

## TRWYN-Y-GORLECH TO YR EIFL QUARRIES

T.P. Young and W. Gibbons

OS Grid Reference: SH348455–SH363461

### Introduction

The Trwyn-y-Gorlech to Yr Eifl quarries GCR site (Figure 6.60) encompasses a superbly exposed transect across the Garnfor Multiple Intrusion, one of the most interesting of a number of major Ordovician intermediate and acidic intrusions that crop out along the north limb of the Llŷn Syncline. An outer microgranodiorite is exposed on the coast at Trwyn-y-Gorlech in the west and in the Yr Eifl quarries to the east. The Yr Eifl quarries also expose the 'Blue Rock', a dark porphyritic hypersthene-bearing microgranodiorite. The centre of the GCR site, the mountainside of Garnfor, exposes an inner, microtonalitic intrusion that is also exposed in the smaller Garnfor Quarry.

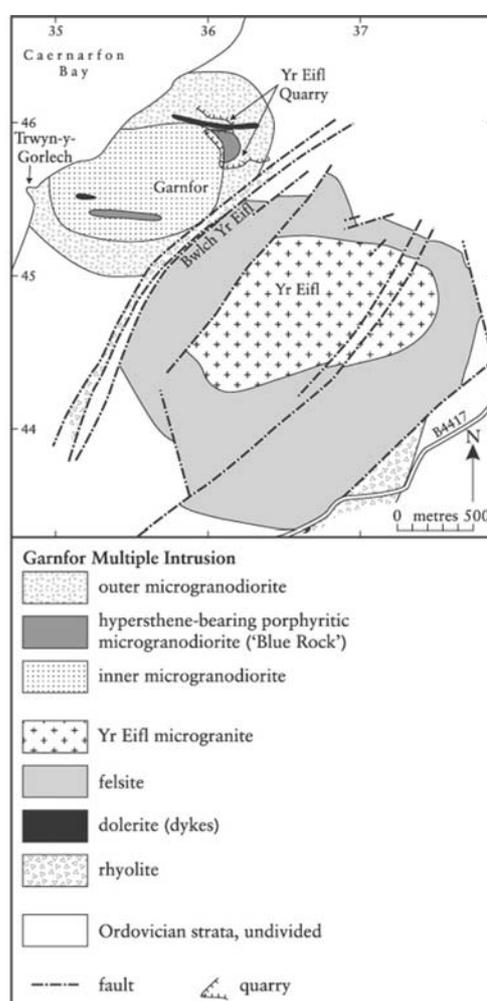


Figure 6.60: Map of the Garnfor Multiple Intrusion, north Llŷn (adapted from Tremlett, 1962).

Tremlett (1962) interpreted the field relationships of the Garnfor Intrusion as indicative of a 'Caledonian' age (end Silurian to Early Devonian). In a subsequent article (Tremlett, 1972), he described the geochemistry of these rocks, but his interpretation relied heavily on the distribution of elements now generally believed to be mobile during alteration and low-grade metamorphism (see Merriman *et al.*, 1986). Croudace (1982) revised the geochemical interpretation of these intrusions using 'immobile' elements and mineral chemistry, and demonstrated a genetic link between the granitoid intrusions and the Moelypenmaen lavas (see

the Moelypenmaen GCR site report), thus establishing the Ordovician age of the intrusions. Leat and Thorpe (1986) reworked the data of Croudace (1982) and argued that the intrusions form part of a peralkaline evolutionary series, together with the Moelypenmaen lavas.

## Description

The Garnfor rocks comprise an outer intrusion of white or pink microgranodiorite and an inner intrusion of microtonalite of grey vitreous appearance, with a finer groundmass than the outer intrusion (both intrusions were described as 'granodiorite porphyry' by Tremlett, 1962). The inner intrusion becomes more mafic, with more enclaves towards its centre and shows a chilled margin at its contact with the outer intrusion. Both inner and outer intrusions are cut by smaller bodies of 'blue rock', a microgranodiorite similar to the outer intrusion but with a bluish-grey groundmass. These field relationships established the relative succession of the intrusions, which were subsequently cut by several dolerite dykes orientated NW–SE.

In petrographical detail, the outer intrusion is porphyritic with cumulophyric clots and individual phenocrysts of plagioclase showing chemical zonation from  $An_{38}$  to  $An_{28}$ , and commonly rimmed by orthoclase. The groundmass includes plagioclase with interstitial quartz, hornblende, biotite and magnetite. The inner intrusion shows similar core-to-rim plagioclase zonation ( $An_{18-20}$ ), with a mafic mineral assemblage comprising magnetite and ilmenite, rare biotite, and scattered pyroxene crystals which become more abundant inwards.

## Interpretation

Croudace (1982) and Leat and Thorpe (1986) referred the intrusions and volcanic rocks of Llín to the 'Lley volcanic complex'. Young *et al.* (in press) have suggested the presence of two distinct volcanic centres on Llín, one around Llanbedrog and the other farther north in the Nefyn district. The Llanbedrog centre, which produced the Llanbedrog Volcanic Group (Woolstonian), is largely restricted to the area south of the Efailnewydd Fault, whereas the products of the more northerly centre, which is slightly older (?Soudleyan–Longvillian), crop out along the northern limb of the Llín Syncline. Both volcanic sequences show an evolution from early trachybasaltic volcanism, through trachydacites, culminating in the eruption of rhyolitic tuffs. It would appear likely therefore that the evolution of the igneous rocks reported by Croudace (1982) and by Leat and Thorpe (1986) did not occur as a single event, but happened on two occasions. The distribution of the large granitoid intrusions, such as the Garnfor Multiple Intrusion, along the northern coast of Llín suggests a closer spatial relationship with the more northerly centre than with the younger Llanbedrog eruptive rocks.

Investigation of the geochemistry of the Garnfor intrusions by Croudace (1982) demonstrated that the rare-earth elements show a negative correlation with  $SiO_2$ , and it was argued that this was likely to have been produced through the fractionation of apatite. The analyses of the Garnfor intrusions plot in the field of trachydacite on the TAS (total alkalis vs silica) diagram and in the field of trachyandesite on the  $Zr/TiO_2$  vs  $Nb/Y$  diagram (Winchester and Floyd, 1977). Tremlett (1962) argued that the range of compositions in the intrusions suggest that magma mixing or contamination was involved, with more basic material progressively contaminating the acid magma. Croudace (1982) demonstrated that the range of compositions was more likely to have been generated through fractional crystallization. Hence, the sequence of lithologies described by Tremlett (1962) derives from the progressive tapping of a magma chamber and the 'xenoliths' are in fact co-magmatic enclaves.

## Conclusions

The well-exposed Garnfor Multiple Intrusion provides evidence for processes operating in an alkaline magma chamber. The geographical location of the intrusion suggests that it is likely to have been associated with a major centre of alkaline volcanism in northern Llín that is of probable Soudleyan–Longvillian age. As such it represents one of the best exposures in North Wales of an arc-related subvolcanic intrusion complex involving multiple intrusive events. It is especially interesting in revealing an acid-to-basic sequence of intrusive events, suggesting the progressive evacuation of a fractionating and possibly layered magma chamber at depth.

## Reference list

- Croudace, I. W. (1982) The geochemistry and petrogenesis of the Lower Paleozoic granitoids of the Lleyn Peninsula, North Wales. *Geochimica et Cosmochimica Acta*, **46**, 609–22.
- Leat, P. T. and Thorpe, R. S. (1986) Geochemistry of an Ordovician basalt-trachybasalt-subalkaline/peralkaline rhyolite association from the Lleyn Peninsula, North Wales, U.K. *Geological Journal*, **21**, 29–43.
- Merriman, R. J., Bevins, R. E. and Ball, T. K. (1986) Geochemical variations within the Tal y Fan intrusion: implications for element mobility during low-grade metamorphism. *Journal of Petrology*, **27**, 1409–36.
- Tremlett, W. E. (1962) The geology of the Nefyn–Llanaelhaearn area of North Wales. *Liverpool and Manchester Geological Journal*, **3**, 157–76.
- Tremlett, W. E. (1972) Some geochemical characteristics of Ordovician and Caledonian acid intrusions of Lleyn, North Wales. *Proceedings of the Yorkshire Geological Society*, **39**, 33–57.
- Young, T. P., Gibbons, W., and McCarroll, D. (in press) The geology of the country around Pwllheli. *Memoir of the British Geological Survey*, Sheet 134 (England and Wales).