TURBIDITE RESERVOIR ARCHITECTURE FROM 3D SEISMIC, OFFSHORE ANGOLA

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Summary

The turbiditic systems of offshore Angola mainly consist of three architectural elements—channelforms (sinuous and to some extent straight), overbankforms and lobeforms. From the 3D seismic attribute displays, these elements are identified and mapped. The distinction of these elements is essential for making the rock volume estimates of the turbiditic systems.

Introduction

The ever-increasing efforts for oil exploration and development in the deep-water areas at present require a thorough understanding of turbidite systems. In the subsurface offshore Angola, recent extensive 3D seismic attribute displays have revealed large turbidite systems with a high variability of depositional architecture. Essential to the rock-volume estimates of these turbidite systems, the different architectural elements, channel-, overbank- and lobe- forms constituting them are identified and mapped.

Turbidite architecture and rock volume estimates

A variety of means – amplitude, coherency and curvature attributes, peeling techniques etc. are utilized to map turbidite architectural elements in the subsurface.

The turbidite systems off Angola consist of commonly sinuous channelforms, and associated overbanks, and lobeforms. The channelforms are characterized by high sinuosities, cutoffs, avulsions and migrations (Fig.1).

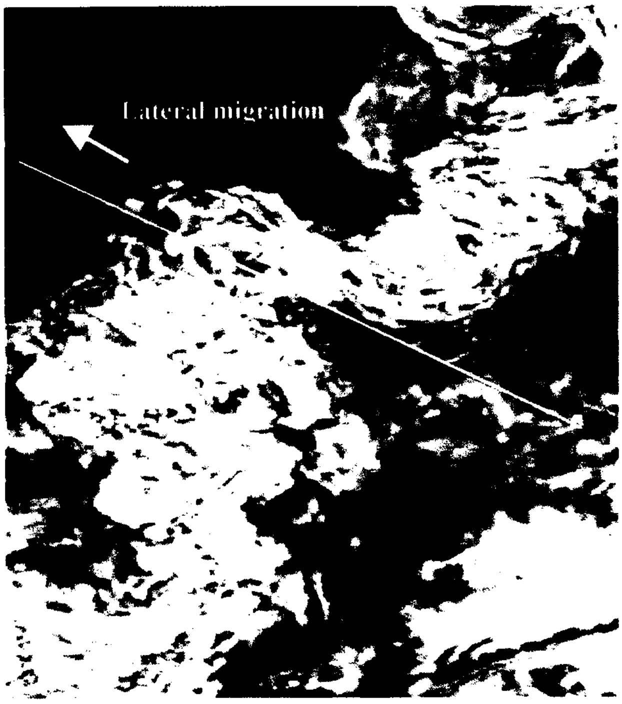

Fig.1 : Highly sinuous channelforms on amplitude map

These characteristics control the gross as well as detailed (extent, shapes, continuity, lateral and vertical stacking of reservoir) architecture of turbidite systems.

A spectrum of deep-water channel behaviors, in term of the degree and extent of lateral migrations versus vertical aggradations, exist. Depending upon this, a variety of lateral and vertical stacking, and amalgamation of reservoirs is expected. Seismically these migrations, although represented in crescent amplitude fields reminiscent of fluvial meander belts, may be discrete or continuous (Fig.2). The discrete migrations in deep-water are favored by the more frequent occurrence of catastrophic turbidity currents and the more aggradational channel build-ups. Generally point-bar type reservoir continuity is not expected to extend the entire extent of the deep-water meander belts, but may be present locally within them.

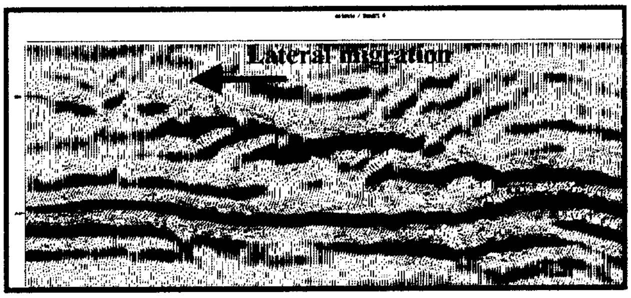

Fig.2: Highly sinuous channelforms on seismic section

A variety of lobeforms or lobeform complexes occurs at the channel termini, and as crevasse-splays and washovers at the channel bends. Flat seafloor gradients are essential for the formation of lobeforms. However, the variables affecting the type of lobeform are: mud versus sand content, volume and energy of the flows, topography, local and regional base-level changes; depth of channel thalweg, degree of levee-breaching and sea-floor gradients. Washovers are not expected to have channels in them. Other lobeforms may or may not have channels. The channels may cut the lobes subsequent to their formation either deeply or superficially; or they may have actively participated in the lobe construction. Increasing mud content generally favors the occurrence of channels in a lobe. A lobeform may consist of an individual lobe, or may consist of several lobes amalgamated to form a lobeform complex. In the channel-terminus lobeforms, updip to downdip, the feeder channel branches into several distributary channels each of which ends in a lobeform. These lobeforms may then amalgamate laterally to form a single lobeform complex, characterized by a continuous seismic reflector (Fig.3). The sediment imput for a lobeform may be sand-rich and the channels in them are likely to be short. Sheet-reservoir lithologies (fairly thick?) are expected in much of such lobes, although laterally stacked mounded reservoir lithologies (corresponding to distributary channels) are developed in the proximal parts.

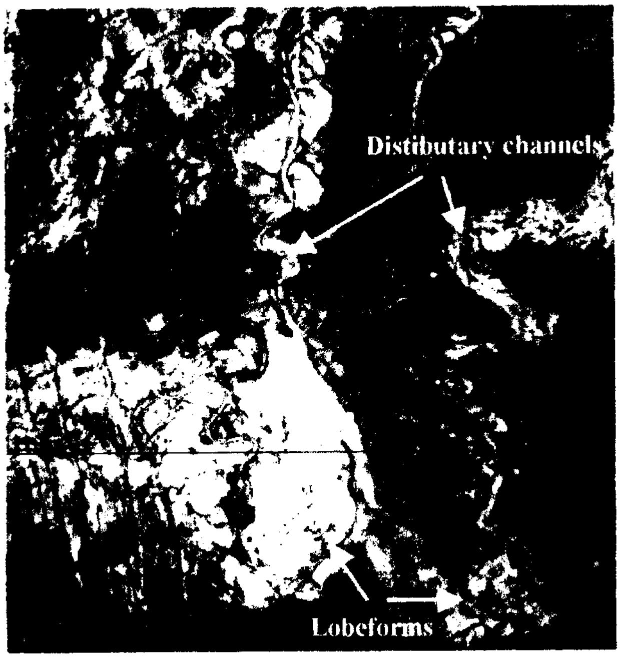

Fig.3 : Lobeforms and distributary channels

The sediment source may be mixed-type (sand+mud) and channels in the lobeforms are likely to be long. Mounded channel-fill as well as continuous sheet reservoir lithologies are expected in such lobeforms. The crevasse-splay lobeform complex consists of channels, overbanks, and several small lobes similar to the crevasse-splay lobeform complex, described in recent fans. Continuous seismic reflectors characterize the washovers that are interpreted to have been formed by the spilling of the turbidity flows at the sinuous bend.

All the above types of architectural elements occur vertically and laterally stacked in a mélange in turbidite complexes. It is essential to unscramble the individual elements, utilizing the recent deep-water meander channels and outcrops as analogs, and map them as such. These different architectural elements are then assigned specific net-to-gross values, not only based on amplitudes (corrected for fluid and wedge effects), but also based on the differences in compaction, seismic geometries, facies associations, drilling and analogs.

Conclusion

Sinuous channelforms with overbanks and lobeforms are the main architectural elements constituting the turbiditic systems, recently identified in offshore Angola (Fig.4). These systems show similarities with recent deep water fans and fluvial meanders systems. The definition of individual architectural elements is essential to understand the reservoir architecture (lateral and vertical stacking, amalgamation...) and estimate the rock volume.

Acknowledgements

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SCHEMATIC EVOLUTION OF CHANNEL FORMS (THAT COULD BECOME NESTED) IN PLAN AND SECTIONAL VIEWS

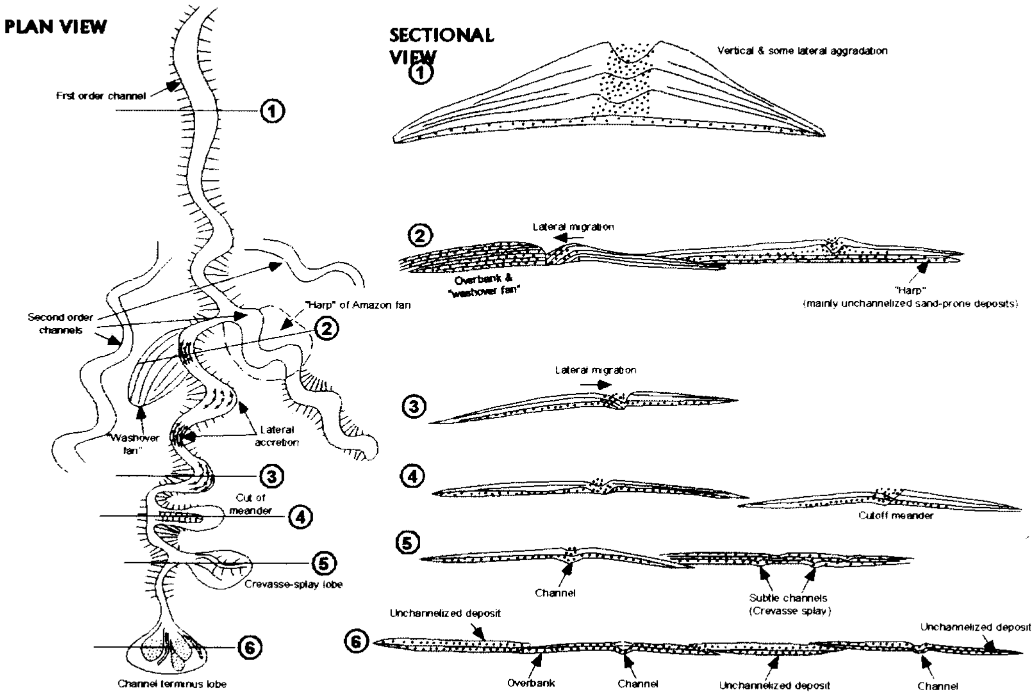

Fig.4