CALLISTO- A New World-Standard Facility for the Calibration of Nuclear Well Logs

J.R Samworth*, Reeves Wireline Technologies,
East Leake, Loughborough, Leicestershire, LE12 6JX, England
rsamworth@reeves-wireline.comv,

and

M.A.Lovell, University of Leicester

ABSTRACT
In the early 1980s a need for a European nuclear well log calibration facility was recognised, to service both the North Sea petroleum industry, and to address the limitations of the extant API calibration test pits. A joint Industry - European Community project, led by AEA Technologies, was set up to address this problem, resulting in the creation of an advanced calibration facility (EUROPA) in Aberdeen. This was commissioned in 1993, but due to commercial difficulties it did not become truly operational.

In 1997 the rock formations had to be removed from their original site, and industry and academic support was sought to create a new body that could organise, maintain and operate an open industry calibration facility. The University of Leicester and Reeves Wireline Technologies of East Leake, UK, proposed a novel solution involving donation of the facility to a new academic-led body, with operation of the facility by Reeves Wireline Technologies, who had available an existing facility at East Leake able to accommodate the most important of the EUROPA rocks. The London Petrophysical Society, Aberdeen Formation Evaluation Society, and the Dutch Petrophysical Society, together with the original sponsors and service companies, all expressed support for the rescue. So, with aid from Shell and the U.K. Government Department of Trade and Industry to facilitate the venture, AEAT donated the technical facility to the University of Leicester and provided transportation to the new site,. This would eventually be re-named CALLISTO - Calibration (at Leicester) and In-Situ Tool Optimisation – and is one of only two publicly accessible logging calibration and test facilities (the other being Houston) providing a platform on which to build and develop research alongside the needs of industry.

In March 1998, twenty articulated trucks brought more than 160 tonnes of rock made up of 108 carefully machined slabs to the Leicestershire site from Scotland, over a 2-week period. The most important of these slabs were transported underwater in large transit tanks to maintain their water saturation.

Figure 1. General view of site during rock installation, showing the transit tanks.

The re-installation had to be carefully executed to keep the slabs fully saturated, as far as possible, during the transfer. Additionally, great care was taken in the order of stacking and alignment of each of the blocks to ensure the best compromise was achieved in uniformity of characteristics. For example, the stacking was in an order such that the most consistent 4 rocks were located in the centre of each stack of 6.

Figure 2. Rock installation, showing handling and block alignment jigs.

The facilities include four tanks, each containing two formations, each six feet thick and comprising six slabs, in freshwater. The formations include three sandstones, three limestones and two dolomites of a range of porosities. All formations have 8.5 inch holes.

Figure 3. General arrangement of facility with a cutaway view of a tank.

The first phase of the move was completed in April 1998, and CALLISTO was officially opened in 1999. Reasonable access is guaranteed to third parties through the University of Leicester; with nominal charges for use which means that the facility runs on a non-profit basis.

All the rocks used in the facility were very extensively characterised using physical, chemical and nuclear techniques. This was done by other workers during the original EUROPA development, and is reported in the references. In addition to measurements on the final slabs, numerous core plugs were taken from the rock off-cuts and from the large removed cores, which can be seen in the displayed examples.

T	Form.	Core Por.	Phi_TN (app lst) (pu)	Rho Bulk den. (g/cc)	PE	Form. Sigma (cu)		T	Form.	Core Por.	Phi_TN (app lst) (pu)	Rho Bulk den. (g/cc)	PE	Form. Sigma (cu)
1	Jas SST	0.46	-0.5	2.640	1.89	7.009		2	Clash SST	19.72	17.1	2.315	1.90	9.845
1	Jas SST	0.39	-0.6	2.642	1.89	6.998		2	Clash SST	17.44	14.9	2.352	1.92	9.494
1	Jas SST	0.43	-0.6	2.641	1.89	7.004		2	Clash SST	17.63	15.1	2.349	1.92	9.523
1	Jas SST	0.50	-0.5	2.640	1.89	7.015		2	Clash SST	17.26	14.7	2.355	1.92	9.466
1	Jas SST	0.51	-0.5	2.640	1.89	7.017		2	Clash SST	17.58	15.0	2.350	1.92	9.515
1	Jas SST	0.46	-0.5	2.640	1.89	7.009		2	Clash SST	16.74	14.2	2.364	1.92	9.386
1	Salt LST	0.32	3.2	2.680	4.81	10.490		2	Plmp SST	13.17	12.1	2.417	1.99	9.711
1	Salt LST	0.36	3.2	2.679	4.81	10.495		2	Plmp SST	12.77	11.7	2.424	1.99	9.654
1	Salt LST	0.33	3.2	2.679	4.81	10.491		2	Plmp SST	13.11	12.0	2.418	1.99	9.703
1	Salt LST	0.40	3.3	2.678	4.81	10.499		2	Plmp SST	12.34	11.3	2.431	1.99	9.592
1	Salt LST	0.37	3.2	2.679	4.81	10.496		2	Plmp SST	11.65	10.7	2.442	2.00	9.493
1	Salt LST	0.50	3.4	2.677	4.81	10.511		2	Plmp SST	10.23	9.4	2.465	2.01	9.288
3	Whit DOL	15.70	22.3	2.543	3.06	10.56		4	Lee DOL	0.77	2.6	2.846	3.15	6.03
3	Whit DOL	13.73	20.2	2.579	3.09	10.29		4	Lee DOL	0.67	2.5	2.848	3.15	6.02
3	Whit DOL	12.38	18.7	2.603	3.11	10.10		4	Lee DOL	0.78	2.6	2.846	3.15	6.03
3	Whit DOL	12.23	18.6	2.606	3.11	10.08		4	Lee DOL	0.88	2.7	2.844	3.15	6.05
3	Whit DOL	11.46	17.7	2.620	3.12	9.98		4	Lee DOL	0.77	2.6	2.846	3.15	6.03
3	Whit DOL	10.61	16.8	2.636	3.13	9.86		4	Lee DOL	0.97	2.8	2.842	3.15	6.06
3	Derb LST	9.20	10.0	2.539	4.95	9.20		4	Frnch LST	22.36	23.8	2.317	4.55	11.44
3	Derb LST	8.46	9.3	2.552	4.96	9.09		4	Frnch LST	24.29	25.8	2.284	4.50	11.71
3	Derb LST	7.90	8.7	2.561	4.98	9.01		4	Frnch LST	24.10	25.6	2.287	4.50	11.68
3	Derb LST	7.32	8.1	2.571	4.99	8.93		4	Frnch LST	24.81	26.3	2.275	4.48	11.78
3	Derb LST	7.36	8.2	2.570	4.99	8.93		4	Frnch LST	24.53	26.0	2.280	4.49	11.74
3	Derb LST	9.29	10.1	2.538	4.95	9.21		4	Frnch LST	22.57	24.0	2.313	4.54	11.47

Figure 4. A sample of the data for the installed rocks.

Since the facility is comprised of “real” rock, it is not possible to apply simple relationships to the calibration of logging tools. Instead, the emphasis was to characterise the rock to a level that particular tool responses could be accurately predicted. As an example of this, attention is drawn to the data in **Fig. 4**, comparing the core porosities to the predicted response of a typical ompensated neutron tool when all the known constituents of the rock are used in the prediction. All the core plugs, off-cuts and the data from the characterisation are currently archived under the supervision of the university, and provide a resource for future research into detail log-core comparisons.

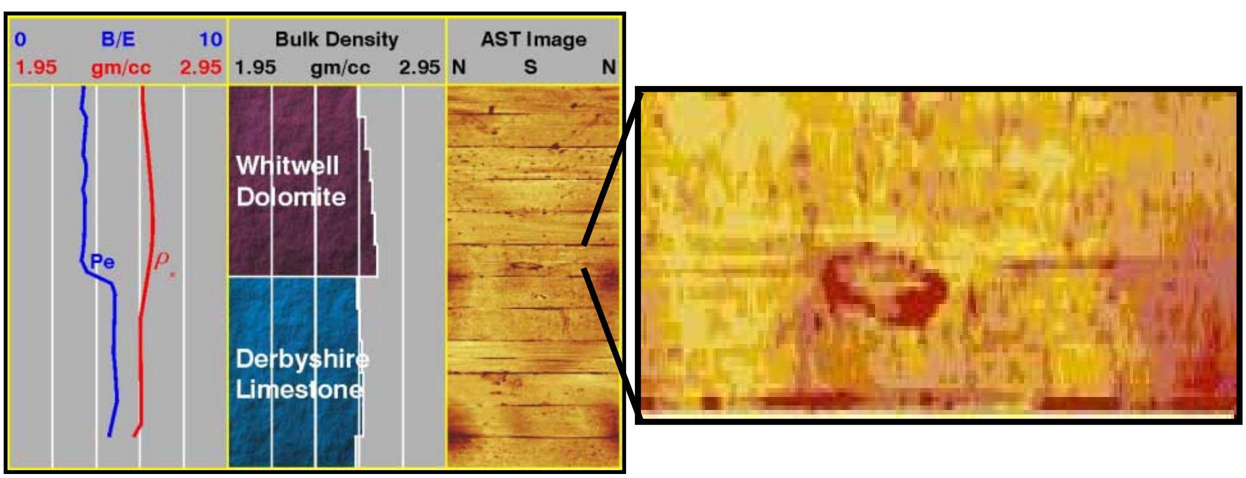

Figure 5. Sample logs in Tank 3 showing a density / PE log and an acoustic image of the vuggy dolomite.

Although primarily intended for nuclear logging tools, running other tools can be valuable. In particular, a variety of vugs and cemented fractures provide interesting features for testing acoustic scanners.

There are numbers of other rocks currently in storage, in addition to the 48 that are operational. These include slabs with 12 ¼" holes and others that were saturated with water of 2 different salinities. These rocks have been allowed to dry out, but the saturation equipment and 5 spare tanks were also rescued, mothballed, and are available to re-commission the other rocks should this become financially viable.

Large blocks of Aluminium, Magnesium, Graphite, Gabbro and Marble were also part of EUROPA and these are again in storage at East Leake for future use as density tool standards.

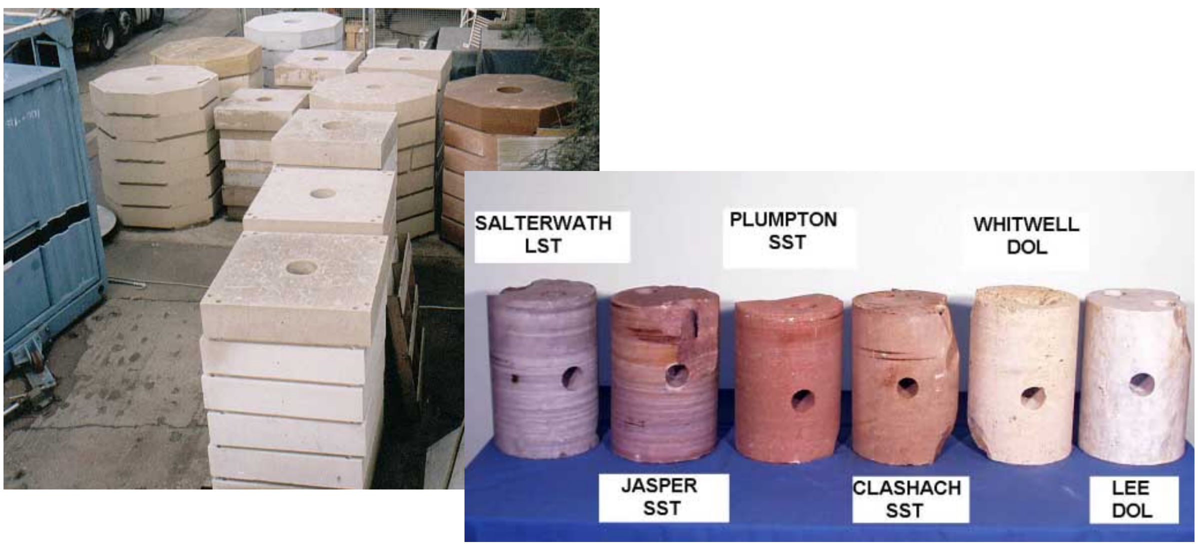

Figure 6. Stored slabs and some of the archived cores.

Europa and Callisto are Jovian moons. Additionally, in mythology, they were daughters of Jupiter. They were therefore sisters, a fact which maintains an appropriate link to the original facility.

References

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