weeks. X-ray computed tomography was then used to image a small section of the pot to determine the spatial distribution of the roots and pore spaces. After 12 weeks of decomposition, the pots were rescanned before a second season of plant growth and a final scan. The final images of the pore spaces and root systems at each phase were then overlayed and compared to determine the proportion of roots that reoccupied previous root channels. The results of this research will be presented and discussed. Improved understanding of the amount of reutilised pore spaces by successive crops will have broader implications for nutrient and water acquisition, help explain microbial and exudate hotspots and soil physical properties.

**Keywords:** Root distribution, X-ray computed tomography, Soil pore spaces, Rhodes grass
**Financial support:**

**(6729 - 3218) Surface caracterization of an entisol using microtomography**

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The soil structure can be defined as the arrangement of soil particles and their pore space, it is important for the maintenance of porosity, aeration, plant growth and microorganisms. The study of soil microstructure is advancing with the use of computerized microtomography (µTC). This work aims to study the microstructure in an Entisol's surface using the µTC. The samples were collected at the Várzea do Barro Farm, in São João-PE. The images were obtained using the Nikon XT H 225 ST, resulting in high-resolution images with 50 micron voxels size. A morphometric analyse were done using Image-J. The images were segmented in three phases: voids, rocks fragment and matrix, where were applied thresholding values using a Pure Voxel Extration (PVE) for each phase. Then the pores were classified in inter-agregate and intra-agregate using the Image J's plug-in Particle Analyzer. The soil's samples had 41,57% of medium porosity, with 41,51% for inter-agregate voids and 0,11% for the intra-agregate voids. The Entisols it's a highly sandy soil, so it's expected for the higher percentage of the inter-agregates. There was a high percentage (73%) for the complex pores, indicating pores with high connectivity.

**Keywords:** Porosity, Microstructure, Soil
**Financial support:** CNPQ

**(4186 - 857) Using X-ray Computed Tomography to assess how plant roots can remediate compacted soils via reorganisation of the rhizosphere**

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Soil compaction is a form of degradation that affects agricultural land on a global scale. Primarily caused by the passage of heavy farm machinery, the effects on soils can be persistent and difficult to alleviate effectively. Currently, deep-tillage practices are used as a short-term solution to lessen soil compaction in agricultural contexts, however this intensifies the risk of permanent subsoil compaction. Plant species that are able to grow in heavily compacted soil may increase the number and size of pores helping to positively alter a degraded soils structure. Hence plants may offer a simple field-scale means to improve a compacted soil via localised structural remediation in the rhizosphere. We analysed the root growth patterns of three non-cultivated plant species often found occurring naturally on compacted soils, suggesting they have an intrinsic ability to grow effectively under such circumstances. Ribwort plantain (*Plantago lanceolata*), dandelion (*Taraxacum officinale*) and spear thistle (*Cirsium vulgare)* plants were grown for 28 days in a sandy-loam soil compacted to 1.8 g $cm^{-3}$ with a penetration resistance of 2.55 MPa. X-ray Computed Tomography was used to observe root architecture *in situ* and visualise changes in rhizosphere porosity with distance from the root surface at a resolution of 35 µm, at 14 and 28 days after sowing. Porosity of the soil was analysed within four incremental zones up to 420 µm from the root surface. In all species the porosity of the rhizosphere was greatest closest to the root and decreased with distance from the root surface. There were significant differences in rhizosphere porosity between the three species, with the spear thistle plants exhibiting the greatest pore space creation across all rhizosphere zones. This study indicates that roots can have a localised effect in increasing the formation of pore space in the rhizosphere, counteracting any initial compression due to root penetration. The resulting structural alteration of the soil indicates the potential for a natural way to create and improve soil structure in heavily degraded soils.

**Keywords:** Compaction, remediation, rhizosphere, porosity, X-Ray Computed Tomography
**Financial support:** NERC, BBSRC, STARS

**(4550 - 1867) Visualization of soil microstructure under conventional tillage and fallow using micro-focus x-ray computed tomography.**

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Tillage affects a soil's structure. In general, soil structure regenerates under fallow but degrades under conventional tillage. However, the effect of fallow and tillage on soil microstructure and morphology is not conclusive. Aggregates ~ 10 mm diameter of an Haplic Cambisol were collected from the top 0.1m in adjacent fields at the University of Fort Hare experimental farm (latitude 32°46'S and longitude 26°50'E). One field was under a five-year-old fallow management (FM) and the other under conventional tillage (CT). Soil aggregates were fixed on a rotary stage that rotated from 0° to 360° and sample absorption radiographs taken at the same step interval. 1000 slices were reconstructed for each sample. CT Pro 3D software® was used to reconstruct the 1000 slices into 3D images. Analysis of 3D soil aggregates was done using VGstudio MAX 3.0®. To avoid the edge effects, a region of interest of 52 ± 0.1 $mm^3$ volume was selected at the middle of the 3D soil aggregates. The pores were classified into seven classes: <50, 50-100, 100-200, 200-300, 300-400, 400-500 and > 500 µm. Sphericity (S) was used to classify pores into three pore shape classes: regular pores (S ≥ 0.5), irregular pores (0.2 < S < 0.5) and elongated pores (S ≤ 0.2). The soil pore distribution, pore shape, pore proportion and visualizations were similar in both treatments. Therefore, both FM and CT had a similar effect to the soil's microstructure and morphology at the time of sampling. The fractions of elongated pores, which are crucial for soil water and gas transport were ≤ 0.1% in both treatments. The low fraction of elongated pores suggest that there is high chance of soil degradation especially by erosion under both treatments. It was concluded that a five-year difference in soil use and management may not affect its microstructure and morphology but other soil properties such as the organic matter.

**Keywords:** Haplic Cambisol; soil microstructure and morphology; x-ray mCT; soil aggregates, soil pores
**Financial support:** National Research Foundation (NRF) [grant number 98690]; Nuclear Energy Corporation of South Africa (NECSA) provided the x-ray µCT scanning facility.

**(9855 - 1040) X-ray computed microtomography against retention curve for assessing porosity in Latossolos (Ferralsols) with contrasting vegetation cover**

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Soil porosity is conventionally measured by the retention curve method and is affected by a number of factors, but mainly by the relative distribution of particles with different sizes, shapes and arrangement. X-ray computed microtomography (microCT) appears as a novel non-destructive and rapid method to characterize the particle arrangement and calculate soil porosity. This work aims to compare the retention curve and microCT methods to assess the total, macro and microporosity of the soil. The work was developed in Silva Jardim, RJ, southeastern Brazil, using Latossolo (Ferralsol) soil samples taken at about 10-cm depth. For both methods, four samples were taken from grass-covered soil, and four samples from bare soil, using either 50-mm-high x 32-mm-wide acrylic cylinders (microCT) or 50-mm-high x 26.5-mm-wide steel cylinders (retention curve). For the determination of the porosity values using the retention curve method, the Richards pressure chamber was used applying the following tensions: 0.01, 0.033, 0.06, 0.1, 0.33, 1.5, 15 bar. For the microCT assays the samples were digitized in a high energy system - Skyscan / Bruker, model 1173. Using the retention curve method, the following average porosity values were obtained in covered and bare soil, respectively: 52% and 45% total porosity, 12% and 5% macroporosity, and 40% microporosity for both cases. Using microCT, porosity values were: 27% and 22% total porosity, 11% and 10% macroporosity, and 16% and 12% microporosity in covered and bare soil, respectively. The study confirmed that grass-covered Ferralsols have higher porosity due to the presence of roots. More importantly, the total porosity measured by the retention curve was considerably higher than that measured by microCT. This may be due to the fact that Ferralsols store most of the water in micropores, whose detection using microCT is limited by the minimum detection limit of the method of 30 µm. Thus, some adaptation of the method is required for monitoring Ferralsols, which are the main agricultural soils of the Brazilian Cerrado (savanna).

**Keywords:** Porosity Soil, Microtomography Technique and Structure of Soil

**Financial support:** CAPES, EMBRAPA SOLOS, COPPE UFRJ, UNESA, UFF

**(3223 - 3216) X-Ray Computed Tomography applied to analyze soil structure under different infiltration techniques**

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Tension Infiltrometer and Simple Ring Infiltrometer are useful in situ techniques which are commonly used to determine soil hydrodynamic properties. Comparing the effects of these techniques on the soil structure in a pore scale is fundamental to identify the ideal in situ method for infiltration and water storage study. This study is being conducted in areas of Caatinga vegetation in the Agreste and Sertão of Pernambuco, Brazil. Infiltration tests were carried out with the two techniques mentioned on the soil surface layer, where undisturbed soil samples were collected of the area in direct contact with the tests. For the pore scale analysis, high-resolution tomographic images (50 micron voxel size) have been obtained with scanner Nikon XT H 225 ST. The grayscale images are segmented in three phases: voids, rocks fragment and matrix. A morphometric analysis of intra-aggregate voids was done in order to quantify their size and shape. Moreover, spatial variability of matrix radiodensity are been studied to obtain more details about voids smaller than the resolution adopted. This study compare soil structural differences caused by these two infiltration techniques.

**Keywords:** infiltration techniques, soil structure, x-ray computed tomography, pores morphometry, spatial variability

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**(3095 - 271) X-ray microtomography analysis of lime application effects on soil porous system**

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Soil liming has demonstrated to be efficient to make acidic soils suitable to agriculture but little research has been done to evaluate its effect on soil structure in the microscale. X-ray microtomography (µCT) is a useful technique to obtain valuable information about the micromorphological characteristics of soil and, thus, can provide important insight into how liming affects such a porous system. In this study, µCT was used to evaluate changes on micromorphological physical properties (porosity, number of pores, pore length, elongation, shape, connectivity and tortuosity) of a soil cultivated under no-tillage (NTS) caused by the application of lime on the surface. A degraded pasture area representing soil conditions before the NTS implementation was also analyzed. Samples from two soil layers (0-10 cm, A, and 10-20 cm, B) were analyzed with a voxel size of 60 µm. Image visualization, processing and analysis were performed in the Avizo Fire 9.0 software. Liming improved the soil chemical attributes only at layer A where it also produced positive effects on the soil porous system within a period of thirty months. We highlight the increase in soil porosity (P) and number of pores (NP) into which the main soil pore was separated, as evidence of such positive effects. For layer A, those pores were found to be longer, more elongated, and more connected for the limed site. However, changes in the pattern of the separated pores, with the formation of cylindrical pores in the horizontal orientation for the limed site, were observed at both soil layers, which can be attributed to stimulation of the soil fauna activity due to liming.

**Keywords:** soil porous system; microtomography; soil structure; soil quality.

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**C1.1.3 - How to use micromorphology to understand palaeosols and polygenetic soils?**

**(5583 - 349) Fate of Co-containing phyllomanganate: Implications for Co sequestration**

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