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The Brampton kame belt and Pennine escarpment meltwater channel system (Cumbria, UK): Morphology, sedimentology and formation

Stephen J. Livingstone *, David J.A. Evans, Colm Ó Cofaigh, Jonathan Hopkins

Department of Geography, Durham University, South Road, Durham DH1 3LE, UK

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ABSTRACT

The Brampton kame belt represents one of the largest glaciofluvial complexes within the UK. It is composed of an array of landform-sediment assemblages, associated with a suite of meltwater channels and situated within a palimpsest landscape of glacial features in the heart of one of the most dynamic parts of the British–Irish Ice Sheet. Glacial geomorphological mapping and sedimentological analysis have allowed a detailed reconstruction of both the morphological features and the temporal evolution of the Brampton kame belt, with processes informed by analogues from modern ice margins. The kame belt demonstrates the development of a complex glacier karst typified by the evolution of subglacial meltwater tunnels into an englacial and supraglacial meltwater system dominated by ice-walled lakes and migrating ice-contact drainage networks. Topographic inversion led to the extensive reworking of sediments, with vertical collapse and debris flows causing partial disintegration of the morphology. The resultant landform comprises a series of kettle holes, discontinuous ridges and flat-topped hills. The Pennine escarpment meltwater network, which fed the Brampton kame belt, is composed of an anastomosing subglacial channel system and flights of lateral channels. The Brampton kame belt is envisaged to have formed during the stagnation of ice in the lee of the Pennines as ice retreated westwards into the Solway Lowlands. The formation of the Brampton kame belt also has particular conceptual resonance in terms of constraining the nature of kame genesis, whereby an evolving glacier karst is a key mechanism in the spatial and temporal development of ice-contact sediment-landform associations.

1. Introduction

Kames constitute some of the most diverse and complex landform and sediment assemblages in glaciated landscapes. Their morphology often comprises an array of ridges, flat-topped hills and depressions which contain a diverse range of glaciofluvial and glaciolacustrine sediments (e.g. Holmes, 1947; Price, 1969, 1973; Paul, 1983; Thomas et al., 1985; Benn and Evans, 1998; Evans and Twigg, 2002; Evans et al., 2009a). Consequently the site-specific interpretation of these landforms is often contentious (cf. Gravenor and Kupsch, 1959; Huddart and Bennett, 1997; Owen, 1997; Thomas and Montague, 1997; Johnson and Clayton, 2003). However, observations of glaciofluvial landform-sediment assemblages along modern glacier margins (e.g. Price, 1966, 1969, 1973; Huddart et al., 1999; Russell et al., 2001, 2005, 2007; Evans and Twigg, 2002; Evans et al., 2009a) are proving increasingly useful in constraining the genesis of kames and their associations with ice-contact fans and esker networks. In light of recent advances it is appropriate to re-appraise models of kame formation in Pleistocene environments. The "Brampton kame belt" in Cumbria (cf. Trotter, 1929; Trotter and Hollingworth, 1932; Huddart, 1970, 1981) represents one of the largest assemblages of glaciofluvial material in the United Kingdom at over 44 km^2 (Livingstone et al., 2008). It represents a major depositional episode during the advanced stages of recession of the Late Devensian (Dimlington stadial) British and Irish Ice Sheet (BIIS) in the Solway Lowlands (Trotter, 1929; Huddart, 1970, 1981). Being able to elucidate the mode of formation of such a large feature, together with its genetic association with a complex suite of meltwater channels on the Pennine escarpment (Fig. 1) to the south (Arthurton and Wadge, 1981), is critical to reconstruct the style of deglaciation at the centre of the BIIS.

This paper has two objectives: to determine the origin of the various components of the Brampton kame belt; and to use this information to constrain the nature, configuration and timing of deglaciation of the area comprising the Solway Lowlands, the Vale of Eden/Pennine escarpment and westernmost Tyne Gap, the core region at the centre of one of the most dynamic parts of the BIIS

* Corresponding author.
E-mail address: s.j.livingstone@dur.ac.uk (S.J. Livingstone).

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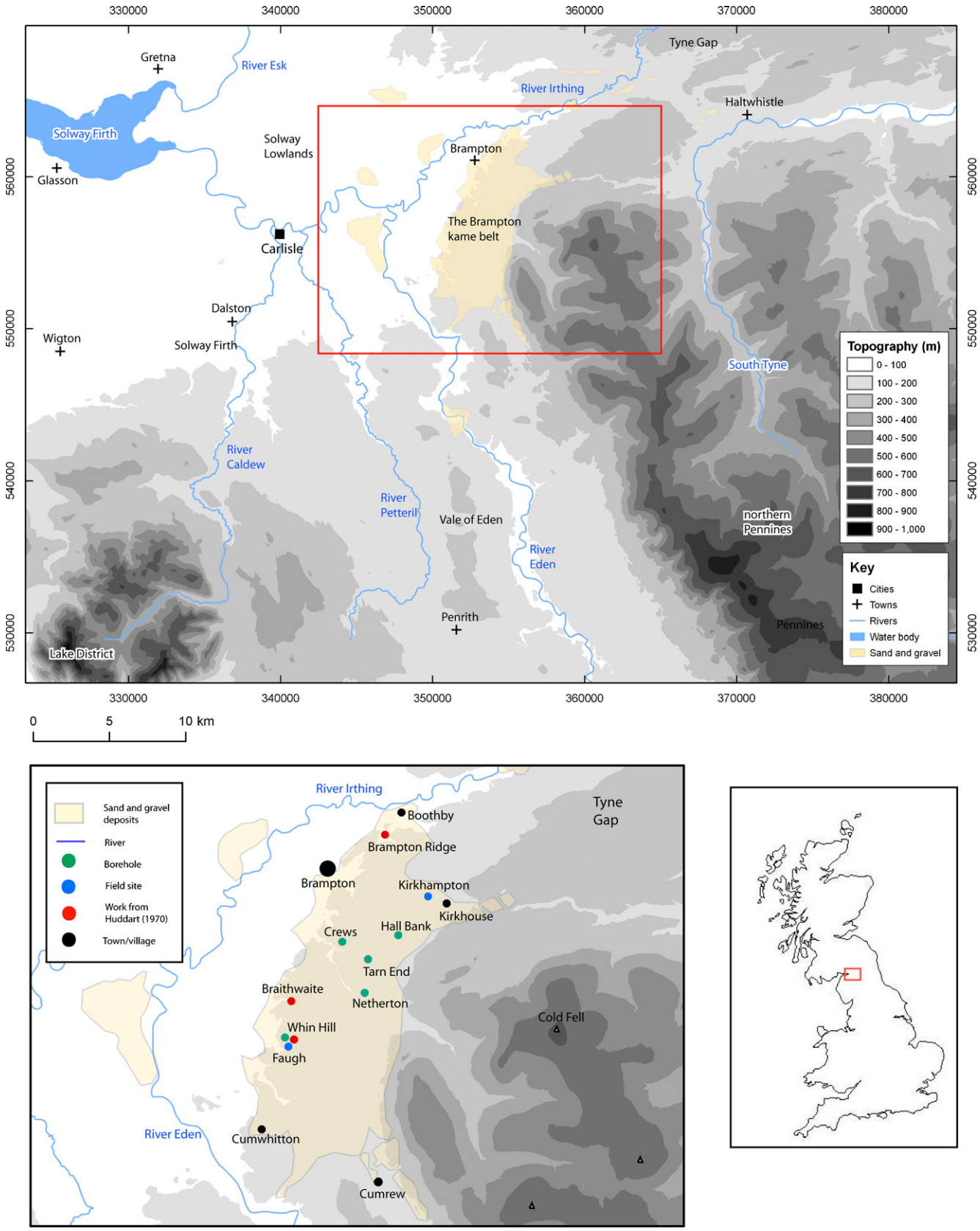

Fig. 1. Topographic map showing the position of the Brampton kame belt within the central sector of the BIIS, and the location of field sites and borehole logs.