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GEOCHEMISTRY OF EXMOUTH PLATEAU AND CARNARVON TERRACE SEDIMENTS OF THE WEST AUSTRALIAN CONTINENTAL MARGIN, INCLUDING ODP LEG 123 CORES

by

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Continental Margin Transects

Geochemistry of Exmouth Plateau and Carnarvon Terrace sediments of the West Australian Continental Margin, including ODP Leg 123 cores.

Projects 121.18 and 121.38

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EXECUTIVE SUMMARY

As part of the Continental Margins Program, several gravity cores were collected from The Exmouth Plateau and the Carnarvon Terrace during Bureau of Mineral Resources (BMR) surveys 53 and 57. These cores were collected from water depths of between 287 to 3320 m. This Record presents all the geochemical results conducted on several cores from those surveys. In addition geochemical data are presented from two cores collected from the Argo Abyssal Plain and the Exmouth Plateau as part of ODP Leg 123.

This Record and these data also form part of a geochemical database which is being systematically assembled from various parts of the Australian continental margin. The purpose of these geochemical databases is to develop an understanding of the controls on the geochemical compositions of sediments from around Australia and hence contribute to an assessment of potential environmental change (both man-made and natural), potential anthropogenic contributions to the continental shelves, and processes controlling formation of some seafloor minerals, including marine phosphorites and manganese rich crusts and nodules.

The data assembled from cores from the Exmouth Plateau and Carnarvon Terrace have been used to develop an understanding of the Late Quaternary palaeoceanography of the north eastern Indian Ocean, with particular reference to the Leeuwin Current. A variety of radiochemical, carbon and oxygen isotope and trace element data have been utilised to determine the mass sediment and carbon accumulation rates in these sediments during glacial and interglacial periods. Sedimentation rates found on the mid-slope of the Exmouth Plateau were abut 2.2 cm/kyr, while those on the Carnarvon Terrace varied between 0.7 and 1.5 cm/kyr. The paleoceanographic results are discussed in detail in McCorkle and others (1993).

The pore water metabolites measured in several cores varied in a systematic way indicating oxic through anoxic near-surface sediment conditions across the continental margin. Anoxic conditions were found at relatively shallow depths in the sediments on the upper-slope, and these data are indicative of higher organic matter inputs to upper-slope sediments than those in deeper water. The manganese inventory in sediments was found to be low (<100 ppm), and lower than typical sediment manganese inventories found on continental shelves. The results suggest a relatively low input of relatively unreactive manganese to the Carnarvon Terrace.

A data base of major and minor trace element concentrations in sediments has been assembled. Preliminary analysis of part of that data suggest that several trace elements (chromium, copper, neodymium, rubidium, strontium, zinc and zirconium) covary with Al_2O_3 and Fe_2O_3, indicating a control on their concentrations and distributions by clay minerals and iron oxyhydroxides. This data base can be used to compare and contrast elemental abundances on the western margin of Australia with similar data bases from the eastern and southern margins. These can be used to assess potential areas of geochemical enrichment in sediments, and to evaluate potential anthropogenic inputs to the sediments and environmental change.

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INTRODUCTION

This Record documents analyses conducted on several cores collected from the West Australian continental margin. The analyses reported here are from cores which were collected from BMR surveys 53 (Exmouth Plateau) and 57 (North Perth Basin) (note here that the cores collected from the Perth Basin are referred to as the Carnarvon Terrace). Also included are data from select geological intervals of two cores collected from ODP leg 123 to the Exmouth Plateau and the Argo Abyssal Plain. The locations of the cores collected are summarised in Table 1, and shown in Figure 1. The different analyses carried out on these various sediments include carbon and oxygen isotopes on benthic and planktonic foraminifera; radiochemistry including uranium contents and excess Thorium 230; pore water metabolites including nitrate, ammonia, silicate and manganese; and, solid phase major and trace elements including biogenic opal, organic carbon and percent calcium carbonate. The types and number of analyses are summarised in Table 2.

The purpose of the Records in this series is to assemble the available geochemical data from different sectors of the Australian continental margin for additional analysis. This Record therefore primarily is a data compilation.

Objectives

The primary objective of the continental margin transects geochemical profiles are to understand the major processes controlling the chemical compositions of continental margin sediments.

The general objectives of the study were;

1. To compile and collate data from the Late Quaternary sediments offshore western Australia, for studies of glacial/interglacial palaeoceanography, with special reference to the Leeuwin Current. Specific objectives included:

a. To determine Late Quaternary sedimentation rates. b. To determine terrigenous and biogenic sediment mass accumulation rates. c. To determine glacial/interglacial variations in carbon fluxes to the seafloor (including direct and indirect indicators), with implications for the palaeoceanography of the Leeuwin Current.

2. To compile and collate major and trace element data from two cores collected from the Exmouth Plateau and Argo Abyssal Plain, as part of ODP Leg 123, with reference to the Cretaceous palaeochemistry of the north eastern Indian Ocean.

3. To determine the major and minor element contents of the sediments, both solid phase and pore water metabolites, and hence, processes controlling their chemical compositions, including biogenic and terrigenous sedimentation, and the formation of marine phosphorites and manganese rich crusts and nodules.

The gravity core data from both the Exmouth Plateau and the Carnarvon Terrace have been utilised for a detailed study of the Late Quaternary palaeoceanography of the Leeuwin Current. This work is still in progress, but the initial scientific analysis of these data has been presented in McCorkle and others (1993). All stable isotopic data were analysed at Woods Hole Oceanographic Institution, Massachusetts, USA. Additional work is being undertaken on both the radiochemical data and trace element data in these cores to determine sedimentation rates and proxy indicators of oceanographic processes. The radiochemical properties of these sediments have been measured to determine sedimentation rates. The radiochemical data were contributed by the University of South Australia. All of these data are presented and summarised here.

The data assembled from the ODP cores includes all XRF analyses conducted on those cores from the Cretaceous period. Part of these data were utilised for an assessment of the Cretaceous palaeochemistry of the Exmouth Plateau and the north east Indian Ocean (Heggie and others, 1992; Heggie, 1992).

Regarding the general overview of the geochemical properties of these sediments, a number of plots have been produced. These include down core profiles of the pore water metabolites, nitrate, manganese, ammonia, carbon dioxide and silicate. These data should be viewed in the context of a systematic distribution of sedimentary metabolites described by Froelich and others (1979). The data from Froelich and others (1979) were collected from the deep-water parts of the Atlantic Ocean in areas of moderate to high organic matter productivity which are appropriate for continental margin sediments. These systematic down-core trends in the pore water profiles can be used as a guide for interpreting the down-core trends of those metabolites measured in sediments from offshore Western Australia.

To provide a preliminary perspective on controls on the chemical composition of sediments from this area (and to easily compare the chemical composition of these sediments with others) a variety of cross-plots have been assembled between various

sediment components. Because alumino-silicates and iron and manganese oxyhydroxides are major phases for the transport of trace elements in the sea, these plots include Al_2O_3 versus all other elements analysed and Fe_2O_3 versus all elements analysed.

This Record complements a suite of sedimentological and other data assembled as part of BMR seafloor sampling surveys to the western margin (BMR Survey 53; Choi and Stagg, 1987), Colwell and others 1990, and ODP Legs 122 and 123 (von Rad, Haq., and others 1992 and Gradstein, Ludden and others 1992).

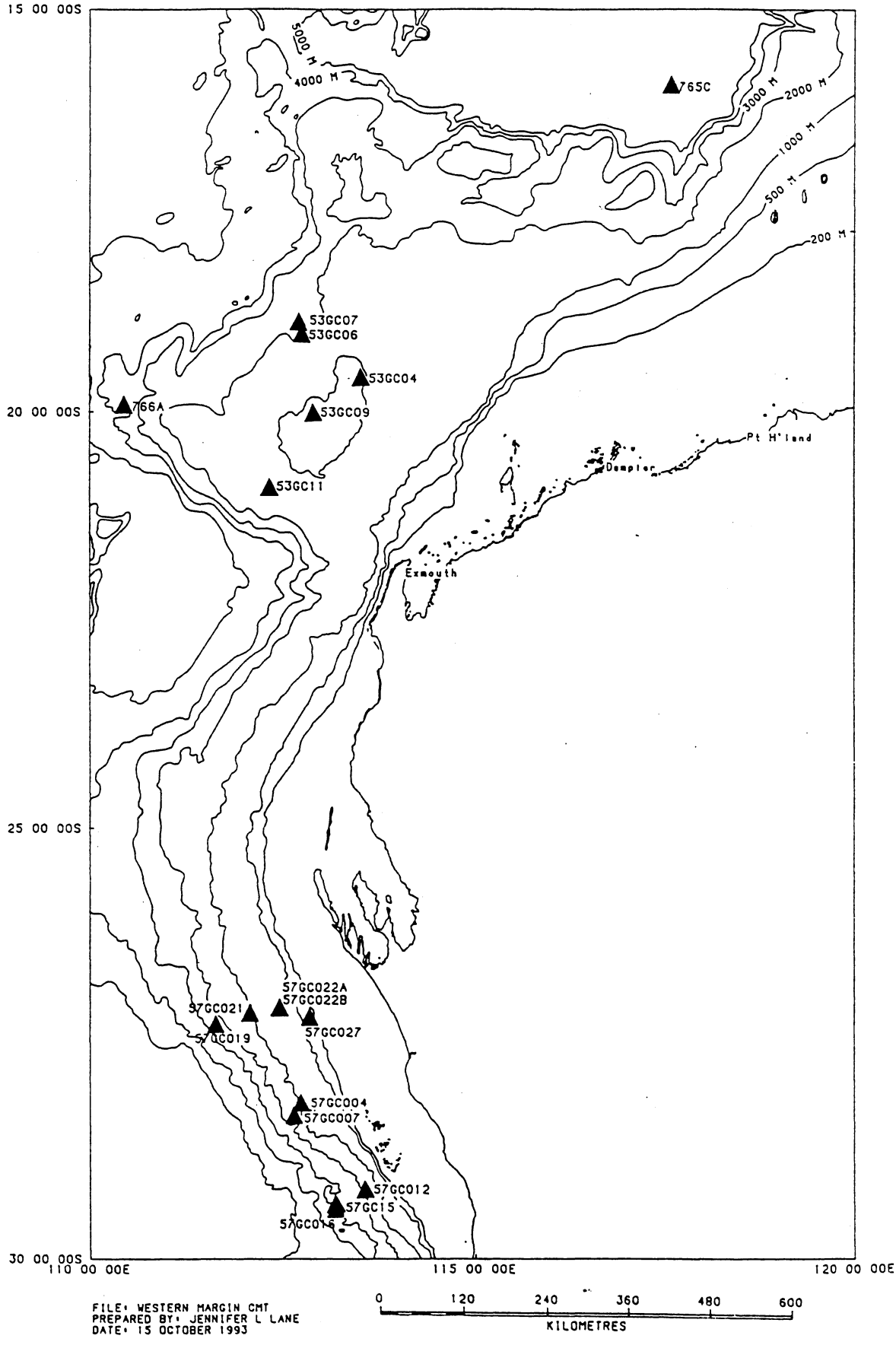


Figure 1. Location of cores collected from the Western Australian Continental Margin

Table 1 Locations of cores collected from the Western Australian Continental Margin

Core	Longitude (deg, min)	Latitude (deg, min)	Water Depth (m)	Recovery (m)	Location
53GC04	113 32.052	19 35.109	956	4.12	Exmouth Plateau
53GC06	112 45.139	19 3.170	1979	4.93	Exmouth Plateau
53GC07	112 45.139	18 53.539	2256	5.00	Exmouth Plateau
53GC09	112 55.253	20 0.253	962	4.40	Exmouth Plateau
53GC11	112 20.013	20 53.688	1432	3.70	Exmouth Plateau
57GC004	112 46.500	28 13.600	864	4.25	Carnarvon Terrace
57GC007	112 40.000	28 20.800	1245	2.00	Carnarvon Terrace
57GC012	113 35.300	29 13.000	1528	1.35	Carnarvon Terrace
57GC015	113 13.000	29 22.900	2750	2.39	Carnarvon Terrace
57GC016	113 07.900	29 25.900	3320	1.31	Carnarvon Terrace
57GC019	111 37.600	27 19.200	2755		Carnarvon Terrace
57GC021	112 05.300	27 11.600	1040	2.57	Carnarvon Terrace
57GC022A	112 28.600	27 06.200	654	1.30	Carnarvon Terrace
57GC022B	112 28.500	27 06.500	651	0.85	Carnarvon Terrace
57GC027	112 50.500	27 14.900	287	1.35	Carnarvon Terrace
766A	110 27.24	19 55.93	3997.5	347.49	western escarpment of the Exmouth Plateau, at the foot of the Gascoyne Abyssal Plain
765C	117 34.49	15 58.54	5717.7	373.35	southern Argo Abyssal Plain

Table 2 Summary of Cores Analysed

Core	Total samples Analysed	Analyses Performed						
		Pore Water	Solid Phase		Radio-Chemistry	$CaCO_3$ (wt%)	Stable Isotopes	
			Majors	Trace			Benthic Foraminifera	Planktonic Foraminifera
53GC04	50	-	-	-	22	22	48	50
53GC06	39	-	-	-	-	-	13	39
53GC07	60	-	60	60	50	50	19	60
53GC09	53	-	-	-	-	-	15	53
53GC11	19	-	-	-	-	-	19	19
57GC004	26	19	26	26	-	-	-	-
57GC007	3	3	-	-	-	-	-	-
57GC012	14	14	13	13	-	-	-	-
57GC015	34	19	18	18	30	30	28	34
57GC016	10	10	-	-	-	-	-	-
57GC019	40	-	40	40	37	37	20	39
57GC021	12	14	-	-	-	-	-	-
57GC022A	12	12	6	6	-	-	-	-
57GC022B	12	12	-	-	-	-	-	-
57GC027	12	12	12	12	-	-	-	-
766A	20	-	20	20	-	-	-	-
765C	29	-	29	29	-	-	-	-

METHODS

Pore Water

The methods used to analyse the pore water compositions were similar to those described in Heggie and others (1987); Heggie and others (1990). The pore water samples were analysed for nitrate, ammonia, manganese, total carbon dioxide and silicate. Sediment cores were split and one-half of the core was sampled for pore water metabolites. Sections of approximately 3 cm of sediment were loaded into centrifuge tubes as soon as the core was split in the laboratory on the ship. Samples were collected at about 10 cm intervals in the top section of core, but at 20 cm intervals in the deeper sections of cores. Pore waters were separated from the sediments by centrifuging at 15, 000 rpm for about 10 minutes. Pore waters were siphoned off and filtered through precleaned 0.45 Nuclepore filters and analysed for ammonia and manganese at sea using colorimetric methods. Nitrate and silicate were analysed at the Australian Institute of Marine Science using standard Technicon Autoanalyzer methods. Total carbon dioxide was analysed at the Australian Geological Survey Organisation (AGSO) laboratories using a OIC (Oceanography International Corporation) carbon analyser. Approximately 1 ml of pore water was acidified with phosphoric acid and the liberated carbon dioxide measured with an infra red detector. Because of the limited volumes of pore water available, these analyses were only conducted on select cores.

Major and Minor Element Compositions

Major and trace element analyses were measured by x-ray fluorescence at the AGSO with methods modified from those presented in Cruikshank and Pyke (1993).

Radiochemistry

Select sediments from the Carnarvon Terrace and the Exmouth Plateau were analysed for their radiochemical properties in order to determine sediment accumulation rates. The uranium-series data were obtained by alpha spectrometry at Flinders University South Australia. Briefly, the samples were dissolved and a calibrated $^{228}Th/^{232}U$ tracer was added. Uranium and thorium isotopes were then separated by a series of ion exchange chromatography in HCl and HNO_3 media. Uranium was further purified by solvent extraction (MIBK) and removal of Fe by di-isopropyl ether extraction. The uranium and thorium isotopes were electroplated onto stainless steel disks from a NH_4Cl solution, and isotope ratios between sample and tracer determined by alpha

counting on a Canberra-Packard Quad Alpha multiple input system linked to a PC with dedicated software. The one-sigma counting statistics yield precisions of ±3% and ±7% for the uranium and thorium concentrations, respectively.

$CaCO_3$ and Organic Carbon

Calcium carbonate and organic carbon were determined by sequential colorimetric titration (Engleman and others, 1985) of the CO_2 released upon acidification of the finely ground sediments with phosphoric acid ($CaCO_3$), and upon oxidation with dichromate/sulfuric acid (organic carbon), using an adaption of the method described in Weliky and others (1983).

Opaline Silica

Biogenic opal was determined by selective extraction of silica into a Na_2CO_3 solution under controlled conditions as described by Mortlock and Froelich (1989), and measuring the dissolved silica concentration in the Na_2CO_3 solution by molybdate-blue spectrophotometry (Stickland and Parson, 1968).

Stable Isotopes

The foraminiferal data were obtained at Woods Hole Oceanographic Institution (WHOI). Stable isotope analyses were carried out using a VG Micromass 602E mass spectrometer, upgraded with triple collectors. Uncrushed foraminiferal samples were roasted under a vacuum at 370°C, and reacted with 100% phosphoric acid at 90°C. Planktonic samples consisted of 10 to 15 individuals, and benthic analyses used 2 to 5 individuals. Instrument precision is ± 0.1 °/oo, and the average precision of replicate analyses of planktonic foraminifera is ± 0.13 °/oo (McCorkle and others, 1993).

RESULTS AND DISCUSSION

Pore Water Geochemistry

The pore water data for eight cores from the Perth Basin (Carnarvon Terrace) are summarised in Tables 3-10. The down core profiles for nitrate, ammonia, silicate, manganese (pore water) and manganese (solid phase) are presented in Figures 3 - 10. The plots have not been interpreted in detail, but a systematic approach to assist in the preliminary interpretation of these plots is shown in the equations, and the predicted down-core metabolite profiles below (Froelich and others, 1979) and in Figure 2.

Organic Matter destruction in Sediments (modified from Froelich and others, 1979)

(1) Oxygen reduction

$$106(CH_2O)16(NH_3)+(H_3PO_4)+138O_2 \rightarrow 106CO_2+16(NH_3)+H_3PO_4+122H_2O$$

(2) Nitrate Reduction

$$106(CH_2O)16(NH_3)+(H_3PO_4)+94HNO3 \rightarrow 106CO_2+55.2N_2+H_3PO_4+177H_2O$$

(3) Manganese Reduction

$$106(CH_2O)16(NH_3)+(H_3PO_4)+236MnO_2+472H^{+}\rightarrow 236Mn^{2+}+106CO_2+ 8N_2H_3PO_4+366H_2O$$

(4) Ferric iron reduction

$$106(CH_2O)16(NH_3)(H_3PO_4)+424FeOOH+848H^{+}\rightarrow 424Fe_{2+}+106CO_2+16(NH_3)+ H_3PO_4+742H_2O$$

(5) Sulphate reduction

$$106(CH_2O)16(NH_3)+(H_3PO_4)+53SO_4^{2-} \rightarrow 53S^{2}+106CO_2+16(NH_3)+H_3PO_4+106H_2O$$

(6) Methanogenesis

$$106(CH_2O)16(NH_3)+(H_3PO_4) \rightarrow 53CO_2+53CH_4+16(NH_3)+H_3PO_4$$

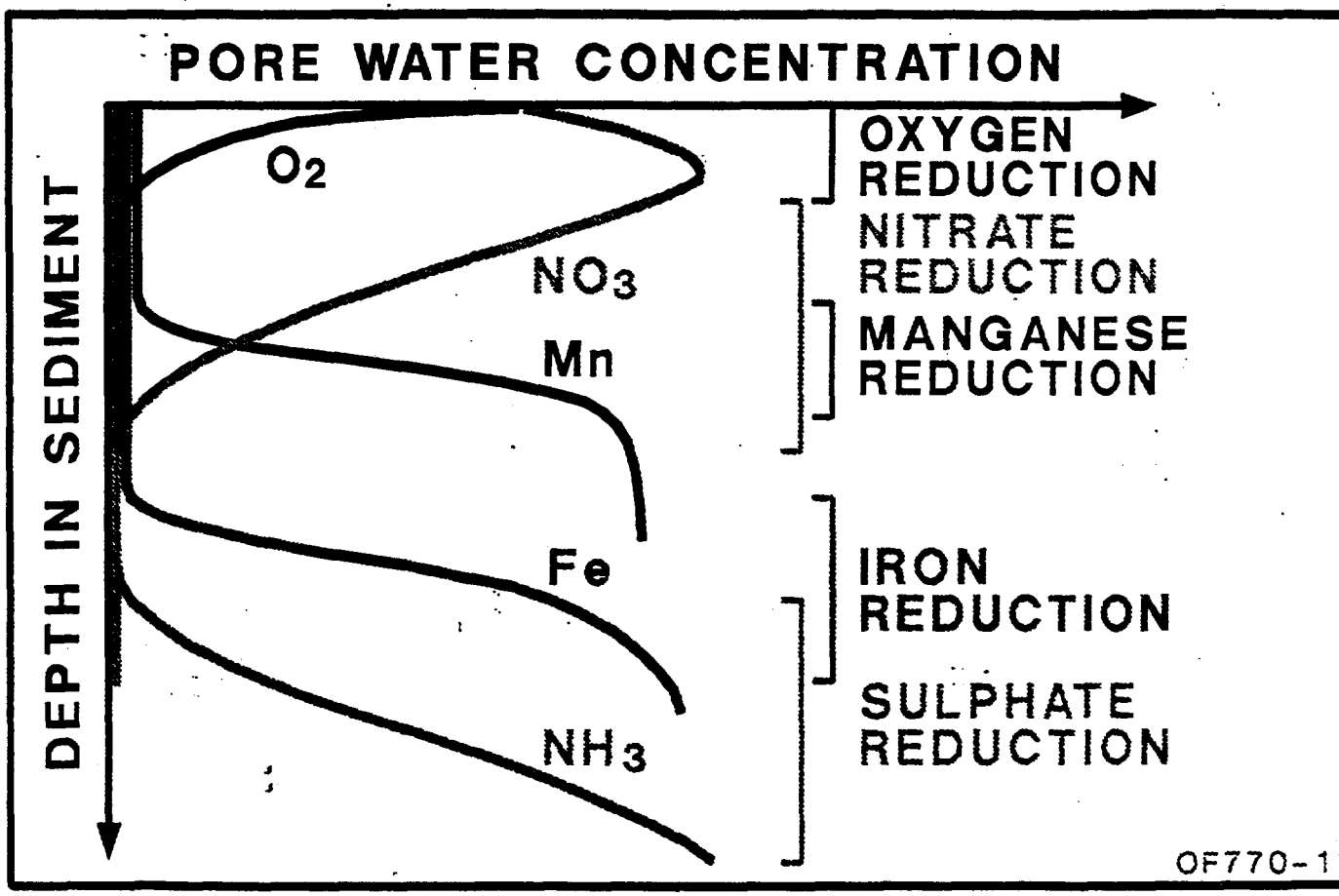


Figure 2. Schematic representation of trends in pore water profiles (After Froelich, 1979)

Table 3 Pore Water results for core 57GC004

Survey	Core Depth (cm)	Depth (cm)	NO3 (umol/l)	NH3 (umol/l)	Mn (pw) (umol/l)	SiO2 (umol/l)	Mn (s) (ppm)
57GC004	0-3	1.5	29.1	<1	0.3	307.1	
	10-13	11.5	6.7	13.1	2.5	328.1	72
	20-23	21.5	3.9	15.4	1.5	341.9	76
	30-33	31.5	6	21.5	1.1	334.9	58
	40-43	41.5	6.3	38.5		348.9	43
	50-53	51.5	4.9	40.1	0.9	334.9	44
	60-63	61.5	5.6	42.4			71
	70-73	71.5	6.7	50.1		397.7	82
	80-83	81.5		37.4	0.2		67
	90-93	91.5	2.5	40.3	0.3	397.7	74
	100-103	101.5	2.1	42.5	0.7		77
	110-113	111.5		46.7	0.6	390.8	69
	120-123	121.5		45.1	0.1		63
	140-143	141.5	1.4	45.1	0.2	383.8	73
	160-163	161.5	0.7	45.9	0.4	390.8	114
	180-183	181.5	2.5	43.9	0.4	397.7	80
	200-203	201.5		45.7			64
	220-223	221.5		53.1	0.3		70
	240-243	241.5		51.5			72

Table 4 Pore Water results for core 57GC007

Survey	Core	Depth Interval cm	Depth (cm)	NO3 (umol/l)	NH3 (umol/l)	Mn (pw) (umol/l)	SiO2 (umol/l)
57	GC007	0-12	6	53.7	9.7		326
		15-18	16.5	42.1	3.8	0.7	237
		20-23	21.5	21.4	7.9	0.8	300
		30-33	31.5	9.1	13.9	1.2	314
		40-43	41.5	4.6	64.8	1	426
		52-55	53.5	3.2	74.4	0.8	489
		70-73	71.5		51.6	0.6	
		75-78	76.5		85.7	0.2	
		85-88	86.5	3.2	79.3	0.2	551
		95-98	96.5		105.2	0.5	
		115-118	116.5	2.8	84.3	0.5	530
		138-138	139.5		86.1	0.3	
		155-158	156.5	1.4	86	0.2	537

Table 5 Pore Water results for core 57GC12

Core	Depth (cm)	Depth (cm)	NO3 (umol/l)	NH3 (umol/l)	Mn (pw) (umol/l)	SiO2 (umol/l)	Mn (s) (ppm)
57GC12	0-3	1.5	6`.6	<1	0.2	293	
	3-6	4.5	25.2	<1	0.4	342	893
	6-9	7.5	15.4	<1	2.0	349	217
	9-12	10.5	10.2	2.2	2.0	369	438
	12-15	13.5	6.1	3.6	4.2	377	310
	18-21	19.5	2.5	3.9	5.9	384	174
	28-31	29.5	2.1	8.5	5.1	391	162
	40-43	41.5	2.5	14.1	3.2	412	153
	50-53	51.5		19.5	2.4		227
	60-63	61.5	2.5	19.3	1.8	482	151
	70-73	71.5		23.7	1.7		96
	80-83	81.5	1.4	36.4	1.4	502	84
	100-103	101.5		39.3	1.3		78
	200-203	201.5	1.4	46.8	1.1	509	101

Table 6 Pore Water results for core 57GC15

Survey	Core	Depth Interval (cm)	Depth (cm)	NO3 (umol/l)	NH3 (umol/l)	Mn (pw) (umol/l)	SiO2 (umol/l)	Mn (s) (ppm)
57	GC015	0-3	1.5	59.5	2.5	1	384	
		6-9	7.5	47.3	3.8	0.2	433	376
		12-15	13.5	45.5	6.2	0.2	516	323
		18-21	19.5	42.7	4.1	0.2	461	286
		24-27	25.5	36.4	3.9	0.2	489	377
		30-33	31.5	37.8	1.8	0.2	482	482
		40-43	41.5	29.1	15.8	0.3	489	593
		50-53	51.5	24.2	17.6	0.5	495	370
		60-63	61.5	18.6	4.1	0.8	439	133
		70-73	71.5	14.4	8.3	0.9	446	159
		80-83	81.5	11.9	4.7	0.9	461	227
		100-103	101.5	2.5	6.6	1.3	502	207
		110-113	111.5	5.3	7.7	1.3	454	216
		120-123	121.5	1.8	9.4	1.4	516	309
		140-143	141.5	0.7	8.6	1	482	260
		160-163	161.5	1.4	9.4	1.1	495	249
		180-183	181.5	1.1	14.8	1.2	544	315
		200-203	201.5	1.4	20.8	1.1	691	282
		220-223	221.5	1.4	32.5		558	221

Table 7 Pore Water results for core 57GC016

Survey	Core	Depth in Core (cm)	Depth (cm)	NO3 (umol/l)	NH3 (umol/l)	Mn (pw) (umol/l)	SiO2 (umol/l)
57	GC016	0-3	1.5	53.9	4.3	0.2	307
		6-9	7.5	43.4	3.9	0.2	419
		12-15	13.5	39.2	3.7	0.2	447
		18-21	19.5	37.1	3.9	0.1	439
		24-27	25.5	35	3.8	0.1	454
		30-33	31.5	32.2	2.1	0.1	475
		40-43	41.5	27.7	3.5	0.1	482
		50-53	51.5	22.8	1.5	0.7	509
		60-63	61.5	17.9	0.5		509
		85-88	86.5		1.6	1.5	

Table 8 Pore Water results for core 57GC021

Survey	Core	Depth in Core (cm)	Depth (cm)	NO3 (umol/l)	NH3 (umol/l)	Mn (pw) (umol/l)	SiO2 (umol/l)
57	GC021	0-3	1.5	56	4.5	0.1	265
		6-9	7.5	19.3	0.3	0.1	286
		12-15	13.5	10.2		0.1	300
		18-21	19.5	5.6	1	0.5	314
		30-33	31.5	3.2	16.1	1	328
		40-43	41.5	2.1	7.6	0.8	349
		50-53	51.5	2.1	9.3	0.8	453
		80-83	81.5	3.2	21.7	0.5	370
		100-103	101.5	1.8	17	0.3	370
		120-123	121.5	1.4	18	0.5	370
		140-143	141.5	1.1	19	0.3	377
		162-165	163.5	1.1	30.8	0.2	391
		180-183	181.5	1.4	24	0.2	412
		200-203	201.5	1.8	24	0.3	412

Table 9 Pore Water results for core 57GC022A,B

Survey	Core	Depth in Core (cm)	Depth (cm)	NO3 (umol/l)	NH3 (umol/l)	Mn (pw) (umol/l)	SiO2 (umol/l)	Mn (s) (ppm)
57	GC022A,B	0-3	1.5	20.7	0.1	0.1	369	
		6-9	7.5	6.3	12.8	1.9	307	
		10-13	11.5	1.8	19.5	2.7	314	109
		12-15	13.5	1.4	17.2	2.2	300	
		20-23	21.5	1.8	20	1.9	286	
		30-33	31.5	1.8	24.6	1.7	314	96
		40-43	41.5	1.4	25.3	1.3	293	
		50-53	51.5	2.1	32.5	1.1	335	77
		60-63	61.5	1.4	37.8	1	321	
		70-73	71.5	1.4	37.8		419	54
		90-93	91.5	3.5	43.4	0.5	391	49
		110-113	111.5					107

Table 10 Pore Water results for core 57GC027

Survey	Core	Depth in Core (cm)	Depth (cm)	NO3 (umol/l)	NH3 (umol/l)	Mn (pw) (umol/l)	SiO2 (umol/l)	Mn (s) (ppm)
57	GC027	0-3	1.5	2.8	39.3	0.3	244	76
		6-9	7.5	3.9	40.1		244	76
		12-15	13.5	2.8	37.5		237	68
		18-21	19.5					82
		20-23	21.5	3.5	40.3		237	76
		30-33	31.5		45.4			83
		40-43	41.5	2.1	42.1	0.2	286	76
		50-53	51.5		43.1			82
		60-63	61.5	2.5	43.4		328	81
		80-83	81.5	3.2	47.9	0.3	321	81
		100-103	101.5	2.5	46.3		335	81
		120-123	121.5	3.9	52.3		335	83

The pore water data illustrated in Figures 3 through 10, generally show the classical down-core distributions of metabolites that have been articulated by Froelich and others, 1979, and found elsewhere in continental shelf, slope and deep-sea sediments. Those cores collected from water depths < 1000 m (57GC004, 57GC022A,B; 57GC027; Figs. 3, 9&10) all show no evidence of a nitrate maximum, indicating that the nitrification reaction 2 (page 9), and the depth of penetration of bottom-water oxygen into the sediments is less than the depth of the first sample interval, < 3 cm. All cores show rising pore water ammonia concentrations, above background (<5 micro molar), in the top few centimetres, indicating anoxic conditions and the onset of sulphate reduction (reaction 5, page 9). The pore water concentration of manganese are low in all cores (generally <3 micro molar), and only one core (57GC22A,B) shows any significant down-core manganese variations. The data are indicative of some recycling of sedimentary manganese between the solid phase and pore fluids. The solid phase manganese is generally in the range 50-100 ppm, and no significant concentration of manganese was found in these sediments as a result of the solid phases-pore water redistribution processes.

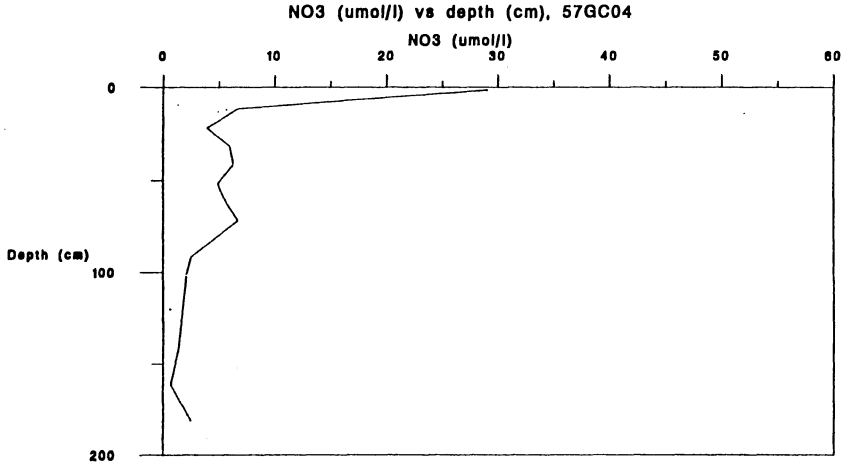
The data from cores collected from the mid-slope in water depths between 1040 m and 1528 m, (57GC021; 57GC012; 57GC007; Figs. 4,5,8) showed somewhat different pore water metabolite profiles than those from shallower water. Nitrate concentrations in these cores were significantly higher in the core-tops (25-60 micro molar), indicating nitrification reactions in the top few centimetres and a deeper depth of penetration of bottom-water oxygen into the sediments. Nitrate concentrations decreases significantly to low levels (<2 micro molar) at depths below 30-50 cm, and these are indicative of de-nitrification (reaction 2, page 9). Manganese oxide reduction is evident in cores, but pore water Mn is generally very low (<1.5 micro molar), although in GC012, Mn concentrations exceeded 5 micro molar, and these data suggest limited manganese recycling between pore waters and sediments. Ammonia concentrations increase rapidly in the sediments to concentrations of between 20 and 100 micro molar, indicating the presence of sulphate reduction reactions. The dissolution of biogenic silica is evident in pore water silicate concentrations which rise systematically in the sediments to asymptotic concentrations of between 350 and 550 micro molar.

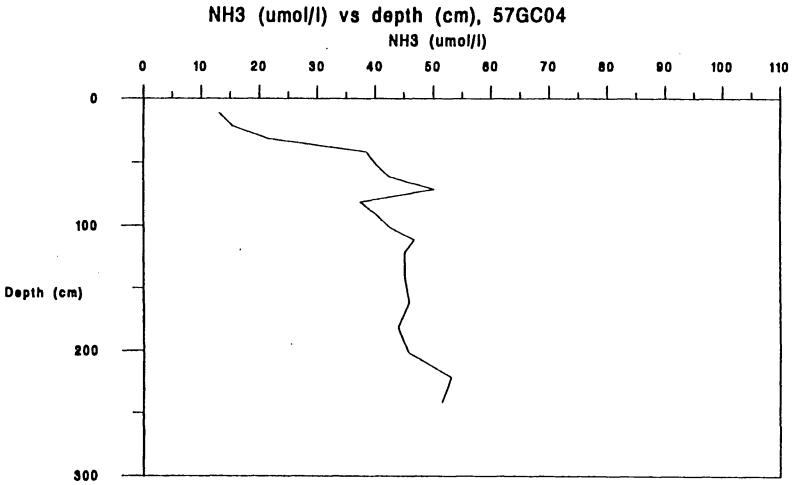
Three cores were collected from the lower-slope in water depths >2000 m (57GC015, 57GC016 and 57GC019; Figs. 6 &7). Nitrate data from both cores show high nitrate (>50 micro molar) in the core-top (nitrification) with concentrations decreasing with increasing depth in the sediments to low levels at depths beyond about 100 cm. Ammonia concentrations are low in the core-tops (<10 micro molar) and increase

slowly with increasing depth in the sediments to values approaching 40 micro molar at about 200 cm in one core (GC15).

The nitrate and ammonia metabolite distributions in all cores are generally indicative of higher inputs of metabolisable organic carbon in the outer-shelf/upper-slope cores than those cores on the mid and lower-slopes. The pore water manganese concentrations measured here (<6 micro molar) are lower than those measured on the eastern margin of Australia (Heggie and others, 1990) and may be indicative of (i) low sediment inventories of manganese oxyhydroxides (ii) unreactive manganese oxyhydroxides in the sediments (iii) little recycling of sediment manganese between sediments and pore waters, or combinations of all three above.

While it is beyond the scope of this documents, these data when considered with the bulk chemical compositions of the sediments (see below) provide clues to the early diagenetic reactions associated with the degradation of organic matter in the sediments, and the occurrences of some seafloor minerals, phosphorites and manganese rich sediments.





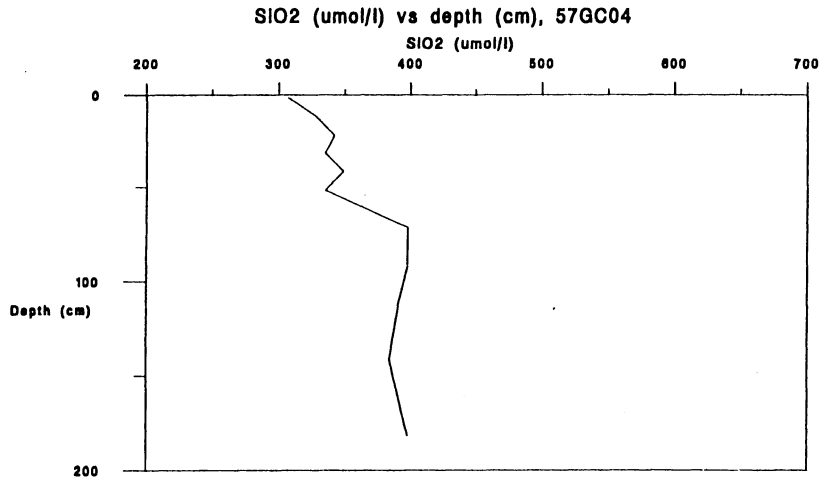
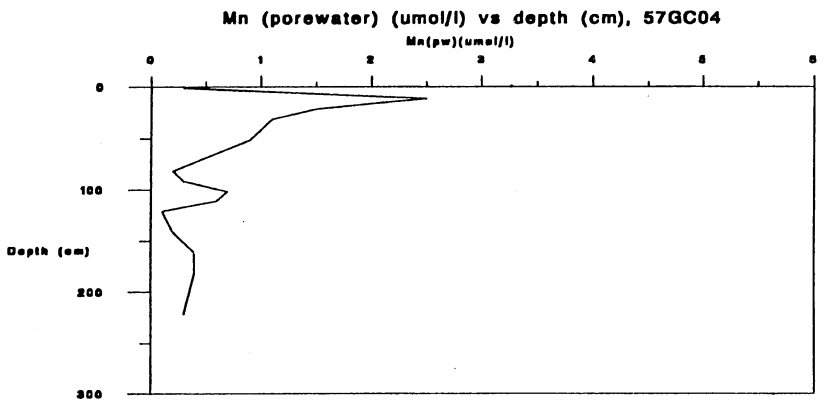


Figure 3a. Down core profiles of NO_3 (µmol/l), NH3 (µmol/l) and SiO_2 (µmol/l) for core 57GC04



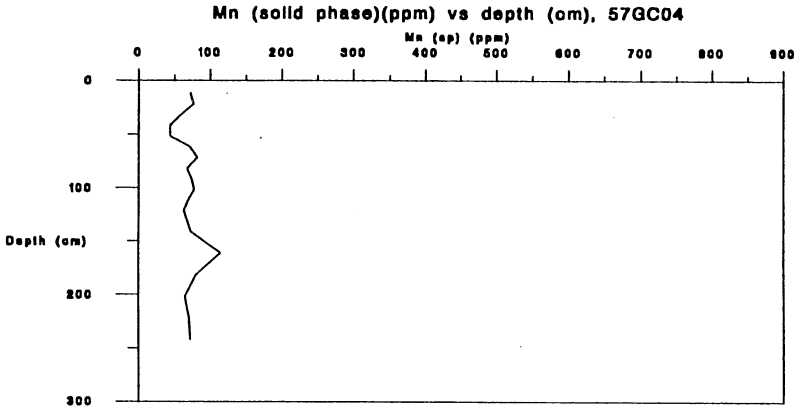
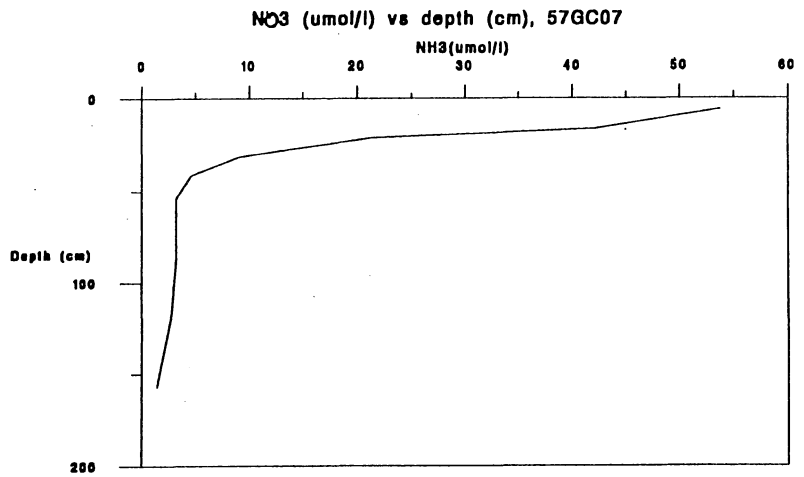
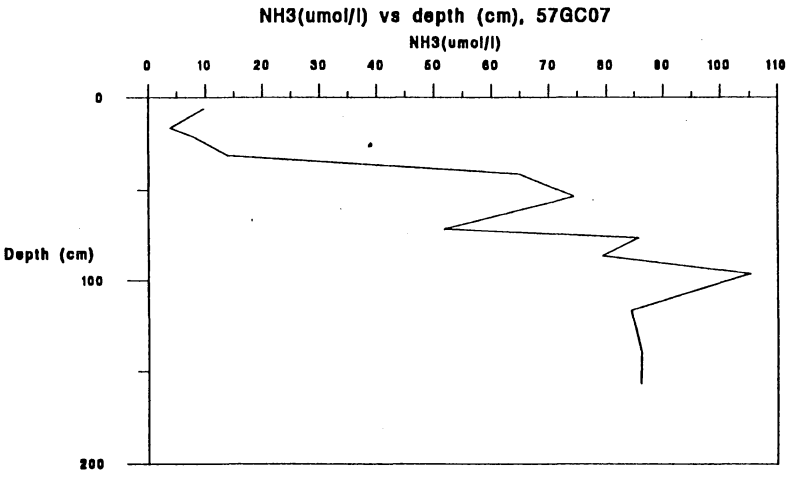
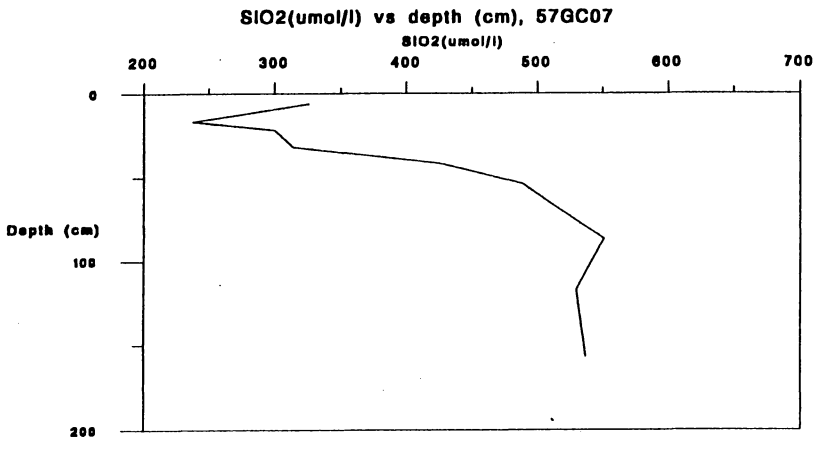


Figure 3b. Down core profiles of Mn (solid phase) (ppm) and Mn-pore water (µmol/l) for core 57GC04







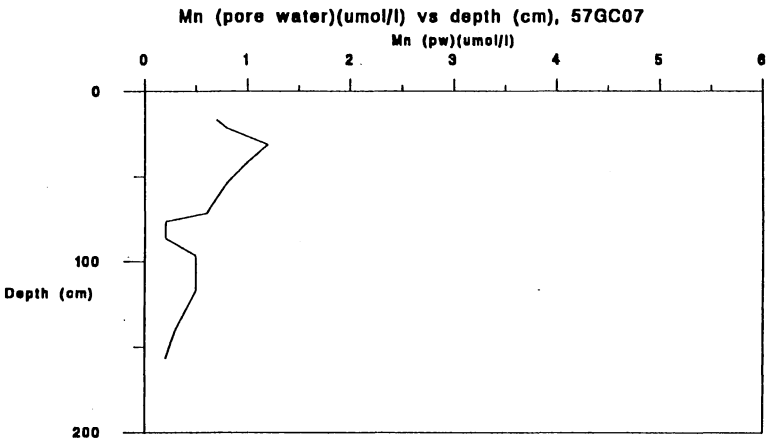
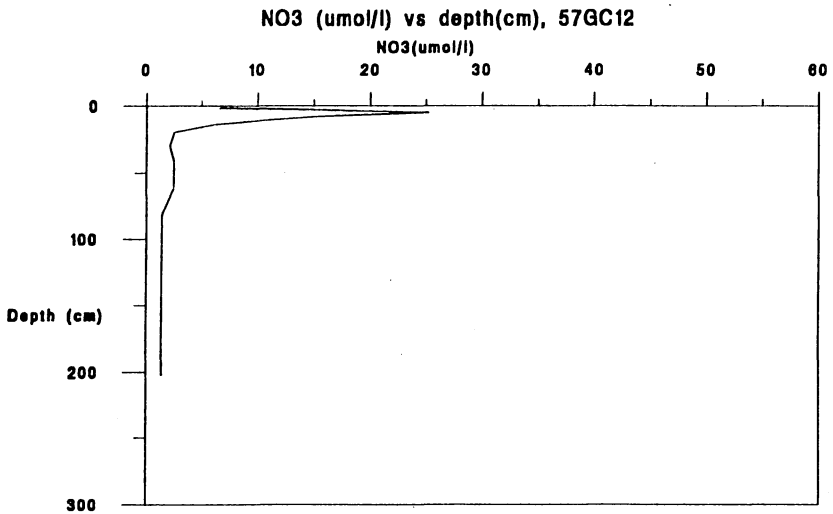
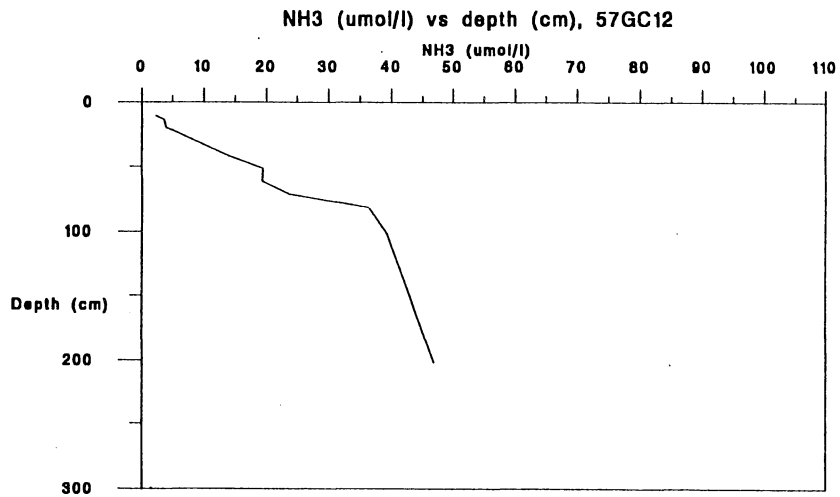


Figure 4. Down core profiles of NO_3 (µmol/l), NH_3 (µmol/l), SiO_2 (mmol/l) and Mn-pore water (µmol/l) for core 57GC07





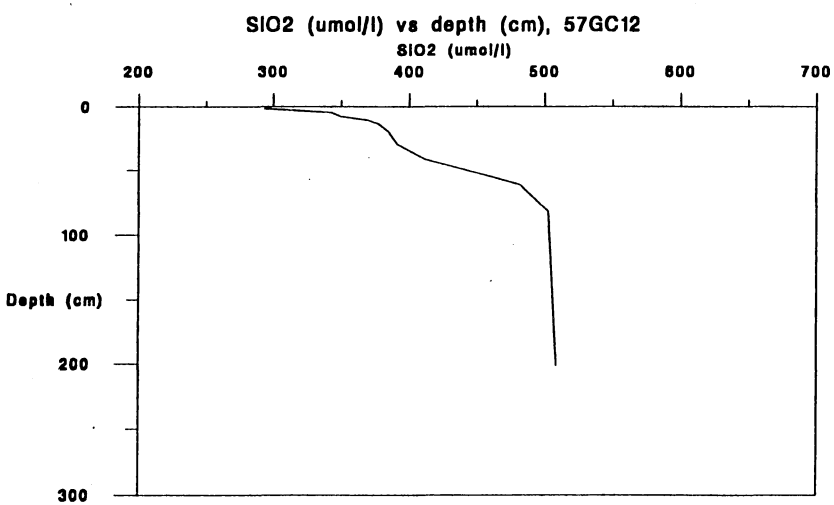
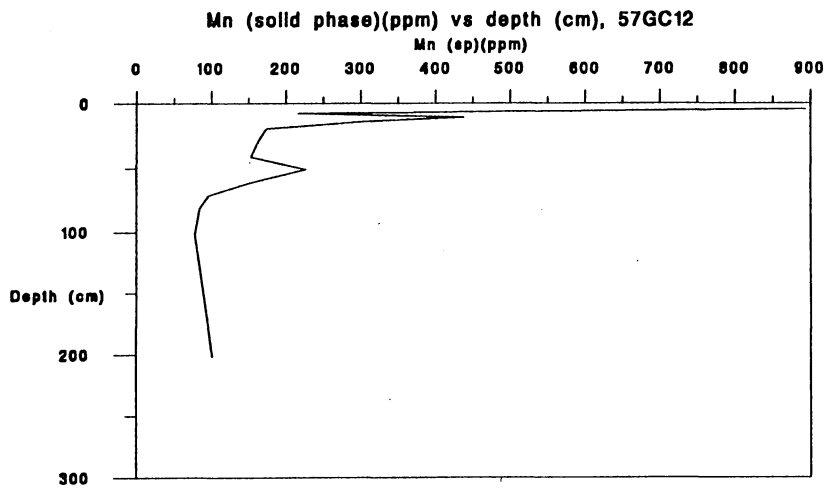


Figure 5a. Down core profiles of NO_3 (µmol/l), NH_3 (µmol/l) and SiO_2 (µmol/l) for core 51GC12



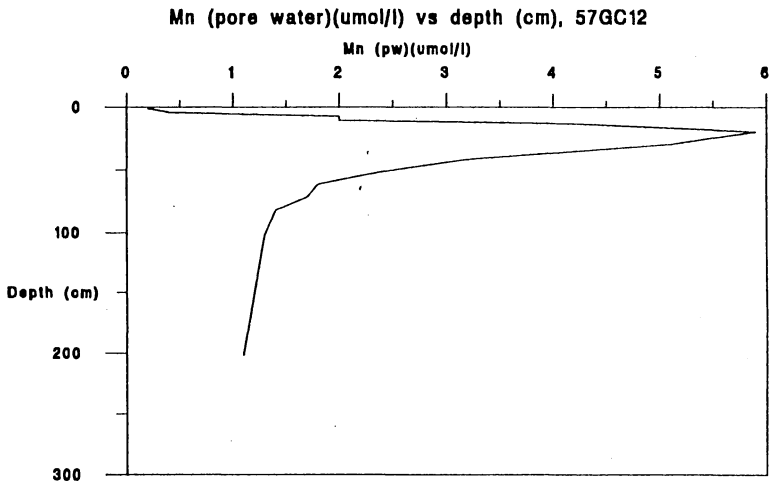
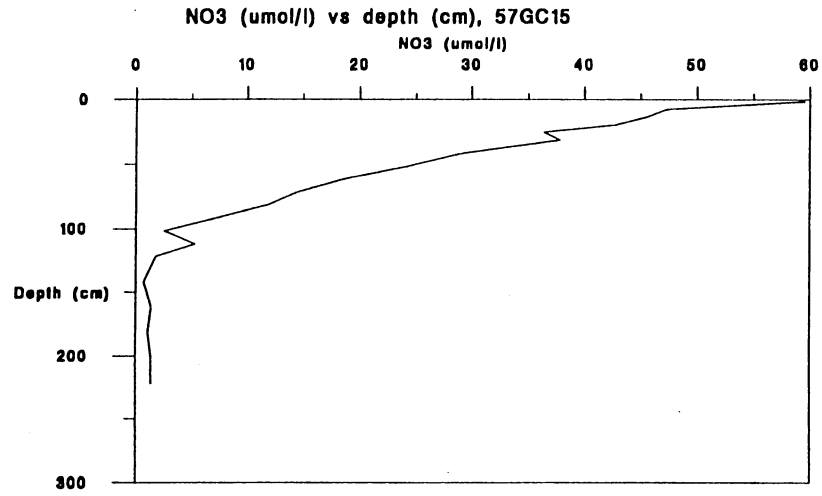
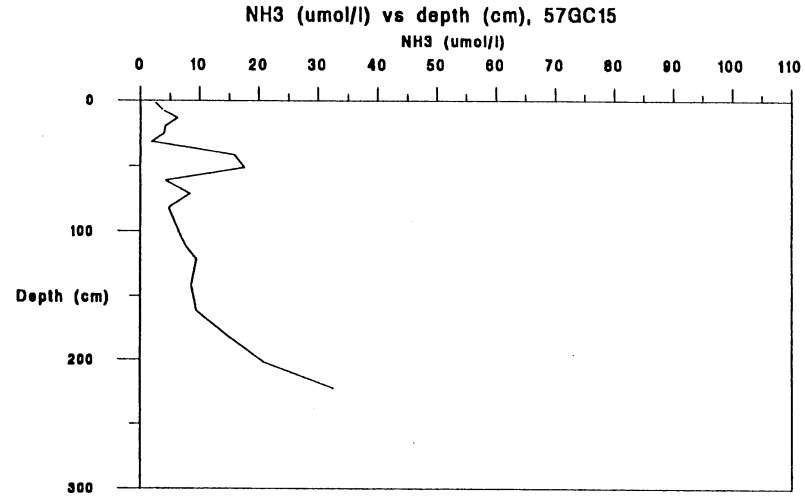


Figure 5b. Down core profiles of Mn-pore water (µmol/l) and Mn-solid phase (ppm) for core 57GC12





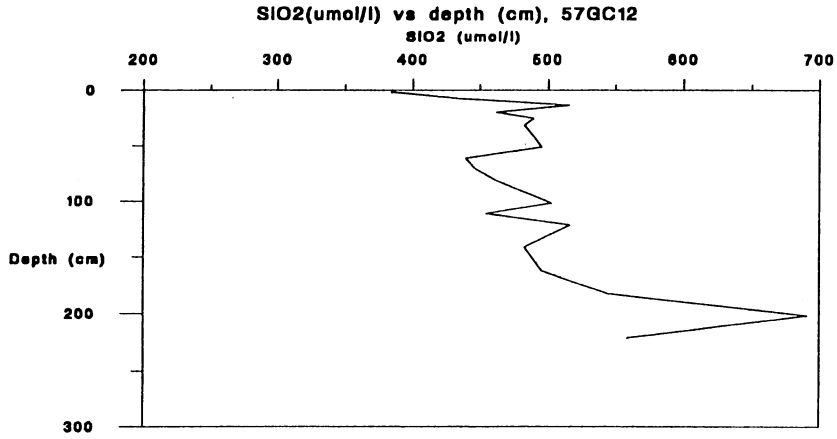
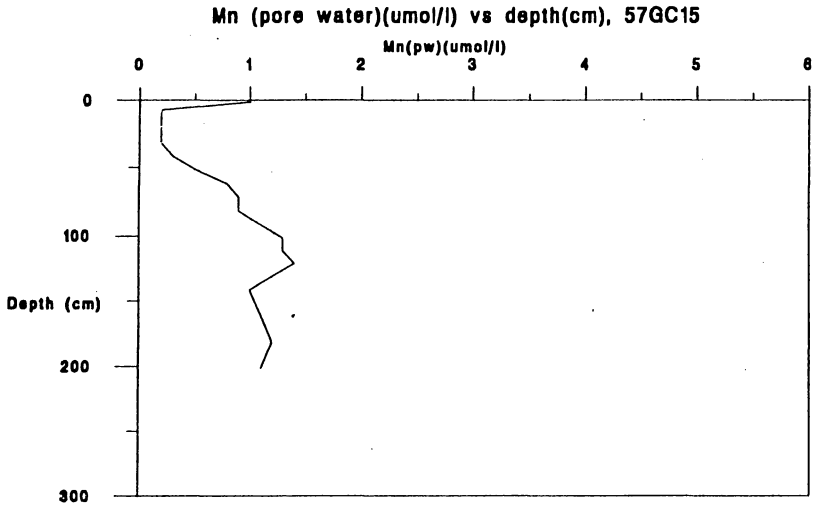


Figure 6a. Down core profiles of NO_3 (µmol/l), NH_3 (µmol/l) and SiO_2 (µmol/l) for core 57GC15



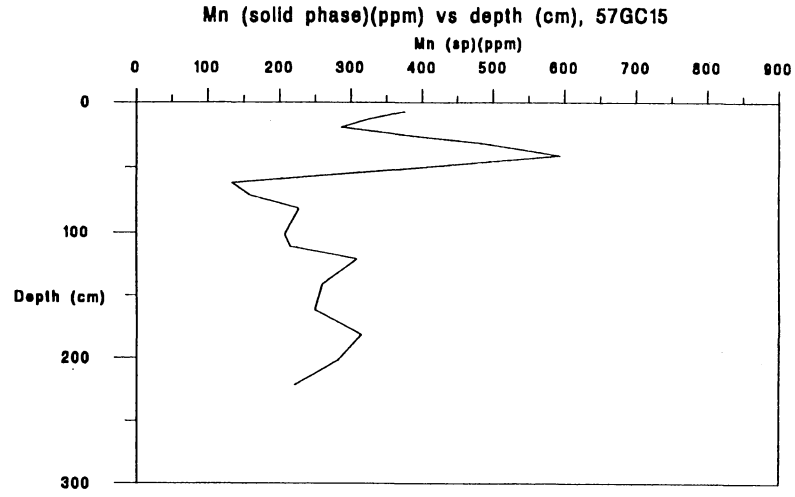
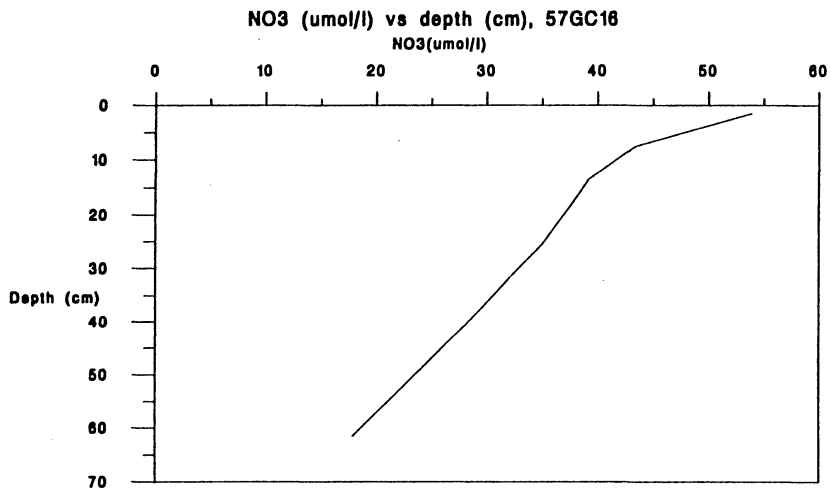
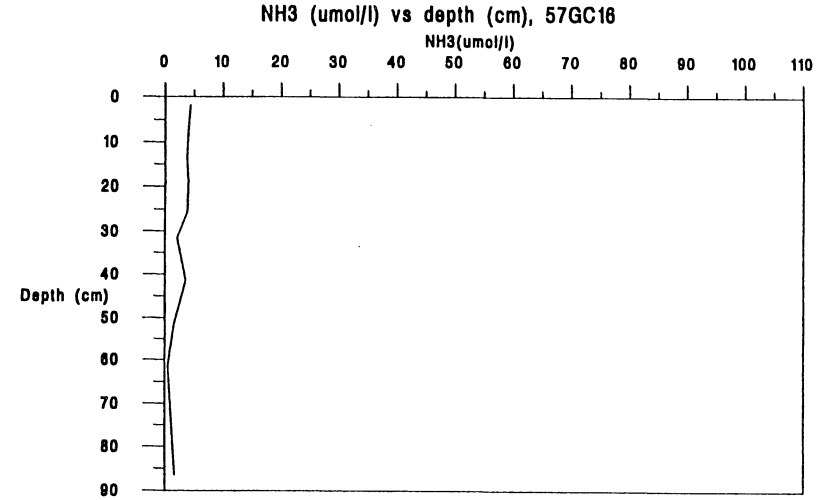
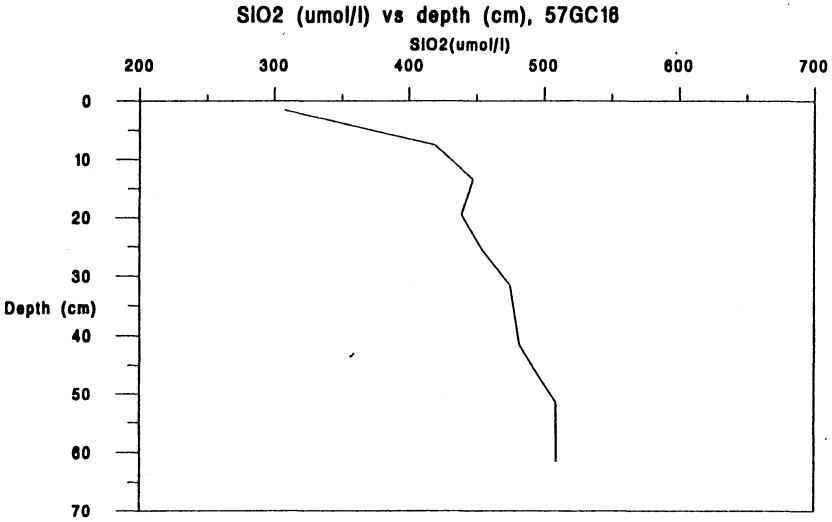


Figure 6b. Down core profiles of Mn (pore water) (µmol/l) and Mn (solid phase) (ppm) for core 57GC15







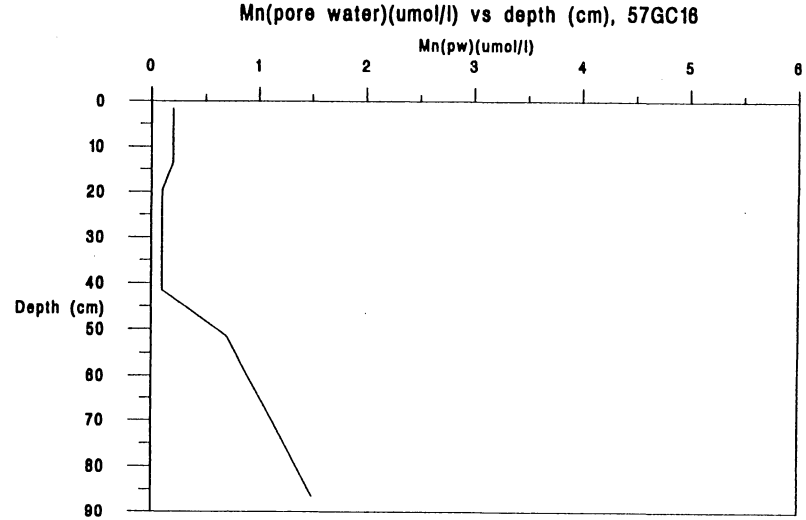
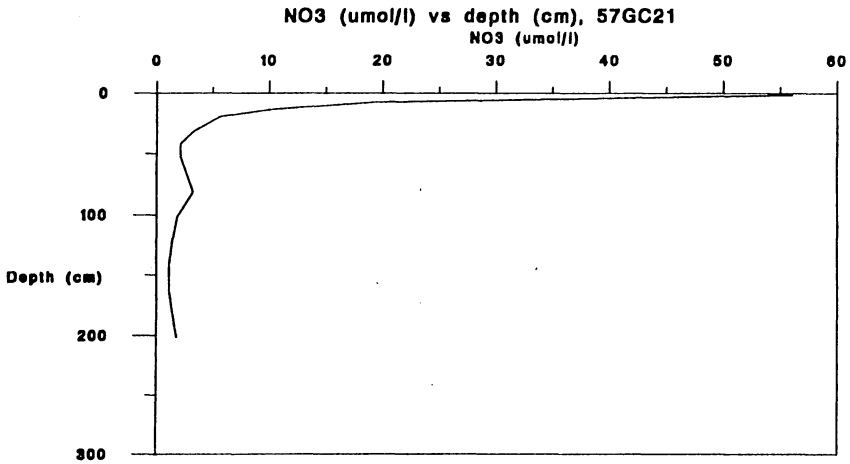
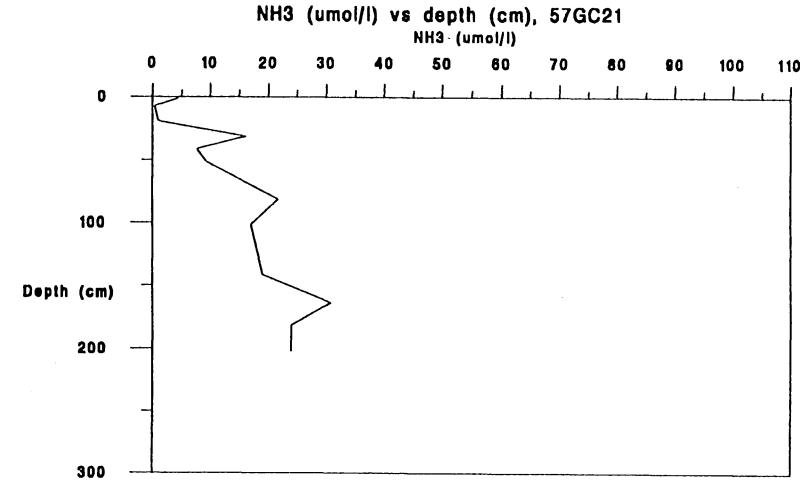
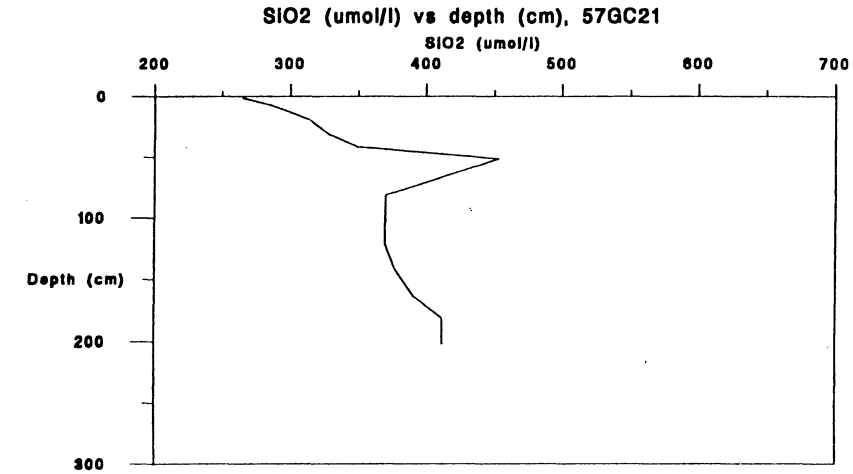


Figure 7. Down core profiles of NO_3 (µmol/l), NH_3 (µmol/l) and SiO_2 (µmol/l) and Mn-pore water (µmol/l) for core 57GC16







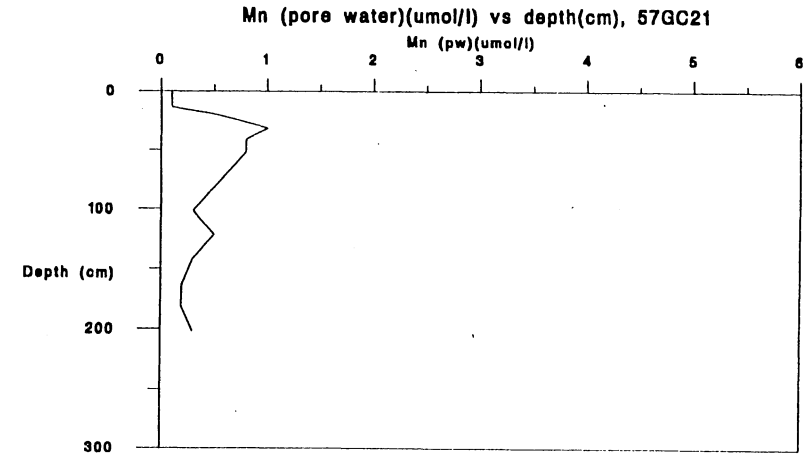
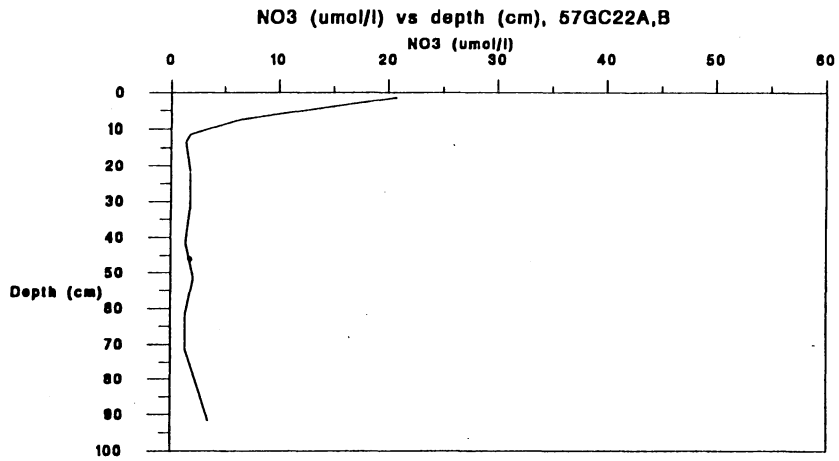
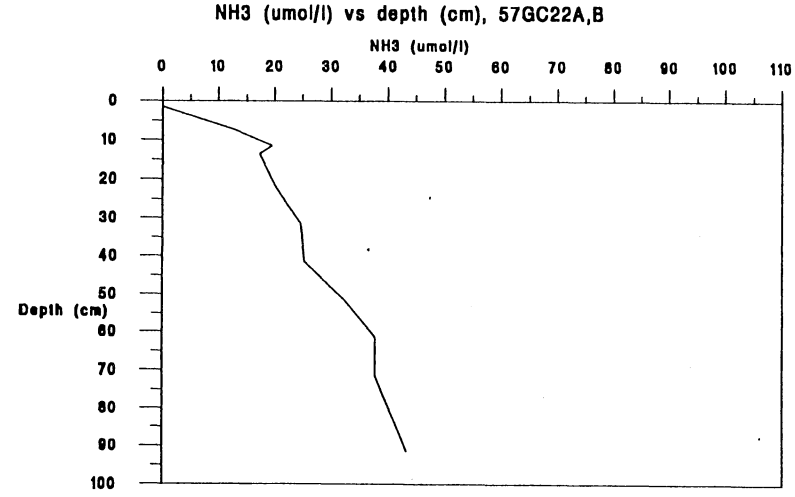


Figure 8. Down core profiles of NO_3 (µmol/l), NH_3 (µmol/l), SiO_2 (µmol/l) and Mn-pore water (µmol/l) for core 57GC21





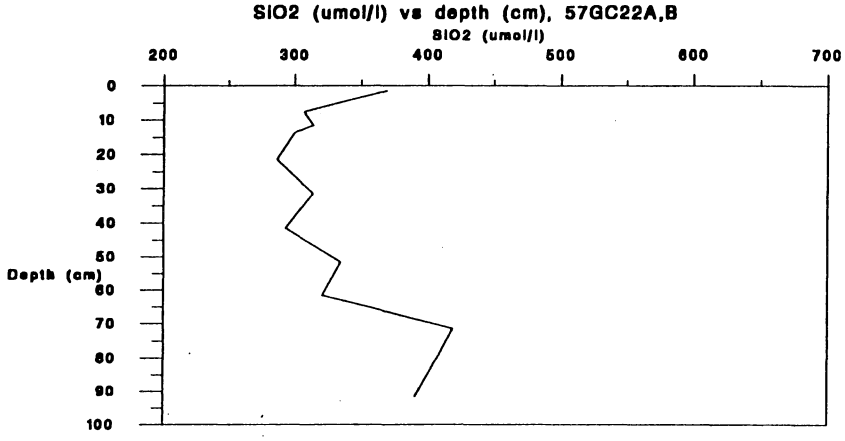
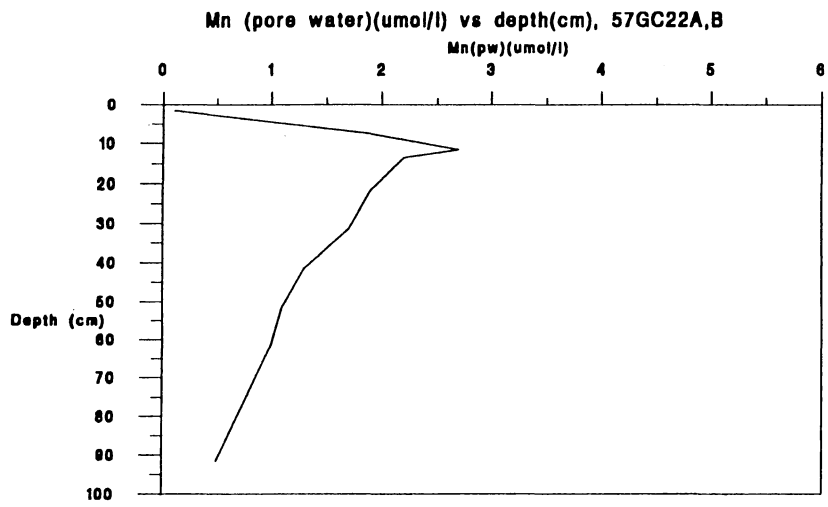


Figure 9a. Down core profiles of NO_3 (µmol/l), NH_3 (µmol/l) and SiO_2 (µmol/l) from core 57GC22A,B



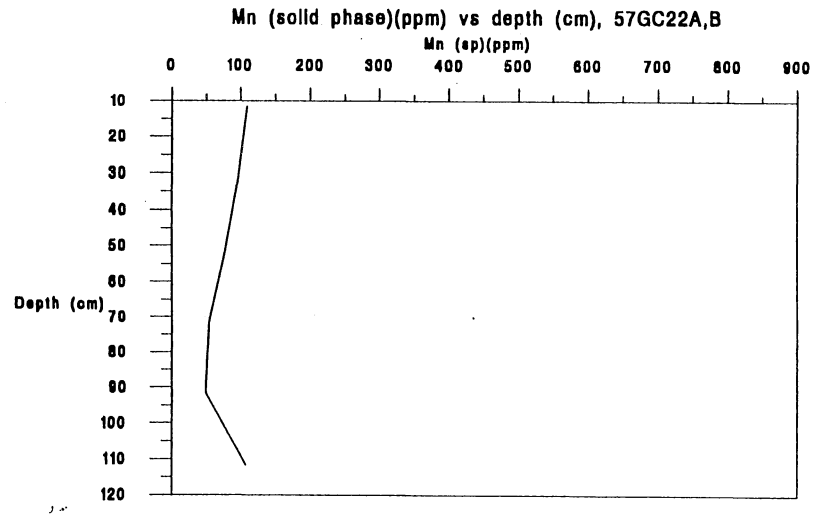
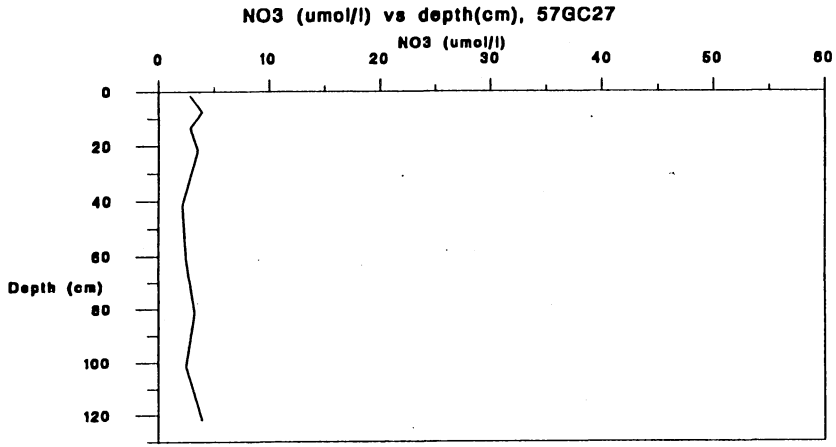
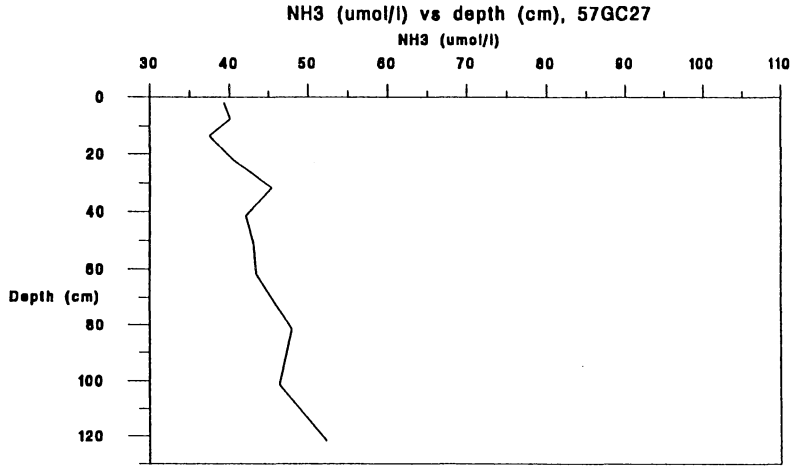


Figure 9b. Down core profiles of Mn-pore water (µmol/l) and Mn-solid phase (ppm) for core 57GC22A,B





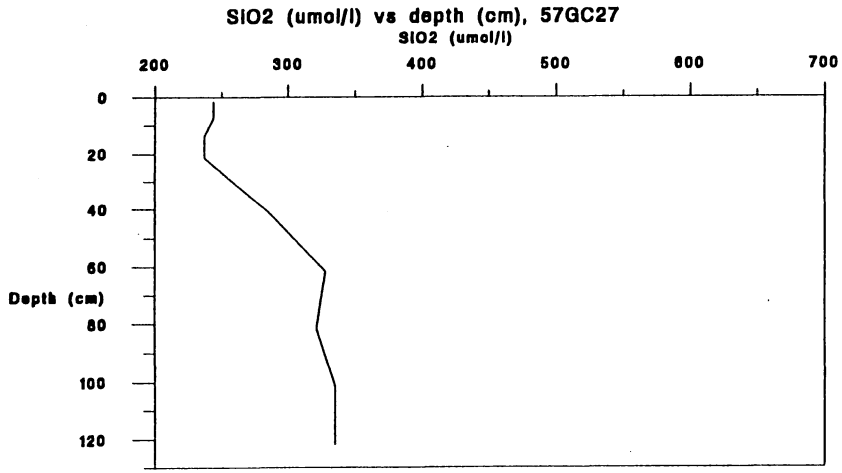
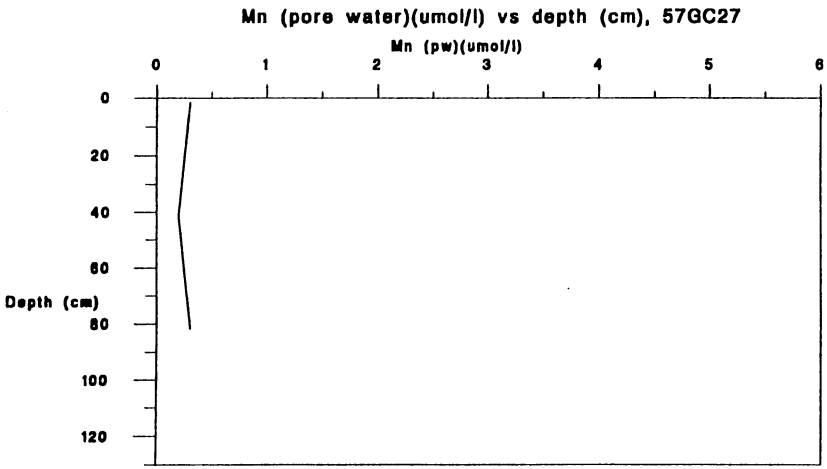


Figure 10a. Down core profiles of NO_3 (µmol/l), NH_3 (µmol/l) and SiO_2 (µmol/l) for core 57GC27



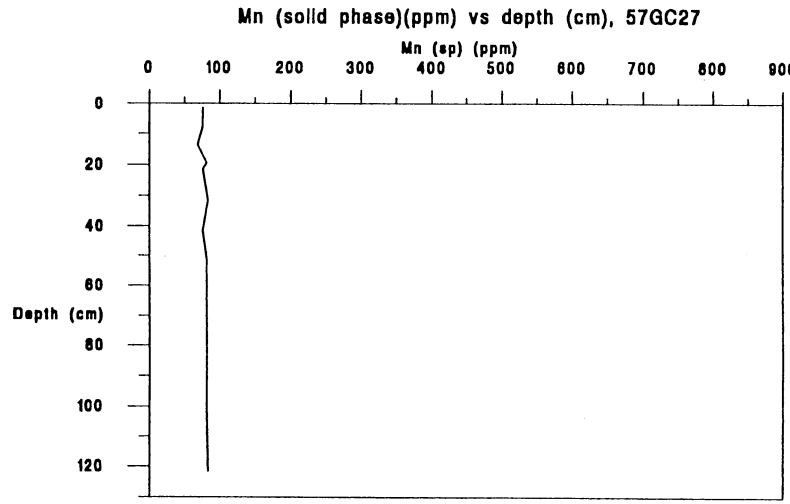


Figure 10b. Down core profiles of Mn-pore water (µmol/l) and Mn-solid phase (ppm) for core 57GC27

Solid Phase Major and Trace element concentrations

The major and trace element concentrations in sediments were determined on nine cores collected from the west Australian continental margin. One core analysed was collected from the Exmouth Plateau; six cores were collected from the Carnarvon Terrace and the other two cores are from ODP Leg 123. The major and trace element data are presented in Tables 11 - 19. The analytical methods, including accuracy and precision, used in determining the major and minor elemental compositions of sediments are discussed in Cruikshank and Pyke (1993).

A number of plots have been produced from these data to provide an easy and preliminary perusal of the ranges of concentrations of most elements measured. These plots here are presented to provide an easy comparison of concentrations between the different geographical areas surveyed, including the sediments from north east Australia (BMR Survey 51), the central NSW coast (BMR Survey 71), and the southern margin (Otway Basin; BMR survey 67). These plots include Al_2O_3 versus all elements (Appendix A).

Because oxyhydroxides of iron are scavengers of trace metals from sea water, the Fe_2O_3 abundance in sediments may exert an important control on the trace element compositions of marine sediments - several plots (Appendix B) show Fe_2O_3 with select major and trace elements. The Fe_2O_3 abundance is positively correlated (although we have not measured this statistically) with aluminosilicates and trace elements arsenic, chromium, copper, nickel, lead, rubidium, vanadium, zinc and zirconium. From the plots, the ranges of concentrations for those elements shown are summarised in Table 20.

To provide a preliminary perusal of potential palaeoceanographic tracers, the elemental ratios of select elements with aluminium have been calculated and their distributions down-core are summarised in Figures 11-15. Other distributions are presented in Appendix C. The down-core distributions of strontium, phosphorus and barium are similar to the calcium carbonate down-core profiles which suggest these may be useful direct tracers for organic matter input into the sediments. The down-core distributions of manganese and chromium, which would be expected to have a strong diagenetic overprint, are similar in many ways to strontium, phosphorus and barium, and this suggests no distinct controls on these elements in Late Quaternary sediments by significant redox gradients.

Table 11 Major and trace element analyses for core 53GC07

Survey	Core	Sample Depth (cm)	SiO2 (wt%)	TiO2 (wt%)	Al2O3 (wt%)	Fe2O3t (wt%)	Fe2O3 (wt%)	FeO (wt%)	MnO (wt%)	MgO (wt%)	CaO (wt%)	Na2O (wt%)	K2O (wt%)	P2O5 (wt%)	S (ppm)	LOI
53	GC07	0.5 - 3.5	8.92	0.05	2.52	1.06	0.97	0.08	0.04	0.82	43.27	1.89	0.39	0.09	1000	40.75
	GC07	5.5 - 5.8	9.2	0.06	2.69	1.13	1.04	0.08	0.05	0.81	43.24	1.83	0.41	0.09	1000	40.32
	GC07	10.5 - 13.5	9.1	0.06	2.76	1.21	1.12	0.08	0.04	0.82	43.01	1.9	0.4	0.08	1000	40.45
	GC07	16.5 - 19.5	9.27	0.07	2.79	1.21	1.1	0.1	0.07	0.78	43.12	1.69	0.38	0.08	900	40.35
	GC07	21.5 - 24.5	7.53	0.05	2.06	0.89	0.77	0.11	0.11	0.66	45.47	1.69	0.39	0.08	900	40.82
	GC07	26.5 - 29.5	6.08	0.03	1.5	0.67	0.56	0.1	0.04	0.56	47.33	1.51	0.28	0.07	800	41.67
	GC07	31.5 - 34.5	5.56	0.01	1.21	0.56	0.45	0.1	0.09	0.54	47.58	1.53	0.19	0.07	900	42.41
	GC07	36.5 - 39.5	5.46	0	1.01	0.44	0.35	0.08	0.02	0.53	47.65	1.6	0.18	0.06	900	42.84
	GC07	41.5 - 44.5	7.37	0.01	1.27	0.56	0.46	0.09	0.01	0.52	46.21	1.58	0.21	0.06	900	42.01
	GC07	46.5 - 49.5	7.62	0.01	1.36	0.59	0.49	0.09	0.01	0.54	45.72	1.71	0.23	0.06	1000	41.95
	GC07	51.5 - 54.5	7.53	0.02	1.45	0.64	0.55	0.08	0.01	0.5	46.21	1.52	0.24	0.06	800	41.6
	GC07	56.5 - 59.5	9.27	0.04	1.53	1.52	1.42	0.09	0.03	0.7	44.17	1.72	0.32	0.06	900	40.49
	GC07	61.5 - 64.5	9.26	0.02	1.71	1.02	0.91	0.1	0.01	0.69	44.31	1.74	0.32	0.07	900	40.69
	GC07	66.5 - 69.5	8.78	0.03	1.75	0.66	0.54	0.11	0.01	0.61	44.98	1.68	0.29	0.07	900	40.97
	GC07	71.5 - 74.5	8.83	0.05	1.81	0.84	0.72	0.11	0.02	0.63	45.16	1.5	0.29	0.07	900	40.63
	GC07	77.5 - 80.5	7.97	0.03	1.68	0.66	0.52	0.13	0.01	0.59	45.51	1.79	0.35	0.07	900	41.16
	GC07	82.5 - 85.5	7.22	0.01	1.42	0.57	0.45	0.11	0.01	0.57	46.31	1.71	0.26	0.07	900	41.67
	GC07	87.5 - 90.5	7.17	0.02	1.33	0.58	0.46	0.11	0.01	0.57	46.4	1.63	0.22	0.07	900	41.81
	GC07	92.5 - 95.5	6.92	0.01	1.28	0.47	0.34	0.12	0.01	0.54	46.38	1.67	0.24	0.07	900	42.23
	GC07	96.5 - 99.5	8.15	0.02	1.47	0.72	0.58	0.13	0.02	0.61	45.35	1.92	0.31	0.08	1000	41.15
	GC07	104.5 - 107.5	8.76	0.03	1.7	0.74	0.58	0.14	0.02	0.61	44.92	2.14	0.44	0.08	1000	40.41
	GC07	114.5 - 117.5	10.02	0.05	1.81	1.35	1.21	0.13	0.02	0.73	43.6	1.78	0.33	0.08	1000	40.06
	GC07	124.5 - 127.5	9.6	0.05	1.88	0.68	0.54	0.13	0.02	0.62	44.02	1.94	0.34	0.07	1000	40.62
	GC07	134.5 - 137.5	10.49	0.06	9.99	1.09	0.97	0.11	0.02	0.86	43.36	2.06	0.6	0.08	1000	31.23
	GC07	144.5 - 147.5	10.8	0.06	2.46	1.1	0.97	0.12	0.02	0.7	42.72	1.65	0.38	0.08	900	39.82
	GC07	154.5 - 157.5	10.68	0.06	2.28	0.89	0.75	0.13	0.03	0.65	42.89	1.69	0.37	0.08	1000	40.21
	GC07	164.5 - 167.5	9.32	0.03	2.05	0.87	0.74	0.12	0.03	0.57	43.94	1.52	0.34	0.08	800	41.07
	GC07	174.5 - 177.5	7.36	0.03	1.83	0.69	0.55	0.13	0.03	0.55	44.71	1.47	0.29	0.08	1000	42.79
	GC07	184.5 - 187.5	10.07	0.06	2.26	0.8	0.68	0.11	0.03	0.62	44.91	1.61	0.34	0.08	1000	39.06
	GC07	194.5 - 197.5	7.38	0.04	1.73	0.8	0.68	0.11	0.03	0.58	45.58	1.48	0.28	0.08	900	41.85
	GC07	204.5 - 207.5	7.34	0.04	1.74	0.7	0.53	0.15	0.03	0.58	45.66	1.55	0.25	0.08	900	41.87
	GC07	214.5 - 217.5	5.74	0.01	1.25	0.61	0.51	0.09	0.04	0.49	47.41	1.5	0.21	0.07	1000	42.47
	GC07	224.5 - 227.5	5.21	0	1.16	0.5	0.38	0.11	0.04	0.48	48.18	1.31	0.21	0.07	800	42.62
	GC07	234.5 - 237.5	5.82	0.02	1.37	0.63	0.5	0.12	0.04	0.52	47.48	1.41	0.22	0.08	900	42.18
	GC07	244.5 - 247.5	7.19	0.04	1.78	0.82	0.68	0.13	0.04	0.58	46.05	1.41	0.28	0.07	900	41.51
	GC07	254.5 - 257.5	8.91	0.05	2.26	1.04	0.88	0.14	0.03	0.69	44.03	1.56	0.35	0.08	900	40.8
	GC07	264.5 - 267.5	10.29	0.09	2.66	1.11	0.91	0.18	0.03	0.85	42.69	1.69	0.41	0.08	900	39.97
	GC07	274.5 - 277.5	10.68	0.08	2.93	1.2	1.02	0.16	0.03	0.85	42.25	1.6	0.41	0.08	1200	39.76
	GC07	284.5 - 287.5	12.39	0.1	3.64	1.5	1.32	0.16	0.03	0.98	40.21	1.73	0.5	0.09	1000	38.7
	GC07	294.5 - 297.5	13.72	0.15	4.24	1.83	1.63	0.18	0.03	1.08	39.1	1.55	0.57	0.09	1000	37.49
	GC07	304.5 - 307.5	13.54	0.14	4	1.86	1.68	0.16	0.03	1.09	38.98	1.56	0.56	0.09	1100	38.03
	GC07	312.5 - 315.5	11.52	0.12	3.21	1.39	1.07	0.29	0.03	0.93	41.25	1.66	0.48	0.08	1000	39.2
	GC07	322.5 - 325.5	7.8	0.05	1.6	0.96	0.83	0.12	0.04	0.69	45.29	1.6	0.29	0.07	1000	41.44
	GC07	332.5 - 335.5	9.8	0.05	1.96	1.46	1.23	0.21	0.04	0.75	43.3	1.54	0.33	0.08	1700	40.53
	GC07	342.5 - 345.5	9.99	0.07	2.33	0.88	0.75	0.12	0.03	0.65	43.71	1.38	0.36	0.08	1100	40.28
	GC07	352.5 - 355.5	10.92	0.09	2.66	1.11	0.98	0.12	0.04	0.71	42.79	1.45	0.42	0.08	1100	39.52
	GC07	362.5 - 365.5	11.16	0.08	2.6	1.01	0.88	0.12	0.04	0.7	42.38	1.58	0.39	0.08	1100	39.77
	GC07	372.5 - 375.5	9.98	0.07	2.14	0.86	0.73	0.12	0.03	0.68	43.38	1.62	0.36	0.07	1100	40.65
	GC07	382.5 - 385.5	9.75	0.05	1.9	1.14	1.01	0.12	0.04	0.72	43.41	1.7	0.33	0.08	1300	40.74
	GC07	392.5 - 395.5	9.7	0.05	2.1	1.01	0.83	0.16	0.04	0.73	43.41	2.09	0.42	0.08	1100	40.2
	GC07	402.5 - 405.5	9.44	0.06	1.98	0.97	0.74	0.21	0.04	0.7	43.86	1.63	0.32	0.08	1000	40.75
	GC07	413.5 - 416.5	8.68	0.06	2.13	0.78	0.66	0.11	0.04	0.63	44.74	1.78	0.4	0.08	1100	40.48
	GC07	424.5 - 427.5	9.51	0.07	2.27	0.94	0.77	0.15	0.03	0.7	43.76	1.82	0.42	0.08	1200	40.22
	GC07	434.5 - 437.5	9.7	0.06	2.09	1.08	0.92	0.14	0.03	0.74	43.74	1.45	0.34	0.08	1100	40.54
	GC07	444.5 - 447.5	10.48	0.08	2.48	1.21	1.05	0.14	0.04	0.79	42.81	1.51	0.41	0.08	900	39.9
	GC07	454.5 - 457.5	10.94	0.09	2.99	1.13	0.85	0.25	0.03	0.83	42.26	1.48	0.48	0.08	900	39.48
	GC07	464.5 - 467.5	11.86	0.12	3.56	1.38	1.18	0.18	0.03	0.95	40.97	1.65	0.55	0.08	900	38.67
	GC07	474.5 - 477.5	11.28	0.11	3.35	1.3	1.14	0.14	0.03	0.93	41.65	1.5	0.49	0.09	900	39.09
	GC07	484.5 - 487.5	7.97	0.05	2.11	0.88	0.75	0.12	0.04	0.74	45.11	1.52	0.35	0.08	800	40.95
	GC07	494.5 - 497.5	8.55	0.06	2.22	1.1	0.97	0.12	0.04	0.8	44.41	1.52	0.36	0.07	800	40.68

Table11 (cont)

Survey	Core	Sample Depth (cm)	Ag (ppm)	As (ppm)	Ba (ppm)	Bi (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Cu (ppm)	Ga (ppm)	Ge (ppm)	Hf (ppm)	La (ppm)	Li (ppm)	Mn (ppm)	Mo (ppm)	Nb (ppm)
53	GC07	0.5 - 3.5	0	2.5	545	<2	8	0	16	5	25	3	<0.5	<2	9	0	432	<2	2
	GC07	5.5 - 5.8	0	2.5	373	<2	7	0	11	4	29	3	<0.5	<2	3	0	325	<2	<2
	GC07	10.5 - 13.5	0	3	336	<2	<5	0	11	9	21	3	<0.5	<2	2	0	277	<2	2
	GC07	16.5 - 19.5	0	1.5	386	<2	<5	0	11	<3	22	3	<0.5	<2	5	0	399	<2	2
	GC07	21.5 - 24.5	0	2	646	<2	13	0	12	8	24	2	<0.5	<2	5	0	926	<2	<2
	GC07	26.5 - 29.5	0	1.5	713	<2	6	0	7	7	18	1	<0.5	<2	7	0	440	<2	<2
	GC07	31.5 - 34.5	0	2	697	<2	6	0	6	8	19	2	<0.5	<2	9	0	939	<2	<2
	GC07	36.5 - 39.5	0	1	579	<2	<5	0	5	15	17	<1	<0.5	<2	7	0	229	<2	<2
	GC07	41.5 - 44.5	0	0.5	525	<2	<5	0	6	4	16	2	<0.5	<2	7	0	133	<2	<2
	GC07	46.5 - 49.5	0	0.5	604	<2	<5	0	6	8	19	<1	<0.5	<2	9	0	132	<2	<2
	GC07	51.5 - 54.5	0	1.5	759	<2	9	0	8	13	18	<1	<0.5	<2	13	0	222	<2	<2
	GC07	56.5 - 59.5	0	1	353	<2	<5	0	5	7	10	2	<0.5	<2	<2	0	183	<2	2
	GC07	61.5 - 64.5	0	2	358	<2	<5	0	6	6	21	2	0.5	<2	3	0	111	<2	<2
	GC07	66.5 - 69.5	0	2.5	420	<2	9	0	5	9	19	<1	<0.5	<2	5	0	134	<2	<2
	GC07	71.5 - 74.5	0	2.5	409	<2	6	0	7	4	13	2	<0.5	<2	5	0	153	<2	<2
	GC07	77.5 - 80.5	0	2.5	423	<2	13	0	7	4	17	<1	<0.5	2	<2	0	150	<2	<2
	GC07	82.5 - 85.5	0	3.5	434	<2	11	0	6	<3	13	1	<0.5	<2	5	0	167	<2	<2
	GC07	87.5 - 90.5	0	2.5	528	<2	<5	0	5	3	14	1	<0.5	<2	10	0	204	<2	<2
	GC07	92.5 - 95.5	0	3	437	<2	5	0	5	7	14	2	<0.5	<2	4	0	169	<2	<2
	GC07	96.5 - 99.5	0	4.5	524	<2	13	0	6	4	28	2	<0.5	<2	6	0	201	<2	<2
	GC07	104.5 - 107.5	0	3	357	<2	<5	0	6	<3	18	2	0.5	<2	6	0	159	<2	<2
	GC07	114.5 - 117.5	0	2.5	360	<2	6	0	6	5	17	2	<0.5	<2	<2	0	180	<2	<2
	GC07	124.5 - 127.5	0	2.5	322	<2	<5	0	6	<3	20	2	<0.5	<2	<2	0	164	<2	2
	GC07	134.5 - 137.5	0	3	323	<2	<5	0	8	9	15	2	<0.5	<2	4	0	208	<2	2
	GC07	144.5 - 147.5	0	2.5	629	<2	10	0	12	10	27	3	<0.5	<2	3	0	321	<2	<2
	GC07	154.5 - 157.5	0	3	363	<2	<5	0	10	8	27	2	<0.5	<2	5	0	231	<2	<2
	GC07	164.5 - 167.5	0	3	368	<2	9	0	8	<3	25	2	<0.5	<2	6	0	218	<2	<2
	GC07	174.5 - 177.5	0	2.5	328	<2	5	0	8	6	14	3	<0.5	<2	3	0	258	<2	<2
	GC07	184.5 - 187.5	0	3.5	269	<2	5	0	6	9	40	1	<0.5	<2	4	0	239	<2	<2
	GC07	194.5 - 197.5	0	4	292	<2	<5	0	7	7	23	<1	<0.5	<2	5	0	254	<2	2
	GC07	204.5 - 207.5	0	3.5	278	<2	8	0	5	7	27	2	<0.5	<2	7	0	261	<2	<2
	GC07	214.5 - 217.5	0	3.5	465	<2	10	0	7	9	35	2	<0.5	<2	7	0	426	<2	<2
	GC07	224.5 - 227.5	0	1	667	<2	<5	0	7	18	15	2	<0.5	<2	6	0	576	<2	<2
	GC07	234.5 - 237.5	0	2	769	<2	13	0	13	12	24	2	<0.5	<2	11	0	536	<2	<2
	GC07	244.5 - 247.5	0	1.5	787	<2	7	0	17	15	32	3	<0.5	<2	12	0	473	<2	3
	GC07	254.5 - 257.5	0	2.5	672	<2	6	0	16	8	25	2	<0.5	3	13	0	441	<2	<2
	GC07	264.5 - 267.5	0	2	200	<2	6	0	9	<3	17	3	<0.5	<2	3	0	187	<2	<2
	GC07	274.5 - 277.5	0	3	224	<2	<5	0	9	<3	38	3	<0.5	<2	3	0	179	<2	3
	GC07	284.5 - 287.5	0	3	216	<2	<5	0	10	3	17	3	<0.5	<2	2	0	161	<2	3
	GC07	294.5 - 297.5	0	2.5	319	<2	12	0	18	5	33	5	<0.5	<2	8	0	214	<2	3
	GC07	304.5 - 307.5	0	3	179	<2	<5	0	8	<3	22	4	<0.5	<2	<2	0	151	<2	3
	GC07	312.5 - 315.5	0	2	225	<2	9	0	12	6	24	4	0.5	<2	<2	0	186	<2	<2
	GC07	322.5 - 325.5	0	2.5	358	<2	13	0	4	<3	31	1	<0.5	<2	3	0	259	<2	<2
	GC07	332.5 - 335.5	0	3	539	<2	7	0	12	9	20	3	<0.5	<2	8	0	392	<2	<2
	GC07	342.5 - 345.5	0	2	860	<2	10	0	16	10	29	3	<0.5	<2	13	0	480	<2	2
	GC07	352.5 - 355.5	0	1.5	659	<2	13	0	16	4	24	1	<0.5	<2	7	0	404	<2	2
	GC07	362.5 - 365.5	0	1.5	603	<2	10	0	13	10	26	2	<0.5	<2	10	0	401	<2	3
	GC07	372.5 - 375.5	0	2	297	<2	7	0	9	6	23	1	<0.5	<2	7	0	228	<2	<2
	GC07	382.5 - 385.5	0	2.5	234	<2	8	0	8	5	24	3	1	<2	<2	0	198	<2	<2
	GC07	392.5 - 395.5	0	2.5	505	<2	12	0	10	6	17	2	<0.5	<2	8	0	361	<2	2
	GC07	402.5 - 405.5	0	2	350	<2	9	0	9	<3	28	2	<0.5	<2	5	0	290	<2	2
	GC07	413.5 - 416.5	0	1.5	580	<2	10	0	11	13	16	2	<0.5	<2	4	0	384	<2	2
	GC07	424.5 - 427.5	0	2.5	495	<2	9	0	15	7	29	3	<0.5	<2	6	0	307	<2	2
	GC07	434.5 - 437.5	0	3.5	330	<2	<5	0	8	<3	32	2	<0.5	2	5	0	247	<2	3
	GC07	444.5 - 447.5	0	2.5	570	<2	8	0	14	10	41	3	0.5	<2	10	0	358	<2	3
	GC07	454.5 - 457.5	0	2	716	<2	5	0	20	7	21	4	<0.5	<2	9	0	393	<2	3
	GC07	464.5 - 467.5	0	2	413	<2	9	0	19	7	18	4	<0.5	<2	4	0	285	<2	4
	GC07	474.5 - 477.5	0	2	431	<2	<5	0	19	10	18	3	<0.5	<2	4	0	265	<2	4
	GC07	484.5 - 487.5	0	1.5	486	<2	<5	0	12	9	14	1	<0.5	<2	10	0	350	<2	<2
	GC07	494.5 - 497.5	0	1	361	<2	<5	0	11	4	18	3	<0.5	<2	<2	0	324	<2	2

Nd (ppm)	Ni (ppm)	Pb (ppm)	Pr (ppm)	Rb (ppm)	Sc (ppm)	Se (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	Th (ppm)	U (ppm)	V (ppm)	W (ppm)	Y (ppm)	Zn (ppm)	Zr (ppm)
8	14	22	<2	8	17	<1	<2	1225	5	<2	<0.5	18	5	18	27	29
4	12	6	6	9	11	<1	<2	1221	<2	2	<0.5	8	<3	17	24	31
<2	12	5	4	10	8	<1	<2	1240	<2	3	1	9	6	16	23	32
2	21	7	<2	9	12	<1	<2	1377	<2	2	<0.5	8	<3	17	24	35
7	16	5	<2	6	14	<1	<2	1602	<2	<2	1	11	<3	17	23	29
7	6	3	4	3	12	<1	<2	1630	3	<2	1	13	4	16	21	27
11	11	3	<2	<1	16	<1	<2	1591	<2	<2	1	9	4	18	20	24
8	1	4	<2	<1	13	<1	<2	1433	<2	<2	1.5	6	<3	17	15	25
8	1	5	3	<1	12	<1	<2	1313	<2	<2	<0.5	5	5	19	16	35
5	3	7	3	1	13	<1	<2	1264	3	2	<0.5	9	7	20	18	30
5	4	4	4	3	12	<1	<2	1265	<2	<2	<0.5	8	<3	21	19	25
<2	4	6	4	3	7	<1	<2	1101	<2	<2	<0.5	5	6	19	19	26
3	6	9	2	6	7	2	<2	1154	3	<2	2.5	13	5	20	20	29
5	6	12	<2	5	9	<1	<2	1170	2	3	4	8	4	18	23	28
7	8	11	2	6	8	<1	<2	1200	<2	3	3.5	9	<3	19	20	29
9	6	11	<2	6	8	<1	<2	1254	<2	<2	1.5	11	<3	18	20	29
4	4	11	<2	4	10	<1	3	1274	<2	<2	1.5	5	<3	17	20	27
3	5	10	<2	3	11	<1	<2	1272	<2	3	2.5	9	5	17	24	26
4	5	13	<2	2	8	<1	<2	1265	<2	2	1.5	7	<3	18	20	24
5	8	46	<2	4	9	<1	<2	1275	<2	2	1.5	12	7	18	72	28
5	7	14	<2	6	5	<1	<2	1215	<2	<2	1.5	7	<3	16	21	26
3	14	11	<2	6	8	<1	<2	1215	<2	<2	1.5	9	4	17	27	30
<2	9	15	<2	7	8	<1	<2	1201	3	<2	3	6	<3	15	25	33
7	13	14	<2	9	7	<1	<2	1172	<2	3	2	10	6	19	27	36
8	22	7	5	8	17	<1	<2	1179	3	2	1.5	25	5	23	33	36
7	17	15	3	9	7	<1	<2	1205	<2	2	1.5	9	4	24	30	33
5	12	13	<2	9	9	<1	<2	1226	5	3	2.5	10	<3	23	26	33
4	9	12	8	9	10	<1	<2	1234	<2	2	1.5	14	<3	19	21	31
10	12	13	<2	6	6	<1	<2	1243	<2	<2	1	8	5	17	25	27
3	10	78	3	6	6	<1	<2	1245	<2	<2	1.5	9	5	17	24	27
4	10	14	2	6	7	<1	<2	1255	<2	3	1	8	5	19	21	27
9	10	5	4	3	17	<1	<2	1315	4	<2	2	15	3	18	26	20
5	6	5	4	2	14	<1	<2	1354	<2	<2	1	12	<3	16	20	18
17	16	5	4	7	15	<1	<2	1297	4	<2	2	21	6	17	25	26
8	20	5	<2	7	15	<1	<2	1213	<2	<2	0.5	22	<3	19	28	31
9	20	6	<2	8	15	<1	<2	1203	<2	<2	1	17	4	19	28	31
3	10	12	4	11	5	<1	<2	1125	4	2	1.5	6	<3	20	24	34
4	12	16	<2	13	4	<1	<2	1088	3	<2	<0.5	7	<3	18	29	34
3	10	15	<2	16	5	<1	<2	1069	<2	3	<0.5	6	<3	19	24	40
5	17	18	<2	21	5	<1	<2	1083	<2	4	<0.5	14	4	18	33	41
3	12	17	<2	20	5	<1	<2	1079	3	3	<0.5	9	<3	18	28	41
<2	15	12	2	14	7	<1	<2	1136	<2	<2	<0.5	11	3	16	29	37
4	14	8	<2	5	8	<1	<2	1212	<2	<2	1	10	<3	16	25	25
7	21	5	3	8	9	<1	<2	1181	<2	3	2.5	12	<3	18	26	30
14	22	6	3	11	14	1	<2	1235	2	3	5.5	30	5	20	35	35
9	21	7	6	13	12	<1	<2	1184	<2	3	4	24	3	20	39	38
15	20	8	3	12	12	<1	<2	1199	<2	2	2	19	5	21	37	37
4	14	10	<2	8	8	<1	<2	1147	4	3	1.5	10	8	20	27	30
3	17	13	3	7	8	<1	<2	1139	3	<2	1	6	7	19	28	30
6	15	10	<2	6	10	<1	<2	1135	<2	2	2	17	<3	19	24	31
3	24	10	<2	7	9	2	<2	1228	<2	<2	3.5	11	5	19	42	31
8	14	9	6	7	10	<1	<2	1227	3	<2	1.5	10	<3	19	32	31
9	30	8	4	9	11	<1	<2	1239	2	<2	1	19	<3	22	34	34
<2	21	10	<2	8	9	<1	<2	1198	3	<2	1	9	6	20	29	31
6	33	7	<2	12	14	<1	<2	1268	4	2	2	23	6	23	36	35
10	18	7	<2	15	14	<1	<2	1257	<2	2	1	26	4	22	31	38
5	17	7	4	18	13	<1	<2	1197	6	3	1	15	<3	21	27	41
7	15	9	<2	18	12	<1	<2	1238	<2	4	1	17	7	21	30	36
4	8	7	<2	10	11	1	<2	1317	5	2	1	12	3	17	21	24
7	14	6	<2	10	10	<1	<2	1354	<2	3	<0.5	8	<3	16	27	23

Table 12 Major and trace element analyses for core 57GC04

Survey	Core	Depth (cm)	SiO2 (wt%)	TiO2 (wt%)	Al2O3 (wt%)	Fe2O3t (wt%)	Fe2O3 (wt%)	FeO (wt%)	MnO (wt%)	MgO (wt%)	CaO (wt%)	Na2O (wt%)	K2O (wt%)	P2O5 (wt%)	LOI
57	GC04	10-13	7.11	0.03	1.34	0.62	0.54	0.07	0	1.24	46.45	1.14	0.22	0.08	41.7
	GC04	20-23	6.78	0.03	1.47	0.54	0.44	0.09	0	1.22	46.63	1.11	0.25	0.08	41.81
	GC04	30-33	5.31	0	0.89	0.32	0.22	0.09	0	1.34	47.88	1.03	0.16	0.08	42.89
	GC04	40-43	2.78	0	0.26	0.18	0.12	0.05	0	1.35	50.29	0.99	0.07	0.07	43.96
	GC04	50-53	2.71	0	0.25	0.17	0.11	0.05	0	1.18	50.67	0.99	0.07	0.07	43.83
	GC04	60-63	3.24	0	0.4	0.19	0.13	0.05	0	1.09	50.43	0.99	0.09	0.1	43.41
	GC04	70-73	3.19	0	0.42	0.18	0.08	0.09	0	1.06	50.41	0.96	0.09	0.11	43.52
	GC04	80-83	3.12	0	0.46	0.2	0.12	0.07	0	1.13	50.26	0.96	0.09	0.09	43.62
	GC04	90-93	3.6	0	0.48	0.18	0.09	0.08	0	1.02	50.12	0.99	0.1	0.09	43.33
	GC04	100-103	4.14	0	0.6	0.22	0.13	0.08	0	0.96	49.89	0.97	0.11	0.1	42.93
	GC04	110-113	4.19	0	0.6	0.34	0.25	0.08	0	0.97	49.83	1.02	0.13	0.09	42.76
	GC04	120-123	4.32	0	0.63	0.26	0.16	0.09	0	1.06	49.51	0.99	0.14	0.09	42.93
	GC04	140-143	5.48	0.02	0.93	0.41	0.32	0.08	0	1.12	48.56	0.99	0.19	0.08	42.14
	GC04	160-163	9.41	0.09	2.53	0.89	0.75	0.13	0	1.13	44.69	1.05	0.38	0.11	39.64
	GC04	180-183	5.71	0.04	1.52	0.53	0.43	0.09	0	1.16	47.63	1.06	0.24	0.09	41.95
	GC04	200-203	3.02	0	0.34	0.21	0.13	0.07	0	1.08	50.42	1.03	0.09	0.07	43.67
	GC04	220-223	4.22	0	0.64	0.24	0.16	0.07	0	1.18	50.35	0.99	0.11	0.09	42.11
	GC04	240-243	4.28	0	0.69	0.27	0.19	0.07	0	1.01	49.85	0.99	0.14	0.09	42.61
	GC04	260-263	4.8	0	0.78	0.27	0.19	0.07	0	0.86	49.49	0.95	0.14	0.09	42.55
	GC04	280-283	5.61	0.02	1.14	0.42	0.32	0.09	0	0.83	48.7	0.98	0.19	0.09	41.95
	GC04	300-303	4.79	0.01	0.73	0.3	0.18	0.11	0	0.89	49.53	0.91	0.14	0.08	42.54
	GC04	320-323	5.55	0.02	1.01	0.34	0.26	0.07	0	0.87	48.98	0.94	0.17	0.08	41.95
	GC04	340-343	2.77	0	0.37	0.19	0.11	0.07	0	0.69	51.42	0.9	0.08	0.1	43.44
	GC04	375-378	2.87	0	0.4	0.2	0.12	0.07	0	0.62	51.5	0.9	0.1	0.08	43.3
	GC04	400-403	3.45	0	0.49	0.25	0.17	0.07	0	0.66	51.21	0.89	0.1	0.09	42.81
	GC04	425-428	7.68	0.05	1.82	0.64	0.52	0.11	0	0.84	47.03	0.97	0.28	0.1	40.53

Table 12 (cont)

Survey	Core	Sample Depth (cm)	Ag (ppm)	As (ppm)	Ba (ppm)	Bi (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Cu (ppm)	Ga (ppm)	Ge (ppm)	Hf (ppm)	La (ppm)	Li (ppm)	Mn (ppm)	Mo (ppm)	Nb (ppm)
57	GC04	10-13	2	<0.5	165	<2	11	4	24	0	8	<1	0.5	<2	15	8	72	7	3
	GC04	20-23	2	1	182	<2	7	5	27	0	9	2	<0.5	<2	12	10	76	5	3
	GC04	30-33	2	1	180	2	18	4	20	0	7	1	0.5	<2	8	7	58	8	3
	GC04	40-43	2	0.5	90	2	<5	3	10	0	3	<1	<0.5	<2	12	5	43	6	<2
	GC04	50-53	2	0.5	87	<2	9	4	15	0	4	<1	<0.5	<2	12	5	44	6	<2
	GC04	60-63	2	<0.5	102	<2	16	5	16	0	4	<1	<0.5	<2	14	5	71	5	<2
	GC04	70-73	2	<0.5	109	<2	8	4	13	0	4	<1	<0.5	<2	7	5	82	7	<2
	GC04	80-83	2	<0.5	110	2	<5	4	21	0	4	1	<0.5	<2	5	5	67	6	<2
	GC04	90-93	2	1	128	3	<5	4	19	0	5	<1	<0.5	<2	13	5	74	6	<2
	GC04	100-103	2	0.5	131	<2	17	3	20	0	5	<1	<0.5	<2	13	5	77	6	<2
	GC04	110-113	2	1	137	<2	9	4	22	0	5	<1	<0.5	<2	7	6	69	8	<2
	GC04	120-123	2	<0.5	140	3	11	3	16	0	5	<1	<0.5	<2	10	6	63	4	3
	GC04	140-143	2	1	108	2	18	3	20	0	6	<1	<0.5	<2	17	8	73	5	<2
	GC04	160-163	3	1.5	226	<2	15	4	41	0	9	3	0.5	<2	23	15	114	6	<2
	GC04	180-183	2	2	122	<2	16	3	29	0	6	2	0.5	<2	10	10	80	6	<2
	GC04	200-203	2	<0.5	98	<2	12	3	14	0	4	<1	<0.5	<2	19	5	64	6	2
	GC04	220-223	2	0.5	97	2	9	3	17	0	6	<1	<0.5	<2	9	6	70	6	3
	GC04	240-243	2	0.5	119	<2	9	3	19	0	5	<1	<0.5	<2	12	6	72	7	<2
	GC04	260-263	2	<0.5	124	2	8	4	17	0	8	<1	<0.5	<2	7	6	72	7	<2
	GC04	280-283	2	0.5	153	2	17	3	27	0	8	<1	<0.5	<2	11	9	80	7	<2
	GC04	300-303	2	<0.5	147	<2	8	8	22	0	6	<1	<0.5	<2	17	6	73	4	<2
	GC04	320-323	2	1	143	<2	13	8	23	0	6	<1	<0.5	<2	14	6	75	6	<2
	GC04	340-343	2	<0.5	90	<2	9	8	20	0	5	<1	<0.5	<2	15	4	72	8	<2
	GC04	375-378	2	0.5	116	<2	8	7	13	0	5	<1	<0.5	<2	13	4	57	7	<2
	GC04	400-403	2	0.5	108	<2	<5	8	15	0	5	<1	<0.5	<2	8	5	84	6	2
	GC04	425-428	3	1	196	<2	17	9	31	0	10	<1	<0.5	<2	16	12	88	6	<2

Survey	Core	Sample Depth (cm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Pr (ppm)	Rb (ppm)	S (ppm)	Sc (ppm)	Se (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	Th (ppm)	U (ppm)	V (ppm)	W (ppm)	Y (ppm)	Zn (ppm)	Zr (ppm)
57	GC04	10-13	14	10	40	0	4	1000	9	<1	3	1811	<2	<2	0.5	21	<3	10	16	31
	GC04	20-23	14	14	<20	0	5	1000	11	2	6	1731	2	<2	2	30	<3	9	17	28
	GC04	30-33	13	10	<20	0	2	1100	4	<1	6	1879	<2	<2	3	18	<3	9	13	21
	GC04	40-43	11	5	<2	0	<1	1000	3	<1	6	2003	<2	<2	2	4	<3	7	8	16
	GC04	50-53	5	6	<20	0	<1	1000	2	<1	6	1970	<2	<2	1.5	10	<3	7	8	11
	GC04	60-63	9	7	<2	0	<1	1000	<1	<1	7	1997	<2	<2	4.5	14	<3	8	8	22
	GC04	70-73	9	7	<2	0	<1	900	6	<1	5	2071	<2	<2	5.5	12	<3	7	10	20
	GC04	80-83	8	6	<2	0	<1	1000	5	<1	5	2125	<2	<2	2	12	<3	6	8	19
	GC04	90-93	8	6	<20	0	<1	900	<1	<1	6	2043	3	<2	3	10	<3	7	9	18
	GC04	100-103	12	6	<20	0	<1	900	<1	<1	5	1979	<2	<2	2	7	<3	8	9	18
	GC04	110-113	4	7	<20	0	<1	900	6	<1	6	1985	<2	<2	2	15	<3	8	11	19
	GC04	120-123	10	7	30	0	<1	900	3	<1	5	2088	2	<2	2	17	<3	8	10	23
	GC04	140-143	17	6	<20	0	3	1000	6	<1	4	2089	<2	<2	2	17	<3	9	11	32
	GC04	160-163	14	15	3	0	13	900	10	<1	7	1727	2	<2	2.5	25	<3	11	25	38
	GC04	180-183	14	12	<20	0	6	900	5	<1	7	1810	<2	<2	2	24	<3	9	17	25
	GC04	200-203	10	8	<2	0	<1	1000	<1	<1	7	1994	<2	<2	3.5	9	<3	8	9	19
	GC04	220-223	11	8	<2	0	<1	1000	<1	<1	5	2000	2	<2	4	13	<3	8	9	15
	GC04	240-243	14	6	<2	0	<1	900	3	<1	7	1939	3	<2	2.5	13	<3	10	11	27
	GC04	260-263	11	9	<2	0	<1	900	<1	<1	5	1865	<2	<2	1.5	17	<3	8	12	25
	GC04	280-283	10	9	<20	0	3	900	2	<1	8	1710	2	<2	2.5	16	<3	8	15	27
	GC04	300-303	16	8	<20	0	2	900	<1	<1	4	1940	3	<2	2.5	14	<3	9	11	23
	GC04	320-323	12	9	<2	0	2	900	3	<1	6	1883	<2	<2	2	15	<3	8	13	33
	GC04	340-343	8	5	<20	0	<1	700	<1	<1	5	1757	<2	<2	2	11	<3	6	9	14
	GC04	375-378	12	7	<2	0	<1	700	3	<1	7	1824	3	<2	2	8	<3	7	9	14
	GC04	400-403	13	6	<2	0	<1	700	<1	<1	4	1636	3	<2	1	10	<3	8	8	15
	GC04	425-428	6	13	<2	0	8	800	9	<1	3	1564	<2	<2	3.5	27	<3	9	19	31

Table 13 Major and trace element analyses for core 57GC12

Survey	Core	Sample Depth (cm)	SiO2 (wt%)	TiO2 (wt%)	Al2O3 (wt%)	Fe2O3t (wt%)	Fe2O3 (wt%)	FeO (wt%)	MnO (wt%)	MgO (wt%)	CaO (wt%)	Na2O (wt%)	K2O (wt%)	P2O5 (wt%)	LOI
57	GC012	3-6	10.3	0.03	1.44	0.55	0.44	0.1	0.05	0.78	44.98	1.26	0.22	0.08	40.22
		6-9	10.33	0.03	1.46	0.52	0.45	0.06	0.01	0.78	45.06	1.22	0.21	0.08	40.2
		9-12	9.99	0.04	1.5	0.54	0.44	0.09	0.02	0.81	45.21	1.19	0.21	0.08	40.34
		12-15	9.89	0.03	1.58	0.57	0.51	0.05	0.01	0.81	45.18	1.15	0.23	0.08	40.39
		18-21	9.57	0.05	1.77	0.6	0.52	0.07	0	0.89	45.17	1.2	0.27	0.08	40.33
		28-31	10.47	0.06	2.33	0.75	0.67	0.07	0	1.06	43.74	1.3	0.36	0.08	39.76
		40-43	6.73	0.01	1.08	0.39	0.3	0.08	0	1.44	46.65	1.11	0.2	0.08	42.19
		50-53	4.2	0	0.27	0.14	0.06	0.07	0	1.27	49.51	1.05	0.07	0.08	43.33
		60-63	5.47	0	0.26	0.2	0.12	0.07	0	1.17	48.96	1.01	0.07	0.08	40.72
		70-73	5.59	0	0.33	0.15	0.09	0.05	0	1.04	48.84	1.05	0.08	0.07	42.78
		80-83	5.19	0	0.38	0.16	0.09	0.06	0	1.04	48.91	1.04	0.08	0.07	43.04
		100-103	4.74	0	0.38	0.14	0.06	0.07	0	0.96	49.37	1.05	0.08	0.07	43.17
		120-123	4.95	0	0.22	0.15	0.09	0.05	0	1.05	49.26	1.02	0.06	0.08	43.13

Table 13 (cont)

Survey	Core	Sample Depth (cm)	Ag (ppm)	As (ppm)	Ba (ppm)	Bi (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Cu (ppm)	Ga (ppm)	Ge (ppm)	Hf (ppm)	La (ppm)	Li (ppm)	Mn (ppm)
57	GC012	3-6	2	1.5	415	3	7	8	22	0	15	2	<0.5	<2	22	9	893
	GC012	6-9	2	1.5	405	<2	8	6	24	0	13	<1	<0.5	<2	18	8	217
	GC012	9-12	2	1	424	<2	11	9	26	0	14	1	0.5	<2	12	8	438
	GC012	12-15	2	1	432	2	17	9	23	0	14	2	1	<2	16	9	310
	GC012	18-21	2	0.5	420	<2	19	6	27	0	16	2	<0.5	<2	10	10	174
	GC012	28-31	2	1.5	467	<2	21	7	33	0	18	3	<0.5	<2	10	13	162
	GC012	40-43	2	1	366	<2	18	7	20	0	13	2	0.5	<2	12	9	153
	GC012	50-53	2	0.5	387	<2	13	6	7	0	6	<1	<0.5	<2	9	5	227
	GC012	60-63	2	<0.5	320	<2	<5	4	4	0	6	<1	<0.5	<2	16	4	151
	GC012	70-73	2	0.5	374	<2	7	5	15	0	8	<1	<0.5	<2	16	5	96
	GC012	80-83	2	<0.5	333	<2	<5	4	11	0	7	<1	<0.5	<2	11	5	84
	GC012	100-103	2	<0.5	314	<2	16	4	11	0	7	<1	<0.5	<2	12	5	78
	GC012	120-123	2	0.5	232	<2	11	3	10	0	9	<1	<0.5	<2	18	4	101

Survey	Core	Sample Depth (cm)	Mo (ppm)	Nb (ppm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Pr (ppm)	Rb (ppm)	S (ppm)	Sc (ppm)	Se (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	Th (ppm)	U (ppm)
57	GC012	3-6	5	<2	11	24	4	0	2	1000	10	<1	4	1921	<2	<2	<0.5
	GC012	6-9	8	<2	12	11	4	0	4	1000	14	<1	5	1946	<2	<2	1
	GC012	9-12	6	<2	15	14	5	0	4	900	9	<1	6	1893	<2	<2	<0.5
	GC012	12-15	5	<2	12	11	3	0	5	900	5	<1	3	1874	<2	<2	0.5
	GC012	18-21	6	3	16	11	3	0	6	900	12	<1	4	1861	<2	<2	1.5
	GC012	28-31	5	3	12	17	3	0	9	1000	11	<1	6	1858	<2	<2	1.5
	GC012	40-43	7	<2	15	11	<2	0	3	1100	7	<1	4	1987	<2	<2	2.5
	GC012	50-53	5	4	10	6	<2	0	<1	1000	3	<1	3	1985	<2	<2	2
	GC012	60-63	6	<2	11	2	2	0	<1	1000	<1	<1	4	2143	2	<2	1
	GC012	70-73	5	<2	8	8	<2	0	<1	1000	8	<1	5	2231	<2	<2	2.5
	GC012	80-83	5	<2	11	8	<2	0	<1	1000	<1	<1	8	2213	3	<2	3
	GC012	100-103	5	<2	16	7	3	0	<1	1000	<1	<1	5	2199	<2	<2	1.5
	GC012	120-123	5	<2	15	5	<2	0	<1	1000	3	<1	5	2110	<2	<2	1.5

Survey	Core	Sample Depth (cm)	V (ppm)	W (ppm)	Y (ppm)	Zn (ppm)	Zr (ppm)
57	GC012	3-6	20	<3	12	18	27
	GC012	6-9	15	<3	12	16	26
	GC012	9-12	20	<3	12	18	30
	GC012	12-15	16	<3	11	20	23
	GC012	18-21	23	<3	12	19	31
	GC012	28-31	28	<3	12	22	35
	GC012	40-43	13	<3	12	16	20
	GC012	50-53	9	<3	12	9	14
	GC012	60-63	4	<3	13	10	14
	GC012	70-73	10	<3	14	11	17
	GC012	80-83	4	<3	15	9	16
	GC012	100-103	7	<3	14	10	17
	GC012	120-123	6	<3	13	7	9

Table 14 Major and trace element analyses for core 57GC015

Survey	Core	Depth (cm)	SiO2 (wt%)	TiO2 (wt%)	Al2O3 (wt%)	Fe2O3t (wt%)	Fe2O3 (wt%)	FeO (wt%)	MnO (wt%)	MgO (wt%)	CaO (wt%)	Na2O (wt%)	K2O (wt%)	P2O5 (wt%)	LOI
57	GC015	6-9	9.69	0.06	2.04	0.72	0.64	0.07	0.02	0.64	45.3	1.1	0.28	0.07	40
	GC015	12-15	8.09	0.02	1.5	0.55	0.43	0.11	0.01	0.59	46.84	1.13	0.22	0.07	40.91
	GC015	18-21	5.34	0	0.58	0.25	0.09	0.14	0.01	0.5	49.76	1	0.11	0.06	42.34
	GC015	24-27	5.06	0	0.53	0.24	0.24	0	0.01	0.38	50.14	0.95	0.1	0.05	42.48
	GC015	30-33	5.15	0	0.62	0.28	0.28	0	0.02	0.41	50.24	0.97	0.1	0.05	42.1
	GC015	40-44	4.63	0	0.53	0.24	0.24	0	0.03	0.43	50.3	0.91	0.09	0.05	42.73
	GC015	50-53	5.45	0	0.74	0.33	0.33	0	0.01	0.45	49.73	0.94	0.13	0.06	42.1
	GC015	60-63	5.76	0	0.9	0.34	0.22	0.11	0	0.44	49.53	1.01	0.14	0.06	41.76
	GC015	70-73	5.44	0	0.79	0.31	0.22	0.08	0	0.43	49.7	0.97	0.13	0.06	42.1
	GC015	80-83	6.19	0.02	1.07	0.39	0.3	0.08	0	0.47	49.12	0.96	0.16	0.07	41.5
	GC015	101-104	11.8	0.12	3.35	1.24	1.14	0.09	0	0.78	42.75	1.07	0.44	0.08	38.3
	GC015	110-113	8.82	0.06	2.08	0.78	0.69	0.08	0	0.62	45.96	1.06	0.31	0.07	40.18
	GC015	120-123	6.4	0.02	0.91	0.63	0.56	0.06	0.01	0.5	48.86	0.97	0.16	0.06	41.44
	GC015	140-143	5.84	0.01	0.97	0.34	0.25	0.08	0	0.55	49.33	0.92	0.16	0.06	41.74
	GC015	160-163	9.22	0.05	1.62	0.64	0.54	0.09	0.01	0.58	46.69	0.99	0.25	0.06	39.83
	GC015	180-183	6.37	0.01	1.01	0.35	0.23	0.11	0.01	0.51	49.4	0.88	0.16	0.06	41.2
	GC015	200-203	4.8	0	0.66	0.22	0.14	0.07	0.01	0.43	50.55	0.95	0.11	0.06	42.18
	GC015	220-223	5.01	0	0.64	0.35	0.23	0.11	0	0.44	50.16	0.92	0.13	0.06	42.25

Table 14 (cont)

Survey	Core	Sample depth (cm)	Ag (ppm)	As (ppm)	Ba (ppm)	Bi (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Cu (ppm)	Ga (ppm)	Ge (ppm)	Hf (ppm)	La (ppm)	Li (ppm)	Mn (ppm)	Mo (ppm)	Nb (ppm)
57	GC15	6-9	3	2	536	<2	9	5	23	0	25	2	<0.5	<2	9	11	376	6	<2
	GC15	12-15	3	1.5	632	<2	23	4	20	0	21	2	<0.5	<2	18	9	323	7	<2
	GC15	18-21	3	1	495	<2	15	4	8	0	12	<1	<0.5	<2	13	5	286	7	3
	GC15	24-27	3	0.5	550	<2	21	3	5	0	10	<1	<0.5	<2	25	5	377	7	<2
	GC15	30-33	3	1	524	2	24	4	8	0	12	<1	<0.5	<2	22	5	482	7	3
	GC15	40-44	3	<0.5	438	<2	10	5	11	0	15	<1	<0.5	<2	15	5	593	9	<2
	GC15	50-53	3	<0.5	382	<2	26	9	11	0	16	<1	<0.5	<2	19	6	370	6	<2
	GC15	60-63	3	<0.5	374	2	12	5	16	0	16	<1	<0.5	<2	14	6	133	6	<2
	GC15	70-73	3	0.5	436	<2	11	2	13	0	15	<1	<0.5	<2	17	5	159	6	<2
	GC15	80-83	2	1	466	<2	14	<2	19	0	15	<1	<0.5	<2	8	6	227	7	<2
	GC15	101-104	3	2	635	<2	12	4	42	0	31	4	0.5	<2	20	16	207	6	4
	GC15	110-113	3	1	511	<2	27	2	26	0	28	3	1	<2	21	12	216	7	<2
	GC15	120-123	2	<0.5	496	<2	22	3	15	0	16	1	<0.5	<2	19	6	309	6	<2
	GC15	140-143	3	0.5	465	<2	5	3	18	0	12	2	<0.5	<2	12	7	260	8	<2
	GC15	160-163	3	1	499	<2	21	3	19	0	27	2	<0.5	<2	11	10	249	6	3
	GC15	180-183	2	0.5	484	2	11	2	16	0	19	1	<0.5	<2	27	6	315	7	<2
	GC15	200-203	2	1	478	<2	9	2	13	0	12	<1	<0.5	<2	21	5	282	7	<2
	GC15	220-223	3	0.5	455	<2	17	3	7	0	11	<1	<0.5	<2	16	5	221	8	<2

Survey	Core	Sample depth (cm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Pr (ppm)	Rb (ppm)	S (ppm)	Sc (ppm)	Se (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	Th (ppm)	U (ppm)	V (ppm)	W (ppm)	Y (ppm)	Zn (ppm)	Zr (ppm)
57	GC15	6-9	10	19	2	0	8	800	11	<1	3	1654	<2	<2	1	17	<3	14	21	37
	GC15	12-15	12	14	<2	0	5	800	8	<1	3	1843	<2	<2	<0.5	11	<3	14	19	29
	GC15	18-21	17	9	<2	0	<1	700	8	<1	4	1934	<2	<2	1	11	<3	15	13	28
	GC15	24-27	20	15	<2	0	<1	700	6	<1	3	1778	3	<2	<0.5	4	<3	17	11	20
	GC15	30-33	21	18	<2	0	<1	700	2	<1	4	1664	3	<2	1	10	<3	18	12	16
	GC15	40-44	14	14	4	0	<1	700	5	<1	6	1660	3	<2	<0.5	9	<3	16	14	18
	GC15	50-53	23	8	4	0	<1	700	6	<1	5	1628	2	<2	0.5	13	<3	18	14	23
	GC15	60-63	15	7	2	0	<1	700	10	<1	5	1614	4	<2	<0.5	9	<3	17	15	23
	GC15	70-73	13	5	<2	0	<1	700	2	<1	3	1641	<2	<2	1	7	<3	17	13	21
	GC15	80-83	11	6	<2	0	2	700	3	<1	4	1644	<2	<2	<0.5	15	<3	15	16	24
	GC15	101-104	10	19	4	0	17	800	14	<1	5	1416	<2	2	<0.5	30	<3	16	30	49
	GC15	110-113	20	12	4	0	9	700	13	<1	6	1594	3	<2	<0.5	24	<3	17	24	32
	GC15	120-123	24	8	4	0	1	600	7	<1	7	1362	<2	<2	0.5	13	<3	18	15	17
	GC15	140-143	17	8	<2	0	2	700	6	<1	5	1630	<2	<2	1.5	14	<3	17	14	23
	GC15	160-163	18	13	3	0	6	700	7	<1	7	1338	5	<2	1	16	<3	16	20	27
	GC15	180-183	15	7	3	0	2	600	6	<1	5	1393	2	<2	<0.5	16	<3	19	18	24
	GC15	200-203	24	9	<2	0	<1	600	<1	<1	5	1396	2	<2	<0.5	8	<3	16	9	19
	GC15	220-223	21	7	<2	0	<1	600	4	<1	5	1439	4	<2	2.5	17	<3	20	13	19

Table 15 Major and trace element analyses for core 57GC019

Survey	Core	Sample Depth cm	TiO2 (wt%)	Al2O3 (wt%)	Fe2O3t (wt%)	Fe2O3 (wt%)	FeO (wt%)	MnO (wt%)	MgO (wt%)	CaO (wt%)	Na2O (wt%)	K2O (wt%)	P2O5 (wt%)	LOI
57	GC019	8.5	0.05	2.26	0.86	0.78	0.07	0.03	0.67	44.79	1.35	0.3	0.08	40.91
		7.84	0.03	2.14	0.81	0.65	0.14	0.02	0.67	45.05	1.44	0.29	0.08	41.43
		6.01	0.01	1.38	0.53	0.43	0.09	0.02	0.55	47.19	1.33	0.22	0.07	42.46
		6.12	0.01	1.35	0.52	0.42	0.09	0.02	0.56	47.13	1.4	0.22	0.07	42.36
		4.11	0	0.59	0.26	0.17	0.08	0.03	0.43	49.57	1.23	0.12	0.06	43.35
		4.78	0	0.63	0.29	0.18	0.1	0.08	0.41	49.45	1.21	0.12	0.06	42.72
		5.17	0	1.18	0.31	0.2	0.1	0.04	0.43	48.96	1.22	0.13	0.06	42.24
		5.24	0.01	0.85	0.34	0.24	0.09	0.03	0.43	48.91	1.22	0.13	0.06	42.52
		5.03	0	0.82	0.35	0.25	0.09	0.01	0.44	48.71	1.26	0.14	0.06	43.01
		5.05	0	0.76	0.33	0.22	0.1	0	0.42	49.02	1.19	0.12	0.06	42.8
		4.26	0	0.7	0.31	0.2	0.1	0	0.41	49.5	1.2	0.12	0.06	43.19
		4.19	0	0.6	0.28	0.16	0.11	0.01	0.41	49.67	1.22	0.12	0.06	43.2
		4.18	0	0.61	0.29	0.11	0.16	0.02	0.38	49.76	1.07	0.11	0.06	43.3
		4.45	0	0.68	0.3	0.19	0.1	0.01	0.39	49.71	1.17	0.12	0.06	42.91
		4.59	0	0.74	0.33	0.22	0.1	0.02	0.4	49.4	1.15	0.13	0.06	42.97
		4.98	0	0.86	0.39	0.27	0.11	0.01	0.4	49.19	1.16	0.15	0.07	42.58
		5.34	0	0.94	0.42	0.32	0.09	0	0.44	48.52	1.21	0.16	0.07	42.7
		5.86	0.02	1.07	0.48	0.37	0.1	0.01	0.48	47.93	1.23	0.19	0.07	42.48
		7.14	0.03	1.26	0.51	0.39	0.11	0.01	0.49	47.27	1.29	0.23	0.06	41.52
		6.28	0.03	9.57	0.42	0.3	0.11	0.01	0.62	48.76	1.2	0.36	0.07	32.48
		5.26	0	0.98	0.34	0.23	0.1	0.01	0.41	48.95	1.18	0.17	0.07	42.42
		4.88	0.01	0.92	0.35	0.25	0.09	0.01	0.44	49.59	1.06	0.16	0.08	42.28
		4.52	0	0.82	0.31	0.2	0.1	0.01	0.43	49.72	1.1	0.15	0.07	42.67
		4.67	0.02	0.93	0.36	0.23	0.12	0.01	0.44	49.41	1.07	0.15	0.07	42.67
		5.25	0.02	1.13	0.44	0.32	0.11	0.01	0.49	48.82	1.13	0.19	0.07	42.24
		6.69	0.03	1.49	0.57	0.44	0.12	0	0.56	47.48	1.18	0.23	0.08	41.48
		7.62	0.04	1.72	0.67	0.54	0.12	0.01	0.65	46.48	1.2	0.26	0.07	41.08
		4.11	0	0.63	0.35	0.24	0.1	0.02	0.45	50.02	1.09	0.13	0.06	42.94
		3.61	0	0.59	0.26	0.13	0.12	0.02	0.41	50.75	0.98	0.11	0.06	42.99
		3.71	0	0.62	0.25	0.11	0.13	0.02	0.42	50.51	1.01	0.12	0.06	43.07
		4.12	0.01	0.78	0.3	0.17	0.12	0.02	0.42	50.05	1.03	0.14	0.06	42.86
		5.69	0.01	1.01	0.39	0.22	0.15	0.01	0.47	48.76	1.1	0.19	0.06	42.1
		6.2	0	1.03	0.48	0.31	0.15	0.01	0.48	48.31	1.11	0.19	0.06	41.92
		5.64	0.01	0.93	0.37	0.21	0.14	0.01	0.44	48.99	1.1	0.17	0.06	42.07
		4.5	0	0.83	0.31	0.08	0.21	0	0.43	49.81	1.07	0.15	0.06	42.64
		3.56	0	0.69	0.26	0.15	0.1	0.01	0.39	50.47	1.05	0.12	0.06	43.18
		3.11	0	0.58	0.19	0.03	0.14	0.01	0.36	51.34	0.9	0.1	0.06	43.15
		7.54	0.04	1.99	0.76	0.63	0.12	0.03	0.62	45.95	1.3	0.28	0.08	41.18
		4.19	0	0.62	0.27	0.14	0.12	0.02	0.42	49.88	1.11	0.11	0.06	43.06
		4.96	0	0.7	0.31	0.14	0.15	0.1	0.39	49.42	1.12	0.13	0.06	42.56

Table 15 (cont)

Survey	Core	Sample depth (cm)	Ag (ppm)	As (ppm)	Ba (ppm)	Bi (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Cu (ppm)	Ga (ppm)	Ge (ppm)	Hf (ppm)	La (ppm)	Li (ppm)	Mn (ppm)	Mo (ppm)
57	GC19	1.5 - 4.5	0	2.5	481	<2	10	0	16	8	24	3	<0.5	<2	7	0	332	<2
	GC19	9.5 - 12.5	0	2	448	<2	7	0	14	10	21	3	<0.5	<2	13	0	296	<2
	GC19	14.5 - 17.5	0	2	498	<2	8	0	9	6	17	2	<0.5	<2	6	0	279	<2
	GC19	19.5 - 22.5	0	2	488	<2	6	0	11	21	21	2	<0.5	<2	8	0	300	<2
	GC19	24.5 - 27.5	0	1	530	<2	7	0	5	15	15	<1	<0.5	<2	13	0	548	<2
	GC19	29.5 - 32.5	0	1.5	570	<2	<5	0	6	18	18	1	<0.5	<2	10	0	1009	<2
	GC19	34.5 - 37.5	0	1	675	<2	6	0	5	13	14	1	<0.5	<2	7	0	569	<2
	GC19	39.5 - 42.5	0	1	636	<2	15	0	5	12	11	<1	<0.5	<2	16	0	466	<2
	GC19	44.5 - 47.5	0	1.5	0	<2	0	0	0	0	13	1	<0.5	<2	0	0	0	<2
	GC19	49.5 - 52.5	0	1	496	<2	12	0	5	22	19	<1	<0.5	<2	12	0	143	<2
	GC19	54.5 - 57.5	0	1	499	<2	9	0	8	16	13	1	<0.5	<2	11	0	160	<2
	GC19	59.5 - 62.5	0	0.5	500	<2	<5	0	7	20	10	<1	<0.5	<2	9	0	258	<2
	GC19	65.5 - 68.5	0	4.5	394	<2	<5	0	5	6	18	1	<0.5	<2	15	0	259	<2
	GC19	70.5 - 73.5	0	1.5	307	<2	<5	0	5	16	9	1	<0.5	<2	3	0	159	<2
	GC19	75.5 - 78.5	0	2	369	<2	<5	0	6	11	14	2	<0.5	<2	10	0	278	<2
	GC19	85.5 - 88.5	0	1.5	389	<2	10	0	6	19	19	1	<0.5	<2	14	0	209	<2
	GC19	92.5 - 95.5	0	0.5	342	<2	6	0	8	16	12	<1	<0.5	<2	8	0	152	<2
	GC19	99.5 - 102.5	0	2	285	<2	<5	0	6	8	17	<1	<0.5	<2	8	0	130	<2
	GC19	109.5 - 112.5	0	0.5	393	<2	15	0	8	7	10	<1	<0.5	<2	11	0	155	<2
	GC19	119.5 - 122.5	0	1.5	452	<2	<5	0	7	11	8	2	<0.5	2	8	0	184	<2
	GC19	131.5 - 134.5	0	1.5	493	<2	<5	0	9	13	9	<1	<0.5	<2	6	0	197	<2
	GC19	141.5 - 144.5	0	1	515	<2	9	0	9	23	22	<1	<0.5	3	2	0	224	<2
	GC19	151.5 - 154.5	0	<0.5	469	<2	<5	0	5	15	13	<1	<0.5	<2	14	0	222	<2
	GC19	161.5 - 164.5	0	1.5	480	<2	<5	0	10	9	22	<1	<0.5	<2	11	0	241	<2
	GC19	171.5 - 174.5	0	1	494	<2	5	0	8	17	46	2	<0.5	<2	8	0	184	<2
	GC19	181.5 - 184.5	0	1	599	<2	<5	0	13	20	8	2	<0.5	<2	7	0	187	<2
	GC19	191.5 - 194.5	0	1.5	493	<2	13	0	16	14	7	2	<0.5	<2	14	0	240	<2
	GC19	201.5 - 204.5	0	1	396	<2	<5	0	5	11	9	<1	<0.5	<2	4	0	335	<2
	GC19	209.5 - 212.5	0	1	463	<2	<5	0	5	22	9	<1	<0.5	<2	8	0	357	<2
	GC19	219.5 - 222.5	0	1	432	<2	<5	0	10	10	11	2	<0.5	<2	12	0	269	<2
	GC19	231.5 - 234.5	0	1.5	415	<2	<5	0	6	20	18	<1	<0.5	<2	13	0	263	<2
	GC19	241.5 - 244.5	0	<0.5	428	<2	12	0	10	17	22	2	<0.5	<2	7	0	166	<2
	GC19	251.5 - 254.5	0	1.5	526	<2	16	0	9	18	35	<1	<0.5	<2	16	0	179	<2
	GC19	261.5 - 264.5	0	1.5	505	<2	10	0	10	16	31	1	<0.5	<2	12	0	147	<2
	GC19	271.5 - 274.5	0	1	431	<2	<5	0	8	11	27	1	<0.5	<2	6	0	149	<2
	GC19	281.5 - 284.5	0	1.5	366	<2	<5	0	7	23	53	<1	<0.5	<2	5	0	153	<2
	GC19	291.5 - 294.5	0	1.5	366	<2	9	0	5	25	7	<1	<0.5	<2	10	0	184	<2
	GC19	301.5 - 301.5	0	2	599	<2	<5	0	16	9	22	2	<0.5	<2	10	0	349	<2
	GC19	311.5 - 314.5	0	1.5	581	<2	14	0	7	23	14	2	<0.5	<2	<2	0	409	<2
	GC19	321.5 - 324.5	0	1.5	637	<2	12	0	4	14	18	<1	<0.5	<2	13	0	1232	2

Nb (ppm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Pr (ppm)	Rb (ppm)	S (ppm)	Sc (ppm)	Se (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	Th (ppm)	U (ppm)	V (ppm)	W (ppm)	Y (ppm)	Zn (ppm)	Zr (ppm)
2	11	10	16	2	8	800	15	<1	<2	1300	<2	<2	<0.5	13	<3	17	23	26
2	3	9	9	3	9	800	16	<1	<2	1393	<2	<2	<0.5	11	4	15	21	25
<2	9	8	4	<2	4	800	14	<1	<2	1582	<2	<2	0.5	8	5	15	17	14
<2	7	10	4	3	4	800	17	<1	<2	1608	4	<2	0.5	9	4	15	17	13
<2	10	17	2	6	<1	700	7	<1	<2	1723	<2	<2	<0.5	4	5	20	14	8
<2	20	20	2	<2	<1	700	10	<1	<2	1675	<2	<2	0.5	<2	8	23	17	15
<2	16	5	3	5	1	700	9	<1	<2	1635	<2	<2	0.5	7	<3	23	16	15
<2	19	3	3	<2	1	700	11	<1	<2	1651	<2	<2	<0.5	6	<3	24	15	15
<2	0	1	3	0	1	700	0	<1	<2	1624	<2	<2	0.5	0	6	23	15	17
<2	17	<1	3	3	<1	700	11	<1	<2	1680	<2	<2	0.5	4	3	22	16	17
<2	11	<1	3	<2	<1	700	9	<1	<2	1720	3	<2	<0.5	4	7	21	16	17
<2	9	<1	7	4	<1	700	4	<1	<2	1698	<2	<2	<0.5	6	5	20	15	10
<2	11	1	57	<2	<1	600	15	<1	<2	1553	34	<2	<0.5	4	4	19	14	11
<2	9	<1	4	3	<1	600	10	<1	<2	1485	<2	<2	0.5	6	<3	21	13	12
<2	11	<1	<2	4	<1	600	13	<1	<2	1494	5	<2	<0.5	6	8	19	14	17
<2	13	<1	4	2	<1	600	17	<1	<2	1474	5	<2	<0.5	9	<3	18	14	19
<2	9	<1	3	4	2	700	16	<1	<2	1423	2	<2	1.5	6	<3	21	13	19
<2	4	3	5	3	3	700	12	<1	<2	1357	<2	<2	1.5	6	6	23	18	21
2	10	3	6	<2	3	700	15	<1	<2	1355	<2	2	<0.5	9	4	28	18	24
<2	10	2	4	<2	5	700	18	<1	<2	1367	<2	2	<0.5	9	<3	23	18	23
<2	<2	<1	24	6	3	600	9	<1	<2	1402	<2	<2	1	10	3	20	15	20
<2	10	1	10	6	4	600	11	<1	<2	1432	<2	<2	<0.5	8	<3	18	16	21
<2	13	<1	5	<2	<1	600	10	<1	<2	1391	<2	<2	<0.5	9	<3	19	15	19
<2	4	<1	3	2	1	600	18	<1	<2	1354	<2	<2	<0.5	11	7	17	15	22
<2	11	3	3	<2	3	700	19	<1	<2	1323	<2	2	0.5	14	8	18	17	24
<2	11	4	4	<2	5	600	16	<1	<2	1310	<2	2	<0.5	16	<3	21	22	27
2	10	5	3	6	7	700	14	<1	<2	1306	3	<2	0.5	8	<3	20	22	28
<2	10	2	<2	4	<1	600	11	<1	<2	1436	<2	<2	<0.5	9	<3	17	14	15
<2	12	3	<2	4	<1	500	11	<1	<2	1467	<2	<2	0.5	8	5	16	15	14
<2	10	3	3	<2	1	600	11	<1	<2	1488	2	<2	1.5	5	11	17	16	15
<2	11	4	12	<2	2	600	9	<1	<2	1477	<2	<2	<0.5	9	11	21	16	16
<2	16	4	4	5	3	600	14	<1	<2	1459	<2	3	<0.5	12	<3	26	15	18
<2	13	4	2	<2	3	600	13	<1	<2	1420	<2	<2	0.5	8	<3	25	18	21
<2	12	2	2	9	3	600	15	<1	<2	1428	<2	2	<0.5	9	<3	25	16	19
<2	8	<1	2	<2	2	600	13	<1	<2	1471	2	<2	<0.5	11	<3	20	14	18
<2	5	5	<2	<2	1	600	13	1	<2	1516	<2	<2	3	21	<3	14	17	14
<2	6	<1	<2	5	1	600	7	<1	<2	1511	<2	<2	1.5	7	<3	12	14	14
<2	8	11	4	<2	9	800	13	<1	<2	1463	4	2	<0.5	16	8	16	23	25
<2	16	8	<2	3	<1	700	8	<1	<2	1746	2	<2	<0.5	8	3	18	14	15
<2	9	29	3	3	1	700	14	<1	<2	1629	<2	<2	0.5	7	6	23	19	15

Table 16 Major and trace element analyses for core 57GC022A

Survey	Core	Depth (cm)	SiO2 (wt%)	TiO2 (wt%)	Al2O3 (wt%)	Fe2O3t (wt%)	Fe2O3 (wt%)	FeO (wt%)	MnO (wt%)	MgO (wt%)	CaO (wt%)	Na2O (wt%)	K2O (wt%)	P2O5 (wt%)	LOI
57	GC022A	10	6.96	0.04	1.72	0.68	0.56	0.11	0	1.3	46.29	1.04	0.26	0.1	41.54
		30	6.05	0.03	1.4	0.47	0.38	0.08	0	1.36	47.1	1.04	0.22	0.1	42.14
		50	3.95	0	0.47	0.2	0.1	0.09	0	1.6	48.99	0.94	0.09	0.1	43.57
		70	3.37	0	0.15	0.11	0.03	0.07	0	1.6	49.47	0.98	0.06	0.07	44.15
		90	3.38	0	0.17	0.11	0	0.1	0	1.5	49.64	0.93	0.05	0.07	44.08
		110	7.13	0.05	1.59	0.6	0.51	0.08	0	1.31	46.27	1.05	0.23	0.09	41.6

Table 16 (cont)

Survey	Core	Sample Depth (cm)	Ag (ppm)	As (ppm)	Ba (ppm)	Bi (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Cu (ppm)	Ga (ppm)	Ge (ppm)	Hf (ppm)	La (ppm)	Li (ppm)	Mn (ppm)	Mo (ppm)
57	57GC22A	10	3	0.5	119	<2	13	2	27	0	9	2	<0.5	<2	8	9	109	4
	57GC22A	30	3	<0.5	113	<2	<5	<2	19	0	8	1	<0.5	<2	12	9	96	7
	57GC22A	50	3	<0.5	60	<2	9	<2	16	0	4	<1	<0.5	<2	4	5	77	6
	57GC22A	70	3	0.5	39	<2	11	0	15	0	2	<1	<0.5	<2	11	4	54	7
	57GC22A	90	2	<0.5	45	<2	19	<2	13	0	2	<1	<0.5	<2	12	4	49	6
	57GC22A	110	3	1	127	<2	16	<2	24	0	7	2	<0.5	<2	18	9	107	5

Survey	Core	Sample Depth (cm)	Nb (ppm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Pr (ppm)	Rb (ppm)	S (ppm)	Sc (ppm)	Se (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	Th (ppm)	U (ppm)	V (ppm)
57	57GC22A	10	2	13	14	3	0	5	1000	5	1	6	1693	<2	2	2.5	28
	57GC22A	30	<2	7	13	3	0	4	1000	10	<1	<2	1801	<2	<2	2.5	25
	57GC22A	50	<2	17	6	<2	0	<1	1100	5	<1	2	2055	<2	<2	2.5	13
	57GC22A	70	<2	5	7	<2	0	<1	1100	5	<1	5	2182	<2	<2	1.5	5
	57GC22A	90	<2	10	5	<2	0	<1	1100	<1	<1	5	2168	<2	<2	1.5	6
	57GC22A	110	3	14	13	<2	0	5	1000	4	<1	6	1716	<2	<2	1.5	21

Survey	Core	Sample Depth (cm)	W (ppm)	Y (ppm)	Zn (ppm)	Zr (ppm)
57	57GC22A	10	<3	10	19	30
	57GC22A	30	<3	10	14	31
	57GC22A	50	<3	8	10	21
	57GC22A	70	<3	8	6	18
	57GC22A	90	<3	9	6	19
	57GC22A	110	<3	9	16	32

Table17 Major and trace element analyses for core 57GC27

Survey	Core	Sample Depth (cm)	SiO2 (wt%)	TiO2 (wt%)	Al2O3 (wt%)	Fe2O3t (wt%)	Fe2O3 (wt%)	FeO (wt%)	MnO (wt%)	MgO (wt%)	CaO (wt%)	Na2O (wt%)	K2O (wt%)	P2O5 (wt%)	LOI
57	GC27	0-3	6.37	0.02	1.07	0.52	0.42	0.09	0	2.01	45.28	1.39	0.21	0.13	42.89
		6-9	6.64	0.03	1.18	0.48	0.37	0.1	0	2.07	45.21	1.26	0.2	0.11	42.67
		12-15	6.39	0.02	1.18	0.49	0.38	0.1	0	2.08	45.02	1.44	0.22	0.11	42.89
		20-23	6.81	0.03	1.27	0.52	0.41	0.1	0	2.07	45.04	1.27	0.21	0.11	42.51
		30-33	6.41	0.02	1.22	0.5	0.39	0.1	0	2.07	45.31	1.25	0.21	0.1	42.74
		40-43	6.89	0.03	1.21	0.5	0.39	0.1	0	2.05	45.08	1.22	0.19	0.1	42.55
		50-53	6.61	0.02	1.19	0.49	0.36	0.12	0	2.06	45.22	1.2	0.21	0.1	42.73
		60-63	6.74	0.03	1.25	0.53	0.39	0.13	0	2.08	45.17	1.23	0.23	0.1	42.48
		80-83	6.39	0.02	1.25	0.5	0.38	0.11	0	2.1	45.37	1.27	0.22	0.1	42.61
		80-83	6.39	0.02	1.25	0.5	0.38	0.11	0	2.1	45.37	1.27	0.22	0.1	42.61
		100-103	6.33	0.03	1.14	0.49	0.32	0.15	0	2.07	45.59	1.21	0.2	0.1	42.67
		121-123	6.49	0.03	1.3	0.52	0.39	0.12	0	2.11	45.34	1.21	0.23	0.1	42.5

Table 17 (cont)

Survey	Core	Sample Depth (cm)	Ag (ppm)	As (ppm)	Ba (ppm)	Bi (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Cu (ppm)	Ga (ppm)	Ge (ppm)	Hf (ppm)	La (ppm)	Li (ppm)	Mn (ppm)	Mo (ppm)	Nb (ppm)
57	GC27	0-3	3	1.5	54	<2	6	<2	23	0	4	<1	<0.5	<2	<2	7	76	6	<2
		6-9	3	1	36	<2	12	<2	20	0	4	<1	<0.5	<2	13	8	76	6	3
		12-15	3	2	54	2	<5	0	21	0	4	<1	<0.5	<2	5	8	68	6	3
		20-23	2	1	52	<2	<5	0	24	0	5	1	<0.5	<2	6	8	82	6	4
		30-33	1	1	31	<2	5	3	19	0	4	2	0.5	<2	9	8	76	5	<2
		40-43	2	1.5	41	<2	15	3	19	0	2	2	<0.5	<2	15	8	83	4	<2
		50-53	2	1	42	<2	10	5	22	0	4	1	<0.5	<2	14	8	76	6	<2
		60-63	2	1	67	<2	<5	4	22	0	5	2	<0.5	<2	6	9	82	6	<2
		80-83	2	1	49	3	15	5	24	0	3	1	<0.5	<2	4	8	81	6	<2
		80-83	2	1	49	3	15	5	24	0	3	1	<0.5	<2	4	8	81	6	<2
		100-103	2	1.5	58	3	9	4	22	0	4	1	<0.5	<2	10	8	81	4	3
		121-123	2	1	43	<2	14	5	24	0	4	1	0.5	<2	16	9	83	7	<2

Survey	Core	Sample Depth (cm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Pr (ppm)	Rb (ppm)	S (ppm)	Sc (ppm)	Se (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	Th (ppm)	U (ppm)	V (ppm)
57	GC27	0-3	11	10	55	0	<1	1400	14	<1	5	1731	2	<2	2	15
		6-9	3	12	<2	0	1	1600	10	<1	6	1803	<2	<2	2.5	15
		12-15	6	11	<2	0	<1	1800	11	<1	6	1750	<2	<2	2.5	10
		20-23	8	13	3	0	2	1800	6	<1	3	1796	5	<2	1.5	20
		30-33	8	11	2	0	<1	1800	7	<1	4	1782	<2	<2	2.5	10
		40-43	20	12	<2	0	2	1800	11	<1	5	1772	<2	<2	2.5	11
		50-53	6	10	2	0	<1	1800	9	<1	7	1778	<2	<2	2.5	15
		60-63	5	12	<2	0	2	1900	10	<1	3	1784	<2	<2	2	15
		80-83	12	12	50	0	<1	1900	9	<1	4	1799	3	<2	2	14
		80-83	12	12	50	0	<1	1900	9	<1	4	1799	3	<2	2	14
		100-103	9	10	<2	0	1	1900	9	<1	5	1788	<2	<2	2.5	11
		121-123	9	12	3	0	3	1900	10	<1	4	1809	<2	<2	2.5	13

Survey	Core	Sample Depth (cm)	W (ppm)	Y (ppm)	Zn (ppm)	Zr (ppm)
57	GC27	0-3	<3	9	8	39
		6-9	<3	8	8	40
		12-15	<3	7	9	42
		20-23	<3	7	8	37
		30-33	<3	7	8	33
		40-43	<3	8	9	38
		50-53	<3	8	9	32
		60-63	<3	8	9	39
		80-83	<3	8	9	38
		80-83	<3	8	9	38
		100-103	<3	8	9	38
		121-123	<3	8	10	37

Table 18 Major and trace element analyses for core 766A

Core	Sample Number (cm)	SiO2 (wt%)	TiO2 (wt%)	Al2O3 (wt%)	Fe2O3t (wt%)	Fe2O3 (wt%)	FeO (wt%)	MnO (wt%)	MgO (wt%)	CaO (wt%)	Na2O (wt%)	K2O (wt%)	P2O5 (wt%)	S (ppm)	LOI
766A	1	49.42	0.86	11.94	6.93	6.93	0	0.47	4.14	3.73	1.91	2.43	0.34	2400	17.89
766A	2	60.62	0.39	9.36	4.46	3.68	0.7	0.02	2.24	4.92	1.51	1.45	0.12	6200	14.48
766A	3	58.1	0.63	11.44	5.6	4.57	0.93	0.02	2.69	3.41	1.75	2.02	0.16	8500	13.93
766A	4	58.07	0.97	10.62	7.74	6.03	1.54	0.02	2.63	2.75	1.6	3.86	0.14	3100	11.58
766A	5	54.33	1.04	11.51	8.36	5.99	2.13	0.02	3.19	4.47	1.88	3.25	0.14	2700	11.89
766A	6	55.57	1.06	11.98	7.07	5.18	1.7	0.02	2.88	3.26	1.45	3.48	0.14	4500	13.1
766A	7	48.11	1.14	15.01	15.55	9.57	5.38	0.03	3.55	1.81	1.64	2.29	0.09	1600	11.2
766A	8	55.7	0.95	13.01	7.06	4.56	2.25	0.02	2.47	3.54	1.45	2.59	0.27	8700	13.12
766A	9	56.3	1	11.98	7.41	4.6	2.53	0.02	2.32	3.15	1.39	2.33	0.16	19700	14.51
766A	10	30.61	0.64	6.81	4.73	4.73	0	0.83	1.66	24.46	1.65	1.4	0.17	700	26.97
766A	11	58.74	0.45	9.49	4.32	3.68	0.58	0.02	2.3	5.28	1.74	1.47	0.09	4100	15.74
766A	12	59.4	0.77	9.23	7.26	5.8	1.31	0.02	2.07	4.64	1.42	3.03	0.16	2300	11.92
766A	13	58.39	0.95	10.46	7.47	5.78	1.52	0.02	2.52	2.84	1.41	3.36	0.14	7300	11.89
766A	14	55.78	1.05	11.9	8.54	6.16	2.14	0.02	3.26	4.12	1.61	3.37	0.14	2700	10.18
766A	15	64.74	0.66	8.63	5.94	4.82	1.01	0.01	1.94	2.11	1.48	2.28	0.11	11600	11.04
766A	16	58.09	0.9	12.5	6.49	4.79	1.53	0.01	2.31	2.89	1.49	2.52	0.15	11000	11.71
766A	17	54.14	0.94	11.71	7.67	5.57	1.89	0.03	2.21	4.22	1.47	2.28	0.17	21700	13.18
766A	18	56.38	1.07	13.5	6.86	4.88	1.78	0.02	2.51	3.05	1.55	2.61	0.19	9600	11.5
766A	19	52.46	0.8	10.8	13.78	6.99	6.11	0.03	7.8	0.89	1.54	1.92	0.12	4800	10.05
766A	20	58.37	0.87	12.6	7.72	5.64	1.87	0.02	3.23	1.74	1.28	4.11	0.22	10400	9.02

Table 18 (cont)

Core	Sample No	Ag (ppm)	As (ppm)	Ba (ppm)	Bi (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Cu (ppm)	Ga (ppm)	Ge (ppm)	Hf (ppm)	La (ppm)	Li (ppm)	Mn (ppm)	Mo (ppm)	Nb (ppm)
766A	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
766A	2	0	4	4873	<2	43	0	79	5	94	15	3	2	20	0	133	<2	8
766A	3	0	4.5	3711	<2	49	0	117	7	72	17	3	3	28	0	147	<2	10
766A	4	0	4	755	<2	34	0	195	8	44	16	2	7	19	0	117	<2	12
766A	5	0	6	643	<2	35	0	225	<3	41	15	2.5	5	15	0	131	<2	9
766A	6	0	5.5	1032	<2	27	0	204	7	49	18	3	7	16	0	104	<2	12
766A	7	0	5	75	<2	96	0	239	<3	42	24	2	11	46	0	147	<2	38
766A	8	0	6	1054	<2	78	0	147	<3	44	19	3	5	33	0	163	<2	16
766A	9	0	10.5	257	<2	63	0	163	<3	56	18	3	5	30	0	141	<2	17
766A	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
766A	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
766A	12	0	5	851	<2	36	0	157	5	28	13	3	6	21	0	143	<2	11
766A	13	0	8.5	1509	<2	43	0	184	<3	47	17	4	5	18	0	114	<2	12
766A	14	0	5.5	652	<2	30	0	215	4	50	16	2.5	5	14	0	129	<2	9
766A	15	0	9.5	1227	<2	47	0	134	4	36	18	4	6	21	0	81	<2	20
766A	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
766A	17	0	10.5	1376	<2	62	0	164	<3	40	17	3.5	5	31	0	211	<2	17
766A	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
766A	19	0	5.5	952	<2	39	0	134	<3	64	18	2.5	3	12	0	177	<2	9
766A	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Core	Sample No	Nd (ppm)	Ni (ppm)	Pb (ppm)	Pr (ppm)	Rb (ppm)	Sc (ppm)	Se (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	Th (ppm)	U (ppm)	V (ppm)	W (ppm)	Y (ppm)	Zn (ppm)	Zr (ppm)
766A	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
766A	2	16	47	12	3	60	16	2	<2	232	3	12	2.5	85	<3	26	87	79
766A	3	19	37	13	3	67	20	2	<2	259	<2	12	2	129	<3	32	113	108
766A	4	15	37	15	5	85	27	<1	<2	135	<2	8	2.5	198	<3	23	163	302
766A	5	15	32	10	<2	69	28	<1	<2	154	2	7	1	208	<3	20	90	166
766A	6	12	38	13	5	82	28	1	<2	153	<2	8	2.5	209	<3	21	132	266
766A	7	37	57	17	6	54	29	<1	5	117	4	10	2.5	215	<3	21	135	317
766A	8	29	41	18	9	87	23	1	<2	172	<2	14	2.5	185	<3	32	94	180
766A	9	26	48	17	8	80	20	2	<2	148	<2	13	2.5	170	3	28	151	206
766A	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
766A	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
766A	12	21	36	15	4	81	18	1	<2	178	2	10	1.5	138	3	20	157	250
766A	13	17	49	17	5	85	25	1	<2	157	<2	9	3.5	193	<3	28	134	224
766A	14	12	34	11	<2	65	27	<1	<2	154	<2	6	2	210	4	20	98	159
766A	15	16	36	12	6	71	16	2	<2	187	<2	10	2	108	<3	21	110	265
766A	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
766A	17	24	49	17	3	84	20	2	<2	169	<2	14	4	176	<3	30	122	200
766A	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
766A	19	17	45	11	3	55	22	2	<2	107	<2	9	1.5	183	<3	25	86	113
766A	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table19 Major and trace element analyses for core 765C

Core	Sample Depth (cm)	SiO2 (wt%)	TiO2 (wt%)	Al2O3 (wt%)	Fe2O3t (wt%)	Fe2O3 (wt%)	FeO (wt%)	MnO (wt%)	MgO (wt%)	CaO (wt%)	Na2O (wt%)	K2O (wt%)	P2O5 (wt%)	S (ppm)	LOI
765C	1	47.61	0.67	8.76	7.86	7.86	0	1.46	1.96	10.77	0.94	2.57	0.14	300	17.07
765C	2	66.67	0.66	12.3	2.6	2.16	0.4	0.03	2.58	0.74	1.22	1.89	0.11	1300	11.27
765C	3	72.35	0.43	8.78	6.2	5.98	0.2	0.55	2.17	0.76	1.14	1.49	0.13	800	6
765C	4	71.04	0.63	8.53	5.26	4.37	0.8	0.04	2.26	0.5	1.13	1.83	0.07	1600	8.84
765C	5	70.42	0.5	7.96	6.15	5.85	0.27	0.13	2.16	0.56	1.07	1.4	0.1	900	9.1
765C	2-10	65.29	0.83	12.09	5.51	4.83	0.61	0.05	2.84	0.64	1.49	2.01	0.1	400	9.18
765C	6	71.11	0.63	8.37	5.1	4.19	0.82	0.14	2.21	0.53	1.12	1.63	0.07	800	9.2
765C	7	62.41	0.55	12.08	8.38	8.1	0.25	0.13	2.4	0.77	1.1	2.88	0.19	400	8.86
765C	8	68.3	0.55	8.51	6.19	5.87	0.29	0.56	2.37	0.97	1.09	1.56	0.26	1600	8.99
765C	9	76.51	0.69	9.13	5.24	4.47	0.69	0.07	2.35	0.54	1.11	1.9	0.08	1600	2.26
765C	10	69.88	0.84	9.21	5.66	4.89	0.69	0.14	2.33	0.79	1.2	1.75	0.23	900	7.75
765C	11	62.58	0.89	10.73	10.22	9.54	0.61	0.05	2.47	0.67	1.43	1.83	0.1	300	8.88
765C	12	64.78	0.85	11.86	5.55	4.89	0.59	0.05	2.79	0.63	1.47	2.06	0.11	400	9.74
765C	13	52.94	0.78	15.48	7.51	7.28	0.21	0.23	2.51	2.87	2.22	3.14	0.11	500	11.95
765C	14	70.34	0.68	9.13	5.14	4.28	0.77	0.04	2.29	0.54	1.25	1.78	0.09	1800	8.5
765C	15	62.24	0.67	11.07	5.97	5.17	0.72	2.17	2.37	1.07	1.27	1.77	0.11	900	11.2
765C	16	76.68	0.36	5.9	4.81	4.61	0.18	0.09	1.58	0.46	0.89	1.2	0.12	1000	7.49
765C	17	68.8	0.42	9.77	5.93	5.62	0.28	0.04	2.38	0.74	1.13	1.32	0.13	700	9.04
765C	18	67.41	0.6	10.4	5.12	4.15	0.87	1.28	1.97	0.79	1.3	1.76	0.13	2200	9.05
765C	19	70.56	0.35	6.67	2.44	1.84	0.54	0.02	1.23	4.02	1.23	1	0.13	3000	12.49
765C	24-25	62.6	0.78	12.22	7.37	6.23	1.03	0.15	2.4	0.67	1.43	2.21	0.1	2000	9.99
765C	42-50	63.59	0.76	11.8	7.27	6.1	1.05	0.04	2.32	0.6	1.41	2.16	0.09	2500	9.81
765C	51-52	70.38	0.79	8.8	5.39	4.71	0.61	0.04	2.12	0.55	1.18	1.64	0.08	600	9.05
765C	60-69	69.02	0.38	7.32	2.73	2	0.66	0.02	1.34	5.02	1.26	1.09	0.14	3800	11.36
765C	94-95	72.89	0.47	9.47	3.38	2.76	0.56	0.03	1.82	0.53	1.06	1.5	0.09	2400	8.56
765C	96-104	73.32	0.48	9.57	3.43	2.79	0.58	0.17	1.86	0.58	1.1	1.55	0.1	2500	7.65
765C	100-101	43.97	0.55	6.52	14.11	12.55	1.4	0.8	1.24	0.57	0.94	1.08	0.09	99900	20.29
765C	106-107	61.94	0.77	12.4	6.95	5.95	0.9	0.17	2.29	0.71	1.41	2.03	0.12	5300	10.79
765C	135-136	63.29	0.7	12.02	7.1	6.04	0.95	0.07	2.39	0.6	1.33	2.31	0.09	1500	10.05

Table 19 (cont)

Survey	Sample Depth (cm)	Ag (ppm)	As (ppm)	Ba (ppm)	Bi (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Cu (ppm)	Ga (ppm)	Ge (ppm)	Hf (ppm)	La (ppm)	Li (ppm)	Mn (ppm)	Mo (ppm)	Nb (ppm)
765C	1	0	24	300	<2	96	0	39	4	168	11	2.5	4	48	0	15128	<2	12
765C	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
765C	3	0	4	0	<2	0	0	0	0	13	13	1.5	<2	0	0	0	<2	<2
765C	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
765C	5	0	4.5	3323	<2	86	0	35	3	75	14	2.5	7	26	0	1069	<2	25
765C	2-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
765C	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
765C	7	0	30	1018	<2	121	0	61	3	103	19	3	3	30	0	1141	3	13
765C	8	0	4.5	5387	<2	83	0	39	4	61	14	2	4	38	0	4581	<2	9
765C	9	0	27	937	<2	71	0	52	4	188	13	1.5	3	28	0	596	33	12
765C	10	0	6	1518	<2	84	0	48	<3	138	14	1.5	3	37	0	1185	<2	16
765C	11	0	5.5	763	<2	110	0	51	<3	108	17	2	5	39	0	433	<2	18
765C	12	0	6	222	<2	116	0	62	<3	240	16	2	4	31	0	399	<2	16
765C	13	0	11.5	1119	<2	88	0	89	7	106	22	2.5	4	36	0	1980	<2	14
765C	14	0	7.5	1969	<2	76	0	52	<3	106	16	2	4	33	0	18422	<2	11
765C	15	0	20.5	590	<2	69	0	44	3	162	12	2	4	26	0	321	<2	11
765C	16	0	8	3423	<2	57	0	28	<3	34	11	2	<2	24	0	759	<2	7
765C	17	0	1.5	2215	<2	72	0	32	<3	102	13	2	3	25	0	380	<2	11
765C	18	0	23	1644	<2	74	0	65	<3	206	15	1.5	4	28	0	10390	2	11

Survey	Sample Depth (cm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Pr (ppm)	Rb (ppm)	Sc (ppm)	Se (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	Th (ppm)	U (ppm)	V (ppm)	W (ppm)	Y (ppm)	Zn (ppm)	Zr (ppm)
765C	1	43	92	31	15	63	24	<1	<2	112	<2	11	<0.5	133	8	40	118	143
765C	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
765C	3	0	12	23	0	48	0	<1	21	112	<2	7	1	0	<3	25	26	47
765C	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
765C	5	28	63	17	9	43	12	<1	<2	129	6	9	0.5	58	<3	34	97	214
765C	2-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
765C	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
765C	7	34	62	43	7	100	17	<1	<2	97	<2	16	1	79	<3	35	126	115
765C	8	29	59	19	8	49	15	<1	<2	181	<2	9	1.5	48	7	50	101	100
765C	9	27	43	24	5	55	16	<1	<2	84	<2	8	1.5	120	4	21	111	113
765C	10	35	47	55	11	54	15	<1	<2	115	<2	8	1	176	3	32	162	135
765C	11	37	57	13	8	57	18	<1	<2	100	<2	10	1	109	5	29	129	170
765C	12	34	79	30	8	65	18	<1	<2	100	3	12	0.5	151	<3	26	95	145
765C	13	25	84	12	4	108	20	<1	3	240	<2	13	1	109	6	28	140	135
765C	14	28	45	26	5	61	14	<1	<2	129	4	11	0.5	119	<3	30	141	108
765C	15	25	53	26	5	52	13	<1	<2	77	<2	7	1	120	3	21	121	105
765C	16	21	51	18	6	37	10	<1	<2	129	<2	7	0.5	33	4	26	78	76
765C	17	26	34	9	10	40	11	<1	<2	122	3	11	<0.5	55	<3	25	60	105
765C	18	33	116	41	7	55	16	1	<2	102	<2	10	1.5	123	6	27	149	117

Table 20 Range in concentration of major and minor elements present in the sediments from Western Australia

Element	Minimum	Maximum
SiO2 (wt%)	0	14
TiO2 (wt%)	0	0.2
Al2O3 (wt%)	0	10
Fe2O3 (wt%)	0	2
FeO (wt%)	0	0.3
MnO (wt%)	0	0.15
MgO (wt%)	0	2.2
CaO (wt%)	0	60
Na2O (wt%)	0	1.5
K2O (wt%)	0	0.6
P2O5 (wt%)	0	0.15
Sulphur (wt%)	0	2000
Silver (ppm)	0	5
Arsenic (ppm)	0	5
Barium (ppm)	0	900
Bismuth (wt%)	0	5
Cerium (ppm)	0	30
Cobalt (ppm)	0	9
Chromium (ppm)	0	45
Cesium (ppm)	0	25
Copper (ppm)	0	60
Gallium (ppm)	0	6
Germanium (ppm)	0	1.5
Hafnium (ppm)	<2	<2
Lanthanum (ppm)	0	30
Lithium (ppm)	0	20
Manganese (ppm)	0	1400
Molybdenum (ppm)	0	10
Niobium (ppm)	0	5
Neodymium (ppm)	0	25
Nickel (ppm)	0	35
Lead (ppm)	0	80
Praseodymium (ppm)	0	10
Rubidium (ppm)	0	25
Scandium (ppm)	0	20
Selenium (ppm)	0	3
Tin (ppm)	0	10
Strontium (ppm)	0	2500
Tantalum (ppm)	0	40
Thorium (ppm)	0	5
Uranium (ppm)	0	6
Vanadium (ppm)	0	35
Wolfram (ppm)	0	15
Yttrium (ppm)	5	30
Zinc (ppm)	5	80
Zirconium (ppm)	5	50

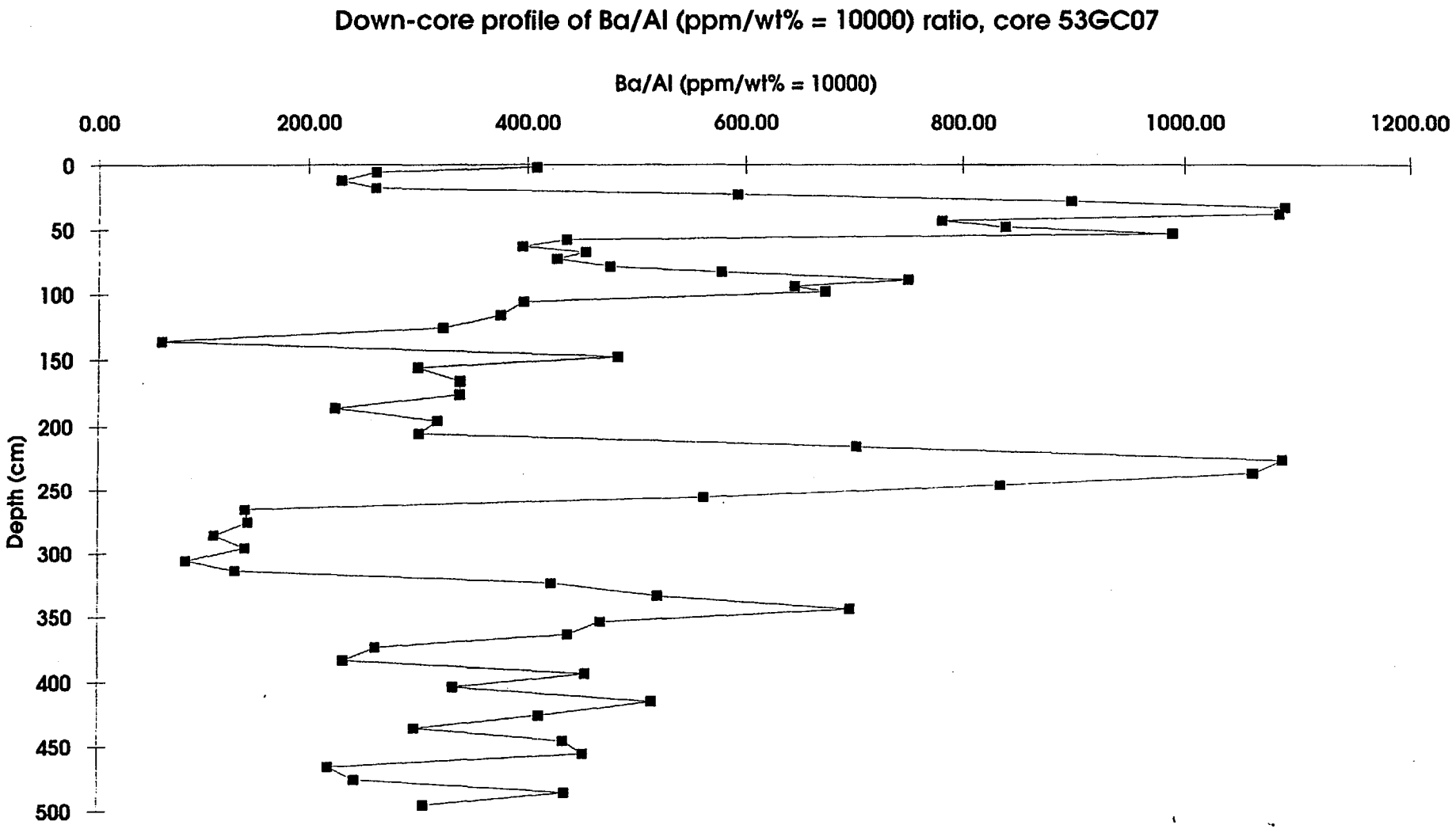


Figure 11. Down-core profile of Ba/Al (ppm/wt% = 10000) ratio, for core 53GC07

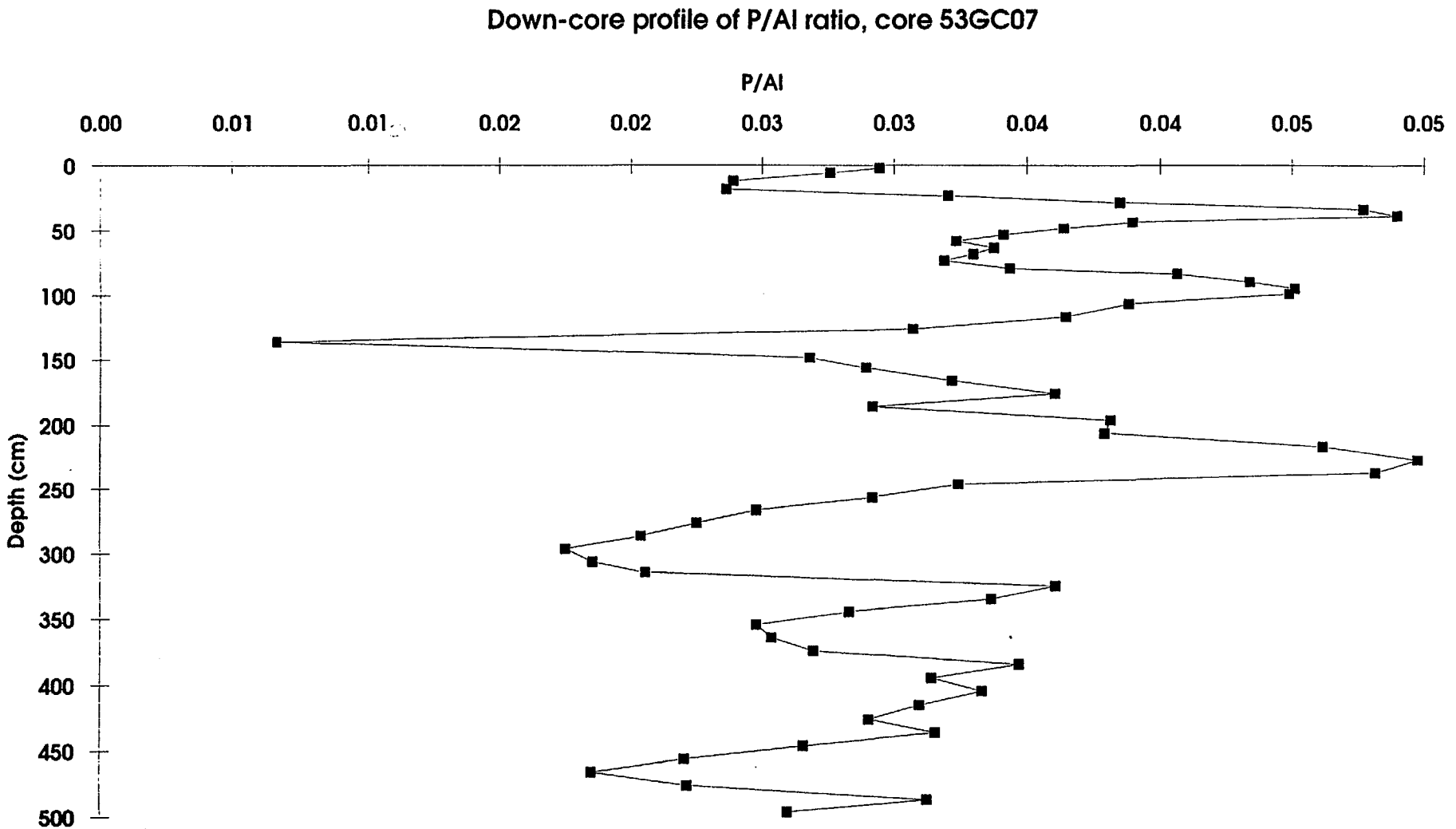


Figure 12. Down-core profile of P/Al (ppm/wt% = 10000) ratio, for core 53GC07

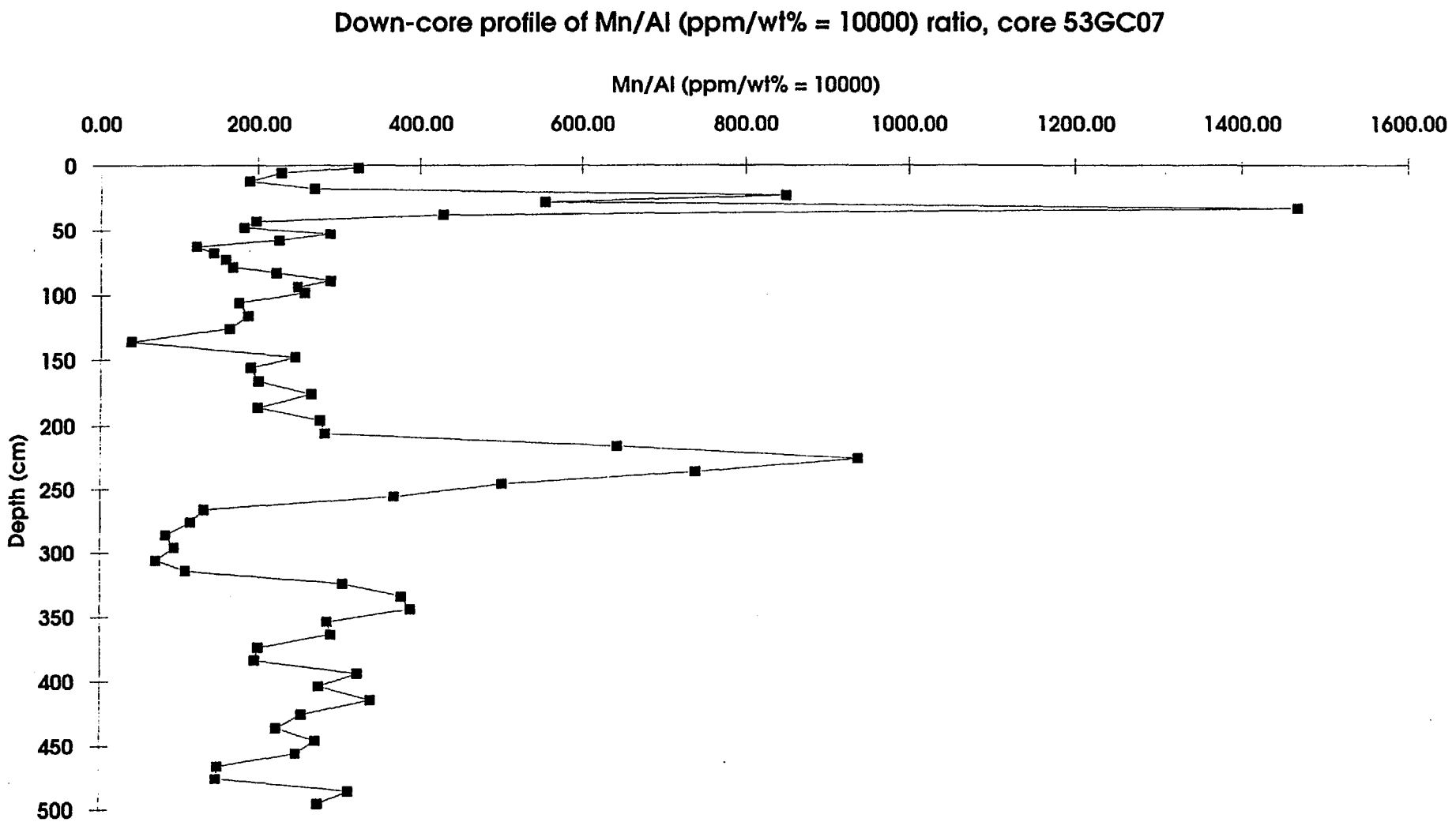


Figure 13. Down-core profile of Mn/Al (ppm/wt% = 10000) ratio, for core 53GC07

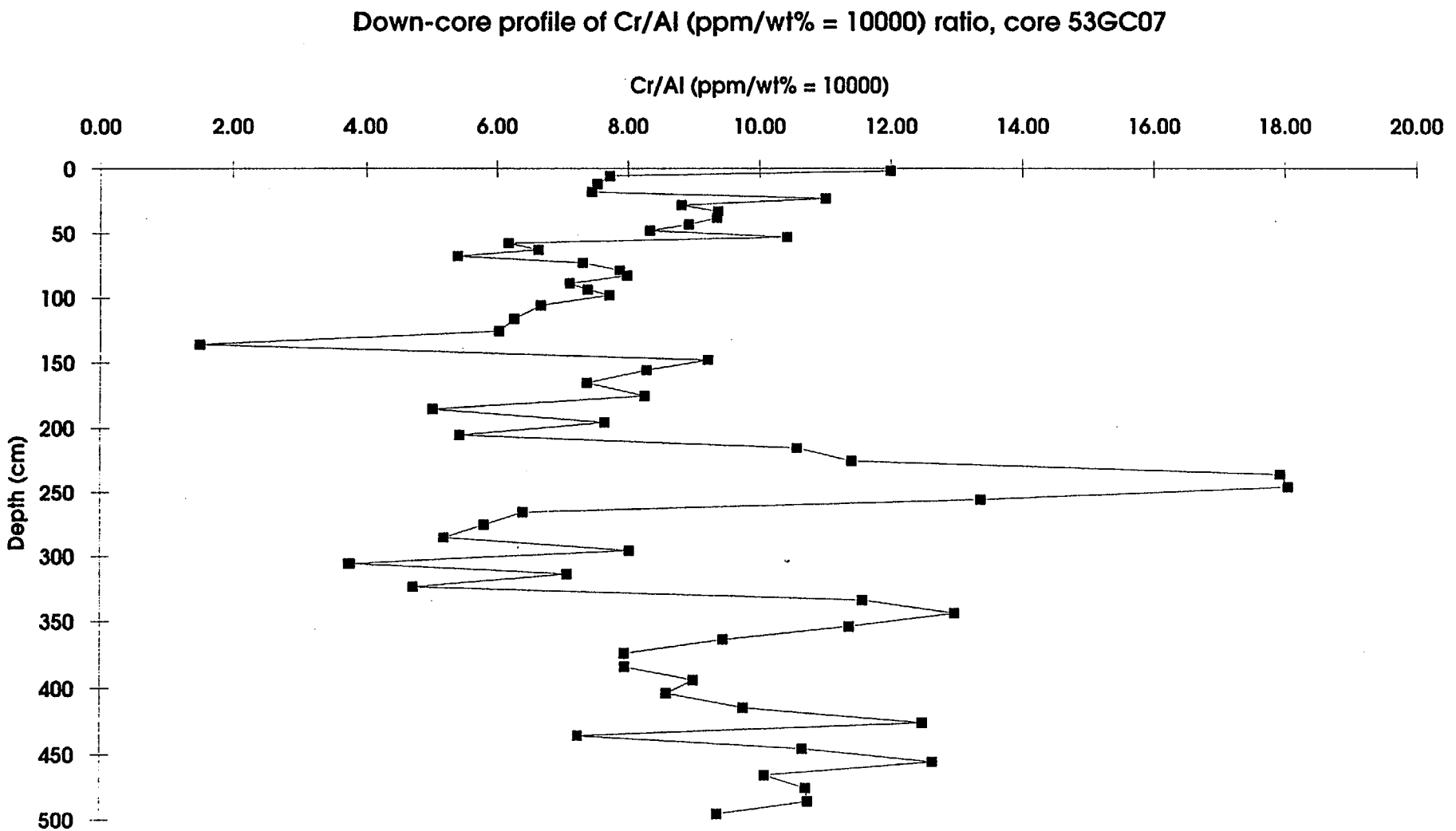


Figure 14. Down-core profile of Cr/Al (ppm/wt% = 10000) ratio, for core 53GC07

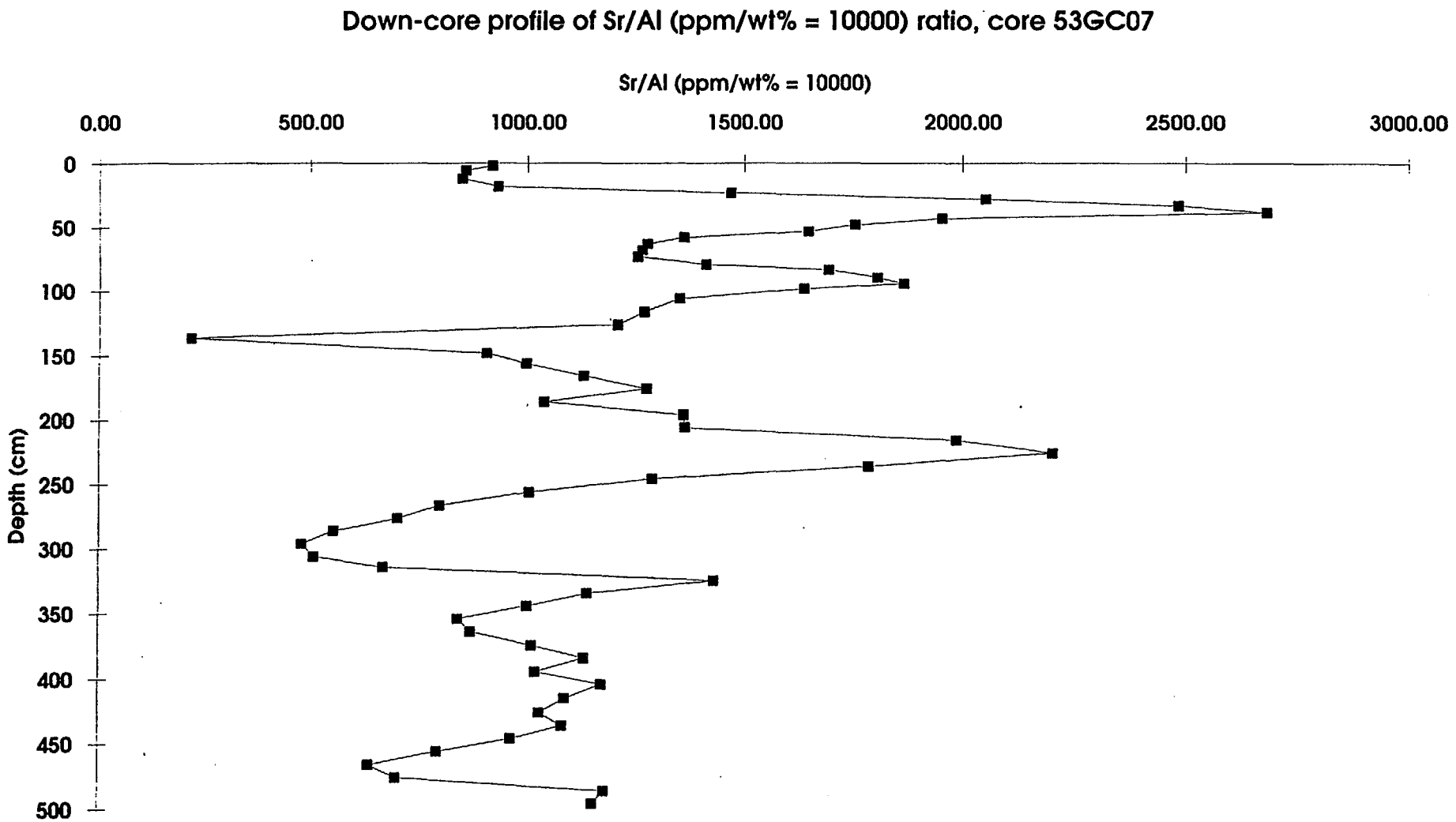


Figure 15. Down-core profile of Sr/Al (ppm/wt% = 10000) ratio, for core 53GC07

Radiochemistry

Several cores were selected from the Exmouth Plateau, 53GC04 and 53GC07, and the Carnarvon Terrace, 57GC15 and 57GC19 to determine sedimentation rates by radiochemical methods. The results of these analyses are assembled in Tables 22-26, along with the calcium carbonate, organic carbon and opaline silica contents of these sediments. These analyses were conducted at the Flinders University of South Australia, School of Earth Sciences. The average Late Quaternary sediment accumulation rates for these cores are presented in the Table 21 below (from McCorkle and others, 1993). In addition, selected samples from six cores from the Carnarvon Terrace were analysed for miscellaneous radiochemistry at Amdel. The results of these analyses are presented in Table 26.

Table 21 Late Quaternary (isotope stages 1-5) ^{230}Th sediment accumulation rates (Veeh and others, in prep).

Area	Core	^{230}Th sediment accumulation rates (cm/ky)
Exmouth Plateau	53GC04	2.27
	53GC07	2.23
Carnarvon Terrace	57GC15	0.67
	57GC19	1.46

The two cores from the Exmouth Plateau (53GC04; 53GC07), collected at water depths of 956 m and 2256 m respectively, had nearly identical sedimentation rates of about 2.2 cm/kyr. These rates are significantly higher than those measured from the Carnarvon Terrace, which varied between 0.67 and 1.46 cm/kyr. Both of these cores were collected from the lower-slope in water depths of about 2750 m. The differences in sedimentation rates from the Carnarvon Terrace reflect local differences in the supply of sediment to the lower-slope.

The average sedimentation rates determined from the radiochemical methods are in good agreement with those determined from oxygen isotope data (see below and McCorkle and others, 1993).

Table22 Percent calcium carbonate, percent organic carbon, percent opaline silica and radiochemical data for core 53GC07

Survey	Core	Depth Interval (cm)	CaCO3 (%)	Corg (%)	Opal (%)	U (ppm)	Th (ppm)	234U/238U	230Th (dpm/g)	230Thx (dpm/g)
53	EPGC07	1-3	78.5	0.29	2	0.89	2.44	1.11+/-0.04	6.36	5.88
		6-8	77	0.28	1.94	-	-	-	-	-
		11-13	77.1	0.23	1.95	0.77	2.34	1.07+/-0.06	5.69	5.23
		17-19	78.6	0.2	1.76	-	-	-	-	-
		22-24	81.5	0.19	1.77	0.7	1.83	1.14+/-0.05	5.45	5.09
		27-29	84.9	0.18	1.69	-	-	-	-	-
		32-34	86.5	0.16	1.7	0.54	1.32	1.07+/-0.05	4.81	4.55
		37-39	85.8	0.23	1.98	-	-	-	-	-
		42-44	83.4	0.29	2.88	0.47	1.11	1.11+/-0.05	4.56	4.34
		47-49	82.7	0.39	2.64	-	-	-	-	-
		52-54	82.2	0.33	2.67	0.39	1.63	1.09+/-0.05	4.73	4.41
		57-59	79.1	0.3	2.76	-	-	-	-	-
		62-64	78.4	0.38	-	2.15	1.63	1.10+/-0.04	4.49	4.17
		67-69	81.2	0.3	2.7	-	-	-	-	-
		72-74	81.2	0.38	2.5	3.46	1.83	1.01+/-0.07	4.63	4.27
		78-80	80.5	0.3	2.62	-	-	-	-	-
		83-85	83.4	0.33	2.21	2.36	1.73	0.99+/-0.03	4.2	3.86
		88-90	84.1	0.26	2.11	-	-	-	-	-
		93-95	85	0.34	2.04	1.43	1.42	1.12+/-0.05	3.72	3.44
		97-99	81.6	0.33	2.61	-	-	-	-	-
		105-107	81.5	0.37	3.03	1.52	1.322	1.12+/-0.05	3.46	3.2
		115-117	78.8	0.28	-	1.79	1.83	1.11+/-0.03	3.56	3.2
		125-127	80.2	0.33	3.11	3.23	1.73	1.16+/-0.04	3.63	3.29
		135-137	77.8	0.24	-	-	-	-	-	-
		145-147	77.3	0.27	2.29	1.63	2.03	1.10+/-0.03	3.39	2.65
		155-157	77.7	0.36	-	-	-	-	-	-
		165-167	80	0.29	2.36	1.76	2.03	1.09+/-0.03	3.26	2.88
		175-177	80.5	0.23	-	-	-	-	-	-
		185-187	82.8	0.33	1.96	1.43	1.63	1.05+/-0.03	2.82	2.5
		195-197	82.6	0.25	-	-	-	-	-	-
		205-207	82.7	0.3	1.78	0.94	1.73	1.06+/-0.06	2.74	2.4
		215-217	85.9	0.34	-	1.7	1.72	1.11+/-0.05	3.01	2.79
		225-227	87	0.26	1.41	0.89	1.02	1.08+/-0.03	2.17	1.97
		235-237	85.8	0.35	-	0.72	1.42	1.13+/-0.07	2.03	1.75
		245-255	83	0.36	1.37	0.75	1.63	1.10+/-0.06	2.21	1.89
		255-257	80.6	0.19	-	-	-	-	-	-
		265-267	76.5	0.29	1.85	1.23	2.54	1.06+/-0.03	2.82	2.32
		275-277	75.8	0.26	-	-	-	-	-	-
		285-287	73.3	0.24	1.7	0.86	2.84	1.04+/-0.03	2.5	1.94
		295-297	69.8	0.24	-	-	-	-	-	-
		305-307	70.9	0.23	1.18	1.02	3.46	1.01+/-0.03	2.41	1.73
		313-315	73.8	0.24	-	-	-	-	-	-
		323-325	81.8	0.21	1.38	1.5	1.83	1.15+/-0.04	1.97	1.61
		333-335	78	0.28	-	1.89	1.83	1.09+/-0.03	2.08	1.72
		343-345	79.1	0.33	2.04	4.71	2.24	1.09+/-0.02	4.74	4.3
		353-355	77.4	0.27	-	3.57	2.54	1.12+/-0.02	3.71	3.21
		363-365	77.5	0.26	1.97	2.06	1.83	1.04+/-0.05	2.39	2.03
		373-375	79.3	0.32	-	-	-	-	-	-
		383-385	78.8	0.32	2.01	1.5	1.83	1.05+/-0.05	1.9	1.54
		393-395	79	0.34	-	1.93	2.03	1.06+/-0.04	2.22	1.82

On a salt-free basis 230Thx = unsupported 230Th

Table 23 Percent calcium carbonate, percent organic carbon, percent opaline silica and radiochemical data for core 53GC04

Survey	Core	Depth Interval (cm)	CaCO3 (%)	Corg (%)	Opal (%)	U (ppm)	Th (ppm)	234U/238U	230Th (dpm/g)	230Thx (dpm/g)
53	EPGC04	0-3	73.8	0.52	-	1.61	3.04	1.02+/-0.04	2.57	1.97
		10-13	77	0.53	-	2.59	2.54	1.09+/-0.02	1.95	1.48
		23-26	85.2	0.37	-	4.44	1.52	1.14+/-0.03	1.87	1.6
		37-40	90.7	0.39	-	4.7	1.02	1.21+/-0.05	2.14	1.94
		47-50	89.9	0.36	-	4.23	1.12	1.12+/-0.04	2.12	1.9
		57-60	89.8	0.32	-	3.58	1.28	1.11+/-0.03	2.01	1.76
		67-70	89.5	0.34	-	2.89	0.92	1.11+/-0.05	2.01	1.76
		77-80	88.2	0.3	-	3.55	1.13	1.09+/-0.03	2.23	1.29
		87-90	87.8	0.32	-	3.41	1.09	1.10+/-0.03	2.12	1.91
		97-100	87.8	0.47	-	3.63	1.01	1.07+/-0.05	2.08	1.88
		122-125	86.3	0.38	-	4.23	1.42	1.06+/-0.04	2.31	2.03
		142-145	86.5	0.34	-	3.57	1.66	1.13+/-0.03	2.17	1.84
		162-165	85.7	0.38	-	3.72	1.65	1.11+/-0.02	2.32	1.99
		182-185	86.1	0.39	-	2.82	1.71	1.09+/-0.02	2.07	1.74
		202-205	86.4	0.38	-	4.3	1.49	1.12+/-0.02	2.79	2.5
		222-225	88.9	0.41	-	4.24	1.09	1.11+/-0.03	2.62	2.41
		242-245	88.2	0.34	-	4.35	1.26	1.09+/-0.03	2.68	2.44
		262-265	80.2	0.35	-	4.42	2.49	1.07+/-0.02	3.04	2.55
		282-285	72.7	0.39	-	3.81	3.27	1.11+/-0.02	2.6	1.95
		302-305	85.3	0.36	-	5.9	1.49	1.09+/-0.02	3.96	3.67
		322--325	84.6	0.38	-	-	-	-	-	-
		342-345	83.6	0.34	-	-	-	-	-	-

All concentration on a salt-free basis

230Thx=unsupported 230Th

Table 24 Percent calcium carbonate, percent organic carbon and radiochemical data for core 57GC15

Survey	Core	Depth in Core (cm)	CaCO3 (%)	Corg (%)	U (ppm)	Th (ppm)	234U/238U	230Th (dpm/g)	230Thx (dpm/g)
57	GC15	1-3	81.5	0.24	0.84	2.26	1.14+/-0.04	7.59	7.14
		6-8	81.6	0.17	1.01	2.91	1.15+/-0.04	7.41	6.84
		11-13	84.2	0.17	1.06	1.9	1.11+/-0.03	6.72	6.35
		16-18	89.5	0.13	1.04	0.93	1.13+/-0.04	6.81	6.62
		21-23	89.9	0.1	1.11	0.76	1.11+/-0.03	6.37	6.22
		26-28	90.2	0.11	0.76	0.95	1.13+/-0.04	6.77	6.58
		31-33	90.1	0.11	0.76	1.07	1.18+/-0.03	6.97	6.76
		36-38	90	0.11	0.69	0.75	1.09+/-0.04	5.14	4.99
		41-43	90.4	0.1	0.67	0.89	1.06+/-0.04	4.93	4.75
		46-48	90.3	0.1	0.69	0.94	1.19+/-0.05	4.43	4.24
		51-53	89.7	0.14	0.9	1.12	1.09+/-0.04	4.14	3.92
		56-58	88.9	0.13	0.6	1.25	1.17+/-0.05	4.22	3.98
		61-63	88.8	0.13	0.64	1.27	1.18+/-0.07	3.53	3.25
		66-68	89.4	0.14	0.72	0.89	1.09+/-0.09	3.33	3.15
		71-73	88.2	0.13	0.86	1.19	1.11+/-0.04	3.32	3.08
		76-78	89.2	0.14	0.61	1.19	1.08+/-0.04	2.96	2.72
		81-83	87.6	0.14	0.65	1.33	1.12+/-0.04	2.94	2.68
		86-88	87	0.16	0.78	1.45	1.07+/-0.04	3.04	2.76
		91-93	84.2	0.15	0.86	1.92	1.05+/-0.04	3.09	2.71
		96-98	79.3	0.16	1.1	2.95	1.01+/-0.04	2.76	2.18
		101-103	76.8	0.17	1.02	3.85	1.02+/-0.03	2.75	1.99
		106-108	72.4	0.13	1.14	4.87	1.05+/-0.03	2.87	2.02
		111-113	83.6	0.11	1.1	2.29	1.19+/-0.04	2.72	2.67
		118-120	88.7	0.1	0.75	1.35	1.04+/-0.03	2.3	2.03
		123-125	86.3	0.1	0.58	1.21	1.10+/-0.03	2.1	1.86
		133-135	87.9	0.12	1.04	1.33	1.10+/-0.03	2.37	2.11
		143-145	87.9	0.15	1.95	1.37	1.05+/-0.03	2.09	1.82
		153-155	84.8	0.13	1.21	1.94	1.11+/-0.02	1.76	1.38
		163-165	82.4	0.13	1.04	2.35	1.10+/-0.03	1.39	0.93
		173-175	86.7	0.14	1.11	1.5	1.12+/-0.02	1.49	1.19

Table 25 Percent calcium carbonate, percent organic carbon, percent opaline silca and radiochemical data for core 57GC19

Survey	Core	Sample interval (cm)	Depth (cm)	CaCO3 (%)	C org (%)	Opal (%)	U (ppm)	Th (ppm)	U/Th	234/238	230Th (dpm/g)	230Thex (dpm/g)
57	GC19	1.5 - 4.5	3.0	78.0	0.30	1.26	0.62	1.5	0.41	1.10	6.92	6.42
		9.5 - 12.5	11.0	78.0			0.50	2.2	0.23	1.22	6.55	6.11
		14.5 - 17.5	16.0	88.1			0.64	1.7	0.38	1.02	6.48	5.99
		19.5 - 22.5	21.0	89.8	0.31	1.26						
		24.5 - 27.5	26.0	88.1			0.56	1.1	0.51	1.08	6.85	6.40
		29.5 - 32.5	31.0	86.4								
		34.5 - 37.5	36.0	86.4			0.48	1.1	0.44	1.15	7.38	6.97
		39.5 - 42.5	41.0	86.4	0.19	1.24	0.43	1.1	0.39	1.37	7.05	6.61
		44.5 - 47.5	46.0	88.1			0.48	0.6	0.80	1.11	6.86	6.46
		49.5 - 52.5	51.0	84.8								
		54.5 - 57.5	56.0	89.8			0.47	0.9	0.52	1.19	5.52	5.11
		59.5 - 62.5	61.0	89.8	0.24	1.16	0.47	0.9	0.52	1.10	5.70	5.32
		65.5 - 68.5	67.0	88.1			0.37	1.2	0.31	1.03	4.97	4.70
		70.5 - 73.5	72.0	88.1								
		75.5 - 78.5	77.0	88.1	0.32	0.74	0.30	1.0	0.30	1.39	4.59	4.28
		85.5 - 88.5	87.0	86.4								
		92.5 - 95.5	94.0	86.4			0.42	1.1	0.38	0.98	4.41	4.11
		99.5 - 102.5	101.0	86.4	0.20	0.80						
		109.5 - 112.5	111.0	84.8			0.65	1.5	0.43	1.07	4.49	3.97
		119.5 - 122.5	121.0	84.8	0.18	1.27						
		131.5 - 134.5	133.0	86.4			0.36	1.1	0.33	1.18	3.38	3.06
		141.5 - 144.5	143.0	86.4	0.20	0.87						
		151.5 - 154.5	153.0	88.1			0.52	1.1	0.47	1.10	3.03	2.61
		161.5 - 164.5	163.0	89.0	0.41	0.82						
		171.5 - 174.5	173.0	89.8			0.52	1.1	0.47	1.35	2.85	2.33
		181.5 - 184.5	183.0	84.8	0.41	0.79						
		191.5 - 194.5	193.0	84.8								
		201.5 - 204.5	203.0	88.1	0.61	0.72	0.58	0.8	0.73	1.20	1.12	0.57
		209.5 - 212.5	211.0	86.4			0.98	0.8	1.23	1.35	2.10	1.12
		219.5 - 222.5	221.0	89.8	0.44	0.61						
		231.5 - 234.5	233.0	88.1			0.43	0.8	0.54	1.14	0.77	0.41
		241.5 - 244.5	243.0	86.4	0.31	1.09						
		251.5 - 254.5	253.0	86.4			0.56	1.2	0.47	1.10	0.86	0.40
		261.5 - 264.5	263.0	86.4	0.12	1.07						
		271.5 - 274.5	273.0	88.1			0.64	1.0	0.64	1.13	0.81	0.27
		281.5 - 284.5	283.0	89.8	0.18							
		291.5 - 294.5	293.0	88.1			2.28	0.6	3.80	1.06	1.26	0.00

Table 26 Miscellaneous radiochemical data on cores 57GC016,57GC012, 57GC021, 57GC015, 57GC04 and 57GC22B from the Carnarvon Terrace (analyses by Amdel)

Survey	Core	Depth (cm)	U238 (mBq/g)	U234 (mBq/g)	U (ppm)	Th232 (mBq/g)	Th232 (ppm)	Th230 (mBq/g)	Ra226 (mBq/g)
57	GC016	0-3	5.6	8.1	0.45	12	2.8	210	76
	GC016	12-15	10	9.7	0.81	5.6	1.4	170	98
	GC016	40-43	3.3	4.4	0.27	8.3	2	180	150
	GC016	75-77	10	9.2	0.81	3.5	0.9	46	29
	GC016	125-128	16	16	1.3	12	2.9	67	41
	GC012	0-3	9.2	13	0.75	18.1	4.4	69	44
	GC021	0-3	5.1	4.6	0.41	5.1	1.2	200	150
	GC015	0-3	7.8	8.6	0.63	11	2.6	200	64
	GC04	0-3	15	18	1.2	12	3	62	39
	GC022B	0-3	13	15	1.1	8.5	2.1	40	19

Stable Isotope Data

The stable carbon and oxygen isotope results for cores from the Exmouth Plateau and Carnarvon Terrace are assembled in Tables 34 - 40. The bulk sedimentation rates for these cores, determined from oxygen isotope data are presented in Tables 27-33 below. These data have been used for a critical assessment of the Late Quaternary (glacial/interglacial) palaeoceanography of the north eastern Indian Ocean, with special reference to the Leeuwin Current (McCorkle and others, 1993).

Table 27 Bulk sedimentation rates for core 53GC04

Survey	Core	Depth Interval (cm)	Bulk Sedimentation Rate (cm/ky)
53	GC04	0-26	2.16
		26-71	3.73
		71-169	1.96
		169-294	2.23

Table 28 Bulk sedimentation rates for core 53GC06

Survey	Core	Depth Interval (cm)	Bulk Sedimentation Rate (cm/ky)
53	GC06	0-21	1.70
		21-60	3.23
		60-109	0.99
		109-249	2.50

Table 29 Bulk sedimentation rates for core 53GC07

Survey	Core	Depth Interval (cm)	Bulk Sedimentation Rate (cm/ky)
53	GC07	0-29	2.37
		29-71	3.52
		71-171	2.01
		171-319	2.65

Table 30 Bulk sedimentation rates for core 53GC09

Survey	Core	Depth Interval (cm)	Bulk Sedimentation Rate (cm/ky)
53	GC09	0-32	2.63
		32-78	3.79
		78-119	0.82
		119-249	2.32

Table 31 Bulk sedimentation rates for core 53GC11

Survey	Core	Depth Interval (cm)	Bulk Sedimentation Rate (cm/ky)
53	GC11	0-32	1.49
		32-78	3.44

Table 32 Bulk sedimentation rates for core 57GC15

Survey	Core	Depth Interval (cm)	Bulk Sedimentation Rate (cm/ky)
57	GC15	0-14	1.16
		14-37	1.91
		37-70	0.65
		70-100	0.55

Table 33 Bulk sedimentation rates for core 57GC19

Survey	Core	Depth Interval (cm)	Bulk Sedimentation Rate (cm/ky)
57	GC19	0-22	1.83
		22-53	2.53
		53-116	1.28
		116-190	1.32

Table 34a Planktonic foraminiferal stable isotope data for core 53GC04

Survey	Sample Interval (cm)	Depth (cm)	G. sacculifer (w/o sac, 250-300 um) δ18O average	δ18O std.dev	d13C average	d13C std.dev
53GC04	0 - 3	1.5	-1.78		1.66	
	5 - 8	6.5	-1.65		1.59	
	10 - 13	11.5	-1.97		1.64	
	18 - 21	19.5	-2.08	0.18	1.20	0.23
	23 - 26	24.5	-1.46	0.02	1.20	0.13
	32 - 35	33.5	-0.82	0.49	1.12	0.34
	37 - 40	38.5	-0.61	0.34	1.05	0.41
	42 - 45	43.5	-0.65	0.16	1.21	0.26
	47 - 50	48.5	-0.58		1.43	
	52 - 55	53.5	-0.59		1.47	
	57 - 60	58.5	-0.75		1.35	
	62 - 65	63.5	-0.75	0.02	1.06	0.18
	67 - 70	68.5	-0.60		1.48	
	72 - 75	73.5	-0.86	0.03	1.17	0.07
	77 - 80	78.5	-0.89	0.13	1.32	0.11
	82 - 85	83.5	-1.03	0.12	1.21	0.17
	87 - 90	88.5	-0.91	0.11	1.10	0.05
	92 - 95	93.5	-0.83	0.25	1.37	0.02
	97 - 100	98.5	-1.02	0.19	1.21	0.11
	102 - 105	103.5	-1.01	0.08	1.13	0.01
	112 - 115	113.5	-0.97		0.78	
	122 - 125	123.5	-1.09		0.95	
	132 - 135	133.5	-0.86		1.04	
	142 - 145	143.5	-0.98		1.28	
	152 - 155	153.5	-0.81		0.90	
	162 - 165	163.5	-0.72		1.36	
	172 - 175	173.5	-1.16	0.16	1.13	0.07
	182 - 185	183.5	-1.16	0.22	1.40	0.21
	192 - 195	193.5	-1.56	0.08	1.21	0.03
	202 - 205	203.5	-1.18	0.37	1.27	0.27
	212 - 215	213.5	-1.53	0.18	1.22	0.04
	222 - 225	223.5	-1.32	0.39	1.49	0.25
	232 - 235	233.5	-1.71	0.20	1.11	0.02
	242 - 245	243.5	-1.83	0.33	1.09	0.14
	252 - 255	253.5	-2.16	0.30	1.01	0.08
	262 - 265	263.5				
	272 - 275	273.5	-1.98	0.11	1.20	0.04
	282 - 285	283.5	-2.03	0.06	1.02	0.01
	292 - 295	293.5	-1.46	0.03	0.68	0.02
	302 - 305	303.5	-0.86	0.08	0.92	0.05
	312 - 315	313.5	-1.10	0.37	0.90	0.11
	322 - 325	323.5	-0.94		1.01	
	332 - 335	333.5	-0.79		0.72	
	342 - 345	343.5	-1.09		0.62	
	352 - 355	353.5	-0.98		0.87	
	362 - 365	363.5	-1.06		0.87	
	372 - 375	373.5	-1.16		0.73	
	382 - 385	383.5	-1.35		0.86	
	392 - 395	393.5	-1.06		1.06	
	402 - 405	403.5	-1.48		1.14	

Table 34b Benthic foraminiferal stable isotope data for core 53GC04

Survey	Sample Interval (cm)	Depth (cm)	C. wuellerstorfi (>250 um) d18O	C. wuellerstorfi (>250 um) d13C	C. wuellerstorfi (>250 um) d18O	C. wuellerstorfi (>250 um) d13C	C. wuellerstorfi (>250 um) d18O	C. wuellerstorfi (>250 um) d13C	U. peregrina (>250 um) d18O	U. peregrina (>250 um) d13C	U. peregrina (>250 um) d18O	U. peregrina (>250 um) d13C	U. peregrina (>250 um) d18O	U. peregrina (>250 um) d13C	U. peregrina (>250 um) d18O	U. peregrina (>250 um) d13C
53GC04	0 - 3	1.5			2.07	0.77										
	3 - 5	4.0					2.45	0.82	1.91	0.81					2.58	-0.12
	5 - 8	6.5			1.87	0.59										
	8 - 10	9.0					1.89	0.75	1.80	0.80					3.04	-0.23
	10 - 13	11.5			1.87	0.65										
	13 - 15	14.0					1.54	0.62	1.82	0.82						
	16 - 18	17.0					2.22	0.66	2.26	0.73						
	18 - 21	19.5			2.22	0.77										
	21 - 23	22.0					2.36	0.51	2.97	0.86					2.57	-0.42
	23 - 26	24.5			2.43	0.60										
	26 - 29	27.5					3.07	0.51	2.45	0.54					3.69	-0.05
	29 - 32	30.5					2.82	0.55	2.98	0.67					3.57	-0.20
	32 - 35	33.5			2.62	0.57										
	35 - 37	36.0					3.42	0.48	2.68	0.62					3.50	-0.11
	37 - 40	38.5														
	40 - 42	41.0					3.01	0.57	3.15	0.72					4.11	-0.24
	42 - 45	43.5			3.22	0.63										
	45 - 47	46.0					3.43	0.45	3.34	0.46					4.10	-0.22
	47 - 50	48.5			3.07	0.58										
	50 - 52	51.0					3.35	0.43	3.32	0.61						
	52 - 55	53.5	3.37	0.55	2.84	0.64					3.80	-0.04				
	55 - 57	56.0					3.48	0.53	3.47	0.55						
	57 - 60	58.5	2.91	0.71	2.98	0.67					3.52	0.03				
	60 - 62	61.0					3.31	0.62	3.19	0.47						
	62 - 65	63.5														
	65 - 67	66.0					3.30	0.43	3.29	0.59						
	67 - 70	68.5	2.97	0.56							3.79	0.00				
	70 - 72	71.0					2.98	0.64	3.39	0.60						
	72 - 75	73.5														
	75 - 77	76.0					3.07	0.65	3.29	0.75						
	77 - 80	78.5														
	80 - 82	81.0					3.19	0.57	2.93	0.81						
	82 - 85	83.5			3.07	0.38							4.03	-0.19		
	85 - 87	86.0					3.04	0.64	2.87	0.59						
	87 - 90	88.5														
	90 - 92	91.0					3.09	0.73	2.86	0.79						
	92 - 95	93.5														
	95 - 97	96.0					2.91	0.59	2.87	0.56						
	97 - 100	98.5			2.53	0.42							3.57	-0.31		
	102 - 105	103.5														
	112 - 115	113.5			2.68	0.45							3.39	-0.17		
	122 - 125	123.5			2.42	0.38							3.27	-0.30		
	132 - 135	133.5			2.60	0.47							3.50	-0.27		
	142 - 145	143.5			2.43	0.53							3.24	-0.13		
	152 - 155	153.5														
	162 - 165	163.5			2.54	0.55							3.56	-0.18		
	172 - 175	173.5														
	182 - 185	183.5			2.76	0.60							3.23	-0.09		

Note - data columns represent replicate analyses
Each analysis based on 2-4 individual specimens
Data not averaged due to mixing of Glacial and Holocene foraminfera

Table 35a Planktonic foraminiferal stable isotope data for core 53GC06

Survey	Sample Interval (cm)	Depth (cm)	G. saculifer w/o sac, 250-300 um d18O Average	d18O Std dev	d13C Average	d13C Std dev
53GC06	1-3	2	-1.90	0.22	2.00	0.19
	6-8	7	-2.32	0.03	1.89	0.07
	11-13	12	-1.83	0.11	1.60	0.15
	16-18	17	-2.13	0.01	1.99	0.16
	21-23	22	-1.07	0.24	1.77	0.15
	26-28	27	-0.52	0.10	1.90	0.07
	31-33	32	-0.75	0.01	1.65	0.23
	36-38	37	-0.61	0.03	1.75	0.19
	41-43	42	-0.49	0.07	1.82	0.02
	46-48	47	-1.01	0.00	2.14	0.18
	51-53	52	-0.93	0.02	2.18	0.29
	56-58	57	-0.58	0.24	1.83	0.30
	61-63	62	-0.77	0.12	1.85	0.09
	68-70	69	-0.95	0.07	1.86	0.02
	73-75	74	-0.92	0.26	1.94	0.02
	78-80	79	-1.05	0.05	1.73	0.11
	83 - 85	84	-1.01	0.17	1.61	0.05
	88 - 91	90	-1.09	0.05	1.73	0.13
	93 - 95	94	-0.98	0.16	1.67	0.12
	103 - 105	104	-1.02	0.03	2.00	0.08
	113 - 115	114	-1.46	0.24	2.05	0.12
	123 - 125	124	-1.24	0.11	1.71	0.01
	132 - 135	134	-1.56	0.04	2.07	0.02
	143 - 145	144	-1.69	0.15	2.09	0.09
	153 - 155	154	-1.46	0.06	1.78	0.04
	163 - 165	164	-1.17	0.44	1.83	0.13
	173 - 175	174	-1.48	0.18	1.93	0.00
	183 - 185	184	-1.65	0.02	1.72	0.01
	193 - 195	194	-1.56	0.01	1.63	0.33
	223 - 225	224	-1.85	0.00	1.82	0.11
	233 - 235	234	-0.99	0.23	1.29	0.15
	243 - 245	244	-1.90	0.02	1.53	0.13
	253 - 255	254	-0.44	0.07	1.61	0.03
	263 - 265	264	-0.58	0.15	1.70	0.14
	268 - 273	271	-0.63	0.06	1.60	0.07
	273 - 275	274	-0.66	0.15	1.50	0.05
	283 - 285	284	-0.64	0.17	1.43	0.10
	293 - 295	294	-0.83		1.45	
	303 - 305	304	-0.65	0.01	1.33	0.31

Table 35b Benthic foraminiferal stable isotope data for core 53GC06

Survey	Sample interval (cm)	Depth (cm)	C. wuellerstorfi >250um d18O	C. wuellerstorfi >250um d13C	C. wuellerstorfi >250um d18O	C. wuellerstorfi >250um d13C	U. peregrina >250um d18O	U. peregrina >250um d13C	U. peregrina >250um d18O	U. peregrina >250um d13C
53GC06	1-3	2	2.51	0.56			3.28	-0.06		
	6-8	7	2.45	0.77	2.37	0.64	3.51	-0.03	4.19	-0.36
	11-13	12	3.91	0.23	3.72	0.38	3.84	-0.38	4.06	-0.30
	16-18	17	2.61	0.59	2.58	0.77	3.87	-0.23	3.08	-0.29
	21-23	22	3.68	0.30	3.85	0.32	4.79	-0.39	4.54	-0.59
	26-28	27	3.93	0.20	3.69	0.24	4.53	-0.41	4.53	-0.47
	31-33	32	3.92	0.27	3.84	0.27	4.81	-0.39	4.52	-0.46
	36-38	37	3.96	0.32			4.67	-0.40		
	41-43	42								
	46-48	47	3.70	0.45			4.32	-0.11		
	51-53	52								
	56-58	57	3.51	0.38			4.44	-0.21		
	61-63	62								

Table 36a Planktonic foraminiferal stable isotope data for core 53GC07

Survey	Sample Interval (cm)	Depth (cm)	G. sacculifer w/o sac, 250-300 um d18O Average	d18O Std dev	d13C Average	d13C Std dev
53GC07	0.5 - 3.5	2	-2.16	0.12	1.33	0.15
	5.5 - 8.5	7	-2.03	0.04	1.37	0.01
	10.5 - 13.5	12	-2.05		1.54	
	16.5 - 19.5	18	-2.03	0.02	1.19	0.27
	21.5 - 24.5	23	-1.90		1.14	
	26.5 - 29.5	28	-1.25	0.03	1.08	0.01
	31.5 - 34.5	33	-1.22		1.15	
	36.5 - 39.5	38	-0.64	0.21	0.84	0.04
	41.5 - 44.5	43	-0.43	0.08	1.15	0.05
	46.5 - 49.5	48	-0.48	0.02	1.25	0.04
	51.5 - 54.5	53	-0.75		1.17	
	56.5 - 59.5	58	-0.69	0.12	1.05	0.04
	61.5 - 64.5	63	-0.72		1.40	
	66.5 - 69.5	68	-0.68		1.27	
	71.5 - 74.5	73	-0.87		1.30	
	77.5 - 80.5	79	-0.81		1.45	
	82.5 - 85.5	84	-0.89		1.19	
	87.5 - 90.5	89	-0.64		1.25	
	92.5 - 95.5	94	-0.77		1.23	
	96.5 - 99.5	98	-0.82		1.15	
	104.5 - 107.5	106	-0.93		1.09	
	114.5 - 117.5	116	-0.96		1.13	
	124.5 - 127.5	126	-0.89		1.09	
	134.5 - 137.5	136	-0.90	0.01	0.87	0.08
	144.5 - 147.5	146	-1.01	0.05	0.80	0.17
	154.5 - 157.5	156	-1.13		1.08	
	164.5 - 167.5	166	-1.14		1.30	
	174.5 - 177.5	176	-1.40		1.23	
	184.5 - 187.5	186	-1.41		1.19	
	194.5 - 197.5	196	-1.67		1.30	
	204.5 - 207.5	206	-1.77	0.29	1.13	0.05
	214.5 - 217.5	216	-1.75	0.02	1.18	0.06
	224.5 - 227.5	226	-1.70		1.13	
	234.5 - 237.5	236	-1.87		1.05	
	244.5 - 247.5	246	-1.48		1.74	
	254.5 - 257.5	256	-1.92		0.99	
	264.5 - 267.5	266	-1.74		1.08	
	274.5 - 277.5	276	-2.04		1.08	
	284.5 - 287.5	286	-2.08		1.05	
	294.5 - 297.5	296	-2.28	0.11	0.89	0.14
	304.5 - 307.5	306	-2.06	0.01	0.77	0.00
	312.5 - 315.5	314	-1.89		0.49	
	322.5 - 325.5	324	-1.03		0.66	
	332.5 - 335.5	334	-0.70	0.20	0.88	0.11
	342.5 - 345.5	344	-0.80	0.09	0.76	0.07
	352.5 - 355.5	354	-0.89		0.78	
	362.5 - 365.5	364	-0.85		0.85	
	372.5 - 375.5	374	-0.67		0.92	
	382.5 - 385.5	384	-0.73		0.87	
	392.5 - 395.5	394	-1.26		0.96	
	402.5 - 405.5	404	-1.02		0.87	
	413.5 - 416.5	415	-1.24		0.79	
	424.5 - 427.5	426	-1.10		0.84	
	434.5 - 437.5	436	-0.71		1.08	
	444.5 - 447.5	446	-0.76		1.50	
	454.5 - 457.5	456	-1.22		1.42	
	464.5 - 467.5	466	-1.35		1.43	
	474.5 - 477.5	476	-1.35		1.56	
	484.5 - 487.5	486	-1.08		1.66	
	494.5 - 497.5	496	-1.33		1.73	

Table 36b Benthic foraminiferal stable isotope data for core 53GC07

Survey	Sample Interval (cm)	Depth (cm)	C. wuellerstorfi >250um d18O	C. wuellerstorfi >250um d13C	C. wuellerstorfi >250um d18O	C. wuellerstorfi >250um d13C	U. peregrina >250um d18O	U. peregrina >250um d13C	U. peregrina >250um d18O	U. peregrina >250um d13C
53GC07	0.5 - 3.5	2								
	3.5 - 5.5	5			2.41	0.78			2.95	0.03
	5.5 - 8.5	7								
	8.5 - 10.5	10			2.34	0.75			3.06	0.00
	10.5 - 13.5	12								
	13.5 - 16.5	15			2.57	0.71			4.20	-0.50
	16.5 - 19.5	18								
	19.5 - 21.5	21			3.30	0.50			3.57	-0.12
	21.5 - 24.5	23								
	24.5 - 26.5	26			2.79	0.51			2.93	-0.11
	26.5 - 29.5	28			3.56	0.54			4.37	-0.56
	31.5 - 34.5	33			3.54	0.40			4.63	-0.62
	36.5 - 39.5	38	3.93	0.26	4.07	0.23	4.60	-0.53	4.63	-0.63
	41.5 - 44.5	43	4.03	0.27	4.06	0.03	4.91	-0.54	4.65	-0.48
	46.5 - 49.5	48			3.80	0.14			4.75	-0.47
	51.5 - 54.5	53			3.75	0.25			4.51	-0.57
	56.5 - 59.5	58			3.94	0.30			4.58	-0.52
	61.5 - 64.5	63			(4.03	0.24)			4.42	-0.31
	66.5 - 69.5	68.0			3.82	0.38			4.29	-0.38

Table 37a Planktonic foraminiferal stable isotope data for core 53GC09

Survey	Sample Interval (cm)	Depth (cm)	G. saculifer (w/o sac, 250-300 um) d18O Average	d18O Std Dev	d13C Average	d13C Std Dev
53GC09	0 - 3	1.5	-2.05		1.12	
	5 - 8	6.5	-2.19		1.21	
	11.5 - 14.5	13.0	-1.68		1.19	
	16.5 - 19.5	18.0	-1.67		1.16	
	21.5 - 24.5	23.0	-1.46		1.00	
	27.0 - 30.0	28.5	-1.64		0.97	
	33.5 - 36.5	35.0	-1.08		0.95	
	38.5 - 41.5	40.0	-1.20		1.13	
	43.5 - 46.5	45.0	-1.05		1.27	
	48.5 - 51.5	50.0	-1.12		1.18	
	53.5 - 56.5	55.0	-0.95		1.46	
	58.5 - 61.5	60.0	-1.00		1.12	
	63.5 - 66.5	65.0	-0.73		1.51	
	68.5 - 71.5	70.0	-1.15		1.32	
	73.5 - 76.5	75.0	-0.68		1.57	
	78.5 - 81.5	80.0	-1.07	0.16	1.75	0.16
	83.5 - 86.5	85.0	-1.10	0.08	1.33	0.06
	88.5 - 91.5	90.0	-0.88	0.08	1.36	0.30
	95 - 98	96.5	-1.03	0.26	1.53	0.10
	102 - 105	103.5	-1.05	0.18	1.59	0.06
	112 - 115	113.5	-0.98	0.12	1.93	0.11
	122 - 125	123.5	-1.33	0.09	2.03	0.05
	132 - 135	133.5	-1.37	0.17	2.14	0.01
	142 - 145	143.5	-1.48	0.03	1.81	0.11
	152 - 155	153.5	-1.52	0.16	1.90	0.11
	162 - 165	163.5	-1.40	0.14	1.90	0.29
	172 - 175	173.5	-1.24	0.12	1.66	0.05
	182 - 185	183.5	-1.45	0.04	1.70	0.19
	192 - 195	193.5	-1.81	0.28	1.88	0.07
	202 - 205	203.5	-1.50	0.01	1.68	0.00
	212 - 215	213.5	-1.66	0.25	1.54	0.08
	222 - 225	223.5	-1.78	0.07	1.33	0.07
	232 - 235	233.5	-1.85	0.25	1.31	0.06
	242 - 245	243.5	-1.49	0.19	1.38	0.03
	252 - 255	253.5	-0.66		1.15	
	262 - 265	263.5	-0.48		1.55	
	272 - 275	273.5	-0.59		1.55	
	282 - 285	283.5	-0.68		1.13	
	292 - 295	293.5	-0.73		1.40	
	302 - 305	303.5	-0.89		1.66	
	312 - 315	313.5	-0.91	0.10	1.37	0.05
	322 - 325	323.5	-1.14		1.83	
	332 - 335	333.5	-1.29		1.42	
	342 - 345	343.5	-1.49		1.75	
	352 - 355	353.5	-1.53		1.86	
	362 - 365	363.5	-0.97		1.52	
	372 - 375	373.5	-1.43		1.54	
	382 - 385	383.5	-0.93		1.73	
	392 - 398?	393.5	-1.58		1.74	
	402 - 405	403.5	-1.04		1.80	
	412 - 415	413.5	-1.70		1.25	
	422 - 425	423.5	-0.90		1.14	
	432 - 435	433.5	-0.80		1.65	

Table 37b Benthic foraminiferal stable isotope data for core 53GC09

Survey	Sample Interval (cm)	Depth (cm)	C. wuellerstorfi >250 um d18O	C. wuellerstorfi >250 um d13C	C. wuellerstorfi >250 um d18O	C. wuellerstorfi >250 um d13C	U. peregrina >250 um d18O	U. peregrina >250 um d13C	U. peregrina >250 um d18O	U. peregrina >250 um d13C
53GC09	0 - 3	1.5	1.63	0.70	2.92	0.64	2.84	-0.08		
	5 - 8	6.5	2.20	0.84	2.13	0.82	2.86	-0.01	2.86	-0.06
	11.5 - 14.5	13.0	2.20	0.70	2.35	0.70	2.79	-0.03	2.54	0.19
	16.5 - 19.5	18.0	3.17	0.63	3.20	0.63	3.18	-0.21		
	21.5 - 24.5	23.0	2.43	0.64	2.66	0.74	3.15	-0.09		
	27.0 - 30.0	28.5	3.15	0.72	3.14	0.66	3.18	-0.02	2.74	0.03
	33.5 - 36.5	35.0	2.89	0.80	3.17	0.66				
	38.5 - 41.5	40.0	3.30	0.67	3.09	0.77	3.78	-0.40	3.42	-0.27
	43.5 - 46.5	45.0	3.23	0.66	3.27	0.67	3.52	-0.13	3.37	-0.04
	48.5 - 51.5	50.0	2.65	0.57	2.94	0.76	3.64	-0.30	3.92	0.05
	53.5 - 56.5	55.0	3.11	0.81	3.30	0.54	3.67	-0.29	3.90	-0.05
	58.5 - 61.5	60.0	3.26	0.62	3.20	0.70	3.94	-0.34	3.91	-0.21
	63.5 - 66.5	65.0	3.01	0.73	2.85	0.83	3.66	-0.07		
	68.5 - 71.5	70.0	3.10	0.55	2.99	0.60	3.83	-0.26	3.29	-0.56
	73.5 - 76.5	75.0	3.02	0.67	2.94	0.69	3.51	-0.33	3.45	-0.31

Table 38a Planktonic foraminiferal stable isotope data for core 53GC11

Survey	Sample Interval (cm)	Depth (cm)	G. saculifer (w/o sac, 250-300 um) d18O	G. saculifer (w/o sac, 250-300 um) d13C
53GC11	1 - 3	2.0	-1.73	1.24
	6 - 8	7.0	-1.48	1.35
	10 - 12	11.0	-1.99	1.25
	16 - 18	17.0	-1.36	0.92
	25 - 27	26.0	-0.71	1.16
	31 - 33	32.0	-0.95	0.83
	36 - 38	37.0	-0.48	1.21
	41 - 43	42.0	-0.86	1.13
	46 - 48	47.0	-0.85	1.46
	51 - 53	52.0	-0.72	1.18
	56 - 58	57.0	-0.61	1.23
	61 - 63	62.0	-0.78	1.34
	66 - 68	67.0	-0.85	1.01
	71 - 73	72.0	-1.27	0.89
	76 - 78	77.0	-0.72	0.86
	81 - 83	82.0	-0.79	1.00
	86 - 88	87.0	-0.70	1.04
	91 - 93	92.0	-0.73	1.53
	96 - 98	97.0	-0.70	1.23
	102 - 105	103.5	-1.04	1.47
	112 - 115	113.5	-0.72	1.46
	122 - 125	123.5	-0.8	1.17
	132 - 135	133.5	-1.22	0.98
	142 - 145	143.5	-1.61	1.41
	152 - 155	153.5	-1.59	1.35
	162 - 165	163.5	-1.39	1.62
	172 - 175	173.5	-1.33	1.53
	182 - 185	183.5	-1.23	1.65
	192 - 195	193.5	-1.26	1.04
	202-205	203.5	-0.96	1.18
	212 - 215	213.5	-0.82	1.02
	222 - 225	223.5	-1.02	1.5
	232 - 235	233.5	-1.2	0.94
	242 - 245	243.5	-1.35	1.6
	252 - 255	253.5	-1.37	1.45
	262 - 265	263.5	-1.83	1.12
	272 - 275	273.5	-1.41	1.48
	282 - 285	283.5	-0.9	1.11
	292 - 295	293.5	-1.38	1.57
	303 - 305	304	-1.78	1.68
	308 - 310	309	-0.93	1.7
	313 - 315	314	-1.07	1.59
	323 - 325	324	-1.09	1.64
	333 - 335	334	-0.56	1.1

Table 38b Benthic foraminiferal stable isotope data for core 53GC11

Survey	Sample Interval (cm)	Depth (cm)	C. wuellerstorfi > 250 um d18O	C. wuellerstorfi > 250 um d13C	U. peregrina > 250 um d18O	U. peregrina > 250 um d13C
53GC11	1 - 3	2.0	2.45	0.68	3.22	-0.05
	6 - 8	7.0	2.22	0.81	2.73	0.17
	10 - 12	11.0	2.76	0.48	2.85	0.23
	16 - 18	17.0	3.27	0.50	3.52	-0.27
	25 - 27	26.0	3.08	0.54	3.79	-0.31
	31 - 33	32.0	2.93	0.55	3.84	-0.25
	36 - 38	37.0	2.96	0.47	4.07	-0.26
	41 - 43	42.0	2.40	0.26	4.14	-0.42
	46 - 48	47.0	2.78	0.63	3.85	-0.22
	51 - 53	52.0	3.03	0.49	3.48	-0.12
	56 - 58	57.0	3.13	0.56	3.43	-0.42
	61 - 63	62.0	3.22	0.44	3.47	-0.20
	66 - 68	67.0	3.15	0.52	3.49	-0.40
	71 - 73	72.0	2.95	0.49	3.88	-0.41
	76 - 78	77.0	2.89	0.48	3.68	-0.24
	81 - 83	82.0	3.05	0.51	3.50	-0.27
	86 - 88	87.0	2.86	0.50	3.35	-0.11
	91 - 93	92.0	3.03	0.55	3.43	-0.47
	96 - 98	97.0	3.33	0.34	3.58	-0.29

Table 39a Planktonic foraminiferal stable isotope data for core 57GC15

Survey	Sample Interval (cm)	Depth (cm)	G. sacculifer (w/o sac, 250-300 um) d18O Average	d18O Std dev	d13C Average	d13C Std dev
57GC15	1 - 3	2.0	-1.36		1.70	
	6 - 8	7.0	-1.03		1.69	
	11 - 13	12.0	-1.26		1.27	
	16 - 18	17.0	0.29		0.77	
	21 - 23	22.0	-0.72		0.78	
	26 - 28	27.0	-0.15		1.16	
	31 - 33	32.0	0.25		0.94	
	36 - 38	37.0	-0.17		0.76	
	41 - 43	42.0	-0.57	0.08	1.33	0.44
	46 - 48	47.0	-0.53	0.06	1.35	0.01
	51 - 53	52.0	-0.50	0.01	1.24	0.20
	61 - 63	62.0	-0.42	0.10	1.21	0.26
	66 - 68	67.0	-0.55		1.32	
	71 - 73	72.0	-0.84	0.03	1.21	0.03
	76 - 78	77.0	-0.74	0.12	1.19	0.02
	81 - 83	82.0	-0.64	0.03	1.27	0.14
	86 - 88	87.0	-1.01		1.39	
	91 - 93	92.0	-1.07	0.10	1.40	0.07
	96 - 98	97.0	-1.09	0.15	1.12	0.23
	101 - 103	102.0	-0.11	0.04	1.23	0.00
	111 - 113	112.0	0.18	0.25	0.97	0.13
	118 - 120	119.0	-0.70	0.09	1.12	0.12
	123 - 125	124.0	0.55	0.02	0.86	0.24
	133 - 135	134.0	-0.15	0.32	1.02	0.05
	143 - 145	144.0	-0.43	0.11	1.52	0.15
	153 - 155	154.0	0.01		1.08	
	163 - 165	164.0	-0.59		1.55	
	173 - 175	174.0	-0.58	0.01	1.20	0.17
	183 - 185	184.0	-0.45	0.32	1.25	0.24
	193 - 195	194.0	0.38		1.00	
	203 - 205	204.0	0.12		0.95	
	213 - 215	214.0	0.35		1.09	
	223 - 225	224.0	0.56		1.24	
	237 - 239	238.0	-0.12		1.43	

Table 39b Benthic foraminiferal stable isotope data for core 57GC15

Survey	Sample Interval (cm)	Depth (cm)	C. wuellerstorfi (>250 um) d18O	C. wuellerstorfi (>250 um) d13C	U. peregrina (>250um um) d18O	U. peregrina (>250um um) d13C
57GC15	1 - 3	2.0	2.53	0.55		
	6 - 8	7.0	2.40	0.48	4.77	-0.50
	11 - 13	12.0	3.06	0.26	4.30	-0.41
	16 - 18	17.0	4.26	0.20	4.49	-0.49
	21 - 23	22.0	3.76	0.18	3.94	-0.30
	26 - 28	27.0	3.78	0.12	3.80	-0.23
	31 - 33	32.0	3.66	-0.12	4.11	-0.34
	36 - 38	37.0	3.39	0.30	3.78	-0.61
	41 - 43	42.0	3.46	0.18	3.92	-0.57
	46 - 48	47.0	3.57	0.01	3.93	-0.80
	61 - 63	62.0	3.26	0.25	3.81	-0.44
	71 - 73	72.0	2.86	0.25	3.56	-0.37
	81 - 83	82.0	3.22	0.31	3.45	-0.26
	96 - 98	97.0	2.79	0.19	4.16	-0.44
	111 - 113	112.0	3.63	0.08	4.58	-0.86
	118 - 120	119.0	3.08	0.41	3.77	-0.23
	123 - 125	124.0	4.02	0.14	4.57	-0.66
	133 - 135	134.0	3.84	0.13	4.62	-0.66
	143 - 145	144.0	2.98	0.70	3.75	-0.11
	153 - 155	154.0	3.72	0.23	4.68	-0.77
	163 - 165	164.0	2.94	0.52	3.50	-0.20
	173 - 175	174.0	3.18	0.25	4.33	-0.41
	183 - 185	184.0	3.47	0.29	4.39	-0.57
	193 - 195	194.0	3.51	0.33	4.36	-0.63
	203 - 205	204.0	4.06	0.04	4.61	-0.66
	213 - 215	214.0	3.77	-0.03	4.17	-0.90
	223 - 225	224.0	3.95	-0.12	4.51	-0.77
	237 - 239	238.0	3.65	0.00	4.29	-0.53

Table 40a Planktonic foraminiferal stable isotope data for core 57GC19

Survey	Sample Interval (cm)	Depth (cm)	G. sacculifer (w/o sac, 250-300 um) d18O Average	d18O Std. dev.	d13C Average	d13C Std. dev.
57GC19	1.5 - 4.5	3.0	-1.17	0.13	1.93	0.25
	9.5 - 12.5	11.0	-1.01	0.02	1.27	
	14.5 - 17.5	16.0	-0.77	0.29	1.66	0.37
	19.5 - 22.5	21.0	-0.80	0.17	1.78	0.12
	24.5 - 27.5	26.0	-0.13	0.06	1.00	0.29
	29.5 - 32.5	31.0	-0.26	0.22	1.47	0.09
	34.5 - 37.5	36.0	-0.06	0.09	1.59	0.17
	39.5 - 42.5	41.0	0.03	0.22	1.51	0.11
	44.5 - 47.5	46.0	-0.15	0.10	1.56	0.15
	49.5 - 52.5	51.0	-0.16	0.02	1.57	
	54.5 - 57.5	56.0	-0.34	0.09	1.29	
	59.5 - 62.5	61.0	-0.52	0.09	1.50	0.30
	65.5 - 68.5	67.0	-0.41	0.15	1.54	
	70.5 - 73.5	72.0	-0.40	0.02	1.58	
	75.5 - 78.5	77.0	-0.42	0.13	1.04	
	85.5 - 88.5	87.0	-0.61	0.32	1.32	0.19
	92.5 - 95.5	94.0	-0.33		0.65	
	99.5 - 102.5	101.0	-0.16	0.04	1.26	0.00
	109.5 - 112.5	111.0	-0.27	0.24	0.78	0.19
	119.5 - 122.5	121.0	-0.68	0.30	1.29	0.40
	131.5 - 134.5	133.0	-0.83	0.17	1.11	0.44
	141.5 - 144.5	143.0	-0.50		0.95	
	151.5 - 154.5	153.0	-0.88	0.49	1.34	0.10
	161.5 - 164.5	163.0	-1.03	0.29	1.58	0.49
	171.5 - 174.5	173.0	-0.74	0.18	1.31	0.30
	181.5 - 184.5	183.0	-0.91	0.18	1.16	0.30
	191.5 - 194.5	193.0	-0.40	0.12	0.89	0.19
	201.5 - 204.5	203.0	-0.09	0.04	1.13	0.06
	219.5 - 222.5	221.0	-0.35		1.12	
	231.5 - 234.5	233.0	-0.44	0.09	1.71	0.04
	241.5 - 244.5	243.0	0.18	0.04	1.01	0.02
	251.5 - 254.5	253.0	0.10	0.04	1.06	0.14
	261.5 - 264.5	263.0	-0.21	0.06	1.42	0.17
	271.5 - 274.5	273.0	-0.09		1.31	
	281.5 - 284.5	283.0	-0.36		1.25	
	291.5 - 294.5	293.0	-0.26		1.28	
	301.5 - 304.5	303.0	-1.33	0.19	1.90	0.19
	311.5 - 314.5	313.0	-0.38		1.61	
	321.5 - 324.5	323.0	-0.08		1.31	

Table 40b Benthic foraminiferal stable isotope data for core 57GC19

Survey	Sample Interval (cm)	Depth (cm)	C. wuellerstorfi (>250 um) d18O	C. wuellerstorfi (>250 um) d13C	U. peregrina (>250 um) d18O	U. peregrina (>250 um) d13C
57GC19	1.5 - 4.5	3.0	3.70	0.13	2.36	0.05
	9.5 - 12.5	11.0				
	14.5 - 17.5	16.0				
	19.5 - 22.5	21.0			4.33	-0.40
	24.5 - 27.5	26.0	3.91	0.17	4.51	-0.55
	29.5 - 32.5	31.0	4.17	0.06	4.70	-0.63
	34.5 - 37.5	36.0	4.12	0.13	4.79	-0.74
	39.5 - 42.5	41.0	3.84	0.29	4.60	-0.63
	44.5 - 47.5	46.0	3.51	0.14	4.46	-0.56
	49.5 - 52.5	51.0	3.83	0.21	4.38	-0.51
	54.5 - 57.5	56.0	3.66	0.14	3.96	-0.49
	59.5 - 62.5	61.0	3.68	0.33	4.12	-0.56
	65.5 - 68.5	67.0	3.26	0.16	4.17	-0.53
	70.5 - 73.5	72.0	3.59	0.19	4.05	-0.63
	75.5 - 78.5	77.0	3.63	0.35	3.97	-0.39
	85.5 - 88.5	87.0	3.44	0.02	4.07	-0.74
	92.5 - 95.5	94.0	3.78	0.11	4.32	-0.56
	99.5 - 102.5	101.0	3.67	0.10	4.35	-0.66
	109.5 - 112.5	111.0	3.84	-0.02	4.67	-0.94
	119.5 - 122.5	121.0	3.36	0.44	4.46	-0.66

SUMMARY

This Record summarises a variety of geochemical and palaeoceanographic data from the western continental margin of Australia, including data from the Exmouth Plateau and Carnarvon Terrace. These data were assembled from analyses of gravity cores collected as part of BMR Surveys 53 (Choi and Stagg, 1987) and 57. The fifteen cores presented here were collected from water depths of between 287 and 2950 m. Data are also presented from the Mesozoic sediments of two cores, analysed for major and minor element compositions, from the Exmouth Plateau and the Argo Abyssal Plain collected during ODP Leg 123.

Several cores collected from both the Exmouth Plateau and the Carnarvon Terrace have been used for a major palaeoceanographic/climatological study of the Late Quaternary, glacial/interglacial palaeochemistry of the north eastern Indian Ocean, conducted between AGSO, Woods Hole Oceanographic Institution and the Flinders University, School of Earth Sciences. The data presented here underpin, in part, those studies. Part of that project determined sedimentation rates from both the Exmouth Plateau and the Carnarvon Terrace using both radiochemical methods and oxygen isotope data from both benthic and planktonic foraminifera, and the identification of various isotopic stage boundaries. Sedimentation rates on the Exmouth Plateau, in water depths of about 2300m, were approximately 2.2 cm/kyr. Sedimentation rates on the Carnarvon Terrace in water depths of about 2700 m varied between about 0.7 and 1.5 cm/kyr. The details of the palaeoceanographic study are published in McCorkle and others (1993). In essence, that study found higher mass accumulation rates of biogenic materials in the sediments during the last glacial maximum, than in Recent sediments. The results indicate some weak upwelling on the western margin of Australia at that time, and suggest some weakening of the southward flowing Leeuwin Current, allowing some upwelling of nutrient rich waters and increased oceanic productivity compared to the present day. A variety of trace elements have been measured in the cores, with the objective of investigating their potential as palaeoceanographic tracers of oceanic processes. The data presented here will underpin that study, but this work is still in progress.

The distributions of pore water metabolites were measured on several cores collected from the Carnarvon Terrace, and these data provide some clues to the diagenetic processes occurring in continental margin sediments that are important and indicative of the formation of some marine minerals including phosphatic-rich sediments on the outer shelf and upper-slope and manganese rich crusts and nodules on the lower-slope. These data above are not indicative of mineral forming processes and must be considered

together with the solid phase data. The pore water metabolites were indicative of a higher input of organic matter, and more extensive diagenesis on the upper -slope as compared to the mid and lower-slope sediments. There was evidence of manganese recycling between pore waters and sediments, but the extent of this appears limited. The inventory of manganese in the sediments (generally <100 ppm), is lower than concentrations generally measured in continental margin sediments (approximately a few percent by weight), and considerably lower than that found in manganese rich nodules and crusts (up to several tens of weight percent manganese). Tables of major and minor elements in sediments have been presented, including a table of ranges of concentrations for easy comparison to other areas of the Australian continental margin, and potential identification of geochemical enrichments in sediments, above elemental crustal abundances. The database of trace and heavy metal abundances in sediments may be used to document 'baseline' environmental conditions, which may be used to document and evaluate anthropogenic contributions to the sediments and environmental change.

The complete set of major and trace element data from two cores collected as part of the ODP Leg 123 survey are presented. Part of these data were utilised for an examination of the palaeochemistry and evolution of the Late Cretaceous sediments on the north western Australian continental margin.

ACKNOWLEDGEMENTS

We thank the Master and crew of RV Rig Seismic for assistance during collection of these cores, and AGSO technical and scientific staff for assistance in processing the cores. XRF analyses were conducted by John Pyke at AGSO. The radiochemistry, organic carbon, calcium carbonate and opaline silica analyses were completed at The Flinders University in South Australia. The radiochemistry analyses on the six cores collected from the Carnarvon Terrace were completed by Amdel. The analyses of select samples for stable isotope analyses were conducted at Woods Hole Oceanographic Institute (WHOI). We thank John Marshall for his review of this Record.

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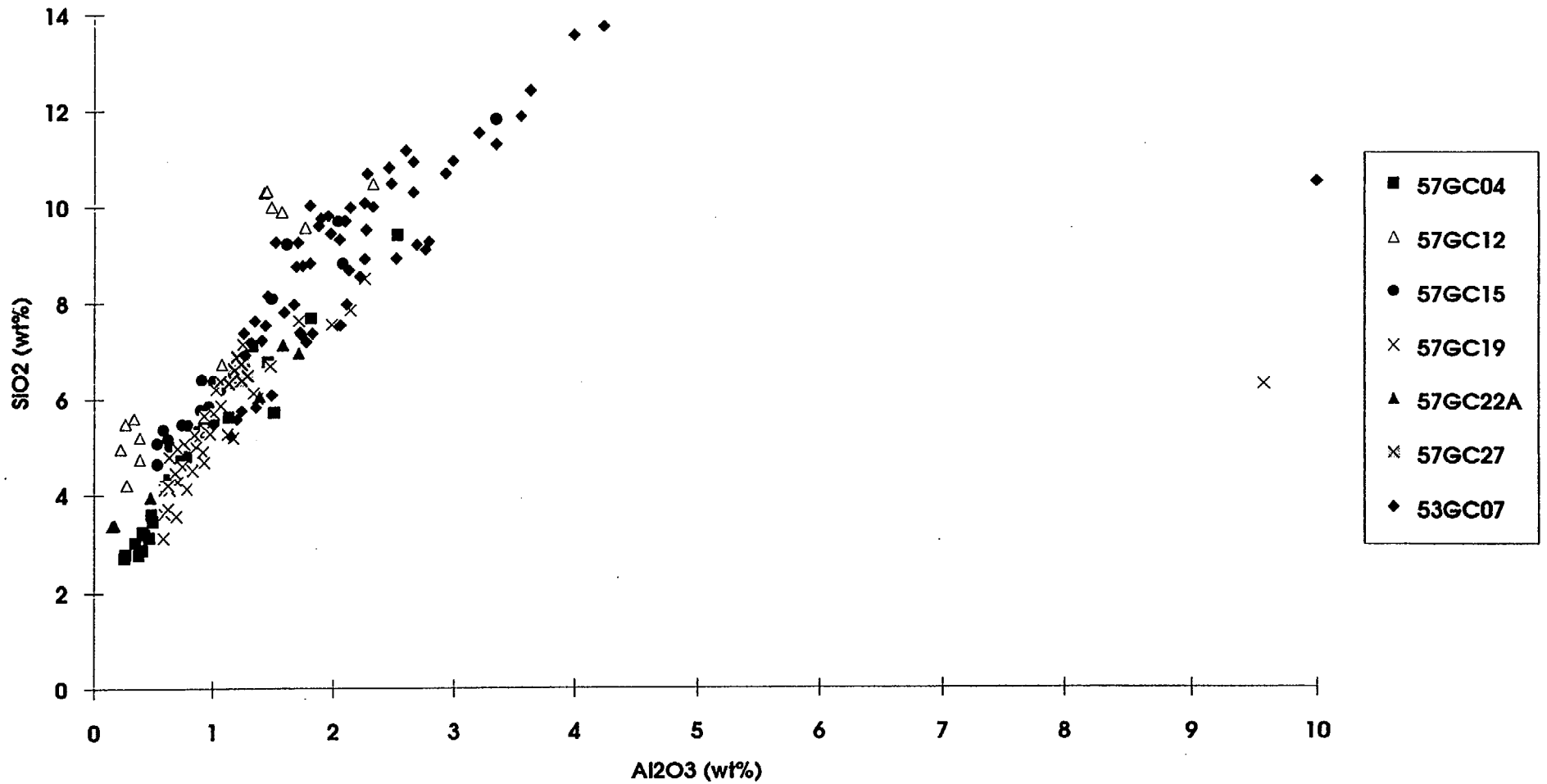
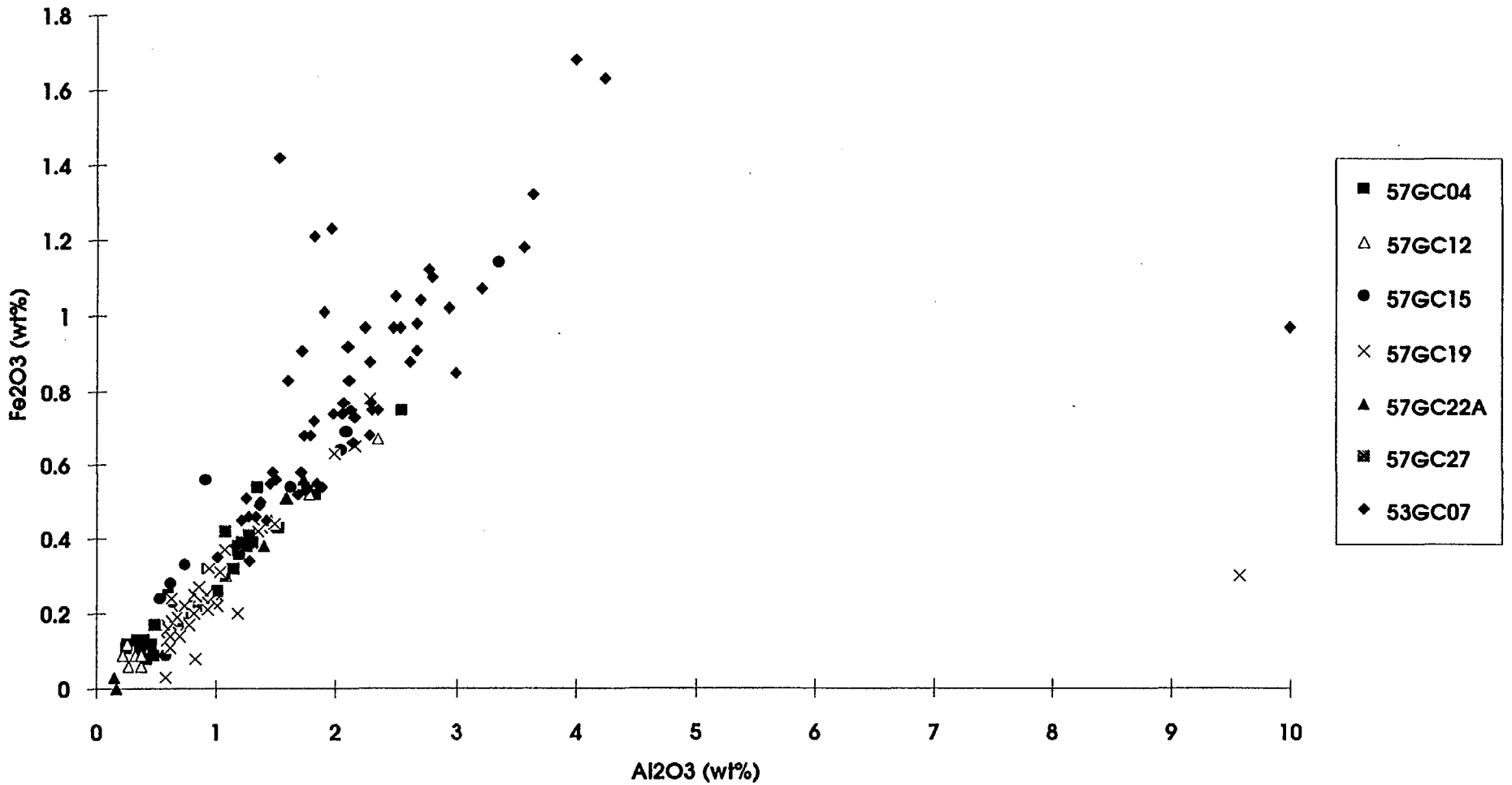
Appendix A: Plots of Al_2O_3 with several select major and trace elements

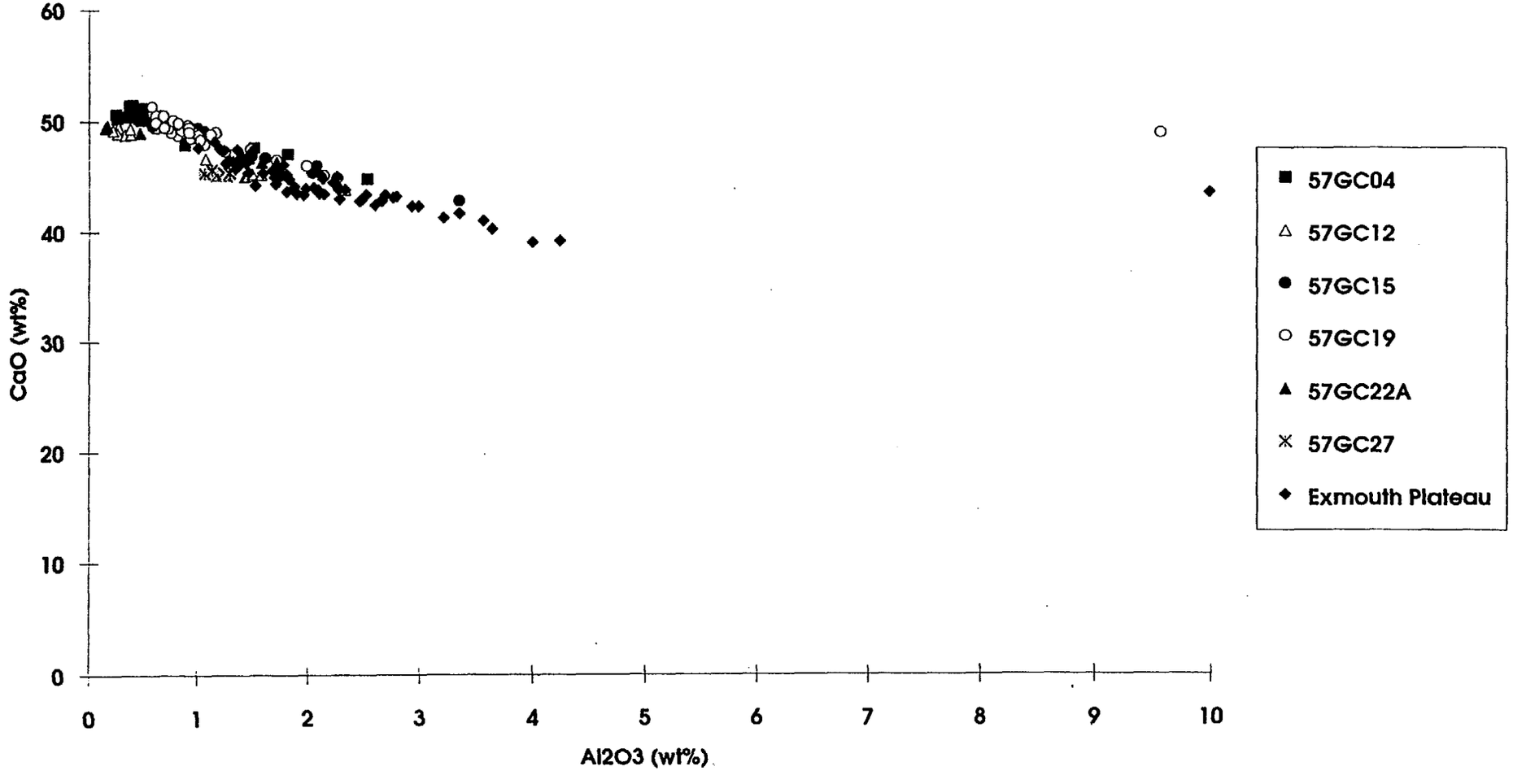
Al2O3 (wt%) versus SiO2 (wt%), Perth Basin and Exmouth Plateau



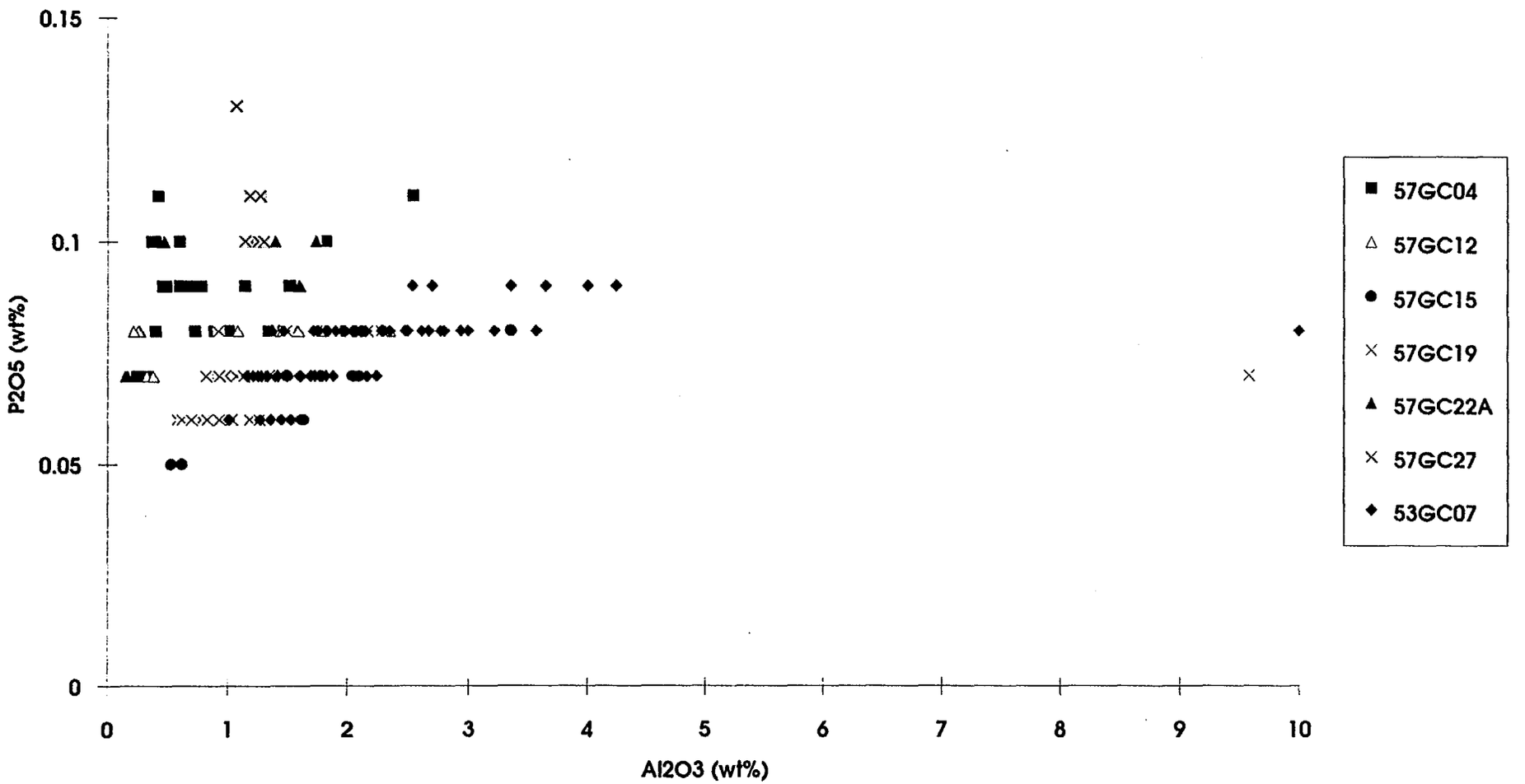
Al2O3 (wt%) versus Fe2O3 (wt%), Perth Basin and Exmouth Plateau

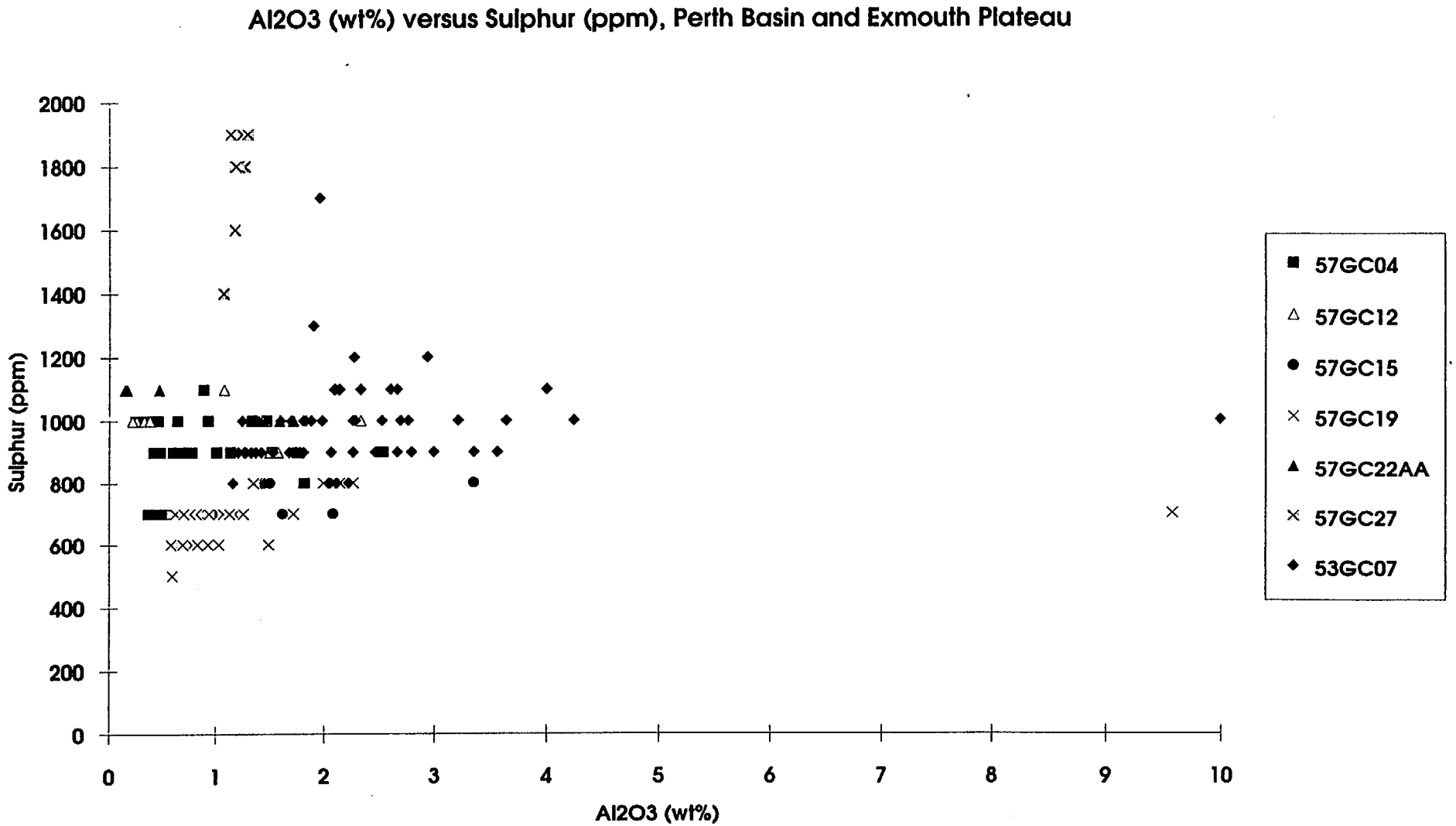


Al2O3 (wt%) vs CaO (wt%), Perth Basin and Exmouth Plateau

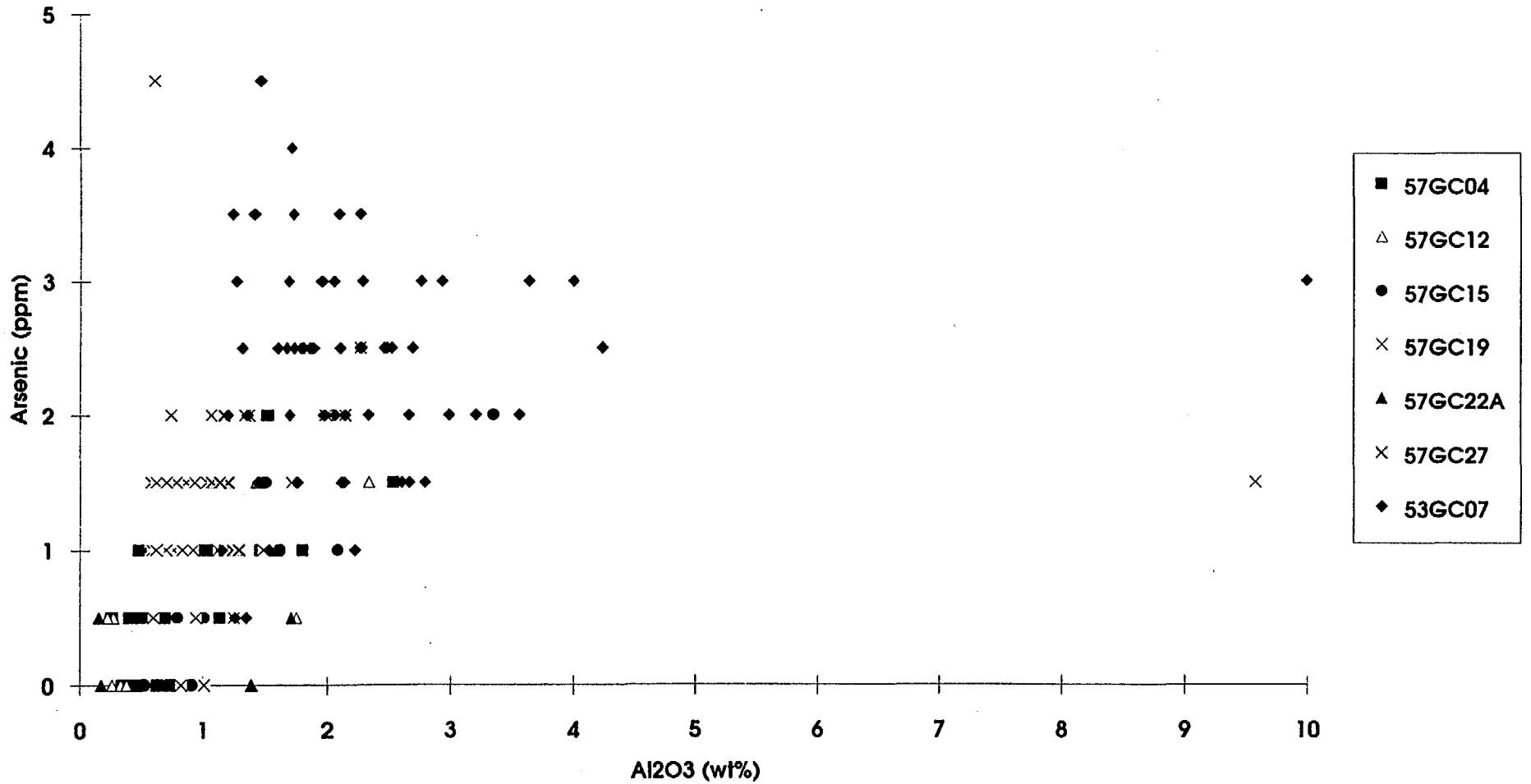


Al2O3 (wt%) versus P2O5 (wt%), Perth Basin and Exmouth Plateau

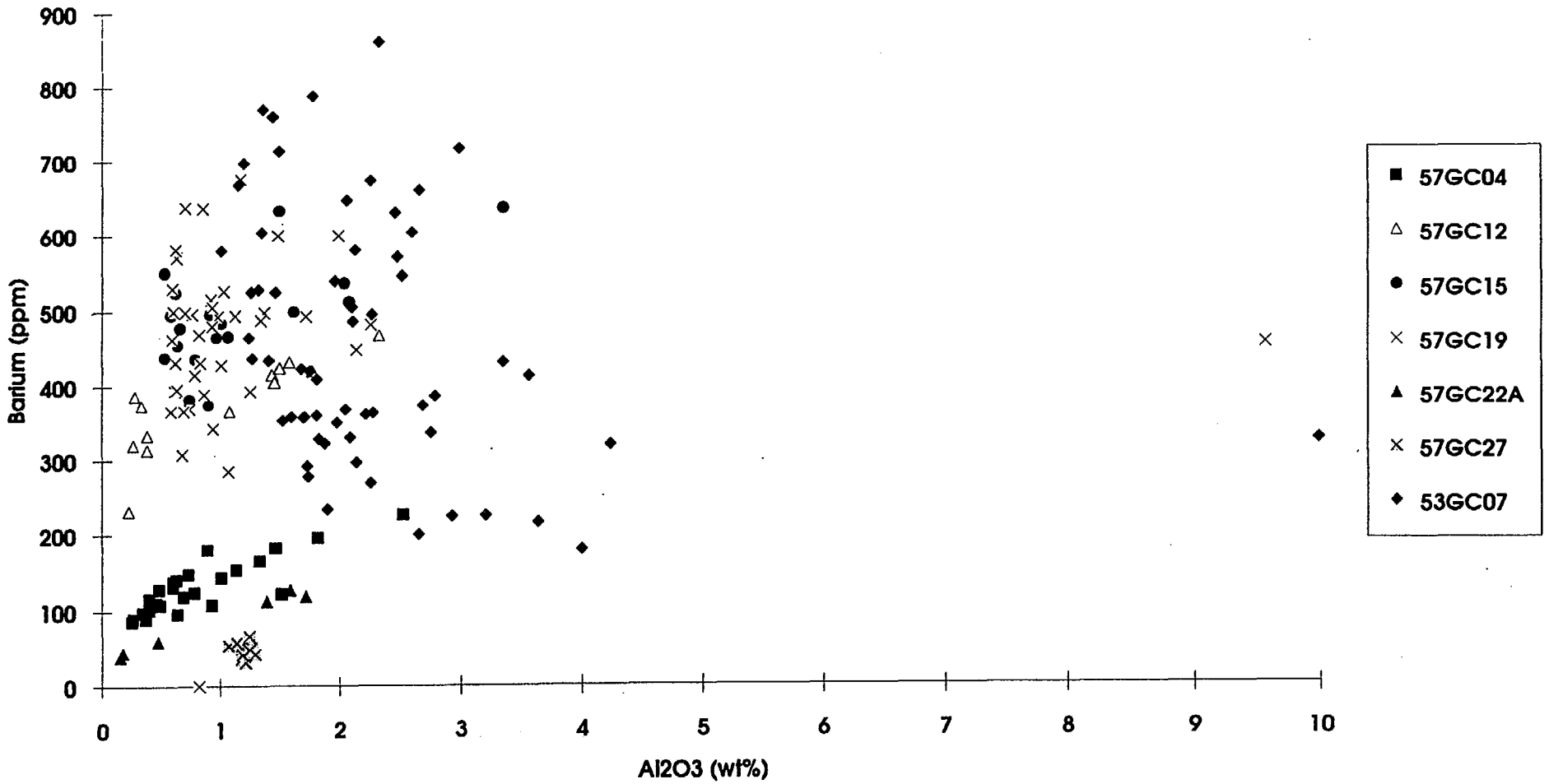




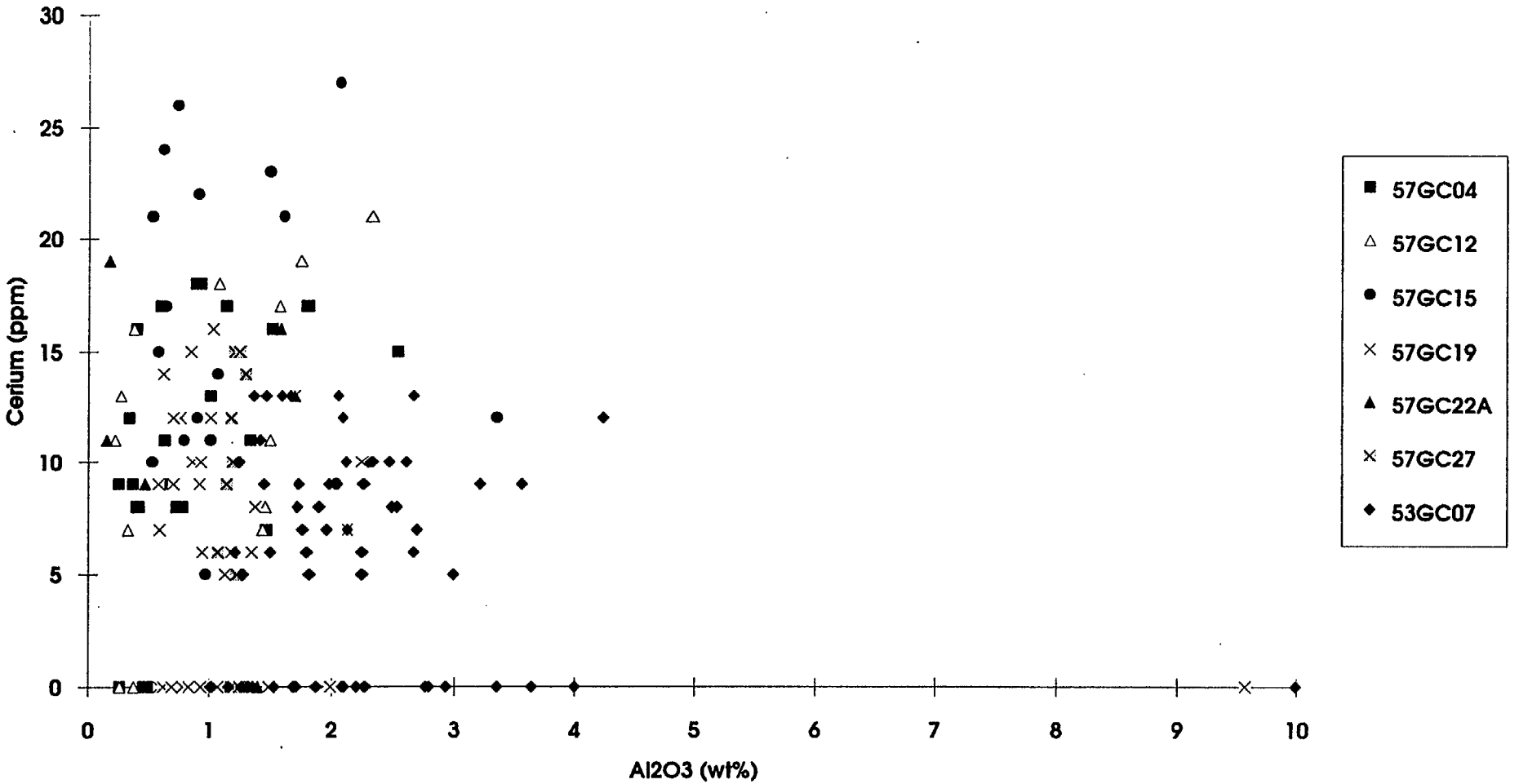
Al2O3 (wt%) versus Arsenic (ppm), Perth Basin and Exmouth Plateau



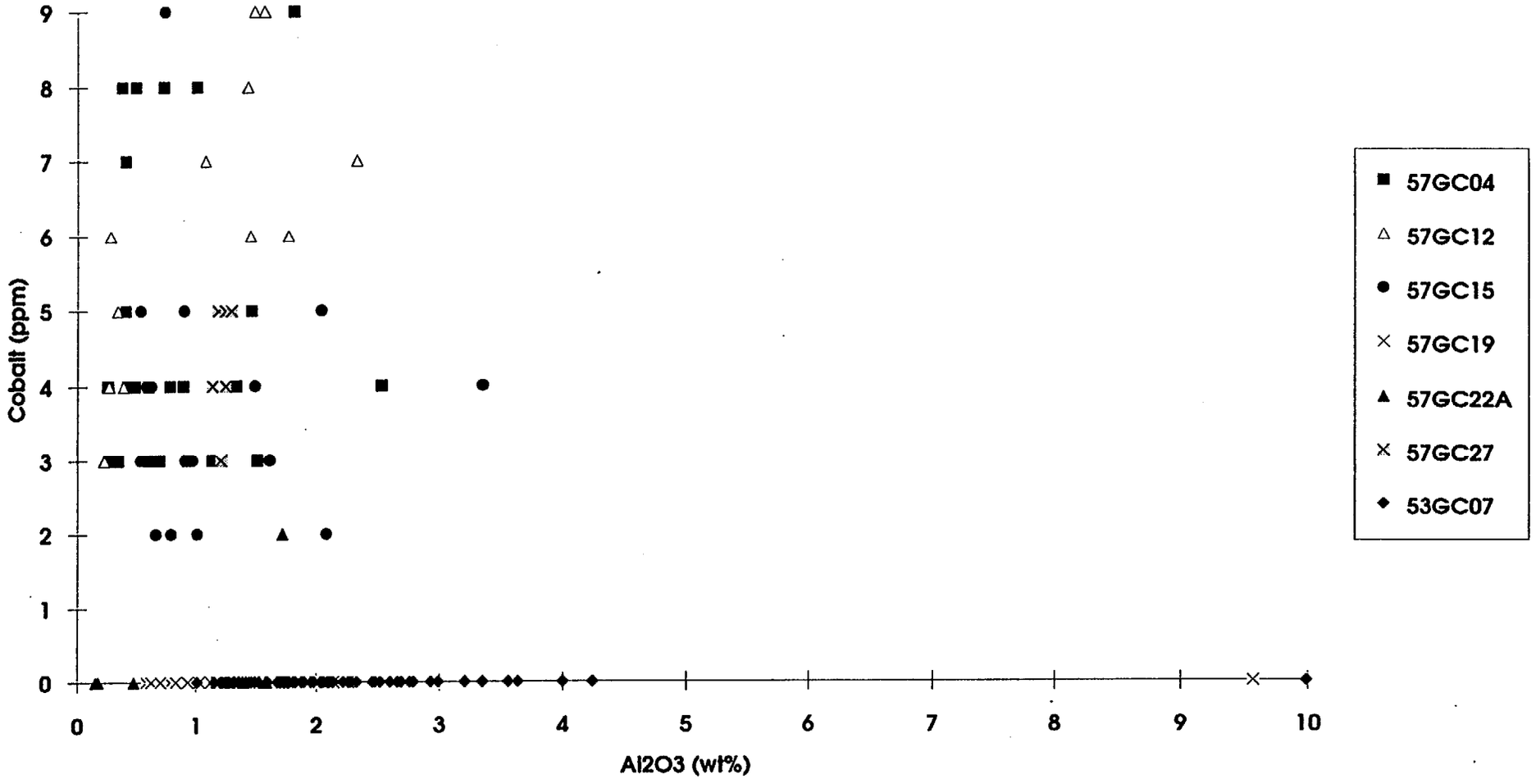
Al2O3 (wt%) versus Barium (ppm), Perth Basin and Exmouth Plateau



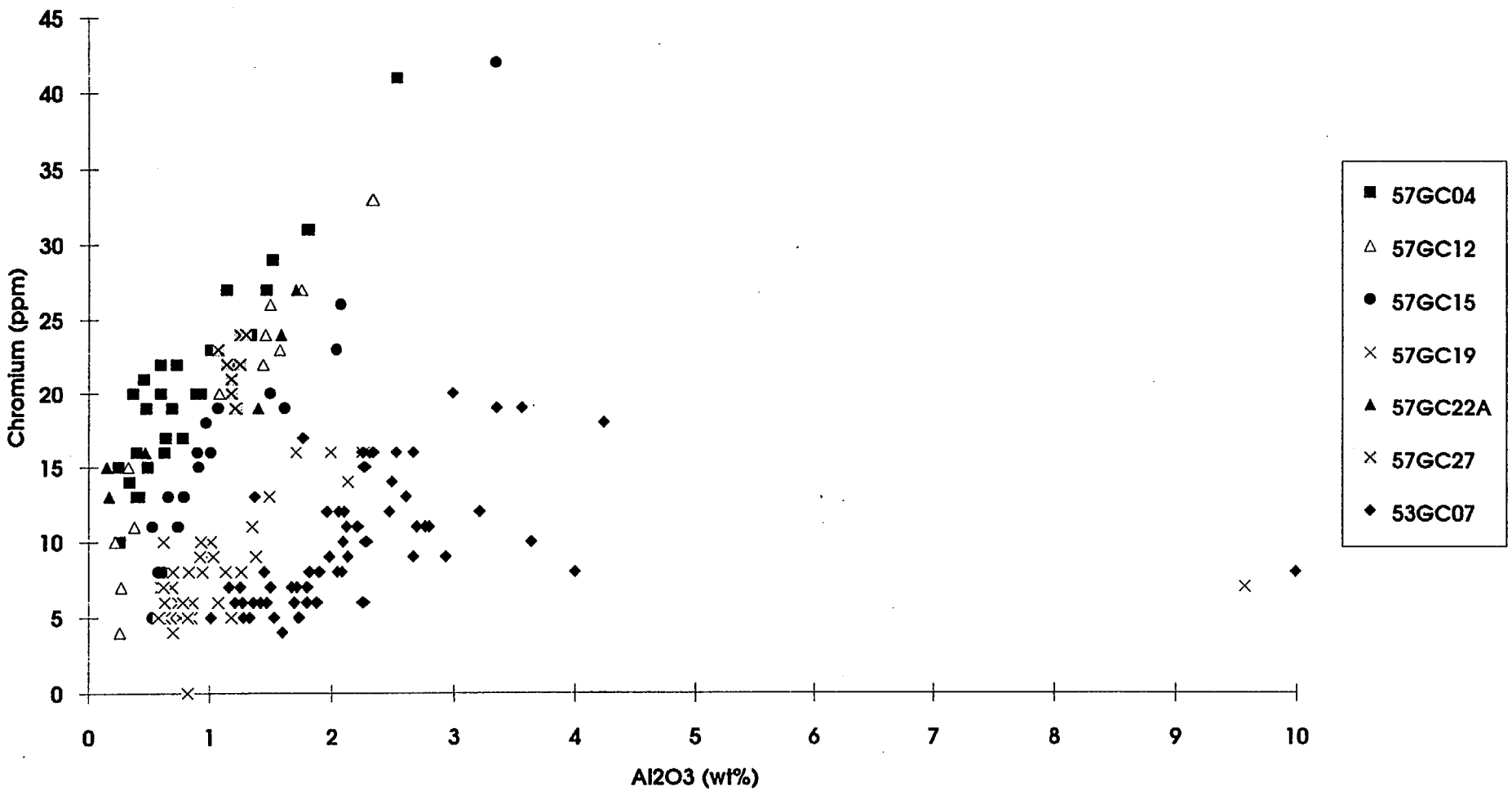
Al2O3 (wt%) versus Cerium (ppm), Perth Basin and Exmouth Plateau

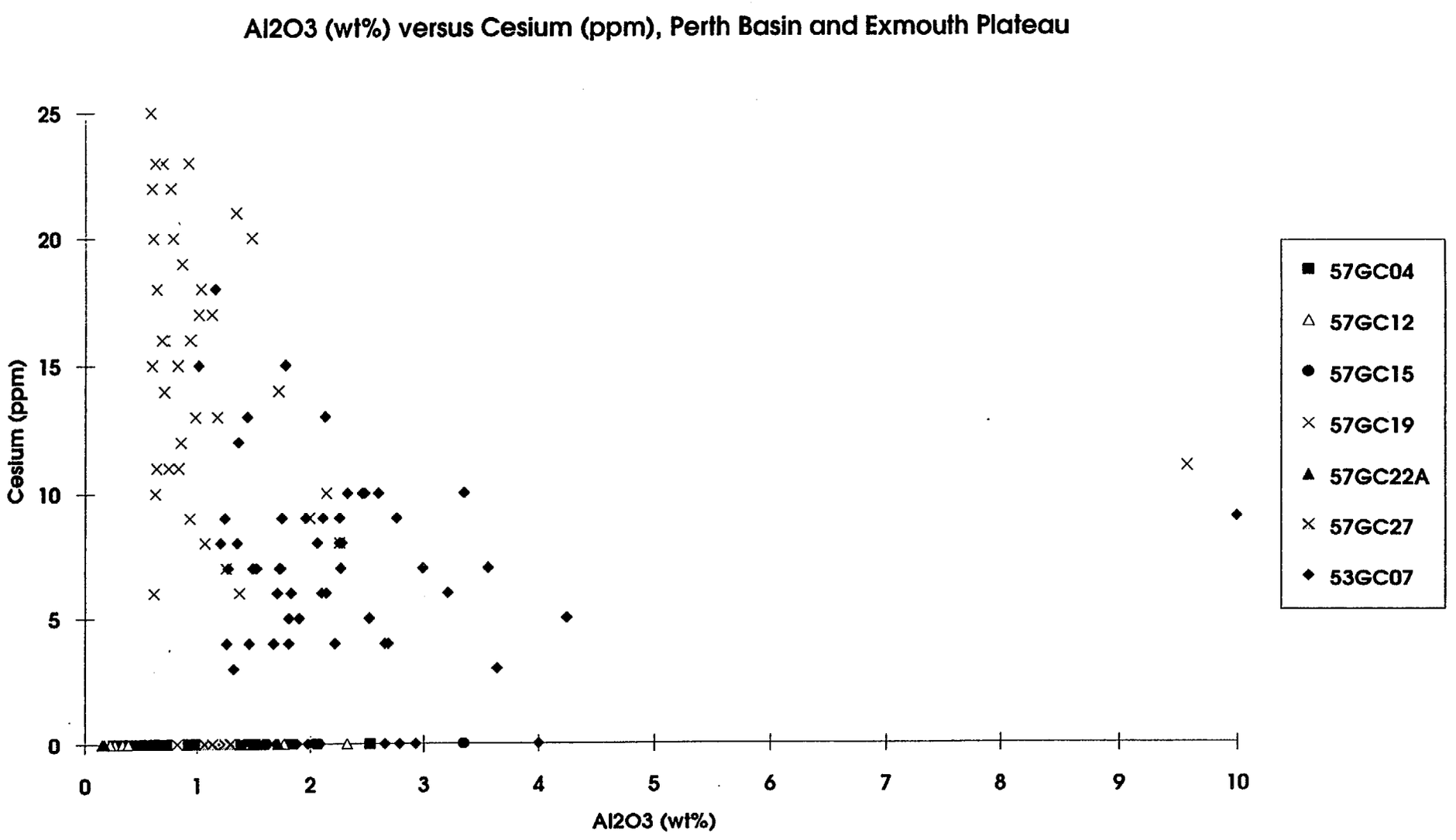


Al2O3 (wt%) versus Cobalt (ppm), Perth Basin and Exmouth Plateau

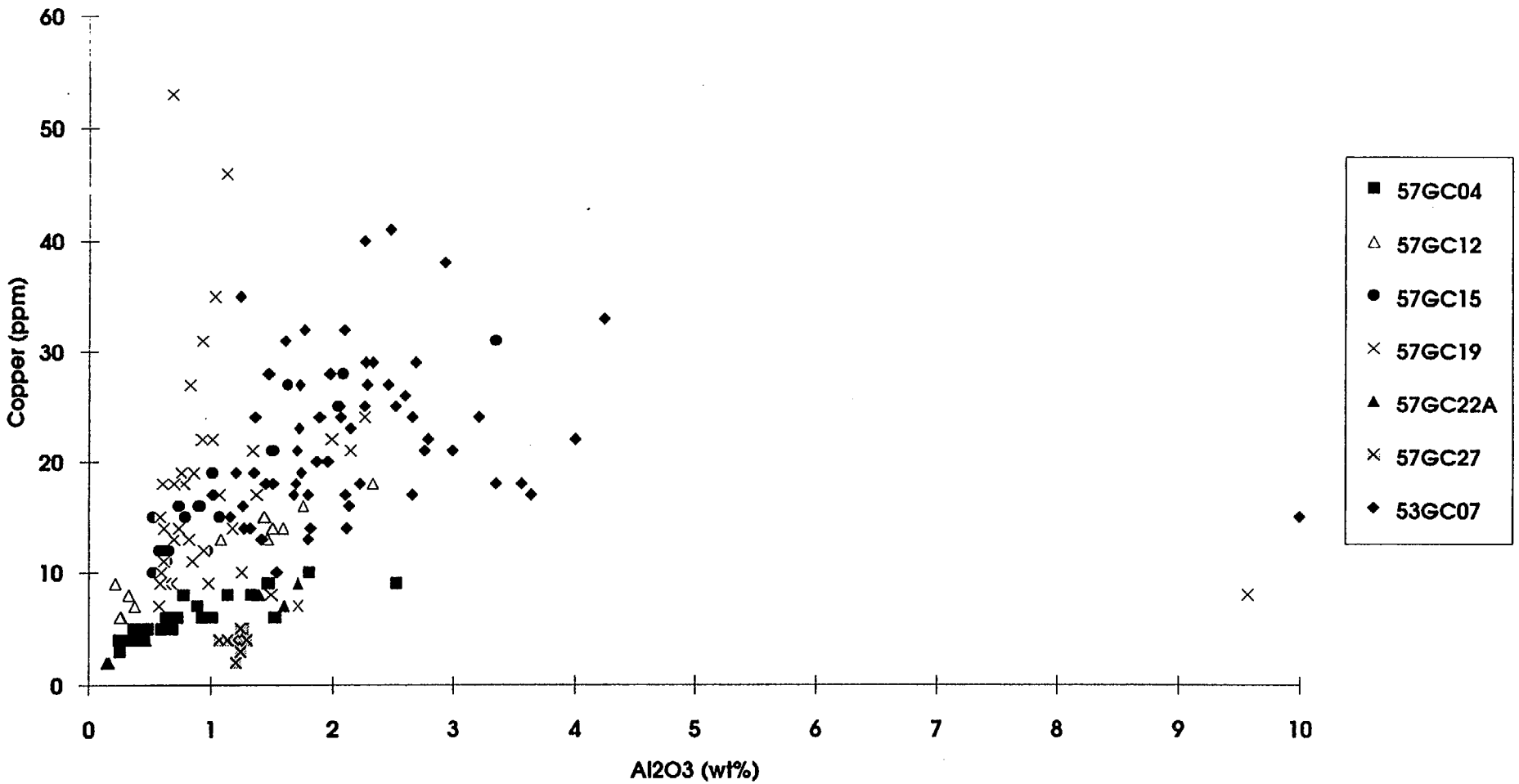


Al2O3 (wt%) versus Chromium (ppm), Perth Basin and Exmouth Plateau

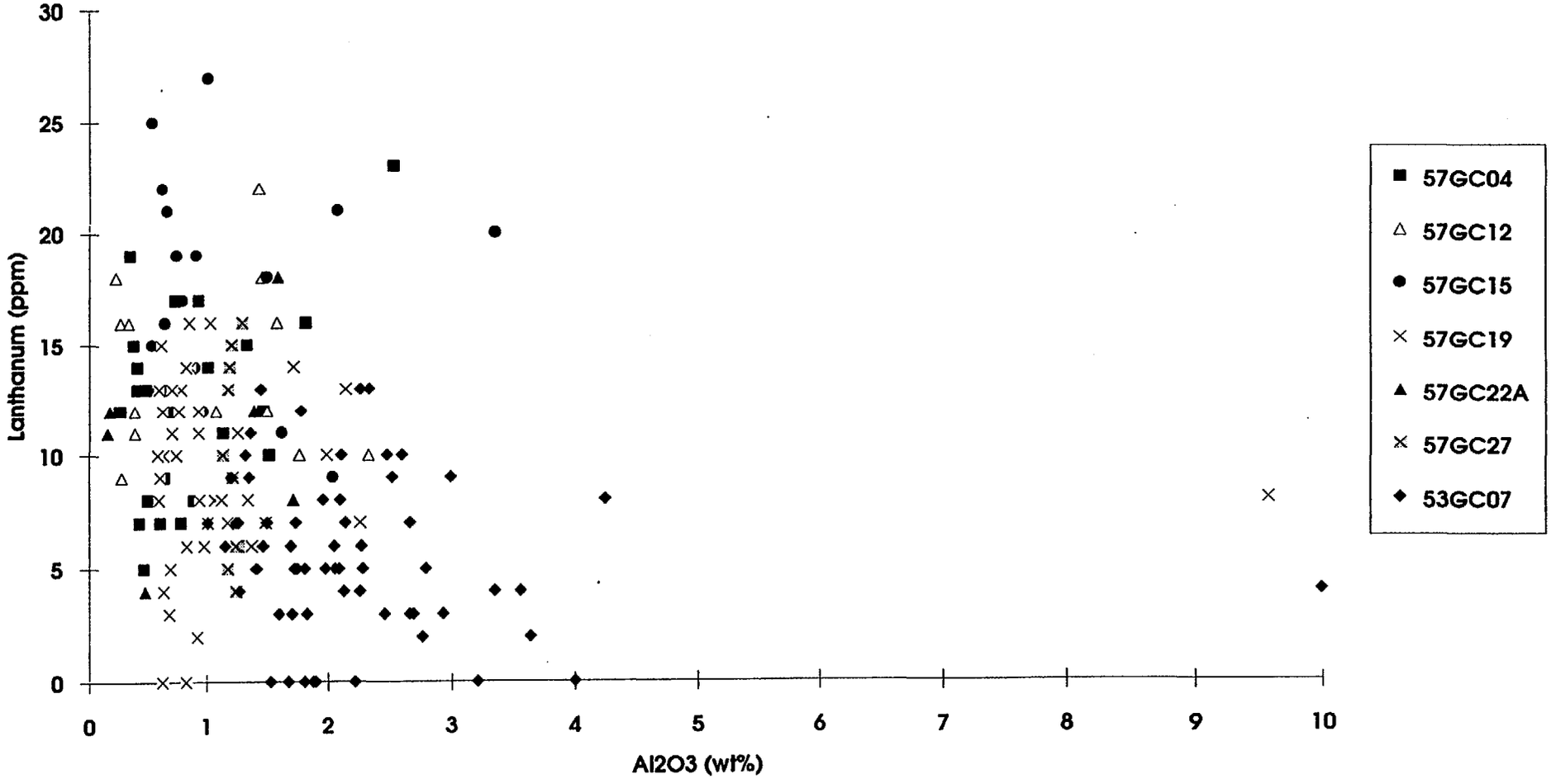




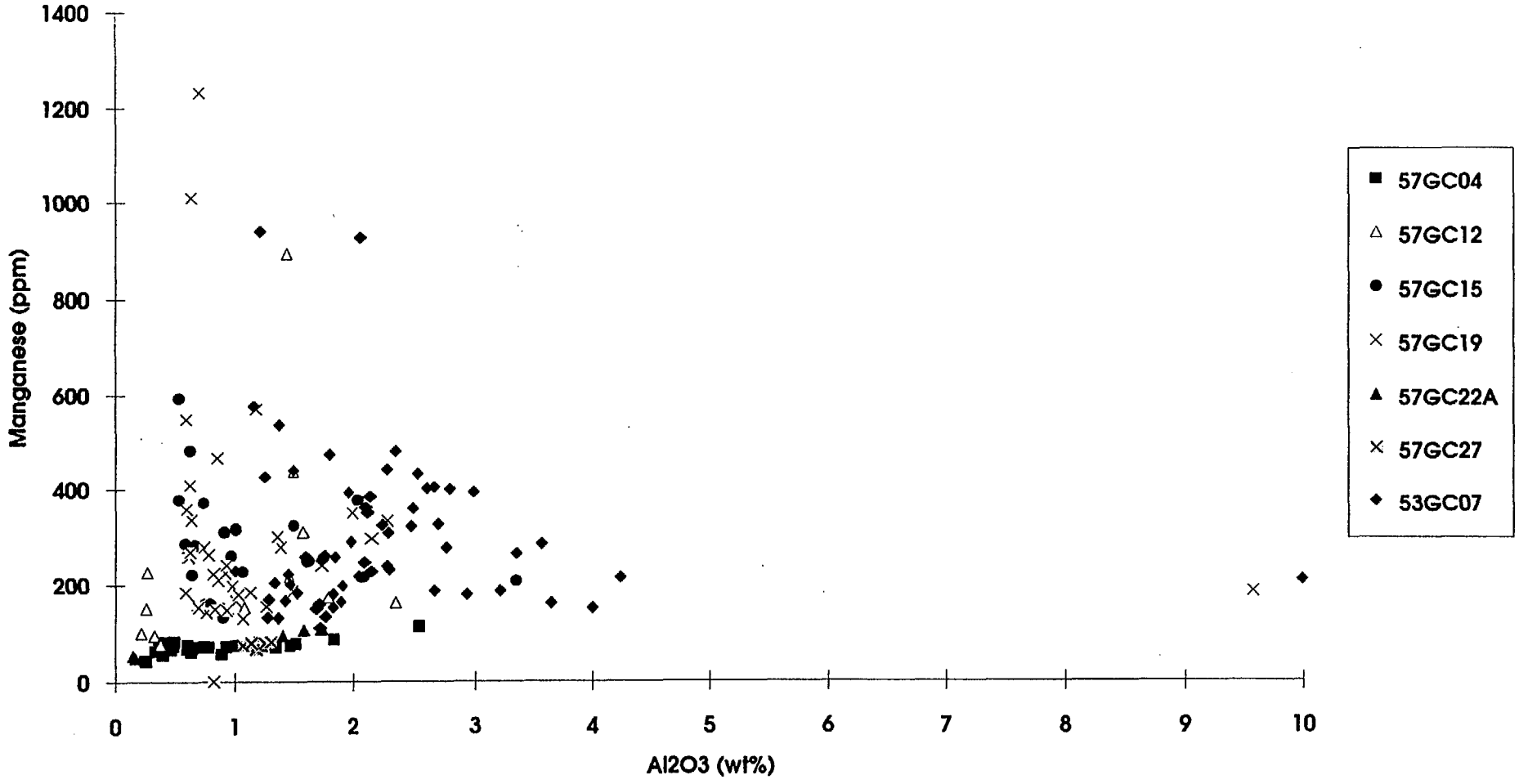
Al2O3 (wt%) versus Copper (ppm), Perth Basin and Exmouth Plateau



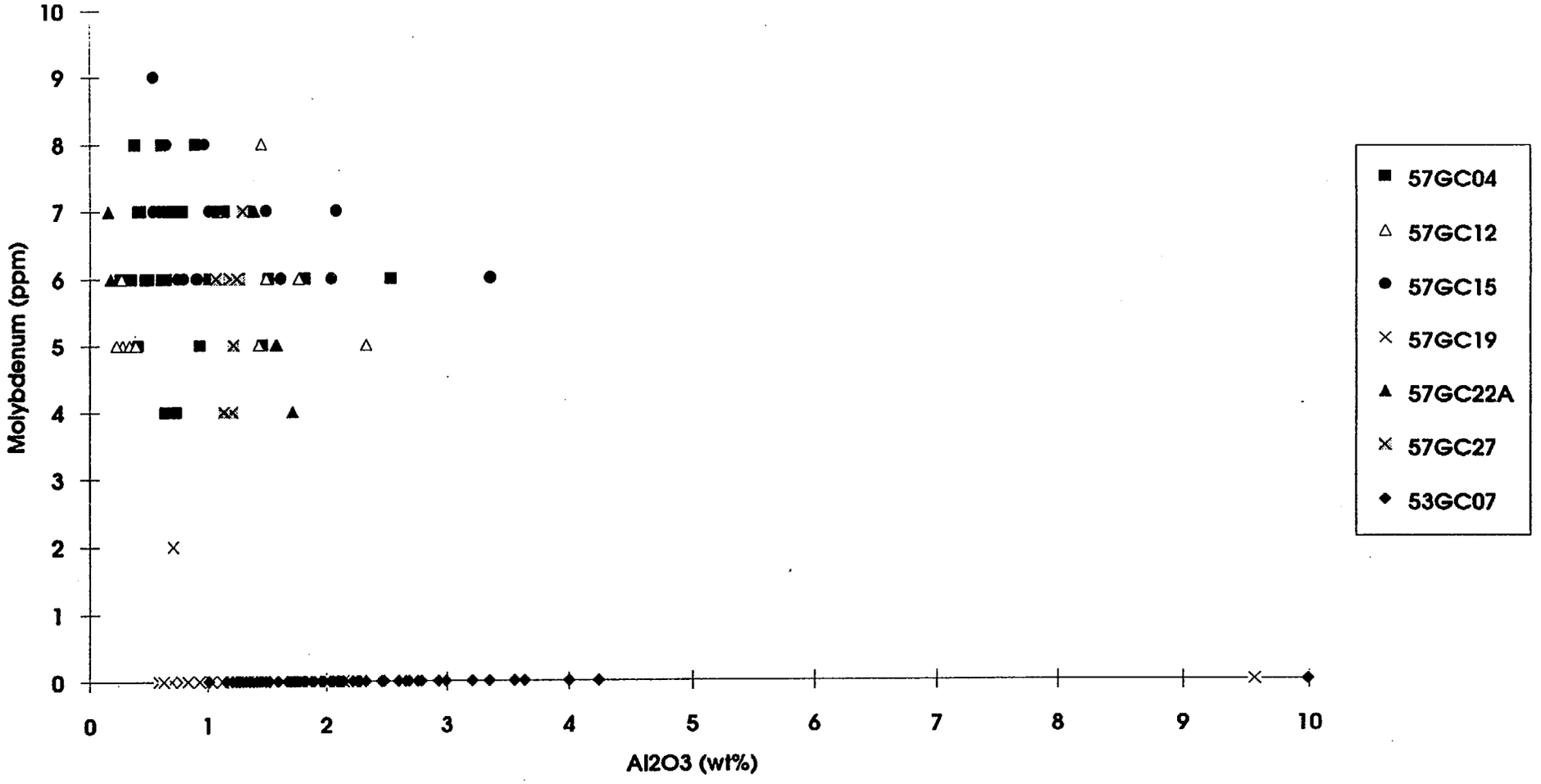
Al2O3 (wt%) versus Lanthanum (ppm), Perth Basin and Exmouth Plateau



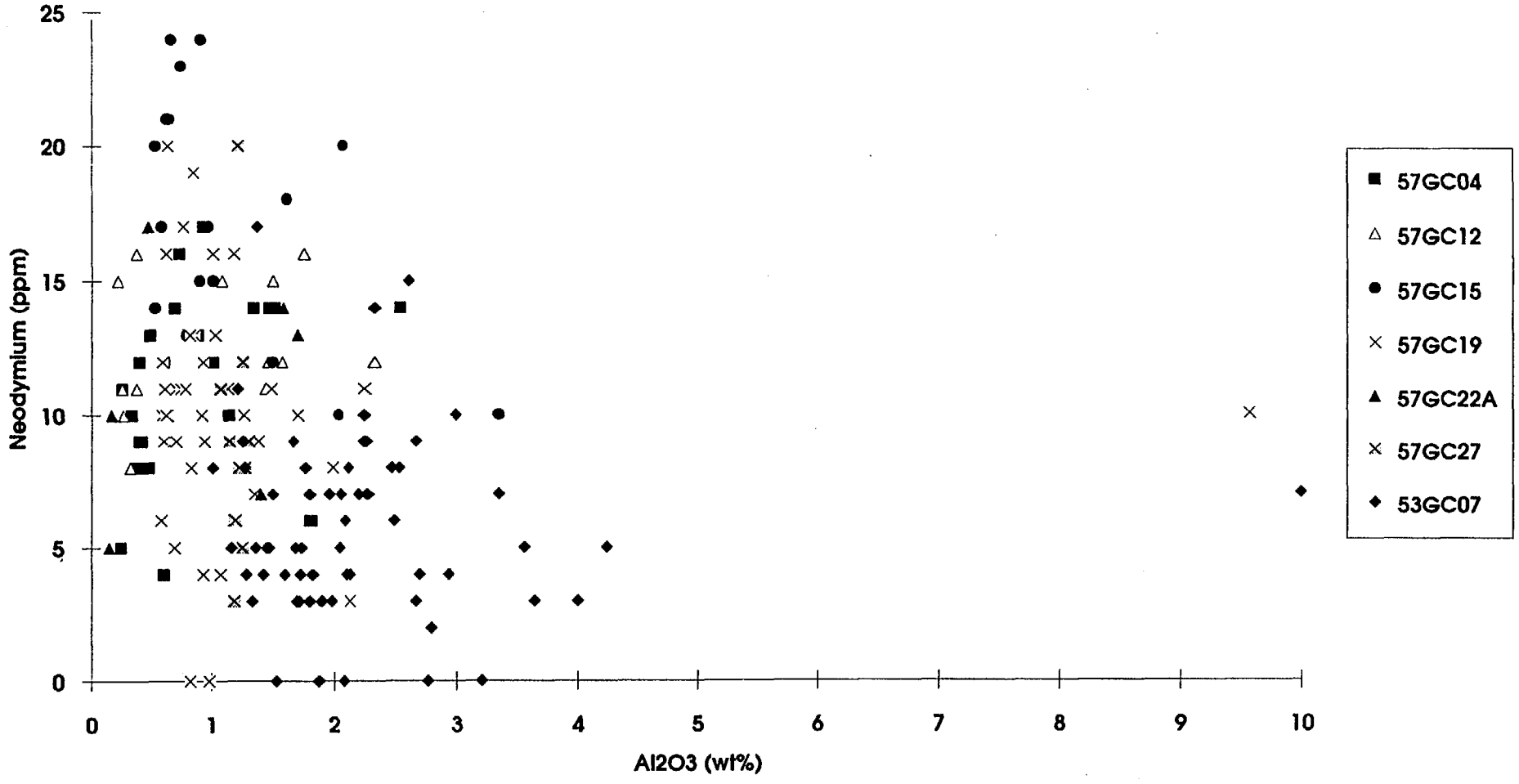
Al2O3 (wt%) versus Manganese (ppm), Perth Basin and Exmouth Plateau



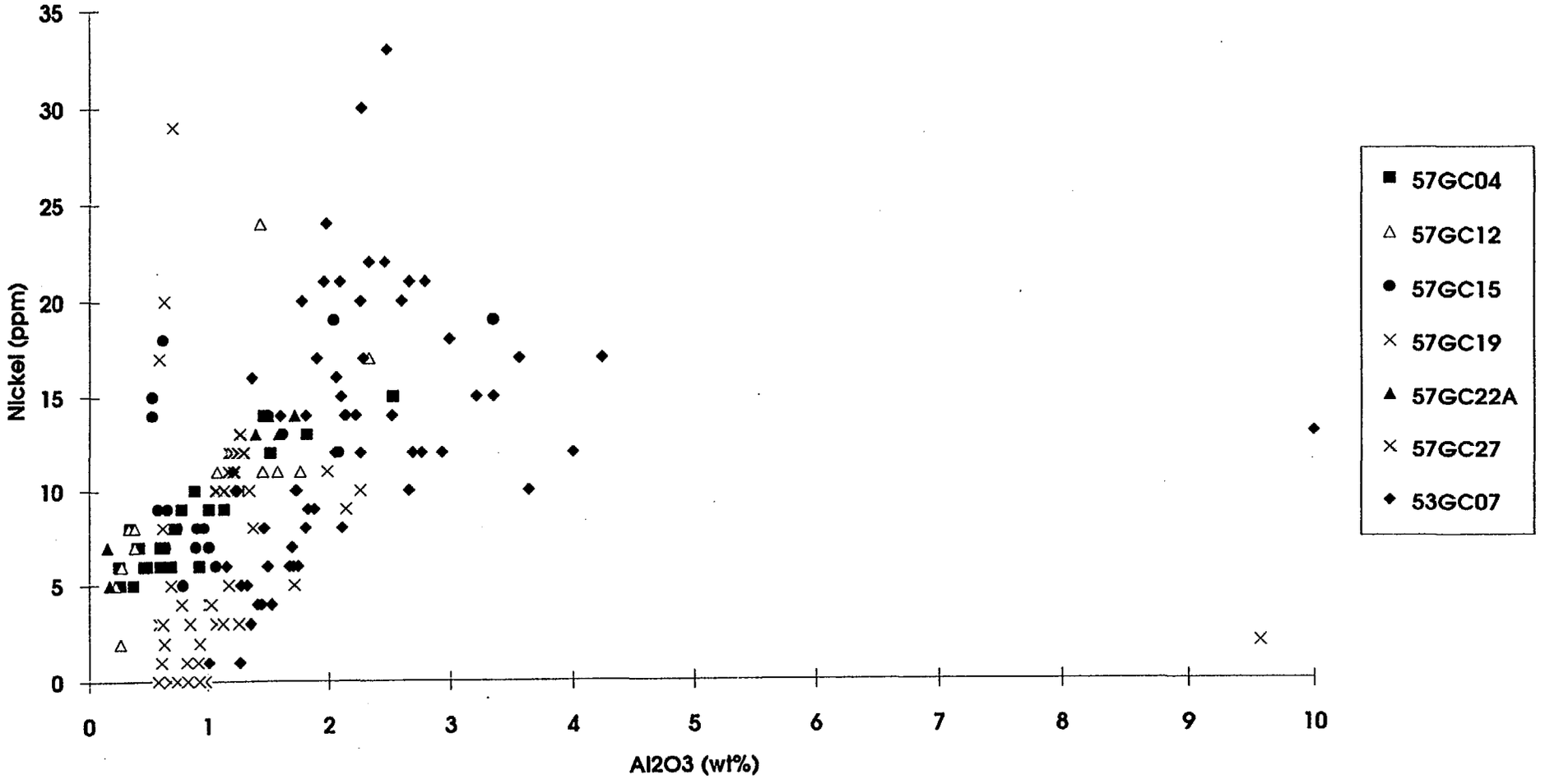
Al2O3 (wt%) versus Molybdenum (ppm), Perth Basin and Exmouth Plateau



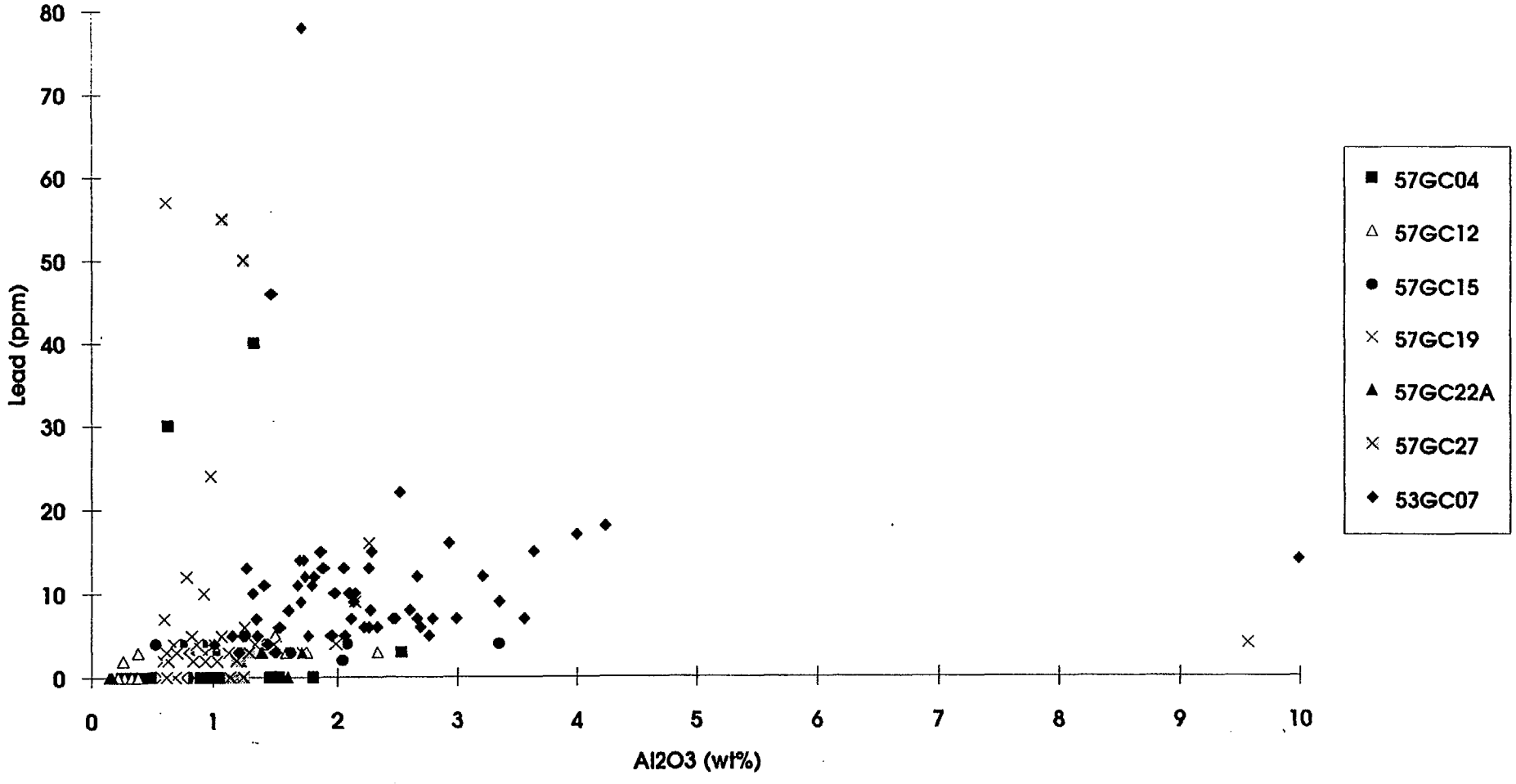
Al2O3 (wt%) versus Neodymium (ppm), Perth Basin and Exmouth Plateau



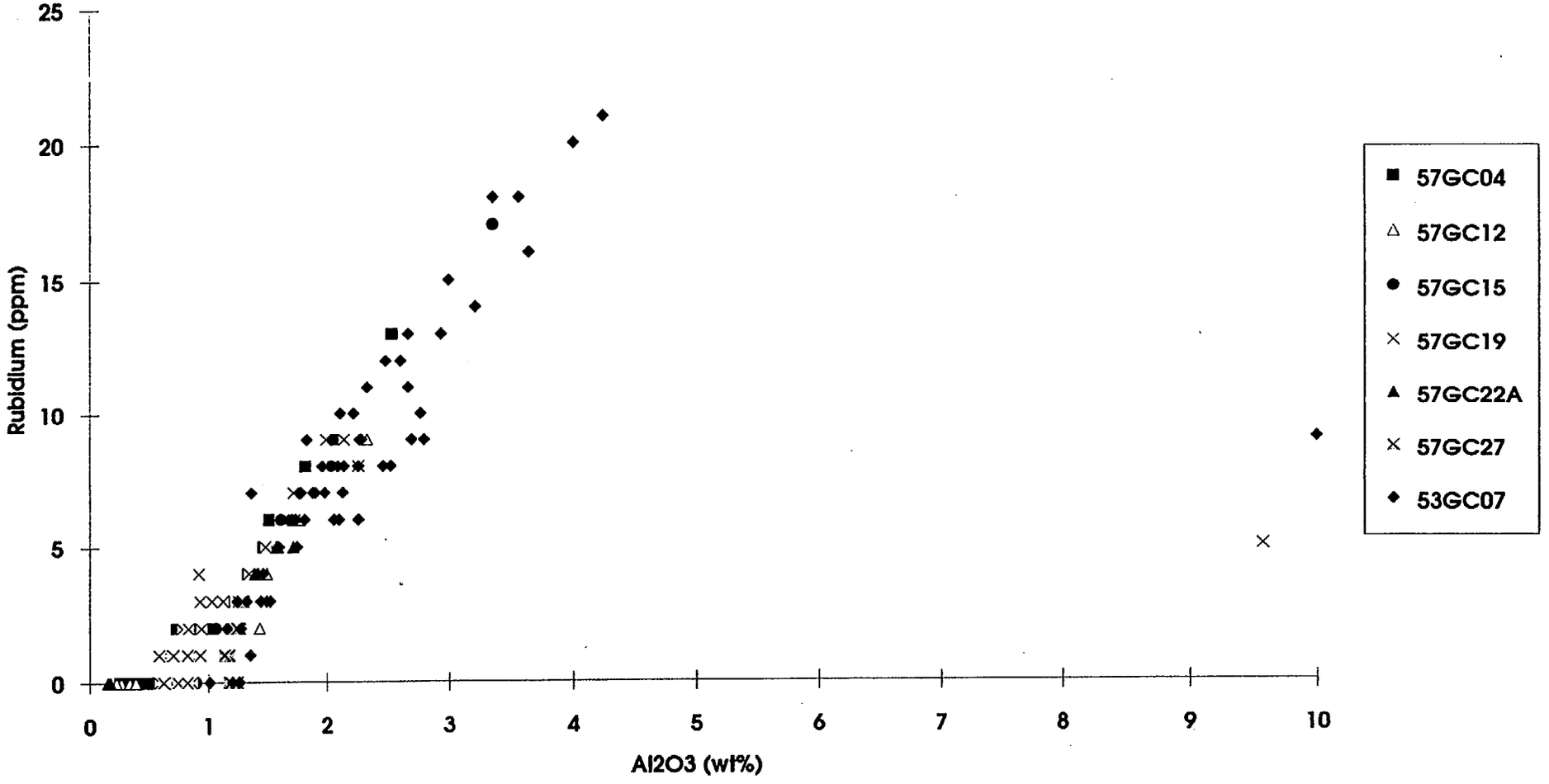
Al2O3 (wt%) versus Nickel (ppm), Perth Basin and Exmouth Plateau

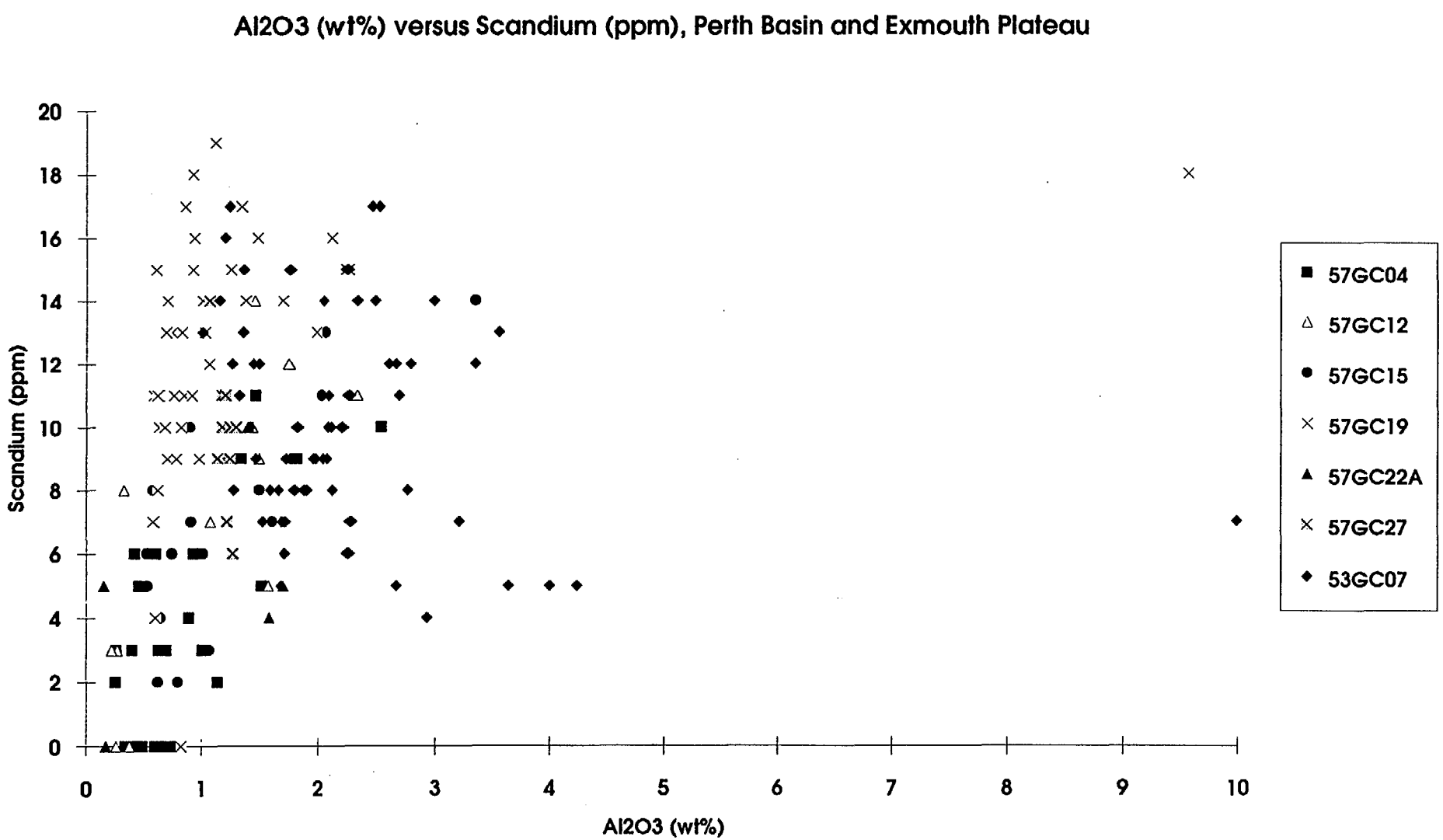


Al2O3 (wt%) versus Lead (ppm), Perth Basin and Exmouth Plateau

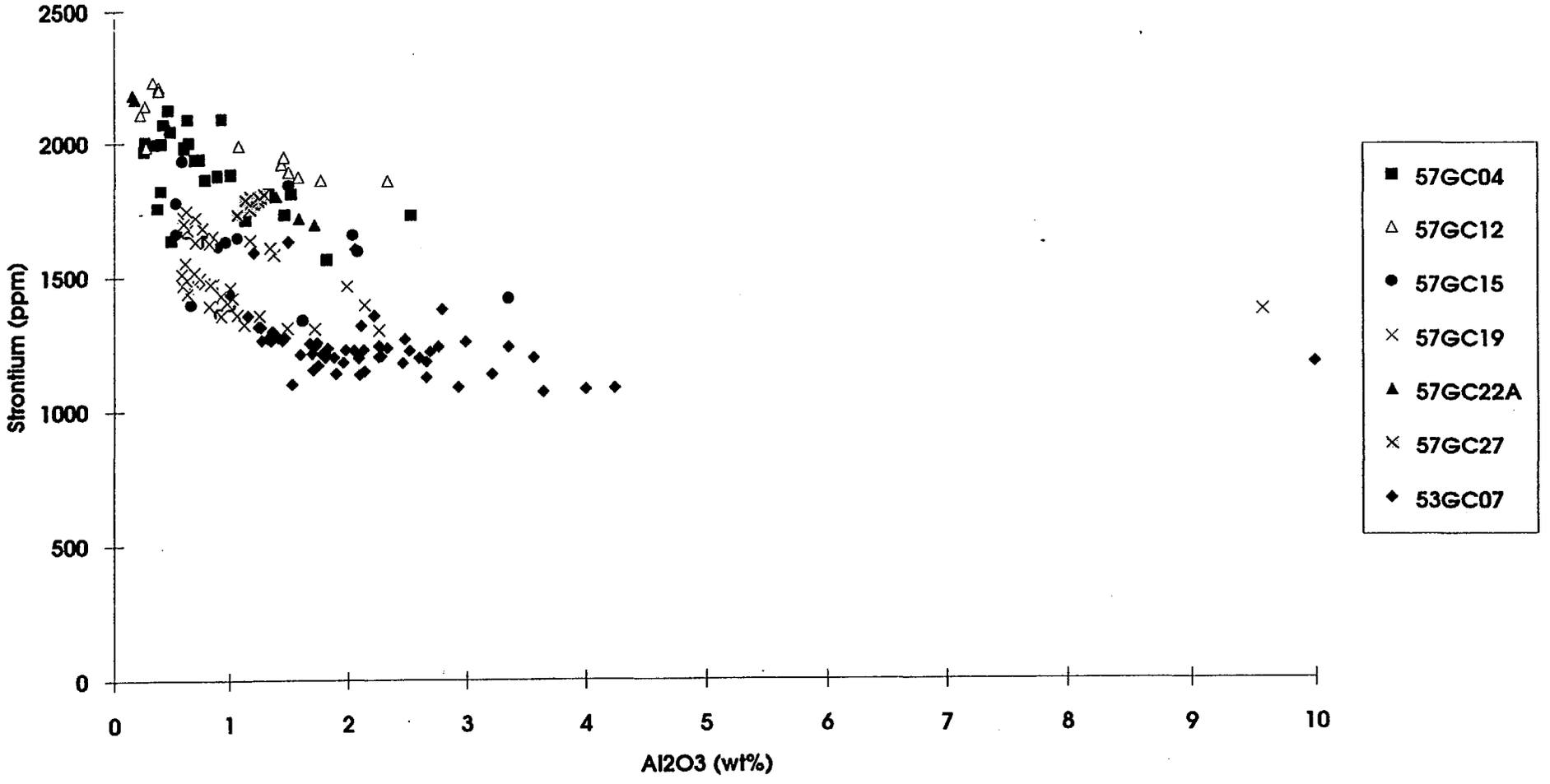


Al2O3 (wt%) versus Rubidium (ppm), Perth Basin and Exmouth Plateau

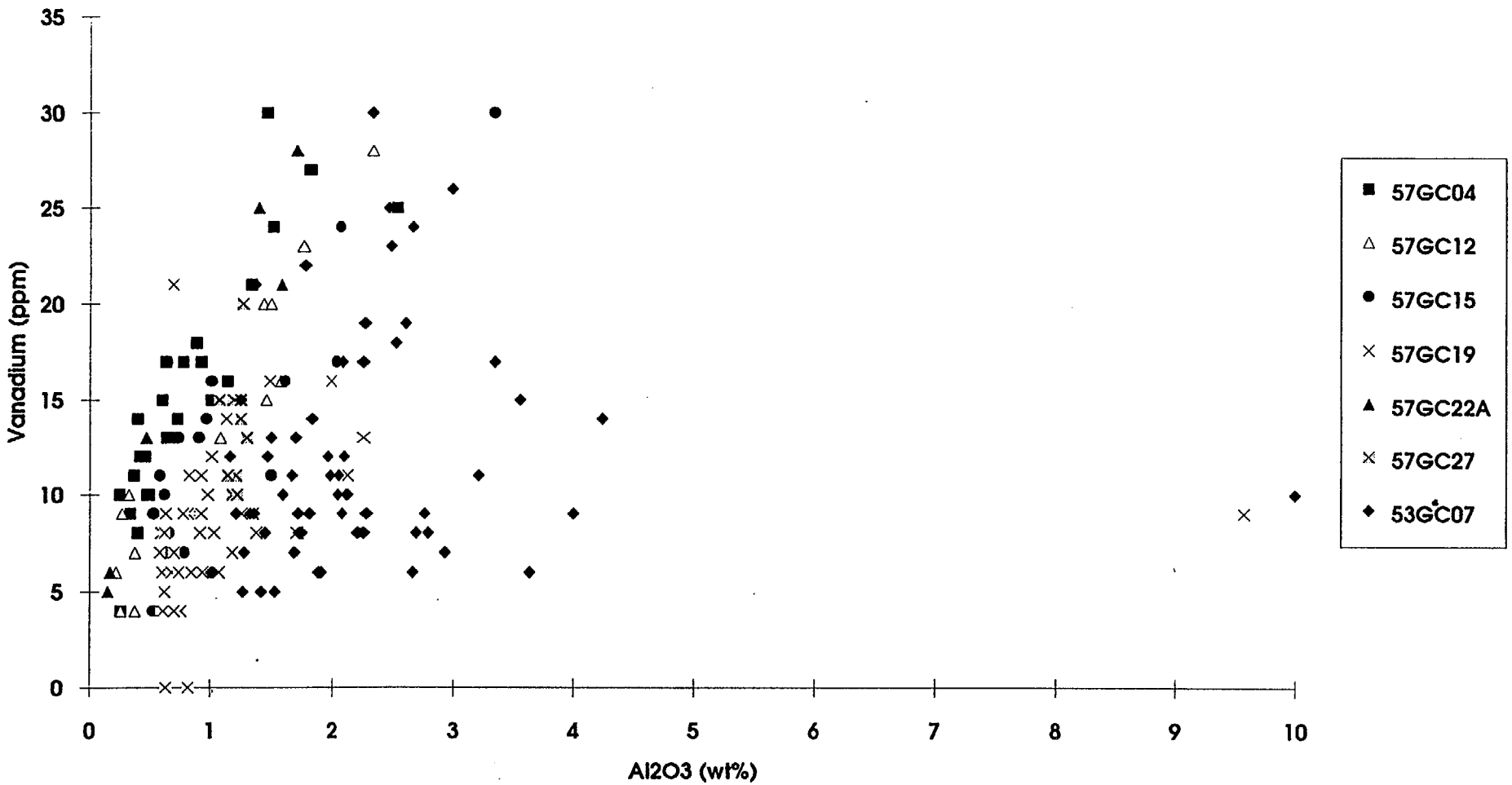




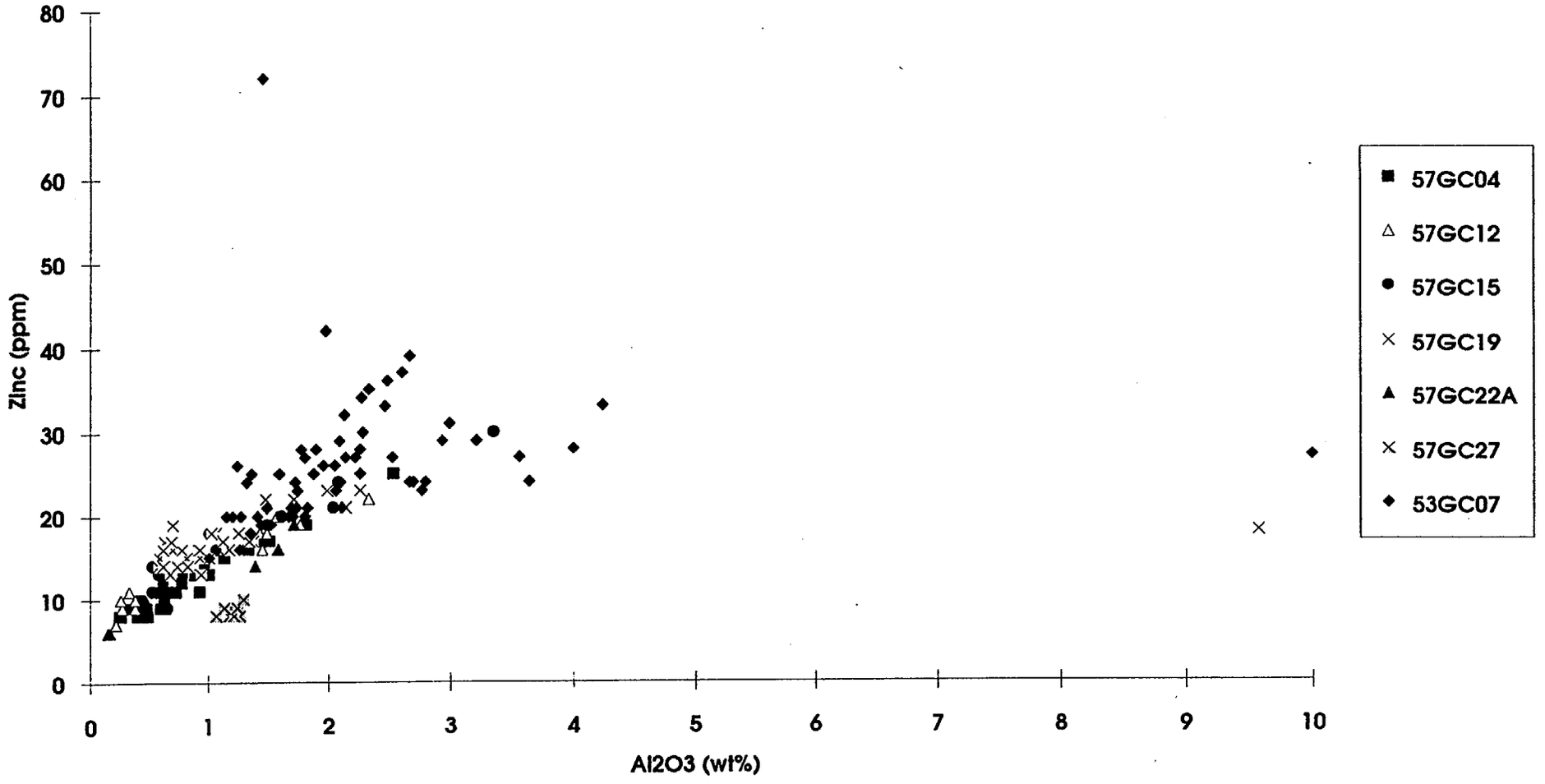
Al2O3 (wt%) versus Strontium (ppm), Perth Basin and Exmouth Plateau



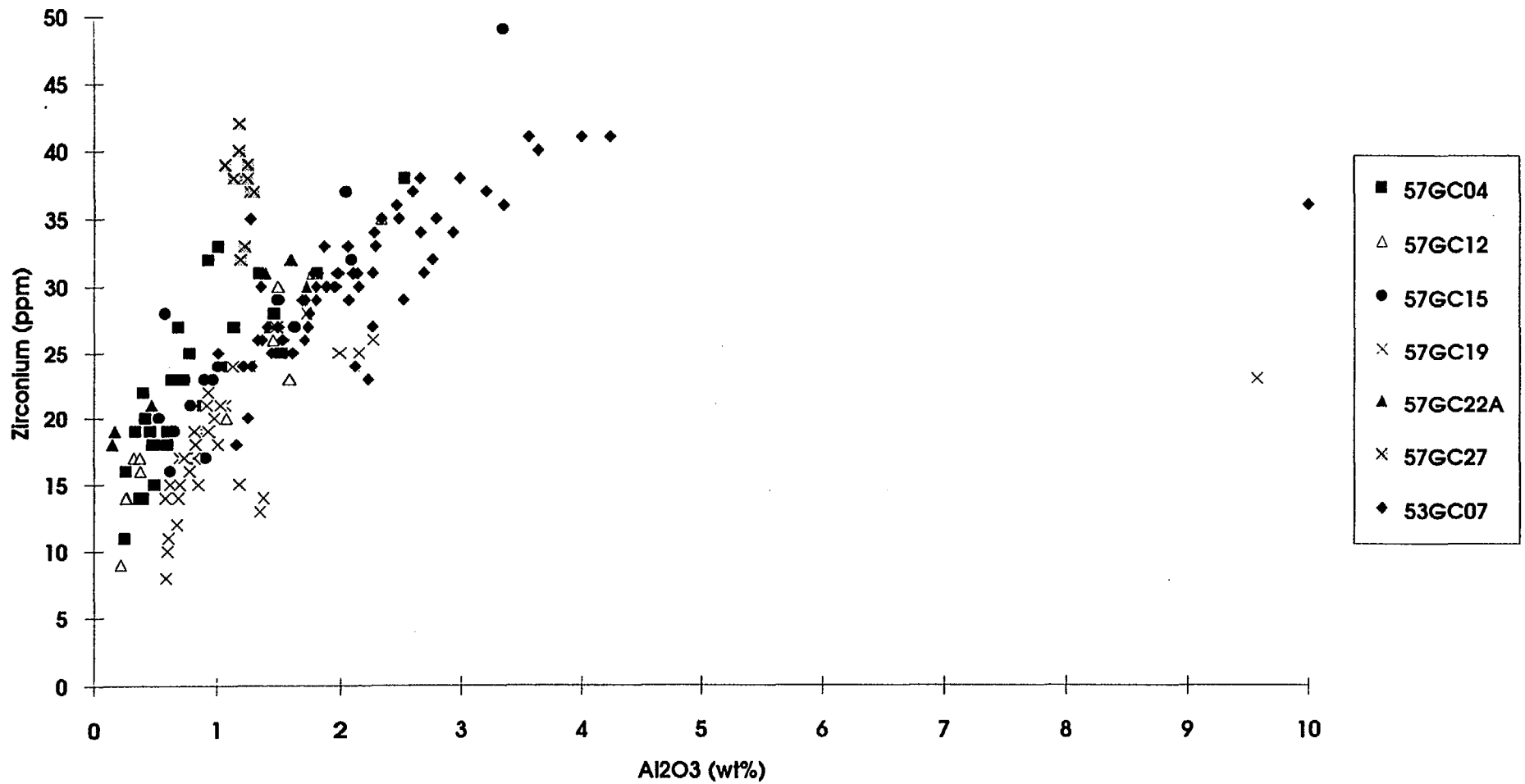
Al2O3 (wt%) versus Vanadium (ppm), Perth Basin and Exmouth Plateau



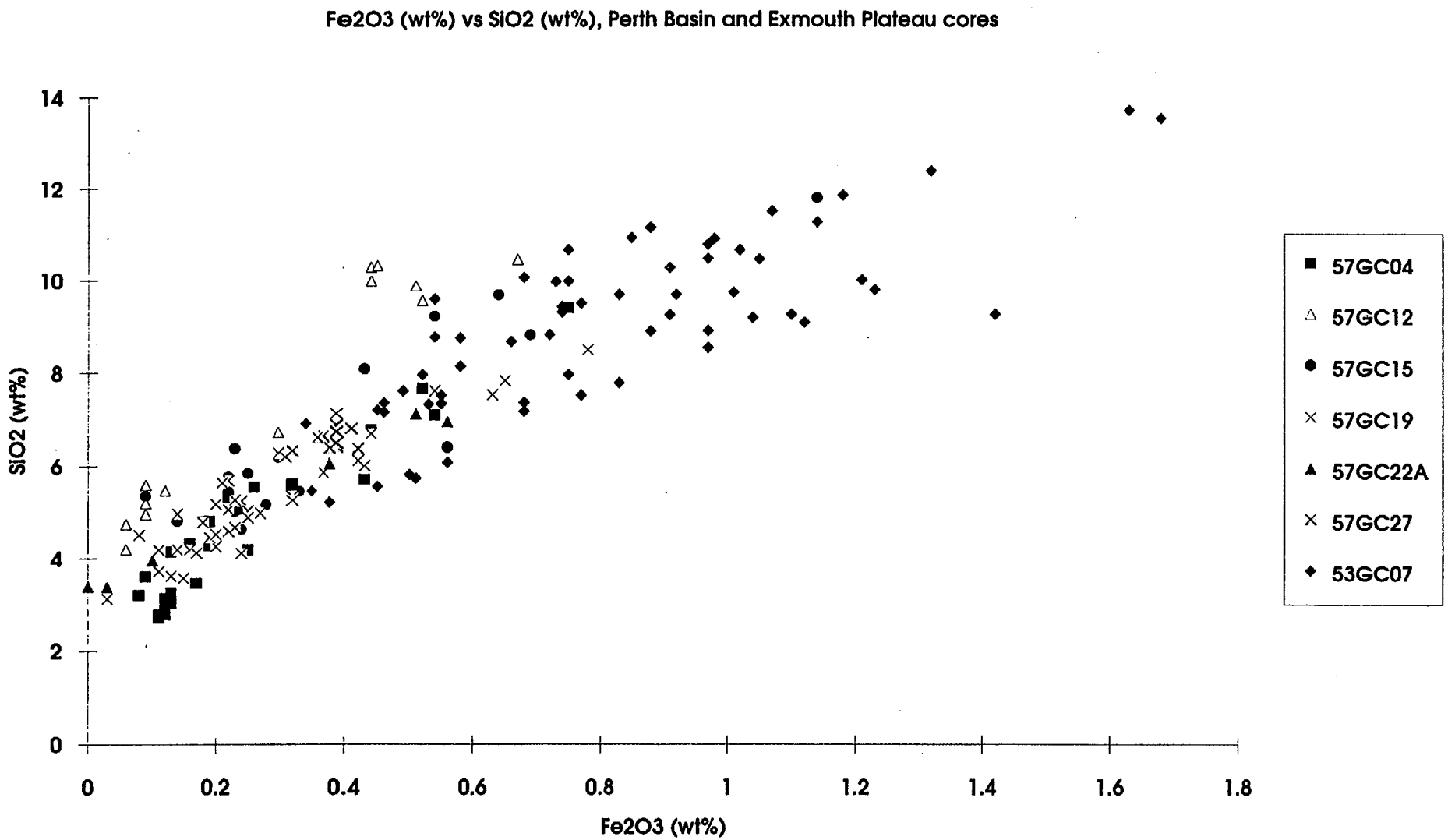
Al2O3 (wt%) versus Zinc (ppm), Perth Basin and Exmouth Plateau



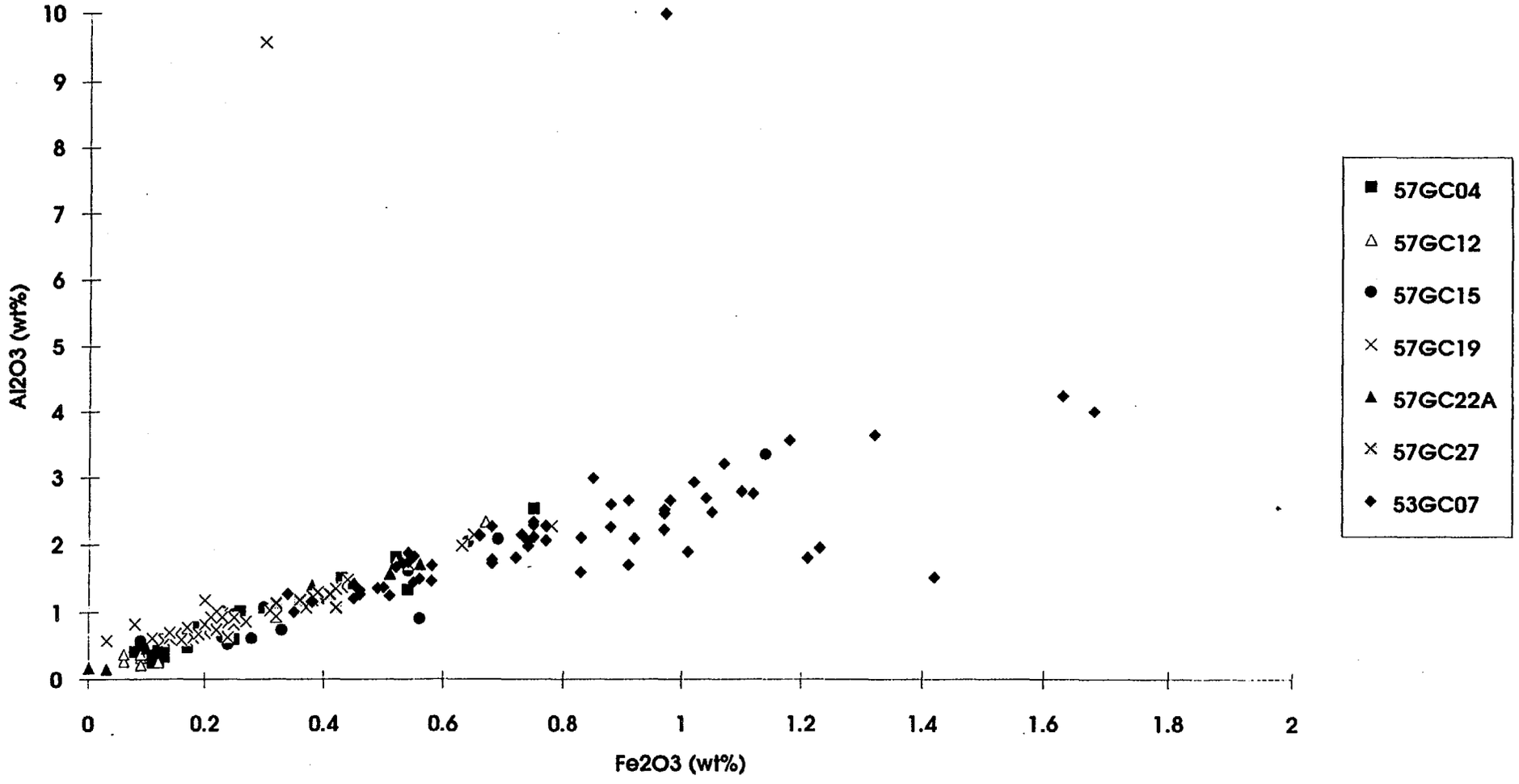
Al2O3 (wt%) versus Zirconium (ppm), Perth Basin and Exmouth Plateau



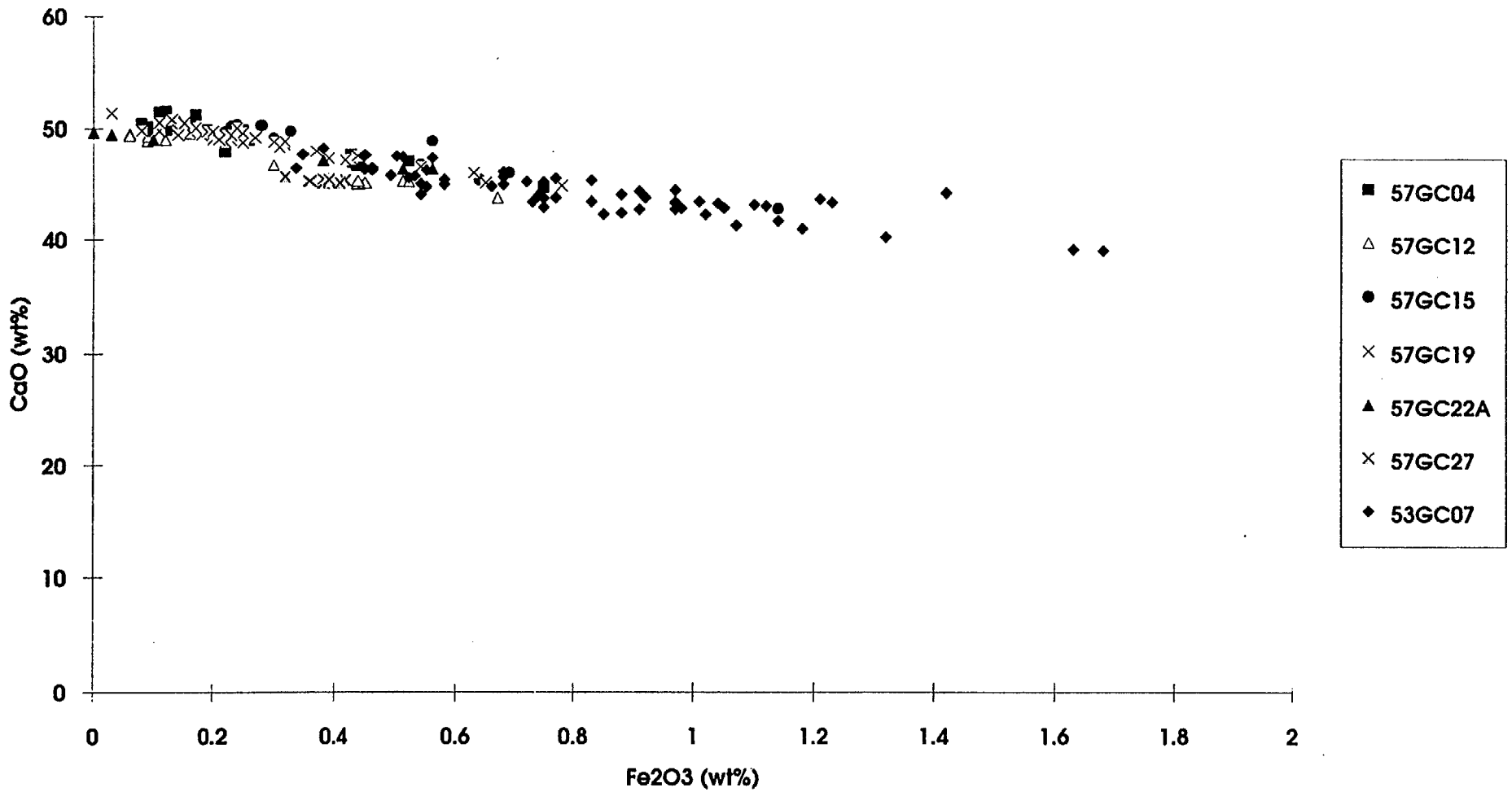
Appendix B: Plots of Fe_2O_3 with several select major and trace elements



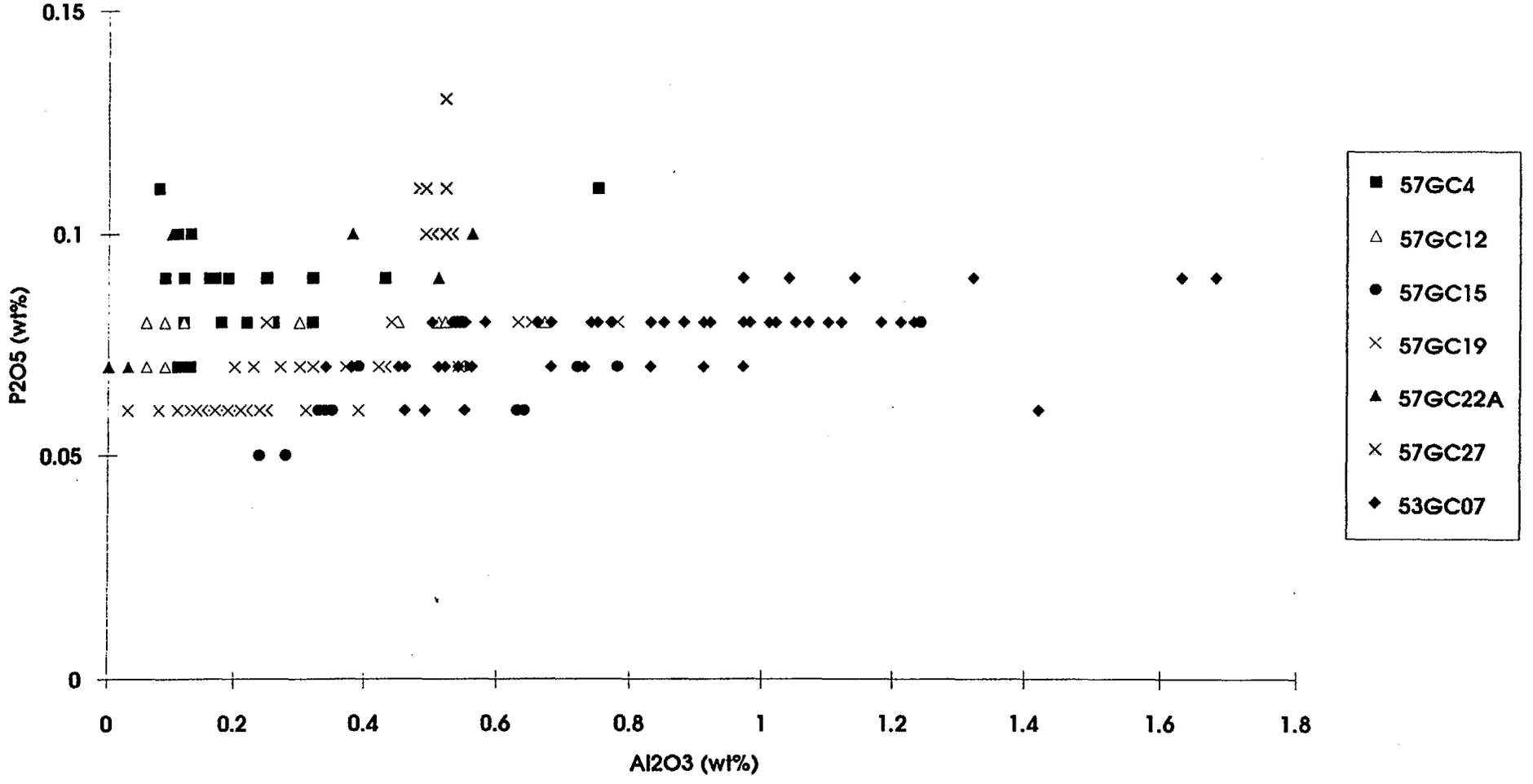
Fe2O3 (wt%) vs Al2O3 (wt%), Perth Basin and Exmouth Plateau



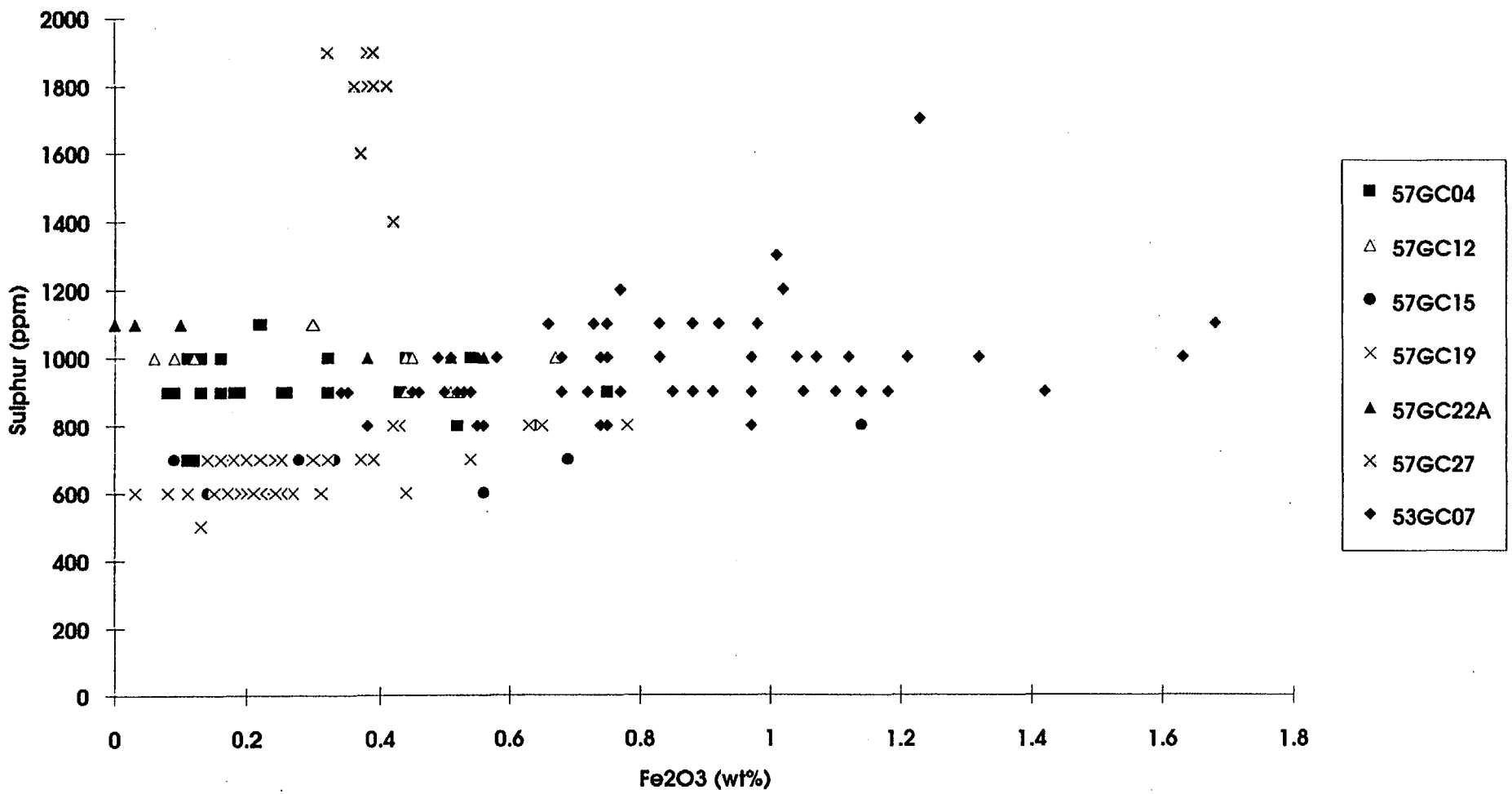
Fe2O3 (wt%) vs CaO (wt%), Perth Basin and Exmouth Plateau



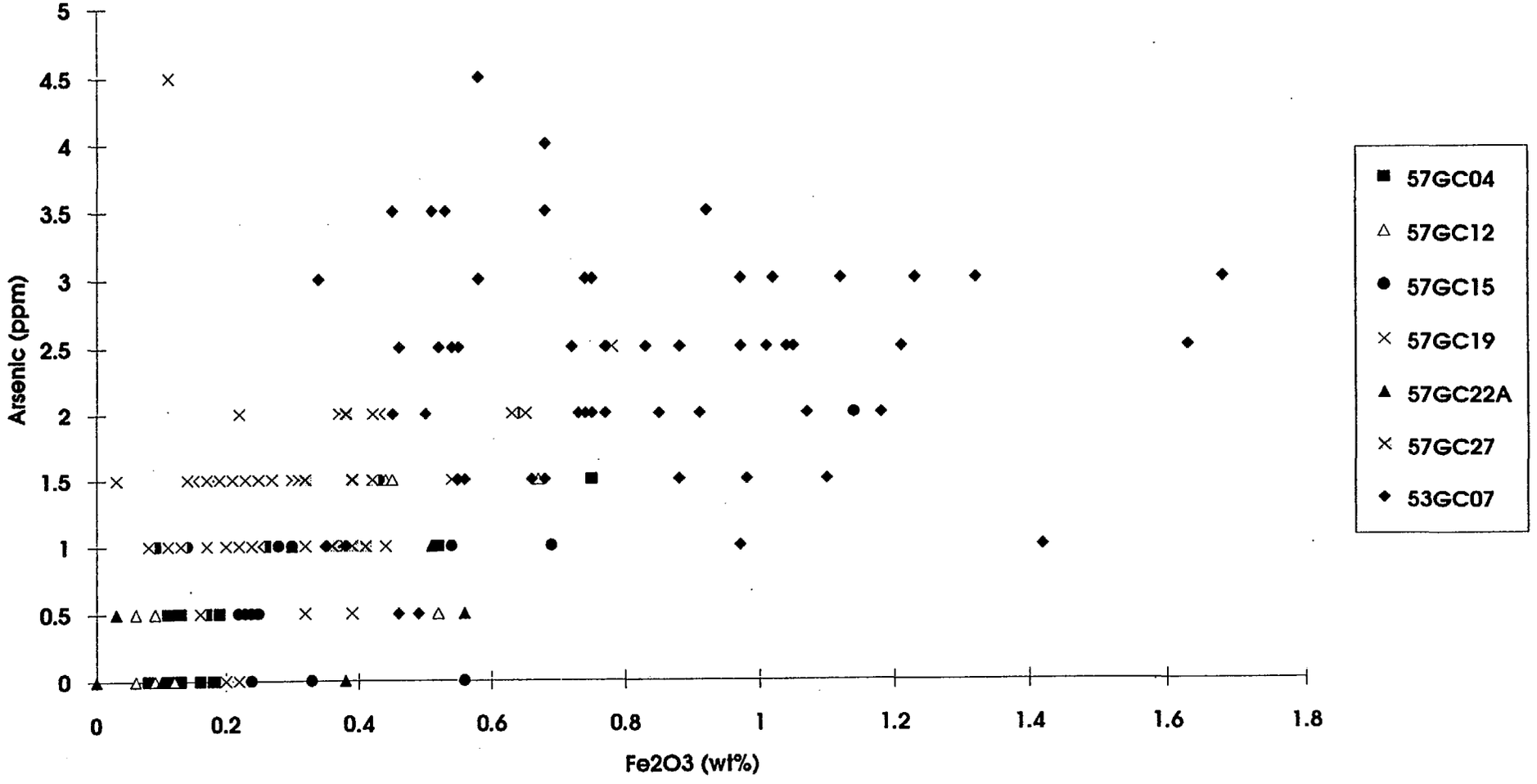
Fe2O3 (wt%) versus P2O5 (wt%), Perth Basin and Exmouth Plateau



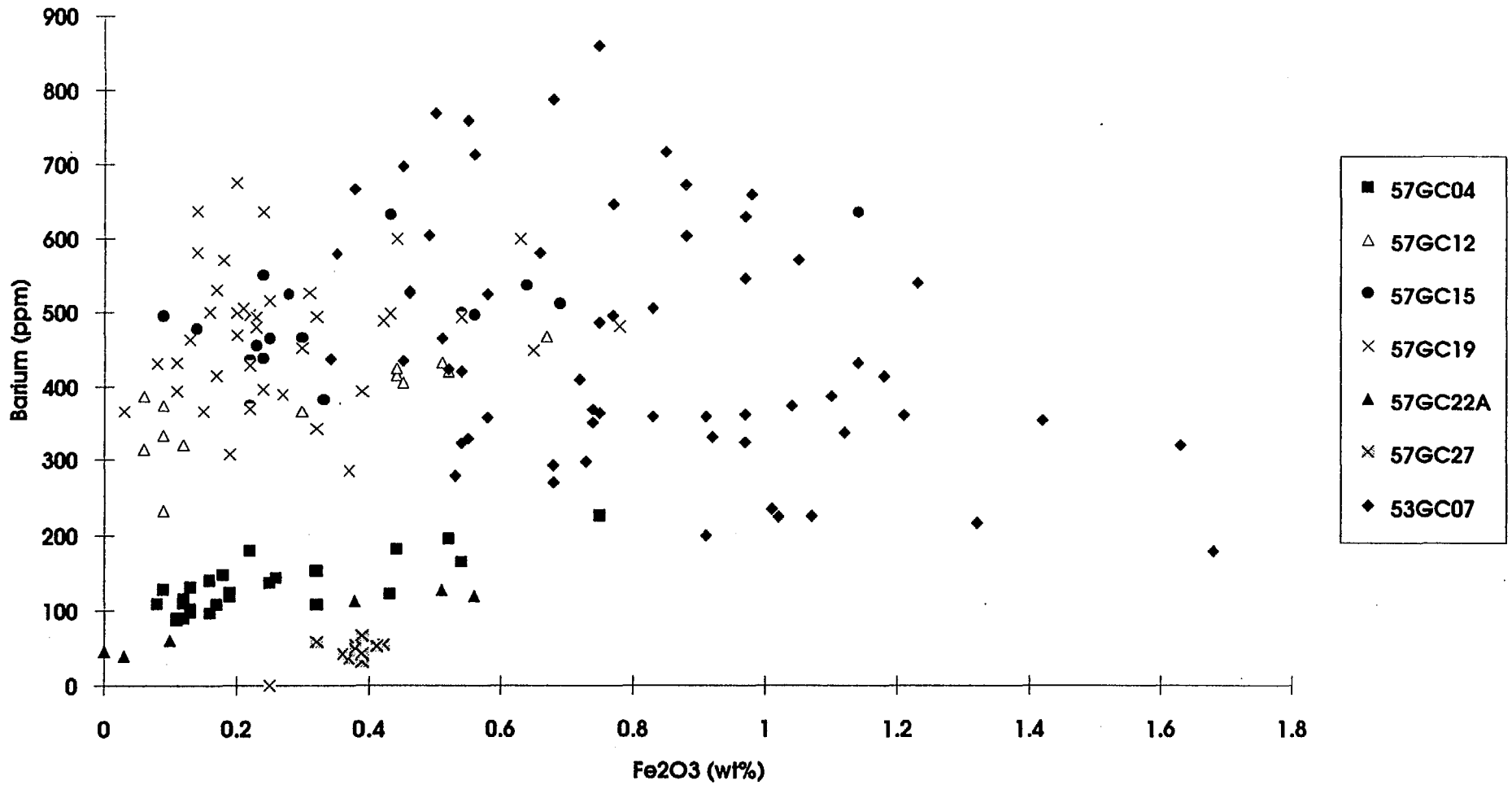
Fe2O3 (wt%) vs Sulphur (ppm), Perth Basin and Exmouth Plateau

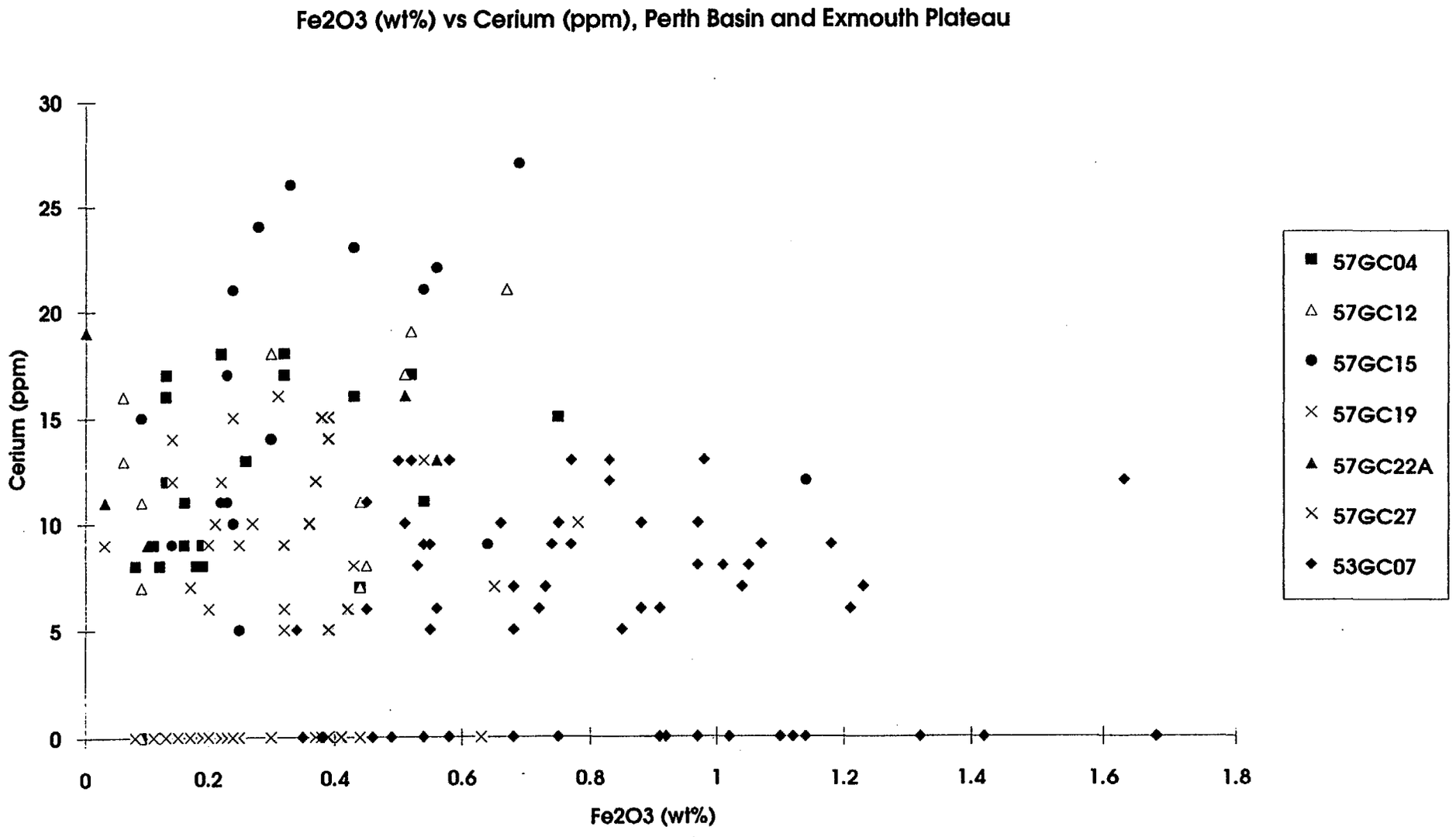


Fe2O3 (wt%) vs Arsenic (ppm), Perth Basin and Exmouth Plateau

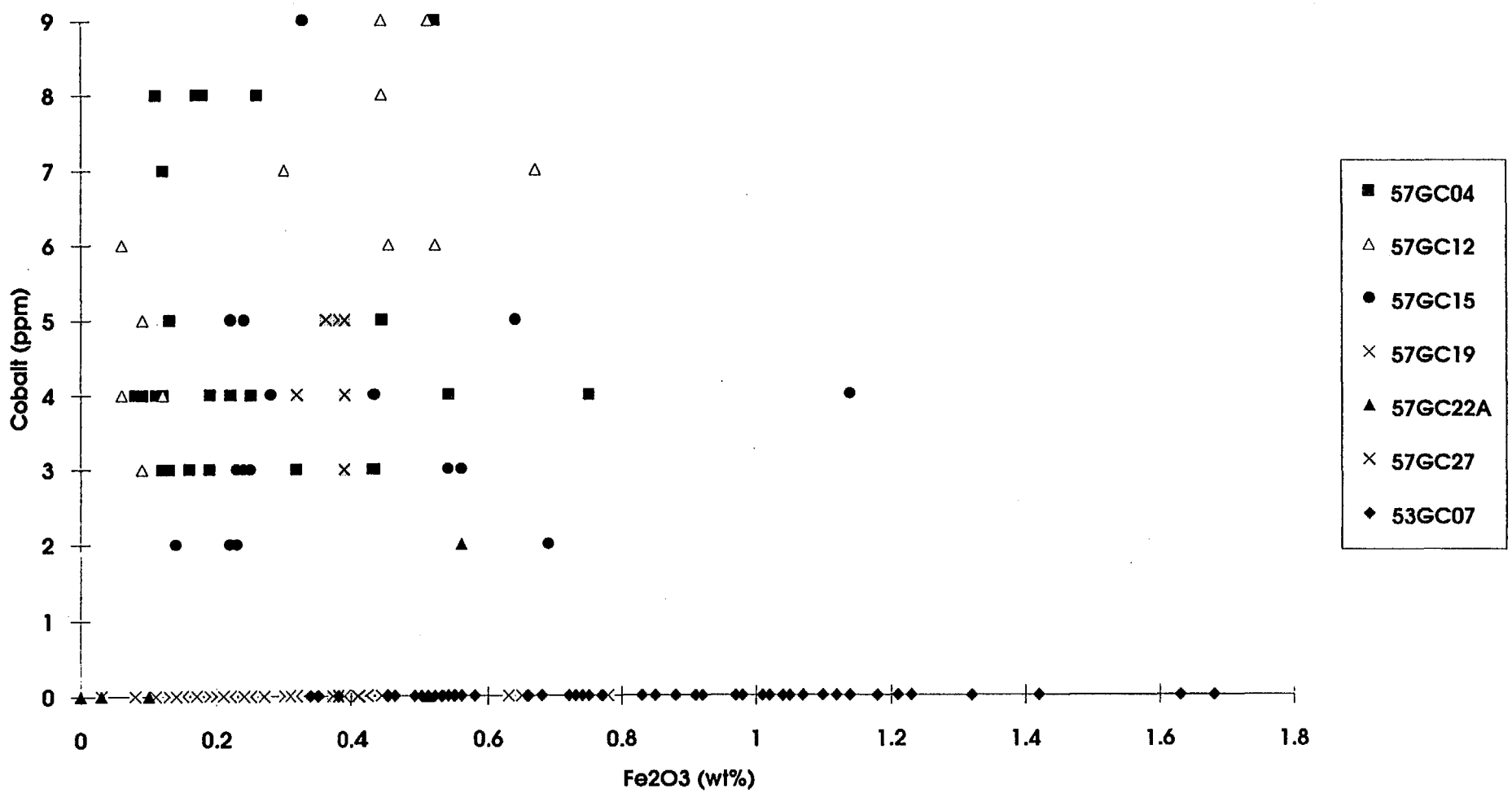


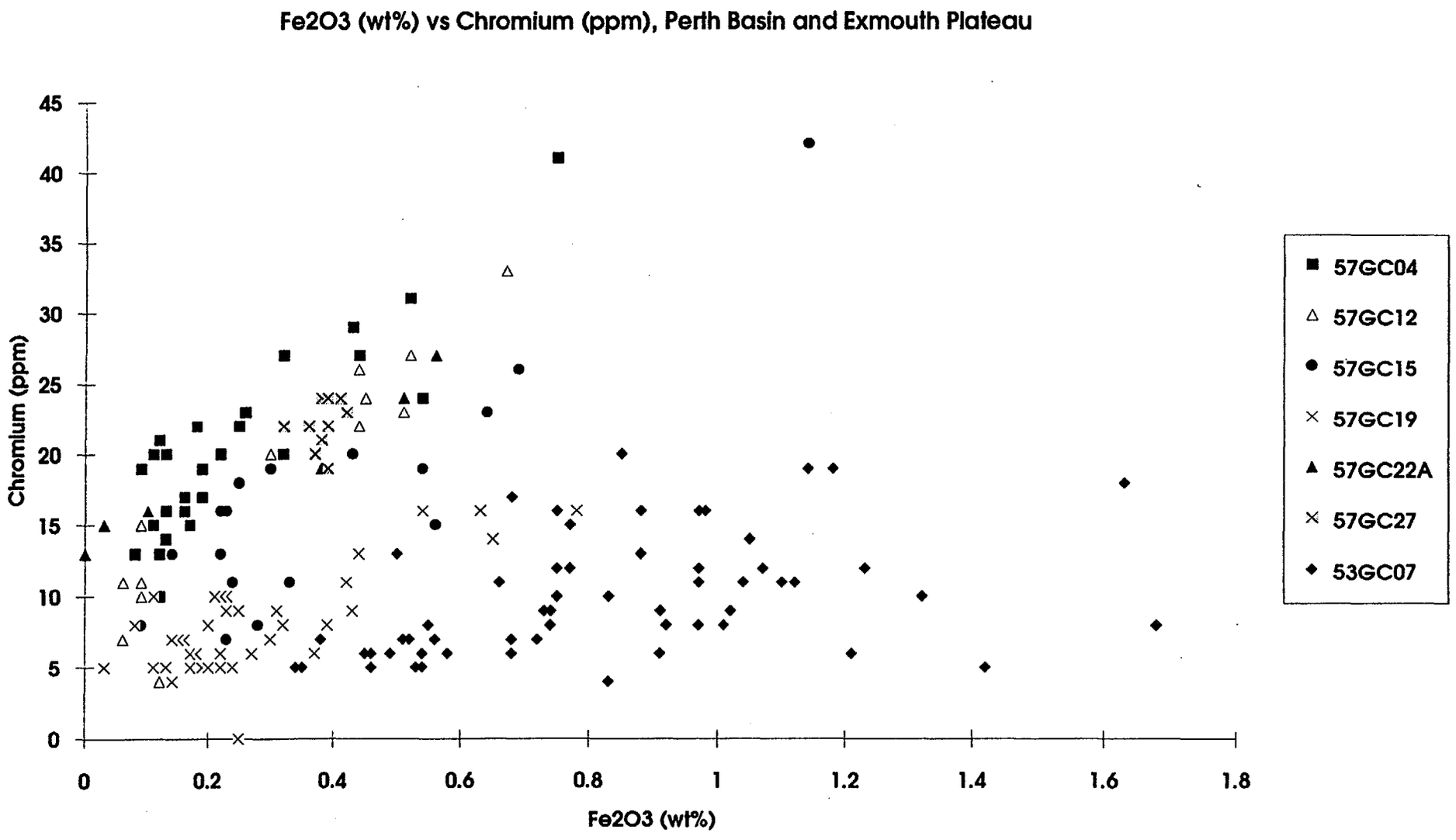
Fe2O3 (wt%) vs Barium (ppm), Perth Basin and Exmouth Plateau



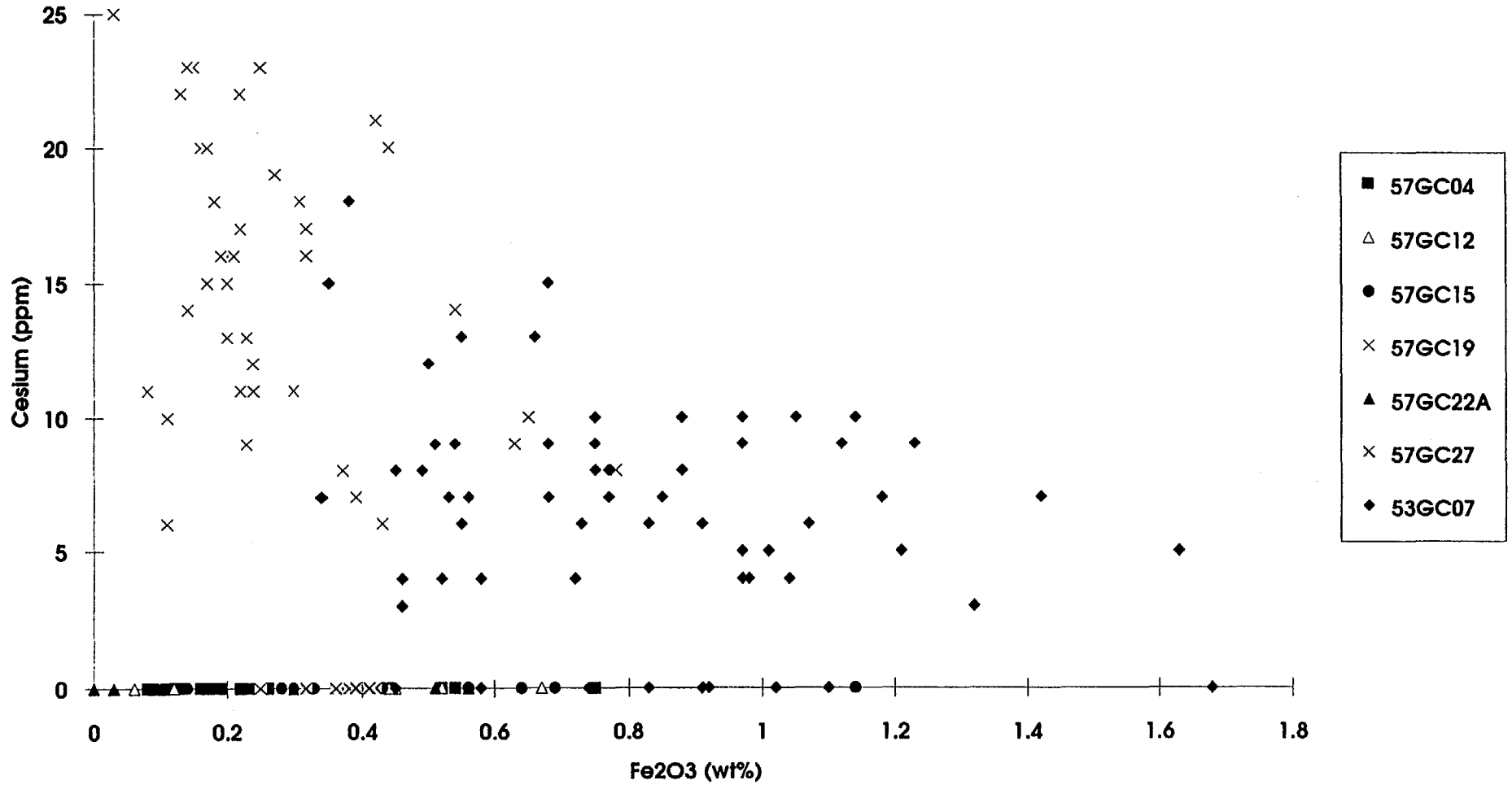


Fe2O3 (wt%) vs Cobalt (ppm), Perth Basin and Exmouth Plateau

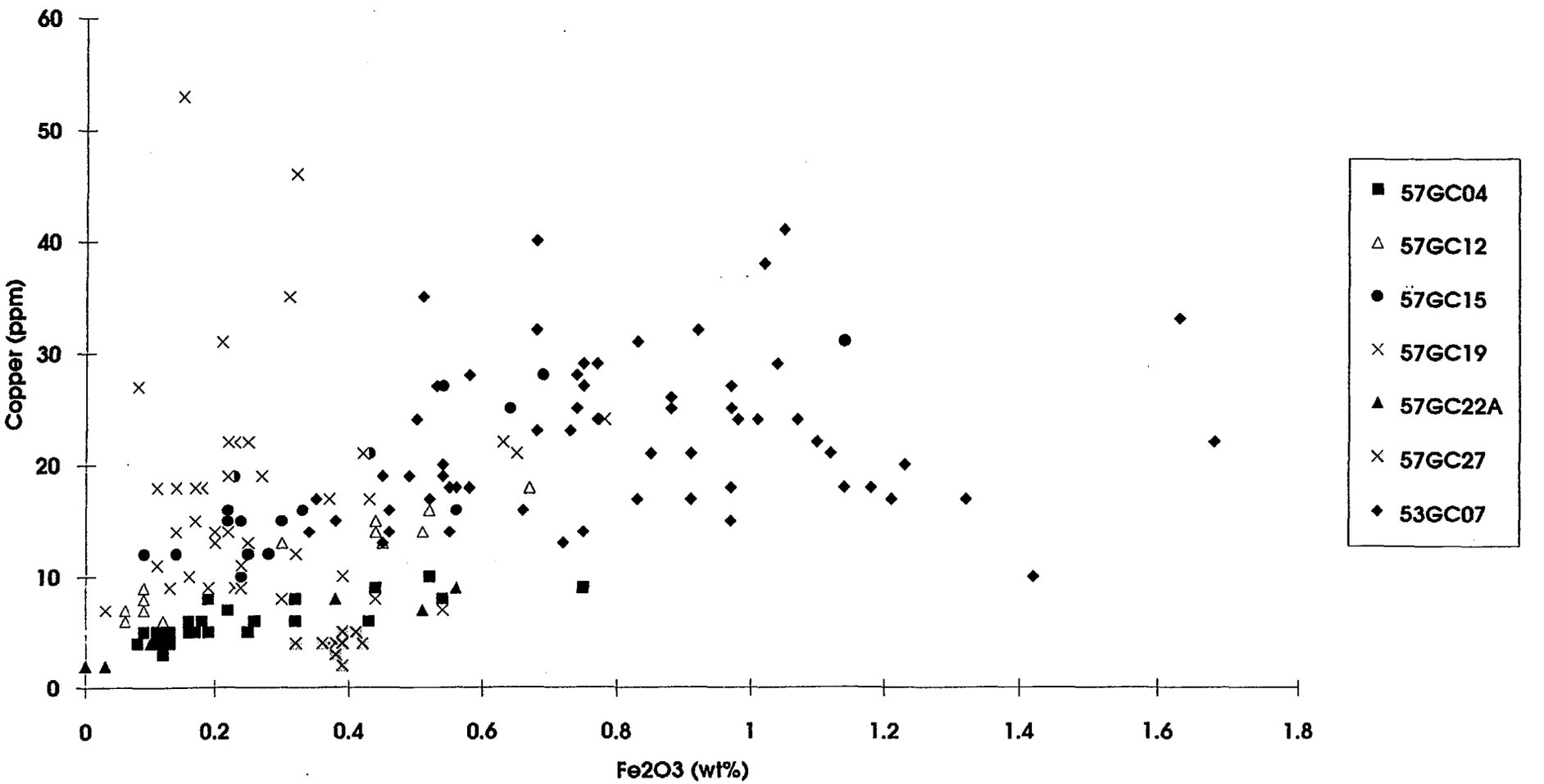




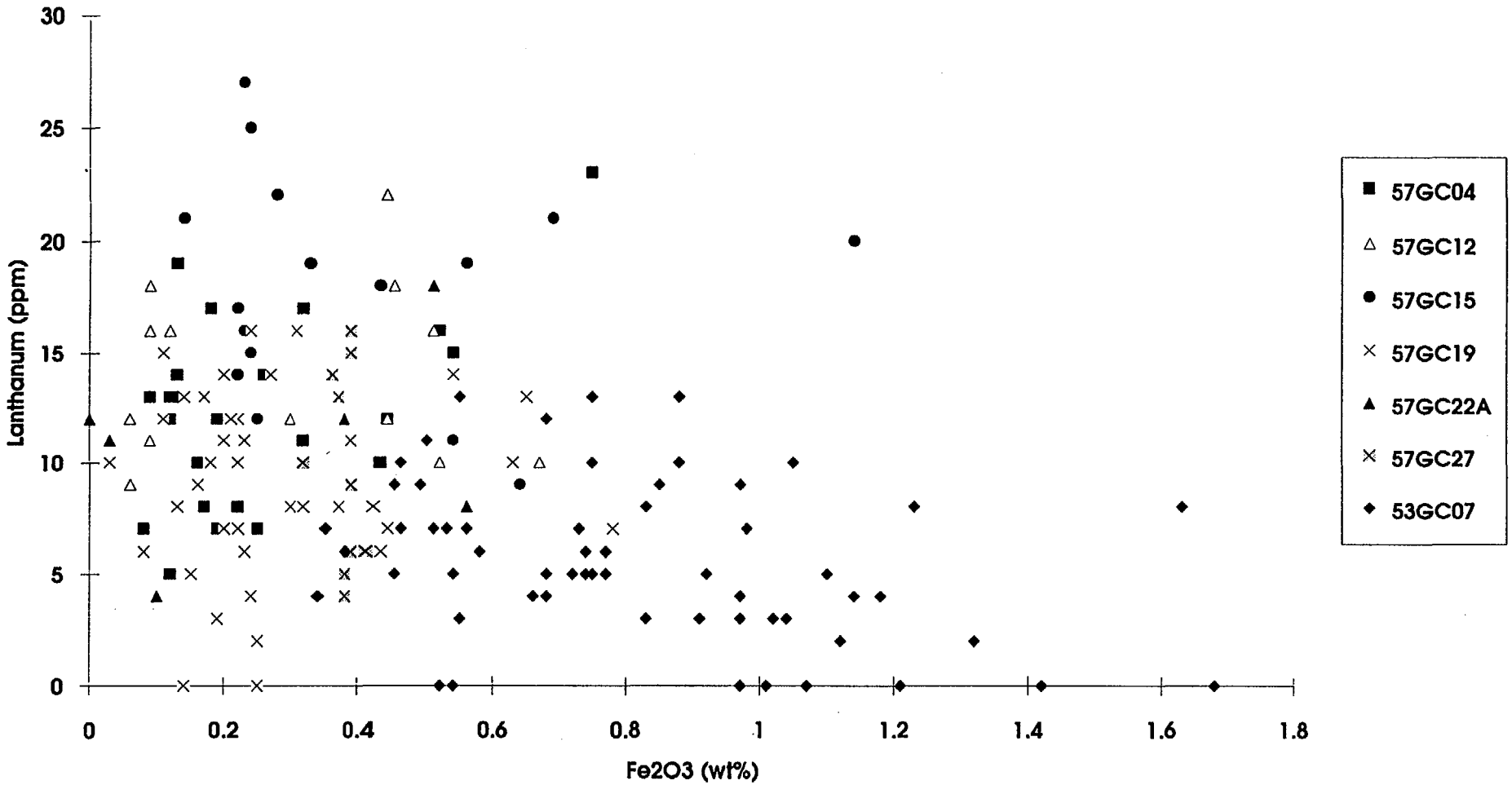
Fe2O3 (wt%) vs Cesium (ppm), Perth Basin and Exmouth Plateau



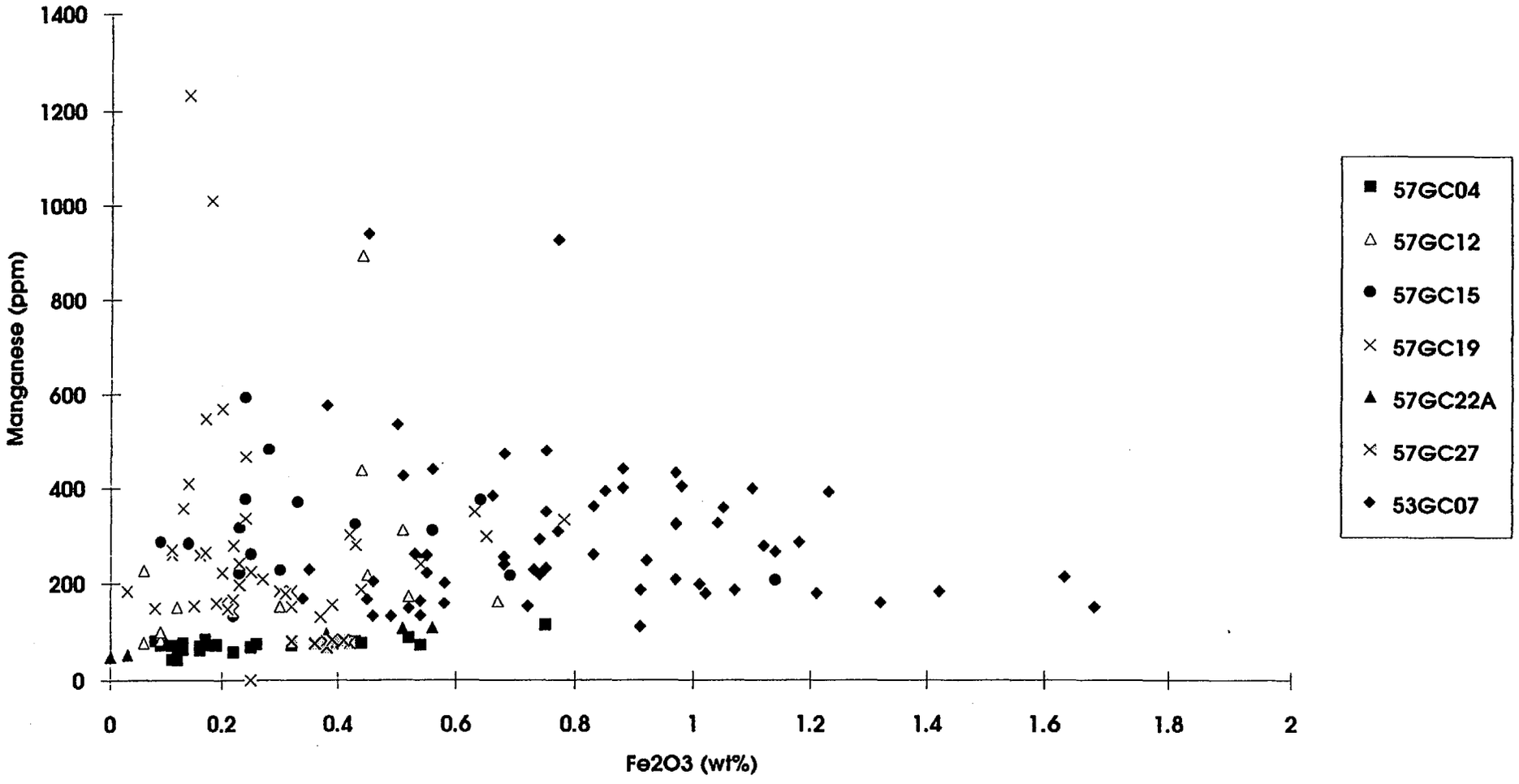
Fe2O3 (wt%) vs Copper (ppm), Perth Basin and Exmouth Plateau



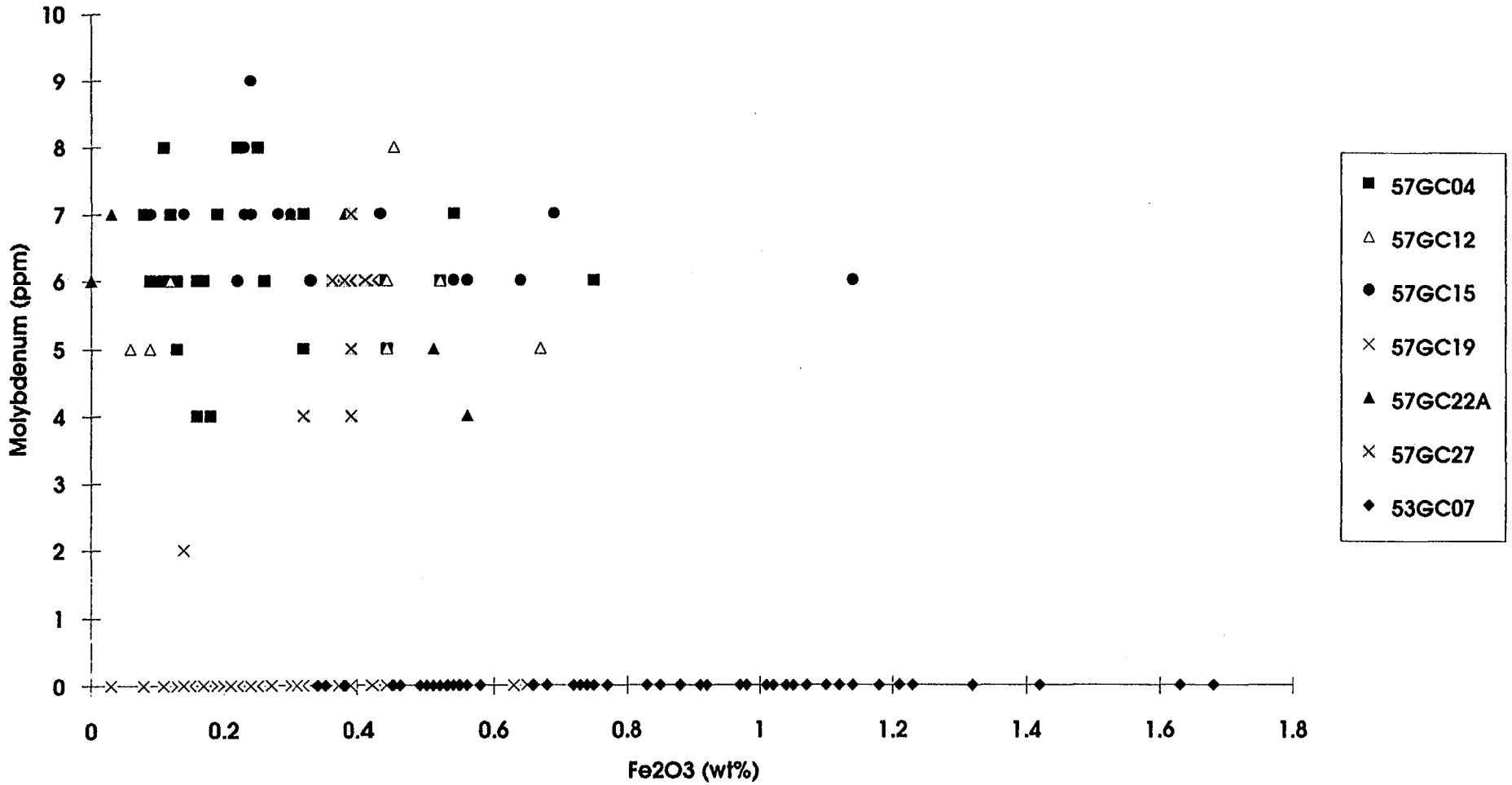
Fe2O3 (wt%) vs Lanthanum (ppm), Perth Basin and Exmouth Plateau



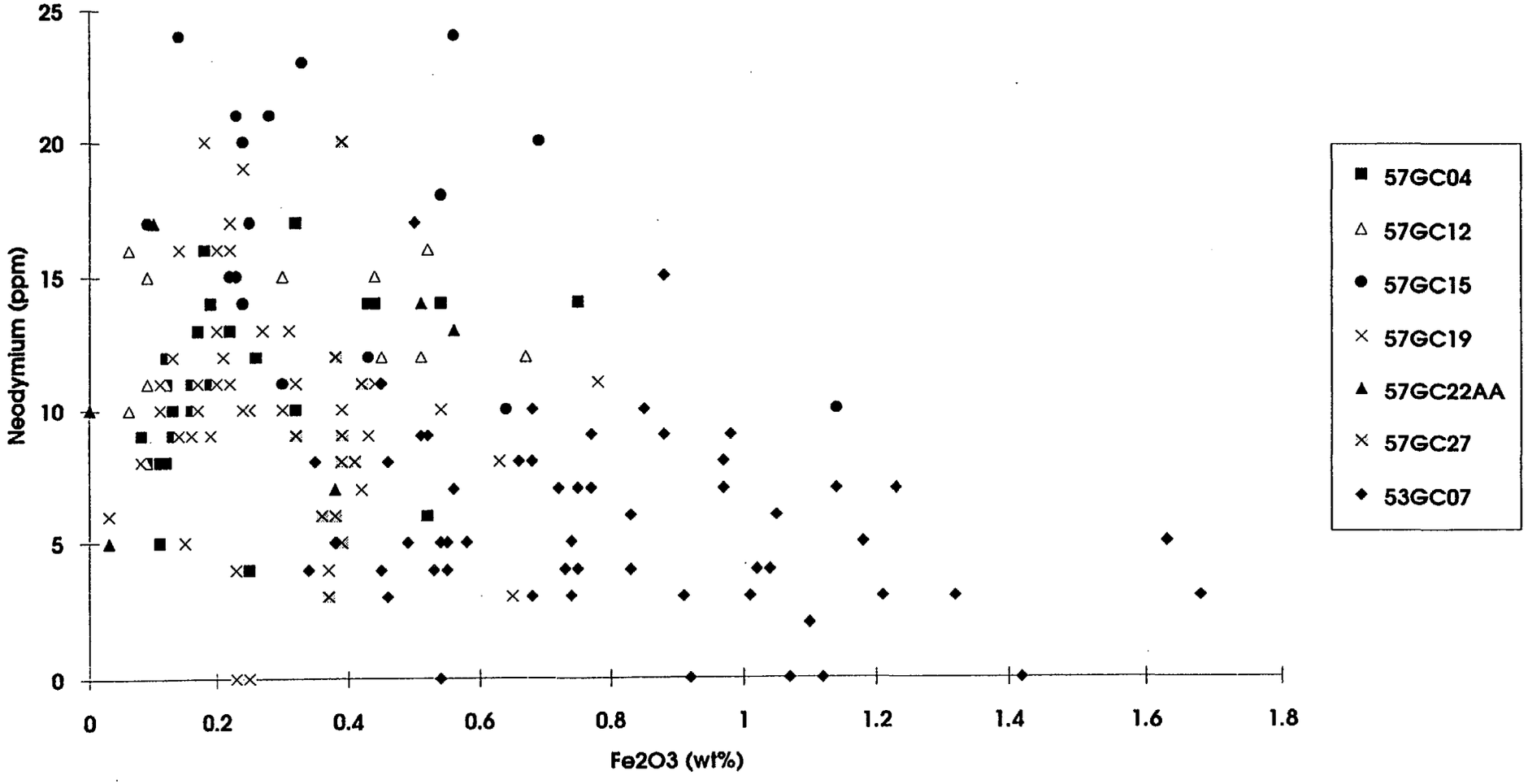
Fe2O3 (wt%) vs Manganese (ppm), Perth Basin and Exmouth Plateau



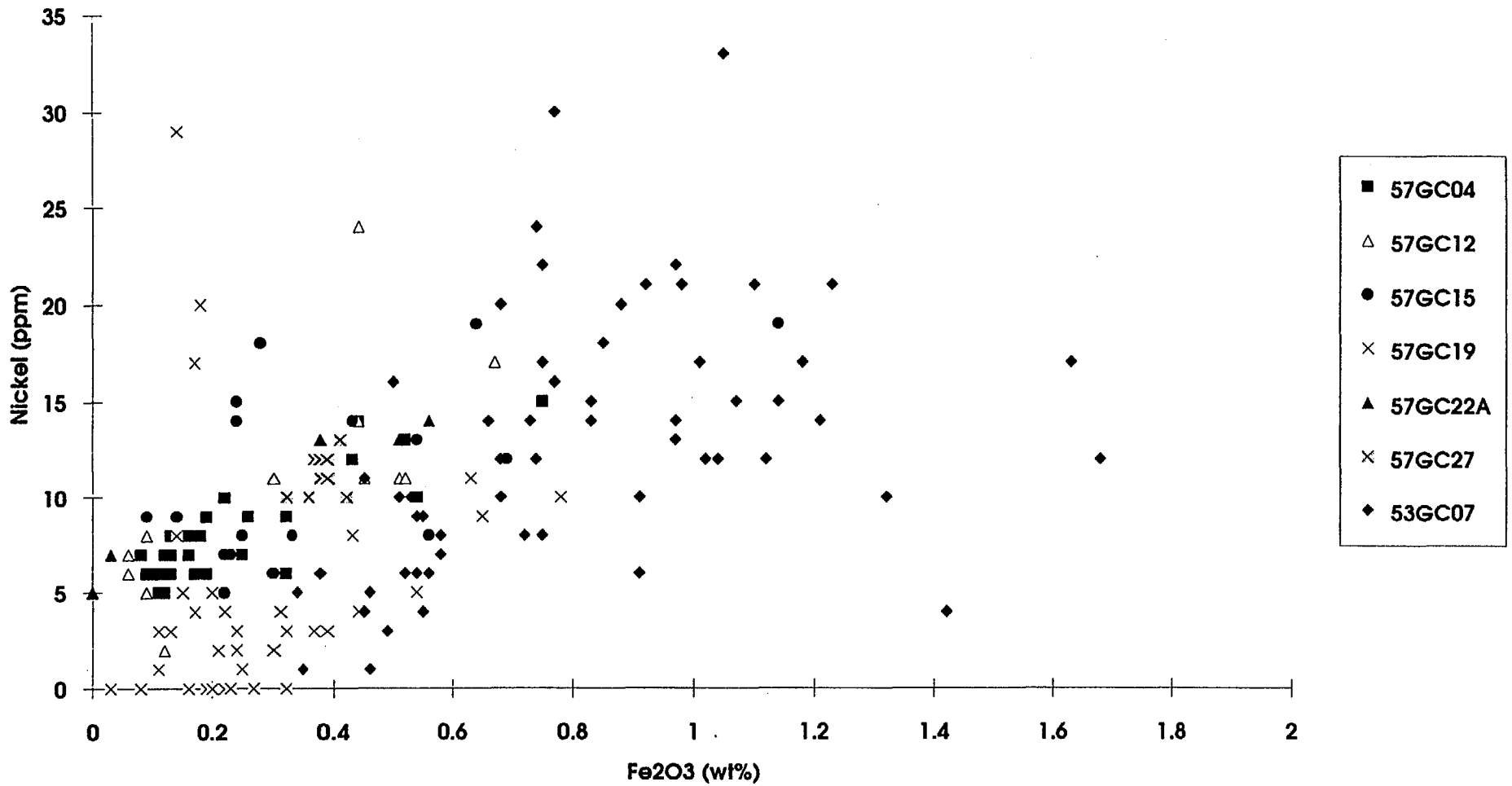
Fe2O3 (wt%) vs Molydbenum (ppm), Perth Basin and Exmouth Plateau



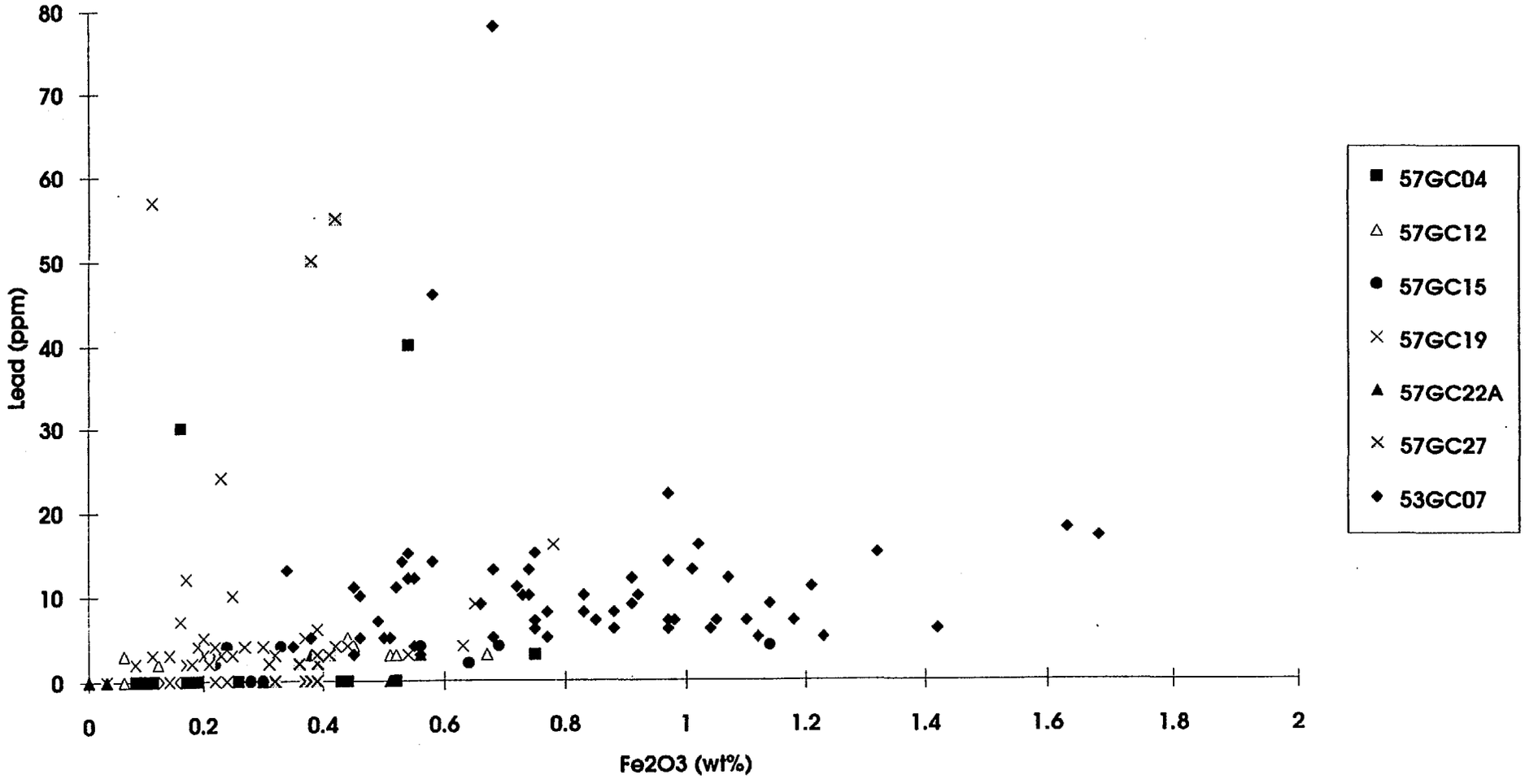
Fe2O3 (wt%) vs Neodymium (ppm), Perth Basin and Exmouth Plateau



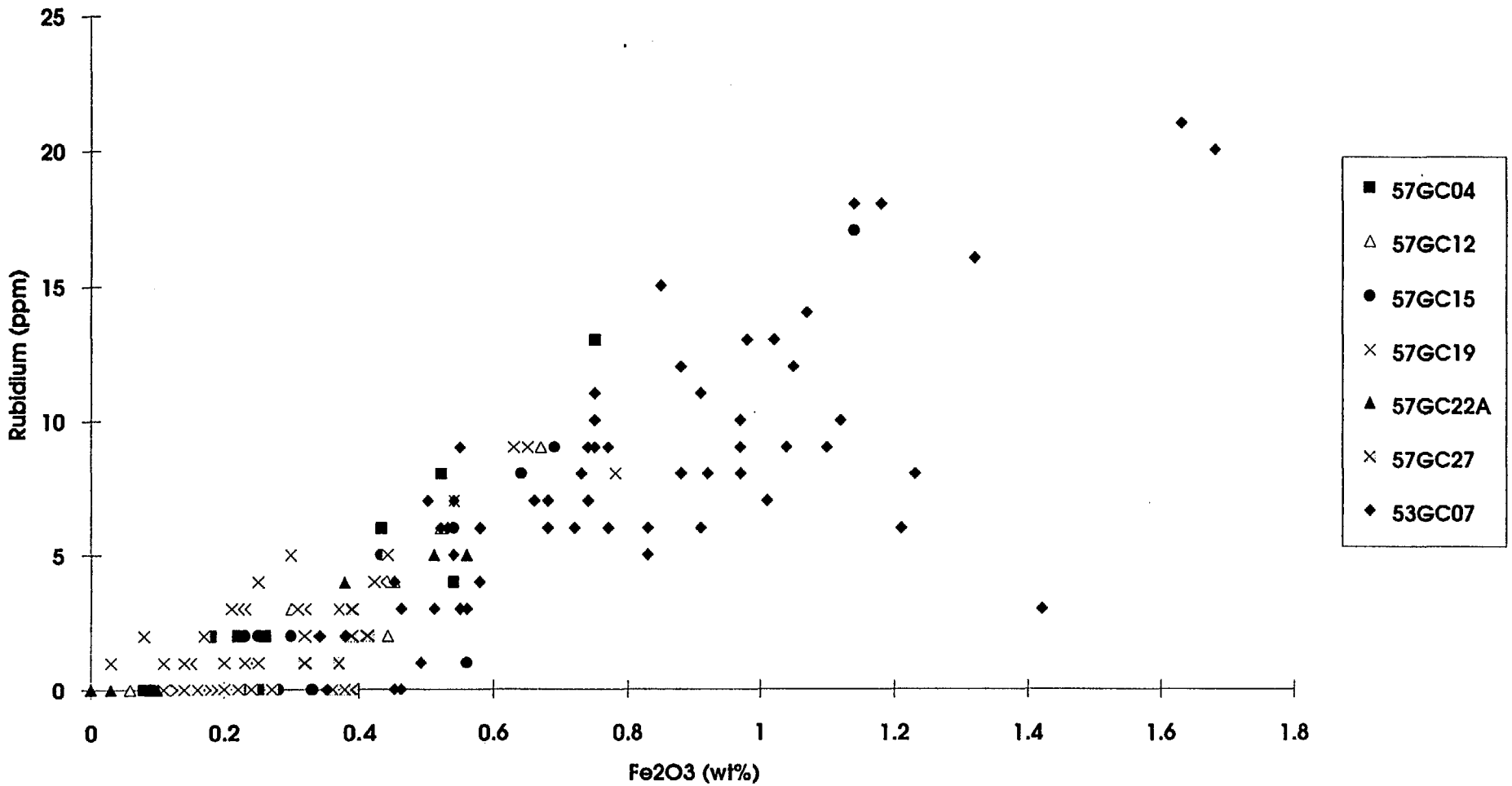
Fe2O3 (wt%) vs Nickel (ppm), Perth Basin and Exmouth Plateau



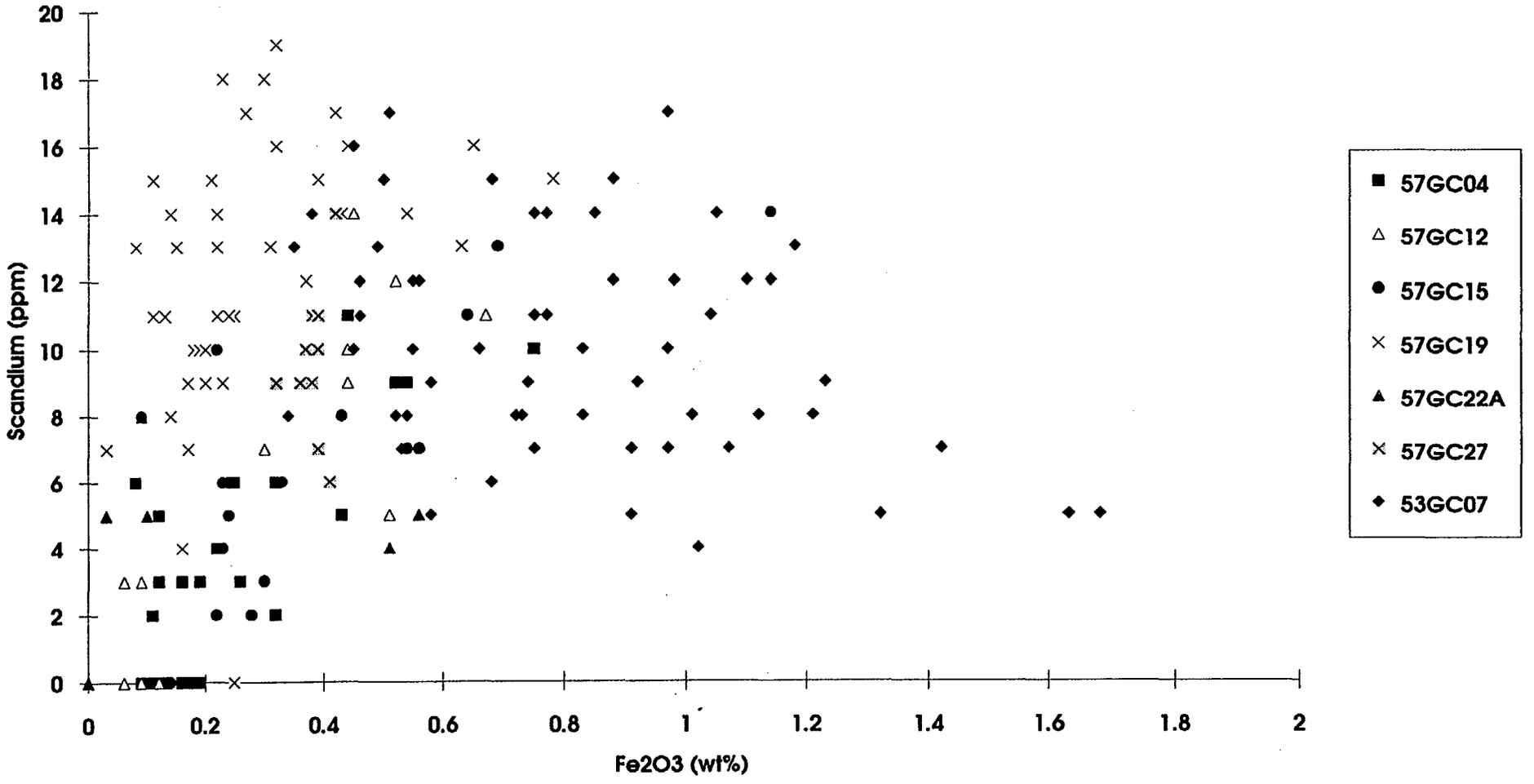
Fe2O3 (wt%) vs Lead (ppm), Perth Basin and Exmouth Plateau



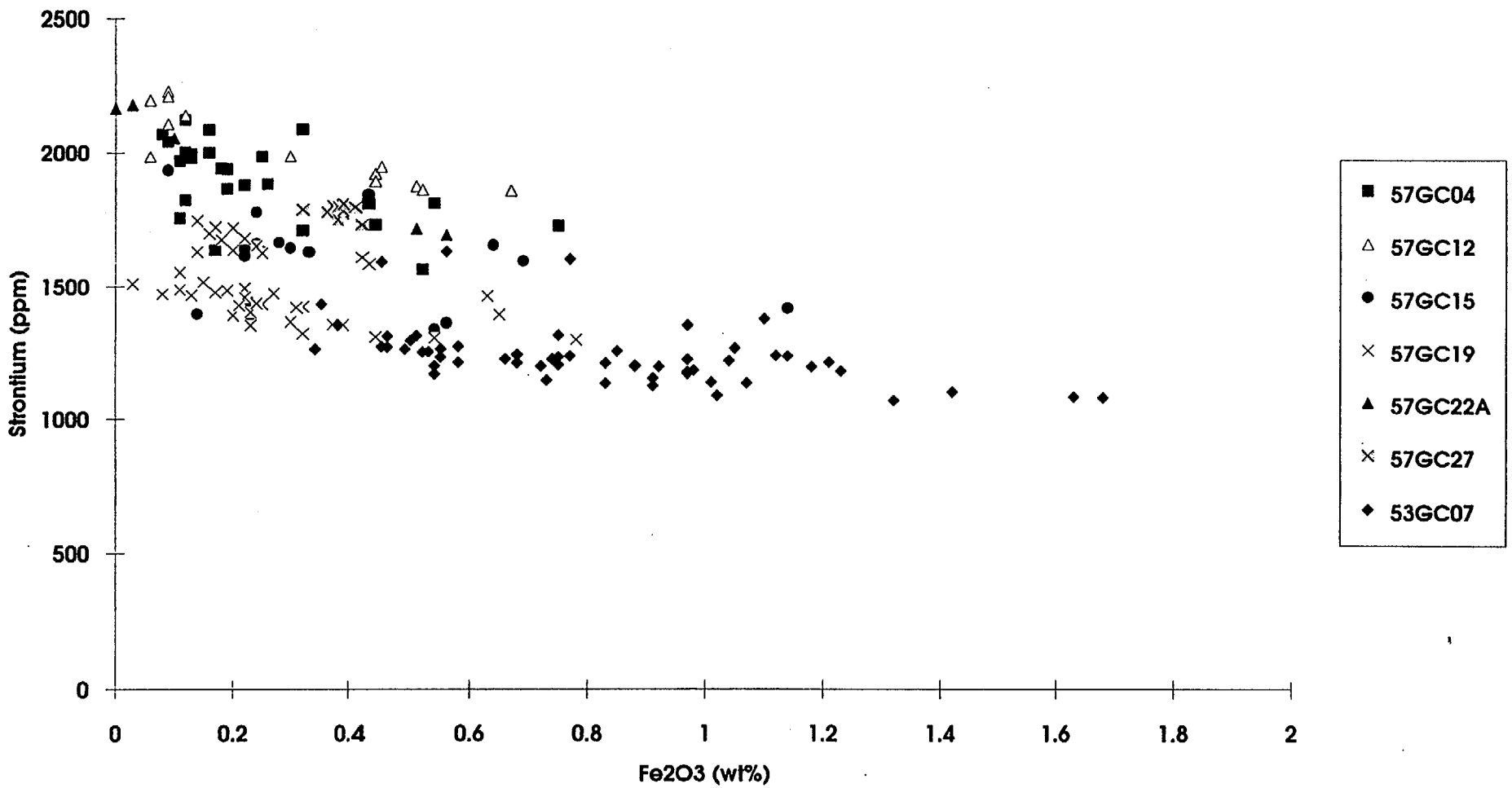
Fe2O3 (wt%) vs Rubidium (ppm), Perth Basin and Exmouth Plateau

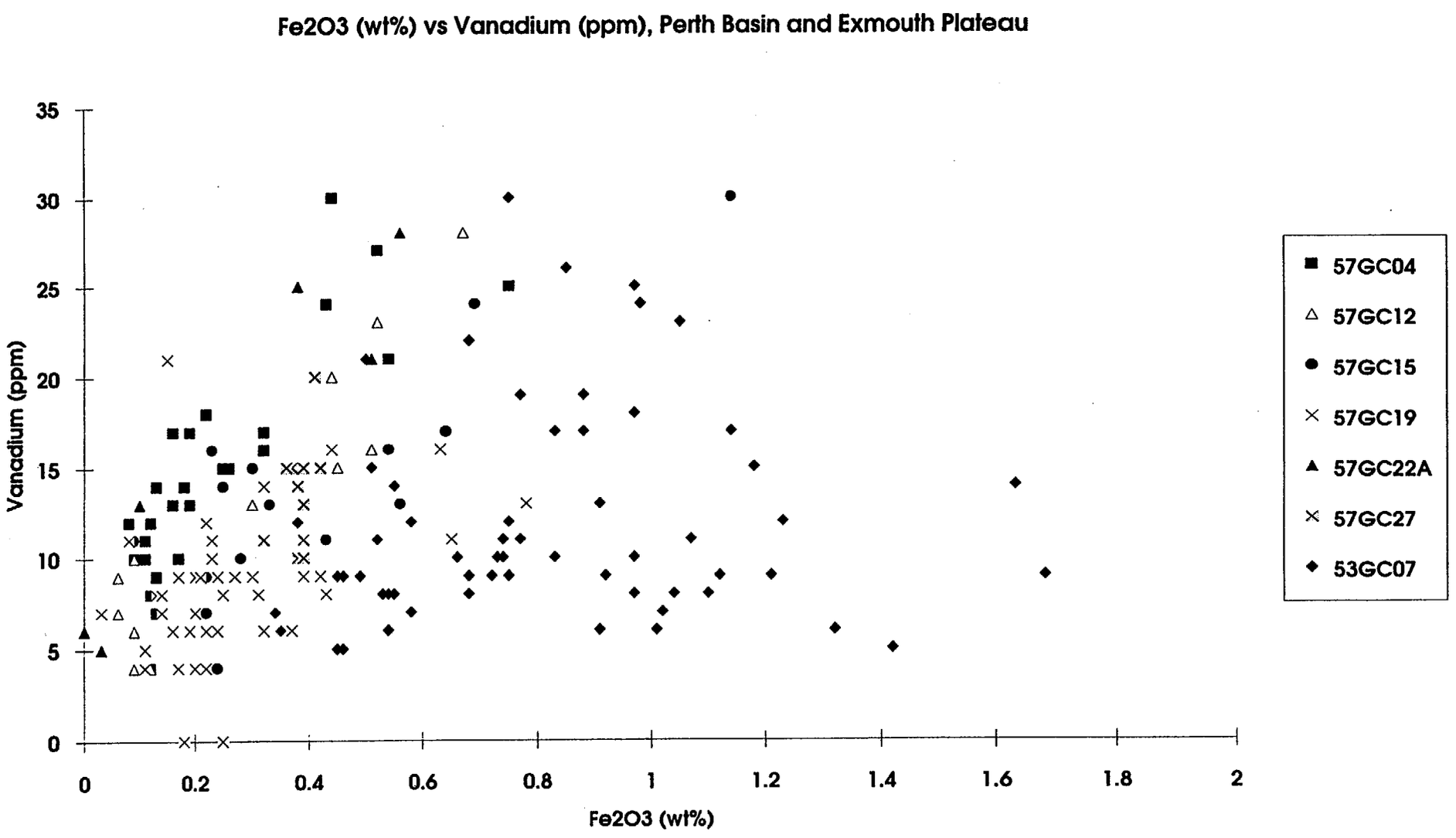


Fe2O3 (wt%) vs Scandium (ppm), Perth Basin and Exmouth Plateau

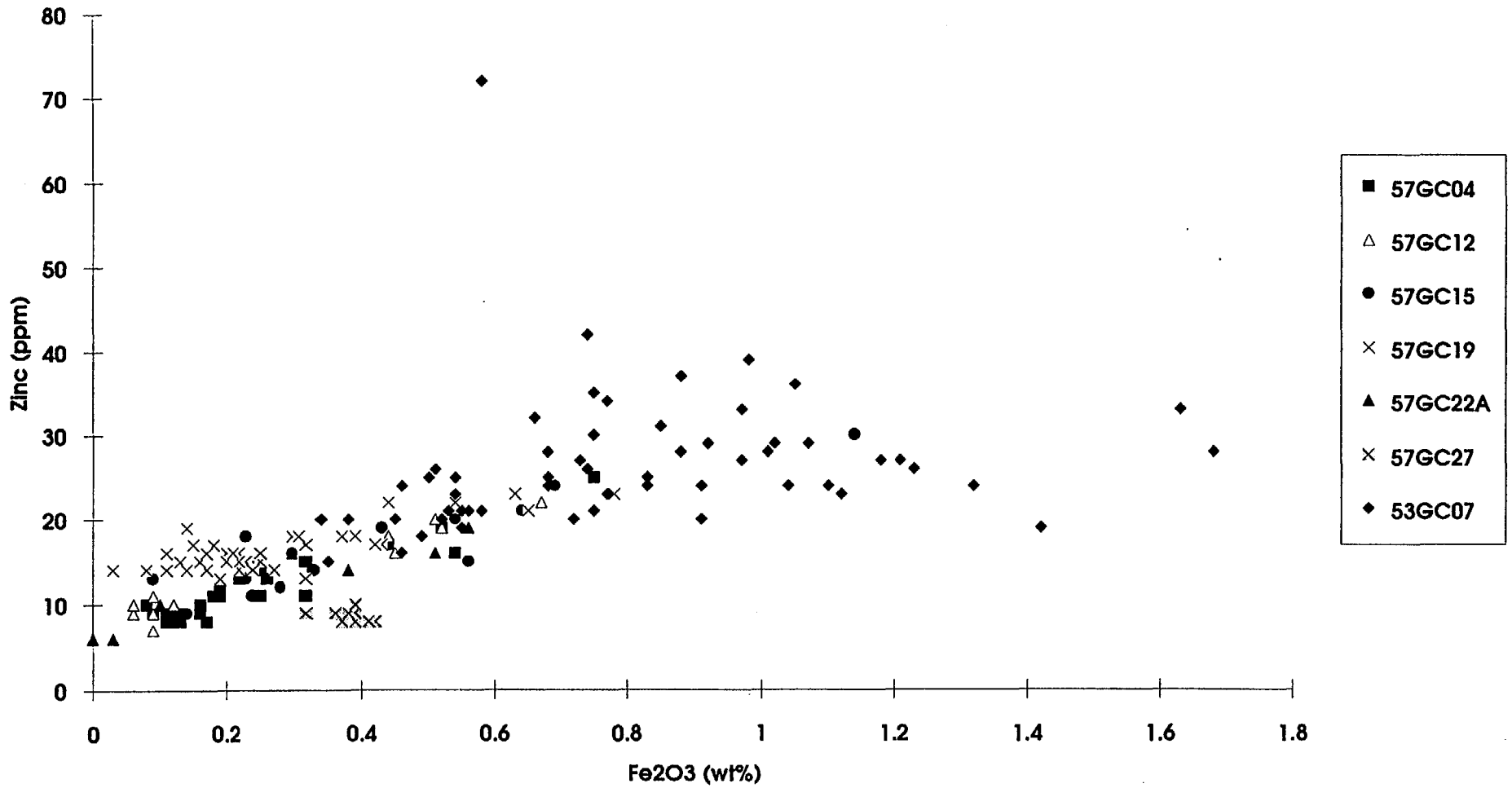


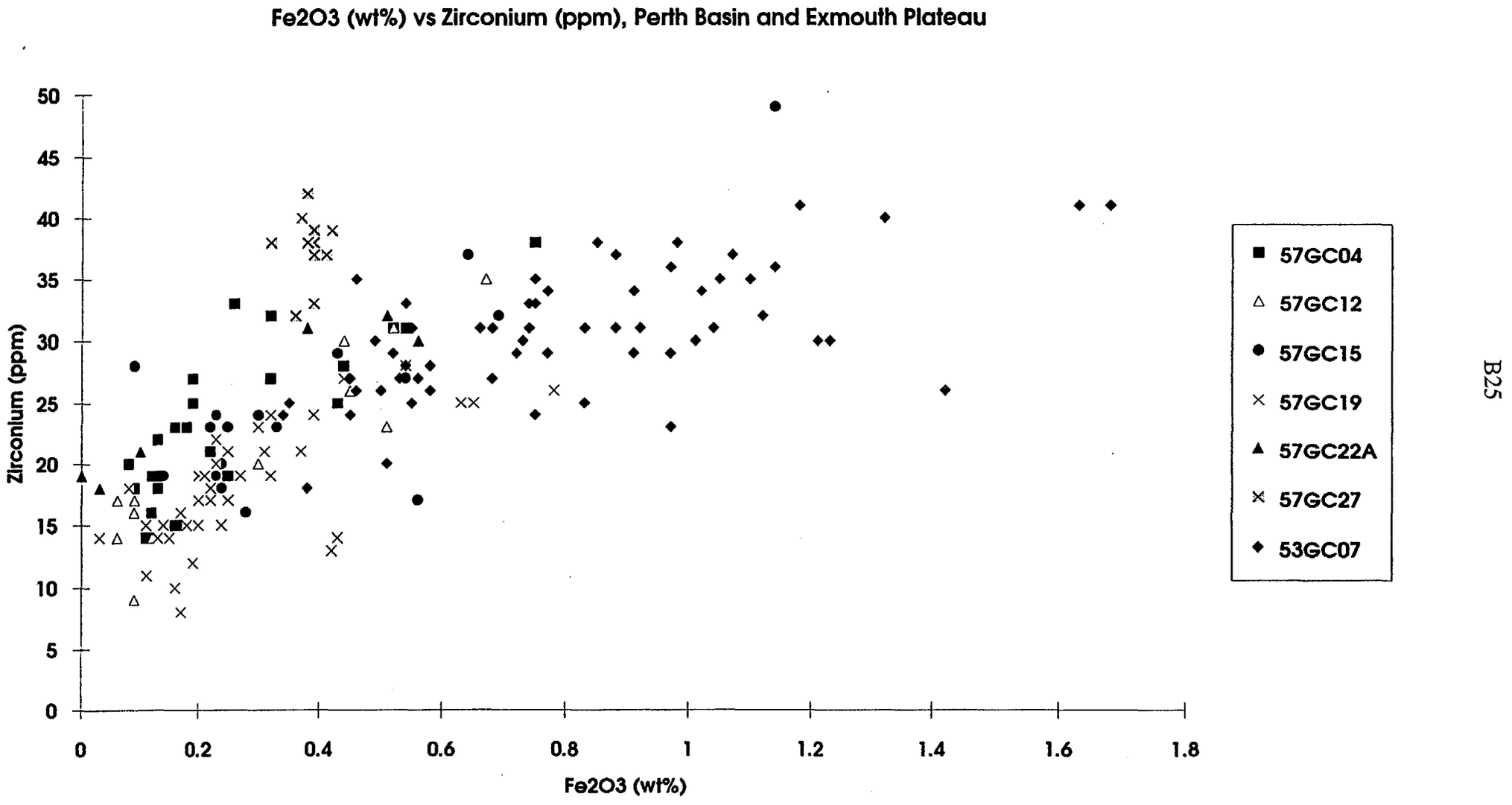
Fe2O3 (wt%) vs Strontium (ppm), Perth Basin and Exmouth Plateau



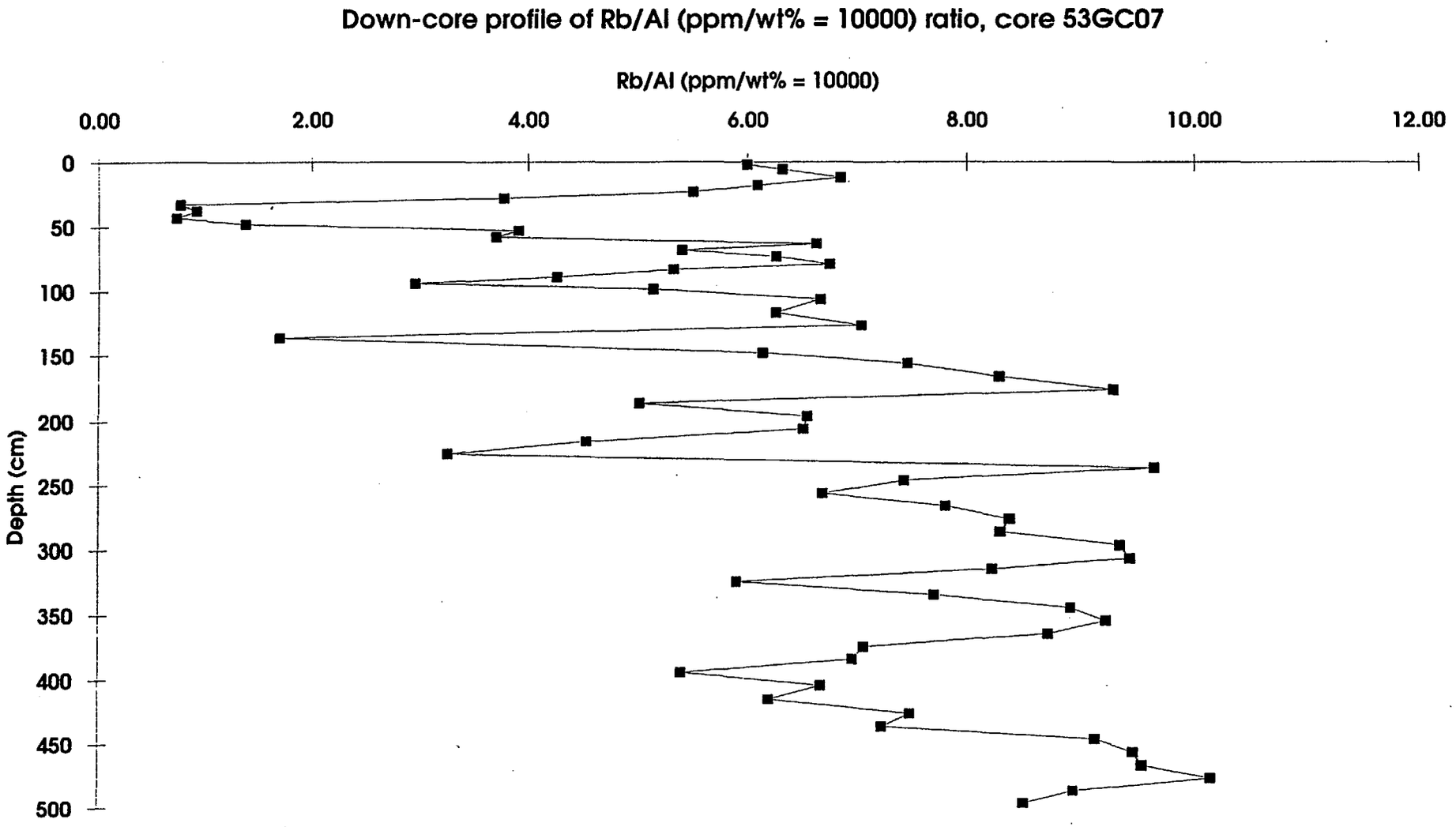


Fe2O3 (wt%) vs Zinc (ppm), Perth Basin and Exmouth Plateau





Appendix C. Down-core profiles of elemental ratios of sediments from core 53GC07.



Down-core profile of Ti/Al (ppm/wt% = 10000) ratio, core 53GC07