

# GEOTHERMIC VARISCAN FRONT DEFINED FROM OIL DRILLING IN THE PORCUPINE TROUGH, OFFSHORE WEST IRELAND



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Oil exploration drilling in the Porcupine Trough west of Ireland, has targeted Mesozoic reservoirs and inadvertently provided samples of sub-Variscan Carboniferous sediments. Drilling from the Tertiary and Mesozoic into the Carboniferous (the Permo-Trias is essentially missing), has shown a substantial break in the typical burial profile as monitored by the vitrinite reflectance technique in 6 wells. When drilling across the Variscan unconformity, changes are seen both in terms of the absolute level of maturity and its rate of change with respect to depth (i.e. the maturity gradient). These changes are related to the amount of section lost during late-Variscan (Stephanian-early Permian) erosion and the elevated heat flow values required to calibrate 1-D basin models. The elevated palaeo-heat flow of 125-138 mW/m<sup>2</sup> calculated for the maximum Variscan burial event may be related to a gravity-defined basic igneous body at basal crust-upper mantle level. Uplift in the range <500 – 3,200 m maps with a WNW-ESE trend arguably related to Variscan thrusting based on analogues with the Sticklepath and parallel faults of SW England. The low levels of background maturity in Westphalian strata places the Porcupine Trough north of the thermal Variscan Front while weaker evidence from the orientation of uplift places the study area south of the structural Variscan Front.

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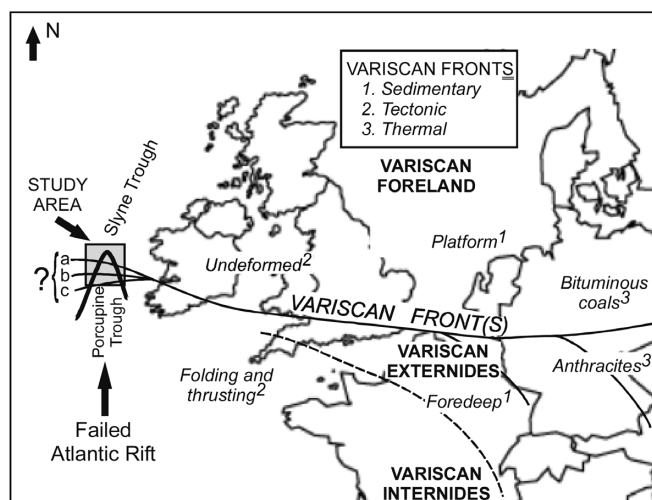
## INTRODUCTION

The late Carboniferous collision between the Gondwanan and Eurussian tectonic plates produced the so-called 'Variscan suture' which is mapped at outcrop as the Variscan Front (Figure 1). Different geological disciplines define an orogenic front by a variety of characteristics (Table 1). This means that there may be a number of Variscan fronts, each based on observation of its own controlling parameter. In Northwest Europe, organic maturity is one of the thermal factors that defines the Variscan Front.

Reflectance-based maturity studies south of the Variscan Front are limited (Cornford *et al.*, 1987), but north of the Variscan Front where the late Carboniferous depositional conditions favoured coals, coal rank maps form the best overview of maturity (Teichmuller, 1985), with detailed studies relating to oil and gas exploration e.g. in the southern North Sea gas basin (Cope, 1986). Anomalously elevated maturities have been described to the north of the Variscan Front in north Germany (Bramsche Massif, Niedersachsen), where coal rank has been influenced by deep igneous intrusions (Buntebarth and Teichmuller, 1979; Stadler and Teichmuller, 1971).

This paper reports some results from a petroleum geochemical study of source rocks, generation, migration and accumulation in the northern sub-basin of the Porcupine Basin between latitudes 51.5°N and 53.0°N (Collinson Jones Consulting Ltd. *et al.*, 1996). The general geology has been extensively reviewed (Crocker and Klemperer, 1989; Crocker and Shannon, 1987), and the deep structure of the Porcupine Trough has recently been defined from virtual field data (Readman *et al.*, 2005).

As in other NW European basins, the Carboniferous may have significant hydrocarbon source potential, particularly for gas (Cornford, 1998). Very little is known about the structures affecting the Carboniferous in the Porcupine Basin. The offshore position of the Variscan Front is critical from a source rock point of view as there is unlikely to have been any post-Variscan generation from the metamorphosed zone to the south of the front. Opinions seem to differ widely as to whether the front can be recognised in the Porcupine area.



**Figure 1.** Location of the Porcupine Trough study area in context of the Variscan Front of NW Europe.

Control	Measurement	Comment
Thermal	Coal rank	Bituminous to the north, anthracites to the south
	Vitrinite reflectance	High reflectance to the south
	Illite crystallinity	High crystallinity to the south
Sedimentological	Platform v Basin	Carbonates and coals to the north and turbidites to the south
Structural	Deformation	Folded to the south and thrusting from the south versus stable shelf with undeformed and block faulted sediments to the north

**Table 1.** Factors commonly used to define the Variscan Front in NW Europe.