## The influence of roots on soil structure: physio-chemical implications

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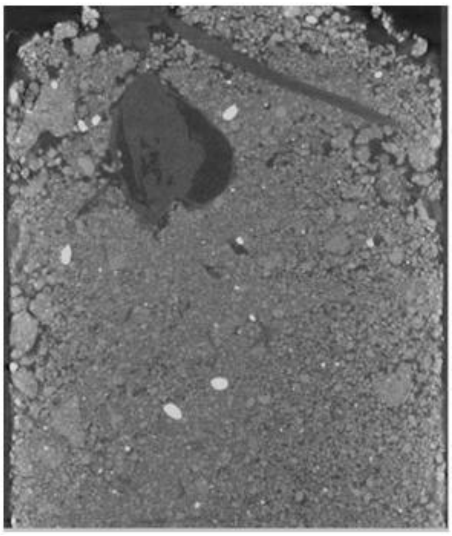
Roots play a crucial role in plant development through the delivery of water and nutrients inherently. Yet, our understanding of how roots interact with the surrounding soil remains limited because soil is an opaque medium which prevents roots from being visualised without disturbing them. When roots penetrate soil they change the structure initially by complex deformation processes as the root expands a cavity, and then by the shrinkage of soil due to water uptake away from the root tip. The implication of these deformations is understood at the macroscopic scale and inferences have been made about the consequences at the root scale. However, detailed measurements of soil structural changes are very limited and have not been mapped with respect to distance from the root. A significant obstacle to progress has been the limited resolution on x-ray scanning instruments and a poor ability to distinguish between soil and water. Both of these limitations have been largely overcome by the new x-ray computed tomography (CT) imaging facility at Nottingham, which allows microscopic changes in soil structure to be imaged as well as the detection of water-filled pores. In this project we measure the structural changes that are generated in soil as a root progresses through the soil profile.

There is a need to interpret this type of soil structural data in the context of the response of the root to its environment. Changes in soil structure almost certainly affect pore-scale pH. We have shown that matric potential and pore scale pH are strongly related to each other, probably through hydrogen ion dilution effects. This is important because pH has been shown to affect cell-wall relaxation, which is implicated in the generation of growth pressure at the root tip. Local pH changes at the root surface will modify nutrient availability and this phenomenon is particularly important for immobile nutrients in soil, such phosphate. Additionally, the creation of new air spaces and local pH changes will change microbial populations, which in turn influence nutrient cycling processes such as nitrification. The inter-conversion of nitrate and ammonium in the soil is important because this processing influences the amount of nitrate leaching through the profile. In this project we are determining the consequences of the changes to soil structure, because of root growth, to the root itself. For example, by measuring root growth pressure as a function of the acidification which is known to occur in drying soil. We also measure changes in nutrient availability as a function of the acidification in the rhizosphere. We are partitioning the effects of acidification due to soil drying and those due to the release of organic acids by the root.



**3 day old wheat seedling in sandy soil at 20 µm resolution**

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