A detailed report on the earthquake (M:6.8) of 18th September, 2011 in Sikkim-Nepal border region

An earthquake of magnitude 6.8 occurred on 18th September at 18:11 hrs IST in Sikkim-Nepal Border region. The preliminary hypo-central parameters of this earthquake, as estimated by the Seismic Monitoring Network of India Meteorological Department (IMD) are given below:

Date of occurrence	**:**	**18/09/2011**
Time	**:**	**18:11 hrs (IST)**
Magnitude	**:**	**6.8**
Focal depth	**:**	**10 Km**
Epicentre		
Latitude & Longitude	**:**	**27.7^{o} N & 88.2 ^{o} E**
Region	**:**	**Sikkim-Nepal Border region.**

The event, which comes under the category of "Moderate earthquake", was also reported widely felt in Sikkim, Assam, Meghalaya, northern parts of West Bengal, Bihar, parts of other eastern and northern regions of India. The epicentre lies in a seismically known and active belt called, Alpide-Himalayan seismic belt. The location of the earthquake is shown on the seismicity map of Sikkim and neighbouring areas given at **Annexure-1.** The main shock was followed by a few aftershocks. A list of aftershocks of magnitude 3.0 and above recorded till 09.30 hours IST of 19th September, 2011, is given below. It may, however, be mentioned that the magnitude and frequency of aftershocks will reduce with the passage of time.

S.No.	Date	Time of aftershocks Hr:Min (In IST)	Magnitude
1	18.09.2011	18 :42	5.3
2	18.09.2011	19:24	4.6
3	18.09.2011	20:35	3.0
4	19.09.2011	00:57	3.4
5	19.09.2011	03:21	3.8

The earthquake source parameters have been disseminated to all concerned state and central government agencies related with initiating relief and rescue operations in the region. The information is also put on IMD's website for public use. The aftershock activity is being continuously monitored and information on significant aftershocks is being transmitted to all the concerned agencies.

The source parameters of the event are estimated using data of a total of **77 seismic** stations in India and across the globe spread more or less in all azimuths (**Annexure-2**). The details of various magnitude estimates are given in **Annexure-3**. The preliminary faulting mechanism of the subject earthquake, as estimated through Centroid Moment Tensor (CMT) and Moment Tensor (MT) solutions are given in (**Annexure- 4 & -5**). The faulting mechanism indicates reverse faulting associated with the tectonic processes related to the collision of Indian and Eurasian plates along the major thrusts in the region. The **centroid moment depth indicated** by the CMT solution (**10 km**.) for the present event matches well with the hypo-central estimates. The CMT and MT solutions are obtained from waveform modelling making use of Body and Surface waves respectively. The process essentially involves in simulating the synthetic seismograms by assuming a known source, path and instrumental characteristics. These synthetic seismograms are then matched with the observed ones at various stations in an attempt to arrive at the characteristics of the source, which produces the best synthetic seismograms matching with the observed ones.

2. A slight magnitude earthquake (M:3.9) also occurred at 06 hours 22 minutes IST on 19th September, 2011 in the Latur district of Maharashtra. This event is located about 1500 kms away from the epicenter of the earthquake in Sikkim-Nepal border region of 18th September, 2011 and hence felt not directly related to it.

3. Strong Motion Accelerographs (SMAs), meant for recording strong ground vibrations of the kind experienced during the subject event, are deployed by academic institutions, viz., IIT (Roorkee), IIT (Kharagpur), etc. in the Himalayan region including northeast India through sponsored projects supported by MoES. These data sets would provide valuable information for designing earthquake resistant structures in the region in future.

4. Past seismicity of the region:

Historical and instrumentally recorded data on earthquakes show that the Sikkim and adjoining area lies in a region prone to be affected by moderate to great earthquakes in the past. Some noteworthy earthquakes that have affected the region are:

(i) Cachar earthquake of 10.01.1869 (M: 7.5),
(ii) Shillong plateau earthquake of 12.06.1897 (M: 8.7),
(iii) Dhubri earthquake of 02.07.1930 (M: 7.1),
(iv) Bihar-Nepal Border earthquake of 15.01.1934 (M: 8.3),
(v) Arunachal Pradesh – China Border earthquake of 15.08.1950 (M: 8.5),
(vi) Nepal-India Border earthquake of 21.08.1988 (M: 6.4)
(vii) Sikkim earthquake of 14.02.2006 (M: 5.7)
(viii) Bhutan earthquake of 21.09.2009 (M:6.2)

The Sikkim and adjoining region is known to be part of the seismically active region of the 'Alpide-Himalayan global seismic belt', with four great earthquakes of the world of magnitude 8.0 and above occurring in this region. The occurrence of earthquakes in the region is broadly associated with the tectonic activity along well known faults in the Himalayas, namely, Main Boundary Thrust (MBT), Main Central Thrust (MCT). Other prominent geological / tectonic features in and around Sikkim include: Tista lineament, Kunchenjunga lineament, Purnea-Everest lineament, Arun lineament and Dhubri fault in the southeast.

In the seismic zoning map of India prepared under the auspices of Bureau of Indian Standards (BIS code IS: 1893: Part I 2002), by a committee of experts representing various scientific institutions including India Meteorological Department (IMD), the **entire area of Sikkim lies in Zone IV**. The seismic **Zone IV** is broadly associated with **seismic intensity VIII** on the Modified Mercalli Intensity (MMI) scale. It may be mentioned that the seismic intensity VIII on MMI scale corresponds to a horizontal ground acceleration range of 51-350 cm / sec^2 or an average acceleration of 172 cm / sec^2 in any direction. The ground acceleration and hence the intensity of an earthquake at a place depends on magnitude of earthquake, distance from the focus, duration of earthquake, type of underlying soil and its damping characteristics and liquefaction potential. The damage to the buildings founded on soft soil or filled up earth is higher than that in the similar type of buildings having their foundation on hard bedrock. Also, the damage will be higher for higher magnitude and long duration earthquakes, less epicentral distance soft soil conditions and areas with high liquefaction potential.

Presently, there is no scientific technique available anywhere in the world to predict occurrence of earthquakes with reasonable degree of accuracy with regard to space, time and magnitude. It is, therefore suggested that appropriate steps may be taken to ensure that the dwellings and other structures in the region are designed and constructed as per guidelines laid down by Bureau of Indian Standards (BIS) to minimize the losses caused by earthquakes. The choice of seismic factor to be adopted for designing and engineering the structures depends on horizontal ground acceleration and various other factors including type of structures, the ground conditions and also importance of structures. For important and critical structures, site specific spectral studies have to be carried out before assessing the seismic design parameters. Suitable seismic design parameters may be adopted as per recommendations of National Committee on Seismic Design Parameters (NCSDP) for designing and engineering Hydroelectric Projects.

5. Causes of earthquakes:

Earthquakes are the result of a process, wherein the underground rocks suddenly break, along a plane of weakness called '*fault'*, when the prevalent stresses exceed the elastic strength of the rock. The buildup of stresses and subsequent release of the strain energy in the form of earthquakes is a continuous process, which keeps repeating in geological time scale. A number of theoretical assumptions that explain the forces, which cause accumulation of stresses inside the earth include: drifting of continents and mountain building process, shortening of Earth's Crust due to cooling and contraction, disturbance of mass distribution on the Earth's surface as a result of erosion of high lands and deposition of sediments in the sea and generation of heat by radioactive material inside the Earth's Crust.

6. **Classification of earthquakes:**

Based on magnitude (M), earthquakes may be classified as *Micro- (M<3.0), Slight- (M:3.0 -4.9), Moderate- (M:5.0-6.9), Great- (M:7.0-8.0) and Very great- (M>8.0).* Earthquakes may also be classified as shallow-focus, intermediate-focus and deep-focus depending upon their focal depths. *Shallow-focus earthquakes*, which constitute about 80% of total energy release on the globe, have their foci at a depth between *0 and 70 km*. and occur along collision and subduction zones, oceanic ridges and transform faults. *Intermediate-focus earthquakes* (focal depth between *71 and 300 km*.) and *deep-focus earthquakes* (focal depth *greater than 300 km*.) occur in subduction zones, such as Andaman-Nicobar island region and northeast India. Most earthquakes originate within the crust and beneath the Moho, the number falls abruptly and dies down to zero at a depth of about 700 km. On an average, it is expected that about two earthquakes of M~8.0, ~20 earthquakes of M~7.0, ~100 earthquakes of M~6.0 and ~3000 earthquakes of M~5.0 are likely to occur every year over the globe. A list of significant earthquakes in the recent past in and around India is given below:

- Uttarkashi earthquake of October 20, 1991 (M: 6.6).
- Latur earthquake of September 30, 1993 (M: 6.3).
- Jabalpur earthquake of May 22, 1997 (M: 6.0).
- Chamoli earthquake of March 29, 1999 (M: 6.8).

- Bhuj earthquake of January 26, 2001 (M: 7.7).
- Sumatra earthquake of December 26, 2004 (Mw:9.3)
- Muzaffarabad earthquake of October 8, 2005 (Ms:7.6)

7. Seismic Zoning of India:

Bureau of Indian Standards *[IS-1893 (Part-1): 2002]*, based on various scientific inputs collected from a number of agencies, has grouped the country into four seismic zones, viz. Zone-II, -III, -IV and –V. Of these, Zone V is seismically the most prone region, while zone II is the least. The Modified Mercalli (MM) intensity, which measures the impact of the earthquakes on the surface of the earth, broadly associated with various zones is as follows:

Seismic Zone	MM Intensity
II (Low intensity zone)	VI (or less)
III (Moderate intensity zone)	VII
IV (Severe intensity zone)	VIII
V (Very severe intensity zone)	IX (and above)

Broadly, Zone-V (12% of land) comprises of entire northeastern India, parts of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Rann of Kutch in Gujarat, parts of North Bihar and Andaman & Nicobar islands. Zone-IV (18%) covers remaining parts of Jammu & Kashmir and Himachal Pradesh, Union Territory of Delhi, Sikkim, northern parts of Uttar Pradesh, Bihar and West Bengal, parts of Gujarat and some portion of Maharashtra near the west coast and Rajasthan. Zone-III (27%) comprises of Kerala, Goa, Lakshadweep islands, remaining parts of Uttar Pradesh, Gujarat and West Bengal, parts of Punjab, Rajasthan, Madhya Pradesh, Bihar, Jharkhand, Chhatisgarh, Maharashtra, Orissa, Andhra Pradesh, Tamilnadu and Karnataka. Zone-II (43%) covers remaining parts of the country.

8. Seismic Hazard and Risk Microzonation:

Microzonation is the process of dividing a geographic domain into small units of likely uniform hazard level and nature. This classification is done based on Geoscientific, Geotechnical, Seismological and Engineering seismological parameters. The Hazard micro zone map is transformed into seismic risk microzonation map with inputs on Vulnerability of Built environment and Anthropological / Sociological inputs. As earthquake prediction is not possible precisely in time and space, seismic Hazard microzonation provides an important tool for generating parameters for site specific structural designing, land use planning and disaster mitigation. Seismic microzonation studies have been completed for Delhi (1:50,000 scale), Guwahati (1:25,000 scale), Sikkim (1:25,000 scale) and Bangalore city (1:25,000 scale). Microzonation map for NCT of Delhi is further being refined at 1:10,000 scale. It is planned to take up microzonation studies for all State Capitals and cities with a population density of half a million lying in Zones III, IV and V. The work will be taken up in phased manner and 30 cities have been indentified to start with. In this connection, detailed guidelines have been prepared for standardization of procedures / methods for adoption taking up these studies.

9. Disaster mitigation:

Loss of lives during an earthquake is mostly due to damage or collapse of houses/ structures. However, any structure can bear the vibration from an earthquake if it has enough strength and sturdiness. Bureau of Indian Standards (BIS) has published criterion for construction of earthquake resistant structures. The design of structure should be such that the whole structure behaves as one unit at the time of vibration rather than assemblage of parts. Important structures like hospitals, fire stations etc. should be made earthquake resistant. However, it is not economical to demolish and reconstruct most of the poorly built structures; for such poorly built structures BIS has prepared guidelines for their retrofitting. In addition to this, HUDCO & BMTPC have also published guidelines and brochures for construction and retrofitting of buildings. Further, losses due to earthquakes can be considerably reduced through proper planning and implementation of pre- and post-disaster preparedness and management strategies by respective state government agencies by working out the possible earthquake effects for various seismic zones.

10. National Program on Earthquake Precursors (NPEP)

It is now recognized that earthquake generation processes are so complex and site specific that often, no two different tectonic environments behave in similar manner in terms of providing clues about the ongoing physical processes in the earthquake source region. It is, thus, necessary to adopt an integrated approach of generation, assimilation and analyses of a variety of earthquake precursory phenomena in critical seismotectonic environments in the country in a comprehensive manner. Towards meeting this objective, a National Program on Earthquake Precursors (NPEP) has been initiated recently by MoES through a multi-institutional and multi-disciplinary mechanism. As part of this, a suite of Multi-Parametric Geophysical Observatories (MPGOs) have been set up at Ghuttu, Shillong and Koyna to monitor various earthquake precursory phenomenon such as, seismicity patterns, crustal deformations, gravity anomalies, electrical resistivity changes, electromagnetic perturbations, water level changes, geo-hydrochemical changes, Radon and Helium anomalies and thermal anomalies, etc. Preliminary analyses of these data sets have provided useful leads on the ongoing tectonic processes in the Koyna-Warna region. It is proposed to intensity these investigations during the XII FYP.

11. Deep drilling program in Koyna region

The Koyna Dam located in Maharashtra, western India is the most outstanding example of Reservoir Triggered Seismicity (RTS), where triggered earthquakes have been occurring in a restricted area of 20x30 sq km since the impoundment of Shivajisagar Lake in 1962. These include the largest triggered earthquake of M~6.3 on Dec 10 1967, 22 earthquakes of M>5, about 200 earthquakes of M~4, and several thousand smaller earthquakes since 1962. Considering the importance of deep borehole investigations, it is proposed to undertake a suite of observations in deep borehole(s) in the Koyna area. The work will be carried out in collaboration with ICDP and the observations will include stress regime, pore fluid pressure and its variations, heat flow and its variation, orientation of faults, study of chemical properties of fluids, before, during and after earthquake. The proposed investigations through the borehole will facilitate i) observation and analysis of data, generated through the operation of borehole for 4-5 year of time, when it is anticipated that a few earthquakes of magnitude ~3 would occur in the immediate vicinity of borehole, ii) continuous observation to study the data in the far and near field of the earthquake and temporal variation w.r.t. occurrence of earthquake and iii) development of a model of RTS mechanism.

12. The critical structures viz., nuclear power plants and dams in the country are designed taking into consideration the past seismicity and the expected ground motions in the region, estimated through a **detailed site specific analysis** using probabilistic and deterministic approaches carried out by earthquake engineering community.

13. Efforts are being made to improve the understanding of earthquake processes and their impacts towards better management and mitigation of the effects of earthquakes in future. A document detailing the proposals planned to be taken up during the XII FYP is attached for kind information.

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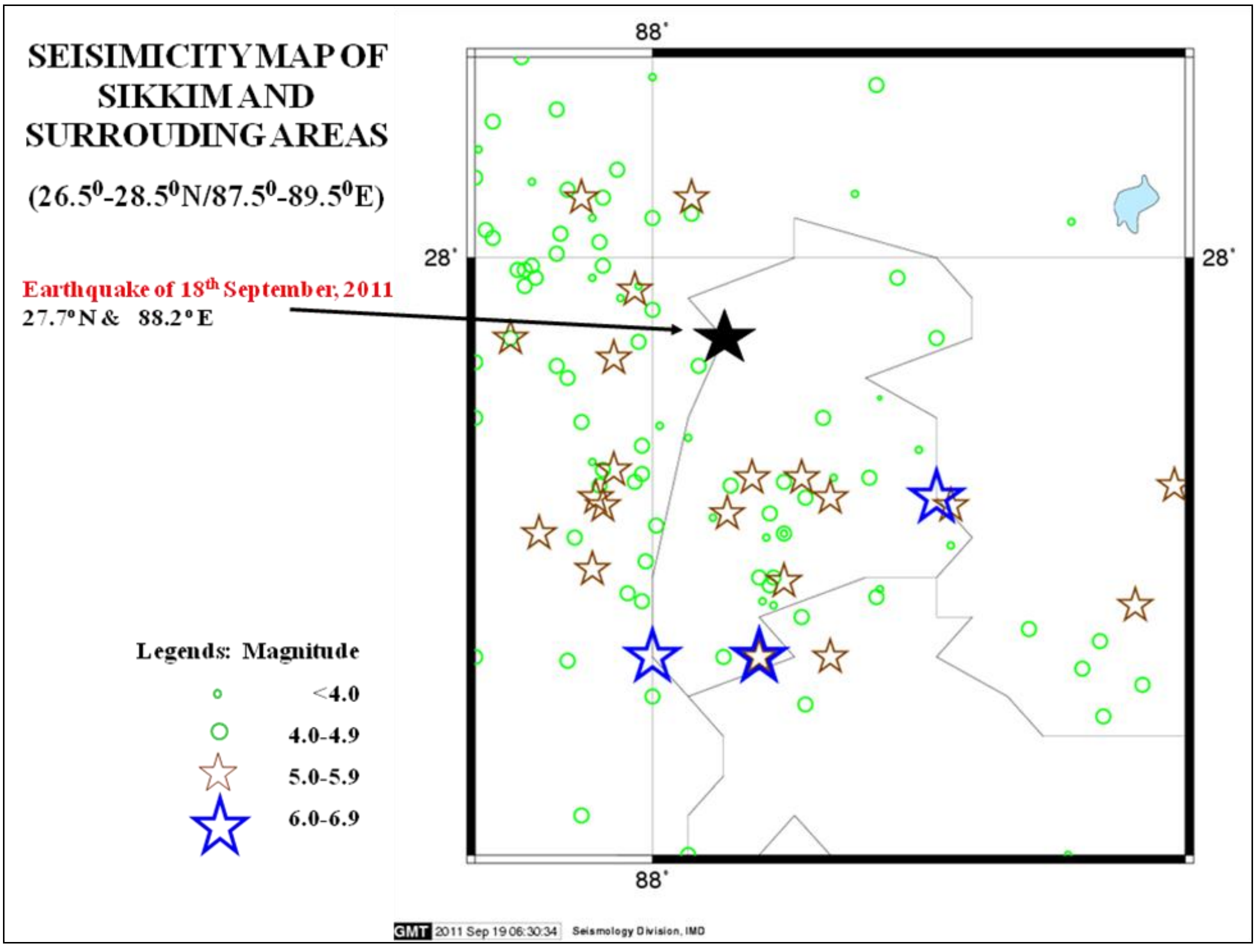
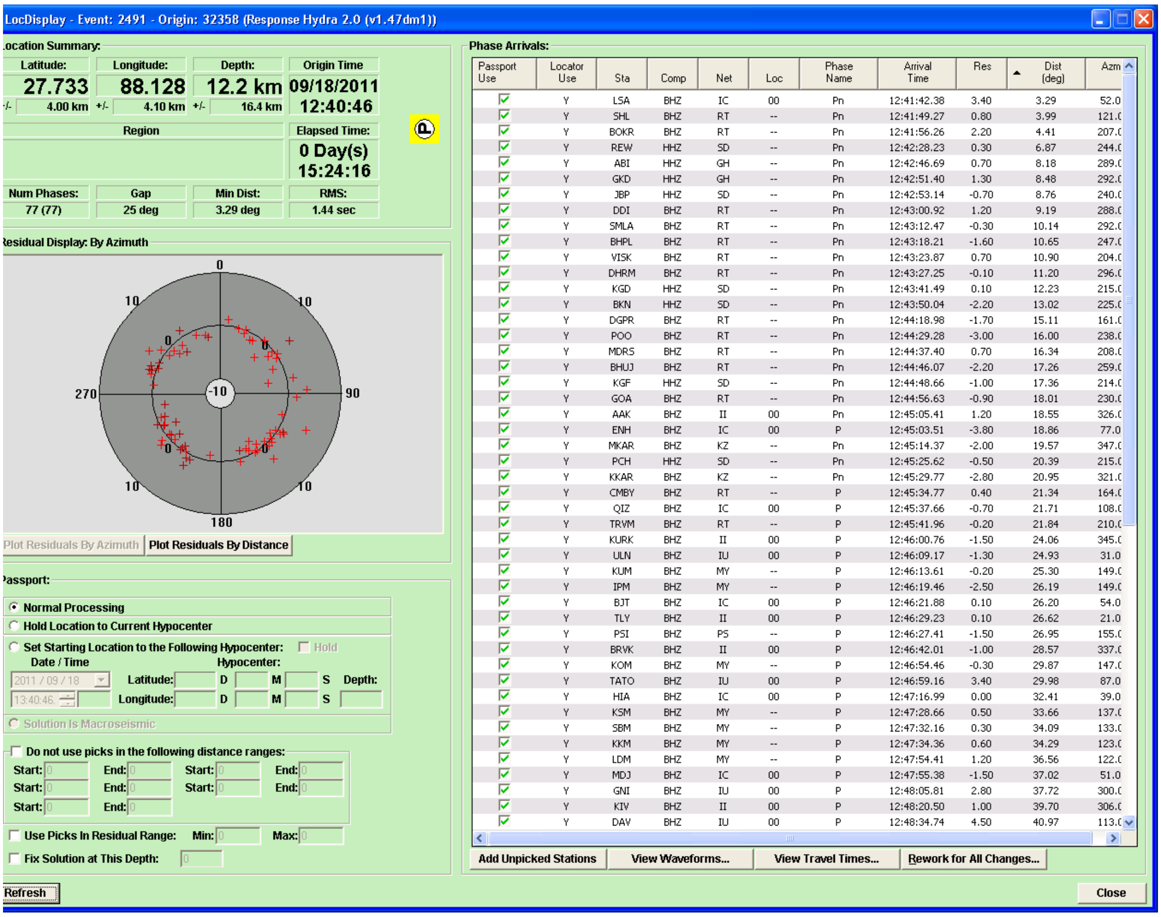
Annexure-1



SEISIMICITY MAP OF SIKKIM AND SURROUDING AREAS
(26.5⁰-28.5⁰N/87.5⁰-89.5⁰E)
Earthquake of 18th September, 2011
27.7°N & 88.2°E
Legends: Magnitude
<4.0
4.0-4.9
5.0-5.9
6.0-6.9
88°
28°
88°
28°
GMT 2011 Sep 19 06:30:34
Seismology Division, IMD

Annexure-2



Passport Use	Locator Use	Sta	Comp	Net	Loc	Phase Name	Arrival Time	Res	Dist (deg)	Azm
✓	Y	LSA	BHZ	IC	00	Pn	12:41:42.38	3.40	3.29	52.0
✓	Y	SHL	BHZ	RT	--	Pn	12:41:49.27	0.80	3.99	121.0
✓	Y	BOKR	BHZ	RT	--	Pn	12:41:56.26	2.20	4.41	207.0
✓	Y	REW	HHZ	SD	--	Pn	12:42:28.23	0.30	6.87	244.0
✓	Y	ABI	HHZ	GH	--	Pn	12:42:46.69	0.70	8.18	289.0
✓	Y	GKD	HHZ	GH	--	Pn	12:42:51.40	1.30	8.48	292.0
✓	Y	JBP	HHZ	SD	--	Pn	12:42:53.14	-0.70	8.76	240.0
✓	Y	DDI	BHZ	RT	--	Pn	12:43:00.92	1.20	9.19	288.0
✓	Y	SMLA	BHZ	RT	--	Pn	12:43:12.47	-0.30	10.14	292.0
✓	Y	BHPL	BHZ	RT	--	Pn	12:43:18.21	-1.60	10.65	247.0
✓	Y	VISK	BHZ	RT	--	Pn	12:43:23.87	0.70	10.90	204.0
✓	Y	DHRM	BHZ	RT	--	Pn	12:43:27.25	-0.10	11.20	296.0
✓	Y	KGD	HHZ	SD	--	Pn	12:43:41.49	0.10	12.23	215.0
✓	Y	BKN	HHZ	SD	--	Pn	12:43:50.04	-2.20	13.02	225.0
✓	Y	DGPR	BHZ	RT	--	Pn	12:44:18.98	-1.70	15.11	161.0
✓	Y	POO	BHZ	RT	--	Pn	12:44:29.28	-3.00	16.00	238.0
✓	Y	MDRS	BHZ	RT	--	Pn	12:44:37.40	0.70	16.34	208.0
✓	Y	BHUJ	BHZ	RT	--	Pn	12:44:46.07	-2.20	17.26	259.0
✓	Y	KGF	HHZ	SD	--	Pn	12:44:48.66	-1.00	17.36	214.0
✓	Y	GOA	BHZ	RT	--	Pn	12:44:56.63	-0.90	18.01	230.0
✓	Y	AAK	BHZ	II	00	Pn	12:45:05.41	1.20	18.55	326.0
✓	Y	ENH	BHZ	IC	00	P	12:45:03.51	-3.80	18.86	77.0
✓	Y	MKAR	BHZ	KZ	--	Pn	12:45:14.37	-2.00	19.57	347.0
✓	Y	PCH	HHZ	SD	--	Pn	12:45:25.62	-0.50	20.39	215.0
✓	Y	KKAR	BHZ	KZ	--	Pn	12:45:29.77	-2.80	20.95	321.0
✓	Y	CMBY	BHZ	RT	--	P	12:45:34.77	0.40	21.34	164.0
✓	Y	QIZ	BHZ	IC	00	P	12:45:37.66	-0.70	21.71	108.0
✓	Y	TRVM	BHZ	RT	--	P	12:45:41.96	-0.20	21.84	210.0
✓	Y	KURK	BHZ	II	00	P	12:46:00.76	-1.50	24.06	345.0
✓	Y	ULN	BHZ	IU	00	P	12:46:09.17	-1.30	24.93	31.0
✓	Y	KUM	BHZ	MY	--	P	12:46:13.61	-0.20	25.30	149.0
✓	Y	IPM	BHZ	MY	--	P	12:46:19.46	-2.50	26.19	149.0
✓	Y	BJT	BHZ	IC	00	P	12:46:21.88	0.10	26.20	54.0
✓	Y	TLY	BHZ	II	00	P	12:46:29.23	0.10	26.62	21.0
✓	Y	PSI	BHZ	PS	--	P	12:46:27.41	-1.50	26.95	155.0
✓	Y	BRVK	BHZ	II	00	P	12:46:42.01	-1.00	28.57	337.0
✓	Y	KOM	BHZ	MY	--	P	12:46:54.46	-0.30	29.87	147.0
✓	Y	TATO	BHZ	IU	00	P	12:46:59.16	3.40	29.98	87.0
✓	Y	HIA	BHZ	IC	00	P	12:47:16.99	0.00	32.41	39.0
✓	Y	KSM	BHZ	MY	--	P	12:47:28.66	0.50	33.66	137.0
✓	Y	SBM	BHZ	MY	--	P	12:47:32.16	0.30	34.09	133.0
✓	Y	KKM	BHZ	MY	--	P	12:47:34.36	0.60	34.29	123.0
✓	Y	LDM	BHZ	MY	--	P	12:47:54.41	1.20	36.56	122.0
✓	Y	MDJ	BHZ	IC	00	P	12:47:55.38	-1.50	37.02	51.0
✓	Y	GNI	BHZ	IU	00	P	12:48:05.81	2.80	37.72	300.0
✓	Y	KIV	BHZ	II	00	P	12:48:20.50	1.00	39.70	306.0
✓	Y	DAV	BHZ	IU	00	P	12:48:34.74	4.50	40.97	113.0

Annexure-3

MagDisplay - Event: 2491 - Origin: 32358 (Response Hydra 2.0 (v1.47dm1))

Location Summary:

Latitude:	Longitude:	Depth:	Origin Time
27.733	88.128	12.2 km	09/18/2011 12:40:46
+/- 4.00 km	+/- 4.10 km	+/- 16.4 km	

Region

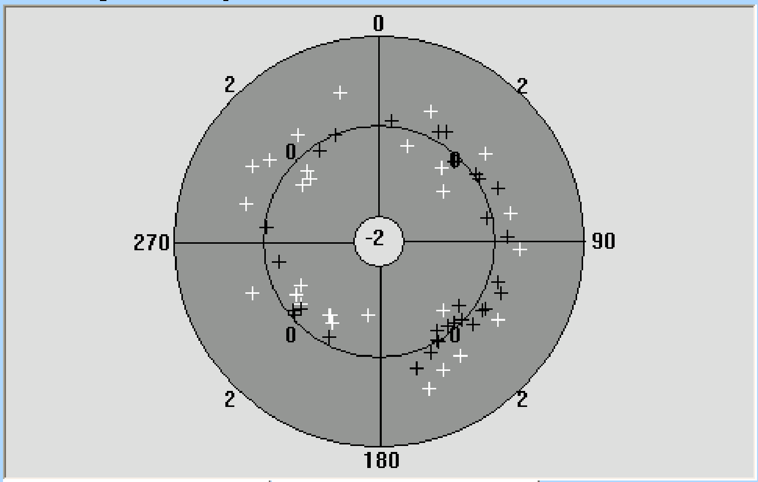
Elapsed Time: 0 Day(s) 15:26:15

Magnitude

6.81 Mb

Mag:	Type:	Quality:	
7.05	Mwp:	33(63)	Show Mwp
6.81	Mb:	31(59)	Show Mb
6.61	Ms:	37(71)	Show Ms
6.20	Ml:	3(6)	Show Ml
6.44	Mblg:	4(13)	Show Mblg
-.-	Md:	-\-	Show Md

Station Magnitude Plot: By Azimuth



Plot Magnitudes By Azimuth: | Plot Magnitudes By Distance:

Passport

Distance Window:	Min:	15
	Max:	100
Period Window:	Min:	0.1
	Max:	3
Max Depth:		800

☑ Manual Time Window

Time Window: 60.00

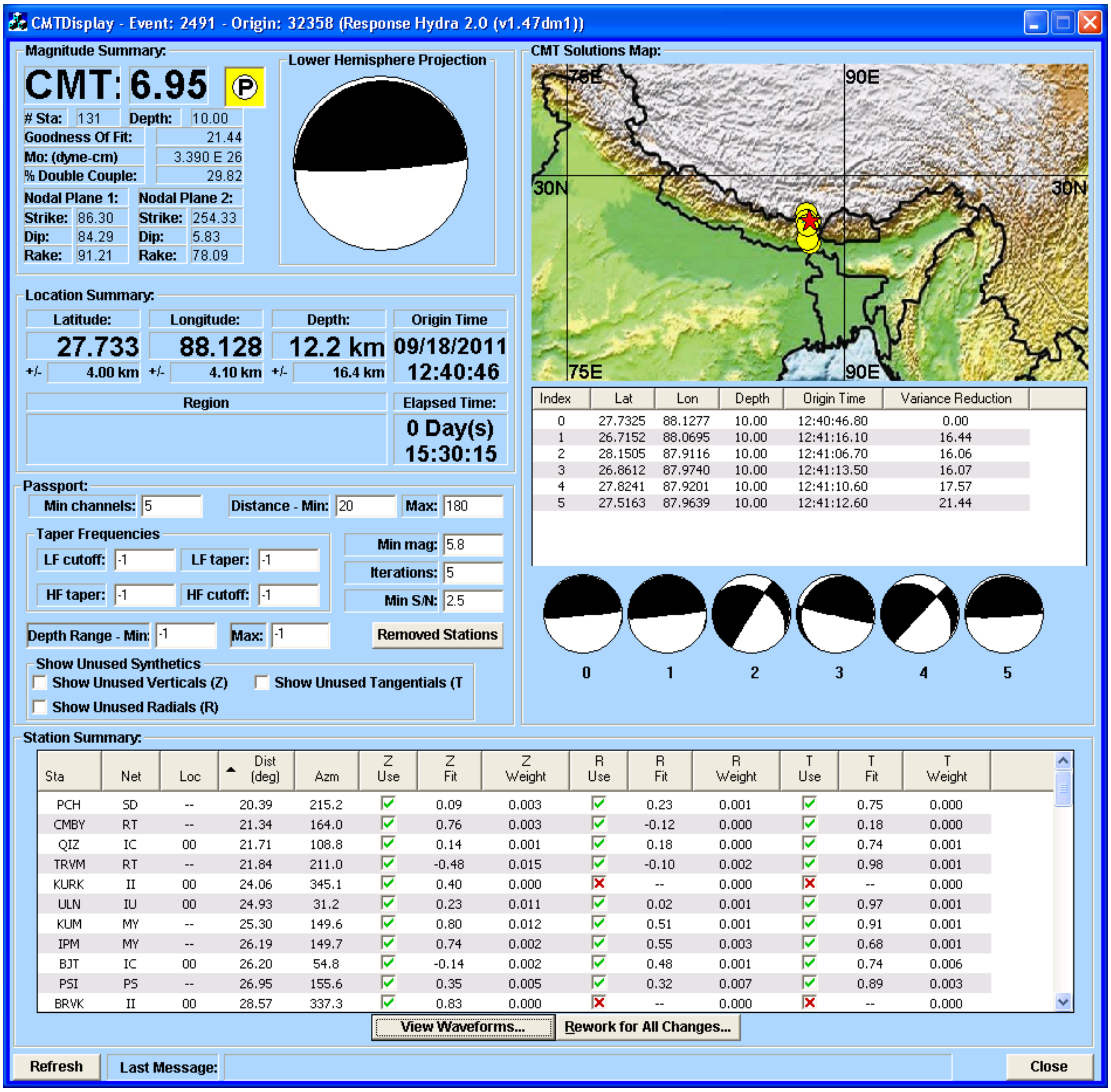
Station Magnitudes:

Use	Sta	Comp	Net	Loc	Mag	Amp Time	Amp (nanometers)	Amp Period	Mag Weight	Dist (deg)	Azi
☑	MAW	BHZ	AU	--	5.86	12:54:29.76	114.8629	1.75	0.00	96.91	189.51
☑	MDJ	BHZ	IC	00	6.02	12:48:02.08	534.3727	0.90	0.00	37.02	51.71
☑	KGF	HHZ	SD	--	6.16	12:45:29.24	4485.2671	1.22	0.00	17.36	214.08
☑	PCH	HHZ	SD	--	6.19	12:45:42.54	2610.5920	1.10	0.00	20.39	215.21
☑	LSZ	BHZ	IU	00	6.22	12:52:37.16	370.7728	0.80	0.00	72.10	241.47
☑	TRVM	BHZ	RT	--	6.30	12:45:47.99	2796.5002	1.10	0.00	21.84	211.01
☑	FITZ	BHZ	AU	--	6.30	12:51:27.54	625.5430	1.05	0.00	58.28	137.03
☑	BFO	BHZ	II	00	6.31	12:52:00.96	636.5034	1.40	0.00	63.29	312.75
☑	KIV	BHZ	II	00	6.37	12:49:13.00	1844.5765	1.10	0.00	39.70	306.38
☑	HIA	BHZ	IC	00	6.39	12:47:41.59	888.5411	0.90	0.00	32.41	39.81
☑	POO	BHZ	RT	--	6.40	12:45:19.17	5876.7393	0.94	0.00	16.00	238.12
☑	TIXI	BHZ	IU	00	6.46	12:50:32.26	1225.1218	1.30	0.00	49.32	15.80
☑	BOSA	BHZ	GT	00	6.46	12:53:39.14	880.5881	1.15	0.00	82.25	232.27
☑	KIEV	BHZ	IU	00	6.46	12:50:16.04	985.9127	1.00	0.00	49.59	314.37
☑	MTN	BHZ	AU	--	6.47	12:51:14.29	1356.5924	1.45	0.80	57.99	128.26
☑	BHUJ	BHZ	RT	--	6.49	12:45:35.39	6093.5229	0.78	3.40	17.26	259.18
☑	GOA	BHZ	RT	--	6.52	12:45:30.51	5943.9448	0.72	3.40	18.01	230.40

Rework For All Changes...

Refresh | Help | Close

Annexure-4


CMTDisplay - Event: 2491 - Origin: 32358 (Response Hydra 2.0 (v1.47dm1))

Magnitude Summary:

CMT: 6.95 (P)

# Sta:	131	Depth:	10.00
Goodness Of Fit:			21.44
Mo: (dyne-cm)			3.390 E 26
% Double Couple:			29.82
Nodal Plane 1:		Nodal Plane 2:	
Strike:	86.30	Strike:	254.33
Dip:	84.29	Dip:	5.83
Rake:	91.21	Rake:	78.09

Lower Hemisphere Projection

CMT Solutions Map:

Index	Lat	Lon	Depth	Origin Time	Variance Reduction
0	27.7325	88.1277	10.00	12:40:46.80	0.00
1	26.7152	88.0695	10.00	12:41:16.10	16.44
2	28.1505	87.9116	10.00	12:41:06.70	16.06
3	26.8612	87.9740	10.00	12:41:13.50	16.07
4	27.8241	87.9201	10.00	12:41:10.60	17.57
5	27.5163	87.9639	10.00	12:41:12.60	21.44

0 1 2 3 4 5

Location Summary:

Latitude:	Longitude:	Depth:	Origin Time
27.733	88.128	12.2 km	09/18/2011
+/- 4.00 km	+/- 4.10 km	+/- 16.4 km	12:40:46

Region

Elapsed Time: 0 Day(s) 15:30:15

Passport:

Min channels: 5 Distance - Min: 20 Max: 180

Taper Frequencies

LF cutoff: -1 LF taper: -1

HF taper: -1 HF cutoff: -1

Min mag: 5.8

Iterations: 5

Min S/N: 2.5

Depth Range - Min: -1 Max: -1

Removed Stations

Show Unused Synthetics

Show Unused Verticals (Z) Show Unused Tangentials (T

Show Unused Radials (R)

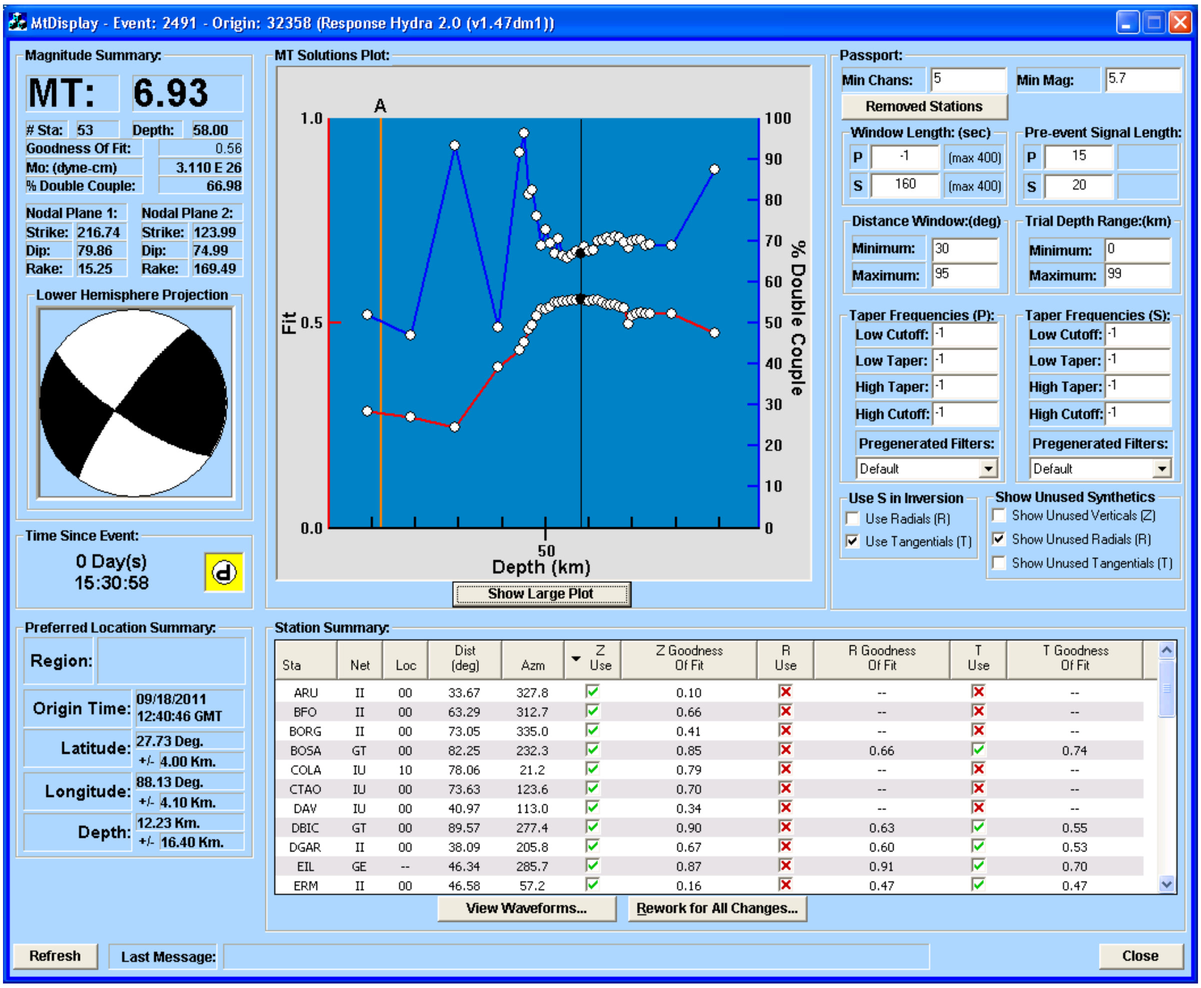
Station Summary:

Sta	Net	Loc	Dist (deg)	Azm	Z Use	Z Fit	Z Weight	R Use	R Fit	R Weight	T Use	T Fit	T Weight
PCH	SD	--	20.39	215.2	✓	0.09	0.003	✓	0.23	0.001	✓	0.75	0.000
CMBY	RT	--	21.34	164.0	✓	0.76	0.003	✓	-0.12	0.000	✓	0.18	0.000
QIZ	IC	00	21.71	108.8	✓	0.14	0.001	✓	0.18	0.000	✓	0.74	0.001
TRVM	RT	--	21.84	211.0	✓	-0.48	0.015	✓	-0.10	0.002	✓	0.98	0.001
KURK	II	00	24.06	345.1	✓	0.40	0.000	✗	--	0.000	✗	--	0.000
ULN	IU	00	24.93	31.2	✓	0.23	0.011	✓	0.02	0.001	✓	0.97	0.001
KUM	MY	--	25.30	149.6	✓	0.80	0.012	✓	0.51	0.001	✓	0.91	0.001
IPM	MY	--	26.19	149.7	✓	0.74	0.002	✓	0.55	0.003	✓	0.68	0.001
BJT	IC	00	26.20	54.8	✓	-0.14	0.002	✓	0.48	0.001	✓	0.74	0.006
PSI	PS	--	26.95	155.6	✓	0.35	0.005	✓	0.32	0.007	✓	0.89	0.003
BRVK	II	00	28.57	337.3	✓	0.83	0.000	✗	--	0.000	✗	--	0.000

View Waveforms... Rework for All Changes...

Refresh Last Message: Close

Annexure-5


MtDisplay - Event: 2491 - Origin: 32358 (Response Hydra 2.0 (v1.47dm1))
Magnitude Summary:
MT: 6.93
Sta: 53 Depth: 58.00
Goodness Of Fit: 0.56
Mo: (dyne-cm) 3.110 E 26
% Double Couple: 66.98
Nodal Plane 1: Strike: 216.74 Dip: 79.86 Rake: 15.25
Nodal Plane 2: Strike: 123.99 Dip: 74.99 Rake: 169.49
Lower Hemisphere Projection
Time Since Event: 0 Day(s) 15:30:58
MT Solutions Plot:
Fit
% Double Couple
Depth (km)
Show Large Plot
Passport:
Min Chans: 5
Min Mag: 5.7
Removed Stations
Window Length: (sec) P -1 (max 400) S 160 (max 400)
Pre-event Signal Length: P 15 S 20
Distance Window:(deg) Minimum: 30 Maximum: 95
Trial Depth Range:(km) Minimum: 0 Maximum: 99
Taper Frequencies (P): Low Cutoff: -1 Low Taper: -1 High Taper: -1 High Cutoff: -1
Taper Frequencies (S): Low Cutoff: -1 Low Taper: -1 High Taper: -1 High Cutoff: -1
Pregenerated Filters: Default
Use S in Inversion: Use Radials (R) Use Tangentials (T)
Show Unused Synthetics: Show Unused Verticals (Z) Show Unused Radials (R) Show Unused Tangentials (T)
Preferred Location Summary:
Region:
Origin Time: 09/18/2011 12:40:46 GMT
Latitude: 27.73 Deg. +/- 4.00 Km.
Longitude: 88.13 Deg. +/- 4.10 Km.
Depth: 12.23 Km. +/- 16.40 Km.
Station Summary:
Sta Net Loc Dist (deg) Azm Z Use Z Goodness Of Fit R Use R Goodness Of Fit T Use T Goodness Of Fit
ARU II 00 33.67 327.8 0.10 -- --
BFO II 00 63.29 312.7 0.66 -- --
BORG II 00 73.05 335.0 0.41 -- --
BOSA GT 00 82.25 232.3 0.85 0.66 0.74
COLA IU 10 78.06 21.2 0.79 -- --
CTAO IU 00 73.63 123.6 0.70 -- --
DAV IU 00 40.97 113.0 0.34 -- --
DBIC GT 00 89.57 277.4 0.90 0.63 0.55
DGAR II 00 38.09 205.8 0.67 0.60 0.53
EIL GE -- 46.34 285.7 0.87 0.91 0.70
ERM II 00 46.58 57.2 0.16 0.47 0.47
View Waveforms...
Rework for All Changes...
Refresh
Last Message:
Close