A review of the paper by Schneider et al. (2019) on metal contamination from mining activity adjacent to the Tasmanian Wilderness World Heritage Area

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INTRODUCTION TO THIS REVIEW

On Monday, 25 February 2019, the Earth Sciences department at the University of Tasmania was contacted by Mr Wes Ford, Deputy Secretary, Environment Protection Authority Tasmania, to review the following paper by Schneider et al. (2019).:

"How significant is atmospheric metal contamination from mining activity adjacent to the Tasmanian Wilderness World Heritage Area? A spatial analysis of metal concentrations using air trajectories models"

The purpose of the review is to provide independent advice to the Tasmanian Government on the issues raised in the paper, as detailed in an email from Mr Ford on the 15th of Feb 2019 (Attachment 1). The reviewer; Associate Professor Sebastien Meffre, has supervised two theses and co-authored two papers on characterising anthropogenic contaminants sediments in the Derwent estuary, which are directly relevant to this review. He also has extensive teaching and research experience in geochemistry and geochronology and knowledge of the mines and mining history of the west coast of Tasmania.

REVIEW OF THE INTRODUCTION SECTION OF THE PAPER

The introduction is largely well written with the aims of the study stated as 1. to assess the extent of metal contamination in the Tasmanian world heritage and surrounding areas using sediment cores from six freshwater lakes; 2. to develop and test a model of airborne contamination transport from historic mining activity and 3. to inform the scientific community and the public about the legacy of metal contamination within the world heritage area to support government initiatives in establishing appropriate regulations and policies to protect the environmental values of this area.

However, the historical background of mining on the west coast is quite limited, with some sections being incorrect, confusing, and not attributed to any references. For instance, mining on the west coast is written as starting underground and moving to open cut in the 1920s, when in fact mining is clearly documented as both open cut and underground in the 1880s, continuing through to the late 2000s (Blainey 2000). Mining at Rosebery is stated as starting in 1936, which contradicts information from the literature (e.g. Blainey 2000) which document mining activity as starting much earlier.

There is no discussion or review of any potential for non-mining related metal contaminants, such as sources from hydro-electric schemes, agriculture, forestry, manufacturing, transport, fire management practices and tourism, which would provide some wider context to this study.

REVIEW OF THE MATERIALS AND METHODS SECTION

The scientific analytical geochemical and geochronological methodology employed by the authors appear to be sound. There are some issues, however, with the way the data is presented, as well as the type of data shown in the figures and the modelling. The modelling and the statistical analysis only consider one possible source of contamination. The findings may have been clearer if other possibilities were included.

REVIEW OF THE RESULTS AND DISCUSSION SECTION

The authors' decision to combine the results and discussion into a single section breaks one of the fundamental rules of scientific writing: namely, that the results are presented in a separate and objective section, before any interpretation or discussion of the findings. In this paper there is no attempt to present the results objectively – the full uninterpreted results are only provided as appendices. Instead, the paper launches immediately into interpretation and modelling which only considers single-source contaminants from mining. The modelling is presented without reference to basic data such as downhole plots (see Fig. 1-2 of this review). Due to this blending of data and interpretation the authors fail to identify evidence that some contaminants may not be solely related to mining. The modelling, presented with the results, is too simple and therefore flawed. The evidence for multiple sources of contamination can be summarised as follows:

1. Pb at Lake Dobson decreases when mining starts on the west coast (Fig. 1).
2. Zn at Lake Dove also decreases when mining starts on the west coast (Fig. 2).
3. The Pb/Zn ratios (Fig. 3) suggest that multiple sources of contamination are present with different Pb/Zn ratios.
4. The oldest contamination occurs well before the commencement of mining on the west coast in 1881. This could be related to element mobility though bioturbation, or improper core handling, or due scatter of the data to much larger uncertainty on the ages than that quoted in the tables. There are no discussions of any of these possibilities in the paper.

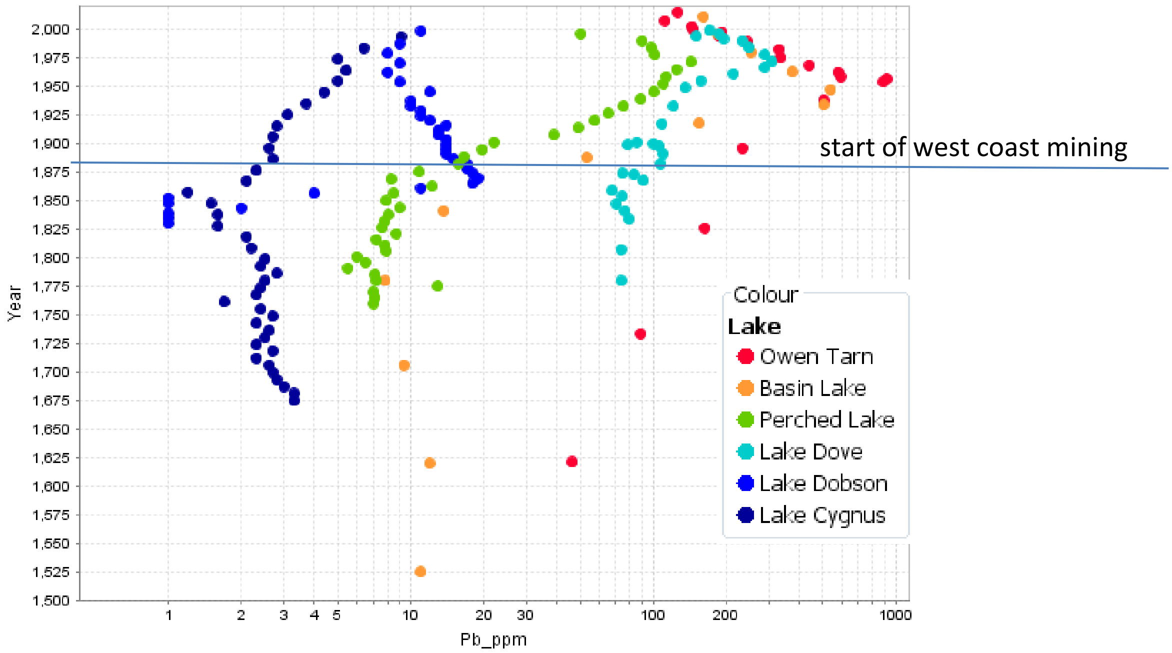

Figure 1 Plot of Pb concentration and modelled year of deposition (based on 210Pb dating) from the data appendices of Schneider et al (2019).

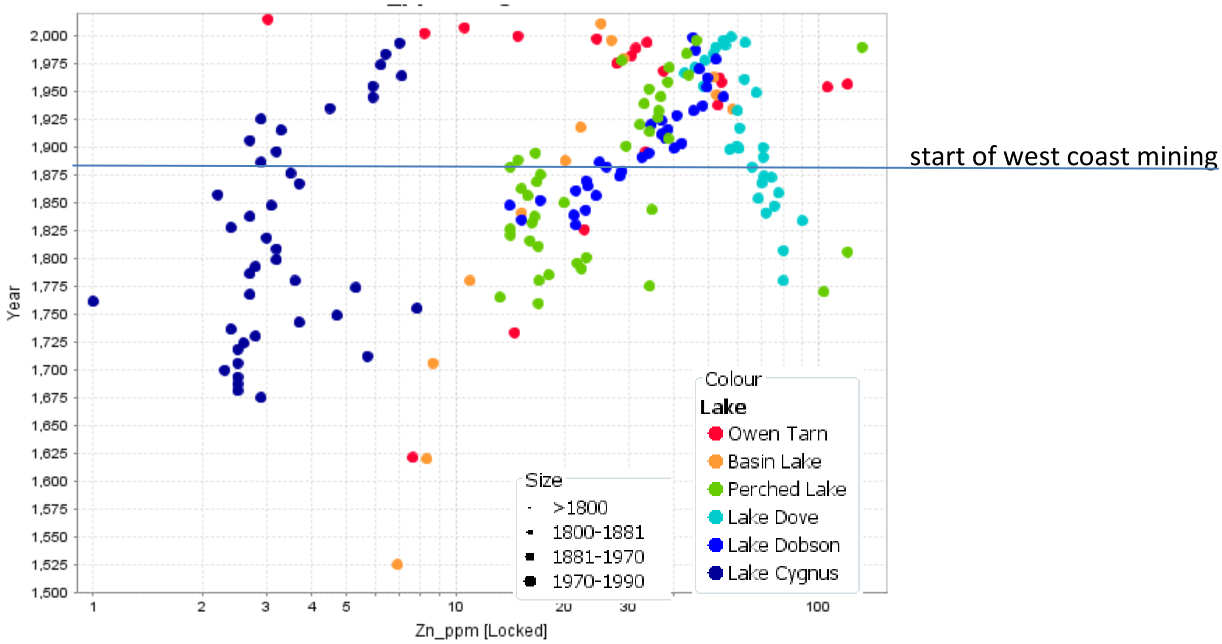

Figure 2 Plot of Zn concentration and modelled year of deposition (based on 210Pb dating) from the data appendices of Schneider et al (2019).

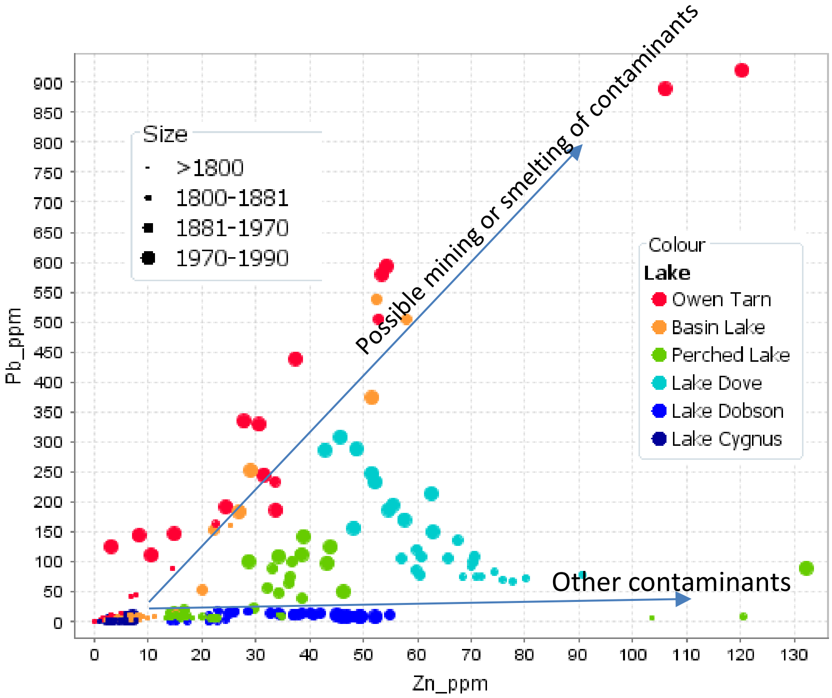

Figure 3 Plot of Zn and Pb concentration from the data appendices of Schneider et al (2019).

The statistical analysis and modelling only looks at one source of possible contaminants, then confuses correlation and causation in the interpretation of the data, to conclude that mining caused the contamination in all the tested lakes. This reasoning is not supported by the data or the principal component statistical analysis in the paper, which indicate that multiple sources of contamination are present.

REVIEW OF THE CONCLUSIONS

The conclusion that mining-related activities caused contamination in the western-most lakes is well supported by the data. However, in the eastern lakes (e.g. Lake Dobson) there is evidence that suggests contaminants may be sourced from elsewhere. The link between open cut mining and the contaminants, one of the major conclusions of the study, is also not supported by the data or by the historical records.

REVIEW OF THE ELECTRONIC APPENDICES

There are several minor technical problems with the appendices:

1. No detection limits are provided although a significant number of analyses are listed as below detection limit.
2. There is no indication of the uncertainty level at which the ages are reported in Table 2 (1 or 2 sigma?).
3. The ^{210}Pb dating table has two tabs, one with an earlier draft version of the data and the other with slightly different numbers and larger uncertainties, labelled “changed by AZ”. This suggests that there was an issue with the calculations that may have been rectified. However, there is no discussion of the issues and the reasons for the changes which does not give this reviewer full confidence that all the calculations are reliable.

RECOMMENDATIONS

- Although the conclusions and discussions of the paper are flawed, because only a single source for contamination has been considered, the overall data appears reliable enough to indicate that contamination has occurred in the mountain lakes. This finding is worthy of further investigation, as quite rightly highlighted by the authors of the study.
- The data indicates that several sources of contamination are present which are currently unexplained. These should be investigated further to determine if mitigation measures are possible or warranted.
- There are many puzzling features of the data that suggest some minor analytical or methodological problems may have occurred. For example, it is very difficult to propose a link for the strong Pb contamination of the Lake Dobson core, peaking in a layer dated at 1860, prior to the onset of west coast mining commencing in the 1880s. Repeating the analysis of several cores taken from the same location would help verify the validity of these results.
- To fully understand the source of the metals, and their potential bio-availability, further geochemical work needs to be undertaken. This type of work has been carried out on the Derwent estuary in Tasmania by Townsend and Seen (2012), Gregory et al. (2013) and Hughes (2015) and has been shown to accurately characterise and identify the source contamination from industrial activities in submerged fine sediments. These techniques include:
    - Modern multi-element analysis of the bulk sediments, which provides data for at least 30 elements. These techniques are cheap and widely available and gives more information on contamination than the 8 elements analysed in the Schneider et al. (2019) paper.
    - Micro-analytical work on the sediment in the cores using a scanning electron microscope to characterise contaminated particles.
    - Sequential leach analysis to determine the mobility of the contaminants.
    - Pb isotopic analysis of the bulk sediments to fingerprint the Pb contamination and allow the source to be determined and linked to its source (see Townsend and Seen 2012).
- The impact on the aquatic life should also be investigated but that is outside the field of expertise of the author of this review.

SUMMARY

Although the results of the paper showing metal contamination in Tasmanian mountain lakes seems reliable, the conclusions of the paper are not supported by the data. Further work needs to be done to clarify the sources and the potential environmental impact of the metals.

REFERENCES

Blainey, G.,2000. The Peaks of Lyell (6th ed.). Hobart: St. David's Park Publishing.

Gregory, D., Meffre, S., and Large, R. R., 2013, Mineralogy of metal contaminated estuarine sediments, Derwent estuary, Hobart, Australia: implications for metal mobility: Australian Journal of Earth Sciences, v. 60, no. 5, p. 589-603.

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Townsend, A. T., and Seen, A. J., 2012, Historical lead isotope record of a sediment core from the Derwent River (Tasmania, Australia): A multiple source environment: Science of the Total Environment, v. 424, p. 153-161.