Stress triggering of the 1927 Gulang earthquake by 1920 Haiyuan shock

*Xiuping Mei[1], Mian Liu[2]

1. Lanzhou Institute of Seismology, Lanzhou, Gansu province, China, 2. Department of Geological Sciences, University of Missouri, Columbia, Missouri, USA

The M = 8 1927 Gulang earthquake occurred 100 km away from, 6.5 years after, the M = 8½ 1920 Haiyuan earthquake. Both of them were located on the Haiyuan fault zone which is one of the big strike slip fault system distributed on the northeastern Tibetan Plateau. The close temporal and spatial spacing between these two earthquakes suggests that the Haiyuan earthquake trigger the Gulang event. Various geological fieldworks indicate that the surface rupture of the Haiyuan earthquake is explicit and straightforward along the NW direction while that of the Gulang event is not clear. Although Gulang earthquake ruptured a complex thrust surface, aerial photographs and satellite images revealed no recent rupture. Here we investigate the Coulomb stress changes which could help us understand how the Gulang shock occurs affected by the Haiyuan event by considering broad parameter ranges.
We consider a model of viscoelastic half space which includes postseismic relaxation of the lower crust and upper mantle to investigate how the Haiyuan earthquake has advanced or delayed the Gulang earthquake. Our calculations suggest that the epicenter of the future Gulang event is totally located in the increased Coulomb stress lobe, where stresses were raised 0.107 bar by the Haiyuan rupture. This value is a little greater than the static stress change threshold. The postseismic stress change induced by Haiyuan earthquake is increased by about 0.1 bar only after 6.5 years at the hypocentral location of Gulang event.
We investigate coseismic Coulomb stress changes on some possible Gulang rupture planes by changing key source parameters including strike, dip and rake angles of receiver faults. The failure mechanism is mainly left-lateral thrusting rather than right-lateral thrusting according to the calculated results. A mechanism of strike=290°, dip=90° and rake=30° is a possible first ruptured fault plane in the process of the Gulang earthquake on which the Coulomb stress change imposed by the Haiyuan shock is the maximum by assuming broad uncertainties of the key parameters. The fault along N15°W direction could be the second failure plane. The 1920 Haiyuan mainshock might promote the rupture of those faults associated with the event of 1927 Gulang event.

Keywords: Coulomb stress changes, Haiyuan earthquake, Gualng earthquake

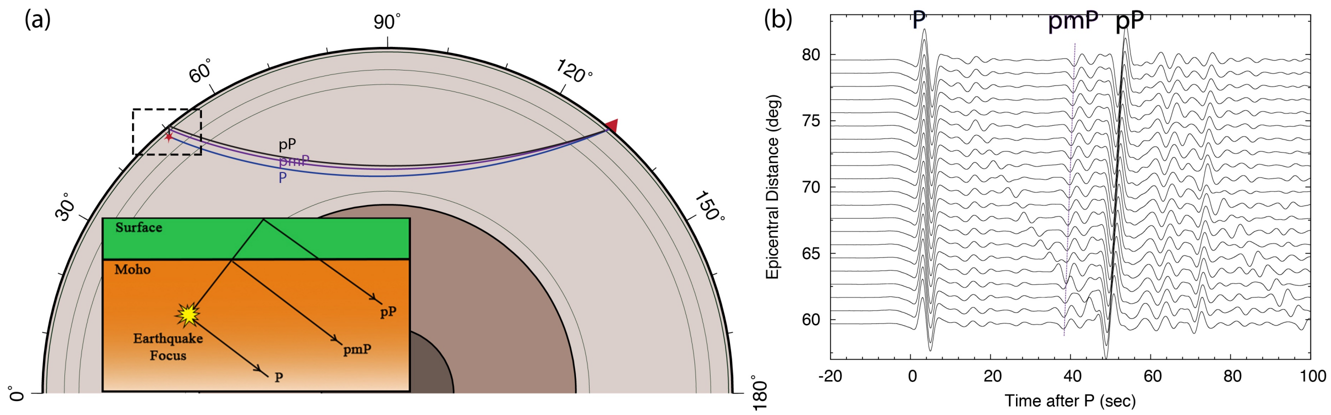
Subducting continental lower crust and crustal thickness variations in the intermediate seismic zone of Pamir-Hindu Kush from Moho underside reflection pmP

Hangqi He[1], *Xiaobo He[1]

1. Dept. of Marine Sciences, Zhejiang University

The Pamir - Hindu Kush region is an orogenic belt presenting two continental converging subduction zones where the Indian and Asian plates collide. Understanding of the regional tectonic history, however, has been hampered due to limited seismological investigations. In this study, we use the Moho underside reflection pmP phases to constrain the crustal thickness variations in the intermediate seismic zone (36-37°N, 69-72°E). The events characterized by focal depth deeper than 100 km and magnitude greater than 5.8 (Mw) are selected. The crustal thickness is determined by identifying depth phase pP along with the Moho underside reflection pmP. The measured thickness in this study varies spatially from 58.1 to 76.2 km, with some uncertainty most likely resulting from the estimation of the average velocity of P-wave (~6.21 km/s) in the crust. The strong Moho variation implies a large structural deformation of the crust, reflecting a complex collision-related mountain building history. We also detect two strong reflections from deep interfaces down to ~97 km below the southernmost Pamir. According to our direct observations and waveform modeling, we further explain the two reflections are perhaps a result of underplating of the subducted Asian lower crust below this region. Our observations here will be complementary to other seismic results such as receiver functions.

Keywords: Moho, Intermediate earthquake, Pamir-Hindu Kush, Lower crust, Crustal thickness

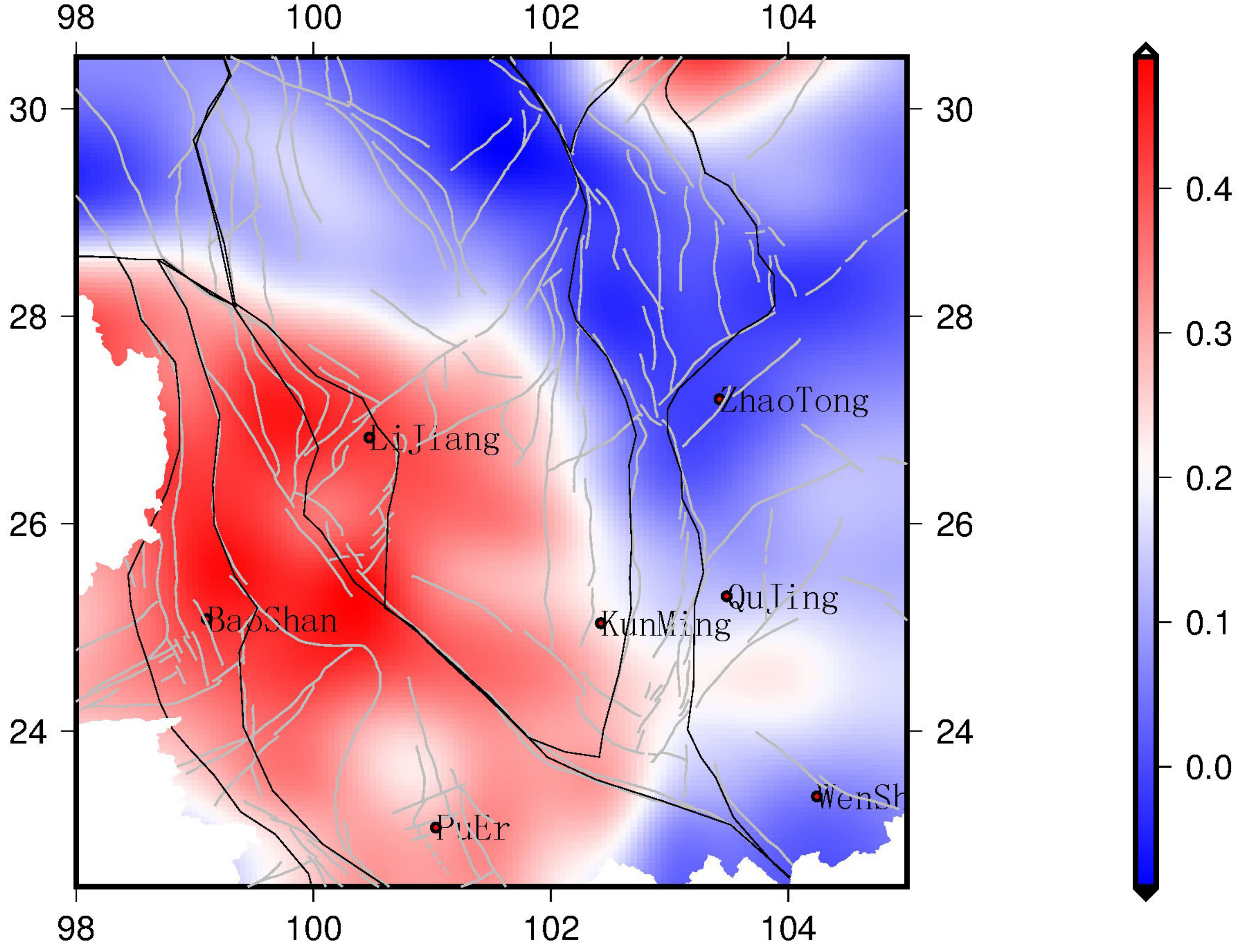


Gravity change in the southeast Tibetan Plateau caused by crustal movement

*Jiapei Wang

Combining crustal movement with gravity change, which is the key problems to analysis and understand the dynamic about the interior of the earth , also is one of the most important ways to study. We can more directly monitor and study the movement process of material inside the earth through plenty of high-precision space-to-ground survey and surface gravity data.Walsh(1975),Reilly, Hunt(1976) analysed the problem combining the surface deformation with gravity change in theory for the first time; Chen .et al(1980) improved the theory and gave the calculation formulas about the surface gravity change caused by deformation and material movement in certain areas; On this basis, Shen et al(2005,2007) propose the thought and theory of coupling movement of crustal deformation and density changes, and derived the equation of gravity potential caused by crustal movement general time-space domain further. On the other hand, Duan(2011) and Liu (2015) simulated the gravity change in the Tibetan Plateau by translational motion of vertical cuboid.In this study, with theory of coupling movement of crustal deformation and density changes and translational motion of vertical cuboid, we separately applied compound trapezoid formula and the latest crustal models to research the gravity change features caused by crustal movement in the Southeast of Tibetan Plateau.

Keywords: Gravity change, coupling movement, crustal deformation, density changes, Southeast of Tibetan Plateau


98
100
102
104
30
28
26
24
ZhaoTong
LiJiang
QuJing
KunMing
BaoShan
PuEr
WenSh
0.4
0.3
0.2
0.1
0.0

Probabilistic seismic hazards for Tibetan Plateau and adjacent regions estimated using multiple seismic source and attenuation models

*Md Moklesur Rahman[1], Ling Bai[1], Nangyal Ghani Khan[1], Guohui Li[1]

1. ITP,CAS, Beijing, China

Tibetan plateau and adjacent region is one of the most seismically active regions of the World. The catastrophic earthquake occurs frequently in this region and causes huge socio-economic losses. For instance, the 2015 Mw7.8 Nepal and the 2008 Mw7.9 Sichuan earthquake caused thousands of casualties and huge unrecoverable damages. The proper seismic hazard quantification is widely used an effective tool to reduce the seismic risk.

In this study, we estimate the probabilistic seismic hazards for the Tibetan plateau and adjacent region based on five attenuation models along with three different seismogenic source models (smoothed gridded, linear, and areal sources). In order to capture the epistemic uncertainties, a logic-tree structure was used assigning different weighting factors for various models. The peak ground acceleration and spectral acceleration at 0.2 s and 1.0 s were quantified for 2% and 10% probability of exceedance over 50 years considering the bed rock site condition. The hazard maps depicted significant spatio-temporal variations. This study provide new constraints on the improvement of seismic zoning map and consequently on the refined seismic building design codes for the Indian-Eurasian continental collision zone.

Keywords: Tibetan plateau, probabilistic seismic hazard, peak ground acceleration, spectral acceleration, logic tree

Teleseismic earthquake relocation and tomography of Tien Shan mountains, northwestern Tibetan plateau.

*Nangyal Ghani Khan[1,2], Ling Bai[1], Junmeng Zhao[1], Guo Hui Li[1], Muhammad Mokleshur Rahman[1]

1. Institute of Tibetan Plateau Research, Chinese academy of sciences, Beijing, P.R. China, 2. COMSATS institute of information technology, Abbottabad, Pakistan

Intra-continental belts have always posed questions regarding the source of seismicity and the controlling factors of the dynamics and formation of the fold and thrust belts. Our study deals with such questions about the world’ s most active intra-continental thrust belt i.e. the Tien Shan. We used teleseismic earthquake relocation and regional tomography to evaluate the share of each neighboring unit in the relatively rapid formation of Tien Shan. We relocated 7094 earthquakes. We defined a cluster as a set of 10 events with a maximum distance of 35 km between the hypocenters, we discarded all the events with less than 10 phase recordings, thereby leaving only the well-recorded events. These new precise locations of hypocenters were used as initial locations for the tomographic inversion. Our huge data set produced high-resolution tomographic results, providing an insight into the dynamics of Tien Shan. We found low-velocity zones beneath Tien Shan to the east of Talas-Fergana fault. This low-velocity zone within the lithospheric mantle is associated with differential subduction of Tarim basin beneath Tien Shan. At shallow crustal depths, to the east of Talas-Fergana fault, we found high-velocity zone beneath Tien Shan, in addition, we found much deeper crustal events in western Tien Shan.

Keywords: Teleseismic relocation, Low-Velocity Zone, Differential subduction

Core-mantle boundary structure beneath the Tibetan Plateau and adjacent regions

*Guohui Li[1,2], Ling Bai[1]

1. Institute of Tibetan Plateau Research, Chinese Academy of Sciences, 2. College of Earth Sciences, University of Chinese Academy of Sciences

We use waveforms from the Chinese Digital Seismic Network and 3-D synthetics to study the structure of D” beneath the Tibetan Plateau and adjacent regions. The synthetics are calculated using specfem3d_globle and based on crust1.0 for the crust, S40RTS for the mantle, and ak135 for the lowermost 300 km above the CMB. We use waveform cross correlation between observed and synthetic waveforms to obtain differential travel-time residuals of S and ScS phases.
The corrected ScS-S differential travel time residuals indicate that a high shear velocity anomaly beneath the Tibetan plateau is adjacent to a low shear velocity anomaly to the west of Tibetan plateau. Slant stacks of Scd signals show that a discontinuity on top of D” exists near the boundary of high and low velocity anomalies. Precursors of ScP to the south of this boundary suggest the existence of ultralow velocity zone (ULVZ).

Keywords: core-mantle boundary, Tibetan Plateau, slant stack

Block boundries of uppercrust in the North-Eastern Tibet from Pg-wave velocity and anisotropy joint tomography

*Shunping Pei[1], Quan Sun[1], Yanbing Liu[1], Xiaotian Xue[1], Zhigang Shao[2]

1. ITP Institute of Tibetan Plateau Research, Chinese Academy of Sciences, 2. Institute of Earthquake Science, China Earthquake Administration

The northern growth of Tibetan Plateau is a improtant scientific question and attract most attention from geologist and geophsicist. The sturcture of three blocks, Ordos, Alax and Tibetean Plateau, and their relationship is a key to resolve this question. We used Pg-wave travel time data from year 1980 to 2015 in this region, to obtain high resolution struction of upper crust by applying 2D velocity and anisotropy. The results show dominent low velocity beneath Tibetan Plateau, high velocity beneath Alax block and very high velocity beneath Ordos block. The anisotropy result show fast direction along fault strike in the three blocks, but fast direction almost pendic to the fault in the boundary zone between three blocks which may be resulted from consitent princinple compress stress effect on the many near random micro-cracks in the active zone. The clear boundies can be determined by tomographic velocity and anistropy, and which suggest northern growth of Tibetan Plateau is a serial process of uplifting, faulting and thrusting effect on the margin of Alax block and Ordos block.

Keywords: North-East Tibetan Plateau, Tomography, Joint inversion , Pg velocity and anisotropy

Internal deformation of lithosphere beneath the central Tibet

*heng zhang[1,2], Dapeng Zhao[3], Junmeng Zhao[1], hongbing Liu[1]

1. Institute of Tibetan Plateau Research, Chinese Academy of Sciences , 2. Department of Earth, Atmospheric and Planetary Sciences, MIT, 3. Department of Geophysics, Tohoku University

We use P-wave data from the Hi-CLIMB and ANTILOPE-II project to determine azimuthal and radial anisotropy tomography in central Tibet. Beneath the Himalayan block, variant FVD (fast velocity directions) are observed between crust and upper mantle. In contrast, the FVD in the Lhasa block exhibits only a slight variation between the lower crust and upper mantle, reflecting a coherent deformation there. Different FVD are revealed near the Bangong-Nujiang suture, which may reflect different parts of the underthrusting Indian plate. In the upper mantle of the Qiangtang block, a E-W trending azimuthal anisotropy with positive radial anisotropy is revealed in the shallower part, whereas a weak anisotropy appears in the deeper part, implying a two-layer anisotropic model. A two-layer lithosphere is detected in the Lhasa block, and both layers are located in high velocity zones. Moreover, the character of lithosphere shows significantly E-W variations beneath the Lhasa block. Our results support a geodynamical model that strong deformation has occurred on both Indian and Eurasian lithosphere.

Keywords: anisotropy, tomography, geodynamics

Upper mantle anisotropy beneath western Tibet revealed by shear wave splitting measurements

*Changhui Ju[1,2], Junmeng Zhao[1], Qiang Xu[1]

1. Key Laboratory of Continental Collision and Plateau Uplift, Institute of Tibetan Plateau Research, Chinese Academy of Sciences , 2. University of Chinese Academy of Sciences

We analyze seismic waveforms recorded by the Y2 array (IRIS) through shear wave splitting (SWS) technique to investigate the upper mantle deformation beneath western Tibetan Plateau. First, STA/LTA method and time frequency analysis are adopted to detect clear SKS wave and determine the frequency band of filtering, respectively. Second, cluster analysis method is selected to determine the optimal time window. Third, an automatic minimum transverse energy method is applied to calculate the fast polarization directions and delay times of the SKS waves. Finally, visual checking is used to ensure the reliability of the results.
After calculating the SWS parameters for every event, we analyze the results for each single station and decide if the SWS can be depicted by a two-layer model or not. Our results indicate the relationship between the upper mantle deformation of western Tibetan Plateau and Indian plate subduction beneath Tibetan Plateau.

Keywords: shear wave splitting, western Tibet, upper mantle anisotropy

