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Fifty months of instrumental accelerator mass spectrometry (IAMS) for long-lived cosmogenic radionuclides

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The unique Ion-Laser InterAction Mass Spectrometry (ILIAMS) system, developed at the Vienna Environmental Research Accelerator (VERA) [1], has been shown to provide isobar suppression of up to fourteen orders of magnitude. Consequently, instrumental accelerator mass spectrometry (IAMS) has become a viable method for the determination of long-lived radionuclides. The major advantage of IAMS is that it bypasses the tedious radiochemical separations that have typically been used to deplete matrices and isobars from samples, allowing fast, simple and inexpensive analysis.

One of our key applications of IAMS is the measurement of the cosmogenic nuclides ^{26}Al ($t_{1/2}$=0.7 Ma) and ^{41}Ca ($t_{1/2}$=0.1 Ma) produced by cosmic ray bombardment in extraterrestrial matter. IAMS allows the direct detection of e.g., ^{26}Al/^{27}Al (~10^{-10}) and ^{41}Ca/^{40}Ca (~10^{-11}) in simply-crushed stony meteorites containing ~1% intrinsic Al and Ca. Isobars of the naturally-abundant elements (~15% Mg, ~0.1% K) do not interfere, making radiochemical separation redundant.

By determining cosmogenic radionuclides in meteorites, we can help to reconstruct their pre-atmospheric irradiation conditions (meteoroid size and individual shielding positions). Combined with, e.g., ^{14}C and cosmogenic noble gas data, more accurate results are possible. In the case of meteorite samples from a larger strewn field, conclusions on fragmentation patterns can be drawn. Finally, the terrestrial residence time of meteorite finds, i.e., the terrestrial age, can be deciphered.

As a result of fifty months of IAMS, we have analysed numerous stony meteorite samples such as Boorama, Dyalpur [2], Elmshorn [3], Haag, Karoonda, Kindberg, Ribbeck [4], Rumanova, Saint-Pierre-le-Viger and Tarda. Remarkably, we have also investigated eight well-described [5] samples from Knyahinya. Notably, we identified eleven “meteorwrongs” [e.g., 2] from museum collections and private clients.

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References: [1] Martschini et al. (2022), *Radiocarbon*. [2] Pittarello et al. (2024), *86th MetSoc.* [3] Bischoff et al. (2024), *MAPS*. [4] Bischoff et al. (2024b), *MAPS*. [5] Graf et al. (1990) GCA.