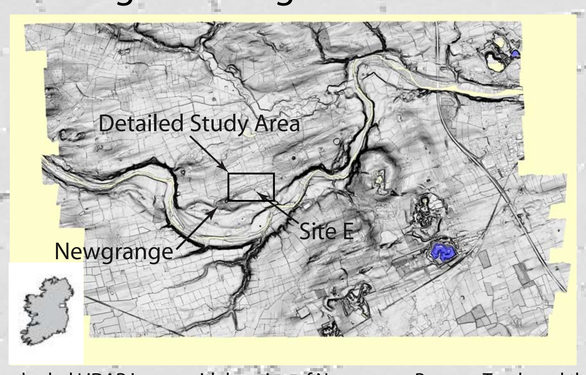
An Assessment of the Archaeological Potential of a Low-Level Airborne Geophysical Dataset from the Boyne Valley, Ireland

Kevin Barton[1], Conor Brady[2] & Robert Meehan[3]

The Brú na Bóinne Research Framework document (Smyth et al. 2009) has advocated a shift in research focus away from sites and towards landscape. It is in this area that remote sensing techniques have an important role. The Brú na Bóinne Remote Sensing Project addresses this aim and is testing and assessing a range of geophysical techniques that will be used in a large-scale systematic remote sensing survey and will be integrated with other remote sensing datasets. The preliminary work presented here is investigating data collected at different scales in defining zones of archaeological potential.

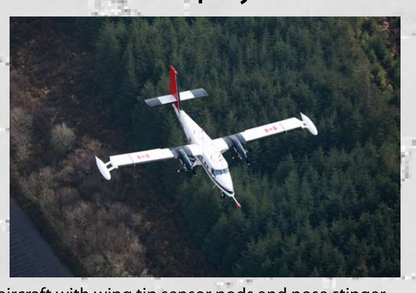
Archaeological Background



Slope-shaded LiDAR image with location of Newgrange Passage Tomb and the study area. (Data courtesy of Meath County Council and the Discovery Programme)

Brú na Bóinne, has been an important ritual, social and economic centre for thousands of years. It was designated a UNESCO World Heritage Site (WHS) in 1993. Although extensive research has been undertaken, this has focused on the excavation of and geophysical survey of some monuments. Little extensive systematic field survey of the wider landscape has taken place. We still lack an in-depth understanding of the site's broad range of archaeological monuments, spanning over 6,000 years from the Neolithic passage tombs to the Battle of the Boyne (AD 1690) battlefield, and the landscape and communities that shaped them..

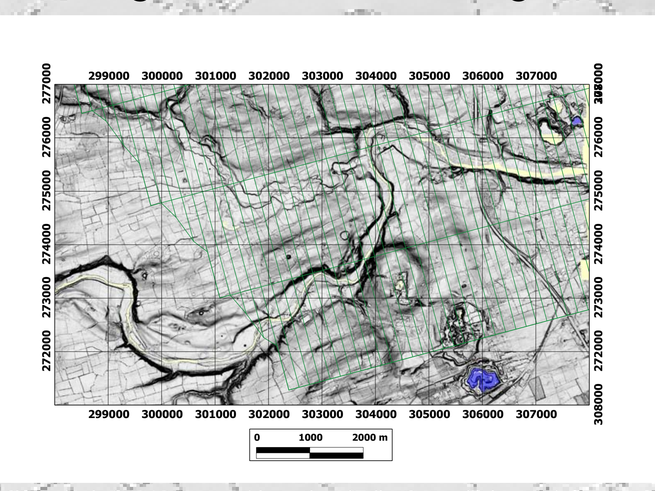
Tellus - Airborne Geophysical Survey



Twin Otter survey aircraft with wing tip sensor pods and nose stinger
(Photo: courtesy Geological Survey of Ireland)

The airborne geophysical data being used in this assessment was collected as part of the Tellus Border Project by the Geological Survey of Ireland and the Geological Survey of Northern Ireland. Data collection was for a regional environmental survey to define background geo-environmental values for rock, soil and water.
Simultaneous geophysical measurements were made using a Twin Otter aircraft. High resolution total magnetic field measurements were made using caesium vapour sensors mounted in the left wing tip and a nose stinger. Electromagnetic measurements were made with a 4 frequency system mounted in the wing tips. A gamma-ray spectrometer with onboard detectors measured K, U, Th and total counts
The combination of sensors provides geophysical and geochemical parameters used to define regional soil/land types and zones.

Tellus - Flight and Tie Line Coverage



Slope-shaded LiDAR image with overlay of Tellus Survey flight and tie lines.

The Tellus airborne dataset was collected during low-level (59m agl) surveys carried out in 2012. The flight line spacing was 200m with tie-lines spaced 2000m apart. The sampling interval along each line is c. 6m.

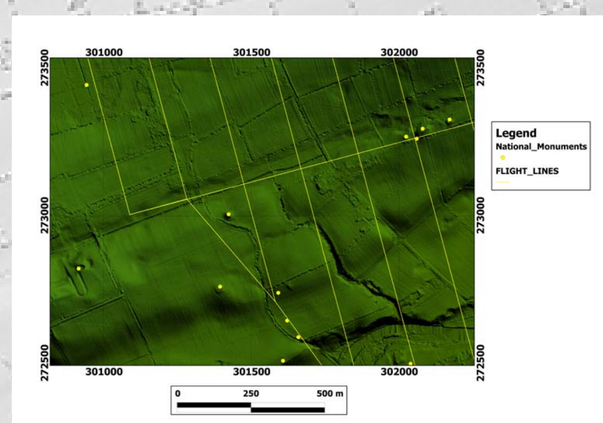
GEEP - Survey Coverage of the Study area

Location of Site E and GEEP survey in Field 112

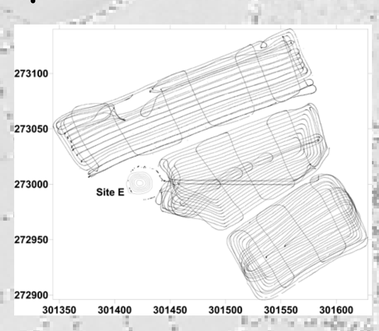
GEEP - Terrestrial Geophysical Exploration Equipment Platform

The GEEP system comprises a tractor unit with datalogger and Wi-Fi antenna. The sled is configured with 4x caesium vapour sensors spaced 1m apart, a centrally mounted DualEM 421S 6-receiver coil EM system, GPS antenna and 3-axis compass. Data are transmitted in real time via the Wi-Fi link from the tractor unit to a datalogger in the trailer unit for quality control.

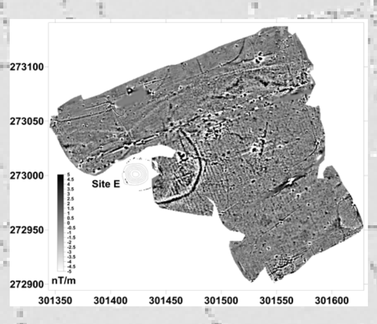
Tellus - Coverage of the Study area



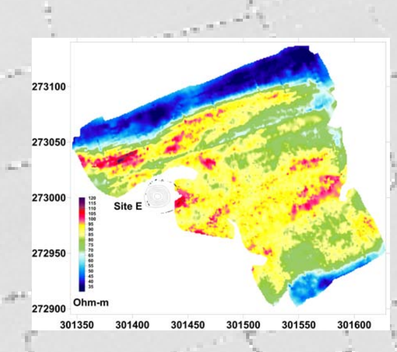
GEEP Electromagnetic and Magnetic data for Field 112



Total field magnetic data were collected along 4 continuous tracks 1m apart with a sampling interval of c. 0.4m.
Electromagnetic data were collected synchronously with the magnetic data along tracks 4m apart with a c. 0.4m sampling interval.

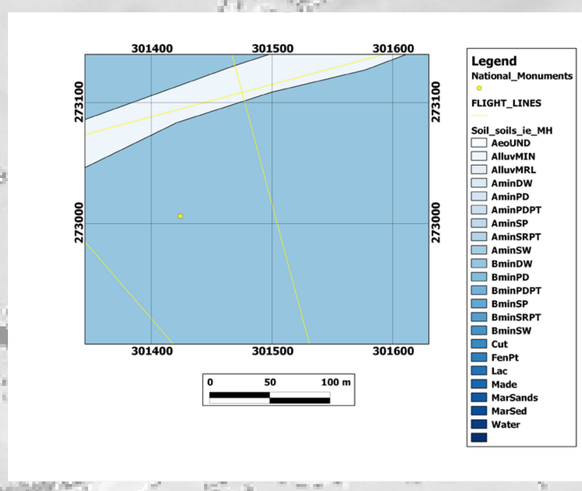


The data from all 4 magnetometer sensors were combined to produce a total field magnetic map. which shows a ditch partially surrounding the Site E mound and evidence of cultivation



The differentiation in the electromagnetic data is interpreted to show the relationship of the archaeology to the soil, subsoil and shallow bedrock geology. The data at a nominal depth of 2m are displayed as resistivity values in Ohm-m. Low resistivity (blue) alluvium is evident at the north and south of the survey area with sub-parallel higher resistivity bands representing glacially derived sediments.

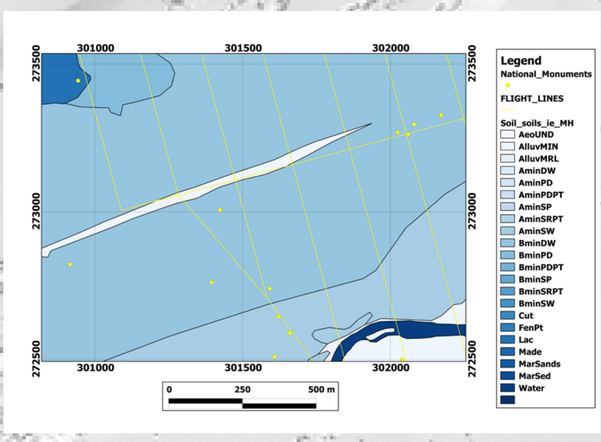
Soils and Tellus Electromagnetic data for Field 112



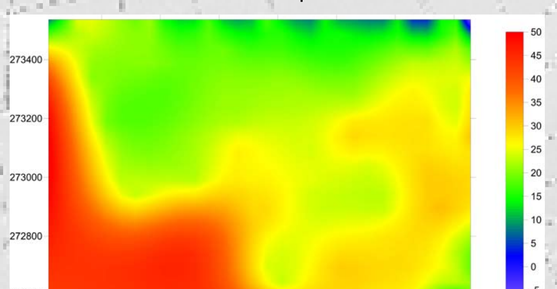
The soils map for the GEEP survey area of Site E in Field 112 show a single class of mineral soil with the thin band of alluvial material lying at the north of the map. The location of two Tellus flight lines and Site E are also shown on the map.

The electrical conductivity map in millisiemens per m for the area of Field 112 shown above does not correlate with the alluvial zone seen in the soils map and as a low resistivity zone evident in the GEEP data. There is some broad conductivity zonation which is not possible to identify without soil sampling.

Soils and Tellus Electromagnetic data for the Study area



The soils around the area of Brú na Bóinne are predominately deep and well drained and of basic (alkaline) chemical reaction. On the north side of the river, where shale bedrock dominates and the soils are clayey, most of the soils are acid and poorly drained. However this changes close to the river where well drained limestone dominated sands and gravels dominate, leading to the well drained alkaline materials. The soils map presented here is based on large scale reconnaissance mapping and shows a broad classification of two types of mineral soil with a thin band of alluvial material. The location of the Tellus flight lines and recorded archaeological monuments are also shown on the map.



The electrical conductivity map in milliSiemens per m for the Study area may have a very broad correlation with the soils map for the area. There appears to be two zones of conductivity perhaps with their boundary running along a line defined by the alluvial band which is not differentiated in this map.

Conclusions: The Tellus data with its 200m flight line spacing may provide a means for broad classification of the soils in Bru na Boinne which may assist in the assessment of the archaeological potential of the area. This hypothesis remains unproven. The available soils mapping needs to be verified by a programme of more detailed soil sampling informed by the Tellus electrical conductivity data. At the moment the GEEP resistivity data with its 4m line spacing appears to be the most appropriate means of soil mapping at an archaeological monument scale. The results need to be verified by soil sampling.

Reference: Smyth, J., Brady, C., Chadwick, J., Condit, T., Cooney, G., Doyle, I., Guinan, L., Potterton, M., Stout, G. and Tuffy, C. 2009. Brú na Bóinne World Heritage Site Research Framework. Dublin: The Heritage Council.

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1. Landscape and Geophysical Services, Claremorris, Co. Mayo, Ireland; 2 . Humanities and Social Sciences Research Centre, Dundalk Institute of Technology, Co Louth, Ireland; 3. Antalamh, Navan, Co. Meath, Ireland

Background Image: Brú na Bóinne LiDAR. Courtesy of Meath County Council, Discovery Programme