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Recent progress in NMR/MRI in petroleum applications¹

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NMR has become an important technique for characterization of porous materials. In particular, its importance in petroleum exploration has been enhanced by the recent progress in NMR well-logging techniques and instruments. Such advanced techniques are increasingly being accepted as a valuable service especially in deep-sea exploration. This paper will outline the recent progress of MR techniques at Schlumberger-Doll Research. **Well-logging** - The second generation NMR well-logging tool and the 2D NMR methods (D-T2, etc) enable measurements at several depths from the well bore allowing a one-dimensional profiling of the fluid. Such data have allowed quantification of fluid invasion during drilling, obtaining the properties of native fluids and identifying oil/gas zones. **MRI**- Rocks from oil reservoirs are heterogeneous (e.g. large range of pore sizes and porosity variation) due to the complex geological and geochemical histories. The spatial pattern of the heterogeneity has not been well studied. We have developed several NMR techniques to quantify pore length scale previously. In order to predict flow over a large length scale, it is necessary to determine spatial heterogeneity and pore connectivity over the relevant size. We have performed MRI on a series of carbonate rocks and found interesting patterns of the heterogeneity characteristics. **Mathematics** - It is well known that the Laplace inversion is non-unique and the resulting spectrum can be strongly dependent on the prior constraints, specific algorithm and noise. However, the different spectra can all be solutions consistent with data. It would be useful to have a robust criterion – independent of algorithms – to determine the properties of the resulting spectrum. Several methods will be described to examine the statistics of the solutions, uncertainty of the spectrum and its integrals and resolution.

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