

Scientific Drilling of the Terrestrial Cretaceous Songliao Basin

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Investigations of critical climate changes during the Cretaceous have the potential to enhance our understanding of modern global warming because the extreme variances are the best-known and most recent example of a greenhouse Earth (Bice et al., 2006). Marine Cretaceous climate archives are relatively well explored by scientific ocean drilling programs such as the Integrated Ocean Drilling Program (IODP) and its predecessors. However, Cretaceous terrestrial climate records are at best fragmentary (Heimhofer et al., 2005). The long-lived Cretaceous Songliao Basin of NE China is an excellent candidate to fill this gap and provide important ocean-continent linkages in relation to environmental change (Fig. 1). This basin, located within one of the largest Cretaceous landmasses (Scotese, 1988), acted for about 100 million years as an intra-continental sediment trap; the present-day area of the basin is about 260,000 km². It provides an almost complete terrestrial sedimentary record from the Upper Jurassic to the Paleocene (Chen and Chang, 1994). Large-scale geological and geophysical investigations of lacustrine sediments and basin structures demonstrate that a rich archive of Cretaceous paleoclimate proxies exists. For example, the basin includes the Jehol Biota, a terrestrial response to the Cretaceous oceanic anoxic events (OAEs),

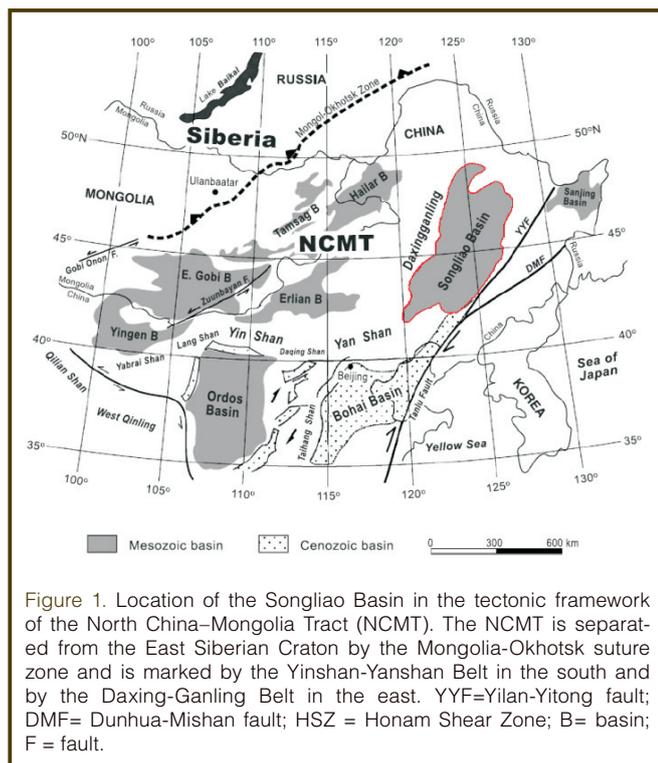
and a potential K/T boundary (Qiang et al., 1998). An ongoing drilling program is supported by the Ministry of Science and Technology of China and by the Daqing Oilfield. It allowed for recovering of nearly complete cores from Upper Albian to the Uppermost Cretaceous in two boreholes (SK-I, SK II; commenced in 2006, Fig. 1). However, the older Cretaceous sedimentary record of Songliao Basin has not yet been cored. For that reason, a scientific drilling program has been proposed to the International Continental Scientific Drilling Program (ICDP) to sample the deeper sedimentary record of the Songliao Basin through a new drill hole (Figs. 1 and 2).

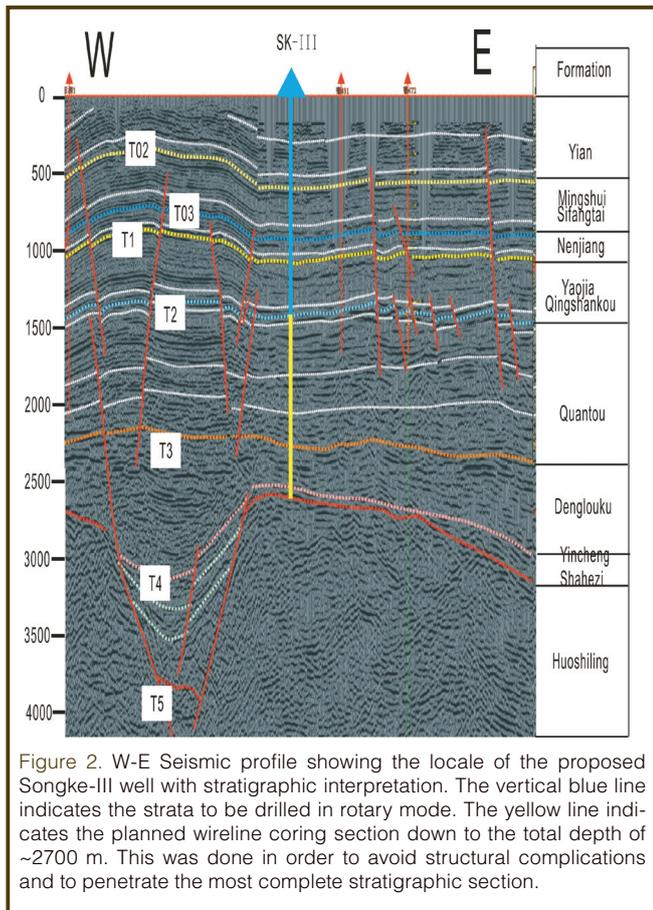
In order to better constrain the scientific objectives, feasibility of deep drilling, and study of the core material, an ICDP workshop on “Deep Terrestrial Scientific Drilling Project of Cretaceous Songliao Basin” was held on 28–30 August 2007 in Daqing, China. The workshop was organized by the China University of Geosciences at Beijing and by the Daqing Oilfield and was jointly supported by the ICDP and sponsors from China: the Department of International Cooperation and Technology, Ministry of Land and Resources, China; Department of Basic Research, Ministry of Science and Technology, China (MOST); Department of Earth Science, National Natural Science Foundation of China (NSFC); and China Geological Survey.

About seventy participants (thirty-one from outside China) from eleven countries took part in the workshop. Three sessions were organized with more than fifty talks to meet the objectives of the workshop including “Evolution of Songliao Basin and East Asia, and Terrestrial Scientific Drilling Program”, “Terrestrial Environment Change and Paleontological Response to Cretaceous Global Change” and “Cretaceous Paleoceanography”.

During the workshop the following five key scientific goals for the project were defined:

- Improve understanding of the geodynamics of deep Earth, in particular the relation between the Cretaceous Super-Chron and Large Igneous Provinces;
- Quantify the biotic response to terrestrial environmental change and the deep biosphere (fossil DNA);
- Refine stratigraphic boundaries to improve the correlation between marine and terrestrial stratigraphy;
- Determine the terrestrial response to OAEs; and





- Investigate the formation of mass terrestrial hydrocarbon source rock.

In order to address these overarching research goals, workshop participants recommended that all boreholes (SK-I, SK-II, and the planned SK-III) should be incorporated into the planned ICDP project. The Upper Cretaceous core from SK-1 will especially serve to focus on the K/T boundary; SK-II cores will be analyzed to investigate mid-Cretaceous events; and samples from the proposed SK-III well will focus on the Lower Cretaceous including the J/K boundary, OAEs, and the evolution of the Jehol Biota. Preliminary results from existing boreholes and outcrop studies presented at the workshop showed great promise. During a field trip to the core curation facility of the Daqing Oilfield Company, the workshop participants were able to examine the cores of the SK-I and SK-II wells.

An important objective was to assess the feasibility of the deep drill hole (SK-III) in the Songliao Basin and its potential to recover strata older than Albian. Discussions of site selection concluded that the project should aim to core from the Albian Quantou to the Upper Jurassic Huoshiling Formations. Several site selection principles for drilling SK-III were defined as follows: to drill the most complete section, to find the least thickness of the overlying strata, and to preferentially drill fine-grained, clay-rich deposits. With these principles in mind, existing data were evaluated for

identification of an optimum drilling location. The existing data base comprises, for example, over 250,000 km of seismic reflection profiles, some 3-D seismic reflection volumes, and about 50,000 wells (without coring). A preliminary site for SK-III has been selected in the center part of the basin (Fig. 2).

Finally, meeting participants agreed to form five strategic teams covering the objectives as outlined above. The goals of this science team are to compose a full drilling proposal and to submit it to ICDP and other potential funding agencies in early 2008.

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