AFGHAN FIELD-NOTES.

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(*On duty with the Afghan Boundary Commission.*)

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Route.

The march of the Afghan Boundary Commission was first from Quetta to Nushki, after crossing the Lora south of the Pishin valley; from Nushki to Khwaja Alí on the Helmund (east of Rudbar) by long and weary marches. We followed the river down to Chahar Burjak, where we crossed it. From this point we went in a more or less northward direction through Kalah-i-Fath past the Helmund Lakes to Lash-Juwain, through the Anardara pass, and passing Sabzawár westwards, to Pahri and eventually to Kuhsán on the Hari Rud, avoiding Herat altogether. Here General Sir Peter Lumsden, K.C.B., joined our party under Colonel Ridgeway.

On the 25th November, the General with a small party left us to go *vid* Chasm-Sabz (not on the old maps) and Panjdeh to these our winter quarters on the Murgháb river. We followed next day by another route to Kushk, finally all meeting at Bála Murgháb. At Kushk, I obtained permission to go off by myself on a geological trip; I returned to the Herat valley by the Band-i-Bábá, went to within a mile of Herat city, afterwards returning over the Band-i-Zurmust to Kila Náu and to Bála Murgháb.

River drainage.

The march from India to the valley of the Murgháb has taken us from Eastern Biluchistan, which belongs to the Indus drainage into the Lora and Helmund basins (Seistan, &c.) and thence over the great watershed south of Herat, into the Central Asian basin of the Hari Rud and the Murgháb. The watershed which divides Southern Afghanistan from Central Asia, is formed as far as we know by the range of mountains called on our maps the Siah Koh, with its western continuation, the Doshakh mountains.

There seems to exist a marked difference in the geological features of the areas divided by this great range, and I intend therefore to treat them separately in these notes.

The time was too limited to admit of a regular geological survey of the country traversed, but I believe the notes collected with the experience gained in my former work in Afghanistan has enabled me to come to fairly accurate conclusions with regard to the geology of the country.

Southern Afghanistan and Biluch desert.

As will even be clear from a view of the old map of Afghanistan[1] the country lying between Nushki and the Helmund, with much of the area to the north of it, is nothing but a desert now, though water may be found in most localities by digging wells.

The features of the whole area are similar to those described between Kandahar and Quetta, consisting of more or less parallel ranges, which run between east—west and north-east—south-west, separated by wide stretches of dasht-deposits, which reach an enormous thickness in the Lower Helmund valley.

The ranges which we crossed in succession south of the Helmund are merely continuations of ranges which I have described already in my memoir on Southern Afghanistan, and I may at once say that, with the exception of one or two points, I could not elucidate any new fact in relation to the rocks which compose the hill ranges *south* of the Doshakh range south-west of Herat; north of these hills the character of the rocks entirely changes.

Ghaziaband range.

Between Quetta and Nushki, I crossed the "Ghaziaband" range at a point south-west of my old route of 1880, and near the village of Karnak. I wish I could have remained a few days in that neighbourhood; there are several points of geology connected with the section of this range which are not at all clear to me. The country is now, however, quite accessible to any one, and will no doubt before long be carefully surveyed.

Siwaliks of Biluchistan.

The range is skirted on its south-east slope by clays, of red and greenish white colour, which re-appear in considerable thickness in the Lora basin. In 1880, I believed them to represent the Gáj beds of Sind, which Mr. Blanford disputes, and I believe on good grounds. Since then I have had an opportunity of seeing the Siwalik rocks of the Deraját, Kohát district and the Trans-Indus Salt-range. There, especially in the latter area, a great thickness of red and greenish-white clays, sandstones and conglomerates overlie the cretaceous beds, and are considered by Wynne to be representatives of the Lower Siwaliks. I was struck with the lithological likeness of these Trans-Indus Siwalik beds with what I remembered the Ghaziaband beds to be;

[1] General Walker's map, 1 inch = 32 mile, 1883.

I have had now a second opportunity of visiting the latter, and the resemblance of them to the Salt-range Siwaliks seems to me perfect. If my supposition is correct, then these beds do not represent Upper but the Lower Siwalik beds. Fossils I have none out of them.

Eocene sandstones of Karnak.

The greenish-grey sandstone and shales which compose the pass leading from Karnak to Panjpai, may be the same as the nummulitic sandstone (Flysch?), which I saw in 1880 in the Ghazia-band pass; but if so, their character changes slightly towards the south-west. I believe the Karnak beds resemble rather the Khojak group of rocks.

Khojak beds.

Between Panjpai and Nushki one crosses the hill ranges which form the south-western spurs of the Khojak Amran mountains, and, as I expected, the geological structure of the hills is the same; the principal rocks are sandstones and hard splintery shales, all much contorted, of exactly the same lithological character as the Khojak beds. Near Kaisar, east of Nushki, I met traps and a granitic rock of similar characters to those of the trap and granitic rocks of Gatai and Dobrai, north of the Khojak.

When I first crossed the latter pass in 1880, it seemed to me probable that the hippuritic limestones, which compose the isolated hills on the north-west side of the Khojak Amran range, dipped below the Khojak sandstone; I therefore believed the latter to belong to the upper cretaceous series, equivalent perhaps to the "Vienna Sandstone" of the northern Alps. Since then I have had an opportunity of actually crossing the Sulemán range,[1] and I found there a formation of sandstone and shales underlying the upper cretaceous beds of the Takht-i-Sulemán, which appear to me to be of the same lithological character as the Khojak beds. If they represent these beds, then the latter would probably belong to the lower cretaceous series rather than the upper, and my interpretation of the broken section of the Khojak would be erroneous. A careful study of the hills between Panjpai and Nushki will, no doubt, settle this point.

Post-tertiaries of Biluchistan.

The valleys between the rugged hill ranges of this part of Biluchistan are partly filled by post-tertiary and recent deposits, mostly gravels and clays, with a capping of a widely spread bed of conglomerate and breccia, which I also found forming extensive plains in Southern Afghanistan.

Aerial formations.

Aerial formations in the shape of blown sand cover large tracts in these wide valleys, and practically all the level country between Nushki and the Helmund is covered with sand-hills. It is characteristic of them that they generally form low hills of crescent shape, with the horns and the scarp turned to leeward; the inclined plane formed by the currents of air are therefore generally dipping westwards and show a rippled surface, resembling closely the accumulations of drift snow on the high Himalayas.

As the sand-hills gradually advance, they uncover here and there the beds below, which are generally a thin plastering of clays on the top of the conglomerate already noticed.[2]

[1] *Supra*, Vol. XVII, part 4.

[2] Memoirs, Geol. Surv. Ind., XVIII, p. 14.

Igneous rocks, of the Biluch desert.

The higher hills between Nushki and Galichah are all formed of igneous rocks, most of them of a basic type. At a few points isolated masses of a granitic rock appear, and near Galichah (Malik Dokan) I met a calcareous contact rock with veins of gypsum and a serpentine with veins of chrysolite, which is quarried by the natives for ornamental purposes.

At Galichah one enters the Lut, a great desert which stretches down to the Helmund river, and the greater part of which is covered with blown sand.

The Helmund basin.

The geological features of the western part of the Helmund area are extremely simple. All the higher ranges are the western and south-western continuations of offshoots from the Siah-Koh, and are composed of upper cretaceous beds (hippuritic limestone) with associated traps and syenitic granite. The limestone is fossiliferous throughout: hippurites are found in great numbers in all beds of this formation. Near the igneous rocks the limestone is converted into a fine-grained white marble.

Hippuritic limestone. Igneous rocks.

Contact rock.

The contact rock between the hippuritic limestone and the trap is precisely of the same character as the rock which contains the gold near Kandahar, and is found in a similar position. It is *in situ* north of Sher Buksh.

Syenitic granite.

The range north of Kala-i-Kah and the greater mass of the hills crossed between this point and Pahri are formed of hippuritic limestone with intrusions of trap. The valley of the Karez-i-Dasht, north of the Anardara pass, is formed of syenitic granite, of later age and intrusive in the trap.

Tertiaries of South Afghanistan, near Pahri.

Red and white clays, very like the beds of the Ghaziaband pass, near Quetta, form some of the lower ranges and plateaux between the trap hills of Sher Buksh and Pahri. Near the latter place the beds of this formation are raised up and dip north-west at a varying angle. Near Chah Gazek I found some remains of mammalian bones in a bad state of preservation. Perhaps these beds are of Siwalik age. They are certainly older than the clays, sandstones, and conglomerates which overlie them, and which further south form widespread areas in the lower Helmund basin.

Mammalian bones.

Afghan Seistan. Newer tertiaries and recent rocks.

The geological features of Afghan Seistan are extremely simple. Only later tertiary and recent deposits are met with. The former are of fluviatile and aerial origin, and overlie the coloured clays with mammalian remains of Chah Gazek.

The prevailing rocks are clays, soft sandstones, and gravels, locally with enormous thicknesses of "loess" beds. The latter are thick unstratified beds of fine silt, with false-bedded sandy layers. Veins of gypsum are frequent, and cavities, occasionally still retaining some lignitic rootlets and stems of plants, are found throughout the deposit; such cavities are also characteristic of the "loess" deposits of Europe, which are now generally supposed to be of aerial origin.

These beds form high scarps along the banks of the Helmund, and lower down along the eastern shores of the Hamún, where they are well exposed. In litholo

gical character they resemble the Upper Manchhars of the Nari gorge, near Sibi, of which they are probably an equivalent.

Post-tertiaries and recent.

Recent and post-tertiary deposits, soft sandstones and conglomerates, both containing worn material from the neighbouring hill ranges, are found in considerable thickness in the Farah Rud, the Kash Rudak, and capping the mammalian beds of Seistan and Biluchistan. Locally the conglomerate is replaced by a hard limestone breccia (near Galichah in Biluchistan), but the group of rocks is everywhere seen to overlap and even to rest quite unconformably on the underlying mammal beds of Seistan. They resemble in general character the post-tertiaries of Sind, of the Deraját, and the Punjab. In general outlines the drainage which produced these beds must have been identical with the drainage of the rivers of the present day, though here and there the area may have been much more extended.

The great watershed of Central Asia.

The range which runs more or less with the 34° North latitude, and which on our maps bears the names of the Siah Koh and Doshakh mountains, marks a complete change in the geological structure of Central Asia. Whereas south of this range no older rocks than of the cretaceous period are known to exist, the Dosbakh range itself consists of palæozoic rocks, and between them and the Tir-band-i-Turkistan range is a series of beds all dipping more or less north or north-east, and comprising the entire upper palæozoic and mesozoic series.

Sections obtained.

Up to the present I obtained the following sections. In the Doshakh range, from Pahri to Zindaján (Herat valley); over the Chillingak pass, east of tbe Doshakh peaks, and from Zindaján to Robat-i-pai; in the Paropamisus, the Band[1]-i-Kaitu, the Band-i-Bába and the Band-i-Zurmust. Unfortunately these sections require connecting before I can form a perfectly clear idea about the structure of these mountain ranges, but I believe that I sball have another opportunity of crossing the Herat valley before leaving Afghanistan, to complete my work. I found the following groups of rocks in the area between the Doshakh range and the Tir-band-i-Turkistan :—

List of formations.

In descending order :—

Recent and post-tertiary	Alluvium of Hari Rud and Murghab sandstone and conglomerates.
Siwaliks, Upper	Sandstones, grits, clays of Ghorian and Tirpul (Hari Rud).
„ Lower	Red and white clays of Chesm Sabz, Sakhra (Murghab).
Cretaceous	Tir-band-i-Turkestan beds.
Jurassic .	Kushk sandstones, Chakán beds.
Trias and Rhaetic	Plant-beds of Band-i-Bába, Zurmust and Naratú.
Permian ?	Talchir conglomerates, sandstones, and shales. Trap.
Carboniferous	Productus beds of Robat-i-pai.

In describing the rocks I will begin with the oldest formation, which was also the first noticed on entering the Central Asian region.

[1] Band = pass.

The Doshakh range appears to be formed of one or more great anticlinals.

Carboniferous.

The south side of the range is composed of hippuritic limestone, but unfortunately I had no opportunity of finding out the relations of the cretaceous beds to the older rocks composing the main range. From what I could learn by crossing the Chillingak pass from Pahri to Zindaján, and from a section made from the latter place to Robat-i-pai (near the centre of the Doshakh hills), it appears that a grey sandstone with friable shales, somewhat resembling in its lithological character the Khojak beds, is overlaid by hard dark-blue limestone with calcspar veins which contains carboniferous fossils in great abundance. There are several species of *Producti*, amongst them *Pr. semi-reticulatus*, *Athyris roissyi*, *Fenestella*, and corals.

These limestones dip about 20° north to north-east below the alluvial deposits of the Hari Rud. Immediately north of Robat-i-pai, on the north side of the Hari Rud valley, all the older beds are hidden by extensive clay and sandstone beds of late tertiary age.

A section through the Paropamisus *viâ* the Ardewan pass (north of Herat) may probably reveal a continuous section, and this I hope to accomplish as soon as the weather becomes more favourable.

The section over the Band-i-Bába from Kushk to Herat is incomplete, as the

Band-i-Bába section.

route which I had to follow over the pass more often than not runs in the direction of the strike of beds and over the debris and recent deposits on the south slope of the range.

I found north-east of Herat the low spurs which reach to within 1,500 yards

Hills near Herat, gneiss.

of the city, and on which the Ziarat Khwaja Abdullah-i-Ansari at Ghazegah is built, to consist of a grey thinly bedded gneiss with granitic veins, dip north-east. The overlying beds I did not see, nor could I find again the carboniferous Productus limestone in the Band-i-Bába section. The part of the Paropamisus intervening between this point and the south side of the Band-i-Bába pass near Palezkár I could not touch anywhere, but from the debris found on the great "fans" south of it, I should say that carboniferous beds will be found north of Herat. The Band-i-Bába is greatly contorted, and the centre range itself is formed by a great anticlinal, which is followed towards the east and south-east by a succession of folds, which probably are continued to the Davendár range.

At the south side of Bába pass near Palezkár I found an extensive formation,

Talchirs near Palezkár.

all the beds of which dip to the east and south-east, seemingly quite unconformably to the gneiss of Ghazegah and the main range; I recognised it at once and without trouble as Talchir, the basal group of the Indian Gondwána system. Boulder beds, conglomerates, greenish sandstones, and shales predominate, accompanied by red and yellow clays and interbedded trap. The latter is a feature which reminded me at once of the boulder-bed of the Karoo formation of South Africa. Both the sandstone and the shales contain traces of plants, belonging to Vertebraria apparently.

Whether these plant-beds rest unconformably on the carboniferous limestones, as the differing dip and strike would indicate, I am at present unable to

say, but hope to settle this point before very long. I could not go east of Kurukh to the Davendar range, where probably the upper beds of the Gondwánas would be met with.

Upper plant-beds of the Bába pass.

In the Bába pass the Talchirs seem to form the lowest beds of the anticlinal and are overlaid by a great thickness of sandstones, limestones, and shales, which form the top of the pass and the long sloping plateau of the north limb of the anticlinal as far as Chakán and Kushk. These beds I believe to represent the entire middle and upper Gondwána series. Plant-beds alternate with great thickness of grits and sandstones, and a few partings of Ostrea beds (limestones) are found towards the upper half of the group.

Sandstones of Band-i-Kaitú.

The sandstones and grits assume an enormous development towards the western portion of the Paropamisus; the Band-i-Kaitú is entirely composed of sandstones, grits, and conglomerates of the character of the Mahadeva sandstone.

Band-i-Zurmust.

Coral limestone.

The Band-i-Zurmust shows a similar geological structure with one difference. Within the group of Talchirs, and towards the lower half of it, appears a grey limestone, containing coral remains and a Nautilus. Plant-beds overlie this limestone, and the north slope of the Zurmust with the Naratú hill seems to be composed of plant-beds of middle Gondwána character. The upper strata of this series between Naratú and Chakán seem to have fewer plant-beds, whereas the Ostrea limestones increase in thickness.

Coast formation.

This group of rocks presents all the appearance of having been deposited along and near a sea-coast line; especially the upper portion of it north of the Zurmust must have been formed along a low sea coast probably of varying outlines, and we thus have beds presenting all the character of our Gondwánas with plants, the strata showing false bedding, alternating in the higher horizons with marine shell limestones.

Shell limestone of Kila Naú. Jurassic.

The plant beds are followed by thick strata of an earthy-white limestone of chalky texture, full of the casts of gasteropods and bivalves, alternating with a white calcareous sandstone with numerous bivalves. These beds form a belt north of the Paropamisus, and are well seen between Kushk and Kila Naú, wherever the affluents of the Kushk and Murghab rivers form deep ravines in the plateaux.

Tir-band-i-Turkistan. Cretaceous fossils.

I believe this white shell limestone series belongs to the upper jurassic epoch; it is overlaid by the Tir-band-i-Turkistan limestones, amongst which I certainly found beds with cretaceous fossils, but the description of which I reserve for my next note.

Tertiaries: Siwaliks.

Red and greenish-white clays are in great force in the wide-stretching high plain of Chesm Sabz, north-east of Kuhsan, and are overlaid near Tirpul, in the Hari Rud valley, by sandstones, silts, clays, and grits. I believe that this series represents the Siwaliks. Similar beds, with great deposits of gypsum, and containing some

fossils, casts of shells of Unio, and the casts of Annelids, I met near Sakhra on the Murgháb.

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