3-D Modeling of the Cerro Toro Axial Channel-Belt, Sierra del Toro, Magallanes Basin, Chile: From Outcrop Observations to Subsurface Uncertainty

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The Upper Cretaceous Cerro Toro Formation outcrops on Sierra del Toro record at least three discrete episodes of conglomerate deposition within an axial channel belt that occupied the foredeep of the Magallanes Basin. A full 3-dimensional (3D) model (12 km x 12 km by nearly 2 km thick) is presented which captures these exploration scale deposits. The model, combined with a data elevation model, captures the main features of the outcropping channel belt. It is based on more than 3 km of measured sections which were correlated with photomosaic mapping to provide a detailed stratigraphic and sedimentological interpretation of the channel belt deposits.

Building such a comprehensive, large scale model presents significant challenges resulting from incomplete or inaccessible outcrop exposures. During model building, these challenges can be captured as uncertainties and addressed to elucidate the range of possible scenarios. Uncertainties associated with individual channel complexes are the morphologies of the basal erosional surfaces (defined by depth and shape) as well as the internal channel architecture. The spatial relationship between complexes is a larger scale uncertainty regarding how the channel complexes are stacked laterally and vertically. We found that in areas with extensive outcrop exposure both the channel morphologies and stacking patterns are well constrained.

Once the uncertainties associated with converting outcrop observations to the model are well understood, the seismic expression of these possible scenarios can be evaluated. Synthetic seismic profiles, created from the 3D model, show the influence of channel complex morphology, internal architecture and facies distribution, and the overall stacking patterns within the channel belt. We find that the fine scale channel architecture and reflection profile frequency both play a significant role in how basal erosion surfaces are interpreted in seismic reflection profiles. Additionally, by analyzing inverted seismic data in conjunction with well-derived rock properties, we are able to better predict channel fill architecture as well as lateral and down dip facies distributions. These multi-scale results help to calibrate predictions of deep-water channel architecture from seismic reflectivity profiles and seismic attributes.