of India. The gap between geology and geodesy is, however, difficult to bridge: the students of the two branches of science have been differently trained, and the best hope of future progress lies in personal collaboration.

Mr. R. D. Oldham, F.R.S., has lately published a memoir ('Memoirs, Geological Survey of India,' vol. 42, part 2, 1917) entitled "The Structure of the Himalayas, and of the Gangetic Plain, as elucidated by Geodetic Observations in India."

When a book on Geodesy is written by a professional geologist it starts on its career with the keen interest of geodesists. But Mr. Oldham's treatise will do nothing towards bridging the gap; its attempts to lower the standard of geodetic accuracy will be resented. As a book it is difficult to follow; for though its language is that of positive assertion, its meanings are frequently obscure. Individual sentences may be strongly worded, yet in the aggregate their collective meaning is uncertain.

In his geodetic calculations Mr. Oldham's first step is to discard the Himalaya Mountains of nature and to substitute for them an "Imaginary Range," the dimensions and contour of which he has designed; he says that the method of geodesy is too laborious. He therefore decides to ignore "the complicated contour of the actual Himalayas." He also assumes in his calculations that his imaginary range has an east and west direction, whereas the true Himalaya extend over 7° of latitude.

Mr. Oldham tries to show that his imaginary range is similar to the true Himalaya in its powers of attraction. The safest way of making such a comparison would be to test the attraction of the imaginary mountains *uncompensated* against the attraction of the true mountains *uncompensated*. But this test is not faced; both the imaginary and the true mountains are assumed to be wholly compensated by underlying deficiencies of matter, and the resultant attractions are thus reduced to small quantities. The attraction of a mountain mass causes deflections of the plumb-line, but if the mass be assumed wholly compensated by underlying deficiencies of matter, its positive attraction will become nullified by the negative attraction, and the deflections will tend to vanish. The deflection of the plumb-line caused at the station of Kaliana by the positive attraction of the true Himalaya is 58″; that caused by the imaginary range is 6″. The discrepancy is no less than 52″, but by taking compensation into account, Mr. Oldham reduces the Himalayan effect from 58″ to 3″, and the effect of his imaginary range from 6″ to 2″ (p. 42). He then compares 3″ with 2″ and argues that a discrepancy of 1″ is admissible.

If we are dealing with a large deflection such as 58″, a discrepancy of 1″ denotes an error less than 2 per cent. But when a large deflection has been reduced by compensation to 3″ a discrepancy of 1″ denotes an error of 33 per cent. Mr. Oldham states that the attraction of the imaginary range (compensated) exceeds that of the true range at all stations, but there are mistakes in his computations (Table 5). At Lambatach in the mountains the effect of the imaginary range (compensated) is 55 per cent. *larger* than that of the true range: whilst at Kaliana, 41 miles distant from the foot of the mountains, the effect of the imaginary range is 33 per cent. *smaller* than that of the true range; errors such as these prove that the imaginary range is not suitable for geodetic investigations.

It is true that when Mr. Oldham first introduces his imaginary range (p. 36) he excuses it on the grounds that it is intended for the preliminary stages and not for the final calculations of the investigation. But he fails to adhere to this stipulation: at the end of his book he arrives at final and positive conclusions concerning the compensation of the Himalaya Mountains (pp. 112, 114), and he claims to have discovered the form of the underground floor of the whole Gangetic trough (p. 119); these conclusions are all based on the imaginary range.

We use the word "trough" for want of a better. The word conveys the idea of a long rock hollow filled with loose alluvium. But at moderate depths alluvium becomes compacted into solid rock: and at greater depths it may become metamorphosed. Mr. Oldham describes the Gangetic "trough" as though it were a simple depression in the rock-surface filled with alluvium, and as though the alluvium were 16,000 feet deep (pp. 7, 8 *et seq.*). This value of the depth is obtained from Middlemiss's measurements of exposed strata at the foot of the Himalaya in Kumaun, north-east of Delhi ('Geological Survey of India,' vol. 24, p. 29). But Middlemiss shows that these strata are built up of the following thicknesses :—

	Feet.
Siwalik conglomerate	3000
Sand-rock	8000
Sandstone	6000

Thus the trough is not a rock-basin containing loose alluvium; it is a basin constructed of ancient rocks in which Tertiary rocks have been consolidated. The dividing line between the northern wall and its solid contents can be discovered only by a geologist. Geodesists have used the word "trough" to denote the crustal zone throughout which the rock is of lower density than normal; and they take the depth of the trough to be the depth to which deficiency of density extends, independently of the kind or age of the rocks involved.

We have now to consider this problem: If the sides and floor of a trough have been formed of ancient rocks, and if its contents consist of Tertiary rocks, can a pendulum be utilized to determine the depth of the lowest Tertiary rocks?

If at any place a pendulum is observed to be swinging at a slower rate than normal, a deficiency of rock in the underlying crust is indicated; whereas if a pendulum is observed to oscillate rapidly, the inference is warranted that the underlying crust is unusually dense. These variations in the rate of swing at different places signify variations in the force of gravity, and constitute what are known as local "gravity anomalies." Wherever a gravity anomaly is observed to be negative, the crust is abnormally light, and wherever a gravity anomaly is positive the crust is dense.

An excess or defect of matter may be near the surface of the crust, or it may be hidden at a great depth. Geodesists have met with difficulties in dealing with this problem of depth: they can prove the existence of an excess of matter in the crust, but they are unable to determine whether the excess is superficial or deep.* Observations have shown that the density of the crust is different in different regions, and varies from place to place, and that these unceasing variations extend downwards to great depths (perhaps 70 miles).

If a pendulum station is situated above the light Tertiary rocks of the Gangetic trough, the gravity anomaly will have a tendency to be negative. But the deeper rocks will affect the pendulum also : and if they are unduly light they will *accentuate* the negative tendency, whereas if they are dense, they will *counteract* that tendency. A gravity anomaly is due to both surface and deep-seated rocks, and the difficulty is to disentangle their respective effects. By means of a sounding-line we can discover the depth of water, and by boring we may discover the depth of alluvium, but a pendulum is not a sounding nor a boring instrument, and observations of gravity do not determine depths of sea or alluvium.

I do not contend that a pendulum can never be used to determine the depth of a particular rock. I will give an instance in which I think it might be so utilized. The Mysore Gold Mines are situated in a small patch of heavy rock (Dharwar schist, density 3·00) which is lying in a surface hollow of the Mysore plateau (gneiss, density 2·67). The patch of heavy rock containing the gold is only 4 miles wide; if pendulum observations on the gneiss surrounding the patch give a constant gravity anomaly, and if the anomaly at once becomes larger at stations on the patch, the increase in the intensity of gravity may be fairly attributed to the excessive density of the patch. No complete investigation has yet been made, but Lenox-Conyngham found that the gravity anomaly on the patch was 0·034 greater than at Bangalore (Professional Paper 15, p. 24, Survey of India): he has calculated that this anomaly would denote a depth of about 13,500 feet for the heavy schist of the patch. The gold-mining operations have now reached a depth of 5000 feet. The reason, which would justify us in this case in attributing the increase in the gravity anomaly to the patch, would be that the pendulum stations on and off the patch being so near together (*i.e.* within 2 to 3 miles) the cause of the increase would appear to be local.

The Gangetic alluvium presents a different problem: its area is great and we cannot attribute anomalies to any local cause such as the lightness of alluvium. The geodetic observations have led us to believe that the Earth's crust north of the alluvium is deficient in density to a great depth, and that south of the alluvium the density of the crust is excessive. Under the Himalaya the density of the crust is below normal: south of the trough there is a zone of excessive density known as the "hidden range" (p. 124). The junction of the two different densities occurs in the crust underlying the alluvium.

* See the writer's paper on the Gangetic Trough, *Proc. Royal Society*, A, vol. **91**, pp. 230, 233.

Mr. Oldham considers that the depth of the trough is about 16,000 feet at the northern edge and that it gradually decreases from north to south (pp. 82, 119). All gravity anomalies that can be made to fit this hypothesis he interprets as due to the lightness of alluvium. But anomalies that do not fit he interprets as due to deep-seated rocks *below* the alluvium. On p. 81 he writes of the station Monghyr: "Though situated close to the southern edge of the alluvium it gives a Bouguer anomaly of −0·031, and a Hayford of −0·024 dyne, and, as it is difficult to believe that there can be a thickness of over 4000 feet of alluvium under this station, we must fall back on the supposition that the anomaly is due to a more deep-seated deficiency of density. A similar, though smaller defect of density at the station of Sasaram, suggests that in both cases the anomaly may be due to a deep-seated defect of density in the rocks below the alluvium."

The fact that the anomalies at Monghyr and Sasaram have to be rejected as untrustworthy measures of the depth of surface alluvium raises the question, What security is there that other anomalies give reliable measures? There is no security; a gravity anomaly is a measure of the density of the Earth's crust, and not of the uppermost layer only.

If the gravity anomalies at alluvial stations were wholly due to the lightness of surface alluvium, they would everywhere be negative; but at several stations on the alluvium the gravity anomalies are positive. On p. 81, Mr. Oldham writes of two stations on the alluvium at which gravity is in excess: "The high positive anomaly at Kisnapur is evidently the result of a deep-seated excess of density in the rock underlying the alluvium, but its magnitude, and the smaller positive anomaly at Chatra, show that the alluvium cannot have any great thickness, comparable to that in the Gangetic trough, for if there were any great thickness of alluvium the negative effect of the defect in density would more largely neutralize the deep-seated excess of density in one case, and in the other would make the anomaly negative, instead of positive." This argument is incorrect; the positive anomalies merely show that there is an excess of matter in the crust, notwithstanding the surface alluvium; they furnish no evidence as to the depth of alluvium.

The gravity anomaly at Mian Mir on the alluvium is +0·040 dyne, showing that gravity is in excess. On p. 85, Mr. Oldham writes: "The positive anomaly at Mian Mir shows that the alluvium cannot have any great thickness here." The positive anomaly at Mian Mir merely denotes that the lightness of the surface alluvium is more than counterbalanced by the density of the deeper rock: it is no proof that the alluvium is shallow.

To illustrate the risks of using gravity anomalies as measures of depth, I will refer to Hecker's observations of gravity over the ocean.* When Hecker was vertically over the Tonga Deep he found that the deficiency

* 'Gravity Determinations on the Ocean.' Berlin, 1910. Hecker assumed the ocean to be isostatically compensated.

of gravity was −0·245 dyne. If Hecker had adopted Mr. Oldham's method, he would have deduced the depth of the Tonga Deep to be 13,300 feet; the sounding lead showed that the true depth was 27,800 feet. When Hecker's steamer crossed the Tonga plateau, he found that the gravity anomaly was +0·264 dyne. If then he had used the argument that a positive anomaly denotes shallow depth, he would have concluded that the Tonga plateau could not be far below the surface of the sea. The soundings showed that it was 8800 feet deep.

If an observation for gravity is taken over the ocean, the presence of water can be allowed for as its density is known. But the density of alluvium when compressed and compacted at moderate and great depths is an uncertain quantity. Mr. Oldham has assumed the average density of the Gangetic alluvium from the surface to a depth of 4 miles to be 2·16. The rock-walls of the trough have a density of 2·67, and he assumes that the contents of the deep trough have a density of 20 per cent. less than the rock walls.

General Sorsbie, author of *Geology for Engineers*, estimates that the mean density of the Gangetic deposits, loose and solid, shallow and deep, would be about 2·4. Mr. Hunter has determined the density of exposed Siwalik sandstone at Hurdwar and Mohan, and has found it vary from 2·35 to 2·60, and these specimens were broken from weathered scarps and were possibly less compact than when buried and compressed by the weight of miles of superincumbent strata. He has determined the density of khankar (carbonate of lime) dug from the surface of the alluvial plains, and has found it to average 2·34. Barrell in his investigations of the Strength of the Earth's Crust assumes 2·5 as the density of the deposits of the Nile and the Niger (*Journal of Geology*, 22, p. 43).

There are thus reasons for doubting whether Mr. Oldham's assumption of density = 2·16 is justifiable, and it will be useful to show the effects upon his results if a density-value of 2·4 be substituted.

Station. (See pp. 84 and 90.)	Distance from northern edge of trough in miles.	Depth of alluvium as deduced from gravity anomaly.	
		Density 2·16 according to Oldham.	If density 2·4 be substituted.
Rajpore	0	15,000	30,000
Dehra Dun	2	12,000	24,000
Roorkee	25	13,000	26,000
Nojli	38	12,000	24,000
Pathankot	1	23,000	46,000

Mr. Oldham claims (pp. 91, 119) that his geodetic values of depth *at the northern edge* of the plains agree with the geological value, namely

16,000 feet. My table shows that his claim can be established only if an unduly low density is assumed for the alluvium. The adoption of the density 2·4 produces a great discrepancy between the so-called geodetic and geological values. It must not be supposed that I am putting forward the depths in the last columns of these tables as probably correct: they are, I think, based on more reasonable assumptions than the figures in the third columns, but the lesson they teach is that the method adopted of deducing depths of surface alluvium from gravity anomalies is unreliable. The magnitudes of the quantities in the last column support the view that the negative anomalies over the Gangetic trough are partly due to the attenuation of the rock that is *below* the Tertiary deposits.

On p. 119, Mr. Oldham writes: "We have also found complete confirmation of the geological deduction that the depth of the alluvium along the outer edge of the Himalayas is great, amounting to about 15,000 to 20,000 feet towards the northern boundary of the alluvial plain, figures which are in complete accord with those deduced from the geological examination of the Siwalik hills. This agreement, between the results of two wholly independent and different lines of research, leaves little room for doubt that we have reached a correct interpretation of the underground form of the Gangetic trough from near its northern limit to the southern boundary, and that its maximum depth is about 15,000 to 20,000 feet, possibly more on some sections, probably less on others, but in most cases lying within the limits named."

In this summary Mr. Oldham claims to have discovered the underground form of the Gangetic trough from north to south, and from east to west. The average width of the trough from north to south is 150 miles; its length from east to west is 1000 miles: it occupies an area of 150,000 square miles. Mr. Oldham claims to have interpreted the underground form of this great alluvial area by means of the "agreement between the results of two wholly independent and different lines of research."

Let us consider upon what grounds these claims are based. The geological deduction from exposed strata is that the depth of the trough *at one point* near its northern edge is 16,000 feet (p. 6); there is no geological evidence of depth east or west of this point, and there is no geological evidence anywhere as to the maximum depth of the trough, or as to the distance from the edge at which the maximum depth occurs (p. 8). The geological "line of research" is thus limited to *one point* in a trough 1000 miles long and 150 miles broad. Certain geodetic results can be brought into approximate agreement with this one geological deduction by the adoption of a particular value of surface density.

But even the alleged agreement itself "between the two wholly independent lines of research" is not clearly indicated. The geological deduction was made in the foothills of Kumaun south of the Ganges, where no geodetic stations exist; in the foothills just north of the Ganges there are two geodetic stations, Rajpore and Dehra Dun. In order to confirm Mr. Oldham's geological conjecture that deep alluvium exists under Rajpore and Dehra Dun, negative anomalies were required (p. 107), and these were obtained by the aid of the Imaginary Range (p. 90). But the anomalies as calculated by the Trigonometrical Survey are positive, and this result has placed Mr. Oldham in a predicament (p. 91). He writes that "these stations cannot be used with any degree of safety in determining the form of the trough." Thus the agreement between the different lines of research can only be maintained if two of the most important geodetic results are excluded from the investigation.

From 1866 to 1870 Captain Basevi observed the pendulum at several places in India; he was a careful observer, but in his day no method had been devised of determining the sway of the pendulum stand. When a pendulum is swinging its stand is swayed by it, and this swaying tends to increase the time of the pendulum's oscillation; consequently if no correction is applied, the deduced value of gravity will be too small; the greater the "flexure" of the stand the greater the error in the observed result. For his observations in India Basevi used a heavy braced stand. In 1870 he decided to swing his pendulums at a high altitude in Ladak, and in order to lighten his loads and to facilitate transport he introduced a special light stand. This light stand he used in his observations at the Indian Station of Mian Mir, and he then transported it across the Himalaya Mountains to the station of Moré (height 15,427 feet). In Ladak he died, and it is not known what became of the light pendulum stand.

In 1903 Colonel Lenox-Conyngham commenced his modern series of pendulum observations, and during his first tour he visited four of Basevi's stations. His observations gave larger values of g than Basevi had obtained, the discrepancies varying from 0·027 at Bombay to 0·044 at Madras and to 0·103 at Dehra Dun. These discrepancies were attributed by Lenox-Conyngham to the omission of the "flexure correction" by Basevi (Survey of India, 'Narrative Reports,' 1903–04, para. 139). Other stations of Basevi's were visited in subsequent years. In 1906 Lenox-Conyngham observed at the station of Mian Mir where Basevi had used his special light stand; at this station the discrepancy between the old and the new results was 0·112.

Basevi's pendulum observations have thus been superseded; they served their purpose well, and their supersession is the inevitable fate of all observations which have been rendered obsolete by modern instrumental improvements. His more important stations have been revisited and their results revised. Eighteen of Basevi's stations have not as yet been revisited by modern observers, but in their stead 108 new pendulum stations have been established in India. If it had not been for the war, the station of Moré would have been revisited by a British observer in 1915 or 1916. Commander Alessio of the Filippi expedition (1913) endeavoured to observe the pendulum at Moré, but the attempt had to be made too early in the year and was frustrated by heavy snow.

Basevi's results were included in Helmert's compilations for the International Geodetic Association. After Lenox-Conyngham had completed his observations at Mian Mir, the International Association in 1909 deduced from them a "flexure correction" for Moré. Helmert was constructing a formula that would give the normal value of gravity in any latitude, and the Association wished to show how this formula agreed with observed results. The Association did not intend to convey to geologists the idea that they would now be justified in building far-reaching theories upon the Moré result.

Unfortunately Professor Borrass, who compiled the report, made the mistake of assuming that Basevi's light stand had been used at *two* stations in India, and that its flexure correction had remained *the same* at both places ('Report, 16th International Geodetic Conference,' 1911, p. 236). He thought that the light stand had been used at Dehra Dun as well as at Mian Mir and Moré. Believing that Dehra Dun and Mian Mir should be classed together and finding that the two corrections were accordant, he adopted a mean correction and applied it at Moré. Borrass stated his flexure corrections as follows:—

Deduced at Dehra Dun	+0·103
Deduced at Mian Mir	+0·112
Mean	+0·107 ±0·004

At Dehra Dun the pendulum had been swung on the heavy stand and at Mian Mir on the light one. The agreement between the corrections deduced by Borrass was fortuitous; Borrass's mean value and his probable error being based on misapprehension have thus no weight.

In September 1916 an article by Mr. Oldham on Basevi's pendulum observations appeared in the *Geographical Journal*, in which the author expressed the opinion that the flexure correction for Basevi's results could be estimated. This had already been done, but such an estimate cannot be made with sufficient accuracy. It is a question of the standard of accuracy required. Basevi omitted the flexure correction, and nothing now can raise his results to the modern standard of accuracy. The flexure of Basevi's heavy stand was apt to vary from station to station, and even the modern stand shows variations of flexure sufficiently great to necessitate a redetermination whenever the apparatus is re-erected. As to the behaviour of Basevi's light stand we know but one fact, namely, that his Mian Mir result requires a correction of +0·112.

Mr. Oldham assumes that Basevi's flexure correction was the same at Moré as at Mian Mir. Basevi recorded that at Mian Mir the stand was erected on a "floor of solid paka masonry": at Moré he recorded that the soil was "very loose and sandy." Between Mian Mir and Moré the stand had to be carried on men's backs for hundreds of miles over high mountains and passes: at Moré the stand was exposed to conditions of temperature, pressure, humidity, and wind totally different from those of Mian Mir.

When Mr. Oldham's article appeared I did not understand its purport. No one had been criticizing Basevi, and his pendulum results were being replaced and extended by the modern series. In his memoir Mr. Oldham supplies a reason for his article. He wished to use Basevi's result at Moré in support of a new theory, and he now feels enabled to state (p. 110), that the Moré results having been discredited have been reinstated. As this vague statement may be taken to mean that responsible authorities have reconsidered their opinion about Moré, I may perhaps explain that by "reinstatement" Mr. Oldham means the article he wrote himself in the *Geographical Journal.*

In his memoir (p. 111) Mr. Oldham estimates the anomaly for Moré as —0·434, and compares it with Borrass's result −0·433, published in 1911. He writes: "The two values of anomaly differ by only 0·001 dyne, and we may take it that the deficiency at Moré is not far from 0·43 dyne." It is hardly necessary for me to point out that the agreement of these two results is no evidence of accuracy. These two results are both derived by the same method from the same observation.

Mr. Oldham's new theory seems to be based upon the anomaly at Moré, namely, −0·434; this is certainly a large negative value, but all anomalies at high altitudes, if deduced on Bouguer's hypothesis, have negative values. Bouguer's hypothesis was that mountains were being supported by the rigidity of the crust. It has been recognized for many years that isostatic compensation must be taken into account, and Hayford's method based on the theory of isostasy has now superseded Bouguer's. The substitution of the theory of isostasy for that of extreme rigidity has had the effect of converting the negative anomalies which formerly obtained at high Himalayan altitudes into positive anomalies.

Instead of deducing the Hayford anomaly by clear steps, Mr. Oldham mixes in the same paragraph two geodetic hypotheses (Bouguer and Hayford) and two systems of mountains, the imaginary and the real (p. 111); and then out of this obscurity he draws the conclusion that "in the Central Himalaya compensation is in the excess" (pp. 112, 114). Having produced no evidence, he writes: "It is evident that the defect of composition has disappeared" (p. 112).

One assumption leads to another, and his next step is to assume that as the compensation is in excess at Moré, the whole extensive mountain area of the inner and higher Himalayas must be over-compensated, buoyant and light. (It might be just as fairly assumed that the gravity anomaly observed at Geneva is applicable to the whole area of Pyrenees, Alps and Carpathians.)

Finally, Mr. Oldham proceeds to the further assumptions that as this great Himalayan area is buoyant, it must be rising (p. 115); that the Earth's crust is being uplifted here by its buoyancy, and that owing to its uplift the crust to the south is being tilted downwards and is creating the Gangetic trough (p. 123). In this way his reinstatement of the Moré result has led up to his theory of the origin of the Gangetic trough.

The Trigonometrical Survey of India has benefited in the past from the collaboration of men who were not professional geodesists, notably, Archdeacon Pratt and Osmond Fisher. These distinguished investigators were endeavouring to utilize the geodetic data for unravelling the secrets of Nature. The welcome that was extended to them was awaiting Mr. Oldham; but his attitude towards geodesy has been different. He has considered it admissible to alter scientific data and to create new data from imaginary ranges. In the same table (pp. 77 and 90) he combines true geodetic data with figures of his own, and an uninitiated reader will never realize that the quantities given under the heading of "Hayford compensation" have not been deduced by Hayford's method.

Mr. Oldham's reference to the Aravalli Mountains is equally inaccurate. This range traverses Rajputana in a north-easterly direction, and terminates near Delhi as a small ridge which is an insignificant topographical feature. Mr. Oldham recalls a geological suggestion made many years ago that this range may once have extended across the Gangetic trough into the Himalaya. He now quotes the deflections of the plumb-line at three stations as evidence in support of this suggestion (p. 97). Two of these deflections however furnish no evidence on the point, whilst the evidence of the third (Sarkara) is adverse. Any reader can check my criticism by examining the map attached to the memoir. If the Aravalli axis is produced it will pass north-west of Sarkara; this will not diminish the northerly deflection at Sarkara. Yet Mr. Oldham sums up as follows: "The geological structure has suggested the possibility of an original extension of the Aravalli range into what is now the Himalayan region; the geodetic observations have supported this suggestion and converted what was only a bare possibility into something more than a probability."

So mistaken indeed are Mr. Oldham's ideas of geodetic principles and accuracy, that when he found his calculation of the depth of the alluvium at Agra was not in accord with the depth obtained by boring, he attributed the disagreement not to his own hypothesis but to the geodetic data (p. 80). He avoided this disagreement not by reconsidering his own assumptions, but by altering the observed results. On p. 112 he says he found it "necessary to apply a correction of −0·02 dyne" to the pendulum results as the latter did not give the depth of the alluvium correctly: and he even suggested that this Agra correction might be applied to Basevi's observations at Moré. The scientific precautions taken in the observation of pendulums become useless if the results, obtained by labour and care, are to be treated as they are in this memoir.

LETTER FROM MR. STEFÁNSSON

[We have much pleasure in publishing the following letter from Mr. Stefánsson, written on 20 July 1918 from St. Stephen's Hospital, Fort Yukon, Alaska. In a covering letter Mr. Stefánsson gives the excellent news that although he does not expect to be quite well for several months, he has sufficiently recovered from his long illness to be able to undertake a lecture tour on behalf of the funds of the Red Cross, beginning at New York on October 6 under the auspices of the American Geographical Society and the American Museum of Natural History.—ED. *G. J.*]

I HAVE recently seen in your *Journal* for February and May of the current year two short references to the work of the Canadian Arctic Expedition. They are as correct as the news sources on which you had to draw admitted.

The impression that I had arrived at Fort Yukon last Christmas was based on the newspaper assumption that I was myself present at the telegraph station from which my messages were sent to the Government and others. I had, however, sent them from the vicinity of Herschel Island by a south-bound trader whose vessel, the *El Sueno*, had been frozen in at Herschel. This was Captain Alexander Allan, who during 1915–16 was connected with the southern wing of our expedition.

It was correctly announced by Dr. Anderson (as you have it in your February note) that my intention was to have the *Polar Bear* attempt to proceed in 1916 from her base near Amstrong Point, Victoria Island, to winter on South Melville Island. She was then to continue south in 1917 by the well-known eastern route. I gave the appropriate orders to the *Polar Bear*, but, during my absence in our new islands north of Melville Island in the summer of 1916, they were not carried out, and the vessel in fact proceeded about 100 miles south, and wintered near Collinson's old quarters in Walker Bay. The reason for her doing so cannot be entered into here. In the summer of 1917 the *Polar Bear* sailed for the mainland before our spring exploring party had time to get south to her. The members of our sledge exploring parties of the springs 1916 and 1917 saw neither the *Polar Bear* nor any other vessel from midwinter of 1915–16 till September 1917. Seventeen of us spent the winter 1916–17 in Melville Island on Liddon Gulf and at Cape Grassy. Our houses were musk-ox hide, our fuel was locally discovered coal, our food ditionary force. It had been his intention to go to the Staff College had not the war intervened, but it was soon evident that the lack of the Staff College training was no drawback in his case. He was soon noted as one of the most brilliant officers on the staff, and his rise was rapid. At first only attached to the staff he became successively General Staff Officer 3rd Grade, 2nd Grade, 1st Grade, till finally he was selected for the position of head of the Intelligence branch of the General Staff in France, which position he held till the day of his death.

In the course of the present war the nation has had to mourn many young and brilliant men, but it may safely be said that it has suffered no more grievous loss than in the death of General Cox. He was a man of untiring energy both physically and mentally, and being a very quick worker he got through an immense amount of work, and his work was of the highest quality. He was equally efficient at survey work of all kinds, or staff work, or at the ordinary work of an engineer officer. He was one of those men, and there are very few, of whom nothing but praise was ever heard. His name was a byword for efficiency. He had great confidence in himself, but was most unassuming. He was full of enthusiasm for the job in hand, whether it was a heavy piece of work or a football match. He never wasted time. He had a most cheerful and lovable disposition.

It is a matter for infinite regret that he should have met with an accidental death when he had just reached, at a very early age, a position which gave full scope for his abilities. If his life had been spared he would surely have attained to the highest positions. He leaves a widow and two children.

W. C. HEDLEY.

To Colonel Hedley's tribute to General Cox's ability as a soldier we should like to add some expression of the loss to geography which his tragic death has occasioned. General Cox was one of the British representatives at the International Map Conference held at Paris in December 1913, and his colleagues will remember with admiration the extraordinary ability, energy, and tact with which he carried through the work especially allotted to him, the discussion of the conventional signs sheet. Unhappily, by reason of the war this work is still unpublished.

General Cox had been a Fellow of the Society for sixteen years, and for several years a member of our Diploma Committee. He was largely responsible for the second and much enlarged edition of Colonel Close's well-known 'Textbook of Topographical Surveying,' and in this, as on his boundary work, he displayed all the talents of a first-rate scientific geographer. Those who have been associated with him in this Society share with his colleagues on the General Staff the sense of sorrow at the loss of one of those rare men who may truly be called irreplaceable.

CORRESPONDENCE

The Nomenclature of Himalaya Peaks

IF a name be given to each Degree Chart as suggested by Sir S. Burrard, and the method of lettering and numbering indicated be followed, it would certainly be difficult to devise a more convenient and scientific system. The remark that the new Degree Sheet shows nothing but numbers and the rays of triangulation, whereas the old chart showed in outline the principal rivers and glaciers, seems however to indicate a retrograde step. The average amateur geographer would probably not only wish to have the rivers and glaciers indicated, but would prefer the rays of triangulation in a different colour (say red), if it did not unduly add to the expense of production.

Colonel Burrard's suggestion that a catalogue of Himalayan peaks should be prepared seems worth carrying out, but a double catalogue, such as described in the *Journal*, seems hardly necessary at the outset. Probably all that would be required would be a revised and considerably enlarged edition of Burrard and Hayden's book, 'The High Peaks of Asia.' In that volume the peaks are tabulated according to height in magnitudes of 1000-feet range, the longitude and latitude and regional name being given. All known peaks above 24,000 feet are summarized, the mountains between 24,000 and 25,000 feet forming the sixth magnitude. The tables might be extended so as to include peaks down to the tenth magnitude (20,000 to 21,000 feet). Even if there were a few thousand mountains in this last group, there should be little difficulty in picking out any particular peak, as the name of the Degree Sheet would be a guide.

Below the tenth magnitude the number in any group would be very large, but it might be sufficient at present to give a supplementary table of peaks of any importance, *e.g.* Jubonu, Narsing, Haramukh, which later on might be amplified and subdivided.

Perhaps I may also be permitted a few notes on nomenclature, as my ideas differ somewhat from those of Colonel Burrard and yourself. In the first place I do not agree that the time has come for regarding the name "Everest" as a suitable designation for the loftiest mountain of the whole system. As already indicated (*Geog. Journ.*, 1917, p. 46), the name "Chomo Langmo" has been independently found by General Bruce and the writer to be applied to the mountain, and until this name has been tested it would be advisable to refrain from a decision. In any case one would prefer to see a Tibetan or Nepalese name applied to the mountain, and Dr. Freshfield's contention that personal names should not be used in the Himalaya is supported by Colonel Burrard except in this particular case. To make an admirable rule and then deliberately break it as regards the chief summit of the whole system seems hardly consistent, and the reasons cited seem inadequate.

Again, as regards K_2, which will now be designated by the unsatisfactory appellation 52 A/13, it might be desirable to consider the application of a name derived from the natives of Baltistan. The merits of names already mooted, *e.g.* Chiring (Sir M. Conway) and Dapsang (Schlagintweit), might be debated once more by a few experts. The headmen of the nearest villages could then be informed of the name finally decided upon. The statement that "the symbol K_2 will serve to record the interesting fact that a mountain exceeding 28,000 feet in height had not been deemed worthy of a name by the people living under its shadow" is somewhat figurative, for Hill Burton's phrase regarding a much smaller mountain—"surrounded by his peers he stands apart from the world in mysterious grandeur"—is truly applicable to the premier peak of the Karakoram.

The application of special descriptive names like Pyramid, Hawk, etc. would of course be less objectionable if translated into the native language used near the base of the mountain, *e.g.* Tibetan and Nepalese. Prof. Garwood gives a summary of such descriptive names used in Freshfield's 'Round Kangchenjunga,' along with Tibetan equivalents, in a supplement to that book. There would naturally in many cases be several peaks with the same designation, but this need cause little difficulty if the name of the Degree Sheet were employed for distinction. In Scotland there are often several mountains with the same name, *e.g.* Ben More. The name when unqualified indicates the highest peak (Perthshire). In the other cases a qualifying local name is applied, *e.g.* Ben More of Assynt, Ben More in Mull.

Lastly, might I be permitted in the interests of Himalayan nomenclature to venture a remark regarding the statement in connection with Kanchenjunga in Burrard and Hayden's volume, that the most recent term applied, namely Kinchinjunga, should be adopted, although probably incorrect etymologically, because "uniformity in spelling is of more importance to geographers than correctness." I must take the liberty of disagreeing in this respect, as I fail to see that there is any excuse for mutilating a good name—and Kangchenjunga is an admirable designation—so that its meaning becomes unintelligible. Presumably it would be possible to secure both uniformity and etymological exactitude. Kinchinjunga is obscure because the first two syllables are derived from the Tibetan words "Kang," snow, and "chen," great. Kangchenjunga therefore seems etymologically to be by far the better term. Dr. Freshfield, in his book on the circuit of the mountain, states that he selected the name from fourteen variants. The selection of one definite name is certainly important. In 1903 three of the names which had been used for the mountain, namely Kangchenjunga, Kangchanjunga, and Kanchinjinga, appeared simultaneously in different survey maps.

Might one suggest that all Asiatic place-names should be submitted before adoption to linguistic experts, who would determine the etymology when possible, and crystallize the spelling and pronunciation.

A. M. KELLAS.

[We are glad to publish Dr. Kellas' letter as the first contribution to that discussion of Sir Sidney Burrard's note which we invited on its publication.

We would add that the present Director-General found himself confronted with an accomplished fact in the case of the name for Mount Everest, and cannot well be held responsible for the single exception to the principle upon which he has acted.—ED. *G. J.*]

The Designation of Points on Maps.

I have read with much interest the article in the September number of the *Journal* on "The Identification of Peaks in the Himalaya," and feel sure that there will be a general agreement that it is desirable to give a name to each degree chart, as proposed by Sir Sidney Burrard, and think that, on the whole, the system proposed by him is simple and practical. But there seems to be some doubt as to the actual procedure followed in giving the peaks numbers, and I venture to suggest a possible system which would not only apply to this particular problem but might also have some utility in other cases.

The suggested system is the following : Imagine each side of a map to be divided into three equal portions, and join the opposite corresponding divisions by straight lines. Then the map is partitioned off into nine approximately

THE HYDROGRAPHY OF THE YUNNAN-TIBET FRONTIER

Lieut. F. Kingdon Ward, B.A.

ON the Yunnan–Tibet frontier, extending southwards along the frontier of Burma also, the supreme structural feature is the parallel arrangement and close proximity to one another of the great mountain chains separating the Tibetan-born rivers Yangtze, Mekong, and Salween. Issuing together from a narrow breach in the plateau-rim between the eastern end of the Himalaya uplift and the western end of the great watershed of China, these parallel ranges, however formed, have determined, at least in part, the upper courses of these rivers, as they now flow. It is of the minor structures raised on these massive foundations, not of the great ranges and rivers themselves, that I intend to write.

The drainage through what may be called the Sino-Tibetan gap flows southwards, parallel to the dividing ranges of granite, slate, schist, and limestone which, whether as actual prolongations of the Tibetan plateau or as independent uplifts (a question to be decided by future exploration), separate and enclose them. The rivers themselves from their birth set out eastwards, under the influence of the Central Asian east-and-west trending axes, but gradually they curve round through a right angle and flow southwards, breaching the rim of the Tibetan plateau as they change direction in conformity with the change in alignment of the mountain ranges.

On the flanks of the breach, through which the hurrying waters crowd southwards, the tendency is for the rivers to spread out fanwise and flow off east and west as the Yang-tze and the Brahmaputra, but the central rivers, hemmed in, continue southwards, crushed close together by the wall-like ranges.

These ranges, however uplifted, are features of original structure, as, indeed, so far as we are concerned here, are the river gorges between them. Later additions are the tributary valleys, with the peaks, passes, spurs, outliers, and similar minor features carved from them. The distinction is relative; simply, it is claimed that the parallel mountain chains, with their longitudinal rift-like valleys, fashioned in the long-distant past, have stood till now substantially as they were formed, during which time those details which make up the general scenery of the region, were engraved on them.

Since the main ranges trend from north to south, and the great rivers flow parallel to them, the tributary streams flowing down the flanks of the divides flow east and west.

Now the width of the divides is so inconsiderable, that although all the heavy rain comes from one direction—the south-west—yet that flank of the divide does not receive an appreciably heavier rainfall than does the other flank, though, on the other hand, the easternmost ranges, owing to their being screened from the impinging rain-clouds by the high ranges further west, against which the moist winds first beat, do receive a progressively diminishing rainfall.

It is clear from this that no marked contrast is to be expected between streams flowing down one flank of a range and those flowing down the other, nor is any such difference found; further, that the westernmost range will be the most dissected by running water, the easternmost least; though, owing to the dense protective forests which, called to life by the adequate precipitation, clothe the former, contrasted with the nakedness of the latter, the resulting appearance is in each case considerably modified.

But with the spurs which, thrusting out east and west from the main divides, are thus blocked out, the case is different. These spurs present flanks to north and south in a region of heavy snowfall, and the contrast in the vegetation on the two slopes is apparent at a glance, and an index of conditions sufficiently different to have far-reaching consequences.

On north-facing slopes, trees (chiefly Larix and Picea sp.) extend to over 15,000 feet, and a thick tangle of scrub (Rhododendron, *Berberis Juniperis*) prevails to over 16,000 feet; while on south-facing slopes tree-growth ceases much lower down, and scrub-growth also somewhat lower. With the more scanty covering of vegetation on south-facing slopes occurs a marked accumulation of scree material. This contrast in the vegetation is a direct effect of the difference in aspect on north-facing and south-facing slopes. On the former, the lingering snow, protected from the spring sunshine, protects in turn the young plants and such seeds as are germinating, and, melting but gradually, ensures to them a constant supply of water.

On south-facing slopes the snow melts rapidly with the returning warmth, and is rudely stripped from the plant carpet at a critical moment, allowing the weakling plants to be exposed to rapid changes of temperature, involving considerable extremes; cold winds, too, play havoc with the delicate seedlings. In the second place this rapidly melting snow causes a volume of water to sweep down the mountain-side, doing great execution by direct attack. Here the poverty of vegetation reacts again. No soil can accumulate, since all the smaller rock *débris* is at once swept away by the water, which is consequently still less impeded in its abrupt descent, and the steepness of the slope depends on the angle at which the fallen material can rest. On the one flank, facing south, we have therefore steep rocky screes with a highly adapted flora of scree plants, poor in varieties; on the other, facing north, a gentler slope covered with a tangled carpet of dwarf shrubs, supporting a thin veneer of soil in which numerous plants can find foothold.

Into the question of plant-life under these abnormal conditions, however, I do not propose to enter here; it is sufficient for our purpose to note changes in the vegetation as indicating a change in the physical conditions, and to inquire first what change has taken place, and, secondly, what other changes does it involve.

If we look at a map of the Yunnan–Tibet frontier region, we notice a marked tendency amongst tributary streams to flow due south parallel to the main rivers, sometimes for a considerable distance, only turning east or west, as the case may be, to join abruptly the main river. The great divides having no thickness, it is evident that a stream simply flowing down from the crest-line for the very few miles which separate it from the next trough, would gather only a small volume of water to itself, as is in fact the case; but many of the tributary streams are of considerable size—are indeed rivers, and this volume they attain by flowing throughout most of their course parallel to the main river, collecting water over a large area. This fact is at once impressed on the traveller who voyages northwards along the frontier, as the smaller valleys, where existent, are utilized for the route in preference to the more difficult gorges of the main river. Moreover, the arid craggy troughs through which the Yang-tze, Mekong, and Salween have made their way offer scant opportunity for cultivation amongst their inhospitable cliffs and desiccated screes, most of the settled population being found away up on the flanks of the ranges.

These tributary streams have their birth, often in glaciers, far up under the peaks of the main watershed, and flow through comparatively open valleys, where are, in summer, broad meadows of gay flowers and mixed coniferous and deciduous-leaved trees; gradually the valley narrows, and tall cliffs grip the thundering water till, swinging abruptly round at right angles, the torrent grinds its way noisily through a jagged-walled arid gorge, and finally plunges into the main river.

This "reversed" valley, narrowing from a broad source in the mountains to a deep chasm at its confluence with the main valley, is characteristic of the region. It might seem, since the unusual—nay, unique—arrangement of the main divides has determined the parallel flow of the big rivers, that the tributary streams flow south for the same reason that they do; that is to say, that the tributary valleys are features of original structure. But every side valley shows clearly that it was carved out by running water, or, in its upper reaches, by ice, while there is nothing to show that the great troughs, though deepened by water, owe their existence to its action; indeed, such evidence as there is points to a tectonic origin. Moreover, the natural course of every tributary stream is down the flank of the main divide, and since some streams follow this course, while others show intermediate stages between this and the extreme south-flowing type, some other reason must be sought.

Consider first an ideal uplift (Fig. 1). Rain, falling equally on either flank of the divide, gives rise to streams which, cutting their way back at the head, block out peaks, separated by cols, thus producing an irregular crest-line. Spurs are formed buttressing the main watershed in the usual way. In the next stage, rain falling on the north and south flanks of these spurs starts a series of tributary streams, flowing north and south, as seen in Fig. 2.

Now, in consequence of that more rapid melting of the snow on south-facing slopes, evidence for which we have seen in the vegetation clothing them, streams flowing in this direction, coming down in spring spate, cut their way back at the head more rapidly than do those flowing idly and

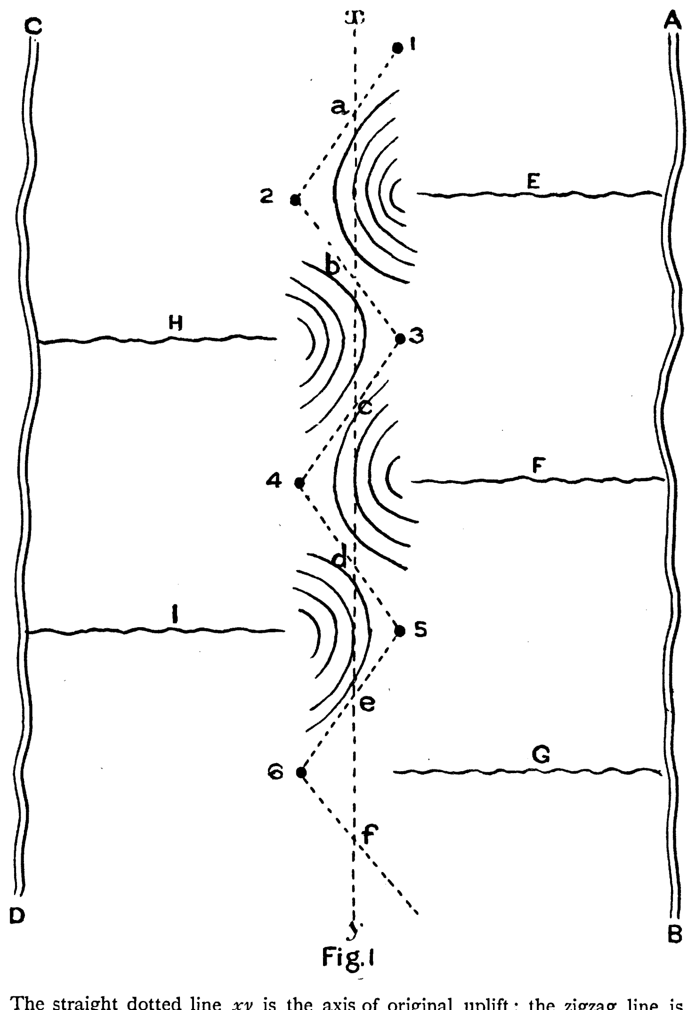

Fig. 1

The straight dotted line *xy* is the axis of original uplift; the zigzag line is the final watershed. AB, CD are main rivers; E, F, G, H, I tributary streams with cirques at their heads. 1, 2, 3, 4, 5, 6 are peaks on crest of main divide; a, b, c, d, e, f are cols between the peaks. The figure is drawn in recollection of a similar diagram in Professor Marr's 'Scientific Study of Scenery.'

with greater regularity—owing to the control exercised by the carpet of vegetation with its entangled soil-film—down north-facing slopes. The result is that, cutting thus rapidly back at the cirque, the south-flowing stream presently taps the headwaters of the next main tributary valley to the north. Next, the increased water-supply enables the swelling stream to cut its channel deeper, while the beheaded stream in its lower course dwindles to a small current, or entirely disappears. At the same time the outline of a barrier range, flanking and parallel to the main range, is marked out. The cutting-back process proceeding, a second stream further north is beheaded, and gradually a spur running more or less diagonally from the middle flank of the range of the main river is carved out (Fig. 3).

Meanwhile the continual cutting back of all south-flowing streams at

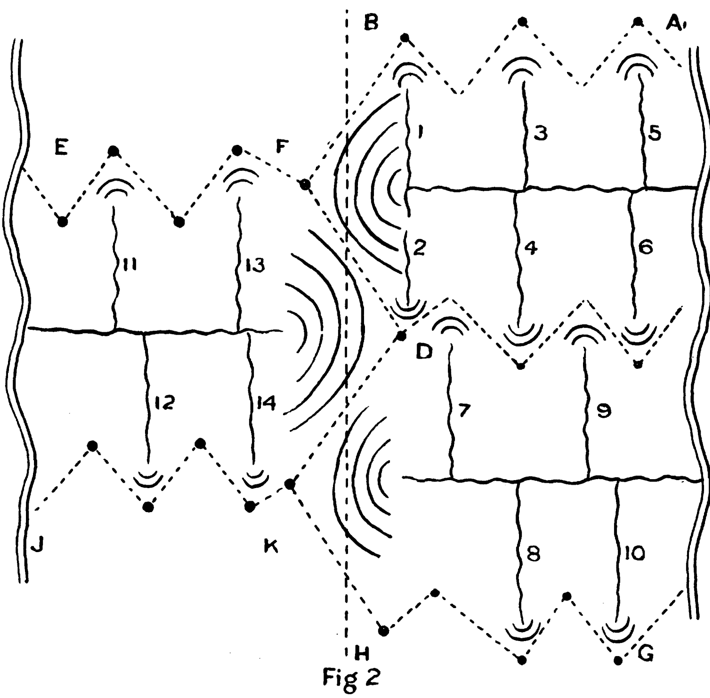

Fig 2

Peaks and cols as in Fig. 1. Nos. 1, 3, 5, 7, 9, 11, 13, are south-flowing streams from spurs AB, CD, EF; 2, 4, 6, 8, 10, 12, 14, north-flowing streams from spurs CD, GH, IK.

the cirques broadens the head of each valley, and with the capture of stream after stream, the original pirate stream, swollen with waters from every direction, still further scours its valley. (But some of the wide valley-heads are ice-worn.)

Lower down, however, especially along that part of its course which remains of the original east or west flowing stream, the waters are more confined as there is less lateral abrasion, the channel being already dug deep; at the same time the vastly increased load which the torrent now transports enables it to corrode its channel vertically with great rapidity.

The decrease in its powers of broadening the lower valley and concentration of effort at deepening it are due to two causes. In the first place, the extreme local aridity as the main trough is approached protects the walls of the gorge, which are attacked neither by rain nor by extreme variations of temperature. In the second place, throughout the frontier region the rocks, at least from the main troughs to an altitude of 12,000 or 15,000 feet, stand nearly vertical, and the strike runs about north-north-

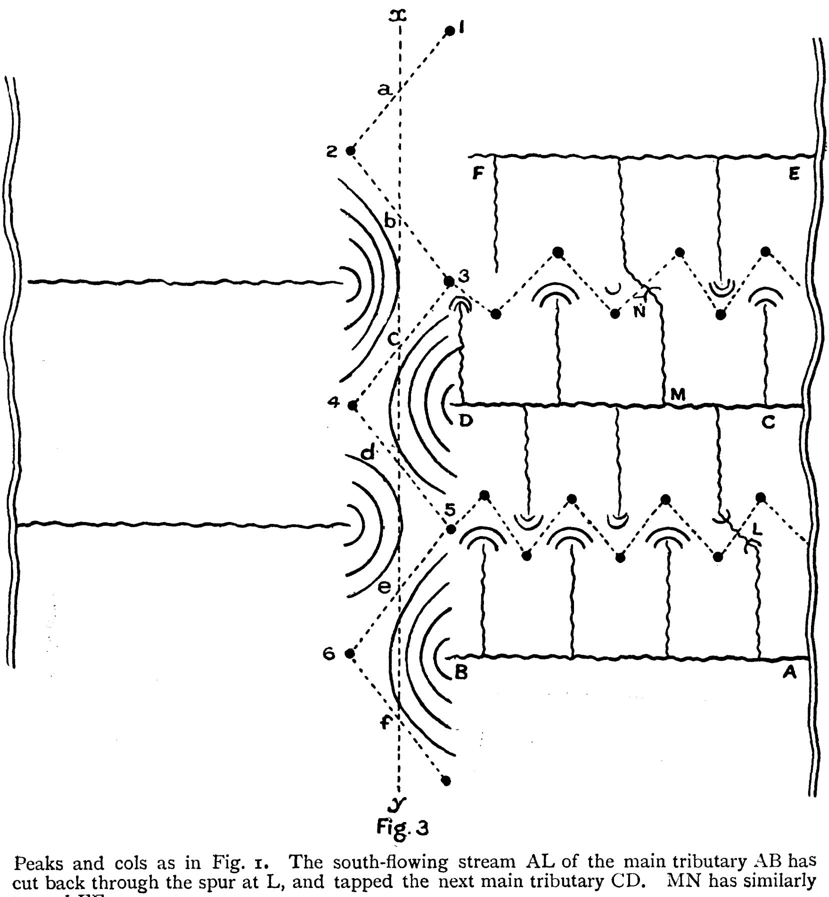

Fig. 3

Peaks and cols as in Fig. 1. The south-flowing stream AL of the main tributary AB has cut back through the spur at L, and tapped the next main tributary CD. MN has similarly tapped EF.

east to south-south-east, or even nearer the north and south line. Consequently, streams flowing in a north and south direction follow a course more or less along the strike of the rocks, while those flowing east and west cross the strike. In the case of schists and slates or shales, standing on edge, the former direction at right angles to the cleavage planes is the line of least resistance; as long as the stream follows the strike, the tendency is for it to cut a broad valley; when it cuts across the strike the tendency is for it to cut a narrow jagged-edged gorge. At high altitudes also the effect of extreme temperatures and of rapid heating and cooling along the cleavage helps to widen the valley.

Indeed, even north-flowing streams may benefit from the advantage thus conferred by the strike of the rocks, and cut their way back sufficiently to tap a small stream to the south, as seems to have been the case with the stream flowing down to the Mekong from the Londre-la.

Eventually, owing to these changes, we find a long south-flowing and a short north-flowing branch of the main tributary. The barrier range to which these changes have given birth also sends small tributaries down either flank, on the one side to the main trough (recognizable by their size as not originating under the crest of the main divide, and often tumbling straight over the precipice, as in the "granite gorge" on the Salween above Cham-p'u-t'ong), on the other to the south-flowing stream. On the original lateral valleys, from which the headwaters have been stolen by the restless activity of these south-flowing streams, and on such valleys as are altogether ignored by them, absorbed in their greedy and headlong work, certain characteristic features are impressed.

Where a tributary stream from the main divide joins the south-flowing stream (which has crossed its valley and worked further north), there is often a waterfall, owing to the more rapid cutting down of its bed by what is now the main stream. The waterfall on what is now the main A-tun-tzw stream, coming down from the crest of the Mekong–Yangtze divide just below the village, seems to have been formed in this way. Originally the present source-stream probably flowed north through the shallow hanging valley above A-tun-tzw, to Adong. The south-flowing A-tun-tzw stream, cutting back at a lower level, tapped it and diverted it south over a fall, stranding the upper part of the Adong valley, where a lakelet has been formed by a barricade thrown across by a side stream.

Again, many high-level valleys are left in the air owing to the turning of their water-supply and rapid deepening of the main channel. Other stranded or "hanging" valleys along this frontier were formed by the over-deepening of the main valley by water while the tributary valleys were filled with ice.

Hanging valleys—flat meadows with lakes or meandering streams—may also occur on the crest of the main divide, especially if a stream on one flank of the divide cuts back into a stranded valley on the opposite flank. The flat summit of the Londre-la (12,000–13,000 feet) on the Mekong–Salween divide is a hanging valley left in the air by the south-flowing stream running down to the Salween, and isolating Francis Garnier Peak (see Fig. 4). Similarly the south-flowing A-tun-tzw stream has isolated the massive outlier due west of the village, completely severing it from the Mekong–Yangtze divide.

Though it is scarcely profitable to point out detailed examples of the structures described, in a region so comparatively unfamiliar, still those acquainted with Major (now General) Davies' map of Yunnan will recognize in the A-tun-tzw and Doker-la streams, and in those flowing from the Tsa-lei-la and Pai-ma-shan, most of the principles involved, as here set forth.

We have then an apparent confusion of ridges, valleys, peaks and outliers with waterfalls, valleys left hanging in mid-air, smoking screes and rushing torrents; then turning to the vegetation, we find meadows surrounded by flower-clad precipices occupying the broad alpine valley heads, magnificent mixed forests lower down, pine-clad slopes fronting

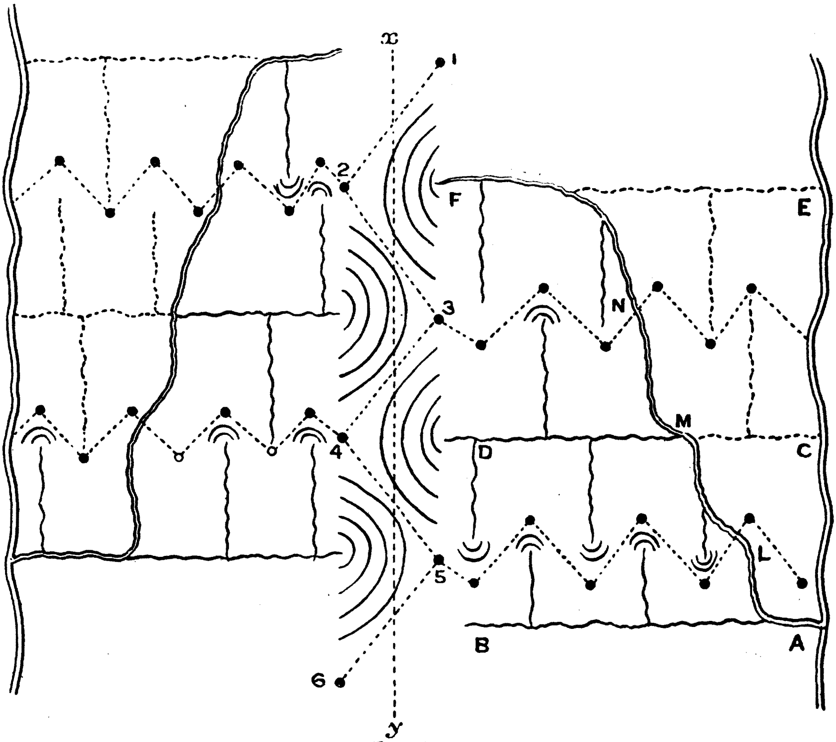

Fig. 4

Lettering as in Fig. 3. Finally resulting south-flowing streams are shown by double line. The upper part of valley CD may be left in the air, owing to rapid cutting down of main stream; and there may be a fall at M. A barrier range is blocked out in the area AEF, streams flowing east and west from it.

the dry river gorges, stark screes with scattered plants, and in the deep valleys of the extreme west an approach to tropical jungle. On north and south facing slopes we find, as already pointed out, a marked difference both in the character and composition of the vegetation, and similar differences still more pronounced are met with as we pass from the easternmost range (the Mekong–Yangtze divide) to the westernmost (the Salween–Irrawaddy divide). Finally, we have to note that, owing to the isolation of barrier ranges by the activity of south-flowing streams, their floras also are isolated more or less, with results well worth investigating.

While therefore, as described in a previous paper read before the Society, many of the hanging valleys and lake basins found at high altitudes on the Yunnan–Tibet frontier, owe their existence to a former generous extension of ice on all the main ranges, others are to be explained as a result of the unequal abrasion of north and south slopes; while also no explanation is offered of the main tributary valleys with broken backs (water or ice falls) nor of looped rivers (to be referred to presently), yet if the selective action of this principle as a sculpturing agent is fully realized: if the part played by a former unequal but universal extension of ice on the several ranges, is recognized, and the fact that these co-workers are in turn subordinate to a single control, namely, the prevailing south-west rain-bearing wind, owing to which the westernmost ranges tend to be washed away more rapidly than the arid easternmost ones, and consequently the westernmost rivers to be filched from their deep beds by yet deeper rivers and drawn headlong westwards —if these three sculpturing and denuding agencies are fully grasped and their several scopes defined—then I believe that the apparently inextricable tangle of spurs and tortuous river courses cease to present that overwhelming confusion which first greets the eye.

How far the argument cited above can be carried—whether by itself it is sufficient to account for the extraordinary courses met with in certain rivers of this region—is another matter. It is not difficult to see that, under certain conditions, a river might be forced to turn back on itself several times, and flow in a W-shaped course. But though the parallel loop does occur in several rivers along the Yunnan–Tibet frontier, and perhaps nowhere else in the world under similar conditions, still it is comparatively speaking so rare, and so striking an occurrence, that each individual case demands separate consideration; for doubtless the conditions are not precisely the same in each case, as for instance with the Ngawchang-hka on the rain-washed Burma side of the frontier, and the Wi-ch'u in the arid heart of south-east Tibet. Courses so whimsical in rivers as far asunder as the Ngawchang-hka, the Wi-ch'u, the Yangtze and the Yalung, which all display this feature more or less marked, cannot be explained by a formula.

In a paper published in the *Geological Magazine* ("Further Geological Notes from the Land of Deep Corrosions") in 1915, I stated that the folded and metamorphosed rocks found in all the river valleys led me to believe that, while the closely woven loops of such rivers as the Wi-ch'u and the Yangtze (at Likiang) resulted from the linking up of two originally distinct rivers flowing in opposite directions, such beheading of one stream by the other might be the result of earth-movement; in fact, movement in one direction combined with movement in another at right angles to the former, giving rise to a screwing motion. Such movements may have actually taken place, giving rise to the east and west trending folds of the Himalayan ranges on the one hand, and to the north and south trending folds of the Yunnan–Tibet frontier on the other. But while there is good reason to believe that such rivers are in fact formed by the confluence of two originally separate streams, the junction may also be effected by the gradual and unequal cutting back of streams as described above, a process which can be seen, in all stages of accomplishment, now at work.

The Wi-ch'u deserves a few words to itself. Like other main tributary streams of the frontier region, it flows due south throughout the greater part of its course and turns abruptly to join the Salween; but before reaching the confluence it indulges in the remarkable wriggle referred to, turning backwards and forwards on itself, loop lying against loop, where the river has impetuously torn its way out through the grandly savage mountain range as though lost in the wilderness and blindly seeking an exit. It is possible to stand on a ridge of rock, and looking down 1500 or 2000 feet, to see the river flowing due south on the one hand and due north on the other, so that it requires an effort of imagination to believe that it really is the same river. Such a wriggle would, of course, occasion no surprise in the case of a river meandering across a flood plain; but when it rushes through deep gorges, with stark rocky mountains capped by snow-peaks towering on every side, the effect is staggering. However, it would need a longer exploration of the valley than I devoted to it to say exactly what has happened, and I must leave it at that.

We may now draw attention once more to the influence this parallel arrangement of the main troughs and tributary valleys has on the people of the country, and on communication between valleys. Travelling up the main river gorges, along which lie the routes between Yunnan on the one hand and Ssuchuan and south-east Tibet on the other, very little cultivation is seen, and the population is correspondingly sparse; owing to the scarcity of rain, all fields need to be terraced and irrigated.

As already remarked, the tributary streams from the main ranges slit the valley walls with narrow jagged gorges, entrance to which is gained with difficulty. The roads from one main valley to the next, however, always follow the main torrents, that is, those flowing more or less south; similarly the roads up the big rivers often leave the main valleys and cross the spurs well up the flank of the divide, though there is generally an alternative track through the deep chasm where the big river rolls boisterously along.

Thus in Fig. 5 to cross from A to C it is necessary to follow the route ADC, while the route up the main valley AB lies parallel to but back from the main river, crossing the cols between the long south-flowing and short north-flowing streams, and turning back to the main trough through the narrow gorge where the joint stream breaks through. Thus crossing from valley to valley, the main peaks of the divide are always outflanked, and though the route is made longer, the gradient is made easier than it would be in case of a frontal crossing of the main divide. The journey from Londre, on the Mekong, over the Doker-la to Aben on the Salween, is an instance of the first; that from the Mekong below A-tun-tzw, *viâ* that village and Adon, over the Tsa-lei-la and down to the Mekong again at Yå-kå-lo, an example of the second.

Once the difficulty of entering the tributary gorge has been surmounted, the valley begins to open out; cultivated slopes and villages are seen, and higher up broad alpine pastures. In fact, in the narrow Mekong basin at least, the population, hidden away behind the spurs and barrier ranges of the containing walls, considerably exceeds that of the main valley. It is

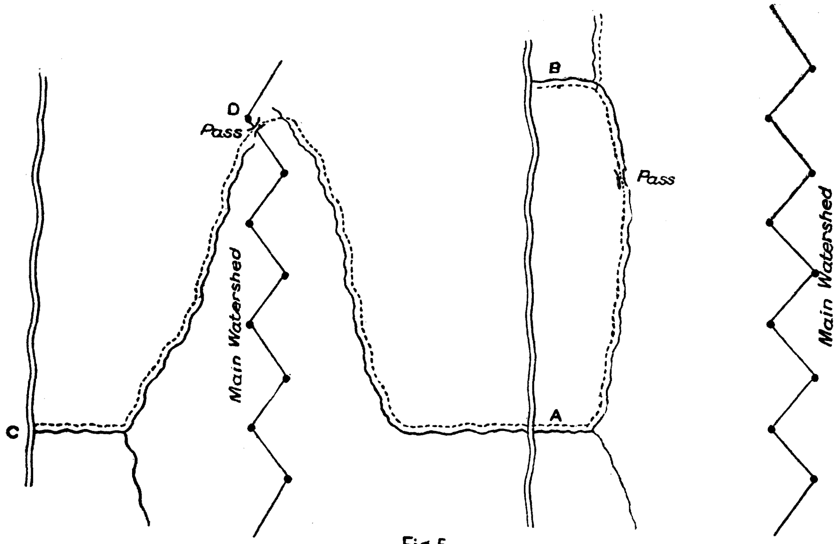

Fig 5

The route from A to C follows the south-flowing streams *viâ* D. Route from A to B follows the inland valleys higher up the flank of main divide, instead of keeping to main trough.

a new world which is opened up to the traveller behind these inhospitable and apparently impenetrable cliffs between 8000 and 12,000 feet high.

To what extent the facilities for intercommunication between the main troughs thus afforded have influenced the peoples of this region it is not easy to say. The routes from south-east Tibet into Yunnan, followed by large numbers of caravans each year, some of which come down as far as Burma, owe their existence to these valleys, and the recent westward movement of the Lisus from the Salween into the Burmese hinterland seems to be a direct result of this ability to cross apparently insuperable mountain barriers with comparative ease. Thus there is by no means that segregation of types one might expect to find in valleys so jealously isolated from one another, such differences as exist being dependent rather on climatic causes. For example, in the rainy region of the Salween, which extends as far as 28° N., we find Lisus and (near the 28th parallel) Lutzw, giving place suddenly to a Tibetan tribe similar in appearance to the Mekong Tibetans, as soon as the arid region is reached, separated by a gorge, passable at certain seasons, and no more than a few miles in length.

Similarly, in the wetter southern portion of the Yunnan Mekong we find Chinese types, and in the arid northern part a Tibetan type; and there is a far wider difference between the tribes north and south of the Salween gorge just referred to than there is between the Tibetans of the Salween and those of the Mekong in the arid region, separated though these latter are by the vast bulk of the Mekong–Salween divide.

On the other hand, considerable as is the difference in appearance between the stone-built houses and irrigated terraces of the arid valley, and the timber houses and cultivated slopes of the higher flanks of the divide, there seems to be no difference between the valley and the alpine Tibetan of the Mekong basin.

There is one further point in the hydrography of this region, which must be briefly referred to, since it is perhaps the most important sculpturing agent, in its effects, at work on the region to-day. I mentioned at the beginning that the rainfall on either flank of any of the main divides was not appreciably different; at the same time, the westernmost ranges, acting as rain screens, receive a far heavier rainfall than do those lying further east. Consequently the snow-line on the Salween–Irrawaddy divide is much lower than it is on the Mekong–Yangtze divide, and this in turn brings other effects in its train.

But the chief point is, that the rain-bearing winds, beating up from the south-west, are impinging first on the Salween–Irrawaddy divide, and the tendency is for all watersheds to move eastwards, and hence for the water to flow, ultimately, not south, but west.

Thus the lesser principle, that tributary streams flowing east or west to a flank behead those lying to the north, one by one, is included in the greater, that the western main rivers will eventually behead and completely divert those further east.

A TRANSYLVANIAN BOUNDARY FOR RUMANIA: NOTES BY COLONEL R. ROSETTI (RUMANIAN ARMY) AND COLONEL SIR THOMAS HOLDICH

THE following notes have been communicated by the President for publication. The first is an extract from a letter written by a distinguished officer of the Rumanian Army, Colonel R. Rosetti, in criticism of certain passages in the recently published book: 'Boundaries in Europe and the Near East,' by Sir Thomas Holdich, reviewed in the October *Journal*. The second note is the author's reply.

CORRESPONDENCE

Notes on the account of Commandant Tilho's Journey: 'Geogr. Jour.,' April 1918.

El Fasher, Darfur, Sudan, 6 Sept. 1918.

I HAVE recently seen the *Geographical Journal* for April 1918, containing an account of the work of Commandant Tilho in Tibesti and Wadai, which interested me greatly. I should like, however, if I may, to point out one or two slight errors in it as regards Darfur.

On page 224, lines 22, 23 and 25, and on p. 225, line 17, the place called Kabiya has been shorn of its first syllable. The name is Kabkabiya, or, as we spell it on our maps, Kabkabia.

On page 244, lines 29, 30, Um-Bakur should be Um-Bakhur, the central consonant of the second word in the name being not a *k*, but the Arabic خ, which is usually expressed by the double consonant *kh*.

On the last two lines of page 244, a "nought" has been omitted from the population of El Fasher, which should read fifteen to twenty thousand.

The statement on page 245, lines 11 and 12, that "the last French officer arrived in these parts from the west only twenty years ago" is not strictly accurate, as Colonel Hilaire and Sous-Lieut. Le Mercier came through here from Wadai on their way back to France in March 1917, only four months before Commandant Tilho.

As regards the large lake on the top of Jebel Marra (p. 244, line 35), it may interest you to know that there is not one lake but two. These lakes were visited in March this year by a party of British officers and officials, accompanied very unwillingly by some natives, as they look upon these lakes as haunted. Major Hobbs, West Yorkshire Regiment, who was one of the party, has written a report with a rough sketch of them; and if you think it would be of any general interest, I will ask him to send you a copy.

R. A. SAVILE (Lt.-Col.),
Governor Darfur Province.

We are indebted to the Governor of Darfur for the above notes, and for his initiative in obtaining the account of Jebel Marra which we publish in this number. The passage on p. 245 referred to "the immense change which has taken place in our feelings towards our excellent friends and allies since the last French officer arrived in these parts only twenty years ago." Had we known that two French officers had very recently just preceded Commandant Tilho we should of course have phrased the allusion differently. They will, we trust, appreciate the spirit of the allusion and forgive its literal inaccuracy.—ED. *G.J.*

The Identification of Mountain Peaks.

Referring to the recent article on "The Identification of Peaks in the Himalaya": a similar difficulty occurred in the hills of New Hampshire, U.S.A., known as the White Mountains. As the country is well settled, many mountains were known by different names in towns on opposite sides. There were a half dozen, or more, Black Mountains in the State. Widespread, and often bitter, feelings were excited regarding the two mountains, each of which is known in its vicinity as Mount Kearsarge. The vessel which sank the *Alabama* was named Kearsarge, after one of these, but high naval officers found it impossible to decide which one was intended.

The Appalachian Mountain Club took up the matter in 1876 and proposed a system of nomenclature described in *Appalachia*, vol. **1**, p. 7. The State was divided into sections, which were lettered. For the principal mountains a number was added, and a second number for secondary peaks. Thus, L 1, 3 denotes the third summit north of the highest summit of the Giant's Stairs. A map was also published in the same volume in which this notation is added. This system is capable of indefinite extension, and has proved extremely convenient for the detailed study of the mountains by the explorers, surveyors, and geodesists of the club. An elaborate study of the name Kearsarge is given in the same volume, page 152.

The method of indicating a star's position on a map by its distance in millimetres from the left-hand and lower edges is frequently used here (see *Harvard Annals*, **26**, p. 202 ; **72**, p. 72, etc.).

Yours very truly,

EDWARD C. PICKERING.

Harvard College Observatory, Cambridge, Mass.,
10 October 1918.

MEETINGS: ROYAL GEOGRAPHICAL SOCIETY: SESSION 1918-1919

First Evening Meeting, 11 November 1918.

The President announced that the Council had that afternoon passed the following resolutions, which were received with acclamation :

> The President and Council of the Royal Geographical Society, meeting on the day of the enemy's surrender, beg leave to offer to His Majesty the King, Patron of the Society, their loyal congratulations on the victorious conclusion of the War.
>
> The President and Council of the Royal Geographical Society, meeting on the day of the enemy's surrender, offer to Field-Marshal Sir Douglas Haig the congratulations of the Society, who are proud to recognize that the Imperial Armies have been led to victory by one of their Fellows.

At the leading of Colonel Sir Charles Close three hearty cheers were given for Sir Douglas Haig. The President then moved the following resolution, which has been communicated to the representatives in London of the King of the Belgians, the President of the French Republic, the Emperor of Japan, the King of Italy, the King of Serbia, the President of the United States, the King of Rumania, the President of Portugal, the King of Montenegro, the King of Greece, the President of China, the President of Brazil, the King of Siam, and the President of Cuba:

> That this meeting of the Royal Geographical Society, being the first of its Session 1918-19, held on the day of the surrender of Germany to the victorious arms of the Allied Nations and of the United States of America, expresses its thankfulness and pride in the results won by the courage, steadfastness, and sacrifices of the Forces and Peoples of the countries that have combined to defend the cause of national liberty ; and requests the President to convey this resolution to the Heads of the Allied Nations and to the President of the United States.

PAPER : The Road from Baghdad to Baku. Colonel G. S. F. Napier.