

**IS 07/06:**

**Documenting igneous sills in the Irish Sector of the  
North Atlantic Igneous Province**

**PROGRESS REPORT III**

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## Introduction

Following a successful first year the one-year research Masters Project IS 07/06 was extended to a three-year PhD with the thesis to be submitted to PIP upon completion. Now nineteen months into the research this is the third progress report to be submitted.

## Original aims and progress to date

### **1 Identify and catalogue sills in the Irish sector of the North Atlantic Igneous Province using 2D seismic data**

Cataloguing of 2D seismic data is complete and the information is proving continually useful for research in other areas of the project.

A structural and geological map of Porcupine basin has been compiled and merged with the regional sill map (Figure 1). Erris is the next target basin. Once these maps are complete, information on the distribution of the intrusive and extrusive components of the North Atlantic Igneous Province and effects of structure/pre-existing geology on sill distribution will be reaped. This 2D dataset must still be compared and contrasted with the 3D seismic datasets.

### **2 Identify and catalogue sills in the Irish sector of the North Atlantic Igneous Province using 3D seismic data**

All sills in the two 3D surveys have been identified and picked. A technical problem with the machine hosting the interpretation software has prevented further interpretation of the geology and structure. The machine has recently been resurrected and interpretation will begin again shortly.

### **3 Create sill morphology database**

A number of variables have been suggested as controls on sill morphology and data obtained from the 2D catalogue was used to investigate the possible controls. As yet, no control has been isolated from the graphs, maps or histograms plotted. Graphs, maps and histograms based on the 3D data will be compiled once 3D interpretation is complete.

#### **4 Implications for climate change**

Steps are being taken to increase the accuracy of the potential greenhouse gas volumes released from the Irish sector: Local host rock TOC and densities will be ascertained, and the extent of the metamorphic aureole will be determined using a profile of the aureole established using vitrinite reflectance (example Figure 2). Samples for vitrinite reflectance and TOC analysis have been collected from the following localities/wells:

- ✂ Portrush, Northern Ireland
- ✂ Staffin Bay, Isle of Skye, Scotland
- ✂ Well 35/8-1, North Porcupine Basin (PAD)
- ✂ Well 56/18-1, North Celtic Sea Basin (PAD)
- ✂ Well 56/26-2, Fastnet Basin (PAD)
- ✂ Ballycastle, Northern Ireland

All samples are currently undergoing processing to extract vitrinite. A number of thermal profiles found in the literature have been catalogued and will be used to establish a realistic range of aureole thicknesses.

The fieldwork undertaken so far has also led to enhanced understanding of the complex nature of the interaction between the intruding magma and host sediments (Figure 3). Field evidence was found illustrating the transgressive nature of sills, a feature which is helpful in identifying sills in seismic sections (Figure 4).

Contact with a researcher in the University of Nottingham has increased our interest in determining the depth of sills and the porosity of the host sediments at the time of intrusion. This data will be useful in establishing whether a significant portion of steam was produced by the heat of the intruding sill or if mostly greenhouse gases were produced. Sill depths from Porcupine, Hatton and Erris basins have been converted from two-way travel time to depth in kilometres and the corresponding values of porosity have been established. Work is continuing to obtain minimum and maximum depth and porosity values.

## **5 Assess the timing of sill emplacement**

In order to link our Irish Sector sills with a palaeoclimate event the timing of sill intrusion and hydrothermal vent formation must be established. A number of radiometric ages for sills have been retrieved from PAD well reports. Stratigraphic dating of sediments onlapping a forced fold associated with intrusion will begin shortly.

In addition to establishing the absolute age of the igneous intrusions, the duration of magma injection will also be investigated.

## **6 Experimental modelling**

Processing of pressure flux and dome shape data from experimental modelling in Oslo is complete. Excavated intrusion shape data must now be processed.

## **7 Investigating sill density and reliability of 2D seismic data**

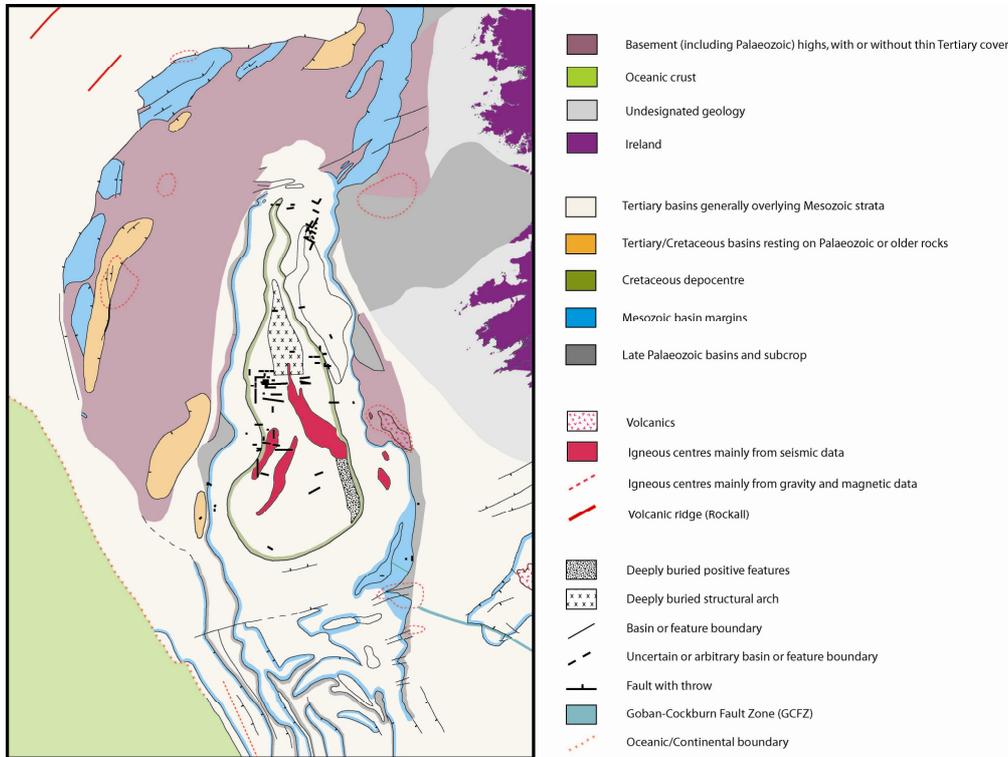
Preliminary estimates of sill density have been calculated using the regional sill map based on the 2D seismic data.. Plotting of the centre points of catalogued sills in 3D space will help with visualising the density of the sills. 3D plotting is underway.

## **Conferences/Presentations**

Work on this project has been presented at a number of conferences/meetings to date:

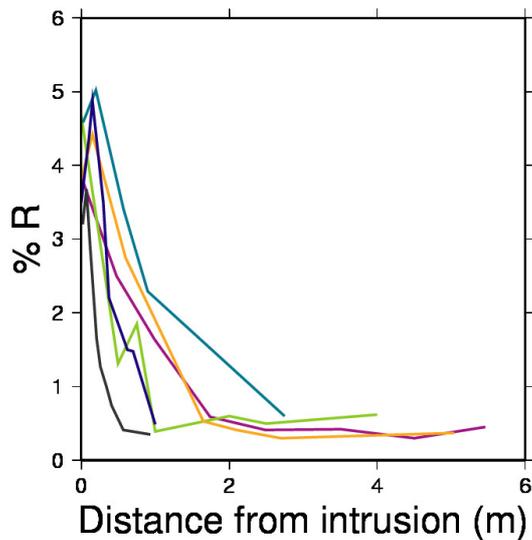
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| Volcanic and Magmatic Studies Group                | Attended meeting                         |
| Irish Geological Research Meeting                  | Oral presentation                        |
| Ken Thomson Commemorative Meeting                  | Poster presentation                      |
| PGP UiO invited speaker                            | Oral presentation                        |
| 33 <sup>rd</sup> International Geological Congress | Poster presentation                      |
| Irish Geological Research Meeting                  | Poster presentation – honourable mention |

## Figures



**1 Map showing regional geology, structural information (adapted from Porcupine-Goban region - Structural Elements Map, PAD 2002) and location of igneous sills based on 2D seismic catalogue.**

## Vitrinite Reflectance Data



**2 Graph showing six intrusion aureole profiles based on vitrinite reflectance (adapted from Bishop & Abbott 1995). Graphs such as this will be constructed for the intrusion aureoles we have sampled. The graphs will aid in establishing the distance heat has travelled away from the intrusion, a factor which has significant implications for greenhouse gas generating potential.**



**3 a) Complex interaction between intruding magma and host sediments (Portrush, Northern Ireland)**  
**b) water-sill interaction with possible later mineralisation (Isle of Skye, Scotland).**



**4 Sill (shaded in white) cutting up through the sediments (separate horizons outlined in green). The transgressive nature of sills is a characteristic that helps with their identification in seismic data.**