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Uplift history of the Kunlun Mountains based on provenance of coarse fraction of fluvial sediment since 8Ma

Akinori Karasuda[1*], Ryuji Tada[1], Zheng Hongbo[2], Shin Toyoda[3], Hitoshi Hasegawa[4], Yuko Isozaki[1], Tomohiro Yoshida[1]

[1]The University of Tokyo, [2]Nanjing Normal University, [3]Okayama University of Science, [4]The Nagoya University Museum

Tarim Basin is located to the north of Tibetan Plateau. At present, Tarim Basin is characterized with very dry climate and the Taklimakan desert is located in the central part of the basin. In previous studies, the desertification of Tarim basin is interpreted as having been triggered by the uplift of Tibetan Plateau (e.g. Zheng et al., 2000, DH Sun et al., 2011). However, the linkage between the two has not yet been proved. The major reason is the difficulty in constraining the timing of the tectonic activity relative to the onset of desertification.

In this study, we tried to extract the tectonic information from the fluvial sequence, which is well dated by magnetostratigraphy. To extract the tectonic information, we conducted the provenance study of quartz, which is common mineral and resistant to weathering, in the coarse fraction of the fluvial sediments.

For the provenance study of quartz, we used Electron Spin Resonance (ESR) signal intensity of quartz and crystallinity index (CI) of quartz. ESR signal intensity of quartz reflects the age of mother rock (Toyoda and Naruse, 2002), whereas CI of quartz reflects physical condition of its formation such as temperature and rate of crystallization (Murata and Norman, 1976). In her study of modern river sediments in the Tarim basin, Isozaki (2009 MS) suggested that quartz in coarse fraction (>63um) of river sediments reflects bedrock geology of the catchment area based on ESR signal intensity and CI of quartz.

We applied this method to the fluvial sequence. Firstly, we identify the provenance changes of river sediments using ESR signal intensity and CI. Second, we interpret the provenance change as the change of mother rocks exposed in the catchment area by comparing the river sediments ESR and CI data with those of pebbles contained in intercalated conglomerates. Finally, we reconstruct tectonic uplift history from the change of mother rocks exposed in the catchment area.

We conducted field survey at Yecheng section in the southwestern Tarim Basin. Fulvial to alluvial deposits with occasional intercalations of eolian sediments deposited between 7.6Ma to 1.8 Ma are continuously explosed along the Yecheng section (Zheng et al., 2010; Tada et al., 2010). We sampled 27 river sediments (9 sandstones and 18 conglomerate matrix) and 21 clasts in conglomerates in 63-500um fraction to measure ESR signal intensity and CI of quartz.

The result revealed three rapid increase of ESR signal intensity at 6.6Ma, 5.2Ma, and 4.0Ma, and rapid increase and decrease at 3.5Ma and 3.0Ma. Comparison with conglomerate clasts data suggests the provenance change during 7.6Ma to 3.5Ma can be explained by the exposure of Mesozoic and Paleozoic sandstones, which was caused by the uplift of leading edge of the Kunlun mountains. The provenance change between 3.5Ma to 3.0Ma can be explained by the exposure of weakly metamorphic rocks, which was caused by the rapid uplift of leading edge of the Kunlun mountains. The provenance change after 3.0Ma can be explained by the exposure of gneiss and granite, which was caused by the further uplift of leading edge of the Kunlun mountains.

In summary, the provenance changes at the Yecheng section are affected by the uplift history of leading edge of Kunlun mountains since 8Ma. Comparison with previous data about onset of desertification in Tarim Basin suggests that the uplift activity including the leading edge of the Kunlun mountains could affect the eolian dust and desert formation in the Tarim Basin after 8Ma.

Keywords: Tarim Basin, Uplift, Provenance study, Quartz, Desertification