Standard for Calculation of Local Magnitude in the Western Canada Sedimentary Basin

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Babaie Mahani and Kao (2019) provided the procedure for calculation of local magnitude (M_L) using ground motion amplitudes recorded at regional seismographic stations within the Western Canada Sedimentary Basin. Taking advantage of new data, they recently updated their model for M_L calculation (Babaie Mahani and Kao, 2020). This short document aims at providing a guideline for standard calculation of M_L using the updated model. The model is applicable for the vertical recorded Wood-Anderson amplitude (WA) within hypocentral distances of 2-600 km and is written as

$$-\log(A_0) = \begin{cases} 0.671 \times log\left(\frac{R_{hypo}}{100}\right) + 0.003 \times \left(R_{hypo} - 100\right) + 3.0 & R_{hypo} \leq 85 \text{ km} \\ -0.881 \times log\left(\frac{R_{hypo}}{100}\right) + 0.003 \times \left(R_{hypo} - 100\right) + 3.0 & R_{hypo} > 85 \text{ km} \end{cases}$$

The procedure for M_L calculation is as follows:

1. Deconvolution of the recording sensor's instrument response.

2. Convolution of the instrumentally corrected waveform in the first step with the WA type instrument response (static magnification of 2800 and damping ratio of 0.8).

3. Extraction of the maximum amplitude (zero to peak; in mm) from the vertical component of the synthetic WA seismogram within a window encompassing the S wave. This window can be estimated as

$$T_{start} = T_o + T_S - 0.5(T_S - T_P)$$

$$T_{length} = 2(T_S - T_P)$$

where T_{start} and T_{length} are the beginning time and total length of signal window, respectively. T_o, T_S, and T_P are the earthquake origin time, and the predicted S- and P-wave arrival times, respectively.

4. Calculation of $-\log(A_0)$ based on the hypocentral distance (R_{hypo}) of the recording station to the earthquake.

5. $M_L = \log(A) - \log(A_0)$ where A is the vertical recorded WA amplitude in mm obtained in the third step.

For detailed information of the procedure, readers are referred to the references at the end of this document.

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References

Babaie Mahani, A., and H. Kao (2019). Accurate Determination of Local Magnitude for Earthquakes in the Western Canada Sedimentary Basin, *Seismological Research Letters, Vol. 90, No. 1, p. 203-211, https://doi.org/10.1785/0220180264*

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