Peer Review Report

Review Report on Constraining the Geochemical Fingerprints of Gases from the UK Carboniferous Coal Measures at the Glasgow Geoenergy Observatories Field Site, Scotland

Original Research, Earth Sci. Syst. Soc.

Reviewer: Xiaoqiang Li
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EVALUATION

Q 1 **Please summarize the main findings of the study.**

This manuscript presents a detailed and well-interpreted geochemical study of gases from the coal measures in order to trace the gas source and geochemical alteration, which can attract the interest of geochemist and environmentalist.

Q 2 **Please highlight the limitations and strengths.**

This detailed study stated an interesting topic involved in reduction of hazardous gases from the subsurface for geothermal activities. A more careful interpretation is needed for the isotopes of CH4 and CO2.

Q 3 **Please comment on the methods, results and data interpretation. If there are any objective errors, or if the conclusions are not supported, you should detail your concerns.**

The data is thoroughly examined, the discussion is well organized and it should be considered for the publication in this journal. But I would see some issues which should be tackled before the acceptance of this manuscript. The most important issue is the interpretation of relatively heavy 13C and 2H of CH4 in gas samples, as stated below

Q 4 **Check List**

Is the English language of sufficient quality?
Yes.

Is the quality of the figures and tables satisfactory?
Yes.

Does the reference list cover the relevant literature adequately and in an unbiased manner?
Yes.

Are the statistical methods valid and correctly applied? (e.g. sample size, choice of test)
Yes.

If relevant, are the methods sufficiently documented to allow replication studies?
Yes.

Are the data underlying the study available in either the article, supplement, or deposited in a repository? (Sequence/expression data, protein/molecule characterizations, annotations, and taxonomy data are required to be deposited in public repositories prior to publication)
Yes.

Does the study adhere to ethical standards including ethics committee approval and consent procedure?

Yes.

If relevant, have standard biosecurity and institutional safety procedures been adhered to?

Yes.

Q 5 **Please provide your detailed review report to the editor and authors (including any comments on the Q4 Check List):**

The detailed comments are shown:

1 Line 206, why the errors of δ2H of the gases measured in this study are so small (0.3‰)? Usually, the quality of δ2H is good if the measured values are within ± 5‰. In my experience with measuring δ2H of hydrocarbon gases, I never have obtained such precision as those in this study. I am just curious, can you explain more about this?

2 Line 276–278, make a note of the meaning of DIC before you use this abbreviation.

3 Line 339–341, could you explain the details on the calculations of δ13CCO2 based on the fractionation factor?

4 Line 302–305, 355–365, the manuscript interprets the relatively enriched 13C and 2H of CH4 in gases due to the oxidation during the depth (63–79 m) (fig 8). This could be one of causes, but the author should explain why in the relative shallow (e.g., 30–50 m) or deep (e.g., 130 m) depth there is no oxidation of CH4. More evidence is needed to support this interpretation. Furthermore, for the most important, if CH4 is partially oxidized, one of the products likely is CO2, which means 13C of CO2 should be very negative due to the addition of CO2 from CH4 oxidation assuming 12C of CH4 is preferentially consumed. While in Fig 8, the 13C of CO2 is relatively stable during that depth. Therefore, the authors should give a detailed or new interpretation for the evolution of isotopes of CH4 and CO2 with depth.

QUALITY ASSESSMENT

Q 6	**Originality**	■■■□□
Q 7	**Rigor**	■■■■□
Q 8	**Significance to the field**	■■■■□
Q 9	**Interest to a general audience**	■■■■□
Q 10	**Quality of the writing**	■■■■□
Q 11	**Overall quality of the study**	■■■■□