Extrapolated equilibrium bottom-hole temperatures for offshore petroleum drill tests in Atlantic Canada

Earth Physics Branch

Energy, Mines and Resources Canada

Open File Report No. 82-17

*Marshall Reiter and Alan M. Jessop

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Abstract

Temperature data have been collected from data files of wells from the continental shelves of Nova Scotia and Newfoundland, and equilibrium temperatures have been estimated by extrapolation to long times since the end of circulation.

Résumé

Les renseignements sur les températures des puits sur la plateforme continentale de la Nouvelle-Ecosse et de Terre-Neuve ont été pris dans les dossiers les concernant et la température originale de la roche a été évaluée en extrapolant la température des boues sur de longues périodes après qu'elles ont cessé de circuler.

This summary presents the temperature data that were used in a heat-flow investigation of the continental shelves of Nova Scotia and Newfoundland (Reiter and Jessop, in prep.). The sites presented here are those where at least three in-situ equilibrium temperatures could be estimated and therefore two resulting geothermal gradients could be calculated. The resulting heat flows after thermal conductivity estimates, could thus be compared. The extrapolation to an equilibrium temperature requires several (at least two) bottom-hole temperature measurements at the same depth, each at a known time since circulation. To obtain an equilibrium temperature at a given depth it is necessary to plot $\ln(t_1/t_2 + 1)$ against T (where t_1 = time of circulation at that depth, t_2 = time since circulation stopped, and T is the measured temperature). The intercept on the T axis is the extrapolated equilibrium temperature (Lachenbruch and Brewer, 1959). This process provides an approximation to the equilibrium temperatures that exist at a distance of several diameters from the current bottom of the well. Uncertainties in the estimate of equilibrium temperature are caused by variations in the position of the temperature tool on the logging sonde and by discrepancies between "drilled depth" and "logged depth". The depth reached during logging is often somewhat less than the depth recorded during drilling.

Temperatures and drilling data were taken from available open-file logs (Resource Management Branch, Energy Mines and Resources Canada). In the Nova Scotia region the time of circulation and the time since circulation ceased were available from the logs for all but two sites. Care was taken in an attempt to insure that the time - temperature history of the data at each depth proceeded in an uninterrupted manner; however, unnoticed interruptions may be present. Approximate corrections to the time of circulation were made to account for the differences between logged and drilled depths. In the Newfoundland region of the study the times of circulation were not available on the logs for about 75% of the locations. In those cases 4 hr. was generally taken as the time of circulation because it is between reasonable minimum expected circulation times (~ 1 hr) and maximum expected times (~ 10 hr). Differences between extrapolated temperatures at these limits of circulation times range from a few degrees K to 10 K. Circulation times were occasionally varied from 4 hr. if drilled and logged depths were either the same or greatly different. Non-systematic errors of 5 K to 10 K would not be unexpected. Non-systematic temperature errors may arise from: uncalibrated equipment, fluid re-entry from the rocks into the well, different locations of the thermometer on the logging sonde, incorrect depths, etc.

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References

Lachenbruch, A.H. and Brewer, M.C. 1959.
Distribution of the temperature effect of drilling a well in Arctic Alaska. United States Geological Survey Bulletin 1083-C, pp. 73-109.

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Estimates of terrestrial heat flow in offshore eastern Canada derived from petroleum bottom-hole temperature data.

APPENDIX 1.

TEMPERATURE DATA FROM OFFSHORE WELLS

WELL NAME		LAT.	LONG.	ELEV	K.B.	DEPTH	TEMP
ABENAKI	K-57	44-16.6N	59-53.5W	-109	31	835	32.0
						1395	47.8
						2182	76.0
ACADIA	K-62	42-51.7N	61-55.0W	-866	13	2799	49.5
						4257	110.4
						4924	136.1
ARGO	F-38	45-27.3N	58-50.5W	-72	31	924	36.8
						2063	57.2
						3348	81.1
BLUENOSE	G-47	44-06.3N	59-21.4W	-8.1	30	1193	25.0
						2981	79.7
						4588	120.0
BRADELLE	K-49	47-58.6N	63-07.1W	-57	30	920	30.6
						1676	43.3
						3099	75.0
						4410	109.2
CHINAMPAS	N-37	44-56.9N	66-35.3W	-63	33	627	33.6
						1729	58.4
						3664	95.0
CHIPPEWA	G-67	44-36.3N	58-39.8W	-70	30	920	31.6
						1996	59.1
						3176	79.4
CREE	E-25	43-44.3N	60-35.9W	-53	31	890	41.1
						1967	58.6
						3463	99.4
DAUNTLESS	D-35	44-44.1N	57-20.7W	-69	30	1016	33.9
						2579	69.4
						4742	114.4
DEMASCOTA	G-32	43-41.5N	60-49.9W	-54	30	2428	72.6
						3636	115.7
						4672	151.4
EAGLE	D-21	43-50.2N	59.34.2W	-51	30	1011	32.2
						2233	67.9
						4003	118.6
						4447	129.7

WELL NAME		LAT.	LONG.	ELEV	K.B.	DEPTH	TEMP
E.POINT	E-49	46-30.4N	61-37.4W	0	10	863	37.2
						1989	47.4
						2893	61.1
						3534	87.9
ERIE	D-26	45-55.1N	59-34.5W	-124	26	643	27.2
						1205	38.9
						2374	61.7
ESPERANTO	K-78	44-47.5N	58-11.3W	-69	28	826	27.4
						1691	50.0
						3538	97.8
EURYDICE	P-36	45-25.9N	60-04.8W	-165	26	849	31.1
						1743	40.4
						2917	62.2
HURON	P-96	44-35.8N	58-23.9W	-84	26	596	38.4
						1579	51.4
						2752	85.0
						3011	89.8
IROQUOIS	J-17	44-45.0N	59-47.2W	-59	31	640	34.4
						1345	45.6
						1925	58.7
MARMORA	P-35	43-45.0N	60-04.7W	-53	30	688	22.9
						1961	61.3
						3440	105.0
						4082	117.2
MIC MAC	D-89	44-38.1N	59-28.3W	-85	30	768	28.9
						1473	45.3
						3044	93.3
MIC MAC	H-86	44-35.5N	59-27.0W	-80	26	923	38.7
						2681	78.9
						4526	122.2
MIC MAC	J-77	44-36.7N	59-26.2W	-63	26	928	32.8
						2628	72.8
						3743	104.4
MISSISAUGA	H-54	44-23.6N	59-22.6W	-124	26	1510	45.8
						3040	86.7
						3975	106.9
MOHEIDA	P-15	43-04.9N	62-16.7W	-112	30	916	21.4
						1946	59.7
						3530	117.8
						4295	136.5

WELL NAME		LAT.	LONG.	ELEV	K.B.	DEPTH	TEMP
MOHICAN	I-100	42-59.6N	62-28.8W	-153	30	2029	53.3
						3371	94.4
						4256	122.4
NASKAPI	N-30	43-29.7N	62-34.0W	-95	26	1014	42.2
						1988	62.6
						2204	67.9
NAUFRAGE	NO.1	46-28.1N	62-27.9W	-22	26	1827	41.7
						3106	63.3
NTHMBLD ST	F-25	46-06.4N	62-03.8W	-30	9	667	35.4
						2074	44.1
						3007	67.8
ONEIDA	O-25	43-14.9N	61-33.7W	-82	26	2092	67.9
						3361	107.8
						4105	141.1
ONONDAGA	B-96	43-45.1N	60-14.1W	-60	30	1608	53.2
						2947	88.9
						3431	100.5
ONONDAGA	F-75	43-44.3N	60-06.5W	-56	30	901	38.5
						1895	66.4
						3448	104.2
PENOBSCOT	B-41	44-10.0N	60-06.5W	-118	30	1972	53.3
						2906	82.8
						3446	93.9
PENOBSCOT	L-30	44-09.7N	60-04.2W	-138	30	1981	60.0
						3557	100.4
						4254	125.0
SABLE I.	4-H-5	43-57.5N	60-07.6W	2	9	3714	97.4
						4024	102.9
						4322	117.8
SABLE I.	NO.1	43-56.1N	59-55.0W	4	4	2142	65.6
						3259	91.7
						4183	114.1
						4606	130.6
SABLE I.	E-48	43-57.3N	60-07.4W	0	6	930	35.8
						1768	63.9
						2545	80.6
						3011	97.4
						3602	113.7

WELL NAME		LAT.	LONG.	ELEV	K.B.	DEPTH	TEMP
SABLE I.	D-47	43-57.0N	60-06.6W	2	5	2371	83.3
						3310	98.3
						3772	112.8
						4200	125.7
SACHEM	D-76	44-35.2N	57-42.0W	-59	30	1173	32.2
						3116	80.3
						4860	114.2
SAMBRO	I-29	43-38.6N	62-48.3W	-194	30	1065	27.1
						1971	49.2
						3065	73.0
SAUK	A-57	43-16.1N	58-37.6W	-63	26	2344	70.0
						3824	98.9
						4395	109.7
THEBAUD	P-84	43-52.0N	60-12.3W	-26	30	2972	88.2
						3995	120.0
						4117	123.8
TRIUMPH	P-50	43-39.9N	59-51.0W	-90	26	2301	66.7
						3959	117.3
						4597	139.2
TUSCARORA	D-61	44-40.2N	58-55.2W	-79	30	971	30.8
						2095	59.7
						3930	112.4
WENONAH	J-75	43-34.6N	60-26.1W	-68	30	874	22.8
						1908	64.7
						3323	117.5
WYANDOT	E-53	43-52.3N	59-23.9W	-121	31	783	27.8
						1564	43.1
						3049	81.7
ADOLPHUS	D-50	46-59.1N	48-22.5W	-115	30	2959	91.4
						3372	107.4
						3682	119.4
ADOLPHUS	K-41	47-00.6N	48-22.0W	-115	32	1242	33.6
						2815	90.6
						3649	113.9
BITTERN	M-62	44-41.9N	51-10.2W	-69	30	771	32.8
						2752	92.2
						4026	124.1
						4645	137.8

WELL NAME		LAT.	LONG.	ELEV	K.B.	DEPTH	TEMP
BJARNI	H-81	55-30.5N	57-42.1W	-140	13	1263	39.3
						2167	61.4
						2279	64.6
						2518	76.6
BLUE	H-28	49-37.5N	49-18.0W	-1486	30	4425	61.6
						5507	127.6
						6096	139.5
BRANT	P-87	44-17.3N	52-42.3W	-99	30	918	26.1
						2559	81.9
						3584	113.9
CAREY	J-34	45-23.5N	52-35.1W	-101	30	2154	68.3
						3038	78.3
						3683	106.1
COOT	K-56	45-45.7N	52-08.5W	-80	30	756	25.7
						2269	68.9
						2896	73.9
						3532	81.9
CORMORANT	K-83	46-02.7N	48-58.1W	-66	30	773	23.6
						2366	73.3
						2985	82.2
CUMBERLAND	B-55	48-26.3N	50-08.0W	-195	30	1311	43.3
						3217	65.8
						4136	102.9
EGRET	N-46	46-26.0N	48-51.7W	-68	30	764	31.0
						1668	48.9
						2745	75.0
EIDER		45-35.0N	51-56.6W	-78	30	2138	56.7
						3063	85.3
						3510	96.2
GANNET	O-54	45-03.9N	52-38.2W	-100	30	737	23.0
						2751	88.3
						3039	100.4
GULL	F-72	44-11.2N	52-27.1W	-97	30	771	20.6
						1951	68.1
						2505	90.6
HERMINE	E-94	45-23.4N	54-29.8W	-83	26	1003	38.3
						1839	61.1
						2482	82.1

WELL NAME		LAT.	LONG.	ELEV	K.B.	DEPTH	TEMP
HERON	H-73	44-02.4N	52-25.7W	-105	26	2083	72.1
						2349	81.7
						3575	125.6
INDIAN HBR	M-52	54-21.9N	54-23.9W	-198	22	2356	48.4
						3157	88.6
						3950	112.8
KARLSEFNI	H-13	58-52.3N	61-46.6W	-174	13	1488	34.7
						2970	78.3
						4108	114.6
MALLARD	L-45	44-14.7N	50-07.4W	-82	26	910	24.0
						2086	56.8
						3512	112.1
MURRE	G-67	46-06.3N	49-09.3W	-65	30	2374	60.6
						3009	81.4
						3321	88.9
OSPREY	H-84	44-43.5N	49-27.4W	-61	26	831	29.6
						2582	67.9
						3465	82.5
PETREL	A-62	44-51.1N	52-54.3W	-86	30	652	17.5
						1198	32.2
						1938	83.9
PHALAROPE	P-62	45-11.8N	51-29.2W	-73	30	957	29.1
						2479	66.1
						3163	82.8
PUFFIN	B-90	44-39.2N	53-42.5W	-107	30	781	31.1
						2689	87.2
						3842	117.5
RAZORBILL	F-54	45-13.4N	52-08.4W	-69	30	921	28.0
						2285	73.2
						3134	95.6
SANDPIPER	J-77	45-36.6N	51-41.1W	-90	26	1200	45.0
						2743	61.4
						3523	79.4
SKOLP	E-07	58-26.4N	61-46.7W	-167	12	1389	33.4
						2571	68.1
						2989	86.4
TERN	A-68	44-27.1N	53-09.2W	-115	30	923	23.9
						2703	82.2
						3556	102.2
						4168	115.0