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Sedimentary architecture models of deepwater turbidite channel systems in the Niger Delta continental slope, West Africa

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Abstract: This paper studied an architecture model of turbidite channel systems based on the shallow-layer high resolution 3D seismic information in the deepwater area in the Niger Delta continental slope, West Africa as a prototype model. Different types of channel systems were identified and the corresponding architecture models were established. The controlling factors, evaluation criteria and spatial distribution of different channel systems were analyzed. This study shows that turbidite channel systems of West Africa could be classified into three types; confined, semi-confined and unconfined, according to the condition of canyon and the levees on both sides. On one hand, along the transport direction, channel system evolves from confined to unconfined. Within channel systems, channel complexes, including two types of incised and enveloped, are the most important reservoir bodies. On the other hand, there is a channel complex evolution from incised to enveloped vertically. The geological factors exert impacts of different levels on the architecture of the turbidite channels in different sedimentary systems or even within the same system.

Key words: Niger Delta continental slope, deepwater deposits, turbidite channel systems, architecture models

1 Introduction

Deepwater sedimentation is an important factor in current oil and gas exploration (Chen, 2003; Jiang et al, 2008; Chen, 2011; Zhu et al, 2012; Wu et al, 2009). However, the study of its reservoir architecture model has lagged behind that of fluvial, alluvial and deltaic deposits (Slatt, 2006). The reasons are as follows. First, deepwater depositional systems cannot be easily observed in the modern environment; contrary to non-marine sedimentation, they deposit in the marine environment where water depth usually exceeds 300 m, as a consequence, it is difficult to use remote-observation techniques to study their sedimentary patterns. Second, outcrops of deepwater sedimentation can barely provide information on a fraction of the entire system; submarine deposits are characterized by large scale of generally several kilometers or even more than ten kilometers in width. The Amazon fan for example, has a canyon breadth of up to 15 kilometers (Shepard and Emery, 1973; Hesse et al, 2001) with thickness from tens to hundreds meters. In short, deepwater sedimentation belongs to large scale units; however, outcrops can only provide limited architectural information of small scale units. Consequently, it is difficult to characterize an entire system only using information from outcrops.

Therefore, 2D or 3D seismic-reflection technologies are needed to characterize the architecture model of turbidite channel systems. Especially in recent years, there has been rapid development of seismic acquisition and processing technologies leading to a continuous improvement in the vertical resolution of seismic data. For this reason, many scholars have begun to apply seismic information to describe and measure deepwater turbidite channels and there have been a series of achievements (Corbeanu et al, 2001; Viana et al, 2003; Samuel et al, 2003; Droz et al, 2003; Saller et al, 2004; Wood and Mize-Spansky, 2009; Shao et al, 2007; Dong et al, 2008; Chen et al, 2012).

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