A VIKING SAGA

Did Norse seafarers really find their way across stormy oceans with the aid of a delicate crystal? Philip Ball unravels a tangled tale

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DURING the Middle Ages, the Vikings set sail in longships to raid settlements and plunder riches, but how did they find their way? They had no magnetic compasses, and the sun and stars would have been obscured on cloudy days and during the long twilight of the northern summer.

According to one suggestion, the answer lies with a special crystal or "sunstone". This, some physicists argue, allowed these seafarers to navigate the north Atlantic by revealing the position of the sun when it was hidden behind clouds, and even after sunset. Yet many archaeologists and historians have serious doubts, pointing to a lack of solid evidence.

It is a debate that doesn't just bear on Viking navigation. It also goes to the heart of what experimental science can and can't contribute to our understanding of the past. But who is right? And what does the archaeological and historical evidence reveal?

The sunstone hypothesis stems largely from a 13th-century manuscript, *St Olaf's Saga*, in which the hero Sigurd tells King Olaf II Haraldsson of Norway where the sun is on a cloudy day. Olaf checks Sigurd's claim using a sólarsteinn or sunstone: *Olaf grabbed a sunstone, looked at the sky and saw from where the light came, from which he guessed the position of the invisible Sun.* Another tale called *Hrafns Saga* fleshes out the details: *The King looked about and saw no blue sky... then the King took the sunstone and held it up, and then he saw where the Sun beamed from the stone.* But what is a sólarsteinn?

Rotate until brightest

In 1967 Danish archaeologist Thorkild Ramskou suggested that the mysterious object could be a chunk of a "birefringent" mineral such as cordierite. As light passes through this type of crystal, rays of different polarisations are refracted by varying degrees. Used correctly, the crystal can work as a natural Polaroid filter, transmitting or blocking polarised light depending on its orientation.

With such a crystal, you can pinpoint the sun in the sky. As sunlight is scattered by tiny particles in the atmosphere, it becomes polarised in a circular pattern centred on the sun. Ramskou suggested you could use this polarised light to find the sun, even when it is hidden behind clouds. The idea is to hold up the cordierite crystal to the sky and rotate it until the light passing through it appears brightest. The crystal's orientation then points towards the position of the sun (see diagram). That knowledge, together with the rough time of day, tells you where north lies. Birefringent minerals such as cordierite and calcite are abundant in Scandinavia. So maybe longships carried these crystals to help the navigators?

In 1994 the idea was finally put to the test – and summarily dismissed – in a study by astronomer Curt Roslund and ophthalmologist Claes Beckman of the University of Gothenburg in Sweden. They found that the small differences in brightness produced when rotating a birefringent crystal in diffuse sunlight are simply too weak for the eye to detect. Besides, they argued, humans are very good at judging the location of the sun behind clouds unaided. The sunstone idea "has no scientific basis", they reported.

This was the opening salvo in what became a long-running debate. In 2005, researchers led by Gábor Horváth at the Eötvös Loránd University in Budapest, Hungary, fought back. Their tests on volunteers suggested that we can't rely on our eyes to locate the sun behind clouds. Subsequent calculations, along with measurements made by Horváth across Europe and in the Arctic, also contradicted Roslund and Beckman: they showed that picking out the patterns of polarised sunlight with sunstones, even under foggy or cloudy skies, is perfectly feasible.

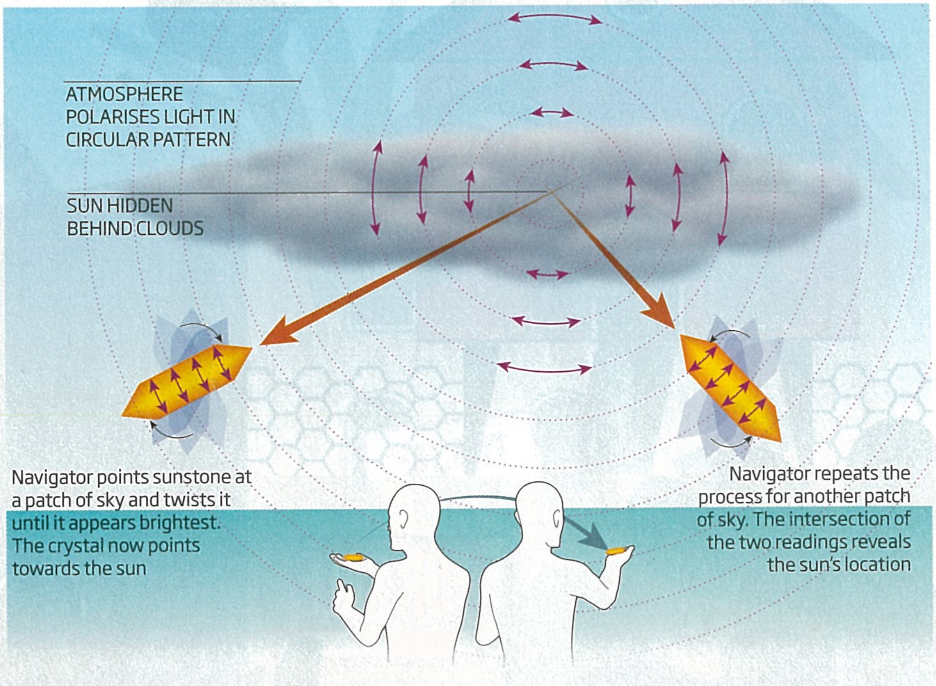
At the University of Rennes in France, optical physicist Guy Ropars had been following these arguments. Although he agreed with Roslund and Beckman's concerns, he realised there was a way to address them.

Our eyes may not be good at recognising subtle changes in brightness against a light background, but they are much better at comparing lights to spot small differences in intensity. Ropars decided to make use of this.

Shine a beam of light through a birefringent crystal and it splits in two. One beam travels straight through, while the other is offset by a small amount. The relative brightness of these beams depends on the polarisation of the light and the crystal's orientation.

Crystal compass

The Vikings could have used polarising crystals called "sunstones" to navigate when the sun was hidden by clouds. Knowing the sun's position and the rough time of day will let them work out where north lies



Practical tool

Ropars and his colleagues used a screen containing a narrow hole, through which light from the sky could reach a birefrigent crystal. Seen through the crystal, the hole appeared as a pair of bright spots corresponding to the two beams. Then they rotated the crystal until the spots were of equal intensity. At this point, the crystal's orientation indicated the sun's position. Ropars says the precision in measuring this with a calcite crystal can be 100 times better than in Ramskou's scheme.

Tests showed that this system can locate the direction of the sun to within 1 degree, even when it is below the horizon. Ropars says the method works even up to the moment at which the first stars appear.

The team even turned this into a practical navigation instrument – the Viking sunstone compass. Light falls through a hole in the top of a wooden cylinder on to a calcite crystal, forming two bright spots on a screen, which can be viewed through a hole in the side of the cylinder. The crystal itself is on a rotating mount, turned by a handle on the lid. "You rotate the crystal to equalise the intensities of the beams," says Ropars. A pointer on the lid then indicates the orientation of the crystal and the direction of the sun, so you can work out where north lies. Ropars and his colleagues hope to commercialise the compass.

So experiments show that the Vikings could have navigated with sunstones. "But this is a different question to 'did the Vikings use sunstones?', which is what most historians are interested in," says Alun Salt from UNESCO's Astronomy and World Heritage Initiative. The problem is that scientists dabbling in archaeology often try to answer questions that no historians are asking, he says. What is needed is solid archaeological evidence.

So far, there's not much to go on. Over the years, a number of Viking objects thought to play a role in navigation have turned up, including wooden sundials. But no sunstones.

Then in October 2002, archaeologists discovered a matchbox-sized calcite crystal in the remains of a shipwreck near the island of Alderney in the English Channel. It was found close to a set of navigational dividers, and tests suggest it could have been used to navigate. However, the ship was Tudor, not Viking.

Could this calcite block have been part of a Tudor ship's guidance system?

GUY ROPARS/AP/PA

Experts suggest this crystal was used to judge the sun's position as it rose and set, to help correct for compass errors caused by the vessel's iron cannons. There is no evidence it was used to guide the ship directly.

Yet the Alderney find does prove that 16th-century sailors possessed such crystals, and lends hope that similar ones could survive in the remains of older vessels. And there is other tantalising evidence besides the Norse sagas to suggest Viking sunstones are not fiction. Archaeologists have found fragments of calcite crystals in a Viking settlement in Iceland. Sunstones are also described in other medieval documents – there are references in 14th- and 15th-century inventory lists from Icelandic monasteries, where the crystals may have been used as timekeeping tools for prayer sessions. Of course, monks weren't sailors. "So we're now looking for mentions of sunstones in navy reports of the 15th and 16th centuries," says Ropars.

Unless definitive evidence turns up, sunstone compasses will remain a testament to human ingenuity rather than a historical reality. If sailors ever used such tools to cross the Atlantic in a reconstructed Viking ship, it would be impressive but prove nothing historically – although it would show how speculation about what might have been can stimulate invention. And for now, maybe that's enough. ■

Philip Ball is a freelance writer based in London