A BOOKLET ON

Tap-Tests: a tool for seismic hazard evaluation in pillars

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Project Objective

A previous SIMRAC project (GAP601a) showed that it may be possible to determine the levels of expected local seismic activity by carefully analysing the seismic response to a single production blast (or ‘Tap’).

A task of SIM020302 was to investigate these findings and develop practical advice for mine personnel involved in evaluating the seismic hazard of pillar extraction.
Background

Complex systems theory holds that the response of a complex physical system to a perturbation can be used to assess how close to instability it is. Here the complex system is a mine rockmass, and the perturbation is a production blast. This work investigated the correlation between the micro-seismic response to production blasting and the general levels of seismic activity in the vicinity.

Test Sites

50-40-RAW, ARM2#: This tiny pillar is at a depth of 1500m below surface, and forms part of the shaft pillar. Seismic activity was expected to be very low here, because of the shallow depth and relatively clean geology. The pillar was some 25m x 30m in extent.

70-SW-36, ARM2#: This pillar was quite long and thin (20m x 100m) and was situated at a depth of 2100m below surface. Relatively high seismicity was expected here from the nearby faults.

72-S-41, ARM2#: A rather large pillar (80m x 100m) at a depth of 2140m below surface. This pillar was not strictly speaking an isolated piece of ground since it lies
adjacent to a large fault, around which no mining has taken place.

72-NE-54a, ARM2#: A deep (2140m) pillar that was relatively large at 40m x 90m. A small fault underneath was not expected to cause problems.

72-NE-56a, ARM2#: A very small pillar, 15m x 50m, at a depth of 2140m below surface. The depth and presence of complex geology caused expectations of appreciable seismicity.

Turfontein shaft of Rustenburg Platinum Mines: The pillar was of approximate dimension 50m x 15m.

Section 336 was used as a site in GAP601a, and this data was analysed further.

104/109 46-48 pillar at Mponeng mine: This pillar was substantially larger than the others, approximately 600m x 70m.

At each of the 7 sites, the micro-seismic response to at least one production blast was recorded. The test procedure was:

1. Glue a single uni-axial high frequency omni-directional geophone to the sidewall close to the active stope with quick-dry cement
2. Use a small 12V battery to power a StandAlone QS† data logger.
3. Record either continuous seismic data or ISS Crack Counter (Seismic Triggered Parameters) data for 2 hours after the blast

† Manufactured by ISS International. See http://www.issi.co.za
Results

The seismic data recorded within 2 hours of the blast was analysed and the cumulative number of acoustic emission (STP) events was plotted as a function of time. At some sites (70-SW-36 at ARM2# and Turfontein) nearby panel blasting in this 2-hour recording period corrupted the signal. The valid data is presented here:
The STP seismic responses were then compared with the seismic event data recorded by the mine-wide seismic systems in the 3 months around the time of the tap-tests.

<table>
<thead>
<tr>
<th>Tap-test site</th>
<th>Number of STP events within 1 hour of blasting</th>
<th>Number of events with $m=1.0$ in 3 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 40 RAW, ARM2#</td>
<td>80</td>
<td>0</td>
</tr>
<tr>
<td>72 NE 56a, ARM2#</td>
<td>170-190</td>
<td>1</td>
</tr>
<tr>
<td>72 NE 54a, ARM2#</td>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>72 S 41, ARM2#</td>
<td>750</td>
<td>5</td>
</tr>
<tr>
<td>Section 336, TauTona</td>
<td>3,000-15,000</td>
<td>19</td>
</tr>
<tr>
<td>104/109 46-8, Mponeng</td>
<td>5,500-10,500</td>
<td>24</td>
</tr>
</tbody>
</table>

Table: Summary of the tap-test data and seismic event data for each of the 6 valid sites.
Discussion

It appears that the seismic response to a production blast recorded by a single temporary sensor can indicate the levels of seismicity in the vicinity. This means that within a few days the levels of expected seismic activity can be estimated for an area. This would be useful for areas of a mine not covered by a seismic network, and could aid assessments of seismic hazard for pillar extraction, before the pillars are mined.

Guidelines for Tap-Tests

Practical guidelines for routine tap-tests:

? Try to schedule the tap-test for a time when only the area of interest is being blasted, or at least know the times of blasting of panels within 300m.
? If the area of interest could be blasted 1 hour before any other areas, this is good enough for a clear tap-test
? Try to install the sensor within 20m of the working face. 10m is ideal.
? Quick-dry cement dries within about 5 minutes and is easy to use for temporary sensor installation. A rock-hammer can usually retrieve the sensor with no damage.
? A 24 A-Hr 12V battery (weight approximately 7kg, dimension approximately 150mm x 150mm x 150mm) is sufficient to power the SAQS unit for 2 days without deep discharging
? High sampling rates, at least 6 kHz, are best for the uni-axial signal
? Suggested STP parameters:
  o **Threshold** should be about 6 times the average LTA of the sensor (try 150 if not sure)
  o **Max number of noise points** = 10
  o **Min event length** = 50
Conclusion

Tap-tests can be easily used to get an indication of the expected levels of seismic activity in a region. This could help in the assessments of seismic hazard for a particular pillar and may be a factor in the decision to extract small remnants.

Acknowledgements

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