短文

# 岷县、漳县6.6级地震的预测过程回顾

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# Sequence Type Estimation of the Minxian-Zhangxian $M_S$6.6 Earthquake and a Review of the Prediction Process

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**Abstract:** After the *M*s6.6 earthquake occurred in the border region between Min and Zhang counties of Gansu Province on July 22, 2013, we preliminarily estimated the earthquake sequence to be a main shock-aftershock type based on the history of moderate-strong earthquake sequences in this area. As time went on, there were more aftershock events. These could be used for further analysis, and then for further decision on the earthquake sequence type. Finally, we determined the *M*s6.6 earthquake sequence that occurred in the border region between Min and Zhang counties, Gansu Province as having been a main shock-aftershock type, with the largest *M*s5.6 aftershock having occurred on the same day as the main *M*s6.6 shock, from a comprehensive analysis of the historical characteristics of moderately strong earthquakes of the earthquake zone, and the space-time evolution characteristics and parameters of the earthquake sequence. These provided a correct basis for anti-earthquake relief work and played an important role in mitigating the earthquake disaster and stabilizing the disturbed society after the earthquake in the earthquake zone and its neighboring areas. Reviewing the forecasting process and the results, we found that we had successfully predicted the *M*s6.6 earthquake that occurred in the border region between Min and Zhang counties on July 22, 2013 several years before it occurred. The magnitude and location of the earthquake had been predicted accurately, and the accuracy of the prediction was much higher than any other example in Chinese earthquake prediction history. Forecasting on a monthly scale, we had indicated at the monthly meeting on earthquake prediction at the end of February, 2013 that there would be a risk of a moderately strong earthquake in Gansu Province from the change in moderately strong earthquake activity on the Chinese mainland. Even for short and impending earthquake prediction from several days to several dozens of days, we had proposed the likelihood of a moderate-strong earthquake happening in Gansu Province and the adjacent areas from the results of previous studies and the cases of earthquakes with $M\geqslant 4.0$ from the time before the *M*s6.6 earthquake occurred. In a meeting about earthquake prediction held several days before the occurrence of the *M*s6.6 event, we made the prediction that there would be an earthquake of $M\geqslant 5.0$ happening somewhere in Gansu Province and the surrounding area within dozens of days. The fact we had successfully predicted the Ms6.6 earth-

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quake on a several-year scale, as well as over a short time period to some extent, reinforces our belief that earthquakes can be forecast. Even with our present level of understanding, we can still capture some information on the gestation and occurrence of earthquakes before the arrival of a disaster. However, in order to achieve the goal of earthquake prediction in China, earthquake scientists still need to make arduous efforts. As long as earthquake scientists use the correct approach, and government supplies the necessary manpower and material resources to predict earthquakes, we believe that there will be a hope to achieve the aim of earthquake prediction with a relief effect. It is promising that we have achieved at least one or two earthquake forecasts.

Key words: Minxian- Zhangxian*Ms*6.6 earthquake; anomaly analysis; earthquake activity; earthquake forecast

## 0 引言

2013年月22日7时45分甘肃岷县漳县发生了6.6级地震。这是甘东南几十年一遇、甘肃省十年一遇的灾难性地震，它给震中区造成了严重的人员伤亡和财产损失，也严重影响了甘东南及其外围诸多地区。甘肃省地震局事先对本次地震有觉察吗？这是人们所关心的问题。对此，我们做了一些回顾性的工作，取得了一些有意义且对今后开展地震预报工作值得借鉴的结果。

## 1 预测过程

### 1.1 数年尺度的成功准确预测

甘肃省地震局分析预报人员[1]早在2005年就对甘东南及其邻区的地震活动性做过系统研究，根据地震活动性的时空演化、历史地震活动特征和地震构造资料的综合分析，给出了如下地震预测要素：

预测震级：6.2±0.61

预测地点：2013年7月22日岷县、漳县交界6.6级地震震中区

预测时间：几年内（2005年至2013年）

2013年7月22日岷县、漳县6.6级地震发生的实际参数和早已发表的甘东南震情研究中预测的地震参数完全一致。

### 1.2 数月尺度的预测

2013年在1月18日四川甘孜州白玉县5.4级、1月30日青海玉树州杂多县5.1级、2月12日青海海西5.1级和2月25日西藏阿里地区改则县5.1级地震发生后的二月底的月会商会上，我们根据地震活动图像的变化，提出中国大陆中强地震活动的主体活动区域可能已由新疆地区转向了青藏块体。接下来地震发生的情况，尤其是芦山地震的发生，验证了我们的上述推断。据此我们曾进一步指出，甘肃地处青藏块体东北缘，存在着发生中强地震的危险性。

### 1.3 数天至数十天尺度的预测

在震前几个月虽然我们注意到了中国大陆中强地震主体活动区域的变迁，但由于甘肃及毗邻地区活动水平不高，我们的预测意见都是“我省发生破坏性地震可能性不大”的低调子。但由于甘肃及周边地震活动性的增强，我们6月底的月会商意见不同于以前。我们在6月底的月会商会上指出我省及边邻地区地震活动性有持续升高的趋势，下月要加强跟踪我省震情发展变化，特别是河西西段和甘东南的震情发展变化。

值得回忆的是我们在7月13日临时会商会上对地震活动性异常的归纳、分析和依此所做的震情判断。具体过程如下：

（1）展示资料，归纳异常。当时主要归纳出两项异常：①地震活动性增强；②准4级地震连发现象的出现。

（2）异常分析。我们根据以往的研究结果（甘肃的4级地震连发对中强地震的指示意义，本文第一作者未发表的手稿）认为，4级地震连发对5级以上地震发生具有指示意义，应震率56 %，最短1天，最长92天。优势时段前45天。

（3）今年4级地震连发应震情况与震情判断。今年甘肃（包括边界）共发生4级以上地震6次。呈现出3组连发事件。第一组是2月5日发生的肃南4.4级和2月7日发生的肃北4.4级地震，5天后的2月12日，毗邻甘肃的青海海西州发生了5.5级地震；第二组是5月15日发生的甘川交界4.9级和6月4日发生的甘川交界4.0级地震，1天后6月5日，毗邻甘肃的青海海西州再次发生了5.3级地震；当时（7月13日），今年的第3组4级地震连发现象又呈现了，即6月24日发生了甘肃肃北4.0级和7月5日发生的肃北4.2级地震。根据甘肃的4级地震连发对中强地震意义和今年的应震情况，我们大胆地在7月13日的临时会商会上提出了甘肃及其毗邻区域在近期可能要发上5级以上地震的预测意见。9天后岷县、漳县6.6级地震发生了。虽然对发生的地点未能确定，震级也不够准确，但我们毕竟在短临预测上还是有所觉察的。

## 2 对预测结果的评价、感悟与反思

（1）预测结果评价

① 数年尺度预测结果之准确前所未有，可以说在中国地震预测历史上又写下了新的篇章(但不能否认含有很大程度的幸运成分)。准确的数年尺度预测结果虽然具有重要科学价值和历史意义，但丝毫不具有减灾实效。

② 数日至数月的预测只达到了某些要素的一定程度的感知。

(2) 感悟与反思

本次地震数年尺度的成功预测再次证明了本人对地震预报一贯坚持的观点[2-4]，即地震预报虽然是个十分复杂的、没有被攻克的世界性难题，我们可能找不到一个解决地震预报的通用方法，但对于一个特定的地区，在特定的条件下，如果预报思路合理、方法得当，要实现一次乃至数次成功的地震预报是可能的。

本次数年尺度地震准确预测，丝毫不具有减灾实效。为什么？因为地震预报的减灾实效关键在于短临预报。至于为什么没有做出准确的短临预报，我觉得有诸多原因。首先是我们缺少进一步的研究工作，当然要开展进一步的研究工作，也不是仅凭笔者的主观愿望就可以做到的，它还需要艰辛的努力和巨大的人力、物力支持。如果有足够的研究经费和一支具有实力的科研队伍，再加上艰辛的努力，我不敢说能使本次预报一定具有减灾实效，但我们可以使它向着具有减灾实效的目标向前再逼近一步。

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