

# Mining and the environment

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In recent years, a great deal has been written and spoken, both in our country and overseas, about the dangers posed to the environment and the ecology by mining operations. The object of this address is to put this problem, and it is a real problem, into reasonable perspective.

I shall try to present the various facets that merit consideration as objectively as possible. In doing so, I shall examine the following factors:

- (1) the importance of mining to South Africa,
- (2) the dangers posed to the environment by mining operations,
- (3) the measures that have already been taken by the authorities and the mining industry to minimize and combat this problem, and
- (4) some examples of what can be done in the future, not only to minimize the problem, but to improve the environment as a result of mining operations.

## Importance of Mining to South Africa

Few countries in the world are as richly endowed with mineral wealth as is South Africa. Although the country's surface amounts to only 0,8 per cent of the earth's land surface, its mineral deposits are comparable in variety and magnitude with those of the world's great nations. Without these deposits, we in South Africa would not have attained our present high standard of living.

This is borne out by the fact that in 1976 the mining and mineral contribution accounted for 12,5 per cent of the gross domestic product, whilst minerals were responsible for about two-thirds of the country's total exports. It is estimated that the mineral production for 1977 could exceed R5000 million. Statistics show that South Africa has the largest known deposits of gold, platinum, chromium, manganese, vanadium, and fluor spar, as well as rich deposits of antimony, asbestos, coal, copper, diamonds, phosphates, titanium, uranium, zinc, and vermiculite.

The energy crisis in 1973 brought a sudden realization of the finite nature of the world's mineral reserves and resources, and of the advantage that some countries have over others. In this respect, we are richly favoured by having 51 different minerals of which 19 are considered to be of strategic value.

Although gold is still South Africa's most important mineral and its biggest money-spinner, important developments have been taking place in regard to our base minerals. The most significant of these developments has been the commissioning of the new harbours of Saldanha Bay and Richards Bay for the export of iron ore and coal respectively. South Africa has now become competitive with other suppliers of such

minerals, and valuable foreign exchange is being earned through these ports, amounting during the past year to some R350 million.

But I am sure that it is not necessary to press this particular point. I think we all agree that mining is vital to the future prosperity of our country.

## Dangers Posed to the Environment by Mining Operations

As we develop our mineral deposits by means of mining and beneficiation operations, disturbances to the environment are bound to occur, and these will upset the delicate balance of nature. An example with which most of us are familiar are the slimes dams and tailings dumps found on the gold mines of the Witwatersrand. Here, where there is continuous contact between water, air, and finely ground siliceous and pyritic material, oxidation occurs, rendering the water strongly acid. This leaches out calcium and other salts from the slimes. Such acidic effluents enter the Vaal River, and have to some extent destroyed the former biological and hydrological ecosystem of the river and its tributaries. The result is a mineralized hard water. Power stations, cooling systems, and even housewives suffer as a consequence.

Associated with this disturbance is the occurrence of white clouds of dust on windy days that originate from the surface of dry slimes dams, resulting in dangerous silica dusts enveloping towns and private dwellings, often in higher concentrations than those found underground.

Coal mining has also damaged the ecology of our public streams, which have been contaminated by acid and other leached-out salts. A further nuisance is sulphurous fumes emanating from burning waste-dumps. These, in addition to having an obnoxious smell, combine with atmospheric moisture, and corrode buildings and steel structures.

One of the first changes noticed in mining operations is the change to the surface surroundings. In the case of strip or quarry mining, large unsightly open quarries and dumps appear, followed by beneficiation plants, slimes dams, rock dumps, and spoil heaps. These operations can give rise to much dust if not controlled.

At the Iscor iron ore mines, the ore is insoluble in water and causes no problems with dissolved solids, but the fine red dust colours the water used and, if permitted to enter a stream, could colour it for long distances.

Where roasting and combustion processes are carried out, atmospheric problems arise from fumes and smoke. Such conditions can affect vegetation, agricultural crops, streams, buildings, and often the inhabitants of the area concerned.

Die verlagings van die watertafel en verdwyning van ondergrondse water is dikwels die gevolg van mynbou. 'n Tipiese voorbeeld is dié van die Verre-Wesrand se goudmyne, waar die dolomitiese kompartemente droog-gelê moes word. Die gevaar van insinkings maak die

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grond onbewoonbaar en selfs ongeskik vir boerdery. 'n Ander voorbeeld hiervan is die ou steenkoolmynvelde in die omgewing van Witbank, waar daar ook insinkings plaasvind.

Stroopmynbou is tans baie gewild, veral by die ontginning van steenkool wat naby die oppervlak voorkom. Hierdie metode kan lei tot 'n herwinning van 95 persent van die steenkoollae, terwyl die topografie en plantegroei daarna herstel kan word.

Ander faktore wat voorheen as onbelangrik beskou is, is dié van geraas en selfs vibrasie. Groot oopgroefmyne maak gebruik van swaar toerusting wat verantwoordelik is vir geraas en stofprobleme, 24 uur per dag, ses dae per week, jaar in en jaar uit. Selfs die boorwerk en skietwerk word op groot skaal gedoen, met versteurings as gevolg van geraas.

### Maatreëls om die Probleem te Bestry

Alvorens mynbou en mineraalherwinnings 'n aanvang neem, is 'n ekologiese studie 'n vereiste om kennis in te win van al die faktore in die beplande gebied. Hiervoor benodig die maatskappy die dienste van 'n ekoloog en ander spesialiste. Sake soos fisiese, biologiese, menslike en ekonomiese kenmerke moet ondersoek word saam met die infrastruktuur, asook sake betreffende bewaring en beskerming van die omgewing, voor, gedurende en na die sluiting van 'n myn. Finansiële voorsiening vir restaurasie behoort ook van 'n vroeë stadium af gemaak te word.

As leidraad vir die ontwikkeling en bedryf van 'n myn is daar heelwat regulasies wat sorg vir die voorkoming van wantoestande en vir die nodige beskerming van die omgewing. So is daar bv. die Waterwet van 1965, en die Wet op Omgewingsbeplanning van 1967, asook die Wet op die Voorkoming van Lugbesoedeling van 1965.

Die Kamer van Mynwese het, in samewerking met die Staatsmyningenieur, 'n kode gepubliseer oor die herstel van oppervlakke wat deur oopgroefmynbou versteur is — 'n bewys van die mynbedryf se erns in hierdie saak.

Twee organisasies wat baie aandag gee aan bewaring van ons bodem is Veldtrust en die Landbou-Unie, wat reeds gesamentlike vergaderings met die mynbedryf gehou het. In 1971 het Veldtrust 'n simposium oor hierdie saak gehou, en daarna 'n waardevolle boek gepubliseer onder die titel 'Habitat RSA'. Latere simposia het weer gegaan oor 'Herverbruik vir Voortbestaan' en oor 'Mynwese en Landbougrond'.

In September 1976 het die Transvaalse Landbou-Unie 'n konferensie gehou oor Mynaangeleenthede. Daar is indringend gekyk na talle faktore in mynbou en die invloed daarvan. Dit ly geen twyfel dat daar 'n goeie wedersydse begrip van die probleme van albei partye is nie. Daar bestaan 'n duidelike behoefte om deeglik na te dink oor beheer wat nou toegepas moet word en moontlike verdere wetgewing vir die nodige beskerming van die hele omgewing.

Op hierdie tydstip het die Minister van Mynwese en Arbeid 'n komitee benoem om hierdie sake te bestudeer en 'n gedragskode op te stel. Hierdie komitee verteenwoordig die Kamer van Mynwese, die Staatsmyningenieur, die Departement van Landbou en Tegnieese Dienste en die Landbou-Unie, en het die kode wat reeds

deur die Kamer van Mynwese opgestel is in beginsel aanvaar, met sekere klein veranderings.

### Verbetering van die Omgewing

Daar is nou groot verwagtings dat steurings wat veroorsaak word, minimaal sal wees en dat groot dele landbougrond wat in die verlede verlore geraak het, herstel sal word en weer as landbougrond gebruik sal kan word. Hierdie vooruitsig is baie belowend in die geval van stroopmynbou waar uitgewerkte groewe deurlopend opgevolg word met grond wat uit vars uitgrawings kom. Die mikpunt is dat sulke uitgrawings finaal bedek behoort te word met bogrond, wat deurlopend vir hierdie doel eenkant opgeberg word.

In die geval van alledaagse oopgroefmyne mag dit onprakties en uiters duur wees om diep uitgrawings weer op te vul. In sulke gevalle, soos bv. Yskor se nuwe Grootegeluksteenkoolmyn te Ellisras, sal uitskothope bedek word met bogrond, en gras en bome wat natuurlik sal inpas by die omgewing sal aangeplant word. Uitskotsteenkoolmateriaal sal met afvalgrond gemeng word om verbranding te voorkom, en sal ook met gras bedek word. Mettertyd, as die groef sy doel gedien het, kan dit met water opgevolg word en as ontspanningsoord gebruik word. So 'n ontspanningsoord in die bosveld sal baie gewild wees, veral gedurende die wintermaande.

Die oop groewe by die Sishenmyn kan, nadat dit uitgedien is, opgevolg word met die groot hoeveelheid ondergrondse water wat nou reeds dag en nag uitgepomp moet word. Vir die inwoners van die Noordwes-Kaap sal dit 'n aangename ontspanningsoord wees waar gehengel, geswem en met hote gevaar sal kan word.

Met betrekking tot landskapverfraaiing en stofbekamping kan met trots verwys word na die welslae van die grasbedekking van die sliedamme en afvalhope van ons goudmynbedryf, 'n tegniek wat deur die bedryf self ontwikkel is en toegepas word.

### The Future

You have, no doubt, recently read about the high-grade deposits of coking coal that have been found in the Venda Homelands in the north-eastern Transvaal. There are indications that good deposits may also be present in the far northern portion of the Kruger National Park, and, in accordance with instructions from the Department of Mines, limited stratigraphical diamond drilling is now being carried out by its Geological Survey Section, as has been done in other national parks. The disturbance caused by the drilling will be very small, and, after the cores have been removed, the holes, which contain water, could become useful sources of water for game.

It would appear that some of these holes, twelve of which have been drilled to date, have intersected high-grade coking coal. Under the circumstances, it is to be expected that a primary steel producer such as Iscor would take a keen interest in the proceedings. To suggest, however, that a large section of the Kruger Park is in imminent danger of being mined and despoiled is, to say the least, unwarranted. These, then, are the facts.

(1) The area in question is extremely remote from existing infrastructure, and the establishment of a mine would be very costly.

- (2) Iscor is concentrating its drilling programme in an area lying roughly between the Beit Bridge–Pretoria railway line and the western border of the Kruger National Park, with a view to keeping future developments as close as possible to the existing infrastructure.
- (3) Iscor is proceeding with the development of the Grootegeluk blend-coking coal mine near Ellisras. It is also considering opening up a mine in the Soutpansberg area, on the western border of Vandaland, to produce straight coking coal. These two mines should produce some 3 million tons of metallurgical coal per year, which should meet the Corporation's requirements up to at least 1983. After that date, consideration will be given to other deposits in the same general area.
- (4) Apart from studying the Geological Survey's drilling data pertaining to the Kruger National Park as they become available, Iscor has not even considered the advisability or practicability of conducting mining operations in the Reserve. Should this eventuality ever arise, and my guess is that it will not do so for many years to come, one would imagine that the procedure would be more or less as follows.
- (a) Permission would have to be obtained from the relevant authorities, which will entail amendment of the Act.
  - (b) The authorities responsible for our national parks have a proud record of successful conservation and the continuing improvement of facilities provided for the general public. Far be it from me to attempt to teach these professionals how to discharge their duties, but I imagine that, if ever they were to agree to mining operations in one of our reserves, they would impose stringent conditions. The following tentative points come to mind:
    - the area to be mined at any one time would have to be limited, say to 50 or 60 km<sup>2</sup> (the total area of the Kruger Park is 19 000 km<sup>2</sup>);
    - the mining company would have to offer an exchange of suitable and acceptable ground;
    - royalties would have to be paid, which would doubtless be ploughed back into conservation;
    - during mining, disturbance to the environment would have to be kept to a minimum, and maximum levels of noise, dust, and fumes would have to be laid down;
    - after completion of the mining, all the dumps would have to be covered with soil and revegetated, and all the surface structures would have to be removed;
    - finally, the restored ground would have to be handed back to the authorities for re-incorporation in the Reserve.
- When, if ever, such arrangements are being considered, the general public and other interested bodies will presumably be informed, and will be given ample opportunity to comment and come forward with suggestions.
- Judging by the experience gained in many countries of late, there is no doubt that countryside that has been disturbed by mining operations can be restored to its original state with a minimum loss to all the parties concerned. There is already a sincere appreciation and understanding between mining on the one hand and agriculture on the other. With our regulatory control, codes of practice, and experience in re-establishing disturbed areas, there is every reason to believe that mining practice in this country will continue to limit itself to a minimum of disturbance to the environment.

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## Book review

National Coal Board. *Gate belt conveyors*. London, H.M.S.O. (Price 95p.)

Although the preface of this handy little book states that it has been written for the guidance of mining-operation trainees, it will prove valuable to the practising engineer as well.

Beginning with a general description of the belt conveyor and an explanation of terminology, the manual then outlines the method of installing and extending a gate belt, and details its operational maintenance and care. The appendix contains some useful information on lifting appliances suitable for gate-belt conveyor installation and extension.

There are some 38 excellent blue and black drawings illustrating the text, which is both succinct and readable. It should be pointed out that the book was written primarily with U.K. longwall-mining layouts in mind, but the various operations described are also applicable to bord-and-pillar working.

At R1.43 (post-free in the U.K.) the book is a bargain, and it is to be hoped that publications of a similar standard on such subjects as trunk conveyors will follow.

R.H.B.

# NIM reports

The following reports are available free of charge from the National Institute for Metallurgy, Private Bag X3015, Randburg, 2125 South Africa.

## Report no. 1733

*A mineralogical investigation of weathered carbonatite from Salpeterkop.* (14th Apr., 1975; re-issued 28th Feb., 1978).

A sample reputed to be carbonatite was investigated mineralogically for determination of the mode of occurrence of niobium, zinc, and thorium in the sample.

The sample was found to consist of earthy goethite cemented largely by opaline silica.

Niobium was present in varying amounts in ten minerals, of which brookite was the most abundant. It had a niobium content of 6 to 12 per cent. Recovery of the brookite would be difficult because 80 per cent of the grains are smaller than  $30\mu\text{m}$ .

Small amounts of thorium are present in small grains of thorite and thorianite.

No discrete zinc-bearing minerals were encountered. Zinc was mainly associated with goethite in the ground-mass of the sample.

A large variety of other minerals were identified, but none was present in economic proportions.

## Report no. 1823

*The recovery of gold and pyrite from a residue dump at Crown Mines.* (10th Jul., 1976; re-issued 28th Feb., 1976).

The application of ore-dressing methods to a residue dump at Crown Mines has been examined. The use of either single-stage or double-stage gravity concentration is advocated for the recovery of the gold. Flotation and wet high-intensity magnetic separation (WHIMS) are not recommended.

The two-stage gravity process facilitates the recovery of most of the pyrite in the residue (over 70 per cent) at commercial grade (40 per cent sulphur), but sacrifices some of the gold obtainable by a single-stage operation. There is little prospect of the commercial recovery of uranium from the dump at Crown Mines.

## Report no. 1829

*An investigation of weathered carbonatite from Salpeterkop.* (20th Jul., 1976; re-issued 28th Feb., 1978).

In the four samples investigated, the composition of the brookite was found to vary from 71 to 86 per cent  $\text{TiO}_2$ , from 6 to 16 per cent  $\text{Nb}_2\text{O}_5$ , and from 5 to 12 per cent  $\text{FeO}$ , with small amounts of calcium, silicon, and potassium.

Yttrium was found to be distributed at random in the fine-grained matrix of the samples and in weathered products of the original primary minerals. Yttrifluorite and xenotime were the only discrete yttrium-bearing minerals, but the grains were smaller than  $8\mu\text{m}$ .

A partial chemical analysis indicated a possible fluorite content of 8,5 per cent and a barite content of 3,7 per cent in one of the samples.

In exploratory tests on the concentration of the ore

samples by gravity, flotation, and magnetic methods, no significant concentration of niobium was obtained.

## Report no. 1932

*A BASIC computer programme for the evaluation of intensity data from the Telsec Lab-X-250 Analyser.* (12th Jan., 1978).

A programme is described that requires 5,8 K of memory and is designed for the processing of the values determined by Telsec Lab-X-250 Analyser for iron, copper, zinc, and lead in products from the beneficiation of sulphide ore. The programme tests the precision of replicate difference counts and applies corrections for spectral overlap, instrumental drift, and day-to-day variations, thus increasing the precision and accuracy, reducing the total measuring time, and eliminating the need for daily adjustment of the instrument and frequent recalibration. A family of linear calibration graphs is used in the evaluation of the corrected measurements. As the programme is written in a fully conversational mode, both the Analyser and the terminal can be used successfully by an operator of relatively low skill.

A detailed description is given of the programme, as well as instructions for the user and guidelines for the ready adaptation of the programme to other analytical applications.

## Report no. 1940

*The extraction of the noble metals with *n*-octylaniline, and its application to the analysis of platinum-bearing materials.* (30th Jan., 1978).

A study was made of the extraction of noble metals with *n*-octylaniline at varying normalities of different mineral acids, and optimum conditions were established for their separation from the base metals commonly present in platinum-bearing materials. The noble metals, with the exception of gold, can be back-extracted with perchloric acid and determined by atomic-absorption spectrophotometry. The procedure was successfully applied to the analysis of mattes, sludges, and flotation concentrates. The lower limit of determination in such materials is 100 p.p.m. for platinum and iridium, 40 p.p.m. for ruthenium, and 10 p.p.m. for palladium and rhodium. Gold was not determined.

## Report no. 1945

*Analyses of the NIMROC reference samples for minor and trace elements.* (28th Feb., 1978).

The results are given of all the determinations made by the cooperating laboratories of minor and trace elements in the 6 NIMROC rock samples prepared by the National Institute for Metallurgy in 1966. Relevant statistical data and a graphical display of the distribution of the results are given for the sets of results for each element.

Recommended values are given for those elements in which the number of results and their quality are reasonably acceptable. A description is given of the procedures that were used in the estimation of these recommended values.

## International futures conference

A conference entitled 'The Road Ahead' is being organized by the 1820 Settlers National Monument Foundation to be held in Grahamstown from 3rd to 7th July, 1978. This multi-disciplinary conference will look at the future, its objective being an examination of the major global problems and challenges mankind will face over the next few decades, and their relation to the Southern African situation in particular.

The delegates will be men and women who make and influence policy in all fields of private and public enterprise. Their position and responsibilities demand an understanding of probable future developments not only within the confines of their own particular vocations but over a much broader spectrum of human endeavour. Such understanding must improve professional productivity and mutual awareness, and make planning more meaningful. The majority of delegates will represent

Academic and Educational Institutions  
Business and Professional Organizations  
Commerce and Industry

Government and Quasi-government Bodies  
Labour Organizations  
The Media  
Research Institutes  
Religious Organizations  
Scientific and Technical Associations  
Socio-Cultural Bodies.

The conference structure comprises five principal areas of interest:

- (i) Natural resources and the environment
- (ii) Community needs — facing the realities
- (iii) The international economic order
- (iv) Human values and social change
- (v) The changing world order.

There will be keynote addresses at daily plenary sessions, while parallel sessions throughout the conference will enable delegates to follow their own particular interests.

Enquiries should be directed to The Conference Officer, P.O. Box 304, Grahamstown 6140.

## Conference of metallurgists

The technical programme has been established for the 17th Annual Conference of Metallurgists sponsored by the Metallurgical Society of the Canadian Institute of Mining and Metallurgy. This year the Conference will be held in Montreal, Quebec, on 27th to 31st August, 1978, together with the 8th Hydrometallurgy Meeting.

Symposia on uranium, titanium, and hydrogen in metals will be featured as part of the programme, each consisting of three sessions and including specially invited papers. The following technical sessions are planned by the individual sections of the Metallurgical Society.

### Basic Science

Interfacial Phenomena in Metals	Sargent and Kirkaldy
Kinetics of Metallurgical Processes	Brimacombe and Pelton
General Physical Metallurgy	Bailon
General Chemical Metallurgy	Masson and Toguri
Iron and Steel	McLean and Guthrie
<i>Non-ferrous Pyrometallurgy</i>	
Physical Chemistry in Non-ferrous Pyrometallurgy	Ajersch and Fairweather
Physical Chemistry and Process Metallurgy	Ajersch and Dugdale
Process Metallurgy	Dugdale and Webster
Titanium Symposium	Lee and Solar

### Hydrometallurgy

General Hydrometallurgy	Stanley
Corrosion in Hydro-metallurgy	Berkovitch and Moniz
Solvent Extraction — Ion Exchange	Lackshmanan

8th Hydrometallurgy Meeting Uranium	Dutrizac and Cooper
<i>Materials Engineering</i>	
Coated Steels	Hyam
Heavy Sections for the Energy Industry	Hunt
Weld Quality in Automatic Welding	Goldak
ASM Hydrogen in Metals Symposium	Tyson
Materials Performance in High-temperature Aggressive Environments	Mills
New Developments in the Forging Industry	Gagnon
<i>Corrosion</i>	
Materials for Scrubbers	Moniz
Corrosion in Hydro-metallurgy	Berkovitch and Moniz
Abrasion-resistant Materials	Moniz and Bruce
<i>Minerals Engineering</i>	
Abrasion-resistant Materials	Moniz and Bruce
Minerals Engineering	Bruce
<i>Iron and Steel</i>	
Continuous Casting in the 80's	Tomson
Billet Quality	Hutchison
Basic Science — Iron and Steel	McLean and Guthrie

The final technical programme with titles and authors of the papers will be published in the June issue of the *CIM Bulletin*; the complete programme including abstracts will be featured in the July issue of that publication.