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Application of TAM III to study sensitivity of soil organic matter degradation to temperature

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Traditionally, studies of soil biodegradation are based on CO_2 dissipation rates. CO_2 is a product of aerobic degradation of labile organic substrates like carbohydrates. That limits the biodegradation concept to just one of the soil organic matter fractions. This feature is responsible for some problems to settle the concept of soil organic matter (SOM) recalcitrance and for controversial results defining sensitivity of SOM to temperature. SOM consists of highly complex macromolecules constituted by fractions with different chemical nature and redox state affecting the chemical nature of biodegradation processes. Biodegradation of fractions more reduced than carbohydrates take place through metabolic pathways that dissipate less CO_2 than carbohydrate respiration, that may not dissipate CO_2, or that even may uptake CO_2. These compounds can be considered more recalcitrant and with lower turnover times than labile SOM just because they are degraded at lower CO_2 rates that may be just a consequence of the metabolic path. Nevertheless, decomposition of every kind of organic substrate always releases heat. For this reason, the measurement of the heat rate by calorimetry yields a more realistic measurement of the biodegradation of the SOM continuum. TAM III is one of the most recent calorimeters designed for directly measuring in real time the heat rate associated with any degradation process. It is designed as a multichannel system allowing the concomitant measurement of to up 24 samples at isothermal conditions or through a temperature scanning mode from 18 to 100ºC, allowing the continous measure of any sample at controlled non-isothermal conditions. The temperature scanning mode was tested in several soil samples collected at different depths to study their sensitivity to temperature changes from 18 to 35 ºC calculating the Q10 and the activation energy (EA) by the Arrhenius equation. It was attempted to associate the obtained EA values with the soil thermal properties determined by differential scanning calorimetry and thermogravimetric analysis. The EA values obtained ranged from -30 to -48 kJ/mol increasing with soil depth and with higher heat of combustion values of the samples obtained by DSC, suggesting that increased SOM recalcitrance involves higher investment of energy by the microbial population to degrade SOM. The calorimetrically determined Q10 values were observed to decrease with soil depth and higher heat of combustión, supporting the hypothesis, as given by different authors, that higher SOM recalcitrance can be associated with a decreased sensitivity to temperature as in agreement with the increasing trend of the activation energy