Seismo-Electromagnetic Emission related with Seismic Waves can trigger TLE

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This paper reports the rare high intensity electromagnetic pulses associated with earthquakes, with different to atmospherics spectrum signature. On the base of actual data records, the cases of generation of anomalous seismo-electromagnetic emission are described.

The 100 kHz bandwidth receiver system measures the three components of magnetic field (B_{NS}, B_{EW}, B_Z), provides U.T. time synchronization (with the <1 msec timing accuracy), calculates 3D elements: arrival Azimuth with Output wave angle (Zenit=0°) and absolute magnetic field waveform. This facility is very important for determining the exit point of the electromagnetic waves and selection of the atmospheric or underground nature of the source.

Using the USGS NEIC and ANSS catalogs of earthquake data (U.T. time, geographical coordinates Latitude and Longitude, depth, magnitude) and 3D elements with time synchronization from 100 kHz bandwidth receiver system it is possible to separate the electromagnetic waves associated with earthquakes from other radio-atmospheric events using data obtained only from one station.

Seismic waves from far away earthquakes passing from the place of 3D electromagnetic field observation due to the seismo-electromagnetic emission were registered. At the moment of Greece (Mw=5.8 (NEIC), March 25, 2007 at 13:57:59.89 U.T.) earthquake the 100 kHz bandwidth 3D receiver system situated in Moscow has made the direct registration of this seismic event. This record has been done at the angular distance of 20.642 degrees from the earthquake epicentre. Azimuth 28° to the earthquake epicentre corresponds to the direction of electromagnetic wave arrival. The duration of direct electromagnetic signal is 0.2 msec. The spectrum has the form of a cone - the higher frequency the lower energy - with the maximum energy in the 15 kHz band. The electromagnetic wave corresponding to the direct signal propagated through the atmosphere waveguide. After that the registration of sub-millisecond electromagnetic pulse associated with P-wave from the Greece earthquake has been done. The duration of P-wave electromagnetic signal is 0.3 msec. It is important to note that the record of seismo-electromagnetic emission was done on the angular distance of 20.642 degrees from the earthquake epicentre and the signal had sub-millisecond duration. The spectrum shows that all energy of the event is localized within the 38 kHz band. The electromagnetic wave propagated from underground source situated under the place of observation. The deeper the source the lower frequencies can be observed in the spectrum on the ground surface. During the triangulation the depth of the electromagnetic wave emitter can be calculated due to the different propagation speed of electromagnetic and seismic waves in lithosphere. These electromagnetic pulses can penetrate to the surface

from the depth down to 33 km. The receiver with very high dynamic range (120 dB) can register the signals from the depth 50-60 km.

Triggering of electrical atmospheric discharges can be caused by a number of physical mechanisms, the non-linear effects connected with the earthquakes among them. Electromagnetic pulses related to seismic waves can provoke positive lightning discharges (+CG) and transient luminous events (TLEs). Cloud-to-ground (+CG) lightning discharges, with charge moment changes in excess of ~600 C·km can generate sprites. The triggered +CG lightning discharges can have the higher peak currents. So the higher probability for TLEs exists during the moments when seismic waves from earthquakes pass through the place of +CG lightning discharges. Huge peak currents of triggered +CG lightning discharges can radiate powerful electromagnetic emission.