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Analysis of blasting damage in adjacent mining excavations

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ABSTRACT

Following a small-scale wedge failure at Yukon Zinc's Wolverine Mine in Yukon, Canada, a vibration monitoring program was added to the existing rockbolt pull testing regime. The failure in the 1150 drift occurred after numerous successive blasts in an adjacent tunnel had loosened friction bolts passing through an unmapped fault. Analysis of blasting vibration revealed that support integrity is not compromised unless there is a geological structure to act as a failure plane. The peak particle velocity (PPV) rarely exceeded 250 mm/s with a frequency larger than 50 Hz. As expected, blasting more competent rock resulted in higher PPVs. In such cases, reducing the round length from 3.5 m to 2.0 m was an effective means of limiting potential rock mass and support damage.

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1. Introduction

Yukon Zinc is a wholly-owned subsidiary of Jinduicheng Molybdenum and operates the Wolverine mine located approximately 280 km northeast of Whitehorse, Yukon, Canada, as shown in Fig. 1. The mine recovers ore from a polymetallic volcanogenic massive sulfide (VMS) deposit consisting of two ore zones on either side of a largely barren saddle zone. The Wolverine and Lynx ore zones each consist of multiple lenses with numerous cross-cutting faults. Current mining faces are accessed by a ramp extending over 200 m vertically at a grade of −15%.

The ore is relatively competent massive sulfide rock with an average geological strength index (GSI) of ~40. The ore, however, is highly fractured and faulted in some zones reducing its competence. The hanging wall is of very poor competency, consisting of argillite, which is graphitic in many regions. The hanging wall has a GSI < 20 and ~10 when encountered in graphitic form. The hanging wall has a tendency to exhibit "chimney" failure where a drift back may unravel in excess of 100% of its drilled height, especially when not blasted carefully. In contrast, the footwall is a somewhat more stable rhyolite with typical GSI ratings between 20 and 30. Nevertheless, due to the presence of clay minerals, it is very susceptible to swelling and washing out in the presence of water.

The relatively shallow dip of the ore, around 35°, precludes the use of conventional horizontal mining such as room and pillar as well as conventional vertical methods such as long hole stoping. Rather, overhand and, more recently, underhand, cut-and-fill mining is employed. Production headings are generally driven 4.5 m × 4.6 m (width × height) at a grade of 2%. When the end of the ore body is reached, paste pipes are installed and one wall is retreat-slashed. After slashing, a cemented tailings backfill (CTB) is pumped from the mill into the stope behind a shotcrete arch barricade. After filling, mining is carried out beside, over or under the paste.

The relatively heavy ground support requirements are dictated by the aforementioned poor ground conditions. Primary support consists of 8 ft regular (2.4 m) and 12 ft super (3.7 m) inflatable rockbolts with respective capacities of 12 t and 24 t. In addition, steel fiber reinforced shotcrete is used prior to bolting in some headings, while regular shotcrete is sometimes applied after bolting. Shotcrete is generally used for intersections, the main ramp, hanging wall exposure and wet footwall exposure. In cases where excavation widths exceed 10 m or ground movement is observed, 18 ft connectible inflatable bolts and/or steel sets may be installed (Shin, 2014a).

Prior to the start of vibration monitoring, instrumentation in use or previously used on site includes multipoint extensometers to measure movement at critical pillars, tilt meters to measure movement of steel arches at the main ramp and load cells to record loading at the shotcrete barricades. A recent addition to the instrumentation program is vibration monitoring carried out with a Blastmate III with a triaxial geophone. Vibration monitoring was introduced following a small-scale wedge failure at the 1150 level, which will be discussed in the next section.

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The aim of the study was to find an effective way of measuring and mitigating the impact of blasting-induced seismic waves on adjacent mining excavations. Once this process is understood, mine planning can be performed with greater confidence in the minimum required pillar distance. In the case of Wolverine, the primary goal was to verify that current blasting practices are not inducing damage in neighboring tunnels. The approach focuses on underground measurements that verify theoretical approaches derived from blasting theory and dynamic wave propagation.

The results are immediately applicable since blasting can be adjusted underground by the engineering and operations department immediately after each blast if required. In addition, precautions can be taken ahead of time if vibration monitoring indicates high or potentially damaging stress wave propagation prior to blasting safety-critical rounds.

A novel aspect of the study is that findings and results are immediately implemented at the discretion of the engineering staff in collaboration with the mining production staff. Moreover, the setup of instrumentation is performed by engineers around the production schedule and does not result in any lost production or downtime. This results in an immediate, direct benefit to operations and further encourages such research at operating mines.

2. Investigation of the 1150 level wedge block failure

Supported ground failed at the 1150 level, 10 m downdrift of a pillar to the 1160WV level on 31 January 2014. A wedge of rock slid in from the right wall which had been previously supported with 8 ft regular inflatable friction bolts rated for 12 t each. A cross-section of the failure is shown in Fig. 2.

A photograph of the wedge failure is presented as Fig. 3. The failure occurred as a result of a combination of three factors: loss of rockbolt friction resistance, separation or slip along a hidden fault plane, and blasting damage from 1160WV level. During excavation, geological mapping revealed a shallow 12° joint set which was assessed by a geotechnical engineer as having a low risk of sliding failure. The hidden fault behind the right wall was not observed during mining of the 1150 level as it was not seen in either the wall or face.

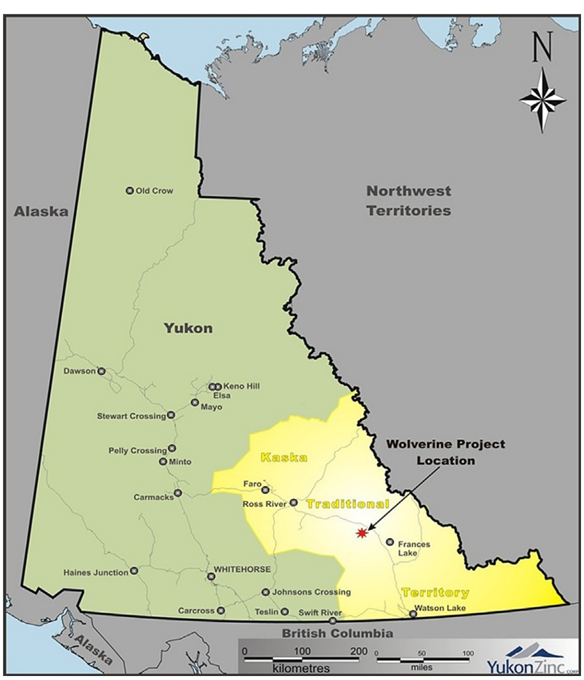

Fig. 1. Wolverine Mine in Canada (YZC, 2014).

After repeated blasting from the 1160WV level 7–10 m away, the frictional resistance of the installed rockbolts was weakened and the separation was induced at the hidden fault. A wedge was formed by the intersection of the joint set and the fault that exceeded the capacity of the installed rockbolts. The wedge then slid into the 1150 tunnel during nightshift. No one was injured.

A rehab plan was issued calling for the region to be shotcreted, re-bolted with 12 ft 24-t friction bolts and re-shotcreted. Another 50 m of the drift were bolted with two rows of the higher capacity 12 ft bolts 1 m apart along the right wall (Shin, 2014b).

The four recommendations from the wedge failure investigation were as follows:

(1) Rehab the region with shotcrete and 12 ft rockbolts;
(2) Modification of the Ground Control Management Plan to include mandatory 12 ft bolting when the slope distance between sublevels is below 10 m;
(3) Pull testing of sublevel regions to verify integrity of rockbolts following vibration damage;
(4) Vibration monitoring to determine the impact of blasting on adjacent drifts.

3. Vibration monitoring

3.1. Wolverine Mine blasting procedure

Underground blasting is carried out at the end of dayshift and/or nightshift in accordance with Part 14 of the Yukon Occupational Health and Safety Regulations. Rounds are loaded primarily with 32 mm × 400 mm Geldyne cartridges while 19 mm × 600 mm Xactex is used for perimeter control. An inert collaring agent, Envirostem, is used in production rounds with greater than 50% massive sulfide ore in the face to minimize the risk of sulfur blasts. The typical powder factor is just under 0.5 kg/t, with loading and drilling performed according to Figs. 4–6.

Note that there are 13 perimeter holes that are not loaded. The remainders of the perimeter holes, shaded in Fig. 4, are loaded with Xactex as shown in Fig. 5. Finally, production holes are loaded as depicted in Fig. 6.

Initiation is achieved with Exel down hole non-electric detonators. The down hole detonators are connected by shocktube to det cord at the face, which is initiated by two independent electric caps connected to the central blasting system. Eighteen detonator periods are available with delay periods as shown in Table 1. Other relevant blasting parameters are included in Table 2.

3.2. Vibration monitoring system

Starting in February 2014, a BlastMate III with a triaxial geophone, calibrated in December 2013, was used to collect vibration data in underground headings. While monitoring is currently ongoing on an as-needed basis, April 2014 was the cutoff for data included in this analysis. Sampling is performed at 2048 Hz over three channels corresponding to the standard orthogonal axes. A sensor check is performed prior to each data collection and the event trigger threshold is set at 8 mm/s, which was found to be about one order of magnitude below most blast peak particle velocity (PPV) while not being sensitive enough to trigger by nearby non-blasting mining activity.

Displacement, particle velocity, acceleration and frequency data are available along the transverse, longitudinal and vertical directions. The peak vector sum (PVS) is also reported for each blast

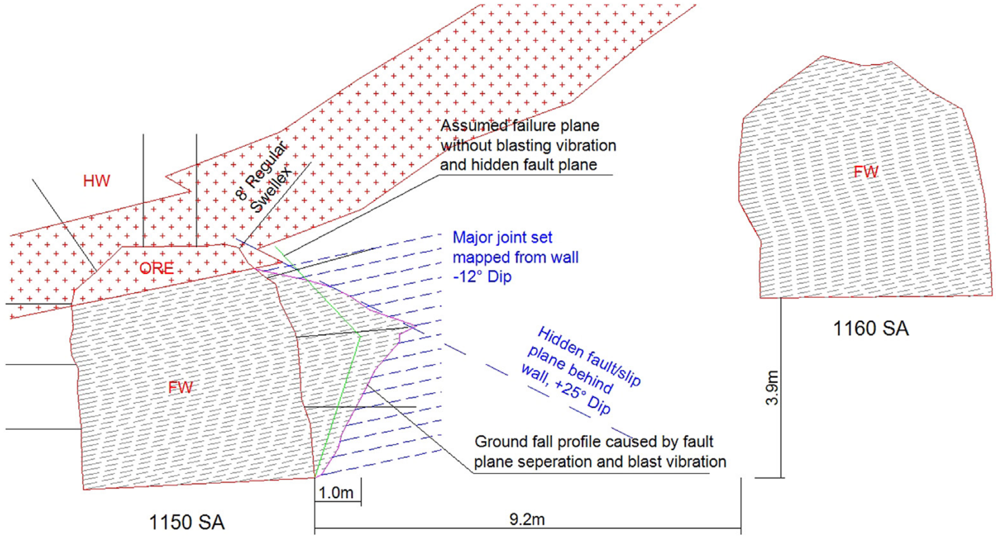

Fig. 2. Cross-section of 1150 wedge failure depicting geology, ground support and proximity to 1160WV level (Shin, 2014b). HW and FW stand for hanging wall and footwall, respectively.

as a measure of the PPV not constrained to one of the three measurement directions.

The PVS is simply defined as

$$PVS = \max\sqrt{v_{\text{axial}}^2 + v_{\text{longitudinal}}^2 + v_{\text{transverse}}^2} \tag{1}$$

For the purposes of this study, the PVS rather than any particular direction PPV is compared to the predicted PPV. The intent behind using PVS is to more accurately back calculate the factor H discussed in the next section by removing the influence of the relative orientations of adjacent excavations. It should be noted however that the peak axial acceleration and PPV are thought to induce damage in the excavation. As a result, the three directional PPVs will also be presented. It is also to be noted that the PVS does not necessarily occur at the same time as a component PPV.

Blasting damage is primarily achieved by stress wave interaction with free surfaces (ISEE, 1998). Compressive stress waves induced in rock are reflected in tension upon encountering a free surface (Kolsky, 1963; Meyers, 1994). Since rock is much weaker in tension than in compression, fracture occurs as a result of the reflected tensile stress waves (Jaeger et al., 2007). As a result, the axial PPV was used as a practical indicator of potential blasting damage and

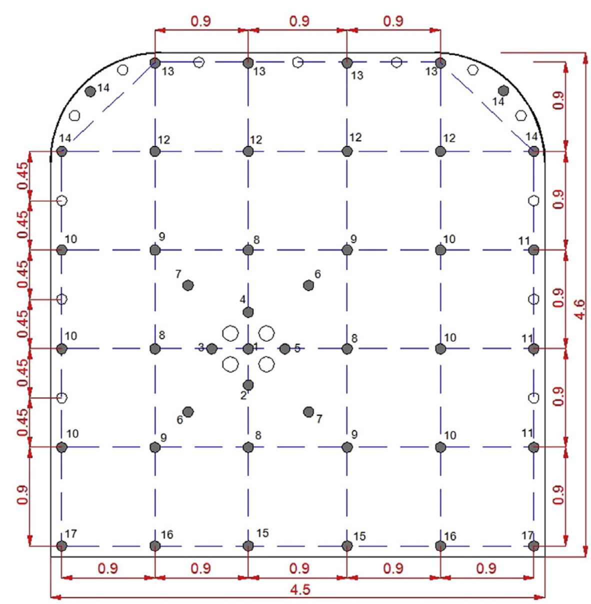

Fig. 4. Wolverine underground 11 drilling pattern. Length is in meter (YZC, 2013).

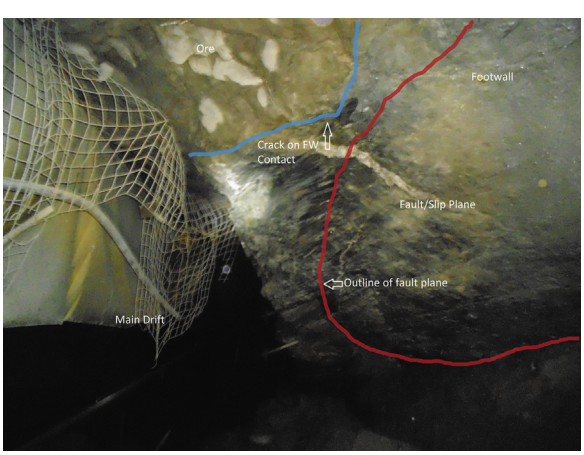

Fig. 3. Photograph of 1150 level wedge failure.

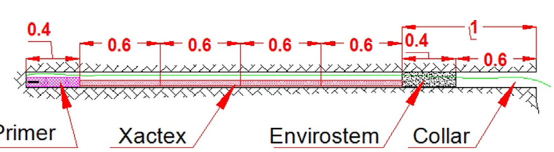

Fig. 5. Wolverine underground 11 perimeter hole loading. Length is in meter (YZC, 2013).

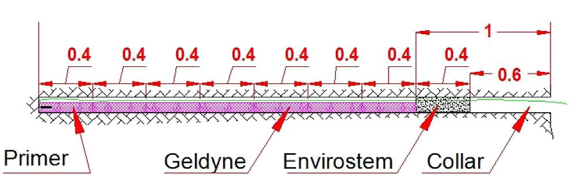

Fig. 6. Wolverine underground 11 production hole loading. Length is in meter (YZC, 2013).

Table 1
Available detonator delays.

LP period	Delay (ms)	LP period	Delay (ms)
0	0	10	3500
1	400	11	4000
2	800	12	4500
3	1200	13	5000
4	1400	14	5500
5	1600	15	6000
6	2000	16	6500
7	2300	17	7000
8	2500	18	8000
9	3000		

Table 2
Wolverine blasting parameters.

Blasting parameters	Description
Primary explosive	Orica Geldyne 32 mm × 400 mm cartridge
Perimeter control	Orica Xactex 19 mm × 600 mm cartridge
Central blasting system	Electric
Production hole initiation	Non-electric caps
Powder factor	~0.4–0.5 kg/t

to gage whether shorter rounds or special loading precautions were warranted.

The mechanism of stress waves damaging adjacent drifts is illustrated in Fig. 7. It can be seen that during normal blasting, compressive stress waves are reflected in tension at the free surface of a nearby tunnel, causing damage to the tunnel at the rock/excavation boundary. When the perimeter holes are detonated first, a boundary is created around the excavation reflecting the stress waves back into the heading being blasted. An alternate method of mitigating damage is to reduce round lengths from 3.5 m to 2.0 m. This reduces the charge weight per delay thereby reducing the magnitude of the stress waves.

By limiting tensile wave propagation to the drift being blasted, the extent of the blast damaged zone (BDZ) is minimized. Without pre-shearing, tensile cracks may develop originating at stress wave reflection interface of the adjacent drift. For stable underground excavations, minimizing the extent of BDZ is critical.

A literature review by Xia et al. (2013) found that shotcrete cracking occurred when vibration exceeded 700 mm/s or more. This corresponds well with recommendations from the Tennessee Valley Authority on vibrations >500 mm/s required to induce cracks in >10 day old concrete (ISEE, 1998).

Vibration monitoring was carried out during the excavation of four tunnels including 1160WV which is thought to have contributed to the 1150 level wedge failure. The results of the vibration monitoring are discussed in the following section.

4. PPV predictions compared to measured PVSs

The PPVs were predicted according to ISEE (1998):

$$PPV = H\left(\frac{D}{\sqrt{W}}\right)^{-1.6} \tag{2}$$

where D is the distance from the blast in meters, W is the maximum charge weight per delay in kg, and H is a factor with an initial value of 1725. The factor H was also back-calculated from the measured data and is presented in Table 3.

Production in the 1160WV level resumed following rehab of the 1150 level with shotcrete and the addition of 12 ft 24-t inflatable rockbolts. Vibrations were monitored in the 1150 level during blasting at slope distances between 10 m and 27 m.

4.1. 1160WV level

Fig. 8 shows that while there is a trend between the predicted and measured PPVs, there is also anomalous data between the predicted 50–100 mm/s range. Another observation is that the recorded PVS value is fairly consistently below the predicted upper range. In other words, this case has the lowest back-calculated factor H as can be seen from Table 3. This implies that energy transfer between the 1160WV production level and the 1150 monitoring level is not efficient. Recalling the fault along which the 1150 wedge failure occurred from Fig. 3, these results are not surprising. Rather, the lower than expected factor H serves to confirm the presence of a structure between the explosives and the vibration monitor that interferes with stress wave propagation. Indeed, as discussed earlier, a fault can act as a free surface to allow for stress wave reflection back to the source. Furthermore, damage occurring at the fault from reflected tensile waves may lead to movement and further dilation. This would reinforce the previous hypothesis of blast-induced damage along the 1150–1160WV fault.

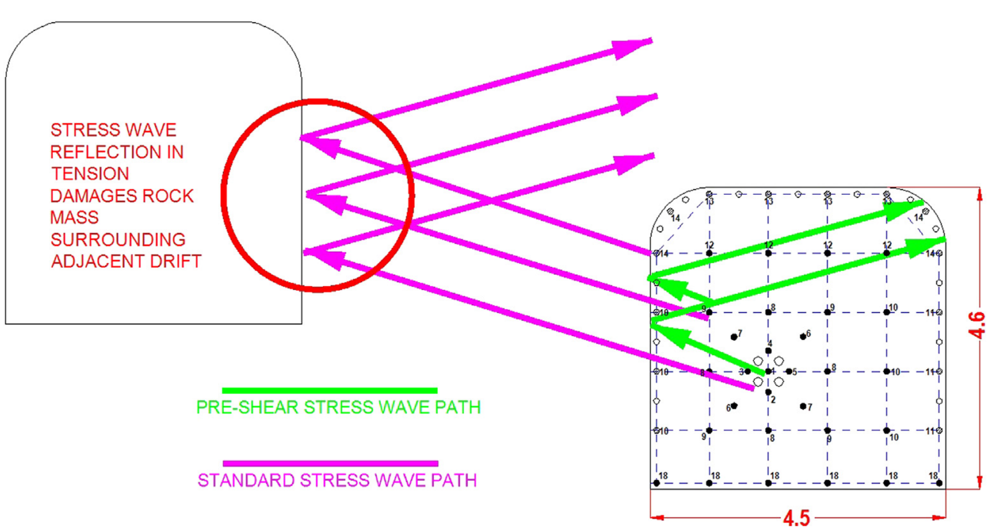

Fig. 7. Mechanism of stress wave induced damage at adjacent excavation. Length is in meter.

Table 3
Blast data summary.

Mining level	PVS (mm/s)			Axial frequency (Hz)			Axial PPV (mm/s)			H			Rock type	Direction of wave propagation relative to strike/foliation
	Min.	Max.	Average	Min.	Max.	Average	Min.	Max.	Average	Min.	Max.	Average		
1160WV ($n = 13$)	41	141	79	13	146	92	28	110	55	424	4375	1357	FW: Chloritic rhyolite	Skewed, crossing fault
1145 south ($n = 19$)	53	234	97	9	175	108	19	175	75	565	4580	2366	FW/ORE: Chloritic rhyolite/massive sulfide	Perpendicular
1145MAR ($n = 2$)	43	90	66.5	171	200	–	48	32	40	1721	2686	2204	FW: Chloritic rhyolite	Parallel
1200 ($n = 5$)	18	224	117	93	171	137	8	154	64.22	242	9370	2429	ORE/HW and ORE: Massive sulfide/argillite	Perpendicular

It is also possible to see from Fig. 8 that changes in the loading pattern, i.e. detonating perimeter Xactex holes prior to the production holes as shown in red squares, pre-shearing, did not appear to play a significant role in reducing vibration compared to standard loading practices.

4.2. 1200 level

The 1200 level was the only case where stress waves traveled through competent massive sulfide ore. As a result, the highest recorded PVSs of over 200 mm/s were from this heading. In two out of three cases where pre-shearing along the contour holes was requested, the measured particle velocities were far lower than predicted. In one case however, the recorded velocity was higher than predicted, as can be seen in Fig. 9.

From Fig. 10, it can be seen that the highest axial velocities occurred at delay 0 corresponding with the perimeter holes detonating. It is possible that more than the perimeter holes were tied in with delay 0, causing a larger than expected particle velocity. About 12 kg of explosives simultaneously detonating would be sufficient to explain the observed particle velocities.

Nevertheless, following the initial spike of just under 80 mm/s in the axial direction, no subsequent delay period caused vibration in excess of 20 mm/s. In this case, a discontinuity was successfully created effectively reflecting stress waves and limiting propagation to the adjacent tunnel.

Fig. 11 illustrates the same heading where a 3.5 m round was taken with pre-shearing. In this case, there is a lack of pronounced initial spike indicating much less explosives used at delay period 0. In contrast to Fig. 10, an effective discontinuity was not created and particle velocity peaked around delays 13–14.

4.3. 1145 level

Vibration monitoring was carried out on the 1145 south level and the 1145–1125 ramp. In both cases, stress waves traveled through chloritic rhyolite footwall. In the former, wave propagation was perpendicular to strike while in the latter it was parallel. Nevertheless, the values of average back-calculated factor H were 2366 and 2204, respectively. The similar figures indicate that blast vibration can propagate across foliation layers without difficulty. This is in contrast to the $H = 1357$ in 1160WV level where it was found that significant structural discontinuities such as faults adversely impact stress wave propagation.

From Fig. 12, it is apparent that 1160WV level has markedly lower measured particle velocities than the other headings. Note that when applying linear regression and setting (0, 0) as a valid point, a higher H is implied for 1145MAR compared to the 1145 south level. While this is based on a limited data set, the two regression slopes are closer to one another than to 1160WV. In this case, more efficient propagation is along strike rather than across strike, which is more intuitive than the inverse suggested by averaging the values of back-calculated factor H. Also note that a regression line is not provided for 1200 due to significant data scatter and that one point with a PPV of around 700 mm/s is not shown on the graph.

5. Vibration mitigation

Two principal methods were attempted to minimize vibrations, i.e. pre-shearing as discussed earlier and shorter round lengths. The notion behind shorter round lengths is that the explosive charge is reduced when drilling 2.0 m rounds compared to 3.5 m rounds.

While Figs. 10 and 11 demonstrate the implementation of pre-shearing, Fig. 13 suggests that it was not operationally successful in reducing vibrations. As expected, vibrations were noticeably reduced with increased distance regardless of the loading and blasting technique employed. However, there was not an observable decrease in PVS when pre-shearing was employed.

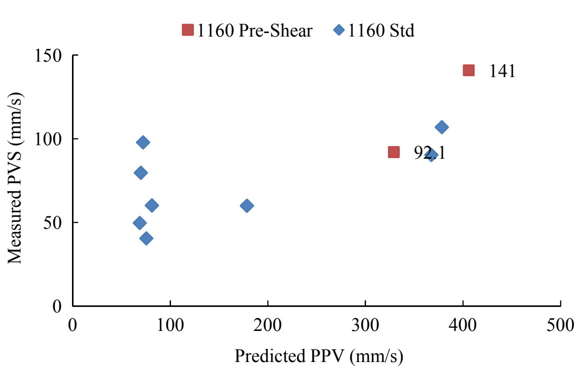

Fig. 8. 1160WV level vibration monitoring.

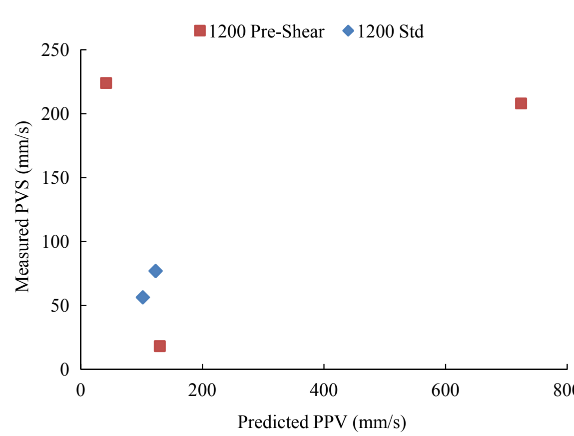

Fig. 9. 1200 level measured and predicted particle velocities.

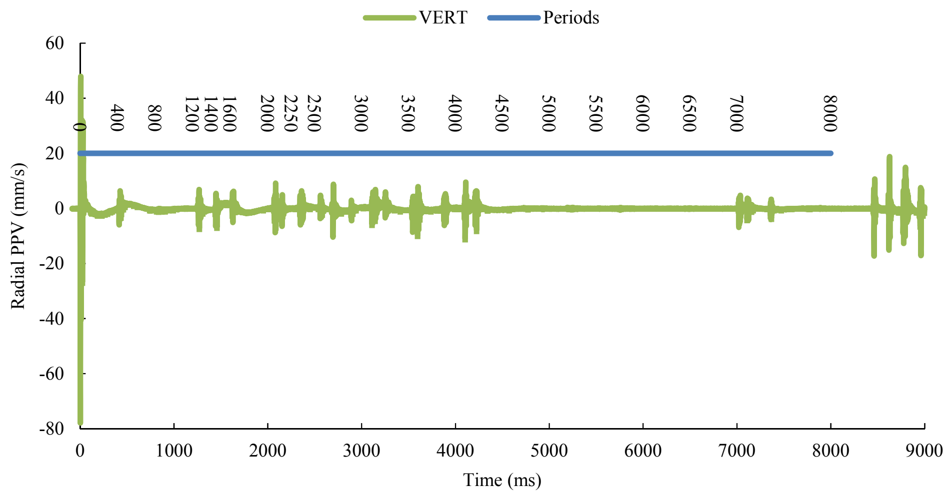

Fig. 10. 1200 level axial particle velocity, 2 m round.

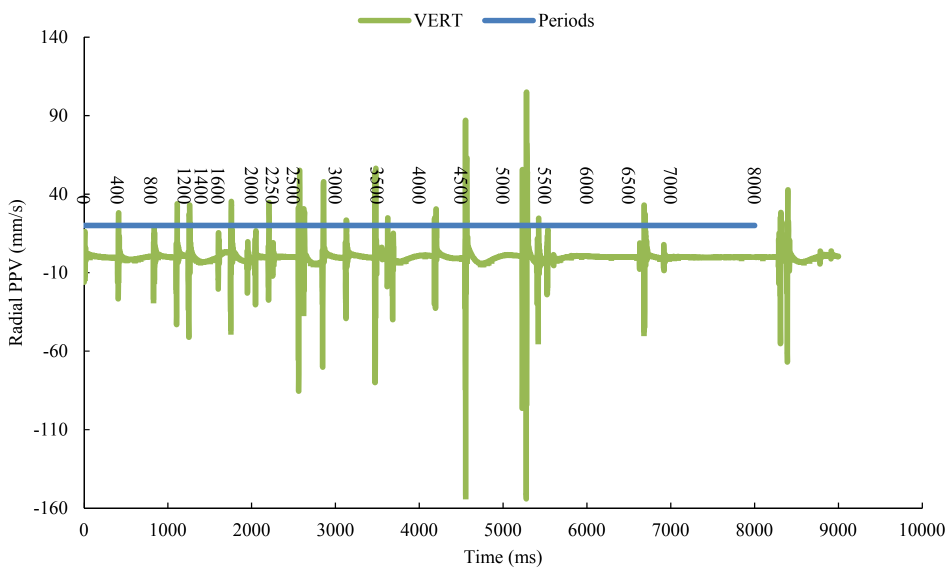

Fig. 11. 1200 level axial particle velocity, 3.5 m round.

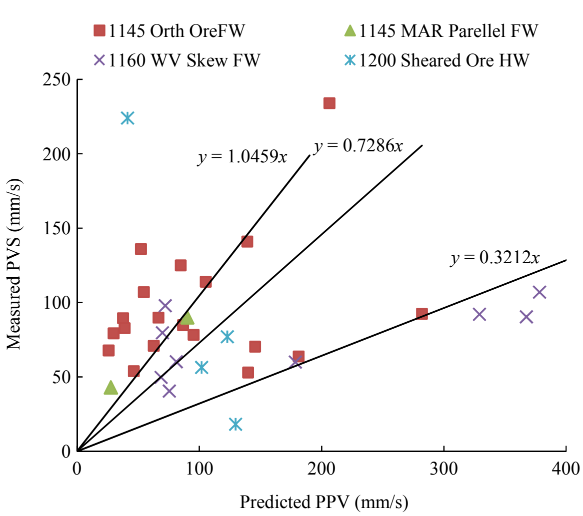

Fig. 12. Measured and predicted vibrations.

In contrast, greater success was achieved when shorter rounds were used. As can be seen in Fig. 14, both the upper and lower bounds of PVS for 2.0 m rounds are lower than those for 3.5 m advances. In particular, there is a noticeable difference between the upper bounds. This suggests that restraining round lengths to 2.0 m compared to 3.5 m was operationally effective in minimizing vibrations.

6. Frequency

The BlastMate III measured vibration frequency up to 200 Hz. It was found that most blasts induced vibrations were greater than 50 Hz with some measurements exceeding 200 Hz. Due to this measurement limitation, it was not possible to accurately measure the distance-dependent frequency characteristics of blasts. Nevertheless, in accordance with fundamental material properties, the relatively high frequency noted is less damaging to structures than waves of lower frequencies. This is exemplified in blasting regulations with regards to higher maximum PPVs at higher frequencies (ISEE, 1998).

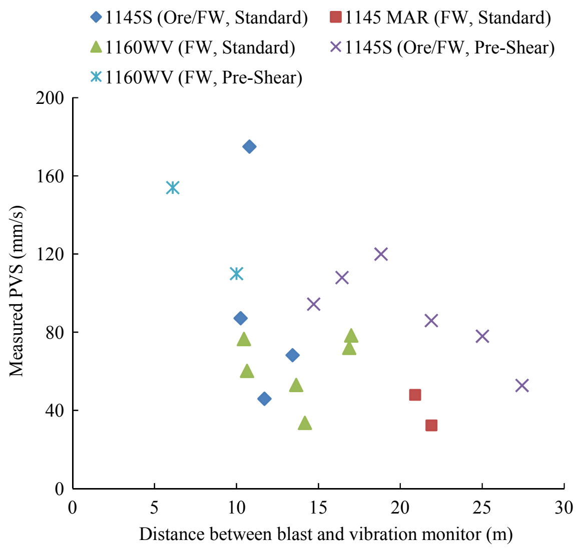

Fig. 13. Impact of pre-shearing on PVS.

7. Pull testing and damage assessment

Following each blast, adjacent tunnels were inspected for damage to the rock mass and installed rockbolts and shotcrete liner. No evidence of liner damage was noted anywhere. In addition, pull tests were carried out to determine whether rockbolts had been loosened by vibration damage. The United States Department of Defense recommends a minimum tunnel spacing S for weak rock (DoD, 1999):

$$S = 1.7Q^{\frac{1}{3}} \tag{3}$$

where Q is the charge weight per delay. For a charge weight of 20 kg which exceeds any loading pattern employed at Wolverine, the minimum safe distance is 4.6 m. This is equivalent to one drift width in Wolverine and is the absolute minimum spacing for adjacent tunnels. The least distance recorded in this study was 6.11 m.

In particular, pull testing was carried out in the 1150 level following rehab and additional blasting in 1160WV level. All tested rockbolts passed the pull tests. It can be concluded that the magnitude and frequency of typical blasting carried out at Wolverine Mine are not detrimental to installed rockbolts in and of itself.

8. PVS and component PPV

It can be seen from Fig. 15 that there is an expected positive correlation between each component PPV and the measured PVS. A more interesting observation from this graph is that the strongest correlation is between axial PPV and PVS, suggesting that higher PVS values, which can be analytically predicted, correspond to higher damage-inducing axial vibrations. This can partly be explained by intentionally positioning the geophone as close to the blast in the adjacent tunnel as possible. When the geophone is in line with the explosives, little transverse motion, that is, down the length of the tunnel is expected. The relatively greater axial separation vs. vertical explains the greater axial motion. With limited vertical offset, the longitudinal vibrations are not efficiently transmitted from one heading to the other. The observed relationship is numerically described below with a sufficiently high coefficient of determination:

$$PPV_{\text{axial,1160WV}} = 0.7PVS \ \left(R^2 = 0.87\right) \tag{4}$$

The relationships were obtained with linear least squares regressions and assigning (0, 0) as a valid data point in reference to the fact that a zero PVS necessarily indicates null component vectors. The low coefficient of determination for the transverse direction, $R^2 = 0.199$, indicates poor stress wave propagation in this direction due to the orientation of the geophone relative to the wave travel path and multiple faults. In this case, stress waves are traveling through multiple foliation structures which result in scattering each time a new round from a slightly different approach angle is blasted.

The linear best fit lines with R^2 values are given for relative comparison only with low values, indicating complex interaction between wave reflections crossing foliation and faults. The low values are also indicative of poor stress wave propagation as opposed to high values, which indicate a good wave propagation with minimal interaction and scatter.

A summary of component PPV and PVSs can be seen in Table 4 with the m taking the place of the regression slope, 0.70 for example in the relationship described above.

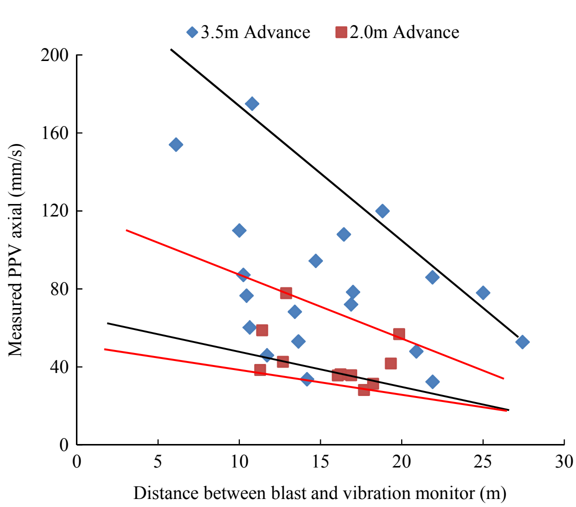

Fig. 14. Round length impact on PVS.

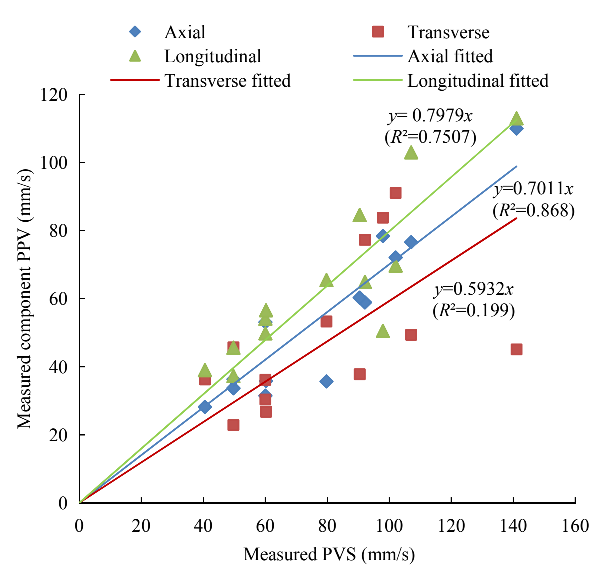

Fig. 15. PVS and PPV components at 1160WV level.

A similar pattern is observed in Fig. 16 with the highest correlation seen between the axial PPV and PVS for 1145 south level:

$$PPV_{\mathrm{axial,1145south}} = 0.77PVS \left(R^2 = 0.75\right) \tag{5}$$

In this case, however, the coefficients of determination for the longitudinal and axial PPVs were within 1% of one another, both rounding to 0.75. A notable fraction of blast energy was transformed into vertical particle motion along the wall.

Finally, transverse particle motion was dominant in the 1200 level as seen in Fig. 17. The ground between the blasts and the vibration monitor was heavily sheared and consists of ore and graphitic hanging wall. In this case, the low correlation between the axial PPV and PVS is not straightforward. The non-normal component PPVs, transverse and longitudinal, have relatively high respective coefficients of determination, 0.98 and 0.91, compared to 0.70 for the axial component. A possible explanation is stress wave behavior at the lithological contact boundaries. In a continuous solid material, efficient propagation would be expected. Stress waves however, are reflected at material boundaries (Meyers, 1994). In this case, wave reflection and interaction may have attenuated P-waves traveling directly from the blast to the sensor and instead facilitated motion in other directions captured by the higher than expected non-normal vibrations observed.

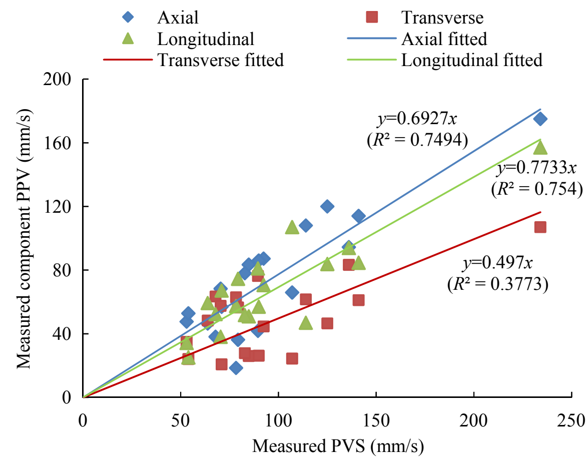

Fig. 16. PVS and PPV components at 1145 south level.

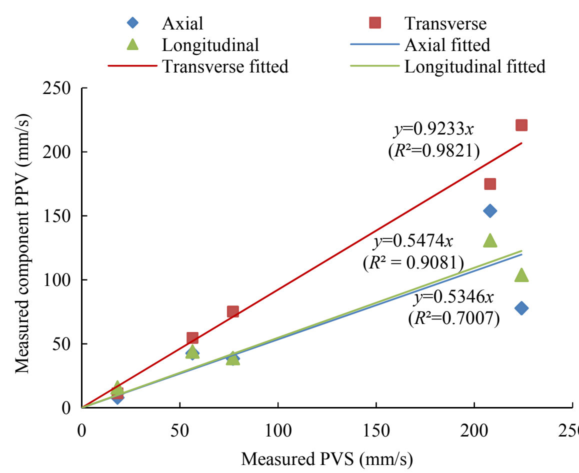

Fig. 17. PVS and PPV components at 1200 level.

9. Conclusions

As noted in the previous section, the PPVs observed in routine blasting at Wolverine Mine do not exceed 250 mm/s and are generally greater than 50 Hz. Visual inspection of installed ground control elements including shotcrete as well as pull testing of rockbolts reveals that damage thresholds have not been exceeded.

It has also been shown that higher velocities can be expected in the more competent massive sulfide ore than the rhyolite footwall or argillite hanging wall. In addition, it is possible to limit stress wave propagation by creating cracks between perimeter holes. The operational caveat to this is that when such action is required, the drilling and loading must be carefully supervised to ensure that technical instructions are accurately carried out. A more effective method of controlling blast vibrations at Wolverine is to limit advance lengths to 2.0 m rather than the standard 3.5 m reducing the maximum charge weight.

Comparing measured PVSs to component PPVs revealed that the most potentially damaging axial vibrations are not always correlated with high PVS. Factors including relative drift orientation, rock type, geological structures and lithological contacts play a role in determining the magnitude of normally oriented or axial vibrations compared to PVS, or PPV regardless of direction.

The mapped fault in the 1160WV level had a notable impact on vibration magnitudes measured in the 1150 level. Since not even the highest measured PPV had a detrimental impact on installed ground support, it is recommended that any anomalously low particle velocities are carefully reviewed to make certain that they are not the result of hidden discontinuities and faults. Indeed, careful inspection of routine blast monitoring may reveal hidden geological structures which may both pose threats to operations and provide opportunities for better understanding the ore deposit.

In order to gain more insight into the impact of blasting activities on adjacent excavations, future study may involve two geophones that can be used to determine stress wave velocities through different rock types. Multiple geophones would also give greater insight into stress wave interaction at lithological boundaries and structures. In addition, the extent of the blasting damaged zone briefly discussed in Section 3.2 can be further studied with numerical modeling.

Table 4
Component PPV and PVS correlation.

Mining level	Regression slope, m			R^2		
	Axial	Transverse	Longitudinal	Axial	Transverse	Longitudinal
1160WV	0.7	0.59	0.8	0.87	0.2	0.75
1145 south	0.77	0.5	0.69	0.75	0.37	0.75
1200	0.53	0.92	0.55	0.7	0.98	0.91

Conflict of interest

The authors wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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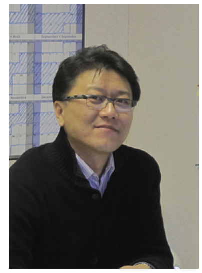

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