SPE-191904-MS

Discrete Net-to-gross Truncated Gaussian Simulation: An Alternative Modelling Approach for CSG Unconventional Reservoirs, Bowen Basin, Eastern Australia

Simone Rattazzi and Alan Hansen, Santos Ltd.

Abstract

Building a representative static model for predicting and monitoring performance of coal seam gas fields presents several complex and unique challenges. The individual reservoirs possess very different coal architectures, often with highly complex seam splitting, amalgamating and structural deformation. The objective was to develop an alternative approach which honoured log and core data capturing both the lateral heterogeneity and vertical signature of the Bowen Basin coals, Central Queensland.

In some areas of the Bowen Basin, coals can be thick and laterally continuous; picking the top and base of each seam works well in small models with homogeneous coals. As seam geometries begin to increase in complexity and coals become more heterogeneous in nature with thinner seams in multiple packages, then a net-to-gross (NTG) approach is often more appropriate. Each method has its merits. The former approach describes the reservoir architecture but implies a certain degree of confidence in coal correlation; in a vast field with complex seam splitting and merging with abundant drilling data, it may not be a practical technique. The later method (NTG) disregards coal seam architecture and reservoir connectivity.

The proposed workflow is designed to take advantage of both net-to-gross characterization and facies modelling technique using a combined hybrid approach. The process is operating on a relatively coarse layered chronostratigraphic framework in which coal is captured as contiguous discrete-NTG “facies” (Figure 1).

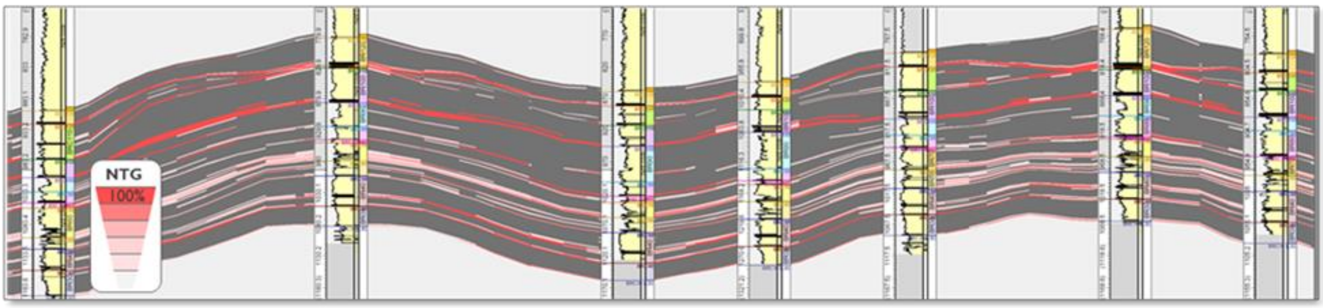

Figure 1: Discrete NTG Model cross-section: coal NTG “facies” are shown with red colors while interburden in grey; well traces display gamma ray log with coalintervals in black and intervals and in yellow.

The Discrete NTG modeling approach provides access to categorical data analysis tools and allows the proper scaling of seams with different coal quality characteristics. The utilization of the Truncated Gaussian Simulation (TGS) ensures the contiguity of facies and mimics transitions between coals and carbonaceous mudstones (or other transitional interburdens). With the adoption of facies vertical proportion trends we are able to replicate a similar coal seam signature laterally away from the well bore. Further detail can be captured by linking different vertical proportion trends in different regions with similar coal signature characteristics (Figure 2).

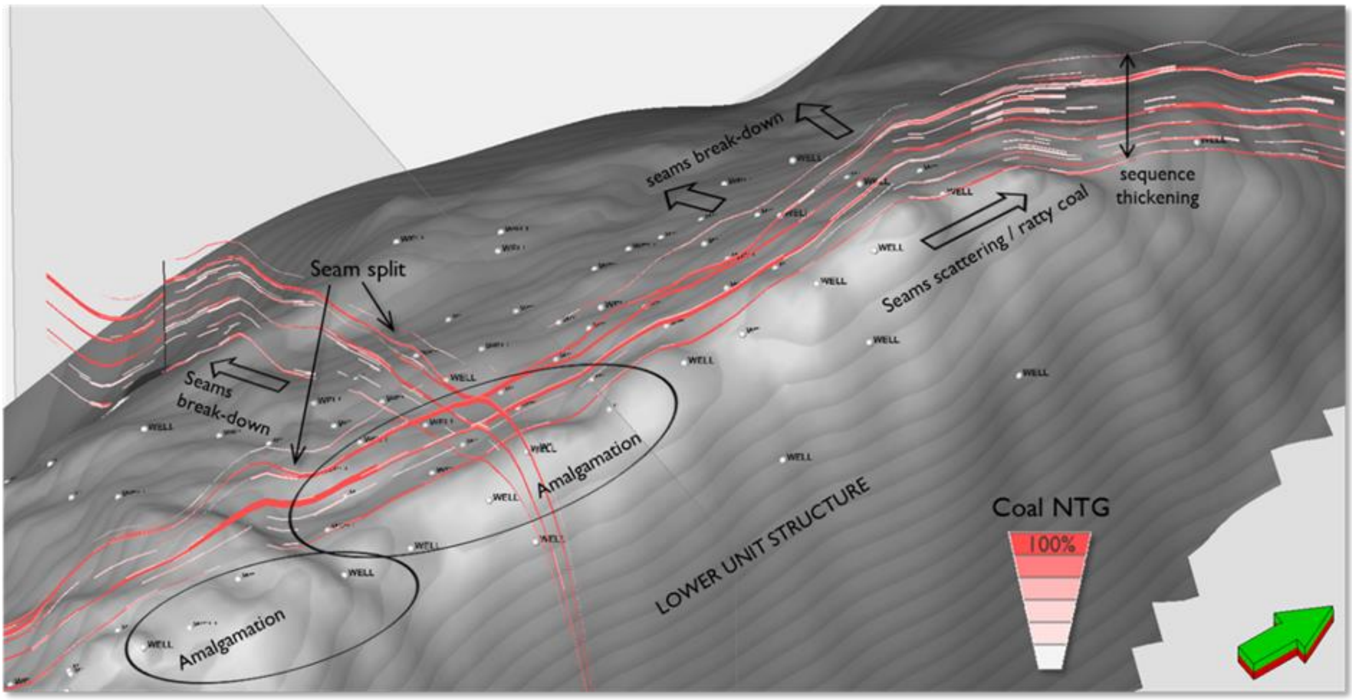

Figure 2: Conceptual depositional model vs. discrete NTG model for a selected NS and EW cross-sections.

The discrete NTG model is ultimately converted-back to a continuous tridimensional property for volumetrics and dynamic modelling purposes. Major reservoir geometries can be reproduced while building the stratigraphic framework. Replication of the finer scale seam splits and amalgamations can be potentially achieved with further upscaling of the continuous NTG property into a yet coarser grid.

The attempt to resolve coal architecture and seam-to-seam connectivity within the static model has improved history matching attempts. The tailoring of different coal facies to the many variables affecting reservoir performance has allowed static and dynamic relationships with strong correlation coefficients to be populated more thoroughly. This refinement is an important step in utilizing all geological knowledge to narrow and reduce the number of equiprobable history matched models. Narrowing this uncertainty will ultimately aid in narrowing the range of future production forecasts.

With the successful geocellular model re-construction of two historical Coal Seam Gas (CSG) fields in the Bowen Basin, the Discrete Net-to-gross Truncated Gaussian Simulation approach has proven to be a valid alternative CSG modelling technique.