

# Book news

## 1. Book reviews

● *Natural gas substitutes from coal and oil*, by S.A. Qadar. Amsterdam, Elsevier Science Publishers, 1985. U.S.\$83.25.

**Reviewer: U. Grimsehl**

This book is the eighth volume in the Coal Science and Technology series.

The author succeeds admirably in his attempt to 'present the subject matter in a clear and comprehensive manner so that even the non-technical reader will find it easy to understand'. However, this leads to the text containing such snippets of 'wisdom' as 'coal is a carboniferous material formed from vegetable matter' and 'crude oil is a thick brownish black flammable liquid'. From such humble beginnings, the author builds up to the state-of-the-art of the production of natural-gas substitutes from coal and oil.

The first two chapters deal with the properties of coal and oil, covering aspects like rank and classification, thermal conductivity, specific heat, porosity, moisture, and heating value of coal; constituents of crude oil, distillation, cracking, hydrotreating, and related processes; and the properties of coal oil.

The third chapter is a comprehensive and well-written review of the chemistry of coal gasification, including thermodynamic and kinetic aspects. A good balance is struck between coal pyrolysis, char gasification, and tar gasification.

Chapter four covers the catalysis of coal gasification. This should be a feast for researchers in this area, but will probably be of little interest to other readers.

The fifth chapter contains information on the coal-gasification processes used in the making of natural-gas substitutes. Commercially proven processes are discussed in detail, including the operating conditions, gas composition, material and energy balances, and technological status. Processes still in the developmental stage are not neglected, and a few promising ones, which are still purely conceptual, are analysed. The author deliberately did not include processes for the production of fuel gas of low and intermediate heating value.

Chapters six and seven cover the chemistry and processes of oil gasification, and will probably be of little interest to the South African reader.

The final chapter deals with the conversion of synthetic gas to SNG, describing gas purification (absorption and adsorption processes), and shift conversion and methanation, and ending with a paragraph on the interchangeability of SNG and natural gas.

The book is well written and easy to read. A very useful and comprehensive list of references is given at the end of each chapter. The text is set in typescript, but this should not bother the average reader and probably helps to keep the price down. The sketches are well made, easy to follow, and not cluttered with too much information. The author index and subject index are useful. The book will probably be of greater use to the professional in industry than to the researcher or academic.

Sadly, the author did not bother to use a consistent

set of SI units. Books written in 1985 should not use outdated units like lb/cu. ft, p.s.i., °F, and BIU/lb, and then mix them with the preferred SI units. The author also uses the unforgivable °K instead of K.

● *High heat production (HHP) granites, hydrothermal circulation and ore genesis*. London, The Institution of Mining and Metallurgy, 1985. 593 pp. £30.

**Reviewer: S.A. de Waal**

This is a collection of papers that were presented at a conference with the same title, organized by The Institution of Mining and Metallurgy and held at St. Austell, England, from 22nd to 25th September, 1985. The meeting was seen as a logical follow-up to the last assembly of the participants of the IGCP Project 26 ('Mineralization Associated with Acid Magmatism') at the University of Exeter in 1979, and served primarily to report on the new developments in the field in the intervening five years.

Basic to the whole theme of the Conference was the idea that certain granite magmas are relatively enriched in the heat-producing radioactive elements U, Th, and K. As a consequence, the plutons resulting from such magmas have rather extended cooling histories that can give rise to extensive convective hydrothermal circulation of fluids in and around those bodies. Such conditions are obviously favourable for the concentration and precipitation of granite-related incompatible elements such as Sn, W, Nb, Ta, F, and B.

In view of the above, the choice of venue for the Conference and the supporting field excursions was most advantageous since the Cornubian granite in south-western England forms a partly covered batholith of about 250 km in length and 40 to 60 km in width. It crops out as a series of plutons with which are associated the well-known Cornwall tin, tungsten, and kaolinite deposits.

As is to be expected, about half of the total of 40 papers deal with a variety of aspects of the Cornubian granite. The remaining papers cover localities ranging from Canada to Thailand. The last paper in the volume (Stone and Exley, pp. 511-593) is a concise review of the nature and evolution of the Cornubian granite and the associated mineralization. These authors show that the Sn-W mineralization, greisenization, and tourmalinization took place in a late-magmatic episode:  $T_h$  of fluid inclusions = 500 to 250°C, salinity (equivalent mass % NaCl) = 40 to 8. The kaolinization of the granite along joints and fissures is widespread. The source of the responsible fluid seems to be partly magmatic but largely of meteoric origin. A complex history of convective circulation and mixing of magmatic and meteoric water in the cooling granite, followed by later hydrothermal episodes unrelated to the cooling process, is suggested.

It should be obvious to the reader that the whole phenomenon of HHP granites gives rise to many basic questions. Among these are the following:

- (1) What is their origin in terms of modern-day concepts of global tectonics?
- (2) What was the effect of the extended cooling history on the granites themselves?

- (3) Where and how are the individual incompatible elements involved in the sequence of events, from emplacement till final cooling?
- (4) What were the temperature and pressure conditions during the precipitation of the incompatible elements?
- (5) Does the word *extended* mean thousands, millions, or hundreds of millions of years?

Most of these questions are addressed in some way or another in the Conference volume, as shown by the following examples.

- (a) It appears that HHP magmas are developed at destructive plate margins and in anorogenic settings by small degrees of partial melting of LIL-enriched mantle and perhaps lower crust (Plant *et al.*, pp. 263–286; Atherton and Plant, pp. 439–478). A long history of crystal fractionation and high crustal levels of emplacement are also advocated.
- (b) Some attempts (Baker *et al.*, pp. 1–8; Savage *et al.*, pp. 315–328) were made to quantify the water–rock interaction.
- (c) Eugster and Wilson (pp. 87–98) discuss the transport mechanism of Sn in granitic hydrothermal systems in terms of solubility and speciation, and conclude that, under geologically reasonable conditions (NNO-buffer, 2M total Cl, 1,5 kbar, feldspar–muscovite–quartz–system), at least 450°C is needed to mobilize Sn. Precipitation of Sn in solution is affected by decreasing T or P and increasing pH and  $f_{O_2}$ .
- (d) The real duration of the ‘extended’ cooling time is somewhat uncertain. The main mineralization event of the Cornubian granite lasted  $ca\ 20 \times 10^6$  years (Stone and Exley, pp. 511–593), but there were recurrences of mineralization at least twice during later times. These later events are believed to be unrelated to the magmatic and radiogenically derived heat, and to be due to later processes. It is of interest in this respect to note that Walraven *et al.* (pp. 393–408) describe radiogenic  $^{87}\text{Sr}$  loss from Bushveld granite, which in effect gives rise to serious problems with Rb–Sr age determination. According to these authors, a hydrothermal event that could have occurred as late as  $400 \times 10^6$  years after the emplacement of the Bushveld Complex, may have been responsible for the observed  $^{87}\text{Sr}$  loss. Whether or not this event forms part and parcel of the Bushveld magmatic episode is debatable.

The papers dealing with granitic systems outside England include reports on the Granite Mountains, Wyoming (Cheang *et al.*, pp. 33–40), the South Mountain Batholith, Nova Scotia (Clarke and Muecke, pp. 41–54), the Bohemian Massif (Dill, pp. 55–70), Nigerian granites (Kinnaird *et al.*, pp. 169–196), Variscan granites, Germany (Möller *et al.*, pp. 213–220), Irish Tertiary granites (O’Connor, pp. 239–250), granites from the Saskatchewan Shield, Canada (Parslow, pp. 251–262), the Namaqualand Metamorphic Complex, South Africa (Robb and Schoch, pp. 301–314), the Sierra Nevada Batholith (Wayne *et al.*, pp. 239–344), the Bushveld Complex (Walraven *et al.*, pp. 393–408; Simpson and

Hurdley, pp. 365–382), the Arabian Shield (Jackson *et al.*, pp. 479–488), Krusnehor/Erzgebirge (Stemprok, pp. 383–392), the Coastal Batholith, Peru (Atherton and Plant, pp. 459–478), the Taquesi Batholith, Bolivia (Harwood, pp. 549–562), and the Mole granite, Australia (Plimer and Kleeman, pp. 563–570).

The Conference volume can best be described as a collection of reports dealing with a wide array of topics related to late acid magmatic and hydrothermal processes. It contains a good deal of information for academic and exploration geologists alike, and will undoubtedly trigger off new attempts to arrive at some grand theory for the complexities involved in the late stages of acid magmatism.

## 2. Recent publications

- Uranium recovery from phosphates and phosphoric acid, by S. Huwyler. 3rd edition. Würenlingen (Switzerland), Swiss Federal Institute of Reactor Research, *EIR-Bericht (C)* no. 1. Apr. 1985. 56 pp.

This report reviews the state-of-the-art of uranium recovery from phosphates and phosphoric acid as given in the literature published mainly in 1983 and 1984. Economics of the techniques are discussed, and information is given on activities in fifteen countries, including 75 patents. In addition, 78 references are cited.

- *Geological aspects of mining productivity: Canada’s base metal resources*, by B.W. MacKenzie. Kingston (Canada), Centre for Resource Studies, Queen’s University, Technical Paper no. 6, Aug. 1985. 115 pp. \$10.

This case study examines some \$3,5 billion of exploration expenditures that have resulted in the discovery of 274 significant base-metal deposits during a long historical timeframe, extending to 1977. It employs an evaluation procedure that was developed for the examination of the effects of the geological characteristics of mineral resources on productivity change in the mining sector. A long-term view of the mining sector is adopted, considering time trends in productivity from the start of the mineral-supply process, through exploration, development, and production phases. The study methodology provides absolute measures of the efficiency with which all ‘factors of production’—mineral resources, labour, and capital—are employed in mining.

Factors of production other than mineral resources are evaluated on the basis of a standard set of present-day economic and technological conditions. In this way, all other ‘inputs’ in the mining-production function are held constant. This evaluation procedure permits the isolation and examination of relative changes in the geological aspects of mining productivity, namely the mineral-exploration expenditures incurred and the quality of mineral resources discovered. Observed time trends reflect the resultant of depletion effects and advances in geological concepts and exploration technology.

Although some of the results may be subject to differing interpretations, the evidence presented does not in general support the hypothesis that the quality of Canada’s base-metal resources is declining. Certainly, ore grades within consistent deposit-type groupings have been

maintained. Any modest deterioration in the productivity of base-metal resources otherwise observed must be weighed against the bias, inherent in the data base, to undervalue more recent discoveries.

● *Taxation policies in the Canadian minerals industry*, edited by M. Wojciechowski. Kingston (Canada), Centre for Resource Studies, Queen's University, 1985.

The mineral industry has a tax regime that is the most complicated and the most unstable of any industrial sector in Canada. The tax system for mining results in economic inefficiencies in the allocation of capital resources, particularly in marginal projects, and is inequitable in its treatment of smaller firms and/or firms with little or no production income. The total tax burden of the sector is not a severe problem at present, thanks to depressed earnings, but there is concern that it will become a problem as the industry adjusts to structural changes and recovers from its present difficulties. All of these problems are addressed in these proceedings, which include papers on problems with the existing regimes as well as proposals for improvement, ranging from radical change to fine tuning of existing taxes. The purpose of the seminar was to present the findings of some of the tax studies being undertaken at present, and to consider their implications for future directions in tax policies. The proceedings also summarizes the group's discussions, conclusions, and areas of disagreement.

● *Mineral policy update 1984: Policy and program changes affecting the Canadian mineral industry*, by M.J. Wojciechowski and M.L. McAllister. Kingston (Canada), Centre for Resource Studies, Queen's University, 1985. \$12.

The Canadian mineral industry operates in a confusing jungle of jurisdictions and authorities, with 10 provincial and 2 territorial regimes each establishing their own regulations, incentive programmes, tax systems, and other mineral-related policies. Federal jurisdiction is paramount in the territories, and covers many aspects of mining in the provinces as well. Furthermore, all these governments are constantly changing programmes and policies. This publication gives brief reports covering a wide range of changes that occurred during 1984. It is the only source gathering this information under one cover for easy access by the mineral industry, investors, government officials, researchers, and students. A list of contacts provides sources for more in-depth information on items of particular interest.

### 3. Mintek reports

The following reports are available free of charge from the Council for Mineral Technology, Private Bag X3015, Randburg, 2125 South Africa.

● **Report M217**

*The selective solvent extraction of palladium by the use of di-normal hexyl sulphide.*

A general description of di-N-hexyl sulphide (DNHS) is given, including the synthesis, purification, toxicity, and recycling ability of the extractant.

The following parameters were tested for the optimum conditions of separation: mode of mixing, amount and concentration of DNHS, concentration of hydrogen ions and of palladium, and temperature.

Further tests were conducted on the application of DNHS in the extraction of various complexes, and on the extractability of silver, gold, base metals, and platinum-group metals. No difficulty was experienced when the co-extracted impurities were washed out with dilute hydrochloric acid and when the palladium was stripped with ammonia.

The conditions determined were applied to two types of refinery solutions, one having a high concentration of palladium and the other being low in palladium. The presence of high concentrations of platinum did not affect the extraction of palladium with DNHS. The purity of the palladium products recovered was generally 99,99 per cent.

● **Report M218**

*Modification of the design of screen boxes for carbon-in-pulp and resin-in-pulp plants.*

Some theoretical aspects of the design of a screen box for carbon-in-pulp or resin-in-pulp plants are considered, and a description is given of how this theoretical study was used as the basis for the modification of the screen boxes on the carbon-in-pulp plant at Western Areas Gold Mine. The resultant changes in the operating characteristics of these boxes are discussed.

In addition, the results are reported of pilot-plant tests done on an interstage screen for a resin-in-pulp plant.

● **Report M225**

*The commissioning, operation, and maintenance of an on-line corrosion-monitoring station for the mining industry.*

The report describes a station that is used for the monitoring of pipe corrosion in the mining industry. The system provides on-line logging of various parameters related to the quality and flow of water through the monitoring system. Up to four different materials are monitored continuously by the use of linear polarization resistance, together with traditional methods of measurement such as that involving corrosion coupons.

The system is relatively compact, and has proved to be sufficiently robust to withstand mining environments. It is hoped that it will be used in the monitoring of parameters on individual sites at mines as an aid to the selection of materials and to problem-solving.

The report includes results from a site survey and illustrates the masking of conditions that can occur when on-line equipment is not used.

● **Report M231**

*The determination of selected lanthanoid elements by atomic-absorption spectroscopy using electrothermal atomization.*

Optimum ashing and atomization temperatures were established for the following lanthanoids in synthetic solutions containing 1 per cent hydrochloric or nitric acid: praseodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium.

Samarium, europium, and terbium were subsequently investigated in more detail. Atomization from a tantalum surface greatly improved the efficiency of atomization of terbium but hardly affected that of samarium and europium. Tantalum-metal strips, boats, and platforms were found to be superior to tantalum carbide coatings for this purpose. Interference effects from the other lanthanoids and yttrium on the reponse of the analyte were established across the widest possible analytical range at ratios of interferent to analyte of 10, 50, and 100:1, and were found to be most severe for terbium and least severe for europium.

Several reference materials were analysed for ten of the lanthanoids, and it was found that samarium, europium, thulium, and ytterbium can be determined direct by atomic-absorption spectroscopy using electrothermal atomization; holmium, erbium, and dysprosium require the use of the method of analyte additions; and terbium, lutetium, and gadolinium cannot be measured by this method with any degree of accuracy.

The laboratory method for the determination of samarium, europium, thulium, and ytterbium is detailed in an appendix.

#### ● Report M233

*A computer programme for the prediction of hydrocyclone performance, parameters, and product size distributions.*

A computer programme was developed, from published work and from data supplied by hydrocyclone manufacturers, for the prediction of hydrocyclone performance, parameters, and product size distributions. This is a practical model that will allow an engineer with little cyclone design experience to design a system accurately.

The user inputs the desired  $d_{50}$  size, the relative densities of the solids and pulp, and the volumetric flow-rate of the pulp. The programme then outputs either the cyclone size that is optimum for the inputted data or all the cyclone sizes that will satisfy the inputted data at the user's choice. If other minerals are present with a relative density differing from that of the bulk solids, the computer programme will calculate their  $d_{50}$  and  $d_{95}$  values. This is of great help in the determination of 'heavies' that have built up in the recirculating load. Finally, if the size distribution of the feed is available, the computer programme calculates the size distributions, mass and volume splits, and relative densities of the overflow and underflow pulp. The imperfection, i.e. a measure of how well the cyclone is functioning, is also calculated.

Three examples were chosen from the literature to show the versatility of the computer programme. The  $d_{50}$  sizes ranged from 10 to 150  $\mu\text{m}$ , the relative densities of the solids from 2,65 to 3,5  $\text{g}/\text{cm}^3$ , and the relative densities of the solids in the pulp from 15 to 55 per cent by mass. There was very good agreement between the predicted and the actual values.

#### ● Report M234

*The solvent extraction of base metals by mixtures of carboxylic acids and non-chelating oximes.*

It was found that divalent transition metals (including zinc, cadmium, and mercury) show synergistic

enhancements of extraction to varying degrees, whereas other metal ions (especially the alkaline-earth metals) usually show antagonistic depressions of extraction. In several instances, therefore, improved separations between mixtures of metals can be obtained.

Differences in the extent of the synergistic and antagonistic effects are rationalized in terms of the specific structural requirements of the extracted metal complexes. Correlations between the experimental synergistic effects and the stability constants of the respective metals with a model nitrogen-donor ligand (1,2-ethanediamine) are given.

#### ● Report M236

*The effect of particle size and colloid stability on the wet high-intensity magnetic separation of uranium from cyanidation residues.*

This report describes an experimental investigation on the magnetic separation of  $\text{U}_3\text{O}_8$  from various size fractions of uranium-gold tailings.

High recoveries were obtained at high grades, even from the finest fraction (smaller than 25  $\mu\text{m}$ ), and an increase in magnetic field did not improve the efficiency of separation. The use of theoretical models did not lead to the correct prediction of the limiting particle size recoverable by magnetic separation.

It was shown that the presence of coarse fractions enhances the recovery of uranium from a very fine fraction, and that 'piggy-back' magnetic separation plays an important role in the capture of slimes. The results also showed that the use of a dispersant considerably improves the selectivity of the separation.

#### ● Report M238

*The beneficiation of fine coal.*

Laboratory flotation tests were carried out on samples of coal fines from three South African collieries. The results indicated that improved efficiency in terms of plant capacity and reagent consumption could be obtained by an increase in the solids content of the slurry and closer control of the sizing of the solids.

It was shown that, even on closely sized feed, flotation did not yield a product of truly low ash content, and that this was due to the bimodal nature of the size distribution of the mineral matter in the coal. The mineral matter was present as 'sand', mainly greater than 75  $\mu\text{m}$ , and as 'silt', mainly less than 10  $\mu\text{m}$ . Flotation proved to be selective only for coal particles containing sand.

Separation with heavy liquid showed that coal particles with ash contents of 3 to 7 per cent could be separated with good yield. Since this material showed almost no difference in flotation response from that of particles with a much higher silt content, the result was an overall best flotation grade of about 10 per cent ash.

Calculations of the density of the ash-free coal showed that this increased from about 1,25  $\text{g}/\text{cm}^3$  for particles with an ash content of 3 per cent to about 1,36  $\text{g}/\text{cm}^3$  for particles with an ash content of 20 per cent. Maceral analysis would be of interest in this respect.

#### ● Report M240

*The spectrophotometric determination of tin in silicates and tungsten-bearing materials.*

This report describes the determination of tin in silicate and tin-tungsten materials by a spectrophotometric method using phenylfluorone [2,6,7-Tri-hydroxy-9-phenyl-3H-xanthenon-(3)] as the chromogenic reagent.

The two types of samples are prepared as follows.

- (a) Silicates are treated with hydrofluoric acid to remove the silica, the residue is fused with sodium peroxide and sodium carbonate, and the melt is leached with sulphuric acid.
- (b) High-tungsten materials are fused with sodium peroxide and sodium carbonate, and the tungstic oxide is precipitated from hydrochloric acid solution.

Tin oxinate is then extracted with chloroform from a chloride solution. For silicates the precision (relative standard deviation) of the method is 0,125 at a tin concentration of 240  $\mu\text{m/g}$ , and for tin-tungsten materials it is 0,046 and 0,085 at a tin concentration of 0,88 per cent and 50  $\mu\text{g/g}$  respectively.

The accuracy of the procedure was established by the analysis of a number of reference samples of siliceous tin ores and tin-tungsten ores. The average deviation from the values for a certified reference material and from the recommended values for 'in-house' reference materials

was about 6 per cent for tin concentrations ranging from 50  $\mu\text{g/g}$  to 0,88 per cent.

The laboratory method is detailed in an appendix.

#### ● Report M242

*Wear and performance of materials in pipelines for the hydraulic conveyance of fused ash.*

Although hydraulic conveyance is becoming accepted as a convenient and economic means of material handling, a major factor limiting its more widespread use is excessive wear of the pipelines. However, a reduction in wear can be achieved successfully by the judicious selection of appropriate materials of construction for pipelines, based on an understanding of their performance relative to the characteristics (such as solid-phase or slurry factors and flow parameters) of conveying.

This report describes a field investigation on the performance characteristics and wear processes of a range of wear-resistant materials that were inserted into a pipeline conveying fused ash. The performance characteristics and final cost-effectiveness of the materials are evaluated in terms of the particular characteristics of the conveying operation.

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## IPMI award for distinguished achievement

The International Precious Metals Institute has announced that Professor Henry C. Taube, Nobel Laureate, will be the recipient of their 1986 Distinguished Achievement Award. Dr Taube is Professor of Chemistry at Stanford University, Palo Alto, California. The award will be presented during the 10th International Precious Metals Conference and Exhibition, which is to be held from 9th to 12th June, 1986, at Lake Tahoe, Nevada. Dr Taube is scheduled to address the Conference on the subject of 'Back Bonding in Traditional Coordination Chemistry'.

Professor Taube was awarded the Nobel Prize in Chemistry in 1983 for his outstanding work on the elucidation of oxidation-reduction (redox) reaction mechanisms involving coordination compounds of transition metals including precious metals.

Dr Taube's research has made a great impact on the sciences of chemistry and biology, and his work has revolutionized the way scientists think of inorganic redox reactions.

