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Book Review

Himalaya and Tibet: Mountain Roots to Mountain Tops

Allison Macfarlane, Rasoul B. Sorkhabi, Jay Quade. Geological Society of America Special Paper 328, 330pp., $70 for non-GSA members, and $56 for GSA members

Mountain belts created by continent–continent collision are perhaps the most dominant geologic features on the surface of the Earth. The youngest and arguably most spectacular of all is the Himalayan–Tibetan orogen, which occupies the east–west trending, high-altitude Himalaya and Karakorum ranges in the south and the vast Tibetan plateau to the north. This orogenic belt, largely created as a result of the Indo-Asian collision over the past 70–50 Ma, is part of the greater Himalayan–Alpine system that was developed by the closure of the Tethys oceans between the two great land masses: Laurasia in the north and Gondwana in the south. The Himalayan–Tibetan orogen is an ideal place for the study of continent–continent collision because it is young and active and thus many first-order relationships can be demonstrated with less uncertainty than can be achieved in older collisional belts. In the past three decades, numerous geologic and geophysical investigations have been conducted in the Himalayan–Tibetan orogen, which have resulted in many books and special volumes in journals. This book, edited by Macfarlane et al., is a new and important addition to the existing collection of books on the subject of Himalayan and Tibetan geology. It is a result of the 11th Himalayan–Karakorum–Tibet Workshop, which was held in Flagstaff, Arizona in April, 1996.

The book is divided into three parts. The first part consists of seven papers dealing with the Tibetan plateau and the geologic history of the northern Himalaya involving the Paleozoic–Mesozoic Tethyan sequence. Gao et al. and Xu et al. provide comprehensive reviews of major results of geologic and geophysical investigations published in recent Chinese literature. Indian scientists also made important contributions to the first part of the book. Due to political reasons, western geologists have long been prohibited from exploring the region near the Karakorum Pass where the border between China and India lies. The paper by Sinha et al. provides a first detailed geologic description of a transect from Leh to the Karakorum Pass in the eastern Karakorum Mountains. Although timing of deformation and the age of major lithologic units along the traverse remain poorly constrained, their work provides new clues for geologic correlation between the Karakorum Mountains in the west and Tibet in the east. The paper by Mikoshiba et al. presents the results of Rb–Sr isotopic study of the Chilas Igneous Complex in Kohistan of northern Pakistan. Their study suggests that the Chilas complex was mainly emplaced at 111 ± 24 Ma, an age similar to that for the earliest phase of magmatism in the Kohistan batholith and the age of plutonism in Ladakh and Karakorum. This result implies that large-scale generation of subduction-related magma occurred in the western Himalaya and the Karakorum mountains during the mid-Cretaceous. The last three papers in the first part of the book deal with sedimentology and volcanic activity in the Tethyan Himalaya. Khan et al. discuss the timing, geochemistry, and tectonic position of a late Cretaceous basaltic sequence in western Pakistan. They suggest that the basalts were an early expression of the northernmost and oldest of the Reunion hotspot trail that affected the Tethyan Himalaya in the late Cretaceous. On the depositional setting of the Tethyan Himalayan sequences, Liu and Einsele made a detailed paleogeographic reconstruction of the Indian passive margin in south-central Tibet during Jurassic time. Hughes and Jell, on the other hand, used trilobites to establish early Cambrian biostratigraphy of the Himalayan region. Their study supports the hypothesis of the existence of a passive margin in northern India in the early Cambrian, which was later deformed and extensively intruded by granites in the latest Cambrian and earliest Ordovician.

The second part of the book consists of eight papers on the geology of the High and Lesser Himalayan crystalline rocks. Among them, three papers by Whittington et al., Pecher and Le Fort, and DiPietro et al., report the results of recent geologic mapping and petrological studies of the western Himalayan syntaxis region, a rather anomalous part of the Himalayan orogen that exhibits highly concentrated Cenozoic strain and extremely rapid exhumation during the past few

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million years. Two papers by Godin et al. and Musumeci and Pertusati deal with the structural evolution of the South Tibet Detachment System in the Annapurna and Khumbu Himal areas, respectively. Both papers present excellent, detailed structural analyses of rocks that experienced ductile deformation within the detachment system. Focusing mainly on the Main Central thrust, Manickavasagam et al. present a petrologic and structural synthesis of Garhwal Himalayan geology in northwestern India, while Upreti and Le Fort discuss the structural evolution of multiply stacked thrust nappes in the Lesser Himalaya near Kathmandu. Finally, Guillot et al. provide a thorough and insightful synthesis of metamorphic history of the High Himalayan crystalline rocks along the entire length of the orogen. Their analysis shows that the western Himalaya exposes higher-grade metamorphic rocks that were exhumed in the Eocene and Oligocene, whereas the eastern Himalaya exposes relatively lower-grade metamorphic rocks that were exhumed in the Miocene. They attribute this systematic variation in metamorphic and unroofing histories along the Himalaya to the counterclockwise rotation of the Indian plate during the Indo-Asian collision.

The last part of the book consists of six papers which focus exclusively on the geology of the Himalayan foreland. Kumar et al. present results of their sedimentologic and magnetostratigraphic studies of Neogene sediments in the western Himalaya north of Delhi. They show how the drainage system has evolved in the past six million years in the Himalayan foreland in response to the contractional deformation. Regarding the foreland geology in the western Himalayan belt, Pogue et al. provide a comprehensive synthesis of stratigraphy and structural geology of the Himalayan foothills in northern Pakistan. Several detailed geologic maps and tables of regional stratigraphic correlation accompany this synthesis. By comparing the geology between northern Pakistan in the west and the central Himalaya of India and Nepal in the east, Pogue et al. conclude that the structural divisions of the two regions are so drastically different that individual thrusts can not be directly correlated. Also in northern Pakistan, Jadoon et al. used surface geology, seismic reflection profiles, and drill-hole data to document the geometry and kinematics of a complexly deformed, thrust triangle zone in the Himalayan foreland. Their kinematic reconstruction implies a slip rate of ~22 mm/year across the Himalayan convergent front in northern Pakistan. The Cenozoic geology of western Pakistan is discussed by Schelling, whose paper provides a rare look at the detailed geology of the north–south trending transpressional system along the western margin of the Indian plate, where Cenozoic folds and thrusts are well developed. A portion of the thrust belt in southwestern Pakistan was mapped by the author which reveals the existence of an east-directed, thin-skinned thrust system. Despite the orientation of the thrust system being parallel to the movement direction of the Indian continent with respect to Asia, no strike–slip-related deformation was identified. This discovery led Schelling to conclude that strain must have been partitioned between strike-slip faults and thrusts along the north–south trending transpressional system. The last two papers of the book deal with mass wasting processes in the Himalayan foreland and neotectonics of the Indian subcontinent. Due to high annual precipitation, repeated catastrophic rainstorms, and periodic occurrence of major earthquakes, large-scale landslides and rock falls are widespread in the Himalaya. The paper by Uhlir and Schramm provides a detailed field description of a series of large landslides in Ankhu Khola Valley ~55 km northwest of Kathmandu. The paper by Bendick and Bilham reports the results of their search for evidence of buckling of the Indian continent. Their field observations and a review of tide-gauge data show that buckling of India, as constrained by the presently available data set, is not conclusively detectable.

Although this book adds a significant amount of new knowledge to Himalayan–Tibetan geology via a detailed documentation of specific regions and cases, the quality and geographic coverage of the papers are highly uneven. The content of the book is strongly biased toward Himalayan geology. Of the 21 papers, only two deal with the geology of the Tibetan plateau proper. Of the rest of the 19 papers, more than half deal with the geology of the westernmost part of the Himalayan belt in Pakistan and westernmost India. Such a geographic coverage in part reflects the uneven distribution of research activities in this vast orogenic system. It also highlights the need for more concentrated efforts in the future research in the eastern Himalaya and the heartland of the remote Tibetan plateau. Nevertheless, I think that the book is a valuable collection for those who are seriously interested in Himalayan–Tibetan geology. However, it is not a very good introduction for those who simply want to follow the most recent progress in the Himalayan–Tibetan research, because the majority of the papers in the book deal with local geologic problems and tend to be very descriptive. In this regard, general readers may quickly lose interest after encountering diverse geographic names and countless lithologic units which are only meaningful to the few who have worked in the area.

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