THE ROYAL SOCIETY

PROCEEDINGS OF THE ROYAL SOCIETY A
MATHEMATICAL, PHYSICAL AND ENGINEERING SCIENCES

Electronic Supplementary Material (ESM)

Direct measurement of the unjacketed pore modulus of porous solids

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Data for Figure 2:

STEP 1			
ΔP [MPa]	ΔV_{total} [mm^3]	ΔV_{system} [mm^3]	ΔV_p [mm^3]
0.00	0.0	0.0	0.0
1.00	33.2	1.5	31.7
2.00	66.4	3.1	63.4
3.00	99.7	4.6	95.0
4.00	132.9	6.2	126.7
5.00	166.1	7.7	158.4
6.00	199.3	9.2	190.1
7.00	232.6	10.8	221.8
8.00	265.8	12.3	253.5
9.00	299.0	13.9	285.1
10.00	332.2	15.4	316.8
11.00	365.4	16.9	348.5
12.00	398.7	18.5	380.2
13.00	431.9	20.0	411.9
14.00	465.1	21.6	443.5
15.00	498.3	23.1	475.2
16.00	531.6	24.7	506.9
17.00	564.8	26.2	538.6
18.00	598.0	27.7	570.3
19.00	631.2	29.3	602.0
20.00	664.5	30.8	633.6

STEP 2				
Δp [MPa]	ΔV_{total} [mm^3]	ΔV_{fluid} [mm^3]	ΔV_{system} [mm^3]	ΔV_p [mm^3]
0.00	0.0	0.0	0.0	0.0
1.00	73.0	25.6	17.4	30.0
2.00	146.0	51.2	34.8	60.0
3.00	219.0	76.8	52.2	90.0
4.00	292.0	102.4	69.6	120.0
5.00	365.0	128.0	87.0	150.0
6.00	438.0	153.6	104.3	180.0
7.00	510.9	179.2	121.7	210.0
8.00	583.9	204.8	139.1	240.0
9.00	656.9	230.4	156.5	270.0
10.00	729.9	256.0	173.9	300.0
11.00	802.9	281.6	191.3	330.0
12.00	875.9	307.2	208.7	360.0
13.00	948.9	332.8	226.1	390.0
14.00	1021.9	358.4	243.5	420.0
15.00	1094.9	384.0	260.9	450.0
16.00	1167.9	409.6	278.3	480.0
17.00	1240.9	435.2	295.7	510.0
18.00	1313.9	460.8	313.0	540.0
19.00	1386.9	486.4	330.4	570.0
20.00	1459.9	512.0	347.8	600.0

Data for Figure 3:

Quartz		Dunnville Sandstone		Berea Sandstone		Silica	
Δp [MPa]	$\Delta\varepsilon$ [$\times 10^{-3}$]	Δp [MPa]	$\Delta\varepsilon$ [$\times 10^{-3}$]	Δp [MPa]	$\Delta\varepsilon$ [$\times 10^{-3}$]	Δp [MPa]	$\Delta\varepsilon$ [$\times 10^{-3}$]
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	0.03	1.00	0.03	1.00	0.03	1.00	0.04
2.00	0.05	2.00	0.06	2.00	0.07	2.00	0.08
3.00	0.08	3.00	0.09	3.00	0.10	3.00	0.13
4.00	0.11	4.00	0.11	4.00	0.13	4.00	0.17
5.00	0.14	5.00	0.14	5.00	0.17	5.00	0.21
6.00	0.16	6.00	0.17	6.00	0.20	6.00	0.25
7.00	0.19	7.00	0.20	7.00	0.23	7.00	0.29
8.00	0.22	8.00	0.23	8.00	0.27	8.00	0.33
9.00	0.24	9.00	0.26	9.00	0.30	9.00	0.38
10.00	0.27	10.00	0.29	10.00	0.33	10.00	0.42
11.00	0.30	11.00	0.31	11.00	0.37	11.00	0.46
12.00	0.32	12.00	0.34	12.00	0.40	12.00	0.50
13.00	0.35	13.00	0.37	13.00	0.43	13.00	0.54
14.00	0.38	14.00	0.40	14.00	0.47	14.00	0.58
15.00	0.41	15.00	0.43	15.00	0.50	15.00	0.63
16.00	0.43	16.00	0.46	16.00	0.53	16.00	0.67
17.00	0.46	17.00	0.49	17.00	0.57	17.00	0.71
18.00	0.49	18.00	0.51	18.00	0.60	18.00	0.75
19.00	0.51	19.00	0.54	19.00	0.63	19.00	0.79
20.00	0.54	20.00	0.57	20.00	0.67	20.00	0.83

Dunnville Sandstone			Berea Sandstone			Silica		
Δp [MPa]	ΔV_p [mm^3]	$\Delta \varepsilon_p$ [× 10^{-3}]	Δp [MPa]	ΔV_p [mm^3]	$\Delta \varepsilon_p$ [× 10^{-3}]	Δp [MPa]	ΔV_p [mm^3]	$\Delta \varepsilon_p$ [× 10^{-3}]
0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00
1.00	1.7	0.03	1.00	1.6	0.05	1.00	3.8	0.04
2.00	3.4	0.06	2.00	3.2	0.09	2.00	7.6	0.08
3.00	5.0	0.09	3.00	4.8	0.14	3.00	11.4	0.12
4.00	6.7	0.11	4.00	6.4	0.18	4.00	15.1	0.16
5.00	8.4	0.14	5.00	8.0	0.23	5.00	18.9	0.21
6.00	10.1	0.17	6.00	9.5	0.27	6.00	22.7	0.25
7.00	11.8	0.20	7.00	11.1	0.32	7.00	26.5	0.29
8.00	13.4	0.23	8.00	12.7	0.36	8.00	30.3	0.33
9.00	15.1	0.26	9.00	14.3	0.41	9.00	34.1	0.37
10.00	16.8	0.29	10.00	15.9	0.45	10.00	37.9	0.41
11.00	18.5	0.31	11.00	17.5	0.50	11.00	41.7	0.45
12.00	20.2	0.34	12.00	19.1	0.55	12.00	45.4	0.49
13.00	21.8	0.37	13.00	20.7	0.59	13.00	49.2	0.54
14.00	23.5	0.40	14.00	22.3	0.64	14.00	53.0	0.58
15.00	25.2	0.43	15.00	23.9	0.68	15.00	56.8	0.62
16.00	26.9	0.46	16.00	25.5	0.73	16.00	60.6	0.66
17.00	28.6	0.49	17.00	27.1	0.77	17.00	64.4	0.70
18.00	30.2	0.51	18.00	28.6	0.82	18.00	68.2	0.74
19.00	31.9	0.54	19.00	30.2	0.86	19.00	72.0	0.78
20.00	33.6	0.57	20.00	31.8	0.91	20.00	75.7	0.82

Data for Figure 4:

Dunnville Sandstone								
Δp [MPa]	$P' = P - p$ = 5.0 MPa		$P' = P - p$ = 20.0 MPa		$P' = P - p$ = 5.0 MPa		$P' = P - p$ = 20.0 MPa	
	ΔV_p - STEP 2 [mm^3]	ΔV_p - STEP 1 [mm^3]	ΔV_p - STEP 2 [mm^3]	ΔV_p - STEP 1 [mm^3]	$\Delta \varepsilon_p$- STEP 2 [$\times 10^{-3}$]	$\Delta \varepsilon_p$- STEP 1 [$\times 10^{-3}$]	$\Delta \varepsilon_p$- STEP 2 [$\times 10^{-3}$]	$\Delta \varepsilon_p$- STEP 1 [$\times 10^{-3}$]
0.00	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1.00	30.0	31.7	20.5	22.2	0.51	0.54	0.35	0.38
2.00	60.0	63.4	41.0	44.3	1.02	1.08	0.70	0.75
3.00	90.0	95.0	61.4	66.5	1.53	1.61	1.04	1.13
4.00	120.0	126.7	81.9	88.6	2.04	2.15	1.39	1.51
5.00	150.0	158.4	102.4	110.8	2.55	2.69	1.74	1.88
6.00	180.0	190.1	122.9	132.9	3.06	3.23	2.09	2.26
7.00	210.0	221.8	143.4	155.1	3.57	3.77	2.43	2.63
8.00	240.0	253.5	163.8	177.2	4.08	4.30	2.78	3.01
9.00	270.0	285.1	184.3	199.4	4.59	4.84	3.13	3.39
10.00	300.0	316.8	204.8	221.6	5.10	5.38	3.48	3.76
11.00	330.0	348.5	225.3	243.7	5.60	5.92	3.83	4.14
12.00	360.0	380.2	245.8	265.9	6.11	6.46	4.17	4.52
13.00	390.0	411.9	266.2	288.0	6.62	6.99	4.52	4.89
14.00	420.0	443.5	286.7	310.2	7.13	7.53	4.87	5.27
15.00	450.0	475.2	307.2	332.3	7.64	8.07	5.22	5.64
16.00	480.0	506.9	327.7	354.5	8.15	8.61	5.57	6.02
17.00	510.0	538.6	348.2	376.6	8.66	9.15	5.91	6.40
18.00	540.0	570.3	368.6	398.8	9.17	9.69	6.26	6.77
19.00	570.0	602.0	389.1	421.0	9.68	10.22	6.61	7.15
20.00	600.0	633.6	409.6	443.1	10.19	10.76	6.96	7.53

Berea Sandstone								
Δp [MPa]	$P' = P - p$ = 5.0 MPa		$P' = P - p$ = 20.0 MPa		$P' = P - p$ = 5.0 MPa		$P' = P - p$ = 20.0 MPa	
	ΔV_p - STEP 2 [mm^3]	ΔV_p - STEP 1 [mm^3]	ΔV_p - STEP 2 [mm^3]	ΔV_p - STEP 1 [mm^3]	$\Delta \varepsilon_p$- STEP 2 [$\times 10^{-3}$]	$\Delta \varepsilon_p$- STEP 1 [$\times 10^{-3}$]	$\Delta \varepsilon_p$- STEP 2 [$\times 10^{-3}$]	$\Delta \varepsilon_p$- STEP 1 [$\times 10^{-3}$]
0.00	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1.00	30.7	32.3	13.6	15.2	0.88	0.92	0.39	0.44
2.00	61.3	64.5	27.3	30.5	1.75	1.84	0.78	0.87
3.00	92.0	96.8	40.9	45.7	2.63	2.76	1.17	1.31
4.00	122.7	129.1	54.6	61.0	3.50	3.69	1.56	1.74
5.00	153.4	161.3	68.2	76.2	4.38	4.61	1.95	2.18
6.00	184.0	193.6	81.9	91.5	5.26	5.53	2.34	2.61
7.00	214.7	225.9	95.5	106.7	6.13	6.45	2.73	3.05
8.00	245.4	258.1	109.2	121.9	7.01	7.37	3.12	3.48
9.00	276.1	290.4	122.8	137.2	7.88	8.29	3.51	3.92
10.00	306.7	322.7	136.5	152.4	8.76	9.21	3.90	4.35
11.00	337.4	354.9	150.1	167.7	9.63	10.13	4.29	4.79
12.00	368.1	387.2	163.7	182.9	10.51	11.06	4.68	5.22
13.00	398.8	419.5	177.4	198.2	11.39	11.98	5.07	5.66
14.00	429.4	451.7	191.0	213.4	12.26	12.90	5.45	6.09
15.00	460.1	484.0	204.7	228.6	13.14	13.82	5.84	6.53
16.00	490.8	516.2	218.3	243.9	14.01	14.74	6.23	6.96
17.00	521.5	548.5	232.0	259.1	14.89	15.66	6.62	7.40
18.00	552.1	580.8	245.6	274.4	15.77	16.58	7.01	7.83
19.00	582.8	613.0	259.3	289.6	16.64	17.51	7.40	8.27
20.00	613.5	645.3	272.9	304.9	17.52	18.43	7.79	8.71

Data for Figure 5:

				Dunnville SS	Berea SS	Silica
P [MPa]	p [MPa]	$P' = P - p$ [MPa]	ΔP [MPa]	$\Delta\varepsilon_V$ [$\times 10^{-3}$]	$\Delta\varepsilon_V$ [$\times 10^{-3}$]	$\Delta\varepsilon_V$ [$\times 10^{-3}$]
15.00	10.00	5.00	0.00	0.00	0.00	0.00
17.50	10.00	7.50	2.50	0.30	0.38	0.94
20.00	10.00	10.00	5.00	0.64	0.79	2.10
22.50	10.00	12.50	7.50	0.99	1.19	3.35
25.00	10.00	15.00	10.00	1.36	1.58	4.61
27.50	10.00	17.50	12.50	1.74	1.95	5.89
30.00	10.00	20.00	15.00	2.14	2.30	7.17
32.50	10.00	22.50	17.50	2.53	2.65	8.49
35.00	10.00	25.00	20.00	2.94	2.99	9.75
32.50	10.00	22.50	17.50	2.73	2.82	8.36
30.00	10.00	20.00	15.00	2.47	2.61	7.17
27.50	10.00	17.50	12.50	2.16	2.37	5.93
25.00	10.00	15.00	10.00	1.83	2.09	4.69
22.50	10.00	12.50	7.50	1.46	1.76	3.43
20.00	10.00	10.00	5.00	1.06	1.35	2.16
17.50	10.00	7.50	2.50	0.62	0.84	0.87
15.00	10.00	5.00	0.00	0.13	0.15	0.09

Data for Figure 6:

		From Eq. (6.1)
$P' = P - p$ [MPa]	B	K_s'' [GPa]
5.00	1.00	2.3
	0.95	2.5
	0.90	2.7
	0.85	2.9
	0.80	3.3
	0.75	3.9
	0.70	4.9
	0.65	6.9
	0.60	13.1
	0.59	16.3
	0.58	22.0
	0.57	34.2
	0.56	80.9

B_c	K_s'' [GPa]
0.55	0.0
0.55	1.0
0.55	2.0
0.55	3.0
0.55	4.0
0.55	5.0
0.55	6.0
0.55	7.0
0.55	8.0
0.55	9.0
0.55	10.0
0.55	11.0
0.55	12.0
0.55	13.0
0.55	14.0
0.55	15.0
0.55	16.0
0.55	17.0
0.55	18.0
0.55	19.0
0.55	20.0
0.55	21.0
0.55	22.0
0.55	23.0
0.55	24.0
0.55	25.0
0.55	26.0
0.55	27.0
0.55	28.0
0.55	29.0
0.55	30.0
0.55	31.0
0.55	32.0
0.55	33.0
0.55	34.0
0.55	35.0
0.55	36.0
0.55	37.0
0.55	38.0
0.55	39.0
0.55	40.0
0.55	41.0

0.55	42.0
0.55	43.0
0.55	44.0
0.55	45.0
0.55	46.0
0.55	47.0
0.55	48.0
0.55	49.0
0.55	50.0
0.55	51.0
0.55	52.0
0.55	53.0
0.55	54.0
0.55	55.0
0.55	56.0
0.55	57.0
0.55	58.0
0.55	59.0
0.55	60.0
0.55	61.0
0.55	62.0
0.55	63.0
0.55	64.0
0.55	65.0
0.55	66.0
0.55	67.0
0.55	68.0
0.55	69.0
0.55	70.0
0.55	71.0
0.55	72.0
0.55	73.0
0.55	74.0
0.55	75.0
0.55	76.0
0.55	77.0
0.55	78.0
0.55	79.0
0.55	80.0
0.55	81.0
0.55	82.0
0.55	83.0
0.55	84.0

0.55	85.0
0.55	86.0
0.55	87.0
0.55	88.0
0.55	89.0
0.55	90.0
0.55	91.0
0.55	92.0
0.55	93.0
0.55	94.0
0.55	95.0
0.55	96.0
0.55	97.0
0.55	98.0
0.55	99.0
0.55	100.0

B	K_s'' [GPa]
1.00	2.3
0.99	2.3
0.98	2.3
0.97	2.3
0.96	2.3
0.95	2.3
0.94	2.3
0.93	2.3
0.92	2.3
0.91	2.3
0.90	2.3
0.89	2.3
0.88	2.3
0.87	2.3
0.86	2.3
0.85	2.3
0.84	2.3
0.83	2.3
0.82	2.3
0.81	2.3
0.80	2.3
0.79	2.3
0.78	2.3
0.77	2.3

0.76	2.3
0.75	2.3
0.74	2.3
0.73	2.3
0.72	2.3
0.71	2.3
0.70	2.3
0.69	2.3
0.68	2.3
0.67	2.3
0.66	2.3
0.65	2.3
0.64	2.3
0.63	2.3
0.62	2.3
0.61	2.3
0.60	2.3
0.59	2.3
0.58	2.3
0.57	2.3
0.56	2.3
0.55	2.3
0.54	2.3
0.53	2.3
0.52	2.3
0.51	2.3
0.50	2.3
0.49	2.3
0.48	2.3
0.47	2.3
0.46	2.3
0.45	2.3
0.44	2.3
0.43	2.3
0.42	2.3
0.41	2.3
0.40	2.3
0.39	2.3
0.38	2.3
0.37	2.3
0.36	2.3
0.35	2.3
0.34	2.3

0.33	2.3
0.32	2.3
0.31	2.3
0.30	2.3
0.29	2.3
0.28	2.3
0.27	2.3
0.26	2.3
0.25	2.3
0.24	2.3
0.23	2.3
0.22	2.3
0.21	2.3
0.20	2.3
0.19	2.3
0.18	2.3
0.17	2.3
0.16	2.3
0.15	2.3
0.14	2.3
0.13	2.3
0.12	2.3
0.11	2.3
0.10	2.3
0.09	2.3
0.08	2.3
0.07	2.3
0.06	2.3
0.05	2.3
0.04	2.3
0.03	2.3
0.02	2.3
0.01	2.3

Data for Figure 7:

	Strain gage readings	
P [MPa]	ε_z [× 10^{-3}]	ε_θ [× 10^{-3}]
0.00	0.00	0.00
2.45	0.02	0.06
4.94	0.04	0.13
7.45	0.07	0.20
9.94	0.09	0.26
12.44	0.11	0.33
14.94	0.13	0.40
17.64	0.15	0.47
19.94	0.17	0.53
22.45	0.19	0.59
24.94	0.21	0.66
27.44	0.23	0.72
29.94	0.25	0.79

	Elastic solution	
P [MPa]	ε_z [× 10^{-3}]	ε_θ [× 10^{-3}]
0.00	0.000	0.000
0.01	0.000	0.000
0.03	0.000	0.001
0.04	0.000	0.001
0.06	0.001	0.002
0.08	0.001	0.002
0.10	0.001	0.003
0.12	0.001	0.003
0.14	0.001	0.004
0.17	0.001	0.005
0.19	0.002	0.005
0.22	0.002	0.006
0.24	0.002	0.006
0.26	0.002	0.007
0.29	0.002	0.008
0.31	0.003	0.008
0.34	0.003	0.009
0.37	0.003	0.010
0.40	0.003	0.011
0.42	0.004	0.011
0.45	0.004	0.012

0.47	0.004	0.013
0.49	0.004	0.013
0.51	0.004	0.013
0.52	0.005	0.014
0.53	0.005	0.014
0.55	0.005	0.015
0.56	0.005	0.015
0.58	0.005	0.015
0.59	0.005	0.016
0.61	0.005	0.016
0.63	0.006	0.017
0.65	0.006	0.017
0.67	0.006	0.018
0.69	0.006	0.018
0.71	0.006	0.019
0.73	0.006	0.020
0.75	0.007	0.020
0.77	0.007	0.021
0.79	0.007	0.021
0.81	0.007	0.022
0.83	0.007	0.022
0.86	0.007	0.023
0.87	0.008	0.023
0.89	0.008	0.024
0.91	0.008	0.024
0.93	0.008	0.025
0.95	0.008	0.025
0.97	0.008	0.026
0.99	0.009	0.026
1.01	0.009	0.027
1.04	0.009	0.028
1.05	0.009	0.028
1.07	0.009	0.029
1.09	0.010	0.029
1.11	0.010	0.030
1.13	0.010	0.030
1.15	0.010	0.031
1.17	0.010	0.031
1.19	0.010	0.032
1.21	0.011	0.032
1.23	0.011	0.033
1.25	0.011	0.033
1.27	0.011	0.034

1.29	0.011	0.034
1.31	0.011	0.035
1.33	0.012	0.035
1.35	0.012	0.036
1.41	0.012	0.038
1.50	0.013	0.040
1.60	0.014	0.043
1.71	0.015	0.045
1.82	0.016	0.048
1.92	0.017	0.051
2.03	0.018	0.054
2.14	0.019	0.057
2.24	0.020	0.060
2.35	0.020	0.062
2.45	0.021	0.065
2.55	0.022	0.068
2.65	0.023	0.070
2.75	0.024	0.073
2.85	0.025	0.076
2.95	0.026	0.079
3.05	0.027	0.081
3.16	0.028	0.084
3.26	0.028	0.087
3.37	0.029	0.090
3.47	0.030	0.092
3.56	0.031	0.095
3.66	0.032	0.097
3.75	0.033	0.100
3.85	0.034	0.102
3.94	0.034	0.105
4.04	0.035	0.108
4.15	0.036	0.110
4.25	0.037	0.113
4.35	0.038	0.116
4.45	0.039	0.118
4.55	0.040	0.121
4.64	0.040	0.124
4.75	0.041	0.126
4.84	0.042	0.129
4.94	0.043	0.131
5.04	0.044	0.134
5.15	0.045	0.137
5.24	0.046	0.139

5.35	0.047	0.142
5.44	0.047	0.145
5.54	0.048	0.147
5.64	0.049	0.150
5.74	0.050	0.153
5.84	0.051	0.155
5.94	0.052	0.158
6.04	0.053	0.161
6.14	0.054	0.163
6.24	0.054	0.166
6.34	0.055	0.169
6.44	0.056	0.171
6.54	0.057	0.174
6.65	0.058	0.177
6.74	0.059	0.179
6.85	0.060	0.182
6.94	0.061	0.185
7.05	0.061	0.187
7.15	0.062	0.190
7.24	0.063	0.193
7.34	0.064	0.195
7.45	0.065	0.198
7.54	0.066	0.201
7.65	0.067	0.203
7.74	0.067	0.206
7.84	0.068	0.209
7.94	0.069	0.211
8.04	0.070	0.214
8.14	0.071	0.217
8.24	0.072	0.219
8.34	0.073	0.222
8.45	0.074	0.225
8.54	0.074	0.227
8.64	0.075	0.230
8.74	0.076	0.233
8.84	0.077	0.235
8.94	0.078	0.238
9.04	0.079	0.240
9.14	0.080	0.243
9.24	0.081	0.246
9.34	0.081	0.249
9.44	0.082	0.251
9.55	0.083	0.254

9.64	0.084	0.256
9.75	0.085	0.259
9.84	0.086	0.262
9.94	0.087	0.264
10.04	0.088	0.267
10.14	0.088	0.270
10.25	0.089	0.272
10.35	0.090	0.275
10.44	0.091	0.278
10.54	0.092	0.280
10.64	0.093	0.283
10.74	0.094	0.286
10.84	0.094	0.288
10.94	0.095	0.291
11.04	0.096	0.294
11.14	0.097	0.296
11.24	0.098	0.299
11.34	0.099	0.302
11.44	0.100	0.304
11.55	0.101	0.307
11.64	0.101	0.310
11.74	0.102	0.312
11.84	0.103	0.315
11.94	0.104	0.318
12.05	0.105	0.320
12.14	0.106	0.323
12.24	0.107	0.326
12.34	0.108	0.328
12.44	0.108	0.331
12.54	0.109	0.334
12.64	0.110	0.336
12.74	0.111	0.339
12.85	0.112	0.342
12.94	0.113	0.344
13.04	0.114	0.347
13.14	0.115	0.350
13.24	0.115	0.352
13.34	0.116	0.355
13.44	0.117	0.358
13.54	0.118	0.360
13.65	0.119	0.363
13.75	0.120	0.366
13.84	0.121	0.368

13.95	0.122	0.371
14.04	0.122	0.373
14.14	0.123	0.376
14.24	0.124	0.379
14.35	0.125	0.382
14.44	0.126	0.384
14.55	0.127	0.387
14.64	0.128	0.389
14.74	0.128	0.392
14.85	0.129	0.395
14.94	0.130	0.397
15.04	0.131	0.400
15.14	0.132	0.403
15.25	0.133	0.405
15.35	0.134	0.408
15.45	0.135	0.411
15.55	0.135	0.413
15.65	0.136	0.416
15.74	0.137	0.419
15.84	0.138	0.421
15.94	0.139	0.424
16.04	0.140	0.427
16.14	0.141	0.429
16.24	0.142	0.432
16.34	0.142	0.435
16.44	0.143	0.437
16.54	0.144	0.440
16.65	0.145	0.443
16.74	0.146	0.445
16.85	0.147	0.448
16.95	0.148	0.451
17.04	0.149	0.453
17.14	0.149	0.456
17.24	0.150	0.459
17.34	0.151	0.461
17.45	0.152	0.464
17.54	0.153	0.467
17.64	0.154	0.469
17.74	0.155	0.472
17.85	0.156	0.475
17.95	0.156	0.477
18.05	0.157	0.480
18.15	0.158	0.483

18.24	0.159	0.485
18.34	0.160	0.488
18.44	0.161	0.491
18.55	0.162	0.493
18.64	0.162	0.496
18.74	0.163	0.499
18.84	0.164	0.501
18.95	0.165	0.504
19.05	0.166	0.507
19.15	0.167	0.509
19.25	0.168	0.512
19.35	0.169	0.514
19.44	0.169	0.517
19.54	0.170	0.520
19.64	0.171	0.522
19.74	0.172	0.525
19.84	0.173	0.528
19.94	0.174	0.530
20.05	0.175	0.533
20.14	0.176	0.536
20.25	0.176	0.538
20.34	0.177	0.541
20.44	0.178	0.544
20.55	0.179	0.546
20.64	0.180	0.549
20.74	0.181	0.552
20.84	0.182	0.554
20.94	0.183	0.557
21.04	0.183	0.560
21.15	0.184	0.562
21.25	0.185	0.565
21.35	0.186	0.568
21.44	0.187	0.570
21.54	0.188	0.573
21.64	0.189	0.576
21.74	0.189	0.578
21.84	0.190	0.581
21.95	0.191	0.584
22.05	0.192	0.586
22.15	0.193	0.589
22.25	0.194	0.592
22.34	0.195	0.594
22.45	0.196	0.597

22.54	0.196	0.600
22.64	0.197	0.602
22.74	0.198	0.605
22.84	0.199	0.608
22.94	0.200	0.610
23.04	0.201	0.613
23.14	0.202	0.616
23.24	0.203	0.618
23.34	0.203	0.621
23.44	0.204	0.623
23.54	0.205	0.626
23.64	0.206	0.629
23.75	0.207	0.632
23.84	0.208	0.634
23.95	0.209	0.637
24.04	0.210	0.639
24.14	0.210	0.642
24.24	0.211	0.645
24.34	0.212	0.647
24.44	0.213	0.650
24.54	0.214	0.653
24.64	0.215	0.655
24.74	0.216	0.658
24.85	0.217	0.661
24.94	0.217	0.663
25.05	0.218	0.666
25.14	0.219	0.669
25.24	0.220	0.671
25.34	0.221	0.674
25.44	0.222	0.677
25.54	0.223	0.679
25.64	0.223	0.682
25.74	0.224	0.685
25.84	0.225	0.687
25.94	0.226	0.690
26.04	0.227	0.693
26.14	0.228	0.695
26.24	0.229	0.698
26.34	0.230	0.701
26.44	0.230	0.703
26.54	0.231	0.706
26.64	0.232	0.709
26.75	0.233	0.711

26.84	0.234	0.714
26.94	0.235	0.717
27.05	0.236	0.719
27.14	0.237	0.722
27.24	0.237	0.725
27.34	0.238	0.727
27.44	0.239	0.730
27.54	0.240	0.733
27.64	0.241	0.735
27.74	0.242	0.738
27.84	0.243	0.741
27.94	0.244	0.743
28.05	0.244	0.746
28.14	0.245	0.749
28.24	0.246	0.751
28.34	0.247	0.754
28.44	0.248	0.756
28.54	0.249	0.759
28.65	0.250	0.762
28.74	0.250	0.764
28.84	0.251	0.767
28.95	0.252	0.770
29.05	0.253	0.773
29.14	0.254	0.775
29.24	0.255	0.778
29.34	0.256	0.780
29.44	0.257	0.783
29.54	0.257	0.786
29.64	0.258	0.788
29.74	0.259	0.791
29.84	0.260	0.794
29.94	0.261	0.796
30.03	0.262	0.799

Data for Figure 8:

p = 10 MPa			
P [MPa]	V_{total} [mm^3]	$V_{cylinder}$ [mm^3]	V_{system} [mm^3]
15.00	0.0	0.0	0.0
16.00	3.1	2.5	0.6
17.00	6.1	5.0	1.1
18.00	8.8	7.6	1.3
19.00	11.8	10.1	1.7
20.00	14.6	12.6	2.0
21.00	17.6	15.1	2.5
22.00	20.6	17.6	2.9
23.00	23.6	20.2	3.5
24.00	26.5	22.7	3.9
25.00	29.5	25.2	4.3
26.00	32.6	27.7	4.9
27.00	35.5	30.2	5.3
28.00	38.2	32.7	5.5
29.00	41.1	35.3	5.9
30.00	44.1	37.8	6.3
31.00	47.1	40.3	6.8
32.00	50.0	42.8	7.2
33.00	52.8	45.3	7.4
34.00	55.9	47.8	8.0
35.00	58.9	50.4	8.5

p = 20 MPa			
P [MPa]	V_{total} [mm^3]	$V_{cylinder}$ [mm^3]	V_{system} [mm^3]
25.00	0.0	0.0	0.0
26.00	3.5	2.5	1.0
27.00	6.6	5.0	1.6
28.00	9.5	7.6	1.9
29.00	12.6	10.1	2.5
30.00	15.3	12.6	2.7
31.00	18.4	15.1	3.3
32.00	21.0	17.6	3.4
33.00	23.9	20.1	3.8
34.00	26.8	22.7	4.1
35.00	29.7	25.2	4.5
36.00	32.8	27.7	5.1
37.00	35.6	30.2	5.4
38.00	38.2	32.7	5.5
39.00	41.1	35.3	5.9
40.00	44.2	37.8	6.4
41.00	47.3	40.3	7.0
42.00	50.0	42.8	7.2
43.00	53.0	45.3	7.7
44.00	56.2	47.8	8.3
45.00	58.9	50.4	8.5

p = 30 MPa			
P [MPa]	V_{total} [mm^3]	$V_{cylinder}$ [mm^3]	V_{system} [mm^3]
35.00	0.0	0.0	0.0
36.00	3.2	2.5	0.7
37.00	6.3	5.0	1.2
38.00	9.0	7.6	1.5
39.00	11.9	10.1	1.8
40.00	14.7	12.6	2.1
41.00	17.5	15.1	2.4
42.00	20.4	17.6	2.7
43.00	23.3	20.1	3.2
44.00	26.2	22.7	3.5
45.00	29.0	25.2	3.8
46.00	32.0	27.7	4.3
47.00	35.1	30.2	4.8
48.00	37.7	32.7	5.0
49.00	40.7	35.3	5.5
50.00	43.8	37.8	6.1
51.00	46.6	40.3	6.4
52.00	49.6	42.8	6.8
53.00	52.4	45.3	7.0
54.00	55.4	47.8	7.6
55.00	58.3	50.4	8.0

Data for Figure 9:

d = 22.4 mm		d = 27.4 mm		d = 35.0 mm	
p [MPa]	V_{system} [mm^3]	p [MPa]	V_{system} [mm^3]	p [MPa]	V_{system} [mm^3]
0.00	0.0	0.00	0.0	0.00	0.0
0.01	56.7	0.01	127.8	0.05	547.1
0.12	96.8	0.10	240.8	0.10	847.0
0.51	113.1	0.51	360.9	0.20	1102.1
1.02	127.2	1.00	399.6	0.30	1236.3
2.02	153.8	2.02	441.3	0.40	1313.8
3.01	176.9	3.03	470.6	0.50	1367.6
4.02	199.8	4.02	496.6	0.60	1406.6
5.01	221.2	5.03	520.3	0.70	1438.2
6.02	242.2	6.01	541.6	0.80	1462.4
7.02	261.6	7.00	562.2	0.90	1481.2
8.01	279.3	8.03	581.9	1.00	1496.4
9.04	298.0	9.02	600.5	1.50	1553.5
10.02	315.8	10.02	618.8	2.01	1588.6
11.01	333.6	11.00	636.1	3.01	1635.8
12.01	351.3	12.02	654.2	4.02	1671.1
13.00	369.0	13.01	671.2	5.02	1699.9
14.00	386.5	14.04	688.9	6.01	1725.2
15.00	404.1	15.02	706.2	7.01	1748.3
16.05	422.4	16.01	723.1	8.02	1769.5
17.00	439.0	17.00	740.1	9.01	1789.2
18.02	456.2	18.00	756.8	10.02	1808.1
19.03	473.5	19.00	773.6	11.01	1826.2
20.05	490.8	20.00	790.4	12.01	1844.2
21.00	507.5	21.01	806.8	13.01	1861.5
22.02	524.7	22.02	823.1	14.01	1879.4
23.02	542.1	23.02	839.6	15.02	1896.7
24.03	559.4	24.03	856.2	16.01	1913.2
25.05	576.7	25.03	872.9	17.00	1929.5
26.01	593.1	26.02	889.7	18.02	1946.3
27.01	610.7	27.01	906.7	19.02	1962.2
28.00	628.2	28.02	924.7	20.02	1978.1
28.91	645.3	28.90	942.9	21.02	1993.8
				22.02	2009.6
				23.02	2025.6
				24.02	2041.2
				25.02	2057.1
				26.02	2073.0
				27.01	2089.8
				28.00	2107.8
				28.98	2128.4

d = 35.0 mm				
p [MPa]	V_{system} [mm^3]	V_{total} [mm^3]	$V_{cyclinder}$ [mm^3]	V_{fluid} [mm^3]
0.00	0.0	0.0	0.0	0.0
0.05	547.1	549.5	0.4	2.1
0.10	847.0	852.0	0.8	4.2
0.20	1102.1	1112.2	1.7	8.4
0.30	1236.3	1251.4	2.5	12.6
0.40	1313.8	1333.9	3.3	16.7
0.50	1367.6	1392.6	4.1	20.9
0.60	1406.6	1436.6	5.0	25.1
0.70	1438.2	1473.3	5.8	29.3
0.80	1462.4	1502.6	6.6	33.6
0.90	1481.2	1526.4	7.5	37.8
1.00	1496.4	1546.5	8.3	41.8
1.50	1553.5	1628.9	12.4	62.9
2.01	1588.6	1689.2	16.6	84.0
3.01	1635.8	1786.4	24.9	125.8
4.02	1671.1	1872.6	33.2	168.2
5.02	1699.9	1951.4	41.5	210.0
6.01	1725.2	2026.5	49.7	251.6
7.01	1748.3	2099.7	58.0	293.4
8.02	1769.5	2171.1	66.3	335.3
9.01	1789.2	2240.7	74.5	377.0
10.02	1808.1	2310.3	82.9	419.3
11.01	1826.2	2378.0	91.1	460.7
12.01	1844.2	2445.7	99.3	502.3
13.01	1861.5	2513.4	107.6	544.3
14.01	1879.4	2581.2	115.8	586.0
15.02	1896.7	2649.3	124.2	628.3
16.01	1913.2	2715.2	132.4	669.7
17.00	1929.5	2781.3	140.6	711.2
18.02	1946.3	2849.1	149.0	753.8
19.02	1962.2	2915.1	157.3	795.6
20.02	1978.1	2981.1	165.5	837.4
21.02	1993.8	3046.9	173.8	879.3
22.02	2009.6	3112.8	182.1	921.1
23.02	2025.6	3178.7	190.3	962.8
24.02	2041.2	3244.7	198.7	1004.9
25.02	2057.1	3310.8	206.9	1046.8
26.02	2073.0	3376.8	215.2	1088.6
27.01	2089.8	3442.8	223.3	1129.7
28.00	2107.8	3510.6	231.6	1171.3
28.98	2128.4	3580.5	239.7	1212.4

d = 22.4 mm- P = 30.0 MPa			
V_f [mm^3]	Δp [MPa]	ΔV_f [mm^3]	$\varepsilon_f = \Delta V_f / V_f$ [$\times 10^{-2}$]
39408.1	0.00	0.0	0.00
	0.01	56.7	0.14
	0.12	96.8	0.25
	0.51	113.0	0.29
	1.02	127.0	0.32
	2.02	153.4	0.39
	3.01	176.3	0.45
	4.02	199.0	0.50
	5.01	220.3	0.56
	6.02	241.0	0.61
	7.02	260.2	0.66
	8.01	277.8	0.70
	9.04	296.3	0.75
	10.02	313.8	0.80
	11.01	331.4	0.84
	12.01	349.0	0.89
	13.00	366.4	0.93
	14.00	383.8	0.97
	15.00	401.1	1.02
	16.05	419.3	1.06
	17.00	435.6	1.11
	18.02	452.6	1.15
	19.03	469.8	1.19
	20.05	486.9	1.24
	21.00	503.3	1.28
	22.02	520.4	1.32
	23.02	537.6	1.36
	24.03	554.7	1.41
	25.05	571.8	1.45
	26.01	588.0	1.49
	27.01	605.4	1.54
	28.00	622.7	1.58
	28.91	639.6	1.62

d = 27.4 mm- P = 30.0 MPa			
V_f [mm^3]	Δp [MPa]	ΔV_f [mm^3]	$\varepsilon_f = \Delta V_f / V_f$ [× 10^{-2}]
58964.6	0.00	0.0	0.00
	0.01	127.9	0.22
	0.10	241.7	0.41
	0.51	365.4	0.62
	1.00	408.4	0.69
	2.02	459.0	0.78
	3.03	497.0	0.84
	4.02	531.7	0.90
	5.03	564.2	0.96
	6.01	594.0	1.01
	7.00	623.2	1.06
	8.03	651.9	1.11
	9.02	679.2	1.15
	10.02	706.2	1.20
	11.00	732.1	1.24
	12.02	759.0	1.29
	13.01	784.6	1.33
	14.04	811.3	1.38
	15.02	837.1	1.42
	16.01	862.7	1.46
	17.00	888.4	1.51
	18.00	913.9	1.55
	19.00	939.3	1.59
	20.00	964.8	1.64
	21.01	990.1	1.68
	22.02	1015.2	1.72
	23.02	1040.4	1.76
	24.03	1065.8	1.81
	25.03	1091.2	1.85
	26.02	1116.7	1.89
	27.01	1142.3	1.94
	28.02	1169.2	1.98
	28.90	1195.0	2.03

d = 35.0 mm- P = 30.0 MPa			
V_f [mm^3]	Δp [MPa]	ΔV_f [mm^3]	$\varepsilon_f = \Delta V_f / V_f$ [$\times 10^{-2}$]
96211.3	0.00	0.0	0.00
	0.05	548.3	0.57
	0.10	849.5	0.88
	0.20	1107.2	1.15
	0.30	1244.0	1.29
	0.40	1324.0	1.38
	0.50	1380.3	1.43
	0.60	1421.8	1.48
	0.70	1456.0	1.51
	0.80	1482.7	1.54
	0.90	1504.1	1.56
	1.00	1521.7	1.58
	1.50	1591.6	1.65
	2.01	1639.5	1.70
	3.01	1712.0	1.78
	4.02	1773.0	1.84
	5.02	1827.2	1.90
	6.01	1877.6	1.95
	7.01	1926.1	2.00
	8.02	1972.7	2.05
	9.01	2017.6	2.10
	10.02	2062.1	2.14
	11.01	2105.4	2.19
	12.01	2148.5	2.23
	13.01	2191.3	2.28
	14.01	2234.5	2.32
	15.02	2277.5	2.37
	16.01	2319.0	2.41
	17.00	2360.4	2.45
	18.02	2403.0	2.50
	19.02	2444.3	2.54
	20.02	2485.5	2.58
	21.02	2526.6	2.63
	22.02	2567.7	2.67
	23.02	2609.0	2.71
	24.02	2650.0	2.75
	25.02	2691.3	2.80
	26.02	2732.6	2.84
	27.01	2774.2	2.88
	28.00	2817.5	2.93
	28.98	2863.0	2.98