Re-examination of scaling relations for crustal earthquakes.

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Some of the scaling formula have been already proposed for crustal earthquakes (e.g. Matsuda (1975), Takemura (1998), Irikura and Miyake (2001), Tajima addition (2013) and Murotani et al. (2015)). Matsuda (1975) and Takemura (1998) showed scaling relations between fault length L and magnitude of earthquakes. Also, Irikura and Miyake (2001), Tajima et al. (2013) and Murotani et al. (2015) proposed scaling relations between fault area S and magnitude or seismic moment.

1) Matsuda (1975) : $\log L=0.6M_j-2.9$
2) Takemura (1998) : $\log L=0.75M_w-3.77$ ($6.8\leq M_w$)
3) Irikura and Miyake (2001) : $M_0=(S/4.24\times10^5)^2\times10^{-7}$ ($6.5\leq M_w<7.4$)
4) Tajima et al. (2013) : $M_0=0.877\times S\times10^{11}$ ($7.5\leq M_w$)
5) Murotani et al. (2015) : $M_0=1.0\times S\times10^{11}$ ($7.4\leq M_w$)

These scaling formulas indicate relation between one variable parameter (i.e. fault length L or fault area S) and the seismic moment or magnitude. When we calculate seismic moment with these scaling formulas and slip amount using the formulas, Mo=μDS and S=LW, the resulting slip amounts vary from formula to formula. When we assume a fault with L=50km and W=20km, we obtain Mw=7.10 and average slip D=1.64 by Irikura and Miyake (2001) and Mw=7.29 and average slip D=3.21 by Takemura (1998). Such differnces would significantly affect the results of seismic hazard assessments.
In this study we proposed a scaling relation of seismic moment with two variables parameters, fault area S and average slip D. We used the same earthquake data used in Irikura and Miyake (2001) and Takemura (1998). We obtained regression line with principal component analysis. The relation between the residual of slip ΔD and the residual of area ΔS could be expressed by logΔ D = -logΔS (Δ D * ΔS = 1), which indicates that fault area S and the average slip D are not independent parameters on earthquake data used in this study.

Keywords: scaling relation, crustal earthquake, earthquake source model, earthquake hazard assessment

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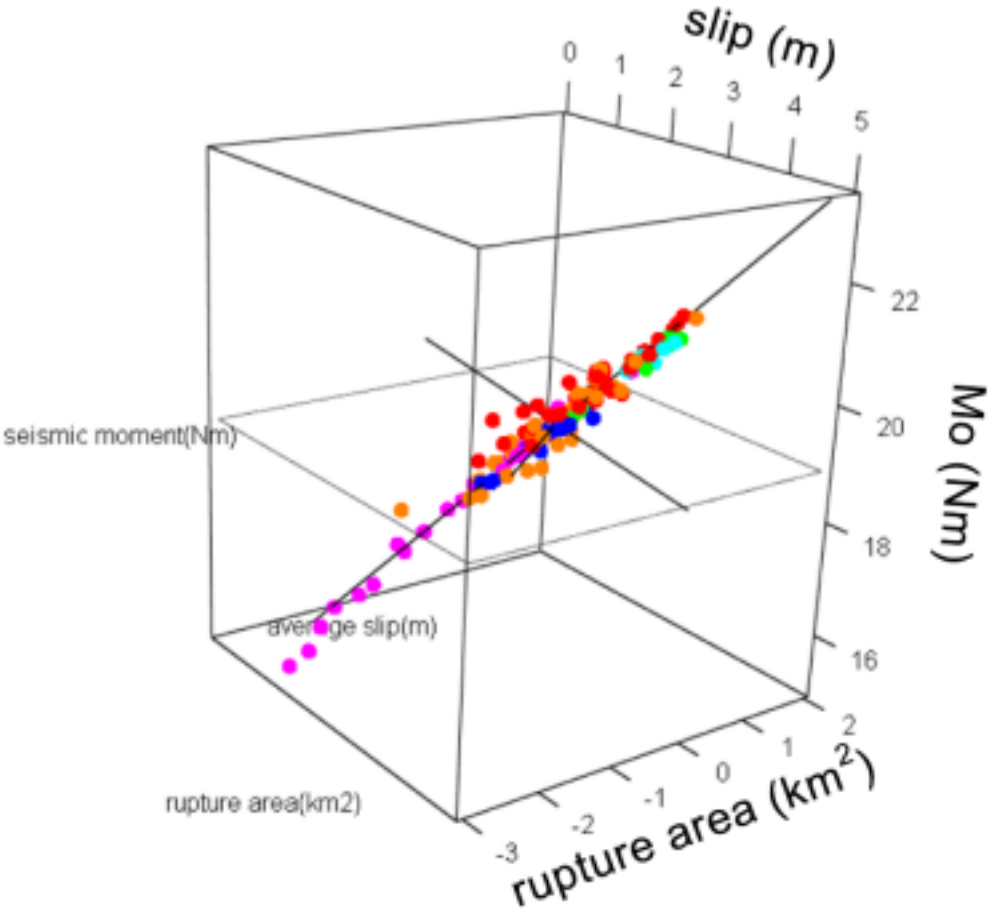

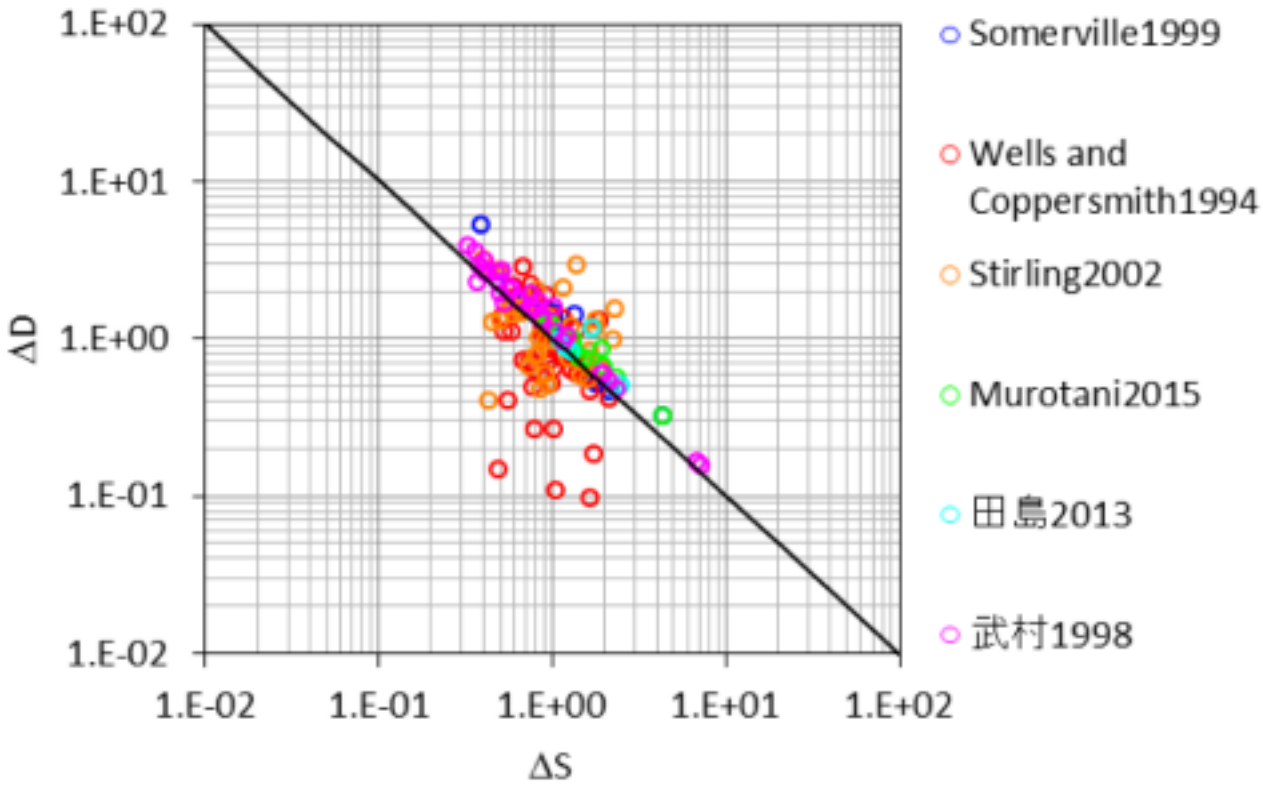

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