Positive Probability Ltd

Note M6: ICP-MS – Rare Earth Interferences

Introduction

The plasma in an ICP mass spectrometer is at sufficiently high temperature than most inorganic compounds are reduced to their elements. However, there are a large number of short-lived compounds that survive long enough to be detected. For example, the argon carrier gas will react to produce ArO and ArN. If HCl was used to digest the sample, then ArH and ArCl will be detected. In addition, some oxides are reluctant to break down completely and, whe barium is present, BaO is frequently detected. These non-elemental species are called interferences and there are at least twice as many of these as there are elements.

It follows that for around 92 atomic numbers – hydrogen to uranium – tthere are more than 300 elements and interferences to be considered. Since the data always contains noise, it means that there are many situations where the conventional algebraic methods of analysis fail. However, the ***Element™*** program uses ***ReSpect™*** to generate the most plausible reconstruction of the data within the noise level from a table of the isotope patterns for all the elements and known interferences.

Data and Data Processing

The data presented here are a mixture of rare earths requiring analysis. Data were acquired over the mass range 140-176 and covered the elements Ce to Hf. Also present was an excess of Ba with 7 isotopes from 130-138 but these were outside the acquisition range. Ba was expected to produce BaO as an interference with 11 isotopes from 146-156. The aim was to exclude BaO from the list of possible interferences and see if ***Element™*** detected it, since for these data, it is not detected using conventional algebraic analysis. BaO was then included in the list of interferences and the program rerun.

This experiment presented a surprise result in that a second, generally unconsidered interference was identified – BaOH. The program was therefore run including BaO and BaOH as interferences.

Results and Discussion

Figure 1 below shows the raw data (plotted as the square root of the intensities so that the weak peaks are visible), the misfit between the data and its reconstruction ignoring BaO and BaOH and the corresponding misfits when these are included.

When only the elements are included in the list of species to be considered there are serious misfits at 154 & 155. It is reasonable to assume that 154 corresponds to BaO and this misfit disappears when this is included as an interference. However, the misfit at 155 remains. Although La was not present in the mixture, LaO would be expected at 155 but its inclusion has almost no effect because its isotope pattern does not fit the data. Somewhat surprisingly, the misfit was reduced to the noise level by including BaOH in the list of interferences. The presence of BaOH was later confirmed by high resolution measurements.

The fully quantified results are shown in the table below. Intensities are expressed as a percent of the total intensity of the species found over the acquired data range.

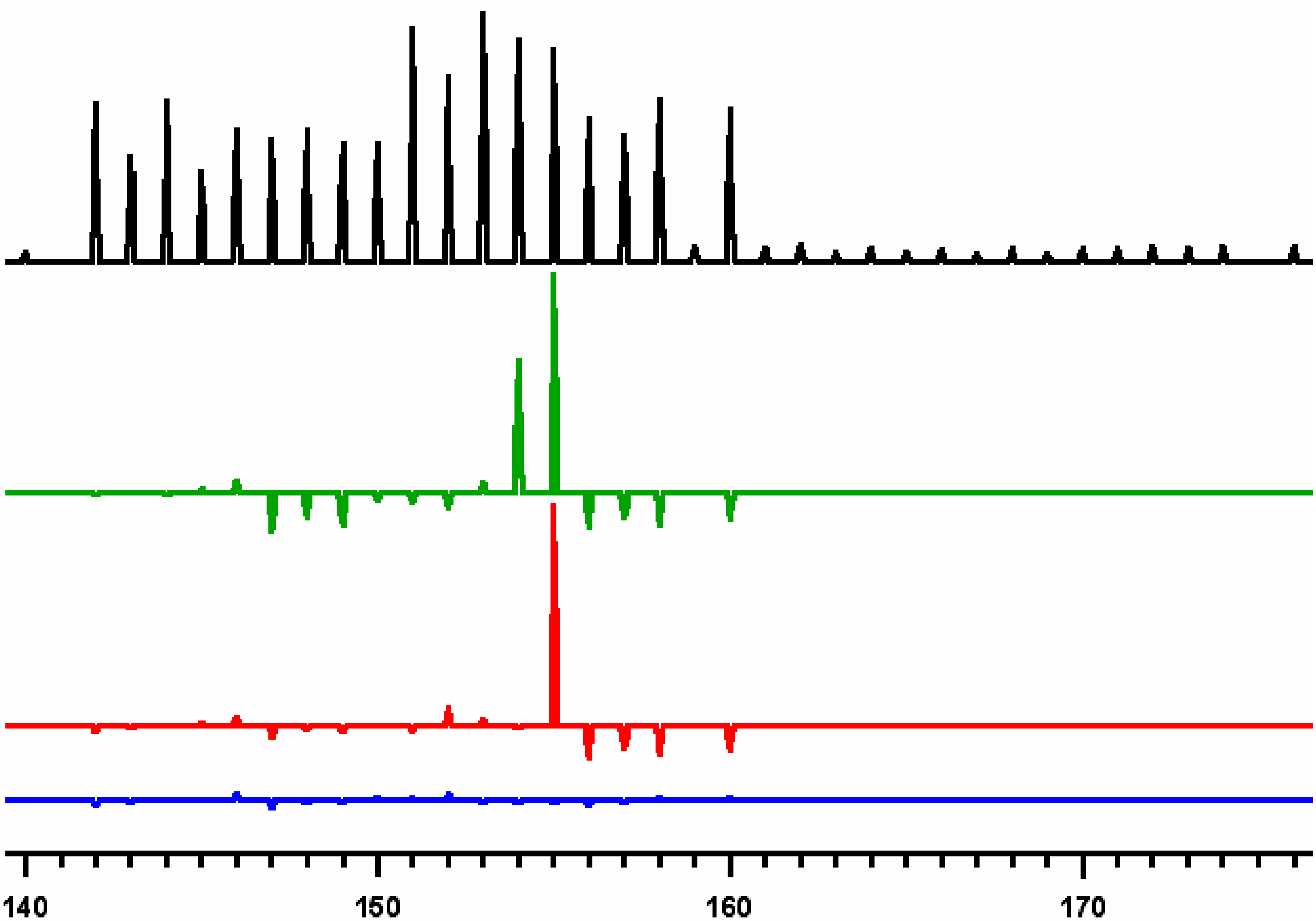

Figure 1. Square root of raw data (black); Misfit ignoring BaO & BaOH (green); Misfit including BaO (red); Misfit including both BaO & BaOH (blue).

Quantified Results Table

Species	% of Total	Error	Species	% of Total	Error
Ce	0.0205	0.0005	Ho	0.0174	0.0005
Pr	0.0000	0.0000	Er	0.0870	0.0010
Nd	19.5541	0.0155	Tm	0.0114	0.0004
Sm	22.1774	0.0165	Yb	0.2096	0.0016
Eu	22.1176	0.0164	Lu	0.0000	0.0000
Gd	21.9097	0.0164	Hf	0.0000	0.0000
Tb	0.0495	0.0008	BaO	5.2833	0.0080
Dy	0.1402	0.0013	BaOH	8.4224	0.0101

Conclusions

This example illustrates the benefit of data reconstruction methods in that they are capable of allowing interferences to be identified and taken into account so that fully quantified results may be obtained.