

# Interplay between the westerlies and Asian monsoon: Cenozoic weathering and climate tales from the NE Tibet

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The interplay between the westerlies and the Asian monsoon has played a critical role in regulating the evolution of the Cenozoic Asian interior environment in response to regional tectonic uplift and global climate change. We provide the first complete long continental silicate weathering and atmospheric moisture oxygen isotopes record from the NE Tibetan Plateau spanning the last 52 Myrs. The silicate weathering intensity in NE Tibet is characterized by a long-term Paleogene decrease, modulated by global cooling, and a Neogene increase that may be related to the East Asian summer monsoon (EASM) intensification. Three major system transitions in regional silicate weathering are identified at ~26–23 Ma, ~16 Ma and ~8 Ma, which are linked to enhanced EASM. The average carbonate  $\delta^{18}\text{O}$  is characterised by a long-term decrease from ca. 43 Ma to 33 Ma and smaller variations after 33 Ma. The  $\delta^{18}\text{O}$  record can be explained by a simple binary mixing model of the atmospheric moisture from the westerlies and the monsoon. In that case, the first-order carbonate  $\delta^{18}\text{O}$  decrease from ca. 43 Ma to 33 Ma was primarily controlled by a remarkable decline in westerly rainfall relative to the monsoon. After ~32 Ma, the contribution from the westerlies could be constant. The lower limits of the carbonate  $\delta^{18}\text{O}$  values are modelled by episodic increases in monsoon rainfall corresponding to enhanced EASM periods at 26–24 Ma, ~16 Ma, and ~8 Ma. Our weathering and oxygen isotopic records indicate that EASM enhancements at late Oligocene, mid-Miocene, and late Miocene were forced primarily by tectonic uplift, with some subordinate influences from the mid-Miocene global climate. Our study thus suggests a summer monsoon climate was dominant over the NE Tibet since the late Oligocene.