The Geology of the Krol Belt.

DURING the past ten years or so considerable advance has been made in our knowledge of the geology of the Himalaya, which has served to show that the structure of these mountains is more complicated than had hitherto been thought. Mr. Auden in a recent publication[1] has dealt with the geology of this mountain range. In the reviewer's opinion it must be regarded as a most important contribution to Himalayan geology, based as it is on detailed mapping and acute observations. The area described is a long narrow belt running E.S.E. from Solon on the Kalka-Simla railway, along the south-west side of the Giri valley, and across the Tons river to the southern part of the Chakrata district. On its north-east side is the area of more highly metamorphosed rocks mapped by Pilgrim and West; on its south-west side is the belt of Tertiary rocks forming the southern edge of the Himalaya.

Broadly speaking, Mr. Auden regards the Krol belt as a thrust mass of Jaunsar-Blaini-Krol-Tal rocks resting on a floor of Simla slates and Tertiary rocks. Separating these two groups is the Krol thrust, which is itself folded. (The well-known outcrops of Subathu beds near Solon are thus regarded as belonging to the underlying group of beds, below the Krol thrust.) The details of the geology, however, are exceedingly complicated, as a glance at the map accompanying the paper will help to show. In addition to the general description of the area itself, many problems which have a bearing on the geology of adjacent tracts are dealt with in a forceful and penetrating way. Brief reference may be made to some of these.

It has lately become increasingly clear to those working in the Himalaya that the importance of the well-known 'Main Boundary fault' of Medlicott and Middlemiss, separating the Siwaliks from the older Tertiary rocks, has been overrated; and Mr. Auden crystallises this change of opinion in a well-reasoned statement, from which the following may be quoted:

"It appears to the writer that the conception of a 'Main Boundary fault', and hence of a basal thrust-plane to the Himalaya, has been carried too far. It arose at a time when the faults were thought actually to mark the successive limits of sedimentation against the uprising Himalaya and when the structure of the pre-Tertiary rocks had not been examined in detail. Recent work by Pilgrim, Wadia, West and the writer has shown the number of thrusts that actually exist in these pre-Tertiary rocks. Some of these cannot be considered minor structures, comparable solely with the minor thrusts, as distinct from the major thrusts, of the North-West Highlands. The Chail thrust of Mr. West is of premier importance. In the Himalaya, as in the Alps, it would appear impossible to regard any single dislocation or *nappe* as having borne the whole burden of the advance upon the foreland."

An illuminating suggestion put forward by Mr. Auden is that the true Blaini beds which underlie a normal Infra-Krol-Krol succession are distinct from beds mapped elsewhere as Blaini, *e.g.*, at Simla (which may come as a shock to some). These latter he would correlate with the Mandhali beds of Chakrata, suggesting that there were two periods of glaciation (or whatever the conditions were which gave rise to those peculiar beds), one at the base of the Jaunsar series and the other below the Krol series. And while this suggestion has a good deal to commend it, explaining a number of difficulties, it is one which must for the time being be regarded as non-proven. An alternative explanation is that Oldham included under the name Mandhali two distinct sets of rocks, the true Mandhali beds at Mandhali village in north Chakrata, which may be in part identical with the Blaini at Solon and Simla; and other beds in South Chakrata, those mapped by Mr. Auden, which are basal Jaunsars.

A good deal of emphasis is laid by Mr. Auden on the effect of varying degrees of metamorphism upon rocks, more especially the bearing it has upon correlation. Apparently the grade of metamorphism displayed by the rocks of the Krol belt is always of an epi-type, in which shearing stress and low temperature have been the main factors. But the degree of metamorphism to which the rocks have been subjected varies considerably from place to place, and frequently makes the correlation of the rocks a matter of great difficulty. Consequently the author lays emphasis on the unsoundness of placing too much reliance on metamorphic grade in problems of correlation. He goes even further, however, and suggests that the *meso*-type of metamorphism displayed by the Jutogh series in the country north-east of the Krol belt may be a local phenomenon related to the intrusion of the granite, and is not by itself to be

[1] *Rec. Geol. Sur. Ind.*, 1934, **67**, Part 4, pp. 357-454.

regarded as evidence in favour of those rocks being older than the rocks of the Krol belt.

As regards the time of the intrusion of the gneissose granite which is found in the Jutogh series, and similar granites elsewhere (the Central Himalayan gneiss of Stoliczka) Pilgrim and West, while refraining from expressing any definite opinion, except that it was probably pre-Chail in age and possibly Archæan, rejected McMahon's view that the intrusion took place during the Tertiary at the time of the upheaval of the Himalayas. Mr. Auden goes further, and puts forward reasons for supposing the intrusion to have taken place during the Palæozoic, suggesting that it occurred in connection with certain crust movements which he suggests took place in pre-Krol times, along a line coincident with the line of the old Aravalli mountains if continued northwards into the Himalayas.

Other aspects of the geology, mostly relating to the lithology of the rocks, are described in detail. But enough has been said to show the importance of this paper in throwing further light on the structure of the Himalaya. It is accompanied by a map of great beauty, which does credit alike to the author who made it, and to the Survey of India who printed it.

W.

Research Notes.

Singular Solutions of Ordinary Differential Equations of the Second Order.

THE methods of obtaining the Singular Solutions, which are applicable when a given differential equation or one of its first integrals involves irrational or transcendental expressions, are described by Srinivasiengar in an important paper published in the *Jubilee Memorial Volume* (Vol. 20) of the Indian Mathematical Society.

In Part II of the same paper the author has discussed a number of topics of interest. Several illustrations of differential equations which possess, what the author calls *incomplete primitives*, are given and the readers are cautioned against calling the *residual* primitive as singular solutions. The author disagrees with the existing theory about Singular Solutions of the second order, and explains how *any singular solution of the equation* $w(x, y, y')=0$ *will satisfy the original equation* $F(x, y, y', y'')=0$ *in a large number of cases* ($w=0$ being the equation giving Singular Solutions of the first order). A new method of obtaining the osculants of the system $f(x, y, a, b)=0$ is also given.

Envelopes of Systems of Surfaces.

IN a paper published in the *Tohoku Mathematical Journal* (**39**, Part I) Srinivasiengar has discussed the methods of obtaining the envelopes of singly infinite and doubly infinite systems of surfaces, when the equations of these systems may contain irrational or transcendental expressions. The results centre round the following theorem, which is proved in the paper:

If one or more of the first partial derivatives of $f(x, y, z)$ *become infinite in virtue of* $\phi(x, y, z)=0$, *the two surfaces* $f=0$, $\phi=0$ *touch each other all along their curve of intersection* (except in very special cases).

Among the corollaries of this result, the following may be particularly mentioned:

If $E=0$ *denotes the envelope of the first species of the system of surfaces* $u(x, y, z)=a$, *it will also be an envelope of the first species of the system* $\phi(u, v)=a$, *where* ϕ *is any holomorphic function of* u *and* v, *and where none of the first partial derivatives of* v *becomes infinite in virtue of* $E=0$.

"Showers" of Positive and Negative Electrons.

PERHAPS the most beautiful phenomenon revealed by the application of Wilson's cloud chamber method to the study of cosmic radiation is the occurrence of "showers" of positive and negative electrons apparently emanating from a point in the neighbourhood of the cloud chamber. In the *Proc. Roy. Soc.* for May, C. W. Gilbert describes the results of his experiments on the production of these showers. The investigations were carried out by him in Switzerland at three different heights above sea-level—3500 metres (Jungfranjoch), 2300 metres (Eigergletscher) and 500 metres (Zürich). Using three Geiger-Muller counters, he investigated the simultaneous coincidences in the three counters caused by the presence