A COMPREHENSIVE STUDY ON SUMATRA EARTHQUAKE

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Abstract: *A devastating earthquake of Mw 9 occurred at 6:28:50 IST on December 26 , 2004 off the West coast of Northern Sumatra which was followed by several number of aftershocks during the subsequent days . Our LF band (low frequencies, 30 – 300 KHz) receiver operating at 40 KHz stationed at Agartala, Tripura University campus (23°N, 91.4°E) collected these data over a period of about one month. We have analysed the data obtained from 27.12.04 to 9.1.05 and have classified them into four categories to produce significant results. It is observed from the analysis that the events which have no regularity or symmetry in the spectrum both before and after the phenomenon, are associated with earthquakes of shallow depth as well as of higher magnitude.*

Introduction: Some studies on the 2004 December 26 Sumatra - Andaman earthquake of Mw 9.3 have been made in recent times. Kennett and Cummins (2005) (ref.[6]) reported the relationship of the seismic source and subduction zone structure for the aforesaid earthquake. The findings of Fine, Rabinovich and Thomson (2005) (ref.[1]) define a curved, 250 km wide, 1000 km long tsunami source region centered over the Sunda subduction zone, which closely matches the seismic source estimated from broadband geophysical data. The extent, duration and speed of 2004 Sumatra - Andaman earthquake was imaged by the Hi - Net array by Ishii, Shearer, Houston and Vidale (2005) (ref.[5]). Similarly the tracking of the rupture of Sumatra earthquake over 1150 km at teleseismic distance was done by Kriiger and Ohrnberger (2005) (ref.[7]).

We have made observations at LF (low frequencies, 30 – 300 KHz) band by a receiver stationed at Agartala, Tripura University campus (23°N, 91.4°E) which collected the electromagnetic waves generated at the earthquake zone and after aftershocks, occurring off the West coast of Northern Sumatra. Similar observations are also made at other frequencies (ELF to VHF) which are stated in different monographs published recently (Hayakawa, 1999; Hayakawa & Molchanov, 2002)(ref.[3]) and (Hayakawa & Fujinawa, 1994) (ref.[4]).

Experimental set up: In our experimental set up (Fig 1), we have developed a receiver which has been operating since October, 2004 in order to detect 40 KHz signal transmitted by Miyakoji station, Japan (37.4°N, 140.85°E). The induced voltage at the antenna is, at first, passed through a band pass filter and then the desired frequency is selected by a series resonant circuit. The tuned voltage is then detected and amplified using quasi – logarithmic amplifier.The data is finally recorded by data acquisition system in order to store the data in a computer. The antenna is a horizontal wire of length 20 meter, placed 10.1 meter above the ground level. The gain of the band pass filter at cut off frequency can be varied from 1 to 10, but currently it is fixed at 8. The q factor of the tuned circuit is 35.

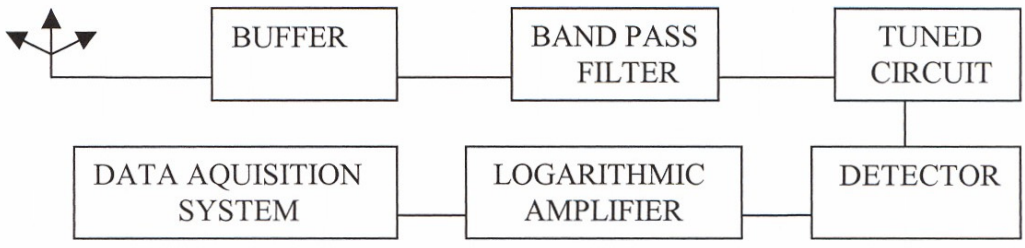

Fig.1

Results: The observations include the time variation of the output signal at 40 KHz frequency during the earthquake events, there being altogether 86400 data in a day. We have, for the present analysis, considered the

observational data from 27.12.2004 to 9.1.2005 (excluding 3.1.2005). The date, time and magnitude of the earthquakes which occurred during the period were taken from the website of USGS.

We have classified the baseline patterns based on the fluctuation of the level of the output voltage. The different classes are stated as follows:

Class I : Symmetry before and after an earthquake event over $\pm$5 min duration.

Class II : A regular and symmetrical pattern before an earthquake event, but irregular and asymmetrical nature of spectrum after the event ($\Delta t = \pm 5$ min).

Class III : Irregular nature of spectrum before an event, but regular nature of spectrum after the event ($\Delta t = \pm 5$ min).

Class IV : No regularity or symmetry is noticed in the spectrum before and after the event ($\Delta t = \pm 5$ min).

From the analysis it can be concluded that the events which exhibit spectra of class IV are generally associated with earthquakes of shallow focal depths and larger magnitudes.

References:

[1] Fine, I.V., Rabinovich, A.B. and Thomson, R.E. : Geological research Letters, 32/16 (1 – 4), 2005.

[2] Hayakawa, M. (ed) : Atmospheric and Ionospheric Electromagnetic phenomena associated with Earthquakes, TERRUB, Tokyo, Japan, 1999.

[3] Hayakawa, M. and Molchanov, O.A. (ed) : Seismo Electromagnetics Lithosphere, Atmosphere – Ionosphere coupling, TERRUB, Tokyo, Japan, 2002.

[4] Hayakawa, M. and Fujinawa, Y. (ed) : Electromagnetic phenomena related to earthquake prediction, TERRUB, Tokyo, Japan, 1994.

[5] Ishii, M.; Shearer, P.M., Houston, H. and Vidale, J.E. : Nature; 435/7044 (933 – 936), 2005.

[6] Kennett, B.L.N and Cummins, P.R. : Earth and Planetary Science Letters, 239/1- 2 (1 – 8), 2005.

[7] Kriiger, F. and Ohrnberger, N. : Nature, 435/7044 (937 – 939), 2005.