LABORATORY ASSESSMENT OF THE EFFICIENCY OF CORE PRESERVATION TECHNIQUES

Jean-Valery Garcia, Kirk Petrophysics Ltd, Aberdeen, UK,
Andrew Hurst, University of Aberdeen, Aberdeen, UK,
Colin Taylor, University of Aberdeen, Aberdeen, UK

This paper was prepared for presentation at the International Symposium of the Society of Core Analysts held in Calgary, Canada, 10-12 September, 2007

ABSTRACT

The main purpose of core preservation is to retain the connate core fluids in undisturbed core samples as close as possible to their native state. Hence fluids will be preserved with their original composition and distribution. Here we describe a series of laboratory tests that were devised to compare the dehydration history through time of sets of core samples that were preserved using different core preservation methods, including three commercial waxes and Lithotarge® foam. Core samples were selected from geologically well-known, clastic and carbonate reservoirs with permeability in the range of 1 mD to more than 1500 mD. A range of permeabilities were tested to permit the investigation of the sensitivity of preservation media to a range of reservoir qualities. Following one year of testing no conclusive trends or differences are found in the performance of the different core preservation waxes. Results show that Lithotarge® foam performs equally well as waxes over periods up to 60 days. The results of this research allow users to make informed judgements regarding which method of core preservation to use based upon the aims of subsequent core analysis programmes and the operational time-frame.

INTRODUCTION

It is current practice to preserve core samples that will be analysed at a later date for logistic matter or offset consultation. In the API recommended practices for core-analysis procedures, core preservation is stated to be one of the major problems in sampling reservoir rocks for laboratory analysis.

The purpose of preservation is primarily to maintain the original core fluids and the distribution of those fluids in the core as sampled at reservoir conditions (Hunt et al. 1988). Additionally, effective preservation prevents changes in the rock, such as mineral oxidation and clay dehydration. Studies have shown the adverse effects of inadequate preservation on routine core-analysis data. For example, after cores are air-dried, falsely high permeability values can be obtained as a result of alteration of clays lining the pore throats. It is well known that effective preservation will prevent irreversible clay dehydration, the physical alteration and collapse of clay mineral microstructures and will ensure more accurate permeability measurements.

Once the core is brought to the surface, it needs to be protected as soon as possible from the effects of wettability alteration that results in the loss of light-end hydrocarbons or oxidation and deposition of heavy-end hydrocarbons (Wendell et al., 1987). Even when

the wettability is known to be altered because of drilling-fluid additives, cores used for special core analysis should be wrapped and sealed to prevent further alteration.
Following the API recommended practices (API RP-40, 1998) the most common method used for core preservation is wax-dipping. I.e. wrapping of cores with Saran plastic wrap followed by a heavy-duty aluminium foil and then sealed with a thick layer of paraffin.

OBJECTIVES OF THE STUDY

The analysis conducted had for purpose to evaluate various core preservation methods using three different commercial and well-known waxes and Lithotarge® (a closed-cell foam) to measure and compare dehydration over time.
Using a selection of waxes that are used in the wrap and dip process, and Lithotarge®, the relative efficiency of each method will be compared using simple laboratory tests.

METHODS AND MATERIALS

Waxes

Numerous commercialised waxes are available and used in the oil industry market. Only few branded one got the reputation to be providing excellent sealing properties.
The three waxes that were tested are labelled wax A, B and C so that subjectivity is avoided.

Lithotarge®

Lithotarge® is utilized as a means of core stabilization implemented at the wellsite, immediately after core recovery. Lithotarge® is a specifically designed close cell foam that is injected in the annulus between core and inner tube. It has been reported by users that it retains core fluids during a certain period.

Rock samples

All preservation media have been used on similar rock samples to facilitate comparison. Samples of clastic and carbonate reservoirs have been selected with a permeability in the range of 1 mD to 1500 mD (Thanks to courtesy of Total S.A., France).
Four 1.5 inch diameter plug samples have been taken adjacent to each other from 9 different reservoir core sections. Prior to the actual dehydration test the 36 samples were cleaned and dried and their rock properties measured. Table 1 gives the average values for 4 samples of each of the 9 sets. I.e. the values for sample ID KP4 are averages of sample KP4a, KP4b, KP4c and KP4d.
Note that when selecting small rock plug samples for this study, we have looked at the loss as a percentage of pore volume which we believe can be directly related to the percentage loss of a whole core pore volume.

Table 1: Rock Properties

Sample ID	GD [g/ml]	Porosity [% Vp]	K_{gas} [mD]
KP1	2.64	24.1	232
KP2	2.64	21.7	1990
KP4	2.64	5.8	4.4
LOT	2.70	29.4	148
LOT1	2.70	33.6	1460
GRM	2.67	15.9	0.07
KP5	2.79	21.2	2.8
TERV	2.70	29.6	7.3
ANST	2.70	20.6	0.6

Dehydration test

The cleaned and dried samples were saturated prior to wax-dipping (3 samples per set) and Lithotarge® treatment (1 sample per set).

The weight loss of the samples is measured over a period of 38 weeks with a weight measurement every 2 weeks for the first 20 weeks and every 4 weeks at the end of the test period.

RESULTS AND DISCUSSION

A graphical representation of three typical experiments is given in the appendix section. It shows the fluid loss as a percentage of the pore volume. The data from the 9 sets of samples show a clear trend of highest percentage loss with the samples with the lowest porosity. There isn't much of a trend with Kg.The data for the wax-dipped samples show an average of fluid loss over a period of 6 and 38 weeks of less than 0.5 percent of the pore volume. For Lithotarge® the fluid loss over a period of 6 weeks and 38 weeks is some 1.7% and 2.8% of the pore volume respectively. Probably the main barrier to weight/fluid loss with the waxes is the Aluminium/Saran wrap which is absent in the Lithotarge® experiment. This has also been identified by Auman, 1986 who concluded that strippable plastics provide a very poor barrier to vapour loss, while sealed, laminated aluminium provide a fairly effective barrier. The study confirms that the three commercial waxes tested have comparable sealing capacity when wrapped in Aluminium/Saran. The Lithotarge® tests show that it preserves core samples effectively over a period of 60 days; during which the weight/fluid loss negligible. Further tests are meant to be done to identify if the fluid loss can be due to drying/setting of the Lithotarge® foam which will allow us to refine the loss using this type of preservation. Moreover, tests on saturated samples without any sealing will be conducted over time to show what would be the weight loss without any preservation and define a more accurate trend on the impact or preservation versus method use over a period of time.

Table 2: Sample properties KP5

Plug I.D.	Porosity (%Pv)	Gas Perm (mD)
KP5a	25.1	3.2
KP5b	23.9	2.2
KP5c	17.8	2.6
KP5d	18.1	3.2

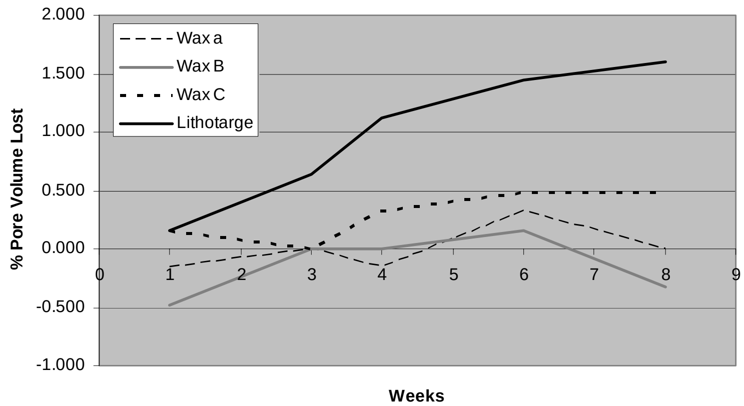

Figure 1: % Pore Volume Lost over 8 weeks

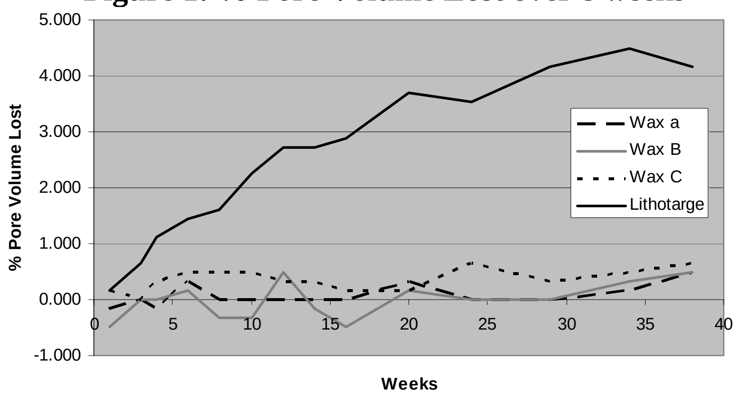

Figure 2: % Pore Volume Lost over 38 weeks

Table 3: Sample properties LOT 1

Plug I.D.	Porosity (%Pv)	Gas Perm (mD)
LOT1a	32.9	1344
LOT1b	32.6	1139
LOT1c	32.8	1654
LOT1d	36.0	1685

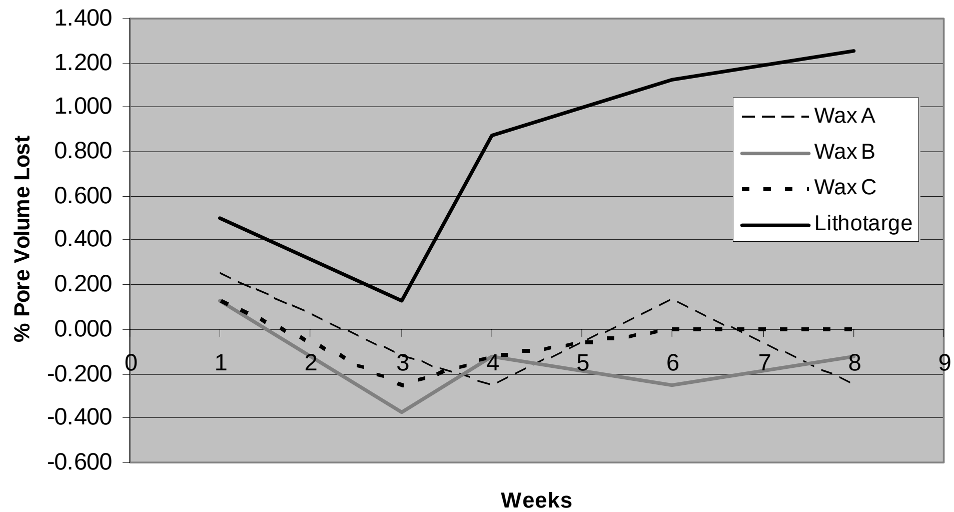

Figure 3: % Pore Volume Lost over 8 weeks

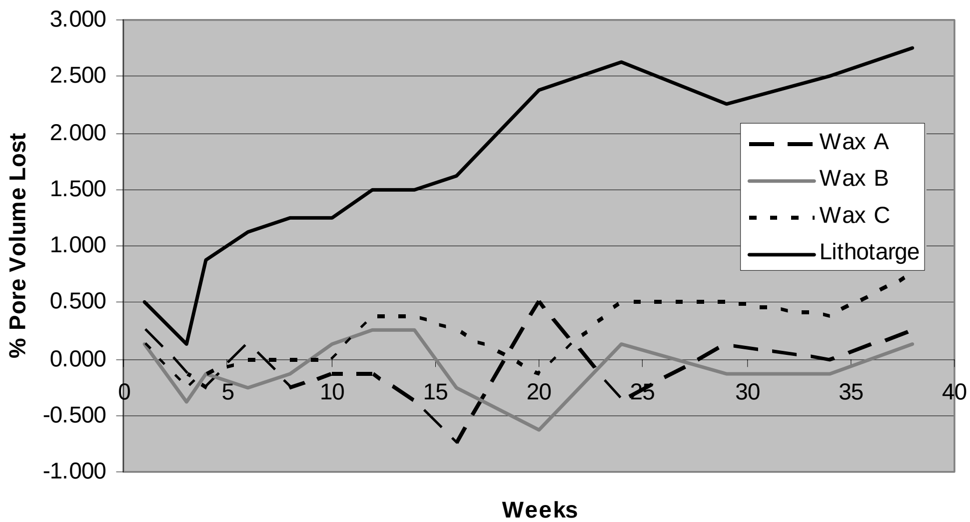

Figure 4: % Pore Volume Lost over 38 weeks

Table 4: Sample properties GRM

Plug I.D.	Porosity (%Pv)	Gas Perm (mD)
GRMa	15.8	0.06
GRMb	16.3	0.08
GRMc	15.7	0.06
GRMd	15.7	0.08

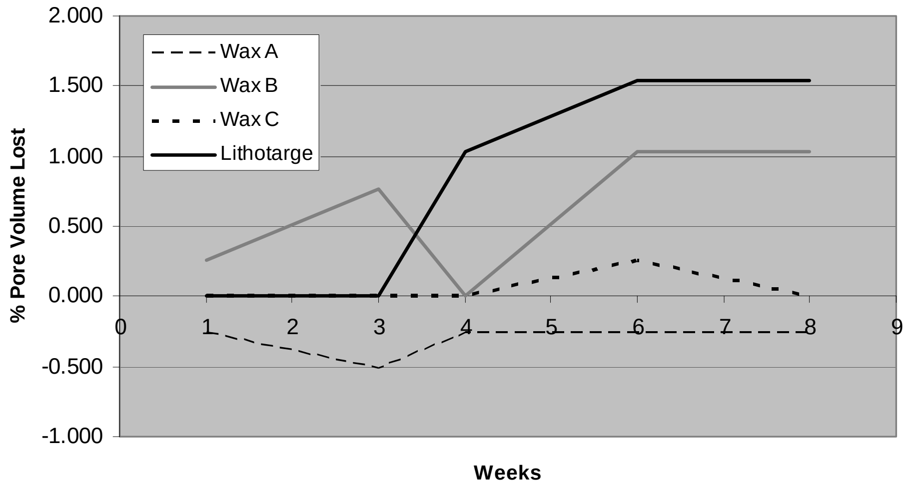

Figure 5: % Pore Volume Lost over 8 weeks

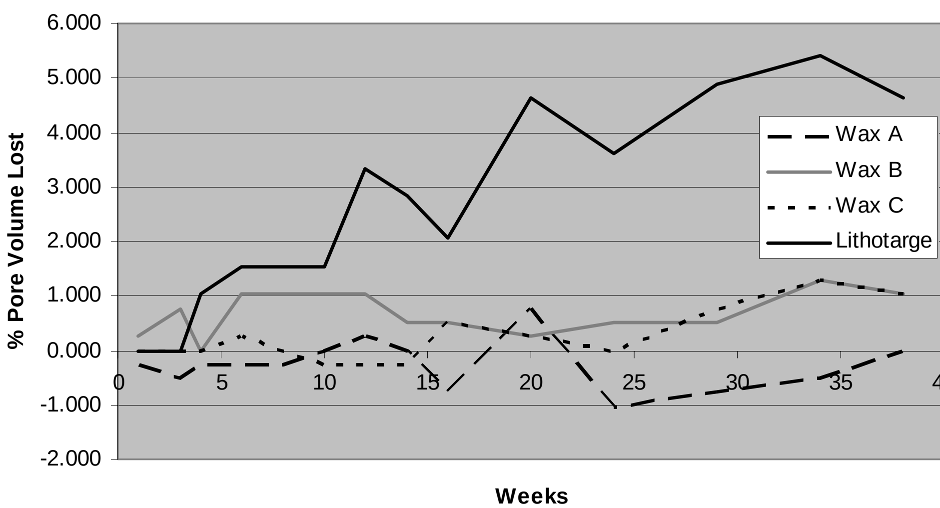

Figure 6: % Pore Volume Lost over 38 weeks

REFERENCES

Auman, J.B., Amoco Production Co.; *A Laboratory Evaluation of Core Preservation Materials*, SPE 15381-PA, 1989.

Hunt, P.K., BP America R and D; Cobb, S.L., Standard Oil Proppants Co, *Core Preservation With a Laminated, Heat-Sealed Package*, Journal SPE Formation Evaluation, Paper Number 15382-PA, December 1988.

Wendell, D.J., Conoco Inc.; Anderson, W.G., Conoco Inc.; Meyers, J.D., Conoco Inc., , *Restored-State Core Analysis for the Hutton Reservoir*, Journal SPE Formation Evaluation, Paper Number 14298-PA December 1987.

Recommended Practice: API RP-40, *Chapter 2.5 "Dips and coatings" & Chapter 2-1 ' Well site core handling procedures and preservation*, 1998.