Foreword

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The Qinghai-Tibet plateau is a fast uplifting area that constitutes the world's highest and thickest, and newest piece of continental plate which has unusual geometric configurations and landscapes. The Qinghai-Tibet plateau consists of multiple terranes, with a complex geological history, including the evolution of the Tethys Ocean basin, the convergence of terranes and island arcs, multiple subductions, multiple collisions and multiple orogens, over a long period of action of continental dynamic processes. Before the Indian and the Asian plates collided, during the Early Paleozoic, it was already a large orogen and terrane collision complex. As a result of the collision of the Indian and Asian plates, the fast uplift of Qinghai-Tibet plateau became the most magnificent event on the earth during the Cenozoic. It formed a vast, seemingly boundless high plateau with borders consisting of mountain chains with very high peaks, and steep gorges.

Twenty articles collected in this special issue on Continental Dynamics of the Qinghai-Tibet Plateau are based on the exploration of continental structures, crustal development features, and driving forces. These include studies on the microscopic and the macroscopic, materials and mechanics, determination and quantities, geometry, kinematics and dynamics near the surface and at depth, geology, geochemistry, and geophysics. Information obtained by these approaches has been used to establish the basic tectonic structure, the terrane configuration and terrane boundaries, the mechanism of structural distortion, as

well as the relative movements of tectonic units, the history of the opening and closing of small oceanic basins, terranes before and after the collisions of the Indian and Asian plates, of the orogens themselves, of the huge strike slip faults, and of the uplift of the plateau, the formation of the adjacent orogenic zones of the margins coupled with the exploration of the deep crust and mantle structures and recognition of the dynamic forces.

(ULTRA) HIGH-PRESSURE METAMORPHIC ROCKS, OPHIOLITE AND SUBDUCTION RELATED ROCKS

The discovery and description of (ultra) high-pressure metamorphic (HPM) zones and ophiolites are the key to the understanding of the terrane margins of the Qinghai-Tibet plateau and the tectonic structure of the plateau. In this issue, Li C et al. (this issue) reported the Central Qiangtang HPM zone of Triassic located to the north of the Bangong-Nujiang suture. Yang et al. (2009) recently discovered another large eclogitic HPM zone of Permian in the Lhasa block, and have been able to prove that the original protolith of the eclogite was oceanic basalt. This oceanic basalt was generated in the paleo-Tethys oceanic basin and subducted to form the eclogites. Thus these rocks are key marker for the division of the Lhasa block in addition to the eclogites. Chen et al. (this issue) demonstrated peridotite blocks as an ophiolitic unit, associated with the HPM zone, providing further evidence of a paleo-Tethys suture in the region. Furthermore, Li H Q et al. (this issue) reported the deformation characteristics of the ductile shear zones in Sumdo Group

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in the eclogite zone, and obtained data of muscovite ^{40}Ar - ^{39}Ar geochronology (220–230 Ma) from ductile shear zones and the zircon SHRIMP U-Pb chronology (190 Ma) of granites in Sumdo region, Lhasa block. This indicates an important Indosinian orogenic event at 220–230 Ma, which caused the closure of the paleo-Tethys Ocean along the tectonic zone of eclogite and the collision between northern part and southern part of the Lhasa block.

Cheng et al. (this issue) constructed a quantitative *P-T* path based on interpretation of reaction textures, chemical zoning of minerals in the Danba domal metamorphic terrane, eastern Tibet, and thus provided important constraints on the crustal thickening processes in the Danba area of the Songpan-Ganze orogenic belt. These are not only contributed to the knowledge of HPM zones in the Qinghai-Tibet plateau, but also to other places in China and the rest of the world. In turn, these discoveries will have an important impact on the further understanding of the tectonic structure and the characteristic configuration of the Qinghai-Tibet plateau, and the converging dynamic activities between the plates.

A wide variety of unusual minerals, including ultra-high pressure phases such as diamond and coesite, highly reduced minerals such as moissanite, and native elements, carbides, alloys, oxides, sulphides (arsenides) and silicates were found from the podiform chromitites of the Luobusa ophiolite in the Yarlung-Zangbo suture (Yang et al., 2007; Robinson et al., 2004; Bai et al., 2000). Xu et al. (this issue) reported thousands of diamond along with over 40 kinds of minerals discovered from the Kangjinla chromitite deposit in the Luobusa ophiolite, providing new key evidence for discussing the origin of the diamond and the hosted chromitite and ophiolite. Silicon-bearing rutile has been found in chromitite from the Luobusa ophiolite, Tibet (Yang et al., 2003). Ren et al. (this issue) reported new experimental results on SiO_2 solubility in rutile up to 23 GPa and 2 000 °C. The solubility of SiO_2 in rutile increases with increasing pressure, from 1.5 wt.% SiO_2 at 10 GPa to 3.8 wt.% SiO_2 at 23 GPa at a temperature of 1 800 °C. The solubility also increases with increasing temperature from 0.5 wt.% SiO_2 at 1 500 °C to 4.5 wt.% SiO_2 at 2 000 °C at a pressure of 18 GPa. The experimental data are useful

for understanding the depth of origin of the SiO_2 -bearing rutile found in nature.

The Dur'ngoi ophiolite at the east section of the A'nyemaqen ophiolite belt in the East Kunlun Mountain is interpreted as a dismembered fragment of paleo-oceanic crust emplaced during closure of the paleo-Tethyan Ocean basin and as the northern border of the Gondwanaland (Yang et al., this issue). Three other suites of oceanic lavas are recognized in the area: island arc volcanic rocks, possible back arc basin basalts and possible post-collisional volcanic and plutonic rocks. The distribution of these rocks suggests north-directed subduction. Opening of the A'nyemaqen oceanic basin started at least as early as Late Carboniferous (308 Ma) and the basin probably closed during the Early Triassic. Three strike-slip faults, i.e., the south margin fault zone of East Kunlun, the Altyn Tagh fault (220–230 Ma), the North Qaidam fault zone (240–250 Ma) were probably generated by oblique subduction and closure of the paleo-Tethyan Ocean basin, and possibly during exhumation of the subducted plate or uplift of the overriding plate, coincident with post-collisional magmatism.

Kou et al. (this issue) reported well-preserved seamount buildups of Permian (268±5 Ma) from the northwestern Qinling orogenic belts, Northwest China. Integration of petrologic and geochemical studies of seamount basalts and lateral correlation of seamount buildups reveals that the Qinling-Qilian-Kunlun orogenic belts were probably the archipelagic oceans during the Permian. Mo et al. (this issue) studied LA ICP-MS Hf isotopic analysis of zircons from gabbro and granodiorite in Gangdese, southern Tibet, and concluded that magma mixing and magma underplating at about 50 Ma may have played an important role in creating the crust of the southern Tibetan plateau. Pei X Z et al. (this issue) gave the results from LA ICP-MS zircon U-Pb isotopes of granitic intrusions in the Pingwu region, Northwest Sichuan, and interpreted the granite intrusions to be syn-collisional granites that resulted from the crustal thickening caused by the collisions.

OROGENIC PROCESSES OF DEFORMATION AND COLLISION, AND UPLIFT MECHANISM

Five articles in this issue reported the orogenic

processes and uplift mechanism. Wu et al. (this issue) reported the South Kunlun thrust (SKT) formed by the southward thrusting in southern East Kunlun in Late Oligocene–Early Miocene, started at 26 Ma and ended at 14 Ma, with displacement or shortening of ~30–35 km across Dongdatan valley and East Wenquan basin. Wang et al. (this issue), using digital elevation model (DEM) analysis, identified that major rivers across the orogen are characterized high river gradient indexes by intensive tectonic uplift. Differential uplift was also identified and the most active region is located to the south of the Xidatan fault with significant differential uplift. Determined by the high-resolution magnetostratigraphy, Pei J L et al. (this issue) demonstrated that the growth strata in the northwestern Qaidam basin began to form at ca. 38.0 Ma and increased sedimentation rates occurred at ca. 37.0 Ma, before the Eocene–Oligocene boundary. It thus enables us to better understand the relationship between climatic changes and the tectonic uplift. Si et al. (this issue) studied zircon grains from a conglomerate of Early Pliocene at Mazartagh in Tarim basin, and obtained ages of three groups: 200–500, 800–1 100, and 1 800–2 000 Ma. By comparison, the younger grains are mainly related to the west while the older are to the regions more eastward. The variations might imply the W-E propagation tectonic activation and uplift of the surrounding orogenic belts. The collision between India plate and Eurasia continent 55 Ma ago caused the convergence between Southwest Tianshan and Pamirs tectonic systems. By means of digital modeling, Qiu et al. (this issue) addressed on the tendency of the convergence in this area in almost 10 Ma and drew a conclusion that the converged borders move northward and stretch southeast. The Southwest Tianshan will move more slowly and suffer less deformation than the Pamirs–West Kunlun system. The Pamir–West Kunlun system will rotate counterclockwise while moving northward and extending westward.

EARTHQUAKE AND DEEP SEISMIC STUDY

By deep seismic reflection profiles recently carried out across the central uplift, Lu et al. (this issue) presented a primary image on the crustal structure of the central uplift area of the Qiangtang terrane in the Tibet plateau. It was interpreted that old crystalline

basements are in the Qiangtang terrane, but differences were noted in the deep structure between the south and north parts of the Qiangtang terrane. The distortion of the upper crust mainly behaves as a thrust action, and the “face-to-face” reflections in the lower crust reveal a deep convergent process of the Indian and the Eurasian plates with their forelands. Utilizing the new data of gravity, magnetic, and magnetotelluric survey, He et al. (this issue) analyzed the characteristics of the three type geophysical attribute (gravity, magnetic, and resistivity) interfaces and the deep architecture and structure of Kumkuli basin. They found that there was zoning from north to south and from west to east. Kumkuli basin has three horizon architectures including metamorphic crystallization basement-fold basement and sedimentary mantle. Xiong et al. (this issue) mainly summarized the three seismic detections to discuss the Moho depth of the Qinghai–Tibet plateau. The result shows that the Moho depth of the Qinghai–Tibet plateau is different, deeper beneath the south than the north and deeper in the west than in the east. In the Qiangtang terrane, the Moho is shallower than both the southern and the northern sides. This trend records the crustal thickening and thinning caused by the mutual response between the India plate and the Eurasia plate, and the eastward mass flow in the Qinghai–Tibet plateau.

Various earthquake fault types on the crust movement in the high region of the Tibetan plateau were studied by analyzing mechanism solutions and stress fields (Xu and Zhao, this issue). The results show that a lot of normal faulting type earthquakes are concentrated in the central Tibetan plateau and the strikes of the fault planes are almost in an N–S direction. The extensions probably are an eastward extensional motion, and the tensional stress in the E–W or NWW–SEE direction predominates earthquake occurrences in the normal event region of the central plateau. The eastward extensional motion in the high Tibetan plateau is attributable to the gravitational collapse of the high plateau and the eastward extrusion of hotter mantle materials beneath the east boundary of the plateau. Zhao and Xu (this issue), based on the analysis of earthquake fault types, mechanism solutions, stress field, and other geophysical data on the crust movement in the Tibetan plateau, demonstrated

that numbers of thrust fault and strike-slip fault type earthquakes with strong compressive stress near NNE-SSW direction occurred in the edges around the plateau except the eastern boundary. The strikes of fault planes of thrust and strike-slip faulting earthquakes are almost in the E-W direction. The compressive stress in N-S or NE-SW directions predominates earthquake occurrence in the thrust and strike-slip faulting event region around the plateau. The compressive motion around the Tibetan plateau edge is attributable to the northward motion of the Indian subcontinent plate. The northward motion of the Tibetan plateau shortened in the N-S direction encounters probably strong obstructions at the western and northern margins.

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