December 10/71
Rexspar
823803
82M

TARGET FEASIBILITY STUDY

Birch Island Fluorspar Deposit

Kamloops, B.C.

TERMS OF REFERENCE

Following discussions between Messrs. Noel O'Brien of Denison Mines Limited, E. Futterer, G.J. Quinn and J.E. Kraft of Noranda Mines, two volumes of data on this property were given to Jim Kraft July 15, 1971 for evaluation purposes.

Vol. 1 "A Report on the Rexspar Fluorspar Deposit" (revised to July '71) contains a summary of Geology, Ore Reserves, Metallurgy, Capital and Operating Costs.

Vol.II Consists of a Book of Plan and Vertical Cross Sections.

Subsequently, two reports received from A.H. Ross and Associates by Denison Mines were given to Noranda on August 13 and October 4. These dealt with areas of potential operating and capital cost improvements.

SUMMARY AND CONCLUSIONS

The Birch Island Fluorspar deposit contains 1,308,000 tons averaging 23.46% CaF_2. In our evaluation of the property - the grade, recovery and cost factors provided by Denison Mines were accepted and a product price provided by Noranda Sales Corporation was used. Seven analysis were calculated using the DCF ROR method. These are shown in accompanying tables and gave the following results:

1. Base Case - Loss on investment

2. Base Case with Mo recovered as a by-product 7.5% return on investment

3. Base Case plus 5% higher cut-off grade and mining rate at 400 t.p.d. - Loss on investment.

4. Base Case plus 5% higher cut-off grade and mining rate at 600 t.p.d. - Loss on investment.

5. Base Case with 15% decrease in operating costs
   plus 20% decrease in capital costs
   15.3% return on investment.

6. Base Case at 2 x mining rate (2000 t.p.d.)
   17.8% return on investment.

7. Base Case at 1½ x mining rate (1500 t.p.d.)
   12% return on investment.

The obvious maximum return on investment is obtained with a significant increase in production rate illustrated by Case 6 which shows a return of 17.8%. However, this case should be considered unrealistic, as the possibility of increasing the reserves to allow a higher production rate is not likely.

Raising the cut-off grade from 15% to 20%, which results in mining a lower tonnage of higher grade ore, shows a loss on investment in both Cases 3 & 4.

Decreasing costs, as in Case 5, shows a return on investment of 15.3%. However, the capital and operating cost decreases used are sizeable and are a reversal of the trend to rising costs, particularly in B.C.

The recovery of molybdenum in Case 2, shows an unacceptable return of 7.5%. At any rate, in view of the current market situation and the poor grade of MoS_2 concentrates which would probably be produced, A.H. Ross & Associates do not recommend any inclusion of revenue associated with MoS_2 .

In conclusion, the proposal does not appear attractive unless a sizeable increase in reserves or decrease in costs could be attained.

DISCUSSION OF PARAMETERS (Base Case)

With the exception of revenue at $43 pst concentrate, all parameters used in this study were taken from the Denison Reports.

1. Production - Plant capacities of 750 and 1000 tpd were considered by Denison. This analysis arbitrarily used the higher figure of 1000 tpd for the Base Case.

2. Grade - The stated grade of the 1,308,000 tons reserve is 23.46% CaF_2, calculated by Denison Mines using a cut-off grade of 15% CaF_2.

3. Upgrading - In a program designed to investigate the possibility of upgrading the flotation feed, five separate tests, including heavy media separation, did not improve the grade. For example, in flotation tests with and without heavy media preconcentration, a 92.5% CaF_2 concentrate had a 90% recovery with the crude ore as opposed to a 79.6% CaF_2 concentrate for the same recovery by flotation of ore preconcentrated by heavy media separation.

4. Recovery - Investigation showed that metallurgical and ceramic grade fluorspar can be recovered by use of conventional flotation processes and equipment. Optimum metallurgy is attained at a concentrate grade of 90% and a recovery of 92.5%. Attempts to upgrade the concentrate beyond 90% produce a sharp drop in recovery. For example, a 95% concentrate has a recovery of 80% - 82.5% CaF_2.

5. Revenue - On the advice of G.J. Quinn of Noranda Sales, a selling price of $43 pst f.o.b. plant was used. This price is for metspar concentrate containing 90% CaF_2. Mr. Quinn cautioned us that this price should be considered a maximum (see G.J. Quinn's memo of July 22/71, attached).

6. Operating Costs - Operating cost breakdown is as follows:

	$ pst of Ore
Mine	0.75
Basic Plant	4.90
Split Milling Circuit	.17
	$5.82

Mine costs at $0.75 seem reasonable. For want of comparable cost data on basic plant costs, a variance factor of -15% was applied against the above figures as recommended in the Denison Report. Please refer to Table I, Case 5.

7. Stripping Ratio - The waste/ore ratio of 0.4/1.0 was accepted as stated in the Denison Report. A check on the drill sections provided substantiates this.

8. Capital Costs - These may be summarized as follows:

Pre-Production	$ 150,000
Mine	600,000
Basic Plant	4,400,000
Split Milling Circuit	350,000
Working Capital	400,000
Total Capital (ROR Base)	$5,900,000

Mine capital costs appear reasonable. A fluorspar beneficiation plant in India, reputed to be the largest in Asia, treats about 550 tpd of ore to produce 140 tpd of product. This plant cost $6 million. In the Denison Report a variance factor of -20% against capital costs is recommended. This change was incorporated into Case 5 which also includes decreased operating costs.

Working capital is one-quarter of annual operating costs and is recovered in the last year of the project.

A salvage value of 10% of capital assets is assumed and added to the final project year's cash flow.

Annual capital expenditure is $60,000/year in Cases 2 & 6 and $40,000/year in Case 5.

9. Taxation - B.C. Mining tax is 15% of taxable income. Taxable income is calculated from operating profit as follows:

Operating Profit

Less Tax free allowance ($10,000)

Less Depreciation (30% declining balance on capital assets and annual capital expenditures)

Less (if any) Terminal Loss - (undepreciated balance or book value less salvage value equals terminal loss)

Less Pre-Production Expenditure - assumed as $150,000 and written off 100% as required.

Equals Mining tax base

Less Processing allowance (15% of Mining Tax Base)

Equals Taxable Income.

Corporation Tax (Federal) is 50% of taxable income. Taxable income is calculated from operating profit as follows:

Operating Profit

Less Depreciation - (100% fast write off of Capital Assets and Annual Capital expenditures)

Less Pre-Production Expenditure - See B.C. Mining Tax

Less Mining Tax Allowance - Use 85% of B.C. Mining Tax as approximation

Equals Income before Depletion (IBD)

Less Automatic Depletion - One-third of I.B.D.

Equals Taxable Income

The mine is assumed to produce from 1974 to 1977 and hence for Federal Tax purposes is subject to 100% fast write-off (depreciation), no tax-free period and automatic depletion.

Taxes were not calculated for Cases 1, 3 & 4 as the operating profits in each of these cases indicates a loss on investment. A detailed tax calculation with subsequent cash flow and discounted cash flow Rate of Return is shown for Cases 2,5,6 & 7 in the accompanying tables.

OTHER CONSIDERATIONS

By-Products

Average total strontium content, which occurs in the form of celestite ($SrSO_4$) is 5.23%. A limited amount of metallurgical work has been done on strontium recovery from the Birch Island material. It has shown that 1) Physical concentration methods would produce a concentrate with high barium (undesireable) 2) Celestite can be recovered by flotation prior to fluorspar, but the effect on subsequent fluorspar flotation, would have to be investigated. In short, an extensive test program would be required to develop any strontium recovery methods. At the current producer price of $40/ton of concentrate, C.I.F. Montreal for a 90+% product, there would appear to be little profit after deduction of freight costs (say $30/ton). The principal markets for strontium are on the East Coast. It is also not proven that a 90+% concentrate could be produced. I have also been advised that the equipment required for strontium extraction is costly.

Two tests were conducted towards production of molybdenite concentrate from a pre-fluorspar flotation sulphide concentrate. Molybdenum content of the final concentrate showed 0.5 lbs. Mo/ton of ore as compared with 1.8 lbs. Mo/ton content in the ore. As with the strontium, considerable furtner test work on Moly would be required. In Case 2, a sensitivity was run with the base case assuming a 50% Mo recovery and a selling price of $1.65/lb.Mo. Operating cost and capital cost were incremented by $0.15/ton and $119,000 respectively, in accordance with recommendations in the Denison report.

Outlook for Additional Tonnage:

The main zone of fluorspar occurs in an altered trachyte cutting across the centre of the property. The deposit itself is about 1300' long,

has an average true thickness of 80' and dips 30° N.W. Two drill intersections occurring on the N.E. and S.E. margins of the main zone have not been delineated. However, they are not of such size or grade as to appreciably increase the size of the main zone. Moreover, the intersection at the southeast margin occurs at a depth of 250 feet, making it almost prohibitive as open pit ore.

Outside the main zone, but within the 4 square mile area of altered trachyte, fluorite mineralization is widespread but below ore grade. No improvement in grade over the main zone is evident here (maximum is 5- 10% CaF_2) as a result of geological investigations in the alteration area, hence the property does not appear to have much potential for finding additional ore.

SELECTIVE MINING

The effect of raising the cut-off grade from 15% to 20% CaF_2 is to increase the grade to 26.89% and decrease the total reserves by 37% to 828,700 tons. This tonnage would sustain a mining operation for four years at 600 tpd or for 6 years at 400 tpd and both operations show a loss on investment as indicated in Cases 3 and 4 on Table I.

The following is a tabulation of cumulative tonnages & grades at various % CaF_2 intervals.

Range of CaF_2	Cumulative Total Tons	% CaF_2
Over 40%	19800	42.50
35-40%	63400	39.06
30-35%	193700	34.65
25-30%	450300	30.58
20-25%	828700	26.89
15-20%	1,308,000	23.46

SENSITIVITY TO DECREASED COSTS, INCREASED PRODUCTION

The Denison Report suggests that capital costs could have a variance of minus 20% plus 15% and operating costs a variance of minus 15% plus 10%. Since any increase in costs (plus variance) would only worsen the base case, the minus variance was applied by decreasing capital and operating costs 20% and 15% respectively as shown in Case 5. The resulting return on investment is 15.3%

If we assume that additional exploration on the property resulted in increased reserves sufficient to double the production rate, the analysis would appear as in Case 6, which shows a return on investment of 17.8%. At 1½ times base case production rate (1500 tpd) the return (Case 7) is 12%. This would indicate that a minimum 15% return on investment could be attained with a production rate between 1500 and 2000 tpd. As noted previously, the possibility of increasing reserves on the Birch Island property is remote.

CASE II MOLYBDENUM RECOVERED AS / /-PRODUCT

BIRCH ISLAND FLUORSPAR REXSPAR & DENISON MINES LTD.

CALCULATION OF CASH FLOW & DCF ROR

	1	2	3	4	5	6
Operating Profit	1,796,046	1,796,046	1,796,046	1,796,046		
B.C Mining Tax						
Tax Free Allowance	10,000	10,000	10,000	10,000		
Depreciation Available	1,659,000	1,179,300	843,510	608,457		
Depreciation Used	1,636,000	1,202,300	843,510	608,457		
Depreciation Deferred	23,000	--	--	1,419,643		
Terminal Loss	--	--	--	848,643		
P.Prod Expend. w/o	150,000	--	--	--		
Mining Tax Base	0	583,746	952,896	328,946		
Processing Allowance	0	87,562	142,934	49,342		
Taxable Income	0	496,184	809,962	279,604		
Mining Tax Payable	0	74,428	121,494	41,941		
Federal Corporation Tax						
Depreciation Available	5,530,000	3,943,954	2,271,172	638,396		
Depreciation Used	1,646,046	1,732,782	1,692,776	638,396		
Depreciation Deferred	3,883,954	2,211,172	578,396	--		
P.Prod. Expend. w/o	150,000	--	--	--		
85% of Mining Tax	0	63,264	103,270	35,650		
Income before Depl. (IBD)	0	0	604	1,122,000		
Automatic Depletion	0	0	0	374,000		
Taxable Income	0	0	0	748,000		
Corp. Tax Payable	0	0	0	374,000		
Mining & Corp. Tax payable	0	74,428	121,494	415,941		
Recapture working Cap.	--	--	--	500,000		
Salvage Value	--	--	--	547,000		
Annual Cap. Expend.	60,000	60,000	60,000	60,000		
Cash Flow	1,736,046	1,661,618	1,614,552	2,367,105		
Mining & Milling Cost	5,470,000					
Pre-Production Expend.	150,000					
Working Capital	500,000					
Rate of Return Base	6,120,000					
DCF Rate of Return	7.5%					

CASE V DECREASE CAPITAL COSTS (20%) AND OPERATING COSTS (20%)

BIRCH ISLAND FLUORSPAR REXSPAR & DENISON MINES LTD.

CALCULATION OF CASH FLOW & DCF ROR

	1	2	3	4	5	6
Operating Profit	1,842,486	1,842,486	1,842,486	1,842,486		
B.C Mining Tax						
Tax Free Allowance	10,000	10,000	10,000	10,000		
Depreciation Available	1,296,000	919,200	655,440	470,808		
Depreciation Used	1,296,000	919,200	655,440	470,808		
Depreciation Deferred	0	0	0	1,098,552		
Terminal Loss	--	--	--	670,552		
P.Prod Expend. w/o	150,000	--	--	--		
Mining Tax Base	386,486	913,286	1,177,046	691,126		
Processing Allowance	57,973	136,993	176,557	103,669		
Taxable Income	328,513	776,293	1,000,489	587,457		
Mining Tax Payable	49,277	116,444	150,073	88,119		
Federal Corporation Tax						
Depreciation Available	4,320,000	2,709,357	1,005,848	40,000		
Depreciation Used	1,650,643	1,743,509	1,005,848	40,000		
Depreciation Deferred	2,669,357	965,848	0	0		
P.Prod. Expend. w/o	150,000	--	--	--		
85% of Mining Tax	41,843	98,977	127,562	74,901		
Income before Depl. (IBD)	0	0	709,076	1,727,585		
Automatic Depletion	0	0	236,359	575,862		
Taxable Income	0	0	472,717	1,151,723		
Corp. Tax Payable	0	0	236,359	575,862		
Mining & Corp. Tax payable	49,277	116,444	386,432	663,981		
Recapture working Cap.	--	--	--	400,000		
Salvage Value	--	--	--	428,000		
Annual Cap. Expend.	40,000	40,000	40,000	40,000		
Cash Flow	1,753,209	1,686,042	1,416,054	1,966,505		
Mining & Milling Cost	4,280,000					
Pre-Production Expend.	150,000					
Working Capital	400,000					
Rate of Return Base	4,830,000					
DCF Rate of Return	15.3%					

CASE VI DOUBLE PRODUCTION RATE

BIRCH ISLAND FLUORSPAR REXSPAR & DENISON MINES LTD.

CALCULATION OF CASH FLOW & DCF ROR

	1	2	3	4	5	6
Operating Profit	3,058,572	3,058,572	3,058,572	3,058,572		
B.C Mining Tax						
Tax Free Allowance	10,000	10,000	10,000	10,000		
Depreciation Available	1,938,000	1,374,600	980,220	704,154		
Depreciation Used	1,938,000	1,374,600	980,220	704,154		
Depreciation Deferred	0	0	0	1,643,026		
Terminal Loss	--	--	--	1,003,026		
P.Prod Expend. w/o	150,000	--	--	--		
Mining Tax Base	960,572	1,673,972	2,068,352	1,341,392		
Processing Allowance	144,085	251,096	310,253	201,209		
Taxable Income	816,486	1,422,876	1,758,099	1,140,183		
Mining Tax Payable	122,473	213,431	263,715	171,027		
Federal Corporation Tax						
Depreciation Available	6,460,000	3,715,630	898,474	60,000		
Depreciation Used	2,804,370	2,877,156	898,474	60,000		
Depreciation Deferred	3,655,630	838,474	0	0		
P.Prod. Expend. w/o	150,000	--	--	--		
85% of Mining Tax	104,102	181,416	224,158	145,373		
Income before Depl. (IBD)	0	0	1,935,940	2,853,199		
Automatic Depletion	0	0	645,313	951,066		
Taxable Income	0	0	1,290,627	1,902,133		
Corp. Tax Payable	0	0	645,314	951,067		
Mining & Corp. Tax payable	122,473	213,431	909,029	1,122,094		
Recapture working Cap.	--	--	--	1,000,000		
Salvage Value	--	--	--	640,000		
Annual Cap. Expend.	60,000	60,000	60,000	60,000		
Cash Flow	2,876,099	2,785,141	2,089,543	3,516,478		
Mining & Milling Cost	6,400,000					
Pre-Production Expend.	150,000					
Working Capital	1,000,000					
Rate of Return Base	7,550,000					
DCF Rate of Return	17.8%					

CASE VII 1.5 TIMES PRODUCTION RATE

BIRCH ISLAND FLUORSPAR REXSPAR & DENISON MINES LTD.

CALCULATION OF CASH FLOW & DCF ROR

	1	2	3	4	5	6
Operating Profit	2,293,929	2,293,929	2,293,929	2,293,929		
B.C Mining Tax						
Tax Free Allowance	10,000	10,000	10,000	10,000		
Depreciation Available	1,770,000	1,254,000	892,800	639,960		
Depreciation Used	1,770,000	1,254,000	892,800	639,960		
Depreciation Deferred				1,493,240		
Terminal Loss	--	--	--	908,240		
P.Prod Expend. w/o	150,000	--	--	--		
Mining Tax Base	363,929	1,029,929	1,391,129	736,089		
Processing Allowance	54,589	154,489	208,669	110,413		
Taxable Income	309,340	875,440	1,182,460	625,676		
Mining Tax Payable	46,401	131,316	177,369	93,851		
Federal Corporation Tax						
Depreciation Available	5,900,000	3,845,512	1,713,202	50,000		
Depreciation Used	2,104,488	2,182,310	1,713,202	50,000		
Depreciation Deferred	3,795,512	1,663,202	0	0		
P.Prod. Expend. w/o	150,000	--	--	--		
85% of Mining Tax	39,441	111,619	150,764	79,773		
Income before Depl. (IBD)	0	0	429,963	2,164,156		
Automatic Depletion	0	0	143,321	721,385		
Taxable Income	0	0	286,642	1,442,771		
Corp. Tax Payable	0	0	143,321	721,386		
Mining & Corp. Tax payable	46,401	131,316	320,690	815,237		
Recapture working Cap.	--	--	--	800,000		
Salvage Value	--	--	--	585,000		
Annual Cap. Expend.	50,000	50,000	50,000	50,000		
Cash Flow	2,197,528	2,112,613	1,923,239	2,813,692		
Mining & Milling Cost	5,850,000					
Pre-Production Expend.	150,000					
Working Capital	800,000					
Rate of Return Base	6,800,000					
DCF Rate of Return	12%					

July 22, 1971.

MEMO TO: File

cc: K. C. Hendrick
J. Gibson

FROM: G. J. Quinn

SUBJECT: DENNISON - FLUORSPAR

Jim Gibson from Exploration asked for some spar prices for an evaluation study he was doing on potential spar out of the Dennison, British Columbia property.

I suggested two delivery points from Kamloops, Japan and Chicago. Carl Hibbeln's approximate costs to Japan totalled $16.31 from the mine. This was made up of $1.65/ton trucking costs to Kamloops plus $4.60/ton railing to Vancouver. Vancouver handling costs would be about $2.00/ton. Estimated ocean freight on a 10,000 ton parcel from Vancouver to Japan would approximate $9.00/Long ton or $8.06/Short ton.

Total costs from Kamloops to Chicago would be higher because of the U.S. duty and high rail costs. Missouri Pacific Railroad had quoted me a combination rate of $35.61 on a trial lot of spar from Brownsville to Regina. Carl Hibbeln used this factor plus another rail estimate to come up with an approximate Kamloops to Chicago rail cost of about $25.00/Short ton. Total cost would then be $32.50/Short ton.

Jim Gibson confirmed the spar would be about 90% CaF_2. Our current price for this grade is $58.25/Short ton f.o.b. Tampico. Deducting $15.00 in freight and taxes before subsidy, the return at the mine would be about $43.00. With subsidy, it would be about $47.00. The approximate delivered price to Chicago ex B.C. would be about $76.00 US/St.

Because the fluoride zone is so small, Jim Gibson's initial estimates indicate it to be one of very low profitability.

GJQ/pm

BIRCH ISLAND FLUORSPAR
OPERATING PROFIT CALCULATION

TABLE I

	1	2	3	4	5	6	7
	Base Case	Mo Recovered as By-Product	20% Cut-Off at 144,000 tpy 400 tpd	20% Cut-Off at 216,000 tpy 600 tpd	Decrease Capital and Operating Costs	Double Production Rate 2000 tpd	1½ Times Production Rate 1500 tpd
Tons Milled/Year	360000		144000	216000	360000	720000	540000
·ade CaF_2	23.46		26.89	26.89	23.46	23.46	23.46
Recovery CaF_2	92.50		92.50	92.50	92.50	92.50	92.50
Tons 90% CaF_2 Concentrate	86802		39797	59696	86802	173604	130203
Revenue PST Concentrate	43.		43.	43.	43.	43.	43.
Gross Revenue CaF_2	3732486	3732486	1711280	2566919	3732486	7464972	5598729
Grade Mo	--	.054	--	--	--	--	--
Recovery Mo	--	50	--	--	--	--	--
Lbs. Mo Concentrate	--	194400	--	--	--	--	--
Revenue/Lb Mo Contained	--	1.65	--	--	--	--	--
Gross Revenue Mo	--	320760	--	--	--	--	--
Total Revenue CaF_2 + Mo	3732486	4053246	1711280	2566919	3732486	7464972	5598729
Operating Cost PST Ore	5.82	5.97	7.60	6.60	4.95	5.82	5.82
›erating Cost Ore	2095200	2149200	1094400	1425600	1782000	4190400	3142800
Stripping Tons (Ratio 0.4/1.0)	144000	144000	58000		144000	288000	216000
Stripping Cost @$0.75PST Waste	108000	108000	432000	64800	108000	216000	162000
Total Operating Costs	2203200	2257200	1137600	1490400	1890000	4406400	3304800
Operating Profit	1529826	1796046	573680	1076519	1842486	3058572	2293929
Total Capital	5900000	6020000	4018000	5140000	4700000	7500000	6800000
Project Life	4	4	6	4	4	4	4
DCF ROR	Loss	7.5%	Loss	Loss	15.3%	17.8%	12%