Cenozoic climate reconstructions associated with the formation of Tibet and the biodiversification of terrestrial ecosystems

Conference or Workshop Item

CENOZOIC CLIMATE RECONSTRUCTIONS ASSOCIATED WITH THE FORMATION OF TIBET AND THE BIODIVERSIFICATION OF TERRESTRIAL ECOSYSTEMS

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The Asian monsoon system is a major feature of Earth's climate, impacting nearly half of the global population. The monsoon system has changed over geological time, intimately tied with the growth of the Himalaya and Tibet since the Paleogene and early Neogene. Here, we aim to untangle the multiple tectonic and climatic controls that led to the modern monsoon system and brought about the notably high biodiversity in this surrounding area via climate reconstructions derived from sedimentary archives of the Tibetan Plateau, South China, and Yunnan Province. Our focus area in Yunnan Province, situated between the Tibetan Plateau and the highly-productive agricultural lowlands of China, has >200 basins with Cenozoic sediments, making it a rich but largely untapped archive of Earth history.

Specifically, we explore Luhe Basin which comprises of a rich but complex mosaic of diverse river-associated terrestrial sediments, including fluvial and flood plain (clay- and silt-sized) sediments interrupted by occasional lignites. Recently, the discovery of early Oligocene volcanic ash beds in the Luhe Basin demanded a re-evaluation of the evolution of the biodiversity in this area. The probable source of the Luhe ash beds are the Mankang volcanic, themselves containing exquisitely preserved floras that we have recently dated as spanning the Eocene-Oligocene transition. These sediments (and likely those in other basins correlated with them) are late Eocene to early Oligocene in age, some 20 million years older than previously thought. This revealed that the modernization of ecosystems in southwestern China occurred across the Eocene-Oligocene transition, far earlier than previously thought, and linked with the major climatic changes at that time.

Preliminary biomarker analyses indicate that the Luhe Basin sediments are thermally immature, containing abundant and diverse plant lipids; *n*-alkanes are dominated by high molecular weight homologues and carbon preference indices >4. Average chain lengths are around 28 but highly variable, as expected for this dynamic-sedimentology setting. Glycerol dialkyl glycerol tetraethter (GDGT) lipids are abundant but strongly dominated by the branched components (BIT indices >0.95). MBT'/CBT-derived (via lake calibrations) mean annual air temperatures are very low (<5°C); these appear unlikely, given its location and presumed palaeo-altitude. Assuming brGDGTs have allochthonous soil sources, calculated MAATs are higher and variable (6° to 12°C), but still lower than co-occurring leaf-derived temperatures, suggesting an origin from surrounding higher altitude soils. Intriguingly, CBT-derived pH values are typically less than 6, suggesting that brGDGTs could instead derive from surrounding peatlands.

Other Yunnan sites include the Maguan and Wenshan lacustrine basins of Miocene age. These also contain a rich, thermally immature biomarker assemblage, but the former has predominance of algal rather than terrestrial organic matter inputs. This has allowed determination of TEX_{86}-derived temperatures ranging from 24° to 30°C (depending on calibration), consistent with the Mid-Miocene pCO_2 estimates (Greenop et al., 2014).

These biomarker analyses are the first to reconstruct the complex climate systems in these heretofore unstudied basins of western and southern China. Although many of these basins are thermally mature (i.e. Jinngu Basin, China) despite their relatively young age and likely reflect their complex tectonic history, many contain rich and diverse biomarker assemblages from which changes in organic matter source, preservation, temperature and hydrology can be reconstructed.

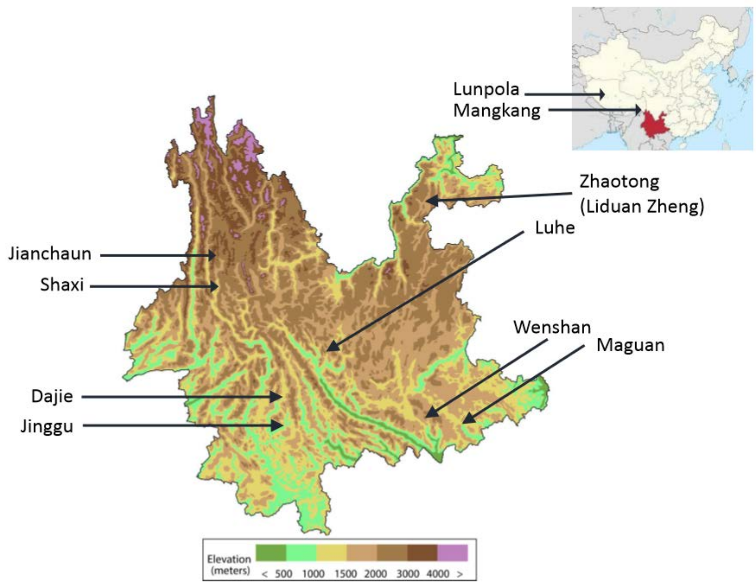

Figure 1. Map of major fossil sites related to this study. *All sites related to this study, with the main focus on the Luhe Basin; near its base is a 34.1 Ma ash and the uppermost part of the section is thought to be ~26 Ma, representing a nearly unprecedented record of early Oligocene terrestrial climate change in China.*

Ding, L., et al., **2017**, Quantifying the rise of the Himalaya orogen and implications for the South Asian monsoon: *Geology*, v. 45, no. 3, p. 215-222.

Greenop, R., et al., 2014, Middle Miocene climate instability associated with high - amplitude CO2 variability: *Paleoceanography*, v. 29, no. 9, p. 845-853.

Spicer, R. A., et al., **2016**, Asian Eocene monsoons as revealed by leaf architectural signatures: *Earth and Planetary Science Letters*, v. 449, p. 61-68.