Digital Applications in Archaeology and Cultural Heritage 2 (2015) 41–54

Contents lists available at ScienceDirect

Digital Applications in Archaeology and Cultural Heritage

journal homepage: www.elsevier.com/locate/daach

RTI and the study of engraved rock art: A re-examination of the Iberian south-western stelae of Setefilla and Almadén de la Plata 2 (Seville, Spain)

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ARTICLE INFO

Article history:
Received 11 March 2015
Received in revised form
6 July 2015
Accepted 9 July 2015
Available online 17 July 2015

Keywords:
Reflectance Transformation Imaging (RTI)
Rock Art
Engraving Techniques
Life Histories
Late Bronze Age
South-western stelae
Iberian Peninsula

ABSTRACT

RTI is a powerful technique for recording, interpreting, and disseminating rock art. RTI enhances the perception of the micro-topography of the rock surface and it is particularly helpful for the study of engraved art. Subtle details, such as the traces left by different engraving techniques, the outlines of motifs or superimpositions are more clearly revealed through RTI's interactive re-light and enhancement tools. This paper describes the application of RTI for the re-examination of two Iberian south-western stelae, Setefilla and Almadén de la Plata 2, whose preserved decoration is engraved. Previous studies focused on the iconographic analysis of motifs and employed methods of examination and recording that posed limitations. Based on the more robust data provided by RTI and supported by RTI's tools for surface interpretation, we provide a new analysis of the decorated surfaces of both stelae, including insights into their manufacturing techniques and later modification.

1. *Reflectance Transformation Imaging* (RTI) and the study of engraved rock art

Reflectance Transformation Imaging (RTI) is a computational photographic method that uses the reflectance properties of any surface to enhance the perception of its shape (Earl et al., 2010; Mudge et al., 2006; Mudge et al., 2012). RTI requires the capture of around 60–70 images of a still object from a fixed camera position with changing and knowable light directions spaced evenly through a hemisphere. RTI software uses these datasets to calculate the reflectance function of the object's surface per-pixel and to extract 2.5D information about its shape (surface normals per-pixel). The resulting RTI files produce isometric (2.5D) representations of the object's surface through interactive re-illumination and the application of various transformations that enhance perception of its texture and shape.

There are two main methods of capturing the images required to produce RTI files. One is a semi-automated method that uses a physical lighting dome of fixed size which is populated with a number of lights whose positions are known. A more flexible system is the so-called *Highlight-RTI* (HRTI) method (Cultural Heritage Imaging, 2013b), which uses a glossy sphere incorporated into the scene to record the highlight of the source for every image. This information is then used to calculate the source light directions during RTI processing. HRTI is ideal for capturing large objects that do not fit within a physical dome or for any setting where a physical dome is not a viable option, such as rock art sites.

RTI processing is quite easy and accessible. The software required, the *RTIBuilder*[1], is open source, and the steps are described in detail in a comprehensive guide published by Cultural Heritage Imaging (CHI) (2011). Once produced, the RTI file can be explored with the free *RTIViewer*[2] (Cultural Heritage Imaging, 2013a), also available from the CHI website. *RTIViewer* enables enhanced perception and interpretation of the object's surface through interactive rendering the surface with dynamic re-lighting and permitting the application of various enhancement transformations, called 'rendering modes', to shape and/or colour information per

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[1] Available at: http://culturalheritageimaging.org/What_We_Offer/Downloads/Process/index.html (last accessed 15/12/2014).
[2] Available at: http://culturalheritageimaging.org/What_We_Offer/Downloads/View/index.html (last accessed 15/12/2014).

http://dx.doi.org/10.1016/j.daach.2015.07.002
2212-0548/

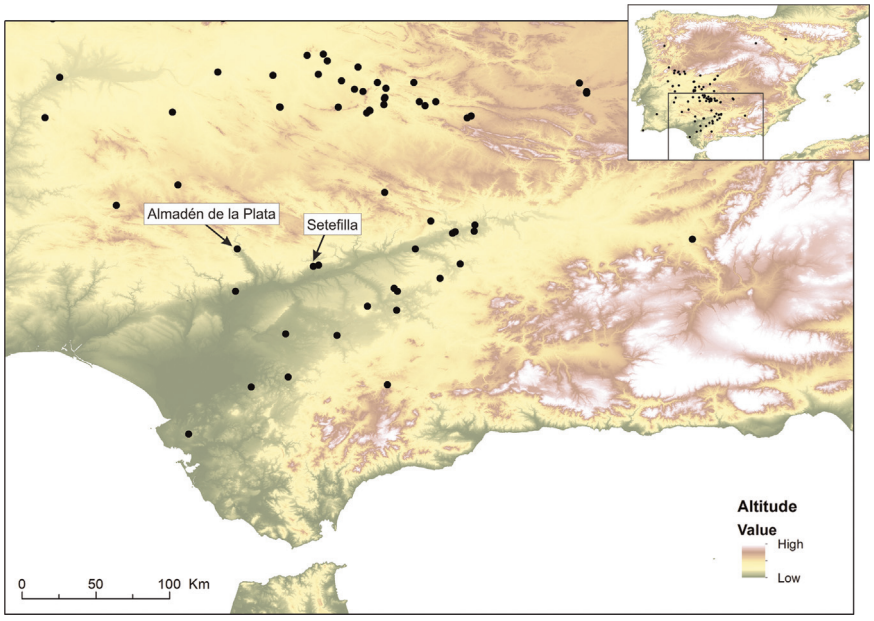

Fig. 1. Distribution of south-western stelae in southern Iberia with indication of the sites where the stelae of Almadén de la Plata and Setefilla were found.

pixel. Specific views can be 'snapshotted' and saved as separate JPEG files or saved as 'bookmarks' associated with the RTI file (bookmarks record the parameters that define a particular view, allowing its recreation and annotation by other viewers), fostering the engagement of multiple researchers in the interpretation of the view or detail in question.

RTI has already been successfully applied for the representation, conservation and analysis of a wide range of cultural heritage artefacts (e.g. Earl et al., 2011', 2010; Kotoula and Kyranoudi, 2013; Piquette, 2011) and its application to rock art is gaining momentum (e.g. Díaz-Guardamino and Wheatley, 2013; Mudge et al., 2006; Mudge et al., 2012; Pitts et al., 2014a; Pitts et al., 2014b). RTI is an extremely powerful technique for recording, interpreting, and disseminating rock art: RTI enhances the perception of the micro-topography of the rock surface and is, therefore, particularly helpful for the study of engraved art. Subtle details, such as natural fissures and cracks in the rock surface, traces left by different engraving techniques or outlines of engraved motifs are more clearly revealed using RTI's interactive re-lighting and enhancement tools and because the use of raking lighting, for example, is familiar to many rock art specialists, RTI provides a relatively 'natural' digital methodology that draws on and enhances the existing interpretative skills of the specialist community. Overall, RTI's interactive rendering tools facilitate the interpretation of the shape of these features and the rock canvas, their interrelationship and structure, allowing archaeologists to explore them in terms of cultural production.

This paper describes the application of RTI for the re-examination of two Iberian south-western stelae, Setefilla and Almadén de la Plata 2 (Seville, Spain), whose preserved decoration is engraved. Previous research on Iberian south-western stelae has typically been focused on the formal analysis of their iconographies: little or no attention has been devoted to the techniques employed in their making, or to the modifications they underwent throughout later stages of their long-term 'lives'. As argued below, these aspects could greatly advance our understanding of Iberian south-western stelae in social, cultural and historical terms. Additionally, research on south-western stelae has usually employed methods of examination and recording that posed limitations for their interpretation, i.e. scale drawings and tracings made from photographs, aided by limited sources of raking light. Based on the more robust data provided by RTI and supported by the use of RTI tools for surface interpretation, here we provide a new analysis of the decorated surfaces of both stelae, including some insights into the techniques involved in their making and later modifications, as well as new interpretative tracings.

2. Iberian south-western stelae: the many dimensions of a late prehistoric 'tradition'

The stelae examined in this paper, those of Setefilla and Almadén de la Plata 2, belong to a well-known stelae tradition that developed in the west and the south-west of the Iberian Peninsula, along the western and south-western periphery of the Iberian Central Plateau and the middle-low Guadalquivir valley, throughout the Late Bronze Age and the beginning of the Early Iron Age (*c.* 1400/1200-750 BC) (Díaz-Guardamino, 2012) (Fig. 1). These are variously known as 'Extremaduran', 'Tartesian','Warrior' or 'South-western' stelae (for recent syntheses see: Celestino Pérez, 2001; Díaz-Guardamino, 2010; Harrison, 2004). More than 130 stelae have been published until now while at least a further dozen have been reportedly found in recent years and await scientific examination.

Traditionally, research on south-western stelae has been focused on the formal analysis, classification and seriation of their iconography and on the cultural affiliation of the objects represented on them (Almagro-Gorbea, 1977; Celestino Pérez, 2001; Gomes and Monteiro, 1977; Pingel, 1974). Relevant issues, such as their landscape dimension, archaeological context, the biographies of these monuments or the techniques involved in their making have only started to be explored more recently (Díaz-Guardamino, 2006, Díaz-Guardamino, 2008, 2010, 2012; Díaz-Guardamino and Wheatley, 2013; Enríquez Navascués and Fernández Algaba, 2010; Galán Domingo, 1993; García Sanjuán, 2011; García Sanjuán et al., 2006).

South-western stelae are large (c. 50–160 cm long), often dressed, stone blocks that bear engraved decoration on one of their sides, usually in their upper and middle regions. The lower