SEISMICITY SURVEY OF TEHRI DAM REGION PRIOR TO THE RESERVOIR IMPOUNDING

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SUMMARY

A short term triparuite seismic survey of Tehri dam region prior to the reservoir impounding has been conducted. The data has been analysed and statistical characteristics of the contemporary seismic activity have been evaluated. Locations of 88 events and fault plane solutions of events associated with Srinagar Thrust, MCT and Uttarkashi Thrust have been reported. The study is intended to enable tracing the variation in seismicity if any due to reservoir impounding.

INTRODUCTION

A 260.5M tall earth and rockfill dam, tallest of its type in India is to be constructed on the river Bhagirathi about 1.5 km down stream of its confluence with the river Bhillangana near Tehri town. The region falling in the lesser Himalayas is bounded by the Main Boundary Fault (MBF) in South-West and by the Main Central Thrust (MCT) in North-East. The shape of the reservoir is in the form of a fork with long extensions along the Bhagirathi and Bhillangana river valleys. Due to the unusual shape of the reservoir some of the regional and local tectonic features present in the area would be submerged as shown in "Fig. 1". In order to permit scientific study of the possible influence of impounding of reservoir on the seismic activity a reconnaissance microearthquake survey has been done in advance of the construction of dam and the reservoir impounding.

In over thirty case the seismic activity or its changes have been related to reservoir impounding. In majority of these cases the quality of data available prior to reservoir filling is not comparable to that obtained during and after filling and therefore the conclusions drawn need further verification. It is in this context that the study reported has been taken up. One of the more recent and scientific study in somewhat similar tectonic setting, near Tarbela reservoir, Pakistan (Jacob, 1979) has shown a slight and temporary decrease in the seismic activity associated with the impounding and has been explained due to the existence of compressional custal stresses in the region. This hypothesis can be tested by the studies initiated in the Tehri Dam Reservoir Region.

INSTRUMENTATION AND FIELD PROCEDURE

Three variable period vertical mode seismometers (MEQ-7000) coupled to the MEQ-800 smoked paper recorders were employed for field recording. Each Seismograph had a builtin provision of variable filter and amplifier setting and also internal digital clock circuitry to provide minute and hour marks on the smoked chart. Interstation time control was achieved by impinging standard radio signals. At randomly selected time intervals five sites individually or upto three simultaneously were occupied during the

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period June 1974 to May 1977 for monitoring the activity. Map in "Fig. 1" shows the recording sites. About 110 days three station simultaneous

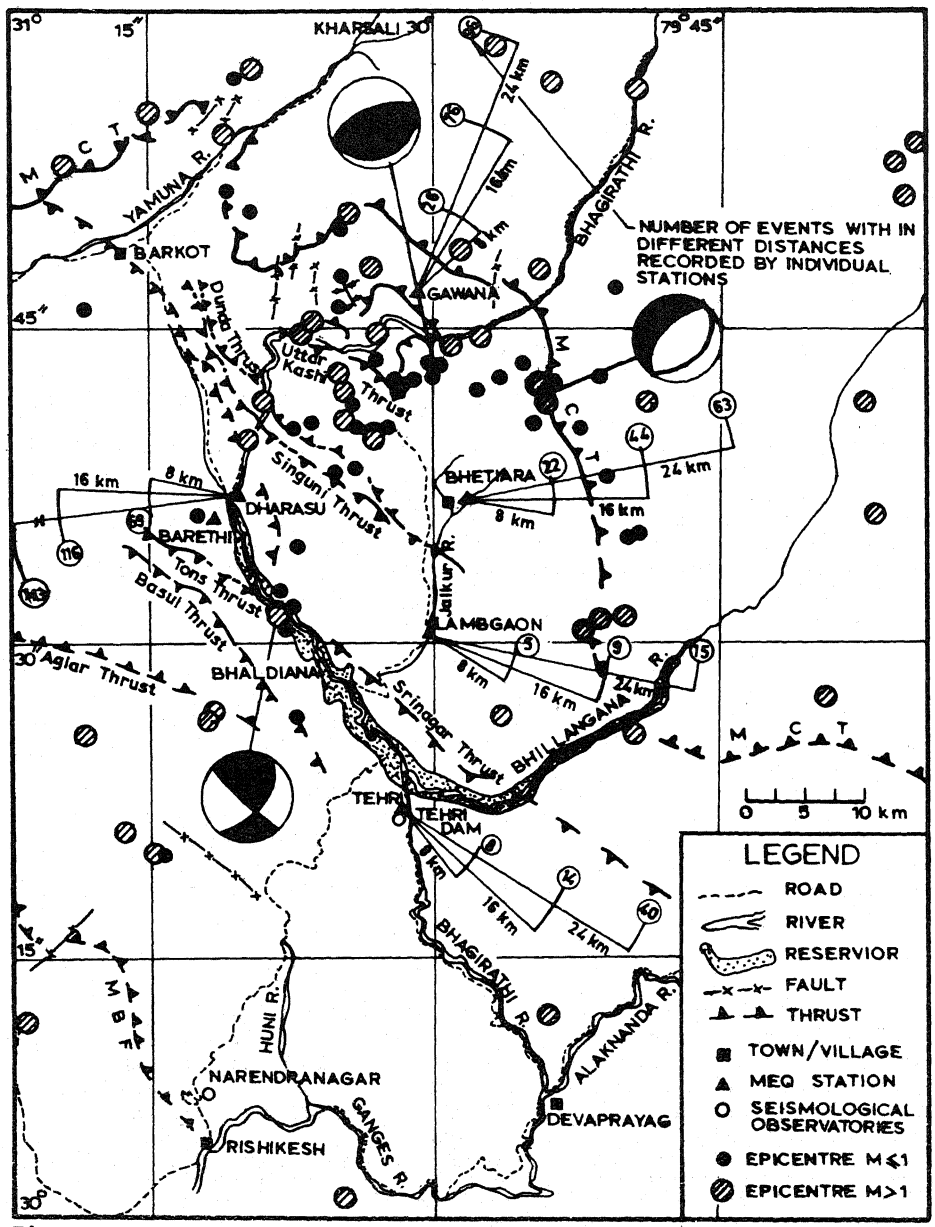

Fig.1_Map of Tehri Garhwal showing epicentre locations

recording from two different station configurations has been done in addition to signal or two station recording for about two and half and one month respectively.

DATA ANALYSIS AND DISCUSSIONS

Statistical parameters of the seismic activity falling within 125 km from each recording site were estimated by studing the temporal and spatial distributions of the observed activity. The data for a site occupied more than once was pooled together for the analysis. Temporal distributions for each site show that most of the activity is confined within 0 S-P 10 Sec and is multimodal with mode value of 9 events at Tehri (THR), 28 events (attributed to a swarm) at Barethi (BRT), 7 events at Lambgaon (LMG), 15 event at Gawana (GWN) and 21 events at Bhetiara (BTA); with no noticable trends in the activity rate with time. Two significant features of the microearthquake activity are (i) no event was recorded for a period of 3 days after the occurrence of Kinnaur earthquake (M=7.0) and (ii) considerable fall in rate of activity at GWN, BRT, BTA after the occurrence of a swarm of 20 events (with an event of maximum magnitude 3.8) possibly associated with the MCT. The least square straight line fits in the daily frequency data for the various sites have been obtained. The daily frequency at THR was 2 events per day. The maximum and minimum frequency was 4.4 and 1.3 at BTA and LMG respectively. Spatial distribution of events with class interval of 0.5 sec (S-P) time has been studied and shows unimodal distribution at GWN and multimodal distribution at THR, BRT and BTA and LMG sites. The spatial distributions has been shown without any regard to differences in their sources due to limitations of the data.

The recurrence relations for the entire data and also data grouped into three ranges of 0 to 5, 5 to 10 and 10-16 sec (S-P) times 'b' have been obtained. The 'b' values range from 0.66 for activity falling within about 40 km to as much as 1.13 for the total activity recorded within 125 km from the respective recording sites.

Locations for 117 events simultaneously registered at three sites having readable (S-P) times were attempted employing simplified half space model with longitudinal velocity of 6.0 km/sec. The locations are reliable for the events falling within the network, however, the errors are expected to increase with increasing distance from the network. The map in "Fig. 1" shows locations of only 88 events so obtained. Others fall outside the map boundary. Locations of 30 events were also made employing HYPOLAYER program (Eaton, 1969), by using a three layer model and freezing the focal depths. The events located within the array show a more or less consistant shift of about 3 km compared to the events located with (S-P) time; whereas for the events falling outside the array significant shift in a random manner was observed as would be expected due to departures from assumed velocity model. Since more events could be located with (S-P) times and P times were generally not dependable, the map with locations from (S-P) times only has been presented in the paper. The locations for events above magnitude 1 show a more scattered distribution whereas locations for events below 1 magnitude show a clustering of activity near Uttarkashi about 40 km away from Tehri Dam site in a region which will not get submerged under the reservoir. Generally speaking MBF is not found to be active whereas MCT has shown considerable activity particularly at locations of transverse features. A protion of Srinagar Thrust which will be submerged under the reservoir has shown

activity. Due to the limited number of instruments and insufficient azimuthal coverage, composite fault plane solutions for three group of events in selected segments of Uttarkashi thrust, Srinagar thrust and MCT were made assuming that events originating in respective limited areas are having identical focal mechanisms. While fitting the nodal planes guidance was also taken from amplitude data. The mechanism parameters for the three sets of events i.e. pole of fault plane (x), auxillary plane (y); pressure (P); tension (T) and null (B) axes in terms of azimuth (ϕ) and plunge (α) are given in Table -I. The solutions are also keyed to the respective locations in the map.

In addition to the events located the events recorded by individual stations only have also been shown on the map. The focal depth range from 5 km to 25 km. However, for the events falling outside the array the estimates may be in greater error due to limited three station data. The observed activity still seems to be mainly confined to the granitic layer of the earth's crust.

CONCLUSIONS

The survey has revealed considerable microseismic activity in the region. Generally speaking the activity is largely confined to the north of Tehri i.e. MBF is inactive relative to MCT. Events have been located in a segment of Srinagar thrust which will be submerged under reservoir and should be of greater interest for study after reservoir impounding. Although the data obtained was too restricted but fault plane solutions have been attempled for events associated with Srinagar Thrust, MCT and Uttarkashi Thrust by polling data for nearby events. The results need further improvements on the basis of additional data.

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TABLE - I SUMMARY OF FAULT-PLANE SOLUTIONS

Events located Near	N*	FAULT-PLANE SOLUTIONS									
		X(0°)		Y(0°)		P(0°)		T(0°)		B(0°)	
Uttar Kashi Thrust	4	333	70	155	20	336	26	157	64	247	06
Main Central Thrust	4	130	30	308	60	134	76	310	14	220	0
Srinagar Thrust	3	129	50	309	40	130	4	296	86	148	48

* N is the number of events used in composite first-motion plots