Magnesium isotope signatures in long-term field trials in Germany

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INTRODUCTION

Magnesium (Mg) is essential macro element for plants and of great importance to biological functions. Isotope fractionations in $^{24}\text{Mg}/^{25}\text{Mg}$ have been observed during nutrient uptake and translocation processes in plants. As liming management will influence the soil pH value, Mg isotopic compositions in soils and plants will change due to the changed Mg uptake by plants. Therefore, investigation of Mg isotopic compositions will likely provide an innovative tool to help characterize the elemental Mg cycle in soil-plant systems.

MATERIALS AND METHODS

Dahlem
Long-term field experiment (established since 1923) in Berlin-Dahlem

- Trials: ±0.5 t CaCO$_3$, ±0.5 t K$_2$O ha$^{-1}$; ± 20 kg P ha$^{-1}$; ± 15 t manure ha$^{-1}$
- Crop rotation: winter wheat, potato
- Soil type: Albic Luvisol.
- Soil texture: Loamy sand (clay content: 3-8\%)

experimental procedure

Soil/plant samples
Freeze dryer
Pressurized microwave digestion system
ICP-MS
Cation exchange chromatography
Multi-collector ICP-MS

RESULTS

Mg concentration and isotopic composition in total pool

![Graph showing Mg concentration and isotopic composition in total pool]

Mg isotopic composition in plants and plant-available pool

![Graph showing Mg isotopic composition in plants and plant-available pool]

- Mg concentration in total pool increased with soil depth with the Mg content in deep subsoil being more than twice of the topsoil.
- Variation in the $\delta^{25}\text{Mg}$ value was observed between the topsoil and subsoil. 0 - 40 cm: Mg was isotopically lighter in soil with liming, below 40 cm: heavier Mg isotopes were enriched in soil with liming.
- In topsoil (0-30 cm): Mg isotopic compositions in the plant-available pool of limed plots were lighter than those in non-limed plots due to enhanced Mg uptake by plants probably.
- Mg fractionations also occurred inside the plants. In both field trials plant organs had similar $\delta^{25}\text{Mg}$ values, with roots and spikes enriching heavier Mg.

CONCLUSIONS

Magnesium concentrations and $\delta^{25}\text{Mg}$ values were measured at various soil depths in both total soil pool and plant-available pool as well as in plants. Magnesium isotopic compositions in the plant-available pool were markedly lighter in soil with liming. We concluded that liming enhanced the Mg uptake by plants and Mg isotope values do yield important information on the biogeochemical Mg processing in the soil-plant systems.

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