3D Geomodeling of Heterogeneous Fluvial Reservoirs of the Williams Fork Formation, Mamm Creek Field, Piceance Basin, CO.

[1]SONNENFELD, Mark D., [2]DEMPSEY, Michael P.,
[3]MENG, Hai-Zui, and [4]NORRIS, Stephen O.

[1]Whiting Petroleum Corp., [2]EnCana Oil & Gas (USA) Inc.,
[3] iReservoir.com, Inc., and [4]J-W Operating Company

ABSTRACT:

3D geomodeling and simulation are increasingly used to optimize down-spacing strategies for tight gas reservoirs. This presentation emphasizes static geomodeling workflow performed in 2003 on a 790 acre subset of Mamm Creek Field, but does not go into dynamic simulation specifics. The overriding objective was to incorporate as much geologic knowledge as possible to the geomodeling workflow, honoring appropriate sources of heterogeneity, yet simultaneously preventing an overly stochastic product.

Nearby outcrop analogs in Coal Canyon provide a key resource for visualization of fluvial reservoir architecture and collection of spatial statistics. These data were integrated with a subsurface data set composed of well log and production data, but lacking 3D seismic data. Whereas extensive spatial statistics have been gathered on point bars within the low net-to-gross "Paludal" and "Coastal" intervals of the Williams Fork (Cole, 2003), less quantitative data exist so far for the higher net-to-gross multi-story composite sandstones of the "Fluvial" interval.

Five key observations about cliff-forming, multi-story sandstone benches were critical for reservoir modeling: 1) most high net-to-gross levels lack discrete basal master surfaces (i.e., are not incised valleys), therefore the base of multi-story sands should not be forced as a stratigraphic correlation; 2) multi-story sands definitely have a preferred stratigraphic context (at least subregionally) as portrayed on proportion curves; 3) multi-story composite sand bodies have much longer correlation ranges than single story bodies; 4) multi-story composite sand bodies nonetheless grade laterally to vertically separated single story bodies (multi-story sands present greater drainage risks between closely spaced wells, but not the virtual certainty one would expect in truly amalgamated sheet sands); and 5) increased channel dimensions are observed in both outcrop and subsurface for the lower "Fluvial" interval, where single stories point bars are 20-30' thick as opposed to 8-15' within underlying "Paludal" and "Coastal" sections.

45 logs within and surrounding the subject geomodel were interpreted for 7 facies "indicators". These largely shape-based log facies are larger-scale than core-scale sedimentologic facies and correspond to sedimentary bodies than can be classified in terms of outcrop-based dimensions suitable for population within the 3D geomodel: 1) Coal, 2) Shaley/Silty Floodplain, 3) Sandy Floodplain/Crevasse Splays, 4) Crevasse Channels, 5) Single Story Channels, 6) Multi Story Channels, and 7) Marine Sand.

In high accommodation fluvial strata such as coal-free sections of the Williams Fork, vertical intervals well over 500 ft exist without high confidence surfaces of correlation. This is because widespread marine shales are lacking and floodplain shales always have some channel sands here that confound any through-going markers. Without explicit correlation surfaces, we tend not to map at vertical scales appropriate to resolving channelbelt trends (<100'-150' max). Net sand maps within the Williams Fork border on the meaningless (re. channel-belt trends) when generated over intervals of several hundred to over 500 feet. Log facies proportion curves were used to subdivide the section into 17 genetic intervals from the basal Cameo Coal to the middle "Fluvial." 100-150 ft intervals were defined based on multi-story sand minima, NOT continuous floodplain shales, which do not exist. These subtle cycles in fluvial architecture, rendered more explicit by the proportion curve methodology, were used as geostatistical domains for mapping of aerial facies proportions and show geologically reasonable channel-belt trends. This methodology provides breakthrough potential for subdividing and mapping high net-to-gross fluvial sections.