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INTERNATIONAL SILICA - SILICON METAL INVESTIGATION

COMALCO LIMITED
95 COLLINS STREET
MELBOURNE

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JUNE 1974

OUTLINE:

Between 5th May and 15th June 1974 a world survey was made of silica-silicon metal production and potential production in the following countries -

The Republic of South Korea
Spain
Portugal
Venezuela

In addition a visit was made to Elkem-Spigerverket a/s head office in Oslo-Norway. Comalco proposed Tasmanian silicon metal furnace operation was discussed. A visit was made to a similar sized Elkem operation to that which Comalco is considering - namely Marnes Quartzite Mine near Bodø and the Salten Verk ferro-silicon furnace complex.

A report detailing this investigation is attached.

Analysis and description of Silica samples collected - The samples were analysed using x-ray fluorescence (XRF) at Comalco Bell Bay Laboratories.

Sample	Location/Description	CAO	AL203	FE203	MGO	NA20	TIO2	MNO
KOREA								
KOR 01	Kim-Hwa Mine - in the far north of South Korea. Reef quartz 1st Grade.	+0.005	+0.013	0.021	+0.010	+0.050	+0.007	+0.002
KOR 02	Kan-Jo Mine in the Yan-Gu area in northern South Korea. Hand sorted reef quartz - 1st Grade	+0.005	+0.013	0.007	+0.010	+0.050	+0.007	+0.002
KOR 03	Korean Quartzite Industries Ltd. Pocheon area just north of Seoul. Hand sorted quartzite rock.	+0.005	0.019	0.005	+0.010	+0.050	+0.007	+0.002
NORWAY								
NOR 01	Elkem - Spigerverket Marnes Quartzite Mine near Bodø in northern Norway. Quartzite from "Pure Quartzite" horizon and used as feed for ferro-silicon	0.012	0.064	0.107	0.025	+0.050	0.052	+0.002

Loss on ignition not determined.
SiO_2 Available by difference.

58603

Sample	Location/Description	CAO	AL203	FE203	MGO	NA20	TIO2	MNO
SPAIN								
SPN 01	Santos-Tabernero processing plant at Guadalajara. Hand sorted quartzite rock hard and fine grained. Minor iron stained joints. High purity ore.	+0.005	0.335	0.046	+0.011	+0.050	0.060	0.002
SPN 02	As above but with more iron staining and softer with higher interstitial clay content.	+0.005	0.307	0.060	0.012	+0.050	0.137	0.002
SPN 03	DANIEL VELASCO LLANDO Mine near Arriondas east of Oviedo in northern Spain. Massive well bedded quartzite rock but generally poorly cemented. High interstitial clay.	+0.005	0.670	0.018	0.045	+0.050	0.056	+0.002
SPN 04	Santos-Tabernero Mine near Veguillas north of Guadalajara. Hand sorted quartzite rock. Fine gained with minor non stained joints.	+0.005	0.339	0.086	+0.011	+0.050	0.216	0.002

Loss on ignition not determined.
SiO_2 Available by difference.

Sample	Location/Description	CAO	AL203	FE203	MGO	NA20	TI02	MNO
SPN 05	Quartzite rock - hard, fine grained bluish colour given to author by Portugese Mines Department. Reported to come from Spanish/ Portugese border area east of Lisbon. Used as road aggregate.	+0.005	0.267	0.075	+0.010	+0.050	0.127	+0.002
PORTUGAL								
POR 01	CPFE Quartz Mine near Visen in north Central Portugal - Milky quartz with ironstained joint planes.	+0.005	+0.013	0.010	+0.010	+0.050	+0.007	+0.002
POR 02	As above but clear quartz with minor clay coating joint/tracture planes.	+0.005	+0.013	0.006	+0.010	+0.050	+0.007	+0.002
POR 03	Massive out cropping quartzite rock 3km north of Penacova in north central Portugal. High alumina from inter-stitial clay content. Minor iron staining.	+0.005	1.256	0.114	0.025	+0.050	0.818	+0.002

Loss on ignition not determined.
SiO_2 Available by difference.

Sample	Location/Description	CAO	AL203	FE203	MGO	NA20	TI02	MNO
VENEZUELA								
VEN 01	Officina-de Mineria "Luis Baey" Quartz prospect in The Guayana Region. Reef Quartz with minor clay coating major fracture planes.	0.029	0.092	0.564	0.063	+0.050	0.019	0.020
VEN 02	As above but from nearby reef quartz deposit and with iron stained joints.	0.018	+0.013	0.027	+0.011	+0.050	+0.007	0.002

Loss on ignition not determined.
SiO_2 Available by difference.

K O R E A

REPORT ON HIGH PURITY SILICA POTENTIAL IN THE REPUBLIC OF SOUTH KOREA

BY: I.D. Picken 14th May, 1974.

Summary :

The Republic of South Korea poses no serious competitive threat to alternative silica sources currently being investigated by Comalco within Australia. The mines from which Korean silica is produced are small "hand-to-mouth" operations with little expertise and mechanization. They are widely scattered throughout the Republic. The northern most mines are reported as being the source of the higher quality silica ore. However, long term security in this area is questionable due to possible increased tension developing along the border.

Introduction

The Republic of South Korea was visited between 8th May and 14th May, 1974. Discussions were held with Nissho-Iwai Co.Ltd. (Japanese trading company) and the Australian Trade Commissioner in Seoul. The three major mines were individually visited.

Almost all silica (quartzite and quartz) mined in Korea is exported to Japan for the manufacture of metallic silicon, silicon carbide, ferro-silicon and sodium silicate. The ore is mined by many small operators from throughout the Republic. The ore is transported by road and rail to the principle mineral collection and export port of Pusan on the south-east coast, situated 488 km from Seoul.

Production for 1973 of +99.5% silica was 239,219 tonnes with an export value of $US 2.595 million. The F.O.B. price at Pusan varies depending on the grade from $US 18 - 30.

Government Policy

The Australian Trade Commissioner in Seoul advised that the government is keen to develop any industry that intends to export. All mining operations would fall into this category.

Mining

Bedded sedimentary quartzite and reef quartz are mined. The higher quality silica ore is reported to come from the mines in the north. Some of the mines in the north are very close to the demilitarized border zone - e.g. Kim Hwa mine which is less than 1 km from the border. Although hostilities are negligable at present it is considered that long term stability for a mine in this area is questionable. To enter this area special passes are required and if granted are conditional on you not taking a camera into the area. The area is heavily patrolled by armed troops.

All the mines are reported as small "hand-to-mouth" type operations, scattered throughout the Republic. This was verified in the cases of those visited.

No large scale or co-operative mining operations are at the present time being contemplated.

The silica is mined from small open cut pits on rocky nobs by drilling and then blasting. Hand sorting was the only method of beneficiation in the mines visited. The ore is then trucked to the rail-head where it is then railed to the mineral export port of Pusan.

Of the mines visited, reserves are less than approximately 0.5 million tonnes. No systematic exploration for additional reserves has been undertaken. No single large high grade deposit has been reported.

Grade and Price

Three grades of silica are produced :

	1st Grade	2nd Grade	3rd Grade
SiO_2 greater than	99.7%	99.5%	99.3%
Al_2O_3 less than	0.03%	0.05%	0.1%
Fe_2O_3 less than	0.03%	0.05%	0.1%

The main proportion of output (60-70%) is of second grade quality. The F.O.B. price at Pusan varies depending on the demand but averages $US 25 (1st grade), $US 23 (2nd grade) and $US 18 (3rd grade). C.I.F. price in Japan as reported by the Australian Trade Commissioner in Seoul are $US 40 (1st grade), $US 30-33 (2nd grade) and $US 25-27 (3rd grade).

It is expected that if the export demand was increased then the grade of silica produced to meet this demand would fall. This fall would be due to the limited ability of many small mining companies and the apparent lack of high quality deposits with large reserves. The present trend is to prolong each mine for as long as possible.

Power

The Korea Electric Company is presently developing low quality coal fields on the north-east coast for power generation. The present oil fired electrical generation system is being changed to coal because of increased oil charges and looming shortages.

Hydro-electric energy is being developed in the north. The new Soyang Dam completed in October 1973 is harnessing the head waters of the Han River, 20 km north of Chun-Chon. This dam has 2 x 100 000 K.V.A. generators and is expected to be full and completely operational by 1976. This dam will

supplement the Kapyong and Fachong Dams also in this general area.

Plans for another hydro-electric scheme and a second steel works in the vacinity of Osan Bay (approximately 60 km south of Seoul) are presently being considered. A decision on this is not expected before June 1974. Iron ore and coal for this scheme would be imported from Australia. Local opinion supports the idea that coal power would be developed first utilising the relatively cheap labour.

Pechiney operate a 30 000 tonne/year aluminium smelter on the east coast at Ulchin using local coal for power.

There is also some mention of a joint Japanese-Korean oil drilling exploration programme in the China Sea.

Concessions for local bulk consumers of electricity can be negotiated, however power is expensive.

Labour

The Republic of South Korea has a population of nearly 30 million people, 6 million of which reside in Seoul. There is an adequate work force available in Korea with some of the rates of pay being :-

(1)	unskilled worker (generally employed daily on a casual rate)	W 15 000 - 30 000 /month ($US 38 - 76/month)
(2)	driver (eligible for additional bonus payments)	W 40 000 - 43 000/month ($US 100 - 110/month)
(3)	senior white collar workers	up to W200 000/month ($US 510/month)

In the upper income groups the inflationary trends are similar to those elsewhere in the world. There is no tax for incomes up to W40 000/month ($US 100) but it then commences on a sliding scale at 10%. No effective unions have been organised.

Transportation

The main export ports are Pusan and Yosu on the south coast. Rail linkages to these ports are standard Japanese gauge. Rail transport of silica ore from the northern deposits approximate W2 000 ($US 5)/tonne for the 500 km distance.

Roads of poor and average standard connect to the rail-heads. The use of rail especially for carting goods producing export income is greatly encouraged by the government. Road transport is generally 4 - 5 times the cost of rail.

For personal transportation taxis are plentiful costing W90 (25¢ US) for the first 2 km and thereafter W40 (10¢ US)/km. Buses are reported as being cheap but the destination is written in Korean. Good train services serve the suburban and country areas.

Weather

April to June has a little light rain and is considered warm. June to August is the rainy season and August to November generally is a fine, clear autumn. The winter, November to April is extremely cold, but with little rain.

Currency

A decimal system with the base unit being called WON (W). As of 8.5.74 the exchange rate is 395.19 being equivalent to $US 1.00. The largest note is W500.

Housing Tax

The owners of luxury homes in Korea are subjected to a housing tax.

The presidential emergency measure Number 3 states : that those homes worth more than W 5 million ($US 12,500) and built on land larger than 300 pyong (1 pyong = 3.3 sq. meters are subject to a progressive property tax along with houses valued at more than W 10 million ($US 25,000) with more than 100 pyong space. Private apartments with more than 70 pyong space are also in a special category together with private houses with elevators and swimming pools. The valuations are based on government posted prices and not the current market price. Approximately 2,000 houses fall in this category.

APPENDIX I

Mines Visited in Korea

1. Company : Kim Hwa Mining Company Limited
   Area : Tae-Pac Mountains District which is approximately 20 km north of Cheolweon. (38° 17'N, 127° 25'E)

Type of Deposit

A series of massive quartz reefs and blows in a medium grained grey granite mass. The quartz is white in colour and slightly milky. The veins and blows pinch and swell and are not continuous. Large books of muscavite and biotite together with massive feldspar are in close association with the quartz. The outcrops examined showed no continuity of strike or dip. The quartz is fractured but the degree varies from vein to vein. Ironstaining is usual on the joint and fracture planes. The surrounding country is ruggard with light vegetation. The company operates all the small silica workings in the area which are scattered over approximately 25-30 sq. km.

Size of Deposit and Grade

The mine is regarded as the largest silicon mining operation in the Republic. The area has been worked "off and on" for the past 12 years mining silica. All production is presently exported in lump form to Japan for the manufacture of lenses and special glass. No exploration has been completed to determine the over all reserves. I estimate that the larger veins and blows would not yield more than 10 - 15,000 tonnes each. This would give total reserves of around 2 - 300,000 tonnes.

The grade control at the mines is estimated by experience only. The silica ore is hand sorted and graded into three types.

	1st	2nd	3rd
SiO_2	+99.7%	+99.5%	-99.5%
Fe_2O_3	-0.03%	-0.08%	-0.1%
Al_2O_3	-0.03%	-0.08%	-0.2%

Some output is sold hand sorted to minus 5 cm mesh. This ore may receive an additional $3/tonne bonus if specifically sought after by the purchaser.

Mining

The quartz is mined from numerous small pits, open cuts and underground shafts and drives. The small pits which collectively produce the mine output are scattered over a wide area. All the pits are not worked at once but on a casual rotationary basis depending on the grade required. The rock is drilled and then blasted. The company operates 15 rock drills and 2 Airman Rotary PDR 250 compressors when mining. The ore is carted in crude man powered carts to sorting areas. The individual workings are very "hand-to-mouth" in operation and no sophisticated mining techniques are employed to ensure maximum extraction from any one pit.

Beneficiation

Hand sorting and sizing is used exclusively. This work is undertaken by a team of 20 - 25 women working 7 days per week. Excessive rain and military manouvers prevent the mine operating at certain times. In certain special cases a $3 bonus is paid to the company for minus 5 cm diameter silica ore. The company is considering a crushing mill to produce minus 200 mesh silica for sodium silicate manufacture.

Tenement

The company controls 16 mining leases each of 2.25 sq. km. The leases are current for 25 years and are able to be renewed after this time.

Production and Transport Economics

The company produces 1500 tonnes/month of silica ore and employs between 60 and 80 people, of this number 20-25 are women used for sorting the silica ore. The employees are paid a monthly base rate of W36,000($US 85) for men and W 18,000 ($US 43) for women. A special allowance of W300/day ($US 0.80) is paid to drill operators and powder monkeys. The mine operates seven days per week each of 12 hours duration except during the Korean festive season which is in February each year. In addition to the mining equipment the company operates 2 GMC 18-20 tonne near dump trucks which cart the sorted and graded ore to the rail at Cho-Sang-Ki 45 km distance by a fair unsealed road. The ore is then railed to Pusan approximately 400 km south-east. The truck haulage was stated as costing W1600/tonne ($US 4.10) and that of the rail as W700/tonne ($US 1.80). The price F.O.B. Pusan is $US 30-33/tonne of 1st quality material. The C.I.F. price Japan is approximately $US 40 per tonne.

The employees are mostly paid casually and live locally. Local opinion considers the area to be remote. It would be difficult to accommodate imported workers as there is no sizeable settlement nearby. The proximity of the border and constant military check and manouvre operations amplifies the long term instability of the area. In winter the temperature drops to around -32°C. The hydro-electric scheme described north of Chon-Chang is approximately 100 km east.

Capital Investment

While low or general western standards is relatively high for Korea, total investment was stated as being W40-50 million ($US 120,000 approx.). The company is considering the purchase from Japan of a drilling rig to test for new ore in the immediate area. For this rig they expect to pay around $US 50,000.

2. Company : Kan-Jo Trading Company
   Area : Yan-Gu - approximately 200 km N.E. of Seoul (38^{o} 05'N - 127^{o} SSE)

Type of Deposit

A massive reef quartz vein filling a shear in a large granitic mass. The granite is fine to medium grained with many fine grained differentiate dykes in close proximity to the quartz reef. Books of muscovite are common within the quartz reef. The quartz strikes SSW-ENE and has a sub-vertical dip slightly to the west. The quartz is fractured, has minor clay and iron staining on the fracture and joint planes and is white in general appearance. The impurities coating the joint and fracture planes originated from the chemical weathering of the flanking differentiate rocks.

The reef strikes perpendicularly through a granite ridge and appears to be terminated at each end by faults. The valleys are deeply incised along the predominant joint and fault planes.

Size of deposit and grade

The mine has been operating for 8 years and approximately 1/3 of deposit has been mined. The remaining quartz ore has the approximate dimensions of - strike 70 m, width 50m and an above valley height of 40m. With a specific gravity of 2.5 gm/cc the estimated reserves are 350 000 tonnes.

The grade is visually determined and stated as being 99.6 - 99.7% SiO_2. All production is exported to Japan.

Mining

The quartz is mined by drilling and blasting from the southern end of the reef. One bench approximately 40m high is operated. The valley floor is presently the lower level of production and no underground mining is contemplated. The mine operates 1 compressor, 5 rock drills (3 of which are kept spare) and a small front end loader. The shot ore is carted to a nearby sorting area.

Beneficiation

Hand sorting of the quartz is undertaken by a team of 10-20 men and women. The sorted ore is stockpiled and hand broken to the required size, which is generally less than 15-20 cm in diameter.

Tenement

The company has a single mining lease (280 hectares) which is valid for 25 years, 8 of which have elapsed.

Production and Transport Economics

The mine employs 25 men and women all of which live locally in Yan-Gu (3 km north of the mine). They are payed from $US 50-100/month depending on the individual's ability. The mine operates seven days a week except when closed by inclement weather.

The mine owns and operates 2 x 8 tonne trucks and contractors supply a further 8 x 8 tonne trucks to transport the 2000 tonne/month (80 tonne/day) production to the rail-head at Chun-Chon (approximately 80 km E.N.E. of Seoul) by a fair quality road.

The trucking cost is $US 4.50/tonne and the ore is sold at Pusan for $US 15-18/tonne. This is the only silica mine in the north-east of the Republic. The mine areas elevation is 500 m A.S.L. making the climatic conditions moderate. The mine has been operating at near break even point but increased Japanese prices have improved the situation over the past 1 - 2 years.

Capital Investment

Investment is very low with the main cost being for 2 mine trucks drills, compressor, front end loader and a small mine office.

3. Company : Korean Quartzite Industries Limited

Area : Pocheon - approximately 70 km N.E. of Seoul (127^{o} 15'E, 37^{o} 45'N)

Type of Deposit

Fine to medium grained thinly bedded quartzite forming a resistant razor back ridge rising 20-30 m above the generally flat river plane. The quartzite has a N-S strike and a sub-vertical dip. The rock is highly fractured with minor iron stains and clay coating the fracture planes. The quartzite has, in places, been recrystallized, this being demonstrated by small vugs, but with well formed quartz crystal clusters.

Variation in purity along strike has allowed the more impure quartzite to be eroded due to its relative softness. The high purity quartzite is hard and resistant to erosion hence its prominent outcrop. The quartzite passes both up and down dip into micaceous siltstones and schists. Quartzite boulders with dark gossanous cavities were noted in the area These cavities appear to be weathered remnants of pyritic rich zones within the quartzite.

Size of deposit and grade

The mine has been in operation for six years but only a small volume of quartzite has been mined to date. The quartzite ridge has approximate dimensions of - strike 200 m, width 30 m and an average height of 25 m. Assuming a specific gravity of 2.5 gm/cc then the inferred quartzite ore reserves are between 2 - 300 000 tonnes maximum.

The quartzite is crushed on site, after sorting, to -25+60 mesh and then bagged. The main percentage of quartzite crushed is exported to Japan for sodium silicate manufacture. The minor purchases are unknown. Analyses of the quartzite is reported to be

SiO_2	99.6%
Fe_2O_3	0.05%
Al_2O_3	0.07%

Mining

The quartzite is mined by drilling and blasting. One rough mining face has been developed on the western face of the razor back ridge. No systematic mine benches have been established. The shot ore forms a scree at the base of the slope from where it is hand sorted and carted on a man powered cart to the crushing works.

Beneficiation

Hand sorting is exclusively used by teams of 10 - 20 men and women working three shifts/day, seven days/week. The hand sorted ore is fed through a jaw crusher (30 cm) thence to a stone roller mill where the product, minus 25 mesh, is packaged in 50 kgm bags for export.

Tenement

The company has a single mining lease covering 271 hectares and an adjoining industrial lease of 10,000 sq. meters upon which the crushing plant is built. The leases are current for 25 years, 6 of which have elapsed.

Production and Transport Economics

The ore sorters are paid a base wage of W30,000/month ($US 75) however, specialist workers such as powder monkeys and drill operators receive an additional allowance. The employees live locally in the Pocheon area.

Production was stated at 1500 tonnes/month (50 tonnes/day). I consider this figure to be exaggerated based on the production observed at the time of my visit. The bagged product is transported by 2 x 12 tonne trucks to the rail at Uijonbu approximately 50 km distance. The road haulage was given as W1,000/tonne ($US 2.50). I suspect this figure is somewhat understated. From Uijonbu the ore is railed to Pusan for export. The product was stated as being sold ex-plant for W12,000/tonne ($US 30). This is in conflict with Nissho-Iwai reports stating a maximum of $US30/tonne F.O.B. Pusan.

Capital Investment

For the mining operation only rock drills and a compressor are used. The crushing plant is relatively substantial with a jaw crusher, conveyor belts and a stone roller mill housed in a solid building. The bagged product is stored under cover awaiting shipment. A sealed road and electric power are within 50 m of the plant.

APPENDIX 2

People Met in Korea

1.	Nissho-Iwai Co. Ltd.	Seoul Office Room 1406-1407 Ssang Yong Building 24, 2-KA Cheo-Dong Chung-Ku Seoul, Korea Phone (26) 8164-9
	Won Myong Choi	Representing Nissho for mineral purchases in Korea.
	A.Okamoto	Assistant Chief Tokyo. Minerals Department
	Takayuki Osada	Assistant Chief Tokyo. Building Materials Department.
	Chan Oh (Chinese)	Nissho representative.
2.	Manly Industrial Co. Ltd.	I.P.O. Box 2348 Seoul, Korea. Phone : 22-6636
	K.Y. Han	President
3.	Kim Hwa Mining Co. Ltd.	Room 501, Wochak Building, 5-32, 2-KA Myung-Dong, Chung-Ku Seoul, Korea Phone : 288448
	K.W. Wang	President
	Mr. Raa	Assistant Managing Director

4. Australiam Embassy

6th Floor
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Seoul, Korea
Phone : 73 4527

Desmond J. Fennessy

Trade Commissioner
(Commercial Counsellor)

N O R W A Y

REPORT ON MARNES QUARTZITE MINE AND SALTEN VERK FERRO-SILICON SMELTER BODØ AREA, NORTHERN NORWAY.

By I.D. Picken

23rd May, 1974

A visit was made to the Marnes Quartzite Mine and the Salten Verk ferro-silicon smelter near Bodø (800 km north of Oslo) between 21 and 22nd May 1974.

The Marnes Quartzite Mine

Location

The mine is owned & operated by Elkem-Spigerverket a/s and situated approximately 20 km SW of Bodø at the mouth of the Salt Fjord Transport to the mine from Bodø was by Cessna 186 amphibian aircraft. Access by road is reported to be long and difficult.

Geology

The mining operation is based on Cambrian to Silurian (Upper Ordovician?) aged massive medium to course grained metamorphosed sediments that have been over folded. The sediments strike NNE (015° - 030° mag) and dip SSE at 18°. The geological sequence in the mine area has been broadly classified, grading from the base (top in outcrop) as:-

Geological Sequence

Base (true)

- Mica schists.
- Quartz mica schists.
- Dirty quartzite with quartz mica schists and mica schists.
- Clean quartzite with mica schists.

mined horizon

- Pure quartzite with minor grey and pink feldspar fragments (0-5%), minute micacious bands and a sericitic marker band.

Top (true)

- Mica schists.
- Calcareous and dolomitic lenses grading to limestone and marble.

Only the "Pure Quartzite" horizon is mined for smelter feed. Like the associated sediments it is banded with mica (muscovite and minor biotite) laminae. Some minor kyanite, garnet and chlorite also is present. Varying amounts of pink and grey feldspar grains (0.5%) are present in the matri of the Pure Quartzite. Easy identification of the feldspar is made where tannic acid derived from the moss cover has chemically altered it. The sediments are massive, exhibiting cross and current bedding structures and are highly jointed.

The Pure Quartzite is nearly 100 m thick and contains a sericitic marker horizon that varies from 0.6 to 1.5 m in thickness and which is approximately 40 m from the top of the sequence. The Dirty and Clean Quartzites, which overlay the Pure Quartzite in outcrop, contain minor pyritic lenses which upon weathering have iron stained the joint planes in much of the overall sequence. Iron has been absorbed into many of the coarser grained quartzite lenses.

The Pure Quartzite is classified by the number of micaceous laminae to the metre. The number in the Pure Quartzite is generally between 0 and 15, each up to 3 mm thick. The physical strength of the Pure Quartzite is low due to the lack of adequate cement bonding the grains.

Analysis

Chemical analysis is determined at the Salten Verk smelter using classical wet chemical and atomic absorption methods. The samples are pulverized in a tungsten carbide ring crusher. Analysis of the Pure Quartzite is reported as:-

SiO_2	-	98.46%
Al_2O_3	-	0.69

Fe_2O_3	-	0.23
$Ti\ O_2$	-	0.04
P	-	0.003

The high alumina and iron percentages are believed to result from the feldspar and micaceous laminae in the ore rock.

Reserves

These are conservatively indicated to be 3 million tonnes. Further exploratory drilling along strike of the Pure Quartzite will, no doubt, increase the figure stated.

Exploration in the immediate mine area is based on percussion drilling at 50 m centres. Percussion drill fragments are analysed over 1 metre intervals. To supplement the percussion drilling, six BQ diameter diamond drill holes were completed. The core is geologically logged, split and then bulk analysed over 2.5 m intervals. Only the visually good sections are analysed.

Production

The Marnes Quartzite Mine is of the open cut type and produces 250,000 tonnes/year. The mine product is crushed and sized dry at an on-site mill, consisting of steel faced jaw crushers and vibrating mesh screens. Around 180,000 tonnes of +40 -120 mm diameter furnace feed quartzite is produced per year. The under-size (-40 mm) is further screened into two fractions of plus and minus 10 mm. Approximately 6,000 tonnes of the +10 mm -40 mm quartzite is sold to the Sulitjelma Gruber Copper Mine for use as a flux in the smelting of the sulphide concentrate to blister copper. The -10 mm quartzite is presently dumped into the Fjord, although some thought is presently being given to its use as a building sand substitute.

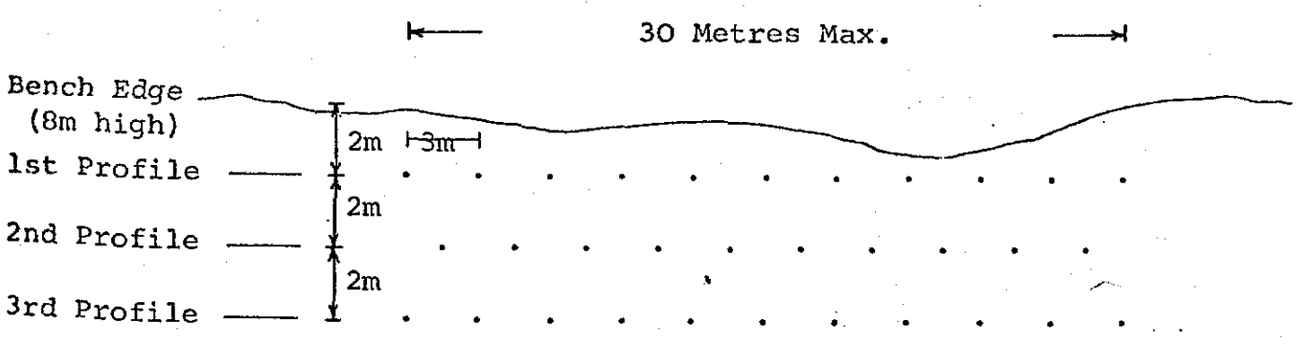
The crushing plant is able to handle 800 tonnes/day. The mine is currently working a 8½ hr 5 day week with 4 weeks annual leave.

To reduce the risk of the mill operators contracting silicoceous the crusher is fitted with dust collectors and the control room well ventilated.

Mining

The open-cut mine is operated by a series of 8 m high benches cut into the Pure Quartzite horizon parallel to the strike. Blasting holes are drilled at the rate of 80 m/shift, using an Atlas Copco ROC-601 drill. Drill rods are changed after 2 metres drilling. The mine has two compressors, one is electric and rated at 18 cubic metres/minute, the second is diesel powered and more portable with a capacity of 12 cubic metres/minute.

Blasts are of 6-7,000 cubic metres every two to three weeks using a 3 profile delayed blasting pattern. Blast holes are 3 metres apart along the bench with the second and third profiles off set by 1.5 metres and spaced 2 metres apart back into the bench. Generally each profile does not exceed 30 metres in length. The shot quartzite is loaded onto a single 20 tonne dump truck using a Norwegian Brøgt X 3 loader. The crushing plant is a 600 m downhill haul from the mine face. A mixture of ammonium nitrate and dieseline (anfo) is double fired electrically with plastic explosive using split second delays between each profile.



Each Profile is Double Fired with a Split Second Delay

Plan of Blasting Technique

5 cm

Transport to Smelter

The stockpiled sized quartzite ore is fed by gates under the stockpile onto a gravity loading 300 tonne/hour conveyor belt, thence to the wharf and ore carrier. The mine/smelter lease the small ore carrier which transports 1,000 tonne quartzite shipments to the smelter from the mine - the trip from the mine to the smelter taking about 5 hours. Freight is stated as being 5 kr/tonne (US 0.94). Engineers are concerned by the volume of fines produced between the crushing mill stockpile and the furnace - 12-15% due to the physical weakness of the quartzite ore.

Production Costs and Capitalization

Total investment in the quartzite mine was stated as being kr 8 million (Norwegian). Quartzite of a size suitable for furnace feed (+40 mm -120 mm) is produced F.O.B. Marnes at kr 12/tonne ($US 2.24), excluding depreciation of mine equipment. Equipment depreciation is around kr 5/tonne. ($US0.94). Hence the stated total price of quartzite (+40 -120 mm) C.I.F. smelter is 22 kr/tonne ($US 4.12).

Employment

Labour is not considered a problem. The mine has 15 fulltime employees:-

5 men	-	blasting, drilling
3 men	-	transporting, loading
2 men	-	crushing - screening plant
4 men	-	servicing equipment
1 man	-	foreman
15 men	-	TOTAL

All personnel live locally and welcome the opportunity to obtain secure, permanent work. The wages vary depending on the employment.

	Basic	Actual
Driller	kr 17.90/day	kr 20.00/day
Crushing Plant operator	kr 17.45/day	kr 19.00/day
Servicing Department	kr 17.00/day	kr 19.00/day

(U.S. $1.00 = kr 5.31 as at May 1974)

Employees considered working in siliceous danger areas are medically checked every 2 years, all others each 3 years.

Power

Power is considered adequate and competative in price. The mine is supplied from the national grid, this being 220 volts, at 50 cycles.

Climate

The mine operates all year round, and is only occasionally closed as a result of adverse weather preventing the loading of, and shipping of quartzite ore to the smelter. The western Norwegian coast is ice free all year round as a result of the warming effect caused by the Gulf Stream current flow.

Salten Verk Ferro-silicon Smelter

Location

The smelter is located 55 km WNW from Bodø at the head of Sørfolda Fjord (67° 25N, 015° 32'E). Road access from Bodø is good being by the E6 and the secondary Fauske/Bodø highways. Both roads are sealed and of good quality.

Power

Salten Verk is based on energy supplies from its own power station, Siso Kraftverk, which has a capacity of 900 million kwh. Elkem-Spigerverket have based construction of the power scheme on the huge Blaarmannsiscen Glacier centred approximately 30 km east of the

smelter. At present the smelter is using 800 million kwh, the excess power being sold under contract to the local grid. This contract will expire in 1976.

The Siso Kraftverk scheme cost kv 160 million (Norwegian) to build. Stage one was completed in 1966 and the final stage recently. Maintenance, running costs and depreciation on the scheme are reported to be kr 25 million/year. The scheme is fully automatic and remotely controlled from Salten Verk. Three people (2 engineers, 1 technician) are required to operate the scheme working normal day shifts. The generators have a 654 metre head pressure of water.

Furnace

Salten Verk consists of three Søderberg electrode system ferro-silicon electric furnaces. The total production is between 80-85,000 tonnes of 75% ferro-silicon per year.

Specification 75% Ferro-silicon

Si	70-80%
Al	max. 2%
P	max. 0.03%
S	traces

The three furnaces are:-

First	30 M.W.	Commissioned	1967
Second	33 M.W.	"	1970
Third	40 M.W.	"	May 1973

Electrodes

Elkem Spigerverket operate a major Søderberg electrode paste plant at the Fiskaa Verk silicon and ferro-silicon smelter near Kristiansand in southern Norway. This plant supplies most of Scandinavia with

electrodes. This is also the companies Research and Development centre.

Raw Material

Apart from the quartzite brought from Marnes the other ingredients required are:

a. Coal: This is mined in the far north near Hammerfest. Mining is underground and in the permafrost zone, hence no water problems in the mine.

b. Coke: Coke is supplied from two sources - the bulk, approximately 2/3, coming from Great Britain and the remaining 1/3 from Norwegian sources. Concern is held for the continuity of supply, especially from Great Britain, due to industrial disputes.

c. Wood Chips: The source is locally cut birch timber. Salten Verk has an on sight chipping plant and buys the logs at the works from a local association composed of farmers and seasonally employed people. The demand is for 20,000 tonne/year but currently 14-15,000 tonne/year is received. This lower value is sufficient to make do for the present.
No royalty is paid on the timber and no competition exists from other consumers in the area.

Employment

The total operation including the power plant & mine employs 230 people.

Wharf

Salten Verk has a single wharf 98 m long with dual parallel conveyor belts and bucket crane unloaders. This system allows two types of material to be unloaded at once from separate ships. The conveyor belts can discharge the material into either stock piles or the day hopper bins for the furnaces as desired. The wharf can accommodate

ships up to 10,000 tonnes. There are no ice problems.

Stockpile

At present the coke and coal is stored both under cover and in the open. Exposure of the reductants is not desirable because of the uncertainty of water content when fed to the furnace. Plans are in hand to cover all reductant stockpiles. Approximately 6 weeks supply of coke is stockpiled because of the uncertainty of supply.

The quartzite feed is re-screened before addition to the smelter so as to maintain the minimum sizing at +40 mm mesh.

Pollution Control

No firm pollution and emission controls are presently in force in Norway, however a governmental statement giving accepted emissions is expected soon. The main emission at Salten Verk is fine amorphous silica and CO_2. The Fiskaa Verk furnace has tried two methods of emission control. The first was an electrostatic filter fitted in 1965. This filter was not successful. The most effective method that controlled emissions to a large degree was found to be a bag filter fitted in 1971. The filtrate is pelletized and put to waste.

Alumina in Furnace Operation

The level of alumina is not detrimental in the actual furnace operation. Valves up to 1.6% and even 2% are tolerable. Alumina increases the power consumption of the furnace and hence reduces the operating efficiency. A silicon furnace is not an efficient method of reducing alumina to aluminium metal. It must be remembered that alumina is a component part of the reductants hence a high alumina silica feed narrows the choice of reductants available.

Feed

The feed to each furnace to produce 1 tonne of ferro-silicon is approximately :

800 kg - coke

500 kg - coal

1,900 kg	-	quartzite
200 kg	-	woodchips - (not always achieved due to shortage)

Future Plans for Salten Verk

Proposals have been submitted to the government for approval to build a fourth ferro-silicon furnace. This furnace would be similar to No. 3 furnace already in operation -40 MW capacity. It is intended to fit gas scrubbers and bag filters to control emissions.

Product

The ferro-silicon is crushed and screened for export. Packing is in bulk and standard pallet boxes. Shipments are in small (up to 800 tonnes), shallow draft barges. The small shipments enable easy delivery in the United Kingdom and German steel centres. These barges usually are back-loaded with coal & coke.

Works Manager:- Leif Kopperstad,
Elkem-Spigerverket a/s,
Salten Verk,
8226 Straumen, NORWAY.
Telephone:- (081) 41600

Geologist in charge:- Tor Söyland Hansen,
Sulitjelma Gruber a/s,
8230, SULITJELMA.

N O R W A Y

REPORT ON POINTS RAISED BY ELKEM - SPIGERVERKET a/s RE, CAPE SORELL QUARTZITE - WEST TASMANIA

BY: I.D. Picken
Oslo, Norway.

May 20th, 1974.

On Monday, May 20th, I discussed the Cape Sorell quartzite project with senior staff of ELKEM-SPIGERVERKET a/s in Oslo, Norway.

Elkem representatives being:

GUNNAR S. SEM	-	Director Special Projects (Ferro Alloys Division)
HANS - PETER GEIS	-	Chief Geologist (Mining Division)
ROALD YSTEBØ	-	Metallurgical Engineer (Engineering Division)

It is obvious that Elkem are keen to participate with Comalco in a metallic silicon operation based on Cape Sorell quartzite. Elkem have had no experience with a consortium type operation as proposed, and are currently considering the implications and our proposals. I am certain no meaningful decision will be considered until our current drilling and analysis programme is complete. Then more concrete plans will be considered.

Helpful advice was given on the direction our exploration programme should follow. The main points suggested are listed:-

1. Detailed stability tests (hot and cold) need to be undertaken on most (if not all) samples analysed. The tests should be by the method described in the report describing ELKEM'S earlier thermal stability tests on Cape Sorell quartzite in 1971. This test is important as Elkem have found by experience large variations from different sections of the same mine. These physical tests should not be completed on the same rock sample. Hence samples need to be sufficiently large to supply product for the various tests.

2. To relate the geological diamond drilling results to surface outcrop detailed surface sampling should be undertaken by shallow percussion drilling and blasting sample trenches along the drill lines. The trenches should be strip sampled over 1 metre sections and the quartzite analysed for impurities and physical strength as described in point 1.

3. Analysis should include Phosphorous (P) for at least some of the samples. In some quartzite deposits this impurity has considerable variations and is not desired in the metal.

4. Initial exploration should "PROVE" sufficient ore reserves to supply the proposed plant with quartzite for a minimum time to recoup capitalization costs of the plant. For each tonne of silicon metal produced, approximately 3 tonnes of quartzite is required for furnace feed. Hence for a 30,000 tonne/year silicon plant the mine should produce approximately 100,000 tonne of suitably sized furnace feed.

5. Elkem have found approximately one third of total mine product - quartzite - is sub-size and hence not suitable as furnace feed due to its fineness. The optimal furnace feed required is 90% plus, being +22 mm - 90 mm diameter.

6. The relatively "high" alumina content of the Cape Sorell quartzite is not considered seriously harmful. The alumina does not disrupt the smooth operation of the furnace. In the furnace the alumina is reduced to aluminium metal and alloyed with the silicon produced. This contamination would only be a problem when selling any surplus silicon metal to a non aluminium alloying consumer. e.g. during tough sales times when maybe it would be necessary to discount the sale price due to the aluminium impurity.

7. Analysis is generally by wet classical chemical methods. At present some ferro-silicon producers are investigating XRF analytical techniques on rock samples that are finely crushed and then briquetted into a disc for analysis. Crushing is completed in a tungsten carbide ring crusher (Siebe Technique).

8. We should aim to extract a trial shipment of 1-2,000 tonne of representative quartzite ore for bulk testing - preferably by Elkem at their smelter near Kristiansand, south-west from Oslo. This trial bulk testing should be undertaken as soon as possible - (preferably during the forthcoming southern summer). "The final test is in the tasting of the pudding!"

N O R W A Y

REPORT ON QUERIES ON CONSORTIUM PROPOSALS RAISED BY ELKEM-SPIGERVERKET A/S FOR CAPE SORELL QUARTZITE VENTURE

By: I. D. Picken 23rd May, 1974

1. Elkem-Spigerverket seem concerned at not being involved with the actual quartzite mining operation. They would prefer to be in on the development of the whole project - including the mining operation.

   The sale price of around A$18/tonne C.I.F. smelter, they felt was unrealistically high. One suggestion was that Comalco receive a royalty on quartzite mined and the smelter consortium own the quartzite mine.

2. Elkem-Spigerverket have not had experience with consortium ventures before and are investigating the implications.

3. The relative political stability of Australia and the promise of large quantities of electric power is considered encouraging.

4. A trial shipment of a suitable sample 1-2 000 tonne is desirable - preferably to one of Elkems smelters in Norway. This shipment should be large enough to run a furnace, similar to what we are considering, for about 1 month.

5. Assorted geological and technical people to visit Cape Sorell when our current exploration programme is complete. They are encouraged by the detail and type of work being undertaken by Comalco.

S P A I N

REPORT ON SILICON PRODUCTION AND POTENTIAL IN SPAIN

BY: I.D. PICKEN 3rd June 1974

Summary

Large areas of high grade massive quartzite rock of Cambrian to Lower Ordovican age exist in northern Spain. At present no known large scale development of this quartzite is underway or being planned. No systematic geological evaluation to determine the chemical purity has been undertaken although it is most probable that suitable quartzite for silicon metal manufacture could be located within this broad belt. Most of the suitable rocks potentially prospective for silicon grade quartzite are inland or a considerable distance from modern wharf facilities. It is possible for large reserves of silicon grade quartzite to exist near the coast but unlikely for it to be near a developed commercial port. Transport in Spain is expensive and there are indications that electric power allocations are increasingly difficult to obtain.

Introduction

Spain was visited between May 28th and June 3rd 1974. Discussions were held with:-

Mr Pedro Morata	Marketing Officer Australian Embassy, Madrid
Professor M. Julivert	Professor of Structural Geology Oviedo University, Oviedo
Mr Hans-Peter Schulz	Translator and International Commercial Relations Consultant, Oviedo

In Spain, and Portugal to a lesser degree, there are abundant Lower Ordovician aged sedimentary rocks widely distributed throughout the country. In this geological sequence beds and lenses of essentially massive and pure ortho-quartzite rocks exist.

Presently it is reported that 48 companies are actually engaged with mining operations in 11 Spanish provinces for silica (quartz and quartzite). In general these companies are small with very low capital investment.

Production of silica has been increasing and according to the Ministry of Industry the total production for 1973 was approximately 600 000 tonnes of which 115 199 tonnes were exported with a value of 42.801 million pesetas ($US 0.75 million). It should be noted that local consumption of silica is near 80% of the total production.

Two quartzite mines were individually visited.

Government policy and industrial development

Industry employs around 26 per cent of the total workforce and factories are considered to be working at satisfactory productive percentages. Foreign investment is significant with approximately 880 companies with a foreign majority control. Companies from USA predominate, followed by Canada, France, Germany and Switzerland.

While encouraging industrialisation the Government has taken advantage of the population density (approximately 35 million) to ensure decentralisation to the provinces. Incentives are granted to approved industries by way of reduced taxation, special credit terms and territorial privileges.

Spain is considered to be on the crest of an economic "boom" which suggests undercurrents of potential instability. Inflation is presently between 15 and 20 per cent and for some luxury items around 40%.

Geology

Discussions with Professor Julivert at Oviedo University in northern Spain, outlined the significance of the abundant

Cambrian to Lower Ordovician aged rocks that constitute much of the basic sedimentary rocks of Spain and Portugal. These sediments are generally steeply dipping, folded and faulted and strike NW-SE. Contained within this broad group are beds and lenses, often massive and large, of essentially pure medium to coarse grained ortho quartzite. This geological sequence is considered to be remarkably consistent in physical characteristics and mode of outcrop.

The sediments of this group have been subjected to mild metamorphism in the SE with the result that they are physically weak and hence relatively easily eroded. Metamorphism generally increases to the NW but not to any great extent. This mild metamorphic progression results in an increase in physical strength resulting in massive craggy outcrops.

Local variations are probable but the broad trend has been closely studied and mapped. The quartzite produced in Spain is based on this group of sediments. No geological investigations with regard to quartzite purity were known to have been undertaken. However, the ceramic industry analyses individual purchases and these analyses are considered reliable. No analytical register or production records are kept for public use but the quartzite produced at Arriondas (75 km east of Oviedo on the north coast) by Daniel Velasco Llano is reported to have the following composition:

SiO_2	98.7%
Al_2O_3	1 - 1.2%
Fe_2O_3	0.05 - 0.10%

While it is generally thought this analysis would be typical there most probably will be variations from this in certain areas - presently unknown.

The combination of low physical strength and relative high purity is exploited to produce the desired finely ground product presently produced. Bands of higher physical strength and well silicified ortho-quartzite exist with the softer material and would be suitable, I am sure, for furnace feed if of suitable chemical quality and enough could be separated.

The University knew of no large planned or producing commercial development of this ortho-quartzite for furnace feed.

The coarse grained nature of the quartzite and lack of extensive silicification makes the rock porous in places and this porosity has allowed iron rich solutions to be introduced along bedding and fracture planes.

Mining

Sedimentary quartzite and reef quartz is mined in Spain. Two quartzite mines were visited each considered important with regard to the Spanish industry. Inspection showed each mining operation to be very small, the larger of the two mines visited producing up to 20 000 tonnes/year of finely ground quartzite. In each mine the production is from outcropping steeply dipping high purity quartzite strata. Mining is open cut and consists of percussion drilling followed by blasting. The proper mining practice of bench development seems unknown. Virtually no geological or engineering practices are used or sought. No individual systematic exploration to prove the continuity of reserves is undertaken. The mines are generally small operations relying on local demand for continued production. The various companies have little financial backing and find major development beyond their financial means.

Beneficiation, treatment and uses

Where beneficiation is warranted it is by hand utilising cheap unskilled outlying village labour. In some cases and especially for quartz a water washing plant is used consisting of a vibrating screen under water jets.

The sorted silica is then usually ground via jaw crushers (iron faced), rollers and cylindrical autoginous grinding mills to the required mesh - usually -3 + 0.1 mm mesh.

The finely ground silica is generally used within Spain for porcelain manufacture and glazes, abrasives, casting sand, white cement, and refractories.

Mention was made of some demand for lump quartzite ore for furnace use near Bilbao on the north-east coast. This ore is presently supplied from small nearby deposits reportedly high in iron. Information regarding this furnace - possibly a ferrosilicon furnace - is being obtained by the Australian Embassy through Spanish contacts and will be forwarded to Melbourne when available.

Production costs

Costs in general vary depending on who you ask and no realistic figures are available. However petrol and diesoline fuels are exceptionally expensive.

Petrol (98 octane) is presently 20 pesetas/litre (US 35¢) and is shortly expected to rise to 25 or 27 pesetas/litre (US 44-45¢). Diesoline fuel is around 10-12 pesetas/litre

Labour is plentiful and wages are considered to be low with large variations depending on the area and job.

1st year medical graduate	-	12,500 Ptas/month ($US 220 per month)
Labourer - unskilled	-	10-15,000 Ptas/month ($US 175-260)
Skilled tradesman (Builder, plumber)	-	20,000+ Ptas/month ($US 350)
Mine personnel	-	15-20,000 Ptas/month ($US 260-350)

Inflation is currently around 15.2% with certain luxury items approaching 40%. The price of labour and basic commodities is generally considered to be escalating prices at an alarming rate.

The rapid increase in transportation costs resulting from high fuel prices is making production of silica for export almost prohibitive for those mines not near an export centre. The principal export ports on the north coast are Gijon and Bilbao, both with modern facilities and able to accommodate large capacity vessels. The quartzite mine visited at Arriondas on the north coast and reported being closest for infrastructure and approximating the required grade was 75 km distant from Gijon. The deposits from which feed is drawn for the reported furnace at Bilbao were not able to be visited for comparison. No information regarding Bilbao operations with regard to silicon - ferrosilicon ore production appears to be readily available. The Australian Embassy in Madrid is currently endeavouring to locate any relevant information on this area for Comalco and will forward it when available. The policy is to restrict the availability of commercial information which may be made available on special application to the Ministry of Industry.

Power

Spain has been developing extensive hydro electric power stations in the north-west to take advantage of the high rainfall in this mountainous area. The hydro electric development is being combined with the development of thermal power installations based on low grade black coal also in the north. The coal is mined using underground scraping methods developed in the United Kingdom and Yugoslavia. The coal is also used to produce coke for the local iron and steel industry centred at Aviles on the central north coast near Oviedo.

It is reported that the total hydro electric potential for Spain has been developed to about 75% of its capacity with at present small excesses of power being sold across the border to Portugal. The cost of thermal electric power is expected to escalate due to higher production costs of the coal resulting from wage increases.

Presently in Madrid there seems to be a tightening of the availability of power. Air conditioners are banned in the mornings, TV not permitted beyond 11 pm, display lighting discouraged and daylight saving introduced.

Currency

A decimal system with the base units being called Pesetas and Centimo (100 centimos to a peseta). The official exchange rate as at 30/5/74 is 57.34 pesetas to each U.S. dollar.

APPENDIX I

Mines visited in Spain

1. Company : Santos Tabernero Minerals
Poligono Industrial El Balconcillo
Ctra. Madrid - Barcelona Km 53
Guadalajara Spain

Area : Office/MiH, Guadalajara - 58 Km north-east of Madrid (4°45' W / 40°35'N)

Mine (major) 3 km south west from Veguillas - 50 km north of Guadalajara (3°05' W / 40°59' N)

Type of deposit

Steeply dipping well cemented and metamorphosed fine grained massive quartzite. The rock is highly fractured and light grey-blue in colour. The joints and fracture planes are iron stained. Some iron has penetrated the rock along grain boundaries. The strike is N-S and the resistant quartzite has resulted in the formation of a small oval plan rounded hill. The quartzite is bounded by grey highly sheared plyllites which are removed by hand during mining operations. The plyllites are relatively soft and have been eroded exposing the quartzite.

Size of deposit and grade

The mine is a small open cut mine and worked by two local labourers on a spasmodic basis. The strike length would approximate 300 metres and the width 60 metres. Assuming a mining depth of 40 metres and an SG of 2.5 gm/cc the reserves would be 1.8 million tonnes.

A second, much smaller, deposit of similar nature is reported approximately 25 km further north. These deposits are the only rocks of this type known in the area.

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Grade is reported as being

SiO_2	98.5 %
Fe_2O_3	0.22%
Al_2O_3	0.3 - 0.5%

Analyses are completed by porcelain manufacturers purchasing the silica.

Mining

The quartzite is mined from the deposit visited by open cut methods. The open cut is situated at the northern end of the hill and follows the quartzite along strike. The quartzite is drilled using a single compressor and two pneumatic drills followed by blasting with gelignite. No bench development in the open cut is evident.

The quartzite is hand carted and sorted into a stockpile using wheel barrows thence to the iron faced jaw crusher and assorted electrically-operated vibrating screens producing +5 cm product. Approximately 5-10% fines are produced by this initial crushing. The mine uses 240 V power from the national grid.

Processing

The fines generated in the initial crushing programme are sold for refractory purposes, building sand and minor local uses. The larger product is trucked to Guadalajara where it is further crushed in a jaw crusher, ground in a cylindrical autogenous mill and classified by cyclone into various mesh grades. The ground product is bagged and sold for abrasives, ceramic glazes, porcelain and white cement manufacture. Some unground quartzite is sold in Bilbao for export. High freight makes this type of sale increasingly difficult.

Tenement

The company has a mining lease for 20 years covering 40 hectares.

Production

The company is presently not producing from the quartzite mines but is buying quartz from small producers reported to be near Guadalajara. This material is iron stained and of poor quality. The company also produces quartz from one small mine some 150 km north east of Guadalajara.

Capital investment

The mining operation would be very low with the main costs being the compressor, drills and initial crushing plant - estimate less than $US 20,000. The milling plant in Guadalajara is more extensive with jaw crushers, conveyor belts, autogenous cylindrical mills, cyclones and bagging facilities. This I would estimate to be near $US 150,000.

Prices

The ground bagged product is sold locally at 700 pesetas/tonne ($US 12.30). Lump quartzite is sold at Valencia and Bilbao for around 1000 pesetas/tonne ($US 17.50). There is a minimal market for lump ore at present and fuel costs are likely to raise the costs greatly in the near future.

2. Company : Daniel Velasco Llano
Uria 17-9
Oviedo Spain
Phone: 21-82-53

Area : Approximately 4 km NE of Arriondas which is 65 km east of Oviedo ($5^{o}10'$ W, $43^{o}25'$ N)

Type of deposit

Based on the extensive Cambrian-Lower Ordovician aged sediments. A massive well bedded medium to coarse grained quartzite dipping to the north at 60-70° and striking approximately east-west. The quartzite has been mildly metamorphosed producing a rock of intermediate physical strength. In the mine area the quartzite is banded with hard and soft layers, the majority of layers being relatively soft. The quartzite outcrops in a large rounded hill flanked by impure limestone.

Size of deposit and grade

The mine is a large open cut operation worked by 5-8 people living locally. The quartzite is massive and the strike would average 1000 metres, width 100 metres and the height above plain level 50 metres. Assuming an SG of 2.5 gm/cc the reserves in this deposit would be 10-12 million tonnes.

The grade is reported to be

SiO_2	98.7 %
Al_2O_3	1 - 1.2%
Fe_2O_3	0.05 - 0.1 %

Analysis is undertaken by purchasers of the mine product - mainly ceramic manufacturers whose analyses are considered accurate.

Reserves of similar grade material in this area would be huge. Some quartzite nearby appears to be contaminated with iron staining percolating along the grain boundaries. The degree and extent of this iron contamination is unknown for at the mine it appears only a surface phenomenon in the top two or three metres.

Mining

The quartzite is mined by open cut methods with no mining benches established. The rock is drilled with pneumatic drills each morning and fired with gelignite by electric detonators. The mined ore is carted by front end loader to the crushing and grinding plant some 20-30 metres from the open cut face.

Processing

No upgrading or beneficiation is necessary of the mined quartzite. The limestone contact is avoided when mining. The quartzite is fed through a jaw crusher (iron faced), roller mills and then screened to various mesh grades ranging down from around 4 cm diameter. The sorted product is stored in hoppers for sale and transport.

Tenement

The mine area is covered by a 40 hectare mining lease current for 20 years and automatically renewable on expiry.

Capital investment

The main investment with regard to the mine is the compressors, 1 electric and 1 diesel, front end loader and pneumatic drills. The milling/crushing plant is well set out and comprised of new equipment seemingly well maintained. I estimate the total investment at around $US 120,000.

Production

Stated to be near 20,000 tonnes/year and the capacity of the crushing and screening plant as being 50 tonnes/day maximum depending on demand. The product is transported in 16-18 tonne loads to various purchasers in northern Spain.

Prices

The crushed product is sold ex-mine for around 100 pesetas/tonne ($US 1.75). This sounds far too low.

Trucking costs are on an hourly basis at 500 pesetas ($US 8.70). The return trip is considered for cost purposes plus loading and unloading time. The maximum trucking load is 16 tonnes on feeder roads and 25 tonnes on principal highways. The distance to the port of Gijon near Oviedo is 75 km on a good sealed road. The estimated travel time both ways would be around 3-4 hours plus loading and unloading.

P O R T U G A L

REPORT ON HIGH PURITY SILICA POTENTIAL FOR METALLIC SILICON PRODUCTION

BY: I.D. Picken 8th June 1974

Summary

All silica ore produced in Portugal is from reef quartz and not quartzite. There are large reserves of high grade reef quartz in and around the granite NE of Porto and in eastern central Portugal. Production is from many small pods and blows and reefs, economic due only to cheap labour. In 1973 there were 73 active producers mining approximately 137,000 tonnes for export. There is the possibility of metallic silicon grade quartzite lenses but the minimum Al_2O_3 reported was 0.5 per cent and mostly plus 1 per cent.

The Government presently favours the allocation of all necessary power to industries proposing to process local raw materials. There is some hydro power still being developed but supplementary atomic power is expected by 1981.

At present there is no metallic silicon produced in Portugal. CPFE are planning to have one 25 KVA metallic silicon furnace in production by mid-1975. Milnorte have ordered two 28 KVA Demag furnaces with the option on a further two of the same size.

Pechiney are considering a ferro-chrome/manganese smelting operation based on reef quartz and impure quartzite at Setubal south of Lisbon.

Introduction

Portugal was visited between 3rd June and 8th June 1974 and discussions were held in Lisbon with:

The Australian Embassy
Chamber of Commerce
Mines Department
Electricity Department
Companhia Portugesa de Fornos Electricos

and in Porto with: Milnorte

CPFE's principal quartz mine at Viesu and ferro-silicon smelter at Nelas were visited and photographed.

Portugal is a country with virtually no mineral resources and a serious trade deficit presently balanced by migrants' remittances from abroad and tourism. To help bridge the trade deficit the Government is keen to develop any industry that processes local raw materials, especially if they produce an export income. Such industries are given Government priority.

Portugal does have substantial reef quartz reserves associated with the granitic masses in the north and to a lesser extent inland east of Lisbon. At present all silica for export and local consumption is produced from these quartz reef reserves. No systematic evaluation or analyses of the quartzite extending into Portugal from Spain has been undertaken.

The 1973 production of silica consisting entirely of reef quartz and not quartzite was 163 325 tonnes of which 137 972 tonnes were exported with a value of $US 1.48 million. This silica was produced from 72 active concessions in 9 different districts. The individual mines are small and the ore is transported by road to various consumers and export centres.

At present no silicon metal is produced but plans are well advanced to build three furnaces in the north at Nelas and Resende with rated capacities of 2 x 28 KVA and 1 x 25 KVA.

Of the silica exported in 1972 73% went to Norway and Italy. The Italian imports were used exclusively for ceramics and the Norwegian imports for silicon and ferro-silicon manufacture. A detailed breakdown of exports is attached in Appendix 1.

Geology

Numerous intrusions of Upper Proterozoic granite constitute approximately the northern one-third of Portugal and also the eastern part of the central zone inland from Lisbon. These granitic masses have many associated quartz reefs and it is from these reefs that Portugal's high quality silica is produced. Reserves of extractable silica from these quartz reefs are considered large by the Portuguese Mines Department. No silica production is based on quartzite rock.

The individual quartz mines are all considered to be small and rarely directly employ more than 10 workers. The larger, more continuous quartz reefs are from 10-20 metres in width but are highly fractured and have iron values generally in the order of 0.5 to 1+% Fe_2O_3.

The high quality quartz suitable for silicon metal production and optics is mined from small Poddie discontinuous quartz blows and reefs, often in association with feldspar but each with sharp contacts. These small pods generally range from 5-10 metres in width and 60-200 metres in length. Extensive hand-sorting and washing is required to produce a top quality product. No detailed analytical results are available for the product from the various mines.

In portugal there are several discontinuous quartzite lenses striking NW-SE passing through the central part of the country from Spain. This quartzite was examined near Coimbra and Aviero. The quartzite near Coimbra at a point 5 km north of Penecova is massive, well bedded, vertically dipping and jointed. The individual beds range in thickness up to 1 metre, but the grade various considerably. In the more pure beds there is minor iron but considerable alumina. A sample from one of the more pure beds had the following analysis:

Portugal: 03.

Al_2O_3	1.256 %
Fe_2O_3	0.114 %
MgO	0.025 %
Na_2O	+0.05%
TiO_2	0.818 %
MnO	+0.002 %
Ca O	+0.005 %

SiO_2 Available by difference.
LOI^2 Not determined.

The Director of Industrial Minerals at the Mines Department in Lisbon indicated that the quartzite was known to assay 0.5% Al_2O_3 in places near the Spanish border east of Lisbon but was in small discontinuous lenses and used presently for road screenings. No consideration had yet been given to possible smelting of this material.

The quartzite near Aviero is highly fractured and iron-stained and not considered suitable for silicon metal manufacture.

Mining

The quartz is mined by drilling and blasting mainly from small pits and open-cuts. Rarely does mining proceed underground. In all operations the ore is sorted by eye and in the larger mines some mechanisation is used to further crush, wash and screen the silica. Equipment such as compressors, jack hammers, small front end loaders, vibrating screens and conveyor belts are usual in the larger mines. The small mines rely almost toally on hand labour.

The sorted and washed ore is trucked in loads up to 35 tonnes to the export centre or point of use within Portugal. Haulage distances up to 180 km are considered reasonable and economic by the producers.

Portugal in general

After the Portuguese Revolution on April 25th 1974 all previously established policy, procedures and plans are in doubt and turmoil. The revolution is not expected to change the over-all development situation greatly in the long term. Costs are expected to increase greatly due to labour cost increases. It is expected the cost increases will curtail certain low profit business activities and some planned ventures relying on cheap establishment costs. The Australian Ambassador in Lisbon considered that Portugal would pull through the current crisis in 6-12 months time and then forge ahead strongly.

Power

Hydro electric power was virtually fully developed in Portugal by 1960 and a similar plan completed in Spain around the same period. Spain has had a larger area to develop and also developed some rivers originating in Spain but flowing into Portugal. There is agreement for sharing power produced from such joint river development schemes.

At present with the large increase in the cost of fuel oil more difficult dam sites are becoming economic. Presently hydro schemes are being built on the Rio Douro inland from Porto and the Rio Mondego near Penecova in northern Portugal. A further two dams are planned for the Rio Douro upstream from Resende. The dams will each be able to generate around 100 kW/hr and are expected to be completed by 1981. There is room for further similar size dams in the north which will be built by the Government gradually.

Portugal possesses virtually no coal. The only deposit being a small 25-30 million tonne deposit of anthracite SE of Porto near Corga. The coal is mined from 3-400 metres underground from an inclined ore body and reported to have around 30% ash due to the thin laminae of shale intermixed with the coal. Present production is 600 000 tonnes/year and this is used solely for electricity generation in Porto.

The consumption of fuel/fuel oil in Portugal is 5 million tonnes per year and none is locally produced. The"Portuguese province" of Angola in 1973 produced 9 million tonnes of oil. The possession of this province before April 25th assured Portugal of fuel supplies. However the present situation is uncertain.

Before April 25th plans were being considered to develop a large petrochemical and refining complex at Sines, about 100 km south of Lisbon based on Angola crude. Sines is an arid desert area presently with no agriculture and little labour. If a refining complex were to eventuate no doubt large scale industry would also follow based on oil-fired furnaces for power. At present the venture has been postponed due to steep costescalation and the uncertainty of oil supply.

To supplement the power shortage it is planned to build a nuclear power station in the Lisbon area to be operational by October 1981. This nuclear power station would use Portuguese fuel enriched overseas.

Ship building

Lisbon presently has one of the largest dockyards in the world, the Lisnave Dock Yards in Lisbon are able to take super tankers up to 1 million tonnes, the largest to date being a tanker of 3/4 million tonnes for a refit. In general the Portuguese build the hull locally then tow this to Sweden for the fitting of the motors and aftermath.

A second large scale dockyard is presently being considered for Setubal on the Rio Sado, about 30 km south of Lisbon.

Trade and economy

The annual per capita income for 1970 was $US 717 and the GNP for 1971 was $US 6.9 billion with a real increase of 4.9% over 1970. The 1970 workforce of 3,030,000 was employed as follows:

	% of workforce	% of contribution to GNP
Industry	35.7	44.0
Agriculture	33.0	17.3
Other	32.2	7.5

The main export income is from the sale of services and goods mainly textiles, food and beverages. Portugal is unable to balance the account and to help build up gold and foreign exchange the country relies heavily on remittances from an estimated 2 million Portuguese migrants working abroad and the spending by approximately 4 million tourists each year.

The rate of inflation is high and officially was 30% for 1973 and at present considered to be around 40%.

Wages were low before April 25th but now are increasing at alarming rates. Many businesses have shut down and at present large question marks hang over the future of big business and long term finance. Wages have been temporarily fixed to a maximum of 7500 escudos/month ($US 302) from a pre-April 25th minimum of 3300 escudos/month ($US 133). As a result of the new maximum wage every worker wants to be on it, hence the economic chaos presently experienced.

The steel industry negotiated a new award after April 25th and in addition to wage rises and a bonus a clause was inserted stating that any future wage rises would be fixed to the productivity of the industry. It is thought that this may follow through to other industries.

It is generally the opinion of all that up until the revolution the employers had it far too easy with regard to wages and labour.

Income tax is low although plans to introduce a sliding scale system are presently being considered.

Fuel

At present fuel is considered expensive in Portugal.

Petrol:	11 esc/litre ($US 0.48)	Super 95 octane
	9.5 Esc/litre ($US 0.41)	85 octane
Diesel:	3.4 esc/litre ($US 0.15)	Dieseline

Area and population

Portugal is a republic situated on the Atlantic side of the Iberian Peninsula. The population in 1972 was 8.7 million (excluding overseas territories). The principal cities are Lisbon (1 million) and Porto (310,000). In addition to the present inhabitants several million Portuguese live and work overseas as temporary or permanent emigrants.

Portugal is less than half the size of Victoria and Lisbon is close to the same latitude with respect to the equator as Melbourne.

The currency

The basic unit is the escudo which is made up of 100 centavos. A "conto" is 1000 escudos.

The official exchange rate on 3.6.74 was 24.726 escudos = $US 1.00

Ferro chrome/ferro manganese proposal

It was mentioned that the French aluminium group Pechiney were considering a ferro chrome/manganese smelter at Setubal about 30 km south of Lisbon. This operation would be based on locally fired oil power and small discontinuous reef quartz and impure quartzite from the east of central Portugal near Evora.

Companies intending to produce silicon metal.

1. CPFE - Companhia Portuguesa de Fornos Electricos

Address - Lerjo de S Cerlos 4
Floor 1-4
Lisbon

Met - Mr Francisco Geraldes
(Marketing Manager)

CPFE are presently producing 75% grade ferrosilicon from their one 20 MW furnace 3 km south of Nelas approximately 100 km SE of Porto ($7^{o}55'$ W, $40^{o}40'$ N). This furnace is old and currently working at around the efficiency or output of a 14 MW furnace.

The company is presently building two 25 KVA furnaces at Nelas. The first is due to be completed in March 1975 and will produce metallic silicon metal. The second furnace is due to be completed in late 1975 and will produce 90 and 75% ferrosilicon metal.

All sales of silicon metal are stated at being fully committed and the agents for distribution are Associated Metals of New York.

CPFE could not see the potential of further expansion due to the lack of electric power allocation. It was considered unlikely that silicon grade quartz exportation would continue to expand since the Portuguese were keen to protect their raw materials and in turn the local industry. They saw the silicon grade quartz reserves as being large.

The present ferrosilicon operation is run in conjunction with a calcium carbide and pig-iron works at Nelas. The quartz is mined from company-owned mines based on reef quartz.

The quartz is won from shallow pits and small open cuts by drilling and blasting. The quartz is hand-graded, crushed, sorted and then trucked in 25 tonne loads to the smelter for refining. In general the quartz veins are from 10-30 metres wide and production is presently stated at around 30 000 tonnes/year.

Silica ore is also purchased from many small operators in the district delivering their product to the smelter gate.

CPFE's main quartz mine NE of Viseu at Mount de Sta Luzia was visited and photographed. The quartz forms a small hill and varies from being clear to milky in colour, most is highly fractured and some is considerably iron-stained.

The hill has formed due to the resistant nature of the quartz relative to the surrounding granite. The total reserves would be limited to around 2 million tonnes. The overall quality and percentage of silicon grade material is unknown.

CPFE are reported to have many production problems due to the limited resources of the "bitty" partners involved in the project to date and the lack of suitable finance and expertise.

2. Milnorte - Metalurgia do Norte Sarl

Address - 2nd Floor
Rua Azevedo Cout Inho 39
Porto
Portugal

Met - Cesar - Machado (Administrating Director)

Milnorte is an electrometallurgical company based in Porto (316 km N of Lisbon) and was formed in August 1973. The company plans to develop a silica/silicon industry in Portugal and to reactivate the small, presently defunct, pig-iron smelter at Vila Real based on scrap iron and small volumes of iron ore. The company plans to build 2 x 28 KVA metallic silicon Demag furnaces at Resende on the Rio Douro approximately 60 km by very windy road east of Porto. The company has an option, expiring in July 1974, for a further 2 x 28 KVA Demag furnace. If this option were exercised a total of 4 x 28 KVA furnaces would be established at Resende.

The power would be drawn from a new hydro electric dam just completed upstream from the smelter site. The present power allocation is 100 MW with a further 100 MW if the other two furnace options are accepted.

Monteforno Valmoesa of Switzerland are supplying all the expertise and buying all Milnorte production for the first five years at the silicon producers ruling price. Monteforno will be the marketing agents for any metal produced for sale.

Milnorte presently control several quartz producing companies in northern Portugal from which Norway's high quality silicon grade quartz is supplied. The mines are reported as being of a similar size to the CPFE mine at Mount de Sta Luzia near Viesu. The principal mining

centres are near Vila Real and to the north and east. These mines would supply the Resende smelter.

The quartz is mined by drilling and blasting followed by hand-sorting then trucking in 30-40 tonne loads to the export centre of Leixões which is the outer export harbour of Porto and presently able to take 15 000 tonne ships. No expansion plans are being considered for this principal northern export centre for the present.

Employment

Milnorte employs approximately 100 people, 20 in the Porto head office and a further 80 in the field.

The average mine worker is presently paid 4000 esc/month ($US 162) and Milnorte consider the upper break-even point at around 8300 esc/month ($US 337). The average production per man is 12 tonnes of quartz per day with a working week consisting of 6 days of 8 hours each.

Road transport

Haulage distances of up to 180 km are considered economic.

Technical assistance - Milnorte

Monteforno Valmoesa
6354 San Vittora Grigioni
Switzerland
P.O. Box 5
Phone: (092) 254441-4
Contact: Dr Renzo Ferrari
Dr Peter Kallfelz

Reported silent backer - Milnorte

Banco Portugues Do Atlantico
110 Rua Ouro L1
Lisbon, Portugal

Points mentioned by Milnorte re Other Companies:

Elkem-Spigerverket

The Norwegian Government has recently ruled that the long term bulk power contracts given to Elkem are invalid. The cost of power delivered to the Kristiansand smelter in southern Norway is likely to be increased 4 or 5 times in the near future.

Canada

A consortium with the large German Hutt Chemical Corporation was signed to build 3 x 30 KVA silicon furnaces.

Pechiney

Virtually finished as a silicon producer in France due to pollution controls and recent power cost increases. Also their operation in Portugal may come under fire as the previous Government granted them power concessions in return for helicopters for use in Africa. The new Government may use political pressure to remove the French Company.

APPENDIX 1 Portuguese Silica Production

I. Production and value Ex-mine 1972-73

Year	Tonnes	Value $US (Million)	$US/tonne
1972	169 769	1.09	6.39
1973	163 325	1.17	7.13

II. Production for various districts 1973

District	Production Tonnes	Production '000 $US	Concessions * Total	Concessions * Active
Braga	32 721	249.7	49	27
Bragança	-	-	1	-
Coimbra	-	-	3	-
Évora	31 474	249.8	4	2
Guarda	2 021	11.6	17	7
Porto	8 115	69.4	15	8
Viana do Castelo	52 768	404.5	20	11
Vila Real	8 632	52.3	14	9
Viseu	27 594	134.2	29	8
TOTAL	163 325	1171.5	152	72

* Some also produce feldspar

III. Production and value for exportation 1972-73

Year	Tonnes	Value $US (Million)	$US/tonne *
1972	130 914	1.37	10.48
1973	136 972	1.48	10.83

* prices are average FOB port of shipment

It should be noted that the figures for 1973 are based on requests from the Mines Department for production. In general the actual value of exploitation effected is less than those indicated.

IV. Main producers for 1973

Silipor, Sílica Mineira Portuguesa, S.A.R.L. - 2 minas cativas (43 894 t)

A.J. da Fonsena, Lda - 16 minas cativas (23 075 t)

Compa.Portuguesa de Fornos Elécritos S.A.R.L. - 3 minas cativas (23 068 t)

Quartzofel - Sociedade Mineira de Feldsparto a Quartzo, Lda - 1 mina cativa (19 388 t)

Quartex, Sociedade Mineira do Alentejo Lda. - 1 mina cativa (12 086 t)

Sociedade Mineira da Gandarela, Lda. - 4 minas cativas (7 500 t)

João Cerqueira Antunes - 5 minas cativas (5 486 t)

Sociedade Mineira da Tapada, Lda - 2 minas cativas (4 931 t)

Ernesto Ribeiro da Cunha - 3 minas cativas (3 118 t)

Sociedade Mineira de Covide, Lda - 2 minas cativas (3 050 t)

Marques e Carvalho, Lda	- 1 minas cativas (3 000 t)
Pacheco, Marques Gomes e Barreto, Lda	- 4 minas cativas (2 372 t)

In addition to the above main producers there were 17 other producers. The two companies Joao Carqueira Antunes and Ernesto Ribeiro da Cunha combined at the end of 1973 to form a company named Uniquartzo (Union of Producers of Quartz and Feldspar Limited).

V. Countries importing Portuguese silica 1972

Country	Tonnes	Value ('000 $US)
Angola	31.6	0.57
Germany (Federal Republic)	2 055.2	69.60
Belgium/Luxembourg	1 092.3	39.00
France	322.0	4.61
Holland	40.0	0.91
Italy	39 612.0	403.22
Finland	50.0	2.00
Norway	55 966.0	539.00
United Kingdom	2 341.1	61.52
Sweden	29 237.0	245.91
Ireland	116.9	5.17
TOTAL	130 914	1,371.5

APPENDIX II — People met

The Australian Embassy:

Address:	Avda Da Liberdade 244 Fourth Floor LISBON PORTUGAL
Phone:	539108, 539109
Office hours:	09.00 to 1300 hours 15.00 to 1900 hours

Mr Kevin T. Kelly	Australian Ambassador
Mr Robert McKay Sim	Third Secretary
Mrs Obneyor	Senior Interpretor

Mines Department

Map Sales:	Academy of Sciences Rua Academia Ciências 19 Second Floor Lisbon, Portugal
Director:	Rua António Emes 5-7 Fifth Floor LISBON PORTUGAL

Director General of Mines and Geological Services:
Mr Limpo Faria

Electricity Department

Address:	Ave Fontes Pereira de Melo 26 Second Floor LISBON, PORTUGAL
Mrs Guida Lamy	Director of Tariffs and Costs
Miss R. Maria	Engineer - certifying various projects

CPFE - Companhia Portuguesa de Fornos Electricos

Address:	Lerjo de S Cerlos 4 First to fourth floor LISBON, PORTUGAL
Phone:	36 5555
Met:	Mr Francisco G. Geraldes, Marketing Manager

Milnorte - Metalurgica do Norte S.A.R.L.

Address:	Rua Azevedo Cout inho 39 Second Floor PORTO,PORTUGAL
Phone:	65 2478 and 69 2518
Plant:	In Campião Cerdoeira Vila Real Portugal
Phone:	97200 and 97201
Met:	Duarte N. De Castro C. Machado Administrating Director

Fredauto Automoveis de Turismo

Address:	Av. Ressano Garcia 36-E LISBON PORTUGAL
Phone:	55 3700 and 539202
Mr Paul Resende	Driver and Interpreter

V E N E Z U E L A

REPORT ON SILICA AND SILICON PRODUCTION IN VENEZUELA

BY: I.D. PICKEN

Summary:
No silicon metal is produced or contemplated being produced in Venezuela. At present low grade reef quartz is mined from small discontinuous veins for smelting into ferro-silicon which is used in the steel industry.
High purity silica sand is used to produce silicon carbide. Some of the sand is also used for casting purposes.

Introduction:
The Republic of Venezuela was visited between 10th and 13th June 1974. Discussions were held in Port of Spain, Trinidad with the Australian Trade Commissioner responsible for Venezuela and in Caracas with the Mines Department, Corporation Venezolana de Guayana and a private mineral prospector.
No silicon metal is produced in Venezuela or its production being contemplated. One company Hornos Electricos de Venezuela S.A., Hevensa, in 1973, completed Stage I of a 24,000 tonne/year ferro-silicon smelter. Silica feed for the furnace is mined in the Oronoco-Caroni river area in the Guayana region in eastern Venezuela. The Guayana is a new development area 450-miles east of Caracas that is extremely rich in natural resources. A major industrial complex is being developed by the government based to a large extent on the huge hydro electric potential of the region. To accommodate the people associated with this development a city named Ciudad Guayana has been built.

Geology:

No large reserves of high purity quartzite are known in Venezuela. There are three known deposits of wind-sorted sand which is suitable for glass manufacture at Aguidi and Trujillo in the north-west and near Temblador in the east. The analysis of this sand varies. One of the more pure sand samples at Aguidi has the following analysis:

SiO_2	99.31	
Al_2O_3	0.21	
Fe_2O_3	0.049	Sample: A51

The silica for ferro-silicon manufacture is mined from many small widely scattered quartz reefs in the Oronoco-Caroni river confluence area in eastern Venezuela. The individual deposits are reported to range between .4 and 3-million tonnes and have a varying analysis, all high in iron. The alumina is giving concern with minimum values around 0.5% Al_2O_3 and generally +1%. No silica suitable for silicon metal production is known in Venezuela.

Current & Potential Ferro-Alloy Producers:

Corporation Venezolana de Guayana:

CVG was formed on December 29th 1960 as a public agency to develop the Guayana region in eastern Venezuela. The region occupies the south-eastern part of the country 450-miles from Caracas and extends from the Oronoco river to the borders of Brazil and Guyana. The area is rich in high grade iron ore and the potential for hydro electric power is around 10-million kw. The Caroni river drains an area of 37,000-square miles with an average flow of 175,000-cu. secs. A drop of 787-feet in the last 130-miles of its course allows the potential production of this hugh power out-put. To facilitate regional development a new city was created and is known as Ciudad Guayana. This city is the centre of technical, administrative, professional and specialized man-power necessary for the success of the programme.

CVG are presently producing through their steel company Siderugical del Orinoco (Sidor) 1.2-million tonnes of steel/year. It is planned to increase this out-put to 4.5-million tonnes. Both billet and direct casting type production is being contemplated. To supply the steel industry with ferro-silicon metal CVG are investigating the costs of installing 2 x 28 KVA ferro-silicon furnaces with an out-put of 50,000 tonnes/year. This plant would be established at Ciudad Guayana. To supply the proposed ferro-silicon smelter CVG is investigating 8-quartz reef deposits all widely scattered in the Oronoco-Caroni river area. The deposits are between 60 and 150 km. from Ciudad Guayana and the individual reserves for each deposit range between 0.4 and 3-million tonnes. The iron content is reported as being high but the alumina is giving CVG some concern as the lower values are near 0.5% Al_2O_3 and generally plus 1%. The deposits are on private land where royalties to the individual landholders are due. The royalties contemplated are 2.0 bolivars ($US 0.47) per tonne mined plus an initial payment of around 100,000 bolivars ($US 23,500).

Hornos Electricos de Venezuela S.A.,Hevensa

Edificio Galipan A-1-A
Ave FCO Miranda
Caracas, Venezuela

Phone: 33 2620

President: Pedro Marquez

(20% Sumitomo shareholding)

HEV is reported to be the only ferro-silicon producer in Venezuela and was not visited because of the relationship with Sumitomo. This company completed Stage I of a 24,000 tonne/year ferro silicon smelter at Ciudad Guayana in 1973. The initial stage is reported to have an annual out-put of 4,500 tonnes of ferro-silicon and employing 61 persons with a total investment

of 3-million bolivar ($US 0.7 million) Stage II is expected to be completed in late 1974 after a further investment of 15-million boliver ($US 3.5 million). Total employment of the finished smelter will be around 122-persons.

Currency:

In Venezuela the Bolivar is the monetary unit. The official exchange rate on 2.7.74 was 4.34 Bolivars to $US1:00.

APPENDIX 1:

Oficina de Mineria
"Luis Baez"
Ave Londres
QTA Negelma
La California Norte
Caracas - Venezuela

or
Apartado (P.O. Box 50.555)

On Wednesday 12th June 1974 I met with Dr Notario representing Mr Luis Baez who was overseas at the time of my visit.
The company has a small reef quartz prospect and a high purity sand prospect near the Oronoco-Caroni river confluence in "The Guayana".
The reef quartz prospect was reported to consist of two primary quartz reefs, the larger reef varying up to 7-metres in width and a strike length of 2-km. The reef was reported to be inclined at around 40-50°.
Analysis was unknown but samples produced were lightly iron stained and coated with minor clay indicating that any ore produced for silicon metal production would need washing.
The second reef was reported to be nearby but smaller in extent.
The total reserves were stated at 3-million tonnes but this figure would vary on depth mined. For a body mined to 100-metres averaging 5-metres in width and a strike of 2-km., and assuming a specific gravity of 2.5 gm/cc. the reserves with 100% recovery would be 2.5 million tonnes.
The quartz was reported to be approximately 130-km south of the Ciudad Bolivar township by fair unsealed roads. The ore would have to be transported in loads of up to 100-tonnes to the smelter site - most probably near Ciudad Bolivar.

APPENDIX 1 (Contd.

The deposit has been drilled with 2-BQ diameter holes intersecting the quartz reef at a reported depth of 50-feet below ground level.

Foote Mineral Company of the United States investigated the prospect some 12-months ago. Foote were reported by Mr Notario to be still interested although they have not made any firm proposals since their initial visit.

The sand deposit was reported to be approximately 110-km north of the Oronoco river and to have SiO_2 values of up to 99.85% after extensive water washing and screening. The washed sand was reported as being +10 -100 mesh in size. The washed sand is trucked to Cuidad Bolivar in 30-tonne loads then barged across the Oronoco river before being delivered to various companies for use in silicon carbide production and use as casting sand. The total reserves of sand was unknown.

APPENDIX 2

PEOPLE MET:

1) AUSTRALIAN EMBASSY

Mr J.S. Nicholls Trade Commissioner

Address: Colonial Building
72-74 South Quay
Port of Spain
(P.O. Box 642)
TRINIDAD W1

Phone: 62-32536, 62-31478

2) MINES DEPARTMENT

Mr A. Bellizzia Director Geological Surveyor

Address: Division De Exploraciones
PISO 19
Caracas, Venezuela

Mr Jean Pasquali Economic Geologist

Address: Division of Geologia Economica
Reducto a Miracielos No. 10-15
Caracas, Venezuela

3) CORPORATION VENEZOLANA DE GUAYANA

Mr Oscar R De Rojas Secretary to President
Mr Ricardo E. Palacios "
Mr Gregor Deratimiroff Chief Geologist

Address: 13th Floor
Shell Building
Caracas, Venezuela

or Apartado 7000
Caracas, Venezuela

Phone: 91 3444

APPENDIX 2 (Contd.)

4) OFICINA DE MINERIA "LUIS BAEZ"

Dr D. Notario (Rep:- Mr L. Baez)

Address: Ave Londres
Qta Negelma
La California Norte
Caracas, Venezuela

of Apartado 50.555
Caracas (105)

586078

E.L. 1/71 CAPE SORELL

A.C.I. Technical Centre Pty. Ltd.

813 Dowling Street, Waterloo, N.S.W., 2017
Postal Address: Box 1, P.O., Waterloo, 2017
Telephone: 690455
Cables & Telegrams: "Carboy" Sydney

19 June 74

Mr. G. Weste,
Exploration Department,
Comalco Limited,
Box 27734, G.P.O.,
MELBOURNE...VICTORIA. 3001

Dear Sir,

Please find attached results of analyses of thirty two quartzites, carried out by X-ray Fluorescence, together with loss-on-ignition at 1000°C. SiO_2 figures are by balance.

Yours faithfully,

D. MacKENZIE,
SECTION LEADER,
SPECTROGRAPHY SECTION

078

586079

A.C.I. Technical Centre Pty. Ltd.

813 Dowling Street, Waterloo, N.S.W., 2017
Postal Address: Box 1, P.O., Waterloo, 2017
Telephone: 690455
Cables & Telegrams: "Carboy" Sydney

19 June 74

COMALCO GROUND QUARTZITE

Sample No:	% Fe_2O_3	% Al_2O_3	% TiO_2	% Cr_2O_3	% CaO	% MgO	% Na_2O	% K_2O	% LOI	% SiO_2 by balance
4A/03	0.13	1.2	0.077	0.001	<0.01	0.22	0.05	0.10	0.44	97.8
4A/05	0.40	1.2	0.13	0.002	0.01	0.36	0.06	0.01	0.22	97.8
4A/06	0.15	0.59	0.081	0.001	<0.01	0.16	0.03	0.06	0.16	98.9
4A/07	0.34	1.3	0.22	0.001	0.01	0.43	0.10	0.05	0.33	97.2
13	0.16	1.3	0.074	0.002	<0.01	0.33	0.03	0.12	0.20	97.8
15	0.028	0.63	0.030	<0.001	<0.01	0.07	<0.01	0.11	0.11	99.0
16	0.053	3.1	0.12	0.002	<0.01	0.25	0.01	0.35	0.48	95.6
20	0.022	0.78	0.088	<0.001	<0.01	0.16	0.02	0.11	0.24	98.6
21	0.024	0.54	0.027	0.001	<0.01	0.14	0.01	0.09	0.18	99.0
22	0.077	0.58	0.056	<0.001	<0.01	0.10	0.01	0.04	0.24	98.9
23	0.012	0.55	0.030	0.001	<0.01	0.08	0.01	0.07	0.38	98.9
24	0.017	0.53	0.018	<0.001	<0.01	0.06	<0.01	0.04	0.42	98.9
28	0.048	1.9	0.063	<0.001	<0.01	0.21	0.01	0.18	0.37	97.2
30	0.044	2.4	0.11	0.001	<0.01	0.26	<0.01	0.25	0.46	96.5
31	0.075	1.1	0.065	0.001	<0.01	0.16	0.01	0.12	0.25	98.2
32	0.035	1.2	0.056	<0.001	<0.01	0.15	<0.01	0.15	0.23	98.2
33	0.019	1.8	0.063	<0.001	<0.01	0.16	<0.01	0.22	0.27	97.5
34	0.070	2.6	0.063	0.001	0.01	0.34	0.01	0.25	1.65	95.0
35	0.026	1.8	0.069	<0.001	<0.01	0.22	0.01	0.19	1.13	96.5
36	0.12	1.1	0.026	<0.001	<0.01	0.22	0.02	0.08	0.79	97.6
37	0.028	2.4	0.098	0.001	<0.01	0.27	0.01	0.23	0.56	96.4
38	0.026	2.2	0.044	<0.001	<0.01	0.09	0.02	0.05	0.90	96.7
44	0.024	1.9	0.050	0.001	0.01	0.25	<0.01	0.12	1.51	96.1
47	0.050	1.5	0.061	0.001	<0.01	0.23	0.01	0.12	0.61	97.4
53	0.034	1.3	0.042	<0.001	<0.01	0.25	<0.01	0.15	0.36	97.9
55	0.14	1.3	0.035	0.001	<0.01	0.24	0.01	0.13	0.37	97.8
62	0.026	1.4	0.033	0.001	<0.01	0.15	<0.01	0.14	0.33	97.9

A.C.I. Technical Centre Pty. Ltd.

813 Dowling Street, Waterloo, N.S.W., 2017
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Telephone: 690455
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19 June 74

COMALCO GROUND QUARTZITE

Sample No:	% Fe_2O_3	% Al_2O_3	% TiO_2	% Cr_2O_3	% CaO	% MgO	% Na_2O	% K_2O	% LOI	% SiO_2 by balance.
63	0.030	2.1	0.048	<0.001	<0.01	0.32	0.01	0.23	0.86	96.4
68	0.065	1.1	0.066	0.002	<0.01	0.29	0.01	0.11	0.63	97.7
69	0.014	1.1	0.033	0.001	<0.01	0.21	<0.01	0.13	0.71	98.8
89	0.075	0.71	0.019	<0.001	<0.01	0.35	<0.01	0.05	0.24	98.6
90	0.055	0.83	0.035	<0.001	<0.01	0.14	0.01	0.07	0.35	98.5.

D. MacKENZIE
SECTION LEADER,
SPECTROGRAPHY SECTION

ENASKE AA31488
COMAL AA58508

COMALCO BELL BAY TO NZAS MELBOURNE
BBE167

FOR: MR G WESTE,
COMALCO EXPLORATION DEPT.,
45 EXHIBITION STREET,
MELBOURNE.

Each sample represents 60 cm of core
Each sample has been analysed twice

SILICA ROCK SAMPLES

Diamond Drill Hole CS DDH-4A Azimuth = 90° Magnetic
Inclination = 48°

SAMP NO.	Depth Metres	CAO	AL203	FE203	NA20	TI02	MGO	MNO	LOI
1	0.0	0.015	4.100	0.132	0.066	0.137	0.322	0.009	
1		0.014	4.101	0.130	0.057	0.133	0.327	0.008	0.48
2		0.021	1.311	0.509	0.155	0.058	0.313	0.009	
2	1.20	0.021	1.282	0,511	0.125	0.058	0.353	0.008	0.40
3		0.016	0.854	0.152	0.135	0.091	0.196	0.005	
3		0.016	0.838	0.150	0.131	0.090	0.194	0.003	0.46
4		0.022	1.824	0.471	0.299	0.367	0.498	0.007	
4		0.024	1.822	0.477	0.272	0.368	0.510	0.007	0.43
5		0.018	0.808	0.451	0.168	0.144	0.319	0.006	
5		0.020	0.797	0.455	0.168	0.147	0.292	0.007	0.24
6		0.014	0.379	0.171	0.078	0.087	0.117	0.005	
6		0.012	0.384	0.170	0.075	0.081	0.129	0.005	0.19
7		0.027	0.847	0.384	0.301	0.217	0.354	0.018	
7		0.030	0.880	0.388	0.281	0.222	0.356	0.019	0.34
8		0.016	1.551	0.308	0.119	0.116	0.223	0.007	
8	4.70	0.015	1.507	0.304	0.095	0.111	0.245	0.006	0.34
9		0.013	10.524	0.313	0.250	0.555	0.519	0.026	
9		0.015	10.553	0.313	0.244	0.561	0.542	0.029	1.45
10		0.012	3.510	0.180	0.101	0.199	0.380	0.008	
10		0.016	3.508	0.181	0.113	0.204	0.370	0.009	0.54

11		0.010	3.412	0.165	0.155	0.208	0.348	0.004	
11	6.40	0.011	3.385	0.164	0.125	0.208	0.352	0.004	0.61
12		0.011	1.416	0.204	0.063	0.098	0.180	0.005	
12		0.011	1.433	0.203	0.105	0.097	0.178	0.005	0.16
13		0.017	0.825	0.174	0.015	0.079	0.217	0.005	
13		0.015	0.825	0.176	0.033	0.080	0.235	0.005	0.08
14		0.025	2.402	0.845	0.257	0.362	0.602	0.010	
14	7.95	0.024	2.384	0.848	0.265	0.359	0.576	0.010	0.43
15		0.010	0.517	0.038	0.038	0.044	0.073	0.003	
15		0.009	0.548	0.038	0.054	0.043	0.078	0.003	0.09
16		0.010	2.412	0.066	0.048	0.132	0.233	0.003	
16		0.011	2.400	0.067	0.087	0.134	0.238	0.003	0.39
17	11.00	0.014	2.559	0.101	0.286	0.259	0.253	0.003	
17		0.015	2.572	0.101	0.281	0.260	0.225	0.003	0.43
18		0.020	3.174	0.270	0.319	0.311	0.423	0.008	
18		0.016	3.139	0.266	0.311	0.308	0.438	0.006	0.58
19		0.024	2.290	0.568	0.191	0.126	0.730	0.007	
19		0.025	2.279	0.571	0.263	0.127	0.696	0.009	0.69
20		0.008	0.666	0.027	0.135	0.094	0.148	0.001	
20	13.33	0.013	0.670	0.030	0.138	0.100	0.160	0.002	0.24
21		0.011	0.423	0.029	0.021	0.035	0.156	0.002	
21		0.011	0.421	0.028	0.047	0.031	0.137	0.001	0.15
22	15.62	0.010	0.497	0.090	0.114	0.068	0.123	0.002	
22		0.012	0.484	0.090	0.099	0.068	0.101	0.003	0.17
23		0.009	0.478	0.014	0.044	0.042	0.082	0.002	
23		0.011	0.478	0.014	0.062	0.042	0.094	0.002	0.35
24		0.009	0.421	0.024	0.051	0.027	0.066	0.002	
24		0.008	0.423	0.020	0.045	0.023	0.062	0.001	0.38
25	17.84	0.022	1.969	0.572	0.278	0.148	0.715	0.006	
25		0.025	1.977	0.577	0.293	0.154	0.717	0.008	0.76
26	18.24	0.028	6.293	0.224	0.272	0.466	0.647	0.005	
26		0.027	6.344	0.226	0.278	0.467	0.725	0.006	2.37
27	18.80	0.017	2.546	0.103	0.129	0.199	0.384	0.003	
27		0.019	2.524	0.101	0.119	0.199	0.363	0.003	0.91
28	19.91	0.012	1.497	0.063	0.090	0.074	0.219	0.003	
28		0.013	1.532	0.061	0.069	0.073	0.233	0.003	0.33
29		0.016	1.367	0.152	0.090	0.099	0.265	0.003	
29		0.013	1.367	0.152	0.086	0.100	0.276	0.004	0.55
30	20.63	0.011	1.872	0.058	0.072	0.111	0.237	0.003	
30		0.012	1.879	0.059	0.092	0.113	0.257	0.003	
31	21.23	0.010	0.849	0.091	0.057	0.076	0.157	0.002	
31		0.010	0.830	0.089	0.047	0.073	0.156	0.002	
32		0.009	1.009	0.046	0.045	0.063	0.173	0.003	
32		0.010	0.992	0.046	0.059	0.064	0.166	0.003	
33	22.73	0.007	1.378	0.027	0.006	0.073	0.165	0.002	
33		0.009	1.411	0.027	0.035	0.073	0.173	0.003	

34	23.17	0.021	1.938	0.085	0.092	0.082	0.297	0.003
34		0.020	1.890	0.085	0.063	0.079	0.300	0.004
35		0.017	1.389	0.036	0.068	0.085	0.197	0.003
35		0.015	1.418	0.036	0.069	0.084	0.231	0.003
36	24.38	0.012	0.777	0.135	0.062	0.034	0.199	0.002
36		0.011	0.793	0.134	0.051	0.035	0.173	0.002
37		0.011	1.689	0.037	0.060	0.103	0.222	0.003
37		0.012	1.685	0.038	0.065	0.105	0.248	0.003
38	25.83	0.016	1.497	0.033	0.069	0.057	0.082	0.002
38		0.016	1.472	0.033	0.063	0.059	0.092	0.002
39		0.022	3.698	0.244	0.092	0.242	0.338	0.003
39		0.021	3.702	0.240	0.156	0.243	0.321	0.003
40	26.51	0.015	3.637	0.225	0.128	0.132	0.352	0.004
40		0.015	3.573	0.224	0.102	0.129	0.342	0.003
41		0.010	2.644	0.096	0.108	0.085	0.264	0.002
41		0.012	2.670	0.096	0.092	0.084	0.208	0.002
42		0.019	3.399	0.117	0.137	0.113	0.430	0.003
42		0.019	3.400	0.118	0.144	0.452	0.003	
43		0.026	1.450	0.271	0.241	0.206	0.629	0.003
43		0.022	1.430	0.270	0.227	0.207	0.600	0.003
44	29.26	0.023	1.403	0.033	0.059	0.051	0.190	0.002
44		0.021	1.383	0.033	0.043	0.053	0.188	0.002
45		0.050	2.223	0.137	0.255	0.100	0.404	0.004
45		0.048	2.214	0.133	0.220	0.096	0.402	0.003
46		0.017	1.471	0.027	0.052	0.051	0.127	0.002
46		0.017	1.502	0.027	0.087	0.055	0.136	0.002
47	32.00	0.013	1.177	0.060	0.074	0.068	0.185	0.003
47		0.014	1.200	0.060	0.083	0.067	0.205	0.003
48		0.013	1.685	0.168	0.060	0.088	0.321	0.004
48		0.011	1.662	0.168	0.046	0.089	0.333	0.004
49	32.84	0.011	1.434	0.129	0.053	0.074	0.288	0.003
49		0.011	1.440	0.135	0.081	0.080	0.296	0.003
50		0.009	1.760	0.041	0.083	0.049	0.172	0.002
50		0.010	1.740	0.039	0.076	0.050	0.159	0.002
51		0.014	6.452	0.225	0.143	0.496	0.448	0.004
51		0.010	6.468	0.223	0.172	0.494	0.424	0.004
52		0.016	1.189	0.474	0.146	0.090	0.400	0.006
52		0.014	1.163	0.479	0.143	0.089	0.421	0.006
53	35.66	0.012	0.900	0.045	0.008	0.047	0.186	0.002
53		0.008	0.943	0.044	0.055	0.050	0.190	0.002
54		0.011	1.126	0.164	0.130	0.037	0.298	0.003
54		0.010	1.058	0.163	0.106	0.035	0.284	0.003
55		0.007	0.999	0.162	0.062	0.041	0.199	0.003
55		0.007	1.029	0.159	0.078	0.039	0.214	0.003
56	37.46	0.011	1.272	0.046	0.001	0.073	0.164	0.002
56		0.009	1.245	0.046	0.001	0.073	0.161	0.002

57		0.008	2.389	0.206	0.113	0.129	0.310	0.003
57		0.008	2.397	0.204	0.122	0.129	0.320	0.004
58		0.011	5.363	0.610	0.158	0.256	0.352	0.003
58	38 41	0.013	5.345	0.616	0.207	0.263	0.354	0.004
59		0.012	2.703	0.072	0.062	0.100	0.270	0.003
59		0.011	2.720	0.074	0.088	0.100	0.259	0.003
60		0.008	1.594	0.172	0.083	0.051	2.204	0.004
60		0.006	1.615	0.170	0.057	0.048	0.193	0.002
61		0.011	2.638	0.072	0.038	0.078	0.311	0.003
61	40 69	0.010	2.691	0.072	0.062	0.076	0.313	0.003
62		0.009	1.001	0.033	0.018	0.042	0.111	0.002
62		0.008	1.029	0.031	0.031	0.038	0.121	0.002
63		0.010	1.532	0.038	0.018	0.051	0.260	0.002
63	41 45	0.011	1.553	0.040	0.043	0.054	0.282	0.003
64		0.015	1.387	0.128	0.158	0.060	0.274	0.003
64		0.012	1.362	0.128	0.150	0.062	0.270	0.003
65		0.008	1.021	0.035	0.094	0.050	0.190	0.003
65		0.008	1.044	0.033	0.104	0.047	0.180	0.002
66		0.009	1.906	0.090	0.041	0.083	0.363	0.004
66		0.008	1.900	0.088	0.060	0.080	0.409	0.003
67		0.013	1.771	0.473	0.167	0.075	0.472	0.007
67	44 50	0.011	1.756	0.471	0.148	0.071	0.565	0.006
68		0.010	0.785	0.074	0.067	0.069	0.247	0.002
68		0.010	0.828	0.075	0.076	0.073	0.240	0.003
69		0.008	0.785	0.020-	0.080	0.039	0.240	0.002
69		0.010	0.801	0.019	0.031	0.041	0.281	0.003
70	46 19	0.013	1.711	0.029	0.071	0.084	0.263	0.003
70		0.011	1.691	0.029	0.066	0.084	0.232	0.003
71		0.016	2.502	0.486	0.190	0.212	0.588	0.006
71		0.019	2.553	0.493	0.225	0.212	0.615	0.008
72		0.019	1.604	0.105	0.160	0.080	0.324	0.004
72	47 55	0.017	1.594	0.104	0.132	0.080	0.316	0.004
73		0.009	2.085	0.153	0.101	0.091	0.322	0.004
73		0.009	2.104	0.149	0.095	0.089	0.295	0.003
74		0.008	3.562	0.093	0.136	0.065	0.177	0.002
74		0.008	3.578	0.094	0.090	0.066	0.188	0.001
75		0.013	4.096	0.066	0.185	0.132	0.251	0.002
75	50 60	0.014	4.149	0.069	0.211	0.139	0.229	0.003
76		0.007	1.491	0.044	0.057	* 87121	0.002	
76		0.009	1.487	0.046	0.055	0.048	0.128	0.003
77		0.009	1.771	0.205	0.088	0.070	0.259	0.004
77		0.008	1.791	0.206	0.083	0.072	0.299	0.004
78		0.006	1.224	0.028	0.046	0.060	0.107	0.003
78	53 65	0.004	1.233	0.026	0.032	0.055	0.083	0.001
79		0.009	2.625	0.064	0.130	0.078	0.189	0.003

79	0.003	2.660	0.063	0.106	0.075	0.188	0.002
80	0.006	1.839	0.268	0.025	0.082	1.106	0.007
80	0.005	1.800	0.266	0.062	0.081	1.107	0.007
81	0.009	2.525	0.168	0.088	0.195	0.302	0.003
81	0.012	2.617	0.168	0.102	0.197	0.320	0.003
82	0.008	5.909	0.252	0.197	0.350	0.698	0.006
82	0.010	5.895	0.252	0.167	0.347	0.702	0.006
83	0.010	1.709	0.391	0.076	0.074	1.663	0.009
83	0.010	1.635	0.392	0.041	0.075	1.723	0.011
84	0.034	1.711	0.581	0.015	0.064	2.202	0.011
84	0.030	1.730	0.577	L.01	0.060	2.202	0.012
86	0.013	2.598	0.314	0.085	0.134	1.292	0.008
86	0.016	2.640	0.314	0.123	0.134	1.238	0.008
87	0.007	1.650	0.099	L.01	0.115	0.337	0.004
87	0.005	1.654	0.098	0.013	0.113	0.320	0.003
88	0.006	1.635	0.111	0.052	0.069	0.235	0.003
88	0.008	1.627	0.114	0.048	0.075	0.243	0.004
89	0.007	0.668	0.093	0.034	0.030	0.320	0.003
89	0.007	0.645	0.095	0.031	0.033	0.347	0.004
90	0.009	0.744	0.071	0.048	0.048	0.141	0.003
90	0.006	0.738	0.070	0.022	0.044	0.144	0.002
91	0.008	12.782	0.863	0.262	0.600	0.779	0.017
91	0.007	12.856	0.858	0.235	0.597	0.765	0.015
92	0.024	2.527	0.354	0.706	0.126	0.850	0.008
92	0.023	2.502	0.351	0.671	0.121	0.831	0.006
93	0.023	4.077	0.742	0.769	0.285	2.202	0.011
93	0.027	4.088	0.747	0.814	0.287	2.202	0.012
94	0.049	7.819	0.707	0.835	0.478	0.577	0.007
94	0.046	7.861	0.708	0.811	0.481	0.592	0.006
95	0.045	2.943	0.288	0.846	0.085	0.417	0.006
95	0.047	2.970	0.287	0.860	0.082	0.417	0.006
96	0.021	4.981	0.191	0.603	0.141	0.327	0.006
96	0.021	4.993	0.190	0.662	0.143	0.357	0.006
97	0.023	0.990	0.323	0.632	0.039	1.061	0.008
97	0.024	0.966	0.323	0.568	0.039	1.036	0.007
98	0.016	2.153	0.579	0.473	0.059	2.023	0.011
98	0.016	2.163	0.575	0.482	0.057	2.030	0.010
99	0.013	2.136	0.422	0.396	0.060	1.374	0.008
99	0.014	2.136	0.421	0.363	0.057	1.344	0.007
100	0.013	1.522	0.388	0.325	0.057	0.725	0.004
100	0.013	1.524	0.384	0.325	0.055	0.724	0.004
101	0.011	4.139	0.263	0.286	0.221	0.786	0.005
101	0.013	4.194	0.266	0.295	0.227	0.758	0.007
102	0.009	1.619	0.190	0.239	0.089	0.616	0.003
102	0.011	1.613	0.195	0.256	0.093	0.626	0.005

56.69

53.74

61.42

62.79

65.84

035

586086

103	0.012	1.397	0.061	0.237	0.055	0.121	0.002
103 68-89	0.012	1.469	0.062	0.218	0.057	0.115	0.003
104	0.012	4.656	0.160	0.263	0.130	0.497	0.004
104	0.011	4.642	0.161	0.284	0.130	0.497	0.004
105	0.012	1.227	0.171	0.190	0.043	0.634	0.005
105	0.011	1.233	0.171	0.232	0.042	0.654	0.005
106	0.011	4.283	0.144	0.267	0.161	0.413	0.004
106	0.012	4.293	0.142	0.281	0.160	0.400	0.004
107	0.010	2.547	0.159	0.204	0.239	0.527	0.004
107	0.010	2.543	0.159	0.213	0.240	0.504	0.003
108	0.012	1.947	0.268	0.165	0.097	0.986	0.006
108 71-93	0.011	1.929	0.268	0.192	0.101	1.000	0.007

End of Hole

...D HARRISON

6/6/74JP/LHL

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TIME SENT 2.05PMB

ENASKE AA31488

COMAL AA58508V

ICE TELEX MESSAGE