

Peer Review Report

Review Report on Heat recovery potential and hydrochemistry of mine discharges from Scotland's coalfields

Original Research, Earth Sci. Syst. Soc.

Reviewer: Gareth Farr

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EVALUATION

Q 1 Please summarize the main findings of the study.

This paper provides a very useful and detailed study of the mine water geochemistry and heat recovery potential of mine water discharges across Scotland's Midland Valley. The use of gravity driven discharges for heat recovery has not yet been exploited in the UK (or Scotland) and thus work like this helps to highlight the potential for localised low carbon heating solutions. The geochemical analysis improves the wider conceptual understanding of these mine water sites and also provides useful suggestion of co-locating future mine water treatment sites with heat networks.

Q 2 Please highlight the limitations and strengths.

Limitations:

-The manuscript will make an excellent paper however some editing (mostly style and language) and restructuring is needed first so that the paper is better to read (See detailed comments)

Strengths:

- The paper covers an important part of the mine water system in Scotland in relation to heat recovery
- The paper contains excellent data and appendices
- The paper is 'topical' and is sure to be widely used by academics and practitioners

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.

Methods: no significant comments

Results: no significant comments

interpretation: no significant comments

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?

Not Applicable.

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

Not Applicable.

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

Dear Authors,

Thank you for sending the paper to review. It will be an excellent addition to the literature however first some editing and restructuring is needed so the paper flows and reads well.

General comment

- Following the journals instructions for authors it indicates that Results and Discussions are recommended to be separate sections and I do think this should be applied as it would make the paper easier to read.

L2: Title suggest mine 'water' discharges

L20: and throughout please changes 'coalfields' not 'coal fields'

L24/25: Need to differentiate between 'mine water geothermal system' and 'discharges' so suggest '....for project stakeholders investigating mine water geothermal systems using boreholes or mine water discharges for heating or cooling purposes'

L31-32 'installation of heating infrastructure is considered' this is a bit ambiguous does it mean in the treatment plant etc ? so suggest change to 'the are -co -designed with mine water geothermal heat networks'.

L38: change 'net zero' to Net Zero

L36 to 45: There is no mention of any UK or Scottish Government Policy for Net Zero - agreed it will reflect UK ambitions but certainly worth adding as no doubt this paper will be read by many in government.

L42: Think this sentence needs a re-write. The end part 'dependence on seasonal weather conditions' isn't really clear is this for renewable heat or fossil fuel heat or is it for demand? Also L44 remove 'and' before weather.

L48: replace 'ground water' with 'groundwater' and then consider if this should actually be 'mine water'.

Technically groundwater will fill the mines then it is referred to as mine water.

L51: First mention of Midland Valley of Scotland so add (MVS) and then throughout.

L49: remove brackets with '(via heat pumps)'. Technically it is via heat exchangers, pumps and heat network or could replace with ' via low carbon heat networks' or similar as you describe the systems later.

L56: add 'coal' before mines so audience is clear this is about coal mines.

L62: needs paragraph break before 'The use of..' to separate the previous paragraph which is about the mining of the MVS and then the next which is about mine water heat systems.

L63-64: You state that open loops are globally widespread (needs references after this)

L67-68: remove text ' a full explanation of mine water geothermal systems can be found in' and then integrate (Banks et al 209) into L67 after '..energy can be harnessed'.

L71: Suggest change 'features' to 'properties' or 'settings'.

L72: is it only the speed of heat migration that is concerning or the distance and longevity of any changes ?

L74: remove 'additional' as if they don't require drilling then they cant have additional drilling.

L74: 'pumping tests' not pump testing - two different things.

L75-76: mine water can also 'break out' at the lowest hydrological point e.g. a river even when there is no shaft or adit present.

L76: remove brackets replace with ‘ their temperature, flow and estimated heat resource have ...’

L77–81: needs a few changes and a re write to include : 1) remove ‘ to protect adjacent mine workings’ this is not the purpose of treatment schemes 2) The Coal Authority covers GB not UK; 3) Mine water treatment systems are not all pumped some treat water from discharges 4) MWTS protect surface waters AND drinking water aquifers where these occur above mine water systems.

L81: there are still some underground coal mines in the UK e.g. Aberpergwm South Wales (drift mine).

L83–83: remove brackets and work words into sentence.

L87–88: remove (and in some cases even earlier) and just have the range of dates over which dewatering has occurred, otherwise sentence sort of contradicts itself.

L91–92: arguably the coalfields didn’t close the collieries closed or coal mining ceased. Reword.

LL93: remove word ‘today’

L96: remove ‘ in nature’

L97–98: this is just another way of saying what is included in the previous sentence so suggest delete to avoid repetition.

L99: ‘could be’ this sentence reads as if we don’t know. Given the references are older and we now know many of the impacts of this, do we need to reword as in ‘ Younger & Robins etc etc predicted that the unmitigated impacts of mine water recovery and break out could include x, x, and x .

L99: delete ‘as documented by’ and just keep (Younger and Robins, 2002)

L110: ‘drainages’ check sentence and this word please.

L111: remove ‘the above’

L113: remove brackets (heat pumps and heat exchangers) and integrate into sentence.

L113: sentence starts with ‘because’ – reword or change.

L115: ‘ which require drilling boreholes into multiple seams’

L117: Can you check that Burnside et al 2016a as per your refs actually includes information on seasonal variability of mine water discharges. Paper is on Caphouse Colliery Hope Shaft which is pumped.

L118: remove brackets at start of sentence and integrate ‘ often deeper’ into sentence.

L119: reword sentence so it doesn’t include ‘by detailing’

L121: remove ‘abandoned mines’ and replace with ‘discharges’ or similar as study doesn’t show potential from mines across the MVS rather discharges from mines across the MVS.

L123: ‘Setting’. This section would be better titled ‘Geological Setting’ and then at L 149: a new section called ‘Hydrogeological Setting’ or if you wish ‘ to have one heading then Geological and Hydrogeological Setting’

L124: Please mention the MVS by name.

L149: see comment above would be nice to have sub heading ‘ hydrogeological setting’ or similar.

L151: remove ‘but’ with ‘and’

L155: remove ‘the mined landscape hosts’ as technically its not the landscape which is above ground.

L155: suggest remove ‘akin to kart aquifers’ as although I totally appreciate the many synergies there are also many differences. Best to keep it factual and just describe the properties of the unmined and mined coalfield.

L149–159: I would expect to see a bit more description in the hydrogeology section. Some good recent work on aquifer properties in the MVS (Galsgow) from UKGEOS (Data release and initial interpretation of test pumping of boreholes at the Glasgow UK Geoenergy Observatory – NERC Open Research Archive) etc also Monaghan et al <https://doi.org/10.1144/qjegh2021-033>

L163 : replace ‘Mine discharge water’ with ‘mine water discharges’

L183–185: please read again as it starts like it the end of another sentence.

L186–7: ‘mine groundwater’ replace with ‘mine water’

L187: remove word ‘naturally’ at start of sentence and reword whole sentence.

L187:188: arguably it is not the hydrogeological properties alone of a mine water discharge that identify which sites most urgently need mitigation, as it also includes other drivers such as cost– benefit analysis based on the cost of treatment and the benefits to the receiving environment. Thus suggest removing this sentence or rewording to take into account the above.

L188–192: rewords sentence and start with ‘Evidence for stratification’ (remove ‘Whilst there is’).

L192: chemistry of oil shales mines: needs reference at end and if possible location of where these mines are, assume in Scotland?

L196–197: needs reference added.

L218: remove description of what MWTS do e.g. ‘locations where they intercept...’- this is already in the introduction and doesn’t need to be in the methods section.

L220: Remove ' Their thermal potential has been detailed in' And just add (Bailey et al 2016) into a sentence . Suggest something like: 'Bailey et al (2016) have compiled data and estimated thermal recovery potential for 12 mine water treatment schemes owned and operated by the Coal Authority.'

L222: remove 'details of which can be found in' and re word sentence.

Table 2: Is this list of CA MWTS worth including in the main body of the report ? more like an appendix to me. Also what is the source of this data ? Bailey et al ? if so add to caption.

L226: remove 'It was stated by' and re word sentence.

L227: remove '(dated 2000)' and just add reference – may need reword of sentence as above.

L228: remove 'We identified sample locations from SEPA records' replace with 'Using records of mine water discharges (SEPA, 200) we identifiedetc'

L232 'were visited not was visited

L232–235: arguably this is sampling methodology rather than identifying sample locations. Suggest move to start of your 'Field sampling and onsite analysis' section.

L236–240: starting 'Since the SEPA data...' this isn't a method it is discussion on the SEPA dataset so should be included in your discussion not method.

L243: replace 'by SEPA' with '(SEPA, 2000)'

L246: again do you need brackets ? integrate into sentence.

L261 – not really a method more of geological setting. Suggest remove or reword.

L263: do you need that comma ?

L269: 'Where required' not sure I get what this means – do you calibrate every day, or when meter goes out of calibration. Please clarify.

L271: ' suggest remove ' As regards sampling' too informal.

L273–289: why is this section numbered whilst elsewhere sampling methods are not numbered ? Suggest make a paragraph from it rather than number.

L291: rather than state you couldn't get a flow meter perhaps reword just to say what you did.

L302: remove 'it was feasible to obtain a flow rate simply' replace with ' was measured'

L207: how did you record flocs suspended in the water – was this a visual assessment if so please detail.

L309: assume 'analytical methods' is Laboratory analytical methods – worth clarifying in title so there is separation between field and lab methods.

L350: this describes field sampling methodology so needs to move into that section

L359: 'each sample' replace with number of samples

L348: please remove 'henceforth in the paper'

L385–386: remove brackets and make whole sentence.

L398–410: this is method not result. Suggest move to methods.

L401: Equation. This is just a suggestion but ΔT is normally used for change in temp across heat pump and Q for flow. You don't need to change but just makes it more in line with how others write. (see Banks et al 2017 for example)

L404–207. Remove brackets and integrate text into single sentence.

L412–414: Blindewells temp and flow – is this your data ? if not please add source of data as ref e.g. (Smith et al 1900)

L414: remove word 'comfortably'

L426: remove 'thus'

L428: I'm not sure what you mean by 'undervalued' can you change or expand ?

L420–429: methods ?

L431–438: methods ?

L433: I think that total needs to be followed by 'estimated' just to take into account flow measurement methods.

L432: remove 'in the' replace with 'during' / remove 'financial year'

L433: total estimated

L443: 'since flow rate was not published' – you can put an information request in to the Coal Authority for this type of data, I don't think it is 'publicised' externally as routine.

L444: 'may have observed and increase in flow' – speculation remove.

L454: 'assigned a very modest' – is 10oc modest if 10.6oc was your mean ? Suggest remove word 'very modest'.

L455: Remove 'Evidently'

L456: 'forecasting' is there a better word ? planning or developing maybe or quantifying ?

L457-458: you may need some pumping even when using discharges – e.g. pumping from discharge to heat plant so we cant rule that one out entirely – but agree it will be much smaller than pumping a borehole.
L460: 12,000 2 bed homes (worth keeping the house size in)
L464-477: Currently this is in the thermal resource section of results, and arguable it is a geochemical result albeit combined with flow data. Suggest remove to geochem section or have separate subheading on iron which would be quite nice.
L464-466: reword and cite source of data. I note that the CA annual report suggests that in Scotland there was 960 tonnes of iron solids prevented from entering Scottish water courses. CA_ARAA_2020-21.pdf (publishing.service.gov.uk)
L465: Is ‘influx’ the best word to use ? Influx of what ? (assume iron but you need to say). Is the 1032 kg/day how much is treated or prevented from entering surface waters ? . possibly reword sentences from L464 to 466 which I think could be covered in one succinct sentence.
L471: ‘reasonable to assume’: worth having a little look at the drivers for MWTS and the cost-benefit approach see comments also on L187:188, as it may indeed not be that reasonable to assume that funding would be available to create treatment sites for all of these discharges.
L480-488 – this almost reads as a caption for a figure.
L489: Discussion needed as to
L491: ‘fluctuate across seasons’ – do you have a reference for this as your data is one off spot data?
L502: note Farr et al 2016 paper shows a variety of temperature responses throughout the year, some deep sources are more stable (subset reported in Fig 2 Walls et al 2021) whilst shallow ones or where rapid recharge to system occurs– can fluctuate –there are also some that are a mixture of both deep and shallow components. Suggest needs reword to reflect that deeper temps are more stable whilst shallow temps can fluctuate – although you may have to note you don’t know which of your sites do this as data is spot temps.
L535: ‘only the sample sites’ replace with only the –add number – sample sites of this study’
L538: Apologies I not a geochemist – can you check sentence as it sounds like your saying Alkalinity is a dominant anion, and I’m not sure alkalinity is an ion at all. (Happy to be wrong but please do check with a geochemist).
L539: You describe ‘Chloride’ as a ‘major component’ would it not make sense to use same terminology as previous sentence e.g. dominant anion.
L702: ‘at the surface’ replace with at ‘mine water discharges’ as arguably you can sample deep borehole water at the surface!
L703: ‘provides a useful dataset’
L711: MVS used, Line 721 Midland Valley Scotland. For conclusion I would use in full for both, as many people will of course read the conclusion quickly and you want to avoid to many acronyms.
L730: remove ‘(provided a demand existing in the vicinity)’ and integrate into sentence.

Acknowledgments

Do you have any landowners to thank or were all of your sites visited located on public land ?

Figures

L741. If you have used BGS map data to create this figure you need to add the copyright.
L749: remove boxes from ‘(those treated by the CA.....)’ and integrate into one sentence.
Table 2. Im not sure what this adds to the paper– suggest into Appendix.
Table 4. Does this include Coal Authority data if yes then cite. If you collected yourself assume you need to acknowledge CA for access to any sites ?

References

Please check format of references as per instructions for authors
SEPA 2000 not included

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

■ ■ ■ ■ □