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Rock-Eval® device for characterization of environmental samples: methods, insights, and applications.

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The Rock-Eval® device is an open-system pyrolysis and oxidation instrument that has been primarily developed to characterize the thermal properties of the sedimentary organic matter using different standardized analytical methods. This device was mainly used to investigate the potential of source rocks for petroleum system explorations (e.g., Espitalié et al., 1977; Espitalié et al., 1986; Lafargue et al., 1998; among others). It has been also used to quantify the total organic carbon (TOC) and the mineral carbon (MINC) contents of any sedimentary rock. Since the 2000s, this technique has been increasingly tested in other geoscience applications including: (1) the characterization of organic matter in soils (e.g., Di-Giovanni et al., 2000; Disnar et al., 2003; Sebag et al., 2006); (2) the study of past climate changes and global carbon cycle (e.g., Baudin et al., 2007, 2010; Rohais et al., 2019; Garcin et al., 2022), (3) the determination of the origin of geothermal scales (Romero-Sarmiento et al., 2022a) and recently (4) the quantification of microplastics in sediments displaying different mineral matrix (Romero-Sarmiento et al., 2022b). Most of these environmental applications required adjustments of the standard Rock-Eval® analytical methods as well as of the signal treatment and interpretation to obtain more accurate and appropriate thermal parameters.

The aim of this work is to summarize these good practices to better characterize environmental samples from different case studies, especially in the framework of the ecological transition. For instance, specific thermal and quantification procedures are now proposed to quantify both organic and inorganic carbon contents in calcareous soils (Sebag et al., 2022; Hazera et al., 2023). For soil samples showing very low organic carbon content, an alternative methodology is also proposed based on the Rock-Eval® oxidation stage only to better quantify the soil organic carbon content (Malou et al., 2023). Furthermore, oxidative emissions from Rock-Eval® device can be used to characterize carbonized biomass (Aubertin et al., in prep). Moreover, some Rock-Eval® parameters seem to be suitable to evaluate the fertilizing or amending effect (IROC% equivalent) of biowaste (Ducasse et al., 2023, Wei et al., in prep). Finally, a quick conversion approach using Rock-Eval® parameters to distinguish polymer families is proposed to quantify the polymer content in natural samples contaminated by plastics (Romero-Sarmiento et al., 2022b), as well as Rock-Eval® pyrolysis parameters are also proposed to follow the impact of plastics on carbon mineralization in soil ecosystems (unpublished internal data). In this work, analytical recommendations about the Rock-Eval® method are therefore provided regarding the nature, the origin, and the geochemical context of the investigated environmental samples.

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