Variations in Re-Os isotopic composition of loess-paleosol sequences from the Yili Basin, NW China

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Continental loess-paleosol sequences preserve as many records of past climate change as marine sediments and polar ice cores. Over the past decades, significant progress has been made in loess-paleosol studies of the monsoon region of China, such as the Loess Plateau, as this region has the most extensive loess deposits (e.g., Fang et al., 1999; Gallet et al., 1996). Extensive loess deposits are also distributed in areas where the modern climate is controlled by a westerly wind system, such as in NW China and Central Asia. The climate in this region differs from the climate in the monsoon region. A correlation between the monsoon region and the westerly wind system region loess-paleosol records would be invaluable for understanding the forcing mechanisms for long-term hemispheric or global climatic evolution. However, loess-paleosol studies in NW China and Central Asia have rarely been conducted.

Over the past decades, many proxy indices, including magnetic, geochemical, biological and sedimentological indices, have been used to characterize paleo-climatic changes in Chinese loess-paleosol sequences, particularly at the Loess Plateau (e.g., Gu et al., 1996; Guo et al., 2002; Heller et al., 1986; Vandenberghe et al., 1997). However, as mentioned by Jahn et al. (2001), few of the indices are of clear and well-accepted climatic significance. The Re-Os isotope system is a potentially powerful tool for obtaining information on sources and transportation process of clastic sediments such as loess, because Re and Os are drastically fractionated during various geological process. However, due to extremely low Os concentrations (less than several tens pg/g), Os isotopic studies of sialic crustal materials are very scarce, except for a few successful studies (Esser and Turekian, 1993; Peucker-Ehrenbrink and Jahn, 2001; Hattori et al., 2003), and more Re-Os isotopic data need to be gathered. Here, we present the Re-Os isotopic data for loess-paleosols from the Zeketai and Kuerdenengbulake sequences in the Yili Basin, NW China.

Depth profiles of the Re-Os isotopic data fluctuate with a distinct periodicity. In the Malan Loess, deposited during Late Pleistocene times, depth profiles of 187Os/188Os ratios (0.904-1.449) are complementary to those of Os abundances (28-61pg/g). These data also form a positive linear array between end-members biotite, with a relatively low Os content and radiogenic 187Os/188Os (187Os/188Os =13.6, Os=3.31pg/g; Peucker-Ehrenbrink and Blum, 1998), and a less radiogenic component. This suggests that the variation in the ratio of biotite to the presumed less radiogenic component contributes significantly to the Os isotopic composition of the Malan Loess, and is most likely caused by wind deposition or erosion because the climate during Late Pleistocene times in the Yili Basin was probably under dry condition (Ye, 2001). The Re-Os isotopic systematics of the Malan Loess, therefore record fluctuations in the intensity of the regional paleo-winds at the Yili Basin. By contrast, for the Middle Pleistocene Lishi Loess, Os abundance fluctuations (25-50pg/g) are accompanied by little variation in 187Os/188Os ratio (mainly 1.206-1.400), and were more likely caused by Os enrichment in pedogenically formed magnetic minerals during paleosol development in wet periods. The Re-Os isotopic signature of loess-paleosols may therefore, provide a valuable new index for paleo-climate fluctuations under both dry and wet conditions. In addition, Re-Os isotopic data for the Yili loess-paleosols are compared with previously reported loess-paleosol data from Loess Plateau (Re =94-617pg/g; Os=22-40pg/g; 187Os/188Os=0.875-1.209). The Re-Os isotopic compositions of these loess-paleosols possess a regional variation, similar to the Sm-Nd isotopic system (Honda et al., submitted), suggesting that Re-Os isotopic composition could also be useful for tracing long-range transported aeolian dust.