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INVESTIGATION OF THE HYDROGEOCHEMICAL DISPERSION OF GOLD AND OTHER ELEMENTS FROM MINERALIZED ZONES AT THE GRANNY SMITH GOLD DEPOSIT, WESTERN AUSTRALIA

Volume 2

D.J. Gray

CRC LEME OPEN FILE REPORT 93

March 2001

(CSIRO Division of Exploration and Mining Report 383R, 1993.
2nd Impression 2001.)

CRC LEME is an unincorporated joint venture between The Australian National University, University of Canberra, Australian Geological Survey Organisation and CSIRO Exploration and Mining, established and supported under the Australian Government's Cooperative Research Centres Program.

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Headquarters: CRC LEME c/o CSIRO Exploration and Mining, Private Bag No 5, PO Wembley, Western Australia, 6913.

RESEARCH ARISING FROM CSIRO/AMIRA YILGARN REGOLITH GEOCHEMISTRY PROJECTS 1987-1996

In 1987, CSIRO commenced a series of multi-client research projects in regolith geology and geochemistry which were sponsored by companies in the Australian mining industry, through the Australian Mineral Industries Research Association Limited (AMIRA). The initial research program, "Exploration for concealed gold deposits, Yilgarn Block, Western Australia" had the aim of developing improved geological, geochemical and geophysical methods for mineral exploration that would facilitate the location of blind, buried or deeply weathered gold deposits. The program commenced with the following projects:

P240: Laterite geochemistry for detecting concealed mineral deposits (1987-1991). Leader: Dr R.E. Smith.
Its scope was development of methods for sampling and interpretation of multi-element laterite geochemistry data and application of multi-element techniques to gold and polymetallic mineral exploration in weathered terrain. The project emphasised viewing laterite geochemical dispersion patterns in their regolith-landform context at local and district scales. It was supported by 30 companies.

P241: Gold and associated elements in the regolith - dispersion processes and implications for exploration (1987-1991). Leader: Dr C.R.M. Butt.
The project investigated the distribution of ore and indicator elements in the regolith. It included studies of the mineralogical and geochemical characteristics of weathered ore deposits and wall rocks, and the chemical controls on element dispersion and concentration during regolith evolution. This was to increase the effectiveness of geochemical exploration in weathered terrain through improved understanding of weathering processes. It was supported by 26 companies.

These projects represented 'an opportunity for the mineral industry to participate in a multi-disciplinary program of geoscience research aimed at developing new geological, geochemical and geophysical methods for exploration in deeply weathered Archaean terrains'. This initiative recognised the unique opportunities, created by exploration and open-cut mining, to conduct detailed studies of the weathered zone, with particular emphasis on the near-surface expression of gold mineralisation. The skills of existing and specially recruited research staff from the Floreat Park and North Ryde laboratories (of the then Divisions of Minerals and Geochemistry, and Mineral Physics and Mineralogy, subsequently Exploration Geoscience and later Exploration and Mining) were integrated to form a task force with expertise in geology, mineralogy, geochemistry and geophysics. Several staff participated in more than one project. Following completion of the original projects, two continuation projects were developed.

P240A: Geochemical exploration in complex lateritic environments of the Yilgarn Craton, Western Australia (1991-1993). Leaders: Drs R.E. Smith and R.R. Anand.
The approach of viewing geochemical dispersion within a well-controlled and well-understood regolith-landform and bedrock framework at detailed and district scales continued. In this extension, focus was particularly on areas of transported cover and on more complex lateritic environments typified by the Kalgoorlie regional study. This was supported by 17 companies.

P241A: Gold and associated elements in the regolith - dispersion processes and implications for exploration (1991-1993). Leader: Dr. C.R.M. Butt.
The significance of gold mobilisation under present-day conditions, particularly the important relationship with pedogenic carbonate, was investigated further. In addition, attention was focussed on the recognition of primary lithologies from their weathered equivalents. This project was supported by 14 companies.

Most reports related to the above research projects were published as CRC LEME Open File Reports Series (Nos 1-74), with an index (Report 75), by June 1999. Publication now continues with release of reports from further projects.

P252: Geochemical exploration for platinum group elements in weathered terrain. Leader: Dr C.R.M. Butt.
This project was designed to gather information on the geochemical behaviour of the platinum group elements under weathering conditions using both laboratory and field studies, to determine their dispersion in the regolith and to apply this to concepts for use in exploration. The research was commenced in 1988 by CSIRO Exploration Geoscience and the University of Wales (Cardiff). The Final Report was completed in December 1992. It was supported by 9 companies.

P409: Geochemical exploration in areas of transported overburden, Yilgarn Craton and environs, WA.
Leaders: Drs C.R.M. Butt and R.E. Smith.
About 50% or more of prospective terrain in the Yilgarn is obscured by substantial thicknesses of transported overburden that varies in age from Permian to Recent. Some of this cover has undergone substantial weathering. Exploration problems in these covered areas were the focus of Project 409. The research was commenced in June 1993 by CSIRO Exploration and Mining but was subsequently incorporated into the activities of CRC LEME in July 1995 and was concluded in July 1996. It was supported by 22 companies.

Although the confidentiality periods of Projects P252 and P409 expired in 1994 and 1998, respectively, the reports have not been released previously. CRC LEME acknowledges the Australian Mineral Industries Research Association and CSIRO Division of Exploration and Mining for authority to publish these reports. It is intended that publication of the reports will be a substantial additional factor in transferring technology to aid the Australian mineral industry.

This report (CRC LEME Open File Report 93) is a second impression (second printing) of CSIRO, Division of Exploration Geoscienceg Restricted Report 383R, first issued in 1993, which formed part of the CSIRO/AMIRA Project P409.

Copies of this publication can be obtained from:
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Appendix 1 - Compiled Analytical Results

Appendix 1: Compiled Analytical results

	Sample	pH	Eh	TDS	Na.i	Mg.i	Ca.i	K.i	Cl.tim	SO4.i	HCO3.at	Br.hp	I.m	Sr.i
1-(ii)	GSR904	7.02	156	4001	1345	82	96	43	1919	440	135	1.82	0.47	0.74
2-(ii)	GSR814	7.11	274	4000	1200	117	136	42	1739	542	nd	2.28	0.96	1.06
3-(ii)	WEG1	7.45	110	25583	8860	500	182	179	13433	2307	216	4.39	0.61	2.1
4-(ii)	WEG2	7.24	269	2207	725	51	90	23	931	312	149	1.52	0.59	0.57
5-(ii)	WEG9	7.16	311	2493	800	63	106	23	1046	345	162	1.68	0.59	0.76
6-(ii)	WEG7	7.52	277	17290	5920	390	215	119	8993	1558	184	1.88	0.60	2
7-(ii)	WEG3	7.34	298	2380	805	50	62	25	1020	306	171	1.05	0.47	0.57
8-(ii)	Goanna Sth	8.33	319	19553	6650	425	227	137	9884	2097	235	4.43	0.93	2.2
9-(ii)	DW15	7.27	194	15889	5080	460	280	125	8184	1633	222	4.51	1.40	3.1
10-(ii)	DW7	7.21	290	33039	10700	805	585	245	17422	3176	169	6.26	1.20	3.8
11-(ii)	DW22	7.07	338	68274	21400	1430	695	425	38794	5423	164	9.37	1.05	5.1
12-(ii)	DW16	7.93	296	5238	1805	78	59	53	2401	704	256	2.19	0.97	0.61
13-(ii)	WEG6	7.49	96	4079	1390	79	71	38	1940	443	186	1.39	0.44	1.02
14-(ii)	WEG8	7.13	260	2121	660	46	70	24	929	285	156	0.984	0.44	0.57
15-(ii)	WEG5	7.12	396	1627	540	38	57	21	629	240	147	0.604	0.53	0.49
16-(ii)	WEG4	7.15	141	13811	4400	420	420	94	7095	1243	226	1.92	0.88	5.5
17-(ii)	800	6.83	205	3417	985	115	112	46	1242	794	222	5.1	1.94	0.96
18-(ii)	801	7	277	2413	725	84	60	38	839	560	194	3.64	1.89	0.53
1-(i)	GSR904	7.02	156	3911	1300	83	95	43	nd	440	nd	nd	0.39	0.74
2-(i)	GSR814	7.11	274	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3-(i)	WEG1	7.45	110	25191	8720	490	184	174	nd	2277	nd	nd	0.46	2
4-(i)	WEG2	7.24	269	2145	680	52	86	23	nd	309	nd	nd	0.61	0.56
5-(i)	WEG9	7.16	311	2343	730	63	101	22	nd	339	nd	nd	0.60	0.74
6-(i)	WEG7	7.52	277	17271	5940	390	210	117	nd	1528	nd	nd	0.57	1.94
7-(i)	WEG3	7.34	298	2383	810	49	62	26	nd	303	nd	nd	0.45	0.57
8-(i)	Goanna Sth	8.33	319	19152	6530	415	224	135	nd	2037	nd	nd	0.73	2.2
9-(i)	DW15	7.27	194	16239	5220	460	290	129	nd	1648	nd	nd	1.42	3.2
10-(i)	DW7	7.21	290	32771	10600	780	585	245	nd	3176	nd	nd	0.80	3.8
11-(i)	DW22	7.07	338	68820	21550	1450	700	425	nd	5483	nd	nd	0.42	5.2
12-(i)	DW16	7.93	296	5642	1950	90	63	56	nd	749	nd	nd	0.86	0.65
13-(i)	WEG6	7.49	96	4223	1450	82	73	40	nd	452	nd	nd	0.59	1.05
14-(i)	WEG8	7.13	260	2218	695	48	73	25	nd	294	nd	nd	0.36	0.59
15-(i)	WEG5	7.12	396	1690	560	40	59	22	nd	249	nd	nd	0.57	0.51
16-(i)	WEG4	7.15	141	13847	4410	420	422	95	nd	1249	nd	nd	0.78	5.52
17-(i)	GRC800	6.83	205	3439	1005	115	113	46	nd	788	nd	nd	1.74	0.97
18-(i)	GRC801	7	277	2431	740	83	61	38	nd	557	nd	nd	1.61	0.54

The -(i) or -(ii) suffix denotes the treatment used (see Section 2.2)
All analyses in mg/L except Eh (in mV) and Au (in µg/L)

Abbreviations
nd - not determined
.i - ICP-AES
.tim - Technicon Industrial method
.al - alkalinity titration
.hp - HPLC
.m - ICP-MS
.a - ASV

	Cs.m	Ba.i	Al.i	Si.i	Ti.i	Cr.i	Mn.i	Fe.i	Co.i	Co.m	Ni.i	Ni.m	Cu.a
1-(ii)	0.0003	0.048	0.004	6	<0.002	<0.005	0.4	0.32	<0.005	0.002	<0.01	0.006	<0.005
2-(ii)	0.0005	0.016	0.01	30	<0.002	<0.005	0.052	0.023	<0.005	0.003	<0.01	0.009	<0.005
3-(ii)	0.0037	0.021	0.014	8.4	<0.002	<0.005	0.32	0.66	<0.005	0.003	<0.01	0.013	<0.005
4-(ii)	0.0002	0.008	0.009	31	<0.002	<0.005	0.017	<0.005	<0.005	0.003	<0.01	0.011	<0.005
5-(ii)	0.0001	0.005	0.023	28	<0.002	<0.005	0.007	0.014	<0.005	0.001	<0.01	0.006	<0.005
6-(ii)	0.0057	0.066	<0.002	17.8	<0.002	<0.005	0.31	0.038	0.032	0.026	0.06	0.086	0.172
7-(ii)	0.0005	0.037	0.007	26	<0.002	<0.005	0.16	0.009	0.02	0.012	<0.01	0.007	0.132
8-(ii)	0.0057	0.048	0.008	9.7	<0.002	<0.005	0.29	0.022	0.014	0.013	<0.01	0.040	<0.005
9-(ii)	0.0063	0.049	0.008	7.6	<0.002	<0.005	0.64	0.91	0.013	0.016	0.03	0.051	<0.005
10-(ii)	0.0048	0.039	0.004	10.9	0.002	<0.005	1.64	0.025	0.13	0.141	0.17	0.255	<0.005
11-(ii)	0.0096	0.038	0.003	10.5	<0.002	<0.005	1.2	0.057	0.049	0.070	0.05	0.229	<0.005
12-(ii)	0.0013	0.007	0.004	8.6	<0.002	<0.005	0.2	0.018	0.005	0.002	<0.01	0.043	<0.005
13-(ii)	0.0012	0.069	0.01	19.6	<0.002	<0.005	0.34	3.3	<0.005	0.002	<0.01	0.009	<0.005
14-(ii)	0.0002	0.008	0.006	29	<0.002	<0.005	0.014	0.017	<0.005	0.001	<0.01	0.006	<0.005
15-(ii)	<0.0001	0.008	0.006	29	<0.002	<0.005	0.002	0.013	<0.005	0.000	<0.01	0.004	<0.005
16-(ii)	0.0099	0.068	0.028	18.1	0.002	<0.005	0.48	1.23	0.007	0.005	<0.01	0.026	<0.005
17-(ii)	0.0027	0.019	0.004	5.8	<0.002	<0.005	0.27	0.2	<0.005	0.001	<0.01	0.009	<0.005
18-(ii)	0.0017	0.011	0.005	6.1	<0.002	<0.005	0.003	0.01	<0.005	0.000	<0.01	0.006	<0.005
1-(i)	0.0003	0.049	0.004	5.9	<0.002	<0.005	0.38	0.025	<0.005	0.002	<0.01	0.012	<0.005
2-(i)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3-(i)	0.0036	0.027	0.01	7.6	<0.002	<0.005	0.33	0.034	<0.005	0.004	<0.01	0.055	0.03
4-(i)	0.0029	0.013	0.009	31	<0.002	<0.005	0.017	0.02	<0.005	0.003	<0.01	0.018	<0.005
5-(i)	0.0001	0.012	0.004	28	<0.002	<0.005	0.01	0.012	<0.005	0.001	<0.01	0.015	0.026
6-(i)	0.0062	0.067	<0.002	17.7	<0.002	<0.005	0.31	0.028	0.02	0.023	0.06	0.100	0.166
7-(i)	0.0005	0.037	0.008	26	<0.002	<0.005	0.16	0.011	0.009	0.014	<0.01	0.025	0.187
8-(i)	0.0060	0.048	0.009	9.3	<0.002	<0.005	0.28	0.031	0.01	0.013	0.02	0.064	<0.005
9-(i)	0.0063	0.051	<0.002	7.3	<0.002	<0.005	0.63	0.025	0.009	0.017	0.03	0.069	<0.005
10-(i)	0.0048	0.039	<0.002	10.4	0.002	<0.005	1.61	0.03	0.12	0.130	0.17	0.247	<0.005
11-(i)	0.0099	0.041	<0.002	10.8	0.003	<0.005	1.29	0.057	0.04	0.062	0.08	0.233	<0.005
12-(i)	0.0015	0.01	<0.002	9.1	<0.002	<0.005	0.21	0.021	<0.005	0.003	<0.01	0.049	<0.005
13-(i)	0.0013	0.068	<0.002	19.6	<0.002	<0.005	0.34	0.02	<0.005	0.003	<0.01	0.025	<0.005
14-(i)	0.0003	0.013	0.004	30	<0.002	<0.005	0.019	0.018	<0.005	0.001	<0.01	0.015	<0.005
15-(i)	0.0001	0.012	<0.002	31	<0.002	<0.005	0.004	0.012	<0.005	0.000	<0.01	0.015	<0.005
16-(i)	0.0106	0.07	0.003	17.8	<0.002	<0.005	0.47	0.033	0.014	0.020	0.01	0.043	<0.005
17-(i)	0.0028	0.02	0.004	5.8	0.002	<0.005	0.095	0.025	<0.005	0.000	<0.01	0.019	<0.005
18-(i)	0.0017	0.012	0.003	6.2	<0.002	<0.005	0.005	0.009	<0.005	0.000	<0.01	0.015	<0.005

	Cu.i	Cu.m	Zn.i	Zn.m	Ga.m	As.m	Y.m	Mo.m	Ag.m	Cd.a	Cd.m	Sn.m
1-(ii)	<0.005	0.009	0.016	0.029	0.001	0.014	0.0002	0.003	<0.0001	<0.002	0.000	0.000
2-(ii)	<0.005	0.136	0.01	0.023	0.003	0.018	0.0013	0.008	0.0001	<0.002	0.000	0.000
3-(ii)	<0.005	0.026	0.078	0.076	0.000	0.083	0.0003	0.031	0.0003	<0.002	0.001	0.001
4-(ii)	<0.005	0.021	0.042	0.047	0.001	0.025	0.0001	0.013	<0.0001	<0.002	0.000	0.000
5-(ii)	0.017	0.024	0.038	0.033	0.001	0.013	0.0001	0.019	0.0001	<0.002	0.000	0.001
6-(ii)	0.19	0.198	0.2	0.203	0.003	0.040	0.0001	0.043	0.0001	<0.002	0.001	0.001
7-(ii)	0.14	0.120	0.11	0.104	0.001	0.007	0.0002	0.034	<0.0001	<0.002	0.000	0.000
8-(ii)	<0.005	0.038	0.018	0.004	0.002	0.050	0.0002	0.021	0.0001	<0.002	0.002	0.000
9-(ii)	<0.005	0.050	0.02	0.021	0.002	0.041	0.0001	0.010	0.0002	<0.002	0.000	0.000
10-(ii)	<0.005	0.110	0.38	0.411	0.002	0.097	<0.0001	0.093	0.0018	0.007	0.007	0.001
11-(ii)	<0.005	0.122	0.15	0.185	0.002	0.163	<0.0001	0.066	<0.0001	<0.002	0.009	0.003
12-(ii)	<0.005	0.061	0.022	0.081	0.001	0.045	<0.0001	0.011	<0.0001	<0.002	0.000	0.000
13-(ii)	<0.005	0.039	0.019	0.032	0.002	0.020	0.0002	0.040	0.0001	<0.002	0.000	0.000
14-(ii)	<0.005	0.027	0.016	0.015	0.000	0.012	<0.0001	0.026	<0.0001	<0.002	0.000	0.000
15-(ii)	<0.005	0.020	0.013	0.015	0.000	0.009	<0.0001	0.027	<0.0001	<0.002	0.000	0.001
16-(ii)	<0.005	0.053	0.029	0.017	0.002	0.053	<0.0001	0.026	0.0001	<0.002	0.000	0.000
17-(ii)	<0.005	0.024	0.019	0.016	0.001	0.015	<0.0001	0.006	<0.0001	<0.002	0.000	0.000
18-(ii)	<0.005	0.021	0.021	0.023	0.000	0.007	<0.0001	0.003	<0.0001	<0.002	0.000	0.000
1-(i)	<0.005	0.017	0.032	0.025	0.001	0.010	0.0004	0.005	0.0001	<0.002	0.000	0.001
2-(i)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3-(i)	0.035	0.122	0.11	0.124	0.001	0.064	0.0002	0.031	0.0003	<0.002	0.002	0.001
4-(i)	<0.005	0.035	0.052	0.064	0.000	0.017	0.0001	0.012	<0.0001	<0.002	0.000	0.000
5-(i)	0.036	0.048	0.078	0.055	0.000	0.010	0.0001	0.018	<0.0001	<0.002	0.000	0.000
6-(i)	0.19	0.232	0.25	0.260	0.002	0.040	0.0002	0.043	0.0001	<0.002	0.001	0.001
7-(i)	0.21	0.192	0.16	0.164	0.001	0.012	0.0001	0.037	<0.0001	<0.002	0.000	0.001
8-(i)	<0.005	0.072	0.053	0.068	0.001	0.048	0.0003	0.020	0.0003	<0.002	0.002	0.001
9-(i)	<0.005	0.080	0.024	0.042	0.001	0.038	<0.0001	0.009	0.0001	<0.002	0.000	0.000
10-(i)	<0.005	0.158	0.38	0.401	0.001	0.095	<0.0001	0.090	0.0014	0.007	0.007	0.001
11-(i)	<0.005	0.441	0.15	0.146	0.000	0.120	<0.0001	0.072	0.0009	<0.002	0.003	0.002
12-(i)	<0.005	0.078	0.019	0.074	0.000	0.085	<0.0001	0.012	<0.0001	<0.002	0.000	0.000
13-(i)	<0.005	0.067	0.024	0.073	0.002	0.032	<0.0001	0.042	<0.0001	<0.002	0.000	0.000
14-(i)	<0.005	0.018	0.018	0.023	0.000	0.009	0.0002	0.025	<0.0001	<0.002	0.000	0.000
15-(i)	<0.005	0.014	0.015	0.016	0.000	0.008	<0.0001	0.026	<0.0001	<0.002	0.000	0.000
16-(i)	<0.005	0.037	0.046	0.048	0.002	0.046	0.0001	0.027	0.0001	<0.002	0.000	0.000
17-(i)	<0.005	0.021	0.017	0.025	0.000	0.016	<0.0001	0.007	<0.0001	<0.002	0.000	0.000
18-(i)	<0.005	0.016	0.021	0.028	0.000	0.008	<0.0001	0.003	<0.0001	<0.002	0.000	0.000

	Sb.m	La.m	Ce.m	Pr.m	Nd.m	Sm.m	Eu.m	Gd.m	Tb.m	Dy.m	Ho.m	Er.m	Tm.m
1-(ii)	0.000	0.0002	0.0003	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0008	0.0001	0.0001
2-(ii)	0.001	0.0026	0.0129	0.0020	0.0061	0.0010	0.0002	0.0016	0.0001	0.0005	0.0000	0.0002	0.0000
3-(ii)	0.002	0.0001	0.0002	0.0000	0.0001	0.0001	0.0000	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000
4-(ii)	0.001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5-(ii)	0.000	0.0000	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6-(ii)	0.010	0.0000	0.0001	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
7-(ii)	0.001	0.0002	0.0002	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
8-(ii)	0.006	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000
9-(ii)	0.003	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
10-(ii)	0.015	0.0000	0.0001	0.0000	0.0002	0.0002	0.0000	0.0001	0.0002	0.0002	0.0002	0.0000	0.0000
11-(ii)	0.022	0.0003	0.0002	0.0000	0.0001	0.0002	0.0000	0.0001	0.0002	0.0002	0.0005	0.0000	0.0000
12-(ii)	0.006	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
13-(ii)	0.001	0.0002	0.0002	0.0002	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
14-(ii)	0.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15-(ii)	0.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
16-(ii)	0.002	0.0000	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
17-(ii)	0.001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
18-(ii)	0.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1-(i)	0.001	0.0003	0.0003	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
2-(i)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3-(i)	0.005	0.0002	0.0002	0.0001	0.0000	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000
4-(i)	0.001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5-(i)	0.001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6-(i)	0.011	0.0001	0.0001	0.0001	0.0000	0.0002	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
7-(i)	0.002	0.0000	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8-(i)	0.007	0.0002	0.0002	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
9-(i)	0.003	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000
10-(i)	0.016	0.0001	0.0000	0.0001	0.0000	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000
11-(i)	0.032	0.0003	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002	0.0001	0.0002	0.0000	0.0000
12-(i)	0.006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
13-(i)	0.002	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
14-(i)	0.000	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
15-(i)	0.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
16-(i)	0.003	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
17-(i)	0.001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
18-(i)	0.001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

	Yb.m	Lu.m	W.m	Au.n (µg/L)	Hg.m	Tl.m	Pb.a	Bi.m	Th.m	U.m
1-(ii)	0.0001	0.0000	<0.0001	0.012	0.0014	0.0003	0.001	0.0004	0.0004	0.001
2-(ii)	0.0001	0.0000	<0.0001	<0.001	0.0012	0.0002	0.002	0.0001	0.0001	0.109
3-(ii)	0.0000	0.0000	<0.0001	0.005	<0.0001	<0.0001	0.001	0.0001	<0.0001	0.002
4-(ii)	0.0000	0.0000	<0.0001	0.011	<0.0001	<0.0001	0.006	<0.0001	<0.0001	0.001
5-(ii)	0.0000	0.0000	<0.0001	0.005	<0.0001	<0.0001	0.004	<0.0001	<0.0001	0.002
6-(ii)	0.0000	0.0000	0.0024	0.007	<0.0001	0.0002	0.002	<0.0001	<0.0001	0.003
7-(ii)	0.0001	0.0001	0.0038	0.003	<0.0001	0.0004	0.009	0.0003	0.0005	0.002
8-(ii)	0.0000	0.0000	<0.0001	0.038	<0.0001	0.0001	0.001	0.0002	<0.0001	0.002
9-(ii)	0.0000	0.0000	<0.0001	0.003	<0.0001	<0.0001	0.001	<0.0001	<0.0001	0.001
10-(ii)	0.0000	0.0000	<0.0001	0.094	<0.0001	0.0010	0.007	<0.0001	<0.0001	0.013
11-(ii)	0.0000	0.0000	<0.0001	0.068	<0.0001	0.0005	0.075	<0.0001	<0.0001	0.007
12-(ii)	0.0000	0.0000	<0.0001	0.002	<0.0001	<0.0001	0.002	<0.0001	<0.0001	0.003
13-(ii)	0.0001	0.0001	0.0013	0.008	0.0008	0.0004	0.003	0.0005	0.0006	0.004
14-(ii)	0.0000	0.0000	0.0009	0.003	<0.0001	0.0001	0.001	0.0001	<0.0001	0.002
15-(ii)	0.0000	0.0000	<0.0001	0.011	0.0002	<0.0001	0.001	<0.0001	<0.0001	0.001
16-(ii)	0.0000	0.0000	<0.0001	<0.001	<0.0001	<0.0001	0.001	<0.0001	<0.0001	0.000
17-(ii)	0.0000	0.0000	<0.0001	0.003	<0.0001	<0.0001	0.001	<0.0001	<0.0001	0.000
18-(ii)	0.0000	0.0000	<0.0001	0.003	0.0011	<0.0001	0.001	<0.0001	<0.0001	0.000
1-(i)	0.0001	0.0001	<0.0001	<0.001	0.0007	0.0004	0.001	0.0005	0.0005	0.001
2-(i)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3-(i)	0.0000	0.0000	<0.0001	<0.001	<0.0001	<0.0001	0.001	0.0002	<0.0001	0.002
4-(i)	0.0000	0.0000	<0.0001	0.017	<0.0001	<0.0001	0.007	<0.0001	<0.0001	0.001
5-(i)	0.0000	0.0000	<0.0001	0.005	<0.0001	<0.0001	0.002	<0.0001	<0.0001	0.002
6-(i)	0.0001	0.0000	0.0060	0.008	<0.0001	0.0002	0.002	<0.0001	<0.0001	0.004
7-(i)	0.0000	0.0000	0.0023	0.007	<0.0001	0.0001	0.012	<0.0001	<0.0001	0.002
8-(i)	0.0001	0.0000	<0.0001	0.034	<0.0001	0.0003	0.002	0.0005	0.0004	0.003
9-(i)	0.0000	0.0000	<0.0001	<0.001	<0.0001	<0.0001	0.001	<0.0001	<0.0001	0.001
10-(i)	0.0001	0.0000	<0.0001	0.101	<0.0001	0.0010	0.008	<0.0001	<0.0001	0.014
11-(i)	0.0000	0.0000	<0.0001	0.072	<0.0001	<0.0001	0.088	<0.0001	<0.0001	0.008
12-(i)	0.0000	0.0000	<0.0001	<0.001	<0.0001	<0.0001	0.002	<0.0001	<0.0001	0.003
13-(i)	0.0000	0.0000	<0.0001	0.004	<0.0001	<0.0001	0.001	<0.0001	<0.0001	0.004
14-(i)	0.0001	0.0001	0.0003	0.004	<0.0001	<0.0001	0.001	0.0003	0.0006	0.002
15-(i)	0.0000	0.0000	0.0005	0.012	<0.0001	0.0001	0.001	0.0001	0.0001	0.001
16-(i)	0.0000	0.0000	<0.0001	<0.001	<0.0001	<0.0001	0.004	0.0002	<0.0001	0.001
17-(i)	0.0000	0.0000	<0.0001	<0.001	<0.0001	<0.0001	0.001	<0.0001	<0.0001	0.000
18-(i)	0.0000	0.0000	<0.0001	0.02	0.0001	<0.0001	0.001	<0.0001	<0.0001	0.000

Appendix 2 - Comparisons of Analyses

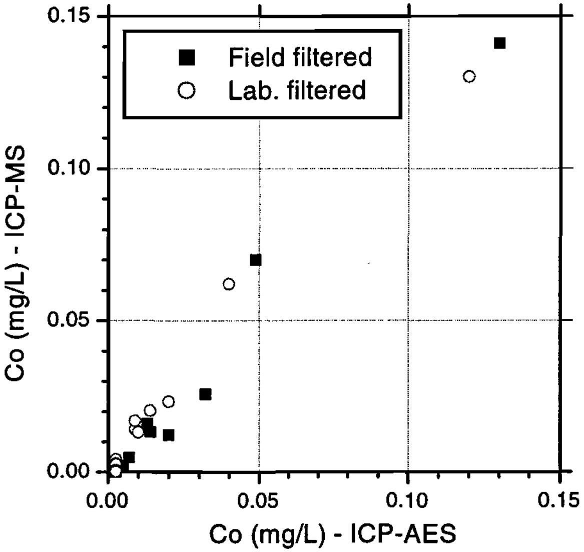

Figure A2.1: Co (ICP-MS) *vs.* Co (ICP-AES).

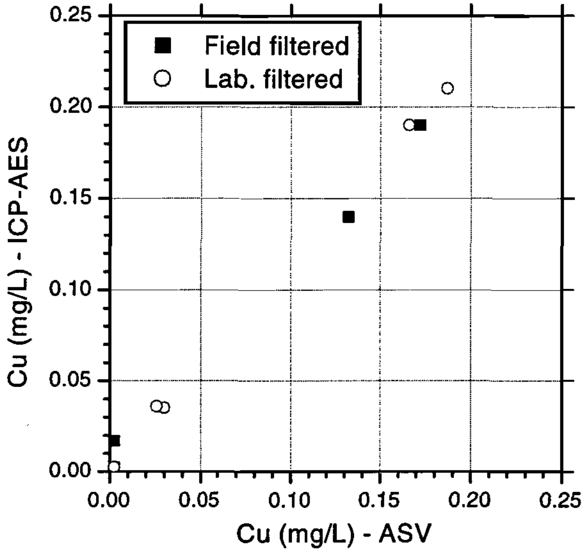

Figure A2.3: Cu (ICP-AES) *vs.* Cu (ASV).

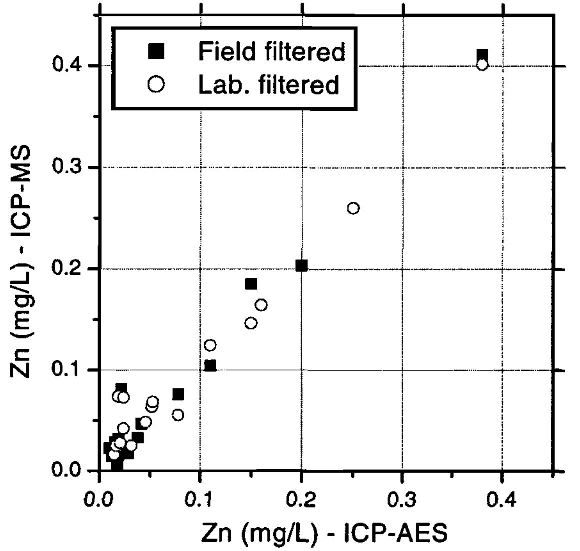

Figure A2.5: Zn (ICP-MS) *vs.* Zn (ICP-AES).

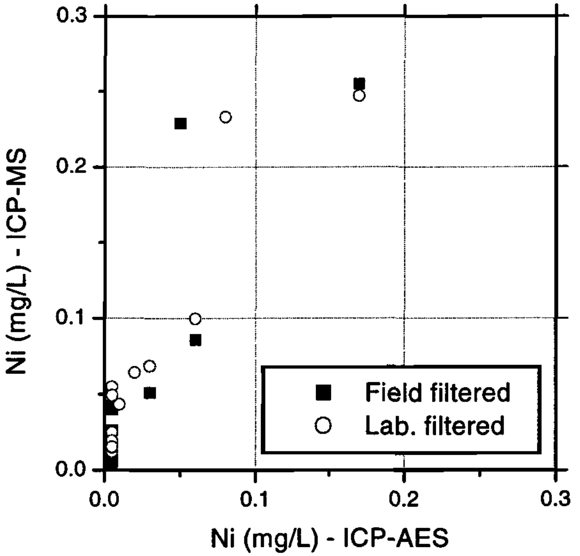

Figure A2.2: Ni (ICP-MS) *vs.* Ni (ICP-AES).

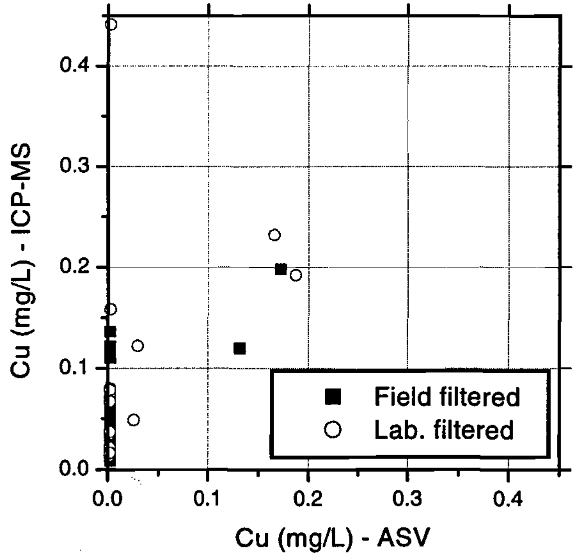

Figure A2.4: Cu (ICP-MS) *vs.* Cu (ASV).

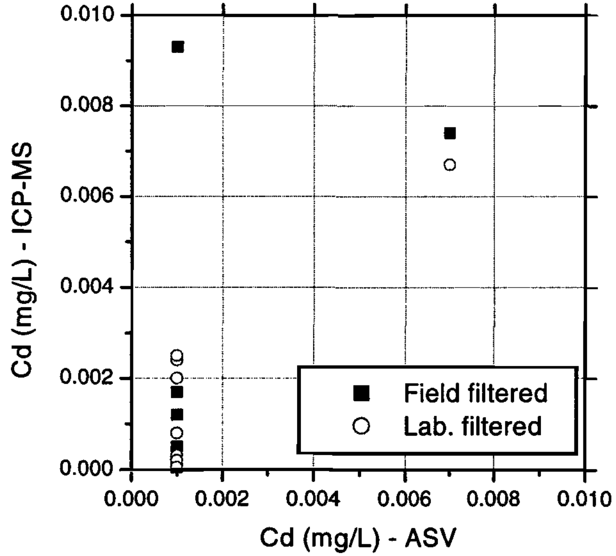

Figure A2.6: Cd (ICP-MS) *vs.* Cd (ASV).

Appendix 3 - Concentrations of Elements/Ions for Laboratory filtered *versus* Field filtered samples

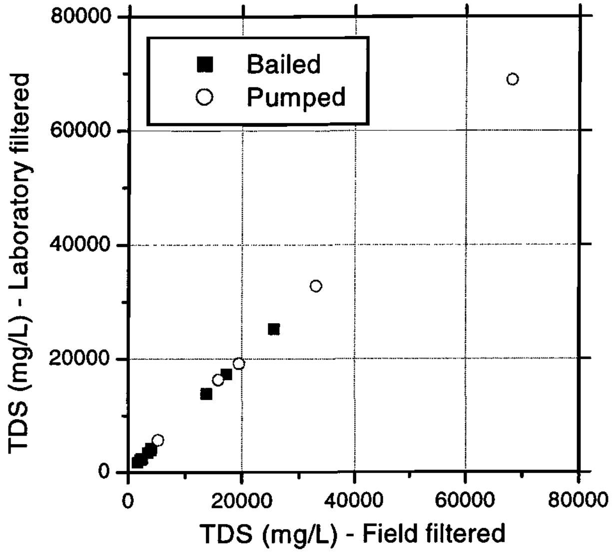

Figure A3.1: TDS for Laboratory filtered *vs.* Field filtered samples.

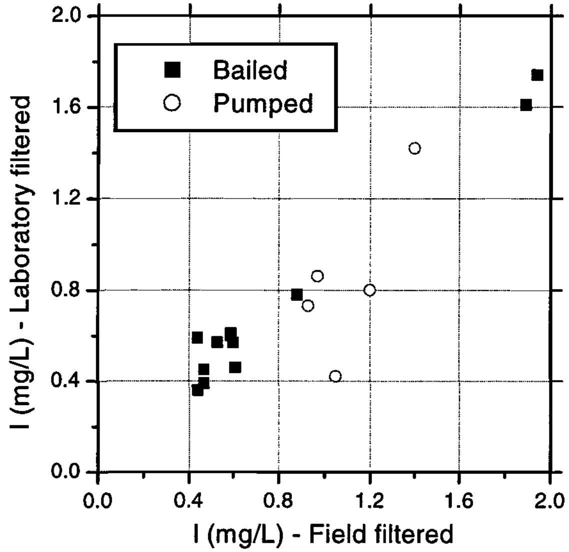

Figure A3.3: Iodine concentration for Laboratory filtered *vs.* Field filtered samples.

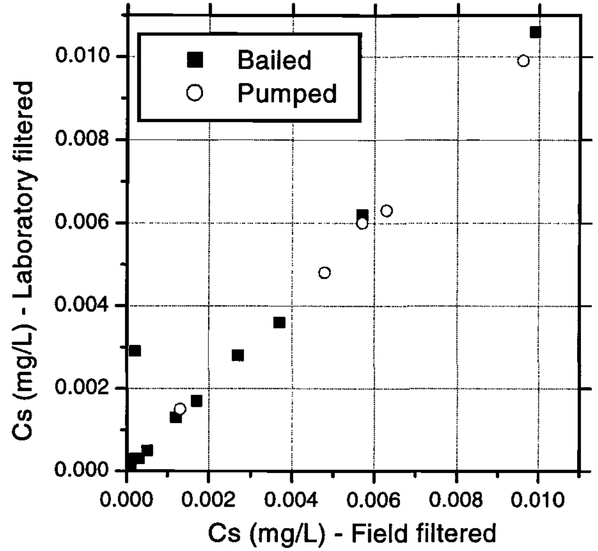

Figure A3.5: Cesium concentration for Laboratory filtered *vs.* Field filtered samples.

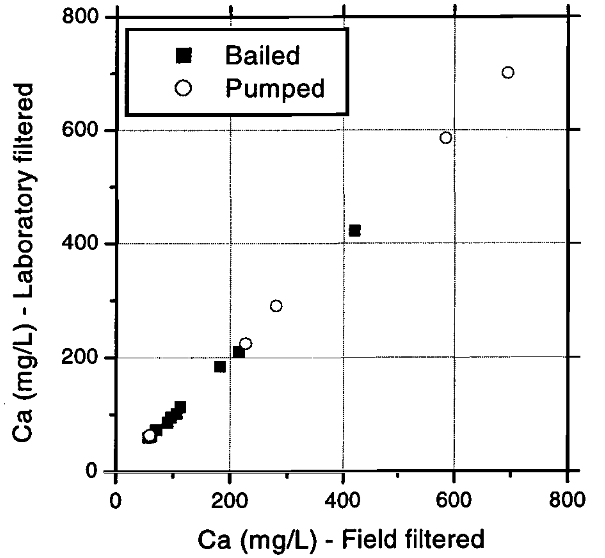

Figure A3.2: Calcium concentration for Laboratory filtered *vs.* Field filtered samples.

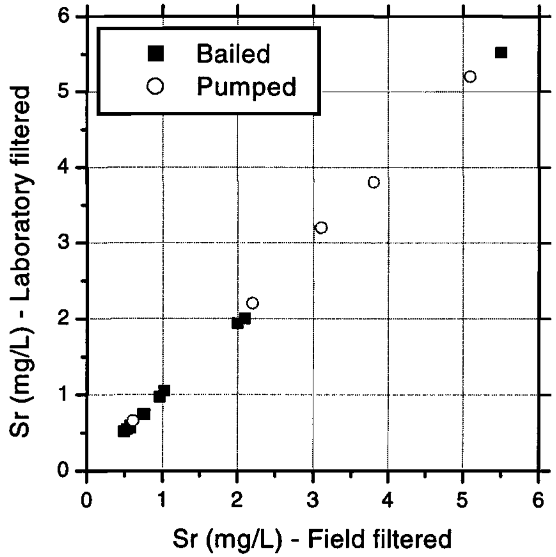

Figure A3.4: Strontium concentration for Laboratory filtered *vs.* Field filtered samples.

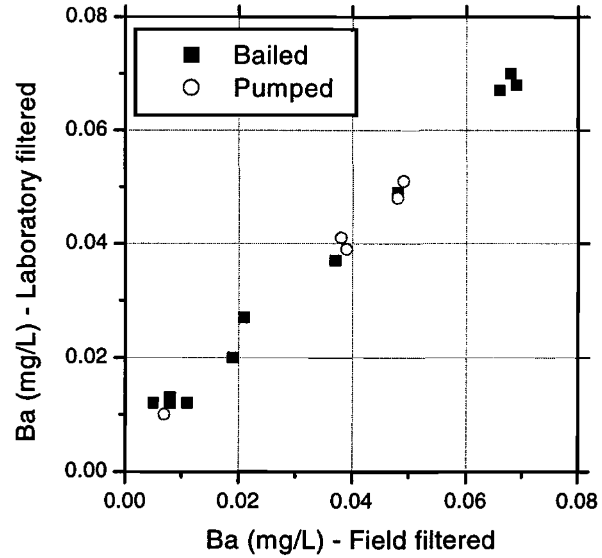

Figure A3.6: Barium concentration for Laboratory filtered *vs.* Field filtered samples.

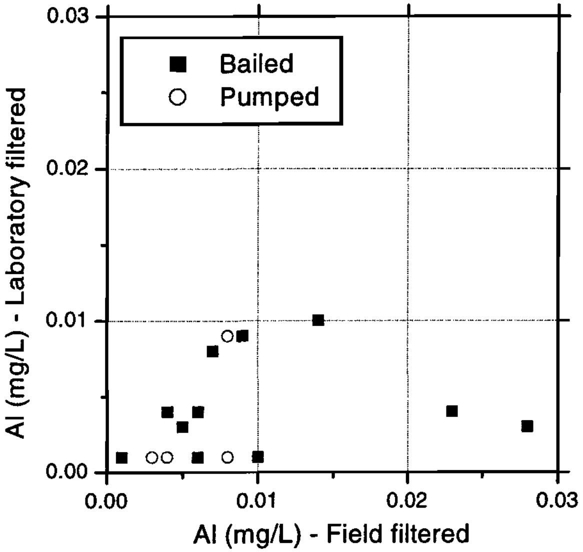

Figure A3.7: Aluminium concentration for Laboratory filtered *vs.* Field filtered samples.

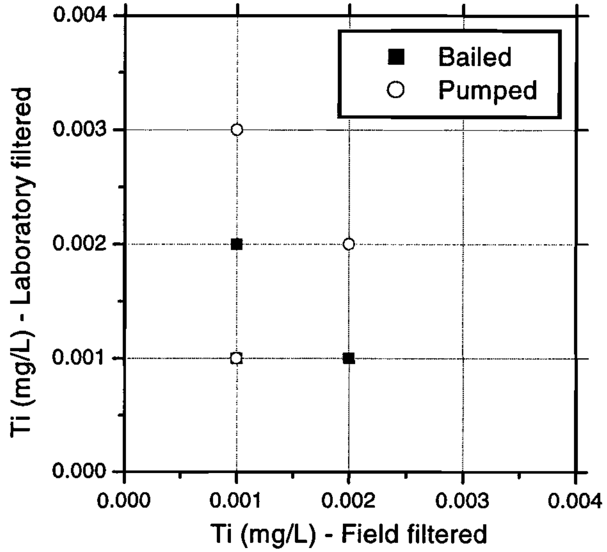

Figure A3.9: Titanium concentration for Laboratory filtered *vs.* Field filtered samples.

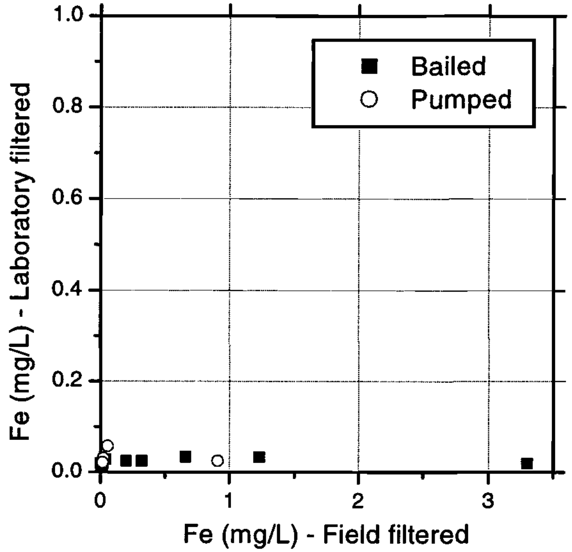

Figure A3.11: Iron concentration for Laboratory filtered *vs.* Field filtered samples.

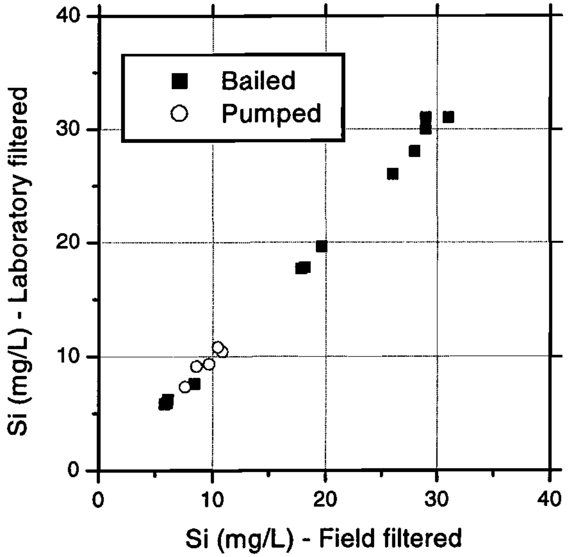

Figure A3.8: Silicon concentration for Laboratory filtered *vs.* Field filtered samples.

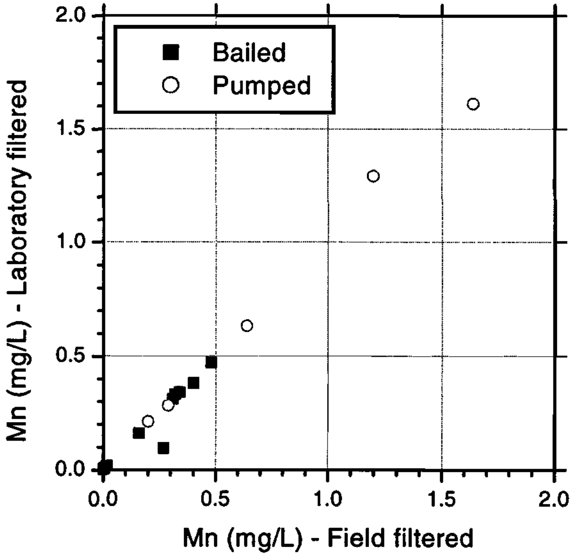

Figure A3.10: Manganese concentration for Laboratory filtered *vs.* Field filtered samples.

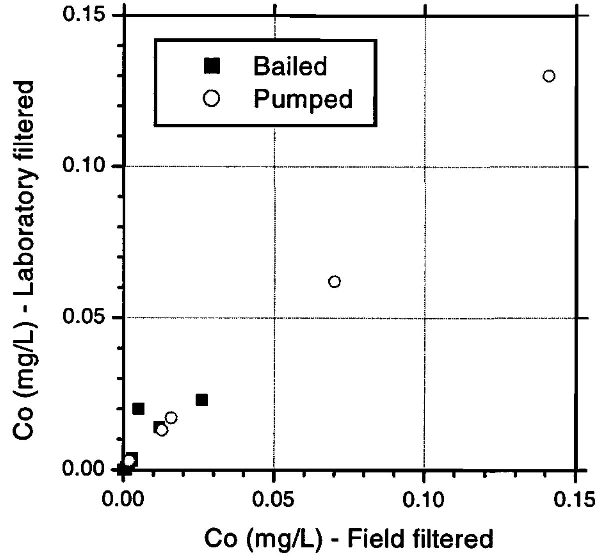

Figure A3.12: Cobalt concentration for Laboratory filtered *vs.* Field filtered samples.

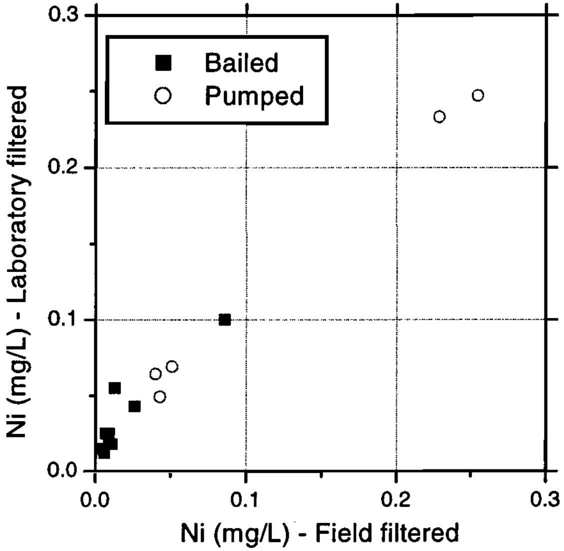

Figure A3.13: Nickel concentration for Laboratory filtered *vs.* Field filtered samples.

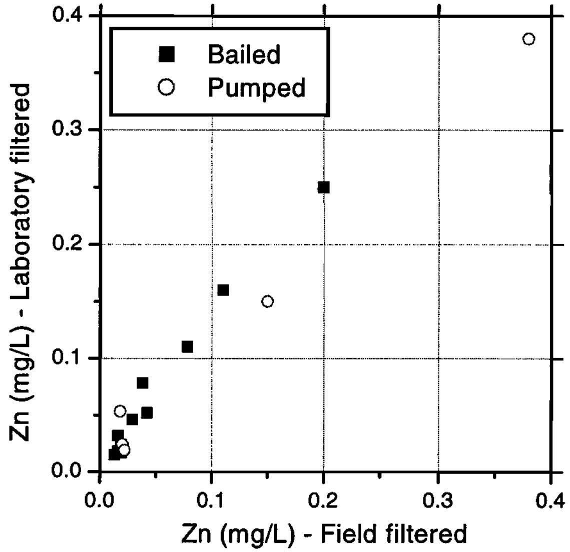

Figure A3.15: Zinc concentration for Laboratory filtered *vs.* Field filtered samples.

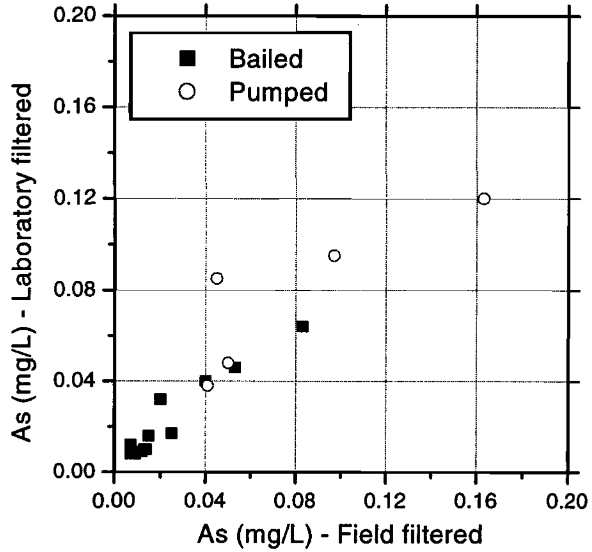

Figure A3.17: Arsenic concentration for Laboratory filtered *vs.* Field filtered samples.

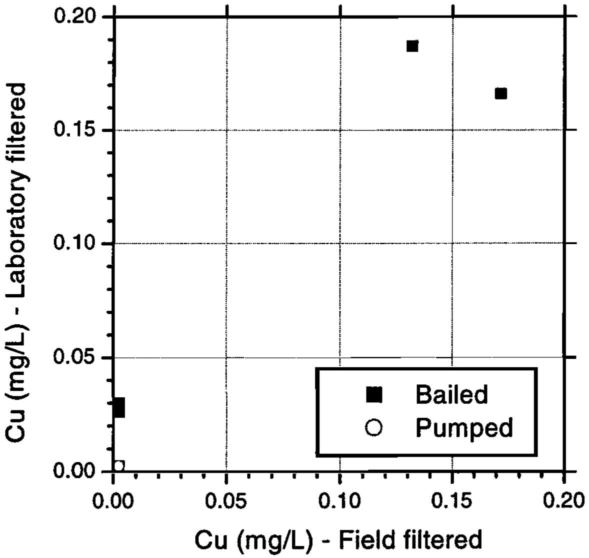

Figure A3.14: Copper concentration for Laboratory filtered *vs.* Field filtered samples.

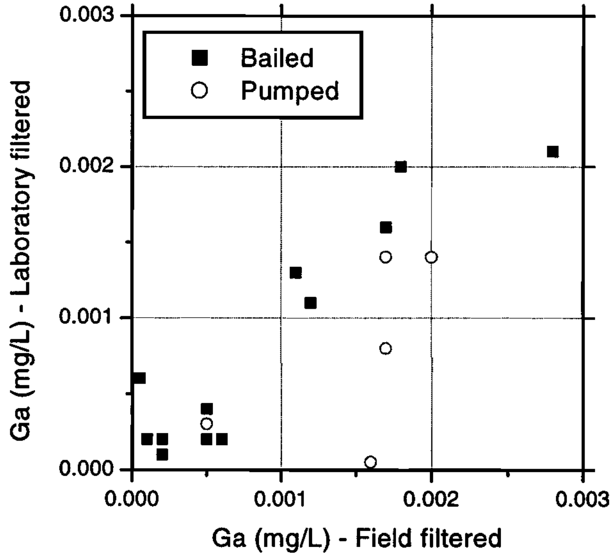

Figure A3.16: Gallium concentration for Laboratory filtered *vs.* Field filtered samples.

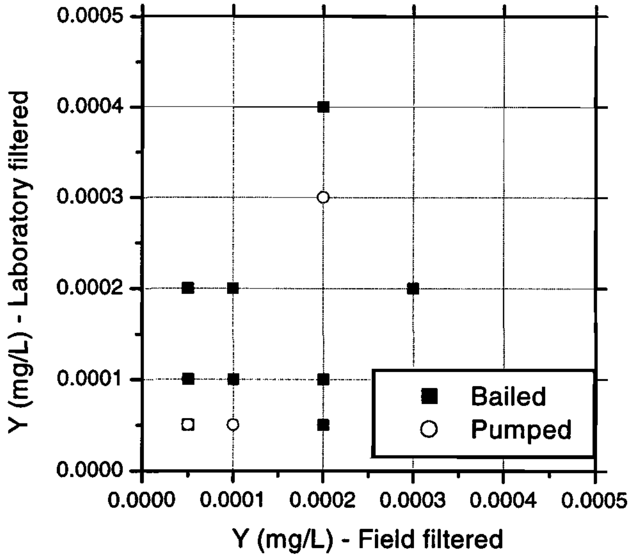

Figure A3.18: Yttrium concentration for Laboratory filtered *vs.* Field filtered samples.

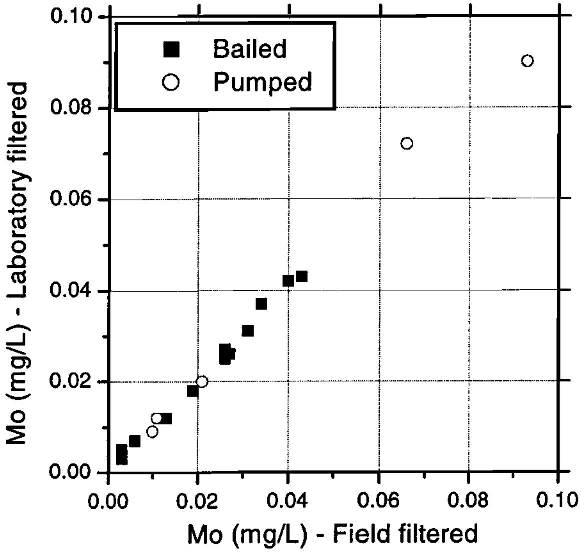

Figure A3.19: Molybdenum concentration for Laboratory filtered *vs.* Field filtered samples.

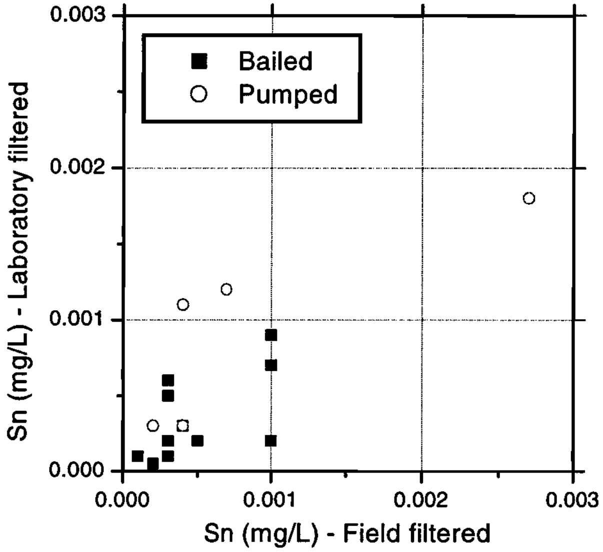

Figure A3.21: Tin concentration for Laboratory filtered *vs.* Field filtered samples.

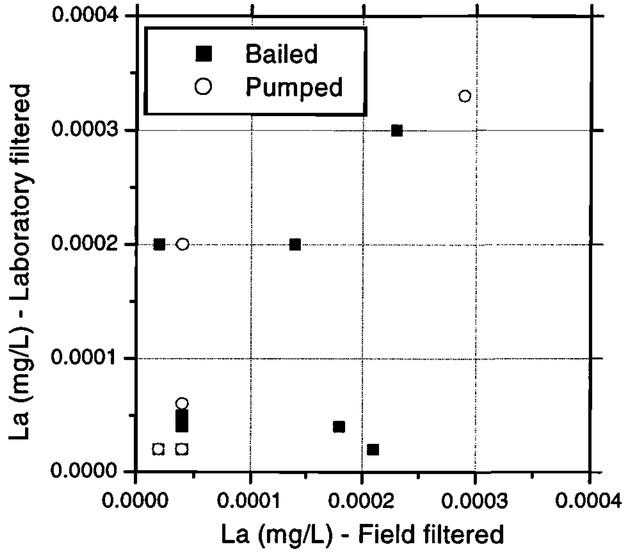

Figure A3.23: Lanthanum concentration for Laboratory filtered *vs.* Field filtered samples.

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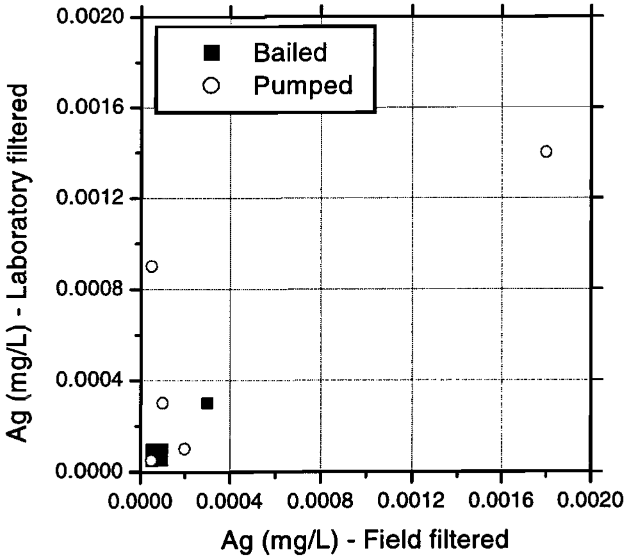

Figure A3.20: Silver concentration for Laboratory filtered *vs.* Field filtered samples.

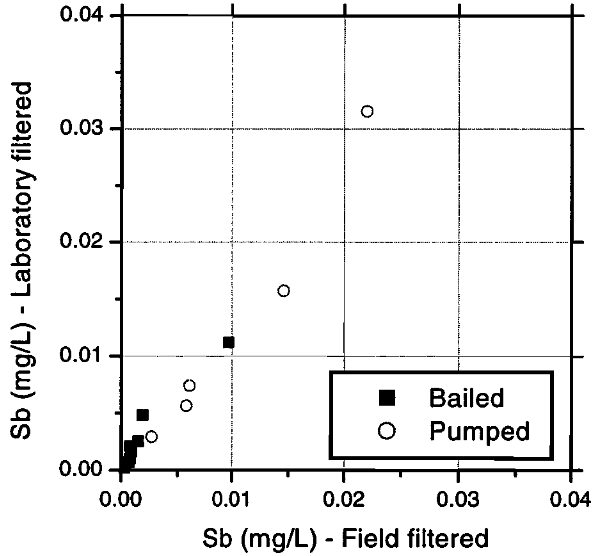

Figure A3.22: Antimony concentration for Laboratory filtered *vs.* Field filtered samples.

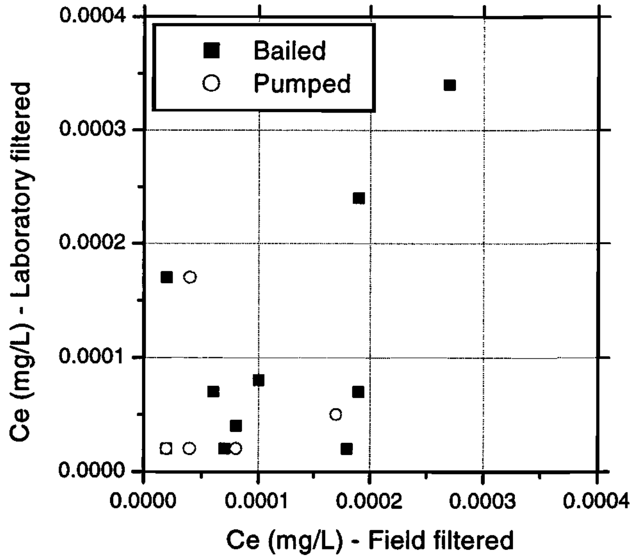

Figure A3.24: Cerium concentration for Laboratory filtered *vs.* Field filtered samples.

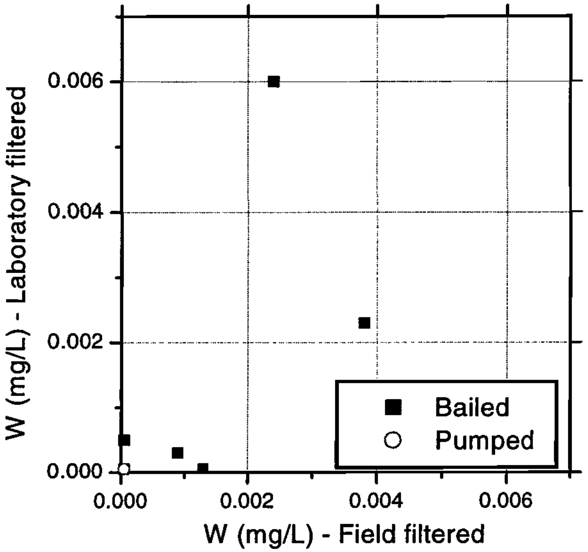

Figure A3.25: Tungsten concentration for Laboratory filtered *vs.* Field filtered samples.

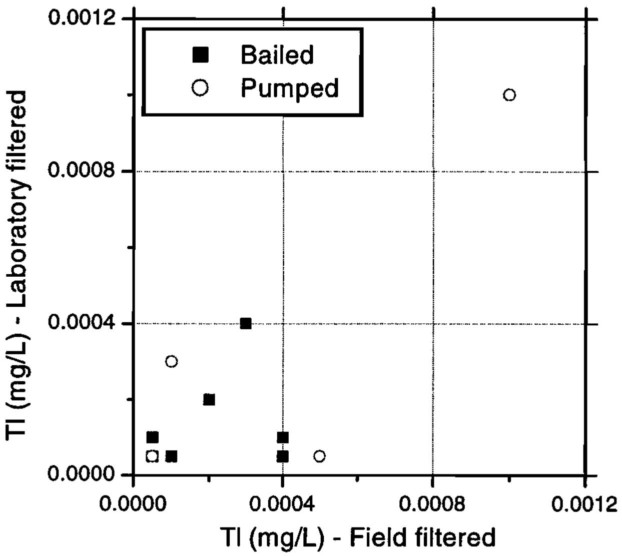

Figure A3.27: Thallium concentration for Laboratory filtered *vs.* Field filtered samples.

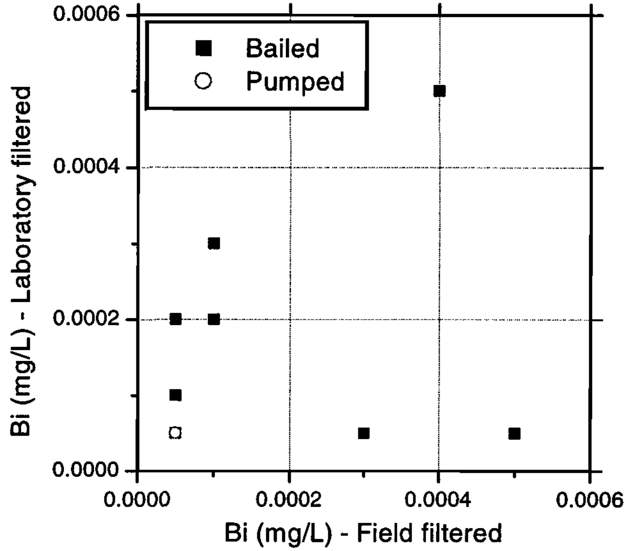

Figure A3.29: Bismuth concentration for Laboratory filtered *vs.* Field filtered samples.

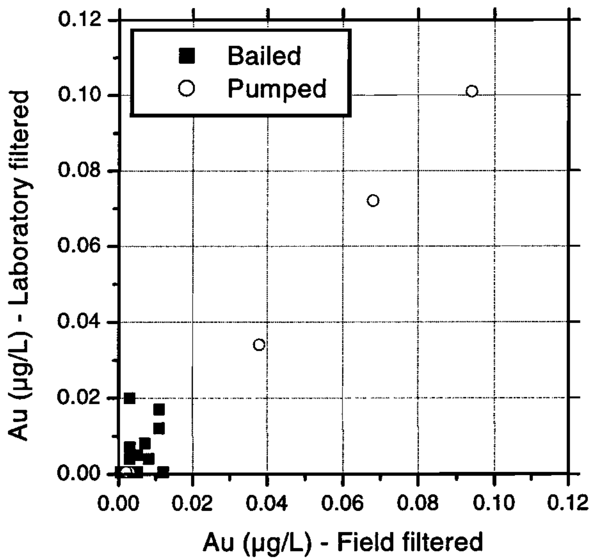

Figure A3.26: Gold concentration for Laboratory filtered *vs.* Field filtered samples.

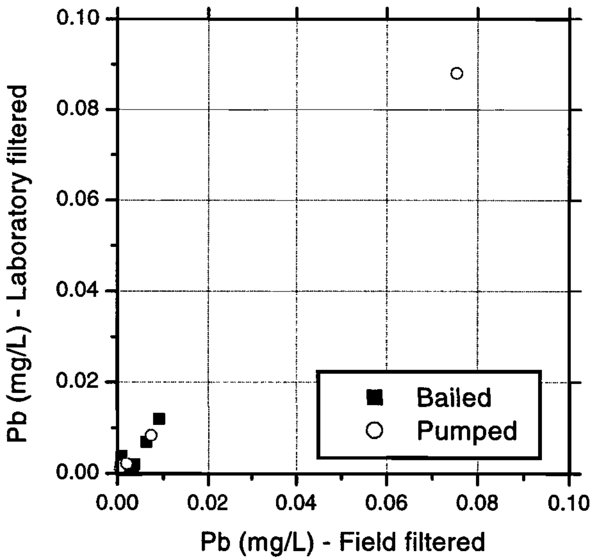

Figure A3.28: Lead concentration for Laboratory filtered *vs.* Field filtered samples.

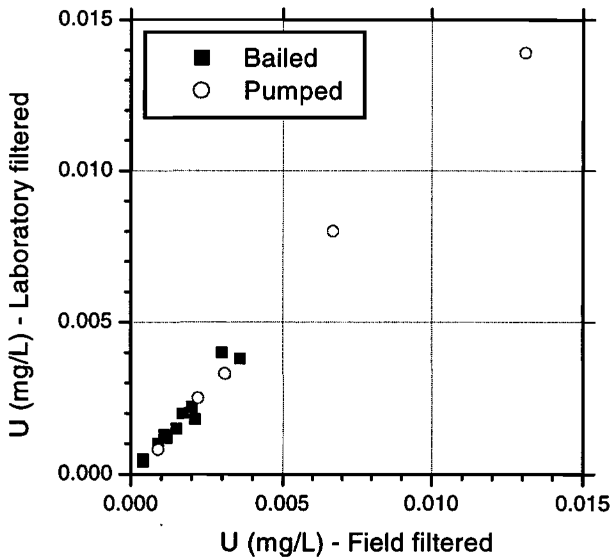

Figure A3.30: Uranium concentration for Laboratory filtered *vs.* Field filtered samples.

Appendix 4 - Element/Ion Concentration Plots

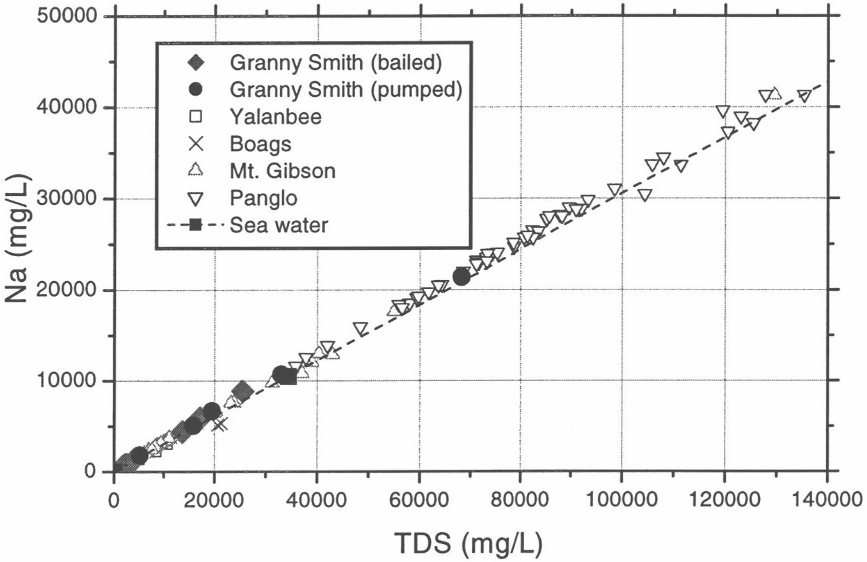

Figure A4.1: Sodium vs. TDS for groundwaters from Granny Smith and other sites.

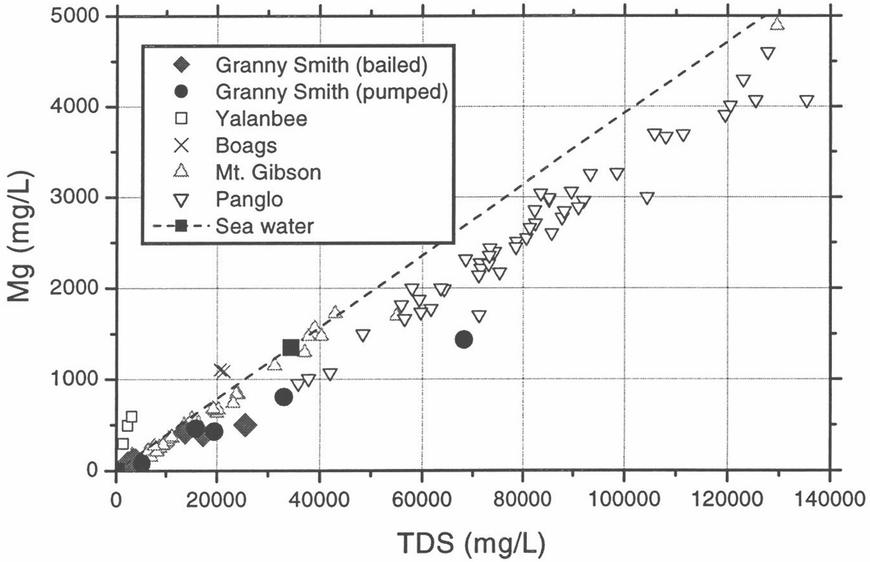

Figure A4.2: Magnesium vs. TDS for groundwaters from Granny Smith and other sites.

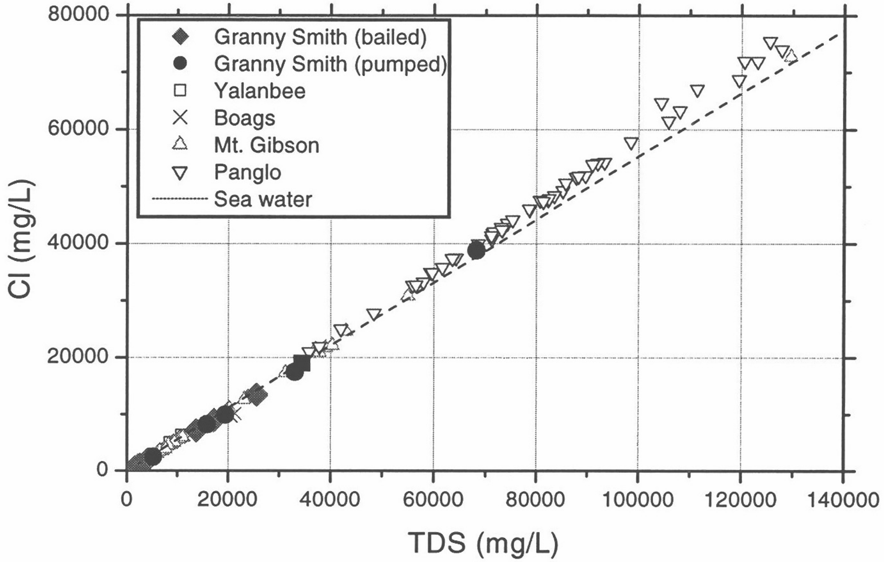

Figure A4.3: Chloride vs. TDS for groundwaters from Granny Smith and other sites.

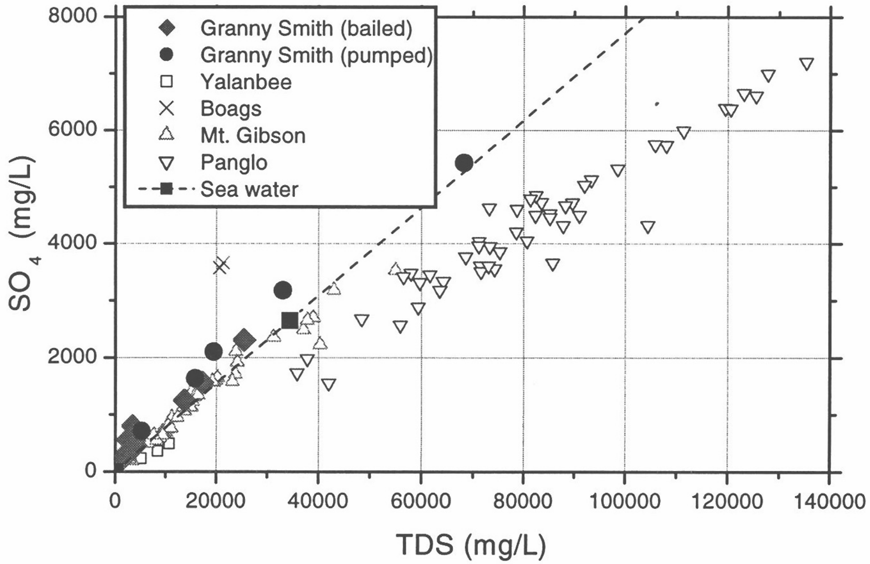

Figure A4.4: Sulphate vs. TDS for groundwaters from Granny Smith and other sites.

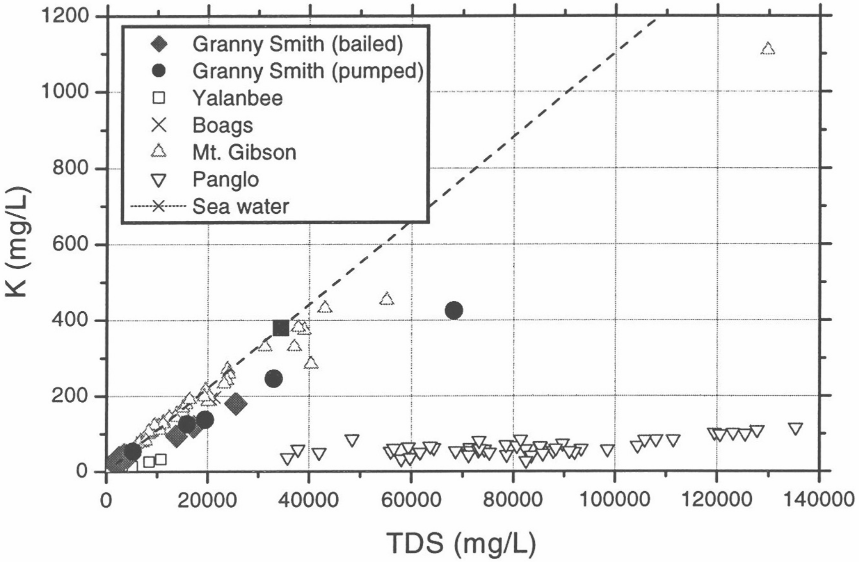

Figure A4.5: Potassium vs. TDS for groundwaters from Granny Smith and other sites.

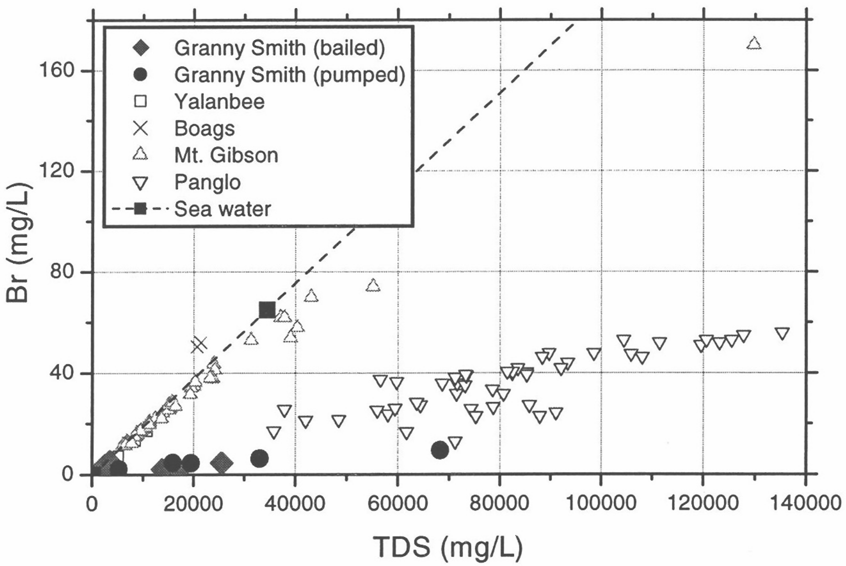

Figure A4.6: Bromine vs. TDS for groundwaters from Granny Smith and other sites.

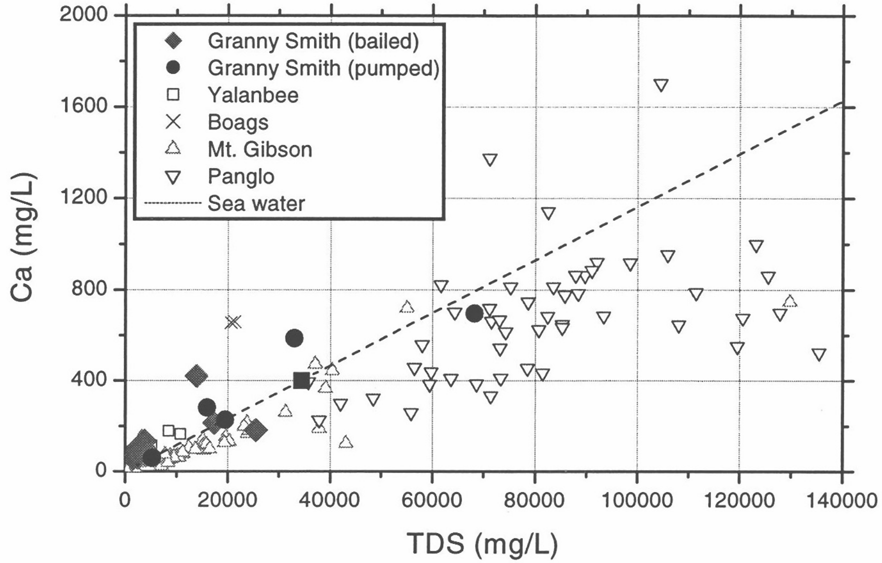

Figure A4.7: Calcium vs. TDS for groundwaters from Granny Smith and other sites.

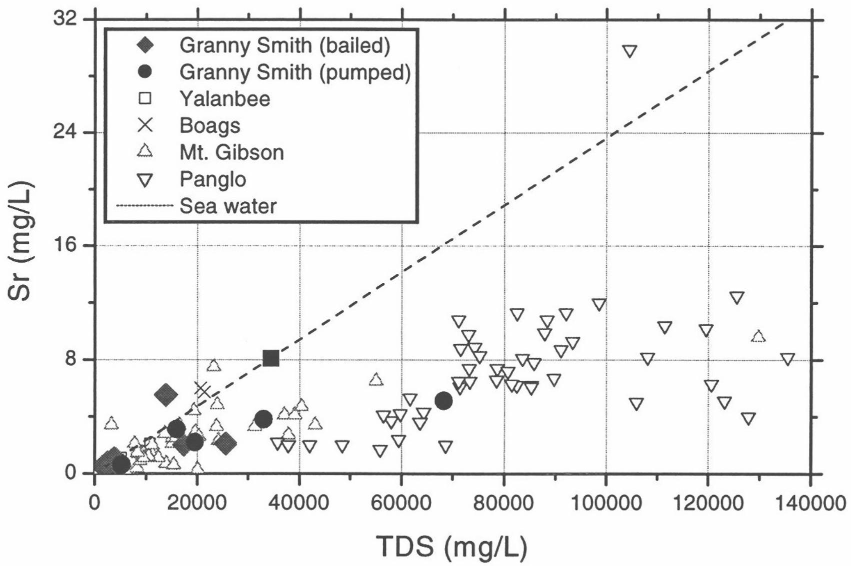

Figure A4.8: Strontium vs. TDS for groundwaters from Granny Smith and other sites.

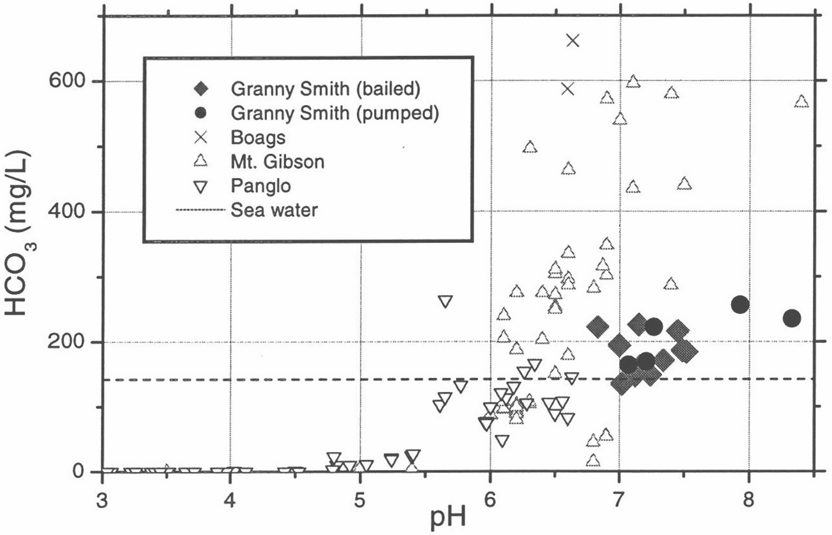

Figure A4.9: Bicarbonate vs. pH for groundwaters from Granny Smith and other sites.

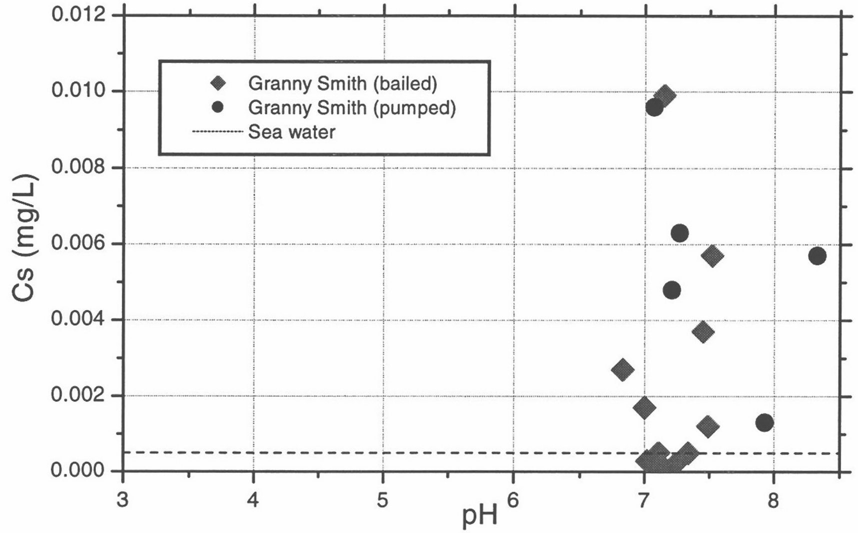

Figure A4.11: Caesium vs. pH for groundwaters from Granny Smith.

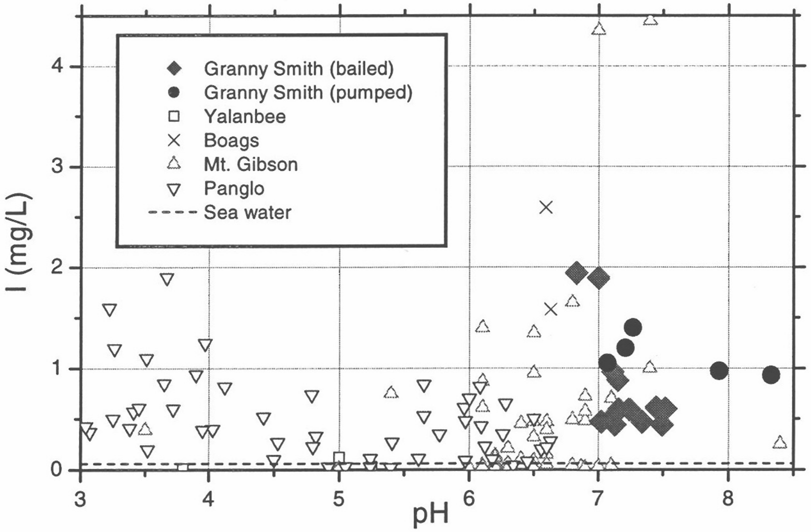

Figure A4.10: Iodine vs. pH for groundwaters from Granny Smith and other sites.

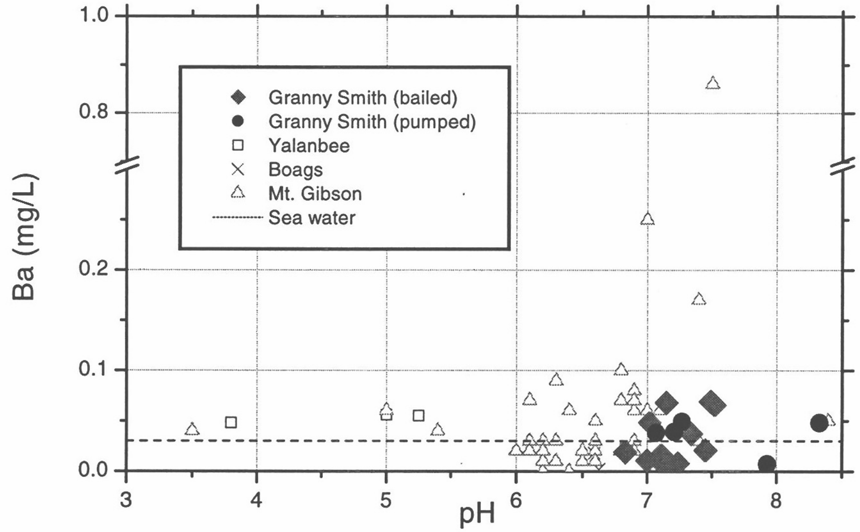

Figure A4.12: Barium vs. pH for groundwaters from Granny Smith and other sites.

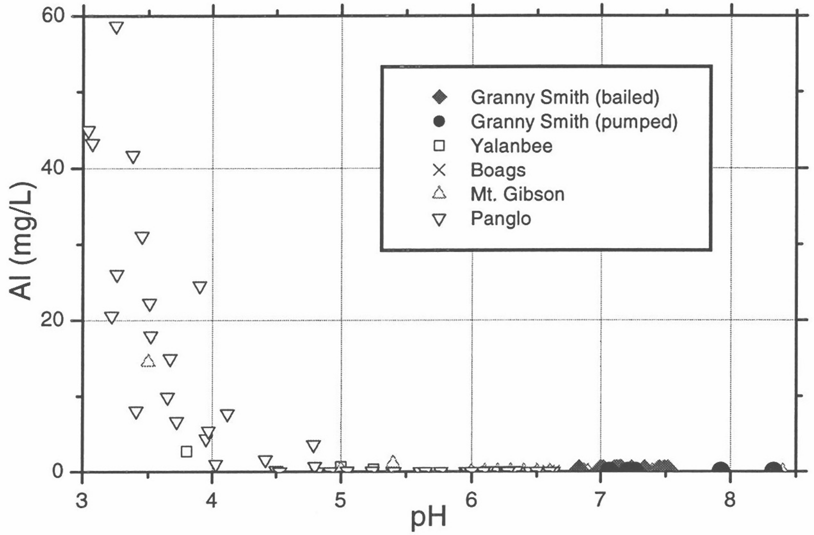

Figure A4.13: Aluminium vs. pH for groundwaters from Granny Smith and other sites.

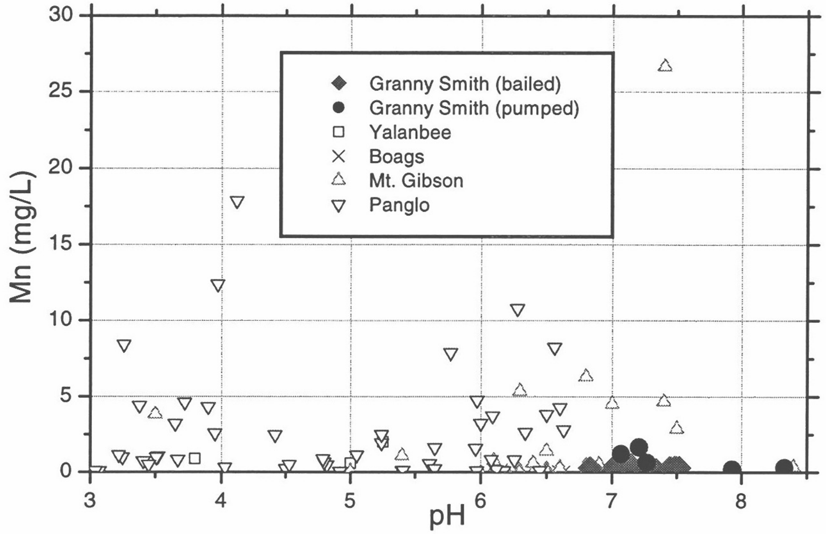

Figure A4.15: Manganese vs. pH for groundwaters from Granny Smith and other sites.

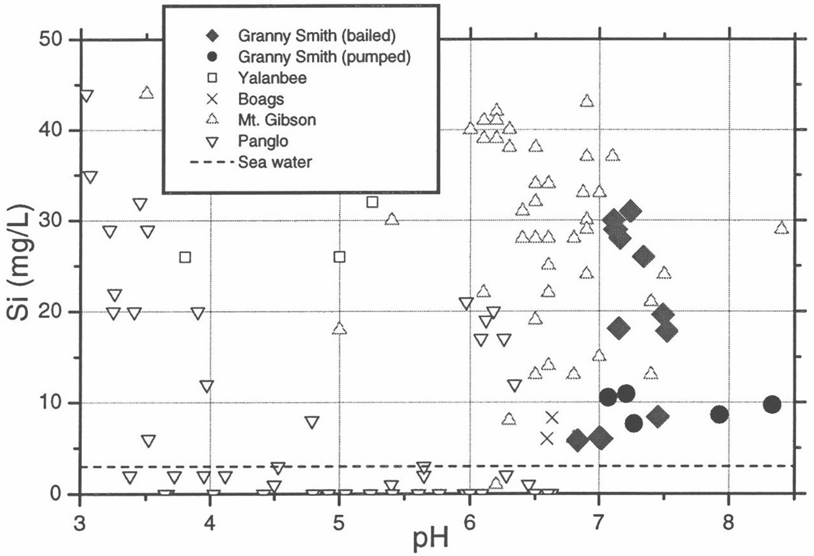

Figure A4.14: Silicon vs. pH for groundwaters from Granny Smith and other sites.

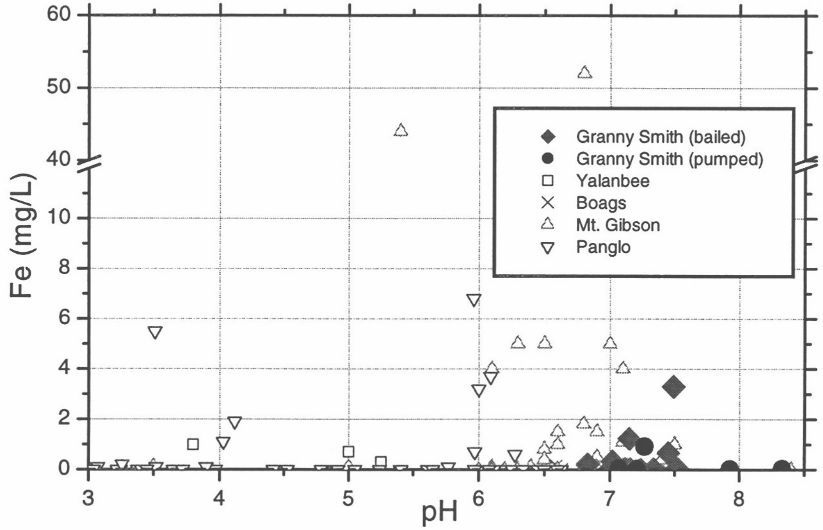

Figure A4.16: Iron vs. pH for groundwaters from Granny Smith and other sites.

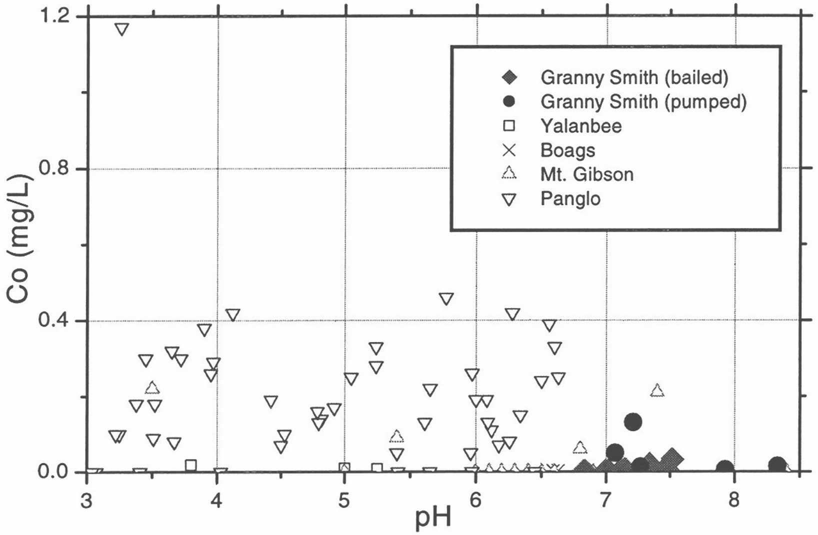

Figure A4.17: Cobalt vs. pH for groundwaters from Granny Smith and other sites.

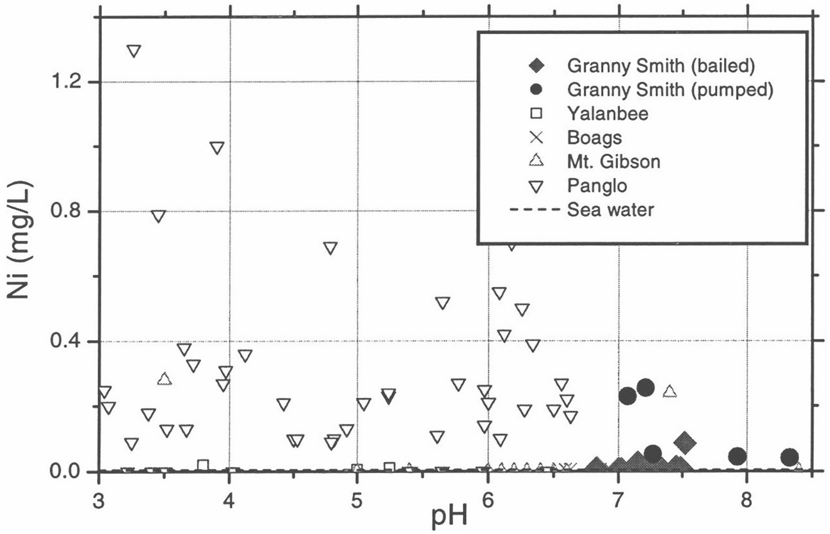

Figure A4.18: Nickel vs. pH for groundwaters from Granny Smith and other sites.

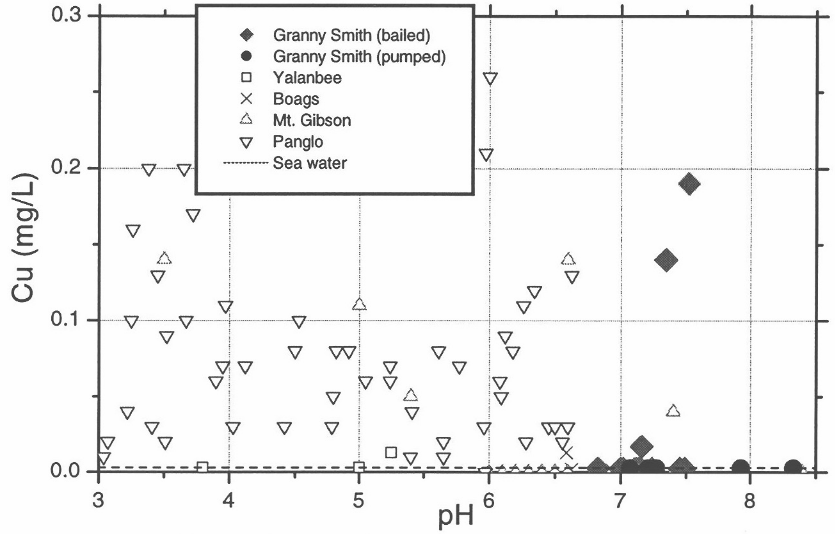

Figure A4.19: Copper vs. pH for groundwaters from Granny Smith and other sites.

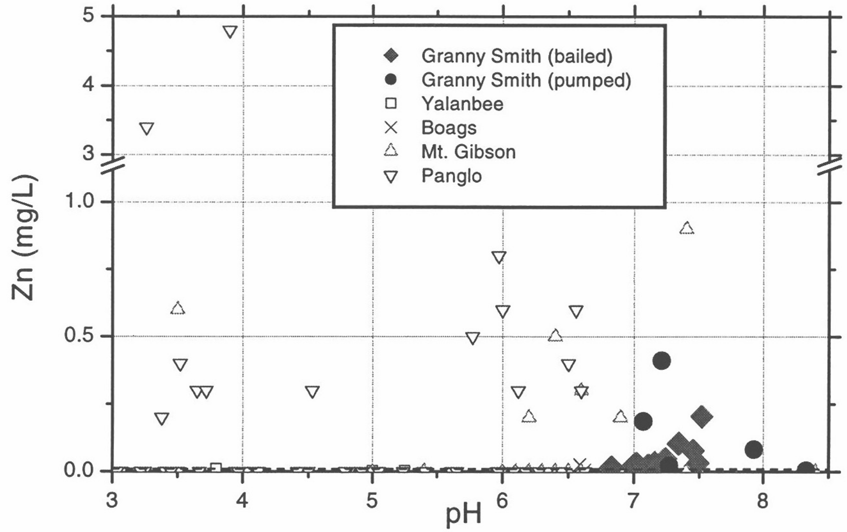

Figure A4.20: Zinc vs. pH for groundwaters from Granny Smith and other sites.

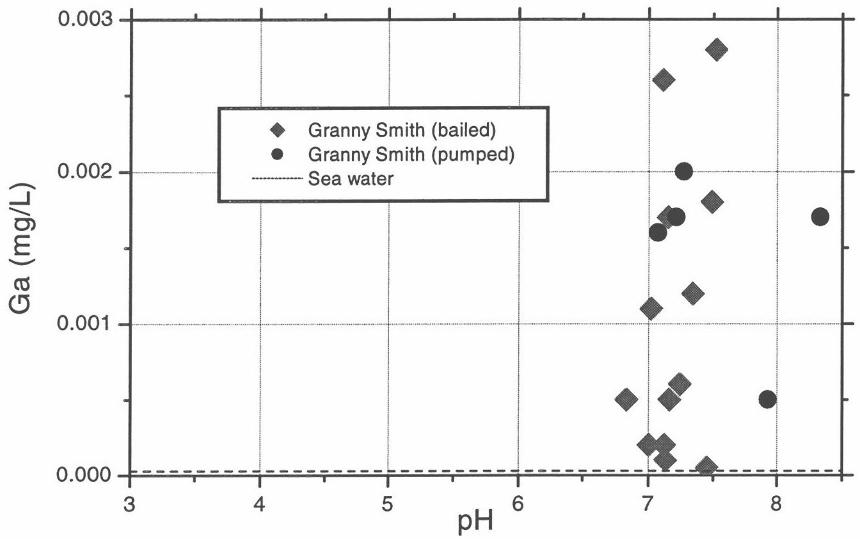

Figure A4.21: Gallium vs. pH for groundwaters from Granny Smith.

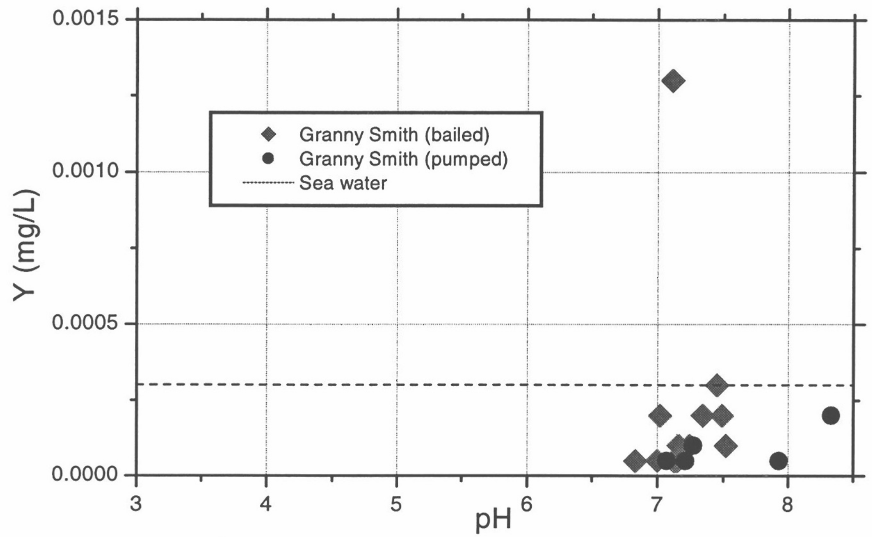

Figure A4.23: Yttrium vs. pH for groundwaters from Granny Smith.

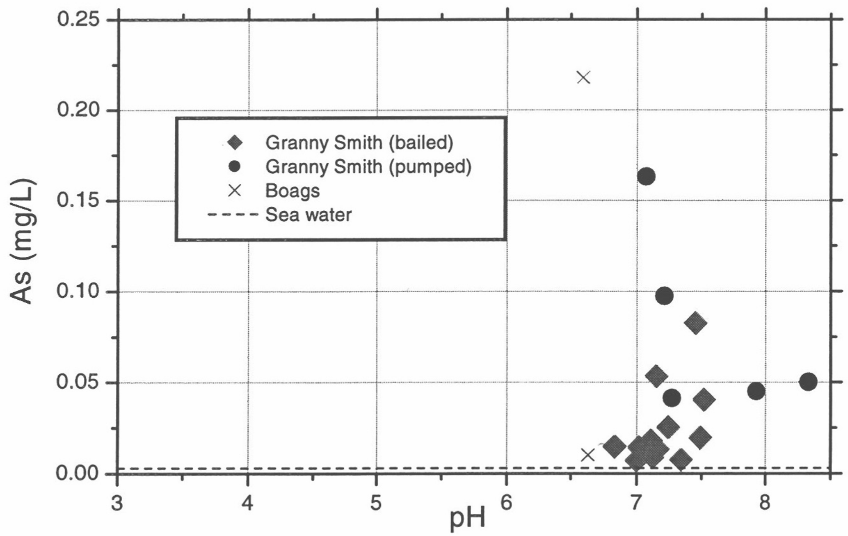

Figure A4.22: Arsenic vs. pH for groundwaters from Granny Smith and other sites.

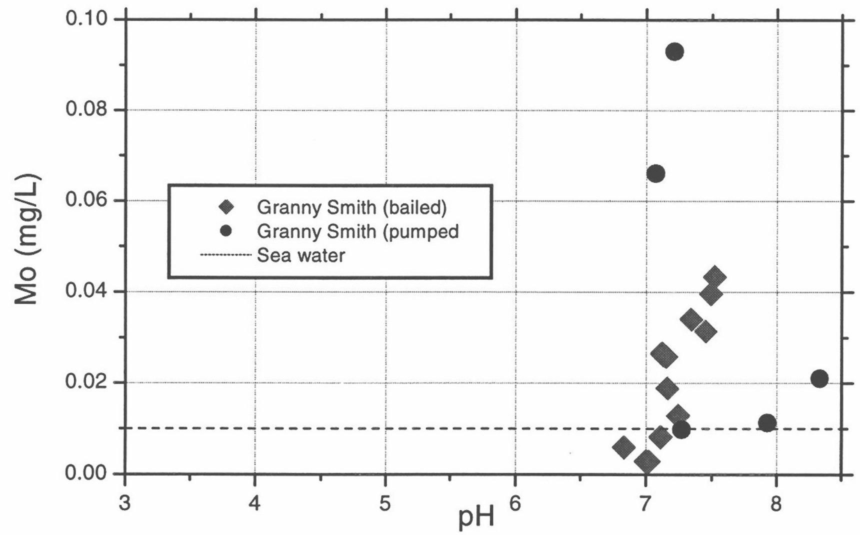

Figure A4.24: Molybdenum vs. pH for groundwaters from Granny Smith.

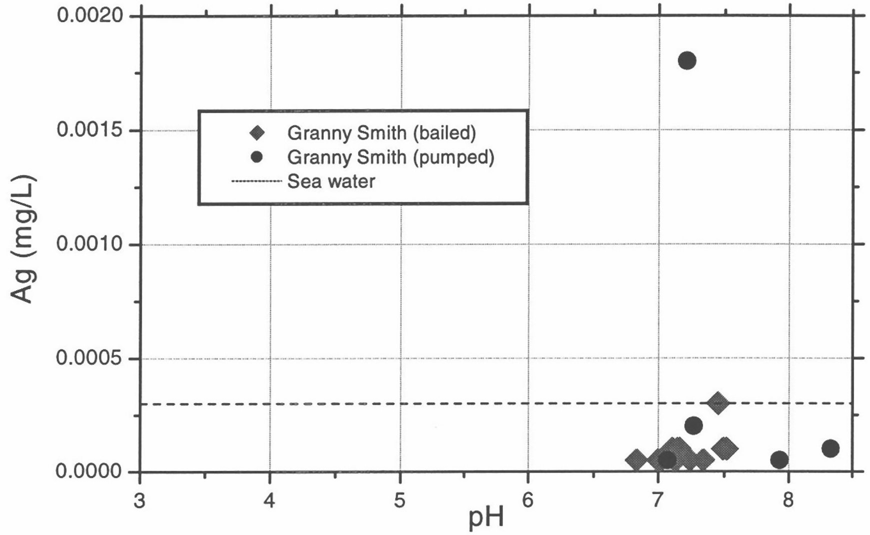

Figure A4.25: Silver vs. pH for groundwaters from Granny Smith.

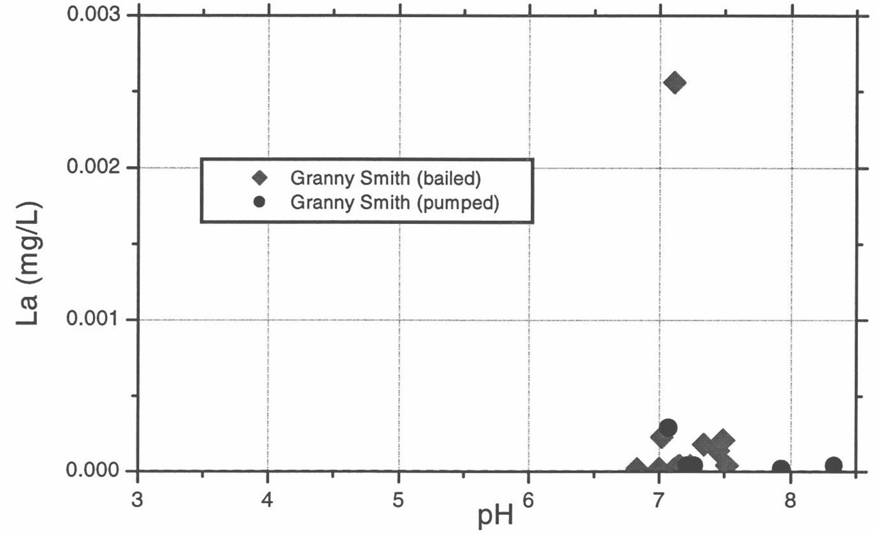

Figure A4.27: Lanthanum vs. pH for groundwaters from Granny Smith.

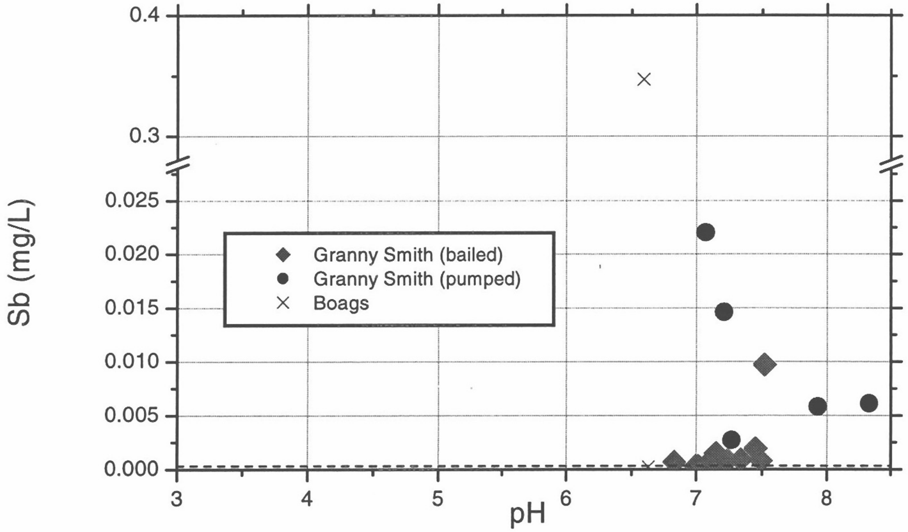

Figure A4.26: Antimony vs. pH for groundwaters from Granny Smith and other sites.

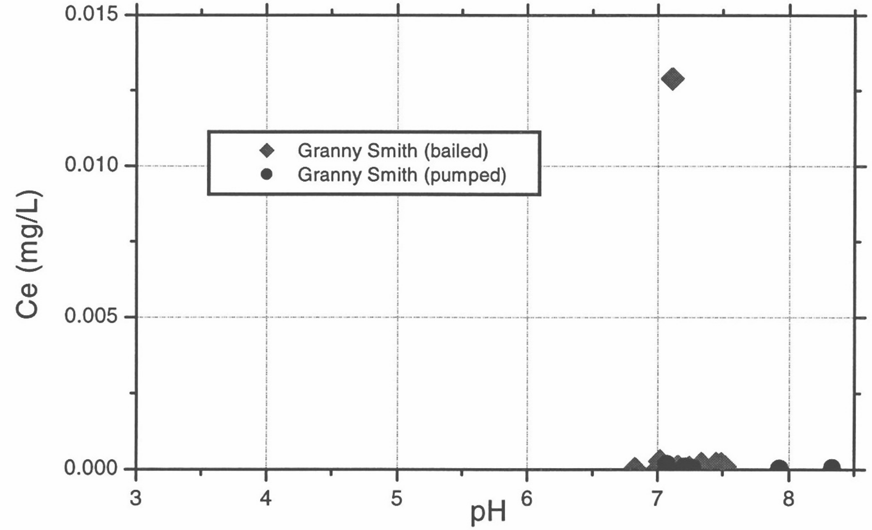

Figure A4.28: Cerium vs. pH for groundwaters from Granny Smith.

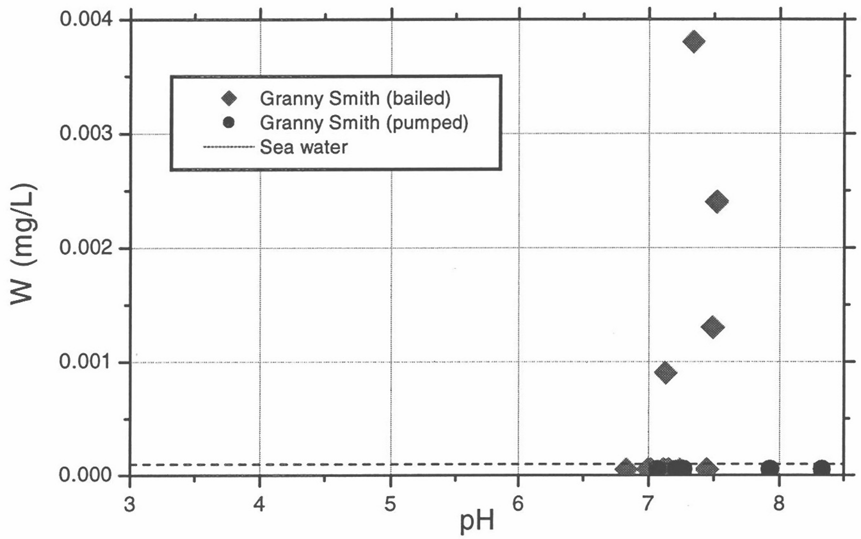

Figure A4.29: Tungsten vs. pH for groundwaters from Granny Smith.

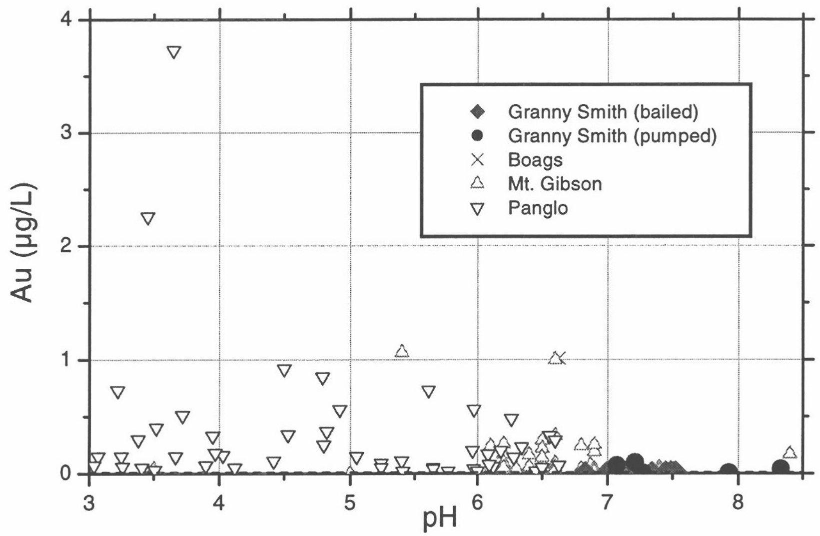

Figure A4.30: Gold vs. pH for groundwaters from Granny Smith and other sites.

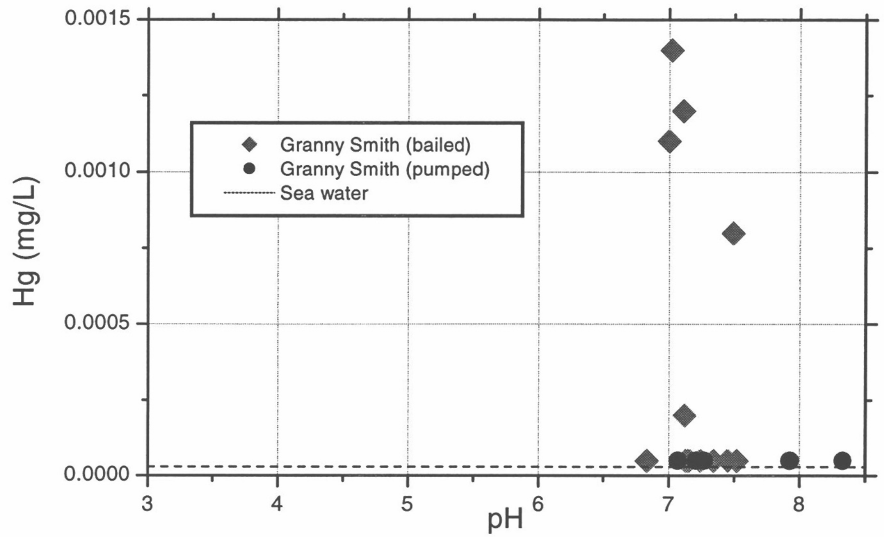

Figure A4.31: Mercury vs. pH for groundwaters from Granny Smith.

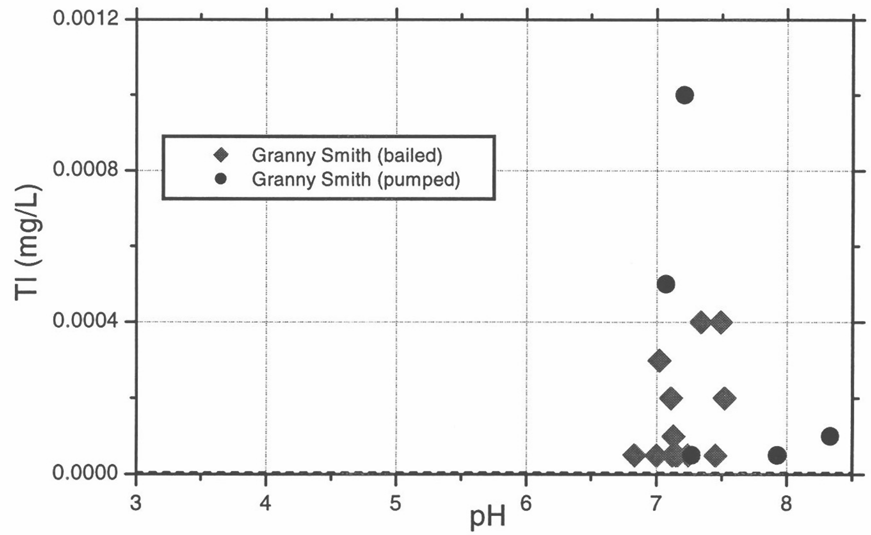

Figure A4.32: Thallium vs. pH for groundwaters from Granny Smith.

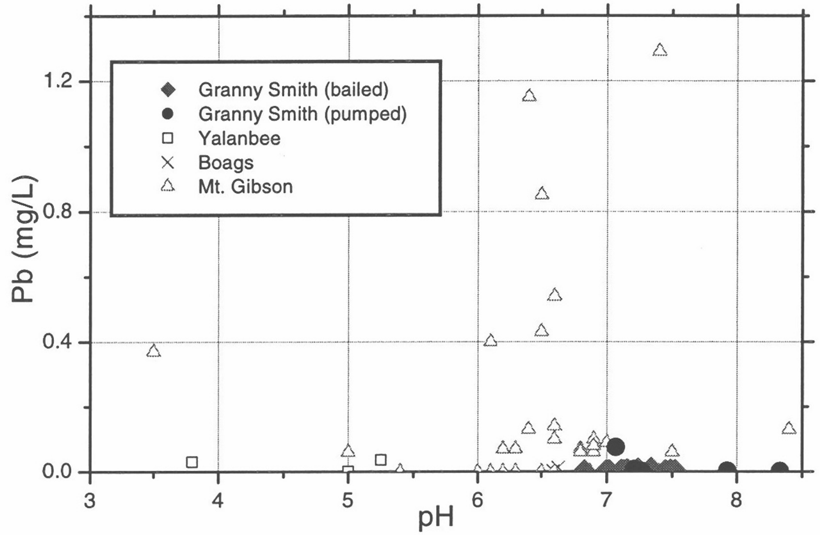

Figure A4.33: Lead vs. pH for groundwaters from Granny Smith and other sites.

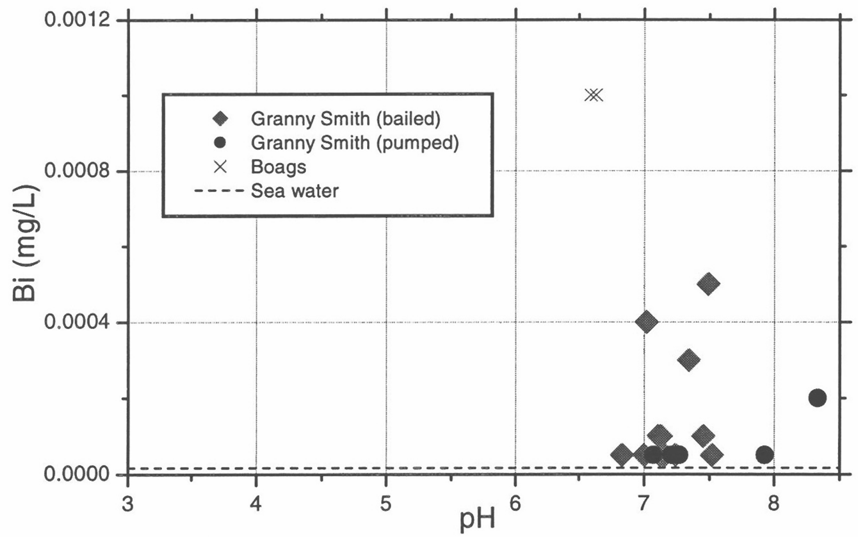

Figure A4.34: Bismuth vs. pH for groundwaters from Granny Smith and other sites.

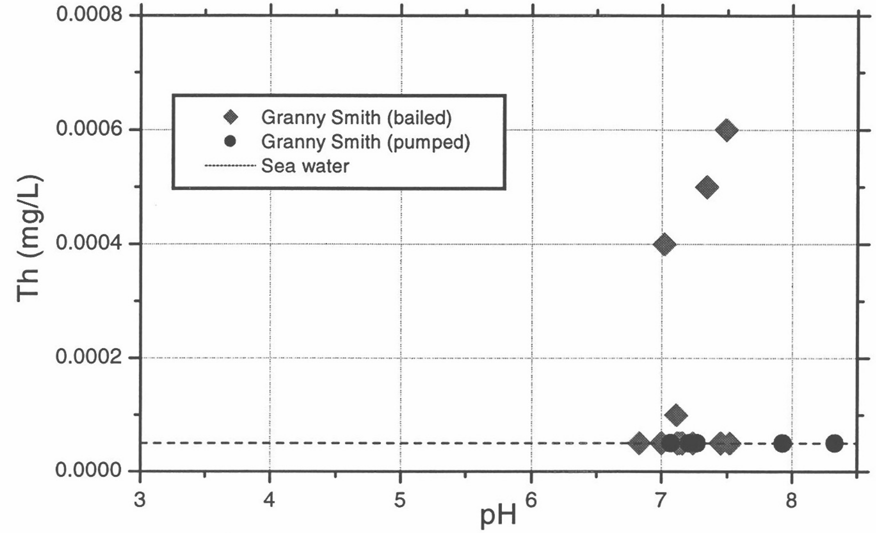

Figure A4.35: Thorium vs. pH for groundwaters from Granny Smith.

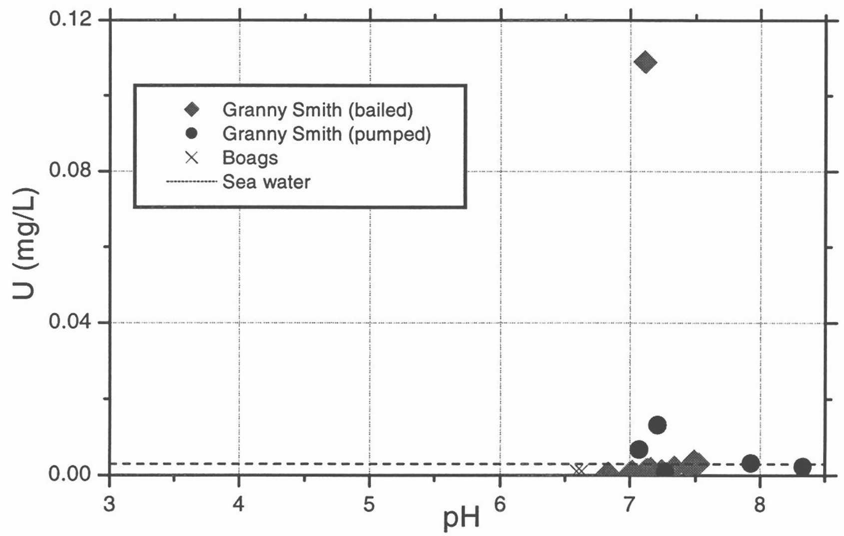

Figure A4.36: Uranium vs. pH for groundwaters from Granny Smith and other sites.

Appendix 5 - Speciation Analysis Output

Appendix 5.1 - Example of PHREEQE Output

```
WEG3
 0000000000 0 0          .00000
 SOLUTION 1
 WEG3
 29 10 2      7.34       5.04       25.0       1.00
   24  8.050D+02  21  5.000D+01  11  6.200D+01  19  2.500D+01  13  1.020D+03
   29  3.060D+02  10  1.682D+02   9  1.000D+00  18  4.700D-01  26  1.200D-02
   31  5.700D-01   8  3.700D-02   5  7.000D-03  30  2.600D+01  18  1.260D+00
   22  1.600D-01  17  9.000D-03  14  1.600D-02  25  1.000D-02  15  1.360D-01
   34  1.070D-01   6  7.000D-03  37  3.400D-02  35  1.000D-03  39  3.800D-03
   38  3.000D-06  27  9.000D-03  40  3.000D-04  32  2.000D-03

SOLUTION NUMBER 1          WEG3


                          TOTAL MOLALITIES OF ELEMENTS
                          ----------------------------

                  ELEMENT          MOLALITY          LOG MOLALITY

                  Al               2.596878D-07         -6.5855
                  As               9.352130D-08         -7.0291
                  Ba               2.696648D-07         -6.5692
                  Br               1.252711D-05         -4.9021
                  TOT ALK          2.758940D-03         -2.5593
                  Ca               1.548401D-03         -2.8101
                  Cl               2.879829D-02         -1.5406
                  Co               2.717562D-07         -6.5658
                  Cu               2.142250D-06         -5.6691
                  Fe               1.613103D-07         -6.7923
                  I                9.938329D-06         -5.0027
                  K                6.399714D-04         -3.1938
                  Mg               2.058585D-03         -2.6864
                  Mn               2.915189D-06         -5.5353
                  Na               3.504937D-02         -1.4553
                  Ni               1.704934D-07         -6.7683
                  PO4              3.877986D-07         -6.4114
                  Pb               4.348039D-08         -7.3617
                  SO4              3.188535D-03         -2.4964
                  Si               9.264909D-04         -3.0332
                  Sr               6.511651D-06         -5.1863
                  U                8.410423D-09         -8.0752
                  Zn               1.638421D-06         -5.7856
                  Sb               8.221491D-09         -8.0850
                  Mo               3.547307D-07         -6.4501
                  Au               1.524574D-11        -10.8169
                  W                2.068900D-08         -7.6843
                  Bi               1.436929D-09         -8.8426


                         ----DESCRIPTION OF SOLUTION----

                                      PH =     7.34
                                      PE =    5.0372
                          ACTIVITY H2O =      .9987
                        IONIC STRENGTH =      .0451
                           TEMPERATURE =   25.0000
                    ELECTRICAL BALANCE =    4.9730D-03
                                  THOR =    3.0984D-02
                      TOTAL ALKALINITY =    2.7589D-03
                            ITERATIONS =   10
                          TOTAL CARBON =    2.9634D-03
                                  ----------------------
```

DISTRIBUTION OF SPECIES

I	SPECIES	Z	MOLALITY	LOG MOLALITY	ACTIVITY	LOG ACTIVITY
1	H+	1.0	5.87D-08	-7.23	4.57D-08	-7.34
2	E-	-1.0	9.18D-06	-5.04	9.18D-06	-5.04
3	H2O	.0	9.99D-01	.00	9.99D-01	.00
5	Al 3+	3.0	2.53D-13	-12.60	4.58D-14	-13.34
6	H3AsO4	.0	7.89D-14	-13.10	7.98D-14	-13.10
8	Ba 2+	2.0	2.10D-07	-6.68	9.82D-08	-7.01
9	Br-	-1.0	1.25D-05	-4.90	1.04D-05	-4.98
10	CO3 2-	-2.0	4.80D-06	-5.32	2.24D-06	-5.65
11	Ca 2+	2.0	1.37D-03	-2.86	6.88D-04	-3.16
13	Cl-	-1.0	2.88D-02	-1.54	2.35D-02	-1.63
14	Co 2+	2.0	2.29D-07	-6.64	1.07D-07	-6.97
15	Cu 2+	2.0	2.75D-07	-6.56	1.29D-07	-6.89
17	Fe 2+	2.0	7.22D-09	-8.14	3.57D-09	-8.45
18	I-	-1.0	9.94D-06	-5.00	8.22D-06	-5.09
19	K+	1.0	6.35D-04	-3.20	5.17D-04	-3.29
21	Mg 2+	2.0	1.78D-03	-2.75	9.14D-04	-3.04
22	Mn 2+	2.0	2.17D-06	-5.66	1.01D-06	-5.99
24	Na+	1.0	3.48D-02	-1.46	2.89D-02	-1.54
25	Ni 2+	2.0	1.43D-07	-6.85	6.67D-08	-7.18
26	PO4 3-	-3.0	4.97D-12	-11.30	8.98D-13	-12.05
27	Pb 2+	2.0	1.33D-08	-7.88	6.21D-09	-8.21
29	SO4 2-	-2.0	2.57D-03	-2.59	1.17D-03	-2.93
30	H4SiO4	.0	9.23D-04	-3.03	9.32D-04	-3.03
31	Sr 2+	2.0	5.79D-06	-5.24	2.71D-06	-5.57
32	UO2 2+	2.0	1.05D-14	-13.98	4.90D-15	-14.31
34	Zn 2+	2.0	1.19D-06	-5.93	5.54D-07	-6.26
35	SbO +	1.0	6.97D-15	-14.16	5.77D-15	-14.24
37	MoO4 2-	-2.0	3.55D-07	-6.45	1.66D-07	-6.78
38	Au+	1.0	1.44D-20	-19.84	1.19D-20	-19.92
39	WO4 2-	-2.0	2.07D-08	-7.68	9.67D-09	-8.01
40	Bi 3+	3.0	2.17D-22	-21.66	3.93D-23	-22.41
51	H3AsO3	.0	3.87D-19	-18.41	3.91D-19	-18.41
52	Cu+	1.0	7.50D-10	-9.13	6.20D-10	-9.21
53	Fe 3+	3.0	1.48D-16	-15.83	3.71D-17	-16.43
54	Mn 3+	3.0	1.89D-26	-25.72	3.42D-27	-26.47
61	UO2 +	1.0	3.32D-17	-16.48	2.74D-17	-16.56
65	OH-	-1.0	2.64D-07	-6.58	2.18D-07	-6.66
66	H3SiO4 -	-1.0	3.65D-06	-5.44	3.02D-06	-5.52
78	MgCO3 0	.0	1.94D-06	-5.71	1.96D-06	-5.71
79	MgHCO3 +	1.0	2.81D-05	-4.55	2.33D-05	-4.63
80	MgSO4 0	.0	2.49D-04	-3.60	2.51D-04	-3.60
81	MgPO4 -	-1.0	3.85D-09	-8.41	3.19D-09	-8.50
82	MgH2PO4	1.0	2.41D-09	-8.62	2.00D-09	-8.70
83	MgHPO4 0	.0	6.16D-08	-7.21	6.22D-08	-7.21
85	CaHCO3 +	1.0	1.89D-05	-4.72	1.56D-05	-4.81
86	CaCO3 0	.0	2.17D-06	-5.66	2.19D-06	-5.66
87	CaSO4 0	.0	1.59D-04	-3.80	1.61D-04	-3.79
88	CaHPO4 0	.0	3.40D-08	-7.47	3.43D-08	-7.46
89	CaPO4 -	-1.0	2.15D-09	-8.67	1.78D-09	-8.75
90	CaH2PO4	1.0	1.42D-09	-8.85	1.18D-09	-8.93
93	NaCO3 -	-1.0	1.46D-06	-5.84	1.20D-06	-5.92
94	NaHCO3 0	.0	3.51D-05	-4.45	3.55D-05	-4.45
95	NaSO4 -	-1.0	2.05D-04	-3.69	1.70D-04	-3.77
96	NaHPO4 -	-1.0	6.19D-09	-8.21	5.12D-09	-8.29
99	KSO4 -	-1.0	5.15D-06	-5.29	4.26D-06	-5.37
100	KHPO4 -	-1.0	1.12D-10	-9.95	9.26D-11	-10.03
101	AlOH 2+	2.0	2.14D-11	-10.67	1.00D-11	-11.00
102	Al(OH)2+	1.0	2.10D-09	-8.68	1.74D-09	-8.76
103	Al(OH)3	.0	5.95D-09	-8.23	6.01D-09	-8.22
104	Al(OH)4-	-1.0	2.52D-07	-6.60	2.08D-07	-6.68
109	AlSO4 +	1.0	6.79D-14	-13.17	5.61D-14	-13.25

110	FeHPO4 0	.0	1.28D-12	-11.89	1.29D-12	-11.89
112	FeOH +	1.0	2.98D-11	-10.53	2.47D-11	-10.61
113	FeOH 2+	2.0	1.12D-11	-10.95	5.24D-12	-11.28
114	FeOH2 +	1.0	4.59D-08	-7.34	3.79D-08	-7.42
115	FeOH3 0	.0	1.06D-07	-6.98	1.07D-07	-6.97
116	FeOH4 -	-1.0	2.57D-09	-8.59	2.13D-09	-8.67
119	FeHPO4 +	1.0	1.11D-18	-17.95	9.18D-19	-18.04
120	FeSO4 +	1.0	5.77D-16	-15.24	4.77D-16	-15.32
121	FeCl 2+	2.0	5.63D-17	-16.25	2.63D-17	-16.58
122	FeCl2 +	1.0	3.34D-18	-17.48	2.76D-18	-17.56
127	FeH2PO4	2.0	1.42D-18	-17.85	6.65D-19	-18.18
131	Fe(SO4)2	-1.0	1.48D-17	-16.83	1.22D-17	-16.91
135	SrHCO3 +	1.0	1.08D-07	-6.97	8.95D-08	-7.05
136	SrCO3	.0	3.88D-09	-8.41	3.92D-09	-8.41
137	SrSO4	.0	6.12D-07	-6.21	6.18D-07	-6.21
139	BaHCO3 +	1.0	2.49D-09	-8.60	2.06D-09	-8.69
140	BaCO3	.0	1.12D-10	-9.95	1.13D-10	-9.95
141	BaSO4	.0	5.71D-08	-7.24	5.77D-08	-7.24
142	MnCl +	1.0	1.17D-07	-6.93	9.70D-08	-7.01
143	MnCl2 0	.0	9.83D-10	-9.01	9.93D-10	-9.00
146	Mn(OH)3	-1.0	2.03D-19	-18.69	1.68D-19	-18.78
148	MnSO4 0	.0	2.09D-07	-6.68	2.11D-07	-6.67
149	MnHCO3 +	1.0	2.39D-07	-6.62	1.98D-07	-6.70
150	MnCO3 0	.0	1.79D-07	-6.75	1.81D-07	-6.74
151	CuCl2 -	-1.0	1.30D-07	-6.88	1.08D-07	-6.97
152	CuCl3 2-	-2.0	8.58D-09	-8.07	4.01D-09	-8.40
153	CuCO3 0	.0	1.53D-06	-5.81	1.55D-06	-5.81
154	Cu(CO3)2	-2.0	2.19D-08	-7.66	1.03D-08	-7.99
155	CuCl +	1.0	9.83D-09	-8.01	8.13D-09	-8.09
156	CuCl2 0	.0	1.01D-10	-9.99	1.02D-10	-9.99
160	CuOH +	1.0	1.08D-07	-6.97	8.89D-08	-7.05
161	Cu(OH)2	.0	3.84D-09	-8.42	3.88D-09	-8.41
165	CuSO4 0	.0	3.05D-08	-7.52	3.08D-08	-7.51
167	CuHCO3 +	1.0	2.01D-08	-7.70	1.66D-08	-7.78
168	ZnCl +	1.0	4.23D-08	-7.37	3.50D-08	-7.46
169	ZnCl2 0	.0	8.51D-10	-9.07	8.60D-10	-9.07
170	ZnCl3 -	-1.0	2.74D-11	-10.56	2.26D-11	-10.65
171	ZnCl4 2-	-2.0	5.68D-13	-12.25	2.66D-13	-12.58
173	ZnOH +	1.0	1.53D-08	-7.81	1.27D-08	-7.90
174	Zn(OH)2	.0	3.31D-09	-8.48	3.34D-09	-8.48
177	ZnOHCl 0	.0	9.31D-09	-8.03	9.41D-09	-8.03
180	ZnSO4 0	.0	1.51D-07	-6.82	1.52D-07	-6.82
181	Zn(SO4)2	-2.0	3.10D-09	-8.51	1.45D-09	-8.84
186	ZnHCO3 +	1.0	7.36D-09	-8.13	6.09D-09	-8.22
187	ZnCO3 0	.0	1.95D-07	-6.71	1.97D-07	-6.71
188	Zn(CO3)2	-2.0	2.54D-08	-7.59	1.19D-08	-7.92
214	PbCl +	1.0	7.01D-09	-8.15	5.80D-09	-8.24
215	PbCl2 0	.0	2.13D-10	-9.67	2.16D-10	-9.67
216	PbCl3 -	-1.0	4.85D-12	-11.31	4.01D-12	-11.40
217	PbCO3 0	.0	3.46D-09	-8.46	3.50D-09	-8.46
218	PbHCO3 +	1.0	1.22D-08	-7.91	1.01D-08	-8.00
219	Pb(CO3)2	-2.0	4.84D-11	-10.32	2.26D-11	-10.65
223	PbOH +	1.0	3.20D-09	-8.50	2.64D-09	-8.58
224	Pb(OH)2	.0	2.23D-11	-10.65	2.25D-11	-10.65
228	PbSO4 0	.0	4.05D-09	-8.39	4.09D-09	-8.39
243	NiOH +	1.0	2.43D-10	-9.61	2.01D-10	-9.70
244	Ni(OH)2	.0	3.15D-12	-11.50	3.18D-12	-11.50
245	NiHCO3 +	1.0	6.88D-09	-8.16	5.69D-09	-8.25
246	NiCO3 0	.0	5.50D-10	-9.26	5.56D-10	-9.26
248	NiCl +	1.0	4.74D-09	-8.32	3.92D-09	-8.41
249	NiCl2 0	.0	3.31D-10	-9.48	3.35D-10	-9.48
250	NiSO4 0	.0	1.51D-08	-7.82	1.52D-08	-7.82
271	H2AsO3 -	-1.0	6.12D-21	-20.21	5.06D-21	-20.30
272	HAsO3 2-	-2.0	1.87D-25	-24.73	8.75D-26	-25.06
274	H4AsO3 +	1.0	1.07D-26	-25.97	8.85D-27	-26.05
275	H2AsO4 -	-1.0	1.21D-08	-7.92	9.97D-09	-8.00

276	HAsO4 2-	-2.0	8.15D-08	-7.09	3.81D-08	-7.42
277	AsO4 3-	-3.0	1.17D-11	-10.93	2.11D-12	-11.68
278	HCO3 -	-1.0	2.65D-03	-2.58	2.19D-03	-2.66
279	H2CO3 0	.0	2.21D-04	-3.66	2.24D-04	-3.65
284	HPO4 2-	-2.0	1.95D-07	-6.71	9.10D-08	-7.04
285	H2PO4 -	-1.0	8.10D-08	-7.09	6.70D-08	-7.17
286	H3PO4 0	.0	4.25D-13	-12.37	4.30D-13	-12.37
291	U(OH)3 +	1.0	4.36D-28	-27.36	3.60D-28	-27.44
292	U(OH)4 0	.0	2.13D-24	-23.67	2.15D-24	-23.67
293	U(OH)5 -	-1.0	1.36D-21	-20.87	1.12D-21	-20.95
307	UO2OH +1	1.0	1.05D-12	-11.98	8.71D-13	-12.06
310	UO2CO3 0	.0	1.37D-10	-9.86	1.38D-10	-9.86
311	UO2CO3)2	-2.0	5.30D-09	-8.28	2.48D-09	-8.61
312	UO2CO3)3	-4.0	2.80D-09	-8.55	1.34D-10	-9.87
320	UO2HPO4	.0	1.30D-13	-12.89	1.31D-13	-12.88
321	UO2HPO4)	-2.0	1.72D-10	-9.77	8.03D-11	-10.10
322	UO2H2PO4	1.0	4.89D-19	-18.31	4.04D-19	-18.39
323	UO2H2PO4	.0	8.56D-24	-23.07	8.64D-24	-23.06
324	UO2H2PO4	-1.0	6.88D-29	-28.16	5.69D-29	-28.25
325	UO2H3SiO	1.0	4.82D-13	-12.32	3.98D-13	-12.40
387	AuCl 0	.0	1.39D-17	-16.86	1.40D-17	-16.85
388	AuCl2 -	-1.0	7.93D-15	-14.10	6.55D-15	-14.18
397	AuOH 0	.0	2.05D-15	-14.69	2.08D-15	-14.68
398	Au(OH)2-	-1.0	5.51D-12	-11.26	4.56D-12	-11.34
410	AuI2 -	-1.0	9.72D-12	-11.01	8.04D-12	-11.09
425	CoOH +	1.0	5.65D-10	-9.25	4.67D-10	-9.33
426	Co(OH)2	.0	1.27D-12	-11.90	1.29D-12	-11.89
427	CoHCO3 +	1.0	6.97D-09	-8.16	5.77D-09	-8.24
428	CoCO3 0	.0	3.52D-10	-9.45	3.56D-10	-9.45
429	CoSO4	.0	2.85D-08	-7.55	2.88D-08	-7.54
430	CoCl +	1.0	6.07D-09	-8.22	5.02D-09	-8.30
433	CoOH 2+	2.0	1.79D-28	-27.75	8.35D-29	-28.08
449	SbO2 -	-1.0	3.55D-13	-12.45	2.93D-13	-12.53
450	SbOOH 0	.0	8.22D-09	-8.09	8.31D-09	-8.08
455	HMoO4 -	-1.0	5.78D-11	-10.24	4.78D-11	-10.32
456	H2MoO4 0	.0	1.22D-14	-13.91	1.23D-14	-13.91
459	BiO +	1.0	9.27D-10	-9.03	7.66D-10	-9.12
461	Bi(OH)3	.0	5.10D-10	-9.29	5.16D-10	-9.29
467	HWO4 -	-1.0	2.13D-12	-11.67	1.76D-12	-11.75
468	H2WO4 0	.0	2.00D-16	-15.70	2.02D-16	-15.69

---- LOOK MIN IAP ----

PHASE	LOG IAP	LOG KT	LOG IAP/KT
Calcite	-8.8115	-8.4749	-.34
Dolomite	-17.4999	-17.0900	-.41
Gypsum	-6.0944	-4.5800	-1.51
Halite	-3.1693	1.5800	-4.75
SiO2(a)	-3.0293	-2.7148	-.31
Al(OH)3a	8.6788	10.3800	-1.70
Alunite	-5.1305	-1.4000	-3.73
Jurbanit	-8.9312	-3.8000	-5.13
Kaolinit	11.2995	7.4400	3.86
Ferrihyd	18.6083	17.0000	1.61
Jarosite	24.6580	24.3000	.36
Tenorite	7.7890	7.6200	.17
Smithson	-11.9055	-10.0000	-1.91
Cerussit	-13.8564	-13.1300	-.73
Theophra	7.5030	10.8000	-3.30
Sphaeroc	-12.6191	-9.9800	-2.64
Au_Metal	-24.9614	-28.6000	3.64
Sb(OH)3	-6.9001	-5.9300	-.97
Uraninit	-24.3839	-13.9200	-10.46
Rutherfo	-19.9589	-14.4622	-5.50
Na-Autun	-55.7923	-47.4100	-8.38
MoO2	-46.2136	-29.9500	-16.26
MoO3	-21.4598	-12.0600	-9.40
PbMoO4	-14.9874	-13.0000	-1.99
FeMoO4	-15.2276	-10.4800	-4.75
CaMoO4	-9.9426	-8.0000	-1.94
WO2	-47.4478	-15.2800	-32.17
WO3	-22.6939	-14.0500	-8.64
FeWO4	-16.4617	-9.4900	-6.97
CO2(gas)	-20.3288	-18.1500	-2.18
Sepiolit	14.1912	15.7600	-1.57

Appendix 5.2 - SI Plots

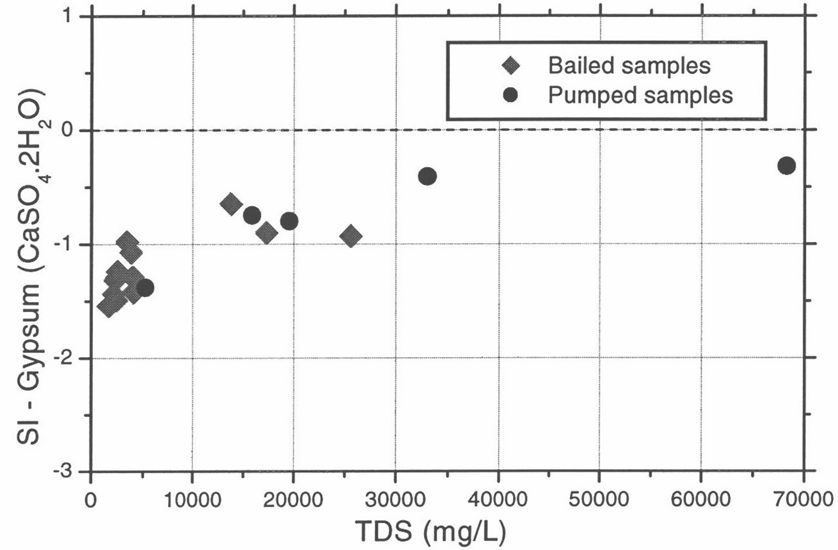

Figure A5.1: SI for gypsum vs. TDS for Granny Smith groundwaters.

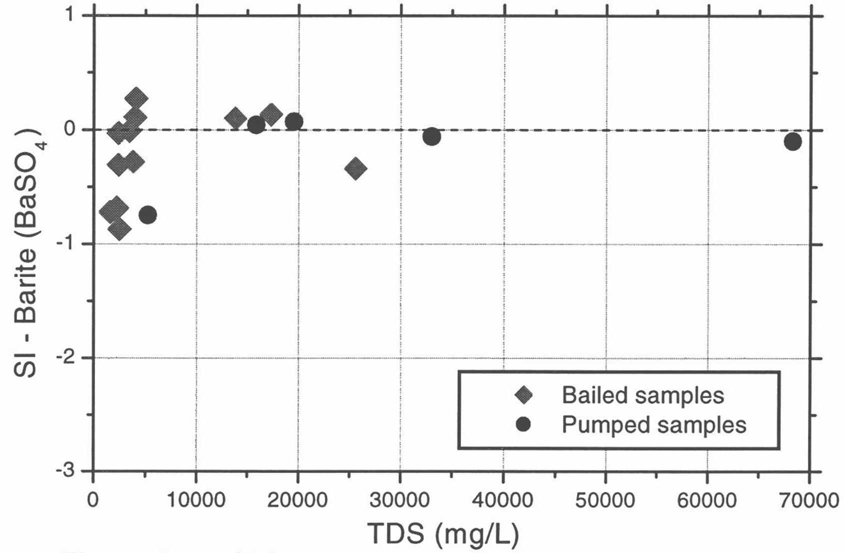

Figure A5.3: SI for barite vs. TDS for Granny Smith groundwaters.

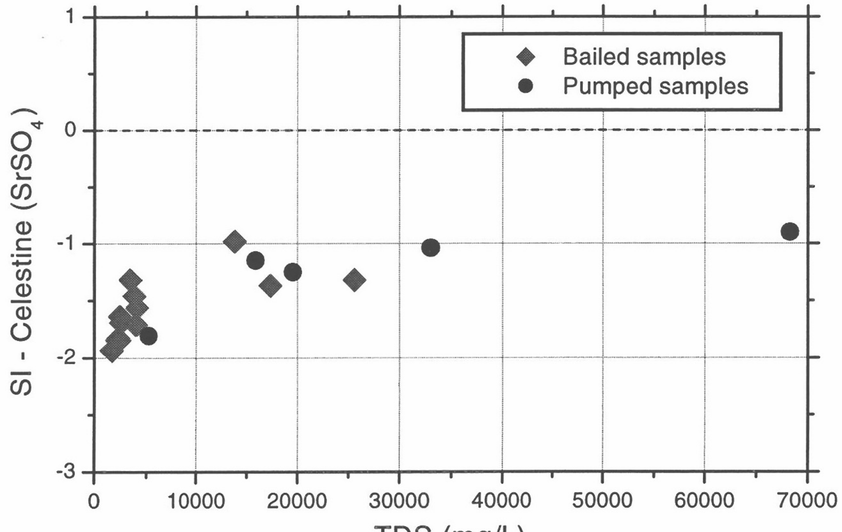

Figure A5.2: SI for celestine vs. TDS for Granny Smith groundwaters.

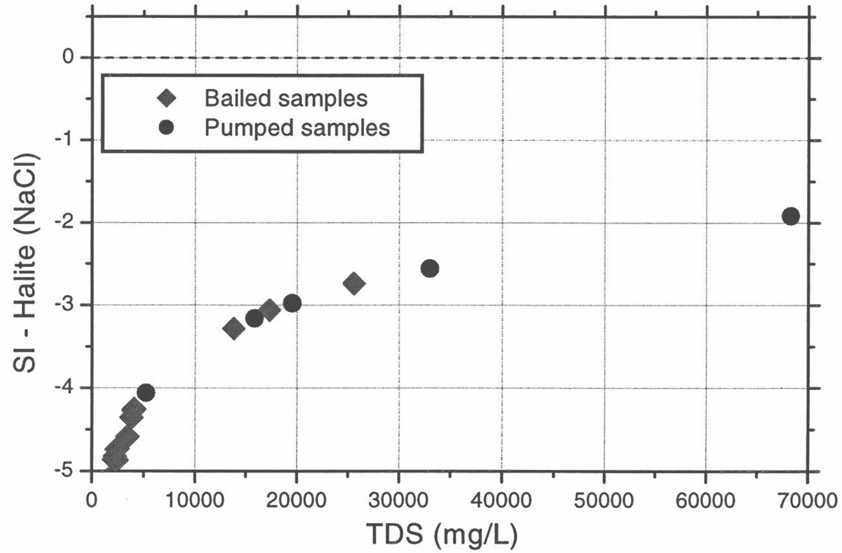

Figure A5.4: SI for halite vs. TDS for Granny Smith groundwaters.

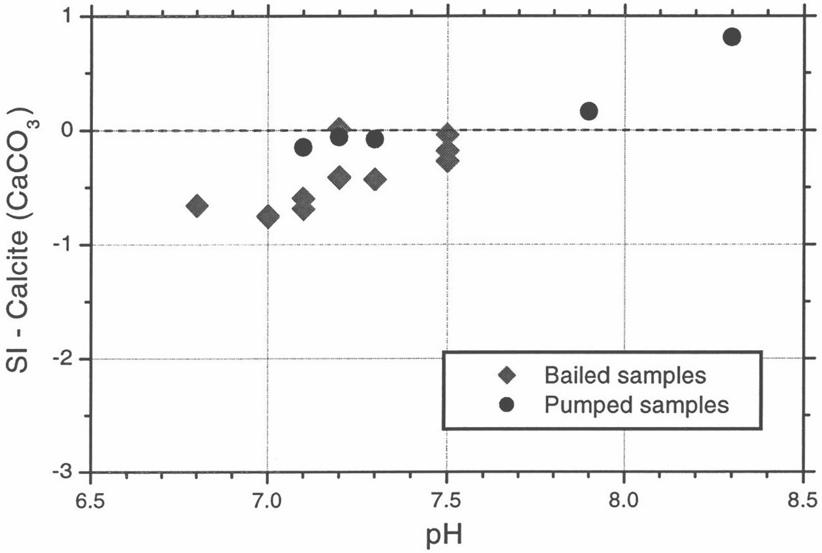

Figure A5.5: SI for calcite vs. pH for Granny Smith groundwaters.

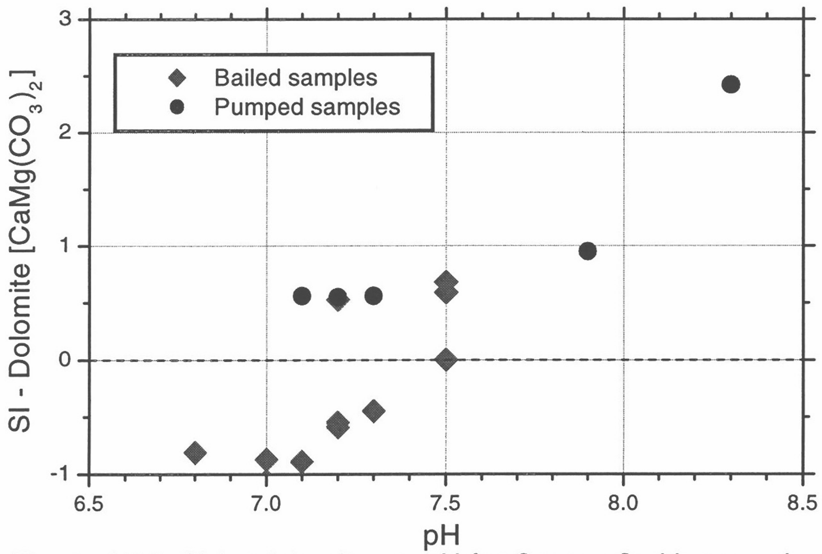

Figure A5.6: SI for dolomite vs. pH for Granny Smith groundwaters.

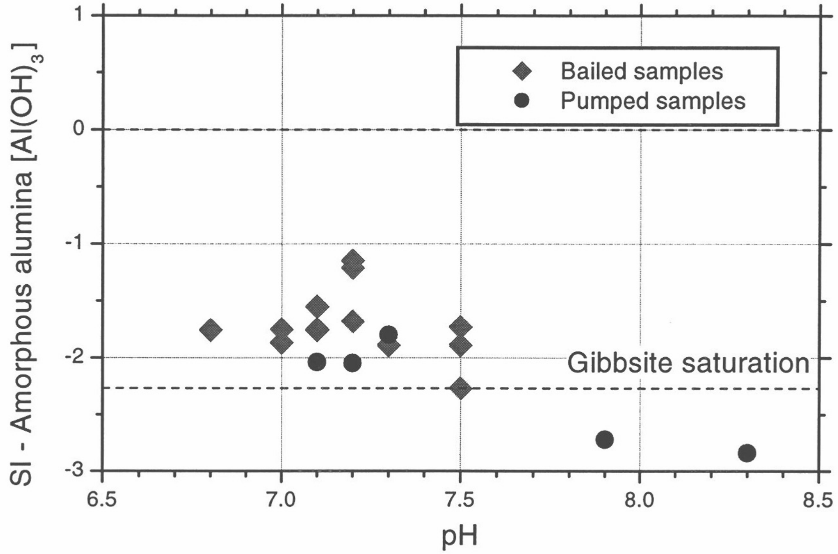

Figure A5.7: SI for $Al(OH)_3$ vs. pH for Granny Smith groundwaters.

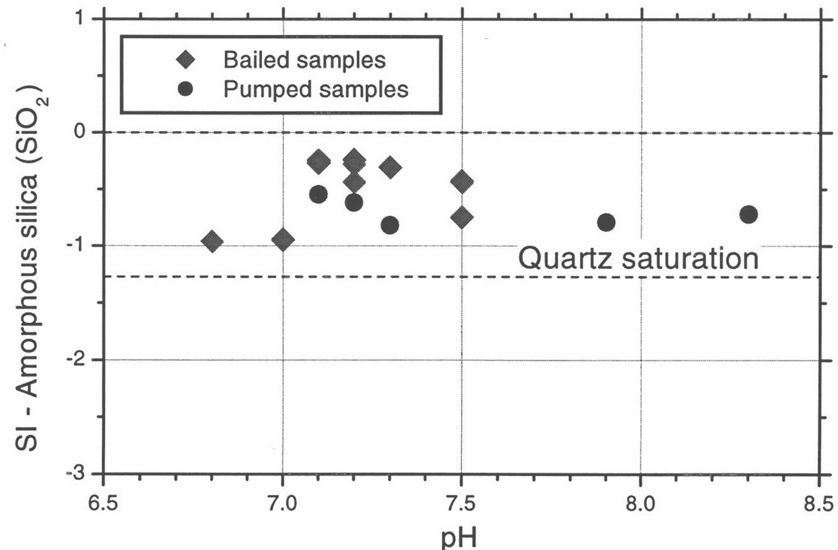

Figure A5.8: SI for SiO_2 vs. pH for Granny Smith groundwaters.

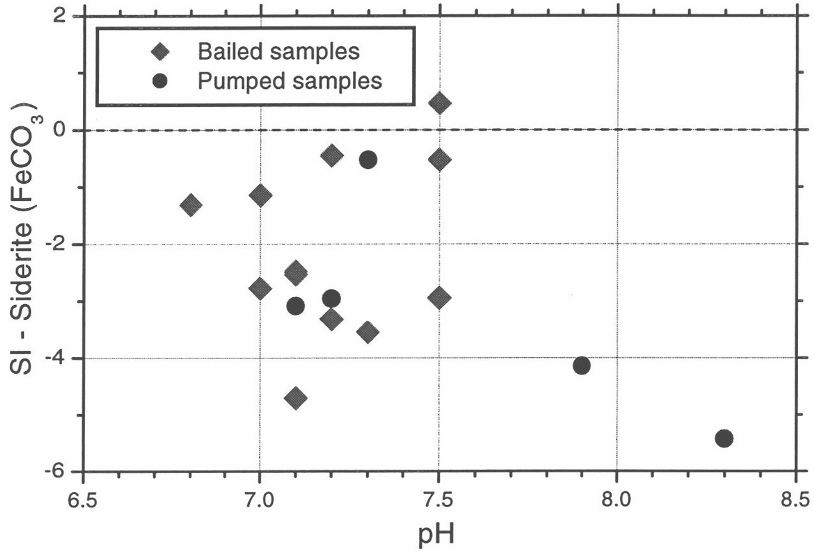

Figure A5.9: SI for siderite vs. pH for Granny Smith groundwaters.

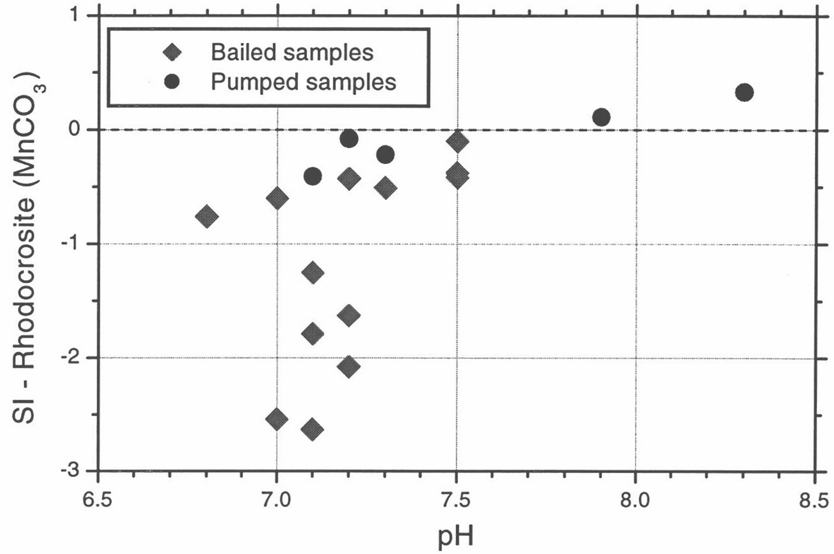

Figure A5.11: SI for rhodocrosite vs. pH for Granny Smith groundwaters.

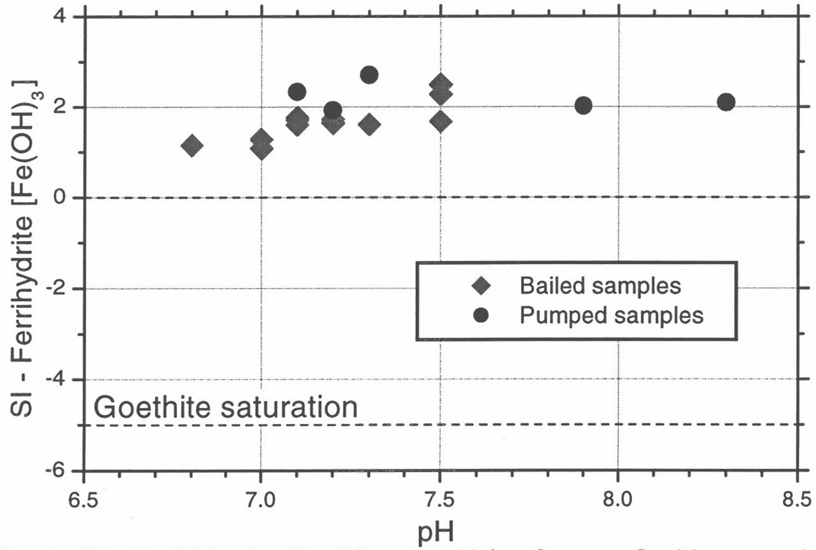

Figure A5.10: SI for ferrihydrite vs. pH for Granny Smith groundwaters.

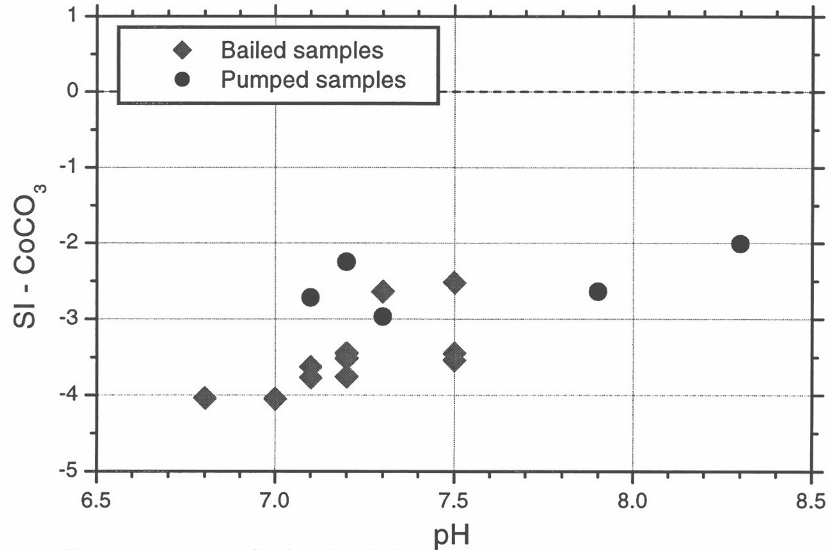

Figure A5.12: SI for $CoCO_3$ vs. pH for Granny Smith groundwaters.

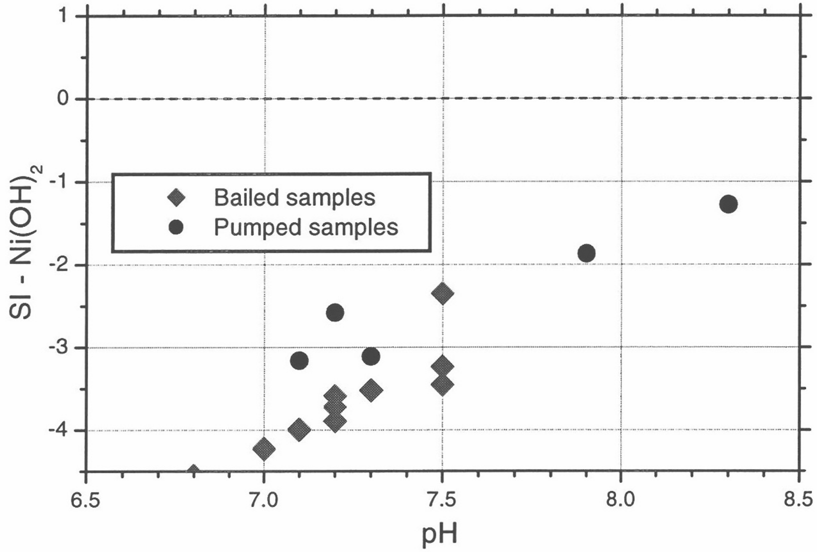

Figure A5.13: SI for $Ni(OH)_2$ vs. pH for Granny Smith groundwaters.

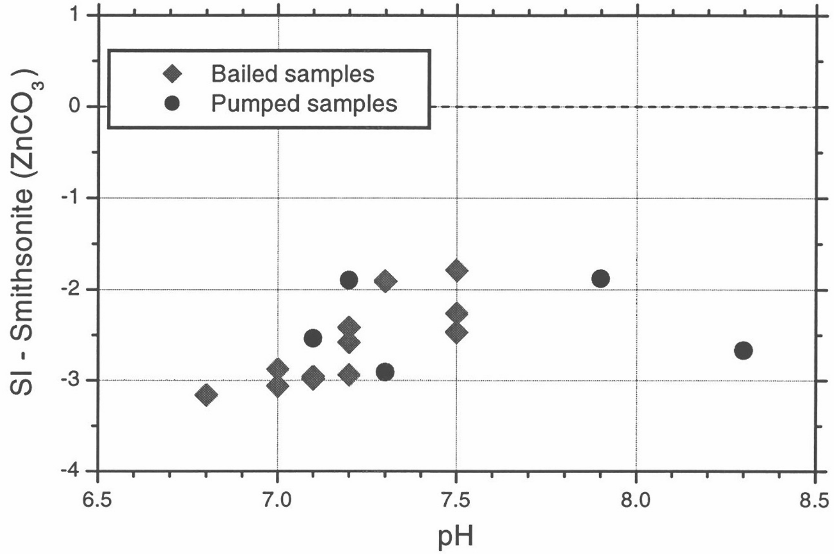

Figure A5.15: SI for smithsonite vs. pH for Granny Smith groundwaters.

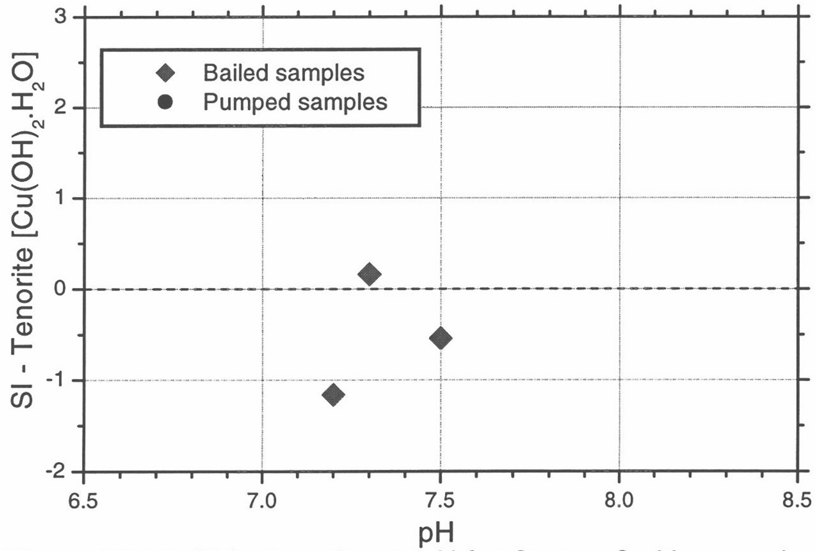

Figure A5.14: SI for tenorite vs. pH for Granny Smith groundwaters.

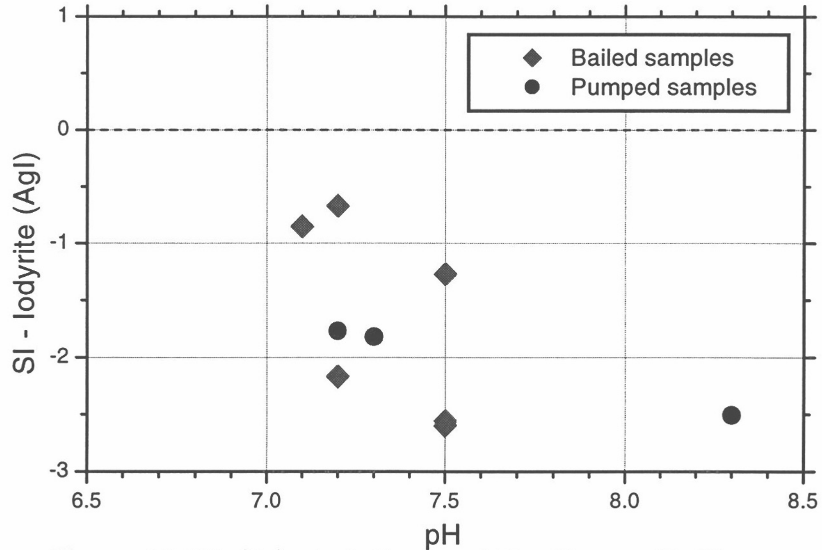

Figure A5.16: SI for iodyrite vs. pH for Granny Smith groundwaters.

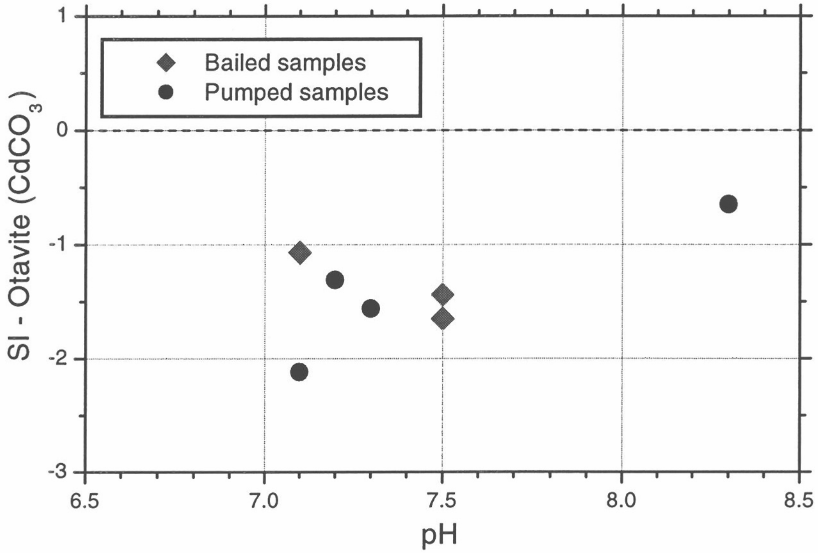

Figure A5.17: SI for otavite vs. pH for Granny Smith groundwaters.

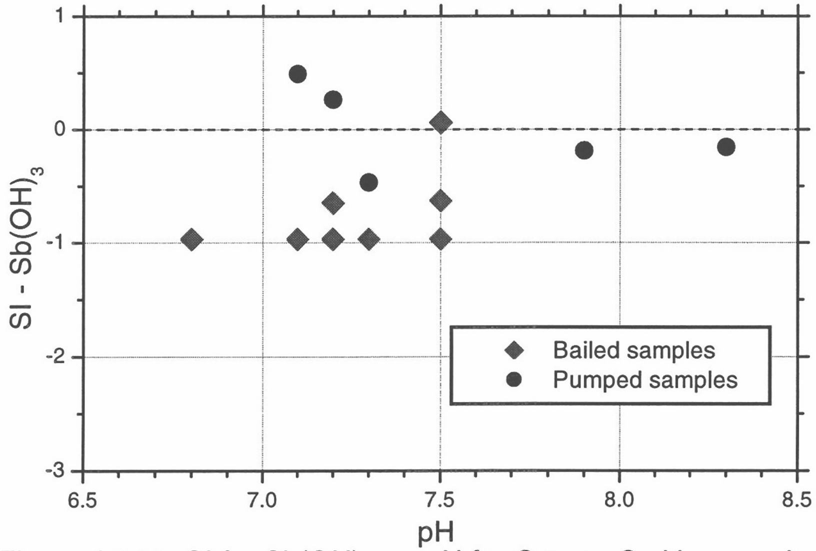

Figure A5.18: SI for $Sb(OH)_3$ vs. pH for Granny Smith groundwaters.

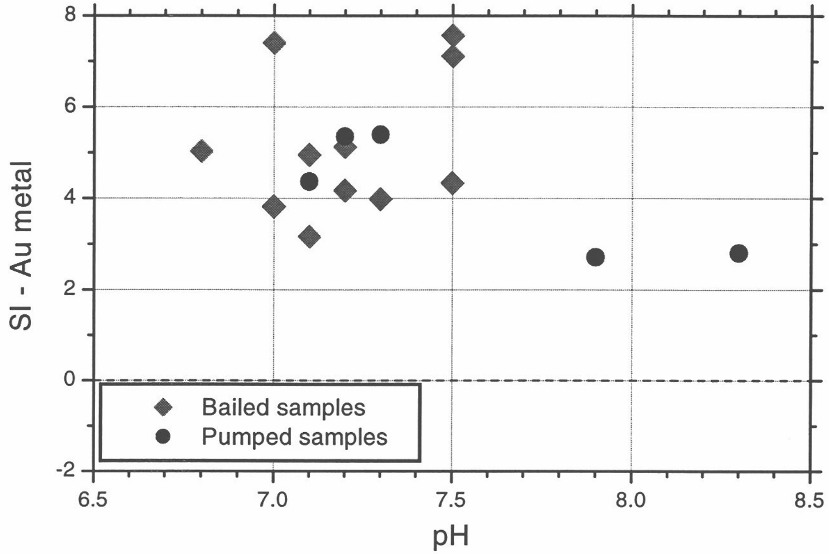

Figure A5.19: SI for Au metal vs. pH for Granny Smith groundwaters.

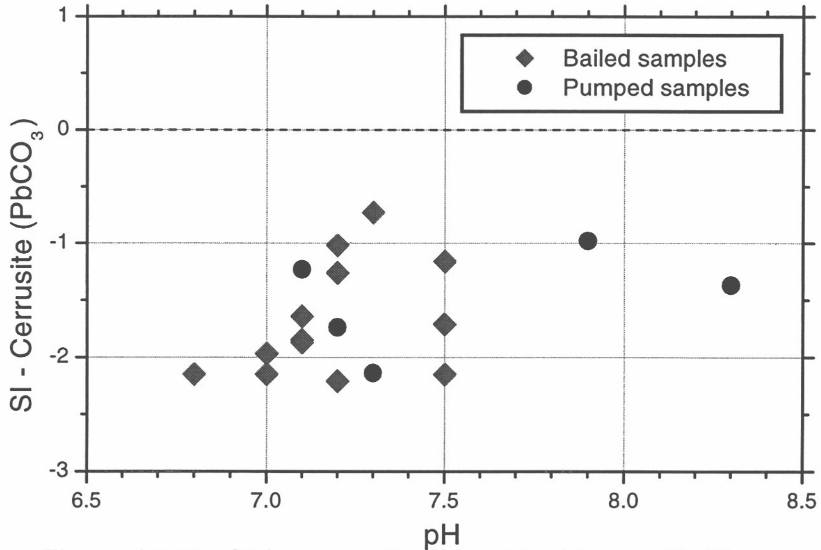

Figure A5.20: SI for cerrusite vs. pH for Granny Smith groundwaters.

Appendix 6 - Element/Ion Distribution Maps

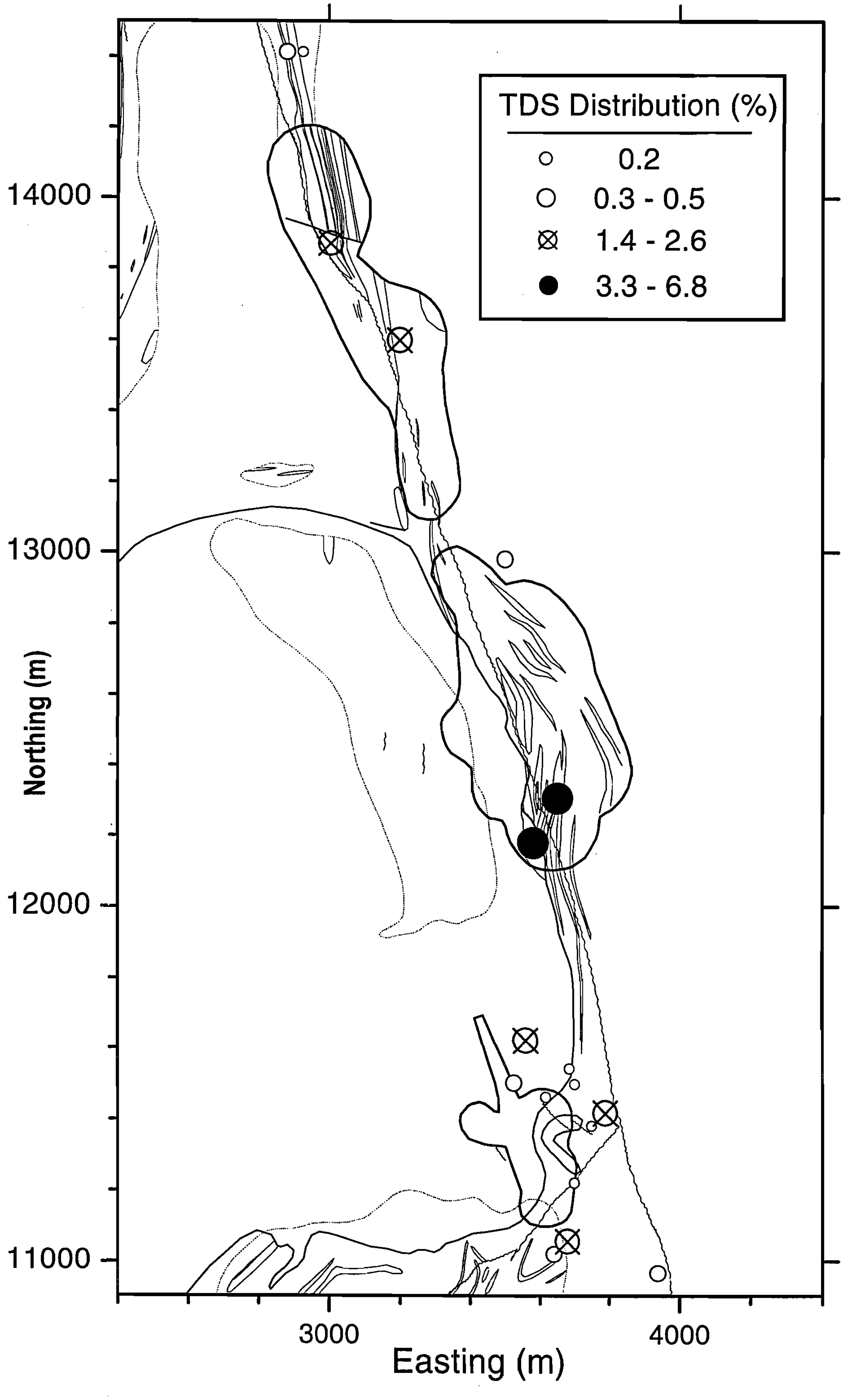

Figure A6.1: Granny Smith – TDS Distribution

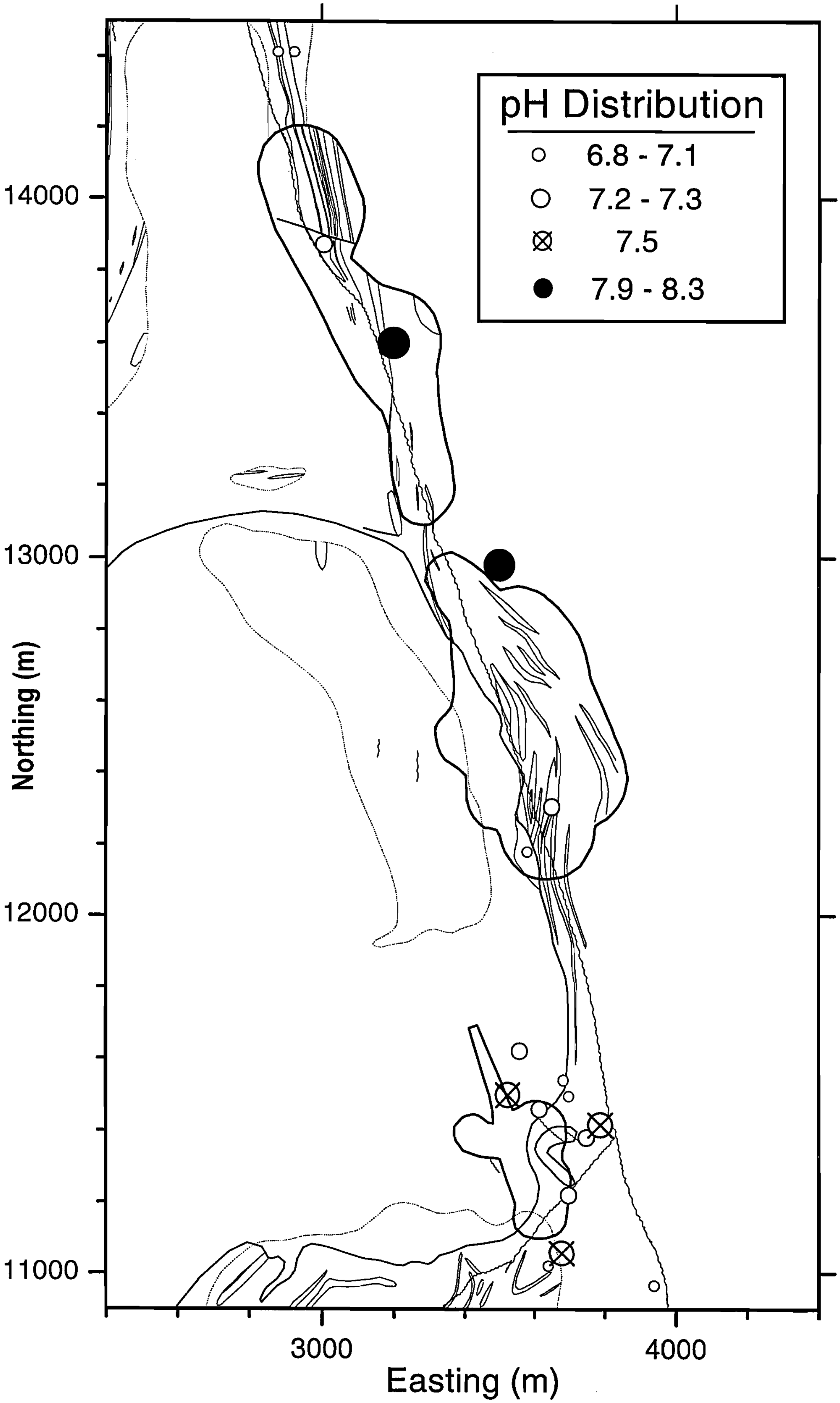

Figure A6.2: Granny Smith – pH Distribution

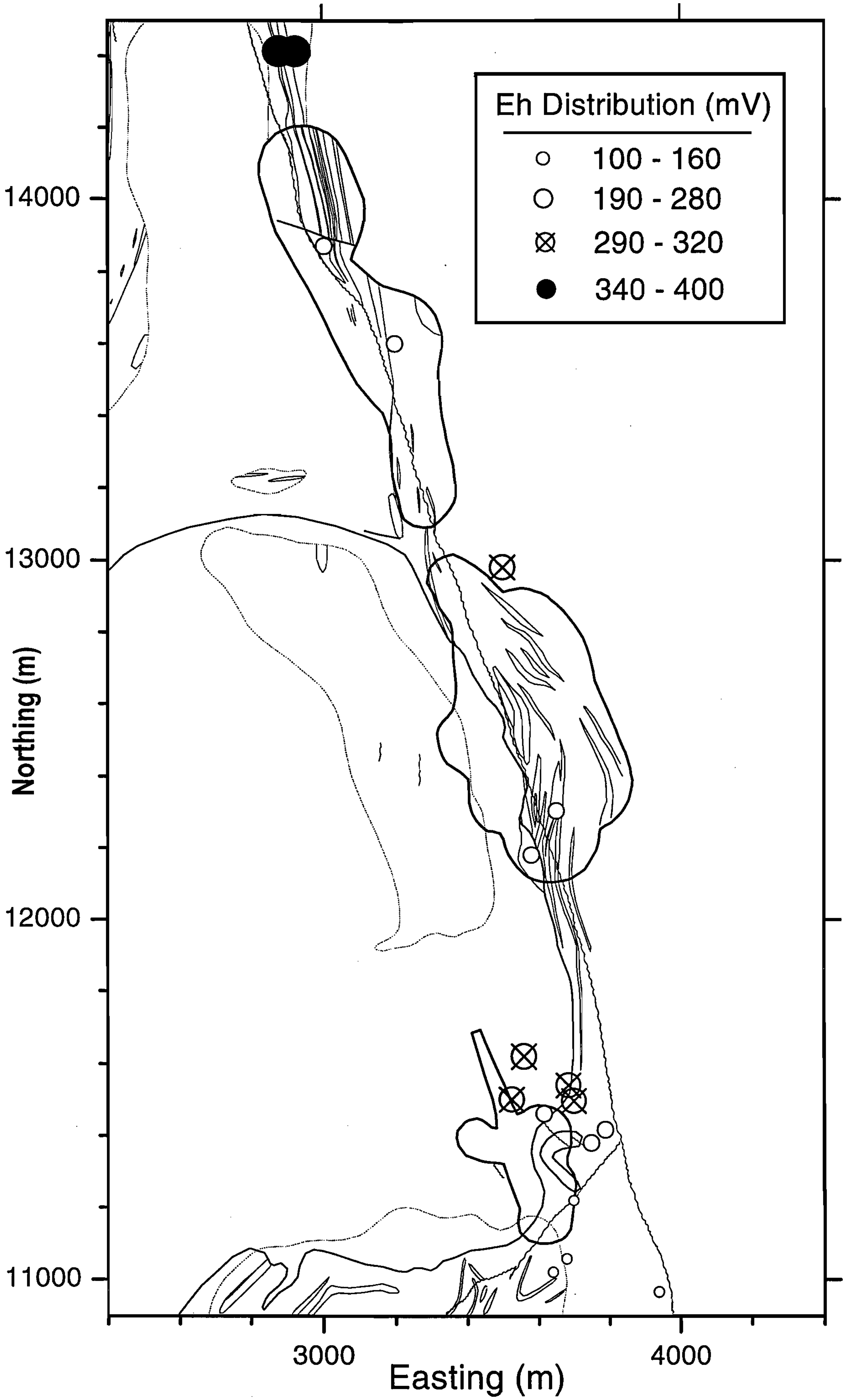

Figure A6.3: Granny Smith – Eh Distribution

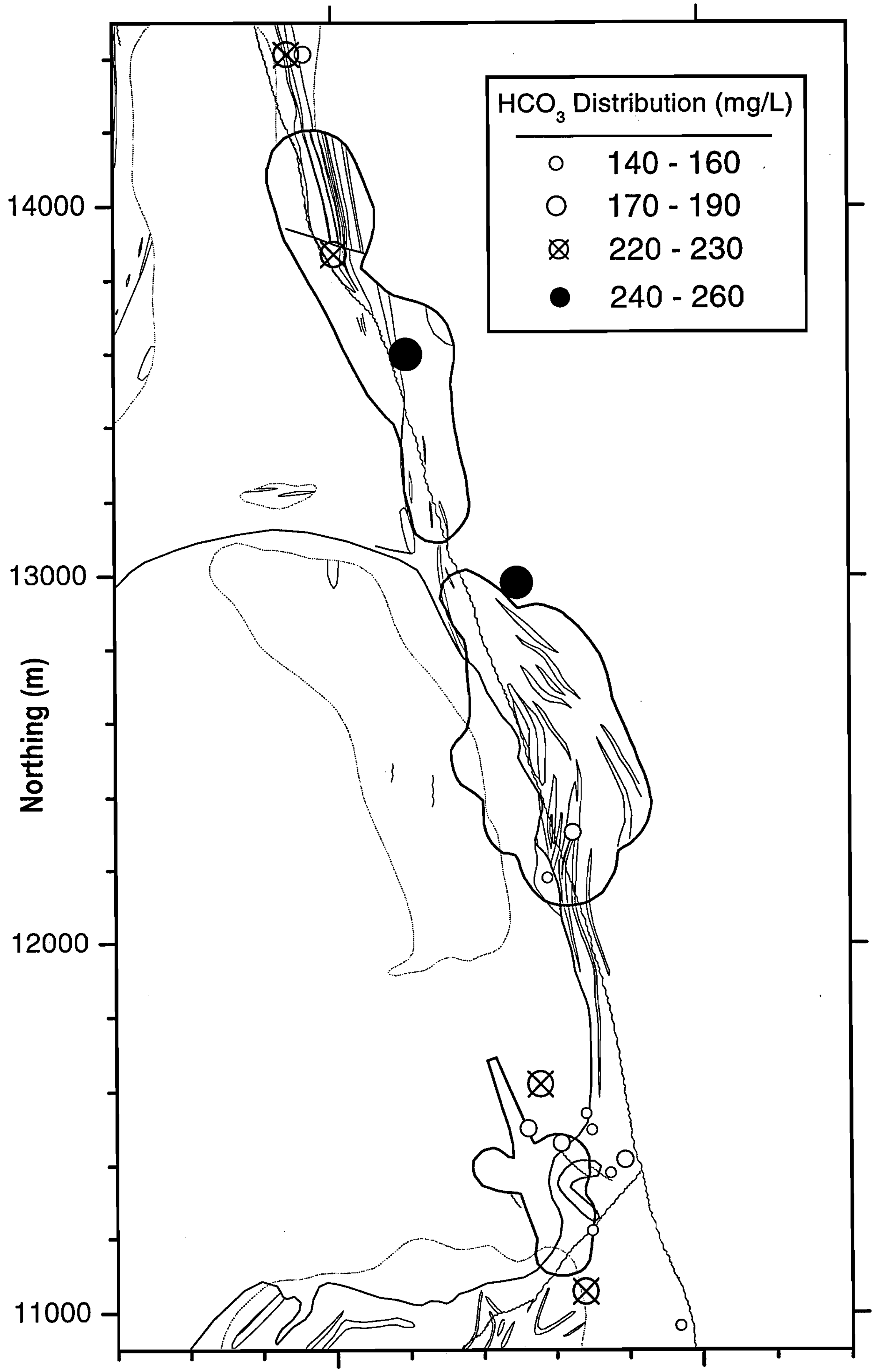

Figure A6.4: Granny Smith – Bicarbonate Distribution

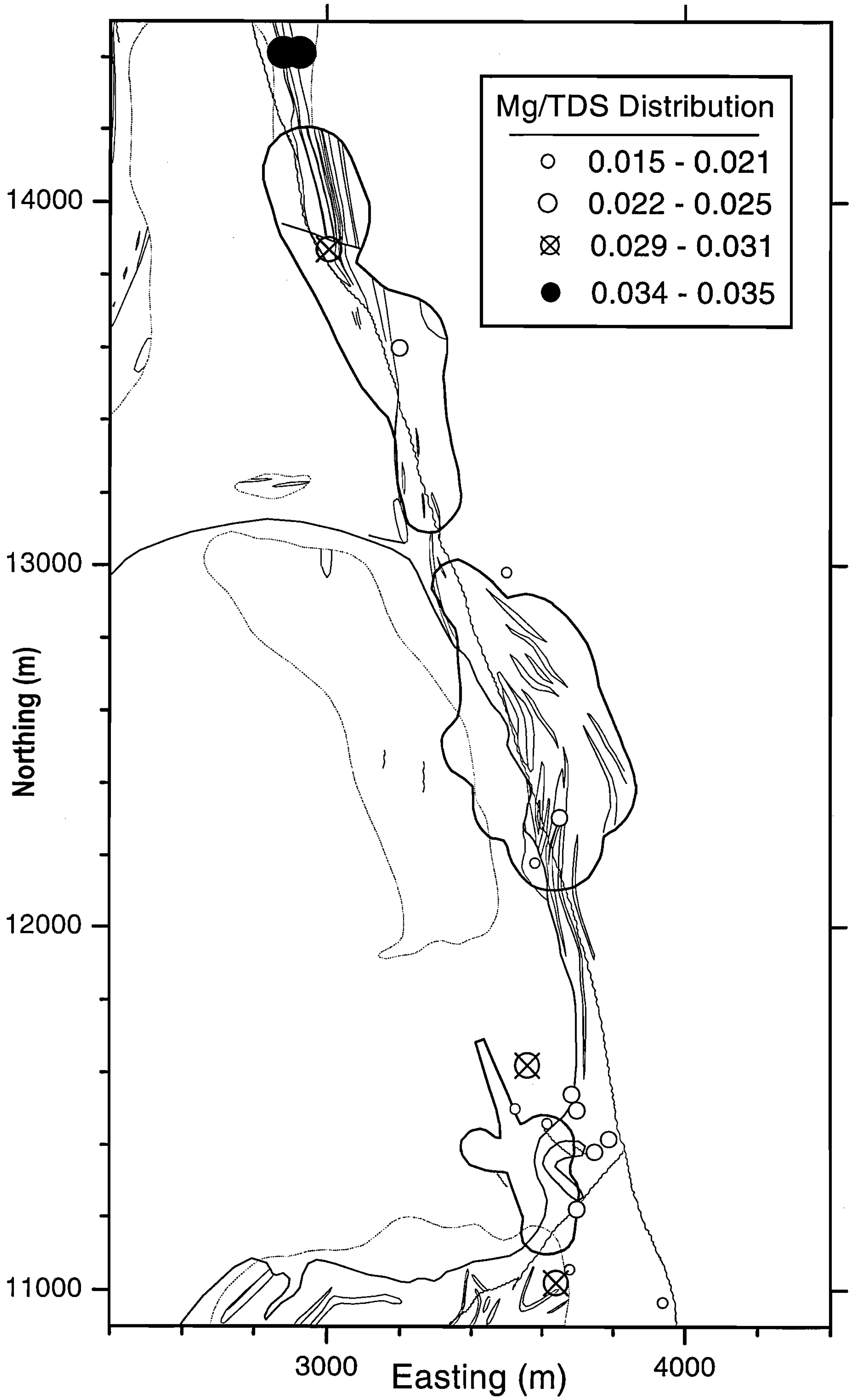

Figure A6.5: Granny Smith – Magnesium/TDS Distribution

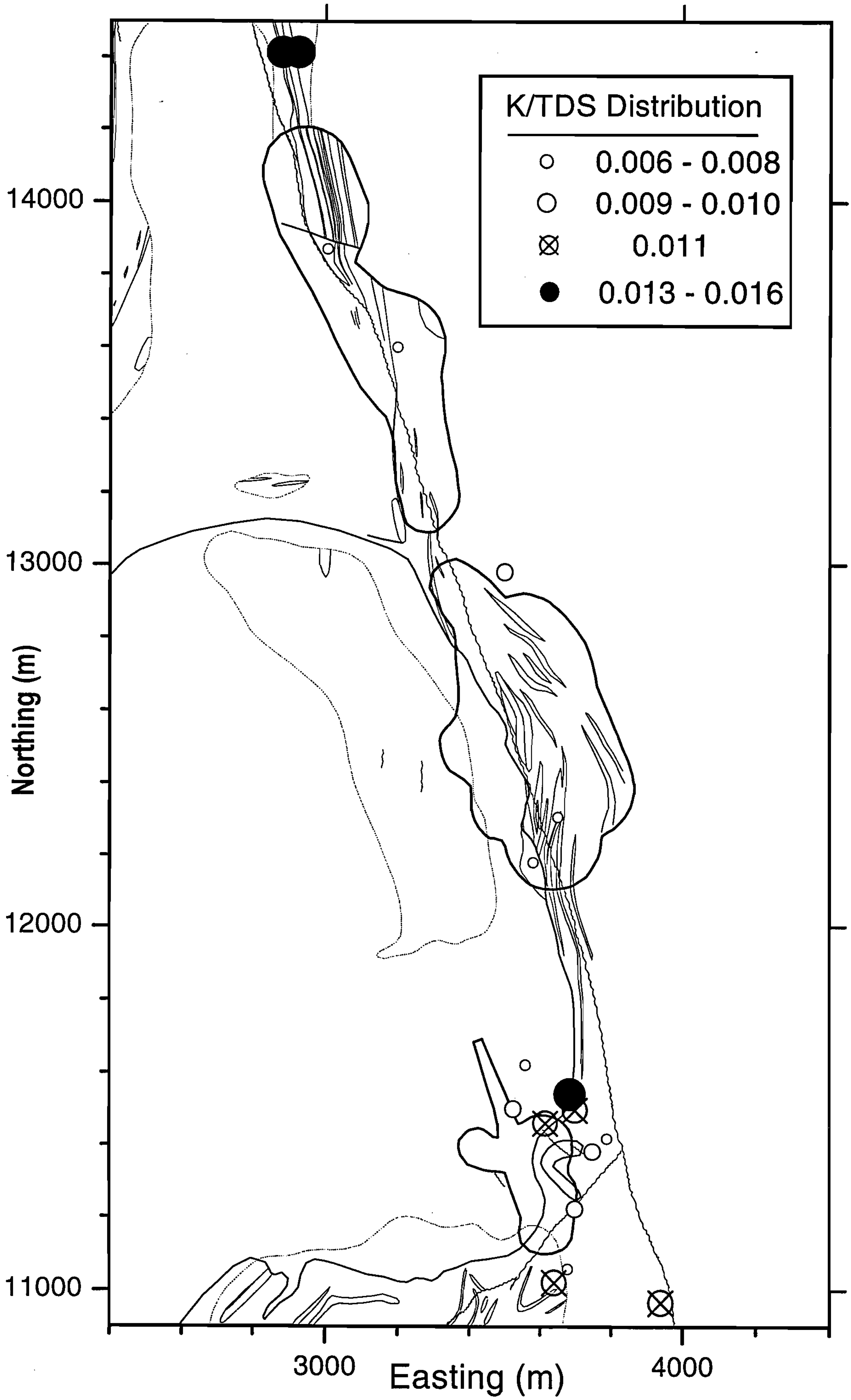

Figure A6.6: Granny Smith – Potassium/TDS Distribution

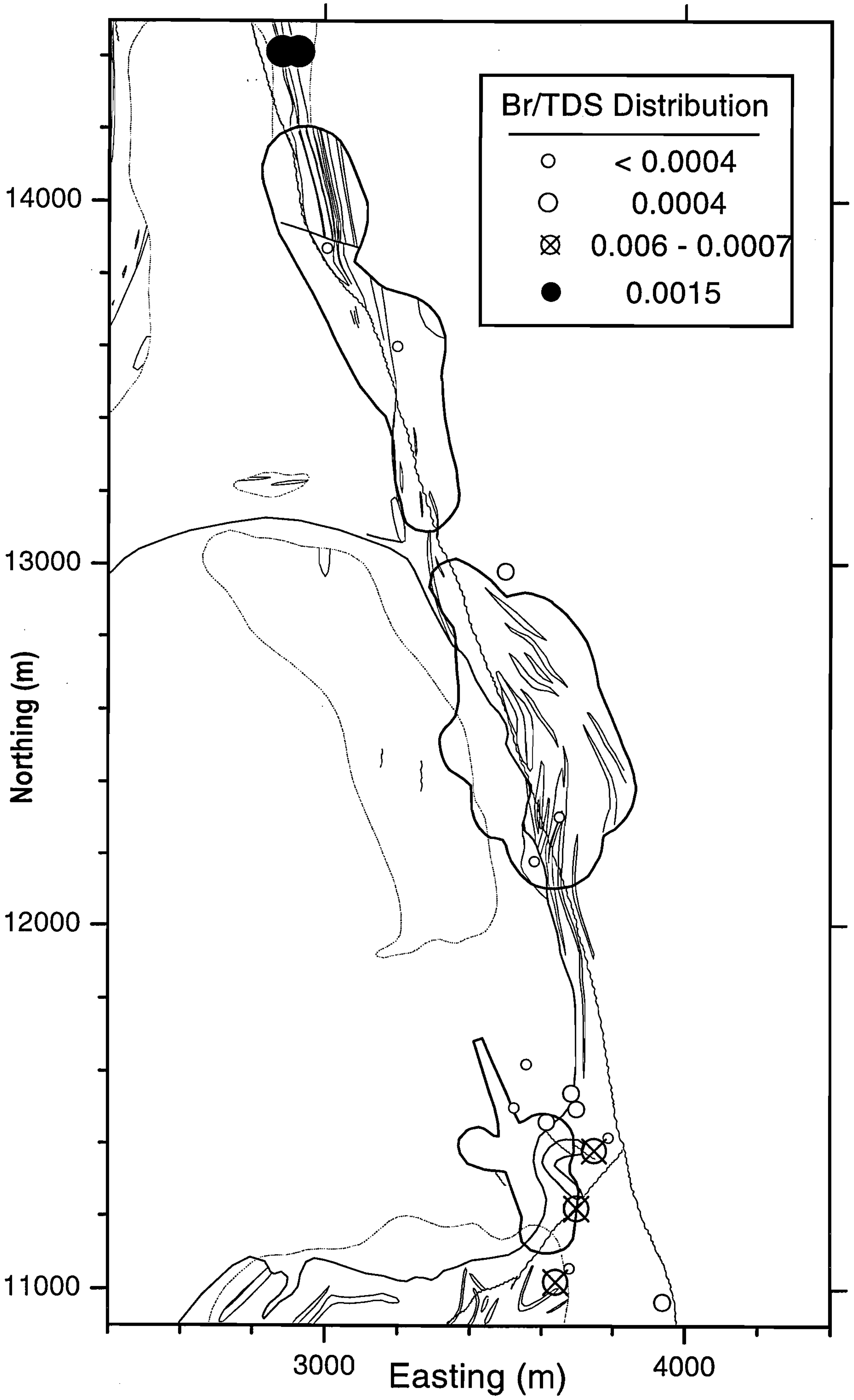

Figure A6.7: Granny Smith – Bromide/TDS Distribution

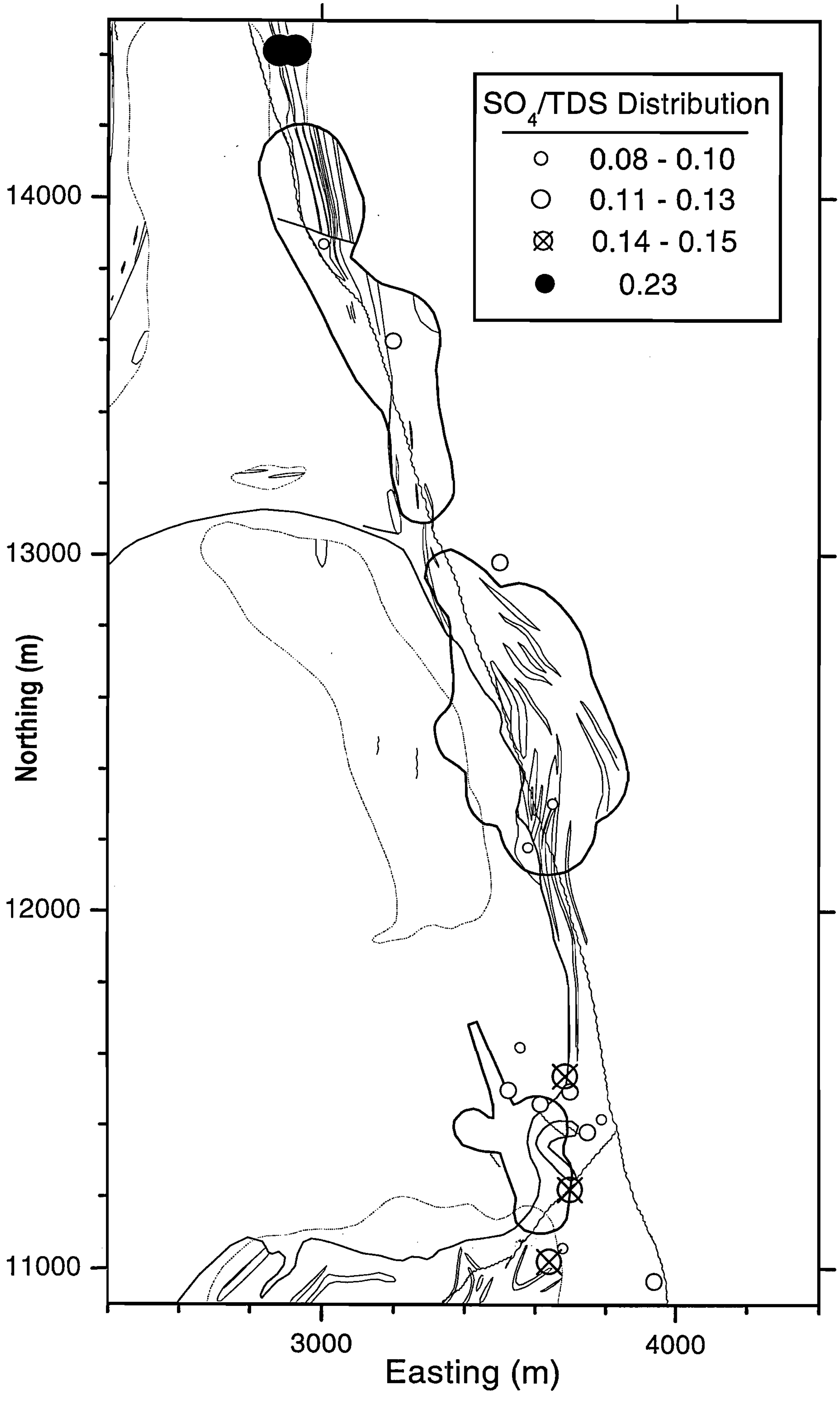

Figure A6.8: Granny Smith – Sulphate/TDS Distribution

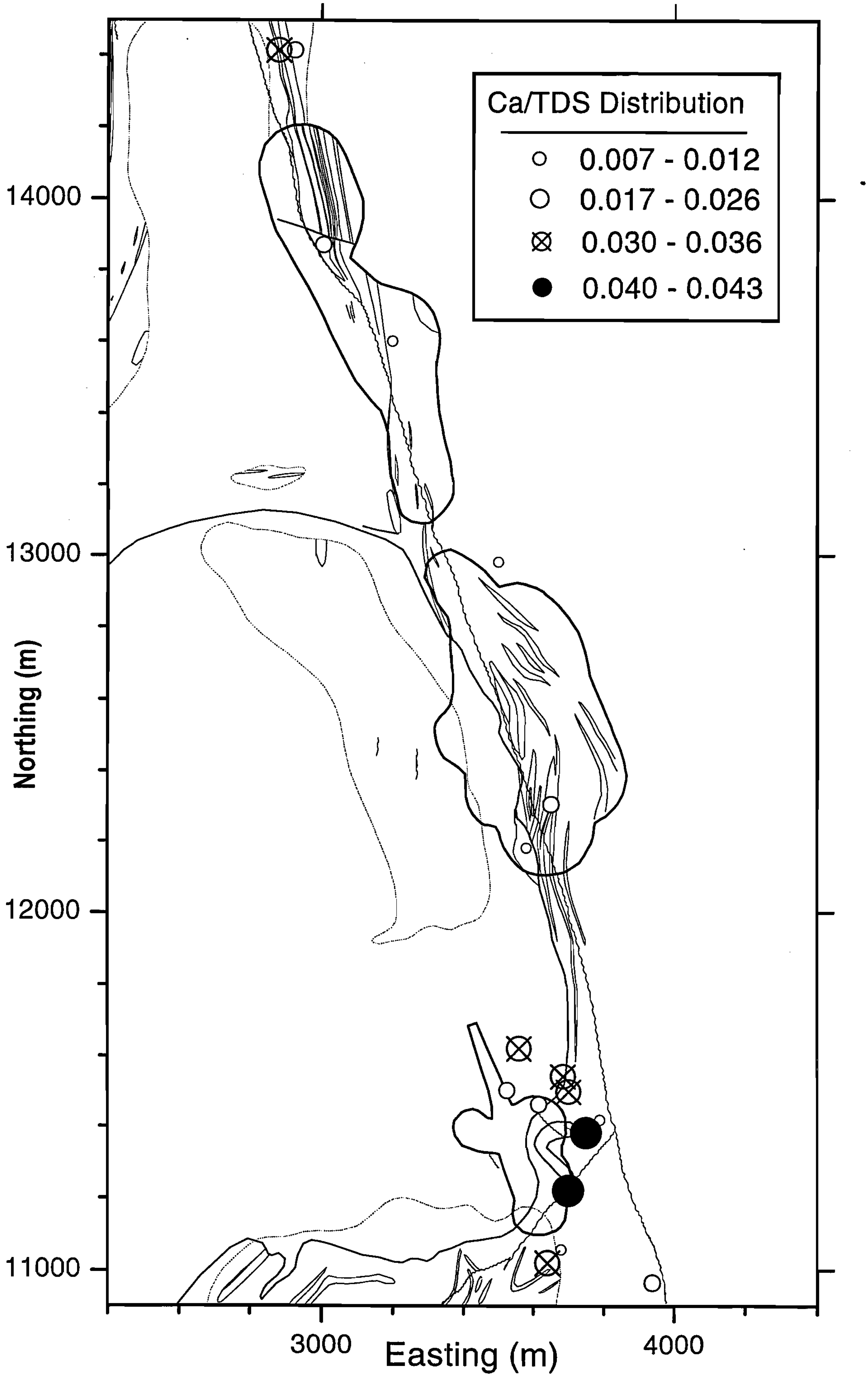

Figure A6.9: Granny Smith – Calcium Distribution

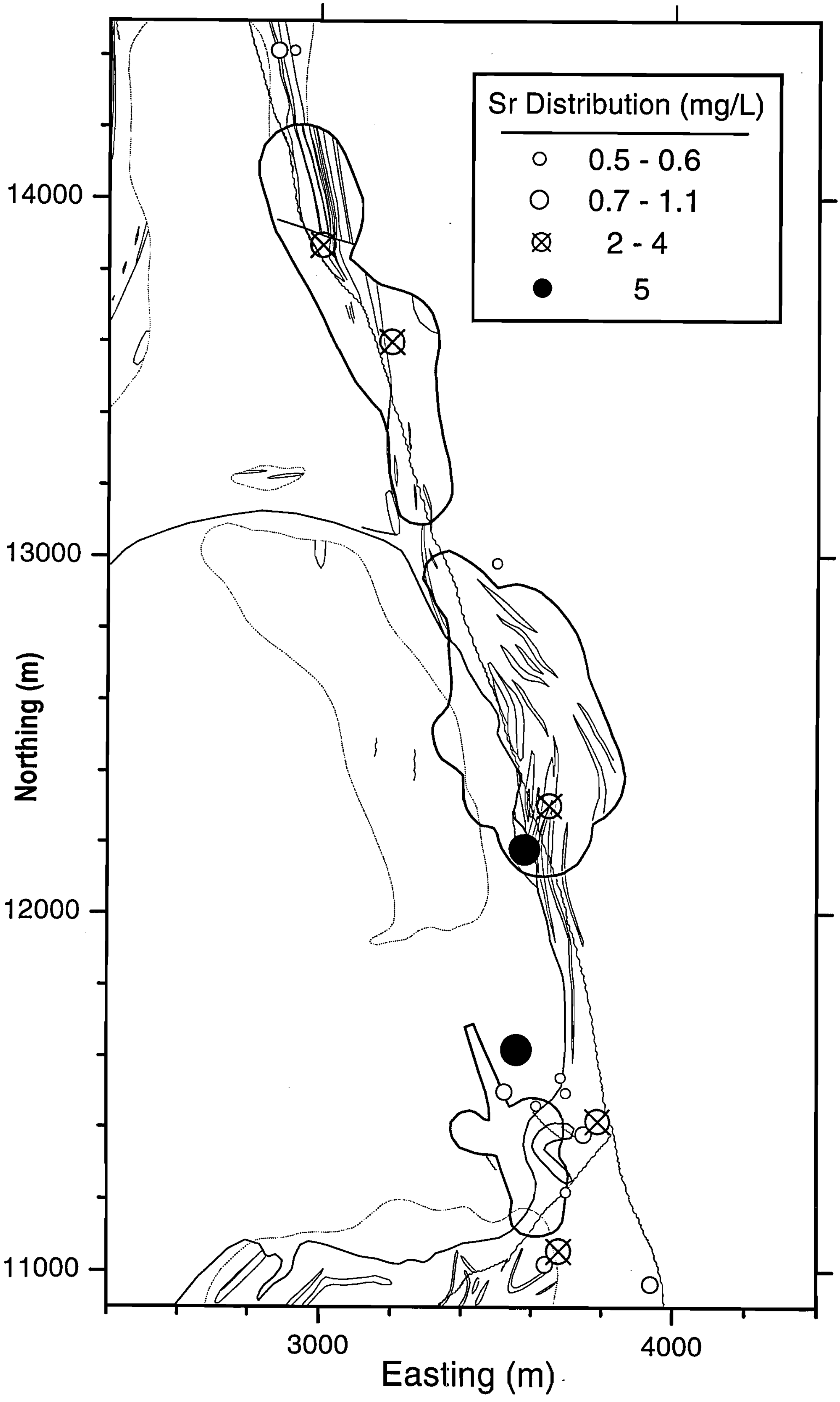

Figure A6.10: Granny Smith – Strontium Distribution

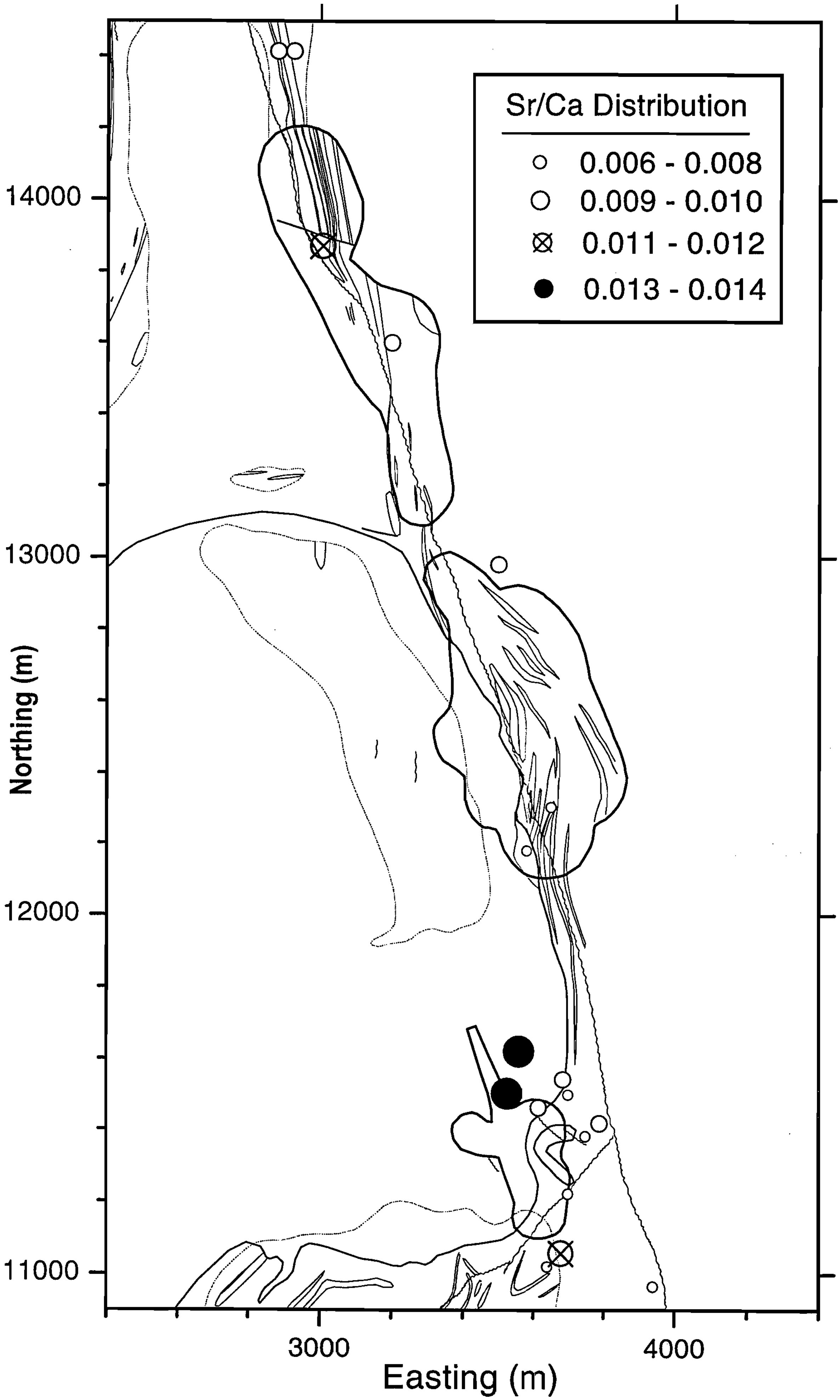

Figure A6.11: Granny Smith – Strontium/Calcium Distribution

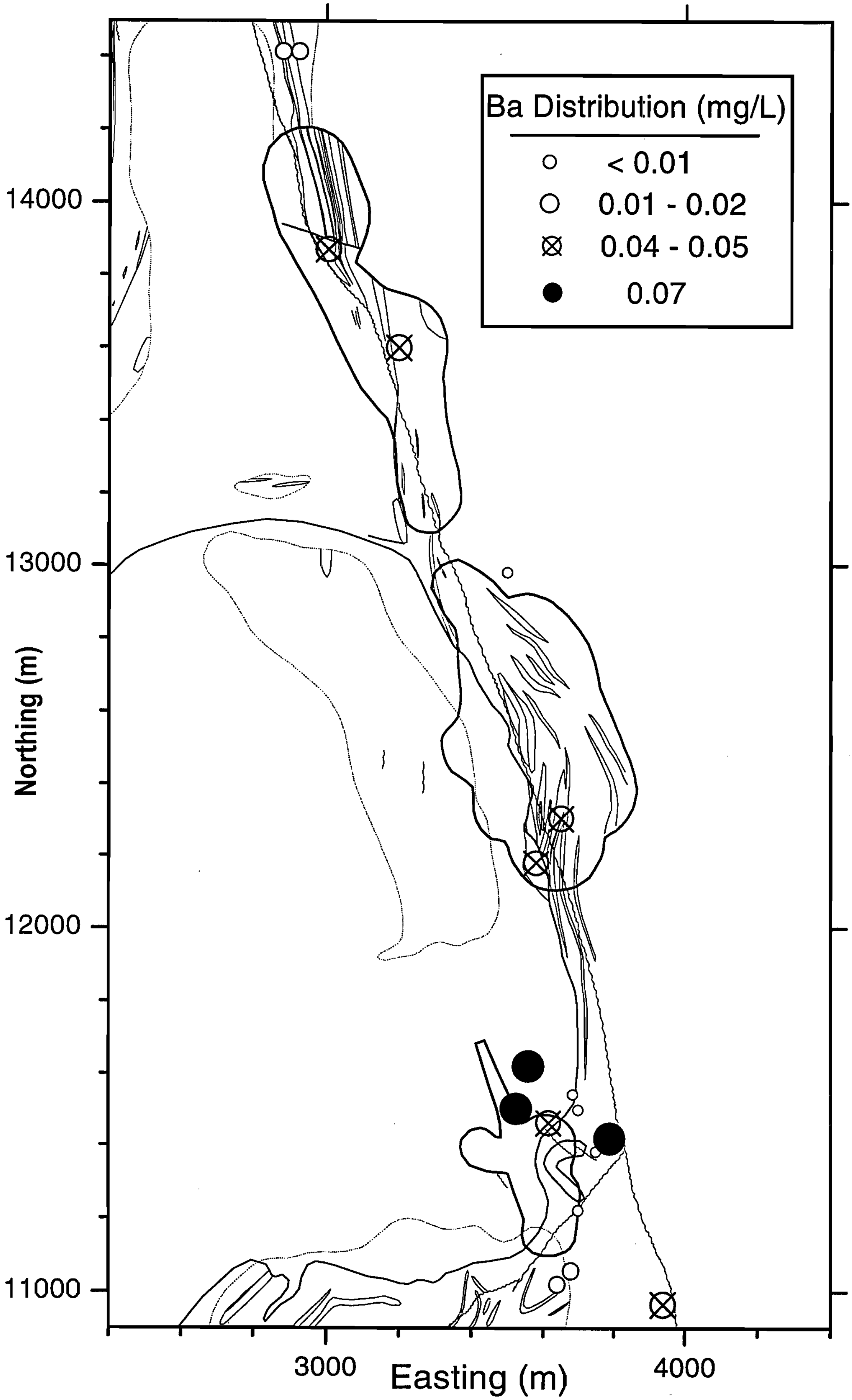

Figure A6.12: Granny Smith – Barium Distribution

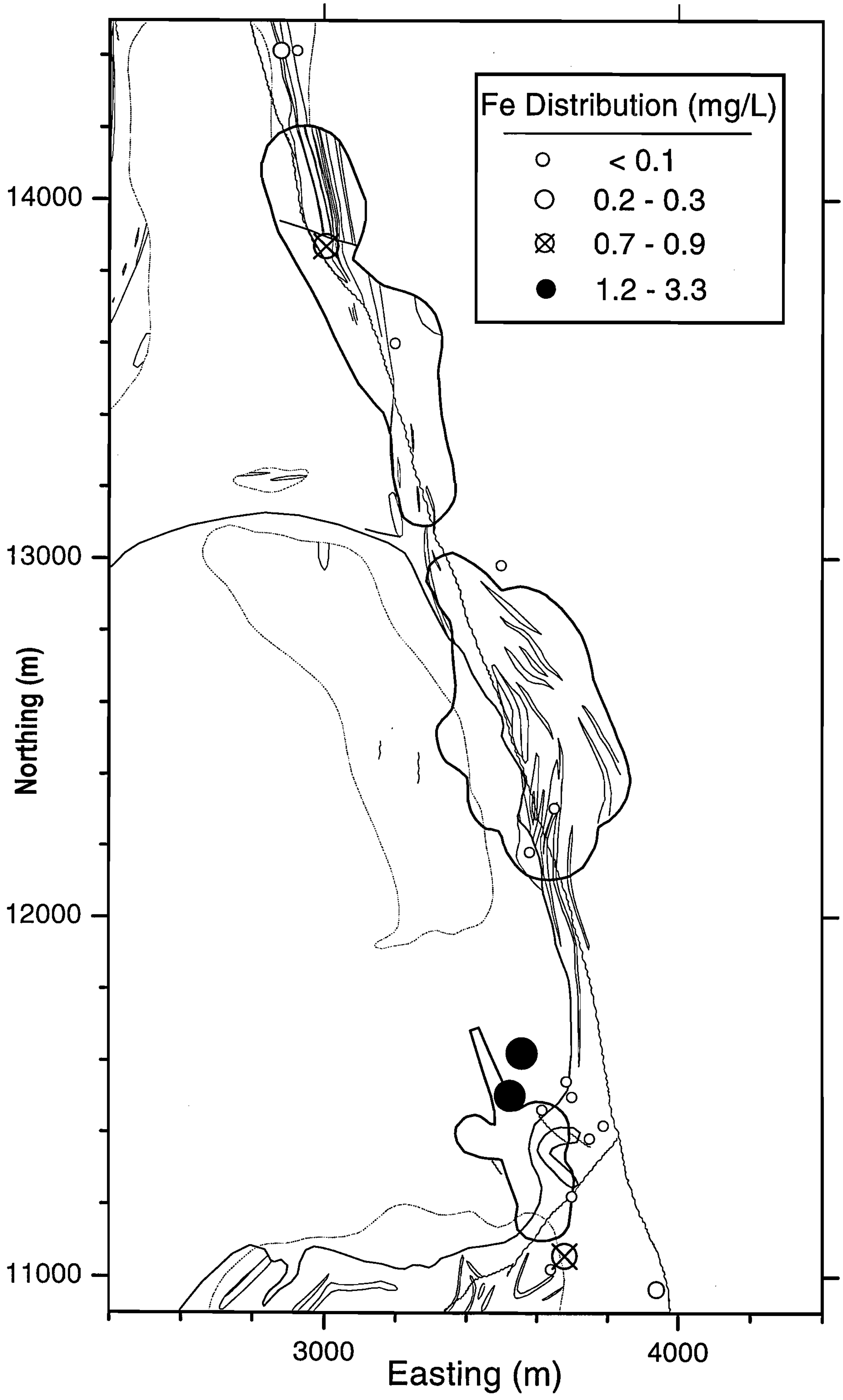

Figure A6.13: Granny Smith – Iron Distribution

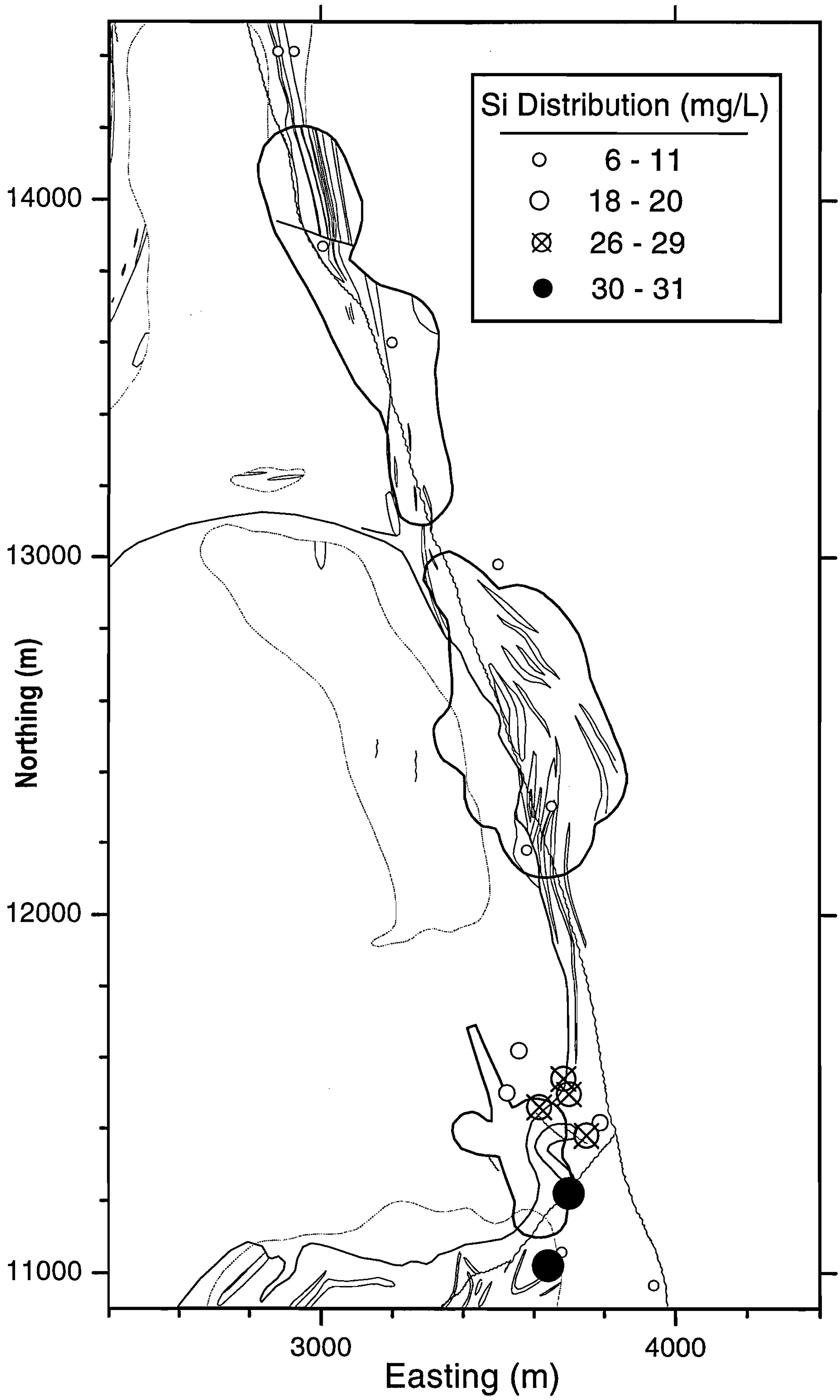

Figure A6.14: Granny Smith – Silicon Distribution

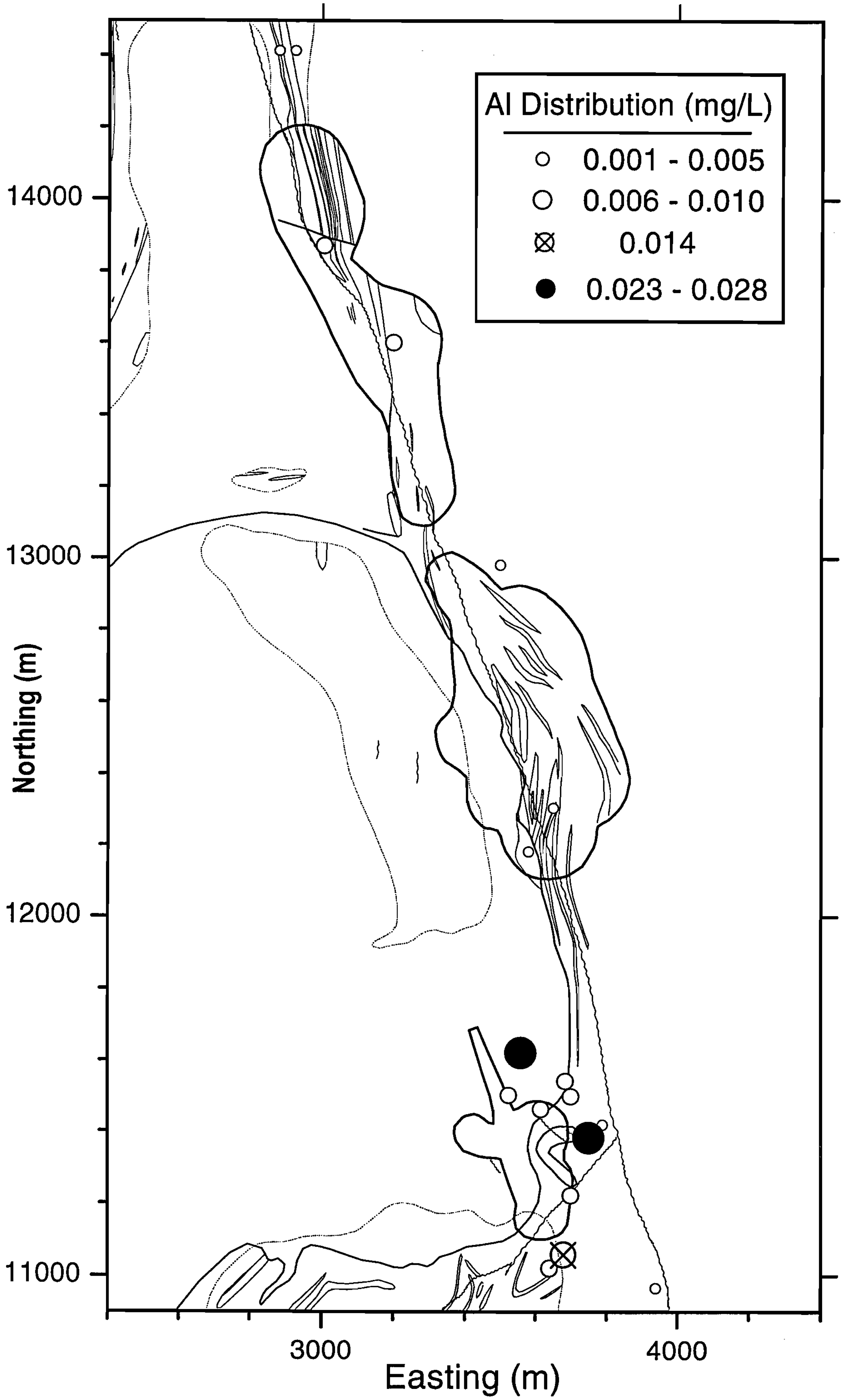

Figure A6.15: Granny Smith – Aluminium Distribution

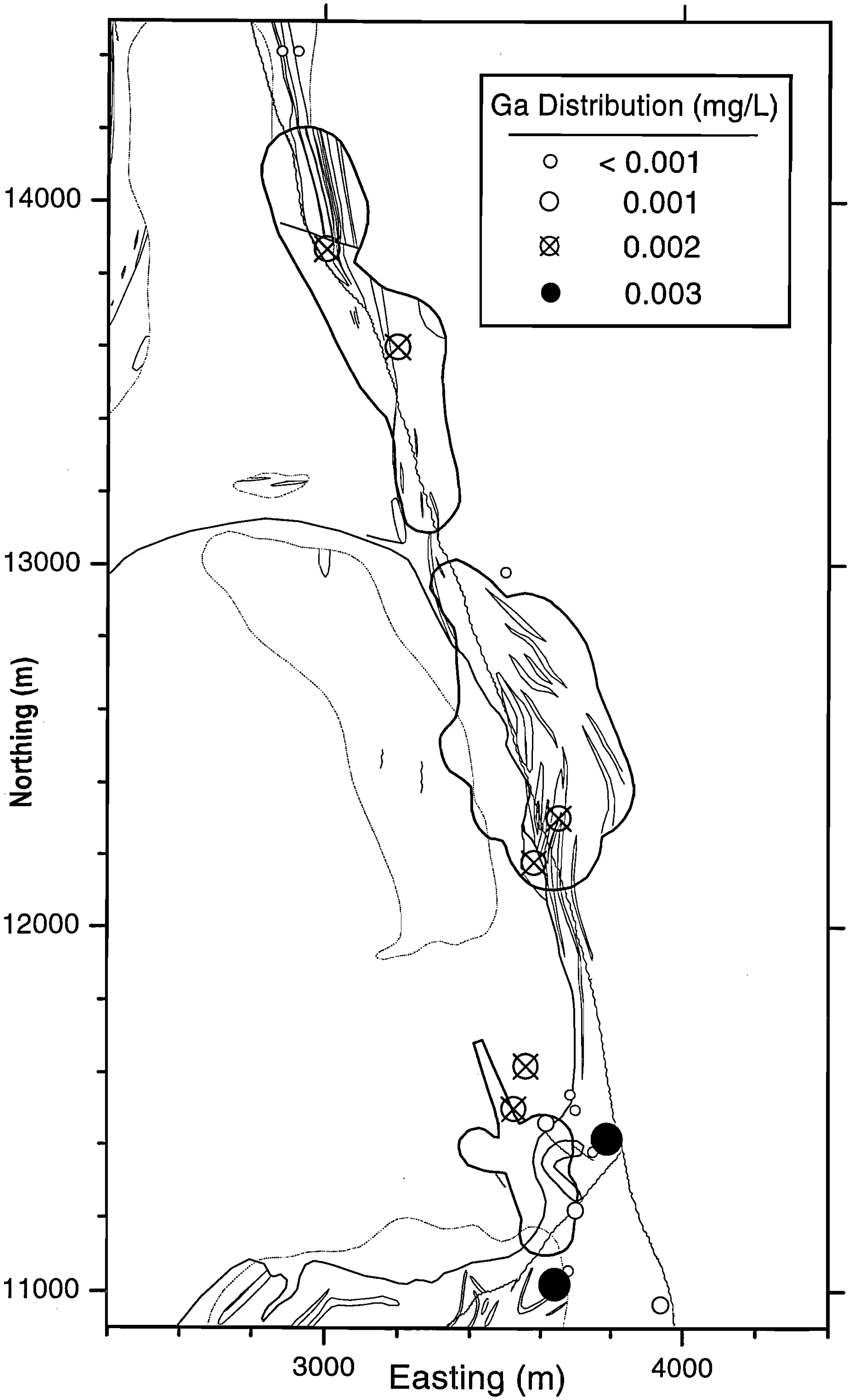

Figure A6.16: Granny Smith – Gallium Distribution

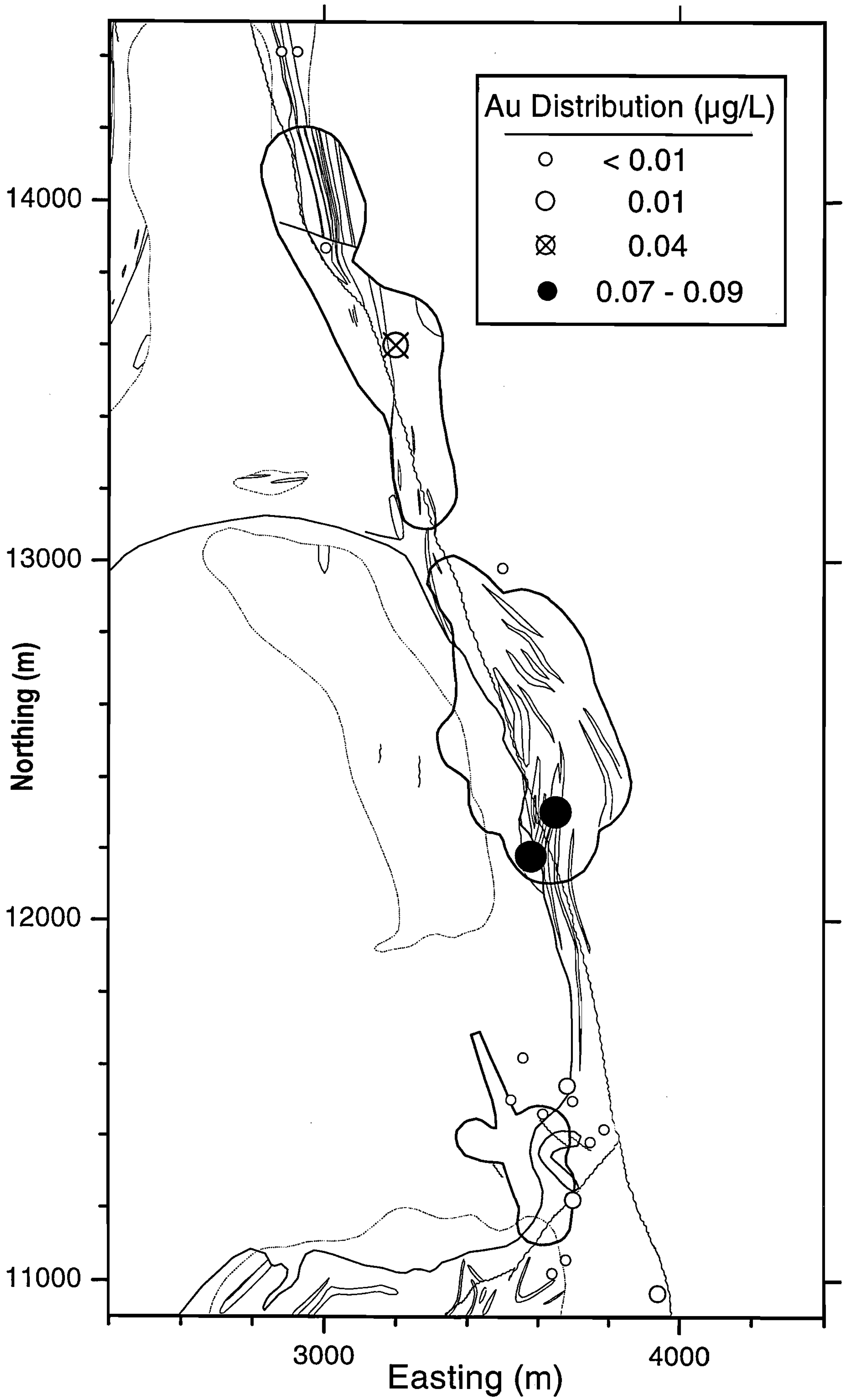

Figure A6.17: Granny Smith – Gold Distribution

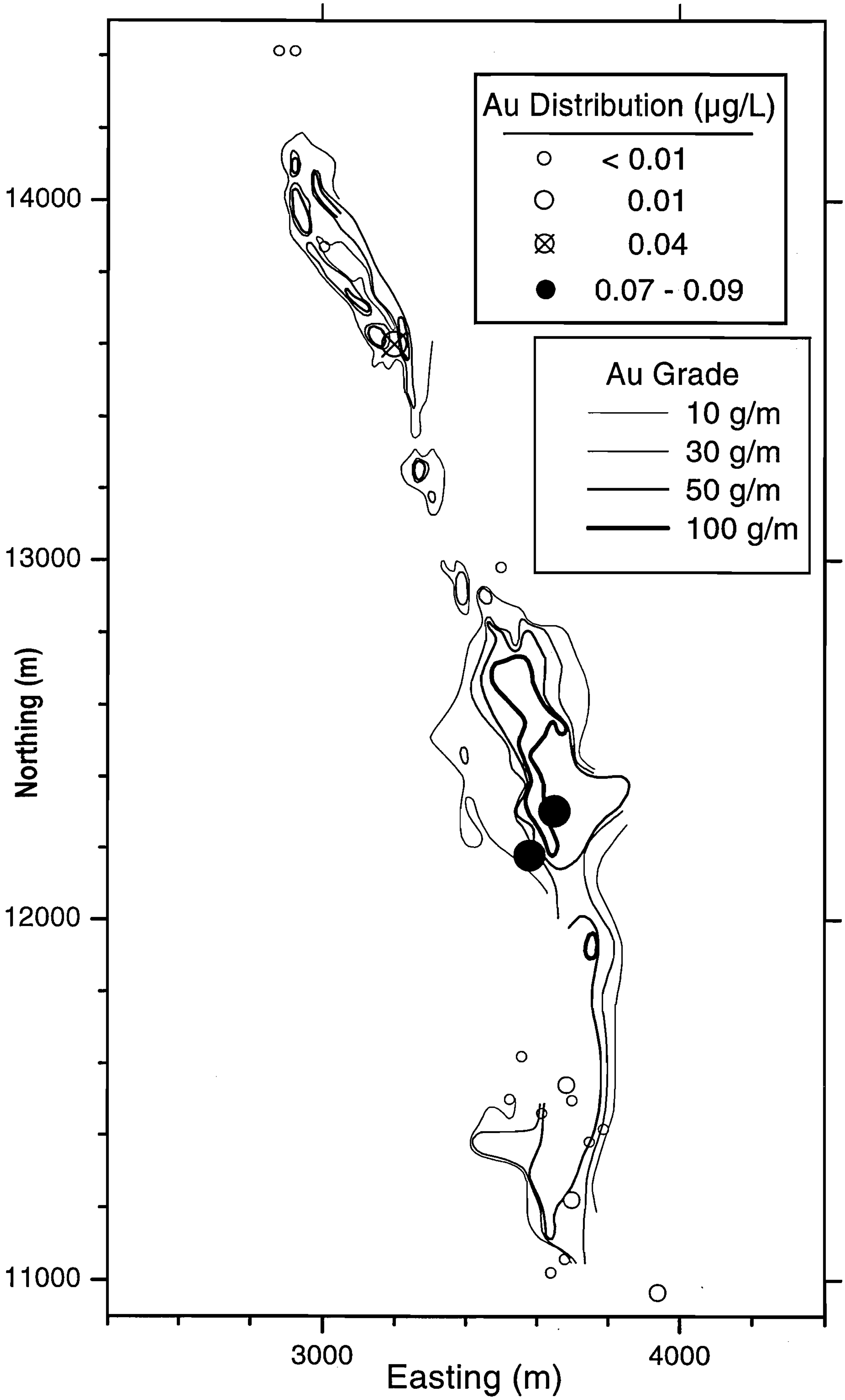

Figure A6.18: Granny Smith – Dissolved Gold Distribution, with superimposed Gold Grade.

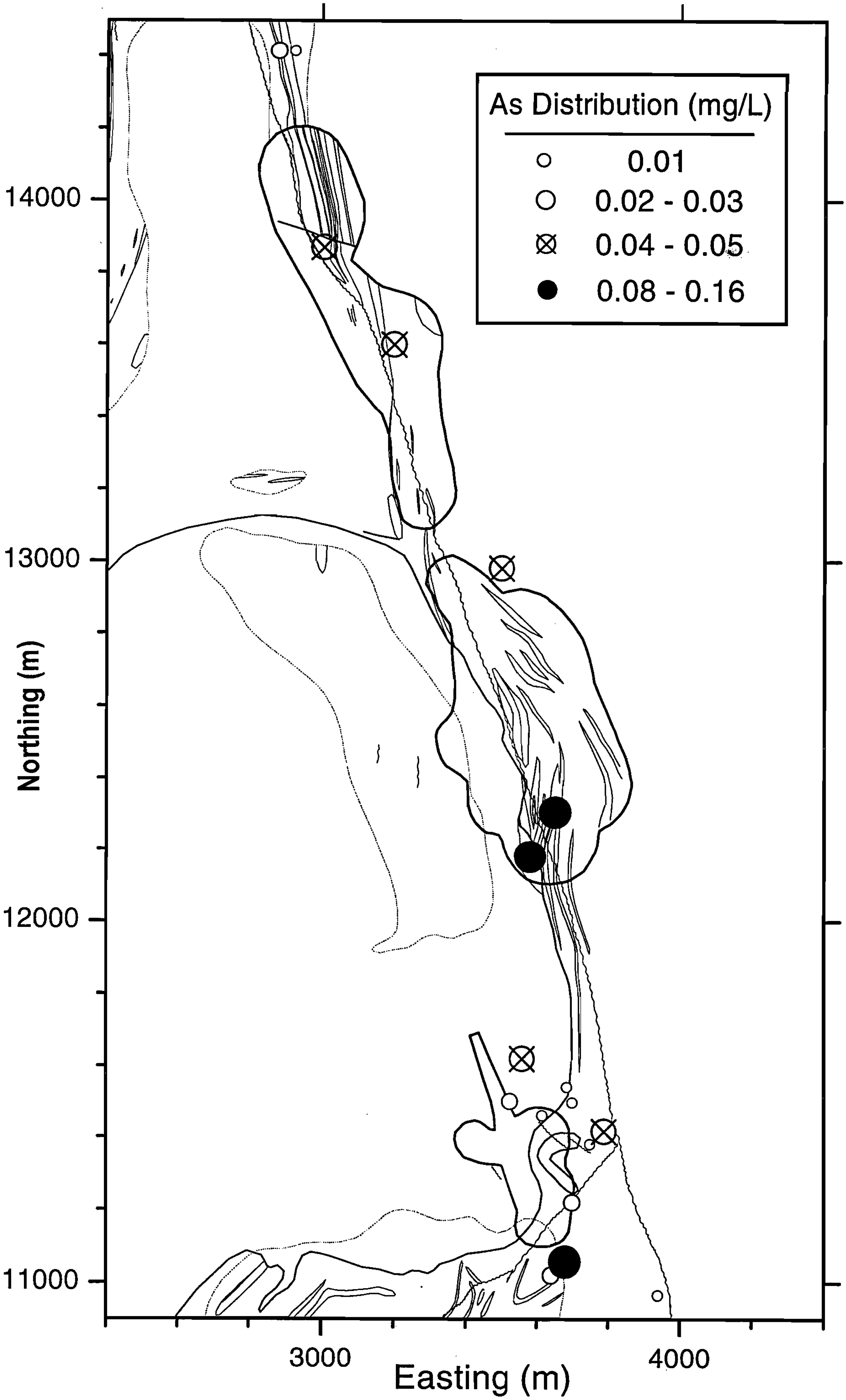

Figure A6.19: Granny Smith – Arsenic Distribution

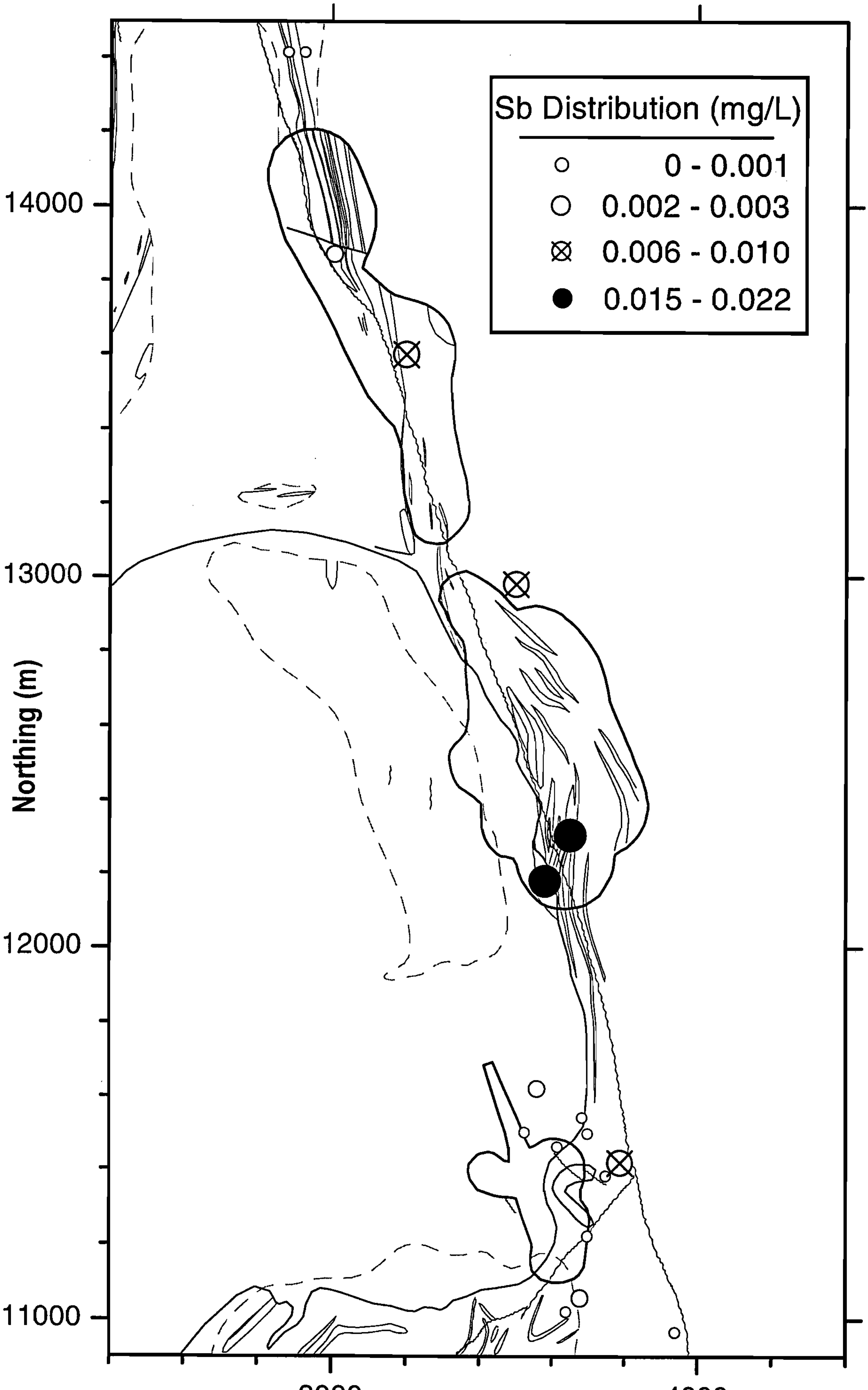

Figure A6.20: Granny Smith – Antimony Distribution

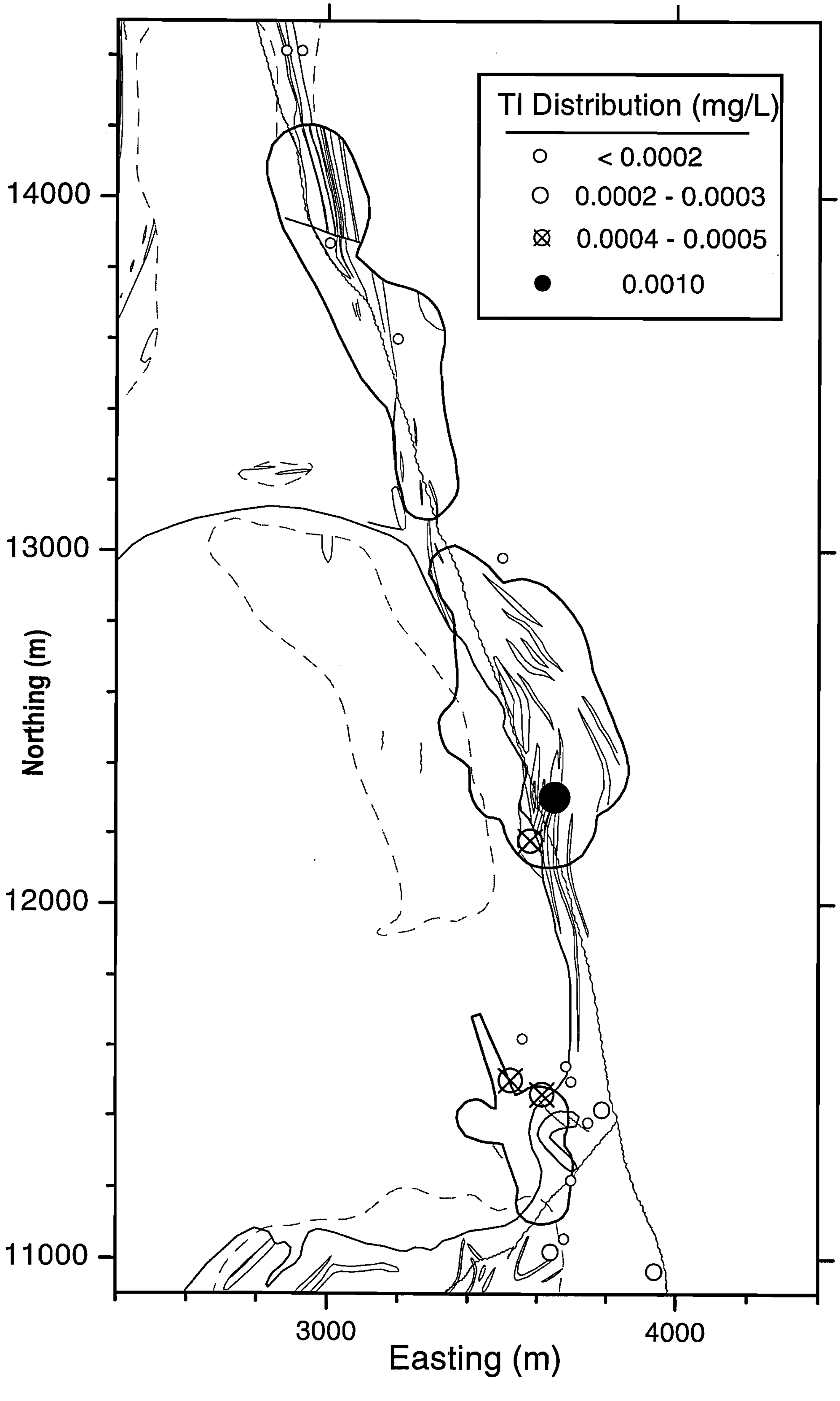

Figure A6.21: Granny Smith – Thallium Distribution

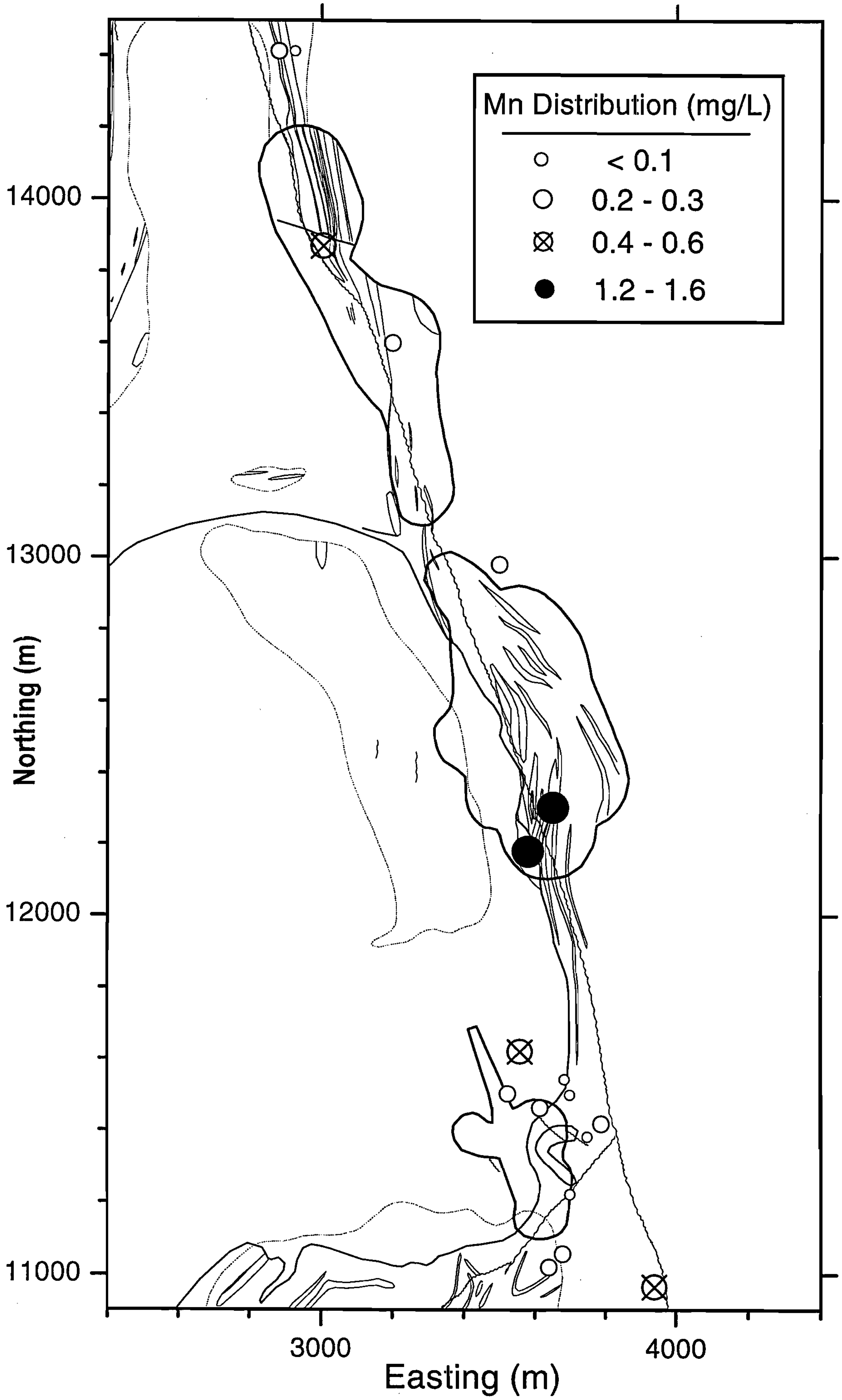

Figure A6.22: Granny Smith – Manganese Distribution

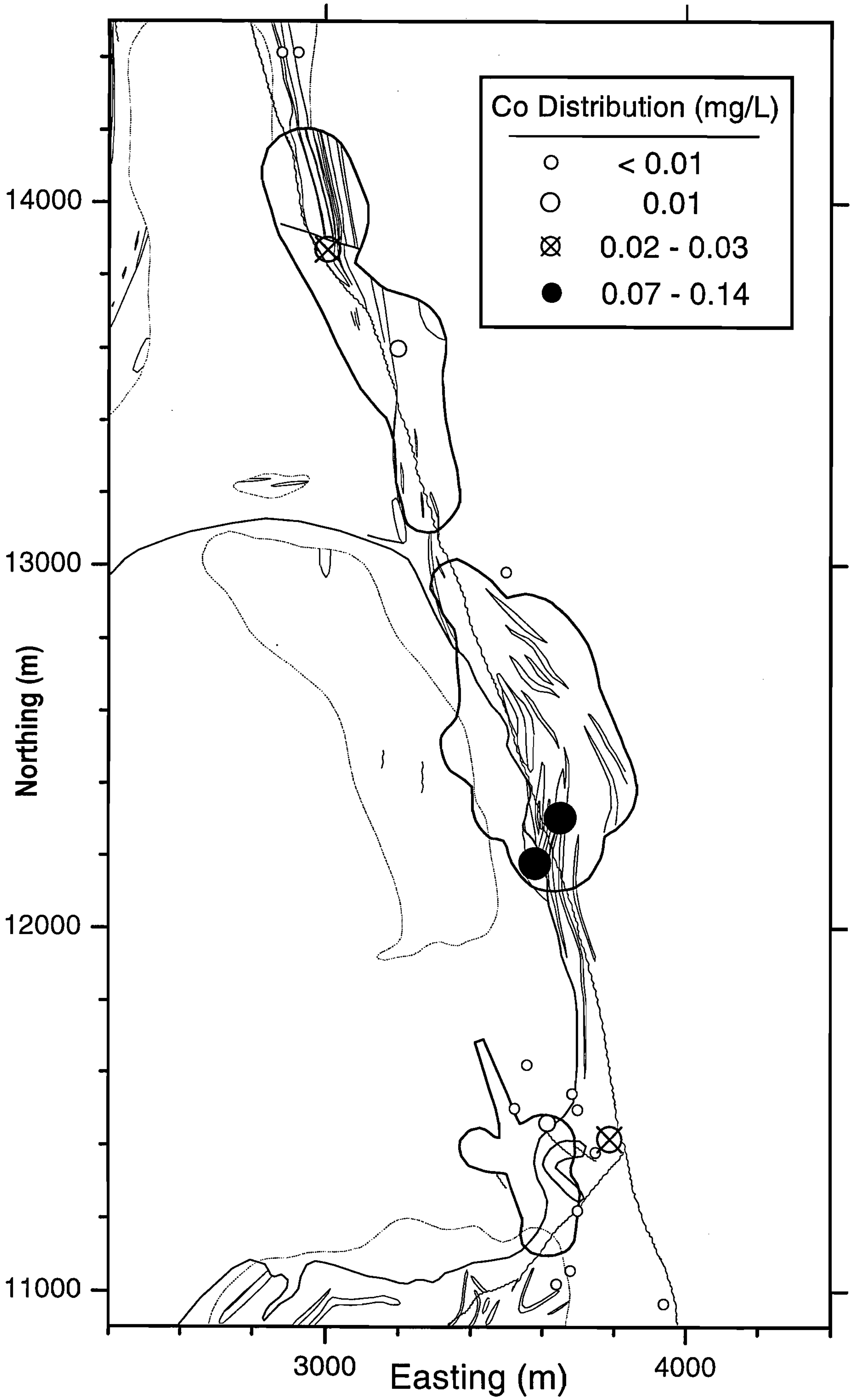

Figure A6.23: Granny Smith – Cobalt Distribution

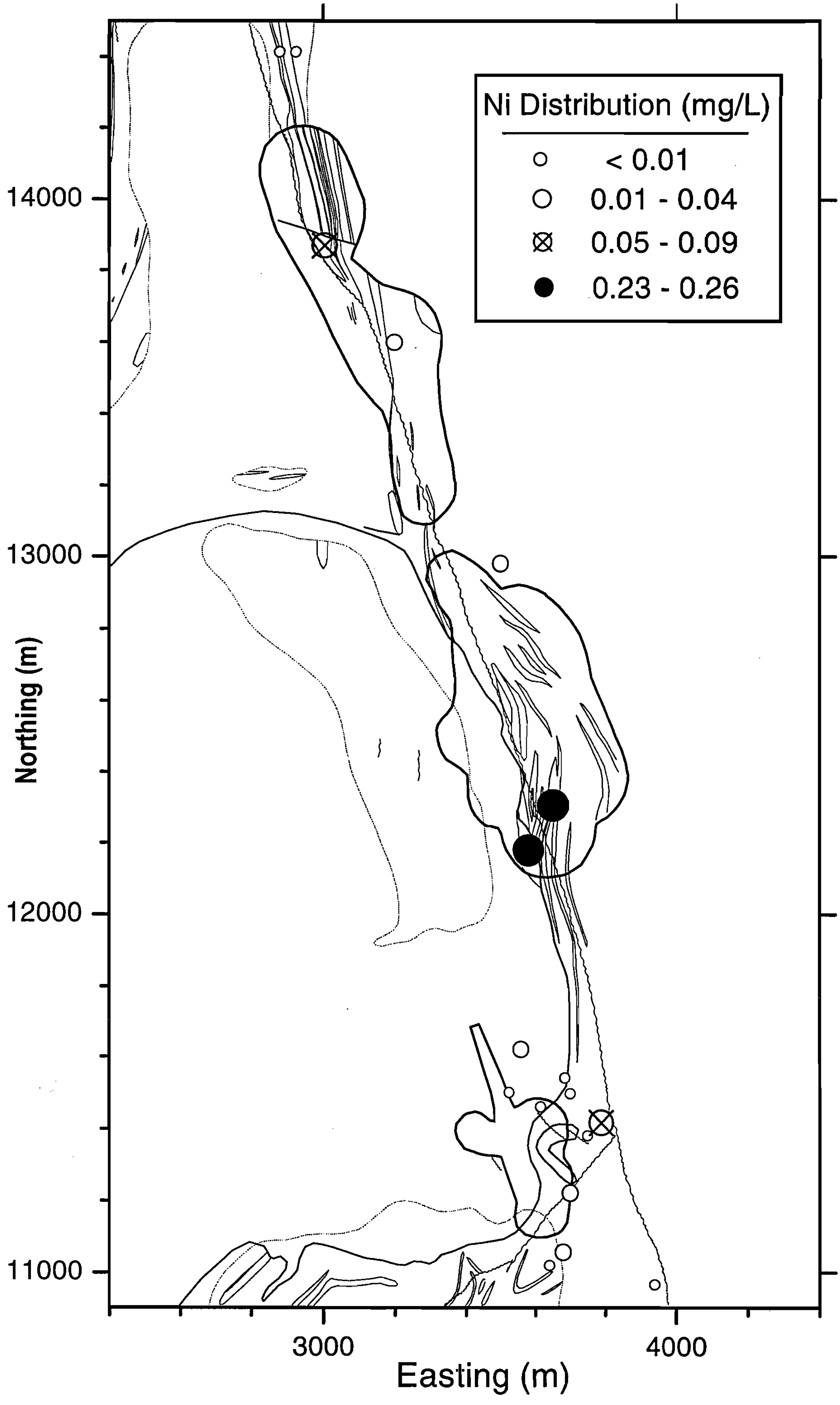

Figure A6.24: Granny Smith – Nickel Distribution

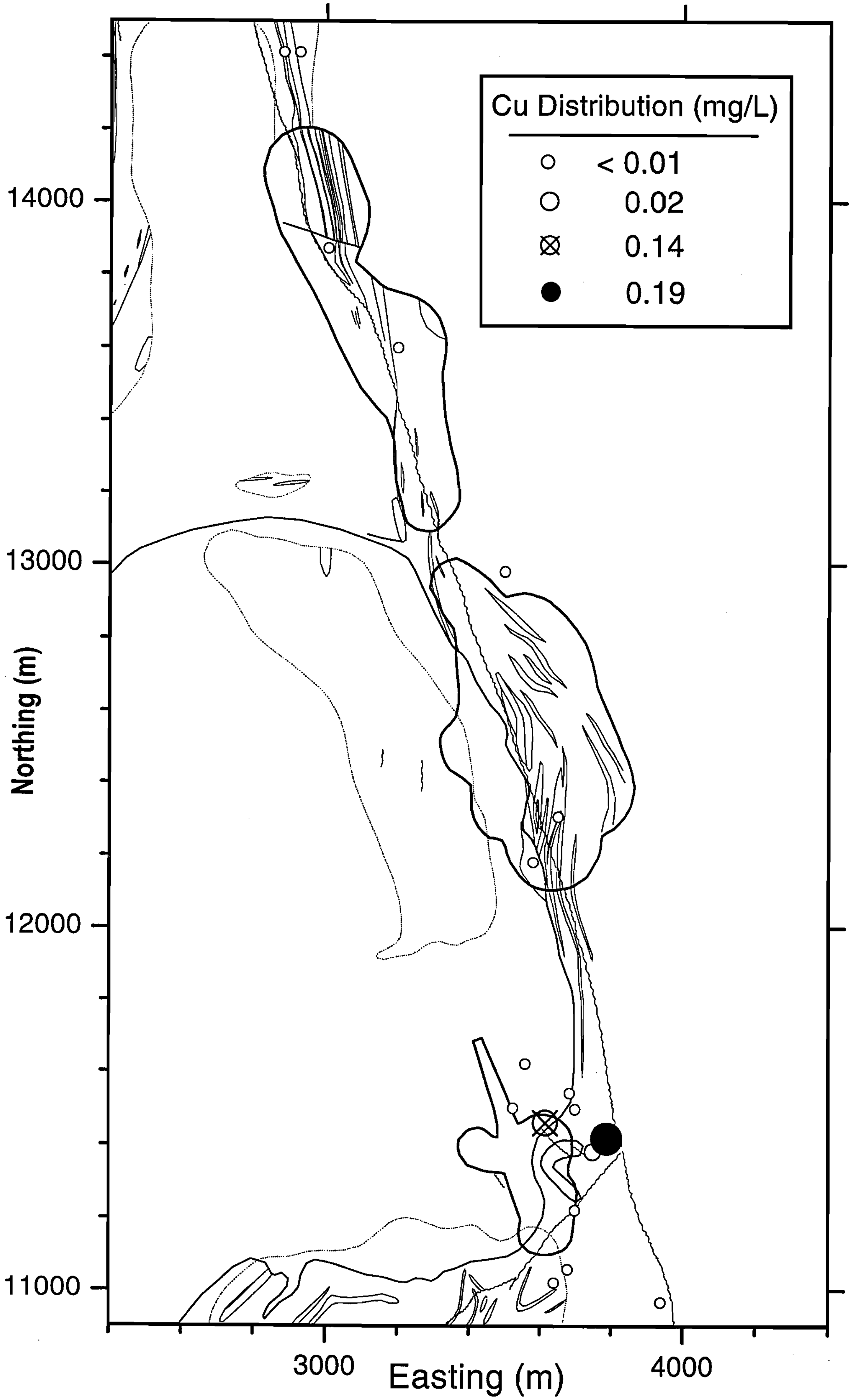

Figure A6.25: Granny Smith – Copper Distribution

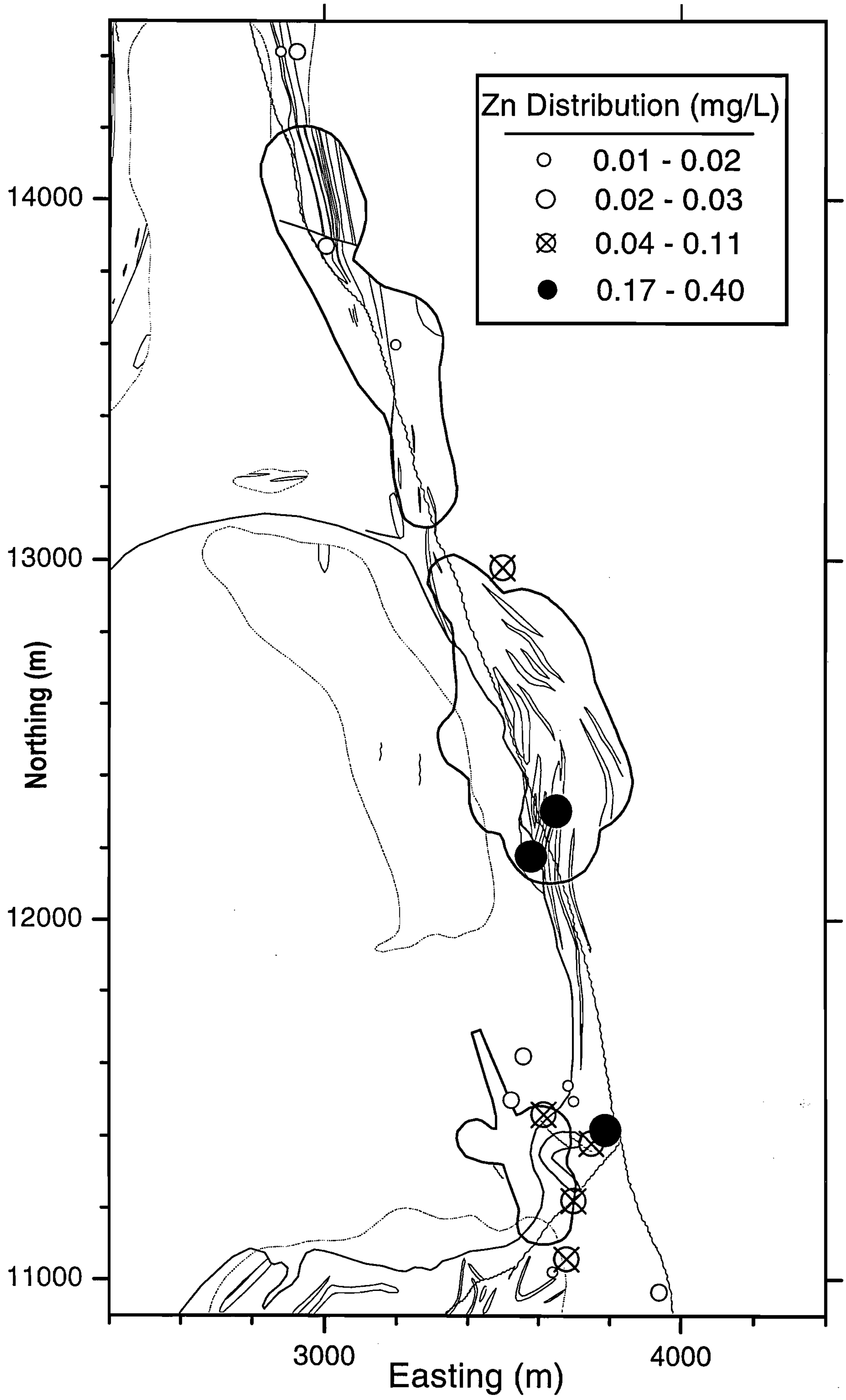

Figure A6.26: Granny Smith – Zinc Distribution

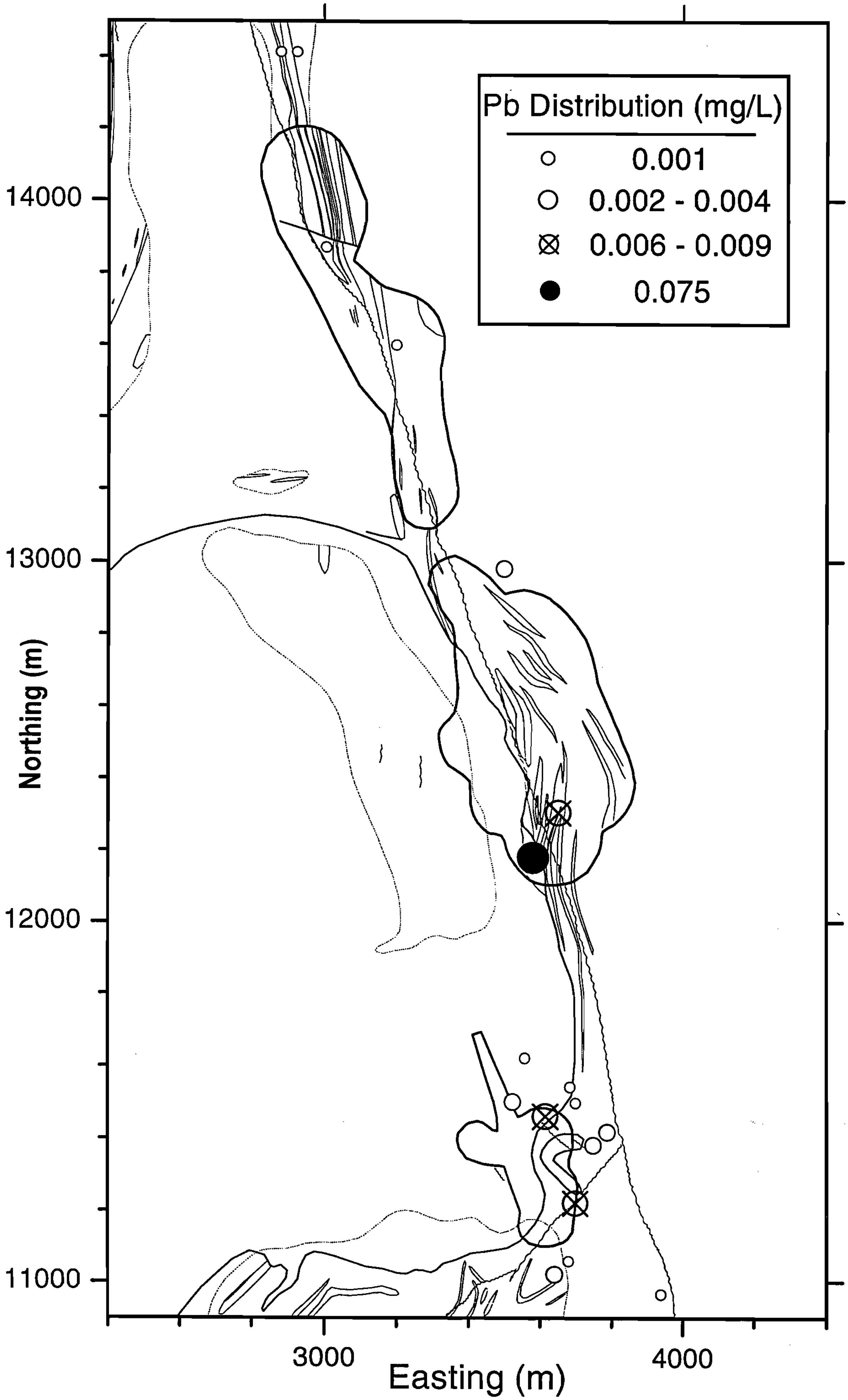

Figure A6.27: Granny Smith – Lead Distribution

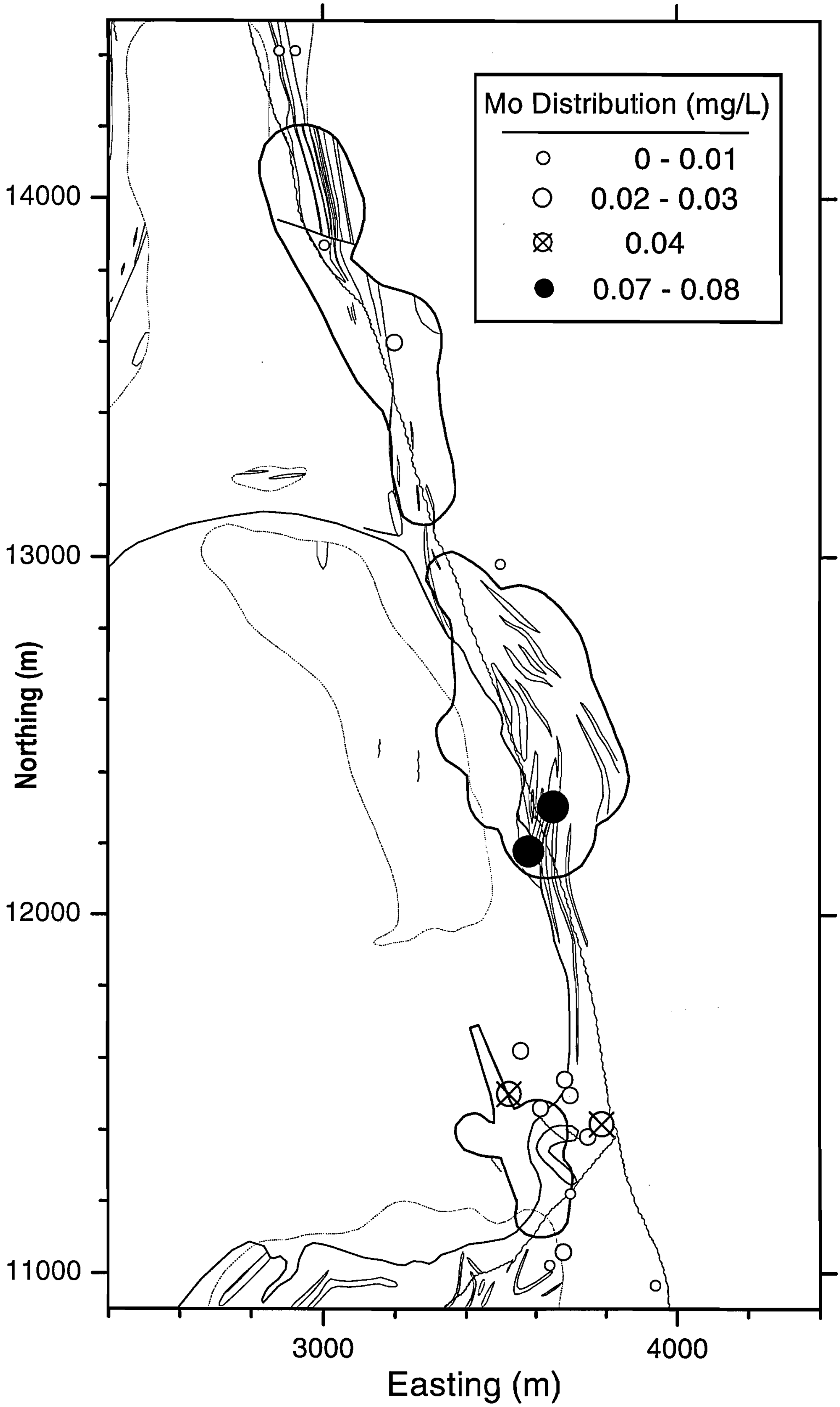

Figure A6.28: Granny Smith – Molybdenum Distribution

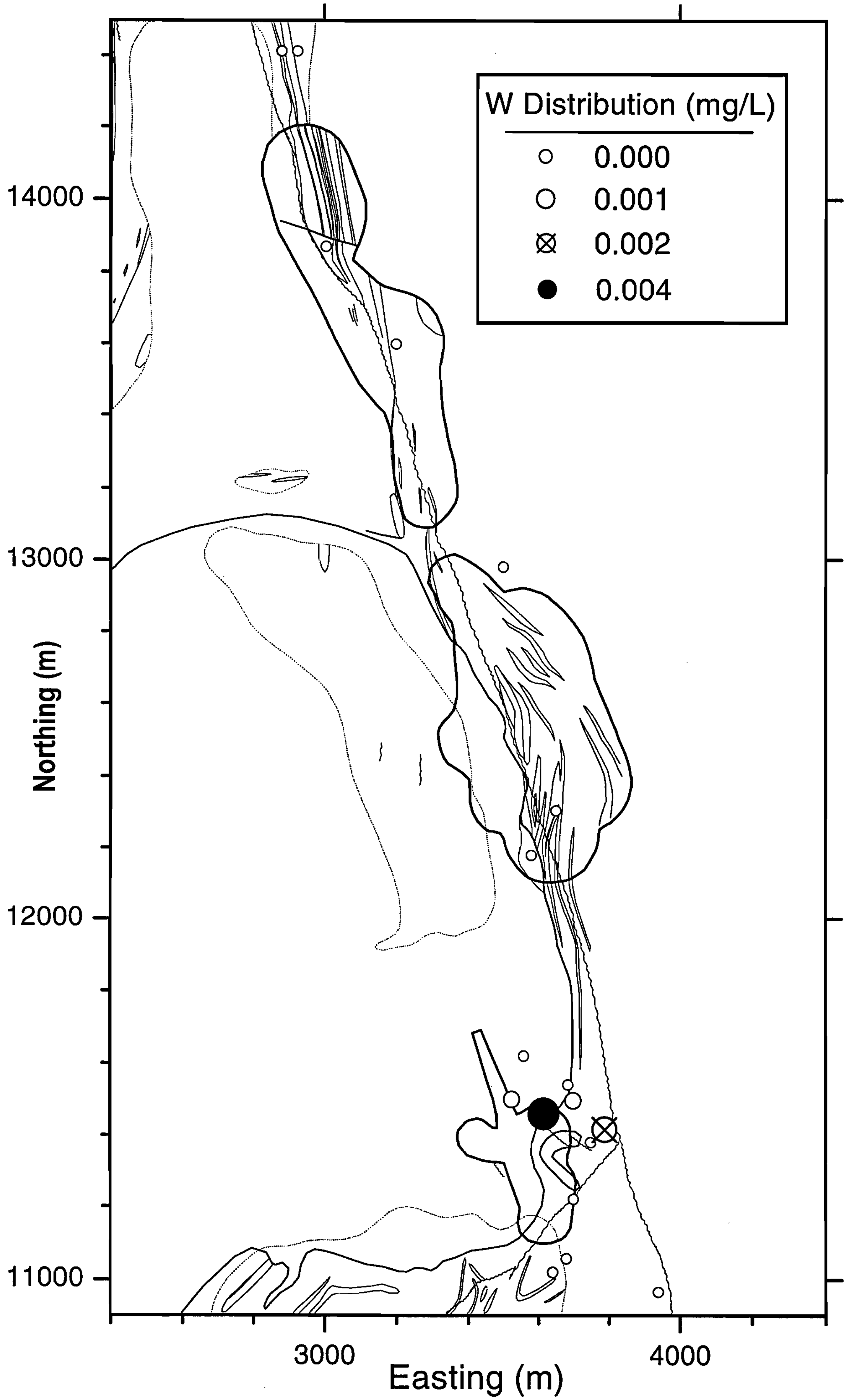

Figure A6.29: Granny Smith – Tungsten Distribution

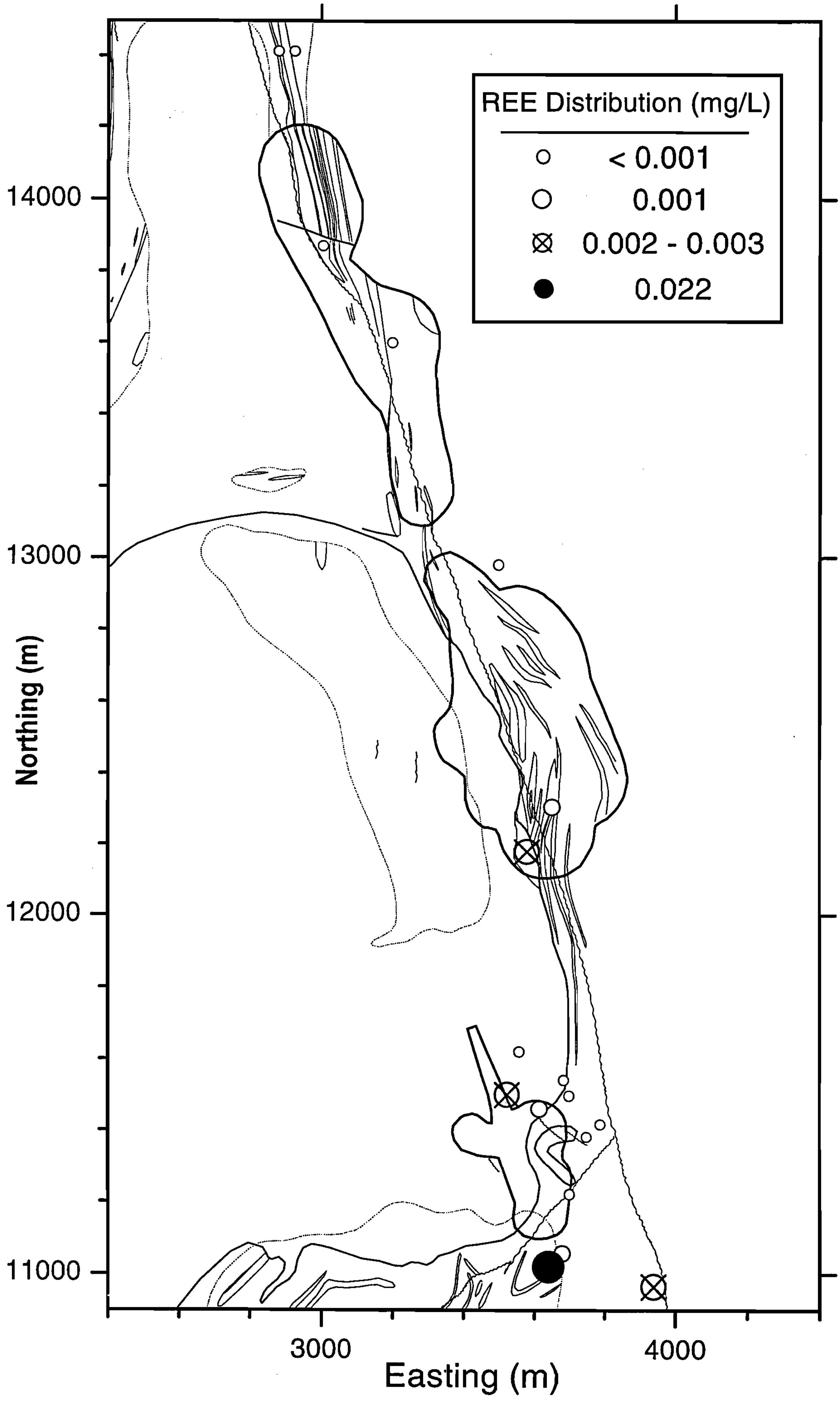

Figure A6.30: Granny Smith – REE Distribution

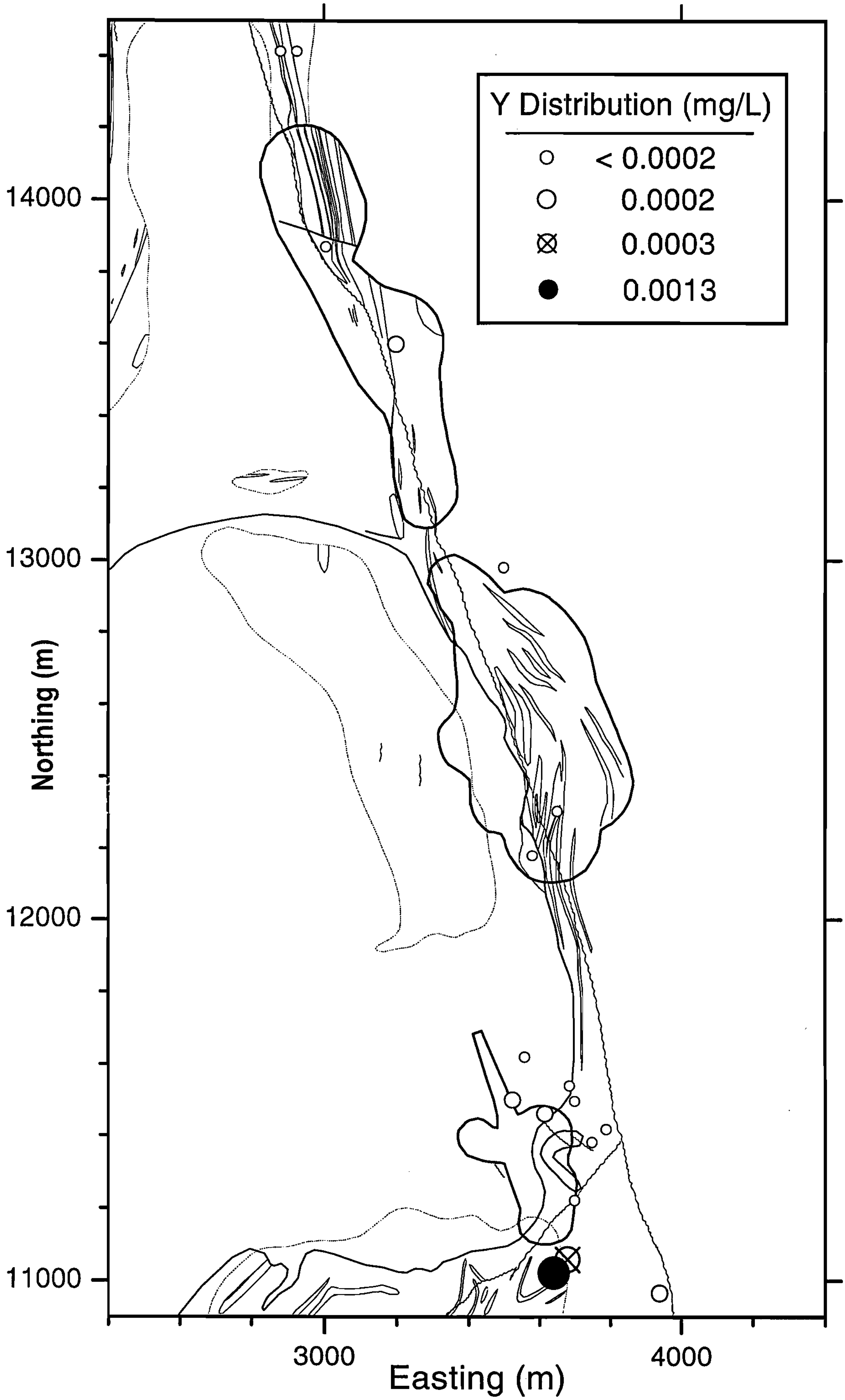

Figure A6.31: Granny Smith – Yttrium Distribution

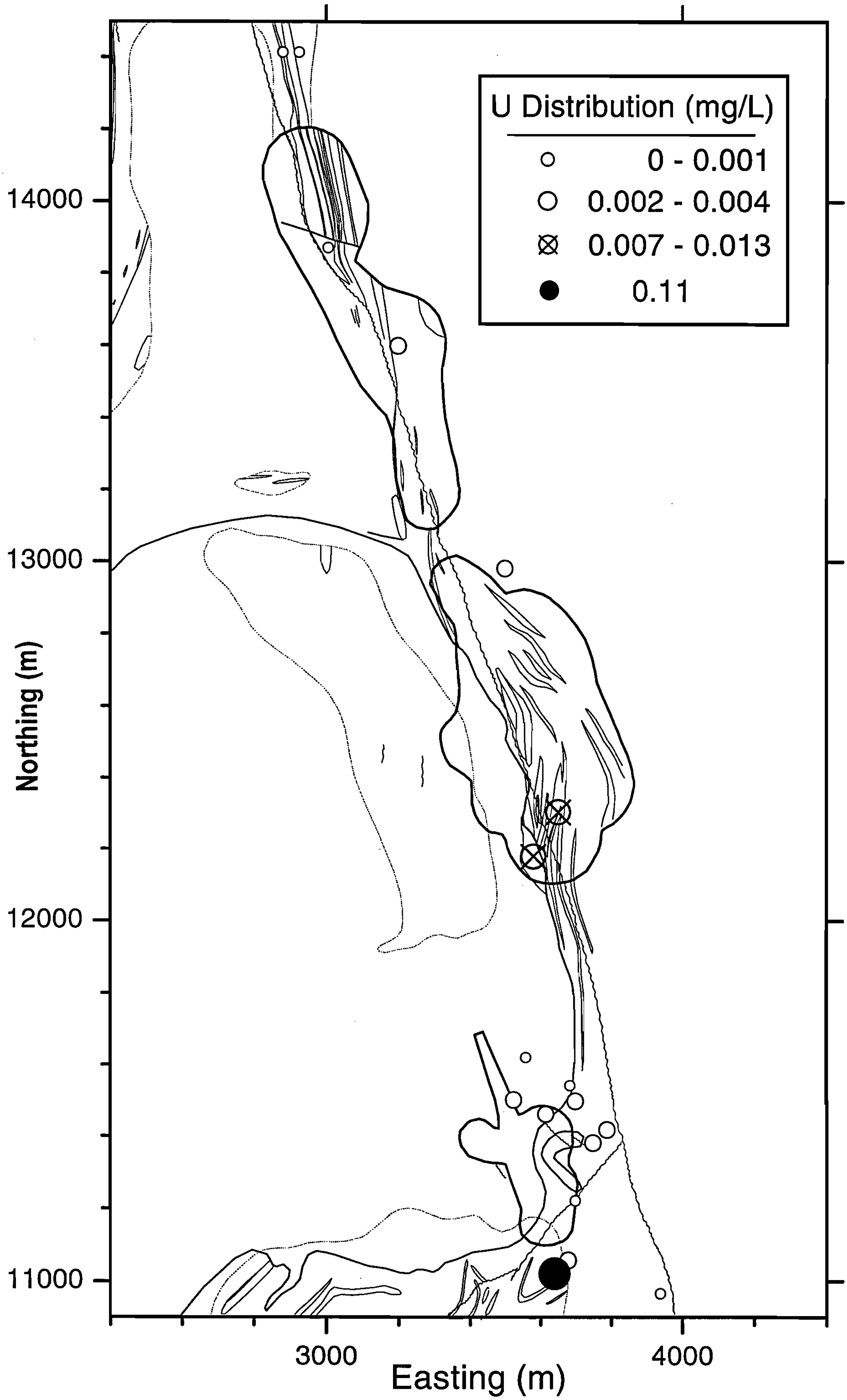

Figure A6.32: Granny Smith – Uranium Distribution

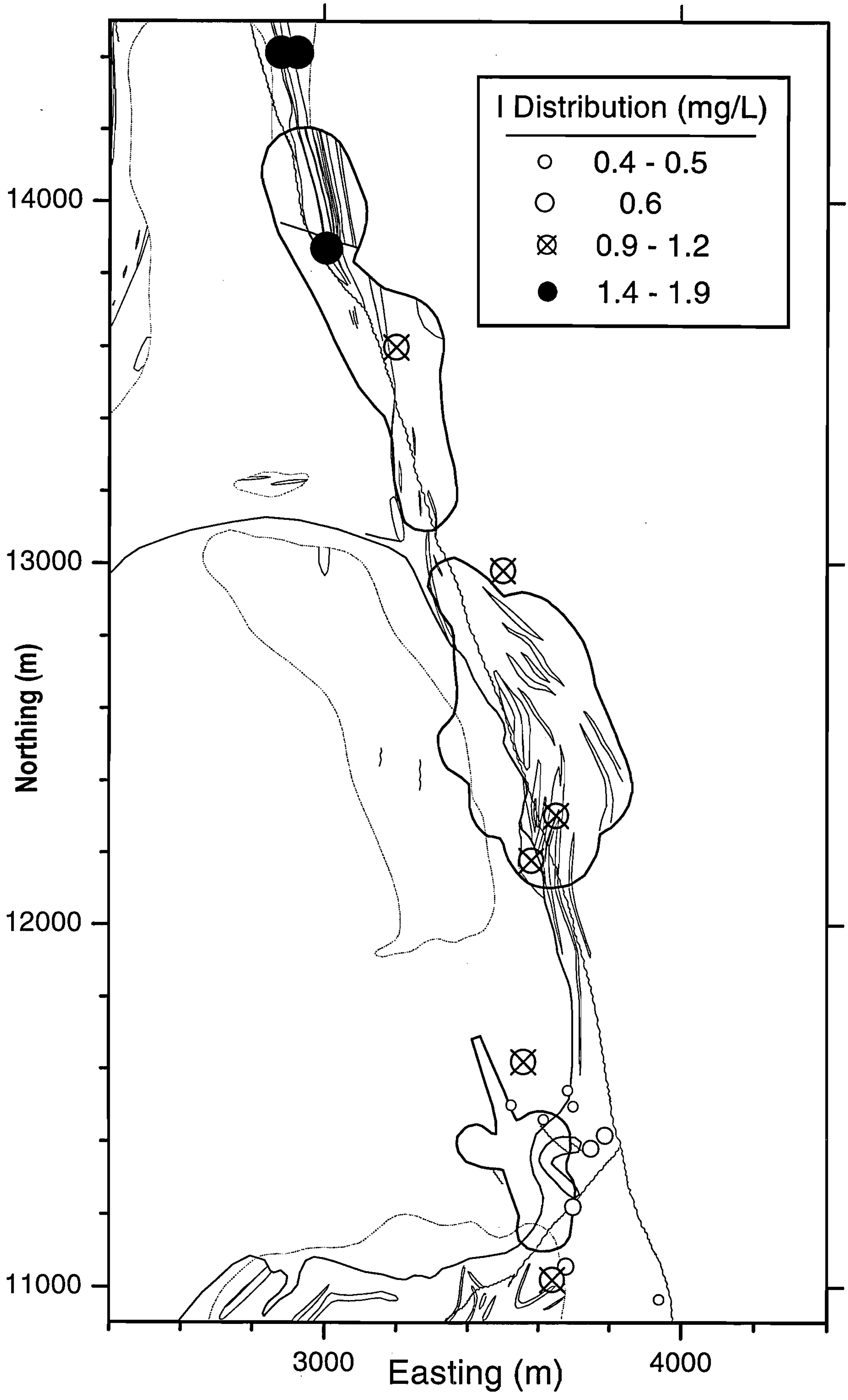

Figure A6.33: Granny Smith – Iodine Distribution

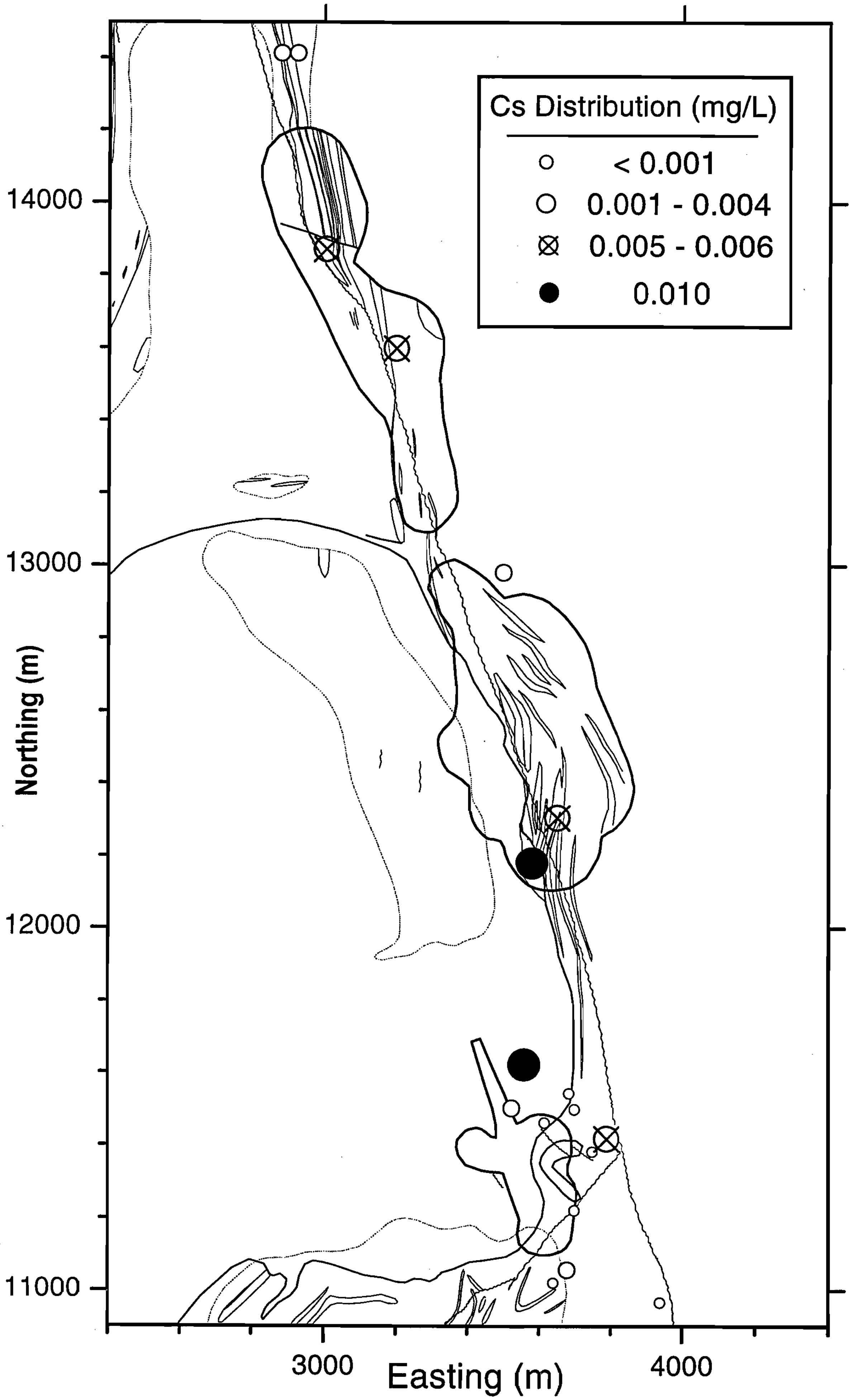

Figure A6.34: Granny Smith – Cesium Distribution

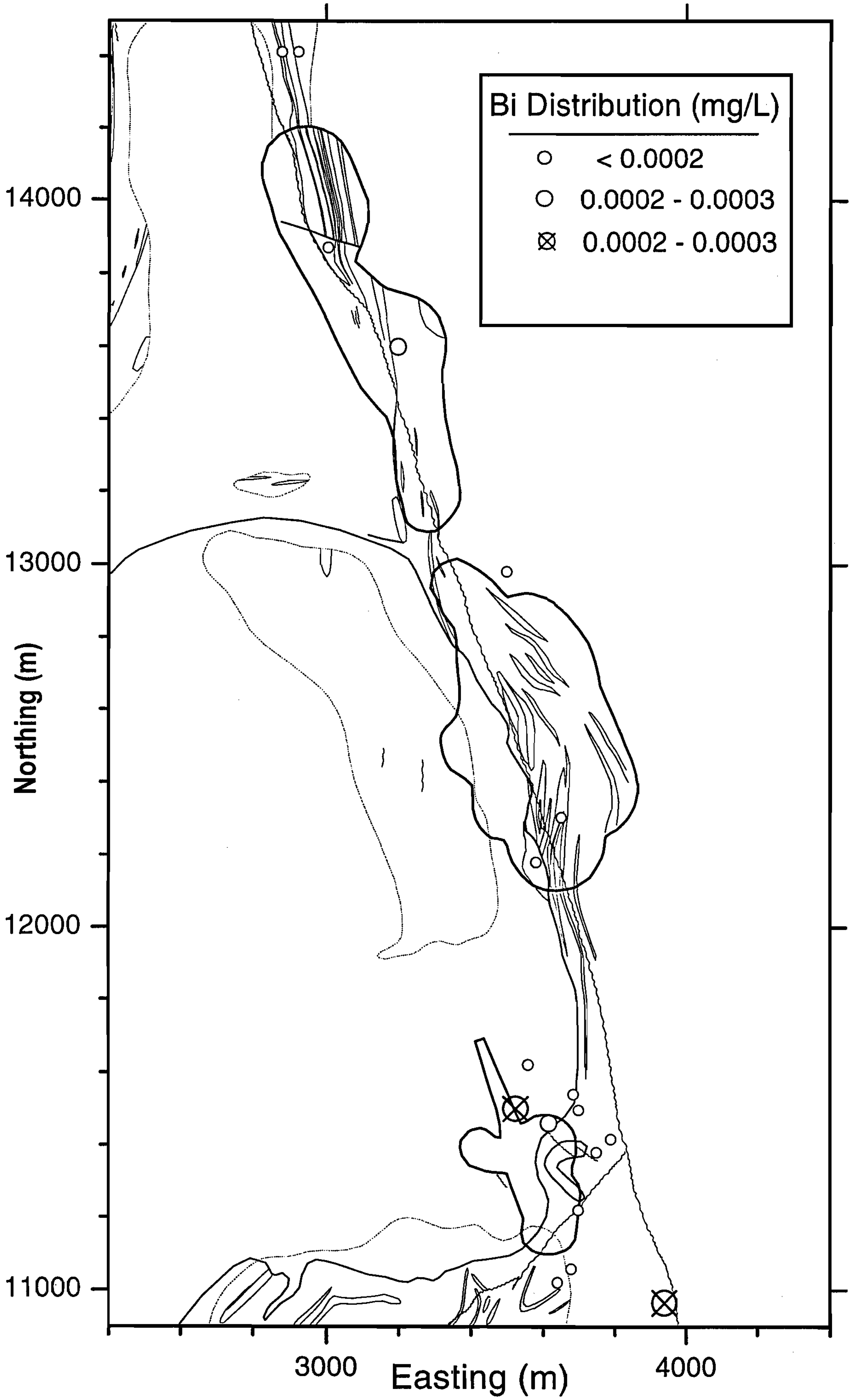

Figure A6.35: Granny Smith – Bismuth Distribution

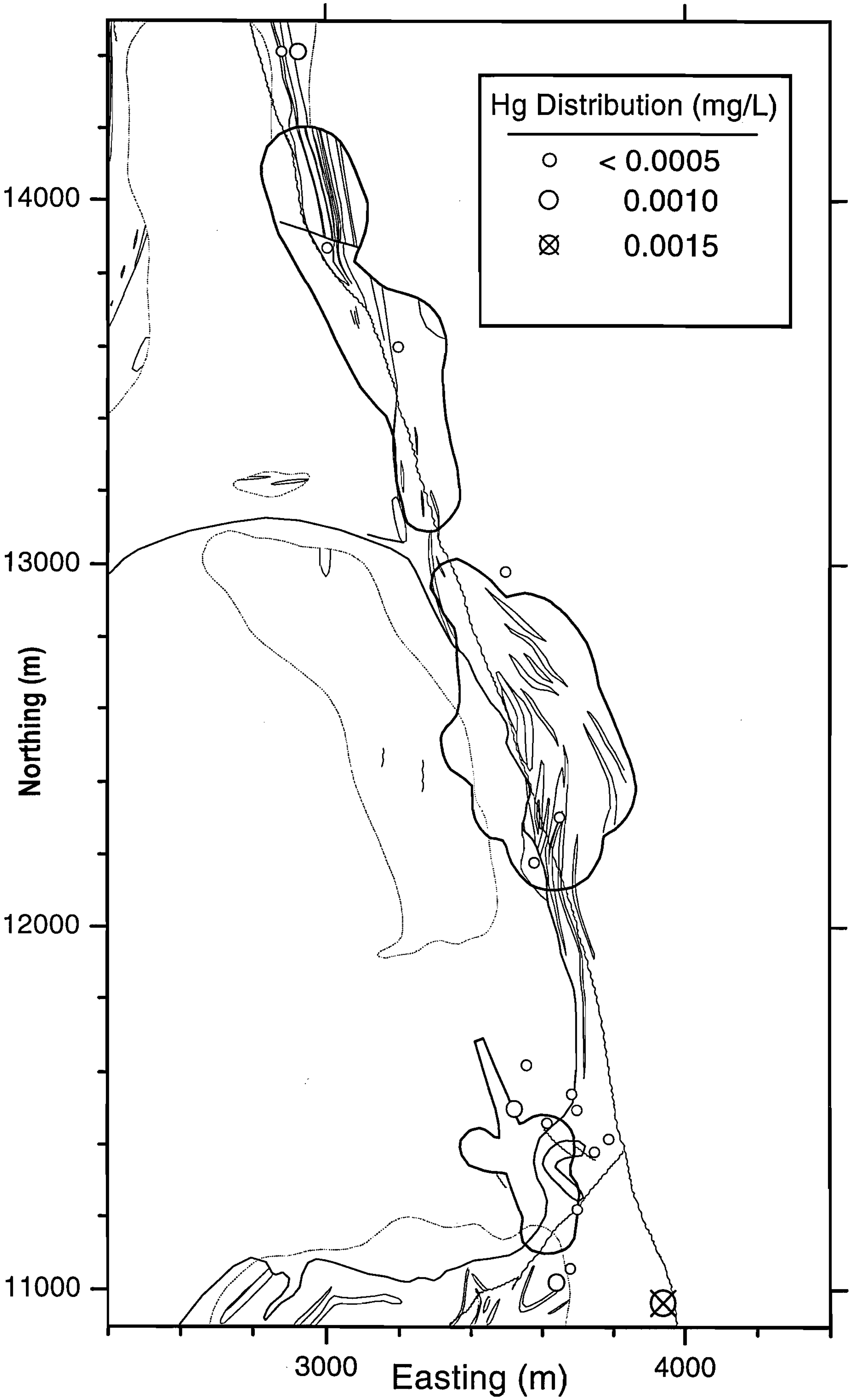

Figure A6.36: Granny Smith – Mercury Distribution

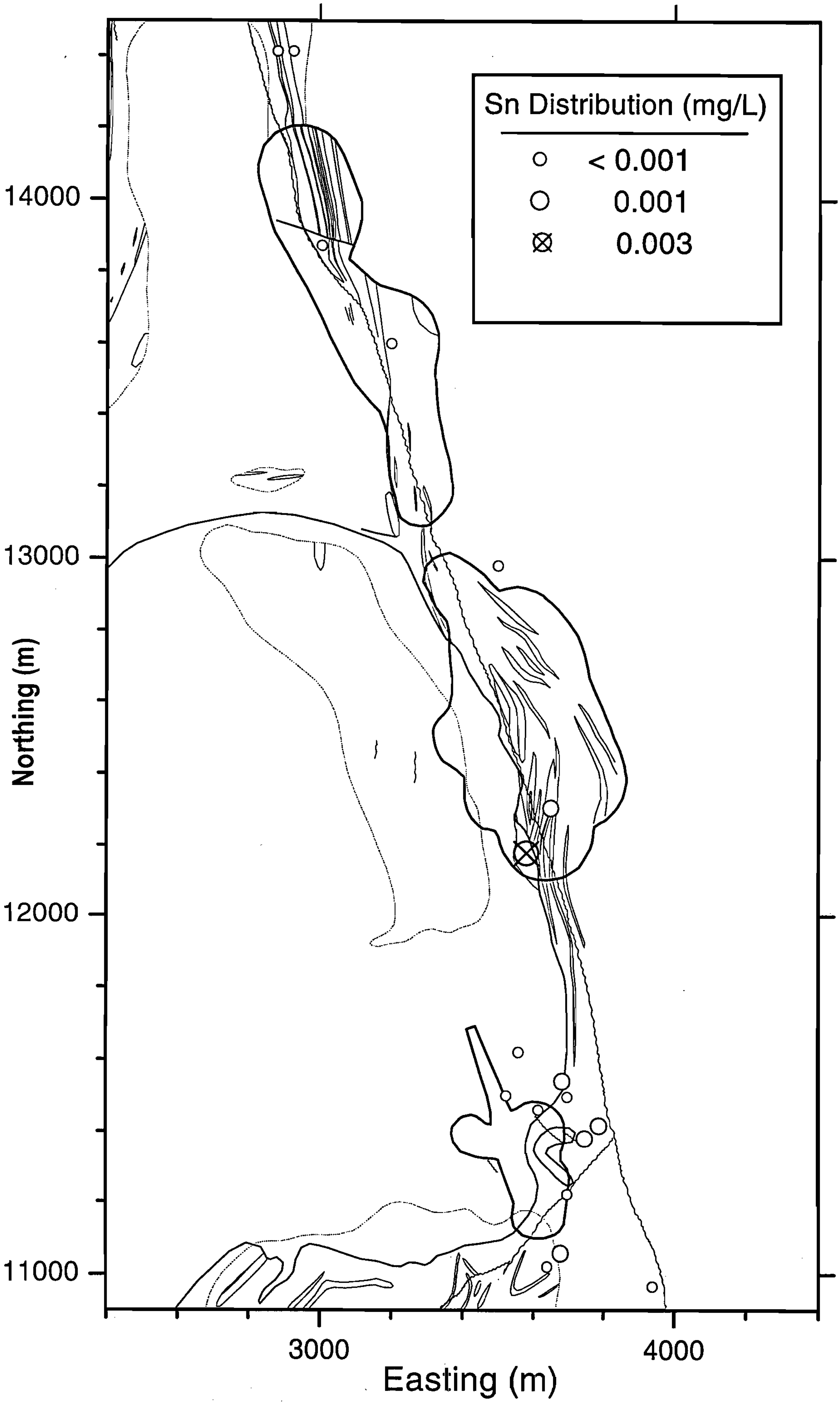

Figure A6.37: Granny Smith – Tin Distribution