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The Paleogene record of Himalayan erosion: Bengal Basin, Bangladesh

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ABSTRACT

A knowledge of Himalayan erosion history is critical to understanding crustal deformation processes, and the proposed link between the orogen's erosion and changes in both global climate and ocean geochemistry. The most commonly quoted age of India–Asia collision is ~50 Ma, yet the record of Paleogene Himalayan erosion is scant — either absent or of low age resolution. We apply biostratigraphic, petrographic, geochemical, isotopic and seismic techniques to Paleogene rocks of the Bengal Basin, Bangladesh, of previously disputed age and provenance. Our data show that the first major input of sands into the basin, in the >1 km thick deltaic Barail Formation, occurred at 38 Ma. Our biostratigraphic and isotopic mineral ages date the Barail Formation as spanning late Eocene to early Miocene and the provenance data are consistent with its derivation from the Himalaya, but inconsistent with Indian cratonic or Burman margin sources. Detrital mineral lag times show that exhumation of the orogen was rapid by 38 Ma. The identification of sediments shed from the rapidly exhuming southern flanks of the eastern–central Himalaya at 38 Ma, provides a well dated accessible sediment record 17 Myr older than the previously described 21 Ma sediments, in the foreland basin in Nepal. Discovery of Himalayan detritus in the Bengal Basin from 38 Ma: 1) resolves the puzzling discrepancy between the lack of erosional evidence for Paleogene crustal thickening that is recorded in the hinterland; 2) invalidates those previously proposed evidences of diachronous collision which were based on the tenet that Himalayan-derived sediments were deposited earlier in the west than the east; 3) enables models of Himalayan exhumation (e.g. by mid crustal channel flow) to be revised to reflect vigorous erosion and rapid exhumation by 38 Ma, and 4) provides evidence that rapid erosion in the Himalaya was coincident with the marked rise in marine $^{87}Sr/^{86}Sr$ values since ~40 Ma. Whether 38 Ma represents the actual initial onset of vigorous erosion from the southern flanks of the east-central Himalaya, or whether older material was deposited elsewhere, remains an open question.

1. Introduction

Study of the erosional history of the Himalayan orogeny is critical to the assessment of models of crustal deformation which differ in the timing and extent of erosion, as well as to the proposed influence of the orogen's erosion on global climate and ocean geochemistry (Raymo and Ruddiman, 1992; Richter et al., 1992).

The most commonly quoted age of India–Asia collision is ~55–50 Ma (Hodges, 2000). However, whilst there is a well dated record of Neogene Himalayan erosion (Burbank et al., 1996; Clift et al., 2001b; France-Lanord et al., 1993), a well-resolved record of Paleogene erosion from the orogen's southern flanks, from sediments in the foreland, remnant ocean, or deep-ocean basins is lacking. Strata are either absent, show only minor detrital input, are of disputed provenance, lack high-precision dating, or are yet to be sampled (Allen et al., in press; Clift, 2006; Clift et al., 2001b; Curray, 1994; Davies et al., 1995; Lindsay et al., 1991; Metivier et al., 1999; Mitchell, 1993; Qayyum et al., 2001; Sinclair and Jaffey, 2001). Sedimentary

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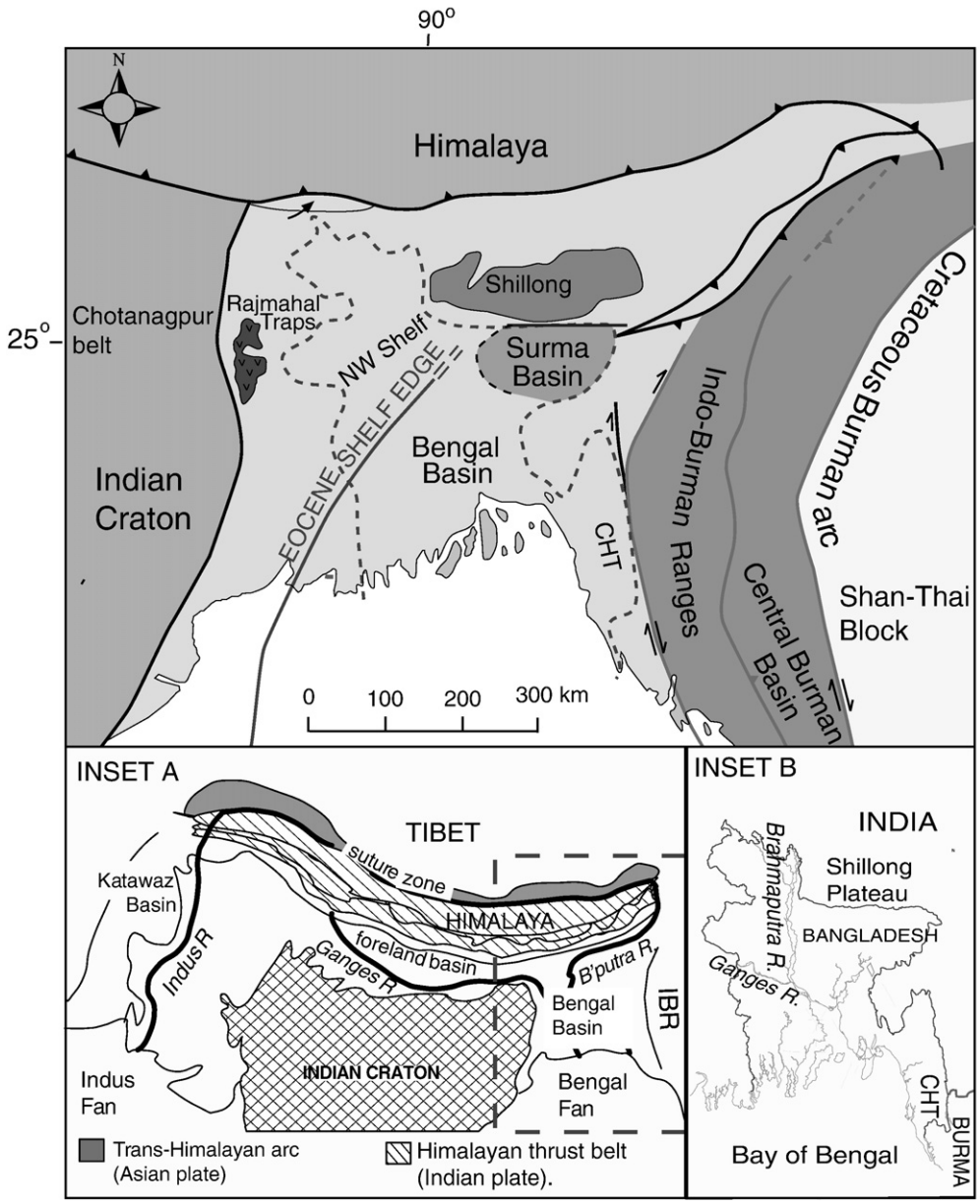

Fig. 1. Map showing the location of the Surma Basin, NW Shelf, main geological features of the wider region, and potential source regions to the basin (Himalaya, Indian craton and Burman margin) during Paleogene sedimentation. Dashed line shows the political boundary of Bangladesh. CHT = Chittagong Hill Tracts. Inset A shows the locations of the main Himalayan sedimentary repositories in the mountain belt's geological context. IBR=Indo-Burman Ranges. Dashed box shows the region of Fig. 1. Inset B shows geographical and political features of the region of Fig. 1.

records pertaining to erosion from the eastern and central part of the orogen are particularly scant. In this paper we identify and date the oldest Himalayan-derived sedimentary rocks in the Bengal Remnant Ocean Basin, Bangladesh (Fig. 1).

2. Geological background

2.1. Himalayan geology

The Himalayan orogen formed when Tethys closed and India and Eurasia collided. In the suture zone, Tertiary molasse separates the Asian plate to the north from the Indian plate to the south (Clift et al., 2001a; Sinclair and Jaffey, 2001) (Fig. 1, Inset A). The Tibetan plateau of the Asian plate is flanked on its southern margin by the Jurassic–Paleogene Trans-Himalayan arc which formed an ancient Andean-type margin to Tethys (Chu et al., 2006; Scharer and Allegre, 1984). South of the suture zone, the Himalaya consists of various lithotectonic units bounded by south-directed thrusts. From north to south these consist of ophiolites and Palaeozoic–earliest Tertiary Tethyan Himalayan sediments (DeCelles et al., 2001; Maheo et al., 2004), the Higher Himalaya characterised by metamorphic rocks with Oligo-Miocene and younger mineral ages resulting from Himalayan metamorphism (Hodges, 2000; Vance and Harris, 1999), the Lesser Himalaya of mostly weakly or non-metamorphosed Indian plate rocks (Hodges, 2000; Richards et al., 2005) , and the Sub-Himalaya which contains foreland basin sediments (Burbank et al., 1996). Flanking the Himalaya in the west and east respectively, are the Katawaz and Bengal remnant ocean basins (Alam et al., 2003; Qayyum et al., 2001).

2.2. Existing Paleogene records of Himalayan erosion

2.2.1. The orogen's western region

In the suture zone, the age of the Indus Group molasse is only precisely constrained by Nummulitic limestones, dated at 54.9 Ma, near the base of the succession (Fig. 1, Inset A; Sinclair and Jaffey, 2001). The molasse comprises detritus predominantly from the Asian