APPENDIX A

MOMENT-MAGNITUDE REGRESSIONS CONSIDERED BY THE WGUEP

By

Christopher DuRoss and Susan Olig

APPENDIX A

Moment-Magnitude Regressions Considered by the WGUEP

Regression	Parameter[a]	Region	Fault Type	Equation	N[b]	R[b]	σ[b]	Notes	GEM rank[c]	BRPEWGII[c]	This study[d]
Hanks and Kanamori (1979)	M_0	California	all	$2/3\log(M_0)$ -10.7	100s	NA	NA	Relation derived from three independent earthquake datasets. D_{ave} in M_0 calculation is average fault-parallel displacement on fault plane; sensitive to fault dip.	-	-	A,B,C
Wells and Coppersmith (1994)	SRL	global	all	1.16log(SRL) + 5.08	77	0.89	0.28	Systematically underestimates moment magnitude (**M**) compared to displacement- and M_0-based regressions	-	X	A,B,C
Wells and Coppersmith (1994)	SRL	global	normal	1.32log(SRL) + 4.86	15	0.81	0.34	Because their dataset was small for normal-slip earthquakes and they found no statistically significant difference between different slip types, they recommend using the more statistically-robust all slip type relations.	-	X	-
Wells and Coppersmith (1994)	A	global	all	0.98log(A) + 4.07	148	0.95	0.24	A based on subsurface rupture length (L_{sub}), not SRL. For segmented faults, L_{sub} likely exceeds SRL if based on L_{seg}.	2	X	AFP
Wells and Coppersmith (1994)	D_{ave}	global	all	$0.82\log(D_{ave}) + 6.93$	56	0.75	0.39	Surface displacement including vertical, horizontal, and net (vector addition of vertical and horizontal) slip	-	-	-
Wells and Coppersmith (1994)	D_{ave}	global	normal	$0.65\log(D_{ave}) + 6.78$	12	0.64	0.33	Because their dataset was small for normal slip earthquakes and they found no statistically significant difference between different slip types, they recommend using the more statistically-robust all slip type relations.	-	-	-
Wells and Coppersmith (1994)	D_{max}	global	all	$0.74\log(D_{max}) + 6.69$	80	0.78	0.40	Surface displacement including vertical, horizontal, and net (vector addition of vertical and horizontal) slip	-	-	-
Wells and Coppersmith (1994)	D_{max}	global	normal	$0.71\log(D_{max}) + 6.61$	16	0.80	0.34	Because their dataset was small for normal slip earthquakes and they found no statistically significant difference between different slip types, they recommend using the more statistically-robust all slip type relations.	-	-	-
Anderson *et al*. (1996)	SRL, SR	global	all	1.16log(SRL) - 0.20log(SR) + 5.12	43	NR	0.26	Earthquakes limited to regions where seismogenic depth is 15–20 km. Regression requires slip rate, which is generally poorly constrained for many faults in the WGUEP region.	2	X	-
Mason (1996) (Ms)	SRL, D_{max}	global	normal	$0.55\log(SRL*D_{max}) + 5.95$	20	0.79	0.20	Regression for Ms not **M**. SRL is average of both straight-line and along-trace lengths.	-	-	-
Hemphill-Haley and Weldon (1999)	D_{ave}	global	all	$0.82\log(D_{ave}*MVCDS) + 6.93$	14	NA	NA	D_{ave} is observed data (from trench sites) and MVCDS is a mode value statistic based on number of observations (n) and percent of fault length that the n observations cover.	-	-	-
Stirling *et al*. (2002)	SRL	global	all	0.8log(SRL) + 5.88	50	NR	0.30	Using updated Wells and Coppersmith (1994) earthquake database, but censored for SRL <10 km, A < 200 km2, D_{ave} <2 m, and **M** < 6.5 (censored instrumental data).	2	X	A,B,C
Stirling *et al*. (2002)	A	global	all	0.73log(A) + 5.09	47	NR	0.26	Using updated Wells and Coppersmith (1994) earthquake database, but censored for SRL <10 km, A < 200 km2, D_{ave} < 2 m, and **M** < 6.5 (censored instrumental data).	2	-	AFP
Wesnousky (2008)	SRL	global	all	1.02log(SRL) + 5.30	27	0.81	0.28	Global dataset, but many Basin and Range Province earthquakes. SRL > 15 km	1	-	A,B,C
Wesnousky (2008)	SRL	global	normal	0.47log(SRL) + 6.12	6	0.36	0.27	Global dataset, but many Basin and Range Province earthquakes. SRL > 15 km. Relatively low regression coefficient.	1	-	-
Leonard (2010)	SRL	Inter-plate	dip-slip	1.52log(SRL) + 4.40	NR	NA	NA	Developed self-consistent relations based on fault scaling relations and definition of moment. Dip-slip earthquake dataset includes megathrust earthquakes. Dataset not explicitly documented.	1	-	-
Leonard (2010)	A	Inter-plate	dip-slip	log(A) + 4.0	NR	NA	NA	Developed self-consistent relations based on fault scaling relations and definition of moment. Dip-slip earthquake dataset includes megathrust earthquakes. Dataset not explicitly documented.	1	-	-

Regression	Parameter[a]	Region	Fault Type	Equation	N[b]	R[b]	σ[b]	Notes	GEM rank[c]	BRPEWGII[c]	This study[d]
Carpenter *et al*. (2012)	L_{seg}	global	strike-slip, normal	$0.88\log(L_{seg}) + 5.67$	7	0.80	NR	Unweighted least-squares regression. Scaling relation for L_{seg} based on observation that SRL often exceeds L_{seg}; using L_{seg} in place of SRL in SRL-**M** regressions will underestimate **M**. Limited range of L_{seg}.	-	-	-
Carpenter *et al*. (2012)	L_{seg}	global	strike-slip, normal	$0.92\log(L_{seg}) + 5.70$	7	0.60	NR	Weighted (by inverse of L_{seg} uncertainties) least-squares regression.	-	-	-

[a] D_{ave} - average displacement; Lsub - subsurface fault length; Lseg - segment length (straight-line); M_O - seismic moment ($m*Lsub*W*D_{ave}$) where m is crustal rigidity of $3x10^{11}$ dyne/cm^2; D_{max} - maximum displacemen; A - rupture area; SR - fault slip rate; SRL - surface rupture length (straight line); W - down-dip fault width.
[b] N - number of earthquakes; R - regression coefficient; σ - standard deviation in magnitude; NA - not applicable; NR - not reported.
[c] GEM rank: 1 - best available, 2 - good (Stirling and Goded, 2012); no value indicated regression not discussed. Xs indicate regressions that the Basin and Range Province Earthquake Working Group II (BRPEWGII) recommended for consideration in the development of the U.S. Geological Survey National Seismic Hazard Maps (Lund, 2012).
[d] A,B,C indicate regressions used for WGUEP category A, B, and C faults (see text for discussion); AFP indicates regressions used for the secondary fault in antithetic fault pairs where the down-dip width is truncated by the primary (master) fault at a relatively shallow seismogenic depth.