

## 5. Discussion

As noticed earlier in section 4.1, the values of formation factor obtained by the static cell are higher than that obtained by the dynamic cell (for a given porosity), for both samples. This translates in a higher cementation exponent  $m$ . One reason for this can be the design of the cell itself and of the way to achieve a stable reading of sample conductivity, for each fluid salinity. In the rectangular (static) cell, because the higher salinity brine is introduced or retrieved via the center of the panels (see Figure 2) there could be some brine left in the corners that will only equilibrate with the new injected brine by diffusion and hence there could be a lower conductivity of the brine in these corners compared to the conductivity of the injected brine. As result the measured sample conductivity will be lowered with respect with what it should be, giving a higher ratio sample to brine conductivities (i.e. formation factor, see Eqn. 11). Using a cylindrical cell has thus the advantage of providing a better replacement of the brine.

In Figure 14 are reported data from both literature and those acquired in this study for Cottesloe and Scarborough beach samples (using the flow cell). Data from literature include natural sand samples and synthetic granular media made of plastic particles of regular geometrical shape (Wyllie and Gregory, 1953). We have bounded these data by the relationship presented in Eqn. 14, with  $m=1.3$ , which corresponds to the original work of Archie (1952) for unconsolidated media and by the same relationship, with  $m=1.8$ , for the upper bound. We see in this figure that our experimental results for Cottesloe and Scarborough beach samples are in agreement with data reported for other beach sands. Considering the data reported in this figure, we observe that Archie's classical formula for unconsolidated media underestimates the formation factor and that the departure from sphericity leads to a larger  $m$  coefficient. Since Archie's work, many authors have proposed alternative formation factor-porosity relationships. Winsauer et al. (1950) suggested that  $a \neq 1$  in Eqn. 14 is a better expression, whereas other authors derived non-power laws dependency to porosity. From a practical point of view, no formula relating the formation factor to porosity for unconsolidated media fits all the experimental data, and, for a given porosity, the formation factor depends on the particle geometry, particle size distribution and subsequent packing.

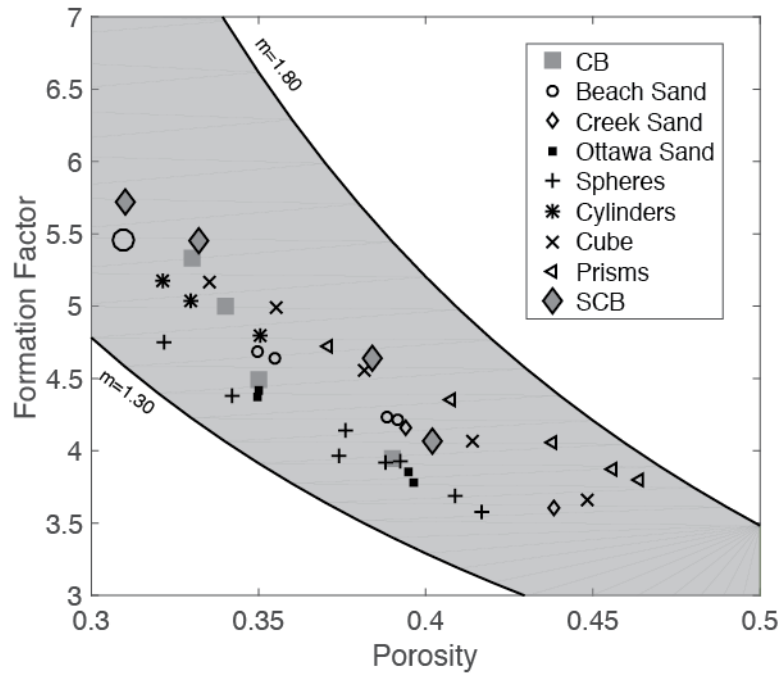


Figure14: Comparison of laboratory results with results from other workers (Wyllie and Gregory, 1953). CB stands for Cottesloe Beach samples and SCB Scarborough Beach samples.

In Figure 15, we compare laboratory data to computed data. Laboratory data are those acquired with the flow cell, which, as discussed earlier in this section, are expected to give more reliable data. Computed data are those obtained for a cube size of  $(700)^3$ , which is above the REV, as presented in section 4.2. We can see that there is an excellent agreement for Cottesloe beach sample, and a good agreement for Scarborough beach sample. At this stage, it is difficult to explain why one sample gave better agreement, and whether it is due to an experimental error or due to the higher content of carbonate grains for Scarborough sample that make the computation less accurate: indeed carbonate grains may present some intra-porosity (as for example micritic phases) and thus have an electrical conductivity.

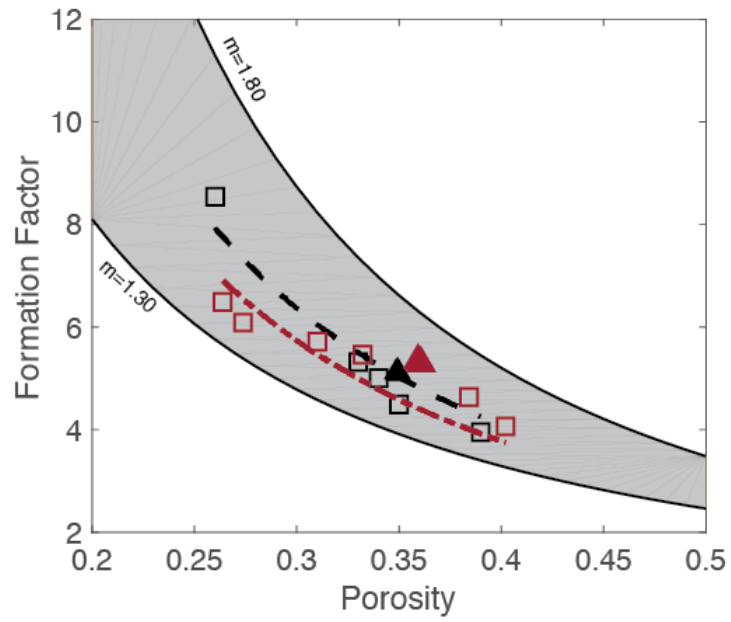


Figure 15: Comparison between laboratory results (in open symbols) and computed ones (in plain symbols). The trends in dashed lines are obtained from the laboratory-measured data.