EARTHQUAKE MAGNITUDE EVALUATION
AT FLORISSANT

by

Lees J. Burrows, B. S.

Digest of
Thesis Presented to the Faculty of the Graduate
School of Saint Louis University in Partial Fulfillment
of the Requirements for the Degree of Master of Science
(Research)

1954

DIGEST

Introduction.

The earthquake magnitude scale was devised by C. F. Richter[1] of the Seismological Laboratory of the California Institute of Technology, Pasadena, California, in 1935. Richter devised the scale as a means for classifying the many small earthquakes occurring in the California region.

Richter defines the magnitude of an earthquake as:

> ". . . the logarithm of the maximum trace amplitude, expressed in microns, with which the standard short period torsion seismometer ($T_0 = 0.8$ seconds, $V = 2800$, $h = 0.8$) would register that shock at an epicentral distance of 100 kilometers."

The original scale met with great success so it was extended to cover earthquakes at large epicentral distances, using instruments of the Pasadena Seismological Laboratory.

Since the magnitude scale was successful at Pasadena, other seismologists working at stations throughout the world began to publish magnitude of earthquakes. Hayes[2] established magnitude scales in New Zealand which were independent of the Pasadena scale.

---

1 "An Instrumental Earthquake Magnitude Scale," Bulletin of the Seismological Society of America, 25, no 1: 1 - 32 (1935).

2 "Measurement of Earthquake Intensity," Dominion Observatory Bulletin, S-61, Department of Scientific and Industrial Research (1941).

Other scales were established for stations which were dependent on the Pasadena magnitudes.[3] Thus, the magnitude published at Strasbourg, for instance, should be the same as that published at Pasadena for the same shock.

The Problem.

The problem of establishing an earthquake magnitude scale based on the seismograms available at the Florissant, Missouri Seismological Station was suggested by Doctor Ross R. Heinrich of the Department of Geophysics, Saint Louis University. The problem was limited to establishing a magnitude scale for shallow earthquakes ($h \leq 50$ kilometers) with epicentral distance greater than 19°. The scale is based on the amplitudes of vertical component surface waves with periods of about twenty seconds recorded on the vertical component Galitzin-Wilip Seismograph located on the grounds of Saint Stanislaus Seminary, Florissant, Missouri.

Procedure and Results.

The procedure for establishing a method by which magnitudes of shallow earthquakes calibrated with those published at Pasadena can be computed was suggested in an article by M. E. Peterschmitt. Peterschmitt outlined the method which he used for the Strasbourg station. The procedure for establishing

---

3 "La Magnitude des Seismes," International Union of Geodesy and Geophysics, Association of Seismology, Comptes Rendus des Seances, de la Conference Reunie a Strasbourg du 4 au 8 Julliat, pp. 86 - 88, (1947).

a magnitude scale, calibrated with the Pasadena scale, for the Florissant seismograms is as follows: 1) For each earthquake for which Pasadena has assigned a magnitude, the epicentral distance is computed, 2) The maximum seismographic amplitude in the range between sixteen and twenty four seconds, and the period of that maximum wave are read, 3) Knowing the period of the wave, the seismographic amplitude of the wave and the constants of the Vertical Galitzin-Wilip, the ground amplitude expressed in microns is found, 4) The logarithm (base 10) of the true ground motion expressed in microns (1 micron = 0.001 mm.) is found as is the logarithm of the distance Δ in degrees, 5) The logarithm of the ground motion is subtracted from the magnitude published by Pasadena, the result of which is plotted against the corresponding logarithms ofthe distance in degrees. The above procedure was repeated f r 106 earthquakes and through the plotted points a curve of best fit was drawn using the method of least squares. This curve is given by:

$$y = 1.25x + 2.98$$

where $y = (M - \mathrm{Log}\, A_{20})$ and $x = \mathrm{Log}\, \Delta^{o}$. Thus the basic magnitude formula becomes:

$$M = \mathrm{Log}\, A_{20} + 1.25\ \mathrm{Log}\ \Delta^{o} + 2.98 \qquad (1)$$

The magnitudes of 53 earthquakes were computed using the above formula. The resulting magnitudes agree with those published by Pasadena for corresponding earthquakes with a difference not greater than $\pm$ 1/2 magnitude unit for reliable data. It was immediately noticed that the differences in magnitude (M Pasadena - M Florissant) exhibited regional trends. A regional correction R_e was computed for several regions by taking the mean value of the difference (M Pasadena - M Florissant) for any region. An outstanding negative trend of R_e was noted in Eastern Asia, the mean value of which is -0.3. As a contrast a positive trend of R_e was noted for the region south of South America. There were not enough earthquakes studied to form a regional correction for each region of the world, but when this is done the magnitude formula can be written:

$$M = \text{Log } A_{20} + 1.25 \text{ Log } \Delta^{o} + R_e + 2.98 \qquad (2)$$

Conclusions.

The magnitudes computed using the developed magnitude equation (1) gives values which are within 1/2 unit of magnitude of those published at Pasadena. If equation (2) is used the values of magnitude are within 1/4 unit of magnitude of those published at Pasadena, providing, of course, that the regional correction R_e is known.