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Investigating the human—environment relationship of early intensive salt production: A case study from the Upper Seille Valley, Lorraine, northeast France

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ABSTRACT

This paper presents the latest findings of multi-disciplinary research into the human—environment relationship of intensive Iron Age salt production in the Upper Seille Valley, Lorraine, northeast France. Investigations focus on the early Iron Age workshop "La Digue" (~625–500 cal BCE; Hallstatt D1–2), where high-resolution borehole sampling has been coupled with conventional excavation and geophysical surveying to establish direct linkages between intensive occupation and the alluvial environment of this site. Detailed insights into human—river interactions have been identified, enhancing current understanding of the environmental context and impact of this important early industry. The workshop's palaeogeographic setting has been reconstructed and new evidence for briquetage disposal practices has been identified, confirming that a close relationship existed between salt-making and the local hydrological regime. A large volume of briquetage waste (broken clay-fired salt-making equipment, ash and charcoal) was dumped into the river at La Digue, causing rapid and deliberate channel blockage, increasing the distance between the workshop and the river. This probably contributed to a localised increase in channel mobility and/or flooding whilst the workshop was active, producing challenging conditions for salt production. The workshop was abandoned following an intense flood event in ~500 cal BCE, coinciding with a major hydrological shift towards wetter floodplain conditions, likely arising from a combination of natural and anthropogenic factors. This study demonstrates the importance of understanding the environmental context of salt production and the roles of water management and briquetage disposal practices, which have been largely overlooked at other intensive salt making sites that employed the "briquetage technique".

1. Introduction

Salt was an important commodity during later prehistory, and is considered to have brought great power and wealth to those controlling its production and trade (Alexander, 1982; Fawn et al., 1990; Flad et al., 2005; Shotter, 2005). It was, for example, one of the earliest known commodities to be taxed (Tora and Vogel, 1993) and it generated considerable revenue for the Roman Empire: Cities such as Rome flourished due to strategic positions on salt trading routes (Shotter, 2005). There was an enormous increase in the scale of production from the late Bronze Age—early Iron Age onwards, with the emergence of a large number of intensive salt making centres across northwest Europe (Fawn et al., 1990; Harding, 2013; Olivier and Kovacik, 2006) (Fig. 1). This has raised important questions about its social and economic implications and the technology involved, which research over the past forty years has begun to address (*e.g.*, Alexander, 1982; Alexianu et al., 2011; Arrowsmith and Power, 2012; de Brisay and Evans, 1975; Fawn et al., 1990; Fielding and Fielding, 2005; Flad et al., 2009; Harding, 2013; Kinory, 2012; Langouët et al., 1994; Nevell and Fielding, 2005).

This paper focuses on harvesting of salt using the "briquetage technique", involving forced evaporation of saline solutions (derived from brine springs, sea water or salt-rich sediments) in furnaces: This was

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Fig. 1. Map of Late Bronze Age, Iron Age and Roman salt-making sites in northwest Europe. Salt was mainly harvested using forced evaporation in furnaces (the "briquetage technique") in northern temperate localities, whilst solar evaporation in lagoons and salt pans was commonly practiced in the Mediterranean region. Redrawn from Harding (2013), Kinory (2012) and Olivier and Kovacik (2006).

the primary method employed during later prehistory (Biddulph et al., 2012; Harding, 2013). Despite the intrinsic link between salt and the environment, which must have played a key role in the establishment, success and longevity of production at these sites, consideration of the environmental context and impact of salt-making is conspicuously absent in an ever-expanding literature, with few exceptions (*e.g.*, Biddulph et al., 2012; Dufraisse and Gauthier, 2002; Grossi et al., 2015; Lane, 2005; Lane and Morris, 2001; Nevell, 2005; Woodiwiss, 1992; ZhiBin, 2008). At best, palaeoenvironmental investigations are typically limited to charcoal and faunal remains recovered during excavation, with virtually no systematic landscape survey coupled with detailed analyses and reconstruction of the environmental history of the immediate and wider area, such as that recommended by Howard et al. (2015). This inevitably limits understanding of site organisation, production activities, environmental impacts, and the implications of natural and/or anthropogenically-induced environmental change for the development and resilience of these intensive production centres.

A multi-disciplinary project, "Briquetage de la Seille", was established in 2001 by Olivier to redress this shortfall, integrating archaeological and palaeoenvironmental investigations in the Upper Seille Valley (Lorraine, northeast France), an intensive Iron Age salt production centre (Fig. 1). Hundreds to thousands of tons of salt were harvested annually from brine springs along a ~10 km stretch of the valley, using forced evaporation in furnaces (Fig. 2) (Olivier and Kovacik, 2006). Enormous quantities of waste were generated, comprising broken clay salt-making equipment ("briquetage"), ash and charcoal, which were dumped next to workshops. The briquetage technique was widely employed during the Iron Age, and concentrated activities on and around workshops, coupled with re-use of sites over extended periods of time, produced a complex archaeological record (Biddulph et al., 2012; Fawn et al., 1990; Fielding, 2005; Harding, 2013; Kinory, 2012; Lane, 2005; Langouët et al., 1994). The full geographical extent of this activity is difficult to establish using excavation alone due to subsequent burial of many sites by alluvium (Bradley, 1992; Fawn et al., 1990; Gurney, 1999; Healey, 1999; Lane, 2005).

The overarching aims of the Briquetage de la Seille project are to reconstruct and elucidate the relationship between intensive salt production activities and changes in the natural environment during later prehistory, and to formulate a methodological framework within which to investigate these issues. Research has encompassed long-term Holocene palaeoenvironmental and palaeohydrological change and human occupation of the Upper Seille Valley to establish a baseline against which any environmental changes at the time of, and/or following, establishment of the industry could be assessed and probable causal factors determined (Jusseret et al., 2015; Riddiford et al., 2012). These landscape-scale investigations (described in Riddiford et al., 2012) suggest the industry had a major impact on the area's sedimentological history and hydrological regime. However, the broad spatial and temporal resolution of this initial work limited the extent to which the precise human—environment relationship of salt production could be established. The present research aims to address this issue through the integration of intensive borehole surveying and excavation at a single site, the early Iron Age workshop of "La Digue" (Figs. 2 and 3). This approach allows direct linkages to be established between the intense, chronologically confined, occupation of La Digue (covering approximately 125 years, from ~625–500 cal BCE, *i.e.* Hallstatt D1–2) and local alluvial environments. The results reveal important new insights into workshop