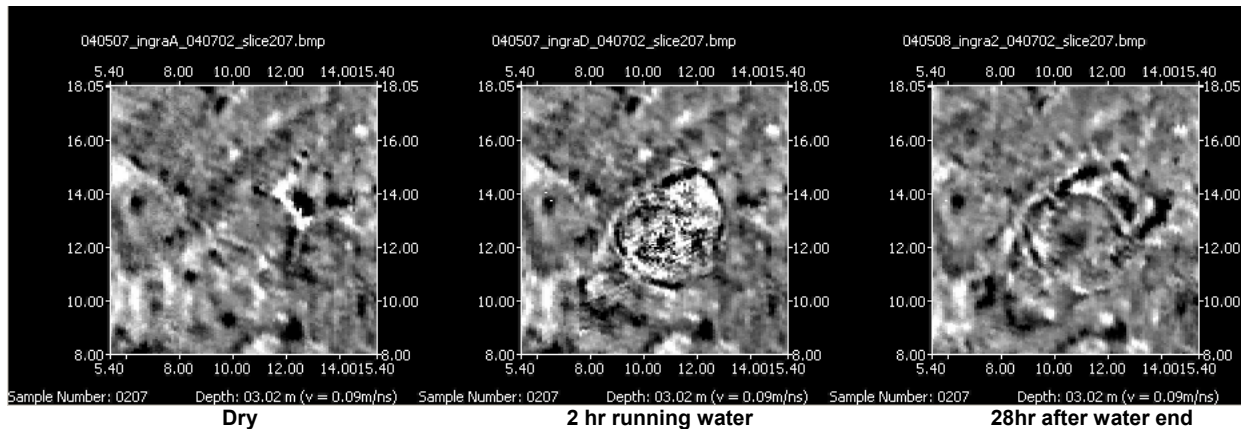


Noninvasive Imaging of Preferential Flow Pathways in the Miami Oolitic Limestones

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In large parts of urban Miami the vadose zone is characterized by oolitic carbonates, where laterally varying small-scale stratigraphy and crosscutting dissolution features control transport pathways. Water from heavy summer storms that pond on the surface to depths of 5-7cm disappear within a fraction of an hour. Subsequent to the rapid infiltration, little is known regarding the nature of water flow pathways and rates in this complex environment.

In order to reach our long-term goal of extracting hydrologically relevant and quantitative parameter volumes we have initiated an integrated study involving full-resolution 3D and 4D Ground Penetrating Radar (GPR) imaging, drilling, excavation, outcrop inspection, lab measurements on samples and synthetic GPR modeling. Preliminary results show that the bulk rock-permeability is controlled by infilled, high-permeability dissolution features, which act as preferential pathways to 'short-circuit' the vadose zone. Wetting front propagation within these dissolution features is in the order of 3m/hr, and even though such features represent only a small portion ($\approx 5\%$) of the total rock volume they possess sufficiently high transmission rates (>1000 litres/hr each) to allow the efficient draining of storm rainwater.



Horizontal slice animation taken from three repeated 3D GPR surveys before, during, and after water injection into a sand-filled dissolution cone. Data were acquired on a 5x10cm grid. The 3D data volumes reveal the anisotropic propagation of the wetting front. The signal patterns in peripheral areas of the 3D survey remain the same throughout the repeats. This indicates no change in water content beyond the reach of the central sink hole, but also the excellent reproducibility of the repeated GPR measurements.