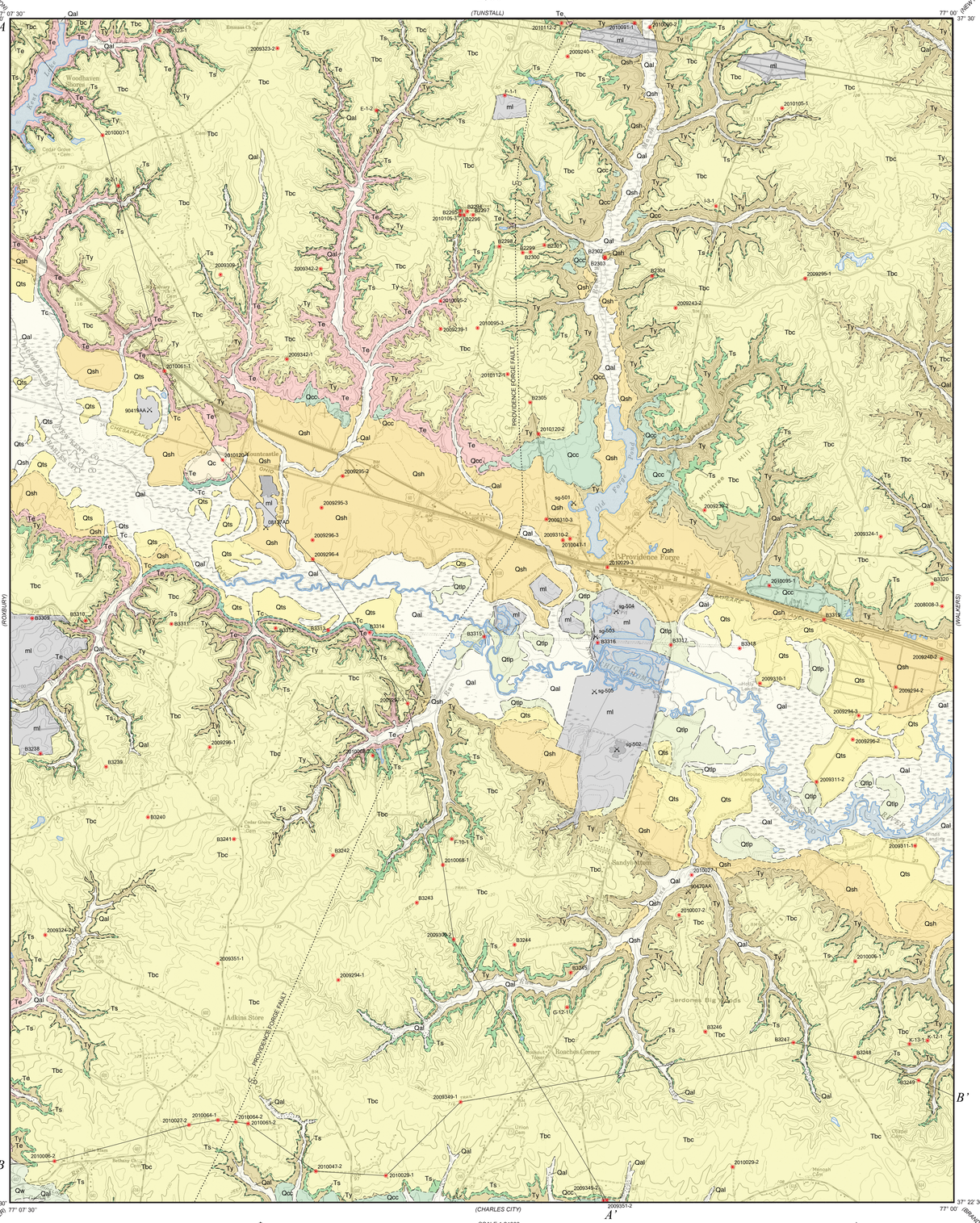
GEOLOGIC MAP OF THE PROVIDENCE FORGE QUADRANGLE, VIRGINIA

AMY K. GILMER AND C. R. BERQUIST, JR.

2011



Basemap, modified U.S. Geological Survey DRG

1969, Revised 1994, Providence Forge Quadrangle, Virginia

Projection: Modified Transverse Mercator
NAD 1927 Datum

Digital cartography by Amy K. Gilmer

MN GN 10° 11' 181 MILS 1° 25' 25 MILS
2010 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET
ANNUAL VARIATION: 0° 1' WEST PER YEAR

SCALE 1:24000
1 0.5 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 0.5 0 1 KILOMETER

CONTOUR INTERVAL 10 FEET
DASHED LINES REPRESENT HALF INTERVAL CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology mapped from July 2009 to June 2010

DESCRIPTION OF MAP UNITS

SURFICIAL UNITS

ml — **Modified Land** – Extensive cut and/or fill related to grading, excavation, and mining-related activities, predominantly areas dredged for sand and gravel extraction. Modified land along roads is not shown, except along overpasses and and rest areas. Holocene. Variable thickness.

Qal — **Alluvium** – Floodplain deposits consisting of pebbly sand, sand, and silt, with interbeds of silt and fine sand. Organic matter is common; includes swamp and marsh environments. Holocene to Pleistocene. Variable thickness.

COASTAL PLAIN UNITS

Qtlp — **Tabb Alloformation, Lynnhaven/Poquoson Members** – Silty, fine- to medium-grained sand grading downward to pebbly sand with heavy minerals common and interbeds of peat and organic mud; surface elevations below 18 feet.

Qts — **Tabb Alloformation, Sedgefield Member** – Clayey, fine-grained sand grading downward to pebbly sand with heavy minerals common; interbeds of peat and organic mud common. Thin deposits of the Tabb Alloformation might be found on broad land surfaces at elevations of less than 28 feet resulting from reworking of Shirley sediments. Allostratigraphic classification was proposed by Doar and Berquist (2009).

Qsh — **Shirley Alloformation** – Gray to brown gravel, sand, silt and clay; occurs above younger alluvial deposits on flats adjacent to Chickahominy River at elevations ranging up to 48 feet above present sea level. Quartzite clasts with the trace fossil *Skolithos* are common. Thickness is typically up to 50 feet (15.2 meters), but could be greater in paleochannels. The type section was defined by Johnson and Berquist (1989). Allostratigraphic classification was proposed by Doar and Berquist (2009).

Qc — **Chuckatuck Alloformation** – Light- to medium-gray, yellowish-orange and reddish-brown sand, silt, and clay with minor amounts of dark-brown and brownish-black peat. Sediments were deposited during a marine transgression where sea level reached a maximum elevation of approximately 58 above present sea level. Morphologic expression of terraces resulting from this event is consistent across the Virginia Coastal Plain where the toe of the scarp cut into adjacent highlands is about 58 feet, and terrace surface (flat) ranges from about 40 to 55 feet. This morphology is found adjacent to today's major estuaries, as well as smaller tributaries like the Chickahominy River. Fluvial-estuarine facies includes, from bottom to top, (1) channel-fill deposits of poorly sorted, cross-bedded, pebbly and cobbly sand interbedded, locally, with peat and sandy silt rich in organic matter, (2) moderately well-sorted, cross-bedded to planar bedded, fine- to medium-grained sand grading up ward into (3) clayey silt and sandy and silty clay. Thickness is up to 26 feet (7.9 meters) but could be greater in paleochannels. The type section was defined by Johnson and Berquist (1989).

Qcc — **Charles City Alloformation** – Medium to light gray, silty fine sand with scattered rounded quartz and quartzite pebbles, cobbles, and boulders; quartzite clasts with the trace fossil *Skolithos* are common. Sediments were deposited during a marine transgression where sea level reached a maximum elevation of approximately 78 above present sea level. Morphologic expression of terraces resulting from this event is consistent across the Virginia Coastal Plain where the toe of the scarp cut into adjacent highlands is about 78 feet, and terrace surface (flat) ranges from about 55 to 70 feet. This morphology is found adjacent to today's major estuaries, as well as smaller tributaries like the Chickahominy River and Rumley Marsh. The typical succession of sediments fines upwards from coarse-grained sand and pebbles to clayey fine-grained sand and clay. Furthermore, soil survey maps show clay-rich sediments underlie these terrace remnants instead of typically sandy sediments of the Yorktown Formation. The type section was defined by Johnson and Berquist (1989). Thickness is up to 40 feet (12.2 meters) but could be greater in paleochannels. Allostratigraphic classification was proposed by Doar and Berquist (2009).

Qw — **Windsor Alloformation** – Gray and yellowish- to reddish-brown sand, gravel, silt, and clay. Occurs on flats at elevations of 60 to 95 feet above present sea level. Fluvial-estuarine deposits consist of muddy, coarse, trough cross-bedded sand and gravel grading upward to sandy silt and clay. Thickness is up to 48 feet (14.6 meters), but could be greater in paleochannels. The type section was defined by Coch (1968) and later amended by Johnson and Berquist (1989).

Tbc — **Bacons Castle Formation** – Gray, red and reddish-brown, fine grained sandy clay and clayey silt commonly exhibiting lenticular bedding; typically found at highest elevations in the map area; ranges in thickness up to 20 feet (6.1 meters); commonly overlies reddish-brown to brownish-yellow quartzofeldspathic sands and pebble to cobble sized gravel, with and without clay. The unit ranges in elevation from 85 to 140 feet above present sea level. Proposed by Coch (1965) and formally named by Coch (1968) and informally subdivided into the Barhamsville (tidal flat deposits) and Varina Grove (fluvial-estuarine sand and gravel) members by Ramsey (1987, 1988).

Ts — **Sedley Formation** – Brownish-tan clayey silt containing very fine grained sand grading downward to coarse-grained sand and granules; larger clasts are very well rounded; glauconite and manganese are common. Lenticular bedding is prevalent throughout the unit. The unit is commonly covered on the sides of stream valleys by colluvium. Average thickness is 2 to 10 feet (0.6 to 3 meters) thick with a maximum thickness of 20 feet (6.1 meters).

Ty — **Yorktown Formation** – Yellowish-brown to bluish-gray clayey fine- to medium-grained sand; heavy mineral and glauconite concentrations range up to about 20% in places. In some places the unit is devoid of shell material, consisting of well-sorted medium-grained sand and in other places the unit contains abundant disarticulated and broken shells, commonly as cemented masses. Abundant *Chesapecten*, *Ostrea*, and *Mercenaria* fragments were encountered during drilling. The unit is commonly covered on the sides of stream valleys by colluvium. Maximum thickness in this map area exceeds 100 feet (30.5 meters) on the east side of the Providence Forge Fault.

Te — **Eastover Formation** – Light gray to dark bluish-gray silty to clayey fine-grained sand (Cobham Bay member) and massive sandy clay (Claremont member). The upper member is locally fossiliferous; contains some shell hashes and abundant *Turritella*. The mollusk *Isognomon maxillata* is a common species in the upper part of the Eastover. Most borings did not enounter shell material. The upper member typically contains subangular to subrounded quartz granules, and abundant flakes of mica. Iron oxide mottling and staining from the weathering of disseminated iron sulfide are common. In this quadrangle the boundary between the two members is gradational. The lower member is sparsely fossiliferous, but does have abundant phosphate fragments and flakes of mica. The unit is commonly covered on the sides of stream valleys by colluvium. Maximum thickness is about 50 feet (15.2 meters). The Eastover does not crop out east of the Providence Forge Fault in this quadrangle.

Tc — **Calvert Formation** – Dark blue to greenish-gray silty to clayey fine- to medium-grained sand with coarse sand common. Blue quartz granules are rare. Heavy mineral and phosphate concentrations range up to 10%. *Chesapecten* and *Mercenaria* fragments were encountered during drilling. Maximum thickness in this map area is 31 feet (9.4 meters). Named by Shattuck (1902) and later revised by Ward (1985).

MAP SYMBOLS

For all contact and fault symbols: lines are solid where the location is exact, long-dashed where the location is approximate; short-dashed where the location is inferred; dotted where the location is concealed.

Stratigraphic Contacts

Fault Contacts
high-angle fault;
"U" on upthrown block, "D" on downthrown block

Mineral Resources

Commodity letter symbol precedes identification number (identification numbers for inactive sites are preceded by "98A-" in Mineral Resources of Virginia database). Identification number for active sites is the Division of Mineral Mining permit number.

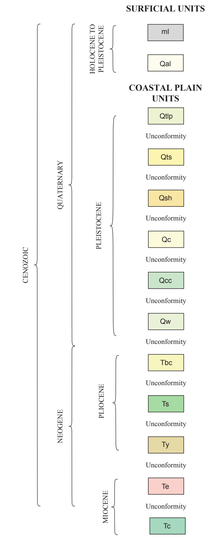
90436AA — Active sand and gravel borrow pit

sg-105 — Abandoned or reclaimed sand and gravel borrow pit

Geologic References

2010006-1 — Geologic Borehole in the VDGMR borehole database

CORRELATION OF MAP UNITS



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SUGGESTED REFERENCE

Gilmer, Amy K., and Berquist C. R., Jr., 2011, Geologic map of the Providence Forge quadrangle, Virginia: Virginia Division of Geology and Mineral Resources Open File Report 2011-7, 1:24,000-scale geologic map.

ACKNOWLEDGMENTS

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Portions of the publication may be quoted if credit is given to the Virginia Department of Mines, Minerals and Energy, Division of Geology and Mineral Resources.

Figure 1. Fluvial channel deposit in the Shirley Formation overlying fine- to medium-grained sand of the Yorktown Formation near Stony Run. Shovel for scale.

Figure 2. Shell fossil "ghosts" in the sands of the Yorktown Formation.

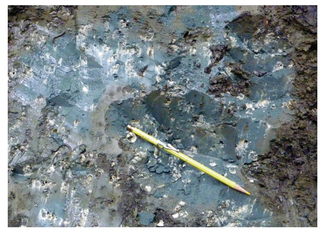


Figure 3. *Turritella sp.* in the Claremont Manor member of the Eastover Formation near Stony Run. Pencil for scale.

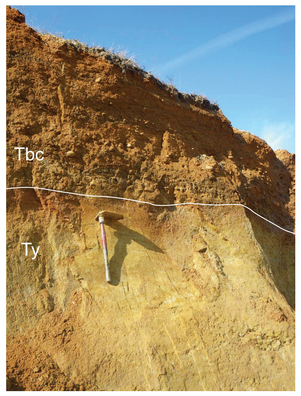
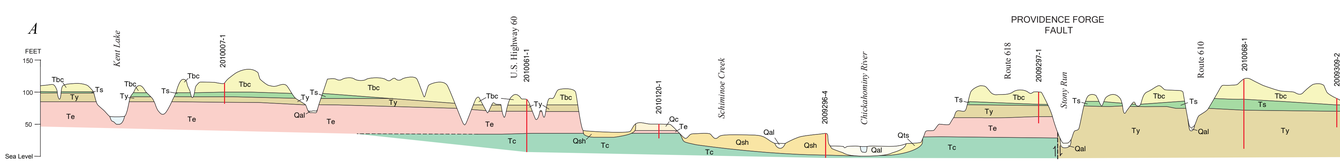


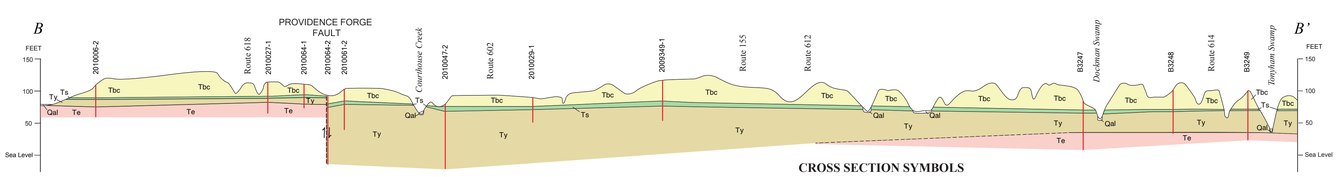
Figure 4. White line shows the contact between the Yorktown Formation and the overlying Bacons Castle Formation. Photo taken in the Sturgeon Point Charles City sand and gravel pit. Shovel for scale.

GEOCHEMISTRY

Repository Sample Number	Latitude	Longitude	Borehole ID	Depth	Map Unit	SiO_2 %	Al_2O_3 %	Fe_2O_3(T) %	MnO %	MgO %	CaO %	Na_2O %	K_2O %	TiO_2 %	P_2O_5 %	LOI %	Total %
R-10343	37.39863	-77.08122	2009294-1	8'	Tbc	73.98	11.35	5.53	0.019	0.37	0.04	0.08	1.23	1.187	0.08	4.53	98.40
R-10344	37.39863	-77.08122	2009294-1	14'-18'	Tbc	90.58	3.74	1.32	0.023	0.05	0.07	0.05	0.67	0.832	0.06	1.17	98.56
R-10345	37.39863	-77.08122	2009294-1	20'-22'	Tbc	92.25	2.43	1.46	0.025	0.06	0.04	0.04	0.59	0.834	0.02	0.75	98.48
R-10346	37.38574	-77.06503	2009349-1	8'	Tbc	64.62	17.05	8.19	0.022	0.49	0.04	0.14	2.18	1.192	0.11	6.58	100.60
R-10347	37.38574	-77.06503	2009349-1	19'	Tbc	79.64	8.64	3.81	0.033	0.19	0.04	0.05	0.79	1.201	0.06	3.42	97.88
R-10349	37.38574	-77.06503	2009349-1	29'	Tbc	91.44	3.7	1.7	0.018	0.07	0.15	0.03	0.38	0.553	0.03	1.46	99.53
R-10353	37.39863	-77.08122	2009294-1	33'	Ts	76.35	5.15	11.3	0.355	0.28	0.14	0.07	1.21	0.526	0.55	3.92	99.84
R-10354	37.39863	-77.08122	2009294-1	37'	Ts	84.53	4.62	5.39	0.02	0.3	0.23	0.12	1.23	0.418	0.22	2.4	99.49
R-10350	37.38574	37.38574	2009349-1	38'	Ts	76.31	6.02	9.36	0.044	0.43	0.03	0.05	1.16	0.809	0.26	3.55	98.03
R-09172	37.37842	-77.0842	2010105-1	25'	Ts	81.13	5.87	5.84	0.064	0.31	0.12	0.05	1	0.537	0.22	4.26	99.39
R-10355	37.39863	-77.08122	2009294-1	52'	Ty	83.23	5.81	2.8	0.014	0.59	0.63	0.15	1.19	0.433	0.15	3.35	98.34
R-10356	37.39863	-77.08122	2009294-1	55-57'	Ty	88.74	2.63	1.85	0.012	0.32	2.9	0.19	0.71	0.336	0.14	3.13	100.90
R-10351	37.38574	-77.06503	2009349-1	42'	Ty	71.9	9.6	7.5	0.646	0.69	0.05	0.06	1.38	0.626	0.2	5.6	98.25
R-10352	37.38574	-77.06503	2009349-1	48'	Ty	92.13	2.92	1.85	0.021	0.18	0.03	0.04	0.53	0.471	0.03	1.26	99.45
R-09166	37.4993	-77.03991	2010090-2	59-60'	Ty	82.24	4.49	2.41	0.02	0.66	2.31	0.28	0.9	0.522	1.28	4.7	99.82
R-09167	37.4993	-77.303991	2010090-2	64-67'	Ty	77.05	2.48	1.41	0.015	0.55	6.4	0.18	0.56	0.336	2.4	7.08	98.46
R-09168	37.4993	-77.03991	2010090-2	74-81'	Ty	62.22	2.01	1.31	0.03	1.03	15.98	0.15	0.47	0.315	1.44	16.81	99.58
R-09169	37.46295	-77.10432	2010061-1	12-13'	Ty	89.93	3.04	2.16	0.026	0.28	0.75	0.25	0.75	0.484	0.19	1.94	99.80
R-09170	37.44509	-77.05147	2010047-1	45-46'	Ty	84.01	2.41	1.3	0.016	0.27	4.29	0.3	0.69	0.375	0.61	4.02	98.28
R-09171	37.37842	-77.0842	2010047-2	99-100'	Ty	24.37	1.74	4.24	0.02	0.95	36.71	0.08	0.7	0.095	0.13	28.96	98.00
R-09173	37.47983	-77.06413	2010105-3	50-52'	Ty	81.63	3.01	2.59	0.016	0.43	4.56	0.26	0.91	0.372	0.12	5.37	99.27
R-09165	37.44223	-77.04557	2010029-3	49'	Te	72.37	4.8	3	0.017	1.18	5.19	0.23	1.13	0.398	0.62	9.84	98.78

Major oxide chemistry of samples collected from boreholes in the Providence Forge quadrangle. Rock unit abbreviations: Tbc – Bacons Castle Formation; Ts – Sedley Formation; Ty – Yorktown Formation; Te – Eastover Formation. Samples analyzed by Activation Laboratories Ltd., Ancaster, Ontario, using FUS-ICP method.





CROSS SECTION SYMBOLS

For all contact symbols: lines are solid where the location is approximate; dashed where the location is inferred;

Stratigraphic Contacts

Fault Contacts
Arrows indicate relative motion

Geologic Borehole in the VGDMR borehole database

Interpretive cross sections:
1. 20x vertical exaggeration.
2. Subsurface structures interpreted from surface observations and geologic borings.
3. Dip-angle of the Providence Forge Fault is uncertain.

Repository Sample Number	Borehole ID	Depth	Map Unit	Au ppb	Ag ppm	As ppm	Ba ppm	Be ppm	Bi ppm	Br ppm	Cd ppm	Co ppm	Cr ppm	Cs ppm	Cu ppm	Hf ppm	Hg ppb	Ir ppb	Mo ppm	Ni ppm	Pb ppm	Rb ppm	Sb ppm	S %	Sc ppm	Se ppm	Sr ppm	Ta ppm	Th ppm	U ppm	V ppm	W ppm	Y ppm	Zn ppm	Zr ppm	La ppm	Ce ppm	Nd ppm	Sm ppm	Eu ppm	Tb ppm	Yb ppm	Lu ppm
R-10343	2009294-1	8'	Tbc	<1	<0.5	7	237	2	<2	2.2	<0.5	5.1	63.6	3.4	22	15	<1	<1	<2	25	24	80	0.8	0.012	13.3	<0.5	38	1.9	8.8	3	107	<1	24	48	664	41.9	68	46	6.57	1.25	0.8	3.09	0.46
R-10344	2009294-1	14'-18'	Tbc	<1	<0.5	<1	196	<1	<2	1.2	<0.5	1.8	19.8	0.4	5	9	<1	<1	<2	5	8	30	0.2	0.005	2.72	<0.5	23	0.8	2.8	1	26	<1	6	35	335	11.1	24	8	1.92	0.54	<0.1	0.84	0.12
R-10345	2009294-1	20'-22'	Tbc	<1	<0.5	1	174	<1	<2	1	<0.5	2	55.1	<0.2	6	10.6	<1	<1	<2	7	10	20	0.1	0.015	2.39	<0.5	19	0.9	2.5	1.2	25	<1	8	32	445	12.1	42	14	2.19	0.64	0.2	1.21	0.14
R-10346	2009349-1	8'	Tbc	<1	<0.5	16	379	2	<2	2.1	0.6	5.5	74.9	6.1	26	9	<1	<1	<2	26	23	120	1.3	0.012	18.7	<0.5	65	2.3	12.6	2.7	160	<1	32	64	442	55.2	84	48	7.89	1.66	<0.1	3.82	0.43
R-10347	2009349-1	19'	Tbc	<1	<0.5	2	162	<1	<2	1.4	0.5	4.9	54.4	1.8	12	16.1	<1	<1	<2	16	17	40	0.4	0.006	7.69	<0.5	32	1.6	6.5	2.3	67	<1	18	39	635	29.1	44	26	4.39	0.95	0.6	2.49	0.29
R-10349	2009349-1	29'	Tbc	<1	<0.5	2	101	<1	<2	1	<0.5	2.7	17.1	0.5	4	5.7	<1	<1	<2	7	6	20	0.2	0.005	2.78	<0.5	14	1.2	2.2	1	25	<1	4	22	232	9.29	15	8	1.37	0.35	<0.1	0.63	0.07
R-10353	2009294-1	33'	Ts	<1	<0.5	33	441	4	<2	<0.5	1.4	42.8	48	2.1	9	5.7	<1	<1	4	28	11	60	0.7	0.006	5.82	<0.5	39	0.9	4.5	5.8	64	<1	20	90	248	16.6	39	18	3.12	0.84	<0.1	2.04	0.26
R-10354	2009294-1	37'	Ts	<1	<0.5	8	303	1	<2	1.4	<0.5	5.8	61.6	1.5	5	4	<1	<1	3	23	9	50	0.5	0.003	4.81	<0.5	50	0.7	4.1	3.6	57	<1	18	70	229	20.3	33	26	3.87	0.98	0.5	1.72	0.22
R-10350	2009349-1	38'	Ts	<1	<0.5	18	177	3	<2	<0.5	0.6	13.1	58.5	2.5	20	9	<1	<1	4	12	11	60	0.5	0.01	7.56	<0.5	27	1	6	4.9	74	<1	26	52	366	29.2	45	28	5.01	1.42	<0.1	2.82	0.38
R-09172	2010105-1	25'	Ts	<1	<0.5	29	267	3	<2	<0.5	<0.5	28.1	101	2.2	6	8.5	<1	<1	5	30	20	40	2.1	0.006	6.59	<0.5	66	0.8	5.3	5.3	101	<1	17	81	294	60.1	112	63	8.81	1.64	0.8	2.11	0.32
R-10355	2009294-1	52'	Ty	<1	<0.5	9	201	<1	<2	3.5	0.9	5.2	46.3	2.5	6	4	<1	<1	6	16	7	50	1.4	0.586	6	<0.5	51	<0.3	4.9	13.2	55	<1	15	48	171	22.4	37	24	3.66	0.9	0.3	1.61	0.2
R-10356	2009294-1	55-57'	Ty	<1	<0.5	7	169	<1	<2	2.2	<0.5	2.4	63.1	1.3	10	4	<1	<1	10	8	5	20	0.6	0.378	2.58	<0.5	119	<0.3	2.8	8	29	<1	11	26	213	14	28	16	2.71	0.71	<0.1	0.88	0.13
R-10351	2009349-1	42'	Ty	<1	<0.5	15	806	3	<2	<0.5	1.3	82.4	65	5.1	17	5.3	<1	<1	<2	63	27	100	1.1	0.006	11.2	<0.5	49	<0.3	9.6	6.2	125	<1	61	104	269	71.5	111	45	13.9	3.99	2	5.1	0.75
R-10352	2009349-1	48'	Ty	<1	<0.5	3	121	<1	<2	0.9	<0.5	2.8	53.3	1.5	5	5.2	<1	<1	3	11	5	30	0.6	0.003	3.31	<0.5	20	0.9	3.2	1.3	41	<1	12	24	247	20.6	31	13	3.82	1.03	0.4	1.31	0.18
R09166	2010090-2	59-60'	Ty	<1	<0.5	13	155	2	<2	4.4	7	3.7	109	2.6	7	8.6	<1	<1	23	16	9	40	0.9	0.648	4.76	<0.5	137	0.3	5.9	7.4	42	<1	30	52	364	28.4	63	48	7.52	1.49	0.9	2.21	0.32
R09167	2010090-2	64-67'	Ty	<1	<0.5	8	126	<1	<2	9.3	12	1.6	70.3	1.8	9	4.5	<1	<1	23	17	5	20	0.8	0.584	3.13	<0.5	289	0.5	3.3	14.4	34	<1	26	99	145	19	32	25	4.21	0.84	0.6	1.9	0.32
R09168	2010090-2	74-81'	Ty	<1	<0.5	9	96	<1	<2	5.2	6.2	1.6	133	0.9	6	4.1	<1	<1	21	16	<5	20	0.8	0.408	2.27	4.9	223	<0.3	2.5	13	30	<1	18	56	142	13.3	23	18	3.06	0.59	0.5	1.24	0.23
R09169	2010061-1	12-13'	Ty	<1	<0.5	8	196	<1	<2	2.2	0.5	3.3	30.9	1.3	4	7.8	<1	<1	15	12	6	30	0.9	0.264	3.04	<0.5	67	0.6	3	9.2	35	<1	10	28	279	13	27	18	3.08	0.62	0.4	1.04	0.17
R09170	2010047-1	45-46'	Ty	<1	<0.5	3	166	<1	<2	2.8	1.9	2.3	133	0.9	4	5.9	<1	<1	13	11	6	20	0.3	0.212	2.27	<0.5	191	0.5	3.1	5.3	22	<1	13	21	201	15.2	35	24	3.83	0.76	0.5	1.05	0.18
R09171	2010047-2	99-100'	Ty	<1	<0.5	24	31	<1	<2	1.5	<0.5	3.5	67.3	1	<1	1	<1	<1	<2	11	5	30	0.8	1.6	2.16	<0.5	387	<0.3	2	2.2	59	<1	5	41	33	9.43	26	15	2.14	0.36	<0.1	0.42	0.06
R09173	2010105-3	50-52'	Ty	<1	<0.5	6	179	<1	<2	2.8	<0.5	3.8	38.2	1.1	3	8.2	<1	<1	5	7	6	30	0.4	0.398	3.42	<0.5	201	<0.3	3.8	2.3	28	<1	13	27	268	21.6	49	20	4.24	1.12	0.6	1.24	0.11
R09165	2010029-3	49'	Te	<1	<0.5	17	369	1	<2	3.8	3.2	2.1	65.4	1.8	6	4.4	<1	<1	41	20	7	30	1.4	1.43	3.46	4.8	293	<0.3	5.5	8.9	48	<1	13	59	163	14.3	31	21	3.25	0.59	<0.1	0.95	0.19

Trace element chemistry of samples collected from boreholes in the Providence Forge quadrangle. Rock unit abbreviations: Tbc – Bacons Castle Formation; Ts – Sedley Formation; Ty – Yorktown Formation; Te – Eastover Formation. Samples analyzed by Activation Laboratories Ltd., Ancaster, Ontario, using FUS-ICP method.