# VARNET 95 : Magnetotelluric measurements in Southwest Ireland as part of an integrated study of the Variscan Front

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**Abstract**

Magnetotelluric fieldwork was carried out in the southwest of Ireland as part of an Integrated Study of the Variscan Front, VARNET. This paper highlights the project, describes the nature of the data collected so far and presents some preliminary results.

## Introduction

The Variscan orogenic frontal zone is a prominent feature on the tectonic map of Europe (Fig.1), postulated to have an extent of about 1500 km from Ireland to northern Germany with a continuation off the west coast of Ireland. It contains a series of fold and thrust structures suggesting a general south to north compression direction. Strike-slip features are also locally associated with the front. The Front is only locally well exposed in southern Ireland and western Germany. The exposure in Germany has been extensively studied (e.g. DEKORP Research Group, 1991). There are, however, large variations in the seismic signatures associated with different sections of the Front, so it is important to quantify and qualify the structures and processes associated with the Variscan orogenesis.

The VARNET group is an interdisciplinary mixture of institutions with the goal of documenting, interpreting and explaining Variscan structures and processes using the expression in the southwest of Ireland as a basis. Methods used include seismics, magnetotellurics and potential field methods.

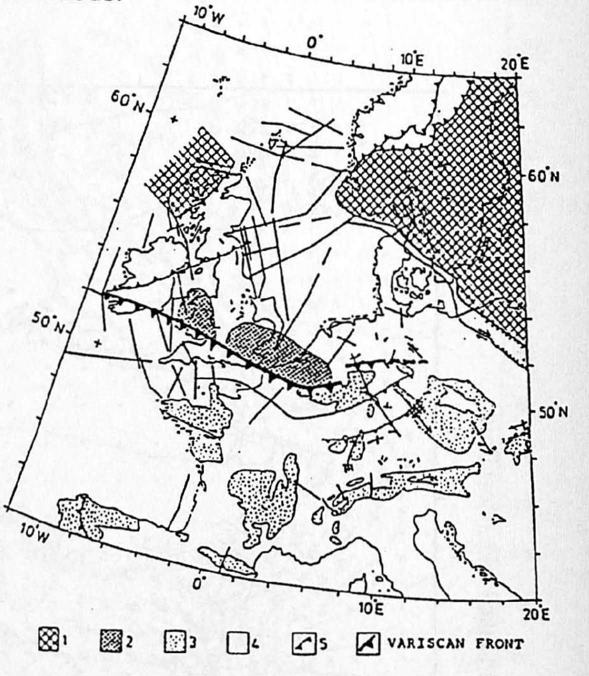


Figure 1: The Variscan Front in Europe. Deep seismic lines are shown, with 1)Precambrian shield crust, 2)Precambrian massifs, 3)pre-orogenic massifs, 4)Fennoscanadian border zone, 5)Caledonian thrusts. Compiled from (Sadowiak et.al., 1991)

The Variscan Front in Ireland has a surface expression that is associated with a boundary, the Killarney-Mallow Fault (KMF) running west to east between Devonian Sandstone in the south and more conductive limestones and clastics in the north. It was decided that a preliminary magnetotelluric analysis should include a profile or array which crossed this boundary, as such a traversal could yield valuable information about the nature of the boundary and the deformation processes involved.

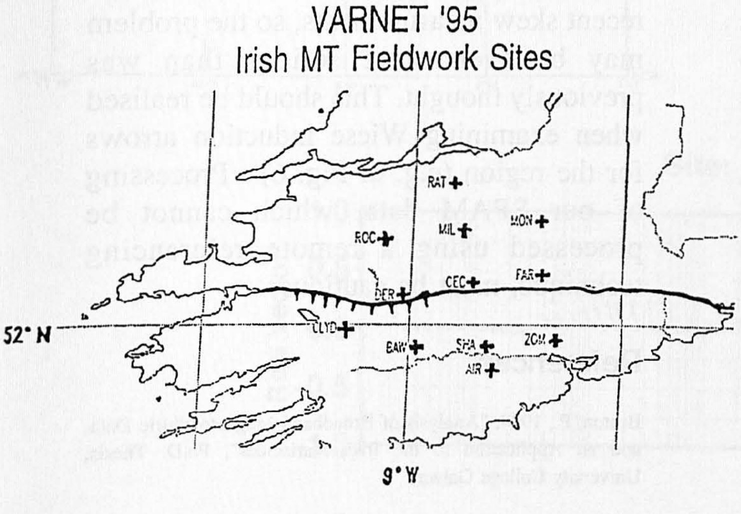


Figure 2 : MT sites used duing the 1995 Fieldwork. The dark line is the "Front".

## 1995 Fieldwork

The preliminary fieldwork was carried out during August 1995 (see Fig. 2) using several types of MT/GDS device including the recently developed SPAM 3 (Short Period Automatic Magnetotelluric device) ( e.g. Ritter, 1995 ) , giving a reliable frequency range of 800 Hz to $10^3$ seconds. Several of the devices allowed remote referencing to be used, and there were times when five devices were running concurrently. Each device was typically used at a site for one week, with a reference site maintained for the duration of the project. In addition to these, 3 long period devices were left for one, two and three months to measure signals with periods of minutes to several days. Five of the sites, RAT, MIL, CEC, SHA and AIR, coincide with a proposed VARNET seismic profile (Denny et.al., 1995).

## Resistivity in Southwest Ireland

The most electrically resistive features are the consolidated sediments such as the Old Red Sandstone and Limestone, with fluid inclusions or mineralisation delimiting faults and strutural boundaries. There is a clear difference between the apparent resistivities north and south of the Killarney Mallow Fault (Bruton,1994).

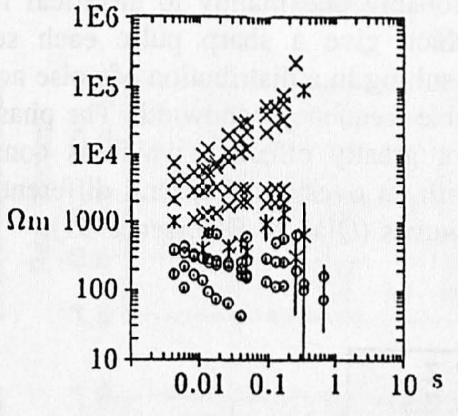


Figure 3. Apparent resistivity vs. period at sites north (o) and south (x) of the KMF (Bruton, 1994)

Skew measurements were made at all sites in the frequency range 2 - 1000 seconds. These were rarely below 0.2 at any period (e.g. Fig. 4), and typically 0.25 or more, revealing the existence of a complex geology.

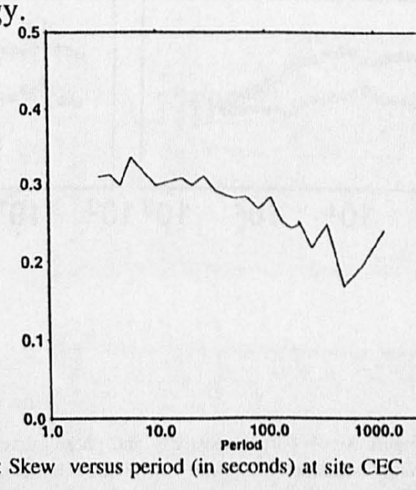


Figure 4 : Skew versus period (in seconds) at site CEC

Single site data processing was done for each site, followed by remote reference processing (Egbert & Booker, 1986; Gamble et.al., 1979) which demonstrated significant differences in the 2 to 30 second period range. In this region, the natural electromagnetic signal is weak, and noise has a strong biasing effect. The significance of this effect is shown in Figure 5, where the curves are distorted by half a decade ( a "strike" direction of east is chosen to illustrate this, even though a strike cannot be said to exist since the dimensionality is more than two ). At some other sites, the distortion is up to nearly 3 decades. The noise level is probably due mainly to electrical fences, which give a sharp pulse each second, resulting in a distribution of noise across a wide frequency bandwidth. The phases are not greatly effected, which is consistent with an overlap of several different noise sources (Qian & Pedersen,1991).

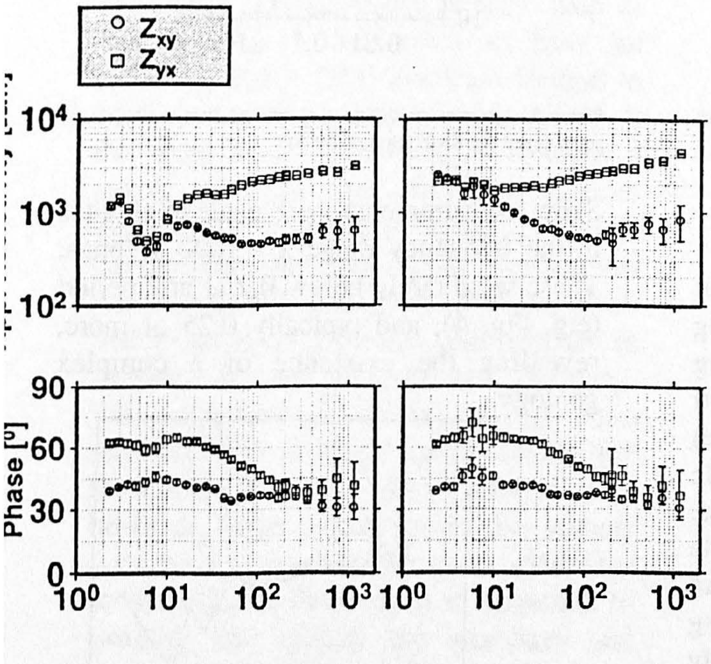


Figure 5 : Apparent resistivity and phase curves over a period range (seconds), at the site CEC. On the left is a set from single site processing, contrasting with the set created using site ROC as a remote reference. Note the noise bias.

Induction arrows indicate a high degree of structure also. A major problem associated with magnetotelluric measurements in Ireland is the presence of the coast effect which has been noted (e.g. Parkinson,1983; Bruton 1994). Bruton has created various models which demonstrate that in the case of some inductive anomalies, residuals due to inductive coupling are prohibitively large. His models were of a much lower dimensionality than that evidenced by the recent skew measurements, so the problem may be even more serious than was previously thought. This should be realised when examining Wiese induction arrows for the region (e.g. in Fig. 6). Processing of our SPAM data, which cannot be processed using a remote referencing technique, must be cautious.

## References


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Figure 6 : A set of Wiese induction arrows from VARNET MT 1995