Monitoring from Orbit whether Mars is still Seismically Active

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In the early years of planetary exploration, seismometers were placed on the Moon and on Mars. Moonquakes were confirmed but attempts to record martian tremors during the Viking missions failed. A new attempt will be made with NASA's landed InSight mission scheduled for launch in May 2018. However, a single point seismometer deployment is not an efficient (and cost-effective) way to gather information about residual tectonic activity on Mars.

My work on pre-earthquake processes has led to the discovery of a stimulated infrared emission from the Earth's surface when stresses build up deep in the crust. The underlying process is the stress-activation of peroxy defects that are ubiquitous in crustal rocks. When the peroxy defects break up, they release electrons (e') and holes (h•), of which the holes have the remarkable ability to flow out of the stressed rock volume, propagating fast (~100 m/sec) and far (tens of kilometers or more) into the surrounding rocks. The h• become trapped at the Earth surface, preferentially at topographic highs. There they recombine emitting IR radiation, which has a unique spectroscopic signature.

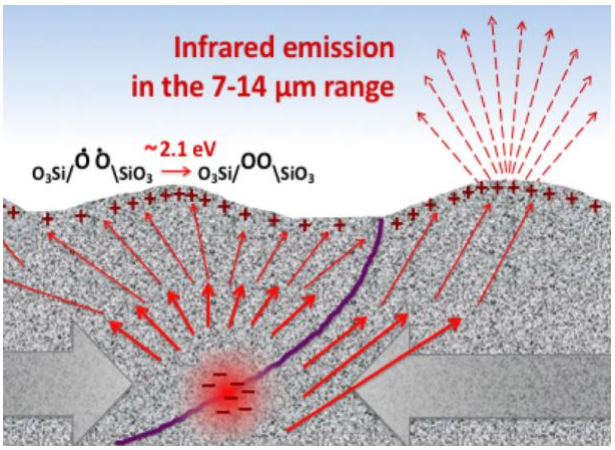

Fig. 1: Stress-activated positive hole charge carriers spreading through the rock column and recombining at the surface with concomitant IR emission

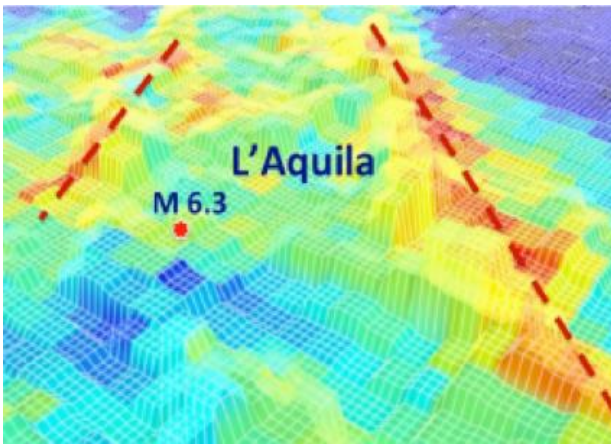

Fig. 2: Enhanced IR emission 3 nights before the M6.3 L'Aquila earthquake in Italy coming from the mountains, incl. Gran Sasso Massif to the right.

Figure 1 shows schematically the basic process. Figure 2 shows an example from Italy, where a strong earthquake was preceded by stimulated IR emission. If this IR can be spectroscopically resolved, the characteristic emission bands of the radiative de-excitation of peroxy (10-14 µm) can be used as fingerprint.

This leads to the following proposal: Place either a simple IR or a hyperspectral IR camera into orbit around Mars and record its IR emission, preferentially from the night-side. Any stresses building up within the martian crust will lead to IR from the martian surface. A favorable factor is that the IR intensity is expected to be highly non-linear and particularly sensitive to relatively low stress levels.