Collecting and Examining Beach Sand: Getting Started

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Grains of sand collected from the beach may be examined for a number of reasons. From the youngster who first peers at a handful of beach sand under a magnifying glass to see the various shapes and colors to the sedimentologist who studies sand grains for clues to the questions of plate tectonics, the collection and examination of sand can be a fascinating activity. Dr. Oliver H. Howe, in an interesting article published in 1946, remarked of one sand sample that under a low power magnifier the various colors of garnet grains contrasted strikingly with the black grains of magnetite, green of epidote and the brilliant grains of quartz.[1] To him a sample of sand was a beautiful collection of minerals in miniature. In a chapter of the Particle Atlas on the determination of geographical origin of dust samples, Skip Palenik cites several examples of how the mineral identity, particle shape, size, and surface texture of sand grains were used to pinpoint a geographic location from which a sample came.[2] For Skip Palenik the microscopic examination of sand is an important forensic tool. Dr. Raymond Siever in an excellent book entitled *Sand*, published in 1988, describes how the mineral compostion, along with the shape of grains of sand can be used as a diagnostic tool to understand the dynamics of the earth's surface.[3] To Dr. Siever a sand sample is a geological history book. Although the collection and examination of sand can involve a serious consideration of mineralogy, geographic origin or geologic history, it can also be collected and examined for the fun and wonder of it.

Because sand is technically a collection of particles in the size range 0.06 mm and 2 mm it is perfectly suited to be examined with a stereo microscope. Individual grains can be picked for further study under the polarized light microscope (PLM) or scanning electron microscope (SEM). Sand is a product of a number of rock degradation processes such as erosion by wind and water, glacial grinding and the action of ocean waters. The natural occurrence of sand throughout the world in a wide variety of forms provides a near endless source of samples for the microscopist. Although many people have studied sand grains for a variety of reasons there are few general books on the subject. There is, for instance, no atlas of beach sands from around the world. This article provides some basic information about collecting and analyzing sand, as well as a review of some of the literature available with notes on illustrations or examples of sands from specific locations.

EQUIPMENT

Beach sands have been collected in practically every container imaginable. We have found ziplock plastic bags and 35 mm film canisters to be most useful. Although documentation of the conditions under which the sand was collected can be very extensive, the crucial information for our collection includes the location of the beach area, the time and date of collection and the name of the collector. The location on the beach is also important; dune, shore area, or beach, and distance from the water line. An overall appreciation of the collection of beach sand grains in the sample can be gained by looking through a hand lens or better through at least a 5X magnifier. The interesting crystal shapes of some of the grains can best be observed under the stereo microscope or scanning electron microscope.

BOOKS AND ARTICLES TO START WITH

Although many people have studied sand grains for a variety of reasons, there does not appear to be any introductory book which describes beach sands and shows the many types of grains that exist. Unfortunately for the beginner, books with illustrations, especially color photographs which would be most interesting, are few. There are, however, several books and articles which help a beginner gain a sense of the many interesting aspects of collection and examining sand.

The book entitled *Sand* by Raymond Siever is an excellent resource book for a sand collector. Although some knowledge of scientific terms is helpful in fully understanding some of the technical issues described in the text, anyone who has looked through a low-power microscope at grains of sand can appreciate the color photographs of sand grains that serve as examples to various aspects of the sand. Written in the style of the journal *Scientific American*, the book provides full explanations of where sand comes from, how sand travels, and ultimately how the study of sand grains helps in reading plate tectonics.

Picture Rocks from Chapel Beach, Lake Superior, MI (26X)

For the person getting started in collecting sands the color photographs of groups of sand grains are particularly interesting. Pure quartz sand from Belize, South America is used to illustrate grains which are angular, showing little evidence of rounding during transport. Similarly, the angular, olivine-rich sand of South Point, Hawaii, is contrasted with rounded quartz from Florida. Two calcium carbonate sands are also shown. The one from Cooper's Bay, New Zealand is mostly shell fragments. In contrast, the other calcium carbonate sand is composed mainly of oolites (rounded shapes), cemented slightly by calcium carbonate precipitated between the grains.

The roughly rectangular shapes typical of gypsum grains and the rounding caused by abrasion during wind transport are illustrated with a microscopical view of a sample from the gypsum sand dunes of White Sands, New Mexico. The fragments of basalt and grains of olivine and pyroxene from black volcanic rock sands are shown to help depict the fragmentation and weathering of basaltic lavas in Hawaii.

In addition to the photographs, page 58 contains a clear illustration showing typical shapes of minerals forming common sand grains, quartz with its equant or spherical particles as well as blades and pencils, feldspar grains with traces of cleavage planes, mica sheets, and the rough irregular forms of amphiboles and pyroxenes. As indicated, the book is an excellent reference for learning about several aspects of sand examination. It was found in the public library.

The article by Howe which appeared in a 1946 edition of *Micro-Notes* is an interesting and perhaps inspiring article on the analysis of sand. Although a bit rambling in style, the keen interest of Dr. Howe in the analysis of sand is clearly conveyed. He does provide some analytical results from specific locations. Howe reported that sand from Topsham, Maine, consisted wholly of mica. He also notes that in Yellowstone Park there is an source of obsidian sand (a natural volcanic glass) which is black in color and has conchoidal fracture.

Some popular field guides to rocks and minerals have sections on sand. The Golden Book* indicates that although most common sand is of the quartz variety, there are also coral sands, gypsun sands, and sands rich in magnetite, monazite, garnet, ilmenite, and rutile. Other guides have general information

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about colored sands. For instance, a guide by Loomis states that "along some shores of the ocean, there occur 'green sands' which are ordinary quartz sands mixed with the dark green mineral glauconite, which is a potassium iron silicate, forming on the ocean bottom as a result of the action of decaying animal matter on iron-bearing clays and potassium-bearing silicates, like feldspar. This is particularly characteristic of some of the sands along the coast of New Jersey.[5]

The *Rock Dictionary*[6] has several entries for colored sands. Black colored sands in beach and alluvial placers are often high in magnetite and ilmenite, but may also contain other dark minerals such as cassiterite, rutile, thorite, betafite, euxenite, columbite, and schorl. Sands rich in green olivine occur in some volcanic regions, such as on the beach at Hansuma Bay, Koto Head area, Oahu, Hawaiian Islands. Greensand is the name given to the Atacamite sand from Peru and from the desert of northern Chile. Red-colored beach sand containing much garnet is found in Nome, Alaska. Perhaps the best known white sands are those composed primarily of gypsum which can be found at White Sands National Monument, New Mexico. (It should be noted that the color of individual sand grains can sometimes be misleading in terms of identification as many minerals occur in several colors.)

For the analyst requiring more technical information, it will be necessary to turn to the texts and papers of sedimentologists. The 1938 *Manual of Sedimentary Petrography* by Krumbein and Pettijohn contains 42 pages describing common minerals found in sedimentary rocks.[7] The section includes significant diagnostic properties and detrital (single grain) characteristics of each mineral. Although this early edition contains no color illustrations, it does have excellent black and white drawings showing the features of individual grains of most of the minerals listed. A number of the drawings represent grains from English sands (including Cornwall, Yorkshire, Devonshire) while American sands include grains from Lake Erie (Cedar Point) and Lake Michigan as well as other areas.

The more recent (1987) text on *Sand and Sandstone* by Pettijohn, Porter, and Siever, although containing sections useful to the experienced sand analyst, will be a disappointment to the beginning sand collector.[8] Unfortunately there are no color photographs and few black and white drawings of individual sand grains. There is one excellent set of scanning electron micrographs showing Amazon Basin river sand grains. Of some interest is an annotated bibliography of sources for the study of sand and sandstone and an interesting section on determining provenance (source) of sand samples.

The McCrone *Particle Atlas* volumes contain a number of photomicrographs of individual mineral grains which can be found in various sands.[9] Only a few, however, are identified as to source: rutile beach sand from Australia (p. 398) and grains found in the red rain of London which originated from the North African Sahara desert (p.560). The chapter on the determination of geographical origin of dust samples by Skip Palenik contains an interesting story about the examination of a Japanese beach sand and other information on the use of sand examination for forensic studies.

Photomicrographs of how individual grains of garnet, epidote, hornblende, kyanite, rutile, sphene (titarite), tourmaline, and zircon appear under the light microscope can be found in Schoile's color guide of sandstones and associated rocks.[10] This excellent atlas of sandstones in thin section published by the American Association of Petroleum Geologists contains four pages of single crystal micrographs and a selected detrital grain bibliography.

The articles and books described in this brief paper are some of the more readily available references. In future articles we hope to describe the analysis of specific sands and will refer to other books which contain analytical notes.

One of the best children's books on sand is one by Sally Cartwright entitled *Sand*. This short book describes many of the properties of the material and gives several interesting activities to help children learn about sand.[11] Although well written, the book did not appeal to three children ages 10, 7, and 4 as much as the color photographs of sand grains found in the other "Sand" books by Siever.

By comparison with beach sand, the examination of commercial sand which contains primarily quartz, is less interesting to the general sand collector. Industrial sands which tend to be nearly pure quartz are materials for more specialized studies. Approximately 40% of industrial sand is used as the principle raw material in glassmaking.[12] Two types are used: white sand in the manufacture of fint or white glass and yellow sand for the manufacture of colored glass. The major difference in the two sands involves the iron and chrome oxide content, with the yellow sand having six times the Fe_2O_3 and ten times the Cr_2O_3 of white sand. Although the white sand is over 99% SiO_2 and the yellow sand over 98.5% SiO_2 the microscopist may find grains of a number of contaminants. Refractory impurities that have been found in some glassmaking sand include: sillimanite, kyanite, andalusite, zircon, spinel, corundum, chromite and kaolin.

The collection and analysis of sand is an interesting and educational activity. Collectors wishing to trade samples or correspond about interesting sand grains should write to any of the authors. ■

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