The research and development of Cross-fault site based information systems

Yue Wenchao [1], Wang Ruiqi[2], Wang Ning[2]

1Beijing Explo-Tech Engineering Co.,Ltd.

2Xi'an University of Science and Technology College of Geomatics, Xi'an, 710054

***Abstract*—In view of location basic data that in cross-fault site based information management and use have incomplete, and many are the paper dielectric storages, inconvenient inquiry and use; venues of fault monitoring data and related foundation of geographic information location separates, does not help carrying on comprehensiveanalysis and other iss ues, discussed has established the cross-fault site based information system the method, to enhance the management, analysis and use cross-fault deformation monitor information.**

Key words–Earthquake prediction; Cross-fault; Deformation monitoring; GIS

Ⅰ.INTRODUCTION

Earthquake is a super short-term geographical phenomenon, with distinct geo-spatial characteristics. In the earthquake zone, abnormal changes before earthquake in various geographical entities and geographic phenomena provide the possibility of earthquake prediction for people. Through the comprehensive analysis of various changes in the geographical information, people can advance in earthquake prediction , and earthquake losses will be reduced to a minimum. As an important tool of acquiring, storing, managing, and analyzing geospatial data, Geographic information systems (GIS) is the most powerful tool integrated analysis of earthquake information, so people have been exploring for years used GIS to aid in earthquake analysis and prediction.

For understanding mechanical process of earthquake faults, capturing earthquake precursors, a variety of cross-fault measurement has been carried out in China . Among them, deformation anomaly, usually as a very important indicator of seismic precursory information. At present, the deformation anomaly observed is a multi-source, is not full of crustal surface reaction activity, both external factors (natural phenomena, such as drought, freezing, temperature, hydrology etc.) and observation field itself factors (such as point stability, Line length and direction, whether to cross fault, fault activity and around the ground vegetation etc.).So,in the analysis of the fault information, how to correctly judge whether the factors of deformation anomaly earthquake precursors has become a pressing matter of the moment.

However, due to various reasons, currently prevailing the original site information is not complete, and many of information storage by the paper media that querying and using have a lot of inconveniences. In addition the fault monitoring data about the site and related basic geographic information separation, is not easy to make a comprehensive analysis of the monitoring data.

In this paper, through the research and development of the fault information system, discusses applying GIS technology to the daily earthquake analysis and prediction.

Ⅱ.THE OVERALL DESIGN OF THE SYSTEM

The final objective to establish fault site based information system is using GIS method to integrating and analyzing the massive data (basic geographic data, seismic data, climate data), and combined with the deformation established analysis model,

thus providing reliable information for earthquake prediction of deformation.

To achieve the following objectives:

1. Quantitative analysis and digital capture of cross-fault site information and Establishment of spatial database;

2.The establishment of quantitative analysis model.

Implements the following features:

According to the leveling value, the baseline value, and the two baseline values calculate the fault activity

Basic time-space analysis and display function of fault deformation anomaly .

Reflect the spatial attribute and spatial relationship of cross-fault site

General idea of the system is as follows:

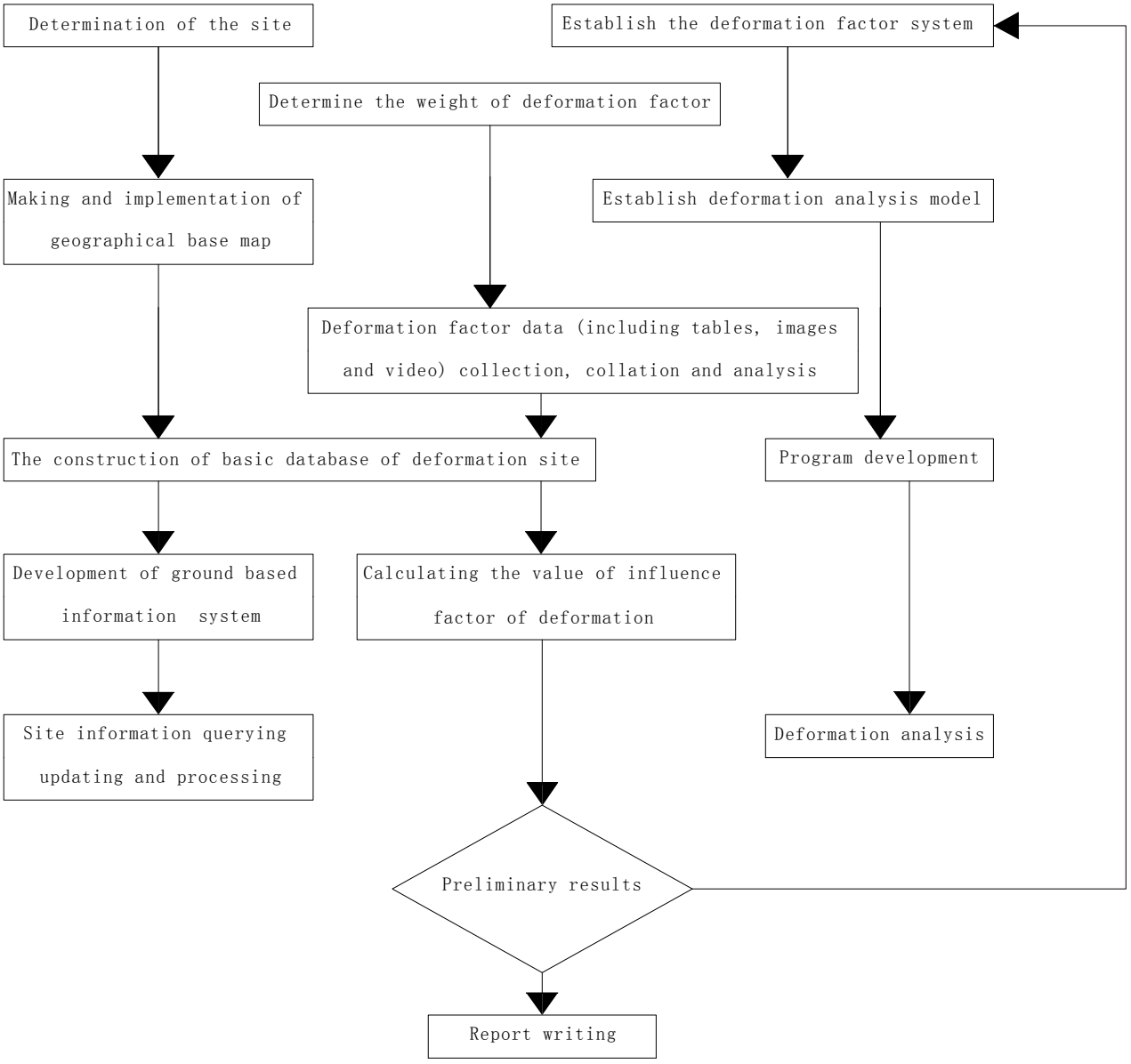


Fig. 1. cross-fault site based information system flowchart

III. DATABASE DESIGN

Taking into account the cross-fault deformation influence factors always has a certain spatial relationship, in order to analyze crustal deformation, first need to build a survey area database, that is to store and manage the cross-fault survey area of fundamental geographic information and the measurement information.

Specific content shown in table 2, which is mainly used for analysis of crustal deformation.

Table 1. the northeastern margin of Qinghai-Tibet block across-fault database design table

Type	Layer name	Layer Content	Illustration
Basic Geographic Map	Relief map	1:500000 relief map	Graphics
	Geomorphologicalmap	1:500000Geomorphological Map	Graphics
	vegetation map	1:500000vegetation map	Graphics
	Geological map	1:500000 Geological map	Graphics
	Image map	SPAOT5 Image map	Graphics
	Administrative map	Administrative map	Graphics
	Natural regionalization map	Natural regionalization map	Graphics
Thematic Layers	Monitoring area map	The survey area division	With attribute
	Tectonic line layer	The tectonic line distribution area measurement	With attribute
	Site distribution map	The measuring conditions of site distribution area	With attribute

Table2. Tectonic line structure of attribute table

Number	
Fault Name	
The nature of the activities (sinistral, strike-slip, thrust)	
Length（km）	
Formation age (Mesozoic-Cenozoic)	
The latest activity (quaternary)	
Seismic activity (along the fault occurred in 5.7 earthquake)	
Occurrence（NEE/60）	
Horizontal throw（m/T）:2000m/Q	
Vertical throw（m/T）：3000m/Q	
Strike-slip rate（mm/a）:0.35	
Pour-slip rate（mm/a）:0.95	
Paleo earthquake count	
Characteristics of tectonic fracture belt	
Geomorphologic features - geomorphic system (the broken	
Geophysical characteristics (density, gravity gradient belt)	
Magmatic intrusion	
Determine the fault activity basis	
Remark	

Table3. The site attribute table

Site Name		
Administrative Region		
Fault Zone		
Area		
Elevation		
Circumstances		
Around the site engineering		
Temperature		
Precipitation		
Monitoring points count		
Measuring section count		
Baseline count		
Changes		

In addition to build a site database, mainly used for basic geographic information management field and deformation monitoring information, analysis and monitoring results of the site.

Table 4 .the northeastern margin of Qinghai-Tibet block across-fault measurement site database design table

Type	Layer Name	Layer Content	Illustration
Basic Geographic Map	General Situation		
	Relief map	1:500 Relief map	Graphics
	Geomorphologic map	1:500 Geomorphologic map	Graphics
	Image map	High resolution remote sensing image	Graphics
	Tectonic line		
Thematic Layers	Monitoring point distribution layer		With attribute
	Segment of Survey		With attribute
	Baseline Layer		With attribute
	Historical Earthquake		
	Around the Engineering		
	Precipitation Conditions		
	Temperature		

Ⅳ. COMPLETION METHOD OF THE SYSTEM

1）Data Preparation

Site refers to the zone where the monitoring points are. The collection of site information should include the following aspects:

(1)General situation of the site refers to of is whole venues of topographic maps or high-resolution mapping, photos and site geological background, and history earthquake, and geography, measuring district range, belongs to which fault and which district (text description) .

Property information: name, belongs district, and belongs fault, and site area, and monitoring points number, and measuring section number, and baseline number, and climate (temperature, precipitation, and pressure), and geological condition, and engineering condition closed to.

(2)Monitoring points information

Including distribution map and information from photos for each monitoring point. Photographs include close-up photos and remote photos. Close-up photos mainly show the damage for monitoring points. Remote photos mainly show the environmental factors surrounding the monitoring points.

Monitoring points properties: point's id, location and photos

(3)Human factor

The surrounding environment and human factors, whether monitoring points is close to the road or in the mountains all will have some degree impact on the result. All above mainly rely on survey crew's observation .

(4)Measurement information past years

It's including high precision leveling and distance measurement.

Leveling ,that is measuring the height difference between monitoring points . The survey road is closed leveling line and it's called measuring section between adjacent points.

Property information : measuring section , height difference measurement results in past years (table information, trend map information)

Distance measurement, that is measuring the distance between monitoring points.

The measure method is reciprocal observation. It's called baseline each between two points. Property information: baseline id, distance measurement results in past years (table information, trend map information).

2）Quantitative analysis and digital capture of cross-fault site information and Establishment of spatial database

Based on actual collection based information of fault site in the wild, in accordance with certain criteria to standardize data, collating, establishing a cross-fault survey sites information database, It provide a information platform for seismic data acquisition, management and updating.

Database includes all of the raw data, general situation of the site, geography, climate, temperature, site geological background, history earthquake, measuring section name, start time of surveying and other basic information . Data will be organized as follows:

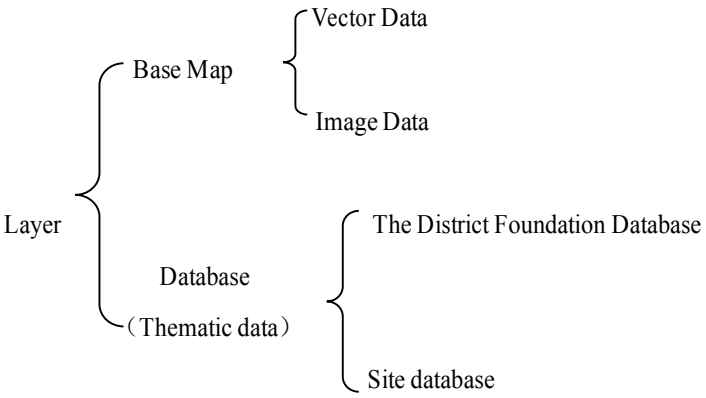
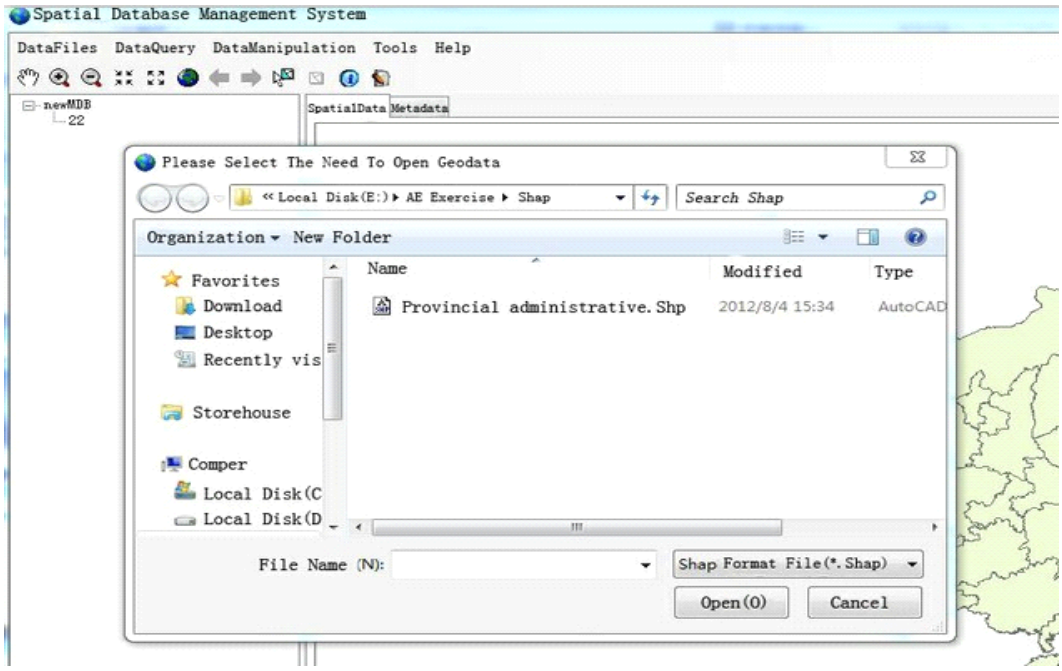


Fig. 2. the fault information database of based data organization method

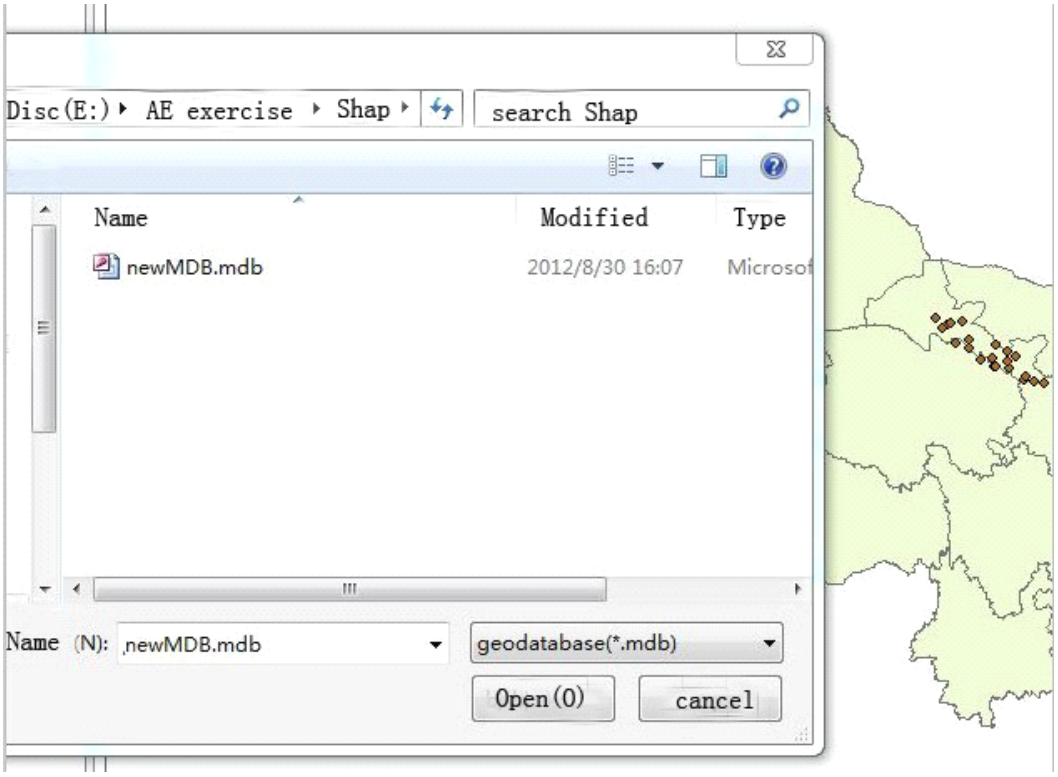
3）System software development

The system software is based on the VS2008 platform for development using c # programming language, this stage realization of the system functions as follows:

1. The overlay of geographical map and floor plan import



2.Established geographic information database of sites, change, maintenan



3. Grounds underlying geographic information from query, update, and simple analysis and processing

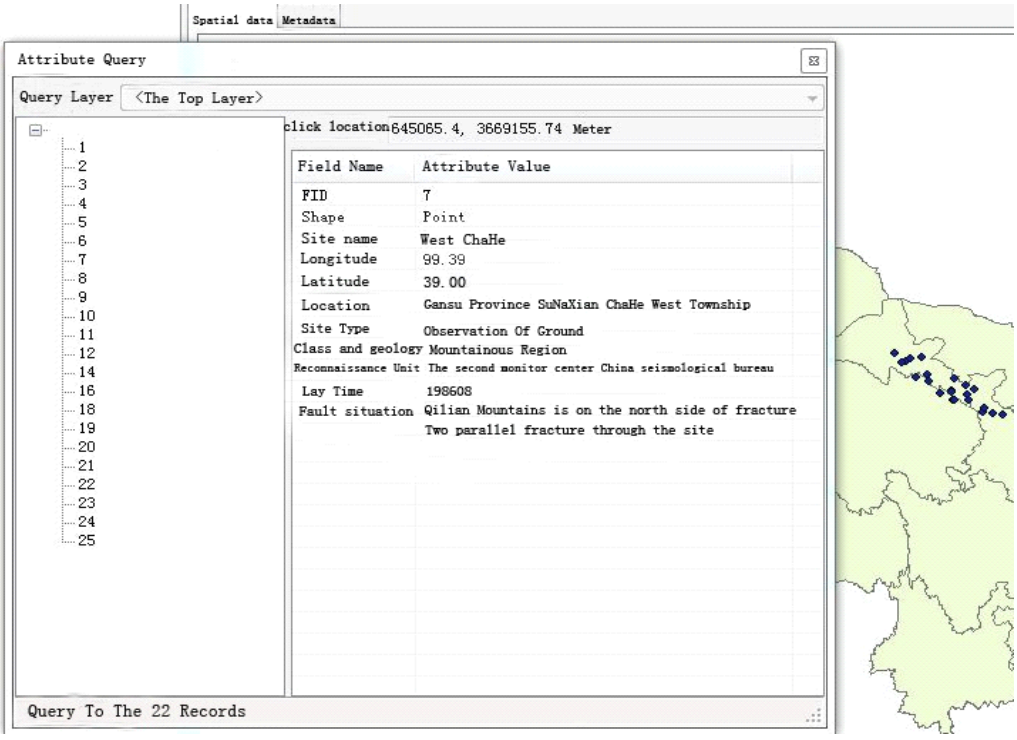


Chart file generated by the data files, has achieved to identify data patterns based on automatically generated as a function of a number of chart paper and visual clarity of expression, Xi Cha He Site baseline data, for example, the following figure:

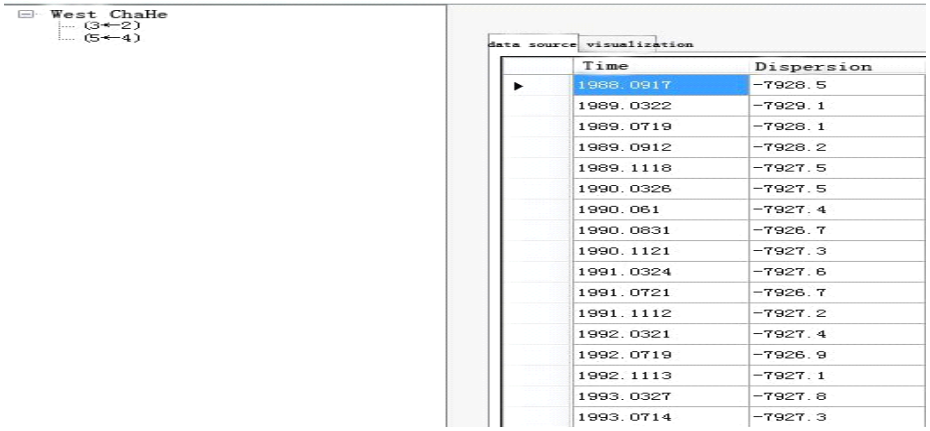


Fig. 3. ground-based data display

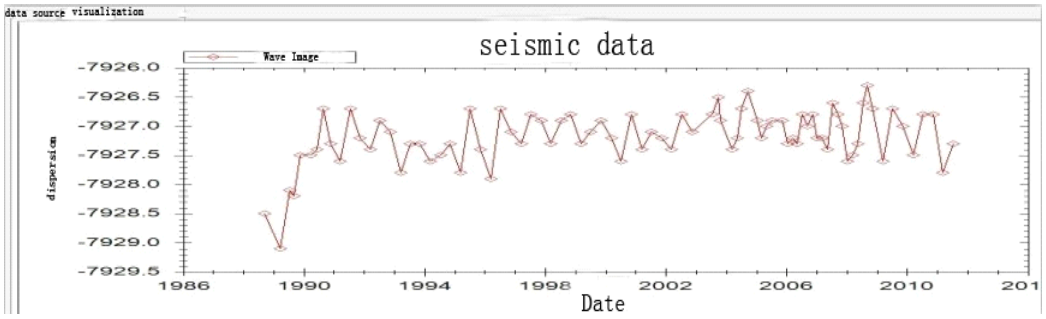


Fig. 4. base line data volatility

V .CONCLUSION

This cross-fault based information systems development, fundamental geographic database, Seismic special subject database, climate and hydrological databases. It can be integrated, analysis of massive data, combined with the establishment of the deformation model, comparative analysis, grey correlation analysis of the abnormal data, which gives an analytical report. Earthquake prediction expert analysis reports can help analyzing your data for earthquake precursors or because of outside temperature, air pressure, destruction, geological and hydrological factors from the impact.

The system is easy to maintain, easy to post data updated in real-time, and Foundation information database also can join the site in picture data, video data, to facilitate on site in stereo, full range of observation and understanding, which is the innovation of the system.

REFERENCES：

[1] Lou Guan Shou, Zhou Wei, Jin Peng et al. Factors across fault deformation interference survey [J]. Journal of Geodesy and geodynamics, 2010, Volume 30, supplement: 68—74

[2] Su Qin, et al. Gengda leveling anomaly and a magnitude 8 earthquake in Wenchuan [J]. Journal of Geodesy and geodynamics, 2009, Volume 29, supplement: 103—105

[3] Li Zhixiong, et al. Earthquake, earthquake information recognition [J]. cross-fault deformation data in Daqing factory 1995, (3):222—227

[4] yellow Fuqiong, et al. The relationship between [J]. Journal of earthquake, deformation behavior and rainfall and groundwater eight house mountain fault 2005, 27 (6):637—646 [5] Li Jie, et al. Analysis of abnormal high values of [J]. Shanxi earthquake, Shandong Linqu leveling in Liujiazhuang, 2003, (1):24—26

[6] Li Jie, et al. Shandong across fault deformation anomaly tracking and seismic risk analysis [R].2009.

[7] Jiao Qing, et al. The effect of solar radiation on the [J]. crustal deformation and earthquake deformation measurements across faults in the Beijing area, 1993, (2):55— 59

[8] Jiang Jingxiang, et al. Xinjiang Heizi across fault deformation measurement data analysis of abnormal [J]. northwestern Seismological Journal, 2002, 24 (1):42—48

The first author：Yue Wenchao，Male，Engineer，Beijing Explo-Tech Engineering Co.,Ltd.，EMAIL:13581870325@139.com Tell ：13581870325