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Solid Earth Discussions

Interactive comment on "Mapping the fracture network in the Lilstock pavement, Bristol Channel, UK: manual versus automatic" *by* Christopher Weismüller et al.

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Summary Comments: When revised this manuscript will likely become a well cited methodology paper that is being published in a very timely manner. The basic structure and the data of this contribution of certainly of sufficient quality to publish. However, the document needs to achieve a stronger alignment of its actual text with its purpose of comparing the effectiveness of manual and automatically derived fracture trace maps and related fracture parameters or information about fracture development from a UAV-derived composite digital map of a very large fracture trace population. The comparison is not sufficiently developed and even lost, as in the Conclusions, in the narrative of the

document. Key matters that need to be addressed are (1) actual presentation of data related to time required to perform each method; (2) a more effective utilization of fracture intensity (P21 in this case) as a discriminator of quality and/or match between the two data sets, including a careful explanation and use of the attributes that compose P21; (3) avoid two unsupported interpretations in the Discussion; and (4) rebuild the Conclusions so that they are actually about the purpose of the manuscript and highlight key outcomes related to that purpose. All of these changes should be achievable and will add real value to the contribution, such that is should become a strong document valued by the research community.

The work is based on an excellent coastal platform exposure of thin-bedded Jurassic limestones at Lilstock, Somerset, England on the south side of the Bristol channel that has been the focus of a number of previous studies about fracture patterns in rocks.

Major Comments: Section 3.2, Line 150 and elsewhere in the text - Repeatedly and with good reason, the point is made that the manual tracing of the fractures in the digital maps is very time consuming and limits a researcher's ability to effectively utilize the large data sets that can now be created through tools such as UAVs and digital imaging equipment, so the development of effective automatic characterizing protocols will greatly enhance the amount and quality of information for analysis by researchers. Yet, the manuscript does not offer any data to justify this statement. For example, stating the amount of time needed to create each of the five manual samples vs. the five digital samples should be simple and effective. Further, then a comment/short narrative could be added into the discussion about the amount of time that would be needed to characterize the entire "bench" automatically and how, for such a modest amount of time, one would have a much richer data set to tackle..... Consequently, the manuscript should be revised to explicitly document the difference in time usage between the two methods, and then should consider the implications of having the quicker, more powerful automatic approach in the discussion.

Line 156 - It is very important to explicitly state that the manual data set is derived the

digital imagery and was not collected in the field (Correct?). This point in the text is a good place to present this point clearly.

Lines 224 to 225, Fig. 4, and S1-P21 difference illustration - This comparison of fracture intensity between the manual and automatic data gathering approaches is presented as being a primary tool for relating the information and quality from the two data sets. Yet, this comparison is significantly underexplained. For example: (1) Why is a P21 comparison such an effective choice for comparing the two data sets? (2) Just how good is the match, particularly as nothing is said to explain and/or characterize the difference illustration in the S1 illustration? (3) Why is no basic explanation provided of what a reader is seeing in Fig. 4, such as the use of meter-square sample areas, or consideration of the sensitivity from P21 varying spatially from 0 to 18 m-1? (4) Why the lack of an actual narrative comparing the two sets of imagery qualitatively, particularly if locations exist where the match is poor and that needs explanation to, for example, show the overall strength of the approach?

Lines 226 to 227 - An expectation is presented that a larger number of traces would generate a greater fracture intensity (P21) than a smaller number of traces. This expectation is not well rooted. Intensity P21 is a function of total trace length in a sample area, and that is a function of both the number of fracture traces AND their individual lengths (the authors show an understanding of this point in Lines 234/235, but have not utilized that understanding here). So, a fracture population with more traces may, in fact, be less intense because its traces are individually shorter than the other population with fewer but longer traces. Therefore, any expectation of differences in P21 between the two fracture trace populations would need to consider both the number of traces and some aggregate representation of the population of lengths, such as the mean length. Further, if the number of traces is thought to be the key parameter, a much more detailed presentation about the total number of traces in each sample window for each of the two sampling procedures is needed. Overall, the underlying logic of this comparison needs to be better developed and then more completely explained,

if utilized.

Line 367 - Given that the discussion covers "classification into fracture generations" and "network analysis", it is not at all clear why "Passchier et al. (XXXX)" needs to be cited, particularly as it is a very shaky citation with no status or occurrence in the references.

Sinuosity values vary so little from one sample window to another and with respect to the sequence of fracture development in the sample window patterns, would it not be better to eliminate all description/discussion of sinuosity from the manuscript, so as to simplify and focus it?

Lines 411 to 413 - An important comparison of difference is made in this sentence, Yet, no evidence or citation from other work is provided to support that this comparison is correct. So, the statement is an unsupported speculation and really needs to be better than that for the purposes of this manuscript.

Lines 419 to 421 - Here is another key point that is incompletely developed and explained. Particular examples of "human bias" should be identified with explanation. Then the highlighted text can be eliminated and replaced with text that has greater meaning and clarity. Further, the replacement text will need to be a few sentences rather than just one sentence, given the importance of this point.

Line 516 and Conclusions - Given the title of the manuscript and the setup of the abstract and introduction, these conclusions show a surprising lack of content related to comparing manual and automatic methodologies. The conclusion should be reorganized to begin with comparison outcomes (e.g., time usage, P21 comparison, managing manual input into automatic interpretation by parameter selection, etc.). It should delete any text related to superiority of manual to automatic unless a substantial addition is made to the manuscript about that matter. Then it can list particular outcomes for the samples of this particular fracture pattern in this particular location and geological setting, which are not the central focus of the contribution of the manuscript. Lines

423 to 425 - Again, examples with identification in figures are needed to support and document this point.

Comments: Line 21 - As this paper has a focus on methodology, the abstract should briefly present an explanation here as to why automatic assignment of fractures into generations cannot yet be done.

Lines 31-32 - The fracture geometries are set and not "evolving" so the explanation for the connectivity increase needs to be replaced/improved.

Lines 51 to 53 - This sentence should be moved to the end of this section (Line 59), so that this paper's purpose and approach is stated completely first.

Line 52 - What is the status of this companion paper (it is not in the reference list)? Can it be cited or does reference need to be made an unpublished source? Or?

Line 84 - Joints and not jointing are unfilled.

Line 104 - "v" - The significance of the radial pattern to the NE is not provided, so this text is superfluous to the later part of this point. If the radial pattern has significance, it should probably be a separate "vi".

Lines 132 to 140 - Text revised to create a narrative that more contrast imagery results for flight altitudes of 100m or 10m vs. 25m, including the removal of the green highlighted text.

Lines 133 to 137 - This highlighted text as written breaks up the narrative flow. It should likely be added to the end of the text on Line 127.

Lines 145 to 148 - This text should be moved up to the end of Line 127 to complete the general description of methodology. Thus, the subsection will finish with the determination of the optimal flight height and the creation of the overview.

Line 154 and elsewhere in the text - Please remember that "this" and "these" are neither pronouns or nouns.

Line 172 - The intensity belongs to the product, the fractures, and not to the process in this case (clearly, fracturing can be intense, but that is not the intended meaning here, as the description is of a "final fracture population".).

Line 201 - Again, can this contribution actually be cited? What is its status? If it does not have an accepted or published status, what can be used as a citation in its place?

Line 214 - Again, can this contribution actually be cited? What is its status? If it does not have an accepted or published status, what can be used as a citation in its place?

Line 222, Section 4.1 - This section would benefit from a revised title and the addition of two subsection headings to facilitate reader understanding: (1) The entire section is about P21 so change the title to be explicit about trace intensities rather than just traces. (2) 4.1.1 Intensity comparison between two methods (3) 4.1.2 Characterization of intensities for automated data - these two subsection titles clearly separate the purposes of these two portions of the text.

Line 224 - Not everyone knows P21, so here is a good location to simply and explicitly define the term. Note: P21 tends to be our best available measure of fracture abundance for natural rock outcrops and does have wide usage, but it is not universally known.

Lines 227 to 231 - If this text is meant to explain why the P21 intensity for the automatically collected data as compared to the manually collected data, it does not achieve that outcome. What is this text attempting to say? It is not clear?

Lines 231 to 233 - This sentence is not about the P21 comparison between manual and automate, but rather a description of the differences in P21 for the automated data set. It should be the first sentence of the next paragraph, which is about spatial variations in P21 for the automated data sets.

Lines 239 to 241 - The description of maximum length needs to allow for censoring by the sample window perimeters. The identified maximum lengths cannot be stated

to be the actual maximum length of any trace that is sampled in a window because of censoring. Now, it is possible to consider the maximum length of traces that are fully contained in a sample window, but that needs to be stated explicitly.

Line 254 and Figure "18" - To preserve order of figure citation, Figure 18 should become Figure 8, and Figures 8 to 17 should be renumbered.

Line 259 and new Figure 9 (old Figure 8) - This figure illustrates length-weight fracture-trace abundance as a function of orientation, so it does not show "fracture strike" in any simple manner. The text is revised in this line to better describe what is being illustrated.

Lines 264 to 265 - This sentence is an interpretation of observations before the observations are fully presented, so it is out of place and should be deleted.

Lines 265 to 266 - Redundant and unneeded sentence

Line 281 - How are these "denser clusters" recognized or statistically defined? A reader must be able to use the criterion/criteria to identify the clusters themselves. If reproducible methodology does not exist, the statement about orientations modes for clusters should be deleted.

Line 288 and Line 289 - text revised in these two locations to more completely and correctly describe the pattern characteristic of the fractures in the NE1 sample window, and in the NE windows vs. the SW windows, respectively.

Line 289 - text revised to more simply and clearly describe the lack of a relative age relationship.

Lines 291 to 293 - Sentence revised to more clearly identify and state differences with citation of Table 4 being placed in the parentheses at the end of the sentence to not distract from sentence meaning.

Line 301 - Adding the word "evolution" to this sentence is important for clarity and

meaning.

Throughout the text – “mapping boundary” should be “map boundary”

Lines 369 to 370 - Are these two sentences needed here? Their contents are not used immediately. Their content should be added where it is needed further into the document.

Lined 373 - Cite published work that supports the lack of sampling bias and similarity of results for exposure of this quality for different operators. Solid Earth has a publication about this matter, for example.

Line 382 - "excessive" requires some more explanation and/or examples to assist reader comprehension

Lines 388 to 395 - Not convinced that this discussion of the comparison of P21 between the manually and automatically acquired datasets is particularly useful because it considers number of traces separately from the distribution of tracelengths, which is somewhat arbitrary.

Lines 411 to 413 - An important comparison of difference is made in this sentence, Yet, no evidence or citation from other work is provided to support that this comparison is correct. So, the statement is an unsupported speculation and really needs to be better than that for the purposes of this manuscript.

Lines 426 to 438 - This paragraph needs an introductory sentence to establish its purpose and why three different characteristics are being "juxtaposed" in one paragraph. An example sentence is offered.

Lines 452 to 453 - This one sentence paragraph is not really needed as written. A clause is added to the opening sentence about generation 5 to preserve overall narrative flow.

Line 460 to 461 - Text revised and added, so as to achieve greater clarity with a more

complete and needed explanation for readers.

Line 464 to 466 - Text revised to more clearly explain situation and to more simply state examples of possible causes.

Lines 467 to 473 - Recommend the elimination of this text because sinuosity is not a distinguishing characteristic for this study.

Lines 504 to 505 - Interpretation is non-unique and unsupported, so it should not be included in the manuscript.

Please see the annotated PDFs for the main text and figures for additional detailed comments about the syntax.

Captions: Figure 1 – Lines 724-725 states “The study areas on “the bench” that are mapped in detail are marked in 725 red.” Yet, the only red in the illustration are the red lines for faults. Is the color incorrectly identified or is something missing from this illustration?

Figure 2 - Line 731 - the object in 2a to 2e should be identified in the caption. Also, 2a to 2f should have scale bars even if they are approximate.

Figure 4 - Line 737 - Please note suggested addition to the text at the end of the caption.

Figure 7 - the labels for the X and Y axes of the three sets of graphs should be larger, so that they are easier to read when viewing the entire figure.

Figure 9 (10) caption improved by explicitly identifying that data belong to manually collected set and providing a better description of the rose diagrams.

Figure 10 (11) Caption - Revise to match revised Figure 9 (10) caption. Eliminate the addition sentence because the network cannot be described as being "oriented NW-SE". The pattern for NE2 can be described as having a strong length-weighted orientation mode that trends NW-SE, but even that information is likely not needed in

the caption here.

Figure 11 (12) - the key at the bottom of the figure should use larger dots so that the colors are easy for readers to distinguish. While these solid circles will be much larger than the actual ones in the plot, that is not an issue because assigning the colors easily to the generations for the readers is the goal.

Figure 13 (14) caption - make the change in the first sentence of the caption for Figures 14(15), 15(16), 16(17), and 17(18).

Tables - Orientation data in all tables - These data should be rounded off to the nearest integer. The use of two significant figures to the right of the decimal point is false precision, particularly for the manually traced lines.

Table 1 – Title expanded to explicitly identify that the characteristics stated in the table related to the automatically generated fracture network

Please also note the supplement to this comment:
https://se.copernicus.org/preprints/se-2020-67/se-2020-67-RC2-supplement.pdf

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Fig. 1.