

# MINE SAFETY INSPECTORATE

INVESTIGATION INFORMATION RELEASE

## High potential incident

<b>Incident date</b>	2 August 2016
<b>Event</b>	Strainburst: E26 sublevel cave (SLC) ore drive 8
<b>Location</b>	Northparkes Mines

### Overview

Following routine firing of a development heading (9740 sublevel ore drive 8) at 6 pm on 2 August 2016 at Northparkes Mines, the re-entry crew saw that a rockfall had occurred about 10 m back from the fired face. The supervisor was notified, who inspected the scene and reported the rockfall to the coordinator and superintendent. All operations in the sublevel cave (SLC) were immediately suspended and the mining manager, operations superintendent and geotechnical engineer inspected the area.

No people were in the area at the time and no injuries resulted from the rockfall.

Figure 1: Strainburst from the left shoulder and resulting rockfall.



## The mine

Northparkes Mines is located in the Central West region of NSW, 27 km north west of Parkes. The mining methods used at Northparkes Mines are block cave, sublevel cave and previously open cut mining.

Ore production at Northparkes Mines is from two underground orebodies, E26 sublevel cave (SLC) and E48 block cave. Ore is crushed underground, hoisted to the surface and conveyed to the processing plant.

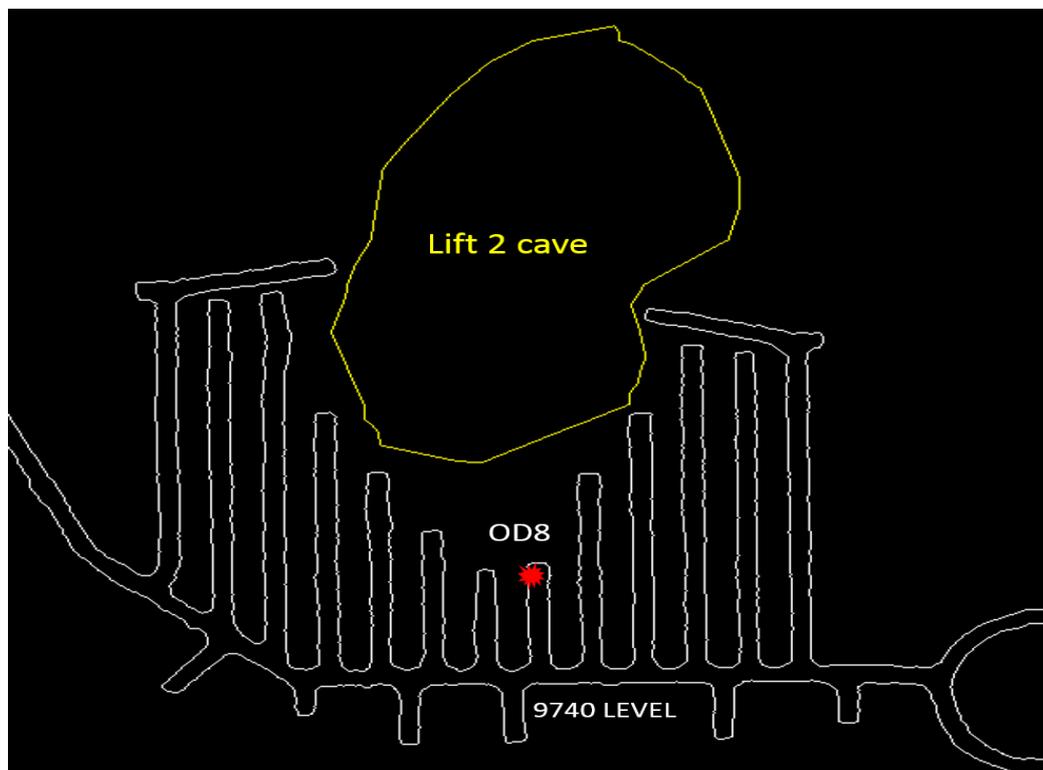
The mine production was 6 million tonnes in 2015.

## The incident site

The incident site was ore drive 8 on the 9740 sublevel cave (SLC) shown in Figure 2. Ore drive 8 is a 5.0 m wide x 4.8 m high drive that was used to excavate 42 m through normal drill and blast practices. The previous 24 hours saw the heading excavated 6 m and at the time of the incident the heading was being fired for the next 6 m excavation (2 x 6 m firings in 24 hours).

The strainburst incident site was 10 m back from the face. A local magnitude (ML) 1.2 seismic event was recorded milliseconds after the face blast at 6 pm.

Figure 2: Location of incident



## The incident

At the time of the incident, the sublevel cave (SLC) was cleared of all personnel ready for blasting.

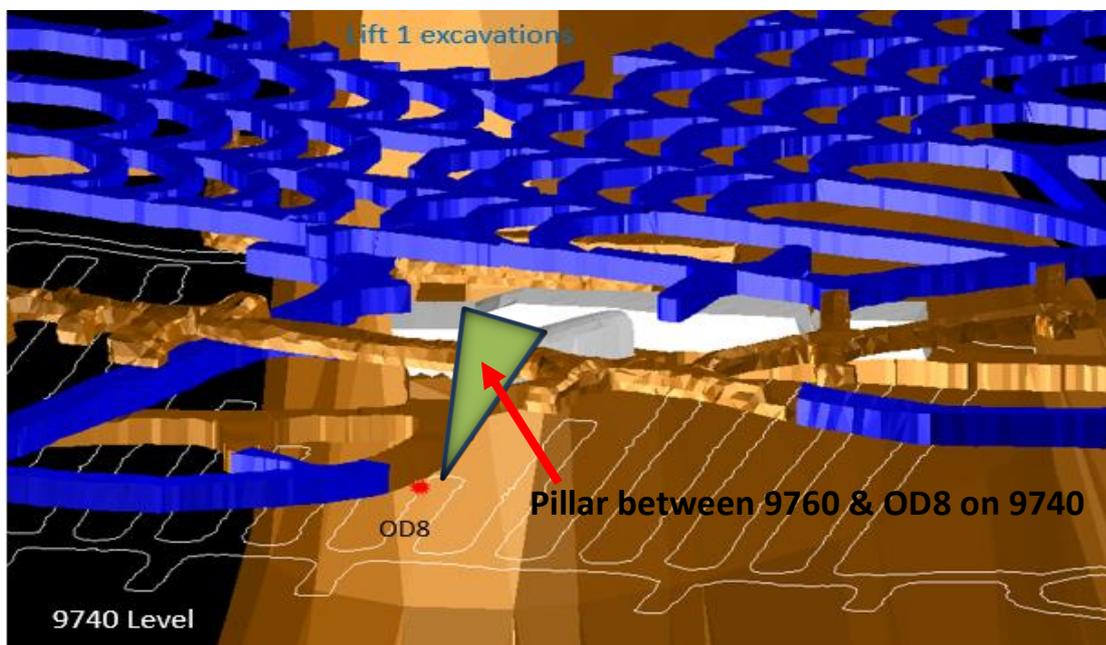
The tunnel failure resulted in the collapse of heavily fragmented material from the left (western) shoulder of the drive and some limited bulking in the side wall in front of the failure. The rockfall is shown in Figure 1. The installed support consisted of 2.4 m rock bolts and mesh. The installed rock bolts were shorter in length than the depth of the failure in the wall.

Damage of this nature is usually associated with an increment of movement on a pre-existing structure or structures. The movement causes excessive strain in the block formed by the structures and the excavation. That material then falls. The seismic event that occurred during or close to the time of the failure – in this case a local magnitude (ML) 1.2 – was a small proportion of the total energy dissipated during the failure.

In this case, there were a number of factors that would have contributed to the initial loading and ultimate nature of failure:

- The general area would be expected to have increased stress due to the proximity of the lift 2 cave to the north and the lift 1 cave above, at some stage in the excavation sequence.
- The ore drive 8 crosscut was below and just offset from 9760 development and stopes. This proximity would further concentrate stress in the 'pillar' between ore drive 8 and the 9760 drive, even though the stress in the general area might otherwise be low, due to the de-stressing effects of the cross cuts.
- The crosscuts were mined 'outside in'. This would have further concentrated stress in the 'pillar' between ore drive 8 and the 9760 drive.
- Monitoring showed high, moderate and low intensity seismicity. In this case with the most intense rock noise, associated with yield through the pillar between 9760 and 9740 levels at the failure site. This is evidence of stress concentration in the 'pillar' and rock mass yield leading up to this fall of ground.

Figure 3: Location of the pillar



Mine Safety inspectors were notified at 12:15 am on 3 August 2016 through the Central Assessment Unit. The scene was preserved and inspections were undertaken by Mine Safety inspectors and Northparkes personnel. Independent geotechnical advice was sourced.

The following corrective actions were taken:

1. The area was barricaded and the sublevel cave (SLC) was suspended for 48 hours to monitor seismicity. The incident was reported and the scene was inspected by Mine Safety, the Mining Manager, Operations Superintendent and Geotechnical Engineer.
2. The central drives (ore drive 5 to 10) were barricaded with no unauthorised entry signs.
3. A presentation was given to crews to re-emphasise the importance of rock-noise/seismicity reporting, ground awareness and changing conditions.
4. An independent review of the incident was conducted along with a ground support review and recommendations, seismicity review of data and schedule sequence.
5. Trigger Action Response Plans were developed that were specific to the sublevel cave (SLC) (Northparkes Mines previously used an existing block cave Trigger Action Response Plan).
6. The rate, cut length and stand-off times were restricted for the remaining drives to allow for stress redistribution.
7. The mine agreed to consult with other block cave mines in order to learn from others' experiences of strainburst.
8. The mine purchased and implemented a seismic analysis package that contained a strainburst hazard assessment function. The mine agreed to expand its existing system with additional geophones and introduced regular laser convergence monitoring.
9. The mine reviewed and updated its ground control management plan.
10. The mine will introduce a formal system in which the results and interpretation of daily and cumulative seismic monitoring results are discussed at an integrated, multi-disciplinary and managerial forum.
11. The mine will introduce a formal system in which ground support designs are reviewed when prevailing geological and geotechnical conditions vary from the original design parameters.

## Contributing factors

Strainburst damage is primarily related to the state of stress and the local mine's stiffness at the potential damage location and only indirectly related to the seismic ground motion.

Considering these factors, it was likely that the excavation of the crosscuts incrementally increased the load in the pillar between ore drive 8 and the 9760 drive. At some point, that pillar yielded. The additional pillar strain manifested as dilation at the surface of ore drive 8.

At this time, accurate prediction of a rock burst event is not entirely possible. Mine operators therefore need to ensure that they are aware of the most significant contributing factors associated with a rock burst event such as:

1. The stress environment being sufficiently high to result in rock failure.
2. A situation in which a state of unstable equilibrium could exist such as low friction bedding planes.
3. A change in the loading system. For example, a reduction in rock strength due to a local change in rock material or structural properties, an increase in stress associated with geological structure or decrease in confinement due to formation of one or more excavations.

4. Stored energy generated by increased depth of mining, bridging strata or geological structures.
5. Seismic monitoring, interpretation, and subsequent decision making should be made through a competent group forum as opposed to in isolation or an individual basis. The evolution of seismic activity in the area was not recognised as a potential future issue.
6. The review and amendment of all ground support designs upon knowledge of varying prevailing geological and geotechnical design parameters. Design reviews were not undertaken until after the incident.

## **Precursors and risk factors**

Precursors and risk factors of this failure can be used as future predictors of potential problem areas. In this particular case there were four previous indicators of potential issues:

1. The proximity of the overlying 9760 mRL excavations and the adverse excavation sequence.
2. The localised crown over-break of adjacent tunnels ore drive 4 to ore drive 10, inclusive, during previous work.
  - a. This was a possible warning sign of over-stressing of crowns and a good indicator of the depth of damage in the crosscuts in this location.
  - b. Excessive overbreak should always be investigated to understand the cause, so that other areas with similar conditions of stress, strength and structure can be treated properly.
3. The particular geological structure observed in the failure location.
4. The development of seismicity across the levels in the months before the failure:
  - a. The seismic record shows that the eventual failure area is at the centre of a seismogenic zone.
  - b. Such occurrences should be investigated in future, to ascertain the cause and likely demand on support/pillars in order to identify appropriate action. In this case, considering the local structure and the overbreak in adjacent crosscuts, the likely interpretation would have been ongoing weakening of the pillar, and the potential risks could then have been used to guide revised ground support selection.
  - c. Analysis of seismic data and subsequent investigation of causes will assist in the design of the appropriate ground support program.