



# The Application of Integrated Monitoring and Warning System on Giant Landslide—A Case Study of West Open Pit Mine in Fushun

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Citation: Cui et al., 2019. The Application of Integrated monitoring and Warning System on Giant Landslide—A Case Study of West Open Pit Mine in Fushun. *Acta Geologica Sinica* (English Edition), 93(supp.2): 340–341.

**Abstract:** The mining of Fushun West Open Pit Mine began in 1901. The mining method is open-pit mining, which mainly produces coal and oil shale. At present, it has formed an open pit of about 6.6km in length from east to west, 2.2km in width from north to south, about 420m in depth and about 10.87km<sup>2</sup> in area. Due to the geological structural factors of the mining area and the mining activities for more than 100 years, many areas of the western open pit slope are in an unstable state, and geological disasters such as collapses and landslides of different scales have occurred.

In August 2012, the giant landslide on south side of West Open Pit Mine in Fushun occurred. According to the results of geological survey and engineering exploration, at present, the landslide in south side of West Open Pit Mine in Fushun inverted fan-shaped in plan view, which is 3100m long in the east-west direction and 1200-1500m wide in the north-south direction. The

vertical height difference of the landslide body is 400-500m, and the main sliding direction is northward. The main sliding surface has two layers, and the main sliding surface is buried between 80 and 252 m. The projected area of the landslide body is 3.37km<sup>2</sup>, and the landslide volume is 452 million m<sup>3</sup>, which is a giant-deep-rock landslide. As the landslide is surrounded by the western open-pit mine and other 11 enterprises, besides 1,147 households, the damage will be immeasurable.

Relying on the “Deformation Monitoring of the Landslide on the South Side of Fushun West Open Pit Mine (2012)”, “The Construction and Operation of Emergency Monitoring System of the Landslide on the South Side of Fushun West Open Pit Mine (2013)” and “The deformation monitoring system operation project of the Landslide on the South Side of Fushun West Open Pit Mine (2014-2017)”, the research on integrated monitoring and warning system for the giant landslide on the south side of

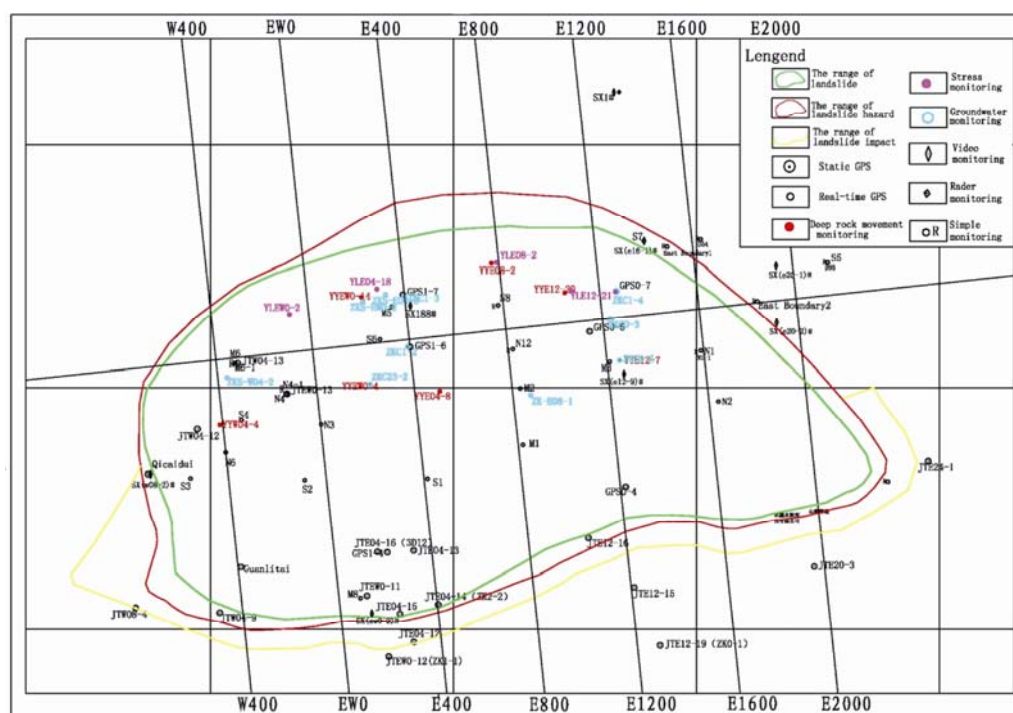


Fig. 1. The distribution of monitoring point of the landslide on south side of West Open Pit Mine in Fushun.

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Fushun West Open Pit Mine was carried out. Based on a full understanding of the geological environment conditions, and combined with 10 monitoring methods such as static GPS, real-time GPS, deep rock movement monitoring, stress monitoring, groundwater monitoring, radar monitoring, 3D laser scanning monitoring, video monitoring, simple monitoring and ground inspection, the comprehensive monitoring results was summarized, and the deformation characteristics of landslides was analyzed. Moreover, the landslide deformation stage was divided and so as the landslide hazard zones. Combined with the results of landslide stability evaluation and the mathematical model besides the physical model of the landslide short-term forecast, the development trend of landslide deformation was forecasted. The main results and understandings are as follows:

1. Study on the geological characteristics and deformation characteristics of the landslide in south side of Fushun West Open Pit Mine. The dip of the south side of the Fushun West Open Pit Mine is consistent with the dip of the strata. The lithology of the south slope is mainly basalt, tuff and granitic gneiss. The unconformity contact interface between granitic gneiss and basalt and the weak structural surface inside the basalt rock mass constitute the potential sliding surface of the landslide.

2. Spatial distribution characteristics of the landslide in south side of Fushun West Open Pit Mine. According to the deformation characteristics of landslide and the difference of horizontal displacement and vertical settlement in deformation

monitoring, the entire landslide is divided into east, middle and west by using the eastward fault of the boiler house-Qiantai Hotel and the  $F_{5-1}$  fault as the boundary line. The western area is the middle and lower part of the W400 line and the W400~E300 line; the middle area is between the W400 and E1600 lines; the east is the east of the E1600 line. From the deformation rate: the middle and western regions are deformed faster and the east is smaller.

3. Study on the evolution stage of the landslide in in south side of Fushun West Open Pit Mine. According to the landslide monitoring data and ground inspection, the deformation process of the landslide is divided into four stages: initial deformation stage (2010.9~2013.4); constant velocity deformation stage (2013.5~2013.8); accelerated deformation stage (2013.9~2014.3); continuous deformation Stage (2014.4 to present).

**Key words:** West Open Pit Mine, giant landslides, monitoring and warning system, Fushun

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