Permafrost and decadal climate oscillations during Holocene peat accumulation on the Qinghai-Tibetan Plateau

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Peatland of the eastern Qinghai Tibetan plateau lies at the convergence of the East Asian and Indian monsoon systems. To understand the evolution of this peatland and its potential to provide new insights into the Holocene evolution of the East Asian monsoon a 6 m peat core was collected from the undisturbed central part of a peat deposit near Hongyuan. The age-depth profile of the recovered peat sequence covers the period from 9.6 to 0.3 kyr BP and is linear indicating that the conditions governing productivity and decay varied little over the Holocene. Using evidence of changes in carbon density, organic carbon content and its $\delta^{13}C$, cold dry periods of permafrost characterised by low density and impeded surface drainage were identified. The low $\delta^{18}O$ and δD values of the spring water emanating around the peat deposit, down to -13.8‰ and -102‰ (VSMOW) respectively, with an inverse relationship between electrical conductivity and isotopic composition indicate precipitation under colder and drier conditions relative to the present day. In view of the current annual mean air temperature of 1°C this suggests conditions in the past have been conducive to permafrost. Inferred periods of permafrost correspond to independently recognised cold periods in other Holocene records from across China at 8.6, 8.2 – 7.8, 5.6 – 4.2, 3.1 and 1.8 – 1.5 kyr BP. The transition to a cold dry climate appears to be more rapid than the subsequent recovery and cold dry periods at Hongyuan are of longer duration than equivalent cold dry periods over central and eastern China. Light-dark banding in the peat on a scale of 15 – 30 yrs from 9.6 – 5.5 kyr BP may indicate a strong influence of decadal oscillations possibly the Pacific Decadal Oscillation (PDO) and a potential link between near simultaneous climatic changes in the PDO, ENSO, movement of the ITCZ and the East Asian Monsoon.

Effect of original clay distribution in limestone on stylolite formation

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Stylolites are very common geological features, yet their formation is still not well understood. It is generally believed that they develop by the stress-driven pressure solution (PS) mechanism. In addition to the role of stress, field evidence suggests that clay minerals play a major role in PS in general, and in stylolite formation in particular [1]-[5]. We recently used a spring-network model [6][7] to show that PS alone is insufficient to form stylolites, and only when clays catalyse dissolution do stylolites grow by simultaneous elongation and thickening.

The present work combines field-work and modeling to address the question: "How and where do stylolites form in limestone and what governs their lateral extent?". We identify two basic groups of stylolites in the field: (1) very long stylolites (10^2 - 10^3 m), which form on pre-existing clay layers. (2) Shorter stylolites (10^{-2} - 10^0 m) which appear as an inter-connected network of stylolites and fractures.

We use our model [6][7] to investigate which stylolite type will form as a function of the initial clay distribution in the host rock. The role of stress, as well as the strain-compensating role of fractures, in the evolution of each end-member is different, as is demonstrated by our findings.

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