Geophysical Research Abstracts, Vol. 9, 02630, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-02630

High-resolution compressional wave attenuation tomography during the Mt. Etna 2002-2003 flank eruption

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A high resolution three-dimensional (3D) structure of seismic attenuation of P waves (Qp) is obtained by analyzing 329 shallow seismic events (depth less than 7 km.), recorded during the 2002-2003 flank eruption at Mt. Etna volcano. Attenuation is estimated using P wave spectra to compute the t* values. In order to find the low frequency level, the event corner frequency and the t* values, we have considered the Brune's model as theoretical far field spectrum, and all the spectra of each event with a signal to noise ratio greater than 1.5 were simultaneously fitted by a least squares inversion method. To improve the methodology and obtain more accurate t* and Q values, we also tested the attenuation frequency dependence. The t* values are then inverted for 3D Qp crustal structure by using a damped least square technique. The 3D tomographic images reveal an anomalous volume of very low Qp values (between 30 and 50), located between 1 and 3 km depth, just beneath the eruptive fissures (summit craters) which is elongated in the N-S direction. We also observe a region with high Qp values (between 140 and 160) below the south-eastern flank of the volcano. The low Qp anomaly is in correspondence with a low Vp and low Vp/Vs region while the high Qp region is related with high Vp and high Vp/Vs zones. Therefore, our preliminary results confirm the hypothesis that the low Qp anomaly is caused by the effect of magma intrusion (magma rich in gas) in the uppermost part of the Etna volcano, leading to the 2002-2003 eruption. This confirms that the attenuation is a physical parameter sensitive to the thermal state of crustal volumes containing molten gas-rich material.