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Was the 2019 Ms6.0 Changning earthquake in Sichuan, China caused by human activities? —— Analysis of fault structure and seismogenic mechanism based on InSAR

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On June 17, 2019, an Ms 6.0 earthquake occurred in Changning, Sichuan, China (the Changning event), which is the largest earthquake within 50 km of the area since records began. It has attracted great attentions as this region is one of the largest shale gas production areas in China. The cause, the fault structure, and the earthquake effects remain the center of debates.

Using Interferometric Synthetic Aperture Radar (InSAR) data, we measure the coseismic deformation and build the fault models of the Changning event and two earlier Ms>5.0 earthquakes (P1:2018/12/16 Ms5.7 and P2:2019/1/3 Ms5.3) using Sentinel-1 and ALOS2 satellite data. From the coseismic interference of ALOS2, the deformation caused by P1, P2, and the Changning event as well as some of their aftershocks can be clearly identified. The deformation caused by the Changning event affects an area of about 150 km^2 and the surface deformation is mainly uplift with a maximum of 17.2 cm (towards the satellite). We obtain two fault models for the Changning event. The model inclining southwest has a smaller fitting error than the model inclining northeast and is more consistent with the distribution characteristics of aftershocks and local underground structure. The final model shows that the Changning event was caused by a fault with left-lateral strike and thrust slip. The strike is 124.9° with a dip angle of 49.8°. The inversed seismic moment is 4.79×10^{17} Nm, corresponding to Mw 5.75.

On the basis of the fault models, we analyze the cause of the Changning earthquake from the following three aspects: (1) Stress change. The cumulative stress change of P1 and P2 on the Changning event fault is less than 0.1 MPa, which is too small to trigger an Ms 6.0 earthquake. Therefore, there is no direct triggering relationship between the Changing event and event P1 or P2. (2) Aftershock distribution. The aftershocks of the Changning event are negatively correlated with time. The Time-Number curve of the aftershocks well obeys the Omori-type aftershocks law. It is inconsistent with the characteristics of a triggered or induced earthquake which has more pre-earthquakes and rapidly decreasing aftershocks. (3) Tectonic backgrounds. The movement of the Changning earthquake fault is accord with the local tectonic motion. Moreover, the causative fault we inferred coincides with a fault located in the basement, which was found by the seismic reflection profile analysis. The fault in the basement is likely to be related to the Changning

earthquake.

Therefore, there is no direct evidence showing that the Changning earthquake was induced by shale gas production or other human activity. We consider that the event is a naturally tectonic earthquake.