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EARLY NORSE NAVIGATIONAL TOOLS

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ABSTRACT: In the History Channel series *Vikings* Ragnar Loðbrok tells his brother Rollo he wants to sail west to raid the rich lands there. His brother points out that no one can sail across the open water. In this scene Ragnar pulls out two tools that while being interesting in the development of the story are both also historically factual. This paper will discuss these two tools, the sól-skuggafjöl and the sólarsteinn, as well as the bearing dial and a more observational technique of polar mirages used by the early Norse sailors as they explored the North Atlantic waters.

KEYWORDS: Bearing Dial, Navigation, Norse, Sailing, Sailors, Shadow Board, Sólarsteinn, Sun Stone, Vikings

Norse sailors are portrayed as hardy, fearless adventurers. The Vikings, a more popular name for Norse sailor, were portrayed further as ruthless, bloodthirsty marauders who pillaged and terrorized the English coast for decades. While neither is completely accurate both are most likely close to the truth. The Scandinavian adventurers were predominantly farmers and fishermen. They sailed the coasts of their country fishing and eking out as successful a living as possible in the harsh climate until lack of food and arable land drove them to seek new areas to farm and fish.

The first recorded raid on the English coast was in 793 at Lindisfarne, a small island off the coast of Northumberland. The Holy Seat was an easy target to the Norse when they came ashore on June 8th of that year. (Fitzhugh/Ward) Some claim the Vikings came to pillage from the beginning of their mission. Others offer that at some point in the negotiations, since Vikings had traded with other areas of the country prior to this encounter, one of the monks, or the bishop himself, might have angered or insulted one of the Norsemen and tragedy ensued. Whoever is correct what happened next set the stage for a hundred plus years of raiding and bloodshed. But

the question of what happened is not as important as how it happened. How did the Norse get to the island in the first place?

From early times Norse sailors stayed close to the coasts using birds, the wind, and visual cues such as polar mirages to travel. The mirages were similar to those in the desert when atmospheric conditions allow images from over the curve of the earth to be seen. Lehn and Schroeder in their article Polar Mirages as Aids to Norse Navigation give the best explanation of the two types of Polar mirages that would have been available to the Norse sailors, even though the sailors themselves may not have known they were farther away than they looked.

The Hillinger effect of mirage occurs when the light rays are gently bent over the horizon. This gives a good interpretation of the image and a reasonable image. In the Hillinger effect it is difficult to ascertain the exact distance between the viewer and the item viewed due to the air temperature and the low aerosol content. (Lehn, Schroeder) The Novaya Zemlya effect is more intense than the Hillinger effect and becomes more distorted as the distance increases. These images would have given the sailors something to look at but to say that they could identify one from the other would be impossible. (Lehn, Schroeder)

These sailors were aware of what islands could be seen from where though so using the Faroes, the Shetlands, and other pieces of land scattered throughout the northern seas the navigators could find their destination in clear weather and relatively calm seas as well as the images from over the horizon that they probably didn't know they were not in close proximity to them.

When I received notification that I was to present at this conference I did what most of us do; I took out my phone and typed in the address of the conference hotel. After that I looked at the three routes offered and made a decision on which route to drive. On the way here I checked

the road conditions on my iPad and found a place to eat with Google. All of these are matter of fact actions that I am certain we have all done. However these are the most cutting edge techniques currently available for those that travel: define your route, check your route, and take your route to your destination.

In the History Channel series *Vikings* Ragnar Loðbrok tells his brother Rollo he wants to sail west to raid the rich lands there. His brother points out that no one can sail across open water. In this scene Ragnar pulls out two tools that while being interesting in the development of the story are both also historically factual; the sun shadow board or *sól-skuggafjöl* and the sun stone, a type of Calcium Carbonate called the *sólarsteinn*.

These two pieces of navigation equipment were at the time as cutting edge as the iPhone, the iPad, and the GPS is today. They allowed the sailors to navigate large stretches of open water without sight of land and successfully reach their destination as safely as possible.

So, What Do We Know?

We know that the *sólarsteinn* is a unique crystal in the mineral world. Called Icelandic Spar or Calcium Calcite the rhombohedral shape of the crystal and its 102° and 78° angles give the stone the capability to give both a positive and a ghost image of whatever is viewed through it. It has been cited since the early 13th Century when *Hrafn's Saga* was written, referencing a solar stone.

The original text of *Hrafn's Saga* is:

"Veður var þykkt og drífanda sem Sigurður hafði sagt. Þá lét konungur kalla til sín Sigurð og Dag. Síðan lét konungur sjá út og sá hvergi himin skýlausan. Þá bað hann Sigurð segja hvar sól mundi þá komin. Hann kvað glögg á. Þá lét konungur taka sólarstein og hélt upp og sá hann hvar geislaði úr steininum og markaði svo beint til sem Sigurður hafði sagt". (Johnson, Helgarson)

Here in the translation you see how King Olaf calls for Sigurður and uses the *sólarsteinn*:

“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”. (Vilhjalmsson)

The stone is held by the sailor or navigator and when one looks through it at the sky there appears a fuzzy circle of yellow light where the sun would be. Orienting the stone then gave the user the azimuth latitudinally and allowed the ship to progress forward. At least that was how it was supposed to work when in 1967 Thorkild Ramskou stated that the Norse had sunstones as a polarization analyzer for finding their location during overcast days. (Ramskou)

By 1994, though, Roslund and Beckman were disputing these suppositions and went as far as to say that ‘We do not know what sort of stone the sunstone was. Nor has any archaeological find of an object with the optical properties of an analyzer been found.’(Roslund, Beckman) In the July 1994 issue of Applied Optics they went on to say ‘no properly conducted experiment has been reported to show light from clouds to be anything but unpolarized.’ (Roslund, Beckman)

This trend to disbelieve the ability of the sólarsteinn continued in some circles until just recently when in July of 2014 a more definitive research proof was published. In Contemporary Physics Ropars, Lakshminarayanan, and Le Floch ran a series of tests on the stone to determine that the properties of the Iceland Spar do indeed conduct themselves in such a manner as to agree with the legends and earlier suppositions.

Coupled that with the piece of a Calcite fragment in Hofstadr and the intact, albeit clouded, complete piece recovered from the sunken Victorian ship at Alderney you have proof of the existence of the stones during the time period discussed and further proof of its ability.(Le

Floch, Ropar, Luca, et. al.) Therefore what we know is that the first part of the legends are true. The Sun Stone did exist and worked as described.

We also know that in the legends of the Faroes a device is described that would explain how many of the vessels were able to traverse open water in bright sunlight. (Marcus) The sól-skuggafjöl, or sun shadow board, was a round piece of wood that floated in a bucket of water. This sól-skuggafjöl consisted of a wooden disc inscribed with concentric circles and a pin inserted in the center. The pin acted as a gnomon and could be moved up or down according to the sun's relationship to the seasons. At midday the shadow of the peg would show the navigator whether he was sailing true to course latitudinally or whether he was off either too far south or too far north. (Marcus) While maps were relatively unknown local knowledge of the seas and directions were used by experienced navigators to travel successfully to their destinations.

The concentric circles were often, through previous experience and voyages, aligned to specific seasons. One circle could be for early spring while another would fit the later summer sun. These were the GPS of the times and as long as you had the sun visible at noon you could determine where you were and if you were going in the right direction. While discussion of this instrument exists no intact piece of a sól-skuggafjöl has been reported or documented. This is where the error begins. There have been pieces of a sól-skuggafjöl discovered. The problem with the discoveries are that these pieces were mislabeled as something else.

What We Are Not So Sure Of

The first piece of a sól-skuggafjöl was excavated from a Benedictine nunnery trash heap at Eystribygð in southwest Greenland in the summer of 1948 by Dr. C. L. Vebæk. (Sólver) The dial measured less than 3 inches {70-72 mm} and was made of oak. (Fitzhugh/Ward)

While the sól-skuggafjöl is mentioned in the Faeroese folk lore referenced by Pastor J. H. Shróter (Marcus) When Captain Sólver saw the piece years later he drew a conclusion that the piece was a bearing dial, completely discounting the idea that the simple piece could have been half of a sól-skuggafjöl. Thirlund in his book Viking Navigation explains how from the moment Sólver saw the piece of wood there was no doubt in his mind: “Captain Sólver took it to the window to study it closely in the daylight. Then he said ‘There is no doubt at all, this is a Sun-compass, a bearing dial.’” (Thirlund)

To add credibility to his conjecture Sólver further talks about a man named Oddi Helgason also called Star Oddi who supposedly was able to compute the directions to the rise of the sun from winter through summer to within an accuracy of $\pm 3^\circ$ using the bearing dial and azimuths of the sun and stars. When the direction of the sun is known this bearing dial became an actual compass with all cardinal directions available. The Norse seamen, according to Sólver, called this *deila ættir* or dividing the horizon. (Sólver) Sólver never seemed to take into account that the piece could have been anything else but a bearing dial and went as far as to commission a workman to create a completed piece extrapolated from the single broken disk.

Even though Sólver in *Vestervejen* calls the bearing dial a sólársteinn this paper will use the term Bearing Dial to differentiate the sólársteinn referenced in Hrafnr Saga (Ropars, Lakshminarayanan, Le Floch) with the device interpreted by Sólver.

I am not going to postulate that the piece of wood was not a Bearing Dial; however, it didn't take long, before others began seeing the misinterpretation of the article. In the January 1954 edition of the Journal of Navigation E. G. R. Taylor, and other noted authorities, take issue with the statements of Sólver and his Bearing Dial. Taylor agrees with others that when Sólver calls the Bearing Dial a sólársteinn he is mistaking the piece of wood for the actual

Iceland Spar previously discussed. This is where some of the misunderstanding began: sun compass or sun stone.

W. E. May after discussing Taylor concludes that there does not seem to be any proof one way or another that this is a Bearing Dial (Taylor). Further R. B. Motzo in the same article questions both the use of the piece of wood as well as the age. Motzo supposes that, as did Taylor, the piece could be a broken embellishment for furniture or more likely a device used to mark the wafers used during Mass called pinta-pane. This latter hypothesis seems the more likely since the object was found on the site of a Benedictine nunnery; the nuns would have stood more in need of such an instrument than of a bearing-dial.” (Taylor). And since the trash dump that the piece was found in was a collection of accumulated debris the actual age of the piece could be off as much as two or three hundred years. (Taylor)

Finally T. C. Lethbridge in the same Taylor article states that the object must be treated as an unknown. He proposes a number of possibilities, though, as to the use, and none of them are as a Bearing Dial. It could be a piece of a butter mold. It could have been the top of a coopered keg. It could have been an identification piece for a fish trap. Of all the items he offers as possibilities he states definitely that he feels the Greenland disk is certainly not a Bearing Dial. (Taylor) And until the Wolin disc was discovered the Greenland disc was all there was.

In 2000 at the archaeological excavation site in Wolin Poland a complete wooden disc was found by the team of Filipowiak. (Stanislawski) If belief in the Bearing Dial hypothesis holds then it is evident that there are possibly two things happening at once. The rings on side A of the dial are indicative of the rings of the söl-skuggafjöl. There is little other use for these three rings if not for latitude. Where the rings led are still open to conjecture but the fact that there are distinct circles carved into the dial shows that at least three destinations or times were marked.

However there are also marks for the cardinal directions in the disc which would indicate that the item could have been used as Sólver proposed as a Bearing Dial. The size of this intact disc at 81-86 mm in diameter and 9 mm in thickness is in line with the partial piece found in Greenland. Both would be small enough to fit in a ship's bucket and yet large enough to be hand held as proposed and described by Sólver. The center pin, or gnomon, would be interchangeable with the handle of a bearing dial as shown in *Vestervejen*.

In support of this dual use hypothesis Bernath, Blaho, et. al, have proposed that the dial is a combination söl-skuggafjöl and Bearing Dial. If this is true then sailors had the ability to multi task their instruments by the time Polish woodworkers and navigators began making and using the pieces. (Bernath, Blaho, Egri, Andras, Horvath)

The flaw in all of this is the hole in the middle of the pieces. The size, roughly 9 mm, would be too large for a gnomon. The size of the upright would obscure some of the measurements. Therefore a handle would have had to have been used as Sólver hypothesized but that too has drawbacks. Both Norse and Polish woodworkers were adept at their craft. However both of these discs are rudimentary. They appear to have been quickly created and poorly measured. It is unlikely that a people that were so detail oriented as to create handles and other tools with intricate carvings to their Gods and nature would create a crudely carved piece of wood with some scratched lines on it.

An answer for the large central hole comes from Blázs Bernáth who interpreted this piece as a Twilight Board. Unlike the Bearing Dial the Twilight Board had a free floating gnomon. Bernáth explains "In this work we suggest that the large central hole of the Uunartoq sundial fragment might have a key role in navigation and its diameter might have been purposefully

chosen. Assuming the use of two sunstones and an appropriate shadow stick the instrument could have functioned even after sunset until the end of civil matutinal and crepuscular periods.”

The Twilight Board worked in obscure light by taking two readings with the sólarsteinn and then pointing the Twilight Board gnomon toward the spot where the two lines intersected. Aligning the gnomon on that spot would then give the navigator cardinal directions and a heading to continue sailing.

The Twilight Board explains many of the discrepancies of the Sólver assumptions while holding to the basic tenets of navigation. Similar to Sólver, though, the Bernáth explanation is another alternate hypothesis for this broken piece of oak. Until a complete example of either a Bearing Dial or a Twilight Board is excavated there is still room for discussion.

CONCLUSION: The sólarsteinn has withstood the test of time and we now have proof that Norse sailors used these to traverse the oceans in overcast weather. Polar mirages are known phenomenon that would have been useful to the Norse sailors as they travelled back and forth from their home land to explore the world. The sól-skuggafjöl, the Bearing Dial, and the Twilight Board are still in discussion. This paper looked at the four tools and offered suggestions for what they could have been or what they were not considered.

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