Recreating an Icy Past: Modelling the Quaternary Galtrim Moraine

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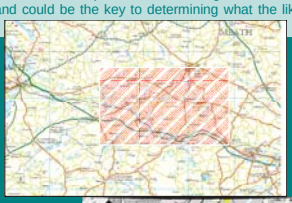
INTRODUCTION

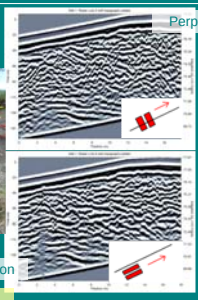
The quaternary period began some 2.6 million years ago and glaciations have occurred globally throughout this time. The last of these ice ages in Ireland began around 30,000 years ago ending close to 11,000 years ago. Knight (1999) argues that the entire global environment has at one point been affected by the actions of glaciers and Ireland is no exception. Glaciations in Ireland shaped the landscape of Ireland today arguably more dramatically than any other force or event ever, esker ridges and morainic belts impose themselves on much of the lowland areas and dramatic valleys provide stunning vistas in much of the upland regions. The climatic events of the past and the growth and decline of the ice sheets in Ireland have created diverse glacial deposits, "comprising the world's most important field of drumlinised ribbed moraine." (McCabe, 2008) It is estimated that approximately 90% of Ireland is covered by glacial deposits but the problem is that so much of what remains is being quarried for the resources contained within them. They are being eradicated at an alarmingly quick rate and this is why now seems like an appropriate time to study them and try and gather all the information they have to give. They impact on not only the physical appearance of the landscape but also on things like drainage patterns, hydrology, farming, development, and could be the key to determining what the likely fate may be of modern glaciers.



STUDY AREA

This work sets out to ultimately reconstruct a model of the glacial past of Ireland centred around Galtrim, Co. Meath. This area comprises a complex system of depositional features of the late Quaternary period in Ireland. Moraines formed at the margins of the ice sheet in a NE-SW alignment locating an area where there was a temporarily stabilised halt in the recession of the ice and is associated with well defined esker systems. Much research in this area (Synge, 1950) has been largely from a geomorphological point of view. The reconstruction of the glacial evolution and deglacial processes in this region are greatly constrained because of the lack of 3–dimensional morphology, limited due to lack of exposures.

GPR TRAINING SITES



Perpendicular-Broadside Orientation

Parallel-Broadside Orientation

The PR-BD Orientation appears to give better definition of hyperboles than the PL-BD. There is also less attenuation of the signal at depth in certain areas. Other features and aspects of a GPR systems will also affect the returned signal and images obtained including gain, frequency of antenna, sampling interval, step size to name a few and these are all being tested so the optimal settings are implemented.

FORWARD MODELLING

The technique of determining what a given sensor would measure in a given formation and environment by applying a set of theoretical equations for the sensor responses. This allows us to interpret the responses obtained in the field using resistivity profiling. Hypothetic models are constructed in RES2DMOD, the apparent resistivity pseudosection is then fed into RES2DINV as if it had been obtained in the field. "The possibility of calculating a resistivity response in advance offers a tool to optimize electrode configurations and spacing, and hence greatly improves the value of the measurements. A better insight is also obtained into how geological structures may affect the size and shape of anomalies in resistivity profiles." (Radstake et al., 1991)

When HIGH/LOW resistivity values exist the output range falls considerably short of the input range

When LOW/HIGH values exist output range exceeds input range

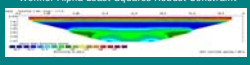
Dipole Dipole array values are generally closer to the input values than Wenner array values

100/1000 Ohm m

1000/100 Ohm m

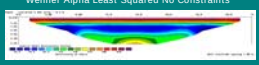
Wenner Alpha Least Squares Robust Constraint

Wenner Alpha Least Squares Robust Constraint



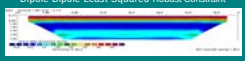
Wenner Alpha Least Squared No Constraints

Wenner Alpha Least Squared No Constraints



Dipole Dipole Least Squares Robust Constraint

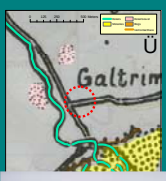
Dipole Dipole Least Squared Robust Constraint

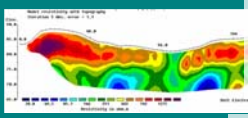


When the thickness of the overlying layer is increase the anomalies between input and output ranges are not as pronounced

When there is a lower range in input values the output values are closer in range for both arrays

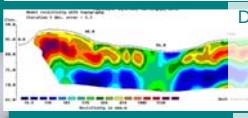
PRELIMINARY RESISTIVITY RESULTS





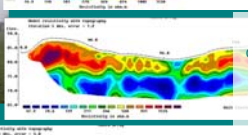
Wenner Array

Greater horizontal coverage, lower point density (310 here), laterally sensitive.



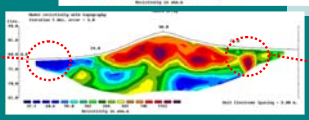
Dipole Dipole Array

Poorer horizontal coverage, higher point density (594 here), vertically sensitive



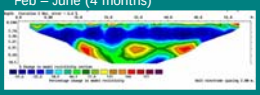
Mixed Array

Combines both, laterally and vertically sensitive, increased horizontal profiling and high point density (904 here)

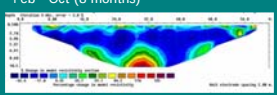


TIME LAPSE RESISTIVITY

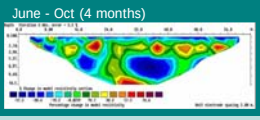
Feb – June (4 months)

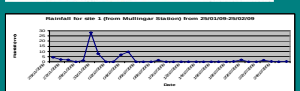


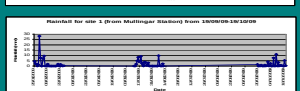
Feb - Oct (8 months)

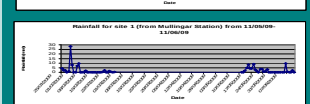


June - Oct (4 months)





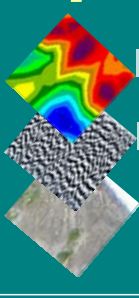




Preliminary results from the resistivity profiling can be seen here. Time lapse resistivity has also been carried out on one esker and one moraine site. The esker site here has experienced dramatic changes in modelled resistivity values and research currently underway is investigating the reasons for this. Rainfall events are one aspect which is believed to dramatically influence the values recorded.

NEXT STEPS

- DEM Analysis
- GIS Analysis
- Bedrock Mapping
- Aspect Analysis
- Slope Analysis
- Ariel Imagery Analysis
- Quaternary Sediment Mapping



- Resistivity Results
- GPR Results
- Sedimentalogical Studies

The aim from this point forward is to continue with the fieldwork gathering as much resistivity and GPR results as is possible. The aim then is to combine this field research with secondary data which will come from a range of sources as seen here. GIS will be employed for mapping and spatial studies of study area Systematic sedimentalogical mapping of available exposures will be carried out in conjunction with remotely sensed satellite data, airborne imagery, including LiDAR data and DEM of the study area.

The ultimate aim then is to try and find the best way in which to combine the results from these various different remote sensing, geophysical techniques and desktop studies. I plan to do this using a range of software and algorithms to try and assess the most useful combinations. The final interpolated method should be able to accurately characterise the areas not surveyed by geophysical methods (given the study area is in excess of 100km2 it would be impossible to survey the whole area at this level). The final model should hopefully give a more thorough insight into the conditions Ireland faced at the close of the last Ice Age and provide clues as to the glacial dynamics and processes at work. The possibility exists that it acts as a suitable proxy for what is currently happening underneath and within modern glaciers like Antarctica and Greenland today due to the Unitarianism ideals that prevail over this subject based on the idea that former ice sheets can be used as an analogue for modern ice sheets.

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