

The Train Of Thoughts And Methods Of Prediction
To The Time, Place And Magnitude Of Strong Earthquake
(The Examples Of Two Accurate Predictions)

(Abstract)

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A. Introduction

Seismic prediction, ESP short-period (ahead several months) and imminent (ahead several days) prediction is now far from solving in the world. While, the level of seismic research and exploration have a direct bearing on the earthquake relief results. That is, suppose the rate of accuracy is raised, it will reduce the wounded and dead and property losses. And this is also our goal and the best achievement of predictions. In the years' research and practice, in order to accomplish seismic short-period and imminent predictions that are valuable and socially beneficial, the following is our main train of thoughts and methods:

1. To combine long with short—to combine earthquake activities in long time with forewarning information, in recent and short time, and to carry on analysis, to take long materials as background and short materials as breakthrough.....

2. To combine big with small on region—to take earthquake activities within the range of seismic belt and related information as background to combine with observation information of some certain seismic stations. That is, to fill information from seismic stations in the blanks, to complement and demonstrate each other, so as to narrow the range and find the goal of fraught earthquake.....

3. To combine inside with outside—besides observation, collection, conduction and analysis of related information from crust lithosphere hydrosphere and atmosphere, we need to analysis the effects of related space physical fields' change. We should not ignore the influence that several physical factors in space have on inducement and restriction of earthquake.

4. To combine active with stable—We not only need to handle and apply some formed historical seismic materials and related experience, but also need to notice and apply present obtained dynamic information. And we should do our best to remove the interfering composition in the dynamic change, and to analysis the reason of change, to find the related relations about earthquake's happen. This is one of main foundations to make a prediction decision.

In the course of research on earthquake prediction, a scientific hard problem in the world only the verified actual earthquake results can judge our understanding level and the degree of understanding we have on the earthquake.

**B. The successful examples of two short-term and imminent
- predictions**

(The abstract of the train of thoughts and methods of predictions)

1. Content of Prediction

The south-west area of China Mainland is situated in the south-east of the Mediterranean-Himalayas seismic belt.

Through comprehensive analysis of medium-range and short-range precursory informations, the prediction cards had been presented to the higher authorities of seismological administration, on Dec 12, 1992 (Note, the original copy of the prediction cards are Chinese and preserved in the prediction centre of seismic Bureau.) the prediction contents are.

1. time: there are two risk regions.

(1). Dec. 25, 1992 (10 days or so)

(2). Feb. 1993.

2. Locality and magnitude:

(1). Area from Lijiang Ninglang to the juncture parts of Sichuan and Yunnan Provinces Magnitude will be 6.0.

(2). Area in the parts of Mojiang-Luchun-Jiangcheng. Magnitude will be 6.5.

2. Basis and Analysis

1. On deducing the future epicenter.

A systematic medium-range studying on seismic activity trend of the whole Yunnan Province China and adjacent areas had been carried out in 1992. The materials from more than 10 methods and means had been used for the comprehensive research. We deduced the medium-range seismic trend background of greater part (in the period of 1993 or a little longer.) A table for predicting risk regions' is thus obtained. (table 1).

Among which Lijiang- Ninglang regions were held as risk areas of earthquake having a magnitude 5-6 in a year to come. On the above studying, a short-range and impending earthquake pursuit monitoring will be carried on.

In these parts of Mojiang and Jiangcheng county to the south-west of Kunming, a seismic gap of earthquake having a magnitude more than 5 had basically formed since 1979. Although the gap had not yet been closed entirely, the trend of its extension can be also seen. It shows that the pattern of seismic activity of this area had originally formed.

After precursory materials such as information of horizontal pendulum dipmeter, the data of rainfall observation at meteorological observatory the data of time and latitude observation at astronomical observatory and the statistics of

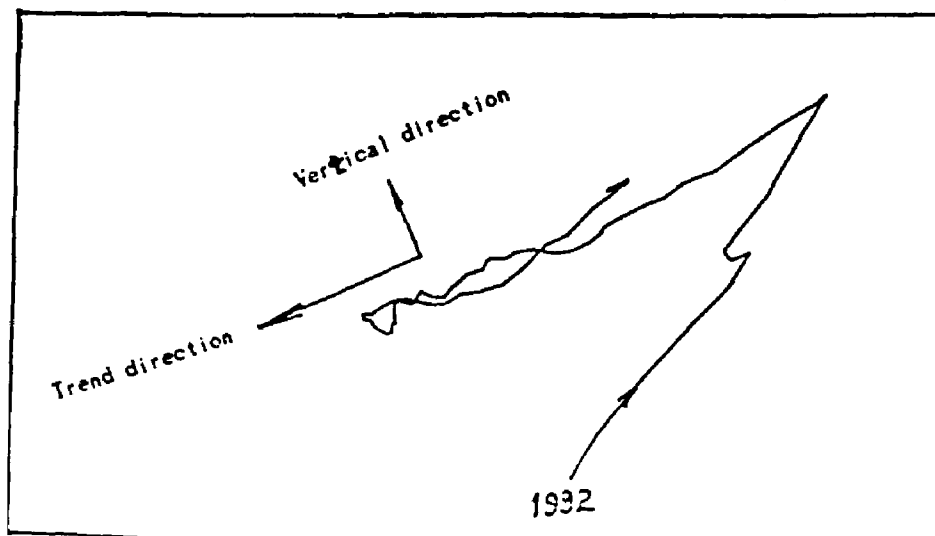
practical earthquakes for the branch areas has been analyzed and treated we can gain the risk directions of earthquake occurrence regions (fig.1). Especially, if the sections interrelated with the geological structure on these directions are all positions of the largest strain, or where the seismic energy is easy to concentrate.

Table 1 Prediction table of risk regions

item number	three essential factors of risk regions						Main anomalous items
	Time of earthquake occurrence and confidence	confidence	scope of risk regions and confidence	confidence	magnitude and confidence	confidence	
risk region I	1993	0.8	(abridged)	0.8	8.2	0.6	The threshold autoregression model
risk region II	1993	0.8	(abridged)	0.8	5.5-6.2	0.8	seismic activity, sunspot activity, energy scanning, energy process, frequency extent, R value, recurrent period
risk region III	1993	0.8	western yunnan (the region of Ninglang, baoshan, Huaping)	0.8	5.8-6.2	0.8	seismic activity, environment factors

These regions or sections are risk areas of forthcoming earthquake. Using these semiquantitative analytical results and the earthquake distribution character ($M > 5.0$) on these directions or regions and the informations given from the statistics, we can infer the region of the forthcoming epicenter. According to the above analysis and conduction the region near by Jiangcheng to the south-west of Kunming had finally been determined as prediction region having strong earthquake of a magnitude 6.5.

Fig 1 Observational vector diagram of dipmeter



2. Analysis of time of earthquake occurrence

Earthquake of magnitude ≥ 5.0 had not occurred for 17 months in the scope of the whole province of study area before the two shocks. Such unusual quiet in shock for an earthquake-prone area like Yunnan province apparently showed that its seismic activity had an anomaly trend. Under the situation, all the collected precursory informations had been studied item by item, such as the anomalous duration and quantity of observational values from horizontal pendulum dipmeter, the distortion of daily variation graph of observational value from magnetic balance, and the anomalous time of appearance and its fluctuation of radon level. Using the precursory results and the informations supplied from the above-mentioned background materials (such as actual seismic activity) to comprehensively analyze, we can decide the time parameter of forthcoming earthquake.

3. Determination of magnitude of the forthcoming earthquake.

Before the shocks the quiet anomaly of earthquake of magnitude more than 5 in the earthquake-prone Yunnan province were not only the anomaly information on the time, but also the anomaly accumulation of energy. Through energy scanning to a small window of one square degree of branch section, the variation value of energy accumulation and release in every region can be computed. If energy would relatively concentrate in some anomalous area inferred by background materials, finally, it provided us the quantitative basis for deciding magnitude of the forthcoming earthquake to a certain extent.

The anomalous extent and anomaly duration of some precursory (such as radon level, terrain tilting) could reach its highest level which has not got since ever. This is also the foundation of predicting earthquake magnitude. Secondly, besides giving an indicative information for predicting the earthquake occurrence region the seismic gap having magnitude $M \geq 5$ formed in these parts of Mojiang and Jiangcheng county to the south-west also indicates that the magnitude of forthcoming earthquake will not be lower than that of this seismic gap.

Through analysis, the magnitude of forthcoming earthquake can usually be about 0.5-1.0 more than that of the seismic gap. After this studying earthquake magnitude of the risk region near Jiangcheng was finally decided as 6.5. (Note, the inferred magnitudes of other regions were a little lower.)

3. Check on prediction of earthquake occurrence (fig 2, table 2).

The two predictions firstly proposed the risk time segment of strong shock, and on this basis the time of earthquake occurrence was furtherly estimated in 'day' as a time unit, furthermore, the risk regions in two risk time segments of the

forthcoming earthquakes in various regions were also decided by different ways and means. The process of analysis and prediction to determine three essential factors, time, locality and magnitude, has thus been completed. And it makes up our mind to write the report to higher seismological administration.

The prediction cards were sent only six day later the earthquakes occurred. Through the examination of actual earthquake, the identical degree of the time, place and magnitude of prediction and actual earthquake is very ideal and inspiringful. It is a good short- range and impending prediction in which three essential earthquake factors had definitely been put forward without any signal of foreshocks. It is also a rather successful try of short-range earthquake prediction.

The success of the prediction results from my research of several years. Meanwhile, it strengthen the confidence of my colleagues and me to surmount key problems of earthquake prediction. Nowadays—how is the prospect of earthquake prediction ? I think that it is reasonably optimistic. It is possible to solve the problem of short-range earthquake prediction.

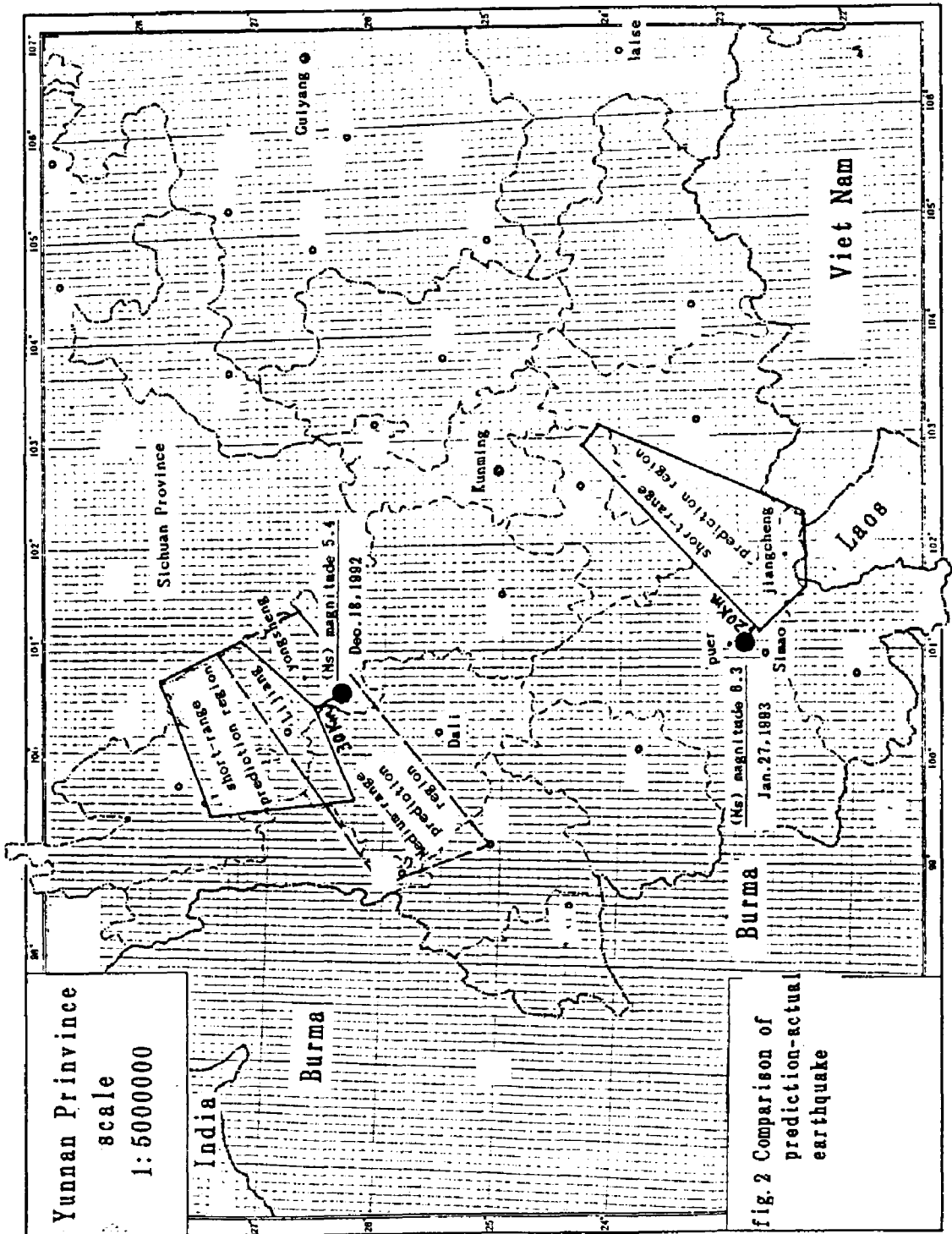
Table 2 Correlation between estimated and Practical earthquake

comparison item three essential factors	estimated earthquake	practical earthquake	error
time	(1) Dec 15, 1992—April 1, 1993 (20 days)	Dec 18, 1992	no
	(2) Feb 1, 1993—Feb 28, 1993 (28 days)	Jan 27, 1993	4 Days
locality	(1) Li Jiang-Kinglang region to the parts of juncture of Sichuan and Yunnan Province.	Southwest to Yongsheng	30km
	(2) Mo Jiang-Luchun Jiangcheng region	South to Puer	20km
magnitude	(1) 6.0	5.4 (Ms)	0.6
	(2) 6.5	6.3 (Ms)	0.2

Earthquake leave the disaster to people. We, earthquake prediction researchers are scouts to fight against the disaster, I should be very glad to go forward hand in hand with the fellows in 'Ten Years International Reduction of Disaster', trying to make a contribution for mankind's disaster reduction.

April 1, 1995

Kunming China



Yunnan Prinvince
scale
1:500000

fig. 2 Comparison of
prediction-actual
earthquake