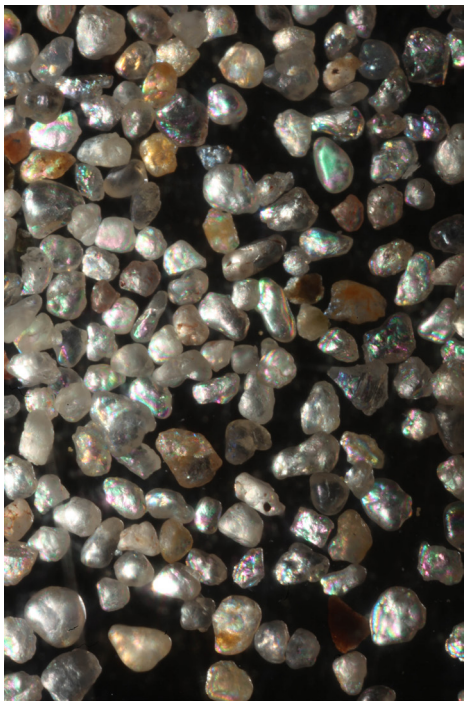
THE SAND BOX

Sand is a material that is fairly common, yet still draws the attraction of many collectors around the world. Not only do these individuals collect the sand themselves; they barter and trade for it with other collectors. Becoming a psammophile, or sand collector, is as easy as scooping a little sand from a nearby beach into a plastic container and carrying it home. So what is it about this grainy matter that makes it so special to so many people? Many people will cite a feeling of wonder when looking closely at the differences from one sample of sand to the next. Sand contains different minerals that can cause it to be different colors based on the origin of the grains. It also can be found almost anywhere so there is never a shortage of sand to observe. It's very important in nature, as well as in industrial items. Part of the fun of sand collecting is also looking around at where the sand was found so as to obtain a better understanding of how the sand got there.

Sand itself is just finely divided rock and is made up of small particles or granules called sand grains. It is commonly transported by wind or water and can appear in the form of beaches, dunes, sand spits, and sand bars. It can even make up the majority of an area's soil composition, as it does in deserts. In more specific, geological terms sand is made up of particles ranging in size from about one-sixteenth of a millimeter to two millimeters in diameter.



Top: Picture Rocks Pack, MI reflected light
Bottom: Picture Rocks Pack, MI cross polarized light

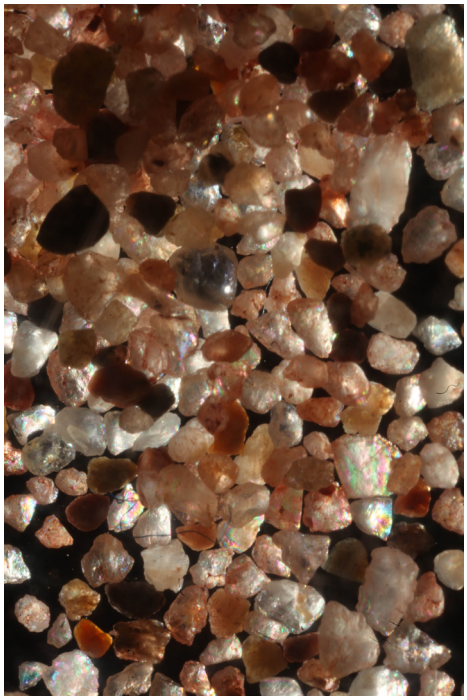
Anything smaller than this is considered a different category called silt. Anything larger is also considered a different category called gravel. One way to test if the material you have found is silt or sand is to rub it between your fingers. If it feels grainy it is sand. If it feels smooth like flour it is silt. The size and shape of sand grains is largely determined by the area in which the sand is found or originated from. Local rock sources are the source of the sand, and the way those rocks break down and become weathered determines what the sand will look like. For instance, areas with primarily limestone will yield bright white sands such as those seen in tropical beaches. Weathering and erosion of granite results in sand with a high feldspar content called arkose. Sands can also be various shades of red, green, gray or black, and brown. Sometimes, small gemstones can be found in sand samples.

Not all sand is actually crushed up rocks, though. Some sand, especially on beaches, can be made partially of marine life remains. Beaches can therefore tell scientists something about the diversity, abundance, and ecology of organisms that dwell in the nearby water. Sand with a carbonate composition indicates that those grains of sand were likely from biological origins. An easy way to test if sand has calcium carbonate in its composition is to remove a small portion of the sample and place a few drops of vinegar on it. This will result in the calcium carbonate dissolving in the vinegar and producing small bubbles of carbon dioxide. If the sand produces bubbles in reaction to the vinegar, it may be biological in origin. If the sand sample in question was taken from a desert, in combination with shell fragments, it could indicate that there may have been an ancient sea in or near that location. Sand can also be used to determine changing sea levels.

Sand can be found in a multitude of places, including the beach and deserts. It helps to shape the landscape of the places where it is found. On beaches the sand dunes occur where some vegetation is present to trap sand grains as they are carried by the wind. As the old vegetation dies, it provides nutrients for a new generation of vegetation to grow on the piles of sand. This traps more sand as the wind carries it and a dune is formed. The dune will continue to grow and sustain itself in this manner. Once a dune is established, the network of roots helps to provide a solid protection in the event of a minor storm. There are also man-made dunes, which are constructed using a bulldozer to push the sand into a pile near buildings as a measure for storm protection. These dunes look very different from natural dunes, as they contain much larger particles than would naturally be carried to a dune by the wind. A few days after construction, most of the lighter particles of a man-made dune will be blown away and a layer of shells will be exposed – unable to be blown away by the wind and artificially placed there by a bulldozer. The artificial dunes are much more easily eroded by inclement weather and are usually washed away by the next storm.

Top: Ontario, NY reflected light
Bottom: Prince Edward Island reflected light

Top: Ontario, NY cross polarized light
Bottom: Prince Edward Island cross polarized light



The dunes in desserts are made in a similar way to the dunes found naturally on beaches. As sand grains are picked up by the wind, they are deposited wherever there is a "wind shadow" in which the air consistently slows down enough to drop the sand grains. In deserts, however, dunes have much more freedom to move around. Through a process called "saltation" the sand grains start to skip across the ground in a similar way to a rock skipping across the water. Sometimes, these sand grains crash into each other and start to form a sheet flow. When these sheet flows occur dunes can move tens of meters in a matter of minutes. This is a real threat to people, buildings, and agriculture in some areas of Africa, the Middle East, and China. Sometimes, to stop the movement of the dunes, oil is poured over top of them. While this does halt the movement of the dunes, it is degrading to the environment. Some have suggested making sand fences, but the best possible design for such fences has not been agreed upon yet. Sand dunes can also experience sand avalanches, in which sand falls quickly along the steep side of the dune. These can be deadly if a person is caught in one.

Not all sand is found in nature, though. Some sands serve industrial purposes, such as in concrete. When concrete is mixed with sand, it forms cement. The sand in cement helps to fill pores and keep the concrete from cracking as it solidifies. Usually, the sand that is used in cement is silica.

Above: Hamoa, Maui reflected light

Above: Oloolo, Maui reflected light

Above: Copper Harbor, MI refleced light

This is generally found in the form of quartz. The sand helps to strengthen the concrete as well. Since silica is easily available and economical compared to other fine particles that could do a similar job it is the primary ingredient added to concrete along with gravel to make cement. Another use of sand is in art. When an artist wants a glass piece to appear "frosted" a fine silica sand is used in a sand blasting machine. The sand has a hardness that is higher than glass, so when the sand blaster turns on the sand particles are blown out through a hose at high speeds aimed at the area of the piece that the artist wants frosted. This causes the sand to make tiny scratches in the surface of the glass, which results in the frosted appearance. Once the machine is turned off, the artist must wait for the dust to settle before opening it and removing the piece. If breathed in repeatedly over time, the silica particles can cause a disease in the lungs known as silicosis. Silica sand is not only used in frosting glass, it is also a component when making many kinds of standard and specialty glass. The chemical purity of this glass is responsible for the color, clarity, and strength of the glass that is made with it. It can be used in the production of everything from sheet glass for buildings, to glass food storage containers, and glass cups and other tableware. When it is pulverized, ground silica is used to make fiberglass insulation. This is all possible because industrial sand is high purity silica with closely controlled sizing.

Since sand has been such a pervasive element throughout many landscapes throughout the world, it is not surprising that it is also included in cultures and rituals around the world. In the Bible, sand is often used to talk about quantities far greater than the human mind can grasp. In Genesis 22:17 God tells Abraham "I will surely bless you and make your descendants as numerous as the stars in the sky and the sand on the seashore." This is a more poetic way of saying that Abraham will have many many descendants. Both the Navajo people and the Tibetan Buddhist Monks use sand in different colors to create temporary artwork. The Navajo people use it in ceremonies to create sand paintings. Rituals and ceremonies are an important part of their culture, used for everything from milestones in life, to asking for luck on a hunt, to common colds and illnesses. Almost all of these rituals and ceremonies involve sand paintings. The Tibetan Buddhists create beautiful sand mandalas with colored sands. The sand mandalas take hours, even days to complete. They are meant to transmit positive energies to the environment and those who view them. Once they are completed, they are systematically wiped away as a reminder of the impermanence of life. The mixed sand is then distributed into flowing water to share the good energies into the world. In Japan sand takes on a slightly different significance. While it is also used in Japanese rock gardens, there is a special type of sand on the beach in Okinawa. Commonly known as Japanese star sand, people come to this beach to sort through the grains to find tiny spiked particles. Local legend states that these tiny star-like grains of sand are the skeletal remains of the children of the Northern Star and the Southern Cross, who were all killed by a giant serpent as they fell into the ocean. In actuality, these tiny marvels are the exoskeletons of protozoa that live on the ocean floor.

They wash onto the beach and are a somewhat popular candidate for scanning electron microscope (SEM) imaging. Sand has also played a role in Egyptian culture, though less directly. One of the contributing factors to the discovery of mummification was from the natural mummification process that occurs when a body is buried in sand in a warm, dry climate.

Sand has helped shape not only landscapes, but also culture, and human productivity. It is prolific and finds its way into almost every aspect of our lives in one way or another; even if it doesn't always look like sand. It is also an amazing indicator of what kind of surroundings it may have come from. Many people collect sand, from young children to older seniors. Every grain has a history to it. Some of it may even perform important functions in industrial uses. Sand is often taken for granted, but upon closer inspection there is much more than meets the eye.

In order to take the pictures that were featured in this article, I used a Canon 5D Mark II and a 65mm macro lens. I set up a work station with a copy stand and an adjustable stage much like what one would see on a microscope. This allowed for minute movements without shaking the sand grains and therefore disturbing them. I used a shutter release cord to minimize any camera shake. I used a small piece of foam core to put the sand on and create a background. I used a single handheld flash to illuminate the sand in each shot. Each frame was taken at 5x, so a comparison of the images shows the sizes of the grains in relation to the grains in other samples. I also included an image of the tip of a ball point pen as a reference to give a more tangible idea of how small the grains of sand actually are. For the cross polarized images, I suspended the sand on a piece of glass between two polarizers and illuminated it from underneath.

Above left: Okinawa, Japan reflected light
Above right: pen for size reference, reflected light

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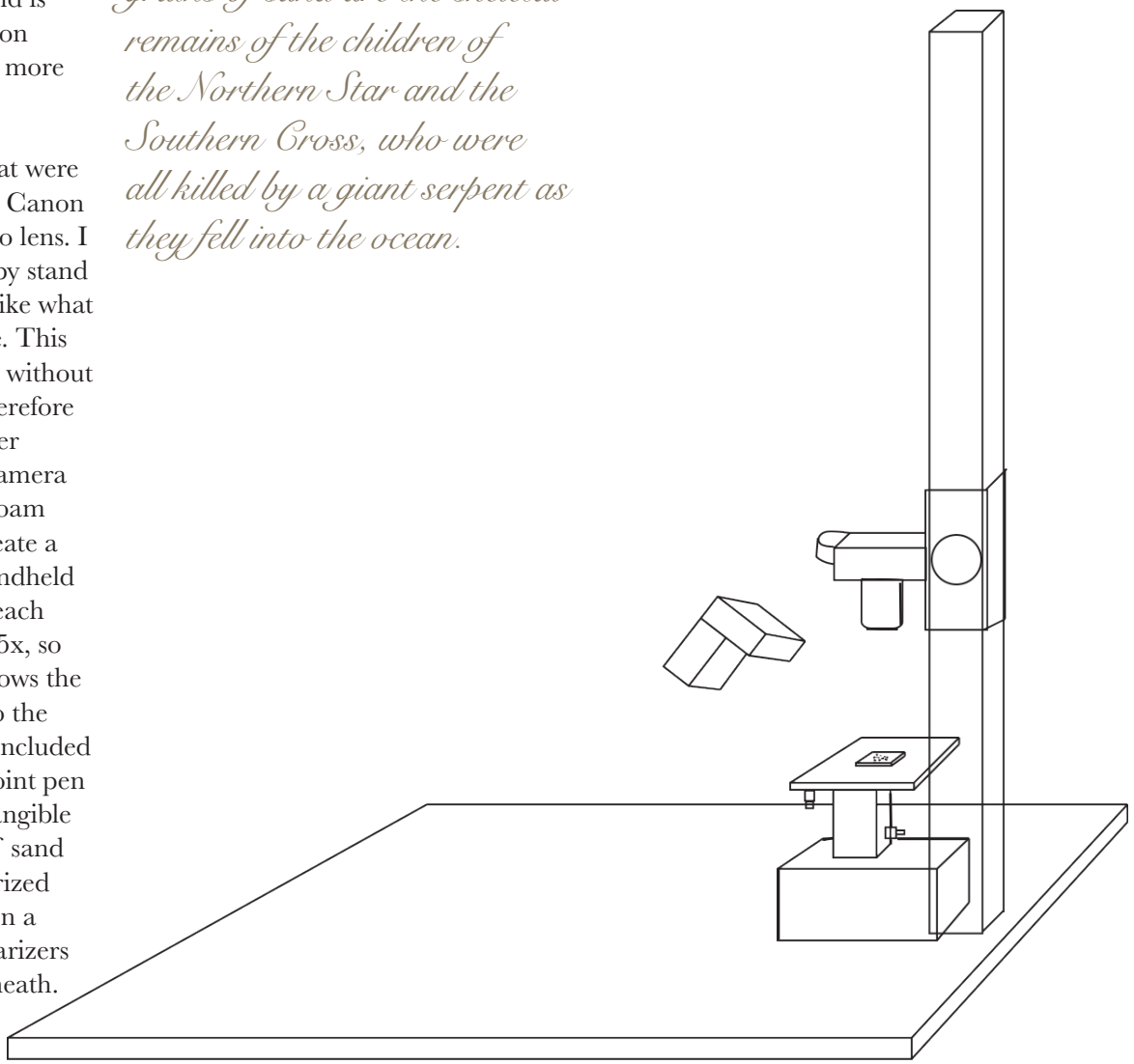

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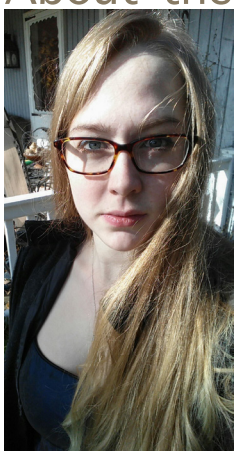
About the Author



Kirsten is a Biomedical Photographic Communications Major at Rochester Institute of Technology, with an immersion in Japanese. Originally from Pennsylvania, she would like to travel to Japan and spend a few years working there after she graduates. Kirsten's love of science developed thanks to her father who never missed an opportunity to enrich her education outside of the classroom. When she later discovered her love of photography in high school, she was extatic to learn that science and photography could work together to create wonderful images. Kirsten is expecting to graduate in the spring of 2017 and is excited to see what the future holds for her.