Investigational Allowances

Relationship to Magruder % RSDs

Caution: There will be math.

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Investigational Allowance aka IA

- The IA is calculated to statistically represent 99% of the analytical results from labs running the same analyte in the same sample.
- NPK IA's follow a specified Table in the OP.
- Other guaranteed mineral nutrient IA's follow specified linear equations, also in the OP.
- The IA is normally subtracted from a lab result to indicate a minimum allowed on the Guarantee.
- Here we wish to compare IA with the current status of inter laboratory reproducibility Robust SDs seen in recent Magruder data.

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Investigational Allowance aka IA

- IA represents 99% of the measurements (R. C. Rund, OP # 28, 1975).
- From Rund, **IA/2.33** represents 68% of the measurements under a Normal curve or 1 standard deviation.
- From the OP IA Tables we calculate an **IA at the Rob. Mean**. Then convert it to the IA_{SD} representing 68% of the measurements or 1 standard deviation.

$$IA_{SD} = \frac{IA_{Rob.Mean}}{2.33}$$

In the following I refer to IA_{SD} as IA.

This allows us to compare IA to Rob. SD

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Investigational Allowance aka IA

The IA Ratio

$$\text{IA Ratio} = \frac{SD_{Robust}}{IA_{SD}}$$

In other words: How many IAs in the Robust SD (between labs)?

I went back and calculated IA ratios for 2017 samples and included them with 2018 report data.

Analyte IA Ratios 2017 to 06/2018

Sample #	Sample Name	n	Rob. Mean	Rob. SD	IA from OP	IA Ratio
Total Nitrogen (%)			ORDERED			
180511	Grade 46-0-0	87	46	0.468	0.880	**1.24**
170311	Grade 28-0-0 Liquid SR	77	28	0.352	0.835	**0.98**
170211	Grade 27-0-0	68	27	0.849	0.816	**2.42**
170811	Grade 21-0-5	82	21	0.307	0.740	**0.97**
170411	Grade 15-15-15 + Micros	81	20	0.405	0.729	**1.29**
170111	Grade 18-46-0 DAP	67	18	0.268	0.704	**0.89**
170511	Grade 16-1-0	78	17	0.217	0.683	**0.74**
180211	Grade 14-14-14	76	14	0.212	0.628	**0.79**
170911	MAP plus S, 12-40-0	73	12	0.212	0.615	**0.80**
171111	Grade 12-0-0-26S	70	12	0.231	0.611	**0.88**
180411	Grade 12-24-12	86	12	0.230	0.607	**0.88**
170711	Grade 7-25-40	67	7	0.528	0.535	**2.30**
171211	Grade 5-15-30	67	5	0.144	0.511	**0.66**
180311	Grade 3-1-2	75	3	0.130	0.490	**0.62**
170611	Grade 2-15-15 w/PO3	82	2	0.150	0.490	**0.71**
180111	Secondary & Micronutrients	10	0.6	0.046	0.490	**0.22**
180512	TSP + Zn	8	0.1	0.035	0.490	**0.17**
Direct Available Phosphorus as P2O5 (%)						
170111	Grade 18-46-0 DAP	38	47	0.727	1.008	**1.68**
171012	TSP, 0-45-0	57	46	0.781	0.994	**1.83**
180512	TSP + Zn	57	45	0.584	0.988	**1.38**
170911	MAP plus S, 12-40-0	54	39	0.828	0.887	**2.17**
180411	Grade 12-24-12	57	25	0.724	0.730	**2.31**
170711	Grade 7-25-40	48	25	0.535	0.730	**1.71**
170411	Grade 15-15-15 + Micros	47	18	0.634	0.709	**2.08**
171211	Grade 5-15-30	47	15	0.301	0.700	**1.00**
180211	Grade 14-14-14	54	14	0.340	0.700	**1.13**
180311	Grade 3-1-2	39	3	0.525	0.670	**1.82**
170511	Grade 16-1-0	46	1	0.115	0.670	**0.40**

IA ratio = Rob. SD/IA_{SD} **Red indicates IA Ratio significantly > 1**

Analyte IA Ratios 2017 to 06/2018

Sample #	Sample Name	n	Rob. Mean	Rob. SD	IA from OP	IA Ratio
Soluble Potassium as K2O (%)			ORDERED			
170711	Grade 7-25-40	85	40	1.040	1.545	**1.57**
171211	Grade 5-15-30	80	30	0.730	1.402	**1.21**
170611	Grade 2-15-15 w/PO3	87	17	0.817	0.992	**1.92**
180211	Grade 14-14-14	92	15	0.531	0.889	**1.39**
180411	Grade 12-24-12	97	13	0.562	0.826	**1.58**
170811	Grade 21-0-5	91	5	0.188	0.434	**1.01**
180311	Grade 3-1-2	80	4	0.255	0.410	**1.45**
170411	Grade 15-15-15 + Micros	77	2	0.220	0.410	**1.25**
170511	Grade 16-1-0	21	2	0.082	0.410	**0.47**
180512	TSP + Zn	13	0.2	0.114	0.410	**0.65**
171012	TSP, 0-45-0	8	0.2	0.095	0.410	**0.54**
170111	Grade 18-46-0 DAP	11	0.2	0.076	0.410	**0.43**
170911	MAP plus S, 12-40-0	12	0.1	0.031	0.410	**0.18**
180111	Secondary & Micronutrients	9	0.1	0.025	0.410	**0.14**
170211	Grade 27-0-0	6	0.1	0.073	0.410	**0.41**
Acid Soluble Calcium (%)						
180111	Secondary & Micronutrients	63	19	1.216	1.000	**2.83**
180512	TSP + Zn	56	14	0.907	0.915	**2.31**
171012	TSP, 0-45-0	63	13	0.713	0.874	**1.90**
170811	Grade 21-0-5	17	7	0.487	0.536	**2.11**
170211	Grade 27-0-0	56	5	0.242	0.425	**1.33**
180411	Grade 12-24-12	19	4	0.317	0.417	**1.77**
170511	Grade 16-1-0	17	0.5	0.041	0.225	**0.42**
170911	MAP plus S, 12-40-0	17	0.4	0.045	0.221	**0.47**
171211	Grade 5-15-30	44	0.4	0.066	0.219	**0.70**
170411	Grade 15-15-15 + Micros	23	0.3	0.053	0.217	**0.57**
180211	Grade 14-14-14	13	0.3	0.045	0.215	**0.48**
170111	Grade 18-46-0 DAP	14	0.3	0.054	0.214	**0.59**
180311	Grade 3-1-2	13	0.05	0.014	0.202	**0.16**
171011	Epsom Salts	10	0.03	0.009	0.201	**0.11**
170711	Grade 7-25-40	6	0.02	0.021	0.201	**0.24**

Analyte IA Ratios 2017 to 06/2018

Sample #	Sample Name	n	Rob. Mean	Rob. SD	IA	IA Ratio
Acid Soluble Magnesium (%)			ORDERED			
171011	Epsom Salts	68	10	0.586	0.697	**1.96**
170411	Grade 15-15-15 + Micros	59	3	0.191	0.336	**1.32**
170811	Grade 21-0-5	21	3	0.189	0.331	**1.33**
170211	Grade 27-0-0	55	3	0.193	0.330	**1.36**
180411	Grade 12-24-12	67	1	0.131	0.273	**1.12**
170911	MAP plus S, 12-40-0	20	1	0.123	0.267	**1.07**
171211	Grade 5-15-30	54	1	0.096	0.259	**0.86**
171012	TSP, 0-45-0	19	1	0.068	0.244	**0.65**
180512	TSP + Zn	19	1	0.086	0.237	**0.85**
170111	Grade 18-46-0 DAP	17	1	0.059	0.236	**0.59**
180211	Grade 14-14-14	48	1	0.052	0.229	**0.53**
180311	Grade 3-1-2	19	0.4	0.039	0.219	**0.41**
170511	Grade 16-1-0	18	0.2	0.018	0.210	**0.19**
180111	Secondary & Micronutrients	15	0.1	0.010	0.206	**0.12**
170711	Grade 7-25-40	7	0.004	0.005	0.200	**0.05**
170611	Grade 2-15-15 w/PO3	8	0.001	0.001	0.200	**0.01**
Total Sulfur (%)						
171111	Grade 12-0-0-26S	38	26	0.832	1.000	**1.94**
170511	Grade 16-1-0	41	19	0.789	1.000	**1.84**
180111	Secondary & Micronutrients	49	16	0.897	1.000	**2.09**
171011	Epsom Salts	51	13	0.565	0.859	**1.53**
180211	Grade 14-14-14	45	10	0.401	0.724	**1.29**
170911	MAP plus S, 12-40-0	47	7	0.362	0.551	**1.53**
171211	Grade 5-15-30	37	5	0.868	0.473	**4.27**
170811	Grade 21-0-5	44	5	0.240	0.467	**1.20**
170411	Grade 15-15-15 + Micros	45	5	0.496	0.429	**2.69**
170111	Grade 18-46-0 DAP	10	2	0.084	0.310	**0.63**
180411	Grade 12-24-12	39	1	0.111	0.258	**1.00**
171012	TSP, 0-45-0	8	1	0.092	0.256	**0.83**
180311	Grade 3-1-2	10	1	0.066	0.247	**0.62**
180512	TSP + Zn	7	1	0.099	0.240	**0.96**
170211	Grade 27-0-0	8	0.2	0.068	0.211	**0.76**
170711	Grade 7-25-40	6	0.01	0.007	0.201	**0.09**

Analyte IA Ratios 2017 to 06/2018

Sample #	Sample Name	n	Rob. Mean	Rob. SD	IA from OP	IA Ratio
Acid Soluble Boron (%)			ORDERED			
180111	Secondary & Micronutrients	52	0.5	0.042	0.079	**1.23**
170411	Grade 15-15-15 + Micros	37	0.3	0.040	0.045	**2.10**
171211	Grade 5-15-30	41	0.2	0.027	0.040	**1.57**
180211	Grade 14-14-14	47	0.2	0.016	0.034	**1.13**
180411	Grade 12-24-12	47	0.06	0.014	0.012	**2.73**
170911	MAP plus S, 12-40-0	12	0.01	0.014	0.005	**6.28**
170111	Grade 18-46-0 DAP	10	0.01	0.007	0.005	**3.24**
180512	TSP + Zn	8	0.01	0.005	0.004	**3.00**
170511	Grade 16-1-0	7	0.004	0.005	0.004	**3.25**
170811	Grade 21-0-5	7	0.004	0.004	0.004	**2.85**
180311	Grade 3-1-2	6	0.002	0.003	0.003	**1.89**
Acid Soluble Cobalt (ppm)						
180211	Grade 14-14-14	21	376	26.116	113.746	**0.53**
171211	Grade 5-15-30	18	288	40.540	87.285	**1.08**
170411	Grade 15-15-15 + Micros	21	32	6.663	10.708	**1.45**
170811	Grade 21-0-5	22	13	3.344	4.842	**1.61**
170511	Grade 16-1-0	16	7	1.904	3.154	**1.41**
171012	TSP, 0-45-0	16	6	1.221	2.924	**0.97**
180411	Grade 12-24-12	23	4	1.398	2.109	**1.54**
180512	TSP + Zn	15	3	0.871	1.967	**1.03**
180111	Secondary & Micronutrients	23	2	0.666	1.560	**0.99**
170111	Grade 18-46-0 DAP	11	1	0.639	1.368	**1.09**
170911	MAP plus S, 12-40-0	10	1	0.558	1.354	**0.96**
170211	Grade 27-0-0	8	1	0.465	1.268	**0.85**
180311	Grade 3-1-2	14	0.4	0.137	1.124	**0.28**
170711	Grade 7-25-40	10	0.4	0.302	1.107	**0.64**
171011	Epsom Salts	9	0.3	0.188	1.101	**0.40**

IA ratio = Rob. SD/IA_{SD} **Red indicates IA Ratio significantly > 1**

Analyte IA Ratios 2017 to 06/2018

Sample #	Sample Name	n	Rob. Mean	Rob. SD	IA from OP	IA Ratio
Acid Soluble Copper (%)			ORDERED			
170411	Grade 15-15-15 + Micros	57	0.6	0.043	0.066	**1.52**
180211	Grade 14-14-14	52	0.1	0.017	0.018	**2.28**
171211	Grade 5-15-30	39	0.03	0.004	0.008	**1.07**
170811	Grade 21-0-5	34	0.01	0.001	0.006	**0.44**
171012	TSP, 0-45-0	37	0.01	0.002	0.006	**0.63**
170511	Grade 16-1-0	29	0.01	0.001	0.006	**0.55**
180512	TSP + Zn	34	0.01	0.001	0.006	**0.55**
170911	MAP plus S, 12-40-0	11	0.002	0.002	0.005	**1.03**
180111	Secondary & Micronutrients	19	0.001	0.001	0.005	**0.68**
180411	Grade 12-24-12	20	0.001	0.001	0.005	**0.33**
180311	Grade 3-1-2	21	0.001	0.000	0.005	**0.21**
170111	Grade 18-46-0 DAP	10	0.001	0.001	0.005	**0.30**
171011	Epsom Salts	11	0.001	0.000	0.005	**0.23**
170211	Grade 27-0-0	10	0.0005	0.000	0.005	**0.19**
170711	Grade 7-25-40	15	0.0003	0.000	0.005	**0.06**
Acid Soluble Iron (%)						
170511	Grade 16-1-0	57	3	0.219	0.263	**1.94**
170411	Grade 15-15-15 + Micros	56	2	0.297	0.248	**2.79**
170811	Grade 21-0-5	63	1	0.125	0.115	**2.54**
171012	TSP, 0-45-0	20	1	0.041	0.084	**1.13**
180512	TSP + Zn	22	1	0.054	0.080	**1.58**
180211	Grade 14-14-14	56	1	0.105	0.068	**3.59**
180411	Grade 12-24-12	25	1	0.030	0.068	**1.04**
171211	Grade 5-15-30	49	1	0.046	0.060	**1.78**
170111	Grade 18-46-0 DAP	18	0.4	0.029	0.048	**1.41**
170911	MAP plus S, 12-40-0	21	0.3	0.017	0.030	**1.31**
180111	Secondary & Micronutrients	15	0.1	0.012	0.012	**2.19**
170211	Grade 27-0-0	16	0.05	0.004	0.010	**0.91**
180311	Grade 3-1-2	19	0.04	0.009	0.009	**2.41**
170711	Grade 7-25-40	10	0.01	0.003	0.006	**1.26**
171011	Epsom Salts	7	0.002	0.001	0.005	**0.58**
170611	Grade 2-15-15 w/PO3	22	0.001	0.001	0.005	**0.45**

Analyte IA Ratios 2017 to 06/2018

Sample #	Sample Name	n	Rob. Mean	Rob. SD	IA from OP	IA Ratio
Acid Soluble Manganese (%)			ORDERED			
170411	Grade 15-15-15 + Micros	58	1	0.087	0.127	**1.59**
180211	Grade 14-14-14	49	0.2	0.012	0.021	**1.32**
170811	Grade 21-0-5	20	0.04	0.003	0.009	**0.92**
171211	Grade 5-15-30	41	0.03	0.003	0.008	**1.02**
171012	TSP, 0-45-0	18	0.02	0.002	0.007	**0.75**
180411	Grade 12-24-12	23	0.02	0.002	0.007	**0.57**
170911	MAP plus S, 12-40-0	20	0.02	0.002	0.007	**0.71**
180512	TSP + Zn	18	0.01	0.004	0.006	**1.35**
170511	Grade 16-1-0	18	0.01	0.001	0.006	**0.57**
180111	Secondary & Micronutrients	11	0.01	0.001	0.006	**0.36**
170111	Grade 18-46-0 DAP	12	0.005	0.000	0.005	**0.21**
170211	Grade 27-0-0	13	0.005	0.000	0.005	**0.16**
180311	Grade 3-1-2	13	0.002	0.000	0.005	**0.08**
171011	Epsom Salts	10	0.002	0.001	0.005	**0.30**
Acid Soluble Molybdenum (ppm)						
170411	Grade 15-15-15 + Micros	24	1292	238.341	388.515	**1.43**
180211	Grade 14-14-14	27	826	115.407	248.944	**1.08**
171211	Grade 5-15-30	25	618	103.623	186.377	**1.30**
180512	TSP + Zn	23	17	3.684	5.971	**1.44**
171012	TSP, 0-45-0	23	12	2.513	4.729	**1.24**
170811	Grade 21-0-5	24	10	2.515	3.910	**1.50**
180411	Grade 12-24-12	25	8	1.938	3.276	**1.38**
170111	Grade 18-46-0 DAP	17	4	1.555	2.116	**1.71**
170511	Grade 16-1-0	11	4	1.042	2.090	**1.16**
170911	MAP plus S, 12-40-0	17	2	1.049	1.732	**1.41**
180111	Secondary & Micronutrients	19	2	1.441	1.685	**1.99**
170211	Grade 27-0-0	11	2	0.470	1.546	**0.71**
180311	Grade 3-1-2	18	1	0.310	1.399	**0.52**
171011	Epsom Salts	18	1	0.350	1.398	**0.58**
170711	Grade 7-25-40	11	1	0.284	1.208	**0.55**

Analyte IA Ratios 2017 to 06/2018

Sample #	Sample Name	n	Rob. Mean	Rob. SD	IA from OP	IA Ratio
Sodium (%)			ORDERED			
180311	Grade 3-1-2	9	1	0.080	0.116	**1.61**
171211	Grade 5-15-30	9	1	0.057	0.078	**1.73**
170411	Grade 15-15-15 + Micros	8	1	0.075	0.058	**2.98**
180211	Grade 14-14-14	12	0.5	0.049	0.051	**2.23**
180411	Grade 12-24-12	11	0.4	0.035	0.045	**1.79**
180111	Secondary & Micronutrients	9	0.3	0.029	0.038	**1.80**
170711	Grade 7-25-40	6	0.3	0.027	0.034	**1.84**
170111	Grade 18-46-0 DAP	7	0.2	0.023	0.025	**2.15**
170211	Grade 27-0-0	8	0.2	0.022	0.022	**2.39**
170911	MAP plus S, 12-40-0	8	0.1	0.013	0.018	**1.70**
170511	Grade 16-1-0	8	0.1	0.008	0.017	**1.03**
180512	TSP + Zn	7	0.1	0.012	0.016	**1.84**
170811	Grade 21-0-5	10	0.05	0.016	0.010	**3.83**
Acid Soluble Zinc (%)						
180111	Secondary & Micronutrients	63	2	0.086	0.157	**1.28**
170411	Grade 15-15-15 + Micros	59	1	0.133	0.150	**2.06**
170911	MAP plus S, 12-40-0	70	1	0.116	0.135	**2.00**
171211	Grade 5-15-30	57	1	0.067	0.122	**1.29**
180512	TSP + Zn	62	0.5	0.034	0.053	**1.52**
180211	Grade 14-14-14	55	0.2	0.020	0.023	**1.97**
171012	TSP, 0-45-0	38	0.1	0.015	0.015	**2.31**
170111	Grade 18-46-0 DAP	31	0.04	0.004	0.009	**1.02**
170811	Grade 21-0-5	36	0.03	0.004	0.008	**1.07**
180411	Grade 12-24-12	58	0.03	0.004	0.008	**1.30**
170511	Grade 16-1-0	33	0.01	0.002	0.006	**0.90**
180311	Grade 3-1-2	33	0.01	0.002	0.006	**0.66**
170711	Grade 7-25-40	19	0.002	0.001	0.005	**0.43**
170211	Grade 27-0-0	20	0.002	0.001	0.005	**0.40**
171011	Epsom Salts	12	0.001	0.001	0.005	**0.62**
170611	Grade 2-15-15 w/PO3	23	0.001	0.001	0.005	**0.40**

IA ratio = Rob. SD/IA_{SD} **Red indicates IA Ratio significantly > 1**

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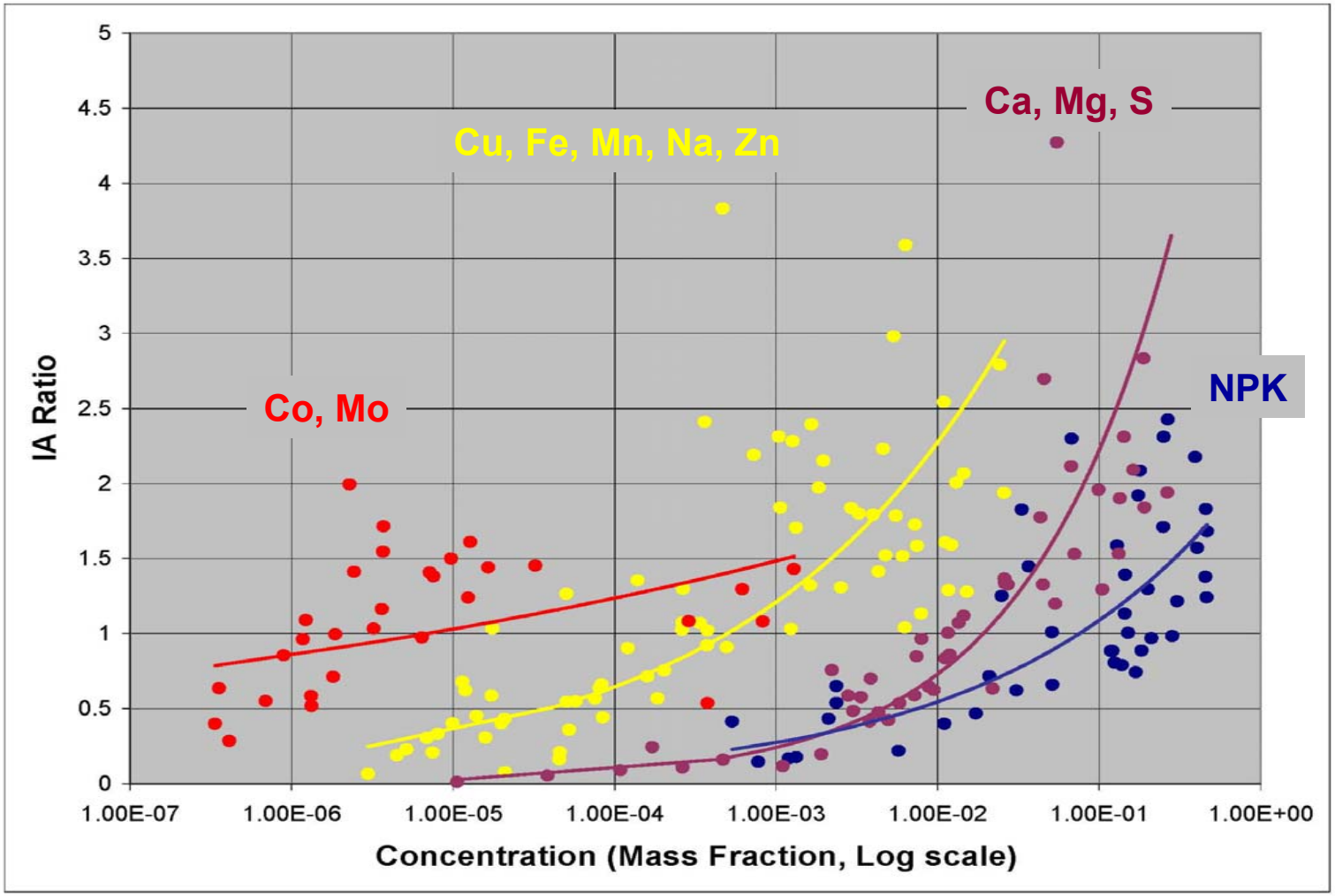
Plot of IA Ratio vs Concentration (mf on Log scale) For Different IA Equation Groups



Ideally these curves should be flat – 0 slope!

IA curves are systematically punitive at higher concentrations.

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Micronutrient IA Calculation

IA is calculated from a Guarantee or Measured Value

IA = Unit + % of Rob. Mean

Analyte	Unit	%
Ca	0.2	5
Mg	0.2	5
S	0.2	5
B	0.003	15
Cu	0.005	10
Fe	0.005	10
Mn	0.005	10
Na	0.005	10
Zn	0.005	10
Co (ppm)	1	30
Mo (ppm)	1	30

IA = 0.2 + 0.05 x Rob. Mean

IA = 0.003 + 0.15 x Rob. Mean

Not many data points but revealing.

IA = 0.005 + 0.1 x Rob. Mean

IA = 1 + 0.3 x Rob. Mean

A series of Linear Equations.

From: AAPFCO OP

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AND THIS IS WHERE WE GO DOWN THE RABBIT HOLE!

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Horwitz Approach, J. AOAC, 1980

Relationship between **σ** (Reproducibility SD) and concentration **C** (mass fraction).

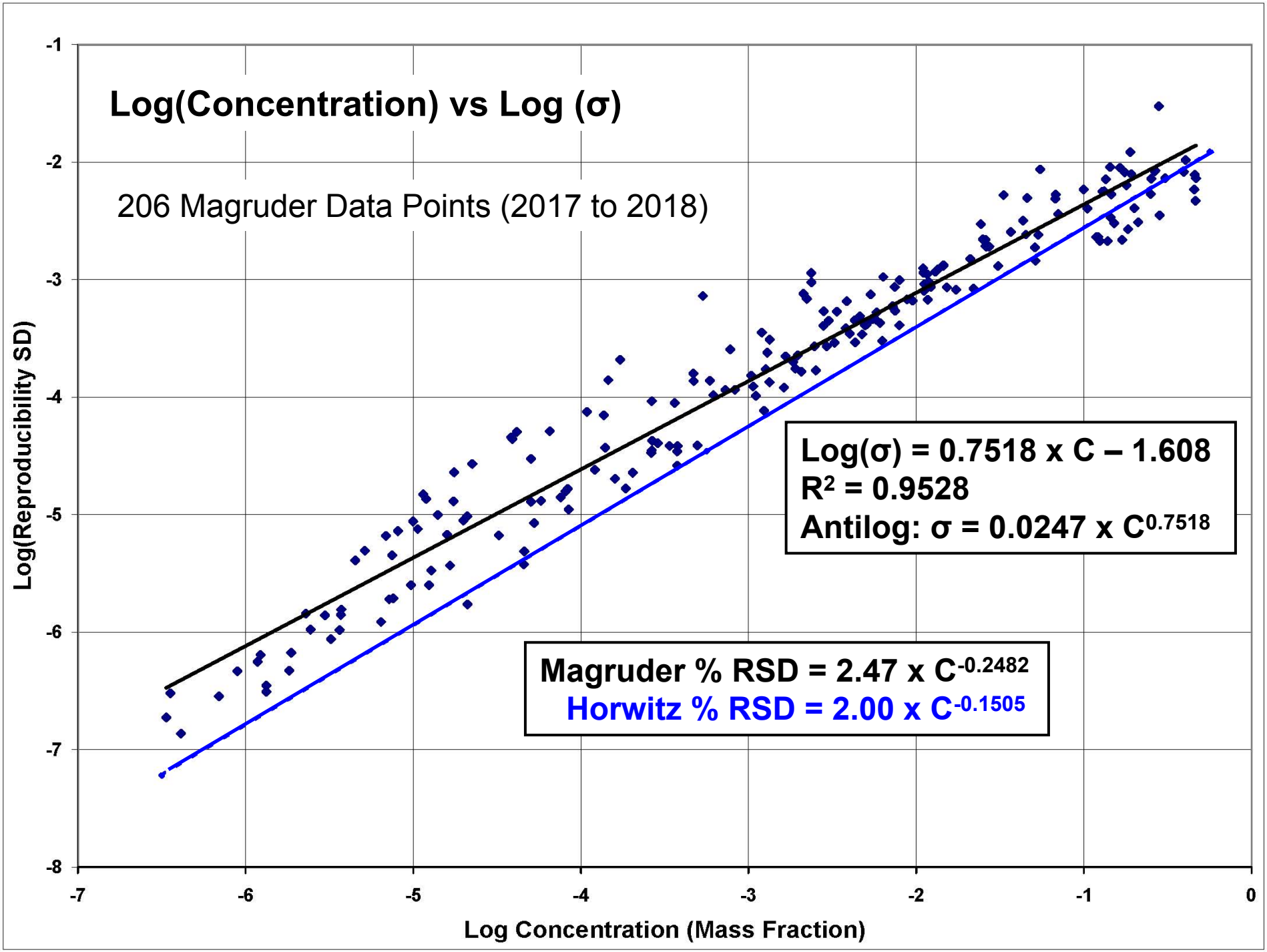
$$\sigma = AC^{B}$$ Where A and B are constants

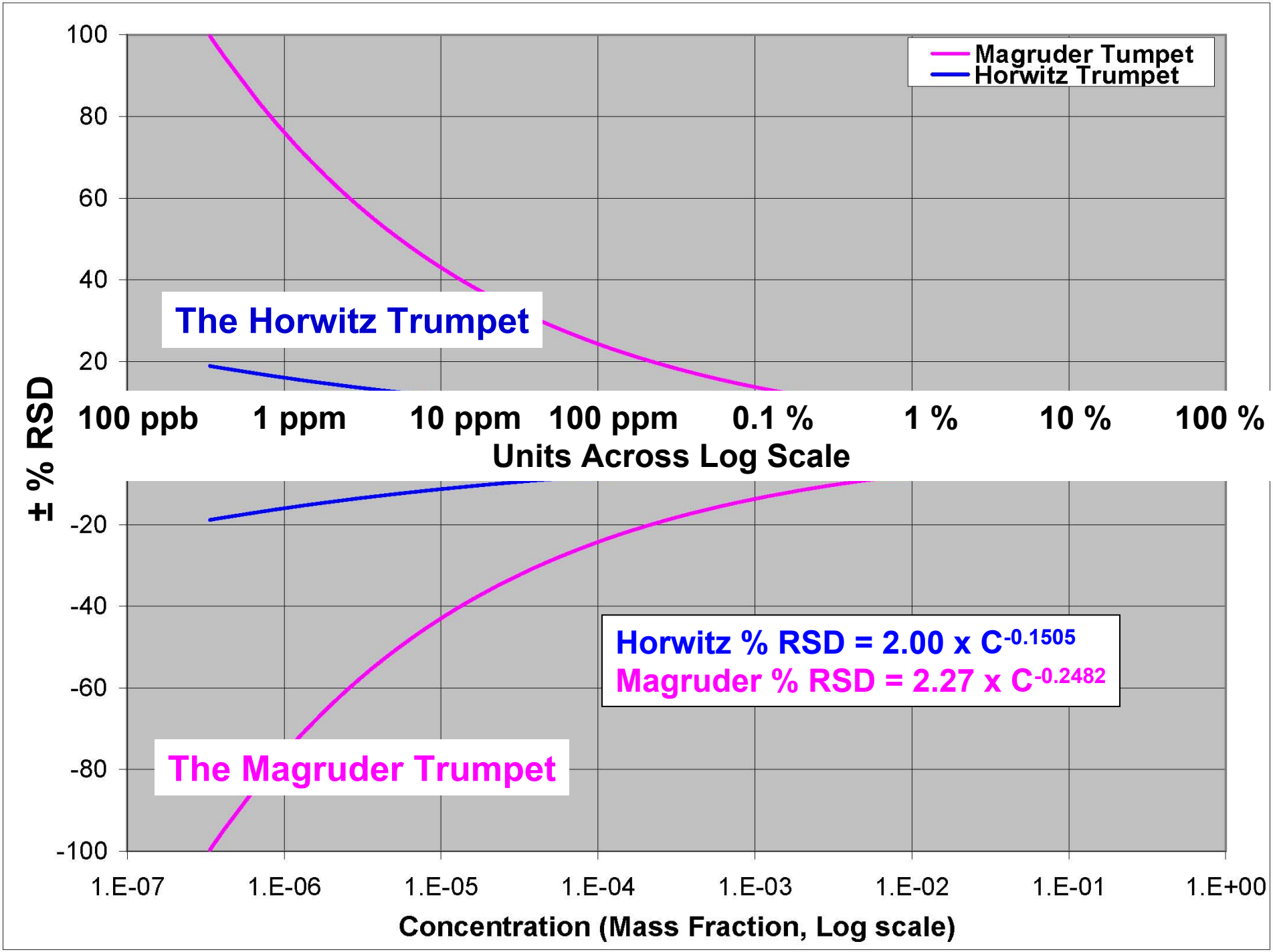
$$\mathrm{Log}(\sigma) = \mathrm{Log}(A) + B \times \mathrm{Log}(C)$$

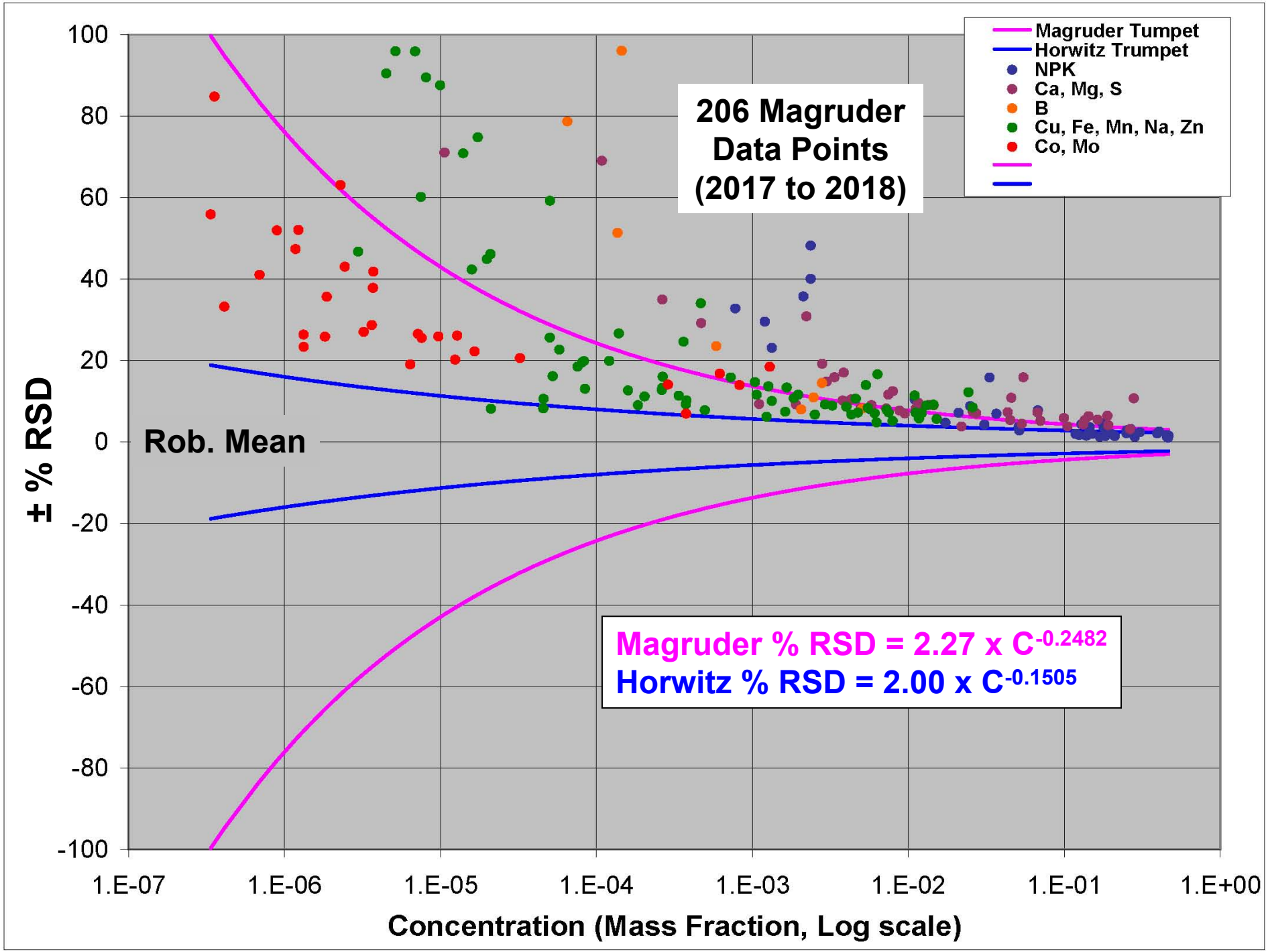
Straight line plot of Log (reproducibility SD) vs Log (concentration)
With Slope B and Intercept Log(A).

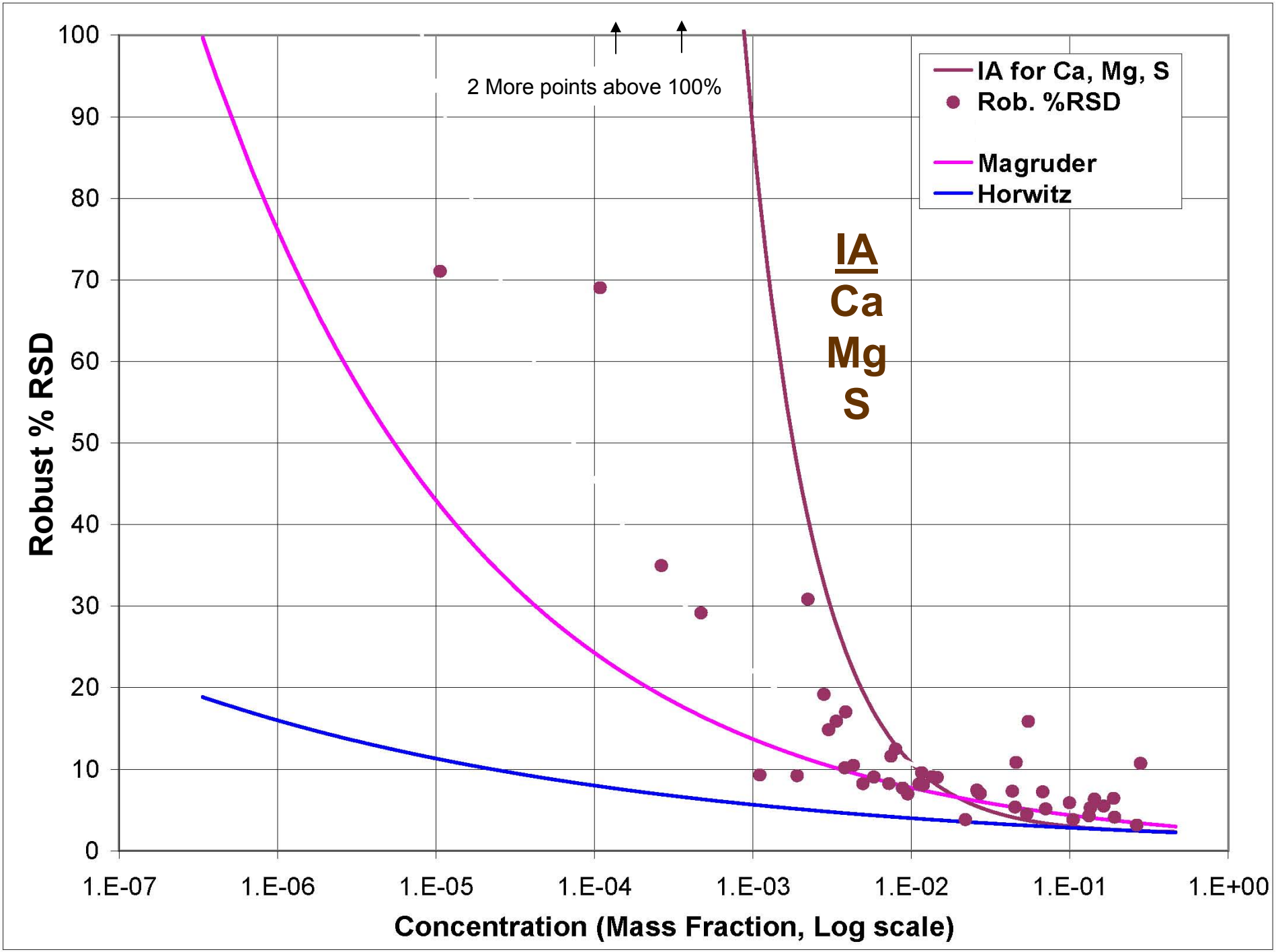
Now we apply this logic to the Magruder Rob. Mean and Rob. SD
For 206 Analytes from 2017 to current and plot this curve:

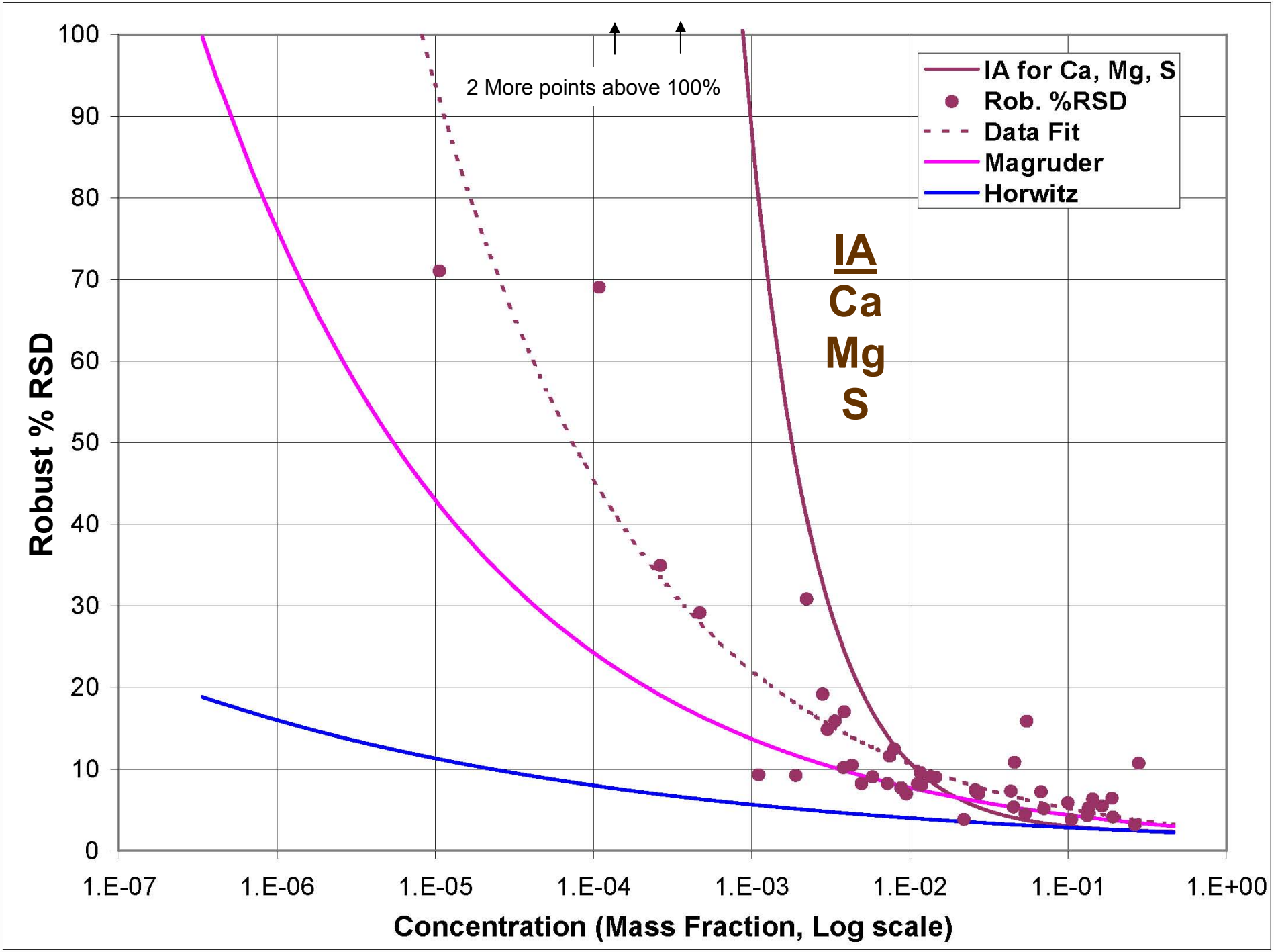
$$\mathrm{Log}(\text{Rob. SD}) = \mathrm{Log}(A) + B \times \mathrm{Log}(\text{Rob. Mean as mass fraction})$$

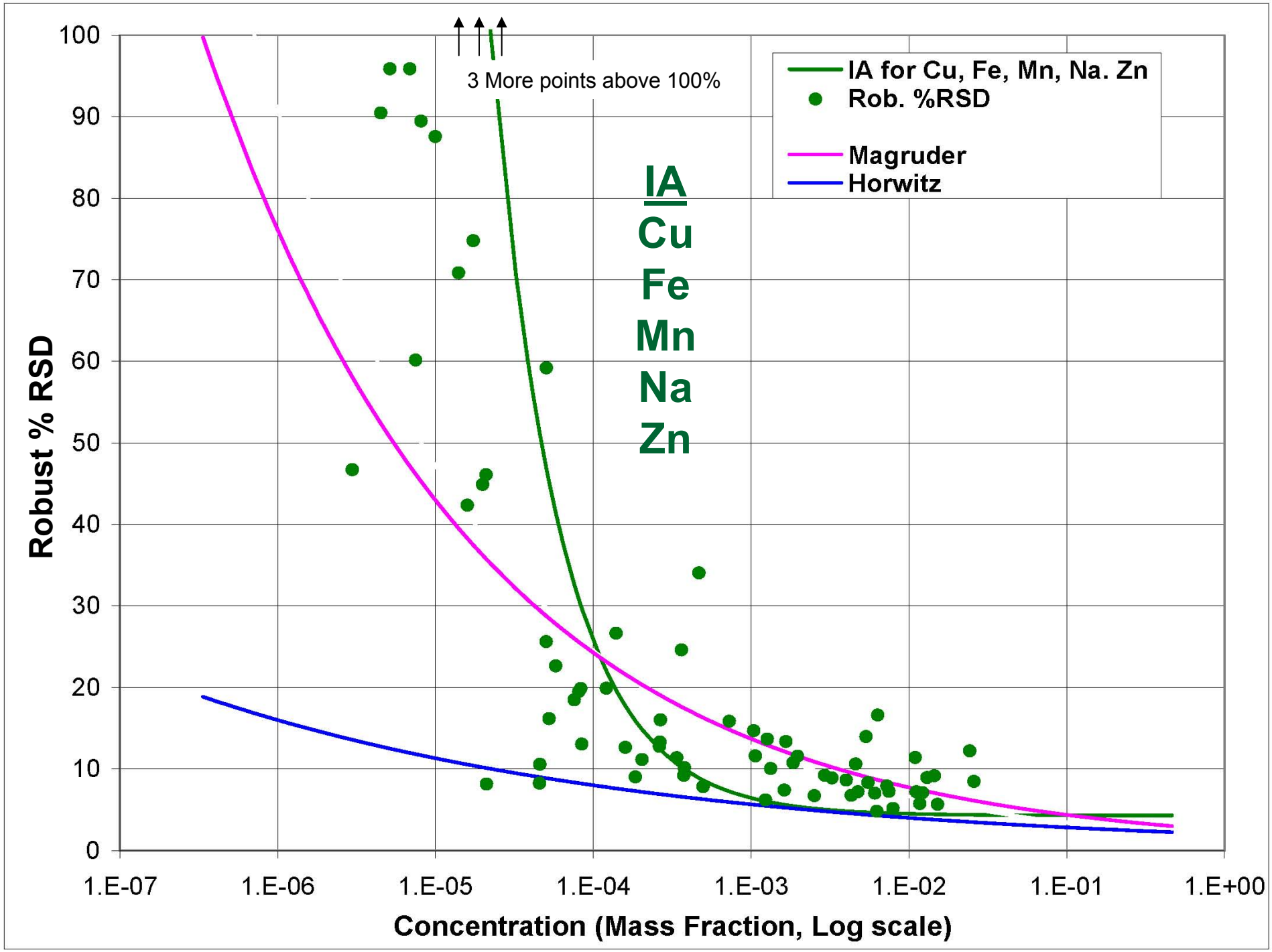

Log(Concentration) vs Log (σ)
206 Magruder Data Points (2017 to 2018)
Log(σ) = 0.7518 x C – 1.608
R² = 0.9528
Antilog: σ = 0.0247 x C^0.7518
Magruder % RSD = 2.47 x C^-0.2482
Horwitz % RSD = 2.00 x C^-0.1505
Log(Reproducibility SD)
Log Concentration (Mass Fraction)
-1
-2
-3
-4
-5
-6
-7
-8
-7
-6
-5
-4
-3
-2
-1
0

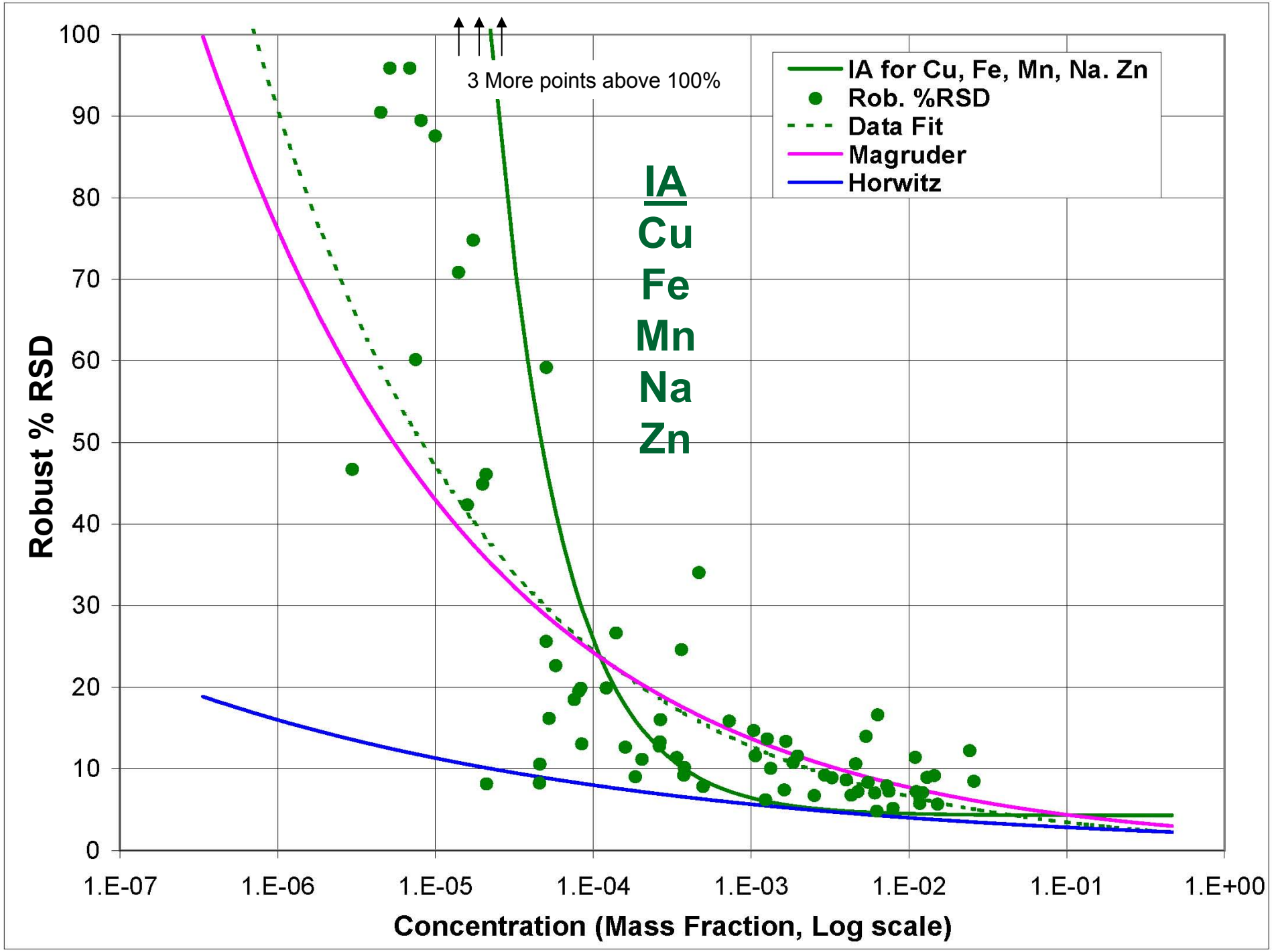

Magruder Tumpet
Horwitz Trumpet
The Horwitz Trumpet
100
80
60
40
20
100 ppb
1 ppm
10 ppm
100 ppm
0.1 %
1 %
10 %
100 %
Units Across Log Scale
± % RSD
-20
-40
-60
-80
-100
Horwitz % RSD = 2.00 x C-0.1505
Magruder % RSD = 2.27 x C-0.2482
The Magruder Trumpet
1.E-07
1.E-06
1.E-05
1.E-04
1.E-03
1.E-02
1.E-01
1.E+00
Concentration (Mass Fraction, Log scale)

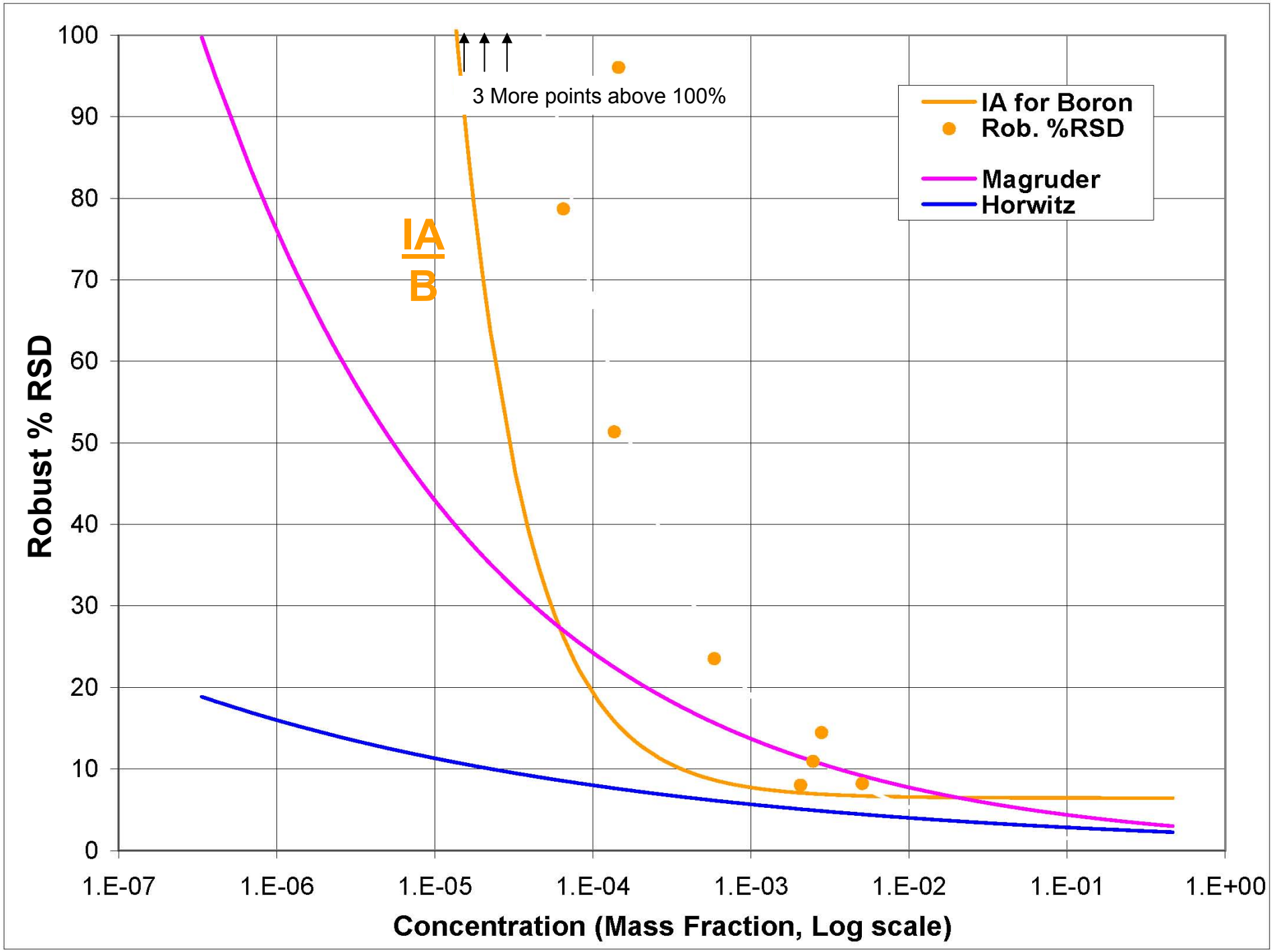

Magruder Tumpet
Horwitz Trumpet
NPK
Ca, Mg, S
B
Cu, Fe, Mn, Na, Zn
Co, Mo
206 Magruder Data Points (2017 to 2018)
Rob. Mean
Magruder % RSD = 2.27 x C-0.2482
Horwitz % RSD = 2.00 x C-0.1505
± % RSD
100
80
60
40
20
0
-20
-40
-60
-80
-100
1.E-07
1.E-06
1.E-05
1.E-04
1.E-03
1.E-02
1.E-01
1.E+00
Concentration (Mass Fraction, Log scale)

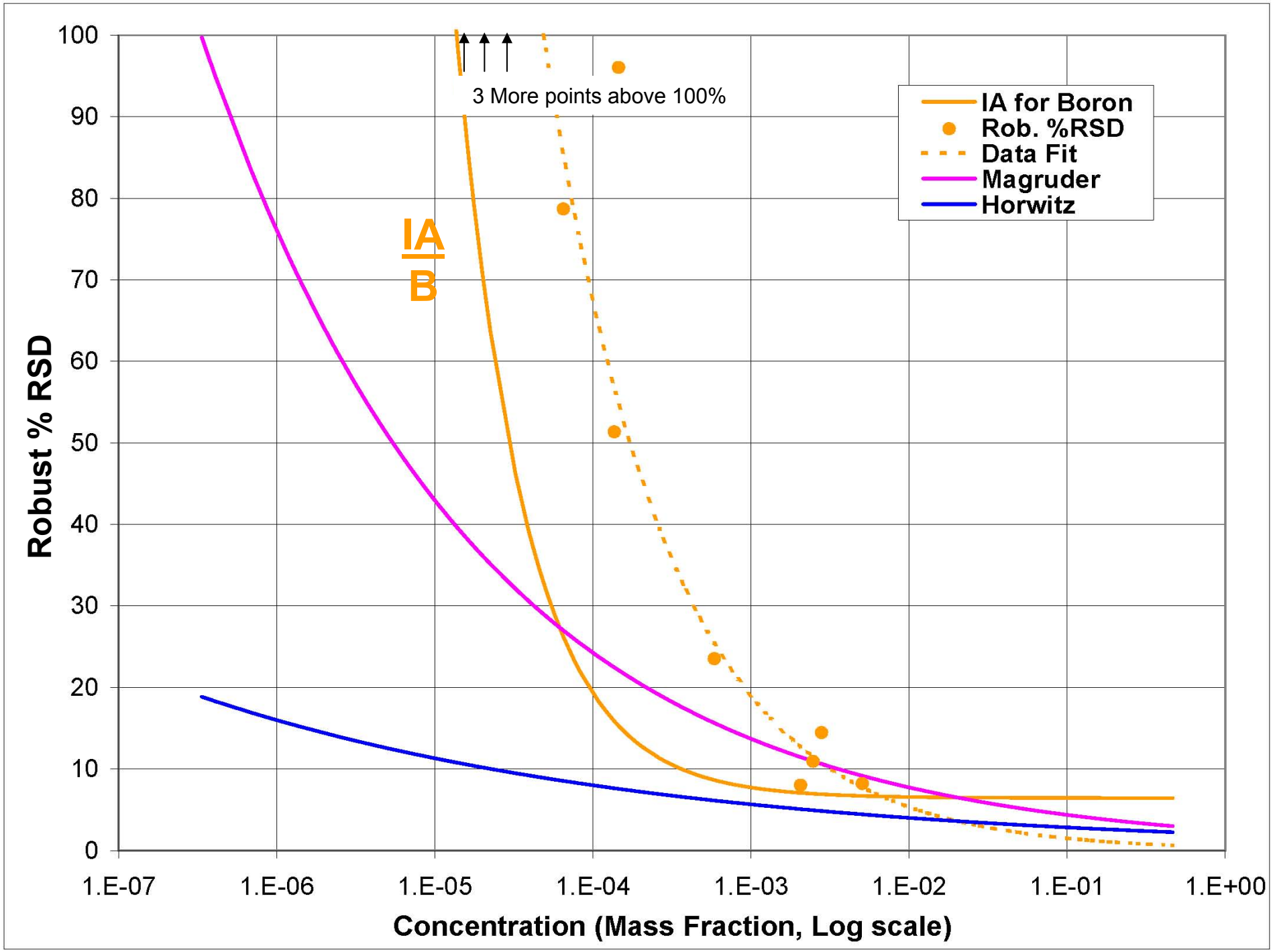

2 More points above 100%
IA for Ca, Mg, S
Rob. %RSD
Magruder
Horwitz
IA
Ca
Mg
S
Robust % RSD
Concentration (Mass Fraction, Log scale)
100
90
80
70
60
50
40
30
20
10
0
1.E-07
1.E-06
1.E-05
1.E-04
1.E-03
1.E-02
1.E-01
1.E+00

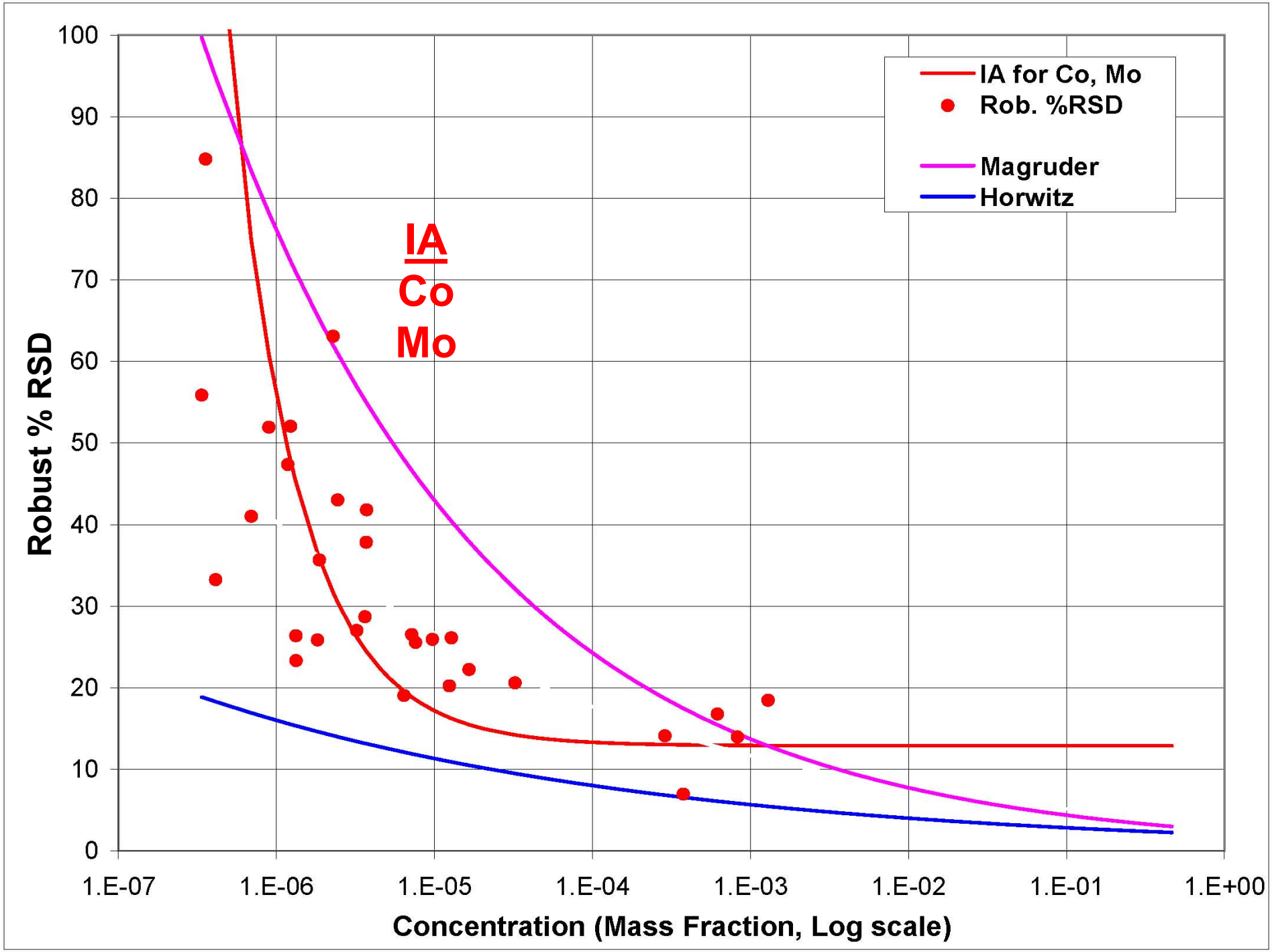

2 More points above 100%
IA for Ca, Mg, S
Rob. %RSD
Data Fit
Magruder
Horwitz
IA
Ca
Mg
S
Robust % RSD
Concentration (Mass Fraction, Log scale)
100
90
80
70
60
50
40
30
20
10
0
1.E-07
1.E-06
1.E-05
1.E-04
1.E-03
1.E-02
1.E-01
1.E+00

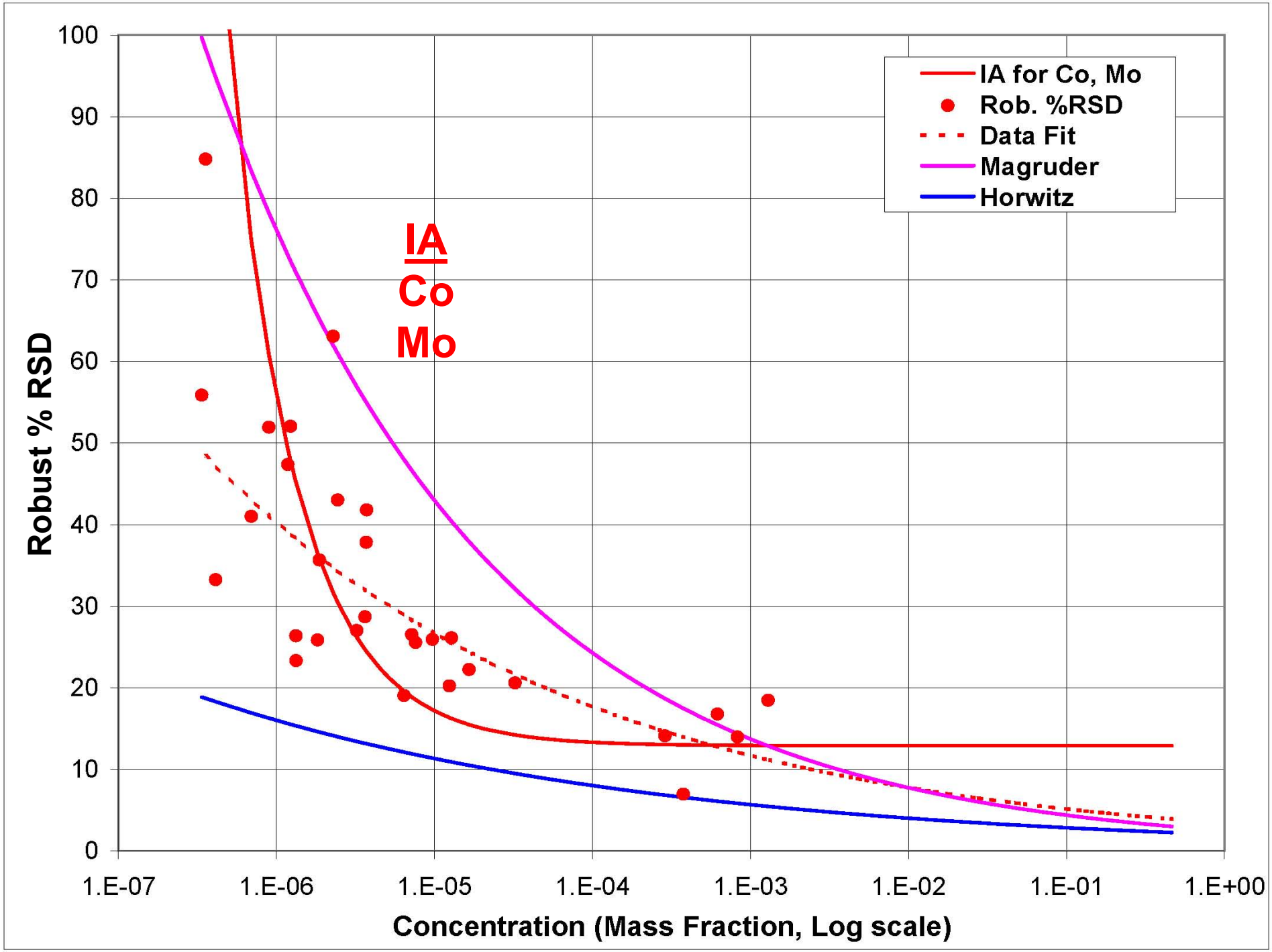

3 More points above 100%
IA for Cu, Fe, Mn, Na. Zn
Rob. %RSD
Magruder
Horwitz
IA
Cu
Fe
Mn
Na
Zn
Robust % RSD
Concentration (Mass Fraction, Log scale)
100
90
80
70
60
50
40
30
20
10
0
1.E-07
1.E-06
1.E-05
1.E-04
1.E-03
1.E-02
1.E-01
1.E+00


3 More points above 100%
IA for Cu, Fe, Mn, Na. Zn
Rob. %RSD
Data Fit
Magruder
Horwitz
IA
Cu
Fe
Mn
Na
Zn
Robust % RSD
Concentration (Mass Fraction, Log scale)
100
90
80
70
60
50
40
30
20
10
0
1.E-07
1.E-06
1.E-05
1.E-04
1.E-03
1.E-02
1.E-01
1.E+00


100
90
80
70
60
50
40
30
20
10
0
Robust % RSD
1.E-07
1.E-06
1.E-05
1.E-04
1.E-03
1.E-02
1.E-01
1.E+00
Concentration (Mass Fraction, Log scale)
3 More points above 100%
IA
B
IA for Boron
Rob. %RSD
Magruder
Horwitz


100
90
80
70
60
50
40
30
20
10
0
Robust % RSD
1.E-07
1.E-06
1.E-05
1.E-04
1.E-03
1.E-02
1.E-01
1.E+00
Concentration (Mass Fraction, Log scale)
3 More points above 100%
IA
B
IA for Boron
Rob. %RSD
Data Fit
Magruder
Horwitz


IA for Co, Mo
Rob. %RSD
Magruder
Horwitz
IA
Co
Mo
Robust % RSD
100
90
80
70
60
50
40
30
20
10
0
1.E-07
1.E-06
1.E-05
1.E-04
1.E-03
1.E-02
1.E-01
1.E+00
Concentration (Mass Fraction, Log scale)


IA for Co, Mo
Rob. %RSD
Data Fit
Magruder
Horwitz
IA
Co
Mo
Robust % RSD
Concentration (Mass Fraction, Log scale)
100
90
80
70
60
50
40
30
20
10
0
1.E-07
1.E-06
1.E-05
1.E-04
1.E-03
1.E-02
1.E-01
1.E+00

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Review of Equations

Analyte	IA from OP % * AV + Unit	Data Fit to $A*C^B$
Ca, Mg, S	0.05 * AV + 0.02	$0.025 * C^{0.6854}$
Cu, Fe, Mn, Na, Zn	0.10 * AV + 0.005	$0.018 * C^{0.7158}$
Co, Mo	0.3 * AV + 1	$0.034 * C^{0.8210}$
Overall Magruder Curve	na	$0.025 * C^{0.7518}$

AV = Assigned Value or Rob. Mean.
C = Assigned Value as mass fraction.

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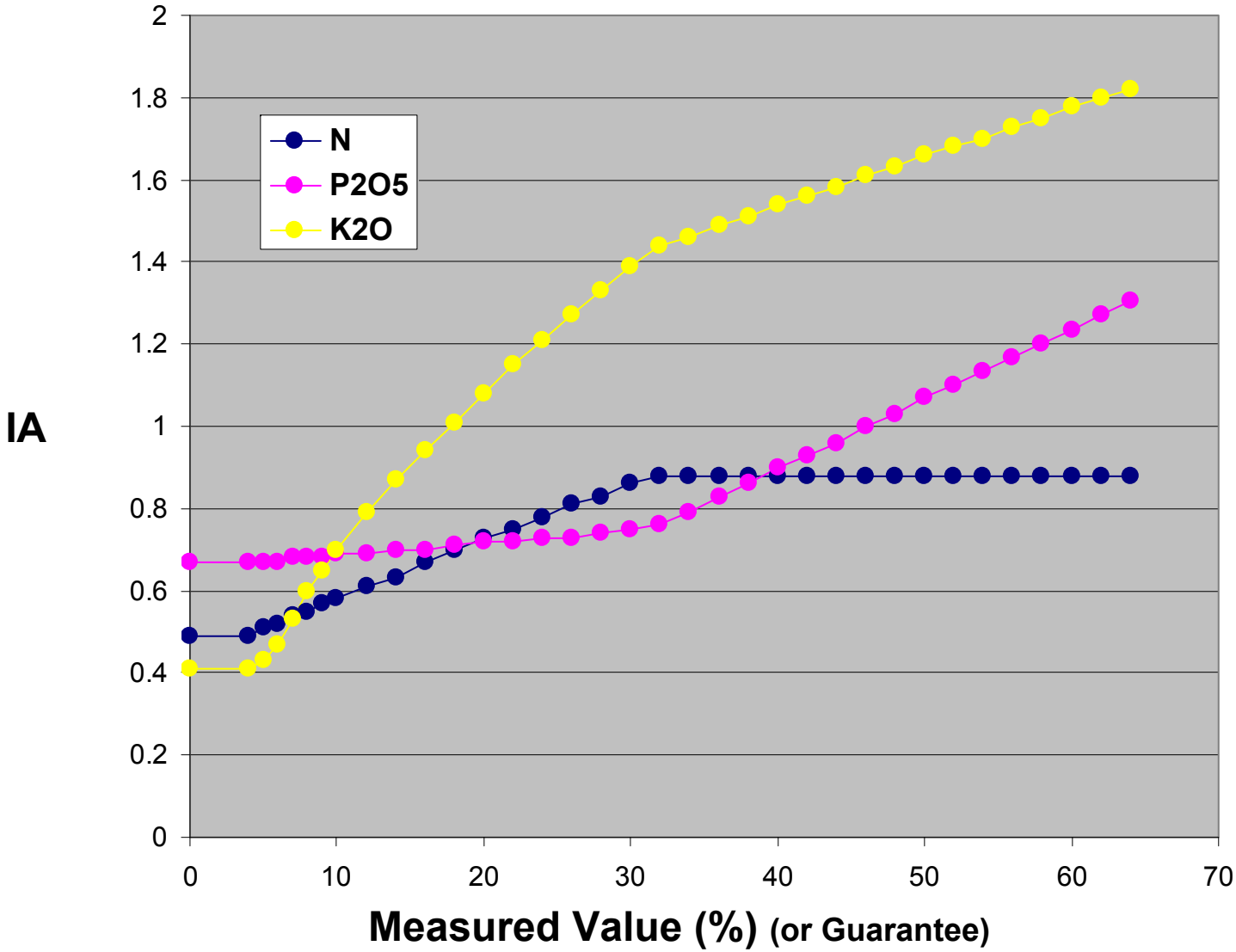
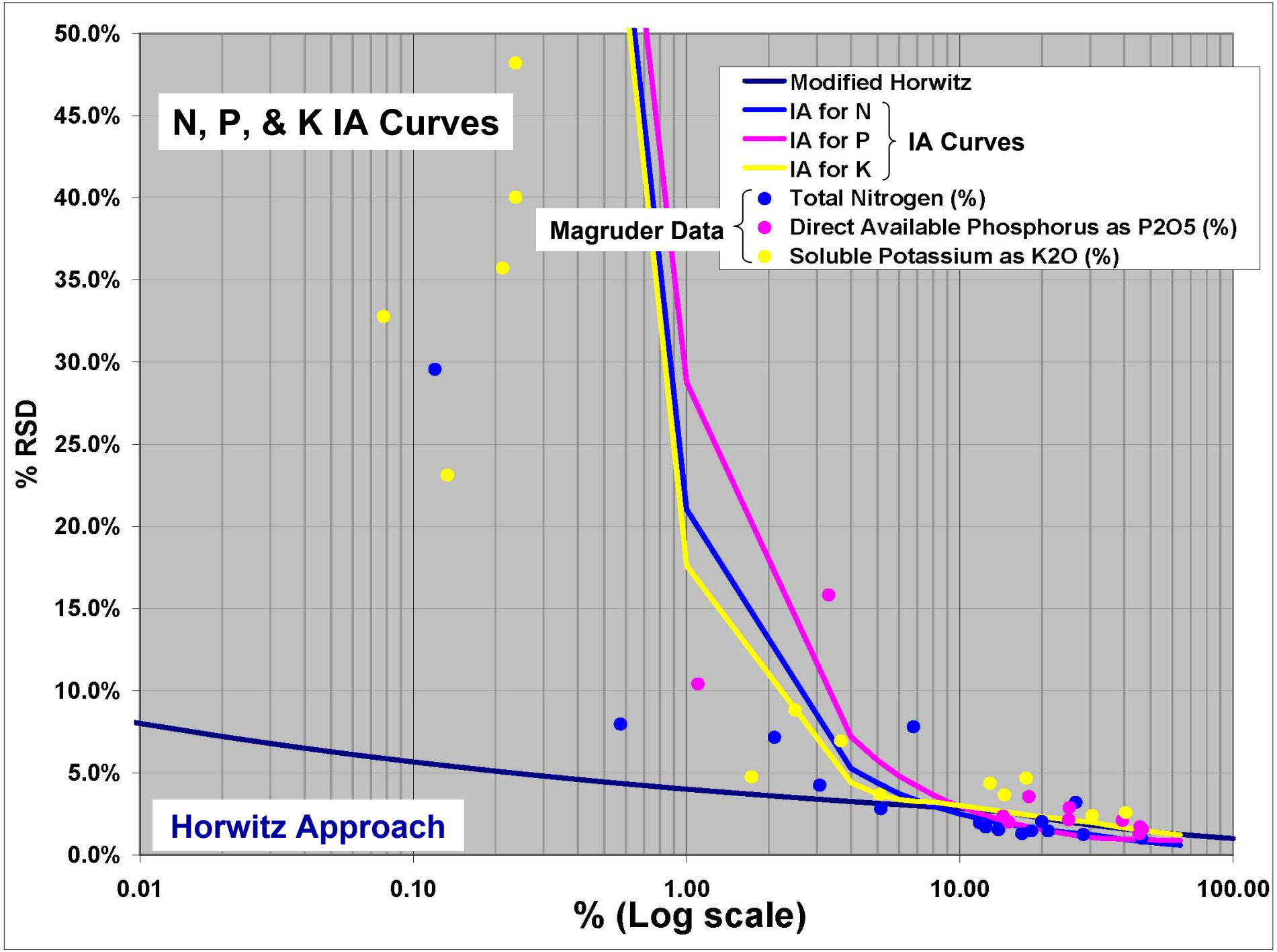
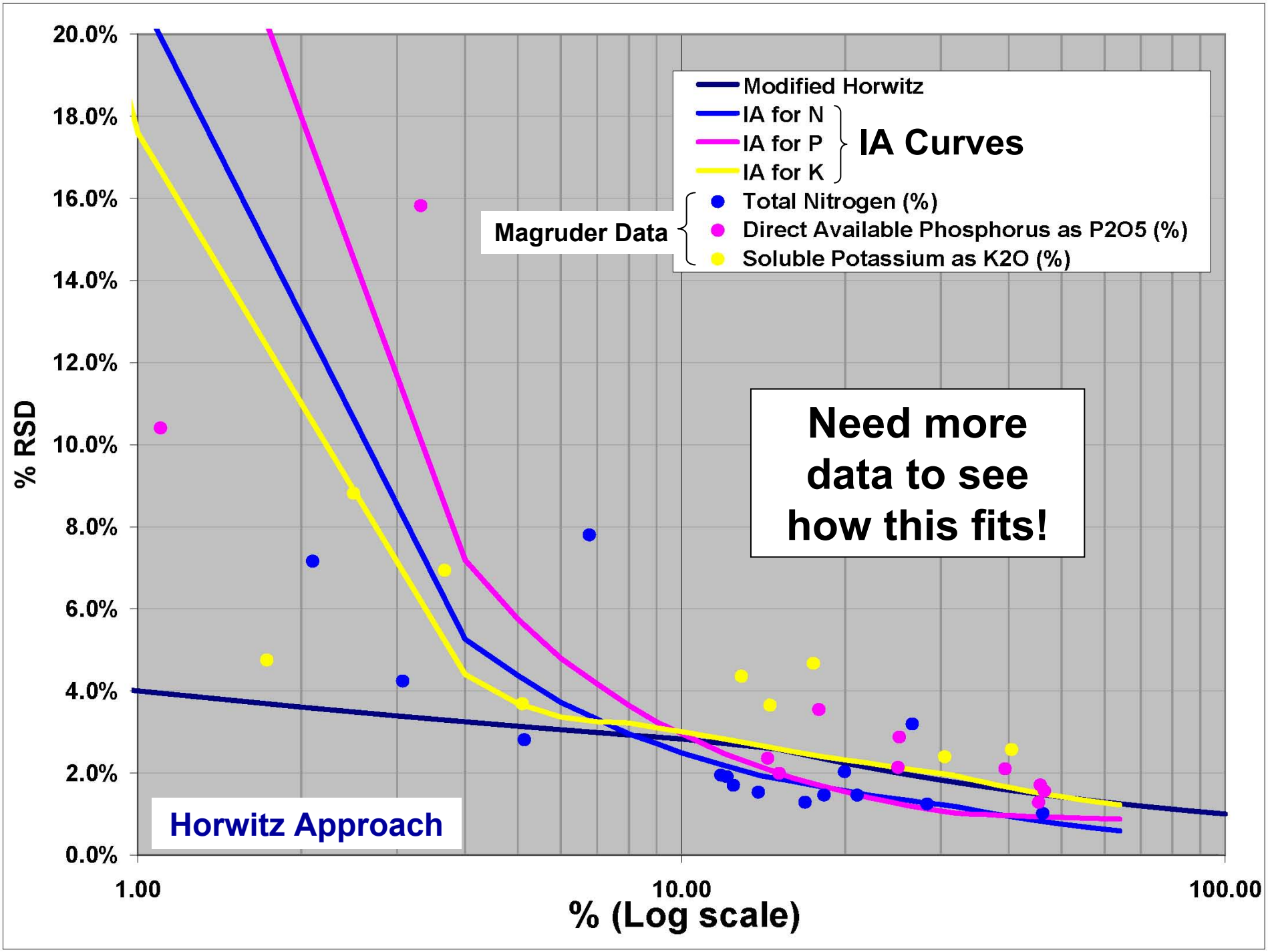
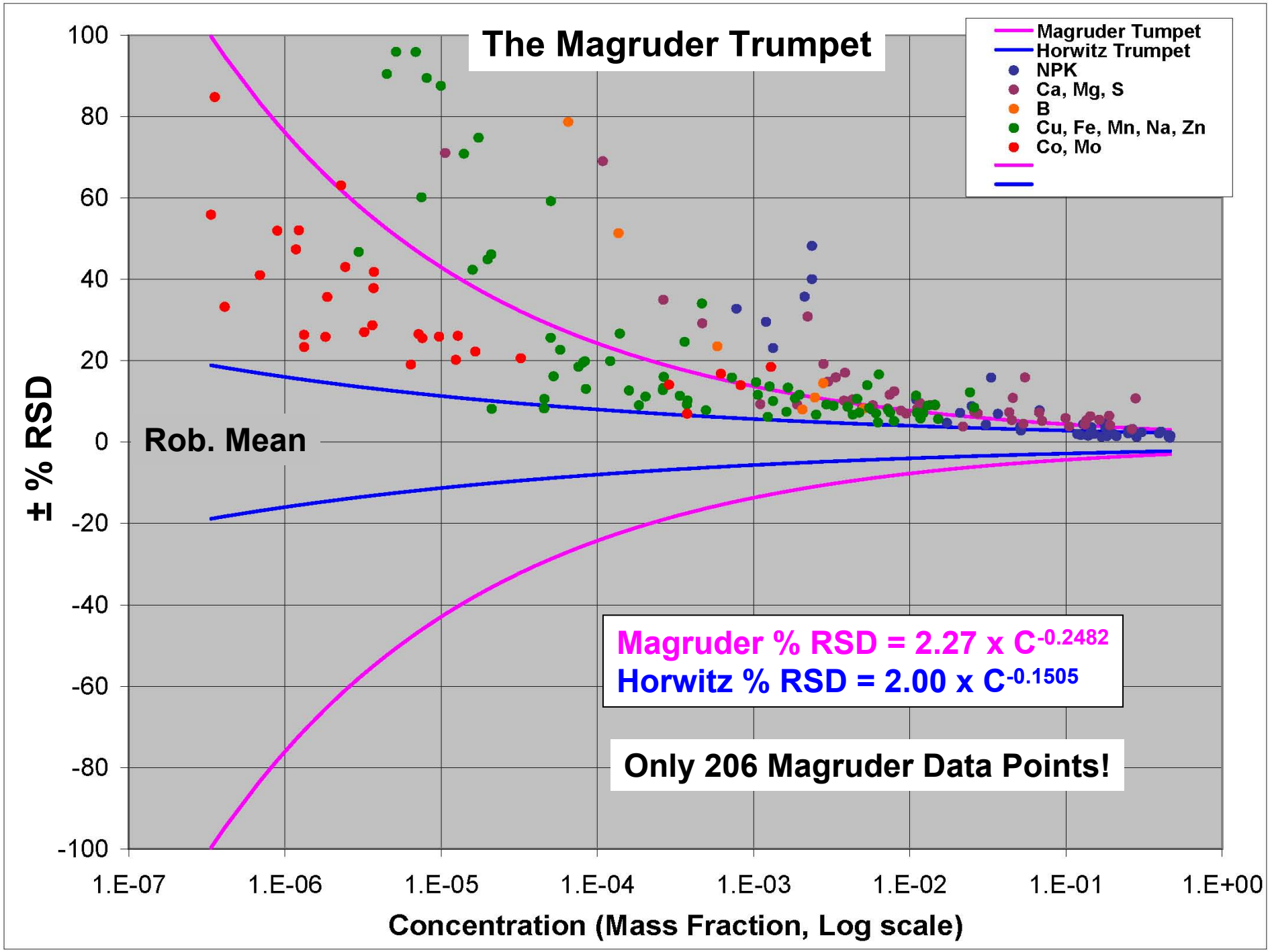
N-P-K IA Table Values
(Plotted from OP)



From: AAPFCO OP


N, P, & K IA Curves
Modified Horwitz
IA for N
IA for P
IA for K
IA Curves
Magruder Data
Total Nitrogen (%)
Direct Available Phosphorus as P2O5 (%)
Soluble Potassium as K2O (%)
Horwitz Approach
% RSD
50.0%
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.01
0.10
1.00
10.00
100.00
% (Log scale)


20.0%
18.0%
16.0%
14.0%
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
% RSD
1.00
10.00
100.00
% (Log scale)
Modified Horwitz
IA for N
IA for P
IA for K
IA Curves
Magruder Data
Total Nitrogen (%)
Direct Available Phosphorus as P2O5 (%)
Soluble Potassium as K2O (%)
Need more data to see how this fits!
Horwitz Approach


The Magruder Trumpet
Magruder Tumpet
Horwitz Trumpet
NPK
Ca, Mg, S
B
Cu, Fe, Mn, Na, Zn
Co, Mo
Rob. Mean
Magruder % RSD = 2.27 x C-0.2482
Horwitz % RSD = 2.00 x C-0.1505
Only 206 Magruder Data Points!
± % RSD
Concentration (Mass Fraction, Log scale)
100
80
60
40
20
0
-20
-40
-60
-80
-100
1.E-07
1.E-06
1.E-05
1.E-04
1.E-03
1.E-02
1.E-01
1.E+00

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Some Considerations

- In time with more data we can refine the Magruder curve.
- Careful parsing of aberrant data points should make the Magruder Trumpet less like a French Horn.
- The Horwitz curve could provide a useful baseline.

In This Discussion

- Unless pointed out, all reference to IA is to IA_{SD}.
- This describes 68% of the data.
- It is more common to allow 95% or 99%.
- This can be achieved by expanding the IA_{SD} observed or calculated, using Normal curve probability factors – one-tail or two-tail depending on need.

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Summary and Conclusions

- Current IA calculations from the OP tend to be more relaxed at lower concentrations and more punitive at higher concentrations.
- The IA Ratio is the first indicator that the OP IA equations may **not** represent the current status of inter laboratory variance.
- There appears to be a strong Log-Log relationship between the Repeatability SD and Concentration across 7 orders of magnitude.
- The NPK IA equations contain non-linear subtleties. We will need a lot more data to see this.
- As we accumulate more data, the Horwitz like approach may be a way to reevaluate IAs. We do need more data to rule out anomalies hampering the data fit.


MAGRUDER
Questions?