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GRAVITY DEFLECTIONS IN THE ANDES.

Colonel C. F. Close, C.M.G., R.E.

SIR THOMAS HOLDICH has recently given a valuable account of the operations of the Peruvian-Bolivian Boundary Commission. All those who have read this account will have realized what excellent work was done by the late Captain H. S. Toppin, whose death in action has deprived us of a very gallant officer and able explorer—a man who was not content with doing anything less than his best.

The joint Commission was faced with a difficulty not uncommonly found in mountainous regions, viz. the disturbance of the level by the attraction of mountain masses. In the neighbourhood of such a giant range as the Andes the disturbance is naturally very considerable, so much so that it becomes a matter of some importance to discover, if possible, its amount. Captain Toppin fully recognized the desirability of examining the question.

In a letter to the present writer, dated 4 May 1914, shortly before he went to France where he was killed, he said, "I am forwarding you all the data we possess respecting the deviation of the plumb-bob between Poto, our base in the Cordillera, and Marte, and shall be very grateful if you can evolve from this material a standard latitude for our maps. The stations 43 and 44 are included because, although not fixed by rigorous triangulation, there is probably not a discrepancy of more than three or four seconds (arc) between the interpolation results and the values that would have been obtained had all three angles been observed. . . . In the first region, unconnected with the triangulation, where we were doing a considerable amount of astronomical work, not only did the mean of a good series of observations . . . differ considerably from the mean of an equally good series on a subsequent night (the difference being sometimes as great as six seconds), but the results also seemed to be affected by the star's altitude. The forest stretched away indefinitely to the north, and 200 miles to the south lay the snows of the Andes. . . . The diagrams have been taken direct from our 1 : 250,000 maps, and if not sufficiently clear, I shall be bringing the originals down . . . shortly."

Then follow the details of the observations for latitude at Marte, Poto, Saqui (27), point 43, confluence Lanza-Tambopata, and point 44. These observations are really excellent, and show what a high degree of precision modern field instruments are capable of in the hands of skilled observers. The following is an abstract of the observations, showing the difference between the astronomical values and the trigonometrical (taking Poto as the standard latitude):—

LATITUDES IN THE CORDILLERA.

Station.	Name.	Astron. latitude.	Pairs.	Trig. latitude.	Trig.—Astr.	Height.
7	Poto ...	14° 40' 35".33	4	Accepted as initial lat.		15214
27	Saqui ...	14° 30' 33".7	1	14° 31' 4".24	+30".5	14610
43	—	14° 18' 32".8	2	14° 18' 49".76	+17".0	7662
44	—	14° 1' 2".0	1	14° 1' 14".58	+12".6	4884
	Confluence					
	Lanza—	14° 0' 48".6	1	14° 1' 3".15	+14".6	2640
	Tambopata					
60	Marte ...	13° 40' 20".13	11	13° 40' 44".1	+24".0	1427

Stations 43 and 44 are not in the main triangulation, but are interpolated from the snow peaks. They should be accurate.

Previous values for the astronomical latitude of the confluence Lanza-Tambopata are—

Fawcett	...	...	...	14° 0' 44"	Theodolite.
Mailles	...	...	...	14° 0' 42".5	Astrolabe.

Captain Toppin's Commission thus observed six excellent astronomical latitudes, one on the south side of the highest peaks of the Andes, and five on the northern slopes. Assuming, for the moment, that the astronomical latitude at Poto, the southernmost point, is errorless, the following are the differences (astronomical—geodetic) between the observed values and those derived by triangulation from Poto :—

Saqui	...	...	—30".5
Hill 43	...	...	—17".0
Hill 44	...	...	—12".6
Confluence	...	...	—14".6
Marte	...	...	—24".0

These negative values imply a deflection of the plumb-bob towards the south, that is, towards the snow range and pampa plateau.

We cannot say what the deflections at these points with reference to any chosen spheroid really are. Calculations of local topographical deflection are valueless, and we do not know to what extent the condition of isostatic equilibrium obtains in the Andes. But there is a general similarity of outline between this part of the Andes and the Himalayas near Mussoorie and Dehra, and by superimposing the two sections it is possible to obtain some idea of a plausible system of deflections. The accompanying diagram shows the two sections, the Indian deflections being taken from Professional Paper of the Survey of India, No. 13, by Major H. L. Crosthwait, R.E., "Isostasy in India," and the Indian section from Professional Paper of the Survey of India, No. 5, "Attraction of the Himalaya Mountains," by Major S. G. Burrard, R.E. The data for the Andes section were furnished by Captain Toppin.

Looking at these sections we should not have been surprised to find on the northern slopes of the Andes southerly deflections amounting to

CROSS SECTIONS OF THE ANDES AND HIMALAYAS.

Thick Line is a section of the Himalaya Mountains through Dehra Dun at an azimuth of 30° E. of N.

Thin line is a section of the Andes passing through 14° 30' S. Lat. 69° 15' W. Long., at an azimuth of about 30° E. of N.

Indus Valley
Sutlej Valley

30 seconds or so. As a fact, we find, if we assume the astronomical latitude of Poto as errorless, a series of southerly deflections averaging about 20 seconds. It is, of course, probable that the Poto latitude is not errorless, and it may very well be affected itself with a southerly deflection. But, all things considered, it is less likely to be affected than the latitudes of stations on the northern slopes.

The advice given, therefore, was to accept the observed latitude of Poto and to reject the observed latitudes of stations on the northern slopes. There was, alas! no opportunity of discussing the matter fully with the Head of the Mission. But the writer knows that he agreed with this conclusion.

2 April 1916.

SIR ERNEST SHACKLETON'S EXPEDITION.

AT the Meeting of the Society on May 8 the President spoke as follows:—

“Before we proceed to the business of the evening I think you would like to know the position in which things stand with regard to the Antarctic and to the prospects of something being done to find out what has happened to Sir Ernest Shackleton's expedition. As you know, no news has come through in the last fortnight from the Weddell Sea, and the time is now drawing to a close, or has almost drawn to a close, in which we can reasonably anticipate any news of the release of the ship which took him out there. There is too much reason to fear it has either met with some misadventure—not necessarily of a fatal nature—or that it is drifting in the ice and has been unable to reach the open sea and return to civilization. That being the state of the case, it is obvious that the question of search and relief has become an urgent question. I have been in communication with the Prime Minister on the subject, and we are still in communication, and to-day I have received official intimation that a small expert Committee is being formed under Government control by the Admiralty, and that we shall receive shortly an invitation to appoint a delegate to represent the Geographical Society upon that Committee, the business of which will be to decide what steps shall be taken to discover what has happened in the Weddell Sea to the ship, which may very possibly have its whole original complement on board, since it is uncertain whether Shackleton would be able to accomplish his very bold undertaking of crossing the Antarctic continent.”

In response to the invitation of H.M. Government the Council appointed Major Leonard Darwin, R.E., Past President, to represent the Society on the Committee, which includes the Hydrographer to the