

Interactive comment on “Biomass uptake and fire as controls on groundwater solute evolution on a southeast Australian granite: aboriginal land management hypothesis” by J. F. Dean et al.

J. F. Dean et al.

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We would firstly like to thank the reviewer for their constructive comments on this manuscript. We have responded to each main point individually, as well as all the specific points. The technical corrections suggested are all accepted. All alterations arising from this review have been made in the final manuscript that we will submit to Biogeosciences for consideration for publication. Here we respond to each paragraph in the order that they are written in the original reviewer comment, and address each specific point as numbered in the review.

General comments:

C1667

“Given that the saprolite is chemically depleted, the authors must account for the loss of these elements. Are the inputs from chemical weathering taken into account when calculating the mass of elements depleted from groundwater by uptake into vegetation?” – The saprolite is depleted in mobile elements, but the expected recipient of these elements, the groundwater, is not enriched but depleted in these species, and we propose that this is due to uptake by vegetation. The element depletions calculated in Table 9, which are matched with plant nutrient usage, are based on the depletions in Group A groundwater calculated in Table 5, so they take into account the inputs from chemical weathering. An extra sentence has been added on page 1841 to make this clear, and the caption of Table 9 has also been modified.

“The authors need to clarify whether these elements are depleted during transport from the surface to the groundwater (infiltration through root zone) or whether the trees are actually accessing the groundwater.” – Edwards & Webb (2009) demonstrated that the uptake of elements by plant roots occurs mostly within the top 50 cm of the soil (page 1840, lines 12-15). This study was carried out in an adjacent catchment to the present study, so we believe that the conclusions are applicable to our study area. The saprolite in this zone of plant uptake is chemically depleted, but the reason that there is no evidence for water-rock interaction is that the plant uptake removes the elements supplied to the groundwater by the rock weathering. An extra sentence has been added on page 1841 to make this clear. Although the trees may access groundwater where it is shallow, there is no evidence that they access deep groundwater.

Specific comments:

1. These details have been provided in the text.
2. The release of Si calculated from Equation 4 is much greater than the Si in the groundwater (after rainfall subtraction; Table 7), indicating that this species is also depleted.
3. The recommended definition of Na as a “beneficial” element is accepted and the

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wording has been changed – we only listed it as a micro-nutrient because it was our understanding that it was defined as such because it is often present in reasonably high concentrations in plants in Australia due its high concentration in soil and groundwater in drier areas. Where HCO_3 is present in high enough quantities in the soil and groundwater, plants can acquire it from these sources, but it may not be the primary source (Wallace et al., 1979).

4. The section on burning frequency has been expanded to provide the calculation procedure.

5. The studies that we referred to were carried out in high rainfall areas in the Northern Hemisphere; we have changed the text in several places to clarify this. We did not mean to imply that the Northern Hemisphere is entirely a high rainfall area, or that the Southern Hemisphere has no high rainfall areas.

6. The aboriginal fire regime was quite consistent for 20,000 years (the oldest groundwater age at the study site), and was replaced, after European settlement, by a less consistent pattern of burning, but a consistent removal of nutrients in agricultural production. Within the uncertainties of the available data, the overall impact of these two periods on depletion of dissolved species in groundwater appears to be the same. This is explained in the text (page 1843, last paragraph).

7. The text and caption for Table 2 have been changed to clarify this. Samples with ^{14}C activity > 100 pMC are younger than 1950. Samples with measureable tritium contain groundwater < 50 yr old, in some cases mixed with older groundwater (pMC < 100).

8. The table titles have been changed to remove the interpretations.

9. Explanation added to table caption (calculated by dividing median rainfall composition by depletion values for Group A groundwater in Table 5).

Technical corrections:

All corrections here are accepted and will be incorporated into the resubmission.

C1669

References:

Wallace, A, Mueller, RT, Wood, RA and Soufi, AM. 1979. Plant uptake of bicarbonate as measured with the ^{11}C isotope. *Plant and Soil* 51, 431-435.

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