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Preface

# Special issue: The 19th Himalaya–Karakoram–Tibet Workshop (HKT19) held at Niseko, Hokkaido, Japan, 10–13 July 2004

The Himalaya and Tibetan Plateau are the loftiest and most extensive highlands on Earth. These highlands serve as a natural laboratory not only for studying lithospheric tectonics and evolution of a collisional orogen, but also for understanding the interactions between mountain uplift and global climatic changes, including the Asian monsoon.

The Himalaya–Karakoram–Tibet (HKT) Workshop is the only international workshop devoted to the presentation of new research findings in the earth sciences and related disciplines, such as global environment and natural disasters, from the HKT region, and discussion of the burning issues. Since the first meeting in Leicester (UK) in 1985 the HKT Workshop has been held almost every year, mostly in Europe, where the study of Himalayan geology was developed. After 1994, when the meeting was held in Nepal, the workshop has generally been held alternately in Europe and Asia. The 19th HKT Workshop in Japan was the fifth to be held in Asia. The 19th Workshop was held on 10–13 July 2004 in Niseko, a famous ski resort in Hokkaido, Japan. The HKT19 Organizing Committee hosted the workshop, together with two 21st Century Center of Excellence Programs, namely, COE for the "Neo-Science of Natural History" (Hokkaido University) and COE for "Dynamics of the Sun–Earth-Life Interactive System" (Nagoya University), and the Division of Earth and Planetary Sciences, Graduate School of science, Hokkaido University, Japan. The HKT19 Workshop is sponsored by International Lithosphere Program (ILP), Tokyo Geographical Society, Geological Society of Japan, Japan Association for Quaternary Research, Hokkaido Prefecture and Niseko Town.

A total of 121 researchers from 14 countries, including Japan (45), P.R. China (19), India (14), Nepal (13), Switzerland (7), Pakistan (6), France (3), USA (3), UK (3), Australia (2), Belgium (2), Germany (2), Italy (1) and Russia (1), actively involved in geology, geophysics, glaciology, environmental science, climate science, paleobotany, biodiversity, natural hazards etc. attended the workshop, and made oral and poster presentations of their research results in five sessions.

HKT19 was the first HKT workshop to be held in Japan. Despite the distance from the HKT region, we believe that Japan is an appropriate venue for such workshop. Apart from Hokkaido, a monsoon (*tsuyu*) occurs in most parts of Japan during June and July. In winter, parts of northern Japan, including Hokkaido, facing the Japan Sea experience some of the world's highest snowfall. Thanks to the water derived from snowmelt, together with a lot of rainfall during the *tsuyu*, Japan has evolved a remarkable form of rice cultivation. If the HKT region did not exist in its present form, Japan probably would have no *tsuyu* and conditions would be very different from those of today. For this reason HKT19 devoted a full day to a special session on the 'Uplift of the Himalaya–Tibet region and the Asian Monsoon: Interactions among Tectonic Events, Climatic Change and Biotic Responses during Late Tertiary to Recent Times'. This aspect was first covered during the previous HKT, and some of the presentations from this special session have been published in *The Island Arc* (vol. 14, no. 4, 2005).

Following the workshop, sixty-seven participants enjoyed a one day (13 July) excursion to Mt. Usu active volcano area, which is one of the active volcanic fields in Japan. Prof. M. Nakagawa of the Hokkaido University gave excellent guidance to the tour. It was an exciting experience for the participants to see the lively Earth, spewing hot vapor here and there, from a close distance. They also observed the damage caused to houses and the public infrastructures by pyroclastic flows and strong ground motions induced by the volcanic activity in 2000.

This special issue consists of presentations given at 19th Himalaya–Karakoram–Tibet Workshop. The contributions cover a wide range of subjects, such as regional tectonics, igneous and metamorphic petrology, geochemistry, and Quaternary geology from areas in and around the HKT region. They are arranged roughly by region from north to south, and range in subject from tectonics, geochemistry and metamorphism to simulation modelling.

De Grave et al. discuss Cenozoic tectonics in Kyrgyz, Tien Shan and the Siberian Altai on the basis of a compi-

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lation of geological data and newly reported apatite fission-track data. They conclude that reactivation and deformation in the interior of the Eurasian continent has gradually propagated northwards since the Miocene, due to the distant effects of the ongoing indentation of India into Eurasia and that the transpressional reactivation of central Asia follows the inherited crustal structure. Buslov et al. review the Cenozoic tectonics and geodynamic evolution of the Kirgyz Tien Shan Mountains, based on geological, thermochronological and geophysical data, and conclude that the building of the Cenozoic Tien Shan and the tectonic layering of the upper lithosphere underlying the area resulted from underplating by the Tarim Plate and overthrusting by the Pamirs. They point out that crustal heterogeneities have influenced the location of the active structures in the northern Kyrgyz Tien Shan.

Qiu et al. describe four ophiolite belts in the western Qinghai-Tibet Plateau detailing their geochemistry, including trace elements, rare earth elements and Sr and Pb isotopes. They demonstrate that mantle peridotites in the ophiolites have undergone at least two processes: first strong partial melting; and then metasomatism by liquids released during the subduction of ocean crust. Acharyya describes two parallel ophiolite belts of Late Mesozoic to Early Eocene age along the eastern margin of the Indian plate, and concludes that the eastern belt of ophiolites was accreted during this period and that the western belt of ophiolites were derived from the eastern belt during the Late Oligocene terminal stage of the India–Burma collision, and propagated westward as nappe structures. Liu et al. suggest from a compilation of reported isotopic age data, as well as new $^{40}Ar/^{39}Ar$ age data and new geologic interpretations on the evolution of the fault, that the Altyn left-lateral strike-slip fault along the northern margin of the Tibetan Plateau has been re-activated many times, following its initiation in the Middle Jurassic. Fu and Awata have determined the time of initiation of the Kunlun fault, which is one of the large left-lateral strike-slip faults in the northern Tibet, as 5.5 Ma, based on a total of 55 km of displacement, with a long-term average slip rate of 10 mm/yr, obtained from the tectono-geomorphic interpretation of satellite remote-sensing images and field geologic and geomorphic observations.

Wang et al. present $^{40}Ar/^{39}Ar$ dates on mica and K-feldspar, and apatite fission-track dates on samples from the south-central Tibetan Plateau between the Qiangtang Block and the Yalung–Zangpo Suture. Their results show that the area experienced three stages of cooling, at 165–150 Ma, 130–110 Ma and ~45–35 Ma, due to the closure of the Bangong–Nujiang Suture Zone, as well as the collision between India and Asia. Zhang and Wang describe the tectonics of southern and south-central Tibet after the Middle Miocene, from earthquake analysis, GPS data and the analysis of deformation styles in the Tibetan Plateau and discuss recent kinematic characteristics. Yamamoto et al. present detailed field observation and structural analysis of the Cretaceous Luobusa Ophiolite, located about 200 km east-southeast of Lhasa in southern Tibet. They show top-to-the-north reverse displacement along the bottom and top boundaries of the ophiolite and conclude that the mantle peridotite formed a north-vergent imbricate structure, due to the continual northward movement of India after India–Asia collision. Thakur et al. deal with the neotectonics of the Sub-Himalaya, the southernmost frontal belt of the Himalayan orogen, which is characterized by Dun structures. They infer the sequential development of these deformation structures during the past 100 kyr, based on geomorphological and stratigraphic analyses, together with optically simulated luminescence age determinations.

Zhu et al. studied the Sangxiu Formation in the eastern part of central Tethyan Himalaya, which belongs paleogeographically to the northeastern margin of Greater India. They investigated major and trace element chemistry and the Sr–Nd isotope compositions of the volcanic rocks in the formation, and consider the Sangxiu basalts to be a consequence of the interaction between the Kerguelen hotspot and the lithosphere on the northeastern margin of Greater India at ~133 Ma. Takahashi et al. have investigated the Chilas Complex which is regarded as a magma chamber in the root zone of the Kohistan paleo-island arc, north Pakistan. The huge basic intrusion consists mainly of gabbronorite and several masses of the ultramafic–mafic–anorthosite (UMA) association. They conclude that the UMA association can be explained as variable crystal cumulates derived from a primary magma and that the gabbronorite originated from fractionation of the residual magma. Khan et al. describe the dyke swarm of basalt and dolerite newly found in the Thelichi Formation of the Kohistan paleo-island arc. The swarm intrudes gabbros and yields a K–Ar age of 134 Ma. The major and trace element geochemistry suggests that the dyke swarm originated in a back-arc basin. Jan and Rafiq describe greenstones intercalated with unusual chloritoid–ilmenite-rich rocks in the Indus Suture mélange of Pakistan. They consider that these chemically unusual rocks are weathered and lateritized basaltic rocks, and estimate that the Kohistan island arc with the basalts was located at, or to the south of, the equator, prior to its northern drift. The basalts were subsequently metamorphosed under temperatures of 400–480 °C during the collision of India and Asia. Khan et al. report the occurrence and the petrochemistry of dykes from the Waziristan Ophiolite, located in the suture zone between the Indian Plate and the Afghan Block. Their geochemical data suggest that the dykes of the Waziristan Ophiolite have transitional characteristics from mid-oceanic ridge basalt to island-arc tholeiite. They propose that the dykes formed in a back-arc basin tectonic setting.

Liao et al. divide the peraluminous granitic bodies distributed in the Tibetan Plateau into six tectonic phases, on the basis of a compilation of reported geochronological and geochemical data and interpret their tectonic evolution since the Late Triassic as related to the subduction of the

Bangong Co–Nujian and the Yarlung Zangbo oceans, and the following collision. Rehman et al. have investigated metamorphism in the Kaghan Valley, north Pakistan, well known for an occurrence of eclogite. Based on their field mapping and thermobarometry of the metamorphic sequence, they re-classify the Himalayan Crystallines into three tectonic units, and suggest that they resulted from the rapid, deep burial of the subduction front of the Indian Plate, and was followed by exhumation from a depth of 90–110 km. Carosi et al. present the results of their study of a structural transect from the upper part of the Lesser Himalaya to the lower part of the Tibetan Sedimentary Sequence in the Lower Dolpo, a poorly surveyed area in Nepal. They describe the structural features observed around the MCT zone, the STDS and the Toijem Shear Zone in the middle part of the Higher Himalayan Crystallines, and point out that simple shear increases toward the tectonic boundaries. Dubey and Bhakuni describe the unusual tectonic superposition of the younger, high-grade metamorphic rocks of the Vaikrita Group in the hanging-wall of the MCT, over the older, lower-grade rocks of the Munsiari Formation in the footwall. They interpret this relationship as due to early normal faulting along the present Vaikrita Thrust (MCT), followed by inversion tectonics. Patel et al. report two groups of apatite fission-track ages from the Chiplakot Crystalline Belt (CCB) in the Lesser Himalaya of Kumaon, India: 9.8–7.6 Ma in the northern part of the CCB and 17.9–12.9 Ma in the southern part, with the northern part thrust over the southern part. On the basis of the fission-track age data and published structural data they show that the CCB has a complex exhumation history. Verma and Sharma report the results of fluid inclusion and geochemical studies of the Neo-Proterozoic Nagthat siliciclastics of the Lesser Himalaya in the Tons valley, India. Their experiments show that the siliciclastics of granitic provenance were heated to a temperature of 200 °C during the Himalayan orogeny. Shah and Moon compare the ferromanganese ores of the Hazara area and the manganese ores of the Waziristan area in Pakistan, mineralogically and geochemically. They conclude that the ores of the Hazara area have a mixed hydrothermal–hydrogenetic source in shallow water or continental shelf environment and the ores of the Waziristan area formed along sea-floor spreading centers within the Neo-Tethys Ocean and were then obducted as part of the Waziristan Ophiolite Complex.

Takagi et al. attempt a determination of the youngest age limit for the Late Pleistocene Tsergo Ri landslide in Langtang Himal, Nepal from fission-track dating of pseudotachylyte. The age of $51 \pm 13$ ka obtained from zircon grains separated from a 10 cm diameter injection pipe of glassy and vesicular pseudotachylyte lies between two subpeaks of the Würm ice age. Chamlagain and Hayashi use 2D finite element technique incorporating elastic material behavior under plane strain conditons for neotectonic fault analysis in the fold-and-thrust belt of the Nepal Himalaya. The results show that the presence of a mid-crustal ramp induces compressive and tensional stresses to the north and south, respectively, of the ramp. Takada and Matsu'ura reveal the geometric evolution process of a plate interface-branch fault system through numerical simulation based on elastic–viscoelastic dislocation theory. Their results show that if the plate interface has a ramp, the gradual horizontal motions of the ramp toward the hanging-wall side occur at half the plate convergence rate. The application of these results to the plate interface-branch fault system at the India–Eurasia collision boundary provides a scenario for the tectonic development of the Himalaya over the last 30 Myr.

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