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Report

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- Porosity (frac.)

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APPENDIX A PICTURES OF WHOLE CORES

1 SUMMARY

Porosity and gas permeability measurements have been performed on 23 whole cores obtained in the Ocean drilling program.

The whole cores were consolidated, vuggy carbonate

The main results are summarised as follows:

- Gas permeability ranged from 0.15 – 6630 mD
- Fractional porosity ranged from 0.040 – 0.335

2 INTRODUCTION AND EXPERIMENTAL PROGRAM

This chapter provides an overview of the used core material and the experimental programs.

2.1 Core material

ResLab received 23 whole cores from the Ocean drilling program for analysis. The whole cores were end-trimmed before the measurements. Table 2.1.1 presents an overview of the core material used in the study.

Table 2.1.1 Core material used in the study

ID	Code	Site	Hole	Core	Sec	Top	Depth	Interval	Length (cm)	Diameter (cm)
1	EHWR	1196	A	005R	01WR	38	38.5	038.0 - 045.0	5.83	5.74
2	EHWR	1196	A	007R	02WR	26	58.5	26 - 33	6.82	5.73
3	EHWR	1196	A	009R	02WR	2	77.5	2 - 8	6.89	5.78
4	EHWR	1196	A	013R	02WR	111	117.3	111 - 118	7.02	5.64
5	EHWR	1196	A	018R	02WR	130	165.4	130 - 137	7.20	5.74
6	EHWR	1196	A	019R	03WR	21	175.4	21 - 28	6.07	5.70
7	EHWR	1196	A	044R	01WR	61	413.3	061.0 - 068.0	6.24	5.70
8	EHWR	1196	A	051R	02WR	101	482.4	101 - 108	7.11	5.68
9	EHWR	1196	A	053R	03WR	58	502.8	58 - 68	5.77	5.70
10	EHWR	1196	A	056R	01WR	93	529.0	93 - 100	7.03	5.77
11	EHWR	1196	A	057R	02WR	36	539.5	36 - 46	10.19	5.70
12	EHWR	1196	A	065R	01WR	116	615.8	116 - 125	7.88	5.80
13	EHWR	1196	A	066R	01WR	68	625	68 - 77	8.95	5.70
14	EHWR	1196	B	013Z	01WR	68	110.6	68 - 78	6.05	8.00
15	EHWR	1196	B	029Z	01WR	57	169.0	57 - 67	6.62	8.00
16	EHWR	1196	B	031Z	01WR	123	178.4	123 - 132	6.03	8.00
17	EHWR	1199	A	002R	02WR	89	11.7	89 - 98	9.08	5.70
18	EHWR	1199	A	005R	02WR	30	28.5	30 - 40	8.68	5.74
19	EHWR	1199	A	007R	01WR	46	45.5	46 - 55	9.12	5.70
20	EHWR	1199	A	009R	07WR	15	72.3	15 - 25	8.57	5.77
21	EHWR	1199	A	013R	04WR	30	106.5	30 - 42	8.73	5.72
22	EHWR	1199	A	016R	04WR	113	136.5	113 - 123	10.60	5.71
23	EHWR	1199	A	018R	01WR	88	151.0	88 - 98	10.26	5.70

2.2 Experimental program

Overview of the experimental program performed is presented in Figure 2.2.1. The experimental procedures are described in the following sections.

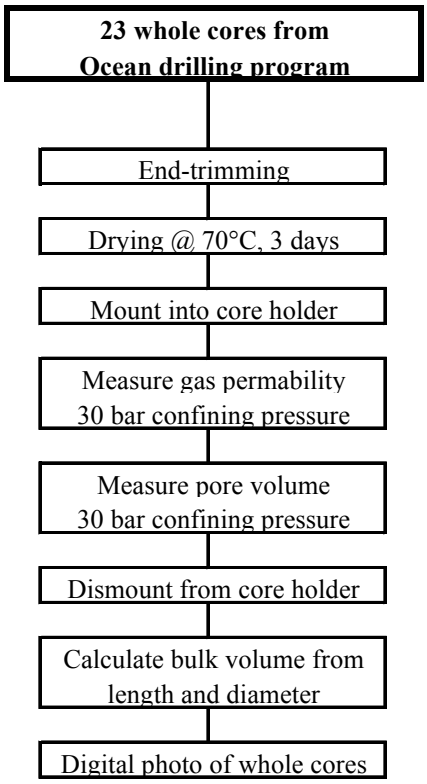


Figure 2.2.1 Experimental program

2.3 Core preparation

All whole cores were end trimmed. Then the whole cores were put into a heat cabinet at 70°C for 3 days to evaporate the water content.

2.4 Gas permeability

The equivalent liquid gas permeability was determined using a standard permeability apparatus with nitrogen gas as the flowing fluid. Permeability was determined using a single gas pressure. An empirical correction is applied to give the equivalent liquid gas permeability (Klinkenberg correction).

2.5 Pore volume

Pore volume was measured while the plug sample was mounted into the core holder in dry state. A helium porosimeter was used. The pore volume was calculated by using Boyles law.

2.6 Bulk volume/ porosity

Bulk volume was calculated from length and diameter. The porosity was calculated from pore volume and bulk volume.

3 RESULTS ROUTINE PROGRAM

3.1 Results from the basic measurements

Table 3.1.1. summarises the measurements of the whole cores used in this study. Included in the table is Reslab ID, length, diameter, weight (dried), bulk volume, pore volume, porosity and gas permeability. Figure 3.1.1. shows a plt of gas permeability vs. porosity.

Table 3.1.1 Results of basic measurements

ID	Depth	Length (cm)	Diameter (cm)	Dry Weight (g)	Bulk Volume (cm^3)	Pore Volume (cm^3)	Porosity 30 bar (frac.)	K_A 30 bar (mD)
1	38.5	5.83	5.74	300.0	150.9	34.7	0.230	7.26
2	58.5	6.82	5.73	312.8	175.9	54.8	0.312	2310
3	77.5	6.89	5.78	318.5	180.8	53.1	0.294	1940
4	117.3	7.02	5.64	359.9	175.4	39.0	0.222	6220
5	165.4	7.20	5.74	398.1	186.3	38.7	0.208	1710
6	175.4	6.07	5.70	304.9	154.9	40.5	0.261	996
7	413.3	6.24	5.70	312.0	159.2	43.0	0.270	4920
8	482.4	7.11	5.68	440.2	180.2	17.1	0.095	5.89
9	502.8	5.77	5.70	357.5	147.2	10.0	0.068	0.15
10	529.0	7.03	5.77	408.0	183.8	32.4	0.176	3580
11	539.5	10.19	5.70	590.6	260.0	37.7	0.145	137
12	615.8	7.88	5.80	428.0	208.2	43.7	0.210	3430
13	625	8.95	5.70	512.9	228.4	37.1	0.163	130
14	110.6	6.05	8.00	542.0	304.1	100.6	0.331	2830
15	169.0	6.62	8.00	567.2	332.8	111.5	0.335	6630
16	178.4	6.03	8.00	651.1	303.1	70.3	0.232	3380
17	11.7	9.08	5.70	443.1	231.7	66.0	0.285	3610
18	28.5	8.68	5.74	502.7	224.6	38.5	0.171	246
19	45.5	9.12	5.70	553.8	232.7	25.6	0.110	43.5
20	72.3	8.57	5.77	541.2	224.1	23.8	0.106	14.3
21	106.5	8.73	5.72	589.9	224.3	9.0	0.040	0.49
22	136.5	10.60	5.71	642.0	271.4	35.7	0.132	528
23	151.0	10.26	5.70	561.1	261.8	52.1	0.199	1640

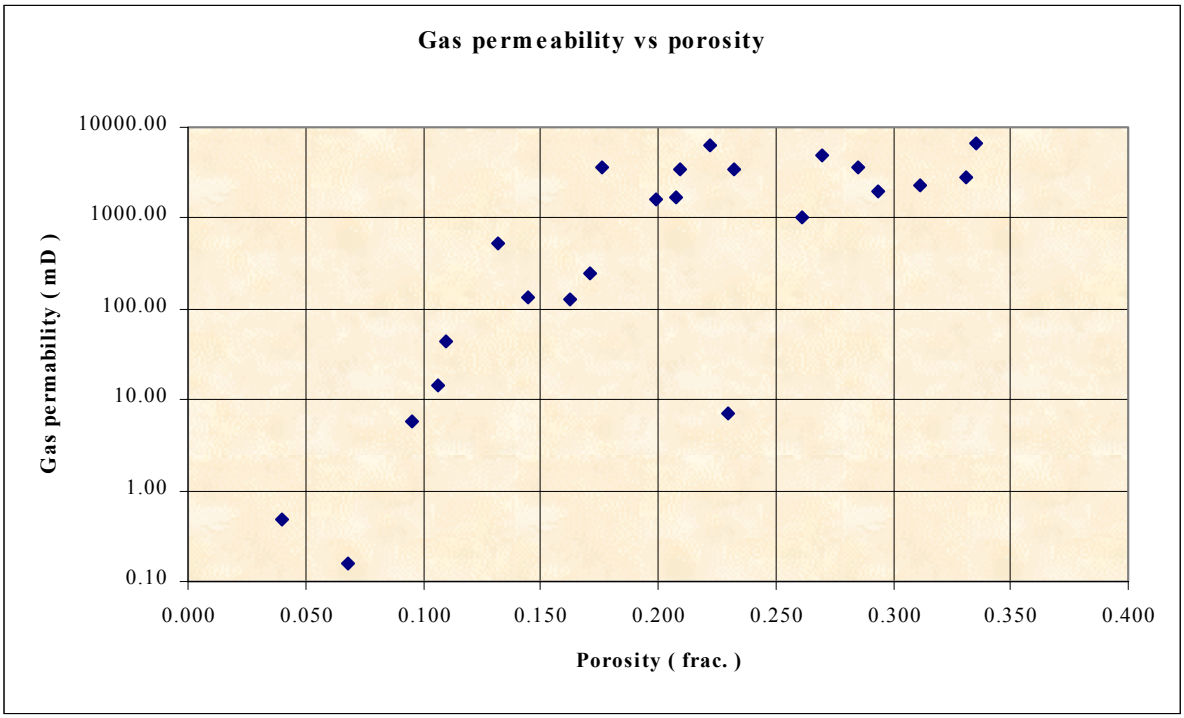


Figure 3.1.1 Gas permeability vs plug depths

4 DISCUSSION

The analysis on the core samples were performed on confined core samples, i.e. the core is installed in a rubber sleeve and a confining pressure os applied to the outside of this sleeve. The rubber sleeve will to some extent fill the vugs situated on the cylindrical surface of the core. This may lead to too low values when the pore volume is measured by helium gas expansion.

The bulk volume of the core samples are calculated using the measured core length and diameter. Normally, this will give a slight overestimation of the bulk volume.
When the two factors above are combined, the resulting porosity may be calculated too low. However, for large core samples as used in the current program, the effect of this may be dicarded.

One core plug (ID 1) does not fit into the permeability/porosity trend of the crossplot.

5 NOMENCLATURE

k_a = Empirical klinkenberg corrected gas permeability (mD)

APPENDICES

APPENDIX A

Pictures of whole cores

1, EHWR, 1196, A, 005R, 01WR, 38, 38.5, 38.0–45.0

2, EHWR, 1196, A, 007R, 02WR, 26, 58.5, 26-33

3, EHWR, 1196, A, 009R, 02WR, 2, 77.5, 2-8

4, EHWR, 1196, A, 0013R, 02WR, 111, 117.3, 111-118

5, EHWR, 1196, A, 0018R, 02WR, 130, 165,4 130-137

6, EHWR, 1196, A, 019R, 03WR, 21, 175.4, 21-28

7, EHWR, 1196, A, 044R, 01WR, 61, 413.3, 61.0-68,0

8, EHWR, 1196, A, 051R, 02WR, 101, 482.4, 101-108

9, EHWR, 1196, A, 053R, 03WR, 58, 502.8, 58-68

10, EHWR, 1196, A, 056R, 01WR, 93, 529.0, 93-100

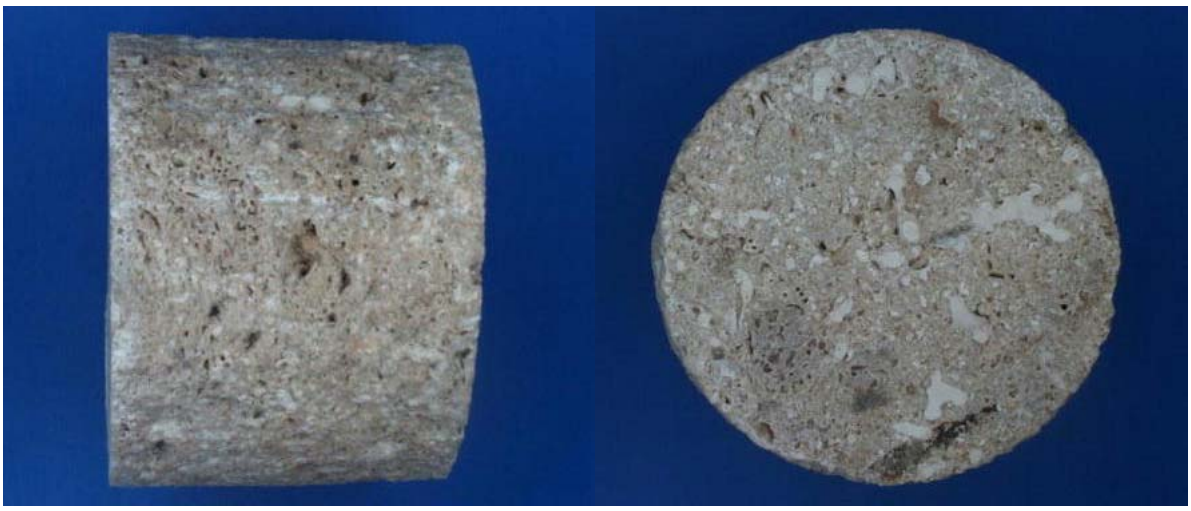
11, EHWR, 1196, A, 057R, 02WR, 36, 539.5, 36-46

12, EHWR, 1196, A, 065R, 01WR, 116, 615.8, 116-125

13, EHWR, 1196, A, 066R, 01WR, 68, 625, 68-77

14, EHWR, 1196, B, 013Z, 01WR, 68, 110.6, 68-78

15, EHWR, 1196, B, 029Z, 01WR, 57, 169.0, 57-67



16, EHWR, 1196, B, 031Z, 01WR, 123, 178.4, 123-132

17, EHWR, 1199, A, 002R, 02WR, 89, 11.7, 89-98

18, EHWR, 1199, A, 005R, 02WR, 30, 28.5, 30-40

19, EHWR, 1199, A, 007R, 01WR, 46, 45.5, 46-55

20, EHWR, 199, A, 009R, 07WR, 15, 72.3, 15-25

21, EHWR, 1199, A, 013R, 04WR, 30, 106.5, 30-42

22, EHWR, 1199, A, 016R, 04WR, 113, 136.5, 113-123

23, EHWR, 1199, A, 018R, 01WR, 88, 151.0, 88-98