

EGU21-13690

<https://doi.org/10.5194/egusphere-egu21-13690>

EGU General Assembly 2021

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Mixed cultures, a sustainable way to accelerate phytomining of rare earth elements, is there a future here?

Nthati Monei¹, Oliver Wiche², Michael Hitch³, and Hermann Heilmeyer²

¹Tallinn University of Technology, Geology, Mining, Estonia (ntmone@ttu.ee)

²Institute for Biosciences, Biology / Ecology Group, TU Bergakademie Freiberg, Freiberg, Germany

³Western Australian School of Mines: MECE, Curtin University, Perth, Australia

This study aims to identify the effects of having narrow leaf lupine grown in a mixed culture with barley at different proportions when different treatment regimens are introduced to the plants. The effects of the usage of fertilizer, NK and NPK on the plants are determined, where the absence and presence and absence of phosphorus will be used to determine the variation in REE accumulation. Furthermore, to investigate how the carboxylate-based strategies for nutrient acquisition in the rhizosphere of *Lupinus angustifolius*, affect the availability of trace elements to the neighbouring species (in this case barley) and are traceable by rare earth element (REE) pattern. Barley (*Hordeum vulgare* L. cv. Modena) was cultivated with narrow leaf lupin (*Lupinus angustifolius*). The experimental design involved both a monoculture (L0) and mixed cultures, where barley was replaced with narrow leaf lupin at two different proportions 11 and 33 % (Lan 11 and Lan 33). To test the influence of fertilizer on the accumulation of REEs, the plants were further treated with two varied fertilizer options; nitrogen (N), phosphorus (P) and potassium (K) and on the contrary just N & K. Elemental concentrations within the leaves and stems of the barley were determined by ICP-MS. In the presence of P (NPK treatment) An increase in LREE is observed in the leaves of barley than in the stems. There is a statistically significant difference between L0 and Lan 11. HREE also shows an increased uptake in the leaves than in stems. The behaviour of both LREE and HREE from the NK treatment show a similar pattern for both stems and leaves, however, at lower concentrations than when P is present. From the obtained results we can conclude that the presence of P increases the availability of REEs, particularly LREE. Furthermore, intercropping with narrow leaf lupin positively influences the uptake of trace REEs, thus increasing their availability to adjacent plants.