



Hydrogeochemical anomalies on the occasion of the M=7.1 earthquake occurred in Kamchatka (Russia) in March 1992

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The Kamchatka peninsula, located in the far east of Russia, is a geologically active margin where the Pacific plate subducts beneath the North American and Eurasia plates. This area is characterised by frequent and strong seismic activity and epicentres are generally distributed offshore along the eastern coast of the peninsula. The energy released by the earthquakes occurring from January 1977 to December 2004 in a circle of a radius of 350 km centred on the capital city Petropavlosk, reveals an increase in the peak energy release in the period 1992-1998. This increase is related to the occurrence of seven earthquakes with magnitudes greater than 6.5 and contrasts with the previous and successive periods when the seismicity has been more moderate. The first of the seven earthquakes happened on March 2, 1992 with $M = 7.1$. For many years, hydrogeochemical data have been collected with a mean sampling frequency of three days in the form of the most common ions and gases in the water of six deep wells and two natural springs in the south area of the Kamchatka peninsula, where the capital city Petropavlovsk is located. The data collected were analysed and differences in the trend and in the spectral content of some hydrogeochemical parameter were pointed out before and after the occurrence of the 1992 earthquake, indicating clear (co)-post seismic effects. Then an evident increase in the CO_2 , CH_4 and H_2 content was revealed, practically at each measurement site, during the two-three years preceding the earthquake, so that long term precursors can be claimed. Finally,

in some hydrogeochemical parameter and in some site, anomalies have been revealed some month before the 1992 earthquake as middle term precursors. Such anomalies were observed also on the occasion of the January 1996 earthquake ($M = 6.9$). The 1992 and 1996 earthquakes, among the seven events previously mentioned, happened nearest (90-120 km) to the measurement sites.