A PRELIMINARY INVESTIGATION OF SOME SEDIMENTS FROM JAMES RIVER, VIRGINIA.*

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Much has been written on finding outcrops of rocks by tracing heavy minerals found in stream sands derived from them.

The purpose of this paper is just the opposite; it is to predict the kinds of heavy minerals that would be found in the stream sands, from the type of rock found in the drainage area. In other words, to present definite evidence of the presence or absence, in the sands derived from these areas, of minerals characteristic of the rocks known to exist there.

Besides determining the various types of minerals found and their place of addition to the sediments, an attempt has also been made to determine the persistence of them by an approximate percentage estimation.

The writer makes no claim for completeness in this study. It was done primarily with the idea of obtaining a brief general survey rather than carry on a thorough investigation, and it is believed that the following identifications and approximate percentages indicate a close relationship between the heavy minerals of the rocks of the region and those of the river sands. It is admitted that a more thorough investigation would be desirable.

The area chosen for study extends along the James River in Virginia, from the vicinity of the town of Vesuvius on the North Branch, and Clifton Forge on the main James River, to a point five miles below Lynchburg; thus covering a drainage area consisting of sedimentary rocks from Cambrian through Devonian, Pre-Cambrian intrusives and extrusives, and crystalline schists.

Space does not permit of a detailed description of the field and laboratory methods. It will suffice to briefly summarize these.

Specimens were collected from the shore of the river at intervals of several miles, at the normal water level and a few hundred feet below the mouth of a tributary stream draining a rather large area. No attempt was made to do accurate sampling; just an average sample picked at random was selected.

The laboratory procedure consisted of first removing the clay and fine material by washing the specimen several times with water

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and dilute hydrochloric acid. After drying, the material was sieved through coarse bolting cloth and the finer separate saved for study. The heavy minerals were separated by means of bromoform having a specific gravity of 2.87. Percentage figures were obtained by rough mineral counts in a field containing a sufficient number of grains to give fairly accurate results.

At Lick Run the drainage is entirely from sedimentary rocks (sandstones, shales, and limestones) of Cambrian, Ordovician, Silurian, and Devonian ages. Minerals found in this sample were: limonite 96%, ilmenite 3, and tourmaline 1%. The high percent of limonite is accounted for by the fact that the stream entering the James River at this locality drains a region containing many mines of Oriskany limonitic iron ore. It is probable that this high percentage of limonite reduces the number of heavy mineral species that are found. However, it indicates the presence of limonite deposits of greater extent than would commonly be found in sedimentary rocks.

At Eagle Rock, the drainage and geological conditions are exactly the same as at Lick Run, hence we would expect to find heavy minerals of the same types and in about the same amounts. This is confirmed by the following statistical results: limonite 91%, ilmenite 5, tourmaline 1, zircon 2, and rutile 1%. The presence of zircon and rutile here and their absence at Lick Run is not considered to be of any particular significance because of the rather common occurrence of these minerals in sedimentary rocks. Examination of another specimen of sand from the first locality would likely show their presence.

At Sherwood Station the James River has received sediments from the same areas as at Lick Run and Eagle Rock, but in addition drainage has been received from regions containing hypersthene granodiorite and the Marshall granite. The latter consists of pink to green granite and quartz monzonite injected by a pegmatite with blue quartz. Common heavy minerals to be expected from this association would include a small amount of amphibole, zircon, tourmaline, and biotite. The hypersthene granodiorite has been altered in places to unakite; it is also cut by dikes of ilmenite and nelsonite. From this occurrence we should expect amphiboles and pyroxenes, zircon, tourmaline, epidote, ilmenite, and biotite. Mineralogical examination gave the following results: ilmenite 45%, limonite 42, tourmaline 5, zircon 5, amphiboles and pyroxenes 2, and epidote 1%. Biotite was not found. This is not surprising inasmuch as biotite does not withstand weathering and transportation and is not commonly found in sediments.

At Wilson Falls drainage has been from the sedimentary rocks mentioned, from the hypersthene granodiorite of the Irish Creek district where tin veins occur, and in addition, from the Catoctin greenstone which consists of metabasalt lava flows and volcanics altered to amygdaloidal and schistose epidote-chlorite amphibolite. Hence, the common heavy minerals that could be expected are amphiboles and pyroxenes, zircon, tourmaline, biotite, epidote, ilmenite; possibly cassiterite, limonite, and chlorite. A study of this sample gave the following results: limonite 77%, ilmenite 15, zircon 3, tourmaline 2, amphibole and pyroxene 2, and epidote 1%. No cassiterite or chlorite was found. This locality is on the South Branch of the James River and unites with the main river at Balcony Falls, from which point the next sample was obtained.

At Balcony Falls no drainage has been received from regions different from those of the foregoing, so no particular change in the heavy minerals should be found. Eighty-eight percent of limonite, 6 of ilmenite, 1 of epidote, 1 of zircon, 1 of tourmaline and 3% of leucoxene confirm this deduction. The addition of leucoxene to the list is probably due to alteration of ilmenite. The absence of amphiboles and pyroxenes may be due merely to the fact that they are present in such small amount that they were not observed in the material examined.

At Rocky Row Run drainage from all previously described areas is present, but a much greater area of the hypersthene granodiorite has been drained. Here this rock contains a high percentage of garnet which should be expected to appear in the stream sediments. Study of the sand from the river gave the following results: limonite 66%, ilmenite 18, fine micaceous grains 5, garnet 3, leucoxene 2, tourmaline 1, zircon 1, epidote 1, amphibole and pyroxene 1, rutile 1, and kyanite 1%. The micaceous material comes probably from the schistose part of the Catoctin greenstone which is here exposed over a large area.

At Pedlar River drainage from the Lovingston granite gneiss has been added to that from the other localities. This is a biotite-quartz monzonite augen gneiss, and should contribute nothing new to the list of heavy detrital minerals. A study of this sample showed: 49% leucoxene, 37 ilmenite, 6 zircon, 3 epidote, 2 tourmaline, 1 muscovite, 1 amphibole and pyroxene, and 1% garnet. No limonite was in the sample studied, doubtless due to its elimination by attrition during transportation, as this locality is more than 20 miles distant from the nearest deposit of limonite. The high percentage of leucoxene may be due merely to conditions of concentration or to increased supply from the Lovingston granite gneiss, or to another exposure of the hypersthene granodiorite.

Drainage into the river at Mt. Athos adds several significant members to the list of formations contributing heavy minerals to the sands of the river. These formations include: the Lynchburg gneiss—a mica gneiss and mica schist in part garnetiferous; the Schuyler Soapstone—soapstone, amphibolite, peridotite; and pyroxenite intrusive into the Lynchburg gneiss; the Cockeysville marble—a marble with mica and graphitic layers; greenstone volcanics—basic lava flows altered to schistose and amygdaloidal epidote amphibolite; and the Wissahickon schist—a chlorite muscovite schist, garnetiferous biotite schist locally containing staurolite, sillimanite, and kyanite. Heavy minerals found were: micaceous material 41%, ilmenite 28, muscovite 10, staurolite 5, leucoxene 5, epidote 3, amphibole and pyroxene 3, kyanite 3, zircon 1, and garnet 1%. It will be seen that staurolite is found at this locality but not previously. This was probably derived from the Wissahickon schist. No sillimanite, tourmaline, or rutile were identified. As at Pedlar River, no limonite was found, probably for the same reason as for its absence at that locality.

From the foregoing the following conclusions may be drawn:

First. In a sediment containing a great preponderance of some heavy mineral, such as limonite, other minerals may be difficult or impossible to isolate.

Second. Limonite will not be transported any great distance from its source.

Third. Local variation of wave and current effects and the conditions under which collection is made will greatly influence the percentages of the minerals found.

Fourth. Sometimes such common detrital minerals as tourmaline and zircon are not found in a small amount of material under observation.

Fifth. A greater variety of minerals is found with an increase in mineral complexity of the rocks of the drainage area.

LOCALITIES FROM WHICH SPECIMENS WERE OBTAINED AND PERCENTAGES OF HEAVY MINERALS FOUND AT EACH

Locality	Limonite	Ilmenite	Tourmaline	Zircon	Rutile	Amphibole and Pyroxene	Epidote	Leucoxene	Garnet	Kyanite	Fine Micaceous Grains	Mica	Staurolite		Total Number Heavy Mineral Species	Total Percent of Heavy Separates by Weight
Lick Run	96	3	1												3	5
Eagle Rock	91	5	1	2	1										5	5
Sherwood Station	42	45	5	5		2	1								6	1
Wilson Falls	77	15	2	3		2	1								6	5
Balcony Falls	88	6	1	1			1	3							6	25
Rocky Row Run	66	18	1	1	1	1	1	2	3	1	5				11	5
Pedlar River		37	2	6		1	3	49	1			1			8	12
Mt. Athos		28		1		3	3	5	1	3	41	10	5		10	10

Sixth. Most of the minerals added to the sediment persist for many miles below their source.

To the best of the writer's knowledge this investigation represents the first work in sedimentary petrography in Virginia west of the Piedmont Province. There are many opportunities for investigation of sediments, both consolidated and unconsolidated, in this region. A further study, with greater thoroughness, along the same lines as presented in this paper might be suggested.