METHOD ADAPTATION FOR THE ANALYSIS OF SAMPLE MATRICES ENCOUNTERED DURING THE EVALUATION OF POTENTIALLY CONTAMINATED SITES IN AUSTRIA

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History of uranium ore in Europe

- Discovery of radioactivity → uranium ore/pitchblende
- Austria: Joachimsthal mine

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- Marie Sklodowska Curie: discovery of radium and polonium in the tailings of the uranium colour production in Joachimsthal

Carl Auer von Welsbach

- inventor of the incandescent light mantle – also called the ‘Welsbach mantle‘

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Anton on wikipedia.de

Standardised Screening Procedure for potentially contaminated sites

- Dose rate/contamination monitor measurements to locate hotspots (on-site)
- Soil samples/wipe tests (on-site)
- Sample Analysis:
    1. Gamma spectroscopy
    2. Radiochemical analysis using LSC and ICP-MS →lower LLD (lower limit of detection) than gamma spectroscopy → classification of radiological waste
- Determination of a nuclide vector for the site
- Prediction of an exposure scenario

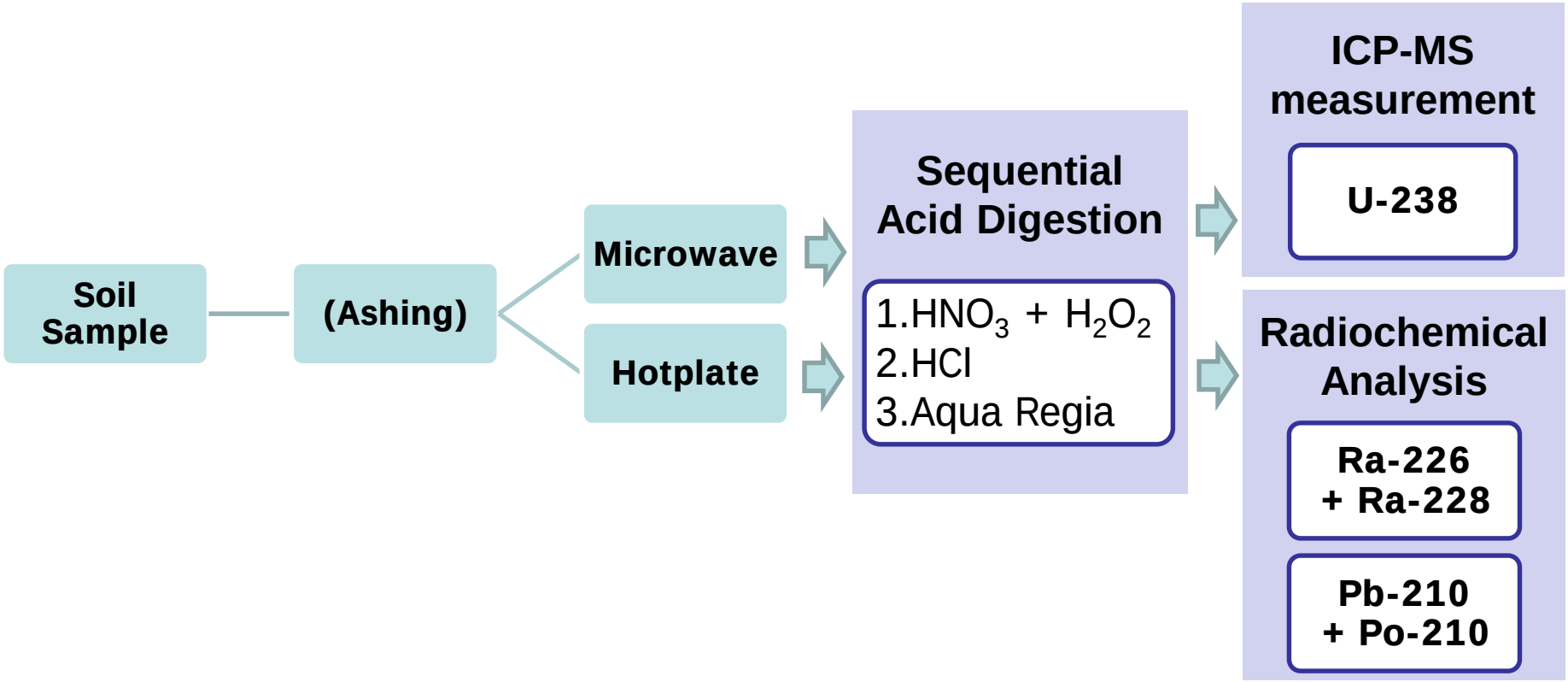
Analysis of Soil Samples

- Radium + daughters Pb-210 and Po-210
- Established method: determination of Ra-226+228 and Pb/Po-210 in water
  → no digestion necessary
- New matrix: soil
- SAMPLES: ~1 g, soil sample, air dried, B1-B5

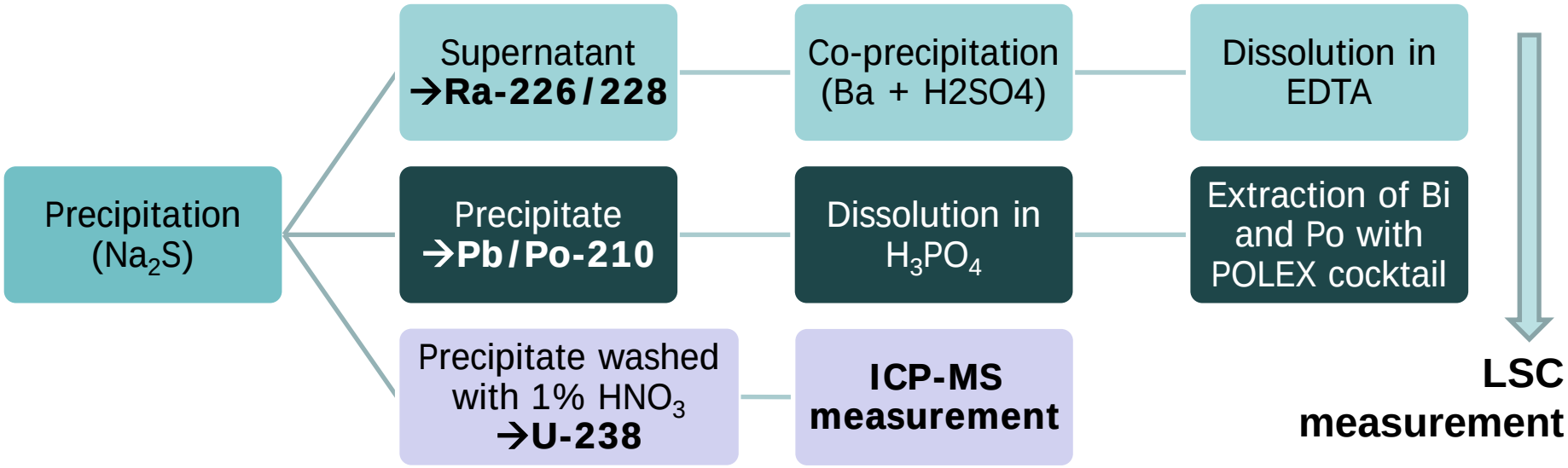
Empirical approach

- Compare different digestion methods:
  - Microwave digestion
  - Hotplate digestion in a beaker
- Check impact of ashing
- Compare use of different acids for digestion:
  - Standard: HNO_3
  - Sequential digestion: HCl and Aqua Regia
    →are the radionuclides extracted with these acids negligible after prior digestion with HNO_3?

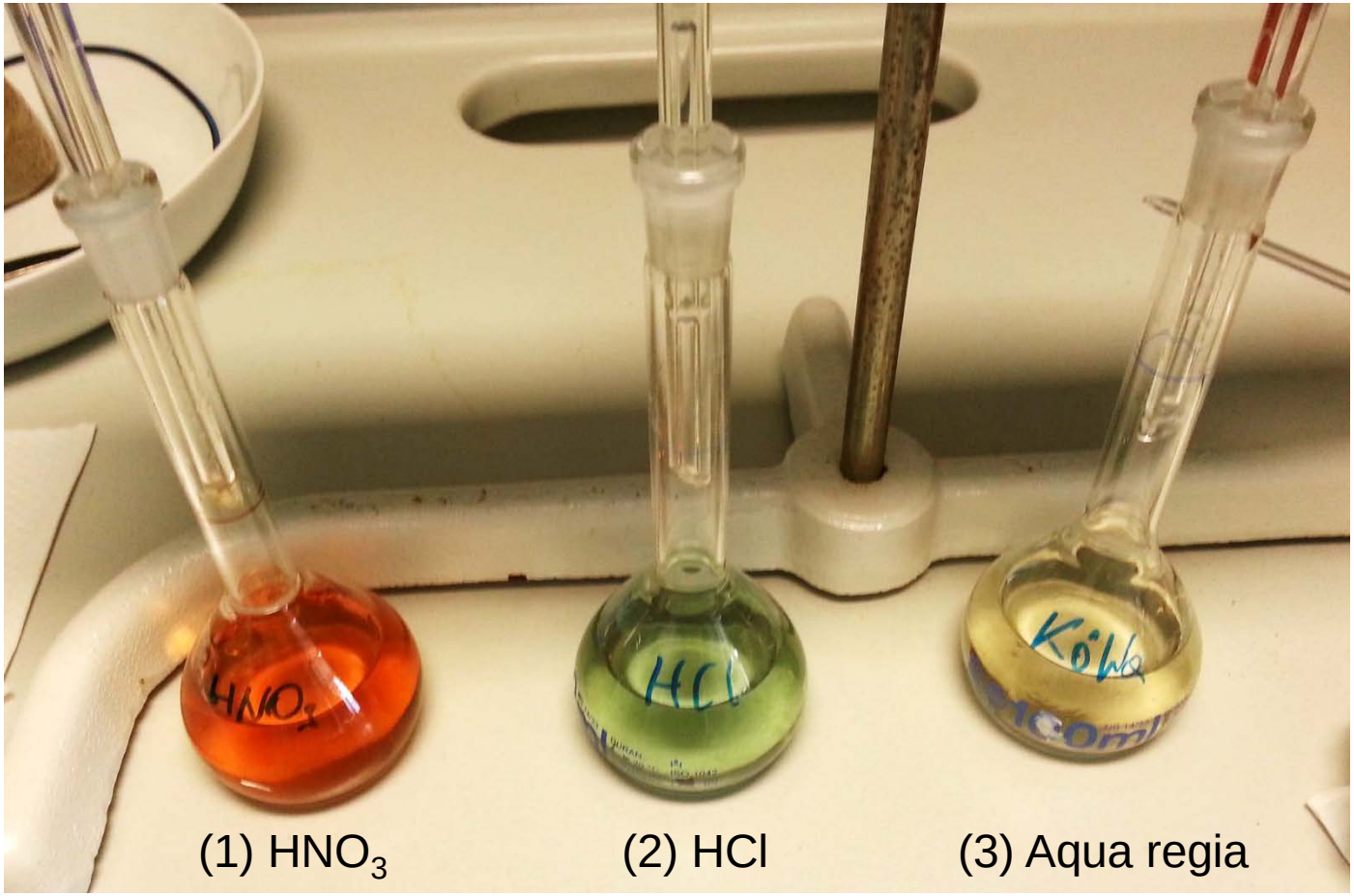
Experimental



Radiochemical Procedure: Po-210, Pb-210, Ra-226, Ra-228



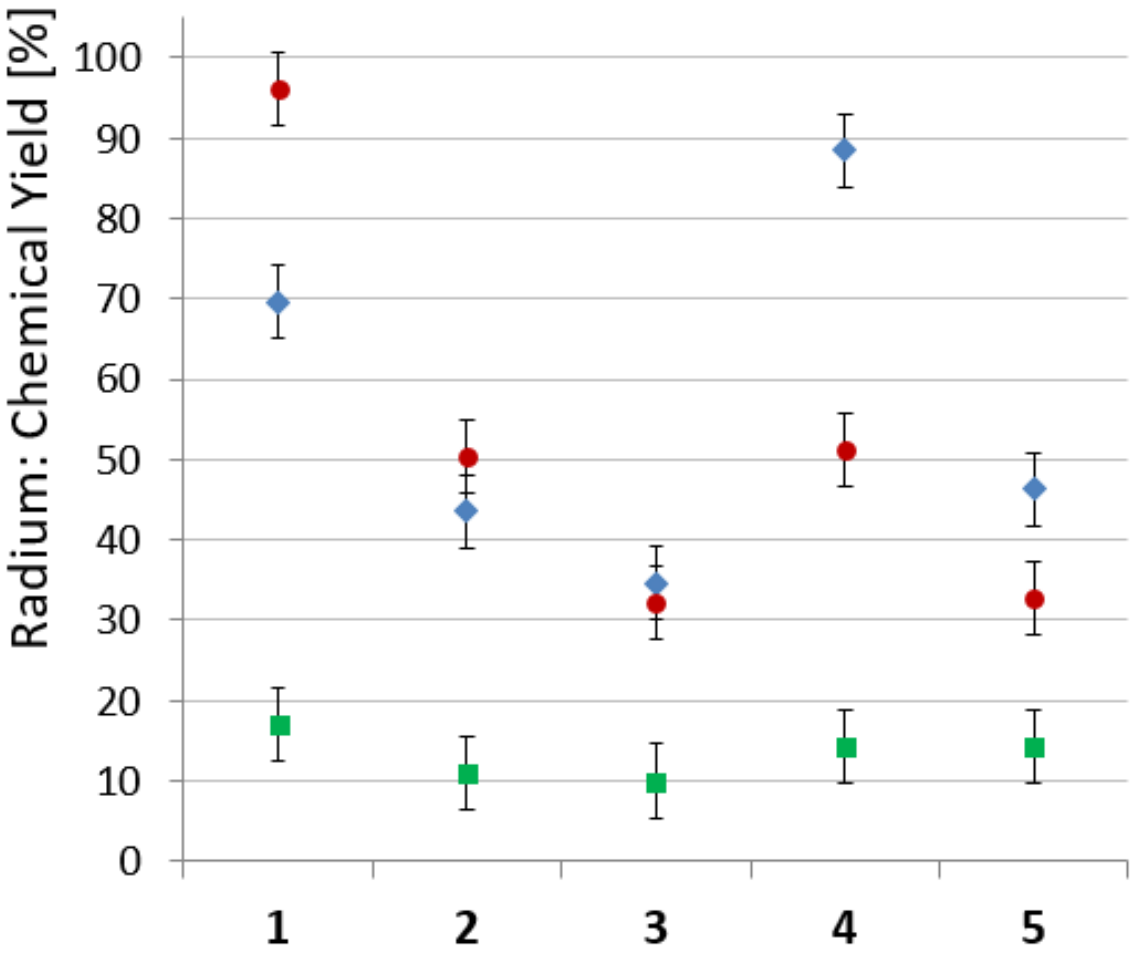
Filtrate after Na_2S precipitation (Radium fraction)



(1) HNO_3 (2) HCl (3) Aqua regia

(Fractions resulting from sequential digestion)

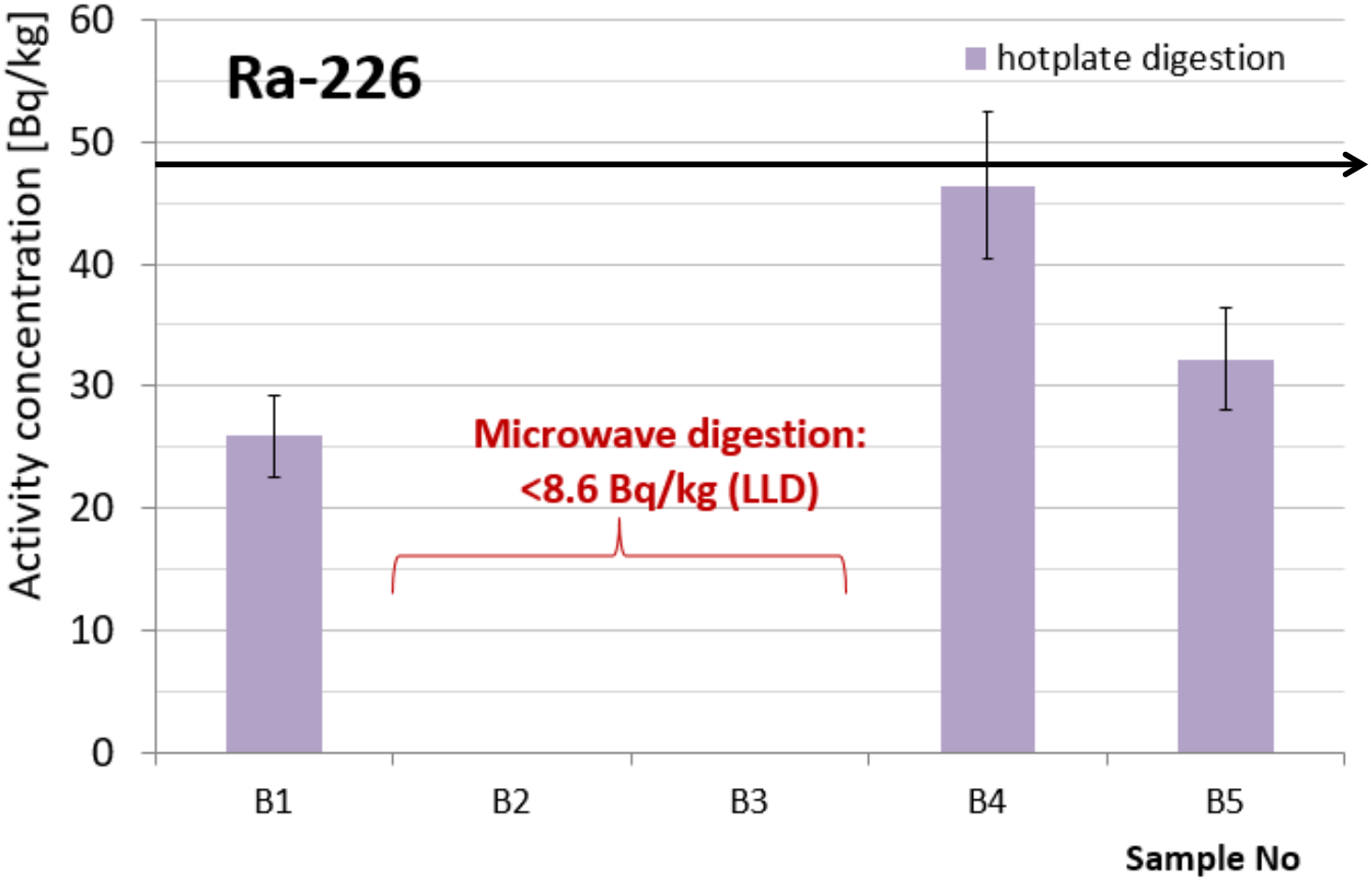
Preliminary Results: chemical yield



Determined through ICP-MS measurement

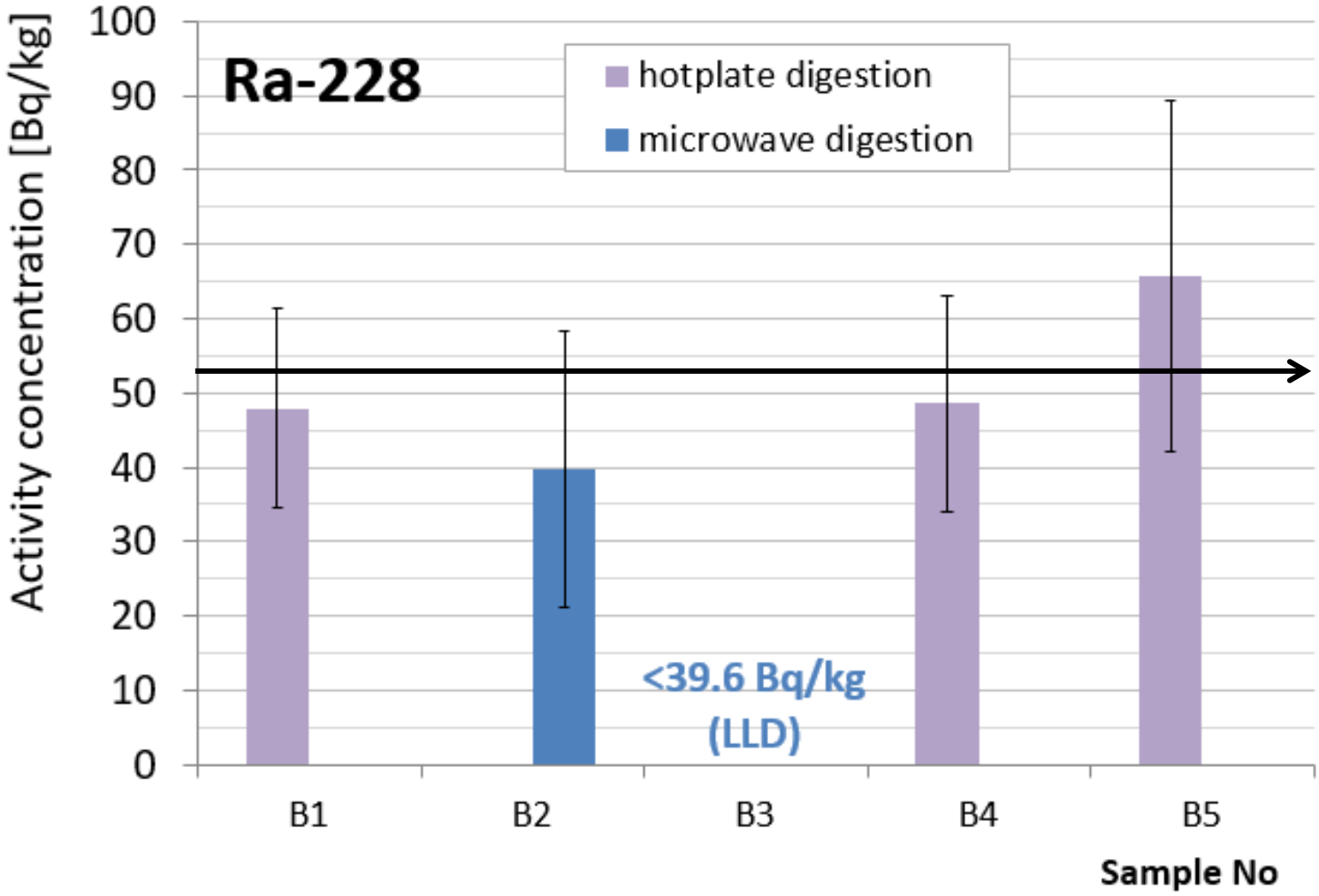
Carriers:
Pb-208, Ba-137/138

Preliminary Results: HNO_3 (1st) fraction

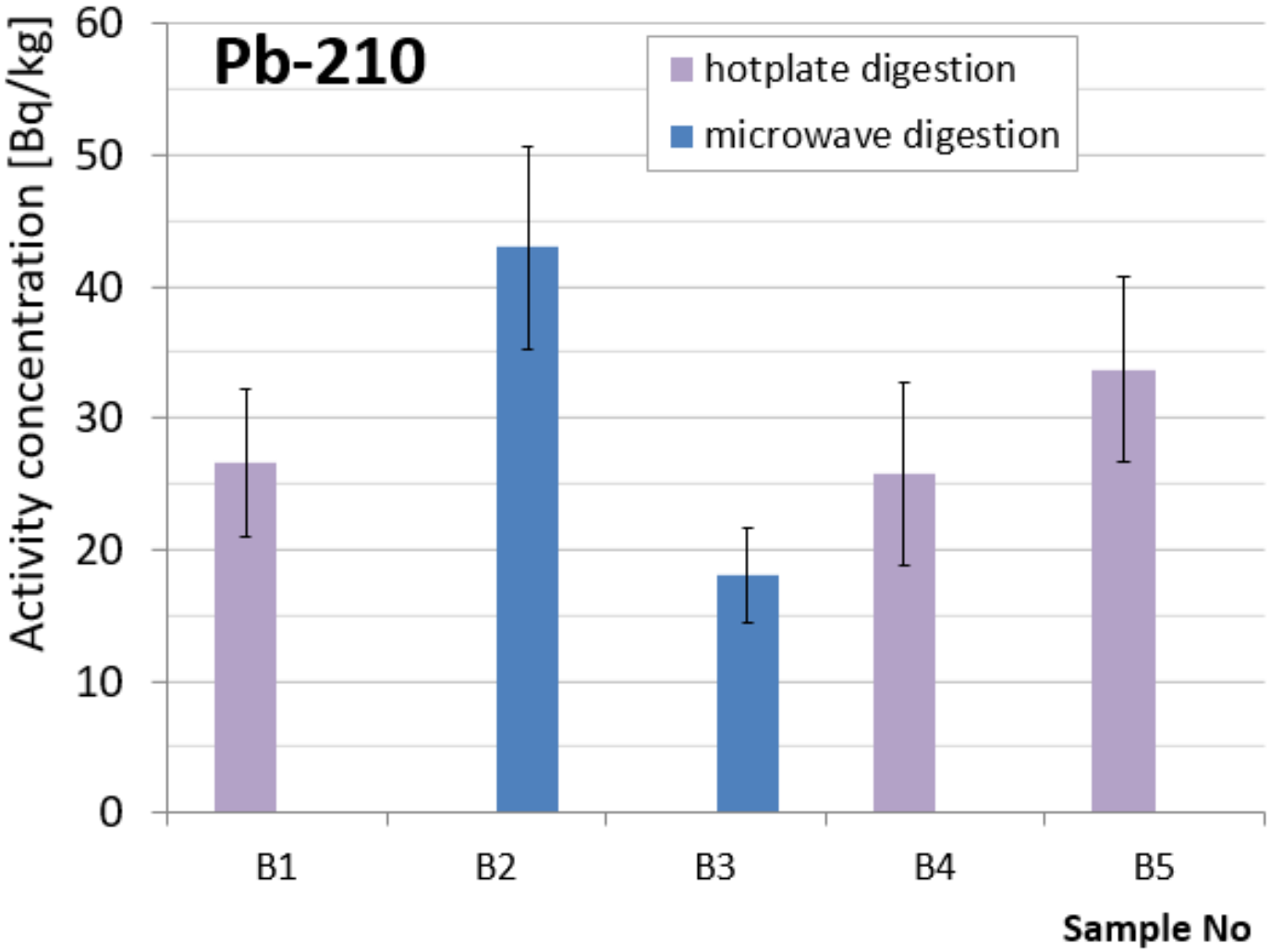


HPGe:
48 ± 18 Bq/kg

Preliminary Results: HNO_3 (1st) fraction



Preliminary Results: HNO_3 (1st) fraction



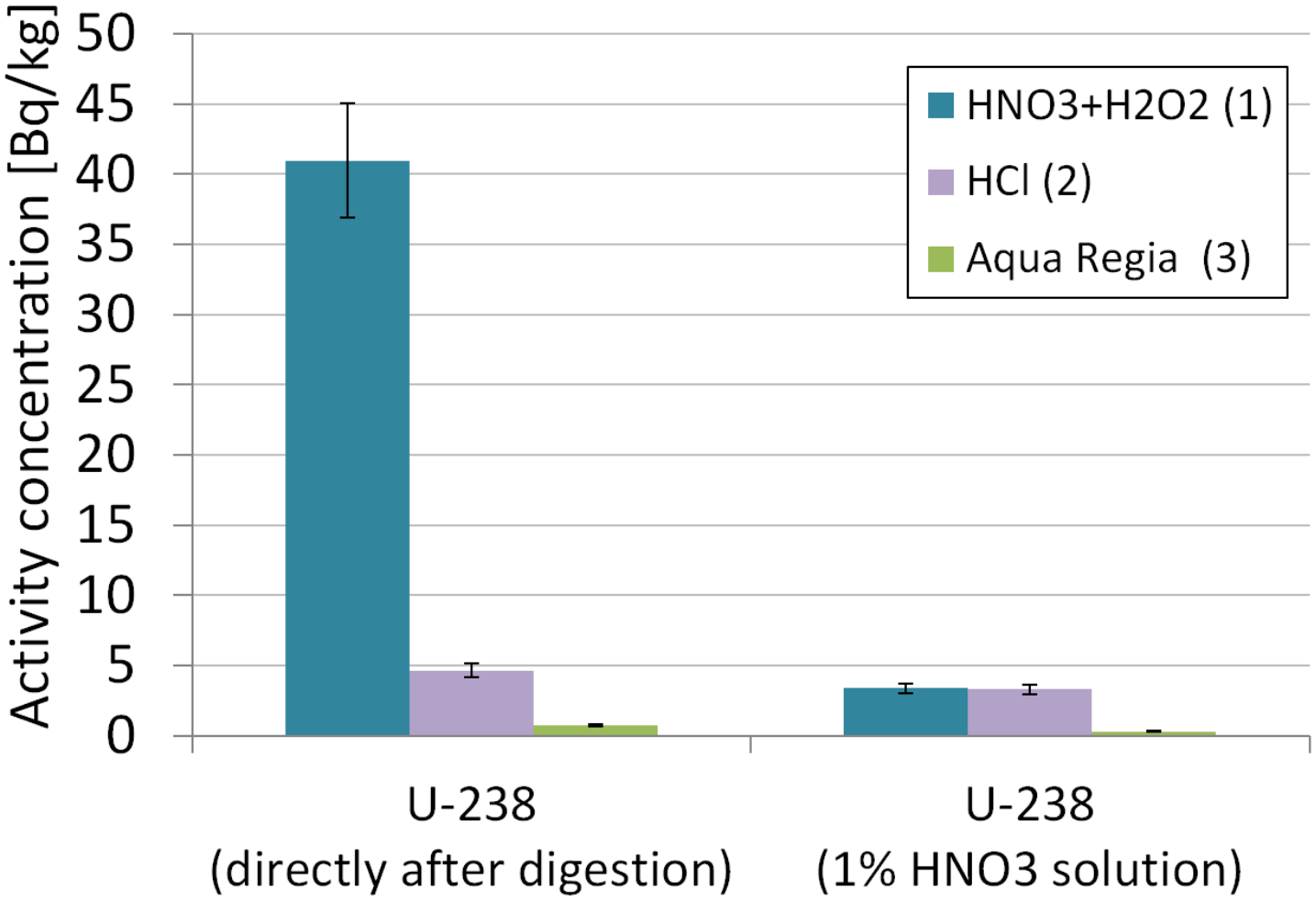
HPGe:
78 ± 27 Bq/kg

Preliminary Results: HNO_3 (1st) fraction

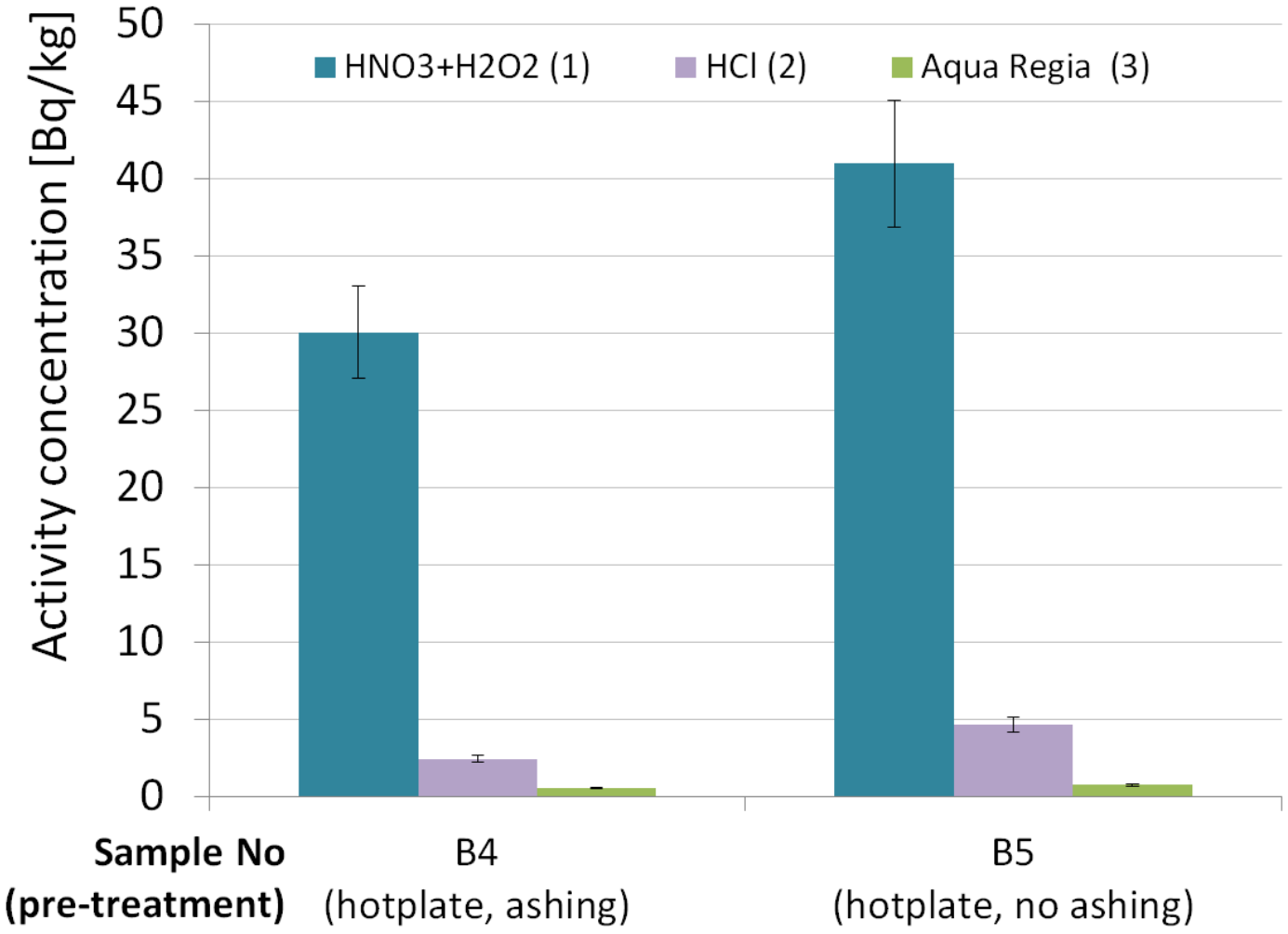
- Po-210:

Sample	Activity Concentr. [Bq/kg]	Error [%]
B1	37.9	16
B2	29.3	17
B3	37.2	16
B4	21.2	19
B5	31.1	19

Preliminary Results: HCl (2nd) fraction



Preliminary Results: U-238 (ICP-MS)



Preliminary Results: Aqua Regia (3rd) fraction

- All measurements below LLD

Summary + Conclusions

- **Chemical Yield:**
  - Needs to be improved and stabilised for Ra-226 and Ra-228

- **HNO_3 digestion:** sufficient for determination of Ra-226/228, Pb-210 and Po-210
  → no digestion with HCl/Aqua regia needed

- **HCl digestion:** option for uranium determination

Summary + Conclusions

- Wet digestion with **hotplate** gave us better results than microwave digestion – also: bigger sample mass possible
- **Po-210 measurement:** precipitate containing Pb/Po needs to be washed with 1% HNO3 multiple times to remove uranium

Next Steps

- Stabilise and improve chemical yield
- Achieve better LLD through use of higher sample mass
- Test method using samples with higher activities and reference materials

Acknowledgements

- BMLFUW – Austrian Federal Ministry for Agriculture, Forestry, Environment and Water Management

Questions?