10th Himalaya–Karakoram–Tibet Workshop, Switzerland, 1995 – Conference report

Since 1985, a series of international annual meetings on the geology of the Himalaya–Karakoram–Tibet region have been held. Leicester, UK (1985); Nancy, France (1986); London, UK (1987); Lausanne, Switzerland (1988); Milan, Italy (1990); Grenoble, France (1991); Oxford, UK (1992), Vienna, Austria (1993); and Kathmandu, Nepal (1994). The 10th Himalaya–Karakoram–Tibet Workshop was held at Monte Verità, Ascona city, in Switzerland on April 3–8 1995. This was the second time that the Swiss held the Workshop, and it was organized by David Spencer, Jean-Pierre Burg and Cinzia Cervato-Spencer of the Institute of Geology, Swiss Federal Institute of Technology (ETH), Zurich. A combination of several factors made this meeting very successful. The ETH geologists have a long record of research in the Himalaya. Augusto Gansser (now 85) is a pioneer Himalayan geologist. His book *Geology of the Himalayas*[1] is a cornerstone of our geologic knowledge of the Himalaya. Gansser, former Chairman of the ETH Institute of Geology and now a retired Emeritus Professor, opened the Workshop with a fascinating talk on his 60 years of geologic work in various parts of the Himalaya, including his visit to the holy mountain of Kailash in 1936. Gansser and Arnold Heim (the son of the famous alpine geologist Albert Heim) published the results of their field work in Darjeeling, Kumaun and south Tibet in a treatise, *Central Himalaya*[2], an original and pioneering piece of work.

The Workshop was well organized. It was held in a charming spot in Switzerland: the ETH Conference Centre at the Alpine hilly station of Monte Verità facing the blue lake of Maggiore. Fees for accommodation and food were subsidized. And more important, 25 participants came from the Himalayan countries – thanks to the fund-raising efforts of the conveners. Some 144 participants from 17 different countries in Europe, North America and Asia attended the Workshop.

The Himalayan Workshops are a timely response to increasing interest among geologists in the Himalaya and Tibet. With an area of some 2.5 million km^2, a mean elevation of 5000 m above sea level and crustal thickness of about 70 km, the Tibetan Plateau is the world's largest highland. Its geological genesis is still an enigma. The Himalaya bordering the southern margin of Tibet is the loftiest and youngest mountain chain on earth. These spectacular mountains hold crucial keys to understanding how mountains resulting from the collison of continental plates form. They are also linked in many ways to the ecology and life in south Asia. Rivers, rain-bearing monsoon clouds, and sediments coming from the Himalaya support agricultural communities, accounting for more than 10% of the world's population; they are also responsible for the formation of the world's largest delta (the Ganges Delta) and the largest marine fan (the Bengal Fan). In recent years, it has also been suggested by Raymo *et al*[3] that the uplift and erosion of high mountains, especially the Himalaya–Tibet region, initiated the ice ages in the northern hemisphere during the past 3 million years. This is possible because high rates of chemical weathering and denudation absorb atmospheric carbon dioxide. This hypothesis was recently featured in a BBC documentary entitled 'Tibet: The Ice Mother', which was also shown at the Workshop.

It was, therefore, appropriate that a special session of the Workshop (with 10 oral presentations) be devoted to 'Geological processes related to uplift, exhumation and elevation of the Himalaya, Karakoram and Tibet'. This author began the session by presenting a sequential history of the uplift and denudation of the Himalaya throughout the Cenozoic, and emphasizing that the rise of the Himalaya seems to have occurred episodically in several distinct phases rather than a steady-rate slow history, a single big boom or merely chaotic events here and there. A one-hour Discussion Meeting had also been scheduled to discuss informally 'The mechanisms and consequences of Tibetan plateau uplift', led by Peter Molnar, a geophysicist who has been pondering on the geodynamic evolution of the Himalaya and Tibet since the early 1970s (Molnar and Tapponnier's influential paper[4] in *Science* is a must to read). During discussions on the uplift history, it seemed that two major ideological camps among Himalayan researchers exist: those who confine the uplift of the Himalaya and Tibet to the Miocene epoch (23–5 Ma) (e g. Molnar), and those who also add a major Quaternary (the past 1.6 million years) phase of uplift to this history (e.g. Gansser).

We know that the Himalaya grew out of the closure of the Tethyan Ocean, which once lay between India and Asia. We also know that the initial boundary between the Indian and Asian tectonic plates, along which Tethys was consumed and subsequent India–Asia collison took place, is represented by the Indus–Tsangpo Suture Zone, first suggested by Gansser in 1964. But the timing of this collision is controversial. Richard Beck of the University of South California presented a summary of his research group's recent paper[5] in *Nature* presenting stratigraphic evidence from the Indus Suture Zone in Pakistan that the collision took place between 65 and 57 million years ago (Ma) at least in northwestern Himalaya. Previously, Searle *et al.*[6] had argued that the collison was at 50 Ma. Another one-hour discussion was devoted to 'The timing of the India–Eurasia collision', headed aptly by Searle and Beck. Much stimulating discussion followed, and with a mood of 'back to the basics', the very definition of 'continental collision' was questioned. 'Continental collision' goes through an early stage of 'ocean floor termination', i.e. when the basaltic ocean floor is completely consumed by the process of subduction, and a later 'continental suturing', i.e. when the shallow marine facies changes into purely continental sedimentation. Beck defined the 'collision' as the former, and Searle as the latter But why not consider both of them as initial and end members of continental collision'? – ocean floor termination initiating the deformation of the colliding continents, prominently involving the accretionary prism, although shallow marine sedimentation is still going on, and continental suturing giving rise to land conditions at the site of the collision. There may be a time span of several million years between these two events. In other words, drifting and converging continental plates 'hit' each other before they actually 'meet' each other.

The Himalaya as we know consists of a series of fold-and-thrust belts. The backbone of these mountains is the Central Crystalline Zone of the Higher Himalaya, which has thrust over the Lesser Himalayan sediments and low-grade metamorphosed sediments along an orogen-scale rupture known as the Main Central Thrust (MCT). Some 20 years ago, Le Fort[7] proposed a model according to which simultaneous metamorphism and thrusting along the MCT brought 'hot' rocks of Higher Himalaya over the 'cold' Lesser Himalaya, causing an 'inverted metamorphism', i.e. metamorphism temperature–pressure conditions increasing upwards the mountains. This model was put forward to answer the enigma of inverted metamorphism in the Himalaya, first observed by several geologists in the late 19th century. There are, however, several other models to explain inverted metamorphism, including granitic intrusions in the Higher Himalaya, differential thrusting of each metamorphic zone, large-scale folding of metamorphic isograds, and ductile shearing distributed across the Central Crystalline rocks. Several talks addressed these issues, and a one-hour Discussion Meeting was devoted to '20 years of MCT models – Which ones work?'. It seems that to relate the Himalayan inverted metamorphism to the MCT a clear definition of the MCT along the strike of the Himalaya is required (Mr. X's MCT in Garhwal may be entirely different from Mr. Y's MCT in Nepal and hence confusing debates) and then it should be considered whether the MCT is a unique single structure in terms of Himalayan metamorphic history or rather a wide zone of multiple thrusts and shearing. Systematic thermochronological and thermobarometric data across the Higher Himalaya are also required to address the 'puzzle' of inverted metamorphism. In the end, we may find that each model, like the four blind men in the famous Indian parable, touches a certain aspect of 'the elephant' and conveys some but not all of the truth, of course with all the likeliness that some of the models are more truthful than others.

John Ramsay, a well-known structural geologist who succeeded Gansser at the ETH Institute of Geology and is now retired (himself succeeded by Jean-Pierre Burg, a convener of the Workshop) gave an overview of the discussions during the four-day Workshop. Ramsay remarked that as Emile Argand's 1916 map of the western Alps has changed little after eight decades, Gansser's 1964 geological map of the Himalaya is essentially valid to this day. What aspects of Himalayan geology may be expected to yield novel discoveries in the future? From the standpoint of structural geology, Ramsay emphasized the need to study the deformation history within the geological divisions of the Himalaya rather than merely viewing each orogen-scale division as an intact unit.

The Abstract Volume was published as No. 298 issue of *Mitteilungen aus dem Geologischen Institute*, ETH (349 pp). A proceedings volume of the Workshop containing selected, referred papers is scheduled to be published in *Tectonophysics* in 1996. A total of 48 oral presentations were made in 10 sessions: Tectonics and Palaeoclimate (2 talks), Southern Tibet (4), Tibetan Plateau (3), Himalayas of Pakistan and India (14), the Main Central Thrust (4), Central and Eastern Himalaya (14), Asian tectonics (4), and Applications of geochronology in the Himalaya (3). Some 52 posters were displayed and each poster was given three minutes to convey its main message, which was a good strategy to handle poster presentations. Overall, the coverage of topics was well balanced, although at the end of the Workshop there was criticism that usually in the Himalayan Workshops much attention is paid to 'hard rock' geology, while many important clues to understand the evolution of the Himalaya are hidden in its sedimentary record ('soft rock' geology). Interestingly, this criticism was made by two stratigraphers, Aymond Baud (Switzerland) and aurizio Gaetani (Italy) as well as by a tectonist, Vikram Thakur (India).

Most of the Indian participants at the Workshop came from the Wadia Institute of Himalayan Geology (Dehra Dun) and the Birbal Sahni Institute of Palaeobotany (Lucknow), which are, in my opinion, two of the best geoscientific research institutions in India, aptly named after the great Indian scientists: D. N. Wadia (1883–1969) and Birbal Sahni (1891–1949). India with its vast resources in Himalayan geology should try to hold one of the Himalayan Workshops in the future – before the new millennium begins!

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3. Raymo, M., Ruddiman, W. F and Froelich, N. J., *Geology*, 1989, **16**, 649–653.
4. Molnar, P. and Tapponnier, P., *Science*, 1975, **189**, 419–426.
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6. Searle, M. P., *et al.*, *Geol Soc. Am Bull.*, 1987, **98**, 678–701.
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