**Captions and References for the Supplementary Material**

**Figure Captions**

**Figure S1.** Bulk petrographic compositions of modern river and terrace sediments from Zanskar. Compositions are classified by Q(quartz), F(feldspathic), and L(lithic) framework grains following the Gazzi-Dickinson method (Ingersoll et al., 1984) and after Garzanti and Vezzoli (2003). All data were corrected for Source Rock Density (SRD; Vermeesch et al. (2016). Fields for Greater Himalaya and Tethyan Himalaya are after Garzanti et al. (2007). Sample numbers follow Table 1.

**Figure S2.** KDE diagrams for detrital U-Pb zircon ages from the Zanskar River Basin and selected Himalayan bedrock. Selected samples are from the Indus and Tar Groups (Henderson et al., 2010) (Wu et al., 2007), Zanskar region Greater Himalaya (Horton and Leech, 2013), Panjal Traps (Shellnutt et al., 2011), and Cambro-Ordovician granites in Zanskar and the NW Himalaya (Pognante et al., 1990; Girard and Bussy, 1999; Kwatra et al., 1999; Miller et al., 2001; Cawood et al., 2007). The Zanskar Greater Himalaya differs somewhat in respect to other exposures of Greater Himalaya across the orogen in that the Zanskar Greater Himalaya is particularly rich in both Cambro-Ordovician (500–440 Ma; pink bar) and Mississippian-Permian (380–245 Ma; orange bar) granitoids and Neoproterozoic high-grade metasediments and metacarbonate protoliths (850–750 Ma; green bar). Compiled bedrock ages for southern Tethyan Himalaya, Greater Himalaya, and correlative strata from the eastern and central Himalaya were plotted (in gray) according to depositional age (Myrow et al., 2003; DeCelles et al., 2004; McQuarrie et al., 2008; Myrow et al., 2010; Gehrels et al., 2011; Hu et al., 2012; Clift et al., 2014; Hu et al., 2015). Labels according to Table 1. Figure adapted from Jonell et al. (2017).

**Figure S3**. KDE diagrams for detrital U-Pb zircon ages for all modern and Quaternary Zanskar River Basin sediments. Color bars indicate age peaks associated with Mississippian-Permian (245–380 Ma) magmatism, Cambro-Ordovician (440–500 Ma) magmatism, and a strong age peak (750–850 Ma) reported in modern Zanskar River sediments from Jonell et al. (2017). Labels according to Table 1.

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