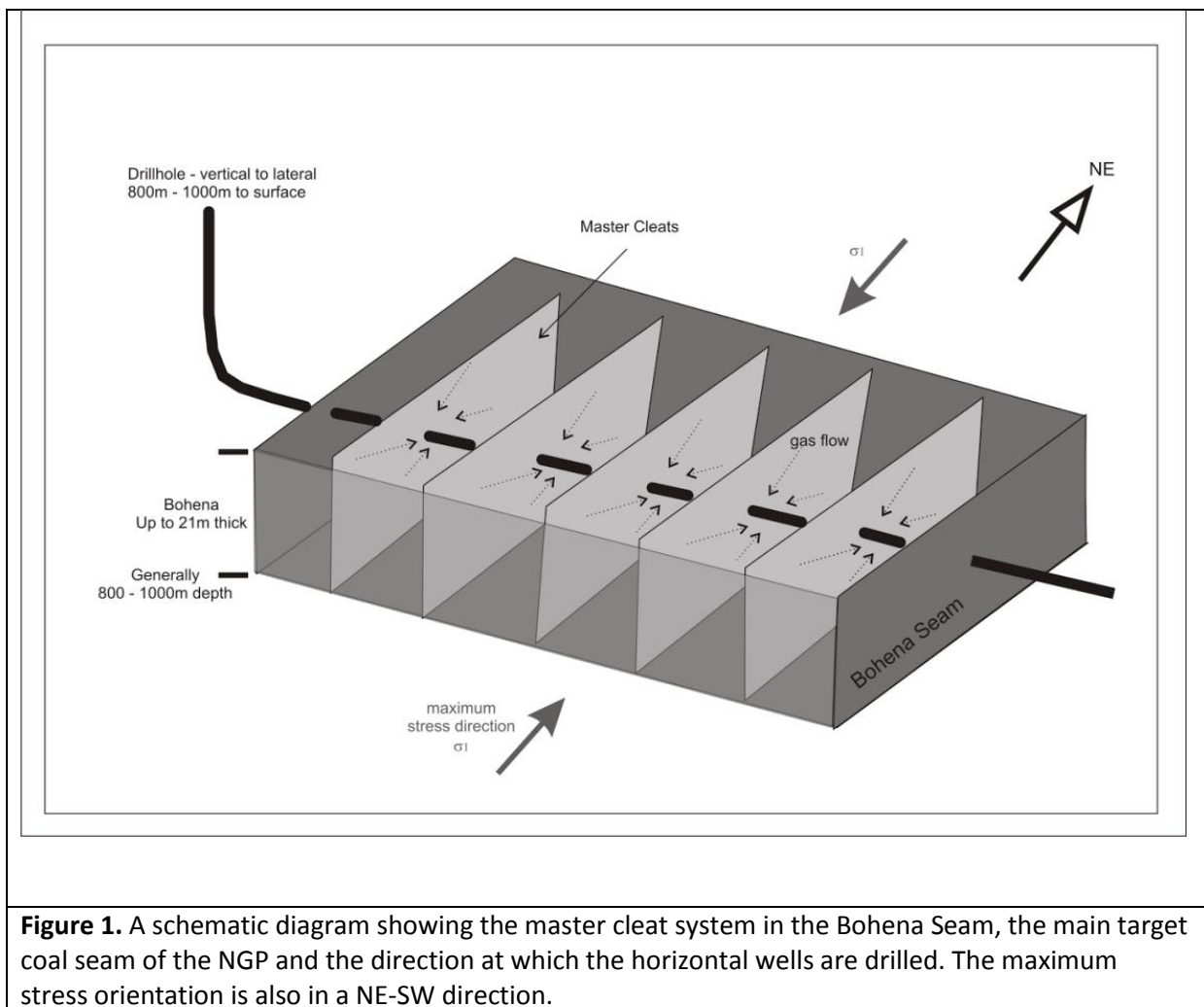


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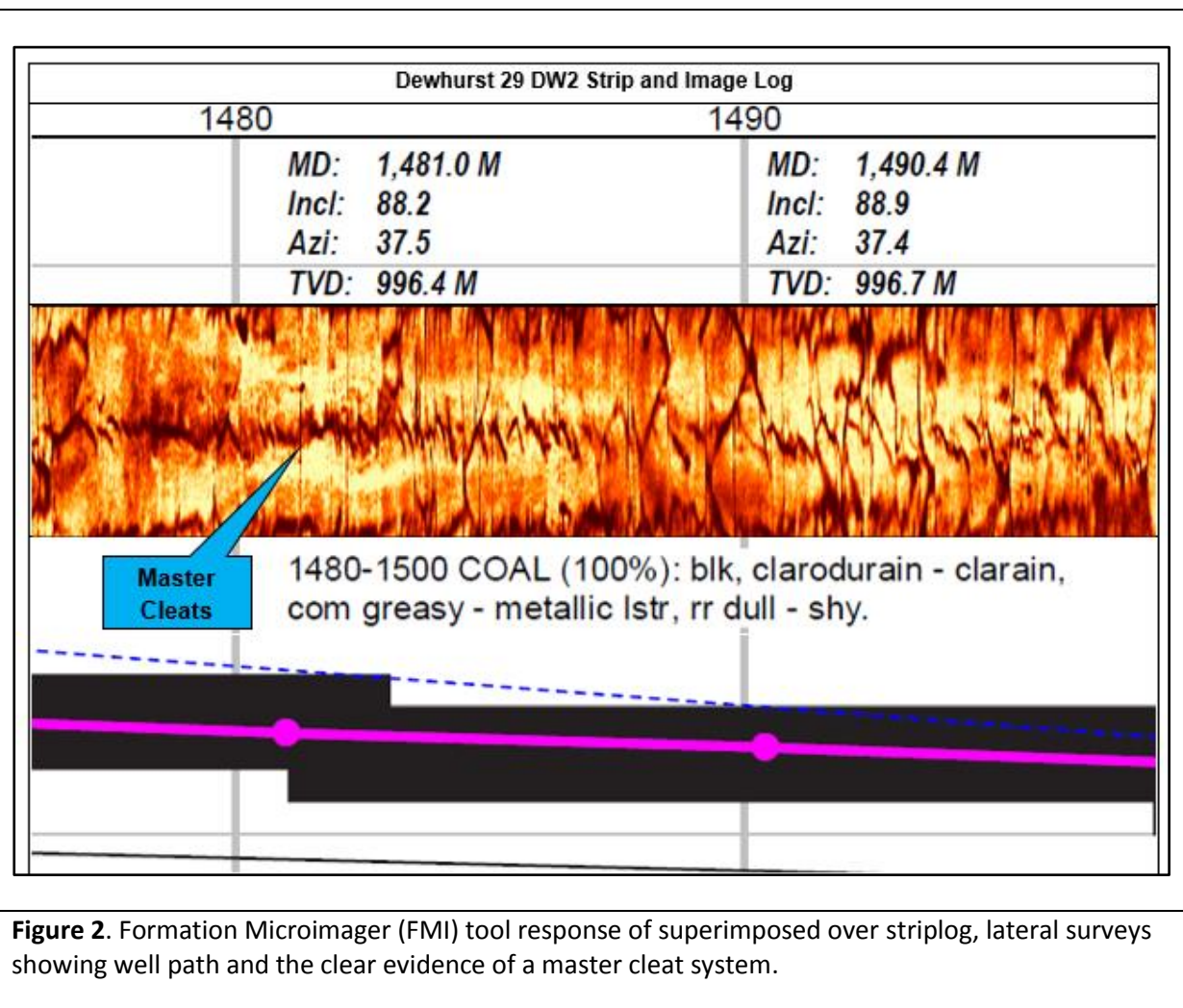
Subject Narrabri Gas Project: Resource Assessment - Appendix A

The main target coal seams in the NGP have an unusual master cleat system that creates a naturally occurring directional permeability that can be successfully used to realise commercially viable production of coal seam gas (Figure 1). The key to successful gas extraction is to drill horizontal production wells perpendicular to master cleat orientation.



The master cleat system in effect acts as gas gathering structures whereby they provide a pathway, with a very large area, for gas to flow from the coal into the horizontal well and then to the surface. The main orientation of this cleat system, over a large part of the NGP, is also sub-parallel with the maximum stress direction. This has the effect of producing a dilating effect on the cleats thereby having a positive effect on the permeability of the cleats.

The master cleat system is imaged in horizontal wells using a Formation Microimager (FMI) tool (Figure 2). The cleats are typically 0.5m to 1m apart, long and relatively continuous vertical fractures. The measured permeability of the reservoir in a vertical well was approximately 10md or less, which is considered relatively low. However, in a lateral well that intersects the master cleat system, the permeability is measured at up to 300md which is considered very good. These permeability data illustrate the presence of the directional or anisotropic permeability related to the master cleats.



Well type and history

Table 1 contains a summary of wells drilled within the NGP area as reported to DRG. The data in table 1 show that early in the project, vertical wells were fraced to enhance gas flows, however the results were generally poor.

The introduction of horizontal drilling in 2009 proved very successful in generating commercial gas flow rates and subsequently no further fracing was trialled.

Vertical Wells Drilled	Horizontal Wells Drilled	Wells Fraced	Year	Activity
11			1998	First CSG well drilled by Eastern Star Gas
2		6	1999	
1			2000	
			2001	
			2002	
			2003	
4	1	4	2004	First horizontal in-seam CSG well drilled and fraced (Bohena 4L)
			2005	
9		9	2006	Last CSG wells fraced (Bibblewindi 9-spot pilot wells)
7			2007	
5			2008	Commenced drilling first series of horizontal wells as part of Bibblewindi East and West Pilots, Tintsfeld Pilot and Dewhurst Pilot
22	60		2009	
6	10		2010	
3			2011	
			2012	Commenced drilling series of horizontal wells as part of Dewhurst North and South Pilots. Last CSG wells drilled by Santos in 2014.
3			2013	
14	2		2014	
			2015	
			2016	Narrabri Gas Project DA and EA Submitted
			2017	
87	73			
160				

Table 1. A summary of the history of drilling within the NGP area, showing a number of wells, well type and completion method.