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# Preface to integrative stratigraphy, biotas, and paleogeographical evolution of the Qinghai-Tibetan Plateau and its surrounding areas

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The Qinghai-Tibetan Plateau (QTP) is well known as the Roof of the World, the Third Pole and the Asian Water Tower. It spans a vast area from the Pamir Plateau in the west to the Longmenshan-Hengduan Mountains in the east, from the Himalaya Mountains in the south to the Kunlun-Qilian Mountains in the north. It stretches approximately 1,200 km from north to south and 2,500 km from east to west. When did the QTP start to uplift? This is still controversial between early and late Cenozoic scenarios. While some scholars advocated its uplift since the India-Asia continental collision at about 65 million years ago in the Paleogene (e.g., Ding et al., 2017, 2022), and the others suggested its uplift since the Miocene (Zheng and Wu, 2018).

The geological and fossil records from the Cenozoic demonstrate that the uplift of the QTP has terraformed the climate system in Southeast Asia, making a significant impact on global climate change, regional distribution of organisms, and biodiversity patterns. As the highest orographic barrier, the plateau effectively hampers the warm and humid seasonal winds blowing northward into QTP, Afghanistan, and even Russia. Meanwhile, the cold dry seasonal winds formed in the northern hemisphere could not flow southward over the Himalaya Mountains into the India Subcontinent, which led to the development of the monsoon system in southern Asia and Southeast Asia. Therefore, it is the uplift of the QTP that altered the topography, climate, environment and ecosystem in the whole Southeast Asia (Liu et al., 2024; Deng et al., 2024; Wang et al., 2024).

In fact, the geological evolution of the QTP before its uplift also reveals its importance. The present QTP is a complex mosaic integrated from several different micro-continents or blocks, including the Cimmerian continents consisting of Lhasa, South Qiangtang, Tengchong, Baoshan, and Sibuma Blocks, the Indian Plate, the Karakoram Block, and the Pamir Block. It also contains a few plate suture zones, from north to south they are the Qilianshan, Kunlun, Jinshajiang, Longmuco-Shuanghu, Bangong-Nujiang, and Yarlung-Zangbo suture zones, some of them represent vast oceans which have since closed such as the Proto-Tethys, Paleo-Tethys, Meso-Tethys (also named as Bangong-Nujiang Ocean), and Neo-Tethys oceans, respectively. Furthermore, geological records show a series of tectonic events

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for continental accretion southwards from the Early Paleozoic through Late Paleozoic to Mesozoic (Zheng et al., 2013). In addition, the QTP also had a complex collision and dispersal history during the Phanerozoic with its surrounding plates such as the Australian and Indian plates to the south, the North China and South China blocks to the east, and the Tarim, Qilian, and Qmodo blocks to the north.

The QTP was also the core of the eastern Tethyan tectonic regime (Wu et al., 2020; Zhu et al., 2022). It played a critical role in understanding the global tectonic dynamics, paleogeography, the evolution of biotas, and changes of their associated living environments. The opening and closure of the Tethys oceans during the Phanerozoic was obviously driven by the interior dynamics of the earth. The Gondwana and the Laurentia continents merged from south to north which led to the closure of the Rheric Ocean along the paleoequator and the formation of the united supercontinent Pangea and its associated semi-closed Archipelago Tethys oceans in the east. It has been widely perceived that the assembly and dispersal of the Pangea were the main driver of the major paleoclimate and biological events. The Tethys oceans were also the center of dynamic energy exchanges between the interior and exterior of the earth fueling marine biodiversification, which has been regarded as a counterpart of the present Western Pacific-Indian Ocean Warm Pool (Shields and Kiehl, 2018; Shen et al., 2023).

During the Paleozoic-Mesozoic transition, a series of Cimmerian continents rifted and drifted northwards from the northern margin of the Gondwana Continents and constitute a complex archipelago paleogeography of the Tethys oceans (Yin et al., 2004; Xu et al., 2022; Şengör et al., 2023). The semi-closed Tethys oceans could be a huge reservoir of methane and organic materials. The intensive volcanism within and in the circum-Tethys regions could resulted in massive release of greenhouse gases and make significant global and regional impacts on the paleoclimate and biological environment. The environmental effects of the felsic volcanism around the Tethys oceans may be seriously underestimated and could be as important as the Siberian and Emeishan large igneous provinces, which are the most plausible causes of the two mass extinctions at the end-Guadalupian and end-Permian respectively (Chen and Xu, 2019; Zhang et al., 2021). Therefore, no matter the paaeogeographical evolution during the Phanerozoic or the geomorphological uplift in the Cenozoic, the QTP has a great impact on the climate and organisms in not only Southeast Asia but also in a global sense.

Stratigraphic framework and fossil faunas are the keys to reconstruct the tectonic assembly and uplifting history of the QTP. Personal scientific expedition on the fossil faunas in Xizang can be traced back to the late 19th century (e.g., Davidson, 1866). In 1951, the Chinese Academy of Sciences organized the Xizang Research Team. A large amount of first-hand geologic materials including various fossils were collected and led to a few publications filling in the gap of stratigraphy and faunas of the QTP. The Chinese Academy of Sciences and State Sports Commission jointly organized another expedition team for the first expedition to the Mt. Qomolangma (Mt. Everest) area in 1959 and the second expedition in 1965, which led to a series of publications titled *A Report of Scientific Expedition in the Mt. Qomolangma Region* (*Paleontological Volumes*) (Xizang Scientific Expedition team of Chinese Academy of Sciences, 1975, 1976a, 1976b), *A report of Scientific Expedition in the Mt. Qomolangma Region (1966–1968)*, *Geology* (The Expedition Team of the Mt. Qomolangma of the Chinese Academy of Sciences, 1974), *Palaeontology of Xizang* (The Scientific Expedition to the Qinghai-Xizang Plateau, Chinese Academy of Sciences, 1980–1982), *Stratigraphy of Xizang* (*Tibetan*) *Plateau* (The Scientific Expedition to the Qinghai-Xizang Plateau, Chinese Academy of Sciences, 1984). These publications for the first time established the stratigraphic framework of Phanerozoic Eonothem and provided a basis for the investigations of the tectonic, paleogeographical evolution, natural resources of the QTP, from which a part of the stratigraphic framework is still used until now.

However, more than half century has passed since the first scientific expedition in the 1950s–1960s, during which the international stratigraphic timescale has been greatly improved. Numerous field investigations have been carried out and a large amount of data and materials have been accumulated from the QTP. In particular, the second comprehensive scientific expedition to the QTP initiated in 2019 carried out a new round of scientific expedition on the geology, paleogeography, paleoclimate, and natural resources of the QTP and great progress has been made during the past five years. However, the new data accumulated after the first expedition has never been systematically summarized and updated, in particular, many old paleontological data and stratigraphic frameworks from the first expedition are clearly out of date and need to be updated. In addition, it has been widely recognized that the QTP was closely related to the Southeast Asian and western Asian regions including Thailand, Myanmar, Pakistan, India, Tajikstan, Khazankstan as well as the Tarim, Tianshan and western Yunnan areas of China in view of geological evolution and the stratigraphic correlation. The paleogeographical evolution of all these regions need to be summarized. Thus, we organized the Special Issue of “Integrative stratigraphy, biotas, and paleogeographical evolution of the Qinghai-Tibetan Plateau and its surrounding areas” and invited authoritative experts to provide a state of the art summary of the stratigraphy, biotas, and paleobiogeography of the QTP and detailed discussions on their implications of the tectonic and paleogeographical evolutions of the QTP with a focus on the evolutions of the Prototethys, Paeotehtys, Mesotethys, and

Neotethys oceans. In addition, the records of major biological and paleoclimate events in the QTP have also been documented if any data is available.

This special issue includes 14 papers that cover all geological periods from the pre-Cryogenian to the Quaternary (Hu et al., 2024; Sun L et al., 2024; Sun Z X et al., 2024; Fang et al., 2024; Chen et al., 2024; Qie et al., 2024; Hu et al., 2024; Shen et al., 2024; Wu et al., 2024; Li et al., 2024; Xi et al., 2024; Liu et al., 2024; Deng et al., 2024; Wang et al., 2024). Compared to the reports from the first expedition, the following progress has been made: (1) The latest timescale of the International Stratigraphic Chart is adopted for the subdivisions and correlation of all systems. The stratigraphy and biotas in the surrounding areas of the QTP are included in each system and the stratigraphy and correlation of the pre-Cryogenian, Cryogenian and Ediacaran of the QTP (Hu et al., 2024; Sun L et al., 2024) are summarized for the first time. (2) The paleobiogeographical affinities, paleoclimate indications from strata, depositional sequence, and biotas are documented in detail and their paleogeographical implications are interpreted. (3) Multidisciplinary stratigraphy including chemostratigraphy, magnetostratigraphy, and high-precision geochronology are added if available. (4) The records of global major biological and environmental events in the QTP are reviewed.

We hope this special issue will stimulate further integrative investigations into the QTP and its surrounding areas.

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