

## ***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.***

**Jennifer Lamp (Referee)**

jlamp@ldeo.columbia.edu

Received and published: 4 June 2019

### General Comments

This paper by Balco et al. is a thorough investigation into the use of the  $^{36}\text{Cl}/^{10}\text{Be}$  cosmogenic nuclide pair (produced in the minerals K-feldspar and quartz respectively in the same granitoid clast) in burial dating. They argue that this pair is more accurate than the commonly-applied  $^{26}\text{Al}/^{10}\text{Be}$  pair for sediments/clasts in the range of 200–500 kyr due to the shorter half-life of  $^{36}\text{Cl}$  compared to  $^{26}\text{Al}$ . In the study, the authors use the technique to uncover information about the age of sediments displaced by a portion of the San Andreas fault in southern California. While their conclusions are

C1

complicated by low nuclide concentrations and difficulties in estimating the  $^{36}\text{Cl}/^{10}\text{Be}$  production ratio for the buried clasts, I find the description of the technique and the authors' comprehensive look at multiple aspects of dating clasts with this novel method to be particularly illuminating and extremely useful to the wider cosmogenic exposure dating community. They investigate quantitatively possible explanations for the scatter in their dataset, in addition to general limits and applicability of the  $^{36}\text{Cl}/^{10}\text{Be}$  burial dating pair. I additionally appreciate the authors including the detailed AMS data calculation spreadsheets in the supplement, and providing their MATLAB scripts online for all to reference.

My only general critique is that I'd like to see a more detailed discussion of the uncertainties associated with using this technique, and the impacts on the final  $^{36}\text{Cl}/^{10}\text{Be}$  ratio. Should “external” errors be used (i.e., those including uncertainties in the production rates in addition to measurement uncertainties) because you're comparing two different isotopes in two different minerals with varying production pathways? While I'm not an expert on  $^{36}\text{Cl}$  cosmogenic dating, I would expect that the multiple production paths for  $^{36}\text{Cl}$  and the  $^{36}\text{Cl}$  production rate dependence on the chemical makeup of the K-feldspars and bulk rock (plus the uncertainty in water content, etc.) could make the error on the  $^{36}\text{Cl}$  concentration (and hence the final ratio) quite large depending on what uncertainties are propagated through the calculations. It's possible that this information could be gleaned from the MATLAB scripts, but it would be nice to see a few sentences of discussion in the manuscript about this.

Overall, this is an excellent paper and I highly support it being published with only minor edits.

Specific Comments – I wonder if the title could be reframed to focus more on the technique than the specific Mission Creek application, as I think the study most convincingly explores the background and limitations of the  $^{36}\text{Cl}/^{10}\text{Be}$  pair as a general burial dating technique. Something like:  $^{36}\text{Cl}/^{10}\text{Be}$  burial dating of granitoid clasts: a case study in the San Andreas Fault system (etc.). Or, something that would highlight

C2

the technique/method over the application in this case.

âĀć Page 2, Eq. 3 and Lines 2-5: Eq. 3 and the variables therein are difficult to interpret at first glance due to the lack of subscripting.

âĀć Page 2 Lines 10-15: See general comment above; does the better precision for the  $^{36}\text{Cl}/^{10}\text{Be}$  pair hold out if production rate/chemical composition uncertainties are taken into account?

âĀć Page 6, Lines 8-10: Do you have pictures of these samples? Perhaps include them in the supplement if not in the main text?

âĀć Page 7, Lines 11-12: Supplementary tables 1 and 2, or supplementary spreadsheets 1 and 2 (SF1, SF2)? I don't see specific supplementary table names in the files.

âĀć Page 8, Lines 2-3: How does the amount/uncertainty of Cl in the HF affect the resulting burial age uncertainty?

âĀć Page 8, Line 5: Table S3 = spreadsheet SF3?

âĀć Page 10, Lines 17-24: What are the uncertainties on these production rates?

âĀć Page 11, Lines 6-7: It would be interesting to provide a plot of either the  $^{36}\text{Cl}/^{10}\text{Be}$  production ratio or just the  $^{36}\text{Cl}$  production rate vs. K-concentration for each sample as part of Fig. 5 or 6. (The reader could glean this from info in the Tables, but it would be nice visual).

âĀć Page 14: Line 31: "...do not show evidence of significant burial" is a little confusing because you also assert that the  $^{36}\text{Cl}/^{10}\text{Be}$  ratios are due to post-burial nuclide production. Perhaps rephrase slightly?

âĀć Page 16, Lines 9-14: Are there any visual differences (weathering features, grain size, etc.) between sample MC-P7-8 and the others?

C3

âĀć Page 16, Lines 14-15: Are these surfaces the same lithology as MC-P7-8?

âĀć Page 17: Lines 10-11: Perhaps rephrase this; e.g. "For the minority of samples in this study that have relatively high nuclide concentrations, and possible arise from relatively low-erosion-rate environments. . ."

âĀć Figure 2: Including a map here that is in between the scale of the inset regional map and the sample map would be helpful; it's a bit difficult to understand the position of the study site.

âĀć Figure 6: Can you add sample labels to Panel A? The bold lines in this panel are difficult to discern; I assume they just all overlap?

âĀć Figure 7: Caption should read MCP-11b instead of MCP-11a.

âĀć Table 1: Are the sample thicknesses and densities listed somewhere? Also, there is a superscript missing for "g-1" under "cosmogenic  $^{36}\text{Cl}$ ".

âĀć Table 3: extra space before the period in the table title.

---

Interactive comment on Geochronology Discuss., <https://doi.org/10.5194/gchron-2019-2>, 2019.

C4