Seismic Insights into the Sedimentary Architecture of the Walloon Sub-Group

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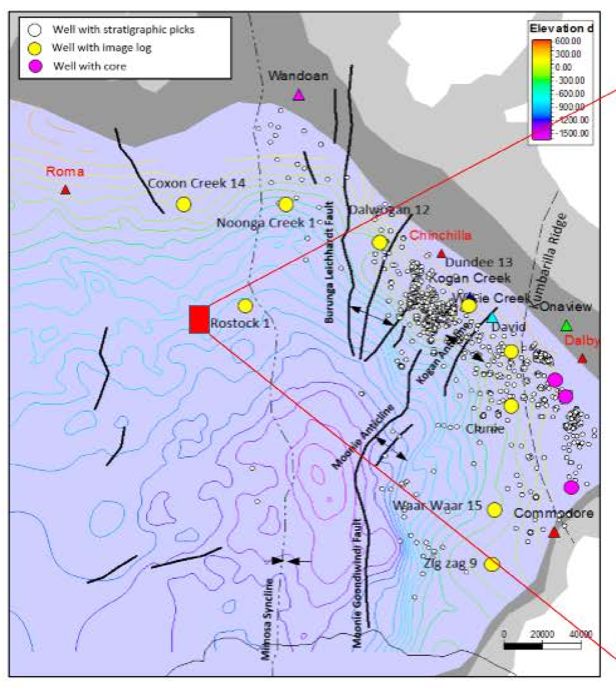
INTRODUCTION

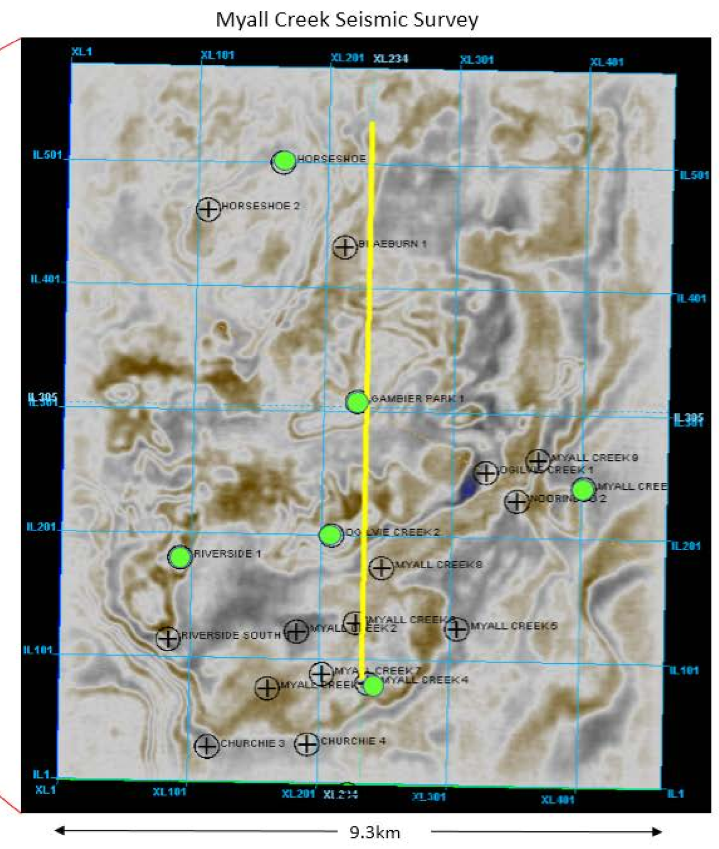
The sedimentology of the Walloon Subgroup (WSG) is well studied and over the past few decades a coherent alluvial facies model has emerged and been tested repeatedly (Exon 1976, Yago 1996, Ryan *et al.* 2012, Martin *et al.* 2013). Despite this existing body of work, there are significant gaps in our understanding of the subgroup's internal architecture and the relative controls upon the distribution of the CSG reservoirs contained therein. In this study an open file 3D PSTM seismic survey recorded on the NW flank of the Mimosa Syncline (complimented by 19 intersecting open file wells with wireline and checkshot data sets) was studied to understand: (1) the geometry of WSG alluvial architecture (and the CSG reservoirs contained therein) and (2) the controls upon the sedimentary organization in the Middle Jurassic Walloon Sub-group. Core analysis, well correlation, seismic interpretation, and attribute analysis were integrated to resolve the WSG's internal architecture.

DATASET



20 wells intersect Walloons (all open file)

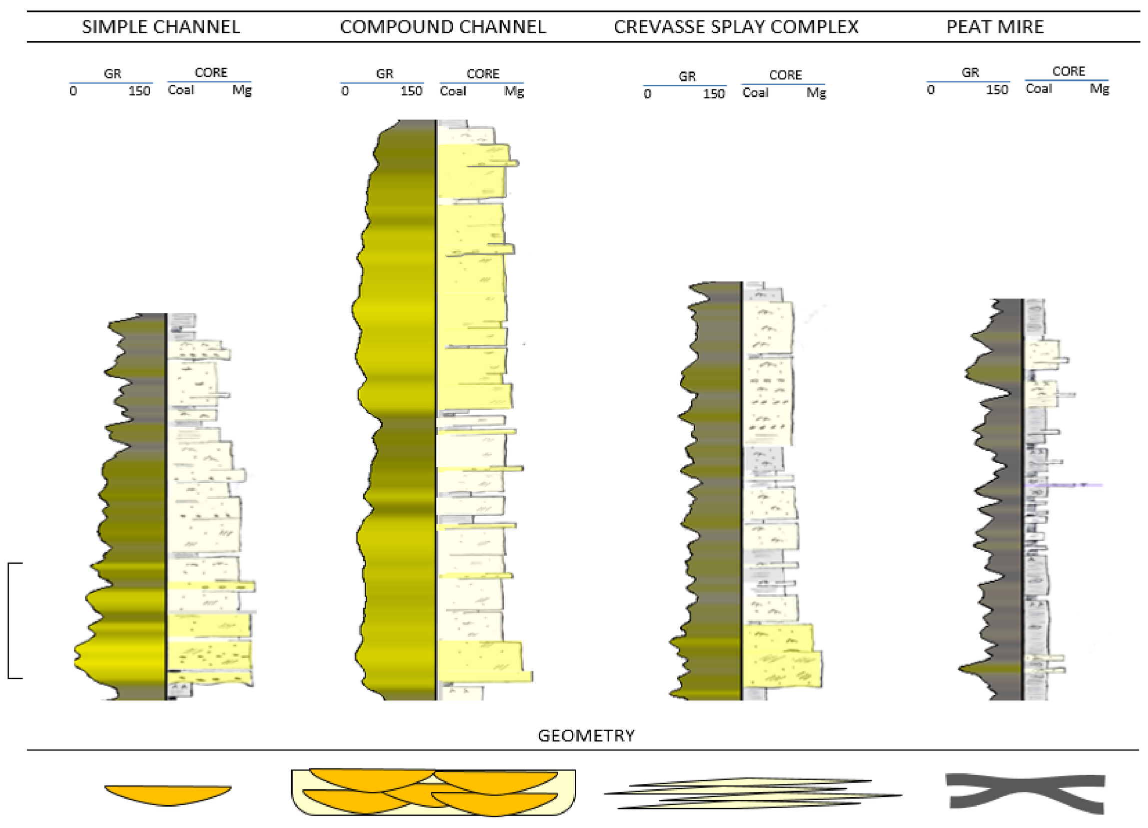
- 6 wells with check shots
- 11 wells with WSG sonic logs
- 5 wells with WSG density logs



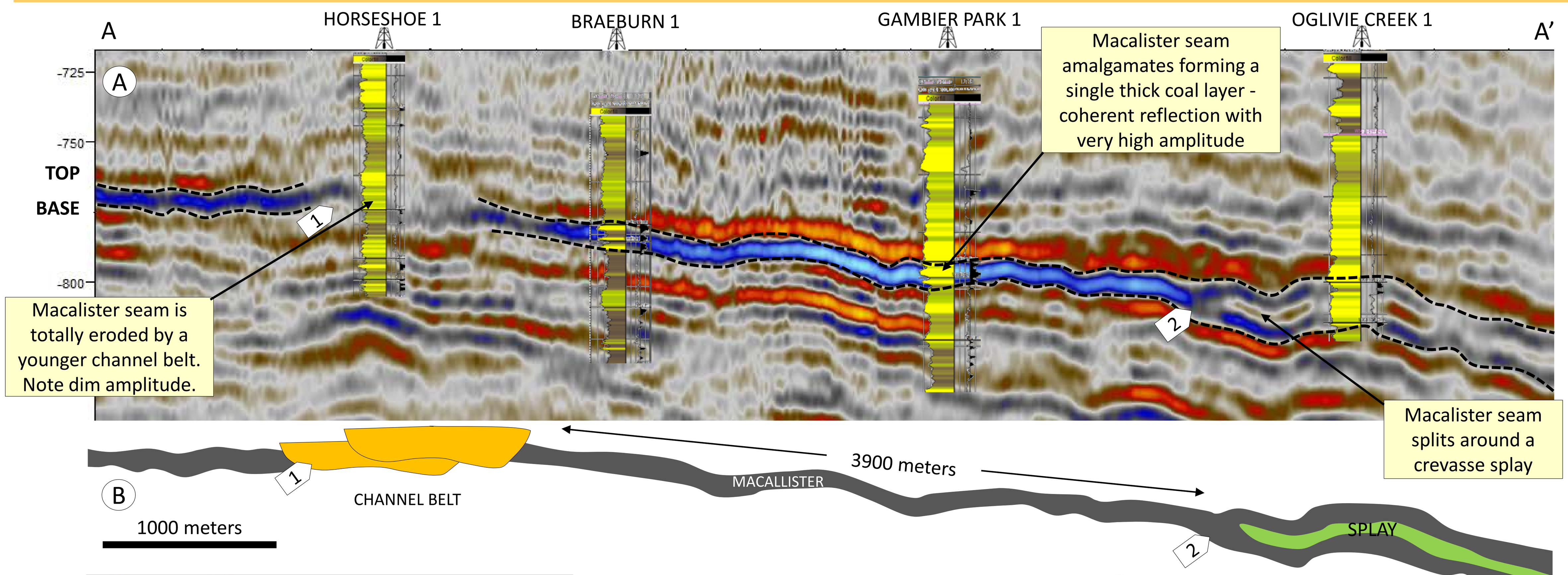
WSG SEDIMENTOLOGY

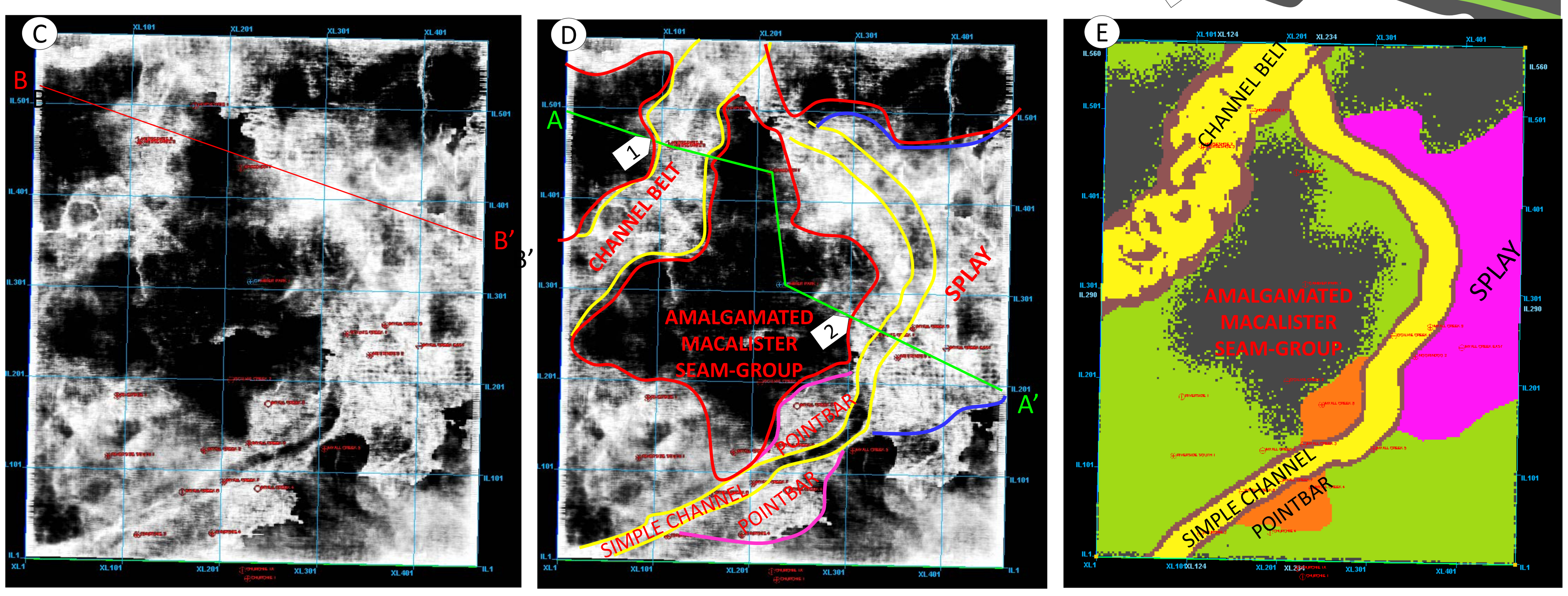
Prior to seismic characterisation, an in-depth study of WSG sediments was undertaken from cored wells. Four basic architectural elements were identified in cores and calibrated to wireline motifs. These include simple isolated channels 6-8 m thick, compound (multi-storey) channel belts 14-18 m thick, stacked crevasse splay complexes 6-8 m thick, and heterolithic peat mire successions up to 10 m thick.

These successions are believed to be seismically resolvable as they are above the seismic tuning thickness of 6-7 m and were tied to seismic reflections via construction of synthetic seismograms in 6 wells.

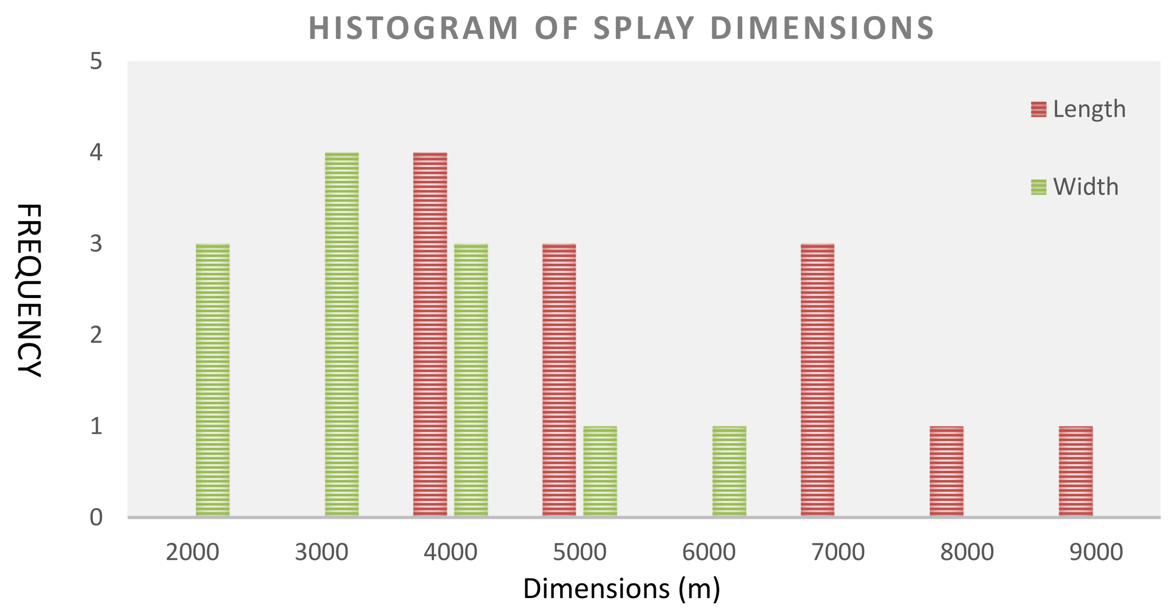


SEISMIC ARCHITECTURE OF A WSG SEAM-GROUP

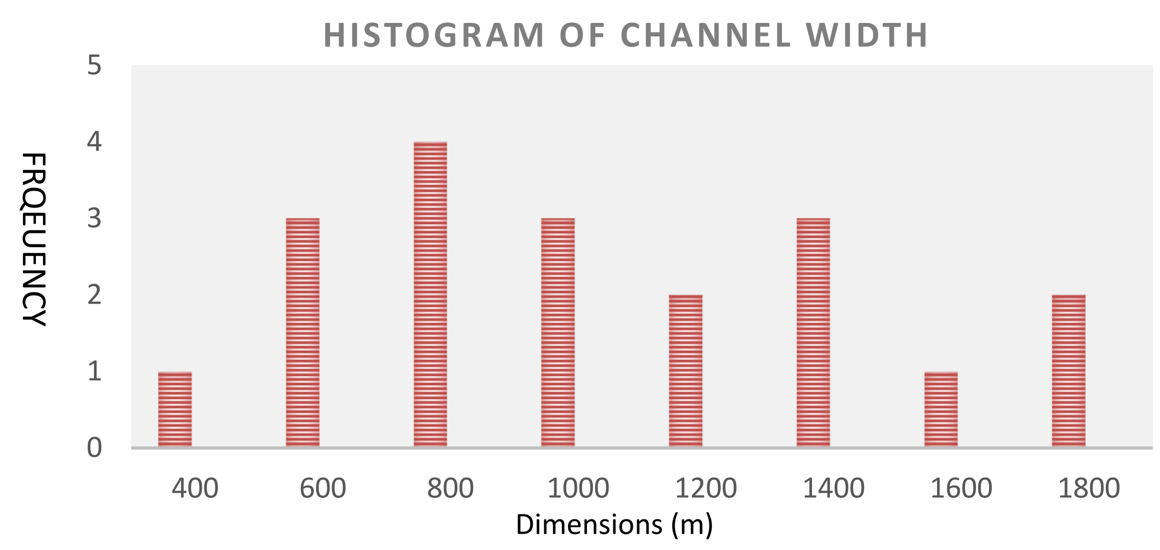




A) Seismic section A-A' in TWT showing relative acoustic impedance; B) Schematic of Macalister seam architecture (A-A'); C) Seismic envelope extracted within Macalister seam-group; D) interpretation of architectural elements; E) facies model constructed in Petrel™ to be used as training image describing the orientation, size, and organisation of WSG alluvial architectural elements in areas without seismic coverage.

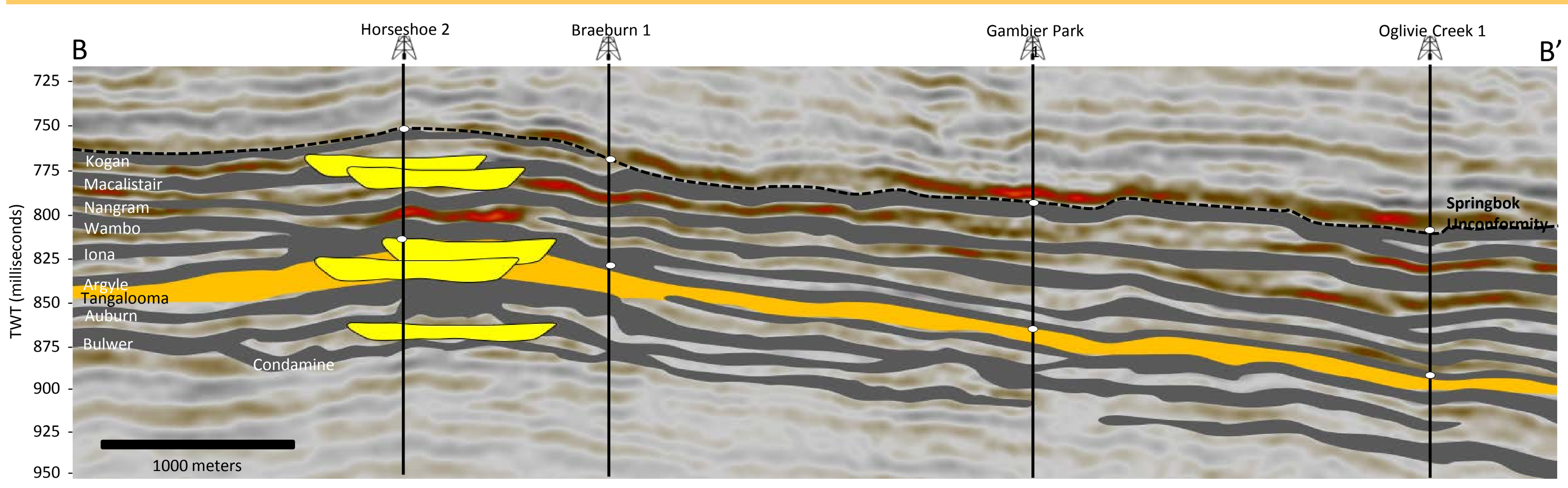


- Within the Walloon Subgroup 12 crevasse splay complexes were identified in the wells were mapped in time on the PSTM survey.
- Average splay length is 5900 meters, average width is 3400 meters, average length:width ratio is 1.7.
- Many smaller splays may be present, but given the 6-8 meter limit on seismic resolution, only stacked splays thicker than this were able to be resolved.

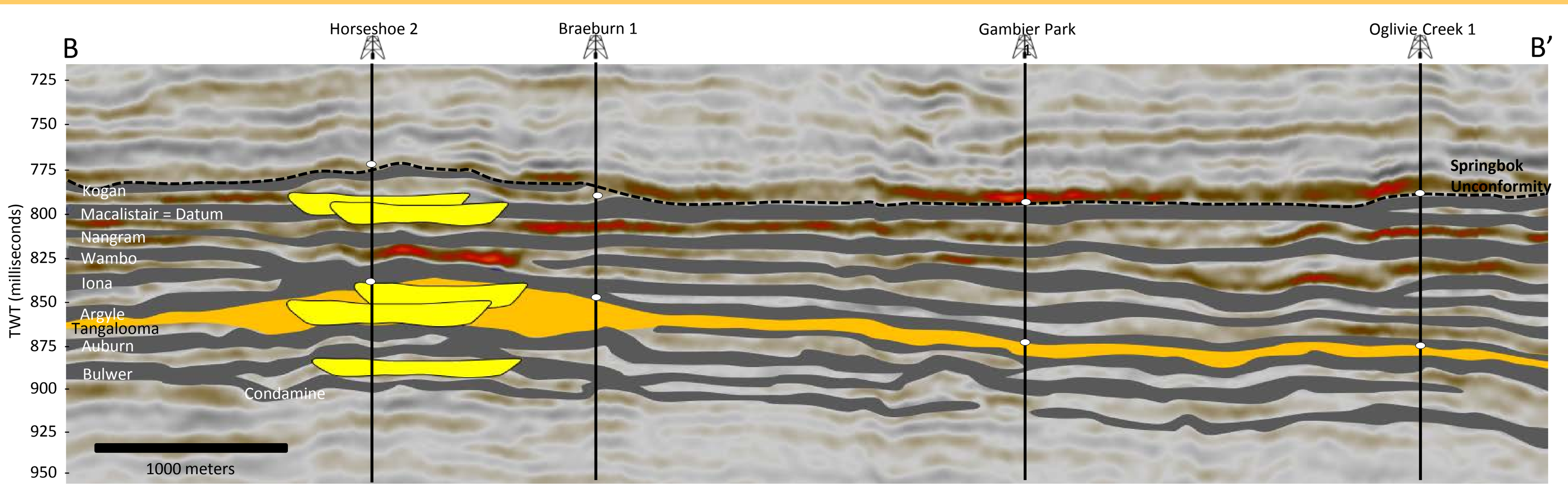


- Channels are generally oriented in NS direction, which agrees with paleoflow interpretation from a BHI in nearby well Rostock 1 (Shields and Esterle in-press).
- 19 channel or partial channels were mapped in time from reflectance or seismic attributes. Average channel width is 1050 meters (stdev 180 meters).
- Often channels become obscured due to interaction with splays (resulting in loss of seismic contrast) or attenuation due to the presence of coal seams.

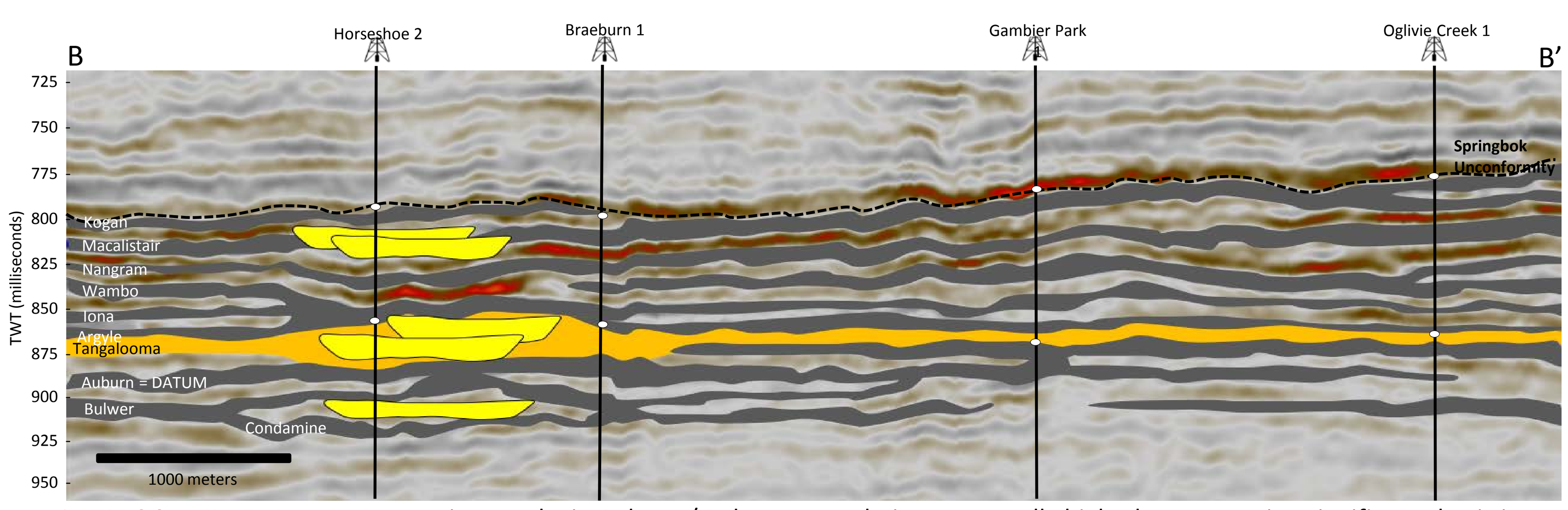
MECHANICS OF WSG COMPENSATIONAL STACKING



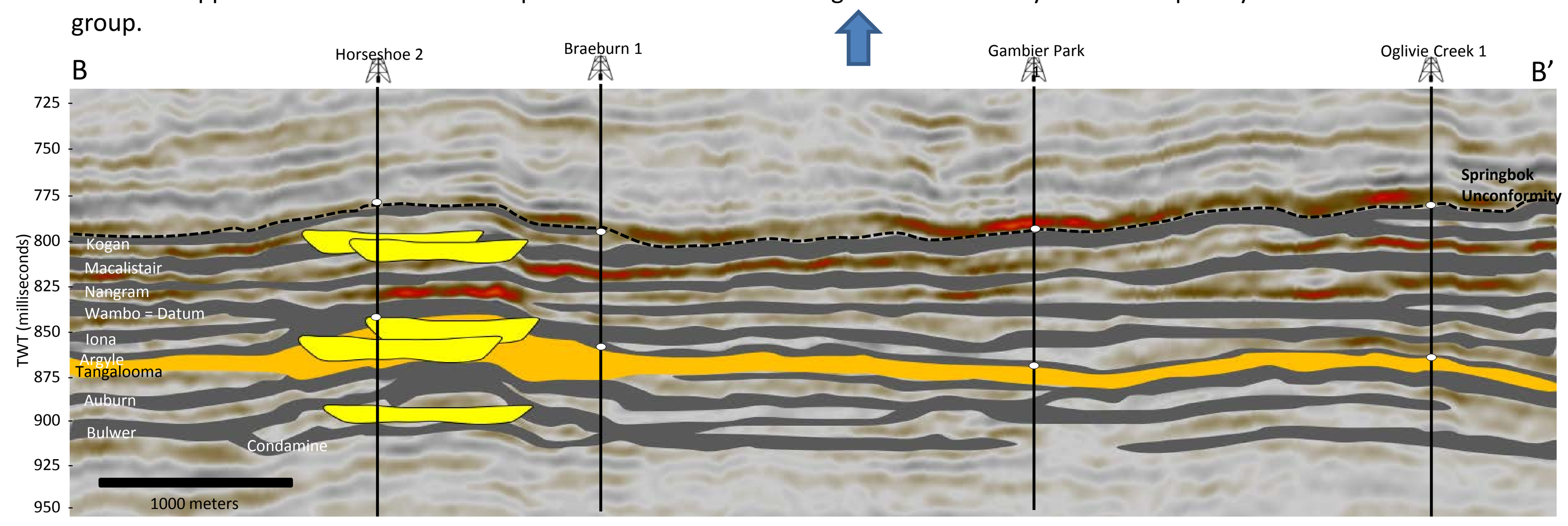
4. PRESENT DAY (Structural section). Channels as well as thick and commonly amalgamated seam-groups coincide with structural highs. On top of the structural highs seam-groups coalesce to form amalgamated organic rich successions with minimal clastic intercalculations. Down the flanks of the anticline the seam groups diverge and split around crevasse splays as accommodation space increases and interburdens become sandier.



3. LATE JUANDAH TIME: The overly thick and amalgamated Lower Juandah seam groups compact more than the surrounding, more heterolithic, WSG succession. This allows for a topographic depression to develop in late Macalister seam-group time ,which results in increased upper Juandah channel development over the structural high. This channel system subsequently erodes the Macalister seam group.



1. TAROOM TIME: Deep structuration results in Aubrun / Bulwer seams being structurally high, thus preventing significant clastic input and allowing for thick and amalgamated (particularly Auburn and Bulwer) seam-group development. This anomalously thick accumulation of Taroom seam-groups results in increased subsidence towards the end of Auburn time resulting in a topographic low allowing development of an over thickened Tangalooma sandstone (observable in Horseshoe 2)



2. EARLY JUANDAH TIME: The overly thick Tangalooma sandstone compacts less than the adjacent WSG section down-dip, thus forms a local topographic high. On top of this high the Lower Juandah seam-groups (Wambo, Iona, Argyle) amalgamated to form a single thick seam group with relatively less clastic input than surrounding areas (see Horseshoe 2 well logs). Off this high the seams split and offlap and become relatively thinner and down-dip the succession is generally more heterolithic.

CONCLUSIONS

Previous studies (eg. Yago 1996) have described differential compaction as the "main factor" controlling the complex organisation of the Walloon alluvial system. In contrast, this study suggests that although a "memory" by which younger elements are influenced by the position of older ones (i.e. compensational stacking) appears to exist, WSG cycles may also be influenced by reactivation of deep seated structural features. On top of structural highs (eg. Horseshoe 2) anomalously thick and homogeneous seams groups amalgamate. Here, the thick coal prone successions compact significantly and thus may attract younger channels that can erode WSG seam groups, thereby reducing the net coal thickness. Down dip and on structural flanks, increases in accommodation space results in thinner coal seam-groups, more splays and an overall increasingly heterolithic succession (eg. Oglivie Creek 1).