

File 1207 Barite Production

B A R I T E S T U D Y

J. H. Matthews

1979-11-09

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Hudson's Bay Oil and Gas Company Limited

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1980-11-27

Mr. Peter Taggart
Cyprus Anvil Mining Corp.
355 Burrard Street
Vancouver, B. C.
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Dear Peter:

The attached barite study by Mr. J. H. V. Matthews was commissioned by HBOG to provide an overview of the barite industry.

Mr. Matthews was formerly a marketing executive with Bariod Petroleum Services Ltd. and has extensive experience in the drilling mud business.

I hope this study is of some benefit.

Sincerely,

Wayne E. Lunt
Sr. Evaluation Analyst

WEL:ma

cc J. G. Simpson

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I GENERAL INFORMATION

- (A) DRILLING MUD - How and why barite is used.
- (B) BARITE STANDARDS - for use in drilling mud.
- (C) BARITE MARKETING
- (D) OTHER USES FOR BARITE - 27% of market in 1968;
10% in 1977
- (E) FUTURE MARKET TRENDS - up. 1968 - 3.76 MM tons
1977 - 5.9 MM tons
2000 - 10-12 MM tons (est.)
- (F) ALTERNATIVES TO BARITE AS "WEIGHT MATERIAL" IN MUD
No serious market inroads expected.
- (G) WORLD BARITE RESERVES, MARKETS AND PRODUCTION

(A) DRILLING MUD - how and why barite is used

Barite (Barium Sulphate $BaSO_4$)

The major market for the material is as a "weighting agent" in drilling fluids. The material is added to the "mud" to increase the density and, in turn, the hydrostatic pressure in a well bore. A high formation pressure is controlled by increasing the hydrostatic. The barite market is good where sub-surface pressures are above normal - eg. Beaufort Sea, MacKenzie Delta, U.S. Gulf Coast, Iran and the North Sea; average where they are normal, eg. Canadian Foothills and Saudi; and poor where the pressures are sub-normal, eg. Lloydminster, Southern Saskatchewan and Kansas. The volume of the barite market is proportional to the drilling activity in the "over-pressured" regions and, to a lesser extent, the activity in the normal pressure regions.

(B) BARITE STANDARDS

Barite as a weight material in drilling mud is expected to conform to API (American Petroleum Institute) standards. These are:

- 1) minimum density 4.2
- 2) grind 95% minus 325 mesh and
- 3) a maximum water soluble solids content of 250 ppm.

add heavy metal under 5ppm

This last specification is too high if the soluble material affects the viscosity of the mud. In practice, the addition of large volumes of barite to a mud system cannot "thicken" or "thin" the fluid. Barite's chemical inertness is a major reason that it is useful as "weight material". When a mud weight of 18 lbs. per US gal. is required, there are over 12 lbs. of barite in each of those gallons. An average drilling system of 1000 barrels would have 504 000 lbs. or 252 tons of barite in suspension. It does not take much contamination in the barite to seriously affect the other mud properties.

Another chemical impurity which, to date, is only monitored in the Canadian Arctic, is the heavy metal content. These do not have to be water soluble to get attention. The claim that some barite may be dumped into the sea, some fish may eat some (even though it has no food value), and the fish may ingest some heavy metal before maybe getting caught and eaten by a native resulted in a ban on Lethbridge or Onoway barite production being used in the Beaufort Sea. Virtually all barite contains traces of lead, mercury, cadmium and other heavy metals. The Canadian barite was roughly double the Nevada content but still only 15-20 ppm. If the economics of a Canadian deposit are being considered, add "heavy metal content preferably under 5 ppm" to the API specs.

(C) BARITE MARKETING

The drilling mud market is supplied world wide by four "majors", alphabetically -

Baroid Petroleum Services Ltd., (N.L. Industries)

IMCO Services Div., (Haliburton Services)

Magcobar Div., Dresser Oilfield Products Group

Milchem Div., Baker Oil Tools Inc.

The market is also supplied by "independents" who work mainly in local areas. Canada, for example, has 35 or 40 independents and they collectively supply over 50% of the market in Alberta, B. C. and Saskatchewan. The majors get 80-90% of the "frontier" work. The situation in any market area is similar, but of course market share for each company or group of companies varies widely. These "mud companies" usually supply all of the products required in mud, well over 100, and well site technical service.

(D) OTHER USES FOR BARITE

Markets for barite, other than drilling mud, accounted for 27% of total production in 1968. This has steadily decreased to 10% in 1977. Tonnage in 1968 - 1.01 MM tons; in 1977 - .6 MM tons. The major markets for this tonnage include paint, glass,

rubber, ceramic products, plastics and brake lining. Barite is also used in the production of other barium chemicals. Some barium carbonate is mined in England but most of the tonnage is obtained from barium (barium sulphate). Barium carbonate in turn is used in the production of other barium chemicals - eg. barium nitrate, chloride, peroxide, sulphate, acetate, oxide, titanate, hydroxide and stearate. Many people associate, unpleasantly, the word barium with medical situations. Its shielding ability allows good x-ray inspection of various human organs, but first comes the business of getting barium in the organ. This shielding property makes barite useful in structures designed for protection from various rays.

There are several other fringe uses of barium but none are expected to change the nature of the market. Some research into other uses continues. Recent developments include:

Finely ground barite and synthetic rubber powder (Rubarite) added to asphalt gives a more flexible surface for runways, roadways etc. Less cracking, better seal coat and longer life are claimed.

Barium metal, air and chlorine have been combined into a "powerful and compact" fuel cell. The high cost of the barium metal has ruled out commercial production to date.

(E) FUTURE MARKET TRENDS /RESERVOIRS

Drilling mud is expected to be the major market for barium far into the future. R & D may change the trend of a higher percentage going to drilling mud each year, but even this is questionable.

The drilling that is important to the barite industry, offshore and ultra deep on shore, is unlikely to peak for many years. Forecasts that the barite market will peak in the mid-eighties are based on pessimistic overall drilling activity forecasts. The shallow Lloydminster, S.E. Alberta, Saskatchewan, Kansas, Oklahoma and Texas work may decrease in that time frame.

The deeper areas, Oklahoma, Texas, Gulf Coast, Beaufort Sea and Labrador coasts, to name a few, probably will still be very active in the year 2000.

It is suggested that the barite market will be 10 to 12 MM tons per year by the year 2000, not the 2.8 MM tons forecast in "Barite" (Bureau of Mines, U.S. Dept. of the Interior).

The world reserves of barite are listed in "Barite", Bureau of Mines, U.S. Dept. of the Interior, Feb. 1979 brochure on Page 4. Of 1730 MM tons of barite "resources", only 103 MM tons are classed as "Reserves". These marketable reserves are projected by the Bureau of Mines to be less than 15 years supply, based on their forecast that the market will peak in the mid-eighties and decrease to 1977 levels by the year 2000.

If my scenario outlined earlier is correct, there is no more than 10-12 years supply available from "Reserves".

Shortages of barite will result in higher prices, which will bring more of the "barite resources" into reserves and bring other products, such as iron ore or titanium into the market.

Accessible barite deposits which can be used to competitively put an acceptable product into any part of the market is a valuable deposit today. The value in constant dollars will almost certainly be higher ten years from now.

(F) ALTERNATIVES TO BARITE AS "WEIGHT MATERIAL" IN MUD

The possibility that recent entries into the mud "weight material" market will gain a meaningful portion of the market is remote. Iron or titanium ore derivatives may be used in local areas where costs are competitive, but initial marketing efforts seem to be directed towards establishing these products as something more valuable than barite. This approach should result in failure to obtain much of the market. Baroid is introducing a titanium oxide (Ilmenite) under the trade name "Bar-gain" and pricing it about 10% higher than barite. Magcobar and Milchen apparently plan to use specular hematite mixed with low grade barite to produce a product that meets API specifications.

Barite, with a specific density of 3.8 to 3.9, can be mixed with enough hematite to raise the SpG to 4.2, but there is doubt that the market place will jump at the opportunity to purchase the mix at a premium price. It is also obvious that barite cannot have a SpG of 3.8. The low gravity solids in this ore would possibly be undesirable solids in a mud system.

"Fer-O-Bar" is a product produced and marketed by Sachtleben-Chemie GmbH in West Germany. It is a "residue from the pyrite roasting process for sulfuric acid production". Other concerns are attempting to use other derivatives of iron ore as a weighting agent.

All of these possible contenders to barite face marketing problems which are quite difficult. The basic cost of ore changes with the market value of titanium or iron. Drilling people are very slow to accept changes, so as long as barite is readily available it will be difficult to convince drillers to try something else. Products that are dirty or dangerous frequently get less than purely economic comparisons in the field trials, and the alternatives are "dirtier" than barite.

It is probable that barite will be the weighting material for many years.

(G) WORLD BARITE RESERVES, MARKETS AND PRODUCTION

The information in the following table is presented to put the world scene in perspective. The numbers are for 1977, the last year available. The USA with 24% of the world's reserves is importing about 40% of its requirements. Their domestic reserves are not always competitive with imported ore. The US market accounts for 44% of the world's consumption. Canada is a minor factor in the world scene. The exports were all from Magcobar's Walton, N.S. mine which is now closed. The world trade is complex and dynamic. Today's pattern is not applicable to last year or next year. It depends on drilling activity levels, particularly in places where high mud weights are required, and this is continuously changing.

BARITE - 1977

<u>Area</u>	<u>Reserves</u>	<u>Production</u>	<u>Area</u>	<u>Mud Consumption</u>
USA	25 000	1 494	USA	2 371
Mexico	4 000	309	Mexico	194
Canada	3 000	139	Canada	60
Peru	4 000	310		
Brazil	4 000	-	S. America	300
Chile	-	22		
Other SA	3 000	-		
Ireland	3 000	330		
France	2 000	165	North Sea	300
W. Germany	2 000	320	North Europe	100
Italy	2 000	150		
Spain	-	90		
Greece	2 000	43		
Morocco	2 000	154	Nigeria	60
Algeria	1 000	-	N. Africa	200
S. Rhodesia	2 000	-		
USSR	4 000	495	USSR	920
Turkey	5 000	45	Saudi	125
			Iran	200
			Syria, Iraq,	
			Trucial States	100
India	11 000	347	India	40
China	5 000	330*	China	?
N. Korea		130		
Thailand	5 000	110		
Other Far East	3 000	-	"Far East"	350
Australia	2 000	-		
All Others	<u>9 000</u>	<u>919</u>	Non Oilfield	<u>582</u>
Totals	103 000	5 902		5 902

* Exports only

WESTERN CANADA

- (A) END USE OF BARITE - 98% drilling mud
- (B) MARKET AREAS - Foothills wells and the MacKenzie Delta/
Beaufort Sea region.
- (C) ESTIMATED PRODUCTION AND SOURCE OF ORE - Mainly Mountain
Minerals, Lethbridge, ore from S.E. B.C.
- (D) RESERVES OF CANADIAN PRODUCING PROPERTIES
Mountain Minerals Co. Ltd. - 5 years⁺
Baroid of Canada - ∅
- (E) RESERVES UNDER CONSIDERATION
Baroid - Macmillan Pass
Yukon Barite - " "
- (F) MARKET OUTLOOK - Tied to deep Foothills and Delta drilling
activity - forecast growth
- (G) PRICING - Shortages will strengthen prices
- (H) ALTERNATIVES - W. Canada almost certainly will continue
100% barite for some years.

(A) END USE OF BARITE

Over 98% of the production in W. Canada goes into drilling mud. Very minor amounts may still go to the glass industry, fiberglas manufacturers and rubber manufacturers, but it is probable that these requirements and other fringe uses are being supplied from foreign sources.

(B) MARKET AREAS

Foothills drilling from the US border N.W. into the Yukon and the Beaufort Sea/MacKenzie Delta region are the two major markets. The 1979 market probably is Foothills-55 000 and Beaufort Sea-15 000 short tons. In 1969 the market was approximately 25 000-Foothills and 10 000-Delta. 1974 was probably 15 000-Foothills and 20 000-Delta.

There were several land rigs operating nearly year-round in the Delta during the late sixties and early seventies. They were shut down due to government regulations and failure to get a pipeline authorized. Canmar Drilling/Dome Pete is the only active operator; their 3 offshore rigs working about 5 months per year each are using three-quarters as much barite as 10 or 12 land rigs used working virtually year round. The geo-pressures in the Delta and Beaufort Sea frequently require high mud weights.

Foothills drilling was rocking along at a medium level in 1969; was nearly extinct in the middle seventies and has come back to historic highs in the last few years. Shale and formation pressures frequently require that mud weights be increased to moderate levels.

(C) ESTIMATED PRODUCTION AND SOURCE OF ORE

Major supplier is Mountain Minerals Ltd., Lethbridge, Alberta. Their sales this year estimated at 50 000 tons. The ore is from their mines at Parsons and Brisco, B. C. and a tailings pond near Invermere. The plant is at Lethbridge. Baroid of Canada is producing part of their requirements at their Onoway, Alberta plant. Ore is from a tailings pond near Spillamacheen,

B. C., and from their Dunphy, Nevada mine. Apparently the mining capacity at Dunphy allowed them to ship ore to the under-utilized Onoway plant. The grinding facilities at Dunphy were 100% committed. The economics must be marginal at best. Baroid is considering importing Chinese ore to the west coast and grinding at Onoway. Production at Onoway in 1979 estimated @ 7500 short tons. Some finished product is being imported by Magcobar, I.M.C. and Milchen from their sources in the Battle Mtn. region of Nevada, estimated at 10 000 short tons.

(D) RESERVES OF CANADIAN PRODUCING PROPERTIES

Baroid is out of ore that can be economically recovered from their Spillamacheen tailings pond. Mountain Minerals is getting into more expensive ore and probably have about 5 years supply. There are differences of opinion on the Mountain Mineral reserve position. Those two, and others, have been unable to locate viable new reserves in central and southern B. C.

(E) RESERVES UNDER CONSIDERATION

Large reserves are located adjacent to the Alaska Highway between mile 397 and 475. The economics for the area are questionable. The ore would probably be trucked to a plant at Fort Nelson, B. C. Plant costs at Fort Nelson would be higher than Lethbridge or Nevada facilities due to the problems of getting labour for seasonal operations. Transportation costs from the mine to plant to marketing stock points limits market area. Rail connections to major market stock points are tortuous. Rates are not available but it seems reasonable to assume that Grande Prairie, for example, would be supplied by truck and anything beyond would not be competitive with material coming from the south.

Transportation to the MacKenzie Delta by barge from Fort Nelson down the Nelson and Liard Rivers to Fort Simpson is a possibility. The barges are small. Probably it would be economical to change to larger barges at Fort Simpson. There is a portage of about 40 miles just west of Fort Simpson. The shipping season is

restricted by both ice and low water levels. Some years the season is just a couple of weeks; insufficient to meet sales commitments.

Baroid for one, and probably many others, have considered developing these deposits. It is unlikely that Muncho Lake area ore would be competitive in a market area large enough to support a mining operation.

Other large reserves are known to exist in the Ross River - Macmillan Pass region of the Yukon Territory. Baroid is proposing to Canmar Drilling that they truck ore from the pass through Ross River, Dawson and up the Dempster Highway to a plant they propose at Tuktoyaktuk. The cost of product at Tuk would be competitive with Nevada product and maybe 10% above Lethbridge. The Canadian product from the B. C. sources contains higher concentrations of the heavy metals and was virtually banned because of objections from ecologists. The heavy metal content of the Macmillan ore is being studied. Justification for the investment depends on a forecast of steadily increasing activity for a minimum of 10 years, both on and off-shore, and an exclusive market.

The Macmillan Pass area probably will only support one active mine, at least for the foreseeable future. Another company with claims in that region, Yukon Barite Ltd., has made noises for several years but probably will have trouble getting into production. In my opinion they have not properly gone about lining up markets.

There are several known deposits in the Yukon. Accessibility and/or transportation cost to the "Delta", and cost to convert ore into a satisfactory product are the two major factors. Ore from the Macmillan Pass would quickly be shut off if another more economic orebody was located. This is one of the major reasons; fuel cost is the other, for proposing that the plant be at Tuk. If the processing resulted in a significant weight loss from ore to finished product, the transportation of ore would become uneconomic and the plant would have to be located at or close to the mine.

Air transport could be considered. Even a slurry pipeline down the old Canol pipe line right of way may be feasible. Norman Wells is about 200 air miles from the pass.

Other reserves have been checked but to date have not been judged economic. Examples are the Fort St. James, B.C. region; Deese Lake, B.C., Queen Charlotte Islands and Kamloops regions. Several deposits are known to exist in N. Ontario, one on McKellan Island in Lake Superior could be a viable source of ore for the world market.

(F) MARKET OUTLOOK

Drilling activity along the foothills and in the MacKenzie Delta will determine the market for barite. Most, if not all, industry forecasts are optimistic for both areas. The Delta probably will show the largest percentage increase assuming that offshore tests continue to give favourable results. Onshore work will probably not start again until a pipeline is authorized. Foothills work should continue at its present brisk pace providing that increased exports of gas are authorized.

The future market volume depends on drilling activity in these areas. The forecast of this drilling activity could best be estimated by your in-house facilities. I suspect they would result in a moderately optimistic outlook. For example, overall market growth 5% per year for the next 10 years. There will be many ups and downs caused by government involvements, but increased gas exports and a pipeline from the Delta surely will be authorized soon.

(G) PRICING

Supply and demand are, as always, the factors that affect price. A time/price table in the "Barite" brochure produced by the US Bureau of Mines (Pg. 8) relates the US picture. Prices, in constant dollars, decreased until the early seventies and have only recovered to 1957 levels during this year. The ex plant price from Mountain Minerals Lethbridge plant for sacked material has been approximately:

<u>YEAR</u>	<u>ACTUAL PRICE</u>	<u>ADJUSTED TO 1977 \$</u>
1965	21	40.01
1969	25	40.80
1974	35	42.70
1976	50	52.90
1977	60	60.00
1978	70	64.40
1979	82	67.25

This is different to the US pattern. The major factor was probably the phasing out of the Baroid operation which shut off the local competition. The price gradually assumed a position competitive to Nevada costs plus freight.

The market in the Delta has been the lowest margin area in the world. Limited competition will undoubtedly allow it to be increased even faster than the average.

Mountain Minerals is presently selling ex plant in the \$82 per ton range. Freight to Hay River is \$50.00 for a total of \$132.00. Nevada production, all in-house for major companies, is costing about \$45 per ton (Canadian) plus freight of \$100.00. Hay River is the most competitive point. Lethbridge gains an advantage the further south one checks.

The value of Canadian production is relative to Nevada prices plus freight to major Canadian markets. The largest volume market point this year would be Grande Prairie. Hay River was the largest for several prior years.

(H) ALTERNATIVES

Considerable R & D has been done on potential alternatives to barite as a weighting agent in drilling mud. The only product known to be on the market is FER-O-BAR. Sachtleben Chemie GmbH, West Germany, is the producer of this 4.7 specific gravity "up-graded iron-oxide base" material. Baroid has announced its intention to market a titanium oxide. The raw material for these

products is plentiful but freight cost to markets will probably limit market penetration.

It is suggested that barite will be the major product used for weighting drilling muds for many years, particularly in the Canadian market.

III EASTERN CANADA

(A) MARKET AND MARKET OUTLOOK -

Barite market is dependent on offshore drilling activity; estimated at 15 000 tons in 1979; forecast to grow at 20% per year over the next 5 years to 37 000 tons in 1984.

(B) PRODUCTION AND SOURCE OF ORE -

Dresser production at Walton terminated
Baroid production ex Buchans should commence in 1980.
Brookfield and Lake Ainsley, N.S. deposits being considered by unknown parties.
Product presently coming from New Orleans.

(C) PRICES -

Prices will reflect Buchans production over the next few years. Newfoundland steady until N.S. gets up to reflect reversal in freight costs.

(A) MARKET AND MARKET OUTLOOK

The market was erratic for several years. Shell, Mobil, Hudson's Bay, Amoco, Total Eastcan, B.P. and others had demand gyrating as their programs started and stopped. The discoveries announced in the last few years indicate that commercial petroleum finds are located off eastern Canada. Programs are starting; none are stopping. The barite market will virtually parallel the rig/month activity. The number of drilling vessels employed next year is expected to be 50% higher than this year. Further substantial activity increases are anticipated; average 20% minimum per year for 5 years.

From a 1979 market of approximately 15 000 tons, very substantial for just 8 vessels averaging 5 months per vessel active drilling time, the market growth can be rapid. The estimate of 20% per year growth should be conservative, and that would be over 37 000 tons in 1984. There is also a potential market in the St. Lawrence Lowlands, onshore Maritimes and Newfoundland and the Eastern Arctic Is. None of these is expected to be a major factor in the next 5 years.

(B) PRODUCTION AND SOURCE OF ORE

Dresser operated a mine and plant near Walton, N. S. for many years. Over 4 million tons of barite were recovered. Most of this was shipped as ore to grinding plants on the Gulf Coast of Louisiana. Some was processed through the mill at Walton, mainly for use in the Maritimes. The mine started to have problems with water coming in from the Bay of Fundy in 1970. The many efforts to overcome the problems were all unsuccessful. Dresser has announced that mining activity at Walton has been terminated.

Asarco operated a lead-zinc mine at Buchans, Newfoundland, but in 1978 the operation was being phased out because of lack of suitable ore. The tailings pond contains a minimum of 500 000 tons of recoverable barite. An agreement apparently has been signed between Asarco and Price Bros. on one hand and Baroid on the other. Production should commence in the summer of 1980. This production should supply Newfoundland on and offshore, the Labrador coast and

Pb + Zn
no problem?

the Arctic Islands for 15-20 years. The Newfoundland government will likely discourage the importation of barite. Competition for that market will be nonexistent unless another barite production facility is located in Newfoundland. The Buchans Mine is connected to the seaport of Botwood by a narrow gauge railroad. It is presumed that barite production will warrant the continued use of this line. The present flow of barite from New Orleans to St. John's and Botwood may be reversed in the next two years. If Buchans barite is competitive in the Gulf of Mexico, that reserve picture could change dramatically.

There have been several reports of interest in various known deposits in Newfoundland and the Maritimes. Certainly Brookfield and Lake Ainslie in Nova Scotia are getting attention. The market off Nova Scotia and south to Georges Bank and other American offshore projects would be available to an efficient operation in Nova Scotia. This market could be worthwhile. The Gulf of St. Lawrence onshore and offshore, P.E.I. and some U.S. states would potentially enlarge the market for N.S. production. However, the prospects of this occurring in the next 5 years are poor. Mud weights required through that area are expected to be in the normal range and with little drilling activity forecast at present, this market will develop slowly.

(C) PRICES

Present retail prices ex St. John's and Botwood, Newfoundland are approximately \$250 per ton. Prices ex Dartmouth are in the \$200 range. These prices do not include technical service. Five years ago those numbers were approximately \$115 in Newfoundland and \$75 in N.S. Production ex Buchans will probably interrupt this trend for one or two years in Newfoundland but the Nova Scotia prices will go up rapidly to reflect freight costs from Buchans to N.S. It would not be realistic to forecast that Buchans production will go to market priced at much less than alternate sources, and the shutdown at Walton leaves N.S. pulling from Missouri or Newfoundland. Buchans should be a profitable operation.

IV U.S.A.

- (A) RESERVES - 24% of world's "reserves" - 25 MM tons
- (B) PRODUCTION - 26% of world's production - 1.5 MM tons
- (C) CONSUMPTION- 44% of world's consumption- 2.6 MM tons
- (D) MARKET OUTLOOK - demand to increase
- (E) PRICES - Constant dollar price increases expected
- (F) ALTERNATE PRODUCTS - being introduced into Gulf Coast.

(A) RESERVES

The USA with 25 MM "reserves" and 250 MM tons of barite listed as "other resources" is not in danger, over the long term, of a shortage of barite. If the price in constant dollars continues to increase, these "other resources" would gradually become economic. A table in "Barite" (US Bureau of Mines) records the price of crushed and ground barite in constant 1977 dollars. From a 1957 high of \$62.90, there was a steady decrease to \$37.56 in 1971. Since then the price has gyrated but generally moved higher. The "constant dollar" high price of 1957 has been equaled in 1979.

(B) PRODUCTION

Production from US sources has been increased in the last few years but not as fast as the market has increased. Obviously there have been foreign sources of ore available at lower cost than domestic sources.

IMC has increased capacity at their Battle Mountain, Nevada facility. Milchem is expected to commence operation at Fancy Hill, Arkansas in 1980. These and other production facility increases are increasing US productive capacity from 1.6 MM tons in 1977 to 1.8 MM tons in 1980.

Imports were running about .7 MM tons in the middle seventies (approximately 35% of market). In 1977 they were .95 MM tons (38%), 1978-1.1 MM tons (40%) and 1979 is expected to show a continuation of the trend. Production from the accessible US reserves in Arkansas and Missouri is decreasing; Nevada ore and/or product can be used in the central states (Utah, Colorado, Wyoming, Oklahoma, West Texas etc.), California and Alaska. It is also being exported to Canada. But it is not competitive with imported ore in the high volume barite market along the Louisiana and Texas Gulf Coasts. Magcobar has shipped ore from Nevada through the Panama to Gulf Coast ports, but it appears to be more expediency than good economics.

Ore is imported into the States from many countries. Most of the imported ore is used on the Gulf Coast. Baroid relies primarily on Peru, but has imported from China, Brazil and Mexico. Magcobar used to rely on Walton, N.S. as its prime source, had nicely got an Irish source operating when Walton was flooded and the North Sea broke loose. Magcobar has obtained ore from Chile, Mexico and other sources as it became available. Milchen has production in Ireland. Chinese ore reportedly is US \$35 per ton FAS China. Indian ore is being increased by government decree from \$28 to \$42 per ton. When ocean freight is added to these prices, the cost FAS Gulf Coast ports startles many people used to having cheap supplies in that market. Security of supply and stabilization of costs are becoming factors in go/no go decisions for US reserves.

Recent publicized reports of barite shortages are correct. The worst problem was along the Gulf Coast of the USA. The shortage was caused by the large increase in deep drilling world wide, and a reluctance or inability of the producers to recognize and react to the situation. Magcobar, for example, had its imported ore from Walton, N.S. reduced because the mine flooded, but it first flooded in 1970. They did not get production increased sufficiently from their sources in Ireland. Baroid was unable to increase the flow of ore from Peru; in fact there was danger that it would be curtailed by the Peruvian government. All companies have purchased ore from other sources as available, but apparently haven't worked out viable long term plans.

The world wide shortage of barite pivoted around the crisis situation along the US Gulf Coast. Ore and product that would have gone elsewhere was diverted with the result that supply was very tight in many places. The Gulf Coast accounts for 40 to 45% of the barite market in the US, nearly 20% of the world market. A decrease in drilling activity there in 1979 was instrumental in alleviating the shortage.

Deposits in Idaho and western Montana are being investigated but apparently have limited reserves. There is limited production from these states.

Nevada will probably be the largest barite producing region for many years to come. In 1977 Nevada produced 77% of the total US production; approximately 1.17 MM tons. This was virtually 100% of productive capacity. New reserves reportedly are adding to the potential for the area.

(C) CONSUMPTION

US consumption of barite is 44% of the total world market, 2.6 MM tons in 1977. The Louisiana Texas Gulf Coast accounted for 40 to 45% of the market, over one million tons. The ultra deep wells from West Texas to Oklahoma require large quantities of barite; possibly 25% of the market. Alaska, both the North slope and Kenai, would have been next in size. Consumption of 200 000 tons or 8% is probably a close estimate. The general Wyoming-Utah area would have accounted for nearly as much market, possibly 6-7%.

The American consumption is possibly a larger part of the world market than expected. They have over-pressured formations in the Gulf that are probably as high as any in the world. Drilling in these formations is very extensive; offshore drilling there is a large percentage of the world offshore drilling figures. The USA is the leader in drilling ultra deep wells. The 25 000' and deeper wells are almost exclusively in the US. These jobs usually require large volumes of weight material.

A third factor is an opinion; the drilling people working in the US are more safety conscious than in many other parts of the world. The cost to clean up a wild well in the Gulf of Mexico is much higher than a similar disaster off Indonesia for example. There is quite an incentive to have safe drilling operations in the US, and a little more barite is frequently the price of safety.

Barite consumption in the USA, when measured against the number of feet of drilling, increased from .00675 tons/ft in 1967

to .01103 tons/ft in 1977. This 63% increase in consumption per foot indicates that a higher percentage of the wells were in high pressure areas and/or more was used as insurance for safety.

(D) MARKET OUTLOOK

The following table is from "Barite", US Dept. of the Interior, February, 1979, Page 11.

Table 7 - Ground barite sold or used for oil well drilling and well footage, 1967-77

Year	Barite for drilling 1000 tons	Oil and gas wells		Barite per foot of drilling (short ton)
		Total Footage 1000'	Average footage per well (feet)	
1967	965	142 959	4 292	0.00675
1968	1 006	148 252	4 627	.00679
1969	1 235	160 949	4 726	.00767
1970	1 119	142 431	4 834	.00786
1971	1 044	128 335	4 701	.00814
1972	1 183	138 286	4 809	.00856
1973	1 326	138 938	5 034	.00955
1974	1 440	153 168	4 656	.00940
1975	1 638	178 506	4 566	.00918
1976	1 986	185 345	4 471	.01071
1977	2 371	215 011	4 626	.01103

Footage drilled increased some 50% over the period but virtually all of the increase was in the last four years.

Note: The scenario for a shortage of barite; drilling up 50%+ in four years; consumption per foot up 15%+ in the same period and total consumption up nearly 65%. There was not enough excess productive capacity to handle that increase.

1978 and estimated 1979 figures are from the Oil and Gas Journal. Barite consumption estimates are mine.

Year	Barite for well drilling	1000' footage drilled	average depth
1978	2 525	231 000	4 770
1979	2 575	240 000	4 920

The US Bureau of Mines is forecasting barite consumption for oil well use at 3 150 000 tons in 1985 and 2 580 000 in 2000. They anticipate that drilling will peak in the mid to late eighties and then start a long slow decrease. Their market projection expects the year 2000 to be back to present levels. This forecast is open to question. For example, the Kansas and shallow Oklahoma and Texas work could start to decline in the late eighties. Off-shore Louisiana and Texas may be "maturing" as exploration areas. Against this:

- (1) more infield drilling may be required to increase recoverable reserves in old producing areas.
- (2) higher risk geological plays will be tested in all areas if the price of oil and gas increases as expected.
- (3) There are still large reservoirs to discover in the US. The "mature" theory - that all the economical reserves have been discovered, was heard 50 years ago in Texas. Texas is far ahead of all other states in footage, active rigs or any other way that drilling activity is measured today. Maybe Texas will be wound down in the next few years, but it is more likely that Texas and other "mature" areas will be active for many years. Any decrease in Texas will be more than offset by increases in other areas.

The level of drilling activity probably never again will show the 50% increase of the last few years, but moderate increases can be forecast.

The barite market, as mentioned before, is most sensitive to drilling activity in "over-pressured" areas. There are deep basins running through Oklahoma and Texas, Wyoming and Utah as well as deep formations offshore Louisiana and Texas that have had very little exploration. The equipment and technical ability to drill to the deepest potential productive horizons (for example in the Gulf) is not yet available. There are indications that production may be possible from 40-50 000' there.

These points lead me to an estimate quite different to the U.S. Dept. of Interior estimate. It is:

The market for barite will continue to grow through the year 2000. Probably the US percentage of the world market will decrease marginally as activity in other parts of the world can be expected to increase at a faster rate.

The estimate:

	<u>1000 tons Barite</u>	<u>Footage</u>
1979	2 575	240 000
1985	3 075	262 500
2000	3 840	293 500

These numbers are based on my expectation that the barite market will grow at 3% per year and drilling activity at 1.5% per year through 1985, then slow to half that rate. Changing political situations and general economic climate will cause large swings in this estimate of average growth.

(E) PRICES

Reference to Table 4, Page 8 of "Barite" was made earlier. This table gives a value, in constant 1977 dollars for both barite ore and crushed and ground barite. Both tables, when updated for 1978 and 1979, will show that ore and barite got back to 1957 prices in 1979. The excess productive capacity available in the mid-fifties resulted in the soft prices that followed for 12-15 years. About 1970 demand and supply were about in balance and prices firmed.

The rapid increase in demand (1977-79) and the depletion of cheap sources in the Missouri Arkansas area simultaneously gave the opportunity and reason for substantial increases in selling prices.

The shortage was most severe along the Gulf Coast. Price increases were sharpest there. Imports from Peru, Ireland, Mexico and other regular channels would not satisfy an increasing market

and cover decreasing domestic production from areas that traditionally supplied the Gulf. Ore from Nevada, including costs to the California coast, was not competitive with Indian ore at \$28 FAS India. The Indian ore, and available ore from many other places, was used to augment regular sources. Recently the Indian government has increased its price to \$42. Chinese ore, at \$35, is presently the bargain ore, but few expect that to last for long.

Nevada ore production is now 78% of total US production. This is 45% of total US demand. It is low cost ore. IMC at Battle Mountain apparently have to use a floatation cycle for part of their production; little doubt that this is the most expensive product in that area. Cost of product from the dry grind ore is probably below \$35 US per ton. Costs vary up to approximately \$50 for the floatation process. The "reserves" in Nevada have been increased in the last year or two. Other US deposits, including many that have been listed in the 250 MM tons of "other resources", are being re-evaluated. As the cost of imported ore increases, more of these will become economic.

Assuming that demand increases as projected, barite prices will increase. Cheap dry grind domestic ore is virtually limited to Nevada. Imported ore will increase until it appears that major production from "other resources" is competitive. Look for a minimum "constant dollar" increase of 1.5 to 2% a year for the next 5 to 10 years.

The US market is depending on imported ore for the bulk of the Gulf Coast market. Any international crisis could have an immediate impact on prices.

(F) ALTERNATE PRODUCTS

The Louisiana Texas Gulf Coast is the obvious marketing area to use for testing alternate products.

The shortage, discussed earlier, is under control at present but for many months the stocks were down to a few days. The R & D, that has been going on for many years, is being tested

in that market. Sachtleben's "Fer-O-Bar" (Pyrite) and Baroid's "Bar-gain" (Titanium oxide) are on the market. Magcobar has announced plans to mix hematite with low gravity barite. Milchen are believed to be planning something similar.

All of these products are coming on the market at premium prices; approximately 10% above barite. It is expected that market penetration in this "tight" situation will be limited, and in the long run, when barite is readily available, they will capture only a small percentage of that market.

V OTHER MARKETING AREAS

Brief production, consumption and market forecasts of:

- (A) MEXICO
- (B) SOUTH AMERICA
- (C) WEST EUROPE
- (D) AFRICA
- (E) EAST EUROPE
- (F) MIDDLE EAST
- (G) FAR EAST

(A) MEXICO

Mexican reserves at 4 million tons are adequate. 1977 production was 309 000 tons. Exports were 115 000 tons. The balance was used in Mexico. The 1979 Mexican consumption is estimated at 250-275 000 tons. Mexican market has increased rapidly in the last few years. Continued strong growth conditional on approval of exports of petroleum products. Barite ore is exported at prices that are competitive in the world market.

(B) SOUTH AMERICA

Peru is the main producing region in South America. Brazil was a major producer but production has dropped due to depletion of active mines. Chile is one of many other countries producing smaller amounts. South American markets, Venezuela, Trinidad, Columbia, Bolivia, Brazil, Argentina etc. consume an estimated 300 000 tons per year. The market is relatively static.

(C) WEST EUROPE

Large volumes of barite are produced in Ireland (330 M tons in 1977), Germany (320 M), France (165 M), Spain (90 M). Grinding facilities in Holland, UK and Norway supply the active North Sea play, estimated at 300 M tons per year for the last few years. Onshore northern Europe consumes another 100 M tons in drilling mud. Germany is the only producing country where the large percentage of production goes to non-oil field uses. Germany produces most of the chemicals derived from barite. Drilling mud market is fairly static. Rapid build-up of activity in the North Sea saw that market increase dramatically from nothing to 300 000 tons in the early seventies. Market prospects should consider that a gradual decrease of activity in the North Sea can be anticipated, resulting in a decreasing market for barite. New discoveries could change this forecast.

(D) AFRICA

Production in Africa is centered in Morocco (154 M tons in 1977). Lesser amounts are produced in Algeria and many other countries. North Africa consumes approximately 200 M tons per year, while Nigeria accounts for another 60 M tons. Future market predictions are difficult due to many political uncertainties in the area.

(E) EAST EUROPE

There is production in USSR (est. 495 M tons in 1977), Turkey (45 M), Greece (43 M), Romania, Bulgaria and Yugoslavia. Consumption in this area is difficult to gauge. The USSR is known to import ore from North Korea, presumably to eastern areas. Total USSR consumption estimated at 920 M tons.

(F) MIDDLE EAST

There is limited production in the area. Ore is imported from many places including India, China, Turkey and Italy. Grinding plants are usually owned 51% by locals; produce most of the finished product. These plants are located in Saudi Arabia, Abu Dhabi, Iran and India. Consumption estimate = Iran (200 M in 1977), Saudi (125 M), Syria, Iraq and the Trucial States (100 M) and India (40 M). Estimates of future market potential would have to be based on political expectations. Iran, for example, is probably near zero now, down from 200 000 tons per year for the last few years.

(G) FAR EAST

Production comes from India (347 M tons in 1977), China (330 M), North Korea (130 M), Thailand (110 M). Consumption from 7 mills in the area is estimated at 350 M tons per year. The major markets are in Indonesia, Phillipines and Malaysia generally. No consumption estimates are available for China, or other communist countries, but they are known to be substantial.

The future market, although subject to many political pressures, should show substantial growth. The offshore drilling through most of the region requires medium to high weight mud. There are reportedly many good petroleum prospects.

VI BARITE PROPERTY EVALUATION

Barite markets in Canada are presently restricted to drilling mud. A property that is geographically located so that marketable barite can compete with present sources is valuable today. A growing market and limited economic ore reserves will increase the value of a deposit. But the potential probably doesn't justify direct involvement by HBOG in the mud business. If barite is available as a by-product from any future production, discussions with Mountain Minerals and the major mud suppliers probably would result in a joint operation beneficial to both parties. Let one of them handle the relatively small mud market.

The following example of the value of a deposit is hypothetical:

The point of sale is 75 miles west of Fort St. John, B.C. Transportation from this "point x" is based on 9¢ per ton mile. Bulk truck haulers should be available at this price. Barite commodity rates are not available from the railroads. Mountain Minerals, as the supplier of the majority of barite presently used is considered to be the competitor.

Sales Point	Present Cost			From "Point X"			Estimated Tonnage 1979	Present Average Retail Price
	FOB Lethbridge	Freight	Total	Miles	Freight Cost	Max. S.P. at Point X		
Fort St. John	82.00	48.80	130.80	75	6.75	124.05	6 000	190.00
Fort Nelson	82.00	54.60	136.60	225	20.25	116.35	4 000	205.00
Grande Prairie	82.00	39.40	121.40	210	18.90	102.50	20 000	185.00
Hay River	82.00	50.00	132.00	685	61.65	70.35	15 000	*160.00
Edson	82.00	32.60	114.60	435	39.15	75.45	5 000	172.00

* Sales at Hay River are bid each year on a trans-shipment basis and without technical service.

The table indicates that barite acceptable in the market would be saleable today in the \$70.00 range FOB "Point X". 30 000 tons of market ore available at \$100/ton. Production and transportation costs from source to Point X would be estimated. The final number, value of the deposit in today's market, follows automatically.