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Sedimentary facies and the context of dolocrete in the Lower Triassic Sherwood Sandstone group: Corrib Field west of Ireland

Susanne Schmid [a,1], Richard H. Worden [a,*], Quentin J. Fisher [b]

[a] *Department of Earth and Ocean Sciences, University of Liverpool, L69 3GP UK*
[b] *Department of Earth Sciences, University of Leeds, LS2 9JT UK*

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Abstract

The Lower Triassic Sherwood Sandstone Group (SSG) reservoir in the Corrib Field is predominantly fine- to medium-grained fluvial sandstone with minor aeolian and playa sediments that formed under semi-arid to arid conditions. There is no evidence of roots, burrows or organic-rich soils in the SSG suggesting an environment with sparse vegetation in the catchment and sedimentation from a predominantly braided sand-dominated river. Dolomite is the main porosity-occluding cement (<25 vol.%) in the Sherwood Sandstone Group reservoir in the Corrib Gas Field, offshore west of Ireland. Dolomite is demonstrably early diagenetic since it is non-ferroan, brightly luminescent, occurs in rocks with high (uncompacted) intergranular volumes and grew before all burial diagenetic cements. Conversely, calcrete is the dominant early diagenetic cement in well 27/5-1 in the SSG, ~50 km south of Corrib. Dolocrete and/or calcrete are represented throughout the entire SSG interval and typically form under conditions of very low sediment accumulation rates. Dolocrete occurs equally in all facies showing that it is not a result of depositional processes. Core goniometry data in the Corrib Field revealed that the general palaeoflow direction was from south to north. During progressive evaporation of river- and ground-water calcite formed first, followed by dolomite further downstream with gypsum formed last if evaporation continues. This well-established pattern indicates that well 27/5-1 has calcrete and Corrib has dolocrete since they both result from evaporative concentration of ground- and river-water during flow down the very shallow Triassic palaeogradient.

Keywords: Corrib; Triassic; Basin; Dolocrete; Palaeoclimate change

1. Introduction

It is well established that calcrete (or caliche) can form in fluvial sediments and it has been recognised that it is controlled primarily by climatic conditions (Goudie, 1973; Goudie, 1983; Wright and Tucker, 1991). Calcite cement typically forms in soils and groundwater in areas with less than 650 mm/year rainfall with mean annual temperatures > 5 °C (Blatt et al., 1980). Calcrete has been widely recognised in ancient fluvial sediments that were deposited under relatively arid conditions. At outcrop these sedimentary rocks typically have a red hue (and are thus known as "redbeds") due to the abundance of iron-minerals. Calcrete typically has a negative effect upon reservoir quality (porosity and permeability) and so is of

* Corresponding author. Tel.: +44 151 794 5184; fax: +44 151 794 5196.
E-mail addresses: ssc@geus.dk (S. Schmid), r.worden@liv.ac.uk (R.H. Worden).
[1] Current address: Geological Survey of Denmark and Greenland, Øster Voldgade 10, 1350 Copenhagen K, Denmark.

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considerable interest to petroleum explorers and producers. Calcrete can form in two main ways: as vadose (or pedogenic) minerals relatively close to the sediment surface or as phreatic (or groundwater) minerals formed around the water table (Wright, 1994). In contrast to calcrete, the origin of dolocrete in both modern and ancient fluvial sediments has been less commonly documented although phreatic dolomite was reported in Upper Triassic fluvial and alluvial rocks in Paris Basin (Spötl and Wright, 1992). Dolocrete has been described as forming either in ribbons (along valleys; Carlisle, 1983; Arakel, 1986) or as a halo around a lake (Colson and Cojan, 1996). The origin of the magnesium has "generally been neglected" (Colson and Cojan, 1996) although Arakel (1986) considered that dolocrete formed as a result of an influx of waters from discrete, Mg-rich source rocks. Colson and Cojan (1996) reported that dolocrete formed due to mixing of (presumably geochemically) incompatible lake and groundwaters.

Redbed non-marine Triassic sediments of the SSG (Slyne Basin, approximately 70 km west of Ireland, Northern Atlantic Ocean; Fig. 1), have thus been studied to identify the depositional environment and the controls on calcite and dolomite distribution. In general, dolomite cement is one of the dominant controls on reservoir quality in the Lower to Middle Triassic Sherwood Sandstone (Burley, 1984; Schmid et al., 2004) and understanding its origin is a crucial step in being able to make reservoir quality predictions in this and neighbouring basins along the Atlantic Margin. Carbonate cement may either be directly related to depositional environment or mass flux during much later burial diagenesis (Morad, 1998). These two contrasting models lead to entirely different ways of making predictions of dolomite distribution and abundance. To address whether sedimentological or mass flux models are required to further reservoir quality prediction, data from two areas (called Corrib Field and well 27/5-1; Fig. 1) have been collected and analysed using core, standard petrographic techniques and geochemical approaches. The Corrib Field contains gas within Triassic sandstone, which is presently buried to approximately 3500 m. The exploration well 27/5-1, situated ~50 km south of Corrib, encountered the same

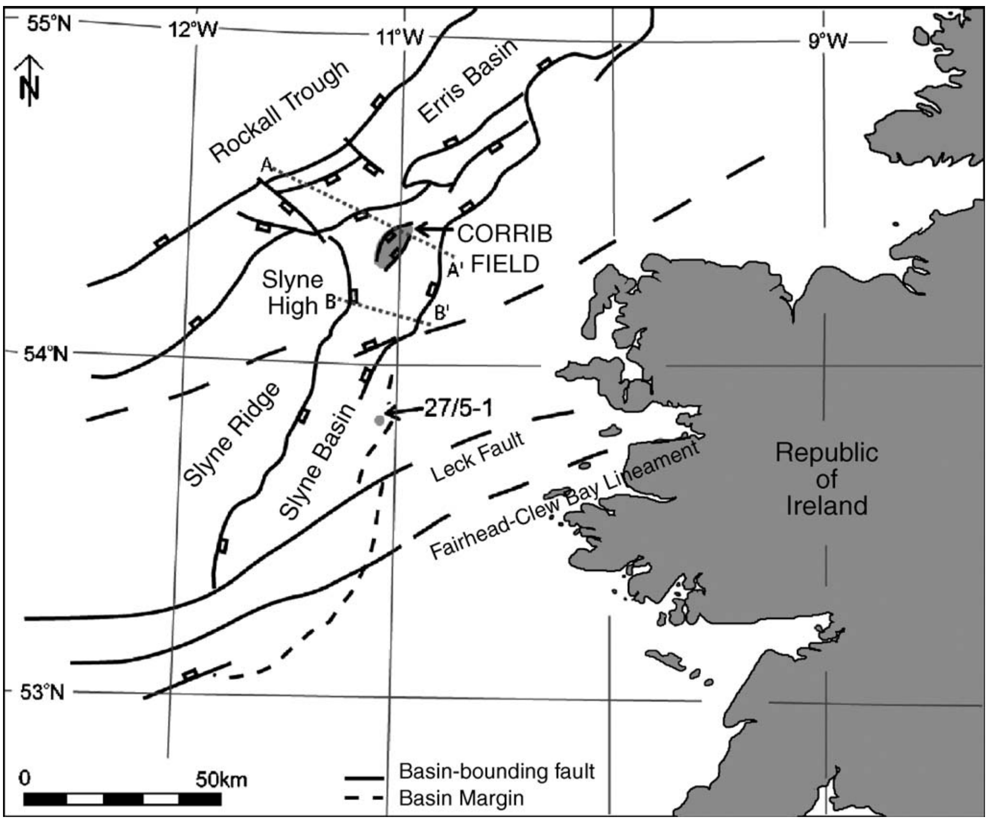

Fig. 1. Simplified structural map of the Slyne Basin and adjacent areas, including the Corrib Field and well 27/5-1 (modified after Dancer et al., 1999; Chapman et al., 1999). Position of sections AA′ and BB′ – see Fig. 2.