**Table S1.** The uranium isotope ratios of sediments on river terraces

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sample No.# | Latitude (N) | Longitude (E) | Age (Ma) | (234U/238U) | 2SE\* |
| LST44 | -29.5960 | 28.7134 | >1 | 0.896 | 0.001 |
| LST62 | -29.0198 | 28.5485 | >1 | 0.897 | 0.001 |
| DL19S-14-2 | 26.2262 | 100.5078 | 1.07 | 0.900 | 0.001 |
| DL19S-14 | 26.2270 | 100.5074 | 1.07 | 0.901 | 0.001 |
| DL19S-12-2 | 26.2340 | 100.5051 | 1.5 | 0.903 | 0.001 |
| DL19S-12 | 26.2340 | 100.5051 | 1.5 | 0.902 | 0.001 |
| DL19S-13 | 26.2328 | 100.5056 | 1.5 | 0.916 | 0.001 |
| DL19S-13-2 | 26.2328 | 100.5056 | 1.5 | 0.909 | 0.001 |

# Sample labeled by LST is from upper reaches of Orange River in Lesotho, and samples labeled by DL is from upper reaches of Yangtze River near Dali, China;

\* 2SE is the analytical error given by MC-ICP-MS. The external error of the whole analytical procedure is ± 0.004.

**Table S2.** The uranium isotope ratio and chemical weathering proxies of topsoil developed on moraine as well as river sediments in the present-day glacial outlet.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Name | Latitude (N) | Longitude (E) | Type | Moraine age (Ka) | (234U/238U) | 2SE\* | CIA# | [Ca/Al]  mol/mol | CDF# | Reference for the moraine age |
| GZ19B-26 | 29.5716 | 102.0000 | topsoil | 0.34 | 1.003 | 0.001 | 36.4 | 0.58 | 0.33 | Owen et al. (2005) |
| GZ19B-22 | 29.5769 | 102.0032 | topsoil | 0.755 | 0.997 | 0.001 | 40.2 | 0.41 | 0.53 | Owen et al. (2005) |
| GZ19B-19 | 29.6876 | 102.0766 | topsoil | 4.645 | 1.007 | 0.001 | 62.4 | 0.06 | 0.93 | Owen et al. (2005) |
| GZ19B-20 | 29.6115 | 102.1047 | topsoil | 7.98 | 1.006 | 0.001 | 49.6 | 0.28 | 0.68 | Owen et al. (2005) |
| GZ19B-20-2 | 29.6115 | 102.1047 | topsoil | 7.98 | 1.004 | 0.001 | 55.2 | 0.21 | 0.75 | Owen et al. (2005) |
| **Average** |  |  |  |  | **1.003** |  |  |  |  |  |
| **2SE** |  |  |  |  | **0.004** |  |  |  |  |  |
| GZ19B-18 | 29.7314 | 102.0675 | topsoil | 53.6 | 1.002 | 0.001 | 53.0 | 0.09 | 0.90 | Wang et al. (2013) |
| GZ19B-18-2 | 29.7314 | 102.0675 | topsoil | 53.6 | 0.986 | 0.001 | 58.2 | 0.14 | 0.83 | Wang et al. (2013) |
| GZ19B-11 | 29.8966 | 102.0136 | topsoil | 94.5 | 0.988 | 0.001 | 67.8 | 0.07 | 0.92 | Wang et al. (2013) |
| GZ19B-14 | 29.8862 | 102.0180 | topsoil | 137.7 | 0.998 | 0.001 | 72.8 | 0.05 | 0.94 | Wang et al. (2013) |
| GZ19B-13 | 29.8885 | 102.0176 | topsoil | 149.85 | 0.991 | 0.001 | 54.9 | 0.15 | 0.83 | Wang et al. (2013) |
| **Average** |  |  |  |  | **0.993** |  |  |  |  |  |
| **2SE** |  |  |  |  | **0.006** |  |  |  |  |  |
| GZ19H-25 | 29.5669 | 101.9901 | sediment | / | 1.004 | 0.001 | 29.2 | 0.92 | / | / |
| GZ19H-28 | 29.5497 | 101.9717 | sediment | / | 1.007 | 0.001 | 29.1 | 0.99 | / | / |
| GZ19H-29 | 29.5501 | 101.9705 | sediment | / | 1.014 | 0.001 | 32.1 | 0.68 | / | / |
| **Average of river sediments** | | | |  | **1.008** |  | **30.1** | **0.86** |  |  |
| **2SE** | | | |  | **0.006** |  | **2.0** | **0.19** |  |  |

\* 2SE is the analytical error given by MC-ICP-MS. The external error of the whole analytical procedure is ± 0.004;

**#**CIA is the chemical index of alteration; CDF is chemical depletion of Ca relative to Al.