EFFECT OF EARTHQUAKES ON OBSERVATIONS OF TIME AND LATITUDE

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ABSTRACT. According to a vast amount of both seismological and astronomical data obtained from China, it has been understood that:1, A large number of anomalies may appear before and after the major earthquake and the anomalous area is usually very large; 2, And therefore the anomalous residuals in the observations of time and latitude before the shock are of profound significance in geophysics.

1, INTRODUCTION

Many major earthquakes($M \geqslant 6.0$) happened in the mainland of China from 1966 to 1979, providing us with a great quantity of data which have been obtained by different methods (1-5). The epicenters of some quakes are close to the astronomical observatories, and therefore corresponding anomalous residuals have been found from the observations of time and latitude therein (6). After carefully studying the data, we have acquired more knowledge about the effect of earthquakes, such as the Tangshan earthquake of 1976 (M=7.8) and the Liyang earthquake of 1979 (M=6.0).

2. PRECURSORY ANOMALIES OF EARTHQUAKE

From fig.s 1A,2A-2B and Table A it is clear that the precursory anomalies of some earthquakes undergo a medium -term stage one or serveral years before the quake. In this stage many tendentious anomalies can be observed by means of different disciplines, such as land deformation, crustal stress, earth resistivity, geomagnetism,gravity, radon content, underground water,etc. Next, from fig.s 1B,2C-2D and Table B it is found that the precursory anomalies also display a short-term stage, about one or several months before the shock, and the anomalous amounts are often very large with an obvious turning point, and so this stage also is called the stage of anomalous acceleration.

A. K. Babcock and G. A. Wilkins (eds.), The Earth's Rotation and Reference Frames for Geodesy and Geodynamics, 405–410.

3. LAND DEFORMATION AND DISPLACEMENT FIELDS

3.1. Land deformation

$|\bar{l}|$, the mean of absolute value of deformation rate l around the epicenter after the Tangshan earthquake, is 28×10^{-6}. There are 4 spots where l amounts to 1×10^{-4}, but it is clear that they are caused by the opposite-direction displacements which lead to the increase of l. In the areas where the displacements amount to 1 m or 2 m, l is mostly $0.7\text{-}24\times10^{-6}$. In comparison with the precursory anomalies of land deformation in the short-term stage listed in Table, it is clear that both amounts are close to each other. In the Haicheng earthquake of 1975, $|\bar{l}|$ is 5×10^{-6} (7). But the max. value of l of the short levelling at Jin Xian (196 km from the epicenter) is 8×10^{-6} for 17 to 2 months before the quake. The deformation rate l observed around the epicenter after the Liyang earthquake is tiny, but some precursory anomalies in medium-or short -term recorded at 4 stations reach $1\text{-}8\times10^{-6}$ .So after a shock in the region around the epicenter, l is close to that observed before the quake in the region far from the epicenter.

3.2. Crustal stress

Table gives the max. value of additional main stress (or inductance value L) observed several months to 1 year before the earthquakes. The amounts are about several bars, with one of them even over 100 bars. Fig.3 shows a possible phenomenon of plastic-hardening process from several months before to the day when the Haicheng earthquake happened(7). Fig.4 shows that the elastoplast deformation would appear 6 months prior to the Liyang earthquake, as in the earthquakes of Tangshan and Songpan of 1976 based on data. According to rock-breaking experiments, when the additional main stress decreases gradually after getting through the max. value and the microfractures appear, the displacement becomes much larger.

3.3. Over 20,000 times of cracking were observed around the area of about 1,000,000 square km during the 2 years just before the Tangshan shock.

3.4. Anomalous residuals in observations of time and latitude

From fig.s 1-2 it is clear that there appeared relatively great anomalous residuals in observations of time and latitude, in Beiing and Nanjing during the period of one or several months prior to the major earthquakes. From fig.s 1j and 2k it is found that the anamalous residuals appeared during the period of short-term precursory anomalies of the quake, possibly resulting from mass moving, density variation, local crustal deformation, displacement, etc., or related to the deviation of vertical line, horizontal displacement and other factors. Suppose the effect of deviation of vertical line on the anomalous residuals amounts to 2/3 of the total, and du, one of horizontal displacements, is 1/6, then the change in the horizontal component of gravity would be 70-140 μg and du=0.2-0.4 m. It is known that the change

https://doi.org/10.1017/S0074180900119801 Published online by Cambridge University Press

in the vertical component of gravity in Tangshan was over 100 μg just 3 months before the quake. As compared with this, there is a possibility that the change in the horizontal component can be 100 μg or so.

3.5. Time and space distribution of anomalous field

Fig.s 5-7 show that the precursory anomalies could appear 3 years before the quake and the areas where anomalies appeared could be over 500 km from the epicenter, indicating a very vast scope of the quake. Next, anomalies extended out obviously after some earthquakes. In the Tangshan earthquake, the speed of extension is about tens of km per day. A large number of anomalies appeared from 45°N to 32°N and the distance was over 1500 km from mid-Aug. to early Sept. in 1976. Figures also show large-scale adjustments of crustal stress and displacement within one month after some large earthquakes.

4. CONCLUSIONS

Although only a small part of the data has been used, it can be seen that the astronomical observatories which have observed the anomalous residuals are situated in the main anomalous areas, with many seismometrical stations around them; at the same time these stations also have recorded a great number of anomalies. Hence the anomalous residuals in observations of time and latitude before the shock are of profound significance in geophysics.

ACKNOWLEDGEMENTS

The author is much obliged to Ye Shu-hua, Director of the Shanghai Observatory, for reading over the manuscript with critical and instructive suggestions; and to Mr. Yang Chang-ming for going over the English abstract.

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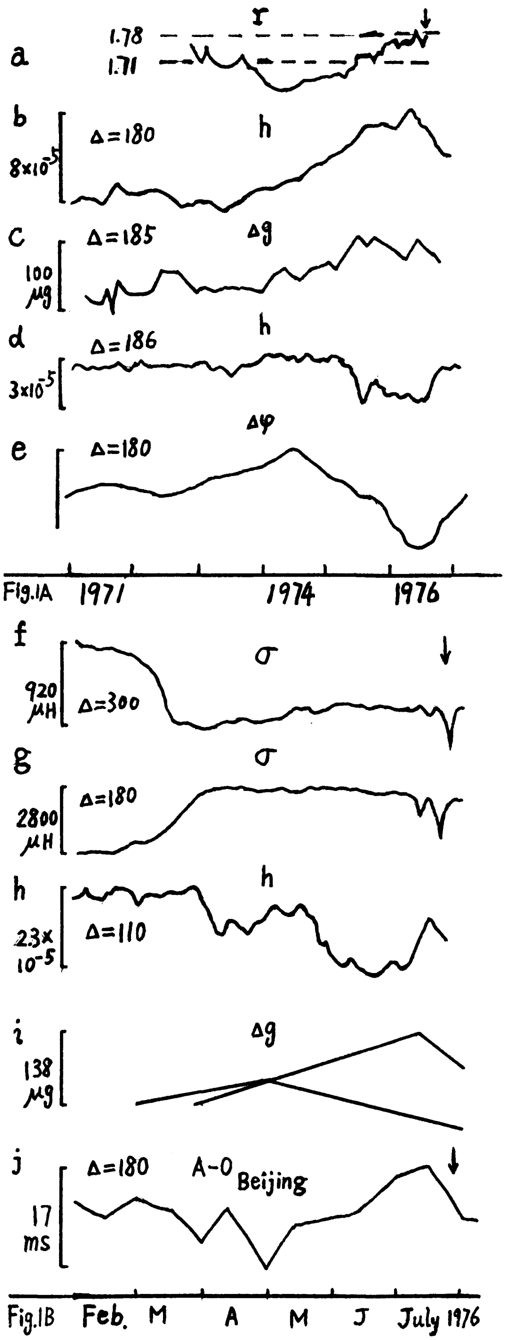


Fig.1, Anomalous change before Tangshan earthquake.

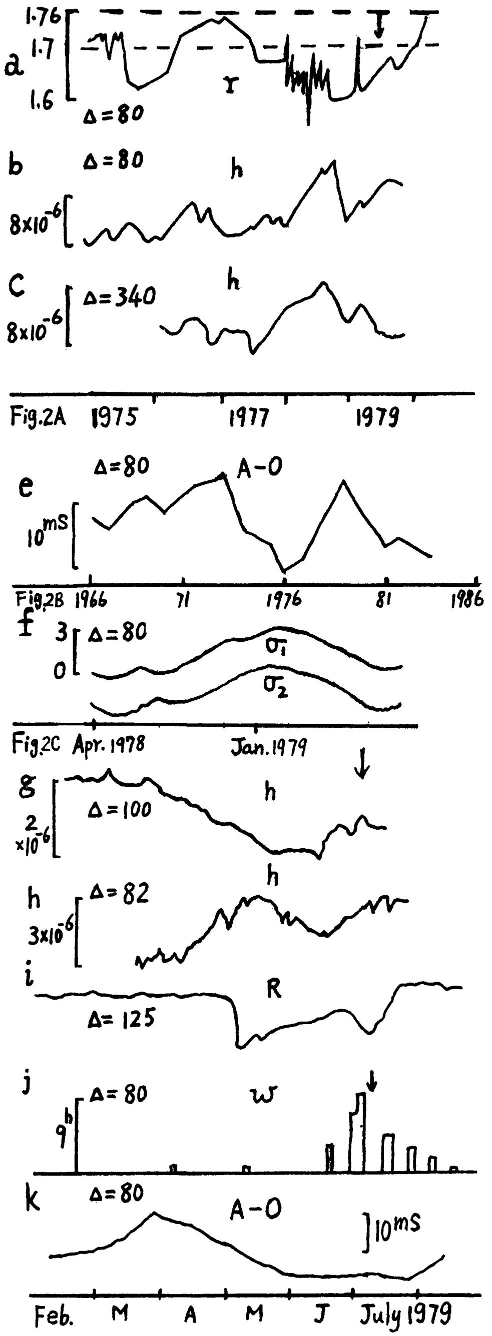
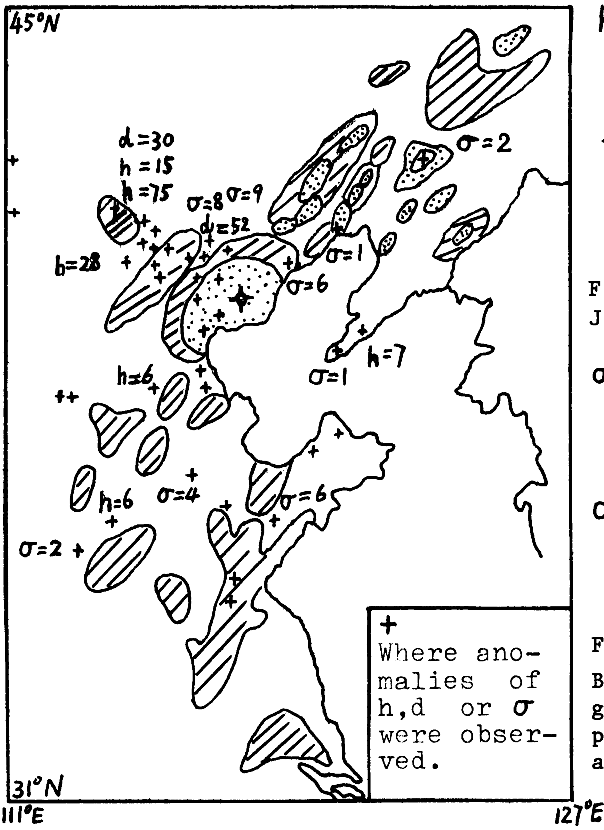


Fig.2, Anomalous changes before Liyang earthquake.



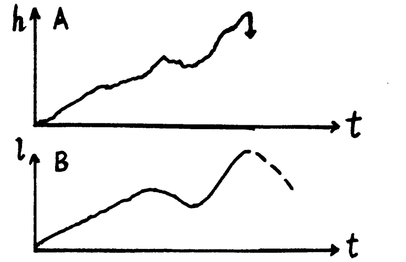


Fig.3,A. Short levelling in Jin Xian. B, Experiment curve.

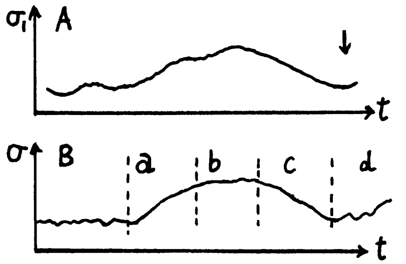
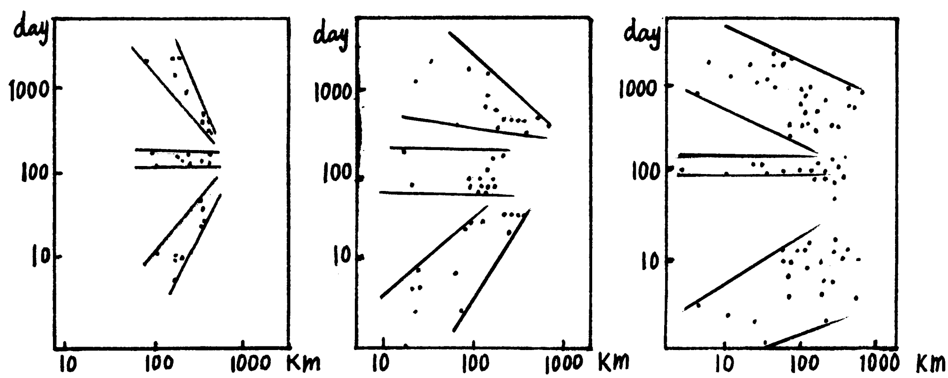


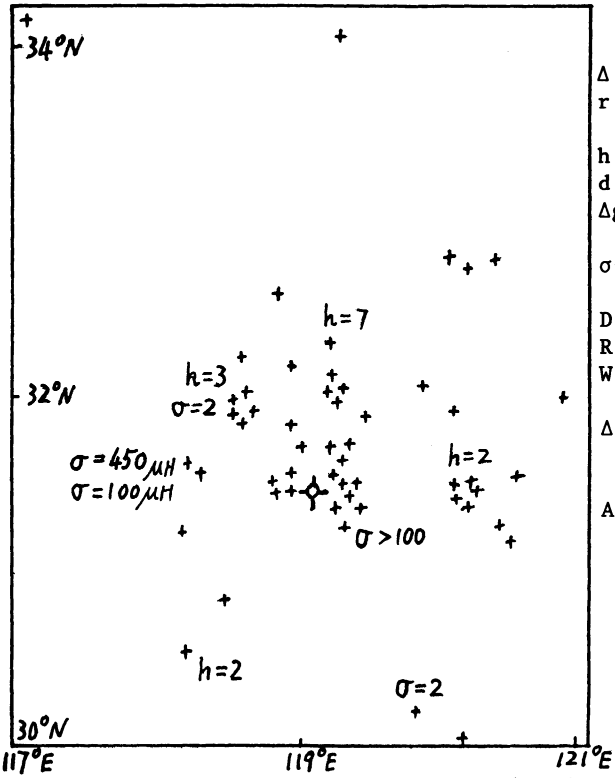
Fig.4,A, σ_1 at Nanjing station
B, Analysis of anomalous stage. a,elastivity. b, Elastoplast. c, Creep. d, Stress adjust.

Fig. 5. Anomalous area of Tangshan earthquake. Epicenter. Anomalous area before earthquake. Anomalous area after quake. + Seismometrical station.



Bohai earthquake Haicheng earthquake Tangshan earthquake
Fig.6 Time space distribution of anomalies in the 3 earthquakes.

https://doi.org/10.1017/S0074180900119801 Published online by Cambridge University Press



Legends
- Δ Epicentral distance (km)
- r Ratio of seismic wave velocity
- h Short levelling
- d Short base line
- Δg Relative difference of gravity(μg)
- $\sigma_1(\sigma_2)$ Max.(min) additional main strees
- D Radon content
- R Earth resistivity
- W Time continuity of ULF waves
- Δϕ Residuals of latitude observation at Beijing Obs.
- A-O Residuals of time observation at Purple Mountain Obs.

Fig.7, Anomalous area of Liyang earthquake.

Tab.A, Anomalous change before Tangshan earthquake

Δ	D	T	M	Δ	D	T	M
105	h	May 75	3	123	d	Oct.75	50
180	h	May 75	75	245	d	Oct.75	30
185	h	May 75	28	185	d	May.76	9
305	h	Jun.75	7	230	h	Apr.76	10
190	h	Jun.75	8	230	h	Mar.76	15
390	h	Jun.75	6	110	h	Apr.76	23
360	h	Nov.75	1	165	h	Apr.76	14
230	h	Sep.75	15	180	h	May.76	60
230	d	Aug.75	19	185	h	Jun.76	18
120	h	Sep.75	52	190	h	Feb.76	8
170	h	sep.75	6	305	h	May.76	2

Table B, Anomalous change before Liyang earthquake

100	h	Jul.78	2	80	σ	Oct.78	2 bar
340	h	Apr.78	8	150	σ	Dec.78	1 bar
80	h	Apr.79	3	75	σ	Nov.78	450μH
80	h	Apr.79	8	20	σ	Aug.78	100bar
100	h	Apr.79	3				

D,Discipline. T,Time of begining. M,Magnitude of anomaly.h(d):$\times 10^{-6}$