Bridging the Gap: Complimenting Subsurface Interpretations with Virtual Outcrop Models

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Abstract

The detailed investigation of geological structures is inherently an outcrop-based undertaking. Remote datasets, such as subsurface seismic and gravity data, are exceptional tools that detail the structure of the subsurface. However, resolution is commonly 15 m at best and it is not possible to determine information such as the kinematics of a fault network (e.g. slickenlines, fault-steps etc.) and the internal dynamics of folding (e.g. brittle flexural slip planes vs. ductile flexural flow). Further to this, reservoir continuity, resource migration pathways, and the prediction of subsurface fluid pressures commonly depend on the characteristics of small-scale (<15 m) structures, which often cannot be resolved remotely. Here we demonstrate how constructing and analyzing virtual three-dimensional structural models from outcrop data compliments primary subsurface datasets and bridges the gap between remote datasets and outcrop-scale structures. The results contribute to our evolutionary understanding of large- (seismic-) scale structures as well as the characteristics of structures below the resolution of the available data. Photogrammetry, structural observations, and structural measurements were used as the basis for interpreting the three-dimensional geometry of a geological structure exposed at surface. Interpretations were used to construct a virtual three-dimensional structural model in Midland Valley's Move™ software suite. Subsequently, a quantitative analysis of the virtual outcrop model was conducted in Move in order to further characterize the exposure. In combination, geological observations, three-dimensional model geometries, and the quantitative model analysis characterize structures below the resolution of many remote datasets. The results are up-scaled into the context of a large-(seismic) scale structure and the difference in resolution is highlighted. Our results highlight how outcrop data can be combined with three-dimensional photogrammetry to construct and analyse outcrop-scale structures. Virtual outcrop models should complement remote datasets. Structures below the resolution of many primary subsurface datasets can unexpectedly enhance or hinder production and, in combination, remote datasets and virtual outcrop models contribute to the successful extraction of resources.