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Search for new final Palaeolithic rock shelter sites in the Federal State of Hesse☆

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ABSTRACT

The eruption of the Laacher See volcano ca. 13.000 years ago profoundly influenced the lifeways of Final Palaeolithic foragers inhabiting the fallout area. Apart from the substantial devastation that affected the proximal area around the eruptive centre (< 50 km), substantial amounts of tephra covered the medial (50–500 km) and distal (500–1000 km) zones of the eruption. In particular, substantial amounts of volcanic ash were transported towards the northeast across Germany and into the Baltic region. In order to find new sites that would allow us to investigate the far-field effects of this cataclysmic event in detail, a predictive model using a legacy dataset of rock shelters in the Federal State of Hesse in Central Germany was developed. Hitherto, only few sites where Laacher See tephra is directly stratigraphically associated with Final Palaeolithic archaeology are known in the region. Following the in silico evaluation of the archaeological potential, two survey campaigns were conducted which resulted in the discovery of several locations that in turn will be subject to keyhole excavations in a subsequent field campaign.

1. Introduction

Environmental change is often regarded to be one of the major triggers of prehistoric culture change and technological adaptation. Particularly, long-term changes and corresponding human responses are typically at the centre of archaeological investigation. However, intense and rapid changes, such as environmental disruptions triggered by volcanic events, may also induce shifts in human lifeways (e.g. Cashman and Giordano, 2008; Oppenheimer, 2011; Riede, 2016b; Sheets, 2015).

During the Late Glacial Interstadial Complex, the eruption of the Laacher See volcano in Germany at around 13,000 cal BP destabilized the ecological framework throughout large parts of Central Europe (Baales et al., 2002; Schmincke, 2006). Among other things, it likely induced a cooling of the northern hemisphere estimated at 0.5 to 2 °C (Graf and Timmreck, 2001; Riede, 2017). In fact, a multitude of hazards can be attributed to the volcanic event and in particular to the ejected tephra which was deposited across Europe in a swath ranging from Italy in the south to north-western Russia in the east (Riede, 2017). At the time of the eruption, Europe was occupied by hunter-gatherer groups generally assigned to the Final Palaeolithic arch-backed point technocomplex, although many workers see regional variation emerging at this time (see Sauer and Riede, 2018 for a summary of arguments for and against regionalisation in this period). Foragers operating in Central Europe at the time of the eruption were subject to the sudden and intense change of environmental conditions. > 300,000 km^2 were covered with ash fallout (Fischer and Schmincke, 1984; Riede et al., 2011). For these Final Palaeolithic hunter-gatherers, the effects of the Laacher See eruption (LSE) likely extended throughout most of their range and affected their lifeways in various ways.

In the proximal zone (0–50 km) around the eruptive centre, numerous Final Palaeolithic sites predating the LSE are known (Baales, 1999; Baales, 2002; Baales et al., 1996; Bolus, 1992; Heinen, 2008; Kegler, 2002). This situation is at least in part related to the massive pumice cover, which led to a favourable preservation of the often ephemeral remains of these highly mobile foragers. Furthermore, the site of Bad Breisig, which post-dates the eruption and lies just the north of the eruptive centre, attests to the recolonization of the desolated near-vent region some decades or centuries after the eruption (Waldmann et al., 2001). In the medial zone (50–500 km), however, excavated sites – and particularly those showing a clear stratigraphic association of LSE tephra and Final Palaeolithic archaeology – are less frequent (Riede, 2012). At the same time, a plethora of surface collections can be attributed to the Final Palaeolithic arch-backed point

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techno-complex, indicating the presence of these foragers in the Central European uplands during the Late Glacial Interstadial Complex (Sauer, 2018).

Using radiocarbon dates and Bayesian modelling (Riede and Edinborough, 2012), network approaches (Riede, 2014) and lithic studies (Dev and Riede, 2012; Riede, 2009), previous research has suggested considerable long-range impacts of the LSE on the culture-historical trajectories of forager groups in northern Europe (Riede, 2008; Riede, 2017). At the same time, this 'Laacher See hypothesis' predicts a depopulation or at least substantial reduction in land-use in the region north-east between the eruptive centre and the North European Plain (Riede, 2012; Riede, 2016a).

We here present a GIS-based predictive model that seeks to find new sites that would allow us to investigate the effects of the LSE on the lifeways of the foragers inhabiting the medial fallout zone. At the current state of research, the model is used solely for explorative purposes rather than for reconstructing past land use. Better understanding the human impacts of the LSE 'on the ground' necessitates the discovery and excavation of new archaeological sites with *both* Final Palaeolithic strata and tephra of the Laacher See eruption. Tephra does not, however, preserve well in open-air archaeological contexts (cf. Housley and Gamble, 2015). Likewise, the preservation conditions for archaeological materials are also often limited in such settings (but see Veil, 2006). Our search for new contexts is therefore focused on rock shelters that are (a) known to be sediment traps for tephra (Grote, 1994) and (b) known to have been attractive features for human settlement in the period (Gehlen, 2001; Grote, 1994; Gumpert, 1933; Kaulich, 1996; Kaulich, 2004; Taute, 1972). We draw on a little-known legacy dataset of potential rock shelter locations collated for the Federal State of Hesse in the late 1980s and 1990s (Fiedler, 1991; Hofbauer, 1991; Hofbauer, 1995) and the currently known far-field distribution of Laacher See tephra (Riede et al., 2011), which together provide the basis for geostatistical analysis, surveying and eventual excavation.

2. Material & methods

2.1. Study area & rock shelter database

The Laacher See Tephra (LST) is distributed over large parts of Central and Eastern Europe (Fig. 1). Although the majority of outcrops is located in the proximal and medial zone, traces of the Laacher See eruption can be found as far as northwestern Russia (Andronikov et al., 2015; Andronikov et al., 2016). The distribution of tephra indicates that the main fan extended eastward from the caldera, with substantial fallout settling in the area today known as the Federal State of Hesse in Germany. While numerous tephra outcrops are known in Hesse, only three archaeological sites show Late Glacial occupation layers associated with volcanic ash. Since these sites are open-air locations, preservation conditions are unfavourable and stratigraphic resolution limited. In contrast, rock shelters usually provide good conditions for the preservation of (geo-)archaeological material. Good examples are the rock shelter sites in the Leinebergland region of Lower Saxony (e.g. Bettenroder Berg I and IX), which contain well-preserved Final Palaeolithic occupation layers capped by a substantial ash cover (Grote, 1990; Grote, 1994).

With the goal of finding archaeological locations similar to Bettenroder Berg, a database of potential rock shelter locations was compiled for the Federal State of Hesse throughout the late 1980s and early 1990s (Fiedler, 1991; Hofbauer, 1991; Hofbauer, 1995). Spending several years on the project, Helen Hofbauer's work eventually resulted in a register of > 700 potential locations. Although at least one rock feature has been excavated in the area subsequently, the selection has been driven by cultural heritage management concerns only and, at any rate, no Palaeolithic material was encountered (Fiedler and Braun, 2004). Unfortunately, the "Rock Shelter Database of Hesse" was never, to our knowledge, actually put to use for finding new Final Palaeolithic

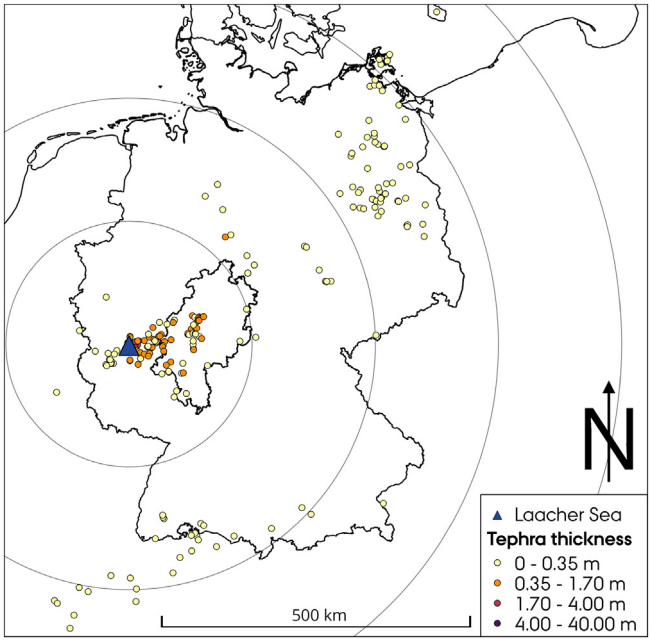

Fig. 1. Distribution of tephra of the Laacher See volcanic eruption (GADM, 2017).

sites in the study area.

In 2017, this register was selected for renewed efforts to locate Final Palaeolithic rock shelter locations in the Federal State of Hesse. The dataset was obtained as scans of 1100 pages, including standardised data entry forms and map sheets. The forms contained information pertaining to the location, morphology, orientation, height and geological context for each rock shelter. This information was digitised using the Tesseract optical character recognition (OCR) software library (Smith, 2007; Smith, 2013) in conjunction with a German language character set and dictionary. Two distinct types of typewritten form were encountered. The first, most straightforward, of these consisted of each attribute on a separate line of text, with keys and values separated by a colon. The second type was more challenging, as the data were structured in tabular form. This required defining subsets of the scanned form for each field, and passing these individually to the OCR engine. However, because the information was entered onto the printed form using a typewriter, and as a result was imperfectly registered with the cell locations, a significant number of errors were introduced in a number of the fields, and a large portion of these data required manual correction. Further processing of the information contained in both form types was conducted using Python, in particular the conversion of coordinates from map sheet plus six or eight figure grid references to full coordinates (GK-coordinates; EPSG: 31467) usable in GIS software. Following this, all the data were manually checked for errors and inconsistencies.

It became apparent that given the age of the dataset, locational information sometimes was not sufficient to locate the potential rock shelter locations in GIS. Since the coordinates where extracted from map sheets, the investigators did not always note the last digits of the individual location. This problem was addressed by cross-checking the individual locations on the copied map sheets in which locations were noted as well. Attributes like location type (e.g. cave, escarpment or individual block) were inconsistently noted and sometimes had to be extracted from the comment column. Other information, like orientation, slope or geological layer where largely incomplete. In these cases, supplementary sampling from digital maps was conducted to retrieve the respective information. In the end, the locational information is the most reliable part of the dataset. Other attributes face challenges in serving as viable data due to inconsistencies and errors. However, for