Bardon Hill

[SK 455 133]–[SK 462 132]

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Introduction

The site includes the crags and spectacular viewpoint of Bardon Hill (which at 271 m elevation is the highest point of Charnwood Forest), and the extensive and deep quarry to the west (Figure 2.13). It is unique in being the only locality to expose the Bardon Hill Complex (Moseley and Ford, 1985), a former volcanic centre made up of two components: the Peldar Porphyritic Dacite (new name) and Bardon Breccia (Worssam and Old, 1988). These units consist of a range of massive and brecciated, fine-grained igneous rocks and are in faulted contact with volcaniclastic rocks tentatively equated with the Bradgate Formation. The origins of the Bardon Hill Complex are problematic; some workers have suggested that it represents associations of intrusions or intrusion breccias (Jones, 1926 and in Bennett *et al.,* 1928), others favour volcanic domes (Moseley and Ford, 1985; Le Bas, 1996), or lava flows (Hill and Bonney, 1891; Worssam and Old, 1988).

The present excavations offer impressive cross-sections through Trias-filled valleys cut deeply into the Charnian rocks, uniquely demonstrating the nature of the erosional processes that moulded the pre Triassic landscape.

Description

The northern face of Bardon Hill Quarry contains the only remaining exposures of the Peldar Porphyritic Dacite ('Peldar Porphyroid' of Jones, 1926). The massive dacite facies of this rock consists of a dark grey to black, fine-grained matrix enclosing phenocrysts of rounded, pale grey to greenish grey glassy quartz, up to 10 mm across, and more abundant *(c.* 40%) phenocrysts of pink or grey plagioclase; greenish grey microdiorite enclaves are also present.

The contact between the Peldar Dacite and Bardon Breccia is a highly complex zone in which, first, the Peldar Dacite changes to a grey dacite breccia, which may be equivalent to the 'purple porphyroid' of Jones (1926). This lithology passes into a heterolithic breccia consisting of highly angular dacite slivers enclosed within a yellow to pink, medium-grained, volcaniclastic sedimentary lithology. Farther south there is a passage into green dacite breccia, consisting of irregular fragments of pink or green, epidotized porphyritic dacite enclosed in a dark grey to black, fine-grained matrix that is highly recrystallized but shows a 'ghost' spherulitic texture in thin section. The green dacite breccia fines towards the Bardon Breccia, and near the contact becomes penetrated by irregular patches and ribbons of dark red, fine-grained sediment: the contact is sharp but obscured by shearing.

The monomictic facies of the Bardon Breccia shown in (Figure 2.13) equates with the 'Good Rock' of Jones (1926). It is a pale green to greenish grey, locally feldsparphyric andesite, intensely epidotized and chloritized. The breccia texture is best displayed on fresh, smooth surfaces that reveal abundant tightly packed, diffuse to sharp-margined fragments of pale green or yellow-green andesite. A rare but highly significant relationship occurs where these fragments exhibit cuspate, 'pseudo-pilloidal' margins part-surrounded by black, fine-grained material. The latter is seen in thin sections to be composed of fibrous chloritic aggregates locally studded with tiny quartzo-feldspathic spherulites. When traced farther south, the breccia texture becomes accentuated due to the development of a granular, crystal-rich, volcaniclastic matrix. This encloses abundant and large, rounded to subangular andesitic fragments, many surrounded by pale yellow or pink, compound rims. The rims commonly feature a dark grey to maroon fine-grained selvage, a few millimetres wide, in which plagioclase microphenocrysts are aligned tangentially along the sharp outer junction with the matrix.

Farther south a hyaloclastite breccia is developed, consisting of a fine- to medium-grained matrix packed with lapilli of spherulitic andesite. It encloses andesite blocks, up to 0.15 m size, which have angular or cuspate margins; they include pale yellow-rimmed andesite, black-rimmed spherulitic andesite (Carney, 1999) and dark grey slivers of the same

material. Other fragments include fine- to medium-grained, laminated, volcaniclastic sandstone and sporadic subangular blocks and lapilli of black to purple, fine-grained dacite with small feldspar and quartz phenocrysts. The volcaniclastic facies of the Bardon Breccia, next seen to the south, carries the same types of clast, but the enclosing greenish grey, sandy matrix locally exhibits a diffuse, wispy or contorted bedding fabric.

Natural exposures of the monomictic and possibly the hyaloclastite facies of Bardon Breccia occur on the summit and southern slopes of Bardon Hill, below the trigonometric point and the radio mast [SK 4612 1318]. The andesite blocks stand out boldly on weathered crags hereabouts (Fig. 2.14), and some have rimmed margins. On the landscaped site to the north, there are large blocks of quarried rock, which in appearance are typical of monomictic Bardon Breccia seen in the main quarry.

An ESE-trending fault zone separates the Bardon Breccia from volcaniclastic sedimentary rocks. The latter dip southwards and constitute an upward-fining sequence. At the base are thickly bedded, normally graded medium- to coarse-grained volcaniclastic sandstones, which in overall appearance resemble the matrix to the hyaloclastite facies of the Bardon Breccia; some beds contain blocks of dark grey to black andesite or dacite. These beds become increasingly intercalated with grey to maroon graded mudstones and siltstones further up-section. They are correlated with either the Bradgate or the Beacon Hill formations of the Maplewell Group, but are of a different facies to those strata farther east, and contain a major local detrital component derived from the Bardon Breccia.

Triassic strata of the Mercia Mudstone Group, comprising red and green mudstones and minor intercalated green dolomitic siltstones, unconformably mantle the Charnian rocks around Bardon Hill. The highly irregular contact is excellently displayed on the northern and southern quarry faces, which show in profile a system of deep valleys, some with slopes in excess of 60°.

Interpretation

The Bardon Hill site presents opportunities for resolving previous arguments concerning magmatic processes occurring within one of the Charnian volcanic centres. The earliest detailed investigations, by Jones (1926), favoured an 'igneous' origin, as intrusions or intrusion breccias, for the Bardon Breccia and Peldar Porphyritic Dacite. Moseley and Ford (1985), who suggested that the Peldar Dacite formed a small intrusive dome within dominantly clastic rocks, held a similar view. Le Bas (1996) considered that the domes at Bardon were emplaced subaqueously. On the other hand, Worssam and Old (1988) thought that these rocks represented an interbedded sequence of lavas and block lavas, though they did not present conclusive evidence to support this assertion.

The present quarry exposures show many highly significant features, which elsewhere are commonly attributed to interactions between magma and wet sediments (Pichler, 1965; Goto and McPhie, 1998). High-level emplacement of the Peldar Porphyritic Dacite into a cover of unconsolidated Charnian strata is demonstrated, for example, by the sediment-injected, heterolithic breccia developed at its margins (Carney, 1999). The pronounced colour change to the green dacite breccia additionally indicates that hydrothermal activity and epidotization accompanied the rapid cooling that promoted widespread spherulitic crystallization at the margin of the dacite.

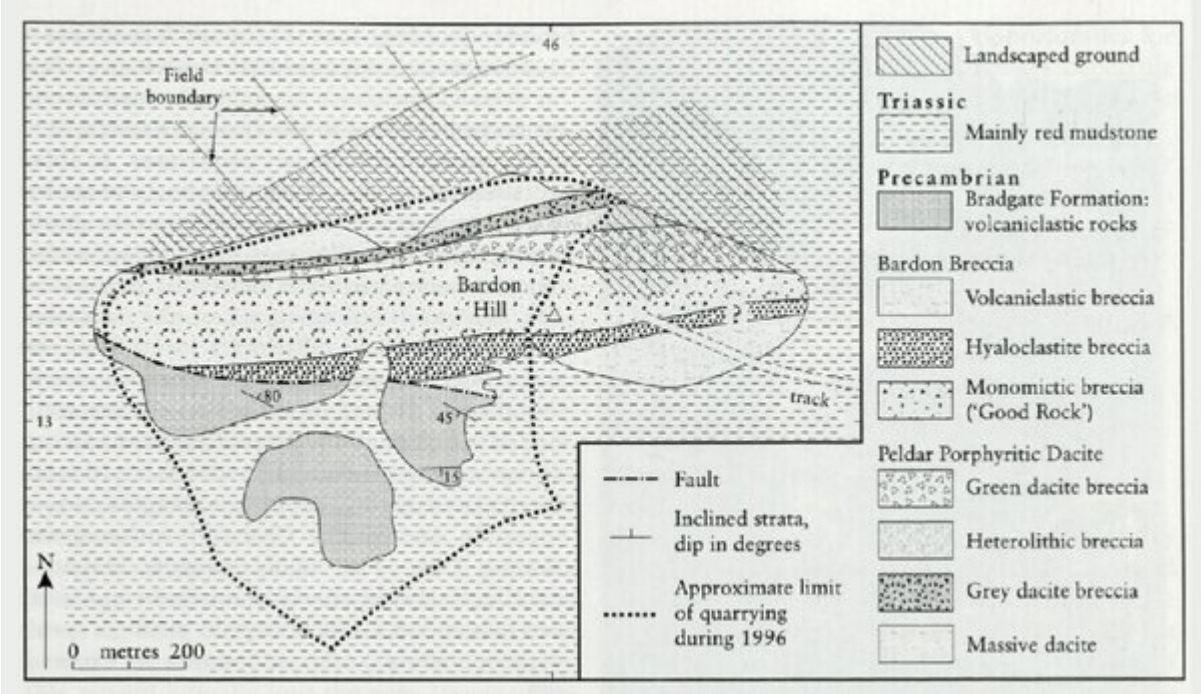
The monomictic facies of Bardon Breccia features a matrix in which the presence of spherulitic material, albeit rare, is diagnostic of localized rapid cooling of the andesite. The hyaloclastite breccia represents a complementary outer zone of more extensive spherulitic crystallization, and disaggregation, akin to rocks attributed to 'quench-brecciation' processes (Hanson, 1991); this produced pervasive spherulitic textures in the clastic matrix, as well as in the black-rimmed andesite fragments. The appearance of sedimentary rock fragments in this breccia suggests that the andesite had totally disintegrated at this stage, mixing with its unconsolidated sediment host to form a peperite lithology. Extrusion of this material as debris flows explains the partly bedded, volcaniclastic facies of the Bardon Breccia. This in turn probably passed laterally into the very coarse-grained, volcaniclastic sandstones now seen in fault contact to the south, suggesting that the Bardon Hill Complex was a source of at least some of the detritus that formed the local sequences of the Beacon Hill or Bradgate formations.

Conclusions

Bardon Hill contains the only exposures of the Bardon Hill Complex, and these rocks give a remarkable insight into the magmatic processes that operated within one of the Charnian volcanic centres. The principal conclusion of the earlier research, that these rocks are largely intrusive, is to some extent endorsed by the present deep quarry sections. The emplacement mechanisms of the Peldar Porphyritic Dacite and Bardon Breccia were nevertheless complex since they involved large-scale physical and chemical interactions between the magmas and water-saturated sediments. Some of the Bardon Breccia was eventually extruded, in the form of a volcaniclastic breccia or 'peperite', supporting the suggestion of Le Bas (1996) that the Bardon centre represents activity from an extrusive volcanic dome. However, the term 'cryptodome' (cf. Goto and McPhie, 1998) may be more appropriate since most of the relationships seen here were formed when the Peldar and Bardon Breccia magmas were enclosed in a sedimentary carapace. The significance of the site to Charnian stratigraphy is undoubted, but in a wider context it also presents opportunities for volcanological studies into processes occurring within a late Precambrian high-level magmatic centre.

The quarry sections demonstrate the highly irregular nature of the basal Triassic surface, providing a possibly unrivalled 'snapshot' of the eroded and mountainous pre Triassic landscape.

References



(Figure 2.13) Geological map of the Bardon Hill site