The sand beneath your feet

Last time you visited a sandy beach what did you do? Lie on the sand? Make sandcastles? Get annoyed at sand in your sandwiches or stuck to your suncream? Did you pay much attention to the sand itself and marvel at how beautiful it is? The chances are that you did not – but magnified pictures of sand show just how amazing it really is.

Dr Gary Greenberg

The picture on pages 10-11 was taken by Dr Gary Greenberg who was a biomedical researcher at University College London. The sand grains are viewed at magnifications of up to 250 times so that each grain is shown up in stunning detail.

The delicate and colourful grains include fragments of crystals, tiny portions of shells – including some spirals – and splinters of volcanic rock. Sand can also include remnants of volcanic explosions, dead organisms and even degraded man-made structures. If you didn't notice all this when you were on the beach it is not surprising as these structures are well beyond the limits of human eyesight.

Dr Greenberg says, "It is incredible to think when you are walking on the beach you are standing on these tiny treasures. Every time I look through my microscope I am fascinated by the complexity and individuality created by a combination of nature and the repeated tumbling of the surf on a beach."

Gary searches through thousands of tiny rocks with acupuncture needles to find and arrange the most perfect specimens, and then uses a painstaking technique to create his images.

He says, "Extreme close up photography normally gives a very shallow depth of field so I had to develop a new process to make the pictures that I wanted. I take dozens of pictures at different points of focus then combine them using software to produce my images.

"Although the pictures look simple each grain of sand can take hours to photograph in a way that I am happy with. The beach nearest my lab is Haiku, Hawaii but my pictures show sand from all round the world from Japan to Ireland."

This stunning image shows that there can be a lot of art in science and science in art.

High-power microscopy reveals that grains of sand may be fragments of shell, rock or crystal.

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Photo: Gary Greenberg (UMass Group)

Clues in sand

Sand from Pismo Beach, California. The grains are mainly chert, quartz and other igneous rock and shell fragments.

Studying sand can reveal both the geological and biological history of a local environment as sand varies from place to place. Sand from near a copper smelter can contain grains of copper; grains can contain worm trails from microscopic worms living in the ocean. Even the grains themselves can contain clues as to where they are from – grains from a desert environment tend to be pitted and pock-marked from where they collide with each other whereas grains from the ocean tend to be worn to a smoother surface.

Can you identify for the following grains in the picture on pages 10-11?

- To the left of the centre is a glassy Y-shape. This is a sponge spicule from the internal skeleton of a sponge. These are made of silica (as is glass) and are hard and sharp enough to cut through your skin.
- Near to this are two microscopic spiral shells. Shells are largely composed of calcium carbonate, $CaCO^3$. By making these shells, the organisms are removing carbon dioxide from the ocean – and form a crucial part of the carbon cycle in the process.
- Below them, some circles on a white fragment are a piece of sea urchin shell which has been eroded by the waves. The circles are the sites where the spines would have been attached.
- Just to the right of the glassy Y is a brown striped tube which was once part of a sea urchin spine.
- A fragment with a lot of holes is a piece of coral. Centre right is a tiny, white, tube-building worm.
- The pink and white bit which looks like a piece of seaside rock is a splinter of shell.

Brightly coloured sand grains are often pieces of metamorphic rock. Colour alone is not enough to identify exactly what each mineral is as a tiny addition of a different chemical (often a transition metal compound) is often sufficient to change the colour.

Moon sand

Dr Greenberg is currently studying lunar sand which was brought to earth by the Apollo 11 Moon landings 40 years ago. Microscopes now are much more powerful than they were back then, allowing the sand to be studied in new ways. The environment on the Moon is very different to that on Earth, having no atmosphere and no water, so the rocks erode in a different way to that found on Earth.

Vicky Wong is Chemistry editor of Catalyst.

Look here!

For further information on the work of Gary Greenberg see *www.sandgrains.com*

For a gallery of some of his other images see *http://tinyurl.com/63kjvy*