

# CSG/CBM Directional Drilling: Evolution And Lessons Learnt

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## Introduction

**D**irectional drilling in coal has been used in Australia since 1995, however its use only became widespread from 2002. Since then its growth has been rapid, and lessons are often being learnt by new operators or contractors attempting the art. Given that the definition of directional drilling is *intentionally deviating a wellbore from the path it would naturally take*, then we shall consider all types of directional drilling, from deviated vertical wells to horizontal sections.

This article attempts to compile the evolution and lessons learnt from directional drilling in coal in Australia and to provide the reader with a basic understanding of the advantages and limitations of directional drilling.

## History of directional drilling in Australia

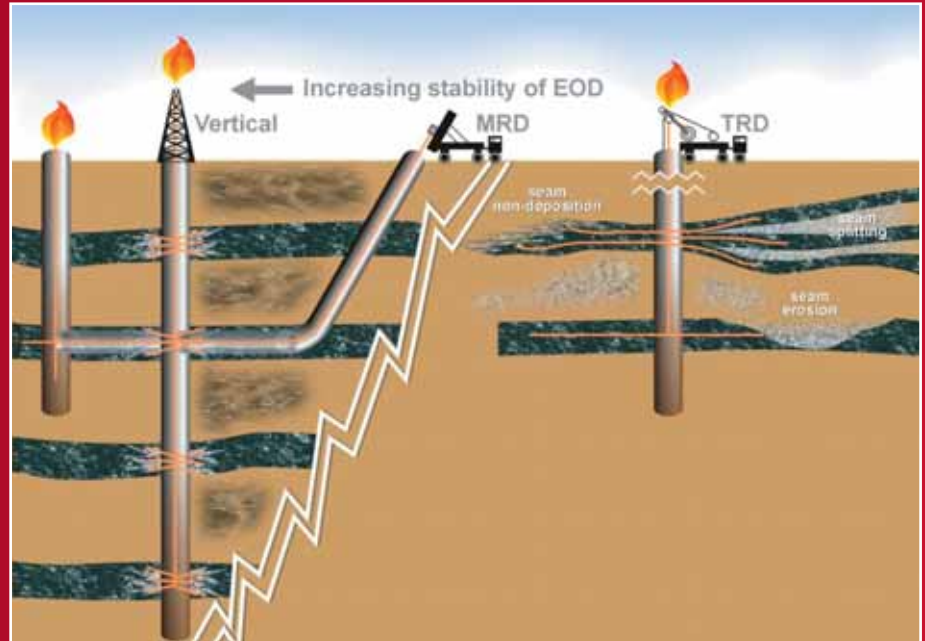
Surface directional drilling rigs were introduced into Australia in the late 1980s by Andy Lukas (of AJ Lucas) for a job at Appin Colliery in a joint venture between Occidental and AGL to test the effectiveness of the then new technology. The business continued with directional drilling: the first horizontal directional drilling (HDD) job performed by AJ Lucas was duplicating the oil pipeline under the taxiway at Sydney Airport for Caltex. Market interest in HDD began to grow and continued into river crossings as Telstra, known at the time as Telecom, rapidly expanded its fibre optic network. Competitors joined the market in the early 1990s.

Pontil, later Major, embarked on lateral CBM drilling at Moura in 1995 for BHP Seamgas. Initially the work was performed to pre-drain methane ahead of mining, but was later changed to CSG production and led to the first gas piped to market in Gladstone.

Directional drilling continued to grow via the HDD market, but the CBM/CSG market was seen as a curiosity by many until 2002.

## Advantages of directional drilling in coal

Directional drilling in coal carries a number of advantages:



Selecting a drilling and completion strategy: directional drilling is only one of a number of drilling and completion strategies.

- Reduced environmental impact (more drainage area per well);
- Less surface infrastructure due to more concentrated operations;
- Simplified land access;
- Better exposure to overall gas reservoir;
- Geological reasons (faults, structures, etc);
- Access to optimal coal cleating orientation;
- Ability to tap into lower permeability areas; and
- Rigs can be smaller and easier to move, not traditional larger oilfield-type spread.

## Making directional drilling work

There are three golden rules to be remembered when considering directional drilling in coal:

- Coal/CSG exploration, drilling, production and workover is a system and must be treated as such;
- The overall gas production result is a function of how successfully all parts are executed; and
- Any damage as a result of any part of the work will affect the final result.

To make directional drilling work you need to obtain fundamental inputs, create outputs, design wells, and source equipment and

personnel. The fundamental inputs are a geological model, a permeability model, a gas-in-place model and a standing water level model.

The necessary outputs are:

- A complete geological model including:
  - Coal seam thickness contour map; and
  - Structures (faults) both known and suspected
- A gas-in-place contour map; and
- Hydrogeology/water reservoir map, including potential recharge direction.

Well planning is an iterative approach where one change affects other parts of the drilling program. A principal design should be created and as many iterations as necessary should be performed to finalise all answers and understand all risks and limitations. Well planning is dependent on strong fundamentals for good results, and each field must be designed individually because of the variability of coal reservoirs. In addition, vertical wells, both normal and deviated, are generally used until the primary geological model is proven. However, 3D seismic may improve confidence to use lateral techniques earlier.

## Limitations of directional drilling

Given that CSG/CBM drilling is mostly a logistics exercise because the wells are drilled so fast, the rig spread and personnel must be efficient in all aspects to achieve commercial viability of a project. Bigger is not always better, and rigs should be sized appropriately to avoid high costs.

There are physical 'break points' that exist at around 1,700 m TD and 2,800 m TD due to drill pipe limitations, principally the onset of pipe buckling, which often means that a larger rig is required.

Directional drilling in coal is not an exact science yet, with interpretation 'on the fly' still required for best results.

Primary limitations are:

- Gamma sensors used for geosteering require a strong transition to 'see' more than 500 mm from the sensor towards the floor or roof interface;
- High ash coal will reduce gamma sensitivity, sometimes making it unusable for geosteering;
- Survey stations carry accumulated error. This error cone gets bigger the further you progress downhole until you 'range' at or near a vertical well. This affects position confidence; and
- Geomodels are a series of assumptions between known points. Directional drilling tests every one of those assumptions.

## Management of downhole risk

While the very best management is management itself, it is strongly suggested that a trigger action response plan (TARP) or a decision tree be jointly developed before the job starts, with input from the drilling and service companies to:

- Decide how long you will spend:
  - Exploring;
  - Fishing for stuck/bogged equipment;
  - Branching and cutting off; and
  - Attempting to intersect a vertical well
- Decide how you will treat tooling failures:
  - Broken or damaged BHA components; and
  - Steering tool signal issues/failures.

## Key lessons learnt

- Drilling forms only part of a project's success rate, but it is often blamed for many 'failures';
- Accept that any geological model will contain errors and have contingencies to deal with variances when they appear;
- Do everything possible to minimise formation damage:
  - Understand your mud programme;
  - Use control balance drilling where appropriate;
  - Keep the drilling time to a minimum; and
  - If there is drilling overbalance, trade off well length for reduced 'time in hole'
- Don't try to use oil and gas thinking in CBM. CBM is different and requires different thinking;
- Understand and exploit rig capacity versus cost for your project;
- Find and use people experienced in CBM drilling in the areas of:
  - Geological and reservoir evaluation; and
  - Drilling and completion
- Be prepared to experiment:
  - Try different drilling and completion techniques;

- Continually update your plans based on real data, not assumptions; and
- Always have a backup plan. Things always go wrong when you need it least!

## Observations and next generation development

For CBM/CSG production, drilling plays a crucial part in the success of the gas production, and how the well is drilled has a far greater affect on final production than traditional oil and gas reservoirs. Even though current CSG gas development is concentrated via vertical wells in high gas areas, such as the Fairview fairway, an increasing requirement exists for directional drilling expertise, as the easily developed high gas areas will be drilled and producing in the next five years. There are plenty of commercially viable lower gas areas or deeper reservoirs existing in Australia and these benefit the most from directional drilling to enable cost-effective production.

Directional drilling in coal has reliably reached 2,500 m TD and managed pressure drilling of coal, pioneered by Lucas, is rapidly developing as an accepted improved method of directional drilling. Lucas has recently completed engineering work for a 4,000 m directionally drilled well and is negotiating for a trial site.

Batch production-style directional drilling will be developed and will rise in importance as the full impact of LNG plant gas requirements become clear, thus dictating the large numbers of wells needed to supply CSG feed stock. Environmental concerns surrounding water production and treatment are becoming more important and further favour directional drilling so that treatment plants can be concentrated in one area.

Over the coming years partial equipment automation will improve repeatability and cater for reduced skilled personnel. ■

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