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REPORT TO ABERFOYLE RESOURCES LIMITED ON A PB ISOTOPE STUDY OF DRILL CORE SAMPLES FROM PROSPECTS IN THE NORTHERN MCARTHUR BASIN, NORTHERN TERRITORY

OPEN FILE

SIROTOPE REPORT SR 166A

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26/08/91

Research Advancing Australia

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1. AIM OF STUDY

The aim of this study has been to assess the likely metallogenic association of mineralized samples from prospects in the northern McArthur Basin by comparing their Pb isotopic composition to the target signature for HYC.

2. SAMPLES AND METHODS

A total of nine samples were submitted in three batches by Aberfoyle via Tony Hosking. Brief sample locations are given in Table 1.

Sulfide (galena + sphalerite) was handpicked from sample No 4 (McA 5). For all other samples representative portions were crushed in a Mn steel mill. In some cases, two subsamples were selected (No 5, No 6, No 9) in an attempt to get a high-Pb portion.

Sulfide from sample No 4 was dissolved in concentrated nitric acid and Pb purified by micro-electrodeposition onto Pt electrodes. About 50-100 mg of each powdered whole-rock sample was weighed into a teflon beaker and digested in a hot mixture of 7N HCl and 7N HNO_3. Lead was extracted by anion exchange methods in dilute HBr acid solutions and purified as for the galena.

Lead isotope ratios were determined on a VG ISOMASS 54E thermal ionization mass spectrometer run in fully automated mode. The results have been normalized to the accepted values of international standard NBS 981 by applying a correction factor of +0.08% per atomic mass unit. Precision estimates, shown as error bars in the upper left hand corner of the accompanying Figures, are based on over 1300 analyses of international standards and natural samples. Also shown are the 95% confidence ellipses for the standard data.

A known amount of ^{202}Pb spike was added all samples except the galena at the initial dissolution stage so that Pb concentrations could be determined simultaneously with isotope ratios. Lead contents are precise to within about ± 5% for low to moderate Pb samples. However, for high Pb samples (about > 1000 ppm), the measurement of the $^{206}Pb/^{202}Pb$ ratio becomes increasingly inaccurate so that the calculated Pb levels are only an approximation.

3. TARGET Pb ISOTOPIC SIGNATURES

The target for shale-hosted Pb-Zn-Ag mineralization in the McArthur Basin is the HYC deposit at McArthur River. Lead isotope data for the galena/sphalerite mineralization (Gulson, 1975; Richards, 1975; Gulson, 1985) show a high degree of homogeneity and are conformable to average crustal Pb evolution models. Wall rocks of the HYC deposit with greater than about 1000 ppm Pb have the same isotopic composition as the ore (Vaasjoki et al., 1985). Low-Pb wall rocks are more radiogenic and define a linear trend which projects back through the orebody value and gives an isochron age of 1620

± 20 Ma.

Discordant and karstic Pb-Zn deposits occur as veins and breccia fillings in the dolomite units of the McArthur, Nathan and Mt Rigg Groups (Plumb et al., 1990). These have variable and generally more radiogenic Pb isotope ratios. Coxco, located about 10 km southeast of HYC, exhibits two main populations (Cook's and Cox's in Richards, 1975; Walker et al., 1983); one the same as HYC and the other variable with $^{206}Pb/^{204}Pb$ ratios up to about 16.4.

Other mineralization, described as statrabound disseminated Pb-Zn deposits (Plumb et al., 1990), such as Barney's and Bald Hills (Richards, 1975) similarly have variable and more radiogenic values than the HYC target.

4. RESULTS

Lead concentrations and isotope ratios are given in Table 2. Data are plotted in the Figures on conventional XY ratio plots ($^{207}Pb/^{204}Pb$ vs $^{206}Pb/^{204}Pb$ = uranogenic Pb diagram; $^{208}Pb/^{204}Pb$ vs $^{206}Pb/^{204}Pb$ = thorogenic Pb diagram). Shown for reference are the average crustal Pb evolution curves, or growth curves, of Cumming and Richards (1975), and the target 95% confidence ellipse for the HYC deposit (Gulson, 1985). Also shown are data for galenas from vein-style mineralization in the McArthur River area (Richards, 1975).

As mentioned in Section 2, there are two subsamples of some of the drill core/rock chips. These are designated /1 and /2 in Table 2. In addition, some of the whole rock powders, and sulfide from No. 4 McA 5 have been analysed in duplicate (denoted R in Table 2).
Features of the data are:

1). The whole rocks have Pb contents ranging from 9 (No. 3 McA 20) to about 2500 (No. 9 BB 6) ppm. Consequently, the isotope ratios for the lowest Pb samples, almost certainly do not represent initial ratios (i.e. Pb isotope ratios at the time Pb was incorporated into the rock/mineralization).

2). Duplicate analyses of galena from sample No. 4 McA 5 (points 6 and 7; Table 2, Figures) have the least radiogenic (i.e. lowest) $^{206}Pb/^{204}Pb$ ratios of all the data from this study. They are considered to represent initial ratios and are considerably different from the HYC target signature.

3). The two subsamples of No. 5 McA 5 (points 8 and 9), with 270 and 290 ppm Pb, plot close to the galena/sphalerite value. Due to their relatively low Pb contents, these data may not be initial ratios.

4). No. 7 and No. 9 (BB2 and BB6 respectively; points 14 to 17) plot in a fairly tight cluster with $^{206}Pb/^{204}Pb$ ratios of about 16.55. These samples have high Pb contents ranging from 1700 to over 2500 ppm and probably represent initial ratios.

5). All of the other data have Pb contents less than 230 ppm and almost certainly reflect a radiogenic component i.e. Pb derived by the *in situ* radioactive decay of U and Th (^{238}U decays to ^{206}Pb; ^{235}U decays to ^{207}Pb; ^{232}Th decays to ^{208}Pb).

6). The low-Pb data appear to define several linear trends (Fig. 1).

5. DISCUSSION

The stratigraphic position of the sulfides analysed is an important consideration in interpreting these results. Mineralization of Barney Creek Formation age, and associated with the Emu Fault, would have a high probability of having the same isotopic composition as the HYC orebody. However, it is also possible that mixing of this major hydrothermal system(s) with smaller more local fluids having more radiogenic Pb, could also occur (e.g. Coxco, Walker et al., 1983). Mineralization with mixed, more radiogenic signatures is considered to have a lower probability of representing a significant resource. Alternatively, such radiogenic mineralization may well have formed in response to a much later diagenetic event.

McA 5 Sulfides The similarity of the Pb isotope results for the sphalerite/galena vein (sample No. 4) and the two sub-samples of No. 5 suggest these data represent an initial ratio for mineralization in drill hole McA 5, despite the relatively low Pb content of the latter samples. However, the dissimilarity of the average ratios of these ($^{206}Pb/^{204}Pb$ ratio of about 16.37) and the target value for sediment-hosted massive sulfide mineralization in the McArthur Basin, point to the existence of different mineralizing solutions being responsible, at least in part, for sulfide deposition. These data are similar to the most radiogenic values for galenas, shown in the Figures, from vein mineralization analysed by Richards (1975). Richards (1975) interpreted these vein leads as probably representing mixture of Pb from the HYC Pyritic Shale Member, having the HYC isotopic composition, with country rock Pb having more radiogenic values. The Pb isotope model age for the sphalerite/galena vein mineralization is 1470 Ma based on the Stacey and Kramers (1975) model.

If McA 5 intersects Barney Creek Formation, then the most plausible explanation of these data are that they represent epigenetic mineralization. However, if the mineralization is stratiform in nature then it most probably represents mixing as discussed above.

Bing Bong Another cluster of analyses which almost certainly represents an initial ratio is the data from BB's 2 and 6 (points 14 to 17 in Table 2 and Figures; Pb contents > 1500 ppm and an average $^{206}Pb/^{204}Pb$ ratio of 16.55). Based on the Stacey and Kramers (1975) model, the age for this cluster is 1370 Ma which is similar to the model ages of other mineralization in the region associated with the sub-Roper Group unconformity, as well as to veins within the HYC. This group therefore also has a low probability of representing Barney Creek Formation age sedimentary/diagenetic Pb mineralization. Sample No. 10 BB 5 (point 18) is also from this area and has a significantly lower Pb content. Thus its isotopic composition probably indicates a component of radiogenic Pb. A U content of about 10 ppm in the Proterozoic would have been needed to change its isotopic composition from 16.55 to the present value.

WM 4 Sample No. 1 (WM 4) has a moderate Pb content (360 ppm) which may or may not represent an initial ratio. With only one sample from this locality, and the uncertainty whether this ratio has been modified by radiogenic addition, no further conclusions can be drawn as to the metallogenic association of this sample.

McA 19, 20 and WM 6 Sample Nos 2, 3 and 6 from DDH McA 19, WM 6 and McA 20 are all from a fairly restricted area (≈ 10 kms) and have Pb contents of ≤ 100 ppm. Hence their isotopic ratios have almost certainly changed by radiogenic addition of Pb. If it is assumed that they formed at the same time (are they all from the same stratigraphic horizon?) then a line can be drawn through the data on Figure 1a, which yields an isochron age of 1440 Ma ± 240 Ma (MSWD of 0.2). If No. 3 is omitted (point 18; on the thorogenic Pb diagram it lies on a different trend), then the isochron age is 1470 (MSWD = 0.1). This is about the same as the Stacey and Kramers model age for McA 5 and about 100 Ma older than the model age for the Bing Bong mineralization.

The significance of both the model age for the vein mineralization in McA 5 and the isochron age for the rocks some 40 km to the north is uncertain. The isochron is based essentially only on three points and yields a large error. However, the age of 1470 Ma is broadly consistent with a minimum Rb-Sr age for the Roper Group of 1429 ± 30 Ma (Kralik, 1982).

6. CONCLUSIONS

The least radiogenic Pb's from McA 5 and BB 2 and 6 are considered to represent initial ratios. These initial ratios are considerably different from the HYC target signature and, respectively, at the upper limit and more radiogenic than galena vein mineralization from the McArthur area analysed by Richards (1975). In addition, the two clusters of samples that represent initial ratios (at $^{206}Pb/^{204}Pb$ ratios of 16.37 and 16.55) do not form a homogeneous target. Hence, it is highly unlikely that another major sediment-hosted deposit is represented by these data. Thus, the high-Pb data from this study are consistent with vein-style mineralization although the possibility that mixing of Pb from two sources, one of which was the HYC source, cannot be discounted.

The rest of the data, with the possible exception of WM 4 and No. 4 McA 5, show some radiogenic component due to *in situ* radioactive decay of U and Pb. It is difficult in these samples to assess their likely metallogenic association. However, the data from McA 19, 20 and WM 6, yield an isochron age which is consistent with the age of younger sediments in the region and the model ages of the high-Pb samples.

7. REFERENCES

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TABLE 1. SAMPLES PROVIDED FOR Pb ISOTOPE DETERMINATIONS.

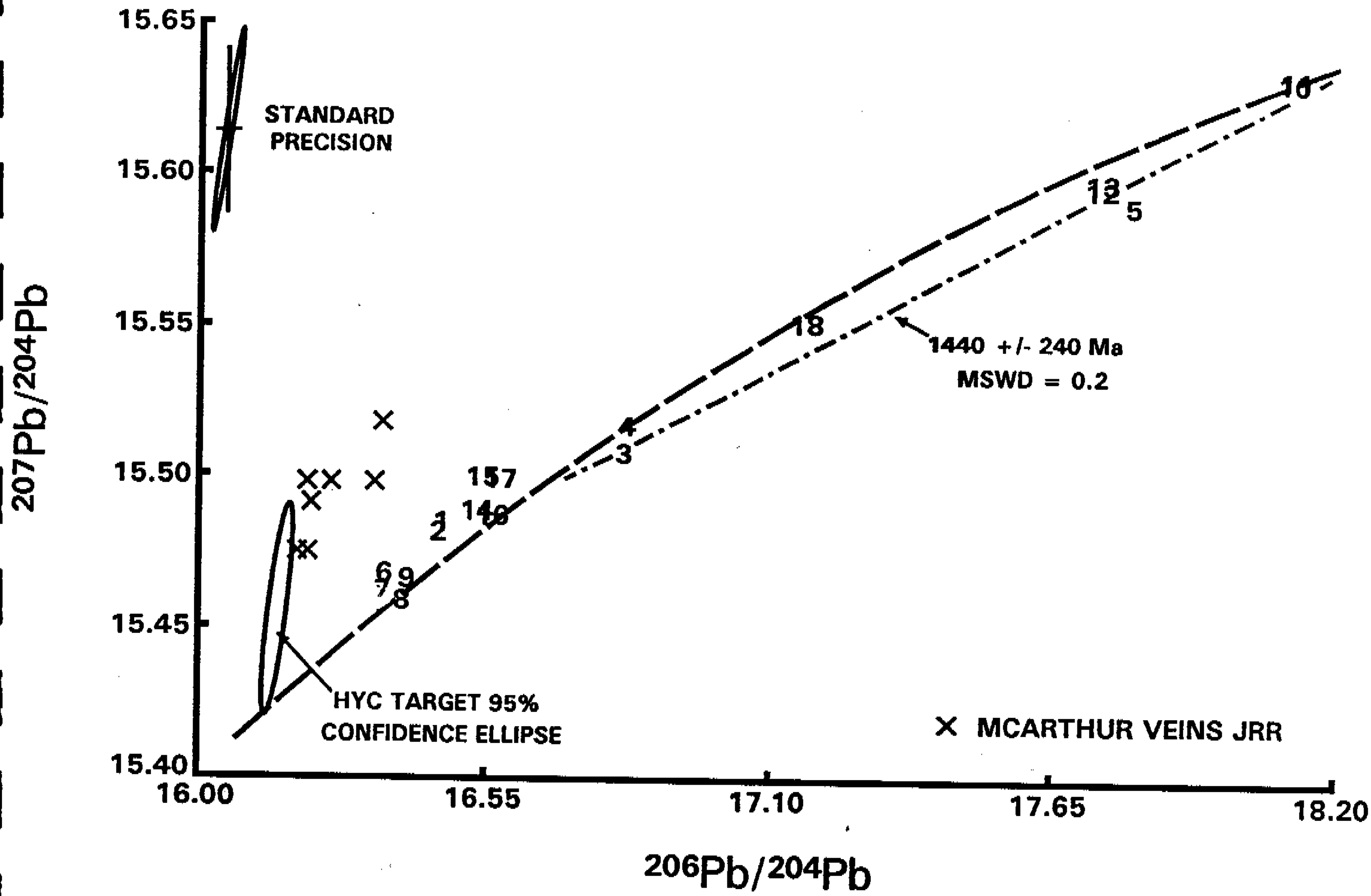
McARTHUR BASIN, NT - SAMPLE LOCATIONS

No. 1	WM 4	(~ 30 cm)	49. 65 - 50. 00 m
No. 2	MCA 19	(~ 35 cm)	252. 65 - 253. 00 m
No. 3	MCA 20	(~ 31 cm)	342. 44 - 342. 75 m
No. 4	MCA 5	5 mm Pb/Zn vein at 355.20 m	
No. 5	MCA 5	(~ 1.0 m)	328. 50 - 329. 50 m
No. 6	WM 6	(~ 1.0 m)	490. 00 - 491. 00 m
No. 7	BB 2	(~ 12 cm)	395. 55 - 396. 67 m
No. 8	BB 2	(~ 50 cm)	416. 10 - 416. 60 m
No. 9	BB 6	(~ 20 cm)	181. 41 - 181. 61 m
No. 10	BB 5	(~ 1.2 m)	339. 42 - 340. 62 m

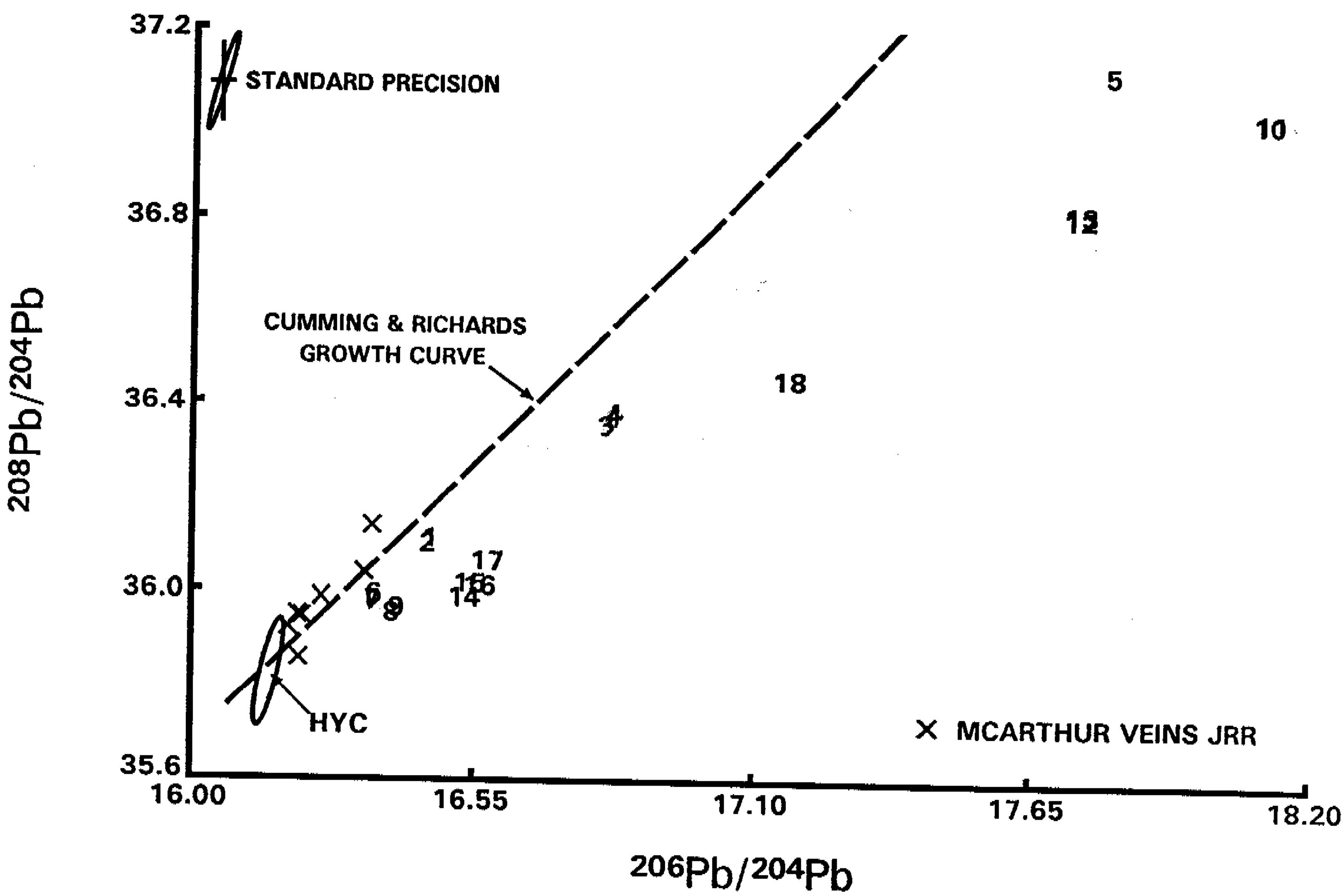
TABLE 2. LEAD ISOTOPE DATA FOR SAMPLES FROM THE NOTHERN McARTHUR BASIN

Sample	$^{208}Pb/^{206}Pb$	$^{207}Pb/^{206}Pb$	$^{206}Pb/^{204}Pb$	$^{207}Pb/^{204}Pb$	$^{208}Pb/^{204}Pb$	Pb(ppm)
1 No 1 WM4	2.1941	0.9408	16.460	15.485	36.115	353
2 No 1 WM4 R	2.1938	0.9408	16.457	15.482	36.103	371
3 No 2 McA 19	2.1622	0.9222	16.817	15.508	36.363	100
4 No 2 McA 19 re	2.1628	0.9224	16.823	15.517	36.384	100
5 No 3 McA 20	2.0846	0.8757	17.803	15.590	37.113	9
6 No 4 McA 5 gn	2.2011	0.9458	16.354	15.468	35.996	
7 No 4 McA 5 gn R	2.2009	0.9457	16.350	15.462	35.984	
8 No 5 McA 5/1	2.1943	0.9434	16.387	15.459	35.957	270
9 No 5 McA 5/2	2.1937	0.9433	16.396	15.466	35.968	287
10 No 6 WM 6/1	2.0436	0.8630	18.113	15.632	37.016	47
11 No 6 WM 6/1 re	2.0437	0.8631	18.113	15.633	37.018	47
12 No 6 WM 6/2	2.0744	0.8789	17.744	15.596	36.808	56
13 No 6 WM 6/2 re	2.0749	0.8790	17.745	15.598	36.819	56
14 No 7 BB2	2.1767	0.9368	16.534	15.489	35.990	1720
15 No 7 BB2 R	2.1772	0.9369	16.544	15.500	36.019	1690
16 No 9 BB6/1	2.1743	0.9350	16.564	15.487	36.014	2620
17 No 9 BB6/2	2.1756	0.9349	16.578	15.499	36.069	2080
18 No 10 BB5	2.1232	0.9057	17.170	15.551	36.456	225

gn denotes galena/sphalerite vein
R denotes repeat chemistry
re denotes repeat micro-electrodeposition
/1, /2 denotes separate subsamples
Pb contents determined by isotope dilution
SAMPLE NUMBER PREFIXES REFER TO PLOTTED POINTS ON FIGURES



STANDARD PRECISION
1440 +/- 240 Ma
MSWD = 0.2
HYC TARGET 95% CONFIDENCE ELLIPSE
× MCARTHUR VEINS JRR
207Pb/204Pb
206Pb/204Pb
15.65
15.60
15.55
15.50
15.45
15.40
16.00
16.55
17.10
17.65
18.20



STANDARD PRECISION
CUMMING & RICHARDS GROWTH CURVE
HYC
× MCARTHUR VEINS JRR
208Pb/204Pb
206Pb/204Pb
37.2
36.8
36.4
36.0
35.6
16.00
16.55
17.10
17.65
18.20

266e

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The Director
Northern Territory Geological Survey
Department of Mines and Energy
GPO Box 2901
DARWIN NT 0801

18th September 1991

Dear Sir,

Re: SIROTOPE REPORT SR166A - McARTHUR BASIN, N.T.

Last April this company obtained a number of samples of drill cores from the Bing Bong area (McArthur Basin), held at the Departmental Core Library in Darwin, for specialist lead isotope determination and interpretation.

We have recently submitted copies of the report on this work by Sirotope, CSIRO, Sydney to your Department.

Aberfoyle has an on-going commitment to lead-zinc exploration in Australia. Lead isotope data can be a valuable determinant in evaluating base metal exploration potential within a given geological province, such as the McArthur Basin.

We believe that this type of data is not readily available for this basin, and that the results contained in Report SR166A could provide a commercial advantage in Aberfoyle's future exploration assessments in this region.

We therefore request an extension of "Closed File" status for this report, for 36 months from the date of sampling.

Yours faithfully,
ABERFOYLE RESOURCES LIMITED
Exploration Division

IB Freytag
Senior Exploration Geologist

GS

cc: ADTG

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Mr B Whitehead
Geoscience Resource Section
NT Department of Mines & Energy
GPO Box 2901
DARWIN NT 0801

18th September 1991

Dear Brian,

RE: McArthur Basin Core Samples

Please find enclosed two copies of Sirotope Report No. SR166A by Judith Dean, covering lead-isotope determinations on drill cores from the McArthur Basin.

The samples were obtained from the Darwin Core Library by Mr Tony Hosking in April this year, on behalf of Aberfoyle. We shall be returning surplus sample material to you by surface mail.

With regard to the technical data in the Sirotope report, we intend to apply to the Director for an extension of "Closed File" status.

Thanks for your assistance in making the core samples available.

Kind regards,
ABERFOYLE RESOURCES LIMITED
Exploration Division

Ian Freytag

Ian Freytag
Senior Exploration Geologist

cc: AJ Hosking - Darwin
ADTG

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