2004-05 AAPG Distinguished Lecture

Abstract

DAVID C. JENNETTE
Bureau of Economic Geology
Austin, TX

Funded by the AAPG Foundation

Making Sense of Turbidite Reservoirs: A Multi-basin Perspective on What Drives Architecture and Rock Properties

Our knowledge of turbidite reservoirs has advanced rapidly over the past 15 years, owing largely to the petroleum industry's acquisition of ever larger and higher frequency 3-D marine seismic surveys. These surveys provide a stunning portfolio of high-resolution snapshots of ancient and modern submarine landscapes and illustrate the intricate details of their accompanying turbidite systems. As 3-D volumes are stitched together and time-stratigraphy across large parts of continental slopes established, subsurface workers can reconstruct characteristics of the ancient shelf, shelf edge, slope, and basin floor environments and deduce the suite of processes and controls that led to the development of the spectrum of turbidite reservoirs. Understanding these basic controls improves our ability to generate models that better predict the broad range of attributes required to ensure commerciality in costly offshore operating environments and/or settings where resolution of the objective is compromised by salt or deep burial.

Subsurface systems like those encountered in the Paleogene of the North Sea and the Tertiary of the Gulf of Mexico, offshore West Africa, and offshore Egypt, together with the outcropping systems of the Permian of West Texas and the Carboniferous Claire Group of western Ireland, provide comparative data sets from which to evaluate the principal mechanisms that establish turbidite reservoirs. We observe contrasting styles of architecture (channel-dominated to sheet-dominated), pattern (straight versus highly sinuous, dendritic versus lobate), sand percent, bed thickness, and grain size and sorting. These characteristics can be tied to (1) the sediment delivery system that, in conveyer belt fashion, controls the composition and volume of sediment available to the shelf edge, (2) triggering mechanisms at the shelf edge that control the volume, feed rate, and concentration of the flows, and (3) sea floor gradients that influence the acceleration, steadiness, or deceleration of flows. Within any one system, much of the reservoir architecture we observe can be tied back to the sand:mud ratio of flows and to sea floor gradient. A fourth factor influencing final architectural character, particularly on the upper slope, is modification by slumping or headwardly migrating erosional nickpoints.

Amid all of the volume-based characterization tools, classical seismic sequence stratigraphy remains one of the stratigrapher's most important characterization tools. Whether applied to outcrops or subsurface data sets, it provides a method to establish reservoir properties of genetically related deposits. Increasing seismic resolution allows subsurface stratigraphers to identify a highly detailed array of reservoir building blocks and systems tracts that lead to better prediction of individual fluid flow units. Sequence stratigraphy also helps identify changes in reservoir characteristics that occurred over a longer unit of geologic time. Such evolutionary changes record systematic variations in the sediment delivery system, shelf edge character that may be driven by a eustasy, climate, or accommodation space.

David C. Jennette

Education:

1982 Allegheny College, Meadville, Pennsylvania; B.S., Geology
1986 University of Cincinnati, Cincinnati, Ohio; M.S., Geology

Experience:

1985-1991 Exxon Company USA, New Orleans, Louisiana, and Houston, Texas; Exploration Geologist
1991-2000 Exxon Production Research Company and ExxonMobil Upstream Research Company, Houston, Texas; Research Geologist
2000-Present Bureau of Economic Geology, the University of Texas at Austin; Research Project Manager

Professional Interests:

Reservoir prediction, reservoir characterization and sequence stratigraphy of clastic depositional systems; current focus is on multidisciplinary analysis of turbidite systems.

Publications:

Authored and co-authored numerous proprietary reports, published papers, and abstracts. Most recent relevant publications:

Jennette, D., Wawrzyniec, Tim, Fouad, Khaled, Dunlap, D. B., Meneses-Rocha, Javier, Grimaldo, Francisco, Munoz, Rafael, Barrera, David, Williams-Rojas, C. T., and Escamilla, Arturo, 2003, Traps and turbidite reservoir characteristics from a complex and evolving tectonic setting, Veracruz Basin, southeastern Mexico: American Association of Petroleum Geologists Bulletin, v. 87, no. 10, p. 1599-1622.

Jennette, D., Garfield, T. R., and Mohrig, D. C., 2000, The interaction of shelf accommodation, sediment supply and sea level in controlling the facies, architecture and sequence stacking patterns of the Forties and Tay basin-floor fans, Central North Sea, in Weimer, P., Slatt, R., Bouma, A., Coleman, J., Lawrence, D., Styzen, M., and Nelson, H., Proceedings, GCS-SEPM Research Conference, p. 203-221.

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