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Magnetic Susceptibility Measurements of Offshore Carbonate Samples

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REPORT

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Title:
Magnetic Susceptibility Measurements of Offshore Carbonate Samples

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Summary:
Magnetic susceptibility measurements were made on 84 samples from offshore carbonate cores for Applied Reservoir Technology Ltd. Samples that had been soaked in a brine were first cleaned before being sent to NGU for the susceptibility measurements. Samples that had a residue of brine with high salt concentration could have a higher susceptibility value than reported here since a salt residue would contribute a negative (diamagnetic) signal. All measured samples had low to negative susceptibilities. The chalk samples were paramagnetic, the susceptibility values ranged from 0.00 to 1.74 $x10^{-5}$ (SI), whereas the diagenetic chalk samples were all diamagnetic. These susceptibility values ranged from -0.80 to -0.31$x10^{-5}$ (SI). The microcrystalline dolomite samples were also diamagnetic; susceptibility values ranged from -0.98 to -0.48 $x10^{-5}$ (SI). The numulitic limestone samples were either diamagnetic or paramagnetic with susceptibility values of samples from -0.28 to +0.38 $x10^{-5}$ (SI). The oolitic limestone samples were either diamagnetic or paramagnetic, these susceptibility values ranged from -0.56 to +1.30 $x10^{-5}$(SI). The sucrosic dolomite samples were paramagnetic with susceptibility measurements ranging from 0.46 to 0.92 $x10^{-5}$ (SI). The vuggy dolomite samples were either diamagnetic or paramagnetic; susceptibility values ranged from -0.70 to +0.06 $x10^{-5}$ (SI). The vuggy limestone samples were all diamagnetic, with susceptibility values from -0.67 to -0.42 $x10^{-5}$ (SI).

Keywords: Geofysikk	Petrofysikk	Magnetometri
		Fagrapport

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Magnetic Susceptibilty Measurements on diskette (MS Word).

1. INTRODUCTION

Core samples, 38cm in diameter by 44cm long, were measured using a MS2C Bartington magnetic susceptibility bridge. All samples were measured in three sequential steps with a background measurement made before and after each set of measurements on individual cores. The susceptibility data is reported in Table 1 and the tabulated data (MS Word) is also included on a diskette.

2. METHODS

The MS2 Magnetic Susceptibility System (Bartington Instruments Ltd) comprises a portable measuring instrument, the MS2 meter, which displays the magnetic susceptibility value of materials when these are brought within the influence of the MS2C sensor. The MS2C sensor is designed for the volume susceptibility measurements of continuous sections of core. The core is passed through the sensor and measurements are taken at different intervals. A minimum of 3 sequential measurements per sample were made.

The sensor is connected to the MS2 meter via a simple coaxial cable. An RS232 serial interface allows the instrument to operate in conjunction with custom IBM compatible software running on a portable PC. The circuitry within the MS2 meter powers the sensor and processes the measurement information produced by it. The measurements are obtained digitally using a time-dependent method. This results in precise and repeatable measurements.

The MS2C sensor operates on the principle of A.C. induction. Power is supplied to the oscillator circuit within the sensor generating a low-intensity alternating magnetic field. Material brought within the influence of this field results in changes in oscillator frequency. The frequency information is returned in pulse form to the MS2 meter where it is converted into a value of magnetic susceptibility. The sensor is particularly insensitive to sample conductivity. The sensor subjects the sample to a non-saturating field which has the advantage of measuring initial susceptibility without destroying any sample magnetic remanence. We used a coil-diameter of 60mm core-dimensions for measuring the samples. All samples were measured using the 0.1 sensitivity range. This provides a ten-fold increase in measuring time as compared to the 1 sensitivity range, and provides for additional noise filtering necessary in weakly magnetic samples. The magnetic susceptibility sensor was directly calibrated to the diamagnetism of water (-0.86×10^{-5} SI). Ultra-pure water with a measured value of 18.2 ohms was used for the calibration of the

MS2C sensor. The theoretical value of 'pure water' is 18.4 ohms. The calibration of the water sample was -0.88 x10^{-5} SI.

The accuracy of the MS2C sensor is 0.2 x10^{-5} SI.

3. RESULTS

All samples were weakly paramagnetic to diamagnetic with low to negative susceptibilities. The chalk samples were paramagnetic, the susceptibility values ranged from 0.00 to 1.74 x10^{-5} (SI), whereas all the diagenetic chalk samples were diamagnetic with susceptibility values ranging from -0.80 to -0.31x10^{-5}. The microcrystalline dolomite samples were also diamagnetic and susceptibility values ranged from -0.98 to -0.48 x10^{-5}. The numulitic limestone samples were both diamagnetic and paramagnetic, values ranged from
-0.28 to +0.38 x10^{-5}.

The oolitic limestone samples had both diamagnetic and paramagnetic behavior with susceptibility values ranging from -0.56 to +1.30 x10^{-5}. The sucrosic dolomite was paramagnetic with measurements ranging from 0.46 to 0.92 x10^{-5}. The vuggy dolomite samples were diamagnetic or paramagnetic. These samples had susceptibility values ranging from -0.70 to +0.06 x10^{-5}. The vuggy limestone samples were all diamagnetic. The susceptibility values ranged from -0.67 to -0.42 x10^{-5}.

4. REFERENCES

Dearing, J., 1994: Environmental Magnetic Susceptibility. Bartington Users Manuel, Bartington Instrument Ltd., Oxford, 102pp.

Table 1: Magnetic Susceptibility Measurements

	Magnetic Susceptibility 10^{-5} (SI)	Magnetic Susceptibility 10^{-5} (SI)	Magnetic Susceptibility 10^{-5} (SI)
Chalk			
CH-010	0.52	0.41	0.18
CH-011	0.39	0.33	0.36
CH-012	0.53	0.52	0.46
CH-013	0.28	0.28	0.28
CH-014	0.28	0.14	0.14
CH-015	0.34	0.36	0.33
Chalk			
CH 11	0.39	0.49	0.52
CH 12	0.32	0.35	0.39
CH 13	0.42	0.42	0.56
CH 21	0.14	0.14	0.14
CH 22	0.17	0.22	0.24
CH 23	0.14	0.00	0.14
CH 31	1.66	1.73	1.74
CH 32	1.59	1.65	1.66
CH 33	1.40	1.26	1.26
Diagenetic Chalk			
DC 010	-0.70	-0.56	-0.56
DC 012	-0.62	-0.46	-0.66
DC 013	-0.63	-0.68	-0.46
DC 014	-0.57	-0.64	-0.66
DC 015	-0.66	-0.71	-0.71
Diagenetic Chalk			
DC 11	-0.56	-0.56	-0.56
DC 12	-0.56	-0.56	-0.56
DC 13	-0.68	-0.57	-0.80
DC 21	-0.46	-0.61	-0.54
DC 22	-0.33	-0.39	-0.45
DC 23	-0.35	-0.39	-0.31

	Magnetic Susceptibility 10-5 (SI)	Magnetic Susceptibility 10-5 (SI)	Magnetic Susceptibility 10-5 (SI)
Diagenetic Chalk			
DC 31	-0.71	-0.75	-0.66
DC 32	-0.73	-0.67	-0.61
DC 33	-0.78	-0.75	-0.60
Microcrystalline Dolomite			
MD 010	-0.56	-0.56	-0.56
MD 011	-0.70	-0.70	-0.70
MD 012	-0.56	-0.56	-0.48
MD 013	-0.75	-0.78	-0.81
MD 014	-0.84	-0.84	-0.84
MD 015	-0.84	-0.84	-0.84
Microcrystalline Dolomite			
MD 11	-0.56	-0.70	-0.56
MD 12	-0.60	-0.48	-0.52
MD 13	-0.56	-0.56	-0.70
MD 21	-0.70	-0.70	-0.70
MD 22	-0.84	-0.84	-0.84
MD 31	-0.70	-0.70	-0.70
MD 32	-0.98	-0.98	-0.98
MD 33	-0.84	-0.84	-0.70
Numulitic Limestone			
NL 11	-0.21	-0.25	-0.18
NL 12	-0.14	-0.28	-0.14
NL 13	-0.18	-0.26	-0.25
NL 21	0.28	0.28	0.28
NL 22	0.32	0.35	0.38
NL 23	0.14	0.14	0.14

	Magnetic Susceptibility 10^{-5} (SI)	Magnetic Susceptibility 10^{-5} (SI)	Magnetic Susceptibility 10^{-5} (SI)
Numulitic Limestone			
NL 010	-0.14	-0.14	-0.14
NL 011	-0.14	-0.14	-0.28
NL 012	0.00	0.00	0.14
Oolitic Limestone			
OL 010	1.10	1.10	0.98
OL 011	-0.56	-0.56	-0.56
OL 012	-0.42	-0.42	-0.42
OL 013	-0.53	-0.48	-0.52
OL 014	-0.56	-0.42	-0.56
OL 015	1.12	1.12	1.30
Sucrosic Dolomite			
SD 010	0.71	0.74	0.64
SD 011	0.48	0.46	0.67
Sucrosic Dolomite			
SD 11	0.70	0.70	0.84
SD 12	0.77	0.74	0.80
SD 21	0.77	0.74	0.81
SD 22	0.77	0.75	0.88
SD 31	0.59	0.46	0.53
SD 32	0.92	0.82	0.75
Vuggy Dolomite			
VD 010	-0.18	-0.14	-0.10
VD 011	-0.28	-0.28	-0.42
VD 012	-0.28	-0.14	-0.28
VD 013	-0.28	-0.28	-0.28
VD 014	-0.56	-0.56	-0.42
VD 015	-0.70	-0.70	-0.70

	Magnetic Susceptibility 10^{-5} (SI)	Magnetic Susceptibility 10^{-5} (SI)	Magnetic Susceptibility 10^{-5} (SI)
Vuggy Dolomite			
VD 11	-0.46	-0.63	-0.66
VD 12	-0.41	-0.36	-0.38
VD 13	-0.42	-0.42	-0.42
VD 21	0.00	0.00	0.00
VD 22	-0.01	0.04	0.06
VD 23	0.00	0.00	0.00
VD 31	-0.28	-0.42	-0.28
VD 32	-0.60	-0.63	-0.66
VD 33	-0.28	-0.42	-0.28
Vuggy Limestone			
VL 11	-0.56	-0.56	-0.42
VL 12	-0.48	-0.52	-0.67
VL 13	-0.60	-0.63	-0.66