Dynamic soil water repellency during infiltration of water, ethanol, and aqueous ethanol solutions in post wildfire soils

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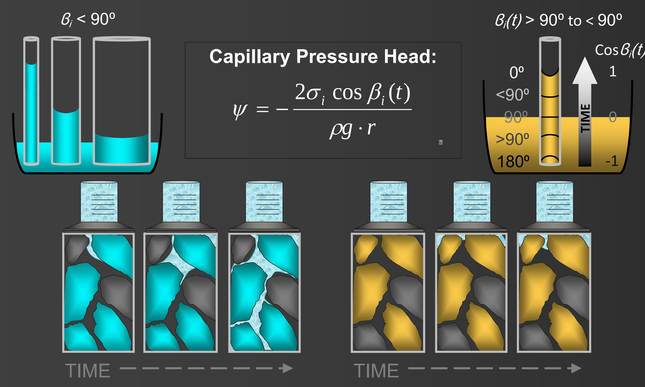
INTRODUCTION

Hydrophobic or water repellent soils (WRS) have been investigated widely over the last 10+ years, generating multiple special issues (Ritsema and Dekker, 2003, 2005; Doerr et al., 2007; Jordán et al., 2013). Currently, **mechanistic understanding** of fundamental drivers of infiltration in such systems remains a challenge. Consequently, reliably modelling flow and transport has proven difficult. This work investigates the concerted effects of 1) **contact angle dynamics** (temporal dependence of repellency) and 2) **fractional wettability** (spatial heterogeneity of repellency) in materials expressing dynamic repellency in WDPT tests. Through 49 **field** and 20 **laboratory experiments** using tension infiltrometers, various analytical approaches were employed to gain mechanistic insight into these dynamic systems.

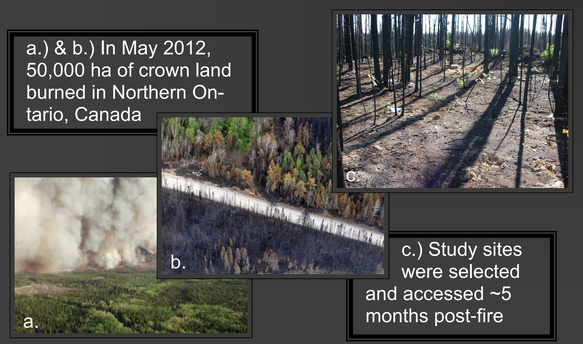
CONCEPTUAL MODEL



Uncertainty in **K(ψ) / K(θ)** and **Storage (ψ - θ)** under the same physical assemblage of pores

FIRE SITE

a.) & b.) In May 2012, 50,000 ha of crown land burned in Northern Ontario, Canada



c.) Study sites were selected and accessed ~5 months post-fire

QUESTIONS

1) At what times are differences in repellency best expressed in dynamic systems?

2) Can early time data reliably inform on longer term behaviours and changes in dynamic water repellent systems?

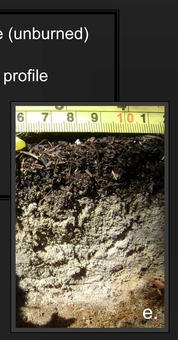
3) How can different fluids be used to generate additional insight into the nature of fractional wettability and contact angle dynamics?

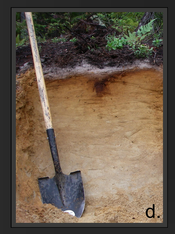
MATERIALS & METHODS

d.) Soil horizons profile (unburned)

e.) Brown material soil profile

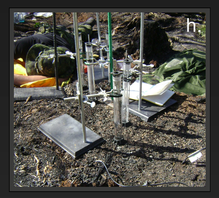
f.) Repellent water drops at OM-mineral Mixed material interface





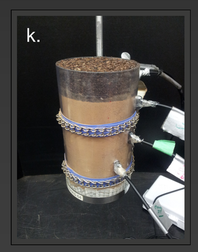
g.) 3D Infiltration in White materials

h.) Multi-test set up in Mixed materials



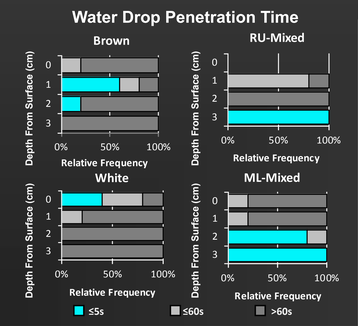
Two sites, 5 materials tested: Brown, Mixed (RU and ML), White, Char

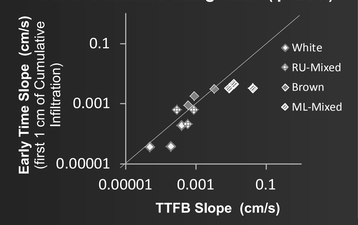
i.) & j.) material prep

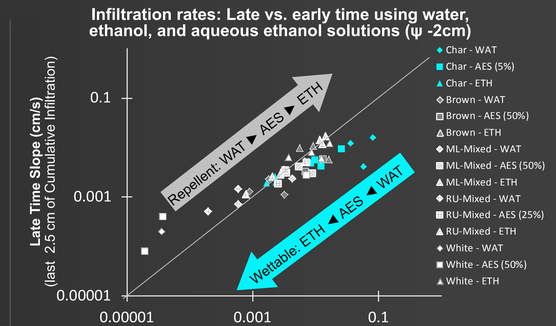


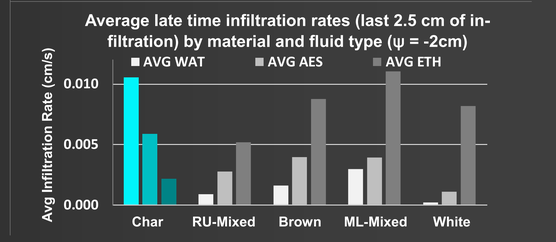
k.) & l.) 9cm column + VMC sensors set up

RESULTS

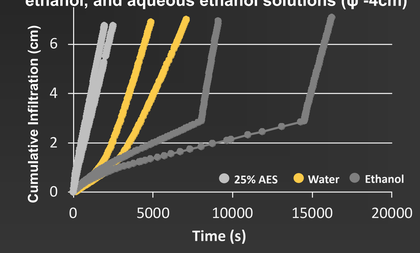


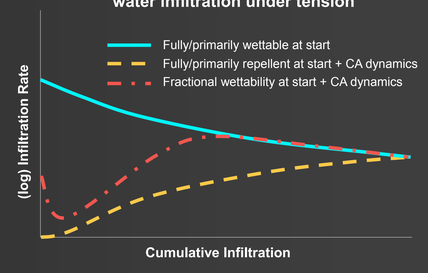






While tension infiltrometers are sensitive to changes in contact angle and fractional wettability, non-uniqueness is generated by the interactions of field heterogeneity, variable fluid properties, and dynamic soil water repellency during infiltration.





CONTRIBUTIONS

1) Fractional wettability and contact angle dynamics are primary drivers of infiltration in dynamic WRS

2) Tension infiltrometers are best able to isolate changes in repellency when negative pressure heads are maintained throughout water repellent layers *and* when longer term / larger (fluid) volume data are collected

3) Insight into which fractions are most active can be gained through multi-fluid testing that includes Molarity of Ethanol Drop—derived aqueous solutions

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