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Neotectonics and the preglacial landscape of eastern Norfolk, UK

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ABSTRACT

The British Geological Survey (BGS) borehole database, relevant maps, and the Memoirs have been researched in order to deduce, by recording the elevation of the base of the Happisburgh and Corton Formations, as much as possible about the preglacial (Cromerian) landscape of eastern Norfolk. A relatively flat low-lying landscape is revealed, with the position of the shorelines during marine highstands before the first glaciation, and what appear to be associated relic regressive surfaces, located. With a W-E trending fault located just north of Norwich, there is also evidence of a neotectonic uplift probably related to that found in the pre-Anglian Bytham valley. But north of the fault the uplift in land level is less, but still consistent with neotectonism consisting of a "tipping" process towards the North Sea sedimentary basin. Evidence for buried fluvial systems has been found, including possible precursors of the current Yare and Wensum rivers. A tentative chronology based on proposals advanced by other workers is presented and its limitations explored. The effect of the karstic surface of the Chalk on interpretation of Crag sequences is also considered.

1. Introduction

This study is based on an analysis of over 1700 sites, mostly borehole records, in Eastern Norfolk. The area is located on Cretaceous Chalk bedrock that dips eastwards towards the current North Sea Basin. Unconsolidated Pliocene and Pleistocene 'Crags' consisting of sands, gravels, and clays overlie the Chalk and are in turn overlain by outwash sands and gravels and tills deposited by Pleistocene ice sheets. The area researched is adjacent to the current Southern Bight of the North Sea, often called the Crag Basin.

Numerous eustatic sea level cycles characterised late Pliocene to Middle Pleistocene time that resulted in eastern Norfolk repeatedly becoming part of the "Doggerland" plain (Cohen et al., 2017) during periods of emergence. Only during the "interglacial" periods did the coastline retreat into eastern Norfolk. The resulting low-lying coastal plain, developed on the western margin of the basin, is thus a composite feature formed and modified through a succession of marine transgressions (Funnell, 1995, 1996; Rose et al., 2001; Rose, 2009). The result is a complex pattern of shallow marine and terrestrial sedimentation (Allen and Keen, 2000; Lee et al., 2006) resulting in a rich palaeo-environmental (West, 1980; Preece and Parfitt, 2000; Preece, 2001; Candy et al., 2006; Preece et al., 2009) and archaeological record (Parfitt et al., 2010; Ashton et al., 2014).

Neotectonism was also involved in the development of the Crag Basin, both as a whole and locally (Rose et al., 2002; Westaway, 2008; Riches, 2010), controlling the evolution of preglacial fluvial systems and the relative distribution of marine deposits (Fig. 1).

Unravelling the complex interaction of eustatic, climatic, and neotectonic changes has been extremely challenging. Within the study area the record of the eustatic changes is highly fragmented. The very limited availability of credible chronostratigraphic markers, either absolute or relative, in the preglacial period has caused considerable problems in establishing time-equivalent horizons (Rose, 2009, 2010). The palaeographic reconstructions have generally revealed landform successions, but at present the ages of these stages an only be assessed from their relative position.

This investigation was initiated in order to seek correlation of results published in recent years (Lee et al., 2003; Read et al., 2007; Leeder, 2008; Westaway, 2008; Parfitt et al., 2010; Riches, 2010; Thurston, 2013) and as much as possible to put them into a consistent geological scenario. In particular it seeks to test their implications with respect to the preglacial landscape and relevant neotectonic processes, using what appeared to be an untapped resource in published literature, namely the British Geological Survey (BGS) borehole database, as well as the relevant BGS maps and Memoirs, and personal observation at three sites.

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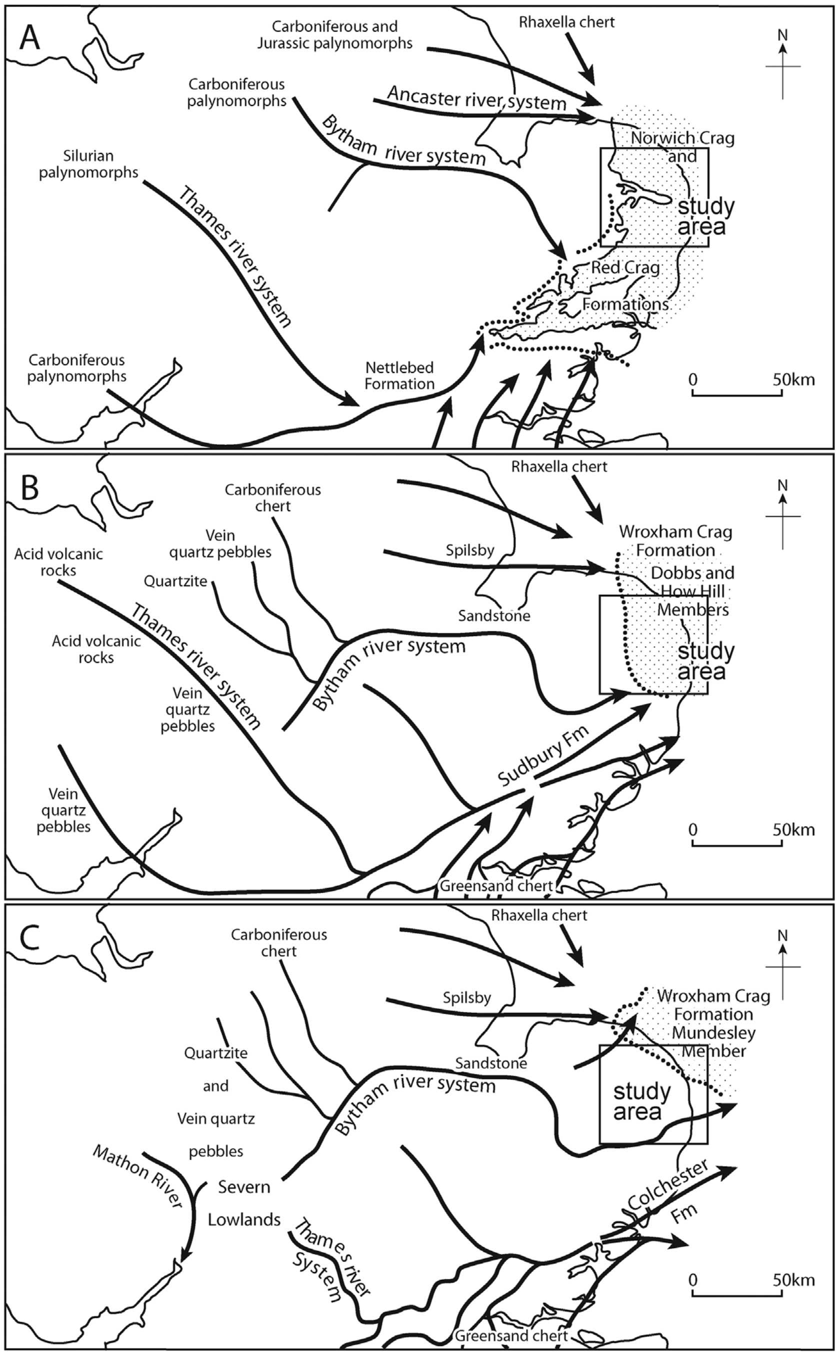

Fig. 1. Models of river systems in southern Britain before lowland glaciation, and their relation with contemporary coastal and shallow marine deposits (Crags).
(A) Early Pleistocene — associated with the deposition of the Norwich Crag,
(B) Early Middle Pleistocene — associated with the deposition of the Dobbs Plantation and How Hill members of the Wroxham Crag,
(C) Middle Pleistocene — associated with the deposition of the Mundesley Member of the Wroxham Crag.
From Rose et al. (2001).

A regionally extensive stratigraphic surface has been constructed, representing the landscape just before the first glaciation. This was the 'Happisburgh Glaciation', the age of which has been contested. The traditional opinion is that it was merely the first phase of the Anglian Glaciation (Preece et al., 2009), but this has been challenged in proposals that it occurred earlier in the 'Cromerian' period (Lee et al., 2004; Hamblin et al., 2005). The palaeo-land surface provides insight into the palaeogeography of eastern Norfolk, prior to this first lowland glaciation, enabling the drainage pattern to be reconstructed and revealing evidence for neotectonism.

2. Geological and geographical context

The North Sea has been periodically active as a depositional centre throughout the Neogene. After the beginning of the Pleistocene at ca 2.6 Ma BP the North Sea sediment was derived particularly from the area of the Baltic via the Eridanos fluvial system (Riches, 2010; Cohen et al., 2017). A large deltaic system formed in the southern North Sea that eventually extended as far as the northern North Sea, with contributions from the rivers of eastern England (Cameron et al., 1992; Overeem et al., 2001; Riches 2010; Gibbard and Lewin, 2016). This is illustrated in Fig. 2. Thus