The East Asian summer monsoon, the Indian summer monsoon, and the midlatitude westerlies at 4.2 ka BP

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The Delingha stable isotope tree-ring record (1) provides exquisite precision and accuracy measurement for the Holocene paleoclimate proxies of the northeast Tibetan plateau, where 90% of annual precipitation now derives from the East Asian summer monsoon (EASM) (2). But does the Delingha $\delta^{18}O_{dendro}$ record correspond to other EASM (3) and globally distributed records for the 4.2 ka BP (∼2200 BCE) megadrought event (4), or does Delingha $\delta^{18}O_{dendro}$ record a different climate event?

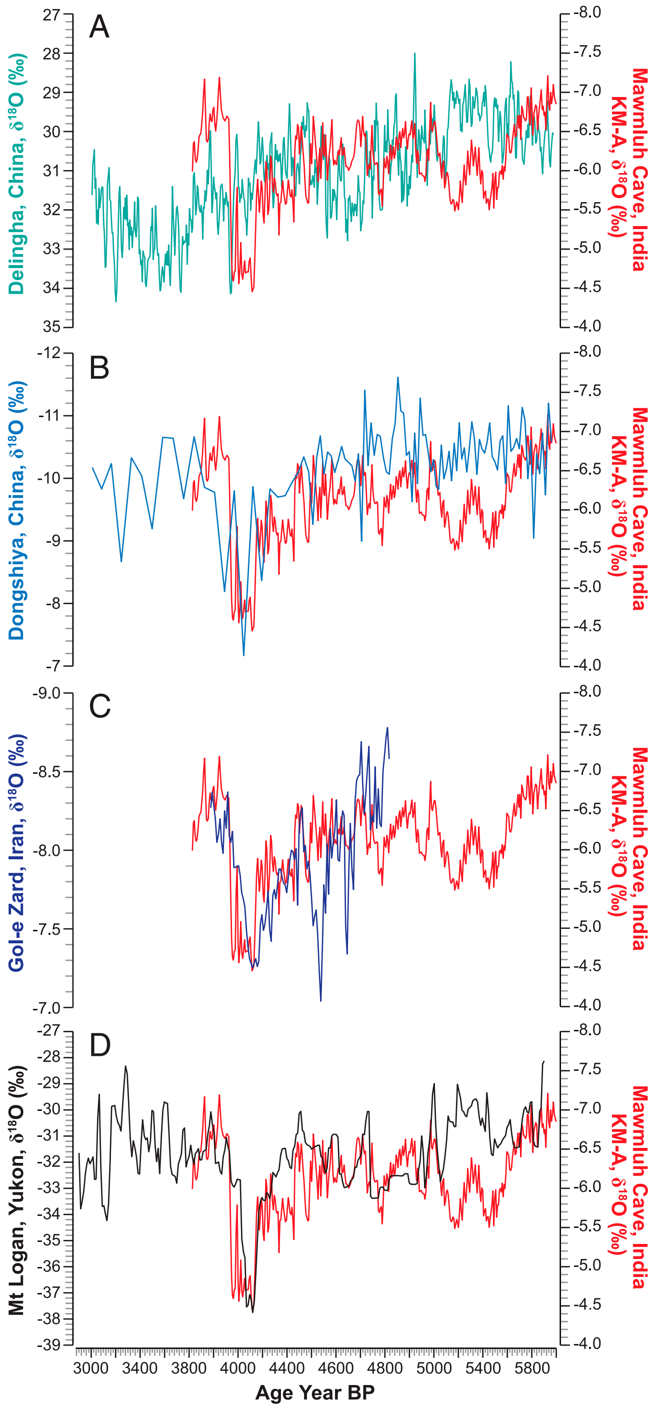

Fig. 1. Four-stage 4.2 ka BP paleoclimate proxies compared to KM-A speleothem $\delta^{18}O$, Mawmluh Cave, northeast India (4): (*A*) Delingha tree rings (1), (*B*) Dongshiya Cave speleothem (5), (*C*) Gol-e Zard Cave speleothem (7), (*D*) Mt. Logan ice core (8).

A trend-point analysis of the Delingha $\delta^{18}O_{dendro}$ record defines a drying trend that "intensified between ∼2000 and ∼1500 BCE" and "thus arguably marks the transition from the mid- to the late Holocene Asian moisture regime" (1). The authors of the analysis conclude that their findings do "not support a significant transition in the hydroclimate … around ∼2200 BCE during the so-called '4.2-ka event' … nor the notion that this rapid climate deterioration and associated global-scale megadroughts should be regarded as a generalized climatic transition from the mid- to late Holocene" (1).

The Delingha megadrought is, however, precisely coincident with the Mawmluh Cave, India, KM-A speleothem's $\delta^{18}O$ four stages that define the 4.2 ka BP event's global type stratum (4), and only differs in its first-stage magnitude (Fig. 1*A*). That is, the Delingha trend-point analysis's cutoffs mark the abrupt high-magnitude $\delta^{18}O$ increase at 2095 BCE, but not the event's first stage more than 100 y earlier. The Delingha record is also congruent with the Hulun Lake, eastern Mongolia plateau 4.2 ka BP abrupt desertification record and the north China EASM 4.2 ka BP event $\delta^{18}O$ record in the Dongshiya Cave speleothem (ref. 5 and Fig. 1*B*).

The KM-A speleothem record, an Indian summer monsoon record, is precisely congruent with the Katlekhor Cave and Gol-e Zard Cave speleothems, western Iran, that document the midlatitude westerlies' 4.2 ka BP event (ref. 6 and Fig. 1*C*). The KM-A record is also precisely congruent with the Mount Logan glacial record for displacement of the Pacific Kuroshio Current at 4.2 ka BP (ref. 7 and Fig. 1*D*).

In the eastern hemisphere, this 4.2 ka BP event record extends from Spain to China, from north to south Africa, to Australia, and to more than 50 subpolar North Atlantic proxies (8). In the western hemisphere, the record extends

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across North America from Wyoming to Massachusetts, down the west coast of South America to Patagonia and Antarctica, and along the Atlantic coast to Brazil (9).

The societal collapse records of adaptive regional abandonments and habitat tracking synchronous with the 4.2 ka BP megadroughts extend from Spain to Mesopotamia, the Nile River and the Indus Valley, and Tibetan Plateau and China. The latter include the flooding and megadrought Liangzhu abandonments in the lower Yangtse delta and the megadrought late Longshan Haidai abandonments in modern Shandong province (10). However, megadrought proxy transfer functions and high-resolution spatiotemporal quantification of regional settlement and abandonment remain desiderata for explaining the societal adaptations to the global 4.2 ka BP event.

1. B. Yang *et al.*, Long-term decrease in Asian monsoon rainfall and abrupt climate change events over the past 6,700 years. *Proc. Natl. Acad. Sci. U.S.A.* **118**, e2102007118 (2021).
2. B.-L. Li *et al.*, Stable isotopes reveal sources of precipitation in the Qinghai Lake Basin of the northeastern Tibetan Plateau. *Sci. Total Environ.* **527–528**, 26–37 (2015).
3. H. Zhang *et al.*, Hydroclimatic variations in southeastern China during the 4.2 ka event reflected by stalagmite records. *Clim. Past* **14**, 1805–1817 (2018).
4. M. Walker *et al.*, Subdividing the Holocene Series/Epoch: Formalization of stages/ages and subseries/subepochs, and designation of GSSPs and auxiliary stratotypes. *J. Quat. Sci.* **34**, 173–186 (2019).
5. N. Zhang *et al.*, Timing and duration of the East Asian summer monsoon maximum during the Holocene based on stalagmite data from North China. *Holocene* **28**, 1631–1641 (2018).
6. S. A. Carolin *et al.*, Precise timing of abrupt increase in dust activity in the Middle East coincident with 4.2 ka social change. *Proc. Natl. Acad. Sci. U.S.A.* **116**, 67–72 (2019).
7. D. Fisher *et al.*, The Mt Logan Holocene–late Wisconsinan isotope record: Tropical Pacific–Yukon connections. *Holocene* **18**, 667–677 (2008).
8. H. Weiss, The 4.2 ka BP event in the northern North Atlantic. *Clim. Past. Discuss.*, 10.5194/cp-2018-162-RC2 (2019).
9. G. Utida *et al.*, Climate changes in Northeastern Brazil from deglacial to Meghalayan periods and related environmental impacts. *Quat. Sci. Rev.* **250**, 106655 (2020).
10. J. An *et al.*, Understanding the collapse of the Longshan culture (4400-3800 BP) and the 4.2 ka event in the Haidai region of China – From an agricultural perspective. *Environ. Archaeol.*, 10.1080/14614103.2021.2003583 (2021).