Geophysical Investigation for Delineating the MCT Concealed Across Kumaltigad HRT, Pala - Maneri Hydro - electric Project, District Uttarkashi, Uttarakhand

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Absrtact

Pala – Maneri Hydro-electric Project envisaged the construction of i) a 74 m high concrete gravity dam across river Bhagirathi near village Pala, ii) a 12.7 km long head race tunnel and iii) a power house at village Aungi to generate 416 MW of power. Geophysical surveys employing magnetic (VF) and seismic refraction techniques are conducted across Kumaltigad Head Race Tunnel (HRT) alignment almost orthogonally for mapping the concealed Main Central Thrust (MCT) which cuts HRT perpendicularly.

The MCT is clearly brought out by 'bipolar' magnetic anomaly as shown in figures (3A & 3B). Seismic profile, laid along the magnetic traverse T-1, has also delineated the thrust, showing parallel displacements in the time segment. Self Potential survey has shown high gradient across the MCT. The throw of the thrust calculated using time lag and velocity of the formation suggest that the lateral extent of the MCT zone might be varying between 50m and 70m. The throw of the thrust is found to be of the order of 20m. The P-wave velocity of the basement rock is between 4000 and 4500 m/sec. The MCT zone depicted in seismic survey is corroborated by the second horizontal derivative of the magnetic profiles.

Introduction

Pala – Maneri Hydro-electric Project envisaged construction of a 74 m high concrete gravity dam across River Bhagirathi near village Pala, a 12.7 km long HRT and a Power House at village Aungi to generate 416 MW hydroelectric power (Fig. 1). Geophysical surveys are taken up at the request of Uttaranchal Jal Vidyut Nigam for the delineation of the concealed MCT. Magnetic (VF) and Seismic refraction surveys are conducted across Kumaltigad HRT alignment almost orthogonally for mapping the concealed MCT, which cuts HRT perpendicularly.

The rocks in this area belong to the Garhawal group and the central Crystallines separated by the MCT and are traced along the Kumalti and Duggada gads near their confluence with the river Bhagirathi. The thrust is no where clearly exposed and is generally concealed by basic intrusion or terrace gravel.

Instrumentation

Magnetic (VF) survey is carried out using MFD-4 Fluxgate magnetometer and the Seismic refraction survey is conducted employing 24-channel SIE refraction seismograph. Self potential survey is conducted using GSI made Potentiometer.

Survey design and data collection

Magnetic measurements are made at every 10 m station interval along Traverses T-1, T-2, T-3 & T-4, laid almost parallel to the proposed HRT and across expected MCT zone, and along Traverse T-5, laid along the line joining two boreholes KDH-1 and JDH-1.

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Fig. 1. Location of the MCT area

The length of the traverses varies according to the need and availability of the spread.

Refraction seismic profile is laid along traverse T-1 (Fig. 2) and the depth below each geophone is obtained using 'Two-way Travel time' technique.

Self Potential observations are taken at 10m interval along Traverse T-4.

Data processing

Magnetic (VF) data is reduced to a base and is filtered using three-point running filter operator. Filtered data is plotted as profiles (Fig. 2) and a contour map (Fig. 4). Magnetic (VF) data is also presented as an Image (Fig. 5) for better demarcation of the MCT. Along each magnetic profile, second horizontal derivative is plotted for locating the central position of the thrust zone (Fig. 3A & 3B).

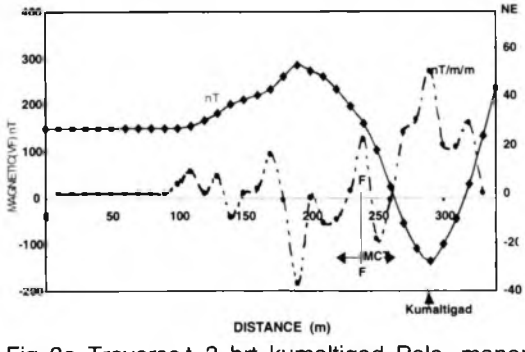

Fig. 3a. Traverse t- 3, hrt, kumaltigad, Pala - maneri hydro - electrical project, uttarkashi, uttaranchal.

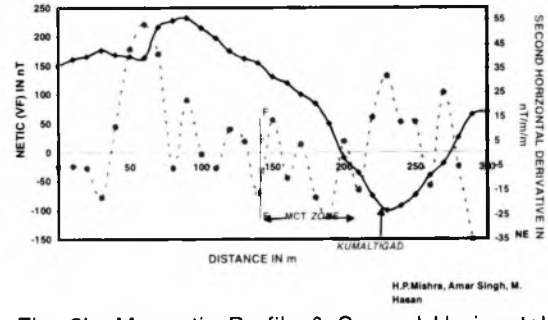

Fig. 3b. Magnetic Profile & Second Horizontal Derivative Across The Mct, Kumaltigad, Uttarkashi, Uttaranchal

Refraction seismic data is presented as Time - Distance graph and depth under each geophone is calculated using extension of Hawkin's method. The position of the fault, thrust zone and the throw of the fault are estimated from the Time - Distance graph / Hodograph (Fig. 6).

Self-potential profile along traverse T-4 is plotted along with magnetic (VF) data (Fig. 2).

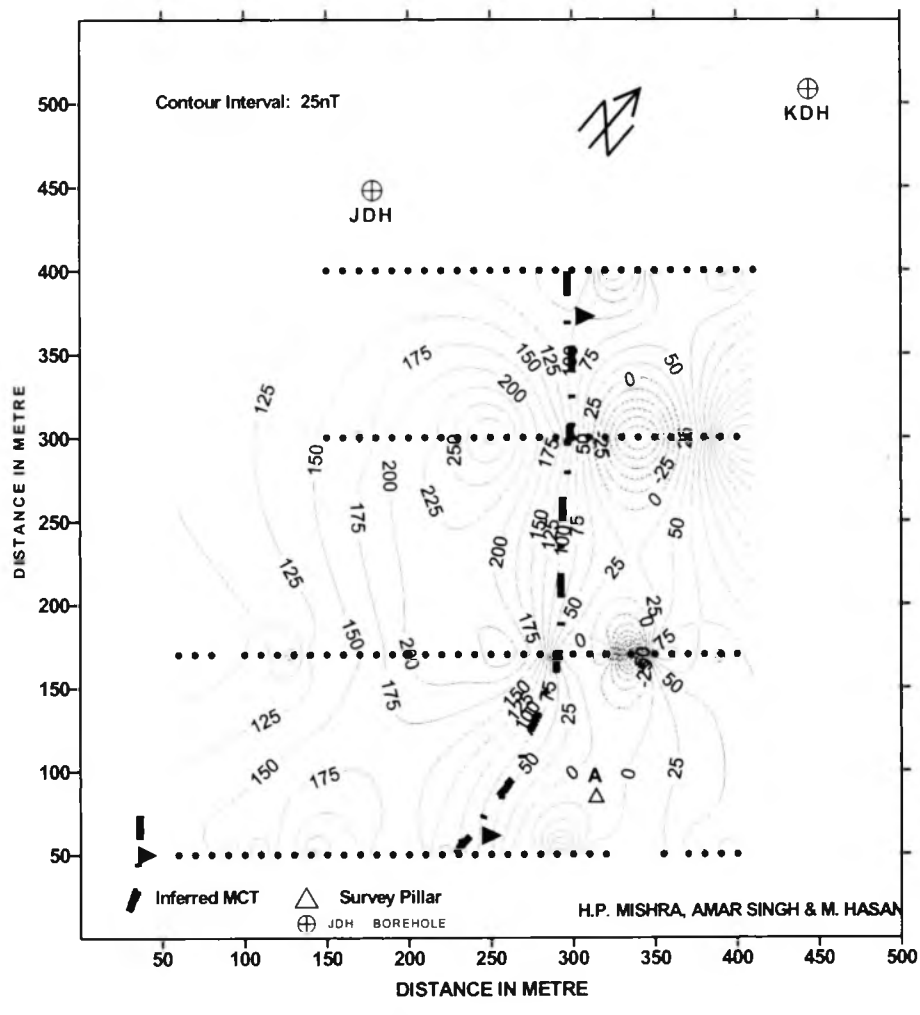

Fig. 4. Magnetic contour map, HRT, Kumaltigad, pala-maneri hydro - electrical project, uttarkashi, uttaranchal

Discussion of Results

Magnetic survey

High magnetic gradient has been observed in all traverses, which is indicative of the presence of fault / thrust (Fig. 2).

The second horizontal derivative of magnetic (VF) data has demarcated the central position of the thrust and the thrust zone, which may be 50 m to 70 m wide.

The Magnetic contour map (Fig. 4) shows the inferred position of the MCT zone, which may be the guideline for modifying the geological setup in the Kumaltigad area. The magnetic image (Fig. 5) has clearly shown the position of the thrust zone.

Refraction seismic survey

The P-wave velocity of the hard rock along this profile is of the order of 4500 m/s, which may be attributed to Quartzite / Schist. The throw of the fault is calculated from T-D plot. A time shift of 7 ms in T – D curve indicates a vertical displacement of 18 – 20 m (calculated using the velocity of overburden

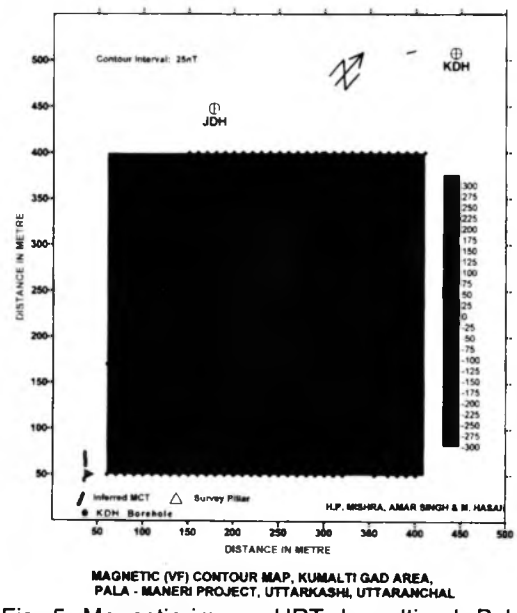

Fig. 5. Magnetic image, HRT, kumaltigad, Pala-maneri hydro - electrical project, uttarkashi, uttaranchal

material as 2500 - 2750 m/s). The lateral extent of the thrust is estimated to be about 45m. The down thrown side of thrust is towards Kumaltigad. The displacement is slightly more at down thrown side than the up thrown side.

Conclusions

1. The MCT is delineated successfully by magnetic and seismic refraction surveys.
2. Point of maximum magnetic gradient delineated the central position of the MCT whereas the second horizontal gradient demarcated the zone of the thrust.
3. Seismic refraction technique confirmed the zone and delineated the throw of the fault.

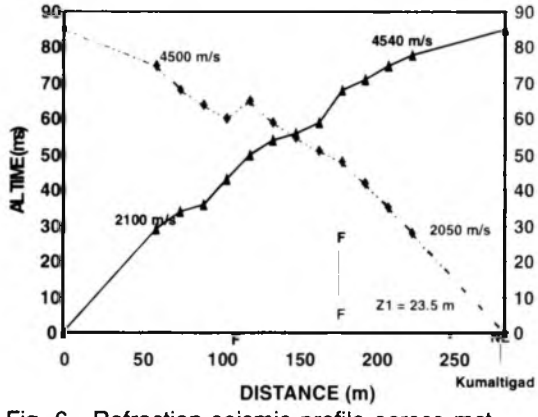

Fig. 6. Refraction seismic profile across mct

4. The lateral extent of the MCT zone was estimated to be from 50 to 70m and the throw of the thrust may be of the order of 20m.
5. Down thrown side is towards Kumaltigad.

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Reference

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