# Passive acoustic emissions analysis in soils: a new way to assess the soil structure dynamics for soil modelling

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# PASSIVE ACOUSTIC EMISSIONS ANALYSIS IN SOILS: A NEW WAY TO ASSESS THE SOIL STRUCTURE DYNAMICS FOR SOIL MODELLING

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Soil structure is usually defined as the 3D spatial organisation of aggregates and pores. In this way, this definition is close to the concept of soil architecture. Soil structure is involved in gas and water flows and storage in soil, and thus determines the chemical and physical environment of soil organisms. Soil structure depends on inherent soil parameters (texture, clay nature, etc.), but also on external factors such as climate, organism activities or soil management though human activities. These factors induce different dynamics of soil structure evolution due to different processes (compaction, cracking, aggregation, etc.) at different spatial and time scales. Soil models are recognised as key tools to understand and/or predict soil functioning. Many models require data on soil structure, but soil structure parameters as well as physical parameters directly related to soil structure (e.g. hydric parameters) are often very simple and fixed in time. Some models of soil structure evolution exist, but are usually specific of one process modifying soil structure. There is then a need of improving the modelling of soil structure dynamics due to combined processes. To reach this objective, the description of the 3D soil structure dynamics is mandatory. Nowadays, 3D imaging methods such as X-ray tomography are getting more accessible and very popular, as they allow 3D description of soil structure (pores size, geometry, connectivity, distribution in space, etc.). Rapid imaging also enables addressing the soil structure dynamics by time-lapse experiments. However, 3D imaging also raise many questions, concerning the image resolution, the time resolution, etc., and it's still necessary to compare and combine methods.

Passive acoustic emissions (AE) are produced in soils by various processes: liquid bridge rupture, crack development, grain friction, grain cementation fracture, rupture of soil fibres, etc. (Michlmayr, et al., 2012). AE productions in soils are then due to particles movement, and our hypothesis is that they could be a useful tool to characterise the soil structure dynamics. Passive AE are indeed commonly used in civil engineering to monitor integrity of concrete structures, but they are still not used in soil science. We have then conducted a feasibility study to evaluate the potential of AE monitoring in soil to assess the soil structure dynamics. Our objective was to answer basic questions such as: (i) Is it possible to record AE during soil structure evolution? (ii) Is this AE signal repeatable? (ii) Is the AE signal linkable to soil structure evolution? (iii) Is AE signal specific to one process of soil structure evolution? Laboratory experiments on undisturbed soil cylinders were conducted and AE were recorded during soil drying using AE sensors (25 – 530 kHz) linked to a multi-channel and real-time AE acquisition system from MISTRAS. The water loss was monitored, as well as the evolution of the soil surface by 2D imaging. The first results obtained were repeatable and showed that AE events were highly correlated to (i) the rate of water loss, and (ii) the soil surface movements.

Michlmayr G, Cohen D, Or D. 2012. Sources and characteristics of acoustic emissions from mechanically stressed geologic granular media - A review. Earth-Science Reviews 112: 97-114.