PIEZOELECTROCHEMICAL (PZEC) EFFECT AND TECTONIC HYDROGEN PRODUCTION THROUGH DEFORMATION OF PIEZOELECTRIC MINERALS IN WATER. Huifang Xu[1] and Kuang-Sheng Hong[1], [1]NASA Astrobiology and Department of Geoscience, University of Wisconsin – Madison (1215 West Dayton Street, Madison, Wiscosnin, 53706; hfxu@geology.wisc.edu)

H_2 can be formed by various processes in nature. For instance, biological generation of H_2 gases has been reported. In which, hydrogen produced by a biological process is associated with CO_2 and CH_4. Yet, many studies have indicated the hydrogen formation in nature through an abiotic process. For example, fault gases with much hydrogen gas occurring in igneous rocks do not contain CH_4, while CO_2 only presents in trace amounts. As a result, the H_2 of fault gases cannot be considered as biogenic. Our early published work suggests that direct-water-splitting process based on nonuniformly strained piezoelectric crystals in water (Hong et al., 2010). Figure 1 schematically showing the charges developed on piezoelectric fiber surface through bending or deformation.

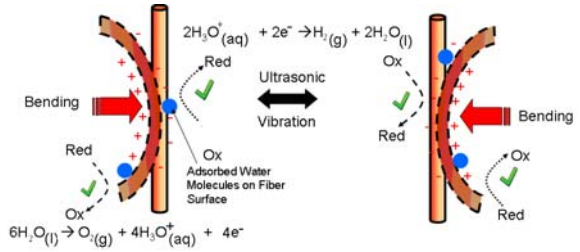

Fig. 1: Diagram showing opposite charges developed on piezoelectric crystal surface, and H_2 and O_2 production in water via oxidation-reduction reactions.

In this paper, we further proved the validation of the PZEC phenomenon in nature by employing strained natural piezoelectric minerals (like quartz and serpentine) for direct conversion of mechanical energy to hydrogen energy (Fig. 2). Accordingly, we emphasized the abiotic process forming hydrogen gas in nature. We demonstrated and claimed that a new pathway for generation of hydrogen gas in natural condition through the earth crust movement as *Tectonic Hydrogen*. This study offers valuable information for the fault movements and earthquake prediction as well as provides a fundamental knowledge for a different mechanism for tectonic hydrogen generation for sustaining microbes in deep subsurface environments.

The present work showed a possible reaction mechanism for direct water decomposition using strained piezoelectric minerals to produce H_2 and O_2. We proposed that the production H_2 in the fault zone can be attributed to this phenomenon. Prior to earthquake, stresses increase acting on the crustal rocks. Hydrogen and oxygen will be produced after the strained minerals in contact with water when sufficient amount of the electric charge have been developed on the minerals' surfaces.

The hydrogen concentration variation in fault zone is related to the fault movements in nature including the earthquake, after shocks, as well as the micro-earthquake. Yet, the connection between fault activities and hydrogen generation in groundwater suggests that H_2 measurements at monitoring stations at the fault zone might provide information on mechanism operative prior to earthquakes and identifying active faults. Accordingly, great amount of energy releasing from the continental crust prior to the earthquake will deform the quartz or serpentine crystals. Hydrogen generation by PZEC effect in nature could occur in any fault active or strained environment. The conditions required for such phenomenon are potentially widespread including the oceanic spreading center, oceanic transform faults and possible subduction zones. Note that the PZEC induced H_2 could be a potential energy souce for deep subsurface microbes.

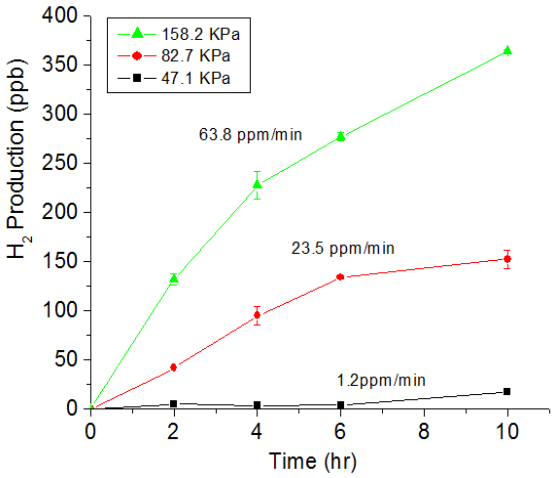

Fig. 2: Hydrogen evolution a quart sandstone under a steady pressure load at 1.58 x 10^2, 0.83 x 10^2, and 0.47 x 10^2 kPa in a closed system at 25 ^oC.

Reference:

[1] Hong, K-S, Xu, H., Konishi, H., and Li, X. (2010) Journal of Physical Chemistry Letters. 1, 997-1002.