



Analysis of Reviewed Event Bulletin reported surface wave magnitudes for the North Korean event of 25 May 2009

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The event occurring on 25 May 2009 at 00:54 UT in North Korea was detected by the International Monitoring System (IMS) network seismic stations and corresponding bulletins were released from automatic and interactive analysis. In the final Reviewed Event Bulletin for the event 72 arrivals from 59 stations were used for location. Of these recording stations 45 reported body wave magnitude estimates resulting in an average body wave magnitude estimate of $mb=4.5$. On the other hand only 15 stations were reported with surface wave magnitude which yielded an average surface wave magnitude of 3.6. Based on these magnitude estimates the event was characterized in the automatic post-processing with the mb - Ms criterion and during the following Standard Event Screening procedure eventually flagged as "not screened out". However, it turned out that this event was only marginally off the screening line. As the event is considered related to a nuclear test explosion this finding motivated a study to investigate the associated Ms values.

Review of the published surface wave magnitudes shows that there is an interesting clustering of the reported magnitude estimates. Six stations had positive magnitude residuals within 0.2 to 0.5 magnitude units while another seven stations had negative residuals of equivalent size. Only two stations had intermediate magnitude residuals. Related to the finding that Ms estimates from stations at shorter distances tend to have negative while more distant stations have positive residuals, the pattern motivated an investigation into the Ms magnitude estimation procedure applied at the IDC. Although the applied procedure could be validated, a few interesting facts were uncovered. First, the surface wave magnitude at one station (ATTU), although being in the negative residual group, is determined from a marginal signal. Second, when looking at the azimuth dependence of these residuals it is found that all positive residuals are from a narrow azimuth range between 290 and 320 degrees from the event, only offset by a single negative residual at MKAR.. Analysis of waveforms in the 20 s period range shows that clear surface wave trains at additional IMS stations in this azimuth range (e.g. KURK, VRAC) can be identified, providing relatively large surface wave magnitude estimates. As such the surface wave magnitude contained in the REB must be considered a low estimate. Using these additional data, the event most likely would have been screened out under the rules applied at the time for Standard Event Screening based on the mb - Ms criterion.