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# *Interactive comment on* "Eliciting geologists' tacit model of the uncertainty of mapped geological boundaries" *by* R. M. Lark et al.

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**Reviewer 3 (C. Bond)**

We are grateful for this reviewer's careful reading of the paper. We cited a good deal of literature on boundary uncertainty. We acknowledged at page 154 l 17 that others have used elicitation in the earth science, and we can expand the list of examples as suggested.

It is *always* true of uncertain quantities in science that they emerge from unique settings and situations. Take a simple example, the porosity of a rock sample. Before we measure a sample its porosity is unknown. That porosity depends on specific factors,

at all spatial scales, in the deposition of the material that constitutes the particular piece of rock, it depends on the inclusion of larger clasts, of any burrowing animals that might have been present soon after deposition, on any factors that influence cementation and subsequent diagenesis, on any mechanical stress or strain imposed subsequently through any folding etc etc. As we learn about these factors for any one case so our uncertainty about the porosity is narrowed down, but that does not affect the fact that a statistical distribution can describe our uncertainty about the porosity of the rock when all we know is that it is from, for example, the Bunter Sandstone. We maintain that the same is true of the boundaries in our scenarios (we note that there is a fair bit of specific information in the description of each), and it is precisely the variability over the possible specific instances of each scenario that the experts are asked to access when considering the 100 notional cases (see page 158, l 2–13.) We will expand on this in the revised paper, perhaps near page 155, l 10 in the current version of the paper.

We agree entirely that the elicitation does not reproduce the workflow of mapping, it was not intended do. We do not seek to elicit the position of the boundary given all available information. Rather, we seek to elicit the distribution of possible true positions of the boundary along a test transect, given the postion of a mapped boundary (assumed to have been mapped by a BGS geologist following BGS surveying procedures). That is because we start with existing linework from past survey and want to be able to quantify its uncertainty so as to be able to apply appropriate buffers to it, for example. This was clearly not made sufficiently explicit in the first version of the paper (see in particular our responses to reviewer 4) and we shall pay particular attention to setting this out in the revised version.

*Detailed comments*

- p 150. This is true, but our emphasis is on the UK.
- p 151, l 7–8. We will edit the sentence to read ‘it can be inferred that the crop



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line for a unit occurs somewhere on a line between one borehole where the unit is seen to be in subcrop beneath superficial material and a second where the contact is below intervening bedrock units'.

- As noted above, we acknowledged in the original paper (page 154 l 17) that others have used elicitation in the earth science, and we can expand the list of examples in the revised version.
- p 154, l 15. This is not the case. Broken lines are certainly used in field mapping, but have in the past been transferred onto maps published by BGS and are used in digital products.
- p 154 l 17 Can add this and other references as suggested.
- p 158 l 13. We can indicate that all the elicited experts are listed as authors of the paper.
- p 160, l 11–15. As noted in the paper the initial individual elicitations were anonymized, but in all cases the participants were willing to acknowledge them. In fact the whole basis of the SHELF approach is structured discussion rather than more or less ad hoc weighting of individual elicitations, which requires that individuals are prepared to discuss and to defend their own views. We can expand on this in the discussion in the revised paper.
- We can expand the explanation of the probability densities in the revised paper.
- Page 163, line 23–27. On the contrary, this particular observation shows that the expert understood the nature of the elicitation. He realized that, out of 100 instances of the scenario as described, in some cases such patches may occur, causing error in the mapped position of the boundary. His assessment of how



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often this might happen directly controls his view as to how biased the overall position of the boundary might be. This is a very useful illustration of the basic concept of how experts "access" possible specific cases consistent with scenarios, which is absolutely fundamental to how expert elicitation of uncertain quantities works. We will expand the paper at page 158 l 7 et seq. to make absolutely sure that this is clear to the reader.

- p 167. See the first paragraph of our response to this reviewer. *Every* measurement in science is unique, from a unique scenario, but we can still describe the variability consistent with the general description of the scenario with a probability distribution, and that is what we do here. This will be emphasized in revision, perhaps near our expansion of the paper near page 158 line 7. The fact that there are differences between the general scenarios, in the tacit mental model of the BGS surveyor, can be seen by a cursory examination of Figure 4 and 5. This will be picked up and emphasized in the discussion of the revised paper.

- p 168, l 1. This reference is particularly interesting, and will be cited here in the revised paper. Note that our elicitations showed how one expert could influence the view of the group as a whole, but that in all cases the final distribution was somewhat modified from what this individual had put as their starting point. Note also that in scenario six there was no consensus, showing that the group did not inevitably 'herd' to a common position.

- p 169, line 11–13. In some cases panel members needed to be reminded that we are considering a notional transect examined exhaustively to test an already-mapped boundary, not a traverse being examined according to normal procedures in order to map a boundary by interpretation. We will expand this in revision.

- p 169, line 20. A 2D map polygon is an individual delineation of a particular mapping unit, i.e. a closed region on the map assigned to a particular unit, or



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a region partially bounded by the end of the map sheet. We accept that this terminology is used mainly in GIS rather than conventional cartography, and will clarify it in revision.

- p 169 l 20–25. This text is identical to the third paragraph of the reviewer's general comment, and our response is set out above.
- p 170, l 20. 'Anchoring' has a specific meaning in the psychological literature pertinent to perception of uncertainty and expert elicitation. We will clarify this in the revised text.
- p 171 line 20. We do not think that explaining all the codes is good use of space, and we tell the reader that they are lithological codes, and give a reference where they can be looked up. We think this is sufficient, but will, of course, follow the editor's advice on this.
- Figure 2, agreed, as noted in response to other reviewers.
- Figure 3, we will do this in the revised paper.

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Interactive comment on Solid Earth Discuss., 7, 147, 2015.



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