PAKISTAN GEOGRAPHICAL REVIEW

1952

VOL. VII

NO. I

ANNUAL SUBSCRIPTION :
INLAND . . Rs. 4/-
FOREIGN . . Rs. 6/-

CONTENTS

DEPOSITS OF COAL, IRON & BAUXITE IN THE EAST INDIAN ARCHIPELAGO

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(Excluding the Philippines and Australian New Guinea)

Apart from the immensely valuable petroleum fields and the somewhat local deposits of tin, the East Indies' chief mineral resources are coal, iron and bauxite. Of these, only bauxite has hitherto been of world-scale economic significance, as the coal deposits have been utilised chiefly for local purposes, and the iron deposits have not been touched.

The Riouw Islands contain the most important bauxite deposits, whilst Sumatra is by far and away the chief coal producer. Borneo's potential is very great in both iron and coal, and Celebes has great iron reserves.

It is unlikely that any of the lesser East Indian islands will be found to have any valuable deposits of coal, iron or bauxite, as they have all been reconnoitred by Dutch geologists in their search for petroleum.

Summary

BY COUNTRIES

Borneo :

There are many coal-bearing areas, especially in Dutch Borneo. The most important are—

(*a*) Poeloe Laoet, with a reserve of about 21,000,000 tons of steam-coal.

(*b*) Barito Basin.

(*c*) Somarinda.

(*d*) Mahakam River, producing 1,70,000 tons a year.

(*e*) Parapattan near Tandjoengredeb, producing 2,40,000 to 3,00,000 tons a year from reserves of about 40,000,000.

There are no producing mines in British Borneo ; the most potentially important fields are—

(*a*) Labuan with reserves of at least 9,000,000 tons of bituminous coal.

(*b*) Silantek with reserves of at least 17,000,000 tons of bituminous coal.

(*c*) Silimopon with reserves of perhaps 15,000,000 tons of bituminous coal.

There are very extensive iron ore deposits in Borneo, the most important being—

(*a*) Seboekoe Island and adjacent mainland areas, with reserves estimated at between 150,000,000 to 300,000,000 tons.

(*b*) British Borneo (Murudu Bay) with reserves of 25,000,000 tons.

Borneo is reputed to have bauxite deposits, but nothing is yet known of them. The establishment of an aluminium factory using hydroelectric power is under consideration for British Borneo.

Celebes :

There are very large deposits of iron ore in Celebes, especially in Central Celebes, where the reserves are estimated at more than 1,000,000,000 tons.

Sub-bituminous coals are known to exist on the island, but their extent is unknown.

Java :

In Java there are reserves of about 15,000,000 tons of sub-bituminous coal and 9,000,000 tons of poorer coal at Bodjong Manik.

New Guinea :

Sub-bituminous coals of unknown extent are known, especially in the Vogelkop district.

Riouw Archipelago and Singkep Islands :

On Bintan there are reserves of bauxite estimated at 23,000,000 tons and 2,000,000 tons on the Singkeps.

Sumatra :

Sumatra is by far the chief coal producer in the Archipelago. The most important occurrences are—

(*a*) The Ombilin area with reserves of about 250,000,000 tons of different types of coal, and an annual output of from 500,000 to 600,000 tons.

(*b*) The Tandjoeng Enim field is worked at Boekit Asem, giving an annual production of up to 900,000 tons (1941) from reserves of over 2,000,000,000 tons of different types of coal.

There are several other areas in Sumatra with good reserves of brown and bituminous coals.

In the Lampong Ranges are iron ores (hematite—Magnitite) estimated to contain from 2,000,000 to 4,000,000 tons of high grade ore.

Summary

BY COMMODITIES

Coal:

Sumatra is the chief producer. The Ombilin area has reserves of about 250,000,000 tons. Its annual production is from 500,000 tons to 600,000 tons. It is a sub-bituminous coal, useful as a steam-coal.

The Tandjoeng Enim field in the Palembang basin is worked at Boekit Asem. Reserves are over 2,000,000,000 tons; production was 900,000 tons in 1941. The coals range in type from brown coal to anthracite.

There are several other areas in Sumatra with good reserves of brown and bituminous coals.

In Dutch Borneo the most important coal area is around Poeloe Laoet, where there are reserves of about 21,000,000 tons of steam-coal. Production was about 200,000 tons a year when the mines closed in 1931.

In the Barito Basin, local mines produce from about 20,000 to 35,000 tons a year, and there is a similar production from the Samarinda district. Just north of the Mahakam River, the East Borneo Coy's mine produces up to 170,000 tons of coal a year, and at other places in the Koetei Province, local coal-mines exist. The Parapattan mine near Tandjoengredeb produces from 240,000 tons to 300,000 tons a year from reserves of about 40,000,000 tons. There are large reserves of coal at many other places.

In British Borneo there are no producing mines. At Silantek there are reserves of at least 17,000,000 tons of bituminous coal. At Labuan there are reserves of at least 9,000,000 tons of bituminous coal. At Silimopopon there may be up to 15,000,000 tons of similar coal. Coal, especially in the form of lignite, occurs in many other, mostly difficulty accessible, places.

In Java there are reserves of about 15,000,000 tons of sub-bituminous coal, and 9,000,000 tons of poorer coal at Bodjong Manik, besides other occurrences of lignite.

There are no important deposits in the eastern Archipelago, although sub-bituminous coals of unknown extent occur in Celebes and the Vogelkop of New Guinea.

Iron:

The most important deposits are in Central Celebes, where there are reserves of more than 1,000,000,000 tons of ore, and in Seboekoe Island off the south-east coast of Borneo where the deposits contain from 150,000,000 to 300,000,000 tons of ore. There are very large deposits on the adjacent mainland of Dutch Borneo, whilst in British Borneo, 25,000,000 tons of ore is known near Murudu Bay. All these ores are of lateritic type, but in the Lampong Ranges of Sumatra are hematite-magnetite ores estimated to contain between 2 and 4 million tons of ore.

Bauxite:

The chief deposits occur in the Riouw Archipelago and the Singkep Islands between Sumatra and Singapore. In Bintan the possible reserves are about 23,000,000 tons, and on the Singkeps about 2,000,000 tons.

There are proposals afoot to build an aluminium factory in North Borneo, using hydro-electric power from a dam to be built on the River Padds.

Description of Occurrences

Coal

Sumatra:

Much the most important coal-bearing districts are those of *Ombilin* in central western Sumatra, and *Tandjoeng Enim* in the Palembang district of southern Sumatra.

The Ombilin coalfield is an infaulted block of Eocene strata in the Tanah Datar division of the Padang Highlands. The coalfield is about 10 km. long and 9 km. wide. It lies on both sides of the Ombilin River, a tributary of the Indragiri R, and is shut off from the coast by high mountains. A railway, about 150 km. long connects the coalfield with the port of Emmahaven on the west coast, *via* Padjang. Mining began in 1893, and the mines are equipped with modern machinery. *Production* has averaged between 500,000 and 600,000 metric tons a year since 1917.

The coalfield consists of 3 sections :—

(1) The Parambahan section,
(2) The Sigalut sections, and
(3) The Sungei Durian section.

The Parambahan section extends from the Ulu Ajer River to the foot of the steep Sigalut Ranges. There are 4 seams up to 10 metres thick each, but are folded and much faulted, and the coal is relatively poor in quality so that this section is not suited to development under prevailing economic conditions. Its reserves are estimated at 20,000,000 tons.

The Sigalut section, extending from the Parambahan River southwards towards the Ombilin River, consists of practically undisturbed uniformally dipping strata. There are 4 seams of economic value, aggregating about 5 metres thickness of coal. The reserves are estimated at 80,000,000 tons, and much of the coal can be open cut.

The Sungei Durian section, with 3 workable coal seams, is estimated to have reserves of 144,000,000 tons.

Thus the total reserves are of the order of 250,000,000 tons.

The Ombilin coal is a high-grade brown coal or sub-bituminous coal with little tendency to coke or sinter, so that although inferior to bituminous coal, it is a useful steam and ship coal and is widely used in the Archipelago. Its moisture content is low and it contains little resin or ash. Much of the coal is friable and to overcome this the fines are briquetted at the coalfield.

Production comes chiefly from 2 seams, one 7′ thick and the other 24′ thick. Underground mining is necessary, and the coal is very liable to spontaneous ignition.

Other Eocene Coal Occurrences in Sumatra :—

(*a*) Near the Sepoetih River in the Lampong district of southern Sumatra, are 2 seams 1·7 metres and 0·7 metres thick.

(*b*) At Kwaloe in eastern Sumatra is a seam 4 metres thick.

(*c*) Near Beligan on the Tjenako River, in the Indragiri district of north-eastern Sumatra are 3 seams, 2 metres, 1·75 metres and 0·75 metres thick.

Coal-bearing Neogene strata are extensively developed in eastern and southern Sumatra. The "Middle Palembang" beds contain the chief seams, and the Palembang—Djambi basin is said to be comparable in area with the carboniferous coalfields of Europe.

The beds are folded and disturbed by faults. The most important area centres about Tandjoeng Enim, 13 miles south of Moera Enim in the Lematang

district of the Palembang Residency. In this region the Neogene lignites have been metamorphosed over considerable areas, and converted to bituminous coal (glance coal) and anthracite, and in places to natural coke by the heat from intruded volcanic rocks. The metamorphosed coal, which is of better quality than the Ombilin coal, is worked by Government collieries at Boekit Āsem about 3 km. south-west of Tandjoeng Enim.

There are 11 seams, with an aggregate thickness of 90 metres of coal, but workings have hitherto been restricted to 3 seams, the Mangoes, Soeban and Petai, which are contained within a thickness of 71 metres of strata.

The reserves of the Tandjoeng Enim field have been estimated as 1,872,000,000 tons of brown coal
67,000,000 tons of transition coal
82,600,000 tons of glance coal
10/15,000,000 tons of anthracite
to depths not exceeding 500 metres.

The mining is carried out in 2 open cuts, the Soeban Cut and the Tapoean Cut. The coal is screened and washed at Tandjoang Enim. The fines are shipped to Batavia to a briquetting plant at Tandjoeng Prik, which supplies about 100,000 tons of briquettes a year to the State Railways.

The Boekit Asem field came into operation about 1917. Production reached 900,000 metric tons in 1941, the total output to the end of 1941 being about 7,872,000 metric tons.

Other areas of metamorphosed coal lie at from 10 to 25 kms. south-west of Tandjoeng Enim. At Kendi-Ringin the reserves are estimated at—

196,000,000 tons of brown coal
39,000,000 tons of transition coal
45,000,000 tons of glance coal.

The Boenian, Serillo and Soekamarinda concessions are estimated to contain a further—

200,000,000 tons of brown coal
2,000,000 tons of transition coal
25,000,000 tons of glance coal.

Neogene coals that have been improved in quality by basalt intrusions are found at Boekit Soenoer near Benkoelen on the west coast of Sumatra, of coal have been proved, but are of no great extent. Seams of brown coal up to 1.5 metres thick, and with a high ash content, occur at various places in the Benkoelen district.

Dutch Borneo

The Palaeogene (Eocene) coals are strongly developed in south-eastern Borneo in association with coarse sandstones and clays. Coal seams in this group of rocks occur on both sides of the Meratoes Mountains, in the Senatin and Koekoesan Mountains, and on the islands of Poeloe Laoet and Seboekoe. Where the series is fully developed it contains 20 seams of coal, with an aggregate thickness of 10.5 metres. Seven of these, totalling 8.4 metres of coal, are contained in a thickness of 70 metres of sediments. The remaining seams are all less than 50 cms. thick.

This Eocene coal has been mined at Poeloe Laoet, Goenoeng Batoe Besar, Pengaron, Martapoera, Goenoeng Koepang, and Malapar, and *large reserves exist.* Further to the north the number and thickness of the seams diminish.

Poeloe Laoet.—Here there are 4 workable seams which dip at from 8° to 45° to the west, and continue with flattened dips beneath the sheltered strait of Laoet (90 metres deep). Faults divide the coalfield into blocks—known from north to south as the *Soengoep*, *Semboeloean*, *Semblimbingan* and *Stagen* sections. The Poeloe Laoet coalmine was in the Semblimbingan section. It continued working until 1931 when competition from the higher grade coals of the Boekit Asem field, and other economic conditions led to its closure. The total production from 1914 to 1931 was 2,632,000 tons, the annual production ranging between 110,000 and 200,000 tons. Reserved were estimated in 1921 at about 21,000,000 tons, distributed as follows :—

Soengoep	10,600,000
Semboeloean	4,200,000
Semblimbingan	3,900,000
Stagen	1,200,000
North of Stagen section	1,400,000

The coal is inferior to the metamorphosed coals of Boekit Asem and Ombilin, chiefly because of its relatively high ash-content. It was mainly used by small steamers trading in the Archipelago, but is not suited to modern marine boilers.

Goenoeng Batoe Besar.—This mine was worked from 1922 to 1931, when it was closed on account of economic conditions. It produced a total of some 778,000 tons, the annual production increasing from 28,250 tons in 1922 to 135,000 tons in 1928.

Other Areas.—Local mines at Riam Kiwa and Riam Kenan, near Maratapoera and Pengaron have produced intermittenly, production ranging from 10,000 tons to 20,000 tons a year. A private mine produced from 10,000 tons to 25,000 tons a year at Goenoeng Koepang, east of the mouth of the Barito River, but this mine closed in 1929.

Near *Boekit Alat*, north of the Melawi River, is a seam of good glance coal 4 metres thick, from which it is estimated that about 1,000,000 tons could be won by open cut.

Eocene coals of fair quality are found also in gently dipping strata in the Selimbau and Katoengau districts of western Dutch Borneo. The seams are 25 cms. to 55 cms. thick and are only of local significance. These coals are worked by local people at Bovenkapoeas, Salimbaustreek and Batoe Dinding, the annual production being between 1,000 and 2,000 tons.

The Neogene sediments of Borneo from a belt 70 miles wide along the east coast, with extensions up the valley of the Barito River.

In the *Barito basin* a number of coal seams has been found, one being 20 meters thick. They have been mined by natives at *Doesoen Landen*, production ranging from 20,000 tons to 35,000 tons a year. The coal is black glance (subbituminous) with a calorific power of about 6,000 cals, per gm. (10,800 B T.U./lb.).

In the south-east some thick coal-seams are found on the eastern slopes of the Meratoes Mountains. The coal contains 20%—30% of moisture.

In the *Balikpapan—Mahakam River* area the Neogene sediments have been explored in some detail for petroleum. Four series of beds are recognised :—

(Youngest and topmost) Pliocene—U. Miocene—include thick lignites with 25%—30% moisture.

Mentawir Beds—include dull coals with 16%—21% moisture.

Poeloebang Beds—include thick seams of glance coal with 11%—16% moisture.

(Lowest) — Palaloean Beds—insignificant coal seams.
(Lower Miocene)

Poeloebang and Mantawir coals are worked on a small scale in the *Samarinda* district, in local mines of *Loa Teboe* and *Djembajan*, a little south of the Mahakam River. The annual output in the pre-war years ranged from 15,000 tons to 30,000 tons.

Coal seams are found in the coastal areas all the way from the Mahakam River to the Mangkalihat Peninsula (*i.e.* most of the *Koetei district*). They are the best Neogene coals in Borneo, and despite their high moisture content are comparable as fuels with the Eocene coal of Peoloe Laoet. A group of six seams, aggregating 8·5 metres of coal, in the area just north of the Mahakam River has been worked since 1913 by the East Borneo Company, with an annual production ranging from 70,000 tons to 170,000 tons, chiefly for use in the company's steamships. Smaller mines at Lao Boekit and Tocajan, working a seam about 1·5 metres thick gave 33,000 tons and 6,000 tons respectively in 1938. This coal has been worked by natives on the same scale since 1914.

From the Mangkalihat Peninsula northwards to Cowie Harbour, thick coal seams are found in Mentawir-stage and younger beds. Along the Berau River (Kelatan River), as many as 70 seams of glance coal, aggregating 111 metres thick have been found. The coal is worked in the *Parapattan* mine, near *Tandjoengredeb*. In the mine area there are 21 seams, 9 of which, varying in thickness from 1 to 2·8 metres, are mined. In pre-war years production ranged from 2,40,000 tons to over 3,00,000 tons. The reserves in the mine area are estimated at about 40,000,000 tons.

In southern *Tarakan* drilling has proved a seam of lignite (brown coal) 10 metres thick over 4 km., and in the eastern part for another 4·5 km. This coal has an average of 25% moisture, 4% ash and a calorific power of about 4,800 calories (8,650 B.T.U./lb.). Elsewhere in Tarakan are similar lignites, but with higher ash-contents.

Two lignite seams occur in Mandoel Island.

On Sebatik Island (Santa Lucia) is a seam of glance coal with only 2% moisture.

BRITISH BORNEO

Silantek :—

The *Silantek* coalfied lies in the razor-backed, jungle-covered foothills of the Kalingang Mountains on the border of Sarawak and Dutch Borneo, some 70 miles south-east of Kuching. The coals, which are post-cretaceous in age,

occur in a shale series which dips at 10° to the south. The area is probably underlain by a granite intrusion, and sills of quarty andesite occupy in the shales.

Three seams of *workable* thickness are known to exist, the Main, Middle and Bottom Seams.

The Main Seam is 3′9″ thick, and outcrops for over 2 miles. It is very soft and friable, so that 80% would pass through a 1″ screen. It contains reserves of some 4,000,000 tons, which is probably a minimum figure.

The Middle Seam, which is 3′ thick, is thought to have the same extent as the Main Seam and a proportionate reserve tonnage.

The Bottom Seam, 2′4″ thick, may have a reserve of 4½ million tons.

The total reserves for Silantek should be about 17,000,000 tons to 1,500′ below the surface.

Proximate analyses give the following figures:

Moisture	...	...	...	1·2% to 3·2%
Ash	...	...	...	6·0% to 22·8%
Volatile Matter	...	...	...	23·0% to 25·8%
Calorific Value	...	...	...	11,100 to 13,900 B.T.U./lb.
Swelling Nos.	...	...	...	0 to 9.

Some of the coals have quite good coking properties. They are sub-hydrous (*i.e.* have a lower proportion of hydrogen than normal coals of the same carbon content), and this is reflected in their low yield of tar. They have an exceptionally high nitrogen content, which could yield valuable ammonium salts.

Abok

This area is some 4 miles from Silantek and contains only one known seam of workable coal. It is 4′3″ thick but contains partings of dirt and carbonaceous shale. In places, it has been altered to a clinker-like material by igneous intrusions, and this makes it difficult to estimate the reserves; they may be put down as 2½ million tons, but extensions of the field are possible. They are not likely to be useful except for local steam-raising purposes. A proximate analysis gives:

Moisture	...	...	...	2·3% to 12·1%
Ash	...	...	...	18·9% to 72·7%
Swelling Number	...	...	...	0 to 1½.

The Silantek—Abok area presents a serious transportation problem due to its remoteness from deep-water harbours, the large area of swampy land between it and the sea, the unnavigable rivers in its immediate vicinity, and the steeply rising hills under which the coal seams dip at 10°.

Sadong.

This coalfield is 3 miles east of *Simunjan* on the Sadong River, and is still joined to that place by an abandoned light metre gauge railway. The mine closed down in 1930 due to the slump and the exhaustion of most of the readily obtainable coal. No reserves of any consequence can be deduced from the present day outcrops, but may be proved by testing.

Moisture	...	...	...	2·4% to 4·7%
Ash	...	...	...	3·9% to 12·9%
Volatiles	...	...	...	9·1% to 45·8%
Calorific Value	...	...	...	11,200 to 13,550 B.T.U./lb.
Swelling Number	...	...	...	0 to 2.

The coal is a medium quality sub-bituminous coal. It is ortho-hydrous.

Igneous intrusions exist and have altered the coal locally.

At *Mukah,* 150 miles north-east of Kuching, is a series of beds covering an area of 130 square miles and including more than 20 seams of ***lignite,*** some of which are up to 25′ thick.

Surface exposures are not great and the deposits have not been worked. The beds dip at 10° and are much faulted. The coals average only 3·5% Hydrogen, which almost certainly indicates carbonisation in situ. They are non-coking and have a relatively high oxygen content so that their calorific value is low. The coal is unlikely to be of any great commercial value without processing, and although the deposits occur near the sea, they are surrounded and overlain by large areas of swamp.

Some 220 miles north-east of Kuching, in a large area on the *Bintulu* and *Tatau Rivers,* are several coal outcrops. The strata are severely folded, but apparently little faulted. The country is low, flat and swampy and covered with dense jungle. Three seams of *workable* coal, totalling about 15′ in thickness have been discovered. All coals from Bintulu are "ortho-hydrous" *i.e.* they have a normal hydrogen content compared with their carbon content. They can all be classified as good quality *lignites.* They have a low moisture

content, low ash and correspondingly high calorific value as compared with other Borneo lignites. The *Silas Outcrop* (8′6″ thick) has only 0·4% ash, which itself contains only 28·05% of silica. These qualities make the coal exceptionally suitable for the production of low ash carbon such as is required for electrodes, aluminium smelting etc. Another seam has good coking properties.

The country is swampy and jungle covered, but the Silas River "is navigable by craft of shallow draught."

In the basin of the upper *Rejang River* in a jungle covered country of low hills and sharp ravines is an extensive coal area. The strata are highly folded and the reserves are unknown, but it is possible to say that very considerable quantities of coal must exist, particularly in the Iran and Merit-Pila Districts. At Pila is a seam 7′ thick. The coals seem to be almost ortho-hydrous and at least one seam makes a good strong coke with little swelling, whilst its exceptionally low ash-content makes it suitable for electrode work.

Ships of 400 tons capacity can go up-stream as far as *Kapit.*

The coalfield at *Brooketon* in Brunei ceased production in 1924, and surface indications do not indicate any sizeable quantity of workable coal available.

The strata dip at high angles and are faulted. The coals are all meta-lignites, without coking properties. They should be favourable for steam-raising furnaces and gas-producers.

At *Labuan* is the only area where at present the question of an immediate production of coal in British Borneo on a relatively modest scale could be seriously considered.

Coal was worked for many years, but production ceased in 1912 due to flooding: it is stated to have been good bunker coal. Four seams were known on the main field.

The best area is in the north of the island where a reserve of 9,000,000 tons, down to 2,000′ may exist with possible extensions beneath the sea.

At *Weston* in North Borneo, surface indications are that there may be considerable reserves in the one known workable seam, but the coals are typical *lignites* with high moisture content and low calorific value, suitable only for steam raising purposes.

There are no transport difficulties.

The coalmines at *Silimpopon*, at the head of Cowie Harbour and near the border of Dutch Borneo, were worked from 1905-1932 : the average yearly production was 57,000 tons. The immediate reserves are about 3,000,000 tons, which is not enough to justify opening them upon a long term policy, whilst no short term policy is applicable. The coals rank as between sub-bituminous and should be good for coking and yield a high per cent of tar and by-products. Further testing may prove reserves of up to 15,000,000 tons.

Java

Four small coal-bearing areas are known in Java.

At *Bajah*, in the Bantam district of south-west Java, are as many as 14 Eocene coal seams, aggregating 4 metres of coal, the thickest seam being 1·3 metres. The coal is of medium quality, but tends to have a high ash content. It was mined by the Japanese who worked up to 7,000 tons a month from it. Reserves are estimated at about 15,000,000 tons.

At *Bodjong Manik*, to the north of Bajah, are Miocene coals of rather poor quality, with reserves estimated at about 9,000,000 tons.

Lignite seams occur at *Sedan* and *Panawan* in northern Rembang province in north-eastern Java.

Celebes.

There are no important deposits in the Celebes. The best is at *Tondong Koerah* where there are 4 seams of sub-bituminous coal between 0·5 and 1·5 metres thick with calorific powers of 5,500 to 6,000 calories (9,900 to 10,800 B.T.U./lb.) and 8% moisture. At some point the coal has been improved by the heat of igneous intrusions.

New Guinea :

Glance coal occurs in the mountainous region of the Vogelkop. Two beds in the *Morna* Coalfield are 8·5′ and 4′ thick. Incomplete analysis shows :—

Moisture	... 2·36%
Fixed Carbon	... 52·00%
Ash	... 3·11%

The heating value of 7,660 calories or 13,790 B.T.U./lb. is relatively high.

Other deposts are at Van Rees Mts. in north New Guinea and in the area of the Bloomen River and the North-West River in Southern New Guinea.

Iron Ore.

The iron ore deposits of the Western Pacific islands are mainly of two distinct types :

(*a*) Small contact metamorphic deposits associated with Tertiary igneous activity. These deposits consist chiefly of *magnetite* and *hematite*, and few of them contain more than a few million tons of high-grade ore. In Indonesia these ores occur chiefly in the western part of the Archipelago, namely Sumatra, southern and western Borneo and southern Celebes.

(*b*) Lateritic ores associated with the belt of serpentinized basic intrusions that extends from the Philippines through Indonesia to New Caledonia. The reserves are large, amounting to several thousand million tons, but have a high moisture content and invariably contain a certain amount of chromium and nickel which makes them difficult to smelt. The lateritic deposits occur chiefly in the eastern part of the Archipelago, particularly in south-eastern Borneo and central and northern Celebes.

In addition, there are black beach sands concentrated by wave action from weathered volcanic rocks along the coasts of Java and Bali.

Celebes :

The greatest development of lateritic ore is in central Celebes, in an area of 4,500 sq. km. Reserves are estimated at more than 1,000,000,000 tons of ore. The *Larona* deposit contains about 373,000,000 tons. The ore consists of lateritic clay, with an average thickness of about 35 ft. At the top there is a capping of hard limonite from 1 to 6 ft. thick. Below is a zone of blocks of hard ore mixed with lateritic clay, the number and size of hard blocks decreasing with depth. It is estimated that the hard ore constitutes about 12,000,000 tons or about 3% of the total.

Contact deposits of magnetite ore occur at *Rante Pao*, South Boni in southern Celebes.

Borneo :

Deposits of lateritic ore, variously estimated to contain from 150,000,000 tons to 300,000,000 tons of ore, occur on *Saboekoe Island*. A large part of the deposit is close to the west coast facing the island of Laoet and extends along

it for 4 miles. It rises from sea-level to a height of 300 ft. The ore consists of perious limonite about 15 ft. thick, of which the upper 7 ft. is the richer.

The average iron content is about 46%.

Very large deposits are also known at Soengaidoca, Pulu Soewangi and Pulu Danawa.

In British Borneo, there is a deposit of limonite at *Tagaho,* south of Murudu Bay. It covers an area of 4½ sq. miles and is said to contain 25,000,000 tons of ore carrying 52% iron. A smaller deposit with about 1,500,000 tons of ore showing at the surface occurs in the Purog River, a tributary of the Lower Labuk River.

Contact-Deposits of magnetite ore occur at Martapoera, Kotawaringin and Tarrah Laset in south-eastern Borneo and the adjacent parts of western Borneo.

Sumatra :

The chief ores are contact deposits and consist mostly of magnetite which is more or less completely altered to hematite above the watertable. The most important deposits are those in the *Ranggal Zone in the Lampong Ranges,* which are estimated to contain between 2 and 4 million tons of ore with 65% iron and from 1 to 10% silica.

Other deposits are at *Atjeh* (*Tapanuli*) along the west coast and in Palembang province.

Bauxite.

Bauxite ore as mined is usually a mixture of aluminous hydrates with clay, limonite and sand. Mixture occur in all proportions and there is no definite dividing line.

East Indies bauxites are lateritic and derived from the weathering of aluminous parent rock. "Laterite" is the term used to define the surface products of long continued tropical chemical weathering, uninfluenced by mechanical erosion. In the process of weathering, silica and oxides of calcium, magnesium, sodium and potassium are carried off in solution by meteoric waters, leaving behind the hydroxides of aluminium, iron and manganese.

Bintan :

Mining of bauxite on *Bintan Island* in the *Riau Archipelago,* south-east of Singapore, began in 1935 and increased rapidly so that Bintan was producing

6% of the world's total by 1940. The Riau (Riouw) deposits are the largest in South Asia.

Year	*Bintan*	*World*
1935	9,932	1,767,000
1936	133,731	2,829,000
1937	198,970	3,746,000
1938	245,354	3,850,000
1939	230,668	4,370,000
1940	275,345	4,500,000

Japan was always the chief buyer of Bintan ore and during the Japanese Occupation, 1,200,000 tons of bauxite were exported to Japan.

Immediately prior to the war, the Dutch planned to establish an aluminium smelting industry at Palembang in Sumatra and the Japanese were forced to abandon plans for a hydro-electric power plant and aluminium refinery at Toba Lake.

The bauxite deposits lie chiefly on Bintan Island and the neighbouring islands off the south-eastern coast. On Kojang Island the bauxite stratum is about 8 metres thick, with white nodules of exceptional purity. With increasing depth, concretions of bauxite decrease and clay increases rapidly. This clay contains most of the silica, so that in the washing process, this is removed.

BINTAN ORE RESERVES, IN METRIC TONS, TO 1945

Location	Proved Ore	Probable Ore	Possible Ore	Total	Average Analysis% Al_2O_3	SiO_2	Fe_2O_3
Kijang	5,051,690	5,320,050	2,497,582	12,869,322	53%	4.32	13.2
Bintan Bay		2,837,394	766,257	3,603,651	55%	4.45	9.1
Tandjoeng Pinang		4,555,849	2,086,568	6,642,417	53.9%	4.30	11.2
Total	5,051,690	12,713,293	5,350,407	23,115,390			

Singkep Island lies about 180 miles south of Singapore. On nearby islets lateritic bauxites exist and the Japanese estimate the following as probable reserves of washed bauxite—

Pesik Island	500,000 tons.
Selajar Island	800,000 ,,
Keling and Lalang Islands	700,000 ,,
Total	2,000,000

The average depth of the deposits is about 6 ft., and there is little or no overburden.

On Keling and Lalang Islands there is no favourable anchorage. Pesik Island is almost surrounded by coral reefs, but access can be obtained through a break at the north side. On the island of Selajar a good harbour at Peneeba provides easy access to the deposits.

Borneo is reputed to have bauxite deposits but no information is available concerning them. There is a proposal afoot to establish an aluminium factory and deep water port facilities at Sipitang in Burnei Bay. It is proposed to dam the waters of the Padas River at Tenom gorge in the Creaker Range and build a power station below the gorge.

SUPPLEMENTARY NOTE ON THE PALAU ISLANDS.

Japanese geologists prospected the islands of Palau, Yap, Saipan, Ponape and Torakku for bauxite in 1935 : the only ore bodies of consequences were found on *Babelthaup Island in the Palau Group.*

About 369,000 tons of bauxite were produced during 1938 to 1944. The Japanese navy took over much of the island for fortification, interfering with mining operations. Mining ceased in May 1944. Plant installations were burned and equipment damaged in the Pacific fighting.

The Palau bauxite is lateritic in type. The surface zone is about 1 ft. thick, and averages 40 to 65% Al_2O_3. The percentage of silica increases and bauxite decreases with depth to the unoxidized zone, being seldom found in sufficient concentration to be termed ore below a depth of 3 metres.

Proved reserves are estimated at 1,855,700 metric tons of washed bauxite. Probable and possible reserves are 2,800,000 metric tons.

Representative Analyses of Bekite Asem Coals.

	1.	2.	3.	4.	5.	Average as Produced.
Proximate						
Moisture ...	28·1	15·7	5·8	1·0	4·4	8·0
Volatile matter ...	20·1	40·4	38·5	3·8	6·2	38·0
Fixed Carbon ...	29·7	43·5	55·4	94·4	84·4	52·0
Ash ...	2.1	0.4	0.3	0.8	5 .0	2.0

Calorific Power						
Calories/gram	...	4,880	6,380	7,540	8,460	7,430	..
B.T.U./lb.	...	8,780	11,480	13,570	15,230	13,375	...
Ultimate							
(dry, ash-free)							
Carbon	...	69·4	74·7	79·0	92·0	94·8	...
Hydrogen	...	5·2	6·25	5·8	3·5	1·3	...
Nitrogen	...	1·5	1·1	...	...	...	...
Sulphur	...	0·5	0·4	0·5	0·5	0·5	...
Oxygen	...	23·7	17·5	14·7	4·0	3·4	...

1. Lignite, 2. Transitional coal, 3. Glance coal.
4. Anthracite coal. 5. Natural coke.

Representative Analyses of Ombilin Coals.

		Average	Samples	Bed A	Bed Ca	Bed Cb
Proximate	...	%	%	%	%	%
Moisture	...	8·4	7·0	9·8	8·7	3·9
Volatile matter	...	33·6	43·0	32·0	35·0	...
Fixed Carbon	...	56·0	48·0	55·0	56·0	...
Ash	...	2·0	2·0	1·4	0·3	1·4
Calorific Power						
Calories/gram	...	7,000	...	7,000	...	...
B.T.U./lb.	...	12,600	...	12,600	...	...
Ultimate						
(dry, ash-free)						
Carbon	...	79·6	...	79·7	80·4	80·5
Hydrogen	...	5·6	...	5·2	5·7	6·9
Nitrogen	...	1·7	...	1·3	1·2	1·8
Sulphur	...	...	...	...	...	0·5
Oxygen	...	13·1	...	13·8	12·7	10·3

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THE PHYSIOGRAPHICAL PERSONALITY OF BALUCHISTAN*

S. ZOHA

1. Introduction.

In the previous article we had, *inter alia*, referred to the role of water in shaping out the physiographical personalisty of Baluchistan without considering there the drainage system in particular. But now with a satisfactory picture of the surface conditions before us we may proceed to describe it in some detail. Before we do so it seems desirable to mention two important facts related to drainage in general. Firstly, drainage is a subtle resultant of the interacting conditions of precipitation on the one hand and of land on the other with the added influence of man. Man by destroying forests and other forms of natural vegetation, by digging out canals, or by constructing dams on the rivers and thus diverting the natural flow necessarily interfere in the original pattern of drainage as initiated by nature; and nature herself, in course of time, modifies the pattern. Yet with all this, and much more, drainage remains a salient element in the environment—a basic trait in the personality—of a geographical region. Secondly, the term "inland drainage", so commonly used, in a way, apt to be misleading, for it points to a peculiar fate of disposal of run-off, not to an actual pattern—at least not always so. After all, if the rivers of a region invariably dry up in the sands or empty themselves into salt lakes (inland drainage) they leave no big problems to be solved except, of course, the problem of irrigating the land if and when necessary. Such rivers have a finality of process and event; and human adjustment is comparatively easier and simpler. But if the rivers, whether they flow into equatorial waters or polar bays, have no such finality or they change their regime frequently, they are decidedly a problem of first magnitude.

In his Census of India Report (1911) Sir Denys Bray characterised Baluchistan as a land of contradictions and contrasts. "For a brief and fitful season", he said, "its rivers are rushing torrents, for the greater part of the year there is hardly a trickle in their giant beds." Most of the rivers of Baluchistan

*Continued from Vol. V No. 2.

literally conform to the above description. But there are quite many which remain waterless not only for a greater part of the year but for many consecutive years while a few, on the other hand, somehow manage to maintain a tricklish flow all the year round.

The explanation of these variations lies partly in the differential distribution of rainfall and partly in the differences of regional or local structure. A detailed analysis of these factors is unfortunately not possible within the limited scope of the present article ; even if attempted, in the absence of scientific date, it would naturally remain largely hypothetical. For the present, however, we can only treat the main rivers of the country in their ordinary existential pattern.

2. Rivers of Baluchistan.

On the extreme north a few miles north east of the Sakir (10,125′) in the Toba Kakar Range rises the Kundar River and flows through a valley of the same. It runs first eastwards then southwards until it again turns north east and, running upto Domandi, meets the Gomal River to exit into the N. W. F. Province after passing by Khajuri Kach. A portion of the river serves as the Baloch-Afghan boundary. Despite the considerable political importance thus attached to it the, Kundar is a typical river of Baluchistan—a river without water. South of the Kundar we meet the Zhob River. It rises in about 67°43′ E. long. and flowing through the centre of the Zhob Plain joins the Gomal near Khajuri Kach after a run of 240 miles. The channel of the river remains waterless for the first 45 miles upto which it is called Lahar ; the rest which has a perennial stream is celled Lora. "The Zhob is a sluggish, turbid river, flowing in a channel varying from 40 to 80 yards in breadth between scarped clay banks about 15 feet high and quite disproportionate to the volume of water usually flowing in it. It is a shallow stream, seldom exceeding two feet in depth in the largest pools and in many places not more than about six inches, and about twenty feet in breadth."[1]

The Zhob River is flanked on the south by the Anambar which rises in about 67° 46′ E. long. as a hill torrent. Flowing east and south east for about 82 miles from its source, under the name of Loralai or Lorali, it receives the Sehan River from the north east and takes an abrupt turn to the south. Here it

1. Baluchistan District Gazetteer Vol. 9 p. 18.

is called the Anambar. Running north to south it traverses the tribal territories as the Beji River and flows south west and then south to debouch into the Kachhi lowlands as the Nari River. The total length of the river in Baluchistan is about 300 miles. Its bed is generally covered with shingle. The principal tributaries are the Kohar or Babai, the Siab the Sehan and the Narechi, all from the east, The Kachhi lowlands of Baluchistan, besides receiving the Nari in its dissipated channels, receives the Bolan River from the north-west. The Bolan rises in about 67°35′ E. long. and frequently disappearing in its bed is finally dissipated in the lowlands after its mountain course of 88 miles. " Unlike the Nari which has a level bed, the current in the Bolan, especially during floods, is very violent owing to its steeper banks and shorter length."[1] We may also mention here the Mula River which passes with a rapid fall through the Central Brahui Range under various names and exits into the south western corner of the lowland.

In Western Baluchistan, beginning from the south, the Kech-Makran valley is drained by a number of torrents descending from the slopes of the bordering ranges of which the Kech-Kaur, flowing from the east, and Nihing, from the west are most important. The two rivers unite to form the Dasht River which breaking through the Gokprosh range, past Talar Band, falls into the Sea by a large tidal creek. Like its affluents, the Dasht is not a continuous stream and fills only after rains. The average depth of the banks is about 25 feet and the width about 200 yards. Northwards, the Rakhshan River drains through the Panjgur Valley. The Rakhshan rises near the junction of the Siahan and the Central Makran range in the eastern side of the Valley, under the name of Nag and flows west-south-west parallel with the Siahan and then, turning northward it bursts through the Siahan Range having joined the Mashkhel River from the Persian side. It then runs under the latter name along the western side of the Kharan basin and enters the Hamuni Mashkhel after a total length of 258 miles. " Though a considerable watercourse, the banks of the Rakhshan are low, shelving and irregular, consisting of the hard clay known as kork. In Panjgur the average depth is about six feet and the width about $1\frac{1}{4}$ miles."[2] The Hamun though described as lake is only a large depression, 54 miles long and 8 to 22 miles broad. There is never much water in it except for a short time after heavy rain. Of the rivers of the Kharan basin none is as important as the Mashkhel River. Most of the rest are only hill torrents which " never contain water except for a few hours

1. **Military Report on Southern Baluchistan ; p. 23.**
2. **Baluchistan District Gazetteer ; Vol. vii ; p. 21.**

at a time in the rare event of a shower of rain". Similarly, in the plains of Chagai the only river with a perennial flow is the Khaisar, besides the lower course of the Pishin Lora and the Tahlab River on the Persian border.

The Pishin Lora rises in the western slopes of the Kand in the Toba Kakar Range, opposite the sources of the Zhob. Flowing south west through the Pishin Valley it bends north and after a detour in the Afghan territory it re-enters Baluchistan from the north and draining through the Nushki, it finally enters the Aamuni Lora. The Hamun is similar to the Hamuni Mashkhel only it is much smaller. "The great amount of silt brought down by the river accounts for the filling up of existing channels and the consequent formation of new ones. It is by reason of these changes that the river is unable to excavate for itself the enormous bed which it possesses higher up, and in big floods the water not only completely fills the channel but overflows forming several new courses for itself."[1]

Contrary to the Pishin Lora, the Hingol, the Porali, and the Hab rivers all flow from north to south into the Arabian Sea. The source of the Hingol lies in the proximity of 29°N. Lat., at the head of the Surab Valley. Known by a variety of names, such as Raj, Gidor Dhor or Nal Kaur, it drains the western side of the Jhalawan division of Kalat State and the north eastern portion of Makran. Like most of the rivers of Baluchistan, the Hingol contains no water in its upper course. Even when it does it requently disappears in underground channels as others do. Yet with a course of 358 miles, the Hingol claims to be the longest river of the country. The Hab and the Porali both rise in the north of the Pab Range. The former runs south east for 75 miles and then bending south west falls into the Arabian Sea near Cape Monze after a total length of 240 miles. The latter draining the Las Bela region enters the Sea at Miani Hor after a run of 175 miles. Owing to the silting of the main channel a branch of the Porali conveys the flood water into the Siranda Lake. The Lake is about 9 miles long and 2 miles broad and has an average depth of 3 to 5 feet but when flooded the level may rise to 10 or 12 feet.

3. The Drainage Pattern.

A further study of the main arteries of drainage mentioned above, would bring us nearer to the hydrographical peculiarities of Baluchistan ; and they

1. Ibid ; Vol. ivA ; p. 20.

could be summarised as follows :—

(*a*) The drainage of the country has, so to say, a centrifugal pattern. The principal watershed lies in the Central Brahui Range, approximately along the 67°E. long. with a secondary one running transversely along lat. 29°N. Consequently, the main rivers sprawl out in all direction.

(*b*) Within this primary pattern there exist large and small basins of various dimensions in which the drainage, though not exactly centripetal, is yet somewhat analogous to it in the sense that the torrent beds descending from the surrounding hills run into a common channel below which forms the hydrological axis of the area.

(*c*) The individul basins of of drainage enclosed by hills, however, do not stand in absolute isolation from one another. There is always a connecting link, a *tungi* or a steep gorge formed by the abrupt bend of the main river and the deep incision of the separating hills. These form the famous *laks* or passes of the country without which the movement of men and the transport of material in Baluchistan would have remained a tragic impossibility. In addition to providing the vital economic linkage these *laks* have imparted to Baluchistan a deep colour of sociopolitical uniformity and have, through a process of controlled communication, preserved its age old human institutions and historical distinctiveness without causing a baneful stagnation. And all this, must be repeated, is not the result of human will or effort but a natural product of the drainage of the region.

Among the other important hydrographical features of Baluchistan we may mention the fact that almost every river is basically impermanent ; it is always waterless except during brief periods of heavy floods. And, with rare exception the various rivers after an apologetic surface flow sweep down into subterranean passages from where they emerge on to the surface only to disappear again.

Apparently these features—the flood and the underground flow—have nothing in common. But, from human point of view, they have a common meaning : in each case the little but precious water which the region possesses and is periodically supplied with by nature goes to waste. In the former, the loss is

as sudden as violent; in the latter, it is slow but not as slight as generally supposed to be. (An efficient harnessing of the flood and an intelligent utilisation of the subterranean water, therefore, are the twin problems associated with the drainage system of Baluchistan.) discuss.

4. Phenomenon of flood.

In a purely physical sense, the floods in the otherwise insipid rivers of Baluchistan have been of enormous value, for by accelarating and intensifying the process of erosion and deposition they have filled the framework of rugged mountains and barren hills of the country with level and smooth plains smiling in contrasting fertility. And agriculturally, their importance can be well imagined by considering the typical case of the Porali River in Las Bela State. Here the Kharif crops are matured by one watering only viz., by once soaking the bed of the embanked fields the flood season which occurs twice a year, in summer and in winter when they are few and uncertain.

But these advantages of the floods are almost inseparable mixed with the ravages which they bring to the land and the people alike, for the constructive processes of all the natural agents, particularly of the rivers, beyond a certain stage turn into destructive ones if allowed to operate freely by man. The human measures adopted to control the processes naturally vary in accordance with the " mechanism " of the agents, and extent of the result desired to be obtained, and the means or resources of control available to man. As far as the control of flood is concerned we find that no satisfactory measures have been evolved and adopted by the people of Baluchistan except the primitive ones, for example, diverting the flood waters into the thirsty fields by constructing earthendams across the river beds. In fact, in quality these dams appear to have fallen inferior to the old barrages or *gabarbands* whose relics are found scattered all over the country. The static, if not actually retrogressive, nature of these measures is all the more undesirable in view of the fact that Baluchistan has undergone a distinct and somewhat progressive desiccation.

A general idea of the inadequacy of the existing nature of flood-control may be had from the fact that embankment are made of earth and boulders. As no regulating arrangements exist at the head of the embankments, water at high floods enters the flood channels, taken off from the up-stream, with enormous

force widening the very channels themselves. After repeated onslought these channals naturally assume the shape and size of big ravines cut deep into the cultivated land, and they go on increasing in width at the cost of the fertile land which is naturally limited in extent. / Frequently the flood water rushing through the primitive channels forms a spill-area and cuts smaller side-ravines connecting the larger ones, thus slowly but steadily transforming the whole cultivated area into a characteristic waste-land. And, with the collapse of the primary embankment which is not infrequent, the catastrophe is made complete.

Here we may also summarise the distribution of flood in space as well as time. The Zhob River is generally flooded in July and August but has never caused any serious damage. Similarly, floods have not been of frequent occurrence in the Loralai District whose rivers like the Zhob get inundated during summer. In Chagai, floods almost invariably occur in winter when the bed of the Khaisar River is sometime filled to the brim but seldom for more than a day. The Pishin-lora, again, is flooded in the winter but owing to the large area commanded by the Lora and its tributaries the floods are sometime very heavy and descend with great violence but they run down as rapidly as they rise. In Makran the Kech-Kaur in the centre of the Kej valley as well as the Nihing cause much diluviam. The rivers of Kharan likewise swell in winter The case with Sibi District is different as severe floods are of frequent occurrence. "In 1885 when the Sind-Pishin Railway was under construction, the Harnai Valley was visited by a series of severe floods, and one of these, which lasted for six days in April swept away several bridges and many miles of temporary roads, caused numerous accidents and did an infinity of mischief, destroying camping grounds, giving rise to malaria and stopping supply of food. After an interval of five weeks the floods again came down more severe than ever .....and this state of successive catastrophes went on without cessation till the end of May."[1] The Nari River is too well known for its notorious spates. Sudden floods in the Bolan too are frequent. "It was such a flood that utterly destroyed the Bolan Railway ere the Mushkef alignment was adopted."[2]

(1) Baluchistan District Gazetteer, Vol. iii, p. 21.
(2) Holdich, Indian Borderland, p. 15.

5. Underground Water.

We may now turn our attention to underground water. In a country where rainfall is so little and uncertain and surface supplies so limited, the subterranean water has naturally dominated the imagination of its dwellers and given rise to various superstitions and semi-religious beliefs. Hundreds of Saints or Pirs, dead in their stony shrines, continue to receive offering for their many miracles connected with the production of water from the ground. In the Bolan Pass, near the southern end of the Bibi Nani bridge, lies the shrine of Bibi Nani who is "the guardian-saint of the water supply". The Kuchiks a section of the Rind Baloch, formerly used to allot a few *Kasa* of grain per *tir* at each harvest to the shrine, the grain thus collected being used for the purchase of sheep which was sacrificed whenever a party of the cultivators went to repair the water-channel. Since 1895 the sacrifice has ceased and it is alleged that the water in the Kaur Bibi Nani, the western tributary of the Bolan River, has decreased in consequence. The brother of Bibi, known as Ghaib Pir by Muslims and as Mahadev by Hindus, is said to have miraculously produced a spring in Sarawan at the spot where he sank into the ground on being pursued by the Gabrs or Zorastrians. The large spring called Chashma at Kalat is said to have been produced by Pir Chatan Shah. One Pir Lakha produced water by his foot from the ground, marked by his shrine, in such a large volume that it flooded part of Sind ! The same Saint has another shrine dedicated to his name in the Loralai District where he is said to have produced three springs of water. Similarly Pir Chhatta produced the springs at the place bearing his name. The water which irrigates the lands in Shahrig is said to have been produced by Shaikh Musa. But Pir Bokhari, whose shrine is held in great reverence by the Wanechis, appears to have surpassed all other in the matter, for he turned the Pui stream into a stream of pure milk !

And these miracles are not attributed only to the dead ; actual living human beings are as often believed to have the power to increase, decrease or stop the flow of springs, rivers, and karezes.

6. The Significance of Superstitions.

Superstitious undoubtedly these tales are, but we may here pause to reflect on their probable significance to us. In the first instance, we must note that none of the prevalent stories suggest the presence of any power.....

god or ghost.....superior to human beings the power to produce water from ground, to increase, decrease or stop the flow of rivers and karezes and springs, all these miracles are invariably attributed to some man or, less frequently, to some woman. Religion, precisely speaking the Islamic faith of the bulk of the people of Baluchistan, has certainly precluded any tendency to associate physical phenomena to superhuman agencies. But so far we know, there is no direct evidence to show that any such association had flourished in the country either in the pre-Islamic period or among the non-Muslim groups of its inhabitants. It may be of some interest to mention here that the Loris of of Baluchistan " look upon fire with special reverence as God's gift to David brought from purgatory where David begged for the wherewithal to melt iron." Although for quite a different reason, the reverential ceremonies associated with fire strongly reflect the neighbourly influences of Persian Zorastrianism, Indian Hinduism too had found its way into the country. There are ample evidence of deityworship both in ancient and comparatively modern times, for example, clay-figurines of women have been un-earthed from the pre-historic sites of the Zhob and the Kulli cultures, but they almost entirely represent ordinary domestic deities or, in certain cases, the goddess of Fertility. Despite these gods and goddesses and many other influences of Hindu religion and culture there is nevere-theless, a conspicuous absence of reverence for water and the corresponding water-goddess. There are no hymns sung to the praise of water, there are no elaborate and ardously pious '*ashnans*' as we find on almost every bank of every river in Northern India. The absence of a Jamuna or of a Ganges in Baluchistan may partly be responsible for it ; principally it seems to be due to some other fact.

A more peculiar feature has still to be noted. The traditional 'guardians of water supply', the *pirs* and the saints having full control on the rivers, the karezes etc., have implicitly no control on water from the air. They do not command the clouds and have not reportedly caused rain. Without stretching the matter too far, we probably would be justified in asking why a *pir* who could and did produce water from ground did not produce rain ? Why there is no such story ? Why no shrine dedicated to any ' guardian of rain ' at all ?

There can be one explanation of all this. The inhabitants of Baluchistan, these illiterate folks, have sub-consciously experienced the full import of their

peculiar environment. Beneath the cloak of the superstitions they seem to have the knowledge that men can and does command the land but not the air ; of the elements of land, water is the most vital and directly within human access for utilization, and, as ground water is rare in the country, it can best be utilized through the good offices of a holy ' guardian '.....the person who has the knowledge of hidden resources of water and in whose perpetual awe no major waste of water could be allowed or tolerated.

We have digressed too far from our original theme and probably we have attempted to put in too much logic in the superstitions of the people. But here, as in other contexts, we do not exactly deal with the superstitions themselves. Moreover, the so-called superstitions are really manifestations of a deeper aspect ; thay are indications of the processess of mental adjustment with the elements of environment forming the elementary bases of thought, habit and action ; and, in a land like Baluchistan. habits of thought and action cannot be easily ignored in the zeal for rapid development and reform.

VALUE OF GEOGRAPHIC TRAINING AND CAREERS FOR GEOGRAPHERS IN PAKISTAN*

NAFIS AHMAD

Parents and guardians as well as the politicians, the businessmen and government officials often inquire about the general usefulness of geographical training and seek information about the possible careers open to those who have followed a university course in Geography.

I feel it will serve some useful purpose if I explain briefly some relevant information and suggestions in this connection. First of all, I shall deal with the question of the usefulness of geographical training in general and then mention various careers which may offer opportunities to trained personnel in Geography in our country which is on the threshold of progress and development.

1. Geography helps to develop a rational and scientific attitude of mind. It inculcates an outlook of sympathetic and reasoned understanding of world problems leading to a proper appreciation of other people's circumstances of life thereby promoting the cause of peace and goodwill. As an educational instrument geography clearly takes its place among those studies whose virtue lies in the intellectual discipline and the cultural training they afford. Indeed the conclusion is inescapable that all educated citizens must know sufficient geography. Many important problems of our country are also related to world problems. In turn, the development of proper relationships among the nations is dependent upon a better understanding of the geographic forces affecting all peoples.

2. A recent memorandum prepared by the Education Committee for the Royal Geographical Society, England sums up the position thus—" Geography is

*Opening speech in the symposium held in the Section of Geology and Geography of the 3rd Pakistan Science Conference held at Dacca, 1951.

unique in its transitional position between the natural Sciences and humanistic studies, a position which enables it to induce in its students critical and literary skill combined with discipline and accuracy of thought. The trained geographer is accustomed to approach a problem from all possible directions just as he is accustomed to analyse a landscape from the point of view of many diverse branches of knowledge. He develops the particular individual skill induced by the habit of seeking correlations of varied and apparently disconnected phenomena and of drawing together the data of natural and social investigation into a synthetic whole. It is this habit and intellectual skill that are the fundamental assets of a geographer. He takes a synoptic and philosophical view of the world and has by no means negligible acquaintance with the studies cognate with geography, *viz.* geology, biology, mathematics, physics, climatology, statistics, history, social anthropology and economics. A well trained geographer should therefore, be regarded as a person of high education especially fitted for posts that demand a wide, human outlook. This should be more widely known among employees than appears to be the case."

3. That the purpose and scope of geography and its part in teaching and general education are still subjects for debate in our country seems surprising. Geography has won full recognition nearly everywhere on equal footing with natural sciences and its educational value in the training of the modern citizen is universally acknowledged. Modern geography derives many of its data from other sciences but uses them in its own way, inter-relating them according to its own discipline in a different context.

4. The geographical way of thinking implies not only the possession of precise knowledge about the world but also the ability to preserve the proper balance of elements borrowed from other sciences dealing with earth and man. The acquisition of the so called geographical angle is a matter of careful training and the inculcation of a scientific discipline based upon theory as well as visual aids and field work.

GEOGRAPHY AND ALLIED SCIENCES

5. On the science side geography has close association and borrows frequently from geology, pedology, meteorology, botany, anthropology, and mathematics. The geographer gathers results and data from the labours of all

these sciences and then establishes correlations and draws conclusions especially in relation to human society and environment.

GEOGRAPHY AND ARTS AND HUMANITIES

6. Similarly, the relation of geography with arts and humanities is very close. Economics, History, Political Economy and International Relations can hardly do without the help of geography. Geography in its own turn obtaining useful data from these specialised studies evolves its own methods of scientific interpretation of world conditions by developing its own fields of economic geography, historical geography, political geography and geo-strategy.

PREPARATION AND STUDY OF MAPS

7. In addition, a special feature of the geographical method is the preparation and study of maps and map intelligence as applied in general to the appreciation of various geographical problems. Thus cartography is inseparable from modern geography as the geographer "with a map is able to express a large section of his knowledge more certainly and more fully and at the same time more simply and with great clarity".

ARTS AND SCIENCE DEGREES IN GEOGRAPHY

8. That being the field and associations of modern geography in its post-graduate teaching both arts and science degrees are awarded. Both M.A. and M.Sc. courses have the common indispensable training in physical basis of geography, World Regional Geography, map making and map intelligence, survey and geographical field work. In addition students offer two or three papers from subjects related to allied sciences or arts. The Scheme of post-graduate courses in practically all Pakistan, Indian and British Universities is as follows :—

POST-GRADUATE COURSE IN GEOGRAPHY

(Common)

1. Physical Basis of Geography.
2. World Regional Geography.
3. Map making and Map Intelligence.
4. Survey and Field Work.

(Optionals) M.Sc.

1. Geomorphology.
2. Pedology.
3. Climatology and Meteorolgy.
4. Anthropogeography.
5. Biogeography.
6. Cartography.

(Optionals) M.A.

1. Economic Geography.
2. Political Geography.
3. Historical Geography.
4. History of Geographical Knowledge.
5. Human Geography.
6. Cultural Landscape.

9. *Education* :—Of course, teaching affords numerous opportunities for geographers, not only in schools and colleges, where the study continues to grow in popularity, but also the Universities and training colleges, which must have full fledged departments. A big void is to be filled up in the matter of trained geography teachers in both Eastern and Western Pakistan.

10. *In Public Services* :—Apart from teaching posts the geographers may properly look for a career in many public services and professional fields.

An advanced post-graduate training in geography in accordance with various specialisations as mentioned above, does lead directly to certain careers in government departments as well as in several independent professions. In government departments geographers will be found useful in a number of Central and Provincial services like the administrative service, surveys, department of meteorology, Ministry of Economic Affairs, Commercial Bureaus, Planning, Communication and Railways. Above all, the geographers can be very useful in the foreign service both at the Ministry's head quarters as well as serving with embassies abroad. Their knowledge of the world, its resources, development, stretegical set up and possibilities of countries where they serve will be found to be a great asset to their intelligent and efficient discharge of duties. In fact, for recruitment to the foreign service geography should become an indispenable qualification. Lastly, the armed services of the country will find in the geography trained youth the right kind of source to draw upon.

11. *Wartime Employment* :—Realizing the great usefulness of geography trained personnel, during World War II a number of countries including Germany, Italy, Soviet Union, U. S. A. and Britain employed many geographers to fill in important posts in map intelligence, planning, meteorology, hydrographic surveys, State departments and in various other advisory capacities.

12. *Professional Employments* :—But the geographers' usefulness is not limited by the ambit of governmental service. In private enterprise, an increasing number of appointments is being made to business and commercial posts in which a knowledge of geography especially when combined with economics is particularly useful. In Britain they include managerial traineeships

secretaryships in business firms, posts in buyers, freight despatch and export departments of large firms, and in market research, in trading concerns and the Mercantile marine. Geographers in Britain and Canada and U. S. A. are obtaining an increasing number of posts in connection with the editing and production of books, periodicals, pictorial magazines, maps, slides and educational films, where an expert knowledge of geography is required. Journalism is yet another field of employment for trained geographers. Advertising goods and sources of commodities and organisation of tourist trade are also among the new avenues of employment for geographers. Thus in various fields of private employment the geography trained man is in increasing demand where grappling effectively with fresh problems involving peoples, countries and resources is the keynote of usefulness.

SUGGESTIONS FOR EXAMINATIONS AND RECRUITMENT

13. Therefore, the usefulness of geography trained man to Pakistan's growing needs in many spheres of Governmental and private employment need hardly be over emphasised. Twofold suggestions are therefore offered. Firstly, a paper in general geography should be made a compulsory one in all Central and Provincial service examinations. Advanced geography should be included as an optional subject in all the above mentioned examinations. Further, for entrance to Foreign Service the candidates should be required to pass a compulsory special paper in geography. In other relevant fields of government employment such as surveys, meteorology, Commercial Bureaus, Economic Affairs, Trade missions, Planning and Publicity departments suitably qualified geographers should be considered for appointment. Secondly, in the light of the above appraisal, a recommendation should be made to all Pakistan Universities to open and develop well equipped post-graduate shools of geography. A committee of experts should be set up to make recommendations with regard to the University courses in geography and the equipment, apparatus and other facilities required for the purpose. A number of promising geograpers should also be sent abroad for training.

THE NATURAL FRONTIER OF PAKISTAN

KHALIL ULLAH KUREISHY

"India may be likened to an island which has but one practicable landing place. The north-west frontier is her one vulnerable spot"[1]. More than seventy years have elapsed since this was written. Colossal changes have taken place during this period. The superficial unity of British control in India has disappeared. The land of difference, disunities and diversities of relief and climate, of outlook and activities,[2] has been divided into Pakistan and Bharat. This brought us the legacy of the defence of the North-West Frontier of West Pakistan which is now much more fortified than it, at the time of writing of the above quoted lines, was. The tribal territory which by virtue of its age-long traditions of liberty and independence was a constant terror to the alien rule, has been converted into a region of most cordial relations with the rest of the Muslim state of Pakistan. The heroic sacrifices of the tribal Mujahids in the liberation movement of Kashmir leaves no ion of doubt about the complete change of heart in them. They are at one with the rest of the populace of Pakistan in defending their motherland. Pakistan Government is equally responsive to this goodwill gesture and is spending some twelve crore rupees annually on the the development of the tribal territory.

Certain other relationships have, anyhow, changed but little. The policy of Afghanistan is still as untrustworthy and oscillating as it was during the early phases of British rule in India. The kingdom of Afghanistan with a length of about 600 miles from Herat to the Khyber and a breadth of about 500[3] miles still serves as a buffer state[4] between Russia and Pakistan. This buffer character of the State of Afghanistan is a matter of redeeming importance to Pakistan which has already been following a policy of conciliation and even appeasement uptil now and seems to be inclined to continue to pursue the same

1. Andrews, W.P., Our Scientific Frontier p. 2.
2. Lyde, L.W., The Continent of Asia. p. 356.
3. Holdich, T.H., India. p. 56.
4. The Anglo-Russian Convention of 1907, fixed the status of Afghanistan as a buffer state between Russia and British India (now W. Pakistan).

policy over the coming years as any weakness of the former country is indirectly Pakistan's own weakness[1]. How and when these sincere efforts of friendliness are going to bear fruits is yet to be seen[2].

Russia stands where it was. The 19th century Imperialist Russia has been metamorphosed into the U. S. S. R. with a new vigour, a fresh zeal and a revolutionary and revolutionising spirit. The swing of China towards communism has made the Sino-Russian power a formidable one in Asia. The nebulous concept of Truman Line of Defence against the spread of communism with complete American indifference and, perhaps, a deliberate ignorance of areas of such top strategical importance as Pakistan, is a matter of academic rather than of practical significance. It is really very astounding that American strategists cannot spare a moment to look at the map of Asia and study out the zones of gravity on it[3]. The fact, however, remains that Pakistan has to feel

1. "A strong and allied Afghanistan would lessen largely the problem of defence". Vincent, A., Defence of India, p. 36.

2. The bogus cry of Pakhtoonistan raised by Afghanistan is a sad commentary on the Pak-Afghan relations. It means a definite disregard by Afghanistan of an international treaty signed between British India and Amir Abdur Rehman, the ruler of Afghanistan, which determined the common boundary by mutual agreement. The delineation took place along the Durand Line in 1894. In the early attempts of the technical demarcation of the boundary some small lengths were left out undemarcated which task was accomplished in the later years again by the mutual agreement of the two governments concerned. In the light of the said agreement which has obviously received its de facto and de jure international recognition and the validity of which has been unequivocally reaffirmed by the British Government, specially in the context of Pakhtoonistan cry, the said cry is not only hollow but a veiled attempt to disrupt the solidarity of Pakistan. It is an encroachment on the territorial integrity of Pakistan. It is characteristically a Nazi tactics directed againsnt the sanctity of international frontiers. Now, the only silver lining around the dark cloud is that Pakistan is too strong for Afghanistan to be cowed down by any unfounded propaganda however vociferous it may be. Afghanistan is bound to realise one day the strength of Pakistan especially when the latter is on the right and the futility of her own claim specially when it is baseless.

3. Now and then some U. S. intellectuals realise the strategic importance of Pakistan and give vent to their views. Capt. Michael Fielding the famous press and radio commentator once said. "The Indo-Pakistan sub-continent is a very important base, but in my opinion the defence of this sub-continent does not lie in India but in Pakistan. Pakistan acts as a shield against the encroachment of communism into this sub-continent because it controls the various routes of approach, to the sub-continent through Iran, through Hindu Kush passes through Chinese Sinkiang via Kashmir and through Burma. Because of this, Pakistan plays vital part in upholding democratic standards in Asia." Victor Bayley, an English writer referring to undivided India of which the present territory of Pakistan formed the western periphery wrote in his book, " Is India Impregnable," as below :—

> " But one postulate may be made and that is that it would be utterly impossible to prepare any plans for warfare in Asia—and perhaps it would be well to include Africa, Australia, New Zealand and the South Sea Islands—without assuming the existence of an impregnable base in India. If India goes, all is lost."

the impact of a very pawerful neighbour with dynamic outlook and a political and military ambition to obtain an outlet towards the warm waters of the Indian Ocean. Pakistan stands in the way of fulfilment of such an ambition. It is the first and the last line of defence against the spread of communism in southern Asia. The whole history of Indo-Pakistan proves that the first effective cheak to an invading army from Central Asia is furnished by the north-western natural frontier of Pakistan. The termination of geographical barriers with the Sutlej in the east of West Pakistan amply demonstrates that it is the last impediment in the way of India-ward bound forces Pakistan is, therefore, the sentinel of the whole of southern Asia. There is but one relieving feature of the whole tangle of responsiblities of Pakistan in the position of a sentinel. It is the geographic nature of her north-western frontier. The frontier is formed by the western off-shoots of the Himalayas which are high enough in their northern section and in the southern sections the effect of aridity more than compensates the debilitating effect of a decrease in altitude. "It marks the ethnic, geographic, and economic division between Central and Southern Asia and it is a strategic frontier on which a stable government may rest"[1]. There are some famous inroads in the frontier which merit a separate treatement but it may be mentioned here that they are covered as to render the passage of a hostile army most difficult.

Physical Background of the Frontier.

The western frontier of West Pakistan is some 1,400 miles long. In the north, the Pak-Afghan boundary begins from the trijunction of the three boundaries of China, Russia and Pakistan about which the report of the Anglo-Russian Pamir Boundary Commission, 1897, gave the following description :—

> ".....a rugged and inaccessible spur of the Sarikol range carries the boundary into regions of perpetual ice and snow to its junction with the main range. Here amidst a solitary wilderness 20,000 ft. above sea level, absolutely inaccessible to man and within the ken of no living creatures except the Pami eagles, three great empires actually meet."

The trijunction, thus, lies in one of the loftiest of mountain formations correctly designated as the 'roof of the world'. The Wakhan province of

1. Afghanistan by Fraser Tytler, p. 14.

Afghanistan prevents direct contact between Russia and Pakistan and is only too narrow and mountainous to be adequately controlled by Afghanistan.

The northern reach of the Durand Line begins from the knot of the Sarikol, Mustagh and Hindukush systems and runs along the latter mountains for a distance of about 400 miles. For the first hundred miles the axis of the Hindukush, as also the frontier, follows an uneven trend towards the west to a point (approx. 36°45′ N & 72°15′ E) which is 20,566 ft. high and overlooks Kila Panja (about 37°N and 72°35′ E) on the Ab-i-Panja or Upper Oxus. Here the distance between Russia and Pakistan is less than 10 miles. Thence the boundary changes its direction to south-west and follows a very irregular course for about 300 miles. Throughout this length the Hindukush forms a water-parting between the Indus and the Oxus systems. The highest peak Sad Ishtragh pinnacles to the sky at an altitude of about 24,170 ft. above sea level. Again, almost throughout this length the terrain towards Pakistan is higher and has steeper slopes than towards Afghanistan. The main crest throws off towards south, in Pakistan, a splendid formation of higher and snow-capped mountains. They include the Tirich Mir, overlooking Chitral (25,400 ft.) and Rakaposhi between the Hunza and the Gilgit (25,500 ft.).

Near Arnawai to the north west of Dir the boundary crosses the united stream of Bashgul and Chitral rivers and then runs along a prominent though subsidiary ridge for some distance till it reaches river Panjkora. Southward from here the boundary again utilises summits of ranges fulfilling the conditions of a stable frontier—at Shingard Pass the height is 12,497 ft. and some distance southward it is 11,351 ft. These ranges carry the boundary to a point near the ancient town of Kumar (Afghanistan) from where it makes an irregular course through the Mohmanad Dara till Landi Khana in Khyber Pass is reached.

Again the boundary follows the summit of Koh Sofed uptil Peiwar Kotal near Parachinar. Here the altitude increases towards west where the height of a peak, some distance to the north of Piewar Kotal, is 15,600 ft. Southward the Sulaimans cradle the boundary. After cutting across upper Kurram it coincides with the southern waterparting of that river for some distance. Thence it continues across the head of the Tochi to Domandi (South-West of Wana) on the Gomal. Further below the Sulaiman mountains are locally known as the Kaisargarh after the name of the high peak (11,300 ft.) in it. Some distance to the south of the summit is situated the peak Takht-i-Sulaiman

(11,290 ft.). In the rear of the Sulaimans there are some flanking lateral valleys including the Zhob which collectively afford means of mobility parallel to that range. These valleys are under Pakistani control, and are well guarded from the dominating site of Fort Sandeman. From Domandi to Chaman the boundary with many zigzags maintains a south-westerly trend with a height of 7,000 to 8,000 ft.

Chaman is almost halfway between Quetta and Kandhar which in turn lies on the Sistan route from the U. S. S. R. From Chaman the boundary runs an irregular course towards south to a point about 40 miles south-west of Quetta. Westward from here upto Koh-i-Malik Siah it crosses the desert of the Helmund some 50 miles to the south of the river dwindling in altitude to the west to a height of 2,000 to 3,000 ft. Malik Siah Koh (6,390 ft.) forms the trijunction of the territories of Afghanistan, Iran and Pakistan and is situated in the midst of wildernesses.

From this point southward the common boundary separates the friendly country of Iran from Pakistan. Firstly it follows the well defined natural features running towards south-east having a height of more than 2,000 ft. Here it touches the Hamun Swamps which receives the combined waters of the Mashkel and the Rakshan. Making a bend around Kuhak (Iran) the boundary runs south-west through the wilderness of western Makran at an altitute of less than 1,000 ft. till it reaches the sea coast to the east of the little fishing port of Gwatar between the Dasht and the Chil rivers and about 50 miles to the west of Gwadar.

Defcnce position of the Frontier.

"The frontier of today is neither a chance growth nor the outcome of a few individual strokes of policy..... ...It is the still unfinished issue of a steady contest with elements of danger carried on unceasingly throughout the generations.. ....."[1]

The British took over the Punjab and adjacent territories of N. W. F. P. in 1849. A definite deliniation of the boundary was made after some 45 years. In the evolution of the effective control of the border regions there arose the controversy of the "backward" and "forward" policies which was so much flood lit in the past that it hardly deserves any comments here. It is a matter

1. Arthur Vincent, Defence of India. p. 25.

of the past. The 'unfinished issue' which the British bayonets could not possibly settle came to a natural end on August 14, 1947, when Pakistan came into being. The creation of a Muslim State with ethnography, ideals and religion common to the tribal belt and the rest of the country, changed the mien of circumstances in no time. Now there exists no question of a forward policy and no need of a backward one. That chapter is now closed for good. Pakistan is an integral whole, ethnographically, ideologically, economically and politically.

With no financial and military problems which formerly confronted British India, Durand Line is the best natural frontier of Pakistan. It is quite well known that no military strength derives from the physical features themselves. Also new weapons and new appliction of old weapons change the character and effectiveness of terrain features. Still the rough arid terrain of the Western frontier of West Pakistan, backed by adequate force as it is, is a great barrier. The mountainous nature of the frontier reduces the possibility of fighting to its slenderest extent. The force of enemy attack is likely to be diminished or broken by employing mainly the element of surprise in these difficult areas. Surprise is achieved as the nature of the ground makes possible the successful concealment of the positions of our troops and impedimenta. The physical character of the surface renders the enemy logistics and supplies inadequate. The mountainous country also forces obstacles to approach upon the enemy. Our defensive force can best utilise the mountainous features as support for its flanks with the result that the frontal area is strengthened with the greatest economy of force. There are obstacles in some of the frontal area too which again make possible a concealment of our strength and dispositions and furnish us with a good cover for a defensive offensive. In these areas, therefore, victory does not depend so much on the strength of the forces themselves as on the adaptation of the forces and their equipments to the terrain.Such an adaptation is difficult but not impossible for an invader Our strategists are however in a better position to utilise the available terrain as a tactical advantage over the enemy as the very disposition of land features ensures the concentration of our forces and a sufficient dispersal of the enemy forces.

A firm hold of the present frontier affords great possibility of fighting a defensive battle away from our own soil It is a great advantage both

strategically and tactically to fight, wherever circumstances permit, a battle in front of the territory defended rather than upon it. If, on the other hand our forces deem it advantageous, for a time, to retreat against too unequal a might of, say, Russia (and the intervening difficult terrain of Afghanistan does not favour such gigantic concentrations) the tribal belt with jumbled corridors of jagged boulders which give cover to guerilla warriors at every step and where one, yard in every two provides an ideal position for an ambush[1] will be the most difficult of all passages for the invading troops. Hundreds of miles of such vastnesses peopled by excellent guerilla fighters the world has ever known will make the lines of communication of the invaders so dangerously insecure that such an invasion will ever remain a prohibitive enterprise even for the mightiest of armies. Over and above it, the need for fighting in the foot hills may not arise at all. With our garrisons at places like Quetta, Fort Sandeman, Ladha, Thul, Wana, Miran Shah, Parachinar, Dardoni, Landi Kotal, etc., etc., we are solidly established within the hills, our forces cannot be taken up by surprise, and are, thus, in a better position to check the hostile movements at the very outset.

An orographic study of the frontier brings into lime light the relative importance of its middle section. The northern section covering a length of about 400 miles lies in a mountainous country formed of a tangle of huge rocky peaks and small patches of barren plains at great altitudes. Here and there the ranges are interspersed with narrow valleys. In the southern 400 miles the ranges dwindle into insignificance but the effect of aridity comes into play.

In the northern section three to four hundred miles are safe. The Pamir heights and the loftiest parts of the Hindukush are impenetrable ramparts. The *Kilik* (15,800 ft.) the *Baroghil* the *Nuksan*, the *Dorah* (14,800 ft.) and the *Spinasuka* are mentionable passes in them. The Spinasuka was negotiated by Alexander[2] with his picked cavalry in an effort to make safe the flank of his main forces going down the Khyber. The Nuksan and specially the Dorah are cannected with Faizabad in Afghanistan and open into Chitral whence a route leads to Nowshera by the Malakand pass. Dargai near Malakand is connected with Nowshera by rail. These passes are difficult even for small forces

1. Defence of India p. 69.
2. Map Opposite page 94, India by Holdich.

especially in winter season and are impossible for big armies. Other minor passes like the *Tigarmansu*, the *Wakhgir*, the *Karambar*, the *Janali* and the *Kahoti* are not worth the name.

The southern 400 miles or so are safe again. From about 66 E. longitude upto Koh-i-Malik-Siah and on to the north of river Dasht on the Makran Coast, the scarcity of water, the scorching heat for the greater part of the year, the barrenness and inhospitability of the land the typical desert of Kharan and Panjgur and their continuation into Iran and the absence of good means of communication, all render this part of the frontier impracticable for the passage of armies save small and ill-equipped ones. Our most cordial relations with Iran make the position all the more satisfactory. Any ingress into Pakistan from this quarter may take place only after traversing long distances through Iran which will definitely mean *causus belli*. At the same time any outside adventure in this direction will not take Iran and Pakistan by surprise. It will be resisted according to the nature and quality of the attack. The military railway running from Nushki to Zahidan, together with the road, is there to facilitate our movement. No sensible army will, however, steer its way through such a hostile desolation. "Any invasion on India (Indo. Pakistan) from the north-west has to choose, as the map will show, between desert and passes, the mountain ranges bar all else. There is little question in the choice and throughout the succeeding ages every invader has come by the passes[1]"

The middle section stretching from near Bajaur (roughly 35° N and 71½° E) to near Nushki (where 66 E longitude cuts the border), a distance of about 600 miles, is the key stone of the defence of north-west frontier. It is here that the mass of mountain ranges varying in altitude from 6,000 to 11,000 ft. are traversed by important passes like the Khyber, the Kurram, the Tochi, the Gomal, and the Bolan-Khojak. In the past all invasions have come by the passes. "Every new flood tends to fit itselt appoximately into old banks[2]." Today again the passes form the lines of greatest expectation. The southern reaches of the frontier are at least as arid as they have been in the past and they afford as difficult a passage to any modern army as they have been affording to the innumerable hordes in the days of old. By seeking to utilise the passes the enemy will, as explained earlier, be forced to fight on a narrow front and at great disadvantage before he can think of deploying towards Pakistan.

1. Vincent A. Defence of India Vol. II. p. 19.
2. Semple E. C. Influence of Geographic Environments, p. 6.

The Tribal Belt.

In connection with the defence of the frontier, it is useful to touch upon the nature and the characteristics of the tribal belt which is the immediate hinterland of the frontier.

It may be dived into three sections.

(*i*) Region to the north of Khyber containing the states of Chitral, Dir and Swat.

(*ii*) From the north of Khyber to about D. I. Khan the region is strategically most important having four out of the five important passes. It is here that population is comparatively less sparce and the region is peopled by no less warriors than Utman Khel, Mohmands, Afridis, Orakzais Turis, Mahsuds, Waziris etc. In the Khyber areas the Afridis together with their southern neighbours Orakzais form one of the biggest compact groups of fighting talents in the tribal territory. It is a happy coincidence that the frontier section which is physically a zone of weakness is backed by the strongest of the demographic elements.

(*iii*) Southward from D. I. Khan the territory is not so well defined,

The habitat of the guardians of our western frontier is a strip of land varying in width from practically nothing at Malakand to about two hundred miles at Sibi. It is a piedmont region of rough and undulating terrain of large boulders and bare ranges vivisected by dry valleys occasionally swelling into tumultuous torrents which subside as quickly as they agitated. Perennial water exists only in privileged localities becoming progressively extinct towards the south. Aridity and the consequent barrenness and extremes of temperature are a keynote to understand the hostility of the environment*. The resultant

*At Drosh the mean maximum and mean minimum temperatures for January the coldest month, are 45 7°F and 31 4°F and for July, the hottest month, 96 7°F and 73 5°F respectively. The annual rainfall at Drosh is 18". Kohat has a mean annual precipitation of about 18" and in the south Miran Shah and Wana have about 13" and 12" respectively. On account of low rainfall the outer hills present almost a bare aspect and cultivation is confined to valleys and intermont basins where irrigation from hill corrents is possible. The annual range of temperature is great. At Parachinar the mean minimum temperature in each of the winter months, December to February, is below freezing point, while the mean maximum temperatures are between 50°F and 55°F. In June and July the hottest months, the mean maximum is about 87°F. As in any other part of the mountain the local conditions vary with elevation and aspect. Further towards the south, as rainfall decreases and the hills get barer and barer, the monthly means of temperature also get higher At fort Sandeman the mean annual rainfall is 10 83". The mean minimum temperature for January is 30 6" while the mean maximum for July is 99 3°F. Climatic Regions of West Pakistan pp. 20-21. by Dr. Kazi S. Ahmad.

landscape is just a monotony of sterile stones, boulders, ridges and ranges. Hidden in these bleaknesses are small patches of greenery and marvellous fertility growing delicious fruits, excellent harvests and rarest flowers where water is available.

The most valued product of the region is that gem of a man otherwise known as a "Pathan" who is the deadliest enemy of the enemies of Islam and the toughest and bravest fighter for the defence of his country. A vast mass of comments is available on the qualities and characteristics of the Pathans in the writings of the Britons who had the opportunities of studying them from close quarters. Most of these writings are the outcome of biased thinking against the only formidable opponents of British rule in the sub-continent. None of the honest writers, however, ever hesitated to express his appreciation of the excellent fighting qualities of the indomitable Pathans. Arthur Vincent wrote :—

> "One of the most important features of the tribesmen is the depth of their religious feelings...Another most marked tribute of the tribesmen is their inherent independence....They are proud to a degree, self reliant as only their life can make them, hardy beyond measure, and absolutely tireless. Their physical fitness would be incomprehensible if one did not consider the climate and country they live in, which allows no weakling to survive....With them it has been said that there is no old age as we understand it, no period of increasing senility, but only death as soon as they can no longer endure the full hardships of their life...Taken as a whole, the frontier tribes are unquestionably among the hardiest men on earth and so much the more redoubtable goes when war is afoot...In older years their strength lay almost entirely in their natural aptitude for guerilla warfare. Without organisation, save a vague leading and much clever inspiration from their headmen, they would conduct a campaign of harrasment for months, raiding, sniping, descending in overwhelming force upon points of whose weakness the opposing military commanders themselves were, may be, scarcely aware. Today, however, whilst they have lost none of that inherent aptitude, their actual military training is steadily bettering—It (the tribal land) is a country of fierce extremes, of fierce people, and of fierce trial.

The country in itself is such as to permit only the survival of the fittest, its people are capable of being redoutable enemies indeed vis-a-vis their potential foes.[1] " The tribal belt contains about 26·4 lakh people. Such a valuable human reserve of sterling qualities and long traditions of confidence in their fighting ability will, together with the regular forces, give the toughest possible resistance to any invaders.

Russia and the Frontier.

The oriental atmosphere of the Southern and Central Asia was disturbed by the approaching influences of the West from two sides. Great Britain had consolidated her position in parts of Madras, Bengal, Orissa and Bihar by 1792, and her influence was constantly pushed forward towards the remaining parts of the sub-continent. Russian movement was directed to the east of Ural Mts. and her advances were consolidated in the Kirghiz Steppes from 1734 to 1863. From here the process of growth of the territory was taking its way towards the Hindukush. The early years of the 19th century witnessed the forward and onward movements of the two Imperialistic powers towards a common destination--the Hindu Kush Range in Afghanistan.

The onward movement, was perhaps, conditioned by the impelling urge to find some stable, solid and secure frontier providing the best halting ground. It seems probable that, at least, the British strategists and politicians were keen to halt on a natural frontier before they outran their strength by a constant forward push and before they came in a direct clash with an equally big power. They, however, thought that the Russian expansionism knew no bounds. The 'Russian Menace', as it was called by the British, was directed against British India itself and as a safe measure Russia was to be kept at a reasonable distance.

The story of Russian interest in the sub-continent of Indo-Pakistan dates back to almost about the beginning of the 19th century or more precisely to the year 1807 when the treaty of Tilsit was signed.

The increasing British influence in the sub-continent coupled in its effect with the gigantic nature of the task of traversing long distances on way to India however, lulled Russia into inactivity for the time being. The first substantial diplomatic move was taken in 1836, when a Russian mission entered Kabul.

1. Defence of India pp 44-50.

The superior position of Britain in Europe, however, compelled Russia to undo the achievements of the said mission. Again in the sixties of the 19th century Russian eastward expansion took its course to the northward side of Afghanistan and India. The kingdoms of Bokhara and Khiva were annexed to Russia. Another Russian attempt to extend her influence over Afghanistan—a door to the sub-continent—began in 1878, when a Russian Envoy was received at Kabul by Sher Ali, the ruler of Afghanistan. In 1881, Merv was ceded to Russia. In 1884, Russia consented to allow an Anglo-Russia commission to demarcate the boundaries of Afghanistan. The sphere of influence of Russia had extended upto the very gates of Afghanistan. British-Indian Government was alerted by the Russian moves so much so that the garrisoning of the frontier and the fortification of the lines of great expectancy was quite vehemently pursued. Lateral means of communication joining the strategic points to the plain cities were constructed and the two railway lines to Quetta were completed. These defensive preparations had the desired effect of distracting Russian thoughts away from India. "Thereafter, she had perforce to content herself in respect of practical steps with an extension towards the Pacific instead of the Indian Ocean, though there is little doubt but that the inner desires of her chancelleries remained the same"[1].

From about 1884, until World War I and during that war the Anglo-Russian tension in the east remained at the lowest ebb. Then the Tsarist regime was over thrown in Russia and the present day communist order was established. The new set up in Russia derives its inspiration from Marxian dialectics in which the opposing forces in nature are constantly at war with each other resulting in making certain old forces go out of being and in giving birth to new forces. Such views when applied to the human society and to the political pattern of the world society of states becomes a very dynamic one. It is a serious blow to the 'maintenance of status quo'—doctrine. British Government in India had, therefore, every reason to be scared by U. S. S. R. and her possible expansion towards the prized colony of India. Lenin is quoted to have said in a meeting of the Third International at Moscow in May 1920, "England is our greatest enemy in the world. British Imperialism is a pest which spreads everywhere. Out task is to root out the British Imperialistic spirit in Turkey, in Persia and in Asia generally. In India we must strike them hardest." At a later stage he declared, "The road to London is through

1. *Ibid*, p. 80.

British policy with respect to her possessions in the East underwent a radical change after World War II in the light of the following considerations :—

1. Although Britain came out victorious in the war, her world supremacy was gone. Even her economic structure was seriously damaged and dislocated.

2. Russia had stood the test with the result that she was all the more invigorated and once again marched on the way to development and, possibly, growth. The War had proved the hollowness of most of the German Geopolitical views but the concept of Mackinder about the Russian Heartland and its pivotal importance was only reaffirmed.

3. America began taking active interest in the affairs of the Old World. Her participation in the war made her realise that she could not remain a distant spectator in the larger interest of peace and her own prosperity and security. The American doctrine of allowing the 'Right of Self Determination' to the peoples of the world, was in antithesis with the Imperial policies of Britain.

4. Britain with her essentially limited spaces and the resultant limited resources could not successfully retain most of the colonies in the Orient. Urge for freedom among the 'natives' had attained colossal dimensions. The truth of the prophesy of Oswald Spengler that Britain would not be able to retain her colonies was amply proved. A wise nation like the British could, then, easily read the writing on the wall.

5. Situation had become more favourable for the implementation by Russia of her scheme of rooting out British Imperialism from Turkey, Persia and India.

These and other international considerations made Britain reorientate her policy towards her colonies. The sub-continent was granted the right of self determination and was divided into Pakistan and India. Britain is, therefore, out of the picture for all practical purposes except for the loose ties of the Commonwealth. The rivalries of Western Democracies (championed by U.S.A.) and Communism have assumed a global character. Any moves or counter moves by Russia or America in any part of Asia are the outcome of the bi-polar

Kabul and India". This substantial, factual and plausible threat caused British bosses in India to tremble under it. They could, anyhow, withstand it so long as Soviet Russia remained comparatively less powerful and was constrained to be contented with the policy of peaceful though revolutionary penetration.

strategy for the success of their respective ideologies. At present the centre of gravity has shifted to the Far East. Turkey, Persia and Pakistan are, however, by dint of their geographical position within an easy reach of Soviet Russia—Pakistan though less vulnerable (the character of the Russia ward frontier of Pakistan makes her so) is more attractive as it opens a way to India and the rest of Southern and south-eastern Asia. For the mighty Russian armies the road from Pakistan to India would be free of all obstacles. No power on earth can stop these armies from reaching the remotest corners of the sub-continent if Pakistan ever falls to them. If at all the sweep of Sino-Russian armies can be halted it can be halted at the western border of Pakistan and nowhere else.

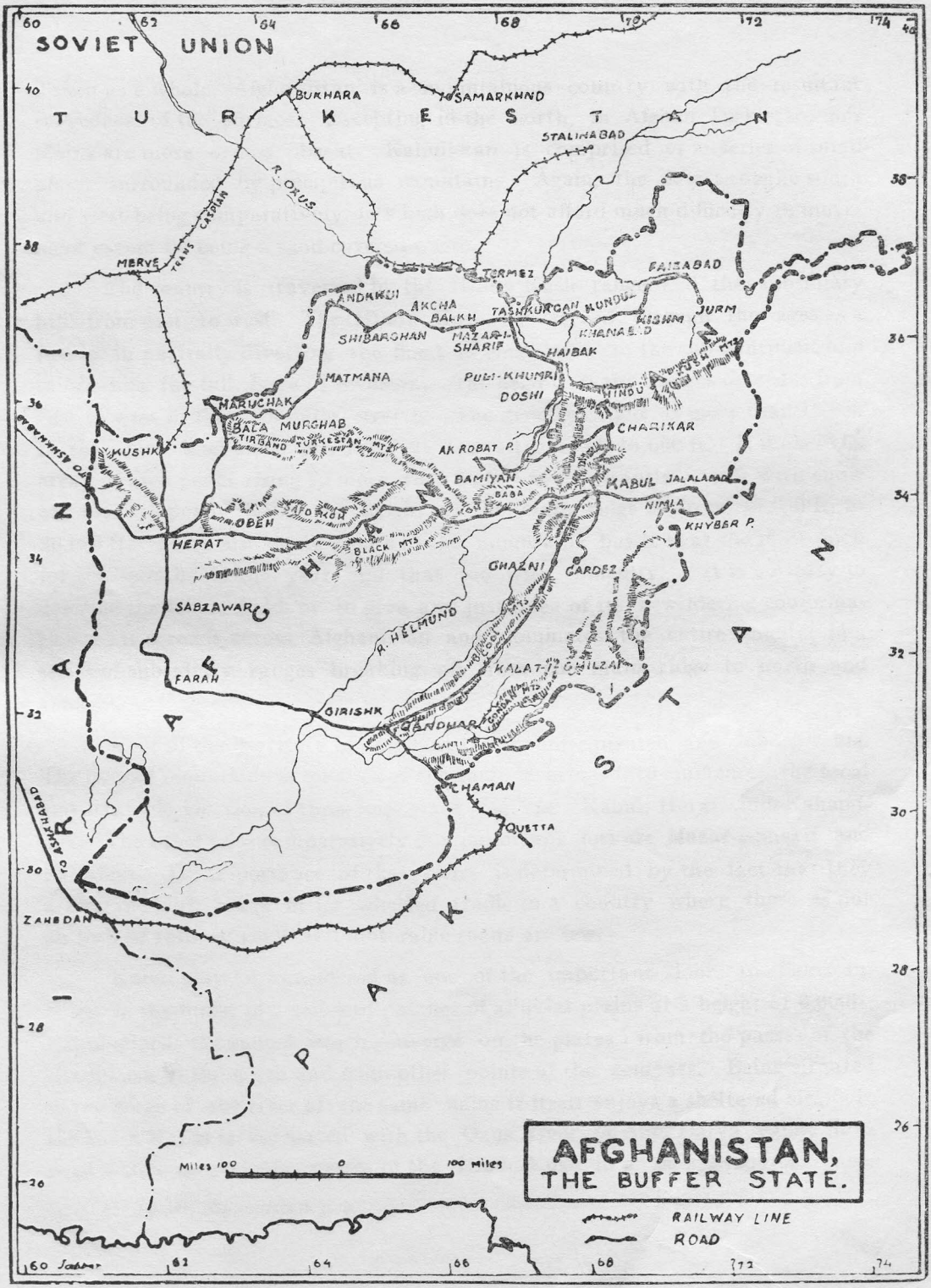
The Intervening Territory.

The intervening territory between Russia and Pakistan in the north-west of the latter country is the buffer state of Afghanistan. Afghanistan has no homogeneity in it either ethnographic, demographic or orographic. "Afghanistan is simply a land where we may find a great variety of racial and linguistic scraps, with rival and even hostile interests, without real bond of common speech or common descent or even common creed ..Whatever else this makes, it does not make a nation scarcely even a true political entity..."[1] The history of Afghanistan is also typically the history of a buffer state with instability as its chief characteristic.

"It is a country of extremes, of high barren plateaux and wide open stretches of sun backed desert, of narrow fertile valleys and rocky mountain spurs..It is a treeless wind-swept country, where in winter an icy blast blows off the high ridges, and in summer whirling 'devils' of sand and dust sweep across the open plains stirred by a hot wind which in the desert country of Sistan reaches a velocity of over 100 miles an hour[2]."

The irregularities of the surface are of special interest to us as they limit the number and usefulness of the means of communication in Afghanistan.

1. Lyde L. W. The Continent of Asia, p. 349.
2. Tytler, Afghanistan, p. 12.


SOVIET UNION
T U R K E S T A N
BUKHARA
SAMARKHND
STALINABAD
R. ORUS
TRANS CASPIAN
MERVE
TERMEZ
FAIZABAD
ANDKHUI
AKCHA
BALKH
TASHKURGAN
KUNDUZ
KISHM
JURM
SHIBARGHAN
MAZARI-SHARIF
KHANABAD
HAIBAK
HINDU KUSH MTS
MATMANA
PULI-KHUMRI
DOSHI
MARUCHAK
BALA MURGHAB
TIRGAND
TURKESTAN MTS
CHARIKAR
AK ROBAT P.
MUSHK
R. ASHNKHABAD
BAMIYAN
BABA
KABUL
JALALABAD
NIMLA
KHYBER P.
PAROPAMISUS MTS
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HERAT
BLACK MTS
GHAZNI
GARDEZ
SABZAWAR
R. HELMUND
KALAT-I-GHILZAI
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I R A N
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Miles 100 0 100 Miles
AFGHANISTAN,
THE BUFFER STATE.
RAILWAY LINE
ROAD

Taken as a whole, Afghanistan is a mountainous country with the resultant ruggedness of the surface. Excepting in the north, in Afghan Turkistan, low plains are more or less absent. Kabulistan is comprised of a series of small plains surrounded by precipitous mountains. Again, the desert of the south and west being comparatively less high does not afford much difficulty in movement except by being a sand-covered waste.

The country is traversed by the Hindu Kush range and the subsidiary hills from east to west. The Hindu Kush has served through the ages as a barrier in partially diverting the flood of emigration to the sub-continent and in breaking the full force of invasion. The height of the ranges decrease from east to west in their 600-mile stretch. The average height is more than 15,000 ft. the snow line being generally at the altitude of 13,000 ft. It makes the array of high peaks rising to more than 18,000 ft. constantly strewn with snow and ice. Opposite Kabul the height of the main ridge is from 15,000 ft. to 20,000 ft. There are many a pass in the mountains but it is at the most open for six months in the year and that too with difficulty. "It is not easy to describe the Hindu Kush or to give any just idea of its bewildering conformation, as it spreads across Afghanistan and dominates the entire country in a series of subsidiary ranges breaking off from the main ridge to north and south"[1].

Most of the territory of Afghanistan is unfrequented and inhospitable. The overall mountainous picture of the surface brings into eminence, the focal and strategic location of three important foci *viz.* Kabul, Herat and Kahandhar. The other two comparatively less important foci are Mazar-i-Sharif and Faizabad. The importance of these cities is determined by the fact that they are served with roads fit for wheeled traffic in a country where there is not an inch of railway track and motorable roads are few.

Kabul may be considered as one of the important doors to Pakistan. It lies in the midst of a series of patches of alluvial plains at a height of 6,000ft. Kabul guards the routes which converge on the plateau from the passes of the Hindukush in the north and from other points of the compass. Being situated in the gorge of the river of the same name it itself enjoys a sheltered site. In the north Kabul is connected with the Oxus River or Amu Darya valley by a road which crosses the passes of the Hindu Kush in a zig-zag course. More

1. Tytler, Afghanistan, p. 5.

difficult routes cannect Kabul with Faizabad in the north-east. The great conqueror Taimur crossed the Hindu Kush by the Khawak pass on this route. Road links exist with Herat to the west and Kahandhar via Ghazni to the south-west. In this way Kabul is connected with places which in turn are connected with Russian territory. Again from here radiates the road towards east which going via Jalalabad and crossing the famous Khyber pass reaches Peshawar in Pakistan.

Herat enjoys a focal position in the north-west of Afghanistan. From here roads radiate to Merv (U. S. S. R.) via Kushk, Askabad (U. S. S. R) through Iran, Mazar-i-Sharif, Kabul and Kahandhar via Farah and Girishk in the south-western desert. The situation of Herat on the 'Flanking bastion' of the Hindu Kush which are not higher than 5,000 ft. here, its nearness to Russian territory, and its situation on the main road to Quetta via Kahandhar assign it a great strategic importance.

Kahandhar is situated at the margin of the Registan. To its south-west is desert and to the nort-beast are fertile valleys. Its strategic importance lies in its situation on the road to Quetta. As mentioned above it is also connected with Kabul.

The distances between important Centres are givon as below :—

1. From Merv to Kushk the distance is 160 miles.
2. From Kushk to Herat the distance is 60 miles.
3. From Herat to Kahandhar distance is 380 miles.
4. From Kahandhar to Chaman (Pakistan) distance is 72 miles.
5. From Kahandhar to Kabul distance is 290 miles.
6. From River Oxus to Kabul *via* Mazar-i-Sharif the distance is about 300 miles.
7. From Termez (USSR) to Landi Khana *via* the Akrobat pass is 530 miles.
8. From Termez to Landi Khana *via* Khawak Pass it is a distance of 550 miles.
9. From Kabul to Peshawar is 190 miles.
10. From Kabul to Kohat through Kurram Pass is 230 miles

The hostile nature of the intervening spaces of Afghanistan between Russia and Pakistan and the long distances necessitating extended and, more or less, unmangeble lines of communication, are such factors which will make any planner of strategy think twice before embarking upon such an enterprise. However, a plan of invasion may be comprehended in a hypothetical manner and it is an interesting fact that in such a vital matter as defence is, the thinking process is mostly hypothetical. It may, therefore, be conjurred up that in the event of military operations the most important route of advance from Russia will be from Herat to Kahandhar. Thence the armies may turn to Kabul and form a 290-mile long front with important nuclei along it to act as bases for further advance. The flank of the advancing forces can be made secure by controlling approaches to Kabul from Mazar-e-Sharif and Faizabad. The inhospitable and difficult shorter routes between the Oxus and Chitral may be utilised by smaller groups assigned with the task of distracting the attention of the defenders of the frontier from the main points of gravity furnished by the defiles in the mountain wall forming the frontier. The natural gates of Pakistan may once again be battered with an unprecendented force as this time they will be backed by an unprecendented will to resist. The geographical nature of these doors shall be discussed in another article under a separate heading.

In the end it may be pointed out that too much emphasis is given by some persons on new inventions and new weapons. No doubt the new weapons are capable of changing the character and the functional value of the terrain to a considerable extent but they in turn have limitations of their own. The aeroplane, for example, can ignore a mountain rampart like the one under dicussion but a massed flight is definitely handicapped by the height and the irregularity of the orographic features coupled in their effect with the depth of the intervening spaces to be covered. Secondly the paratroop landing is feasible comparatively on not too big a scale. Now a too unequal resistance may succumbl to such a landing. On the other hand the same strength of paratroops may fall an easy prey to a stronger opposing force. In fact even the loftiest of mountain walls is no impediment in the way of an overwhelmingly bigger power while at the same time every small hillock is a barrier even today provided it is backed by a relatively equal strength. In the discussions of the present nature about the practcability or otherwise of certain land features, therefore, a verdict is to be passed with the usual presumption of 'other things being equal.'

The possibility of other things being equal is not too far to seek. It is quite obvious that if at all the western frontier of West Pakistan is ever awakened from its slumber of centuries by the thundering echoes of gun shots it shall be the outcome of the bi-polar (Moscow-Washington) strategy and presumably as a part of another world war. Under such a circumstance the fight will, in all probability, not be an unequal one and as such the nature of the frontier will play a decisive role. Also the screening heights are again of unabated importance in harbouring bases and piles for an atomic warfare.

PHYSIOGRAPHY OF CHITTAGONG HILL TRACTS WITH SPECIAL REFERENCE TO THE KARNAFULI VALLEY

A. I. H. RIZVI

Chittagong Hill Tracts is the South-Eastern district of the Province of East Bengal and is the only hilly region within the eastern wing of Pakistan. During recent years it has aroused great interest and is sometimes referred to as 'Eastern Pakistan's land of promise.' Some optimistic estimates of the 'hidden treasures' of this unexplored area are surely over exaggerated while, at the same time, a view which accepts no possibilities of development in any direction is also based on unscientific attitude. What is needed, is an extensive geological survey of the region before a correct estimate of its mineral wealth could be made. In the present article an attempt has been made to present a physiographic study of the Hill Tracts on the basis of existing material which, however, is very meagre, and can be enriched only through a thorough geological investigation of the area.

The district of Chittagong Hill Tracts together with Lushai Hills and a similar belt of territory know as Arakan Hill Tracts lying to the east of the district form one geographical unit. Geomorphologically two distinct features *i.e.* the hills and the valleys, which occur one after the other in alternate succession, can be recognised.

Little information is available regarding the geological structure of the area, because practically no geological work has been done so far but "more or less successful efforts have been made to split up this thick mass of sediments into different series on the basis of their lithological composition. The most frequently exposed beds are the Tipam sandstones and the Surma series. The former are earthy sandstone and the latter are mainly clays. Both these rocks. weather in situ into excellent forest soils. The Tipam sandstones also yield a soil very suitable for tea.'' *

*H. Crookshank—Paper or Geology and the Soils of Pakistan, page 7.

The hills consist mainly of sandstons and soft shales. Comparatively newer alluvial deposits like clay and sand are also found to occur.

Generally the hills are of low elevation. In most cases they rise to few hundred feet above sea level, but elevations over 3000 feet are also not very uncommon. Keokradang which lies to the east outside Pakistan boundary is supposed to be the highest point, with an elevation of 4034 ft. Other high points are Rakhamoin Tang (3017 ft.) Politatut (2857 ft.) Teimagyaung Pya (3160 ft.) Obum Tang (2494 ft.) etc. A number of parallel ridges are aligned in a north-west to south-south-east direction with valleys in between, the hills being the anticlines and the valleys synclines. The synclinal valley are drained by streams which run parallel to the strike of the ridges and are consequent streams. The slope of the area is in general, towards the valley of the Karnafuli river, which for most of its course, flows transversely. The streams either flow from the north to the south or from the south to the north. A number of large streams from the north as well as from the south serve as tributaries to the Karnafuli.

Most of the valleys formed by the rivers are covered with very thick growth of forest, of which only a very small part has been cleared. As may be expected these valleys are very fertile and can be converted into arable lands for the cultivation of rice, as well as a number of plantation crops like tea, cinchona, rubber, teak and mahogany and thus offer some possibilities of lightening the burden of over populated districts of East Bengal. The streams like the Sangu, the Matamuhari, the Feni and the Chengi have uncovered some deposits of lignite, which though known to exist since the last quarter of the previous century still await proper use and exploitation.

The most prominent river of the Hill Tracts is the Karnafuli which rises in the Lushai Hills a few miles north of Lungleh. The total length of the river is about 170 miles. The course of the river in its earlier reaches is tortuous and winding through lofty hills covered with dense forests. Then are inrumerable precipitous rocky gorges of sandstone, rapids and falls with occasional deep and dark pools of varying sizes. It enteres Chittagong Hill Tracts district four miles below Demogiri. The course of the Karnafuli from Demagiri to Chandraghona (the place where it enters the plains of Chittagong district) are very much different from its earlier course. The valley slopes are steep and abrupt but they gradually diminish in height towards the Chittagong plains. They are mostly covered with elephant grass. The underlying rock of river valley, here,

for the most part consist of clay. The north-south flow of the river, as determined by the longitudinal ranges, is maintained upto Barkal from where it flows in north-east to south-west direction to Kaptai Mukh where Kaptai Khal joins the Karnafuli from the south. From Kaptai Mukh to its entrance into Chittagong Plain the Karnafuli takes a very winding course occasionally rutning at right angles but the general direction of the flow is from east to west. The chain of hills running in north-west to south-east direction west of Rangamati, attaining elevates upto more than a thousand feet, together with other similar ranges of various elevations arranged parallel to one another, are crossed through by the Karnafuli in its transverse course which is perpendicular to the strikes of these anticlinal folds forming the chains of hills. The probable explanation for the abrupt change of direction by the river appears to be the presence of a gap in the otherwise continuous ranges of hills. This gap has either been created by the vertical erosion by the river itself or by some earth movement resulting into a fault. The accumulating evidences weigh heavier in favour of the former explanation.

The physical history of the Chittagong Hill Tracts dates back from the Tertiary era when great geo-dynamical forces gave rise to earth movements which are of supreme importance in the history of Indo-Pakistan sub-continent because they materially altered the old geography of the Indian region by submerging segments of the Mesozoic continent of Gondwana and by upilfting the sediments of Tethyan geosyncline into the lofty Himalayan system. As a result of these isostatic changes brought about by slow secular upheaval, two principal gulfs were formed, one to the west of the sub-continent known as the Sind Gulf and the other to the east named as the Eastern Gulf which was sub-divided into Burma Gulf and Assam Gulf by the Arakan Yoma Ridge which owe its rise to Eocene movement of the Tertiary period. The Assam Gulf with which we are presently concerned then extended right north upto the Khasi Garo Hills. The great Brahmaputra and many other smaller streams emptied their load into this gulf which as a result of continued dcposition of sediments dwindled in size and extent and receded to the south. The recent westward deflections of the Brahmaputra lend support to the view that it was then flowing more to the east than now, and was depositing its pile of sediments in areas close to the Arakan Yoma. The Hill Tracts of Arakan and Chittagong together with the Lushai Hills in the north form the foothills of the Arakan Yoma on the

eastern side. The present site of this hilly belt was the continental shelf of the newly risen mountanous area and was shallower than the rest of the Assam Gulf of which it was a part. The great deposits of the mighty Brahmaputra and its tributaries quickly filled up parts of the shallow sea and the processes of delta formation working at a rapid pace extended the emerging land southward. Consequently the newly formed delta was an elongated peninsula extending from North to South. It is not improbable that the ever increasing longitudinal delta might have further divided the Assam gulf, leaving a very narrow and shallowd epression between itself and the rising land of the Arakan Yoma. Numerous short and swift streams arising from the eastern highlands must have played an important role in filling up this depression. The alternate layers of sand and sandy clay occurring in the Hill Tracts may be associated with the flood and off-season deposits.

This hypothetical assumption of a narrow eastern depression seperated from the Assam gulf by the elongated peninsula explains with considerable success the formation of the transverse Karnafuli valley as the remnant of a valley made by one of the eastern streams which persisted with regard to the direction of its flow during the upheaval of these ridges. So the Karnafuli valley may be conceived as an antecedent stream throughout its east-west course, *i.e.* from Barkhal to the sea. The upper course of the Karnafuli which conforms to the north-south alignment of the ridges was an independent consequent stream later on captured by the antecedent Karnafuli. Boulders and conglomerates of various sizes, some of them being very large are often found to be embeded in the clayey layers. It is difficult to believe that large boulders like these were dragged all the way from the north by the Brahmaputra with so low a velocity of the stream. Obviously they have rolled along much swifter streams which deposited them over the clayey deposits of the sluggish Brahmaputra. Once it is accepted that east to west streams with steep gradients and short courses are likely to have existed and played a part in the partial filling of the depression east of the projecting alluvial peninsula, the formation of the Karnafuli valley can be easily explained.

It may, therefore, be concluded that the transverse-Karnafuli had the same course before the hills were formed. When the ranges of hills rose the river dug itself further and further down and managed to keep pace with the evolution, so that the course of the river was not broken.

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