An investigation of numerical facies models of coal seam gas reservoirs; Walloon Subgroup, Surat Basin

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INTRODUCTION

The Walloon Subgroup (WSG) represents a prolific coal seam gas (CSG) resource which underpins three large CSG to liquefied natural gas (LNG) projects operating along the Australian east coast. These mega-projects require long term forecasts of gas production, predictions which are often derived via the dynamic simulation of numerical reservoir models. Reservoir models consist of hierarchical collections of inter-related rock and fluid parameters. The facies model, representing paleogeography, serves as the foundation of this linkage as it defines the three-dimensional (3D) geometry and distribution of coal seams. This thesis is comprised of complementary studies aimed at investigating and enhancing the predictive capability of numerical facies models in the Walloon Subgroup. Construction of predictive facies models requires a comprehensive understanding of regional depositional trends, local facies architectures and depositional processes as well as computer routines able to translate this information into numerical 3D grids.

COMPONENTS REQUIRED FOR INCREASINGLY PREDICTIVE CSG FACIES MODELS

SCREENING STUDY

- Regional analysis of CSG parameters
- Core description
- Seismic attribute analysis
- Software development

BASIN ANALYSIS

- Dynamic reservoir modelling
- BHI interpretation
- Structural analysis
- Numerical facies modelling

RESERVOIR ARCHITECTURE

- Production forecasting
- Palaeogeographic reconstruction
- Sedimentary process analysis
- Model validation & interrogation

FACIES MODELLING

- Palaeogeographic model definition
- Define templates and controls upon alluvial architecture of the WSG
- Test & develop approaches for numerical facies model construction

Present gaps in our understanding highlight the requirement for further studies aimed at 1) refinement of the WSG’s regional stratigraphic and palaeogeographic models, 2) delineation of the WSG’s reservoir scale internal alluvial architecture, 3) identification of the processes or mechanisms controlling reservoir-scale facies relationships within the WSG and 4) development of workflows better able to represent alluvial facies in numerical reservoir models. The focus of this dissertation is to explore these conceptual gaps leading to improved numerical facies models of the WSG.

REFERENCES


FIELD SCALE

- Coal Geology 1, 185-195.
- Australian Journal of Earth Sciences, 64 (4), 455-469.
- Australian Journal of Earth Sciences, 62 (8), 949-967.

FACIES MODELLING ADVANCES

1. Defined geometry: Templates derived from seismic and well data that describe the 3D geometry and distribution of WSG architectural elements (Shields and Esterle 2015).

2. Depositional process: Interrogation of seismic and well data has revealed that compensational stacking is a key processes responsible for the WSG’s complex alluvial organisation (Shields et al 2017A).

3. Computer routines: Development of a computer routine able to replicate the mechanics of compensational stacking and translate this understanding into numerical 3D grids (Shields et al. 2017B).

FIELD SCALE

- Observed field data: WSG facies architecture as described from mining bore and exposures in the NE of the Surat Basin (Leblang et al. 1981). Complex organisation of coal bodies including seam amalgamation, bifurcation and wash out.

- Previous generation of facies models: An early WSG facies model constructed via existing geo-statistical algorithms. Absent are the complex features observed in the mining bore data. Not predictive with respect to flow-paths or reservoir continuity (Ryan et al. 2012).

- Next generation facies models: A facies model outcome generated using the newly developed PETREL plugin. This realization uses the 3D geometrical templates resolved from seismic, together with automated representing the mechanics of compensation stacking. Provides a more representative model outcome when compared to observed data (Shields et al. 2017B).