

Digital Appendix supplementary figures for Gibling et al article

(See Text—Figure 2A for Asian locations and Text—Figure 3 for Australian locations).

- S1. Upstream view of the Gandak River and sand flats near Patna, India. Note the flat nature of the landscape and the minimal degree of incision of the channel into adjacent alluvium, in accord with the prolonged and widespread flooding experienced in this area. The sand bars are in use for agriculture during the dry season. Photo by M.R. Gibling.
- S2. Upstream view of Baghmata River anabranch at Benibad near Muzzafarpur, India. Note the flat nature of the landscape and the minimal degree of incision of the channel into adjacent alluvium, in accord with the prolonged and widespread flooding experienced in this area. Scientists are standing on a low levee a few metres high and tens of metres wide that borders the channel. See details in Sinha et al. (2005). Photo by M.R. Gibling.
- S3. Upstream view of Baghmata River anabranch near Nawada, India. Scientists are standing below a crevasse channel (at lower right), a metre-thick splay from which buried an orchard during the previous season's flooding. This site provides field evidence for the frequent overbank flooding indicated in the flood map. See details in Sinha et al. (2005). Photo by M.R. Gibling.
- S4. Alluvial fan lobe in foreground, where a temple is built on the lobe, and in the middle distance. The lobe is cut by an incised channel about 40 m deep, shallowing distally. The site lies within the Himalayan Foothills of India, in the intermontane valley of Pinjaur Dun, bounded to the north (left) by the Main Boundary Thrust and to the south (right) by the Siwalik Hills. The topmost strata of the lobe date to ~24 ka B.P., and incision post-dates this period of deposition. Fans in Pinjaur Dun are tilted, and incision was a response to uplift on the Main Boundary Fault (Tandon et al. 2006, Singh and Tandon 2007). Photo by M.R. Gibling.
- S5. Cliffs about 30 m high along the southern margin of the Ganga Valley near Kannauj, northwest of Kanpur, India (Text—Figure 2B). Downstream view. The cliffs are cut into late Quaternary alluvium which dates back to about 27 ka B.P. downstream at Bithur. See details in Gibling et al. (2005) and Sinha et al. (2007). Photo by M.R. Gibling.
- S6. Cliffs about 20 m high along the southern margin of the Ganga Valley near Kannauj, northwest of Kanpur, India (Text—Figure 2B). Downstream view. Note the shallow gullies cutting through the cliffs, part of a narrow belt of badlands bordering the valley in this area (Sinha et al. 2007). Photo by M.R. Gibling.
- S7. Clastic dikes of red clay, with some white calcite precipitates, cutting through silty alluvium in cliffs along the Yamuna Valley near Kalpi, India. The dikes terminate below a discontinuity within the Quaternary section, just above the level of the photo. Note the distorted stratification in the alluvium which, along with the dikes, suggests deformation due to earthquake activity. Measuring stick is 50 cm long. See details in Gibling et al. (2005). Photo by M.R. Gibling.
- S8. Near-vertical calcite vein that transects ~5 m of alluvium in terrace cuts, at Chillahia on the Belan River, India. Hammer is 30 cm long. See details in Gibling et al. (2008). Photo by M.R. Gibling.
- S9. Fluvial sand sheet exposed in bank of anabranch, Cooper Creek, Australia. The topstratum of the bank is dark mud attributed to anastomosing rivers similar to those of the present day. The pale substratum is an unusual exposure of a widespread sand sheet proven from

augering, drilling and trenches across much of the Channel Country. The sand sheet dates from MIS 3 back to about 750,000 years before present, and represents periods of enhanced fluvial discharge and sediment transport linked to secular variation in precipitation (Gibling et al. 1998, Nanson et al. 2008). Undercutting of the soft sand has caused bank migration, toppled trees, and resulted in unusual amounts of sand on the adjacent point bar. Photo by M.R. Gibling.

- S10. Relict meanders and point bars with scroll-bar topography on alluvial surface, Cooper Creek, Australia. White bar is 2 km long. The relict topography represents the top of a near-surface sand sheet attributed to an earlier period of enhanced fluvial activity. See Rust and Nanson (1986) for details. Aerial photo CAB 7059 Run 4 Number 141, General Manager, Australian Surveying and Land Information Group, Canberra.
- S11. Source-bordering eolian mound in Ganga Valley (Gahira Bypass Section), near Unnao north of Kanpur, India. The silts were dated to early-mid Holocene by Srivastava et al. (2000). Photo by M.R. Gibling.
- S12. Eolian mound in Ganga Valley, showing thick units of poorly stratified silt, with a vegetated cap and paleosol. Photo by M.R. Gibling.
- S13. Close-up of yellow silt in eolian mound, Ganga Valley (DVD 12), showing poor stratification and weakly defined red layers, suggesting incipient paleosols. Trowel is 15 cm long. Photo by M.R. Gibling.
- S14. Source-bordering eolian mound of weakly stratified sand and silt in the Belan Valley, India. Eolian deposits in the valley yielded dates from about 14 to 7 ka B.P., representing a period of climatic instability as the monsoon intensified following the Last Glacial Maximum (Gibling et al. 2008). Photo by M.R. Gibling.
- S15. Poorly stratified sand with disseminated shell fragments in eolian mound, Belan Valley (DVD 14). Lens cap is 5 cm in diameter. Photo by M.R. Gibling.
- S16. Baraila Tal (large lake), Bihar, India. Abundant pale mounds in the foreground are the “chimneys” of crustacean burrows, extending up to 15 cm above the mud surface. Mounds in the distance are piles of lake reeds collected by local farmers. See Sinha et al. (2005). Photo by M.R. Gibling.
- S17. Carbonate-cemented erosional surface (discontinuity) within alluvial cliffs along Yamuna Valley near Kalpi, India. Several similar surfaces, which mark both pedogenic and groundwater carbonate accumulation, divide the cliff succession into aggradational/degradational rhythms (see text). Hammer is 30 cm long. See Gibling et al. (2005) and Sinha et al. (2007) for a description of these rhythms. Photo by M.R. Gibling.
- S18. Colluvial gully fills up to 10 m thick in cliffs along the Yamuna Valley near Kalpi, India. Strata filling a major gully dip systematically to the right across most of the illustrated cliff face, and are cut by two successive gully fills at right of the photo. Cliff is 10 m high, and the topmost cliff strata represent the cultural level of human occupation. The gully forms and fills are analogous to modern badland features that border the modern Yamuna River. See Gibling et al. (2005) for a detailed account of these gully fills, which yielded a date of 36 ka B.P. Photo by M.R. Gibling.
- S19. Thick calcrete on terrace surface at Benar near Jodhpur, in the Thar Desert of northwest India (north of the Luni River in Text-figure 2A. See Dhir et al. (2004) for details. Photo by M.R. Gibling.
- S20. Close-up of calcrete in DVD 19 to show closely packed nodules. Scale is 9 cm long. Photo by M.R. Gibling.

- S21. Gullied badlands behind incised valley of the Yamuna River near Kalpi, India. Gullies are well vegetated and up to 15 m deep, and they dissect late Quaternary alluvium along a broad belt bordering the river. Photo by M.R. Gibling.
- S22. Gullied cliff face along the Betwa River near Kotra, India (Text—Figure 2A). Gullies are up to 15 m deep and form part of a wide belt bordering the river. They cut into an undated alluvial succession that contains erosional surfaces and comprises stacked aggradational/degradational rhythms. The succession contains fluvial carbonate gravels derived from erosion of floodplain deposits. Tough material in foreground is an older, well cemented alluvial unit. See description in Gibling et al. (2005). Photo by M.R. Gibling.
- S23. Gullied cliff face along the Yamuna Valley at Tilauli near Allahabad, India. The main part of the cliff consists of red-brown floodplain silt and clay. At the cliff top is an indurated, well stratified yellow silt 3 m thick that is rich in gastropods and interpreted as a lacustrine unit. Shells yielded a date of 15.5 radiocarbon years B.P. (Williams and Clarke 1995), calibrated to ~18.8 ka B.P. The change from floodplain to lake deposition at the cliff top represents a period of reduced discharge on the alluvial plain. Subsequent incision by the Yamuna River post-dates the lacustrine unit, and is attributed to enhanced discharge during intensification of the Southwest Indian Monsoon following the Last Glacial Maximum (Tandon et al. 2006). Photo by M.R. Gibling.
- S24. Close-up of lacustrine unit at Tilauli (DVD 23). The unit is 3 m thick, and has partly slumped down the cliff in the foreground. Note gullied landscape and Yamuna Valley in distance. Photo by M.R. Gibling.
- S25. Alluvial terrace (centre-right) where the Gandak River has cut through alluvium from a tributary valley near Kalopani, Nepal Himalaya. The higher cliff at centre-left is largely cut through bedrock. Hut in fields at centre-right of photo is 5 m high. Photo by M.R. Gibling.
- S26. Alluvial terrace from the tributary Miristi Khola, incised by the Gandak River north of Tatopani, Nepal Himalaya. House on terrace top is 8 m high. See Monecke et al. (2001) for a description of the alluvium. Photo by M.R. Gibling.
- S27. Terraces at base of Gandak Valley south of the Main Central Thrust near Tatopani, Nepal Himalaya. The valley cuts through the Annapurna and Dhaulagiri Massifs, 8 km above sea level, parts of which are visible in the distance. The valley is about 6.5 km deep. People on bridge in foreground for scale. Photo by M.R. Gibling.
- S28. Close-up of terraces in DVD 27 to show coarse-grained alluvium and occurrence of terraces in small rock-cut embayments. People on bridge in foreground for scale. Photo by M.R. Gibling.
- S29. Alluvial terraces of the Belan River, India, with Kaimur Hills of the Indian Craton visible to the south. The river at left is cut into Proterozoic quartzites, and the terrace succession at right commences with channel-base groundwater calcrete, which projects as ledges into the river. People are standing on the top of the calcrete. The alluvium in the cliff yielded dates of about 90 to 20 ka B.P. (Williams et al. 2006). Photo by M.R. Gibling.
- S30. Alluvial terrace and cultivated inset terrace, Belan River, India. The alluvium at this location yielded dates back to about 13 ka B.P. (Gibling et al. 2008), a quite different spectrum of ages from the terrace succession shown in DVD 29, about 5 km upstream. Photo by M.R. Gibling.
- S31. Strath (bedrock) terrace on Proterozoic quartzite, with thin alluvial cover, Chopani–Mando, Belan River, India. The terrace level on the far bank of the river was the site of Palaeolithic and Mesolithic settlements (Gibling et al. 2008). Photo by M.R. Gibling.

- S32. Charity Creek on the Manning River, New South Wales, Australia, looking upstream. At the bend at the extreme left, the alluvial terrace has been partially stripped away by flood events in the 1968 to 1978 period, leaving an expanse of gravel. Site of “catastrophic stripping” described by Nanson (1986). Photo by M.R. Gibling.
- S33. Close-up of Charity Creek site at river bend at extreme left in DVD 32, looking downstream. The alluvial terrace has been stripped away over a width of about 50 m, leaving an incised terrace margin and a gravel expanse. Photo by M.R. Gibling.

REFERENCES

- Dhir RP, Tandon SK, Sareen BK, Ramesh R, Rao TKG, Kailath AJ, Sharma N. 2004. Calcretes in the Thar Desert: genesis, chronology and paleoenvironment. *Indian Academy of Science, Proceedings (Earth and Planetary Science)* 113:473–515.
- Gibling MR, Nanson GG, Maroulis JC. 1998. Anastomosing river sedimentation in the Channel Country of central Australia. *Sedimentology* 45:595–619.
- Gibling MR, Tandon SK, Sinha R, Jain M. 2005. Discontinuity-bounded alluvial sequences of the southern Gangetic Plains, India: aggradation and degradation in response to monsoonal strength. *Journal of Sedimentary Research* 75:369–385.
- Gibling MR, Sinha R, Roy NG, Tandon SK, Jain M. 2008. Quaternary fluvial and eolian deposits on the Belan River, India: paleoclimatic setting of Paleolithic to Neolithic archeological sites over the past 85,000 years. *Quaternary Science Reviews* 27:391–410.
- Monecke K, Winsemann J, Hanisch J. 2001. Climatic response of Quaternary alluvial deposits in the upper Kali Gandaki valley (West Nepal). *Global and Planetary Change* 28:293–302.
- Nanson GC. 1986. Episodes of vertical accretion and catastrophic stripping: A model of disequilibrium flood-plain development. *Geological Society of America, Bulletin* 97:1467–1475.
- Nanson GC, Price DM, Jones BG, Maroulis JC, Coleman M, Bowman H, Cohen TJ, Pietsch TJ, Larsen JR. 2008. Alluvial evidence for major climate and flow regime changes during the middle and late Quaternary in eastern central Australia. *Geomorphology* 101:109–129.
- Rust BR, Nanson GC. 1986. Contemporary and palaeo channel patterns and the late Quaternary stratigraphy of Cooper Creek, southwest Queensland, Australia. *Earth Surface Processes and Landforms* 11:581–590.
- Singh V, Tandon SK. 2007. Evidence and consequences of tilting of two alluvial fans in the Pinjaur dun, Northwestern Himalayan Foothills. *Quaternary International* 159:21–31.
- Sinha R, Gibling MR, Jain V, Tandon SK. 2005. Sedimentology and avulsion patterns of the anabranching Baghmata River in the Himalayan foreland basin, India. In Blum MD, Marriott SB (Editors). *Fluvial Sedimentology VII*, Special Publication 35: International Association of Sedimentologists. p. 181–196.

Sinha R, Bhattacharjee PS, Sangode SJ, Gibling MR, Tandon SK, Jain M, Godfrey-Smith D. 2007. Valley and interfluvial sediments in the Southern Ganga plains, India: Exploring facies and magnetic signatures. *Sedimentary Geology* 201:386–411.

Srivastava P, Shukla UK, Mishra P, Sharma M, Sharma S, Singh IB, Singhvi AK. 2000. Luminescence chronology and facies development of Bhur sands in the interfluvial region of Central Ganga Plain, India. *Current Science* 78:498–503.

Tandon SK, Gibling MR, Sinha R, Singh V, Ghazanfari P, Dasgupta AS, Jain M, Jain V. 2006. Alluvial valleys of the Gangetic Plains, India: Timing and causes of incision. In Dalrymple RW, Leckie DA, Tillman RW (Editors). *Incised Valleys in Time and Space*, Special Publication 85: SEPM (Society for Sedimentary Geology). p. 15–35.

Williams MAJ, Clarke MF. 1995. *Quaternary Geology and Prehistoric Environments in the Son and Belan Valleys, North Central India*, Memoir 32: Geological Society of India. p. 282–308.

Williams MAJ, Pal JN, Jaiswal M, Singhvi AK. 2006. River response to Quaternary climatic fluctuations: evidence from the Son and Belan valleys, north-central India. *Quaternary Science Reviews* 25:2619–2631.