火山性地震のエンベロープ幅から推定される火山の散乱特性の深さ分布
Depth distributions of seismic scattering characteristic beneath volcanoes inferred from envelope widths of volcano-seismic events

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Volcanoes produce highly scattered seismic wavefields, which are characterized by the mean free path (l_0) and the quality factor of medium attenuation for *S* waves (Q_s). Previous studies have estimated mean free paths at various volcanoes to be around 100-1000 m, but their depth distributions remain to be determined. We estimated one-dimensional (1D) l_0 and Q_s structures using the envelope widths of volcano-seismic events at Taal (Philippines) and at Nevado del Ruiz (Colombia) in a high frequency band (5-10 Hz). in which scattered *S* waves are dominant and the assumption of isotropic *S* waves radiation is held. The envelope width is defined as the ratio of the cumulative amplitude to the peak amplitude in the envelope seismogram band-passed between 0 and 5 Hz at each station.

Our estimated envelope widths increase with increasing source-station distances of up to around 5 km, beyond which they show decreasing or constant trends. Envelope widths are also dependent on the source depth. We performed envelope waveform simulations using the Monte Carlo method of Yoshimoto (JGR, 2000), and estimated the depth-dependent structures of the mean free path (l_0) and intrinsic medium attenuation for *S* waves (Q_s). Those simulated trends were fitted to the observed envelope width trends for various source depths. Our best-fit results were obtained for a three-layer model with l_0 = 0.5, 10, and 100 km and Q_s = 50, 100, and 250; the first (surface) layer has a thickness of 1 km and the third layer extends below a depth of 3 km.

The surface layer is strongly heterogeneous, consistent with previous seismic explorations using artificial explosions at various volcanoes; it may consist of unconsolidated materials characterized by strong scattering effects, and its low Q_s value likely results from the presence of hydrothermal fluids and/or elevated dissipation in hydrothermally altered rocks containing clay minerals. The second and third layers with l_0 = 10 and 100 km, respectively, are similar to the normal crust. Although various volcanic structures such as magma chambers and hydrothermal reservoirs have been estimated below 1 km depth at these volcanoes, these structures apparently produce heterogeneities similar to those in the normal crust. However, the scatter in the observed envelope widths may represent localized anomalies or three-dimensional distributions of heterogeneous regions.

