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2004-2006 GEST* Fellow at NASA Goddard Space Flight Center, Planetary Geodynamics Lab.
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Since 1989 Adjunct Prof., Physics Dept., San Jose State University, San Jose, CA.
Since 1989 Principal Investigator at the Carl-Sagan-Center, SETI Institute, Mountain View, CA.
Since 1985 at NASA Ames Research Center, from 1985 to 1987 as NRC Senior Associate.

Before coming to the USA

Ph.D. 1959, Marburg University, Germany, Mineralogy/Crystallography; Post-Doc, Pennsylvania State University, Ceramic Technology/Chemistry, 1960–1962; Assistant Professor, Chemistry, University of Göttingen, Germany, 1962–1969; Professor of Geosciences, University of Cologne, Germany, 1970–1987; Visiting Scientist at Stanford (1973, 1974); Visiting Professor University of Namur, Belgium (1974-1976); Visiting Professor University of Dijon, France (1977); Visiting Professor Cornell University (1981); Visiting Scientist Arizona State University (1982-1984); and Visiting Scientist University of Paris VI (1986).

Research Interests

Defects and impurities in crystals caused by the incorporation of traces of H_2O, CO_2 and other gas/fluid components into oxide materials and minerals. Proton conductivity. Organic chemistry in the solid state, low-z element segregation in the solid state and origin of Life. Organics in dust grains in the diffuse interstellar medium. Valence fluctuations in oxygen anion sublattice in oxide materials and silicate minerals activated by temperature, stress, and UV. Semiconductor aspects of mineral and rock physics in relation to earthquake and pre-earthquake phenomena.

Recent Publications

Freund, F. *Toward a Unified Solid State Theory for Pre-Earthquake Signals*, Acta Geophys. 2010.

Freund, F.T. *Pre-Earthquake Signals: Underlying Physical Processes*, J. Asian Earth Sci. 2010.

Derr, J.S. St-Laurant, F., and Freund, F.T. *Earthquake Lights*, Encycl. Solid Earth Geophys. 2010.

Freund, F.T. Hoenig, S.A., Braun, A., Dahlgren, R.P., Momayez, M. and Chu, J.J. *Softening rocks with stress-activated electric current*, Intl. Symp. In-situ Rock Stress (ISRSV) Aug. 25-27, 2010.

Freund, F.T., Kulahci, I., Cyr, G., Ling, J., Winnick, M., Tregloan-Reed, J., Freund, M.M., 2009. *Air ionization at rock surface and pre-earthquake signals*. J. Atm. Sol-Terr. Phys. 71, 1824–34

Balk, M., Bose, M., Ertem G., Rogoff, D. A., Rothschild, L.J. and Freund, F.T., 2009. *Oxidation of Water to Hydrogen Peroxide at the Rock-Water Interface due to Stress-Activated Electric Currents in Rocks*, EPSL 283 (2009) 87–92, http://dx.doi.org/10.1016/j.epsl.2009.03.044

Freund, F.T., 2009. *Stress-activated positive hole charge carriers in rocks and the generation of pre-earthquake signals*. In: Hayakawa, M. (Ed.), Electromagnetic Phenomena Associated with Earthquakes. Research Signpost, India, p. 41-96 ISBN: 978-81-7895-297-0.

Freund, F.T. (2008), *Earthquake probabilities and pre-earthquake signals*, *Current Sci*., 94, 1-2.

Freund, F.T., Takeuchi, A., Lau, B., Al-Manaseer, A., Fu, C.C., Bryant, N.A., Ouzounov, D., (2007) *Stimulated infrared emission from rocks: assessing a stress indicator*, *eEarth* 2, 1-10.

Freund, F., A. Takeuchi, and B.W.S. Lau (2006) *Electric Currents Streaming out of Stressed Igneous Rocks – A Step Towards Understanding Pre-Earthquake Low Frequency EM Emissions*. *Phys. Chem. Earth*, 31, 389-396.

Freund, F.T., 2007. Pre-earthquake signals – I: *Deviatoric stresses turn rocks into a source of electric currents; II: Flow of battery currents in the crust.* Nat. Hazards Earth Syst. Sci. 7, 1-7.

St-Laurent, F., J.S. Derr, and F. Freund (2006) *Earthquake Lights and the Stress-Activation of Positive Hole Charge Carriers in Rocks*, *Phys. Chem. Earth*, 31, 305-312.

Ouzounov, D., and F. T. Freund (2004), *Mid-infrared emission prior to strong earthquakes analyzed by remote sensing data*, *Adv. Space Res.*, *33*, 268-273.

Freund, F. (2003), *On the electrical conductivity structure of the stable continental crust*, *J. Geodynamics*, *35*, 353-388.

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

Synergistic Activities

Early in my career I became aware of a previously unknown electronic rearrangement among oxygen anions, a redox reaction, by which O^{2-} donates an electron to a low-z element such as hydrogen (H^+) or carbon (derived from solute CO_2). The oxygen thereby changes its valence to O^- while the low-z element becomes chemically reduced. This reaction, first published in 1976 and through the 1980's and 1990's, has been consistently ignored by the geoscience and mineral physics communities for whom the acceptance of this discovery would mean a paradigm shift that nobody seemed to be willing to take. I continued to work along this line of research, even with very little or no funding, employing all available analytical techniques to validate the physical underpinning of this fundamentally important reaction in the solid state. A long list of publications testifies to the "origin of Life" aspect of this work.

The break-through came after I started to look in the late 1990's and early 2000's at the valence fluctuations on the oxygen anion sublattice from a semiconductor perspective and, thence, to the generation of electric currents in rocks that are subjected to deviatoric stresses. This opened the door to approach non-seismic pre-earthquake signals from an angle that had never before been used. This was a road that propelled me into another intense controversy, this time with seismologists who had developed over the years a skeptical attitude towards all claims that earthquakes can be forecast beyond the statistical probability of their models.

As we make progress in demonstrating the validity of my semiconductor approach to pre-earthquake signals, the resistance in the seismology community starts to erode. Key to this new development is my growing collaboration with colleagues in neighboring disciplines, in physics, geophysics, geomagnetism, ionospheric physics and related areas.

I view the broader impact of my professional and scholarly activities in the transfer of knowledge that comes out of a discovery made over 30 ago. I view my academic career as setting an example for the younger generation that a paradigm-shifting discovery may require an enormous amount of patience and the willingness to pursue an idea with dogged persistence. What I found many years ago has the potential to profoundly affect the way we look at and study a wide range of natural phenomena, from the putative origin of Life to non-seismic pre-earthquake signals, to the effect of tectonic forces on processes at the surface of the Earth, to the sun-Earth connection mediated by the ionospheric current vortices which in turn generate forces within the Earth.

Collaborators & Other Affiliations

My recent work has been done in collaboration with mostly undergrad students. Throughout my career I have been the advisor to over 50 undergraduates, many of them through NASA-sponsored programs, to 12 PhD students, and to 6 Post-Docs.