



# Optically-stimulated luminescence profiling and dating of historic agricultural terraces in Catalonia (Spain)



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## ABSTRACT

Dating agricultural terraces is a notoriously difficult problem for archaeologists. The frequent occurrence of residual material in terrace soils and the potential for post-depositional disturbance mean that conventional artefactual and lab-based dating methods often provide unreliable dates. In this paper we present a new technique using luminescence field profiling coupled with OSL dating to produce complete (relative) sequences of dates for sedimentary stratigraphies associated with agricultural terraces and earthworks. The method is demonstrated through a series of case-studies in western Catalonia, Spain, in which we reconstruct the formation sequence of earthwork features from the Middle Ages through to the present day. OSL profiling at the time of archaeological survey and excavation permitted spatially and temporally resolved sediment 'chronologies' to be generated, and provides the means to interpret the environmental and cultural archives contained in each. The case-studies presented here show that luminescence approaches are a valuable tool to reconstruct landscape histories.

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## 1. Introduction

Farming communities have created terraced landscapes all over the world to produce diverse crops and to provide level grazing for livestock. In dry land agriculture the benefits of terraces include the redistribution of sediment to create soils with improved root penetration and better water retention. Terraces are often connected to what people consider 'traditional' forms of work and agriculture, and together with the fact that terraced landscapes are frequently considered 'scenic' they contribute to how we perceive local and regional landscape character (Pedroli et al., 2013). Terraces are therefore widely regarded as important elements of landscape heritage for both environmental and cultural reasons. Much previous research on terrace systems has been carried out by specialists in environmental and agricultural disciplines (e.g. Cots-Folch et al., 2009; García-Ruiz, 2010; García-Ruiz et al., 2010; Bevan and Conolly, 2011).

Given these considerations it is all the more surprising that the histories of terraced landscapes are poorly understood. There are two key problems relating to the chronological development of

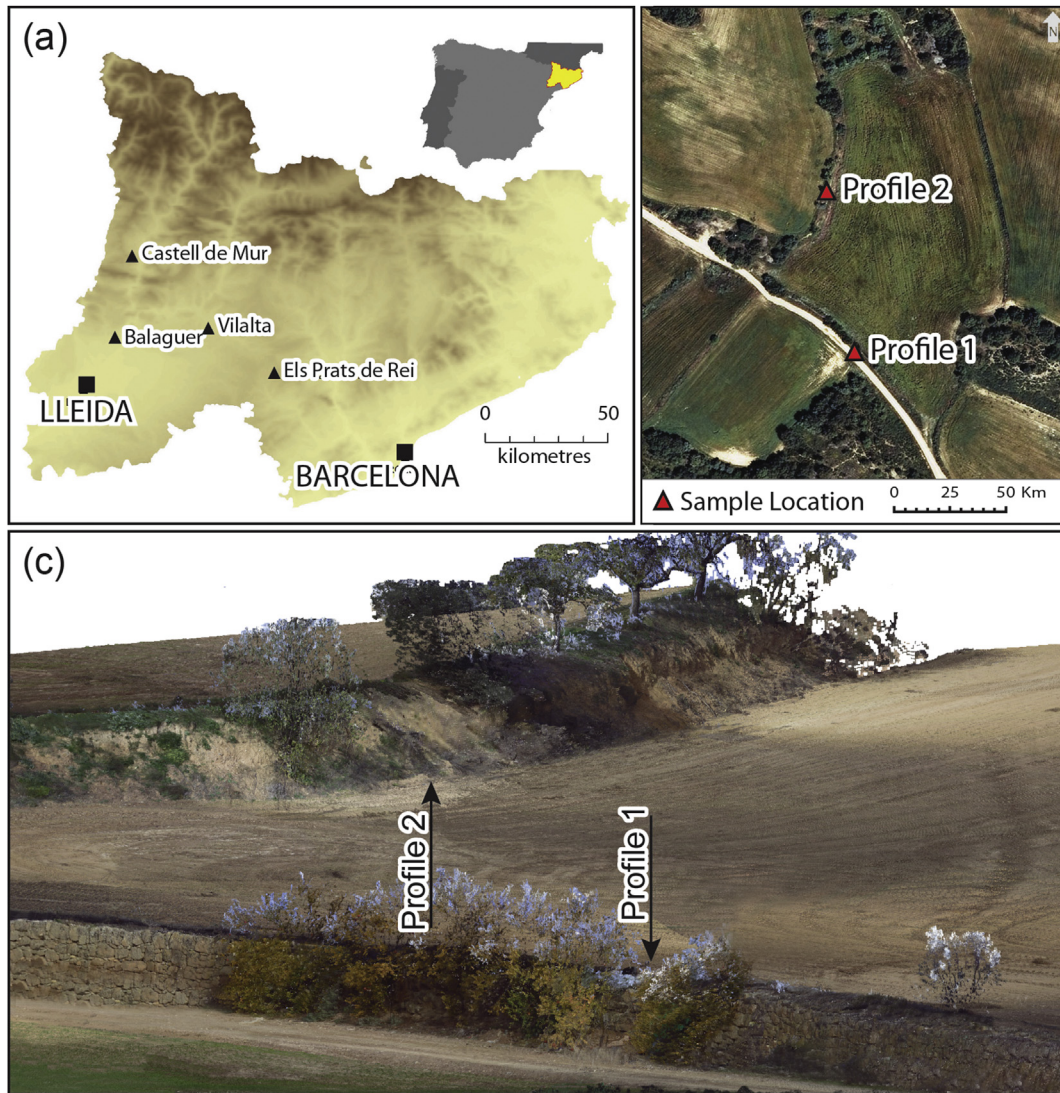
most terraces systems: first, to know when they were originally established; and second, to understand how they developed over time. In this paper we present the results of a pilot study designed to address these questions by using field- and laboratory-based luminescence profiling to establish detailed stratigraphies of the entirety of the exposed terrace profile, coupled with the dating of the associated sediments by optically-stimulated luminescence (OSL).

Our case-studies are located on four different terrace systems in western Catalonia (Spain), where we worked in the framework of the *Canvis i continuïtats* research programme led by the University of Lleida (Fig. 1a). The overall aim of this project is to develop new approaches to studying historic landscapes by combining documentary research, retrogressive map analysis, historic landscape characterisation and scientific approaches to dating landscape features (Bolòs, 2014).

Catalonia preserves some of the most useful documentary sources in medieval Europe for understanding the exploitation and organisation of the medieval landscape from the 9th century AD onwards (Bolòs, 2004). In contrast to many parts of the Mediterranean, these detailed records enable the accurate identification of many historic field systems on steep slopes which are terraced today (Bolòs, 2004: 327–8; Torró, 2007). This strongly suggests that

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**Fig. 1.** (a) Location map, (b) GoogleEarth image of the Balaguer field system, showing the positions of the two profiles, and (c) representative 3-D model of any one study area; this image shows the Balaguer field system, from a perspective looking at the check-dam in the foreground (see Fig. 2a) and the earthen bank in the background.

various terrace systems have existed from at least c. AD 1000. The Catalan landscape also exhibits a range of terrace types including check-dams, terraced fields, step terraces, braided terraces and irrigated terraces (for basic terrace typology see Grove and Rackham, 2001: 108). For these reasons it provides a good region to test methods for dating terraces. Four areas were selected for investigation (Fig. 1a): the first concerns the field systems 2.5 km NW of the town of Balaguer, a region of low-lying and undulating topography, with both check dams and stepped contour terraces with stone walls (Grove and Rackham, 2001: 108) (Figs. 1b and 2a). The second area investigated, located 350m W of the village of Vilalta is in an area of similar relief, but instead characterised by a straight stepped terrace landscape, with prominent walls built of squared stones, which strike linearly across the landscape. Site 3 is located 2.8 km SE of Els Prats de Rei. Here, the terraces form a braided terrace landscape, with individual terraces aligned sub-parallel to the valley axis, which step progressively up/down slope along switchbacks which delineate the terrace ends (Fig. 2b). The fourth area investigated was at the Castel de Mur, in a region of much more pronounced relief with steep bedrock slopes with both

stepped and braided terraces (Fig. 2c), and additionally include features related to an irrigation system.

## 2. Approaches to dating terraced landscapes in the Mediterranean

Despite being widespread features in today's Mediterranean landscape, mention of terraces is frequently absent from ancient or medieval texts. The reasons for this omission are uncertain: it could be that terraces were so commonplace they were considered unremarkable, yet some scholars of classical Greece have gone as far to argue that they did not exist in Antiquity (e.g. Foxhall, 1996; Foxhall et al., 2007). There is also a perception that since terraces are continually repaired and rebuilt through history, detailed studies would prove unproductive (e.g. Lee, 2001). The assumption that features which are still in use are likely to be of low value for understanding ancient patterns has significantly hampered archaeological knowledge of Mediterranean landscapes: for example, the archaeological potential of field boundaries is rarely considered, even when they are major earthwork features that

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