

Modelling the impact of C4 Biofuel Crops (*Miscanthus* spp) on soil carbon storage in different climates

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Background and Methods

The simulation of soil organic carbon (SOC) dynamics under biofuel crops, in addition to their fossil fuel offset, is critical for the evaluation of carbon (C) sequestration [1]. We tailored the RothC model [2] to simulate C3- and C4-SOC stock changes under *Miscanthus*. The expanded model (RothC_M) is designed to be coupled to a crop model, using residue inputs to the soil from the respective plant parts. The model used data from a 14-year *Miscanthus* trial at Rothamsted (UK) to calibrate turnover rates of C in litter, rhizomes and roots and the decomposability of their residues. Parameters were evaluated on a 10-year trial at Pisa (Italy).

Results and Discussion

Combining residues when applying inverse modelling (A) underestimates inputs (Tab. 1), while the estimate based on yield (B) matches RothC_M for *M. x giganteus*, but not for *M. sinensis*, possibly due to overestimating belowground inputs.

Method	A		B	C
	Low	High		
Genotypes				
Gig-1 (Italy)	3.50	6.12	8.20	8.01
Gig-1 (UK)	3.55	6.40	6.09	6.38
Sin-11	1.60	3.13	5.97	3.24

Table 1 Estimated C inputs ($\text{t ha}^{-1} \text{yr}^{-1}$) to SOC by inverse modelling using RothC 26.3 [2] with default values of residue decomposability (A), based on yield [3] (B), and RothC_M (C)

Calibrated RothC_M simulates accurately SOC changes in the UK. However, in Italy the calibrated model needed further adjustment of rhizome, root and root exudate turnover to simulate observed SOC. Observations and modelling of C3 and C4 SOC indicate a C sequestration of approximately 1.8 and 3 $\text{tC ha}^{-1} \text{yr}^{-1}$ in the UK and Italy, respectively.

Further simulation will test the hypothesis of a delay in rhizome turnover using new observations, and discuss the sensitivity of the model to parameter changes.

[1] Lemus and Lal (2005) *Critical Reviews in Plant Sciences*, **24**, 1-21. [2] Coleman *et al* (1997) *Geoderma*, **81**, 29-44. [3] Hillier *et al* (2009) *Global Change Biology Bioenergy*, **1**:267-281.

Synergistic Arsenic and Pb incorporation into synthetic jarosite

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Jarosite can incorporate many ionic substitutions into its general structure $\text{KFe}_3(\text{SO}_4)_2(\text{OH})_6$ [1], making it especially suitable for trapping unwanted, potentially toxic species in the environment. This mineral has been shown to incorporate arsenic in acidic environments (e.g. acid mine drainage), as well as in metallurgical processes where its precipitation is used for the long-term disposal of arsenical waste [2,3]. Anionic substitutions in jarosite have been reported to affect in turn its cationic substitutions [4]. However, the effect on its cationic retention capacity is not yet well understood. The goal of this work was to investigate the influence of As(V) incorporation into the jarosite mineral structure on its Pb(II) retention capacity.

K-jarosite and arsenojarosites [$\text{KFe}_3(\text{SO}_4)_{2-z}(\text{AsO}_4)_z(\text{OH})_6$] were synthesized, for which the arsenate substitution ranged from 16 to 80 mol% (of As+S), and Pb(II) retention experiments were performed equilibrating these at pH 2.

The Pb(II) retention capacity was increasingly enhanced by the presence of As(V) in the jarosite structure, reaching values of up to almost one order of magnitude higher Pb(II) retention for the highest As-jarosite investigated as compared to the As-free jarosite. This suggests a generalized synergistic effect of cationic heavy metal retention with arsenate incorporation.

The specific mechanisms of Pb(II) retention in this synergistic process will be presented for the different systems investigated, as well as their influence on the jarosite structure. Also, the effect of different modes of incorporation of both species during the jarosite synthesis will be shown.

The results of this work have important environmental implications: through the synergistic process encountered, remediation enhancement of cationic pollutants is possible in a concomitant fashion with arsenate attenuation in acidic mining and metallurgical environments.

[1] Dutrizac & Kaiman (1976) *Can. Mineral* **14**, 151-158. [2] Savage *et al* (2005) *Chem. Geol* **215**, 473-498. [3] Slowey *et al* (2007) *Appl. Geochem* **22**, 1884-1898. [4] Kendall *et al* (2013) *GCA* DOI: 10.1016/j.gca.2013.02.019