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# Evolving settlement patterns, spatial interaction and the socio-political organisation of late Prepalatial south-central Crete

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## ABSTRACT

Simulations of spatial interaction in archaeology have been successful in predicting the emergence of central sites, and political and economic hierarchies that match observed long-term settlement patterns. It still remains unclear, however, to what degree such models can effectively allow for uncertainty in the archaeological record, especially when it comes to incomplete and unevenly distributed settlement data, and how best they might incorporate artefact-scale evidence. This paper aims to address these issues, while attempting to tackle widely debated aspects of socio-political organisation and cultural interaction in the prehistoric Cretan landscape at the period immediately before and after the foundation of the first palace of Phaistos, one of the less well documented Bronze Age phases. We employ a simulation of spatial interaction inspired by approaches first developed in urban geography and combine this with regression-based predictive modelling to address the uncertainty introduced by missing settlements. We use evidence from artefact analysis partly to calibrate and partly to validate our model. We conclude that such an approach can contribute to more convincing archaeological theories about socio-political organisation, cultural affinity and regional identity by providing new evidence even in the presence of very fragmented data.

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## 1. Introduction

Spatial interaction models, as applied in geography, history and archaeology, are a family of computational approaches that address how people, goods and/or ideas might flow across a network of geographical locations. Such models have made visible contributions in recent archaeological interpretations of settlement evolution, population movement, cultural transmission, trade systems and changing socio-political organisation (Bevan and Crema, 2014; Bevan and Wilson, 2013; Davies et al., 2014; Knappett et al., 2008, 2011; Osborne, 2013; Palmisano and Altaweel, 2015; Rivers et al., 2013; Rivers and Evans, 2014; Wilson, 2012a). The first adoption of spatial interaction models in archaeology goes back to an emphasis on ‘gravity models’ in processual archaeological studies of the 1960s and 70s (Alden, 1979; Hodder and Orton, 1976:187–195), and later to the more carefully flow-balanced, ‘entropy-maximising’ procedures introduced by Rihll and Wilson in the late 1980s (Rihll and Wilson, 1987, 1991). Thereafter, there was little or no further development for

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more than two decades, before their renewed discussion in the past five years. This most recent phase of application continues to stress cross-disciplinary collaboration with physicists and urban geographers and is reinforced by its clear links to the science of networks (Newman, 2010). It also reflects a growing realisation that archaeological research has the potential to constructively contribute to advances in contemporary urban science (Batty, 2013; Bettencourt, 2013), offering an abundance of material evidence and a greater time-depth against which scientific methods and theories can be evaluated (Ortman et al., 2014, 2015; Paliou et al., 2014; Smith, 2012; Wilson, 2012b:39).

Despite these promising developments, the application of computational approaches which were originally developed to examine modern social processes to prehistoric and historic research presents many challenges. Recently, simulations of spatial interaction have been employed in archaeology mainly to estimate the flow of goods and people within a known settlement distribution over time and explore the spatial dynamics that could have given rise or contributed to the collapse of hierarchical settlement structures and networks of interaction in geographic space (Bevan and Wilson, 2013; Davies et al., 2014; Knappett et al., 2008; Palmisano and Altaweel, 2015; Rihll and Wilson, 1987; Rivers et al., 2013). These models have met a certain degree of success

in “predicting” the emergence of central sites, sometimes suggesting political and economic hierarchies that match observed long-term (and usually large-scale) patterns in the archaeological record. A basic advantage of these approaches is that they have modest requirements in terms of data input, the latter often being restricted to providing a set of known site locations within the geographic area of interest with only basic site size information or indeed none at all. It still remains unclear, however, to what degree they can successfully allow for uncertainty in the archaeological record, especially when it comes to incomplete and unevenly distributed settlement data, and how best they might incorporate material culture evidence.

Here we aim to address some of these issues, while tackling widely debated aspects of socio-political organisation and cultural interaction in the prehistoric Cretan landscape at the period just before and after the rise of the so-called First Palaces. The social structure of Prepalatial to Protopalatial Cretan society is an issue that has received much attention in recent years, with conflicting views among Aegean Bronze Age researchers (Schoep et al., 2011). In this paper we look into the potential of simulations of spatial interaction, combined with attention to artefact-scale and surface survey evidence, to support and advance archaeological theories on socio-political organisation, cultural affinity and regional identity by providing new evidence even in the presence of a very fragmented set of data. The focus of this discussion will be on south-central Crete in the era immediately before and after the foundation of the first palace of Phaistos (EM III-MM I, ca. 2300–1850 BC), a period often associated with the emergence of more complex socio-political organisation and the initial stages of one of the earliest urban societies in Europe.

## 2. Archaeological background

Over the last fifteen years, both new discoveries and the reappraisal of existing archaeological evidence on Cretan settlement patterns, administration, architecture, burial, production and consumption of material culture artefacts have continued to foster intense debate. Traditionally, discussion has focused strongly on the formation of hierarchical centralised polities and states on the island, especially during the Protopalatial and Neopalatial period, with the assumption that major palatial sites at Knossos, Phaistos, and Malia were political, economic and religious centres of wider hinterlands (Bevan, 2010; Cherry, 1984, 1986; Renfrew, 1972, 1986; Schoep, 2001; Whitelaw, in press). Contrasting strands of more recent emphasis have also countered with the need to explore various degrees of state centralization (Adams, 2006; Knappett, 1999; Schoep, 1999) and more spatially dispersed and/socio-politically heterarchical distributions of power among elite groups (Driessen et al., 2002; Hamilakis, 2002; Schoep, 2002, 2006; Schoep and Knappett, 2004). In addition, special attention has been devoted to studying regional, and possibly diverse, trajectories of social development, urbanisation and polity formation in the Prepalatial era (Legarra Herrero, 2009, 2011a; Schoep and Tomkins, 2011:5–7; Whitelaw, 2004, 2011:115). Despite the fact that the debate until now has been far from conclusive, it has become obvious that in pushing forward such discussions, we need to address the production and consumption of material culture at both large and small scales wherever possible, whilst also investigating changes in settlement structure at the regional and sub-regional level. Such endeavours are not unproblematic, since they are often undermined by the state of preservation of the archaeological record, particularly in the late Prepalatial era, which is admittedly one of the less well documented periods in Cretan Bronze Age (Whitelaw, 2011:164).

The case of south-central Crete, one of the most intensively researched regions on the island, is central to narratives of social change in late Prepalatial period and instructive of both the challenges and opportunities presented by our current evidence. The area comprises the foothills of Mount Ida to the north, the Mesara valley, namely the largest agricultural basin on Crete, and the Asterousia mountains to the south (Fig. 1). The site of Phaistos is the only widely accepted major centre in the Mesara valley during the Prepalatial and Protopalatial periods, nonetheless the likelihood of competing centres in the wider region at the end of Prepalatial era has also been suggested on the basis of limited evidence. One type of artefact that has been used to support theories on the existence of more than one local nodes of power in south-central Crete, both immediately before and at about the time of the emergence of the First Palace of Phaistos, are Minoan seals (Fig. 2). Seals are thought to have played a role in Minoan economic and administrative transactions, as well as in the expression of personal, community and regional social identities (Karytinos, 2000; Relaki, 2011; Sbonias, 2011). In his thorough study of Early Minoan seals Sbonias (1995, 2011) concludes that patterns in the production and consumption of the more elaborate pieces across south-central Crete are suggestive of social change within the final Prepalatial period (EM III-MM IA): for the greater part of this phase (EM III-Early MM IA) the distribution of fine ivory seals, in particular, indicate the existence of an extended network of interaction with many localities of production and consumption (especially at Hagia Triada, Platanos, Marathokephalo, Koumasa, Archanes and Moni Odigitria; Fig. 1, Table 1; Sbonias, 2011:280) which exceeded the regional scale (Sbonias, 1995:84–102; 2010, Table 100; 2011, Fig. 9.2). In contrast, at the end of MM IA and probably the beginning of Protopalatial (MM IB), the analysis of seal data suggests more exclusive networks of communication at a sub-regional level. Two groups of elaborate seals with distinctive styles are dated to this period and thought to be products of south-central Cretan workshops. A “white pieces” group (Table 2, Figs. 1 and 2; see also Sbonias, 1995:102–121; 2010, Table 100; 2011, Fig. 9.5) has mainly been associated with the site of Moni Odigitria on the northern edge of the western Asterousia, where a comparatively large number of seals of this type have been excavated from the tholos tombs discovered at the site. Further looted pieces of uncertain origin, which were formerly part of the Mitsotakis collection,<sup>1</sup> belong to this stylistic group and probably originate also from the same cemetery (Sbonias, 2010:201, 2011:281; Vasilakis, 2010:52). In addition, a relatively large number of ‘white pieces’ has been associated with the Kali Limenes region, close to the south coast, while much smaller numbers have been found at other sites on Crete. This production and distribution pattern, according to Sbonias suggests the presence of an elite group residing at Moni Odigitria whose members were acting as “agents of innovation” in order to reinforce their social status. Similarly, elaborate seals belonging to the “soft stone” group (Table 2, Fig. 2) have been found in relatively large numbers at the cemetery at Platanos in the Mesara valley, which has been proposed as the likely production centre of these artefacts. A few specimens belonging to this group have also been discovered in the central Asterousia region, at the tholos tombs of Lebena, Krotos, Christos, Hagios Kyrillos, but also at M. Odigitria (Fig. 1, Sbonias, 2010:224). The distribution of soft stone seals perhaps indicates the presence of a second microregional network with Platanos as its major node which extended in Mesara valley and in central Asterousia (Sbonias, 2010:224).

A more formal quantitative comparison of the seal assemblages in the two aforementioned time periods can be made using a Brainerd–Robinson (B–R) co-efficient of similarity (Cowgill, 1990;

<sup>1</sup> Now owned by the Greek state (Vasilakis, 2010:52).

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