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Physical and mechanical Properties from different emplacement environments

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We report results of measurements of the physical and mechanical properties of basalts formed in different environments. We tested material from extruded lava flows from Mt. Etna volcano, Italy (EB) and fresh columnar basalts formed in an intrusive environment, from Seljadur, Iceland (IB). Laboratory measurements of ultrasonic wave velocities and fluid permeability have shown that EB has much lower velocities and much higher permeability than SB. Optical and scanning electron microscopy shows clearly that the EB contains a much higher level of pre-existing crack damage than the SB. We suggest that the origin of the microcracks in the EB is thermal stressing. Therefore, in order to verify that the differences in physical and transport properties are due to the higher crack density, we thermally stressed samples of both basalts at temperatures up to 900C. Following the thermal stressing, the wave velocities in SB decreased by about 40% and its permeability increased by several orders of magnitude. By contrast, the values for thermally stressed EB remained essentially unchanged. Moreover wave velocities in microcracked (EB and thermally treated SB) rocks are highly affected by the application of increasing pressure, with respect IB not thermally treated. We ascribe these changes to the significantly increased level of crack damage caused by the thermal stressing, which is again revealed by microscopic observation. Unexpectedly, however, the moduli and strength of SB do not decrease markedly following thermal stressing. Even by considering that moduli are intermediate between dynamic and static values due to the frequency dependence, results show that the influence of microcracks on strength and modulus depends crucially on the crack density, as-

pect ratio and linkage, which is suspected to originate for SB a combination of high crack density but low crack connectivity. We consider such data to be of fundamental importance in reliably interpreting large scale in-situ geophysical measurements and modeling volcanic processes. For example, interpretations of tomographic data and estimates of volcano instability need to use physical and mechanical rock parameters appropriate to the specific conditions being studied.