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Porosity and permeability prediction for marine and continental drilling samples by mobile NMR core scanning devices

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NMR techniques are widely used in the oil industry and are one of the most suitable methods to evaluate in-situ formation porosity and permeability. Recently, efforts are directed towards adapting NMR methods also to rock types investigated in scientific boreholes. We present the results of a research project, which was targeted to develop and test mobile NMR core-scanners for their usage as porosity and permeability predictor on ODP /IODP rock samples. The objective was to establish fast and non-destructive NMR laboratory methods to determine routinely rock porosity and to give estimates on the pore size distributions. This was achieved in different steps, namely (1) porosity analysis by mobile NMR instruments on drill cores of different rock types, (2) studying the influence of external and internal magnetic field gradients for the estimation of pore size distributions, (3) comparison of NMR logging and core data, (4) test standard NMR calculation schemes to predict permeability on drill cores and (5) development of a new model theory for accurate permeability prediction on low porosity rocks. T2 measurements were made on full cylindrical and split semi cylindrical cores, including limestone, sandstone, basalt, peridotite, shale and unconsolidated clay-rich sediments with varying values of porosity, pore size and magnetic susceptibility. Porosity calculated from amplitudes of transverse relaxation measurements with all instruments agree with porosity values determined by independent measurements. T2 measurements, recorded within the homogeneous magnetic field of a Halbach core-scanner, can be used for permeability prediction. In the case

of sandstone and limestone samples with high porosity, a standard calculation scheme from NMR logging in oil industry shows good results. However, for samples with low porosity the standard methods fail. The reason is the built up of high internal magnetic field gradients which are associated with small pore sizes. To overcome this restriction, a new petrophysical model theory was developed to correct T2 measurements for the internal gradients and to calculate effective pore radii from T2 distributions. This allows to calculate permeability accurately by the use of the Kozeny-Carman equation.