Title: *Fractal and Lacunarity Analysis of X-ray CT of vineyard soil samples with two different management practices*
Authors: J. Caniego, F. San José and F.J. Muñoz

Soil structure controls important physical and biological processes in soil–plant–microbial systems that are dominated by the spatial heterogeneity of soil structure. Pore space shows a high degree of complexity and irregularity and can be studied well within the theory of fractal geometry. Then, soil is usually characterized by a set of fractal dimensions. In the last years, this kind of study has been supported by techniques such as computed tomography (CT) and 3D image analysis. These techniques allow us to obtain a reconstruction of the complex pore structure of the soil and its spatial distribution at a broad range of scales enabling the study of the pore space without disturbing the samples. A set of fractal dimensions let us firstly quantifies the differences in soil geometry, which may be caused by different soil managements or depth, and afterwards they can be used as parameters in geometric models at pore scale. However, the description or the modeling of soil geometry, using only the fractal dimensions is, somewhat, incomplete, in fact, objects with the same fractal dimensions show strikingly visual differences. These differences are attributed to texture or textural patterns.
Lacunarity is a multiscale measurement of the spatial heterogeneity or texture of an object. Although it was introduced in order to characterize the distribution of gaps of fractal objects with the same fractal dimension, its use has been extended to describe not fractal objects. Lacunarity quantifies deviation from translational invariance at a fixed scale and is obtained by the mean square deviation of the fluctuations of the mass distribution probability divided by its average squared. The generalization of this notion to several scales allows us to study the scaling of that measurement which, on a log-log plot, results in a straight line for fractal objects.
In this work we analyzed the three-dimensional structure of soil pore space with X-ray computed tomography of twelve intact soil columns from a Spanish Mediterranean vineyard soil with two different management practices (conventional tillage versus permanent cover crop of resident vegetation). Our results suggested that lacunarity analysis provide promising tool to characterize the texture of soil macropore structure and could discriminate soil different treatments. Finally, we test whether this measure complements the set of fractal dimensions in order to achieve a complete description of the geometry of soil structure.