Capabilities of single particle ICP-MS as a tool for the identification of colloidal mineral phases in natural samples.

Sequential vs simultaneous acquisition.

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INTRODUCTION

In this study, using the capability of the ICP-MS for multi-elemental analysis and for single-particle measurement, two qualitative and/or quantitative methodologies are proposed for the identification of the different mineral phases in natural samples. First, operating ICP - sector-field MS (Element II from ThermoScientific), a sequential approach for the distinction of 2 different clay minerals and 1 aluminium oxide at sub-femtomole per element (i.e. Al, Si, Fe, Ti, Mg) per particle was achieved. Then, using an ICP - time-of-flight MS (Vitesse from Nu Instruments), the simultaneous multi-elemental analysis allowed determining the distribution of multiple elements in individual colloids.

SAMPLE PREPARATION

A Suspend in a 50 mL tube 100 mg L⁻¹ and 50 mg L⁻¹ for clays and Al₂O₃, respectively; B shake for 2 min & let settle for 15 hours, C sample top 10 mL.

Sequential acquisition

- Dwell-time = 1 ms
- Data point = 20000
- Analysis time = 80 s

Simultaneous acquisition

- Dwell-time = 0.0765 ms
- Data point = 840000
- Analysis time = 64 s

All the following steps were programmed on Matlab for the data treatment after sequential acquisition:

- Conversion intensity to mass using the regression parameters and the nebulization efficiency
- Conversion mass to mole using the molar mass
- Ascending sorting of the mole for each element individually
- Addition of the mole of Al, Fe, Mg and Ti
- Plot (n[Al]+Fe+Ti+Mg) vs n[Si]

Data treatment steps are integrated in Vitesse software. Comparisons are visualised using Nu Quant² charts to allow a quick review of the data. Final data choices are then exported in a CSV file used to plot the following publication ready graphs.

- Sequential acquisition allows the differentiation of the mineral phases. However, it is impossible to determine the elemental ratio distribution of individual particles.
- Simultaneous acquisition shows that elemental ratios in the colloids are not perfectly distributed and highlights the presence of impurities in the mineral samples.

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REFERENCES

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2. Pace et al., Analytical Chemistry (2011)