

GEOHART is a Geotechnical Consultancy specialising in the following areas:

- **Underground Mining Rock Mechanics**
- **Shaft Assessments and Reviews**
- **Open Cut Mine Slope Stability Assessments (e.g. High & Low Walls and Waste Dumps)**
- **Road Slope Stability Assessments**
- **Blast Vibration Monitoring**
- **Non-Destructive Testing of Installed Rock Reinforcement**

GEOHART was established by Wouter Hartman – Principal Geotechnical Engineer who has more than 20 years industry experience in exploration, underground and open-cut mining operations, mining and civil tunnelling consulting industries in UAE, Dubai, Chile, Australia, Indonesia and South Africa.

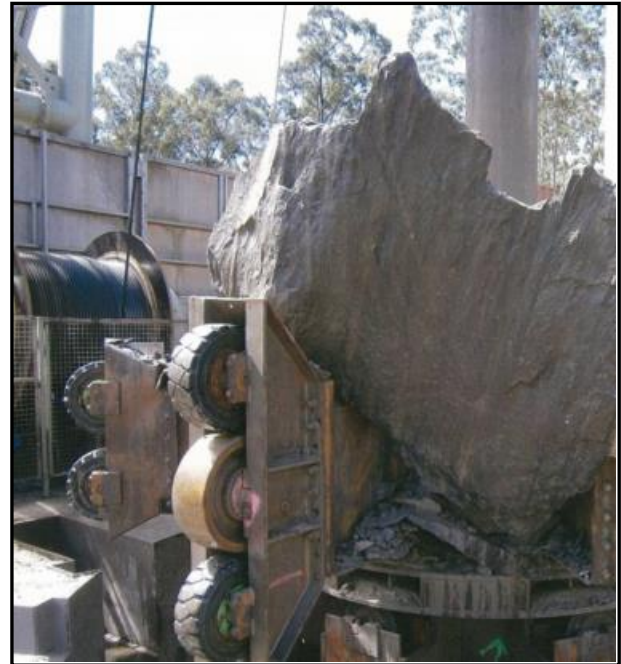
GEOHART has expanded to offer a wide range of deep, intermediate and shallow gold, copper, lead/zinc, shallow to intermediate platinum, copper, lead/zinc, gold, brown and black coal mining experience. The experience is coupled with ground support design and project management. Our consultants have extensive experience in decline shaft / drift tunnel support design and seismic system initiation, monitoring and damage assessment, as well as risk management.

Geohart were extensively involved in the recent research in shear rigidity of rock reinforcement elements in association with the Mining Research Centre UNSW-Sydney-Australia and ACARP. They were also instrumental in the development of a world-first field shotcrete shear testing device and have extensive experience in shotcrete applications for underground mine and tunnel excavations.

Shaft Related Experience

1. Abergeldie Complex Infrastructure - Austar Coal Mine Pty 5.5m diameter Kitchener Up-cast Vent Shaft. Geohart was

engaged to assess the spalling failure mechanism for the shaft.



2. Straits Resources - Tritton Copper Mine Larsens Ventilation Shaft: Geotechnical Investigation for the Larsens Project ventilation shaft; drill-hole assessment, rockmass classification, raisebore stability assessment and recommendations.

3. George Fisher Mine: Design of support for rehabilitation work in secondary decline. Evaluation of ground conditions in main declines and access ways. Ground control evaluation and design for shaft ancillary excavations.

4. Anglo Platinum Rustenburg section: Design of shaft support system for Paardekraal 2 shaft complex sinking operation barrel and stations (2 vertical shafts complex). Review and design of shaft pillar(s), extraction methodology. The shaft system was originally designed to intersect only the upper orebody but changing economic circumstances made the extension to the lower orebody a viable economical proposition. This extension required a revision of the shaft tower

requirements (at reef intersection), a re-design of the inner and outer pillars sizes as well as of extraction sequences and methodologies.

Design of inclined shaft local and regional support system for the Turffontein UG2 expansion (feasibility level) as well as the incline shaft connection from the Turffontein Merensky horizon to the Ultra deep shaft (pre-feasibility level).

5. Ballarat Vent Shaft: Review of the Geotechnical Investigation completed by Coffey Mining - Hobart Office, offering some suggestions for changes to be made.

6. Kestrel Coal Mine Vent Shaft: Review of Geotechnical Investigation on behalf of Rio Tinto - high level review for shafts and two incline drifts (Boxcut currently under construction).

7. Bleskop, Brakspruit and Turffontein Shafts - RPM Rustenburg Section (Anglo Platinum) Regular inspections of shaft barrel conditions and statutory stability evaluation and modelling for shafts and ancillary excavations. Evaluation and design of rehabilitation support work for the stations at the lower levels of the Turffontein inclined shaft complex.

8. Latrobe Valley, Vic: Oct 2004: – 1300m deep, 4m diameter shaft - Geotechnical Investigation for the proposed shaft (This was for a coal drying project).

9. Olympic Dam Operation – WMC – Clark Shaft: 7.5m diam. - Operational shaft. A Risk Assessment for all their operating shafts was conducted. There was a proposal to mine the Green west stopes within close proximity of Clark shaft. Wouter was project manager for the 3D stress/strain analysis to determine any effects from the proposed green west stopes - i.e. Shaft Tilt, Shaft Ovaling (conducting the 2D finite element analysis on the shaft concrete lining to check whether there would be any significant damage to the concrete lining structure). Major Geological Structures were detected to possibly intersect the shaft.

Blasting vibration was investigated and proved to be more of a problem than the mining itself. Seismicity could have presented some problems if occurred on a regular frequency. Other important excavations around the shaft, i.e. ore bins, crusher, loading transfer excavation, were also assessed from a stress analysis point of view.

10. Newmont Pajingo – Jandam Fresh Air Rise – Ventilation Shaft: Review of all Ventilation shafts constructed at Pajingo prior to conducting the geotechnical investigation for the JANDAM Return Air Rise (700m Deep). The initial 70m was very poor rock, not conducive to raiseboring and was seen as an unacceptable risk. The mine decided to push forward with the raisebore but needed advice to stop short before poor material was intersected - a pillar was designed between the blind bore and raisebore section.

11. Dendrobium – BHP Billiton – Ventilation Shaft: March 2001: Completed the geotechnical investigation work for Walters Construction – Mining Division Contractors. The 180 metres deep shaft, 4.3m in diameter - costing \$4.07 million. Initial proposal was for raiseboring. Recommendation was not to proceed with raisebore, but instead to do a blind bore sink – Abergeldie contractors did the construction of the shaft.

12. No. 14B – Vent Shaft – Impala Platinum 1200m deep Conventional Sink. Completed the Geotechnical Investigation, designed the 75mm thick steel fiber shotcrete inclusive of the shaft ground support pattern.

13. No. 11B – Vent Shaft - Impala Platinum: Conventional Sink. Completed the Geotechnical Investigations and designed the 75mm thick steel fiber shotcrete inclusive of the shaft ground support pattern.

14. No. 1A Vent Shaft - Impala Platinum, 6m diameter Raisebore Shaft: 1060m deep shaft - carried out the Geotechnical Investigations, experiencing failures within the shaft to around 80m below surface. Following completion of the raisebore shaft, groundwater

was seeping in at a high rate resulting in the shaft walls to fail (i.e. "exfoliate"). During the final rehabilitation process two shift bosses were injured during one night shift. We were requested to commence an investigation immediately into the cause of the failure. During the investigation the coal mines rescue fibre optic televiewer (on loan) was severely damaged following a wall slab failure.

15. Impala Platinum – No. 10-Shaft (Merensky Reef): Triple decline system - mainly shaft inspections for the vertical shaft. The shaft had already been in operation. Design of the ground support for the triple incline system; and review and inspection of the de-stressing slot which was intended for the protection of the three stations (plat's) within the incline shaft.

16. Impala Platinum – No. 9-Shaft (Merensky & UG2 Reef): Essentially Tabular ore body – Reef Dips between 9-11 degrees towards the east - mainly shaft inspections - the shaft had already been in operation on commencement of work. A 3-dimensional numerical, stress / strain and displacement analysis of the shaft was conducted, as there was a proposal to reduce the size of the UG2 shaft pillar and determination of the effect on shaft stability had to be established.

17. Vaal Reefs – Anglo Gold (Ashanti) – No. 2-Shaft & 5-Shaft: Conducted mainly shaft inspections; the shaft had already been in operation at commencement of work – We provided input into the mine planning to mine the shaft pillar and the possible effects on the shaft stability.

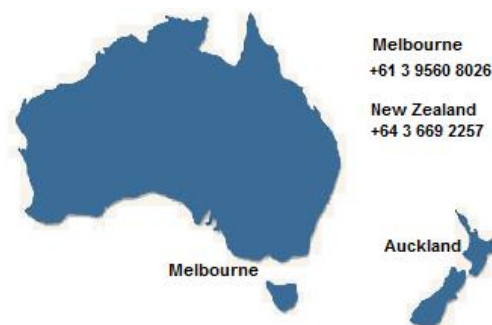
- An integrated Geotechnical Service at Endeavor Mine (NSW), ACG News Letter, August 2006.
- Development of a laboratory facility for testing shear performance of installed rock reinforcement tendons, Virginia, Coal Ground support conference, Morgan Town, 2005 (US).
- Risk Management Process for Practicing Geotechnical Engineers, AUSIMM, Bulletin, 2004 (Australia).
- Understanding the Performance of Rock Reinforcement Elements under shear Loading through Laboratory Testing – A 30 Year History – Ground Control in Mining Technology and Practice, 10-13 November 2003 (Sydney, Australia).
- Lessons Learnt in Decline Support Design October – SANIRE 2000 – Bushveld Conference, South Africa

Specific Services:

- **Geotechnical Site investigations and Reporting**
- **Shaft Stability Assessments and reviews.**
- **Finite Element Analysis for Shafts, Slopes and Dump Stabilisation**
- **Geotechnical Project Management for Feasibility Projects**
- **Risk Assessments (Activity and Process orientated) and ground related incident investigation**
- **Material property review for shaft stability**
- **Ground Control Management Plan (GCMP) Development and Reviews**

Publications / Referee Papers / Presentations

- Deep Coal Mining Challenges at The Xuandong Mine in China. Ground Control Conference, Morgan Town. 2012.
- Block modeling for the purpose of visualising geotechnical borehole data at Tritton Mines – ANZ Conference. 2012.
- Shaft Pillar Stability – Risk Management. EAGCG May 2007.



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Certification: ISO 9001:2008; ISO 14001:2004; BS OHSAS 18001:2007

