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Correlation between trace element concentrations and Th levels in Polycast materials

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The trace elements of twenty three 25gr. samples of Polycast materials (12 monomer, 3 core acrylic, 4 surface acrylic and 4 acrylic) have been analysed. An evidence of a correlation between the concentrations of some of these elements and the Th concentration has been found.

The observed count rates (per unit weight , corrected for decay to the irradiation day) of neutron activated isotopes of nine trace elements (^{141}Ce, ^{203}Hg, ^{51}Cr, ^{198}Au, ^{122}Sb, ^{46}Sc, ^{59}Fe, ^{65}Zn and ^{60}Co) are presented in Table 1. together with the measured Th concentrations. Since this analysis has been initiated after the sample irradiations, no effort has been made to present the data in absolute concentrations. This step would have required simultaneous irradiation of known standards for each of the elements. The normalised count rates presented here are simply proportional to the absolute concentrations since the irradiation conditions (6 hours irradiation at the same position in the NRU reactor with a monitored reactor power stable to within 5% during the irradiation time) were similar. However small (about 3g.) Shop acrylic samples have been reported by the Guelph group at the Chalk River collaboration meeting in September '90 to have concentrations of about 0.5ppm for Fe, 0.1ppm for Zn, 20ppb for Cr, 1ppb for Co and 30ppt for Sb.

The average of the Th levels in those samples was about 35ppt. No evidence of a correlation between the Th levels and the levels of other elements was observed by the Guelph group.

The normalised count rates of neutron activated isotopes of specific traces are shown in Figures 1. to 9. as a function of the Th levels measured in the samples. A correlation is clearly evident for some trace elements (i.e. ^{51}Cr with a correlation factor r=0.83 and ^{59}Fe with r=0.58), while almost non-existent for some others (e.g.^{203}Hg with r=0.23).

Core and surface acrylic samples exhibit quite different count rates for some of the n-activated trace isotopes analysed, confirming the evidence of an inhomogeneous distribution of impurities (and also of Th) in the acrylic.

Focussing on the monomer data set (12 samples), it appears that all samples with Th levels above 3 ppt contain much larger concentrations of especially Cr (and also Fe and Zn), which may be understood as a leaching contamination for SS containers (delivery trucks, piping, etc.) since Cr is known to migrate to the SS surface. However the Th and the other trace elements levels observed in monomer are a small fraction of the concentrations observed in finished acrylic, therefore priority should be given to identifying and avoiding (or at least reducing) the contaminations occuring after the mix-room.

The observed correlations between Th and trace element concentrations may be used either to identified the sources of Th contamination (as mentionned in the case of the monomer samples) and/or to select low Th materials on the basis of their trace concentrations. For example, a requirement of a ^{51}Cr count rate not exceeding 500 counts/day·gr. (represented by an arrow on Fig. 3.) would select all but one samples with a Th level below 5 ppt and reject all samples above that concentration. Other trace elements (like Fe, usually present at about 0.5ppm in acrylic) may also be suitable for similar selection procedures.

sample	Th	Ce141	Hg203	Cr51	Au198	Sb122	Sc46	Fe59	Zn65	Co60
ID	(ppt)	Count rate (Counts per day and per gr. of sample)								
Monomer:										
29	1.2	23	100	118	600	800	2	32	60	3
33	<1.6	10	186	178	2242	1031	4	34	43	2
16	1.9	16	74	331	1974	2647	4	26	149	5
24	1.9	16	57	315	2541	2559	6	35	156	19
25	2.4	40	45	608	2641	1417	8	64	117	4
13	3.0		117	229	1262	960	13	50	144	26
27	3.0		77	87	1800	325	4	34	43	
30	3.0	59	111	151	3077	1600	4	76	97	3
31	5.0	22	213	853	8692	4767	6	68	139	6
23	6.3	63	308	1257	2758		14	254	400	17
28	7.0	62	162	1524	3401	1659	35	848	66	9
32	8.3	117	140	598	4643	3470	34	181	176	8
17	38.0	102	248	2807	4189	7445	49	5935	215	64
Core acrylic:										
21	3.4	22	449	349	1333	809	4	35	733	4
48	3.8	12	58	276	1078	440	2	61	166	11
20	4.6	60	171	297	2486	7553	9	33	690	18
Surface acrylic:										
46	9.0	60	209	2162	9426	4952	16	418	1470	71
19	10.0	58	169	1684	30267		43	250	970	67
18	16.0	57	565	615	4609	3818	22	102	343	18
47	43.0	146	202	3625	12550	4570	28	376	1258	96
Acrylic:										
35	2.6	83	146	356	30589	1556	9	162	381	12
34	9.6	158	81	676	14113	6500	15	430	567	13
14	20.0	38	18	593	9890		20	109	513	9
15	23.0	39	193	1315	6528	1149	19	133	135	11

Table 1.

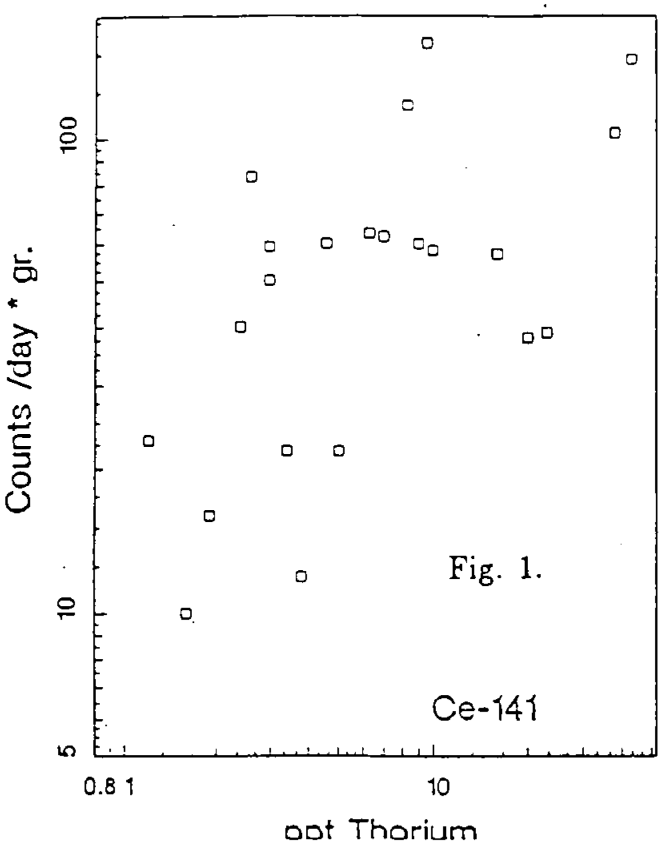

Fig. 1.

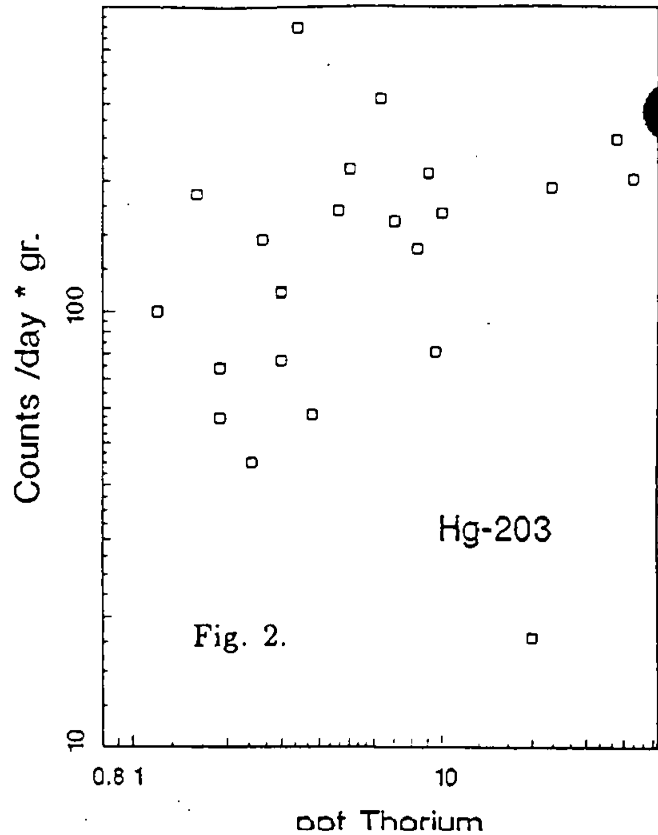

Fig. 2.

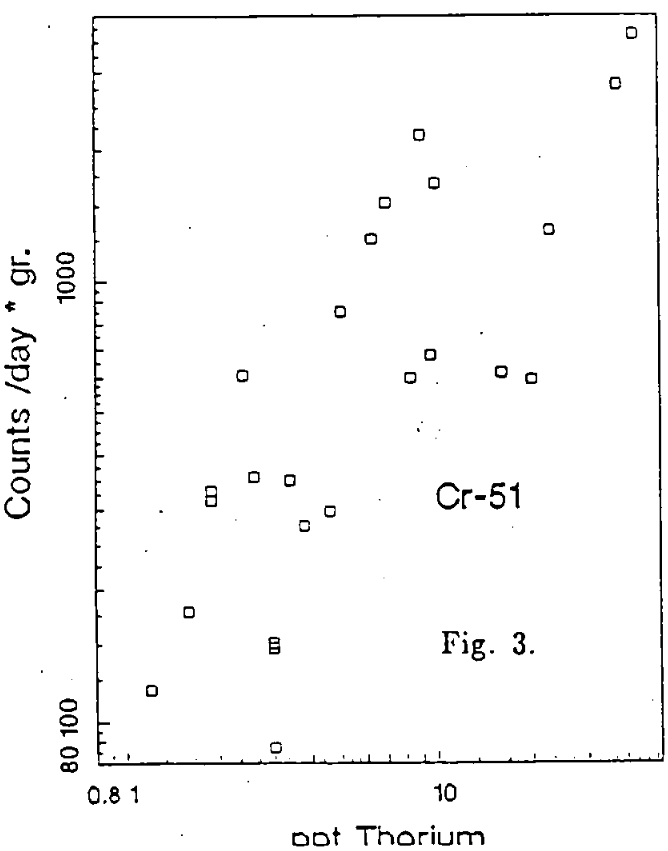

Fig. 3.

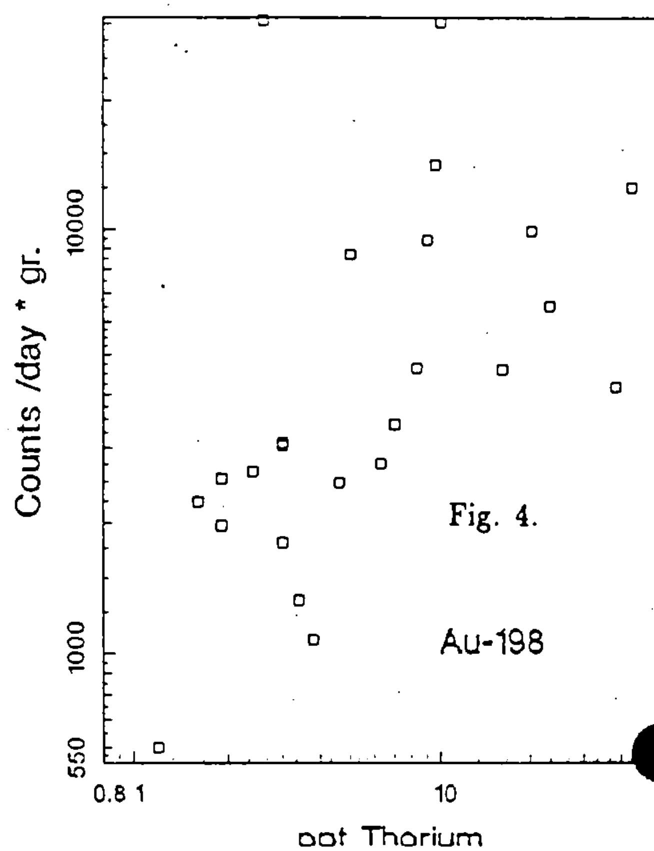

Fig. 4.

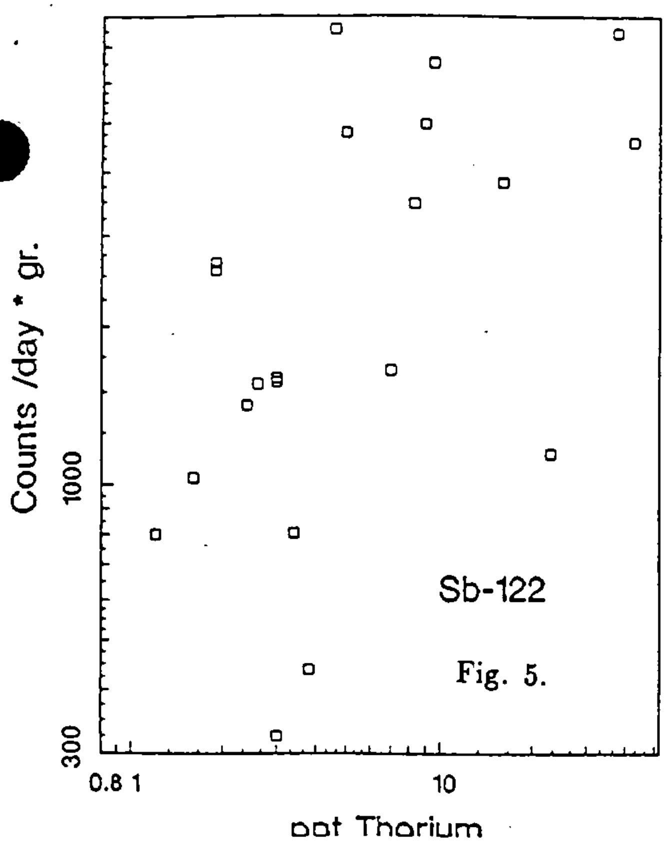

Fig. 5.

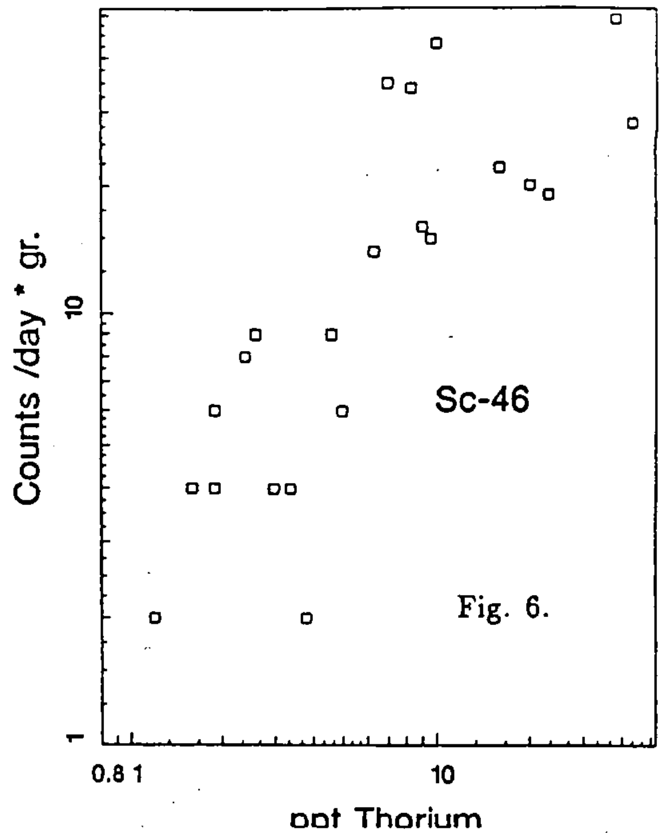

Fig. 6.

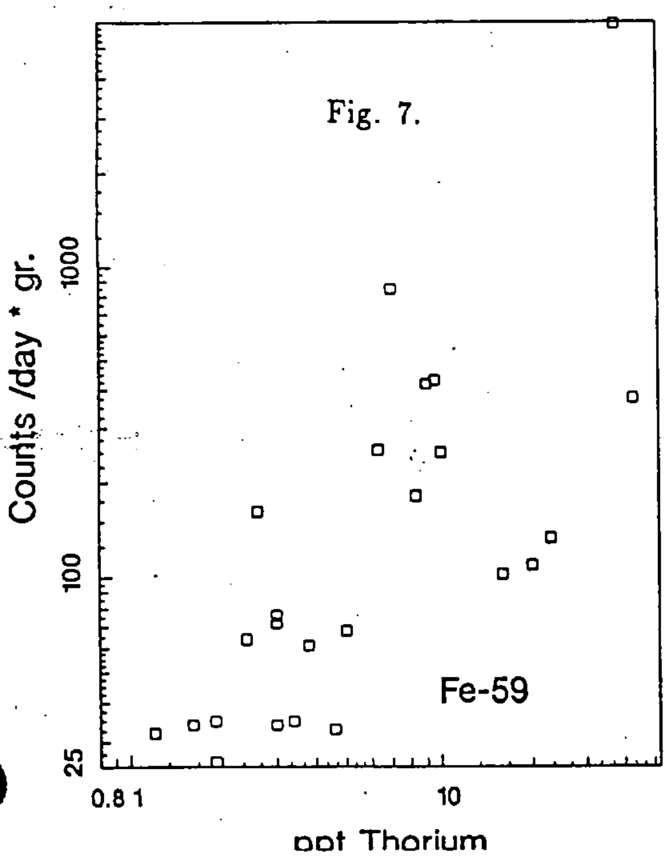

Fig. 7.

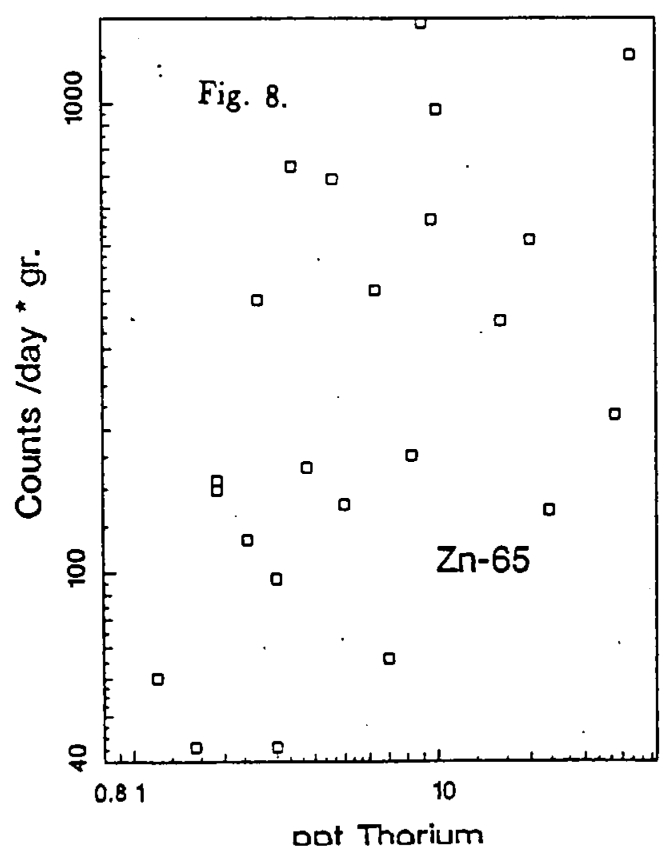

Fig. 8.

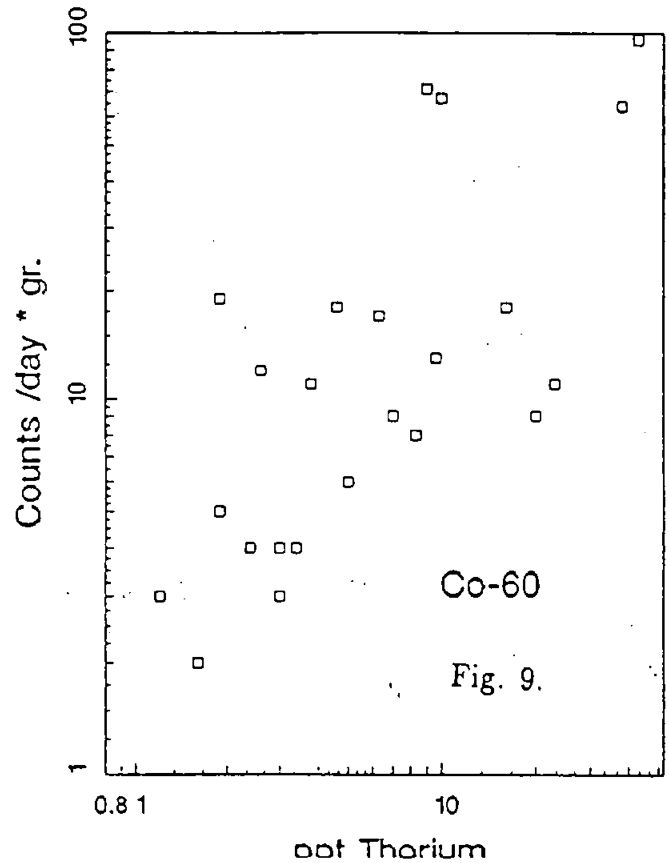

Fig. 9.