Sharing not permitted

Same Binding Agent with Different Stabilization Capacities Regulates Soil Organic Carbon Across pH Gradients in Tropical and Subtropical Soils

Akari Tokunaga[1](s257481r@st.go.tuat.ac.jp), Han Lyu[1], Mayuko Seki[2], Haruo Tanaka[1], Arief Hartono[3], Jegadeesan M[4], Kannan P.[4], Makoto Shibata[5], Tetsuhiro Watanabe[5], Shinya Funakawa[5], Soh Sugihara[1]

1 Tokyo University of Agriculture and Technology 2 Kyoto Prefectural University 3 IPB University 4 Tamil Nadu Agricultural University 5 Kyoto University



EGU26-17787

1. Introduction

SOC represents the largest carbon pool in terrestrial ecosystems, and understanding the accumulation mechanisms of MAOC, the stabilized form of SOC, is crucial for maintaining the global environment. Previous studies suggest that Mineral associated organic matter: MAOC is regulated not only by the abundance of these binding agents but also by their OC-stabilization capacity, both of which are likely pH-dependent yet remain poorly quantified.

① **Clarify the controls** (e.g., precipitation, net primary production (NPP), binding agents) on MAOC.

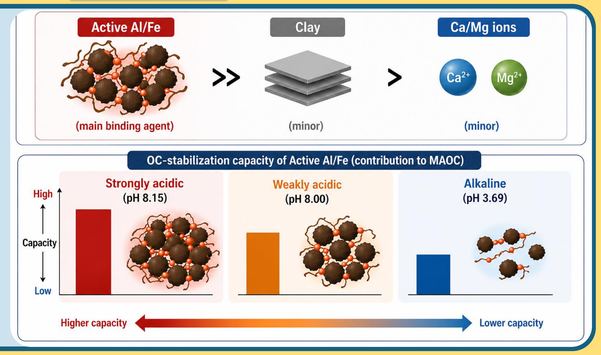
② **Quantify OC-stabilization capacity of main binding agents**, with the investigation of their OC-stabilization mechanism across soil pH gradients.

4. Conclusion

① **Active Al/Fe**, rather than clay or Ca/Mg ion, is the main binding agent of MAOC across all pH groups.

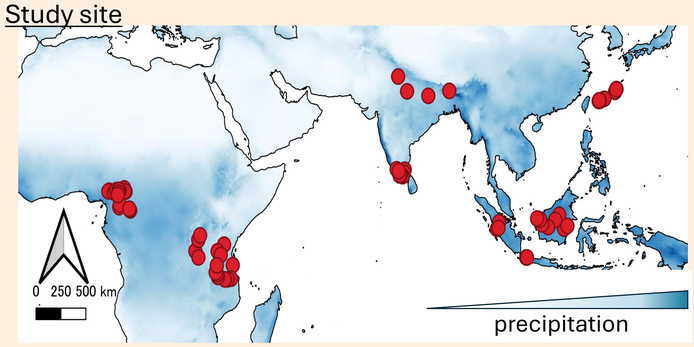
② The **OC-stabilization capacity of active Al/Fe** is **higher in strongly and weakly acidic soils than in alkaline soils.**
⇒ The abundance and capacity of active Al/Fe account for the MAOC.

③ In alkaline soils, **active Al/Fe stabilizes non-necromass C but not necromass C**, which partly explains the lower OC-stabilization capacity than strongly and weakly acidic soils.



2. Materials and Methods

Study site



pH classification

Strongly acidic (pH < 5.5) — Weakly acidic (5.5 ≤ pH < 7) — Alkaline (pH >7)

No.		MAT	MAP	NPP	EP
		℃	mm y^{-1}	g cm^2	mm y^{-1}
32	Strongly acidic	24 ± 2	2070 ± 780	860 ± 150	780 ± 800
26	Weakly acidic	24 ± 3	1660 ± 780	740 ± 240	280 ± 940
15	Alkaline	28 ± 2	820 ± 90	340 ± 100	−1330 ± 410

measured properties

◆Soil pH, Total C (TC), Clay content, exchangeable Ca/Mg (Ca_{ex}+Mg_{ex}), oxalate extractable Al/Fe (Al_o + Fe_o)(as **active Al/Fe**)(extracted by MAOC fraction),

◆**MAOC** (C within MAOM fraction: ≧ 1.7 g cm^{-3} & < 53 μm)

◆**Necromass-C** (amino sugars)

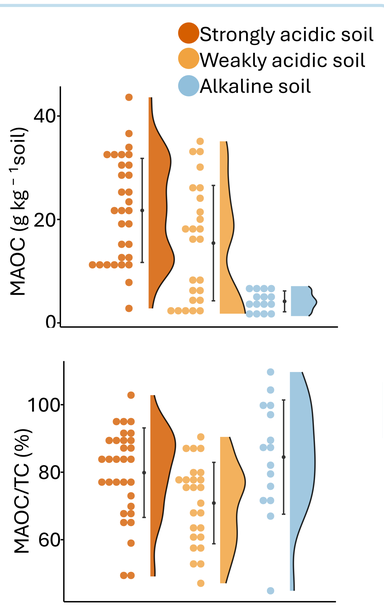
Calculations

◆SEM analysis was conducted using the variables that showed significant correlations with MAOC in the Spearman correlation analysis.

◆Based on the SEM analysis, we constructed a composite polynomial and calculated the carbon fixation capacity per molecule of Binding Agent.

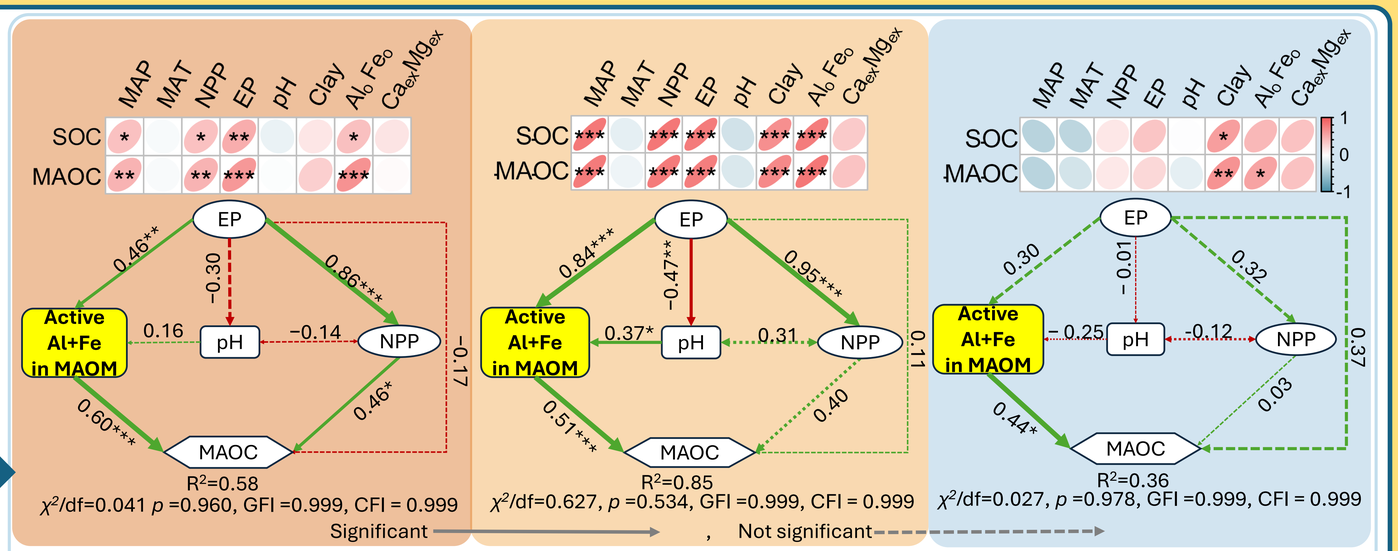
◆Microbial Necromass C (MNC)
= MurA × 45 + (GlcN/179.17-2 × MurA/251.23) × 179.17 × 9

3. Results & Discussion



MAOC accounts for the majority of TC (78 ± 14%).

MAOC: Acidic < Alkaline
However, **the importance of MAOC does not depend on pH.**

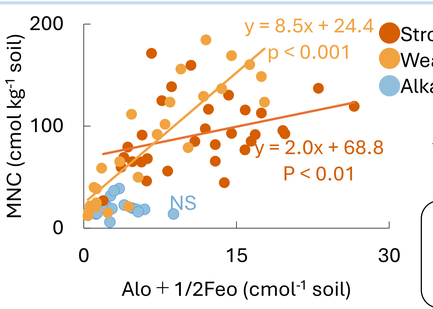


The controls for MAOC are NPP and active Al/Fe.
Active Al/Fe should be the main binding agent for MAOC in all pH groups.

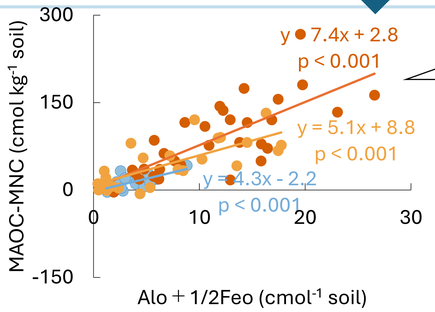
⇒ **MAOC = *a*(Active Al/Fe in MAOM fraction) + *b*NPP + *c*EP + ε_1,**
Al_o/Fe_o = *d*EP + *e*pH + ε_2, NPP = *f*EP + *g*pH + ε_3, pH = *h*EP + *i*NPP + ε_4.
a–*i*: path coefficients derived from the unnormalized SEM, ε_1–ε_4: residual errors for each equation.

	Strongly acidic	Weakly acidic	Alkaline
a: OC-stabilization capacity of active Al/Fe (mol mol^{-1})	8.15	8.00	3.69

OC-stabilizations of active Al/Fe : alkaline soils < strongry / weakly acidic soils



Only strongly / weakly acidic soils correlated with active Al/Fe.



Significantly correlated and with a similar slope across all pH groups.

In alkaline soils, active Al/Fe **stabilizes non-necromass C but not necromass C, it partly explain the lower OC-stabilization capacity than acidic soils.**