A case study on the reservoir characterization of the Doug A sandstone in the Uinta Basin, Utah. Challenges and perseverance...

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Crescent Point Energy acquired Ute Energy Upstream Holdings in November 2012. This included 270 net sections of land. In 2014 Crescent Point Energy began the process of acquiring 3D seismic in the Randlett and East Rocky Point area for the purpose of developing the significant resources within the Green River and Wasatch Formations (Figure 1).

Figure 1 Randlett area with CPG lands and Randlett 3D (blue polygon). Doug A sand fairway (Red polygon).

The Doug A sandstone is part of a lacustrine deltaic sequence found within the Green River Formation that is shale dominated (Figure 2). This formation was deposited in the upper Paleocene/ Eocene.

Figure 2 Cross-section and OIP map derived from geological mapping for the Doug A sandstone.

Acquisition of seismic was challenged by the presence of the Uinta Basin hookless cactus, requiring Crescent Point to engage the services of close to eighty botanists in advance of recording, to map and flag all cacti within the prospect area. In addition to botanical challenges, topography and surface geology presented challenges for acquisition and processing that required significant effort to overcome (Figure 3).
Three iterations of processing and reprocessing along with acquisition of a vertical seismic profile (VSP) were required to adequately understand and design a strategy to deal with these challenges caused by subsurface geology. Significant surface and interbed related multiples were present in the data which required improvements using non-velocity filtering methodologies to achieve the require S/N needed to map the Doug A sandstone (Figure 4). Additional complexity included horizontal transverse isotropy (HTI) which significantly affected the far angle/offset traces of CMP gathers (Figure 5). This was especially important to the mapping the Doug A sandstone as porous sandstone expressed itself only on far and ultra-far offsets/angles in CMP gathers. Estimations of Thomson parameters were required to improve the S/N in the gathers especial at far offset/angle.

Figure 3 a) Hookles cactus of Utah (photo US Fish and Wildlife), b) flagging of cactus in the field (Dawson Geophysical).

Figure 4 a) VSP tie to original processing, b) velocity analysis on CMP gathers showing multiples.
Synthetic modelling of the Doug A sandstone indicated that far to ultra-far stacks were required to map prospectivity within the formation. $V_p$ and $V_s$ of shales and porous sandstones on logs are virtually identical and only bulk density showed any significant change in reflectivity between sand and shale (Figure 6).

Pres-stack inversion was used to estimate the density term. The improvements in S/N from processing allowed for accurate wavelet estimation. A low frequency model was built using only a single well with no reservoir quality sand in the interval (shale case). Pre-stack inversion was able to resolve the
reflectivity of sand in high net to gross areas. The inversion results were less effective in lower net to gross sands. However, this was still sufficient to corroborate the geological mapping and highlight a previously unidentified sand (Figure 7).

Figure 7 Bulk density extraction showing a similar distribution to the OIP map (Figure 2b) with an additional sand body identified to the east of the main pool.