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Permeability prediction from MICP and NMR data using an electro-kinetic approach

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The accurate modelling of oil, gas and water reservoirs depends fundamentally upon access to reliable rock permeabilities which cannot be obtained directly from downhole logs. Instead, a range of empirical models are usually employed. We examine a new model that has been derived analytically from electro-kinetic theory and is equally valid for all lithologies. The predictions of the new model and four other common models (Kozeny-Carman, Berg, Swanson, van Baaren) have been compared with measurements carried out on fused and unfused glass bead packs as well as on 91 rock samples representing 11 lithologies and 3 coring directions. The new model provides the best predictions for glass bead packs and for all the lithologies. The crux of the new model is to have a good knowledge of the relevant mean grain diameter, for example, from MICP data. Hence, we have also predicted the permeabilities of 21 North Sea well cores using all 5 models and 5 different measures of relevant grain size. These data show that the best predictions are provided by the use of the new model with the geometric mean grain size. We have also applied the new model to the prediction of permeability from NMR data of a 500 m thick sand-shale succession in the North Sea by inverting the T_2 spectrum to provide a value for the geometric mean grain size. The new model shows a good match to all 348 core measurements from the succession, performing better than the SDR, Timur-Coates, HSCM and Kozeny-Carman predictions.