

# Experimental study of the possibility of sky-polarimetric viking navigation

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## Abstract

*Between the 9-13th century the Vikings ruled the northern area of the Atlantic ocean. Being prominent seafarers and experienced navigators, they covered huge distances throughout the ocean and discovered Iceland, Greenland and the eastern coasts of North America. This outstanding performance assumes a thorough and precise navigational method, about which there is not enough information at all. The only historical finding is the fragment of a wooden sun-compass that could have been used for navigational purposes. The other clue to solve the mystery of Viking navigation is the mysterious sunstone which frequently occur in various Viking sagas as a tool for determining the solar position even if the sun is occluded by clouds, fog or the horizon. This sunstone could be a dichroic or birefringent crystal, by which the skylight polarization can be analysed. We conducted field experiments and psychophysical laboratory studies to examine the applicability of the alleged sky-polarimetric Viking navigational method. Measuring the error functions of the different steps of this navigational method, we determined how usable it is under different weather (sky) conditions. In our talk we summarize our results in this topic.*

# Experimental Study of the Possibility of Sky-Polarimetric Viking Navigation

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Between the 9-13<sup>th</sup> century the Vikings ruled the northern area of the Atlantic Ocean. Being prominent seafarers and experienced navigators, they covered huge distances throughout the ocean and discovered Iceland, Greenland and the eastern coasts of North America. This outstanding performance assumes a thorough and precise navigational method, about which there is not enough information at all. The only historical finding is the fragment of a wooden sun-compass that could have been used for navigational purposes. The other clue to solve the mystery of Viking navigation is the mysterious sunstone which frequently occur in various Viking sagas as a tool for determining the solar position even if the Sun is occluded by clouds, fog or the horizon. This sunstone could be a dichroite or birefringent crystal, by which the skylight polarization can be analysed. We conducted field experiments and psychophysical laboratory studies to examine the applicability of the alleged sky-polarimetric Viking navigation method. Measuring the error functions of the different steps of this navigational method, we determined how usable it is under different weather (sky) conditions.

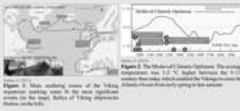


Figure 1. Map showing some of the Viking territories and the location of the sun-compass. Figure 2. The Model of Viking Navigation. The average error function for the sun-compass is shown in the plot. Below of Viking navigation method.

### The Viking era and the method of climatic optimum

The fourth millennium before present (BP) the Vikings sailed across the North Atlantic region in the 9<sup>th</sup> century. Their excellent sailing and navigational skills were demonstrated by the discovery of the Vinland (North America) in 1000 AD. The Vikings sailed across the North Atlantic region in the 9<sup>th</sup> century. Their excellent sailing and navigational skills were demonstrated by the discovery of the Vinland (North America) in 1000 AD. The Vikings sailed across the North Atlantic region in the 9<sup>th</sup> century. Their excellent sailing and navigational skills were demonstrated by the discovery of the Vinland (North America) in 1000 AD.

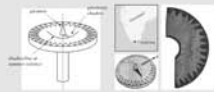


Figure 3. Model of the sun-compass and the model of Viking navigation. The sun-compass is shown in the top left. Below of Viking navigation method.

### The sun-compass

The sun-compass is a navigational instrument used by the Vikings to determine the solar position. It consists of a circular dial with a gnomon and a scale. The sun-compass is used to determine the solar position by measuring the length of the shadow cast by the gnomon. The sun-compass is used to determine the solar position by measuring the length of the shadow cast by the gnomon.

### The mysterious sunstone

The mysterious sunstone is a crystal that is used to determine the solar position. It is a dichroite or birefringent crystal. The sunstone is used to determine the solar position by measuring the length of the shadow cast by the gnomon. The sunstone is used to determine the solar position by measuring the length of the shadow cast by the gnomon.

### Navigational based on skylight polarization

Navigational based on skylight polarization is a method of navigation that uses the polarization of skylight. It is a method of navigation that uses the polarization of skylight. It is a method of navigation that uses the polarization of skylight. It is a method of navigation that uses the polarization of skylight.



Figure 4. Sunstone, the diagram showing the sun's position and the resulting shadow. The sunstone is used to determine the solar position by measuring the length of the shadow cast by the gnomon.

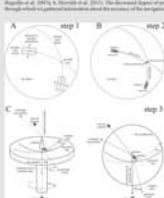


Figure 5. The steps of the navigational method. Step 1: Determination of the direction and the resulting shadow. Step 2: Determination of the sun's position. Step 3: Determination of the sun's position.

### Laboratory study of the first navigational step

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Figure 6. Experimental setup used for the laboratory investigation of the first step of the navigational method. The sun-compass and the sunstone are shown in the photograph.

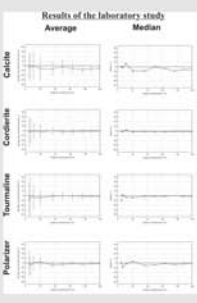


Figure 7. Results of the laboratory study. The table shows the average and median values for Calcite, Calcite, Tourmaline, and Polarizer.



Figure 8. Number of cases where the first step was not changed in the polarimetric study through the results of the different numbers of experimental conditions.

### Psychophysical study of the second navigational step

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Figure 9. Results of the psychophysical study. The graph shows the number of cases where the second step was not changed in the polarimetric study through the results of the different numbers of experimental conditions.

### Summary

Summary: The study examined the applicability of the alleged sky-polarimetric Viking navigation method. The results show that the method is usable under different weather conditions.

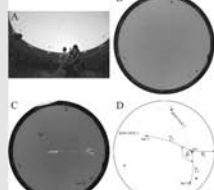


Figure 9. Experimental setup used for the laboratory investigation of the second step of the navigational method. The sun-compass and the sunstone are shown in the photograph.

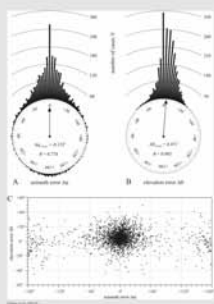


Figure 10. Results of the psychophysical study. The graph shows the number of cases where the second step was not changed in the polarimetric study through the results of the different numbers of experimental conditions.

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ELTE Gothard Asztrfizikai Observatórium és Multidiszciplináris Kutatóközpont • MTA Csillagászati és Földtudományi Kutatóközpont Konkoly Thege Miklós Csillagászati Intézet • Vas Megyei TIT Egyesület



## Ég és Föld vonzásában – a természet titkai

Projekt azonosítója:

TÁMOP-4.2.3.-12/1/KONV-2012-0018

SZÉCHENYI 2020



MAGYARORSZÁG  
KORMÁNYA

Európai Unió  
Európai Szociális  
Alap



BEFEKTETÉS A JÖVŐBE

NEW CHALLENGES IN ASTRO – AND ENVIRONMENTAL INFORMATICS IN THE BIG DATA ERA

Szombathely, Hungary, 14-16 May, 2014

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*Proceedings of the  
workshop*

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14-16 May, 2014*

**New challenges in astro- and  
environmental informatics  
in the Big Data era**

Proceedings of the workshop

Szombathely, Hungary

14-16 May, 2014

Edited by  
J. Kovács and Gy. M. Szabó

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Published by

Gothard Astrophysical Observatory of Eötvös Loránd University

in conjunction with

Vas County Scientific Educational Association

Sponsored by

TÁMOP-4.2.3.-12/1/KONV-2012-0018

"Ég és Föld vonzásában – a természet titkai"

Printed by Yellow Design Kft.

ISBN 978-615-5288-07-4

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