

PLACER DEVELOPMENT LIMITED

MEMORANDUM

TO: Distribution

DATE: June 30th 1971

FROM: J.H. Eastman

RE: Adanac Mining and Exploration Co. Preliminary Review of Ruby Creek Molybdenum Deposit, Atlin, B.C.

Attached is a report on the Adanac Molybdenum prospect in the Atlin area of British Columbia.

A recently compiled feasibility study suggested that the prospect, if put into production, could do little more than pay back interest on its capital debt, without being able to repay much of it before close-down. Our review suggests that unjustifiable procedures were used to up-grade the ore reserves used in the feasibility study and that the economic picture is thus even worse.

A hypothetical case incorporating all the most optimistic possible assumptions was evaluated. Even this case indicated a loan pay-back period exceeding ten years, occupying some two-thirds of the indicated total life.

J.H. Eastman

HKT/1mh

c.c., T.H. McClelland/A.E. Gazzard/J.D. Little R.G. Duthie J.L. McPherson E.A. Scholz L. Adie J.H. Eastman/Eng. File File (2)

ADANAC MINING AND EXPLORATION CO. PRELIMINARY REVIEW OF RUBY CREEK MOLYBDENUM DEPOSIT, ATLIN B.C.

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GEOLOGICAL MEMORANDUM

H.K. Taylor A.D. Drummond PAGE

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AIM

To present a preliminary review of the Ruby Creek Molybdenum prospect owned by Adanac Mining and Exploration Company, to indicate whether further study or action is warranted. The deposit is located near Atlin, B.C.

The deposit was first brought to Placer's attention in 1969 and was declined. Kerr-Addison Mines then spent \$2.7 million on underground exploration, bulk sampling, pilot plant milling and a feasibility study. The last was compiled and assembled by Chapman, Wood and Griswold. In May 1971, Kerr-Addison notified their withdrawal.

This report and the accompanying geological appendix were compiled mainly from a few days' study of Volumes II and IV of the Feasibility Study, from drill data made available, and from discussions with Messrs. J.D. Pelletier and W.W. Bennett.

FINDINGS AND COMMENT

Ore Reserve

Various determinations have been:

				M.S. Tons	% MoS ₂	Cut-Off Grade
Chapmar	n, Wood	l, Griswold	1969	69	0.14	Prob. 0.10
Adanac	1971,	"Fixed Adj	ustment"	70.7	0.146	Part. 0.10 Part. 0.15
Adanac	1971,	"Variable	Adjustment"	104.2	0.160	Part. 0.10 Part. 0.19
**	11	11	11	119.8	0.155	0.10
Placer	1971,	Geological	Reserve	49.9	0.14	0.10

Higher-Grade Zone Only:

Adanac 1	971, F.A.	24.2	0.184	0.15
Adanac 1	971, V.A.	33.6	0.189	0.15
Placer 1	971	13.0	0.18	0.14

Strip ratios for the Adanac "Variable Adjustment" (explained below) reserve would be 1.04:1 for the higher-grade zone and 0.53:1 for the remaining 70.6 million tons. Except for a possibility of small extensions to the southwest and south-east under 400-600 feet of cover, the ore structure is closed.

Up-Grading

Comparison of about 900 feet of parallel drilling and raising indidated that bulk samples averaged 17% higher than the drill assays. Drill assays exceeding 0.2% MoS_2 tended to be down-graded by bulk sampling, while assays in the 0.05-0.1% MoS_2 range were substantially up-graded: This effect is not uncommon in sampling experience and is explainable by statistical theory.

Unfortunately, justifiable up-grading of low-grade material within the generally high-grade environment of the underground workings was followed by wholesale up-grading of all other low-grade, wherever it might be. This doubtful procedure yielded the so-called "Variable Adjustment" reserve, which was inflated by large tonnages of material drill-assayed at 0.05-0.1% MoS₂ and arbitrarily up-graded to 0.1-0.15% MoS₂. The 104 million ton reserve must therefore be regarded with strong suspicion.

Feasibility Study

Some figures are summarized below:

Molybdenum Price	\$1.82/1b. U	J.S. = \$1.13 (Cdn.net per 1	lb. MoS ₂
Working Cost	Averages \$2	.70 per ton :	in early year	rs.
Concentrator recovery	90 - 94% av	veraging 93%		
Finance	By loans at	2.5%		
Outputs	Per day Per year	\$15,000 t. 5.25 m.t.	18,000 t. 6.3 m.t.	20,000 t. 7.0 m.t.
Capital (excl.p.p. interest)		\$70 m.	\$74 m.	\$80 m.
Life of 104 m.t. ore reserve		20 yrs.	17 yrs.	15 yrs.
Unpaid debt at close-down		\$69 m.	\$60 m.	\$57 m.
Cash flow to equity		NIL	NIL	NIL

Most Optimistic Case

To assess roughly how far things <u>might</u> be improved a modified estimate was made. The dubious ore-reserve estimate was accepted, as also was the \$1.82 molybdenum price (currently about 15¢ lower). Capital and working costs were cut to what may be below the minimum possible for this remote area. Taxation was assumed nil till capital had been redeemed.

	15,000 tpd	20,000 tpd
Capital (inc.p.p. interest)	\$55 m.	\$65 m.
Working cost (early years)	\$2.25 per ton	\$2.10 per ton
Years to retire Capital Debt	13-14	10
Ore required to retire Debt	73 m. tons @ 0.166%MoS ₂	70 m. tons @ 0.167%MoS ₂
Remaining life (of 104 m. tons)	6 yrs.	5 yrs.
At approx. annual cash flow before taxes	\$4 m.	\$6 m.

Conclusions

Even on over-optimistic assumptions, the project is risky, marginal and unattractive. Short of a drastic and permanent increase in molybdenum price relative to costs, it is difficult to see any factors open to improvement. There is too little ore of too low a grade at too awkward a locality.

The writers of this report and the geological appendix have had time to examine only parts of the feasibility study and Adanac's supporting data; but consider however, that they have studied adequate information to validate their conclusion.

ORE RESERVES AND MINING SEQUENCE

Previous to the Kerr-Addison work, ore reserves at Adanac had been estimated as 69 million tons at $0.14\% \text{ MoS}_2$. The new estimates are based on two alternative presumptions; a uniform 15% up-grading of all drill assays, and a variable up-grading affecting mainly the lower values. These adjustments were suggested by comparisons of drilling and bulk sampling. New reserves on the two bases are given as:

	+159	<u>k Adj</u> .	<u>Var</u> .	<u>Adj</u> .
	Tons x106	% MoS ₂	Tons x10 ⁶	% MoS ₂
Proved & Probable				
Initial Pit	23.833	0.184	33.225	0.189
Onward Pit	43,595	0.123	67.425	0.147
	69.428	0.146	100.650	0.161
Inferred				
Initial Pit	0.387	0.183	0.387	0.205
Onward Pit	0.851	0.132	3.197	0.135
	1.238	0.148	3.584	0.143
TOTAL	70.666	0.146	104.234	0.160

Pit designs were based, apparently, only on the less conservative "Variable Adjustment" basis. Benches were 40' high, wall slopes 45° and the density factor 12 cu. ft. per short ton. Cut-off grades were 0.15% MoS₂ for the initial pit and 0.10% MoS₂ thereafter.

Mining Sequence (apparently as slices from top down):

	Tons x10 ⁶	% MoS ₂	Waste x 10 ⁶	Strip <u>Ratio</u>
	6,293	0.210	2.534	0.4
	7.373	0.185	13.680	1.9
	5.613	0.184	0.933	0.2
	7.027	0.184	15.827	2.3
	7.306	0.183	1.799	0.25
Total Initial Pit	33.612	0.189	34,733	1.04
Onward Pit	70.622	0.146	37.433	0.53
	104.234	0.160	65.414	0.63

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The initial Pit contains 15,575 m. tons between 0.1 and 0.15% MoS_2 . If this is assigned 0.125% MoS_2 , total tonnage above 0.1% cut-off is:

	Tons x10 ⁶	% <u>MoS</u> 2	Waste x10 ⁶	Strip <u>Ratio</u>	
Initial Pit, over 0.15%	33.612	0.189	34.733	1.04	
0.10 - 0.15%	1 5 .575	0.125	-	-	
Initial Pit, over 0.1%	49.187	0.169	19.158	0.39	
Onward Pit, over 0.1%	70.622	0.146	37.433	0.53	
Total over 0.1%	119.809	0.155	56.591	0.47	

Annual Mining and Stripping (at 18,000 tons milled per day):

	104.0	-	81.0	0.78
10415 0-17		-	<u> </u>	.
Vears $8-17$	6.0	_	3.0	0.5
Year 7	6.0	-	6.0	1.0
Years 1-6	6.0	-	7.5	• 1.25 🔫 — 🗡

All the figures in this section are those claimed in the Adanac Feasibility Study.

GRADE ESTIMATION AND ADJUSTMENT

Adanac Work

Kerr-Addison mined an adit 1,600 feet westward into the highest grade area of the deposit, drove north and south for about 800 feet, and put up eight raises adjacent and parallel to drill-holes from surface. A total of 95 pairs of comparative assays were made or composited, most covering 10 feet, for a total of between 850 and 900 feet of raising. Assays of core and bulk samples were duplicated in two laboratories, and agreed or selected results were used for comparison.

	Drill Assays	Bulk Sample Assays
Arithmetic Mean	0.144% MoS2	0.169% MoS ₂
% Increase	-	16.8
Variance of Data*	0.022	0.009
Standard Deviation*	0.148% MoS ₂	0.097% MoS ₂
Most Frequent Values*	0.0 - 0.02% MoS ₂ and 0.10 - 0.16 MoS ₂	0.04 - 0.08% MoS ₂ and 0.12 - 0.18% MoS ₂

* Determined by Placer

The direct relation became a justification for an across-theboard increase of all drill grades. In a more comp'ex approach, a "bestfit" curve was drawn, indicating 160% up-valuation of 0.05% MoS₂ drill grades and smaller up-valuations of 80% of 0.1%, 32% of 0.15% and 4% of 0.2%. Higher-grade assays were down-graded. This curve, whose mathematical justification is unknown, was used for the alternative "Variable Adjustment" on which ore reserve declarations, mining grades and cash flow estimates were all based.

The adjustment was applied to all grades, within and without the high-grade core area.

Placer Work

The 95 sets of paired assays were subjected to regression analysis. Linear regression (Y = A + BX) correlated poorly. It was felt that if the assays had come from a roughly log-normal population, the logarithmic-linear equivalent (Y = AX^B) might give a better picture of the relation of bulksample and drill assays. This proved to be so, though with a correlation coefficient still barely over 0.5. Data for two regression fits are given below. Y is bulksample assay, X = drill assay, A and B are constants for the curve of best fit, R = correlation coefficient.

Function	<u>A</u>	<u>B</u>	<u>R</u>	Crossover (Y = X)
Y = Z + BX (linear)	0.11	0.41	0.385	0.185% MoS ₂
$Y = AX^B$ (logar.)	0.35	0.35	0.522	0.197% MoS ₂

The Adanac "Variable Adjustment" curve corresponds to the formula $Y = 0.46X^{0.49}$, and thus appears to be far from the optimum fit. The practical effect, however, is not large; as indicated in the following table which depicts the adjustments made to drill grades by various procedures. All figures are % MoS₂.

Drill Assay	Adanac Fixed 15% Up-Grading	Adanac Variable Adjustment Y = 0.46X ^{0.49}	Linear Adjustment Y - 0.11 + 0.41X	Best-Fit Variable Adjustment Y = 0.35X ^{0.35}
0.00	0.000	0.000	0.110	0.000
0.05	0.057	0.111	0.130	0.123
0.10	0.115	0.171	0.151	0.156
0.15	0.172	0.190	0.171	0.180
0.2	0.230	0.210	0.191	0.200
0.3	0.345	0.240	0.232	0.230
0.4	0.460	0.280	0.272	0.254
0.5	0.575	0.324	0.313	0.275

Discussion

Where mineralization is by randomly scattered veinlets, it is normal for bulk-sampling to exhibit lower variance than drill sampling. The effect is well-known in statistical theory, whereby large samples exhibit lower variance than small samples taken from the same population. It follows that, irrespective of any overall up-grading or down-grading, small samples assaying high tend to over-value; while small samples assaying low within a generally higher-grade environment tend to under-value. The assay returned by a small drill sample tends to reflect its luck in hitting or missing a veinlet, while the larger raise sample has a better chance of intersecting a representative proportion of veinlets. One cannot, therefore, quarrel seriously with an adjustment system of the type used, provided that its use is confined to the environment for which it was determined. Lacking further supporting information, extension outside is indefensible. The Feasibility Study itself expressed doubts on this point (Vol. II Page IX - 5) but, immediately went on to use the "Variable Adjustment" to up-grade large amounts of peripheral material assaying consistently low and therefore probably correctly valued. Ground drillsampled at perhaps 0.05 - 0.07% MoS₂ and well below cut-off was up-graded to perhaps 0.13% MoS₂, and then included in onward-pit ore reserves.

Summary

The Geological Department (Dr. A.D. Drummond), studying results for the 4,700 - 4,800' bench which contains the adit parts of the raises, and the bulk of meterial assaying better than 0.20% MoS_2 , considered that there was little reason to up-grade this section. Both drilling and bulksampling averaged 0.18% MoS_2 .

The Engineering Department (H.K. Taylor), concedes that there may be a reasonable case for some value adjustment, and for up-grading of lowergrade material within the higher-grade core area, but considers up-grading of any peripheral low-grade material to be unwarranted.

Either way, the ore-reserve as declared must be regarded as seriously over-valued. Dr. Drummond's estimate of the geological reserves is:

	Tons x10 ⁶	<code>%MoS₂</code>
Above 0.14% MoS ₂	13.0	0.18
0.10 - 0.14	36.9	0.12
Above 0.10% MoS ₂	49.9	0.14

ECONOMICS OF THE FEASIBILITY STUDY

Three tonnage cases were worked out, for 15,000 \times 8,000 and 20,000 tons per day. The tabulated results (below) were for 100% loan finance at 7.5% interest, Mo at 1.82 U.S. per 1b. equivalent to \$1.129 Cdn. per 1b. MoS₂ net at mine, \$1. Cdn. = 96¢ U.S., concentrator recovery = 92% in Year 1, 94% for new ore thereafter, 90% for stockpiled ore. All cases presumed the "Variable Adjustment" grade basis.

Working Costs (18,000 t.p.d.

	Years <u>1-6</u>	Year _7	Years <u>8-17</u>
Mining, per ton handled	40.7¢	40.7¢	41.5¢
Strip Ratio	1.25	1.0	0.5
Mining per ton milled	91.5¢	81.4¢	62.3¢
Milling and Power	127.2¢	127.2¢	127.2¢
General and Admin.	51.7¢	51.7¢	51.7¢
TOTAL, per ton milled	\$2.704	\$2.603	\$2.412

		15,000 tpd	18,000 tpd	20,000 tpd
Capital (\$m.)	•	,		
Pit Preparation		3.465	3,465	3.465
Roads		.500	.500	.500
Pit Equipment		4.920	5.417	6.543
Conc. & Surface Plant		50.672	53.350	57.900
Townsite		5.551	5.551	5.551
Options & Royalties		0.480	0.480	0.480
Working Capital & Inven	tory	4.600	5.000	5.600
TOTAL Capital (excl.pre intere	e-prod. est)	70.188	73.763	80.039
Life (Years)		19.8	16.5	14.9
Profit over whole life	(\$m.)	92.852	105.945	112.790
Interest Paid	(\$m.)	92.852	92.039	89.127
Loan Repayment	(\$m.)	-	12.515	21.296
Unpaid Loan	(\$m.)	69.558	59.857	56.777

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ECONOMICS OF HYPOTHETICAL "MOST OPTIMISTIC" CASE

The Adanac feasibility study displayed cash flow schedules for outputs of 15,000, 18,000 and 20,000 t.p.d. All failed dismally to retire any significant proportion of the capital debt over the entire life of the postulated ore reserves. As noted elsewhere, the Exploration Department and the writer consider the ore reserve to have been unjustifiably inflated by the up-grading procedures used. The economics are, therefore, even worse than those of the study's projections.

To assess roughly what improvement might be required, further cash flows have been compiled on a "most favourable assumption" basis. For this purpose, the Adanac ore reserves were accepted, despite misgivings. Capital and working costs were reduced to what were considered the lowest likely levels, assuming economical design and efficient operating; but bearing in mind the remoteness of the site, the necessity to generate power and the circuitousness of the supply route. Finally, the feasibility study's molybdenum price was used, despite being higher than now obtainable.

Summary of Input Figures

	Optimisti	<u>.c</u> <u>F</u>	easibility
Capital for 15,000 t.p.d.	\$55 m.		\$70 m.
for 20,000 t.p.d.	\$65 m.		\$80 m.
Working Cost	(15,000 tpd) ((20,000 tpd)	[18,000 tpd)
Mining per ton mined	30.0¢	30.0¢	40.7¢
Mining per ton milled (@1.25:1)	\$0.675	\$0.675	\$0.915
Concentration & Power	1.100	1.000	1.272
General & Admin.	0.475	0.425	0.517
	\$2.25	\$2.10	\$2.70
Grades (%MoS ₂)	5 yrs @ 0.189	4 yrs @ 0.18	9 Same
	1 yr. @ 0.163	1 yr. @ 0.18	0 General
	14 yrs @ 0.146	10yrs.@ 0.14	6 Sequence
Plant Recoveries	93%		90-94%
Molybdenum Price:			
Gross, U.S. \$ per 1b. Mo.	\$1.82		\$1.82
Net, Cdn. \$ per lb.	\$1.13		\$1.13

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•	Optimistic	Feasibility
Sales Charges	Incl.	-
Interest Rate	8%	-
Finance:	100% debt	~
Repayable from 100% of available cash flow.		
Taxes	None till debt retired.	- '
Results	.	
· · ·	15,000 t.p.d.	20,000 t.p.d.
Years to retire debt (approx.)	13-14	10
Ore milled to debt retirement ((approx.) 73 m. tons	70 m. tons
at grade of (% MoS ₂)	0.166	0.167
Remaining life (of 104 m. tons	ore res.) 6	. 5
at approx. annual ca before taxes	ash flow \$4 million	\$6 million

A shortened cash flow schedule for the first seven years is given overleaf.

TABLE 1 - ADANAC CASH FLOW PROJECTIONS - EARLY YEARS ONLY

All figures in \$,000 Canadian. No taxes till capital is retired. Mo Price = \$1.82 U.S. per 1b. Interest = 8% Capital and Working Costs are "Most Optimistic" assumptions.

	Years	1	2	3	4	5	6	7	8 on
15,000 T.P.D.									
Rev./ton (\$) Cost/ton (\$)		3.97 2.25	3.97 2.25	3.97 2.25	3.97 2.25	3.97 2.25	3.97 2.25	3.43 2.175	3.07 2.175
Revenue Cost Working Profit Less Interest Less Current Cap. expl. etc. Less Loan Rep. Bal. = Cash Fl.		20842 11812 9030 4400 400 4230	20842 11812 9030 4062 400 4568	20842 11812 9030 3696 400 4934 -	20842 11812 9030 3301 400 5329 -	20842 11812 9030 2875 3000 3155	20842 11812 9030 2623 400 6007 -	18008 11419 6589 2142 400 4047 -	16118 11419 4699 (1818 Yr.8) Av. 920
LOAN BALANCE	55,000	50770	46202	41268	35939	32784	26777	22730	(13-14 Yrs.) (To Retire)
20,000 T.P.D.									
Rev./ton (\$) Cost/ton (\$)	ŕ	3.97 2.10	3.97 2.10	3.97 2.10	3.97 2.10	3.79 2.10	3.07 2.025	3.07 2.025	3.07 2.025
Revenue Cost Working Profit Less Interest Less Current Cap. Less Loan Rep. Bal. = Cash Fl.		27790 14700 13090 5200 500 7390 -	27790 14700 13090 4609 500 7981	27790 14700 13090 3970 500 8620 -	27790 14700 13090 3281 500 9309 -	26530 14700 11830 2536 3500 5794 -	21490 14175 7315 2072 500 4743	21490 14175 7315 1693 500 5122 -	21490 14175 7315 1283 Yr. 8 Av. 1100 -
LOAN BALANCE	65,000	57610	49629	41009	31700	25906	21163	16041	(+10 Yrs.) (To Retire)

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DIVISION OF CANADIAN EXPLORATION LIMITED

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VANCOUVER 5, B. C. CANADA

MEMORANDUM

то:	H.K. TAYLOR	DATE:	JUNE 11, 1971
FROM:	A.D. DRUMMOND	FILE:	GRID 104-N-11
RE:	RUBY CREEK MOLYBDENITE DEPOS ADANAC MINING AND EXPLORATIO	IT N LTD.	

INTRODUCTION

On June 4, 1971, discussion with Mr. J.D. Pelletier and Mr. W.W. Bennett lead to an investigation of the Kerr-Addison feasibility report. Of particular interest was the validity or degree of confidence to be placed on the "indicated adjustment factors" used to "upgrade" the orebody.

A geological assessment of the adjustment factors was undertaken and is outlined below.

DEFINITION OF GRADE DISTRIBUTION

Vertical sections showing 100' bench and 100' core assay composites were used to assess the distribution of molybdenite within the Ruby Creek deposit. The 100' composites were contoured at .10, .14 and .20% MoS₂ on bench plans to give the horizontal grade distribution per 100' slice through the deposit. Bench plans from 5100 to 4300 inclusive were constructed.

The 4700' bench (elevation 4700 to 4800 feet) includes the Kerr-Addison adit and parts of the raises. From contouring the composite core assays, it is noted that (1) the 4700 bench contains the only appreciable volume of material greater than .20% MoS₂ (See Figure 1), (2) the bulk sample from the drift and raises is almost entirely within the area of greater than .20% MoS₂ on the 4700 bench, and (3) other benches between 4300 and 5100 indicate only minor volumes of material equal to or greater than .20% MoS₂.

A comparison of composite core and raise assays is outlined below for the 4700 bench (i.e. between 4700 and 4800 feet elevation).

			- 2					
Location	<u>00-8N</u>	<u>00-4N</u>	<u>00-2N</u>	<u>00-1N</u>	00-00	<u>2W-2N</u>	<u>2E-2N</u>	Average
Drill Core	.16% MoS ₂	.26% MoS ₂	.15% MoS ₂	.13% MoS ₂	.16% MoS ₂	.25% MoS2	.16% MoS2	.18
Raise	.16	.30	.18	.13	.09	.18	.22 (partia bench heigh	al .18 nt)
Difference w.r. to core	. = =	+.04	+.03	~~	07	07	+.06	

The above indicates that the areas defined by the core assays has not been significantly changed when the bulk sample raise assays were added.

GEOLOGICAL RESERVES

The tonnage per 100' bench, using a cut-off grade of .10 and .14% MoS_{22} is outlined below. There is no consideration of a stripping ratio as this is a geological and not a mining reserve.

TABLE 2 - GEOLOGICAL RESERVES

Cut-Off		.10% MoS ₂	.14%	6 MoS2	Combined	¥.10% MoS.	
Bench	Tons	Grade	Tons	Grade	. Tons	Gradé	
4900	750,000	.12	125,000	.15	875,000	.12	
4800	5,183,000	.12	125,000	.14	5,308,000	.12	
4700	9,691,000	.12	7,749,000	.19	17,440,000	.16	
4600	8,500,000	.12	2,956,000	.17	11,456,000	.13	
4500	7,438,000	.11	1,644,000	.17	9,082,000	.12	
4400	3.333.000	.12	•~.••.		3,333,000	.12	
4300	1,983,000	.11	417,000	.14	2,400,000	.12	
TOTAL	36,878,000	.12	13,016,000	.18	49,894,000	.14	

The Kerr-Addison feasibility report gives (1) a proven, probable and inferred tonnage of 70,666,000 tons of .15% MoS₂ at a .10% MoS₂ cut-off grade (this figure is listed as "plus 15% adjustment") and (2) a proven, probable and inferred tonnage of 104,234,000 tons ef .16% MoS₂ at a .10% MoS₂ cut-off grade (this figure is listed as "variable adjustment"). Variable adjustment factor diagram is attached.

CONCLUSIONS

The bulk sample was taken from a restricted and significantly higher grade area within the Adanac deposit.

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Grade comparison between 100 foot core and raise (bulk sample) composites is not significantly different. This means that the deposit can be modelled on 100 foot benches using core assays only.

Geological reserve comparison is shown below. (Includes tonnage of proven, probable and inferred at .10% MoS₂ cut-off grade).

1. 49,894,000 of .14% MoS₂ 2. 70,666,000 of .15% MoS₂ 3. 104,234,000 of .16% MoS₂

(core only).
(plus 15% adjustment) Kerr-Addison.
(variable adjustment) Kerr-Addison.

The figure based on "the variable adjustment factor" is, in my opinion, high by a factor of 100%.

mmø

A.D. Drummond, Ph.D. Research Geologist

ADD:s1b Attach (2)

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