Lime Craig Quarry

[NN 5340 0187]

Introduction

Lime Craig Quarry is critically important for understanding one of the major terrane boundaries in the British Isles, namely the Highland Boundary Fault zone, which marks the junction between the Dalradian and Midland Valley terranes. The rediscovery in 1981 of early Ordovician fossils in the Highland Border Complex here resulted in a major reappraisal of the relationship between this complex and the Dalradian metasedimentary succession to the north.

Although Stubblefield had extracted a silicified fauna by acid etching a piece of the limestone in the early 1940s, his results were never published, and it was 40 years before a similar exercise was undertaken (Curry *et al.,* 1982). This involved the processing of over 7.5 tonnes of limestone, yielding almost 1700 identifiable silicified fossils, three-quarters of which are trilobites (Ingham *et al.,* 1986). These can be matched very closely with faunas of the upper Ibex (or Canadian) Cassinian Stage of North America. Not only does the fauna indicate the palaeogeographical position of this part of Scotland during the Ordovician, but its age has been used to show that the origins of the Highland Border Complex are not related to the Dalradian (Bluck *et al.,* 1984; Curry *et al.,* 1982, 1984; Ingham *et al.,* 1986), in contrast to some earlier models (Johnson and Harris, 1967; Henderson and Robertson, 1982; Ikin and Harmon, 1984).

Description

The geological setting of Lime Craig Quarry is described by Bluck and Lawson (1992), and the site of the radio mast on the ridge of steeply dipping Old Red Sandstone conglomerate to the south-east provides an excellent vantage point from which to view the markedly contrasting landscapes on each side of the Highland Boundary Fault zone. The quarry has long been abandoned, and the relationships between the various units there are structurally complicated but were elucidated by mechanical excavations in the early 1980s ((Figure 13.3); Bluck *et al.,* 1984; Curry, 1986; Ingham *et al.,* 1986). To the immediate north-west of the quarry area are steeply dipping sandstones and shales of the Achray Sandstone of probable Caradoc–Ashgill age, bounded to the north-west and south-east by mid- to late Devonian wrench faults. Much of the intervening ground is covered by quarry spoil but comprises deformed black shales and sandstones of probable Ordovician age, overlain unconformably by the basal sandstones of the lower Old Red Sandstone Arbuthnot Group. These are truncated by a prominent SW–NE dolerite dyke of Carboniferous or younger age intruded along the Gualann Fault, a NW-dipping normal fault that can be traced south-west as far as the west side of Loch Lomond. On the southeast side of the northern end of the dyke, at the edge of the quarry, is an area of dark-coloured serpentinite, whereas along this side of the intrusion to the south-east is a brown-weathering carbonate serpentinite.

The bulk of the quarry is composed of vertical or subvertical grey limestone (the Dounans Limestone), unconformably overlain by, and locally faulted against, steeply dipping sandstones and conglomerates of the Arbuthnot Group, which forms the towering back face of the quarry. The limestones contain clasts, up to gravel size, of serpentinite, gabbro, dolerite, spilite and other basic igneous rocks. The limestones are extensively dolomitized, and only in one small, probably fault-bounded, area in the middle of the quarry were they sufficiently pure for commercial extraction. This area was almost completely quarried out, but in the early 1980s the quarry waste yielded large quantities of the purer limestone for acetic acid dissolution. These provided both the impetus for wider analysis of the Highland Border Complex and the most precise age for any part of it.

Interpretation

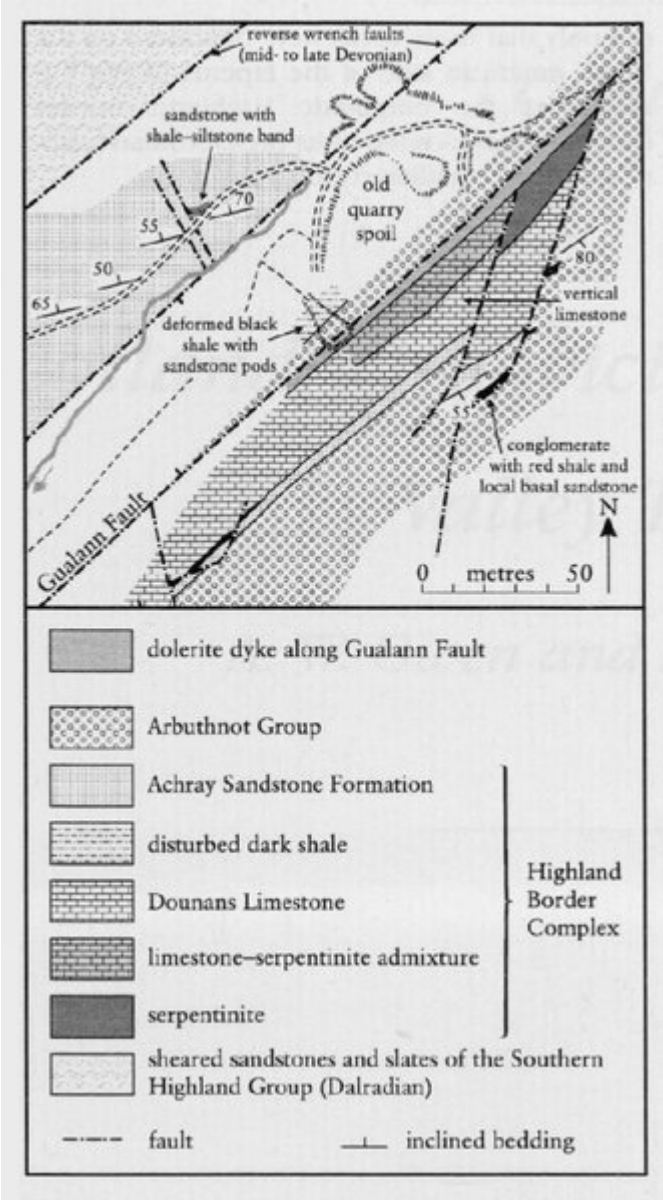
The Dounans Limestone is thought to have been deposited in shallow water above an ophiolitic substrate (Bluck *et al.,* 1984), obducted in the Early Cambrian (Dempster and Bluck, 1991), which provided the serpentinite and other clasts. The limestone yielded silicified trilobites, brachiopods, gastropods, bryozoans, ostracods, crinoids, an orthocone and

various undetermined fossil remains (Ingham *et al.,* 1986). A conodont fauna of very low abundance is also present, with only 48 elements being recovered from an estimated 71 kg of rock (Ethington and Austin, 1991). Disarticulated trilobite specimens comprise over 75% of the shelly fossils and are strongly North American in their palaeobiogeographical affinities. Thirteen trilobite species are present, but 80% of the trilobite remains belong in one species, *Ischyrotoma stubblefieldi* Ingham. This species and several others are close to or conspecific with species from the Cassinian Stage of the late Ibexian (mid-Arenig) of Laurentia; a correlation supported by the conodonts. Other, less precise, Ordovician ages have been obtained from microfossils in younger parts of the Highland Border Complex (Curry *et al.,* 1984). The palaeontological evidence indicates that the Highland Border Complex is much younger than the deposition and early episodes of metamorphism and deformation of the Dalradian Supergroup. Nor could the Arenig carbonate platform indicated by the Dounans Limestone and fossiliferous limestone clasts in Ordovician and younger conglomerates in the Midland Valley (Ingham *et al.,* 1986) have been adjacent to an uplifting Dalradian block shedding copious quantities of siliciclastic sediment (Stuck, 1995). The complex probably formed part of the cover sequence of the Midland Valley Terrane (Bevins *et al.,* 1992) and was only brought into juxtaposition with the Dalradian block in the Devonian,(Bluck, 1984, 1995). The debate is by no means over, however, as there is still a conflict between the evidence for stratigraphical and structural continuity between parts of the Highland Border Complex and the Dalradian Supergroup at some localities (Tanner, 1995; in Bluck *et al.,* 1997) (see the Leny Quarry site report) and the palaeontological and sedimentological evidence for very different histories until the late Devonian.

Conclusions

Lime Craig Quarry exposes the rocks on the Highland Boundary Fault. Fossils from the limestones are closely related to the North American Cassinian division of the Ordovician (approximately mid-Arenig in age). This provides the most precise age yet determined for any part of the Highland Border Complex. The fossils show not only that these rocks were deposited on the North American side of the Iapetus Ocean but also that the enigmatic Highland Border Complex shared none of its pre-Devonian history with the Dalradian rocks to the north.

References



(Figure 13.3) Geological map of Lime Craig Quarry showing the faulted Highland Border complex and Lower Old Red Sandstone, from Bluck et al. (1984, fig. 7) and Bluck and Lawson (1992, fig. 10.2).