Bureau of Mineral Resources, Geology & Geophysics

RECORD

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MINOR METALS AND RARE EARTH ELEMENTS IN AUSTRALIAN BASE METAL ORES

- A Reconnaissance Assay Survey

by L J David
Commodity Geologist
(Base Metals)

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ABSTRACT

A reconnaissance assay survey of ore samples was undertaken to approximately gauge the content of the rare earth elements (REEs) and the so called minor metals in selected base metal sulphide deposits of Australia. With the exception of the anomalous Mt Lyell samples, the low REE contents recorded are consistent with contents reported in the small amount of work that has been done on other world sulphide deposits. Known associations of the surveyed minor metals with the various base metals are broadly confirmed. Production of REEs from Australian base metal sulphide deposits is unlikely in the foreseeable future.

INTRODUCTION

Significant interest in the use of the Rare Earth Elements (REEs) in high powered magnets and experimental "warm" superconductor materials, and of the minor metals in the electronics industry, was generated in the late 1980s. These metals should continue to play a role in the future, as research into new uses of these elements and new materials is undertaken.

A reconnaissance assay program commenced in early 1989, to approximately gauge the content of these minor metals in ores from major Australian base metal mines and in two deposits at an advanced stage of development.

In April/May 1989, three random samples (1kg weight) of crushed, ground ore (mill feed) and of any mill feed stockpiles were requested and received from the operating mines. Composite core samples were received from the two deposits being developed. Sample numbers and their sources are listed in Table 1. There were 53 samples, each of approximately 500 g weight dispatched to Australian Assay Laboratories, Perth, Western Australia on 2 June, 1989 for assay.

It is emphasised that because of the small number of samples taken they should not be considered to be representative of the relevant mill feed, orebodies or deposits. As a result only a broad interpretation of the assay results has been attempted, which should be regarded as approximate only.

Sample Preparation

Mill feed samples were riffle split into two 500 g (approx) samples. Single composite samples (also 500 g approx) were made from equal riffle splits of the samples from each of the stockpiles and selected core samples groups. The core samples were grouped according to designated "ore grade" category (high, medium or low) for the Lady Loretta deposit, and the source orebody for the Thalanga deposit.

Remnant sample split and laboratory residues, after analysis, were retained.

Table 1: Sample Numbers and Mines/Deposits Sampled.

SAMPLE #	MINE/DEPOSIT	SAMPLE TYPE
8981001	Cadjebut (Zn/Pb) mine, Western Australia	Mill feed
002	"	"
003	"	"
004	CSA (Cu/Zn/Pb) mine, New South Wales	Mill feed
005	"	"
006	"	"
007	Elura (Zn/Pb) mine, New South Wales	Monthly composite mill feed
008	"	"
009	"	"
010	Mt Lyell (Cu/Ag/Au) mine, Tasmania	Mill feed
011	"	"
012	"	"
013	Lady Loretta (Zn/Pb) Deposit, Queensland	Medium grade ore drill core
014	"	High grade ore drill core
015	"	Low grade,baritic ore drill core
016	Selwyn (Starra) Cu/Au mine, Queensland	Sulphide ore mill feed
017	"	"
018	North (Zn/Pb/Ag) mine, New South Wales	CHECK SAMPLE annual composite
019	Selwyn (Starra) Cu/Au mine, Queensland	Sulphide ore mill feed
020	Warrego (Cu/Bi/Au) mine, Northern Territory	Monthly composite mill feed
021	"	"
022	"	"
023	ZC (Zn/Pb/Ag) mine, New South Wales	Annual Composite mill feed
024	Woodcutters (Zn/Pb) mine, Northern Territory	Mill feed
025	"	"
8981026	Woodlawn (Zn/Pb/Cu) mine, New South Wales	Complex ore mill feed
027	"	"
028	"	"
029	Mount Isa (Zn/Pb/Cu) mine, Queensland	Weekly composite Cu mill feed
030	"	"
031	"	"
032	"	Weekly composite Pb/Zn mill feed
033	"	"
034	"	"
035	North (Zn/Pb/Ag) mine, New South Wales	CHECK SAMPLE mill feed annual composite
036	Hellyer (Zn/Pb/Cu) mine, Tasmania	Low grade Zn ore SAG mill discharge
037	"	High As ore arsenic stockpile
038	"	Medium Zn ore stockpile
039	"	High grade Zn ore stockpile
040	"	"
041	"	"
042	Mount Isa (Zn/Pb/Cu) mine,	Pb/Zn tail
043	"	Cu tail
044	Lady Loretta (Zn/Pb) Deposit, Queensland	Medium grade ore drill core
045	"	High grade ore drill core
046	Rosebery (Zn/Pb/Cu) mine, Tas. (incl Que River ore)	Monthly composite mill feed
047	"	"
048	"	"
049	Thalanga (Zn/Pb/Cu) Deposit, Queensland	Central orebody drill core
050	"	Eastern orebody drill core
051	"	Western orebody drill core
052	Selwyn (Starra) Cu/Au mine, Queensland	Leached ore stockpile
053	"	Oxide ore s'pile

Lotus File:SAMPLNUM

Acid Digest and Assay Procedures

The elements assayed in each of the samples were:

copper	(Cu)	lanthanum	(La)
lead	(Pb)	cerium	(Ce)
zinc	(Zn)	praseodymium	(Pr)
cadmium	(Cd)	neodymium	(Nd)
antimony	(Sb)	samarium	(Sm)
scandium	(Sc)	europium	(Eu)
gallium	(Ga)	gadolinium	(Gd)
indium	(In)	terbium	(Tb)
thallium	(Tl)	dysprosium	(Dy)
selenium	(Se)	holmium	(Ho)
tellurium	(Te)	erbium	(Er)
germanium	(Ge)	thulium	(Tm)
hafnium	(Hf)	ytterbium	(Yb)
yttrium	(Y)	lutetium	(Lu)

Sample break-down was by mixed acid digest for germanium, tellurium, antimony and selenium and a mixed acid/hydrofluoric acid leach was used for all other elements. For the REEs, an ion exchange process was then used to remove interference elements before assay by the Inductively Coupled Plasma (ICP) Spectrometry (Optical) method.

Scandium, hafnium (10ppm detection limit) and gallium were also assayed by ICP-Optical Spectrometry but indium assays were determined by Analabs, Perth, Western Australia using ICP-Mass Spectrometry. Copper, lead, zinc, germanium, tellurium, antimony and selenium were assayed by Atomic Absorption Spectroscopy (AAS). Hafnium (5ppm detection limit) was assayed using the pressed disc/X-Ray Fluorescence technique.

PREVIOUS WORK

A literature survey has indicated that very little work has been done on REE behaviour in and around sulphide deposits. Only scattered brief references are made to the other minor metals of this reconnaisance survey in publications which focus on other subjects. These mainly consist of analyses of specific minerals rather than the minor metal content of major metal ores.

GEOLOGICAL OCCURRENCE

Deposits in which the minor metals, other than the REEs, constitute the principal economic commodities are rare, despite the relative abundance of these metals in the earth's crust. Study of the geological setting of these minor metals has mainly been confined to economic deposits of the major metals such as aluminium, base metals, tungsten and tin in which they occur as minor constituents. Available data have been summarised in the "Economic Geology" section of this report.

Carbonatites contain by far the largest REE contents, which may exceed 15,000ppm. REEs in the earlier phases of a carbonatite complex are relatively widely distributed in the minerals calcite, apatite and pyrochlore. In the later phases they become concentrated in the rare earth minerals (Henderson 1984).

Kimberlites (which may exceed 4500ppm) have the next highest REE content of the basic and ultrabasic rock suite, while most of the other members of the suite contain less than 1000ppm total REEs. Komatiites have especially low contents of less than 100ppm. Intermediate and acid rocks have generally low to moderate total REE contents of up to 400-500ppm, with some up to 1000ppm.

Most sulphide and oxide ore minerals are not good hosts for REEs.

Bence suggested (Whitford et al, 1988) that europium is enriched in many polymetallic volcanogenic massive sulphide (VMS) deposits and in active mid-ocean ridge "black smokers". Whitford et al (1988) recorded much higher contents for each of the REEs in a massive pyrite sample (0.008-0.7ppm) compared to a massive ore sample (1.03-24.6ppm) both taken from the PQ lens at Que River, Tasmania. The REE contents in the massive pyrite sample are comparable to that in ore samples assayed, in this survey, from Hellyer and Rosebery, Tasmania.

ECONOMIC GEOLOGY

Minor Metals

Most of the material for this section has been drawn from US Bureau of Mines (1985) and US Geological Survey (1973).

Antimony is produced as a by-product of base metal and silver mining and may be extracted from tetrahedrite, a copper/silver/antimony sulphide. Stibnite is the main ore mineral of antimony, and often occurs in siliceous veins with small amounts of pyrite, other metal sulphides and minor gold. These veins are usually associated with granite, diorite or monzonite and are emplaced at shallow depths. Stibnite also occurs in more mineralogically complex deposits with pyrite, arsenopyrite, cinnabar or scheelite and base metal sulphides.

Cadmium is mainly sourced from zinc ores with minor contribution from copper and lead ores. Cadmium content of zinc ores is partially dependent on the ore formation temperature with higher temperature contact metamorphic and replacement deposits containing less cadmium than lower temperature hydrothermal or sedimentary-type deposits. Hawleyite and greenockite are the principal independent cadmium sulphide minerals but are not known to form economic cadmium deposits.

Gallium is recovered during alumina production and the processing of some zinc ores. Up to 1% gallium has been recorded in sphalerite, up to 500ppm in galena and up to 100ppm in chalcopyrite. Sphalerite from the "lead belt" in the tri-State area of Kansas, Missouri and Oklahoma in the USA averages about 50ppm gallium and contains up to 200ppm. Bauxites have a similar average gallium content and may reach 100ppm.

Germanium is a minor constituent of some base metal ores and its main source is as a by-product of zinc production. It commonly reaches 0.01 - 0.05% in sphalerite and 0.01 - 0.1% in enargite (a copper/arsenic sulphide). Minerals include germanite (which may also contain appreciable gallium), argyrodite, renierite and others which normally form in sulphide mineralisation at low to intermediate temperatures. Germanium can be concentrated in clays as a result of weathering.

Brief production from the Apex deposit, Utah, USA of gallium/germanium ore hosted by leached iron oxides in dolomite/limestone occurred from 1985 to 1987. Recoverable reserves were estimated at 167,000 t grading 0.039% gallium, 0.079% germanium, 1.91% copper and minor zinc/silver (M J, 1985).

Indium is a trace constituent of mainly zinc, but also of lead, deposits. Concentration in zinc ores can vary widely but sphalerite commonly contains 10-20ppm indium and can reach levels of 1% indium. Chalcopyrite and tetrahedrite can contain up to 1500ppm indium.

Scandium, in the mineral thortvietite, has been mined in small amounts from pegmatites in Norway and Madagascar. However, the major potential source is from tungsten deposits in which scandium is a minor constituent of wolframite and other tungsten minerals. Scandium has also been extracted as a by-product of uranium processing, although scandium contents are relatively low, and it can reach relatively high levels in phosphate minerals.

Selenium shows a preference for copper sulphides and pyrite, although it does occur in lead sulphides (1085ppm in galena from Mississippi Valley type mineralisation in West Canada, Mercer 1976). It is of relatively higher abundance in stratabound copper/lead/zinc deposits of volcanic origin.

Rare Earth Elements and Yttrium (Henderson 1984)

Until 1965 monazite (55-65% rare earth oxides or REOs) was the most important commercial rare earth elements bearing mineral. Beach sand placer deposits in Brazil provided the first major world source of monazite in 1895 and other placer deposits were developed in India. Since 1967 Australian mineral sands deposits have been the most important source of monazite, as a by-product of ilmenite, rutile and zircon production. Minor xenotime (yttrium phosphate) is also produced. Alluvial tin mining in Malaysia produces monazite and minor xenotime by-product concentrates.

Primary bastnasite, a fluocarbonate mineral (60-75% REOs) in carbonatite igneous rocks, has been the dominant source of Rare Earth Elements (REEs) in the world since 1965 with the Mountain Pass carbonatite deposit in California, USA, being the major producer (average REO content 5-15%). China is emerging as an important producer of REOs from primary bastnasite, monazite and other rare earth minerals associated with magnetite, specularite and hematite in the Bayan Obo iron ore deposit (up to 6.19% REO). The tabular iron orebodies occur in steeply dipping dolomites and are thought to have been derived from solutions of carbonatite affinity. Several REE bearing carbonatite bodies have been identified in Africa and bastnasite (with minor monazite) bearing veins were mined in Burundi, Central Africa until 1980. Secondary enrichment of REEs may result from deep weathering of carbonatite bodies such as in residual soils overlying carbonatites in Kenya (grading about 5% REO) and Brazil.

Although economic concentrations of REEs are normally associated with carbonatites, the major world production in the 1950s and early 1960s was from a monazite bearing shear at Steenkampskraal, South Africa. By-product recovery of monazite is being considered at the Buffalo fluorspar mine near Naboomspruit, South Africa.

The Korsnas mine in Finland produced a rare earth concentrate (ore minerals: monazite, apatite) between 1961 and 1972, as a by-product of the mining of galena from a vein in migmatitic mica gneiss.

Pegmatites provide a minor source of rare earth minerals.

AUSTRALIAN PRODUCTION/RESOURCES

Minor Metals

Antimony is extracted, as an antimony-lead product, from Broken Hill lead ores by Broken Hill Associated Smelters at Port Pirie, South Australia. Antimony oxide is produced from stibnite ores of the Hillgrove Mine in the New England area of New South Wales (AMIAR 1987).

Cadmium is a by-product of the smelting of zinc concentrates from the Rosebery, Elura, Que River, Broken Hill and Mount Isa mines at the Risdon zinc refinery in Tasmania; lead-zinc smelting of Broken Hill and other concentrates at Cockle Creek, NSW, and smelting of the Broken Hill lead concentrates at Port Pirie, SA (AMIAR 1987).

Gallium content of the Brockman REE deposit, in the East Kimberleys of Western Australia, is reported to be significant. A plant built by Rhone-Poulenc Chemie, of France, commenced extraction of gallium as a by-product of alumina production at Pinjarra, Western Australia in mid 1989 but the company was considering curtailment of operations in early 1990, mainly as a result of low gallium prices. The gallium source is the caustic liquor containing aluminium and minor gallium piped from the nearby Alcoa alumina refinery.

Indium occurs at Broken Hill, NSW, and in a number of base metal deposits around Herberton, north Queensland. The Baal Gammon copper/silver/tin deposit is the most significant of a number of indium bearing deposits west of Herberton.

Scandium oxide (about 130kg) was extracted between 1954 and 1961 at Port Pirie, South Australia, from uranium ore mined at Radium Hill, South Australia. Uranium processing residues at Port Pirie are estimated to contain several tonnes of scandium. Tailings dams at Mary Kathleen, Queensland, also contain scandium (Bureau of Mineral Resources 1988).

Selenium is recovered from tankhouse slimes at the Port Kembla copper refinery and at the Cockle Creek lead/zinc refinery, Newcastle, both in New South Wales (AMIAR 1987).

Rare Earth Elements and Yttrium

Monazite and minor xenotime concentrates produced as a by-product of ilmenite, rutile and zircon extraction from mineral sands deposits on the east and west coasts are the only form of REE and yttrium production under way in Australia (AMIAR 1987).

Pronounced enrichment of REEs occurs in the weathered zone of carbonatites at Mt Weld, Western Australia. A previously published measured resource figure of 1.35Mt at 23.5% total rare earths (20% cut off) is now considered conservative (Carr Boyd Minerals Ltd, 1990).

Parts of the large Olympic Dam copper/uranium/gold deposit (450 Mt measured and indicated resource) in South Australia contain 2000-2700ppm cerium, 200ppm-1800ppm lanthanum and 35-135ppm yttrium (Towner et al 1987). The REE minerals bastnasite and florencite have been identified (Roberts and Hudson 1983).

The Brockman rare earths deposit near Halls Creek in Western Australia contains proved and probable reserves of 9 Mt at about 0.075% REO and 0.124% yttrium oxide (Towner et al 1987).

The depleted Mary Kathleen uranium deposit, Queensland, contained significant levels of REEs, attributed to the uranium minerals allanite and stillwellite, but these were not recovered. Uranium production ceased in 1982.

There are numerous occurrences of REEs associated with uranium in the Mt Isa region in Queensland and the Olary district in South Australia and with pegmatites in several locations in Australia. Minor production was recorded from a pegmatite deposit at Cooglegong, WA (Towner et al 1987).

ASSAY RESULTS

Assay results are presented in APPENDIX 1 and graphs of these results, plotted against sample number, are in APPENDIX 2. The mines and deposits sampled are shown on the copper, lead, zinc assays graph (APPENDIX 2, Figure 1). Elements are grouped arbitrarily, rather than with regard to any particular element association.

Cadmium and Antimony (APPENDIX 2, Figure 3)

Highly anomalous cadmium (1490ppm, 1570ppm) and exceptionally high antimony (5100ppm, 6700ppm) assays for the two Woodcutters samples are associated with only moderately elevated zinc and lead contents.

North Mine, Hellyer and Elura samples gave the next highest antimony assays. Low antimony assays, relative to samples from the other lead-zinc and polymetallic mines and deposits, were recorded in the Cadjebut and Woodlawn samples

As could be expected, cadmium and antimony are broadly sympathetic with zinc and lead contents (respectively) and, in general, cadmium exceeds antimony content. However, Elura, Woodcutters and some of the Hellyer samples exhibit the reverse relationship despite higher zinc than lead content.

Scandium, Indium and Gallium (APPENDIX 2, Figure 4)

Scandium assays are anomalous in two of the Mt Lyell samples and the high arsenic ore sample from Hellyer but no significant correlation with base metals is evident. Assays of the copper and the lead/zinc tail samples from Mt Isa indicate that sulphide concentration has no effect on scandium content of the copper tail but enriches scandium in the lead/zinc tail. This element is also enriched in the samples from the weathered zone of the Selwyn deposit.

Indium assays are highest in the high grade samples from Lady Loretta, one from the Eastern orebody at Thalanga and the Woodlawn samples. Samples from Lady Loretta (medium grade), Woodcutters, and the volcanogenic Hellyer, Rosebery and Thalanga deposits returned high assay results. The low grade baritic Lady Loretta ore and high arsenic ore at Hellyer yielded particularly low assays. An overall positive correlation exists between zinc and indium contents, although the Cadjebut, Elura and the Broken Hill samples are notable exceptions. A marked decrease of indium, relative to the mill feed ore samples, occurs in the Mt Isa lead/zinc tail while the copper tail shows only a marginal decrease after sulphide concentration.

Gallium appears to be most abundant in the ore samples with significant copper (APPENDIX 2, Figs 2 and 4), especially those of the Selwyn and Warrego copper/gold mines. Exceptions are the relatively low gallium contents of the Mt Isa copper ore samples and the relatively high gallium contents of copper poor Elura samples. Cadjebut and Broken Hill samples gave relatively low gallium assays. Despite low gallium in the Mt Isa copper ore the affinity for copper is supported by the depletion of gallium in the copper tail and the enriched gallium content in the Mt Isa lead/zinc tail.

Selenium and Germanium (APPENDIX 3, Figure 5)

Many of the assays for these two elements were below the analytical detection limit.

Where selenium values are recorded, they are significantly elevated in samples taken from the VMS deposits of Tasmania and Woodlawn, particularly from the Hellyer mine. Samples from CSA Mine at Cobar and a medium grade core sample from Lady Loretta lead/zinc deposit also have significant selenium content. The Mt Isa copper tail sample exhibits enrichment of selenium.

Germanium assays were above the detection limit only in samples from Mt Lyell, Lady Loretta, and the ZC Mine. The high grade core samples from Lady Loretta gave much higher assays than the other Lady Loretta samples, and there appears to be some correlation with zinc content.

Rare Earth Elements (REEs) (APPENDIX 2, Figures 6-10)

The most obvious feature is the highly anomalous lanthanum (80-175ppm) and cerium (119-256ppm) assays of the Mt Lyell mine samples. A high content of the other light REEs (through to gadolinium) is also evident. A REE bearing phosphatic layer has been mapped at the top of the main mineralised horizon of the Prince Lyell deposit, and contains apatite concretions with monazite-chalcopyrite intergrowths (Hendry 1981).

Marked enrichment in REEs, compared to primary ore samples, is observed in the two samples taken from the weathered portion of the Selwyn deposit.

The content of lanthanum, cerium, neodymium and terbium is higher in the CSA, Warrego, Woodcutters, high arsenic Hellyer, Rosebery, Thalanga and the Broken Hill ore samples. The Broken Hill samples also have a high yttrium content.

The europium content of the VMS deposits of Rosebery and Thalanga is much higher than in the genetically similar deposits of Woodlawn and Hellyer. Broken Hill samples also have elevated europium contents.

Hafnium, Tellurium and Thallium

As shown in APPENDIX 1 all the assay results for hafnium, tellurium and thallium were below the analytical detection limit.

CONCLUSIONS

The association of gallium with copper ores is of interest as the traditional sources of gallium (as a by-product) are bauxite and zinc ores. Sphalerite is probably responsible for the elevated gallium content in the Elura lead/zinc samples and also, at least partially, in samples from the VMS deposits of Woodlawn, Hellyer, Rosebery and Thalanga.

Elevated indium content is observed in the samples from the Hellyer, Rosebery and Thalanga VMS deposits. The same or greater amounts of indium occur in the samples from the Woodcutters and the Lady Loretta deposits.

Selenium is also enriched in many of the VMS deposit samples and in one from Lady Loretta, together with two of the CSA samples. As selenium substitutes for sulphur in sulphides (US Bureau of Mines, 1985), the high content in the VMS deposits may reflect the generally high pyrite content, as found by Bence (1983).

With the exception of cadmium and antimony, only small amounts of the minor metals are recovered worldwide (range of about 50 kg for scandium to 95 t for tellurium, Bureau of Mineral Resources, 1988) compared to relatively large resources contained in base metal and other mineral deposits.

The high REE content of the Mt Lyell ore samples sets them apart from those of the other Tasmanian VMS deposits.

REE enrichment in the samples from the weathered portion of the Selwyn deposit is consistent with lower mobility of REEs in arid environments, compared to intense humid chemical weathering environments, as observed by Balashov (Henderson 1984).

Except in the case of Mt Lyell, the REE assay data in this survey are consistent with low REE contents of the few other world base metal deposits for which such data have been reported. The REE grade of monazite concentrates from mineral sands and the economic bastnasite bearing carbonatite intrusive deposits far exceeds the highest REE assays recorded in this survey. Thus economic extraction of these elements from sulphide ores in Australia appears unlikely in the foreseeable future.

The reconnaissance nature of the data collected in this survey has permitted some analysis of the more obvious relationships between base metal sulphides and the minor metals. Wider and more comprehensive sampling and more detailed analysis of resulting data is required if these relationships are to be confirmed and others observed.

ACKNOWLEDGEMENTS

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Aberfoyle Resources Ltd	Mt Lyell Mining and Railway Company Ltd
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Cyprus Gold Australia Inc	Peko Mines
Denehurst Ltd	Woodcutters Joint Venture
Mt Isa Mines Ltd	

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APPENDIX 1:
Assay Results

Table 1: Sample Numbers and Mines/Deposits Sampled.

SAMPLE #	MINE/DEPOSIT	SAMPLE TYPE
8981001	Cadjebut (Zn/Pb) mine, Western Australia	Mill feed
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018	North (Zn/Pb/Ag) mine, New South Wales	CHECK SAMPLE annual composite
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021	"	"
022	"	"
023	ZC (Zn/Pb/Ag) mine, New South Wales	Annual Composite mill feed
024	Woodcutters (Zn/Pb) mine, Northern Territory	Mill feed
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030	"	"
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032	"	Weekly composite Pb/Zn mill feed
033	"	"
034	"	"
035	North (Zn/Pb/Ag) mine, New South Wales	CHECK SAMPLE mill feed annual composite
036	Hellyer (Zn/Pb/Cu) mine, Tasmania	Low grade Zn ore SAG mill discharge
037	"	High As ore arsenic stockpile
038	"	Medium Zn ore stockpile
039	"	High grade Zn ore stockpile
040	"	"
041	"	"
042	Mount Isa (Zn/Pb/Cu) mine,	Pb/Zn tail
043	"	Cu tail
044	Lady Loretta (Zn/Pb) Deposit, Queensland	Medium grade ore drill core
045	"	High grade ore drill core
046	Rosebery (Zn/Pb/Cu) mine, Tas. (incl Que River ore)	Monthly composite mill feed
047	"	"
048	"	"
049	Thalanga (Zn/Pb/Cu) Deposit, Queensland	Central orebody drill core
050	"	Eastern orebody drill core
051	"	Western orebody drill core
052	Selwyn (Starra) Cu/Au mine, Queensland	Leached ore stockpile
053	"	Oxide ore s'pile

Lotus File:SAMPLNUM

ANALYSIS REPORT

Australian Assay Laboratories Group

PERTH: 3 Halley Road, BALCATTA 6021
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BUREAU OF MINERAL RESOURCES

REPORT : BA 021509 15 Page(s) Date : 21/07/89

Client reference : 8906263

Cost code :

Copies to : L J DAVID

Samples : Type Preparation code
Received : 02/06/89

Analysis	Code	Quality Parameter	Detection	Units
Y	D300/IEX	Prec.10 %	0.1	ppm
La	D300/IEX	Prec.10 %	0.1	ppm
Ce	D300/IEX	Prec.10 %	0.5	ppm
Pr	D300/IEX	Prec.10 %	0.5	ppm
Nd	D300/IEX	Prec.10 %	1	ppm
Sm	D300/IEX	Prec.10 %	0.5	ppm
Eu	D300/IEX	Prec.10 %	0.1	ppm
Gd	D300/IEX	Prec.10 %	0.2	ppm
Tb	D300/IEX	Prec.10 %	0.5	ppm
Dy	D300/IEX	Prec.10 %	0.1	ppm
Ho	D300/IEX	Prec.10 %	0.1	ppm
Tm	D300/IEX	Prec.10 %	0.1	ppm
Yb	D300/IEX	Prec.10 %	0.1	ppm
Lu	D300/IEX	Prec.10 %	0.05	ppm
Cu	D3000G/AAS	Prec.10 %	10	ppm
Pb	D3000G/AAS	Prec.10 %	25	ppm
Zn	D3000G/AAS	Prec.10 %	10	ppm
Sc	D3000G/ICP-ES	Prec.10 %	1	ppm
Cd	D3000G/AAS	Prec.10 %	1	ppm
Hf	D3000G/ICP-ES	Prec.10 %	10	ppm
Ge	D210/AAS	Prec.10 %	0.5	ppm
Te	D210/AAS	Prec.10 %	0.5	ppm
Sb	D210/AAS	Prec.10 %	0.5	ppm
Tl	D300-CR	Prec.10 %	2	ppm

Continued

Australian Assay Laboratories Group

In	SPEC	Prec.10 %	0.05	ppm
Se	D210/AAS	Prec.10 %	0.5	ppm
Ga	D300/ICP-ES	Prec.10 %	10	ppm
Er	D300/IEX	Prec.10 %	0.3	ppm
Hf	XRF/D410	Prec.10 %	5	ppm

Senior Chemist : Alastair Inglis

ANALYSIS REPORT

Australian Assay Laboratories Group

REPORT : BA 021509

Sample	Y	La	Ce	Pr	Nd	Sm
8981001	9.40	9.80	19.7	3.70	5	2.00
8981002	4.50	8.10	11.1	<0.5	3	1.30
8981003	8.70	14.1	22.8	0.5	5	2.00
8981004	11.9	17.4	35.1	2.40	11	2.20
8981005	13.0	16.8	36.0	1.60	13	3.10
8981006	13.6	36.6	58.3	4.30	16	3.30
8981007	2.60	16.0	14.0	<0.5	1	0.5
8981008	3.00	6.10	6.30	<0.5	<1	0.5
8981009	2.10	6.60	12.8	2.00	7	1.20
8981010	11.4	175	256	25.6	76	7.70
8981011	12.5	173	253	25.0	77	8.60
8981012	9.60	81.1	119	13.7	37	4.60
8981013	6.90	13.7	20.1	3.20	7	1.40
8981014	3.70	9.90	6.70	1.70	<1	0.7
8981015	5.20	1.30	2.50	<0.5	<1	<0.5
8981016	8.70	17.7	41.4	4.60	10	1.50
8981017	6.50	14.4	23.7	4.40	9	1.60
8981018	17.6	24.3	37.6	6.50	14	2.30
8981019	6.20	12.6	21.3	3.20	5	1.50
8981020	8.80	30.9	50.9	9.30	25	3.80
8981021	8.00	27.4	44.6	7.00	19	3.30
8981022	7.60	24.2	39.8	7.00	17	2.60
8981023	18.2	15.4	30.1	7.00	15	3.60
8981024	6.30	15.3	25.7	7.80	8	1.70
8981025	9.30	28.4	45.0	6.60	17	4.10

Data in ppm unless otherwise stated.

ANALYSIS REPORT

Australian Assay Laboratories Group

REPORT : BA 021509

Sample	Y	La	Ce	Pr	Nd	Sm
8981026	10.6	13.6	25.7	3.50	13	2.00
8981027	8.30	14.6	25.3	1.30	9	1.50
8981028	12.9	16.7	27.0	4.00	12	2.60
8981029	4.20	10.3	14.5	1.00	8	1.50
8981030	3.40	10.5	14.9	0.6	5	1.00
8981031	6.20	11.3	18.0	1.10	6	1.30
8981032	5.40	11.6	18.1	1.30	7	1.00
8981033	7.10	13.7	20.6	1.60	8	1.80
8981034	9.60	13.0	24.0	0.5	11	1.50
8981035	17.2	21.9	38.8	6.00	13	2.50
8981036	4.40	9.00	13.5	3.70	7	1.50
8981037	12.9	25.1	42.5	5.20	17	3.10
8981038	1.80	3.50	4.80	<0.5	1	<0.5
8981039	1.20	2.60	1.10	<0.5	<1	<0.5
8981040	3.30	7.80	12.9	0.5	4	0.5
8981041	1.10	3.20	5.70	1.40	1	<0.5
8981042	6.70	13.1	22.3	4.40	11	2.00
8981043	4.60	11.0	17.7	3.50	10	2.00
8981044	5.50	16.9	24.9	3.80	11	2.30
8981045	3.90	2.80	5.70	0.5	3	1.00
8981046	9.60	25.0	44.6	7.20	19	3.80
8981047	8.90	24.9	44.6	7.80	19	3.30
8981048	11.1	31.4	55.7	7.00	25	4.60
8981049	11.1	13.8	25.2	7.80	13	2.50
8981050	13.2	24.8	45.8	12.5	21	4.10

Data in ppm unless otherwise stated.

ANALYSIS REPORT

Australian Assay Laboratories Group

REPORT : BA 021509

Sample	Y	La	Ce	Pr	Nd	Sm
8981051	9.50	10.5	23.8	5.30	15	3.10
8981052	15.9	31.7	56.3	13.7	32	5.40
8981053	31.6	17.8	33.1	10.2	26	5.10
SO-2	--	--	--	--	--	--
CCU1	--	--	--	--	--	--
CPB1	--	--	--	--	--	--
CZN1	--	--	--	--	--	--
MP1a	--	--	--	--	--	--
AAL1	--	--	--	--	--	--
Sb-hyd	--	--	--	--	--	--
SY-2	116	79.5	161	22.6	83	17.0
SY-3	650	1250	2100	140	720	89.4

LABORATORY STANDARDS

Data in ppm unless otherwise stated.

ANALYSIS REPORT

Australian Assay Laboratories Group

Sample	Eu	Gd	Tb	Dy	Ho	Tm
8981001	0.1	1.60	0.5	1.20	0.1	<0.1
8981002	<0.1	0.5	<0.5	0.7	<0.1	<0.1
8981003	0.1	1.40	<0.5	1.00	0.1	<0.1
8981004	0.1	2.00	<0.5	2.10	0.2	0.1
8981005	0.1	2.40	0.5	2.20	0.4	0.2
8981006	0.3	2.60	1.00	2.10	0.4	0.1
8981007	0.3	0.2	<0.5	0.2	<0.1	<0.1
8981008	0.3	0.3	<0.5	0.4	<0.1	<0.1
8981009	0.6	0.8	0.5	0.5	0.2	0.1
8981010	2.30	4.30	<0.5	2.20	0.4	<0.1
8981011	2.90	4.90	<0.5	2.50	0.6	0.2
8981012	1.40	2.40	0.5	1.70	0.3	<0.1
8981013	0.5	1.20	<0.5	1.20	0.2	<0.1
8981014	0.2	0.5	0.5	0.6	0.1	<0.1
8981015	<0.1	0.5	<0.5	0.7	0.1	<0.1
8981016	0.2	1.40	<0.5	1.30	0.1	<0.1
8981017	0.1	0.7	<0.5	1.10	0.1	<0.1
8981018	1.40	3.10	1.00	2.90	0.5	0.2
8981019	0.2	1.30	<0.5	1.20	0.1	<0.1
8981020	0.8	3.30	0.5	2.00	0.3	0.2
8981021	0.6	2.70	0.5	1.80	0.3	0.1
8981022	0.4	2.20	0.5	1.70	0.3	0.1
8981023	1.40	2.90	1.00	3.00	0.5	0.2
8981024	0.2	1.10	1.50	0.9	0.3	0.2
8981025	0.2	2.10	1.00	1.30	0.1	0.2

Data in ppm unless otherwise stated.

ANALYSIS REPORT

Australian Assay Laboratories Group

Sample	Eu	Gd	Tb	Dy	Ho	Tm
8981026	0.2	1.90	0.5	2.00	0.3	0.2
8981027	0.3	1.40	<0.5	1.50	<0.1	0.2
8981028	0.4	2.20	<0.5	2.30	0.4	0.2
8981029	0.3	1.50	0.5	0.9	0.1	0.1
8981030	0.2	0.9	<0.5	0.6	<0.1	<0.1
8981031	0.3	1.50	<0.5	0.9	0.1	<0.1
8981032	0.4	1.10	<0.5	1.00	0.1	0.1
8981033	0.4	1.30	0.5	1.20	0.2	0.1
8981034	0.4	1.60	0.5	1.40	0.3	0.2
8981035	1.20	2.80	1.00	2.80	0.5	0.3
8981036	0.2	0.7	0.5	1.00	0.4	0.2
8981037	0.6	2.60	0.5	2.40	0.4	0.2
8981038	<0.1	<0.2	<0.5	0.3	<0.1	0.1
8981039	<0.1	<0.2	<0.5	<0.1	<0.1	<0.1
8981040	0.2	0.6	<0.5	0.7	<0.1	0.2
8981041	<0.1	<0.2	<0.5	0.2	<0.1	<0.1
8981042	0.4	1.40	1.00	1.30	0.2	0.2
8981043	0.3	1.70	0.5	1.00	0.3	0.2
8981044	0.4	1.20	1.00	1.10	0.2	0.1
8981045	0.2	0.9	<0.5	0.7	0.1	0.1
8981046	1.00	2.70	0.5	2.10	0.5	0.3
8981047	0.9	2.10	<0.5	1.70	0.4	0.2
8981048	1.10	3.20	1.00	2.40	0.8	0.3
8981049	1.00	2.20	1.50	1.70	0.8	0.4
8981050	1.30	2.90	2.50	2.30	0.9	0.5

Data in ppm unless otherwise stated.

ANALYSIS REPORT

Australian Assay Laboratories Group

Sample	Eu	Gd	Tb	Dy	Ho	Tm
8981051	0.7	2.30	2.00	1.80	0.6	0.4
8981052	0.9	4.20	2.50	3.50	1.10	0.5
8981053	1.00	4.70	2.50	5.90	1.60	0.7
SO-2	--	--	--	--	--	--
CCU1	--	--	--	--	--	--
CPB1	--	--	--	--	--	--
CZN1	--	--	--	--	--	--
MP1a	--	--	--	--	--	--
AAL1	--	--	--	--	--	--
Sb-hyd	--	--	--	--	--	--
SY-2	2.60	17.3	2.00	20.5	4.80	2.10
SY-3	13.0	63.5	9.50	73.1	18.1	7.20

LABORATORY STANDARDS

Data in ppm unless otherwise stated.

ANALYSIS REPORT

Australian Assay Laboratories Group

REPORT : BA 021509

Sample	Yb	Lu	Cu	Pb	Zn	Sc
8981001	0.9	0.10	31	2.19%	13.3%	7
8981002	0.4	0.05	32	2.20%	13.5%	6
8981003	0.9	0.10	33	2.22%	12.6%	4
8981004	1.50	0.20	2.81%	450	1720	5
8981005	1.60	0.20	3.00%	310	1520	4
8981006	1.10	0.20	1.73%	620	1750	5
8981007	0.2	0.05	1440	5.26%	7.52%	1
8981008	0.2	<0.05	1480	5.37%	7.40%	<1
8981009	0.2	0.05	1590	5.56%	7.91%	<1
8981010	1.00	0.20	9730	150	610	12
8981011	1.20	0.20	1.81%	220	650	10
8981012	1.10	0.20	1.43%	30	540	5
8981013	0.6	0.10	504	9.65%	19.5%	1
8981014	0.2	0.05	560	31.4%	34.3%	<1
8981015	0.7	0.10	90	1.17%	16.1%	<1
8981016	0.8	0.20	2.00%	250	670	3
8981017	0.4	0.05	3.29%	190	430	4
8981018	1.20	0.20	1400	13.4%	10.3%	4
8981019	0.6	0.05	1.90%	150	300	2
8981020	0.7	0.10	2.03%	240	450	2
8981021	0.7	0.10	1.78%	120	250	2
8981022	0.6	0.10	2.11%	150	290	2
8981023	1.50	0.20	1760	5.85%	8.61%	3
8981024	0.4	0.10	750	10.8%	15.5%	1
8981025	0.5	0.10	750	10.2%	15.6%	1

Data in ppm unless otherwise stated.

ANALYSIS REPORT

Australian Assay Laboratories Group

REPORT : BA 021509

Sample	Yb	Lu	Cu	Pb	Zn	Sc
8981026	0.8	0.10	1.70%	3.38%	7.20%	4
8981027	0.7	0.10	1.60%	3.33%	7.47%	4
8981028	1.10	0.20	1.55%	3.13%	7.09%	4
8981029	0.3	0.05	3.93%	1110	1430	2
8981030	0.3	0.05	3.48%	710	1090	2
8981031	0.6	0.10	3.21%	430	1050	2
8981032	0.5	0.05	820	7.27%	8.34%	1
8981033	0.7	0.10	840	7.58%	9.12%	1
8981034	1.20	0.20	830	8.48%	9.35%	1
8981035	1.60	0.30	1360	13.4%	10.2%	4
8981036	0.5	0.10	6690	9.59%	14.4%	2
8981037	1.40	0.20	2520	5.47%	7.02%	11
8981038	0.2	<0.05	1.15%	8.38%	13.9%	<1
8981039	0.1	<0.05	6720	9.87%	16.7%	<1
8981040	0.3	0.05	5210	9.10%	14.6%	2
8981041	0.1	<0.05	4230	9.78%	17.2%	<1
8981042	0.6	0.10	550	1.76%	2.78%	2
8981043	0.4	0.05	1660	460	930	2
8981044	0.5	0.10	1040	13.6%	18.2%	2
8981045	0.4	0.05	280	12.2%	39.0%	<1
8981046	1.00	0.10	5400	4.60%	10.0%	5
8981047	1.00	0.20	6040	4.31%	10.3%	6
8981048	1.30	0.20	6090	5.27%	11.8%	5
8981049	0.7	0.20	4.31%	7.07%	19.5%	1
8981050	0.9	0.20	1.22%	5.18%	14.3%	1

Data in ppm unless otherwise stated.

ANALYSIS REPORT

Australian Assay Laboratories Group

Sample	Yb	Lu	Cu	Pb	Zn	Sc
8981051	0.8	0.20	4.04%	5.47%	12.0%	2
8981052	1.70	0.30	700	46	230	7
8981053	2.50	0.40	5490	<25	110	7
SO-2	---	---	<10	<25	115	10
CCU1	---	---	25.8%	1100	3.25%	---
CPB1	---	---	2450	66.0%	4.29%	---
CZN1	---	---	1400	7.61%	43.8%	---
MP1a	---	---	1.39%	4.36%	18.6%	---
AAL1	---	---	150	470	2000	---
Sb-hyd	---	---	---	---	---	---
SY-2	17.6	3.00	---	---	---	---
SY-3	61.1	7.60	---	---	---	---

LABORATORY STANDARDS (CCU1 to SY-3)

Data in ppm unless otherwise stated.

ANALYSIS REPORT

Australian Assay Laboratories Group

REPORT : BA 021509

Sample	Cd	Hf	Ge	Te	Sb	Tl
8981001	230	<10	<0.5	<0.5	<0.5	<2
8981002	232	<10	<0.5	<0.5	<0.5	<2
8981003	228	<10	<0.5	<0.5	<0.5	<2
8981004	5	<10	<0.5	<0.5	2.90	<2
8981005	4	<10	<0.5	<0.5	2.80	<2
8981006	5	<10	<0.5	<0.5	2.40	<2
8981007	205	<10	<0.5	<0.5	360	<2
8981008	200	<10	<0.5	<0.5	360	<2
8981009	216	<10	<0.5	<0.5	420	<2
8981010	2	<10	<0.5	<0.5	1.70	<2
8981011	3	<10	2.00	<0.5	0.5	<2
8981012	2	<10	3.00	<0.5	1.00	<2
8981013	452	<10	2.00	<0.5	80.0	<2
8981014	1280	<10	11.0	<0.5	330	<2
8981015	318	<10	5.00	<0.5	35.7	<2
8981016	1	<10	<0.5	<0.5	9.10	<2
8981017	<1	<10	<0.5	<0.5	3.50	<2
8981018	460	<10	<0.5	<0.5	420	<2
8981019	<1	<10	<0.5	<0.5	8.80	<2
8981020	4	<10	<0.5	<0.5	6.80	<2
8981021	2	<10	<0.5	<0.5	7.00	<2
8981022	<1	<10	<0.5	<0.5	8.20	<2
8981023	310	<10	2.00	<0.5	110	<2
8981024	1490	<10	<0.5	<0.5	5100	<2
8981025	1570	<10	<0.5	<0.5	6700	<2

Data in ppm unless otherwise stated.

ANALYSIS REPORT

Australian Assay Laboratories Group

Sample	Cd	Hf	Ge	Te	Sb	Tl
8981026	417	<10	<0.5	<0.5	14.8	<2
8981027	450	<10	<0.5	<0.5	9.40	<2
8981028	421	<10	<0.5	<0.5	14.5	<2
8981029	2	<10	<0.5	<0.5	13.2	<2
8981030	1	<10	<0.5	<0.5	10.7	<2
8981031	1	<10	<0.5	<0.5	11.5	<2
8981032	308	<10	<0.5	<0.5	140	<2
8981033	334	<10	<0.5	<0.5	180	<2
8981034	340	<10	<0.5	<0.5	160	<2
8981035	479	<10	<0.5	<0.5	430	<2
8981036	508	<10	<0.5	<0.5	540	<2
8981037	210	<10	<0.5	<0.5	440	<2
8981038	488	<10	<0.5	<0.5	310	<2
8981039	600	<10	<0.5	<0.5	560	<2
8981040	518	<10	<0.5	<0.5	680	<2
8981041	607	<10	<0.5	<0.5	840	<2
8981042	100	<10	<0.5	<0.5	80.0	<2
8981043	1	<10	<0.5	<0.5	13.0	<2
8981044	412	<10	<0.5	<0.5	100	<2
8981045	1250	<10	8.00	<0.5	190	<2
8981046	355	<10	<0.5	<0.5	220	<2
8981047	374	<10	<0.5	<0.5	190	<2
8981048	417	<10	<0.5	<0.5	270	<2
8981049	675	<10	<0.5	<0.5	120	<2
8981050	590	<10	<0.5	<0.5	120	<2

Data in ppm unless otherwise stated.

ANALYSIS REPORT

Australian Assay Laboratories Group

Sample	Cd	Hf	Ge	Te	Sb	Tl
8981051	398	<10	<0.5	<0.5	110	<2
8981052	2	<10	<0.5	<0.5	1.00	<2
8981053	2	<10	<0.5	<0.5	0.5	<2
SO-2	<1	15	--	--	<0.5	--
CCU1	115	--	--	--	--	--
CPB1	150	--	--	--	--	--
CZN1	1380	--	--	--	--	--
MP1a	650	--	--	--	--	--
AAL1	8	--	--	--	--	--
Sb-hyd	--	--	--	--	24.0	--
SY-2	--	--	--	--	--	--
SY-3	--	--	--	--	--	--

LABORATORY STANDARDS

Data in ppm unless otherwise stated.

ANALYSIS REPORT

Australian Assay Laboratories Group

Sample	In	Se	Ga	Er	Hf
8981001	0.12	<0.5	10	0.8	--
8981002	0.09	<0.5	10	<0.3	--
8981003	0.09	<0.5	10	0.9	--
8981004	4.28	<0.5	30	1.00	<5
8981005	4.04	2.00	30	1.60	<5
8981006	2.78	4.00	30	1.60	<5
8981007	0.06	<0.5	40	<0.3	--
8981008	0.07	<0.5	30	<0.3	--
8981009	0.08	<0.5	40	0.6	--
8981010	0.66	4.00	30	0.9	<5
8981011	0.79	<0.5	30	1.10	<5
8981012	0.36	<0.5	20	0.7	<5
8981013	11.2	<0.5	20	0.3	--
8981014	31.4	<0.5	20	<0.3	--
8981015	1.25	<0.5	<10	<0.3	--
8981016	0.25	<0.5	50	<0.3	<5
8981017	0.28	<0.5	40	<0.3	<5
8981018	0.32	<0.5	10	1.40	--
8981019	0.13	<0.5	40	<0.3	<5
8981020	2.19	<0.5	40	0.7	<5
8981021	1.58	<0.5	40	0.4	<5
8981022	1.71	<0.5	50	0.5	<5
8981023	0.92	<0.5	10	1.70	--
8981024	13.2	<0.5	20	0.5	--
8981025	10.2	<0.5	20	0.5	--

Data in ppm unless otherwise stated.

ANALYSIS REPORT

Australian Assay Laboratories Group

Sample	In	Se	Ga	Er	Hf
8981026	19.9	4.00	30	0.8	--
8981027	18.9	4.00	30	0.3	--
8981028	18.5	5.00	30	1.10	--
8981029	1.73	<0.5	10	0.4	<5
8981030	14.3	<0.5	10	<0.3	<5
8981031	1.58	<0.5	10	<0.3	<5
8981032	4.68	<0.5	20	<0.3	--
8981033	4.72	<0.5	20	0.3	--
8981034	5.16	<0.5	20	0.9	--
8981035	0.30	<0.5	10	1.40	--
8981036	10.0	8.00	30	0.3	--
8981037	1.79	4.00	30	1.10	--
8981038	12.0	8.00	30	<0.3	--
8981039	14.5	4.00	30	<0.3	--
8981040	6.64	5.00	30	<0.3	--
8981041	8.65	7.00	30	<0.3	--
8981042	1.85	<0.5	30	0.8	--
8981043	0.33	2.00	10	0.7	<5
8981044	13.4	3.00	20	0.7	--
8981045	21.5	<0.5	20	0.3	--
8981046	10.3	2.00	30	1.10	--
8981047	11.7	3.00	30	0.6	--
8981048	10.8	3.00	30	1.10	--
8981049	15.8	<0.5	50	1.00	--
8981050	30.1	2.00	30	2.00	--

Data in ppm unless otherwise stated.

ANALYSIS REPORT

Australian Assay Laboratories Group

Sample	In	Se	Ga	Er	Hf
8981051	8.32	<0.5	40	1.40	--
8981052	0.14	<0.5	40	2.30	<5
8981053	0.23	<0.5	50	3.70	<5
SO-2	--	<0.5	25	--	--
CCU1	--	--	--	--	--
CPB1	--	--	--	--	--
CZN1	--	--	--	--	--
MP1a	--	--	--	--	--
AAL1	--	--	--	--	--
Sb-hyd	--	--	--	--	--
SY-2	--	--	--	15.5	--
SY-3	--	--	--	46.8	--

LABORATORY STANDARDS

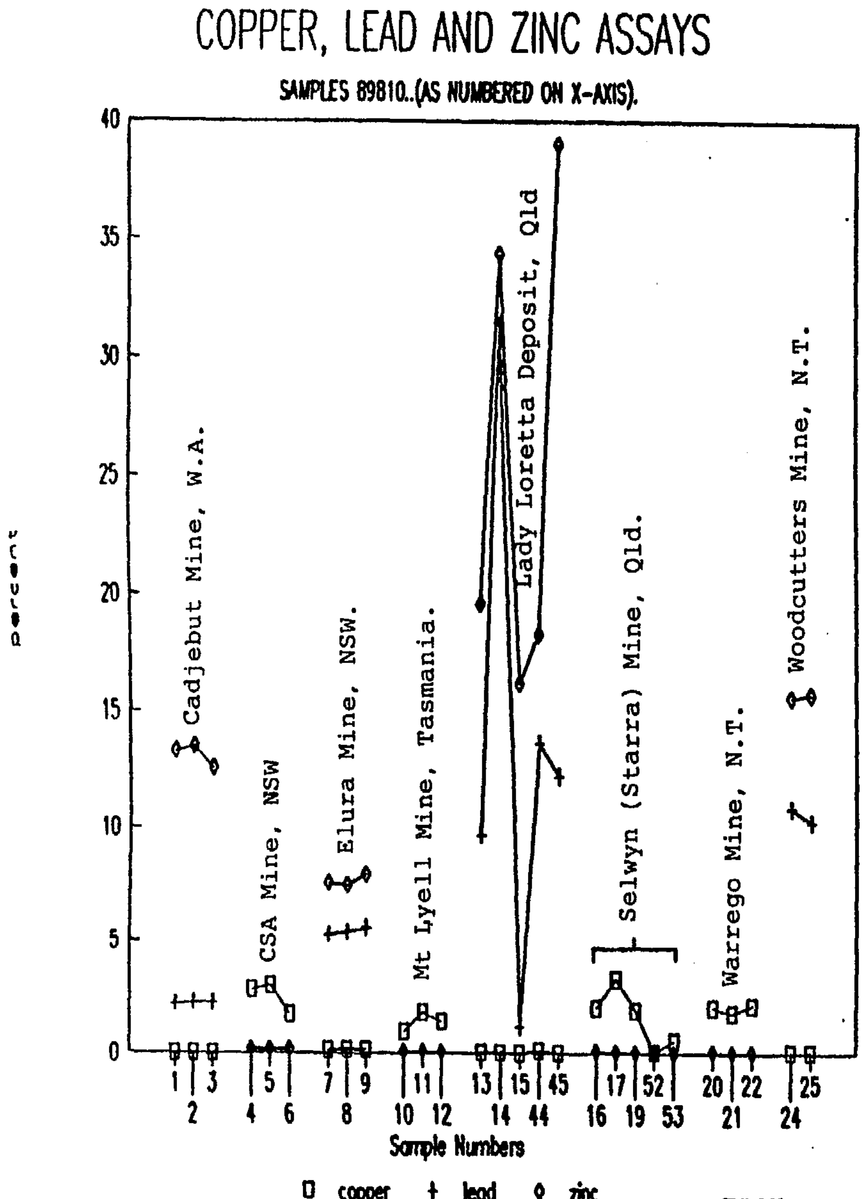
Data in ppm unless otherwise stated.

APPENDIX 2:
Graphs of Assay Results

Table 1: Sample Numbers and Mines/Deposits Sampled.

SAMPLE #	MINE/DEPOSIT	SAMPLE TYPE
8981001	Cadjebut (Zn/Pb) mine, Western Australia	Mill feed
002	"	"
003	"	"
004	CSA (Cu/Zn/Pb) mine, New South Wales	Mill feed
005	"	"
006	"	"
007	Elura (Zn/Pb) mine, New South Wales	Monthly composite mill feed
008	"	"
009	"	"
010	Mt Lyell (Cu/Ag/Au) mine, Tasmania	Mill feed
011	"	"
012	"	"
013	Lady Loretta (Zn/Pb) Deposit, Queensland	Medium grade ore drill core
014	"	High grade ore drill core
015	"	Low grade,baritic ore drill core
016	Selwyn (Starra) Cu/Au mine, Queensland	Sulphide ore mill feed
017	"	"
018	North (Zn/Pb/Ag) mine, New South Wales	CHECK SAMPLE annual composite
019	Selwyn (Starra) Cu/Au mine, Queensland	Sulphide ore mill feed
020	Warrego (Cu/Bi/Au) mine, Northern Territory	Monthly composite mill feed
021	"	"
022	"	"
023	ZC (Zn/Pb/Ag) mine, New South Wales	Annual Composite mill feed
024	Woodcutters (Zn/Pb) mine, Northern Territory	Mill feed
025	"	"
8981026	Woodlawn (Zn/Pb/Cu) mine, New South Wales	Complex ore mill feed
027	"	"
028	"	"
029	Mount Isa (Zn/Pb/Cu) mine, Queensland	Weekly composite Cu mill feed
030	"	"
031	"	"
032	"	Weekly composite Pb/Zn mill feed
033	"	"
034	"	"
035	North (Zn/Pb/Ag) mine, New South Wales	CHECK SAMPLE mill feed annual composite
036	Hellyer (Zn/Pb/Cu) mine, Tasmania	Low grade Zn ore SAG mill discharge
037	"	High As ore arsenic stockpile
038	"	Medium Zn ore stockpile
039	"	High grade Zn ore stockpile
040	"	"
041	"	"
042	Mount Isa (Zn/Pb/Cu) mine,	Pb/Zn tail
043	"	Cu tail
044	Lady Loretta (Zn/Pb) Deposit, Queensland	Medium grade ore drill core
045	"	High grade ore drill core
046	Rosebery (Zn/Pb/Cu) mine, Tas. (incl Que River ore)	Monthly composite mill feed
047	"	"
048	"	"
049	Thalanga (Zn/Pb/Cu) Deposit, Queensland	Central orebody drill core
050	"	Eastern orebody drill core
051	"	Western orebody drill core
052	Selwyn (Starra) Cu/Au mine, Queensland	Leached ore stockpile
053	"	Oxide ore s'pile

Lotus File:SAMPLNUM



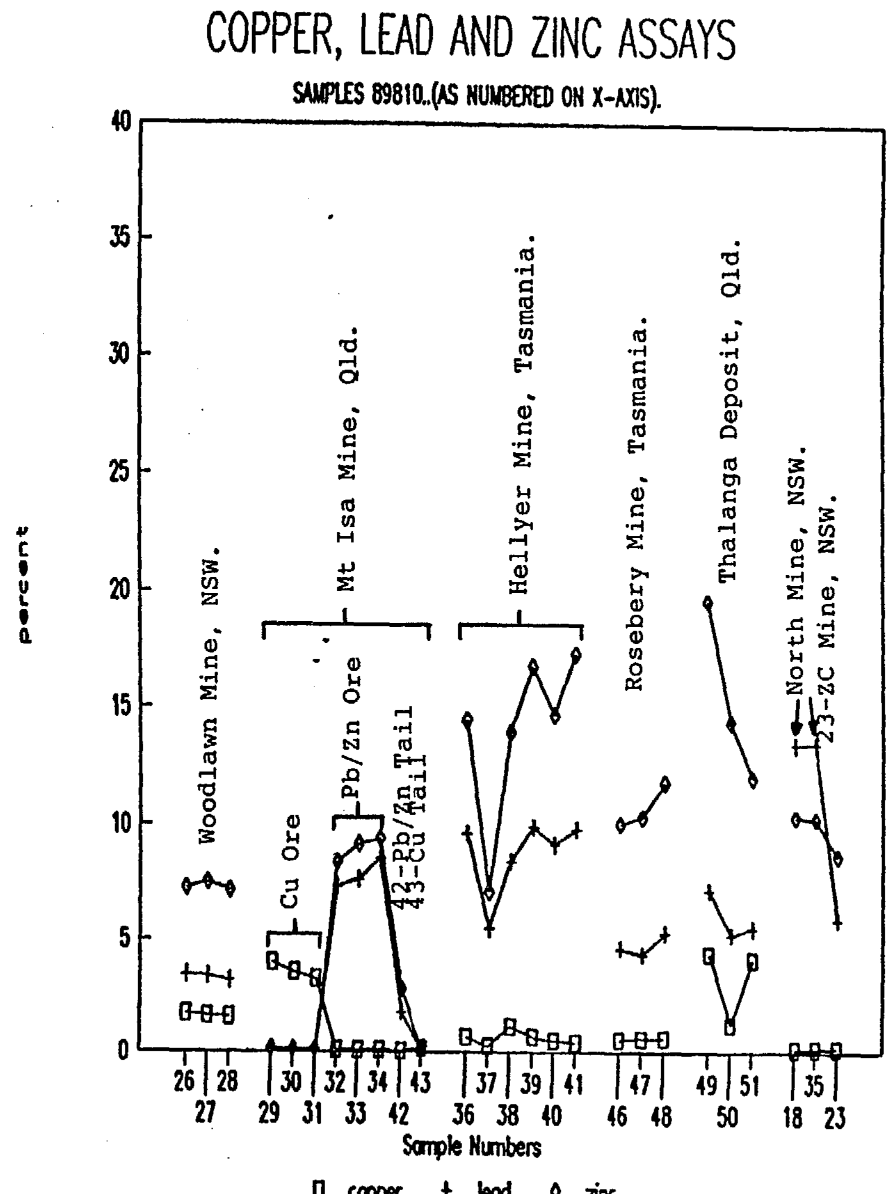
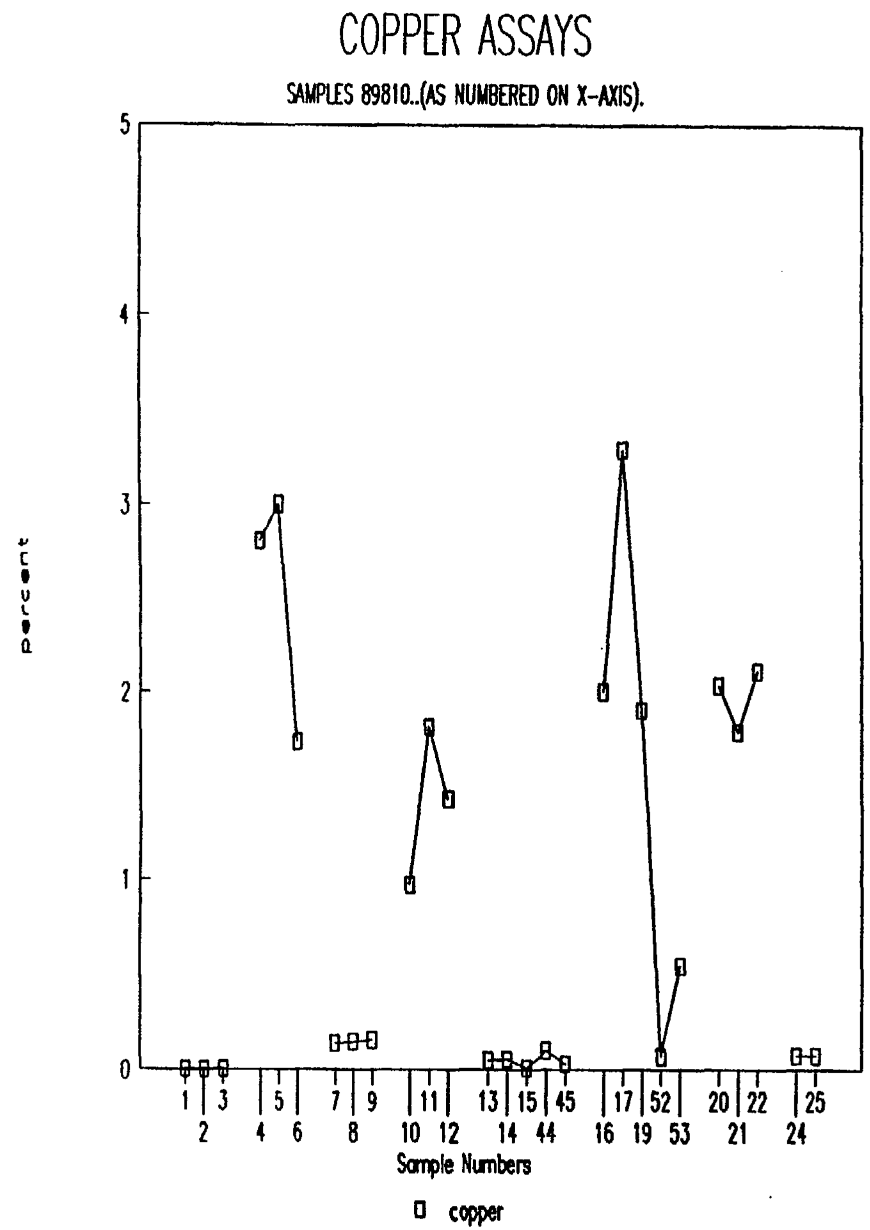


FIGURE 1 : Cu, Pb, Zn Assays and Mines/Deposits Sampled


COPPER ASSAYS
SAMPLES 89810..(AS NUMBERED ON X-AXIS).
percent
Sample Numbers
copper

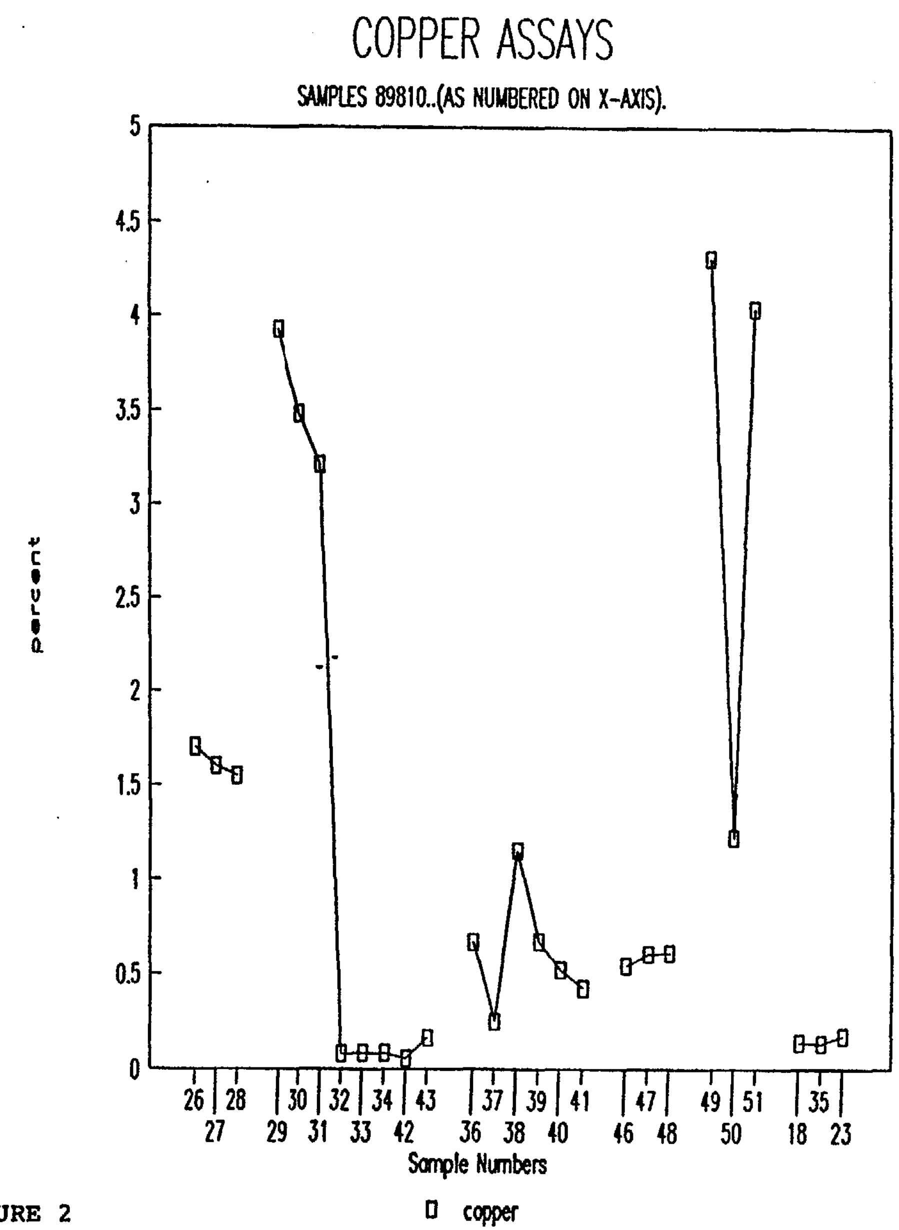
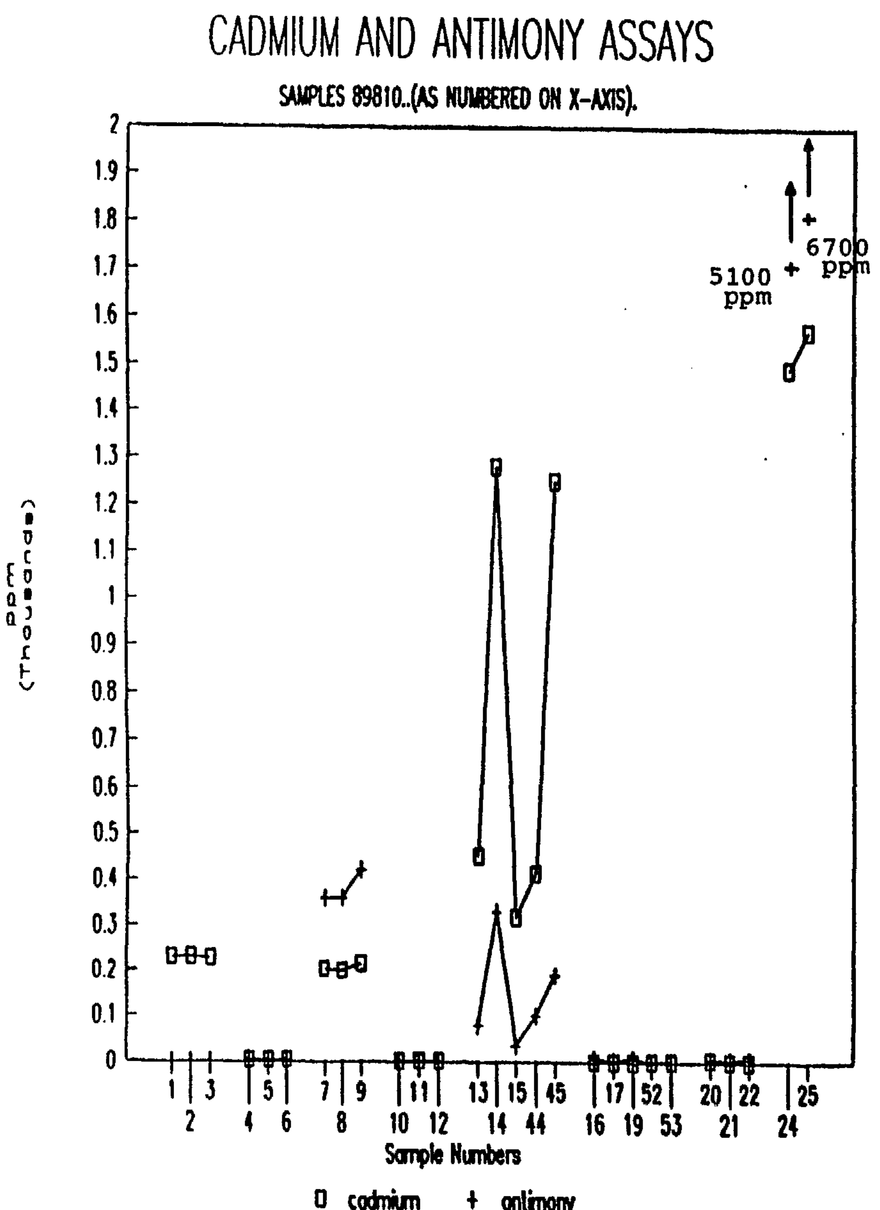

COPPER ASSAYS
SAMPLES 89810..(AS NUMBERED ON X-AXIS).
percent
Sample Numbers
copper

FIGURE 2


CADMIUM AND ANTIMONY ASSAYS
SAMPLES 89810..(AS NUMBERED ON X-AXIS).
ppm (Thousands)
5100 ppm
6700 ppm
Sample Numbers
cadmium
antimony

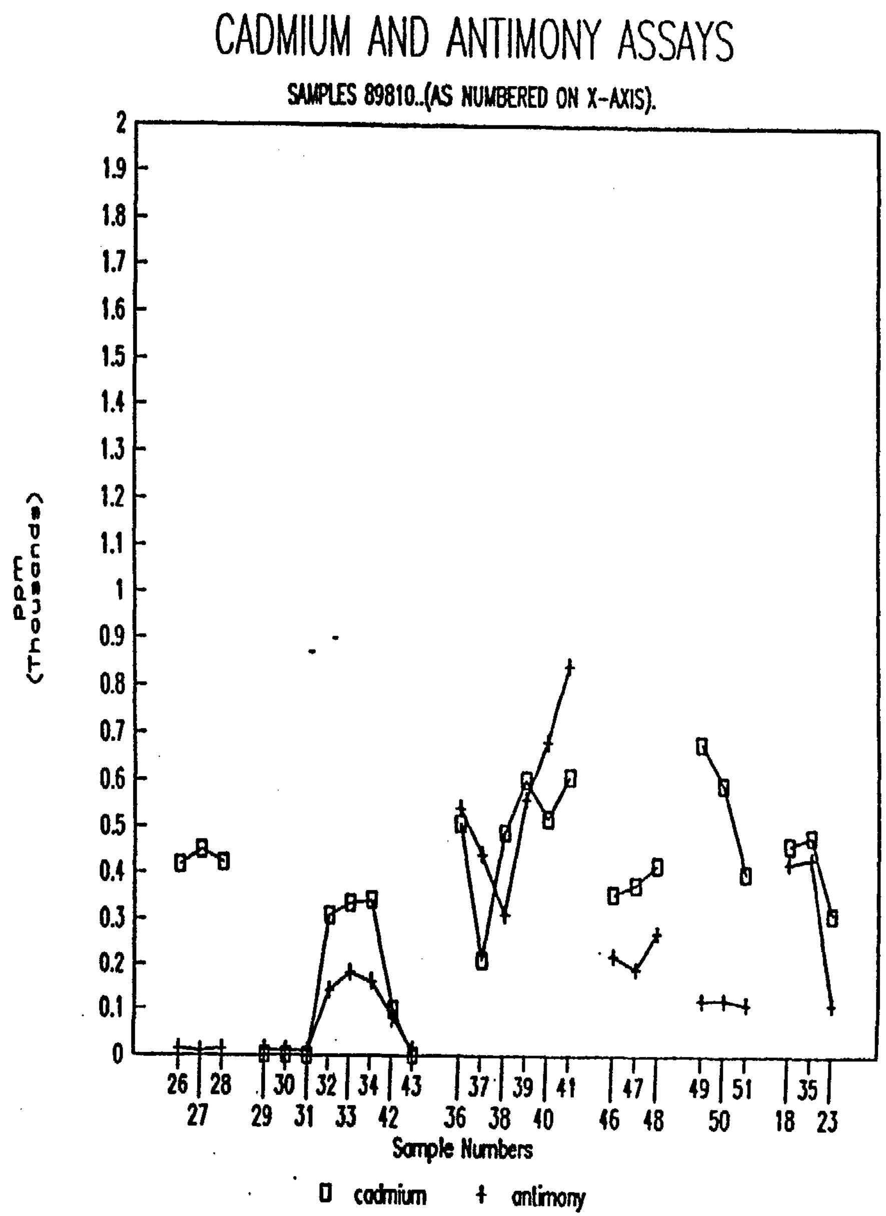
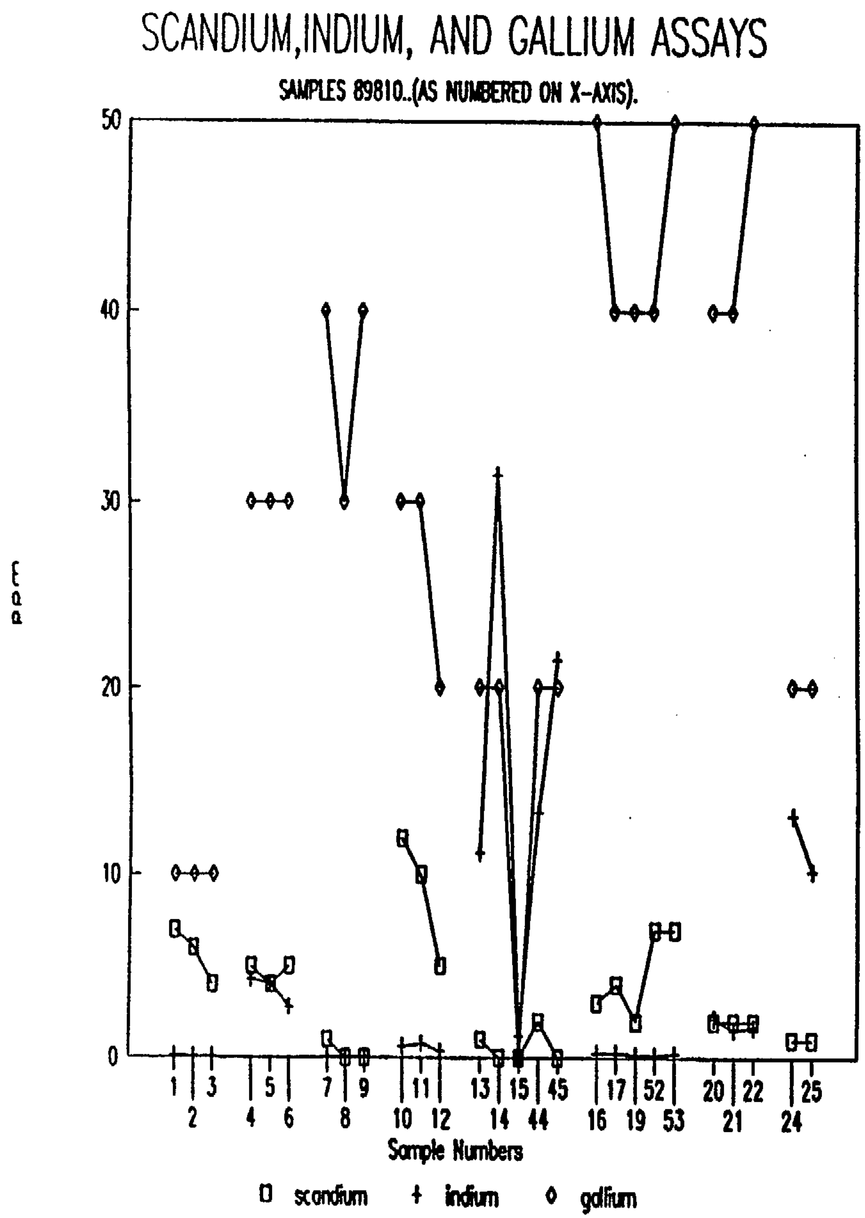

CADMIUM AND ANTIMONY ASSAYS
SAMPLES 89810..(AS NUMBERED ON X-AXIS).
ppm (Thousands)
Sample Numbers
cadmium
antimony

FIGURE 3


SCANDIUM,INDIUM, AND GALLIUM ASSAYS
SAMPLES 89810..(AS NUMBERED ON X-AXIS).
ppm
Sample Numbers
scandium
indium
gallium

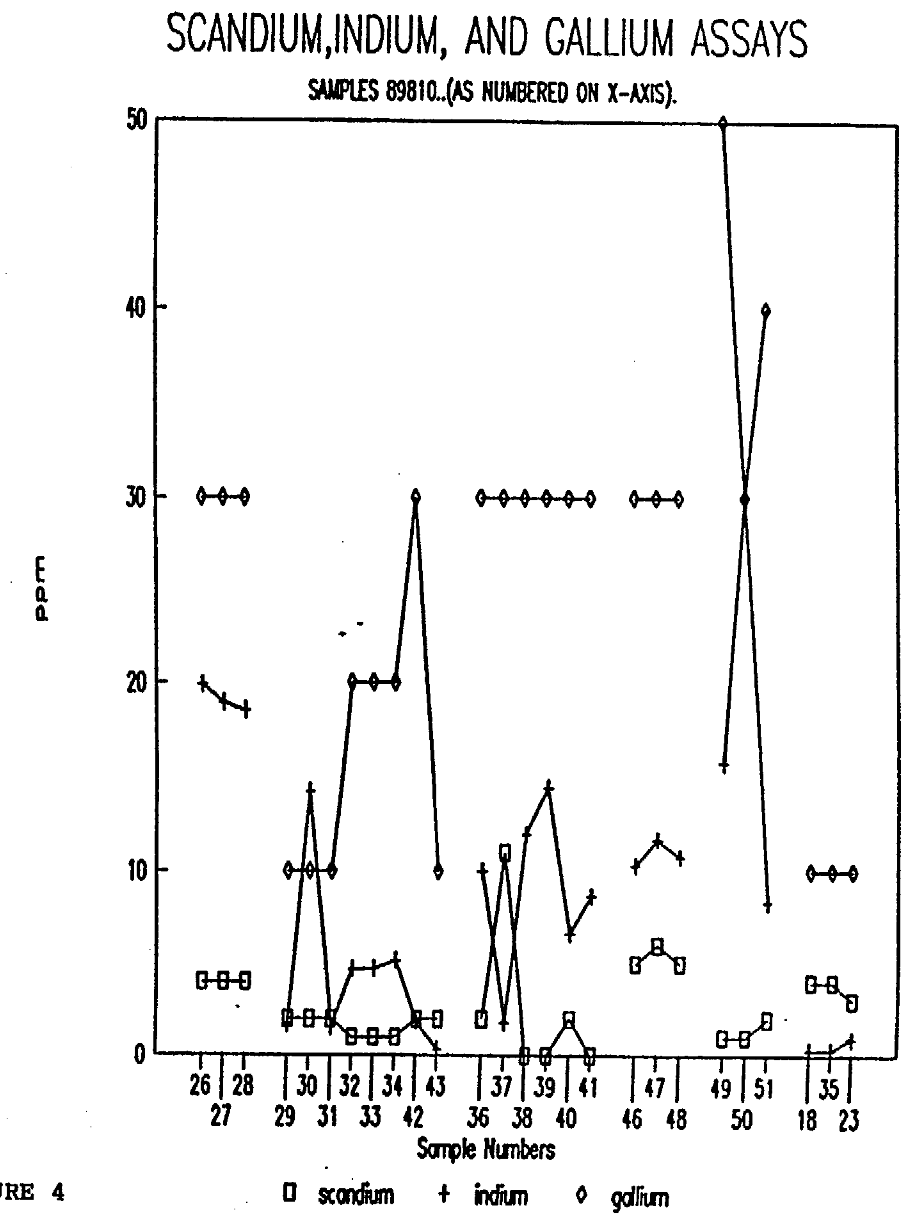
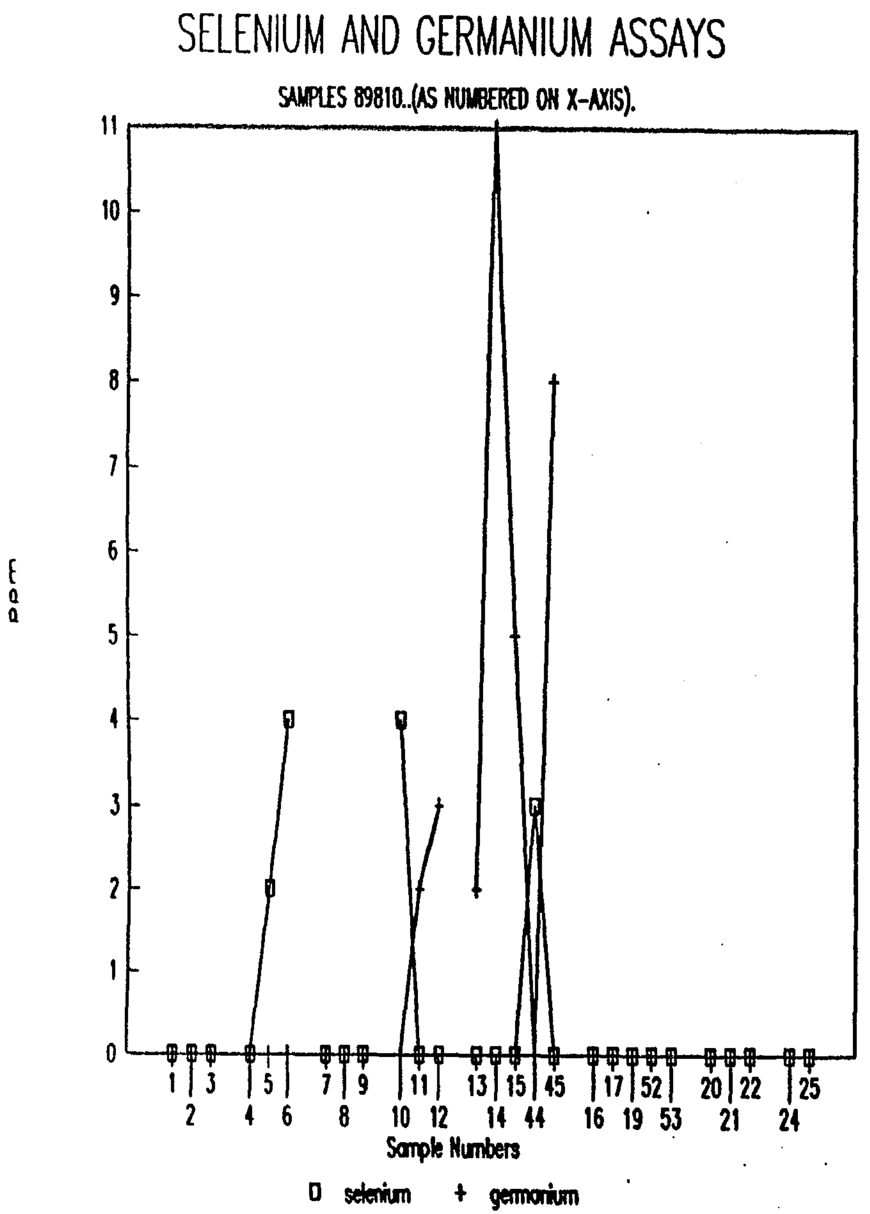
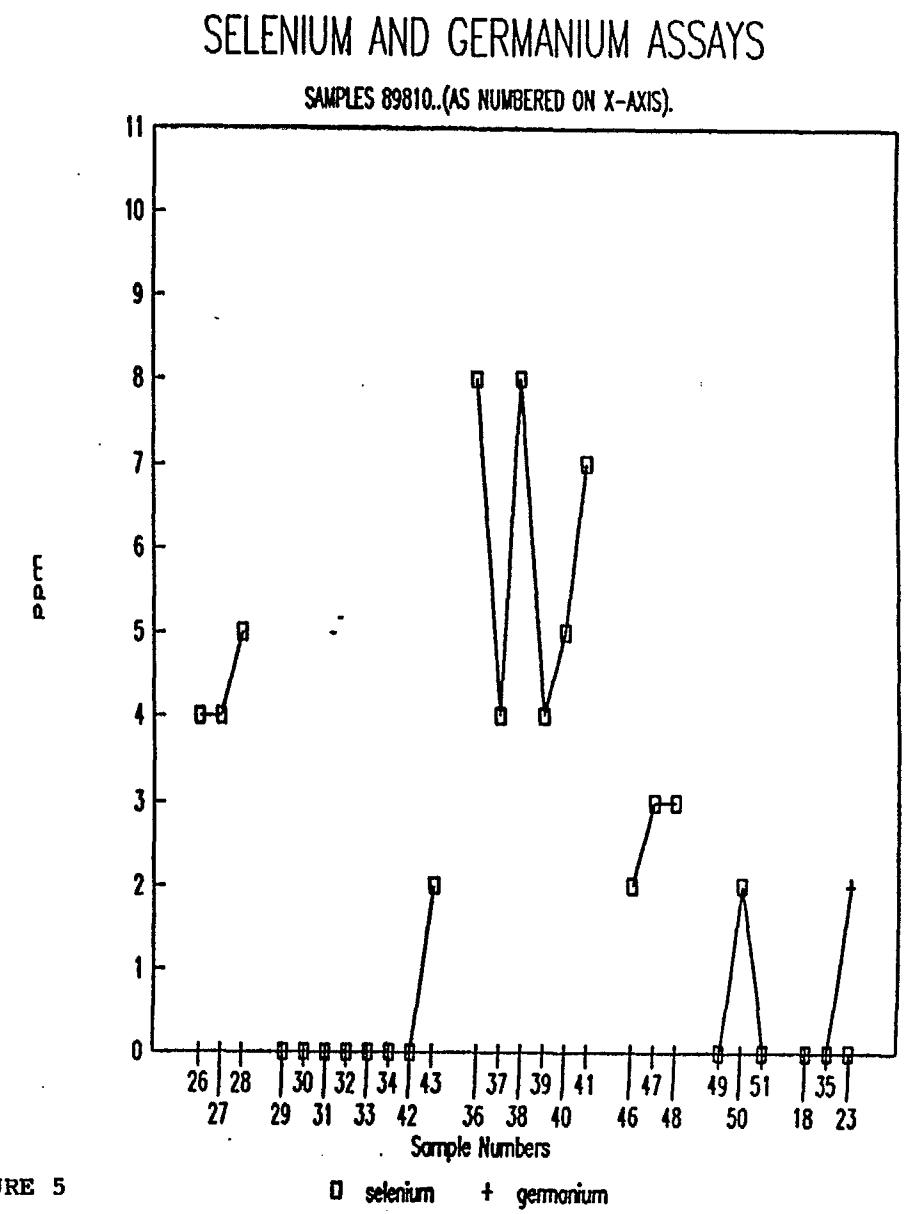

SCANDIUM,INDIUM, AND GALLIUM ASSAYS
SAMPLES 89810..(AS NUMBERED ON X-AXIS).
ppm
Sample Numbers
scandium
indium
gallium

FIGURE 4

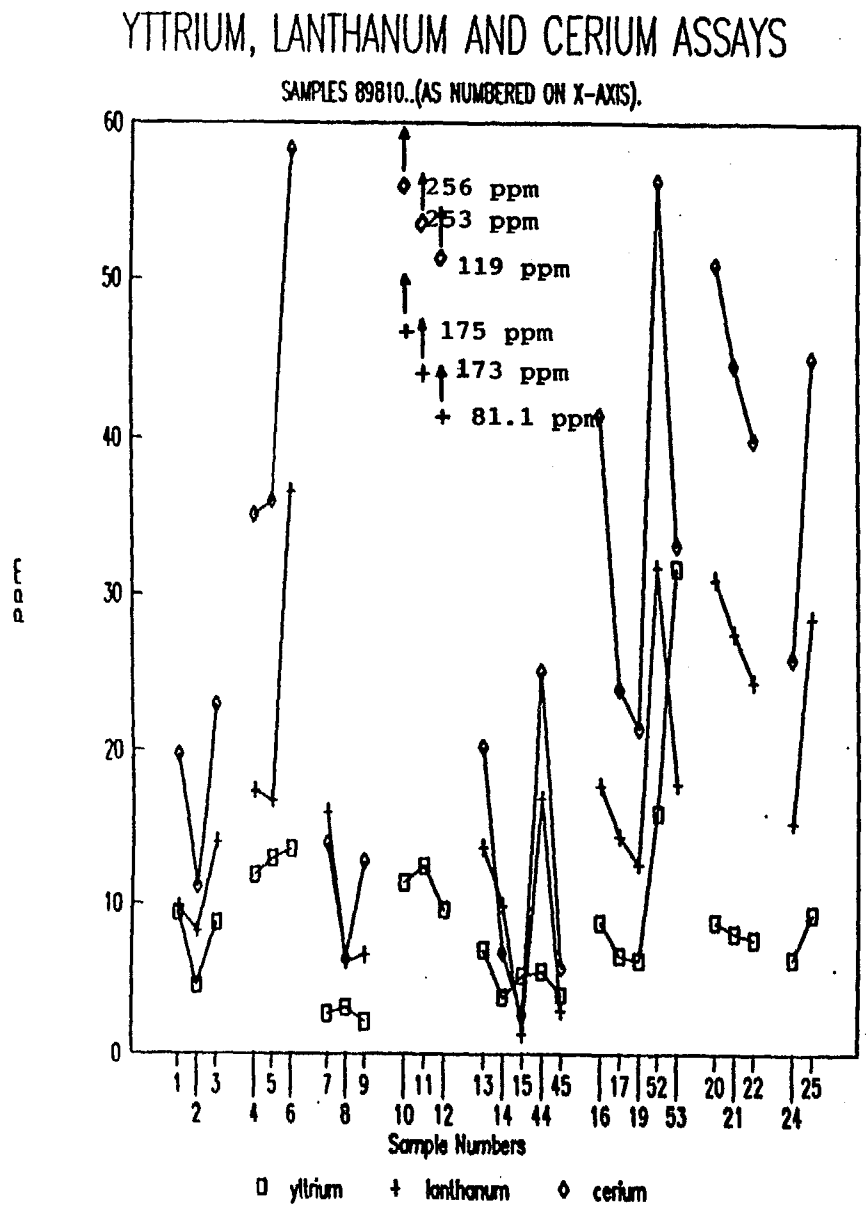


SELENIUM AND GERMANIUM ASSAYS
SAMPLES 89810..(AS NUMBERED ON X-AXIS).
ppm
Sample Numbers
selenium
germanium



SELENIUM AND GERMANIUM ASSAYS
SAMPLES 89810..(AS NUMBERED ON X-AXIS).
ppm
Sample Numbers
selenium
germanium

FIGURE 5


YTTRIUM, LANTHANUM AND CERIUM ASSAYS
SAMPLES 89810..(AS NUMBERED ON X-AXIS).
ppm
256 ppm
253 ppm
119 ppm
175 ppm
173 ppm
81.1 ppm
Sample Numbers
yttrium
lanthanum
cerium

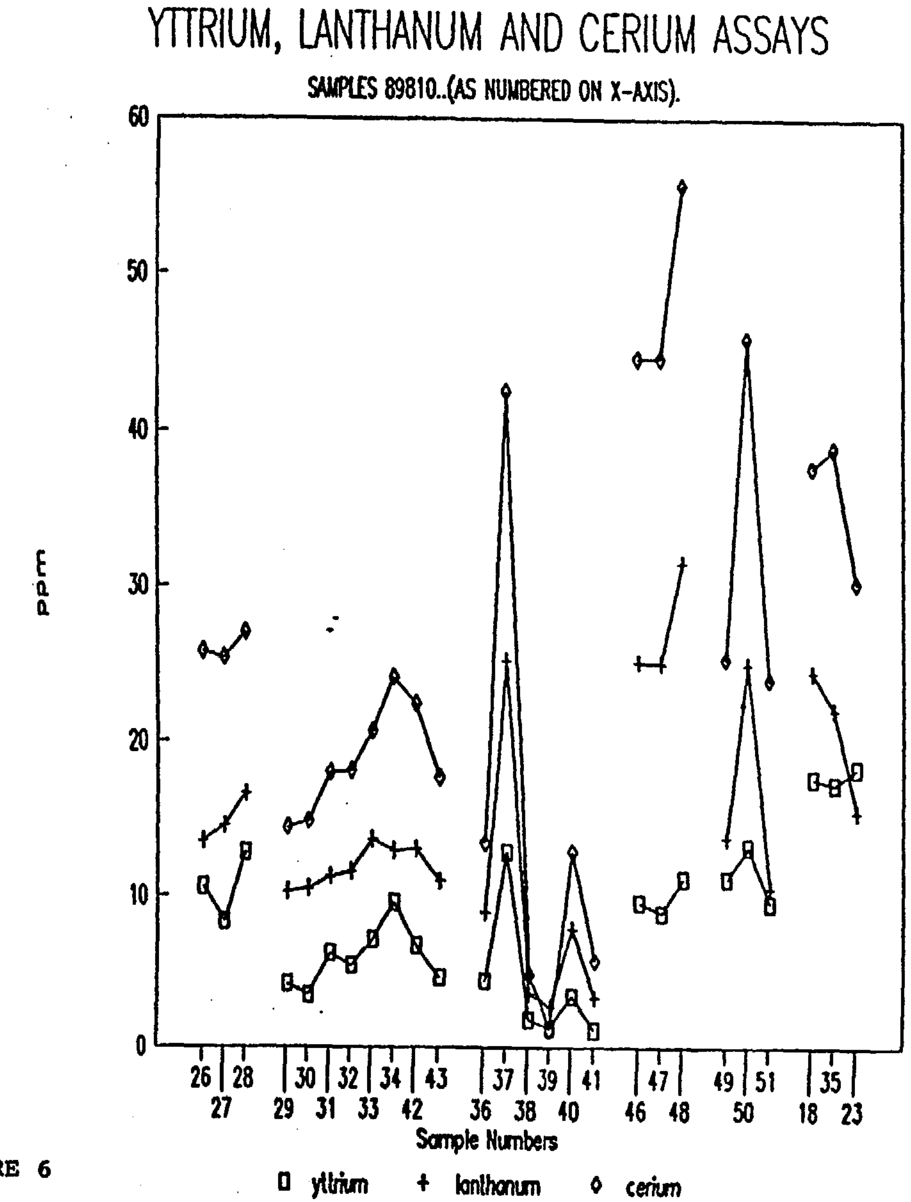
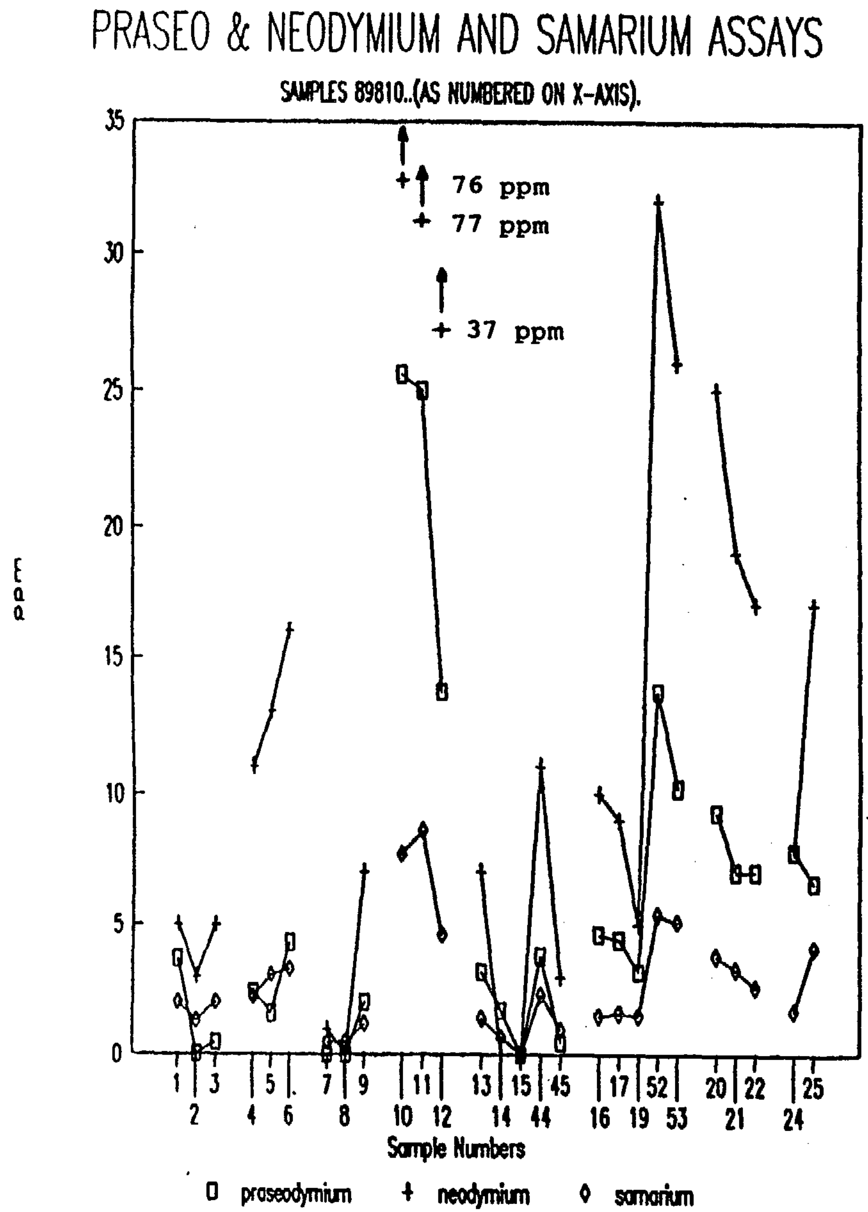

YTTRIUM, LANTHANUM AND CERIUM ASSAYS
SAMPLES 89810..(AS NUMBERED ON X-AXIS).
ppm
Sample Numbers
yttrium
lanthanum
cerium

FIGURE 6


PRASEO & NEODYMIUM AND SAMARIUM ASSAYS
SAMPLES 89810..(AS NUMBERED ON X-AXIS).
ppm
76 ppm
77 ppm
37 ppm
Sample Numbers
praseodymium
neodymium
samarium

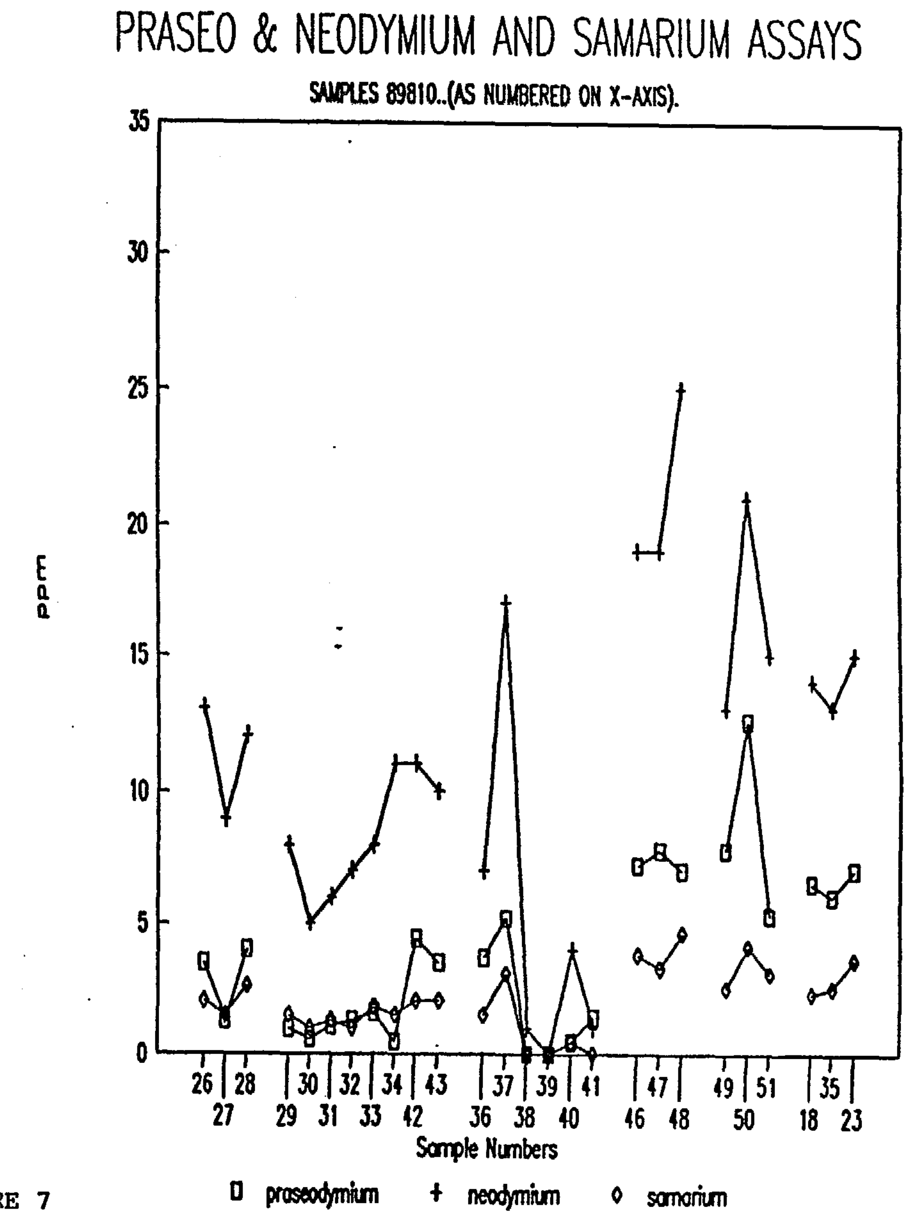
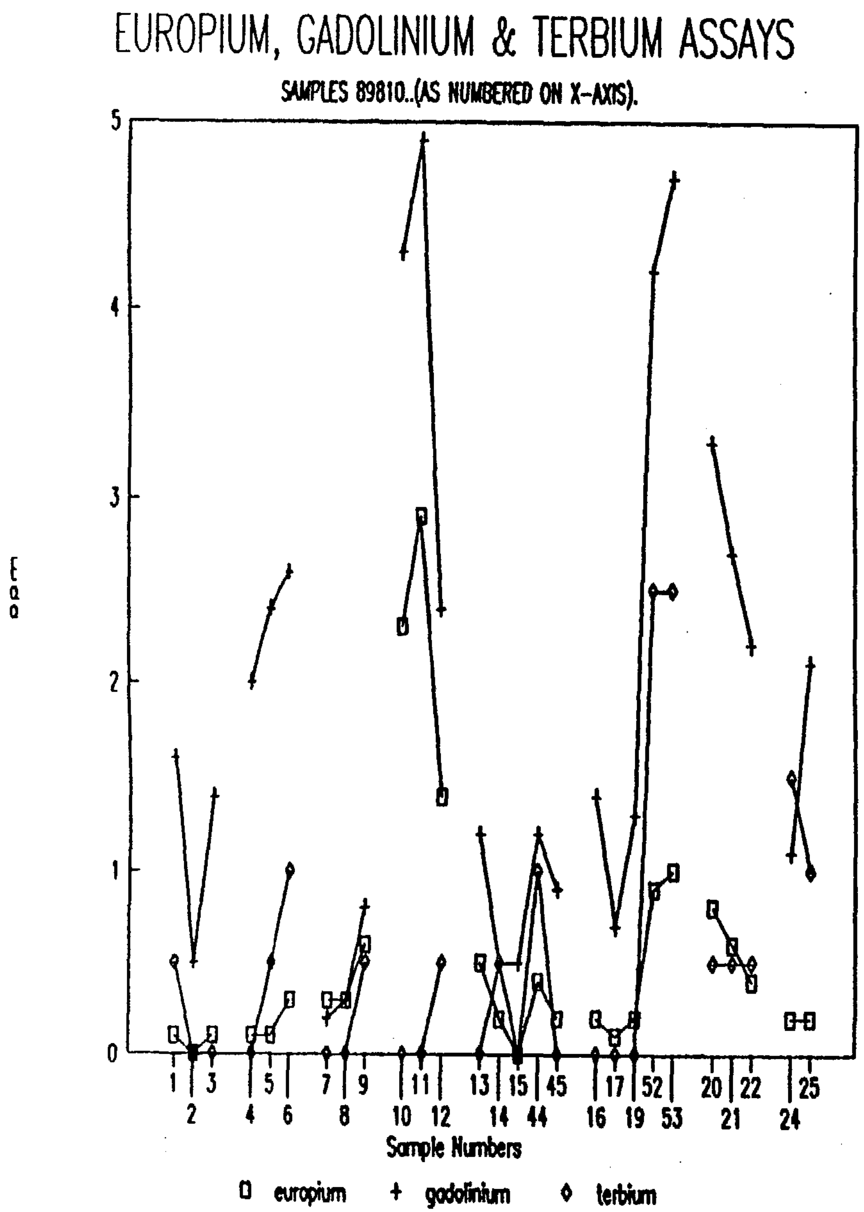

PRASEO & NEODYMIUM AND SAMARIUM ASSAYS
SAMPLES 89810..(AS NUMBERED ON X-AXIS).
ppm
Sample Numbers
praseodymium
neodymium
samarium

FIGURE 7


EUROPIUM, GADOLINIUM & TERBIUM ASSAYS
SAMPLES 89810..(AS NUMBERED ON X-AXIS).
ppm
Sample Numbers
europium
gadolinium
terbium

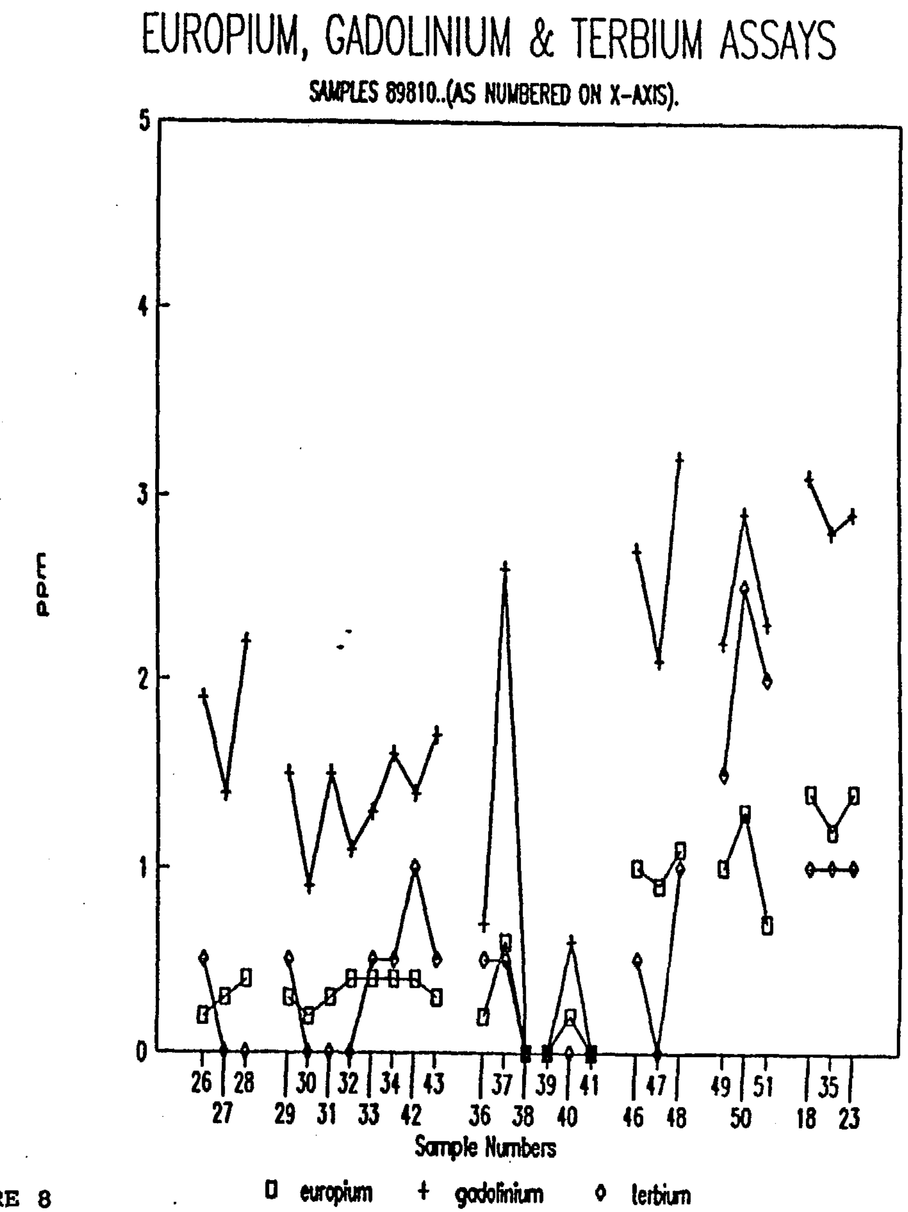
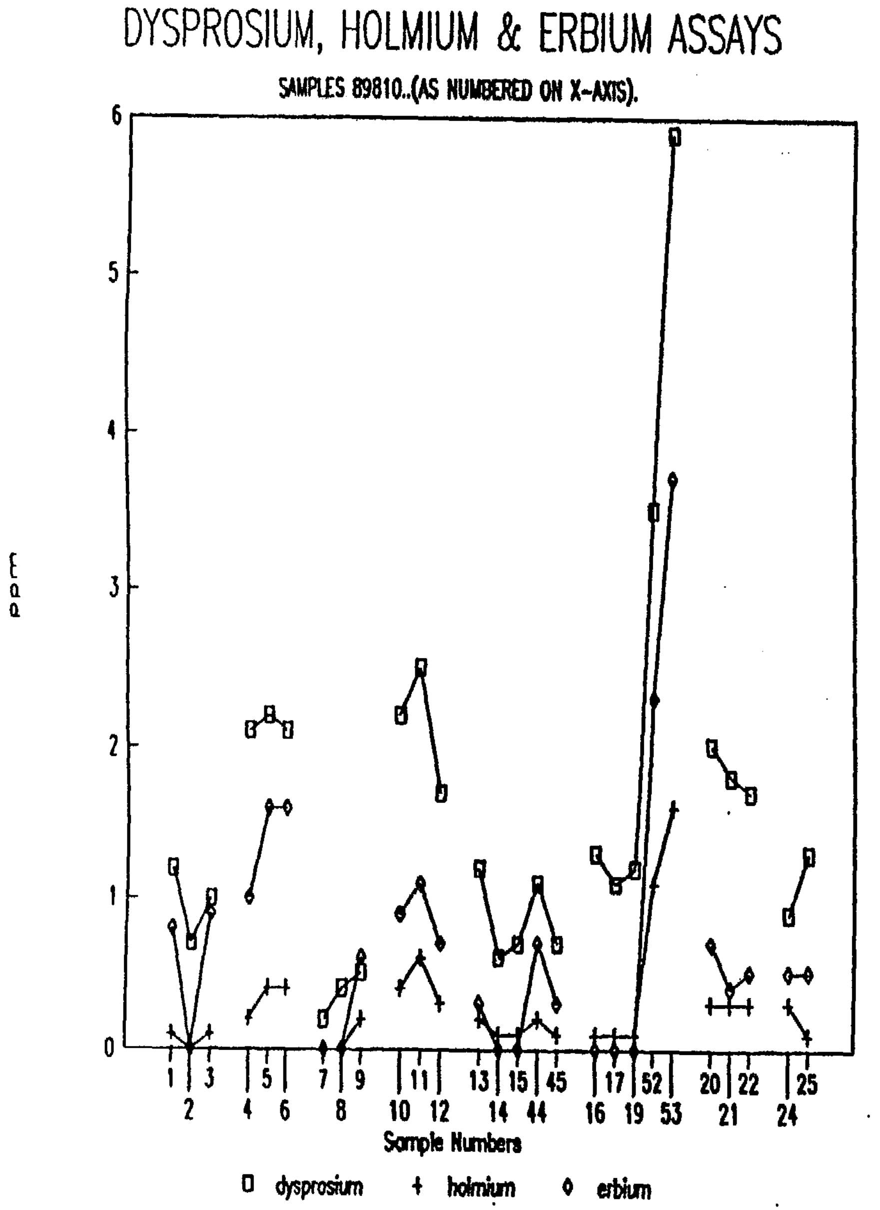

EUROPIUM, GADOLINIUM & TERBIUM ASSAYS
SAMPLES 89810..(AS NUMBERED ON X-AXIS).
ppm
Sample Numbers
europium
gadolinium
terbium

FIGURE 8


DYSPROSIUM, HOLMIUM & ERBIUM ASSAYS
SAMPLES 89810..(AS NUMBERED ON X-AXIS).
ppm
Sample Numbers
dysprosium
holmium
erbium

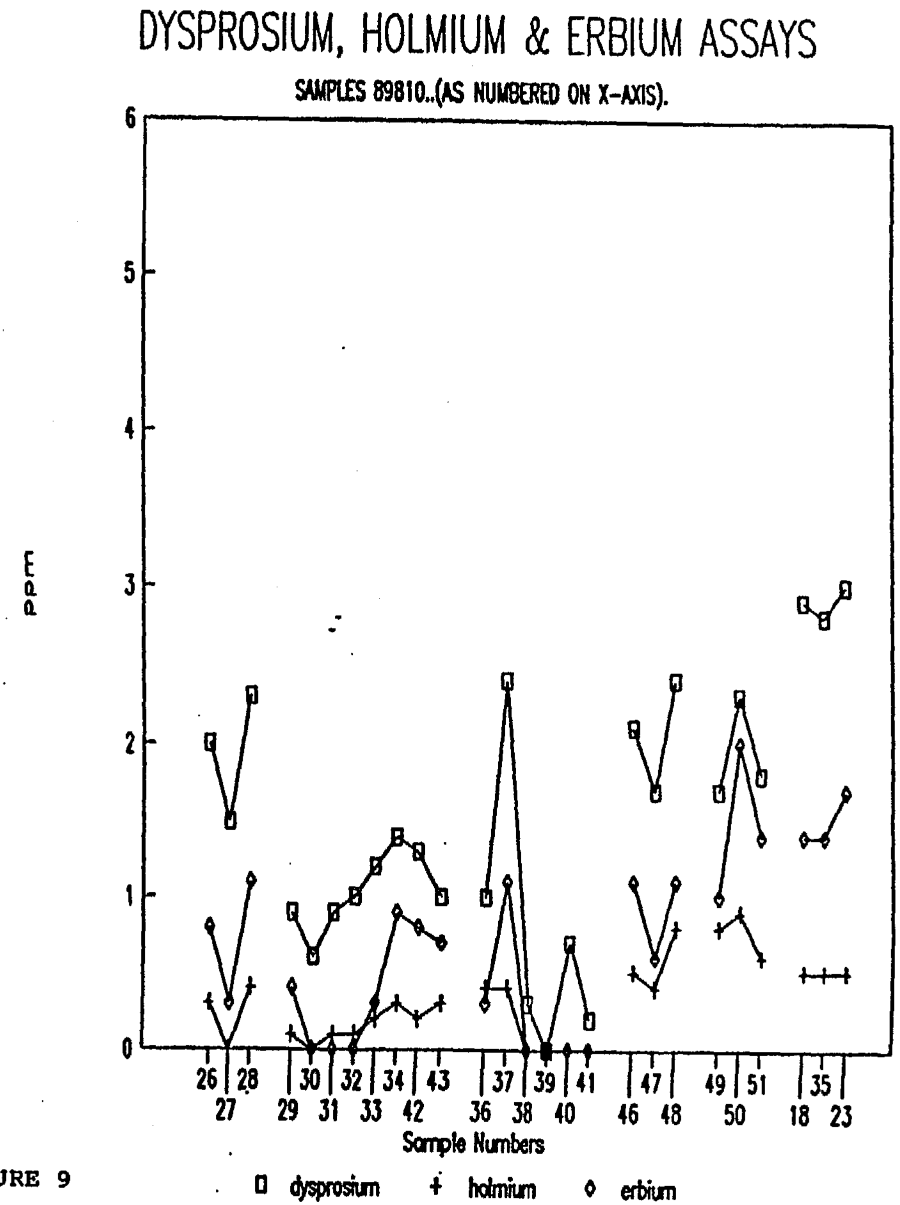

DYSPROSIUM, HOLMIUM & ERBIUM ASSAYS
SAMPLES 89810..(AS NUMBERED ON X-AXIS).
ppm
Sample Numbers
dysprosium
holmium
erbium

FIGURE 9

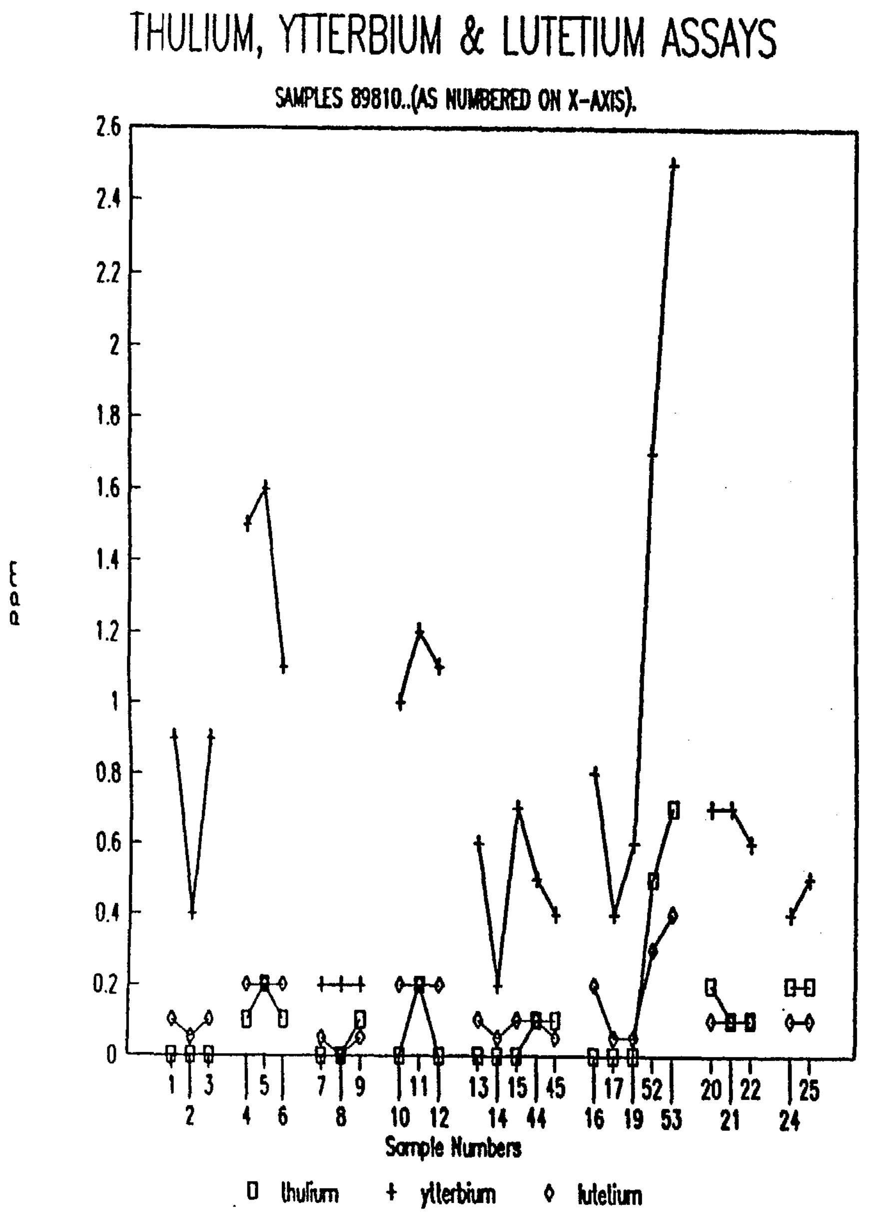
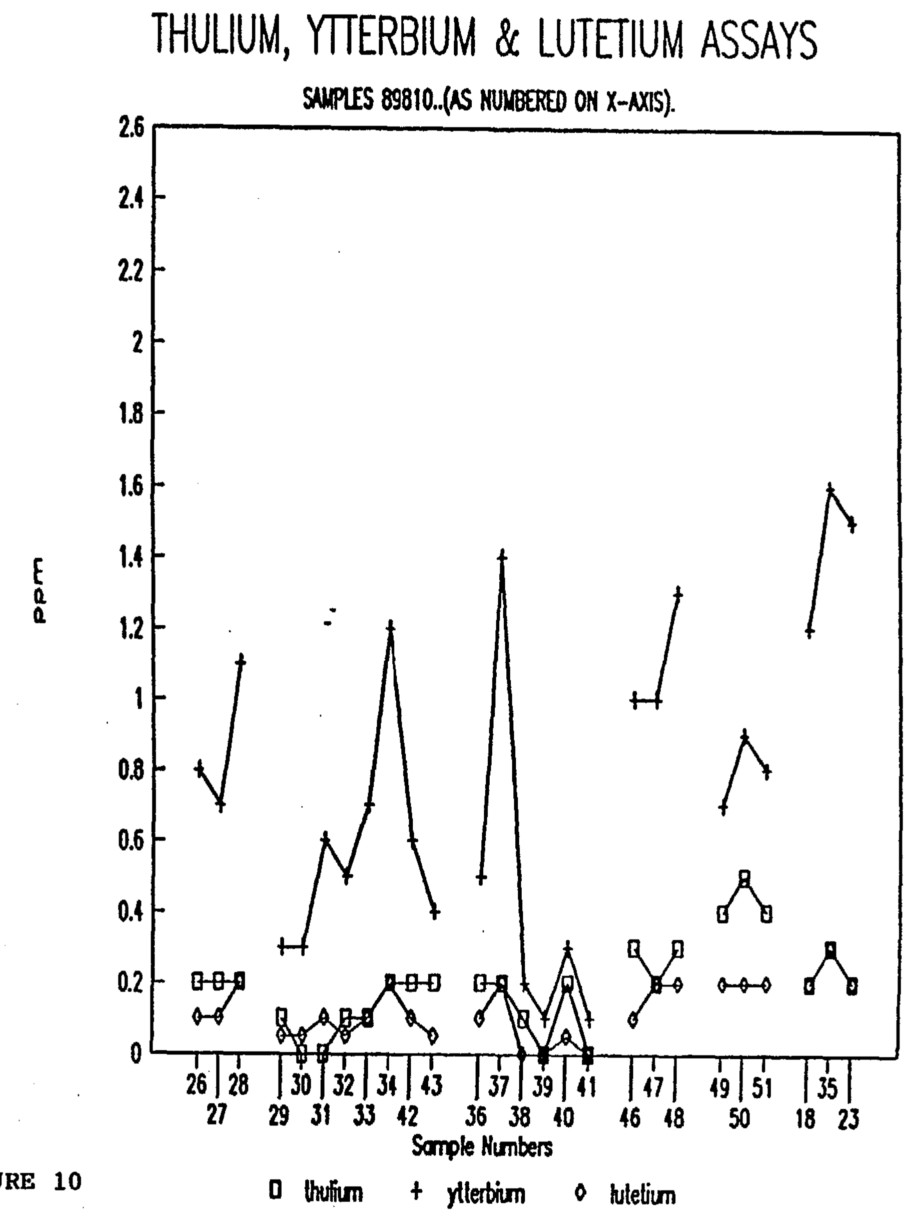

THULIUM, YTTERBIUM & LUTETIUM ASSAYS
SAMPLES 89810..(AS NUMBERED ON X-AXIS).
ppm
Sample Numbers
thulium
ytterbium
lutetium

FIGURE 10


THULIUM, YTTERBIUM & LUTETIUM ASSAYS
SAMPLES 89810..(AS NUMBERED ON X-AXIS).
ppm
Sample Numbers
thulium
ytterbium
lutetium