

Seismic inversions

Here we tried to approach the rupture process of the 2008 Wenchuan earthquake based on the teleseismic data. We have formed a more comprehensive data set by manually selecting 62 body waves and 77 surface waves. Besides the fault geometry inferred from Global CMT (GCMT), we tested two plausible complex fault geometries. Based on these intermediate results, we concluded that

1) Right-lateral strike-slip rupture of the second major asperity of our preliminary result more likely occurred on a high angle fault rather than the fault plane inferred from the Global CMT. 2)Near the hypocenter, a concurrent rupture on both high angle and low angle faults could explain the data equally well.

I. Single-fault Model





Figure 2a.1. Cross-section of slip distribution of Model A. The red star indicates the hypocenter while the color and arrows shows the slip amplitude and direction, respectively.

Model B: We then updated the preferred model by replacing the low angle fault plane with two high angle fault segments along the curved Beichuan fault.



Figure 2b.1 3D view of the slip distribution of Model B. The red star indicates the hypocenter while the color shows the slip amplitude.

33°00'

32°00' -

Rupture process of the 2008 Mw 8.0 Wenchuan Earthquake

Guangfu Shao & Chen Ji, , Department of Earth Science, University of California, Santa Barbara Zhong Lu, EROS Center of Cascades Volcano Observatory; Ken Hudnut, Pasadena office, United States Geological Survey Jing Liu-Zeng, Institute of Tibetan Plateau research, Chinese Academy of Sciences.



Figure 1.3. Surface projection of preferred single-fault model (Model I). The focal mechanisms of seven major aftershocks are reported by the Global CMT.



Figure 2b.2. The surface projection of Model B

Comparison of Data and synthetics

I: 39 P waves

CAN $\frac{135}{78}$ P CTAO $\frac{135}{65}$ P GUMO $\frac{105}{41}$ P TARA $\frac{99}{71}$ P WAKE $\frac{85}{57}$ P MIDW $\frac{76}{79}$ P MIDW $\frac{69}{67}$ P MIDW $\frac{91.1}{78}$ P MIDW $\frac{111.6}{79}$ P MIDW $\frac{91.1}{78}$
$\begin{array}{c} P \\ CTAO \frac{135}{65} \\ P \\ GUMO \frac{105}{41} \\ P \\ TARA \frac{99}{71} \\ WAKE \frac{85}{57} \\ P \\ MIDW \frac{76}{79} \\ MIDW \frac{69}{67} \\ \end{array}$
$\begin{array}{c} P \\ P \\ GUMO_{41} \\ P \\ TARA_{71} \\ P \\ WAKE_{57} \\ P \\ MIDW_{69} \\ \hline P \\ MIDW_{67} \\ \hline P \\ P \\ MIDW_{67} \\ \hline P \\ P \\ MIDW_{67} \\ \hline P \\ P \\$
$\begin{array}{c} P \\ GUMO_{41}^{P} \\ P \\ TARA_{71}^{P} \\ WAKE_{57}^{P} \\ MIDW_{67}^{76} \\ P \\ MIDW_{67}^{69} \\ \end{array}$
$P = TARA \frac{99}{71} + 122.5 Minor product a statement of the statement$
$P = TARA \frac{99}{71} + 1223A$ $P = 157.4$ $WAKE \frac{85}{57} + 157.4$ $I = 111.6$ $I = 111.6$ $P = 100$
$\frac{P}{WAKE_{57}^{85}} + \frac{157.4}{157.4}$ $\frac{P}{JOHN} \frac{76}{79} + \frac{111.6}{79} + \frac{111.6}{79} + \frac{111.6}{79} + \frac{91.1}{100} + \frac{91.1}{67} + \frac{91.1}{100} + \frac{91.1}{67} + \frac{91.1}{100} + $
$\frac{P}{JOHN} \frac{76}{79} \qquad \qquad$
$\frac{P}{JOHN} \frac{76}{79} \qquad \qquad$
MIDW ⁶⁹ ₆₇
· · · ·
$^{P}_{ADK} \xrightarrow{44}_{60}$
P A
PET 44
$^{P}_{KDAK_{71}}$ A
$COLA_{69}^{25}$
P 25 97.4
P TIXI <u>11</u> 42
-20 0 20 40 60 80 100 120

5				
$\begin{array}{c} P \\ PAB \\ \hline 82 \end{array}$	18	6.4 P SFJD	349 80	109.9
$\frac{P}{TIRR} \frac{306}{58}$	25	1.8 P SUMG	348 73	132.6
$\frac{P}{KN} = \frac{303}{48}$	29	7.4 P KBS	<u>347</u> 59	127.2
P GNI <u>297</u> 47	33	5.8 P BORG	338 75	154.1
P LSZ $\frac{249}{85}$	15	0.3 P KEV	336	165.8
P RER 227	16	3.6 P KONC	326	171.9
P DGAR $\frac{222}{48}$	23	9.0 P AA ESK	325 72	156.2
P COCO $\frac{189}{42}$	And man And	9.8 P ARU	³²²	288.7
P UGM 168	26	3.5 P	39 322	230.5
^P 167		2.9 P SUW	317	231.9
65 P 160 ABWA	18	6.7 P GRFO	³¹⁵	203.2
P 149		6.0 P BFO	68 315	210.5
P 145		4.7 P	70 313	183.3
58		33B	74	

II: 23 SH waves

$CTAO \frac{135}{65}$	\sim	471.1
SH GUMO	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	352.7
SH 85 WAKE	∧ <u></u>	600.9
57 SH 69		682.1
MID w 67 SH 44		411.6
ADK 60	\sim	431.4
PET $\frac{44}{45}$		161.9
$\operatorname{BILL}_{51}^{25}$	M	A
$\begin{array}{c} \text{SH}\\ \text{YAK} \\ \frac{21}{35} \end{array}$	Why	256.1

-20 0 20 40 60 80 100 120 140

NI 297 1 458.5 SH COCO 189 944.4 SH VSU 322 617.4 $\underset{\text{UGM}}{\overset{\text{SH}}{39}} \xrightarrow{168} \underset{\text{SUW}}{\overset{1065.6}{59.5}} \xrightarrow{\text{SH}} \underset{\text{SUW}}{\overset{317}{59}} \xrightarrow{557.5}$ SH 160 783.8 SH 160 382.5 $\underset{WRAB}{\text{SH}}_{\text{so}}^{145}$ -20 0 20 40 60 80 100 120 140 -20 0 20 40 60 80 100 120 140

III. 77 Surface waves

$UD_{TAO} \frac{135}{65}$	0.756
$UD UMO \frac{105}{41}$	1.405
UD 99 ARA ₇₁	
UD 85 AKE ₅₇	
UD DHN <mark>76</mark> 79	
JD IDW <mark>69</mark>	0.652
$_{\rm DK}^{\rm JD} \frac{44}{60}$	0.204
$\stackrel{\text{JD}}{\text{ET}} \frac{44}{45}$	0.219
$_{\text{DLA}}^{\text{JD}}$	
$\frac{\text{JD}}{\text{SILL}} \frac{25}{51}$	
UD 11	0.137
42 0	500 1000 1500 2000 2500 3000 3500
JD 326	0.760
65 JD 325	
JD 322	0.965
39 JD 322	0.806
SU 57 JD 317	0.818
UW 59 JD 315	
$RFO \frac{515}{68}$	0.818
FO $\frac{513}{70}$	0.820
SB 74	
$AB \frac{312}{82}$	0.994
1RR 306 58	1 024
KN 303 48	
0	500 1000 1500 2000 2500 3000 3500
SH VAO ₆₅	
^H 3WA ¹⁶⁰ 54	0.604
$\begin{array}{c} \text{SH} \\ \text{AU} \\ \hline 84 \\ \hline \end{array}$	
$^{\text{SH}}_{\text{RAB}}^{145}_{58}$	0.754
$rao \frac{135}{65}$	0.645
$_{\rm JMO}^{\rm SH}_{41}$	0.144
SH ARA <mark>99</mark> 71	0.250
SH 94 NTN <mark>87</mark>	0.352
SH 85 AKE ₅₇	
SH IIDW <mark>69</mark>	0.795
SH DHA 67 89	
0	500 1000 1500 2000 2500 3000 3500
SH 325	0.747
> v	ΛΛ 0.851
5K 73 1 5H 322	
$\frac{322}{39}$	
$ \frac{H}{RU} \frac{322}{39} + \frac{322}{39} + \frac{322}{57} + \frac{322}{57} + \frac{317}{57} $	0.740 0.740 0.605
$\frac{322}{39} + \frac{322}{39} + \frac{322}{57} + \frac{322}{57} + \frac{317}{59} + 3$	0.740 0.605 0.602
$\begin{array}{c} \text{RU} & \frac{322}{39} \\ \text{H} & \frac{322}{39} \\ \text{H} & \frac{322}{57} \\ \text{H} & \frac{322}{57} \\ \text{H} & \frac{317}{59} \\ \text{W} & \frac{317}{59} \\ \text{H} & \frac{315}{68} $	0.740 0.605 0.602

 $-20 \ 0 \ 20 \ 40 \ 60 \ 80 \ 100 \ 120 \ -20 \ 0 \ 20 \ 40 \ 60 \ 80 \ 100 \ 120$

------0.306 0.605 AB¹⁴⁵ 58 1500 2000 2500 3000 0.736 0.766 0.522 0.149 -----0.328 0.472 0.665 ------0 500 1000 1500 2000 2500 0.454 H RR 306 0.394 0.364 0.314 ER 227 AR 222 0.403 $CO \frac{189}{10}$ 3 <u>34/1</u>

0.761

Here, we constrain the slip model by combined inverting the teleseismic data and 3 tracks of ALOS InSAR images. A complex six-segment fault geometry has been used to approximate the concurrent rupture along the low angle Pengguan Fault (figure 3.2a) and the high angle Yingxiu-Beichuan-Qingchuan Fault (figure 3.2b).

LOS displacement



Figure 3.1 (a) LOS unwrapped displacements at resampled points. The color indicates the displacement amplitude and the black lines denote the fault plane boudaries. (b) After removing the possible unwrapping errors, which are simultaneously constrained during the inversion. (c) Final residuals after further removing the synthetic contribution of this earthquake.

Slip model



Figure 3.2a. The surface projection of the slip distribution on the Pengguan fault. The red arrows denote the slip direction of dominated asperities. The color shows the slip amplitude.



Figure 3.4b. 3D view of the slip distribution of the Beichuan fault. The red star indicates the hypocenter while the color shows the slip amplitude.



Figure 3.4a. 3D view of the slip distribution on the Pengguan fault. The red star indicates the hypocenter while the color shows the slip amplitude.



What is the dynamic condition of such a complex concurrent rupture?



Preliminary result of Combined Inversion: Seismic data + InSAR data

Track 471: 29 Feb. 2008 - 31 May 2008 Track 473: 17 Feb. 2008 - 19 May 2008 Track 474: 5 March 2008 - 5 June 2008



Figure 3.2b. The surface projection of the slip on the Yingxiu-Beichuan-Qingchuan fault.

