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Ground rock deformation events and their possible effects in the near-Earth space

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Recently, laboratory and *in situ* ground investigations of rock deformation events have received an important help from space observations. In fact, ionospheric and magnetospheric perturbations detected on board of *LEO* (Low-Earth_Orbit) satellites (radiation belt particle precipitations, variations of temperature and density of the ionic and electronic components of the ionospheric plasma, electric and magnetic field fluctuations) aim at reconcile these phenomena not only with Sun or atmospheric effects but also with Earth activities. In principle Earth natural disasters, as earthquakes, the impact of anthropogenic electromagnetic radiation on the near-Earth space, atmospheric electromagnetic emissions during thunderstorm activity, and effects of Sun and cosmic rays on the geomagnetic cavity could be studied by a dedicated space mission. The privileged zone for investigating these phenomena appear to be the so-called topside ionosphere. On a macroscopic scale it has been shown that in the Earth's crust, rock microfracturing preceding fracture releases gas (radon, helium) and causes electrical conductivity changes as a function of microcrack number and dimension and of pore fluids redistribution. Local deformation fields, rock microfracturing, gas emission, fluid diffusion, also have been associated with microscopic phenomena like rock dislocations, charged particle generation and motion, electrokinetic, piezomagnetic and piezoelectric effects. It has also been proposed that charge carriers could be activated in dry rocks mainly by the increasing external stress. In this case also dry rocks can become a source of highly mobile electronic charge carriers, which increase the electric conductivity and may propagate through the rock as a charge cloud. These

mechanisms have been considered as the main sources of EM fields observed at the Earth's surface. One of the possible and fascinating applications is concerned with the so-called seismo-electromagnetic emissions consisting of broad band (from DC to a few tens of MHz) electromagnetic fields generated by seismic sources in the seismogenic layer of the upper lithosphere and transmitted into the near Earth's space, before, during, and after an earthquake. Within this framework, earthquake-related ground strain deformation events (like fault creep strains) and consequent EM fields can be seen as coupling elements which affect the Earth-near-Earth Space interaction mechanisms. What is lacking is the demonstration of a causal relationship with explained physical processes and looking for a correlation between data gathered simultaneously and continuously by space observations and ground-based measurements. Coordinated space and ground-based observations imply available test sites on the Earth surface to correlate strain and EM data, collected by appropriate networks of instruments, with EM, plasma, and particle data detected on board of LEO satellites. At this purpose the ESPERIA space project has been performed for the Italian Space Agency. Electromagnetic emissions possibly caused by stress changes in the Earth's crust, including those related to strong earthquakes, are a main scientific objective of this mission. Two ESPERIA instruments have been built and will be tested in space. They are the ARINA and LAZIO particle detectors, and the EGLE search-coil magnetometer. The launch of ARINA is scheduled for next September 2005, on board the RESURS DK-1 Russian LEO satellite, and that of LAZIO-EGLE for February 2005 on board the ISS. The talk will include the justification, science background, and characteristics of the ESPERIA project as well as the description and testing of ESPERIA Instruments (ARINA and LAZIO-SIRAD) in Space.