Solid Earth Discuss.,
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Solid Earth
Discussions

Interactive comment on "Electrical Formation Factor of Clean Sand from Laboratory Measurements and Digital Rock Physics" *by* Mohammed Ali Garba et al.

Mohammed Ali Garba et al.

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Referee Comment #1 Line 123: why do you choose to study natural sands made of quartz and carbonates? Why not pure quartz sands or pure carbonate sands first?

Authors Reply These sands are the sands found in the Perth Basin and so this was driven by a practical aspect. Furthermore, within our department, we work on projects that involve electrical resistivity surveys of the coastal area, and thus it was appropriate to perform some laboratory work in relation to these projects.

Authors changes none

Referee Comment #2 Line 126: what is the carbonate/quartz content (in %) of the two sands? Have the quartz and carbonate grains the same grain size distributions?

Authors Reply Thank you for this comment as this is indeed a needed information. We completed the sentences L. 126 as follow.

Authors changes Line 126: "All the samples are composed of quartz and carbonate, in a proportion 80%/20% (in volume), respectively, as determined from the 3-phase Watershed segmentation presented in section 3.2.2 of this manuscript." Grain size was determined by micro CT-image analysis and is between 16μm - 794μm (median 140μm) for quartz grains and 19μm - 446μm (median 168μm) for carbonates grains and between 15μm - 606μm (median 159μm) for quartz and 15μm - 415μm (median 172μm) for carbonate grains for Scarborough and Cottesloe beaches, respectively.

Referee Comment #3 Line 130: how are you sure that after compaction the sandpack is homogeneous?

Authors Reply We do not make any statement in the text as whether the sand pack is homogeneous or not, but simply claim that our experimental method of deposition reproduces a packing as close as possible as the one in-situ.

Authors Changes none

Referee Comment #4 Line 158: you should add some words about the "non-conventional" rectangular cell. Why did you use such a geometry? What was the objective of using this configuration?

Authors Reply Thank you for your comment. Firstly, we will not agree that the rectangular cell is a "non-conventional" one. In the text we have explained the difference between two cells in the operation procedure. However you are absolutely correct that we have to explain why we are using such different geometries.

Authors Changes: After line 156 we have added: Thus, the utilization of this rectangular shape "static cell" drastically reduces the experimental time, moreover the sample

preparation for "static cell" is easier than for "flow cell"

Referee Comment #5 Figures 1 and 2: add the scale

Authors Reply we completed the caption of this figures as follow

Authors Changes The height of the flow cell is 27cm. for Figure 1 and The length of the static cell is 29.8cm. for Figure 2

Referee Comment #6 Line 195, equation 3: use sigma_w instead of C. C is generally used to denote the concentration, not the electrical conductivity.

Authors Reply Yes , I agree with the comment. And this has been corrected in the manuscript.

Authors Changes We have replaced Cw by σw

Referee Comment #7 Line 201: maybe show an example of sigma_rock vs sigma_water with the fitting straight line.

Authors Reply This is a very good suggestion and we added the following sentence in the text and an additional figure.

Authors Changes L.201 Added: “Such as a plot is given in Figure 3 for the example of Cottesloe Beach sample with porosity 33%”

Referee Comment #8 Table 1: maybe provide the adjustment coefficient to provide an estimation of the quality of the value of FF

Authors Reply Thanks for the suggestion: however adding the correlation coefficients for all FF would make the tables (already quite large) very difficult to read, so instead we completed the text with the range of Rˆ2 we obtained.

Authors Changes L. 341: we added : “Correlations coefficients were very good to excellent and varied between 0.975 and 0.999 and between 0.974 and 0.996 for the flow cell, for Scarborough and Cottesloe samples, respectively, and between 0.882 and

0.993 and between 0.987 and 0.999 for the static cell, for Scarborough and Cottesloe samples, respectively.

Referee Comment #9 Figure 7: add the unit for the electrical field.

Authors Reply Thanks for the comment. The unit of the electric field here is in order of magnitude of (μV). This is not the point; the potential electrical field is relative field. The gradient of the electric field is essential for electrical conductivity in the porous media. Which the contrast of colour shows the local change of electric fields, in the near to grain contacts and pore throats this electric field is changing more than inside of pore volume. This also could vary by adding surface conductivity to the grains or clay conductivity in the sample. Our aim for showing these images here is to show the heterogeneity of the potential field, calculated from simulations.

Authors Changes We added the following in the caption of Figure 7 (now 8) “Colorbar indicates regions of high (red) and low (blue) potential field in arbitrary unit”

Referee Comment #10 Figure 8: if I am right, this figure is not referenced in the text. Colorbar and unit are missing.

Authors Reply Please see reply above

Authors Changes we added in the caption: "Color indicates regions of high (red) and low (blue) potential field in arbitrary unit."

Referee Comment #11 Figure 9: could you add the error bars, for both porosity and formation factor? Also add the value of the cementation exponent for the dashed lines corresponding to the fit of the experimental data.

Authors Reply Thank you for your suggestion

Authors Changes We have changed Figure 9 (now 10)

Referee Comment #12 Line 380: to validate your approach, a figure is missing, showing the comparison of the measured and compared value. I suggest you to plot mea-

sured FF/porosity and computed FF/porosity, as well as the 1:1 line.

Authors Reply Actually, the point of the method we show here is to compare trends between two properties (e.g FF and porosity) obtained by the two different approaches (lab abd computation), and NOT to compare values. We have explained it in the introduction l. 97 to L.104. Data from the lab and from the computation have been obtained at different scales so they fundamentally DO NOT have to match However we added an additional figure in the discussion that compares laboratory and computation data

Authors Changes An additional Figure (#15) has been added

Referee Comment #13 Discussion: again, a comment on the interest of the unconventional cell is required. A comment about the deviating trend of the measured data for the Cottesloe sand with unconventional cell is missing.

Authors Reply Thank for that comment, we have reflected it in the text

Authors Changes We have added after line 346 the following “Some deviations between the results obtained for both static and flow cells may be due to non-uniform compaction of the samples in a case of the flow cell and or non-complete fluid replacement in the case of flow cell. “

Referee Comment #14 Figure 13: informations are missing in the caption. Which data are from experimentally measured values, from image-computation? The dots corresponding to this study are missing (for comparison). Moreover, the references of the data should be provided (for instance, "from Smith et al.").

Authors Reply: we have completed the caption

Additional Comment Please also refer to the new version of the discussion

Interactive comment on Solid Earth Discuss., https://doi.org/10.5194/se-2018-133, 2019.

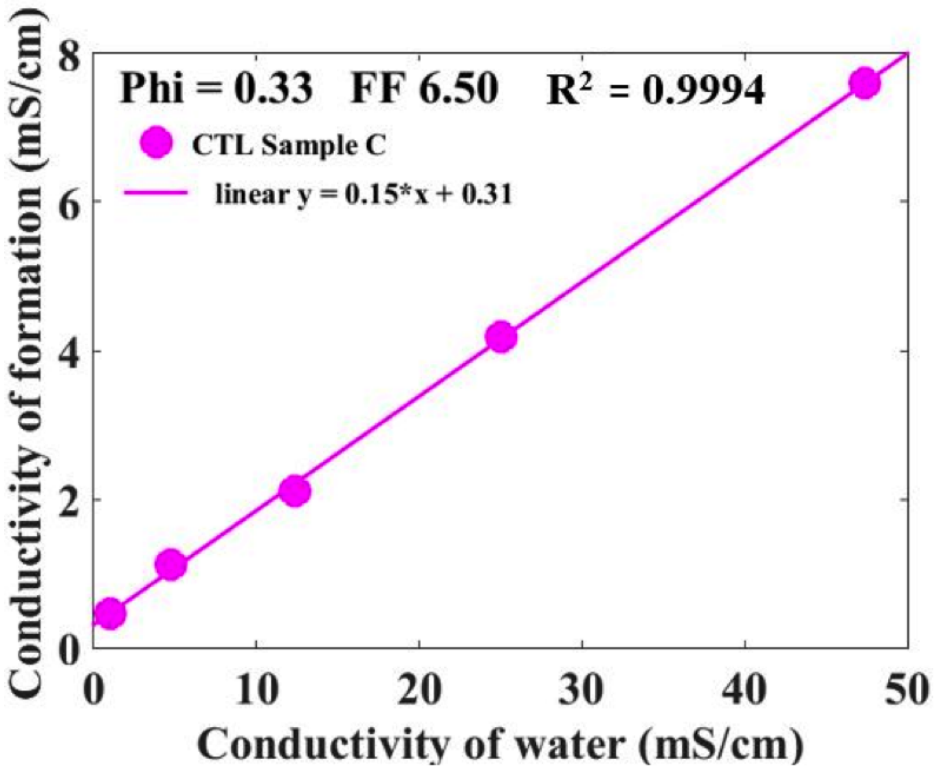

Fig. 1.

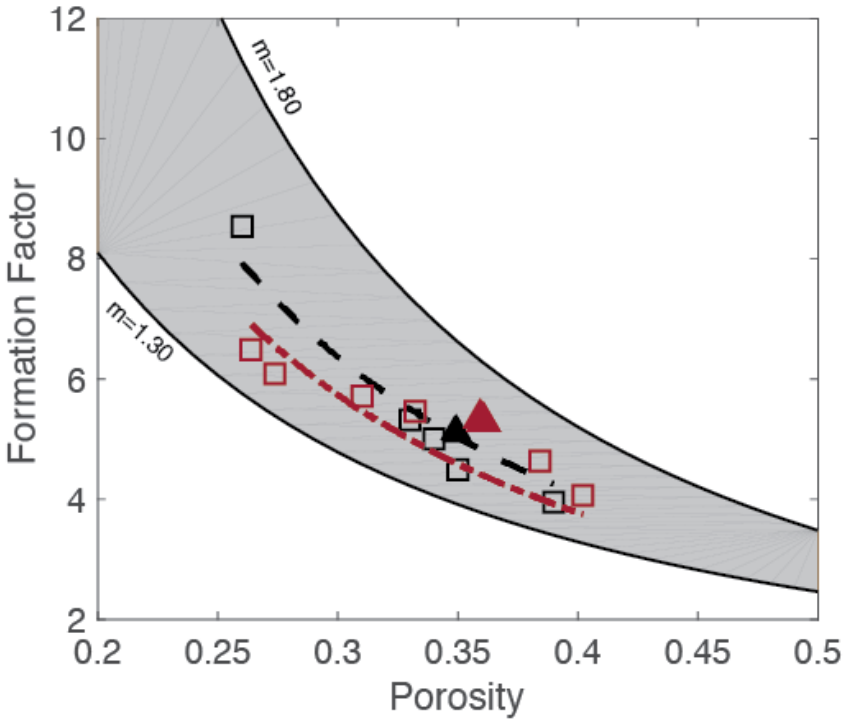
12
10
8
6
4
2
Formation Factor
m=1.80
m=1.30
0.2
0.25
0.3
0.35
0.4
0.45
0.5
Porosity

Fig. 2.