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The role of provenance in the diagenesis of siliciclastic reservoirs in the Upper Triassic Yanchang Formation, Ordos Basin, China

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Abstract: A better understanding of the controls on reservoir quality has become essential in the petroleum exploration in recent years. Determining the original composition of the sediment framework is important not only for paleogeographic reconstructions, but it is also vital for predicting the nature of physical and chemical diagenesis of the potential reservoirs. Depositional setting and diagenesis are important factors in controlling the type and quality of most siliciclastic reservoirs. We studied the Upper Triassic Chang 8 and 6 members, where the relationship between sediment provenance and diagenesis was examined. The study attempts to clarify sediment provenance and post-depositional diagenetic modifications of the sandstones through systematic analytical methods including petrographic macro- and microscopic analysis of grain and heavy mineral types, and measurements of the palaeocurrent direction of the Yanchang Formation sediments in the outcrops in order to determine the provenance of the studied sediments. Furthermore, the relationship between framework grains, pore types and diagenesis of the sediments was analyzed by thin section petrographic characterization using a polarizing microscope. Additionally, a JEOL JSM-T330 scanning electron microscope (SEM) equipped with a digital imaging system was used to investigate the habits and textural relationships of diagenetic minerals. On the basis of our results, we believe that sediment provenance is a significant factor which controls the type and degree of diagenesis which may be expected in sandstones. In the Chang 8 and 6 members, the formation of chlorite rims and laumontite cement was observed where volcanic rock fragments constitute a large part of the framework grains. Furthermore, high biotite content provides abundant iron and magnesium and enables the formation of chlorite rims due to biotite hydrolysis. In addition, ductile deformation of biotite leads to strong mechanical compaction of the sediments. Conversely, high feldspar content diminishes the degree of mechanical compaction, however the dissolution of feldspar minerals in sandstones is commonly observed. Apart from feldspars, quartz and other rigid framework grains highly control the degree of mechanical compaction during the initial stage of burial (0-2 km).

Key words: Provenance, diagenesis, tight sandstones, Yanchang Formation, Ordos Basin

1 Introduction

The key properties of hydrocarbon reservoirs are porosity and permeability. These properties control not only the amount of gas or oil in place but also rate of petroleum extraction. The success of many hydrocarbon exploration efforts depends to a large extent on accurate prediction of sandstone reservoir properties. Additionally, an accurate risk assessment is a critical stage in exploration, where reservoirs have been buried to depths greater than 3,000 m and have been exposed to temperatures greater than 100 ºC (Taylor et al, 2010).

It is commonly believed that reservoir quality is determined by sedimentary facies type and distribution, diagenesis processes and also, to some extent by fracturing, such as in case of siliciclastic reservoirs.

Mechanical and chemical stability of sandstones is strongly linked to grain composition (De Ros et al, 1994; Bloch et al, 2002). The detrital composition of sandstones is controlled by the geological evolution of the provenance, including rock types and tectonics, palaeoclimatic conditions and depositional processes (Zuffa et al, 1995; Morad et al, 2000).

The degree of primary porosity is controlled by grain size, sorting, roundness and composition as well as by

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