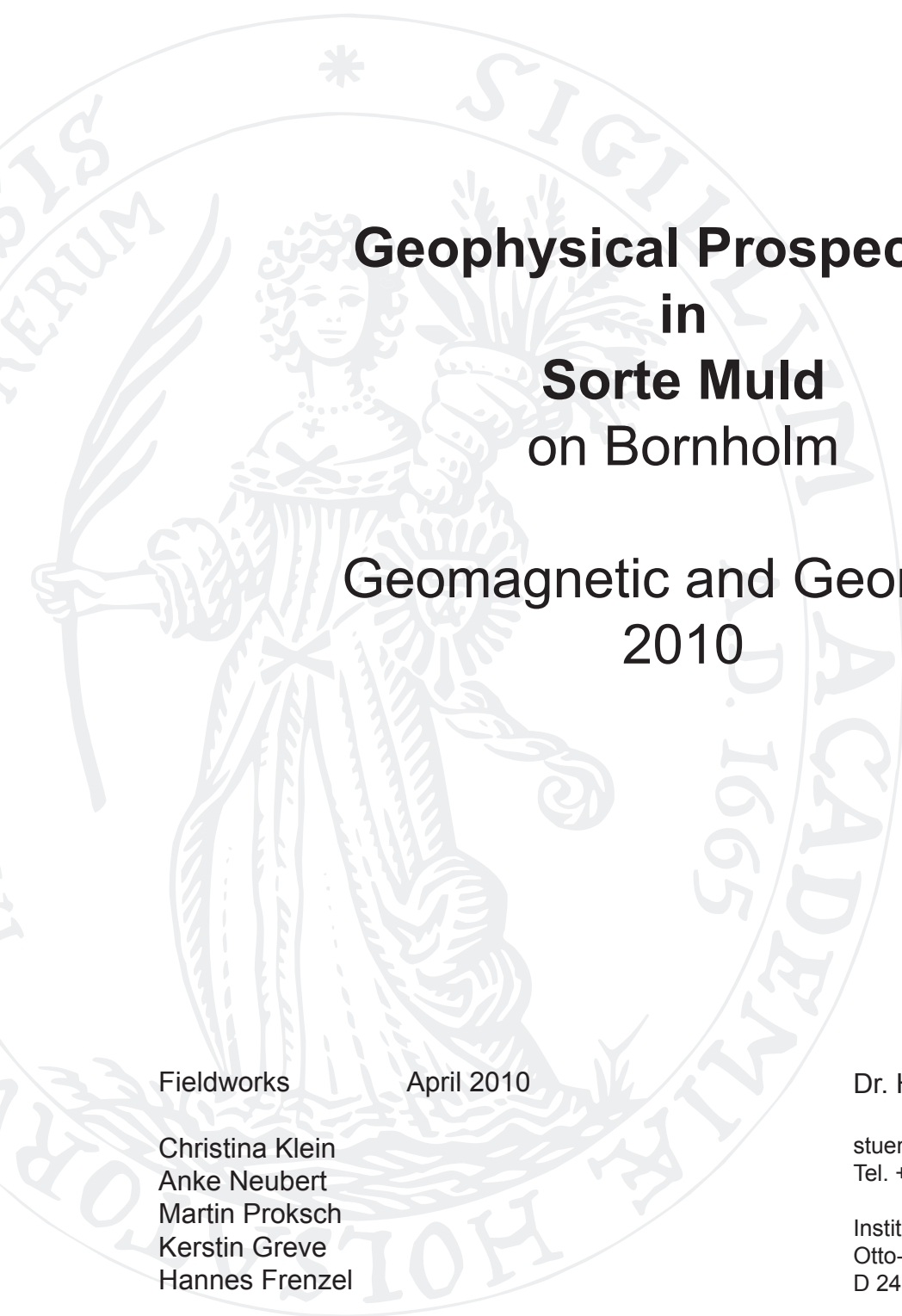


C | A | U

Christian-Albrechts-Universität zu Kiel

Institut für Geowissenschaften

Geophysik-Archäometrie



# Geophysical Prospection in Sorte Muld on Bornholm

## Geomagnetic and Georadar 2010

Fieldworks

April 2010

Christina Klein  
Anke Neubert  
Martin Proksch  
Kerstin Greve  
Hannes Frenzel

Dr. Harald Stümpel

stuempel@geophysik.uni-kiel.de  
Tel. ++49 431 - 880 3903

Institute of Geosciences - Geophysics  
Otto-Hahn-Platz 1  
D 24118 Kiel

# Contents

## **1. Methods of fieldmeasurements**

1.1 Geomagnetic

1.2 Georadar

1.3 Navigation

## **2. Sorte Muld**

Fixpoints

Geomagnetic data

Georadar data

## **3. CD - with data, digital pictures and drilling results from Hannes Frenzel**

## 1. Methods of fieldmeasurements



## 1.1 Geomagnetic

The geomagnetic survey was accomplished with a magnetometer array consisting of 6 Fluxgate magnetometers of the firm Dr. Förster (type Ferrex DLG 4.032.82). On our measurement cart (picture to the right) the magnetometers are mounted with a distance of 0.50 cm to each other. So the fieldwork will cover a space of 3 meters with parallel profiles.

The system will accumulate 10 data values per second in profile direction. The average working speed is between 0.6 m/s and 1.2 m/s. The DGPS will send one event-trigger per second. This event will be recorded with the data and it will be used for later correlation with the laminar GPS-coordinates.

The single Fluxgate magnetometers are measuring the vertical component of the earth magnetic field. Each sensor contains two of these magnetometers, which are situated in a vertical distance of 0.6 m to each other. The measured variable, which describes the difference of both signals with a resolution of 0.0238 nT, will be recorded digital to an 8-channel data logger. The resolution of the sensors is around 0.5 nT. With calculating the differences between the measurement signals disturbing signals e.g. geological structures in the depth or anomalies that are situated sideward will be attenuated and extinguished respectively. The penetration range is depending on the size of the sought object. Bigger anomalies are also well located in larger depths. For more exact estimations you have to accomplish calculations with predetermined boundary conditions.



Foto: H.Frenzel

The results are shown in greyscale pictures in the following chapters. Minimum values will be displayed light grey, according to the lower magnetisation of the subsoil, and dark grey corresponds to high magnetisation values. The picture resolution is 0.20 x 0.20 metres. And for expressing the dynamic range of the near-surface magnetic field there are several pictures with differing greyscale ranges for each location and one picture with a coloured scale.

## 1.2 Georadar

Beside geomagnetic as the classical prospecting method we used Georadar on places with special interest. Ground penetrating radar (GPR) is a reflective method compared to the foregoing described potential method geomagnetic and provides therefore the highest vertical resolution. A short high-frequency electromagnetic pulse will be sent into the ground and adjacent all possible reflection answers will be recorded over a certain time.

Reflections occur at horizons in the subsurface if there is sufficient contrast in the electrical properties. Out of the two-way-traveltime you can appreciate the depth of the reflector if you know the exact velocity of propagation in the medium. The average speed of an electromagnetic wave in the subsoil is between 8 – 12 cm/ns.

For the measurements we used a 2-channel measuring equipment (SIR-20) from GSSI. The antenna frequency was 400 MHz. Antenna with lower frequencies will have a bigger penetration depth but antenna with higher frequencies deliver a more accurate picture of the upper soil horizon.

The navigation follows the same configuration as described in the geomagnetic chapter.

The data will be displayed in time-slices and radargrams in the according location chapters. A radargram is the profile, which you are walking along while collecting data with the GPR-antenna. It is a vertical section into the underground in with it is possible to identify typical reflections. But an interpretation only with radargrams is not simple. Instead it is common to compute time-slices, which is the summation of the amplitude of the reflected signal in a certain time window. The result is a picture of an area that is comparable with a plane in an archaeological excavation. Now it is possible to follow a particular structure through different depths.



Foto: A.Neubert



Foto: A.Neubert

### 1.3 Navigation

#### Surveying and mapping

Each location has its local coordinate system. This system was used for the geophysical investigations. Supporting points were situated inside and outside of the measuring area.

The continuous position determination during the geophysical measurements was accomplished with a DGPS-system from Leica. The first step was to execute a positioning inside of the local coordinate system with the mobile part of the DGPS-system. With enough satellites it is feasible to get an accuracy of 0.02 m.

During the measurements the GPS-antenna on the magnetic cart will send 5 local coordinates per seconds in real-time to the navigation laptop. There the positions will be recorded and displayed on the screen so it is possible to monitor the measurement progress. While investigating only one person is needed to handle the system.

Later on the coordinates will be combined with the magnetic data. Some measurement gaps can appear, which are caused by positioning errors. This can happen when there are too less satellites or the GPS-antenna is shielded. The error margin is set to 0.20 m, which is equivalent to the pixel size of the magnetic data picture.

The used fixed points at each site are presented on the according page.

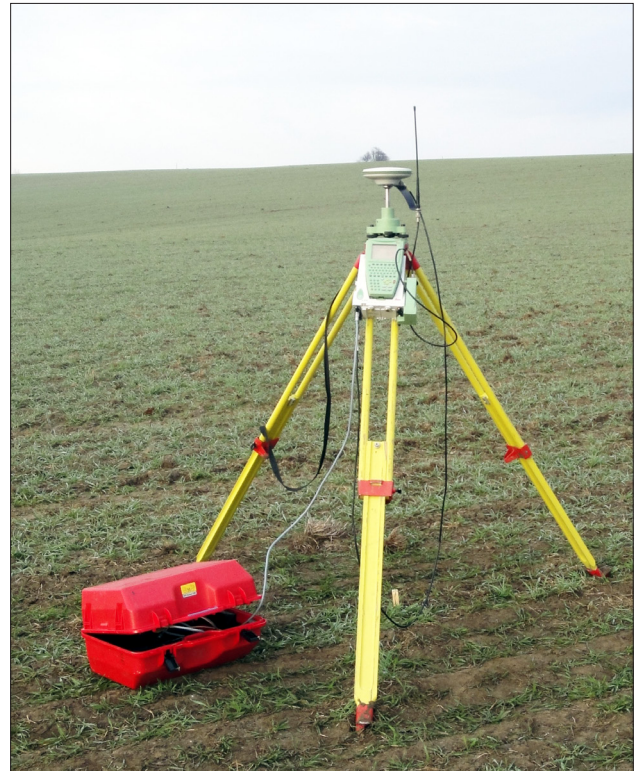


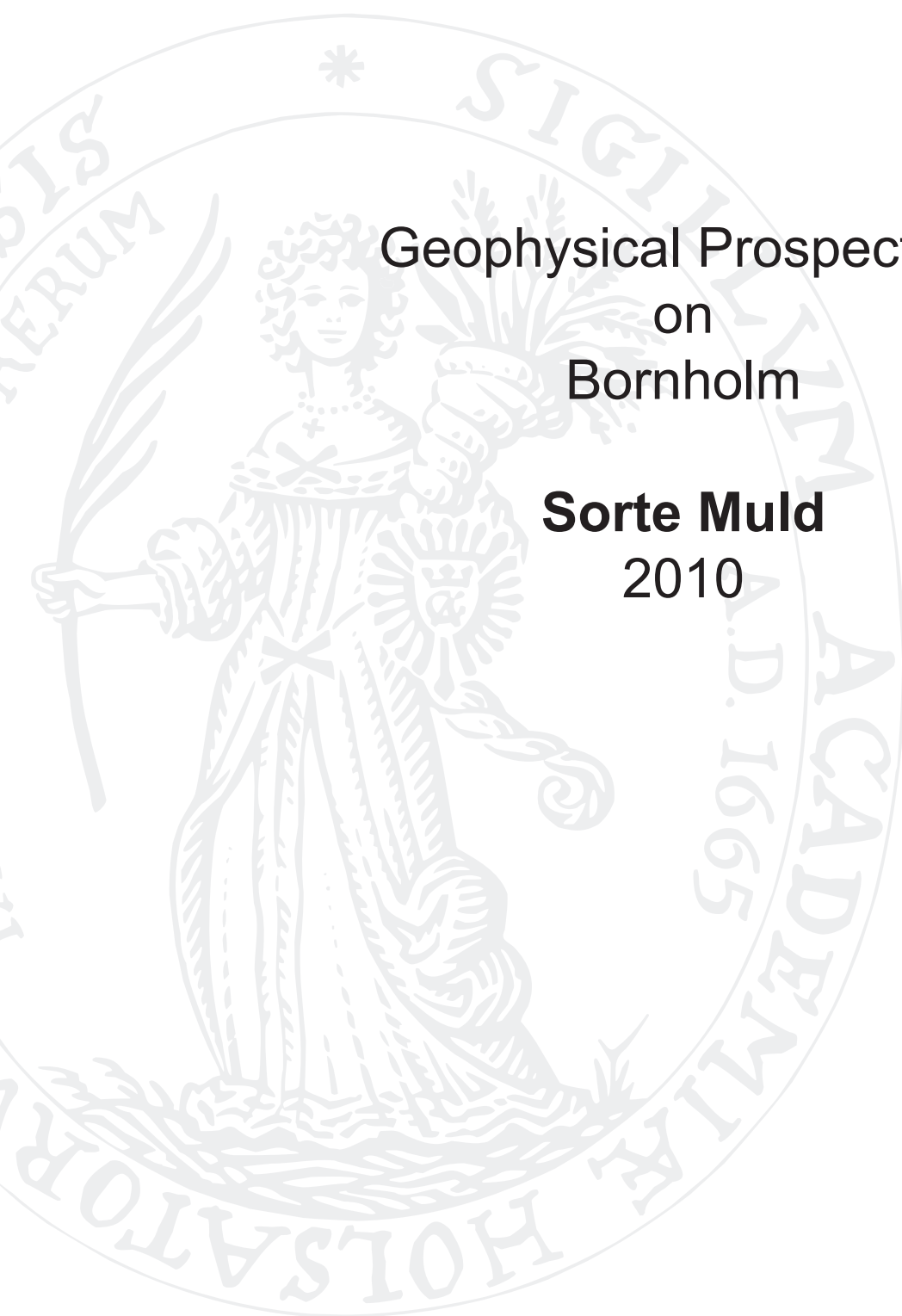
Foto: A.Neubert

C | A | U

Christian-Albrechts-Universität zu Kiel

Institut für Geowissenschaften

Geophysik-Archäometrie



# Geophysical Prospection on Bornholm

## Sorte Muld 2010

## 2. Sorte Muld

### Fixpoints

Local coordinates	Sorte Muld		
Pointnumber	East	North	Height
2	35584.9830	52505.2800	42.4250
3	35666.0550	52084.0250	47.8270
4	34979.8140	52041.7090	32.1360
7	35419.8350	51743.0500	50.3000
139-02	35895.0470	51404.7920	68.0900
11	34835.0450	50979.5320	56.3200
PIG	35122.2800	52203.1700	54.3000

WGS84 coordinates	Sorte Muld		
Pointnumber	Latitude	Longitude	Height
2	55° 07' 26.82771" N	15° 06' 37.24325" E	100.2730
3	55° 08' 02.38263" N	15° 06' 54.93613" E	74.6230
4	55° 07' 48.76873" N	15° 06' 50.28553" E	80.0037
7	55° 07' 47.32864" N	15° 07' 29.00501" E	64.2850
139-02	55° 07' 12.96643" N	15° 07' 36.97702" E	88.5400
11	55° 07' 52.56501" N	15° 07' 20.99553" E	86.4644
PIG	55° 07' 37.71759" N	15° 07' 04.12074" E	82.4680

## 2. Sorte Muld

### Geomagnetic data

overview picture

Sorte Muld (all area)	greyscale	-12nT	-	+12nT
Sorte Muld Topography (all area)		min	-	max

Sorte Muld (2D high pass center part detail)

	greyscale	-9nT	-	+9nT
Sorte Muld (2D high pass SE part detail)	greyscale	-9nT	-	+9nT

Svendshøj-Engegård	greyscale	-12nT	-	+12nT
Svendshøj-Engegård	greyscale	-6nT	-	+6nT
Svendshøj-Engegård	greyscale	-4nT	-	+4nT
Svendshøj-Engegård Topography		min	-	max

Kjøleregård (raw data)	greyscale	-16nT	-	+16nT
Kjøleregård (2D high pass)	greyscale	-16nT	-	+16nT
Kjøleregård (2D high pass)	greyscale	-9nT	-	+9nT
Kjøleregård Topography		min	-	max

Dalshøj (raw data)	greyscale	-24nT	-	+24nT
Dalshøj (substract field continuation)		-24nT	-	+24nT
Dalshøj (substract field continuation)		-12nT	-	+12nT
Dalshøj Topography		min	-	max

## 2. Sorte Muld

### Georadar data

Plan of the Georadar areas related to the Geomagnetic

Timeslices in different depths

Plan of the radargramms with sketched in anomalies

Radargramms with anomalies

**3. CD - with data, digital pictures and  
drilling results from Hannes Frenzel**

