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Seismic LCAI Coupling Supported by Pressure Stimulated Rock Current: Multi-parameter Observations and Numerical Simulation

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Multiple parameters anomalies appeared before medium-strong earthquakes have long been observed and analyzed. The spatio-temporal relations of multiple anomalies were attributed to the coupling of lithosphere, coversphere, atmosphere and ionosphere (LCAI in brief) related with the seismogenious activity and final shocking. However, the mechanism of LCAI coupling is not yet clear and the process of LCAI coupling is much fuzzy, which hinders the scrutinizing of reported anomalies, and leads to great difficulty in discriminating the inconsistency for single parameter as well as the uncertainty among multiple parameters.

From laboratory experiments on rock specimens partly loaded to fracturing we discovered that there were pressure stimulated rock current (PSRC) developing with the applied pressure, and there was stepped increment of PSRC as well as sharp rise of PSRC appearing in the late phase of loading rock to failure. The measured PSRCs were measured in an amplitude of 2~8000na, which depending on rock-minerals and porewater of different rock specimen. The enhancement of surface infrared radiation and the reduction of surface rock dielectric, which lead subsequently to the enhancement of microwave brightness temperature (MBT), could be attributed the production of PSRC and its propagation to rock surface both in laboratory and seismogenious zone.

Ground observations in Luding, China, and Fukushima, Japan, showed that the arriving of PSRC from underground was able to disturb the near-surface electric field, and led further to the local atmospheric ionization and earthquake light near ground surface. Abnormal drop of atmospheric electric field and simultaneous rise of MBT were observed preceding the M6.8 Luding earthquake, 2022, and earthquake lighting and horizontal magnetic vector disturbance were observed accompanying with the M7.3 Fukushima earthquake, 2023.

The arrival of PSRC from seimogenious zone or hypocenter is to change the atmospheric electric field, which was believed being able to penetrate upward from ground surface to ionosphere. An atmospheric electric field penetration model was modified and used to simulated the ionospheric disturbance due to the seismic PSRC inhomogeneous appeared on ground surface. The ionospheric TEC disturbance related with the M8.0 Wenchuan earthquake in 2008, the M9.0 Tohoku earthquake in 2011, the M7.8 Nepal earthquake in 2015 and the M7.5 Turkey earthquake in 2022 were carefully simulated, respectively, according to the position of MBT anomalies or supposed PSRC occurrence. The simulation results were visualized in a 3D spheroid space and

contrasted to the reported TEC anomalies retrieved from satellite or ground observations. Particularly for the great Nepal earthquake in 2015, we scrutinized the observed multiple anomalies, including TEC and VLF, possible related with the LCAI coupling, and rooted the seismic anomalies to the simulated underground high-stress accumulation regions on and above the subduction fault.