Using Field Analogue Data for Deterministic Subsurface Modeling of Fluvio-Deltaic Reservoirs in Incised Valley Settings (Carboniferous, Kentucky, USA)

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ABSTRACT

Incised valleys are extensive geomorphologic features with a high potential of encasing coarse-grained sediments in mud-dominated environments, thereby forming potentially good reservoirs. Even though they have been recognized throughout the geological record, most of our knowledge on the genesis, geometry and infill architecture of incised valleys comes from Quaternary case studies. Which helped providing a good understanding of the mechanisms of formation and geometry of incised valleys, however stratigraphic architecture and heterogeneities of their infill needs further investigation. For which, the study of outcrop analogues, has proven to be a very useful investigation tool. In this context, we studied the Pennsylvanian successions of eastern Kentucky, an excellent field laboratory for the study of ancient incised valleys. The Breathitt Group is a succession of Lower to Middle Pennsylvanian fluvio-deltaic deposits, infilling an elongated foreland basin developed during the Alleganian orogeny. Stratigraphic cyclicity in the deposits is commonly attributed to high-magnitude glacioeustatic fluctuations driven by Gondwanan glaciations. Therefore, making the Breathitt Group an environment prone to the development of incised valleys fills (IVF). We studied, through detailed sedimentological logging, and characterised in terms of porosity and permeability, a total of 20 extensive roadcuts distributed along two roads covering a total of ~22km, near Pikeville. More than 300m of stratigraphic succession are exposed, in which several IVF are very well exposed. Special attention was given to IVF geometry, history of infill as well as repartition of heterogeneities. In parallel, 36 boreholes, covering an area of 120sq.km located between the two studied roads, were used to build a subsurface 3D geological model using a deterministic approach. Due to the proximity of the outcrops and the modelled area, the conceptual model and stratigraphic correlations for the model were directly transferred from the outcrop. In the field, three types of IVF architectures were identified, providing tools for the recognition and modelling of such reservoirs in the model. Within these reservoirs, facies-scale heterogeneities and their impact on porosity and permeability were integrated through upscaling of small-scale models built from outcrop data. The workflow and data used in this study are planned to be further applied for the Mauritus Fm in the Southern North Sea.