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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.

Anonymous Referee #2

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General Comments

This manuscript presents an interesting perspective on solute transport in a system in southeast Australia where annual ET > MAP. Groundwater is depleted in major elements relative to precipitation (normalized with Cl), and the authors propose that uptake of nutrients by vegetation and subsequent loss through biomass burning has controlled groundwater chemistry over the past 20,000 years. The paper is generally well-written and presents a strong approach to studying this system.

However, there are a few inconsistencies between the data and the conceptual model presented by the authors. First, the authors demonstrate that the saprolite is depleted

in mobile elements (Ca, Mg, Na, K, Mn) relative to the unaltered granite. However, the authors also state that the groundwater shows no evidence for water-rock interaction. 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?

Also, evaporation does not change the chemical composition of the water, only concentrates the elements that are present, so the conclusions here rely solely on transpiration and preferential uptake of elements by plants relative to Cl. 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. If it's the former, why is there no evidence for water-rock interaction when the saprolite is demonstrated to be chemically depleted? If it's the latter, where is the evidence for trees that access water that is up to 20 m deep?

Specific Comments

1. Please define groundwater more specifically. Is all sampled water in a connected aquifer? Are the wells located in the saprolite or the fractured bedrock?

2. For Eqn. (4), do the measured Si concentrations match the mass balance of this equation?

3. The authors discuss Na and HCO3 as plant micro- and macronutrients, respectively (e.g. pg. 1840), but this is not consistent with Marschner's Mineral Nutrient of Higher Plants, which lists micronutrients as Fe, Mn, Cu, Zn, Ni, Mo, B, and Cl. Na is listed only as a "beneficial" element because it is not universally required. Please change the wording or provide support that these plants require Na. It is also unclear why more Na would be removed from groundwater than Mg, given that Mg is a macronutrient. To my knowledge, HCO3 is not a compound that plants acquire from water.

4. Please expand on how burning frequency was calculated.

BGD
11, C1066–C1068, 2014

5. High rainfall sites are often referred to as being in the Northern Hemisphere; however, many high rainfall areas are in the Southern Hemisphere, so this is not an accurate distinction.

6. Can the authors comment on why groundwater depletion is not dependent on the age of the groundwater?

7. Please clarify identification of waters as modern or old based on 14C and tritium.

8. Table titles should be concise and not include conclusions or interpretation of the data.

9. Table 9: how was "percentage of rainfall input depleted in groundwater" calculated?

Technical Corrections

p.1832, l.9: ". . .were filtered through 0.45 um filter paper and acidified using nitric acid."

Table 4. % Change in composition should not have so many significant figures.

Table 5. Change "Net species addition/depletion" to "Net species change" to avoid implying that the parameter is a ratio of addition to depletion

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Interactive comment on Biogeosciences Discuss., 11, 1827, 2014.