Field excursion to the igneous and sedimentary rocks of the Crediton Trough, 5th January, 2012

S.E. McVicar Wright[1] and R.C. Scrivener[2]

McVicar Wright, S.E. and Scrivener, R.C. 2012. Field excursion to the igneous and sedimentary rocks of the Crediton Trough, 5th January, 2012. *Geoscience in South-West England*, **13**, 142-145.

The purpose of the field excursion was to examine rocks of Permian age cropping out in the Crediton Trough. The trip included visits to five locations where a range of sedimentary strata and igneous rocks was exposed.

[1] *Camborne School of Mines, College of Engineering, Mathematics and Physical Sciences, University of Exeter, Cornwall Campus, Penryn, Cornwall, TR10 9EZ, U.K.*
[2] *Demmitts Farm, Posbury, Crediton, EX17 3QE, U.K.*

Keywords: Permian, sedimentary strata, igneous rocks, Crediton Trough.

Introduction

The red sedimentary rocks of predominantly Permian age in the Crediton Trough of Devon are included in the Exeter Group - a term introduced (Edwards and Scrivener, 1999) to include all the formations between the unconformity at the base of the New Red Sandstone and the overlying Aylesbeare Mudstone Group of Triassic age (Table 1). Locally interbedded with the sedimentary rocks are lavas collectively known as the Exeter Volcanic Rocks.

The sedimentary history of the Exeter Group (Edwards and Scrivener, 1999) began with the deposition of the Cadbury Breccia on the northern margin of the Crediton Trough and was concentrated in the east of the basin. Sediment supply was from the north and gave rise to a thick, coarse, clastic alluvial fan sequence. As the Crediton Trough developed with continued extension, alluvial-fan sedimentation switched to the west, the Bow Breccia was formed and the direction of sediment supply changed with a likely source from the west or south-west. The Knowle Sandstone represents the upper, outer and finer-grained part of the Bow Breccia alluvial fan. A prolonged period of active extension and uplift occurred before the deposition of the Creedy Park Sandstone, and was probably responsible for the abandonment of the Bow Breccia alluvial fan. The overlying Crediton Breccia indicates a change in the direction of basin filling from west to east, to south-west to north-east. The overlying Newton St Cyres Breccia has features suggestive of deposition on the lower parts of an alluvial fan, transitional to a proximal braidplain, and it shows a distal thinning and fining into the Shute Sandstone. Active extension of the Crediton Trough is likely to have ceased towards the end of the Permian and was marked by the deposition of the aeolian Dawlish Sandstone under the influence of a northerly directed wind.

The volcanic rocks associated with the Exeter Group include basalts and lamprophyres with minor occurrences of rhyolite and agglomerate. Radiometric dating indicates they were erupted just before the intrusion of the Dartmoor granite at 280 Ma (Edwards and Scrivener, 1999).

West Sandford [SS 8107 0285]

The Bow Breccia and Knowle Sandstone, which are of Early Permian age, are exposed at this locality. The Bow Breccia typically contains clasts of Culm sandstone, shale, slate, vein quartz, hornfels, a minor fraction of argillised and iron-stained acid igneous rocks and rotted lamprophyres in a matrix of red-brown silty sandstone. Igneous pebbles dominantly present are quartz-porphyry, acid tuff and rhyolite (ignimbritic). The sandstone component increases upwards through the formation. The Bow Breccia is interbedded with lamprophyric lavas and basalts at the junction with the overlying Knowle Sandstone. In some locations the Bow Breccia can be seen to overly the Cadbury Breccia, suggesting a disconformable contact. Spores sampled from the base of the Bow Breccia at Lower Creedy House, suggest an Early Permian age, but these may have been reworked from Carboniferous rocks. The depositional environment of the Bow Breccia was dominated by debris flows and grain flows, and in some areas partly reworked by sheet floods as part of the alluvial system in the Crediton Trough at the time.

The Knowle Sandstone is a reddish brown, moderately to well cemented and well bedded sandstone. Interbeds of breccia are visible and breccia clasts are similar to those in the Bow Breccia. Lavas of the Exeter Volcanic Rocks are interbedded at two levels and these include lamprophyric microsyenites and olivine basalts. The base is gradational from the underlying Bow Breccia and the top is marked by a strong disconformity overlain by the Creedy Park Sandstone. At West Sandford Barton there is a lamprophyric lava flow resting on the Knowle Sandstone and components of this are visible in the rocks found here and in thin section (Figures 1a and b). The breccia beds are sharply or erosively based and overlain by beds of sandstone with sharp or abruptly transitional bases. Breccia clasts include sandstone, slate, vein quartz, hornfels and igneous rocks including ignimbritic acid tuff and quartz porphyry. In the lowest part of the section the sandstone is ashy and tuffaceous.

Period	Group	Crediton Trough	
		Crediton to Silverton	Clyst Hydon area
Triassic	Aylesbeare Mudstone Group		Aylesbeare Mudstone Group (where undivided) Clyst St Lawrence Fm.
		unconformity	
Permian	Exeter Group	Dawlish Sandstone Poltimore Mudstone Bussell's Mudstone Shute Sandstone Newton St Cyres Breccia Crediton Breccia Yellowford Fm. Creedy Park Sandstone	
		unconformity	
		Knowle Sandstone[1] Thorverton Sandstone[1] Bow Breccia[1] Cadbury Breccia	Higher Comberoy Fm. Cadbury Breccia Upton Formation
		unconformity	

Fm. = Formation, [1] Formations containing isolated volcanic members (Exeter Volcanic Rocks)

Table 1. *New Red Sandstone Stratigraphy of the Crediton Trough (from Edwards and Scrivener, 1999).*

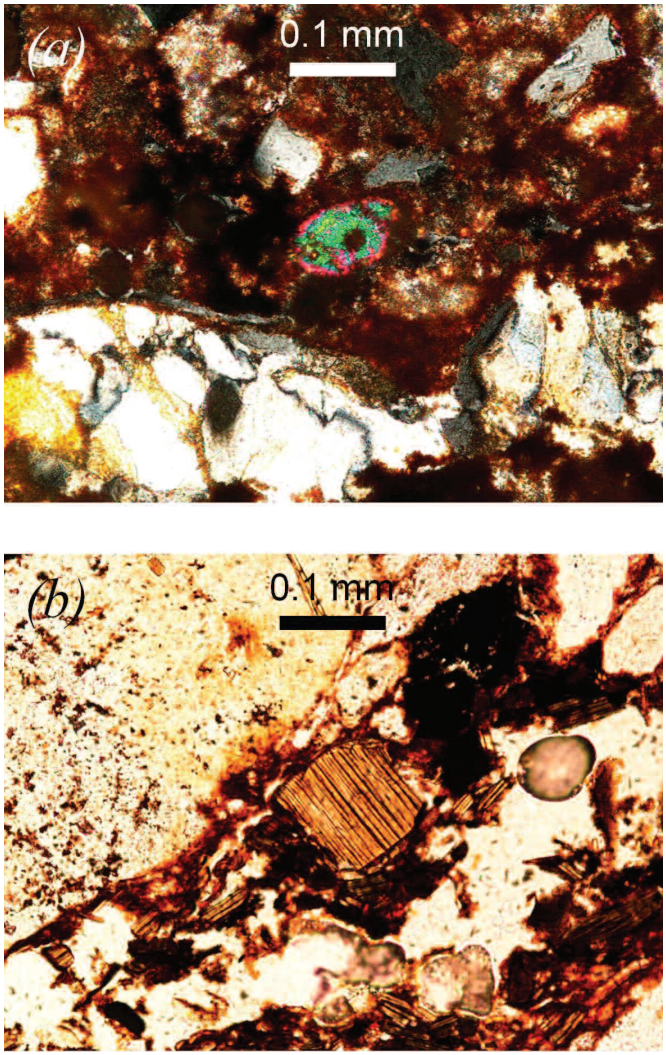

Figure 1. *Thin sections of Knowle Sandstone. (**a**) Zircon with high birefringence colours under cross-polarised light and at 20x magnification. (**b**) Possibly volcanic-related, fresh-looking biotite under plane polarised light and at 20x magnification.*

Knowle Hill Quarry [SS 789 022]

An outcrop of lamprophyre is exposed in this quarry where it was described by Teall in Ussher (1902) from faces up to 30 m high, as having close affinity with minette. The upper levels were recorded as being vesicular and, in part, scoriaceous, but the rocks were more massive below. At the present day, the quarry is overgrown and partly backfilled (Figure 2a), but there are several exposures, mostly of the more massive type of material. It is composed of feldspar, biotite and olivine, the last mostly showing alteration to 'iddingsite' (Figure 2b). Secondary carbonate veining of the lamprophyre is also common (Figure 2c).

The rocks from Knowle Hill Quarry have been described more recently as olivine-biotite lamprophyre and olivine microsyenite, and an Ar-Ar plateau age of 281.8 ±0.8 Ma was obtained for biotite from lamprophyre at this locality (Edwards and Scrivener, 1999).

Uton Quarry [SX 824 986]

Uton Quarry was also described by Ussher (1902), who provided an illustration of basalt resting on sandstone. This section is now obscured, but in an adjacent pit to the east there are faces in purplish grey basalt (Figure 3a), mostly massive, but veined by a vesicular variety (Figure 3b). Towards the south of this pit, the basalt is increasingly broken on subvertical fractures, and at the back face is a prominent fault, trending WNW-ESE. The fault and the minor fractures are associated with white clay-filled veins and a black manganese oxide mineral (probably pyrolusite) (Figure 3a). The basalt is a potassium-rich alkali variety, rich in altered olivine, and with much secondary carbonate (Figure 3c).

Newton St Cyres Golf Course [SX 883 999]

This locality provided exposures of the Crediton Breccia and the Shute Sandstone. The Crediton Breccia is generally a finer-grained breccia than seen in the Bow Breccia below. It contains abundant rhyolite and quartz-porphyry fragments with REE and isotopic signatures suggesting a Dartmoor source and

Figure 2. *Knowle Hill Quarry. (**a**) Overgrown entrance at present day. (**b**) Lamprophyre with 'iddingsite'. (**c**) Lamprophyre veined by secondary carbonate.*

Figure 3. *Uton Quarry. (**a**) South-west edge, with possible fault passing through, and black manganese oxide staining on the quarry walls. (**b**) Fallen block on north-east side showing vesicles confined to a single layer. (**c**) Carbonate vein on north-east side.*

also strong evidence for suprabatholithic volcanism. Thin sections from the lower part of the Crediton Breccia show biotite in the matrix that may be weathered (Figure 4a). Tourmalinised slate clasts may indicate erosion of the granite aureole. The Crediton Breccia was probably deposited on the proximal part of an alluvial fan, the distal parts of which are represented by the Yellowford Formation (Table 1). The depositional environment of the Crediton Breccia was dominated by low and high viscosity debris flows in the west and tractional sheetfloods in the east. An increasing organization of fluvial sedimentation throughout the formation suggested the Crediton Breccia fan became more distal in character.

The Shute Sandstone (Figure 4b), which is a lateral equivalent of the Newton St Cyres Breccia (Table 1) and therefore can be assumed to be of Late Permian age (Edwards and Scrivener, 1999), consists of unconfined sheetflood deposits that are indicative of a more distal alluvial fan setting. The lithology is a reddish-brown silty sandstone and sandy siltstone, and lenses of breccia are visible at outcrop. The sandstones contain red-stained quartz grains with flakes of mica, and Quantitative Evaluation of Minerals by Scanning electron microscopy (QEMSCAN) reveals the full range of other minerals present in this deposit (Figure 4c). In general, the Shute Sandstones are moderately to well sorted and cross-bedding is sometimes present, which suggests deposition from unconfined tractional sheetfloods that had a possible source from the west or south-west.

Cromwell's Cutting, Pitt Hill, Crediton [SS 8165 0020]

The Newton St Cyres Breccia is well exposed at this locality (Figure 5a) and is believed to be the proximal part of an alluvial fan, represented in its more distal extent by the Shute Sandstone. It may also have a greater affinity in composition to the Heavitree Breccia of the Exeter area than to the Crediton Breccia and, therefore, may have a slightly different source. The Newton St Cyres Breccia, which is reddish brown in colour, is distinctive for the occurrence of 'murchisonite' (Figure 5b), which is a flesh-pink coloured potassium feldspar (perthite) that increases in abundance towards the top of the formation. It is also distinguished from the Crediton Breccia by its more sandy matrix and greater degree of cementation. Clasts, which rarely exceed 50 mm in size, include shale, slate, pelitic hornfels, chert, potassium feldspar, vein quartz, quartz-porphyry, acid lava and tuff, granite and tourmalinised igneous rocks.

A sedimentary log (Figure 5c) of the section in Cromwell's Cutting (Edwards and Scrivener, 1999) indicates sandstone beds and lenses are present in the Newton St Cyres Breccia and these were probably deposited by sheetfloods over the debris flow-dominated areas of the fan. Beds tend to be erosive and palaeocurrents, where visible, suggest flow was from west to east. The section at Cromwell's Cutting is near to the base of the formation and shows planar cross-bedded breccias suggested to be transverse bar forms within a fluvial channel (Edwards and Scrivener, 1999). Sharp bases and sharp tops are indicative of discrete episodic depositional events. Bisaccate pollen from Fordton Cross suggests the breccia to be of Late Permian age.

Acknowledgements

We are indebted to Messrs Andy Gray and George Mortimer for permitting access to the Knowle Hill and Uton quarries respectively. We also thank Dr. G. Warrington for helpful assistance on the day of this excursion.

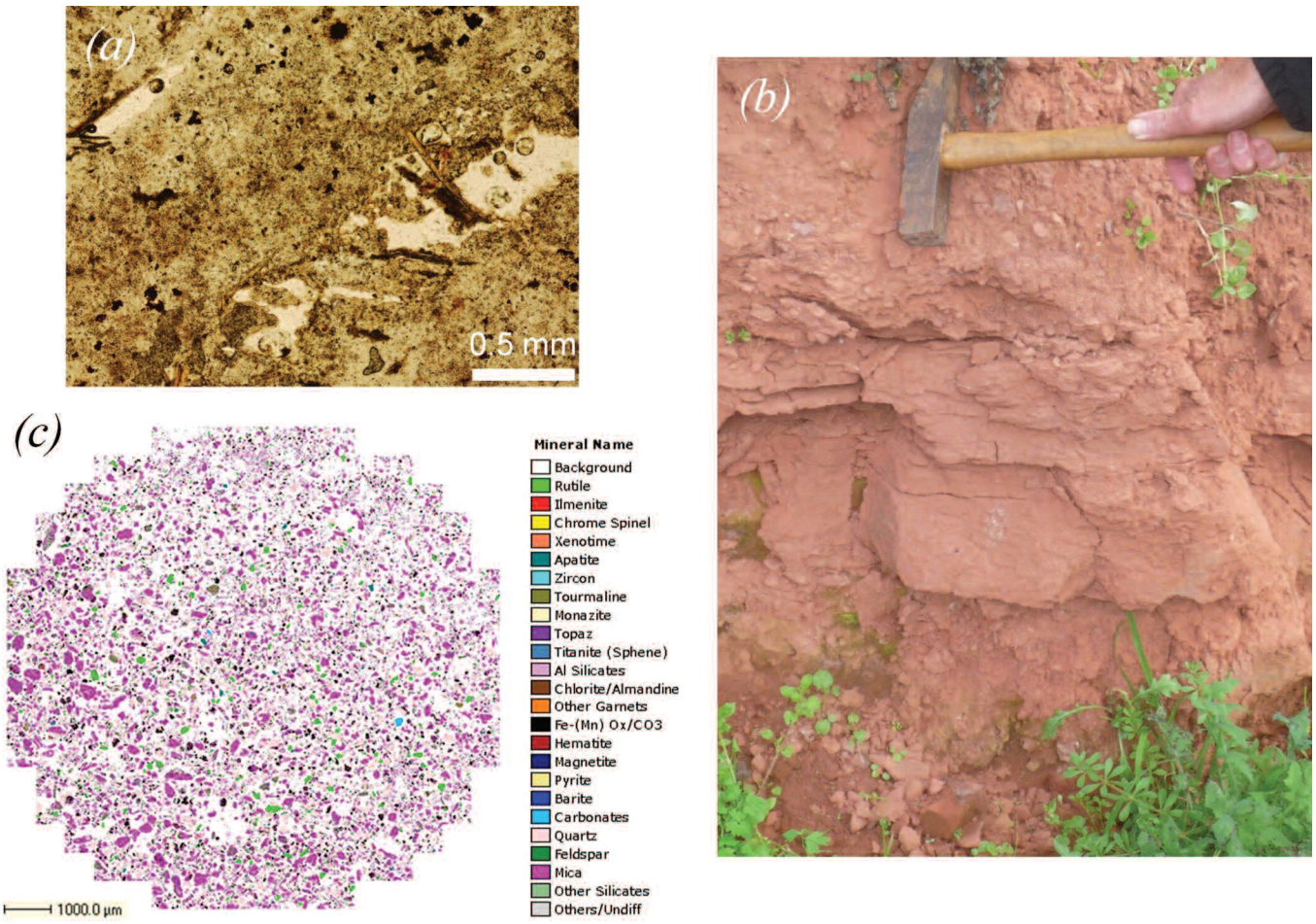

Figure 4. *(**a**) Thin section of Lower Crediton Breccia under plane polarised light and at 5x magnification showing biotite in the matrix. (**b**) Shute Sandstone with Newton St Cyres Breccia above at Newton St Cyres Golf Course. (**c**) Panned concentrate of Shute Sandstone mounted in resin and analyzed with the QEMSCAN at Camborne School of Mines, University of Exeter.*

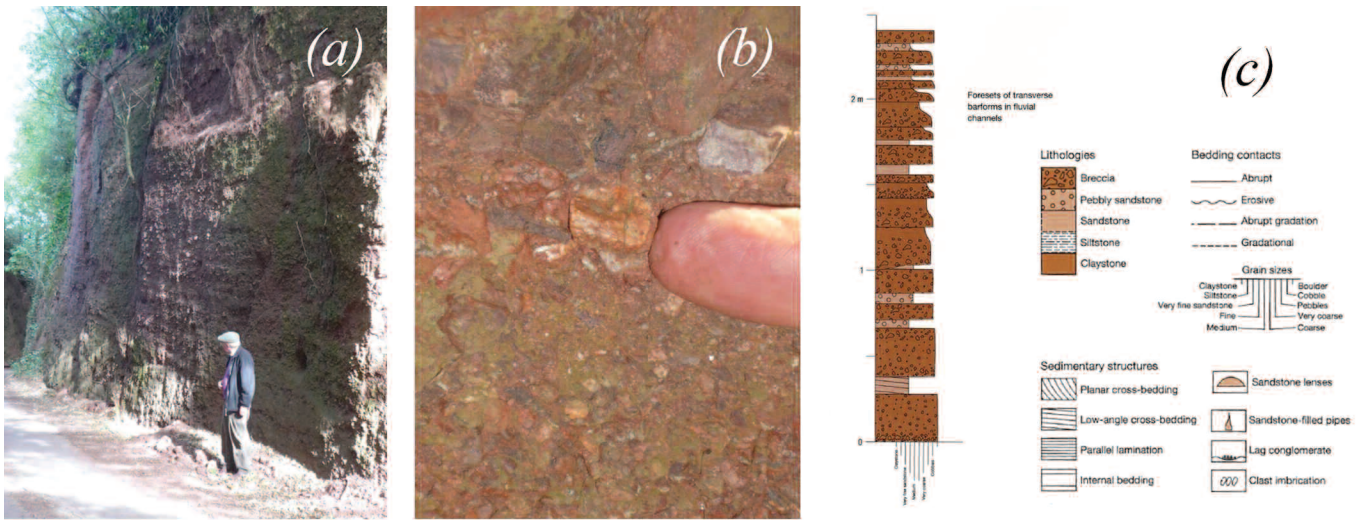

Figure 5. *Cromwell's Cutting, Pitt Hill, Crediton. (**a**) Bedded Newton St Cyres Breccia. (**b**) Detail of 'murchisonite' clast. (**c**) Sedimentary log of section (after Edwards and Scrivener, 1999).*

REFERENCES

EDWARDS, R.A. and SCRIVENER, R.C. 1999. Geology of the country around Exeter. *Memoir for 1:50:000 Geological Sheet 325 (England and Wales).* HMSO, London.

USSHER, W.A.E. 1902. The geology of the country around Exeter. *Memoir of the Geological Survey of Great Britain*, Sheet 325.