Comments on the Kim et al. Paper

The manuscript submitted for publication by Kim et al., in HESS seeks to evaluate the impact of seismic events on groundwater dynamics and geochemistry, in the case of the September 12, 2016 Gyeongju earthquakes in Korea.

This scientific issue is of importance and in the scope of the scientific themes published in HESS. The work is based on an annual monitoring of groundwater level, temperature and electro-conductivity of several wells in the geographical area impacted by the seism. Such a monitoring should allow the authors to study the variations of the above parameters before, during and after the earthquakes, which should be at the heart of a discussion on the potential hydrological modifications linked to the seismic events, which is actually not the case. The authors rather based their discussion on geochemical data, including Sr isotope ratios and Rn data, of water samples collected in January 2017, after the seism and on a statistical analysis ("Self-Organizing Map (SOM) ") of the hydro-geochemical characteristics of the groundwaters.

Except if I have misunderstood the manuscript, I do not really understand such a choice, and I have many difficulties to really understand the arguments developed by the authors to sustain/defend the interpretations given in the discussion. The discussion under its present form is based on many general considerations on the origin of Sr isotope ratios and Rn concentrations in groundwaters, which are not new, and whose interest for the present study is not convincing.

I'm surprised that the discussion is no more hierarchical / structured around the following questions:

-What information can be deduced from the annual monitoring of the hydrogeochemical parameters analyzed before, during and after the earthquake, in terms of hydrogeological modifications of water reservoirs related to the earthquake.

- How the geochemical data collected after the seismic event, in particular the Sr and Rn data (but perhaps not only, because the other chemical information is not really discussed in the article) can be used to constrain the different scenarios based on the annual monitoring or to choose among them.

Also, I do not really understand the relevance of the SOM analysis, as made and used in this paper. I'm wondering if making the SOM analysis at the start of the article does not lead the authors to forget to do a relatively extensive presentation and discussion of the data, especially the geochemical data, relevant for their purpose. The latter is to build a sound conceptual model to explain possible mechanisms for the hydrological and geochemical responses of groundwaters to the earthquake.

The SOM analysis indicates the presence of strongly related parameters. Why not rely on this information to examine in more detail the key geochemical parameters, and to discuss their variability in binary or other diagrams, in order to evaluate their meanings in terms of water reservoirs, of water pathways,.., involved in the formation of groundwaters, and that could have been modified in response to the earthquake..?

Actually, very little is done with the geochemical data: just a rapid presentation of the data in the 87Sr/86Sr vs. 1/Sr and Ca vs Sr diagrams. Why? Is it because they do not help much? Why not looking at Piper diagrams for example or other binary mixing

diagrams, that can give information about the different sources potentially involved in the geochemical constitution of groundwaters (in terms of rock water interaction or in terms of water mixing)

To summarize, the construction of the paper under its present form is for me very confused. At this stage the interpretations remain very hypothetical and poorly justified by the data, even if the database is of good quality and the question of how to constrain the hydrological modifications related to earthquakes is interesting.

Therefore, I do not recommend publication of this manuscript under its present form: I encourage the authors to restructure and rewrite their paper in order to better justify and defend their interpretations, before resubmitting it at HESS or in another journal.

Other comments

L.253 and L. 358-359: If the SOM analysis simply leads to conclude that the classification obtained is close to the classification based on lithostratigraphic unit data, we can question the interest of such an analysis. It is well established today that at the first order the chemical composition of groundwater is controlled by the interactions of the waters with the aquifer rocks!

As already suggested above, would not it be more relevant to use some key geochemical parameters to evaluate if the geochemical differences between the different groups or the geochemical dispersion within a single water group can or cannot be related to hydrological characteristics of the aquifers (connectivity between reservoirs for example,). Such information could eventually be used as arguments to prove or defend some hypotheses made in the discussion section.

L. 345-356: The conclusion, that the large variation of Sr isotopic ratios in the groundwater can be explained by the nature of the aquifer lithology, is again not a very new conclusion.

L. 361-362 I do not understand why this grouping is different as the one given L 253

L. 372 : All what explained here is maybe right but without sound arguments it is difficult to be convinced/ Why invoking exchanges processes…based on which observation? If there is no sound observation, it is a possible scenario, but likely, one among others....

Idem L. 400 when is invoked a seawater intrusion…

L. 391- 392 : I fully agree with the authors that with only geochemical and isotopic data on water samples collected after the earthquakes, it is difficult here to be very conclusive ("it is difficult to confidently determine an effect of upwelling because data were only collected after the earthquake, not prior"). This is true here but more or less all along the discussion. It is why, above, I have suggested the authors to discuss first the annual monitoring data, the only one collected before, during and after the earthquake, and then only the other geochemical data, including Sr isotope ratios and Ra concentration data.