

Pressure solution in chalk

M. Safaricz and I. Davison

ABSTRACT

Pressure-solution residues in the Cretaceous to Paleocene chalk from the North Sea area were studied to understand the pressure-solution process and fluid flow. Residue seams reach lengths and thickness of more than 800 and 0.15 m (2625 and 0.5 ft), respectively. Seams can present significant barriers to fluid flow because they have nanodarcy permeability and hold back large pressure differentials.

Stylolite amplitudes decrease when they merge, making it difficult to quantify volume loss. Measuring amplitudes allows volume-loss estimates using a new dissolution ratio method. The sum of the thicknesses of all residues is multiplied by the maximum amplitude-to-residue thickness ratio. On average, 30 mm (1.2 in.) of chalk had to be dissolved to produce a 1-mm (0.04-in.)-thick residue. The volume loss of chalk from Flamborough averages about 50% and is 60% in the Machar oil field, United Kingdom Central Graben.

The minimum fluid volume required to produce the volume loss in 1 unit volume of preserved chalk on the Machar field is estimated to be 8000 unit volumes. This and the stable isotopes of vein carbonates imply that the pressure-solution process involved an open-fluid system. High illite content in mixed layered illite-smectite and high illite crystallinity of clays in the pressure-solution seams in the Machar reservoir indicate high diagenetic maturity, with implied temperatures in the range of 200–360°C (392–680°F), which is greater than the present-day reservoir temperature of 85°C (185°F). The anomalously hot temperatures are interpreted to be produced by deep mineralizing fluids transported from the Central Graben. The lack of abundant veining in the chalk and the large fluid volumes involved in the chalk dissolution suggest that this was an open pressure-solution system.

INTRODUCTION

Pressure solution in carbonate rocks is a very important phenomenon that affects the quality of hydrocarbon reservoirs. The Cretaceous chalk of the North Sea is a principal reservoir horizon in the Central Graben area. It is particularly prone to pressure solution because of its fine grain size, and stylolitization is a widespread phenomenon. Stylolites can pose important barriers to fluid flow. This

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