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Reconciling late Quaternary transgressions in the Bohai Sea, China to the global sea level changes, and new linkage of sedimentary records to three astronomical rhythms

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The Bohai Sea in China was formed by subsidence during the Cenozoic. Some 2000-3000 m of fluvial, lacustrine and marine sediments has been deposited in the basin (IOCAS 1985), and these sediments have great potentials in high-/low-latitude interaction, environmental impacts on ancient human activities, and other important issues (Liu, 2009; Yi et al. 2012a), because it is influenced by the Siberian–Mongolian Highs and the ITCZ, and is close to the Nihewan basin and the Zhoukoudian site which are both world-renowned for the discovery of Homo erectus.
Since the 1970s, hundreds of studies have been conducted around the Bohai Sea and the major results could be summarized as follows (Zhao et al., 1978; IOCAS, 1985; Liu, 2009, and references therein): (1) constrained by radiocarbon dating, TL/OSL or geomagnetic excursion, three transgressions (T1, T2, T3) developed during the Holocene, marine isotopic stage (MIS) 3 and MIS 5, respectively; and (2) regressions occurred at the beginning of glacial stages, i.e. MIS2 and MIS4. However, apparent inconsistency could be found between T2 and T3, and the question is that in the context that MIS 3 is an inter-stadial stage with a global sea level of 60∼80 m lower than the present (Chappell et al. 1996), how did T2 occur in the Bohai Sea, and why did T2 have much larger influence than T3 which occurred at the beginning of MIS 5?
To correlate regional environmental changes with global pattern and thus to detect the potential interaction between various driving factors on orbital timescales, three cores with a high recovery rate were drilled in the south Bohai Sea. This study was conducted following three perspectives: chronology (Yi et al. 2012b), sea-level change (Yi et al. 2012c) and paleoclimatology (Yi et al. 2012a), and the main results are as follows:
1. Chronology. Luminescence and radiocarbon dating methods were applied in dating these coastal/marine sediments: (1) For Holocene samples, most of the radiocarbon dates agree well with OSL ages. (2) For pre-Holocene samples, radiocarbon dates cluster at 40-50 14C ka BP, whereas OSL ages are in stratigraphic order from 11 to 176 ka. Because the self-consistency of the quartz OSL ages and the stratigraphic agreement in the three cores, we suggested that the quartz OSL ages are more reliable with respect to date the samples from the south Bohai Sea. (3) The three marine stratums identified in the south Bohai Sea are likely to be formed during the Holocene, MIS 3-5, and MIS 6-7, respectively.
2. Sea-level change. Because of uncertainties in regionally tectonic activities and insufficient fossils deposited in the sediment, the methods develop for sea-level studies, i.e. the exploitation of dated geomorphologic features and the biologically based sea-level transfer functions, can not be applied in this area. Thus, we first develop a proxy from sediment grain-size analysis with clear indicative meaning, and then quantitatively reconstruct sea-level variation for the south Bohai Sea. The reconstruction indicates that relative sea-level changes in the study area track global sea-level variation, and also indicate substantial regression from 70 to 30 ka, and potentially subarial exposure from 38 to 20 ka. Our results document the feasibility of reconstructing relative sea-level change by numerical partitioning of sediment grain size data, demonstrating the potential for future applications.
3. Paleoclimatology. Three proxy indices were employed, i.e. grain size, magnetic susceptibility and tree-pollen abundance, to infer paleoenviromental changes. When placed on the calibrated radiocarbon and OSL based age model, bulk sediment variations in grain size demonstrated potential modulation in response to the Asian monsoon intensity (Wang et al., 2001, 2008; Cheng et al., 2009), and thus we refined the chronology through astronomically tuning it to the July insolation at 65°N synchronously, in accordance with the method of Ding et al. (1994). The most noticeable feature of these coastal sediment variations is the little internal similarity between records compared with high similarity with external forcing indicating that the coastal sediments in the south Bohai Sea integrate different influences from various environmental factors: (1) the grain-size variation represents Asian monsoon intensity which was dominated by both solar insolation (major) and global ice volume (minor) forcing; (2) the magnetic susceptibility indicates river incision processes which were sensitive to orbital tilt with influence

from solar insolation; (3) the vegetation coverage responded to global ice volume coupled obliquity changes; and that (4) neither external nor internal factors could dominate the paleoenvironmental evolution on orbital timescales in an independent way, and they are both integrated in a complex pattern.

Therefore, combining all of these results, we report those great similarities between regional and global sea-level patterns and the nonlinear interaction and the complex response to driving processes in a coastal evolution.

However, all of these studies only used the upper part of cores within marine strata, and the rest containing lacustrine sediment is still in process. Sediment grain size, magnetic susceptibility, color reflectance were finished, and the magnetostratigraphic, environmental magnetism and element analysis are ongoing. More results about high-/low-latitude interaction and relative sea level will be released in three years, and anyone who has interests in cooperation will be welcome (Email: yi.liang82@gmail.com).

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