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Correlating pre-seismic Groundwater Electrical Conductivity and tectonics: a step towards earthquake prediction

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Correlation between groundwater Electrical Conductivity (EC) and earthquakes has been found, using a newly developed algorithm, based on frequency domain signal analysis applied with six months of data collected in four different monitoring wells at the northern part of Israel. Data were measured at a sampling resolution of 1/60 Hz (1 measurement/minute) both in phreatic and confined parts of the cretaceous carbonates. Changes in groundwater prior to seismic events is considered to be related to several aspects of pre-seismic crustal deformation. Both increases and decreases in groundwater, oil, or gas pressure and flow rate have been interpreted as possible precursors, at distances up to several hundred kilometers from the earthquake epicenter (Roeloffs, 1988). At the fault zone, episodic flow of high pressure water between local compartments was suggested to precede earthquake occurrence generating electrical and/or magnetic signal (Byerlee, 1993). Aquifer breaching of various scales was considered as the mechanism leading to mixing of different water type from adjacent lateral source (Cicerone et al., 2009) and adjacent vertical source (Wang et al., 2016). Chemical precursory changes were attributed also to exposure of fresh rock surfaces to groundwater by expansion of the rock volume (dilation) and enhanced permeability (Skelton et al., 2014). Based on statistical analysis, Cicerone et al. (2009) concluded that, (1) large amplitude precursory anomalies tend to occur before the large magnitude earthquake, (2) the number of precursory anomalies tends to increase the closer in time to the occurrence of the earthquake and (3) the precursory anomalies tend to occur close to the eventual epicenter of the earthquake. Our current study shows that all earthquakes of Mw>3, occurring along the Dead Sea Transform as far as 500 km, are preceded by a clear indication with the processed EC signal in the time frame of several days. Conversely, earthquakes with epicenter located on the Cyprus Arc subduction zone, as far as 200 km from the monitoring stations show no effect on the processed EC signal. We conclude that groundwater EC precursory signs for earthquakes with magnitude larger than 3 Mw might be detectable using our newly developed algorithm. Thus, detection is strictly related to the tectonic system on which continues monitoring is performed.

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