Control effect of huge faults on the structure of surrounding regional rock mass in the whole mountain: implications for the distribution pattern of coseismic landslides

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Introduction

Earthquakes and earthquake induced landslides are the most threatening geological disasters in nature. Coseismic landslide, as a surface catastrophic effect induced by earthquakes, has drawn much scientific attention. The fact that seismic faults play a control role in the occurrence of landslide has been generally recognized. Many relating researches focused on the relationship between landslide distribution patterns and the distance to the co-seismic fault, peak ground acceleration (PGA) of the earthquake, and types of faults based on remote sensing interpretation and GIS method. Many statistical methods including fuzzy analytic hierarchy process, principal component analysis, and logistic regression, were used to evaluate landslide susceptibility in an earthquake event considering the main role of faults. However, how the faults affect the distribution patterns of coseismic landslides has not been clearly understood.Therefore, in this study we examined this issue based on a case study on the landslides triggered by the 2008 Wenchuan earthquake, in China.

Method

We selected Qingping part of Longmenshan faults generating the Ms 8.0 earthquake as a target region. First, measurements of rock mass structure were conduceted. In-situ field rock mass structure investigations, 2m*2m measurement network was used, in laboratory, fractures that were visible to the naked eye in the field were sketched and counted using a square frame (0.3 *0.3 m) along profiles oriented across the faults. Then fracture density was calculated to determine the characteristics of fractured system of the crustal rock mass in the fault zone area. Finally, Wenchuan earthquake landslides distribution patterns was combined to deeply discuss the effects of faults on landslides.

Result

The results of spatial variations in fracture density with increasing distance from the Jiangyou-Dujiangyan fault were shown in Fig 1. As can be seen in Fig. 1, fracture density is much higher in the faults zone than other areas and sharply decreases with further increase after it exceeds a certain distance (CD) from the main fault. In Yingxiu-Beichuan fault, this CD is 3030 m in hanging wall and 1170 m in footwall, while in Jiangyou-Dujiangyan fault, this CD is 1350m in the hanging wall. Fracture density also increases when subsidiary faults across. The results showed that occurrences of fractures are strongly concentrated around the faults zone, such as Yingxiu-Beichuan fault and Jiangyou-Dujiangyan fault, presence of secondary faults also has a strong relation with fracture density distribution. Most co-seismic landslides for wenchuan earthquake in the research area distributed on the concentration part of rockmass factures.

Discussion

In this study, we found that there are control effects confined to a certain range of huge faults on the surrounding regional rock mass structure, showing a great impact on rock mass structure in a large scale. A concept named “fracture zone” was defined to express this phenomenon.

The results suggest the existence of remarkable hanging wall effect of rock mass structure, since the width of fracture zone in the hanging wall is greater than that in the foot wall. The fracture zone of Yingxiu-beichuan fault hanging wall is much wider than that of Jiangyou-dujaingyan fault, indicating that

there is a stronger control effect on rockmass structure of Yingxiu-beichuan fault compared with Jiangyou-dujaingyan fault.

Most co-seismic landslides for wenchuan earthquake distributed on the concentration part of rockmass factures, namely fracture zone. Distinct “hanging wall” effect of rockmass structure is consistent with the distribution pattern of coseismic landslides in the research area. Results indicate that the control effect has directly impacts on the distribution pattern of Wenchuan coseismic landslides

Conclusion

1. A control effect confined to a certain range of huge faults on the structure of surrounding regional rock mass in the whole mountain by using fracture density method, this effect was defined as “fracture zone” effect, which has directly impacts on the distribution pattern of Wenchuan earthquake induced landslides.
2. The control effect on surrounding regional rock mass structure were also founded in other huge faults, we argue that this effect is universal, which could be also suitable for other huge faults. The control effect marks long-term dangerous zones, since fragmented rock mass is vulnerable to subjected to failure, which has implications for disaster prevention in mountainous areas where faults are active.

Reference

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