

Exploring the southwest Canning Basin: GSWA Waukarlycarly 1 and the Kidson Sub-basin seismic survey

by

LS Normore and Y Zhan

Introduction

Geoscience Australia's (GA) Exploring for the Future Initiative is a four-year program (2016–20) focused on Northern Australia, to gather new data and information about the potential mineral, energy and groundwater resources concealed beneath the surface. As part of this initiative, two major projects have investigated the southern Canning Basin in northern Western Australia. The initial phase, co-funded by the Geological Survey of Western Australia's (GSWA) Exploration Incentive Scheme (EIS), was the acquisition of a deep crustal seismic survey across the southern Canning Basin between the middle of June and late August 2018 to better understand the subsurface geology of this underexplored region. The second phase of this program, funded by GA, was the deep stratigraphic drillhole, GSWA Waukarlycarly 1, located along the Kidson Sub-basin seismic line within the Waukarlycarly Embayment.

Kidson Sub-basin seismic survey

The Kidson Sub-basin seismic survey is the longest continuously acquired seismic line in Australia, running 872 km from Kiwirrkurra near the Western Australian/Northern Territory border to Marble Bar in the eastern Pilbara (Fig. 1). Prior to the survey, a vast area of the southeastern Canning Basin was very poorly covered by seismic data, compared to other parts of the Canning Basin, and consequently was one of the least geologically understood potential hydrocarbon provinces in onshore Australia. The nature of the basement beneath the basin was also inadequately understood. The main objectives of the survey were to:

- establish the subsurface geology of the Kidson Sub-basin and other components of the southern Canning Basin, including the extent and nature of sub-basin boundaries and troughs
- identify regional faults, folds and other structural elements
- image the structure of the basement below and adjacent to the southern Canning Basin, including the extent of major tectonic units such as the Centralian Superbasin, the west Arunta Orogen, the Paterson Orogen and the Pilbara Craton, and the nature of their boundaries.

Geokinetics Inc. (now SAExploration [Australia] Pty Ltd) was contracted as the project operator to carry out data acquisition and Velseis Pty Ltd undertook the data processing.

The final survey data is good quality, particularly in the Kidson Sub-basin, showing continuous parallel reflectors across the depocentre and faulting near the basin margins (Fig. 2). Constraints from nearby petroleum exploration well Kidson 1, as well as projections from more distant offset wells including Frankenstein 1, Patience 2, Wilson Cliffs 1 and Contention Heights 1, will shed light on the Paleozoic stratigraphy and depositional history of the southeast Canning Basin during ongoing detailed interpretation.

Data from the Kidson Sub-basin seismic survey are available for download through GSWA's petroleum database, WAPIMS (www.dmirs.wa.gov.au/wapims), including the seismic report, navigation, SEG-Y in time and depth domains, and velocity profile.

GSWA Waukarlycarly 1 stratigraphic drillhole

Stratigraphic drillhole GSWA Waukarlycarly 1 began drilling on 1 September 2019 in the Waukarlycarly Embayment, southwest Canning Basin, reaching a total depth of 2680.53 m on 30 November 2019. The drilling was conducted by Perth based DDH1 Drilling with InGauge Project Engineering and Well Management providing the Drilling Management Services. Access to the site was from Port Hedland via Marble Bar or alternatively through the Metals X Nifty Copper Minesite airstrip. Pason Australia provided live online data of drilling parameters and mudgas. The main objectives of the stratigraphic drilling include:

- correlation of seismic reflectors and their corresponding stratigraphic horizons across the southern Canning Basin
- continuously coring through the entire Canning Basin stratigraphy
- obtaining 100 m of core from the pre-Canning Basin basement
- acquisition of downhole geophysical surveys, including a standard suite of wireline logs and a vertical seismic profile.

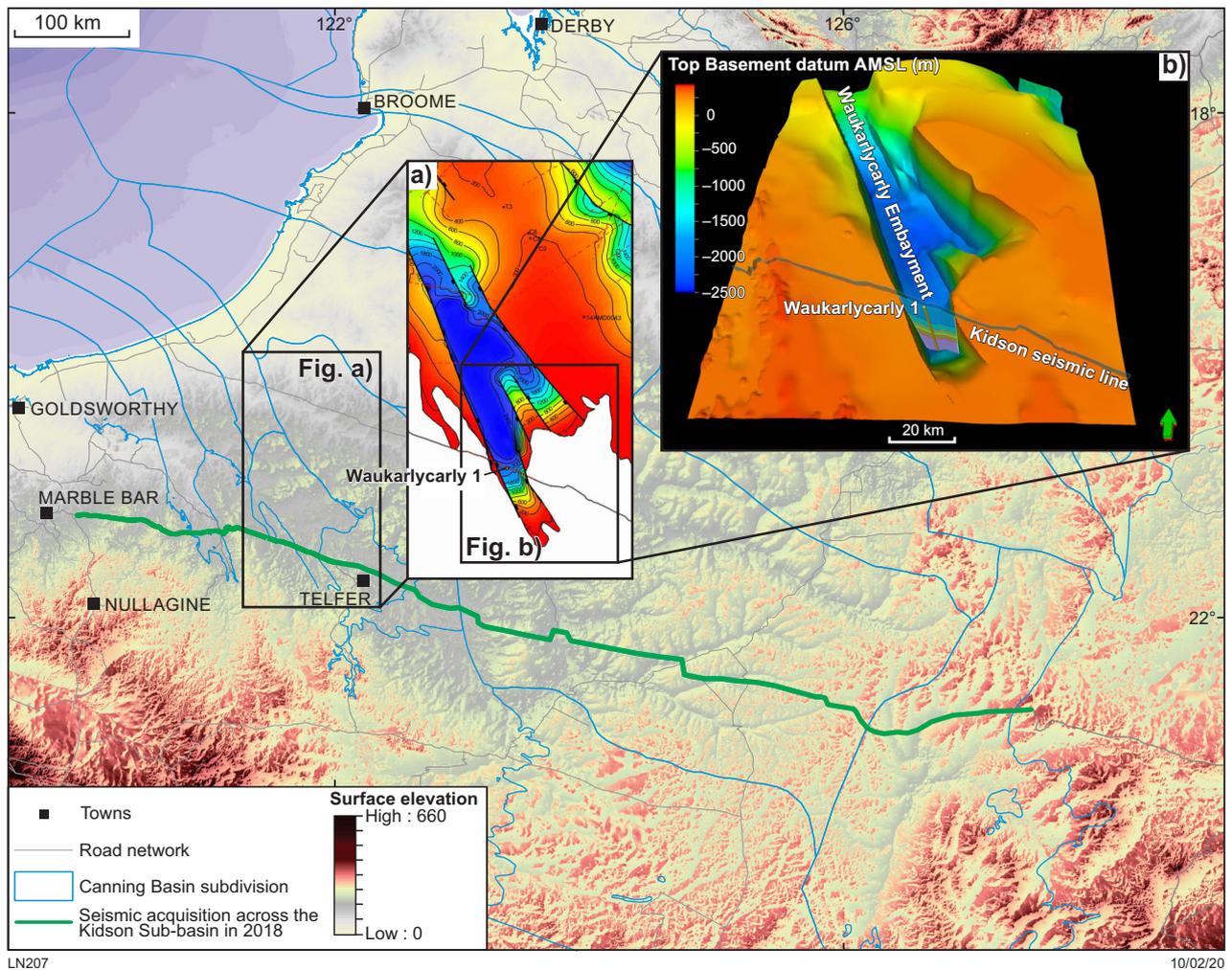


Figure 1. Regional map showing location of the Kidson Sub-basin seismic line with insets: a) depth to basement map (metres) of the southwest Canning Basin showing the location of GSWA Waukarlycarly 1 in the southern Waukarlycarly Embayment along the Kidson seismic line and H96-01. White dashed lines are 2D seismic lines. Modified after Zhan (2018); b) oblique 3D model of the depocentre of the Waukarlycarly Embayment showing the proposed well site. Arrow points north. Abbreviation: AMSL, average mean sea level

The Waukarlycarly Embayment was selected as the general location of the stratigraphic drillhole primarily due to the complete lack of pre-Permian subsurface geological knowledge in this area. A number of additional factors helped define the exact location of the drillhole, including an existing cleared area, available water bores, established stakeholder engagement in the area and budgetary limitations on final total depth.

Well design

The final well design consisted of a top-hole rotary-drilled interval to 580 m followed by a continuously cored section to a total measured depth of 2680.53 m. The rotary-drilled section was broken into three stages, starting with a 311 mm (12¼")-diameter hole down to 23.63 m, followed by a 216 mm (8½")-diameter hole to 218.00 m and finally a 156 mm (6⅞")-diameter hole to 580 m. For well control safety a blow out preventer (BOP) was installed after the 216 mm-hole section; however, the selected site was chosen so the well did not intersect any potential structural hydrocarbon traps as interpreted from the Kidson Sub-basin seismic line. Cuttings were collected at 3 m intervals over the 580 m-long rotary-drilled section.

There were three stages of continuous coring to total depth (Table 1); SQ core from 580 to 727.10 m (147.10 m length), PQ core from 727.10 to 1602.00 m (874.90 m length) and HQ core (e.g. Fig. 3) from 1602.00 to 2680.53 m measured depth (1078.53 m length).

All the primary objectives of the GSWA Waukarlycarly 1 stratigraphic drillhole were successfully achieved. Each core tray was photographed dry, wet and under ultraviolet light as soon as possible after core reached the surface, utilizing the specifically designed facilities of the DDH1 'GeoShack' (Fig. 4). The full core and cuttings were analysed using the GSWA HyLogger-3 at the Perth Core Library. The GSWA Waukarlycarly 1 basic data, Well Completion Report will be released in the second quarter of 2020. A number of post-well analyses are planned, including organic and inorganic geochemistry, geochronology, routine core analysis and various paleontological studies prior to the release of the interpretative Well Completion Report and a Digital Core Atlas.

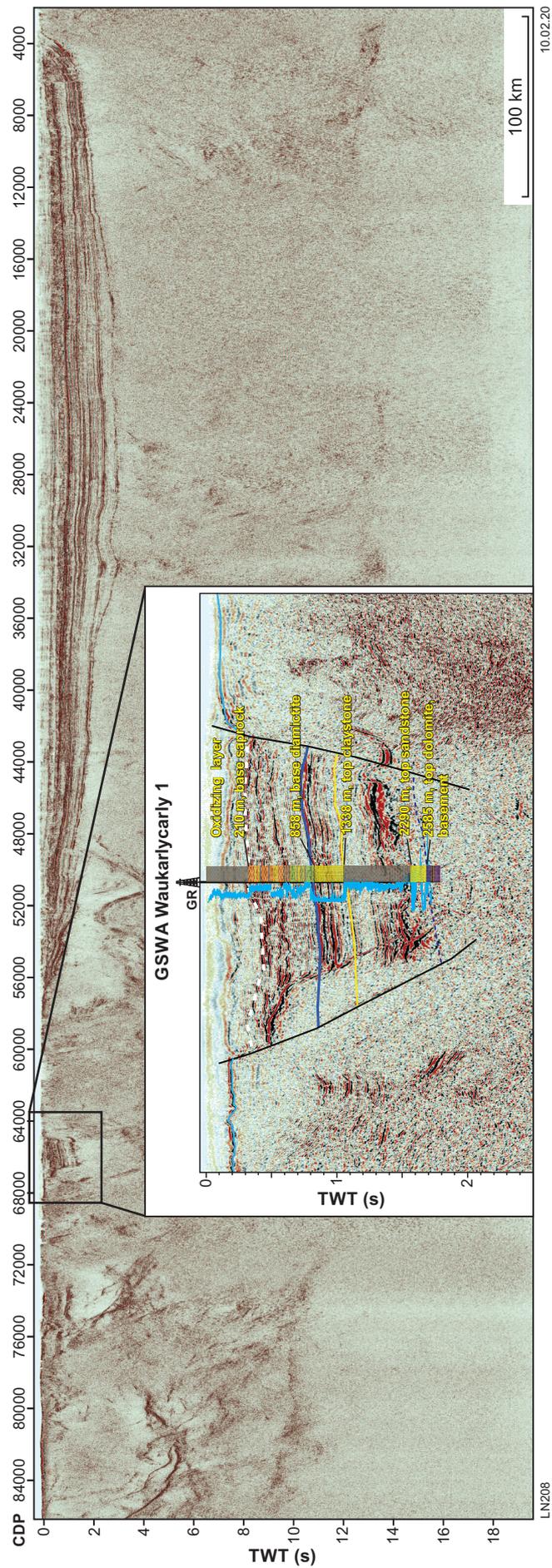


Figure 2. Kidson Sub-basin seismic line with inset of Waukarlycarly Embayment seismic section. Abbreviation: SP, shot point

Table 1. Cuttings and core recovery

<i>Drill type</i>	<i>Sample</i>	<i>Hole diameter</i>	<i>Depth from (m)</i>	<i>Depth to (m)</i>	<i>Recovery</i>
Rotary	Cuttings	12¼"	0	23.63	21.00
Rotary	Cuttings	8½"	23.63	218.00	194.37
Rotary	Cuttings	6⅝"	218.00	580.00	362.00
Core	SQ core	5¾"	580.00	727.10	147.10
Core	PQ core	4½"	727.10	1602.00	874.90
Core	HQ core	3½"	1602.00	2680.53	1078.53



Figure 3. Fresh HQ size diamond drill bit with DDH1 Drilling's ER01 rig in the background



Figure 4. Core ready to be photographed and processed in DDH1 Drilling's GeoShack

References

Zhan, Y 2018, A seismic interpretation of the southwestern Canning Basin, Western Australia: Geological Survey of Western Australia, Report 178, 34p.