Coda Energy Localization - Observations

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Abstract

Coda waves, first recognized by Aki (Aki, 1969; Aki and Chouet, 1975) as a superposition of incoherent waves scattered by distributed heterogeneities in the Earth, offer a powerful and most cost-effective tool for quantitative estimation of the properties of small scale heterogeneity in a seismic active region. S-coda characteristics such as scattering coefficient and amplitude decay rate, known as coda Q^{-1}, have been measured throughout the world to study the temporal and spatial variations of the heterogeneities. However, the large variability of coda Q^{-1} measurement has been frustrating to quantify the small-scale heterogeneous characters such as fractures and/or inclusions. Coda Q^{-1} was measured for a single station, assuming that the coda amplitude decay rate is the same, independent of the lapse time window. This assumption may be justified if the scattering and absorption properties vary smoothly over the area.

Taking advantage of dense seismic network, we measured earlier coda amplitude distribution within an area by normalizing them using lapse time window after 60 s assuming that the late coda has been smoothed over a large area. We'll present some examples observed in La Reunion Island, France and Hida region, Central Japan.

(1) Observations in La Reunion Island: Figure 1 a and b represent the coda amplification ratio between lapse time window 30-40 s and 60-70 s, relative to station BOR. If the scatterers have a randomly uniform spatial distribution in this area, the coda site amplification factor should be independent of event and/or lapse time window. Surprisingly, for most of the stations the ratios are not close to 1.0. It is 1.0 at BOR by the definition, but decreases rapidly and systematically away from the summit area. Similar tendency of the coda amplification ratio distribution patterns were found for another event pairs suggesting that we may not attribute this observation to the source-dependent scattering process. In fact, the trend of the contour matches the three magma paths in this volcanic island very well.

(2) Observations in Hida region: A temporal seismic array were deployed in this region from July to October 1996, operated by Group96 joined with RCEP, DPRI, Kyoto University, Nagoya University, and ERI, Tokyo University. All stations were equipped with 3-components, 2 Hz, velocity seismometers. Figure 2 represents the site corrected, 25-35 s coda amplitude distribution normalized to station KTJ in Hida region for frequency bands of 1-2(1.5), 2-4(3.0), and 4-8(6.0) Hz, respectively. Each estimation is the average over at least 20 events. The triangles indicate the stations. For frequency 1.5 Hz, there is a coda energy concentration area around station TKN where the coda amplitude is higher with a factor of more than 3 relative to station KTJ. Stations AMJ, MOZ, ARM, and KYJ located along the Atotsugawa Fault zone also show relatively high values with a factor about 1.4. However, we cannot see a clear pattern around the fault zone due to the insufficient density of the array along the fault. Interestingly, high coda amplitude area around station TKN becomes much less significant, with the factor decreased to about 1.4, as the frequency increased to 3.0 Hz while the high values at the stations along the Atotsugawa Fault zone remained. Then, the coda amplitude becomes nearly uniform when the frequency reaches to 6.0 Hz. Unfortunately, there are no reliable data for frequencies lower than 1 Hz and/or higher than 8 Hz. The results from multiwindow analyses indicating high scattering in side the coda concentration area for frequency band 1-2 Hz.

The preliminary analyses for the newly established station around mountain Yakedake suggest that it might be strong scattering resonance under the volcanoes.

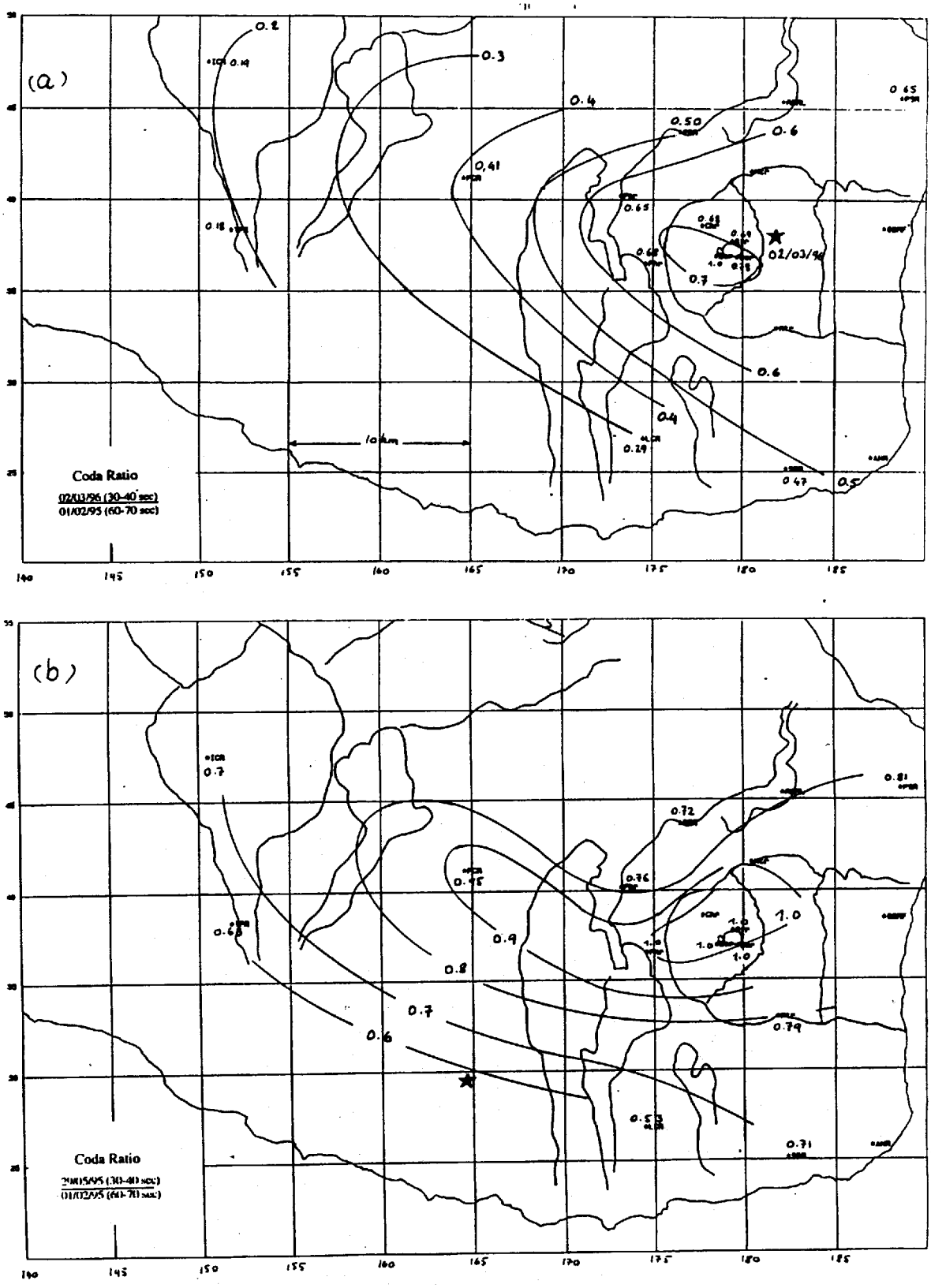

Figure 1. Maps of coda amplification ratio between 30-40 sec and ~~70-80~~ 60-70 sec at all stations in La Reunion Island. (a), (b), and (c) represent the results for different earthquakes (indicated by stars). The similarity of the pattern of the contours demonstrating that source effect is not significant. The scale of the grid is 5x5 km^2.

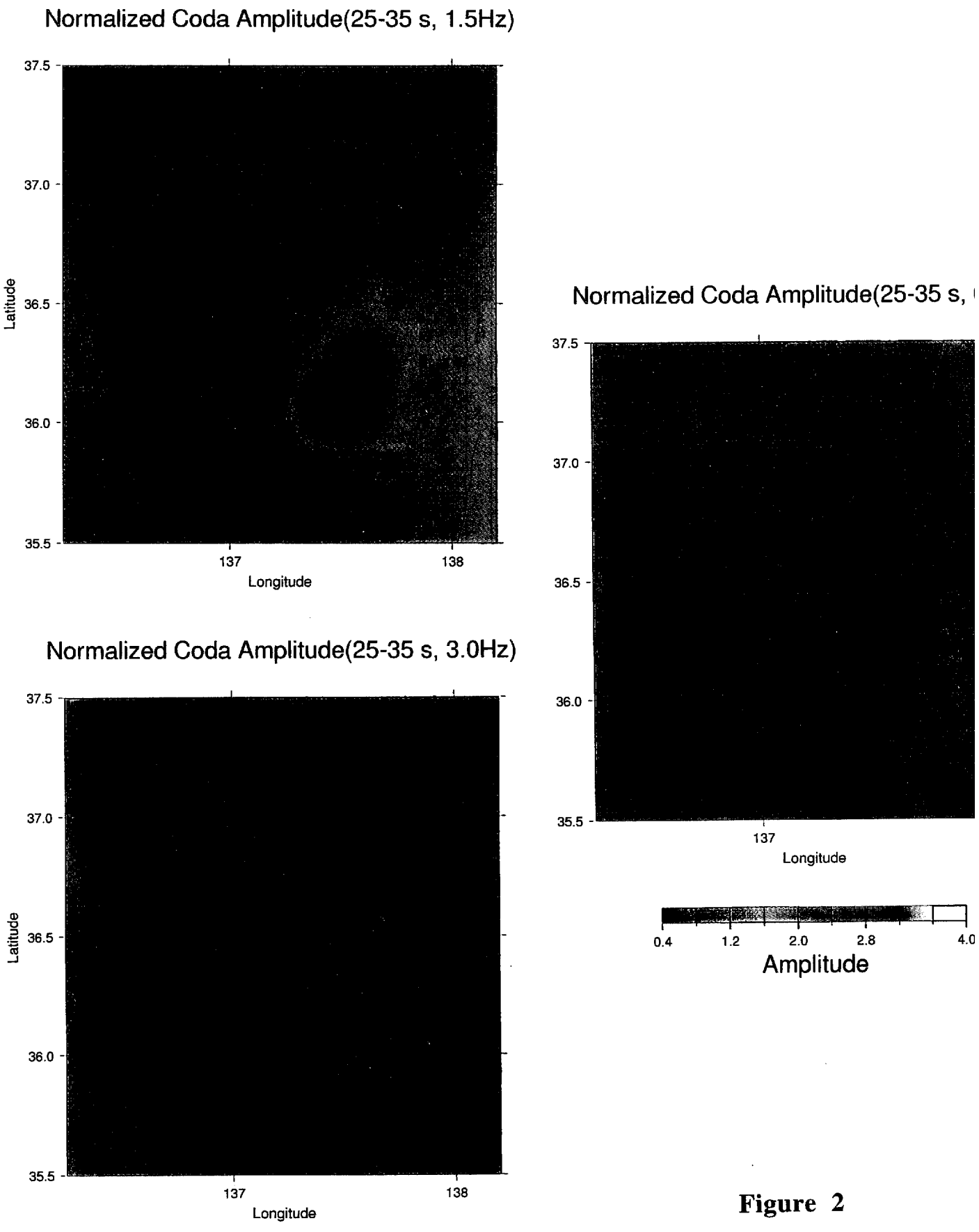
Normalized Coda Amplitude(25-35 s, 1.5Hz)
37.5
37.0
36.5
36.0
35.5
Latitude
137
138
Longitude
Normalized Coda Amplitude(25-35 s,
37.5
37.0
36.5
36.0
35.5
137
Longitude
0.4
1.2
2.0
2.8
4.0
Amplitude
Normalized Coda Amplitude(25-35 s, 3.0Hz)
37.5
37.0
36.5
36.0
35.5
Latitude
137
138
Longitude

Figure 2