

Optical stalagmite grey scale as a proxy of temperature from Central China

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With precise chronology and geochemical indicators, stalagmites could reveal climate changes on both short[1] and long time scales[2] and provide direct evidence for investigating climate driving mechanism. Some stalagmites with clear laminations could provide the precise details of the duration of abrupt climate events[3]. In addition to geochemical indicators, optical grey scale levels have been reported to be another useful proxy, which could reveal details of both local rainfall or temperature change[4-5]. Because of uncertainties this approach has not become as popular as other proxies.

A growing stalagmite, named as HS19-04, with clear annual growth bandings, collected in 2019 from Heshang Cave, located in the middle reaches of Yangtze River (30.44°N, 110.42°E), Central China, shows that the optical grey scale information has the potential to be an efficient climate indicator. Based on U-Th dating combined with layer counting, the chronology of HS19-04 has been precisely constructed, indicating this stalagmite was growing from 1650AD, with an average growth rate over 400 $\mu\text{m}/\text{yr}$. Using the image processing software 'Image-J', the layered structure of HS19-04 has been recorded and transformed into a scale of grey values (256 grey values, 0= black; 256= white). The comparison between the grey scale data and the instrumental annual mean temperature in Yichang shows that the dark layers of HS19-04 correspond to high temperatures. Based on the response, the local temperature variation from 1650AD has been reconstructed by the grey scale sequence of stalagmite HS19-04.

[1] Zhang et al. (2018) *Sci. Rep.* **8**, 12344. [2] Chen et al. (2016) *Science* **534**: 640-646. [3] Liu et al. (2013) *Nature Geosci.* **6**: 117-120. [4] Muangsong et al. (2011) *Science Asia*, **37**:262-267. [5] Niggemann et al. (2003) *Quaternary Sci. Rev.* **22**: 555-567.