Seismicity, structure and Local Stress Fields around the Downstream of Jinsha River, Western China

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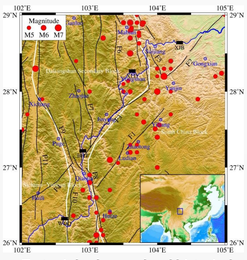
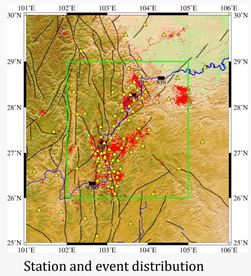
Introduction: In the downstream of Jinsha River, 4 large dams are built or under construction. Among them, Xiangjiaba and Xiluodu reservoir have been filled since Oct. 2012 and May 2013 respectively. Baihetan and Wudongde are under construction. In order to monitor earthquake activity around these reservoirs, a dense seismic network has been operated along the downstream of Jinsha River since Jan. 2016, which is much denser than before. From Jan. 2016 till July. 2018, more than 10 thousand of earthquakes have been located by the intensive network. It is obvious that small quakes became more active and frequent since 2013 and continued till Dec. 2017. Earthquake clustered along the upstream section of Xiluodu, and also along the EW direction branch formed by aftershocks of Aug.3 2014 Ludian M 6.6.



Tectonic background and historical M≥5.0 earthquakes since 1900

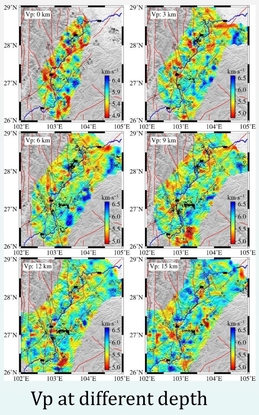


Station and event distribution recorded by the intensive network

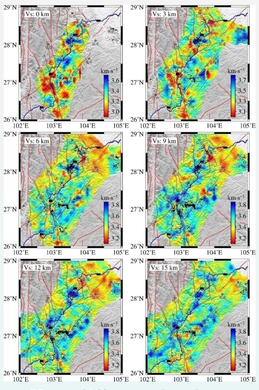
F1: Zhaotong-Ludian fault; F2: Huarong Shan fault; F3: Lianfeng fault;
F4: Ninghui fault; F5: Mabian-Yanjin fault; F6: Sanhekou-Yanfeng fault;
F7: Ganluo-Zhuhe fault; F8: Xiaojiang fault; F9: Zemu He fault;
F10: Pudu He fault; F11: Anning He fault.

3Dvelocity structure and seismicity

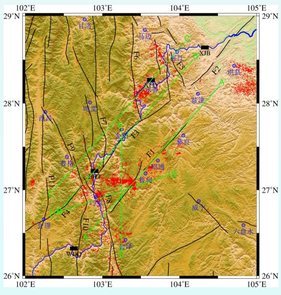
Using the seismic data from January 2016 to July 2018 recorded by 84 seismic in the Lower Jinsha River and double-difference tomography method, we obtained the high-resolution 3D velocity structure and the precise location of earthquakes in this area.

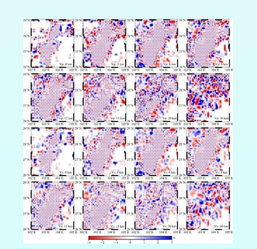


Vp at different depth



Vs at different depth



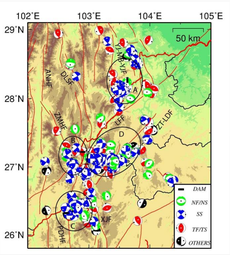


Time-distance curves and epicenter distance distribution

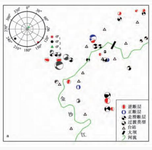
Vp and Vs along different profiles

Focal mechanism and Stress Field

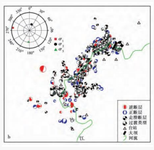
CAP and GPAT method are used to invert focal mechanisms for earthquakes with magnitude of M≥2.0 from Jan. 2016 to July 2018 recorded by the reservoir network. We obtained total of 542 focal mechanism solutions. Then we use iterative joint inversion method (IJIM) to invert stress field for four sub-regions, named as the Xiluodu dam area, the Baihetan dam area, the Wudongde dam area, and the Ludian source region, in order to investigate the current stress environment and the effect of impoundment.



Total of 542 solutions obtained by this research

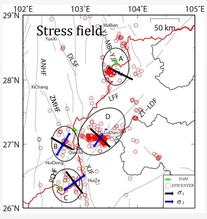


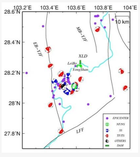
a. Before 2013.5(37)



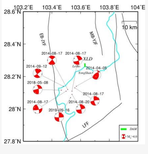
b. 2013.5-2013.10 (674)

Focal Mechanism in Xiluodu dam area(Diao et al. 2014)



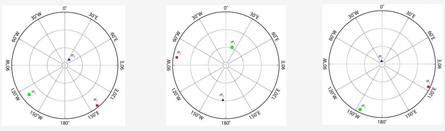


a. total of 59



b. M≥4.0

The obtained focal mechanism in Xiluodu dam area (2016.1.1-2018.07)



a. Before 2013.5 b. 2013.5-2013.10 2016.1.1-2018.7

Stress principal axes in Xiluodu dam area during different time period

Conclusion

1. Earthquakes are mainly located in areas with high-Vp and Vs or high-low-speed transition zone in the studied region. For example, the Yongshan earthquake cluster, Ludian earthquake region, and the Gongxian area.
2. Small earthquakes are continuously active in Yonshan region near Xiluodu dam, with their focal mechanism solutions dominated by thrust and strike-slip that is inconsistent with local geological structure. This may be related to the pore pressure and interaction between small faults due to the infiltration and diffusion of reservoir water.
3. The maximum principal stress axes in the study area are roughly in NW-SE direction, and the minimum principal stress axes are roughly in NE-SW direction.
4. Stress field changing has been observed in Xiluodu dam and its adjacent area in 3 time periods, that is before impoundment, the initial stage of impoundment, and 4 years later. The stress field dramatic change has taken place in the time period of the initial stage of impoundment. 4 years later, the principal stress axes becomes more similar with the stress field before the impoundment, but with the minimum principal stress axis is more vertical.
5. R value is 0.84, which is much higher than R before impoundment, also indicating the medium stress state in the region changed from compression to tension.
6. Untill July 2018, focal mechanism solutions in the Ludian M6.6 aftershock area are mainly thrust and strike-slip types, and the strikes of nodal planes are distributed in two dominant directions which is near EW and NE direction respectively, indicating that there may be a buried structure in the EW direction. Different kinds of faults controlled the seismicity in this area.