Rockburst support in high stress areas at Brunswick Mines
Introduction of BMS

Fully owned & operated by Xstrata Zinc Canada

• The mine has been in operation since 1964 and currently produces around 7500 tons per day of ore containing (in order) zinc, lead and silver.

• The ore body consists of close to ten sub-parallel massive sulfide lenses. The length of the ore body is 1200 m in depth from surface with a width of up to 200 m.

• There is 100 km of active drifts for a total 400 km.

• The mine is divided by 7 levels and 23 active sub levels.
History of Rockburst Support

• Modified conebolts (MCB’s) have been introduced for ground support in burst-prone underground hard rock mines in Canada in the early 2000’s.

• They have quickly contributed to safer mining conditions through their ability to deform with the violently failing ground and control the extent of damage caused to excavations by severe dynamic loads.
Dynamic Support – Rockburst Support

- Modified Cone bolts and 00 Gauge straps and regular screen.
- ‘Cone’ absorbs seismic energy through the action of ploughing through resin and steel stretching.
- Used extensively at Brunswick in areas prone to seismicity and Rockbursting.
Introduction of BMS

- Very large scale of mechanical properties:
  - Dyke (UCS up to 250 MPa and SG of 2.6)
  - Sulfide (UCS up to 200 MPa and SG of 4.3)
  - Meta sediment (UCS up to 70 MPa and SG of 2.6)

- Very high stress environment
- High rate of seismic activities
Introduction Xstrata Zinc Brunswick Mine

• 1990’s – Severe regional instabilities.
• Moved to pillarless pyramidal mining.
• Paste backfill introduced.
• Development of tunnels through paste backfill.
• Destress and mass blasting methods.
• Ground support improvements with shotcrete and modified cone bolts.
• Mine wide seismic monitoring with ISS system.
We mine in high-stress conditions and therefore we generate seismicity:

- Canadian Shield – high $\sigma_H$: $\sigma_V \sim 2.5:1$
- On average in 2006 we generated 100-500 events/day; 15,000-20,000 events per year, so far this year about 200/month.
- Seismicity can cause extensive damage to drifts and costly delays to production.
- We need to understand the mechanisms in order to manage the risk.
Ground Control in a 40 y.o. Mine – Facts and Challenges

We deal with a variety of ground conditions:

- High Stress, \((\sigma_H : \sigma_V \sim 2.5:1)\)
- Low Stress, Destressed.
- Big contrast in rock properties (super stiff orebody and soft weak HW and FW).
- Very large extraction ratio – relaxation.
- Seismicity.
- Ageing Ground Support and intensely corrosive conditions (pH~2).
Modified Cone Bolt

The modified cone has a blade on the end to aid in the mixing process. It also prevents the bolt from turning while being tensioned.

The greased bar is designed to keep the resin from bonding to the bar.

The cone is designed to plow or yield through the resin matrix.

The other end consist of a dome nut, spherical seat and a 6” x 6” washer plate.
Modified Cone Bolt

- ¾” x 90” long standard length
- C/w spherical seat, regular dome nut and a 3/8” x 6” x 6” domed washer plate
- The MCB is coated with grease as a debonding agent.
Burst Simulation
Burst Simulation
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Mine Mesh Strap

- 12” x 7’ or 10’ 4” x 4”,
  - 0/0 gauge (.305 nominal)
- The mines mesh strap links the surrounding bolts to provide added strength and resistance in the event of a rockburst.
- The strapping can be installed radially or longitudinally around the opening or a combination of both.
EXAMPLE OF A GOOD INSTALLATION!

CORRECT OVERLAP (3 SQUARE OF STRAP!!!)

Conebolt in the good square 2 x 2
Distance OK between 00 gage straps?

Split set?

Good overlap of mesh strap?
EXAMPLE OF A GOOD INSTALLATION!

Correct overlap

Good distance of 3 feet between straps
If this support would be challenged by a seismic event, do you think it would be effective?
EXAMPLE OF A GOOD INSTALLATION!

Correct distance between row of “Mesh Strap”
3 feet between straps

Good overlap of strap, second square, 1 foot overlap
Mine Longitudinal

Zone 19
Fall of ground in 225_8-3 DD North - approximately 300 tonnes of massive sulphides

No change to conditions in 225_8-3 DD South

The floor of the rock pillar between the 2 drill drifts heaved 1-2 ft.

The access to 225_8-3 will be closed indefinitely.

Approximately at least 15 cm of instantaneous drift closure (floor to back)
1125 2 sub Failed Shotcrete Pillar
Seismicity – Mn 3.4 Event Location

Position of drill

Mn 3.4 event plots here

Minor secondary burst in back (~4t)

Major burst which damaged back and west wall (~150-180t)
Lost Drill only 1 month old - 2000

Brow of the 326 crosscut cave, which occurred on Friday, October 13th, 2000.

The cave trapped a drill (located 40 SW of the photo), fortunately the driller was evacuated four hours before the damaging seismicity hit. The east brow of the photo is a thin meta-sediment band, the north wall of the failure a east striking joint, 70° dip (not shown)
...and Found – 2010 (10 years later)

1000-2 sub

Area completely destressed.

Increase in metal prices allowed mining of low grade stringer to the south.

While mucking the ore, the drill appeared in the drawpoint!