Department of Energy & Climate Change

South West Approaches prospectivity

Promote United Kingdom 2014

Introduction

Lying on the continental shelf south-west of England, the Western Approaches Trough as defined by Evans (1990; Fig. 1), contains up to 8 km (25,000 feet) of Permian to Recent strata (Fig. 2) resting unconformably on metamorphosed Devonian to Carboniferous basement. Approximately 50% of the Trough lies in French waters, where it is known as the Mer d'Iroise, and its Shelf Edge Basin projects into Irish waters. Sea-bed depths are mostly less than 600 feet. The UK sector of the Western Approaches Trough has remained unlicensed since the first phase of exploration ended in 2002. Following the completion of a Strategic Environmental Assessment of the region (SEA8), the whole of UK acreage within the Trough is available for licensing once more.

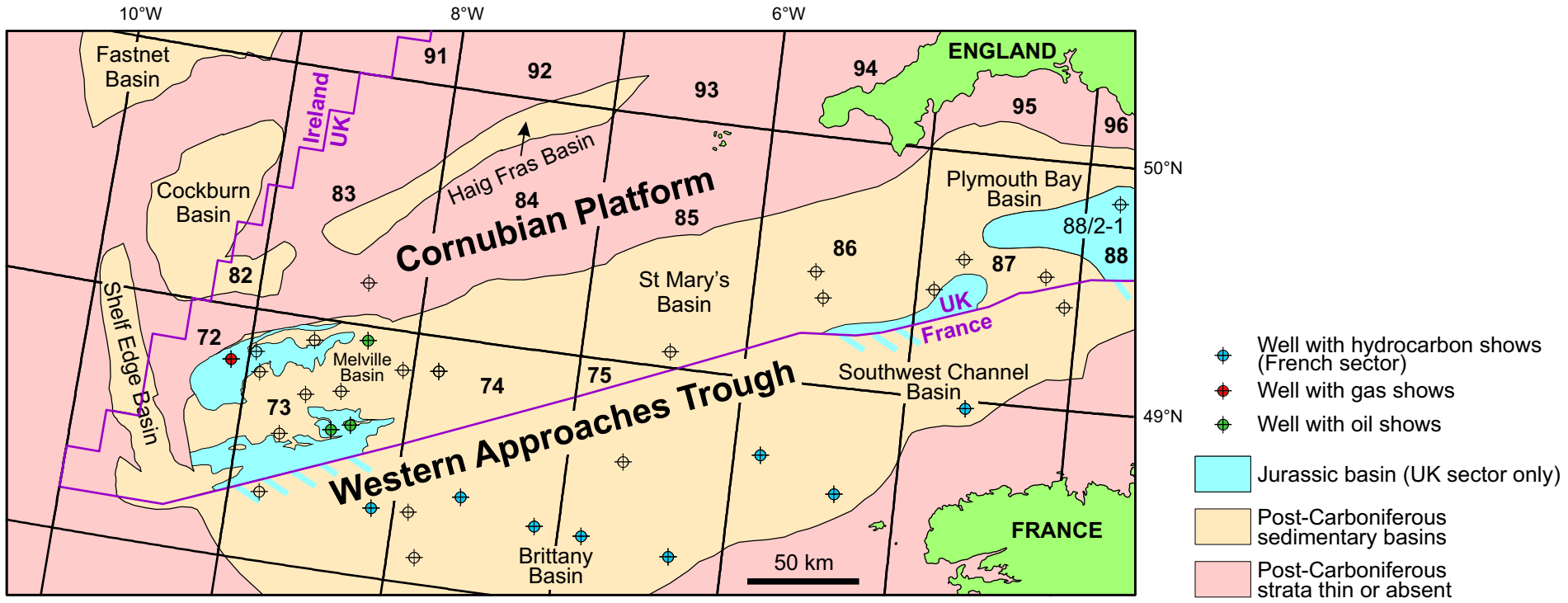

Fig. 1 Major tectonic elements of the region (modified after Evans, 1990)

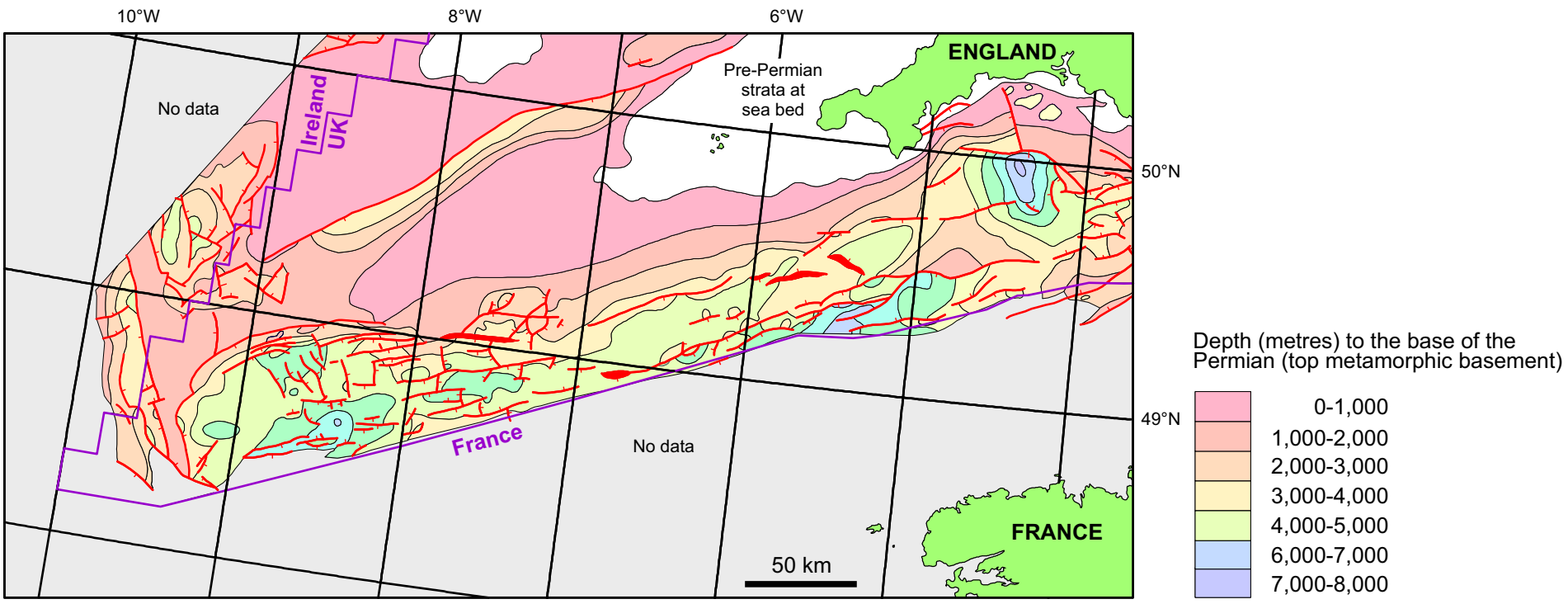

Fig. 2 Depth to the base of the Permian (after Evans *et al.,* 1990)

The Mesozoic fill of the Western Approaches Trough was punctuated by Late Cimmerian uplift and peneplanation that was extensive across the UK sector, but less significant in French waters. Folded and faulted Triassic red beds beneath the resultant unconformity include significant fluvial sandstone and halite units, and they are locally overlain by Lower Jurassic marine strata in UK waters in the Melville, St Mary's and Plymouth Bay basins. It is these Lower Jurassic strata, thicker and more extensive in the French sector, that include the principal source rocks of the region. Above the Late Cimmerian unconformity, the relatively thin Lower Cretaceous succession includes continental and succeeding marine strata with locally interbedded volcanics. The Upper Cretaceous Chalk Group forms a relatively uniform blanket unit between 1,100 - 1,800 feet in thickness.

Tertiary deposition in the Western Approaches Trough was interrupted by two, Paleocene to early Eocene and late Eocene to mid-Oligocene episodes of basin inversion. Upwards of 1,300 feet of strata were eroded from the Melville Basin in these episodes. The preserved Tertiary sediments thicken generally southwestwards to around 6,000 feet at the edge of the continental shelf.

History of Exploration

Exploration of the Western Approaches Trough for hydrocarbons commenced with the acquisition of 2D seismic data in the early 1970s. Twelve wells have been drilled subsequently in the Melville Basin (Fig. 3), with traces of dead oil and gas encountered in Lower Triassic Sherwood Sandstone in wells 73/14-1 and 72/10-1A respectively. Traces of oil were also recorded in Lower Jurassic Lias Group mudstones in well 73/13-1 and in the Lower Cretaceous section in well 73/4-1. Although none of the thirteen wells drilled in French waters (Fig. 1) encountered commercial hydrocarbons, eight of these recorded oil and or gas shows to confirm the potential for a working petroleum system in the region.

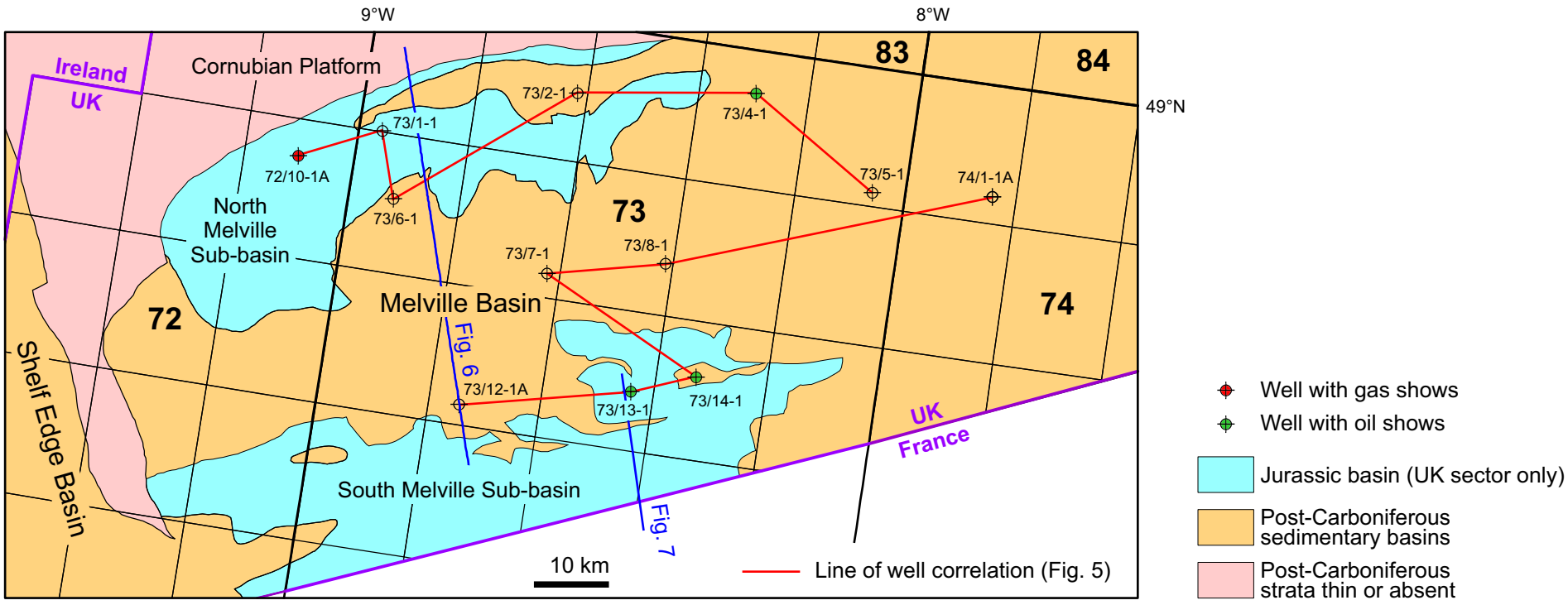

Fig. 3 Location of UK wells in the Melville Basin, Western Approaches Trough

Well stratigraphy

Figure 5 illustrates the stratigraphy encountered in the 12 Melville Basin UK wells. The principal reservoir target for most has been the Lower Triassic Sherwood Sandstone Group, sealed beneath red-bed mudstones and evaporites of the Triassic Mercia Mudstone Group. Some of the wells have instead or additionally targeted sandstones interbedded within the Lower Cretaceous succession.

The lithostratigraphy encountered by the Melville Basin wells is summarised in Figure 4. Note that although well 73/1-1 drilled a 50 foot Hettangian-age Lias Group sandstone unit in the North Melville Sub-basin, equivalent sandstones are not suspected to be widespread in the region.

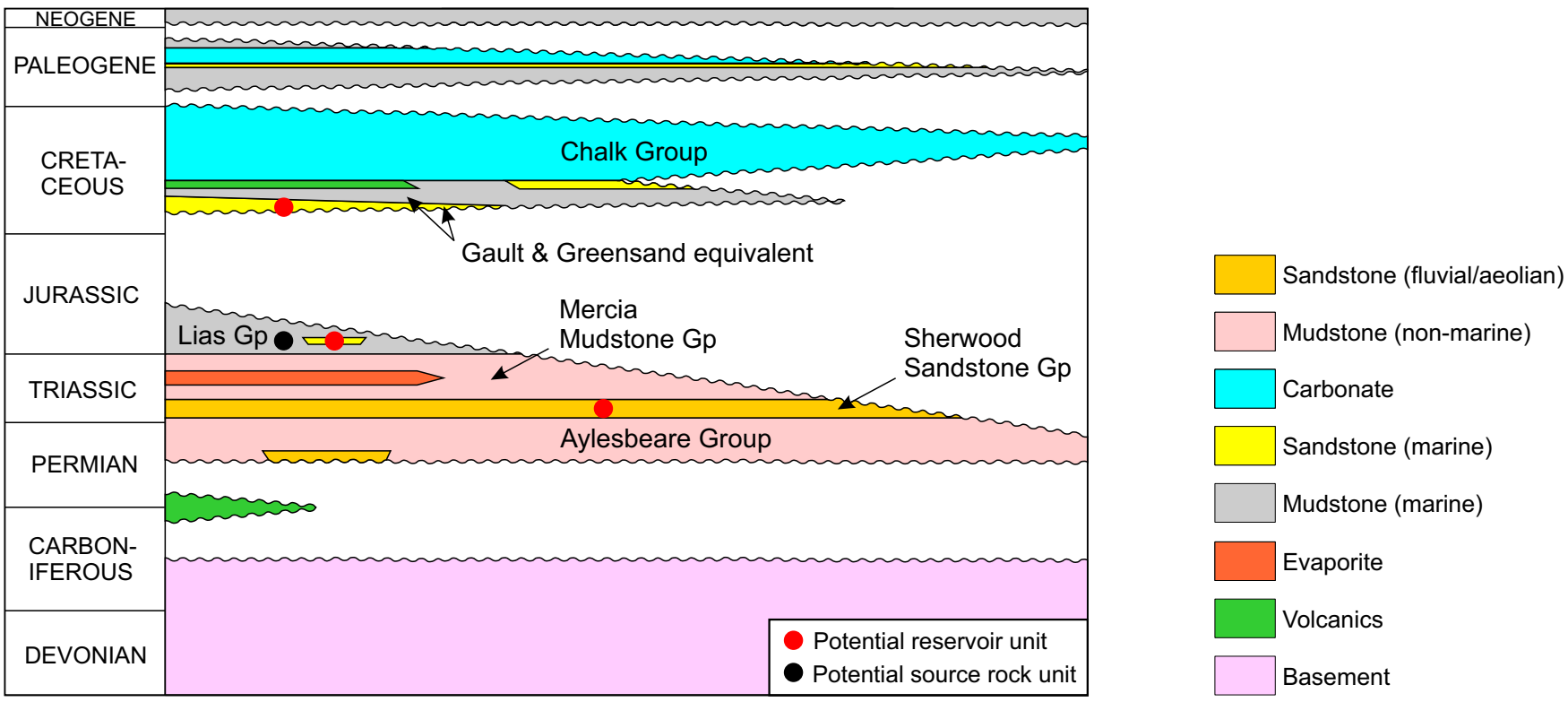

Fig. 4 Simplified stratigraphy and principal lithofacies in the Western Approaches Trough

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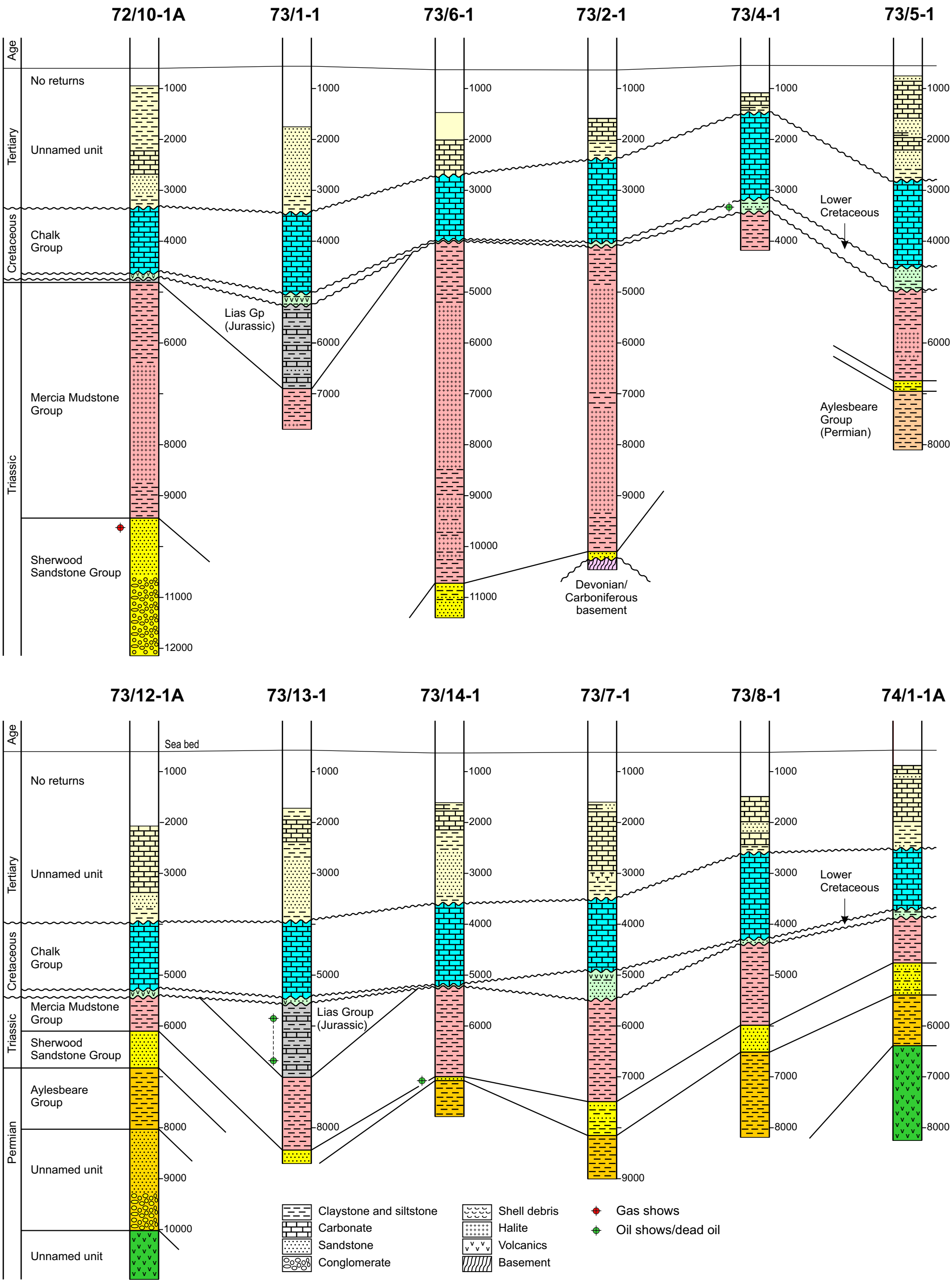

Figure 5 Stratigraphy encountered in the 12 Melville Basin exploration wells: all depths are in feet below KB (see Fig. 3 for the well locations)

Structural style

The Permian to Lower Jurassic structure of the Melville Basin is dominated by tilted half-graben, such as those depicted on the representative geoseismic section (Fig. 6) and seismic profile (Fig. 7). Some of the graben-bounding faults continue through the Cimmerian Unconformity into the overlying Cretaceous strata with much reduced throws, only locally greater than 100 feet. In parts of the Melville Basin, the upper Triassic to Oligocene strata are also variably deformed by halokinesis of the Triassic Melville Halite unit. The undrilled Shelf Edge Basin is interpreted to contain a drape of up to 5,000 feet of Aptian-Albian to Recent sediments overlying a series of slope-parallel half-graben that may be largely filled by earlier Cretaceous strata.

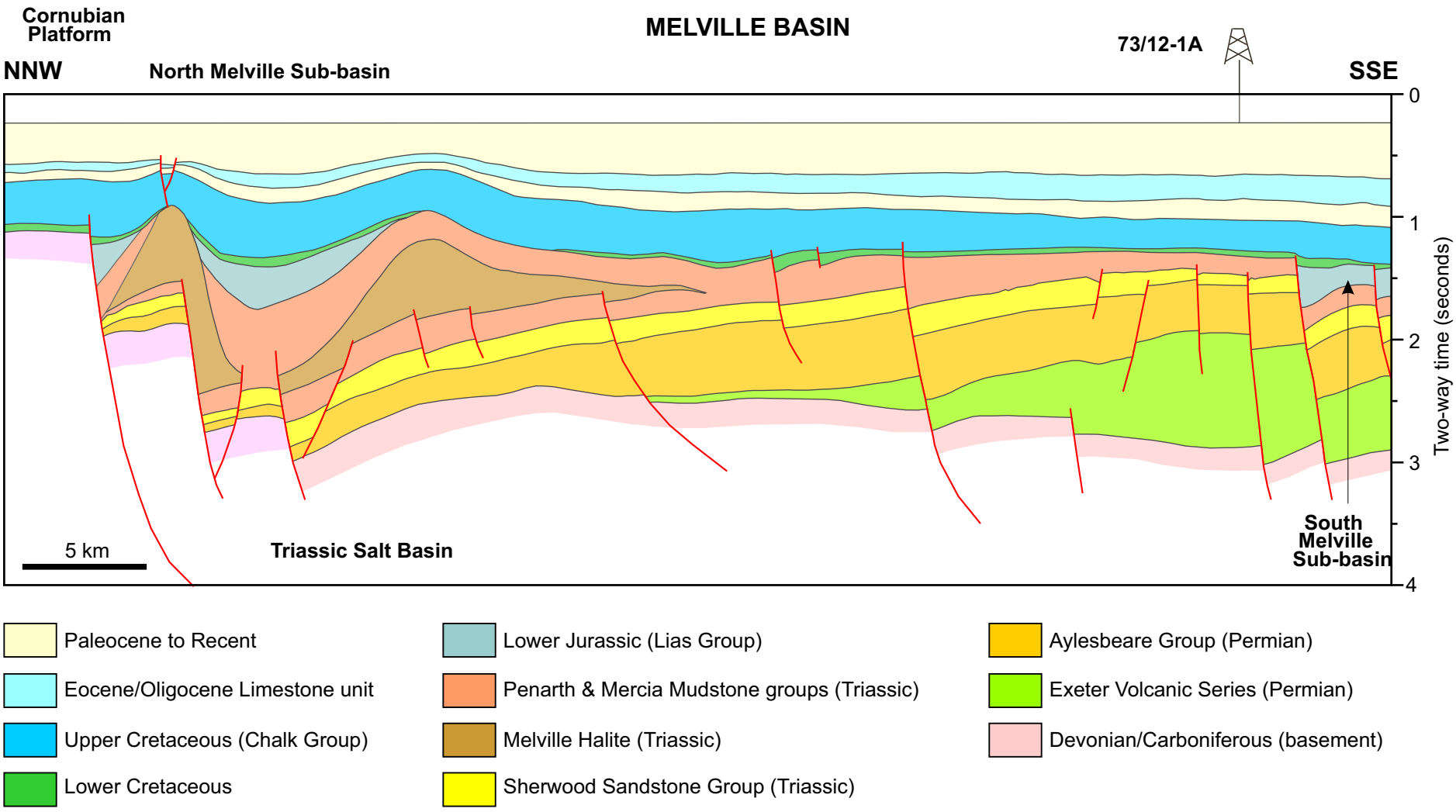

Fig. 6 Representative NNW-SSE geoseismic section across the Melville Basin (see Fig. 3 for line of section)

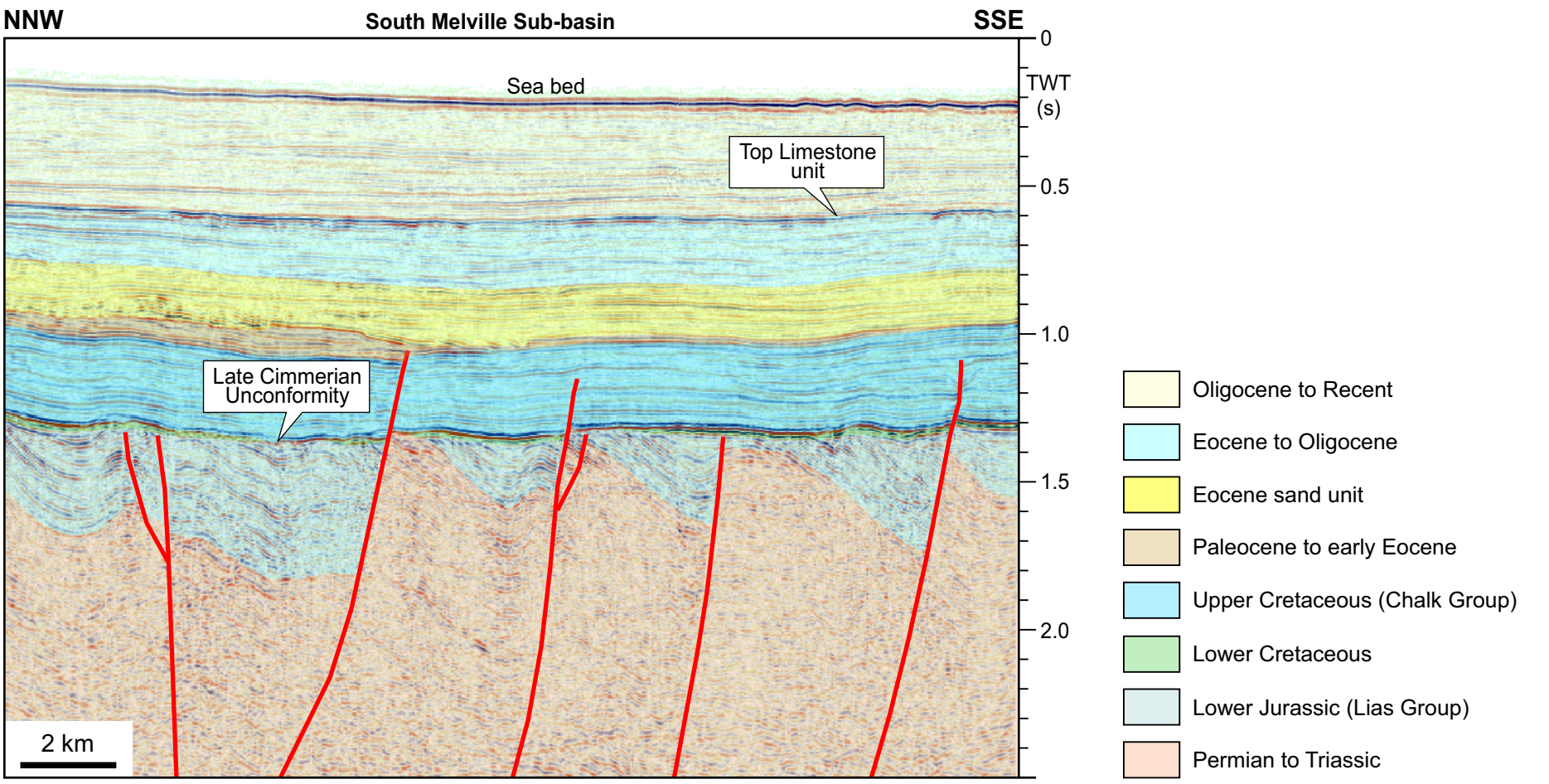

Figure 7 Representative NNW-SSE seismic profile across the southern part of the Melville Basin (see Fig. 3 for line of section)

Principal reservoir targets

Figure 8 illustrates representative well sections for the two principal reservoir targets in the region. The Sherwood Sandstone Group consists of up to 1,000 feet of dominantly fluvial, locally conglomeratic red arkose and quartz arenite. Sandstone log porosity is mainly between 12-15%; horizontal core permeability ranges between 1-1,000 mD, and net:gross is up to 0.6 in the South Melville Sub-basin. Equivalent Triassic sandstones contain more than 430 million barrels of recoverable oil in the Wytch Farm oilfield in southern England. The Melville Basin's Lower Cretaceous sandstones are up to 190 feet thick, very porous, and mainly shallow-marine. In the undrilled Shelf Edge Basin these sandstones overlie a much thicker unit, presumed to be pre-Albian, Lower Cretaceous in age. Equivalent strata in southern England are dominated by lacustrine facies, but also include fluvial sandstone units there.

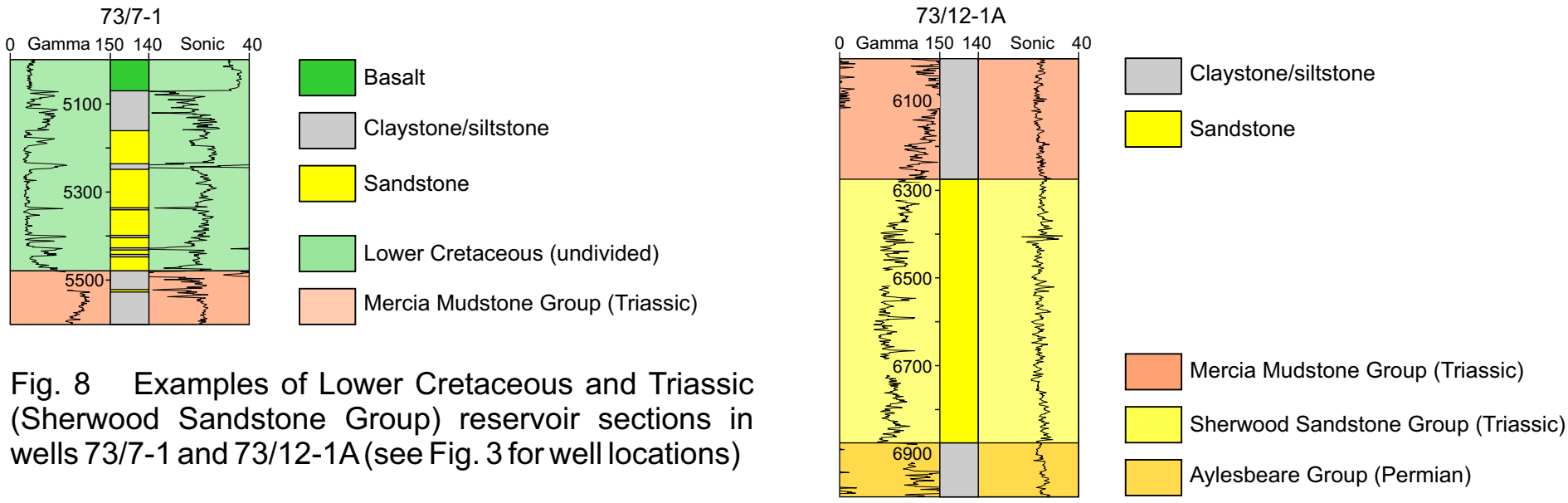

Fig. 8 Examples of Lower Cretaceous and Triassic (Sherwood Sandstone Group) reservoir sections in wells 73/7-1 and 73/12-1A (see Fig. 3 for well locations)

Source rocks

Lower Jurassic Lias Group marine mudstones constitute the only viable source rock interval in most of the Western Approaches Trough. Up to 4,000 feet are preserved in the North Melville Sub-basin, and up to 5,000 feet are present in the South Melville Sub-basin. In Plymouth Bay Basin well 88/2-1, total organic carbon content ranges between 3.2 - 11.2% in 1,500 feet of Hettangian- to Pliensbachian-age oil-prone mudstone (Evans, 1990). This interval has better oil-generating potential than basal Lias Group mudstones in the well. Lower Cretaceous mudstones may also have source-rock potential in the Shelf Edge Basin, but their maturity there is unknown.

Maturity modelling suggests that the Lower Jurassic strata are largely immature for oil generation above 8,000 feet current depth of burial, approximately 2 seconds two-way time. The North Melville Sub-basin is largely shallower than this, and hence has only limited oil-generating potential. The base of the Lower Jurassic deepens to more than 10,000 feet in South Melville Sub-basin block 73/17, and it is significantly deeper than this in adjacent parts of the French sector. In the Brittany Basin there, the Lower Jurassic section may have entered the oil window in the early Cretaceous, and remains within the oil window at the present day (Ruffell, 1995).

Summary of principal plays

1.The Sherwood Sandstone play has greatest potential in tilted fault block closures directly adjacent to the deepest-buried South Melville Sub-basin Jurassic sections or on valid migration routes from the Brittany Basin Jurassic source kitchen in French waters. The shortest migration routes should be expected in a 20 km-wide zone adjacent to the UK/French median line. All of the exploration wells drilled in UK waters up to now have been at greater distance from these source kitchens. Secondary recharge may be required for those traps affected by topseal breach of early Cretaceous charge during Cenozoic uplift (Ruffell, 1995).

2. Integrity of their topseal is a major risk for Lower Cretaceous fault-bounded or low-relief 4-way dip sandstone traps in the Melville Basin. There may be better Lower Cretaceous prospectivity in the undrilled Shelf Edge Basin, but the distribution of potential reservoir sandstones there is currently unknown.

References

Evans, C.D.R. 1990. *United Kingdom offshore regional report: the geology of the western English Channel and its western approaches*. London: HMSO for the British Geological Survey.

Ruffell, A. 1995. Evolution and hydrocarbon prospectivity of the Brittany basin (Western Approaches Trough), offshore north-west France. *Marine and Petroleum Geology*, **12,** 387-407.

For more information contact:

Joy Gray Email: joy.gray@decc.gsi.gov.uk

Toni Harvey Email: toni.harvey@decc.gsi.gov.uk