Lake Baikal Earthquake of August 27, 2008: fast field experiment and preliminary results

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ABSTRACT

The earthquake source was located under the bottom of Lake Baikal, its southern part. Its moment magnitude was 6.3 (according to Harvard), and source mechanism was normal fault, which is typical for this region. The earthquake was felt on a significant territory of the Baikal area; however it was not accompanied by disastrous destructions and victims due to the low density of population and to location of the epicenter in the Lake.

The only one permanent seismic station Talaya is situated in the epicentral zone; it belongs to IRIS system but the record of the main shock is clipped. The next nearest station is situated in Irkutsk (at a distance of 70 km). Therefore, the temporal network of seismic stations was disposed for the detailed study of source zone. The first temporal stations began recording in the first days after the earthquake. To September 7, the total number of stations reached 10, which allows us to expect the obtaining of high-quality observational data unique for this region. During first weeks of observations, the number of events daily recorded by the whole system exceeded 10.

If the level of the aftershock activity remains rather high, the large number of events will be recorded at special digital field stations. These records yield the data on

1. the development of aftershock process in time;
2. source mechanisms of aftershocks;
3. the geometry of aftershock cloud and its connection to the main shock source;
4. the determination of the velocity structure of the source zone.

Thus, the results of the analysis of the near-field observational data together with the regional data will give us a new knowledge about this region of the southern Baikal. At the moment of abstract submission, field observations have been continued. The study is supported by the Russian Foundation for Basic Research, project No. 08-05-00598.

Key words: epicentral observations, aftershock area, source mechanism

PRESENTER'S BIOGRAPHY

Arefiev Sergei was born in 1952 at the seismic station Khorog (the Pamir, Tadjik Republic) in the family of seismologists; graduated from the Dagestan State University, Makhachkala in 1974; PhD degree, in 1980; Professor, in 2002. From 1989 he heads the Laboratory of strong earthquakes and seismometry. He took part in the field work in the epicentral zones of many earthquakes: 1970 Dagestan; 1975, 1983 Kum Dag; 1984 Gazli; 1988 Spitak; 1991 Ratcha; 1994 Shikotan; 1995 Neftegorsk; 2004 Altai; 2008 Baikal, being the team leader since 1984. Recent years he studies the following subjects: seismicity and seismic regime, seismic source study (field experiments and modeling), seismic hazard assessment, experimental study of aftershocks.

Directiviy effect on PGV attenuation relations in March-31st -2006 Silakhor earthquake

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ABSTRACT

Rupture directivity effect causes spatial variations in strong ground motion parameters. It causes difference between the strike- normal and strike- parallel components of horizontal ground motion amplitudes. These variations become significant for strong ground motion velocity. A modification factor is defined to take in to account the effect of rupture directivity in empirical velocity attenuation relations. The modifications are based on modeling March-31st-2006 Darbeastane- Silakhor earthquake, using finite element method, applying ANSYS software. The ground motion parameters that are modified include ratio of strike –normal (V_n) to strike- parallel (V_p) component of horizontal velocity and strike- normal component to average horizontal velocity (V). The ratio of strike- normal to strike- parallel velocity is large in both the forward directivity direction, where velocity is larger, and in the backward directivity direction, where velocity is smaller. We therefore expect the strike- normal to strike parallel ratio to be mainly controlled by directivity angle. Also the variation of fault normal velocity to average horizontal velocity ratio by directivity angle (θ) is defined from earthquake modeling. It shows V_n to V ratio is controlled by directivity angle. This ratio has the same trend in 2006 Darbeastane- Silakhor earthquake strong ground velocity data. In this research the equation for V_n to V_p variations by directivity angle is recommended. We used Somerville et al. (1997) directivity model parameters as $\cos^2\theta$ to define directivity effect on V_n to V ratio. Therefore, directivity factor is the determined to account in empirical strong ground velocity attenuation relations.

Keywords: directivity, Darbeastane- Silakhor earthquake, Finite-element method, velocity attenuation relations

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Rupture process of the 12 May 2008 Wenchuan, China, earthquake

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Time-domain moment-tensor inversion was used to obtain the focal mechanism of the M_W 7.9 Wenchuan earthquake. The inverted results show that the motion of the Wenchuan earthquake is mainly oblique thrusting with some right-lateral faulting (strike 225°/dip 39° /rake 132°). The scalar seismic moment M_0 is 9.4×10^{20} Nm, corresponding to a moment magnitude of M_W7.9. The average stress drop in the Wenchuan earthquake is estimated to be about 18 MPa, and the peak stress drop, which occurred at the hypocenter, was 65 MPa. The imaged spatio-temporal evolution of the rupture on the fault plane shows that the M_W7.9 Wenchuan earthquake was a complex event produced by the ruptures of four concentrated-slip patches or asperities on the fault plane. Our result from the inversion is confirmed by the field observation. The coincidence between the two concentrated-slip patches and the great destruction in the Yingxiu-Dujiangyan-Wenchuan and Beichuan areas and the good agreement between the inverted peak slips and the observed largest surface offsets indicate that extensive, significant fault slip that breached the surface, was one of the most important factors for the cause of serious damage in these two meizoseismal areas. The inverted spatio-temporal rupture process of the Wenchuan earthquake shows that the earthquake is a complex asymmetric bilateral rupture with overall strong northeast directivity, with high irregular rupture velocities and long rupture duration of about 90 s. These characteristics account for the northeasternward elongated meizoseismal areas and the asymmetric distribution of aftershocks that are significantly more numerous to the northeast of the epicenter of the Wenchuan earthquake, and much less so to its southeast. The significant difference in damage between the meizoseismal areas (Yingxiu-Dujiangyan-Wenchuan and Beichuan-Qingchuan areas) which are located in the hanging wall of the causative thrust fault, and minor damage areas such as Chengdu-Deyang-Guang'an areas which are located in the foot wall of the causative thrust fault can be attributed to the effect of the asymmetric dipping fault geometry, i.e. the hanging/foot wall effect.

Key words: Wenchuan earthquake, rupture process, moment tensor inversion

PRESENTER'S BIOGRAPHY

Yun-tai CHEN, geophysicist, born in Xiamen of Fujian, China, in 1940. He obtained his B.Sc. degree in 1962 from Department of Geophysics, Peking (Beijing) University, China, and his Ph.D. in 1966 from Institute of Geophysics, Chinese Academy of Sciences, Beijing, China. Presently he is Professor and Honorary Director of Institute of Geophysics, China Earthquake Administration, and Honorary Dean of the School of Earth and Space Sciences, Peking University. He is a Member of Chinese Academy of Sciences (CAS) and a Fellow of the Academy of Sciences for the Developing World (TWAS). He is a Bureau Member of the International Union of Geophysics and Geodesy (IUGG). He is a Member of Seismological Society of China, and a Member of American Geophysical Union (AGU). Research fields: theory of seismic source, digital seismology.

Representative Styles of Deformation along the Surface rupture, north to Beichuan, of the 2008 Wenchuan Ms 8.0 Earthquake, China

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ABSTRACT

The May 12, 2008, Ms 8.0 Wenchuan earthquake occurred along the Longmenshan fault, a thrust fault on the eastern margin of Tibet Plateau. The surface rupture was more than 200 km long. Although pre-existing scarps were identified between Yingxiu (the epicenter) and Beichuan (the most destroyed town), but no one noticed any active evidence along the part north to Beichuan before. The more than 60 km long surface rupture in this earthquake along this part lets us reevaluate its activity.

Our detailed surveying at representative sites along the northeastern part shows that the rupture commonly is a relatively simple 1- to 3-m-high scarp with minor hanging-wall deformation and localized uplift, folding, and tension fissures along the scarp crest. For individual scarps, the width of deformation is about 10 to 50 m. Excavation shows that most of the scarps near surface are probably formed by folding instead of faulting. The northwestward tilting of the hanging wall formations result from the action of the Longmenshan fault. The value of the vertical coseismic displacements decreases from southwest to northeast, while the amount of the dextral displacements does not change evidently, so the proportion of horizontal movement becomes higher northeastward. Near the northeastern end of the rupture, the surface deformation along the fault mainly acted as tension fissures and small lumps of the ground.

Moreover, many pre-existing scarps have also been recognized on this part in field investigation after the earthquake. In comparison with just one scarp, which was formed in this earthquake, developed in T_1 terrace, generally two kink-shaped scarps can be discriminated in higher terraces. Furthermore, the higher terrace showing larger deformation indicates the influences of active structures on terraces have continuously acted for a long time.

Key words: Surface rupture, Wenchuan Earthquake, Deformation styles, fold scarps

PRESENTER'S BIOGRAPHY

Li Chuanyou, an Associate Researcher in Institute of Geology, China Earthquake Administration, was born in 1971, Shandong province, China. Li graduated from the Department of Geology, Chengdu Institute of Technology in 1994, with a bachelor's degree. At the same year, Li passed the entrance examination of postgraduate to Institute of Geology, State Seismological Bureau and began to study in the institute. In 1997, Li graduated and got a M.S. Degree in tectonic geology. And from this year on, Li worked in Institute of Geology, in major of Earthquake Geology, active tectonics, paleoearthquakes, and Neozoic tectonics. From 1999 to 2005, Li studied for a Dr. Degree under direction of Prof. Zhang Peizhen and succeeded. Li has published tens of papers mostly in Chinese these years.

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The 8th June 2008 Mw=6.4 earthquake in NW Peloponnesus: preliminary results from seismic, GPS and field data

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ABSTRACT

On June 8, 2008 at 12:25 UTC a strong earthquake occurred (M=6.4) in NW Peloponnesus, western Greece. The focal mechanism was determined as strike-slip by several institutions operating in central and eastern Mediterranean. This event is the largest strike-slip earthquake to occur in western Greece during the past 25 years. The hypocentre was located near the village Mihoi in Achaia prefecture (NW Peloponnesus), at a depth of about 18 km. A NOA team conducted field investigation one week after the event. There was no surface rupture. The geology of the area is mostly clastic sedimentary rocks and recent sediments (alluvium). Many rock falls, slides and liquefaction features have been found as is typical for an earthquake of this size. Double-difference relocations of 370 aftershocks show a linear pattern of events and define a clear NE-SW striking main shock fault plane. The aftershock region extends approximately 30 km in length, and the width of the surface projection of the aftershocks is as large as 10 km. The depth of the aftershocks rarely exceeds 22 km. Analysis of high-rate GPS data from the permanent GPS network of NOA showed that station RLS (Riolos) which is located 12.8 km to the N5°W of the epicentre was displaced co-seismically 7 mm to the North in agreement with right-lateral kinematics of the rupture. Static (Coulomb) stress transfer analysis indicates loading of faults at mid-crustal levels near the towns of Patras (north) and Amaliada (south), respectively. The earthquake put more emphasis on the role of strike-slip faulting in the deformation of western Greece also indicating that seismic strain is partitioned between strike-slip and normal-slip events due to obliquity of the Nubia (Africa) subduction and the N-S extension of the overriding Aegean upper plate.

Key words: Achaia earthquake, seismotectonics, Greece, GPS

PRESENTER'S BIOGRAPHY

Dr George Drakatos received his BSc (1980) in Geology at the University of Athens, Greece, and his Post-Graduate Diploma (1987) in Seismology and Earthquake Engineering at the International Institute of Seismology and Earthquake Engineering (Tsukuba, Japan) and his PhD (1992) degree in seismology at the University of Athens, Greece. His research involves studies of crustal structure, applications of tomography, aftershock analysis, and risk management studies. Since 1984 he is employed at the Institute of Geodynamics of the National Observatory of Athens and since 2003 is employed as Research Director. He has been involved in several EU and national funded projects and he has more than 70 publications in scientific journals and international conference proceedings.

Imaging the Wenchuan Earthquake and its aftershocks using back-projection of Teleseismic P-Waves and Point-Spread Function Deconvolution

Alexander Hutko & Thorne Lay

Applications of seismic wave back-projection and reverse-time methods to earthquake finite-source rupture imaging have increased with ready availability of large digital data sets and expanded computer processing capabilities. For large earthquakes, these approaches offer potential for explicitly resolving rupture attributes that are treated parametrically in conventional modeling and inversion procedures. Teleseismic P-wave back-projection source imaging using large aperture networks in Alaska, Europe and Japan is applied to the May 12, 2008 Wenchuan earthquake. Our images show clear rupture propagation towards the northeast extending for approximately 220 km. This computationally fast method uses information contained in the direct teleseismic *P*-waveform, an important attribute for real time monitoring applications. However, time resolution, network aperture, rate of wave slowness variation across the network, and signal coherence are key issues that limit imaging resolution. Back-projected wavefields have many space-time artifacts due to intrinsically limited resolution associated with the data acquisition geometry and seismic wave periods relative to wavefront curvature. Complexity of the back-projected wavefield for a large event produced by the source-receiver geometry can be reduced by deconvolving empirical or theoretical point-spread functions (the space-time image formed from back-projection of signals from the same network for an effective point-source) from the data images. This facilitates measurement in back-projection images of key rupture attributes such as average rupture velocity and minimum rupture extent. These faulting characteristics can then be used for rapid assessment of shaking and provide a priori constraints on finite-fault slip model inversions. Within only a few hours of the main shock, hundreds of aftershocks followed. Identifying aftershocks following a large earthquake is a significant challenge for real time monitoring applications. We modified the back-projection technique to act as an earthquake detector, similar to spotlight techniques used for CTBT monitoring. We show that this computationally fast method successfully identifies most aftershocks in the USGS earthquake catalog as well as some that are not in the catalog.

The 2008 Wenchuan earthquake and active period of the broad plate boundary zone

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ABSTRACT

The 2008 Wenchuan M8 earthquake attacked China and generated the huge disaster in Sichuan, Shangxi and Gansi provinces on May 12th. Ishikawa(2007) pointed that the active period along the plate boundary between Eurasian plate and India-Australian plate form Java trench to north Anatolian fault started in 1997. After the Wenchuan earthquake, the temporal change of the seismic activity along the broad plate boundary between the India-Australian plate and the Eurasian plate was analyzed using PDE monthly, weekly and QED catalogues (USGS) and the Utsu catalogue (released June 2002) for the historical events.

Mogi (1974) showed that the active and quite periods of the seismicity had been alternately repeated along this plate boundary and the last active period was from 1931 to 1951. Using the recent data, the new active period including the 2008 Wenchuan earthquake was clearly pointed. This active period started in 1997 in the western Tibet and the epicenters spreaded to Turkey in 1999 and to India in 2001. The earthquakes, the 2001 Kunlun M8.1, the 2004 Sumatra M9.0, the 2005 Sumatra M8.6, the 2005 Pakistan M7.6 the 2006 Java M7.7 and the 2007 Sumatra M8.5 earthquakes are followed them. So the rate of the occurrence of large earthquake is about 1.5 events per 1 year. In the former active period from 1931 to 1951 pointed by Mogi, that rate is about one event per 1 year and the seismicity was very high especially in the eastern part of the border area between China and India, including three M8 events (1934 M8.3, 1950 M8.6, 1951 M8.0). The earthquakes in the last but one active period from 1889 to 1918 located along the Sumatra and in the western part of Tibet. On the contrary, the large earthquakes occurred so few in the calm period from 1952 to 1996 and the rate of the occurrence is one event per 10 years. So the velocities of the plate movements are not constant like conveyor and they move like stick and slip.

Some hypocenters in this active period located near the recent ones, for example, the 2005 Pakistan M7.7 - the 1905 M8.6, The 2000 Turkmenistan M7.5 - the 1895 M7.7. As two past active periods continued about 20 years or more, this active period will continue more 10 years.

Key words: Wenchuan earthquake, plate boundary, active period, stick and slip.

PRESENTER'S BIOGRAPHY

The author is a seismologist, and developed the software to analyze the seismicity named SEIS-PC, but now working at the magnetic observatory of Japan Meteorological Agency. He worked at the Meteorological Research Institute, Matsushiro Seismological Observatory and the headquarter of JMA. He is interested in the earthquake prediction and tectonics.

Variation of aftershock decay pattern in the Himalaya-Tibetan Plateau region

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Aftershock decay pattern of any region has a strong bearing on its geo-tectonic setup. The rate of decay defined by the P-value can be estimated using the modified Omori's law. This approach is applied to the strong earthquakes of the Himalaya-Tibetan Plateau region, to study the local seismo-tectonic variations. It is found that the P-value is normal (P=1) for the 2005 Kashmir earthquake in the western Himalaya, reducing to 0.9 for the 2008 Sichuan earthquake towards east. Much lower values around 0.8 are found for earthquakes in the Tibetan plateau region. A P-value map of the Himalaya-Tibetan plateau region is developed which indicate the local variations.

On 12 May 2008 an earthquake of magnitude 7.9 devastated the northwestern Sichuan province of China. This earthquake occurred along the northeast trending Longmenshan fault bordering the Tibetan Plateau on the west on the Sichuan Basin on the east. The focal mechanism depicts a thrust fault mechanism with the northwest dipping fault plane correlating well with the tectonic fault. This plane also hosts a component of right-lateral strike slip consistent with the local tectonics and orients well along the trend of aftershock distribution. Broadly, the Sichuan earthquake is a consequence of the northward convergence of the Indian plate against the Eurasian plate resulting in eastward crystal extrusion of Tibetan Plateau accompanied by clockwise rotation of several tectonic blocks of the Eurasian landmass. More specifically, it occurred along the northeast trending Longmenshan fault, due to over-thrusting of a weak Tibetan crustal block over a mechanically stronger Sichuan Basin. Estimation of p value using about 164 aftershock data provides a value of 0.87, comparable to a value of 1.0 obtained for the Muzaffarabad earthquake in western Himalayas, indicating a normal rate of decay of the aftershocks in the months ahead. We infer that aftershocks of magnitude exceeding 5 may occur for duration of about 7 months, says January 2009.

Rupture process of the 2008 Wenchuan, China, earthquake inferred from teleseismic waveform inversion

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ABSTRACT

The 2008 Wenchuan earthquake occurred in the central part of China at 6:28 UTC on May 12, 2008. The Global CMT solution shows a thrust type mechanism striking southwest direction with prominent non-double couple component, which may indicate temporal and spatial changes of the source mechanism. Geological investigations found surface deformations with averages of 2 to 3 m vertically and 1 m horizontally, indicating a thrust type due to an east-west compression, along the Longmen Shan Thrust Belt. They also suggested that the southern one of three main active faults consisting of the Longmen Shan Thrust Belt was initially broken and then the rupture transferred to the middle one of the faults at about 100 km to the northeast of the epicenter. Geodetic studies showed a thrust type mechanism in the southern part and a right lateral type in the northern part of the source area from the forward modeling of the geodetic deformation in order to better explain InSAR data. The above studies indicate that the 2008 earthquake ruptured in the multi fault planes and should not be expressed with only a single planar fault. We investigated the source process of the May 12, 2008 Wenchuan earthquake using teleseismic waveform data. We estimated optimal source fault geometries from the residual analysis and then applied the waveform inversion for two main fault planes with dips of 33 and 64 degrees. The slip distribution showed a thrust motion around the epicenter, while it showed a lateral motion from about 100 km to the northeast of the epicenter to the end of the fault. The maximum slip and total seismic moments are 10.7 m and 1.12E+21 Nm (Mw 8.0), respectively. We simulated broadband seismic waves through realistic three-dimensional Earth structures using a spectral-element method to compare GCMT solution, a source model with single fault plane, and our preferred model with multi fault planes. The synthetic waveforms using our preferred model well explains observed data for both body waves and surface waves in the frequency band of 5 to 150 seconds, and the residual sum of squares between their waveforms is systematically smaller than that for other simpler source models. The stress changes using our resultant slip distribution showed positive changes in the second ruptured fault induced by the first fault. We interpreted that the source fault of the 2008 earthquake was composed of at least two main fault planes with low and high dip angles and the rupture might transfer between the faults at the mainshock.

Key words: Wenchuan earthquake; source process; asperity; teleseismic wave; stress change.

PRESENTER'S BIOGRAPHY

Takeshi Nakamura graduated from Faculty of Sciences, Kyushu University in Japan and received a Doctorate of Science in 2006. He has been a post-doctoral researcher in Department of Oceanfloor Network System Development for Earthquakes and Tsunamis (DONET), Japan Agency for Marine-Earth Science (JAMSTEC) since 2006. He belongs to a project group, DONET, which aims to develop a real-time dense ocean floor network system in the seismogenic zone of megathrust earthquakes and contribute to disaster reduction and mitigation. He works on real-time analysis, wave propagation, anisotropy, and source process of large earthquake using seismic and tsunami waves.

Rupture process and stress transfer in the Mw 7.8 earthquake in Tocopilla, Northern Chile on November 14, 2007.

by Sophie Peyrat, Raul Madariaga, Elisa Buforn, Jaime Campos and the Montessus de Ballore team

A large Mw=7.8 earthquake occurred on 14 November 2007 in the Northern Chile gap, just North of the site of the large Mw=8 Antofagasta earthquake of July 1995. This earthquake ruptured the interplate seismic zone over a length of more than 150 km and generated a series of plate interface aftershocks. Then, on 16 December 2007, a large M=6.8 aftershock occurred near the southern bottom of the fault plane of the main event. This event is of the « slab push » type, i.e. an event that occurred inside the subducted Nazca plate due to along slab compression; aftershocks of this event demonstrate that it occurred on an almost vertical fault. The 2007 event took place just after the installation of new accelerometric networks by Chilean, German and French researchers and short period instruments by our Chilean colleagues. The accelerometric data combined with far fields seismic data and SAR images provide a quite complete image of the rupture process. The earthquake broke a long (150 km) and narrow (about 30 km) zone of the plate interface just above the transition zone. Using a new non-linear inversion method we determined that rupture occurred on two well mapped patches of roughly elliptical shape. We will discuss the stress transfer during this event and the rupture mechanics at the transition zone. Soon after the main event a surge in seismicity was observed on the Benioff zone at 100 km depth that is mainly of tensional (slab-pull) nature. We will also discuss the consequences of this event for models of gap filling earthquakes in Chile proposed in the 1970s.

The Zemmouri-Boumerdes (Algeria) earthquake of May, 21st 2003, (Mw=6.9): Present day studies status

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ABSTRACT

The Zemmouri-Boumerdes region have been struck by strong earthquake on May 21st 2003 with magnitude Mw=6.9. This event generated huge casualties and life losses. According to the preliminary study performed, this earthquake is associated to the offshore segment of the south Mitidja fault system. The focal solution of this seismic source shows a reverse mechanism with a weak strike slip component. From May 21st to late October 2003, the seismological network has recorded a large number of aftershocks. In this paper we present an overview on the history of the fracture inside the Mitidja basin in relation with the May 21st 2003 earthquake. The mainshock and aftershocks relocation showed that the fault plane is mainly located offshore. All suggested source models showed that the fault trace should be located offshore between 5 and 13 km distance from the coast of Zemmouri. Seismic data (teleseismic and strong motions) showed two high slip regions on both parts of the epicenter. Offshore investigations found that spatial correlation exists between these two high slip patches and two segmented cumulative scarps recognized on the slop and at the foot of the margin. Larger damage observed in the western part of the epicenter is attributed to a shallow asperity. In the eastern part of the epicenter where the asperity is deeper according to the interferometric data the damage is less.

Key words: Boumerdes earthquake, seismic source

PRESENTER'S BIOGRAPHY

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A correlation between the *b*-value and the fractal dimension from the Indian Ocean great earthquake of 2004

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ABSTRACT

A great earthquake of magnitude 9.0 (Mw)(USGS) struck off the West Coast of northern Sumatra (Indonesia) at 00:58:53 hours (GMT) leading to generation of devastating tsunami. The epicentre of the mainshock was located at 3.244°N and 95.825°E (USGS) and the depth is 10 km (USGS). It had rupture up to 1300 km. It was followed by huge number of aftershocks. The b-value, a-value and fractal dimension of spatial distribution of 7673 earthquakes have been estimated for the entire data set (1973 to Jan 30, 2006) and 4908 aftershocks (Dec 26, 2004 to Jan 30, 2006) dividing the area into four blocks. The b-value was estimated by least-square fit using Guttenberg- Richter relation, however, fractal dimension was estimated by correlation integral method. The b-values range between 0.40 to 1.72. These estimates are also compared with the estimates obtained from the analysis of the earthquake data for the same region during February 16, 1973 to just before the occurrence of mainshock. In general, b-value and fractal dimension for spatial dimension of earthquakes are comparable for both data sets for respective blocks. Sumatra region has lowest b-value (0.89 and 0.75 for entire data set and aftershocks, respectively). However, block 1 of Andaman region has highest b-value as 1.45 for aftershocks. Nicobar region has the b-value 1.24 and 1.25 and a-value 8.78 and 8.67 for entire data set and aftershocks, respectively. Highest fractal dimension is estimated for Nicobar region as 1.885 and 1.871 for entire data set and aftershocks, respectively. In general, the fractal dimension ranges between 1.825 to 1.484 for entire data set and 1.871 to 1.102 for aftershocks. Fractal dimension is very close to each other for the blocks except block 1 of Andaman region, which has 1.484 and 1.102 for entire data set and aftershocks, respectively.

The b-value, a-value and fractal dimension of spatial distribution of earthquakes was also estimated for a 1□x1□ having 50% overlapping grid to map the entire region for both of the data sets. The result shows that b-value and fractal dimension have good correlation.

Key words: Andaman-Sumatra region, b-values, correlation integral, Fractal dimensions, Guttenberg- Richter power law distribution and Seismicity.

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Dr. Jayant N. Tripathi obtained his B.Sc.(Hons.), M.Sc.Tech.(Exploration Geophysics) and Ph.D.(Seismology) degrees from Banaras HIndu University, Varanasi, India in 1983, 1987 and 1994, respectively. He also obtained the M.E. (Software Engineering) degree from MNREC, University of Allahabad in 1998. He was appointed as a Lecturer at University of Allahabad, Allahabad in 1992, and presently working as Reader in Geophysics. Dr. Tripathi was awarded JRF and SRF of UGC, New Delhi. He was awarded Spanish Government Fellowship for Foreign Scientists for stay in 2002. He has to his credit several scientific papers in renowned International and National journals of repute and attended many International and National conferences. He is also member of many professional bodies. He is very actively involved in several sponsored Research and Development projects of DST and CSIR. Dr. Tripathi is also serving as a administrative head of the Department of Earth & Planetary Sciences at University of Allahabad, Allahabad.

Relocations of the M_W7.9 Wenchuan mainshock and its aftershock sequences

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The M_S8.0 (M_W7.9) Wenchuan earthquake of the 12 May 2008 was the largest destructive earthquake in China since the M_S 7.8 (M_W 7.6) Tangshan earthquake of 28 July 1976. It ruptured more than 300 km along the Longmenshan fault zone that bounds the Tibetan plateau and the Sichuan basin. By using the double-difference earthquake location algorithm, we have relocated the Wenchuan mainshock and its aftershock sequences of 789 with $M_L \geq 3.0$ that occurred from May 12, 2008 to May 28. It is found that the epicenters of aftershocks are located in a NE-SW trending zone about 310 km in length and less than 30 km in width which clearly coincides with the strike direction of one of the nodal plane with strike of 225°, dip 39° and rake 117°, obtained by the moment tensor inversion. The vertical cross-sections along the strike direction NE-SW and the direction perpendicular to the strike NW-SE of the projections of the relocated hypocenters also show that the aftershocks are clustered around this nodal plane. The agreement of the NE-SW trending hypocentral distribution of the aftershocks with the nodal plane striking 225° and the NE-SW strike, SE thrust of the Longmenshan Fault Zone (LFZ) indicates that the plane striking 225° is the causative fault of the 2008 Wenchuan earthquake, and overall, the Wenchuan mainshock rupture was a predominantly thrust event with a small right-lateral strike-slip component on a plane dipping 39° with a strike of 225° and rake 117°. It also indicates that while the Wenchuan main shock was mainly caused by the rupture of the NE-SW striking Yingxiu-Beichuan Fault (YBF), the ruptures of the two nearly parallel NE-SW striking faults, Maoxian-Wenchuan Fault (MWF) to the west of the YBF, and Pengxian-Guanxian Fault (PGF) to the east of the YBF, also played important roles in the Wenchuan main shock rupture.

Key words: Wenchuan earthquake, earthquake relocation, aftershock

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Relocation of the *M*8.0 Wenchuan earthquake sequence in part: preliminary seismotectonic analysis

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ABSTRACT

The *M*8.0 Wenchuan earthquake of May 12, 2008 occurred at the southwestern end of the Beichuan-Yingxiu fault, which is the central segment of the central controlling fault of the Longmenshan thrust nappe zone. This earthquake ruptured more than 300km long unilaterally from southwest to northeast, and generated a 240km long surface rupture along the Beichuan-Yingxiu fault characterized by right-lateral oblique faulting and a 72km long surface rupture along the Guanxian-Jiangyou fault characterized by dip-slip reverse faulting. To investigate its deep coseismic deformation and rupture process, we performed the double-difference relocations for the *M*8.0 mainshock and its 2741 aftershocks between May 12 and June 26 using the catalog from the Sichuan seismography network and temporary stations. Most relocated events occured in the upper crust at depths of 0-20km, and fewer in the lower crust from depth of 25 to 40km, which may correspond to faulting in the lower crust. An aseismic layer appears beneath the Longmenshan thrust nappe zone between 20 and 25 km depth after relocation, which may be in agreement with the detachment for thrusting of the nappe zone. Spacial distribution of the relocated aftershocks and focal mechanism solutions suggest that the earthquake ruptured from south to north unilaterally with segmentation characteristics. The seismic belt formed by the aftershocks may be divided into two segments by the Gaochuan stepover in Anxian. The width of the seismic belt becomes narrower from south to north in map view, implying that the dip of the seismic fault may become steeper northward. The focal mechanism solutions suggest that rupturing in the south segment where the initial rupture point located may be dominated by thrust slip with fewer component of strike slip, while it may be dominated by dextral strike slip in the north segment. From Beichuan to the northeastern end of the rupture zone, the seismic belt cannot be correlated with any fault in the north segment of the Longmenshan thrust nappe zone, even cuts athwart the Qingchuan fault. It can be concluded that no controlling fault in the north segment of the Longmenshan thrust nappe zone was involved in earthquake generating and rupturing. The section of hypocenters in this part delineates a near vertical rupturing plane perpendicular to the strike of the seismic belt, and the focal mechnism solutions show great dextral strike slip component.

Key words: the *M*8.0 Wenchuan earthquake, relocation of earthquake sequence, double difference algorithm, seismotectonics

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Ailan Zhu is an associate professor in seismology. She received B.S. degree in Coal Geology from Shandong Mining Institute in 1987 and M.S. degree in Seismology and Geology from the Institute of Geology, State Seismological Bureau (now CEA) in 1991. After working for 10 years in the Seismological Bureau of Hebei Province, she furthered her education at the Institute of Geology, CEA, and received Ph.D degree in Structural Geology in 2006. Her Ph.D thesis focused on earthquake relocation and microseismicity analysis along the major active faults in the western Sichuan region. Since 2007, she has been working for the Earthquake Administration of Shanghai Municipality as a seismologist. Her current research interests concentrate on earthquake relocation, and active tectonics study using relocated microseismicity.