

SPOTLIGHT

on mining and metallurgical developments in the O.F.S.

by P. N. HARRIS*

The Colloquium on 'Recent Mining and Metallurgical Developments in the Orange Free State' was held at the Civic Centre in Welkom on the 4th and 5th May, 1983. The Chairman of the Orange Free State/Klerksdorp Branch of the Institute and Acting General Manager of Unisel Gold Mining Company, Mr D. A. Parfitt, opened the proceedings, and Professor A. N. Brown gave the welcoming address.



Mr E. Schmidt presenting the opening address

In the opening address, Mr E. Schmidt, Consulting Engineer of Anglo American Company, stressed the changing nature of the Free State Goldfield, which is entering its 'second life', exemplified by the mining of

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remnant areas, and the sinking of new shafts into low-grade orebodies. The problems of high capital cost, marginal recovery grades, and increasing depth present a new challenge to mining engineers. Mr Schmidt stressed that a colloquium at this time presented an ideal opportunity to participants to review changes and new ideas, to increase productivity, reduce costs, and improve gold recovery.

A total of 323 persons attended the colloquium, including 13 wives of members. Of the 310 delegates, there were 198 members, 76 non-members, 15 students, and 21 representatives of company affiliates. The proceedings were organized jointly by the O.F.S./Klerksdorp Branch and the two Technical Committees of the Institute (Mining and Metallurgical), and were something of an experiment. Instead of the usual segregation of miners and metallurgists, the colloquium was aimed at an all-round exchange of information and mixing of Institute members. This turned out to be a great success.

On the first day four technical sessions were held, consisting of 7 mining papers in two sessions chaired by Mr G. C. Krafft and Dr O. K. H. Steffen, and 7 metallurgical papers in two sessions chaired by Mr V. J. Moore and Mr W. A. Gilbert. Thirty minutes were available for the presentation and discussion of each paper. The delegates had preprints of the papers, which added to the quality of the presentations. The second day was set aside for excursions to mines and local visits, which many delegates considered to be the outstanding feature of the colloquium.



Professor A. N. Brown (left) and Mr D. A. Parfitt at the opening of the Colloquium

The organization in general was of the very highest standard, and our Free State hosts went out of their way to treat their guests royally. Highlights were the cocktail party at the President Steyn Canteen on the third day, and the banquet at the Welkom Civic Centre on the following evening. Unfortunately, some delegates wilted under the social pressure and seem to have disappeared on the second day, when the technical excursions took place!

Technical Papers

A wide range of topics was covered in the 14 papers, which were presented in the magnificent auditorium of the Welkom Civic Centre.

Application of the O.F.S. Seismic System

In an interesting paper on the seismic network covering the Anglo American mines, 'Application of the O.F.S. Seismic System' by D. Lawrence, D. A. Arnold, and B. Davies, Dave Lawrence gave a brief history of the development of this seismic study and the reasons for it. In general, a system of scattered mining has been adopted in the Free State, and therefore the major source of seismic events is related to movements along the plane of the major faults. Using case studies, he indicated how information from seismic studies had been used in determining the location of a new major shaft system, and assessing the hazards of underground mining methods.

Shaft Sinking and Equipping

Two papers were presented on shaft sinking, both emphasizing the effect of improving a project's net present value by reducing the overall time spent in sinking.

In the first paper, Sam Goodwin explained the methods adopted at Beatrix Gold Mine — 'Concurrent Shaft Station Equipping during Sinking' by S. Goodwin and E. Simpson. During sinking, the service winder is generally under-utilized; with careful planning and good organization it can therefore be used for station equipping without delaying the sinking. Two simple calculations were given to indicate the significant financial benefits that could accrue from the successful implementation of this procedure.

The second paper, 'Pre-sinking Harmony No. 4 Shaft with the MATLA Headgear', was presented and written by Sam Preston. To replace stope face in the north section and open up the north-eastern section of the mine, it had been decided that a new twin-shaft system should be sunk. An estimated two months was saved on the project by making use of the MATLA sinking headgear, which enabled pre-sinking operations to continue while the permanent sinking headgear and service winders were being installed.

Labour Control

The magnitude of the problems in controlling a diverse and complex labour force on a very large mine were reviewed by Gerry Emère in his paper 'The Introduction of a Computerized Labour Control System on Harmony Gold Mine'. Harmony employs some 27 000 Black workers, drawn from ten different areas of Southern Africa, to produce 7 Mt of ore per year. The recently

enhanced sophistication of work categories, training, pay scales, leave, unemployment, death benefits, etc., has made efficient manual control impossible. A computerized system known as EXTAS is in the process of implementation, and combines effective recording of attendance, maintenance of records, and the production of status and other reports.

Operational Research in Mining

The paper 'The Use of Operations Research Techniques to Assist Mine Planning and Control' by M. Splaine, S. J. Brenner, and M. A. Field was presented by Mike Splaine, and concentrated on the application of four operations research techniques. To illustrate their potential value in the mining field, Mike described practical case studies. In one example, simulation had been used to minimize the cost of an underground tramming system without impairing its efficiency, while the use of linear programming to solve optimization problems was also cited. Many mining situations occur when neither the function nor the constraints are linear and the solution becomes more difficult, and in that case a complex computer system such as 'Goldopt' becomes necessary. The use of control charts enables management to detect trends or changes, but does not give a measure of their significance. The adoption of a statistical technique such as linear correlation analysis can provide such a measure, as was shown with an analysis of daily gold head grades.

Fire Detection

An electronic system for continuously monitoring the underground environment for certain combustion products was outlined in the paper 'The Fire Detection System on Free State Geduld Mines Limited' by P. L. J. Viljoen and D. H. Hofman. The system consists of Beacon combustion particle detectors and Spanair gas analysers, the recordings of which are displayed on a surface console. After early teething troubles, this system is now giving good results.

Drilling Techniques

The drilling of boreholes is an essential part of any exploration undertaking, and the rapid rise in drilling costs could jeopardize many such programmes. In presenting the paper 'Surface and Underground Drilling Techniques as Applied to Exploration', by B. A. Dukas and H. C. Morkel, Hein Morkel discussed the wide range of techniques now available both to increase the accuracy of information and to reduce costs. The paper not only covered drilling techniques, i.e. deep wire-line, coning and non-coning, etc., but examined other factors such as drilling fluids, borehole surveys, and methods of controlling hole deviation.

Batch Cyanidation

Hartebeestfontein Gold Mine uses a reverse-leaching process, i.e. the ore is first treated for the extraction of uranium and the pulp is then treated for the extraction of gold. In his paper 'Neutralization of Acidified Pulps and Subsequent Batch Cyanidation', Brian Broekman described how some of the problems associated with the reverse-leaching system had been investigated and overcome to reduce the loss of gold in plant residues. Im-

provements to the process have increased the dissolution of gold without increasing the cyanide consumption.

To overcome many of the disadvantages of using mercury as a medium for gold recovery, Anglo American Research Laboratories have developed their intensive cyanidation process. Richard Dewhurst discussed the operation and results obtained from such a plant installed at Vaal Reefs East in a paper entitled 'Intensive Cyanidation for Coarse Gold Recovery', by R. F. Dewhurst, S. P. Moul, and J. A. Coetzee. The paper highlighted many of the potential pitfalls in such a new installation, especially with the leaching reactor and the Mintek electrowinning cell. The results achieved in improved gold recovery and reduced health hazards handsomely justified the investigation.

Flotation

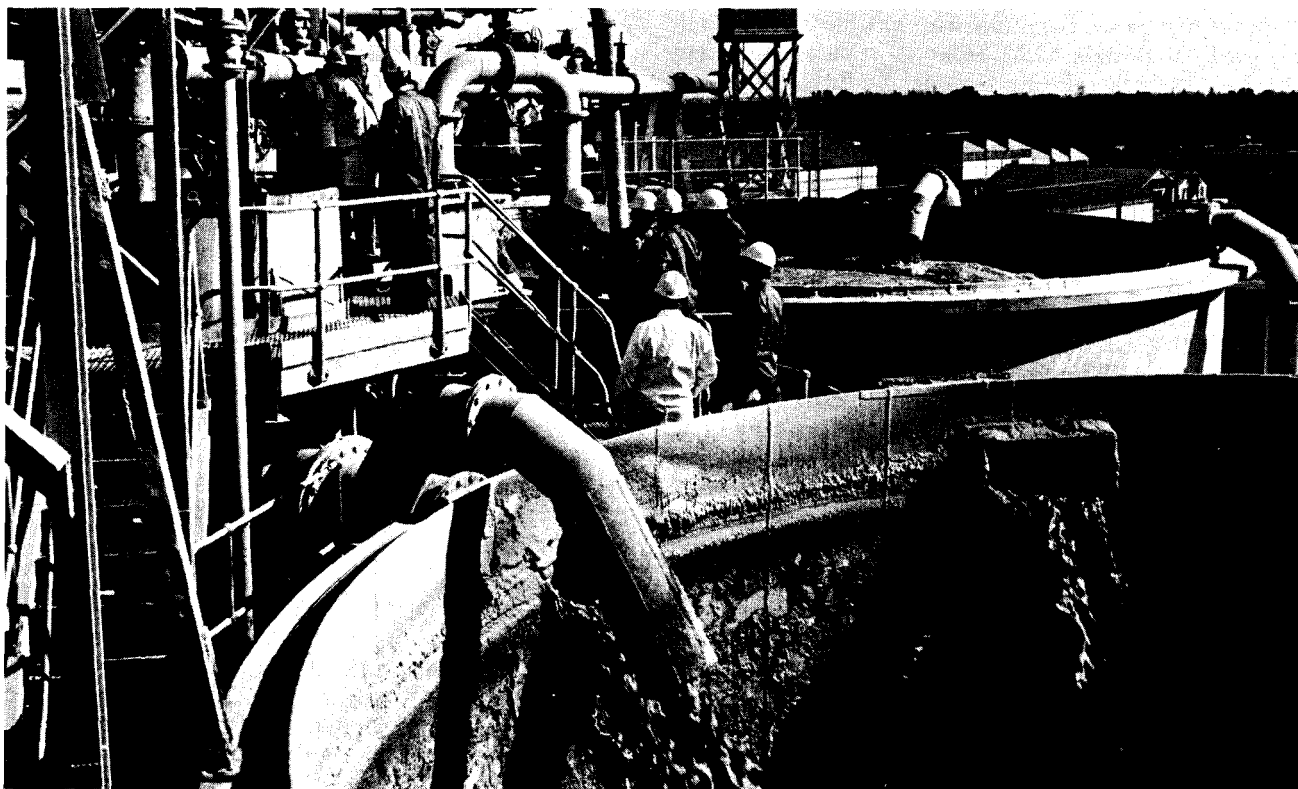
The addition of a mixture of MIBC and paraffin to the normal reagents in a flotation plant in order to improve mineral recovery was outlined by Dr Brian Loveday of Anglo American Research Laboratories in his presentation of the paper 'Improved Flotation of Gold from O.F.S. Residues' by P. A. J. Cabassi, P. K. Radcliffe, and B. K. Loveday. Tests carried out at President Steyn and President Brand have shown an increase in gold production of about 10 per cent. However, similar tests on feed sources from outside the Free State have not produced these improvements, nor has there been any improvement in the uranium recovery, indicating the need for further research.

Gold Recovery Using Carbon

Three papers were presented on the use of carbon in the recovery of gold.

The first paper, 'Problems Encountered during Commissioning of the CIP Plant', written and presented by Andrew Briggs, examined the situation at Beisa Uranium Mine. The initial problem was the presence of wood chips in the circuit, and the inability of the screens to extract these, leading to constant blockages. The introduction of a Mintek tank with a wood-chip elutriator eliminated the problem. The inefficiency of the original air-agitated tanks led to a build-up of material, and these were replaced by mechanical agitators. The carbon losses were drastically reduced by the use of EPAC (equalized-pressure air-cleaned) screens. Long elution times also affected the capacity of the circuit, and difficulties were encountered with the imported electrowinning cells. The adoption of the Mintek steel-wool cell, the proposed installation of a dewatering classifier, and the revision of the kilns will overcome this problem.

The next two papers indicated how gold that had previously been lost to waste could be recovered. Brian Strong presented his paper 'The Use of Carbon Columns for Additional Gold Recovery', which described the recovery of gold from filtrate at Vaal Reefs West Plant. Some 72 kg of gold were recovered over a three-month period, which had paid for the capital cost of the plant. A similar plant is now in operation at Vaal Reefs East. In the second paper, 'The Use of a NIMCIX Carbon Column to Recover Gold from Metallurgical Plant Waste Waters' by F. C. Harvey and R. A. V. Smith, Chris Harvey described the recovery of gold held in solution in plant waste water by use of a Mintek open-bath electrowinning cell. Although the design has not been finalized, the recovery of gold, silver, and copper



Visit to the acid plant at President Brand Mine

with this process has more than justified the costs involved.

Harmony Plant

The final paper of the colloquium was that by Dr E. Kirby and V. W. Hills, 'Recent Advances in Metallurgy at Harmony Gold Mining Co. Ltd'. Evan Kirby examined in detail the design and operation of a new uranium plant at Merriespruit. The Virginia plant had a large amount of calcines, both in stockpile and from the acid plant, which could not be treated in the gold plant. A CIP plant was erected to treat some 18 kt per month, and was commissioned in October 1981. The success of Western Deep Levels in recovering gold from regen. aqueous solution (i.e. spent solution from the regeneration of solvent), encouraged Harmony to adopt a similar system, leading to the recovery of 14 kg of gold in the first five months. Following tests, a plant is planned to recover gold from non-acid filtrate, and testwork is under way to recover gold from roaster-bed calcines. Work is also in progress to reduce acid consumption at the Harmony Plant, and to improve the gold recovery by reducing the roaster temperatures on calcine plants.

Mine Visits

Delegates spent the second day of the colloquium visiting various Free State Mines.

Free State Geduld

Twenty-four delegates visited the new five-shaft complex. After an underground visit, which included a

close examination of the water-reticulation system, the visitors were shown around the shaft crush and the new hostel. Of special interest were the arrangements in the elliptical shaft of 10,6 by 9,6 m utilizing 4 skips and 4 cages, and with a hoisting capacity of 280 kt per month. The raise-bored water dams, which were very effective, were also of interest.

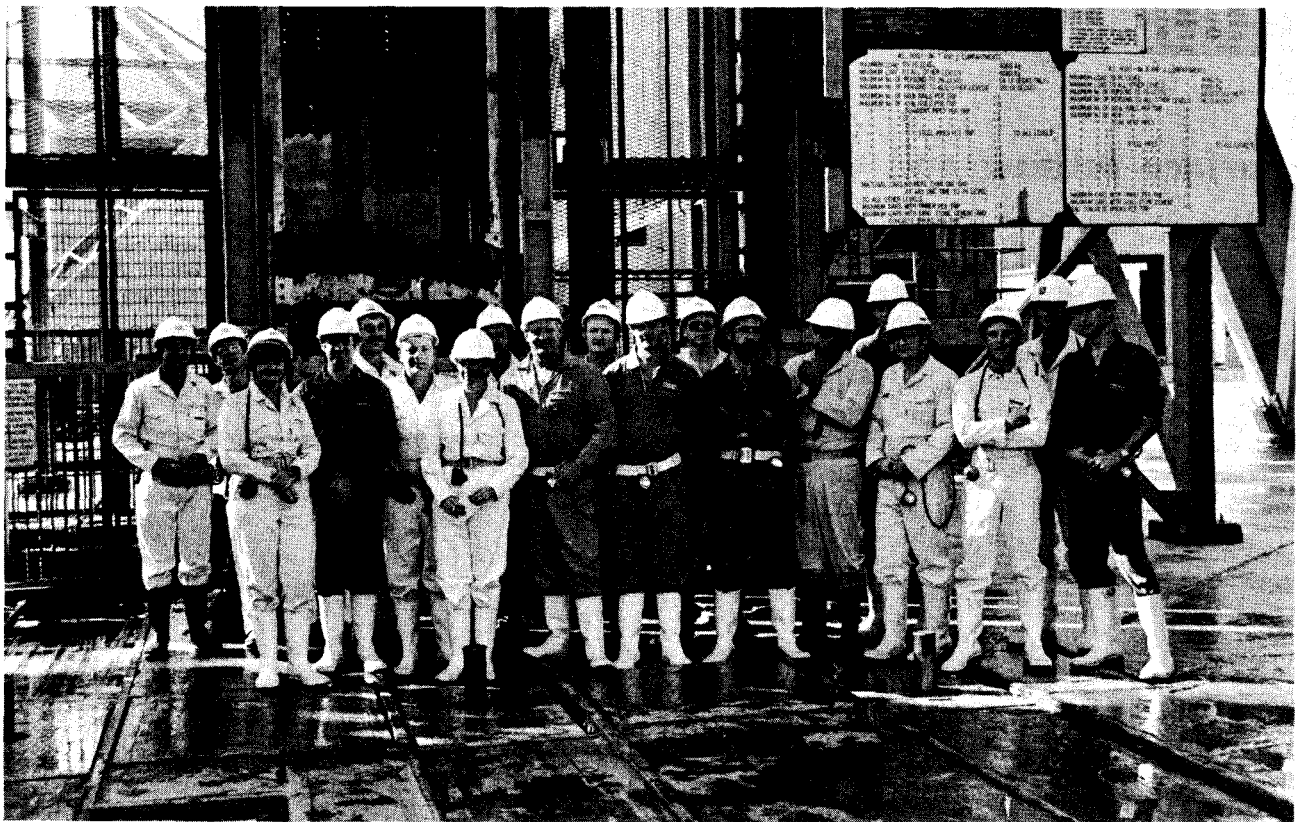
President Steyn

Visitors to President Steyn Gold Mine were given a detailed picture of the programme followed by the mine over the past five years to improve the underground environment. During this period, the mine reduced the stope-face wet-bulb temperature from 30,2 to 28,5 °C. In the same period, production and productivity increased by 21 and 38 per cent respectively, and accidents decreased by over 50 per cent.

Harmony Gold Mine

Twenty-three delegates visited the metallurgical complex, and saw many of the changes and improvements highlighted in Dr Kirby's paper. The visit concentrated on the Virginia carbon-in-pulp plant, which is virtually trouble-free in its operation, and the Merriespruit uranium plant, which is designed to treat 200 kt of slime per month.

Other delegates visited the No. 2 and 4 shafts. At No. 2 shaft, the computerized crush control system was seen in operation. Delegates were left in no doubt that they were seeing something which could well be considered by all gold mines in the not-too-distant future. Unfortunately, the MATLA headgear had been removed from No. 4 shaft;



Well-acquainted visitors at President Steyn Mine

nevertheless from the explanations provided in the earlier paper, the advantages could be clearly seen. The visit ended with a look at the new hostel complex, which is being built with precast sections.

Conclusion

The organizers and their hosts in the O.F.S. are to be

congratulated on the quality of the papers and the mine visits, which demonstrate the progress made in the Free State Goldfields, and on the social activities, including the cocktail party and the banquet, which enabled both delegates and hosts to discuss mutual interests in a convivial atmosphere.

Mechanization of mining

The South African Institute of Mining and Metallurgy is to hold a one-day colloquium on 'Developments in the Mechanization of Mining Operations' during September 1984.

The technical programme will emphasize recent developments in the mechanization of mining operations in South Africa. Both surface and underground mining will be covered. Those interested are invited to submit titles for proposed papers, together with a brief synopsis of not more than 250 words outlining the content and conclusions of their papers. Papers should relate to examples, case histories, or concepts of mechanization, and could cover, *inter alia*, sampling, drilling, blasting, cleaning, support, and transport within the underground

or open-pit environment.

These papers will be considered for publication in the *Journal of the South African Institute of Mining and Metallurgy*, and the standard of the papers will therefore have to meet the requirements of the Institute.

Synopses must be submitted for approval by 13th January, 1984, along with the author's intention of attending the colloquium. It is proposed that each author will have approximately 20 minutes for the presentation and discussion of his paper.

All enquiries and synopses should be forwarded to: The Secretary, The South African Institute of Mining and Metallurgy, P.O. Box 61019, MARSHALLTOWN, 2107.

Surface mining and quarrying

The Second International Surface Mining and Quarrying Symposium is being organized by The Institution of Mining and Metallurgy in association with the Institute of Quarrying. It will be held in Bristol, England, from 4th to 6th October, 1983.

Some 45 papers covering a wide range of surface-mining and quarrying activities will be presented during the three days of technical sessions. Particular emphasis will be placed on geotechnics, slope stability, design,

planning, in-pit crushing, drilling, blasting, dredging, ore-reserve estimation, ground water, mine planning by the use of computers and graphics, bucket wheel excavators, and site rehabilitation.

Four alternative one-day technical visits are planned for 7th October in south-western England and Wales.

Further details are obtainable from the Secretaries of The South African Institute of Mining and Metallurgy.