WHO NEEDS TO STOP FOR DIRECTIONS? —

Mysterious sunstones in medieval Viking texts could really have worked

A new study says Vikings could have used these stones to navigate to Greenland.

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When the Vikings first sailed to Greenland in the late 10th century, they didn't have compasses to guide them; that technology wouldn't reach Europe until the late 16th century. So how did they do it? A new computer simulation says an unusual method mentioned in an eight- or nine-hundred-year-old Icelandic saga would have been precise enough to get Viking ships safely to Greenland.

"The Viking legends (so-called sagas) refer to mysterious tools, sunstones, with which they could determine the position of the invisible Sun in cloudy or foggy weather," archaeologist Gabor Horvath told Ars Technica.

In *The Saga of King Olaf,* the titular king—who ruled Norway from 955-1030, around the time the Vikings settled Greenland—visits a chieftain in a remote part of the country to investigate some cattle thefts. There, he spends the night in a strange rotating house and has a strange dream, which the chieftain's sons interpret as a vision of the kings who would succeed Olaf as rulers of Norway. One part of the text describes a stone that allows the king to peer through dense clouds and snow to determine the position of the Sun:

> “The weather was thick and snowy as Sigurður had predicted. Then the king summoned Sigurður and Dagur (Rauðúlfur's sons) to him. The king made people look out and they could nowhere see a clear sky. Then he asked Sigurður to tell where the Sun was at that time. He gave a clear assertion. Then the king made them fetch the solar stone and held it up and saw where light radiated from the stone and thus directly verified Sigurður's prediction.”

That sounds a bit like a magic trick, but objects called solar stones or sunstones also show up in church inventories from Iceland. An archaeologist named Thorvild Ramskou suggested that the seemingly mystical stones might actually have been mundane navigational instruments for determining the position of the Sun, though at the time he wasn’t exactly sure how they worked. Archaeologists and historians now think the Viking solar stones might actually have been a mineral called calcite, or Icelandic spar, which has a crystal structure that polarizes light.

Normally, if you look through a calcite crystal, you see double. But when you line the crystal up at a right angle to the light, the double image resolves into a single point. A set of 2011 experiments showed that looking through a calcite crystal could work out the direction of the Sun and, thus, which direction is west, to within a few degrees even under twilight conditions. And a new study says that Vikings could have reliably found their way across 1,600 miles of ocean from Norway to Greenland using only sunstones to navigate.

Simulating a Viking voyage

Horvath used a computer program to simulate 1,000 voyages from the port city of Bergen, Norway to the settlement of Hvarf on the southern coast of Greenland. Each trip started on either the spring equinox or summer solstice, with a randomly selected amount of cloud cover. To make the 1,600-mile, three-week voyage, the simulated Vikings would need to sail west at a latitude of roughly 60º21’N.

At sunrise on the first day of the voyage, the program simulated the first sighting using a calcite, cordierite, or tourmaline sunstone. Thanks to the 2011 experiments, the program knew each crystal’s margin of error, which depends on the cloud cover and the Sun’s angle in the sky. So it picked a random heading from that from within the range of error and set sail at 11MPH. The simulated ship would follow that heading until the next sighting, when the program would generate a new one.

That process repeated until the virtual ship travelled far enough to reach Greenland. If the voyage ended with the ship close enough to see the mountains of Greenland’s coast, it counted as a success. And overall, it worked pretty well. As long as the simulated navigator took a sighting at least once every three hours, the Vikings arrived safely more than 92 percent of the time.

“Nobody knows whether the Vikings really used this method,” wrote Horvath and his colleagues. “However, if they did, they could navigate with it precisely.”

But if the navigator took a sighting every four hours, the ship made it to Greenland only 32.1 to 58.7 percent of the time. With sightings every six hours, the success rate dropped below 10 percent. Clearly, Viking navigators couldn’t afford to slack off. Veering too far north might put a ship on some unsettled part of the northern Greenland coast, where they ran the risk of running out of food or water before reaching port. The alternative could be even worse.

“In cases when the sailing routes tended considerably southwards, Viking voyages never reached Greenland, but terminated with the death of the whole crew in the Atlantic Ocean or reached North America,” wrote Horvath and his colleagues. That kind of navigational error might be what brought Viking settlers to the coast of Newfoundland around the year 1000.

Of course, like all simulations, this one tests a very simple version of reality. Ships sailing across the North Atlantic encounter storms, strong winds, and ocean currents, and a ship with its sails furled for the night could still drift off course by morning.

“All these will be studied by us in the future,” Horvath told Ars. He wants to find the environmental conditions that cause successful sunstone navigation to break down. “If it could be consistently shown that the breakdown of successful navigation only occurs for simulated conditions [which are] far from, or rare in, reality, then this would well demonstrate the robustness of our findings presented here,” he said.

Nothing new under the Sun

Archaeologists and historians now have good reason to think that calcite or other minerals could have been the sunstones from medieval texts; what they still don’t have is archaeological evidence that Vikings actually *did* use these minerals as navigational instruments. No calcite, cordierite, or tourmaline crystal has turned up at a Viking archaeological site so far. But

archaeologists found a piece of calcite on the wreck of a British warship, Alderney, which went down off the Channel Islands in 1592—and the crystal was near some navigational instruments.

If the sunstones described in Icelandic sagas and Church inventories really are navigational tools made of crystal, it may not actually be surprising that they work so well. When Ramskou suggested the idea in 1967, he wasn't sure at first exactly how sunstones enabled Vikings to find the Sun at twilight or amid cloud cover.

But a ten-year-old in Copenhagen read the journal in which Ramskou published his article, and the excited young archaeology enthusiast told his father about the Viking sunstones. The kid's father happened to be a Scandinavian Airlines (SAS) navigator at Copenhagen, and he thought the idea of looking through a filter to locate the Sun's heading on a cloudy day sounded familiar. Aviators at the time used sheets of polarizing plastic, mounted on something resembling a sextant, to do exactly the same thing when they were flying at high latitudes where a magnetic compass wouldn't work reliably.

The SAS navigator apparently got in touch with Ramskou, who immediately identified a few polarizing crystals, including cordierite, which turns from yellow to dark blue when it's at a right angle to the Sun's rays. He tested it on an SAS flight from Greenland to Denmark, with encouraging results. So if Horvath and his colleagues are correct, 20th century pilots may have been using the same method as the medieval Vikings.

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