Dissolution of loess-paleosol samples in 3M HCl at 80℃, and its paleo-climatic implication

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Chinese Loess Plateau is mantled by thick deposit of eolian dust inferred as loess-paleosol sequence. Loess is the weakly weathered deposit formed during glacial period, while paleosol have undergone strong pedogenesis process under warm-wet interglacial climate. Alternation of loess and paleosol in the sequence corresponds to the cyclic climate of the past. In this work, samples of a loess-paleosol section which covers last glacial-interglacial period were collected, and the depletions of minerals were substituted by the depletions of elements, e.g. Mg and Ca, relative to Al. All authigenic matters were removed by 30% H_2O_2 and 0.5 mol/L HOAc leaching and CBD treatment.

Dissolution experiment of a pretreated loess sample in 3mol/L HCl at 80□ shows that the Mg, Ca and Al released by the acid increase with time, but the increase rate decrease rapidly. Small amounts of elements can be released after 4 hours, and the elemental ratio remain constant after 3 to 4 hours. Detail analysis on the released Na, K and P together with the XRD pattern of solid sample before and after dissolution show that the unstable minerals, including apatite, biotite, chlorite, vermiculite and smectite, are totally dissolved, and the stable minerals such as quartz and feldspar are nearly unaffected. In natural weathering process, Mg and Ca are readily released from these unstable minerals while Al is precipitated in secondary minerals such as vermiculite and smectite, which can also be dissolved in strong acid. Thus, depletions of Mg and Ca bearing minerals can be determined by depletions of Mg and Ca to the stable tracer Al. Mg/Al and Ca/Al ratios can serves as weathering intensity index.

Based on the above method, samples of loess-paleosol were pretreated and dissolved in 3mol/L HCl 4 hours at 80℃. All elemental concentrations released by HCl were measured on an ICP-AES, with error about 2% for elemental concentrations and 0.5% for elemental ratios.

The sampled loess-paleosol section, which covers last 130 Kyr, can be divided into four downward sub-layers, S_0, L_1, S_1 and L_2. The weak weathering of loess samples (L_1, L_2) is illustrated by high Mg/Al and Ca/Al ratios, while the strong weathered paleosol samples (S_0, S_1) are characterized by low Mg/Al and Ca/Al ratios. The variations of weathering intensity, especially Mg/Al ratios, show strong linkage to solar isolation, since both of them have strong precession cycle of about 23 Kyr. Intense weathering was always accomplished by the maximum of solar isolation. We interpret this may be caused by the orbital variations of East Asian summer monsoon.