Marine Geology xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Marine Geology

journal homepage: www.elsevier.com/locate/margo

Invited research article

Controls on modern erosion and the development of the Pearl River drainage in the late Paleogene

Chang Liu[a], Peter D. Clift[a,b,*], Andrew Carter[c], Philipp Böning[d], Zhaochu Hu[e], Zhen Sun[f], Katharina Pahnke[d]

[a] Department of Geology and Geophysics, Louisiana State University, Baton Rouge 70803, USA
[b] School of Geography Science, Nanjing Normal University, Nanjing 210023, China
[c] Department of Earth and Planetary Sciences, Birkbeck College, University of London, London WC1E 7HX, UK
[d] Max Planck Research Group for Marine Isotope Geochemistry, Institute of Chemistry and Biology of the Marine Environment (ICBM), University of Oldenburg, 26129, Germany
[e] State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences, Wuhan 430074, China
[f] Key Laboratory of Marginal Sea Geology, South China Sea Institute of Oceanology, Chinese Academy of Sciences, 164 Xingangxi Road, Guangzhou 510301, China

ARTICLE INFO

Keywords:
Zircon
Nd isotope
Erosion
Provenance
Pearl River
South China Sea
International Ocean discovery program
IODP site U1435

ABSTRACT

The Pearl River and its tributaries drains large areas of southern China and has been the primary source of sediment to the northern continental margin of the South China Sea since its opening. In this study we use a combination of bulk sediment geochemistry, Nd and Sr isotope geochemistry, and single grain zircon U-Pb dating to understand the source of sediment in the modern drainage. We also performed zircon U-Pb dating on Eocene sedimentary rocks sampled by International Ocean Discovery Program (IODP) Expedition 349 in order to constrain the source of sediment to the rift before the Oligocene. A combination of Nd and Sr isotopes shows that the Gui, Liu and Dong Rivers are likely not important sources. Single grain zircon dates emphasize the importance of the westernmost tributaries (Hongshui and Yu Rivers), which drain the highest topography and tectonically active areas, as the primary sediment producers. Our data indicate that climate is not the primary control on erosion patterns and intensities. Zircon dating also shows that the Gui and Liu Rivers are not generating large sediment yields. Discrepancies between these new data and earlier samples make the role of the Dong River hard to determine, although Nd isotopes suggest that it is not dominant. The source of sediment during the Eocene at IODP Site U1435 appears to have been a relatively local basement source, or a regionally restricted river only draining nearby areas of the Cathaysia Block, similar, but not identical, to the modern Dong River. There is no evidence for a large regional river and we exclude sediment transport from the southwest (Indochina). Our data are consistent with small drainage systems dominating the basin until the end of the Oligocene (~24 Ma), after which the Pearl River expanded towards its modern state as a result of headwater capture largely towards the west.

1. Introduction

Drainage systems are born and develop in response to interactions between climate and tectonic processes. As new ocean basins open or mountain ranges rise, drainages reorganize in response to the changing topography and discharge supplied as result of precipitation (Brookfield, 1998; Clark et al., 2004). In so doing they can be sensitive indicators of continental processes, which are then preserved in the sedimentary record within basins supplied by those rivers. The major rivers of Southeast Asia have been the subject of significant speculation about their development, as a result of their proposed interaction with the uplift of the Tibetan plateau (Clark et al., 2004; Clift et al., 2006; Zheng et al., 2013). In this respect the Pearl River (Fig. 1) has typically been considered anomalous in that it is generally not thought to have been involved in major headwater capture during plateau uplift, but may be more closely tied to the development of the South China Sea (Clark et al., 2004). In this study we assess the geographic diversity of sources within the modern river in order to map crustal heterogeneity and to see where the modern river derives its sediment. We use this knowledge to interpret Eocene fluvio-deltaic sedimentary rocks collected by coring within the South China Sea to determine how the Eocene Pearl River compares with the modern. This then allows us to

* Corresponding author at: Department of Geology and Geophysics, Louisiana State University, Baton Rouge 70803, USA.
E-mail addresses: pclift@lsu.edu, pclift@whoi.edu (P.D. Clift).

http://dx.doi.org/10.1016/j.margeo.2017.07.011
Received 18 June 2016; Received in revised form 11 July 2017; Accepted 16 July 2017

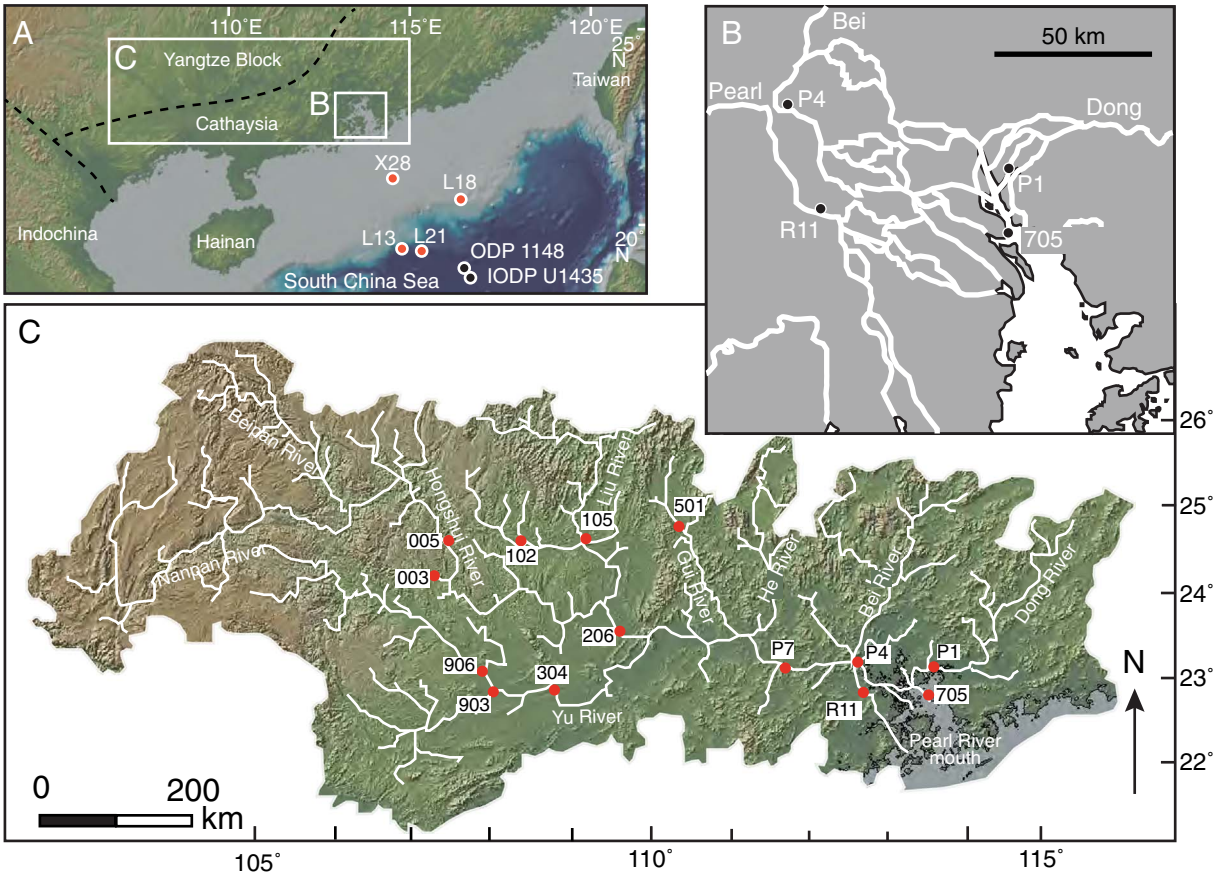

Fig. 1. A) Map showing the Pearl River area in a regional context, as well as the location of IODP Site U1435, ODP Site 1148 and industrial wells. B) Close-up image of the distributary system in the Pearl River Mouth area. C) Map showing the distribution of the Pearl River tributaries, as well as the sampling locations.

understand how the river has developed to its present state.

The modern Pearl River Drainage (PRD) covers 8600 km^2 and flows across the South China tectonic block, composed of both the Yangtze Craton and the Cathaysia Block (Yao et al., 2013) (Fig. 2). The Pearl River is one of the major sediment sources to the northern part of the South China Sea, although flux from Taiwan's many smaller rivers has been significantly greater in the recent geologic past (Milliman and Meade, 1983). The climate of the PRD is dominated by the East Asian

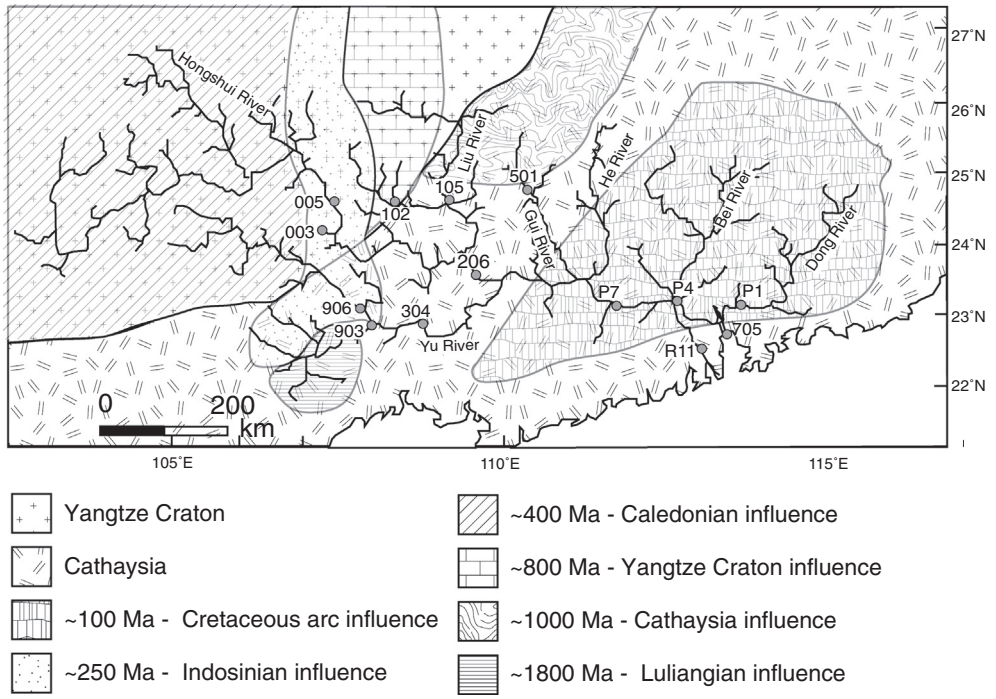

Fig. 2. Map showing the major tectonic blocks within the Pearl River catchment, as well as the sample locations. Cathaysia block covers the SE area from which most of our samples are derived. The Yangtze block includes only three of the samples in the NE of catchment. The boundary between these two blocks is modified after He et al. (2014). Subdivisions within these blocks are defined based on the results of the analysis presented here.