Kailas: geology of a sacred mountain

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Standing isolated on the barren Tibetan Plateau, the gleaming white snow-clad pyramid of Mount Kailas is a remnant of massive conglomerates formed within the Himalayan orogeny. Reached by an approach walk through the Himalayas in western Nepal, the circuit of Kailas on the pilgrims' kora path offers some views of the impressively exposed geology.

Mount Kailas is quite simply the most sacred mountain in the world. Remote as can be in the windswept and awfully cold highlands of western Tibet, it is revered by the great religions of Asia. To the Buddhists, it is the throne of the gods, known in the Tibetan language as Kang Rinpoche, the *Precious Snow Mountain.* The Hindus have provided its international name, Kailas; they regard it as the abode of their great god Shiva, and also as the physical embodiment of Meru, the mythical 'World Pillar' which rises to the centre of heaven. The Jain sects of India know Kailas as Ashtapada, where their founder gained spiritual enlightenment. And for Tibet's pre-Buddhist Bonpo religion, Kailas is the *Nine Storey Swastika Mountain,* the very soul of their world.

For all its illustrious credentials, Kailas reaches only to the unremarkable altitude of 6675 m. It attracts its reverance and awesome symbolism largely due to the fact that it is a singularly beautiful mountain. It is an almost perfectly symmetrical four-sided pyramid, draped with a veneer of the cleanest snow (Fig. 1). A fortuitous sequence of strong conglomerates has been eroded into profiles which allow all old snow to avalanche down precipices directly into the melt zone; so there are no glaciers of dirty ice, except a very small and clean one tucked away under its north-eastern flank. It has neither long shoulders nor neighbours which are high enough to retain any snow cover. Instead, the great snow pyramid rises in splendid isolation above the barren mountains and plains of the Tibetan Plateau. In the clear light of the high altitudes, its pure white snow achieves almost luminous qualities, and Kailas is a beacon which can be seen from afar in any direction (Fig. 2).

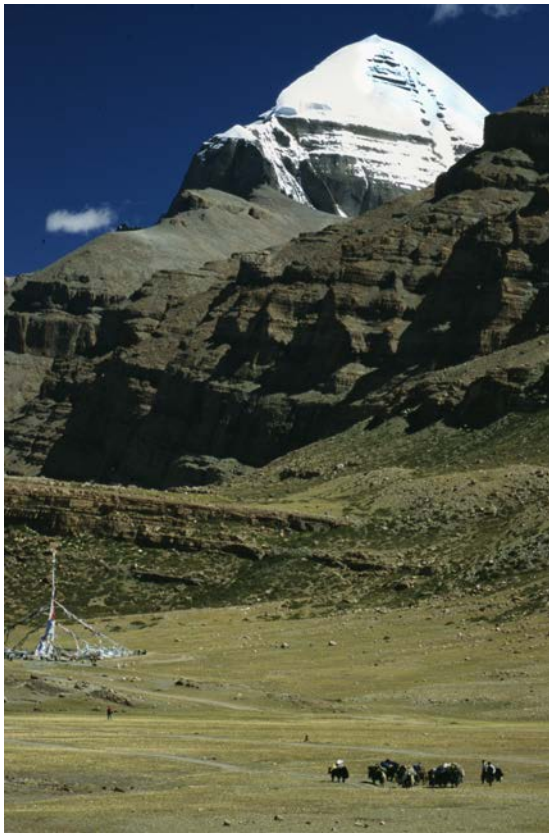


Fig. 1. The gleaming snow cone of Mount Kailas towers above the conglomerate walls of the Lha Chu canyon when viewed from close to the Chukku monastery. (All photos by Tony Waltham.)

Fig. 2. Mount Kailas rises from the barren ridges of the Kailas Range when viewed from the south across the Barga Plains and the bare rolling hills which lie along the Zangbo Suture. In the left foreground, the Chiu monastery stands on a crag of volcanics with a view out over the holy lake of Manasarovar. Kailas is 38 km from the monastery.

So it is not surprising that Kailas has achieved almost supernatural status. Pilgrims have been coming to it for over a thousand years, although westerners have only known of its existence for about 200 years. Buddhist pilgrims have walked or ridden yaks across the vast wastes of the Tibetan Plateau, from Lhasa, Ladakh, Qinghai or Bhutan. China's invasion of Tibet almost put an end to these pilgrimages, but the new Chinese roads (actually very rough tracks) now allow most Buddhists to come by truck. Hindu holy men, the *sadhus,* have a shorter approach from India or Nepal, but have to cross the high Himalayan passes.

No pilgrim comes to climb the mountain; Kailas has never been climbed and never will be, for it is the abode of the gods. Instead, they come to complete a *kora* (*parikarama* in Sanskrit or Hindu), a clockwise walk around the sacred site (alhough the Bonpo go round in the opposite direction). There are valleys on both

east and west sides of Kailas, draining to the Barga Plain to the south, and linked by the pass of Dolma La which climbs to nearly 5700 m around the north side (Fig. 3). The kora is therefore just over 50 km long. For a westerner it is a delightful three days of trekking through a stunning landscape; for an acclimatized Tibetan it is a single day's brisk walk. A *sadhu* in bare feet takes longer, as does a truly dedicated Buddhist who postrates himself round the entire kora. Liberation into a better world is assured for Buddhists and Hindus alike who complete 108 koras, and there is a steady stream of monks and *sadhus* who set out on this monumental task of devotion.

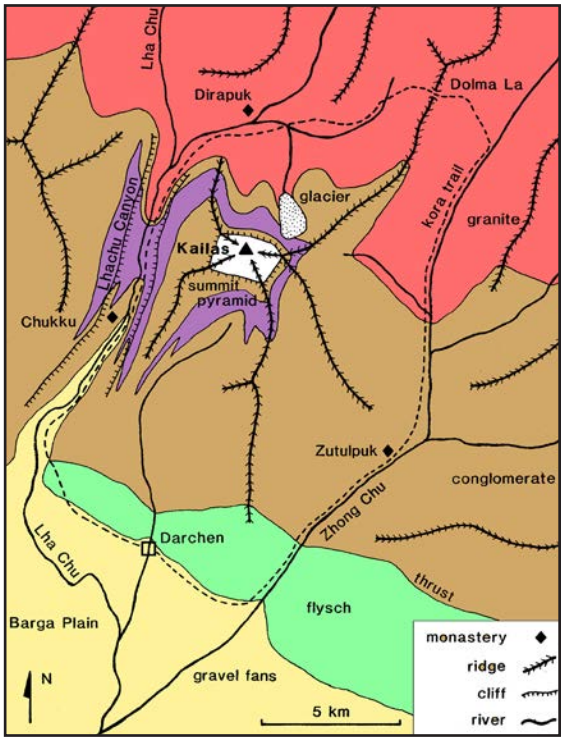


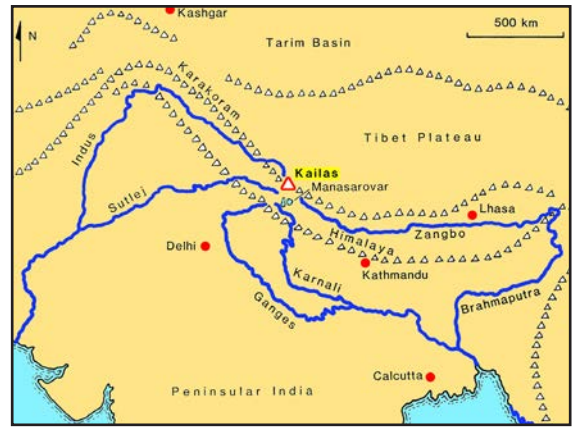
Fig. 3. Outline geological map of Mount Kailas and the valleys which provide the kora route around it. The open ornament in the conglomerate marks the massive facies; this interdigitates with the bedded conglomerates and the outcrops are much more complex than can be shown at this scale.

Asian watershed

In Hindu cosmology, Mount Meru is the mythical peak of the universe, from which flow all the rivers of the world. Kailas is seen as the physical embodiment of Meru, because it is so close to the source of the great rivers of Asia.

The drainage lines of central Asia have had to fit themselves around the Himalayan mountain chains, which have largely risen to their lofty heights in times since the main rivers were established. The Kailas Range is virtually an eastern continuation of the Karakoram, lying just north of the main Himalayas. Between these two mountain chains, the Indus and the Zangbo (Tibetan for *The River,* which subsequently becomes the Brahmaputra) are the two trunk rivers, draining west and east, respectively, before they each find their own way through the Himalayas. The highest headwaters of both rivers are within sight of Kailas. Just

Fig. 4. The location of Mount Kailas within the Himalayan mountain chains, between the Tibetan plateau and the Indian sub-continent, with the major rivers all radiating from it. Lake Manasarovar drains into the salt lake of Rakas Tal, immediately to its west, which has no outlet.



south of the mountain, the Sutlej rises, drains west through the red canyonlands of Tsaparang, and cuts through the Himalayas to join the Indus in lowland Pakistan.

The source of the Ganges, the most holy of Hindu rivers, is in the Himalaya directly southwest of Kailas; one of its tributaries, the Karnali, rises much closer to Kailas before it takes a tortuous course through the gneiss ridges of the Nepal Himalayas. The geography of Kailas is certainly awesome; the rivers, the watersheds, the routeways all point right to it (Fig. 4).

Direct runoff from Kailas gathers in the rocky streams on each side of the mountain. These drain south onto very broad alluvial fans on the windswept Barga Plains, and ultimately into the salt lake of Rakas Tal, trapped between the new mountain chains. Just to its east, Manasarovar is a deep blue expanse of water, immensely holy to Hindus, who regard it as formed from the mind of Brahma. Because its overflow escapes to Rakas Tal, Manasarovar is not salt, and it is the highest freshwater lake of its size in the world; it is yet another element in the symbolism of Kailas.

Kailas conglomerates

The clean lines of the sacred mountain owe much to their formation in a series of unusually massive conglomerates, which were named as the Kailas Conglomerates by the Swiss geological expedition that passed by in 1936. Although only of Palaeogene age, these are strong rocks, well lithified with a siliceous cement. They have an exposed thickness of 2000 m, although their top is not seen, and they form the entire pyramid of Mount Kailas. Massive bedding is a feature of the conglomerates. A single unit, lacking any major bedding planes in a thickness of more than 300 m, forms the precipitous walls of the northern half of the Lha Chu canyon, on the west side of Kailas (Fig. 5). There is significant lateral change of facies in all directions, and there is no comparably thick bed on the eastern side of the kora where the Zhong Chu

Fig. 5. The view north up the Lha Chu valley where it widens out from its canyon, with Kailas high above to the east. The facies change in the conglomerates is clearly seen in the cliffs on the right; the massive unit forms the steepest unbroken wall seen in profile in the canyon, and its more bedded continuation forms the nearer terraced cliffs.

Fig. 6. The north face of Kailas seen past the prayer flags at the prostration point above the Dirapuk monastery.

Fig. 8. An outcrop of Kailas Conglomerate about 3 m across. The cobbles and pebbles are mostly of granite and light volcanics, with a few blocks of darker glassy lava.

valley is much more open. Individual beds there and on the summit faces are just tens of metres thick.

Local dip is a few degrees to the south, but the conglomerates are otherwise little deformed. Jointing is also on a massive scale, so that the rock forms steep cliffs, little affected by fracture weaknesses. The nearly horizontal bedding planes and nearly vertical joints are picked out by the terraced snowfields and gullies on each of Kailas's four faces (Fig. 6). On the south face, a fortuitous combination creates the almost complete swastika outline – an important religious symbol for pilgrims of the Bonpo sect.

The kora route over the Dolma La lies on Mesozoic granite (Fig. 7). This lovely fresh rock contains feldspars up to 20 mm across, with smaller hornblendes and biotites; it has numerous small, dark xenoliths, and there is one zone with a gneissic texture, but no migmatite is seen on the kora trail. The granite forms a basement to the sedimentary sequence, but there is major northward overlap by the conglomerate cover. The palaeosurface of the igneous rock forms a buried upland which rises steeply to the north, and marks the northern boundary of the conglomerate outcrop.

Fig. 7. Just east of the Dolma La, the kora route crosses a felsenmeer of frost-shattered granite blocks. The corrie on the right has lost its Pleistocene ice, but an impressive suite of moraine ridges survives from the glacier. The small lake drains out through the permeable till of older end moraines, towards the Zhong Chu valley below the granite peaks in the left distance.

Predictably, pebbles in the conglomerate include many of the granite, but there are far more of porphyritic volcanics, and the proportion of volcanics appears to increase higher in the succession. Most of these are broadly andesitic in composition, but there are isolated pebbles of rhyolite and obsidian (Fig. 8). Their origin is likely to be an Eocene volcanic suite which marked the contemporary plate boundary; some of these volcanics survive at outcrop in the mountains north of Kailas.

Tibetan terranes

It is now recognized that the great high plateau of Tibet owes its origins to terrane accretion on a uniquely grand scale. Between Permian and Cretaceous times, three fragments of continental material drifted north attached to the largely basaltic floor of the Tethys Ocean. Where the

oceanic plate was subducted, the continental units were accreted onto the margin of the overriding Asian plate and became the three Tibetan terranes. The Indian subcontinent moved north on the same plate movement, and its Palaeogene collision with the Asian plate marked the final demise of the Tethys Ocean and the initial rise of the Himalayas. The convergence was so powerful that the accreted zones of Tibet were caught in massive north–south compression. Some extrusion occurred towards the east, but the main result was that the terranes were shortened and thickened; the consequent surface uplift created the Tibetan Plateau.

Immediately south of Kailas, the trough of the Barga Plains marks the Zangbo Suture, which separates the Lhasa Terrane from the Himalayas. This is a line of massive shearing and thrusting which was active along the Himalayan margin. Exposed at the mouth of the Zhong Chu valley, thrust sheets of flysch and ophiolitic serpentinite overlie the broken ends of the Kailas Conglomerates on the fringe of the largely buried suture zone (Fig. 9). Convergence at this plate boundary continued through the Tertiary, even though the Indian and Asian continental blocks were by then tight against each other. Massive underthrusting culminated in the late Tertiary uplift of the Himalayas, and to a lesser extent the Kailas Range. Today's major rivers were established as these mountain chains started to rise; so the Indus and Zangbo largely evolved in the suture between the plate-edge mountains. All the rivers were then forced to cut their own deep gorges through the Himalayas as the mountains continued to rise throughout the Tertiary and Quaternary. Remote behind the midpoint of the Himalayan chain, Kailas suffered minimal fluvial erosion, and survived because the rivers' headwaters radiate away from it.

The rocks of Kailas appear to be a relic of an earlier stage of activity on the same plate convergence zone. Subduction during the early Eocene created a chain of andesitic volcanoes a little way north from the southern edge of the Lhasa Terrane, which was by then the leading edge of the Asian plate. These volcanic cones probably grew to great heights, and were then further uplifted on top of the granite within the rising orogenic belt. Facing the last remains of the Tethys Ocean, they collected orographic rainfall and were subject to powerful erosion on their steep slopes. The coarse detritus was carried south and deposited in huge alluvial fans on the gently sloping granite ramparts (Fig. 10). When buried and lithified, these became the Kailas Conglomerates, and their overall grain size decreases towards the south. They appear to be essentially a molasse type of material, directly associated with the orogenic uplift. The rounded pebbles of lava and granite are mature enough to suggest erosion of an established mountain zone. Pyroclastic flows and lahars may well have existed, but they have been re-eroded to form the conglomerates seen in the Kailas region today.

Fig. 10. The north face of Kailas, seen from the climb to the Dolma La. The bedded conglomerates, which form the snowbound mountain, were deposited as debris fans from a palaeo-upland of granite, of which a remnant forms the shadowed ridge in silhouette.

The Kailas Conglomerates may therefore be recognized as a by-product of the broader Himalayan orogenesis. In similar vein, the mountain could be described merely as an erosional remnant of a pile of orogenic debris. But the geology provides only the bones of a mountain. Kailas is much more; its rocks, its location and its profile combine with an undefinable magical quality to make it one of the most distinctive mountains in the world.

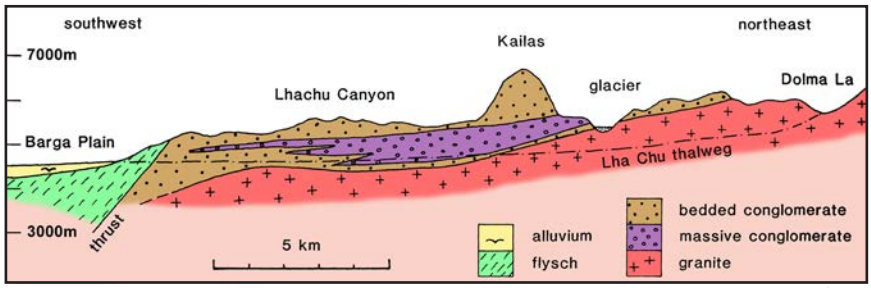


Fig. 9. Sketch geological section through Mount Kailas and its foothills southwest from the pass of Dolma La; geological symbols are as in Fig. 3.

Suggestions for further reading

Dewey, J.F., Shackleton, R.M., Chang, C. & Sun, Y. 1988. The tectonic evolution of the Tibetan Plateau, *Philosophical Transactions of the Royal Society, London, Series A,* v.327, pp.379–413.

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