An Innovative Fluorescence Spectroscopic Method for Characterization of Heterogeneous Cores

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Accurate characterisation of heterogeneous reservoir formations is critical to reservoir upscaling and modelling. Petrophysical properties such as porosity and permeability are usually obtained from core plugs of limited sizes of 1 or 2 inches in diameters and 1 or 2 inches in lengths sampled at certain intervals. Extrapolation of the discrete core plug properties to log scale (~0.5-1 ft) can sometimes be difficult in heterogeneous reservoir formations. A relatively rapid method for characterising continuous cores using fluorescence spectrophotometry has been under development at CSIRO Petroleum. The method involves the analysis of fluorescence labelled core slabs using a spectrophotometer and obtains continuous 3-D pore volume information at a regular grid of 3.5x3.5 mm from cm to metre scales. This method enables the "missing link" between core plugs and log data to be filled.

Initial laboratory testing and experiments using nano-graded fluorescence dyes and a customised sampling stage enabled us to obtain 3-D pore volume information on core slabs of 6x10 cm in dimensions each time. Irregular shaped and large cores can also be measured manually using a fibre optic probe connected to the spectrophotometer. Experiments were carried out on artificial sandstones with known porosities and permeabilities and on a range of reservoir rocks from two petroleum-producing basins in China. Calibrations with a number of techniques including high-resolution optical scanning, UV stereo microscopy and Scanning Electron Microscopy (SEM) imaging, 3-D X-ray micro CT scanning and Mercury Injection Capillary Pressure measurements indicate that this method is extremely sensitive and has an excellent reproducibility.