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1997-2007: the first example of a long-term geochemical monitoring. results and perspectives from the Umbria region seismic area

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The long-term geochemical monitoring carried out over the Umbria-Marche seismic area has allowed us to model the fluid circulation and interpret the chemical and isotopic temporal variations of thermal springs as well as of some gas vents. Coinciding with the 1997-98 seismic crisis, wide temporal variations of geochemical parameters were recorded, highlighting the occurrence of phenomena having regional interest besides modification only locally detected. An enhanced CO2 degassing at regional scale caused a pH-drop in all the thermal waters as a consequence of a partial pressure CO2 increase. Besides the enhanced CO2 degassing, broadly higher addition of radiogenic-derived volatiles to the CO2 dominant fluids were recorded. The main effect of local interest was the sudden modification detected at the Bagni di Triponzo thermal spring. The water temperature dropped by 2°C and 20°C preceding by four and two days, respectively, the occurrence of the deep located ML 5.6 event occurred on March 26, 1998. This variation was associated to a decrease of the water flow rate showing that the thermal water component had disappeared. The chemical composition of the dissolved gases revealed that a CO2-rich gas phase was always mixed with an atmospheric-derived component dominated by N2. Variations in both the chemical and isotopic compositions of the dissolved gases were also observed as pre, syn and post seismic phenomena related to the seismic shock of March 1998. While the anomalous CO2 discharge was closely related to the movement of the normal faults responsible for the Mw 5.7, 6.0 and 5.6 mainshocks that characterized the earlier seismic phase, a clear compressive sign is recognizable in the transient disappearance of

the deep-originated components related to the Mw 5.3, event occurred on March 26, 1998. Anomalies were mainly detected in concomitance to the seismicity but they also lasted after the end of the seismic crisis. The observed geochemical anomalies do not appear to be linked to single seismic events, but appear to be driven both by rock permeability changes and microfracturing induced by crustal deformations. Although the latter characterize the seismogenic process, the rock permeability variation and the microfracturing do not appear to be necessarily associated to seismicity, as also observed by elevation changes in the Umbria-Marche area. As a matter of fact, the long-term geochemical monitoring carried out over a time span of a decade including the entire seimic crisis, provided us new tools towards a better understanding of both the fluids/tectonic structures relationships and the development of the seismogenetic process.