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Use of rare earth oxides and iron oxides as soil erosion tracers in water erosion experiments at hillslope scale

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The characteristics of the ideal soil erosion have been defined by several authors, for example by Zhang et al. (2001). Despite intensive research on erosion tracers in the last decades there is not a single tracer fulfilling all these characteristics. That is why research on different soil erosion tracers remains as an active field. Two desirable characteristics in erosion tracers are that they should be relatively inexpensive (to purchase and analyze) and that they should be determined with high accuracy in soil or sediment. The availability of multiple tracers is another of the key requirements.

In this communication we present our preliminary results on the use of two different sets of erosion tracers. One set are iron oxides with different magnetic and optical properties (Fe3O4, -Fe2O3 and FeOOH) analyzed by NIRS and magnetic susceptibility measurements. The other set consists of five rare earth oxides (La2O3, Pr6O11, Nd2O3, Sm2O3 and Gd2O3) analyzed using inductively coupled plasma mass spectrometry (ICP-MS). These two groups were studied under controlled and natural conditions, through several water erosion experiments, in field plots with different soil management, crops and scale.

In one experiment these tracers were used to determine the source of sediment within sprinkle irrigated fields planted with cotton on shoulders. For this purpose, rainfall simulations were performed under controlled conditions at two scales, one with a portable rainfall simulator at small scale (0.81m2) and with the sprinkler irrigation system in the whole cotton field (2450 m2). Furrows were tagged with both groups of tracers, keeping shoulders untagged (where cotton was planted). Soil samples before and after the rainfall simulations were collected as well as sediment samples. In another experiment four olive orchard plots (330 m2) with different soil managements (cover crop and conventional tillage) were also tagged with the two groups of tracers. Soil samples were taken at the time of the soil tagging and after 1 and half year, as well as the sediment generated during the rainfall events that occurred during this period. In both experiments comparison of the concentration of the different tracers in the soil and sediment samples allowed determination of the source of sediment.

This communication explores the performance of both set of tracers. It presents the relative advantages and disadvantages of both approaches, and the quantitative and qualitative information provided about sediment redistribution in the two evaluated systems (rain fed orchard and irrigated field crop). It also discuses the potential of these specific tracers as a complement of traditional soil losses measurements in understanding erosion processes and evaluating specific soil conservation techniques.

References:

Zhang, X.C., Friedrich, J.M., Nearing, M.A., Norton, L.D., 2001. Potential use of rare earth oxides as tracers for soil erosion and aggregation studies. Soil Science Society of America Journal 65, 1508–1515.