Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.11661

A new palynological approach to reconstruct palaeoelevation: Vertical Space Coexistence Approach

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The surface elevation history of the Tibetan Plateau (TP) is crucial for understanding the climate-biology evolution. However, paleoelevation records have been hotly debated. Here we try to reconstruct the paleoelevation of the northern TP using pollen records from three sites of the Qaidam Basin deposited during 18-14 Ma (mid-Miocene), via a newly-developed Vertical Space Coexistence Approach (VSCA). The VSCA includes considerations on temperature gradients and lapse rates when identifying altitudinal ranges of NLRs identified for a fossil flora. According to the VSCA, the palaeoelevation of the Qaidam Basin was lower than ~1,480±470 m asl with surrounding mountains higher than ~2,480±470 m asl. In contrast to previous reconstruction attemps using a “modified” Coexistence Approach, the VSCA can refine the paleoelevations of the basin and mountains, and indicates that a high-relief northern TP has been basically in existence in the mid-Miocene, with an overall lower altitude by about 1,000 m, compared to the present-day. This case study indicates that the VSCA method is a promising tool in reconstructing the paleoelevation.

We approach the paleoelevation reconstruction with VSCA in five steps. Step I. Considering pollen assemblages to represent the scenario of modern flora, giving its geographic location and vertical characteristics, e.g., longitude and latitude, elevation ranges of vegetation units. Step II. Obtaining elevation ranges of genera and families through compiling the altitudinal information available for the individual species. Step III. Identification of corrected modern elevation caused by latitude difference between the modern calibration site employed in Step II and latitudinal position of the fossil site for which an altitudinal reconstruction is intended. Step IV. Given the temperature difference between paleo- and modern temperatures of a site near sea-level, at a comparable latitude, paleo-temperature lapse rate (from modeling), the paleoelevation is obtained. Step V. After obtaining paleoelevation intervals of all genera or families, the maximum paleoelevation of the basin is identified as the high limit of the taxon having the lowest maximum palaeoelevation in the record. The minimum paleoelevation of the surrounding mountains is defined as the low limit of the taxon having the highest minimum Paleoelevation