Hyperspectral stratigraphy and provenance of the Walloon Subgroup, Surat Basin, Queensland

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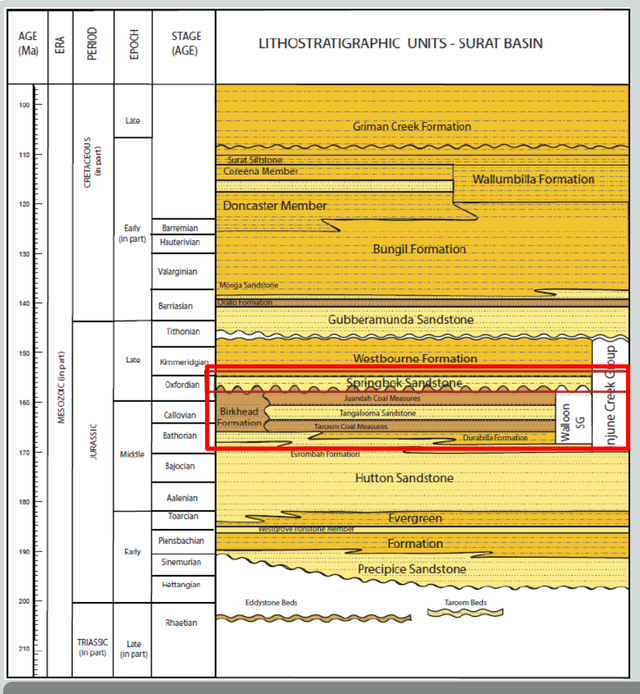
The Jurassic Walloon Subgroup, a productive coal seam gas source, is commonly divided into sub-units based on different proportions and thicknesses of coal and sandstone. However, correlation across the basin is challenging due to high lateral variability and a lack of extensive stratigraphic markers. The Walloon Subgroup is also, in places, incised by the overlying Springbok Sandstone, sometimes interpreted as far down as the Tangalooma Sandstone. The extent of the Springbok incision was confirmed using organic stable isotope trends, which can be applied as stratigraphic markers, as they represent global changes in the ocean-atmosphere carbon reservoir (Hentschel et al., 2016). There is still some uncertainty surrounding the continuity of the different Walloon sub-units with the Eromanga Basin's Birkhead Formation. Recent correlations based on geophysical logs (Sliwa et al., 2014; OGIA) suggest that only the Tangalooma Sandstone seems to be continous with the Birkhead Formation, as the overlying Juandah Coal Measures appear to have been eroded and the underlying Taroom Coal Measures mapped to pinch out towards the Nebine Ridge to the west of the Surat Basin. In order to test this hypothesis, hyperspectral scanning of five Surat Basin cores and one Eromanga Basin core was conducted, in an attempt to utilize this data as a hyperspectral correlation tool. Dating of detrital zircons, as well as a detailed characterisation of the Walloon interburden sediments throughout the Surat Basin and across the Nebine Ridge in the west should shed more light on a possible sediment provenance.

1. BACKGROUND



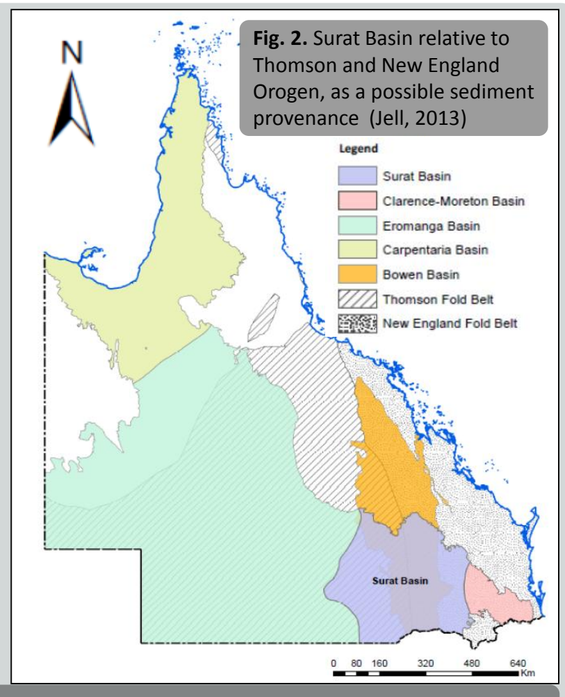


Fig. 2. Surat Basin relative to Thomson and New England Orogen, as a possible sediment provenance (Jell, 2013)

Fig. 1. Surat Basin chrono-stratigraphy after McKellar (1999), Scott et al. (2007) and Wainman et al. (2016). Sub-division of Walloon Subgroup based on different proportions of coal and sandstone. Note: Correlation errors of Walloon sub-units frequent due to nature of fluvial-lacustrine depositional system, lack of marker horizons and uncertainty regarding extent of Springbok incision

2. METHODOLOGY

Well	HyLogger™	XRD	Geochronology
Mitchell 1	Yes, VNIR, SWIR and TIR	-	Samples under prep.
Indy 3	Yes, VNIR, SWIR and TIR	Currently being undertaken	Samples under prep.
Pleasant Hills 25	Yes, VNIR, SWIR and TIR	-	-
Chinchilla	Yes, VNIR, SWIR and TIR	-	Samples under prep.
Jordan 3	Yes, VNIR and SWIR only	-	-
Dalby 1	Yes, VNIR and SWIR only	Yes	-

Table. 1. Overview of study wells and analyses being undertaken; Note: Hylogger system utilizes different spectrographs recording absorption in visible near-infrared (VNIR) and short-wave infrared (SWIR) range (detect phyllosilicates, amphiboles, carbonates, sulphates and iron oxides), as well as an additional thermal infrared system (TIR), which detects non-hydroxylated silicates (quartz and feldspars)

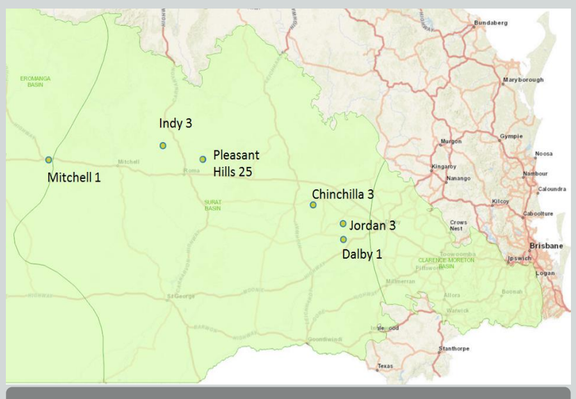


Fig. 3. Map of Surat and adjacent Eromanga Basin, showing location of study wells

Analyses currently being conducted

- Core from six wells throughout the Surat Basin and in the Eromanga Basin, east of the Nebine Ridge was hyperspectrally scanned (Table 1, Fig. 3)
- Accuracy of Hylogger results will be validated by XRD analysis of a suite of selected samples (in progress)
- Conventional sandstone petrology will give insight into diagenetic history (in progress)
- Dating of detrital zircons using laser-ablation inductively coupled plasma mass-spectrometry (LA-CPMS) will be conducted to determine the provenance of the Walloon Subgroup's clastic strata (in progress)

3. PRELIMINARY RESULTS AND IMPLICATIONS FOR ONGOING WORK

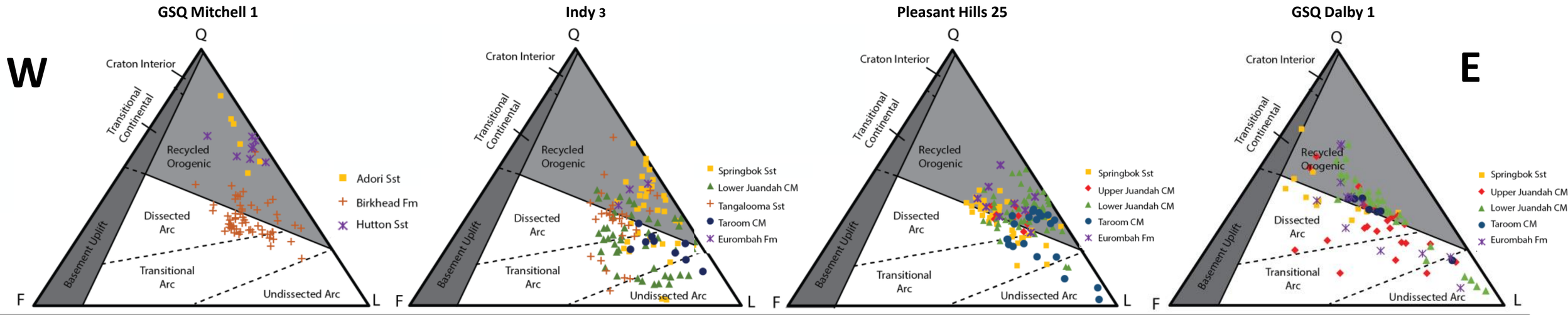


Fig. 4. For selected sandstone intervals (thickness >1m) the average mineral composition as determined by Hylogger was plotted in tectonic provenance ternary plots after Dickinson and Suczek (1979). Hylogger mineralogy was confirmed through thin section petrology and XRD (Bein, 2016; this study). Note: no TIR data was available for Dalby 1. Therefore, existing XRD data was plotted instead. Sediments in eastern Surat Basin are mainly arc derived, but changes to mixed arc-recycled orogen derived occur towards the Nebine Ridge. Mineralogy of the clastics in Mitchell 1 (Eromanga Basin) confirm change in provenance as described in the literature (Alexander and Sansome, 1996) from mainly craton derived sediments of the Hutton Sandstone, to an volcanic arc source of the Birkhead sediments. Detrital zircon geochronology is being conducted in order to test this.

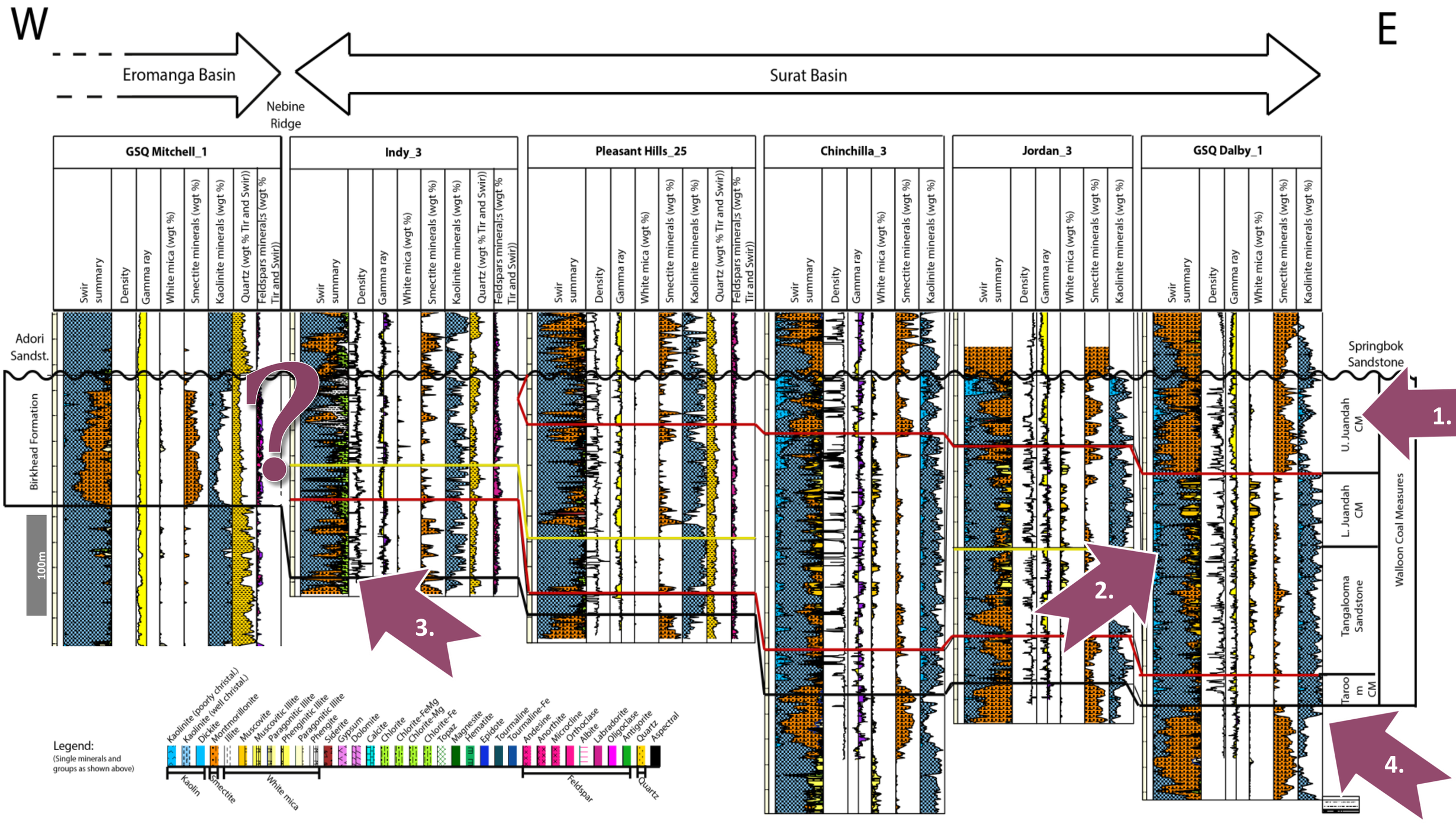


Fig. 5. Cross-section showing the results of the Hyogger scan, including a summary of mineralogy as detected by SWIR spectroscope only, Gamma-ray and density log where available, white mica content (wgt. %), smectite content (wgt. %), kaolinite content (wgt. %) and quartz and feldspar content (wgt. %), where core was scanned using the TIR system. **Note: 1**. Smectite content of upper part of the Walloon Subgroup decreases from east to west (Fig. 5) as a possible result of the differential Springbok incision, which is interpreted to be as far down as the Tangalooma Sandstone in the west of the Surat Basin (Hentschel et al., 2016; Sliwa et al., 2014; OGIA). **2.** Increased white-mica content in Lower Juandah Coal Measures in eastern wells only; but **3.** increased chlorite content in Indy 3 only (western Surat Basin); conventional sandstone petrology will be conducted to test, if chlorite is primary or secondary. **4.** Sudden increase in smectite content downhole marks boundary between Eurombah/Durabilla and Taroom Coal Measures. **5**. Mineralogical character of the Birkhead Formation is similar to Eurombah/Durabilla Formation's composition; further testing of continuity between Walloon Subgroup and Birkhead Formation is necessary.

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