Pitscurry and Legatesden Quarries

[NJ 728 267] and [NJ 737 263]

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Introduction

The intermediate fractionation stages of the 'Younger Basic' magmatic event, which are collectively termed the Middle Zone (MZ), are best represented in the Insch intrusion, especially in the area around Pitcaple. The Insch MZ rocks are mainly olivine-free, two-pyroxene gabbros, with mineral compositions broadly intermediate between those of the Lower Zone (12) and Upper Zone (UZ) cumulates respectively, but displaying much greater textural diversity and structural complexity than either. Two principal textural variants are found throughout the Insch MZ, associated in approximately equal abundance, namely gabbroic cumulates and relatively fine-grained granular gabbros (FGG). However, their precise distribution and relationships are difficult to define, partly because of generally poor natural exposures, and partly because this area of the Insch intrusion lies within a major shear-belt (Read, 1956; Ashcroft *et al.,* 1984; Kneller and Leslie, 1984) so that the original rocks have been substantially modified. The Insch MZ rocks were originally described as a separate intrusion of hypersthene-gabbro, apparently unrelated to the main differentiation series (Read *et al.,* 1965) but Clarke and Wadsworth (1970) recognized a distinct cumulate element that partly bridges the gap between LZ and UZ, and all the MZ gabbros are now interpreted as integral components of the Insch sequence (Wadsworth, 1988; Gould, 1997).

The most important exposures of the Insch MZ gabbros are found in quarries, especially in the Pitcaple area (Figure 3.9). Two separate, but neighbouring quarries (Pitscurry and Legatesden) provide complementary information about the different MZ components and their relationships. Because both quarries lie within one of the main shear-belts affecting the Insch intrusion, much of the gabbroic material has been deformed and amphibolized, so that the primary mineralogy is often difficult to decipher. However, this is an intrinsic part of the petrological variety of the area, and the localities selected are representative of the whole range of MZ gabbro types, including exceptionally fresh samples of the original gabbros as well as a complete spectrum of secondary modifications.

Description

Pitscurry Quarry

This is a large working quarry, which provides extremely fresh material from three texturally distinct varieties of gabbro; the relatively coarse-grained MZ cumulates and two types of fine-grained gabbro of characteristically granular (?recrystallized) appearance. Most of the granular gabbros are aphyric (fine-grained granular gabbro or FGG), but some contain abundant plagioclase phenocrysts (porphyritic granular gabbros or PGG). Despite the continuous exposure, the field relationships between these different gabbro components are difficult to decipher, largely because the face is too steep to be readily accessible, but partly because of the combination of prominent jointing and local deuteric alteration along the joint planes.

In general terms, the relatively coarse-grained gabbros, assumed to be MZ cumulates, are found at the western end of the working face. They consist of cumulus orthopyroxene (En_{47}), augite ($Ca_{45}Mg_{32}Fe_{23}$) and plagioclase (An_{60}), and appear to be unlayered.

The rest of the working face comprises members of the fine-grained granular gabbro suite. In the central part of the face the rocks are olivine-bearing, which is unusual, but their textural features are typical of the more commonly encountered olivine-free types of FGG. These gabbros consist of olivine (Fo_{63}), augite ($Ca_{45}Mg_{41}Fe_{14}$) and plagioclase (An_{63}) and are also exceptionally fresh. Farther east they pass into PGG with an abundance of large plagioclase phenocrysts (An_{80} zoned to An_{65}) in a ground-mass virtually identical to the olivine-bearing FGG described above.

These varieties of granular gabbro (normal FGG, olivine-bearing FGG and PGG) are also encountered in the same relative positions in the newly-developed quarry area above the main working face, close to Pitscurry Wood, but even here there is as yet no direct evidence of their age relationship, only negative features in the sense that there are no obvious chilled margins, intrusive veins, or xenoliths of one rock type in another.

The more southerly part of the quarry area consists mostly of coarse-grained gabbroic rocks, with textural features similar to the MZ cumulates elsewhere, but they have been thoroughly amphibolitized. Pitscurry Quarry also contains examples of the later pegmatitic granite sheets. These are best seen in the western face, where they form a 10 m-thick, approximately horizontal sheet, with minor offshoots (Figure 3.10). Smaller inclined or vertical sheets are seen in the northern face. In addition to feldspar, quartz and micas, these pegmatites contain garnet, black tourmaline (schorl) and rare beryl (Leslie, 1987).

Legatesden Quarry

This small quarry (no longer worked) is entirely within MZ cumulates, but displays gradations from fresh material at the NW end of the exposure into moderately deformed and amphiboli-tized rocks elsewhere. The fresh gabbros consist of cumulus plagioclase (An_a) and orthopyroxene (En_{55}), together with scattered subhedral grains of opaque oxide, and a small amount of interstitial augite and biotite.

Just to the SE of the central part of the main quarry face, close to a 2 m-wide sheet of pegmatitic granite, the cumulates exhibit well-developed layering, consisting of an alternation of felsic and mafic units on a relatively small scale (centimetres to tens of centimetres). Some of the mafic layers are rather wispy and laterally impersistent, and there is also an indication of upward grading from the principal mafic layer in this outcrop. The base of this layer is also remarkably uneven in a way that is reminiscent of loading structures in sediments and clearly implies a considerable degree of post-cumulus instability. Unfortunately these layered cumulates have been thoroughly altered in proximity to the pegmatite sheet, and now consist predominantly of chlorite, moderately sodic plagioclase, which is rather strained and locally recrystallized, and epidote. As well as this local modification of the cumulates, there is also a more general increase in degree of shearing and alteration from NW to SE in the quarry. The earlier stages appear to involve plagioclase deformation and the replacement of the original pyroxene by colourless amphibole. More advanced alteration results in the recrystallization of plagioclase (and formation of epidote) and the development of chlorite at the expense of the secondary amphibole. Detailed discussion of the textural and mineralogical modification to gabbros involved in shear zones is given by Kneller and Leslie (1984).

Interpretation

Although the Insch MZ has obvious geographical coherence, lying between the LZ to the east and the UZ to the west and NW and displays broadly intermediate petrological characteristics, in detail it turns out to be unexpectedly complicated. This is seen not only in the intricate association of MZ cumulates and granular gabbros (FGG and PGG), but also in the absence of a simple cumulate stratigraphical sequence from SE to NW (Wadsworth, 1988). Both of these features imply that there was considerable disruption during and after the formation of the Insch MZ, and there have been many different interpretations of this unit, both in terms of its internal complexity and its relationship to the adjacent LZ and UZ cumulates. It is hoped that investigations in the Pitcaple area, in particular in the large working quarry at Pitscurry, will eventually resolve the situation.

Whittle (1936) was the first to investigate the Insch (MZ) hypersthene-gabbros and, on textural grounds, concluded that the granular gabbros are older than the coarse-grained gabbros (now regarded as cumulates) and have been thermally metamorphosed by them. Read *et al.* (1965) were more concerned with the significance of the hypersthene-gabbro unit as a whole, rather than with the internal textural features, and decided that it represents a distinct intrusion, invading the Insch cumulates (LZ and UZ) and not directly related to them. To Read and his colleagues, the main significance of the hypers-thene-gabbros lies in their lack of olivine (and relative abundance of orthopyroxene), which they took to indicate large-scale contamination of the regionally available 'Younger Basic' magma by argillaceous sedimentary material.

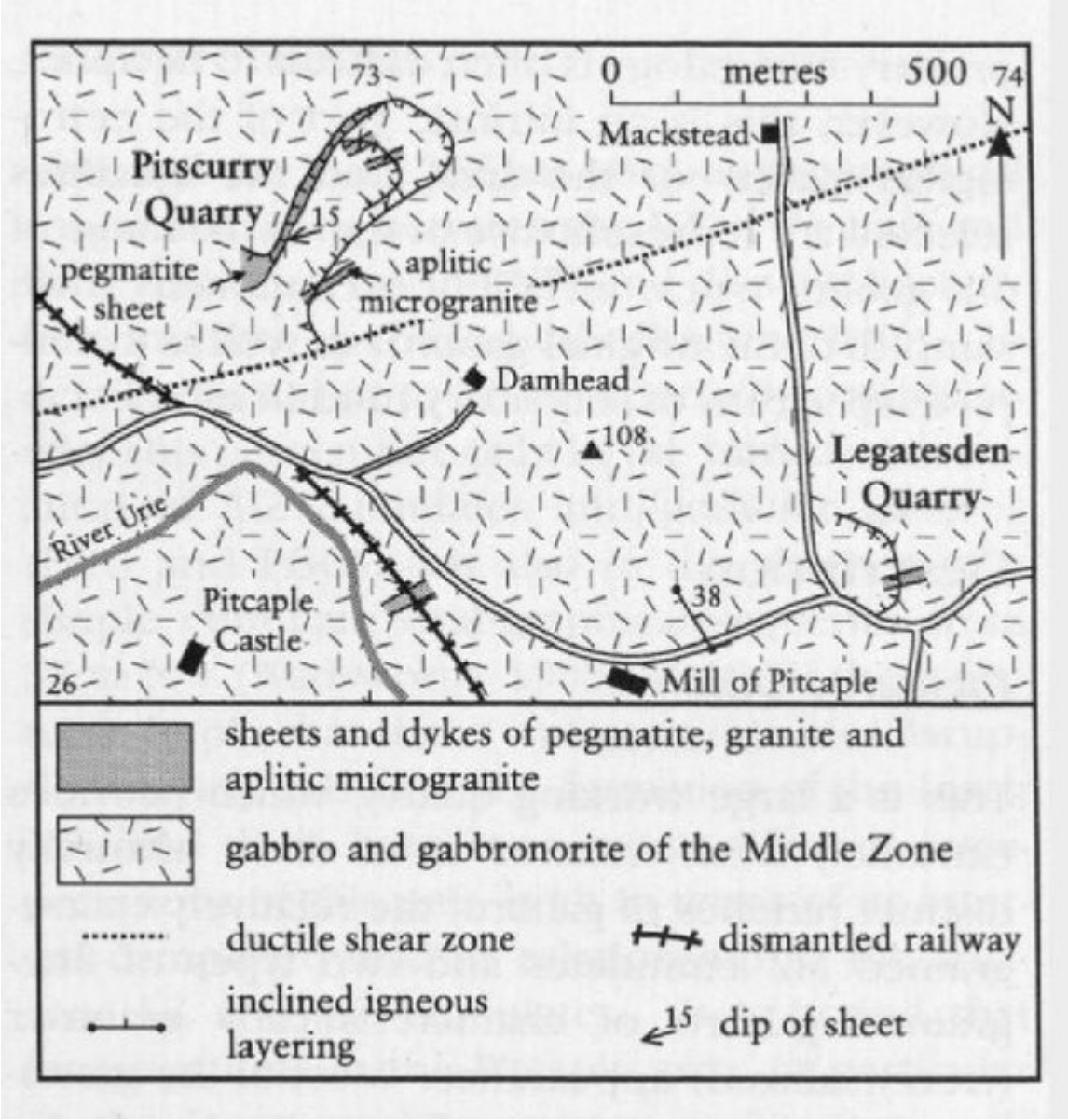
Clarke and Wadsworth (1970) re-interpreted the coarse-grained hypersthene-gabbros as an integral part of the Insch cumulate succession, thus defining the MZ stage of differentiation. However, they believed the associated granular gabbros to be slightly younger than the cumulates, and to represent invasion by pulses of the parental 'Younger Basic' magma. Wadsworth (1988) was persuaded by the mineralogical evidence that the MZ cumulates and the granular gabbros are both part of a coherent, intermediate fractionation stage. He suggested that the FGG and PGG represent material which crystallized near the intrusion margins (probably the roof) and subsequently foundered into the contemporary cumulate pile from time to time as large 'rafts' of essentially solid material. Such a mechanism would not only explain the intimate association of MZ cumulates and FGG/PGG, but might also account for some of the structural complexity of the cumulate succession. One important line of evidence is the occurrence of abundant small FGG xenoliths in a MZ cumulate matrix at Candle Hill [NJ 662 265], between Pitcaple and Insch (Wadsworth, 1988).

However, it must be emphasized that although Pitscurry quarry provides excellent exposures of the various MZ components, their precise relationships are not immediately evident, and await a more thorough investigation.

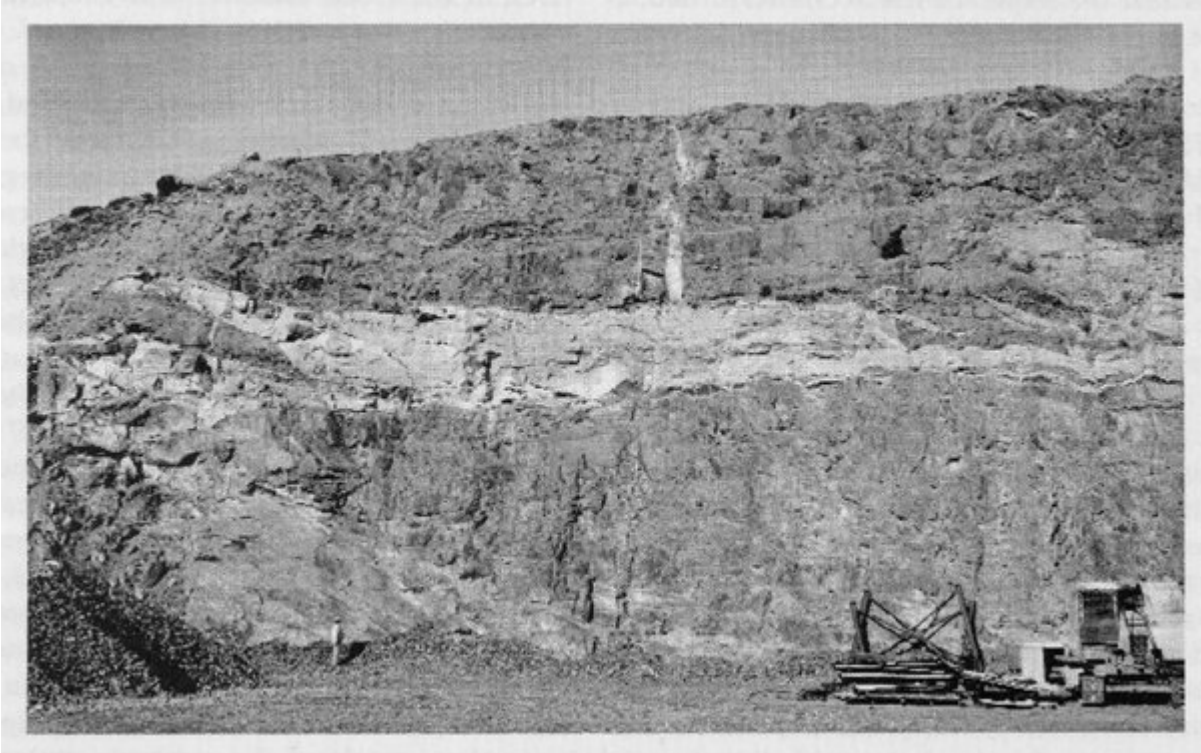
Conclusions

Pitscurry and Legatesden quarries are representative of the Middle Zone (MZ) of the 'Younger Basic' layered sequence. Between them they provide access to the great variety of Insch MZ rocks, both primary and secondary (shear-belt modification), as well as later pegmatitic granite sheets. Pitscurry is particularly important in terms of the close association of unusually fresh MZ cumulates and granular gabbros, whereas Legatesden is significant in displaying small-scale layering in MZ cumulates (rarely seen elsewhere), with evidence of post-cumulus instability.

References



(Figure 3.9) Map of the area around Legatesden and Pitscurry quarries, Insch intrusion, from BGS 1:10 000 Sheet NJ72NW (1989).



(Figure 3.10) Norite of the Middle Zone, Insch intrusion, intruded by a 10 m-thick sheet of pegmatitic granite with narrow veins branching off the main sheet, Pitscurry Quarry Pitcaple. (Photo: BGS no. D4332.)