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VI.2 Analysis of Global P-wave Attenuation Characteristics using ISC Data Files

A study has been undertaken to derive the global attenuation characteristics of P-waves based upon data files from the International Seismological Centre (ISC). The main motivation behind the study has been the failure of commonly accepted attenuation relations to provide good magnitude estimates at epicentral distances below 20 degrees. In fact, using the Gutenberg and Richter (1956) or Veith and Clawson (1972) amplitude-distance curves at close distances usually leads to an overestimation of earthquake magnitudes (m_b), sometimes by a full magnitude unit or more, relative to teleseismically derived m_b estimates.

For the study presented here, 136 globally distributed seismograph stations were selected. Most of these were WWSSN stations, and all of them are stations with fairly consistent reporting of amplitudes and periods of P-phases of detected seismic events. Altogether 6 years of data (1971-76) were included in the data base, giving a total of about 214,000 log A/T observations in the distance range 0-90^o.

The observed values of log A/T - m_b(ISC) are plotted versus epicentral distance in Fig. VI.2.1, and compared to the Veith-Clawson (1972) and Gutenberg and Richter (1956) relationships. In the plot all data within each 1 degree interval have been averaged to obtain a fairly smooth curve, The following major points may be noted:

a) Below 20 degrees the observed averages generally lie at least 0.5 m_b units higher than the conventional correction factors, thus confirming the bias effects mentioned earlier.

b) Although there is a local maximum between 15 and 20 degrees, this is not by far as pronounced as indicated in the conventional attenuation relations.

We also did some studies to investigate the effects of possible error sources in the data base, and preliminary conclusions are as follows:

1. <u>Possible ISC m_b bias at low or high magnitudes</u>. We first note that all ISC m_b values are based on stations only at epicentral distances at least 20 degrees, so that the bias effects at closer distances

should be relatively small. Nonetheless, we compared, for one year, the attenuation curves obtained using ISC and NORSAR reference m_b, respectively. As shown in Fig. VI.2.2, the resulting effect is only a baseline shift (independent of distance), thus this problem would not cause a change in the shape of the attenuation relationship.

2. Effects of instrument saturation and 'clipping'. This is potentially a serious problem, since, for large events, it may result in close-in stations reporting too low magnitudes. To investigate this, we subdivided all reference events into magnitude bins of 0.5 m_b units, and plotted the resulting curves separately as shown in Fig. VI.2.3. It is seen that there are indeed significant differences, although the main conclusions a) and b) remain unaltered. However, this problem will be subjected to further investigation.

There may also be other sources of bias effects, such as the lack of consistency in station reports and possible effects of frequency-dependent attenuation, but we have at this stage little possibility to investigate these further. Our main conclusion is that the conventionally used P-wave attenuation relationships should be revised for short distances, and we believe that this study will provide a useful first step for such a revision.

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References

Gutenberg, B., and C.F. Richter, 1956: Magnitude and energy of earthquakes, Ann. Geofisica 9, 1-15.

Veith, K.F., and G.E. Clawson, 1972: Magnitude from short-period P-wave data, Bull. Seism. Soc. Amer. 62, 435-452.

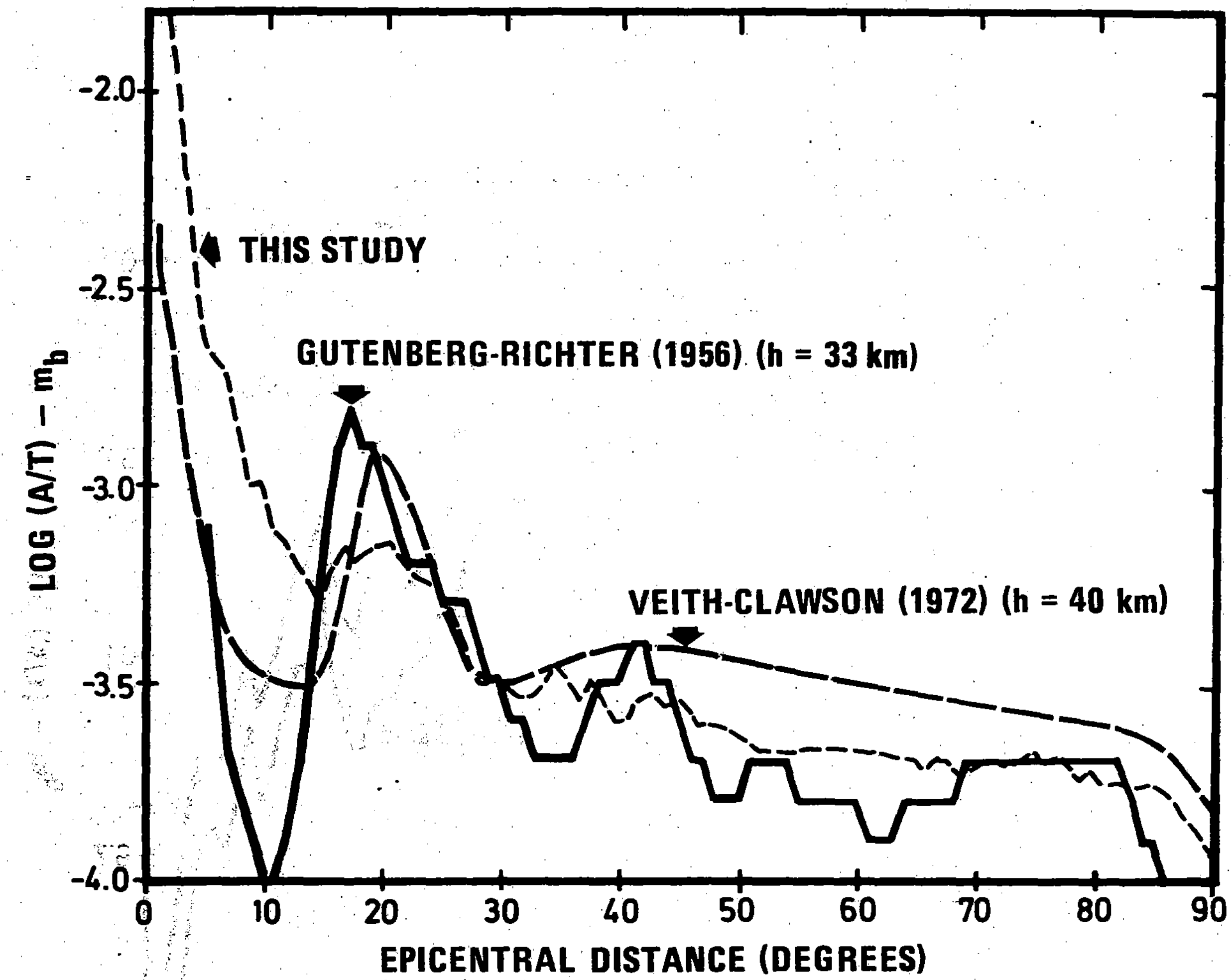

Fig. VI.2.1 Average observed magnitude correction factors based on ISC data for 23,198 events and 136 stations. Averages have been computed and plotted within each 1 degree distance interval. Note the considerable deviations from 'standard' curves at distances below 20 degrees.

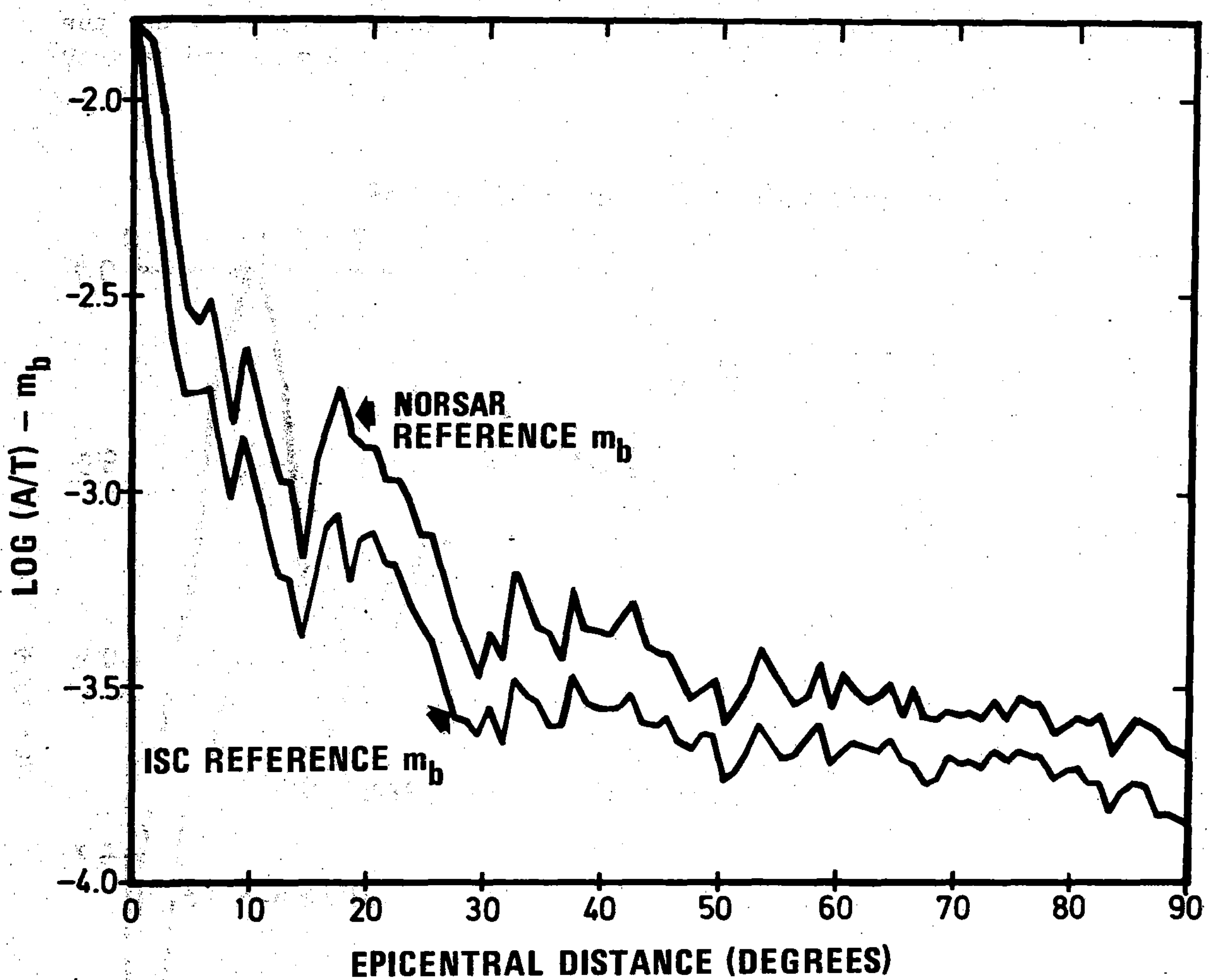

Fig. VI.2.2 Comparison of observed magnitude correction factors using NORSAR and ISC m_b values as a reference. The bias effect of about 0.2 m_b units is independent of distance.

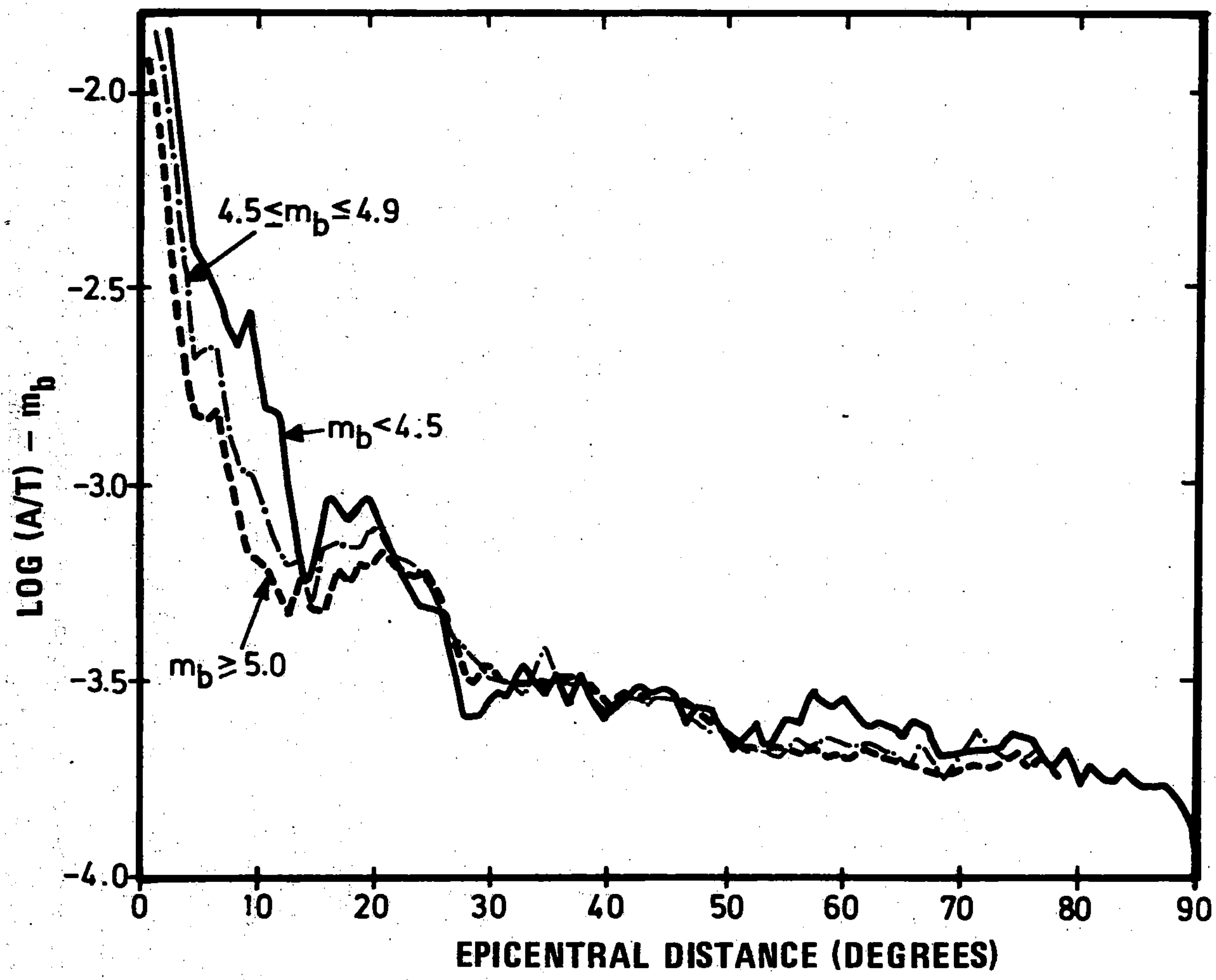

Fig. VI.2.3 Comparison of observed magnitude correction factors using as a data base events of different magnitudes. Using small reference events (m_b<4.5) results in higher correction factors within 20 degrees distance than using larger events.