A Big Earth Data Platform for Three Poles

**Deep fine structure data set of crust and upper mantle in typical areas of southern China (2019-2020)**

1、Description

（1）An Ms 6.0 earthquake struck Changning county, Sichuan basin, SW China on 17 June 2019, which caused huge casualties and economic losses. Four Ms greater than 5.0 events subsequently occurred around the Changning source area, three of which occurred within one week. In order to better understand the mechanism of these moderate-sized earthquakes, we determine 3-D high-resolution velocity models around the source area simultaneously relocating earthquakes using double-difference tomography. In the present study, we use a total of 53,487 P-wave and 52,527 S-wave arrival times from 8818 events recorded at 39 seismic stations. Our results show that focal depths of the Changning mainshock and most aftershocks are ~5–10 km, and they form a fault plane with a steep dip angle. Most earthquakes are underlain by the zone with low Vp, low Vs, and high Vp/Vs anomalies, reflecting the existence of fluids there. These results suggest that the Changning mainshock and other moderate-sized earthquakes might be associated with the influence of fluids that could decrease effective normal stress on the fault planes. These fluids might be related to the hot and wet mantle upwelling in the big mantle wedge due to the deep subduction of the Indian plate down to the mantle transition zone. A clear high-to-low velocity transition zone is observed at ~10 km depth beneath the Gongxian and Xingwen swarms, which matches well with the detachment layer revealed by deep seismic soundings in the area. All these results suggest that the structural contrast could control the mainshock generation and aftershock extension.  
（2）The Tanlu fault zone is the most significant active fault in eastern China, which generated the great 1668 Tancheng earthquake (M 8.5). It is still unclear whether or not there is a link between the great earthquake generation and the upper-mantle structure. To address this issue, we study P-wave upper-mantle tomography beneath eastern China using 44,047 teleseismic P-wave arrival times. Our results show that at depths<150 km, high-velocity (high-V) anomalies appear west of the Tanlu fault zone, whereas low-velocity (low-V) anomalies are visible east of the fault zone. Strong lateral heterogeneities are revealed along the fault zone. At depths of 230–470 km, northwest of the Tanlu fault zone, there are obvious low-V anomalies that may reflect hot and wet mantle upwelling, whereas to the east high-V anomalies are visible, which may reflect the detached Eurasian lithosphere (downwelling). In the mantle transition zone (MTZ), both high-V and low-V anomalies are revealed, and the widespread high-V anomalies may reflect the stagnant Pacific slab. Beneath the hypocenter of the 1668 Tancheng earthquake, intermittent low-V anomalies are revealed in the upper mantle down to the MTZ depth, which may reflect hot and wet mantle upwelling flow. Integrating the present results with previous findings, we deem that the Tancheng earthquake was affected by fluids from the hot and wet mantle upwelling associated with the lithospheric delamination. Complicated mantle convection, including both upwelling and downwelling flows, may occur under the Tanlu fault zone in the big mantle wedge above the stagnant Pacific slab in the MTZ.  
（3）Since the occurrence of the 2008 Wenchuan earthquake (Ms8.0), many researchers have conducted extensive seismological and geophysical observations and investigations and obtained important results about the Longmenshan fault zone.  
Crustal structure inferred from local tomography shows that seismic velocity exhibits significant changes across the Wenchuan earthquake hypocenter from the south to the north. To the south, obvious low-velocity (low-V) anomalies exist, whereas strong lateral heterogeneities are revealed to the north, which may explain why the aftershocks extend northeastward. The Wenchuan earthquake occurred at the boundary between high-velocity (high-V) and low-V anomalies and a significant low-V zone is revealed below the mainshock hypocenter, suggesting that the nucleation of the Wenchuan earthquake was related to partial melts and/or fluid effects and associated with the reduction of effective normal stress on the fault plane, due to high temperature and high pressure in the Longmenshan fault zone caused by the India-Asia collision. The upper-mantle structure inferred from teleseismic tomography shows that the Longmenshan fault zone is located in the transition zone from low-V anomalies beneath the Songpan-Ganzi block to high-V anomalies beneath the Sichuan basin. This structural feature extends down to 200−300 km depths. High-V anomalies in the mantle transition zone are connected with those in the upper mantle beneath the Burma arc, indicating that the Wenchuan earthquake could be associated with upwelling of hot and wet materials in the big mantle wedge formed by the deep subduction of the Indian plate. These results suggest that the generation of the Wenchuan earthquake was related to structural heterogeneities in not only the crust but also the upper mantle. In addition, the Wenchuan earthquake may be related to the lower crustal flow, crustal shortening and Zipingpu Reservoir triggering.

2、Keywords

Theme：Earthquake relocation,Travel time data,Crust mantle structure,Seismic velocity,Tomography,Vp/Vs ratio,Seismology  
Discipline：Solid earth  
Places：Changning, Sichuan, Tanlu fault zone, Longmenshan fault zone  
Time：2020, 2019

3、Data details

1.Scale：None

2.Projection：

3.Filesize：15.0MB

4.Data format：None

4、Space scope

|  |  |  |
| --- | --- | --- |
| - | north：28.8 | - |
| west：105.5 | - | east：104.0 |
| - | south：27.9 | - |

5、Time frame:2018-12-31 16:00:00+00:00--2020-12-30 16:00:00+00:00

6、Reference method

References to data:

Deep fine structure data set of crust and upper mantle in typical areas of southern China (2019-2020). A Big Earth Data Platform for Three Poles, doi:10.11888/Disas.tpdc.2713512021

References to articles:

Zhang, B., Lei, J., & Zhang, G. (2020). Seismic evidence for influences of deep fluids on the 2019 Changning Ms 6.0 earthquake, Sichuan basin, SW China. J. Asian Earth Sci. 200, 104492.  
  
Lei, J., Zhao, D., Xu, X., Du, M., Mi, Q., & Lu, M. (2020). P-wave upper-mantle tomography of the Tanlu fault zone in eastern China. Phys. Earth Planet. Inter. 299, 106402.  
  
雷建设, 赵大鹏, 徐锡伟, 杜沫霏, 张广伟, 孙长青, 米琦, 鲁明文, 杨宇, 何静, 张冰, 田凡凡. (2018). 龙门山断裂带深部结构与2008年汶川地震发震机理.科学通报, 63(19), 1906-1916.

7、Supporting project information

Deep processes and resource effects of major geological events during the Yan Mountains period

8、Data resource provider

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