A typology of lead-bale slags based on their physico-chemical properties

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ABSTRACT: A typology of lead bale smelting slags for descriptive purposes and for recognition in the field is proposed. Extensive SEM/EDX studies of bale slags from Yorkshire, and from Cumbria and Derbyshire, are used to illustrate the typology. The melting points of 23 slags have been determined and experiments with synthetic slags conducted. This has led to an understanding of some of the mechanisms involved in slag formation, and of the temperatures which were developed in typical bales. This in turn has led to an explanation of different types of bale which have been encountered by this author and others.

Introduction

Lead smelting in England and Wales in the medieval period was carried out on carefully-constructed bonfires known in the Mendips and Derbyshire as bales and further north as bales; in this paper the spelling bale will be used, regardless of area. The open fire had to be situated in a position where there was exposure to wind of a consistent direction and strength. Therefore, many were placed with an aspect ranging from south through to west, although this was not always the case. Bales were superseded in England around AD 1570 by the ore hearth, which was powered by foot or water driven bellows and resembled a blacksmith’s hearth. The change from bale to ore hearth is described in detail by Kieman (1989).

Excavations have been carried out at Beeley and Totley, Derbyshire (Kieman and van de Noort 1992) with a reconstruction of a later bale from a contemporary description. More recently, a bale site has been excavated at Linch Clough, Derbyshire (Bevan et al 2004). In Yorkshire and the North Pennines, Raistrick (1927) described a bale at Winterings, Swaledale, and more recent discoveries of bales have been reported by Beadle (1980), Fairbairn (1994) and Pickin (1992). Work specifically in Swaledale is reported by Barker (1978), who assigned a radiocarbon date of AD 1439–69 to material from a bale at Calver, and by Barker and White (1992). Sites at Calver Hill have been described in more detail by Smith and Murphy (2003).

Slag studies using a scanning electron microscope with an energy dispersive X-ray detector (SEM/EDX) have been reported for sites at Fell End, Arkengarthdale, and Spout Gill, Swaledale (Murphy 1992). A more recent paper (Murphy and Baldwin 2001) has described bales in Swaledale and neighbouring Wensleydale together with brief descriptions of SEM studies.

Bale smelting technology is poorly understood, although it is known that various forms of hearth existed. In the course of the investigations referred to above, it became apparent that different types of slag are found at bale sites, but the relationships between slag types, compositions and their conditions of formation have not been addressed in detail. The present work set out to examine a substantial body of bale-smelting residues, characterising them by determining their chemistry and melting points and, by inferring the conditions under which the slags were formed, understanding the processes used.