

DEPARTMENT OF
MINES AND TECHNICAL SURVEYS

MINES BRANCH

SCIENTIFIC AND TECHNICAL PAPERS
PUBLISHED BY THE STAFF IN 1964

OTTAWA

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FOREWORD

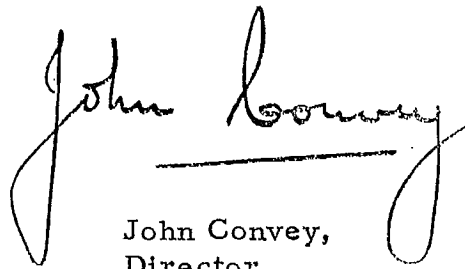
Information Circular IC 151 (June, 1963) was the first in a series of annual reviews of the scientific and technical papers published by the staff of the Mines Branch. This Information Circular is the second supplement to IC 151 and is divided into three sections.

Section 1 consists of the titles of papers published during 1964 in the Mines Branch Series (Monographs, Research Reports, Technical Bulletins, and Information Circulars) together with an abstract or summary of each paper. These reports are available from the Queen's Printer, Ottawa, at the prices indicated and may be ordered by the catalogue number given for each report. (Pre-1962 reports are listed in Canadian Government Sectional Catalogue No. 12, July 1962).

Section 2 lists the titles of all papers published in scientific and technical journals during 1964 by the Mines Branch staff. An abstract or summary again accompanies each title in order to inform the reader of the main content of the paper. The periodicals containing these papers are available in many technical libraries.

Section 3 contains a list of the 1964 titles available in the Investigation Report Series and also of the titles from previous years that have now been released for general distribution. This series includes the results of investigations carried out by the Mines Branch at the request of industry and of other government agencies and also of investigations initiated by the Mines Branch of specific materials and processes. Many Investigation Reports are not available because they are either confidential or of very limited interest. Those that are listed in this Information Circular are available for reference in the divisional files, but in most cases there are no additional copies for distribution. However, it is felt that even this limited availability will be of value to many individuals or companies with specific interests and will help prevent unnecessary duplication of investigations already made by the Branch.

I hope that this supplementary index will be as well received as the first in this series and that it will provide the reader with a more complete view of the work of the Mines Branch in aiding Canada's mineral and metallurgical industries.



John Convey,
Director.

February, 1965

AVANT-PROPOS

La circulaire d'information IC 151 (juin 1963) a été la première d'une série de rapports annuels scientifiques et techniques publiés par la Direction des mines. La présente circulaire d'information constitue le deuxième supplément à IC 151 et elle est divisée en trois sections.

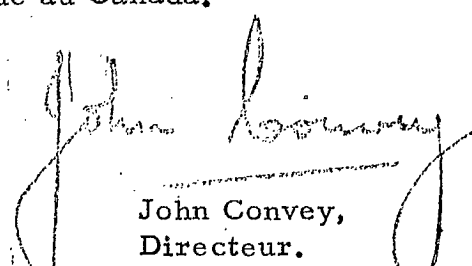
La première section embrasse les titres des études publiées en 1964 dans la série de la Direction des mines (monographies, rapports de recherche, bulletins techniques et circulaires d'information) de même qu'un résumé de chaque étude. On peut se procurer ces rapports chez l'Imprimeur de la reine à Ottawa, au prix indiqué, ou les commander selon le numéro de catalogue assigné à chaque rapport. (Les rapports antérieurs à 1962 sont énumérés au Catalogue sectionnel de gouvernement canadien n° 12, juillet 1962).

La section n° 2 comprend tous les titres des études publiées en 1964 dans les journaux scientifiques et techniques par le personnel de la Direction des mines et un résumé accompagne chaque titre pour renseigner le lecteur sur le sujet traité. Les périodiques dans lesquels les études ont été publiées se trouvent dans plusieurs bibliothèques techniques.

La section n° 3 comprend une liste des titres de 1964 disponibles dans la série des rapports de recherche de même que les titres des années précédentes qui sont maintenant offerts au public. Cette série comprend les résultats de recherches effectuées par la Direction des mines à la demande de l'industrie ou d'autres organismes du gouvernement, de même que de recherches entreprises par la Direction des mines sur des matériaux ou des procédés particuliers. Plusieurs rapports de recherche ne sont pas disponibles parce qu'ils sont confidentiels ou d'un intérêt très limité. Ceux qui sont énumérés dans la présente circulaire d'information sont disponibles pour consultation dans les dossiers de division mais, dans la majorité des cas, il n'existe pas d'exemplaires supplémentaires pour la distribution. Cependant nous croyons que même cette disponibilité restreinte pourra être utile à nombre de personnes ou sociétés qui ont des problèmes particuliers et pourra prévenir la duplication inutile de recherches déjà faites par la Direction.

Nous espérons que cet index supplémentaire sera aussi bien accueilli complète des travaux de la Direction des mines qui est au service de l'industrie minéralogique et métallurgique au Canada.

février, 1965


John Convey,
Directeur.

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Previous Reports in This Series

Information Circular 151 (1962)

Information Circular 162 (1963)

SECTION 1 - MINES BRANCH SERIES

MONOGRAPHS

Mines Branch Monograph No. 870
In preparation.
Water Survey Report No. 14

Mines Branch Monograph No. 871.
In preparation.
Water Survey Report No. 15

Mines Branch Monograph No. 873.

Bentonite in Canada
by J.S. Ross*. 1964. 68p. Illus.,
tables.

This report describes in detail many aspects of bentonite in Canada and includes sections on definitions, properties, identifications, uses, specifications, history and production, trade, consumption, occurrence, reserves, exploration, mining, milling, laboratory investigation, technology, marketing and outlook.

World outlook is for a noteworthy increase in bentonite consumption in the immediate future. In the long term, some of this increase will possibly be affected by substitutes and more efficient usage.

Most of Canada's bentonite requirements in the foreseeable future will be for the swelling type. The main market for bentonite lies in Canada's industrial east, but no suitable deposits are found east of Manitoba. If a good-quality swelling bentonite could be located in Manitoba its proximity to main markets would assure its ready sale.

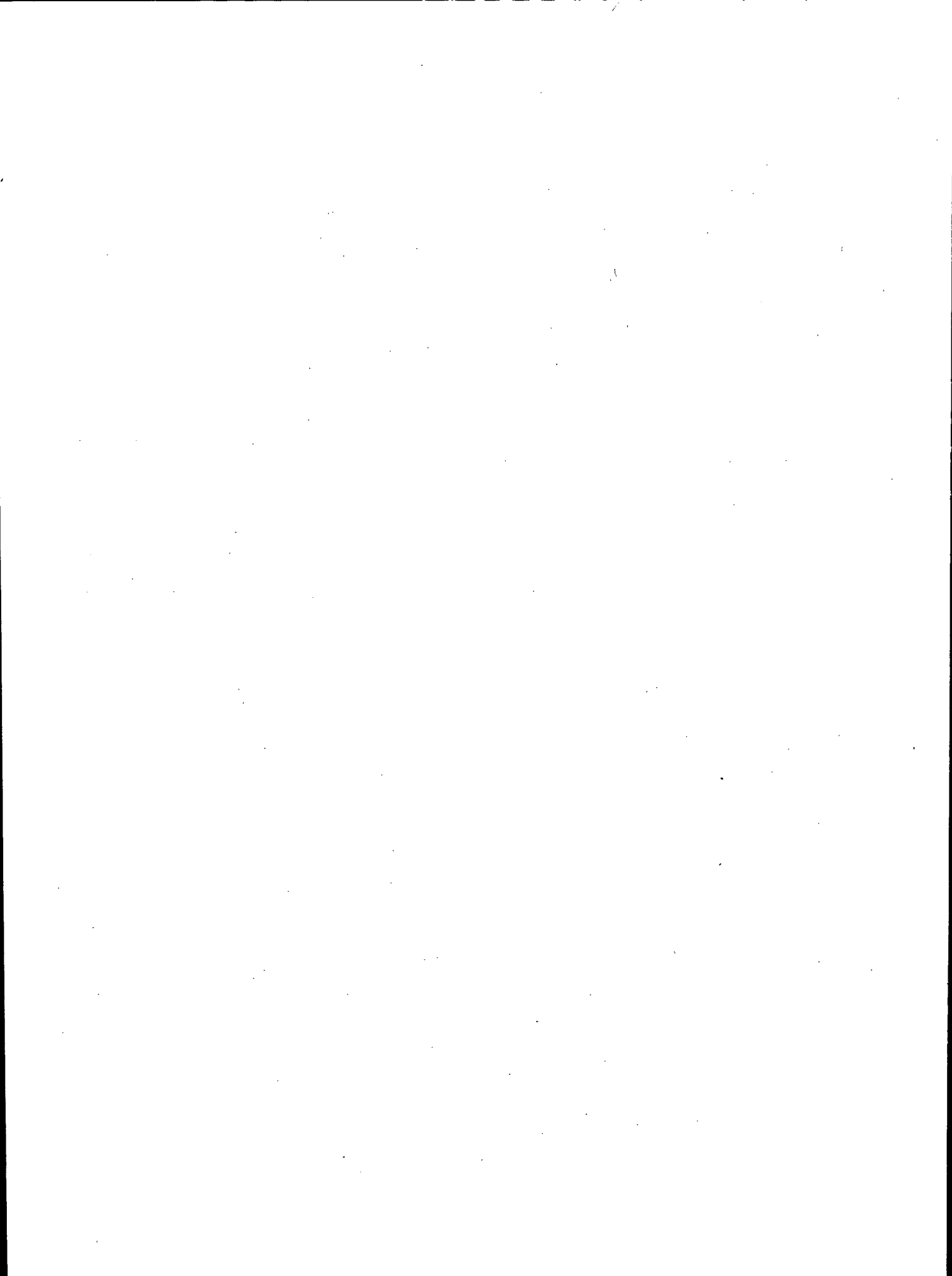
Although Canadian bentonite is competitive in quality for many uses, it has yet to be generally accepted for steel-foundry application and iron-ore-concentrate pelletizing. Canada's requirements for the latter were about 10,000 tons in 1962. By the end of 1965, they should increase to 100,000 tons a year with a consumption value of about \$3 million. In the same period, consumption for all uses should reach a value of about \$5 1/2 million a year. Thus, a challenge and an opportunity exist for the establishment of a Canadian source of high-quality bentonite. Exploration for this commodity is relatively simple and inexpensive and several of the geological horizons described are of interest. The main problem will be in the testing and tailoring of the clay to meet consumers' specifications. The mining industry is urged to accept this challenge and, to be successful, the cooperation of the iron and steel industries is essential.

Incomplete preliminary testing indicates that a few Canadian bentonites show promise for iron-ore pelletizing. The Mines Branch is attempting to tailor these to meet the requirements of the pelletizing industry.

*Senior Scientific Officer, Mineral Processing Division, Mines Branch.

\$3.75

Cat. No. M32-873



RESEARCH REPORTS

R 102. *In preparation.*

R 110. *In preparation.*

R 124. *Ixiolite--A Columbite Substructure*

E.H. Nickel*, J.F. Rowland and
R.C. McAdam. Jan. 1964. 19p.
Illus., tables.

Ixiolite, first described in 1857 and mentioned in the literature only a few times since then, has generally been regarded as a discredited mineral species. A re-examination of samples from the type locality in Finland, however, has provided significant new information indicating that ixiolite is a valid species with distinctive characteristics. X-ray diffraction studies show that ixiolite is orthorhombic with $a=5.73$, $b=4.74$ and $c=5.16A$, space group *Pcan*. The unit-cell content is $(Ta, Fe, Sn, Nb, Mn)_4O_8$. The ixiolite unit-cell is a sub-cell of columbite, with similar parameters except for b , which is one-third of the columbite b parameter. Structurally, ixiolite can be regarded as a disordered form of columbite.

Published as a paper in *Amer. Min.*, Vol. 48, Nos. 9 and 10, 1963, pp 961-979.

*Senior Scientific Officer, Mineral Sciences Division, Mines Branch.

25 cents

Cat. No. M38 -1/124

R 125. *Hot-Dip Galvanizing With Less Common Bath Additions*

J.J. Sebisty* and R.H. Palmer**,
Feb. 1964. 44p. Illus., tables.

Galvanized coating formation in "aluminum-free" and "aluminum-containing" baths otherwise alloyed with individual additions of elements not normally encountered in commercial galvanizing practice, has been investigated.

None of the elements investigated gave indications of commercial promise when combined with aluminum and lead at concentrations applicable to continuous strip galvanizing practice. Coating formation was generally unaffected by small additions, whereas higher levels were detrimental for various reasons, including neutralization of the inhibition of the iron-iron reaction normally provided by aluminum at short immersion times.

Presented as a paper at the 7th Inter. Gal. Conf., Paris, France.
*Senior Scientific Officer, Non-Ferrous Metals Section, Physical Metallurgy Division, Mines Branch.
**Research Metallurgist, Canadian Zinc and Lead Research Committee.

75 cents

Cat. No. M38 -1/125

R 126. *Ion Bombardment of Single Crystals of Aluminum.*

R.L. Cunningham*, K.V. Gow**
and J. Ng-Yelim***. March 1964.
6p. Illus., tables.

This paper presents the results of bombarding the (100), (110), and (111) surfaces of aluminum single crystals with a narrow beam of 8-kV argon ions. The crystals were tilted at the angles required to bring $[110]$, $[100]$, $[112]$, and $[111]$ directions parallel to the beam. The experiments were designed to study the effect of incident ion direction

on ejection directions and etching rates.

Etching rates, as judged by the occurrence of matte spots, were least when the beam was parallel to the close-packed [110] directions and greatest when parallel to high index directions making large angles with the [110] directions. Low etching rates were also observed when the beam became parallel to [100] and [112] directions. Any anisotropy in surface migration rates was shown to be negligible in controlling etching rates under the conditions of these experiments.

Published as a paper in *J. Appl. Physics*, Vol. 34, No. 4 (Part 1), Apr. 1963, pp 984-989.

*Principal Scientist, **Senior Scientific Officer and ***Technical Officer, Physical Metallurgy Division, Mines Branch.

25 cents

Cat. No. M38 -1/126

R 127. *Measurement of Free Cyanide Concentration by Continuous Potentiometric Titration*
J. C. Ingles*, July 1964. 24p. Illus., tables.

The use of commercially-available precision metering pumps makes possible the continuous argentometric titration of free cyanide in process solutions. End-point indication, provided by continuous measurement of the potential of a silver wire-reference electrode combination, gives a good approximation of the actual cyanide content of the samples and, further, is ideally suited to automatic control of cyanide addition to the process. The re-

sponse time is of the order of 2 minutes, but could be reduced. The procedure requires a clarified solution and is not applicable to unfiltered ore pulps or slurries.

*Head, Chemical Analysis Section, Extraction Metallurgy Division, Mines Branch.

50 cents

Cat. No. M38 -1/127

R 128. *In preparation.*

R 129. *Uranium in Alloy Steel*
C. E. Makepeace*, July 1964. 76p. Illus., tables.

The effect on the mechanical properties at room temperature and at elevated temperatures, of adding uranium to alloy steel in plate and sheet form, was investigated in thirty-two factorial experiments. Statistically significant results indicate that uranium forms a stable compound, probably uranium monocarbide, which is not affected by prior heat treatment. Adding less than one-half per cent uranium was observed to result in an increase in the time to reach 0.1% creep strain and a decrease in the susceptibility to hot cracking in alloy steel sheet. *Scientific Officer, Eldorado Mining and Refining Limited, seconded for experimental work to the Physical Metallurgy Division, Mines Branch.

\$1.00

Cat. No. M38 -1/129

R 130. *Activation Energy Calculation from a Linearly-Increasing Temperature Experiment*
T. R. Ingraham* and P. Marier**.

3p. Illus., table.

A simplified method has been developed for the determination of the activation energy of a heterogeneous reaction having linear kinetics.

The thermal decomposition of calcium carbonate has been used as an example and it has been shown that when the logarithm of the weight loss per unit area of powder compacts is plotted against the reciprocal of absolute temperature, for a run done with a linear heating rate, a linear relationship is obtained. When the logarithms of the heating rate and the absolute temperature are included, results for a variety of heating rates can be completely correlated. Heating rates of less than 5 degrees per minute are recommended.

An activation energy of 48.4 ± 2 kilocalories per mole has been estimated for the decomposition reaction and 7 ± 3 kilocalories per mole for the formation reaction.

Published as a paper in *Can. J. of Chem. Eng.*, August, 1964. *Head, and **Scientific Officer, Research Section, Extraction Metallurgy Division, Mines Branch.

25 cents

Cat. No. M38 -1/130

R 131. *A Thorian Intermediate. Member of the Britholite-Apatite Series - Physical and Chemical Studies*
M. R. Hughson* and J. G. Sen Gupta**, September 1964, 15p. Illus., tables.

In 1954 J. P. Girault identified as britholite an occurrence of a thorium-bearing cerian silicate apatite mineral from Oka, Quebec. The Oka mineral is clove brown, massive, and has a dull resinous luster. The measured specific gravity of a concentrate of this mineral is 3.86 and the calculated value is 3.95. The higher index of refraction n_d is 1.72. The Oka mineral is hexagonal with $a_0=9.48 \text{ \AA}$ and $c=6.96 \text{ \AA}$ (ignited material). The possible space groups are $P6_3$ or $P6_3/m$.

An accurate ion exchange separation technique was developed by using Dowex 50W-X8 cation exchange resin (50-100 mesh) and was applied to the quantitative separation of rare earths from phosphates, common elements and thorium all of which are present in the Oka mineral.

The physical and chemical data thus obtained indicate that the probable formula is: $(Ca, Ce \text{ etc.}, Th, Mg, Fe, Na, Ti)_5 [(P, Si, Al)O_4]_3 (OH, F)$ which is similar to the theoretical formula proposed by Machatschki in 1939 for britholite.

Published as a paper in *Amer. Min.*, Vol. 49, July-August, 1964.

25 cents

Cat. No. M38 -1/131

R 132. *A Study of the Constitution of the Titanium-Rich Corner of the Titanium-Aluminum-Molybdenum System*
A. J. Williams*. Sept. 1964. 31p.

The constitution of the titanium-rich corner of the titanium-alu-

minum-molybdenum system, based on a four-hour annealing time, has been investigated. Vacuum heat-treatment and metallography have been used to determine the β -transus on nine constant titanium sections of this system in the composition range of 0-25 wt % molybdenum and 0-15 wt % aluminum. Four discontinuities in the β -transus surface have been discovered. These discontinuities appear to indicate the presence of four three-phase fields contiguous with two-phase fields in the titanium-aluminum binary diagram discovered by several other workers.

*Senior Scientific Officer, Physical Metallurgy Division, Mines Branch.

75 cents

Cat. No. M38 -1/132

R133. *The Viscosity of Pure Liquid Zinc, Determined by Oscillating a Cylindrical Vessel*

H.R. Thresh*. July 1964. 30p. Illus., tables.

An oscillational viscometer has been constructed to measure the viscosity of liquid metals and alloys to 800°C. An enclosed cylindrical interface surround the molten sample, avoiding the free surface condition found in many previous measurements. Standardization of the apparatus with mercury has verified the use of Roscoe's formula in the calculation of the viscosity. Operation of the apparatus at higher temperatures was also checked, using molten lead. Extensive measurements on five different samples of zinc of not less than 99.99% purity indicate that (i) impurities at this level do not influence the viscosity,

and (ii) the apparatus is capable of giving reproducible data. The variation of the viscosity, η , with absolute temperature T is adequately expressed by Andrade's exponential relationship $\eta V^{1/3} = Ae^{\frac{C}{VT}}$; where A and C are constants and V is the specific volume of the liquid. The values of A and C are given as 2.485 x 10⁻³ and 20.78, 2.444 x 10⁻³ and 88.79, 2.169 x 10⁻³ and 239.8, respectively, for mercury, lead, and zinc. The error of measurement is assessed to be about 1%. No pre-freezing phenomena were found in the vicinity of the freezing point of the zinc samples.

*Senior Scientific Officer, Physical Metallurgy Division, Mines Branch.

75 cents

Cat. No. M38 -1/133

R 134. *Accelerated Test for Determining the 28-Day Compressive Strength of Concrete*

V. M. Malhotra*, N. G. Zoldners**, and R. Lapinas***. Oct. 1964. 43p. Illus., tables.

This report presents the results of accelerated curing of concrete test cylinders using a boiling-water method. Briefly, the method consists of standard moist-curing of test specimens for 24 hours, followed by boiling for 3 1/2 hours and testing for compression one hour later.

The analysis of test data indicates that the relationship between the accelerated- and 28-day standard-cured strengths can be represented by a hyperbolic function of the type $Y = \frac{X}{AX + B}$ with an accur-

acy of \pm 12 per cent. The established relationships appear to be independent of the cements, aggregates and admixtures used.

*Senior Scientific Officer, **Head, Construction Materials Section, Mineral Processing Division, Mines Branch.

***Manager, Technical Control, Mount Royal Paving and Supplies Limited, Montreal, Que.

\$1.00

Cat. No. M38 -1/134

R 135. *In preparation.*

R 136. *Mechanism of Thermal Decomposition of Ammonium Metavanadate*
M. Taniguchi* and T. R. Ingraham**. Nov. 1964. 7p. Illus., tables.

When ammonium metavanadate is roasted at 225°C, ammonia and water are eliminated in the ratio 2:1 and an intermediate compound identified by weight loss and chemical analysis as $(\text{NH}_4)_2 \cdot \text{O} \cdot \text{V}_2\text{O}_5$ is formed. An X-ray diffraction pattern for this material is reported. Transpiration experiments have been used to establish the free energy of this reaction. The second stage of the decomposition involves an endothermic and an exothermic process, both of which occur with the production of a gaseous product. The liberation of ammonia is not quantitative, and its oxidation on the vanadium pentoxide, in the last stage of decomposition, is suggested as a possible source of the exothermic heat.

Published as a paper in Can. J. of Chem., Vol. 42, 1964.

*National Research Council of Canada, Postdoctoral Fellow.

**Head, Research Section, Extraction Metallurgy Division, Mines Branch.

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Cat. No. M38 -1/136

R 137. *Split Fractures in Tension Tests of Steel*
H. H. Bleakney*. Nov. 1964. 20p. Illus., tables.

This report describes an investigation of the mechanism by which split fractures are produced in tension tests of steel. As part of the attempt to determine the conditions under which such fractures occur, a 4 1/2 x 4 1/2 inch billet of steel containing 0.23% carbon, 3.20% chromium and 0.55% molybdenum was obtained, and sixteen 1-inch-square test bars were cut from it. These were quenched variously in water, oil, and air, from 1600°F (870°C) and tempered at 1300°F (705°C). Almost the whole range of fractures, including cup-and-cone, star, and splits, of varying severity, were obtained from subsequent tension tests.

The conclusion was drawn that cup-and-cone fractures occurred when the axial breaking stress reached the transverse breaking strength and that split fractures occurred when the reverse effect occurred.

*Head, Rheology and Fracture Section, Physical Metallurgy Division, Mines Branch.

50 cents

Cat. No. M38 -1/137

R 138. *Premium Strength in Sand-Cast Magnesium Alloys*

B. Lagowski* and J. W. Meier**. June 1964. 36p. Illus., tables.

The paper describes results of a study of some of the factors affecting high mechanical properties and their proper distribution throughout the casting. Experimental work was carried out first on test plates of 1/2-inch to 2-inch thickness, and later checked on more complicated castings. Variables studied included proper use of chills to ensure directional solidification and elimination of the effect of unsoundness in plates of various thickness, as well as more efficient heat treating techniques for the various alloys. Results on commercial casting shapes showed that high properties, even in sections of 2-inch thickness, could consistently be obtained which are equal or in some cases higher than typical properties reported for separately-cast test bars. Mg-Al-Zn alloys show a greater sensitivity to adverse solidification conditions than the finer-grained zirconium-containing alloys. The newly developed Mg-Zn-Ag-Zr alloys showed exceptionally high properties, exceeding those obtainable in any commercial magnesium alloy.

*Senior Scientific Officer, **Principal Metallurgist, Non-Ferrous Metals Section, Physical Metallurgy Division, Mines Branch.

75 cents

Cat. No. M38 -1/138

R 139. *Thermochemistry of the Co-S-O System from 950 to 1200°K*

T. R. Ingraham*. Nov. 1964. 14p. Illus., tables.

Total pressures produced by the decomposition of CoSO_4 and by the decomposition of mixtures of CoO and Co_3O_4 were measured, using a Pyrex bellows mercury manometer. At temperatures in excess of 782°C , in the presence of its gaseous decomposition products, CoSO_4 produces CoO . At temperatures less than 782°C , the oxide product is a mixture of CoO and Co_3O_4 .

Free energies for the sulphate and oxide decomposition reactions were combined with published data on CoO , CoS , Co_9S_8 , SO_3 and SO_2 to produce thermodynamic phase diagrams for the various univariant and bivariant equilibria existing between 950 and 1200°K .

The transition from β to α cobalt sulphate occurs at $675 \pm 10^\circ\text{C}$ and involves 0.60 ± 0.04 kcal/mole.

Published as a paper in Can. Met. Quart., Vol. 3, No. 3, July-Sept., 1964.

*Head, Research Section, Extraction Metallurgy Division, Mines Branch.

25 cents

Cat. No. M38 -1/139

R 140. *Properties of Sand-Cast Magnesium Alloys. Part V: Mg-Zn-Ag-Zr Alloys*

B. Lagowski* and J. W. Meier**. October 1964. 16p. Illus., tables.

An earlier investigation of Mg-Ag-Zn-Zr casting alloys showed a promising group of alloys in this system. Additional work on the development of proper foundry and

heat treating techniques resulted in the introduction of several high-strength, high-ductility Mg-Zn-Ag-Zr casting alloys which offer attractive possibilities for use in structural applications where economic considerations are not critical.

*Senior Scientific Officer, **Principal Metallurgist, Non-Ferrous Metals Section, Physical Metallurgy Division, Mines Branch.

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Cat. No. M38 -1/140

R 141. *Magnesium Content.
Effect on Properties of
Binary Aluminum-
Magnesium Alloys*

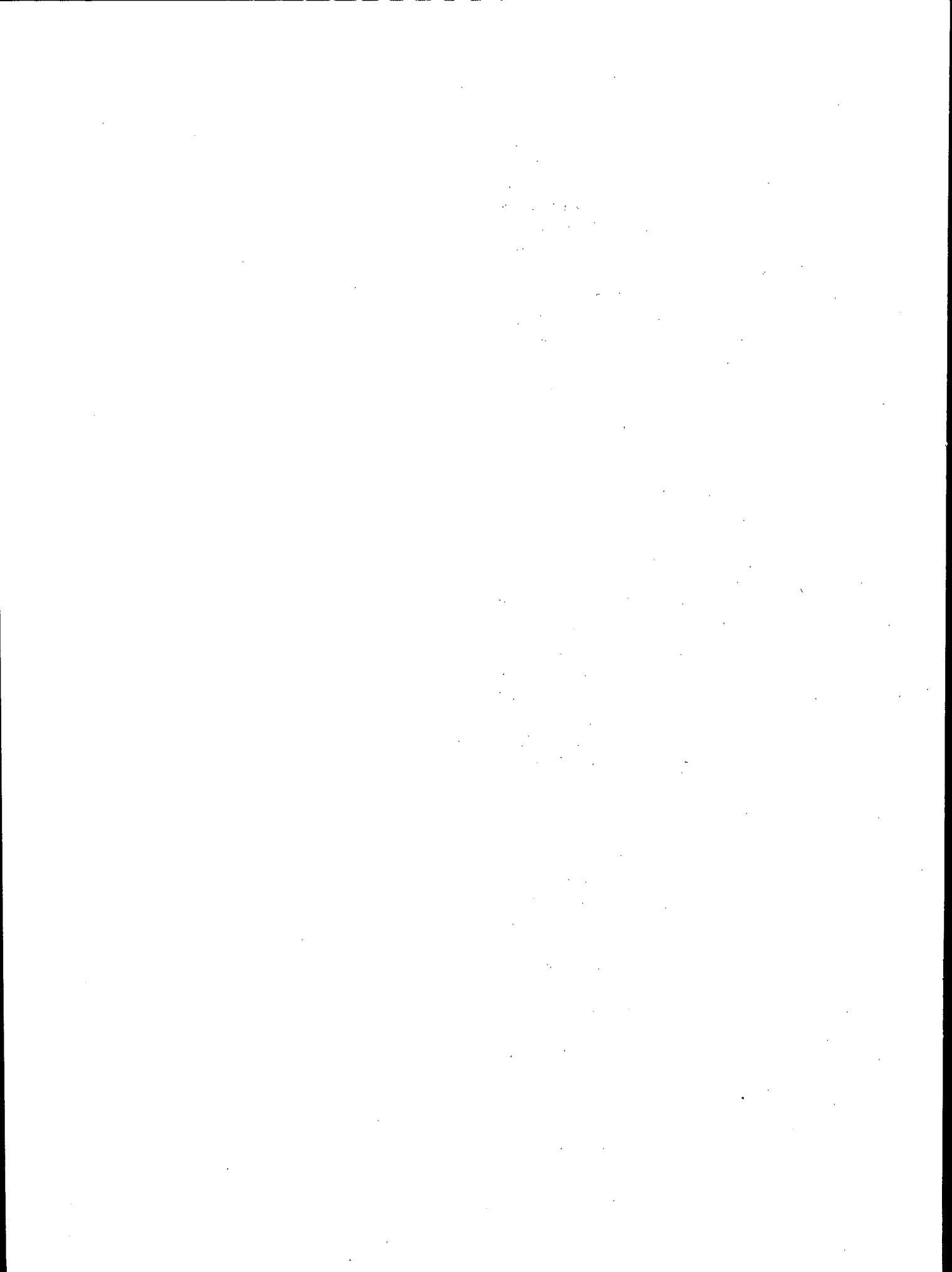
W.A. Pollard*. Nov. 1964. 15p.
Illus., tables.

In both normal purity and high purity cast aluminum-magnesium alloy there is a critical magnesium content below which the tensile properties of separately cast test bars of the Dow type show a marked decrease in ductility.

The main part of the work to be reported was a comparison between the effects of varying magnesium content and casting shape (cast-to-shape test bars and test bars cast from heavily chilled sand cast plates) on binary aluminum-magnesium alloys made from normal and high purity materials).

25 cents

Cat. No. M38 -1/141



TECHNICAL BULLETINS

TB 51 *Lightweight Concrete
Aggregates From Clays
and Shales in Ontario*
H. S. Wilson*, October 1963. 52p.
Illus.

The first half of the report includes a description of the various types of lightweight aggregates, the properties of lightweight concrete, the history of the expanded-clay and -shale industry, and production processes. Various theories on the causes of bloating are outlined and discussed. The laboratory equipment and test procedures are described, and a brief account of the Palaeozoic and Pleistocene geology of Ontario and Quebec is given.

The second half of the report consists of brief descriptions of the 111 locations from which 211 samples were taken, and the results of the tests made. Fifty-five samples from 30 locations show promise of being suitable raw materials for production by the rotary kiln process. Some others might be used in the sintering process.

*Senior Scientific Officer, Mineral Processing Division, Mines Branch.

75 cents

Cat. No. M34-20/51

TB 52. *A Radiotracer Test at
the Noranda Smelter,
July 15-18, 1963*

J. L. Horwood* and H. P. Dibbs, Jan. 1964. 44p. Illus., tables.

A radioactive tracer test was conducted at the smelter of Noranda Mines Ltd., Noranda, Quebec, July 15-18, 1963. Copper-64, a radioactive isotope, was introduced as

cuprous oxide into a ladle of converter slag that was returned in the usual manner to a reverberatory furnace. The rather rapid decay of copper-64 to half its activity every 12.8 hours required careful precautions to ensure delivery of the copper source to the test site at the scheduled time; samples from the test were counted at Noranda.

The almost complete recovery of the tracer material from the furnace was verified by calculating and adding the amount removed in each ladle during these operations; this total activity corresponded with the activity of the source measured at the time of injection. Additional experiments were subsequently conducted in Ottawa with known activities of copper-64 to determine the efficiency of the sample geometry and the counting efficiency of the scintillation counter.

*Senior Scientific Officers, Physics and Radiotracer Subdivision, Mineral Sciences Division, Mines Branch.

75 cents

Cat. No. M34-20/52

TB 53. *Experimental Studies
Relating Mineralogical
and Petrographic Features
to the Thermal Piercing
of Rocks*

J. A. Soles* and L. B. Geller**, Jan. 1964. 17p. Illus., tables.

The mineralogical relations, petrographic features and certain other physical properties of several classical rock types are compared with the results of laboratory scale jet-flame piercing tests on large samples of the rocks. The comp-

arison has provided information which may be used to assess the potential usefulness of jet-flame rock drills in areas where the geology is known.

*Petrologist, Mineral Processing Division, and **Scientific Officer, Fuels and Mining Practice Division, Mines Branch.

50 cents

Cat. No. M34 -20/53

TB 54 *Ceramic Clays and Shales of British Columbia*

J. G. Brady* and R. S. Dean**, Jan. 1964. 24p. Illus., tables.

Canada, in general, lacks good-quality clays and shales useful to the ceramic industry, particularly high-quality kaolin and fire clay deposits. British Columbia is no exception, but there is a wider variety of clays there than in many of the other provinces. Common brick, facing brick, drain tile, building tile, flower pots, pottery, sewer pipe, flue liners, and conduits are all manufactured from British Columbia's common clays and shales. Some local fire clays are used in the manufacture of refractories, brick, tile, sewer pipe, conduits or flue liners, and a few stoneware clays are available. There are also useful deposits in certain areas where the potential market is now limited, and in the northern areas of the province where transportation charges are high.

In the present study, ceramic properties and mineralogical composition are investigated, problems associated with processing are discussed, and the results of differential thermal analysis and X-ray diffraction analyses are correlated with ceramic properties.

Published as a paper in *Jour. of Can. Cer. Soc.*, Vol. 32, 1963, pp 46-71.

*Head, Ceramic Section, and **Scientific Officer, Mineral Processing Division, Mines Branch.

25 cents

Cat. No. M34 -20/54

TB 55. *The Determination of Oxygen by Fast Neutron Activation Analysis*

Hugh P. Dibbs*. March 1964. 26p. Illus., tables.

An account is given of the quantitative determination of oxygen by fast neutron activation. The method, which is both rapid and non-destructive, covers a very wide range of oxygen concentrations and is almost free from matrix effects. A description is presented of the shielding requirements and of the automatic system for sample transfer. Interference effects that may arise from the presence of certain elements are also discussed.

*Senior Scientific Officer, Physics and Radiotracer Subdivision, Mineral Sciences Division, Mines Branch.

75 cents

Cat. No. M34 -20/55

TB 56. *Mineralogy of the Mount Pleasant Tin Deposit in New Brunswick*

W. Petruk*. July 1964. 43p. Illus., tables.

The Mount Pleasant tin deposit in New Brunswick is unusually complex and contains a wide variety of minerals. The tin-bearing minerals are cassiterite and stannite. Cassiterite is the chief tin mineral and it occurs as disseminations in

mineralized rock, fluorite masses, and sulphide veins. The cassiterite in the mineralized rock and sulphide veins occurs as small grains. Stannite was found mainly as irregular grains and minute inclusions in sphalerite and arsenopyrite.

*Senior Scientific Officer, Mineralogy Section, Mineral Sciences Division, Mines Branch.

75 cents

Cat. No. M34 -20/56

TB 57. *In preparation.*

TB 58. *In preparation.*

TB 59. *In preparation.*

TB 60 *Procedure for the
Fabrication of Printed
Circuit Boards*

A.H. Bettens*. Sept. 1964. 16p.
Illus.

The use of printed circuits in electronic equipment designed for research applications is described. Details of the procedure used and materials employed are given. These techniques are illustrated by specific examples of equipment in use in the Mineral Sciences Division.

*Senior Technician, Physics and Radiotracer Subdivision, Mineral Sciences Division, Mines Branch.

50 cents

Cat. No. M34 -20/60

TB 61. *Improvement of Cadmium
Plating Bath Compositions*
W. Dingley* and J. Bednar**. Dec.
1964. 5p. Illus., tables.

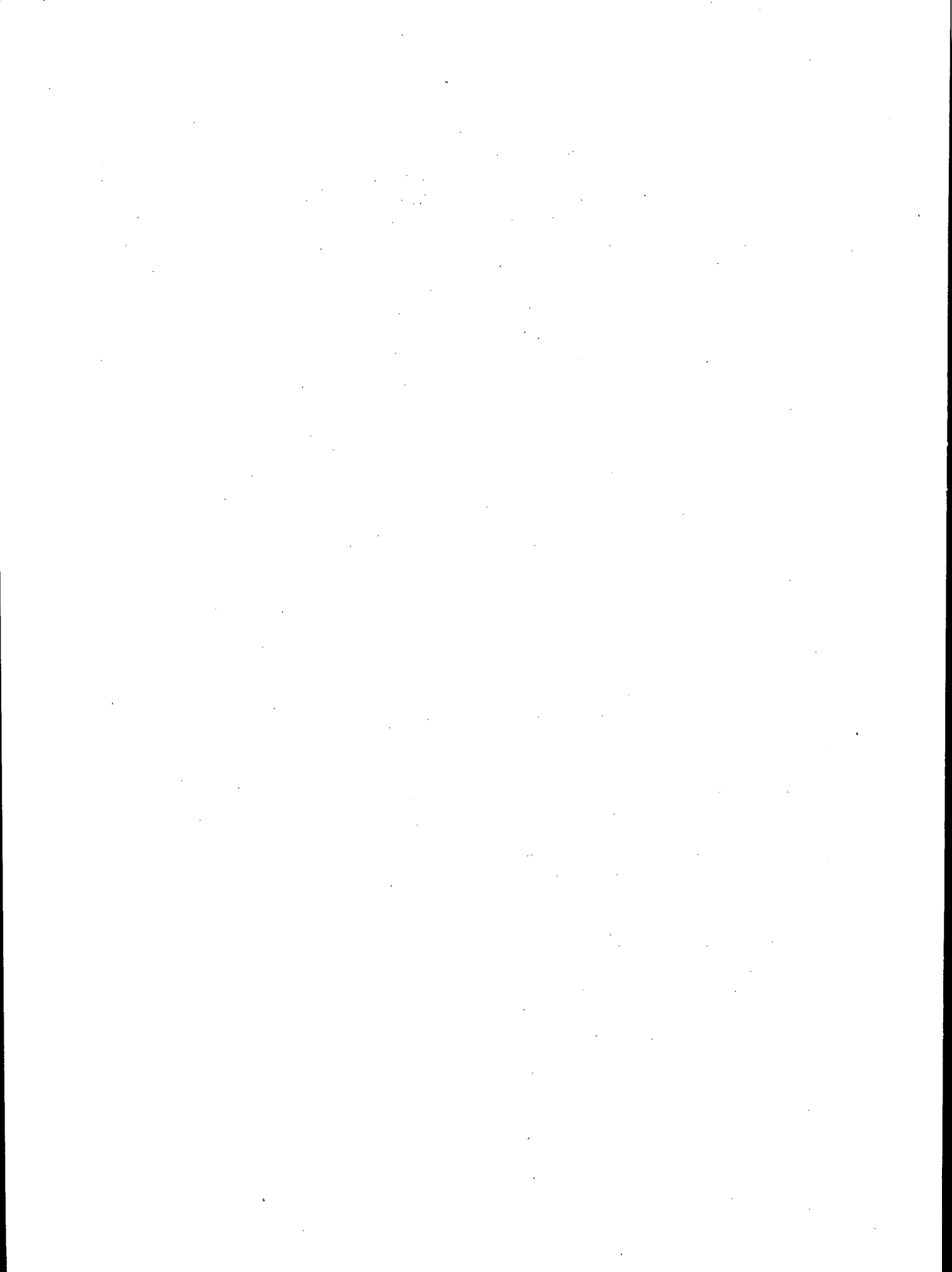
A great deal of cadmium electroplating now is being done in industry. In view of the recent improvements in cyanide zinc plating baths recommended by the authors, and since the chemistry of cadmium is similar to that of zinc to a certain extent, it was decided to investigate cyanide cadmium plating baths to determine whether they could be improved in a somewhat similar manner.

Published as a paper in the 52nd Annual Tech. Proc. of the Amer. Electro. Soc., June, 1964, pp 66-70.

*Technical Officer and **Technician, Pyrometallurgy and Corrosion Subdivision, Extraction Metallurgy Division, Mines Branch.

25 cents

Cat. No. M34 -20/61



INFORMATION CIRCULARS

- IC 155. *Bibliography of High Temperature Condensed States Research Published in Canada, October-December, 1963*
N. F. H. Bright*. Jan. 1964. 37p.

This report contains bibliographic information concerning research work on high-temperature condensed states published in Canadian journals during the period October to December, 1963. A short list of compilations of data published in the United States on the high-temperature properties of materials is included. A list of laboratories and research workers in the United Kingdom, active in high-temperature condensed states research, is also included.

*Head, Physical Chemistry Section, Mineral Sciences Division, Mines Branch.

75 cents

Cat. No. M38 -3/155.

- IC 156. *Report on the Cambridge International Summer School for Quantitative Methods in Reflected-Light Microscopy*
E. H. Nickel*. December 1963. 55p.

The International Summer School for Quantitative Methods in Reflected-light Microscopy was held at Cambridge, England, from June 23 to July 2, 1963. This report summarizes the lectures and laboratory sessions given in the following courses: preparation of polished sections, the reflecting microscope, reflectivity of ore minerals, micro-indentation hardness, rotation properties in reflected light,

electron-probe micro-analysis, systematic mineral identification based on hardness and reflectivity, and ore mineral textures.

*Senior Scientific Officer, Mineralogy Section, Mineral Sciences Division, Mines Branch.

\$1.00

Cat. No. M38 -3/156

- IC 157 *Salt, and the Canadian Salt Industry*
R. K. Collings*. April 1964. 38p.

This report outlines the origin of the three major types of salt deposits occurring in the world, namely brine deposits, bedded rock salt deposits, and salt domes. Methods currently used to recover salt from these deposits are described in some detail. Sections on the properties and uses of salt, in particular its use for ice control and in soil stabilization, are included.

Canadian salt occurrences are listed and developments within the Canadian industry from 1886, the year of the first recorded production, to the present are outlined. Current Canadian operations are described and detailed statistics of production, trade, and consumption for the period 1950 to 1963 are listed. A short section on world production of salt, with production statistics of the main producing countries for 1962, is included.

Finally, several of the more recent developments relating to salt processing are noted, and two techniques for upgrading salt, namely the thermal adhesive method and electronic sorting, are described. *Head, Non-Metallic Minerals Sec-

tion, Mineral Processing Division,
Mines Branch.

75 cents

Cat. No. M38 -3/157

IC 158. *Polarographic and
Amperometric Methods
Applied to Metallurgical
Analysis*

A. Hitchen*. April 1964. 14p. tables.

A general outline is given for the determination of copper, nickel, cobalt, zinc, lead, cadmium, bismuth, manganese, uranium, molybdenum, vanadium, sulphate and fluoride by polarographic or amperometric methods in a variety of ores or metallurgical products. The detection of oxygen in gas mixtures by an amperometric method used as a safety device is also discussed.

*Senior Scientific Officer, Chemical Analysis Section, Extraction Metallurgy Division, Mines Branch.

50 cents

Cat. No. M38 -3/158

IC 159. *Bibliography of High
Temperature Condensed
States Research Published
in Canada, January-
March, 1964*

N. F. H. Bright*. April 1964. 11p.

This report contains bibliographic information concerning research work on high-temperature condensed states published in Canadian journals during the period January to March, 1964.

*Head, Physical Chemistry Section, Mineral Sciences Division, Mines Branch.

50 cents

Cat. No. M38 -3/159

IC 160. *Exploitation of a Small
Peat Bog*

T. E. Tibbetts* and R. E. Kirkpatrick**. May 1964. 52p. Illus., tables.

Description of the methods devised by a Canadian company to produce and process peat and other materials occurring in a small peat bog are presented in detail. The steps in bog preparation for production, such as draining, clearing and stripping, are described. Production topics covered are bog layout, use of vehicle runways, cultivating, windrowing, loading, shredding, and piling. Included in the description of the processing of the peat are the techniques followed for drying and packaging.

The preparation of other materials occurring on, in and under the bog such as floral moss, compost materials and bog lime, is briefly described.

The descriptions of production and processing are illustrated by a number of sketches. Also included are details of production costs, selling prices, and profits.

*Head, Coal and Peat Preparation and Surveys, Fuels and Mining Practice Division, Mines Branch.

**Production Manager, Grand Falls Peat Co. Ltd., Grand Falls, New Brunswick.

\$1.00

Cat. No. M38 -3/160

IC 161. *Analyses of Coal and
Coke During 1963*

William J. Montgomery* and G. C. Behnke**. May 1964. 19p.

The Solid Fuels Laboratory of the Fuels and Mining Practice Division is responsible for all analytical work on coal and coke, including that reported in the official "Analysis Directory of Canadian Coals", which is published by the Mines Branch (but only at intervals of five or more years). This information circular, issued as the fourth of an annual series, tabulates the analyses of commercial and special samples of coal and coke received by the Division during 1963.

It must be clearly understood that no responsibility is taken by the Division for the accuracy of the sampling procedures adopted for procuring the samples for which analyses are reported in this circular, excepting those taken by Divisional officers.

*Head, Solid Fuels Laboratory, and
**Technician, Fuels and Mining Practice Division, Mines Branch.

50 cents

Cat. No. M38 -3/161

IC 162. *An Index of Scientific and Technical Papers Published by the Staff in 1963*

50 cents

Cat. No. M38 -3/162

IC 163. *List of Certified Electrical Apparatus, Certified Fire-Resistant Conveyor Belting and Certified Diesel Engines for Coal Mine Use.*
(Second Edition)

G.K. Brown*. August 1964. 25p.

The principal information pre-

sented in this circular is a complete list of the electrical apparatus which has been certified by the Department of Mines and Technical Surveys as being suitable for use in coal mines. In addition to the electrical apparatus there is a list of conveyor belting which has been certified fire-resistant by the Department, as well as details of a diesel engine certified for use in an underground locomotive. The period covered is from the opening of the certification service, in September 1955, until June 30, 1964. This report is the second of a series of lists of certified apparatus which will be issued from time to time. The scope and background of the certification service are covered briefly in the preface, and references are given for those interested in obtaining more detailed information.

*Certification Officer, Fuels and Mining Practice Division, Mines Branch.

25 cents

Cat. No. M38 -3/163

IC 164. *Bibliography of High Temperature Condensed States Research Published in Canada, April-June, 1964*

N.F.H. Bright*. July 1964. 11p.

This report contains bibliographic information concerning research work on high-temperature condensed states published in Canadian journals during the period April to June, 1964.

*Head, Physical Chemistry Section, Mineral Sciences Division, Mines Branch.

50 cents

Cat. No. M38 -3/164

**IC 165 The Dissemination of
Technical Information to
Canadian Industry**

John Convey* and F. T. Rabbitts**.

This is one of a series of studies on research in Canadian industry sponsored by the Applied Research Committee of the National Productivity Council. This study has been carried out as a contribution to the following objects of that Council:

- (i) The extension of industrial research programs in plants and industries as a means of achieving greater productivity, and
- (ii) The dissemination of information related to applied research.

*Director and **Senior Scientific Officer, Mines Branch.

75 cents

Cat. No. M38-3/165

IC 166. In preparation.

**IC 167. Bibliography of High
Temperature Condensed
States Research Published
in Canada, July-
September, 1964**

N. F. H. Bright*. Oct. 1964. 10p.

This report contains bibliographic information concerning research work on high-temperature condensed states published in Canadian journals during the period July to September, 1964.

*Head, Physical Chemistry Section, Mineral Sciences Division, Mines Branch.

50 cents

Cat. No. M38-3/167

***SECTION 2 - PAPERS PUBLISHED IN
PERIODICALS***

THE UNIVERSITY OF CHICAGO
LIBRARY

MINERAL PROCESSING DIVISION

Surface Water Quality in Major Drainage Basins and Northern Areas of Canada

by J.F.J. Thomas, Jour. Amer. Water Works Assoc., Vol. 56, No. 9, Sept. 1964.

This article summarizes information on the chemical quality of major Canadian surface waters obtained from surveys carried out by the Mines Branch since 1948. Urgent and steadily increasing demands for these data have necessitated considerable compromise in carrying out the surveys; in some instances, the number of waters studied in each basin and the sampling frequency have been less than desired. Furthermore, in order to disseminate the information as quickly as possible, little attempt has been made to interpret in detail the data in the eleven reports published to date.¹⁻¹¹ This initial survey of the chemical quality of Canadian surface waters will be completed with the publication of two Water Survey Reports now in preparation.

Technical Advances in Milling and Process Metallurgy in Canada During 1963

by D.E. Pickett, Can. Min. Jour. Vol. 85, No. 2, Feb. 1964.

In 1963, significant advances were made in the expansion of metallurgical research facilities in Canada, and in the general attitude toward research. In response to this increasing world competition, industrial research activity in 1963 appeared to be directed mainly to-

ward the planning and construction of new research facilities. This activity may have been partly catalysed by major concessions made by the government to encourage industrial research. Two large mining and metallurgical companies completed new modern research centres and a third centre is under construction. Perhaps significant of a new trend, these centres are located away from company production plants and near major cities and leading scientific educational institutions.

In general, metallurgical research appeared to be oriented mainly toward physical metallurgy and the development and utilization of metal products. However, mineral dressing and process metallurgy were not neglected and significant contributions to fundamental knowledge in these fields were made, especially by the universities.

Non-destructive Methods of Testing Concrete - Part I

by V.M. Malhotra, Cement and Concrete, Vol. 5, No. 1, April-June, 1964.

This is the first in a series of three articles on non-destructive testing of concrete. This article deals with hardness tests for concrete. Different methods of hardness testing are briefly mentioned and the Schmidt-testing hammer based on the rebound principle is described in detail. The calibrating procedure for the hammer is given and its advantages and limitations are discussed.

Bentonite - A Challenge for Canadian Industry

by J.S. Ross, Can. Instit. of Min. and Metallurgy Bull. June 1964.

Although Canadian bentonite is competitive in quality for most uses, it has not been accepted for the pelletizing of iron ore concentrates. In 1962, Canada consumed about 10,000 tons of imported bentonite for this use. By the end of 1965, the planned domestic consumption for this purpose alone will probably be more than 100,000 tons a year, valued at about \$3 million. Consequently, a challenge exists for the establishment of a Canadian source of high-quality bentonite for pelletizing. Such a bentonite would also be suitable for the two other major applications--well drilling and foundry use.

Brief mention is made of such topics as the identification, properties, occurrences, exploration, applications, technology and laboratory testing of this clay. In particular, the type of bentonite in demand, the geological horizons warranting exploration, and simple preliminary test methods are discussed.

Accelerated Hardening of Concrete With a View to Rapid Control Tests

by V. M. Malhotra and N. G. Zoldners, Pit and Quarry, Oct. 1964.

This article reports the results of concrete from three different construction projects, supplemented by additional laboratory mixes. A total of 106 concrete test batches were tested, using Akroyd's modified boiling method.

Minerals Earning Important National Role

by J.S. Ross, Mining Engineering, Nov. 1964.

Although Canada's industrial minerals production is overshadowed in value by its big brother, the metals, it has recently reached maturity in a healthy state according to domestic and world standards. The nation is self-sufficient in most minerals. Current activity will not only increase this self-sufficiency but assist greatly in the nation's balance of international payments.

This nation must now start to lay the foundation for an industrial minerals industry that will eventually become much more significant. This will entail development of (1) strong and aggressive industry associations, (2) standard testing procedures and standard specifications wherever possible, (3) municipal and industrial planning boards to make the fullest economic use of an industry with depleting resources, and (4) more research to produce more sophisticated products for competition with substitute materials and to supply a larger part of Canada's requirements of manufactured products.

The Courageous Cobalt Camp

by L.E. Djingheuzian, Northern Miner, Annual Number, Nov. 26, 1964.

Seventh International Mineral Processing Congress

by L. E. Djingheuzian, Proc., New York, Sept. 20-26, 1964, C. I. M., Vol. 57, No. 632, Dec. 1964.

Developments in Industrial Minerals in 1963

by H.M. Woodrooffe, Can. Min. Jour., February 1964.

Industrial Minerals 1963

by H.M. Woodrooffe, Canada Year Book, 1964.

Development in Asbestos in 1963

by H.M. Woodrooffe, Can. Min. Jour., February 1964.

The Thermal Conductivity of Concrete

discussion by N.G. Zoldners and V.M. Malhotra of paper by D. Campbell-Allen and C.P. Thorne, (London), Dec. 1964.

A Study of Deterioration of Structural Concrete Made With High-Alumina Cement

discussion by N.G. Zoldners and V.M. Malhotra, Proc. of the Institution of Civil Engineers (England), Vol. 27, Feb. 1964.

Rapid Field Assessment of Strength of Concrete by Accelerated Curing and Schmidt Rebound Hammer

discussion by V.M. Malhotra and N.G. Zoldners, Amer. Concrete Instit. Jour. Sept. 1964.

Correlation Between Particle Shape and Surface Texture of Fine Aggregates and Their Water Requirement

discussion by V.M. Malhotra, Mat. Res. and Standards, Vol. 4, No. 12, Dec. 1964.

Experiences With the Kelly Ball Test

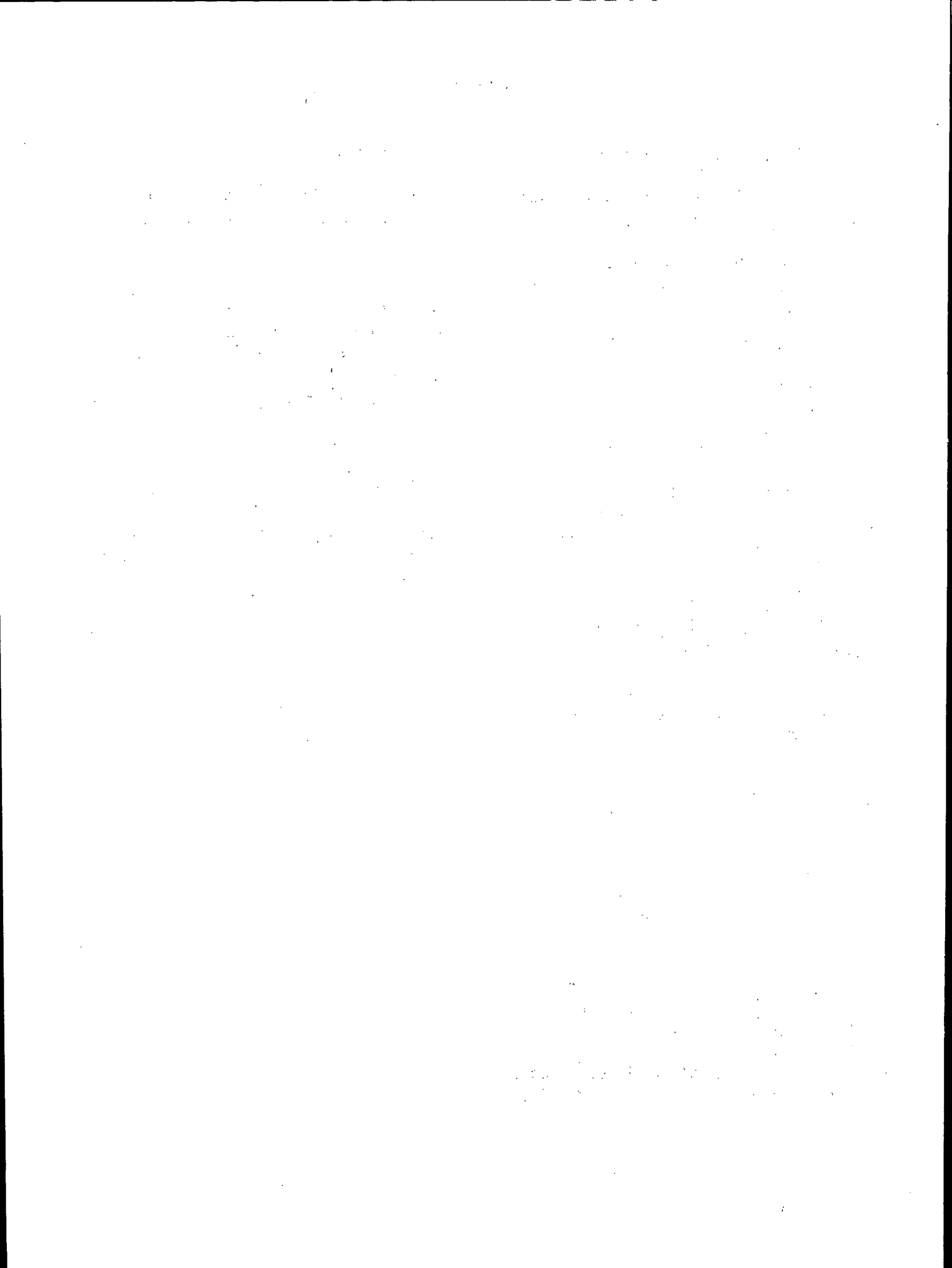
discussion by V.M. Malhotra, Amer. Concrete Instit. Jour., Jan. 1964.

High-Temperature Behavior of Aluminous Cement Concretes Containing Different Aggregates

discussion by N.G. Zoldners and V.M. Malhotra, Mat. Res. and Standards, Aug. 1964.

Predicting Compressive Strength from Properties of the Fresh Concrete

discussion by V.M. Malhotra, Mat. Res. and Standards, Vol. 3, No. 6, June, 1963.



EXTRACTION METALLURGY DIVISION

Controls in the Cyanide Process
by K. W. Downes, Can. Min. Jour.,
Oct. 1964.

Although the chemical reactions that may occur in cyanidation are numerous and complex, the essential problem in the cyanidation of a gold ore is this: that, assuming the gold has been unlocked, conditions should be adjusted so as to maximize the rate of dissolution of gold and silver while minimizing the rates of dissolution of all other constituents.

The five variables, grind, alkalinity, cyanide concentration, oxygen concentration, and contact time, constitute the principal items that should be considered in the cyanide process. The control of these variables is discussed.

Automatic Control of Alkalinity in a Gold Cyanidation Mill
by F. J. Kelly and C. S. Stevens,
Can. Min. Jour., January 1964.

An alkalinity controller based on a novel conductimetric sensing probe (1) was field tested during the past summer at Delnite Mines Limited located in the Timmins Ontario area. The test was a cooperative effort in which the control equipment was installed by personnel of the Mines Branch, Department of Mines and Technical Surveys and operated by the Delnite mill staff. The purpose of the test was to determine if the conductivity probe was applicable to the control of alkalinity in a gold-cyanide circuit, and to determine the economic

advantages of the controller in this application. The control circuit was a modified Foxboro dynalogue recorder-controller activated by the conductivity probe. The controller in turn drove a variable speed motor on a platform-type reagent feeder used to supply quicklime to the circuit as required.

Activation Energy Calculation from a Linearly-Increasing-Temperature Experiment
by T. R. Ingraham and P. Marier,
Can. Jour. of Chem. Eng., Aug. 1964.

For Abstract see R 130, page 4.

A Thorium Intermediate Member of the Britholite-Apatite Series-Physical and Chemical Studies
by M. R. Hughson and J. G. Sen Gupta, Amer. Min., Vol. 49, July-Aug. 1964.

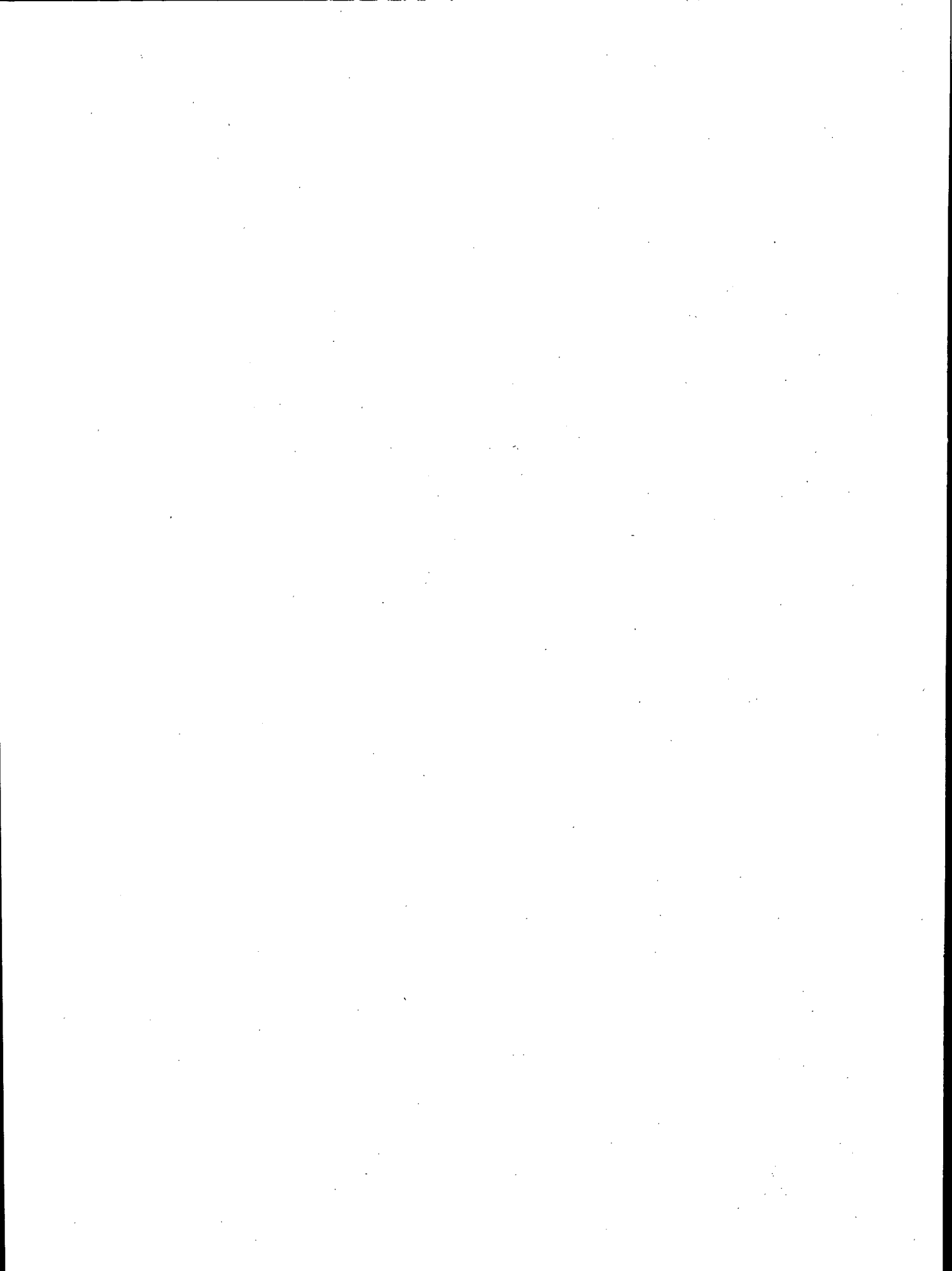
For Abstract see R 131, page 5.

Mechanism of Thermal Decomposition of Ammonium Metavanadate
by M. Taniguchi and T. R. Ingraham, Can. Jour. of Chem., Vol. 42, 1964.

For Abstract see R 136, page 7.

Thermochemistry of the Co-S-O System from 950 to 1200°K
by T. R. Ingraham, Can. Met. Quart., Vol. 3, No. 3, July-Sept., 1964.

For Abstract see R 139, page



MINERAL SCIENCES DIVISION

Determination of the Heavy Atom Content in Chlorite by Means of the X-ray Diffractometer

by W. Petruk, Amer. Min., 49, 61-71, Jan. - Feb. (1964).

A relationship between the approximate iron content in chlorite and intensity data obtained by means of the X-ray diffractometer has been established. Twenty-nine chemically analysed chlorites whose compositions range from those of the iron-rich varieties to those of the magnesium-rich varieties were studied. The results show that the intensities of X-rays diffracted from even-ordered basal planes of chlorite are proportional to the number of heavy atoms (Fe+Mn+Cr) in the octahedral layers of the mineral. A ratio of these intensities, expressed by the term $(I_{002}+I_{004})/I_{003}$, was selected as a variable factor representing the intensity, and its relationship to the number of atoms in the octahedral layers of chlorite was derived.

The Analysis of Rocks and Ores, by X-ray Diffractometer

by W. Petruk, Can. Min., 8, 68-85, Part 1, (1964).

This paper deals with the use of the X-ray diffractometer as a means of analysing a variety of rocks and ores. Three different methods were investigated; an internal standard method, a method requiring calculation of the mass absorption coefficients of the individual constituents of the sample, and a method which involves meas-

uring the relative intensities of reflections from the sample holder. Tests on a variety of known samples indicate comparable accuracies, and that the mean deviation is 3-5 units. The major source of error is believed to be in sample preparation.

Niobophyllite - The Niobium Analogue of Astrophyllite; A New Mineral from Seal Lake, Labrador

by E. H. Nickel, J. F. Rowland and D. J. Charette, Can. Min., 8, 40-52, Part 1, (1964).

Niobophyllite, the niobium analogue of astrophyllite, is described for the first time. A chemical analysis indicates the following composition: $(K, Na)_{2.95}(Fe, Mn)_{6.35}(Nb, Ti)_{2.02}(Si, Al)_{7.70}(O, OH, F)_{31}$. Niobophyllite is triclinic, with space group P1 or P $\bar{1}$ and the following unit-cell dimensions: $a_0 = 5.391$ A, $b = 11.88$ A, $c = 11.66$ A, $\alpha = 113.1^\circ$, $\beta = 94.5^\circ$ and $\gamma = 103.1^\circ$. The specific gravity is 3.42 (meas.) or 3.406 (calc.). Niobophyllite is biaxially negative with $2V = 60^\circ$ and the following refractive indices: $\alpha = 1.724$, $\beta = 1.760$ and $\gamma = 1.772$. Z is normal to the plane of perfect cleavage, in contrast to astrophyllite, where X is normal to the cleavage.

Latrappite - A Proposed New Name for the Perovskite-Type Calcium Niobate Mineral from the Oka Area of Quebec

by E. H. Nickel, Can. Min., 8, 121-122, Part 1 (1964).

The name "latrappite" is proposed for the variety with a high niobium content, the name being derived from the small community of La Trappe, Quebec, about one-half mile from the deposit in which the mineral was discovered. Latrappite is hereby defined as follows: A mineral with the perovskite structure and a composition corresponding to the general formula ABO_3 , in which the "A" and "B" cation sites are occupied predominantly (in excess of 50 mol. %) by calcium and niobium, respectively. The name niobian perovskite is to be retained for those niobium-bearing perovskites in which titanium predominates.

The Decay of 33 sec Kr^{90}
by R. H. Goodman, J. E. Kitching
and M. W. Johns, Nuclear Phys.,
54, 1-16 (1964).

The separation of 33 sec Kr^{90} from the other fission products has been achieved by gas chromatography and the resulting activity studied by the techniques of scintillation spectroscopy. The energies and intensities of 36 transitions in Rb^{90} have been measured. Beta-gamma and gamma-gamma coincidence experiments have led to the formulation of a decay scheme which involves 27 of these transitions and establishes levels in Rb^{90} at 0.0, 0.12, 0.23, 0.656, 1.63, 1.78, 1.80, 2.02, 2.28, 2.41, 2.48, 2.70, 3.19 and 3.60 MeV. The decay energy of Kr^{90} is 4.56 ± 0.02 MeV.

High Temperature Inorganic Chemistry

by Norman F. H. Bright, Chem. in Canada, 32, July (1964).

The development and comprehension of high-temperature inorganic chemical processes and reactions, then, is part of the stuff of modern living. For this reason, therefore, it is entirely appropriate that the Inorganic Chemistry Division of The Chemical Institute of Canada should concern itself with such problems, and hold a Symposium to discuss them. On Wednesday, Thursday and Friday, September 2-4, 1964, a Symposium on High-Temperature Inorganic Chemistry will be staged in the Science Building of Carleton University in Ottawa.

High Temperatures

by Norman F. H. Bright, Chem. in Canada, 34, October (1964).

The subjects discussed in the Symposium on High Temperature Inorganic Reactions covered a wide spectrum and were so arranged that, while the lectures on the whole of the first day dealt primarily with the solid state of matter at elevated temperatures, those on the second morning dealt with the solid state in conjunction with the gaseous state; those on the second afternoon dealt mainly with the liquid and glassy conditions at high temperature, while the final morning session was devoted to the gaseous phase itself at high temperatures.

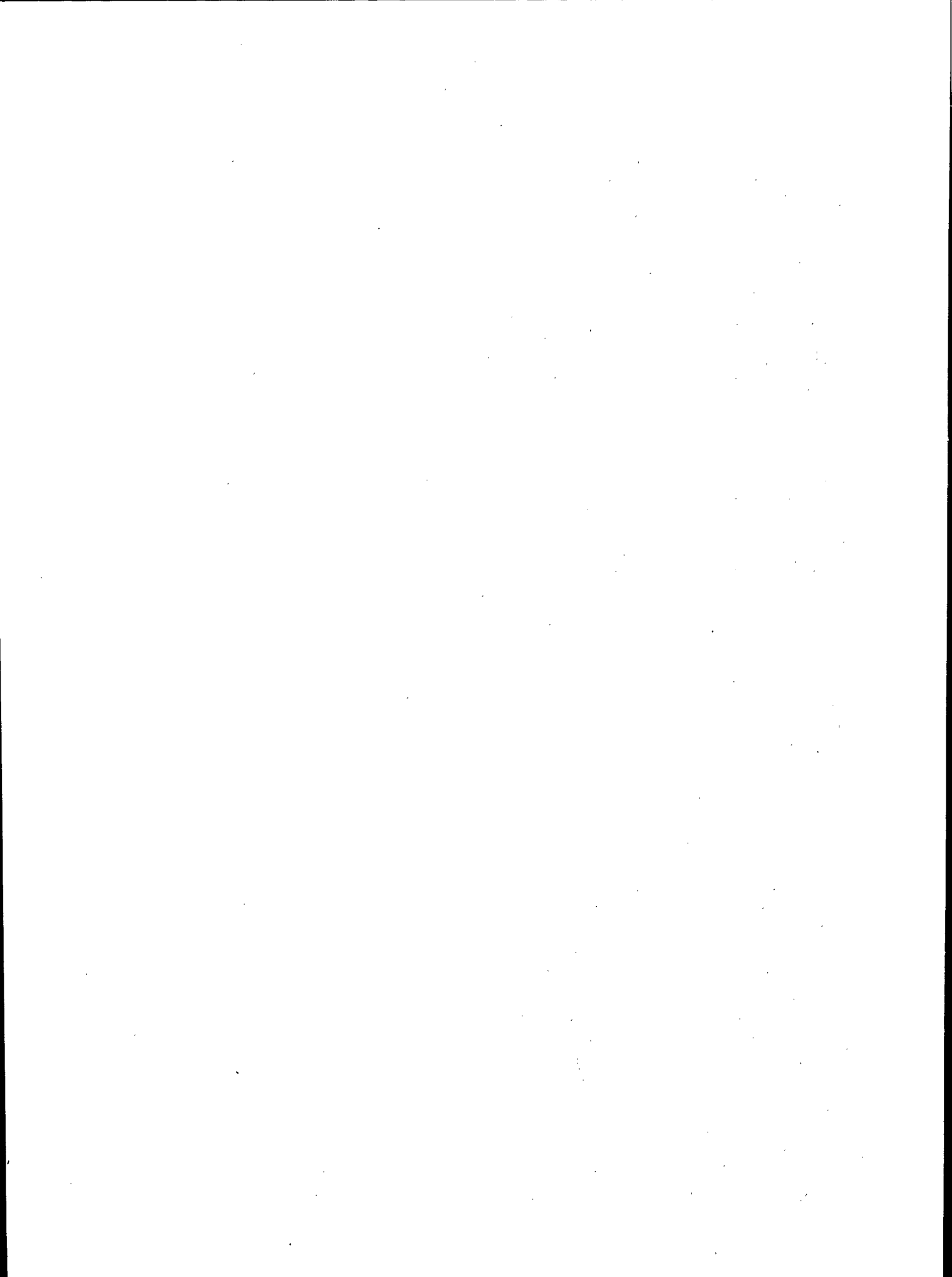
Fe-Ta-Oxides: Phase Relationships at 1200°C
by A.C. Turnock, Jour. Amer. Ceram. Soc., (in press).

Subsolidus phase relationships between the oxides in the system Fe-Ta-O have been experimentally determined at 1200°C, 1 atm, total pressure, and variable partial pressures of oxygen.

Tantalum pentoxide reacts readily with either ferrous or ferric oxide in the subsolidus, and the following ternary compounds have been synthesized: $\text{Fe}_4\text{Ta}_2\text{O}_9$, $\text{Fe}_3\text{Ta}_2\text{O}_8$, FeTaO_4 , FeTa_2O_6 , solid solutions between the two latter compounds and also tantalian magnetites.

New Fire Assay Method for Iridium
by G.H. Faye, W.R. Inman and P.E. Moloughney, *Analyt. Chem.*, 36, 366-368, Feb. (1964).

The tin-collection scheme for the determination of the precious metals has been extended to include iridium. During the fusion process, the collection of both microgram and milligram quantities of iridium from synthetic charges is essentially complete. Tin powder is used to recover iridium from the parting-acid solution. Ion exchange and solvent extraction procedures are used to isolate iridium prior to its gravimetric or spectrophotometric estimation. The proposed method has been successfully applied to the analysis of a flotation concentrate, a copper-nickel matte, and a specimen of osmiridium from New Guinea.



FUELS & MINING PRACTICE DIVISION

Dust Research in West Germany by T. S. Cochrane, CIMM Bull., 57, No. 627, 719-728, July (1964).

Three dust research institutes were visited in West Germany, namely:-

1. The Dust Research Institute of the Accident Prevention and Plant Safety Association, Bonn;
2. The Silicosis and Dust Control Centre of the Coal Mining Association, Essen-Kray;
3. The Silicosis Institute of the Workmens Compensation Board, Bochum.

It is not the purpose of this paper to discuss the entire organizational detail and research programs of these dust institutes. Rather, the author intends only to draw attention to certain highlights of organization, dust measurement, and development trends which he considers should be of interest to Canadian mining personnel. It is hoped that the detail can be obtained by use of the bibliography included at the end of the paper.

A Sonic System for the Determination of 'In Situ' Dynamic Properties and for the Outlining of Fracture Zones by G. E. Larocque, Proc. 6th Symp. on Rock Mechanics, Univ. of Missouri, Rolla, Oct. (1964).

This paper describes a sonic system developed for probing the rock around mining openings. With

this system transit time measurements of a few hundred microseconds to many milliseconds can be made with an accuracy of 5%. The sonic apparatus is relatively portable and entirely independent of external power requirements, allowing its use in remote mining locations. A hammer blow is used as a source of signal. For transit time measurements between boreholes hydraulically wedged transmitting and receiving units have been developed; surface receiving units have also been developed and used.

In this paper the basic assumption on which sonic transit velocity is related to fracture zone is stated and some of the possible applications of such measurements outlined. Field measurements to substantiate some of the statements made are included in the paper.

Deformation Around a Mine Shaft in Salt

by K. Barron and N. A. Toews, Proc. Rock Mechanics Symp., Queen's Univ., Mines Branch, (1964).

The recovery of potash from the vast deposits in Saskatchewan has presented conditions unique in Canadian mining history. Recognizing this, The International Minerals and Chemical Corporation (Canada) Ltd. proposed that research be initiated, in both the potash and the overlying salt, to obtain information pertinent to mine design, stability, safety and economy. This resulted in a cooperative research program involving the company, Dr. S. Serata, consultant, and the Mines Branch, Dept. of Mines

and Technical Surveys, Ottawa,

Initial studies were made in the unlined portion of the shaft in the salt above the potash beds. Measurements were made of displacements, relative to the shaft axis, of points on the surface of the shaft and within the solid surrounding the shaft. A diametral extensometer and an extensometer to measure the longitudinal deformation of boreholes around the shaft were used.

The objective of these measurements was to obtain data on the creep (or deformation as a function of time) of salt around a simple opening and to correlate this data with theoretical ideas on the behaviour of the material.

Some Cases of Residual Stress Effects in Engineering Work

by D.F. Coates, Proc. G.S.A. Conf. on State of Stress in the Earth's Crust, Elsevier, (1964).

Some actual cases are presented that describe the effect on engineering projects from detrimental fracture and flow that are a result of residual stresses. The following cases occurred in Canada on both mining and civil engineering projects.

- 1) Floor upheaval in an open pit
- 2) Horizontal deformation of a power tunnel
- 3) A large rock burst

Classification of Rocks for Rock Mechanics:

by D.F. Coates, Inter. Jour. of

Rock Mechanics and Min. Sci., 1, 421-429, (1964).

In the field of rock mechanics efficient communication between the laboratory and the field engineers, operators and contractors is important. For example, a rock may be described as a Cretaceous shale with quartz and pyrite, etc. However, some of the principal factors of practical interest would be: (a) is it jointed, badly fractured, distinctly layered or massive; (b) does it fail in a brittle or plastic manner; (c) is it viscous before failure; (d) can the information be interpolated between boreholes, etc.? Hence it is important that the significant properties of both the substance and the mass be recognized and the appropriate information obtained so that an initial appraisal can be made of any potential problems.

A review of rock mechanics' applications, of important properties and of other classifications is presented. A proposal is then made for a classification system to be used initially in this field.

Stockage Souterrain du Gas Naturel dans le Sud de

L'Ontario et du Québec
by R.P. Charbonnier, Parue au Bull. de l'A.F.T.P. 161, du 30 Septembre 1963. Assoc. Francaise des Tech. du Pétrole

Following the recent completion of the Trans-Canada gas pipeline, the consumption of natural gas is expected to grow very rapidly in southern Ontario and Quebec--in a trend similar to that which has

occurred in the eastern United States in recent years.

The United States data show the importance of underground storage of natural gas as a solution to irregular consumption problems and winter peak demand periods. The situation in Canada is likely to be very similar.

In the present study various aspects of underground gas storage are considered, including an example of evaluation of market requirements in southern Ontario, a survey of the design and operation of partly depleted fields and aquifer reservoirs, and some cost data.

The present facilities and future possibilities of gas storage in southern Ontario and Quebec are also studied, and show the desirability of further investigations of the storage gas pool possibilities in that area.

A New Type of Mineral Classification Equipment

by R. P. Charbonnier, Trans. of the Eng. Instit. of Canada, 6, No. E-2, Nov. (1963).

In recent years, the Lavodune, a new process of mineral classification, has been developed in France, and adopted in a number of size or gravity separation plants in several countries. This process seems to have attractive possibilities for the sorting of coal, ores, sands, and many mineral or chemical products. It was originally derived from extensive studies on the hydraulic transportation of solids and on the separation of sands

from waters, made by Sogreah, which is the engineering subsidiary of Neyrpic, one of the largest manufacturers of hydraulic equipment in the world.

As a detailed description of the Lavodune apparatus was published in the literature (1) in 1958, and more recent results (2) appeared in 1959, the process will not be described here in detail. This paper is mainly prepared to summarize a number of recent laboratory and industrial results of performances, obtained in the classification of various materials, and also to indicate some new developments based on the Lavodune principles, which will now be briefly analyzed.

The Compound Water Cyclone: A New Cleaner for Fine Coal Slurry

by J. Visman, Coal Min. and Proc., Maclean-Hunter Pub. Corp., Chicago, Ill., U.S.A. 32-35, Feb. (1964).

A description is given of an improved type of water cyclone for the cleaning of coal fines and slurries.

The application of this cleaner as part of a two-stage circuit has a number of advantages that are normally not combined in other systems for the cleaning of coal in bulk.

Design data are presented for three commercial sizes of compound water cyclones now available to the industry. Typical results obtained on a semi-commercial scale are presented as an indication of the potential value of the

compound water cyclone for the coal mining industry.

Coal - 1963

by T. E. Tibbetts and J. W. Griffith, Ann. Min. Review of Can. Min. Jour., 85, No. 2, 126-129, Feb. (1964).

Conditions in the coal industry in Canada during the past thirteen years have become more and more difficult as the competitive position of coal with respect to other fuels has weakened. Petroleum fuels, including natural gas, have largely replaced coal as a residential fuel and have made considerable inroads into commercial and industrial markets.

Comparison of Canadian Energy Prospects-Potential of Coal-in-Oil Fuels

by G. A. Vissac and R. P. Charbonnier, Eng. Jour., April (1964).

It appears that coal-in-oil slurries, transported in existing or new large-diameter pipelines from Alberta to the Vancouver, Toronto and Montreal areas, are likely to offer attractive solutions to our future requirements for energy which should be both inexpensive and produced in Canada when possible. In addition to other sources of coal and oil, the Athabasca sands oils, after some partial processing to bring their API gravity to about 20, and the high calorific value coals from Alberta may be the most suitable components of coal-in-oil fuels for fuel, metallurgy, transportation, industrial markets of British Columbia and central Canada, and

possibly for exports without government subsidies.

An Investigation of Fuel-Oil Additives to Prevent Super-Heater Slagging in Naval Boilers

by G. K. Lee, E. R. Mitchell, R. G. Grimsey and Lt. Cmdr. S. E. Hopkins, Proc. of the Amer. Power Conf., 26, 531-552, April (1964).

The paper describes part of a continuing research program aimed at minimizing the slagging of boiler surfaces when burning Caribbean source high-vanadium fuel oil under conditions that prevail in naval boilers. These conditions are more severe than in most stationary boilers, therefore, the latter may also benefit from the program.

Using a laboratory rig, the composition of an effective additive was established. To accomplish this 17 fuel-oil additive compositions were evaluated in 33 combustion tests. In 11 tests, the influence of both salt water spray and soot blowing on the structure and weight of superheater deposits was measured. Through this program, and with the co-operation of a chemical manufacturer in the United States, a commercial additive was developed. A practical evaluation commenced in July 1963 in a one year shipboard trial at sea.

The First Conference on Fuel Technology in Canada

by E. R. Mitchell, Jour. of the Instit. of Fuel, April (1964).

The conference was organized

into three technical sessions dealing with Canadian fuel technology in the broadest sense. The theme of Session I was "Fuel Technology in the Canadian North." It comprised three panels, the first dealing with "Internal Combustion Applications," the second with "Space Heating," and the third with "Gas Turbine and Aircraft Fuels." The theme of Session II was "Industrial Fuel Applications." It also comprised three panels, the first dealing with "Combustion," the second with "Steam Generation," and the third with "Special Fuel Uses." The third session dealt with "Atmospheric Pollution" in one panel. Altogether 22 papers were presented. A list of the papers presented and their themes completes Section 2 of of this paper.

High Intensity Combustion for Pulsating and Sonic Heating Systems

by L. B. Geller, G. K. Lee and E. R. Mitchell, *Ashrae Jour.*, Sept. (1964).

Through long years of pragmatic research, engineers have developed a variety of combustion systems. Coal is now being burned in steam generators at rates up to 100,000 lb/hr with an amazing degree of automation. Natural gas and fuel oil are also being burned at equivalent high rates, but, in addition, these fuels are burned with complete automation. Combustion efficiencies are as high as 99%, and the overall conversion efficiency from fuel to steam is as high as 90%.

Difficult problems remain to be solved, however, relating to such

phenomena as ignition, flame propagation, uncontrolled explosions, interference of ash with the combustion process, ash removal, ash deposition on heating surfaces, and corrosion. Solutions to these problems, essential to further gains in combustion and energy conversion efficiencies, will be difficult to achieve unless a more scientific, less "trial and error," approach is taken than in the past.

A Pulsating Combustion System for Space Heating

by J. Alebon, G. K. Lee and L. B. Geller, *Proc. Boyer Conf.*, Aug. (1964).

The phenomenon of pulsating-combustion has been known for at least 50 years. It has been rediscovered and seriously studied since the early 1930's. Since then much theoretical work has been done and some developments have progressed to the stage of public acceptance. One, a Canadian invention, is the gas-fired "Pulsamatic" space-heating furnace. The underlying theories of its combustion system, its principal design and operating features, and research on noise suppression are described in the paper.

The Reduction of Asphaltene

by H. Sawatzky and D. S. Montgomery, *Fuel, Jour. of Fuel Science*, Nov. (1964).

Considerable amounts of hydrogen have been added to the asphaltene and most of the sulphur has been removed by treatment with lithium metal in ethylenediamine.

However, further reduction of these partially reduced asphaltenes appears difficult. Only under very high hydrogen pressures at room temperature did any further hydrogenation appear to occur. The partially reduced asphaltenes appear to form olefinic bonds readily. This seems to occur when exposed to light and air at room temperature, and also during hydrogenation attempts under low hydrogen pressures with heating. Considerable portions of the partially reduced asphaltenes could not be recovered from the catalysts when the hydrogenation attempts involved heating at 90° to 130°C.

Concepts and Measurement of the Mechanical Properties of Rock

by H. R. Hardy, Ann. Meeting of the Soc. of Min. Eng. of the AIME, New York City, New York, Feb. (1964).

The author is taking a new approach to the study of the deformation properties of rock (those mechanical properties which relate load, deformation, and their time derivatives) which takes into account the effects due to the various factors mentioned. This involves careful control of temperature and the deformation of specially shaped rock specimens under various sets of specific loading conditions, followed by the analysis of the resulting data using the method of mechanical models. This approach will result in the development of equations for the various rocks relating load, deformation, loading rate, deformation rate and time. It is intended that these equations should

be valid within ranges of the parameters that are consistent with practical applications.

Energy Requirements of the Canadian Steel Industry

by J. H. Walsh and F. J. Pearce, Submitted to Section IV A, Industry, of Division IV, World Power Conf., Lausanne, Switzerland, Sept. 13-17, (1964).

Current improvements to both blast furnace and steel-making processes have led to decreased energy consumption in the production of steel; these improvements in turn have had a major effect on the steel plant energy balance. The purpose of this paper is to review some of the important implications of this change.

The current rapidly changing technical developments in the Canadian steel industry are interpreted in relation to the energy resources available to the industry. Certain stabilized practices are projected, and energy requirements are based on these assumed conditions. The demand for energy in various forms, both imported and domestic, is estimated with reference to modern developments in transportation.

Hydrogenation of a Coker Distillate Derived from Athabasca Bitumen

by A. R. Aitken, W. H. Merrill and M. P. Pleet, Can. Jour. of Chem. Eng., Oct. (1964).

A coker distillate of Athabasca bitumen was hydrogenated over a fixed bed of cobalt molybdate on al-

umina catalyst. The effect of reaction pressure on the rate of catalyst deactivation was investigated at 896°F., an hourly space velocity of 2.0 and pressures from 1,000 to 3,000 p. s. i. The following expression was derived from the results of these experiments which relates reaction pressures and the hourly increase of the oil product specific gravity at these conditions.

$$\frac{\Delta \text{S.G.}}{\Delta \theta} = \frac{1.24 \times 10^6}{\text{p.s.i.}}$$

The yield and quality of the hydrogenated oil products and the relative hydrogen consumptions were determined at the following operating conditions:

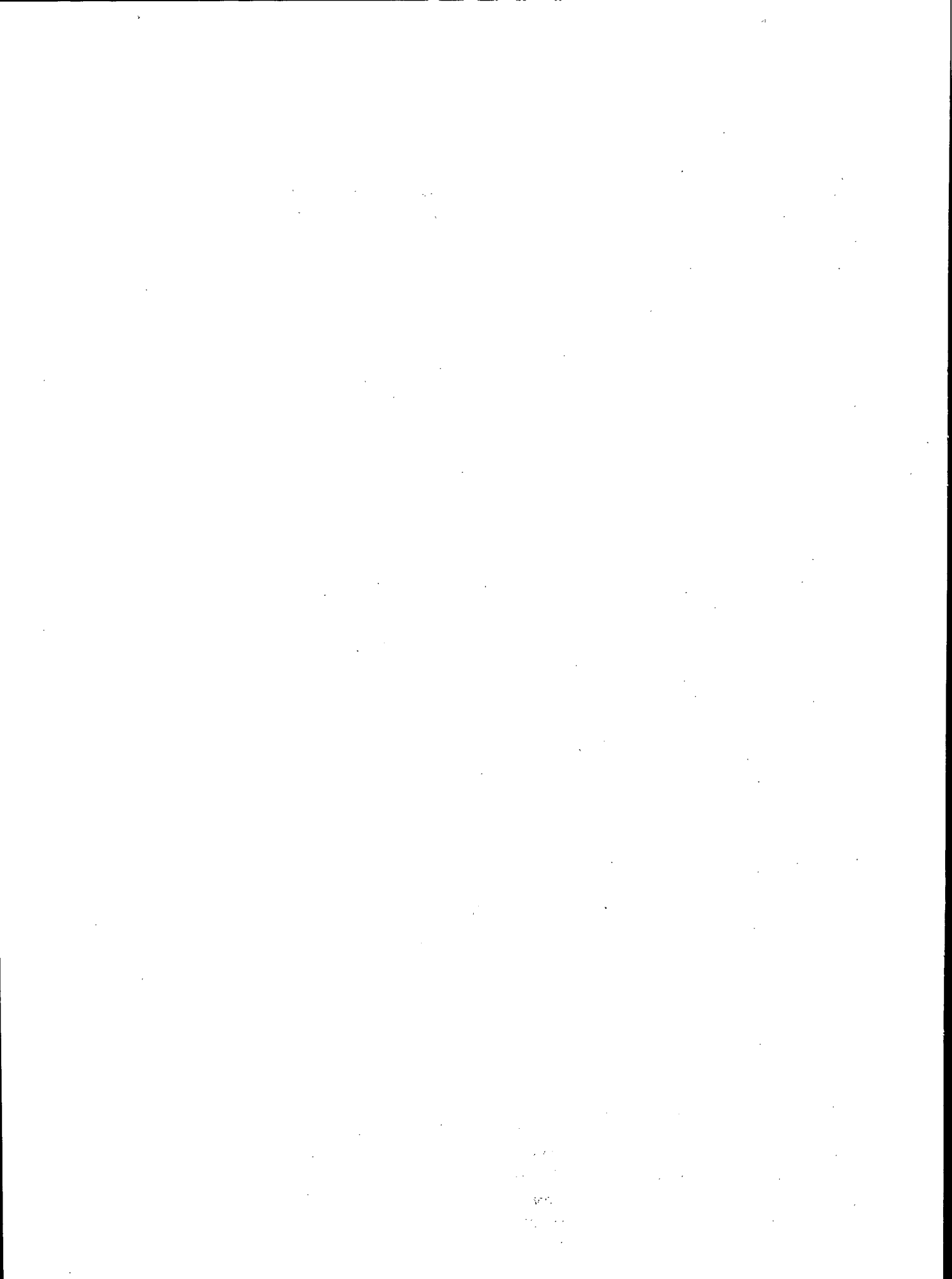
1. Pressure-1,000-10,000 p. s. i.;
Temperature-797-896°F.
Space velocity-2.0 hr. ⁻¹.
2. Pressure-3,000 p. s. i.;
Temperature-797-896°F.
Space velocity-1.0-4.0 hr. ⁻¹.

*Interpretation of the f_a
Versus H/C Diagram of Naturally
Occurring Organic Materials*
by M. F. Millson and D. S. Montgomery, Fuel, Jour. of Fuel Science, Nov. (1964).

In the study of complex substances which are essentially composed of carbon and hydrogen, interpretation of the f_a versus H/C diagram in terms of molecular structures obscures some important relations implicit in the diagram. For some purposes of structural analysis a hydrocarbon molecule, or average molecule, may be considered equivalent to two hydro-

gen atoms and a set of diradical structural units. Consideration of the f_a versus H/C diagram in terms of such diradical units illuminates some interesting relations and possible solutions to problems of structure.

*Comments on 'Problems in
Designing Stable Open Pit Mine
Slopes*
by D. F. Coates, Bull. CIMM, Oct. (1964).



PHYSICAL METALLURGY DIVISION

Ion Bombardment of Single Crystals of Aluminum
by R. L. Cunningham, K. V. Gow and Joyce Ng-Yelim, *Jour. App. Phys.*, 34 (4), 984-989 (1963).

For Abstract see R 126, page 3.

Study of Metal Flow in Aluminum Test Bar Moulds by Fluorescent Screen Radiography
by W. A. Pollard, *Trans. AFS* 71, 296-304 (1963).

The metal flow in some test bar moulds used in various countries for aluminum alloys has been studied by fluorescent screen radiography and the results recorded on motion picture film. Characteristic features of the flow in the moulds have been noted and suggestions made for possible improvements in some of the designs.

Characteristics of Sand Cast Magnesium-Zinc Alloys
by B. Lagowski and J. W. Meier, *Trans. AFS* 72, 561-574 (1964).

The magnesium-zinc alloy system is today the most important base for high-strength magnesium alloys. Unfortunately, published data on properties of binary Mg-Zn casting alloys is limited and controversial. It was, therefore, necessary to undertake a systematic study of the effect of composition and various melt treatments on foundry characteristics, amenability to heat treatment, mechanical properties and metallographic

structure of this alloy series. Work on grain refinement of magnesium-zinc alloys included superheating, carbon inoculation and additions of small amounts of aluminum, iron, manganese, titanium and zirconium. Results of the investigation show the necessity of considerable revision of long established data.

Development of High-Strength Magnesium Casting Alloys Containing Silver, Zinc and Zirconium
by B. Lagowski and J. W. Meier, *Trans. AFS* 72, 310-320 (1964); *TAM Daily Reminder* 1-45 (Oct. 1964).

A study of the properties of sand-cast Mg-Ag, Mg-Ag-Zr and Mg-Ag-Zn-Zr alloys has been completed and the results show that all of these three alloy groups have good ductility and are amenable to solution strengthening. Precipitation hardening, to any appreciable extent, was found only in certain alloys of the Mg-Ag-Zr system and some of these alloys show exceptionally high yield strength.

A more detailed study of proper heat treating techniques for some of these alloys resulted in the introduction of several high-strength, high-ductility Mg-Zn-Ag-Zr casting alloys which offer attractive possibilities for use in structural applications where considerations are not critical.

Premium Strength in Sand Cast Magnesium Alloys
by B. Lagowski and J. W. Meier, *Trans. AFS* 72, 561-574 (1964).

For Abstract see R 138, page 7.

Development of Premium Quality Magnesium Alloy Mortar Base Casting

by J. W. Meier and B. Lagowski, Proc. Annual Meeting, Magnesium Assoc., New York, pp A1-A11 (1964).

The application of a sand-cast magnesium alloy mortar base was considered at the end of World War II due to the obvious advantages of light weight and the relief of limited forging capacity. Unfortunately, the properties of the magnesium casting alloys then available were not sufficient to achieve the weight reduction necessary for comparable strength, and lack of reliability of casting quality defeated the project.

The use of high-strength alloys (ZK61, QE22, and especially the recently introduced ZQ64) and the application of premium quality casting methods has now made possible the development of a magnesium alloy medium mortar base casting which is 10% lighter than the standard aluminum alloy forging and has up to 30% higher strength with twice the rigidity.

Comparison Between the Flow of Water Solution and Molten Aluminum in Moulds by Fluorescent Screen Radiography by W. A. Pollard, Trans. AFS 72, (1964).

The fluorescent screen radiographic method of investigating

metal flow in moulds was used to give a direct comparison between the flow of water solution and molten aluminum under similar conditions. The results show that under conditions of transient flow with low hydrostatic pressure (as in the early stages of pouring) there is a considerable difference between the flow patterns of the two liquids. Thus the validity of the water analogy method of studying metal flow is questionable under these conditions.

Magnesium Content Effect on Properties of Binary Aluminum-Magnesium Alloys

by W. A. Pollard, Trans. AFS 72, 587-599 (1964).

For Abstract see R 141, page 9.

Metal Inert Gas Welding of Tin Bronze Castings

by M. J. Nolan and K. Winterton, Trans. AFS 72, 251-262 (1964).

Considerable experimental work has been done to determine a suitable welding method for the repair of tin bronze castings. Preliminary investigations with the metal-arc, carbon-arc, tungsten inert-gas and metal inert-gas processes indicated that best welds were produced with metal inert-gas welding. With other processes, there was a greater tendency for generally poor mechanical properties associated with cracking and porosity.

Metallurgical investigations indicate that weld porosity may derive from hydrogen in the sand-

cast base metal. Steam-reaction porosity is inhibited by a higher degree of deoxidation in the weld metal.

Some of the cracking problems are associated with the brittle tin-rich delta constituent, which is precipitated in increased amounts in the weld metal and in the heat-affected zone. Lead, often blamed for cracking troubles, does not appear to be harmful in small amounts.

An experimental procedure has been developed for metal inert-gas welding using a modified bronze composition of filler wire with enhanced silicon and phosphorus content, which will produce joints with good mechanical properties, comparable with those of the base material, and substantially free of welding defects.

Welding Progress in the USSR
by K. Winterton, *Welding and Metal Fabrication (U.K.)* 32 (3), 99-105 (March 1964).

This is a first-hand account of a visit to the USSR in 1963, in which the author reviews welding work in progress at various centres in the USSR. With processes such as electroslag welding, friction welding and cold welding, unique contributions have been made. At the Paton Institute for Electron Welding in Kiev, there is a staff of over 2,000 people and work is in progress on all aspects of welding.

Deformation Twinning in Hadfield Steel
by W. N. Roberts, *Trans. Met. Soc.*

AIME 230, 372-377 (April 1964).

Hadfield steel has been studied by transmission electron microscopy to determine the microstructure of the cold-worked material, which has been a subject of controversy for many years. The presence of f. c. c. deformation twins in specimens deformed in tension, by hammering, and by explosive shock loading at room temperature has been established by electron diffraction. No evidence of a martensite was detected in any of the specimens. Small amounts of δ martensite were identified in the hammered specimens.

Dislocation Distribution in Deformed Single Crystals
by Z. S. Basinski and S. J. Basinski, *Phil. Mag.* 9 (97), 51-80 (1964).

Dislocation etch pit distributions and slip lines were studied on copper single crystals oriented for single glide and deformed in tension at 4.2°K. Slip lines on the cross slip plane were observed from the earliest stages of deformation and their character changed during the transition to Stage II. The distribution of forest dislocations is much more isotropic and less homogeneous than that of dislocations crossing other planes.

The ratio of the forest to other dislocation densities in Stage I is about 1:15 but tends to 1 in Stage II. The flow stress correlates better with the forest than with main glide dislocation density; twist experiments support this conclusion.

An Electron Microscope Study of Dislocation Arrangements in Fatigued Al + 1% Mg Crystals by J. T. McGrath and G. W. J. Waldron, *Phil. Mag.* 9 (98), 249-259 (Feb. 1964).

A study has been made by transmission electron microscopy of aluminum + 1% magnesium crystals fatigued in plane bending. A specimen preparation technique has been used that allows selected areas of a fatigued surface to be examined. It is shown that a surface substructure exists, which is associated with "persistent markings" observed optically. Electron micrographs of areas between striations show bands of loops and line dislocations similar to those observed in copper and other face-centred cubic metals, but quite different from the structures seen in fatigued aluminum crystals. It is suggested that the substructure is formed as the result of a stress concentration effect at the roots of intrusions, and that the differences between fatigue structures observed in aluminum and aluminum-magnesium crystals are explainable in terms of ease of cross-slip.

Dislocation Structures in Fatigued Copper Single Crystal by E. E. Laufer and W. N. Roberts, *Phil. Mag.* 10 (107), 883 (Nov. 1964).

In a series of papers on the fatigue of f. c. c. metals, Segall et al (1961) and Segall (1963) found no correlation between fatigue striations observed on the specimen surface and the dislocation structure observed by transmission electron

microscopy. Evidence is presented to show there is a unique dislocation structure associated with fatigue striations near the specimen surface.

Orientation Determinations of Crystals Using Ejection Patterns Resulting from Ion Bombardment by R. L. Cunningham and Joyce Ng-Yelim, *Jour. App. Phys.*, 35 (7), 2185-2188 (July 1964).

Data on six common metals are presented to indicate the general usefulness of ion bombardment for orientation determinations of f. c. c. and b. c. c. crystals. The accuracy is 3° or better and is attained by the use of hemispherical collectors and a simple optical projection device. No film processing is involved and a complete determination, including all operations, usually takes less than 20 min.

Deformation in Cobalt and Other Close-Packed Hexagonal Metals by K. G. Davis and E. Teghtsoonian, *Cobalt*, No. 22, 31-35 (Mar. 1964).

The purpose of the present paper is to compare the deformation characteristics of cobalt and the other hexagonal metals.

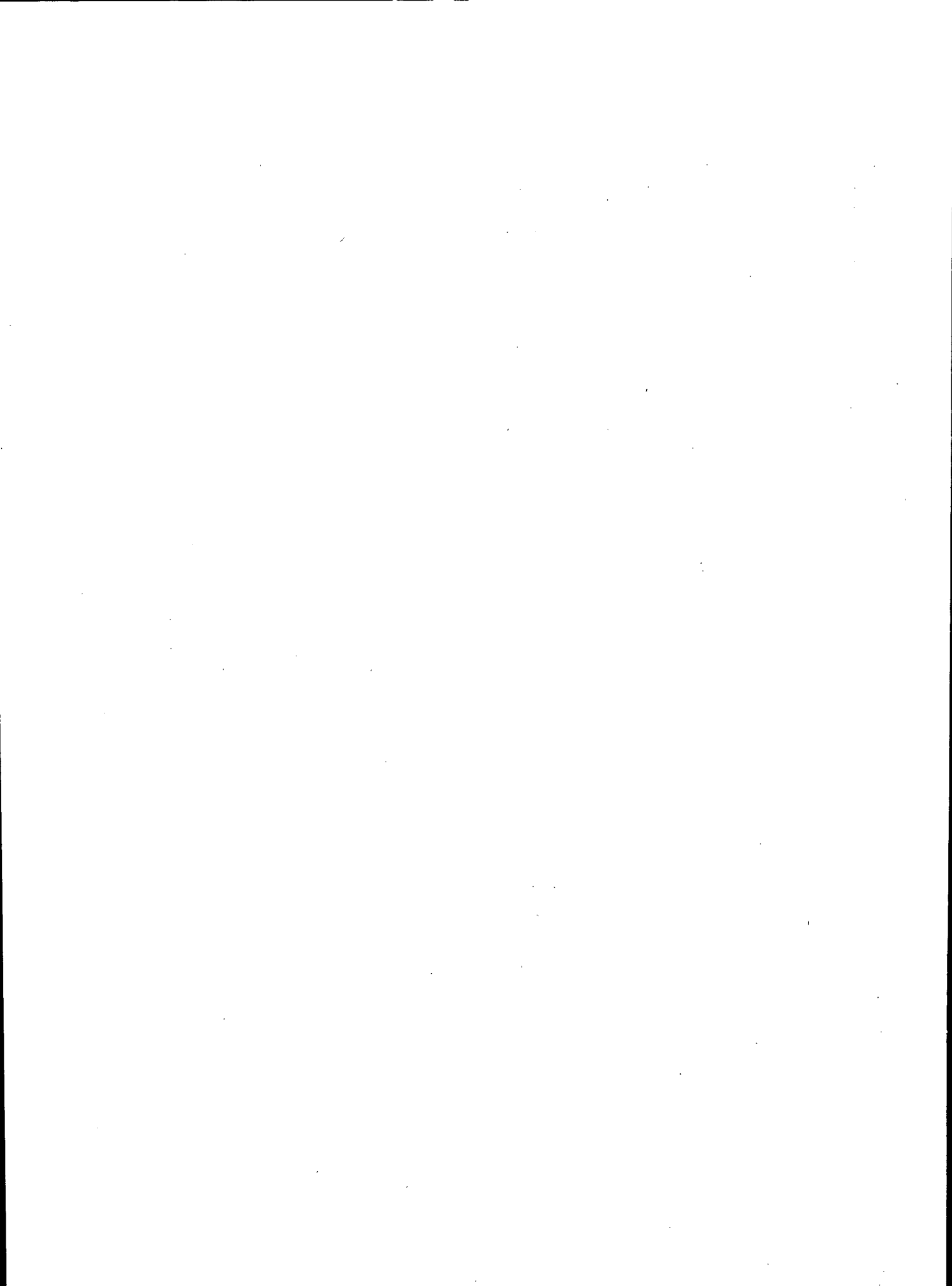
Cobalt differs from cadmium, zinc and magnesium in two important aspects. First, it has a much higher melting point, 1492°C compared with 321, 420, and 650°C, respectively; thus recovery is not a complicating factor in tests carried out at temperatures up to room temperature. Second, cobalt has a

low stacking fault energy, demonstrated by the existence of a phase transformation from hexagonal to face-centred cubic at 420°C and confirmed by the wide separation of the partial dislocations seen in electron transmission microscopy. Cadmium, zinc and magnesium are believed to have comparatively high stacking fault energies. A comparison between the deformation properties of cobalt and of the other close-packed hexagonal metals is therefore to some extent a study of the effect of stacking fault energy.

*Substructures in Melt-Grown
Zinc-0.1% Thallium Alloy
Crystals*

by K.G. Davis and P. Fryzuk, *Acta Met.* 12, 950-952 (1964).

Sections cut from single crystals of a Zn-0.1% Tl alloy grown by the Czochralski technique were examined for substructure, using a combination of autoradiography and etch pitting. Two distinct types were found, a) an impurity substructure in the form of cells elongated in the direction of the basal plane trace and, b) an array of dislocations were concluded to have been formed by the action of thermal stresses set up around regions of high thallium content in the impurity substructure.



***SECTION 3 - AVAILABLE INVESTIGATION
REPORTS***

ABBREVIATIONS USED FOR ORIGINATING DIVISION (PAGES 47-52)

MPD - Mineral Processing Division

EMD - Extraction Metallurgy Division

MSD - Mineral Sciences Division

FMPD - Fuels and Mining Practice Division

PMD - Physical Metallurgy Division

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IN 1964 FOR DISTRIBUTION

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per Co. Ltd., Cowichan Lake,
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- IR 61-39
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by H. S. Wilson - MPD
- IR 61-83
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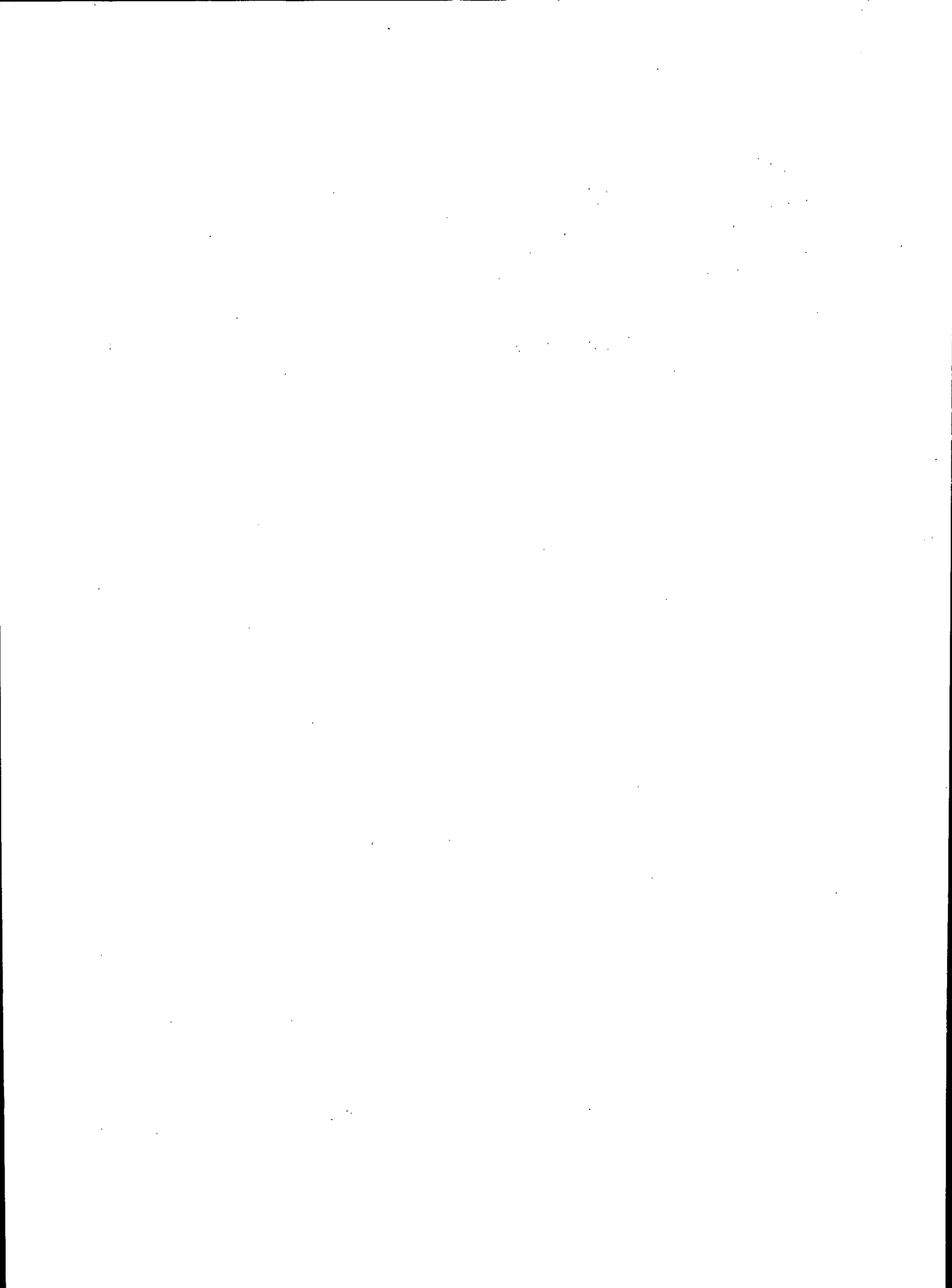
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Bismuth Recovery from a Sample of Mill Tailing from Molybdenite Corp. of Canada Ltd., Val d'Or, Quebec
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by K. E. Bell and L. Zemgals - MPD
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Evaluation of Developments Used in Iron Ore Flotation
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Surface Water Quality in the
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A Progress Report for the
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by J. F. J. Thomas - MPD

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Determination of Zinc in Magnesium Alloys by the Method Detailed in Document ISO/TC79/SC-1(UK10) 186 (Tentative Method for the Determination of Zinc in Magnesium Alloys-Ion-Exchange Mercuric Thiocyanate Complex Procedure by A.E. Larochelle and W.R. Inman - MSD
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Examination of Ruptured New Brunswick Hydro Pipe by D.E. Parsons - PMD
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Rod Mill Grinding of Coke from Algoma Steel Corporation Ltd., Sault Ste. Marie, Ontario by T.F. Berry - MPD
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