

## THE CHRONOLOGY OF THE PERMIAN SUCCESSION IN DEVON – AN UPDATED REVIEW



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In Devon, continental deposits that rest unconformably on Carboniferous rocks affected by the Variscan orogeny have been assigned to the Permian on the basis of isotopic dating of interbedded volcanics and scarce biostratigraphic evidence from the Exeter Group. Limited magnetostratigraphic information from that and the succeeding Aylesbeare Mudstone Group supported that interpretation. This has now been augmented by new evidence which has allowed refinement of the dating of the succession following recognition, in the uppermost Exeter Group, of the end of the Kiaman Superchron, an important Wordian (Mid-Permian) event. Younger Mid-Permian deposits and an incomplete Late Permian succession have been identified following the recognition of divisions of the Illawara Superchron in the Aylesbeare Mudstone. A substantial hiatus separates the latest Permian and youngest Triassic deposits and the system boundary is not present in the rock succession.

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### INTRODUCTION

The post-Variscan succession in Devon commences with the Exeter and overlying Aylesbeare Mudstone groups. Warrington (2005) reviewed the limited isotopic, biostratigraphic and magnetostratigraphic evidence of the Permian age of formations that constitute these groups. Isotopic ( $^{40}\text{Ar}/^{39}\text{Ar}$ ) analyses indicated Early Permian (Sakmarian to Artinskian) ages for Exeter Volcanic Rocks (EVR) in the lower part of the Exeter Group. The upper part of that group was interpreted as no older than Roadian (early Mid-Permian), on biostratigraphic (palynological) evidence. There was no isotopic or biostratigraphic evidence for the age of the Aylesbeare Mudstone. Reversed palaeomagnetic signatures had been obtained from the EVR and some sediments in the Exeter Group, and reversed and normal signatures from the Aylesbeare Mudstone. The Aylesbeare Mudstone is succeeded unconformably by the Chester Formation (formerly the Budleigh Salterton Pebble Beds; Ambrose *et al.*, 2014) for which a late Olenekian to early Anisian (late Early to early Mid-Triassic) age had been proposed on the basis of magnetostratigraphy.

Warrington (2005) suggested, from the then published magnetostratigraphic evidence, that the Permian–Triassic boundary was above the Aylesbeare Mudstone and not represented in the rock succession; this was illustrated in a subsequent contribution (Warrington *et al.*, 2012). However, Gallois (2014) proposed correlation of the base of the Aylesbeare Mudstone with that of 'TR1', the lowest of four tectonic-stratigraphic successions recognised in the southern North Sea (Hounslow and Ruffell, 2006), and that the group was of Induan to early Olenekian (Early Triassic) age.

There has been little change to the isotopic evidence and none to that noted by Warrington (2005) in the biostratigraphy from the Exeter Group. Advances in the magnetostratigraphy have been made with the publication of additional information

from that group and the full results of the study of the Aylesbeare Mudstone (Hounslow *et al.*, 2017). The position of the 'Illawara Reversal', at the end of the Kiaman Superchron in the Wordian (mid Mid-Permian) has been identified, and dates for levels in the uppermost Exeter Group and the Aylesbeare Mudstone succession inferred by reference to a Geomagnetic Polarity Timescale. The Permian–Triassic boundary is confirmed as being above the Aylesbeare Mudstone, as suggested by Warrington (2005).

The Permian timescale and the isotopic, biostratigraphic and magnetostratigraphic information now available from the succession in Devon are reviewed in the following sections.

### THE PERMIAN TIMESCALE

The timescale adopted for the Permian is from the International Commission for Stratigraphy (ICS) *International Chronostratigraphic Chart* (Version 2017-2), except for the base Sakmarian age which is that advocated by Ramezani and Bowring (2018, fig. 1) and used by the Subcommittee on Permian Stratigraphy (SPS) in the latest issue of its newsletter (*Permophiles* **65**, 53; December 2017). The other stage boundary ages used by those authors correspond with, or are very similar to, those adopted by the ICS and SPS which are retained here (Figure 1).

### THE ISOTOPIC DATING RECORD

Two occurrences of the EVR in the lower part of the Exeter Group have yielded  $^{40}\text{Ar}/^{39}\text{Ar}$  dates; other dates from the EVR are from K/Ar analyses and have wide error ranges (Warrington, 2005). A  $^{40}\text{Ar}/^{39}\text{Ar}$  plateau age from the Killerton lamprophyre (290.8±0.8 Ma) places that around the Sakmarian–Artinskian