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Modification of groundwater circulation induced by the Central Italy earthquakes: the case of Torbidone system (Norcia Plain, Italy)

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Earthquakes are known to influence hydrological systems inducing variations of water wells level, transient and permanent changes of springs and streams discharge and alteration of water chemistry.
On October 30th 2016, in Central Italy, a MW 6.5 an earthquake occurred at a depth of about 8 km. The epicenter was located about 5 km NNE of Norcia. This shock was part of a long sequence, with many earthquakes of MW higher than 5. All the mainshocks show a normal fault mechanism, NNW-SSE trending, in accordance with the regional extensional field.
Right after the October 30th event, the Torbidone spring, located in the Norcia Plain and dry since the 1979 Norcia earthquake (MW= 5.9), was suddenly re-activated. Its discharge continued to rise almost continuously during the following months, reaching the highest value (1.68 m3/s) in May 2017. In the following months, the discharge began to lower and in December 2017 it was halved (0.76 m3/s). The Torbidone spring feeds the Sordo River, in which a significant discharge increase, in large part due to the contribution of the Torbidone spring, was observed.
A multidisciplinary approach (hydrogeological, structural, geochemical and isotopic), was used to determine the possible causes of the observed groundwater flow variations and to forecast the possible mid-term / long-term evolution of the Torbidone spring, both in terms of flow regime and groundwater quality and more in general to define the modifications induced on groundwater circulation in the region interested by the seismic events.
The reconstructed structural setting allowed us to suppose a hydraulic connection between the Torbidone spring and the eastern aquifers hosted within the Meso-Cenozoic carbonate sequence, with the groundwater flowpath coming from the deepest part of these aquifers. This is supported by data on the chemical composition of groundwater, which show that the Torbidone water is particularly rich in SO4 and Mg if compared with other nearby springs; this suggests a chemical interaction within the Triassic dolomitic-evaporitic sequence that sustains the regional basal groundwater flow.