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Interactive comment on "Chlorine-36/beryllium-10 burial dating of alluvial fan sediments associated with the Mission Creek strand of the San Andreas Fault system, California, USA" *by* Greg Balco et al.

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General comments

This excellent paper presents a new approach to burial dating using the cosmogenic nuclide pair 10Be and 36Cl, respectively measured in quartz and K-feldspar of the same sediment clasts. The study is very well designed and presented, and represents a significant contribution to the field of quantitative geomorphology, as this novel strategy extents burial age determinations towards younger time ranges in comparison with the commonly applied 10Be-26Al nuclide pair. Although only few data could finally be used to actually conclude on the burial age of the studied sediment units

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Discussion paper

(and thus on the minimum slip rate of the related section of the San Andreas Fault), the authors used the inconclusive measurements to explore the limits and challenges of the method, which will be very helpful for future applications of paired 10Be-36Cl measurements. I only have a few mostly very minor comments and suggestions for clarifications.

Specific comments

Line 22 – page 2, line 1: maybe clarify that "sediment is exposed to the surface cosmic-ray flux during erosion" refers to processes in the source area of the material and also includes bedrock

Page 2, 7-9: It would be appropriate to be a bit more specific, i.e. to give examples of the methods that you compare the cosmogenic nuclide burial dating with and add references. Do you mean to imply here that burial dating is only useful in arid regions?

Line 22: Please clarify "short relative to the half-life. . .": what does this quantitatively mean and why is it important? E.g. in the case of 36Cl, should the surface exposure period be less than 300 ka? Otherwise the ratio would be dominated by the decay rate?

Page 3, line 17-18: Bierman et al., GCA (1995) attempted to use cosmogenic 36Cl produced from Cl in fluid inclusions in quartz to quantify erosion rates and exposure ages. I think it would be appropriate to cite this study.

Page 5, line 28: "dated to 0.5 – 1.1 Ma" using which method?

Page 5, Line 33 – Page 6, lines 2: I guess the samples from the three stratigraphic levels were taken along a horizontal transect and not on a vertical transect due to issues of accessibility?

Page 7 line 14: "a double-isotope-dilution method": I guess you refer to the routinely used isotope dilution technique that is described e.g. in Ivy-Ochs et al, NIMB (2004) and Desilets et al., Chemical Geology (2006)? Otherwise please clarify.

Page 8, line 7: in which SGS lab the aliquots were analyzed?

Page 9, line 6: Please note that thermal neutrons are directly produced during spontaneous fission of U, but indirectly during decay of U and Th through alpha,n-reactions (see Gosse and Phillips, 2001; therein called “nucleogenic” instead of radiogenic 36Cl, which would be probably more correct)

Page 10, lines 1-2 and 16: Please quantify the “small effect” of these different muon-related scaling differences. E.g. according to the models you use for the calculations, what are the muogenic 10Be and 36Cl contributions in the range of altitudes of the considered catchments?

Page 11, line 8: for completeness it could be added that 36Cl production from K spallation and 10Be production in quartz are assumed to scale identically.

Lines 9-11: Here again, please quantify the “significant fraction” of 36Cl produced from muons in the considered depth range. This sentence seems in contradiction with lines 1-4 of the same page, where you imply that the muon-related 36Cl production and associated inaccuracies in the considered subsurface are low enough to be insignificant. Please clarify.

Lines 15-17: It should probably be added that the predicted production ratios depend on altitude and feldspar composition and are therefore different. Which sample-specific characteristics are included in the “calculated surface production rates” that you use to normalize the nuclide concentration: scaling, but also feldspar composition, right? I guess the calculations are those in equation 1?

Page 11, line 17-Page 12, line 2: What would happen if the samples were not steadily eroded? On page 16, lines 18-19, you seem to imply that if the sample didn’t originate from a steadily eroding surface, the burial age could not be determined – probably due to the varying production rate ratio? Is this issue unique to the 36Cl-10Be pair?

Page 12, lines 9-11: this seems like a circular argument: you use the comparison of

the observed to calculated ratio to check whether or not the sample is at steady state erosion (lines 3-5), and here you use the same comparison to conclude that the applied reference production rates are accurate. Please clarify.

Fig. 7, caption: Regarding the sentence that starts with "Note that the steady erosion. . .", please specify "high erosion rates". According to the diagram, the simple exposure line lies below the steady erosion line from the left-most erosion rate ($\sim$15 m/Ma) on, so over the whole spectrum of considered erosion rates.

Page 16, lines 3-5: Please clarify how you determined 0.2 Ma burial at a depth of 1000 g cm-2. Is this just a scenario that could explain the measured nuclide concentration assuming 100% production during burial?

Page 17, line 5: Please clarify where the burial age "near 0.5 Ma" comes from.

Technical corrections

Page 1, line 14 and Page 17, line 27: add OLD after 260 ka.

Page 2, line 12: remove the last "the"

Page 5, line 5: San Gorgonio Pass region and San Bernardina Mountains are not visible on Figs 2 and 3. For readers who are not familiar with these locations, more specifications about the geographic relationship between them and the study site will be helpful.

Page 5, lines 29-30: I guess "late Pleistocene alluvial fans" refers to the yellow signature in Fig. 2, which is called "late Quaternary" in the legend. To facilitate reading, please be consistent between text and legend.

Lines 30-31: avoid using two times "estimated"

Page 10, line 15: estimating

Line 24: Note that this parameter is the production rate of epithermal neutrons (from

fast neutrons) in the atmosphere

Fig. 6, right panel: For better readability, I suggest writing some of the names, e.g. those of the surface samples, on the left side of the curves.

Fig. 7, caption: sample MCP-11a does not exist, it should be b. For clarity, put the last sentence of this caption before “Note that the steady erosion. . .”.

Page 13, lines 7-8: “a possible explanation for this mismatch is that” could be removed

Page 14, lines 7-11: this sentence is too long and therefore hard to read. Does “highlights” refer to “agreement between the calculated and observed 36Cl/10Be ratio. . .”? If yes, it doesn’t seem logical.

Table 1: the caption only describes parts of what is shown in the Table

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