Fractured Carbonate Reservoirs Part 1: Development and Testing of New Automated Methods for the Capture of Quantitative Fracture Data from Outcrop Analogues

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Natural fracture systems commonly act as an important control on the production of hydrocarbons from carbonate reservoirs. In the subsurface, significant enhancement of fracture models can be gained through the study of appropriate outcrop analogues (i.e. fracture orientation, spacing, height, connectivity etc.). However, a major bottleneck in the utilization of outcrop data is the time required for the collection of statistically meaningful fracture data from geological field work and/or remote sensing data. In order to eliminate this bottleneck we have successfully adapted 3D seismic technologies, originally developed for automated fault extraction, for the automated extraction of bedding and fracture data from a range of different digital remote sensing data types. The results derived from automatic analysis of the remote sensing data have been independently quality-controlled using traditional outcrop-based field studies on world-class carbonate exposures (USA, Europe, Middle East). The analyzed data include ground-based and airborne LIDAR-derived photorealistic models and orthorectified Quickbird satellite imagery combined with satellite-derived digital elevation models. Data are derived from surface surveys and also subsurface tunnel survey. The examples have been chosen in order to 1) capture variability in terms of fractured carbonate reservoir types and structural setting, and 2) to develop and prove the technology using a range of remote sensing data types and different data qualities. We contend that the research has led to development of a rapid and robust method that allows for the extraction of statistically representative fracture populations. The new technology frees the structural geologist from laborious digitizing work, and provides access to a plethora of relevant fracture data. The technology therefore allows the geologist to better focus on the interpretation and analysis of relevant outcrop analogue data in order to better parameterize the building of subsurface fracture models.