MARIE CURIE ACTIONS

Insights into the fractionation of stable isotopes of post-transition elements: Humidity cell study of tailings from Kidd Creek

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I – Stable Isotopes

MARIE CURIE ACTIONS

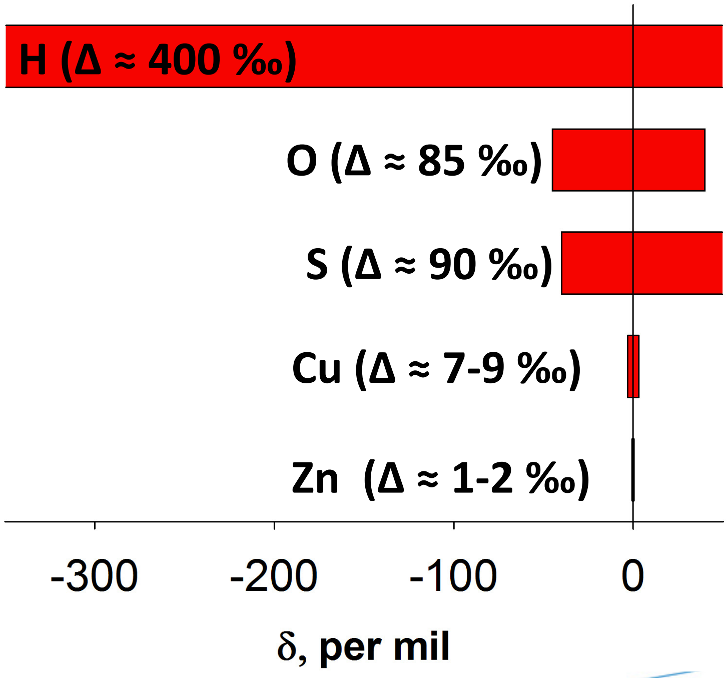
- 1912 Thomson identified the occurrence of isotopes (Ne)
- 83 naturally occurring stable elements; ¾ have 2 or more stable isotopes
- Delta notation

$$\delta^x E = \frac{\frac{x}{y}E_{spl}}{\frac{x}{y}E_{std}} - 1$$

x>y

II – Non-Traditional Stable Isotopes

R	2/1 H	13/12 C	65/63 Cu
$\Delta m/m_{avg}$	66.666 %	8 %	1.56 %



II – Non-Traditional Stable Isotopes

IRMS – Isotope Ratio Mass Spectrometer, e.g.: Cl, Br

TIMS – Thermal Ionization Mass Spectrometer, e.g.: Ca, Os, Pb, Sr, Nd, U, Th

MC-ICP-MS – Multi Collector Inductively Coupled Plasma Mass Spectrometer, e.g.: Mg, Cu, Zn, Ge, Tl, Hf, W

***In situ* analysis :**

SIMS – Secondary Ion Mass Spectrometer

Laser Ablation – MC-ICP-MS

II – Non-Traditional Stable Isotopes

- Present-day and paleo-environmental systems
- Tracing of pollution (metal contaminants, water, atmosphere, anthropogenic vs natural)
- Redox processes and paleo redox processes
- Plant nutrition cycles
- Biomarkers

III – Zinc

- 5 stable isotopes:

  64 Zn: 48.63%

  66 Zn: 27.90%

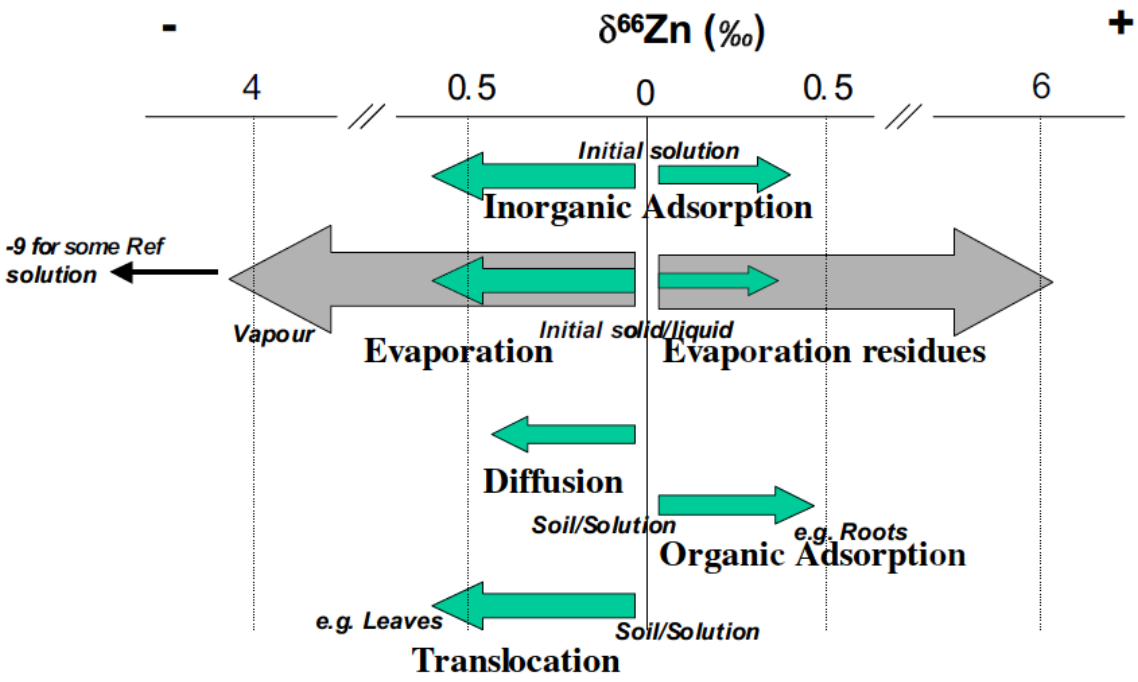
  67 Zn: 4.1%

  68 Zn: 18.75%

  70 Zn: 0.62%

- First ionization energy: 9.39 eV
- Oxidation states: 0, 2+ (considered not redox sensitive)
- Relatively volatile at high T
- Important biochemical element

III – Zinc



Cloquet *et al.* 2008

III – Zinc

- Aranda *et al.* 2012: tracer for metal contamination at a mine site in Colorado
- Borrok *et al.* 2008/9: AMD impacted surface water streams in the US and Europe

IV – Kidd Creek Massive Sulfide Deposit

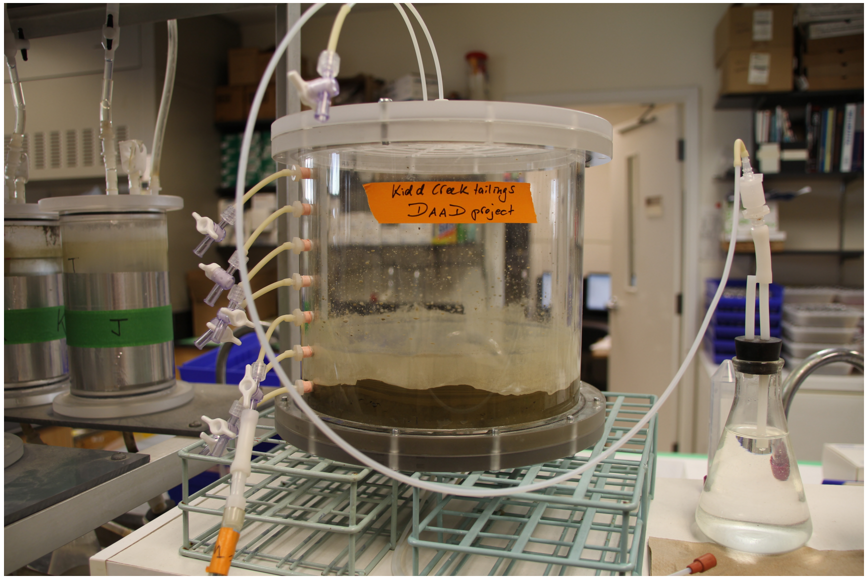
•Tailings impoundment:

- 62 wt% solids
- 12 km^2
- 10-25 wt% pyrite, 1-2 wt% pyrrhotite, 1-2 wt% sphalerite and chalcopyrite (+ secondary Cu and Ag sulfides)
- Not radioactive

•Earlier studies on the tailing's leaching potential:

- pH plateaus at 5.7, 4.0 and 1.3
- Buffering through dissolution of ankerite-dolomite, siderite, gibbsite, aluminosilicates
- Elevated release of Cd, Co, Cr, Ni, Pb, V, **Zn**

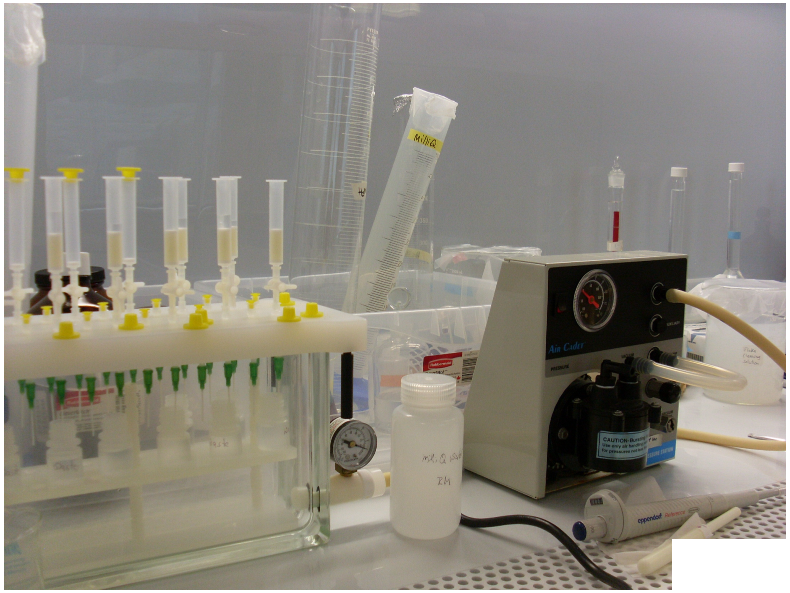
V – Methodology

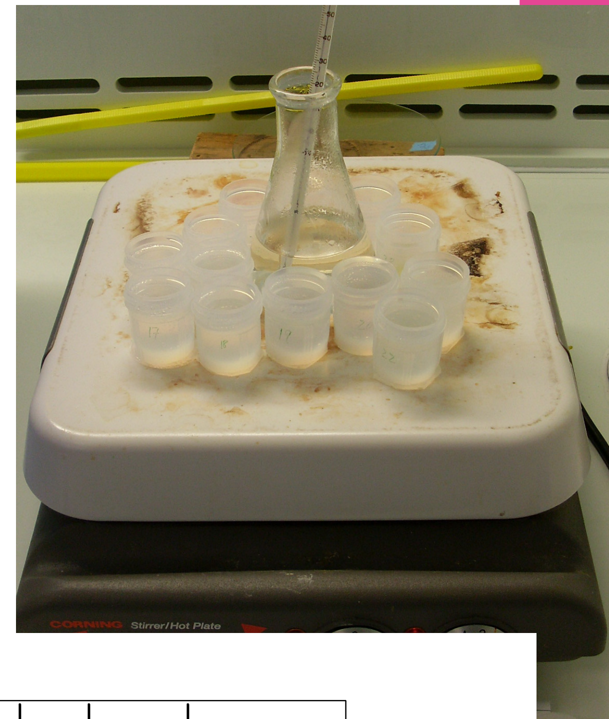


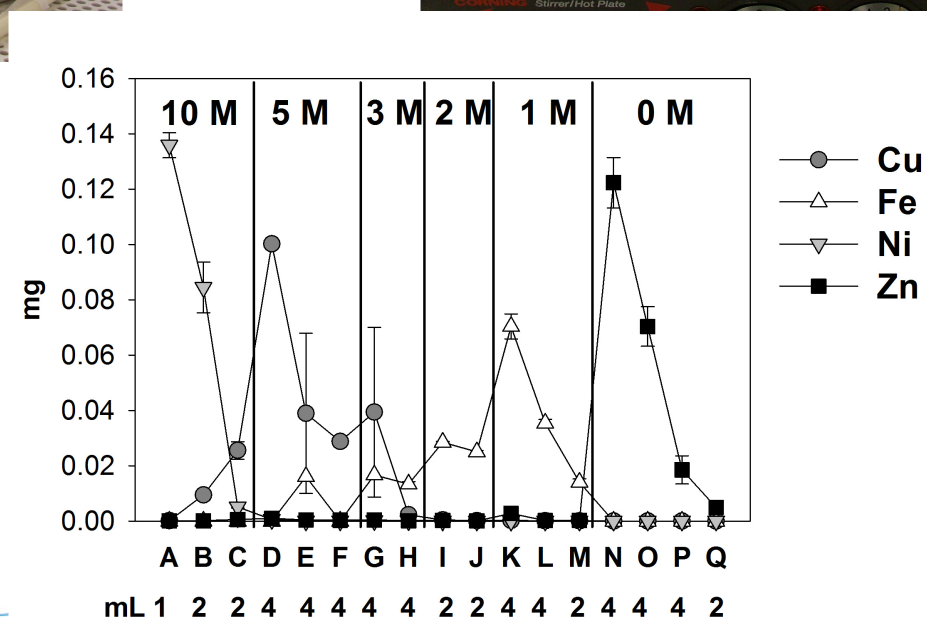
- ASTM D 5744 (2001) humidity cell to accelerate weathering
- 7 day cycle (day 1: flush, day 2-4 dry air cycle, day 5-7 wet air cycle)
- Minimum of 20 weeks duration
- Leachate: physicochemical parameters, cation and anion concentrations, Zn isotope ratios

Main objectives: monitor zinc stable isotopes to potentially discriminate the main processes connected to zinc mobilization

V – Methodology







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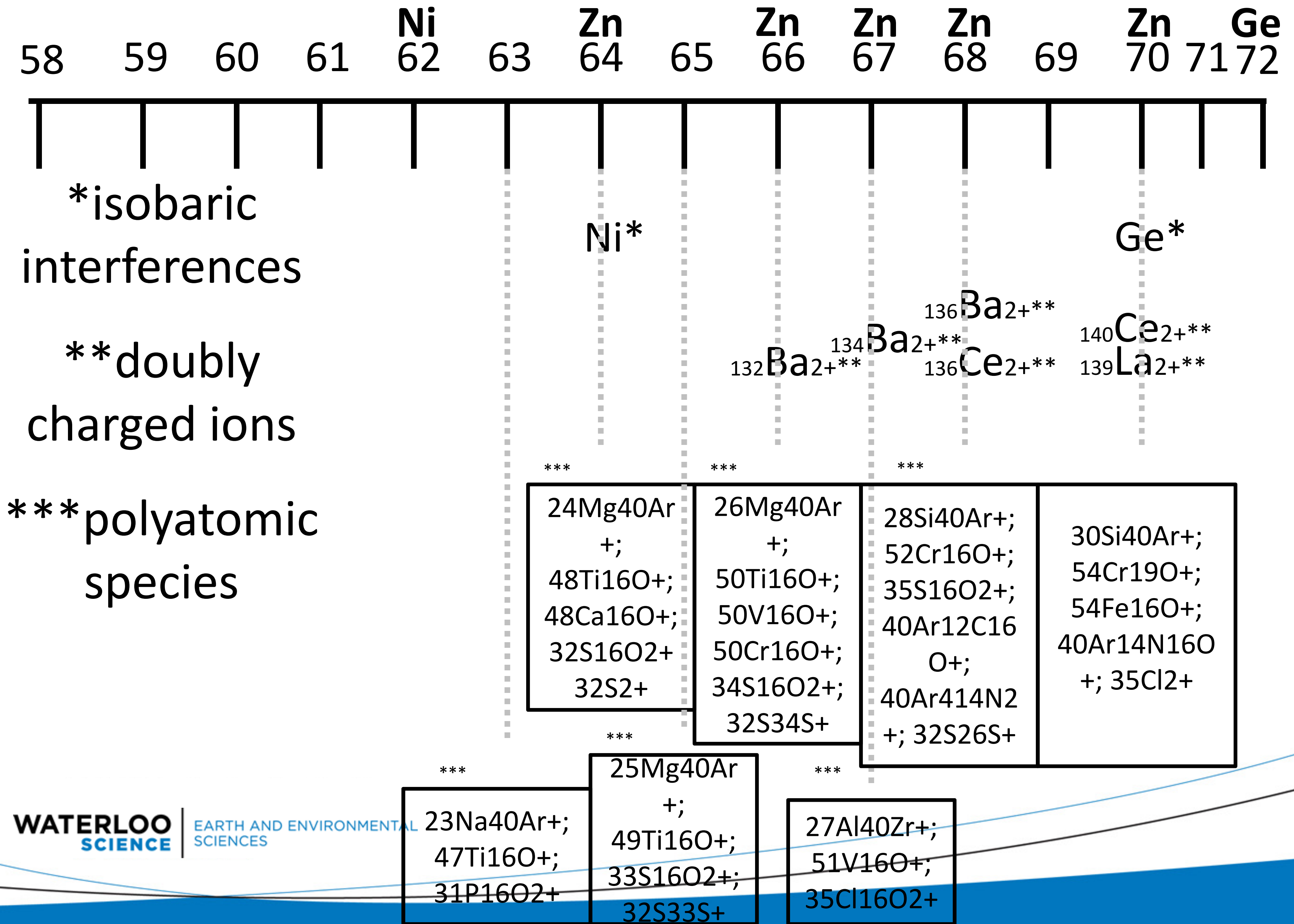
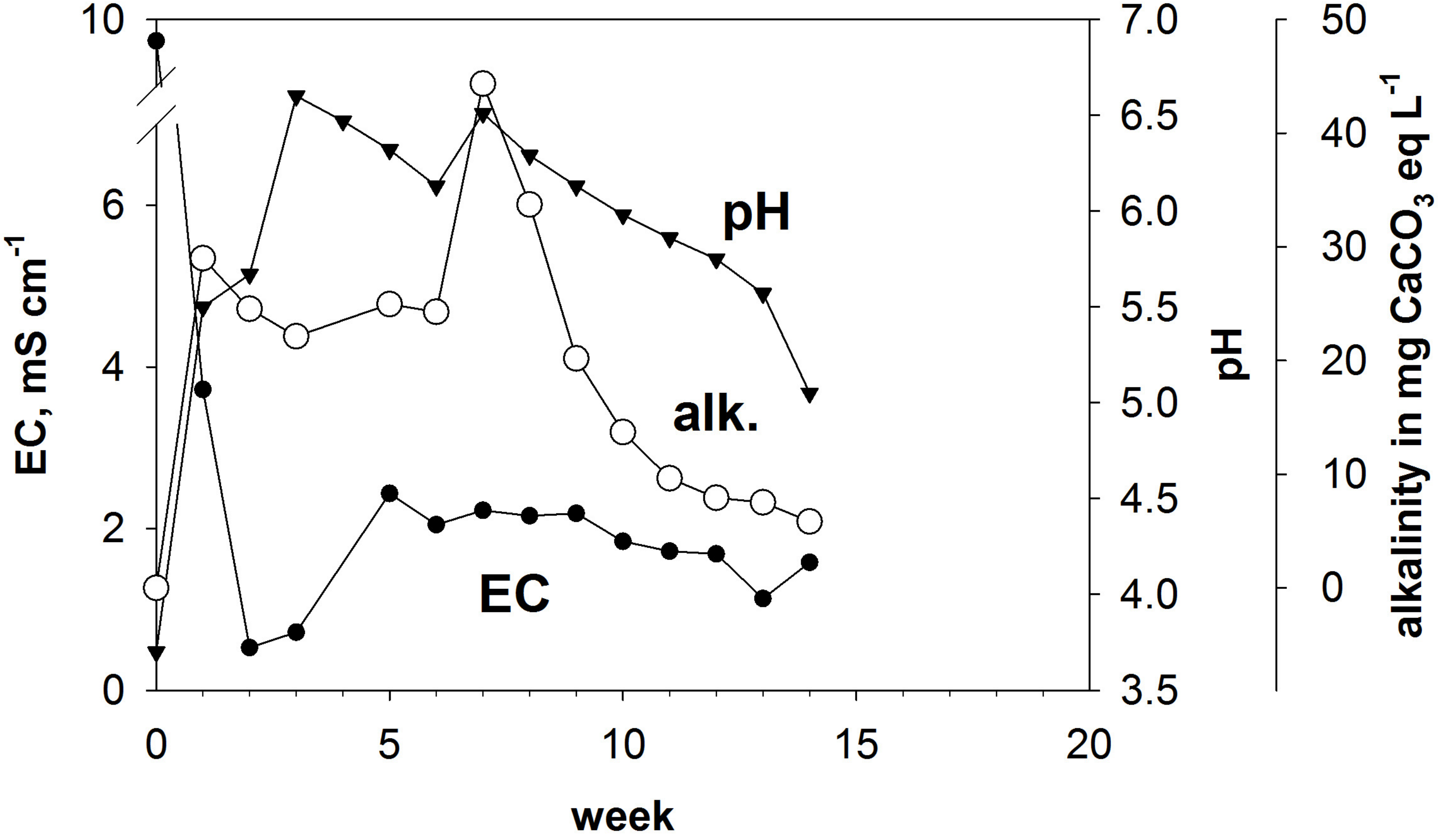


VI – Preliminary Results



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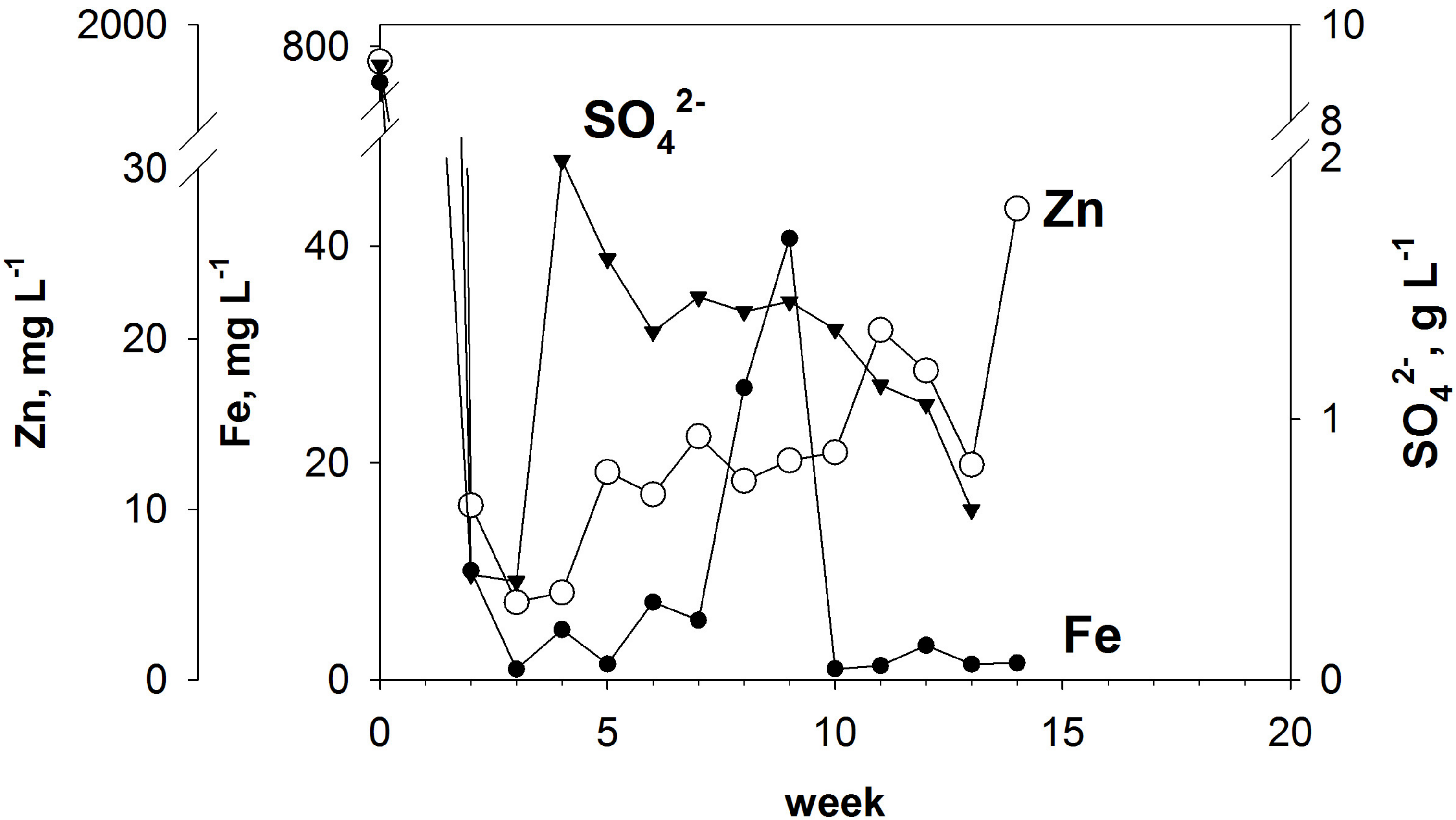

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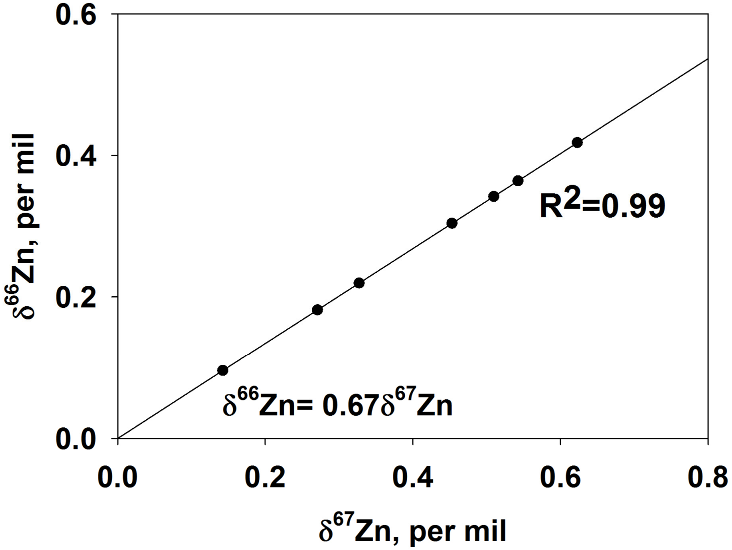

Mass dependent fractionation:

$$\delta^{66}Zn = \left(\frac{66-64}{67-64}\right)\delta^{67}Zn \rightarrow 0.666$$

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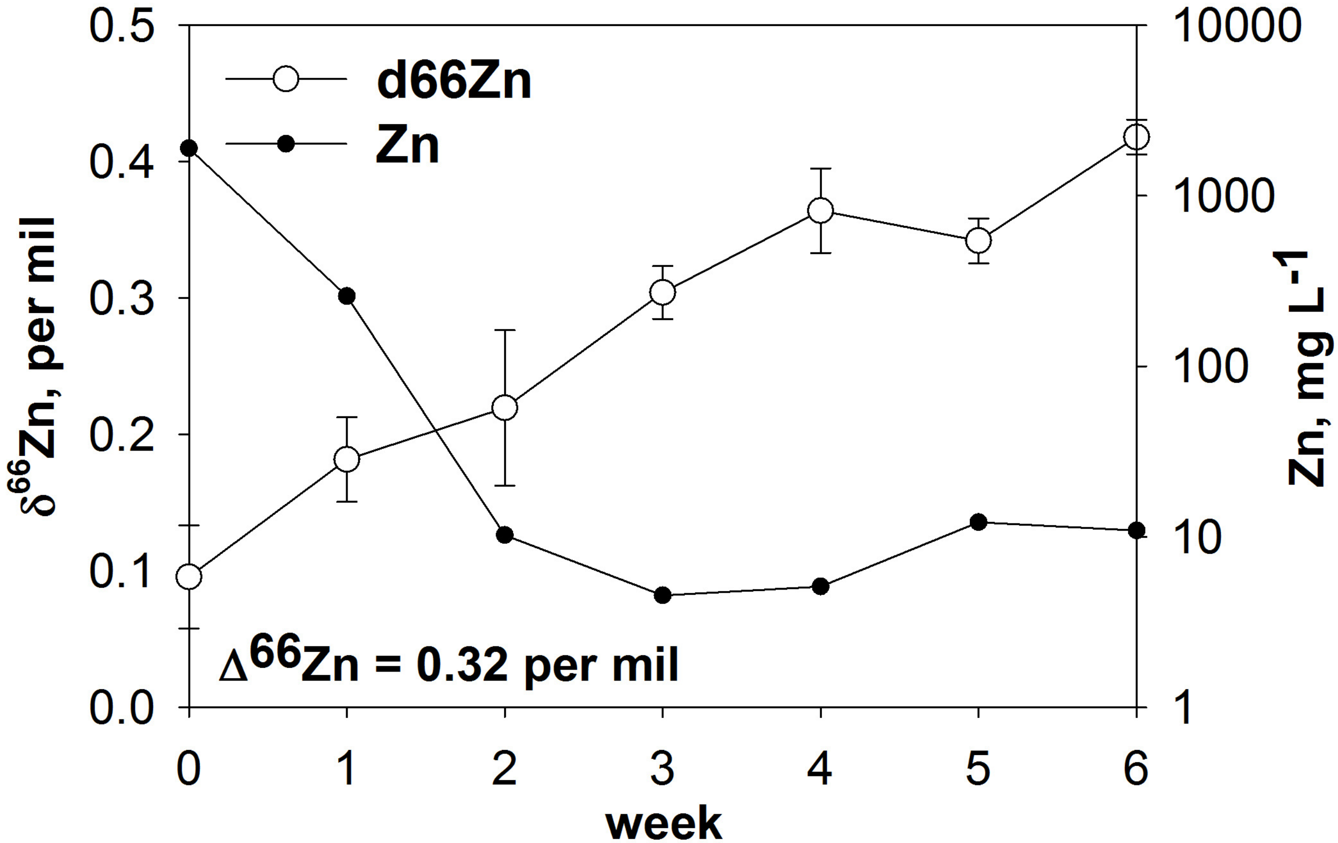

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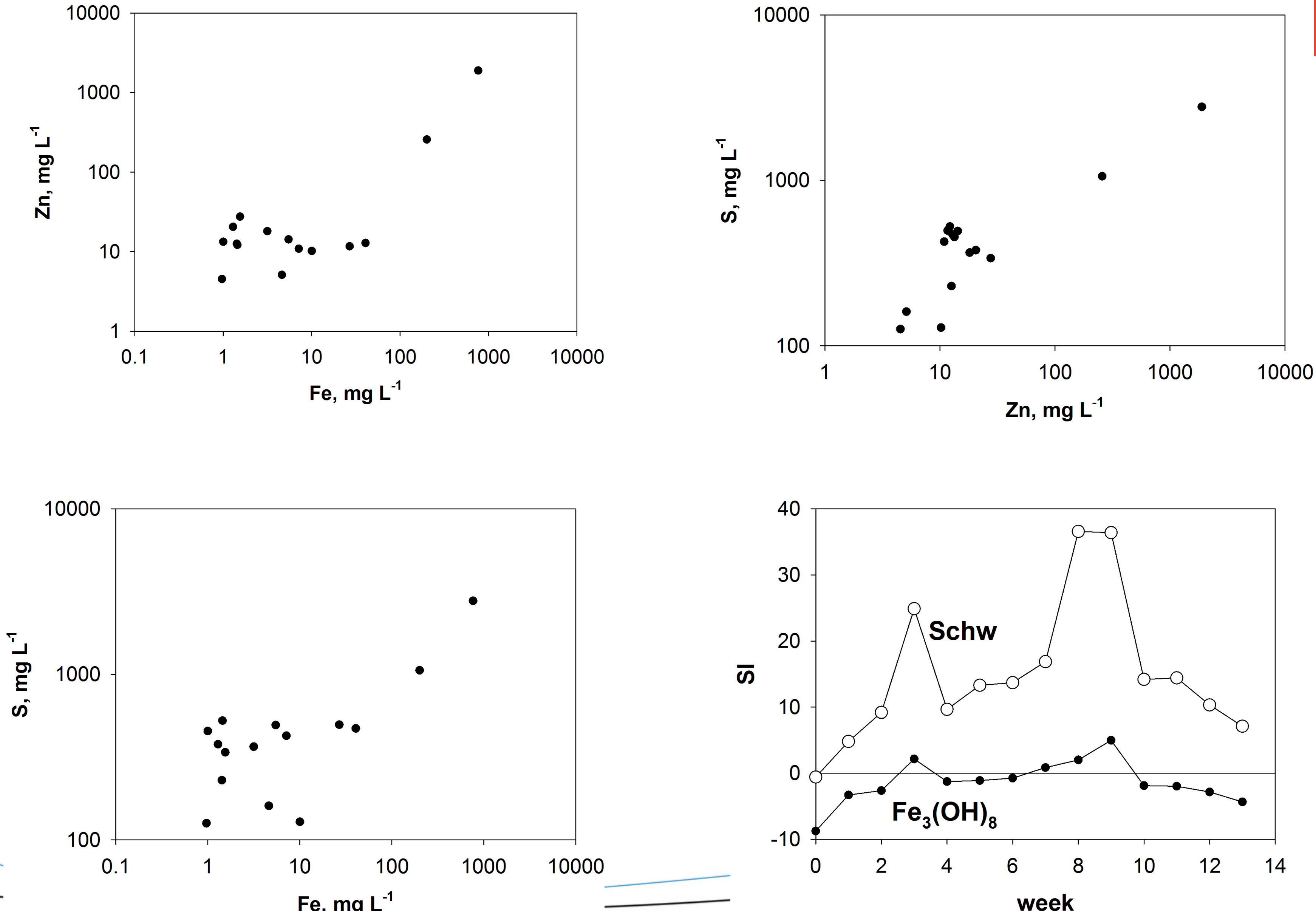

VI– Preliminary Results

- Zn mobilization through dissolution of iron hydroxides, (oxyhydroxy)sulfates, desorption and resorption onto newly formed tertiary iron hydroxides
- Kinetic fractionation in open system conditions

VII – Summary and Outlook

- Separate zinc from complex metalliferous matrices
- Analyse stable zinc isotope ratios by MC-ICP-MS
- First results in mine environments show isotope fractionation
- Interpretation ?!?