

AMC

CONSULTANTS

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DIGGING DEEPER

REVIEWING RESOURCE MODELS

Pat Stephenson

When AMC receives a mineral resource model a series of checks are undertaken, depending on the use to which the model will be put. This is done for quality control purposes and to avoid incurring costs on the client's behalf for work based on an incomplete or incorrect model.

The starting point in every case is a copy of the resource model, the drill hole database from which the model was derived and a written report detailing the resource estimate. AMC then loads and evaluates the model, checking that the evaluation provided matches the tonnes and grade reported by the client. AMC will do enough work to ensure that it understands how the model was created and the purpose for which it was created. It is essential that the model can be discussed with the geologist who prepared it.

When AMC is required to accept Competent Person responsibility for work based on the resource model, such as when preparing a publicly reported ore reserve estimate, additional work is required. AMC will then review the model and its documentation to a level sufficient to satisfy the requirements of the JORC code with respect to Competent Person responsibility. Any issues that would prevent the AMC consultant from signing off as a Competent Person are immediately referred to the client.

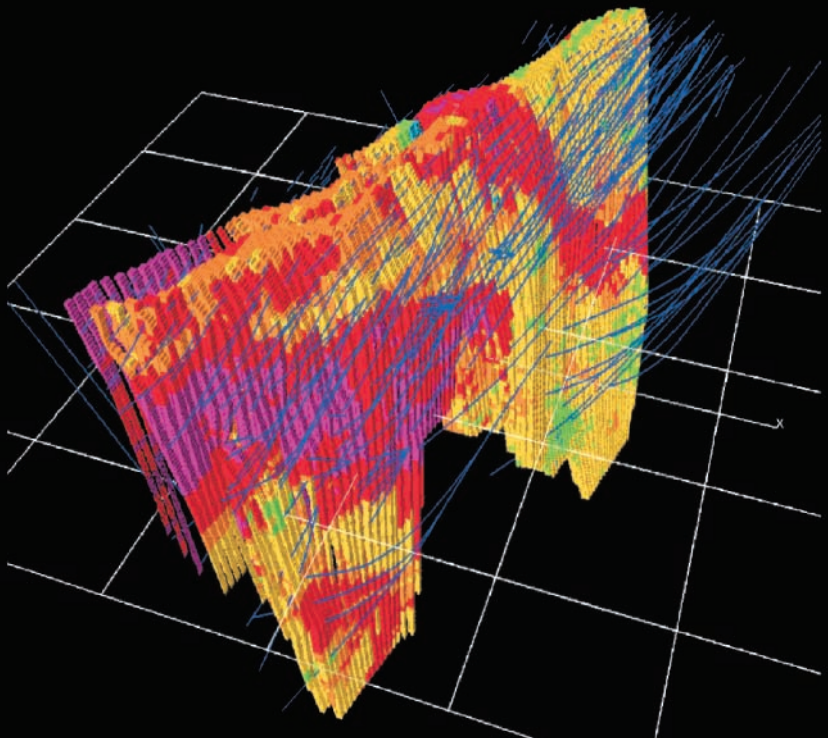
In other cases, such as mine design work where AMC will not be taking Competent Person responsibility. AMC will review the model and its documentation to a level sufficient to be confident that the work can proceed and will not be fatally flawed because of problems with the model. Again, any concerns are referred to the client.

If the client has specifically instructed AMC not to review the resource model then this will be stated in the scope of work and will also be stated in a disclaimer in AMC's report. This situation is not desirable as it often leads to high costs for wasted mine planning effort, which the client incurs before errors in the model are discovered. Of course in this situation an AMC consultant could not be Competent Person for an ore reserve estimate derived from the resource model.

Clause 8 of the JORC Code requires the client to obtain AMC's written consent to the form and context of any inclusion of AMC's work in a public report. There is now a Competent Person consent form available from the ASX at www.asx.com.au/professionals/companies/competent_person_consent_form.doc



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PASTE BACKFILL BULKHEAD FAILURES AND PRESSURE MONITORING AT CAYELI MINE

Mehmet Yumlu

Safe and efficient placement of paste fill requires a detailed understanding of paste fill characteristics from production to final fill exposures. Mobilization of uncured paste fill as a result of a bulkhead failure is a safety hazard and can lead to significant consequences, including danger to personnel, property damage and production losses and delays.

Since inception of paste filling in 1999, there have been three major bulkhead failures incidents at Cayeli Mine. Fortunately, there was no injury to personnel when the failures occurred. The failures however were very violent and resulted in severe damage to equipment and caused significant production delays (Figure 1 and 2).

Post failure investigations revealed that, in all Cayeli cases failure occurred in small and blind stopes during last stage of filling while tight filling. Stopes were overfilled by about 10% and there were problems with air relief holes. These bulkhead failures were attributed one or a combination of factors; fast filling rate; continuous filling or inadequate plug fill cure time; overfilling during the tight filling stage due to the absence, blockage or inadequate use of air breather holes; lack of adequate fill management and fill monitoring controls; inadequate bulkhead design.

Based on AMC's recommendations and guidelines Cayeli set up comprehensive field instrumentation and monitoring program in order to investigate the development and magnitude of paste fill pressures inside and behind the bulkheads during and after fill placement (Figure 3).

AMC has helped Cayeli to analyse and interpret the field pressure instrumentation data (Figure 4). The results indicated that the loading conditions in the paste fill and the resultant lateral loads on the bulkheads are complex and depend such factors as tailings properties (type, particle sizing and specific gravity), paste fill recipe (slump, solids content, and cement type and content), filling rate, filling placement sequence and stope size and geometry.

Based on Cayeli pressure monitoring test results, the following general conclusions can be drawn (Table 1 on page 4):

- Despite the same fill recipes and fill rise rates used, bulkhead pressures were significantly different. The difference is attributed to different stope size and filling sequences.
- Continuous filling with no cure time leads to higher bulkhead pressures. This is due to the higher pore water pressure and slower pore water pressure dissipation with ongoing filling.
- At the same fill rise rate, staged filling results in lower bulkhead pressure. This is attributed to the higher fill strength in the plug fill. The rest time enables pore water pressure dissipation and longer fill cure times. The weight of ongoing filling is partially distributed to the stope sides as a result of arching.



Figure 1 Property damage caused by a bulkhead failure (transformer)



Figure 2 Property damage caused by a bulkhead failure (Fargo truck)

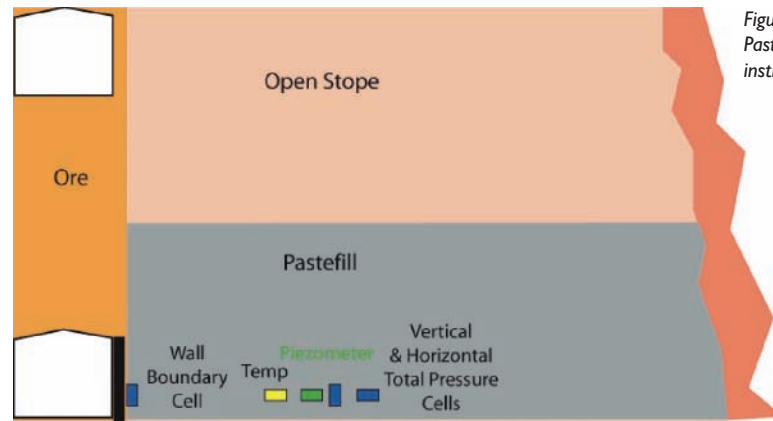


Figure 3 Paste fill pressure instrumentation setup

- Temperature changes during cement hydration can impact on pressure readings. Tests show that an increase in temperature increases pressure and a decrease in temperature decreases pressures.

Prior to the bulkhead failures, Cayeli shotcrete bulkheads were designed for a maximum working pressure of 32 kPa. Fill placement was continuous and managed by restricting fill rise to a maximum of 0.43m per hour. Pressure-monitoring results indicated that bulkheads could be subjected to up to 100 kPa, even at the restricted fill rise rate of only 0.35m per hour:

Based on the evaluation of pressure monitoring test results and findings from the bulkhead failures,

Cayeli has made the following design and operational changes in their paste fill system: (1) revised shotcrete bulkhead design; (2) new fill recipe; (3) revised fill placement procedures; and (4) new fill risk management and monitoring procedures. Site-specific new operating practices now in place allow safe and efficient fill placement. To date, Cayeli has filled more than 50 blind stopes without any failure incidents. The revised bulkhead design and fill placement sequence has therefore shown to be successful.

Going forward, Cayeli is considering instrumenting every single bulkhead with a pressure cell, transferring the pressure data to the paste plant

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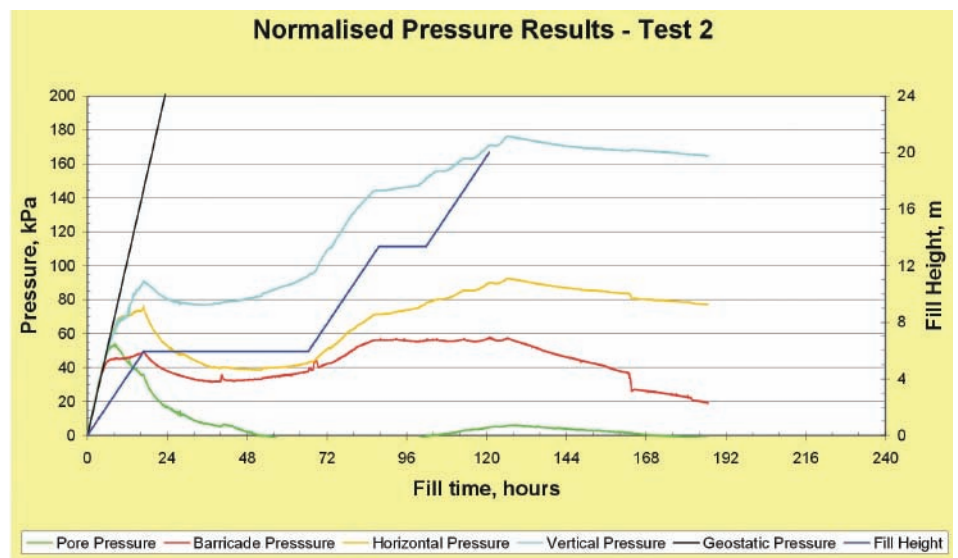


Figure 4 Paste fill pressure results for Test 2

MESSAGE FROM THE MANAGING DIRECTOR



I collect old mining books. My best finds have been made in Perth, Harare, North Bay and other towns that service a broad mining hinterland. In my home city, Melbourne, I find books from Victoria's gold era, but otherwise the pickings are slim. I am just getting into eBay.

Some books have provenance; a copperplate inscription "Mine Manager, Wiluna, 1913" or "Ballarat School of Mines 1896" on an inside page. Some have an unusual history, like copies of "The Mining Journal", "The Industrial Australian and Mining Standard" and "The Engineer" which I rescued from an underground level of the Broken Hill South mine that I visited with AMC's Paul Gardner. They were all I could carry in the front of my overalls; I left dozens of volumes behind.

Mining books are rarely expensive. They are so unsought that they often lie in cardboard boxes in back rooms of secondhand bookshops, and one must ask for them to be brought out. There are specialist bookshops for enthusiasts on railways, military history, computers and, of course, pornography, but not on mining. Until about 20 years ago, the Victorian Department of Mines sold back-copies of old reports for a dollar or two. My copies of annual reports from the 19th century and special reports on the goldfields are now rarities. I wish I had had the foresight to buy all that were offered.

My favorite historical characters were the great men and rogues of the mining industry, often one and the same. I have both biographies of the bloated Horatio Bottomley who fleeced investors in West Australian Loan and General Finance Corporation, Associated Gold Mines of Western Australia and several other companies while living in London almost entirely on champagne. I have several biographies and autobiography of Herbert Hoover, the tireless self-promoter whose vision and ambitions were bigger than the mining industry. Perhaps one day I will find a biography of Whittaker Wright, the dominant figure in West Australian finance in London, who took poison in 1904 when convicted of deliberately falsifying company balance sheets.

Herbert Hoover is an abiding interest for me. He had the means and opportunity to rewrite his own life story, so some truths are buried deep. His success with Sons of Gwalia is well known, the failures at Lancefield and in Victoria less so. I would like one day to explore the story of the Consolidated Deep Leads, which Hoover called "the greatest pumping operation in mining history", and which cost its shareholders millions for no return.

JH Curle was a mining engineer and successful travel writer. His views on eugenics made him a pariah when the Nazis rose to power. His books are a mix of humorous personal and mining history, observant travel experience and racism. Of his degree at Cambridge he wrote: "The University authorities were approached as to a mining course, but it was soon evident they knew rather less of mining than I did; it was outside their ken. It ended in a scratch course in geology, chemistry, and hydrostatics; but of their practical bearing on mining I learned nothing, and left the University in complete ignorance of the profession I hoped to enter." Curle, a friend of Hoover, traveled the world for years as a mining journalist for *The Economist* and wrote "The Gold Mines of the World" to much industry acclaim.

Randolph Bedford was a mining reporter and also a popular writer; his "Billy Pagan, Mining Engineer" (1911) is a rarity on my wish list. Fortunately his autobiography "Naught to Thirty-Three" was republished in 1976 and is readily available. Alf "Smiler" Hales was also a mining reporter at the beginnings of Broken Hill and later author of more than fifty novels. Many of them are written in dialect and, to me, are largely incomprehensible unless read aloud.

There are many, many other industry characters who wrote down their lives. Some, like WS Robinson, G Lindesay Clark, JR Gray and Oscar Comettant were published in their own time. The tradition continues with "Hardrock Gold" by Tom Morrison, a mining engineer whose career began in the early 1970s but who has the skill to write about the industry as I remember it thirty years ago.

We owe a tremendous debt to our contemporaries who have published memoirs that were otherwise lost. To Ron Manners for "So I Headed West" by WH Manners, to Ian Hore-Lacey for "Broken Hill to Mt Isa" by WH Corbould and to several others. Some of the most interesting stories, like Richard Pope's diaries of mining in Cornwall, America, Ballarat, Bendigo and Broken Hill, can only be found only in manuscript form in library historical collections and await a wider audience.

I was fortunate to discover Geoffrey Blainey's work early. He has made the greatest single contribution to my mining library and to setting down Australia's mining history. There were others helping to cover the field; Ian Auhl in South Australia, Kett Kennedy in Queensland and Weston Bate in Victoria. Many local histories such as "Angor to Zillmanton" by Colin Hooper, "Gold at Gaffneys Creek" by Brian Lloyd and Howard Combes, "Nothing But Gold" by Robyn Annear or "The Mile That Midas Touched" by Gavin Casey and Ted Mayman are examples of this genre. A list of such local histories would be very long.

Then there are the mining novels. My collection includes "Golden Soak" by Hammond Innes, "The Barrier" by Ken Walker, "Gold Mine" by Wilbur Smith and "Twenty Fourth Level" by Kenneth Benton. All could be described as "underground escapism".

The humorous books include "And There's Gold Out There" by Ed Waller and "The Pitt Street Prospector" by Blue Garland. There aren't many, although "The Money Miners" by Trevor Sykes still makes me smile about a serious matter.

As I look at my bookshelves I realize that I have mentioned only a few titles and authors. All of the old textbooks on mining, prospecting and assaying are of interest. The recent conference volumes on mining history, industrial and engineering history and industrial archaeology are valued references. I even have a mining textbook in Russian, given to me in Tashkent, which has better colour illustrations than any mining textbook in English.

There must be many books waiting for me to discover them. The investment is small and the pleasure they bring is great.

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PROMOTIONS



Andrew Hall

Andrew was recently promoted to Regional Manager, Melbourne. Andrew's expertise is in business and operational analysis, open pit and underground strategic and operational planning, feasibility studies, project evaluation, benchmarking studies and project management.



Paul Harper

Paul joined AMC as a Principal Mining Engineer in November 2002 and has fulfilled the role of Project Manager for feasibility, pre-feasibility and conceptual studies. He has also undertaken benchmarking, contract and operational reviews. Paul became the Regional Manager for AMC's Melbourne office in July 2005 and has recently been appointed General Manager in July 2007. As General Manager, Paul is responsible for over 120 staff who provide a broad range of high quality services to the exploration, mining and financial industries across Australia and the world.



Pat Stephenson

Pat was recently promoted to Regional Manager, Vancouver. Pat's primary areas of expertise are Mineral Resource/Ore Reserve auditing and review, metalliferous mining geology expert witness activities, valuation of exploration properties and preparation of Independent Consulting Geologists reports. He has, for the last three years, been managing the development of AMC's geological services. Through his JORC and CRIRSCO activities, Pat already has an established contact base in Canada, which will help to underpin AMC's expansion into this country.



Frank Greblo

Frank was recently promoted to Mining Group Manager, Melbourne. Frank has extensive experience in both underground and open pit mining projects having worked within the Australian and African mining industry for over 22 years. Frank will lead a team of over 20 engineers.



Sonia Konopa

Sonia was recently promoted to Principal Geologist. Sonia's primary areas of expertise are resource project management, technical data collection and database management, 3D geological modelling, geostatistical analysis, resource estimation work and resource project evaluation and auditing.



Rod Webster

Rod was recently promoted to Geology Group Manager, Melbourne. Rod has over 25 years industry experience, with his primary areas of expertise being in deposit modelling, resource estimation and due diligence reviews. He has worked in coal, base and precious metals, nickel, copper, uranium and mineral sands. His experience covers all facets of general geology focusing on deposit evaluation from the initial drilling through deposit definition, resource/reserve estimation and finally mine design.

INDUSTRY INVOLVEMENT

Peter McCarthy has been appointed to a Reference Committee on Earth Resources Innovation in Victoria by the Department of Primary Industries. This committee will advise on the economic case for government's potential role in directly supporting earth resources innovation and to take stock of the R&D capability and activities in the State.

AMC recently supported the 15th annual Underground Victorian Mine Rescue Competition which was held in Bendigo, from 3 to 5 August. Ten teams, from Victoria, New South Wales and Western Australia, participated in the competition hosted by Bendigo Mining, Fosterville Gold Mine and the Huntly CFA training ground. Teams competed in eight events during the three days – Search and Rescue, First Aid, Rope Rescue, Fire Fighting, Theory, B.A. Practical, Skills and Spence Herd. AMC proudly sponsored the Search and Rescue event, this year won by Stawell Gold Mine. Our congratulations go to Stawell Gold Mine who were also the overall 2007 competition winners.

PASTE BACKFILL BULKHEAD FAILURES AND PRESSURE MONITORING AT CAYELI MINE

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Measured Parameters	Test 1	Test 2	Test 3
Stope name	S860 S15	S820 N07	S880S13-P2
Stope type	Open	Blind	Blind
Peak bulkhead pressure	98 kPa	50 kPa	72 kPa
Peak vertical pressure	Not measured	90 kPa	90 kPa
Peak horizontal pressure	Not measured	75 kPa	90 kPa
Peak pore water pressure	100 kPa	53 kPa	53 kPa
Peak temp. – bulkhead	24–39°C (+15°C)	22–33°C (+11°C)	25–36°C (+11°C)
Peak temp. – stope	20–37°C (+17°C)	21–37°C (+16°C)	25–41°C (+16°C)
End of geostatic loading	10 hours (3.5 m)	6 hours (2.1 m)	4 hours (1.4 m)
Start of arching	20 hours (7.0m)	12 hours (4.2m)	18 hours (6.3m)

Table 1 Summary of pressure monitoring test results

and filling until a threshold bulkhead pressure is reached. Ongoing pressure tests are planned for this purpose. The mine is also looking to automatically monitor the airflow in blind stope breather holes as an indicator of potential over pressuring.

Only a combination of properly engineered bulkhead design, bulkhead construction and better management of fill placement can provide safe and efficient filling practices. Bulkhead pressures are very site specific and any bulkhead design should be based on actual pressure monitoring results.

AMC has the expertise and knowledge to help clients optimise their paste backfill system from the conception of designs through to the implementation in order to achieve a safe and efficient backfill system.

This is a summary of a paper presented at the Minefill 2007 Conference in Montreal, Canada.



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