# The rheology of rhizosphere formation by root exudates and soil microbes

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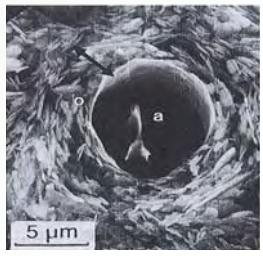
## Background

- The rhizosphere is the interface between the plant and soil.
- Exudation and enhanced cycles of wetting and drying produce a highly aggregated soil structure that may improve the capture of resources and resilience to stress.
- Underlying processes causing rhizosphere structure formation are poorly understood.

## Hypotheses

- Root exudates initially disperse soil, thus easing root penetration and releasing nutrients.
- Soil microbes then transform exudates into biological glues that gel soil.

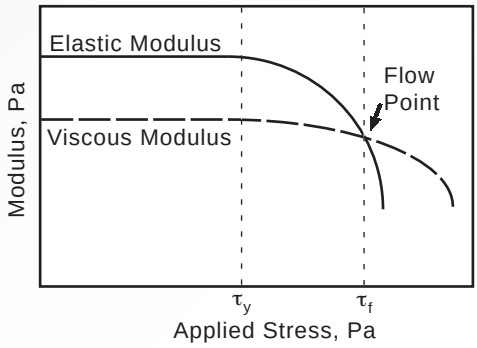



SEM from Dorioz *et al*. (1993) shows evidence of dispersion and aggregation in the rhizosphere.

## Methods

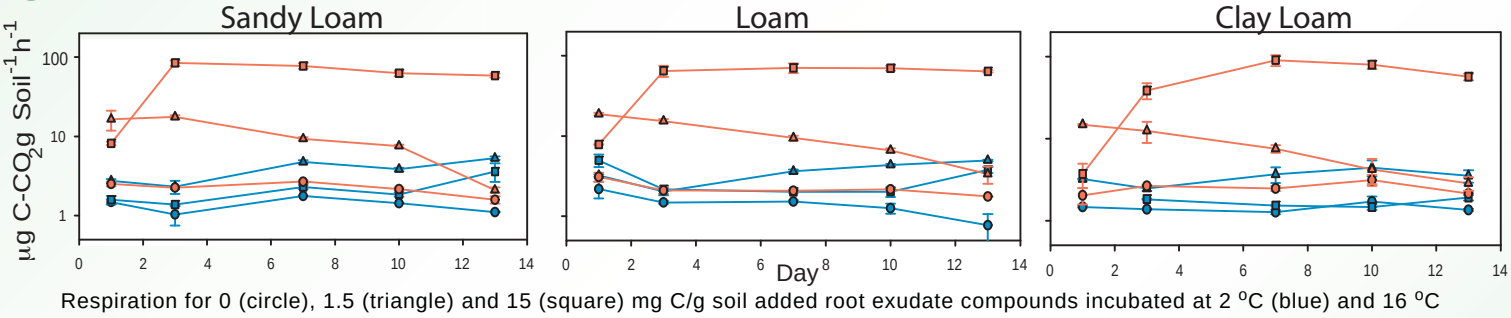
- Three Cambisols - sandy loam, loam and clay loam.
- Amended with 0, 1.5 or 15 mg C/g soil of root exudate compounds (Paterson *et al*., 2007).
- Incubated for 14 days at 2 $^{o}$C to suppress and 16 $^{o}$C to allow for microbial decomposition.
- $CO_2$ evolution measured by GC during incubation.
- Soils wetted to a range of water contents.
- Rheological behaviour tested in a parallel plate rheometer using an amplitude sweep test (Markgraf & Horn, 2007).

## Rheology and Flow Point

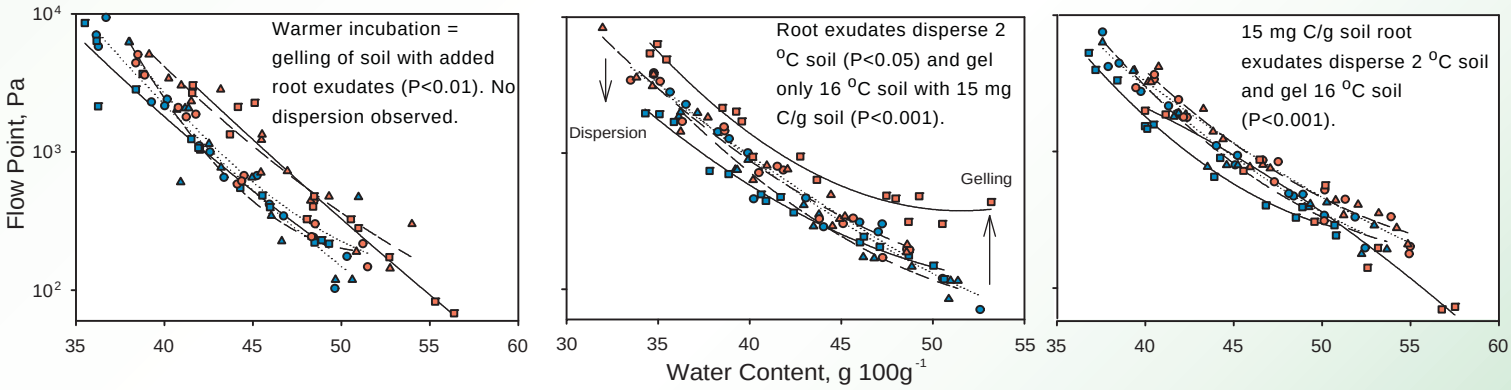



The elastic and viscous modulus decreases once the yield stress ($\tau_y$) is exceeded and structure collapses completely at the flow point ($\tau_f$).

## Results




Respiration for 0 (circle), 1.5 (triangle) and 15 (square) mg C/g soil added root exudate compounds incubated at 2 $^{o}$C (blue) and 16 $^{o}$C (orange). Colder incubation suppressed microbial activity significantly.




Flow point for 0 (circle), 1.5 (triangle) and 15 (square) mg C/g soil added root exudate compounds incubated at 2 $^{o}$C (blue) and 16 $^{o}$C (orange). The flow point is the stress where internal structure breaks down and the soil flows.

## Conclusions

- Dispersion observed for soils with added root exudate compounds where microbial activity suppressed by 2 $^{o}$C incubation.
- Gelling observed for soils with added root exudate compounds and microbial activity at 16 $^{o}$C incubation.
- Impacts depend on soil texture and amount of added root exudate compounds.

Dorioz JM, Robert M, Chenu C (1993) The role of roots, fungi, and bacteria on clay particle organization: An experimental approach. Geoderma 56,179–194.
Markgraf W, Horn R (2007) Scanning electron microscopy – energy dispersive scan analyses and rheological investigations of South-Brazilian soils. Soil Sci. Soc. Am. J. 71, 851-859.
Paterson E, Gebbing T, Abel C, Sim A, Telfer G (2007) Rhizodeposition shapes rhizosphere microbial community structure in organic soil. New Phytologist 173, 600-610.

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