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The Neogene and Quaternary of England: landscape evolution, tectonics, climate change and their expression in the geological record

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ABSTRACT

During the Neogene and Quaternary, tectonic and climatic processes have had a profound impact upon landscape evolution in England and, perhaps as far back as 0.9 Ma, patterns of early human occupation. Until the Late Miocene, large-scale plate tectonic processes were the principal drivers of landscape evolution causing localised basin inversion and widespread exhumation. This drove, in places, the erosion of several kilometres of Mesozoic cover rocks and the development of a regional unconformity across England and the North Sea Basin. By the Pliocene, the relative influence of tectonics on landscape evolution waned as the background tectonic stress regime evolved and climatic influences became more prominent. Global-scale climate-forcing increased step-wise during the Plio-Pleistocene amplifying erosional and depositional processes that operated within the landscape. These processes caused differential unloading (uplift) and loading (subsidence) of the crust ('denudational isostasy') in areas undergoing net erosion (upland areas and slopes) and deposition (basins). Denudational isostasy amplified during the Mid-Pleistocene Transition (c.0.9 Ma) as landscapes become progressively synchronised to large-scale 100 ka 'eccentricity' climate forcing. Over the past 0.5 Ma, this has led to the establishment of a robust climate record of individual glacial/interglacial cycles enabling comparison to other regional and global records. During the Last Glacial-Interglacial Transition and early Holocene (c.16–7 ka), evidence for more abrupt (millennial/centennial) scale climatic events has been discovered. This indicates that superimposed upon the longer-term pattern of landscape evolution is a more dynamic response of the landscape to local and regional drivers.

1. Introduction

Traditionally, the Late Cenozoic (Neogene and Quaternary) has been considered a somewhat benign period of UK Earth History with comparatively little landscape development occurring over several tens of millions of years (e.g. Hancock and Rawson, 2002). Relative to past global-scale tectonic events (e.g. Caledonian and Variscan Orogenic phases) this assessment perhaps holds some truth. Nevertheless, continuing from the Late Mesozoic and Palaeogene, the landscape from the beginning of the Neogene Period (23.02 Ma) has been in a state of constant flux, with the form of the modern landscape owing its existence to a wide range of tectonic and climatic drivers that have controlled geological processes (Westaway et al., 2009; Candy et al., 2010; Green et al., 2012; Gibbard and Lewin, 2003, 2016; Westaway, 2017). By 23 Ma, global climate had cooled progressively from the 'greenhouse climates' that dominated earlier parts of the Palaeogene (Zachos et al., 2001, 2008) to the onset of 'icehouse climates' and the onset of large-scale glaciation in Antarctica (Kennett, 1977; Zachos et al., 1992) (Fig. 1a). The global configuration of the continents also broadly resembled the contemporary palaeogeography, with continued opening of the North Atlantic and closure of the Tethys Ocean leading to the formation of the Alpide Mountain Belt across southern and central Europe and Asia (Fig. 1b). Ongoing tectonics, corresponding to Alpine compression and the effects of the Iceland Mantle Plume strongly influenced landscape evolution during the preceding Palaeogene (Gibbard and Lewin, 2003; Newell, 2014) continuing into the Early and Mid-Miocene (Tiley et al., 2004; Williams et al., 2005; Westaway, 2010). However, during the Late Miocene the impact of these regimes subsided as the regional tectonic stress regime evolved. Instead, landscape evolution was driven by differences in relative crustal loading caused by vertical

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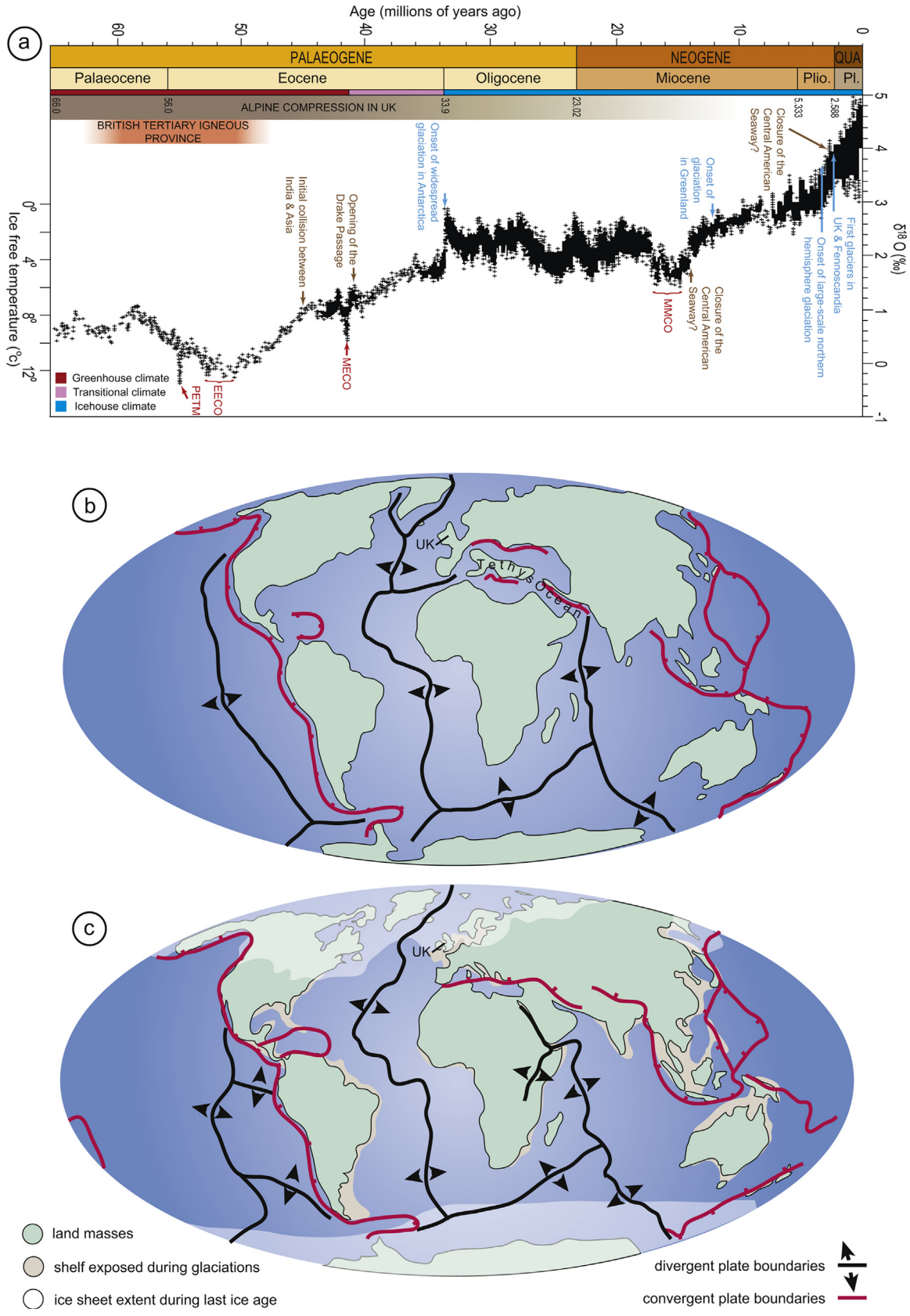

Fig. 1. (a) The Cenozoic time-scale showing major climatic trends (from Zachos et al., 2008; Newell, 2014) with key tectonic (brown) and climatic (warm – red, cold – blue) events. Global palaeogeography during the Mid-Miocene (b) and following the last Quaternary glaciation (c). Based on maps produced by C.R. Scotese (2002); http://www.scotese.com, (PALEOMAP website).

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