

Quartz OSL dating of deep marine sediment: how accurate and how far back?

A case study from the Sea of Japan

*Saiko Sugisaki¹, Andrew Murray², Jan-Pieter Buylaert^{2,3}, Ryuji Tada⁴, Yasufumi Satoguchi⁶, Yoshitaka Nagahashi⁵, Ken Ikehara¹, Tomohisa Irino⁷, Richard W. Murray⁸, Carlos A. Alvarez-Zarikian⁹

1. Geological Survey of Japan, AIST, 2. Aarhus University, 3. Technical University of Denmark, 4. The University of Tokyo, 5. Fukushima University, 6. Lake Biwa Museum, 7. Hokkaido University, 8. Boston University, 9. Texas A&M University

Quaternary hemi-pelagic sediments in the Japan Sea record millennial and orbital scale changes in the East Asian Monsoon as alternations of dark and light layers. To explore the development and evolution of monsoonal patterns and their relationship to past changes in the Japan Sea, cores were drilled at Sites U1424 and U1425 during the IODP Expedition 346. Based on the data from Site U1424, a sediment age model was constructed using tephro-stratigraphy, and magneto-stratigraphy and the sediment colour profile tuned to the $d^{18}O$ profiles of both LR04 and Chinese stalagmite (Lisieki and Raymo, 2005, Cheng et al., 2016). The tuned age model for Site U1424 over the last 640 ka is consistent with that from LR04 within its age uncertainty of <5 ka (Tada et al., 2017).

In this study, we have used OSL dating of fine-grained detrital quartz (of aeolian origin) to provide high-resolution numerical age models for the late Quaternary in the cores from Sites U1424 (hole U1424C) and U1425 (hole U1425C). The objectives of this study are 1) test the quartz fine-grained OSL dating limitation, 2) test the reliability of the OSL ages by comparison with tephro-stratigraphy and the orbitally-tuned age model.

The dose recovery ratio is 0.95 ± 0.01 ($n=178$) for samples from core U1425C and 0.913 ± 0.01 ($n=248$) for U1424C for a $180^\circ\text{C}/10\text{s}$ preheat and 140°C cut-heat. Dose rates were determined using high resolution gamma spectrometry, and vary considerably, from 1.04 to 4.19 Gy/ka. The equivalent dose from both cores increases with depth, up to 700 Gy. However, the OSL ages appear to underestimate from ~ 150 ka, with saturation at ~ 250 -300 ka. This underestimation may be related to systematic underestimation of field water content (and so overestimation of dose rate) at depth. The ages indicate a more or less constant sedimentation rate back to ~ 120 ka for U1424C. This is in contrast to core U1425C which shows a pronounced change in sedimentation rate at ~ 120 ka and ~ 40 ka for U1425C. The OSL ages are in good agreement with Toya, Aso-4, Aira-Tn tephra at 112, 87 and 30 ka, and with the orbitally-tuned age model, for the U1424C. However there are discrepancies during MIS 4/3 and 2/1 in U1425C, where the OSL ages suggest increased sedimentation rates; these are not present in the orbitally-tuned age model. Given the good agreement between the two approaches in U1424C, where the sedimentation rate appears to be relatively constant, there seems no reason to doubt the reliability of the more direct OSL data in U1425C.

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