

## ***Interactive comment on “Storage and routing of water in the deep critical zone of a snow dominated volcanic catchment” by Alissa White et al.***

### **Anonymous Referee #1**

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#### General Comments

This study employed physical measurements of stream discharge, groundwater heads, and vertical variability of water content, combined with hydrochemical and isotopic measurements to help understand the functioning of water in the critical zone at the Jemez CZO over a one-year period. The authors conclude, rather surprisingly, that a deep aquifer in fractured tuff is the principal contributor to streamflow and is better connected to recharge/discharge than shallower perched or soil-zone water reservoirs. The study has a reasonably broad base of data from which to make inferences, and in general the reasoning is clear and the final inferences seem sound. My only real

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criticism is that the findings do not seem very generalizable. It is nice to know that this one, very small, catchment in the Jemez Mountains functions in this particular way, but what can we take away from this study that can be more generally applied? Does it help us, even in part, to answer larger questions that have been raised previously?

#### Detailed Comments

137: “uplifted” is really not the best word to describe formation of rhyolite domes; “emplaced” would be better.

140: Describing the Bandelier Tuff as “Pleistocene aged” is redundant; “Pleistocene” is a time interval and “aged” is not needed.

198: “Isotopes” are defined as variations of an element characterized by different numbers of neutrons. Water is a molecule, not an element, and therefore water does not have isotopes. “Isotopologues” is the correct terminology

245: Equations 4 and 6 do not actually give the corrected age until they are solved for “t”. Equation 5 does not give the  $^{13}\text{C}$  fraction from carbonate dissolution; it gives the  $^{13}\text{C}$  fraction from atmospheric carbon.

280: What principle does the Decagon EC-5 soil-moisture sensor work on?

428: The statement “both  $\text{Ca}^{2+}$  and DIC concentrations of shallow groundwater increase simultaneously, which is consistent with calcite dissolution...” is puzzling. In general, calcite will dissolve more when  $\text{Ca}^{2+}$  and DIC concentrations decrease, not increase. If the system contains no calcite and it is introduced, then its dissolution will be marked by increases in concentration, but we are dealing here with a system where the calcite is presumably fixed in the rock matrix.

449: “Isotopologues” rather than “isotopes”. . (Same thing for the Figure 9 caption). Also, the compositions of the isotopologues are plotted in terms of their  $\delta\text{D}/\delta^{18}\text{O}$  abundance, not “in space”.

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462-463: Note that the exponential ages are greater than the period over which the tritium input has remained constant (since 1992). The calculated ages are thus going to be biased young because the actual input TU was greater than the assumed.

532: The meaning of “cubic shape of the rising water table” is not clear.

556-560: The idea is not well expressed. It is the drying out between precipitation events that inhibits the infiltration of water, not “episodic recharge”.

568-570: I’m not clear on the reasoning here. The much higher water content observed between 1.5 and 4.0 m during the October survey (Well 2C; Fig. 6) has to be due to infiltration of precipitation over a long period of time. The difference in volumetric water content between October and the other surveys is roughly 0.25. Over 250 cm of vadose zone, this amounts to about 600 mm of water. What is the total July-October precipitation? I doubt that it amounts to 600 mm. Certainly the 0.25 mm immediately antecedent precipitation is irrelevant! So where this water came from is something of a mystery.

583: What is the value of the “depth corresponding to the gravel-like layer”?

587: The text repeatedly refers to “lenses” of high water content. Given that these are evidenced only on 1-D vertical profiles, how can you know that they are shaped like lenses in 3-D?

600: What is meant by a “blind fault”? Usually this indicates a fault that does not outcrop at the surface, and thus would not appear on a geological map.

613: “positive Si concentration pulses” is very awkward. Why not say “found pulses of high Si concentration. . .” instead? The sentence is run-on and its meaning hard to decipher.

621-622: “are produced by calcite dissolution” is preferable to “are a function of calcite dissolution”. Calcite as a mineral may be present in the perched aquifer, but calcite dissolution is a process that is “active” or “operative” or some other active verb. Give

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the number(s) for the figure you are referring to in this paragraph.

650-653: If the Site 2 water is not found in La Jara Stream, then how does it discharge? It must leave the system somehow.

656: “isotopologues” rather than “isotopes”

657: idem

679-684: By far the most diagnostic indicator of geothermal water in the Jemez is elevated Li. Was Li measured?

688: “isotopologues”

688: I’m not sure that the extent and permeability of some of these “stores” qualifies them to be termed “aquifers”.

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