CHAPTER VI

R E S U M E

RETROSPECT

The author has investigated the drainage and slope characteristics of the Kosi river basin, a tributary of the river Ramganga in the Central Kumaon with special reference to the lithology and structural controls. His studies comprised morphometric analysis, aerial photo-interpretation and field observations. The morphometric analysis was based on Survey of India 1:50,000 sheets, and on the drainage tracings from the aerial photographs. The geological data is that mainly of Heim and Gansser and Merh. Field investigations were also helpful in confirming certain geological conclusions. However, for the most part, considerable emphasis was placed on photo-interpretation. Morphogenetic mapping after Demek (1968) was also attempted for a part of the basin, and such a study has fully illustrated the practical utility of geomorphic mapping.

Geologically, the Kosi basin falls in four major lithotectonic zones. The northernmost Nagthat-Deoban group of metasediments comprising quartzites, limestones, chlorite schists and slates, is separated from the rocks of the Almora nappe by the North Almora fault. The crystallines of Almora nappe comprising phyllonites, granitic gneisses and mica-schists with quartzites, form a broad synform and cover nearly 50% of the basin area. These crystallines rest over the Krol-Nagthat group of metasediments along another tectonic contact, the South Almora thrust. The latter metasediments consist of compact limestones, quartzites and slate sequences, and lie thrusted over the sandstones and shales of Siwaliks along the Main Boundary fault. Within the Siwaliks, the Lower Siwalik compact sandstones lie over the Upper Siwalik sandstones and shales, and this tectonic contact between the two is the southernmost thrust in the basin.

Apart from the above tectonic lineaments, there are numerous joint sets, reverse faults and sub-vertical faults in the basin. Notable among those are the Ramgarh thrust within the Krol-Nagthat metasediments, the Kuchgad-Khairna nala N-S fault occupying the axial-plane of a local anticline, and frequently occurring smaller N-S to NE-SW dislocations which have not only shifted the North Almora fault but have also controlled the offsetting of the channel segments in the basin.

Morphologically, the basin has a reverse 'S' shape trending E-W, the acute western arc of which cuts through the Siwalik strata before emerging into the alluvial plains near Ramnagar. The maximum basin relief is of the order of 2200 metres. The Kosi channel's longitudinal profile reveals 14 breaks. The author has correlated these breaks with tectonic rejuvenation, climatic accidents and consequent deposition of terraces. The slope distribution within the basin has been grouped into two main categories, viz. those belonging to the metasediments showing typical hog-back strike ridges, and those within the peneplained crystallines where due to linear degradation, only isolated ridge summits stand out in topography irrespective of variations in lithology. Within the metasediments the

Siwalik strata display smoother gentler dip slopes and short scarps, whereas the metasediments of the Krol-Nagthat and Nagthat-Deoban groups show more rugged strike ridges having greater micro-relief and less distinct hog-backs.

The lithologic variations have also contributed to the relief variations within each lithotectonic zone. Of peculiar interest is the area along the southern periphery of the basin occupying the highest elevations. The author considers this to be more a tectonic phenomenon, the entire group of metasediments being successively upthrown along the Main Boundary fault and Ramgarh thrust.

The bedding joints have contributed to the trellis drainage pattern. The peneplained crystallines however, display sub-dendritic drainage. Major tributaries follow the general strike of rocks, strike valleys are common but they also follow the tectonic lineaments.

The Nagthat-Deoban block of metasediments is an upthrown block along the North Almora fault, and this uplift has caused the rejuvenation of the Kosi river such that it has cut deeply through rocks, giving rise to entrenchment at several places.

South of the crystallines on crossing the South Almora Thrust, the river shows a sudden appearance of spectacular terrace levels. It is found that the N-S tectonic lineament has played a significant role in this part of the river's course. Here onwards the Kosi channel alternately widens and narrows, the former stretches following the weak zone of anticlinal crests and major fault lines, whereas the latter occupy across-strike orientation. There are some evidences of past glaciation, particularly in the topographic expression in this polycyclic landscape. Further work on this aspect is however essential.

DISCUSSION

The four major lithotectonic zones comprising the basin have undergone at least four stages of deformation, and structures related to each have influenced the Kosi drainage evolution. The lithologic variations within each tectonic zone have also manifested in the control of channel gradients, breaks in the longitudinal profiles, narrowing of channels in certain parts, alignment of ridges, variations in erosional potential and formation of dip slopes. The salient features of the influence of lithology and structure are summarised below.

Lithologic Influence

1. The smaller order channels in the harder lithologies like compact quartzites, dolomitic limestones and gneisses, have given rise to gradients ranging between 20° to 30° in the upper reaches. Also, these hard rocks have attained higher elevations in all the zones. In the Krol-Nagthat group along the southern fringes of the basin, the gradients of first order channels are still more steeper (35°-40°) in the upper reaches. Of course, this very high relief here is due to tectonic causes as well, and not entirely due to the effect of hard rocks only.

2. The gneissic bands within the Almora crystallines outcropping in the area north of Sual confluence, have produced breaks in the longitudinal profile. These bands, which are hard and compact, and have least erosional potential, acted as barriers initially to produce cataracts which in due course were smoothened out resulting into the breaks. On the other hand the soft mica-schists and micaceous quartzites in this zone being easily erodable, have facilitated entrenchments of the order of 5 m to 50 m in various sections.

3. The Kosi channel has alternate wide and narrow stretches. Whenever the channel cuts across the regional strike it has been observed to narrow down suddenly. This sudden narrowing of channel is due to differences in lithologic competency. In the crystallines, the narrowness of the channel with deep entrenchment is partly due to the fact that the river cuts across the strike of schists, quartzites and gneisses. In the Deoban-Nagthat group, Deo gad as also parts of Lamgada gad, are seen to cut across the strikes of quartzites. Here again, the across-strike segments are well defined and straight, the channels being narrow. Another good example of this phenomenon is in the downstream portion between Seti to Basela, where the Kosi flows at sharp angles to the strike ridges of Krol limestone and shales. In the Siwalik zone too, the river bed which is normally very wide (300-1200 metres), suddenly narrows down to a width of 100 metres at the contact of hard Lower Siwaliks (sandstones) with the overlying relatively softer Upper Siwaliks (sandstones and shales) near Garjia.

4. The formation of high ridges is also controlled by lithologic variations. In the metasedimentary and

sedimentary rocks like those occurring in the Nagthat-Deoban, Krol-Nagthat and Siwalik zones, this effect is very obvious. It is clearly seen that in the zone of Deoban-Nagthat group, the hardest quartzites and dolomitic limestones have formed the highest strike ridges. The chlorite schists, which are softer, occupy the northern slopes of the Dolomite ridges. The softer slate horizons make up the lowest and the much dissected ridge remnants in the valleys of Menol gad and Mansa rauli. In the Krol-Nagthat group however, the lithologic control on the ridge heights is not prominent, since this entire zone is a sort of sandwiched between the South Almora thrust and the Ramgarh thrust. In the Almora crystallines, the compact gneisses have given rise to the ridge crests (e.g. the Chaubatia-Sialikhet gneissic band). The scattered ridge top in the crystallines are the erosional remnants of an earlier topography that has undergone subsequent peneplanation.

5. The erosional potential of various lithological type is governed both by the inherent compactness and composition, cleavages and joints. The sum total of these has resulted in varying erosion potentials in the area. The hard quartzites and limestones are least eroded, and form the highest elevations in basin topography. This is also true in the case of the gneisses of Kapaleshwar-

Mukteshwar area. The quartzites, belonging to the Krol-Nagthat group form the drainage divides of Kuch gad and Khairna nala. In the crystallines, the crumpled schists are the most erodable, next come the mica schists and finally the micaceous quartzites. These quartzites thus stand out as "Ribs" in an otherwise undulating schist topography. In the Siwalik zone, the Middle Siwaliks exposed near the basin mouth, are the most erodable (clay beds and soft sandstones) as compared to the compact sandstones of the Lower Siwaliks. The latter therefore have attained maximum elevations in this zone.

6. The dipping metasedimentary strata acted upon by the fluvial processes have resulted into formation of dip slopes and scarp slopes. The topographical slopes and the dips of rocks reveal an interesting relationship. In the case of hard rocks like quartzites of the Deoban-Nagthat zone, the difference between these two is of the order of 20°-25°, the topographic slope being the gentler. This variation is reduced to 15° or so in the case of softer chlorite schists in the same zone. Same thing is also observed in the sandstones of the Siwalik group. Another feature of slopes is that the dip slopes are longer than the

steeper scarp-slopes. In the case of Almora crystallines where due to peneplanation, the topographic surface has become moderately undulating, the formation of dip slopes is not observed. On the southern limb of the synform, the regional dips are of the order of 20°-25° north and on this the topographic slopes show still lesser values so that successive lithologic variations cut across without forming any marked dip slopes. The northern limb being slightly steeper, its strike ridges show relatively larger dips and here the formation of dip slopes on a small scale, is however, observed.

Structural Influence

The planar structures like the faults, thrusts and joints have played an important role in controlling the drainage patterns, offsetting the main channels, widening of beds, formation of flat valleys and deepening of valleys. The influence of the various structural elements on the landscape evolution of the Kosi basin could be summarised as under:

1. In the areas where relief is available and the drainage channels descend rapidly their courses are controlled by the jointing in rocks. The first and

second order channels generally have steeper gradients than the higher order channels, and the former follow trace of bedding joints, particularly in the metasediments and the sedimentary rocks. The resulting pattern is of trellis type. The second order channels flowing over the steeper slopes, descend by the shortest route, and form a parallel to sub-parallel drainage (e.g. the area north of Someshwar and in Siwaliks). On the scarp slope side, the drainage pattern is usually parallel to sub-parallel. Where the effects of lithologic variations are not pronounced and the area is relatively subdued in topography, joints appear to have played a minor role and the resulting drainage pattern is dendritic to sub-dendritic. Here, only the finer channels following the foliation joints, form trellis patterns.

2. The NS jointing which is prevalent in the entire basin, except in the Siwalik rocks, has contributed to the offsetting of the trunk stream. The major tectonic lineaments like the North Almora fault and the Main Boundary fault, have controlled the drainage courses over long distances, notable example is of Sai nala, Niral gad, Kosi between Basela and Kumeriya. The offsetting of

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