Rainfall seasonality changes in northern India across the 4.2 ka event

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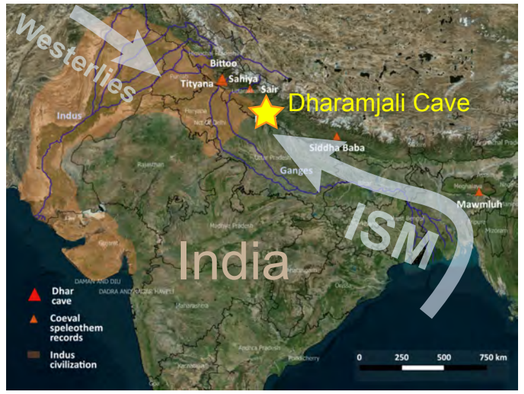


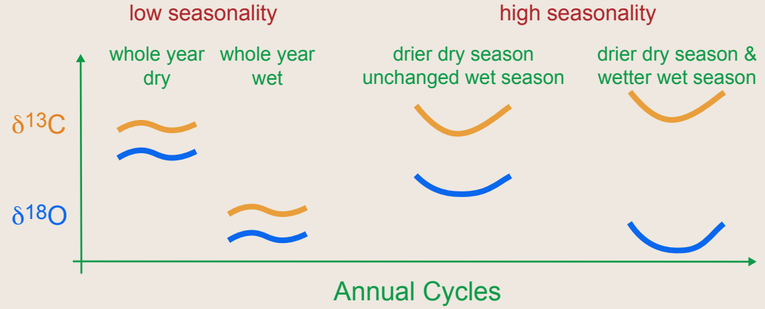
The **Indus Civilization** in (semi-)arid NW India has been studied since long [refs. 1-9] but remains puzzling, also due to lack of high resolution palaeoclimate records. Key research questions include:

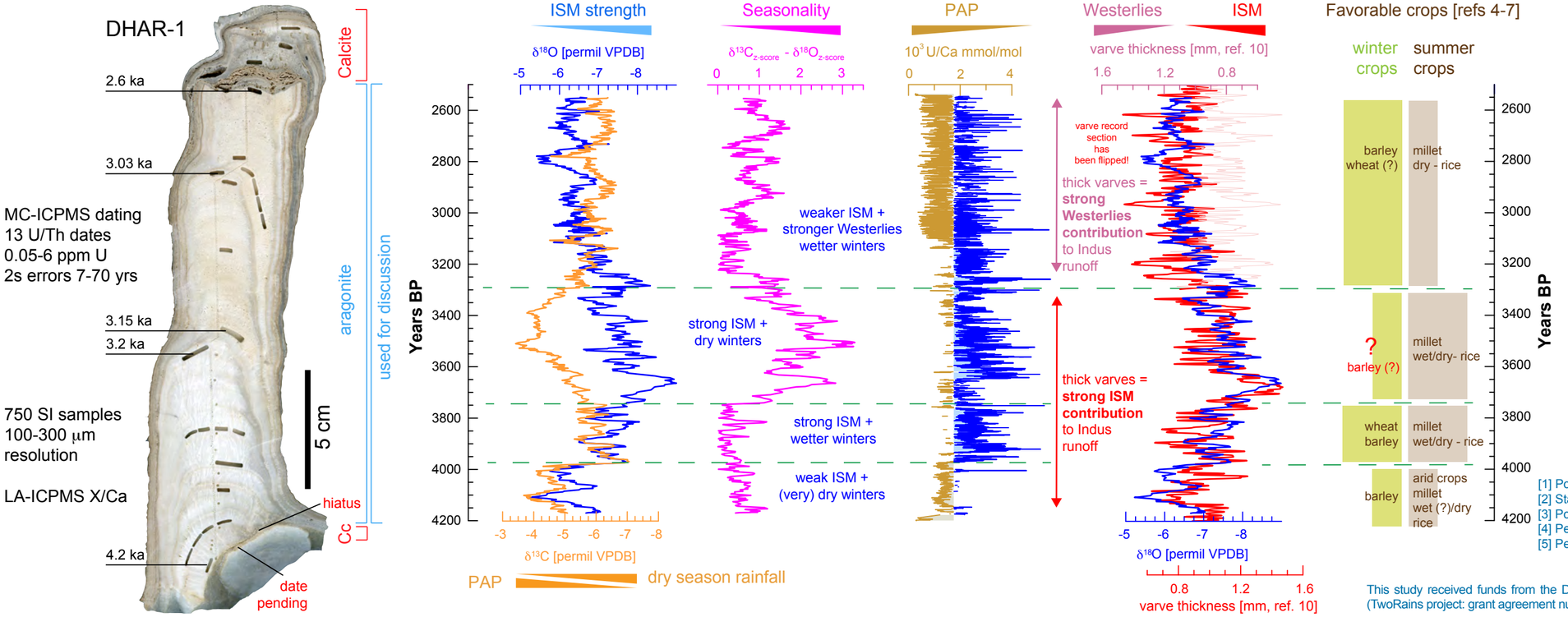
- **When and why did the Indus Civilization leave their cities to disperse across NW India?**
- **What was the role of climate change in that process?**
- **How did seasonality affect agricultural practices?**

Indian Summer Monsoon and Westerlies interaction leads to complex climatology. Seasonality (relative importance of ISM vs Westerlies precipitation) changed considerably. Stalagmite-based multi-proxy datasets help reconstructing changes in seasonality and the relative contribution of winter and summer rainfall.

A stalagmite from N India shows how ISM and Westerlies interacted, and how seasonality changed. Shifts in seasonal moisture supply might have impacted agricultural practices.

Possible expressions of rainfall seasonality & proxy response





Stalagmite DHAR-1 from NW India records ISM and Westerlies moisture supply between ca. 4.2 and 2.9 kyrs BP.

Multi-proxy data allow identification of changes in ISM versus Westerlies rainfall over NW India. ISM strength is indicated by $\delta^{18}O$, dry season dryness by $\delta^{13}C$ and U/Ca, and seasonality changes by the distance between $\delta^{18}O$ and $\delta^{13}C$ z-scores.

Times of correlation between $\delta^{13}C$ and $\delta^{18}O$ indicate the ISM regime with low seasonality, while anticorrelation or lack of same indicate increased seasonality (winter dryness).

Comparison with a marine Indus river runoff record suggests a shift from an ISM-dominated regime to a Westerlies-dominated one around 3.3 kyrs BP.

We hypothesise that changes in the relative importance of summer *vs.* winter rainfall could have influenced agricultural practices and crop selection.

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