Earth Surf. Dynam. Discuss.,
https://doi.org/10.5194/esurf-2019-54-RC1, 2019

Earth Surface Dynamics Discussions

Interactive comment on "Early–mid Miocene erosion rates measured in pre-Dead Sea rift Hazeva River using cosmogenic ^{21}Ne in fluvial chert pebbles" *by* Michal Ben-Israel et al.

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Received and published: 7 October 2019

Ben-Israel and co-authors analyze stable (21Ne) and unstable (10Be, 26Al) cosmogenic nuclides in detrital Miocene sediments from the NW Arabian plateau to calculate paleo-erosion rates and compare these to "modern" rates obtained from bedrock outcrops. They interpret an approximate 2-fold difference in concentrations to result from erosion rates that were 2x faster during the early-mid Miocene, which could be reasonable considering evidence for a wetter climate in the region at that time. On the positive side, this work illustrates the unique ability of the stable cosmogenic nuclide 21Ne to record erosion rates averaged over relatively short time intervals (if we can consider

100s of kyr short) in ancient, well-shielded sedimentary deposits; such information cannot be obtained with 10Be or 26Al. The authors are careful in their consideration of various potential complications of their data – post-burial deposition, changes in elevation through time, and how different types of detrital material (quartz sand v. chert pebbles) could have experienced very different pathways to the final deposition site. I also really like the use of different types of detrital material to assess the possibility of 21Ne inheritance. But I see several areas that require improvement. Most concerning for me is the discussion of the uplift-history constraints, which I don't find very convincing, but are critical for the final interpretations, as the difference in measured 21Ne concentrations between modern and mid-Miocene samples can be explained either by a change in elevation through time or a change in erosion rates. But even if there has not been a change in elevation, the difference in erosion rates reported (2-4 mm/kyr v. 4-12 mm/kyr) is not huge, and those mid-Miocene rates are still pretty darn slow. Is this really a story about how climate affects erosion rates, or could the conclusion be that it doesn't affect them all that much?

I'm also concerned by the small number of samples obtained from the outcrops (only two), and the possibility that the rates reported are not representative of modern rates (often spot samples from outcrops lead to a wide range of erosion-rate estimates). Are there any other modern erosion rates that have been reported that can be used to corroborate the results presented here? Is there a reason a modern erosion-rate estimate wasn't made from modern detrital sands in the region, even if that rate would not be from exactly the same drainage area as the early-mid Miocene samples?

I think the difference between the detrital quartz sand and detrital chert pebbles can be better emphasized in the final interpretations/conclusions of the paper. It seems that the quartz-sand results are not considered in the final interpretations due to the possibility that the quartz experienced multiple periods of deposition and exposure prior to the last deposition, hence it contains inherited 21Ne (if that's the reason that the erosion rates for the quartz samples are not reported, the authors should state

that explicitly rather than leaving it for the readers to infer; still I think the erosion rates should be reported). But rather than making it seem as if those samples were just a waste of time, it could be helpful to emphasize how in recycled sediments, inherited 21Ne can be a real problem. I like the approach here of measuring different types of detrital material to assess this possibility! That could be highlighted, rather than hidden.

Finally, I think the introductory paragraph can be improved; several of my line-specific comments refer to my confusion about where the paper is going just in the first several sentences.

Line-specific comments:

l. 36-37: Older landscapes are transient? Odd wording. Also, this sentence doesn't really follow from the previous ones. You've discussed river systems and sediment archives, now we're on to preservation of landscapes themselves? Be more precise and focused.

l. 38: Okay, so the focus is on quantifying erosion rates from surfaces? This is not easy to follow.

l. 41: If the focus is on erosion, don't change the terminology here to "surface processes", as that encompasses much more than just erosion.

l. 43: Now you've explained that the focus is on sedimentary deposits, not slowly eroding surfaces. I suggest rewriting this whole paragraph with a clearer focus on what information you want to give to the reader. What is the main problem, why is it difficult to address, how are you going to do it?

l. 51: Wouldn't it be the other way around, i.e., the Afar plume leads to magmatic events, and maybe even influenced tectonics?

l. 67-69: This means that the deposition associated with the river started prior to ca. 20 Ma? Or do you interpret only the upper part of the Hazeva Formation to be associated with the river, meaning that fluvial deposition started after 20 Ma? Please clarify.

l. 99-101: How is this history of the quartz sand known? If this history is going to be important for explaining differences between 21Ne measured in quartz vs. chert, then a fuller explanation is needed. One potential worry with quartz sand is that it could be aeolian in origin; can this be ruled out? What size fraction of sand was processed?

l. 90-105: I suggest moving this paragraph to the geological setting, as it provides the geological context for the samples collected.

l. 109: How deeply shielded were the collected samples? Deeply enough to rule out post-depositional 21Ne production?

l. 113: I suggest "accumulated cosmogenic nuclides only during exhumation", as the samples that experienced the full sedimentary cycle also accumulated nuclides during exhumation.

l. 156-157: Is this because you assume the U and Th are equally distributed throughout the rock? Is that a reasonable assumption?

l. 212-217: Don't assume that your readers remember that EJC5 and EJC3 were the surface samples of from the "in situ" outcrops, remind us.

l. 214-215: This detail concerning the scaling of production rates belongs in the methods, not the discussion.

l. 223-224: I don't see the added value of reporting equivalent exposure times (if that is what is meant by "simple exposure time"), given that you are mainly interpreting the measured concentrations in terms of erosion rates. Or is the goal to give readers a sense of the averaging timescale of these erosion rates? If the latter, I suggest rewording to make this clear.

l. 224-226: It is important, but why? I can make a guess, but it would better if you explain.

l. 230-231: Could you please briefly remind me what those differences in concentra-

tions are?

l. 237-239: A bigger overview map that includes the Suez rift in addition to the all the other relevant sites mentioned here would be very helpful.

l. 237-242: These uplift constraints are crucial for your interpretation of whether or not there the Miocene samples show a faster erosion rate compared to today or reflect a similar erosion rate with a lower nuclide paleo-production rate. Given their importance, some more details on these uplift constraints would be very helpful. Although I have not checked each of the references in detail, I disagree with how you have referenced the Wilson et al. (2014) interpretations. Despite many reasons why these interpretations of uplift histories from river profiles should be considered suspect, their interpretation for your field area is that most of the modern elevation gain occurred since 20 Ma, and it looks like more than half of that is since 10 Ma (see their Fig. 17). For that reason, I don't agree at all with your statement that it is reasonable to presume that the western flank of the Arabian Peninsula (or the NW edge, corresponding to your field area) reached its current elevation prior to the initiation of the Hazeva fluvial system at ca. 18 Ma.

l. 255-258: I can guess why you do not mention erosion rates from the quartz sand – because you suspect it has inherited 21Ne – but it seems like an oversight. I suggest to not "hide" those results, but rather emphasize how recycling of quartz sand can lead to incorrect results.

l. 281-287: Mostly I've been able to work out myself whether you are referring to surface uplift or rock uplift up until now, but in this section in particular I cannot follow your meaning. In this paragraph, and ideally throughout the manuscript, specify which one you are referring to.

l. 285: But this is not an accurate representation of the uplift history for your field area as interpreted by Wilson et al. (2014).

l. 288-300: This evidence for a wetter early to mid Miocene climate seems reasonable, and I agree that such a climate would likely erode faster than low-relief, hyperarid landscapes. But the mid-Miocene erosion rates reported here, which might be considered maximum rates given the uncertainty in the paleo-elevation, still seem very slow. How do rates of 4 to 12 mm/kyr compare with erosion rates measured from similar environments today? (Incidentally, I realize I'm assuming that the landscape relief is relatively low, but it would be helpful to actually show a slope/relief map to see whether or not that's the case.)

Figure 2: As mentioned above, a broader overview map would be very helpful. In 2B, is that a person near the bottom? Highlighting or circling him/her in some way would make it easier to understand the scale of this photo. Likewise, in 2C, is that a dog?

Figure 3: Given the overall focus on erosion rates, I find it odd that the calculated erosion rates are not shown in this figure. Why not use those instead of the effective exposure ages?

Editorial comments:

l. 35: always specify what you mean after "this", e.g., this lack of information?

l. 64: "comprise" rather than "compose"

l. 71: I'd suggest "disruption" rather than "dismantlement"

l. 81: What "cycles" are you referring to here? Okay, you clarify it in the next sentence, but please instead clarify at your first instance of using this term.

l. 86: This what should hold true?

l. 96: comprising, not composing

l. 210: Please refer to "denudation" or "erosion" rates throughout, not "rates of surface processes", which is unnecessarily vague.

l. 221: lots of needless words here, please shorten to “erosion rates between 1 and 5 mm/kyr”

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