AIRPORT COMMUNICATION AS SEISMIC PRECURSOR

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ABSTRACT

Before the occurrence of any medium to large magnitude earthquake, the geomagnetic field in and around the potential Epicentral area is reduced. One of the major reasons is the rise of temperature at the hypocentral area. As the geomagnetic field is reduced, it adversely affects the transmission, propagation and reception of electro-magnetic waves.

This was observed prior to the occurrence of the Sumatran earthquake and tsunami of 26 December 2004. It was understood after the earthquake. It was seen that all aircrafts going to Australia from the northern hemisphere were having some unusual experience. While crossing a particular location in Indonesia, the auto-pilot system of the aircraft was getting disengaged. It was puzzling. Several trials were taken by Australian Civil and Military planes. But all of them had the same experience of disengagement of auto-pilot system. After the earthquake such a phenomenon was either not observed or the number of incidences were reduced. After few weeks, this stopped completely. Bapat (2006) had given a mathematical formula to explain this observation.

The latest example is from Haiti. Few hours before the occurrence of the Haiti earthquake of January 2010 a plane could not establish any contact with the Air traffic Control. It was forced to be diverted to some other airport.

This particular happening could be used as a very short time earthquake precursor. It is proposed to discuss this observation from theoretical, practical and experimental details.

Keywords: aviation communication, seismic precursor, reduction of geomagnetic field

1. INTRODUCTION

Earthquake has been one of the major natural disasters which is most feared. This is partly because it comes suddenly and with practically little notice. During current century a number of destructive earthquakes have occurred. The two major and very large magnitudes (M > 9.2) have occurred in Sumatra (Indonesia) on 26 December 2004 and the other in Tohoku in Japan on 11 March 2011. The Sumatran earthquake has taken a death toll of about 250,000 lives in twenty-three countries. The Tohoku earthquake has caused considerable damage to the Fukushima Nuclear Power generating plant. In addition, there were three earthquakes of magnitude around 8.0 in India, China and Pakistan. These are Bhuj (Gujarat) earthquake of 26 January 2001 and Pakistan earthquake of 08 October 2005. These two earthquakes have taken a death toll of about 100,000 lives. The Sichuan earthquake of 12 May 2008 had taken a death toll of about 80,000 lives. There have been some moderate size destructive earthquakes in New Zealand, Philippines, Korea, China, El Salvador, Costa Rica, Canada, Iran, Italy, Greece etc. It is really very sad that despite these astronomical death figures it has not been possible even to grotesquely predict the occurrence of destructive earthquake. Under such conditions it is likely that people in general and scientists in particular may feel disappointed with a little sense of frustration. However, there is silver lining to this dark cloud. This is recent advances in earthquake prediction. A large number of researchers such as Bapat (2003, 2008, 2010 a), Bernard, P. et al. (1997); Friedemann (2006), Hayakawa (2010), Pulinets (2011) etc have been trying to develop proper methods of earthquake prediction or appear to have reached almost perfection in their works. It is hoped that within next few years the technique of earthquake prediction could reached to a sufficient level of maturity. It needs to be mentioned with a sense of deep regret that Italian seismologists are presently undergoing legal grinding for not properly assessing the seismic situation and predicting occurrence of a moderate size earthquake at L’Aquila in Italy.

2. DEVELOPMENT OF EARTHQUAKE PREDICTION

The subject of earthquake prediction has undergone several changes during last three decades or so. Till about 1980, the prediction of earthquake was a forbidden topic for most of the engineers and some scientists were venturing to endeavor and explore the possibilities of prediction of earthquake. It was perhaps the first attempt by a Japanese scientist Tsuneji Rikitake (1976) to open the subject of earthquake prediction and discuss it extensively with facts and figures. By 1990 a large number of Engineers, Scientists, Disaster Managers and Administrators started believing that earthquake could be predicted. It was also realized that funding of research in the fields of earthquake prediction could be socially useful and economically advisable. Normally, after occurrence of any deadly earthquake, the Government gives monitory compensation to the relatives of the dead persons. If the number of deaths is large then the compensation amount also rises correspondingly. If there is useful research on earthquake prediction, then people could be warned in advance and effectively, the number of deaths would definitely be reduced.

3. METHODS OF PREDICTION

During the initial research period the entire emphasis in earthquake prediction research was mostly and naturally confined to seismological, geophysical, geological, geotectonic parameters. There was remarkable progress about it. But the findings could not be put to practical use. It was for the first time in 1976, that Chinese Scientists could successfully predict the occurrence of a destructive earthquake. It was Haicheng earthquake of 04 Feb 1975 of Magnitude 7.3. But incidentally the parameters used for prediction were none of the scientifically accepted geological or seismological parameters. The Chinese scientists had made a confirmed earthquake prediction based mostly on observing abnormal animal behavior. It was big success. But unfortunately within a span of one year or so, a destructive earthquake occurred at Tangshan on 28 July 1976, magnitude 7.8 and it had taken a death toll of about 240,000 lives. This was big surprise to the world especially after the success of Haicheng earthquake in 1975. Subsequently, the pro and con of earthquake prediction were discussed and deliberated. One of the major findings was that the prediction based technology, should consider those seismic precursors, which appear for a short time before earthquake. Other geological, seismological and geophysical parameters are measured or could be measured at any time. But there are some parameters which appear for a very short time few hours before earthquake. These are abnormal animal and human behavior, total electron content (TEC), Outgoing Long Wave Radiation (OLR) etc. Friedemann (2011) had observed that successful earthquake prediction is possible by using non-seismic, non-geological and non-geophysical methods.

4. SEISMO-ELECTRO MAGNETIC EFFECT

Before the occurrence of any moderate to large magnitude earthquake, it has been observed that the Epicentral and hypocentral areas experience thermal rise. The temperatures rise is primarily due to the movement between two parts of the earthquake causative fault. Initially, the movement is on nano-scale, then on micro scale then finally it a case of ground rupture. As a result the sub surface and surface temperatures rise is abnormal. The rise in temperature, as per law of physics, decreases. The decrease in the value of geomagnetic field adversely affects the propagation and reception of electromagnetic waves. This is known as Seismo-Electromagnetic effect. King, C.Y. (1983), Bapat (2010 b); Ouzounov et al; (2006); Pulinets, S. and D. Ouzounov (2010). have discussed it. It affects all electromagnetic instruments such as Radio, Television, Wireless Communication, Airport Communication etc. If a radio station is transmitting programs at say, 1000 kHz then the same would be received in the potential Epicentral area at higher frequencies such as 1100, 1200, 1300, 1400 … 1500, 1600 kHz. This effect was observed for the first time after the

Tashkent Earthquake of January 1966. This effect is seen a few weeks before the occurrence of medium to large earthquake (M > 6.5). Similarly, reception of television programs is highly disturbed and it has audio, visual and spectral disturbances. This is seen about ten hours before the occurrence of earthquake. The landline communication is highly disturbed and there is lot of background noise a few hours before the occurrence of earthquake. The best indicator is mobile phone (Cell phone). About 100 to 150 minutes before the occurrence of moderate to large magnitude earthquake, the mobile telephone first starts mal-functioning and then becomes non-functioning. This has been observed prior to the occurrence of number of earthquakes such as Bhuj (Gujarat, India) earthquake of M = 8.0, of 26 January 2001, Kashmir earthquake of M = 7.9 of 08 October 2005, Sumatran earthquake of M = 9.3 of 26 December 2004 etc.

4.1. Effect on cable Telephones

After the Latur earthquake, it was reported that the telephone reception was highly disturbed. To observe the adverse effect on telephone service, data about the number of telephones installed and the number of complaints received per month were collected. On an average it was found that the number of complaints were about 3000 per month (with about + or – 10 to 15 % variation). The number of telephones per month was more or less constant. The data about complaints included all sorts of complaints such as malfunctioning, administrative financial etc. The earthquake occurred on 29 Sept 1993 and the data about complaints for the period Jan to Sept 1993 are as shown in Table 1.

The Latur earthquake occurred on 29^{th} September 1993. On an average there were about 3000 complaints per month for the period January to April. Since May, the number of complaints started rising. The number of telephones was more or less unchanged. The complaints for the subsequent months were as shown in Table 1.

The data in Table 1 indicate that the geomagnetic field started undergoing change sometime in May 1993 and it went on changing. After examining the data in Table 1, it is observed that the rise in number of complaints during a span of about five months is about 53 % of the original value (From 3000 to 4600). The process of stress building was accelerated during May to September and the earthquake occurred on 29^{th} September 1993. During the post-seismic period, some temporary new telephone exchanges were installed and there was a considerable rise in the used telephone lines. With this background the data during post-seismic period was not used. It would thus be seen that the Seismo-electromagnetic effect is seen few months before the occurrence of earthquake. At present there are only three locations about the likely distance to which the telephone communication is disturbed. These are (a) Latur earthquake magnitude 6.3 in 1993 and the effect was observed at Latur Town located at a distance of 35 km from epicenter.

In addition to the observed terrestrial and sub-terrain effects, the air traffic is adversely affected during the pre-seismic periods. This type of effect was suspected for long time but positive results about such an effect have been observed recently in Australia. Geographically, the Australian continent is located at the south-end corner of the global map. All international flights to Australia have to fly over Indonesia, which is famous for its seismic and volcanic activity.

The adverse effect on Air communication was for the first time observed about six weeks before the Sumatran earthquake of M = 9.3 on 26 December 2004. All airplanes going to Australia, while flying over the potential seismic area (at that time) were experiencing something which was definitely unusual. The Auto-pilot system was getting disengaged. Secondly, there was difficulty in air communication. Even Military planes were also experiencing similar difficulty. It was not properly understood at that time (before 26 December 2004). But subsequent observations confirmed the adverse effect on electronic communication.

The effects of seismic activity on aviation are seen mostly during the pre-seismic periods. These are about wrong readings of magnetic compass and associated navigational instrumental facility. Prior to the occurrence of any destructive earthquake, the sub-surface temperature in the potential Epicentral region increases. Whenever a magnet is subjected to heat it reduces its magnetic properties and effective magnetism .At a particular temperature, known as Curie temperature, it loses the entire magnetism. In the case of geomagnetism the reduction is noticeable and it could affect the navigation of the aircraft. On 3rd January there was a magnitude 8.0 earthquake in Papua region of Indonesia. A week before the occurrence of the earthquake, it was observed by the Australian Civil Aviation Department, that the Autopilot systems of all aircrafts were disengaged while crossing over a particular area in Indonesia. It was puzzling at that time but subsequent investigations revealed that the area happened to be the potential Epicentral area of the large earthquake. A few hours before the occurrence of the Haiti earthquake of M = 7.0 on 12 January 2010, an airplane could not establish contact with the airport and was forced to be diverted to other airport.

5. MATHEMATICAL EXPLANATION OF PHENOMENON

A few days before the occurrence of earthquake (about 4 to 6 days before the occurrence of moderate to large magnitude earthquake) the reception on radio and radio communication is highly disturbed. The disturbance is seen in the form of rise in reception frequency. If the transmission is at 2000 kHz frequency then the same would be received in the potential Epicentral area about 4 to 6 days before earthquake at 2100, 2200,…2500, 2600 kHz etc. This rise in reception frequency could be explained with the following equation:

$$f = 1/\,2\pi\sqrt{(LC)} \quad \text{..................................(1)}$$

Where f is frequency received by the receiver

L is inductance

C is capacitor … (it may vary for different types of receivers)

2 and π are constants

It would thus be seen that the transmitted frequency does not change. The above equation is valid for coil-magnet type receivers and also for ferrite type receivers. It is only at the reception end that the frequency is apparently enhanced. The term L is in denominator and in square root sign. As even a little change in the value of L (primarily the geomagnetic field) would change the received frequency. Above Equation (1) explains the phenomenon of Seismo-Electro-Magnetic Effect. If this explanation is understood then the physics of earthquake of movement of two sections of rock along a geological or tectonic fault and the rise in sub-surface temperature is clearly explained. There have been reports about rise in reception frequencies prior to earthquakes in India, Turkey, Iran, Japan, USA, Russia, Indonesia, and Pakistan etc. In some countries the broadcasting frequencies are monitored. The reception of the transmitted frequencies is monitored at these stations. In case the reception of frequencies is within the tolerance limits then it is assumed that there are little changes in geomagnetic field. It is also known that cloud lightning; hailstorm may also change the reception of frequency. But this is transient and has short duration. The effect on radio is seen about a week in advance.

6. USING THE SEISMIC INPUT FOR AVIATION

All planes flying in the seismically active regions may be provided with suitable maps with latitude, longitude and length of the active faults, which are capable of generating medium to large magnitude earthquakes. The pilots and navigators would be attentive while flying over the fault areas. They would watch the communication properly with the nearby airport and also note whether there is any adverse effect on the auto-pilot system of the air plane.

The Airports in seismically active region and within about fifty to one hundred kilometers of the fault would keep a log of such incidences of (a) difficulties in radio communication (b) disengagement of auto-pilot system and (c) any other abnormal magnetic observation during aviation. The date of commencement of disturbances during aviation may be recorded and during the subsequent period the number of disturbances with dates may be kept. A systematic log of all such incidences would help in keeping a seismic watch in the area. If an air plane is not able to establish contact with concerned airport then it could be taken as a very short term (of few hours) seismic precursor of any impending earthquake. It would thus be seen that air plane communication could be highly effective tool during intermediate term (few months) and short term (few hours).

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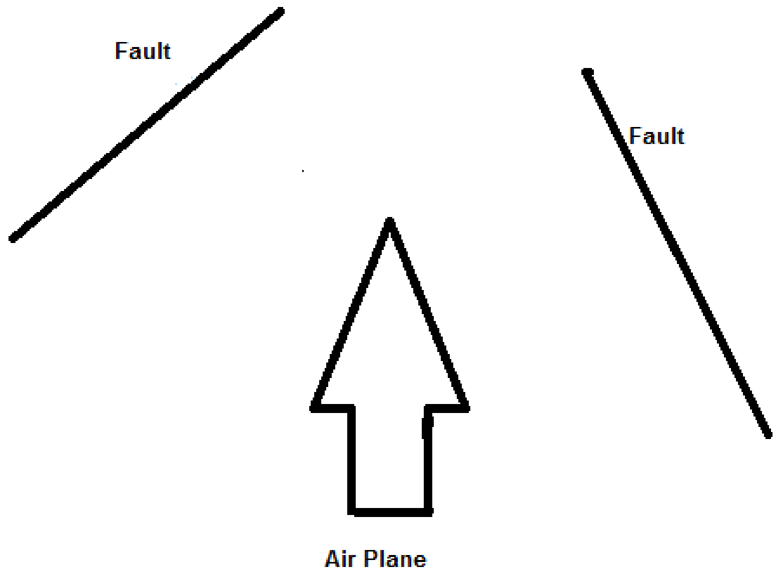

Fig 1. Air Plane flying in seismic area would be given details of the seismogenically active faults in the area

Table 1. Number of telephone complaints at Latur telephone exchange per month.

Month in 1993	Number of complaints
January	3000
February	3000
March	3000
April	3000
May	3200
June	3400
July	3700
August	4000
September	4600