MINERALOGY OF ALLUVIAL SAND OF THE KABUL RIVER NEAR CHARSADDA

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Heavy minerals, from washed alluvial sand of the Kabul river in the Doab area near Charsadda are described. The main minerals present are magnetite, garnet and ilmenite but hypersthene, clinopyroxene, hornblende are also present. Radioactive minerals are either absent or present in very insignificant amounts.

Introduction

For many years Kabul river sand has been used as a cleaning abrasive by goldsmiths of Peshawar area. When concentrated, this sand is found to contain a number of heavy minerals such as garnet, magnetite ilmenite, epidote etc., with hardness close to 6. Work on the utilisation of this sand for producing sand papers, floor abrasive bricks and grinding wheels is being carried out in these laboratories. The nature of the concentrate and the angularity of many of the grains were studied. This paper deals essentially with mineralogical description of the heavy sand used in this connection.

The main bulk of heavy mineral concentrates was obtained from local panners of Charsadda area. Sample Nos. 1-6 represent various fractions of the origin al heavy concentrate. In addition, the authors collected samples A-F from three branches of the Kabul river namely Shahalam, Naguman and Sardaryab rivers as shown on the accompanying sketch map (Fig. 1).

Analytical Procedure

The samples were treated as follows: The original heavy mineral concentrate was passed through mesh screens Nos. 52, 60, 72, 85, 100 and 120 (B.S.S.) so as to give portions of differing fineness. The heavy mineral concentrate did not require any panning prior to sieving because it was already washed by the village panners. Samples A-F were panned in the Laboratory but were not sieved because these samples were mainly to estimate the ratio of heavy minerals to total sand in the alluvium. For that, 200 g. of each sample (A-F) were taken and panned. During panning all the flaky and light minerals were washed out and the residue was now mainly heavy minerals.

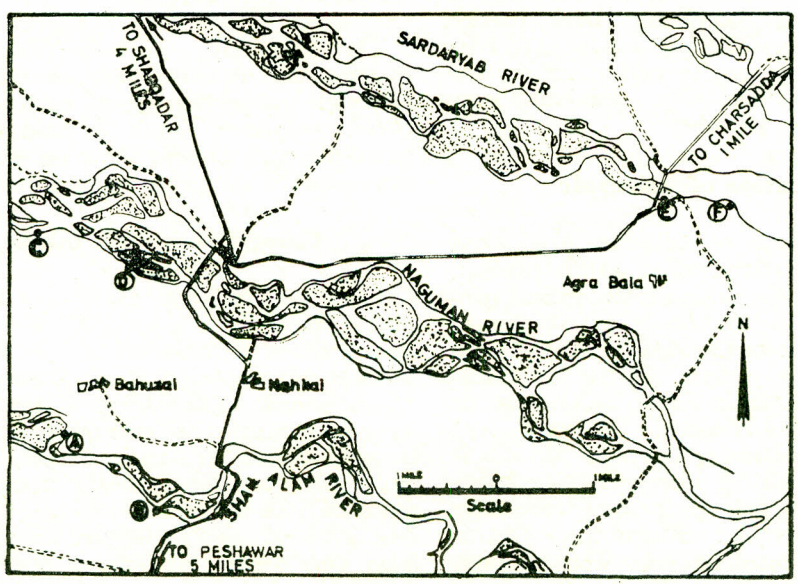

Fig. 1.— Showing locations of sample A-F.

The original heavy concentrate, samples 1-6 and samples A-F were then passed through bromoform of specific gravity 2.69, thereby separating minerals with specific gravities greater or less than this figure. The minerals with specific gravities greater than 2.69 were taken as the final heavy mineral concentrate. The samples were then dried and magnetite was separated from them by passing a hand magnet approximately quarter of an inch above the sand.

The dried concentrates were next examined under an ultravoilet lamp to detect the presence of fluorescent minerals. None was found in any of the samples. Radioactivity was tested for using a Geiger Muller Counter (Type FH-90, Karl Kolb). Samples D, E and F produced counts slightly above background but these were quite insignificant.

Representative portions for examining under the polarizing microscope were obtained by coning and quartering. Two slides of each sample were mounted in oils with refractive indices of 1.54 and 1.62. In the identification of the mineral grains optical properties such as form, refractive index, pleochroism, cleavage, twinning, extinction angle, interference colours, interference figures and approximate optic axial angles were used. The grains were also observed under reflected light, and in certain cases qualitative chemical tests were also carried out.

The grains were systematically counted, using a mechanical stage. A minimum of 250 grains were counted in each slide, the identification of the minerals having previously been carried out by two operators. The quantity of magnetite was calculated as a weight percentage of the heavy minerals, whereas other minerals were calculated by grain percent.

Identification of Minerals

In the identification of minerals from sand samples in which thousands of grain are present, it is not possible to examine all the optical properties of each grain. Generally a few criteria need to be established for the identification of each mineral species. The criteria for the identification of the minerals listed in Table 1 and 2 can be found in several publications, Milner[1] and Stauffer.[2-3] The mineral grains were all identified when mounted in oil with refractive index 1.62 and some physical properties were also studied with a binocular microscope. Grains consisting of two or more minerals were counted as rock fragments.

Hematite was easily distinguished from the ilmenite by the blood red colour on thin edges, but it is possible that the ilmenites may include small percentages of other weakly magnetic opaque minerals.

Mineral Variations in Samples 1-6

The main heavy minerals in the Kabul river sand concentrate are garnet, ilmenite, magnetite, hypersthene, clinopyroxene, epidote and hornblende. The percentages of all other minerals are small (Table 1). The percentage of each mineral varies from sample to sample and some show a definite relation between percentage and screen size (Table 2). The trends are largely a reflection of the relative sizes of crystals formed by each mineral in the rocks from which they were derived.

Garnet.—The percentage of angular grains of pink garnet varies from 8 to 61 and the average is 36. The quantity of garnet in each sample decreases with increasing fineness so that sample No. 6 which has been passed through 120-mesh sieve contains the smallest percentage.

Magnetite.—The percentage (by weight) of magnetite varies from 1-59 and the average is 21 percent. In contrast to garnet, sample No. 6 contains the highest percentage.

Ilmenite.—The percentage of ilmenite varies from 10-28 and the average is 19 percent. Similarly to the magnetite, the finer samples 4,5 and 6 contain the highest percentages.

The percentages of both clinopyroxene and hypersthene decrease with increase in fineness although the percentages of each are small compared to garnet, magnetite and ilmenite. The other minerals present show no obvious relationship between the percentages and sizes of grains.

Comparison with other Areas

The heavy mineral content of the river sand near Charsadda is similar to the river sands of other areas of the former N.W.F.P., R.A. Khan and Tahirkheli,[4] found that the heavy minerals in the sand from Amb, Hazara district are as follows; abundant magnetite and lesser amounts of ilmenite, zircon, monazite, garnet, uraninite, uranothorite, amphibole and scheelite. Stauffer[2] reported from the Hazara district the presence of ilmenite and magnetite in quantities ranging from 5-88 percent and trace to 63 percent, respectively. Apart from these, hematite, iron-

TABLE 1.—SHOWING PERCENTAGES OF MINERALS IN ORIGINAL KABUL RIVER CONCENTRATE AND IN DIFFERENT FRACTIONS OF IT.

Minerals	Original concentrate	Sample 1 <52>60	Sample 2 <60>72	Sample 3 <72>85	Sample 4 <85>100	Sample 5 <100>120	Sample 6 <120
Magnetite ..	19	1	1	10	16	39	59
Garnet ..	35	51	61	50	34	14	8
Ilmenite ..	22	10	10	16	26	28	23
Epidote ..	2	1	4	2	5	3	1
Hornblende ..	3	3	2	2	3	4	1
Clinopyroxene ..	3	15	5	5	7	2	1
Sillimanite ..	—	1	Tr	2	Tr	Tr	Tr
Iron oxide ..	2	Tr	1	Tr	1	1	1
Hypersthene ..	2	8	5	4	1	1	Tr
Tourmaline ..	1	Tr	1	1	1	1	Tr
Sphene ..	Tr	—	—	Tr	Tr	—	—
Leucoxene ..	—	Tr	—	—	—	—	—
Rutile ..	Tr	—	—	Tr	Tr	—	Tr
Carbonate ..	Tr	Tr	Tr	Tr	1	Tr	Tr
Quartz ..	1	Tr	Tr	Tr	Tr	Tr	Tr
Olivine ..	Tr	—	1	—	Tr	Tr	Tr
Apatite ..	1	Tr	Tr	Tr	Tr	1	1
Hematite ..	—	—	—	—	—	—	—
Zircon ..	1	—	—	—	—	1	3
Monazite ..	—	—	—	—	—	Tr	—
Kyanite ..	Tr	—	—	Tr	Tr	Tr	Tr
Clinozoisite ..	—	—	—	—	—	—	Tr
Topaz ..	Tr	Tr	Tr	Tr	—	—	—
Rock Fragment ..	6	9	7	5	4	3	1

TABLE 2.—SHOWING PERCENTAGES OF MINERALS IN WASHED CONCENTRATES FROM 6 LOCALITIES ON THE KABUL RIVER.

Minerals	Sample A	Sample B	Sample C	Sample D	Sample E	Sample F
Magnetite	8	4	6	11	15	17
Garnet	29	20	23	17	18	14
Ilmenite	21	16	16	14	15	19
Epidote	9	8	11	11	8	8
Hornblende	6	7	9	10	11	12
Pyroxene	5	4	6	4	2	3
Iron Oxide	4	6	5	4	2	3
Hypersthene ..	2	2	2	1	1	1
Tourmaline	2	3	1	1	Tr	1
Sphene	2	2	1	3	5	3
Leucoxene	2	2	3	2	1	2
Rutile	1	2	1	1	Tr	Tr
Carbonate	1	5	3	3	3	4
Sillimanite	Tr	1	1	Tr	Tr	Tr
Quartz	Tr	4	1	5	3	3
Olivine	Tr	Tr	—	Tr	Tr	—
Apatite	Tr	3	1	1	1	2
Hematite	Tr	1	Tr	Tr	Tr	Tr
Zircon	Tr	Tr	1	1	1	1
Kyanite	—	2	—	—	Tr	Tr
Topaz	—	Tr	1	Tr	Tr	Tr
Andalusite	—	—	—	—	Tr	—
Clinozoisite	—	—	—	—	Tr	Tr
Rock Fragment ..	5	6	7	8	8	5

oxide, pyrite, zircon, monazite, scheelite, gold, kyanite etc. are also present.

Perhaps the most outstanding difference between the Kabul river sand from Charsadda and Indus river sands is that of radioactivity. As reported earlier, the Kabul river sand shows little radioactivity above normal background whereas a random sample of Indus river sand from Attock Bridge produced a count ten times background. This is presumably due to the presence of radioactive minerals like uraninite, uranothorite, and monazite Tahirkheli,[4] which are absent from the Kabul river sand near Charsadda.

Conclusions

(1). The examination of Kabul river sand from this area shows that the main heavy minerals present are garnet, magnetite and ilmenite. (2). Hypersthene, clinopyroxene, hornblende and epidote are also common, the other minerals occurring in very small amountso nly. (3). The percentage (by weight) of heavy minerals in samples of the Kabul river alluvial sand varies from 1-2.5 percent (Table 3). (4). None of the concentrates shows significant radioactivity above normal background. With the exception of possible monazite in sample No. 5 no grains of radioactive minerals were observed. (5). Relatively high percentages of magnetite suggests that it might be economically possible to extract this mineral. A much more extensive sampling programme would have to be carried out to find out if the magnetite concentrations are widespread or quite localised. (6). The heavy minerals are typical of those derived from metamorphic and igneous rocks. Apart from this no other regional geological deductions can be made due to the limited nature of this study.

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TABLE 3.—RESULTS OF BROMOFORM SEPARATION OF SAMPLES A-F OF KABUL RIVER SAND.

Sample number	Weight of heavy mineral concentrate after panning 200 g. of river sand	Weight of heavy minerals after bromoform separation		Weight of magnetite separated by hand magnet	Weight of light minerals after bromoform separation	Percent heavy minerals in 200 g. of river sand	Percent magnetite in heavy minerals
		Magnetite included	Magnetite removed				
A	5·5733	3·7737	3·4579	0.3158	1.7996	1.9	8.3
B	3.3606	2.0916	2.0056	0.0860	1.2690	1.0	4.1
C	7.4071	4.9793	4.6959	0.2834	2.4278	2.5	5.7
D	5.6986	4.9036	4.3729	0.5307	0.7950	2.5	10.7
E	5.4946	4.2646	3.6342	0.6304	1.2300	2.1	14.7
F	3·5359	2.7249	2.2559	0.4690	0.8110	1.4	17.2

Weight in g.; Percentages in the last two columns were calculated to nearest tenth of a place.