Facies Modeling and Reservoir Potential Estimation of the Williams Fork Formation, Piceance Basin, CO

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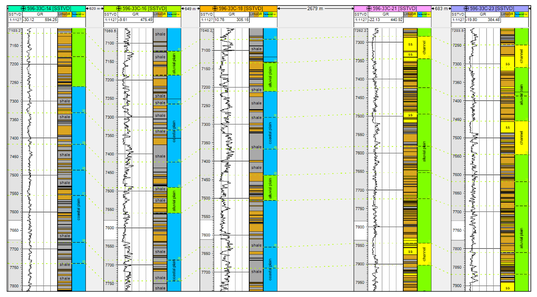
Introduction

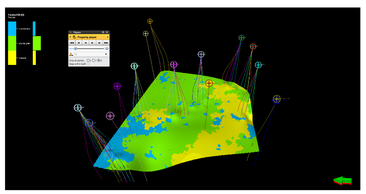
The Piceance Basin in northwest Colorado contains trillions of cubic feet of natural gas in tightly packed (6-12% porosity, 0.1-2 microdarcy permeability) fluvial sandstones, primarily in the Williams Fork Formation of the Mesaverde Group (Pranter, Sommer pg. 900). For the purposes of this project, 85 of Marathon Oil's wells were analyzed in Garfield County, Colorado in order to estimate reservoir potential in the zones where the property model was run. The lithologies and facies of the Williams Fork were interpreted using spectral gamma ray logs on Petrel in order to predict the facies of the formation where no well data was provided. Additional sequence indication simulations were run in order to compare and search for the best fit regarding the different property models. Finally, using the models as a guide, reservoir sandstone bodies were estimated in the Upper Williams Fork.



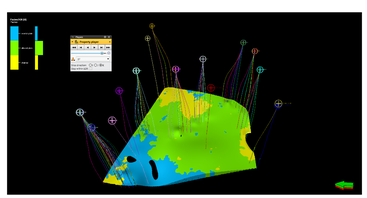
Wireline logs showing examples of the gamma ray data from the Marathon wells. To the immediate right, there is a lithology bar depicting shale as gray, shale/sandstone as brown, and sandstone as yellow. To the right of that, the facies are depicted with blue representing coastal-plain, green as alluvial-plain, and yellow as channel.

Background

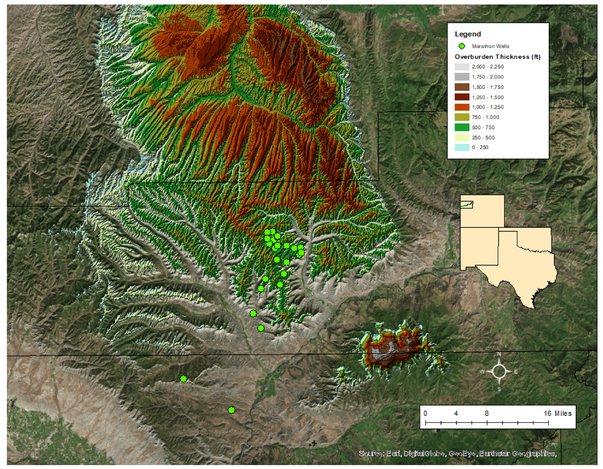
The Williams Fork formation is a hypothetical alluvial-plain setting with sinuous to anastomosing fluvial systems close to the Cretaceous shoreline (Cole, Cumella pg. 93). The lower (sand-poor) part of the formation is dominated by a braided river, and the upper (sand-rich) formation is characterized by meandering fluvial deposits as well as distal alluvial-plain sediments (Pranter, Cole pg. 1030). The lenticular, point-bar, and crevasse splay sandstone bodies exhibit a fining-upward succession from medium to fine grained trough cross-beds to fine-grained ripple-laminated sandstone with a general structural dip of less than 7 degrees (Cole, Cumella pg.86). The succession of these facies is due to the gradual decrease in flow velocity (Pranter, Cole pg. 1037).

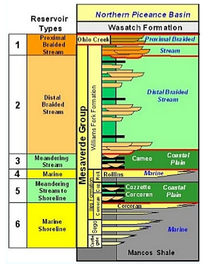


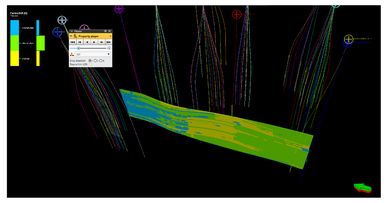
Upper Williams Fork (Sand-Rich)



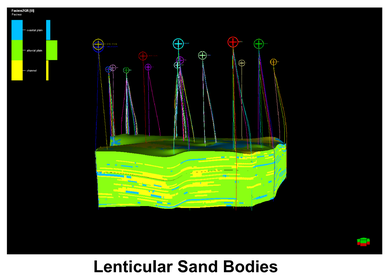
Lower Williams Fork (Sand-Poor)



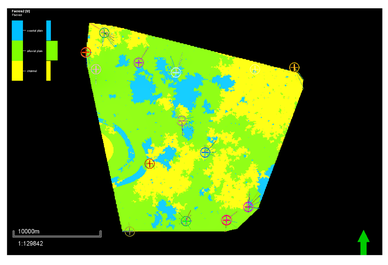




Fence Diagram Depicting Facies Change



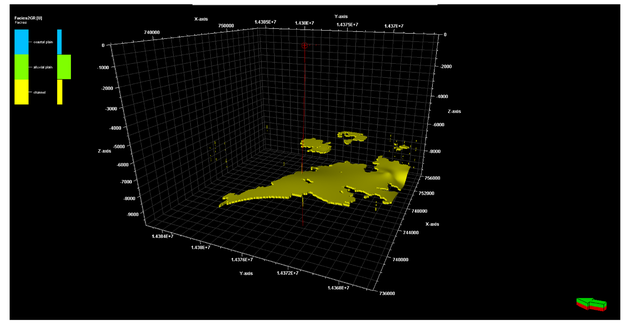
Lenticular Sand Bodies



2D View of Upper Williams Fork

Facies Modeling

After the Marathon wells were loaded into Petrel, a 2D well section window was created and the Gamma Ray logs were evaluated. Since there was only one log to base lithologies, a template was created so that a GR greater than 90 yielded shale, between 50-90 yielded sandstone/shale, and less than 50 yielded sandstone. A facies template was created using the same input parameters that matched shale to coastal-plain, sandstone/shale to alluvial-plain, and sandstone to channel. Formation tops were picked across all 85 of the logs, resulting in 40 zones between each of the horizons. Finally, other defining characteristics (such as strike and dip directions) were included in order to get the most realistic model. Multiple sequence indication simulations were run in order to find which model best fit the average.



The channel facies layer to the left may hold reservoir potential since there are an insufficient number of wells draining the sand body (Cumella, Ostby pg. 171).

Results and Reservoir Estimation

On average, the sand packages in the sequence were roughly 20-25%, alluvial-plain made up the majority of the facies model at 61%, and the coastal-plain facies made up 19% of the model. Next, a potential sandstone reservoir was picked with the help of the property player and 1D filter tools. According to a previous study, well density has to be greater than 20 acres in order to adequately drain the lenticular reservoirs in the Williams Fork (Cumella, Ostby pg. 171). Because of this, there is reason to believe there is reservoir potential about 10 acres to the Southwest of CHEVRON-MARATHON-23A-11D at around 7000 feet TVD.

Future Research

For a future research project, one could potentially find production data of the Marathon wells in Garfield County and create a reservoir engineering model or well engineering model to match the facies model. An analysis could be made through Petrel to see if the reservoir picked in this project would truly be economic or not.

References

Cole, R. D., and S. P. Cumella, 2005, Sand-body architecture in the lower Williams Fork Formation (Upper Cretaceous), Coal Canyon, Colorado, with comparison to the Piceance Basin subsurface, Cretaceous sand body geometries in the Piceance Basin area of northwest Colorado: The Mountain Geologist, v. 42, p. 85–107.

Cumella, S. P., and D. B. Ostby, 2003, Geology of thebasincenteredgas accumulation, Piceance Basin, Colorado, in K. M. Peterson, T. M. Olson, and D. S. Anderson, eds., Piceance Basin 2003 guidebook: Denver, Colorado, Rocky Mountain Association of Geologists, p. 171–193.

Pranter, M. J., R. D. Cole, H. Panjaitan, and N. K. Sommer, 2009, Sandstone-body dimensions in a lower coastalplain depositional setting: Lower Williams Fork Formation, Coal Canyon, Piceance Basin, Colorado:AAPGBulletin, v. 93, p. 1379–1401

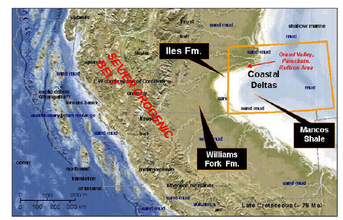


Figure 4. Late Cretaceous (~75Ma) paleogeography of the western United States. Colorado is outlined in orange. Modified from Blakey (2003).