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Late Permian fossils from Devon: regional geological implications

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Current resurvey of the Exeter district (L50 000 geological sheet 325) by the British Geological Survey (BGS) has resulted in a revision of the relationships and nomenclature of lithostratigraphic units in the 'New Red Sandstone' (NRS) in part of that district (Bristow and Scrivener 1984; Bristow et al. 1985). These beds underlie the Budleigh Salterton Pebble Beds (BSPB), the base of which was, 100 years ago, arbitrarily advocated as the base of the Triassic sequence in the region (Irving 1888). Middle Triassic vertebrates from the overlying Otter Sandstone Formation were hitherto regarded as the oldest stratigraphically useful fossils; lower beds had yielded only sporadic trace fossils and derived Devonian and Carboniferous material (Warrington et al. 1980). Despite this lack of biostratigraphical evidence, the sequence below the BSPB was generally regarded as Permian.

In 1965, radiometric (K/Ar) dates from two rocks of the Exeter Volcanic Series (Miller et al. 1962; Miller and Mohr 1964) were used to infer an age of c.280 Ma, the age then attributed to the Carboniferous - Permian boundary (Harland et al. 1964), for deposits low in the NRS near Exeter (Laming 1965). Stratigraphically lower NRS beds in the Crediton Trough and Torbay areas were regarded as probably late Carboniferous (Stephanian), and the youngest pre-Variscan sediments then known in Devon were Westphalian A in age (Laming 1965). This stratigraphic evidence constrained the culmination of Variscan folding and emplacement of the Cornubian granite batholith, with related minor igneous activity and mineralisation, to a very short interval during the late Carboniferous.

NRS sediments around Exeter have been examined for palynomorphs. Borehole cores from the upper part of the Whipton Formation at Shilhay, Exeter (SX 9194 9206), have yielded terrestrial assemblages dominated by poorly preserved bisaccate gymnosperm pollen. Specimens are scarce and indeterminate in most preparations, but one (BGS registered number MPA 26247) contains determinable specimens including *Lueckisporites virkkiae*, the presence of which establishes the age of the assemblage as late Permian (Kazanian to Tatarian; Warrington in: Smith et al. 1974, pp. 36-37). Associated taxa, including *Perisaccus granulosus, Klausipollenites schaubergeri, Jugasporites delasaucei, Protohaploxypinus microcorpus* and *Lunatisporites spp*., are compatible with that age.

The palynological dating of the Whipton Formation, the lowest NRS formation at Exeter, has major implications for the late Palaeozoic history of south-west England. The base of the NRS at Exeter is shown to be considerably younger than previously envisaged, and from that level, up to the middle Triassic Otter Sandstone Formation, the succession must now be regarded as representing, at most, only late Permian and early Triassic time. Stratigraphically lower NRS beds in the Crediton Trough and Torbay areas (Laming 1965) may also be younger than previously envisaged. A longer interval is thus demonstrated between the youngest pre-Variscan sediments in Devon, now known to be Westphalian C (Freshney et al 1979), and the earliest postVariscan deposits at Exeter. In relation to a current geochronometric time scale (Forster and Warrington 1985), this interval may span up to 40 million years, from c.300 Ma (end of the Westphalian) to c.260 Ma (beginning of the Kazanian). It thus accommodates the culmination of Variscan orogenesis, emplacement of the Cornubian batholith at 290 to 280 Ma (Darbyshire and Shepherd 1985, 1987) followed by a phase of quartz porphyry intrusion at 280 to 270 Ma (Darbyshire and Shepherd 1985), development of the main tin mineralisation in the Cornubian province around 270 Ma (Halliday 1980; Darbyshire and Shepherd 1985), and uplift and erosion of the Dartmoor Granite, fragments of which, dated at 281 ± 7 Ma, occur in breccias overlying the Whipton Formation near Exeter (Bristow et al. 1985).

Exeter Volcanic Series rocks dated by K/Ar methods comprise a mica lamprophyre (minette) from Killerton (Miller et al. 1962) and a basalt from Dunchideock (Miller and Mohr 1964). A mean age of 279 ± 6 Ma from Killerton (Miller et al. 1962) has been recalculated to 291 ± 6 Ma using revised decay constants (Thorpe et al. 1986); the Dunchideock date of 281 ± 11 Ma (Miller and Mohr 1964) has not been recalculated. These rocks are acknowledged to have undergone secondary alteration and the ages obtained are therefore potentially lowered by Ar loss. Thus an age of at least 285 Ma, near the Carboniferous - Permian boundary (Forster and Warrington 1985), is considered a minimum for these rocks but appears anomalous in relation to that of 260 Ma or less indicated by the Whipton Formation palynomorphs for NRS beds around Exeter that have been regarded as associated with the volcanic rocks. A reassessment (Scrivener 1984) of the relationships between these rocks in the Exeter area has demonstrated that the lavas there rest directly on a weathered surface of folded Carboniferous rocks and themselves have a deeply weathered and locally lateritised upper surface that is overlain unconformably by NRS sandstones and breccias. Separate outcrops of lava may comprise remnants of a more extensive sheet that was locally completely removed by, erosion prior to deposition of the Whipton Formation. A substantial time gap is thus indicated between the extrusion of the lavas and the deposition of NRS sediments around Exeter.

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