Determination of Local Magnitude for Earthquake recorded by Sultanate of Oman seismological network


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Magnitude of Earthquakes

• Once the earthquake is located, the next question comes, what is the size of the earthquake?

• The concept of magnitude scale was introduced Richter 1935, at the California Institute of Technology, he define the Standard Earthquake, as the Earthquake with $M_L = 0$ which has maximum trace amplitude = 1 Micron recorded by a Standard seismograph (wood–Anderson seismograph) at 100 km from the epicenter.
wood-Anderson seismograph

(Natural period = 0.8 sec., Magnification = 2800, Damping Factor = 0.8 Km⁻¹).

Instrumental Response of the Wood-Anderson seismograph
\[ M_L = \log A_{WA}(D) - \log A_0(D) + S \quad (\text{Richter, 1935}) \]

- **\( A_{WA} \):** is the maximum trace amplitude recorded by wood–Anderson torsion seismograph.
- **\( D \):** is the Hypocentral distance
- **\( \log A_0 \):** *Distance correction (Attenuation)* term
- **\( C \):** Station Correction Term
Distance correction: (Bakun and Joyner, 1984)

- \( \log A_0 = n \log (\Delta/100) + k (\Delta - 100) + 3.0 \)

- \( n \): geometrical spreading coefficient
- \( k \): anelastic attenuation
Data Used


Tectonic Elements surrounding Oman

Data Used
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<tr>
<th>Station</th>
<th>Lat.</th>
<th>Long</th>
<th>Sensor</th>
<th>Reading</th>
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**Selected EMC Stations**
92 shallow Earthquakes with Magnitude range from 2 – 5.3 (According to EMC Bulletins)
A total of 424 horizontal records have been used

Epicenters of the Data Used (EMC Bulletins)
Simulation of Wood –Anderson Seismograms Using OBSPY software
ML = log $A_{WA}(D) + n \log(\Delta/100) + k(\Delta - 100) + 3.0 + S$

(Richter, 1935)

- ML, n, k, S

- We develop the inversion Software of Manoochehr, 2009 to solve our calculation problem.
Genetic Algorithm

Flow Chart for Genetic Algorithms

1. Initialize Population
2. Evaluate Fitness
3. Select Survivors
4. Randomly Vary Individuals
5. Output Results
6. Check if satisfy constraints?
   - Yes: Proceed to next step
   - No: Randomly Vary Individuals and Output Results

3- Methodology
-\log A_0 = 0.95 \log \left( \frac{r}{100} \right) + 0.0011(r-100)+S
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Results

ML from ISC

ML from Oman Stations

$R^2 = 0.3973$
Results

Current Study

$M_L$ from ISC

$R^2 = 0.7867$
$M_L = \log A_{WA}(D) + 0.95 \log \Delta + 0.0011 \Delta - 2.1$
The current study is the first attempt to develop a local magnitude scale for Sultanate of Oman seismic network.

A new script had been developed to convert the recorded events at Earthquake Monitoring Center (EMC) to Wood-Anderson seismogram for Oman seismic Stations. 424 horizontal records of 92 events had been selected to drive a distance correction function (Zero magnitude earthquake) by an updated inversion software of the Manoochehr, 2009. The inversion process results in the parameters of the distance correction function \( n, k, c \)

- \( n \) (geometrical spreading factor) is found to be 0.95 while
- \( k \) (inelastic attenuation) is found to be 0.0011

- The station correction is calculated for the selected stations and lie in the range – 0.2 to 0.2

- The new ML for earthquake recorded at Oman Stations can be expressed as

\[
M_L = \log A_{WA}(D) + 0.95 \log \Delta + 0.0011 \Delta - 2.1
\]
- Substantial enhancement in magnitude calculation in Oman is observed, while comparing the new results with those calculated in ISC.

- As mentioned in the current presentation, the magnitude range of the data used is between 2 to 5.3. Therefore, extension of the current study toward the lower magnitudes is essential.
Thank you for your attention