

Peer Review Report

Review Report on Origin and affinities of the Malmberget iron oxide–apatite deposit, northern Sweden: insights from magnetite chemistry and Fe–O isotopes

Original Research, Earth Sci. Syst. Soc.

Reviewer: Fernando Tornos

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EVALUATION

Q 1 Please summarize the main findings of the study.

Use Fe–O stable isotopes and trace element geochemistry of magnetite for stating that the Malmberget iron deposits in Sweden are of magmatic–hydrothermal origin

Q 2 Please highlight the limitations and strengths.

Strengths:

- * A major topic of debate
- * Use of novel iron isotopes

Limitations

- * Too long and repetitive
- * There are several statements that need clarification: the temperature limit of melts and hydrothermal fluids, terminology of fluids...
- * Assumed statements without geochemical base.
- * Authors contradict themselves by saying that perhaps their methods are erroneous but use them without any discussion on why they should be used

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.

Stated in Q2 and Q5

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?

No.

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

No.

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)

No.

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):

The manuscript by Henriksson et al. on the stable isotope geochemistry of the Malmberget deposit proposes that the Fe–O isotopes can be useful tracers on the origin of IOA deposits. The manuscript is part of a saga of papers used in similar deposits, reaching similar conclusions. Thus, the conclusions are not new but more of regional interest.

The paper reads well and should be of interest to the readers of the journal despite is quite long and repetitive and can be significantly shortened out without losing information.

My major concern is that along the paper the authors state that the methods used can have severe pitfalls but do not state how to sort that out. There are some contradictions that need to be clarified such as the control of the redox state on the trace element content of magnetite. If there are concerns about the use of the trace element geochemistry for tracing the origin of magnetite, you should state them and why you continue using it as a tracer of the origin. I am not an expert in iron isotopes but perhaps there is some need of explaining if iron isotopes fractionate with temperature as other stable isotopes and if the recorded values can only be explained by the evolution of magmatic–hydrothermal fluids.

Some other issues

- Line 60. Bauer et al. (2018) and Sarlus et al. (2020) should be quoted here
- This paragraph is a bit chaotic – clarify the most significant contributions to the origin of these deposits. I perhaps miss the studies of Naslund.
- Line 103. So, you state that 800°C is the magic number between magmatic and hydrothermal processes... why? Recent melt inclusion data suggest that these systems have very different temperatures of homogenization.
- Line 103. If understood well, your hypothesis is that you can distinguish between high temperature magmatic systems and low temperature hydrothermal systems. Can you distinguish between magmatic processes or high-temperature hydrothermal processes? As with other stable isotopes, this looks quite difficult. Could you clarify? It's a key issue of the paper.
- Line 129... this seems a repetition of what is above.
- Line 142. Are these the key references of IOA in Nörbotten?
- Line 172. So, no coeval? Needs some emphasis.
- Line 177. Is hematite coeval with magnetite? Which is the origin of hematite? Could it be hydrothermal or even supergene? No maghemite?
- Line 204. All this paragraph has been already discussed. Delete
- Line 216. So, all the discussion is based on six samples from one drillcore? To which extent are they representative of such a large deposit?
- Line 274. Why these minerals are "skarn" minerals? They can be metamorphic or even igneous. Actinolite–tremolite are a solid solution.
- Line 286. Here, you quote average values but no other statistical data so don't know if values are homogenous or the size of the sample. Perhaps this can go in a table with more details.
- Line 315. I get confused... both melts and aqueous fluids are fluids.
- Line 333. This is an important statement.
- Line 348. Low oxygen fugacities? What means low? If calc–alkaline melts you should expect rather high oxygen fugacities. Are these melts reduced ilmenite–rich melts derived from crustal melting? DFMQ from +0.2 to +3.7 is the field of reduced melts and below that of calc–alkaline melts.

- Line 352. This statement seems to be contradictory. You say that these diagrams have major problems and later use them. I don't understand what is the geochemical background that supports that the trace element composition of magnetite depends if precipitated from any magmatic-hydrothermal fluid or from any melt. Also, why you discuss the use of magnetite as a tracer of the type of mineralization? There is abundant literature that shows that magnetite from a single deposit plots in many very different fields.
- Line 382. Do not understand this statement.
- Line 387-. Already discussed.
- Line 410: Well, there is a lot of discussion here. This is a rather strong argument here and to my knowledge, this is not the opinion of the Reich et al. (2022) paper.
- Line 414. Which kind of alteration? Hydrothermal? Supergene?
- Lone 418-. Again, highly repetitive.
- Line 430. This seems to be new. What is the exact significance of this statement?
- Line 433-. Can be shortened significantly.

QUALITY ASSESSMENT

Q 6	Originality	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q 7	Rigor	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q 8	Significance to the field	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q 9	Interest to a general audience	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q 10	Quality of the writing	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q 11	Overall quality of the study	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>