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Christian-Albrechts-Universität zu Kiel

Institut für Geowissenschaften

Geophysik-Archäometrie

Geophysical Prospection in Rispebjerg on Bornholm

Geomagnetic and Georadar 2010

Fieldworks April 2010

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Contents

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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.

Foto: H.Frenzel

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 lager depths. For more exact estimations you have to accomplish calculations with predetermined boundary conditions.

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.

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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 200 MHz in Rispebjerg. 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

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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.

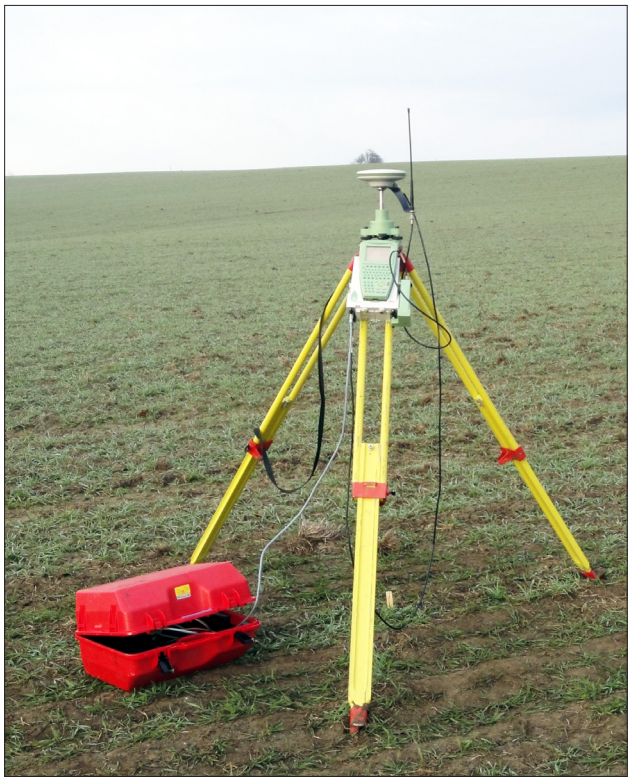

Foto: A.Neubert

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Rispebjerg

2010

2. Rispebjerg

Fixpoints

Local coordinates	Rispebjerg		
Pointnumber	East	North	Height
1	42281.9770	40393.4770	30.8530
2	42396.9760	40507.2760	26.0970
3	42447.6450	40503.2320	24.4030
4	42503.3100	40498.9430	22.3350
6	42270.0870	40617.4050	40.5770
SNAP	42186.5650	40403.6740	44.0200

WGS84 coordinates	Rispebjerg		
Pointnumber	Latitude	Longitude	Height
1	55° 01' 31.24823" N	15° 00' 35.81665" E	63.2746
2	55° 01' 34.93425" N	15° 00' 29.35392" E	58.5159
3	55° 01' 34.80614" N	15° 00' 26.50139" E	56.8219
4	55° 01' 34.67035" N	15° 00' 23.36761" E	54.7539
6	55° 01' 38.48875" N	15° 00' 36.50681" E	72.9936
SNAP	55° 01' 31.57283" N	15° 00' 41.18824" E	76.4415

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2. Rispebjerg

Geomagnetic data

overview picture with geomagnetic	greyscale	-4nT	-	+4nT
overview picture (including Tatyana N. Smekalovas results)	greyscale	-4nT	-	+4nT
Rispebjerg (lower area)	greyscale	-6nT	-	+6nT
Rispebjerg (lower area)	greyscale	-4nT	-	+4nT
Rispebjerg Topography (lower area)		min	-	max
Rispebjerg (upper area)	greyscale	-6nT	-	+6nT
Rispebjerg (upper area)	greyscale	-4nT	-	+4nT
Rispebjerg Topography (upper area)		min	-	max

Georadar data

Positon plan of the radarprofiles and examples

Radargramms and first structures/interpretations

Radargramms and drillings (all drillings on the CD at the end)

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