

Corresponding author(s): Alexander Diehl

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Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our [Editorial Policies](#) and the [Editorial Policy Checklist](#).

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a Confirmed

- | | | |
|-------------------------------------|-------------------------------------|--|
| ☐ | ☒ | The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement |
| ☐ | ☒ | A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly |
| ☒ | ☐ | The statistical test(s) used AND whether they are one- or two-sided
<i>Only common tests should be described solely by name; describe more complex techniques in the Methods section.</i> |
| ☒ | ☐ | A description of all covariates tested |
| ☒ | ☐ | A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons |
| ☒ | ☐ | A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals) |
| ☒ | ☐ | For null hypothesis testing, the test statistic (e.g. F , t , r) with confidence intervals, effect sizes, degrees of freedom and P value noted
<i>Give P values as exact values whenever suitable.</i> |
| ☒ | ☐ | For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings |
| ☒ | ☐ | For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes |
| ☒ | ☐ | Estimates of effect sizes (e.g. Cohen's d , Pearson's r), indicating how they were calculated |

Our web collection on [statistics for biologists](#) contains articles on many of the points above.

Software and code

Policy information about [availability of computer code](#)

Data collection	no specific software was used
Data analysis	Maps were created using ArcGIS® software by Esri. Quartz solubility was calculated using the software package Loner AP (developed by R.J. Bakker 2008, Fluid Inclusion Laboratory Leoben). Vapor-brine equilibria were calculated with the software SOWAT (sowatfinc_plotdata, version 0.1 / 2007). Thermodynamic equilibrium calculations for the Sabatier reaction and mineral buffer reactions were performed with SUPCRT92 software. Reaction path models were conducted using Geochemist Workbench.

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio [guidelines for submitting code & software](#) for further information.

Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our [policy](#)

Hydrothermal vent fluid data produced in this study is tabulated in the article and provided in the supplementary materials. Hydrothermal vent fluid data used for

Research involving human participants, their data, or biological material

Policy information about studies with [human participants or human data](#). See also policy information about [sex, gender \(identity/presentation\), and sexual orientation](#) and [race, ethnicity and racism](#).

Reporting on sex and gender	This study did not involve human participants or biological material.
Reporting on race, ethnicity, or other socially relevant groupings	This study did not involve human participants or biological material.
Population characteristics	This study did not involve human participants or biological material.
Recruitment	This study did not involve human participants or biological material.
Ethics oversight	This study did not involve human participants or biological material.

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☐ Behavioural & social sciences ☒ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see [nature.com/documents/nr-reporting-summary-flat.pdf](https://www.nature.com/documents/nr-reporting-summary-flat.pdf)

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	Sampling and chemical analysis of submarine hydrothermal vent fluids from the Jøtul hydrothermal field at the Knipovich Ridge.
Research sample	Inorganic environmental submarine hydrothermal fluids.
Sampling strategy	Sampling was performed with isobaric gas-tight fluid samplers. A systematic sampling campaign was performed to sample each location that was encountered during the seagoing research expedition.
Data collection	Chemical data was collected during the research expedition and in the aftermath by the authors in multiple environmental laboratories.
Timing and spatial scale	Samples were collected during a sea going research expedition from 18 Aug-28 Sep 2024 to the . As many samples as possible were collected, dependent on technical and weather conditions.
Data exclusions	no data was excluded
Reproducibility	Vent fluid samples were measured in replicates. Reference standard materials were measured along with the samples to verify the results.
Randomization	Sampling deep sea environments is a technically challenging procedure. We systematically sampled all fluid orifices that we encountered during our expedition. All samples were treated identically.
Blinding	We systematically sampled all fluid orifices that we encountered during our expedition. During laboratory treatment all samples have the exact same appearance. Samples were given GeoB sample numbers instead of location identities.

Did the study involve field work? ☒ Yes ☐ No

Field work, collection and transport

Field conditions	Variable weather conditions and sea states.
Location	Jøtul hydrothermal field at the Knipovich Ridge. Water depth of 3000±100m. Latitude: 77° 26' ±1' N; Longitude: 07° 42' ±1' E

Access & import/export

Our study area is located in the Norwegian exclusive economic zone. We have retrieved a national research permit for "scientific research for natural resources on the Norwegian continental shelf" from the Norwegian Offshore Directorate (reconnaissance license, no.888/2024) that was signed on 19-April-2024. The import/export of equipment/samples was to our best knowledge in fully in accordance with national and international laws.

Disturbance

Remotely operated vehicle operations. Sampling of vent fluids is a minimal invasive procedure. Some single vent orifices collapsed during the operations.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☒	☐ Clinical data
☒	☐ Dual use research of concern
☒	☐ Plants

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Plants

Seed stocks

This study did not involve plants or seed stocks.

Novel plant genotypes

This study did not involve plants or seed stocks.

Authentication

This study did not involve plants or seed stocks.