



Phosphorus biogeochemistry regulated by carbonates in soil

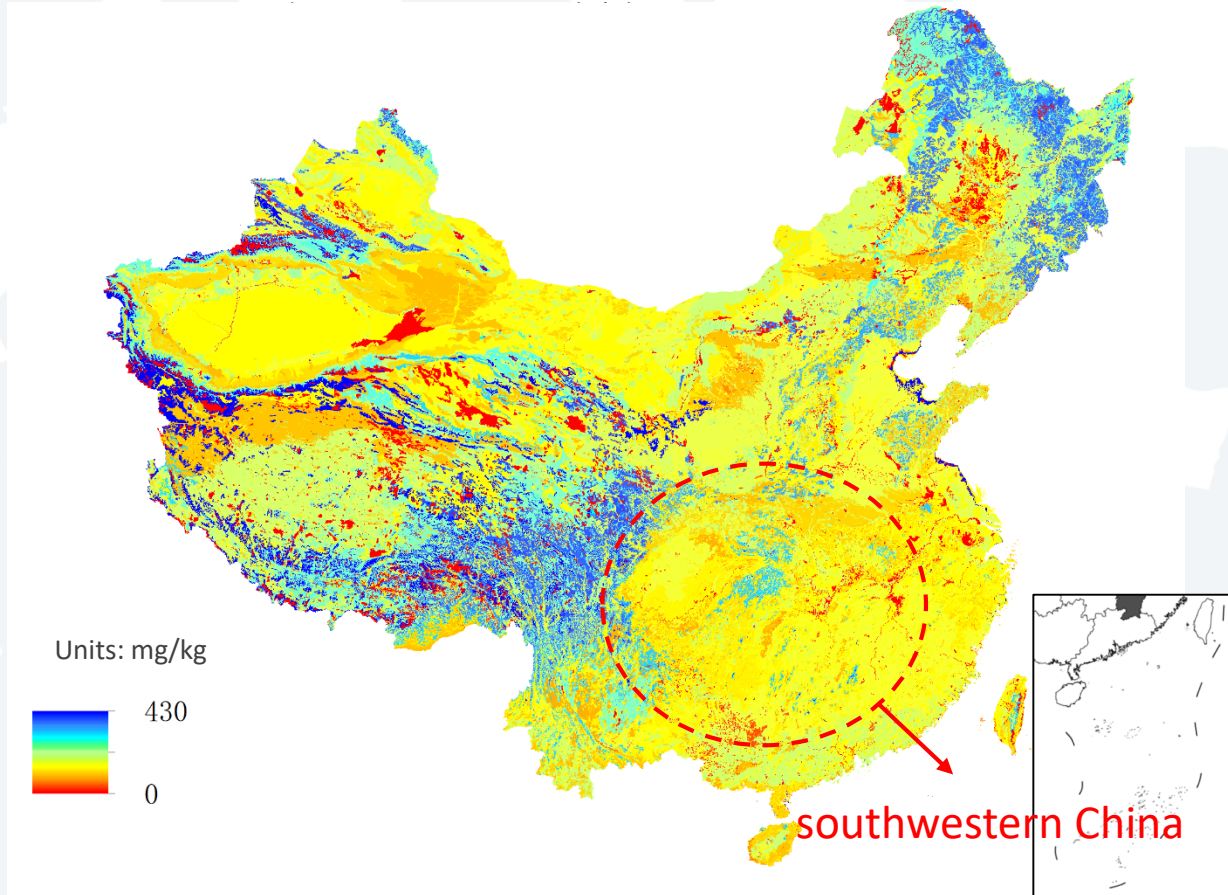
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Background: P deficiency in karst soil rich in carbonates

- Distribution map of soil total phosphorus in China (1990)

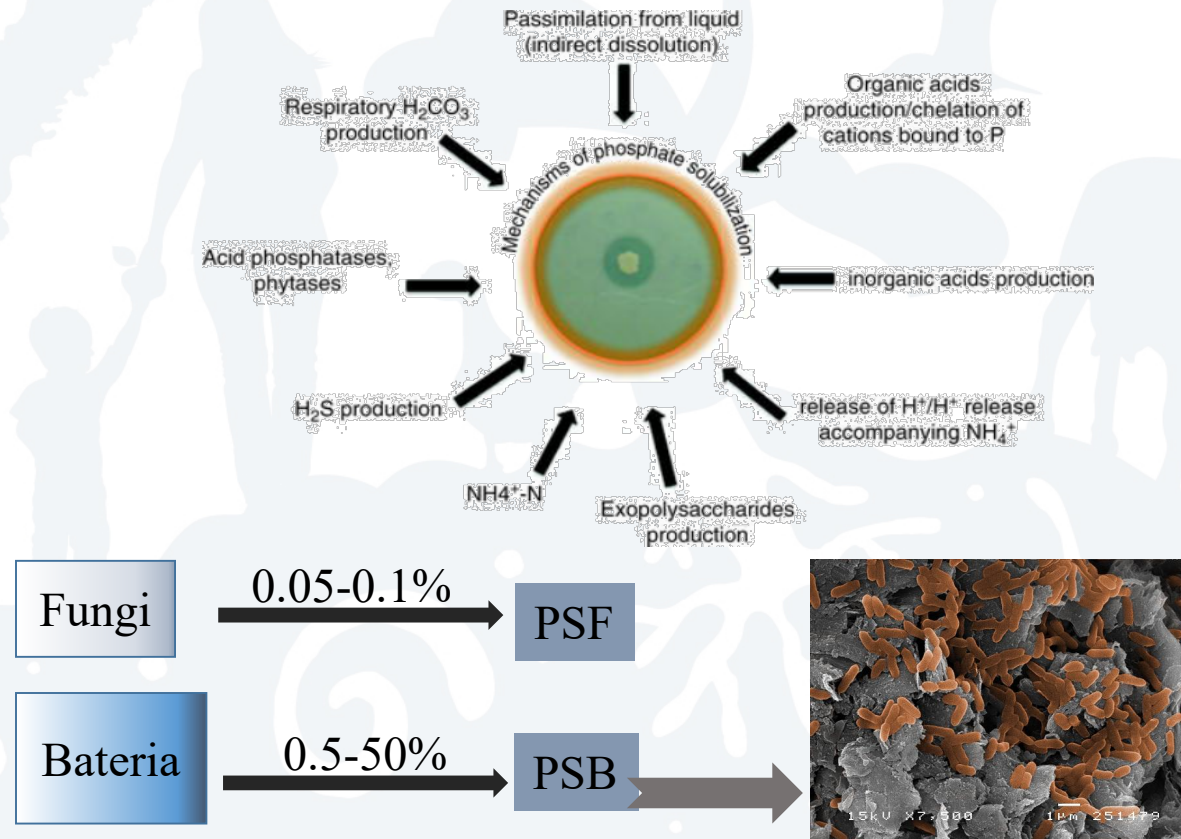


- Soil carbonate from karst region is an important carbon sink on Earth (accounting for ~7-25%);
- Phosphorus (P) is an essential soil nutrient for plant growth;
- Karst regions in the southwest of China are covered by P-deficient soil.

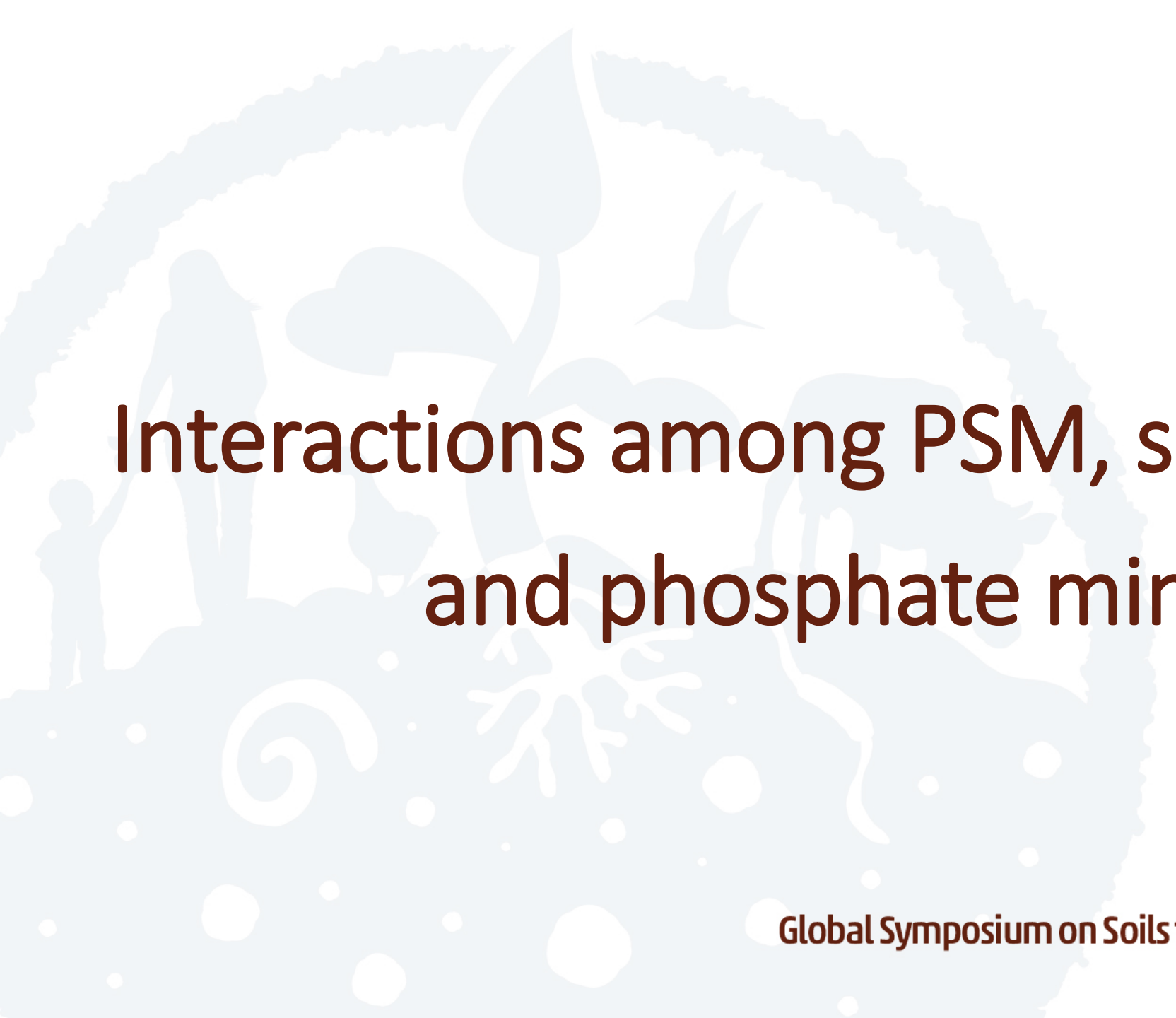
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Phosphate-solubilizing microorganisms (PSM)



- PSM consists of phosphate-solubilizing fungi (PSF) and phosphate-solubilizing bacteria (PSB);
- PSB accounts for 0.5-50 % of the total bacteria populations;
- PSM have potential for prompting the release of P from soil phosphates.

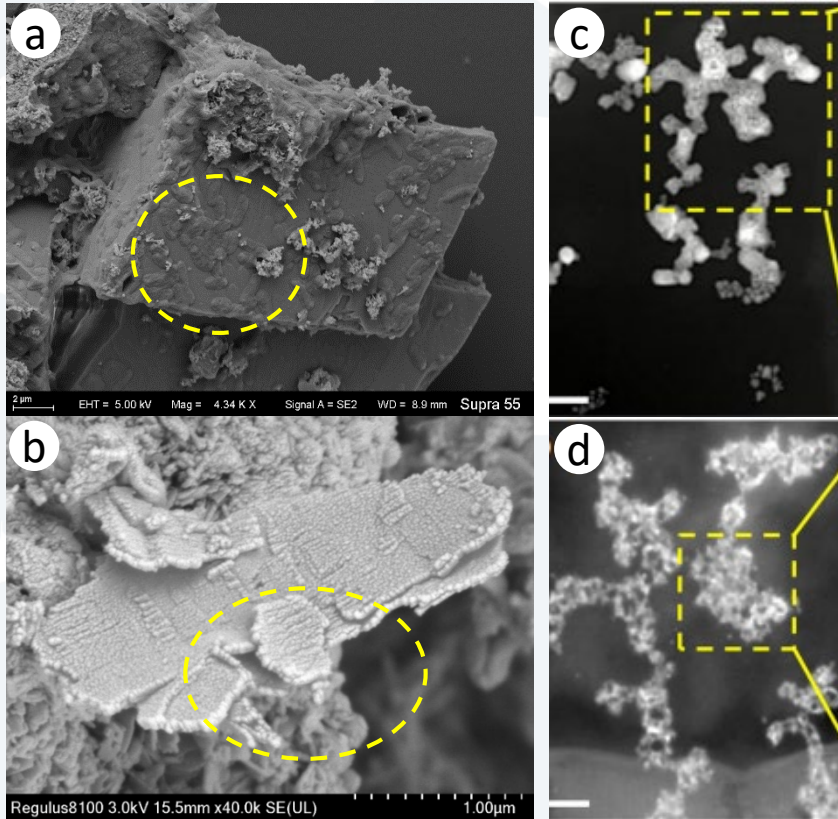


Interactions among PSM, soil carbonate and phosphate minerals

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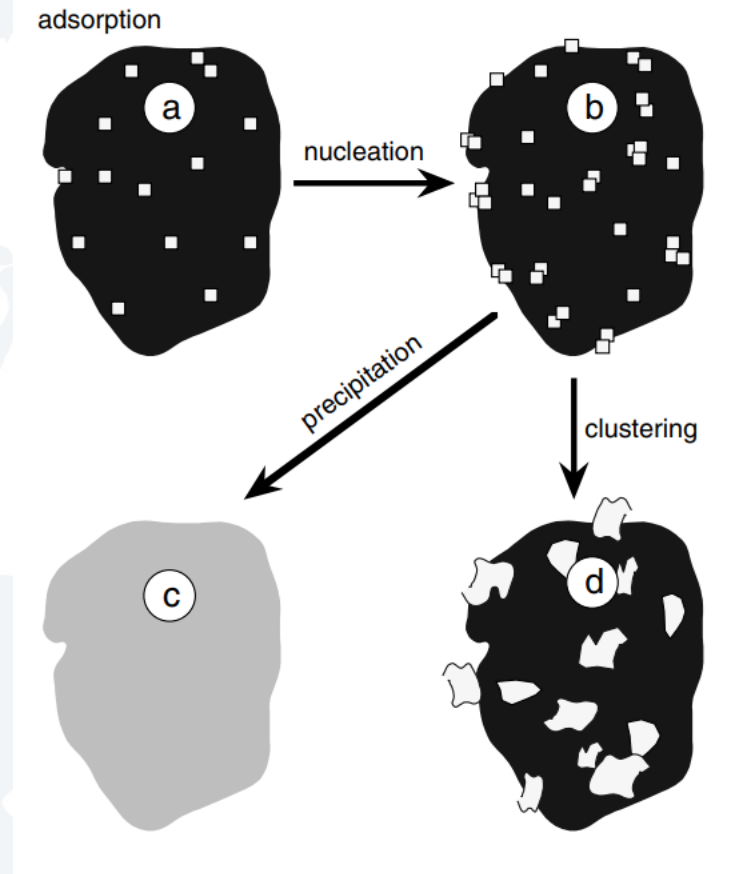


PSM in bioweathering and biomineralization



- The adsorption of PSB on CaCO_3 surface promote the carbonate weathering;
- More available P is released in bioweathering;
- The biomineralization of Ca-P phases restricts the P release in ecosystem.

Basic geochemistry: adsorption, nucleation and precipitation of Ca-P phases



- An illustration of P sorption on carbonate

(Fendorf et al. 1992)

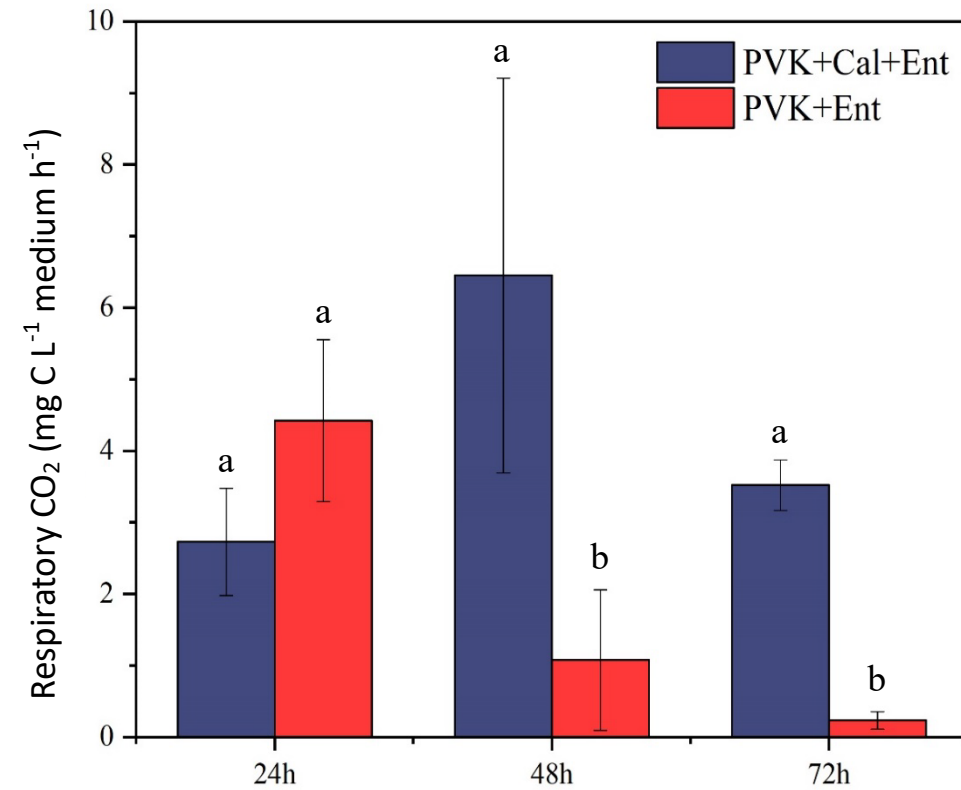
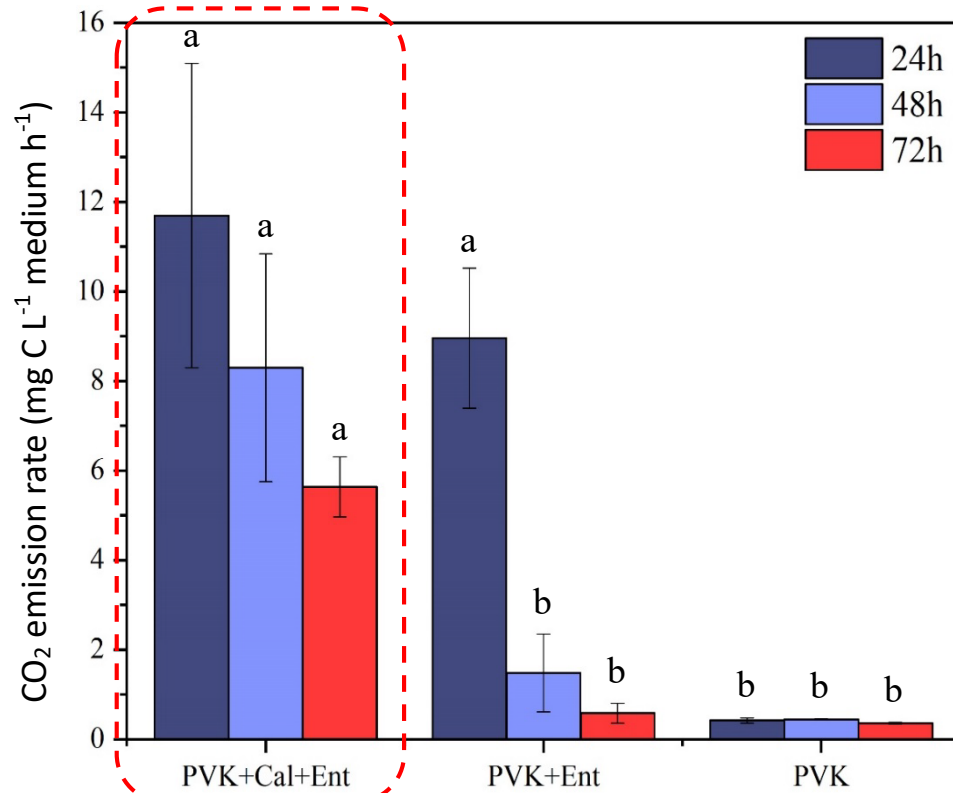
- Adsorption is the dominant sorption mechanism at low P concentration ;
- Ca-P nucleation begins with increased PO_4^{3-} loading;
- Further increases in PO_4^{3-} loadings results in surface precipitation or surface clusters;
- Ca^{2+} and Mg^{2+} on carbonate surface act as bridges to PO_4^{3-} species.

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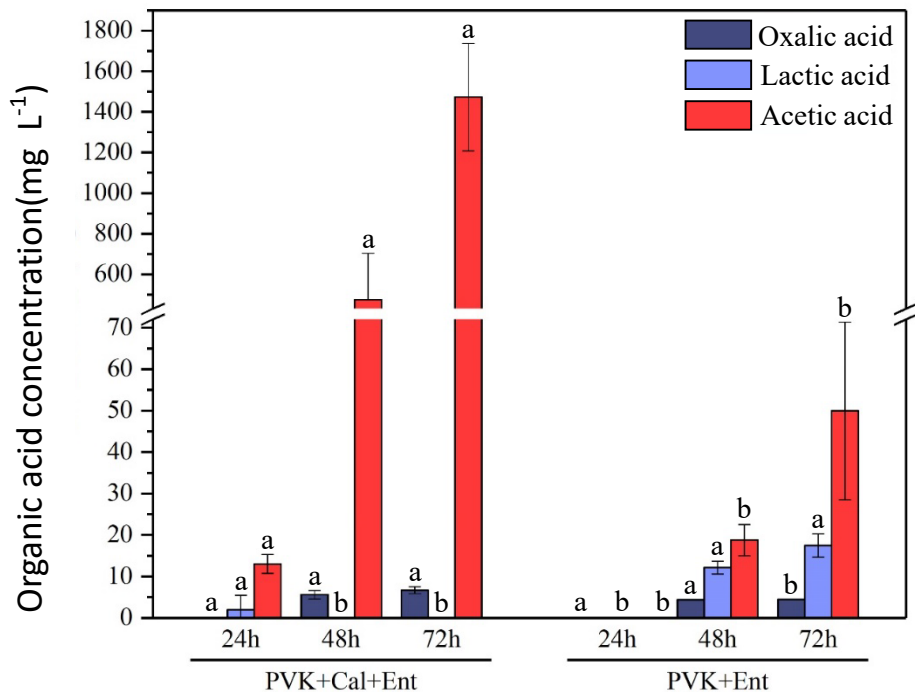
Biogeochemistry: influence of carbonate to PSM

- Variation of CO₂ emission rate stimulated by calcium carbonate (CaCO₃)
- Variation of respiratory CO₂ stimulated by calcium carbonate (CaCO₃)



Biogeochemistry: influence of carbonate to PSM

- Variation of organic acid concentration stimulated by calcium carbonate (CaCO_3)



- CaCO_3 significantly increased the release of CO_2 in the medium ;
- The released CO_2 mainly comes from the PSB respiration;
- PSB prefers to produce more organic acids (especially acetic acid) with the stimulation of CaCO_3 .

Conclusions

- Adsorption, nucleation, and precipitation all promote the Ca-P phases formation;
- Soil carbon and phosphorus cycles are tightly corelated to PSMs;
- Phosphorus availability is suppressed by soil carbonate minerals in karst regions.

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Thank you !

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