Concentration of heavy minerals in Son river

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Recent sediments of the Son river at Chopan reveal the concentration of 8.46% heavies in coarser (60–120 mesh) and 43.52% in finer fractions (120–230 mesh) by weight. Mineral species include magnetite, ilmenite, garnet, sphene, zircon, kyanite, tourmaline, staurolite, monazite, sillimanite, rutile, hornblende, apatite, anatase, epidote, limonite, hematite and pyrite. Magnetite is the dominating heavy mineral over the other heavies followed by ilmenite and garnet. The economic minerals indicate the presence of 160.30 kg magnetite, 33.50 kg ilmenite, 22.16 kg zircon and 2.6 kg monazite in one tonne of sediments of size 60–230 mesh. Ilmenite, zircon, monazite and tiny spherical ball-shaped grains of magnetite are more common in finer fraction. Considering the higher concentration of economic heavy minerals a trial of beneficiation is necessary for the recovery of magnetite, ilmenite, zircon and monazite.

INCREASING demand of minerals and metals encourages search of the unexplored resources of river sediments. Mineralogical studies on Indian rivers[1–7] reveal the presence of a variety of light and heavy minerals in river deposits. Gold is reported to occur in soil, subsurfacial mantle and in buried gravel bed in the banks of the Ib river and its tributaries in Raigarh[8]. Tiny gold particles were recovered in the streams of Singhbhum and Ranchi district (Bihar)[9]. The economic potentialities of these minerals have however not yet been worked out.

The present work is aimed at studying the heavy minerals of the Son river sediments and to estimate their economic concentration. Sand samples were collected in a grid pattern at a depth of about 18 to 20 inches from the channel bars and braid bars of the river bed lying from latitudes 24°30'50" N to 24°32'30" N and longitudes 83°0' E to 83°2'30" E near Chopan, district Sonbhadra, UP (Figure 1).

After removal of clay fractions by decantation, sand samples were dried and subjected to sieving using ASTM sieve set (sizes 10, 18, 35, 60, 120, 230, 270 and 325 mesh). Twelve samples were analysed and 1 kg sediment of each sample was taken and treated for 15 min on a sieving machine (Retsch, Germany). Individual fractions were carefully recovered, weighed and the percentage of each fraction determined (Table 1). Different fractions were studied under binocular and petrological microscopes. The fraction above 60 mesh size contained quartz, feldspar, micas and rock fragments with very small amount of heavy minerals. Since heavy mineral concentration is higher in sediments of size below 60 mesh, the fractions 60–120 mesh and 120–230 mesh were considered for heavy mineral separation.

Heavy minerals were separated from light minerals using the standard method and bromoform (sp. gr. 2.85) as the heavy medium. The grains were then washed with carbon tetrachloride to remove the coating over the grains and dried. The fraction 60–120 mesh contained 8.46% heavy minerals and 91.54% light minerals by weight whereas the finer fraction (120–230 mesh) had 43.52% heavy and 56.48% light minerals. The separated

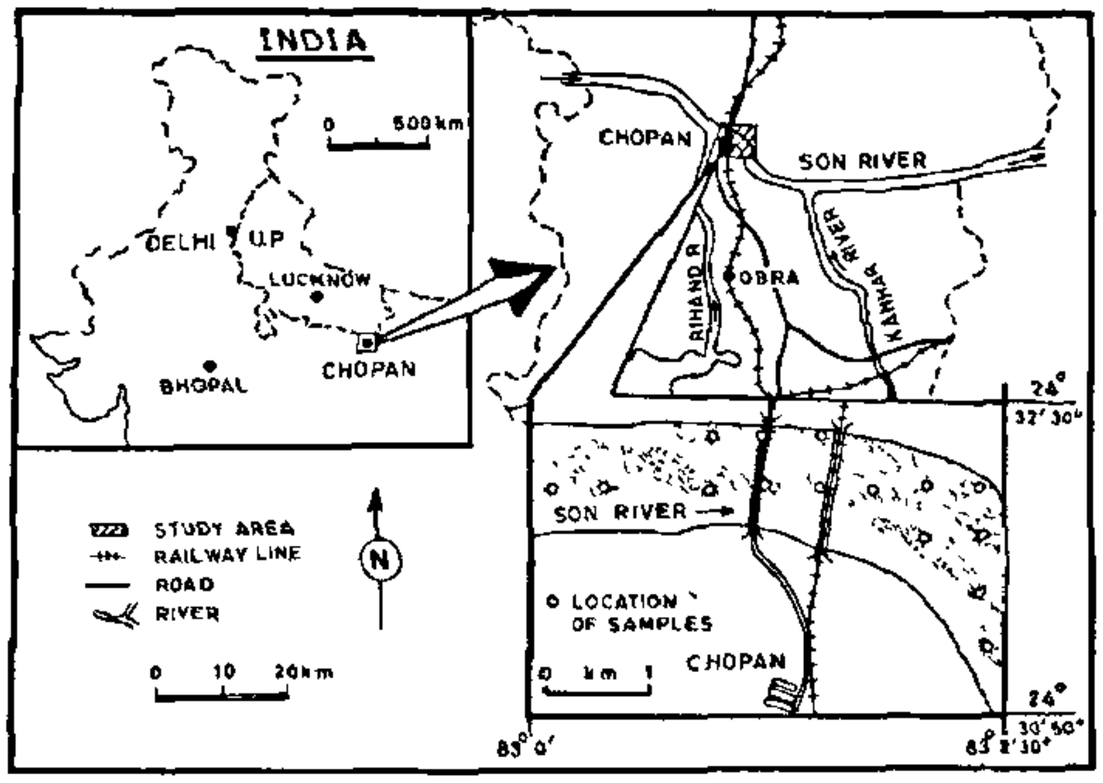

Figure 1. Location map

Table 1. Average grain size frequency distribution

Grain size (mm)	> 2 00	2 00–1 00	1 00–0 50	0 50–0 25	0 25–0 125	0 125–0 0625	< 0 0625
Grain size (in mesh)	> 10	10–18	18–35	35-60	60–120	120–230	< 230
Frequency (wt %)	0 023	5 71	40 93	35 50	16 64	0 91	0 28

heavy minerals were mounted on glass slides and studied under a petrological microscope.

The population of heavies indicates abundance of magnetite, ilmenite, garnet, sphene, zircon, kyanite, tourmaline, staurolite and monazite. Magnetite dominates (52.52%) over the other heavy mineral species followed by ilmenite (10.94%) and garnet (10.52%). Magnetite occurs mostly as subangular to subrounded grains in coarser fractions; however well-rounded spherical ball-shaped grains are particularly abundant and confined to finer fractions. These grains are blackish in colour and highly magnetic. Ilmenites are greyish black, exhibit whitish tinge in reflected light and are less magnetic in comparison to magnetite. Garnet varies from 13.99% in coarser fraction to 7.05% in finer fraction (average 10.52%). The grains are mostly light pink with high relief; however, some colourless grains are also present. Sphene is common in coarser fraction (13.05%). These grains are pale brown and have high relief. Tourmalines are mostly brown, few pink in colour with subrounded shape and high pleochroism. Metamorphic mineral kyanite shows its variable occurrence and contains 6.15% in coarser and 1.09% in finer fraction. Zircon comprises 10.67% in finer fraction and occurs as rounded, prismatic and elongated forms. Atomic mineral monazite occurs mostly as rounded grains with high relief and exhibits pale yellow colour. Oval-shaped grains show an extinction angle of 2 degrees. Their concentration in finer fraction is comparatively higher than the coarser fraction.

Besides the above common heavy minerals, other minerals of insignificant quantity include sillimanite, rutile, hornblende, apatite, anatase, epidote, limonite, hematite and pyrite. The average concentration of heavy minerals in both the fractions is shown in Table 2.

Table 2. Average concentration of heavy minerals (grain %)

Heavy minerals	Fraction (60–120 mesh)	Fraction (120–230 mesh)	Average (%)
Magnetite	45 89	59 18	52 52
Ilmenite	8 95	12 93	10 94
Garnet	13 99	7 05	10 52
Sphene	13 05	2 19	7 62
Zircon	0 37	10 67	5 52
Kyanite	6 15	1 09	3 62
Tourmaline	2 61	1 62	2 12
Staurolite	2 05	0 26	1 16
Monazite	0 37	1 09	0 73
Sillimanite	0 56	0 91	0 73
Rutile	–	0 58	0 29
Hornblende	1 12	0 39	0 75
Apatite	–	0 06	0 03
Anatase	0 18	–	0 09
Epidote	0 75	0 06	0.40
Limonite	2 78	0 97	1 98
Hematite	0 56	0 78	0 67
Pyrite	–	0 13	0 07

Table 3. Concentration of economic heavy minerals in one tonne sediments

Minerals	Raw sediments (of all sizes) (kg)	Weight (%)	Raw sediments (60–230 mesh)	Weight (%)
Magnetite	28 13	2 81	160 30 kg	16 03
Ilmenite	5 88	0 58	33 50 kg	3 35
Zircon	3 89	0 39	22 15 kg	2 21
Monazite	0 46	0 05	2 6 kg	0 26

The heavy minerals of economic importance present in the Son river sediments are magnetite, ilmenite, zircon and monazite. These sediments at Chopan constitute 16.03% magnetite, 3.35% ilmenite, 2.2% zircon and 0.26% monazite by weight in the fraction 60–230 mesh. However, their concentration is higher in the fraction 120–230 mesh. A total of 2100 grains were counted and the weight of the individual mineral has been calculated by multiplying the volume with their respective specific gravities (volume $= \frac{4}{3}\pi r^3$, where r is the radius of the grains which have been considered as a spherical body). It was observed that if one tonne (1000 kg) of raw sediment is treated for extraction of mineral it would give rise to 175.500 kg sample of grain size 60–230 mesh providing 28.13 kg magnetite, 5.88 kg ilmenite, 3.89 kg zircon and 0.45 kg monazite. However, one tonne sample of size 60–230 mesh would yield 160.30 kg magnetite, 33.50 kg ilmenite, 22.15 kg zircon and 2.6 kg monazite (Table 3). The ratio of magnetite to raw sediments 1:35 indicates higher concentration of magnetite which may be beneficial for metallurgical purposes.

Karve and Majumdar[10] suggested the technique for separation of heavy minerals of beach sands. In this process, minerals are separated by a series of electrostatic and electromagnetic separation techniques together with dry tabling. This technique can also be used in the present case for recovery of magnetite, ilmenite, zircon and monazite.

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Do human platelets possess LDL-receptor specific for Apoprotein 'B' or cholesterol?

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The study, addressed to resolve the paradoxical interaction of human platelets with lipoproteins especially low-density liproprotein (LDL), revealed that: a) unlike human lymphocytes, platelets did not possess the conventional LDL receptor specific for Apoprotein 'B' moiety of LDL; b) platelets possessed a 69 kDa surface glycoprotein (containing cystein as well as mannose residues and having isoelectric point ≃ 5.0) which had the inherent ability to bind cholesterol moiety in the LDL particle. Based upon these observations, it is proposed that LDL may have two types of cellular receptors responsible for (i) cholesterol endocytosis through Apoprotein 'B' specific 160 kDa receptor and (ii) transmembrane signalling through cholesterol-specific 69 kDa receptor.

KEEPING in view the lipoprotein modulated increased platelet activity in both hypercholesterolemic animals and human subjects[1], various investigators explored the possibility that the platelets, like other cells, may possess a functional receptor specific to apoproteins. Although many workers demonstrated the occurrence of lipoprotein receptor on the platelet surface they failed to demonstrate the typical characteristics of low-density lipoprotein (LDL) receptor found in other cell types[1, 2]. This paradox got further strengthened by the observation that platelets derived either from normolipidemic subjects or from patients with familial hypercholesterolemia (FH), whether homozygous or heterozygous were shown to possess lipoprotein receptor[1]. Recently we have shown that exogenous cholesterol had the inherent capacity to induce initiation-promotion coupling of phospholipases 'D' and 'A_2' leading to the regulation of various second-messengers within human platelets[3–5]. Consequently it became in this context imperative to explore the possibility for the existence of another type of lipoprotein-receptor which had the affinity for cholesterol rather than apoprotein moiety in the LDL particle.

Gel-filtered platelets and lymphocytes from the blood of normal healthy donors were obtained by standard procedure[2, 6]. LDL fraction from fresh fasting plasma of normal healthy donors was isolated[2]. This LDL fraction as well as Apoprotein 'B' (Sigma) was radioiodinated with $Na^{125}I$ according to standard procedure[2]. The ^{125}I-LDL fraction was dialysed with Tyrode's buffer and centrifuged for five minutes at 11,000 rpm (6000 *g*) before use. Cholesterol (either labelled or unlabelled) was dissolved in ethanol and subsequently mixed with Tyrode's-albumin buffer (pH = 7.4) to obtain various concentrations of cholesterol. The final ethanol concentration in the incubation buffer never exceeded 0.5% and corresponding amounts of ethanol was added in the control samples.

In order to understand the interaction of cholesterol as well as LDL with human platelets, three types of experiments were initially designed: (i) Platelets at a final concentration of 10^8 cells/ml in Tyrode's-albumin buffer enriched with 2 mM EGTA + 2 mM EDTA were exposed to cholesterol (50 µg/ml final concentration) for a period of two hours at 25 °C; at the end of the incubation period, the platelet pellets were processed for the determination of total cholesterol, phospholipid and protein by standard procedures[7–9]. (ii) Cell pellets obtained from gel-filtered platelets and lymphocytes (cultured for 24 h in a serum-free medium to increase the LDL-receptor expression within these cells) were suspended in lysis buffer (10 mM Tris; 50 mM NaCl; 0.5% Triton X-100 and 0.1 M PMSF pH = 7.4) and protein pellets, obtained through chloroform-methanol precipitation method, were dissolved in electrophoresis buffer and subjected to 10% slab gel electrophoresis followed by western blotting. The blotted nitrocellulose was washed with buffer 'A' (10 mM Tris + 50 mM NaCl + 2 mM $CaCl_2$ pH = 8.0) and subsequently incubated with buffer 'A' enriched with 3% BSA for 2 h and followed by another incubation with buffer 'A' enriched with ^{125}I-Apoprotein 'B' for two hours. The nitrocellulose paper was washed thrice with buffer 'A' at 25°C and subsequently subjected to autoradiography as per the standard procedure. (iii) Platelets at a final concentration of 10^8 cells/ml were pre-exposed to Tyrode's-albumin buffer enriched with either chelating agents (2 mM EGTA + 2 mM EDTA) or chelating agents + 20 µM polycystein (Sigma) or chelating agents + cholesterol (50 µg/ml) for half an hour at 25°C and subsequently ^{125}I-LDL at a final concentration of 4 µg ml was added and again incubated for two hours at 25 °C. The results of these three types of experiments revealed (i) acquisition of cholesterol by platelets was highly selective and saturable without any significant change in platelet protein or phospholipid content (Figure 1*a*), (ii) human lymphocytes (known to possess LDL-receptors) had the ability to bind apoprotein, indicating the exi-