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Breaking Peroxy Bonds in H_20 Ice Doped with H_20_2 to Create Positive Hole Charge Carriers

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Abstract

The electric conductivity of rocks in the Earth's crust increases when they are stressed such as before major earthquakes. The increase is due to peroxy defects, which – when broken – release positive-hole charge carriers. Water ice doped with hydrogen peroxide represents a model system, where this process can be studied. Blocks of pure H_2O ice and H_2O_2–doped H_2O ices, frozen first at –20° C and then cooled to –80° C, will be stressed at one end with a piezoelectric transducer (pzt) to activate positive hole currents flowing down the stress gradient. Pure H_2O ice should produce no such currents. Stressing H_2O_2-doped H_2O ices, however, should lead to a 100-1000 times increase currents. These stress-activated currents are carried by defect electrons, generated by the break-up of the peroxy bonds of H_2O_2 molecules embedded in the ice structure. These defect electrons are associated with the oxygen anion sub-lattice and known as positive holes. H_2O_2–doped H_2O ices represent analogs to igneous and high-grade metamorphic rocks, which naturally contain peroxy defects, typically O_3Si-OO-SiO_3, and also produce positive hole currents when subjected to stress. These positive hole currents are crucial to understand pre-earthquake phenomena.

Methods

By using purified water doped with H_20_2 we hope to create the simplest peroxy bond possible. We are attempting this to validate the process in which igneous or metamorphic rocks will generate positive charge carriers when subjected to extreme stress [*Freund*, 2002; *Freund et al.*, 2006]. Most igneous and metamorphic rocks will contain other impurities that may contribute to these charge carriers, but by using purified water ice doped with hydrogen peroxide we hope to eliminate any possibilities and have nothing but pure peroxy bonds. Instead of mechanical stress applied by a hydraulic press, stress will be applied with a piezoelectric transducer (pzt) by way of 20-40 kHz ultrasonic waves (Figure 1). We expect the currents to be in the pico- or nanoampere range. We'll also conduct conductivity experiments by applying a voltage to the ice during ultrasound activation of the positive hole charge carriers.

References

Freund, F. (2002), Charge generation and propagation in rocks, *J. Geodynamics*, *33*(4-5), 545-572.

Freund, F. T., et al. (2006), Electric currents streaming out of stressed igneous rocks - A step towards understanding pre-earthquake low frequency EM emissions, *Physics and Chemistry of the Earth*, *31*(4-9), 389-396.

Methods

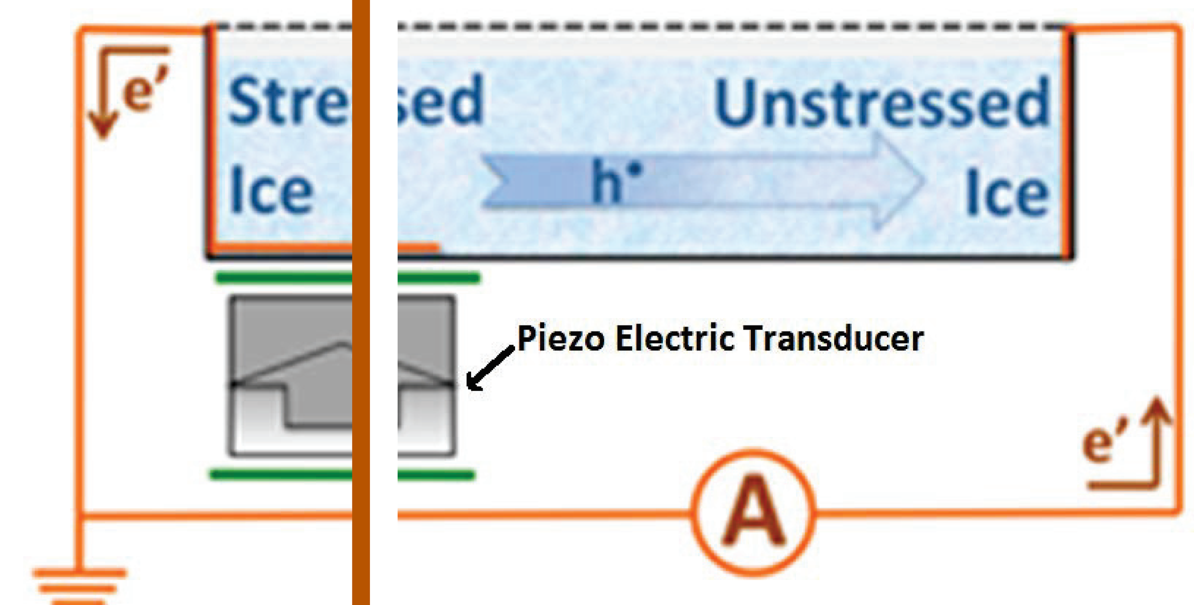

***Figure 1.** Side vi ' of ice sample in stress gradient experiment showing th stressed and the unstressed subvolume, and the test circu with a picoammeter A.[3]*

Results

We hope to d monstrate the generation of stress-activated hole currents in H_2O_2-doped H_2O ices, capable of flov ng out of the stressed sub-volume. This will provid insight into the nature of similar hole currents that a observed upon stressing igneous or high-grade met norphic rocks. We hope to confirm that the outflov currents generated by stressing rocks are due to the oreak-up of peroxy defects and the formation of m bile positive hole charge carriers, h•. The advantage H_2O ices is that, by doping them with H_2O_2, we can i roduce at will the progenitors of the positive hole ch ge carriers.[4]

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