RIVER TERRACES AND CRUSTAL MOVEMENT IN THE AREA AROUND NARAYANGHAT, CENTRAL NEPAL.

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सारांश

क्षेत्रीय स्तरमा भू–पृष्ठको चालको प्राकृतिबारे जानकारी पाउन नारायणघाट आसपासका सिवालिक पहाडहरूमा खोलाले बनाएका टारहरू तथा त्यहाँका विभिन्न भू–आकृतिको अध्ययन गरिएको थियो। हवाई चित्रको अध्ययन तथा माटोको रंग दाँज्ने काम समेत गरिएको उक्त भू–सर्भेक्षण कार्यको आधारमा टारहरूलाई ६ समुहमा विभाजन गरिएको छ। टारका सतहहरू विकृत भएको पाइएको छ र विगत समयमा काली गण्डकी नदी बगेको सतहको चिन्ह हालको सतह भन्दा १७० मिटर माथि पाइएको छ। तद्नुरूप, बितेको अन्तिम अन्तर हिमपात काल अगावै देखिने त्यस इलाकाका शिवालिक शृंखलाको क्रमशः उत्थान भएको ठहर हुन्छ।

ABSTRACT

The river terraces and hill landforms have been surveyed in the Siwalik mountains around Narayanghat in order to understand the nature of regional crustal movement. The river terraces are classified into six groups by airphoto interpretation and a field survey including soil colour comparison. Deformation of terrace surfaces were found, and a past course of the Kali Gandaki has been identified to exist at an altitude of 170m high above the present river bed. Accordingly, the Siwalik mountains in the area have upheaved since pre-Last Inter-glacial time.

INTRODUCTION

One of the important ways to know the regional trend of vertical crustal movement is a series of measurements of relative height of a chain of river terraces along a river course. River terrace deformation along the Kali Gandaki river which originates from the northern side of the Great Himalayan Range has been investigated in order to know the nature of the crustal movement in Central Nepal (Yamanaka and Iwata, 1982; Iwata, et al. 1984). The Kali Gandaki may be one of the most well-investigated rivers in Nepal, because river terraces are extensively developed along its course (Fort, 1976; Fort et al., 1982; Sharma et al., 1980).

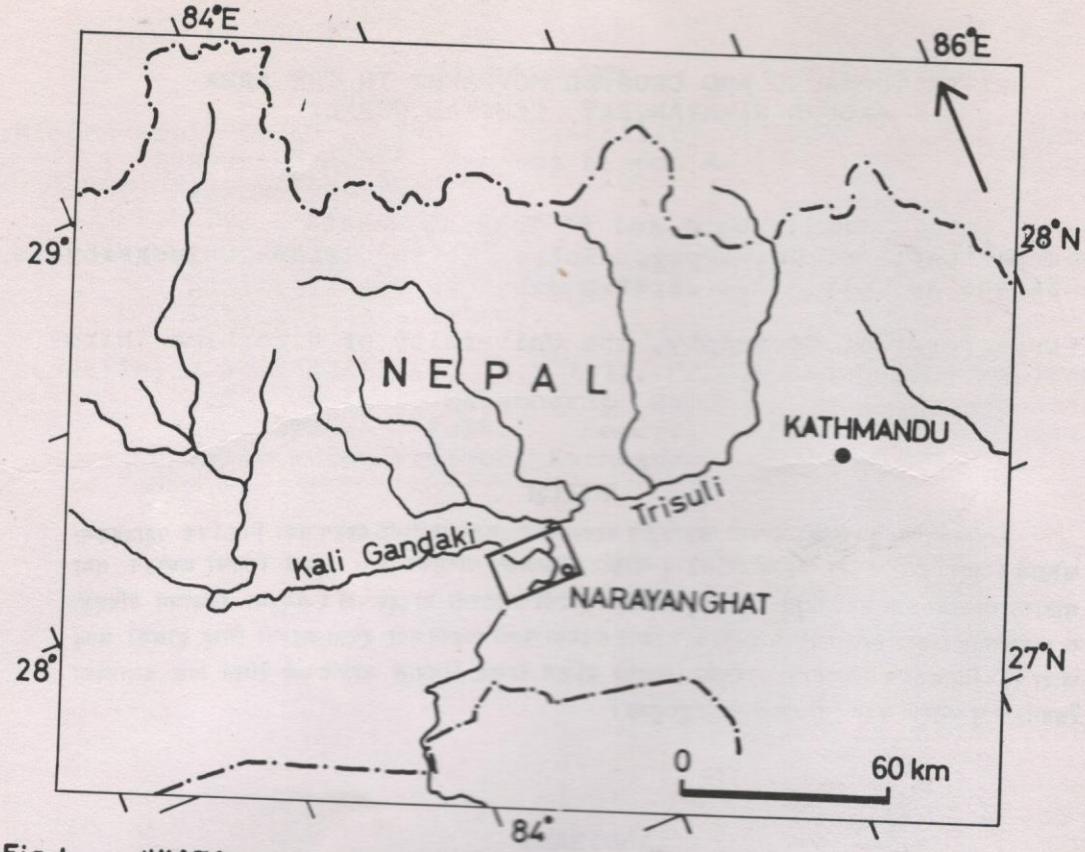

Fig. 1 IWATA & NAKATA 70%

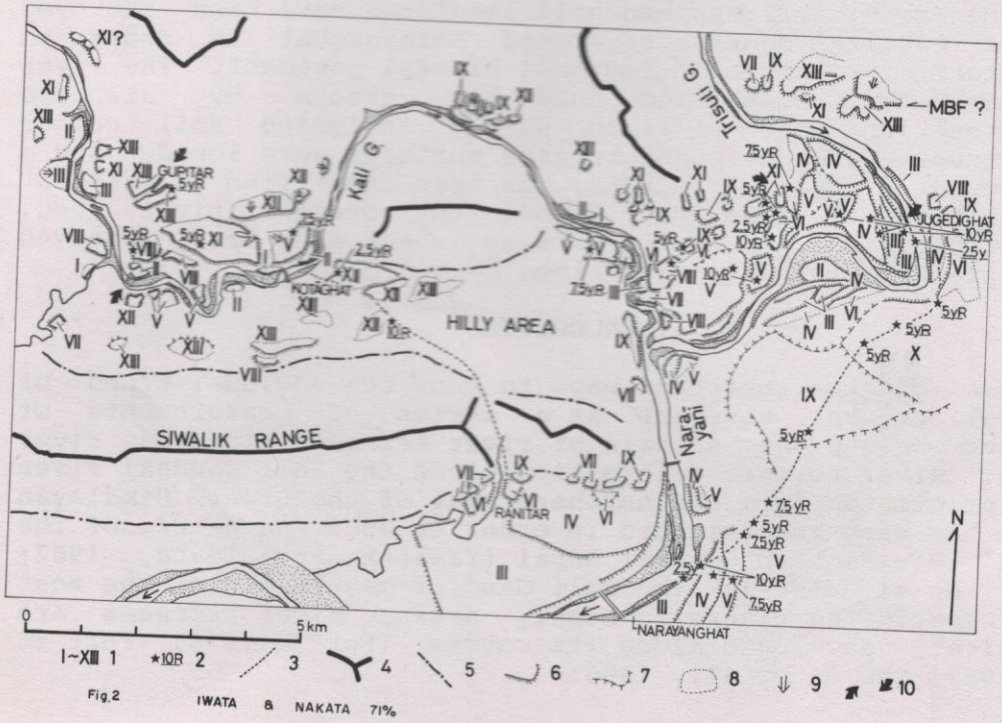

Fig. 2 IWATA & NAKATA 71%

The Kali Gandaki crosses the Main Boundary Fault in the area around Narayanghat, Central Nepal. The Main Boundary Fault is one of the most important geologic boundaries in Nepal. It separates the young Siwaliks of the Sub-Himalayas from the pre-Tertiary rocks of the Lower Himalayas on the north. Geomorphologically, it has been known as the major important boundary between the Mahabharat Range, and the Siwalik low mountains and hills. In many places, it has been observed as active faults, but no apparent active fault occur on the terraces in the area around Narayanghat (Nakata, 1982; Nakata et al., 1984). It is a problem whether these terraces show distinct deformation at and around the Main Boundary Fault.

The purposes of the present study are to make clear the following items: 1) classification of the river terraces, 2) deformation of the river terraces, and 3) relation between the terrace gravels and the Siwalik conglomerate, and to discuss the characteristics of crustal movement in the area.

The field survey was carried out in December, 1982, as a part of the research project for "the Crustal Movement on the Nepal Himalayas". In order to check the river terrace classification made by air-photograph interpretation, soil colour o the terraces and hills was recorded by comparison with Munsel Soil Colour Charts, in addition to the observation of the terrace morphology and sediments. Then, the relative heights of each terrace above the river bed were measured by a pocket altimeter.

The study area is situated at the northern border of the Chitwan dun and the Main Boundary Fault runs roughly in east-west direction at the northern end of the study area (Fig. 1). The Kali Gandaki and the Trisuli Gandaki change their names to the Narayani Gandaki below the confluence and flows out of the mountains into the wide dun valley, as the Narayani forms a wide fan.

CLASSIFICATION OF RIVER TERRACES

Distribution of the river terraces in the study area is shown in Fig. 2. It shows rather discontinuous distribution so that the correlation of the terraces is easy neither on the air photographs nor in the field. Thirteen levels of the terraces were recognized, and successively, they were divided into 6 groups according to their morphological features and the soil colour which was observed in the field (Table 1). Typical cross sections of the river terraces are given in Fig. 3.

Table 1 Classification of the river terraces around Narayanghat and measured soil colour

River Terrace Classification		Soil colour		
		Kali	Trisuli	Narayani
Highest	XIII			
	XII	5 YR 10 R		
Higher	XI	2.5YR 5 YR	5 YR	
	X	5YR	2.5YR 5 YR	
	IX			
	VIII	5YR		
M1	VII			
Middle M2	VI		5YR	5YR 7.5YR
	V		7.5YR 10YR	
	M3 IV	7.5YR	10YR	7.5YR
			10YR	10YR
	III			
Lower	II		10YR	10YR
	I		10YR	10YR
Present riverbed			2.5Y	2.5Y

Table 1 IWATA and NAKATA

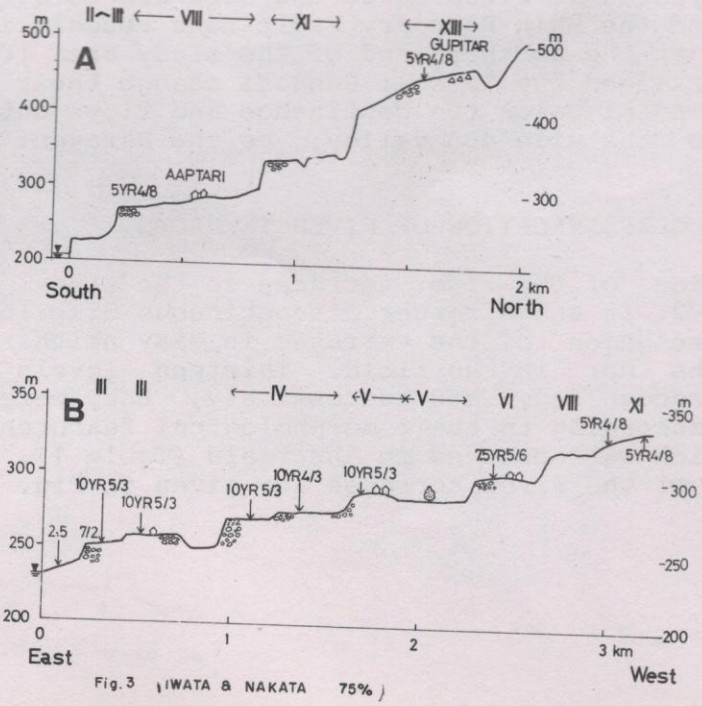

Fig. 3 IWATA & NAKATA 75%

Highest Terraces are located at higher places more than 150 m in altitude above the present riverbed. Their surfaces are sloping by erosion and covering with scree materials. Red soil occurs on them. Higher Terraces occupy considerable extent at Kota in the Kali Gandaki and at the left bank of the Trisuli Gandaki near the Kali-Trisuli confluence. The latter shows morphology of a terraced fan. On the other hand, small fragments of higher terraces, showing round ridge-like forms, scatter on the higher positions along the valley. The higher terraces are covered with red soil, which is about 1m thick. Middle Terraces are subdivided into three groups: from the high M1 terrace group to the low M3 terrace group. Among them the M2 terrace group extensively develops on the upper course from the confluence, but the low M3 terrace group are better developed than the M2 terrace group below the confluence. On the M3 terraces one can find some irregular topography inferred to the past channels and bars. Lower Terraces mainly develop in the dun valley and occupy an extensive area as recent fans. Relatively fresh topography related to past channels can be clearly observed on the air photographs.

Any absolute dating has not been obtained from the deposits of these terraces. According to the sequence, morphoogy, and degree of soil development, the present authors have presumed the ages of these terraces as follows: The relatively fresh topography with brown coloured soil indicates that the ages of the Lower Terraces are the Holocene, while the dissected topographies and red coloured soil suggest that the Highest and Higher Terraces might be formed in pre-Last Interglacial time. Accordingly, the Middle Terrace groups are likely to be corresponded with terraces formed during the Last Glacial and/or Last Interglacial. This relative chronology of the terraces in this area does not conflict with that in the upper course of the Kali Gandaki (Iwata et al, 1984).

DEFORMATION OF TERRACES

A popular way to make clear the crustal movement is to plot relative height of the river terraces above the present river bed against the distance along the suitable valley axis. Roughly speaking, the Kali Gandaki terraces decrease their relative height upstream to the west of the study area, while the terraces in the dun valley also decrease downstream to the south (Iwata et al., 1984). In the present study area, however, the distance along the river is so short and river terraces distribute so limitedly that any suitable river terrace profile can not be obtained.

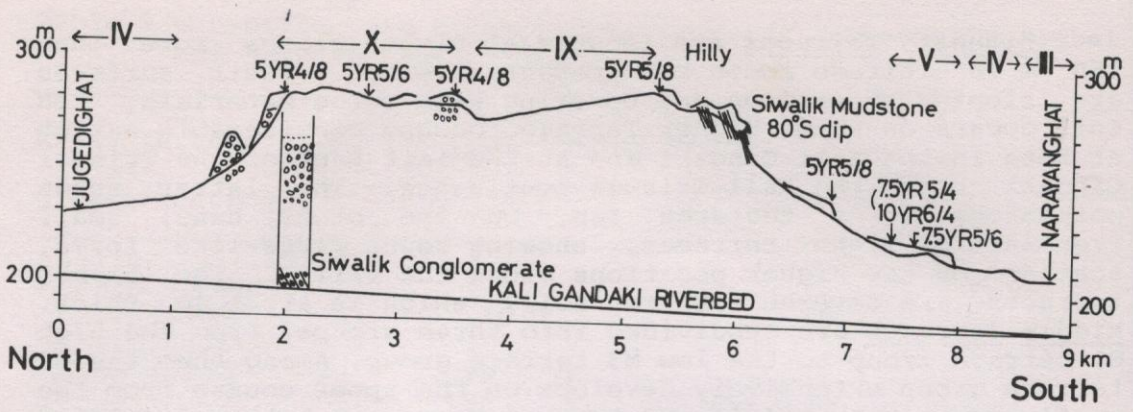

Fig. 4 IWATA & NAKATA 70%

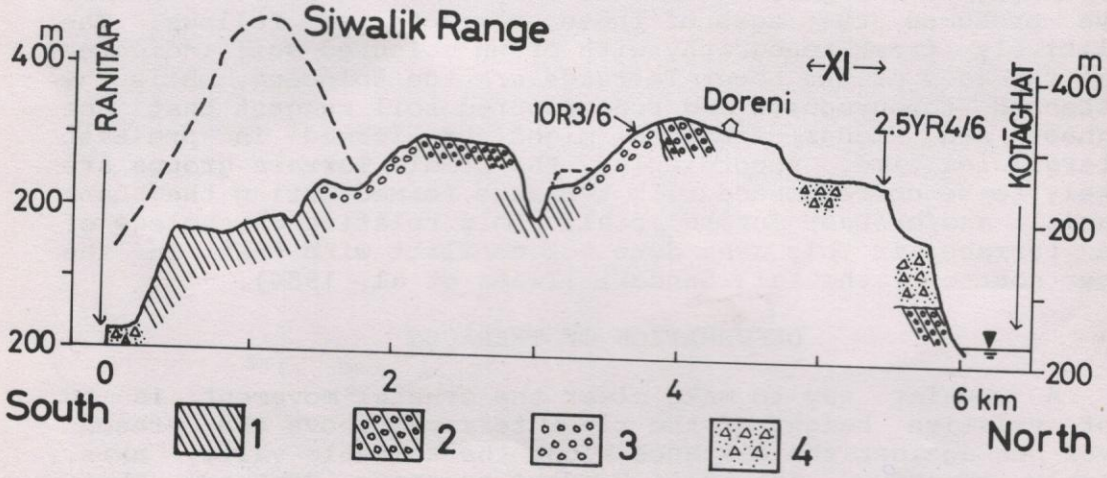

Fig. 5 IWATA & NAKATA 70%

The present authors have found that the large higher terrace situated between Jugedighat and Narayanghat has a weakly reverse sloping surface (Fig. 4). This wide terrace is divided into two: the X terrace is bounded on the south by the IX terrace. There exists a low subdued cliff between these two terraces. The X terrace is nearly flat and represents slighly rolling surface. On the other hand, the IX terrace is apparently inclined to the north. The gradient of the surface varies from 1/100 in the north to 1.5/100 in the south. At the southern end of the IX terrace, the steeply tilted Siwaliks, composed of alternation of mudstone and conglomerate, form hilly topography. This southern end of the terrace lies on an east extension-line of the Siwalik range, which rises abruptly above the dun valley and gradually increase their height to the west up to 1,500 m. This range may be one of axes of uplift. It can safely be said that the northward tilting of the terrace surface is due to the upheaval of the area at around the extension line of the Siwaliks. Accordingly, this terrace deformation suggests that the uplift of the Siwaliks has persisted since at least pre-Last Interglacial Glaciation in whose period the deformed terrace might have been formed as already mentioned above.

RELATION BETWEEN THE TERRACE GRAVELS AND THE SIWALIK CONGLOMERATE

There exists a hilly low land on the north of the uplift axis of the Siwalik range, which was mentioned just above. It occupies the area between the Siwalik range and the present Kali Gandaki to the west of Kotaghat, and extends to the east up to the present Narayani Gandaki (Fig. 2). The altitude of the hill tops is at around 350 m and relic flat surfaces exist in various places.

The geomorphological and geological sections along the route between Ranitar and Kotaghat are shown in Fig. 5. The southern part of the hill is mainly composed of mudstone, while the northern part seems to be composed of conglomerates. These beds dip steeply north. Some slopes are covered with rounded and subrounded gravels, ranging from cobble to pebble in size, which were washed out from the conglomerates.

The present authors could not find terrace gravels covering the Siwaliks. It may be easy to distinguish between the terrace gravels and the Siwalik conglomerate, because the latter dips steeply and materials included in the conglomerate are smaller in size and better in sorting than the terrace gravels. In spite of lack of the evidence of the river sediments, it was inferred from the topographical situation and the concordance of the summit level in the hilly area that the Kali Gandaki flowed through the area.

The base level of the Kali Gandaki river has bee controlled by the altitude of the Gangetic Plain at least i its lower course. The large scale topographic situation betwee the Himalayan mountains and the Gangetic plain has bee basically the same as present. Accordingly, the altitude of th Gangetic plain and the dun valley has been the same as present Accordingly, when the Kali Gandaki flowed through the hill area mentioned above, the altitude of its riverbed at that tim might be nearly the same altitude as the present riverbed. I is likely that the altitudinal difference between presen riverbed and the past one indicates the relative upheave of th mountains against the dun valley and/or the Gangetic plain.

The age in which the Kali Gandaki flowed through the hilly area has not been known yet. But, the fragmentary flat surfaces in the hilly area have nearly the same altitude as the highest terrace group, and the area is covered with real red soil (10R 3/4). These facts suggest that a few hundred thousand years have passed since the Kali Gandaki flowed there. Accordingly, it is concluded that the Siwalik hilly terrain may have been uplifted about 170 m during last several hundred thousand years.

SUMMARY

The present authors obtained the following results:

1) The river terraces in the study area are classified into six groups: the Highest, Higher, Middle 1 (M1), Middle 2 (M2), Middle 3 (M3), and Lower Terrace groups.

2) The Highest and Higher Terrace groups were formed during pre-Last Interglacial time.

3) The Higher Terrace situated between Jugedighat and Narayan-ghat is slightly inclined to the north.

4) There exists a hilly area in the Siwalik mountains. The area is an ancient riverbed of the Kali Gandaki and its relative height above the present riverbed attains to 170m.

5) Accordingly, the present authors conclude that the Siwalik mountains in the area have upheaved since pre-Last Interglacial time.

FIGURE CAPTIONS OF IWATA and NAKATA

Figure 1 Central Nepal and the study area.

Figure 2 Distribution of the river terrace in the area around Narayanghat. 1: River terrace classification, 2: Soil colour, 3: Profile and section in Figs. 4 and 5, 4: Mountain ridges, 5: Boundary between mountain and hilly area, 6: Cliff of river terrace, 7: Indistinct cliff of river terrace, 8: Flat surface in the hilly area. 9: Scree cover, 10: Locations of river terrace sections in Figure 3.

Figure 3 Cross sections of the river terraces. A: Gupitar section, B: Jugedighat section.

Figure 4 Profile of the terraces along the moter load between Jugedighat and Narayanghat.

Figure 5 Geomorphological and geological sections along the route from Ranitar and Kotaghat. 1: Siwalik mudstone, 2: Siwalik conglomerate, strike: N75°E and dip: N50°, 3: Cobble and pebble stones covering slopes, 4: Terrace gravel.

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to Prof. K. Kizaki, Ryukyu Univ., the leader of the research project for "the Crustal Movements of the Nepal Himalayas", to the members of the project for their collaboration during the field survey, and to the Topographical survey Branch, Kathmandu, for the facilities on air-photographs. This study was financially supported by the Grant-in-Aid for Scientific Research from the Ministry of Education, Science and Culture, Government of Japan.

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