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General characteristics of landforms along the main valleys in western Bhutan

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ABSTRACT

The author has several geological, geomorphological and pedological aims in our project in Bhutan (Figs. 1, 2) as follows:

(1) Geomorphological and photo-interpretational studies focused on characteristics of landform and landscape changes after 1960's detected from declassified CORONA photographs of USGS, SPOT images, JERS-1 images and field survey.

(2) Geomorphological and pedological studies focused on characteristics of microlandforms and soil properties at permanent monitoring vegetation plots.

(3) Geomorphological observation and geochronological studies on dating of various Quaternary deposits related to landform and Quaternary environmental changes.

(4) Geomorphological and geohistorical studies focused on hazard map.

Then several provisional results are obtained as the belows.

Bhutan has been subject to dangerous glacial lake outburst floods (GLOFs) because there are so many glaciers and glacial lakes in high mountainous area. On October 6, 1994, a GLOF happened in the upper drainage of the Pho Chu (River) which is one of tributaries of the Mo Chu (the Sankosh River) (Ageta et al., 2000; Fig. 3). On the basis of hydrological data we have clarified the characteristics of discharge along the Mo Chu, showing seasonal changes related to monsoon, and that the discharge at the GLOF in 1994 was about 3 times as much as the maximum discharge during this year (Fig. 4). Using several satellite photos and images, the author showed actual changes between the status of the glacial lake, including other ones, in 1960's (before the outburst; Fig. 5) and 1994 (after the outburst; Fig. 6).

Topographic, geological and pedological surveys were performed at and around the next three vegetation plots along the Mo Chu valley.

a. Chu Chu Mero plot near Gasa village
b. Gayza plot near Gayza village
c. Tashitang plot near Tashitang village

The Chu Chu Mero plot includes ridge top, slope and valley bottom. The pH
values of surface humic soil are lower at the ridge and higher on the slope. The EC values of surface humic soil are higher at the valley bottom and lower on the slope. Thickness of litter and humic layer including litter is larger at the ridge and valley bottom than that at the slope. Thickness of weathered bedrock and/or unconsolidated materials is the largest at the valley bottom and larger at the ridge than on the slope. There seem to be some relationships between these characteristics and the vegetation. At Gayza plot the author got different topographic, geological and pedological characteristics. Weathered and/or consolidated layers on ridges are much thicker here than those at Chu Chu Mero plot. It seems to be related to the landcreep topography.

Along the Mo Chu and the Punakha Chu, fluvial terraces are classified into the Higher, Middle and Lower surfaces in terms of relative height. Though the terrace deposits of each surfaces mainly consist of sub-rounded to rounded boulders and cobbles, they locally contain intercalated sand layers. Furthermore varved lake sediments about 20 m thick are present to the north of Wangdiphodrang, though the original geomorphic surface related to the silt sediments does not remain. The author has obtained several samples of these sand and silt sediments for dating, and dated several Quaternary ages using OSL (Optically Stimulated luminescence) dating technique. On the basis of them he has presented Quaternary geohistory along the Mo Chu (the Sankosh River).

Mass movement is very active in the Bhutan Himalaya owing to the heavy intensities of rainfall, the sharp earthquakes and steepness of mountain slopes. For example, in and around Tala, south-western Bhutan, huge traces of slope failures occur at some places. Our geological survey shows landslides took place by shearing on a bedding plane in the area underlain by metamorphic rocks. As a result, river channels shift in the dip direction of the bedding plane and asymmetric valleys have developed. Along the Mo Chu there is a typical asymmetric valley where a lot of landcreep masses are on the dip slope. Since mass movement like the above sometimes induces a natural disaster, geomorphological and/or hazard maps are useful for mitigation of the damage. Therefore the author tried to make an initial geomorphological map along the Mo Chu and to discuss on hazard of natural disaster due to mass movement and a flood.

(Reference)
Fig. 1  Map showing the study area of the Bhutan expeditions
Fig. 2 Satellite photo of northern Bhutan
(copyright: SOJUZKARTA 1985)
Fig. 3 Expansion of Lugge Tsho (GLP12) and Drukchung Tsho (GLP13).

(Ageta et al., 2000)
Fig. 4 Discharge along Mo Chu (River) in 1994
Fig. 5 Glacial lakes in Lunana, northern Bhutan

(15 Nov., 1968; Data available from USGS EROS Data Center, Sinoux Falls, SD)
Fig. 6  Spot Image of northern Bhutan on 25 December, 1994

(copyright: CNES)