Marine and Petroleum Geology 86 (2017) 573–586

Contents lists available at ScienceDirect

Marine and Petroleum Geology

journal homepage: www.elsevier.com/locate/marpetgeo

Research paper

Understanding the geometry and distribution of fluvial channel sandstones and coal in the Walloon Coal Measures, Surat Basin, Australia

Fengde Zhou*, Daren Shields, David Titheridge, Stephen Tyson, Joan Esterle

School of Earth and Environmental Sciences, University of Queensland, Brisbane, QLD 4072, Australia

ARTICLE INFO

Article history:
Received 30 January 2017
Received in revised form
22 May 2017
Accepted 14 June 2017
Available online 15 June 2017

Keywords:
Geometry
Channel
Coal
Walloon Coal Measures
Surat basin

ABSTRACT

Understanding the controls on coal seam distribution and geometry is fundamental for planning coal seam gas production. In the Jurassic Surat Basin of South East Queensland, Australia, the spatial continuity of coal seams in the Walloon Coal Measures is highly variable and often difficult to map and predict, even with closely spaced (<1000 m) drillings. This paper investigates the frequency and location of thick sandstone in relation to thick coal seams or plies across three broad stratigraphic divisions, Upper Juandah (UJ), Combined Lower Juandah-Taroom (CLJT) and Condamine Coal Measures (CCM), within the Walloon Coal Measures. Basic depositional facies, e.g. channel, floodplain, marginal mire, and coal mire, were interpreted from geophysical logs. An in-house code was used to count the number of coal plies thicker than 2 m, and channel sandstones thicker than 5 m for the UJ and CLJT and 3 m for the CCM at each borehole. Isopleth maps of the numbers of both coal plies and channel sandstones were generated across the basin for the three subdivisions. Results show that there is an upward stratigraphic trend from thick to thin, and then to thick stacked coal plies. This corresponds to a similar vertical thickness change in channel sandstones. The incidence of thick coal and thick sandstone is associated with rising base level within an early transgressive systems tract which was followed by a high stand prior to a regional erosive event above the UJ. Thick and stacked coal plies have a marked tendency to occur in belts adjacent to the thick channel thoroughfares in the basin.

1. Introduction

The Surat Basin is a broad intra-to peri-cratonic basin that covers an area of about 300,000 km^2 in south-east Queensland and northeast NSW (Rigby and Kantsler, 1987; Ryan et al., 2012; see Fig. 1). Strata within the basin dips gently (a few degrees) towards its central axis, the Mimosa Syncline, which is coincident with the underlying Taroom Trough of the Permo-Triassic Bowen Basin (see Fig. 2; Ryan et al., 2012). The Surat Basin is the largest coal seam gas (CSG) basin in Australia (AGRA, 2012). Most of the CSG resources present within the basin occur in the Middle Jurassic Walloon Subgroup (WSG; Jones and Patrick, 1981; Scott et al., 2004) that predominantly comprises the 'Walloon Coal Measures' (WCM; Cameron, 1970). The WCM thicken from 40 m in the southern and western parts of the basin to greater than 300 m in the northern and eastern parts of the basin (Fig. 3). Of this total thickness, the cumulative coal thickness is also greater in the northern and eastern parts of the basin. This area of large net coal thickness is often referred to as the WCM gas fairway (Hamilton et al., 2014).

Previous workers (e.g. Exon, 1976; Green et al., 1997; Yago, 1996; Hoffman et al., 2009; Ryan et al., 2012; Hamilton et al., 2014) interpreted the WCM as having been deposited in a fluvio-lacustrine environment within a vast alluvial plain, where peat (coals) accumulated in the interfluves of active channels. Shields and Esterle (2015) suggested a composite meandering to anastomosing fluvial system with a southeast-oriented trunk, fed by smaller tributaries that compartmentalise the coal deposits within the fairways. Models based on densely drilled areas (Morris and Martin, 2016) or 3D seismic suggest fluvial channels are narrow, from 0.5 to 2 km in the south, becoming wider (0.9–3 km) in the north (Shields and Esterle, 2015; Zhou et al., 2016). Channel type varies along depositional strike from stacked or amalgamated (sandy braided) in the northern and western margins of the basin to distributed and isolated (anastomosing) systems further south

* Corresponding author.
E-mail address: f.zhou1@uq.edu.au (F. Zhou).

http://dx.doi.org/10.1016/j.marpetgeo.2017.06.020
0264-8172/

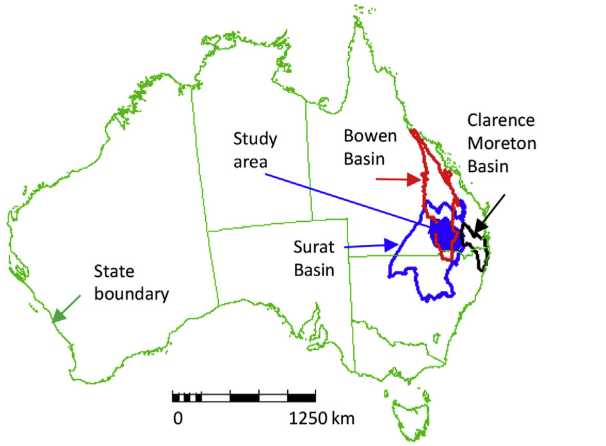

Fig. 1. Locations of the Study area, Surat Basin, Bowen Basin and Clarence Moreton Basin in Australia. State and Territory boundaries were downloaded from http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/1259.0.30.001July%202011?OpenDocument/State and Territory ASGC Ed 2011 Digital Boundaries in ESRI Shapefile.

and into the interior of the basin (Shields and Esterle, 2015). These observations are generally consistent with a north to south proximal to distal variation of an alluvial sedimentary environment within a large south easterly prograding drainage system that experiences fluctuations in base level as the basin develops.

Martin et al. (2013) reported two classes of coal types (I & II). Class I developed in forested mires, associated with thick sandstones developed in channels. It dominates the largest net coal and sequences in seams up to 8 m thick that extend for 3–5 km. Class II occurs at decimetre to meter scale seams that are developed in open mires and associated with finer grained sediments developed in floodplain or lake environments. The overall distribution of thick Class I versus thin Class II coal plies is still poorly defined at a regional scale, and they may be end members of the mire spectrum (Martin et al., 2013). Coal bodies in general, occurring within the interfluves or infilling abandoned channels and lakes, range in width from 500 m to about 5000 m (Ryan et al., 2012; Esterle et al., 2013; Morris and Martin, 2016; Zhou et al., 2016).

Previous models (above paragraphs) do not indicate whether there is a preferential increase in thickness and width of the two coal types in the areas of maximum subsidence in response to

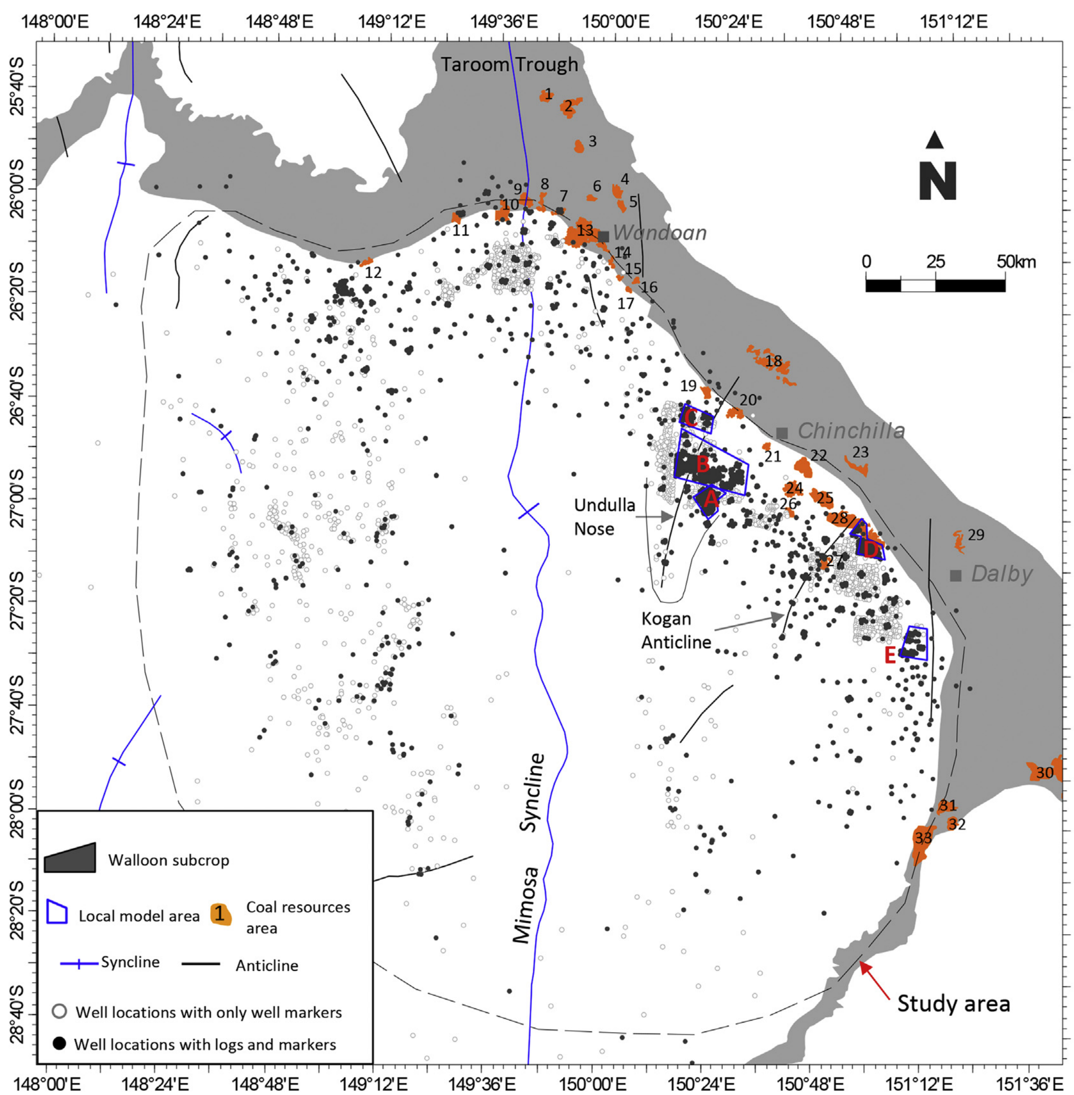

Fig. 2. Locations of the Walloon Subcrop, boreholes with/without well markers and logging data, five local model areas, and 33 coal resources areas (DNRM, 2016). Local area A = Lauren, B=Berwyndale + Talinga + Kenya + Argyle, C=Bellevue + McNulty, D = Kogan North + Daandine, E = Tipton.