ON THE GENERAL MODULATION MODEL FOR
IMPENDING EARTHQUAKE PREDICTION
临震预报的广义调制模式

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1978年以来，我们提出了短临预报的调制模式。这个模式把震源过程、前兆和外因（如磁暴，固体潮和大气压力变化）有机地结合起来。本文进一步把调制模式广义化，即调制可分：过源调制、过场调制、无震调制和直接调制；调制的对象除地学现象外，把人和生物也包括在内。调制模式预报地震的思想是：大震前震源地方和其附近的调整场区已很不稳定了（有四种不稳定形式），此时平时不起作用的外因也可调制震源过程和触发地震。这种被调制了的震源过程所引起的前兆的出现时间就与外因出现的时间具有一定的相关性。在实际中发现外因出现日期与前兆出现日期同步时（此日称调制显示日或同步日）则预报转入短临阶段。此后要加强观测，特别要注意外因再出现的日期和前兆集中出现的日期发震。

In 1978, we based on the temporal fluctuation of precursors preceding the 1975 Haicheng earthquake with magnitude 7.3 to propose the modulation model[1]. This model combined the source process with both external factor action and precursor in causation. From this model we had discussed the preliminary way toward the earthquake prediction with accuracy of day. In 1980 and 1981, we discussed farther this model and forcasting[2][8]. This paper will generalize the modulation model and present a lot of examples for earthquake prediction.

Generalization of the modulation model

The objective of modulation model　　According to the combination model[4], a preparing earthquake source is consisted of the stress accumulating element and the two stress adjustment elements located at both end of the stress accumulating element or adjustment field located around the source region. Therefore, modulation of external factors on the

source process can be divided into modulation on the stress accumulation element and modulation on adjustment element or adjustment fields, which had been discussed in[2].Besides, there are aseismic modulation and direct modulation. The former is external factors to modulate the aseismic creep and other prosses, after which there is not any earthquake to occur, the latter is that the external factors induce directly some pretending precursors, after which there is not any earthquake to occur too.

Among the above mentioned modulations only direct modulation is not related to the interior of the earth.

Index responding to modulation   In order to make a short term and impending earthquake prediction, one tried to find the indexes of predicting earthquake.Several years ago, we found some precursors having sudden change such as radon content variation, water table change, tilt storm, gas emission from earth, animalanomalous behavior and human being's anomal reaction, specially the reaction of patients, are often synchronous with external factors and the Synchronization is very useful for predicting earthquake.These above precursors may be regarded as index responding to modulation.For example,the animal anomalies before the Haicheng earthquake have some things to do with the magnetic storm and lunar phase.In general, human's reaction is a direct modulation.If the external factor modulation leads to earthquake occurrence, at the same time, and the external factors strigger the human's illness, the disaster is more serious.Therefore, when we issue the earthquake prediction,we should take into account of the medical effects and make some prevention[5]. In this sense, the general modulation model include some contents of seismosociology.

External factors making modulation   For the short- term and impending earthquake prediction, major external factors are magnetic storm, weather variation and tidal force.When any one among the above three factors synchronrize with precursors, we should make thinking on the short-term or impending prediction.We call the date in which the external factors synchronize with precursors the appearence day of modulation or synchronous day.

Application of modulation model to prediction

Application of modulation model to earthquake prediction had been discussed in[1][2][3], The essential view points are stated as follows.

Earthquake source process immediately before earthquake is so unstable, that external factors can modulate the earthquake source process, but the earthquake source is in stable state in its earlier stage,

those external factors can not modulate the source process.It means,if we found external factor synchronize with precursors, we may consider that the process in source and its nearby become unstable, and an earthquake will occur probably in the near furture.According to the appearance day of modulation, we shall be able to predict the possible earthquake generation day.A concrete predicting method is stated as follows.

After the appearance day of modulation,the forthcoming day on which the magnetic storm,sudden weather change and high tidal force appear are the possible generating earthquake date.Besides, we may use the common-surability time（9 days or 7 days）to predict the possible generating earthquake date, namely

$$T_E = T_M + n9(\text{day}) \qquad (1)$$
$$T_E = T_L + n7(\text{day}) \qquad (2)$$
$$n = 0, 1, 2, 3, \cdots\cdots$$

where T_E is generating earthquake date, T_M and T_L are the appearance day of modulation by magnetic storm or atmosphereic variation and by the moon, respectively.

Checking the generated earthquake date in terms of modulation

1.Baichike（百尺口）earthquake

An earthquake of magnitude 4.8 occurred in Hebei province in 1968. The radon variation was observed in Xincheng（新城）which is near to the epicenter（Baichike）before the earthquake, such as shown in Fig.1. From Fig.1, we can see June, 25, and July 10, are the appearance date of modulation.The earthquake took place in following date having analogical high tide.The Baichike（百尺口）earthquake is the first example on the radon content of well in relation with lunar phase in our country, .
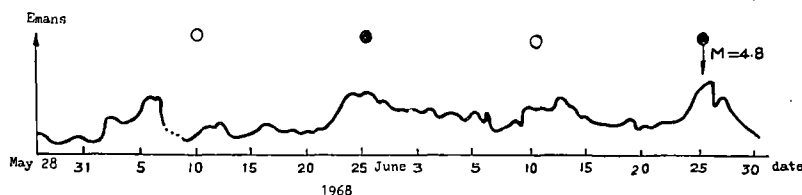

Fig.1　Variation of radon content of well in relation
with lunar phase in Xincheng（新城）
O Open circle denotes full moon
● Solid circle denotes new moon

2.Luhuo（炉霍）earthquake

On January 29, 1973, 8 days before the Luhuo earthquake（M=7.9）, there was sudden increace of radon emission of water in Guzhe（姑咱）, Kangding county（康定县）, which is 160 km to the epicenter.This sudden increace is shown in Fig.2.From Fig.2, we can see January 29th is the appearance day of modulation.According to(1),the February 7th is gene-rating earthquake date. In fact, the Luhuo earthquake took place on Feb-ruary 6 in which the anomalous low atmospherical pressure appears in the epicenter region and the neighboring region.The mechanism of influence of atmospherical pressure on the earthquake had been discussed in[6].
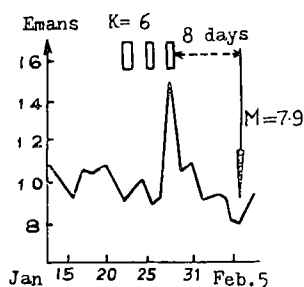
Fig.2   Generating date of Luhuo earthquake associated
        with sudden change in radon emisson of spring
        in Guzhe and magnetic storm（Jan.29）.The open
        rectangle denote a magnetic storm.

3.Haicheng earthquake

On January 8, 1975, the magnetic storm synchronize with the earth gas anomaly and the animal behavior anomaly, we consider this day to be the appearance day of modulation. Such as Fig.3.From（1）, we can predict the Jan.17 Jan.26 and Feb.4 are the possible earthquake date In fact, the Haicheng earthquake（M=7.4）took place on Feb.4, 1975. Besieds, there is a low pressure weather to appear in the epicenter and the neighboring region in this day. It is interested that the largest after-shock（M=6）in Haicheng region occurred on May 18, 1978.On May 9, a megnetic storm synchronize with underground water dropping and radon emission variation of well observed in Fengcheng（风城）which is about 100 km east from epicenter(Fig.4).We regard the day as the appearance day of modulation. According to formula（1）, we can know May 18 is first possible earthquake day. In this day, a low pressure weather appeared and the earthquake occurred. Comparing Fig.4 with Fig.3, they are analo-gous each other.
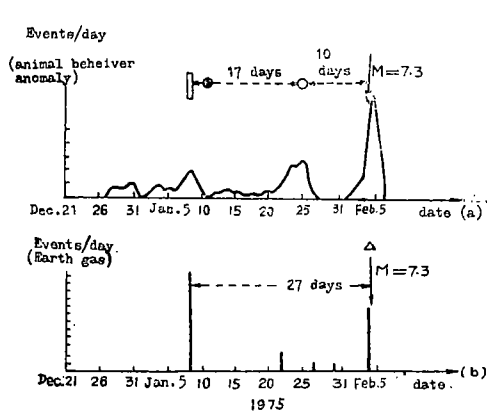
Fig.3　The 1975 Haicheng
earthquake（M=7.3）
△　low atmospherical pressure

Fig. 4　The 1978 Haicheng
earthquake (M = 6)

4. Lungling（龙陵）earthquake

The 1976 Lungling earthquake （M=7.4）took place on May 29, According to [7], on May 4, foreshocke and tilt storm were observed in 260 km and 280 km from the epicenter, respectively. On May 2—3, the magnetic storm was observed, such as shown in Fig. 5. Therefore, we recognize May 3—4 to be the appearance day of modulation. From (1), 12—13, 21—22 and 30—31（May）are possible earthquake date. In fact, the earthquake took place on May 29. This date is near to the date（30—31）estimated from (1).

5. Yanyuan（盐源）eartnquake

On November 7 , 1976 Yanyuan eartnquake（M=6.9）occurred. For this eartnquake, the F-November is the appearance date of modulation, such as shown in Fig 6. From (1), November 9th is possible generating earthquake date. Considering lunar phase, November 7th is possible generating earthquake date. In result, the earthquake took place on this day.

6. Bainmuren（凹音木仁）earthquake

On September 23, 1976, the Bainmuren earthquake （M=6.2）occurred. During the period of 50 days before this earthquake, there were three times sudden change of radon content observed in Shitzishan（石咀山）which is 100 km east-west from the epicenter. Among them, September 10th is near to synchronize with a magnetic storm and full moon, such as shown in Fig. 7 . From (2), September 17th and September 24th are possible generating earthquake date. The judgement from(1) is not accurate.

7. Songpon（松潘）earthquake

On August 16, 1976, Songpon earthquake（M=7.2）took place,　On Au-

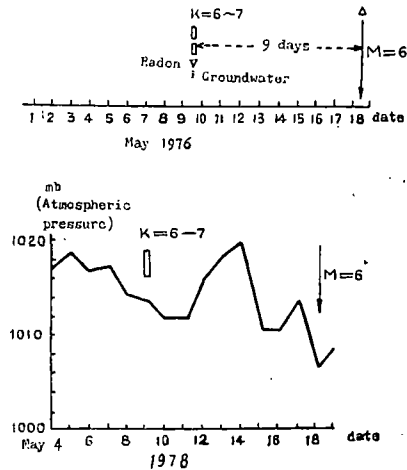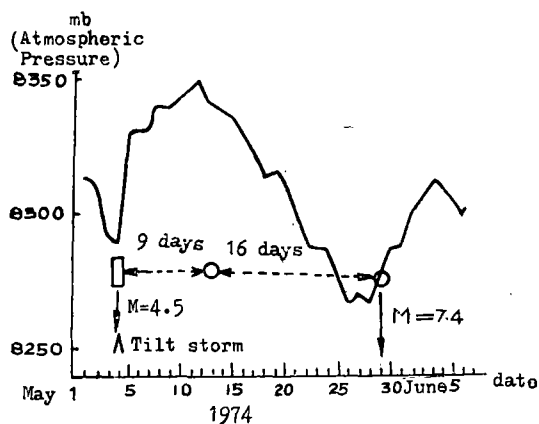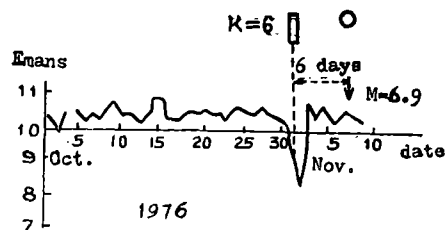Fig. 5   The 1976 Lungling
eartnquake

Fig. 6   The 1976 Yanyuan
earthquake （M＝6.9）

gust 16, a sudden change of radon content of well observed in Gushe(姑咱),
Kangding(康定), which is about 200 km from the epicenter, such as shown
in Fig. 8. At the same time, there were a magnetic storm and full moon.
From (1), we know August 19th is possible earthquake date. According to
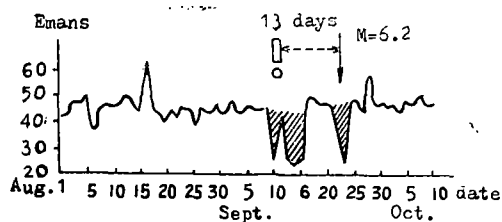(2), August 17th is possible date. They are near to the real earthquake
date.

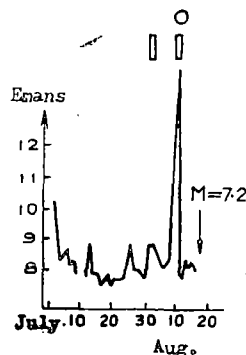Fig. 7   The 1976 Bainmuren
earthquake（M＝6.2）

Fig. 8   The 1976 Songpon
earthquake（M＝7.2）

Discussion

1. The physical mechanism of formula (1) is that after a magnetic
storm, on the multiplied nine day there often are the magnetic storm
repeat, such as shown in Fig. 9, or anomalous low pressure weather,
which may trigger earthquake.

Physical mechanism of formula (2) is that after new moon and full
moon, the first seventh day is that day on which the variation rate of

tidal force is the largest, such as Fig.10.Besides, on the multiplied seven days,the sudden weather change often occurs.The above-mentioned factors are possible to trigger earthquake.
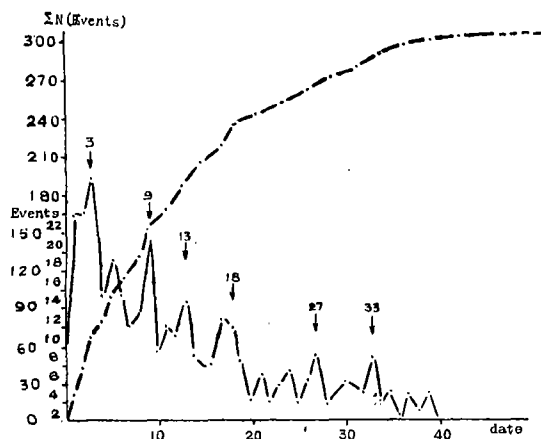

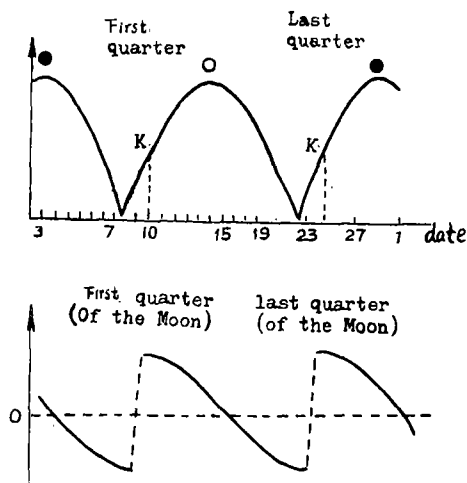Fig. 9 Interval frequency of
magnetic storm for
1959—1979 in the Lanzhou

Fig.10. upper figur is tidal
force, lower figur is the
tide variation rate

2.In Japan,5 days before Jan.14, 1978 Izu-Oshima earthquake(M=7), a sudden change of radon emission (quoting from Wakita) was synchronous with new moon. Regarding Jan.9, as the appearance day of modulation, We may use (2) to predict the earthquake generation day to be Jan. 16, which is near to the real earthqcke occurrence date.

3.The possiblity of the appearance day of modulation is

$$P = \frac{n_1}{N} \cdot \frac{n_2}{N} \qquad (3)$$

here N is total of days of one month, n_1 is number of external factor days, n_2 is days on which the sudden changing precursors appear. If we take $n_1 = 5$, $n_2 = 5$, we have P=25/900≈1/40, It means, the appearance day of modulation has a few pretending factor.

4.Of course, when we make impending prediction, we should take into account of other character of precursors, such as amplitude and frequency of precursors.

Reference

〔 1 〕郭增建、秦保燕、李海华、徐文耀，论海城地震的短临前兆模式，地 震 地 球 化学文集，1978.

〔 2 〕郭增建、秦保燕，论短临地震预报的调制摸式，西北 地 震 学 报，Vol. 2 ，№. 1 ，1980.

〔 3 〕郭增建、秦保燕，倍九法的物理机制，地震地质，№. 2 ，1981.

〔 4 〕郭增建、秦保燕、徐文耀、汤泉，震源孕育模式的初步讨论，地球物 理 学 报，Vol. 17 ，1973.

〔 5 〕王家华，地震社会学中的某些医学问题，西北地震学报，Vol. 3 ，№. 4 ，1981.

〔 6 〕郭增建、秦保燕、李海华、徐文辉，磁暴、天气韵律与发震时间，地震战线，No3，1977.

〔 7 〕强祖基等，1978年 5 月18日海城6.0级地震前兆及区域地震活动特征，西北地震学报，Vol. 4 ，No. 3 ，1982.