An Overview of the Main Central Thrust and a Regional Shear Zone across the Kaligandaki River, Nepal

Harbhajan Singh[1*], Mugdha Patwardhan[2], and Yogendra Deva[3]

[1]Consulting Engineering Geologist, Kurukshetra, Haryana, India
[2]Consulting Engineering Geologist, Indore, Madhya Pradesh, India
[3]Consulting Engineering Geologist, Noida, Uttar Pradesh, India

(*Corresponding E-mail: harbhajan.geokuk@gmail.com)

Abstract: Investigations for a proposed hydropower project on Nepal's Kali Gandaki River focused on the Main Central Thrust (MCT) and a prominent regional shear zone. Field traverses revealed lithological transitions from slates and Quartz-Mica Schist to Quartz-Biotite Gneiss, defining the MCT more precisely than prior regional interpretations. A persistent crushed leucocratic quartzo-feldspathic gneiss zone, aligned with off-white landslide scars and NW–SE river bends, appears to exert greater influence on engineering geology than the MCT. While the tightly bound MCT is unlikely to compromise major structures, the shear zone poses geotechnical risks, particularly for pressure and drop shafts, warranting targeted investigations.

Keywords: ***Kali Gandaki River, Main Central Thrust (MCT), Regional shear zone, Hydropower project.***

Introduction

Hydropower development in the Himalayas requires detailed understanding of tectonic and lithological conditions due to complex structural geology (Panthi, 2006; Acharya et al., 2024). The Kali Gandaki River basin, situated at the boundary between the Higher and Lesser Himalayas, hosts the Main Central Thrust (MCT), a major tectonic boundary. Previous interpretations of the MCT's disposition vary, influencing engineering decisions for proposed headworks, tunnels, and powerhouse structures. This study aims to clarify the MCT's location and identify additional structural features, particularly a regional shear zone, to inform geotechnical risk assessments for the project's water conductor system.

Study Area

The study area encompasses the Kali Gandaki River and Mristi Khola valleys in central Nepal, from upstream of Tatopani to Ghatte Khola (Figure 1). The proposed hydropower project comprises headworks, a headrace tunnel, surge shaft, forebay, pressure shafts, and a powerhouse complex. Lithological mapping reveals slates downstream, Quartz-Mica Schist (QMS) in the midsection, and Quartz-Biotite Gneiss (QBG) upstream, with the Main Central Thrust (MCT) interpreted at the QMS–QBG contact. Field exposures along Mristi Khola, including road cuts near Baskot village (Figure 2), provided key insights into the MCT and an associated regional shear zone (Interpreted MCT, Figure 1).

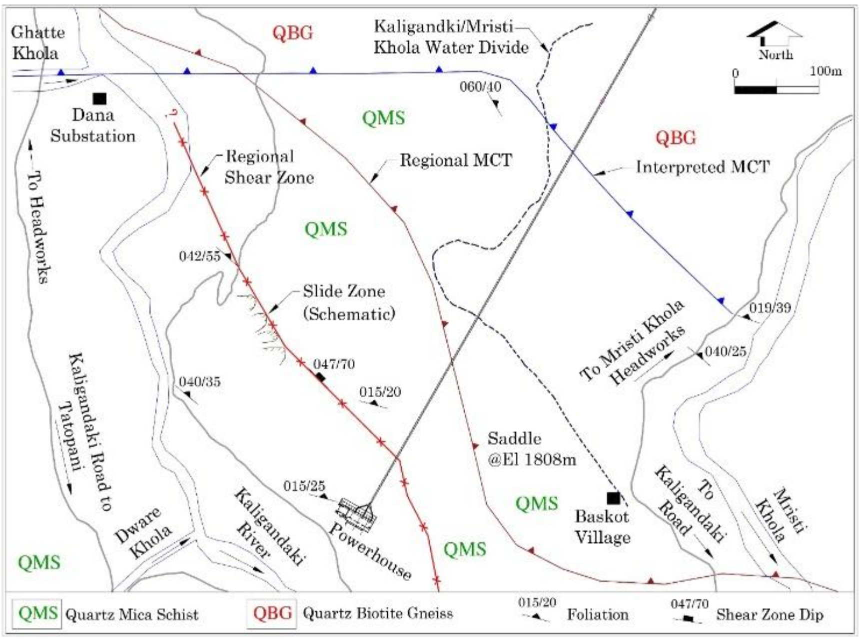

Figure 1, The orientation of the interpreted MCT relative to the regional MCT.

Results

Field investigations reveal a well-defined contact between QMS and QBG, representing the MCT, with exposures tighter than previously mapped along the Kali Gandaki–Ghatte Khola stretch.

A persistent crushed leucocratic quartzo-feldspathic gneiss zone (Figure 3), aligned with landslide scars and NW–SE river bends, indicates a regional shear zone of possible post-MCT origin.

Structural measurements show a dip of N047°/70°, steeper than the MCT. While the MCT itself may have limited engineering impact, the shear zone (Figure 4) intersects the powerhouse back slope and is likely to influence excavation, pressure, and drop shaft stability, highlighting the need for further geotechnical investigation.

Figure 2, 'Tight' MCT - the QMS/ QBG contact in Mristi Khola.

Figure 3, The crushed and kaolinized gneiss in the shear.

Conclusion

The geological framework for the proposed Kali Gandaki hydropower project is strongly influenced by a regional shear zone rather than the MCT. Accurate identification of lithological contacts and structural zones is critical for assessing geotechnical risks. While the tightly bound MCT is unlikely to compromise the water conductor alignment, the shear zone poses significant potential hazards for the powerhouse and associated shafts. Targeted geotechnical drilling and continuous monitoring are recommended to guide safe design and construction. The study underscores the importance of integrating structural geology with engineering geological assessments in Himalayan hydropower projects.

Figure 4, Landslide scars lined along the shear zone.

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