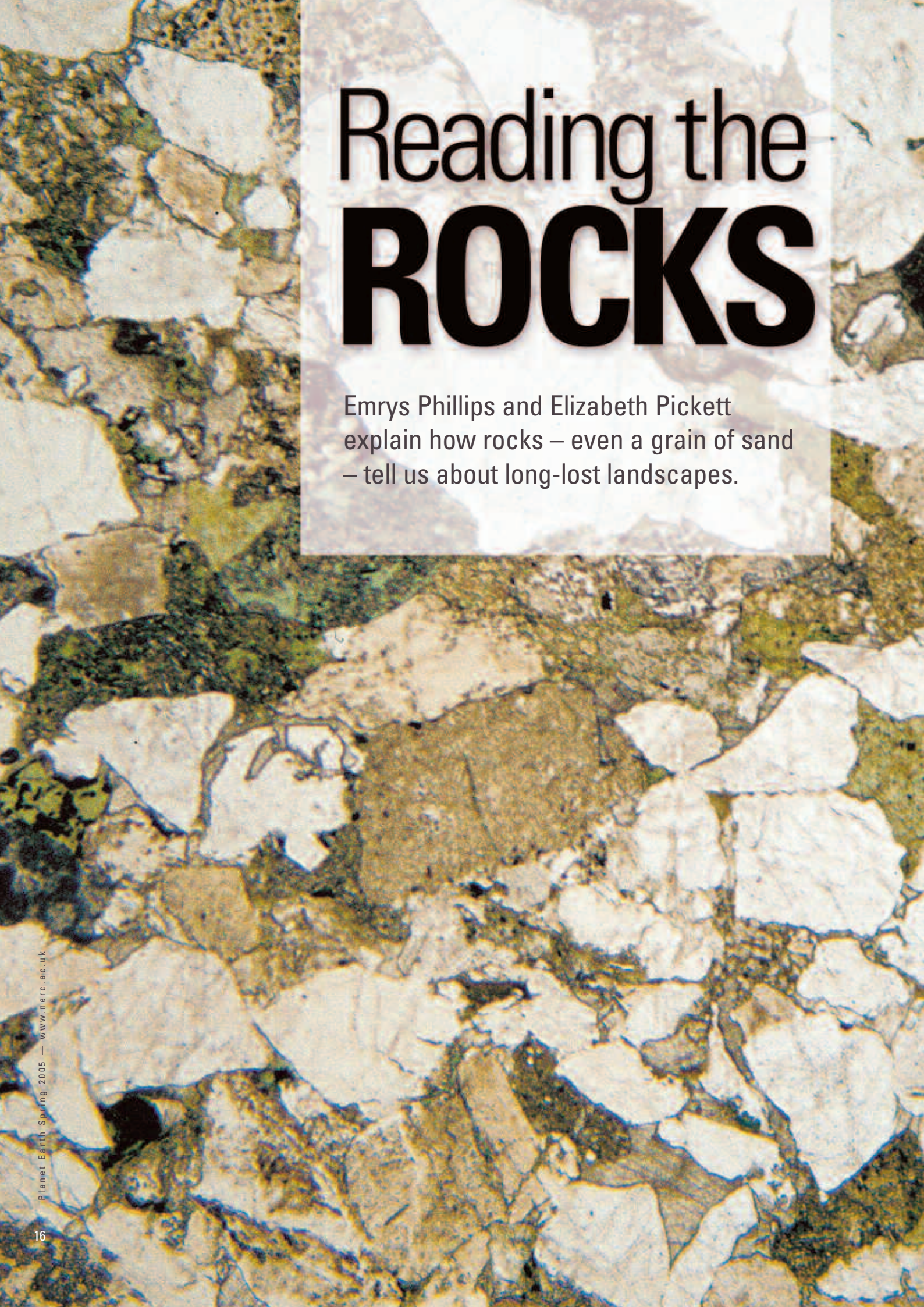
Reading the ROCKS

Emrys Phillips and Elizabeth Pickett explain how rocks – even a grain of sand – tell us about long-lost landscapes.



Sandstone – under the microscope you can see angular fragments of the colourless minerals quartz and plagioclase as well as broken volcanic rock fragments

The aftermath of a flash flood.

It may be hard to visualise, but the distinctive red sandstones underlying the rolling hills of Ayrshire and Lanarkshire in central Scotland tell a tale of ancient landscapes where rivers meandered through barren semi-desert, flanked by volcanoes.

During the Devonian period, around 415 to 400 million years ago, Scotland, lay south of the equator, and was part of a large landmass known as the 'Old Red Sandstone Continent'. This continent contained a large part of what is now northern Europe, as well as most of North America and Greenland.

The ancient Scottish rivers carried sand and gravel that built up on the riverbed in thick layers, later becoming sandstone and a pebbly rock known as conglomerate. These rusty red rocks tell us the rivers flowed in a climate similar to that of south-western USA and Israel today. The colour comes from an iron-rich cement which binds the sand grains and pebbles together.

Rounded pebbles now locked within the conglomerate once rolled and bounced down ancient rivers, and they suggest the Devonian climate was seasonal with occasional heavy winter rain storms. Such large fragments of rock must have been moved when rivers were swelled by flash floods cascading down normally dry valleys in the surrounding landscape. These floods would have cut deep into the underlying bedrock, washing huge volumes of sandy and gravelly sediment down into the main river.

As the river flowed downstream, ripples formed on its sandy bottom. These ripples are now preserved in the sandstones and act as geological signposts, showing that the rivers flowed towards the south-west. You can also find mudstones between the thick beds of river sandstone. These would have been laid down in standing pools left on the floodplain after the waters subsided, or as mud settling out of stagnant water trapped in channels abandoned when the rivers periodically changed course.

Rock samples taken from ancient river deposits reveal yet more secrets when thinly sliced and placed under the microscope. The shape, size and composition of individual sand grains help geologists to understand river processes, and tell us about the geology of the hills through which they flowed.

The grains in the Devonian sandstones of Lanarkshire and Ayrshire are mostly coarse and angular. They are a complex mix of rock fragments and mineral grains, and this suggests they were washed rapidly down the river to be dumped as floods subsided, or the river dried up under the subtropical sun.

But not all the grains are angular. Some are small, well-rounded grains of quartz. Normally, rounded grains mean the sand has moved slowly, ie the river has had enough time to smooth rough edges. That doesn't fit here where broken fragments make up most of the sandstone. Instead, the rounding is due to wind action. A fine layer of sand and dust would have been left to dry by receding flood waters. Exposed to the wind, the grains were buffeted and smoothed by swirling dust devils, triggered by the heat of the subtropical sun. The windblown sand collected into small dunes. These are sometimes preserved amongst the river sands as finely layered or 'pinstriped' beds of aeolian sandstone. Rounded grains of sand were also blown into the nearby streams to be mixed with the coarser river sand and gravel.

> The grains were buffeted and smoothed by swirling dust devils

Pebbles within the sandstones and conglomerates don't just tell us about climate and river processes. They also provide important insights about the hills surrounding the Devonian river valleys. Under the microscope we can see that the pebbles include volcanic rocks, sandstone, granite and much older metamorphic rocks. The angular volcanic pebbles are dark grey to rusty red basalt, as well as a lighter grey rock known as andesite. They have not travelled very far, and must have come from nearby volcanoes that spewed molten rock and ash onto this already barren landscape. The metamorphic rocks tell of even older landscapes. They were originally sandstones and mudstones that became buried deep underground, where they were changed (metamorphosed) by extreme heat and pressure. Over millions of years, these rocks were once again revealed at the Earth's surface, to be weathered and eroded by flash floods and the meandering Devonian rivers.

So next time you walk across a sandstone landscape, remember the fascinating history the rocks underfoot can reveal. For many geologists, understanding long-vanished continents, landscapes and climates from the clues locked within rocks is the most exciting part of earth sciences.

Wide sweeping meanders in the River Clyde, near Eastfield, Lanark

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