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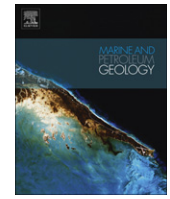

Diagenesis and reservoir quality of Miocene sandstones in the Vienna Basin, Austria

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A B S T R A C T

A study of the diagenetic evolution of Neogene sandstones in the Vienna Basin (Austria) was undertaken to unravel the controls on reservoir quality. These rocks present a ~2000 m succession of relatively similar lithic arkoses with the deepest rocks buried progressively to nearly 3000 m and thus present an opportunity to study sequential diagenetic changes. The Neogene sandstones sit above Alpine allochthonous nappes and autochthonous Mesozoic sediments that include Jurassic source rocks. Oil has been produced from Badenian marine sandstones at about 1700 m but reservoir quality is marginal. Thirty-eight samples from 892 m to 2774 m were studied using petrography, XRD, SEM, microprobe, infrared spectroscopy and a range of modelling approaches. The sandstones contain abundant ductile grains and a variety of carbonate grains. The main eogenetic cements include clay coats, pyrite and possibly glauconite. The main mesogenetic cements include the dominant calcite, kaolinite and minor quartz. Smectite was replaced predominantly by illite with minor growth of grain-coating chlorite. Thermal histories for each sandstone sample were calibrated by modelling the degree of smectite to illite transformation. These sample-specific thermal histories were then used to model quartz precipitation revealing that quartz cement, the most important cement in many sandstones worldwide, is of negligible significance here because (1) there has been insufficient time since deposition, or (2) the geothermal gradient is not high enough or (3) calcite cement filled the pore space before quartz cement could grow. Instead porosity has been controlled by the abundance of detrital ductile (lithic) grains and the abundance of detrital carbonate grains which have been variably dissolved and reprecipitated as ferroan calcite cement. The highest porosity for a given depth decreases with increasing depth due to compactional processes. Porosity is highest for samples where both the detrital ductile grain and carbonate cement contents are low. The accumulation of oil in the middle part of the section has had no discernable effect on porosity since diagenesis is mostly controlled by compactional and carbonate recrystallisation processes and oil probably entered the reservoir late in the diagenetic sequence, after ductile compaction and growth of carbonate cements had already occurred.

1. Introduction

Reservoir quality is one of the key controls on prospectivity during petroleum exploration. It is important to have a detailed understanding of what controls reservoir quality to assist with the appraisal of the economic viability of petroleum discoveries. When a petroleum discovery has been made in a basin, it is essential to gain as much understanding of reservoir quality to help focus further exploration and appraisal efforts (Selley, 1997).

As far as clastic sediments are concerned, the first control on reservoir quality is primarily a function of the basic presence of sand as opposed to silt or mud. However, during burial the deposited sand never retains its original porosity, fabric or even mineralogy as it becomes sandstone (Worden and Burley, 2003). During exploration, remote sensing techniques and analogue studies can help to identify the presence of sandstone but they do not usually help to find high porosity sandstones that have been preserved from major diagenetic alteration and porosity-loss. It is essential to study core samples to understand what diagenetic changes have occurred and what has controlled reservoir quality.

Diagenesis comprises a broad spectrum of physical, geochemical and biological post-depositional processes by which original sedimentary mineral assemblages and their interstitial pore waters interact in an attempt to reach textural and thermodynamic equilibrium with their environment (Worden and Burley, 2003).

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