Dear Hafidha Khebizi

Thank you for your recognition of our work and constructive suggestions. This is very helpful for us to improve the quality of the manuscript, and also brings confidence for us to continue to explore. Thank you for sharing the very rewarding work you do. We get a lot of inspiration from your work. We would like to express my heartfelt thanks.

We've responded to each of your comments, as detailed below:

Note: *Italic blue* is the comment. Black is the reply.

Dear authors and colleagues of the scientific community,

I congratulate the authors for their interesting work entitled Gypsum as a potential tracer of Earthquakes: a case study of the Mw7.8 2 earthquake in the East Anatolian Fault Zone, southeastern Turkey, and I hope it will be published soon. To find out the relationship between geothermal fluid anomalies and earthquakes, the authors performed a systematic hydrogeochemistry and isotopic analysis of the geothermal fluids in the East Anatolian Fault Zone (EAFZ). The results show that earthquakes reconstructed these geothermal fluids.

Reply: Thank you for your recognition of our work. Thank you.

Considering gypsum as an earthquake tracer is excellent reasoning for analysing the impact of anomalies after the earthquake, and the work could be a great reference for future studies related to the earthquake.

Reply: Yes, through the analysis of groundwater after the earthquake, we discovered the potential value of gypsum as an earthquake warning. It is hoped that this work will attract the attention of more researchers and colleagues, and incubate more meaningful achievement.

To enrich this excellent analysis, I have some remarks concerning the implication of *macroscopic and microscopic aspects of geothermal fluids before and after the earthquake, notably the relation with the structural geology of the region. For this, some questions seem important to be asked.*

First, from a macroscopic point of view, it is necessary to understand, in the normal case (before the earthquake), from a geological point of view, if the existing deformations (faults) already have effective structures for the infiltration of meteorological waters and the implication of the disposition of the thermal springers according to the faults. After the earthquake, is there any sampling from Miocene groundwater and soil? Is there recent salt precipitation in the Miocene and upper Eocene-Oligocene soil and/or in the soil of the surrounding springer sources? Is there a rise in the ground level due to fault action, and are there marine intrusions that occurred after the strike-slip? Is there significant contamination of the water table (increased electrical conductivity)?

Reply: Hot springs and fault zones are often associated. Hot springs are considered as one of the potential means of earthquake warning. A large number of research results have been published in Japan, the United States, Iceland, Spain, China, Turkey... ... In EAFZ, many hot springs have been systematically studied, and the results show that these hot springs contain material supply from deep crust and even mantle. Therefore, it is highly possible to obtain valuable information by conducting post-earthquake hydrochemical and isotopic analyses of these hot springs.

Unfortunately, we only collected water samples after the earthquake and did not analyze soil samples. Your comment is a very good suggestion, reminding us that detailed analysis of surrounding rock may be needed in future work. Thank you.

Salt precipitation and electrical conductivity (EC). Before we can answer your question, we need to explain an error in the manuscript. Our sample was taken in March 2023 (within one month after the earthquake). In the video 1 we provided, the macro abnormal changes of HS14 were diluted by the adjacent stream, coupled with the fact that the samples were taken within one month after the earthquake and no soil samples were collected, **we could not accurately determine whether salt precipitation existed**. By comparing the EC of the same hot spring during the seismically quiet period and the seismically active period, we found that the EC of HS14 increased slightly (varying from 990 to 1305). Data of EC pre-earthquake from *Yuce, G., Italiano, F., D'Alessandro, W., Yalcin, T. H., Yasin, D. U., Gulbay, A. H., Ozyurt, N. N., Rojay, B., Karabacak, V., Bellomo, S., Brusca, L., Yang, T., Fu, C. C., Lai, C. W., Ozacar, A., and Walia, V.: Origin and interactions of fluids circulating over the Amik Basin (Hatay, Turkey) and relationships with the hydrologic, geologic and tectonic settings, Chemical Geology, 388, 23-39, 2014.*

Seawater intrusion was evident after the earthquake. Na^+ and Cl^- of HS14, HS15 and HS16 increased significantly, indicating the possible existence of seawater intrusion (Fig. 6 manuscript).

Rise in the ground level due to fault action is common. We have made a detailed study on the post-earthquake surface rupture and post-earthquake risk analysis. Article link： *Liang, P., Xu, Y., Zhou, X., Li, Y., Tian, Q., Zhang, H., Ren, Z., Yu, J., Li, C., Gong, Z., Wang, S., Dou, A., Ma, Z., and Li, J.: Coseismic surface ruptures of MW7.8 and MW7.5 earthquakes occurred on February 6, 2023, and seismic hazard assessment of the East Anatolian Fault Zone, Southeastern Turkiye, Science China Earth Sciences, doi: 10.1007/s11430-024-*

1457-7, 2024.

Screenshot from Liang et al., 2024 doi: 10.1007/s11430-024-1457-7 (If the picture cannot be displayed, please check it in the attachment, thank you).

From a microscopic point of view, gypsum is easily and quickly influenced by contact with water, thanks to its physicochemical characteristics, in particular its very high dissolution rate and its solubility in water that make it an excellent tracer of hydrochemical anomaly but also a tracer of lithological instability (Khebizi et al., 2022; Khebizi et al., 2023). For this, I am pleased to invite you to read the part concerning the gypsum implication on the lithological instability in my article published in Larhyss Journal and my oral communications, which expose, for the first time in Algeria, a new concept of the lithological vulnerability of the subsurface. Although the study areas differ, the analysis presented in my work shows the indication of gypsum dissolution at the regional scale as an excellent major risk indicator. The lithological vulnerability of the subsurface concept can be applied to different situations around the world, notably the case of earthquakes. It highlights the hydrodynamic anomalies' relation with the structural and geological context of the area to be studied.

Thank you very much for your sharing. It's a fantastic set of work. From my personal point of view, I can't agree with you more. Gypsum's very high dissolution rate and solubility in water can be used for risk warning of earthquakes and geological disasters. Thank you again for your information. Your work gives us great encouragement and confidence.

Second, if there is a remarkable increase in calcium concentration in water after the earthquake, how do you explain the reaction of carbonate dissolution and the origin of CO2? Is it linked to magmatic activity? In this case, is there a signature of other gases on other cations? Or is it only related to carbonate since the calcite dissolution is linked to the mineral's surface to be in direct contact with water?

In my opinion, Ca may come from carbonate or igneous rocks. In order to accurately restrict the source area of Ca, we are also considering introducing Ca isotopes to distinguish its sources. Ca isotopes in carbonate rocks are lighter than those in igneous rocks and mantle. Ca isotope has a good potential in the source region that restricts Ca.

The index of CO_2 source region is very mature. Geothermal gases are well studied at EAFZ. The C isotope study of CO_2 shows that CO_2 is controlled by deep carbon and inorganic carbonate (−5.6 to −0.2‰) (*Italiano, F., Sasmaz, A., Yuce, G., and Okan, O. O.: Thermal fluids along the East Anatolian Fault Zone (EAFZ): Geochemical features and relationships with the tectonic setting, Chemical Geology, 339, 103-114, 2013.*). He isotope analysis also shows a large proportion of the mantle.

Explanation of the specific process: gypsum dissolution and carbonate dissolution are together. In the manuscript, PHREEQC was used to simulate the water-rock reaction process (Fig. 7). The results show that gypsum dissolution alone is not enough to explain the Ca content in the samples, indicating that calcite and other minerals are involved in the water-rock reaction. Combined with previous studies, we believe that CO_2 from deep water is first dissolved in water, and then reacts with gypsum or calcite. CO_2 is associated with magma, but does not form volcanic eruptions and may only exist in deep areas of partial melting.

Allow me to add that the underground water circulation, which is controlled by faults and hydraulic parameters (permeability), determines water-rock equilibrium. In this case, water-rock equilibrium depends on the host rock spatial disposition of rock that guides water mineralization and the different processes. Consequentially, the water-rock equilibrium changes from one area to another due to changes in water mineralization according to the host *rock lithology. For this, the information that can be taken from the geological map is that springer's water is related to ophiolite rocks. So, I think water geochemistry indicates similar water-rock interactions for all sources. However, a mineral's enrichment zoning can occur due to (i) the meteorological conditions, (ii) the proximity of the springer water from seawater, and/or (iii) the distance from the upstream. The earthquake reconstructed these geothermal fluids depending on the energy released which controls hydrothermal circulation and amplifies interactions with the surrounding environment whether at depth or on the surface. For this, vulnerability zoning in a horizontal and vertical direction can be done according to chemical variation, notably gypsum and probably halite enrichment. It can be indicated as shown in Fig. 8.*

I can't agree with you more. Water-rock reaction is affected by meteorology, rock properties, permeability, porosity, temperature, pressure... Multiple factors control. At present, our work is limited to the analysis of water chemistry and isotopes, and there is a lot of work to be done in the future. These works involve not only geochemistry, but also rock mechanics, numerical simulation and other interdisciplinary fields, and we hope to have more like-minded colleagues to explore together.

Earthquake warning is the most difficult problem faced by mankind. Groundwater is considered as one of the means to explore earthquake early warning. However, groundwater in its natural environment is very complex. There is still a long way to go to explore the relationship between groundwater and earthquakes.

Finally, the discussion on this topic is very significant, and the structural and lithological vulnerability and their tracers after the earthquake using vulnerability mapping of the Turkey *earthquake seems very interesting for future work.*

Thank you for your recognition of our work, your recognition is our driving force forward.

Sincere thanks and best wishes.