Book review

Pearson, J. S. *Ocean floor mining.* Park Ridge (New Jersey), Noyes Data Corporation, 1975. 201 pp.

In this age when doubts are being expressed about the continued availability of mineral resources in the foreseeable future, the ocean floors offer an unexploited source of vast quantities of minerals — in particular manganese, nickel, cobalt, copper, lead, zinc, silver, and gold.

In precise technical detail that reads like science fiction, John S. Pearson gives a broad range of information on the current known distribution patterns and possible exploitation techniques of these resources under the following headings:

— Geography of ferromanganese nodule deposits
— Technology relating to manganese nodule recovery
— Off-shore mining
— Studying the environmental impact
— Economic considerations
— Legal considerations.

It becomes abundantly clear from this well-documented technical volume that ocean-floor mining is destined to become an important factor in the World's supply of minerals — not only to those directly involved in the business of exploiting the mineral wealth, but also to the rest of the Earth's population who will be indirectly affected by the impact on World markets of the minerals so produced; by the ecological consequences of disturbing the ocean floor and disposing of mining and treatment wastes; and by the legal complexities of the ownership and control of these reserves.

H.M.W.

NIM reports

The following reports are available free of charge from the National Institute for Metallurgy, Private Bag 7, Auckland Park 2006.

Report no. 308

A mineralogical study of gold particles in pulp residues from the Bracken Gold Mine. (7th Mar., 1968. Re-issued Oct. 1975.)

The size, association, and physical condition of gold particles in pulp residues from the Bracken Mine were examined. The gold occurs as thin plates and wirelike inclusions in the gangue, and ranges from 7 to 500 microns across. In the pulp residues it occurs mainly as free particles, but a few inclusions in the micaceous minerals were also observed.

For comparison, an investigation of ten polished sections of original ore from the Kimberley Reef, Bracken Mine, was undertaken. This study showed that approximately 75 per cent of the number of gold grains observed were smaller than 20 microns. The gold grains in the original ore were found to be untarnished and generally associated with gangue minerals, i.e., quartz and phyllosilicates. The gold particles in the pulp residue, on the other hand, were mostly tarnished; and, since the tramp iron in this pulp was in a highly oxidized state, it is considered that this is the cause of the formation of the tarnished layers on the gold particles. Treatment with dilute nitric acid was found to remove this oxidation layer.

It is considered that this film of iron oxide inhibits the dissolution of the gold grains on which it is present.

Report no. 377

Examination of pulp samples, treated with cyanide, for coated gold. (7th Aug., 1968. Re-issued Oct. 1975.)

Gold particles in pulp samples and concentrates from the Winkelhaak and Bracken Gold Mines were found to be enveloped by coatings, probably iron oxides. It was observed that the presence of metal shavings as contaminants in the sample investigated was probably responsible to a large degree for the coated condition of the gold particles. The degree of oxidation of the metal shavings appears to be directly proportional to the degree of coating of the gold particles; the more oxidized the metal shavings, the heavier the coating on the gold particles. It was found that the heavily coated gold grains were feebly magnetic, and this indicates that this coating probably stems from the oxidized magnetic metal shavings.

All the gold particles observed in concentrates obtained from the cyanide tanks of the Winkelhaak and Bracken Gold Mines were enveloped by a heavy coating. In both samples, the metal shavings were also highly oxidized. The fact that no particles of uncoated gold were found in these two concentrates indicates that the uncoated gold must already have been dissolved when the concentrates were taken from the cyanide tanks.

Report no. 385

The determination of the nature of coatings on gold particles. (2nd Aug., 1968. Re-issued Oct. 1975.)

Gold concentrates from the lining of a tube mill at the Kinross Mine were investigated with the electron microprobe, and three ways in which elements occurred in the gold could be distinguished.

Silver and copper were the major elements in solid solution. In addition, traces of nickel and cobalt were found in heavily coated grains, cobalt and sulphur in medium-coated grains, and cobalt, nickel, sulphur, and manganese in lightly coated grains.

Iron and manganese were the major elements found as coatings on the heavily and medium-coated gold grains, whereas the lightly coated grains contained only iron. Traces of nickel, cobalt, sulphur, and silicon could also be present as coatings.

Small local concentrations of elements were present as inclusions of minerals in the gold grains. These minerals were identified as quartz, aluminium silicates, pyrite or

pyrrhotite, and chalcopentlandite.

The investigation proved that the reddish-brown coating on gold grains consisted mainly of iron oxide and manganese oxide.

Report no. 452

The Purlex Process — a description of the pilot plant leading to the use of the process in South Africa. (13th Jan., 1969. Re-issued Oct. 1975.)

This report briefly describes the pilot plant and highlights the important findings of the testwork. Particular attention is paid to the problems that arose during the two-year period of operation and the steps taken to solve these problems.

Average values are given for the important parameters in the various test periods.

Report no. 482

Review of work on the treatment of pegmatites. (9th Apr., 1969. Re-issued Sep. 1975.)

A review is given of the work on the treatment of pegmatites that has been carried out at the National Institute for Metallurgy since 1964. Experimental work on the flotation of pegmatites has not resulted in any solution to this problem. However, the Institute's policy of providing assistance and advice to pegmatite producers has been encouraging. This policy led to a study of the following subjects: mechanical concentration, spodumene recovery by heavy-medium separation, dry concentration for the recovery of spodumene and tantalite—columbite, and the recovery of tantalite—niobium minerals, mica (muscovite), lepidolite, and beryl by various methods.

Report no. 1443

Gravity concentration tests on four samples from Tantalite Valley, S.W.A. (5th Jul., 1972. Re-issued Sep. 1975.)

Four samples containing tantalite –columbite were examined. The samples were found to be amenable to gravity concentration procedures. It is predicted that concentrates assaying 60 per cent of Ta_2O_5–Nb_2O_5 can be obtained by jigging at a coarse size, and then regrinding and tabling the jig concentrates.

It is recommended that any further treatment of the materials examined should be done in conjunction with the treatment of any other tantalite-rich ores that may become available from the area.

Report no. 1489

The breakage of Söderberg electrodes. (10th Nov., 1972. Re-issued Nov. 1975.)

In an attempt to formulate a programme of research on the reduction of breakages in the Söderberg electrodes used in the South African ferro-alloys industry, a survey was made of the relevant literature and visits were paid to the manufacturers of electrode paste and to the users of the electrodes.

The major causes of breakage appear to be thermal shock and poor quality of the binder used in the manufacture of the electrode paste. Details of these factors are given in the Appendix.

It is concluded that the National Institute for Metallurgy can do little in the way of research to overcome these problems, which can best be handled by the electrode users and the manufacturers of electrode paste.

Report no. 1545

A mineralogical investigation of leach residues from the Blyvooruitzicht Gold Mine. (22nd May, 1973. Re-issued Nov. 1975.)

It was found that most of the gold is present in the residues as free gold, only a portion of it being visibly coated with oxides and sulphides of iron, manganese, and silver. Of the free-gold grains, more than 80 per cent are smaller than 100 μm, whereas more than 90 per cent of the gold grains included in the gangue minerals, sulphides, and thucholite are smaller than 50 μm.

There is no marked difference between the composition of the free gold in the residues and that of the gold in the original ore.

The overall dissolution rates of a set of coated and a set of uncoated gold grains in a 0,027 per cent NaCN solution do not vary much from one set to the other, but a variation in dissolution rate from less than 1 μm/h to more than 4 μm/h was encountered in the same set. The coatings of coated gold disappeared after a while but re-appeared on some of the gold grains near the end of the leaching experiment.

From this investigation it is apparent that no unequivocal conclusion can be drawn about the reason for the presence of gold in the leach residues. However, a likely reason is that the dissolution during leaching is too slow for the largest gold grains to be completely dissolved in the time allowed.

Report no. 1583

Preliminary tests on winnowing for the recovery of mica. (12th Nov., 1973. Re-issued Sep. 1975.)

This report records the results of the recovery of mica by winnowing from two samples of mica ore. This method of concentration was found to result in mica concentrates containing less than 0,5 per cent impurities.

The mica content of a run-of-mine sample was estimated as 52 per cent, of which 76,0 per cent was recovered as concentrate. Mica finer than 20 mesh was not recovered. A waste-dump sample had a mica content of 23 per cent, of which 52 per cent was recovered as concentrate.

It is concluded that winnowing is eminently suitable for the recovery of mica from an ore, and a treatment procedure incorporating this method of concentration is recommended.

Report no. 1652

The identification of diamonds from Premier, Finsch, and Jagersfontein Mines by statistical analysis of data obtained from instrumental neutron-activation analysis.

Instrumental neutron-activation analysis was used to establish the chemical composition of the impurities in a selection of diamonds from three different sources. Discriminant analysis was applied to a training set of 96 samples representing diamonds from Premier, Finsch, and Jagersfontein Mines, together with six unidentified test samples from these mines, in an attempt to identify the sources of the test samples.

Eighty-five per cent of the training samples were accurately classified when a selection of 16 elements that contributed most to the differentiation of the sources were used. The sources of the test samples were subsequently declared, and it was found that four of the six identifications were correct. If the constraints under which the classification procedure operated are taken into account, the results obtained are even more significant.

Report no. 1723

The determination of zirconium and aluminium in zirconium–aluminium alloys.

A method for the rapid determination of zirconium and aluminium in zirconium–aluminium alloys is described. After dissolution of the alloy in sulphuric acid to which ammonium sulphate has been added, zirconium is determined spectrophotometrically with Arsenazo III by a published procedure. Aluminium is determined on the same solution by atomic-absorption spectrophotometry after a preliminary extraction of zirconium into a chloroform solution of di-(2-ethylhexyl) phosphoric acid (HDEHP).

Report no. 1739

The determination of trace amounts of noble metals in sulphate media.

The determination of noble metals and gold in sulphate media is examined, the sulphate being present as metal sulphate or free sulphuric acid or both. The procedures examined were collection by fire assay, separation by precipitation as the sulphide, ion exchange using phenyl azodiaminopyridine resin, and conversion of the sulphate to free sulphuric acid by cation exchange followed by removal of the acid by evaporation. Each one of the noble metals was finally determined by atomic-absorption spectrophotometry.

Evaporation of the sulphate media to a low volume, and addition of the media to the flux and nickel sulphide used as the collector of noble metals, followed by fire assay, gave low and inconsistent results. Precipitation as sulphides in the presence of copper as a carrier gave recoveries greater than 90 per cent for microgram quantities of all the noble metals except iridium. With the pyridine-substituted ion-exchange resin, similar recoveries were obtained for all the noble metals except gold and rhodium. Conversion of the sulphate ions to free sulphuric acid by ion exchange, and removal of the free acid by evaporation, gave marginally higher recoveries. A high recovery for gold was obtained by use of a separate aliquot portion of the sample and a different ion-exchange resin.

The precision of the last three procedures is similar and ranges from 1 to 12 per cent, depending on the element to be measured and its concentration in the sample solution. Separation of the noble metals and measurement are most rapid when the pyridine-substituted resin is used.

Report no. 1771

The determination of silver, selenium, tellurium, antimony, tin, lead, and arsenic in anode sludges.

Published procedures for the determination of the individual elements have been used as the basis for the compendium of methods presented. These procedures have been suitably modified to extend their applicability to the analyses of anode sludges.

Silver is determined by Volhard's titration, a further correction being made by use of atomic-absorption spectrophotometry. Selenium and tellurium are determined gravimetrically on the same sample solution by precipitation as the elements. Lead is determined volumetrically as the lead chromate after separation of the lead sulphate. Volumetric methods are used for the sequential determination of antimony and tin after the separation of selenium and tellurium by precipitation, and of arsenic by volatilization. Arsenic, after it has been extracted into water, is determined spectrophotometrically by the molybdenum-blue method.

A brief account of the experimental work involved in the development of the methods, and the respective accuracy and precision obtained for each method, is given.

Report no. 1772

A study of copper recovery by lime roasting and leaching.

The National Institute for Metallurgy undertook a programme of research to investigate the feasibility of lime roasting and leaching for copper extraction. This process includes the following major steps: fluosolids roasting, leaching, and electrowinning, limestone being added to the roaster feed to form a compound with the sulphur as calcium sulphate and so prevent pollution by sulphur dioxide.

Laboratory tests were conducted on various copper sulphide concentrates, but the pilot-plant work was done on only one. This latter part of the work was done on the three basic process steps separately and also on a continuous basis in a small pilot plant.

A detailed cost study was made for a proposed flowsheet. Basic assumptions for these estimates included extraction values of 98 per cent for copper and 10 per cent for iron. It was also assumed that no sulphur dioxide was given off and that the concentration of iron determined the size of the bleed stream. Under such conditions, the process was found to be competitive with toll smelting and refining. A conventional smelting–refining process would, however, be still cheaper.

The results obtained indicated that extractions of the assumed order could be obtained in a plant of the scale used. The effects of certain alterations to the original flowsheet on operating costs are indicated, and an outline is given of possible future research should further work on the process be undertaken.

Corrigendum

The Special Issue of Volume 76 of the *Journal* ('Recent Advances in Mineral Dressing, October 1975) should be corrected as follows.

The wording under the photograph on page 42 should read:
Fig. 2—Average rock distribution on Model 16, 20 to 40 mm, 49 t/h.

The wording under the photograph on page 43 should read:
Fig. 1—Average rock distribution on Model 13, 32 to 65 mm, 30 t/h.

THE SOUTH AFRICAN INSTITUTE OF MINING AND METALLURGY

INFORMATION ON MEMBERSHIP

The Institute was founded in 1894 as the Chemical and Metallurgical Society of South Africa. In 1904 it was reconstituted as the Chemical, Metallurgical and Mining Society of South Africa and in 1956 it became the South African Institute of Mining and Metallurgy.

The objects of the Institute are to advance the science and practice of mining and metallurgy, to afford opportunities for the interchange and recording of knowledge of mining and metallurgy, and to ensure high standards of professional conduct and competence.

Membership benefits include monthly issues of the *Journal* of the Institute; meetings, colloquia and symposia, at which papers are read; excursions to mining and industrial concerns; and the use of club facilities at Kelvin House. Technical journals received on an exchange basis are available to members at the Johannesburg Public Library. The current membership of the Institute is over 1700.

Membership applications are accepted from suitably qualified persons and the requirements for entrance to the various grades of membership are summarized below.

Fellows shall be not less than 30 years of age, and shall be university graduates in pure or applied science or shall produce evidence to the satisfaction of the Council that they have successfully completed a co-ordinated course of study in pure or applied science of at least three years' duration at an approved university or institution deemed by the Council to be of equivalent status. Members shall have been employed in senior technical positions in important mining or metallurgical undertakings for at least five years or they shall have practised as mining or metallurgical consultants for at least five years. They shall be practising their profession at the time of application.

Entrance fee R10,00, Annual subscription R20,00.

Letters of designation: F.S.A.I.M.M.

Members shall be not less than 25 years of age and shall be university graduates in pure or applied science, or shall have successfully completed co-ordinated courses of study in pure or applied science of at least three years' duration. They shall have been engaged in work of an approved technical character in the mining or metallurgical industries, of which not less than two years shall have been in positions of responsibility. A candidate shall be practising his profession at the time of his application.

Entrance fee R8,00, Annual subscription R18,00.

Letters of designation: M.S.A.I.M.M.

Associates shall be not less than 25 years of age, and shall have been engaged in positions of responsibility in, or associated with, the mining or metallurgical industries for periods of not less than three years. If, however, the candidate for admission to the higher grade of Associate is at the time of his application already a Student, he need satisfy the Council only that he is, at the time of his application, engaged in a position of responsibility in or associated with the mining or metallurgical industries. In all cases the applicants shall satisfy the Council that they are fit and proper persons to become Associates.

Entrance fee R8,00, Annual subscription R18,00.

Graduates shall be not less than 21 years of age and shall be university graduates in pure or applied science, or have completed co-ordinated courses of study in pure or applied science of at least three years' duration at an approved university or institution. They shall not remain Graduate members after attaining the age of 30 years without the permission of Council.

Entrance fee R2,00, Annual subscription R12,00.

Students shall be persons not less than 18 years of age who are being educated or trained in a manner approved by the Council to occupy a technical position in or associated with the mining or metallurgical industries and who, furthermore, shall not have attained the qualification required for a higher grade of membership.

They may remain Students until they have obtained the necessary qualifications for transfer to a higher grade of membership, but not after the end of the Institute's financial year in which they attain the age of 28 (twenty-eight) years. They shall then transfer to a higher grade to retain membership of the Institute. The Council may relax the provisions of this clause in such cases as it considers appropriate.

Entrance fee nil, Annual subscription R5,00.

Other. The Council has the power to elect to the grade of Fellow or Member candidates who may not fulfil all the requirements for entrance to these grades but whose status, professional achievements, and practical experience in mining or metallurgy justify such election.

Applications. Requests for membership application forms should be addressed to the Secretaries, South African Institute of Mining and Metallurgy, P.O. Box 61019, Marshalltown, Transvaa

DIE SUID-AFRIKAANSE INSTITUUT VIR MYNBOU EN METALLURGIE

INLIGTING OOR LIDMAATSKAP

Die Instituut is in 1894 gestig as die Chemiese en Metallurgiese Vereniging van Suid-Afrika. In 1904 is dit omvorm tot die Chemiese Metallurgiese en Mynbouvereniging van Suid-Afrika en in 1956 het dit die Suid-Afrikaanse Instituut vir Mynbou en Metallurgie geword.

Die doelstellings van die Instituut is om die wetenskap en die praktyk van mynbou en metallurgie te bevorder, om kennis aangaande die mynbou en metallurgie uit te ruil en te boekstaaf en om 'n hoë beroepstandaard in gedrag en bekwaamheid te verseker.

Lidmaatskapvoordele sluit in maandelikse uitgawes van die *Joernaal* van die Instituut, vergaderings, colloquia, simposia, besoek aan myne en nywerheidsondernemings en die gebruik van klubfasiliteite in Kelvin-huis. Tegniese tydskrifte wat op 'n uitruil-basis ontvang word is by die Johannesburgse Openbare Biblioteek tot lede se beskikking. Die huidige lidmaatskap van die Instituut is oor die 1700.

Aansoeke van behoorlik gekwalifiseerde persone om lidmaatskap word aanvaar onderworpe aan die vereistes vir toelating tot die onderskeie lidmaatskapgrade soos hieronder saamgevat.

Genote moet minstens 30 jaar oud wees, 'n universiteitsgraad in suiwer of toegepaste natuurwetenskap besit of aanvaarbare bewys aan die Raad lewer dat hulle aan 'n goedgekeurde universiteit of instelling wat die Raad van gelyke status ag, 'n gekoördineerde studiekursus van minstens drie jaar in suiwer of toegepaste natuurwetenskap met welslae afgelê het. Lede moes vir minstens vyf jaar in senior tegniese hoedanighede by 'n erkende mynboukundige of metallurgiese onderneming werksaam gewees het, of hulle moes minstens vyf jaar as raadgewers in die mynbou of metallurgietegniek gepraktiseer het. Ten tye van hul aansoek moet kandidate hul beroep beoefen.

Toetreegeld R10,00, Jaarlikse ledegeld R20,00.

Titelletters: F.S.A.I.M.M.

Lede moet minstens 25 jaar oud wees en in besit wees van 'n universiteitsgraad in suiwer of toegepaste natuurwetenskap of 'n gekoördineerde studiekursus van minstens 3 jaar in suiwer of toegepaste natuurwetenskap met welslae afgelê het. Hulle moet by 'n mynboukundige of metallurgiese nywerheid werk van goedgekeurde tegniese aard gedoen het, waarvan minstens twee jaar in 'n verantwoordelike hoedanigheid. Ten tye van sy aansoek moet 'n kandidaat sy beroep beoefen.

Toetreegeld R8,00, Jaarlikse ledegeld R18,00.

Titelletters: M.S.A.I.M.M.

Assosiate moet minstens 25 jaar oud wees en moes minstens drie jaar lank 'n verantwoordelike pos beklee het in, of verbonde gewees het aan, die mynboukundige of metallurgiese nywerheid. Indien die kandidaat vir toelating tot die hoër lidmaatskaprang van Assosiaat ten tye van sy aansoek reeds 'n Studentelid is, moet hy die Raad slegs tevrede stel dat hy ten tye van sy aansoek 'n verantwoordelike betrekking in, of verwant aan, die mynboukundige of metallurgiese nywerheid beklee. In alle gevalle moet die aansoekers die Raad oortuig dat hulle geskikte en bevoegde persone is om Assosiaatlede te word.

Toetreegelde R8,00, Jaarlikse ledegeld R18,00.

Graduate moet minstens 21 jaar oud wees en moet 'n universiteitsgraad in suiwer of toegepaste natuurwetenskap besit of aan 'n goedgekeurde universiteit of instelling 'n gekoördineerde studiekursus van minstens drie jaar in suiwer of toegepaste natuurwetenskap met welslae afgelê het. Hulle kan nie Graduaatlede bly nadat hulle 30 jaar oud geword het nie.

Toetreegeld R2,00, Jaarlikse ledegeld R12,00.

Studente is persone wat minstens 18 jaar oud is en die soort opleiding deur die Raad goedgekeur, ondergaan, om hulle vir 'n tegniese aanstelling in, of verbonde aan, die mynboukunde of metallurgiese nywerheid te bekwaam, en wat daarnewens geen kwalifikasie vir 'n hoër lidmaatskaprang besit nie.

Hulle kan Studente bly totdat hulle vir 'n hoër lidmaatskaprang kwalifiseer, maar nie na die einde van die Instituut se boekjaar waarin hulle 28 (agt-en-twintig) jaar oud word nie. Hulle sal dan na 'n hoër rang oorgeplaas word om hul lidmaatskap van die Instituut te behou. In verdienstelike gevalle kan die Raad toegewings maak wat hierdie klousule betref.

Toetreegeld nul, Jaarlikse ledegeld R5,00.

Ander. Die Raad besit die bevoegdheid om kandidate wat nie aan die vereistes vir toetrede tot hierdie grade voldoen nie, maar wie se status, professionele prestasies en praktiese ervaring in mynbou en metallurgie dit regverdig, tot die grade van Genoot of Lid te verkies.

Aansoeke. Versoeke om lidmaatskap-aansoekvorms moet aan die Sekretarisse, Suid-Afrikaanse Instituut vir Mynbou en Metallurgie, Posbus 61019, Marshalltown, Transvaal.