

Interactive comment on “Estimates of mean residence times of phosphorus in commonly-considered inorganic soil phosphorus pools” by Julian Helfenstein et al.

Anonymous Referee #2

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Helfenstein et al. propose a method to calculate the mean residence time (MRT) of inorganic phosphorus (P) in different soil inorganic P pools based on data from short-term isotope exchange data. The short-term isotope exchange data is gained in isotope exchange studies that have been conducted in order to estimate the capacity of the soils to sorb P. The experiments typically last for 90 minutes and during this time the ^{33}P activity in the soil solution decreases strongly due to sorption to the soil solid phase. Isotope exchange experiments have been used by Frossard et al. and other working groups to learn about the plant availability of different P pools in soil. I have doubts about the validity of the approach proposed here for the following reasons. First, the calculation of MRT is based on the assumption of steady state (inputs=outputs).

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However, it is highly questionable whether this assumption is correct. In the experiments used by the authors, typically 10 g of sieved soil are oversaturated by 100 ml of water and put on a shaker until the end of the experiment. Being oversaturated with water and kept on a shaker is not a natural condition for soils. Thus, very likely the soils move away from steady state during these experiments due to this disturbance. Thus, the assumption of study state is very likely violated in the experiments, on which the calculation is based. Second, the authors derive MRTs of more than 10,000 years (Fig. 4) from experiments that last only for a much, much shorter period of time, which is problematic since the exchange processes measured over a short period of time are extrapolated by a factor of $> 1,000,000$. Third, the calculation proposed by the authors (Equation 1) is based on the assumption that the specific ^{33}P activity of the soils solution (^{33}P in solution to total inorganic P in solution) is stable during the 90-minutes experiment. This assumption is not correct. During 90-minutes experiments the specific ^{33}P activity of the decreases exponentially, which means that the ratio of ^{33}P and total inorganic P decreases, which is mostly due to adsorption of ^{33}P to the soil solid phase. This change of the specific ^{33}P activity is problematic because ^{33}P is used as a tracer, and the ratio of the tracer to the inorganic P in the soil solution is changing continuously over the course of a short-term experiment. The proposed approach would require that the ratio of ^{33}P to inorganic P in the solution is stable, but the specific ^{33}P activity of the soil solution approaches a stable value only over longer periods of time. In addition (and less importantly), the description of the applied calculation is incomplete, and the calculation of the variables n and m, which are derived from short-term experiments is not explained in the present manuscript.

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