2018 Report from the Chinese Working Group of IGCP 608

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IGCP 608 “Cretaceous ecosystems and their responses to paleoenvironmental changes in South to East Asia and the Western Pacific” was issued and supported by IGCP on 11 March 2013. In this project, the spatial-temporal paleoenvironmental and paleoecosystem changes during the Cretaceous in the South to East Asia and Western Pacific region will be delineated on the basis of paleoproxy data and a diversified fossil record from wider areas and different locations. Participating countries include China, India, Iran, Japan, Korea, Japan, Korea, Malaysia, Mongolia, Myanmar, Pakistan, Philippines, Russia, Thailand, Vietnam, Australia, France, New Zealand, Romania, Spain, Switzerland, United Kingdom and U.S.A. Estimated duration of the project is five years (2013-2017).

The Cretaceous “greenhouse” period is known for elevated atmospheric CO₂ levels and much higher global sea levels than today. The Cretaceous period is thus an ideal study-object for the unraveling and understanding the development of ecosystems due to modern and future climatic changes. A great variety of well-preserved environments and ecosystems of the past can be found in the Cretaceous geological records of Asia and the Western Pacific rim. The proposed projects’ aim is to delineate such Cretaceous ecosystems and how they responded to the paleo-environmental changes that affected the South-East Asian and adjacent Western Pacific region. The project comprises two groups of major topics to be discussed over five years: 1) Variations of Cretaceous terrestrial and marine environments in Asia and the Western Pacific. The terrestrial strata widely distributed in South and East Asia yield abundant biotic and lithological indicators essential for deciphering how the ecosystems, under which life developed, were affected by paleoclimatic and paleoenvironmental changes. It is thus expected to obtain important results such as the establishment of close links between atmospheric CO₂ levels, global temperature and precipitation, climatic zonation patterns, paleo-weathering conditions and orbital-scale paleoclimatic fluctuations. Marine sediment records in the Western Pacific rim and Eastern Tethys region provide several significant information on the Cretaceous marine paleoenvironmental changes. 2) Evolution of Cretaceous terrestrial and marine ecosystems in Asia and the Western Pacific. A diversified fossil record witnesses terrestrial and marine ecosystems in Paleo-Asia and the Pacific. This project will plot the paleobiogeographic distribution of life on the largest continent and in the ocean, correlating the several faunas and floras in time and space. Further investigation will be carried out on the structures and processes of evolution for terrestrial and marine ecosystems, and such important topics as faunal and floral diversity and their turnover, patterns of extinctions and subsequent recoveries discussing will be discussed. This project has an important role in promoting communication at the level of geoscience among the various Asian countries. The results of this project will increase and enhance our knowledge and understanding of present and future climatic changes using past global warming and the effects on the ecosystem as an example. Our results are expected also to promote scientific interest and public awareness in the dynamic ecosystems of the Cretaceous Earth as the past analogy of modern greenhouse Earth.

In 2018, the China working group of IGCP 608 mainly carried out field investigations on Cretaceous-Paleogene in southern Tibet, Tarim, Songliao Basin, Guangxi and Hunan. Some of the work extended to Jurassic and Quaternary paleoclimatic related fields. The research covered marine (southern Tibet and Tarim) and non-marine (Songliao, south China). The Cretaceous-Paleogene stratigraphic sequence, paleontology, paleoclimate and biological evolution are the basis for discussing the climate change laws during this period. We have made a comparative study of marine and continental sedimentary records. In marine, our field survey focuses on Yuandong, Gyangzi and Gamba, Zedang, Tingri and Saga in Tibet and as well as in Tarim Basin, Xinjiang. Seven Cretaceous-Paleogene stratigraphic and palaeontological profiles have been newly surveyed this year, and abundant microfossils (including radiolarians, foraminifera, ostracods, microgastropods, etc.), large fossils (such as gastropods, bivalves, and corals) have been obtained. In nonmarine, field investigations are mainly conducted in Hunan, Guangxi, Shaanxi, Sichuan, Guangdong and Western Liaoning. Important progress was made in our project (e.g. Cao et al., 2018; Jiang et al., 2018; Lei et al., 2018; Li et al., 2018a, b, c; Wang et al., 2018; Xing et al., 2018; Zhang et al., 2018) which include the following major scientific achievements:

1 Marine Cretaceous

1) Detrital zircon U-Pb and radiolarian biostratigraphy in Tethys Himalaya: Constraints on the timing of initial India-Asia collision (Wang et al., 2018). K-Fe marine sedimentary sequences consisting of Asian-margin strata of the Gangdese arc and Indian-margin strata of the northern Tethys Himalaya provide constraints on the initial process of India-Asia collision and the timing of the closure of the Neo-Tethys Ocean. Abundant radiolarian fossils were obtained from the Zongzhao Fm located along the southern margin of the Yarlung-Zangbo Suture Zone in

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southern Tibet, and 73 species from 50 genera were identified and assigned to the K2, T. pulchra-H. barbui, P. spinose, D. formosa, D. koslovae, and A. pseudonilus zones, and the late E, T. tetradica and B. campechenis zones. The late P, E radiolarians in this succession are comparable with the radiolarian zones RP5 and RP6 in New Zealand, indicating a 61.5-55.5 Ma age. Zircons in the sandstones of the K1-E Zongzhou and Jiachala formations are dominantly younger than 200 Ma, with a major peak in the age distribution between 176 and 187 Ma, consistent with their being derived from the Gangdese arc or an intra-oceanic island arc. In contrast, detrital zircons in the K1 Gyabula Fm have dominantly Archean to Cambrian U-Pb ages, which are interpreted herein as derived from the Indian continent. This paper presents two strikingly different models both of which can explain the changes in the sedimentary provenance between the Gyabula and Zongzhou formations from the southern Indian continent to the northern arc and in the radiolarian fauna in the Zongzhou Fm as follows: the initiation of either (a) India-Asia collision or (b) collision of India with an intra-oceanic island arc no later than the late Paleocene (58.3 Ma).

2) First report of Early Eocene marine micro gastropod from the Zhipure Fm in Yadong, southern Tibet, China (Li Xinfa et al., 2018). Eocene Zhipure Fm was investigated in Gulupu section, Duina, Yadong for micropalaeontologic stratigraphy in the past three years and micro gastropods were firstly found in this study. 25 species of 18 micro gastropod genera were identified and 25 species are systematically described and illustrated. This is the first report of Eocene marine micro gastropods in southern Tibet, which can provide new basic biostratigraphy data to explore the late evolutionary history of Neo-Tethys.

3) Foraminiferal response to the PETM recorded in the SW Tarim Basin, central Asia (Jiang et al., 2018). The P/E boundary interval is the most significant climatic transition during the Cenozoic, when the PETM caused rapid warming and severe fluctuation of the Earth system, especially in marine settings. The SW Tarim Basin represents a distal branch of the NE Tethys, exposing Paleocene to Eocene successions that include the Qimugen Fm and provide optimal section for investigating the P/E boundary transition. By detail field-based lithological records and the planktonic and benthic foraminiferal assemblage analysis, the P/E boundary was defined within the black mudstone bed of the Qimugen Fm. The planktonic foraminiferal assemblages recorded in the Qimugen Fm may be subdivided into four biozones, including bioevents of G. pseudomenardii, G. lucorenensis, and P. wilcensis. Planktonic foraminiferal turnover is marked by the cool water subbotinids disappearance, give way to warm water muri cate taxa, co-varying with the gradual disappearance of benthic foraminifera. The foraminiferal assemblages together with other identified microfossils suggest a shallow marine environment in which transgressions related to the sea level fluctuation in Tethys took place in P-E boundary interval.

4) Cenozoic nanofossil changes linked to climate deterioration during the PETM in Tarim Basin, NW China (Cao et al., 2018). The PETM event was a dramatic global warming similar to 55.93 Ma ago that resulted in biological extinction events, lithological changes, and major deviations in 8C-13 and 8O-18. The southwestern Tarim Basin exposes successive Paleogene strata as a result of Tethys evolution and is considered an ideal region for PETM research. Based on calcareous nanofossil biostratigraphy, stable isotopes and XRD were also used to analyse the Paleocene-Eocene transition in the Tarim Basin. At the Bashibule Section, the PETM interval is characterized by (a) an abrupt negative shifts in 8C-13 (organ), 8C-13 (carb) and 8O-18 (-3 \%, -4.5 \% and -3\% respectively); (b) an obvious negative correlation between the K-mode (Discoaster, Fasciculithus, and Ericsonia, etc.) and r-mode (Bciebion, Chiasmolithus, Towalus) nanofossil taxa coincident with a robust Rhomboaster-Discoaster assemblage; and (c) a significant increase in the percentage of detrital input along with an increase in gypsum content. In the upper part of the Qimugen Fm Microcrintholithus and Brauraudospheera are commonly found right up to the top where most of the nanofloras suffer a sharp decrease. In the overlying Gaijitage Fm, calcareous nanofossils disappear completely. These events indicate that the southwestern Tarim Basin was a warm shallow continental shelf during the deposition of the Qimugen Fm. From the early Eocene, the environment changed conspicuously. Evaporation increased and sea level fell, which led to an acid climate. This climate mode continued within the youngest unit studied, the Gaijitage Fm, characterized by the deposition of thick evaporates. Consequently, most of the marine plankton became disappear, because of the significant climate shift.

2 Non-marine Cretaceous

1) Ostracods of the non-marine Lower Cretaceous Dabeigou Fm at Yushuxia (Luoping basin, North China): Implications for the early Jehol Biota age. The Dabeigou Fm in the Luoping basin in northern China is well known for its continuous non marine Lower Cretaceous deposits and the preservation of the early Jehol Biota, including abundant ostracods. However, the age of the Dabeigou Fm is still disputed. Ostracod analysis on samples from the Dabeigou Fm revealed 14 species of 9 genera, which biostratigraphically belong to the Luopingella-Tortina-Taporacypsis Zone. Most of the species range from the latest Jurassic to the earliest Cretaceous. However, some species show a closer relation with ostracods from the upper Lower Cretaceous Dadianzhi Fm (upper Hauterivian to Barremian), the Yixian Fm (lower Aptian) of North China, and the Purbeck-Wealden Group (uppermost Triasian to lowermost Aptian) of Britain. Combined with the biostratigraphy of other fossils and the U-Pb age, it is suggested that the ostracod fauna of the Dabeigou Fm and the origin of early Jehol Biota might be of Early Cretaceous age entirely.

2) Deccan volcanoism caused coupled pCO2 and terrestrial temperature rises, and pre-extinction extinctions in northern China (Zhang et al., 2018). Evaluating the terrestrial climate record provides a critical test of the roles of Chixulub impact and Deccan Traps volcanoism during the K-Pg mass extinction. Most evidence came from marine records, but new clumped isotopes data from paleosol carbonates in Songliao Basin provide a terrestrial climate history from northern China. This reveals there was a pre-impact warming caused by the onset of Deccan Traps volcanoism, whereas the following short-term cooling then another warming episode were likely caused by Chixulub impact and post-boundary volcanoism, which suggests that the pCO2 levels were probably the main control on the latest Cretaceous cooling and the climatic fluctuations across the K-Pg boundary interval in northern China. In the Songliao Basin, the
pre-impact Deccan Traps volcanism links to losses of half of the lacustrine charophytes and almost all of the lacustrine ostracodes; this suggests that the Deccan Traps volcanism had already destabilized the ecosystem and caused extinctions prior to the Chicxulub impact.

3) Middle Cretaceous pCO₂ variation in Yumen, Gansu province and its response to the climate events (Lei et al., 2018). The palaeo-atmospheric CO₂ concentration (pCO₂) variation in the Yumen, Gansu Province during the middle Cretaceous has been reconstructed using the newly established plant photosynthetic gas exchange mechanistic model, and the results show that the pCO₂ values are in the range of about 550-808 ppmv. The present pCO₂ values are almost the same as the pCO₂ results (531-641 ppmv) of the previous study according to the recent standardization of the stomatal ratio method, and much lower than the pCO₂ results (882-1060 ppmv) according to the Carboniferous standardization of the stomatal ratio method. The present pCO₂ variation is not only within the error range of GEOCARB II and GEOCARB III but also is similar to the reconstructed results based on the biochemistry and carbon isotope models. Besides, the present Brachyphyllum specimens were collected from four consecutive horizons of the upper Zhonggou Formation of the Hanxia Section, and the reconstructed pCO₂ exhibits the reconstructed pCO₂ exhibits a decline trend during the late Aptian to early Albian. This decline variation is probably associated with the Oceanic Anoxic Events (OAE1b) and the cold snap event. With the combination of pCO₂ during the Albian to Cenomanian recovered by the plant photosynthetic gas exchange mechanistic model, the pCO₂ showed a prominent increase during the late Aptian to early Cenomanian, which indicates a response to the greenhouse warming during the middle Cretaceous. Therefore, the mechanical model of the plant photosynthetic gas exchange shows a relatively strong accuracy in the reconstruction of the pCO₂ and can reflect a strong relation between the atmospheric CO₂ concentrations and climatic events.

Key words: IGCP 608, Cretaceous, ecosystems, paleoenvironmental changes, Asia-Pacific

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References

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