

deficiency of mass, when transferred to the subcrust under the plains, is 8". The significant fact is not so much the reduction of deficiency below the mountain range as the location of a deficiency under the plains between the foot of the slope and the southern station of observation. In Fisher's hypothesis this is the important feature which brings about a more rapid variation of deflections than follows from the assumption of simple compensation.

The results of the calculation upon the second hypothesis give 20" as the variation of deflection between Dehra Dun and Kaliana, with an average deflection of 12", against the observed 30" and 16". The calculated variation and average deflection for the interval between the foot of the hills and the southern edge of the plains are, respectively, 24" and 10", the observed values being 43" and 16". The differences between Fisher's quantities, based on the second hypothesis, and those observed, approach, on an average, 35 per cent. of the observed values.

Both hypotheses, that of simple and that of general compensation, fail to give results in accord with observation, when Fisher's numerical values are used. In his second hypothesis his assumption of a three-mile depression of the crust is inadequate. As pointed out by Col. Burrard in his paper, to explain Himalayan deflections by a hidden synclinal, we must assume the latter to be seventy to eighty miles wide and six miles deep under Siliguri, seven miles south of the foot of the slope, and two miles deep under Jalpaiguri, thirteen miles south of Siliguri, the rock composing the synclinal basin to have a density of 2.7, and the sediment filling the synclinal to have a density of 1.9. As Col. Burrard says, it is doubtful whether the density of sediment, when under a pressure of a vertical column six miles high, would remain as small as 1.9; any increase in its value will require the depth of the supposed synclinal to be increased.

In connection with Fisher's investigation, there is an interesting point. Putting aside his computed figures, we see that both he and Burrard agree in considering that the observed facts cannot be explained by only the visible Himalayan mass and its vertically underlying root. Both investigators are forced to conclude the existence of a third factor, a source of negative attraction under the plains at the foot of the hills. Fisher prefers to adopt the idea of deficiency extending under a relatively wide belt of the crust due to the depression of the latter into the liquid substratum, the outer surface of this depressed tract being brought up to sea-level by the deposition of the Siwalik beds and alluvium. This hypothesis leads to the assumption of very doubtful values of some of the unknown quantities, as has been shown above. Burrard's hypothesis differs from Fisher's in that he would localise the deficiency in a rift in the crust subsequently filled in by deposits.

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Dehra Dun, U.P., India, April 3.

SURELY Col. Burrard and Major Cowie have misread the review; it did not dismiss Col. Burrard's speculations, but pointed out that he had himself dismissed, with what appeared to be inadequate examination, an hypothesis which seemed fully capable of explaining the facts. The sentence which has elicited their letters was intended to refer solely to the memoir under review, and had no application to other publications by the same author. The memoir did not, in fact, contain any detailed investigation of an hypothesis which, if tested numerically and in its completeness, appears to be at least as capable of affording an explanation of the facts as that propounded by Col.

Burrard. The reviewer may point out that the limited amount of space at his disposal compelled the omission of reference to many points of which he was well aware, and had fully considered, but in view of the publication of these letters he may be permitted to amplify the argument of the paragraph in the review which has called them forth.

Mr. Fisher's investigation assumes an isostasy by flotation, and, what is an almost inevitable consequence, that the flotation is not confined to the area of the range, but that, as an iceberg has generally an under-water extension helping to support the visible mass, so the lighter "crust" under the plains is borne down into the denser "substratum" or "subcrust" by the weight of the mountain range. This interpretation is in accord with the evidence of the pendulum, which shows that the defect of gravity under the mountains is continued under the plain, and only gradually decreases with increasing distance from the range; it is also in accord with conclusions drawn by the Geological Survey long before the observations of variations in the force of gravity and of deflection of the plumb-line in the neighbourhood of the foot of the hills were published, and the constants used by Mr. Fisher, so far as they are special to the Himalayas, were taken from these reports.

According to the hypothesis, a station near the edge of the hills, such as Kurseong, would be affected (1) by the positive attraction of the visible masses; (2) the negative attraction of the "root" or downward thickening of the "crust" into the "substratum"; (3) by the negative attraction of the submerged portion of the "crust" under the plains, replacing denser "substratum"; and (4)—though Mr. Fisher did not separately consider this—by the negative attraction of the alluvial deposit of the plain, the mean density of which is less than that of average rock. Of these (1) is the same whatever hypothesis of isostasy is adopted; (2), it appears from Mr. Hayford's investigation of the effect of an isostasy produced by compensation limited to a ten-mile stratum, between twenty-five and thirty-five miles depth from the surface, would somewhat increase the deflection at a station situated on the edge of the hills (*e.g.* Kurseong), and make but little alteration at a station twenty or thirty miles out in the plain (*e.g.* Jalpaiguri); (3) and (4) would both produce their maximum effect at a station situated like Kurseong, and have comparatively little influence at one situated like Jalpaiguri. Here we have three separate corrections, all working in the same direction, and all attaining their maximum at the same station, and it is not inconceivable that together they might afford an explanation of the peculiarities noticed by Col. Burrard.

It is obviously useless, at the present stage of our knowledge, to enter into detailed calculations of an imaginary range, but some approximate calculations made by the reviewer indicate that the increase in the difference of deflection as between Kurseong and Jalpaiguri due to (2) would be of the order of 4", to (3) of the order of 8", and to (4) of not less than 9", or a total increase in the calculated difference of deflections amounting to more than 21", as compared with Col. Burrard's unexplained anomaly of 30". These figures have no value, except as indicating that there is another hypothesis, besides that of the "rift," which would account for a change in the amount of deflection near the foot of the range, of the same character and order of magnitude as that actually observed.

It must be added that this explanation can only be taken as applying to the Himalayas; the conditions in the Vindhya are entirely different and require to be considered apart.

THE REVIEWER.