QUANTITATIVE POROSITY MAPPING OF RESERVOIR ROCK CORES BY PHYSICALLY SLICE SELECTED NMR

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Abstract A unique feature of NMR saturation measurements is the facility to study the saturation state in a defined region of a long (≥1 foot) core sample and thus measure the porosity profile. This paper addresses the three steps necessary to implement quantitative physical slice selection: (i) construction of a NMR probe of dimensions commensurate with the slice thickness required, (ii) demonstration that the characteristics of the probe are appropriate for quantitative porosity measurements and (iii) establishing and testing a NMR measurement protocol.

The results reported were obtained with a Bruker MSL300 console in conjunction with a Bruker 2 kW class C amplifer and an Oxford Instruments 31 cm horizontal bore superconducting magnet operating at 0.66 T (28.3 MHz for ^{1}H NMR).

The dimensions of the physical slice are primarily controlled by the size of the NMR probe and the position of radiofrequency screening. Two options can be considered to define a physical slice; first, the slice thickness can be determined solely by the length of the NMR probe, and second, radiofrequency screening can be implemented to modify the slice profile from a

longer length probe. Both approaches have been evaluated, the first in detail.

This method has been developed into a practical system and used to measure the axial porosity profiles of three brine saturated long core samples: Berea sandstone, Bedford limestone and a composite core sample. For the Berea core a mean NMR porosity of 13.0±0.3% was obtained; the gravimetric porosity was 13.4±0.1%. The corresponding values for the Bedford core are 13.8±0.3 and 13.3±0.1% porosity, respectively. Both of these samples exhibit homogeneous porosity distributions.

To investigate heterogeneous porosity distributions a composite of five short cores, including both sandstones and carbonates, was studied. The NMR porosity profile obtained clearly maps the porosity variation, based on the individual core porosities, and integration of the profile gave a mean porosity of 19.8±0.6% ; the gravimetric porosity was calculated similarly giving 20.8±0.1%.