

Pedogenesis and stabilization of soil organic carbon in a charcoal production plot

JEAN-THOMAS CORNELIS*, BRIEUC HARDY, BRUNO DELVAUX AND JOSEPH DUFÉY

Earth and Life Institute – Environmental Sciences, Université catholique de Louvain, Louvain-la-Neuve, Belgium
(*correspondence: jean-thomas.cornelis@uclouvain.be)

Charcoal addition to soil has the potential to improve physical, chemical and biological functions of soil [1], while being used as a potential long-term sink for atmospheric CO₂ due to the intrinsic recalcitrance of aromatic components [2]. Our hypothesis is that production process and addition of charcoal in soil can influence the pedogenic processes governing the soil capacity to stabilize organic carbon (OC).

The experimental site is located in an oak forest in the loessic silt belt of Belgium. The well-drained and acidic (pH 3.8-4.3) soil is classified as a Luvisol with an argic horizon occurring at 30 cm depth. We carried out the mineralogical and physico-chemical analysis (i) in an ancient charcoal production plot (1750-1870), and (ii) in the reference forest soil. Moreover, we analyzed the content of labile and stable (mineral-protected and recalcitrant) OC in charcoal-enriched, organo-mineral (Ah), eluvial (E) and argic (Bt) horizons.

The soil-pH increases by 0.6-0.8 units and the base saturation is until eight fold higher after the addition of charcoal. In the eluvial E horizon just below the charcoal accumulation, we observe a slight decrease of the content of amorphous and crystalline iron oxides, which provide reactive hydroxylated surfaces for OC associations. The mass of stable OC per unit area in the soil below the ancient charcoal production plot is significantly higher (13.9 kg.m⁻²) than in the reference Luvisol (5.8 kg.m⁻²). Charcoal, as residues of slow pyrolysis, strongly increases the sequestration of C in soil through (i) intrinsic recalcitrance and (ii) charcoal-organo-mineral interactions. Indeed, the part of humified, dissolved or colloidal OC released from charcoal and stabilized upon silicates and oxy-hydroxydes is not negligible (5.6 kg.m⁻²). Finally, the pedological modifications induced by the charcoal production process do not significantly influence the stable OC stock. Therefore, the addition of charcoal will lead to higher C sequestration in topsoil without affecting the subsoil capacity to stabilize OC.

[1] Glaser B., Lehmann J. & Zech (2002) *Biology and Fertility of Soils* **35**, 219-230. [2] Baldock J. & Smernik R. (2002) *Organic Geochemistry* **33**, 1093-1109.

Spectral Gamma-ray applications to marine organic-rich sediments of the Lower Jurassic of Portugal

G.G. CORREIA^{1*}, L.V. DUARTE¹, A.C. PEREIRA¹, R.L. SILVA¹ AND J.G. MENDONÇA FILHO²

¹Universidade de Coimbra, Departamento de Ciências da Terra and IMAR-CMA, 3000-272 Coimbra, Portugal
(*correspondence: gil.correia@gmail.com)

²IGEO and LAFO, Universidade Federal do Rio Janeiro, 21949-900 Rio de Janeiro, Brazil

This study is based on a high-resolution gamma ray analysis, performed on the hemipelagic Lower Jurassic organic-rich units of the Lusitanian Basin (Portugal). This time interval, namely the Late Sinemurian-Pliensbachian, is recognized as one of the most important potential oil source rock in Portugal [1].

Supported by more than 1000 gamma-ray measurements from outcrop and laboratory, the obtained data (total GR, Th, U and K) were correlated with several mineralogical (by X-Ray diffraction) and geochemical parameters, such as total organic carbon (TOC), insoluble residue (IR) and sulfur. From our results, and similarly to other case studies [2], we emphasize the relation between U and TOC, whose maximum value reaches 20%. A fair to good correlation is generally observed between these two variables (Fig. 1), however other lithological and geochemical (e.g. IR) parameters of the organic-rich facies may determine some variations.

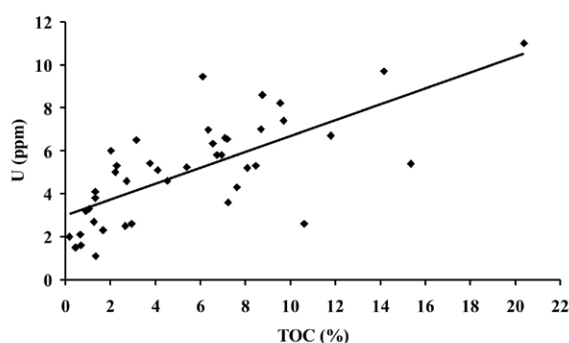


Figure 1: U/TOC correlation of the studied Lower Jurassic samples, with the U values obtained in laboratory.

This work has been financially supported by project PTDC/CTE-GIX/098968/2008 (FCT - Portugal).

[1] Duarte *et al.* (2010), *Geologica Acta* **8** (3), 325-340. [2] Luning & Kolonic (2003), *Journal of Petroleum Geology* **26**, 153-174.