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Origin of the Phoksundo Tal (lake), Dolpa district, western Nepal

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ABSTRACT

The typical geomorphic features of a landslide such as horseshoe shaped steep scarp and debris mounds are observed adjacent to the southeastern end of the Phoksundo Lake. The mounds consist of rock detritus ranging from cobble size to boulders of several tens of meters in diameter. The total volume of the debris deposited on the left side of the Bauli Gad is estimated to be about 1.5 billion m^3. The Phoksundo Lake is originated due to landslide damming resulting from a mountain collapse. The detritus is overlying the glacial drift. It implies that one of the glacial valley walls became unstable after the glacial retreat and collapsed over its own glacial drift, probably triggered by an earthquake. The mountain collapse may have occurred around 30 to 40 ka, just after the early substage of the glacial advance in the Last Glacial age.

INTRODUCTION

The Phoksundo Tal (lake) is the second largest lake in Nepal. It is about 5 km long, 800 m wide and covers an area of 4.5 km^2. It is located along the Bauli Gad canyon incising the southern fringe of the Dolpa plateau behind the Dhaulagiri Himal (Fig. 1, 2 and 3). The lake is over 200 m deep and the lake water level lies at about 3552 m above msl. The water drains out from the southern end of the lake through a 170 m high waterfall, giving rise to the highest waterfall in Nepal.

There is a legend on the origin of the Phoksundo Tal. According to the legend, in the eighth century a witch from Tibet belonging to an indigenous animistic belief called Bonn submerged the canyon along with the village by flooding it as a revenge for the betrayal of the villagers.

ORIGIN OF THE PHOKSUNDO TAL

A field survey was carried out in 1991 in the Phoksundo Tal area. Aerial photographs and topographic maps of 1:50,000 scales were also studied. A large steep scarp of a a horseshoe shaped landslide and a slightly rugged but gently sloping

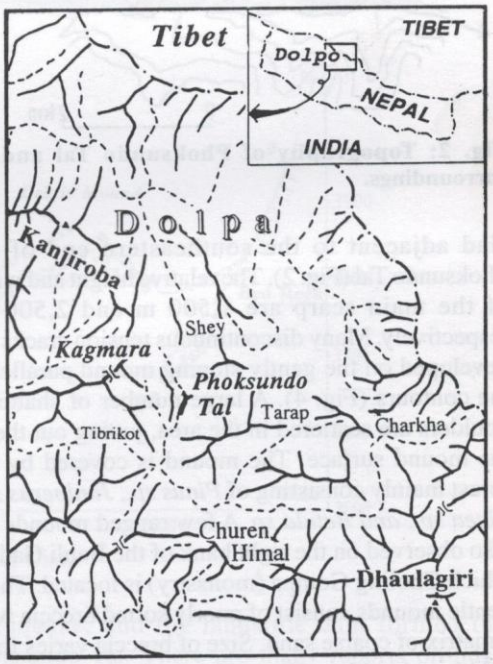

Fig. 1: Location map of the study area.

mound in front of the main scarp occur along the foot of the main scarp on the left bank of the Bauli

Fig. 2: Topography of Phoksundo Tal and its surroundings.

Gad adjacent to the southeastern end of the Phoksundo Tal (Fig. 2). The relative height and width of the main scarp are 1,500 m and 2,500 m, respectively. Many discontinuous tension cracks are developed on the gently sloping mound parallel to the contours (Fig. 4). A large number of shattered boulders are scattered in the area, jutting out the of the mound surface. The mound is covered by the forest mainly consisting of *Pinus sp., Juniperus sp., Picea sp., and Betula sp.* A few ragged mounds are also observed on the right bank of the Bauli Gad on which Choling Gompa (monastry) is located. These gentle mounds consist of poorly sorted breccia with a matrix of coarse sand. Size of breccia varies form cobble to boulder of several tens of meters (Fig. 5). A huge rock mass is recognized at Loc. 1 (Fig. 6). Such facies of the stratum is indicative of detritus produced by dry avalanches. Considering the characteristic landform adjacent to the southern end of the lake and the stratum of which the mound is composed of, the Phoksundo Tal must have originated by a landslide damming. The detritus produced by the collapse of a mountain chunk of 2.5 km x 1.5 km dammed up the canyon of the Bauli Gad giving rise to the Phoksundo Tal. A part of the detritus in the upstream section must have been submerged by the lake. The total volume of the detritus is estimated to be about 1.5 billion m^3. The secondary collapse of the detritus is also recognized in the southern part of the landslide dam adjacent to the fall, marked by a horseshoe shaped scarp (Fig. 2). A large landslide or mountain collapse of a similar scale also occurred in Mt. Bandai, Japan in 1888 which was related to the volcanic activity.

Presently, the debris mound is incised by the Bauli Gad. Terraces of more than two levels have developed on the detritus on both sides of the stream. (Fig. 4). In the past, the lake level was 20 m higher than at present. It may imply that there was more precipitation in this region in the past and this can be correlated to pluvial period in Holocene.

Geological and geomorphological survey indicate that the Phoksundo Tal was formed due to damming of Bauli Gad by a mega scale mountain collapse. The detritus damming up the stream overlies a light brown sediment, which is intensively eroded like pleats. The bed is also distributed outside of the detritus and forms ridge like topography and is subjected to intense erosion. Towards the downstream, the ridge extends to an altitude of 3,200 m above msl. The sediment is composed of angular to subangular grains rich in fine sand or silt and shows some amount of sorting. This characteristic sediment is a glacial till, and the ridge like topography made by these sediments represent the terminal moraine (Fig. 7). The glacier presumably advanced from the eastern flank of the Kanjiroba Himal (Fig. 7). The present outlet of the lake water is on the bed rock in the southwestern end of the lake, and is not located on the detritus or the till deposit. A big cave which is recognized at the boundary between the till and the detritus on the south facing wall of the landslide dam is thought to be a former drainage tunnel (Fig. 6).

The development of the Phoksundo Tal along the Bauli Gad valley may be summarized as follows: A valley glacier occupied the Bauli Gad valley down to

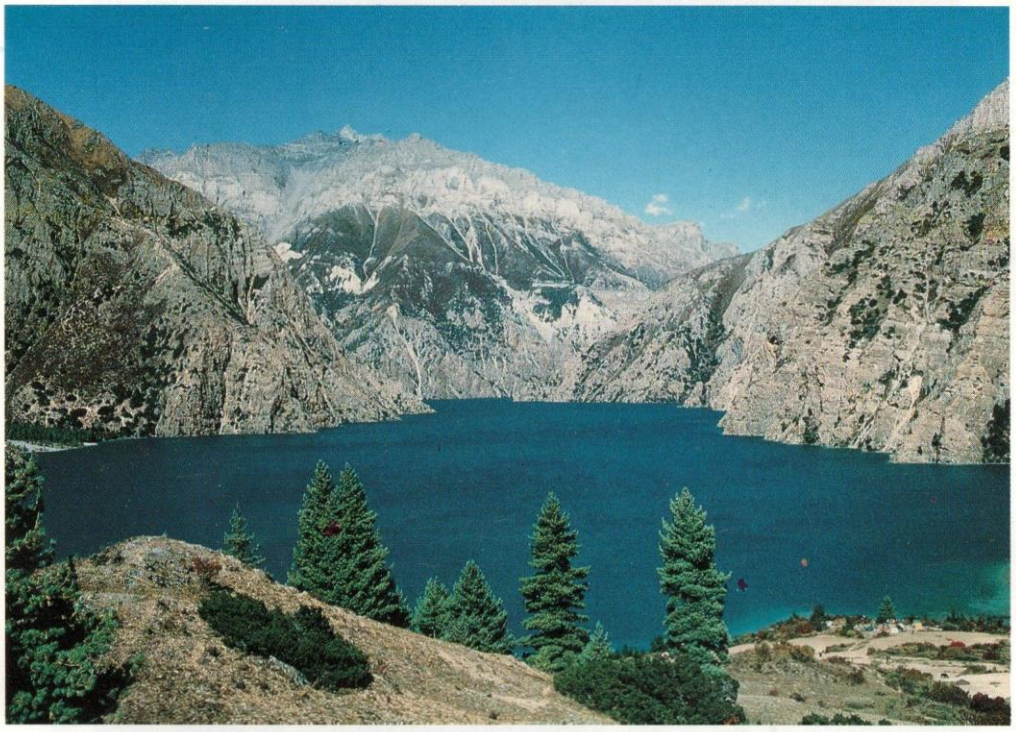

Fig. 3: An overview of Phoksundo Tal from debis mound.

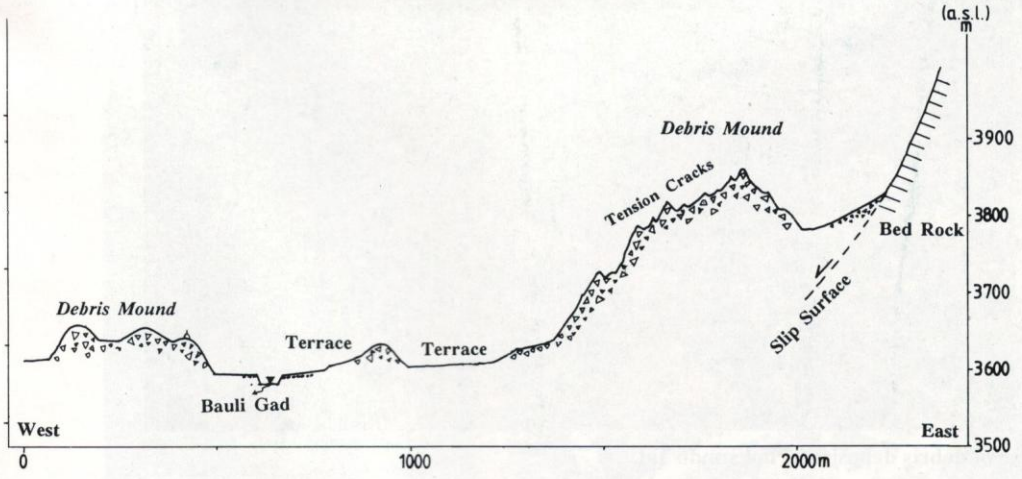

Fig. 4: Geomorphic profile of debris mound damming up Bauri Gad.

3200 m above msl in the past glacial age, forming a large U-shaped valley behind the terminal moraine (Fig. 8). After the retreat of the glacier, however, one of the side walls of the U-shaped valley became unstable due to release of the lateral load. Subsequently, the mountain collapse occurred perhaps triggered by some events such as an earthquake, and the landslide dam formed the Phoksundo Tal. There are many reports on huge landslide dams in Asia which were sometimes very disastrous and led to catastrophe (Li, 1995). "Tianchi" lake in Urumqi, Sinkiang Uigrs Autonomous Province, China, is the most typical landslide dam in Tibet, China (Deng and Ding, 1990).

Fig. 5: Nature of debris deposit of Phoksundo Tal.

AGE OF PHOKSUNDO TAL

The detritus in the area is mostly covered with loess in which intercalate reddish soil layers (Loc. 2, Fig. 9). In Nepal, weathered red soil occur on the terraces older than 30,000 years before present (Yamanaka and Yagi, 1984). There were two major substages of glacial advance in the Last Glacial age, the early and late substage. The ages of these substages are thought to be 50-40 ka and 20 ka, respectively. Scale of glacier in the early substage is estimated to be larger than that in the late substage and the former advanced downward to lower position of ca. 3,000 m above msl than the late one (Iwata, 1976; Yagi and Minaki, 1991). The lowest end of the glacial till in the Phoksundo Tal area is located

Fig. 6: Main scarp of landslide, debris mound, damming up the canyon and glacial till overlain by detritus, southern flank of landslide dam of Phoksundo Tal.

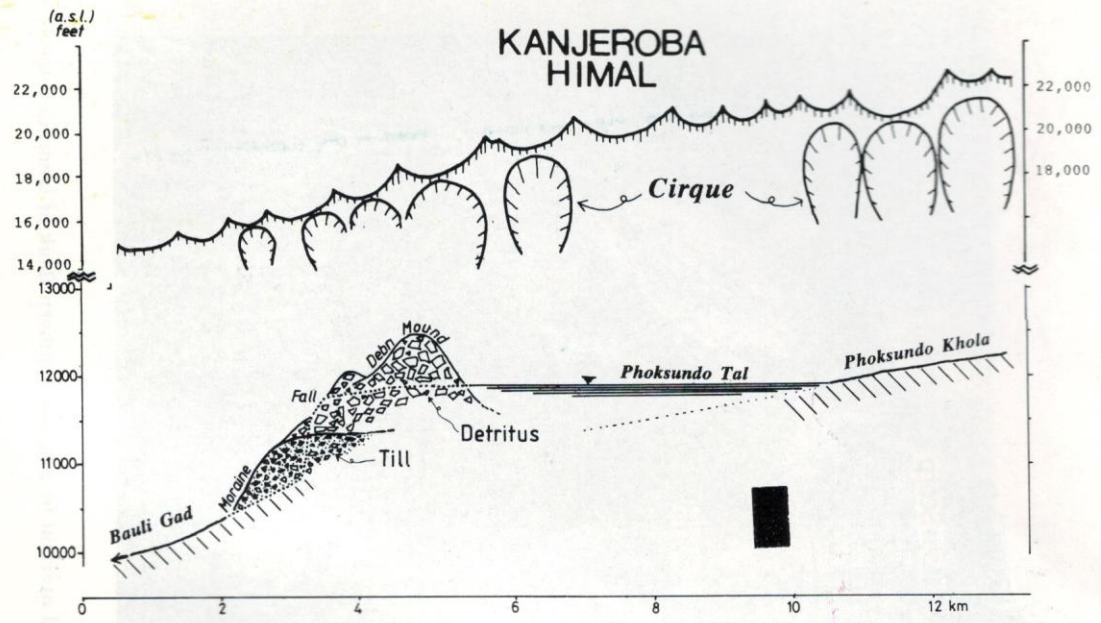

Fig. 7: Longitudinal profile along the Phoksundo Tal.

Fig. 8: Glacial till forming moraine ridge, southern downstream of the Phoksundo Tal.

an elevation of 3,200 m above msl. These facts indicate that the Phoksundo Tal was formed about 30-40 ka before present, just after the early substage of the glacial advance in the Last Glacial age.

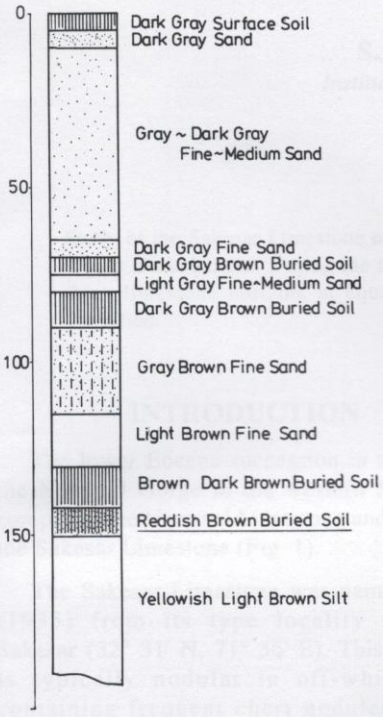

Fig. 9: Columnar section of surface soil at Loc. 2.

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