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Stimulated infrared emission from rocks: assessing a stress indicator

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Abstract. To study the effect of stress-activated positive hole (p-hole) charge carriers on the infrared (IR) emission from rocks, we subjected a portion (~10 vol.%) of a large (60×30×7.5 cm^3) block of anorthosite, a nearly monomineralic (Ca-rich feldspar) igneous rock, to uniaxial deviatory stress up to failure. We measured the IR emission from a flat surface ≈40 cm from the stressed rock volume over the 800–1300 cm^{-1} (7.7–12.5 μm) range. Upon loading, the intensity and spectrum of the IR emission change. Narrow bands near instantly appear at 930 cm^{-1} (10.75 μm), 880 cm^{-1} (11.36 μm), 820 cm^{-1} (12.4 μm) plus additional bands in the 1000–1300 cm^{-1} (10.0–7.7 μm) range. Upon further loading the bands broaden and shift. Their intensities increase but also fluctuate. Near the emission maxima at 300 K, at 1150 cm^{-1} and 1030 cm^{-1} (8.7 and 9 μm), barely any intensity increase occurs suggesting that the temperature of the surface does not actually increase. We propose that the observed narrow IR emission bands arise from vibrationally excited O-O stretching modes which form when p-hole charge carriers (activated in the stressed rock) spread into the unstressed portion of the rock to the surface, where they recombine and radiatively decay. The effect, stimulated IR emission due to hole-hole recombination, may help explain the enhanced IR emission seen in night-time satellite images of the land surface before major earthquakes known as "thermal anomalies''.

Discussion Paper (PDF, 6435 KB) Interactive Discussion (Closed, 6 Comments) Final Revised Paper (eE)

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