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Geological notes and local details for the area around Butterleigh, Devon (SS 90 NE): part of the Tiverton (310) 1:50 000 Sheet

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Jonathan R Lee

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British Geological Survey offices

Keyworth, Nottingham NG12 5GG

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Parent Body

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Foreword

This report is the published product of a study by the British Geological Survey (BGS) examining the geology of the area around Butterleigh, Mid Devon. The brief report presents some of the observations and ideas that have underpinned the geological mapping of the area.

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Contents

Summary

This report describes the geological survey that was undertaken in the Butterleigh area of the Tiverton 1:50 000 sheet during 2005. The geological succession consists of Carboniferous Culm deposits, passing upwards into breccia and mudstone of the Permian Exeter Group, Regolith Head, Valley Colluvium and Alluvium of Neogene age.

1 Introduction

This geological report is designed to be used in conjunction with 1:10 000 geological field slips SS 90 NE that form part of the 1:50,000 Geological Sheet Tiverton (310). H. De La Beche and W.A.E. Usher originally mapped these as part of Old Series Sheets 21 and 26 during the mid- and late- nineteenth centuries.

The area covered by the report is located on the eastern side of the Exe Valley between Tiverton and Cullompton, and includes the villages of Butterleigh and Bickleigh. A broad north-south trending watershed exists that divides the Burn River and its tributaries that drain westwards into the River Exe, and a small network of streams that drain eastwards into the River Culm in the vicinity of Cullompton. The topography of the district consists of a prominent hill-vale relief with surface elevations ranging from 81m OD to 261m OD.

Most of the land within the report area is rural with the land-use given over to a mixture of arable and livestock farming, and some set-aside. Terrain with sandy and gravely soils overlying sandstone and breccia, is predominantly arable with wheat and barley or grass grown for silage production. Muddy and more poorly drained soils are generally used for grazing cattle.

2 Geological Notes

The bedrock and superficial geology of the Butterleigh area (SS 90 NE) consists of Palaeozoic bedrock of Carboniferous and Permian age, overlain by Neogene deposits comprising Regolith Head, Valley Colluvium and Alluvium. The following sections provide some observations and the rationale behind the mapping.

2.1 CARBONIFEROUS – CULM (BUDE FORMATION)

2.1.1 Description and mapping rationale

Culm crops-out throughout much of the western half of the report area where it forms a steeply undulating topography. Exposures of Culm are rare and recognition of the deposit within this mapping exercise has largely been based upon indirect evidence - namely the distinctive morphology of slopes that develop on Culm.

Slopes formed on Culm bedrock exhibit an extremely variable form that appears to be controlled by both regional and local trends in structure and lithology. This topographic variability is characteristic and provides a reliable method for identifying the bedrock material. Specifically, slopes developed on Culm tend to be very irregular in form and frequently comprise several convex-concave breaks of slope caused by alternating mudstones and sandstones. Areas of hill slope colluvium are often well developed and can extend well up the valley side.

Soil brash can also be a useful indicator of the underlying geology however both the shape and lithology of clasts can be similar to that found in soils developed upon the younger Permian breccias and regolith head. Typically, soils developed on Culm have a pale pink hue and contain locally derived clasts such as purple sandstones (with rounded edges) and fissile mudstones. Far-travelled clasts such as vein quartz are rarely seen.

Occasional outcrops of bedded sandstone and fissile mudstone were observed in the floor of several paths and tracks and these beds all showed a consistent east-west strike with variable dip to either the north or south. Several larger outcrops of Culm were recorded. For example, some 350m east of Backswood Farm (NW Quarter) is a small quarry [962092] that shows a 3m thick sequence of horizontally-bedded sandstone separated by thin horizons (up to 0.3m) of massive to thinly-bedded grey mudstone. Further to the south (SW Quarter) at Leighpool Copse [953058], bedded gravely sandstones can be seen in the streambed adjacent to the road. These sandstones dip at 26° towards the north. To the north of Butterleigh, two exposures were seen in disused quarries to the southeast of Borough Farm [973092], and north of Sunnyside Farm [974088]. Thinly bedded mudstones, gravely sandstones and muddy fine conglomerates were recorded at both sites, whilst directional measurements at the latter site revealed dips of around 35° to the northeast.

The general east-west strike of the Culm in the Butterleigh area is consistent with observations made to the north around Tiverton SS 91 SE (Lee, 2005), and within the western part of the Tiverton Sheet west of the River Exe (Booth and Lee, unpublished observations; Colin Waters, personal communication, 2006). The northerly and southerly dips of beds across SS 91 SE and SS 90 NE suggest that the Culm has been deformed into a series of east-west striking asymmetrical folds.

2.2 PERMIAN - EXETER GROUP – CADBURY BRECCIA

2.2.1 Description and mapping rationale

Breccias crop-out throughout the central and southeastern part of the district where they rest unconformably upon the Culm. Exposures of breccia are rare and mainly restricted to small roadside sections through verges. Mapping the spatial extent of the breccia was mainly determined by the examination of slope form which is distinctively different to that exhibited by the Culm, and the composition of the soil and soil brash.

By contrast to the Culm with its undulating slopes, slopes formed on breccia tend to have a simple concave-convex form of moderate steepness (>20°). Hill slope colluvium tends to be very poorly developed and if present, tends to be restricted to the lower slopes of valleys. Soils developed on the breccia are similar to those developed on Culm, however the clasts within the

soil tend to have a higher degree of edge rounding and contain a suite of more far-travelled clast types such as vein quartz, weathered basalt and andesite.

An exposure of massive breccia was noted in the car park of the Butterleigh Inn at Butterleigh [975083]. The breccia here consisted of sub-rounded clasts of sandstone, mudstone and vein quartz. To the north of Butterleigh at [981091], 0.6m of massive breccia with sub-angular to sub-rounded clasts of vein quartz, mudstone and sandstone was exposed in the southern road embankment. Imbrication was evident in places suggesting a local palaeoflow direction towards the north and east. Near Hillersdon Park on the eastern edge of the report area, a small exposure of massive sub-angular breccia was recorded within road cuttings at [993082]. Similar materials were observed in road cuttings at Stokehouse [979058] and on the road heading southwest from Bunneford Cross [988064]. Although the exposures of the breccia are not as good as further north on SS 91 SE, the broad sedimentological properties lend support to previous interpretations of this deposit as the proximal facies of an alluvial fan sequence (Lee, 2005).

The breccia mapped in the Butterleigh area has previously been called the 'Tiverton Breccia' by Hodgson and Lambing (1994), however the continuity of mapping of deposits further to the north on SS 91 SE, and its lithological composition suggest a regional correlation with the 'Cadbury Breccia' of the Exeter Group (Edwards and Scrivener, 1999; Lee, 2005).

2.2.2 Basal contact of Exeter Group around Butterleigh

The nature of the contact between the Cadbury Breccia and underlying Culm is highly variable and warrants some discussion. Within the SW quarter for example, the base of the breccia can be observed to undulate in elevation by about 15m with an overall dip towards the northeast and east-northeast. In other places, the base of the Cadbury Breccia flanks across a range of elevations. Although in certain instances (see next paragraph), the possibility of faulting appears more feasible, the widespread occurrence of this basal boundary geometry is more easily accommodated by a sedimentary mode of origin. In this model, the undulating basal contact of the breccia reflects a series of deep incisions along structural and lithological planes of weakness that existed upon the upper surface of the Culm. These incisions are likely to have formed a series of both local and regional palaeo gulleys, valleys and canyons, and would have occurred following the folding of the Culm but prior to and during the early stages of the deposition of the Cadbury Breccia. The breccia was then deposited as part of an alluvial fan sequence, by a series of high-energy ephemeral rivers or streams. Topographic lows (e.g. valleys, gulleys and canyons) on the Culm were thus progressively scoured and in-filled by clastic material until drainage was able to develop followed a new regional palaeo-slope unconstrained by the prexisting Culm topography. The alluvial fan sequences developed according to the regional dip of the base of the breccia and orientation of bedding planes and clast imbrication, which is towards the northeast (Lee, 2005).

Around Butterleigh [975082] the geometry of the base of the breccia can be seen to cross-cut several major contours dipping north to south (to the west of Butterleigh) and northeast-southwest (to the east of Butterleigh) along the base of valleys. The overall dip of the base of the breccia here appears to be towards the southwest – the opposite of the regional dip. This raises the possibility that in places, the boundary between the Culm and Cadbury breccia may well be fault controlled.

2.3 PERMIAN - EXETER GROUP – RED SANDY MUDSTONES

On the eastern side of the Butterleigh district, the Cadbury Breccia passes laterally into fine-grained sandy mudstones. The base of these mudstones was not encountered, but the upper boundary varies between 115m and 130m elevation. There were no exposures of this deposit observed anywhere on SS 90 NE but their existence is inferred using both slope morphology and soil composition.

Placing and locating the mappable boundary between the breccia and the mudstone was evident in two principal ways. Firstly, by observing a horizontal concave break of slope and downslope transition from pebbly to silty soils – for example around Trinity [994057]. Secondly, a more undulatory concave break of slope with variable patches of stony and silty soil – for instance, to the north and east of East Butterleigh [983093]. Both of these boundaries are interpreted slightly differently. The first horizontal boundary is more suggestive of a sharp, abrupt contact, whilst the second more diffuse boundary, points to a degree of intercalation between the two units.

Similar deposits at identical elevations can be found to the north around Tiverton (Lee, 2005). Examination of these deposits revealed that they were intercalated with the Cadbury Breccia and represented the more distal facies of an alluvial fan sequence. A similar geometric arrangement and mode of origin is also invoked here.

2.4 NEOGENE DEPOSITS

2.4.1 Alluvium

There are several areas on SS 90 NE where alluvium has been mapped. The main area is the Exe Valley in the northwest corner of the survey area where alluvium occupies the modern flood plain. No river terraces are evident in this part of the Exe. Within this area, the alluvium consists of a dark grey mud with large cobbles of sub-rounded Culm sandstone. Alluvium also crops-out within the Burn Valley downstream of Underleigh Cottages [965075] west of Butterleigh, where it forms a c.30-50m wide tract trending down valley towards Bickleigh. Between Fulford Water [996089] and Cruwyshayes [997094], alluvium is present within a small river valley draining east towards Collumpton.

2.4.2 Regolith Head

Much of the bedrock in the Butterleigh area is covered by *in situ* weathered material and is particularly well preserved on the plateau and interfluve areas. It is well developed on the Culm and Cadbury Breccia where it can be seen overlying its parent material in several of the small disused quarries (e.g. Leigh Barton [951955]). The regolith is typically up to 1m in thickness and consists of fractured and broken-up bedrock material, and is distinguishable from its host material by the sub-angular morphology of the clasts. In places the clasts are vertically aligned which is evidence for periglacial frost heave.

2.4.3 Valley colluvium

Many of the valleys within the study area contain valley colluvium. Across the sheet, the distribution of valley colluvium forms a dendritic arrangement that closely mirrors the drainage network. It consists of bedrock-derived material that has moved down the valley sides under the

influence of gravity. Accumulations appear to be thicker and more extensive over Culm bedrock or Exeter Group sandy mudstones, whilst those accumulations in areas of Cadbury Breccia are generally thin.

3 Conclusions

The geology of the area around Butterleigh (SS 90 NE) is very similar to ground to the north around the Tiverton district (SS 91 SE). The base of the succession is represented by the purple sandstones and mudstones of the Culm (Bude Formation), and these crop-out over much of the western half of the survey area. Structurally the Culm has been extensively deformed, and comprises a series of east-west striking asymmetrical folds, with fold limbs dipping to the north and south. Following the uplift and folding of these beds, the Culm was incised into prior-to and during the deposition of the Cadbury Breccia (Permian) and the sandy mudstones that was deposited over this undulating and irregular land-surface as an alluvial fan complex. The regional dip of the basal surface of the Cadbury Breccia, coupled with bedding plane and clast imbrication directions, suggests that the alluvial fan complexes were prograding in a northeasterly direction. Blanketing these Palaeozoic sediments, are a range of Neogene deposits, these include regolith head, valley colluvium and alluvium.

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Most of the references listed below are held in the Library of the British Geological Survey at Keyworth, Nottingham. Copies of the references may be purchased from the Library subject to the current copyright legislation.

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