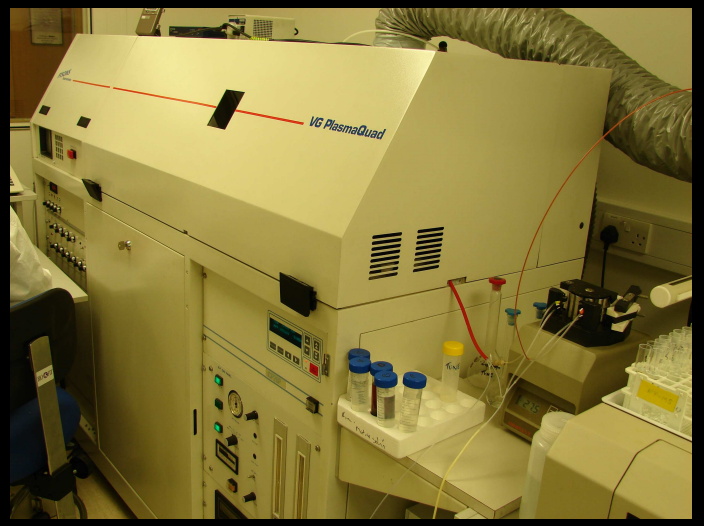
AN INTRODUCTION TO ICP-MS

ICP-MS: What is it????

- The (Inductively Coupled Plasma – Mass Spectrometer (ICP-MS) is an instrument which measures most of the elements in the periodic table.
- The first papers on ICP-MS were published in the 1980s.
- Since that time, many improvements and refinements have been made to each generation of ICP-MS instrumentation.



Which elements can we detect?

[a] The detection limits are based on a 98% confidence level (3 standard deviations).
[b] Identifying a single part per trillion of an element in a solution is analogous to locating a single white raisin in a house (2,700 sq. ft) full of regular raisins.

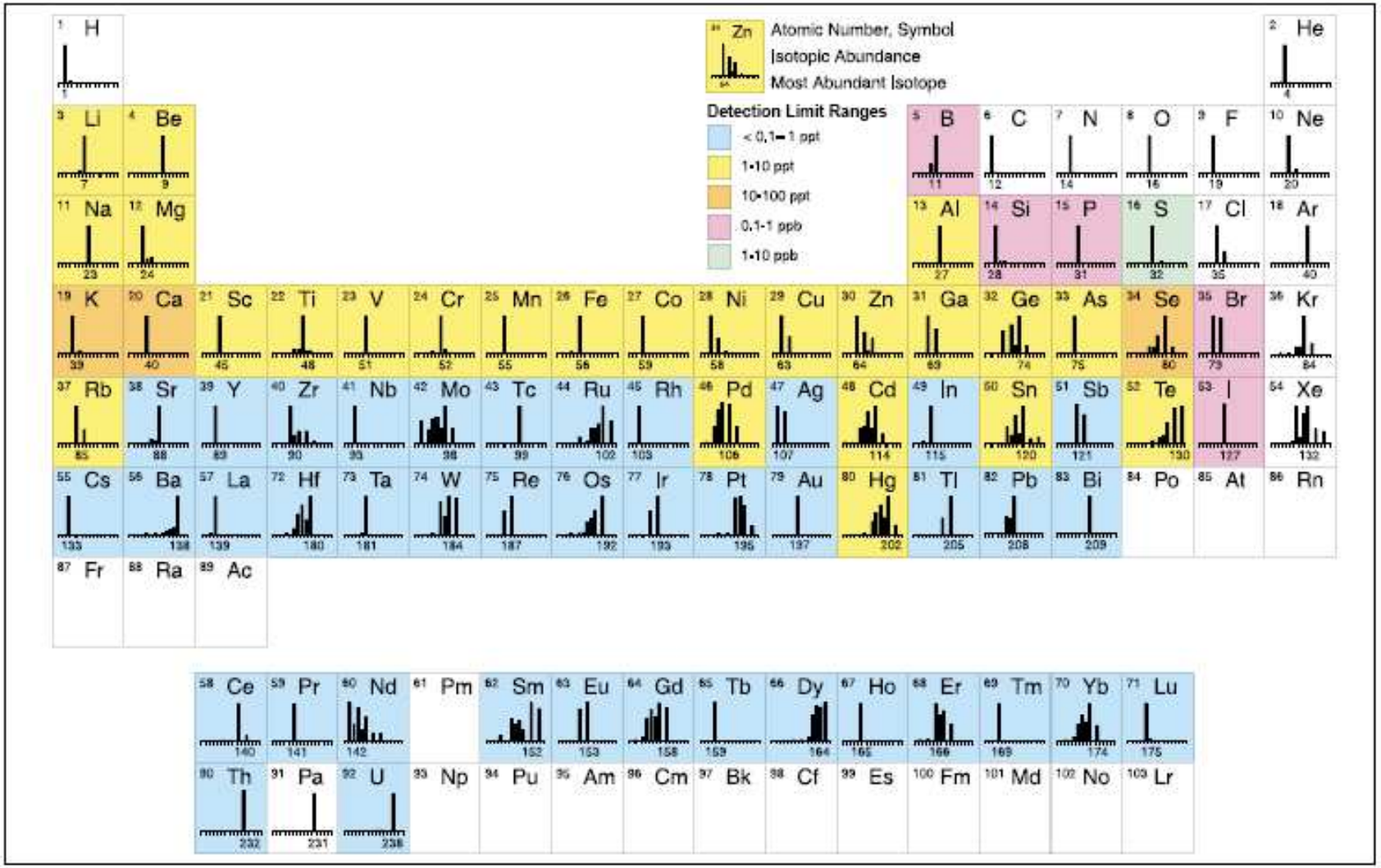


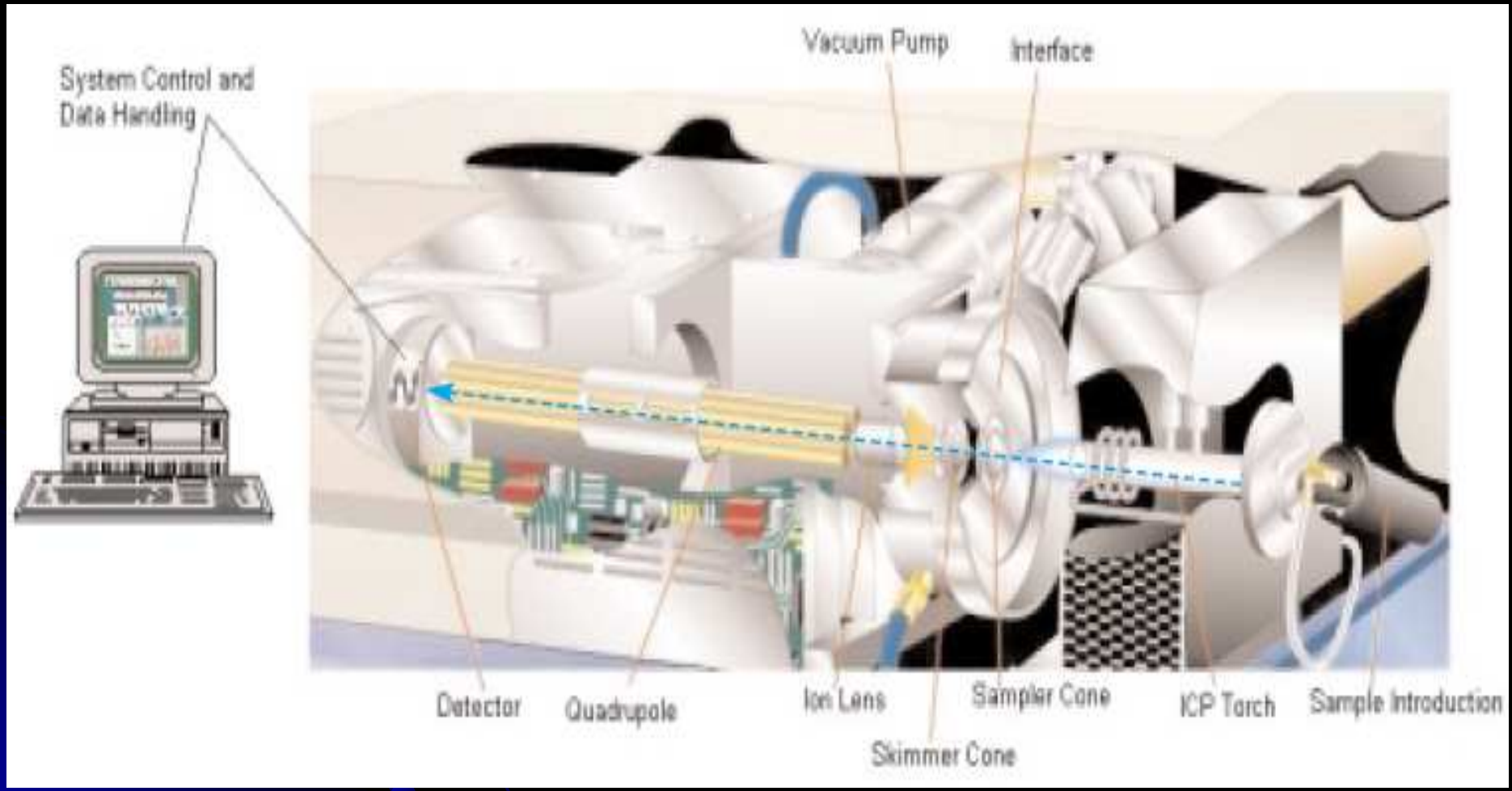
Figure 1. Elements determined by ICP-MS and approximate detection capability.

What does it consist of?

An ICP-MS consists of the following components :

- **Sample Introduction System – consists of the peristaltic pump, nebulizer, and spray chamber and provides the means of getting samples into the instrument.**
- **ICP Torch – generates the plasma which serves as the ion source of the ICP-MS, converting the analyte atoms to ions.**
- **Interface – links the atmospheric pressure ICP ion source and the high vacuum mass spectrometer.**
- **Vacuum System – provides high vacuum for ion optics, quadrupole, and detector.**
- **Lens – focuses ions into a beam for transmission into the quadrupole.**
- **Quadrupole – acts as a mass filter to sort ions by their masstocharge ratio (m/z).**
- **Detector – counts individual ions passing through the quadrupole.**
- **Data Handling and System Controller – controls all aspects of instrument control and data handling to obtain final concentration results.**

The different component parts



How does it work?

Sample introduced into nebulizer → Nebulizer converts samples into small droplets

↓

Droplets carried through spray chamber into the plasma

↙

Plasma ionizes the elements present in the droplet

↘

Ions pass through the interface and are focussed onto the lens

↙

Ions are separated by the MS on the basis of their m/z ratio

↘

Measured by the detector

↙

Data system converts signal intensities into concentration

What are the advantages?

ICP-MS offers many benefits to laboratories performing trace metal determinations:

- **ICP-MS offers detection limits equal to or better than those attainable using Graphite Furnace Atomic Absorption (GFAA) with much higher productivity.**

- **ICP-MS can easily handle both simple and complex sample matrixes.**

- **ICP-MS has detection limit capabilities that are superior to those obtained in Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES).**

Data handling: Drift Correction

♫ Many geochemically important elements including the Rare Earth Elements (REE), are associated chemically with minerals that require alkali fusion for their decomposition.

♫ As a result, the total salt content of the solution for analysis can exceed 2% (w/v).

♫ Even after a 10-fold dilution of these solutions the sampler cone of the ICP-MS can become blocked over a period of time, resulting in a gradual loss of sensitivity.

♫ This loss in sensitivity over time is known as drift and to get accurate estimates of trace elements present in samples we need to correct the ICP-MS outputs for this drift.

♫ Drift correction is achieved with the help of an in-house MS-DOS based program called Turbo-Pascal.

Preparation of data for drift correction

MS-Excel File

Run	Label	TimeStamp	75As	82Se	115In
0			85	91	146
1	blank	########	24.406	4.892	-626.125
2	blank	########	-10.739	-2.669	97.318
3	blank	########	-10.04	-2.223	528.807
	Mean of bla	########	1.209	0	0
	SD of blank		20.092	4.242	583.584
	%RSD of blank		1662.256	0	0
1	2.5ppb	########	1098.738	-1.89	-74008.96
2	2.5ppb	########	1020.949	-9.003	-73247.28
3	2.5ppb	########	1036.614	-3.885	-73108.87
	Mean of 2.5	########	1052.1	-4.926	-73455.03
	SD of 2.5ppb		41.142	3.669	484.678
	%RSD of 2.5ppb		3.91	74.476	0.66
1	5ppb	########	2286.099	-0.777	-45319.23
2	5ppb	########	2283.366	-1.334	-45273.43
3	5ppb	########	2310.966	-2.111	-46402.04
	Mean of 5p	########	2293.477	-1.407	-45664.9
	SD of 5ppb		15.208	0.67	638.791
	%RSD of 5ppb		0.663	47.611	1.399
1	10ppb	########	4275.288	-3.775	3849.193
2	10ppb	########	3982.383	-2.997	921.24
3	10ppb	########	3937.159	-7.78	-207.863
	Mean of 10	########	4064.943	-4.851	1520.857
	SD of 10ppb		183.562	2.566	2093.939
	%RSD of 10ppb		4.516	52.906	137.682
1	50ppb	########	19438.93	-7.11	362272.6
2	50ppb	########	19152.46	-1.664	394345.8
3	50ppb	########	20407.24	-2.554	414391.1
	Mean of 50	########	19666.21	-3.776	390336.5
	SD of 50ppb		657.542	2.921	26289.54
	%RSD of 50ppb		3.344	77.363	6.735
1	proc blank	########	138.794	5.365	-105052.5
2	proc blank	########	122.143	4.474	-105062
3	proc blank	########	108.156	2.028	-105053.1
	Mean of pro	########	123.031	3.956	-105055.9
	SD of proc blank		15.338	1.728	5.3
	%RSD of proc blank		12.467	43.681	0.005

CSV (MS-DOS) File

Run	Label	TimeStamp	75As	82Se	115In
0			85	91	146
1	blank	########	24.406	4.892	-626.125
2	blank	########	-10.739	-2.669	97.318
3	blank	########	-10.04	-2.223	528.807
	Mean of bla	########	1.209	0	0
	SD of blank		20.092	4.242	583.584
	%RSD of blank		1662.256	0	0
1	2.5ppb	########	1098.738	-1.89	-74008.96
2	2.5ppb	########	1020.949	-9.003	-73247.28
3	2.5ppb	########	1036.614	-3.885	-73108.87
	Mean of 2.5	########	1052.1	-4.926	-73455.03
	SD of 2.5ppb		41.142	3.669	484.678
	%RSD of 2.5ppb		3.91	74.476	0.66
1	5ppb	########	2286.099	-0.777	-45319.23
2	5ppb	########	2283.366	-1.334	-45273.43
3	5ppb	########	2310.966	-2.111	-46402.04
	Mean of 5p	########	2293.477	-1.407	-45664.9
	SD of 5ppb		15.208	0.67	638.791
	%RSD of 5ppb		0.663	47.611	1.399
1	10ppb	########	4275.288	-3.775	3849.193
2	10ppb	########	3982.383	-2.997	921.24
3	10ppb	########	3937.159	-7.78	-207.863
	Mean of 10	########	4064.943	-4.851	1520.857
	SD of 10ppb		183.562	2.566	2093.939
	%RSD of 10ppb		4.516	52.906	137.682
1	50ppb	########	19438.93	-7.11	362272.6
2	50ppb	########	19152.46	-1.664	394345.8
3	50ppb	########	20407.24	-2.554	414391.1
	Mean of 50	########	19666.21	-3.776	390336.5
	SD of 50ppb		657.542	2.921	26289.54
	%RSD of 50ppb		3.344	77.363	6.735
1	proc blank	########	138.794	5.365	-105052.5
2	proc blank	########	122.143	4.474	-105062
3	proc blank	########	108.156	2.028	-105053.1
	Mean of pro	########	123.031	3.956	-105055.9
	SD of proc blank		15.338	1.728	5.3
	%RSD of proc blank		12.467	43.681	0.005

Performing drift correction

We will look at how we do drift correction with DBSCORR, in Dr. Polya's Lab.

So, lets proceed folks!!!!!