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A COMPUTATION OF THE OPEN PITTABLE PHOSPHATE RESOURCE AT THE MARTISON CARBONATITE, NORTHERN ONTARIO

on behalf of

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Dual # 2.17496

March 1997

INTRODUCTION

At the request of Donald McKinnon a resource computation was undertaken of the phosphate deposit at the Martison carbonatite complex in northern Ontario. The study included the computation of an open pit to determine the volume of overburden required to be removed as well as overall stripping ratios in the mineralized ground. The evaluation, which also involved a compilation and review of all previous work, was undertaken by John Reedman in the Winnipeg office in late February and early March 1997.

LOCATION AND PHYSICAL FEATURES

The Martison carbonatite complex is located in the James Bay Lowlands about 70 km northeast of the town of Hearst (population 5,000) and 15 km southwest of Martison Lake from which the complex derives its name (Fig. 1). The terrain is typical of this part of Ontario consisting of spruce forest, muskeg and numerous small lakes and rivers. The topographic relief at and around the complex only varies within a few metres and the ground is poorly drained. The nearest all-season road access is a logging road 40 km to the SSW. A further 30 km to the south the town of Hearst is located on the Trans-Canada highway and main railway line. Access for the drilling undertaken in 1982 and 1983 was by a winter road put in by Shell Canada Resources Limited in 1982.

GEOLOGY

Due to the widespread cover of thick glacial drift very little is known of the geology in the area. The only data regarding the geology of the Martison complex itself is all from drill holes on the deposit. Core samples of fresh carbonatite show it that varies from a fine- to coarse-grained biotite sövite (calcite-rich carbonatite) to beforsite (dolomite-rich carbonatite) with accessory apatite and magnetite. The carbonatite also displays local fracturing and brecciation. Occasionally glacial drift lies directly on weathered carbonatite bedrock, but in most cases a layer of residuum formed as a result of the weathering of and dissolution of carbonates from the carbonatite parent overlies the carbonatite bedrock.

The residuum, which varies in thickness from less than a metre to more than 100 metres, was classified into five types by the Shell geologists: (1) apatite sand; (2) phosphatic silt and clay; (3) cemented phosphate; (4) fragments of type 3 in type 1 or 2; and (5) non-phosphatic clay. Boulders and blocks of weathered carbonatite may occur within the residuum and it is not always certain that a hole stopped in weathered carbonatite has actually reached bedrock. Highly weathered, friable carbonatite can be difficult to distinguish visually from true residuum which can be identified by the fact that it contains no calcareous material. The bedrock surface is highly irregular with a karst-type topography and the thickest residuum probably occupies sinkholes in the carbonatite.

The most common mineral in the residuum is apatite occurring as small euhedral grains and fragments thereof commonly coated with limonite. Apatite grains and fragments may also occur cemented in a fine matrix of secondary phosphates (type 3 above). Other minerals include

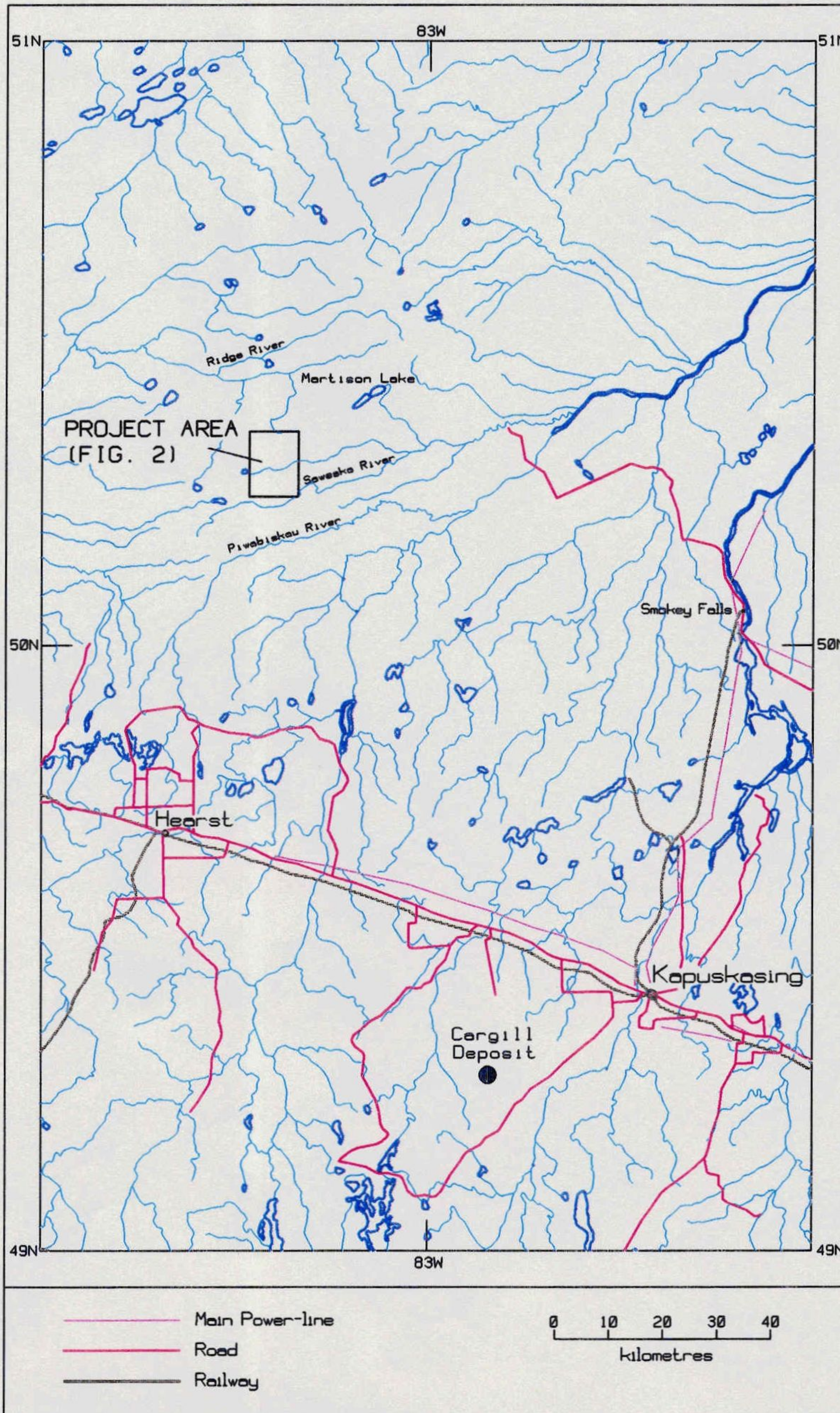

Fig. 1. General Location Map

magnetite, which may be locally concentrated as a magnetite sand, haematite, ilmenite, goethite and clays. The niobium mineral, pyrochlore, occurs as tiny yellow and red grains in the finer fractions. The rare earth mineral, florencite, has been identified and Lakefield Research tentatively identified monazite, another rare earth mineral, in one sample.

MINING AND EXPLORATION HISTORY

Numerous carbonatite complexes are known to occur in this part of Ontario along the Kapuskasing High to the east of Martison Lake and along the Albany Forks structure to the northwest. However, exposure is very poor over much of this area due to thick glacial drift cover and the presence of some of these carbonatite complexes has only been inferred from the Ontario Government aeromagnetic maps. Such was the case for the Martison complex which was first tested by the South Ridge Syndicate (Uranium Ridge Mines and others) in 1965 when a single drill hole on an aeromagnetic anomaly intersected a boulder of cemented secondary phosphates considered to have been derived from a carbonatite.

In 1980 Selco drilled a number of diamond drill holes in the area as part of a diamond exploration project. Four of these holes were within three kilometres of the Martison complex and carbonatite was reported to have been intersected in one of them.

Staking was undertaken by Shell Canada Resources Limited between April 1980 and June 1981. In February 1981 Shell engaged Kenting Earth Sciences Ltd. to fly an airborne survey with a flux-gate magnetometer and Scintrex's TRIDEM electromagnetic system. The EM anomalies were all ascribed to flat-lying conductors within the overburden and there was no correlation with the magnetic amomalies, three of which, designated A, B and C (Fig. 2), were selected for testing by drilling. Five reverse circulation holes for a total of 478 metres were drilled by Shell in 1981, two on anomaly B drilled previously by the South Ridge Syndicate and three on anomaly A. Residuum derived from weathered carbonatite and rich in phosphate was intersected overlying carbonatite bedrock at both sites beneath glacial drift well over 30 metres thick.

One refractive seismic test profile and two resistivity profiles were run across anomaly A by Shell in order to see whether geophysics could be used to determine depth of overburden and depth to bedrock. The seismic work was undertaken by Shell personnel and the resistivity work by D.T.F. Consultants. As a result of the surveys it was concluded that, although refraction seismic could not determine depth to the overburden/residuum contact, it could be used to map the bedrock surface. In the case of the resistivity survey it was concluded that neither depth of overburden nor depth to bedrock could be determined.

In 1982 Shell resumed drilling with a further 38 holes drilled for 2,954 metres. With the exception of one hole, 82-13, which was drilled on anomaly C and only intersected low phosphate values, the drilling was all on anomaly A, the largest of the three anomalies. Reverse circulation drilling was used for 32 of the holes and was undertaken by Forage Moderne Inc. of Val d'Or, Quebec. Short lengths of NQ core were obtained from carbonatite bedrock in holes 82-02, 82-05, 82-07 and 82-11. Midwest Drilling Ltd. of Winnipeg were contracted to drill six holes (82-32 to 82-37) using a sonic drill to obtain core samples from the residuum for metallurgical tests which were conducted by Lakefield Research of Canada Limited.

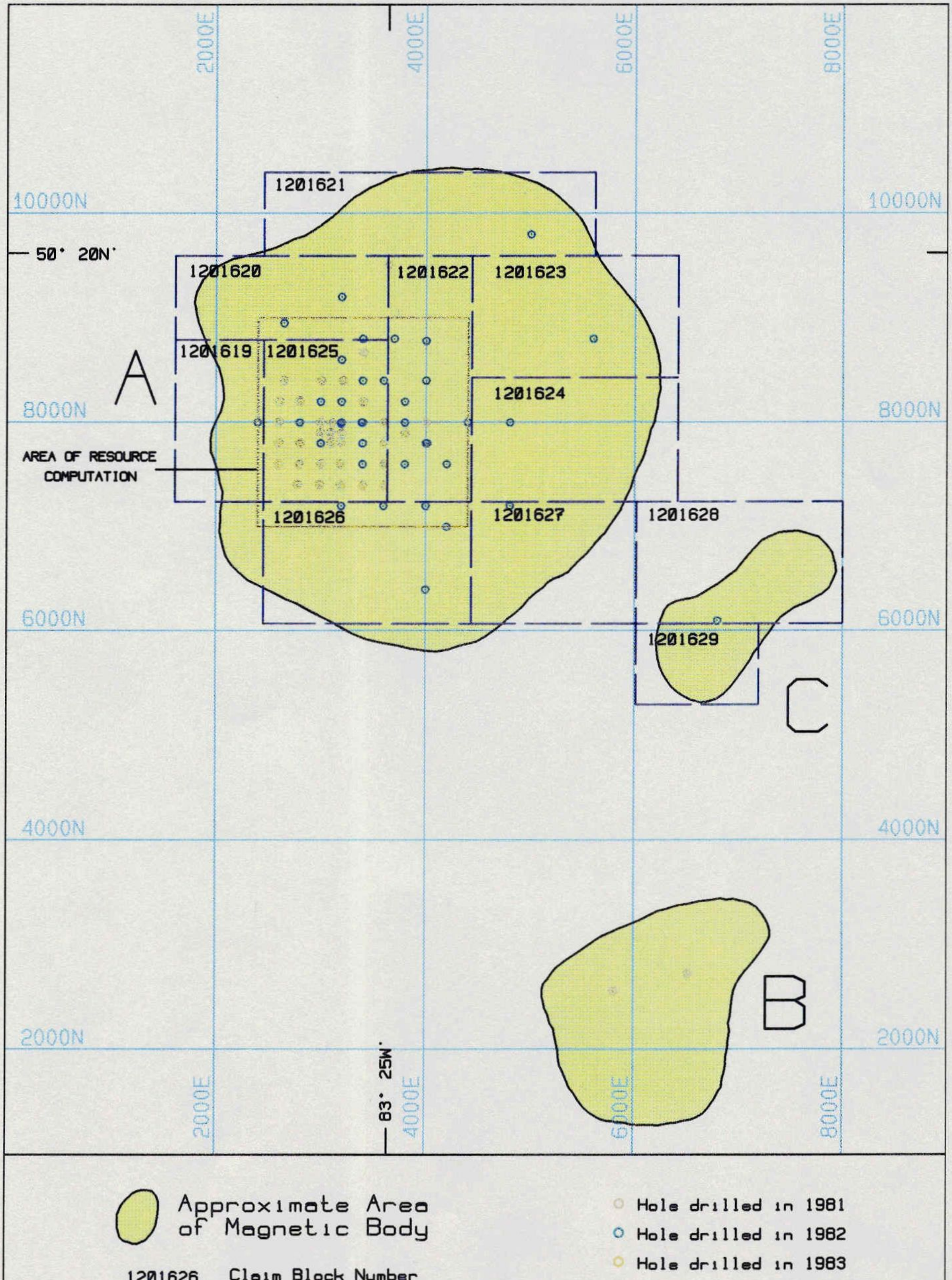

FIG. 2. Drill Hole Location Plan

A total resource of 145 million tonnes grading 20.1% P_2O_5 and 0.35% Nb_2O_5 was computed by Shell using a cut-off of 10% P_2O_5. Metallurgical tests on a sample with a head grade of 22.3% P_2O_5 and 0.72% Nb_2O_5 produced phosphate concentrates grading 32.0% to 34.8% P_2O_5 with recoveries ranging from 75% to 68% and pyrochlore concentrates grading 40.8% to 46.7% Nb_2O_5 with recoveries ranging from 40.4% to 30.3%.

A preliminary capital operating cost estimate was made by Kilborn Limited in August 1982 based on a mine/mill complex designed to produce one million tonnes of phosphate concentrate per annum. This put capital costs at $29 million and total annual operating costs at $36 million.

Following a corporate decision by Shell in 1982 to withdraw from mineral exploration the property was acquired by Camchib Mines Inc. and Eastern Petroleum Corporation in December 1982. From February to March 1983 Camchib drilled 29 holes within anomaly A for a total of 2783 metres, focusing their attention on Area 2 where Shell had outlined a resource of 77 million tonnes grading 20.22% P_2O_5. The holes were drilled by Midwest Drilling Ltd. using the sonic drill so that core samples of the residuum could be recovered. Due to problems with hard rock a number of holes were completed by switching the drill to reverse circulation for a total of 767 metres of reverse circulation drilling. In addition a total of 11.2 metres of BQ core were recovered from bedrock in a few holes.

A resource calculation was made by Camchib Mines for the area drilled in 1983 using a cut-off of 14% P_2O_5 over a minimum thickness of 9 metres. In addition all zones >0.62% Nb_2O_5 were be included if they occurred above 14% P_2O_5 regardless of the phosphate content. Rectangular polygons with a maximum range of 200 metres or half-way to the next hole were used and resulted in 59 million tonnes grading 23.2% P_2O_5 and 0.39% Nb_2O_5.

Golder Associates (Eastern Canada) Ltd. were engaged to undertake a geotechnical study of the deposit and advise on possible pit slopes. Piezometers were placed in seven holes, nine holes were logged geotechnically and geotechnical samples were taken from six holes. Since all mining would have be undertaken below the water table which varies in depth from zero to 6.2 metres, ground water control is of major concern. Due to hydrological conditions it was concluded that perimeter wells would not be effective and ground water could be controlled for mining by a combination of horizontal drains, gravel filter blankets, drainage ditches, sumps and possible internal pumping wells. Hydraulic conductivities are generally low and ground water control was not considered to be a major problem. The glacial till will provide favourable foundation conditions for any necessary buildings and mill installations. However, muskeg and peat will pose problems for access and road haulage. It was also considered that ground water from the residuum might need treatment before discharge to surface waters. The following pit slopes were recommended: 26.5° in overburden, 22° in residuum, and 45° in rock. The surrounding flat topography means that there are no suitable depressions for tailings disposal. However, it was recommended that excavated overburden would provide good material for the construction of berms and ring dykes for the disposal and containment of tailings.

A. H. Ross & Associates were engaged to undertake metallurgical investigations and cost estimates for the Martison project. The lab work was undertaken by Lakefield Research of Canada Limited on a single bulk sample made up by compositing 437 samples from 13 drill holes. The capital and operating costs produced by Kilborn were updated and modified to reflect the latest ore grade estimates, recovery factors and flowsheet design. Based on a millfeed grade of 25% P_2O_5 and a recovery of 78% to produce one million tonnes of phosphate concentrate per annum grading 36% P_2O_5 the estimated capital cost was $28.686 million with total annual operating costs of $31.903 million.

OWNERSHIP

The 11 claim blocks numbered 1201619 to 1201629 shown on Fig. 2 are all held by Donald McKinnon. The assessment dates are the 9th March 1997 for all the the blocks with the exception of 1201625 which has an assessment date of 14th March 1997.

RESOURCE ESTIMATE

Data Base

A total of 1,557 phosphate assays from 72 drill holes together with summary geology logs were taken from the original drill logs and assays sheets and entered on computer file using the BORSURV software package which was used for the resource and open pit computations. In addition to the phosphate assays, 1,001 assays for Nb_2O_5, 122 assays for total iron, 653 geochemical analyses for La and 683 geochemical analyses for Nb were also entered on file.

Hole locations, which were taken from the original logs, all refer to the drill grid used by Shell Canada Resources Limited in 1982. Most of the holes drilled by Camchib Mines Inc. in 1983 were surveyed, but no survey information was found for the 1981 and 1982 holes. As a result, elevations of the 1982 holes were all taken as 1000. Since topographic relief within the drill grid area is within one or two metres, no significant error is introduced. Location of the 1982 holes may be out by several metres to 10 metres, but this will not have a significant effect on the results since hole spacings are of the order of 100 to 200 metres.

Methodology

A set of working sections at a horizontal scale of 1/7500 with a vertical exaggeration of 5:1 was plotted showing the basic geology and phosphate values as histograms (see Appendix for similar sections at 1/10000). In addition to the sections, levels were plotted at 5-metre intervals. These plots formed the basis for the evaluation and were used to compare with the block model and computed open pit.

Bench composites were computed at 5-metres intervals starting at the 970 elevation, being the top of the first bench in residuum below the glacial overburden. Interpolations were made independently for each 5-metre bench using inverse distance squared with a 150 metres search radius and 25mx25m blocks and the three closest intersections. Due to the wide separation of the drill hole intersections and nature of the deposit it was considered that a 3-D interpolation was not appropriate.

A 3-D surface for the base of the overburden was computed on a 25-metre square grid to match the blocks of the block model and read into the block model truncating all blocks where necessary at the computed overburden/residuum interface. The COMPUPIT program was used to generate a number of trial pits and compute reserves, waste and overburden removal required. A pit slope of 22° as advocated in the 1983 report by Golder Associates for the residuum was used throughout. For purposes of a future economic analysis a progressive pit was computed for an annual production of one million tonnes of phosphate concentrate using a cut-off of 20% P_2O_5.

The resource computations were confined to the area bounded by eastings 2400 and 4400 and by northings 7000 and 9000. A specific gravity of 2.0 was used throughout.

Results

Global Resource

The global resource was computed between elevations 970, which is the shallowest residuum, and 850. The results of running the computation with various cut-offs are shown in Table 1.

Table 1. Global resources at various $\%P_2O_5$ cut-off grades.

CUT-OFF	TONNES	$\%P_2O_5$	$\%Nb_2O_5$
0	223,918,000	13.80	0.34
5	171,192,000	17.27	0.36
10	127,250,000	20.75	0.39
15	94,777,000	23.73	0.40
20	63,454,000	26.87	0.35
25	37,100,000	30.00	0.31
30	17,748,000	32.93	0.27

The very high phosphate grades in the deposit are immediately apparent from this table where even at a zero cut-off the average deposit grade is almost 14% P_2O_5 and at a cut-off of as high as 30% P_2O_5 there are still over 17 million tonnes of residuum. Considering that apatiite has a P_2O_5 content of 42% significant portions of the residuum must be composed of almost pure apatite sand or secondary phosphate rock.

The frequency distribution of phosphate values in the residuum (Fig. 3) suggests the presence of two populations, one with a mean value of about 28% P_2O_5 and the other with a mean value of about 8% P_2O_5. It is considered most likely that the higher grade population is due to the phosphate enrichment by the formation of secondary phosphates which is a common feature in similar carbonatite deposits in other parts of the world.

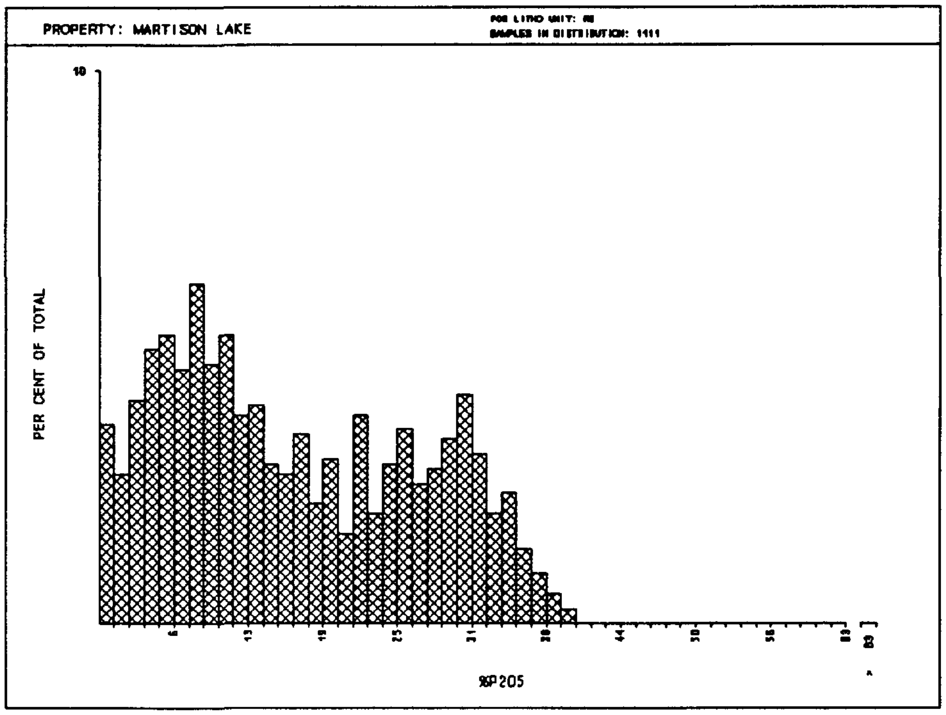

Figure 3. Frequency distribution of $\%P_2O_5$ in the residuum.

Although the bedrock surface beneath the residuum is very irregular and there is some uncertainty concerning the continuity of the residuum between drill holes, the current resource computation is considered to be reasonably conservative and there is every reason to believe that further drilling, both within and outside the boundaries of the current computation, could significantly increase the overall resource

The Nb_2O_5 values in the residuum show a positively skewed distribution (Fig. 4) and there is no correlation with phosphate (Fig. 5), though the richest phosphate zones tend to be lower in niobium. This can be seen in Table 1 where there is a steady decrease in the average Nb_2O_5 grade as the phosphate cut-off is raised from 15% to 30%.

Open Pit Computations

Earlier work on the deposit had only involved global resource calculations and, although it was clear that a pitting operation would involve the removal of considerable amounts of overburden, no computations or assessments were made of this important aspect which is fundamental to any evaluation of the deposit's possible economic viability.

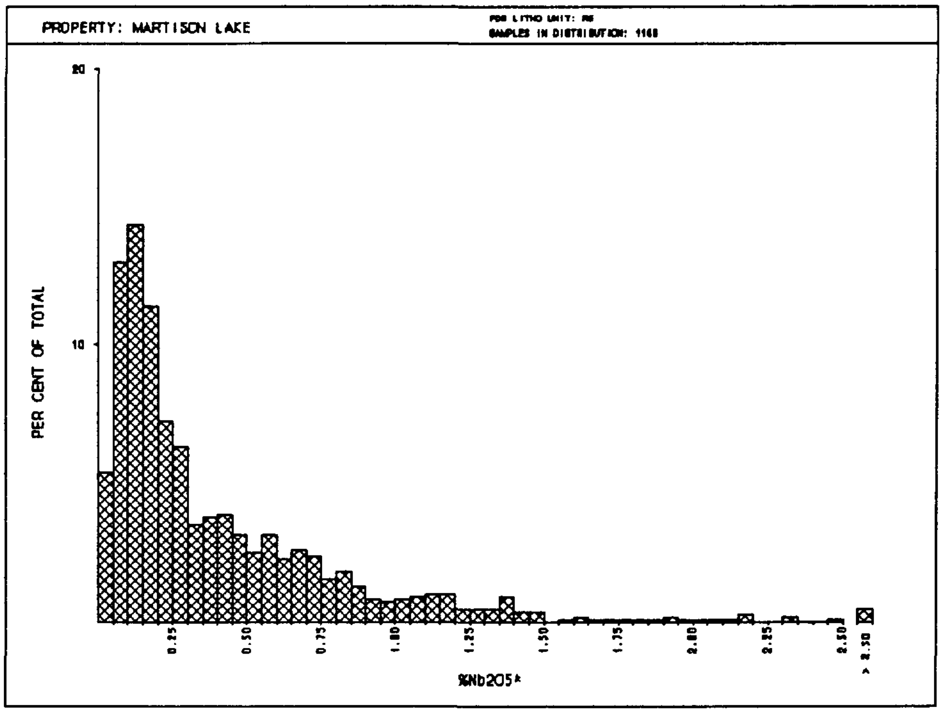

Figure 4. Frequency distribution of Nb_2O_5 values in the residuum.

The first computation involved putting a pit down to the 860 elevation for a total depth of 140 metres trying to maximise the recovery of the areas of higher grade material centred roughly on 3200E, 7400N and 3100E, 7900N. Pit slopes of 22° as recommended by Golder Associates for the residuum were used. The overall results are given in Table 2, the pit outline is shown on a total grade x thickness plot in Fig. 7 and plan of the final pit is shown in Fig. 6. The fact that there is waste at zero grade in Table 2 at a zero cut-off is due to the fact that there are some blocks within the pit outside the interpolation range for computing grades and in such cases the blocks are regarded as rock without any grade attributes.

The volume of overburden requiring stripping for the pit in Table 2 is just over 50 million cubic metres. The stripping ratio for waste removal in Table 2 applies to the rock or residuum that falls below grade in the pit and does not include the overburden. In terms of a stripping ratio the overburden tonnage to ore tonnage varies from approximately 1.4 (at zero cut-off) to 3.6 (at a cut-off of 20% P_2O_5).

If the results in Table 2 are compared with the global resource computation in Table 1, it can be seen that at a cut-off of 10% P_2O_5 just over 53 million tonnes of ore are available representing 42% of the global resource at the same cut-off with a very similar average grade.

Based on a yearly production rate of one million tonnes of phosphate concentrate grading 36% P_2O_5 and a mill recovery of 70% the pit shown in Fig. 6 has sufficient reserves for a mine life of 20 years using the grade and tonnage at the 10% cut-off (Table 2).

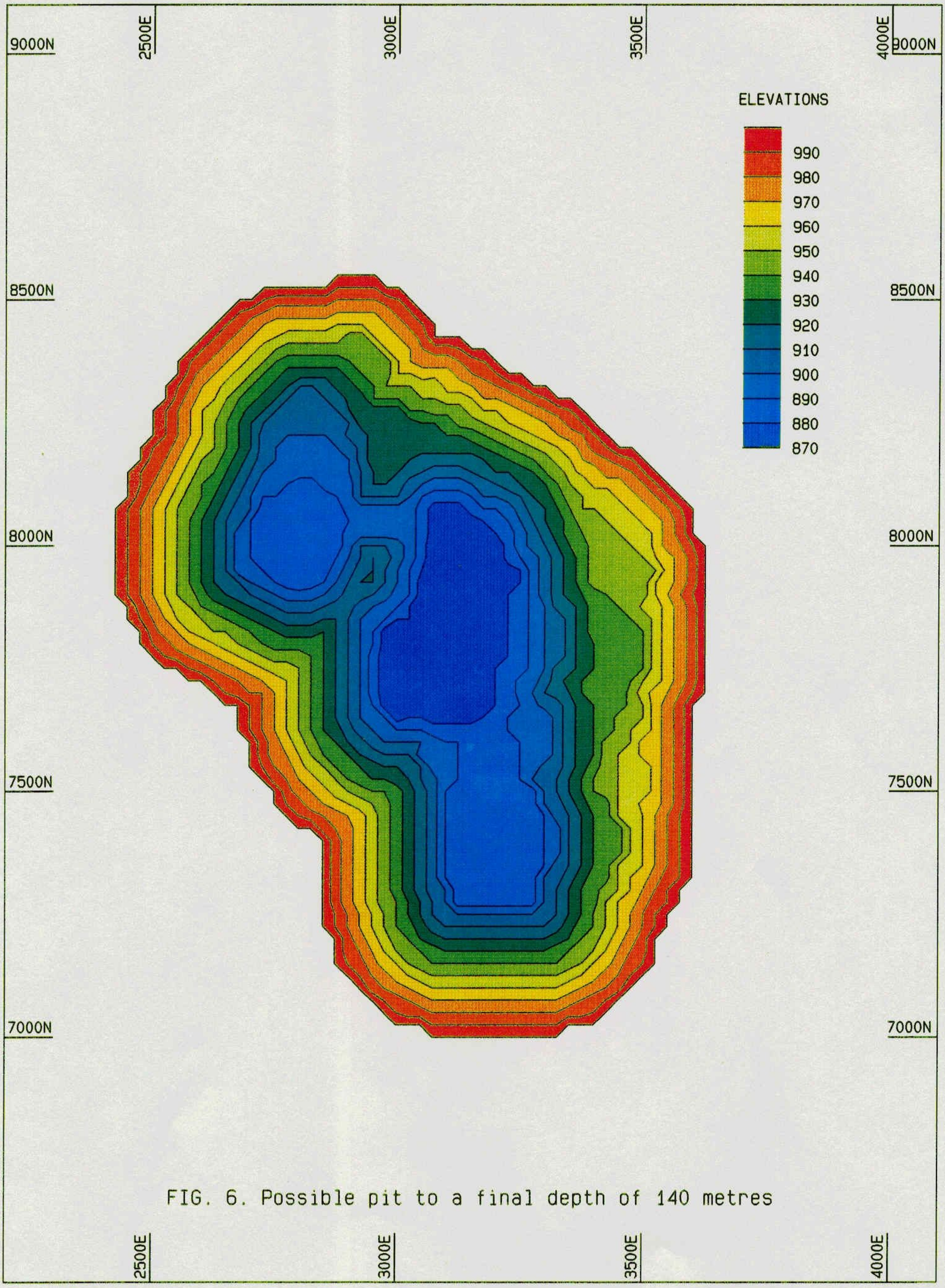

FIG. 6. Possible pit to a final depth of 140 metres

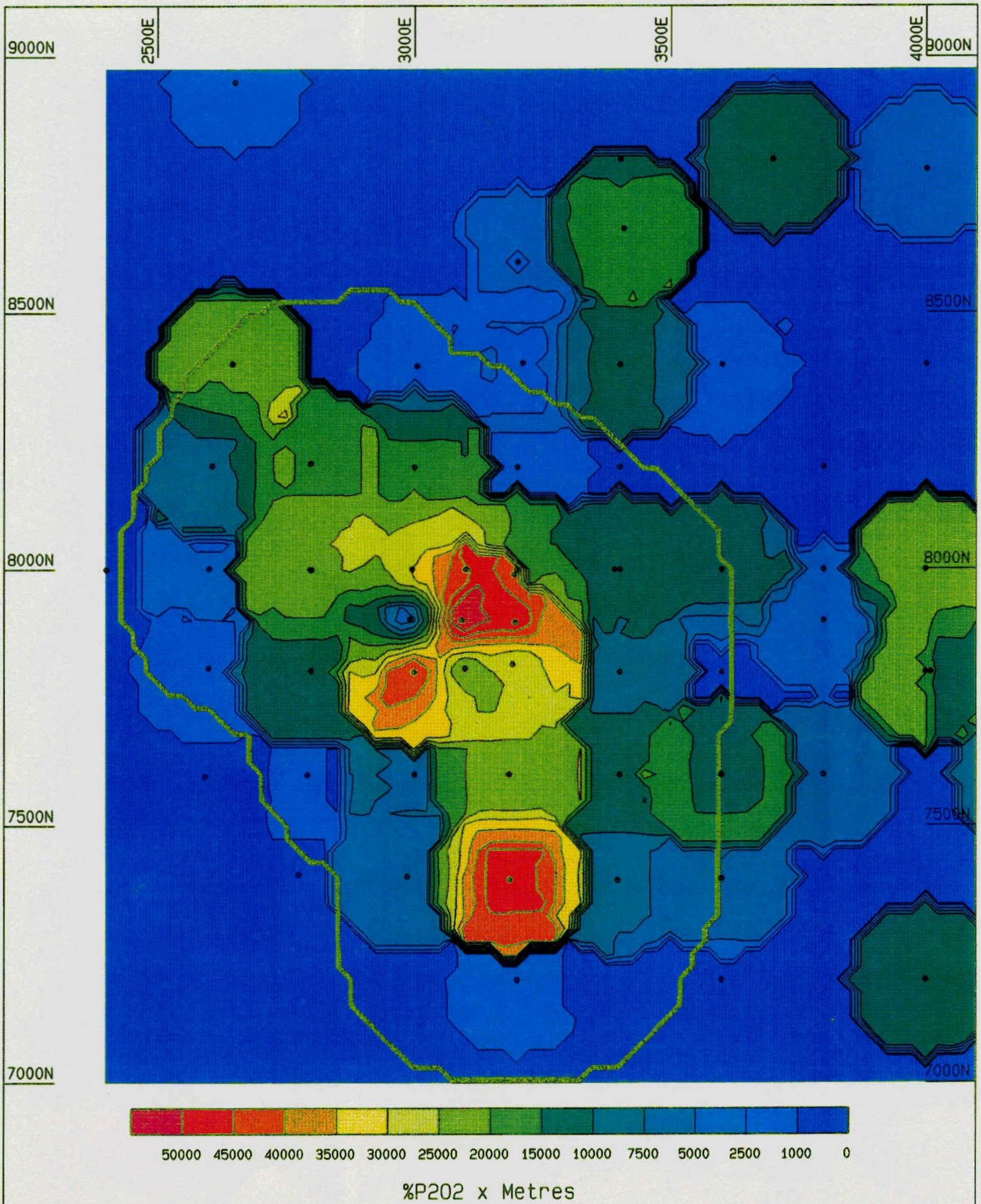

FIG. 7. Total Grade Thickness Plot with Pit Outline

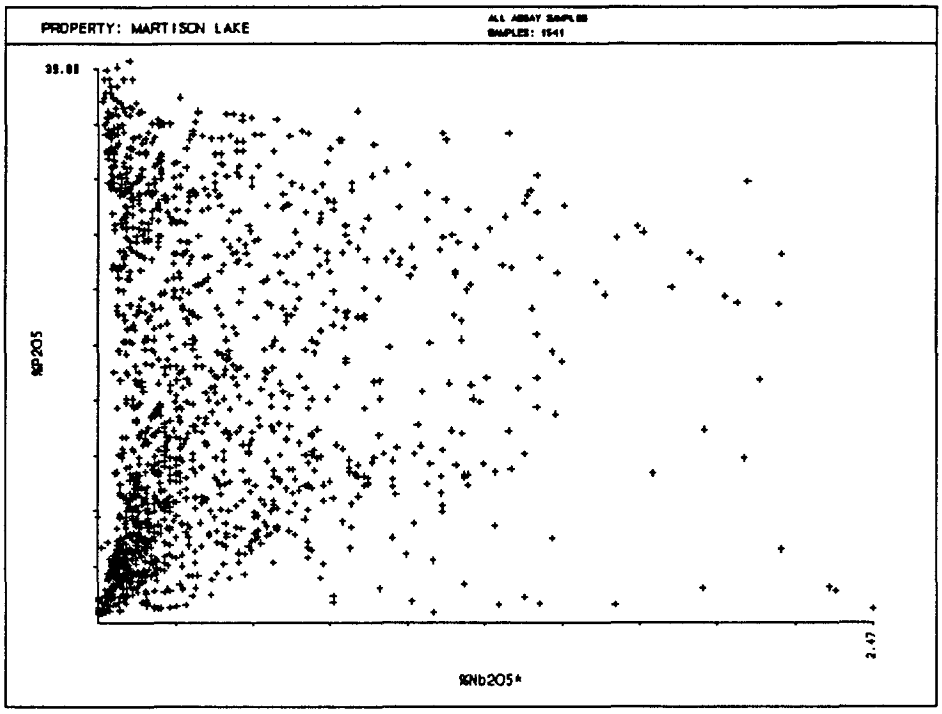

Figure 5. Scatter diagram of $\%P_2O_5$ against $\%Nb_2O_5$ in the residuum.

Table 2. Resource computations at various cut-off for the pit in Fig. 6. Volume of overburden for all cut-offs is 50,132,700 cubic metres.

	ORE			WASTE			W/O
CUT-OFF	TONNES	$\%P_2O_5$	$\%Nb_2O_5$	TONNES	$\%P_2O_5$	$\%Nb_2O_5$	RATIO
0	68,568,600	17.70	0.34	4,297,250	0	0	0.06
5	62,881,800	18.94	0.33	9,984,100	1.59	0.21	0.16
10	53,377,900	20.93	0.35	19,488,000	4.62	0.24	0.37
15	41,658,600	23.37	0.35	31,207,300	7.48	0.27	0.75
20	27,777,800	26.29	0.34	45,088,100	10.57	0.30	1.62

It is clear that a considerable amount of overburden would have to be stripped before any residuum could be mined and the overburden stripping ratios in the early years of any mining operation would be high. In order to examine this aspect and provide some realistic possible mine production figures that could be used in an economic analysis of the project, a progressive pit computation was made for a ten year period based on an annual production of one million tonnes of phosphate concentrate grading 36% P_2O_5. A recovery rate of 70% was assumed and mining was selected to maintain a millhead grade of at least 22% P_2O_5. The results are tabulated in Table 3 and stages of the pit at two-year intervals are shown in Figs 8 to 12..

Table 3. Resource computations of a possible pit to produce one million tonnes of phosphate concentrate grading 36% P_2O_5 per annum over a ten year life.

Year	Cubic Metres Overburden	Tonnes of Ore	$\%P_2O_5$	%Nb2O5	Tonnes of Concentrate	Tonnes of Waste	$\%P_2O_5$	W/O Ratio
1	4,834,200	1,823,300	30.18	0.10	1,069,900	2,100	0.00	0.00
2	5,715,300	2,172,100	23.79	0.44	1,004,600	159,700	3.65	0.07
3	4,593,400	2,414,900	22.87	0.46	1,073,700	98,300	8.08	0.04
4	3,629,100	2,314,700	24.83	0.47	1,117,400	1,270,900	9.94	0.55
5	1,749,600	2,453,200	22.50	0.38	1,073,500	441,400	3.26	0.18
6	2,884,700	2,488,400	23.32	0.07	1,120,500	2,985,900	10.20	1.20
7	2,810,200	2,204,100	23.16	0.12	1,000,800	3,481,700	5.47	1.58
8	2,158,300	2,317,800	22.72	0.34	1,024,100	2,159,400	8.55	0.93
9	1,632,000	2,378,600	23.04	0.55	1,065,500	1,976,200	8.00	0.83
10	717,200	2,300,000	24.18	0.65	1,081,300	2,128,300	8.80	0.93
TOTAL	30,724,000	22,867,100	23.91	0.36	10,631,300	14,703,900	8.02	0.64

In pitting operations it is normal to consider unconsolidated overburden in terms of volume separately from the waste rock that is to be mined. In Tables 2 and 3 this has been done and the waste to ore stripping ratio only refers to the below-grade mineralized material. However, at this deposit the mineralized residuum is largely unconsolidated or semi-consolidated and, though much of it will require ripping and some blasting may be even necessary in the more heavily cemented parts, in terms of mining costs much of the residuum should be similar to the overburden. Thus, the overburden could be considered in terms of tonnage and combined with the waste residuum for stripping costs. If this is done using the same S.G. of 2.0 (the overburden may average slightly less than this), total stripping ratios vary from 1.52 to 5.23 for the pit in Table 2 depending on cut-off. At a cut-off of 10% P_2O_5 the overall stripping ratio is 2.24. However, the overall average stripping ratio is somewhat misleading since it is obvious that it would be much higher in the earliest years and decline as the pit progresses. The overall stripping ratios for each of the ten years in Table 3 is as follows: 5.30, 5.34, 3.84, 3.68, 1.61, 3.52, 4.13, 2.79, 2.20, and 1.55 with an average of 3.33.

The stripping ratios will vary depending on pit design and the cut-off used to determine what is included as ore and no doubt some improvement can be made with optimum pit design plans. However, there is little room for significant change from the ratios computed in this resource evaluation given the thick overburden cover and in the earliest years of any pitting operation stripping ratios of 4.50 to 5.00 will pertain. As the pit deepens, the stripping ratio will decrease

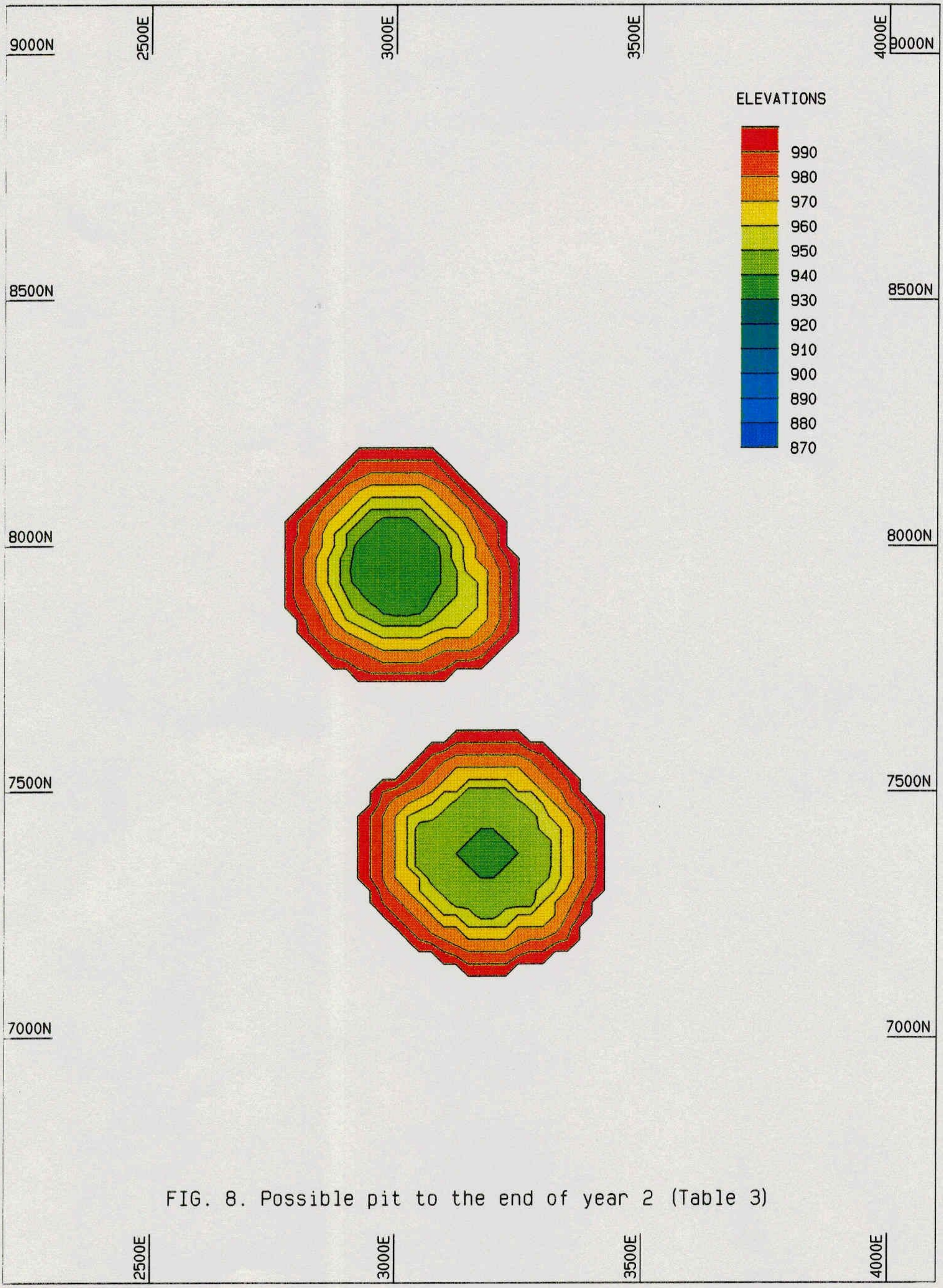

FIG. 8. Possible pit to the end of year 2 (Table 3)

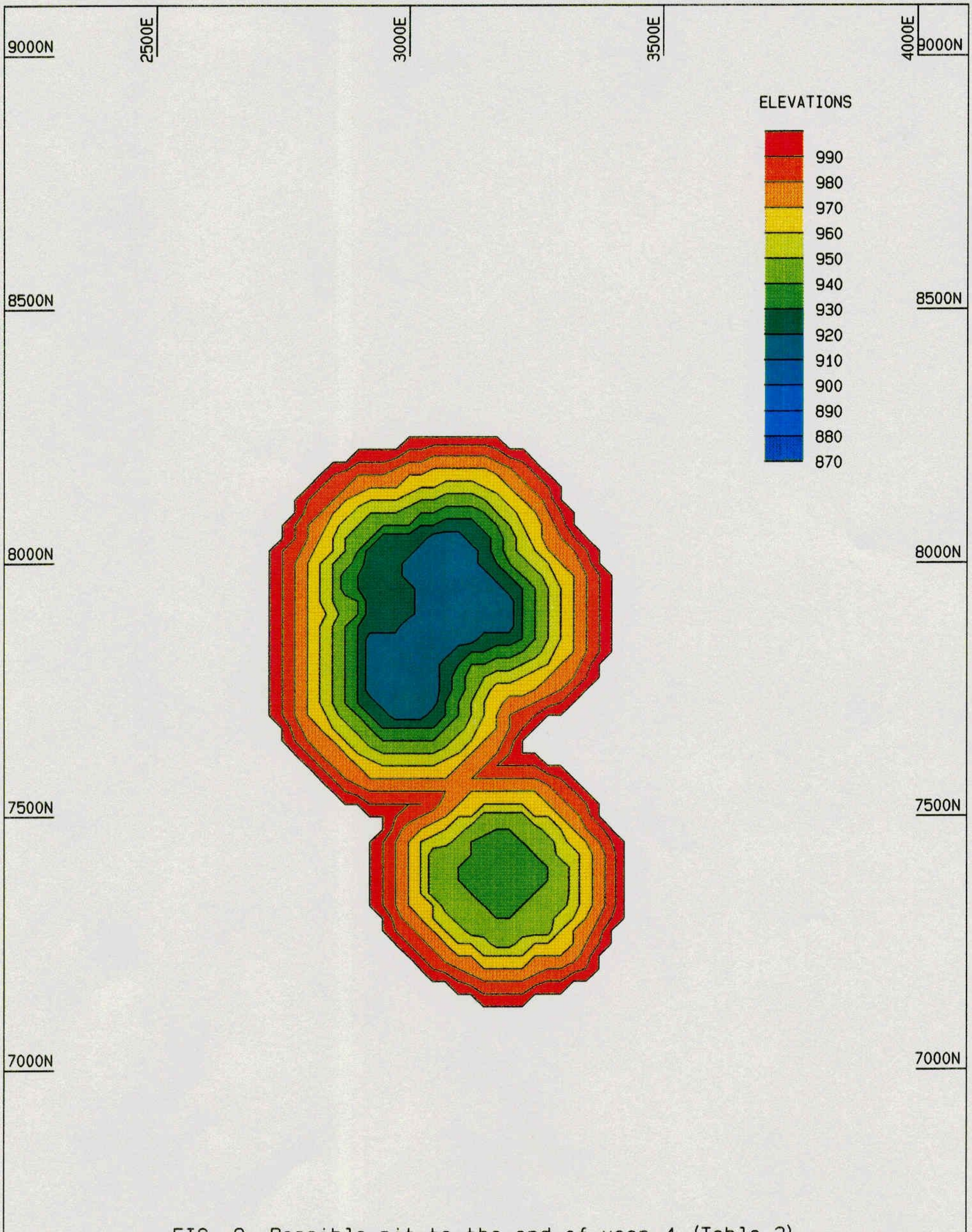

FIG. 9. Possible pit to the end of year 4 (Table 3)

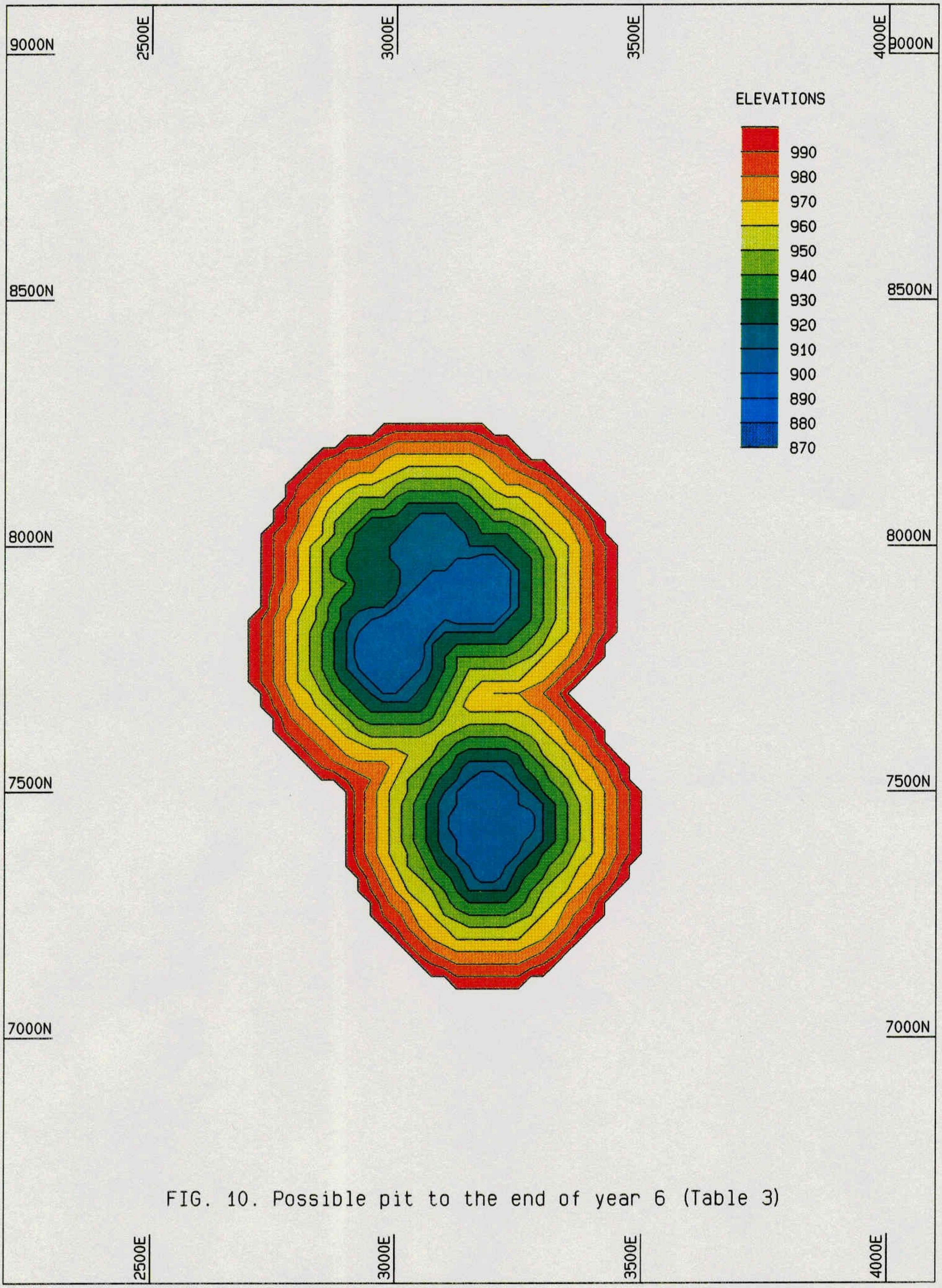

FIG. 10. Possible pit to the end of year 6 (Table 3)

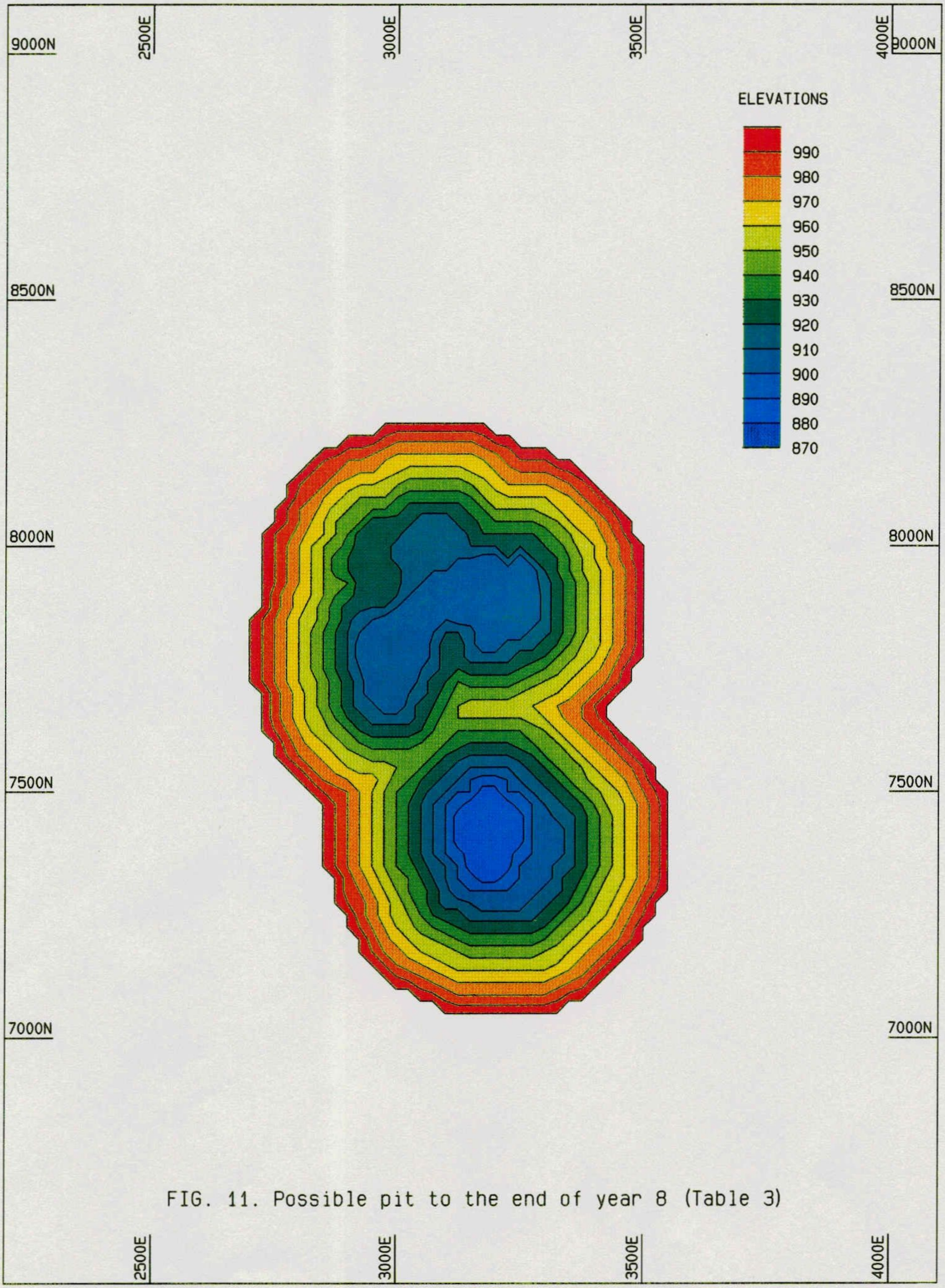

FIG. 11. Possible pit to the end of year 8 (Table 3)

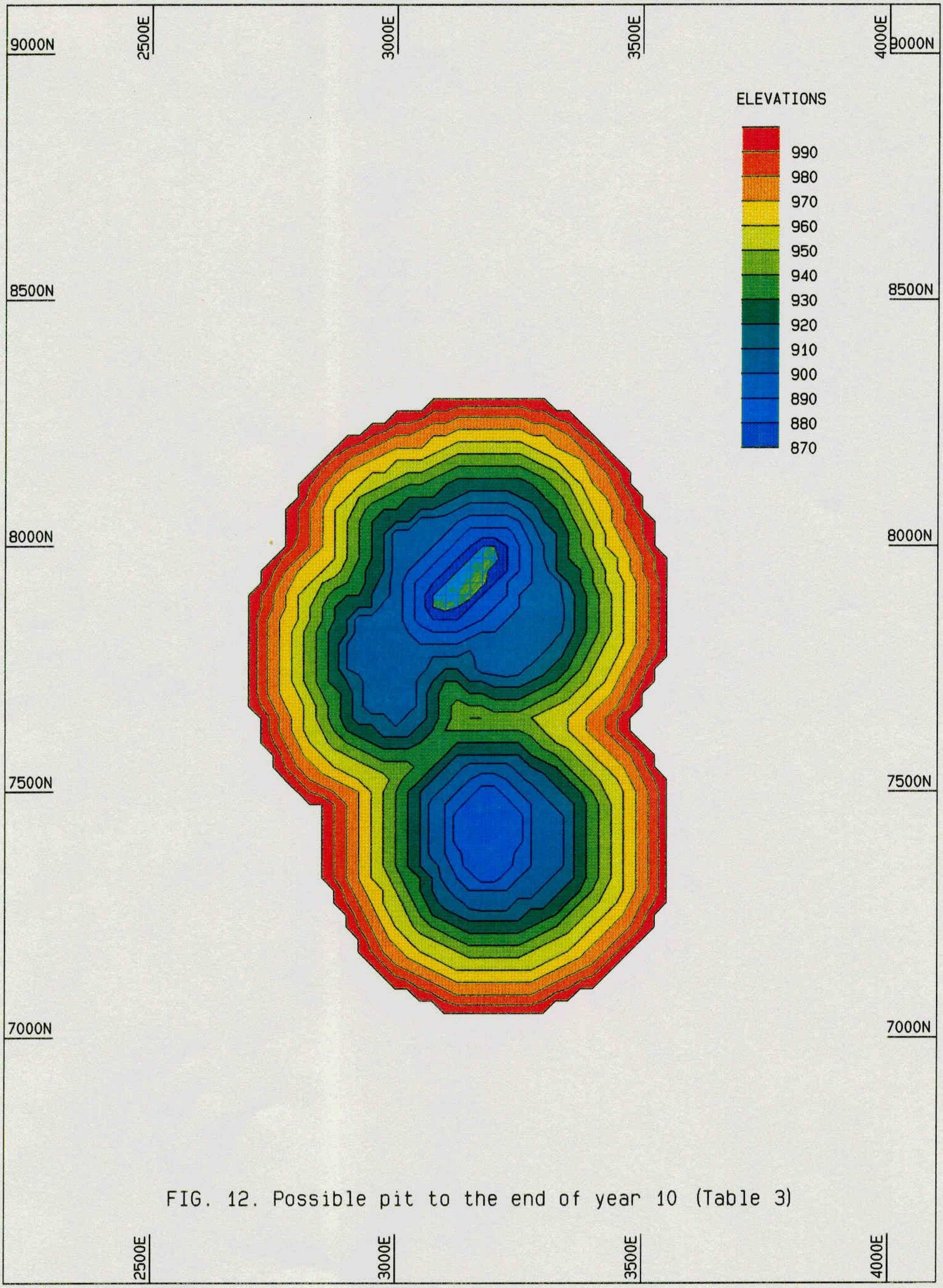

FIG. 12. Possible pit to the end of year 10 (Table 3)

towards values of 2.0 or slightly less resulting in an overall average of 2.5 to 3.0 or slightly more.

Niobium Resource

Grades of $\% Nb_2O_5$ have been computed since there is a possibility that pyrochlore could be produced as a by-product. However, the grades are on the low side and mineral dressing tests have shown that recoveries are low with a significant proportion of the pyrochlore being very fine-grained and so that much of it is lost to slimes. In this regard the deposit is very similar to other residual deposits over carbonatites in other parts of the world in which attempts to produce pyrochlore have not been successful. The chief exception to this is the fabulous Araxá deposit in Brazil which dominates world niobium production with reserves in excess of 400 million tonnes grading 2.48% Nb_2O_5.

Rare Earths

Both Shell and Camchib Mines undertook routine assays for lanthanum and Camchib ran a number of composites for all rare earth elements. However, although elevated values occur, no method of feasible recovery was devised or even considered as a possibility during the metallurgical tests. There does not appear to be much hope for profitable recovery of rare earths as a by-product. Much more detailed work at a number of other carbonatite complexes with higher rare earth contents in other parts of the world has not proven successful. There are exceptions and the rich carbonatite deposit at Mountain Pass in California worked by Molycorp is the world's major producer of rare earths outside China.

Discussion of Results

There is insufficient drill data at the Martison deposit for the computation of mining reserves and additional drilling would have to be undertaken. However, enough work has been done to establish the deposit as a major resource. Compared to similar deposits in the world which are currently mined for phosphate, the grades at Martison are very high. For example, phosphate was successfully mined to supply a small fertilizer plant near Tororo, Uganda in the 1960's and early 1970's from residual soils grading 12% to 14% P_2O_5 overlying the Sukulu Carbonatite. Operations only ceased at Sukulu as a result of a collapse in the nation's infrastructre during the Amin regime. In Brazil the residual mantles over a number of carbonatites in different parts of the country have been worked for many years at grades of 8% to 15% P_2O_5. Total Brazilian production in 1995 was 3.59 million tonnes of phosphate concentrate (Mining Annual Review, 1996).

Compared to sedimentary phosphate deposits with grades of 60% to 75% BPL (bone phosphate of lime) the concentrates from igneous sources are high grade and generally exceed 80% BPL ($1\%\text{BPL} = 0.458\% \; P_2O_5$). For example, apatite concentrates from the Kola Peninsula in Russia grade 86% BPL as does the concentrate produced by Foskor at the Palabora carbonatite in South Africa. Analyses undertaken by Shell and Camchib show that the Martison apatite is a high quality product and meets industry requirements for phosphate and, as in the case of other producers of apatite concentrate, a final grade in excess of 80% BPL should not prove difficult to attain.

CONCLUSIONS

In terms of both size and grade the Martison phosphate deposit is a world class deposit of its type. Resource computations show that significant tonnages are accessible to an open pit operation. Geotechnical studies by Golder Associates conducted on behalf of Camchib Mines Inc. in 1983 do not anticipate any serious problems regarding pit stability and ground water control. Due to the thick overburden cover, overall stripping ratios inclusive of overburden and waste rock will range from 4.5:1 to 5:1 in the earliest years and decline as operations proceed. The average overall stripping ratio over the life of a pit that could access 53 million tonnes of residuum grading 20.93% P_2O_5 would be 2.2:1.

There is a possibility that a pyrochlore concentrate could be produced as a by-product, but with a deposit grade of only 0.35% Nb_2O_5 and anticipated problems in achieving satisfactory recoveries, this is not considered likely.

Although there is insufficient drill data to form the basis of a firm mining decision and mine plan, both the global and open pit resources computed are considered to be reasonably conservative. There is also considerable exploration potential both within and outside the current drill grid for adding further reserves.

No economic study has been undertaken at this stage, but the large volumes of overburden that need to be stripped to gain access to the mineralized residuum are obviously a major obstacle and may be the major factor in determining whether or not the resource can support a viable mining operation.

John H. Reedman
B.Sc., M.Phil., M.I.M.M., C.Eng.

7th March 1997

REFERENCES

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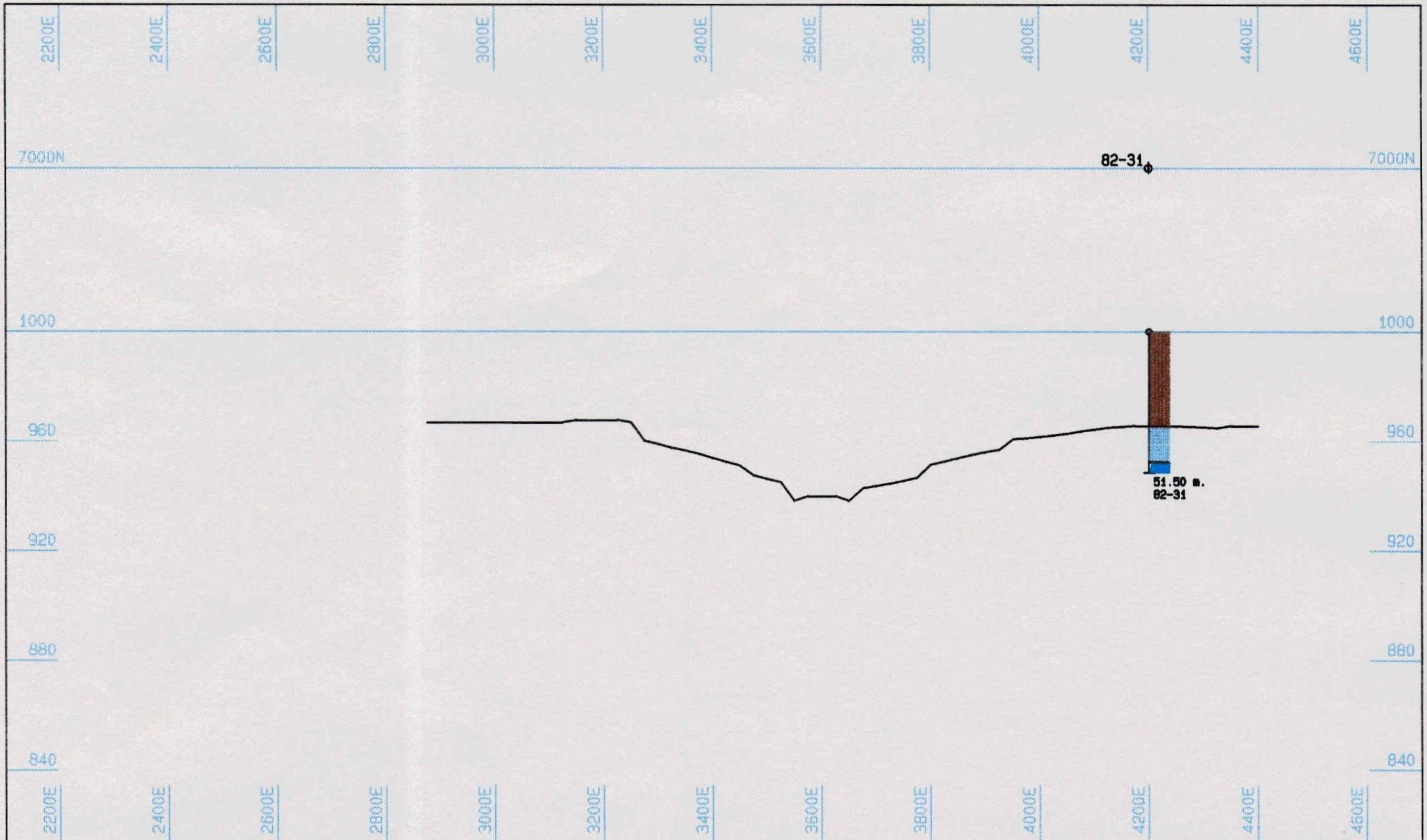
APPENDIX

SECTIONS AT A HORIZONTAL SCALE OF 1:10000

VERTICAL EXAGGERATION: 5:1



Geological Legend:

- Glacial Overburden
- Clay
- Residuum
- Weathered Carbonatite
- Carbonatite Bedrock

J. H. REEDMAN & ASSOCIATES LTD

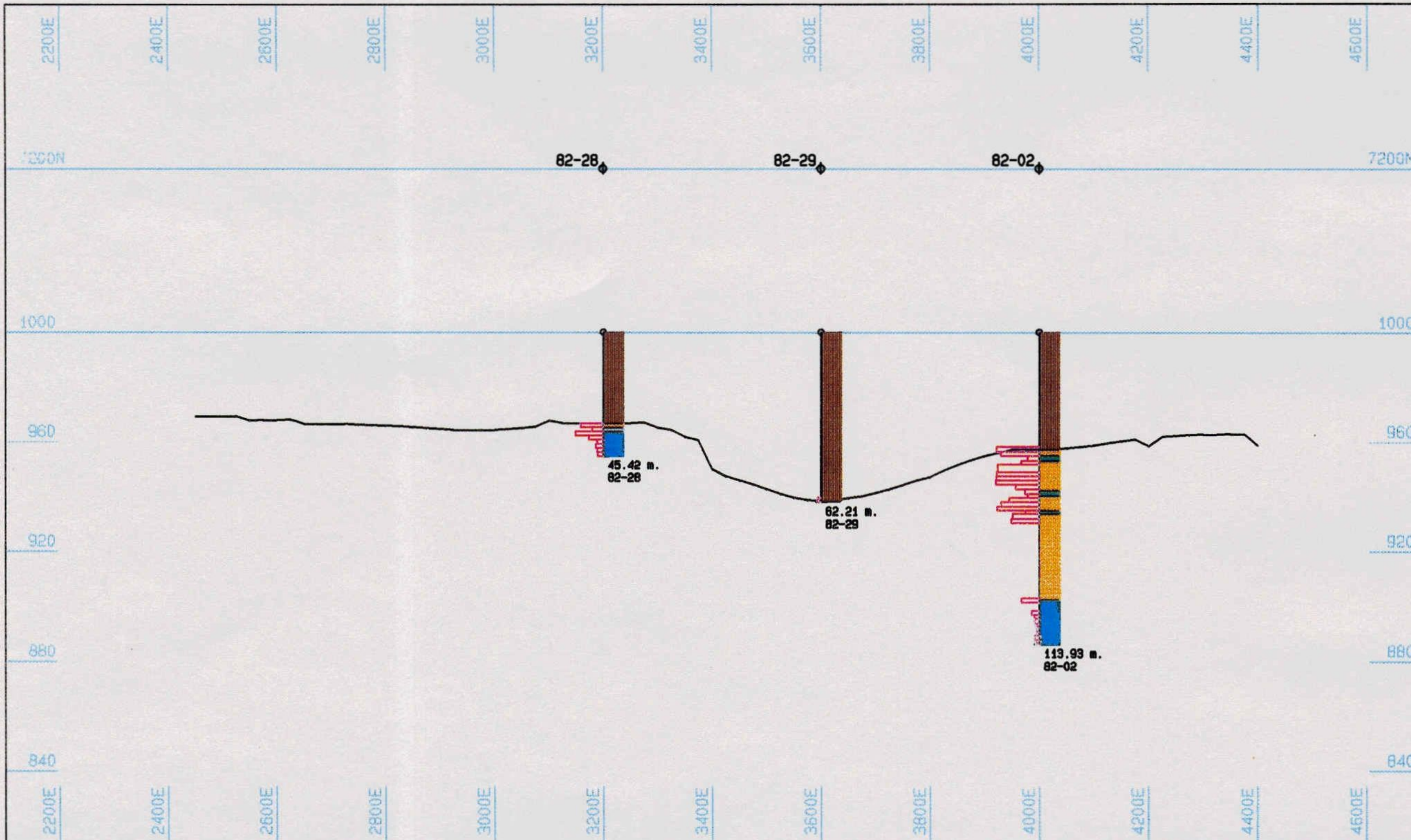
MARTISON PHOSPHATE DEPOSIT

SECTION 7000N

Northern Ontario

Bar Graph: 1 cm = 40% P205

VERTICAL EXAGGERATION: 5:1	
DATE: 97/03/07	SCALE: 1/10000



Geological Legend:

- Glacial Overburden
- Clay
- Residuum
- Weathered Carbonatite
- Carbonatite Bedrock

J. H. REEDMAN & ASSOCIATES LTD

MARTISON PHOSPHATE DEPOSIT

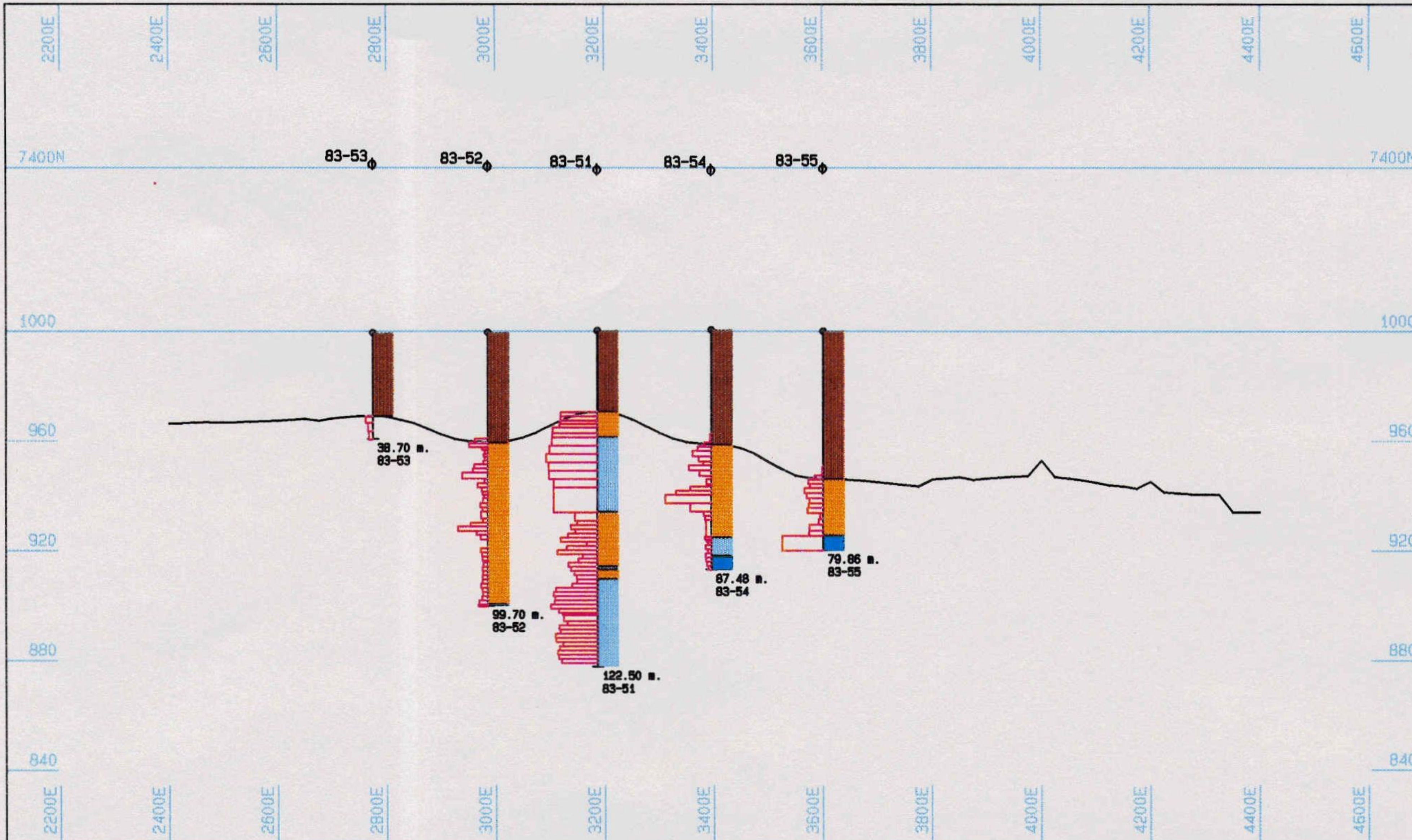
SECTION 7200N

Northern Ontario

Bar Graph: 1 cm = 40% P205

VERTICAL EXAGGERATION: 5:1

DATE: 97/03/05 | SCALE: 1/10000



Geological Legend:

- Glacial Overburden
- Clay
- Residuum
- Weathered Carbonatite
- Carbonatite Bedrock

J. H. REEDMAN & ASSOCIATES LTD

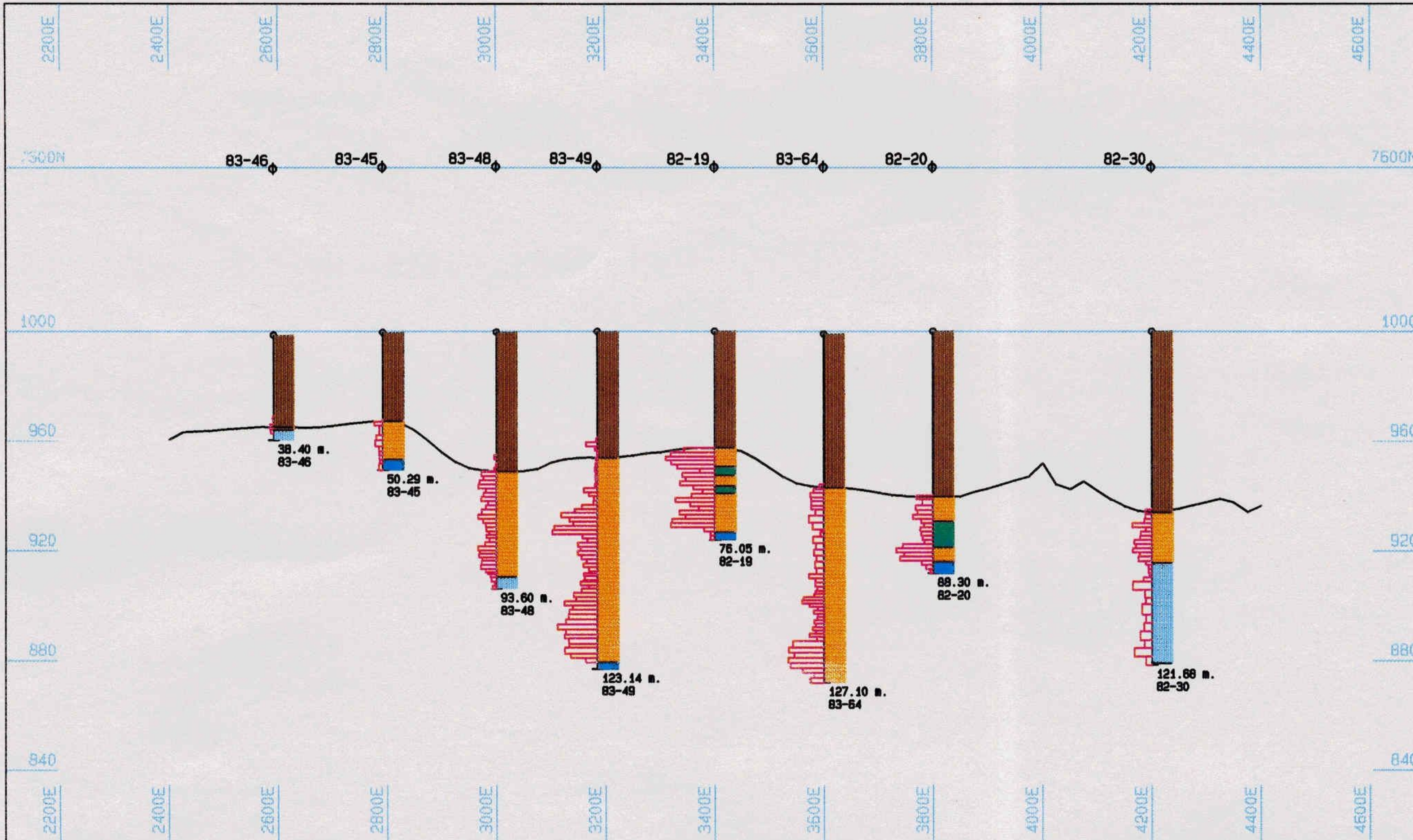
MARTISON PHOSPHATE DEPOSIT

SECTION 7400N

Northern Ontario

Bar Graph: 1 cm = 40% P2O5

VERTICAL EXAGGERATION: 5:1	
DATE: 97/03/05	SCALE: 1/10000



Geological Legend:

- Glacial Overburden
- Clay
- Residuum
- Weathered Carbonatite
- Carbonatite Bedrock

J. H. REEDMAN & ASSOCIATES LTD

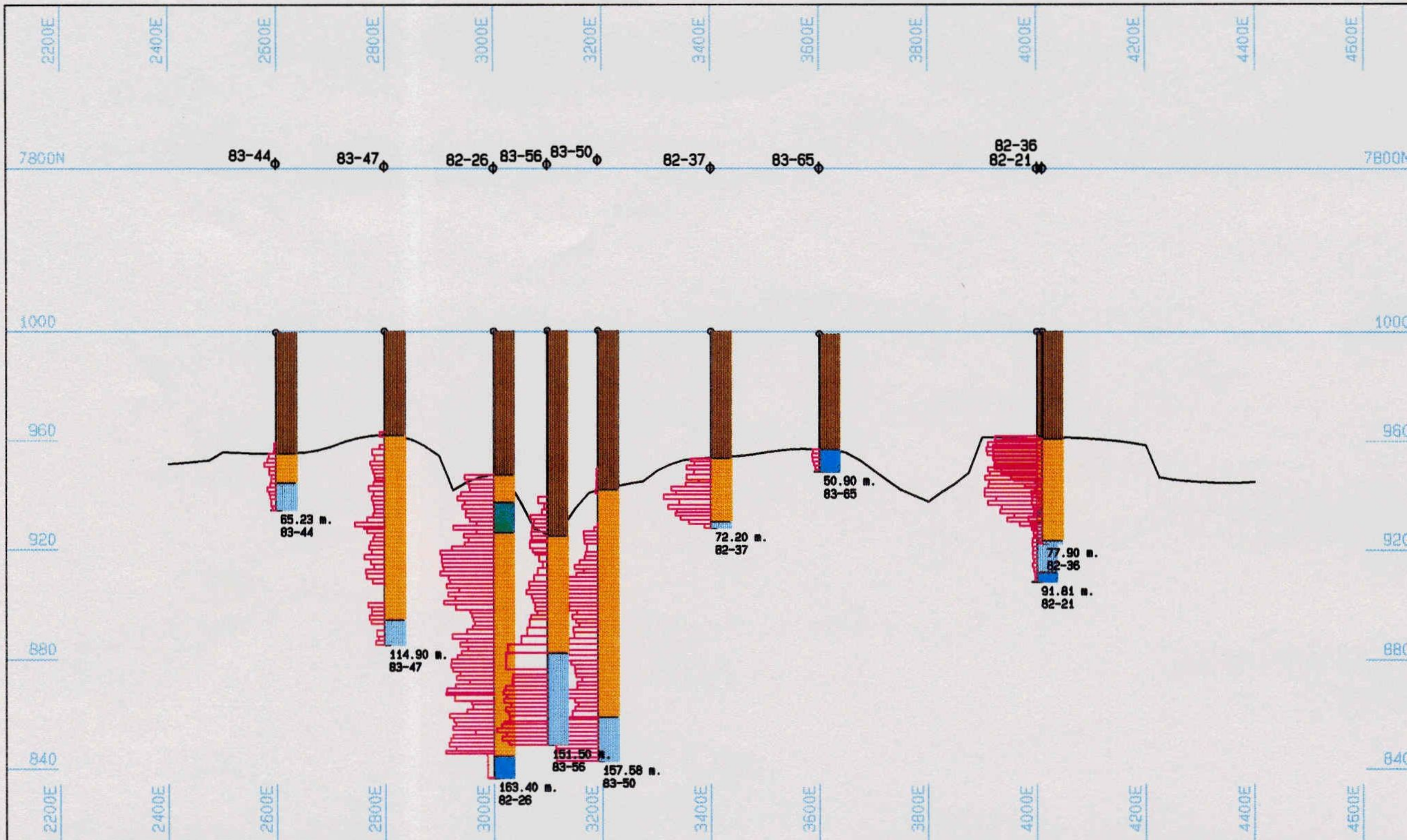
MARTISON PHOSPHATE DEPOSIT

SECTION 7600N

Northern Ontario

Bar Graph: 1 cm = 40% P2O5

VERTICAL EXAGGERATION: 5:1	
DATE: 97/03/05	SCALE: 1/10000



Geological Legend:

- Glacial Overburden
- Clay
- Residuum
- Weathered Carbonatite
- Carbonatite Bedrock

J. H. REEDMAN & ASSOCIATES LTD

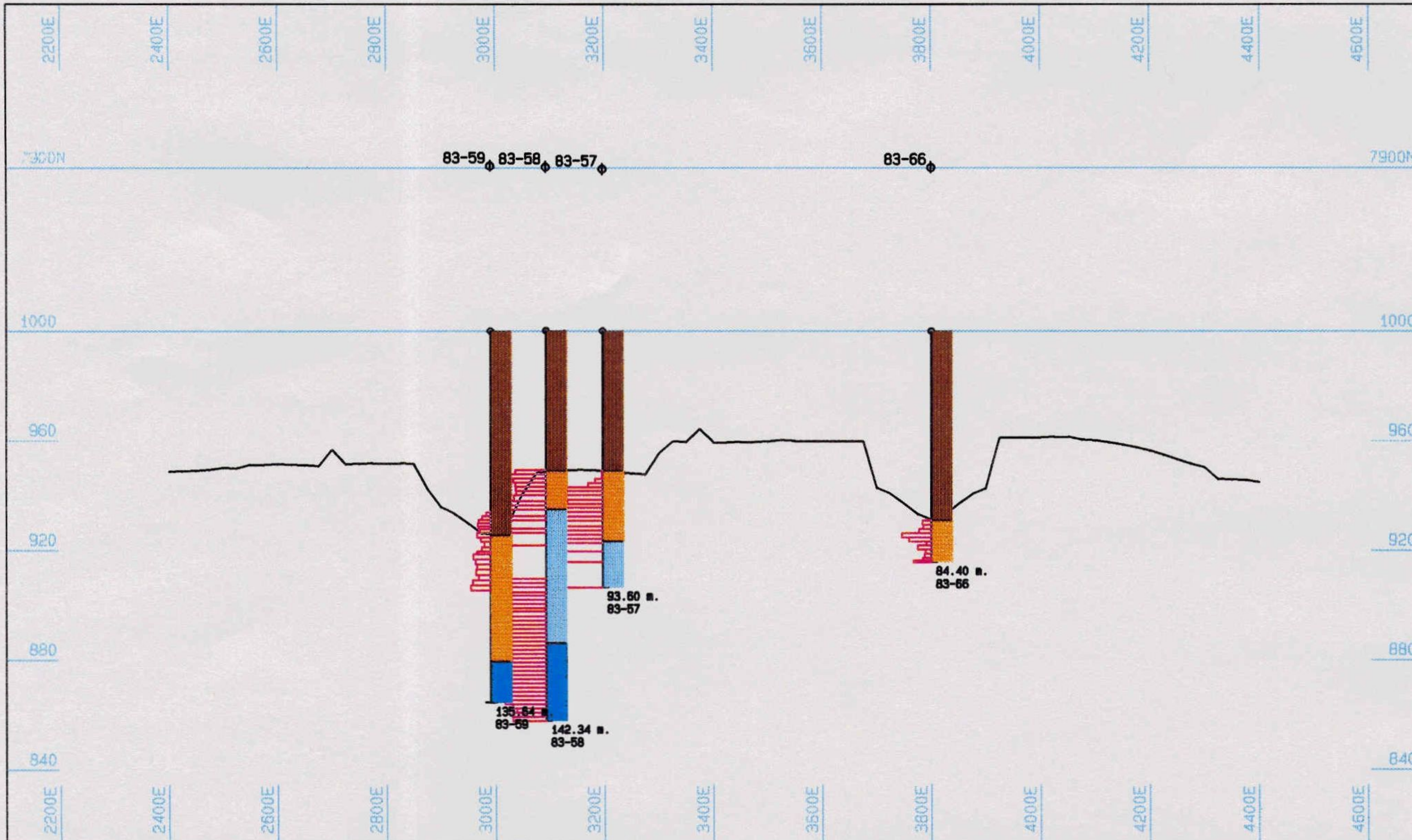
MARTISON PHOSPHATE DEPOSIT

SECTION 7800N

Northern Ontario

Bar Graph: 1 cm = 40% P205

VERTICAL EXAGGERATION: 5:1	
DATE: 97/03/05	SCALE: 1/10000



Geological Legend:

- Glacial Overburden
- Clay
- Residuum
- Weathered Carbonatite
- Carbonatite Bedrock

J. H. REEDMAN & ASSOCIATES LTD

MARTISON PHOSPHATE DEPOSIT

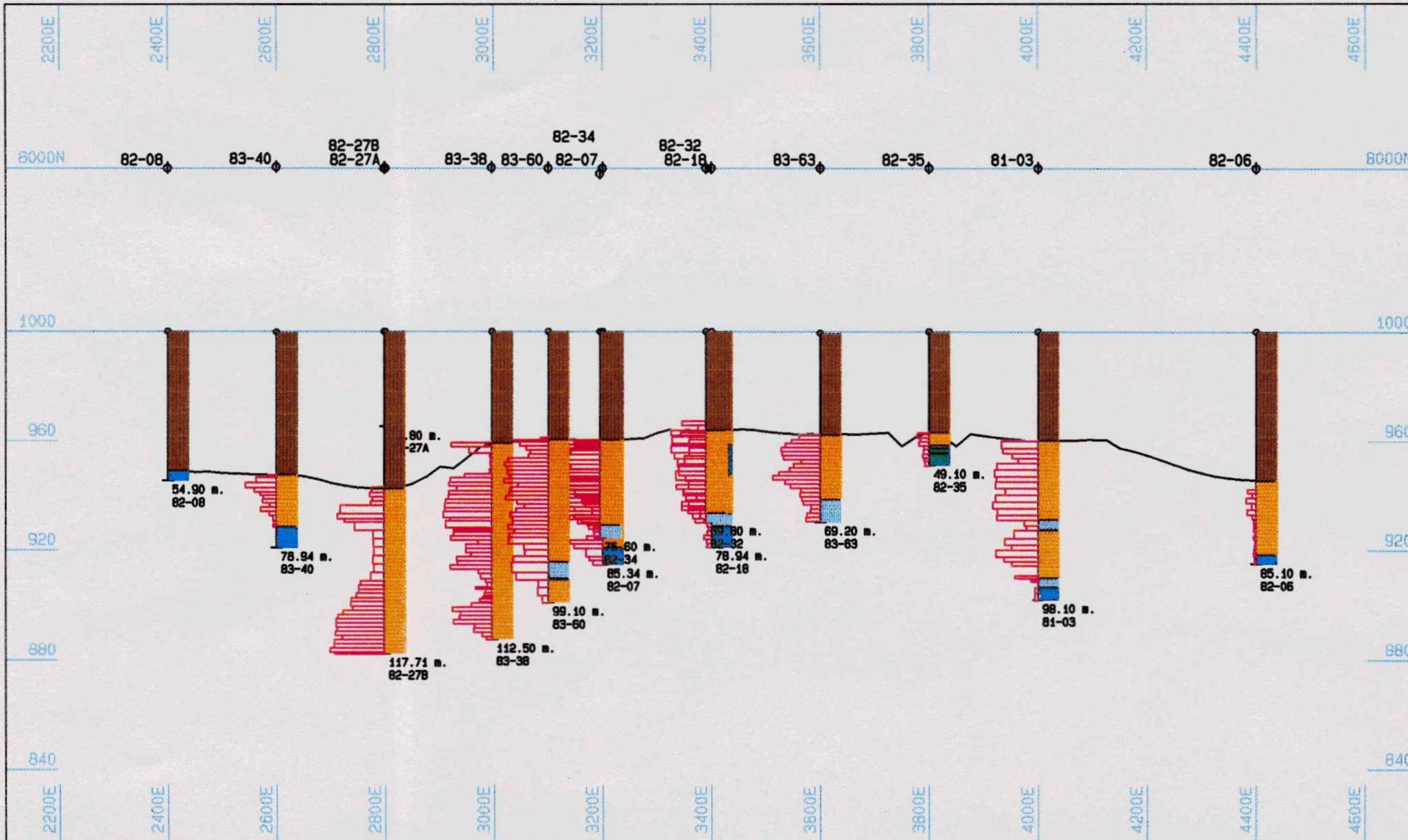
SECTION 7900N

Northern Ontario

Bar Graph: 1 cm = 40% P205

VERTICAL EXAGGERATION: 5:1

DATE: 97/03/05 | SCALE: 1/10000



Geological Legend:

- Glacial Overburden
- Clay
- Residuum
- Weathered Carbonatite
- Carbonatite Bedrock

J. H. REEDMAN & ASSOCIATES LTD

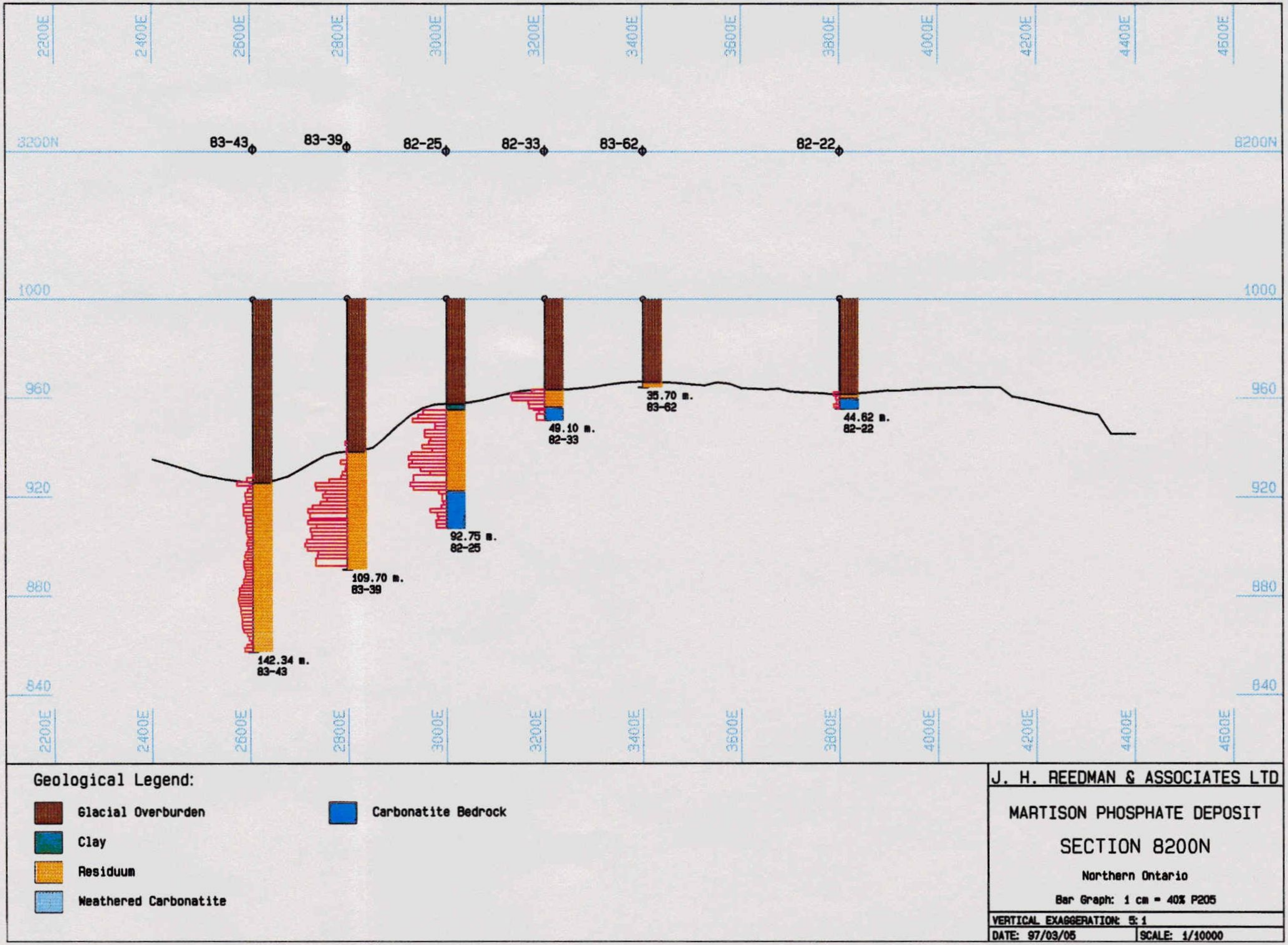
MARTISON PHOSPHATE DEPOSIT

SECTION 8000N

Northern Ontario

Bar Graph: 1 cm = 40% P2O5

VERTICAL EXAGGERATION: 5:1	
DATE: 97/03/05	SCALE: 1/10000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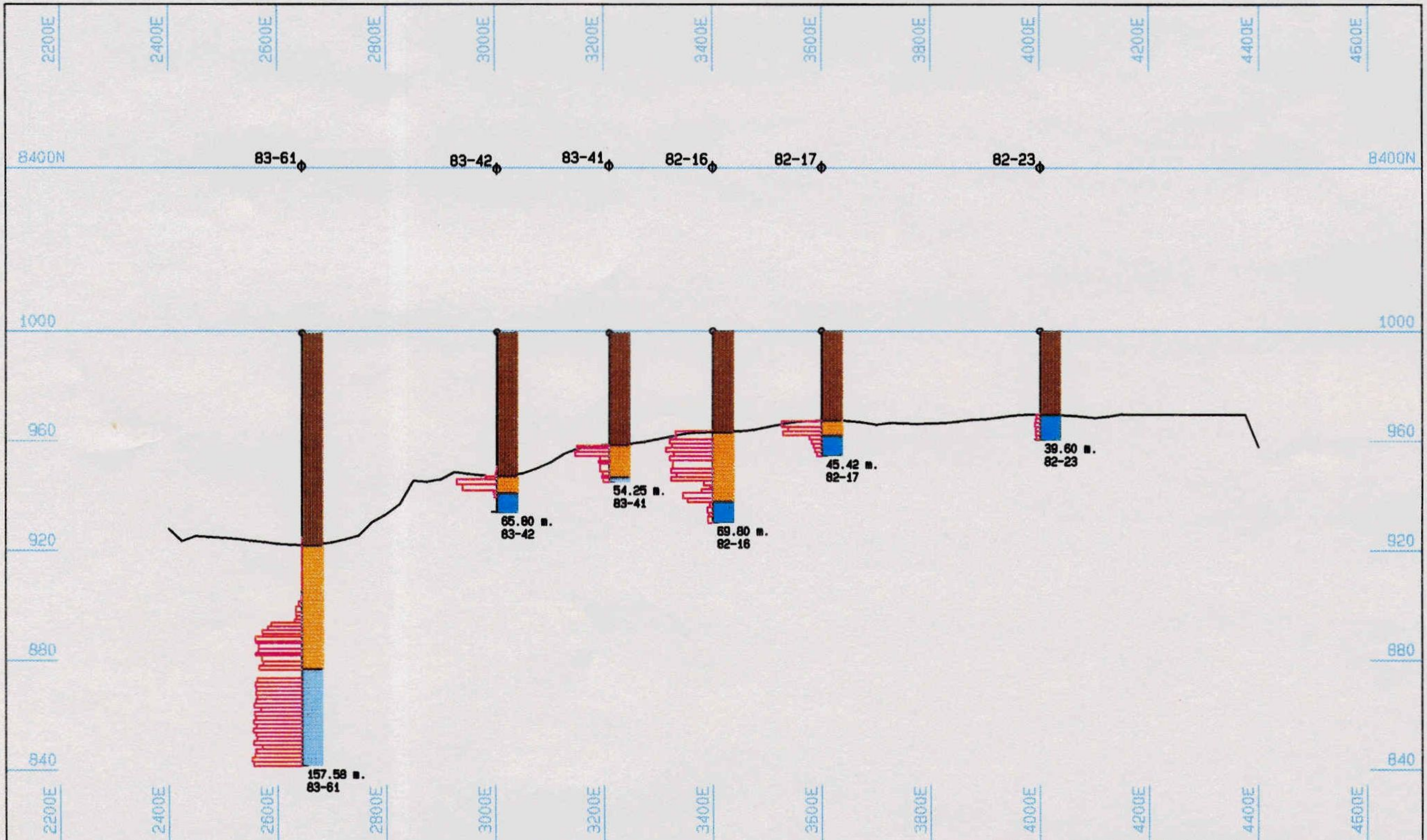
4600E
8200N
83-43
83-39
82-25
82-33
83-62
82-22
1000
960
920
880
840
35.70 m.
83-62
44.62 m.
82-22
49.10 m.
82-33
92.75 m.
82-25
109.70 m.
83-39
142.34 m.
83-43
Geological Legend:
Glacial Overburden
Clay
Residuum
Weathered Carbonatite
Carbonatite Bedrock
J. H. REEDMAN & ASSOCIATES LTD
MARTISON PHOSPHATE DEPOSIT
SECTION 8200N
Northern Ontario
Bar Graph: 1 cm = 40% P2O5
VERTICAL EXAGGERATION: 5:1
DATE: 97/03/05
SCALE: 1/10000



Geological Legend:

- Glacial Overburden
- Clay
- Residuum
- Weathered Carbonatite
- Carbonatite Bedrock

J. H. REEDMAN & ASSOCIATES LTD

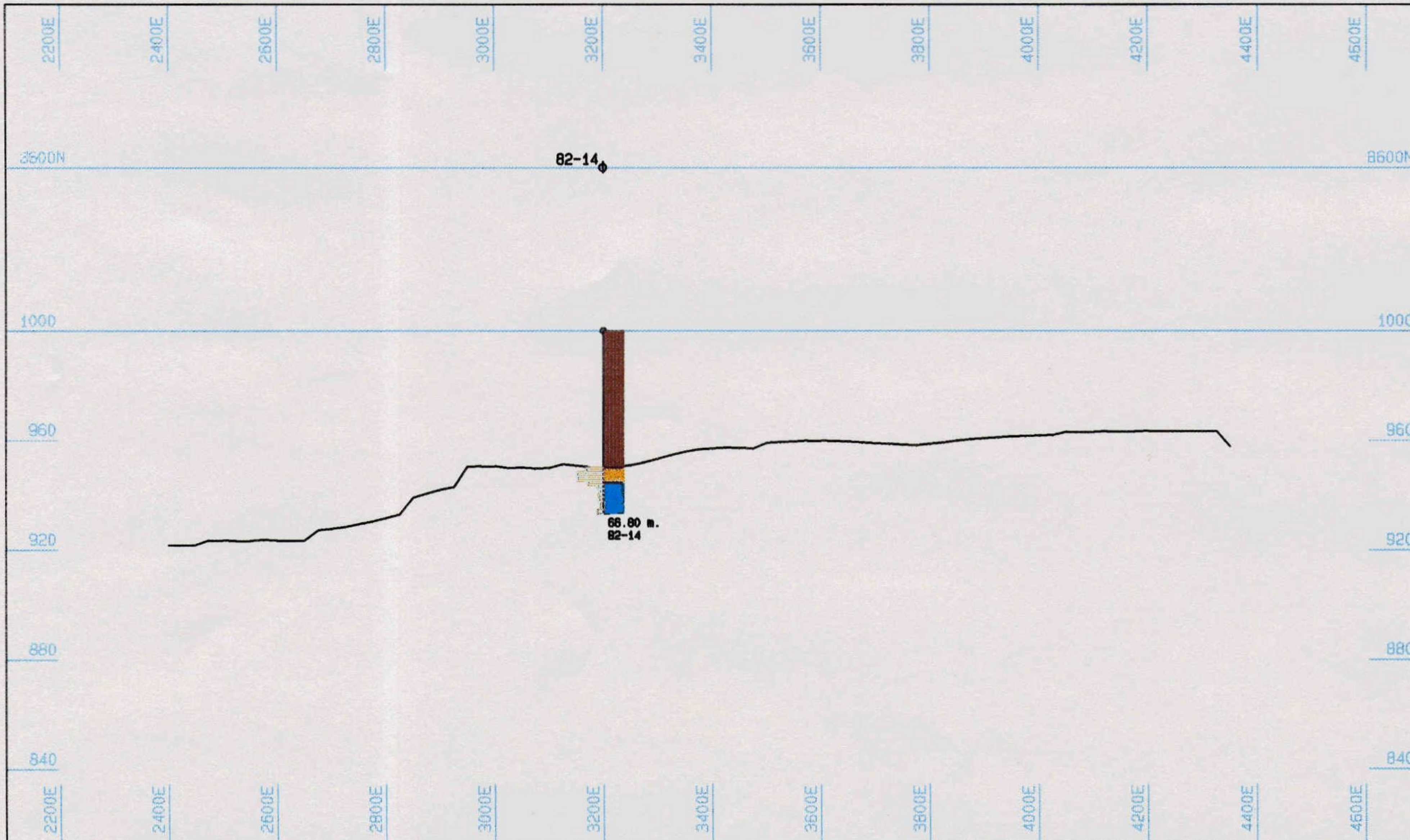
MARTISON PHOSPHATE DEPOSIT

SECTION 8400N

Northern Ontario

Bar Graph: 1 cm = 40% P2O5

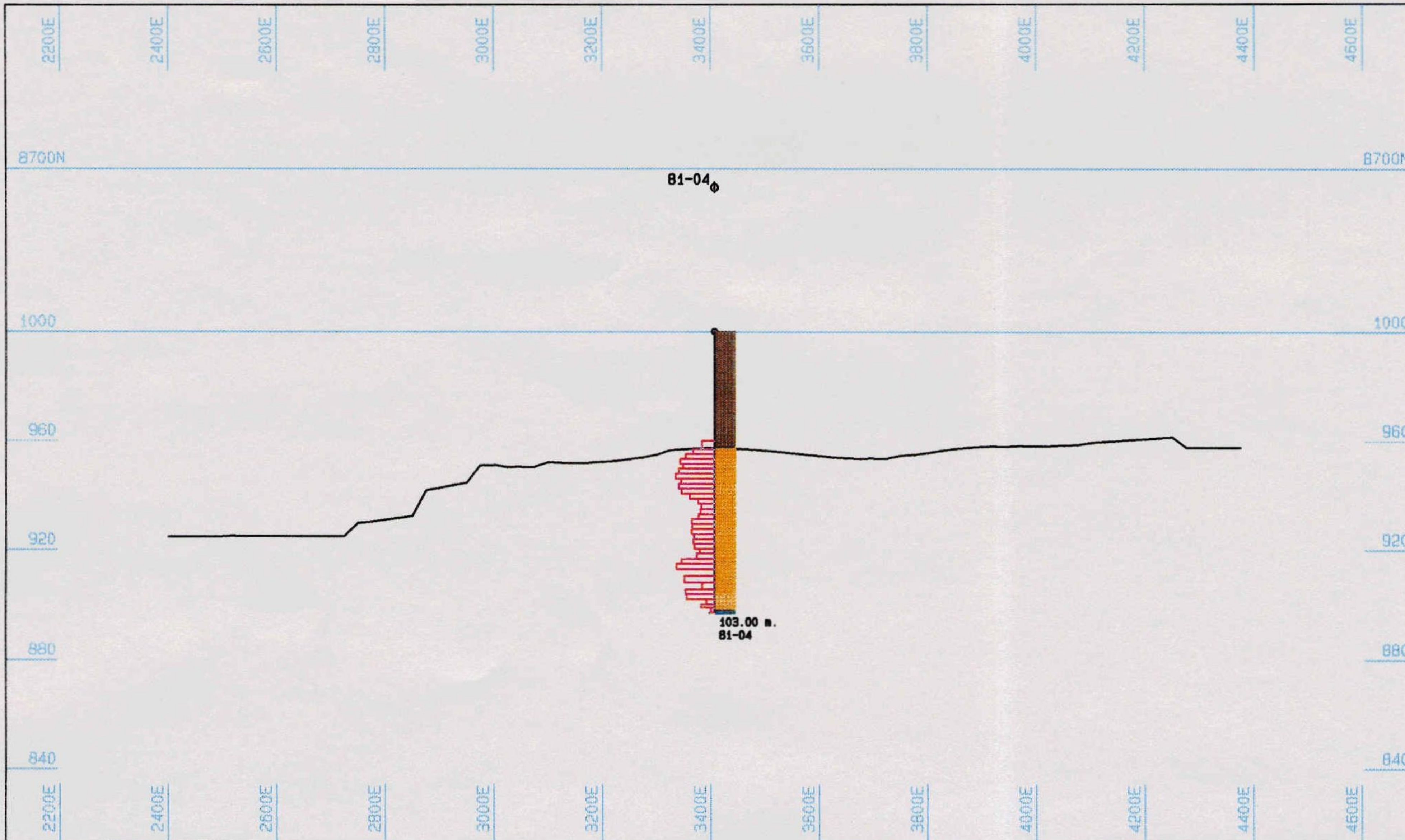
VERTICAL EXAGGERATION: 5:1	
DATE: 97/03/05	SCALE: 1/10000



Geological Legend:

- Glacial Overburden
- Clay
- Residuum
- Weathered Carbonatite
- Carbonatite Bedrock

J. H. REEDMAN & ASSOCIATES LTD	
MARTISON PHOSPHATE DEPOSIT	
SECTION 8600N	
Northern Ontario	
Bar Graph: 1 cm = 40% P205	
VERTICAL EXAGGERATION: 5:1	
DATE: 97/03/05	SCALE: 1/10000



Geological Legend:

- Glacial Overburden
- Clay
- Residuum
- Weathered Carbonatite
- Carbonatite Bedrock

J. H. REEDMAN & ASSOCIATES LTD

MARTISON PHOSPHATE DEPOSIT

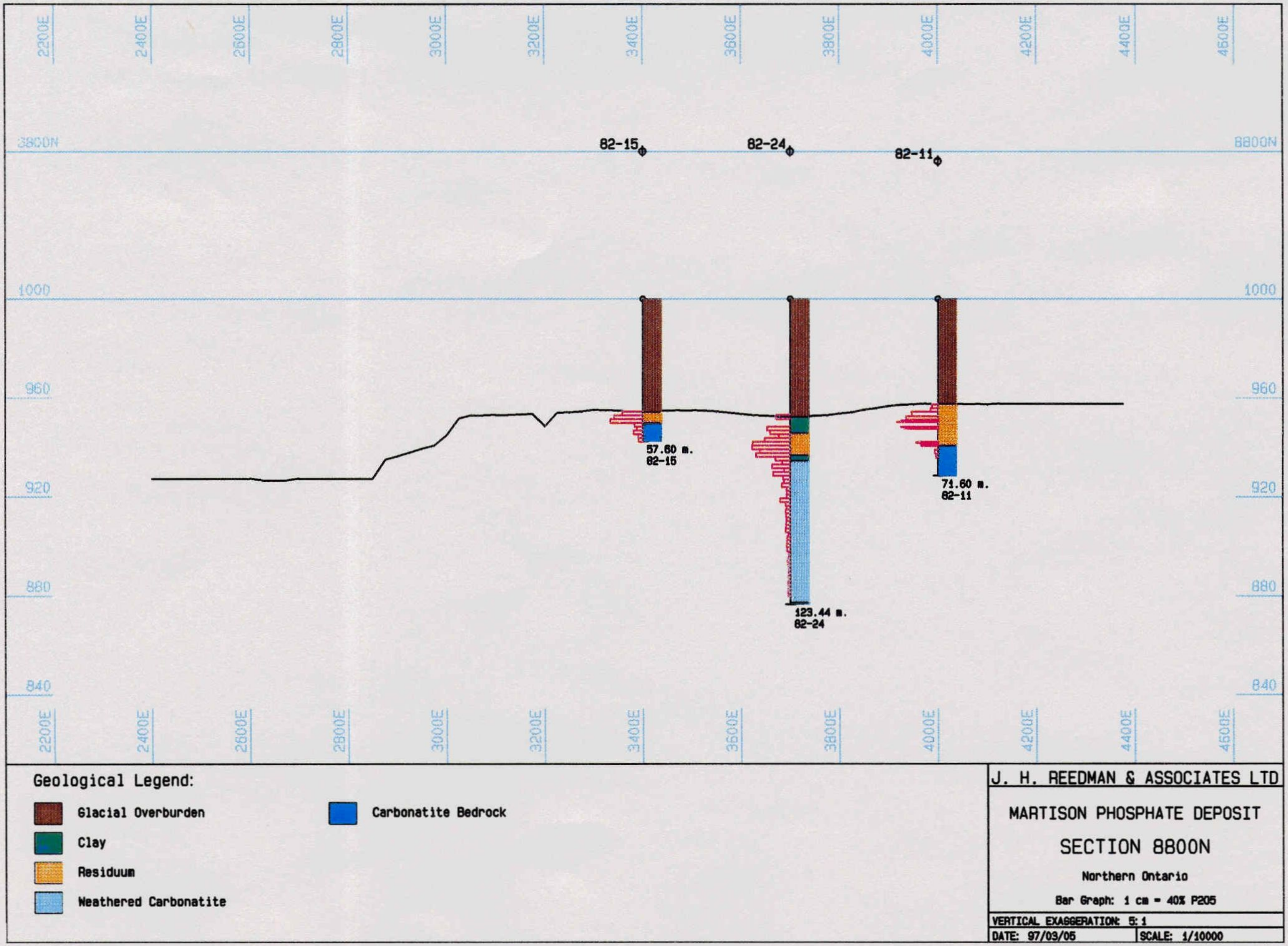
SECTION 8700N

Northern Ontario

Bar Graph: 1 cm = 40% P205

VERTICAL EXAGGERATION: 5:1

DATE: 97/03/05 | SCALE: 1/10000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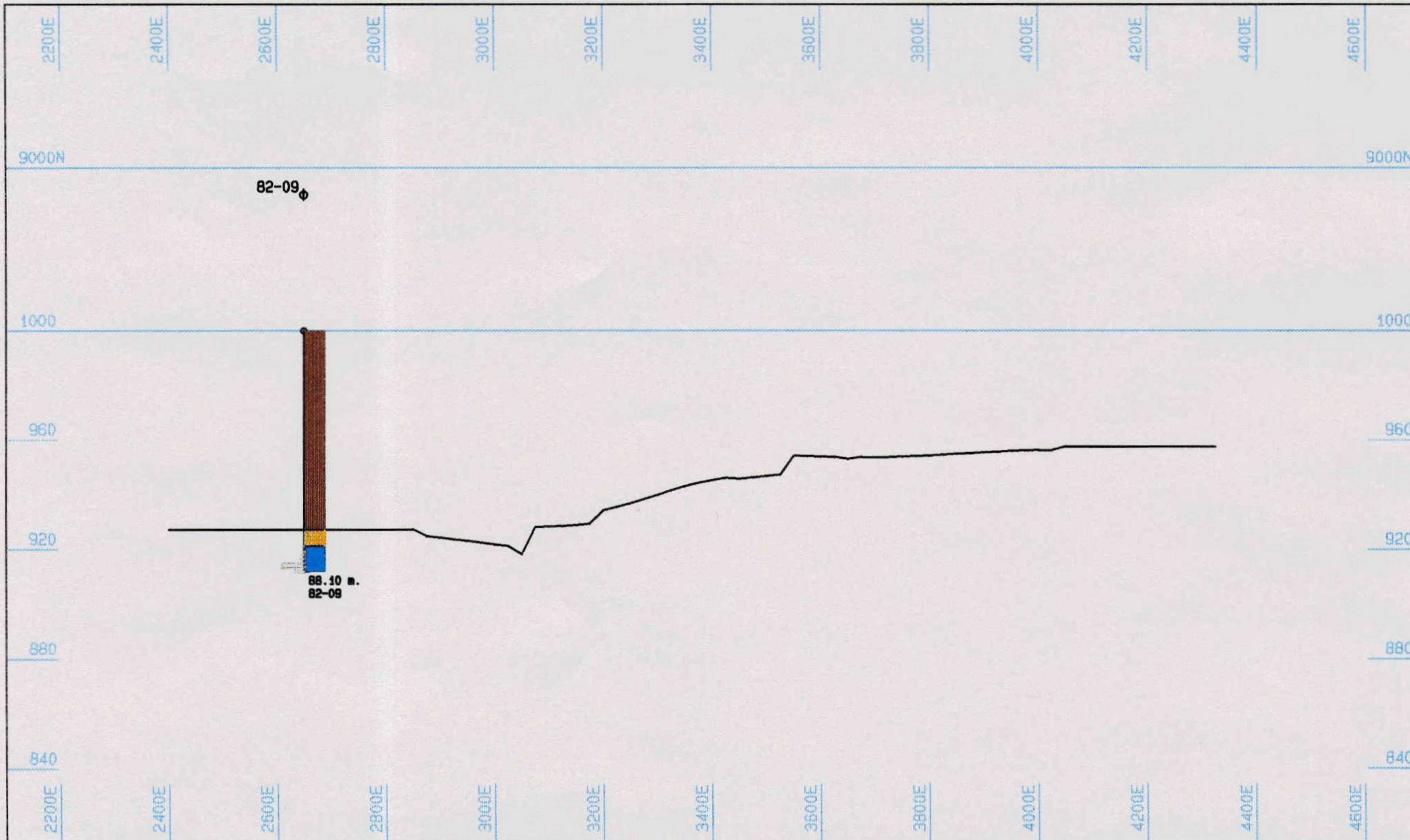
82-15
82-24
82-11
1000
960
920
880
840
57.60 m.
82-15
123.44 m.
82-24
71.60 m.
82-11
Geological Legend:
Glacial Overburden
Clay
Residuum
Weathered Carbonatite
Carbonatite Bedrock
J. H. REEDMAN & ASSOCIATES LTD
MARTISON PHOSPHATE DEPOSIT
SECTION 8800N
Northern Ontario
Bar Graph: 1 cm = 40% P205
VERTICAL EXAGGERATION: 5:1
DATE: 97/03/05
SCALE: 1/10000



Geological Legend:

- Glacial Overburden
- Clay
- Residuum
- Weathered Carbonatite
- Carbonatite Bedrock

J. H. REEDMAN & ASSOCIATES LTD

MARTISON PHOSPHATE DEPOSIT

SECTION 9000N

Northern Ontario

Bar Graph: 1 cm = 40% P205

VERTICAL EXAGGERATION: 5:1

DATE: 97/03/05 | SCALE: 1/10000

Ontario | Ministry of Northern Development and Mines

Declaration of Assessment Work Performed on Mining Land

Mining Act, Subsection 65(2) and 66(3), R.S.O. 1990

Transaction Number (office use): W9760.00190

Assessment Files Research Imaging

Personal informatio... nd 66(3) of the Mining Act. Under section 8 of the Mining Act, the infor... it work and correspond with the mining land holder. Questions about th... of Northern Development and Mines, 6th Floor, 933 Ramsey Lake F...

42J06SW0008 2.17496 SOUTH OF RIDGE LAKE 900

2.17496

Instructions: - For work performed on Crown Lands before **recording** a claim, use form 0240.
- Please type or print in ink.

1. Recorded holder(s) (Attach a list if necessary)

Name: DONALD McKINNON.	Client Number: 168276
Address: BOX 1130	Telephone Number: 705-268-8822
TIMMINS, ONTARIO P4N 7H9	Fax Number: 705-268-5532
Name	Client Number
Address	Telephone Number
	Fax Number

2. Type of work performed: Check (✓) and report on only ONE of the following groups for this declaration.

- [x] Geotechnical: prospecting, surveys, assays and work under section 18 (regs)
- [ ] Physical: drilling, stripping, trenching and associated assays
- [ ] Rehabilitation

		Office Use	
Work Type: Section 18 other.		Commodity	
		Total $ Value of Work Claimed	$7,650.00
Dates Work Performed From 24 02 97 (Day Month Year) To 07 03 97 (Day Month Year)		NTS Reference	
Global Positioning System Data (if available)	Township/Area: SOUTH of RIDGE LAKE	Mining Division	Porcupine
	M or G-Plan Number: G-1716	Resident Geologist District	Timmins

Please remember to: - obtain a work permit from the Ministry of Natural Resources as required;
- provide proper notice to surface rights holders before starting work;
- complete and attach a Statement of Costs, form 0212;
- provide a map showing contiguous mining lands that are linked for assigning work;
- include two copies of your technical report.

3. Person or companies who prepared the technical report (Attach a list if necessary)

Name: J. H. REEDMAN + ASSOCIATES	Telephone Number: 204-885-6022
Address: 89 DICKENS Dr. WINNIPEG, MANITOBA R3K 0M1	Fax Number: " "
Name	Telephone Number
Address	Fax Number
Name	Telephone Number
Address	Fax Number

MAR 10 1997
4:7
PORCUPINE MINING DIVISION

4. Certification by Recorded Holder or Agent

I, WENDY SIMS KORBA (Print Name), do hereby certify that I have personal knowledge of the facts set forth in this Declaration of Assessment Work having caused the work to be performed or witnessed the same during or after its completion and, to the best of my knowledge, the annexed report is true.

Signature of Recorded Holder or Agent: [signature]		Date: March 10/97.
Agent's Address: BOX 1130 TIMMINS ONT P4N 7H9	Telephone Number: 705-268-8822	Fax Number: 705-268-5532

5. **Work to be recorded and distributed.** Work can only be assigned to claims that are contiguous (adjoining) to the mining land where work was performed, at the time work was performed. A map showing the contiguous link must accompany this form.

	Mining Claim Number. Or if work was done on other eligible mining land, show in this column the location number indicated on the claim map.	**Number of Claim Units.** For other mining land, list hectares.	**Value of work performed** on this claim or other mining land.	**Value of work applied** to this claim.	**Value of work assigned** to other mining claims.	**Bank.** Value of work to be distributed at a future date.
eg	TB 7827	16 ha	$26, 825	N/A	$24,000	$2,825
eg	1234567	12	0	$24,000	0	0
eg	1234568	2	$ 8, 892	$ 4,000	0	$4,892
1	1201625	12	$7650	$4800		$2850
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
		Column Totals	$7650.	$4800		$2850

2.17496

I, Wendy Sims Kobza, do hereby certify that the above work credits are eligible under
(Print Full Name)
subsection 7 (1) of the Assessment Work Regulation 6/96 for assignment to contiguous claims or for application to the claim where the work was done.

Signature of Recorded Holder or Agent Authorized in Writing	Date
Wendy Kobza	March 10/97

6. **Instructions for cutting back credits that are not approved.**

Some of the credits claimed in this declaration may be cut back. Please check (✓) in the boxes below to show how you wish to prioritize the deletion of credits:

- ☑ 1. Credits are to be cut back from the Bank first, followed by option 2 or 3 or 4 as indicated.
- ☐ 2. Credits are to be cut back starting with the claims listed last, working backwards; or
- ☐ 3. Credits are to be cut back equally over all claims listed in this declaration; or
- ☐ 4. Credits are to be cut back as prioritized on the attached appendix or as follows (describe):

Note: If you have not indicated how your credits are to be deleted, credits will be cut back from the Bank first, followed by option number 2 if necessary.

For Office Use Only

Received Stamp	Deemed Approved Date	Date Notification Sent
RECEIVED MAR 10 1997	June 8/97	
	Date Approved	Total Value of Credit Approved
	Approved for Recording by Mining Recorder (Signature)	

Ontario | Ministry of Northern Development and Mines

Statement of Costs for Assessment Credit

Transaction Number (office use): W9760.00190

Personal information collected on this form is obtained under the authority of subsection 6(1) of the Assessment Work Regulation 6/96. Under section 8 of the Mining Act, the information is a public record. This information will be used to review the assessment work and correspond with the mining land holder. Questions about this collection should be directed to the Chief Mining Recorder, Ministry of Northern Development and Mines, 6th Floor, 933 Ramsey Lake Road, Sudbury, Ontario, P3E 6B5.

Work Type	Units of Work Depending on the type of work, list the number of hours/days worked, metres of drilling, kilometres of grid line, number of samples, etc.	Cost Per Unit of work	Total Cost
OPEN PIT RESOURCE COMPUTATION	10.93	$ 700 / DAY	$ 7650.00
Associated Costs (e.g. supplies, mobilization and demobilization).			
Transportation Costs			
		2.17496	
Food and Lodging Costs			
		Total Value of Assessment Work	$ 7650.00

Calculations of Filing Discounts:

1. Work filed within two years of performance is claimed at 100% of the above Total Value of Assessment Work.
2. If work is filed after two years and up to five years after performance, it can only be claimed at 50% of the Total Value of Assessment Work. If this situation applies to your claims, use the calculation below:

TOTAL VALUE OF ASSESSMENT WORK × 0.50 = Total $ value of worked claimed.

Note:
- Work older than 5 years is not eligible for credit.
- A recorded holder may be required to verify expenditures claimed in this statement of costs within 45 days of a request for verification and/or correction/clarification. If verification and/or correction/clarification is not made, the Minister may reject all or part of the assessment work submitted.

Certification verifying costs:

I, WENDY SIMS KORBA (please print full name), do hereby certify, that the amounts shown are as accurate as may reasonably be determined and the costs were incurred while conducting assessment work on the lands indicated on the accompanying Declaration of Work form as Wendy Sims Korba (recorded holder, agent, or state company position with signing authority) I am authorized to make this certification.

Signature	Date

Ontario
Ministère du Développement du Nord et des Mines

État des coûts aux fins du crédit de jours de travail

Numéro de transaction (à l'usage du bureau)

Les renseignements personnels contenus dans la présente formule sont receuillis en vertu du paragraphe 6 (1) du Règlement sur les travaux d'évaluation. Aux termes de l'article 8 de la *Loi sur les mines*, le public a accès à ces renseignements, qui serviront à revoir les travaux d'évaluation et à correspondre avec le détenteur du terrain minier. Adressez toute question sur la collecte de ces renseignements au registrateur de claims en chef, ministère du Développement du Nord et des Mines, 6e étage, 933 Ramsey Lake Road, Sudbury (Ontario), P3E 6B5.

Type de travaux	**Unités de travail** Indiquez le nombre d'heures de travail/jour, de mètres de forage, de kilomètres de lignes de quadrillage, d'échantillons, etc., selon la nature des travaux.	Coût par unité de travail	Coût total
Coûts connexes (p.ex. fournitures, mobilisation et démobilisation).			
Frais de transport			
Frais de nourriture et d'hébergement			
		Valeur totale des travaux d'évaluation	

2.17496

Calcul des remises pour dépôt :

1. Les travaux dont le rapport est déposé dans les deux ans après leur date d'exécution donnent droit à des crédits à 100 % de la valeur totale susmentionnée des travaux d'évaluation.
2. Les travaux dont le rapport est déposé entre deux et cinq ans après leur date d'exécution donnent droit à des crédits à 50 % seulement de la valeur totale des travaux d'évaluation. Si cela s'applique à vos claims, utilisez la formule suivante :

VALEUR TOTALE DES TRAVAUX D'ÉVALUATION × 0,50 = Valeur totale des travaux demandée.

Nota :

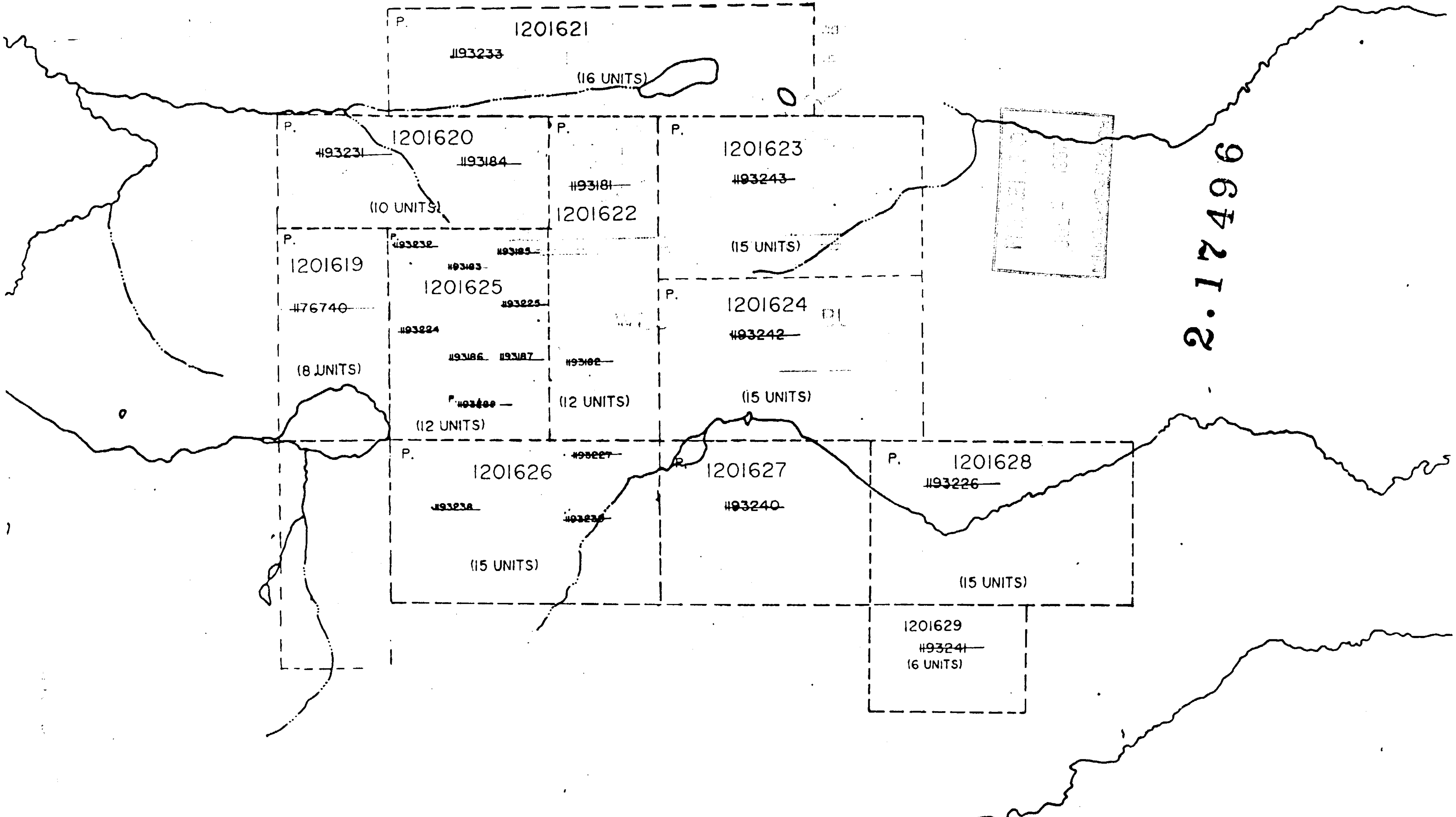
- Les travaux exécutés il y a plus de cinq ans ne sont pas admissibles à des crédits.
- Le titulaire enregistré peut être tenu de vérifier les dépenses indiquées dans le présent état des coûts dans les 45 jours suivant une demande de vérification, de correction ou de clarification. Le ministre peut rejeter la totalité ou une partie des travaux d'évaluation présentés si le titulaire ne respecte pas cette exigence.

Attestation des coûts :

Je soussigné, ______________________ (nom et prénom en lettres moulées), atteste par la présente que les montants indiqués sont aussi exacts que possible et que les coûts ont été engagés pour exécuter les travaux d'évaluation sur les terrains indiqués dans la déclaration ci-jointe d'exécution. À titre de ______________________ (titulaire enregistré, représentant ou indiquez le poste occupé dans l'entreprise vous autorisant à signer), je suis autorisé à faire cette attestation.

Signature	Date

SOUTH OF RIDGE LAKE
G1716



Ministry of
Northern Development
and Mines

Ministère du
Développement du Nord
et des Mines

Ontario

Geoscience Assessment Office
933 Ramsey Lake Road
6th Floor
Sudbury, Ontario
P3E 6B5

Telephone: (888) 415-9846
Fax: (705) 670-5863

August 7, 1997

DONALD MCKINNON
BOX 1130
TIMMINS, Ontario
P4N-7H9

Dear Sir or Madam:

Submission Number: 2.17496

		Status
Subject: Transaction Number(s):	W9760.00190	Deemed Approval

We have reviewed your Assessment Work submission with the above noted Transaction Number(s). The attached summary page(s) indicate the results of the review. WE RECOMMEND YOU READ THIS SUMMARY FOR THE DETAILS PERTAINING TO YOUR ASSESSMENT WORK.

If the status for a transaction is a 45 Day Notice, the summary will outline the reasons for the notice, and any steps you can take to remedy deficiencies. The 90-day deemed approval provision, subsection 6(7) of the Assessment Work Regulation, will no longer be in effect for assessment work which has received a 45 Day Notice.

Please note any revisions must be submitted in DUPLICATE to the Geoscience Assessment Office, by the response date on the summary.

If you have any questions regarding this correspondence, please contact Steve Beneteau by e-mail at beneteau_s@torv05.ndm.gov.on.ca or by telephone at (705) 670-5855.

Yours sincerely,

Blair Kite

ORIGINAL SIGNED BY
Blair Kite
Supervisor, Geoscience Assessment Office
Mining Lands Section

Correspondence ID: 11175

Copy for: Assessment Library

Work Report Assessment Results

Submission Number: 2.17496

Date Correspondence Sent: August 07, 1997

Assessor: Steve Beneteau

Transaction Number	First Claim Number	Township(s) / Area(s)	Status	Approval Date
W9760.00190	1201625	SOUTH OF RIDGE LAKE	Deemed Approval	June 08, 1997

Section:
18 Other DATA

Correspondence to:
Resident Geologist
South Porcupine, ON

Assessment Files Library
Sudbury, ON

Recorded Holder(s) and/or Agent(s):
WENDY SIMS KORBA
TIMMINS, ONTARIO

DONALD MCKINNON
TIMMINS, Ontario

Correspondence ID: 11175

42J06SW0008 2.17496 SOUTH OF RIDGE LAKE