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Canada Centre for Mineral and Energy Technology | Centre canadien de la technologie des minéraux et de l'énergie

TECHNICAL VISITS IN AUSTRALIA, 1976

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Canadian Metallurgical Fuel Research Laboratory

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ENERGY RESEARCH PROGRAM
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INTRODUCTION

The period January 26th to June 25th, 1976 was spent attached to the Central Research Laboratories of The Broken Hill Proprietary Co. Ltd., Shortland, N.S.W., 2307, Australia. The Laboratories are situated close to the city of Newcastle, about 110 miles north of Sydney. Newcastle is one of the largest ports in Australia, especially for coking coals from the Hunter Valley area to Japan.

The BHP is a large diversified company, having profitable Minerals and Oil and Gas Divisions as well as the Steel Division. The Central Research Laboratories (CRL) are situated close to the second largest steelworks in Australia (the largest, at about 6 million tonnes per year, is located at Port Kembla near the town of Wollongong on the south coast). Research at CRL is concentrated on iron and steelmaking, minerals beneficiation, coal and coke, and fuel technology. Physical metallurgical research and secondary processing are concentrated at a second research establishment located at Melbourne. It was interesting that such a relatively small steel company by world standards could maintain two research centres with duplication of the associated infrastructures.

Contact had been made through several technical visits to (at that time) the Mines Branch by personnel from CRL, in particular Dr. T.G. Callcott who has achieved international renown for his development of the Auscoke formed coke process and is this year's recipient of the Melchett Medal from the Institute of Fuel. Later, two people from CRL (Mr. G. Davies and Mr. R.N. Rawson), both from Dr. Callcott's group, were attached to the Canadian Metallurgical Fuel Research Laboratory through the Canadian Carbonization Research Association. Thus, it seemed opportune for an officer from CANMET to visit Australia and arrangements were made through Dr. H.W. Worner (Member of the Executive of CSIRO, who spent a sabbathical leave at CANMET in 1974) and Dr. R.G. Ward (previously Stelco Professor of Metallurgy, McMaster University), General Manager at BHP in Research and New Technology.

Dr. D.F. Coates, the Director-General of CANMET, generously agreed that this officer's salary should continue whilst in Australia and that ERL should underwrite his return air fare. Gratitude is expressed to Dr. Coates for this. For their part, BHP offered to fund visits to their operations, CSIRO laboratories and universities; ample opportunity was taken of this

offer. A portion of the visit to the Queensland coal fields was funded by the Utah Development Company Limited arising from a close liaison between CMFRL and Utah International in San Francisco.

This report does not attempt to give a complete description of all aspects of the five months spent in Australia, but records notes (sometimes dictated) of the technical visits undertaken. The writer is indebted to Mr. K.J. Figgis, Manager, CRL, for making arrangements for these visits on his behalf. The fact that Mr. Figgis had previously been the Assistant General Manager of the largest steelworks in Australia helped in making these arrangements. In brief, extensive visits were made to the metallurgical coal producing areas of central Queensland (exports $\sim$ 20 million tonnes/year), the iron-ore producing areas of north-western Australia (exports $\sim$ 90 million tonnes/year), the extensive brown-coal deposits of Victoria, steelplants at Newcastle, Port Kembla, Whyalla and Kwinana (Western Australia) and University and CSIRO laboratories in Sydney and Melbourne. During the return journey to Canada, the Technical Research Centre of NKK was visited in Kawasaki, Japan and discussions were held with NKK on future CCRA-NKK technical meetings.

Whilst at CRL, the writer was attached to Dr. Callcott's section and became involved in aspects of formed and conventional coking, solids transport, coke behaviour in the blast furnace and the testing and evaluation of iron ores. In particular, the areas of coal pipelining (BHP were contemplating a 50-km coal-water slurry pipeline from mines above the Port Kembla escarpment to a coal washery at the steelplant on the coast) and the high-temperature behaviour of coke under blast furnace conditions were studied. The relevance of research projects to the works situation was valuable, as compared with the relative isolation of some CANMET programs. The possibility of mutual projects was discussed, including the exchange of coal samples and standardization of experimental coke oven procedures. A joint program for SO_2 adsorption on a lignite char using the packed-bed filter was also discussed with the Institute for Materials Research in Melbourne.

Visits to modern coal preparation plants (the larger Queensland plants having sufficient capacity to handle the combined product from all of the new proposed Kootenay-area coal mines) updated the writer's knowledge in coal preparation. Some of the plants were equipped with Visman Compound Water Cyclones and it was gratifying to be able to explain their principle of operation to the preparation plant supervisors. The opportunity was taken to attend the International Coal Preparation Congress held in Sydney, May 23-28th. Canadian delegates were conspicuous by their absence, in view of the necessary interest in new developments in ash reduction of western Canadian coking (and low-rank) coals. Dr. J. Visman would have been the only Canadian delegate had not this writer and Dr. E. Capes of N.R.C. (whose expenses had been paid by the U.S. company holding the licence to his patent on spherical agglomeration) attended.

There is much interest in coal liquefaction in Australia but research activities are badly co-ordinated and not likely to lead to long-term benefits to the country. There was little interest in high-pressure coal gasification (apart from the Lurgi type) but flash pyrolysis was being pursued enthusiastically at CSIRO.

The following lectures were presented while in Australia:

(a) Two lectures entitled "The Requirements of Raw Materials for Ironmaking, their Assessment, and Methods Available to Tailor Burden Feed to Desirable Properties" - presented to final year metallurgy students, University of Newcastle, March 22nd and April 12th.

(b) "The Future of Coking Coals in Canada" - presented to Newcastle Branch of the Australasian Institute of Mining and Metallurgy, April 9th.

(c) "Coking Coal in Canada" - presented to the Queensland Coal Preparation Society (at Ipswich, near Brisbane), May 18th.

VISITS TO CSIRO DIVISION OF PROCESS TECHNOLOGY
AND
THE AUSTRALIAN COAL INDUSTRY
RESEARCH LABORATORIES LTD. (ACIRL),
SYDNEY, AUSTRALIA, FEBRUARY 24, 1976

* * * * *

CSIRO Division of Process Technology**

Head: Mr. A.V. Bradshaw (Professor of Applied Metallurgy at Imperial College, London, until October 1975)

Mr. R.A. Durie: Section engaged on research into Australian coals and their utilization as a source of energy, and research on specialized industrial carbons.

Dr. K. McG. Bowling

1. Drying and Induration of Iron Ore Pellets (C.G. Thomas)

A reversible updraft-downdraft pot grate simulator had been developed. The actual pot was lined with water-impregnated Kaowool. Factorial-design optimization experiments had been done to relate pellet drying and firing parameters to resultant pellet properties, such as reducibility, etc. The simulator could be used, for example, to obtain the best firing conditions for goethite-containing pellets made from iron ore fines. This goethite often occurs within hematite grains, causing disintegration on heating.

The presence of goethite is the reason why some W. Australian iron ores are crushed and sold as sinter feed rather than as lump ore. Because feed size distribution affects sinter quality, this parameter may become a restriction in future Japanese contracts.

**In the Minerals Research Laboratories of CSIRO, P.O. Box 136, North Ryde, N.S.W., 2113.

2. Reduction of Iron Ores (Dr. J.K. Wright)

Reaction rate studies using a small rotary kiln were being done. Photomicrographs showed slag (<1100^{o}C) filling voids in pellets and limiting reduction. Reaction had taken place around each grain but formation of a layer of sponge iron seemed to inhibit the reaction. Swelling was inhibited by the addition of a very small amount of slag-forming material (<1%).

Hamersley Iron Pty. Ltd. are again interested in a direct reduction process of the SL/RN type utilizing a non-coking coal deposit close to Perth, Western Australia. Hamersley are also reportedly still interested in the Allis Chalmers ported-kiln direct reduction process; the Falconbridge SL/RN kiln at Sudbury is being converted to this process and Hamersley lump ore has been treated in the Niagara Falls pilot rotary kiln.

Gaseous reduction of iron ore was studied at CSIRO using a heavy retort. The method of weight loss measurement was simple and could be used at CMFRL in Ottawa to overcome the problems currently being experienced with the load cell and Burghardt apparatus. A counter-balanced brass beam on knife edges was used, small weight changes being measured with a Mettler balance (non-beam) using a print-out system. The Mettler balance was connected to the counter-weight end of the beam using a chain. Friction at knife edges was not a problem and an accuracy of 0.1 g in about 20 kg was claimed.

3. Demineralizing Char From Low-Rank Coals (H.W. Rottendorf)

This activity mainly concerns utilization of the Victorian brown coals and was explained by Dr. H.W. Worner (now a member of the Executive of CSIRO) during his visit to Ottawa in 1974. The work has similarities with J. Visman's stripping of alkaline earth cations from lignites using an ion exchange principle.

One technique used is to bubble SO_2 through the char. The demineralized char is made denser by the cracking of hydrocarbons into pores to make it suitable for electrode manufacture for the aluminum industry.

4. The Utilization of Fuel; Coal Carbonization and Pulverized Fuel Combustion (P.L. Waters and G.A. Donau Szpindler)

Dr. Waters had done much early work with Hesp (now living in Austria) on the addition of antifissuring agents to high-ash, high-volatile, low-rank N.S.W. coals. The efforts in coal carbonization were phased out at CSIRO and their Illinois 250 kg oven given to ACIRL; however, CSIRO still retains a BM/AGA apparatus in working order.

A 1-ft square fluidized bed was being used for experiments relating to the combustion of pulverized high-ash coal and colliery wash-plant rejects. The bed could easily be converted to the spouted mode and materials for combustion were introduced through an upward tube into the spout. However, particles >½ inch could not be accommodated in the spouted bed.

5. Oil-From-Coal, Flash Pyrolysis (I.W. Smith)

This work has received wide publicity in the world's scientific press, although the concept is not unique (e.g. the Occidental Petroleum - Garrett Process in the U.S.). However, it may be applicable to the Canadian situation as a means for utilization of the western low-rank coal deposits for both power generation and synthetic crude production without requiring the extremes of high temperature and pressure needed by coal hydrogenation processes under development in the U.S. and elsewhere.

Briefly, the volatile matter is skimmed off the coal feed by flash pyrolysis (100 micron coal, residence time $\sim$ 1 second), the temperature controlling the relative proportions of tars and gases obtained. Depending on the feed coal, 20 to 30 percent more volatile matter can be obtained using flash pyrolysis than using conventional carbonization (because secondary reactions, such as cracking, are suppressed). The higher the temperature (range 500-1000^{o}C), the more the gas.

Uses for the char-gas-tar product are many, but one example may be (i) utilization of char in conventional power generation, (ii) a part of the gas in power generation using a higher temperature gas turbine, (iii) steam-reforming of the remainder to manufacture hydrogen for hydrogenation of the tar fraction (perhaps using the Extendoil Process) to make synthetic crude for gasoline production.

Engineering-scale pyrolysis studies are continuing at CSIRO Sydney (fluidized-bed and entrainment pyrolyzers) with the organic chemistry being handled by CSIRO at Melbourne. Drawbacks to the process may include char entrainment in the tar product and combustion characteristics of the high-ash char.

Australian Coal Industry Research Laboratories Limited***

ACIRL is a non-profit company, drawing its financing from contract research and Federal and State coal agencies. As well as the coal carbonization and utilization facilities at the Sydney laboratories, it has other mining and coal preparation research stations in New South Wales and Queensland.

Deputy Director of Research: F. Pollard (A.H. Hams, the Director, was on leave)

J.F. Cudmore (who visited EMR in 1972)

The main activities at the Sydney laboratories of ACIRL are coal carbonization and coal liquefaction.

During Mr. Cudmore's visit to Ottawa in 1972, it was agreed to exchange coal samples for Australian-Canadian blend testing. Australian coal is from a different geological age from western Canadian coal (Permian as opposed to Cretaceous). A sample of western Canadian coal was sent to ACIRL, but this was carbonized alone and no reciprocal sample was sent to Ottawa. The reason for this was that the Australian coal industry would not sanction an exchange of samples because of the competition from Canada for the Japanese market.

The Carbolite 230 kg (cost two years ago $60,000 Australian) temperature-programmed movable-wall oven (although Australian coals do not show carbonization pressure properties) was given praise for its dependable performance. Purchase of such an oven may be the best route for the second CMFRL Edmonton oven. The ACIRL carbonization test fee is only $400 Australian (∿ $520 Canadian).

The oil-from-coal hydrogenation work is being done in small autoclaves and the program mainly involves the characterization of Australian coals for solvent extraction.

ACIRL use a fully automatic Gieseler plastometer (upper limit 50,000 ddpm) of Japanese manufacture. Details were supplied of reference calibration oils with various viscosities. Also, Mr. Cudmore agreed to an exchange of

***Box 169, Chatswood, N.S.W. 2113

samples with Ottawa which would provide an access to Australian coals and allow the fully automatic plastometer in Ottawa to be compared with the established Australian instrument. However, transport of samples, test date and conditions would have to be rigorously controlled for a meaningful exchange. Mention was made of the effect of crucible shape on fluidity results and also the "toffee-apple" effect (semi-coke adhering to the stirrer and separating from the fluid coal in the crucible, giving an artificially high fluidity result), as seen by Dr. Miyazu of NKK in a film taken during a Gieseler plastometer test.

VISIT TO COAL OPERATIONS
IN THE BOWEN BASIN AREA
OF CENTRAL QUEENSLAND
MARCH 29 TO APRIL 2, 1976

* * * * * * *

The Bowen Basin of Central Queensland is one of the world's major sources of coking coal, known reserves being in excess of 10 thousand million tonnes. Production of coking coal is currently close to 20 million tonnes per year and exports to Japan exceed the total tonnage of metallurgical coals exported from Canada. The coal is of high quality from the metallurgical viewpoint and mining conditions are somewhat easier than in Western Canada because in the main, strip mining is practised. Also, the shorter distance to the coast (180 miles as opposed to 700 in Canada) makes transportation costs less than in Canada. Coal from the Blackwater area is exported through the Port of Gladstone whereas coal from the more northern areas is exported from the bulk loading terminal at Hay Point just south of Mackay.

Geologically, the coals are Upper and Lower Permian in age and the mines are located on the western flank of the Mimosa syncline on the northwest strike of the Basin. The open cut mines operate along strikes up to 12 miles in length and coal is extracted from seams between 3 and 10 metres thick using 60 cubic yard draglines for overburden removal. Underground mines operate in the Blackwater area, but these are experiencing mining problems.

The first part of the week was spent as the guest of B.H.P. mainly visiting Queensland Mining Company (subsidiary of B.H.P.) properties. A meeting of the Queensland Coal Preparation Society was attended on the Wednesday evening and the rest of the week was spent as guest of the Utah Development Company. This company is a subsidiary of Utah International, San Fransisco, and the introduction to Utah Development was through Mr. John Messineo of Utah International; work is being done for Utah International in Ottawa on one of their coal properties in British Columbia (Carbon Creek). Mr. Ken Bateman, Chief Metallurgist in charge of coal preparation for Queensland for Utah Development Company, escorted the writer around the Utah mines.

The operations visited were as follows:

1. Leichhardt Colliery, Blackwater (B.H.P.)

This underground colliery is located 10 miles south of Blackwater which is 180 rail miles from the deepwater Port of Gladstone. The nominal output from the mine is 800 thousand tonnes a year, but problems in siderite occurrences in one of the seams and other mining difficulties have considerably lessened the annual output, probably to less than 500 thousand tonnes a year. Coal is washed very crudely in a simple preparation plant using a jig system. Fine coal is not washed.

2. Cook Colliery of B.H.P.

This colliery is close to the Leichhardt Colliery and mines the same seams. However, it is not as deep and a drift is used rather than a shaft.

3. The South Blackwater Mine of Thiess Brothers Limited

This was the first open cut mine visited and the surface operations and washing plant were seen. A flow sheet of the 420 ton/hour coal preparation plant is available from the writer. The plant employs screening of the 3" x 0 raw coal at ¼ inch, the plus ¼ inch material being washed in Drewboys dense medium baths and the minus ¼ inch material passing to two-stage Visman compound water cyclones. Use of the Visman cyclone by the Thiess Company was interesting because of it's development in EMR. It would appear that in this coal preparation plant, the compound water cyclone system was working well for ¼ x 0 material; in all other coal preparation plants seen, dense medium cyclones were used for coarse material and flotation for fine material. Thus the compound water cyclones were eliminating the necessity for a flotation circuit and also the heavy medium recovery circuit associated with magnetite heavy medium cyclones.

4. The South Blackwater Mine of Utah Development Company

The nominal annual production from this mine is 4 million tonnes and the coal preparation plant has a similar flow diagram to the remainder of the Utah mines to be described next. Briefly, run-of-mine coal is broken to a top size of 1¼ inches in rotary-breakers and stockpiled. The raw coal from the stockpile enters the preparation plant and is deslimed at 30 mesh, the 1¼ inch by 30 mesh oversize being washed in heavy medium cyclones. The overflow from these cyclones is dried in centrifuges before passing to the rail loading bin via the product coal stockpile. The minus 30 mesh material from the primary desliming screens is further deslimed in cyclones, the 30 mesh by 200 mesh material passing to flotation cells and vacuum filters before going to the product stockpile. The minus 200 mesh material from the secondary desliming cyclones passes to the tailings thickener together with the reject from the flotation cells. Thus, although the very fine material is discarded, the flow sheet is designed for a very high throughput with a minimum of maintenance, 12 to 14 thousand tonnes of raw coal per day.

5. The Goonyella, Peak Downs and Saraji Mines of Utah Development Company

These mines are located 240 kilometres north of Blackwater and, as mentioned, the coal is railed to the Hay Point loading facility close to Mackay. Nominal production capacity is 4 million tonnes per year from Goonyella, 5 from Peak Downs and 4.5 from Saraji. Thus the total Utah production per year is 17.5 million tonnes. Most of this coal goes to Japan although perhaps up to 25 percent goes to Europe.

The unit trains transport about 8 thousand tonnes of coal whereas those in Canada transport 10 thousand. This difference is due to the small 3'6" gauge for the Queensland railways.

The Goonyella and Peak Downs mines are serviced from the new town of Moranbah whereas the Saraji mine and the mine to be developed at Norwich Park will be serviced from the town of Dysart. The coking properties of coal from the Utah mines is similar to the properties of Western Canadian coal. The coals are low to medium volatile (Saraji 19.5%, Peak Downs 21.5%, Goonyella 26%) with ash contents for the washed coal between 8 and 10% and F.S.I.'s between 6 and 8 (Goonyella coal actually gives an F.S.I. of 9). The sulphur content is low (0.6%) and the recovery in the washery plants is 70 to 75% for Goonyella, 60 to 65% for Peak Downs and 65 to 70% for Saraji.

From the point of view of blending with Canadian coals to make a coke oven feed, the coking coals from the Utah mines fall in the top left hand quadrant of the Miyazu diagram of maximum fluidity versus mean reflectance in oil. Thus the Australian coals are reasonably high in fluidity, i.e. above 60 ddpm, but low in rank as compared to American prime coking coals (e.g. Pocahontas). The Canadian coking coals from the Crows Nest area fall in the bottom right hand quadrant of the diagram, that is to say they are high in rank but low in fluidity. Thus Australian and Canadian coals could produce an acceptable coking blend, although the addition of some low rank high volatile coal and some high rank medium volatile coal might be necessary for fluidity bridging purposes.

VISITS TO AUSTRALIAN IRON AND STEEL PTY. LTD. (BHP) PORT KEMBLA WORKS, APRIL 14-15, UNIVERSITY OF WOLLONGONG, APRIL 15, AND CANBERRA, ON APRIL 20-21, 1976

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Port Kembla Works of A.I.S. (Mr. Eric Booth, Supt. of Research)

This integrated steel works is very similar in size and range of products to the Hilton Works of Stelco in Hamilton. Consequently, there is an "open book" agreement between the two companies to exchange information. The plant is situated on the coast, receiving local coal from the southern part of the Sydney coal basin, limestone from Japan, and iron ore from Whyalla and western Australia. The No. 5 blast furnace (nominally 6.5 thousand tonnes/day) is the largest in the southern hemisphere.

This blast furnace was seen during the two days spent at Port Kembla, together with the new sinter plant (Lurgi), docks, stockyards and sampling areas, and the coke ovens. The No. 5 blast furnace is to be rebuilt next year at an estimated cost of $20 million. It has operated unsatisfactorily since commissioning because of bad design features.

The Nippon Steel coke reactivity test is being used at Port Kembla and apparently is being used by the Japanese for the evaluation of the blending potentials of coals. The Gakushin-type retort is put into the furnace at 1100^{o}C and held for one hour with nitrogen passing through. Carbon dioxide (5 l/min) is then reacted with the coke for two hours and the weight loss reported as the complement of 100. Heating the coke up in nitrogen affects reactivity and reproducibility of results.

A new coke oven battery (No. 7) is contemplated for Port Kembla possibly with coal preheating using the "Precarbon" process. Briquette additions may be considered for the No. 2 battery, overcoming blending problems by buying Japanese technology. The test program involved six or seven ovens (shovel charged) and coke quality was up by about 2 points. The briquettes were made using the "Auscoke" pilot plant. Currently, coal samples are in Japan (NKK) for bench-scale evaluation. One question requiring resolution is whether the weakly-caking blend component should be selectively briquetted.

A Wilputte 300 kg movable-wall coke oven was used for experimental purposes. The MW oven was purchased because of the suspected coking pressure characteristics of Wongawilly coal, although in fact this coal provides no problems in this area. The oven had a back-pressure control valve actuating a butterfly valve in the off-take pipe. This pipe requires occasional cleaning by burning out with a torch.

Department of Metallurgy, University of Wollongong (N. Standish, Associate Professor)

Professor Standish had organized the recent highly-successful international symposium on blast-furnace aerodynamics and also spent four months at McMaster University, Hamilton in 1972.

Whilst he was very dynamic and full of ideas, his departmental tri-annual budget of only $24,000 (Australian) was preventing him from doing much research.

CSIRO Headquarters, Canberra (Dr. H.W. Worner, member of the Executive, Emeritus Professor of Metallurgy, University of Melbourne)

Dr. Worner had spent three periods attached to CANMET, the last one in 1974 associated with development of the packed-bed filter in ERL and PMRL. His recent appointment to the Executive of the CSIRO required approval by the Governor-General for Australia.

General directions of scientific research in Australia were discussed and, in particular, the flash pyrolysis of coal. Privately, Dr. Worner felt that the packed-bed filter might be applicable to flash pyrolysis.

He hoped that CSIRO funding would be increased so that more support could be given to universities in Australia.

Canadian High Commission, Canberra (Mr. J.W. Patterson, First Secretary, Minerals and Energy)

The encouragement of the exchange of scientists between Canada and Australia was discussed as well as areas of expertise in Australia which would be beneficial to Canada. The flash pyrolysis of coal (especially for sub-bituminous western coals) and coal solvent refining, were suggested.

VISITS TO MELBOURNE AND WHYALLA, MAY 3 TO MAY 7, 1976

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1. Institute of Materials Research, Department of Metallurgy, University of Melbourne

The Institute of Materials Research has a large program underway on research and development of Victorian brown coals and the reason for visiting the Institute was primarily to discuss a joint program between CANMET and the Institute on the adsorption of SO_2 onto chars made from low rank coals. The initial contact had been made by Professor H.W. Worner when he was attached to PMRL in 1974.

The Institute of Materials Research is part of the Department of Metallurgy, University of Melbourne, and it operates on a non-profit self-supporting basis wholly engaged in research. Investigations are sponsored under contract by industry and other organizations in Australia and overseas. Work encompasses the fields of extractive and physical metallurgy, ceramics, coal utilization, water treatment and other fields. While it is administratively attached to the Department of Metallurgy, staff members of the Institute generally do not become involved in teaching commitments.

People seen: Mr. G.V. Cullen, Manager; Dr. D.W. Boland, Chairman of the Department; Dr. N.B. Gray, Senior Lecturer in Metallurgical Engineering. The prospect of the joint program between CANMET and the Institute had also been brought up in a visit by Mr. Cullen to Canada, when he discussed the possibility of a study regarding SO_2 adsorption on brown coal char with the Department of the Environment (Duane Salloum). Subsequently, correspondence has been exchanged between him and Dr. Eric Smith and a joint program proposed. The interested company in Australia is Broken Hill Associated Smelters (BHAS) who have shown interest in liaison with Canada. BHAS are interested in the project because of the possibility of concentrating SO_2 from their smelter gases to be used for the manufacture of liquid SO_2, H_2SO_4, or elemental sulphur.

Work completed to date represents Phase 1 of the project in Melbourne and involves bench-scale work on an adsorption-desorption column (6 ft long, 0.4 I.D.). This work has generated sufficient design parameters to cover a model for a pilot plant. The next phase of the work would involve construction of a pilot plant but money is tight. A deal was proposed in which information obtained in Melbourne would be given to CANMET in exchange for further work being done, using the packed bed filter developed in PMRL, possibly the 600 lb per hour unit in Building 2 of ERL. First of all, it would be advantageous to study a Canadian char using the equipment in Ottawa and also using the bench-scale rig in Australia. However, CANMET would be expected to sponsor bench-scale work in Melbourne. This would have advantages in that design parameters could be obtained from the existing rig possibly for less money than would be available if the equipment were developed in Canada.

In this writer's estimation, the proposed deal should be studied carefully as it benefits both parties, especially further development of the novel packed bed filter system patented in Canada. The packed bed filter could also be used for generating the char as well as adsorption and later desorption by heating the char up to about 500°C. High temperature operation would of course be costly from CANMET's viewpoint as heat resistant steels would be required for a fairly expensive unit. However, a considerable amount of development money has already been spent on this apparatus and now is not the time to look back, especially in the light of utilization of low rank coals in Canada.

The following topics were also discussed:

(a) Use of brown coal char in electrodes for alumina reduction.

(b) Preparation of carbons with specified chemical reactivity and their use in reduction processes.

The Okstad and Hoy method for measurement of carbon reactivity was discussed and the equipment seen. The same technique has been used in Building 2, ERL, but reproducibility of the activation energy for the Boudouard reaction of 86 kilocalories per mole has not been obtained in Ottawa. This technique however seems to be the best available for the measurement of carbon activity. The studies carried out in Melbourne included the effect of heat treating chars and changing their surface properties on reactivity. The addition of transition elements had no effect on reactivity but doping with alkalis and alkaline earths increased reactivity. Magnesium was found to be inactive and lithium the most active.

(c) Extraction of metals from effluents by calcium-loaded brown coal and related materials.

This topic had been discussed at length with the Department of the Environment in Ottawa and interest had been shown because of the possibility of removing mercury from effluent wastes, especially the pulp and paper plant at Dryden. It is claimed that mercury can be removed in concentrations of 60 parts per billion down to levels of 0.5 parts per billion, using brown coal loaded with calcium ions from a lime slurry (acting as an ion exchange medium). Work is continuing at the University of Sherbrooke (Coupal and Lalancette) on a similar application for peat using a moving filter technique and a 10 ft by 10 ft filter bed is claimed to be able to treat 25 thousand gallons per day. A higher flow rate can be achieved through brown coal char, which is also cheaper than peat. However, the main advantage is that the mercury level can be dropped to less than 1 part per billion in a 1 to 2 inch bed at the rate of 50 to 100 gallons per hour per square foot bed area, whereas other available processes can only reduce the mercury level to between 2 and 5 parts per billion.

(d) Extraction of metals from solution by contact with brown coal and related materials.

More information on the four topics mentioned above is available from the writer.

The Dean of the Faculty of Engineering, Professor Stan Seaman was met briefly; he intends to visit Ottawa next year during a round the world trip looking into the utilization of lignites and brown coals.

2. <u>Visit to the Hydrocarbons Division of the Department of National Resources 460 Bourke Street, Melbourne</u>

People seen: Dr. K.D. Lyall, Assistant Secretary, Coal Branch; Mr. Cedric F. Gartland, First Assistant Secretary, Hydrocarbons Division. The nomenclature used for senior personnel in the Department of National Resources is somewhat different from that used in Canada. The Department of National Resources is divided into several divisions, the First Assistant Secretary reporting directly to the equivalent of a Deputy Minister. Thus, Dr. Lyall as Assistant Secretary falls immediately into one of these divisions. Dr. Lyall spent two years attached to the Mining Research Laboratories as an NRC Postdoctorate Fellow from 1965 to 1967.

The Coal Branch is mainly a policy making area keeping abreast with all aspects of coal technology from mining through preparation to processing to synthetic fuels in anticipation of assisting with an energy policy for Australia. Unfortunately, the Branch is understaffed and efforts are being made to recruit more people with the necessary expertise. Coal research in Australia is funded through NCRAC (National Committee for Research on Australian Coals). The main body holding together coal research in Australia is ACIRL especially in the field of coal mining. It is in this area in particular that Australia lacks expertise, as is seen by the mining problems currently being encountered in the Bowen Basin area of Queensland. Indeed the Nebo development had just been announced (Bowen Basin area Queensland, approximately 5 million tonnes per year of coking coal) and the best coking coal from this deposit will be obtained by underground techniques. Coal pipelining was discussed with respect to the Canadian situation and obviously the same problems do not arise in Australia so that less emphasis is being placed on energy transportation.

With respect to processing of coal to synthetic fuels Dr. Lyall felt that the best bet at the moment and in fact the only possible route to be followed is solvent refined coal (SRC). In fact there are two major proposals in Australia for development of an SRC plant and it is possible that Australia may in fact have the first SRC operating plant in the world. These proposals are:

(a) Development of a coal property owned by Theiss Bros. in Queensland, with Mitsui in Japan to produce a metallurgical coal substitute for use in Japan.

(b) Solvent refined coal using Victorian brown coal proposed by the Nissho-Iwai group, part of Kobe, Mitsubishi and Ube Industries consortium.

Thus, SRC is considered to be the direction to go both from the point of view of producing a synthetic coking coal and also gases and light oils. Also, should technology advance to such a stage when liquids can be produced, then the plants will be in place. The efficiency of coal gasification plants using hydrogenation is good but their development is seen as a long term operation in the United States. In the short term, more simple gasification units such as Koppers Totzek, Lurgi or the Winkler gasifier are considered to be on the horizon and the slagging gasifier using the Lurgi principle currently being developed in the U.K. would offer considerable benefits (a plant requiring 36 Lurgi gasifiers would only require 9 if a slagging system could be used).

Obviously thoughts on further processing of coal and general problems in the energy area regarding coal in Australia are similar to the views held in Canada, and the International Coal Research meetings are doing much to foster co-operation in these areas. The next one is to be held in Australia next October.

3. Visit to the Operations of the State Electricity Commission of Victoria in the Latrobe Valley

This visit was arranged through Mr. Bruce B. Bennett, Manager, Corporate Development, Gas and Fuel Corporation of Victoria and Mr. Ralph Higgins of the SEC, Herman Research Laboratory. Dr. David Aladice took the writer on this visit to the Latrobe Valley. During the drive, aspects of coal conversion were discussed, and again it became apparent that solvent refined coal is the preferred route and the flash pyrolysis method being studied at CSIRO is not popular in other parts of Australia. Apparently this is because the amount of char produced would be six times the amount required for power generation, apart from problems in char combustion.

It would also appear that the SEC would welcome visitors for relatively short terms (3 to 6 months) from Canada to work in the area of coal conversion in their research laboratories. They have had people from abroad before and paid them some salary as well as given them opportunity to travel within Australia. Others from ERL could benefit from this and the address to write to is Mr. Ralph Higgins, Herman Research Laboratory, SECV, Howard Street, Richmond 3121, Victoria. Dr. Aladice also expressed an interest in spending some time at ERL or possibly Ontario Hydro.

Eighty percent of the state of Victoria's power is generated in the Latrobe Valley using brown coal to fire power station boilers. This brown coal (1 to 2 percent ash, ¼ percent sulphur, 55 to 70 percent water) occurs in seams up to 30 metres in height with very little overburden. It is mined using bucket wheel and bucket chain excavators (see World Coal, October 1975, pages 17 to 21). The deposit is huge; total geological reserve 100 thousand million tonnes, proven reserves 65 thousand million tonnes, inferred, 35 thousand million tonnes. The mineable reserves with a 3 to 1 overburden ratio are 11 thousand million tonnes, 500 million tonnes already having been mined. Approximately 25 million tonnes per year are mined at present. Although the ash content of the brown coal is low, it is mainly of an organic nature with cations attached to functional groups in the coal structure. Power generation in the area is about 1400 megawatts.

Both the Yallourn and Morwell open cuts were seen. Some of the coal from the Yallourn seam is sent by rail to the briquette factories (4 of these) at Morwell. The factories were built at Morwell to use coal from the open pit there but this coal did not briquette well and feed for the briquette plants has to come from the other pit 10 miles away. Siting the briquette plants at Morwell was an expensive mistake by SEC. The brown coal is extruded rather than briquetted, the moisture content being reduced to about 15 percent and the heating value of the coal being virtually doubled. The briquetting factory processes 12 thousand tonnes per day of raw coal, producing 4 thousand tonnes of briquettes and 6 thousand tonnes of water (which goes to the atmosphere). The process involves drying the coal in rotary heat exchangers, the coal passing down longitudinal pipes with steam (from the power plant) passing around the pipes. The dried coal is cooled and briquetted or extruded. It is used in some local power plants and has other industrial applications.

One of these industrial applications is the production of a brown coal char briquette at the Australian Char Proprietary Limited, Morwell (Mr. G.L. Kennedy, Technical Manager). The brown coal briquettes (made from minus 4 millimetre coal, mainly minus 1 millimetre, pressed at 800 kilograms per square centimetre) are the feed to the char plant. The plant uses two Lurgi vertical shaft reactors with carefully controlled temperature profiles to prevent spalling of the briquettes during charring at 900^{o}C. Volatiles and tar from the charring briquettes are used in the burners in the shaft reactors. The plant in fact represented a successful formed coke-type of operation. The char product is a high quality carbon with the following proximate analysis: Ash 2 to 3%, Volatile Matter 2 to 5%, Fixed Carbon 91 to 95%, and the surface area is about 750 m^2/gm. Much of the product is exported and some is used in Australia for carburisation in basic oxygen steelmaking. The plant was established in 1969 as a pilot plant to see if there is a market for the product. Although the plant operates well it was unclear whether or not it would be expanded.

Close to the plant was a Lurgi gasifier in disuse which had used brown coal briquettes as feed. The oxygen plant was no longer there but basically the plant is the same as at Sasol in South Africa and if it could be renovated, would make an excellent pilot unit for testing various low rank coals.

Again, the Nissho-Iwai consortium was discussed and indeed it looks as though this consortium will take part of the output (perhaps 3 million tonnes per year giving 1 million tonnes per year product) from one of the open cuts for an SRC plant on site, the coking coal substitute being railed to the coast for transportation to Japan.

Leaflets on the Latrobe Valley brown coal deposits and power stations and also on the Australian Char Proprietary Limited process are available from the writer.

4. Visit to the Melbourne Research Laboratories of B.H.P.

People seen: Dr. G. Brown
Dr. Noam White

Work was being done on solvent refined coal, the approach being to characterize the liquid products. Australian crudes are generally deficient in heavy ends which have to be imported. SRC can help to alleviate this situation and different coals with different solvents are being tried in an agitated autoclave. Lower pressures and temperatures cannot be used in SRC because the desired compounds are stable at the more severe conditions but may decompose and crack under milder conditions.

High density bricks made out of natural hematite were being used for heat storage. These are heated up to about 750°C (limit of container materials) in off-peak hours, the bricks giving out heat during peak hours. Home units are available and Mr. Ed Littlejohn of Capital Communications, Ottawa, has expressed interest in this development.

Solar heating panels were also being developed at MRL.

5. Visit to CSIRO Division of Mineral Chemistry, P.O. Box 124, Port Melbourne 3207, May 4th

People seen: Mr. David E. Roney, Research and Development Planner
Dr. I. Gray

Mr. Roney, who had spent a month in the United States with Dr. J.H. Walsh in 1975, was interested in the present structure of EMR and the new matrix management system at CANMET. Apparently CSIRO are contemplating a similar exercise.

Because of time limitations only two areas were seen on the technical side of the CSIRO Laboratories.

(a) Research is being done on the behaviour of gangue during pellet induration. This work is in conjunction with pellet behaviour studies during reduction at the North Ryde Laboratory of CSIRO (see page 5). Electron probe analysis is being done on intermediate gangue phases during induration, attempts being made to produce single crystals of individual phases. However, the phases found cannot be fitted into known equilibrium diagrams. The objective of the work is the production of strong pellets for electric furnace steelmaking (e.g. in Indonesia and the Phillipines) with a minimum amount of gangue material. Calcium ferrite formation was being studied. This direction of study could be profitably done in Building 2 using composite pellets, i.e. studying mineralogy as a function of temperature.

(b) Liberation of mineral particles was being studied using an electron beam scanning technique to produce a composite map of each particle. For instance in flotation, small amounts of sphalerite on chalcopyrite (which may not be seen by visual techniques) could cause particles to float. The technique may be used for process control in mineral processing circuits. It was considered to be better than the Quantimet approach being used in Ottawa by Dr. Petruk.

With regard to flash pyrolysis of coals by the CSIRO method, Mr. Roney felt that there was a future for this in Australia. It's main application may be as an initial unit in power generation.

The remainder of the week (Thursday and Friday) was spent at the Whyalla plant of BHP, South Australia. The Iron Baron and Iron Knob quarries were visited together with the pellet plant and magnetite plant on the Thursday.

The following day, discussions were held with the combustion engineer who was pleased with the operation of oxygen probes in soaking pits and the lime kiln. A tour was made of the coke oven department, construction of a new battery being started using Wilputte ovens but with Japanese-manufactured doors and jambs. Apparently the Japanese equipment gives better sealing. A smokeless charging car will be used with the effluent going into a main along the coke side of the battery followed by further scrubbing at the outlet of the main.

Finally, the blast furnace department was seen, one of the major problems there being alkali and zinc circulation within the furnaces. There are two furnaces at Whyalla, No. 1 at a thousand tons per day and No. 2 at just over 2000 tons per day. Alkali and zinc build-ups are removed by running a lean slag (acidic), washing out the impurities through the bottom of the furnace. The zinc problem was associated with refractory attack and using up space in the furnace rather than any effect on the reduction behaviour of the iron ore. The zinc comes mainly from the lump ore used in the furnaces from the nearby quarries.

VISIT TO THE PILBARA IRON ORE REGION OF NORTH-WESTERN AUSTRALIA JUNE 7-11

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The phenomenal growth of the minerals industry in western Australia is well-known. The iron ore deposits of the Pilbara region have been developed since the late 'sixties, the present exports totalling about 90 million tonnes per year. In effect the industry is a giant earth moving operation inland with rail transportation to ports on the Indian ocean. The mined ore is of such a high grade (often 68% Fe_2O_3; usual shipping blend 62-64% Fe_2O_3) that apart from primary, secondary and tertiary crushing, there is no beneficiation. Most of the ore is shipped (mainly to Japan) as lump, the fine material being sold as sinter fines, although two of the companies (Hamersley and Cliffs Robe River) have pellet plants with capacities of about 3 million tonnes per year. However, the pellet operations are unprofitable at the moment.

Japanese steelmills, the biggest customers for western Australian iron ore, are tending to crush the lump ore on receipt for use on sinter strands. This trend towards sized blast furnace burdens may either keep prices of lump ore at unrealistic levels or force the Australian producers to install further pellet plants in the long term. This was underlined by the realization in Japan that air pollution in the form of NO_x in steelworks is from the sinter strand. However, this apparent limited future for Australian lump ores did not appear to be appreciated by the producers themselves.

The same general attitude seemed to be being taken towards the testing of iron ores under simulated blast furnace conditions, although particular care was being taken in the installation of sampling stations to meet ISO/TC102 specifications. With regard to physical testing, tumble and compression tests were done routinely to meet the letter of the contracts. Reducibility tests were generally done (one per shipload), but only for the benefit of the customer. Indeed, there is a distinct lack of interest in the activities of ISO/TC102/SC3 in Australia, so much so that the Chairman of the Australian Committee (Mr. L.C. Bogan, Superintendent of Raw Materials and Extractive Processes, BHP, Newcastle), is threatening resignation unless more action is taken. Whilst the Australian situation may be unique because of the amount of lump ores shipped, for the future it would seem important to maintain an active experimental program in the area of iron ore testing.

The visit to the Pilbara involved extensive travelling. The first leg of the journey was a flight across Australia to Perth, followed on the same day by a visit to the Kwinana works of BHP. Three days were actually spent in the Pilbara (800 miles north of Perth). Dr. E.H. Nickel (previously Head of the Mineralogy Section, Mineral Science Division, Mines Branch) was visited at the CSIRO laboratories in Perth on the last day of the trip.

The itinerary was as follows:

1. Kwinana Works of BHP, P.O. Box 160, W.A. 6167, 7th June

R.J.M. Delbridge, Manager

V.C. Rule, Raw Materials and Sinter Superintendent

This small ironmaking operation was in part established to satisfy the Western Australian Government requirement for raw materials producers to establish secondary processing within the State. Ore is railed from Koolyanobbing to a single 2000 tonne/day blast furnace. Coke is brought in by ship from eastern Australian steelmaking centres. Generally, a high silicon-content foundry iron is produced for sale in China and Europe. A strand produces sinter at 1.2 basicity (SiO_2/Al_2O_3) for foundry iron production and 1.8-2.0 for pig iron. The blast furnace productivity is about 2.2 tonnes/m^3/day, equivalent to the best Japanese practice.

2. Mount Newman Mining Co. Pty. Ltd., W.A. 6753

W.B. Willis, Chief Geologist

Unfortunately, the mine was on strike during the visit, but an appreciation could still be obtained of the scale of operations. Approximately 40 million tonnes/year of ore are shipped (after primary and secondary crushing) to Port Hedland on the 250 mile privately-owned railroad. Thus, the mine output is greater than Canada's total annual exports.

Details of the geology of the deposit and operations within the mine are available from the writer.

3. Port Hedland

G.G. Smith, Quality Control Superintendent

C. Malabre, Chief Metallurgist (a Canadian)

Tertiary crushing and ship loading facilities for the ore from Mount Newman.

4. Cliffs Robe River Iron Associates, Cliffs Western Australian Mining Co. Pty. Ltd., Cape Lambert, W.A.

Fred R. Madden, General Manager, Operations (a Canadian)
Peter M. Cameron, Technical Plant Superintendent

Pellet plant, using drum pelletizers and straight grate induration.

5. Hamersley Iron Pty. Limited, P.O. Box 21, Dampier, W.A. 6713

D.E. Brownscombe, Chief Metallurgist

Ship loading facilities and pellet plant. There was also a small metallurgical laboratory at Dampier for plant-related problems. The laboratory was equipped with a CSIRO reverse updraft-downdraft pot grate pellet induration simulator and apparatus for the high-temperature testing of iron ores.

VISIT TO THE TECHNICAL RESEARCH CENTRE, NKK, KAWASAKI, JAPAN, 29TH JUNE, 1976 AND TO THE NEW OGISHIMA WORKS OF NKK

Dr. T. Miyazu, Manager, Ironmaking Section, Technical Research Centre

Mr. Y. Okuyama

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Technical discussions were held in the morning and the new Ogishima works was visited in the afternoon prior to a meeting with Mr. H. Tsubaki, Deputy General Manager, Coal, Coke and Energy, at the Head Office in Tokyo to discuss further CCRA-NKK technical co-operation. Brief notes on the days discussions and activities are given below:

1. Coke Hot Strength

Coke structure in relation to reactivity (to CO_2) was discussed. Reactivity decreased in the structural progression isotropic, fine mosaic, coarse mosaic and fibrous. Examples (photomicrographs) were given showing this progression for cokes from single coals, there also being a progression of mean reflectance and strength (DI^{30}_{15}):

isotropic	-	Miike (Japanese indigenous H.V.), Ro = 0.8, DI^{30}_{15} = 73
fine mosaic	-	Moura (Australian M.V.), Ro = 1.1, DI^{30}_{15} = 92
coarse mosaic	-	Vicary Creek (Canadian M.V.), Ro = 1.4, DI^{30}_{15} = 91
fibrous	-	Itmann (U.S. L.V.), Ro = 1.8, DI^{30}_{15} = 95

The higher rank of coalification (i.e. Ro) of western Canadian coals explains why Japanese steelmakers do not rely entirely on the closer Australian supply (apart from the strategic aspect). Queensland and western Canadian coals generally have similar inert contents but the higher rank of coalification in the western Canadian coals makes them a desirable blend component.

The effect of alkalis on coke behaviour in the blast furnace was discussed in some detail. There are indications that the behaviour of alkalis is more complex than the commonly-held view that the role of alkalis is merely to catalyze the Solution Loss reaction.

(i) Degradation due to CO_2 represents only about 50% of the total degradation in the furnace.

(ii) Measurements from a quenched blast furnace had indicated very little increase in coke alkali content below 1100°C (17 m below stock line). This temperature is close to the transition range between chemical and diffusion kinetic control for the Solution Loss reaction, and the question arises as to whether the chemical effect of alkalis is applicable over only a narrow stack temperature range.

(iii) Tokyo University claim to have identified alkali-carbon "compounds" in cokes collected from tuyères. The approximate configuration is postulated to be alkali atoms joining carbon hexagonal plates. Using EPMA, sodium is found to be concentrated around pores whilst potassium is evenly distributed throughout the coke piece ($Na_2O \sim 2\%$ in ash, $K_2O \sim 10\%$). This alkali content is postulated to cause cracking and result in weak coke strength in the blast furnace.

In one experiment, a hole was drilled in a piece of coke and filled with Na_2O. When subjected to compression, the piece of coke cracked preferentially below the hole containing the Na_2O, presumably because of either softening of mineral matter or graphitization of the carbon structure.

(iv) Dr. Miyazu summed up the role of alkalis in the following possibilities:

(a) Catalytic action on Solution Loss reaction indirectly results in decrease in coke strength.

(b) Formation of C-Na and C-K type compounds directly results in a decrease in coke strength.

(c) Ash attack.

(v) The equipment for testing coke strength at 1500°C was seen. This equipment was built originally for evaluating formed coke at a cost of $70,000.

2. Partial Briquetting of Coke Oven Charges

NKK blend the briquettes with the loose coal prior to oven charging whereas other practices (e.g. NSC) charge directly using two hoppers. Blending is practised by NKK because the low softening point of the pitch ($\sim 60^{o}C$) causes sticking in the briquette hopper. To minimize briquette breakdown, the briquettes are gently introduced into the charge hopper (spiral slide), but this effectively decreases the charge hopper volume.

3. Visit to the New Ogishima Steelworks

At a time of apparent recession in the world steel industry, it was interesting to see the final stages of construction of a new integrated steel plant on reclaimed land in Tokyo Bay.

The No. 1 blast furnace ($\sim$ 8000 t/day) will operate on a sinter burden but the proposed No. 2 is expected to operate on pellets. One of the reasons for this is based on increasingly stringent air pollution restrictions in Japan; NO_x from steel plants to a large part comes from the sinter strand where it originates almost entirely from the nitrogen in the coke. If this aspect of air pollution is as important as claimed, it does not auger too well for the future of direct shipping ores to Japan, especially as a large proportion of these are already crushed for agglomeration on arrival.

The five coke dry quenching units (CDQ), costing $3 million each, use a technology developed by NKK, rather than copying the Russian installations. The sealed coke discharge car is hoisted above the quench tower through which inert gas is blown. Carl Still ovens are being used (first time by NKK) and a computer control system with feed-back from thermocouples is being installed. Accurate control of coking time is anticipated to result in a 5% energy saving in the carbonization process.
(For a more comprehensive description of the Ogishima Steelworks, see "Ogishima: NKK's New Island Steelworks", Metals and Materials, p. 33, June 1976).

MEETING AT NKK HEAD OFFICE, TOKYO, TO DISCUSS FUTURE CCRA-NKK TECHNICAL CO-OPERATION, 29th JUNE, 1976

* * *

Present: Mr. H. Tsubaki, Deputy General Manager, Coal, Coke and Energy, Iron and Steel Technological Department

Mr. T. Nishio, Manager, Overseas Projects Department (Interpreter)

Dr. T. Miyazu, Manager, Ironmaking Section, Technical Research Centre

Mr. Y. Okuyama, Ironmaking Section, Technical Research Centre

Dr. D.A. Reeve, EMR, Secretary of the CCRA Technical Committee

The discussions were mainly between Mr. Tsubaki and the writer. Mr. Tsubaki made it clear that all future correspondence with NKK on this subject should be addressed to him only. He claimed that the present meeting was the first time he had been approached regarding the place and time of a second CCRA-NKK technical meeting. He appeared to appreciate the different intentions of the joint technical meetings and the recent ITC-sponsored Coke Mission to Japan.

The following suggestions were made:

Date and place of next meeting: NKK Head Office, April 1977.

NKK can spare two days for the meeting; 1½ days for technical sessions, ½ day to visit the new Ogishima Steelmaking Complex. Further technical visits in Japan could be arranged by the Canadian contingent.

Proposed agenda items:

(i) The applicability of the partial briquetting process to eastern Canadian coal blends.

(ii) Observations on the behaviour of coke in blast furnaces.

(iii) Systems for sampling and analysis of coal and coke (e.g. the automatic determination of moisture and ash at the new Ogishima works - important for blending).

(iv) Environmental control systems for coke plants.

Some time at the meeting should be left open for general discussions.

Following discussion of these suggestions at the next CCRA Technical Committee and Board of Directors meetings in September, contact should be made with Mr. Tsubaki again with any counter-suggestions from Canada. NKK is definitely not interested in discussing formed coke.

The following impressions were also formed from the meeting:

(a) Whilst it was stressed that both sides should make equal contributions and NKK certainly favours further meetings, it was difficult not to get the feeling that NKK expect to be making the major contribution to the meetings.

(b) In the car, Dr. Miyazu had mentioned that a five day meeting in Japan might be appropriate, including a visit to the Fukuyama works. Mr. Tsubaki said that NKK could only "spare" two days.
In talking about the number of attendees from Canada at the next meeting, Mr. Tsubaki did not wish to put any restrictions on numbers and immediately talked about coke oven managers (as opposed to researchers) visiting NKK to discuss advances in Japanese coke oven operating technology. He mentioned that it was very important to sell his company's technology abroad, giving environmental control systems and coke dry quenching technology as examples. Thus, he also appears to regard the CCRA-NKK technical meetings as an outlet for the sale of NKK coke oven technology in Canada.

Partial Briquetting of Eastern Canadian Coal Blends

Dr. Miyazu offered to test the applicability of eastern Canadian coal blends to partial briquetting. Two samples (50 lb each) of each blend should be sent to the Technical Research Centre and tests will be done using petroleum pitch. Sufficient sample for 250 kg oven tests would also be acceptable.