NOTES AND NEWS

MINERAL CONCENTRATES OF BEACH SAND

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INTRODUCTION

The purpose of this paper is two fold: (1) to describe in detail the concentrates of heavy minerals, the unconcentrated sand, and the gravel found on the beach of Lake Ontario at Toronto, and (2) to discuss the apparent relation which exists between the specific gravity and size of grains in beach concentrates of heavy minerals.

The three specimens of sand and one of gravel which are described, were collected by Dr. James H. C. Martens from the shore of Lake Ontario, just east of the entrance to Toronto harbor. At this locality, the shore of the Lake is one along which materials are moving constantly, according to Coleman.[1] Coleman has also shown that the cliffs of glacial and interglacial deposits at Scarborough Heights east of Toronto, are receding and furnishing the sands and gravels which make up the beach at Toronto.

Two of the specimens were collected from the dark bands or streaks of heavy minerals concentrated on the beach by the action of the waves. These specimens will be spoken of hereafter as the black opaque (chiefly magnetite and ilmenite) concentrate and the garnet concentrate. The other specimens represent the material which is unconcentrated with respect to heavy minerals or as it might be termed the light portion of the beach sand, and the gravel.

Both the black opaque and the garnet concentrate form thin layers on the beach and at places were seen to grade completely from one to the other. Besides the concentrates collected, Dr. Martens noted a gradational material between the heaviest and lightest specimens, which appeared to be rich in pyroxenes and amphiboles.

The Beach Material

The magnetite grains were extracted from weighed portions of the sands with an ordinary hand bar magnet. The non- magnetic residues were separated by means of the heavy liquid bromoform (specific gravity, 2.8) in the ordinary manner. Percentage weights of the magnetic portion and the grains having specific gravities greater and less than 2.8 were determined. Permanent mounts in Canada balsam were made of the portions having a specific gravity greater than 2.8. These mounts were studied and grain counts made. The results of these counts and other quantitative data are found in Table I.

Besides the detailed studies of the heavy separates of the different sand specimens, mechanical analyses were made of each of the sands, the results of which are given in Table II.

It should be noted that sample No. 141 is the finest of the three and there is a progressive increase in grain size from sample No. 141 to No. 143.

A microscopic examination of the different sieve separates showed that the garnet grains in the black opaque concentrate, specimen No. 141, were retained with

[1] Coleman, A. P., Glacial and Post Glacial Lakes in Ontario: *Univ. of Toronto Studies, Publ. of the Ont. Fisheries Research Lab. No.* **10,** pp. 68–69, Toronto, 1922.

TABLE I

Sample No.	141[2]	142	143
	Percentage Weight	Percentage Weight	Percentage Weight
Magnetite	27.91	5.86	12 grains in a 10 gram sample.
Heavier than 2.8	71.61	88.2	1.1
Lighter than 2.8	.48	5.94	98.9
	Grain count percent.	Grain count percent.	Grain count percent.
Ilmenite	66.0	3.9	2.4
Garnet	28.0	56.0	7.5
Zircon	2.4	....	....
Tourmaline	2.0	....	....
Augite	1.2	4.8	15.3
Rutile	....	....	1.2
Light colored Pyroxene	....	4.8	12.2
Carbonate	....	....	1 grain
Leucoxene	....	1.6	14.6
Hornblende green	....	27.0	45.7
Hornblende brown	....	....	1.2
Monazite	....	1.6	....
Plagioclase	0.6	....	....

few exceptions on the 70 mesh sieve. The black opaque minerals (magnetite and ilmenite) made up over 85 percent of the material on the 100, and over 95 percent of that on the 140 and 200 mesh sieves.

TABLE II

Sample No.	141	142	143
Sieve No.	Percent wt. Retained	Percent wt. Retained	Percent wt. Retained
6	....	....	....
12	....	....	....
20	trace	trace	trace
40	0.08	0.74	12.24
70	4.86	34.72	85.26
100	52.58	56.44	2.28
140	40.46	7.14	....
200	1.42	.20	....
270	trace	trace	....
Pan	....	....	....
Total	99.40	99.24	99.88

[2] Number of specimens in the Sedimentary Petrographic Collection at Cornell University, Ithaca, N. Y.

The garnet concentrate, No. 142, showed a similar distribution of the different minerals, except that in this specimen garnet grains constituted about 60 percent of the material on the 70 mesh and 90 percent of that on the 100 mesh sieve. The black opaque constituents made up between 80 and 90 percent of the small amounts on the 140 and 200 mesh sieves. In the latter specimen the hornblende and pyroxene grains were found principally on the 70 mesh sieve.

The heavy grains in the unconcentrated specimen, No. 143, are present in only small amounts and are distributed like those in the heavy concentrates.

1 2 3 4 5 6 7

FIGURE I

(1) White to pink quartzite (4) Orthoclase crystal
(2) Gneiss (dark colored) (5) Granitic gneiss (light colored)
(3) Dense gray limestone (6) Vein quartz
(7) Chert (dark colored)

The gravel sample consisted of 100 pebbles representative of those on the beach where the sand samples were collected. The photograph Figure 1, illustrates the several types of pebbles found. Dense gray limestone pebbles similar to No. 3 in the figure made up approximately 65 percent of the sample. The predominance of this type of pebble indicates that their source was rather close at hand. The other pebbles noted and figured, with the exception of the black chert, originated undoubtedly in the rocks of the Laurentian shield.

SPECIFIC GRAVITY—GRAIN SIZE RELATIONSHIP

The mineral composition of a band or streak of sand formed by the oscillating action of water currents in the superficial layers of a sediment, is apparently dependent upon two factors; the specific gravity and the size of the mineral grains being concentrated. This relationship is well illustrated by the black opaque and garnet concentrates just described. These specimens are characteristic of the bands and streaks ("pay-streaks") encountered in consolidated and unconsolidated sediments, in that they are rich quantitatively in heavy minerals although they are deficient in variety.

It would be extremely difficult with the data at hand to reconstruct a single sand, which would possess the characteristics of the parents of the two heavy concentrates already described. It is very evident though that this hypothetical parent would show a more normal distribution of grain sizes than either of the two concentrates. If now it were possible to follow this parent through the processes of concentration, some general ideas in regard to the way concentration is accomplished might be discovered. All this is impossible, and thus the data at hand concerning the concentrates is interpreted in the light of what is known of sedimentation. An analytical study of the figures given in Table I, shows that 75 percent of the grains of the black opaque concentrate have a specific gravity greater than 4, while only 10 percent of the grains of the garnet concentrate have this high gravity. The mechanical analyses of these sands show that 58 percent of the grains of the black oqaque concentrate were retained on sieves up to and including 100 mesh, while in the garnet concentrate 92 percent of the grains were retained on the same sieves. Some allowance can be made in the case of the garnet concentrate for the extremely light minerals (specific gravity less than 2.8) which were retained on the larger sieves. The microscopic examination of the sieve separates show that the mixing of the garnet and black opaque grains in the two concentrated specimens was not at random but followed a general rule. This rule may be stated as follows: when sand grains are concentrated by wave action, grains of approximately the same specific gravity and size will be found in the same band and where mixing takes place between minerals of varying specific gravity in the same band, the minerals which are deficient in specific gravity will be larger in size.

The rule just stated is based on the principle that a current which is incompetent to carry grains of a given specific gravity and size would be competent to carry grains of a lower specific gravity provided they were of the same size as the first grains. Thus it may be concluded, and the conclusion is borne out by the facts observed in the two concentrates described, that when sand grains of low specific gravity (3–3.5) are mixed in a band or streak with grains of predominately higher specific gravity (5) the grains of lower specific gravity are larger in size. Thus, where the concentration of heavy minerals on beaches has taken place, one would expect to find the minerals of greatest specific gravity at the lowest point on the beach profile succeeded usually with some mixing of grains, up the profile, by concentrates of lower specific gravity and finally by the unconcentrated sand.

A teaching fellowship in mineralogy has been established at Stanford University. This fellowship is open to graduate students who intend to specialize in mineralogy and preference will be given to those who have had one year of graduate work. The chief duty of the fellow is to assist in laboratory instruction in mineralogy. Not more than ten hours work a week will be required. The amount of the fellowship is $750, out of which the tuition fee of $300 must be paid.

Application for the year 1930–31, accompanied by testimonial letters, should be made to Professor A. F. Rogers, Box 87, Stanford University, California.

Those in charge of the Journal wish to suggest that every effort be made by contributors possessing unfinished articles to complete the manuscripts and send them to the Editor before leaving for summer work. By so doing it is hoped that sufficient material might be accumulated to insure undelayed issues through the summer months.

Mr. Samuel G. Gordon of the *Academy of Natural Sciences of Philadelphia* has recently returned from a seven and a half months trip to South America and South Africa. He visited the Bolivian tin deposits and various mines in Southwest Africa, the Union of South Africa, Rhodesia and the Belgian Congo. He collected ninety boxes of specimens including some extraordinary finds of azurite.