Novel survey methods shed light on prehistoric exploration in Cyprus

S.T. Stewart[1,*], P.M.N. Hitchings[2], P. Bikoulis[2] & E.B. Banning[2]

Evidence for the earliest occupation of Cyprus (*c.* 11 000–8500 cal BC) has been elusive as it often consists of small, diffuse and unobtrusive scatters of debris from stone tool manufacture. Yet tracing these sites is crucial if we are to understand how humans first explored the island, learned to exploit its resources and introduced useful flora and fauna from elsewhere. Our approach to this problem is to employ new methods of pedestrian survey and predictive modelling so as to investigate a route that could have linked the coast and the interior.

We focus on the Tremithos River Valley (Figure 1), which would have made an ideal corridor between early settlements on the coast and resource-rich parts of the Troodos foothills, particularly their high-quality chert sources. Previous survey work on the Idalion Survey Project (Stewart 2004, 2006, 2007; Stewart & Morden in press) has identified many chert sources and lithic scatters in the Troodos foothills and the headwaters of the Tremithos River.

The Tremithos Valley has three well-defined topographic zones. In the north, mixed pine forest, scrub hills and pillow lavas occupy the uplands, while agricultural land (mostly orchards and wheat fields) extends along river terraces to just south of the village of Ayia Anna (Figure 2). South of that point, the valley opens into a wide plain of alluvial and colluvial deposits, flanked by limestone and chalk formations, through which the river meanders in a series of oxbows south and east to the Tremithos-Kiti Dam. The only previous archaeological work in the Tremithos Valley is limited to this area (Baudou & Englemark 1983; Held 1992), much of which is now inaccessible because of extensive military use. South of the dam, the river enters the flat coastal plain, now mostly agricultural (Figure 3).

Our project uses an innovative combination of predictive modelling and Bayesian allocation pioneered during the Wadi Quseiba Survey in north-west Jordan (Hitchings *et al.* 2013; Banning *et al.* 2016; Stewart *et al.* 2016).

The predictive modelling focuses on the varying probability of finding archaeological material in association with different landscape features, and especially on the recognition that erosion and deposition have either destroyed or made inaccessible some parts of the late Pleistocene and early Holocene landscape. In the two areas to which we have access, there is considerable difference in how ancient landscapes have survived. In the upper Tremithos, erosion and flooding would have washed away much of the ancient landscape, and we must direct our attention to areas that might have survived this, such as terraces and spurs above

[1] *Trent University Archaeological Research Centre, 1600 West Bank Drive, Peterborough ON K9J 7B8, Canada*
[2] *The Archaeology Centre, University of Toronto, 19 Russell Street, Toronto ON M5S 2S2, Canada*
[*] *Author for correspondence (Email: salstew@gmail.com)*

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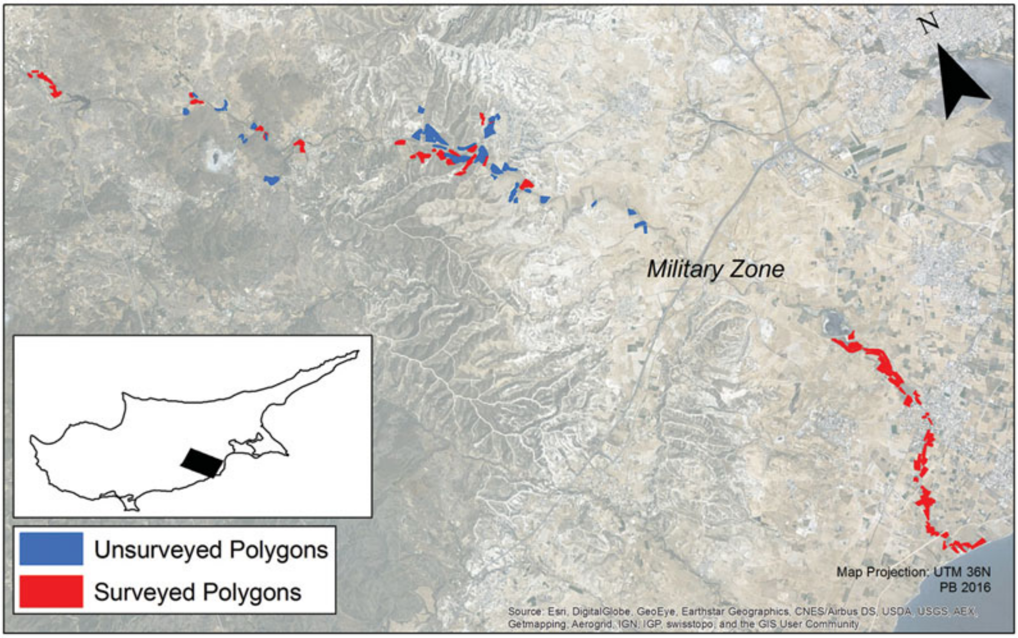

Figure 1. Tremithos Valley, south-west Cyprus.

Figure 2. River terrace, upper Tremithos.

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Figure 3. Coastal plain, lower Tremithos.

the river. Conversely, in the coastal plain, alluvial deposits would bury ancient landscapes, which might now only be visible in areas of natural or anthropogenic down cutting. Instead of surveying a random selection of areas within the survey zone, or all of them, we direct our attention to those parts of the landscape—'polygons' in our usage—in which it is most probable that target archaeological material survives and is potentially detectable. We are thus able to conduct survey as efficiently as possible. Additionally, rather than make the unrealistic assumption that any amount of search in an area is sufficient to locate its archaeological remains, we use the concept of 'sweep widths', as estimated by calibrating the survey team's effectiveness at discovering artefacts in fields with different kinds of ground cover, to track our coverage of polygons (Banning *et al*. 2011, 2016).

But the most unusual aspect of our method lies in how we allocate search effort to these polygons. Our initial estimates of the probabilities associated with each polygon (or 'priors') allow us to use a formula for optimally allocating the amount of survey effort, as measured in metres the team can walk, available each day (Koopman 1980; Banning 2002; Hitchings *et al*. 2016). This formula assigns particular quantities of effort to the few polygons with the highest probability densities (probability divided by the polygon's area), while other polygons initially receive no survey. Following the first pedestrian survey of these polygons, we use the sweep widths to estimate our coverage and, for any polygon in which the survey did not find a site, we calculate its 'posterior probability', using Bayes's Theorem (Bayes

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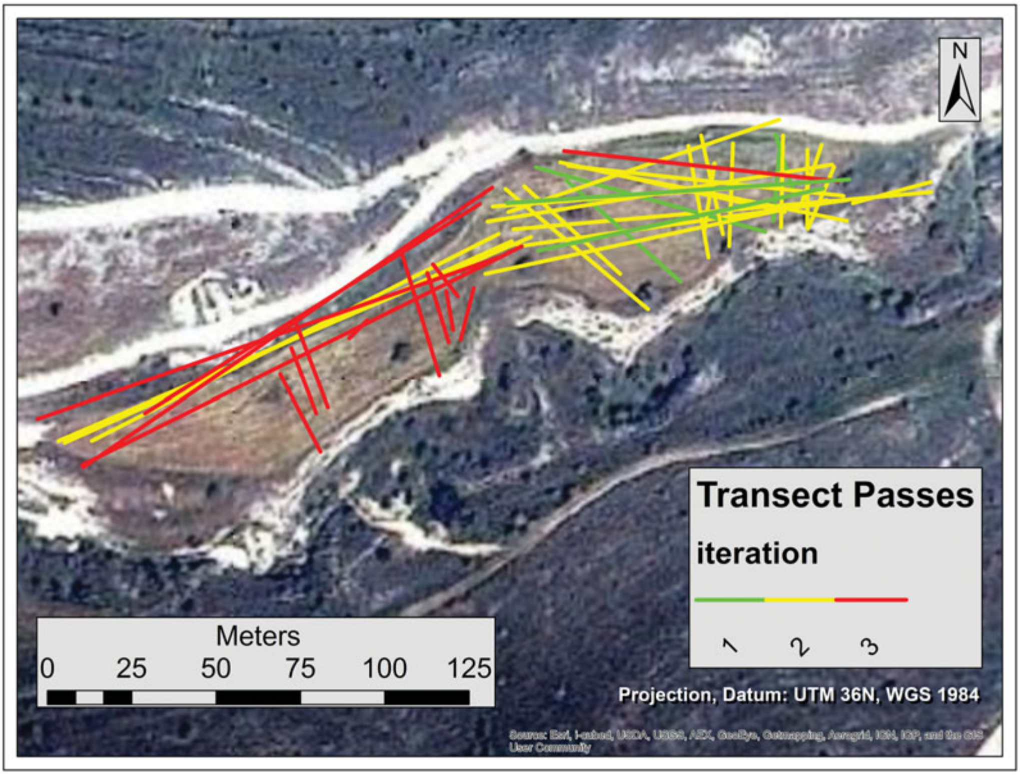

Figure 4. Example of survey transects.

1763; Buck *et al.* 1996) to determine the conditional probability that there could be a site there that we have missed, given the amount of coverage to date. We reiterate this process after each day's survey to update our estimates of archaeological potential, and the allocation algorithm frequently assigns additional increments of survey to polygons that we have already surveyed (Figure 4), while also diverting the survey team to previously unsurveyed polygons once the ones initially thought to have high potential have been 'exhausted'.

These methods have proved highly successful at identifying stone tool scatters and small sites from the headwaters to the mouth of the Tremithos River. In the upper Tremithos, most occur on river terraces and spurs or hills overlooking the river, frequently at confluences of the river and minor tributaries (Figure 5). These confluences may mark 'crossroads' linking the Tremithos with a variety of interior destinations. In addition, sites tend to be located in places that would have been convenient for chert acquisition and waymarking from prominent landscape features. In the south, near the mouth of the river, we located a small scatter in an area stripped for housing development (Figure 6). We were able to locate many of these elusive early sites in part because we did not expend scarce resources surveying where the target prehistoric landscape was either eroded away or deeply buried.

The assemblages from these sites have stone tools and manufacturing debris similar to those at small sites previously identified farther north in the Troodos foothills. They are

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Figure 5. Confluence of Tremithos and tributary.

Figure 6. Mouth of the Tremithos.

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aceramic and are typologically consistent with the earliest known assemblages on the island (Simmons 1999; Ammerman *et al.* 2006; McCartney *et al.* 2010: 143).

These sites probably represent early forays into an unfamiliar and unpopulated landscape following landings on the island and possibly settlement on the coast. Future excavations at two of the sites will help us explore their role in accessing the interior resources of the island.

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