

Hydrol. Earth Syst. Sci. Discuss., referee comment RC1  
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## Comment on hess-2021-611

Anonymous Referee #1

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Referee comment on " $\delta^{13}\text{C}$ ,  $\text{CO}_2$ □/□ $^3\text{He}$  and  $^3\text{He}$ □/□ $^4\text{He}$  ratios reveal the presence of mantle gas in the  $\text{CO}_2$ -rich groundwaters of the Ardennes massif (Spa, Belgium)" by Agathe Defourny et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-611-RC1>, 2022

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Review of:  $\text{CO}_2/^3\text{He}$  ratios reveal the presence of mantle gas in the  $\text{CO}_2$ -rich groundwaters of the Ardennes massif (Spa, Belgium) by Defourny et al.

Overall, the manuscript is quite well written and easy to follow. The research presented here brings further constraints on the source of gas in Belgium  $\text{CO}_2$ -rich groundwaters. However, there is one important point that needs improvement in the paper. The authors keep referring to the Eifel mantle plume. However, the origin of the Eifel volcanic province is still matter of debate and the noble gas data from the Eifel area and more generally from the Central European Volcanic Province are not consistent with a plume origin but with an upper mantle source, i.e., similar signature as the MORB mantle (Moreira et al., 2018, Bekaert et al., 2019). The data in the present study cannot allow to distinguish between plume versus MORB source as the helium isotopic ratios are strongly influenced by crustal radiogenic production. But since the present data are consistent with previous  $\text{CO}_2$  and noble gas data from Eifel, it seems more consistent that the source of gas in the Belgium groundwater is the upper mantle. Therefore, I strongly recommend the authors to discuss this latter point in their paper, at least that the origin of the Eifel volcanic province is still debated, that a plume origin is not a consensus, and that their  $\text{CO}_2$  and noble gas data, while consistent with a mantle origin (which is the key aspect of this study), cannot be used to distinguish plume vs MORB. In particular, I would suggest to change the wording in the abstract ("buoyant Eifel mantle plume"), and all the reference to the Eifel "plume" (as in Figure 2, lines 78-82, 190, 219, 231, etc).

Minor comments:

Lines 22-29, 57-64: References are missing.

Line 65: typo, volcanic

Line 98-99: problem format of references, this is the case in several other places (e.g., line 144)

Line 117: 10 per cent

Line 119: samples located, please correct

Line 130-135: This should be moved to the discussion, this is not part of the results.

Captions Figures 4, 5. Carbogazeous; in relation

Equation 1: In fact, He in the samples is a mix of 3 components (air, crust and mantle) so this equation is not really valid.

Line 173: The value of 6.5 is for the subcontinental lithospheric mantle, not for the upper mantle. Please precise this for consistency, as you keep talking either about plume or MORB.