iesc
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fact sheet

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Subsidence from longwall coal mining

What is subsidence?

Subsidence is a localised lowering of the land surface. It occurs when underground voids or cavities collapse, or when soil or geological formations (including coal seams, sandstone and other sedimentary strata) compress due to changes in moisture content and pressure within the ground.

What is longwall mining?

Longwall mining is currently the main method of underground coal mining in Australia. It is safer and more efficient than other underground coal mining methods, and it involves extraction of large rectangular panels of coal by progressively shaving slices of coal from the longwall face, under the protection of hydraulic roof supports (Figure 1).

This method removes all of the coal from the longwall face, and allows the roof and overlying rock to collapse into the void left behind. The coal is collected on a conveyer and transported to the mine's processing facilities.

Where does longwall mining occur in Australia?

Most longwall mining occurs in the coal basins of New South Wales and Queensland. Mining depths are often between 200 and 600 metres below ground surface in New South Wales, and usually at a shallower depth in Queensland.

How does longwall mining cause subsidence?

As coal is excavated the weight of the overlying ground originally supported by the coal becomes supported only by the remaining pillars or walls. This causes the mine void walls to compress and the overlying rock to crack and tilt into the void. In longwall mines, the rock immediately above the void typically collapses into the void as mining progresses, forming a layer termed a 'goaf'.

Subsidence at the ground surface occurs as underlying strata collapse into the void, and compaction of the goaf, overlying rock and

Figure 1. View of coal shearer and hydraulic supports along a longwall face. Source: MSEC, 2007.

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retained walls and pillars occurs (Figure 2). The ground at the surface subsides vertically and, at the edges of the subsidence zone, it tilts and moves horizontally towards the centre of the zone.

Groundwater is also extracted during mining operations, which reduces groundwater pressures in the overlying and surrounding rock and may allow for some compression of materials to occur as they lose water.

How much subsidence occurs?

The amount of subsidence above a deep longwall mine is typically 1 to 2 metres, but could be 2 to 3 metres for a thick seam mined at shallow depth (Holla and Barclay, 2000). The Southern Coalfield of New South Wales has experienced subsidence of up to 1.8 metres (Jankowski et al, 2008). The main factor that governs the amount of observed subsidence is the extracted coal seam thickness (Australian Government, forthcoming). Other factors include mine geometry, depth to the mine, and geological conditions. The main geological condition that affects subsidence is the proportion of thick sandstone and conglomerate layers in the strata above the mine, which can act as a 'bridge' to reduce the amount of subsidence that occurs at the surface.

When does subsidence occur?

Most subsidence from longwall mining occurs within a few days after coal extraction. Final compaction of collapsed strata, and subsidence at the surface, generally occurs

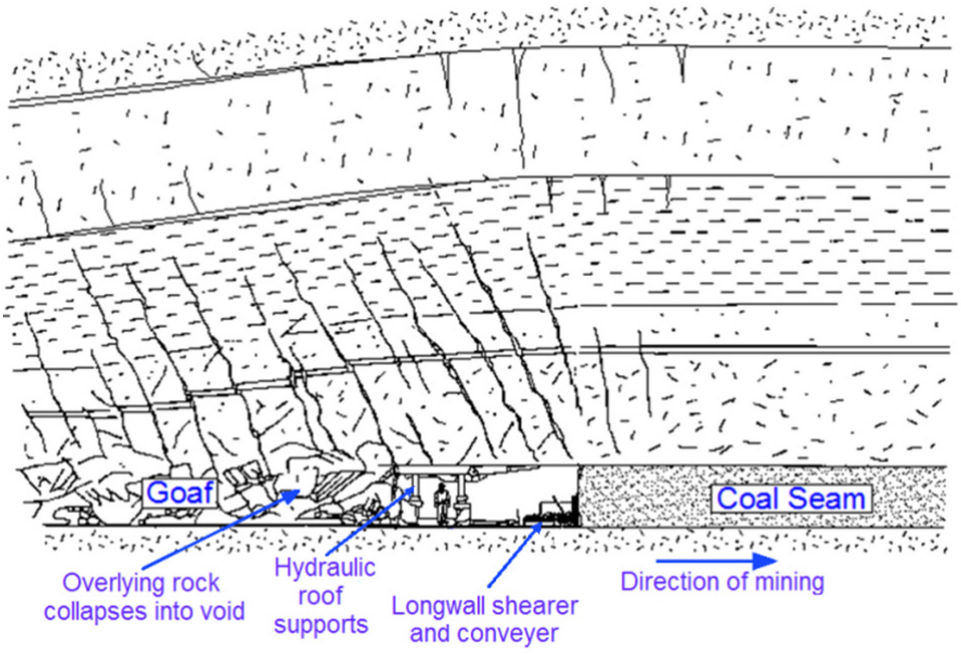

Figure 2. Mechanism of subsidence in longwall mine. Source: MSEC, 2007.

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within 1 to 2 years (Australian Government, forthcoming).

What are the potential impacts of subsidence?

Subsidence may cause:

- structural damage to buildings and services (including pipelines, and sewers), and reduced serviceability of roads and railways;
- surface cracking, especially in areas towards the edges of subsidence zones;
- fracturing and vertical drainage of groundwater from shallow aquifers, reducing the water available to springs, peat swamps; and other ecosystems; and
- surface water diversion, reducing the water supplied to features such as streams, lakes and peat swamps (NSW DoP, 2008).

How is subsidence due to longwall mining predicted?

Measured and recorded subsidence at existing coal mining sites is used to predict the likely magnitude of subsidence from new and proposed longwall panels. Numerical modelling tools are also available to assist with predictions of subsidence, but are considered to be less reliable than the 'experience-based' empirical methods.

How is subsidence due to longwall mining measured?

Subsidence monitoring is undertaken during mining using a range of measurement techniques, including ground surface surveys, airborne and satellite based techniques, and underground monitoring of ground movements (Dunnicliff, 1993). Ground surveying using global positioning systems is currently the most common technique used in Australia. However, satellite-based techniques are becoming increasingly accurate and cost-effective. A combination of different monitoring methods is often used.

How can subsidence impacts due to longwall mining be minimised?

Mining layouts are typically designed to minimise subsidence. Designs are based on information from geological investigations, physical testing of the ground, and computer modelling of subsidence. By retaining strategically located pillars of coal or reducing the width of the longwall panel, increased support of the overlying ground is provided and subsidence can be reduced (Hanson 1988-1989). Mine sites can also be located and designed to avoid important environmental and heritage assets, and infrastructure.

How are the impacts of subsidence regulated?

In New South Wales, underground mining lease holders are required to prepare Subsidence Management Plans (SMPs) to predict potential impacts of underground operations and identify how important natural and built features are to be managed. Management may involve the avoidance of damage to particular features, mitigation of damage, or rehabilitation of subsidence related impacts.

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The New South Wales *Mine Subsidence Compensation Act (1961)* provides for compensation or repair services where damage to 'improvements' occurs from coal mine subsidence. The Act is implemented by the New South Wales Mine Subsidence Board, which is responsible for reducing the risk of mine subsidence damage to properties by assessing and controlling the types of buildings and improvements which can be erected in Mine Subsidence Districts.

In Queensland, the *Environmental Protection Act 1994* requires that subsidence predictions and impact mitigation measures are developed prior to mine development approval (Australian Government, forthcoming). The Queensland government also administers the Abandoned Mines Lands Program, which provides compensation to home owners affected by collapses of old collieries in the city of Ipswich.

Future directions: knowledge gaps and strengthening the science

Australian research into subsidence has focussed heavily on the coalfields of New South Wales, and especially those of the Sydney Basin. A greater understanding of subsidence in other regions where longwall coal mining is proposed may assist in developing more tailored management approaches to suit local conditions.

The Australian Government Department of the Environment has initiated studies on tools and approaches for predicting, monitoring and managing subsidence from coal mining, and investigations into water-related issues, including impacts on peat swamps.

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