Electric and acoustic coupling during mechanical action in rocks (current status)

H.G. Silva[1,*], M.P.F. Graça[2], J. H. Monteiro[2], M. Bezzeghoud[1], R.N. Rosa[1], S. K. Mendiratta[2], M. Tlemçani[1]

[1]*Geophysics Center of Évora and Physics Department, University of Évora, Portuga* [2]*Physics Department, University of Aveiro, I3N, University of Aveiro, 3810-193 Aveiro, Portugal*

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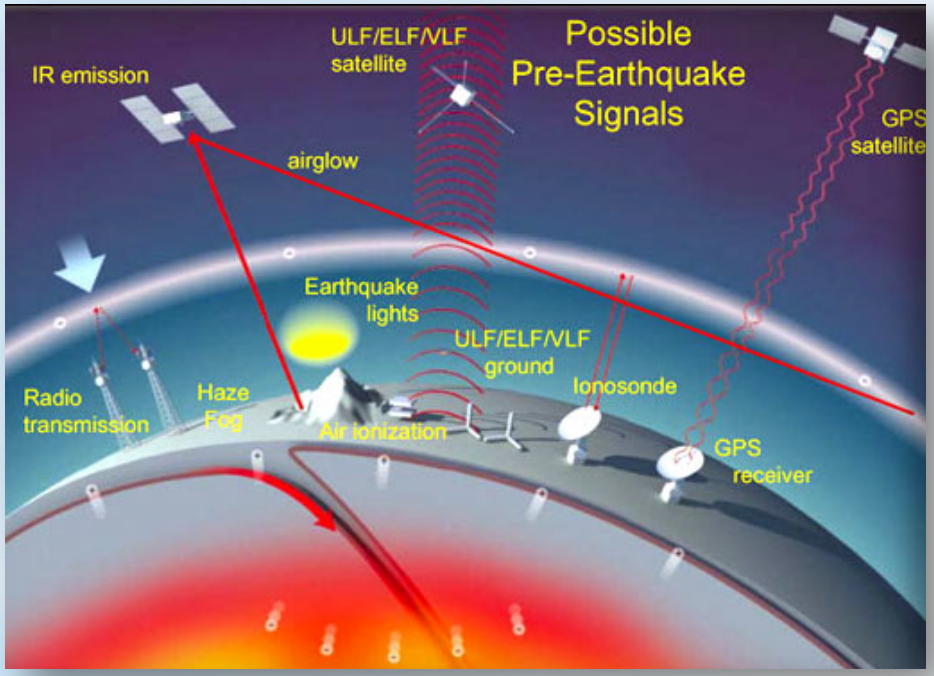
Outline

1. Motivation
2. Field Observations
3. Electric and acoustic coupling
4. Current Status

Motivation

Seismo-electromagnetic phenomena (SEP) include:



Extracted from http://www.quakefinder.com/

1. Unusual electrical signals,
2. Abnormal ultra-low-frequency (ULF) electromagnetic emissions,
3. Very-low-frequency (VLF) and low-frequency (LF) radio anomalies associated with ionosphere perturbations,
4. Variation of total electron content,
5. Atypical infrared emissions.

All correlated with the preparatory stage of impending earthquakes.

Motivation

GEOPHYSICAL RESEARCH LETTERS, VOL. 17, NO. 9, PAGES 1465-1468, AUGUST 1990

LOW-FREQUENCY MAGNETIC FIELD MEASUREMENTS
NEAR THE EPICENTER OF THE M_S 7.1 LOMA PRIETA EARTHQUAKE

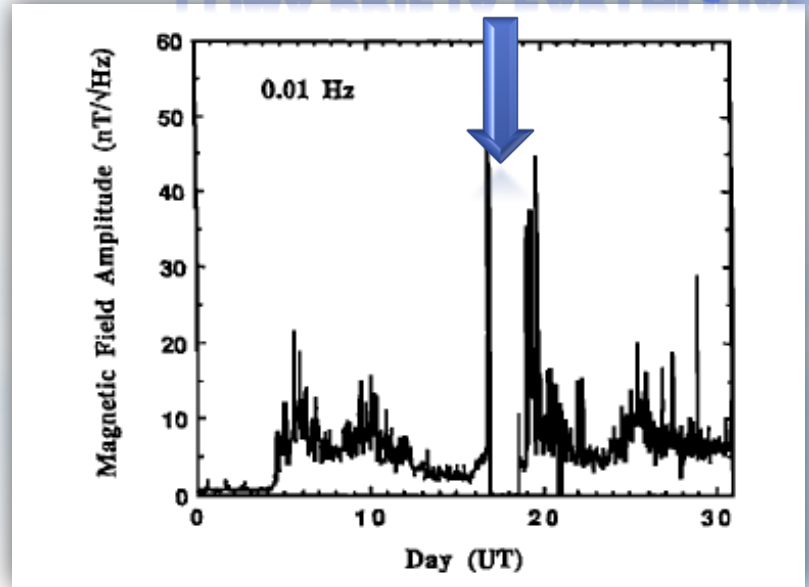
A. C. Fraser-Smith, A. Bernardi[1], P. R. McGill,
M. E. Ladd, R. A. Helliwell, and O. G. Villard, Jr.

STAR Laboratory, Stanford University

The first high quality ULF magnetic field seismic precursor measured

LOMA PRIETA EARTHQUAKE

ULF magnetic field measurements near (about 7 km) the epicenter of imminent Loma Prieta earthquake have revealed anomalous activity almost two weeks before the earthquake with a remarkable increase three hours before.



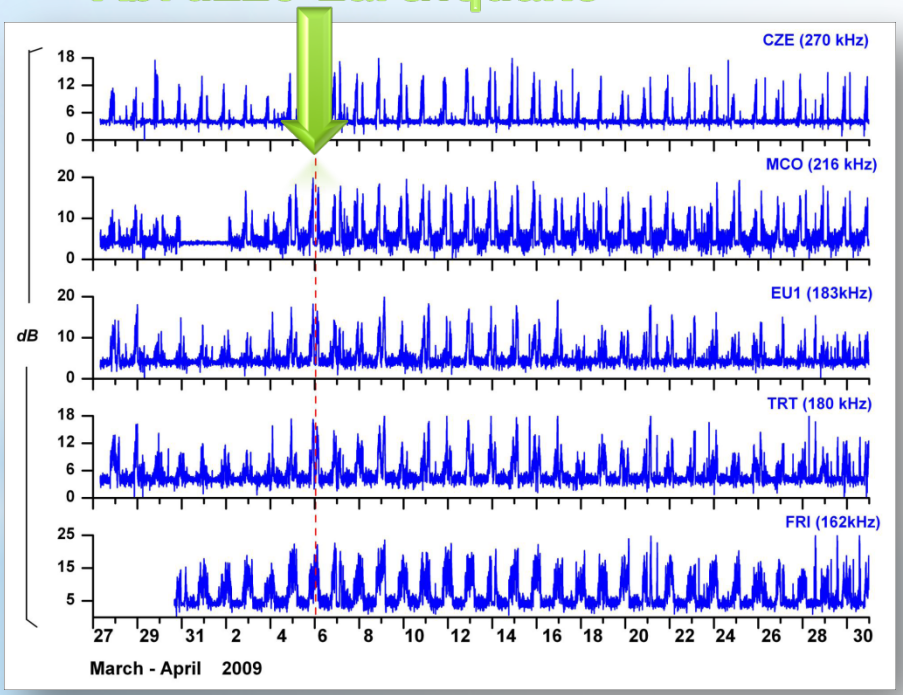
Motivation

A pre seismic radio anomaly revealed in the area where the Abruzzo earthquake (M=6.3) occurred on 6 April 2009

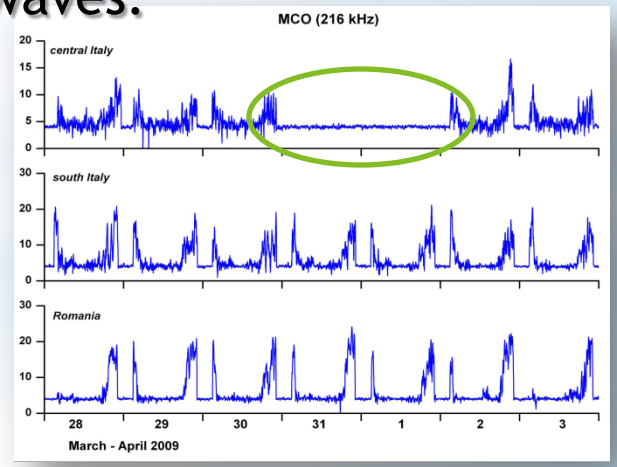
P. F. Biagi[1,2], L. Castellana[1], T. Maggipinto[1], D. Loiacono[1], L. Schiavulli[1], T. Ligonzo[1], M. Fiore[3], E. Suciu[4], and A. Ermini[5]

VLF/LF radio anomalies are another SEMG phenomena

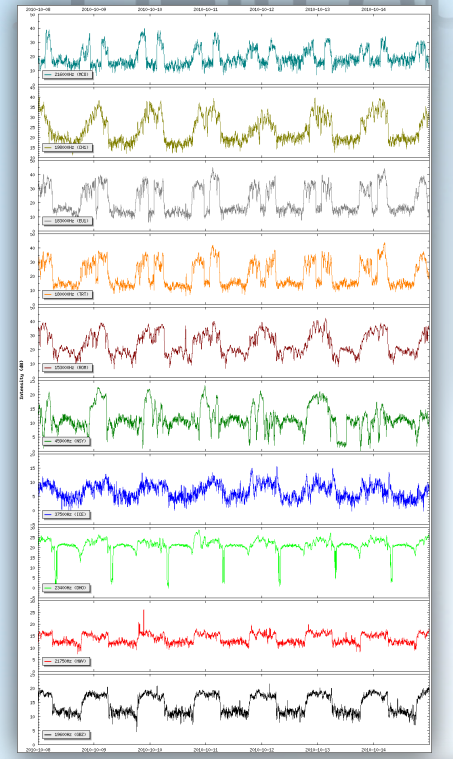
Abruzzo Earthquake



Pre-seismic anomalies in VLF/LF radio signals connected with ionosphere disturbances resulting from atmosphere-lithosphere coupling assisted by atmospheric gravity waves.



*Field Observations



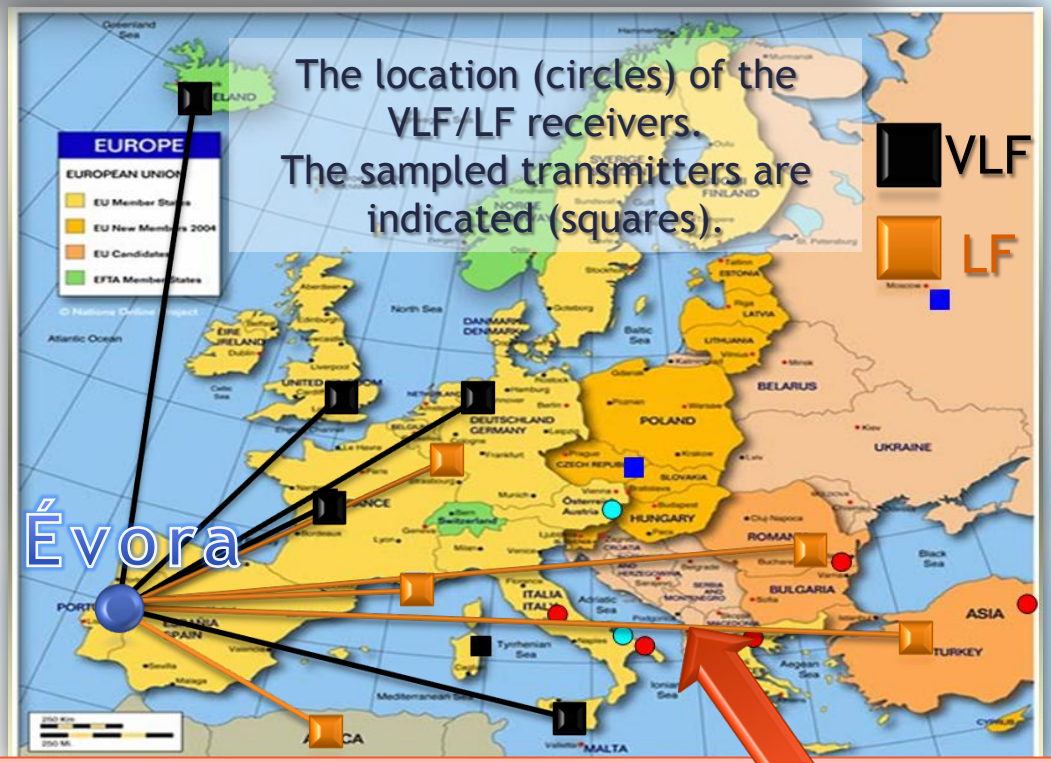
Seismo-electromagnetic phenomena in the western part of the Eurasia-Nubia plate boundary

H. G. Silva[1], M. Bezzeghoud[1], J. P. Rocha[1], P. F. Biagi[2], M. Tlemçani[1], R. N. Rosa[1], M. A. Salgueiro da Silva[3], J. F. Borges[1], B. Caldeira[1], A. H. Reis[1], and M. Manso[4]

[1]Geophysical Centre of Évora and Physics Department, ECT, University of Évora, Portugal
[2]University of Bari and Inter-Department Centre for the Evaluation and Mitigation of the Volcanic and Seismic Risk, Italy
[3]Department of Physics and Astronomy, FCUP, University of Porto, Portugal
[4]EDISOFT, Lazarim, Portugal

Received: 10 October 2010 – Accepted: 10 December 2010 – Published: 28 January 2011

We aim to extend the INFREP network to the southwest of Europe.

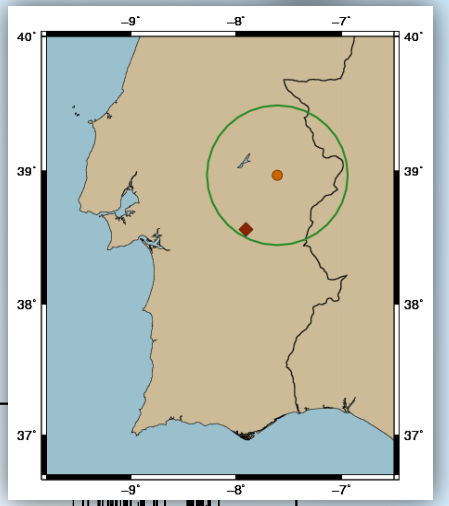


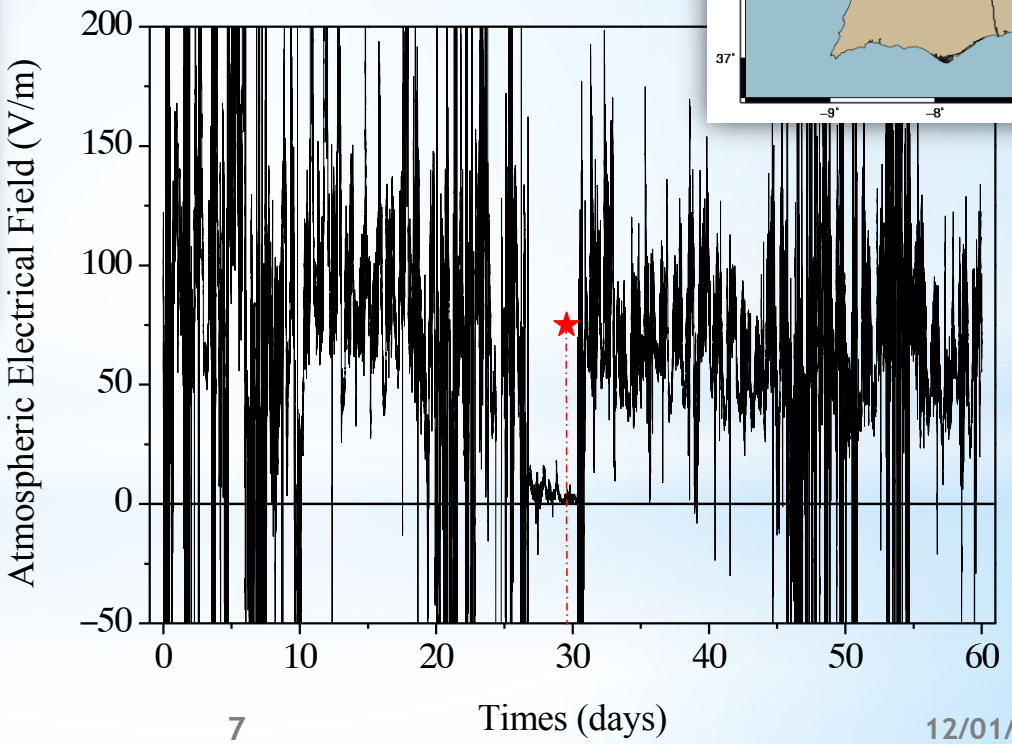
Extracted from http://beta.fisica.uniba.it/infrep/

The radio paths from the transmitters to the receiver must cross the epicentral area

Field Observations

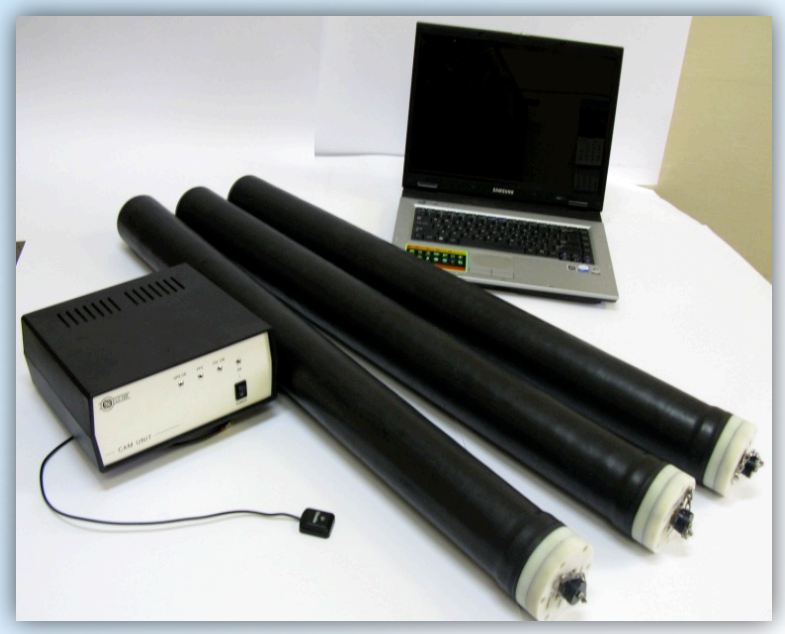
Significant suppression of the vertical component of the AEF in Évora at the time of the *M* = 4.1 Sousel earthquake of 27 March 2010.





The atmospheric electrical field (AEF) plays a vital role in electromagnetic seismic precursors and systematic measurements are lacking.

Field Observations



This part of the project aims to equip seismic stations, like BBWM network, with three-component ULF magnetometers. Installed in specific sites that accomplish significant seismic activity with low noise levels.

It is planned that these equipments establish the first stage of Iberian monitoring network of seismic related ULF electromagnetic emissions. These could possibly integrate the SEGMA array.

Extracted from http://sole-terra.aquila.infn.it/

*Electric and acoustic coupling

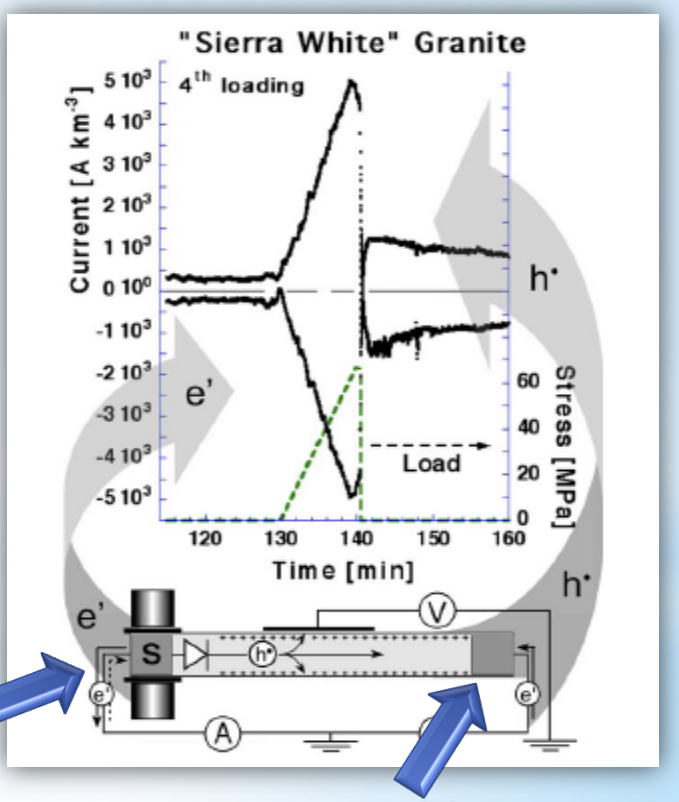
Electric currents streaming out of stressed igneous rocks – A step towards understanding pre-earthquake low frequency EM emissions

Friedemann T. Freund [a,b,*], Akihiro Takeuchi [b,c], Bobby W.S. Lau [b]

[a] NASA Goddard Space Flight Center, Planetary Geodynamics Laboratory, Code 698 Greenbelt, MD 20771, USA
[b] San Jose State University, Department of Physics, San Jose, CA 95192-0106, USA
[c] Niigata University, Department of Chemistry, Niigata 950-2181, Japan

Stress activated semiconductor effect

New laboratory experiments indicate a mechanism responsible for the different seismo-electromagnetic emissions. It is based on stress activated p-type charge carriers in igneous rocks creating a *battery* effect that successfully describes various SEM events.



stressed region
+
charge creation

unstressed region

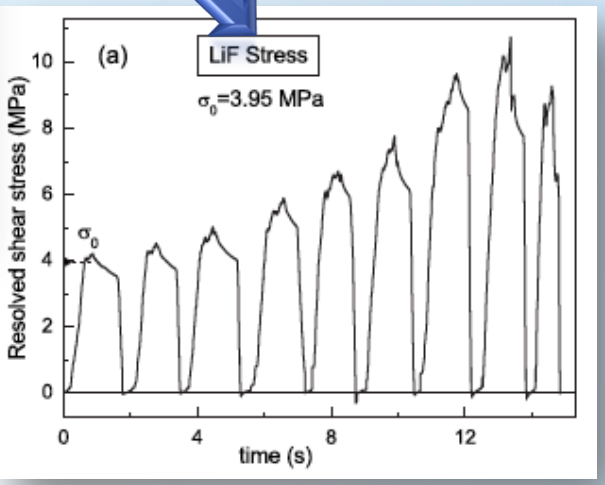
Electric and acoustic coupling

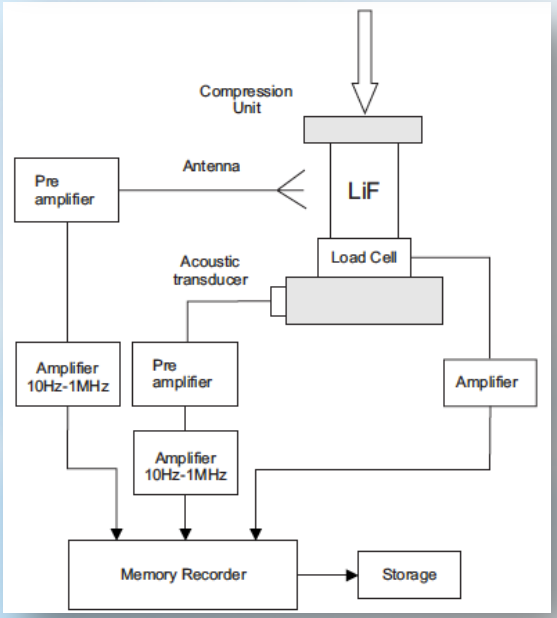
Load cycle

PHYSICAL REVIEW B **76**, 024106 (2007)

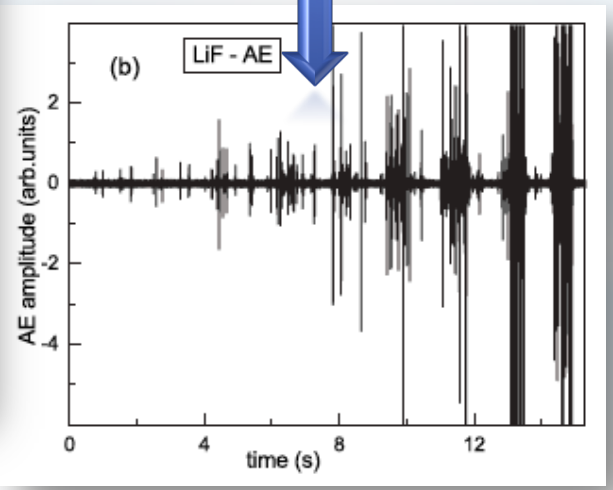
Mechanism of electromagnetic emission in plastically deformed ionic crystals

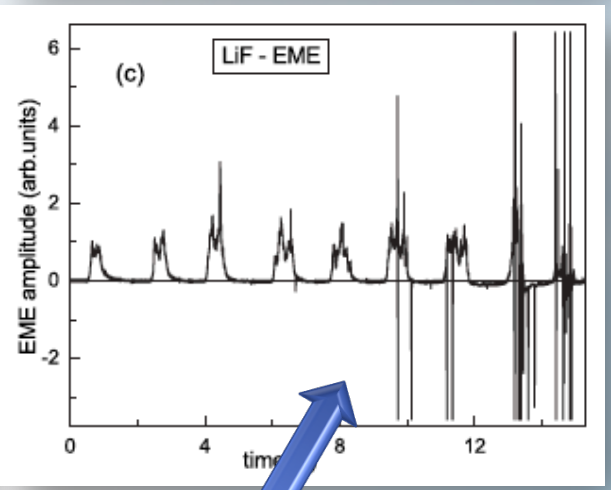
V. Hadjicontis,[1,*] C. Mavromatou,[1] T. N. Antsygina,[2] and K. A. Chishko[2]
[1]*Department of Solid State Physics, University of Athens, Panepistimiopolis, Zografos, TK 157 84, Athens, Greece*
[2]*B. Verkin Institute for Low Temperature Physics and Engineering, 47 Lenin Avenue, 61103 Kharkov, Ukraine*
(Received 13 February 2007; revised manuscript received 30 May 2007; published 12 July 2007)





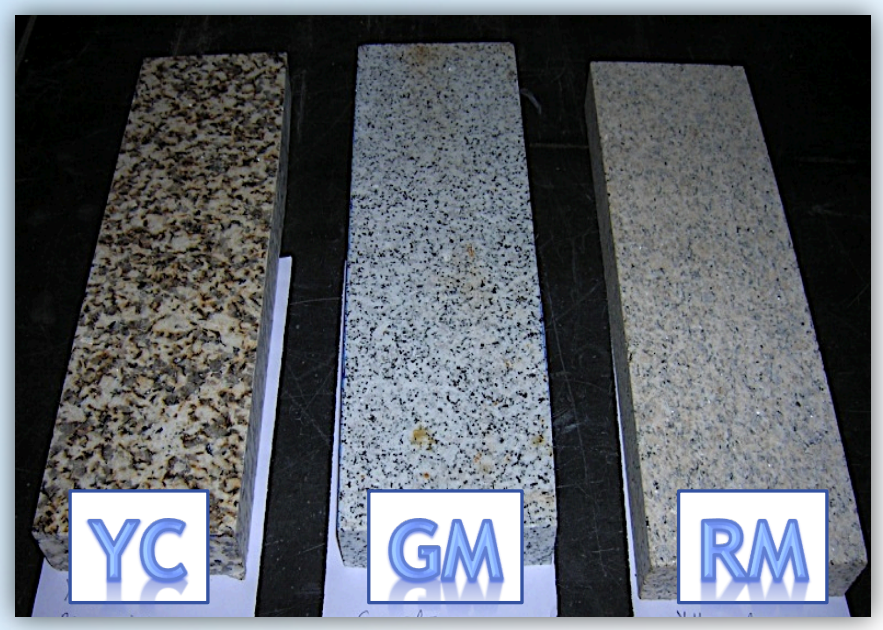
acoustic emission





EM emission

Current Status



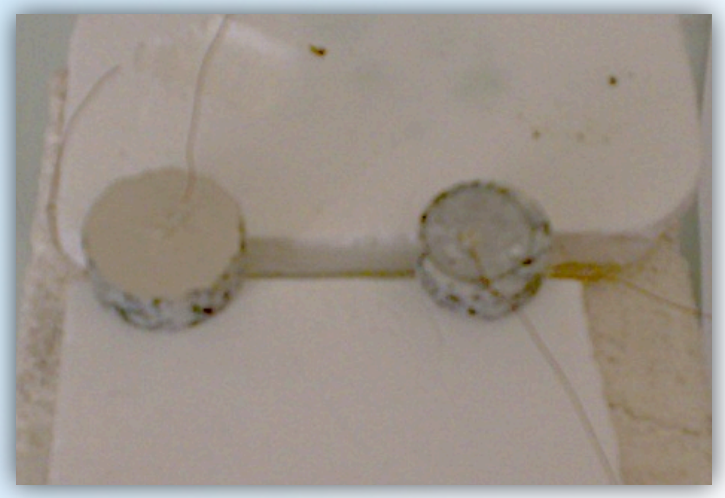
GM is a quartz diorite grey coloured and medium grained rock with homogeneous appearance, dominantly biotitic;

YC is a coarse grained biotitic granite, yellow coloured and characterized by an abundance of large feldspar megacrystals usually showing poorly defined shapes;

RM is a medium grained homogeneous pophyroid granite, with light rosy colour determined by the tonality of the feldspar crystals that stand out from a greyish with matrix containing dark grains.

The objective is to clarify the rule of water, pressure and temperature on the electrical charge transport in small scale rock samples.

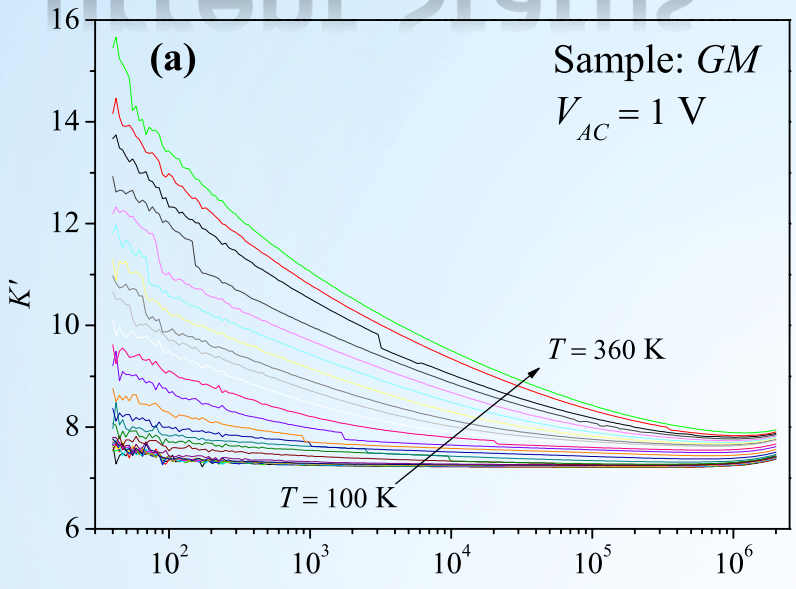
Current Status

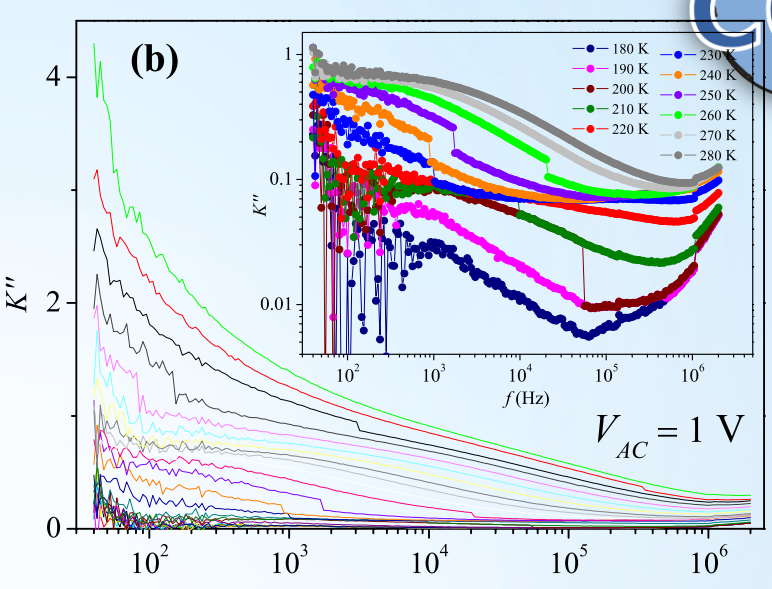


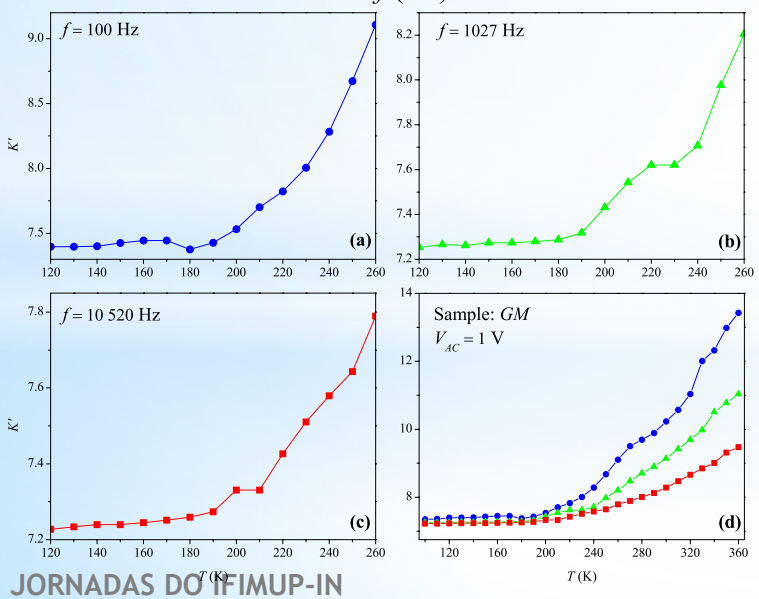
Circular samples with approximately 24 mm diameter and 2-4 mm in thicknesses were prepared. Once cut and carefully polished (with a 15µm polishing disc) the samples here heated from room-temperature (RT) up to ~400 K and after cooled down again.

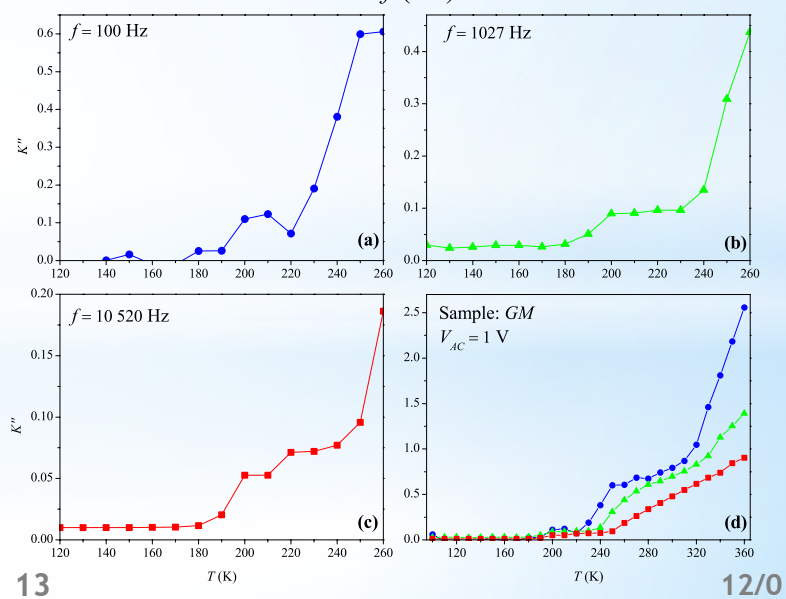
Circular electrodes with a diameter of 20 mm were then established using silver conductive paint (now we are considering the use of CNT to enhance the contact area). The samples were submitted again to a heat treatment at ~400 K to evaporate the silver paint solvent.

Current Status

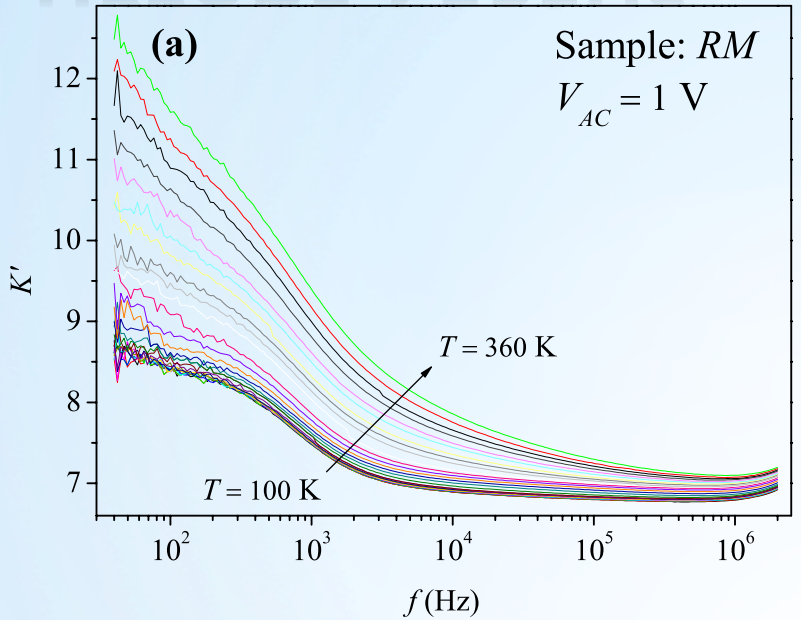


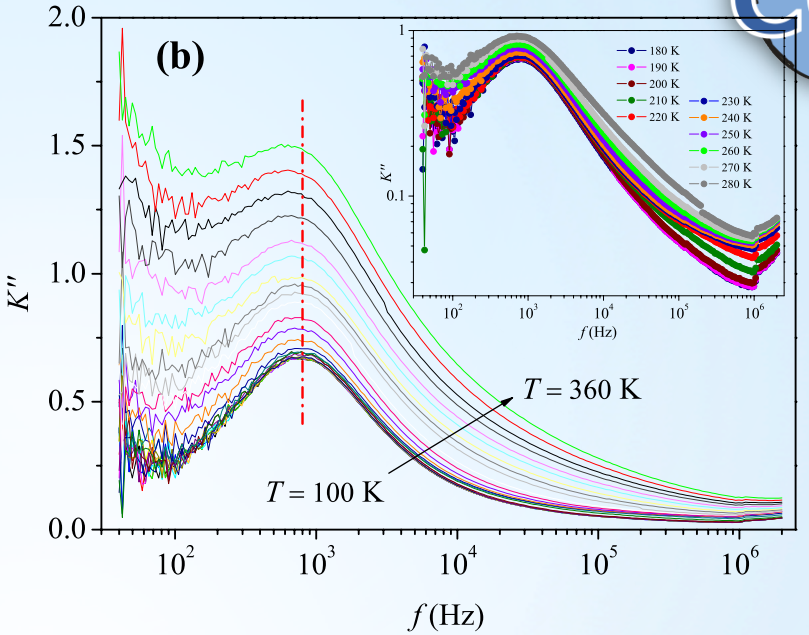


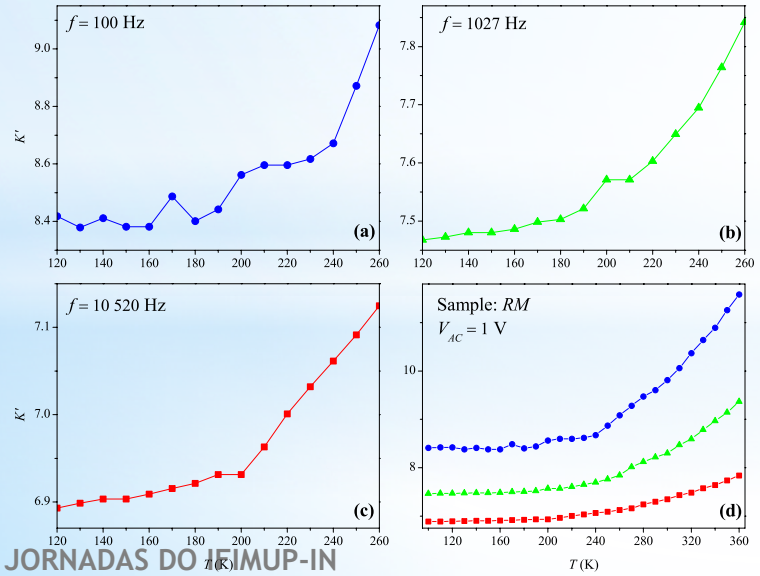


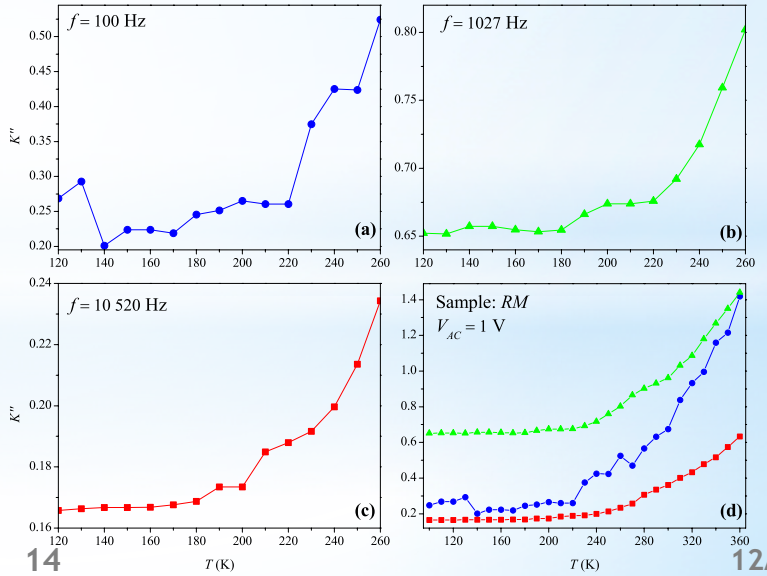


*Current Status









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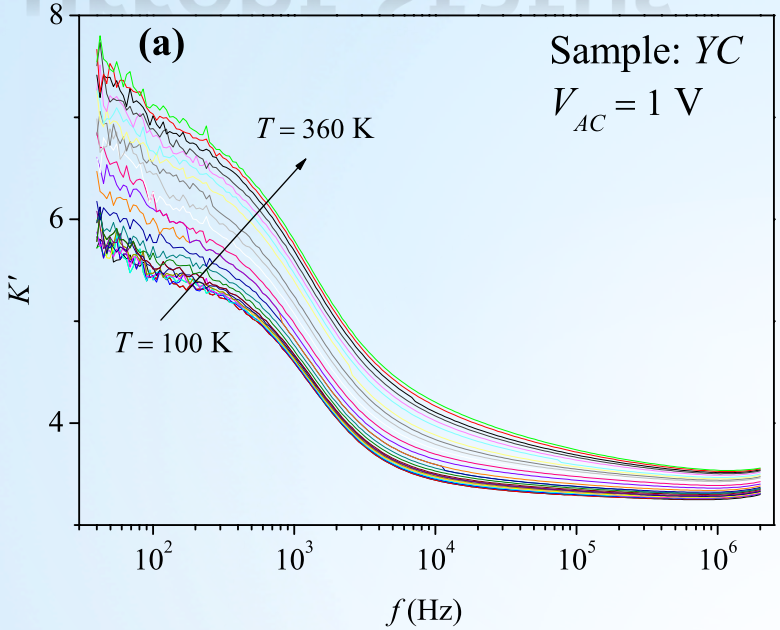

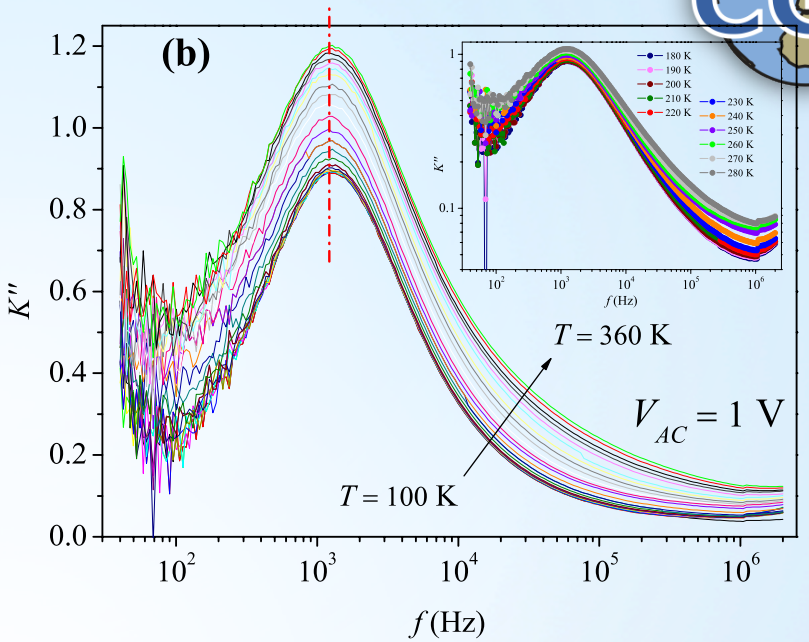

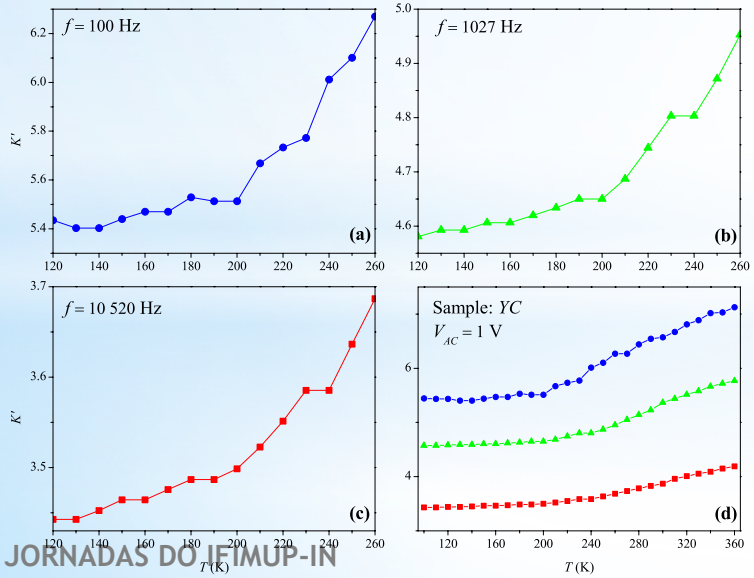

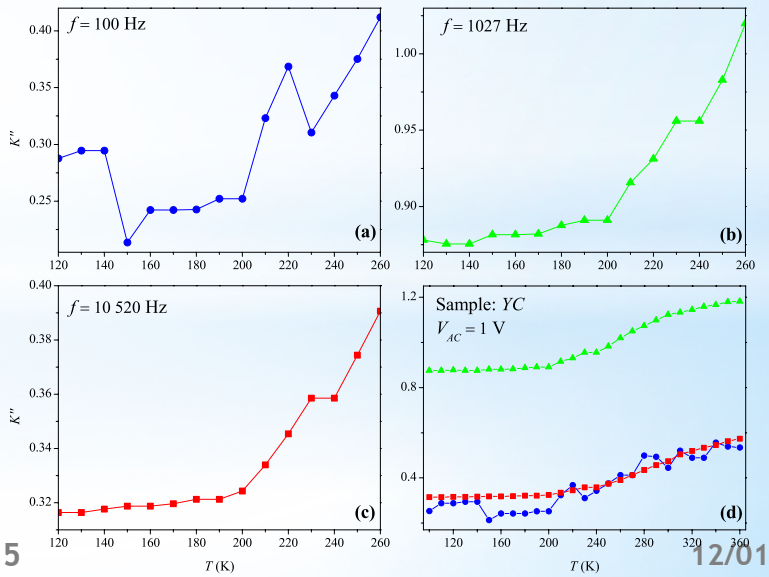

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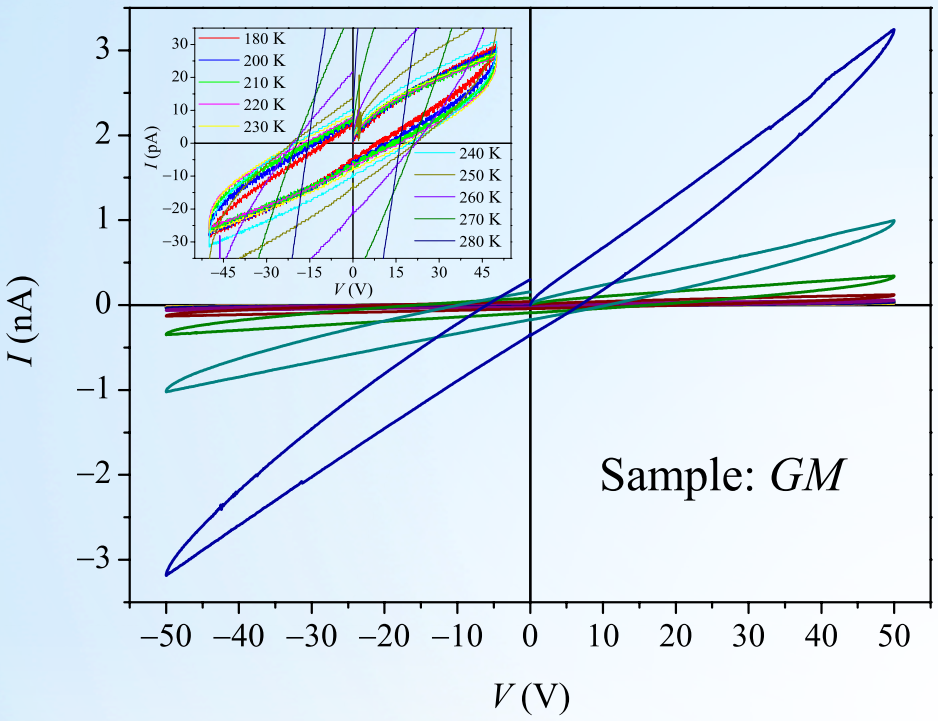
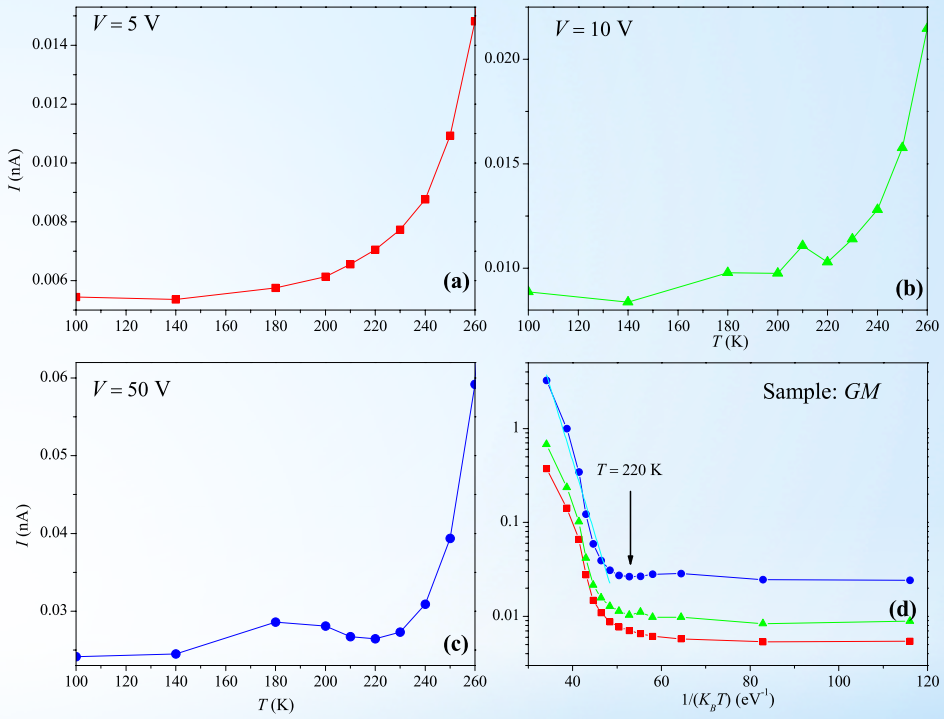
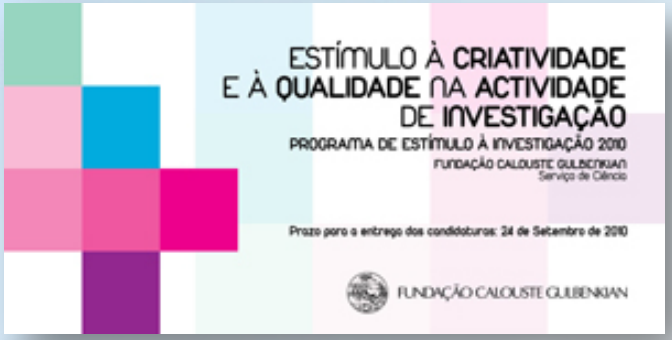




- ✓ Our final objective is to Investigate possible mechanisms of charge creation in crust materials and conditions.



*Founding and Support

*Thank you for attention

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[1]*Geophysics Center of Évora and Physics Department, University of Évora, Portuga* [2]*Physics Department, University of Aveiro, I3N, University of Aveiro, 3810-193 Aveiro, Portugal*

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