



Stepwise expansion of desert environment across northern China in the past 3.5 Ma and implications for monsoon evolution

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A systematic study of the last glacial cycle along three transects across the Chinese Loess Plateau shows that sand-sized particle content within loess decreases rapidly from north to south, and that markedly high sand particle contents in loess horizons occur only in the northern part of the Plateau. This suggests that variation in the sand-sized particle fraction within loess near the desert margin is closely linked to migration of the southern desert border in northern China where sand grains move mainly in saltation or modified saltation mode near the ground surface. As desert margin shift is essentially controlled by the amount of monsoon precipitation, the sand-sized particle content within loess is regarded as a new and readily-applied proxy for variations in the strength of the East-Asian summer monsoon. A continuous record of sand content in loess along the loess-desert transitional zone shows that the Mu Us Desert migrated southward at 2.6, 1.2, 0.7 and 0.2 Ma, suggesting a stepwise weakening of the East-Asian summer monsoon during the past 3.5 Ma. This evolutionary pattern is significantly different from that previously inferred from loess magnetic susceptibility records, a widely-used monsoon proxy. Our results further suggest that changes in global ice volume may have been an essential factor in controlling Plio-Pleistocene monsoon evolution, and that the anticipated future melting of polar ice cover may lead to a northward migration of the monsoon rainfall belt in northern China.