Journal of Archaeological Science: Reports 2 (2015) 227–234

Contents lists available at ScienceDirect

Journal of Archaeological Science: Reports

journal homepage: http://ees.elsevier.com/jasrep

Assessing the application of laser scanning and 3D inspection in the study of prehistoric cairn sites: The case study of Tahkokangas, Northern Finland

Aki Hakonen *, Jari-Matti Kuusela, Jari Okkonen

Archaeology, Faculty of Humanities, University of Oulu, 90570, Finland

ARTICLE INFO

Article history:
Received 16 October 2014
Received in revised form 23 January 2015
Accepted 8 February 2015
Available online 18 February 2015

Keywords:
Laser scanning
3D inspection
Prehistory
Cairns
Finland

ABSTRACT

Laser scanning has the potential of becoming an indispensable documentation method in archaeology. To test its application in interpretatively challenging archaeological settings, a part of the prehistoric cemetery of Tahkokangas in Northern Finland was scanned. The site consists of stone settings of varying form whose elevation and morphology indicate a date of 600–200 BC. A boulder field where six of the ten settings on the site are located was scanned. The structures were difficult to interpret on-site due to their inconspicuous nature. In this paper, in order to circumvent the problem, the gathered 3D data is processed into meshes and false colored by height. The meshes and the height colorization allow detailed structural interpretation of the settings.
The 3D material allows new directions for the study of the site. Previously undetected extensions of the largest stone setting were discovered. Also the structural analysis of the setting suggests that additional support structures may have been used. Along with the findings, limitations and advantages of laser scanning and 3D inspection are discussed. The results and conclusions show laser scanning to be a useful documentation method even when studying indistinct sites for which the scanner was not originally designed for. Still, the method does not produce new information, but merely aids in its perception and interpretation.

1. Introduction

Terrestrial Laser Scanning (TLS) has been successfully used in multiple archaeological assignments. From preservation to presentation, the reasons for its use have varied from case to case. In this paper the limits and advantages of laser scanning are studied through a scan of a Finnish Iron Age burial site. The site, Tahkokangas, is located 5 km from downtown Oulu in Northern Finland (Fig. 1). It contains ten shallow stone settings (meaning cairns formed of approximately one to three stone layers) dated to Pre-Roman Iron Age (500–1 BC in Finnish chronology). Six of them are situated in a boulder field formed alongside a ridge created during the last glaciation.

In the autumn of 2011 seven of the structures were excavated (Kuusela, 2012). During the excavations the boulder field and the six structures located in it were recorded with a laser scanner, after which three of the scanned structures were completely excavated. Aside from a single piece of a flint artifact, the burials were unfurnished. A year after the excavation two unexcavated structures were damaged when metal detectorists dug after signals. The data collected with TLS contains the only three dimensional documentation of the structures prior to the unauthorized intrusion.

TLS is a fairly new technique in archaeology. Perhaps because of this, and the cost of the equipment, it is often negatively seen as a novelty, its usage frequently limited in publications to atypical archaeological sites, such as architectural heritage (see e.g. Al-kheder et al., 2009; Alshawabkeh et al., 2010; Barton, 2009; Lambers et al., 2007; Schreiber et al., 2012; Szocs et al., 2006) and cave sites (see e.g. Rüther et al., 2009; Lerma et al., 2010; Burens et al., 2011; Rodríguez-Gonzálvez et al., 2012; Núñez et al., 2013; Puchol et al., 2013). Usually the application is for conservation or visualization, but some studies include actual interpretation derived from the 3D data itself (see e.g. Montani et al., 2012: 3351–3352; Rüther et al., 2009: 1853; Schreiber et al., 2012: 16–17). Practical interpretative use of laser scanning on sites which are difficult to interpret and whose architectural dimensions are almost nonexistent, i.e. most prehistoric archaeological sites, appears to have been somewhat insufficiently studied. As the equipment becomes more accessible and less expensive, the use of laser scanning is going to grow exponentially, along with photogrammetric methods (for recent examples see De Reu et al., 2014; Green et al., 2014). The question is can laser scanning be useful where it is not designed to be used.

The most useful application of TLS is for the documentation of a uniform surface, like the aforementioned cave walls or masonry. The method has also been used in conjunction with the stratigraphic excavation method, where the surfaces of layers are documented in 3D (e.g. Doneus and Neubauer, 2006; Moser et al., 2010; see Doneus et al.,

* Corresponding author. Tel.: +358 408449930.
E-mail address: aki.hakonen@student.oulu.fi (A. Hakonen).

http://dx.doi.org/10.1016/j.jasrep.2015.02.001
2352-409X/

Fig. 1. The location of Tahkokangas, indicated by the dot.

2011 and De Reu et al., 2014 for photogrammetric examples and Losier et al., 2007 for a 3D reconstruction example). These surfaces contain few occlusions that hinder the post processing of the acquired data. In fact most cases of archaeological application of TLS in Finland have involved documentation of walls from the historical period (e.g. hitherto unpublished research from Old Rauma). This usage has inadvertently solidified into a paradigm of method: The majority – if not all – of the archaeological sites in Finland at which laser scanning has been used during excavations have been from the historical period. This also seems to be a global trend, although there are examples of laser scanning used as a documentation tool in prehistoric settings (see e.g. Biwall et al., 2011; Doneus and Neubauer, 2006; Moser et al., 2010).

Due to the acidity of the soil in Finland, mostly inorganic material has survived from prehistoric times. This includes burnt bone, charcoal and most notably stone. Sometimes the only features left by human activity are recognizable in the patterns of stones. Tahkokangas is a particularly difficult site to interpret, because it is built, as many other similar sites in the area, partly into a boulder field. Only a keen eye has the ability to distinguish between naturally formed features and man-made structures. This study hopes to contribute to the growing application of laser scanning and expand its creative use by testing the method on an inconspicuous site.

2. Tahkokangas and the Early Iron Age in Northern Ostrobothnia

The site was first discovered by archaeologists in 1983. It remained in obscurity until a survey in 2010 led to a thorough investigation of the site. Initially twelve barely visible stone structures (named Settings 1–12) were identified, of which three were ruled out in the later excavations as either naturally formed or modern. Based on the morphology of the structures, the site has been interpreted as a prehistoric cemetery (Hakamäki, 2012).

The structures are located on a moraine ridge, which rose from the sea as an island due to post-glacial rebound around 800 BC. Judging by the location of the structures relative to the shoreline, the optimal date for the site's use is between 600 and 200 BC, when the shore to the northeast formed a small cove about 30 m from the nearest structure (Hakonen, 2013). The island formed a formidable landmark during this period, which may be a reason for its use as a burial site (Hakamäki, 2012). Another suggested reason is the abundance of red-hued stones in the immediate area, which seem to have been the preferred cairn building material in the eastern coast of the Bothnian Bay (Väänänen, 2012). The island fused with other landmasses around 200 BC, probably marking the end of its use. Trying to provide an accurate date for the site solely on shore displacement chronology is problematic and all given dates should be regarded as rough estimates. Despite chronological uncertainties, the site seems to be connected with a larger assemblage of Late Bronze Age (1000–500 BC) and Early Iron Age sites at the Oulu River estuary (Fig. 2). Nearly 300 cooking pits divided into 23 separate sites form the majority of archaeological sites in an area of 100 km^2. Cooking pits are on average two meter wide and one meter deep pits, whose bottom is lined with burnt rocks and charcoal. They have been associated, in addition to food preparation, with seal train oil production (Forsberg, 1999; Ikäheimo, 2005; Okkonen and Äikäs, 2006; Ylimaunu et al., 1999). According to recent interpretations, their use is related to social stratification resulting from increased trade in Late Bronze Age Europe (Kuusela, 2013). The proximity of Tahkokangas to the cooking pit network, along with the similar dating, indicates that the remains are connected.

Seven of the stone settings at Tahkokangas were excavated, but no human remains were discovered. This is typical for Early Iron Age inhumation burials in the area. Acidity of the soil tends to dissolve any organic material within a millennium. Thus the only traces left by inhumations from most of the prehistoric period are soil stains, which are visible in sandy deposits. Decaying material also increases the level of phosphorus in the soil and elevated phosphorus levels ideally indicate human activity (see e.g. Okkonen, 2010). However, the phosphorus levels in Tahkokangas were sporadic, indicating that the soil samples were either taken from the wrong stratum or the soil itself was untestable with the used method (Linderholm, 2012). Another explanation is that the amount of deposited organic substance was lower than on similar inhumation sites. This has sparked an imaginative but plausible interpretation of excarnation, the exposing of a corpse to natural elements, being used in burial customs in prehistoric Finland (Hakamäki, 2012). Circumstantial evidence for this is found from surrounding regions, from Swedish and Finnish Lapland, Kola Peninsula and Estonia (Hakonen, 2013). Nonetheless, the soil being moraine with widely varying grain size, problems with sampling is the simpler explanation. Cremation cannot be used to explain the missing remains as no burnt bone was found.

No prehistoric finds other than a single fragment of a flint artifact were found during the excavation. Metal detector signals from the site were caused by assault rifle cartridges, as the area was used in military exercises up to 1990's. In fact the main archaeological data offered by the site is related to the structures themselves. Traditional methods of documentation such as plan drawing and photography lack depth perspective, making interpretation of indistinct structures difficult and overly reliant on observations made in the field. For this reason laser scanning was decided to be tested.

3. Collection and manipulation of the 3D-data

The 3D-data analyzed here was collected within a single work day, prior to the excavation of any of the measured structures. Preparations required nearly two days, as the moss covering the boulder field had to be cleared first (Fig. 3). The structures present in the scan are Settings 7 to 11 (Fig. 4). The scanner, Leica ScanStation 2, was used in conjunction with a total station and a RTK-GPS, Trimble R8 GNSS Receiver, to accurately document the boulder field. The scanner produced a complex data package, which was then processed with Leica's point cloud