Post – 1991 Uttarkashi Earthquake Seismicity Pattern in the Garhwal Himalaya Region

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The area under study falls in the Garhwal region of the Lesser Himalaya. The region lies between the Alaknanda River on the east and the Tons River on the west. This study area of the Lesser Himalayan sub-province encompasses a number of NW-trending transverse tectonic features (Valdiya, 1976; Fuchs and Sinha, 1978). The main tectonic elements of the region are shown in Figure 1. The major tectonic features have an average strike along NW-SE.

The aim of this paper is to present an analysis of local seismic activity of Garhwal Himalaya region recored since the Uttarkashi earthquake (m_b = 6.6; October 20, 1991). A total of 430 seismic events recorded by an analog micro-earthquake network during the two-year period from January, 1993 to January, 1995 are analyzed. Epicentral locations of the 430 seismic events recorded by the array are shown in Figure 1. About 70% of the events are found to lie in the aftershock zone of the Uttarkashi earthquake of October 20, 1991, in the vicinity of the Main Central Thrust. Some epicenters are also observed to the south of Main Central Thrust. The micro-earthquake activity is found to be concentrated in the region bounded by the Budhakedar, Bhatwari and Manpur stations.

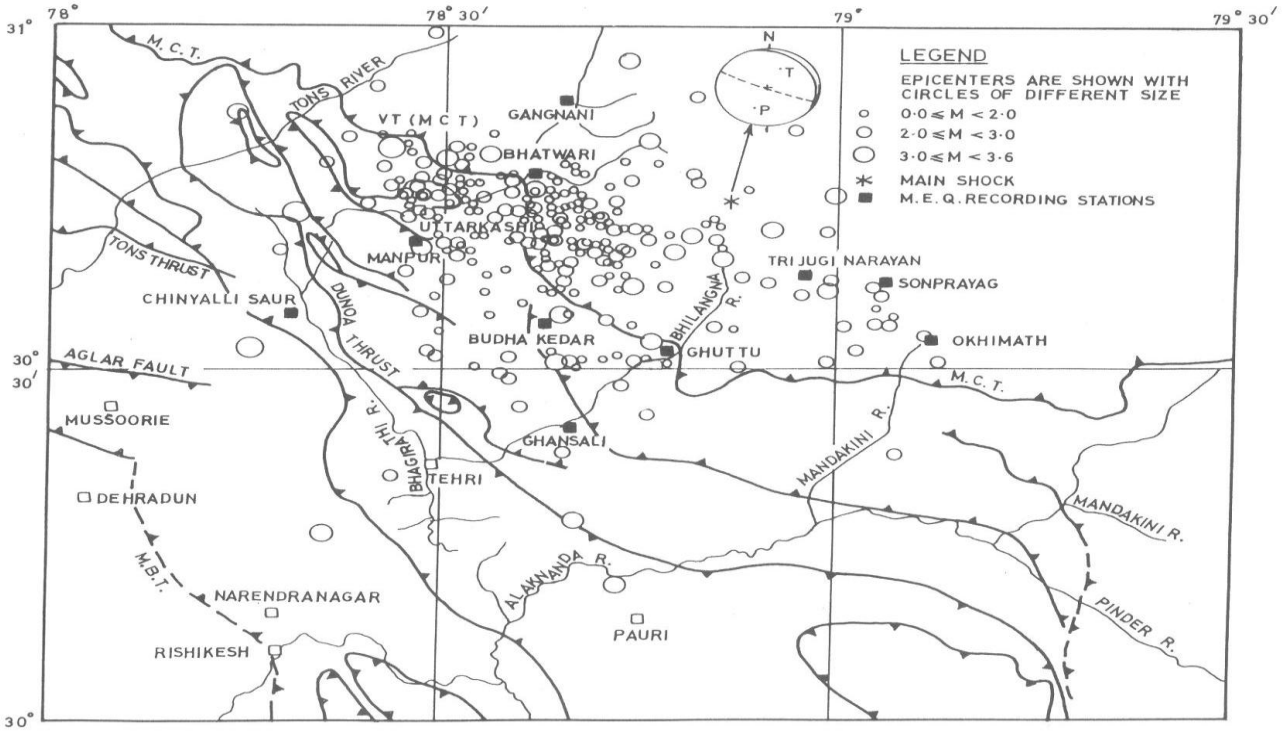

Figure 1. Tectonic map of Garhwal Himalaya region showing epicenters of local earthquakes recorded during January, 1993 to January, 1995, and focal mechanism of Uttarkashi earthquake of October 20, 1991.

Coda magnitudes of the events are calculated from the total signal duration using the relation given by Tsumura (1967) and Lee and others (1972). The coda lengths have been measured from the P onset to the point where the signal amplitude falls to the background noise level preceding the event. Out of a total of 430 events, 253 events are found to have coda magnitudes up to 2.0, 146 events have magnitudes between 2.1 and 3.0 and for 31 events the magnitudes are more than 3.0. The majority of the earthquakes are

observed to have their foci within the upper 15 km of the crust but a substantial number of events, 68 in number, have deeper focal depths between 15-28 km. The focal depth distribution along with coda magnitudes are given in Table 1. The focal depths of microearthquake events recorded prior to the Uttarkashi earthquake were also mostly above 15 km as reported by Agrawal and Kumar (1982), Khattri and others (1989), and Sharma and Wason (1994).

Table 1. Magnitude (M) and depth (H) distribution of epicenters

M	H≤10 Km	10<H≤15 Km	H>15 Km	Total
0.0-2.0	190	51	12	253
2.1-3.0	57	52	37	146
3.1-3.5	5	7	19	31
Total	252	110	68	430

Composite focal mechanism solutions have been determined for two clusters of microearthquake events. In doing this, we assume that all the events in each cluster have the same focal mechanism. In the first focal mechanism solution,18 microearthquake events which occurred within the region 30° 30' N to 30° 45' N & 78° 28' E to 78° 45' E are considered, whereas in the second solution, 20 events have been considered which occurred within 30° 40' N to 30° 50' N & 78° 26' E to 78° 45' E. The composite fault plane solutions for both the clusters of micro earthquake events are characterized by reverse faulting with a small strike-slip component. The main shock of the Uttarkashi earthquake was also characterized by reverse mechanism. However, in both the composite focal-mechanism solutions the pressure axes are observed to be sub-horizontal.

From depth sections oriented NW-SE and SW-NE, it can be seen that some of the events after the Uttarkashi earthquake of October 20, 1991, originated below the detachment surface. The distribution of focal depths of the events, the pattern of occurrence and composite focal-mechanism solutions of the clustered events, suggest that the local seismic activity during the period of investigation resulted from the ongoing readjustments in the area.

Acknowledgment

This study was undertaken under a research project funded by DST, Govt. of India, New Delhi under its Himalayan Seismicity Program.

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Cite as: Wason, H.R., 2010, Post-1991 Uttarkashi Earthquake Seismicity Pattern in the Garhwal Himalaya Region, *in* Leech, M.L., and others, eds., Proceedings for the 25th Himalaya-Karakoram-Tibet Workshop: U.S. Geological Survey, Open-File Report 2010-1099, 2 p. [http://pubs.usgs.gov/of/2010/1099/wason/].