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Interactive comment on "Geosystemics and Earthquakes" *by* Angelo De Santis et al.

Dr. Freund

friedemann.t.freund@nasa.gov

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This is an excellent paper, which discusses the wide range of observables that have been reported for pre-earthquake conditions. Congratulations to the authors.

on p. 25, L 13-14 the authors touch upon a question that has been discussed for many years, namely the physical cause of the IR emission. The paragraph begins with the words "The nature of the detected IR anomaly as a real temperature change, or perhaps just an emission in the IR frequency band, is a debated issue." They continue with the statement that there might be "IR irradiation with no actual temperature change (e.g. Freund, 2011)" and contrast this with "some recent works identified SLHF (Qin et al., 2011) and surface temperature anomalies (Qin et al., 19 2012) occurring before large EQs, thus supporting the possibility for some actual change of temperature too."

From my perspective, there is no contradiction. Here is why.

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Figure 1 illustrates the basic scenario that, deep in the Earth's crust, where peroxy defects (typically O3Si-OO-SiO3) abundantly exist in igneous and high-grade metamorphic rocks, peroxy defects become activated. As the peroxy bonds break, they release two types of electronic charge carriers, electrons e' and holes h•.

The e' are confined to the stressed rock volume, but the h• have the ability to flow out of the stressed rock volume, spreading fast (on the order of 100 m/sec) and far (on the order of kilometers to tens of kilometers) into the surrounding rocks. The h• are electronic charge carriers, in semiconductor parlance "defect electrons in the oxygen anion sublattice". They propagate as electronic charge states. No mass transport. Since they are positively charged, they repel each other. When they arrive at the Earth's surface, they tend to go to the topographic highs such as hill tops and mountain tops. There they become trapped at the ground-to-air interface. The more h• arrive, the higher the number density per unit surface area.

Eventually, at sufficiently high number densities, the h• will begin to recombine, forming new O3Si-OO-SiO3 bonds as depicted in the top left of Figure 1. The recombination is an exothermal reaction, yielding about 2.1 eV energy. This energy is channelled into the two oxygens (valence 1-) that form the peroxy bond. They become vibrationally highly excited to the tune of ~20,000 degrees Kelvin equivalent. During de-excitation, the newly formed peroxy bonds emit IR radiation as depicted in the top right of Figure 1. The IR photons are emitted at discrete energies corresponding to the downward quantum transitions of the O-O bond in its vibrational manifold. This IR emission consists of a series of sharp bands in the spectral region 10-14 µm plus "pink noise" over the same spectral region and beyond towards even longer wavelengths.

We have experimentally obtained more than 10 of these IR emission bands (Freund and Scoville, unpubl.) We used them to derive the Morse potential of the O3Si-O<>O-SiO3 bond and found perfect agreement with high-level quantum mechanical calculations of the O3Si-OO-SiO3 defect in silica glass (Ricci et al. "Modeling disorder in amorphous silica with embedded clusters: the peroxy bridge defect center" Phys. Rev.

B, 64, 224104 1-8, 2001).

However, the success of this determination should not close our minds toward the fact that any stimulated IR emission from vibrationally very "hot" systems is not a "clean" process. Instead of just falling down the quantum ladder within the peroxy vibrational manifold, energy is being channelled sidewise to other atoms in the peroxy neighborhood, causing them to become vibrationally excited. They will then emit their own IR photons. Eventually, the system will "thermalize", meaning literally that each newly formed peroxy bond on the surface of the Earth will become a "hot spot", surrounded by a small halo where the neighboring atoms have actually increased their Joule temperature.

Hence, there is no contradiction between the co-occurrence of stimulated IR emission and the "warming" of the Earth surface – no contradiction between "hot" IR emission and "the possibility for some actual change of temperature too" as quoted in the De Santis et al. paper. It's all part of the same physical process.

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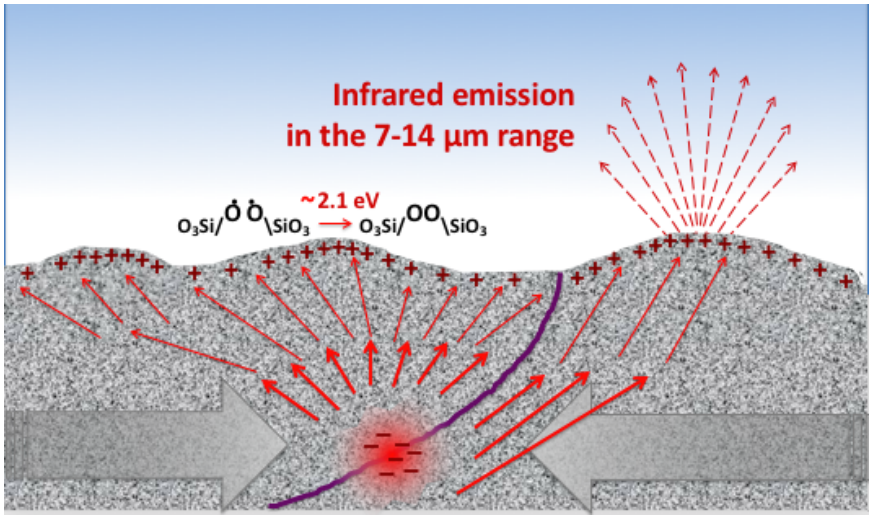

Figure 1 Schematic representation of the basic processes involved in the stress activation of peroxy defects in a rock volume that will become the hypocenter of an earthquake, the propagation of h• charge carriers and their trapping at the Earth's surface, their exothermal recombination to new peroxy bonds, and the stimulated emission of IR photons of specific wavelengths (Freund unpubl).

Fig. 1. IR emission by radiative de-excitation of peroxy bonds

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