

Investigation and analysis of leveling deformation anomaly at Daixian station in Shanxi

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ABSTRACT

The leveling measurements at Daixian station appeared increasing trend since March 25, 2013, which is credible, showing normal fault activity. According to the environmental survey, it contains some interference factors: first, the wind is big when the leveling measures in the afternoon, which has certain influence on the measurement results, but the impact is random and should be near the base value and not appear a trend. Second, the point BM3 was maintained during Sep. to Oct. in 2012 and occurred cracks in 2013, showing that the poor stability around the point. In addition, the change of recorded program is only to change the way of data record and can not affect the observation results during the same period.

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The leveling measurement at Daixian station appear 1.5 mm increasing trend since March 25, 2013, showing normal fault activity (Fig. 1). It is thought to be associated with big wind during observation, and it could be related to the change of recorded program during the same period. In order to figure out the reason, some researchers arrived at Daixian station to verify the anomaly.

1. Geographic, geological structure and basic data of Daixian station

1.1. The fault distribution around the Daixian station

The short-range leveling at Daixian station is located in Yukou village, Yukou town, Daixian county and crosses Wutai piedmont fault. The length of fault is 95 km, and the strike and the dip angle is

50°–60°, 60°–70°, prospectively. The fault is normal fault with high dip angle and northwest dip.

1.2. Lithology characteristic around the Daixian station

The short-range leveling measurement at Daixian station is laid on gneiss series of Wutai group in the Archean, which is mainly black quartz and hornblende gneiss. The quaternary strata are mainly yellow and gray clay in the pleistocene epoch, pluvial-alluvial fan and modern sand-gravel layer in the Holocene. The identification point in the east of fault is bedrock which is gneiss, and the west identification point is soil. The BM2-BM3-BM4 line is measured each day, including the BM2-3 across fault. BM1-BM2, BM3-BM7, BM7-BM8 and BM4-BM5 measuring lines are checked each month (Fig. 2).

1.3. Hydrogeology of Daixian station

The short-range leveling at Daixian station crosses the Wutaishan northern piedmont fault in the southern boundary of Daixian depression, which makes basin and mountain contact directly and the subsidence center of Daixian depression tend to the south. The sedimentary thickness in the Cenozoic is 2.4 km. The elevation difference is 0.7 km between the mountain of uplifted

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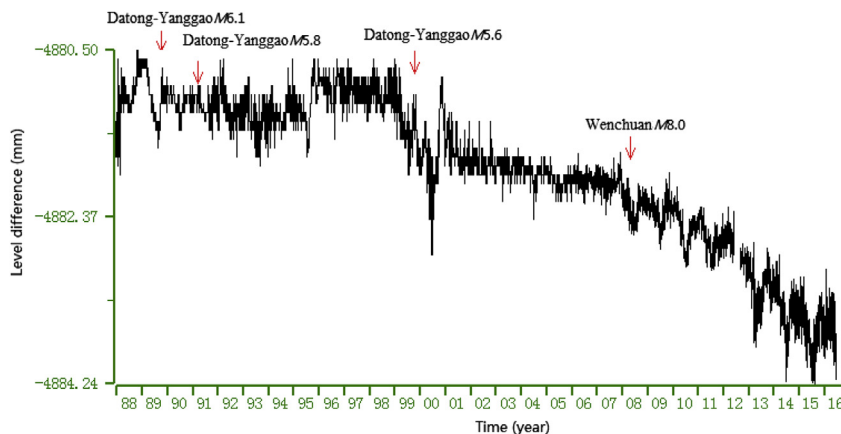


Fig. 1. The observation curve (BM2-3) of short-range leveling in Daixian station.

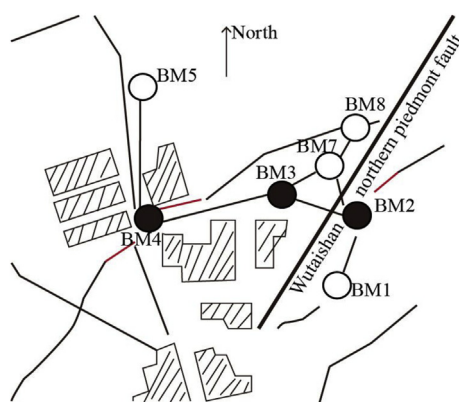


Fig. 2. The field layout of fixed leveling in Daixian station.

wall and the basin of downthrown wall. There is no hydrological monitoring point near station (Fig. 3).

2. Observation system of short-range leveling at Daixian station

The short-range leveling at Daixian station is located near Yukou village and 2 km away from the station. BM2 is an bedrock point, and BM3 and BM4 are soil points. The length of BM2-BM3 section (NS) is 0.2875 km, including 6 measuring points. The length of BM3-BM4 section (EW) is 0.3175 km, including 6 measuring points which are fixed piles with ordinary concrete along simple road and good observation condition. The used instrument is DiNi12 digital level.

3. Data variation characteristic of short-range leveling at Daixian station

The level difference curve of BM2-3 measuring line decreased 1.0 mm from Oct. 1988 to Oct. 1989, and the 6.1 Datong-yanggao swarm on Oct. 18, 1989 which is 120 km away from station, occurred in the reverse increasing process. The curve decreased 1.0 mm from Jan. 1995 to Sep. 1995 and reversely rose subsequently, occurring the Ms6.4 Baotou earthquake on May 3, 1996 which is 300 km away from station. The curve dropped accelerately since March 1999 and Datong-Yanggao Ms5.6 earthquake on Nov. 1, 1999 occurred in the extensional process. The curve appeared turning back before the Datong-Yanggao Ms5.6 earthquake and the

anomaly amplitude continuously increased after the earthquake, then the anomaly turned back until June, 2000, which had the amplitude 0.9 mm and was the adjustment of regional stress field. The curve was basically flat from 2001 to 2007 and showed new base value. The measuring line of Daixian station all had the several months accelerating turning back of anomaly before the Ms6.1 Datong-Yanggao earthquake in 1989, the Ms6.4 Baotou earthquake in 1996 and the Ms5.6 Datong-Yanggao earthquake in 1999, indicating that it has certain monitoring capacity to moderate-strong earthquakes near the station. The curve appeared small concave pocket change in July 2005, which was caused by rain submerging leveling points. The two leveling lines observed each day appeared drastically changes simultaneously and the maximum amplitude was 0.5 mm, showing the increasing extensional stress of the fault. Then the Wenchuan Ms8.0 earthquake occurred May 12, 2008, and the curve turned back after the earthquake. It basically recovered baseline until June 2008. This change was probably related to the Wenchuan Ms8.0 earthquake. The curve had not annual variation from 2001 to 2007, which was probably associated with great range stress change and fault activity closure of the Wenchuan Ms8.0 earthquake. The curve has annual variation since 2008, which may be related to wide range of stress adjustment and fault activity of the Wenchuan Ms8.0 earthquake [1–4] (Fig. 1).

Instrument replacement: the leveling instrument changed from Ni007 to digital DiNi12 since 2008. However, the replacement of instrument had not obvious influence on the observation data of two measuring lines (Fig. 4).

The influence of rainfall: according to the rainfall data since 1996, the rainfall in 1997 and 1999 had little change, but the curve had different change. The rainfall was different from 2002 to 2007, but the leveling curve changed little, showing that rainfall had little influence on the observed value. Therefore, the accelerating change of anomaly in 1999 and 2008 was not caused by rainfall, while it was the reflect of the Datong-Yanggao Ms5.6 earthquake and Wenchuan Ms8 earthquake (Fig. 5).

The leveling measurement at Daixian station appeared increasing trend since March 26, 2013, the amplitude of which is about 1 mm, showing normal fault activity. 2–3 cross-fault measuring line and 3–4 non-cross-fault measuring line all changed.

4. Investigation research of deformation anomaly

4.1. Examination of instrument working state

The instrument examination at Daixian station is carried out based on Ref. [5], and calibrate results is qualified. All parts of level

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