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Introduction

From source to sink: Exploring the Quaternary history of the Nile

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1. Introduction

Nearly two thousand five hundred years have elapsed since the Greek historian Herodotus (ca. 485–425 BC) posed a number of fundamental questions about the source, age, and flood regime of the River Nile. Herodotus travelled widely in Egypt in around 450 BC – mainly in the Delta and Lower Egypt, but he may have journeyed as far upstream as Aswan and the First Cataract. A keen observer of nature, with a questioning intellect, Herodotus very quickly discerned that the dark alluvial soils of Egypt were very different from the desert soils of Syria and Libya, and inferred that they were derived from the Ethiopian headwaters of the Nile. Herodotus was the first to recognize that Egyptian civilization was, as he put it, "*the gift of the river*" (Griffiths, 1966) since he understood that, without the regular and reliable hundred days of flooding during the summer months, and the annual deposition of silts along the floodplains, agriculture would not have been possible on any significant scale under the desert climate of the Nile Valley.

Curbing and controlling the floods led to the construction of canals and dams, more extensive irrigation, and the development in Egypt of what Karl Butzer (1976) has called '*Early Hydraulic Civilization*'. By contrast, in northern Sudan, floodwater farmers of the Kerma Period (2400 BC to 1450 BC) were able to exploit favourable channel and valley floor topographies – commonly without the need for such interventions (Welsby et al., 2002; Macklin et al., 2013). Herodotus also made some very perceptive observations about how changes in river channel form could influence the extent of floodplain inundation. He worked out that in the nine hundred years preceding his visit, the accumulation of Nile sediments along the floodplain downstream of Memphis had led to a substantial reduction in the height of the annual flood in that reach. Previously, the entire area was flooded once the river level had increased by four metres, but by the time Herodotus visited this region, a rise of eight metres was required before an inundation would occur. He also took a boat out to sea from the delta during the time of the summer flood and collected samples of Nile mud suspended in the surface waters of the Mediterranean. This prompted him to speculate that ten to twenty thousand years would suffice for a major distributary channel to entirely silt up. Finally, having found shells on hills near the coast and seeing the effects of salt weathering on the pyramids, he wondered about sea level fluctuations and movements of the land.

Almost all of the themes touched upon by Herodotus in the 5th Century BC are the subject of detailed new research and discussion in this Special Issue on *The Quaternary history of the River Nile*. Indeed, Herodotus can justly be regarded as the father of modern Nile River studies. Today's Quaternary scientists, of course, benefit from many advantages – practical and theoretical – not available to Herodotus. This has allowed us to explore the varied sedimentary archives of the Nile basin from source to sink and over a range of timescales. We can now consider the sediments throughout the entire river basin (Garzanti et al., 2015), the longer-term flood history over glacial–interglacial cycles (Williams et al., 2015a), the more recent history of abrupt climate change, Holocene flooding, and channel dynamics (Macklin et al., 2015), as well as the long-term pattern of flow, sediment yield and palaeoclimate recorded offshore (Hennekam et al., 2015; Revel et al., 2015). Fig. 1 provides a summary of the key depositional settings in the Nile basin and offshore that have been examined in the papers of this Special Issue. It also shows more broadly how the fluvial system responds to, processes, and stores, changes in climate and catchment conditions. A distinctive feature of the Quaternary Nile is the extended

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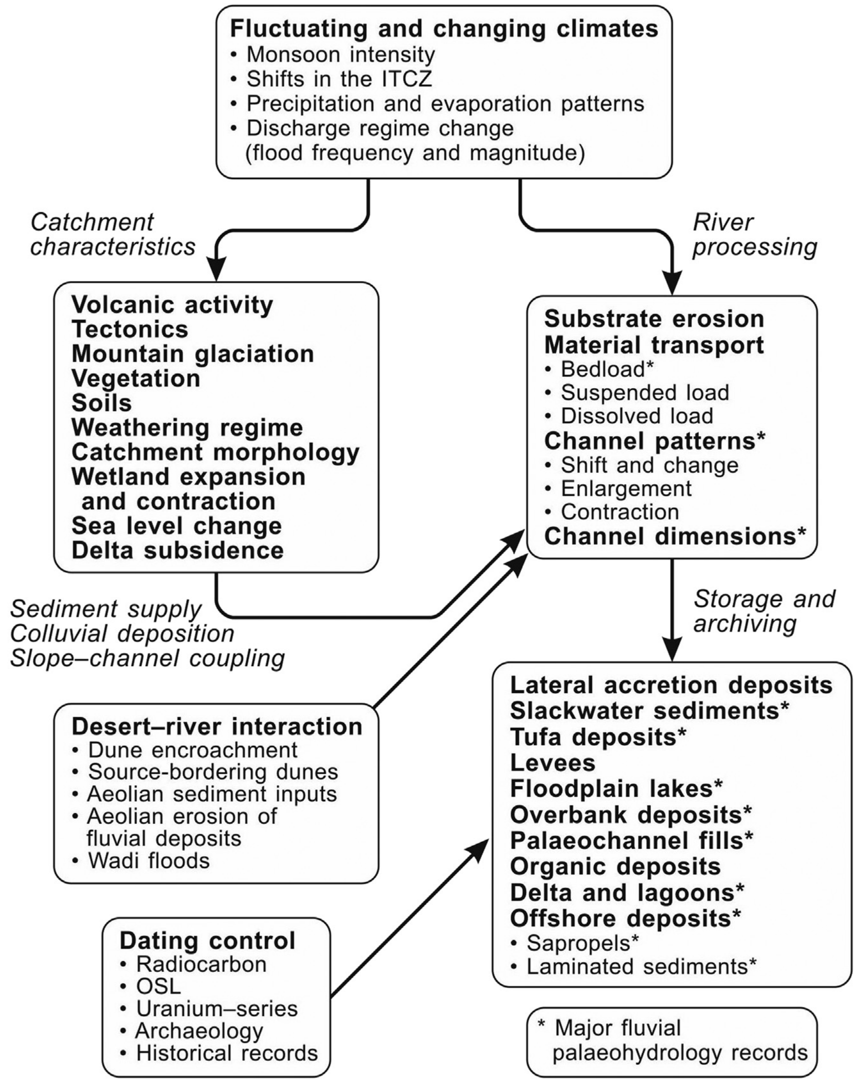

Fig. 1. Diagram showing how the Nile fluvial system responds to and records the effects of climatic change. The key controls on catchment flow regime and sediment supply are also shown. Sediments are transported in various forms in the fluvial environment and interactions with the desert are especially important in the Nile Valley. The dimensions and dynamics of river channels and palaeochannels may also reflect climate controls. The sedimentary signals of change are recorded in a range of sedimentary environments (both onshore and offshore) and the major archives of environmental change examined in the papers in this special issue are shown (modified from Macklin et al., 2012). The principal dating methods employed in the study of the Nile fluvial archive are also shown. Major direct human impacts upon the fluvial system – such as the construction of large dams – are not shown.

record of interaction between desert and river. This has taken place at a range of scales and includes processes such as the encroachment of aeolian dunes into the channel zone (see Vermeersch and van Neer, 2015), the deflation of river channel sands to form source-bordering dunes (Williams et al., 2015b), and the reworking of ancient aeolian deposits by fluvial processes (Woodward et al., 2015) (Fig. 1). As several papers demonstrate, in the absence of suitable materials for radiocarbon dating, Optically Stimulated Luminescence (OSL) can provide a robust dating framework for these interactions.

Most of the papers in this Special Issue formed part of a session convened by the editors at the European Geosciences Union (EGU) General Assembly in Vienna in April 2014. Full details can be found here: http://meetingorganizer.copernicus.org/EGU2014/session/14771.

The principal aim of this session was to bring together researchers from a range of disciplinary backgrounds (e.g. geomorphology, Egyptology, prehistoric archaeology, geoarchaeology, palaeohydrology, palaeoceanography, palaeoclimatology, palaeolimnology, palaeoecology, isotope geochemists, dating specialists and others) to advance our understanding of how the Nile catchment sediment system has responded to global climate change over a range of Quaternary timescales and to explore the implications of these changes for the past record of human activity in the Nile Valley.

The River Nile drains one of the largest drainage basins (>3,250,000 km^2) on Earth and is one of only seven mega-basins with areas >2.5 million km^2. This vast catchment contains a remarkable diversity of climates, landscapes, and ecological settings matched by the wealth and variety of its Quaternary sediments and landforms. The Nile Valley also has a long and exceptionally rich history of human occupation – it formed an important corridor for the movement of people during the Paleolithic and it nurtured the agricultural innovation, social organization and cultural exchange that led to the emergence of early complex societies (Butzer and Hansen, 1968; Wendorf and Schild,