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TN #:	254799
Document Title:	Willow Rock Energy Storage Center Supplemental AFC Volume II - Appendix 54A - Part VI
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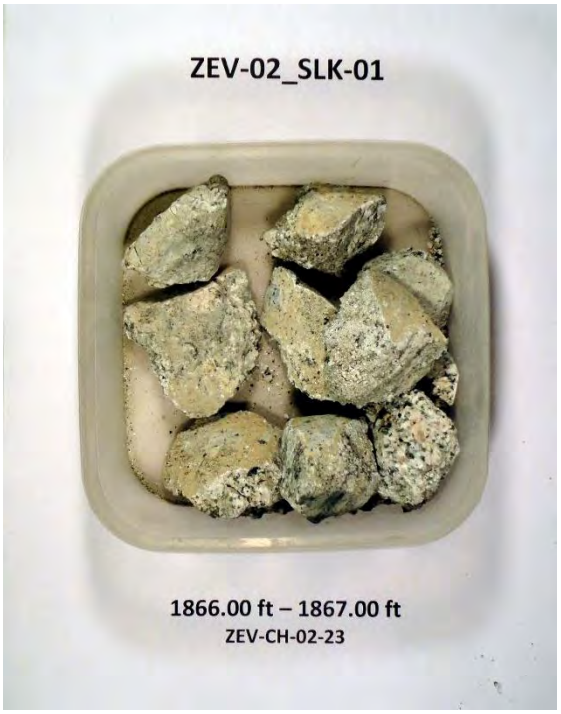
Submitter Role:	Applicant Representative
Submission Date:	3/1/2024 4:46:44 PM
Docketed Date:	3/1/2024

APPENDIX J

BEFORE AND AFTER PHOTOGRAPHS OF SLAKE DURABILITY TEST SPECIMENS



ZEV-02_SLK-01—Before

ZEV-02_SLK-01—After

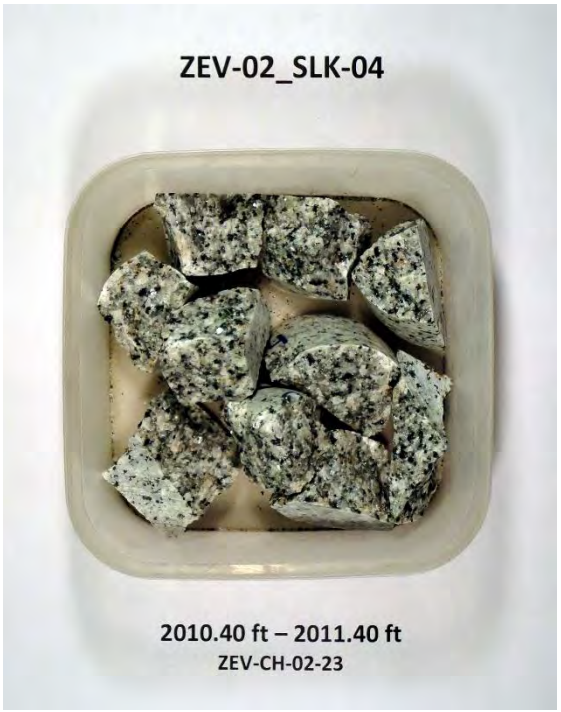
ZEV-02_SLK-02—Before

ZEV-02_SLK-02—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens

ZEV-02_SLK-03—Before

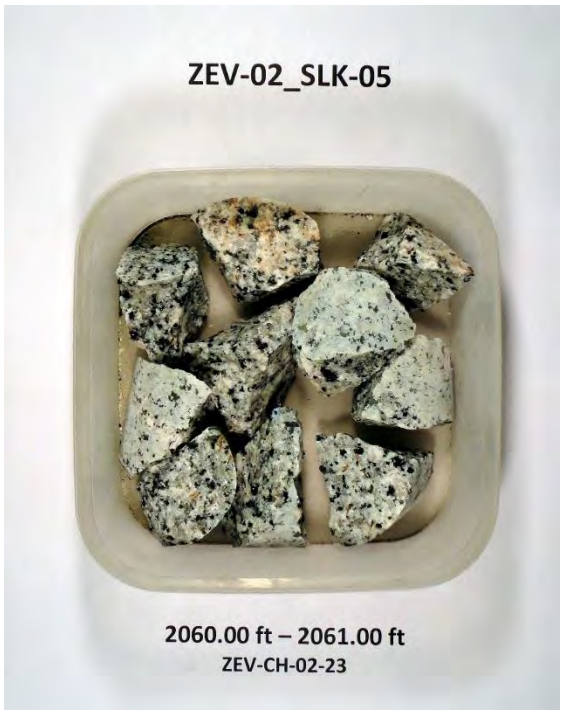
ZEV-02_SLK-03—After



ZEV-02_SLK-04—Before

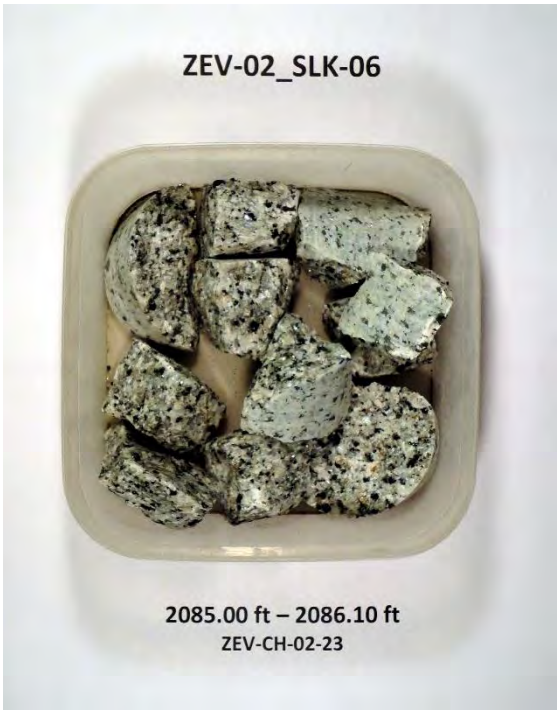
ZEV-02_SLK-04—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*



ZEV-02_SLK-05—Before

ZEV-02_SLK-05—After



ZEV-02_SLK-06—Before

ZEV-02_SLK-06—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

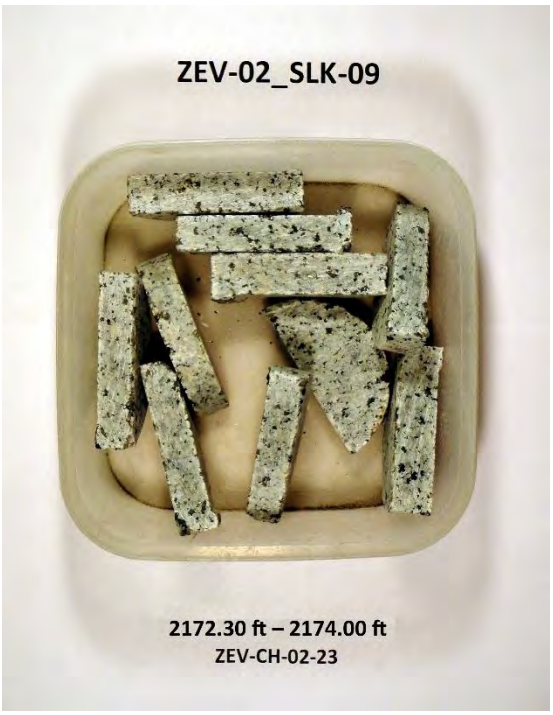
ZEV-02_SLK-07—Before

ZEV-02_SLK-07—After

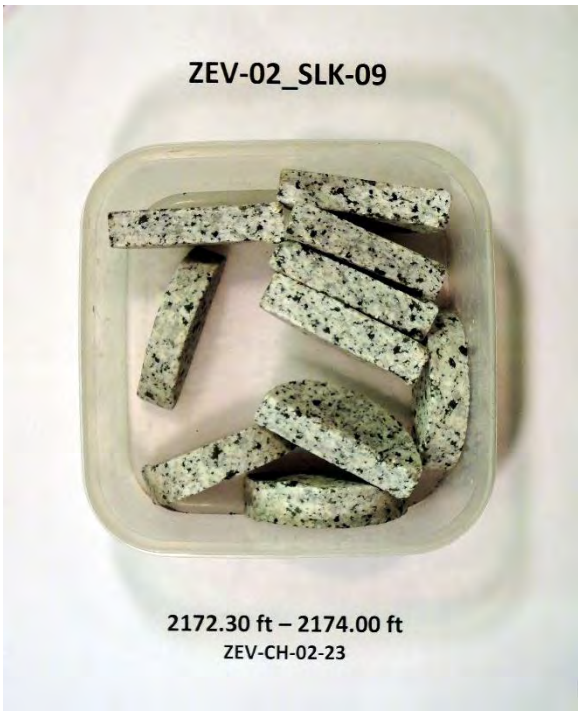
ZEV-02_SLK-08—Before

ZEV-02_SLK-08—After

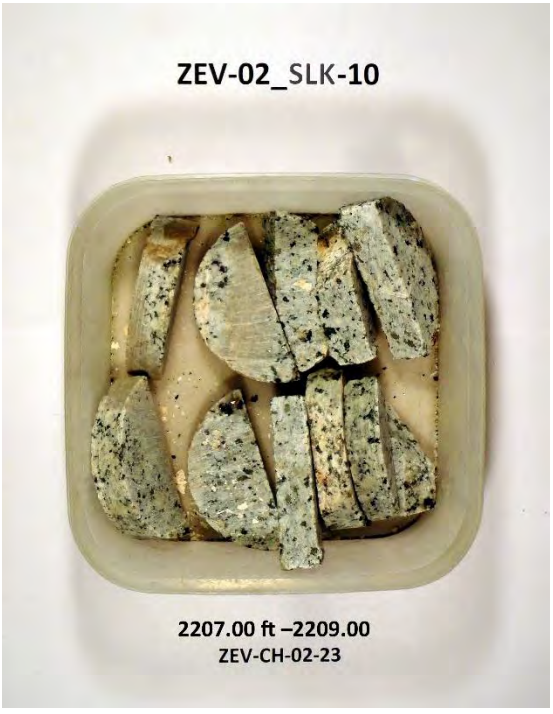
Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*



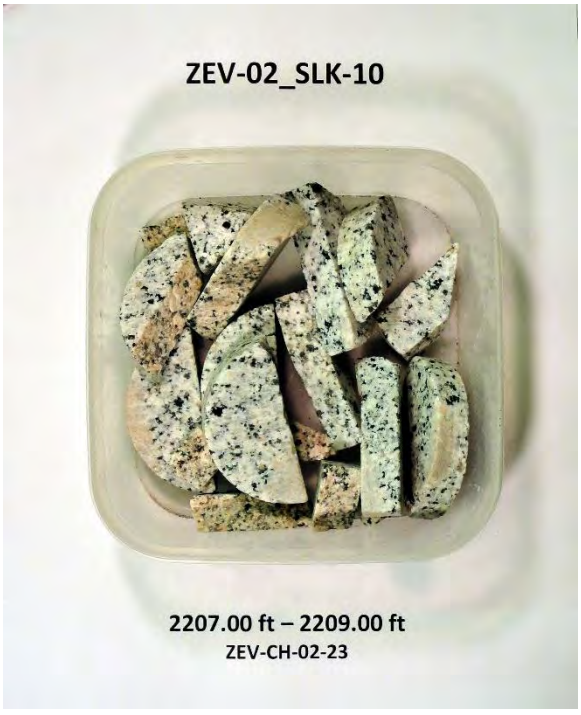
ZEV-02_SLK-09—Before



ZEV-02_SLK-09—After



ZEV-02_SLK-10—Before



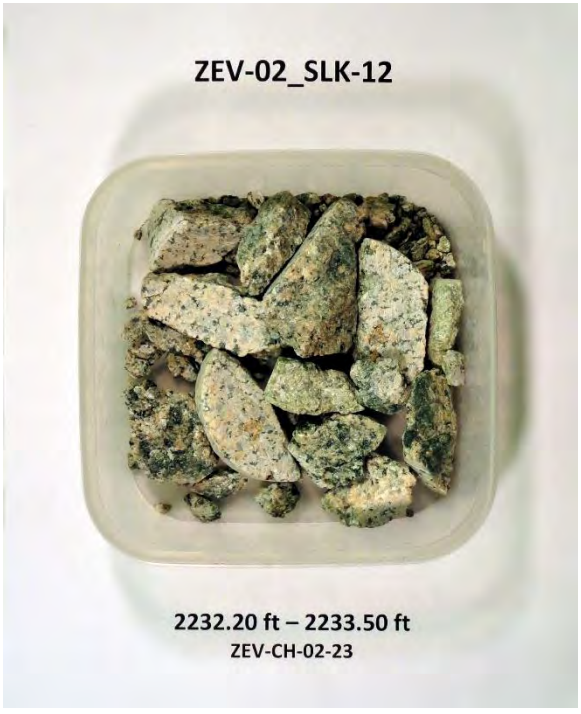
ZEV-02_SLK-10—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-02_SLK-11—Before

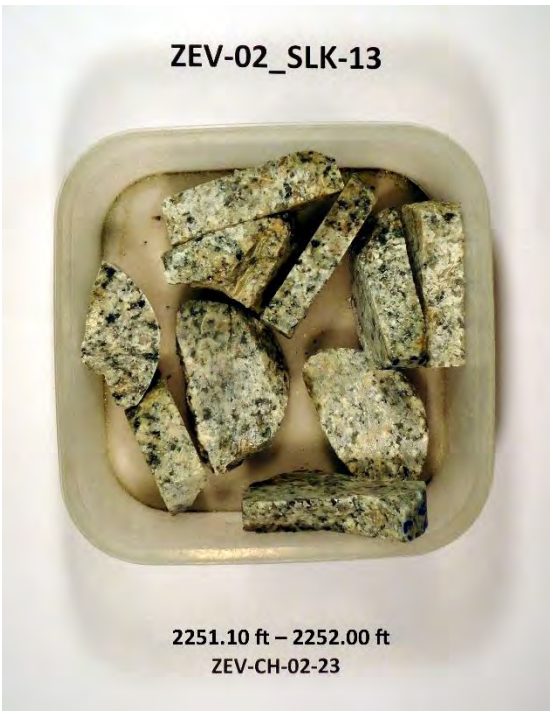
ZEV-02_SLK-11—After

ZEV-02_SLK-12—Before



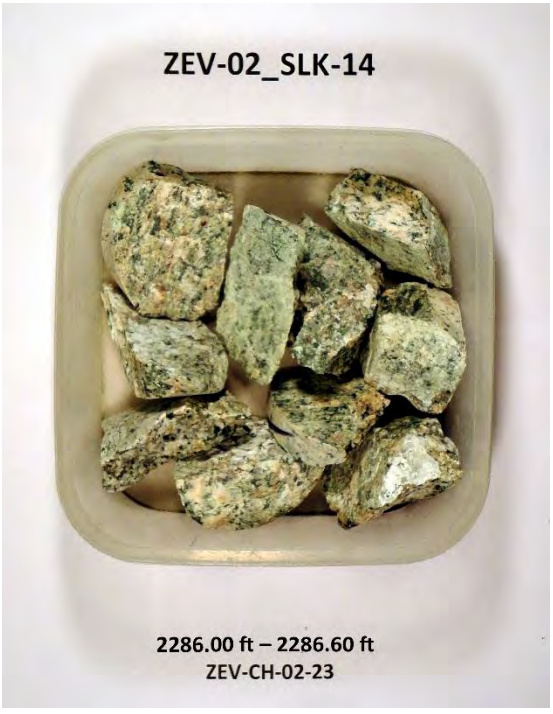
ZEV-02_SLK-12—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

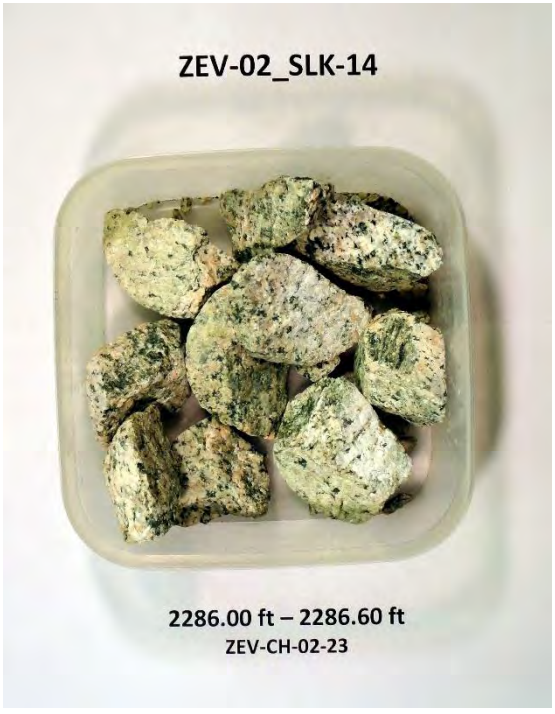


ZEV-02_SLK-13—Before

ZEV-02_SLK-13—After

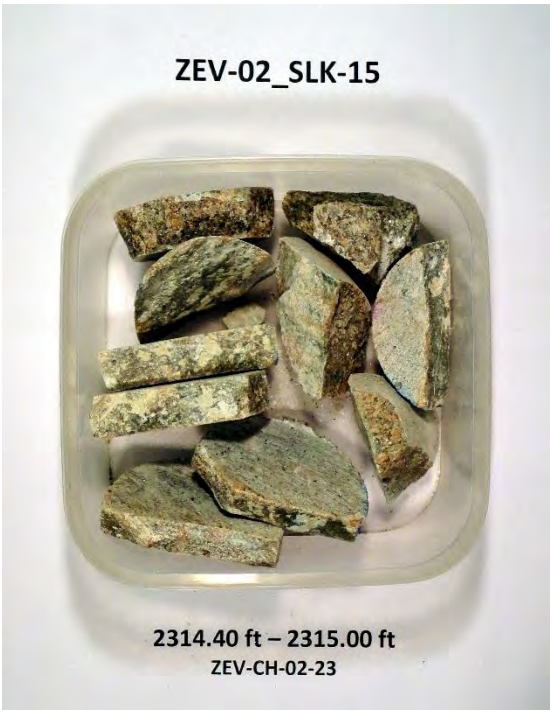


ZEV-02_SLK-14—Before

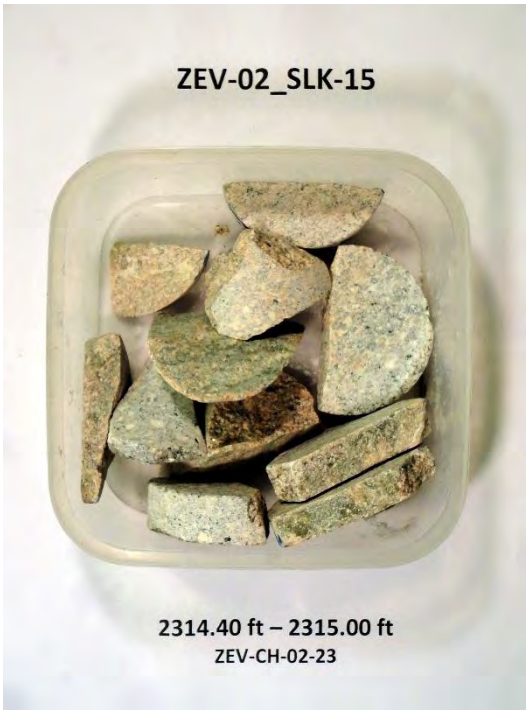


ZEV-02_SLK-14—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*



ZEV-02_SLK-15—Before



ZEV-02_SLK-15—After

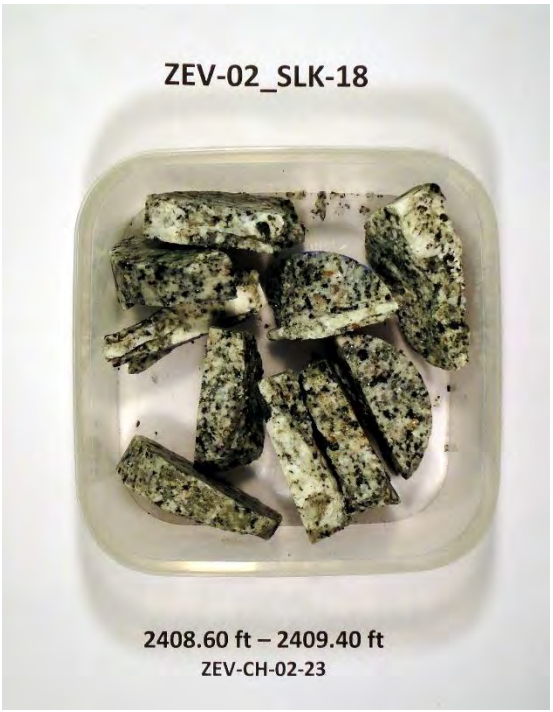
ZEV-02_SLK-16—Before

ZEV-02_SLK-16—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-02_SLK-17—Before

ZEV-02_SLK-17—After



ZEV-02_SLK-18—Before

ZEV-02_SLK-18—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-02_SLK-19—Before

ZEV-02_SLK-19—After

ZEV-02_SLK-20—Before

ZEV-02_SLK-20—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-02_SLK-21—Before

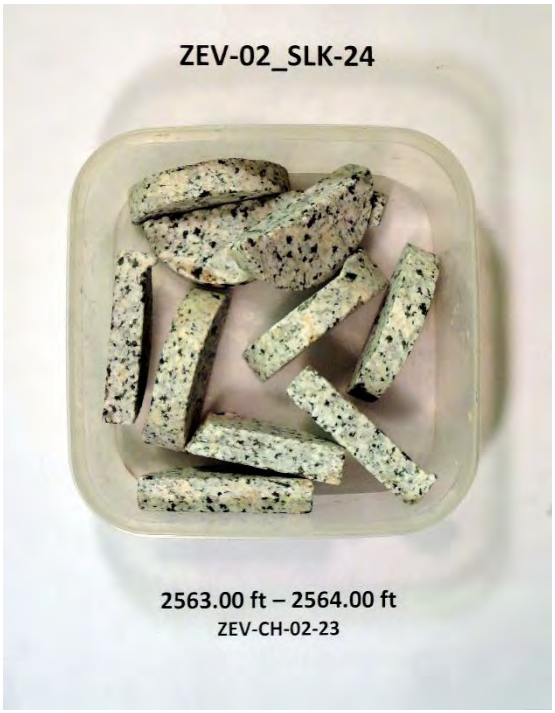
ZEV-02_SLK-21—After

ZEV-02_SLK-22—Before

ZEV-02_SLK-22—After

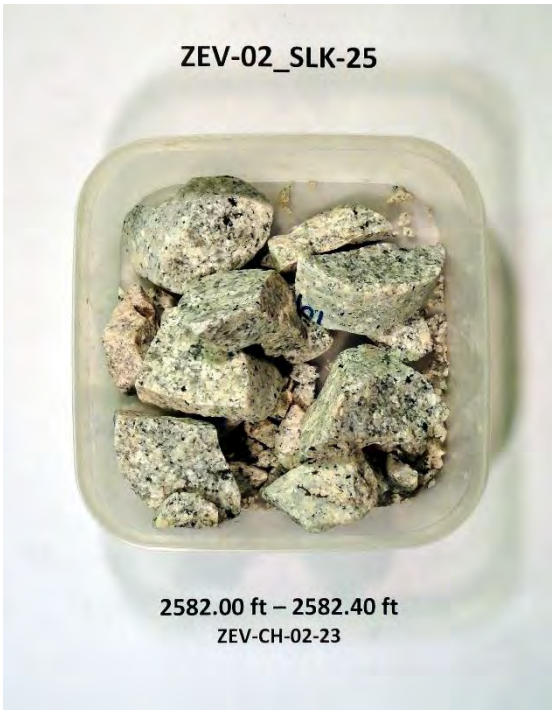
Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-02_SLK-24—Before



ZEV-02_SLK-24—After

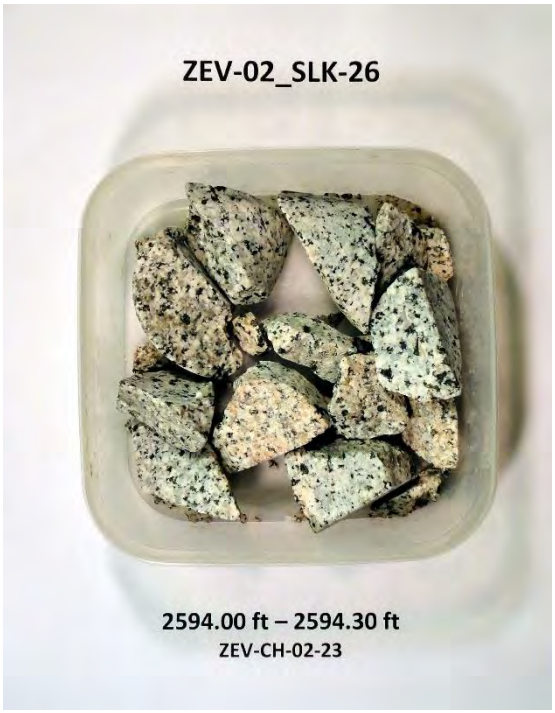
ZEV-02_SLK-25—Before



ZEV-02_SLK-25—After

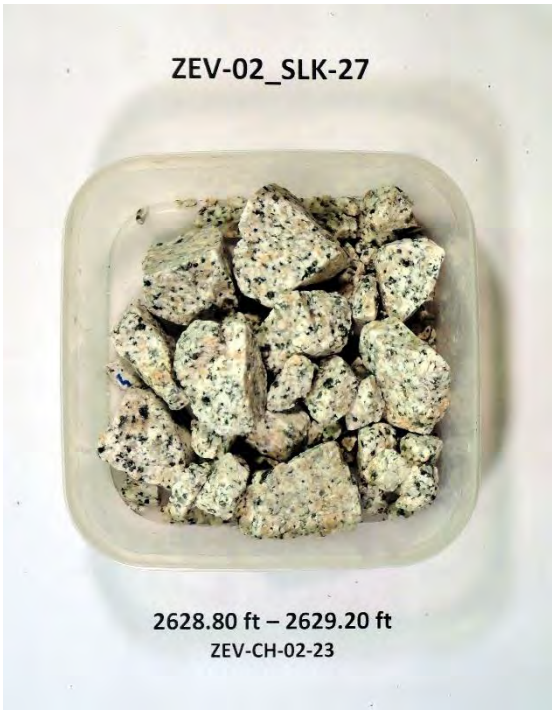
Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-02_SLK-26—Before



ZEV-02_SLK-26—After

ZEV-02_SLK-27—Before

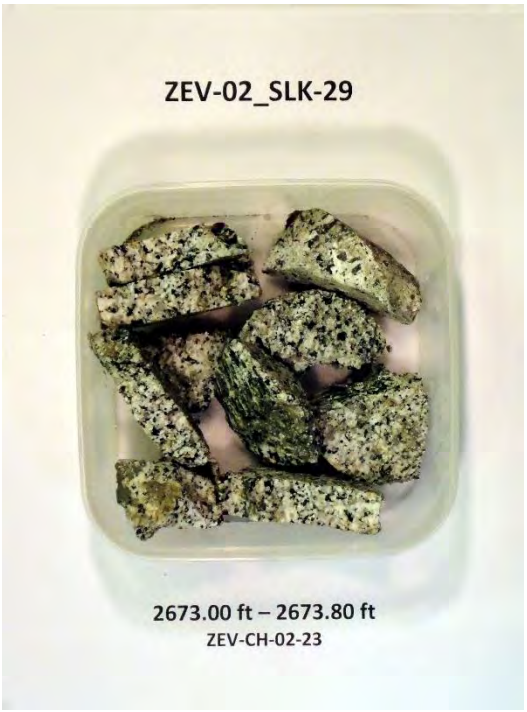


ZEV-02_SLK-27—After

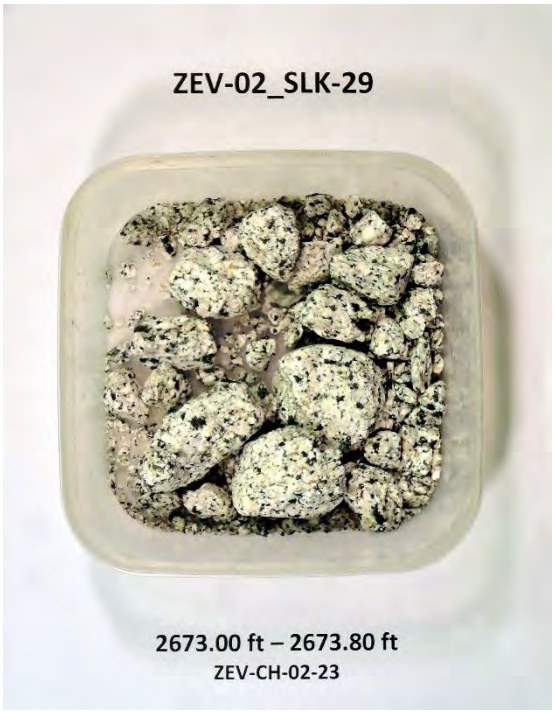
Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-02_SLK-28—Before

ZEV-02_SLK-28—After

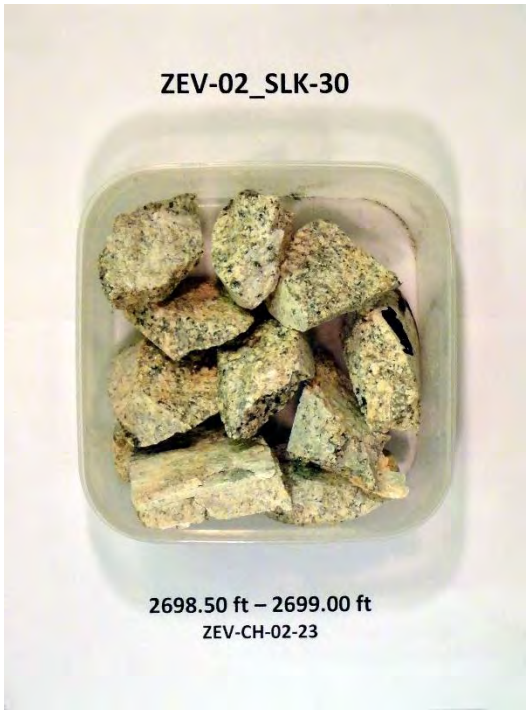


ZEV-02_SLK-29—Before

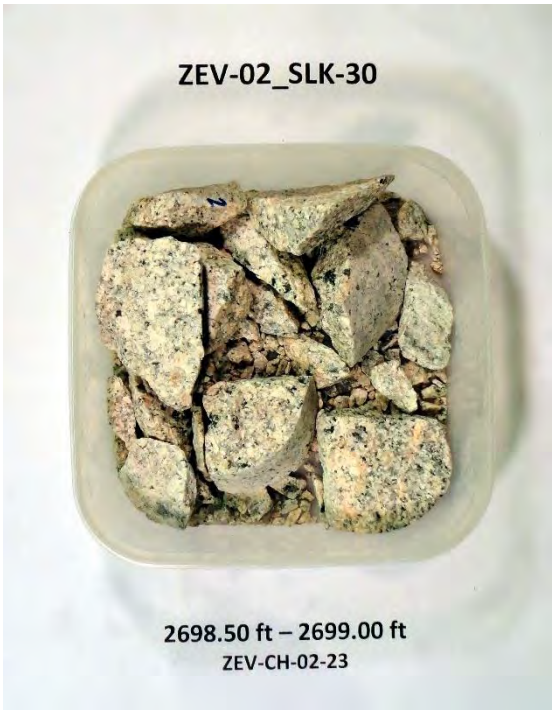


ZEV-02_SLK-29—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

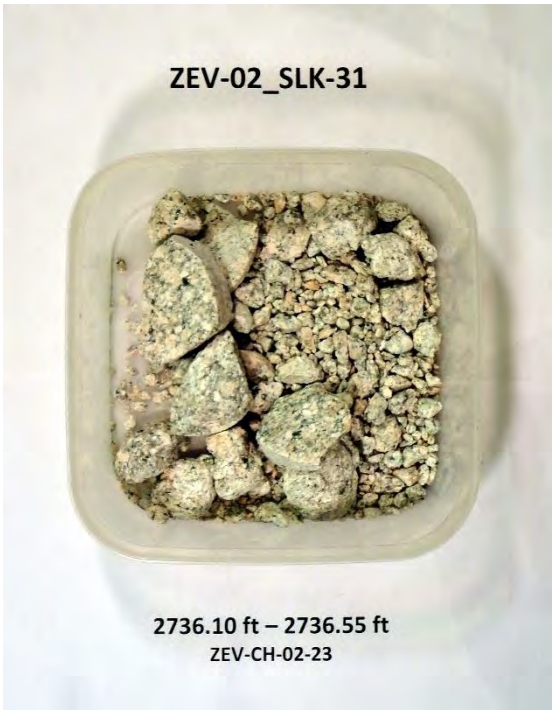


ZEV-02_SLK-30—Before



ZEV-02_SLK-30—After

ZEV-02_SLK-31—Before

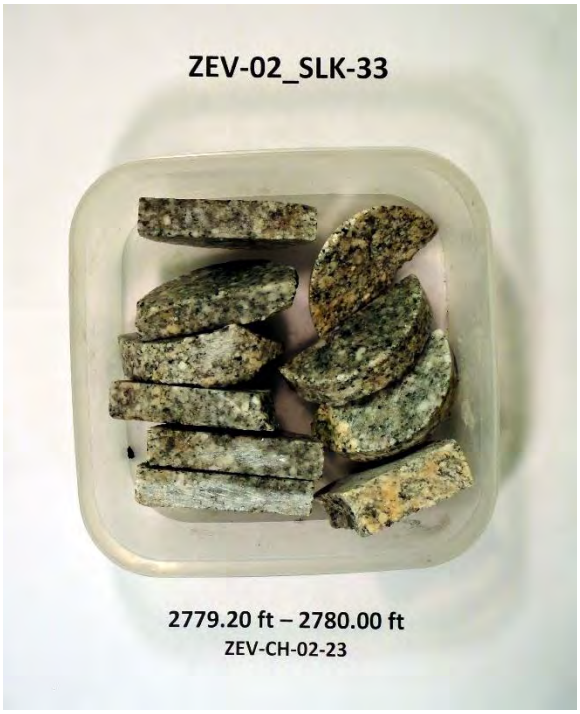


ZEV-02_SLK-31—After

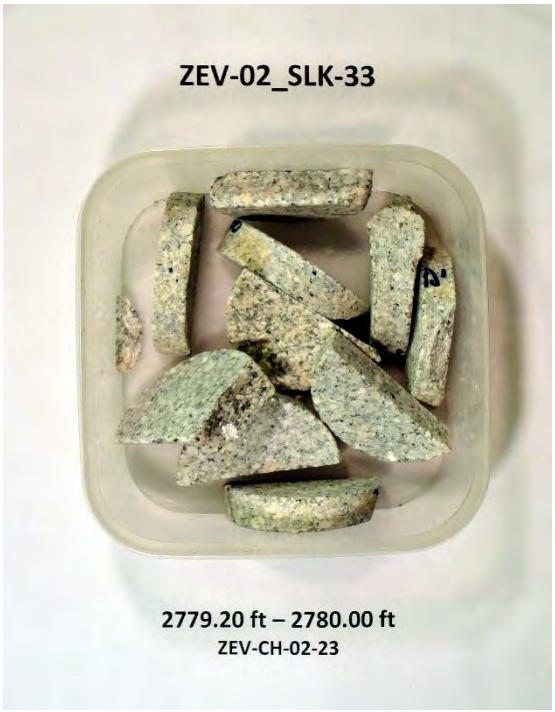
Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-02_SLK-32—Before

ZEV-02_SLK-32—After

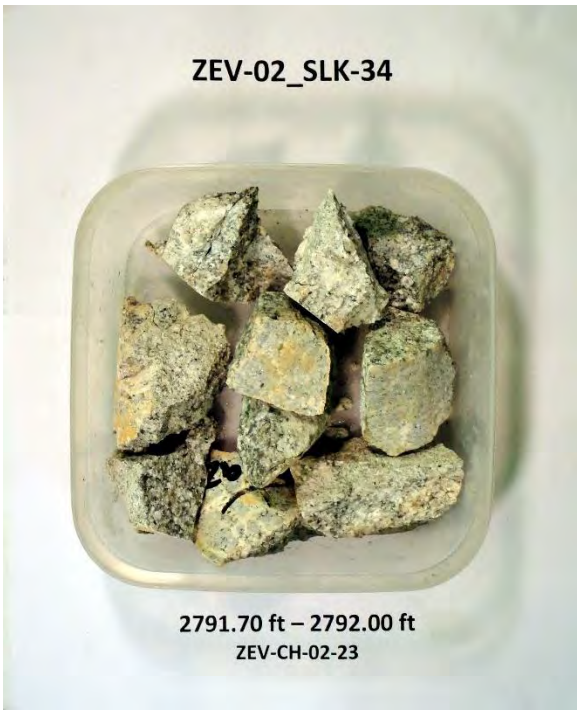


ZEV-02_SLK-33—Before

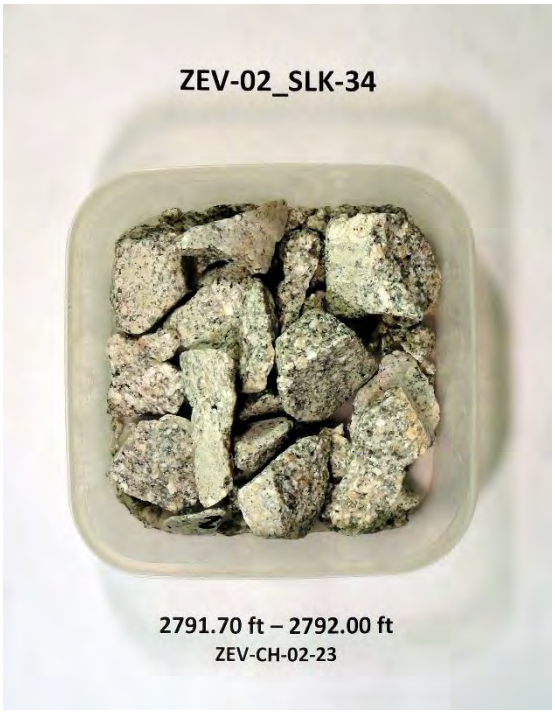


ZEV-02_SLK-33—After

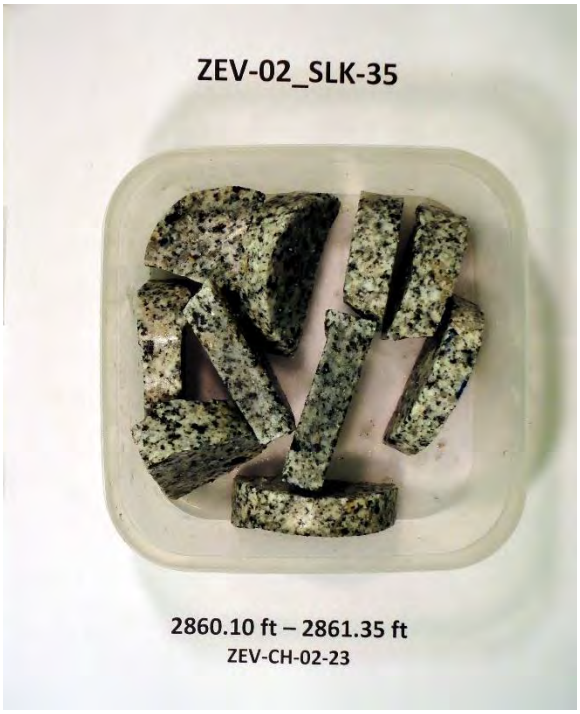
Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*



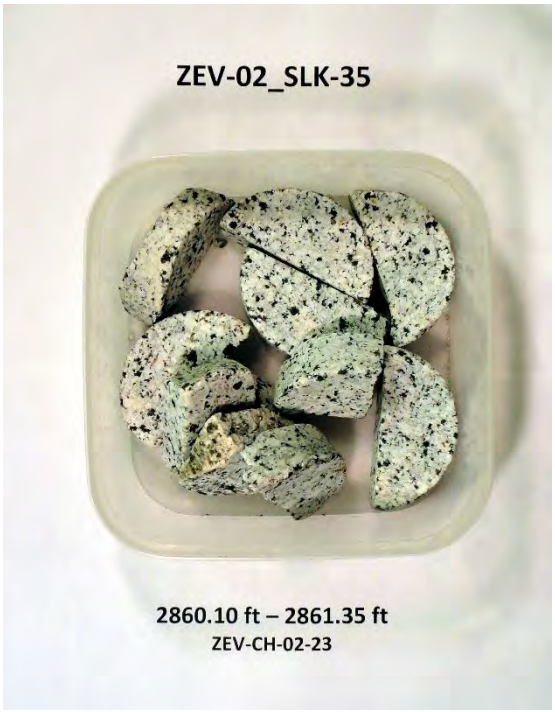
ZEV-02_SLK-34—Before



ZEV-02_SLK-34—After



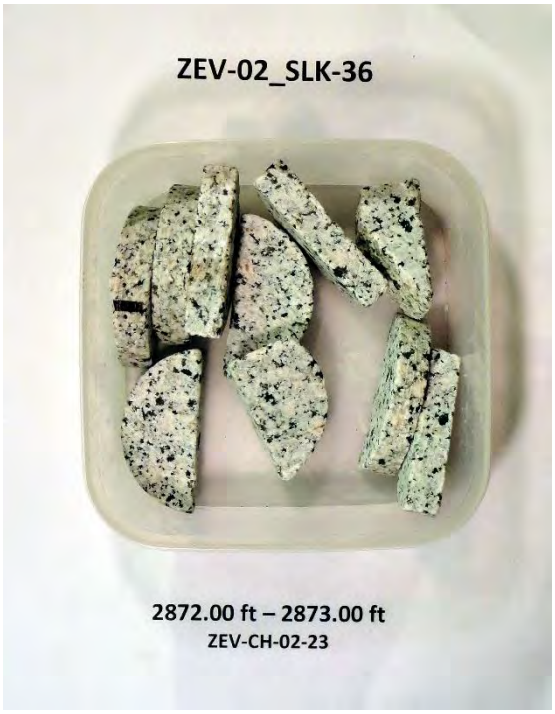
ZEV-02_SLK-35—Before



ZEV-02_SLK-35—After

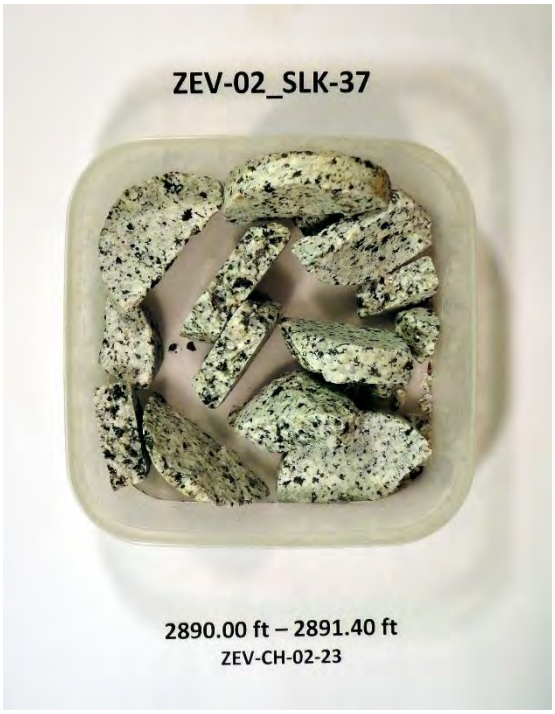
Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-02_SLK-36—Before



ZEV-02_SLK-36—After

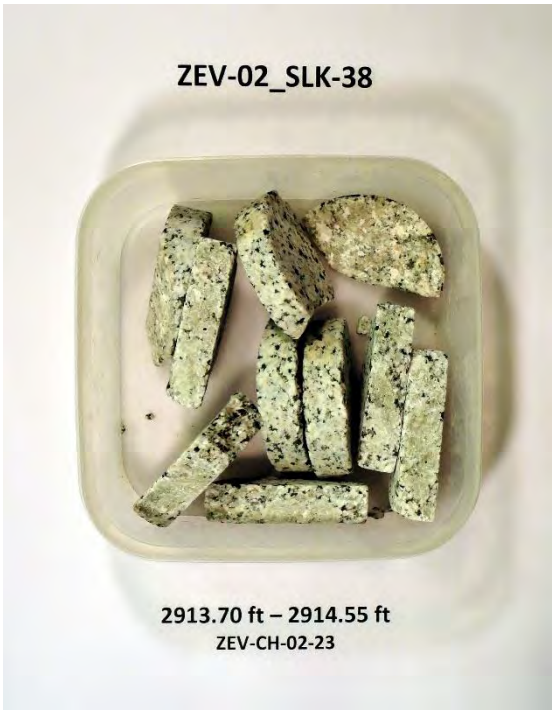
ZEV-02_SLK-37—Before



ZEV-02_SLK-37—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-02_SLK-38—Before



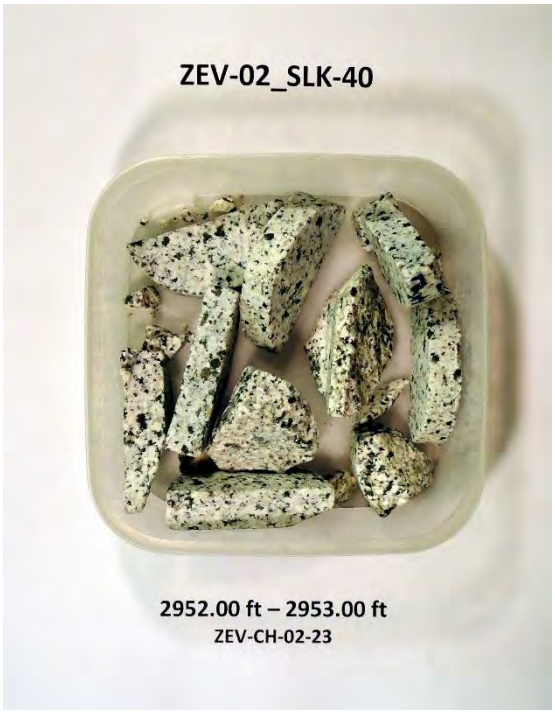
ZEV-02_SLK-38—After

ZEV-02_SLK-39—Before

ZEV-02_SLK-39—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-02_SLK-40—Before

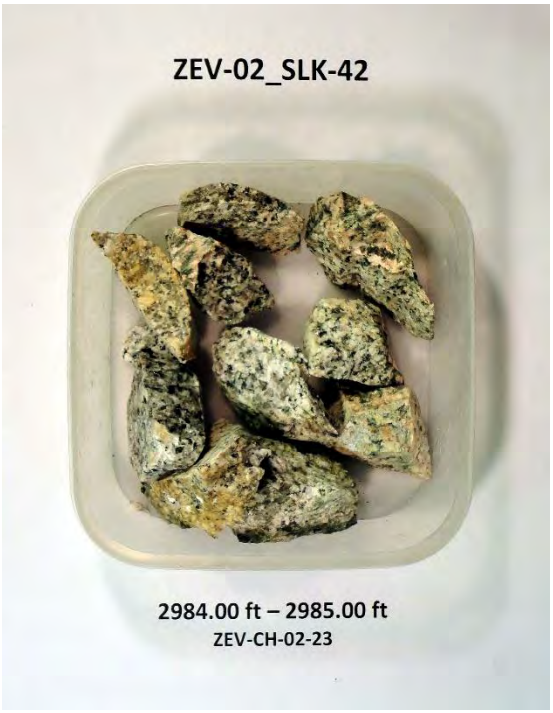


ZEV-02_SLK-40—After

ZEV-02_SLK-41—Before

ZEV-02_SLK-41—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*



ZEV-02_SLK-42—Before

ZEV-02_SLK-42—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(concluded)*

APPENDIX D

TRIAXIAL COMPRESSION TEST DATASHEET

AGAPITO ASSOCIATES, INC.
2913 Hill Avenue, #B
Grand Junction, CO 81504 USA
970-242-4220

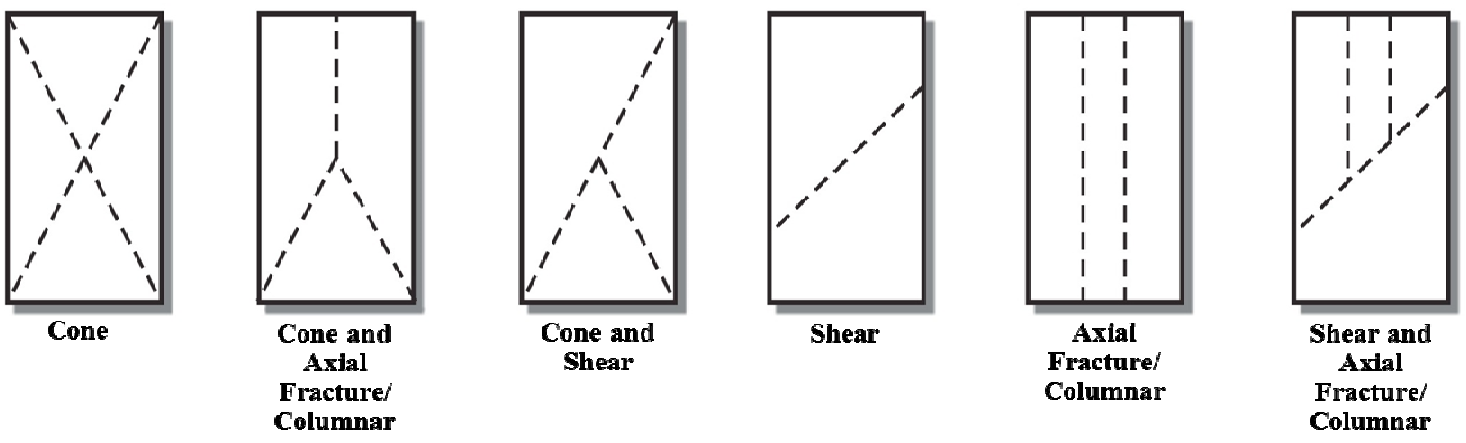
TRIAXIAL COMPRESSION TESTS

CLIENT	Lane PES	**HOLE NUMBER**	ZEV-CH-01-23
JOB NUMBER	951-20	**MOISTURE CONDITION**	As received
DATE	May 16, 2023	**TEMPERATURE**	Ambient

Specimen No.	Hole No.	Interval From (ft)	Interval To (ft)	Length of Interval (ft)	Weight (oz)	Diameter D_1 (in)	Diameter D_2 (in)	Axial Length (in)	Length-to-Diameter Ratio	Area (in^2)	Volume (in^3)	Density (pcf)	Specific Gravity
ZEV-01_TRI-01	ZEV-CH-01-23	2,010.10	2,011.00	0.90	38.37	2.39	2.39	5.49	2.3	4.48	24.57	169	2.70
ZEV-01_TRI-02	ZEV-CH-01-23	2,035.00	2,036.00	1.00	38.21	2.39	2.39	5.46	2.3	4.48	24.46	169	2.70
ZEV-01_TRI-03	ZEV-CH-01-23	2,071.00	2,072.00	1.00	38.03	2.39	2.40	5.42	2.3	4.50	24.40	168	2.70
ZEV-01_TRI-04	ZEV-CH-01-23	2,104.10	2,105.40	1.30	36.47	2.38	2.38	5.26	2.2	4.45	23.43	168	2.69
ZEV-01_TRI-05	ZEV-CH-01-23	2,200.10	2,201.00	0.90	38.09	2.40	2.40	5.40	2.2	4.53	24.43	168	2.70
ZEV-01_TRI-06	ZEV-CH-01-23	2,237.00	2,238.30	1.30	38.79	2.39	2.40	5.52	2.3	4.50	24.88	168	2.70
ZEV-01_TRI-07	ZEV-CH-01-23	2,441.33	2,442.00	0.67	37.61	2.40	2.40	5.32	2.2	4.53	24.11	168	2.70
ZEV-01_TRI-08	ZEV-CH-01-23	2,467.50	2,468.10	0.60	38.17	2.40	2.40	5.50	2.3	4.53	24.91	166	2.65
ZEV-01_TRI-09	ZEV-CH-01-23	2,477.00	2,477.66	0.66	38.24	2.40	2.40	5.47	2.3	4.52	24.77	167	2.67
ZEV-01_TRI-10	ZEV-CH-01-23	2,980.00	2,981.00	1.00	38.15	2.40	2.40	5.43	2.3	4.51	24.50	168	2.69
ZEV-01_TRI-11	ZEV-CH-01-23	3,009.25	3,010.00	0.75	38.64	2.40	2.40	5.47	2.3	4.52	24.73	169	2.70
ZEV-01_TRI-12	ZEV-CH-01-23	3,018.00	3,018.41	0.41	38.61	2.40	2.40	5.49	2.3	4.53	24.87	168	2.69

Specimen No.	Lithological Description	Confining Pressure (psi)	Failure Load (lb)	Failure Stress (psi)	Failure Mode Notes	Comments
ZEV-01_TRI-01	Granite	1,500	117,985	26,365	Shear	
ZEV-01_TRI-02	Granite	2,500	167,480	37,363	Shear	
ZEV-01_TRI-03	Granite	1,500	142,710	31,691	Shear	
ZEV-01_TRI-04	Granite	2,500	185,260	41,616	Shear	
ZEV-01_TRI-05	Granite	1,500	93,275	20,605	Shear	
ZEV-01_TRI-06	Granite	2,500	165,480	36,747	Axial/Shear	
ZEV-01_TRI-07	Granite	1,500	140,660	31,041	Shear	
ZEV-01_TRI-08	Granite	2,500	115,565	25,519	Shear	
ZEV-01_TRI-09	Granite	1,500	119,080	26,317	Axial/Shear	
ZEV-01_TRI-10	Granite	2,500	73,750	16,343	Shear	
ZEV-01_TRI-11	Granite	1,500	161,545	35,732	Shear	
ZEV-01_TRI-12	Granite	2,500	146,070	32,268	Axial	

Failure Mode Sketches



APPENDIX E

BEFORE AND AFTER PHOTOGRAPHS OF TRIAXIAL COMPRESSION TEST SPECIMENS

ZEV-01_TRI-01—Before

ZEV-01_TRI-01—After

ZEV-01_TRI-02—Before

ZEV-01_TRI-02—After

Figure E-1. Before and After Photographs of Triaxial Compressive Strength Test Specimens

ZEV-01_TRI-03—Before

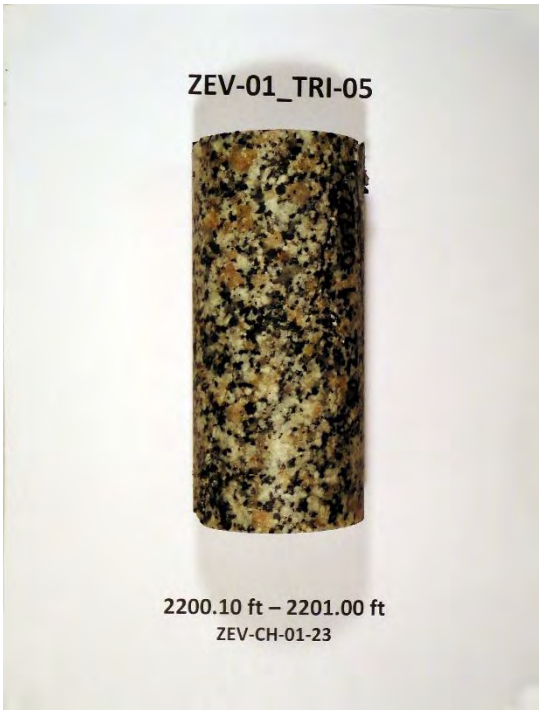
ZEV-01_TRI-03—After

ZEV-01_TRI-04—Before

ZEV-01_TRI-04—After

Figure E-1. Before and After Photographs of Triaxial Compressive Strength Test Specimens *(continued)*

ZEV-01_TRI-05—Before



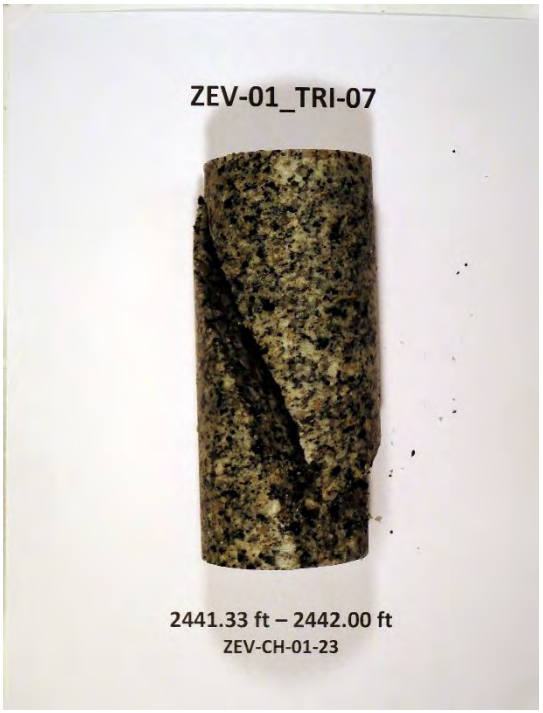
ZEV-01_TRI-05—After

ZEV-01_TRI-06—Before

ZEV-01_TRI-06—After

Figure E-1. Before and After Photographs of Triaxial Compressive Strength Test Specimens *(continued)*

ZEV-01_TRI-07—Before



ZEV-01_TRI-07—After

ZEV-01_TRI-08—Before

ZEV-01_TRI-08—After

Figure E-1. Before and After Photographs of Triaxial Compressive Strength Test Specimens *(continued)*

ZEV-01_TRI-09—Before

ZEV-01_TRI-09—After

ZEV-01_TRI-10—Before

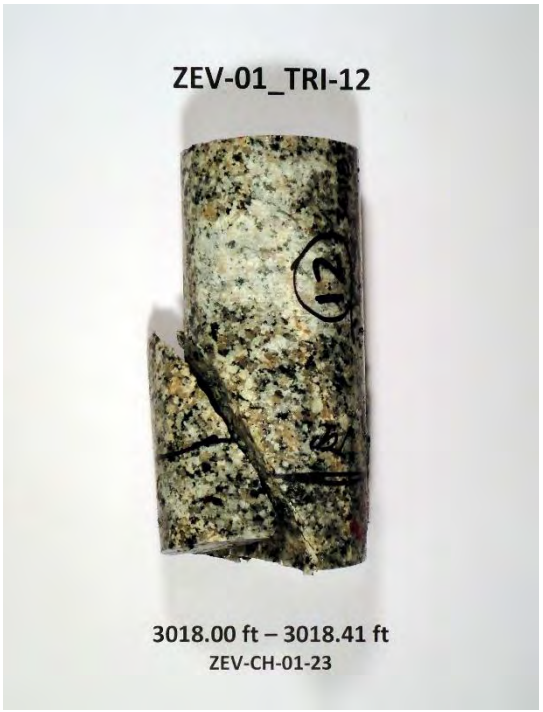
ZEV-01_TRI-10—After

Figure E-1. Before and After Photographs of Triaxial Compressive Strength Test Specimens *(continued)*

ZEV-01_TRI-11—Before

ZEV-01_TRI-11—After

ZEV-01_TRI-12—Before



ZEV-01_TRI-12—After

Figure E-1. Before and After Photographs of Triaxial Compressive Strength Test Specimens *(concluded)*

APPENDIX F

SPLITTING TENSILE STRENGTH (BRAZILIAN) TEST DATASHEET

AGAPITO ASSOCIATES, INC.
2913 Hill Avenue, #B
Grand Junction, CO 81504 USA
970-242-4220

INDIRECT TENSILE STRENGTH (BRAZILIAN) TESTS

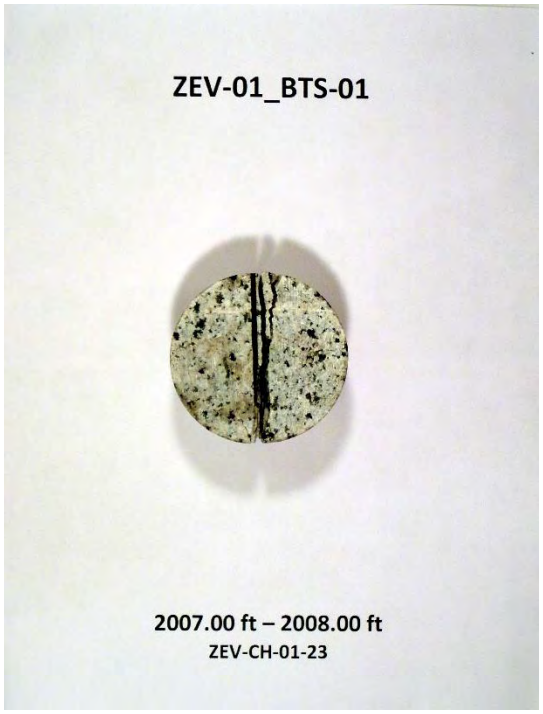
CLIENT	Lane PES	**HOLE NUMBER**	ZEV-CH-01-23
JOB NUMBER	951-20	**MOISTURE CONDITION**	As Received
DATE	May 16, 2023	**TEMPERATURE**	Ambient

Specimen No.	Hole No.	Depth From (ft)	Depth To (ft)	Length of Interval (ft)	Weight (oz)	Diameter D_1 (in)	Diameter D_2 (in)	Axial Length (inch)	Area (inch^2)	Density (pcf)	Specific Gravity
ZEV-01_BTS-01	ZEV-CH-01-23	2,007.00	2,008.00	1.00	9.35	2.38	2.38	1.36	4.45	167	2.7
ZEV-01_BTS-02	ZEV-CH-01-23	2,032.00	2,033.00	1.00	9.46	2.39	2.39	1.37	4.49	167	2.7
ZEV-01_BTS-03	ZEV-CH-01-23	2,067.00	2,068.80	1.80	9.83	2.40	2.40	1.40	4.52	167	2.7
ZEV-01_BTS-04	ZEV-CH-01-23	2,096.00	2,097.00	1.00	9.63	2.40	2.40	1.37	4.52	168	2.7
ZEV-01_BTS-05	ZEV-CH-01-23	2,218.70	2,219.70	1.00	9.89	2.40	2.40	1.41	4.51	168	2.7
ZEV-01_BTS-06	ZEV-CH-01-23	2,243.00	2,244.00	1.00	9.37	2.39	2.39	1.35	4.49	167	2.7
ZEV-01_BTS-07	ZEV-CH-01-23	2,419.00	2,420.33	1.33	9.80	2.40	2.40	1.39	4.53	168	2.7
ZEV-01_BTS-08	ZEV-CH-01-23	2,456.00	2,456.90	0.90	9.94	2.40	2.40	1.41	4.53	168	2.7
ZEV-01_BTS-09	ZEV-CH-01-23	2,487.00	2,488.00	1.00	9.61	2.40	2.40	1.38	4.53	166	2.7
ZEV-01_BTS-10	ZEV-CH-01-23	2,978.00	2,978.58	0.58	9.23	2.40	2.40	1.31	4.51	168	2.7
ZEV-01_BTS-11	ZEV-CH-01-23	3,004.58	3,005.41	0.83	9.23	2.40	2.40	1.32	4.53	167	2.7
ZEV-01_BTS-12	ZEV-CH-01-23	1,519.30	1,520.10	0.80	8.26	2.40	2.41	1.23	4.54	160	2.6
ZEV-01_BTS-13	ZEV-CH-01-23	1,623.50	1,624.90	1.40	9.05	2.40	2.40	1.30	4.51	167	2.7
ZEV-01_BTS-14	ZEV-CH-01-23	1,794.40	1,795.40	1.00	6.77	2.40	2.39	0.98	4.51	165	2.6
ZEV-01_BTS-15	ZEV-CH-01-23	1,929.00	1,930.40	1.40	6.91	2.40	2.40	1.01	4.51	163	2.6
ZEV-01_BTS-16	ZEV-CH-01-23	2,032.00	2,033.00	1.00	9.46	2.39	2.39	1.37	4.49	167	2.7
ZEV-01_BTS-17	ZEV-CH-01-23	2,067.00	2,068.80	1.80	9.83	2.40	2.40	1.40	4.52	167	2.7
ZEV-01_BTS-18	ZEV-CH-01-23	2,096.00	2,097.00	1.00	9.63	2.40	2.40	1.37	4.52	168	2.7
ZEV-01_BTS-19	ZEV-CH-01-23	2,129.20	2,130.50	1.30	9.30	2.39	2.39	1.34	4.47	168	2.7
ZEV-01_BTS-20	ZEV-CH-01-23	2,161.10	2,162.00	0.90	7.04	2.39	2.39	1.02	4.47	166	2.7
ZEV-01_BTS-21	ZEV-CH-01-23	2,185.10	2,186.60	1.50	6.65	2.40	2.40	0.98	4.52	162	2.6
ZEV-01_BTS-22	ZEV-CH-01-23	2,243.00	2,244.00	1.00	8.73	2.39	2.39	1.27	4.48	165	2.7
ZEV-01_BTS-23	ZEV-CH-01-23	2,284.25	2,285.00	0.75	9.24	2.40	2.40	1.33	4.51	166	2.7
ZEV-01_BTS-24	ZEV-CH-01-23	2,302.00	2,303.25	1.25	8.61	2.41	2.40	1.32	4.54	155	2.5
ZEV-01_BTS-25	ZEV-CH-01-23	2,323.00	2,324.00	1.00	8.01	2.40	2.40	1.33	4.53	144	2.3
ZEV-01_BTS-26	ZEV-CH-01-23	2,371.25	2,372.00	0.75	8.58	2.40	2.40	1.27	4.53	161	2.6
ZEV-01_BTS-27	ZEV-CH-01-23	2,397.66	2,399.33	1.67	8.94	2.40	2.40	1.31	4.53	162	2.6
ZEV-01_BTS-28	ZEV-CH-01-23	2,524.20	2,525.33	1.13	8.84	2.40	2.40	1.26	4.52	168	2.7
ZEV-01_BTS-29	ZEV-CH-01-23	2,535.50	2,536.50	1.00	8.63	2.40	2.40	1.25	4.52	165	2.6
ZEV-01_BTS-30	ZEV-CH-01-23	2,584.75	2,585.67	0.92	8.58	2.42	2.41	1.31	4.57	154	2.5
ZEV-01_BTS-31	ZEV-CH-01-23	2,618.00	2,619.00	1.00	9.01	2.40	2.41	1.29	4.54	167	2.7
ZEV-01_BTS-32	ZEV-CH-01-23	2,622.80	2,624.50	1.70	8.78	2.40	2.40	1.24	4.54	168	2.7
ZEV-01_BTS-33	ZEV-CH-01-23	2,655.33	2,656.50	1.17	8.95	2.40	2.40	1.27	4.53	168	2.7
ZEV-01_BTS-34	ZEV-CH-01-23	2,686.90	2,689.45	2.55	7.94	2.42	2.41	1.28	4.57	147	2.4
ZEV-01_BTS-35	ZEV-CH-01-23	2,739.70	2,740.70	1.00	8.74	2.39	2.39	1.29	4.50	163	2.6
ZEV-01_BTS-36	ZEV-CH-01-23	2,773.70	2,775.35	1.65	8.80	2.40	2.40	1.27	4.51	166	2.7
ZEV-01_BTS-37	ZEV-CH-01-23	2,803.00	2,804.35	1.35	8.98	2.39	2.39	1.31	4.49	165	2.7
ZEV-01_BTS-38	ZEV-CH-01-23	2,842.20	2,843.20	1.00	8.46	2.41	2.40	1.30	4.54	155	2.5
ZEV-01_BTS-39	ZEV-CH-01-23	2,874.80	2,876.00	1.20	9.10	2.40	2.40	1.42	4.51	153	2.5
ZEV-01_BTS-40	ZEV-CH-01-23	2,902.50	2,903.30	0.80	8.88	2.40	2.40	1.27	4.52	167	2.7
ZEV-01_BTS-41	ZEV-CH-01-23	2,942.00	2,943.00	1.00	9.25	2.40	2.40	1.35	4.52	164	2.6

Specimen No.	Lithological Description	Failure Load (lb)	Splitting Tensile Strength (psi)	Failure Mode Notes
ZEV-01_BTS-01	Granite	8,425	1,661	Tensile - Center
ZEV-01_BTS-02	Granite	5,789	1,129	Tensile - Center; Secondary failure at pre-existing fracture
ZEV-01_BTS-03	Granite	7,213	1,364	Tensile - Center
ZEV-01_BTS-04	Granite	6,432	1,247	Tensile - Center
ZEV-01_BTS-05	Granite	3,132	590	Tensile - Center
ZEV-01_BTS-06	Granite	3,546	699	Tensile - Center
ZEV-01_BTS-07	Granite	7,539	1,440	Tensile - Center
ZEV-01_BTS-08	Granite	8,007	1,502	Tensile - Center
ZEV-01_BTS-09	Granite	6,576	1,265	Tensile - Offcenter
ZEV-01_BTS-10	Granite	7,425	1,501	Tensile - Center; Secondary failure at pre-existing fracture
ZEV-01_BTS-11	Granite	6,559	1,319	Tensile - Center; Secondary failure at pre-existing fracture
ZEV-01_BTS-12	Granite	3,077	665	Tensile - Center; Secondary failure at pre-existing fracture
ZEV-01_BTS-13	Granite	3,503	716	Tensile - Center
ZEV-01_BTS-14	Granite	4,726	1,278	Tensile - Center
ZEV-01_BTS-15	Granite	4,791	1,256	Tensile - Center
ZEV-01_BTS-16	Granite	-	-	Duplicates from Previous Testing, Not tested
ZEV-01_BTS-17	Granite	-	-	Duplicates from Previous Testing, Not tested
ZEV-01_BTS-18	Granite	-	-	Duplicates from Previous Testing, Not tested
ZEV-01_BTS-19	Granite	6,835	1,361	Tensile - Center
ZEV-01_BTS-20	Granite	4,087	1,066	Tensile - Center
ZEV-01_BTS-21	Granite	2,886	782	Tensile - Center; Secondary failure at pre-existing fracture
ZEV-01_BTS-22	Granite	5,601	1,174	Tensile - Center
ZEV-01_BTS-23	Granite	2,506	499	Tensile - Center
ZEV-01_BTS-24	Granite	946	190	Tensile - Offcenter
ZEV-01_BTS-25	Granite	1,222	244	Tensile - Offcenter
ZEV-01_BTS-26	Granite	4,030	840	Tensile - Center; Secondary failure at pre-existing fracture
ZEV-01_BTS-27	Granite	3,741	756	Tensile - Center; Secondary failure at pre-existing fracture
ZEV-01_BTS-28	Granite	6,229	1,314	Tensile - Center
ZEV-01_BTS-29	Granite	4,711	999	Tensile - Offcenter
ZEV-01_BTS-30	Granite	555	112	Tensile - Offcenter; multiple failures along fractures
ZEV-01_BTS-31	Granite	4,916	1,013	Tensile - Center
ZEV-01_BTS-32	Granite	6,412	1,366	Tensile - Center
ZEV-01_BTS-33	Granite	3,139	656	Tensile - Center; Secondary failure at pre-existing fracture
ZEV-01_BTS-34	Granite	586	121	Tensile - Center
ZEV-01_BTS-35	Granite	7,660	1,582	Tensile - Center
ZEV-01_BTS-36	Granite	4,965	1,042	Tensile - Center; Secondary failure at pre-existing fracture

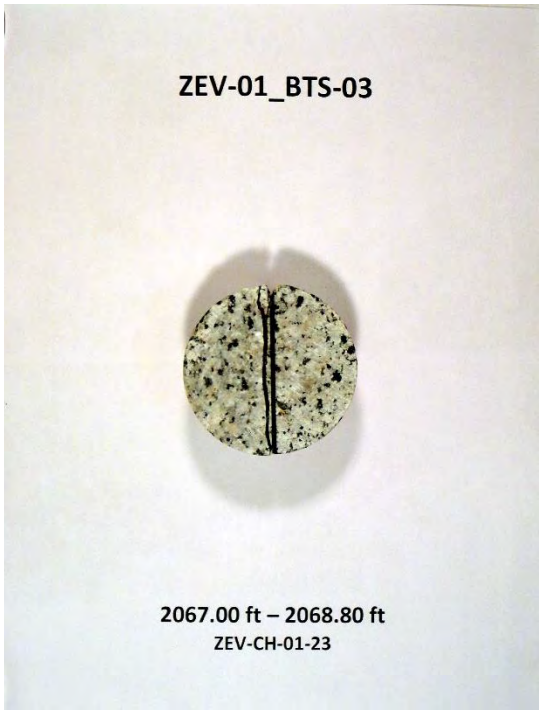
APPENDIX G

AFTER PHOTOGRAPHS OF BRAZILIAN TEST SPECIMENS

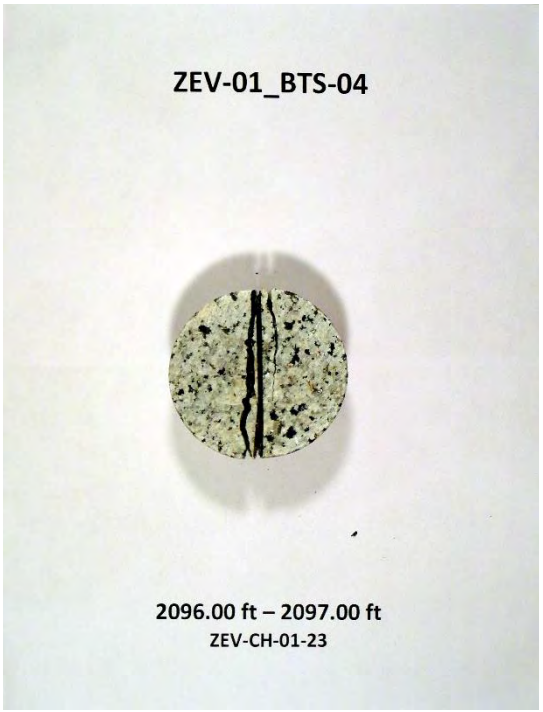


ZEV-01_BTS-01—After

ZEV-01_BTS-02—After



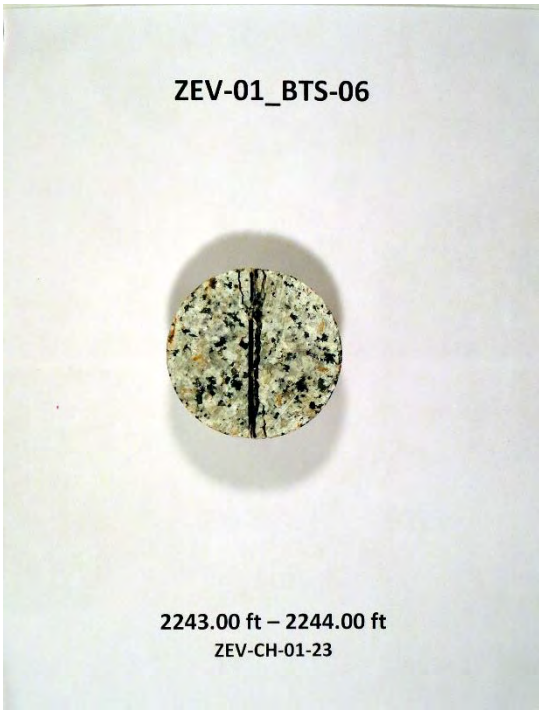
ZEV-01_BTS-03—After



ZEV-01_BTS-04—After

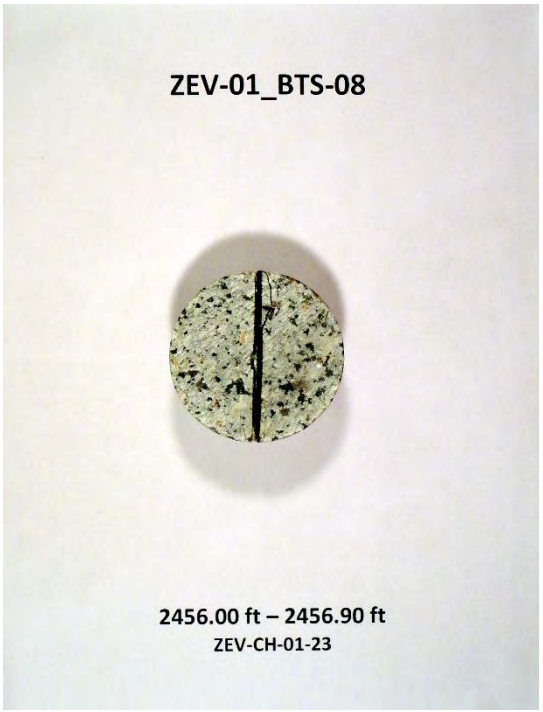
Figure G-1. After Photographs of Brazilian Test Specimens *(continued)*

ZEV-01_BTS-05—After



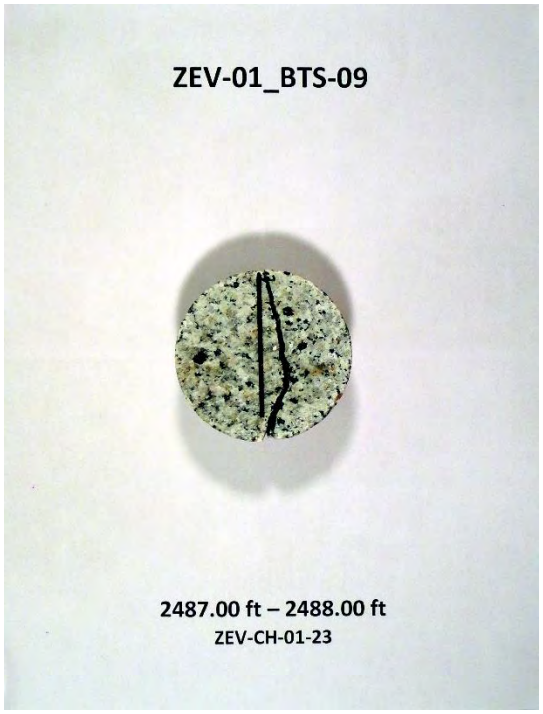
ZEV-01_BTS-06—After

ZEV-01_BTS-07—After

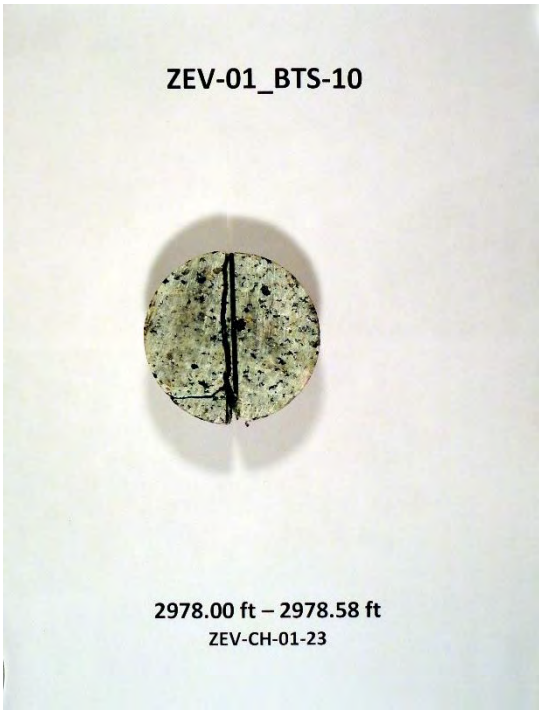


ZEV-01_BTS-08—After

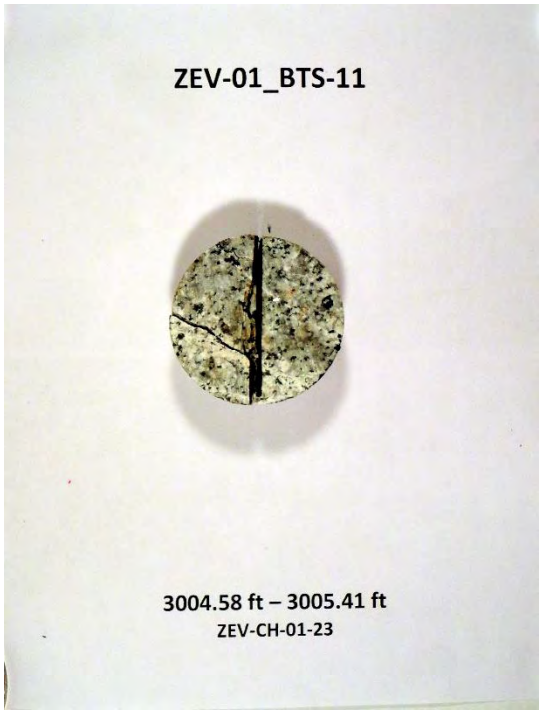
Figure G-1. After Photographs of Brazilian Test Specimens *(continued)*



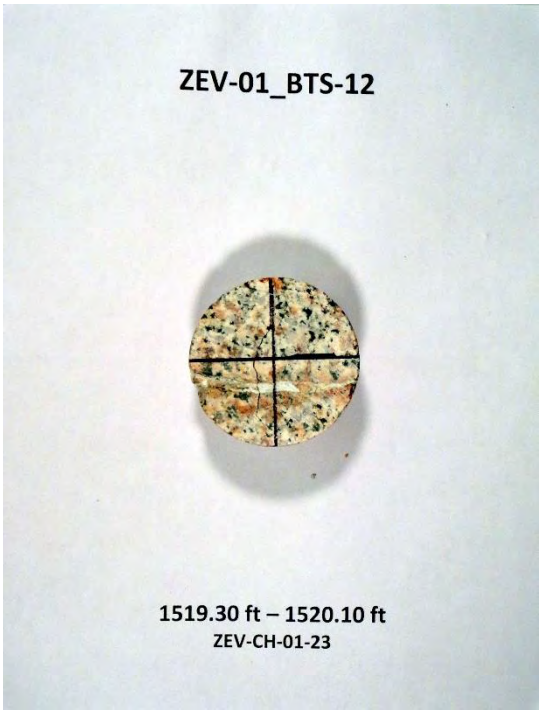
ZEV-01_BTS-09—After



ZEV-01_BTS-10—After

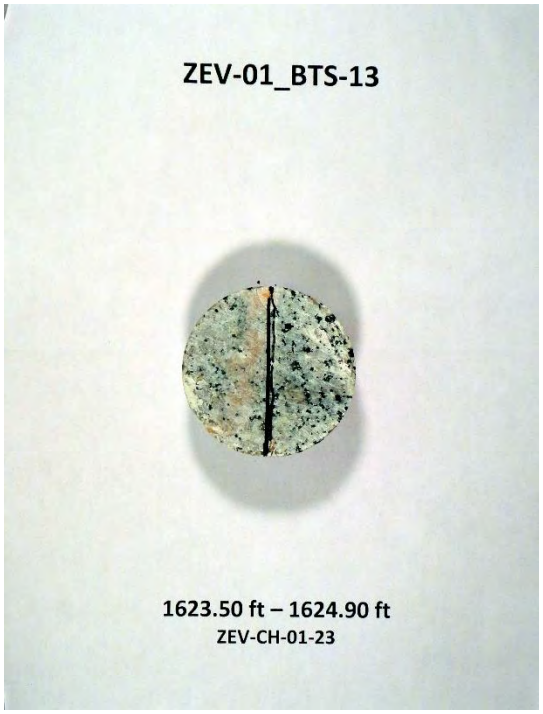


ZEV-01_BTS-11—After



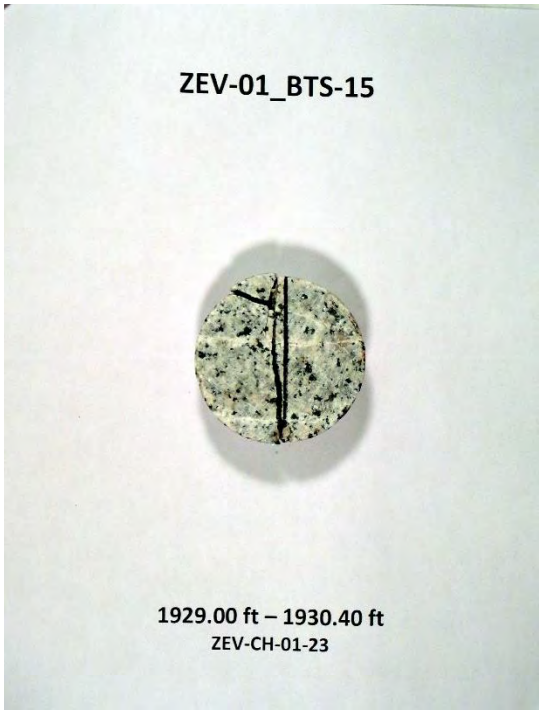
ZEV-01_BTS-12—After

Figure G-1. After Photographs of Brazilian Test Specimens *(continued)*

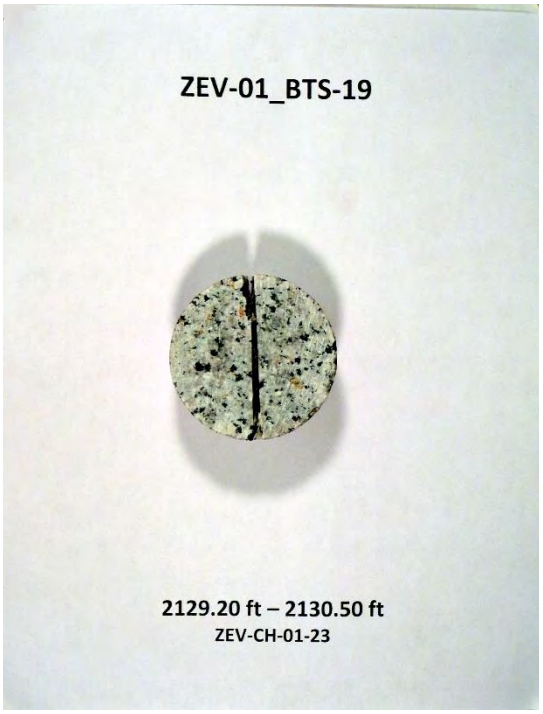


ZEV-01_BTS-13—After

ZEV-01_BTS-14—After



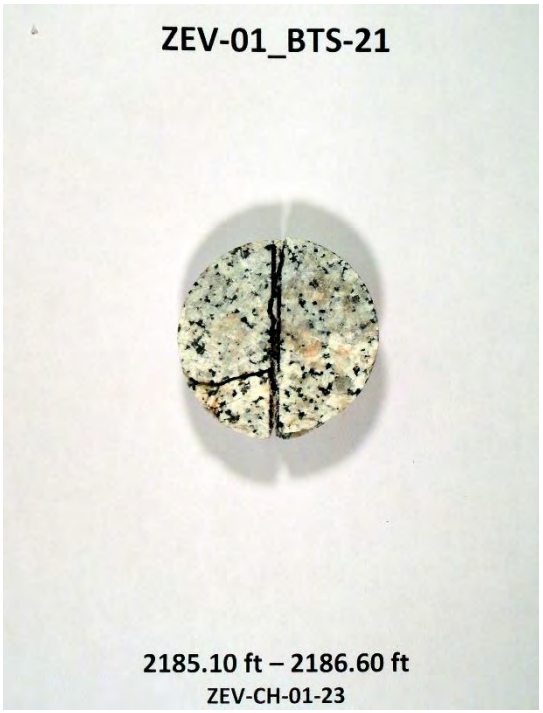
ZEV-01_BTS-15—After



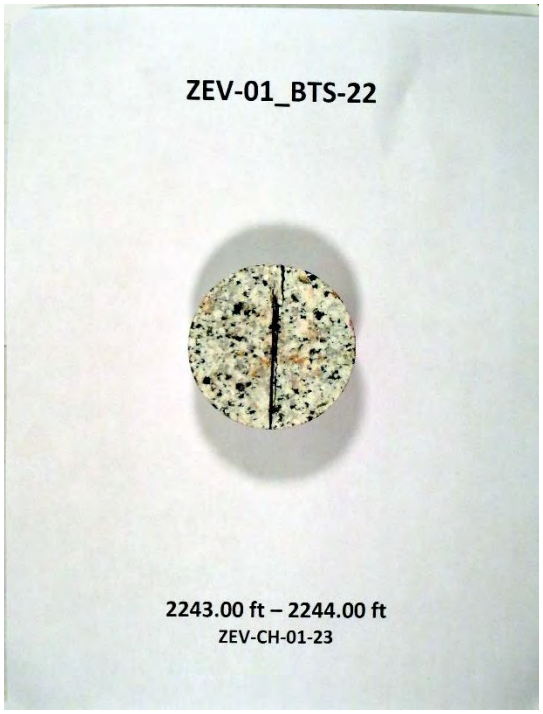
ZEV-01_BTS-19—After

Figure G-1. After Photographs of Brazilian Test Specimens *(continued)*

ZEV-01_BTS-20—After



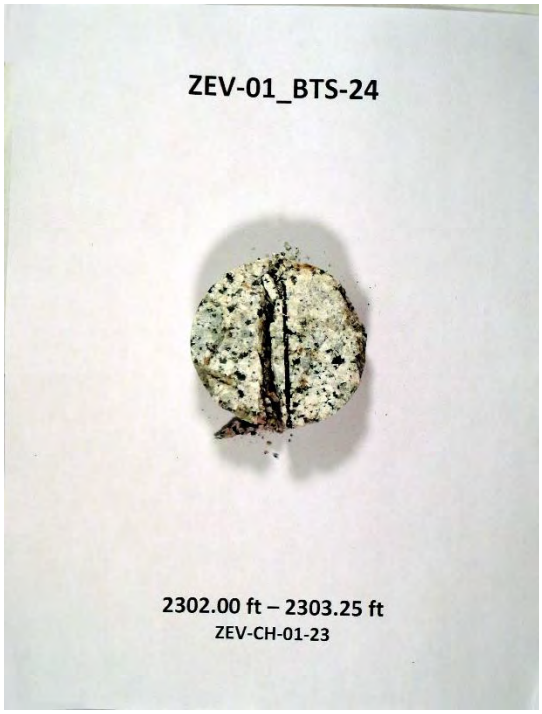
ZEV-01_BTS-21—After



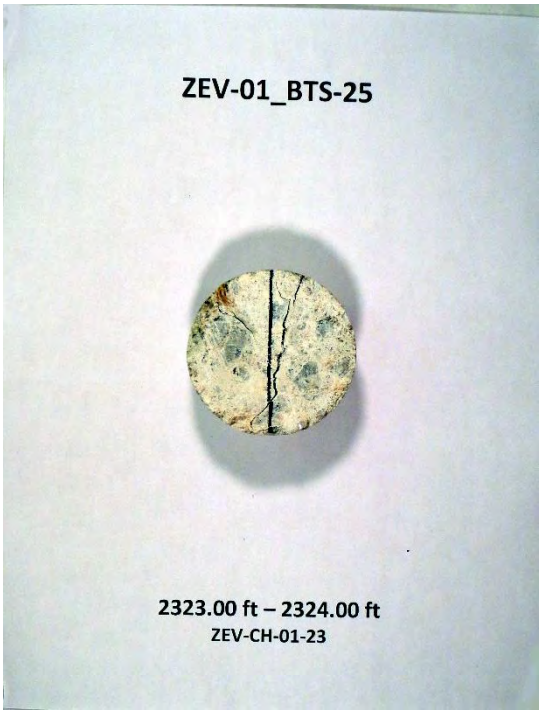
ZEV-01_BTS-22—After

ZEV-01_BTS-23—After

Figure G-1. After Photographs of Brazilian Test Specimens *(continued)*

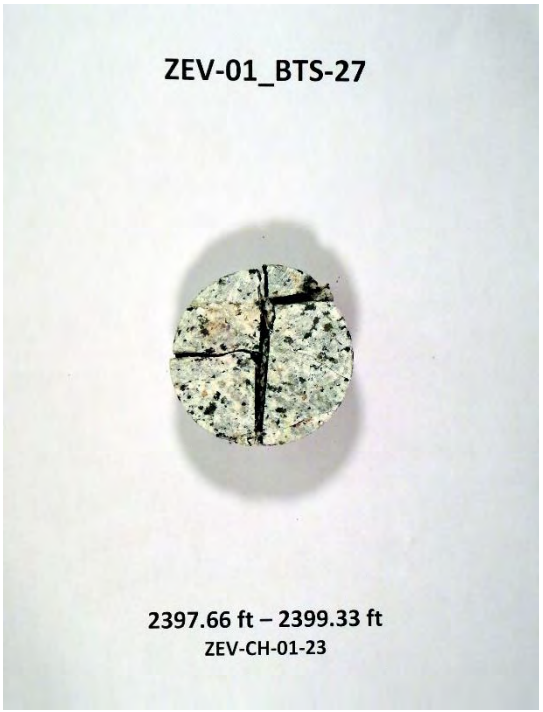


ZEV-01_BTS-24—After



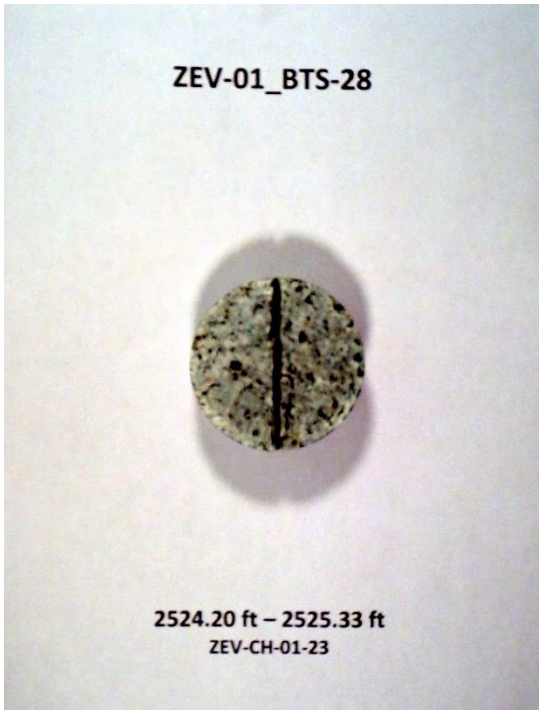
ZEV-01_BTS-25—After

ZEV-01_BTS-26—After

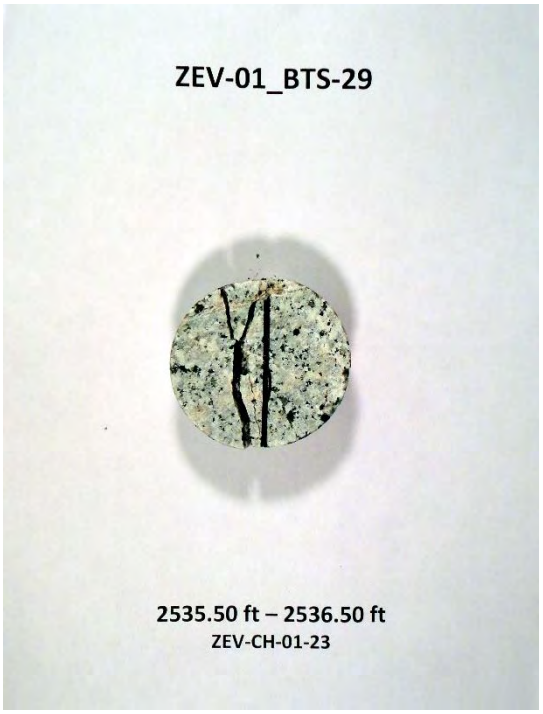


ZEV-01_BTS-27—After

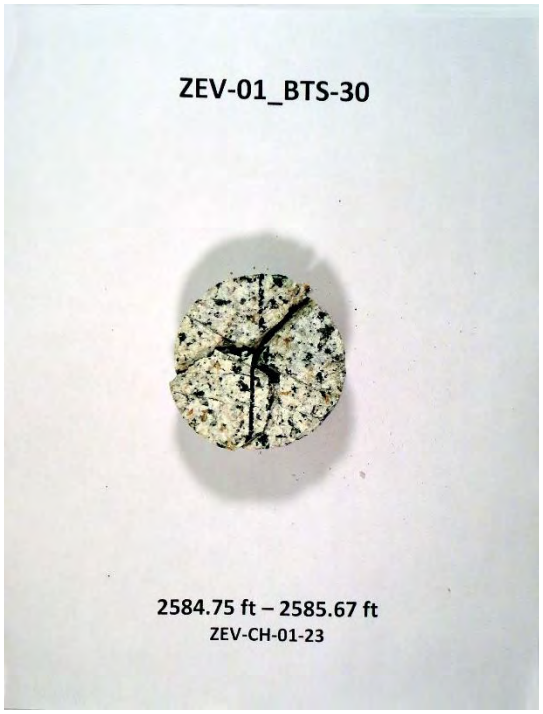
Figure G-1. After Photographs of Brazilian Test Specimens *(continued)*



ZEV-01_BTS-28—After



ZEV-01_BTS-29—After

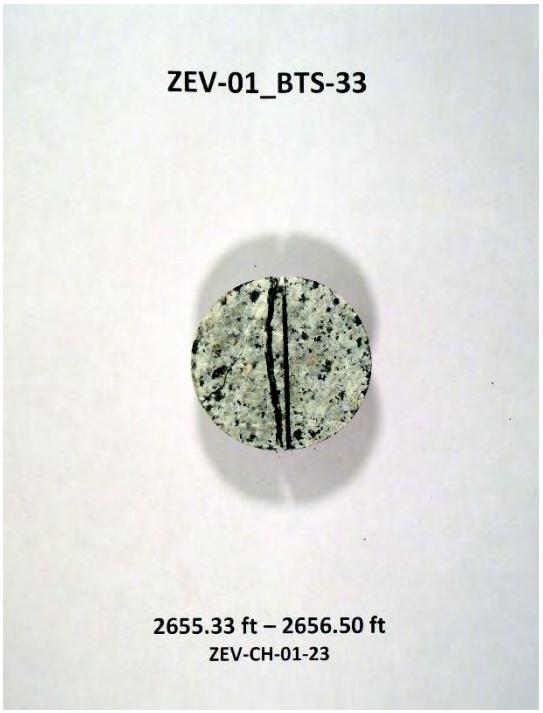


ZEV-01_BTS-30—After

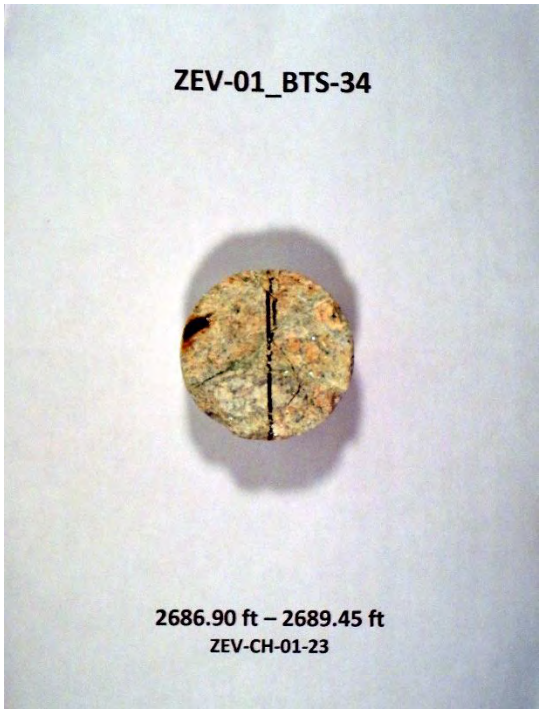
ZEV-01_BTS-31—After

Figure G-1. After Photographs of Brazilian Test Specimens *(continued)*

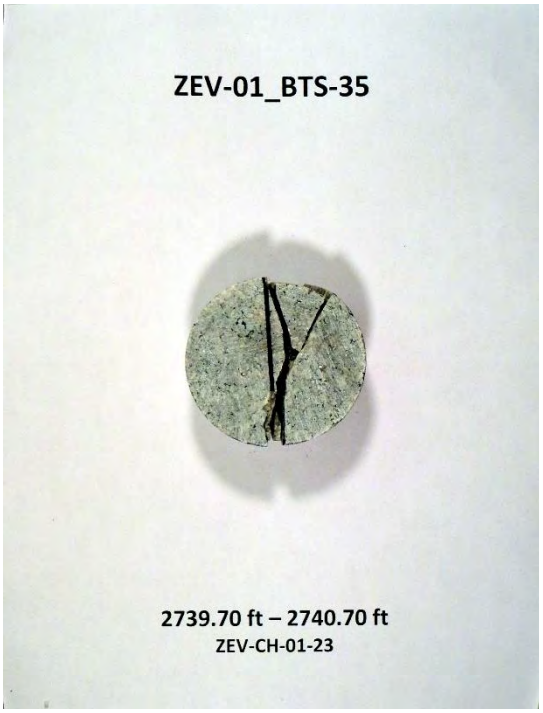
ZEV-01_BTS-32—After



ZEV-01_BTS-33—After



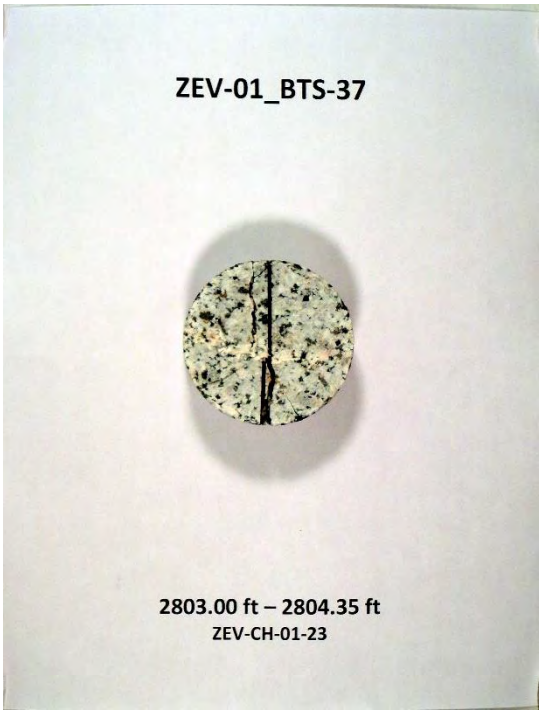
ZEV-01_BTS-34—After



ZEV-01_BTS-35—After

Figure G-1. After Photographs of Brazilian Test Specimens *(continued)*

ZEV-01_BTS-36—After

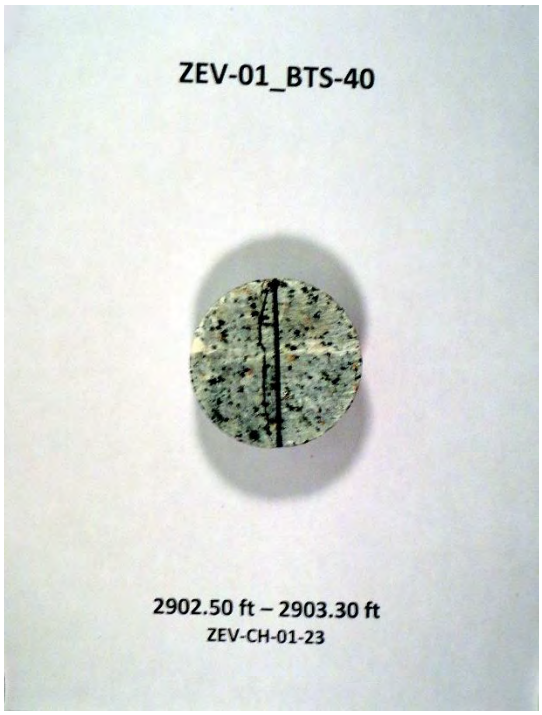


ZEV-01_BTS-37—After

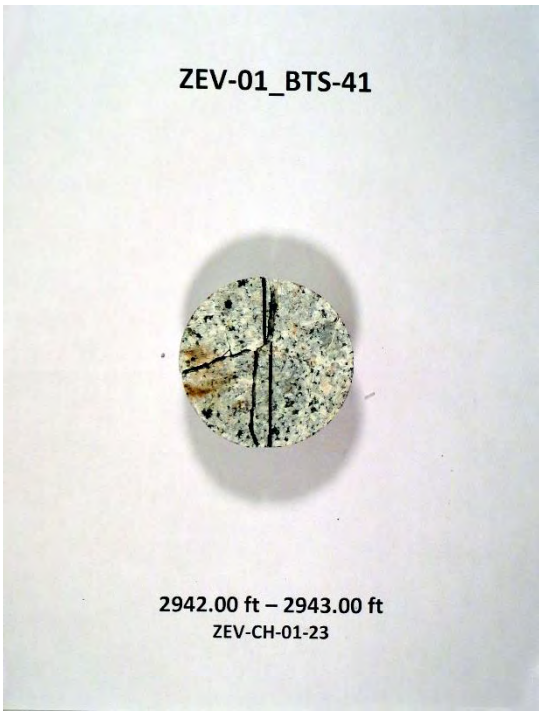
ZEV-01_BTS-38—After

ZEV-01_BTS-39—After

Figure G-1. After Photographs of Brazilian Test Specimens *(continued)*



ZEV-01_BTS-40—After



ZEV-01_BTS-41—After

Figure G-1. After Photographs of Brazilian Test Specimens *(concluded)*

APPENDIX H

POINT LOAD TEST DATASHEET

AGAPITO ASSOCIATES, INC.
2913 Hill Avenue, #B
Grand Junction, CO 81504 USA
970-242-4220

POINT LOAD TESTS

CLIENT	Lane PES	**HOLE NUMBER**	ZEV-CH-01-23
JOB NUMBER	951-20	**MOISTURE CONDITION**	As Received
DATE	May 16, 2023	**TEMPERATURE**	Ambient

Sample No.	Hole ID	Depth From (ft)	Depth To (ft)	Failure Gauge Pressure (psi)	"Failure Load" P (lb)	Test Orientation (A/D)	D (inch)	W (inch)	D_e (inch)	D_e^2 (inch^2)	Uncorrected Point Load Index, I_s (psi)	Size Correction Factor, F	Corrected Point Load Index, $I_{S(50)}$ (psi)	UCS (psi)	Lithology
ZEV-01_PLT-01	ZEV-CH-01-23	2005.00	2005.80	2,606	4,518	A	1.24	2.39	1.94	3.78	1,195	0.99	1,189	24,961	Granite
ZEV-01_PLT-02	ZEV-CH-01-23	2036.00	2037.00	1,664	2,885	A	1.34	2.39	2.02	4.07	708	1.01	716	15,044	Granite
ZEV-01_PLT-03	ZEV-CH-01-23	2062.00	2062.80	2,207	3,826	A	1.34	2.40	2.02	4.09	936	1.01	947	19,895	Granite
ZEV-01_PLT-04	ZEV-CH-01-23	2094.60	2095.90	1,030	1,786	A	1.28	2.40	1.98	3.91	457	1.00	458	9,611	Granite
ZEV-01_PLT-05	ZEV-CH-01-23	2195.80	2196.50	1,578	2,736	A	1.30	2.40	1.99	3.97	689	1.01	693	14,548	Granite
ZEV-01_PLT-06	ZEV-CH-01-23	2238.30	2239.60	1,899	3,292	A	1.32	2.39	2.00	4.02	819	1.01	826	17,344	Granite
ZEV-01_PLT-07	ZEV-CH-01-23	2243.00	2244.00	1,007	1,746	A	1.24	2.39	1.94	3.78	462	0.99	459	9,647	Granite
ZEV-01_PLT-08	ZEV-CH-01-23	2426.00	2427.00	2,885	5,002	A	1.28	2.40	1.98	3.91	1,278	1.00	1,281	26,893	Granite
ZEV-01_PLT-09	ZEV-CH-01-23	2447.33	2448.60	2,801	4,856	A	1.30	2.40	1.99	3.97	1,223	1.01	1,230	25,820	Granite
ZEV-01_PLT-10	ZEV-CH-01-23	2472.80	2473.50	1,484	2,573	A	1.32	1.56	1.62	2.62	982	0.92	899	18,886	Granite
ZEV-01_PLT-11	ZEV-CH-01-23	2978.00	2978.58	1,593	2,762	A	1.26	2.40	1.96	3.84	719	1.00	717	15,063	Granite
ZEV-01_PLT-12	ZEV-CH-01-23	2993.00	2994.00	1,349	2,339	A	1.20	2.40	1.92	3.67	638	0.99	630	13,224	Granite
ZEV-01_PLT-13	ZEV-CH-01-23	3017.25	3017.91	2,587	4,485	A	1.26	2.40	1.96	3.85	1,164	1.00	1,163	24,415	Granite
ZEV-01_PLT-14	ZEV-CH-01-23	1562.4	1563.40	696	1,207	A	0.98	2.40	1.73	3.00	402	0.94	379	7,965	Granite
ZEV-01_PLT-15	ZEV-CH-01-23	1565.50	1566.45	313	543	A	1.26	2.40	1.96	3.85	141	1.00	141	2,958	Granite
ZEV-01_PLT-16	ZEV-CH-01-23	1575.00	1576.30	1,880	3,259	A	0.98	2.40	1.73	3.00	1,086	0.94	1,025	21,528	Granite
ZEV-01_PLT-17	ZEV-CH-01-23	1623.50	1624.90	1,917	3,324	A	1.14	2.40	1.87	3.48	955	0.98	932	19,570	Granite
ZEV-01_PLT-18	ZEV-CH-01-23	1646.00	1646.70	1,263	2,190	A	0.94	2.40	1.70	2.88	759	0.94	710	14,916	Granite
ZEV-01_PLT-19	ZEV-CH-01-23	1647.35	1648.25	1,550	2,687	A	0.96	2.40	1.72	2.95	912	0.94	858	18,009	Granite
ZEV-01_PLT-20	ZEV-CH-01-23	1754.90	1755.50	830	1,439	A	0.98	2.39	1.73	3.00	480	0.94	453	9,508	Granite
ZEV-01_PLT-21	ZEV-CH-01-23	1760.70	1761.60	1,552	2,691	A	1.02	2.39	1.77	3.12	862	0.95	821	17,249	Granite
ZEV-01_PLT-22	ZEV-CH-01-23	1779.60	1781.30	1,117	1,937	A	0.98	2.39	1.73	3.00	646	0.94	610	12,804	Granite
ZEV-01_PLT-23	ZEV-CH-01-23	1831.10	1831.70	1,038	1,800	A	0.98	2.39	1.73	3.00	600	0.94	567	11,898	Granite
ZEV-01_PLT-24	ZEV-CH-01-23	1867.80	1868.30	1,550	2,687	A	0.96	2.39	1.71	2.94	915	0.94	860	18,050	Granite
ZEV-01_PLT-25	ZEV-CH-01-23	1932.30	1932.90	1,936	3,357	A	0.96	2.39	1.71	2.94	1,142	0.94	1,073	22,542	Granite
ZEV-01_PLT-26	ZEV-CH-01-23	1933.00	1933.60	1,025	1,777	A	0.98	2.39	1.73	3.00	592	0.94	559	11,745	Granite
ZEV-01_PLT-27	ZEV-CH-01-23	1937.20	1938.00	2,081	3,608	A	1.00	2.39	1.75	3.06	1,181	0.95	1,119	23,502	Granite
ZEV-01_PLT-28	ZEV-CH-01-23	1961.00	1961.50	180	312	A	0.96	2.40	1.72	2.94	106	0.94	100	2,093	Granite
ZEV-01_PLT-29	ZEV-CH-01-23	1961.50	1962.00	757	1,312	A	1.00	2.39	1.75	3.06	429	0.95	407	8,539	Granite
ZEV-01_PLT-30	ZEV-CH-01-23	2133.00	2133.60	1,762	3,055	A	0.98	2.39	1.73	2.99	1,021	0.94	963	20,226	Granite
ZEV-01_PLT-31	ZEV-CH-01-23	2177.50	2178.00	468	811	A	0.98	2.40	1.73	3.00	270	0.94	255	5,356	Granite
ZEV-01_PLT-32	ZEV-CH-01-23	2244.00	2244.60	2,206	3,825	A	1.20	2.40	1.92	3.67	1,043	0.99	1,030	21,626	Granite
ZEV-01_PLT-33	ZEV-CH-01-23	2265.83	2266.41	664	1,151	A	1.20	2.40	1.92	3.67	313	0.99	310	6,504	Granite
ZEV-01_PLT-34	ZEV-CH-01-23	2312.50	2322.00	235	407	A	1.18	2.39	1.90	3.59	113	0.98	111	2,341	Granite
ZEV-01_PLT-35	ZEV-CH-01-23	2342.75	2343.50	1,635	2,835	A	1.26	2.40	1.96	3.85	736	1.00	735	15,443	Granite
ZEV-01_PLT-36	ZEV-CH-01-23	2367.58	2368.00	1,984	3,440	A	1.16	2.40	1.88	3.55	969	0.98	950	19,955	Granite
ZEV-01_PLT-37	ZEV-CH-01-23	2530.00	2531.00	1,832	3,176	A	1.20	30.50	6.83	46.63	68	1.75	119	2,504	Granite
ZEV-01_PLT-38	ZEV-CH-01-23	2554.00	2554.80	-	-	-	-	-	-	-	-	-	-	-	Granite
ZEV-01_PLT-39	ZEV-CH-01-23	2590.00	2591.00	52	90	A	1.26	2.41	1.96	3.86	23	1.00	23	490	Granite
ZEV-01_PLT-40	ZEV-CH-01-23	2603.00	2603.80	384	666	A	1.22	2.41	1.93	3.74	178	0.99	177	3,711	Granite
ZEV-01_PLT-41	ZEV-CH-01-23	2632.75	2634.33	1,152	1,997	A	1.22	2.40	1.93	3.73	535	0.99	531	11,145	Granite
ZEV-01_PLT-42	ZEV-CH-01-23	2669.67	2670.25	189	328	A	1.16	2.41	1.89	3.56	92	0.98	90	1,896	Granite
ZEV-01_PLT-43	ZEV-CH-01-23	2689.85	2690.65	380	659	A	1.24	2.40	1.95	3.79	174	1.00	173	3,629	Granite
ZEV-01_PLT-44	ZEV-CH-01-23	2722.30	2722.90	2,360	4,092	A	1.30	2.39	1.99	3.96	1,034	1.00	1,039	21,814	Granite
ZEV-01_PLT-45	ZEV-CH-01-23	2763.25	2763.90	1,584	2,746	A	1.18	2.40	1.90	3.60	763	0.98	750	15,751	Granite
ZEV-01_PLT-46	ZEV-CH-01-23	2775.90	2776.10	1,040	1,803	A	1.16	2.40	1.88	3.54	509	0.98	499	10,474	Granite
ZEV-01_PLT-47	ZEV-CH-01-23	2804.35	2805.00	1,524	2,642	A	1.20	2.40	1.91	3.66	721	0.99	712	14,957	Granite
ZEV-01_PLT-48	ZEV-CH-01-23	2844.12	2844.70	1,313	2,276	A	1.26	2.39	1.96	3.84	593	1.00	591	12,421	Granite
ZEV-01_PLT-49	ZEV-CH-01-23	2873.30	2874.00	299	518	A	1.22	2.40	1.93	3.72	139	0.99	138	2,897	Granite
ZEV-01_PLT-50	ZEV-CH-01-23	2910.30	2911.00	482	836	A	1.22	2.38	1.92	3.70	226	0.99	224	4,699	Granite

APPENDIX I

SLAKE DURABILITY TEST DATASHEET

AGAPITO ASSOCIATES, INC.
2913 Hill Avenue, #B
Grand Junction, CO 81504 USA
970-242-4220

SLAKE DURABILITY TESTS

CLIENT	Lane PES	**HOLE NUMBER**	ZEV-CH-01-23
JOB NUMBER	951-20	**MOISTURE CONDITION**	As Received
DATE	May 16, 2023	**OVEN TEMPERATURE**	230 ± 10 °F

SYMBOLS:

A	Weight of drum plus sample at natural moisture content (oz)	**D**	Weight of drum plus oven-dried sample before second cycle (oz)
B	Weight of drum plus oven-dried sample before first cycle (oz)	**W_F**	Weight of drum plus oven-dried sample after second cycle (oz)
C	Weight of drum (oz)		

Specimen No.	Hole ID	Interval		Length of Interval (ft)	A (oz)	B (oz)	C (oz)	D (oz)	Water Temperature Cycle 1		W_F (oz)	Water Temperature Cycle 2		Moisture Content (%)	Slake Durability Index I_d(2)	Retained Materials Description	
		From (ft)	To (ft)						Before (°F)	After (°F)		Before (°F)	After (°F)			Lithology	Type*
ZEV-01_SLK-01	ZEV-CH-01-23	2,009.00	2,010.00	1.00	71.800	71.760	53.410	71.725	61.6	69.0	71.705	71.0	78.0	0.2%	99.7	Granite	I
ZEV-01_SLK-02	ZEV-CH-01-23	2,034.00	2,035.00	1.00	71.720	71.670	53.410	71.645	61.6	69.0	71.620	71.0	78.0	0.3%	99.7	Granite	I
ZEV-01_SLK-03	ZEV-CH-01-23	2,070.00	2,071.00	1.00	70.655	70.595	52.665	70.550	61.6	69.0	70.515	71.0	78.0	0.3%	99.6	Granite	I
ZEV-01_SLK-04	ZEV-CH-01-23	2,102.00	2,102.90	0.90	71.520	71.445	53.655	71.385	68.8	73.0	71.350	78.0	81.9	0.4%	99.5	Granite	I
ZEV-01_SLK-05	ZEV-CH-01-23	2,197.00	2,198.20	1.20	73.750	73.705	54.915	73.665	68.8	73.0	73.635	78.0	81.9	0.2%	99.6	Granite	I
ZEV-01_SLK-06	ZEV-CH-01-23	2,224.50	2,225.50	1.00	72.280	72.245	55.315	72.205	68.8	73.0	72.175	78.0	81.9	0.2%	99.6	Granite	I
ZEV-01_SLK-07	ZEV-CH-01-23	2,247.00	2,248.00	1.00	72.880	72.840	55.400	72.795	71.8	72.0	72.770	81.9	81.9	0.2%	99.6	Granite	I
ZEV-01_SLK-08	ZEV-CH-01-23	2,409.16	2,410.33	1.17	70.980	70.955	53.405	70.870	66.4	72.3	70.840	65.9	73.2	0.1%	99.3	Granite	I
ZEV-01_SLK-09	ZEV-CH-01-23	2,439.00	2,440.96	1.96	70.100	70.085	53.405	70.035	66.4	72.3	70.015	65.9	73.2	0.1%	99.6	Granite	I
ZEV-01_SLK-10	ZEV-CH-01-23	2,448.60	2,450.00	1.40	71.210	71.200	52.665	71.145	66.4	72.3	71.120	65.9	73.2	0.1%	99.6	Granite	I
ZEV-01_SLK-11	ZEV-CH-01-23	2,977.00	2,977.91	0.91	72.275	72.250	53.645	72.190	72.3	73.6	72.130	73.2	74.6	0.1%	99.4	Granite	I
ZEV-01_SLK-12	ZEV-CH-01-23	3,005.50	3,006.50	1.00	72.135	72.110	54.910	72.005	72.3	73.6	71.905	73.2	74.6	0.1%	98.8	Granite	I
ZEV-01_SLK-13	ZEV-CH-01-23	1,979.30	1,980.60	1.30	71.405	71.365	53.755	71.210	82.0	80.0	71.140	59.4	65.5	0.2%	98.7	Granite	I
ZEV-01_SLK-14	ZEV-CH-01-23	1,983.30	1,984.20	0.90	71.440	71.350	53.420	71.200	82.0	80.0	71.070	59.4	65.5	0.5%	98.4	Granite	I
ZEV-01_SLK-15	ZEV-CH-01-23	2,138.50	2,140.00	1.50	70.025	70.000	52.670	69.860	82.0	80.0	69.810	59.4	65.5	0.1%	98.9	Granite	I
ZEV-01_SLK-16	ZEV-CH-01-23	2,174.70	2,175.80	1.10	70.335	70.265	53.655	70.120	80.0	79.4	70.045	64.4	68.9	0.4%	98.7	Granite	I
ZEV-01_SLK-17	ZEV-CH-01-23	2,197.00	2,198.20	1.20	72.605	72.560	54.915	72.400	80.0	79.4	72.345	64.4	68.9	0.3%	98.8	Granite	I
ZEV-01_SLK-18	ZEV-CH-01-23	2,224.50	2,225.50	1.00	72.790	72.745	55.325	72.610	80.0	79.4	72.565	64.4	68.9	0.3%	99.0	Granite	I
ZEV-01_SLK-19	ZEV-CH-01-23	2,247.00	2,248.00	1.00	73.545	73.495	55.405	73.265	79.4	77.4	73.160	67.4	71.6	0.3%	98.1	Granite	I
ZEV-01_SLK-20	ZEV-CH-01-23	2,275.25	2,276.25	1.00	70.235	70.175	52.825	70.000	79.4	77.4	69.870	67.4	71.6	0.3%	98.2	Granite	I
ZEV-01_SLK-21	ZEV-CH-01-23	2,319.25	2,320.33	1.08	68.900	68.885	52.975	68.035	79.4	77.4	67.615	67.4	71.6	0.1%	92.0	Granite	II
ZEV-01_SLK-22	ZEV-CH-01-23	2,350.50	2,351.66	1.16	71.400	71.345	53.415	71.240	67.5	70.2	71.195	67.8	71.0	0.3%	99.2	Granite	I
ZEV-01_SLK-23	ZEV-CH-01-23	2,360.08	2,360.75	0.67	70.190	70.135	53.405	70.035	67.5	70.2	69.990	67.8	71.0	0.3%	99.1	Granite	I
ZEV-01_SLK-24	ZEV-CH-01-23	2,514.67	2,516.00	1.33	70.515	70.375	52.690	70.265	67.5	70.2	70.215	67.8	71.0	0.8%	99.1	Granite	I
ZEV-01_SLK-25	ZEV-CH-01-23	2,560.00	2,561.00	1.00	71.685	71.525	53.650	69.030	68.5	69.8	68.040	68.1	70.6	0.9%	80.5	Granite	II
ZEV-01_SLK-26	ZEV-CH-01-23	2,567.33	2,568.00	0.67	73.180	73.125	54.920	72.790	68.5	69.8	72.720	68.1	70.6	0.3%	97.8	Granite	I
ZEV-01_SLK-27	ZEV-CH-01-23	2,635.25	2,636.50	1.25	74.045	73.930	55.320	73.820	68.5	69.8	73.775	68.1	70.6	0.6%	99.2	Granite	I
ZEV-01_SLK-28	ZEV-CH-01-23	2,666.00	2,667.00	1.00	72.895	72.855	55.415	72.680	79.0	76.0	72.610	70.2	71.1	0.2%	98.6	Granite	I
ZEV-01_SLK-29	ZEV-CH-01-23	2,682.00	2,683.70	1.70	70.070	70.000	52.820	69.365	79.0	76.0	69.110	70.2	71.1	0.4%	94.8	Granite	I
ZEV-01_SLK-30	ZEV-CH-01-23	2,737.00	2,739.00	2.00	71.760	71.735	53.000	71.570	79.0	76.0	71.500	70.2	71.1	0.1%	98.7	Granite	I
ZEV-01_SLK-31	ZEV-CH-01-23	2,772.40	2,773.00	0.60	71.140	71.090	53.415	71.030	71.0	74.3	71.000	69.8	73.8	0.3%	99.5	Granite	I
ZEV-01_SLK-32	ZEV-CH-01-23	2,825.20	2,825.80	0.60	71.205	71.145	53.415	70.965	71.0	74.3	70.900	69.8	73.8	0.3%	98.6	Granite	I
ZEV-01_SLK-33	ZEV-CH-01-23	2,891.45	2,892.00	0.55	68.770	68.630	52.670	67.145	71.0	74.3	66.040	69.8	73.8	0.9%	83.8	Granite	II
ZEV-01_SLK-34	ZEV-CH-01-23	2,903.30	2,903.70	0.40	69.945	69.905	53.665	69.730	73.7	74.8	69.630	73.6	74.4	0.2%	98.3	Granite	I
ZEV-01_SLK-35	ZEV-CH-01-23	2,935.70	2,938.50	2.80	72.110	72.020	54.925	71.340	73.7	74.8	70.680	73.6	74.4	0.5%	92.2	Granite	II

* Type I = Retained pieces remained virtually unchanged
II = Retained materials consist of large and small pieces
III = Retained materials is exclusively small fragments

APPENDIX J

BEFORE AND AFTER PHOTOGRAPHS OF SLAKE DURABILITY TEST SPECIMENS

SLK-01—Before

SLK-01—After

SLK-02—Before

SLK-02—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens

SLK-03—Before

SLK-03—After

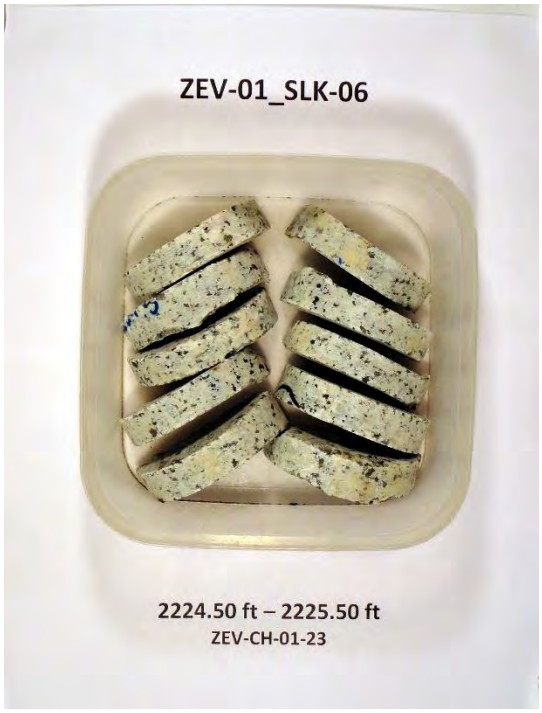
SLK-04—Before

SLK-04—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

SLK-05—Before

SLK-05—After



SLK-06—Before

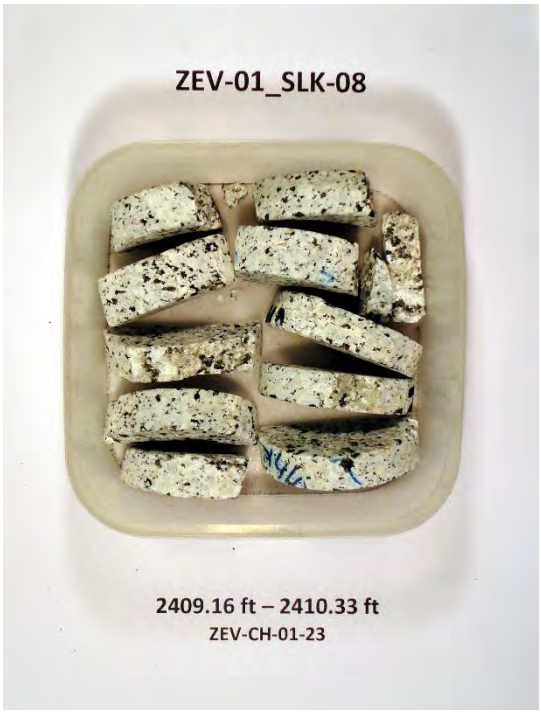
SLK-06—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

SLK-07—Before

SLK-07—After

SLK-08—Before



SLK-08—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

SLK-09—Before

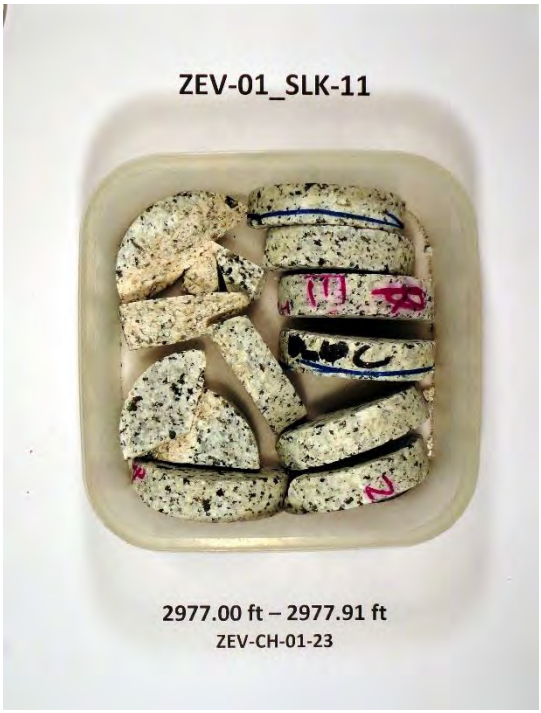
SLK-09—After

SLK-10—Before

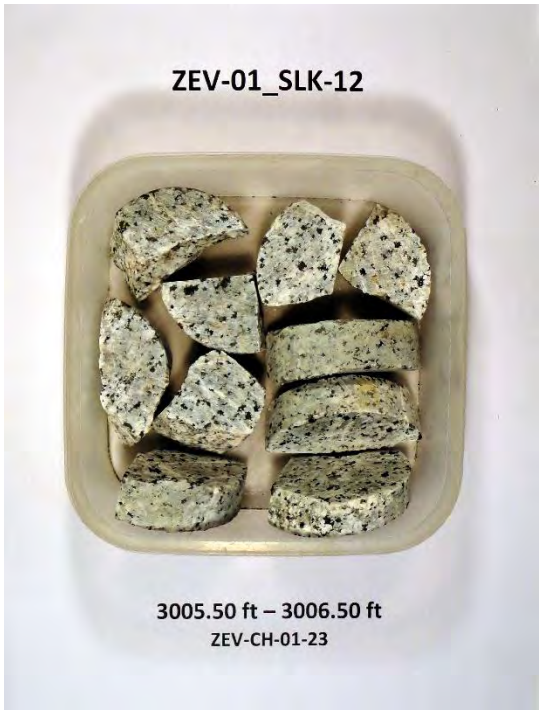
SLK-10—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

SLK-11—Before



SLK-11—After



SLK-12—Before

SLK-12—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-01_SLK-13—Before

ZEV-01_SLK-13—After

ZEV-01_SLK-14—Before

ZEV-01_SLK-14—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-01_SLK-15—Before

ZEV-01_SLK-15—After

ZEV-01_SLK-16—Before

ZEV-01_SLK-16—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-01_SLK-17—Before

ZEV-01_SLK-17—After

ZEV-01_SLK-18—Before

ZEV-01_SLK-18—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-01_SLK-19—Before

ZEV-01_SLK-19—After

ZEV-01_SLK-20—Before

ZEV-01_SLK-20—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-01_SLK-21—Before

ZEV-01_SLK-21—After

ZEV-01_SLK-22—Before

ZEV-01_SLK-22—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-01_SLK-23—Before

ZEV-01_SLK-23—After

ZEV-01_SLK-24—Before

ZEV-01_SLK-24—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-01_SLK-25—Before

ZEV-01_SLK-25—After

ZEV-01_SLK-26—Before

ZEV-01_SLK-26—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-01_SLK-27—Before

ZEV-01_SLK-27—After

ZEV-01_SLK-28—Before

ZEV-01_SLK-28—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-01_SLK-29—Before

ZEV-01_SLK-29—After

ZEV-01_SLK-30—Before

ZEV-01_SLK-30—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-01_SLK-31—Before

ZEV-01_SLK-31—After

ZEV-01_SLK-32—Before

ZEV-01_SLK-32—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-01_SLK-33—Before

ZEV-01_SLK-33—After

ZEV-01_SLK-34—Before

ZEV-01_SLK-34—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-01_SLK-35—Before

ZEV-01_SLK-35—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(concluded)*

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ROCK MECHANICS TESTING RESULTS FOR BOREHOLE ZEV-CH-03-23

Prepared for

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December 11, 2023

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ROCK MECHANICS TESTING RESULTS FOR BOREHOLE ZEV-CH-03-23

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1.0 INTRODUCTION

Lane Power and Energy Solutions, Inc. (Lane) commissioned Agapito Associates, Inc. (Agapito) to complete a rock mechanics laboratory study to determine the mechanical properties of rock samples from core hole ZEV-CH-03-23, originating from the Zevzar site near Rosamond, California. Shipments of core were delivered to Agapito's Grand Junction, Colorado laboratory from September 2023 to October 2023. This laboratory report provides results of the rock mechanics core testing performed by Agapito on behalf of Lane.

2.0 LABORATORY PROCEDURES

Prior to testing, specimens were prepared according to ASTM International (ASTM) standard D4543-08.[1] The following test types were performed by Agapito according to ASTM standards where applicable:

- Uniaxial (unconfined) Compressive Strength (UCS) test: D7012-13[2]
- Triaxial compression test: D7012-13[3]
- Splitting tensile strength test (Brazilian): D3967-08[4]
- Point Load Strength (Point Load) test: D5731-08[5]
- Slake Durability test: D4644-08[6]

3.0 TEST RESULTS

The laboratory results for the UCS tests are summarized in Table 1. Triaxial Compression test results are summarized in Table 2. Brazilian test results are presented in Table 3. Point Load results are presented in Table 4 and Slake Durability test results are presented in Table 5. Point Load testing has been shown to provide an approximation of compressive strength, and using a conversion factor of 21.0 to convert the Corrected Point Load Index ($I_{S(50)}$) into approximate UCS provides the best approximation over a variety of rock types.[7]

Elastic properties are normally calculated from sample data collected between 0% and 55% of the ultimate strength of a sample, where most competent rock experiences its most-linear zone of elastic deformation. For some samples the zone of elastic deformation occurred at lower than

[1] ASTM, "Standard Practice for Preparing Rock Core as Cylindrical Test Specimens and Verifying Conformance to Dimensional Shape Tolerances," Designation D4543-08.
[2] ASTM, "Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperature," Designation D7012-13 (Methods C and D).
[3] ASTM, "Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperature," Designation D7012-13 (Methods A and B).
[4] American Society for Testing and Materials (ASTM), "Standard Test Method for Splitting Tensile Strength of Intact Rock Core Specimens," Designation D3967-08.
[5] ASTM, "Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classification," Designation D5731-08.
[6] ASTM, "Standard Test Method for Slake Durability of Shales and Similar Weak Rocks," Designation D4644-08.
[7] Rusnak, J. and Mark, C. (2000), "Using the Point Load Test to Determination the Uniaxial Compressive Strength of Coal Measure Rock," *19th Ground Control Conference in Mining*, West Virginia University, pp. 362–371.

expected of percentages of ultimate strength. Some samples did not enter elastic deformation for a sufficient period to collect elastic properties. Elastic properties, therefore, were calculated individually based on data from zones of elastic deformation present for each specimen rather than the standard 0–55% of ultimate strength. Table 6 provides a summary of samples whose elastic properties were calculated using nonstandard data ranges.

The datasheet for the UCS tests with failure mode descriptions is presented in Appendix A. Stress-strain plots for UCS tests are in Appendix B. The before and after photographs of UCS test specimens are displayed in Appendix C. The datasheet for the Triaxial Compression tests with failure mode descriptions is presented in Appendix D, and the before and after photographs of Triaxial Compression test specimens are presented in Appendix E. The Brazilian test datasheet is presented in Appendix F, and after photographs of the Brazilian test specimens are presented in Appendix G. The Point Load test datasheet is presented in Appendix H. The Slake Durability test datasheet is presented in Appendix I, and the before and after photographs of the Slake Durability test specimens are presented in Appendix J.

Table 1. Uniaxial Compressive Strength Test Results

Specimen No.	Hole ID	Depth From (ft)	Depth To (ft)	Rock Type	Weight (oz)	Average Diameter (inch)	Axial Length (inch)	Density (pcf)	Failure Load (lb)	UCS (psi)	Young's Modulus† ($\times 10^6$ psi)	Poisson's Ratio†	Young's Modulus‡ ($\times 10^6$ psi)	Poisson's Ratio‡
ZEV-03_UCS-01	ZEV-CH-03-23	1588.91	1589.75	Granite	37.22	2.38	5.36	169	111,045	24,992	10.75	0.32	11.06	0.15
ZEV-03_UCS-02	ZEV-CH-03-23	1632.00	1633.00	Granite	37.04	2.37	5.38	168	67,255	15,188	9.28	0.19	8.39	0.07
ZEV-03_UCS-03	ZEV-CH-03-23	1721.41	1722.00	Granite	36.72	2.37	5.41	167	65,970	15,017	9.12	0.20	9.05	0.07
ZEV-03_UCS-04	ZEV-CH-03-23	1832.66	1833.41	Granite	38.12	2.39	5.49	167	66,370	14,797	8.76	0.22	8.06	0.07
ZEV-03_UCS-05	ZEV-CH-03-23	1909.70	1910.50	Granite	36.07	2.36	5.33	168	34,525	7,909	6.88	0.33	6.67	0.15
ZEV-03_UCS-06	ZEV-CH-03-23	2019.20	2019.90	Granite	36.93	2.39	5.35	166	91,715	20,362	10.70	0.27	10.64	0.11
ZEV-03_UCS-07	ZEV-CH-03-23	2076.00	2077.00	Granite	36.84	2.40	5.26	168	29,960	6,646	8.31	0.38	8.03	0.09
ZEV-03_UCS-08	ZEV-CH-03-23	2103.00	2104.00	Granite	40.08	2.40	5.72	167	6,675	1,475	1.24	-	1.22	-
ZEV-03_UCS-09	ZEV-CH-03-23	2112.00	2113.00	Granite	38.01	2.39	5.41	168	88,020	19,550	10.04	0.30	9.77	0.17
ZEV-03_UCS-10	ZEV-CH-03-23	2190.00	2191.00	Granite	35.97	2.40	5.38	160	16,180	3,583	1.83	0.29	1.63	0.13
ZEV-03_UCS-11	ZEV-CH-03-23	2212.40	2213.50	Granite	38.51	2.37	5.58	168	71,900	16,257	9.40	-	8.62	-
ZEV-03_UCS-12	ZEV-CH-03-23	2224.00	2224.65	Granite	37.38	2.40	5.38	166	83,850	18,589	11.43	0.19	11.53	0.09
ZEV-03_UCS-13	ZEV-CH-03-23	2254.20	2255.50	Granite	38.27	2.40	5.41	169	72,725	16,103	9.35	0.17	8.59	0.11
ZEV-03_UCS-14	ZEV-CH-03-23	2279.00	2280.00	Granite	38.06	2.40	5.40	169	87,880	19,470	10.47	0.17	9.86	0.07
ZEV-03_UCS-15	ZEV-CH-03-23	2308.20	2309.40	Granite	38.46	2.39	5.46	169	67,690	15,069	9.78	0.20	9.20	0.10
ZEV-03_UCS-16	ZEV-CH-03-23	2321.00	2322.00	Granite	38.00	2.39	5.39	170	114,705	25,541	11.10	0.23	9.96	0.11
ZEV-03_UCS-17	ZEV-CH-03-23	2352.50	2354.00	Granite	38.34	2.39	5.46	169	81,550	18,181	10.66	0.18	10.73	0.08
ZEV-03_UCS-18	ZEV-CH-03-23	2384.50	2386.00	Granite	38.46	2.39	5.46	169	80,690	17,945	9.84	0.24	8.76	0.08
ZEV-03_UCS-19	ZEV-CH-03-23	2412.40	2414.00	Granite	38.73	2.39	5.52	168	70,480	15,661	9.72	0.25	9.03	0.08
ZEV-03_UCS-20	ZEV-CH-03-23	2444.00	2445.50	Granite	37.27	2.39	5.32	169	62,820	14,006	10.25	0.19	8.28	0.07
ZEV-03_UCS-21	ZEV-CH-03-23	2461.00	2462.00	Granite	35.33	2.39	5.10	167	32,140	7,179	-	-	-	-
ZEV-03_UCS-22	ZEV-CH-03-23	2527.33	2528.00	Granite	37.87	2.39	5.46	167	41,340	9,224	6.74	-	6.43	-
ZEV-03_UCS-23	ZEV-CH-03-23	2576.00	2576.91	Granite	38.24	2.40	5.41	169	87,240	19,333	10.91	0.24	10.82	0.13
ZEV-03_UCS-24	ZEV-CH-03-23	2603.50	2604.00	Granite	38.24	2.41	5.52	165	15,875	3,493	1.99	-	1.32	-
ZEV-03_UCS-25	ZEV-CH-03-23	2648.00	2648.66	Granite	37.57	2.40	5.34	168	102,825	22,748	9.97	0.29	8.72	0.14
ZEV-03_UCS-26	ZEV-CH-03-23	2677.58	2678.41	Granite	37.18	2.38	5.36	169	98,115	22,096	10.27	0.33	9.87	0.16
ZEV-03_UCS-27	ZEV-CH-03-23	2701.00	2701.50	Granite	35.48	2.38	5.84	148	4,510	1,014	0.26	0.32	0.21	0.12
ZEV-03_UCS-28	ZEV-CH-03-23	2724.75	2725.16	Granite	35.98	2.37	5.18	170	29,740	6,744	7.45	0.18	8.24	0.08
ZEV-03_UCS-29	ZEV-CH-03-23	2740.00	2740.50	Granite	37.10	2.40	5.28	168	37,520	8,318	6.05	-	6.10	-
ZEV-03_UCS-30	ZEV-CH-03-23	2876.16	2876.91	Granite	38.49	2.40	5.85	157	6,100	1,345	0.33	-	0.20	-
ZEV-03_UCS-31	ZEV-CH-03-23	2879.00	2880.00	Granite	38.56	2.40	5.89	157	6,430	1,426	0.51	-	0.32	-
ZEV-03-UCS-32	ZEV-CH-03-23	2943.00	2943.50	Granite	37.33	2.39	5.36	167	42,175	9,375	6.43	-	4.53	-
ZEV-03_UCS-33	ZEV-CH-03-23	2983.66	2984.16	Granite	37.01	2.40	5.36	164	71,520	15,773	10.09	-	8.03	-

†Tangent calculation method.
‡Secant calculation method.

Table 2. Triaxial Compression Test Results

Specimen No.	Hole ID	Depth From (ft)	Depth To (ft)	Lithology	Weight (oz)	Average Diameter (inch)	Axial Length (inch)	Density (pcf)	Failure Load (lbs)	Confining Pressure (psi)	Corrected Failure Stress (psi)	Triaxial Compressive Strength (psi)
ZEV-03_TRI-01	ZEV-CH-03-23	1,898.70	1,899.70	Granite	36.9	2.38	5.35	168	120,410	1,500	27,500	26,000
ZEV-03_TRI-02	ZEV-CH-03-23	1,901.20	1,902.00	Granite	36.3	2.38	5.24	169	202,450	2,500	46,214	43,714
ZEV-03_TRI-03	ZEV-CH-03-23	1,902.00	1,902.80	Granite	34.9	2.37	5.04	169	153,620	1,500	35,025	33,525
ZEV-03_TRI-04	ZEV-CH-03-23	2,246.00	2,247.70	Granite	36.1	2.36	5.33	164	227,815	2,500	52,732	50,232
ZEV-03_TRI-05	ZEV-CH-03-23	2,246.00	2,247.70	Granite	34.9	2.40	5.08	164	213,135	1,500	47,575	46,075
ZEV-03_TRI-06	ZEV-CH-03-23	2,246.00	2,247.70	Granite	36.1	2.40	5.24	165	269,100	2,500	60,263	57,763
ZEV-03_TRI-07	ZEV-CH-03-23	2,468.70	2,470.00	Granite	34.1	2.39	4.97	165	135,535	1,500	30,592	29,092
ZEV-03_TRI-08	ZEV-CH-03-23	2,468.70	2,470.00	Granite	34.6	2.39	4.99	167	167,430	2,500	37,908	35,408
ZEV-03_TRI-09	ZEV-CH-03-23	2,468.70	2,470.00	Granite	33.9	2.39	5.00	164	144,955	1,500	32,741	31,241
ZEV-03_TRI-10	ZEV-CH-03-23	2,689.00	2,689.75	Granite	37.9	2.39	5.39	169	170,725	2,500	38,687	36,187
ZEV-03_TRI-11	ZEV-CH-03-23	2,684.00	2,685.00	Granite	37.3	2.39	5.38	167	133,270	1,500	30,117	28,617
ZEV-03_TRI-12	ZEV-CH-03-23	2,694.75	2,695.25	Granite	38.1	2.39	5.44	168	133,840	2,500	30,422	27,922
ZEV-03_TRI-13	ZEV-CH-03-23	2,722.50	2,723.00	Granite	41.1	2.41	5.82	167	-	-	-	-
ZEV-03_TRI-14	ZEV-CH-03-23	2,723.33	2,724.16	Granite	37.1	2.40	5.29	168	77,475	2,500	17,746	15,246
ZEV-03_TRI-15	ZEV-CH-03-23	2,723.33	2,724.16	Granite	36.6	2.40	5.19	169	109,320	1,500	24,551	23,051
ZEV-03_TRI-16	ZEV-CH-03-23	2,777.66	2,778.33	Granite	33.4	2.40	5.19	153	12,370	2,500	3,344	844

Table 3. Indirect Tensile Strength (Brazilian) Test Results

Specimen No.	Hole ID	Depth		Rock Type	Weight (oz)	Average Diameter (inch)	Axial Length (inch)	Density (pcf)	Failure Load (lb)	Splitting Tensile Strength (psi)
		From (ft)	To (ft)							
ZEV-03_BTS-01	ZEV-CH-03-23	1561.50	1562.50	Granite	9.09	2.39	1.33	165	6,815	1,366
ZEV-03_BTS-02	ZEV-CH-03-23	1633.08	1634.41	Granite	9.06	2.37	1.32	167	6,602	1,338
ZEV-03_BTS-03	ZEV-CH-03-23	1722.08	1723.16	Granite	8.81	2.36	1.33	164	4,563	927
ZEV-03_BTS-04	ZEV-CH-03-23	1878.70	1879.60	Granite	9.11	2.38	1.35	164	1,935	384
ZEV-03_BTS-05	ZEV-CH-03-23	1913.80	1914.60	Granite	8.94	2.37	1.31	168	5,655	1,163
ZEV-03_BTS-06	ZEV-CH-03-23	2019.90	2020.40	Granite	8.46	2.40	1.21	168	4,677	1,028
ZEV-03_BTS-07	ZEV-CH-03-23	2074.60	2076.00	Granite	8.92	2.40	1.28	166	5,449	1,127
ZEV-03_BTS-08	ZEV-CH-03-23	2092.70	2093.80	Granite	9.38	2.40	1.34	168	5,651	1,122
ZEV-03_BTS-09	ZEV-CH-03-23	2111.40	2112.00	Granite	8.32	2.40	1.19	167	5,653	1,258
ZEV-03_BTS-10	ZEV-CH-03-23	2175.20	2176.00	Granite	8.89	2.40	1.28	166	2,894	600
ZEV-03_BTS-11	ZEV-CH-03-23	2193.50	2195.00	Granite	8.63	2.40	1.27	162	2,292	478
ZEV-03_BTS-12	ZEV-CH-03-23	2218.00	2219.00	Granite	8.55	2.39	1.25	164	6,432	1,370
ZEV-03_BTS-13	ZEV-CH-03-23	2254.20	2255.50	Granite	8.79	2.39	1.28	165	5,632	1,172
ZEV-03_BTS-14	ZEV-CH-03-23	2276.40	2277.00	Granite	8.73	2.40	1.25	167	3,843	816
ZEV-03_BTS-15	ZEV-CH-03-23	2306.60	2308.20	Granite	7.86	2.39	1.15	165	5,999	1,393
ZEV-03_BTS-16	ZEV-CH-03-23	2321.00	2322.00	Granite	8.54	2.39	1.22	168	5,475	1,194
ZEV-03_BTS-17	ZEV-CH-03-23	2352.50	2354.00	Granite	8.99	2.39	1.30	167	6,151	1,265
ZEV-03_BTS-18	ZEV-CH-03-23	2384.50	2386.00	Granite	9.10	2.39	1.30	168	7,440	1,521
ZEV-03_BTS-19	ZEV-CH-03-23	2412.40	2414.00	Granite	8.10	2.39	1.17	166	2,157	491
ZEV-03_BTS-20	ZEV-CH-03-23	2438.40	2440.60	Granite	8.82	2.38	1.30	164	6,288	1,293
ZEV-03_BTS-21	ZEV-CH-03-23	2482.83	2483.25	Granite	9.20	2.39	1.35	164	-	-
ZEV-03_BTS-22	ZEV-CH-03-23	2526.83	2527.25	Granite	8.99	2.39	1.30	166	5,114	1,047
ZEV-03_BTS-23	ZEV-CH-03-23	2559.83	2560.00	Granite	9.64	2.40	1.38	167	8,503	1,640
ZEV-03_BTS-24	ZEV-CH-03-23	2578.83	2579.58	Granite	9.19	2.40	1.31	168	6,083	1,232
ZEV-03_BTS-25	ZEV-CH-03-23	2654.00	2654.50	Granite	8.91	2.39	1.28	167	7,396	1,535
ZEV-03_BTS-26	ZEV-CH-03-23	2677.58	2678.41	Granite	8.80	2.38	1.30	165	6,800	1,405
ZEV-03_BTS-27	ZEV-CH-03-23	2707.00	2707.50	Granite	8.52	2.38	1.26	164	6,987	1,481
ZEV-03_BTS-28	ZEV-CH-03-23	2740.00	2740.50	Granite	8.96	2.40	1.30	165	5,150	1,053
ZEV-03_BTS-29	ZEV-CH-03-23	2759.91	2760.33	Granite	8.82	2.40	1.29	163	2,639	542
ZEV-03_BTS-30	ZEV-CH-03-23	2939.58	2940.00	Granite	8.63	2.38	1.26	165	3,887	822
ZEV-03_BTS-31	ZEV-CH-03-23	2946.50	2947.00	Granite	9.39	2.40	1.35	167	7,537	1,485

Table 4. Point Load Test Results

Specimen No.	Hole ID	From (ft)	To (ft)	Lithology	"Failure Load" P (lb)	Test Orientation (A/D)	Corrected Point Load Index, $I_{S(50)}$ (psi)	Estimated UCS (psi)
ZEV-03_PLT-01	ZEV-CH-03-23	1,539.25	1,540.50	Granite	340	A	104	2,175
ZEV-03_PLT-02	ZEV-CH-03-23	1,576.00	1,577.00	Granite	4,463	A	1,288	27,051
ZEV-03_PLT-03	ZEV-CH-03-23	1,598.75	1,599.66	Granite	3,043	A	824	17,300
ZEV-03_PLT-04	ZEV-CH-03-23	1,616.33	1,617.00	Granite	4,170	A	1,140	23,946
ZEV-03_PLT-05	ZEV-CH-03-23	1,617.08	1,618.00	Granite	3,946	A	1,093	22,956
ZEV-03_PLT-06	ZEV-CH-03-23	1,618.18	1,619.00	Granite	1,808	A	488	10,256
ZEV-03_PLT-07	ZEV-CH-03-23	1,701.25	1,701.75	Granite	4,657	A	1,282	26,928
ZEV-03_PLT-08	ZEV-CH-03-23	1,701.83	1,702.33	Granite	2,502	A	717	15,056
ZEV-03_PLT-09	ZEV-CH-03-23	1,778.16	1,779.00	Granite	3,251	A	900	18,906
ZEV-03_PLT-10	ZEV-CH-03-23	1,851.00	1,851.70	Granite	1,602	A	438	9,194
ZEV-03_PLT-11	ZEV-CH-03-23	1,869.30	1,869.70	Granite	3,344	A	914	19,201
ZEV-03_PLT-12	ZEV-CH-03-23	1,869.70	1,870.10	Granite	3,261	A	880	18,484
ZEV-03_PLT-13	ZEV-CH-03-23	1,921.60	1,922.00	Granite	3,979	A	1,123	23,586
ZEV-03_PLT-14	ZEV-CH-03-23	1,922.00	1,922.40	Granite	5,238	A	1,459	30,638
ZEV-03_PLT-15	ZEV-CH-03-23	1,922.40	1,922.80	Granite	4,451	A	1,179	24,755
ZEV-03_PLT-16	ZEV-CH-03-23	2,020.40	2,021.00	Granite	3,835	A	1,034	21,717
ZEV-03_PLT-17	ZEV-CH-03-23	2,077.00	2,077.60	Granite	3,797	A	1,050	22,056
ZEV-03_PLT-18	ZEV-CH-03-23	2,105.50	2,106.00	Granite	2,306	A	621	13,041
ZEV-03_PLT-19	ZEV-CH-03-23	2,111.40	2,112.00	Granite	3,168	A	912	19,145
ZEV-03_PLT-20	ZEV-CH-03-23	2,175.20	2,176.00	Granite	1,278	A	349	7,322
ZEV-03_PLT-21	ZEV-CH-03-23	2,196.00	2,196.60	Granite	688	A	190	3,999
ZEV-03_PLT-22	ZEV-CH-03-23	2,218.00	2,219.00	Granite	3,976	A	1,086	22,816
ZEV-03_PLT-23	ZEV-CH-03-23	2,237.00	2,237.70	Granite	5,203	A	1,385	29,088
ZEV-03_PLT-24	ZEV-CH-03-23	2,254.20	2,255.50	Granite	2,866	A	773	16,231
ZEV-03_PLT-25	ZEV-CH-03-23	2,271.60	2,272.65	Granite	1,094	A	299	6,275
ZEV-03_PLT-26	ZEV-CH-03-23	2,306.60	2,308.20	Granite	2,474	A	695	14,585
ZEV-03_PLT-27	ZEV-CH-03-23	2,321.00	2,322.00	Granite	3,974	A	1,116	23,433
ZEV-03_PLT-28	ZEV-CH-03-23	2,352.50	2,354.00	Granite	3,707	A	1,014	21,295
ZEV-03_PLT-29	ZEV-CH-03-23	2,389.20	2,390.00	Granite	4,371	A	1,180	24,770
ZEV-03_PLT-30	ZEV-CH-03-23	2,417.00	2,418.50	Granite	3,674	A	1,013	21,271
ZEV-03_PLT-31	ZEV-CH-03-23	2,451.60	2,453.00	Granite	614	A	161	3,391
ZEV-03_PLT-32	ZEV-CH-03-23	2,478.00	2,478.40	Granite	4,633	A	1,220	25,618
ZEV-03_PLT-33	ZEV-CH-03-23	2,533.41	2,533.83	Granite	1,160	A	301	6,323
ZEV-03_PLT-34	ZEV-CH-03-23	2,577.83	2,578.33	Granite	5,233	A	1,342	28,174
ZEV-03_PLT-35	ZEV-CH-03-23	2,602.75	2,603.33	Granite	815	A	214	4,488
ZEV-03_PLT-36	ZEV-CH-03-23	2,631.83	2,632.33	Granite	1,637	A	441	9,261
ZEV-03_PLT-37	ZEV-CH-03-23	2,654.66	2,655.25	Granite	3,424	A	913	19,171
ZEV-03_PLT-38	ZEV-CH-03-23	2,684.00	2,685.00	Granite	2,422	A	655	13,760
ZEV-03_PLT-39	ZEV-CH-03-23	2,721.16	2,721.66	Granite	4,175	A	1,170	24,567
ZEV-03_PLT-40	ZEV-CH-03-23	2,751.75	2,752.25	Granite	295	A	75	1,569
ZEV-03_PLT-41	ZEV-CH-03-23	2,835.58	2,836.00	Granite	3,979	A	1,033	21,688
ZEV-03_PLT-42	ZEV-CH-03-23	2,853.00	2,853.58	Granite	3,154	A	828	17,398
ZEV-03_PLT-43	ZEV-CH-03-23	2,879.00	2,880.00	Granite	144	A	35	740
ZEV-03_PLT-44	ZEV-CH-03-23	2,939.58	2,940.00	Granite	2,115	A	565	11,870
ZEV-03_PLT-45	ZEV-CH-03-23	2,949.25	2,949.50	Granite	1,144	A	308	6,475

Table 5. Slake Durability Test Results

Specimen ID	Hole ID	Sample Depth		Lithology	Slake Durability		
		From (ft)	To (ft)		Moisture Content (%)	Index, I_d (2)	Retained Material Description (Type) *
ZEV-03_SLK-01	ZEV-CH-03-23	1897.70	1898.70	Granite	0.3%	99.7	I
ZEV-03_SLK-02	ZEV-CH-03-23	2021.70	2023.10	Granite	0.3%	99.7	I
ZEV-03_SLK-03	ZEV-CH-03-23	2074.60	2076.00	Granite	0.2%	99.6	I
ZEV-03_SLK-04	ZEV-CH-03-23	2092.70	2093.80	Granite	0.3%	99.5	I
ZEV-03_SLK-05	ZEV-CH-03-23	2112.00	2113.00	Granite	0.2%	99.7	I
ZEV-03_SLK-06	ZEV-CH-03-23	2151.00	2151.60	Granite	0.3%	99.4	I
ZEV-03_SLK-07	ZEV-CH-03-23	2187.00	2188.04	Granite	0.2%	93.4	II
ZEV-03_SLK-08	ZEV-CH-03-23	2245.00	2246.00	Granite	0.2%	99.7	I
ZEV-03_SLK-09	ZEV-CH-03-23	2277.50	2279.00	Granite	0.3%	99.0	I
ZEV-03_SLK-10	ZEV-CH-03-23	2306.60	2308.20	Granite	0.2%	99.6	I
ZEV-03_SLK-11	ZEV-CH-03-23	2335.00	2335.80	Granite	0.2%	99.2	I
ZEV-03_SLK-12	ZEV-CH-03-23	2359.70	2360.50	Granite	0.2%	99.4	I
ZEV-03_SLK-13	ZEV-CH-03-23	2389.20	2390.00	Granite	0.2%	99.7	I
ZEV-03_SLK-14	ZEV-CH-03-23	2417.00	2418.50	Granite	0.2%	99.7	I
ZEV-03_SLK-15	ZEV-CH-03-23	2451.60	2453.00	Granite	0.2%	98.9	I
ZEV-03_SLK-16	ZEV-CH-03-23	2486.00	2487.00	Granite	0.3%	99.1	I
ZEV-03_SLK-17	ZEV-CH-03-23	2532.00	2532.75	Granite	0.6%	94.4	II
ZEV-03_SLK-18	ZEV-CH-03-23	2562.83	2563.58	Granite	0.2%	99.3	I
ZEV-03_SLK-19	ZEV-CH-03-23	2604.50	2605.41	Granite	0.6%	90.9	II
ZEV-03_SLK-20	ZEV-CH-03-23	2648.00	2648.66	Granite	0.4%	97.9	I
ZEV-03_SLK-21	ZEV-CH-03-23	2674.50	2675.50	Granite	0.1%	99.6	I
ZEV-03_SLK-22	ZEV-CH-03-23	2717.08	2717.58	Granite	0.2%	99.5	I
ZEV-03_SLK-23	ZEV-CH-03-23	2757.00	2758.00	Granite	0.3%	97.5	I
ZEV-03_SLK-24	ZEV-CH-03-23	2798.58	2799.58	Granite	0.7%	92.8	II
ZEV-03_SLK-25	ZEV-CH-03-23	2867.00	2867.58	Granite	0.7%	44.6	II
ZEV-03_SLK-26	ZEV-CH-03-23	2917.77	2918.33	Granite	2.0%	23.9	III
ZEV-03_SLK-27	ZEV-CH-03-23	2983.66	2984.16	Granite	0.3%	99.0	I

* Type I = Retained pieces remained virtually unchanged
II = Retained materials consist of large and small pieces
III = Retained materials is exclusively small fragments

Table 6. List of Samples with Modified Data Ranges Used for Elastic Property Calculation

			Range of data used for elastic properties calculation (percent of sample maximum strength)			
			Tangent Properties		Secant Properties	
Specimen No.	Hole ID	Test Type	Lower Limit	Upper Limit	Lower Limit	Upper Limit
Standard Procedure	-	-	45	55	0	50
ZEV-03_UCS-05	ZEV-CH-03-23	UCS	20	30	0	25
ZEV-03_UCS-06	ZEV-CH-03-23	UCS	43	53	0	48
ZEV-03_UCS-10	ZEV-CH-03-23	UCS	32	42	0	37
ZEV-03_UCS-13	ZEV-CH-03-23	UCS	30	40	0	35
ZEV-03_UCS-27	ZEV-CH-03-23	UCS	30	40	0	35
ZEV-03_UCS-32	ZEV-CH-03-23	UCS	40	50	0	45

APPENDIX A

UNIAXIAL COMPRESSIVE STRENGTH (UCS) TEST DATASHEET

AGAPITO ASSOCIATES, INC.
2913 Hill Avenue, #B
Grand Junction, CO 81504 USA
970-242-4220

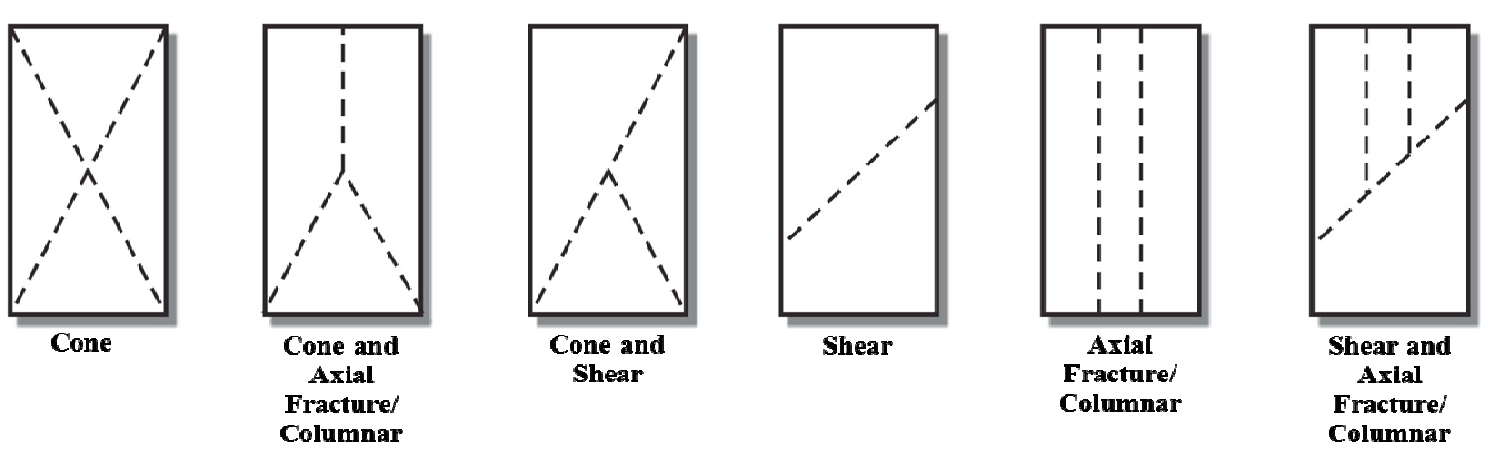
UNIAXIAL COMPRESSION TESTS

CLIENT:	Lane PES	**HOLE NO:**	ZEV-CH-03-23
JOB NO:	951-20	**MOISTURE CONDITION:**	As received
DATE:	October 4, 2023	**TEMPERATURE:**	Ambient

Specimen No.	Hole No.	Depth From (ft)	Depth To (ft)	Length of Interval (ft)	Weight (oz)	Diameter D_1 (in)	Diameter D_2 (in)	Axial Length (inch)	Length-to-Diameter Ratio	Area (inch^2)	Density (pcf)	Specific Gravity
ZEV-03_UCS-01	ZEV-CH-03-23	1,588.91	1,589.75	0.84	37.22	2.38	2.38	5.36	2.3	4.44	169	2.7
ZEV-03_UCS-02	ZEV-CH-03-23	1,632.00	1,633.00	1.00	37.04	2.37	2.38	5.38	2.3	4.43	168	2.7
ZEV-03_UCS-03	ZEV-CH-03-23	1,721.41	1,722.00	0.59	36.72	2.36	2.37	5.41	2.3	4.39	167	2.7
ZEV-03_UCS-04	ZEV-CH-03-23	1,832.66	1,833.41	0.75	38.12	2.39	2.39	5.49	2.3	4.49	167	2.7
ZEV-03_UCS-05	ZEV-CH-03-23	1,909.70	1,910.50	0.80	36.07	2.36	2.35	5.33	2.3	4.37	168	2.7
ZEV-03_UCS-06	ZEV-CH-03-23	2,019.20	2,019.90	0.70	36.93	2.40	2.39	5.35	2.2	4.50	166	2.7
ZEV-03_UCS-07	ZEV-CH-03-23	2,076.00	2,077.00	1.00	36.84	2.40	2.40	5.26	2.2	4.51	168	2.7
ZEV-03_UCS-08	ZEV-CH-03-23	2,103.00	2,104.00	1.00	40.08	2.40	2.40	5.72	2.4	4.52	167	2.7
ZEV-03_UCS-09	ZEV-CH-03-23	2,112.00	2,113.00	1.00	38.01	2.39	2.39	5.41	2.3	4.50	168	2.7
ZEV-03_UCS-10	ZEV-CH-03-23	2,190.00	2,191.00	1.00	35.97	2.40	2.40	5.38	2.2	4.52	160	2.6
ZEV-03_UCS-11	ZEV-CH-03-23	2,212.40	2,213.50	1.10	38.51	2.37	2.37	5.58	2.4	4.42	168	2.7
ZEV-03_UCS-12	ZEV-CH-03-23	2,224.00	2,224.65	0.65	37.38	2.40	2.40	5.38	2.2	4.51	166	2.7
ZEV-03_UCS-13	ZEV-CH-03-23	2,254.20	2,255.50	1.30	38.27	2.40	2.40	5.41	2.3	4.52	169	2.7
ZEV-03_UCS-14	ZEV-CH-03-23	2,279.00	2,280.00	1.00	38.06	2.40	2.40	5.40	2.3	4.51	169	2.7
ZEV-03_UCS-15	ZEV-CH-03-23	2,308.20	2,309.40	1.20	38.46	2.39	2.39	5.46	2.3	4.49	169	2.7
ZEV-03_UCS-16	ZEV-CH-03-23	2,321.00	2,322.00	1.00	38.00	2.39	2.39	5.39	2.3	4.49	170	2.7
ZEV-03_UCS-17	ZEV-CH-03-23	2,352.50	2,354.00	1.50	38.34	2.39	2.39	5.46	2.3	4.49	169	2.7
ZEV-03_UCS-18	ZEV-CH-03-23	2,384.50	2,386.00	1.50	38.46	2.39	2.39	5.46	2.3	4.50	169	2.7
ZEV-03_UCS-19	ZEV-CH-03-23	2,412.40	2,414.00	1.60	38.73	2.39	2.39	5.52	2.3	4.50	168	2.7
ZEV-03_UCS-20	ZEV-CH-03-23	2,444.00	2,445.50	1.50	37.27	2.39	2.39	5.32	2.2	4.49	169	2.7
ZEV-03_UCS-21	ZEV-CH-03-23	2,461.00	2,462.00	1.00	35.33	2.39	2.39	5.10	2.1	4.48	167	2.7
ZEV-03_UCS-22	ZEV-CH-03-23	2,527.33	2,528.00	0.67	37.87	2.39	2.39	5.46	2.3	4.48	167	2.7
ZEV-03_UCS-23	ZEV-CH-03-23	2,576.00	2,576.91	0.91	38.24	2.40	2.40	5.41	2.3	4.51	169	2.7
ZEV-03_UCS-24	ZEV-CH-03-23	2,603.50	2,604.00	0.50	38.24	2.40	2.41	5.52	2.3	4.54	165	2.6
ZEV-03_UCS-25	ZEV-CH-03-23	2,648.00	2,648.66	0.66	37.57	2.40	2.40	5.34	2.2	4.52	168	2.7
ZEV-03_UCS-26	ZEV-CH-03-23	2,677.58	2,678.41	0.83	37.18	2.38	2.38	5.36	2.3	4.44	169	2.7
ZEV-03_UCS-27	ZEV-CH-03-23	2,701.00	2,701.50	0.50	35.48	2.38	2.38	5.84	2.5	4.45	148	2.4
ZEV-03_UCS-28	ZEV-CH-03-23	2,724.75	2,725.16	0.41	35.98	2.40	2.34	5.18	2.2	4.41	170	2.7
ZEV-03_UCS-29	ZEV-CH-03-23	2,740.00	2,740.50	0.50	37.10	2.40	2.40	5.28	2.2	4.51	168	2.7
ZEV-03_UCS-30	ZEV-CH-03-23	2,876.16	2,876.91	0.75	38.49	2.41	2.40	5.85	2.4	4.54	157	2.5
ZEV-03_UCS-31	ZEV-CH-03-23	2,879.00	2,880.00	1.00	38.56	2.40	2.39	5.89	2.5	4.51	157	2.5
ZEV-03-UCS-32	ZEV-CH-03-23	2,943.00	2,943.50	0.50	37.33	2.39	2.39	5.36	2.2	4.50	167	2.7
ZEV-03_UCS-33	ZEV-CH-03-23	2,983.66	2,984.16	0.50	37.01	2.40	2.40	5.36	2.2	4.53	164	2.6

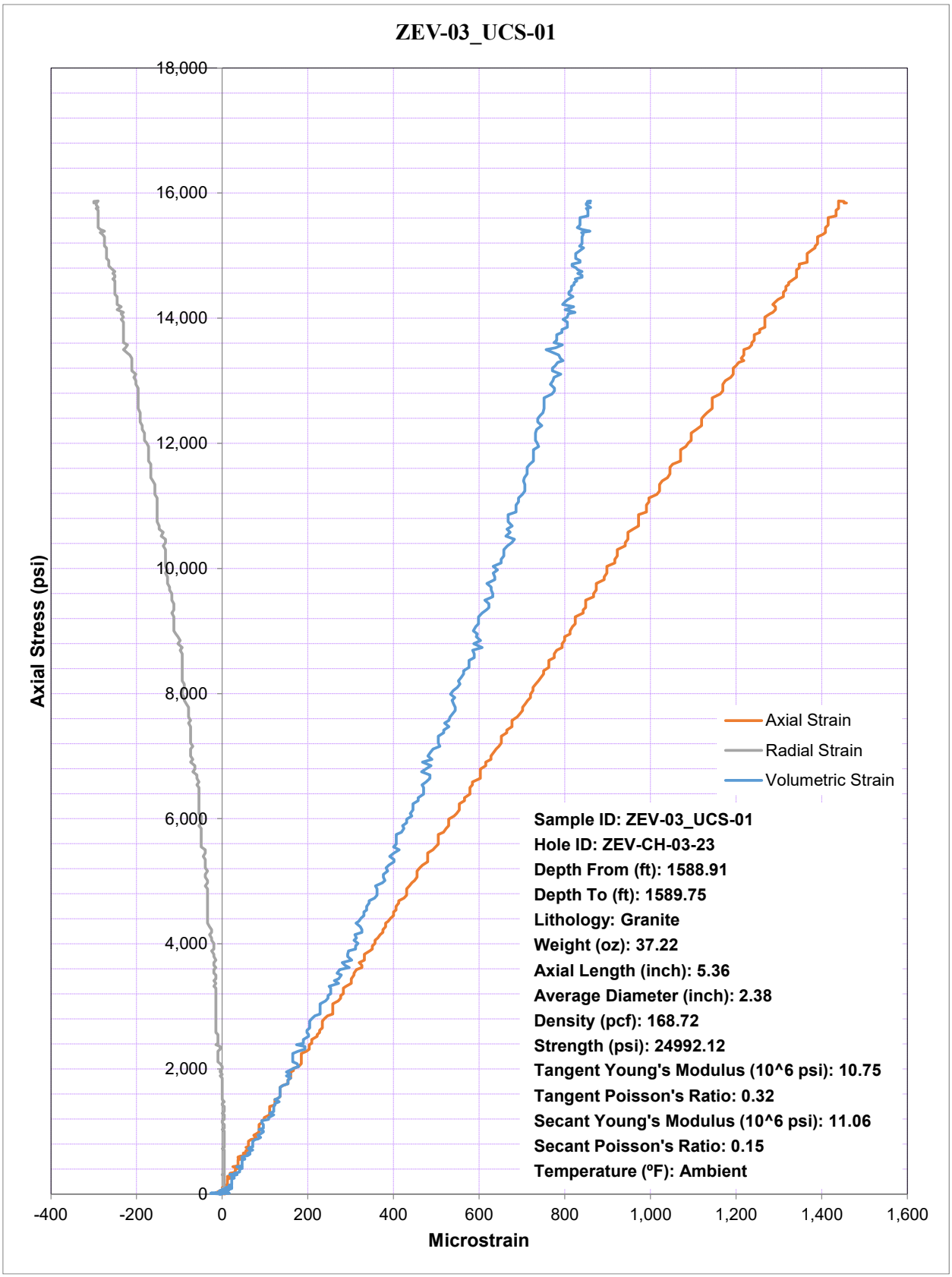
Specimen No.	Lithological Description	Failure Load (lb)	UCS (psi)	Failure Mode Notes	Comments
ZEV-03_UCS-01	Granite	111,045	24,992	Axial	
ZEV-03_UCS-02	Granite	67,255	15,188	Shear	Shear along single pre-existing fracture
ZEV-03_UCS-03	Granite	65,970	15,017	Axial	failed partially along pre-existing fracture
ZEV-03_UCS-04	Granite	66,370	14,797	Shear	Along pre-existing fracture, single plane
ZEV-03_UCS-05	Granite	34,525	7,909	Axial	failed partially along pre-existing fracture
ZEV-03_UCS-06	Granite	91,715	20,362	Axial	
ZEV-03_UCS-07	Granite	29,960	6,646	Shear	Failed partially along pre-existing fractures
ZEV-03_UCS-08	Granite	6,675	1,475	Shear	Failed along pre-existing fracture
ZEV-03_UCS-09	Granite	88,020	19,550	Axial	
ZEV-03_UCS-10	Granite	16,180	3,583	Axial	
ZEV-03_UCS-11	Granite	71,900	16,257	Axial	
ZEV-03_UCS-12	Granite	83,850	18,589	Axial/Shear	
ZEV-03_UCS-13	Granite	72,725	16,103	Axial	
ZEV-03_UCS-14	Granite	87,880	19,470	Shear	
ZEV-03_UCS-15	Granite	67,690	15,069	Axial/Shear	Partially along pre-existing fracture.
ZEV-03_UCS-16	Granite	114,705	25,541	Axial	Multiple fracturing.
ZEV-03_UCS-17	Granite	81,550	18,181	Axial/Shear	
ZEV-03_UCS-18	Granite	80,690	17,945	Shear	
ZEV-03_UCS-19	Granite	70,480	15,661	Axial	Failed partially along pre-existing fractures
ZEV-03_UCS-20	Granite	62,820	14,006	Axial	Failed partially along pre-existing fractures
ZEV-03_UCS-21	Granite	32,140	7,179	Axial	Failed mostly along pre-existing fractures
ZEV-03_UCS-22	Granite	41,340	9,224	Axial	Prolonged failure
ZEV-03_UCS-23	Granite	87,240	19,333	Axial	
ZEV-03_UCS-24	Granite	15,875	3,493	Axial	
ZEV-03_UCS-25	Granite	102,825	22,748	Shear	
ZEV-03_UCS-26	Granite	98,115	22,096	Axial	
ZEV-03_UCS-27	Granite	4,510	1,014	Shear	Prolonged failure
ZEV-03_UCS-28	Granite	29,740	6,744	Axial	
ZEV-03_UCS-29	Granite	37,520	8,318	Axial	
ZEV-03_UCS-30	Granite	6,100	1,345	Axial	Prolonged failure
ZEV-03_UCS-31	Granite	6,430	1,426	Axial	Prolonged failure
ZEV-03-UCS-32	Granite	42,175	9,375	Axial	Failed partially along pre-existing fractures
ZEV-03_UCS-33	Granite	71,520	15,773	Axial	

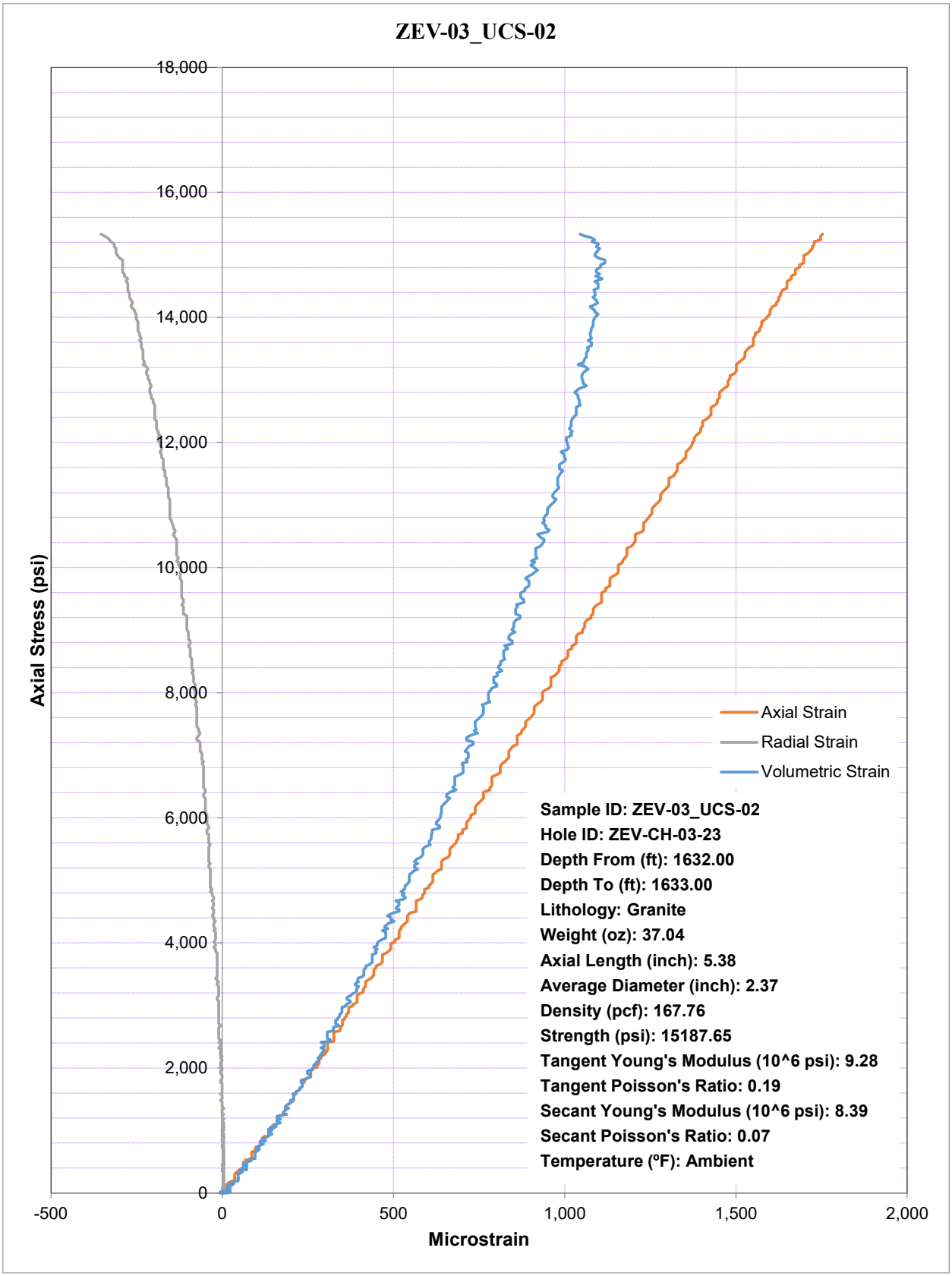
Failure Mode Sketches

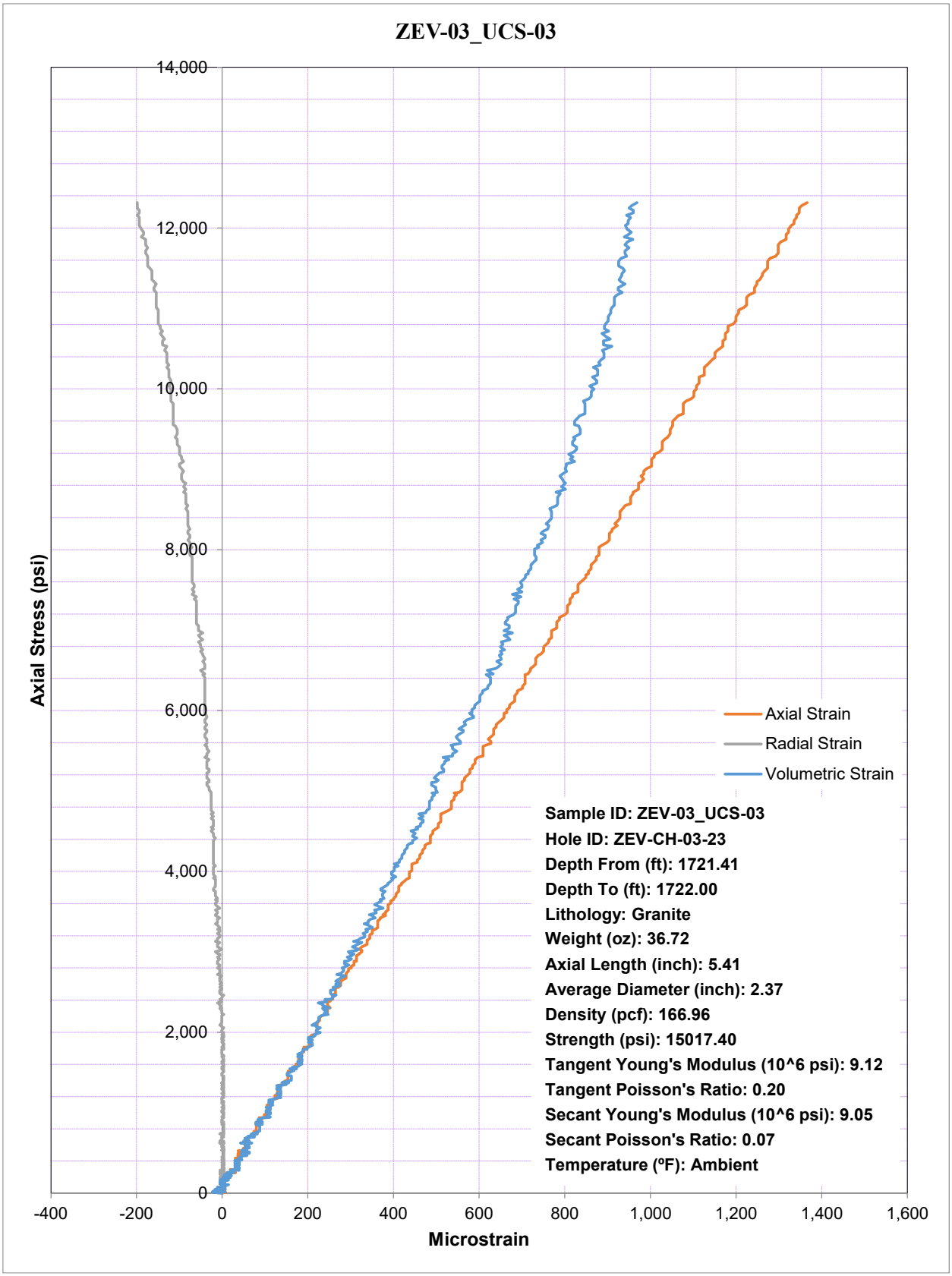


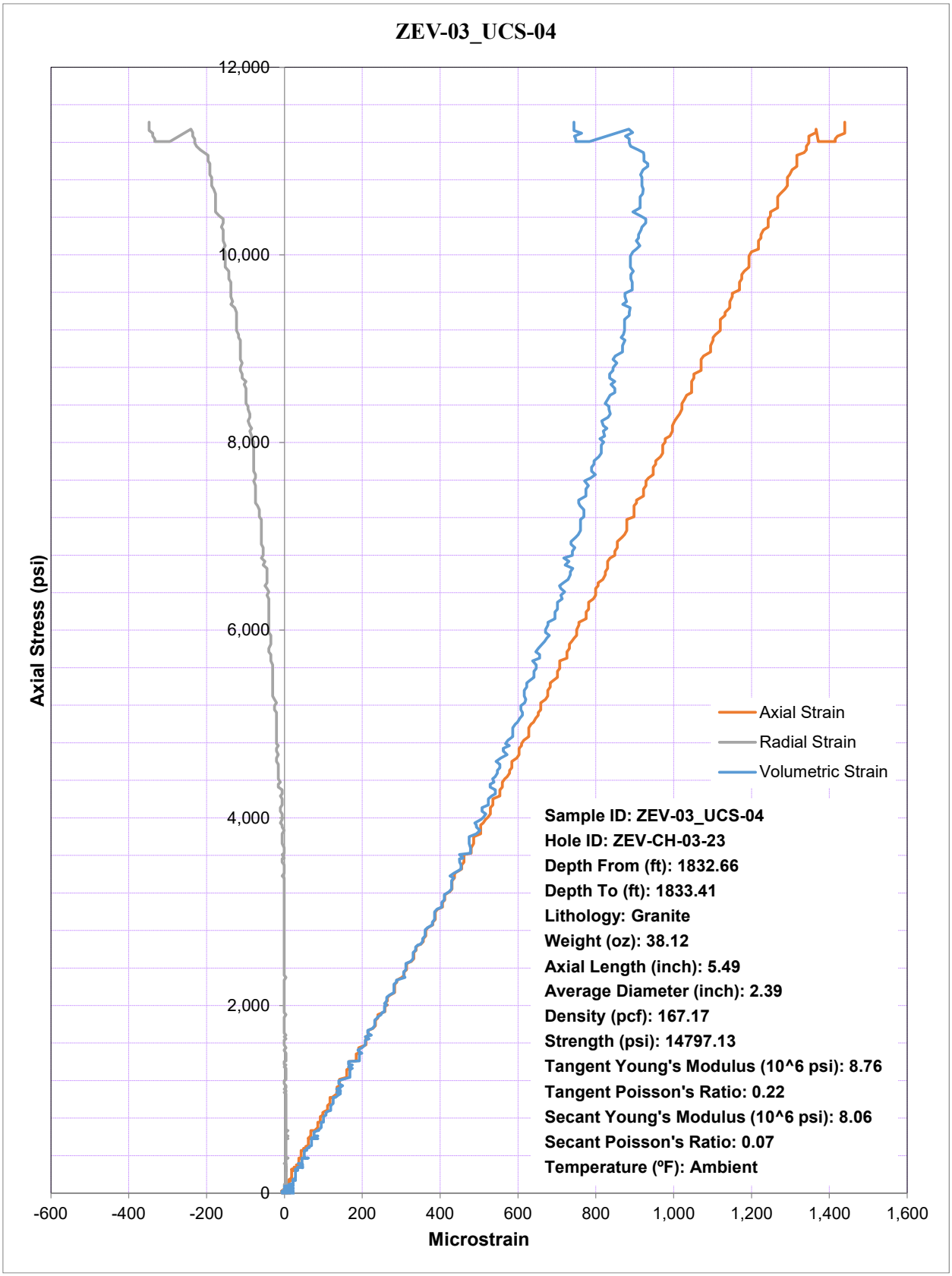
APPENDIX B

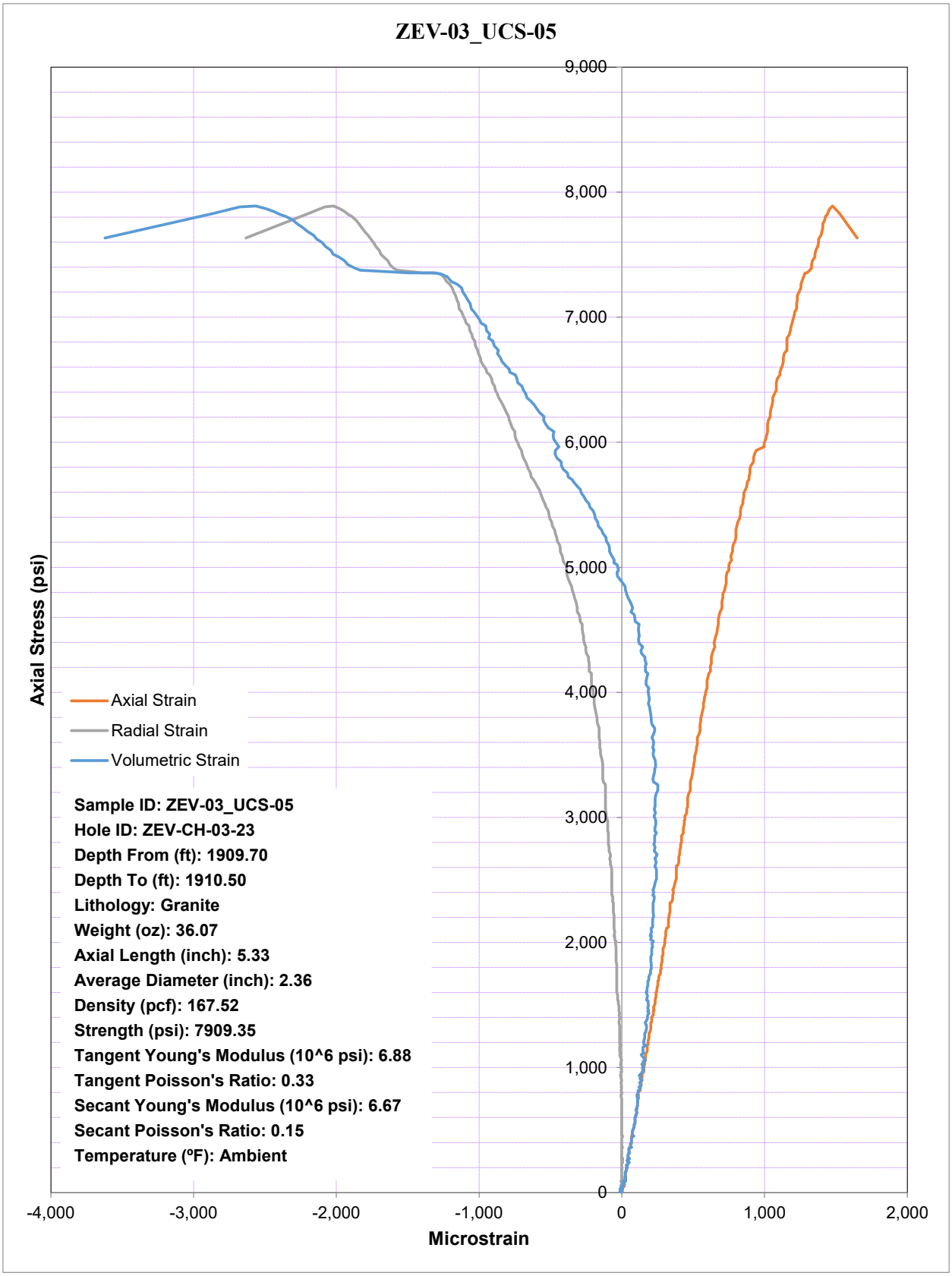
STRESS-STRAIN PLOTS FOR UNIAXIAL COMPRESSIVE STRENGTH TEST SPECIMENS

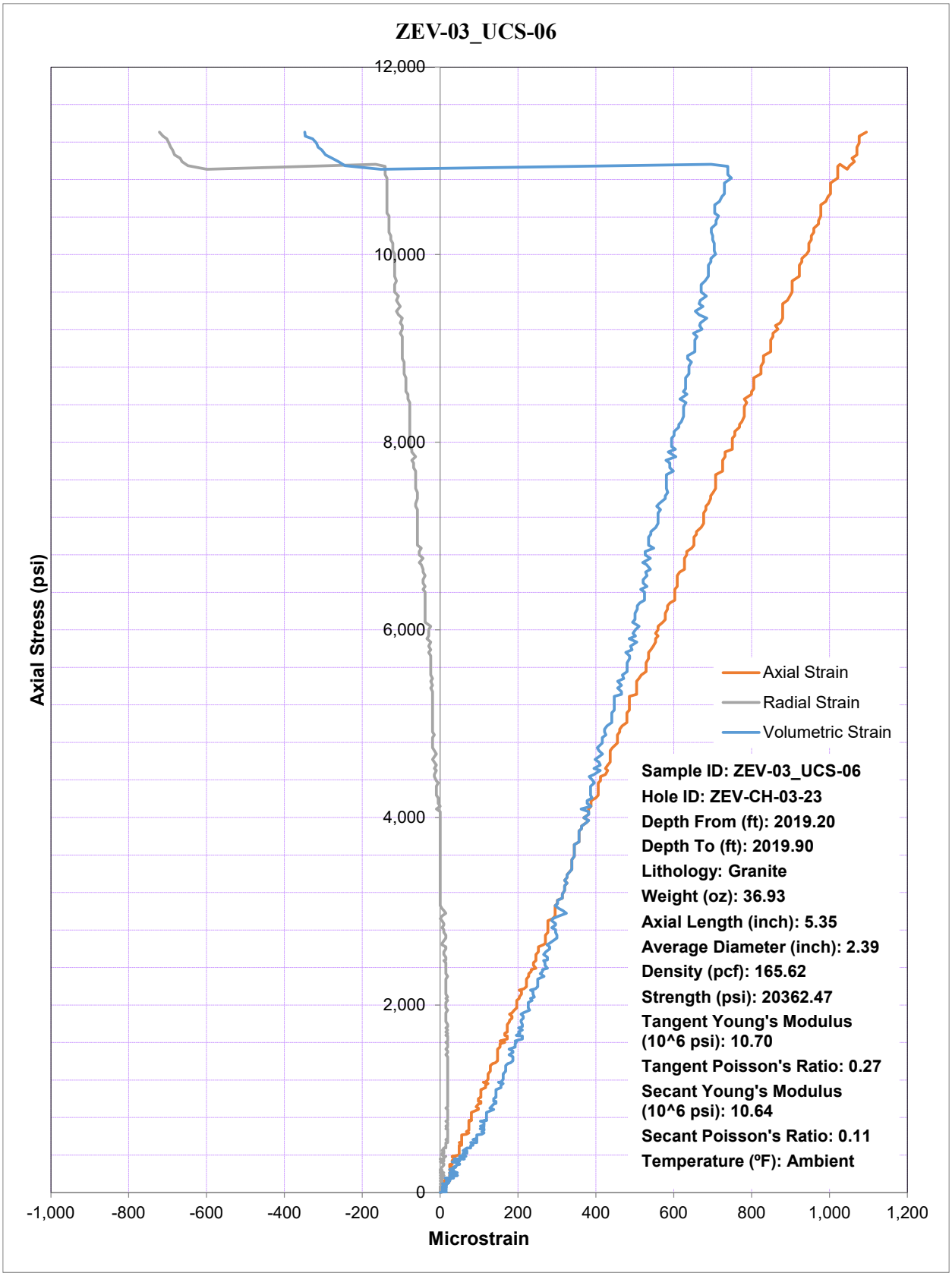

ZEV-03_UCS-01
Axial Stress (psi)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-400
-200
0
200
400
600
800
1,000
1,200
1,400
1,600
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-01
Hole ID: ZEV-CH-03-23
Depth From (ft): 1588.91
Depth To (ft): 1589.75
Lithology: Granite
Weight (oz): 37.22
Axial Length (inch): 5.36
Average Diameter (inch): 2.38
Density (pcf): 168.72
Strength (psi): 24992.12
Tangent Young's Modulus (10^6 psi): 10.75
Tangent Poisson's Ratio: 0.32
Secant Young's Modulus (10^6 psi): 11.06
Secant Poisson's Ratio: 0.15
Temperature (ºF): Ambient

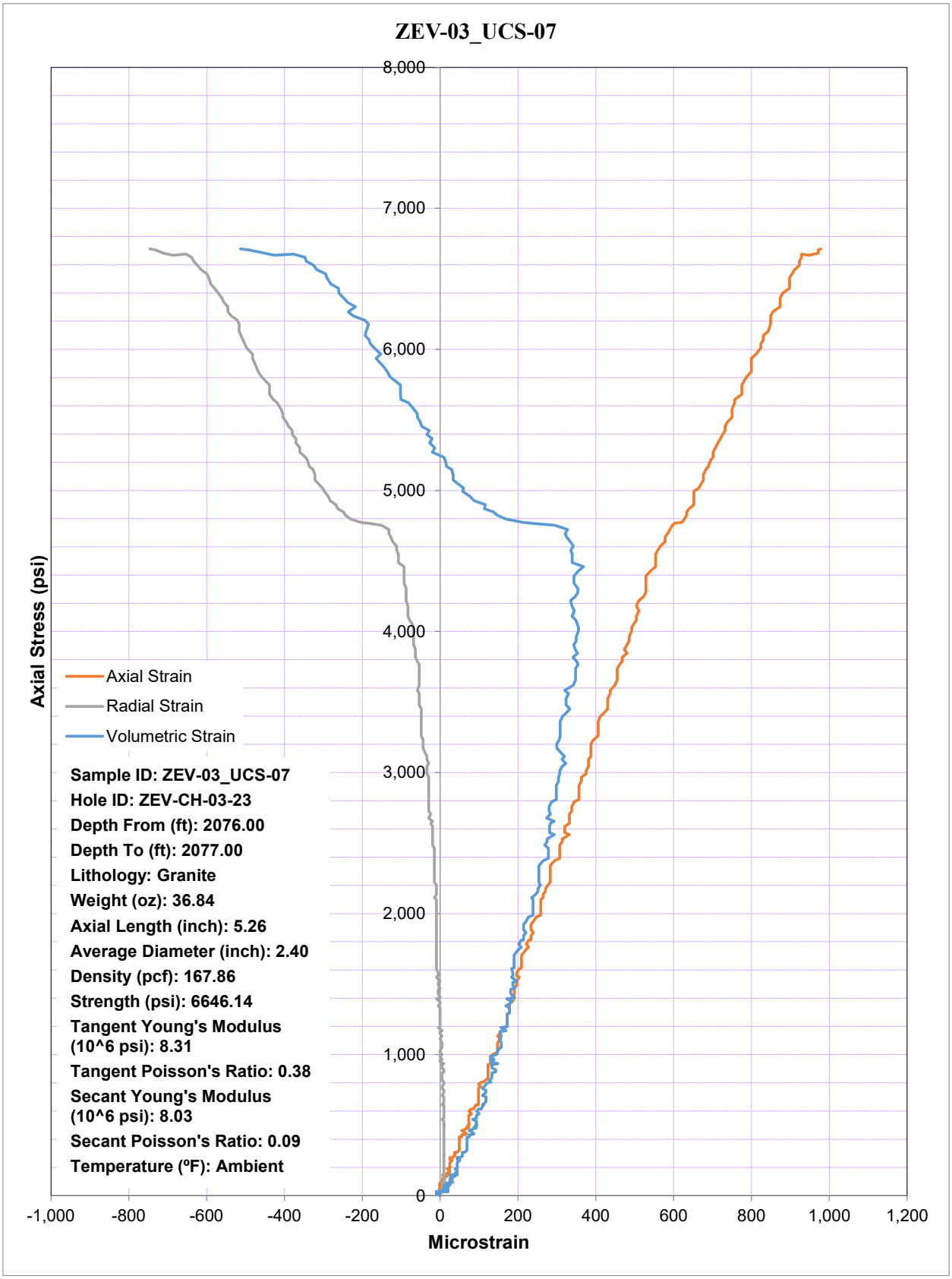

ZEV-03_UCS-02
Axial Stress (psi)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-500
0
500
1,000
1,500
2,000
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-02
Hole ID: ZEV-CH-03-23
Depth From (ft): 1632.00
Depth To (ft): 1633.00
Lithology: Granite
Weight (oz): 37.04
Axial Length (inch): 5.38
Average Diameter (inch): 2.37
Density (pcf): 167.76
Strength (psi): 15187.65
Tangent Young's Modulus (10^6 psi): 9.28
Tangent Poisson's Ratio: 0.19
Secant Young's Modulus (10^6 psi): 8.39
Secant Poisson's Ratio: 0.07
Temperature (ºF): Ambient

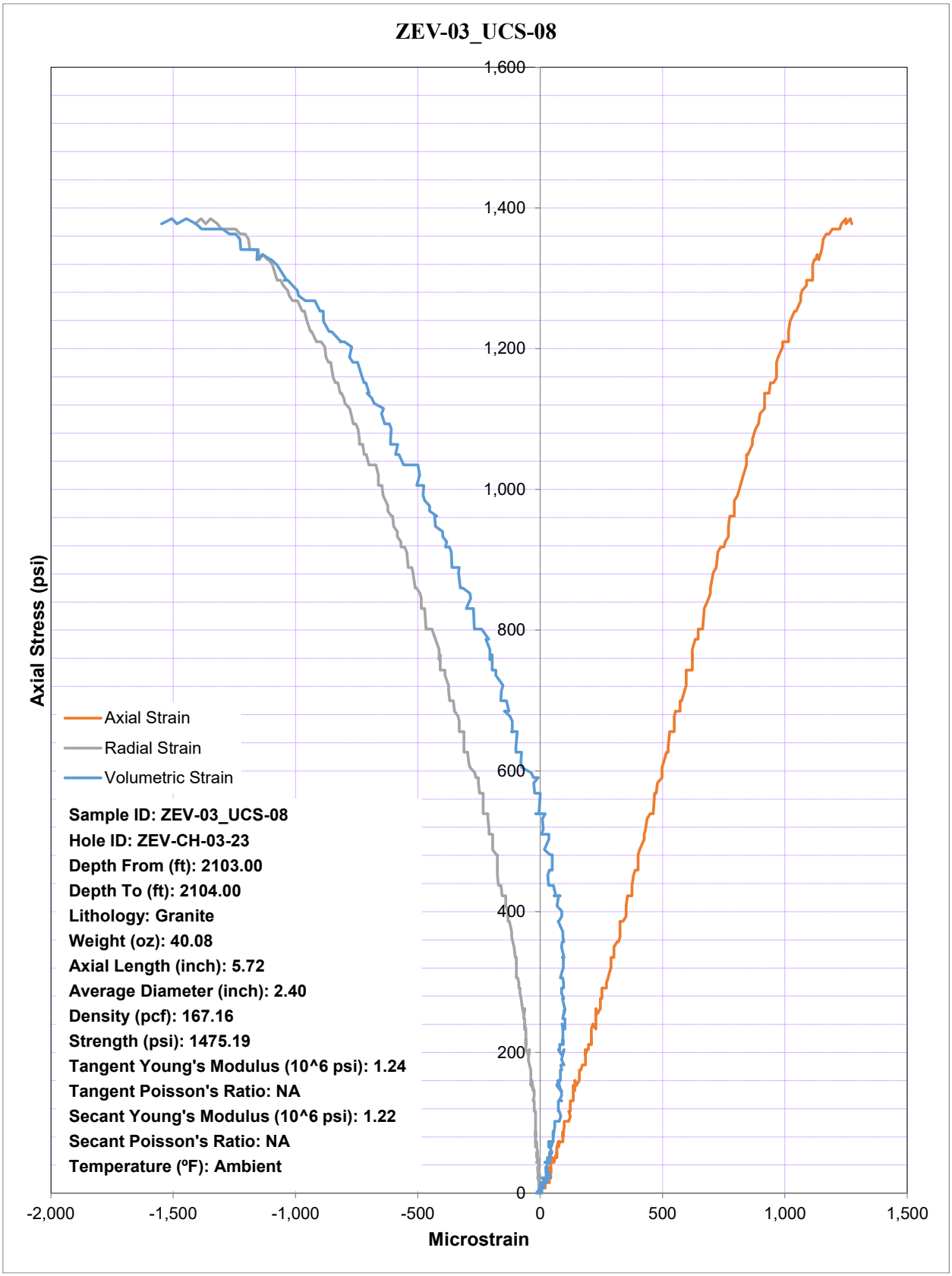

ZEV-03_UCS-03
Axial Stress (psi)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-400
-200
0
200
400
600
800
1,000
1,200
1,400
1,600
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-03
Hole ID: ZEV-CH-03-23
Depth From (ft): 1721.41
Depth To (ft): 1722.00
Lithology: Granite
Weight (oz): 36.72
Axial Length (inch): 5.41
Average Diameter (inch): 2.37
Density (pcf): 166.96
Strength (psi): 15017.40
Tangent Young's Modulus (10^6 psi): 9.12
Tangent Poisson's Ratio: 0.20
Secant Young's Modulus (10^6 psi): 9.05
Secant Poisson's Ratio: 0.07
Temperature (ºF): Ambient

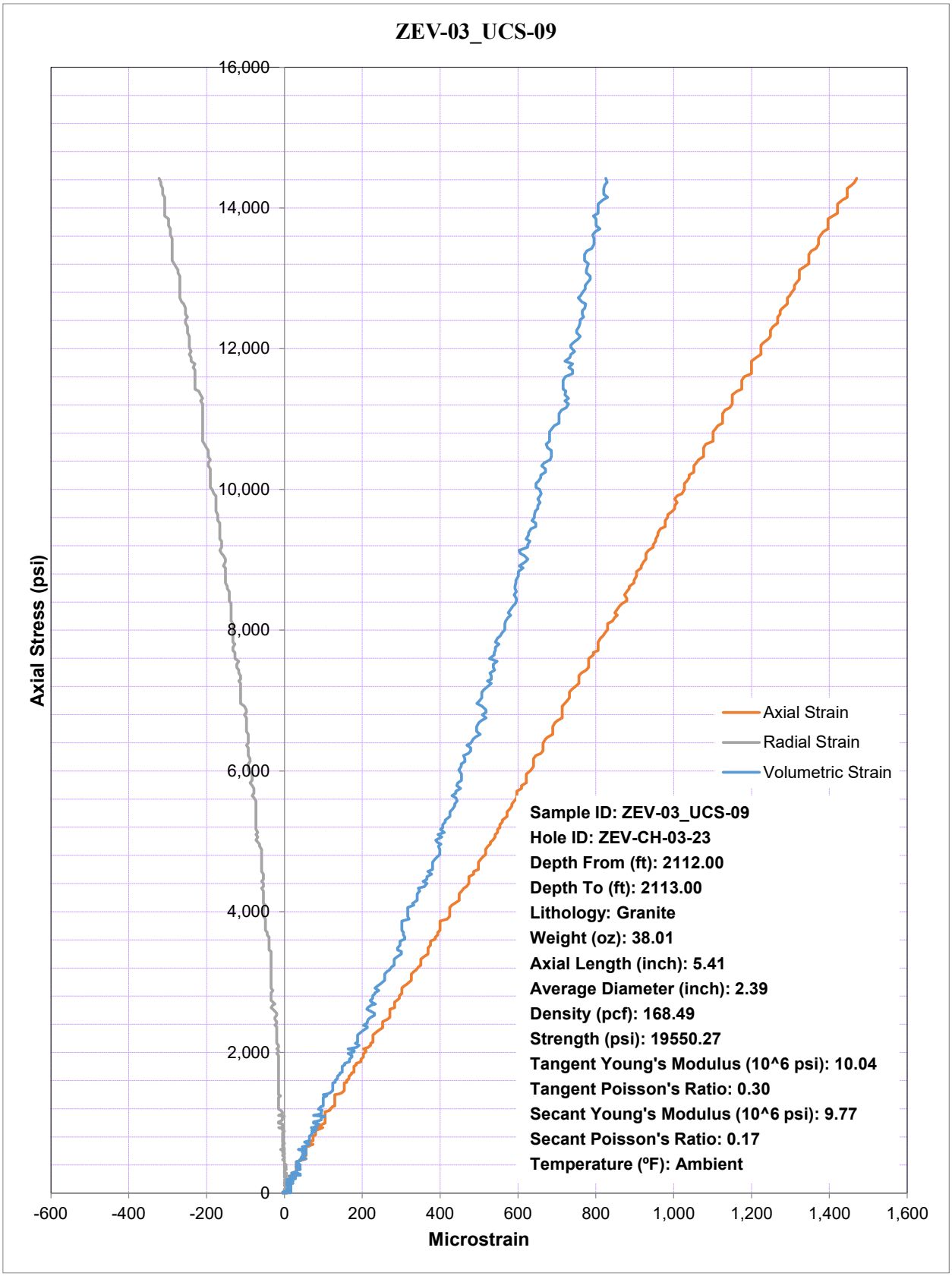

ZEV-03_UCS-04
Axial Stress (psi)
12,000
10,000
8,000
6,000
4,000
2,000
0
-600
-400
-200
0
200
400
600
800
1,000
1,200
1,400
1,600
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-04
Hole ID: ZEV-CH-03-23
Depth From (ft): 1832.66
Depth To (ft): 1833.41
Lithology: Granite
Weight (oz): 38.12
Axial Length (inch): 5.49
Average Diameter (inch): 2.39
Density (pcf): 167.17
Strength (psi): 14797.13
Tangent Young's Modulus (10^6 psi): 8.76
Tangent Poisson's Ratio: 0.22
Secant Young's Modulus (10^6 psi): 8.06
Secant Poisson's Ratio: 0.07
Temperature (ºF): Ambient

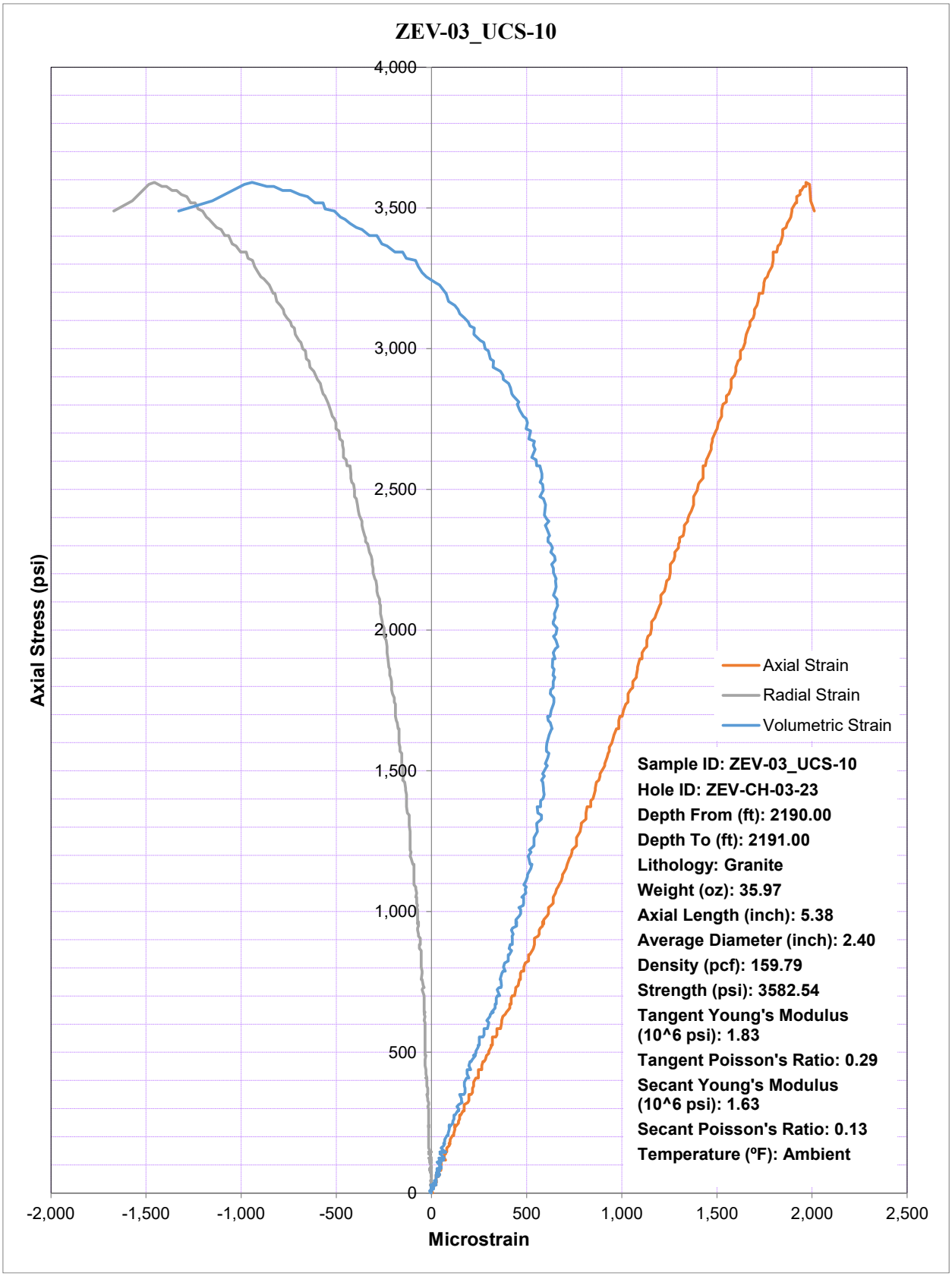

ZEV-03_UCS-05
Axial Stress (psi)
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
-4,000
-3,000
-2,000
-1,000
0
1,000
2,000
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-05
Hole ID: ZEV-CH-03-23
Depth From (ft): 1909.70
Depth To (ft): 1910.50
Lithology: Granite
Weight (oz): 36.07
Axial Length (inch): 5.33
Average Diameter (inch): 2.36
Density (pcf): 167.52
Strength (psi): 7909.35
Tangent Young's Modulus (10^6 psi): 6.88
Tangent Poisson's Ratio: 0.33
Secant Young's Modulus (10^6 psi): 6.67
Secant Poisson's Ratio: 0.15
Temperature (ºF): Ambient

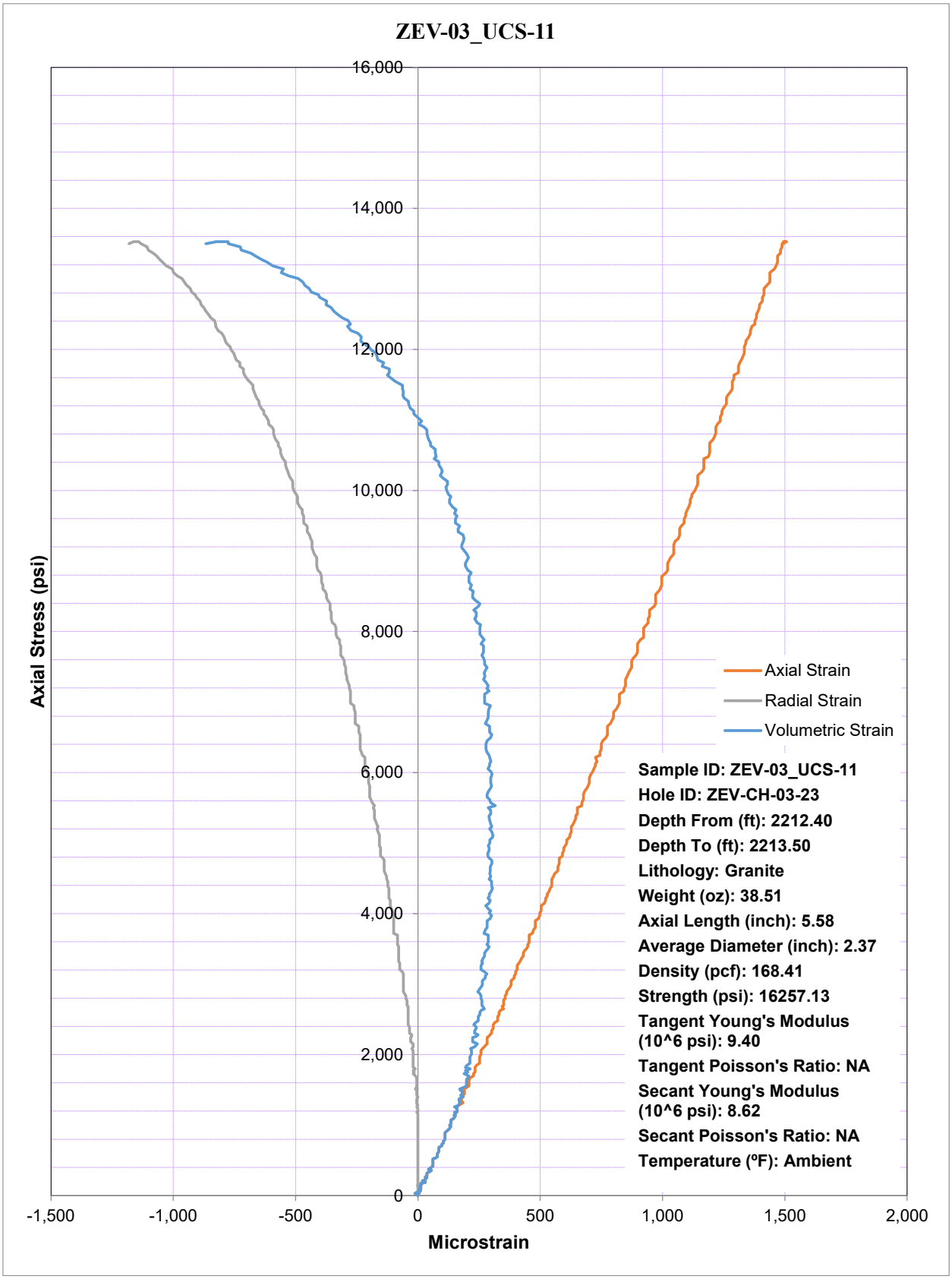

ZEV-03_UCS-06
Axial Stress (psi)
12,000
10,000
8,000
6,000
4,000
2,000
0
-1,000
-800
-600
-400
-200
0
200
400
600
800
1,000
1,200
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-06
Hole ID: ZEV-CH-03-23
Depth From (ft): 2019.20
Depth To (ft): 2019.90
Lithology: Granite
Weight (oz): 36.93
Axial Length (inch): 5.35
Average Diameter (inch): 2.39
Density (pcf): 165.62
Strength (psi): 20362.47
Tangent Young's Modulus (10^6 psi): 10.70
Tangent Poisson's Ratio: 0.27
Secant Young's Modulus (10^6 psi): 10.64
Secant Poisson's Ratio: 0.11
Temperature (ºF): Ambient

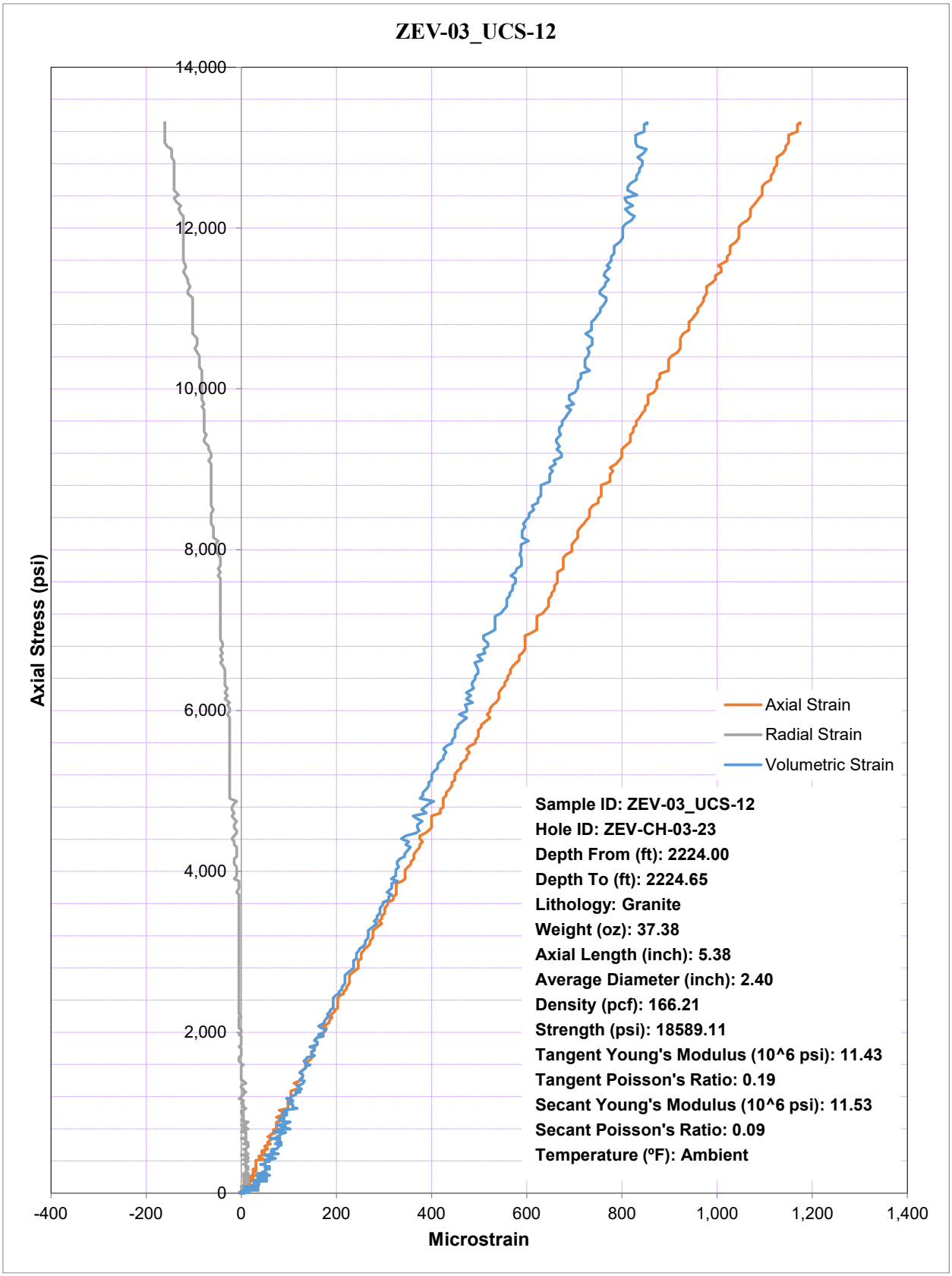

ZEV-03_UCS-07
Axial Stress (psi)
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
-1,000
-800
-600
-400
-200
0
200
400
600
800
1,000
1,200
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-07
Hole ID: ZEV-CH-03-23
Depth From (ft): 2076.00
Depth To (ft): 2077.00
Lithology: Granite
Weight (oz): 36.84
Axial Length (inch): 5.26
Average Diameter (inch): 2.40
Density (pcf): 167.86
Strength (psi): 6646.14
Tangent Young's Modulus (10^6 psi): 8.31
Tangent Poisson's Ratio: 0.38
Secant Young's Modulus (10^6 psi): 8.03
Secant Poisson's Ratio: 0.09
Temperature (ºF): Ambient

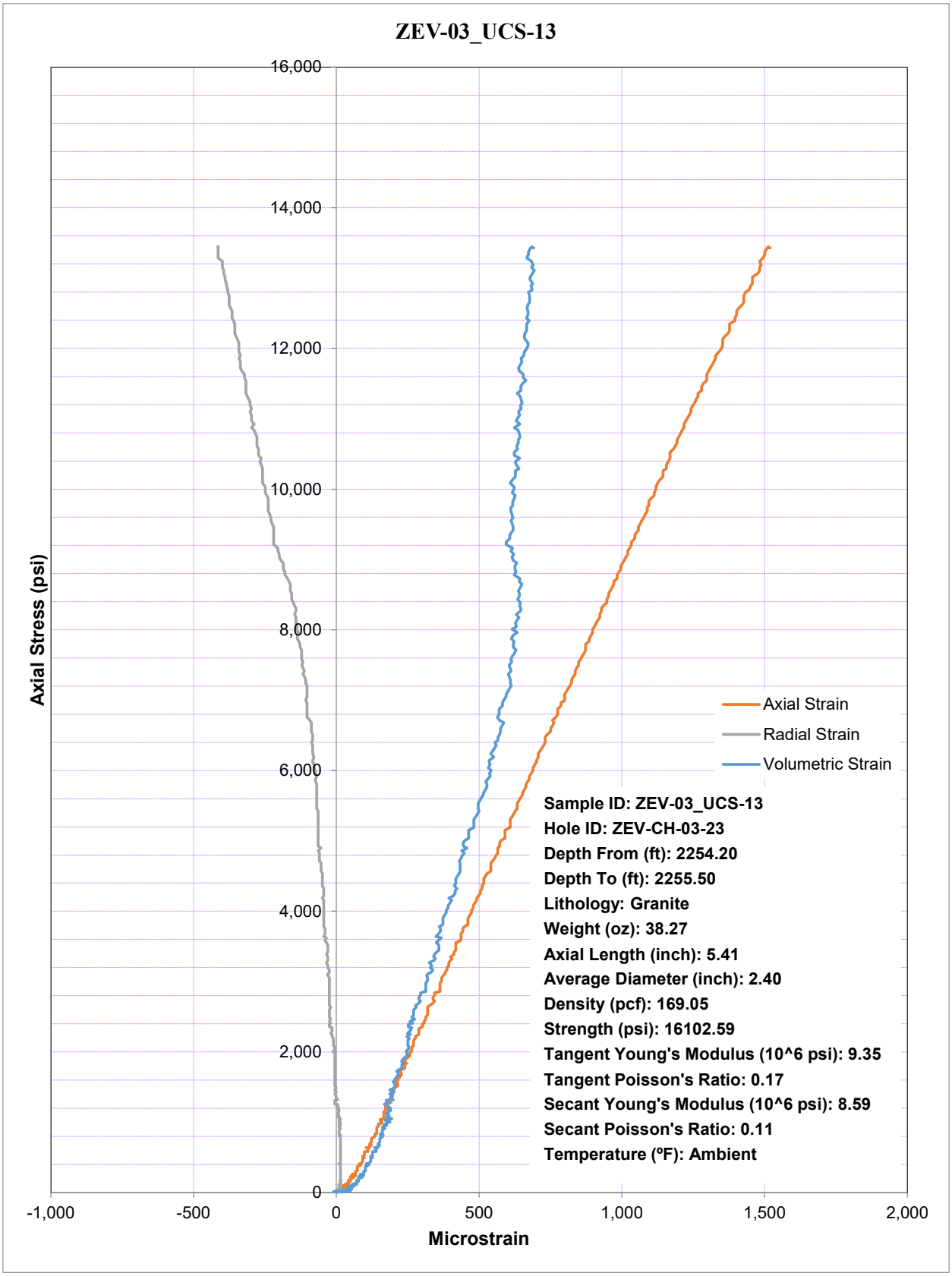

ZEV-03_UCS-08
Axial Stress (psi)
1,600
1,400
1,200
1,000
800
600
400
200
0
-2,000
-1,500
-1,000
-500
0
500
1,000
1,500
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-08
Hole ID: ZEV-CH-03-23
Depth From (ft): 2103.00
Depth To (ft): 2104.00
Lithology: Granite
Weight (oz): 40.08
Axial Length (inch): 5.72
Average Diameter (inch): 2.40
Density (pcf): 167.16
Strength (psi): 1475.19
Tangent Young's Modulus (10^6 psi): 1.24
Tangent Poisson's Ratio: NA
Secant Young's Modulus (10^6 psi): 1.22
Secant Poisson's Ratio: NA
Temperature (ºF): Ambient

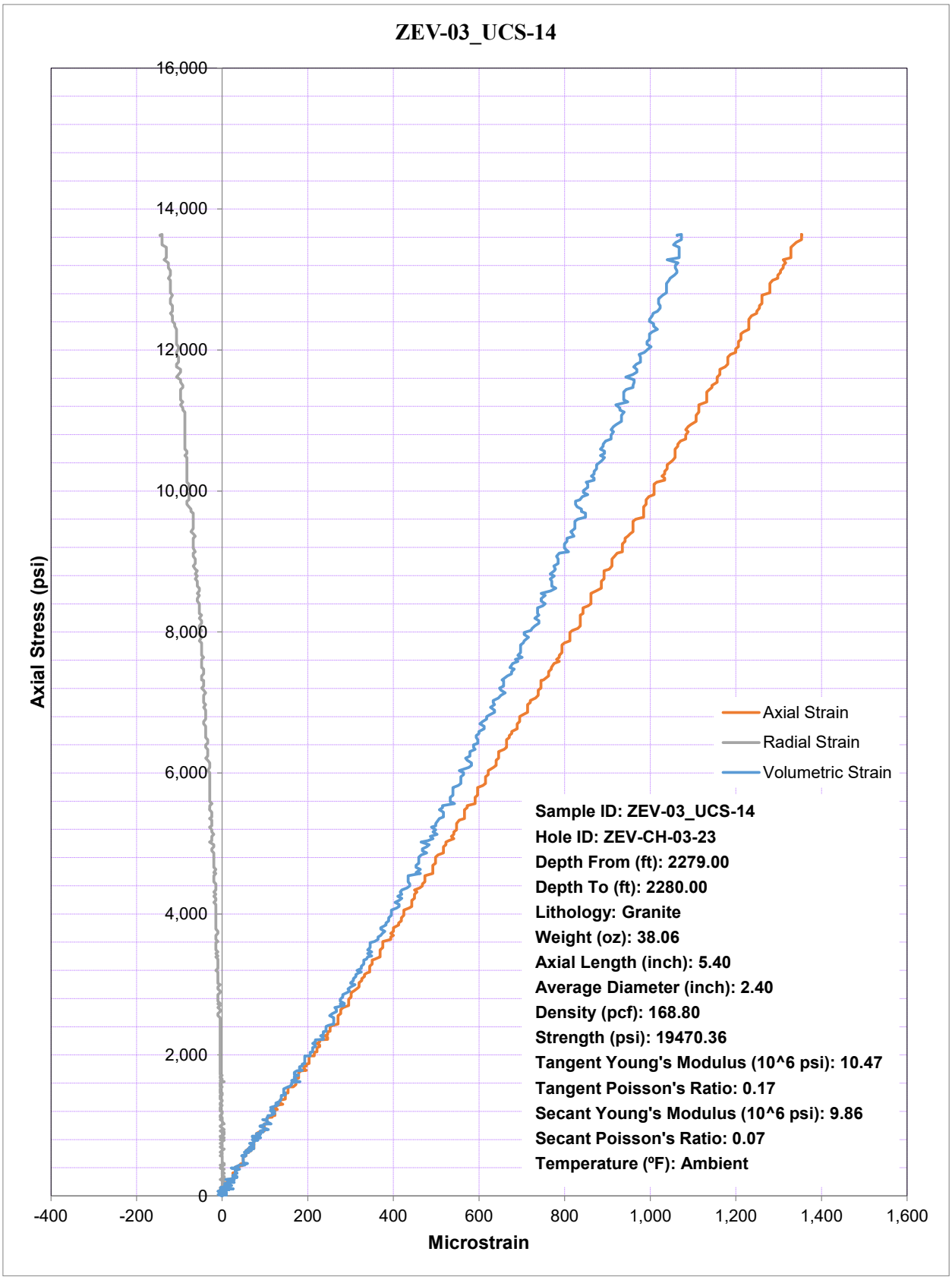

ZEV-03_UCS-09
Axial Stress (psi)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-600
-400
-200
0
200
400
600
800
1,000
1,200
1,400
1,600
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-09
Hole ID: ZEV-CH-03-23
Depth From (ft): 2112.00
Depth To (ft): 2113.00
Lithology: Granite
Weight (oz): 38.01
Axial Length (inch): 5.41
Average Diameter (inch): 2.39
Density (pcf): 168.49
Strength (psi): 19550.27
Tangent Young's Modulus (10^6 psi): 10.04
Tangent Poisson's Ratio: 0.30
Secant Young's Modulus (10^6 psi): 9.77
Secant Poisson's Ratio: 0.17
Temperature (ºF): Ambient

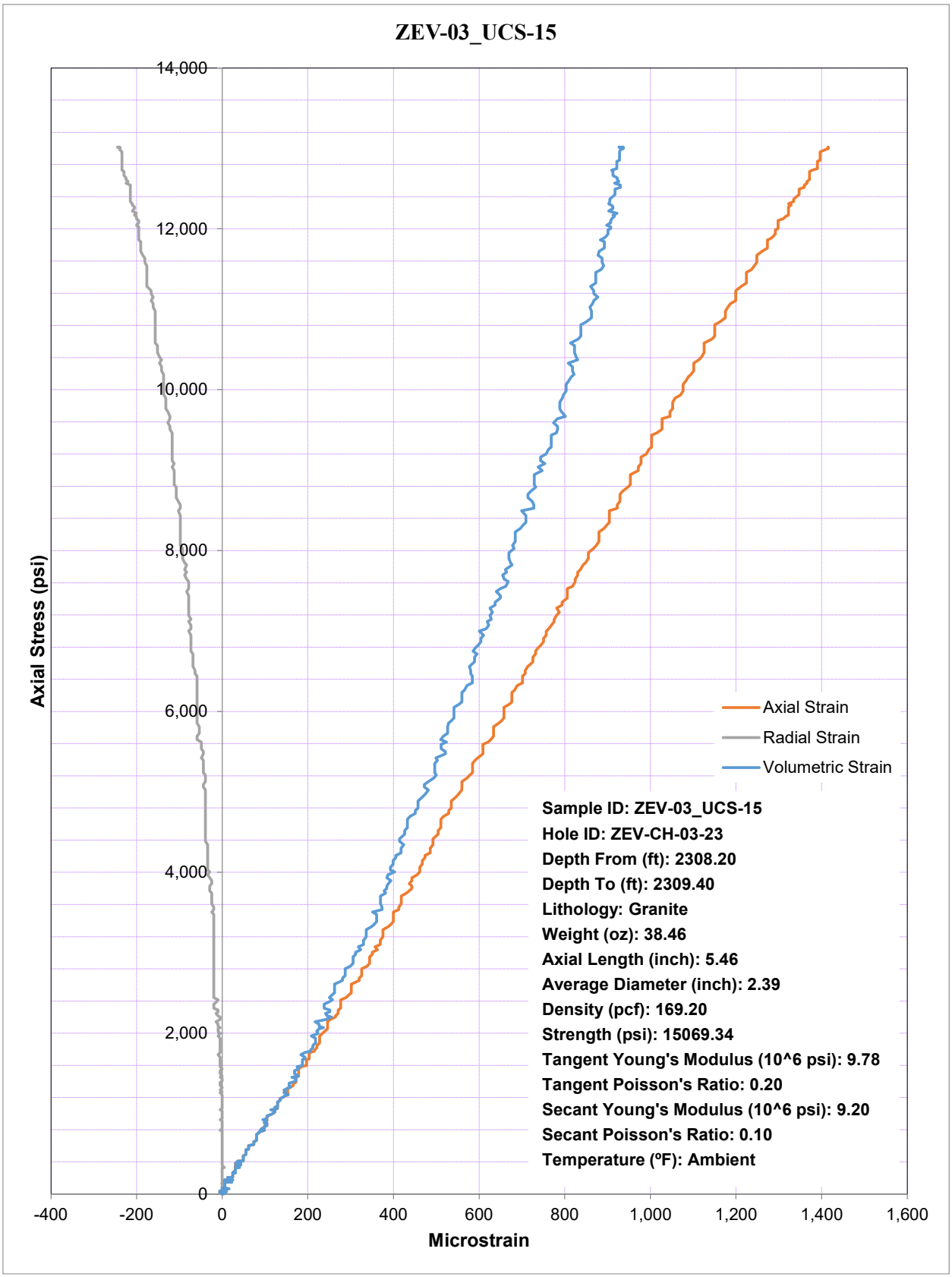

ZEV-03_UCS-10
Axial Stress (psi)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
-2,000
-1,500
-1,000
-500
0
500
1,000
1,500
2,000
2,500
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-10
Hole ID: ZEV-CH-03-23
Depth From (ft): 2190.00
Depth To (ft): 2191.00
Lithology: Granite
Weight (oz): 35.97
Axial Length (inch): 5.38
Average Diameter (inch): 2.40
Density (pcf): 159.79
Strength (psi): 3582.54
Tangent Young's Modulus (10^6 psi): 1.83
Tangent Poisson's Ratio: 0.29
Secant Young's Modulus (10^6 psi): 1.63
Secant Poisson's Ratio: 0.13
Temperature (ºF): Ambient

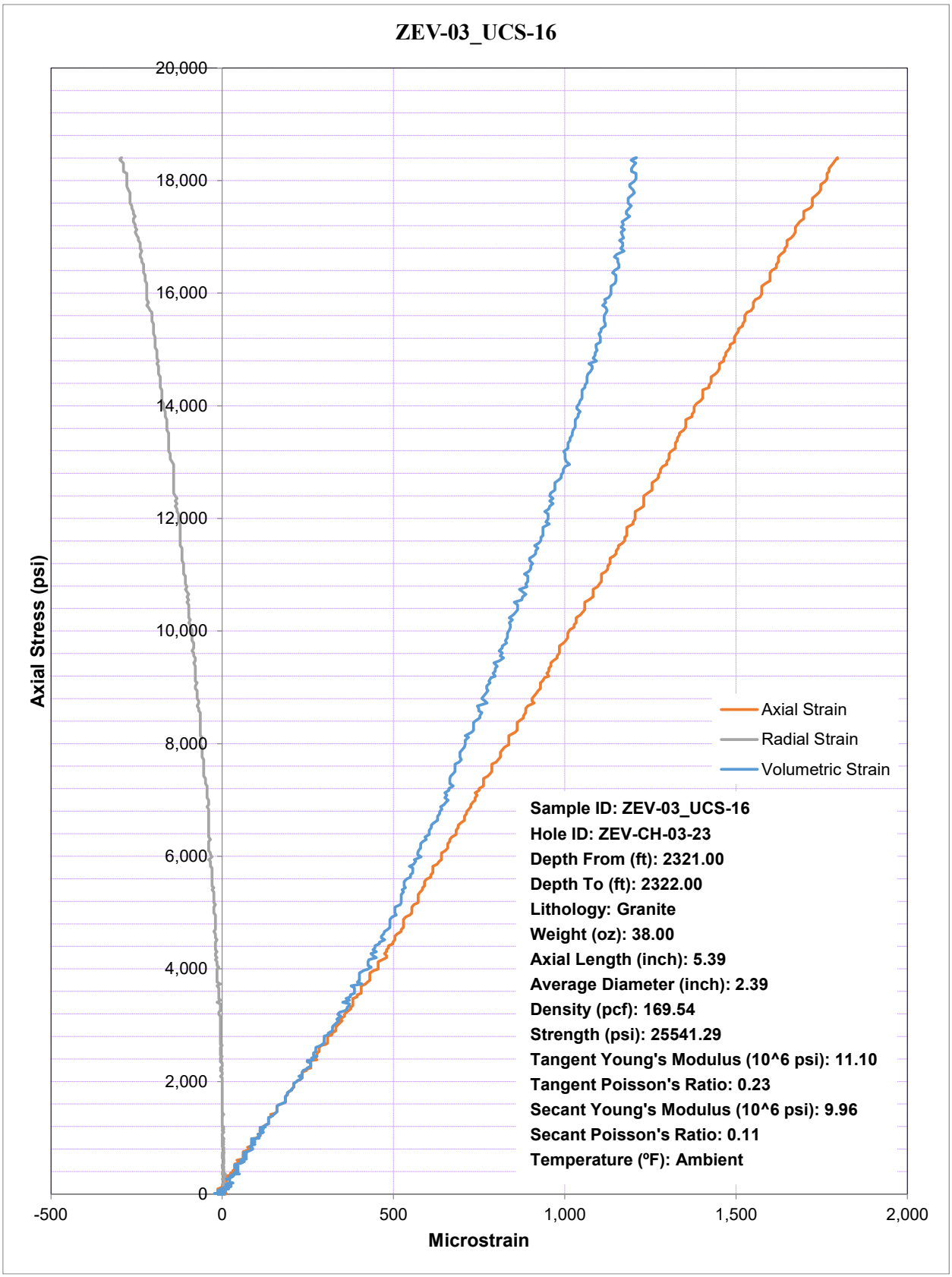

ZEV-03_UCS-11
Axial Stress (psi)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-1,500
-1,000
-500
0
500
1,000
1,500
2,000
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-11
Hole ID: ZEV-CH-03-23
Depth From (ft): 2212.40
Depth To (ft): 2213.50
Lithology: Granite
Weight (oz): 38.51
Axial Length (inch): 5.58
Average Diameter (inch): 2.37
Density (pcf): 168.41
Strength (psi): 16257.13
Tangent Young's Modulus (10^6 psi): 9.40
Tangent Poisson's Ratio: NA
Secant Young's Modulus (10^6 psi): 8.62
Secant Poisson's Ratio: NA
Temperature (ºF): Ambient

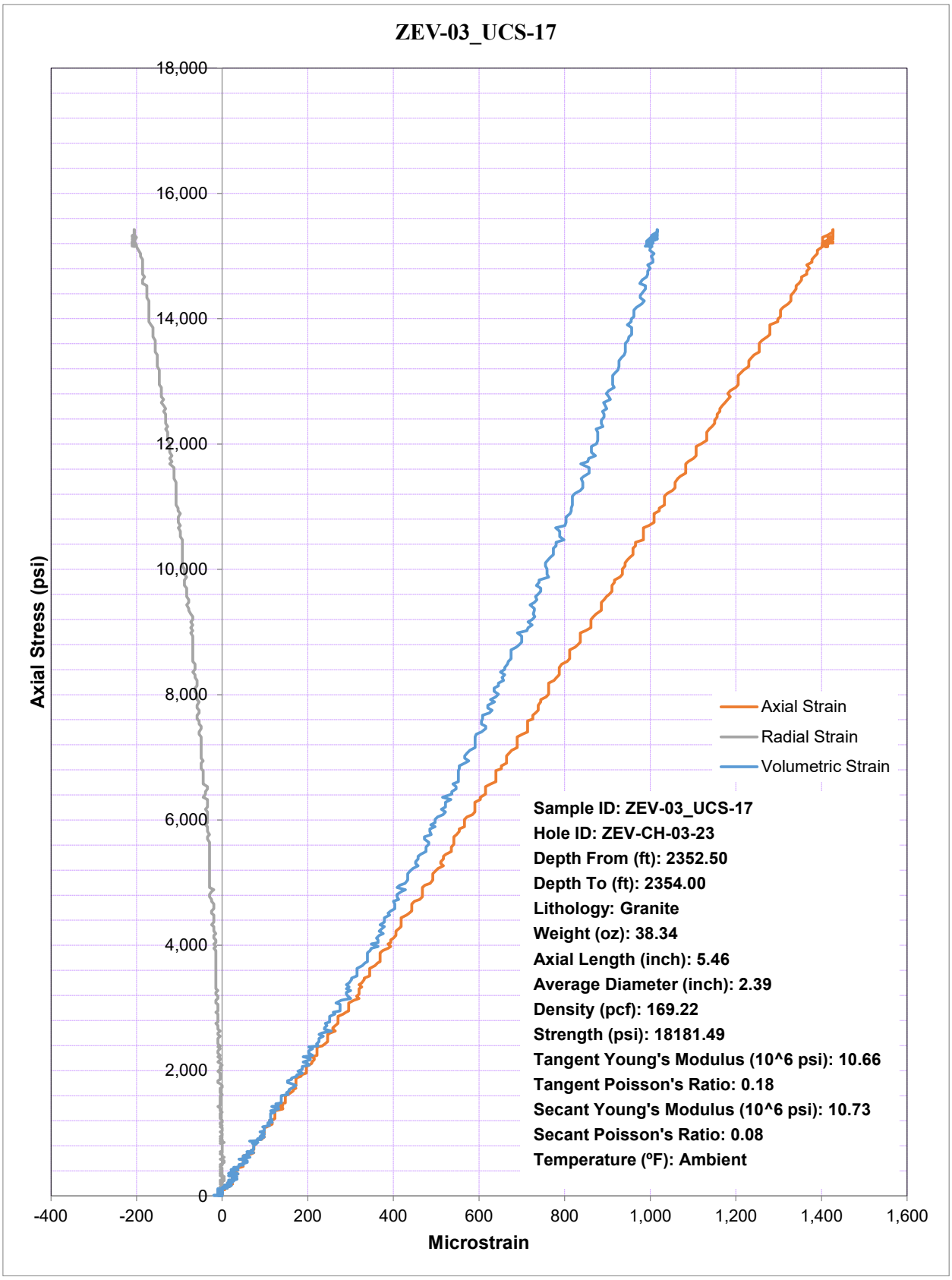

ZEV-03_UCS-12
Axial Stress (psi)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-400
-200
0
200
400
600
800
1,000
1,200
1,400
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-12
Hole ID: ZEV-CH-03-23
Depth From (ft): 2224.00
Depth To (ft): 2224.65
Lithology: Granite
Weight (oz): 37.38
Axial Length (inch): 5.38
Average Diameter (inch): 2.40
Density (pcf): 166.21
Strength (psi): 18589.11
Tangent Young's Modulus (10^6 psi): 11.43
Tangent Poisson's Ratio: 0.19
Secant Young's Modulus (10^6 psi): 11.53
Secant Poisson's Ratio: 0.09
Temperature (ºF): Ambient

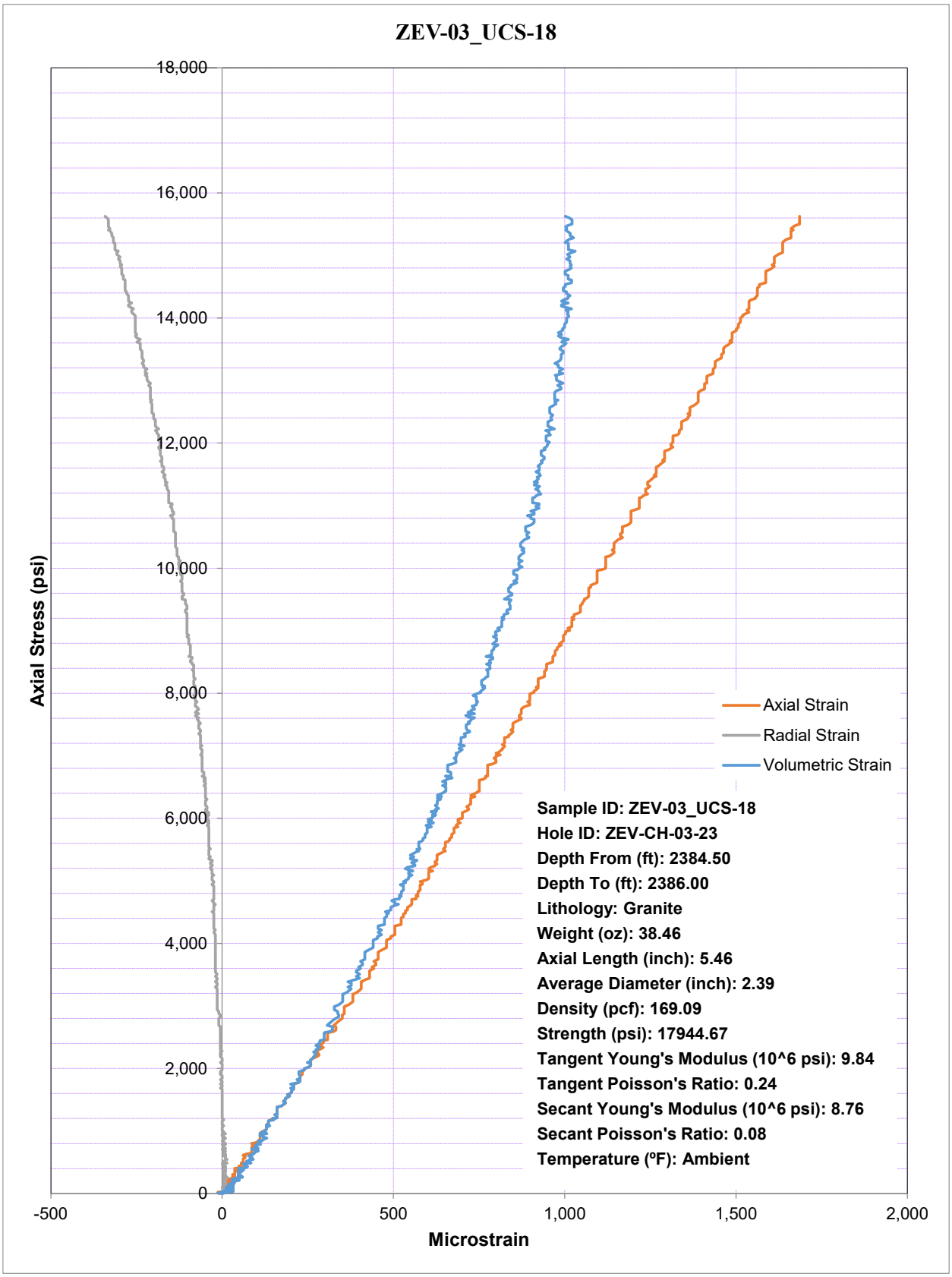

ZEV-03_UCS-13
Axial Stress (psi)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-1,000
-500
0
500
1,000
1,500
2,000
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-13
Hole ID: ZEV-CH-03-23
Depth From (ft): 2254.20
Depth To (ft): 2255.50
Lithology: Granite
Weight (oz): 38.27
Axial Length (inch): 5.41
Average Diameter (inch): 2.40
Density (pcf): 169.05
Strength (psi): 16102.59
Tangent Young's Modulus (10^6 psi): 9.35
Tangent Poisson's Ratio: 0.17
Secant Young's Modulus (10^6 psi): 8.59
Secant Poisson's Ratio: 0.11
Temperature (ºF): Ambient

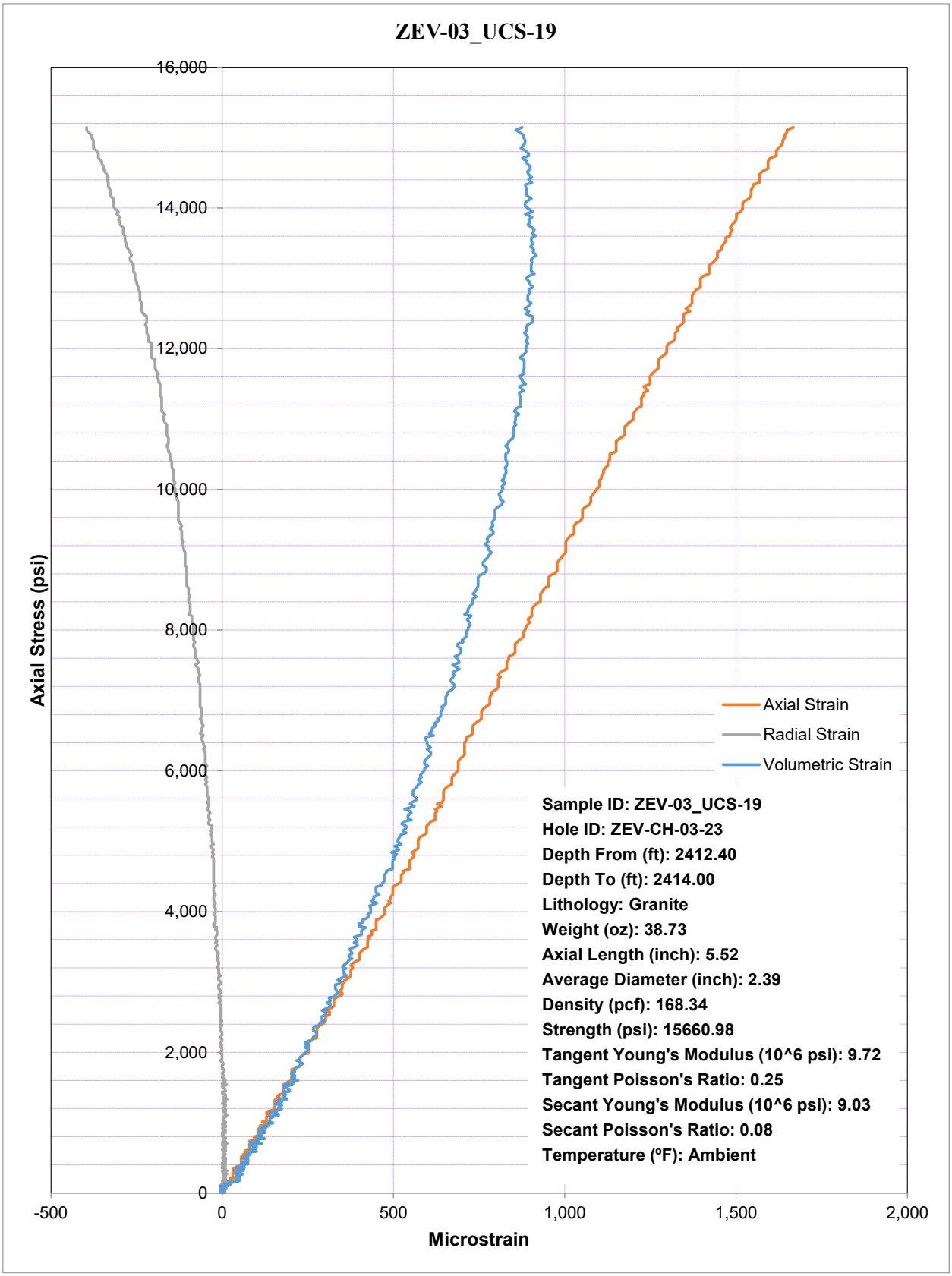

ZEV-03_UCS-14
Axial Stress (psi)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-400
-200
0
200
400
600
800
1,000
1,200
1,400
1,600
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-14
Hole ID: ZEV-CH-03-23
Depth From (ft): 2279.00
Depth To (ft): 2280.00
Lithology: Granite
Weight (oz): 38.06
Axial Length (inch): 5.40
Average Diameter (inch): 2.40
Density (pcf): 168.80
Strength (psi): 19470.36
Tangent Young's Modulus (10^6 psi): 10.47
Tangent Poisson's Ratio: 0.17
Secant Young's Modulus (10^6 psi): 9.86
Secant Poisson's Ratio: 0.07
Temperature (ºF): Ambient

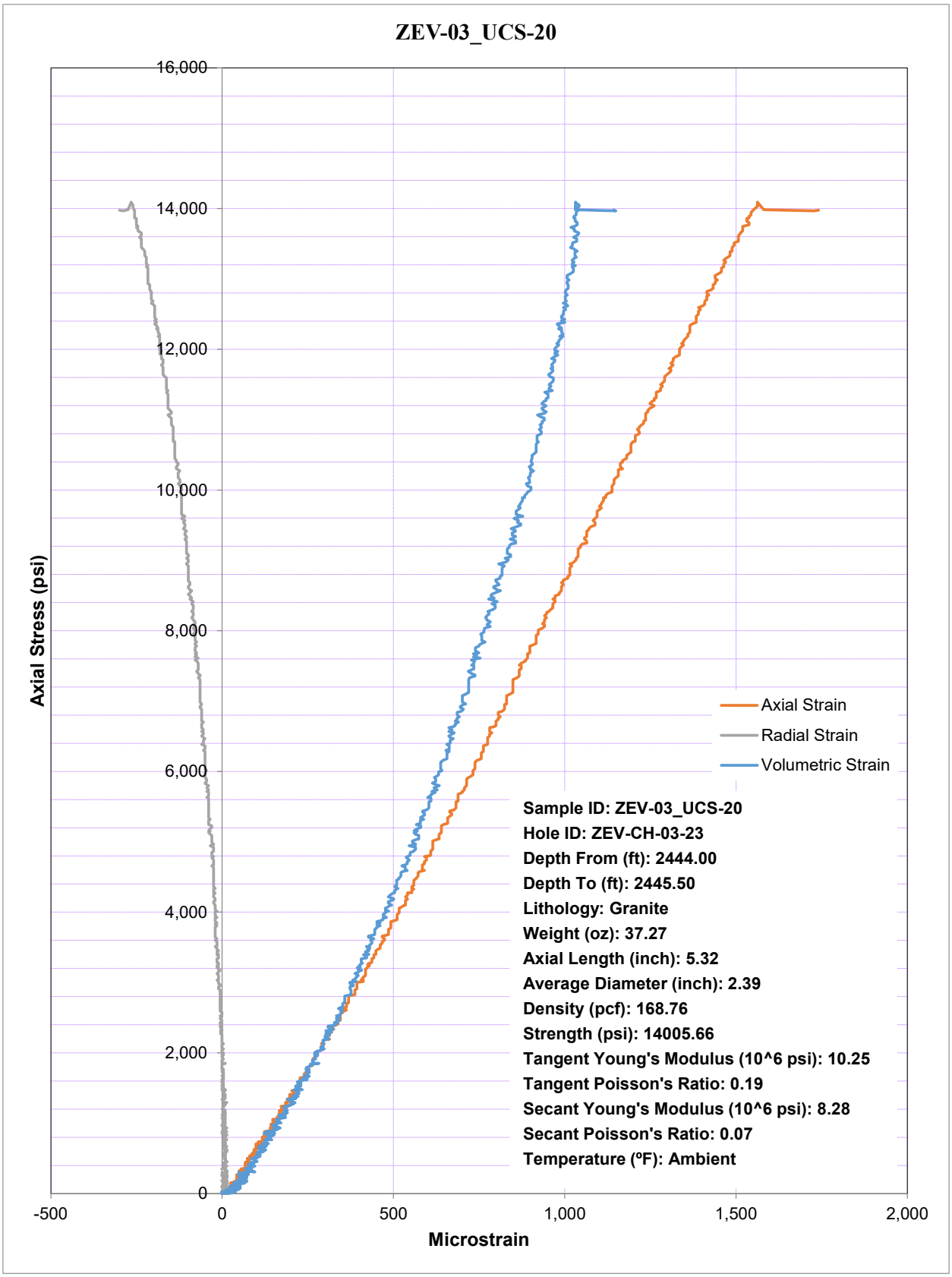

ZEV-03_UCS-15
Axial Stress (psi)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-400
-200
0
200
400
600
800
1,000
1,200
1,400
1,600
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-15
Hole ID: ZEV-CH-03-23
Depth From (ft): 2308.20
Depth To (ft): 2309.40
Lithology: Granite
Weight (oz): 38.46
Axial Length (inch): 5.46
Average Diameter (inch): 2.39
Density (pcf): 169.20
Strength (psi): 15069.34
Tangent Young's Modulus (10^6 psi): 9.78
Tangent Poisson's Ratio: 0.20
Secant Young's Modulus (10^6 psi): 9.20
Secant Poisson's Ratio: 0.10
Temperature (ºF): Ambient

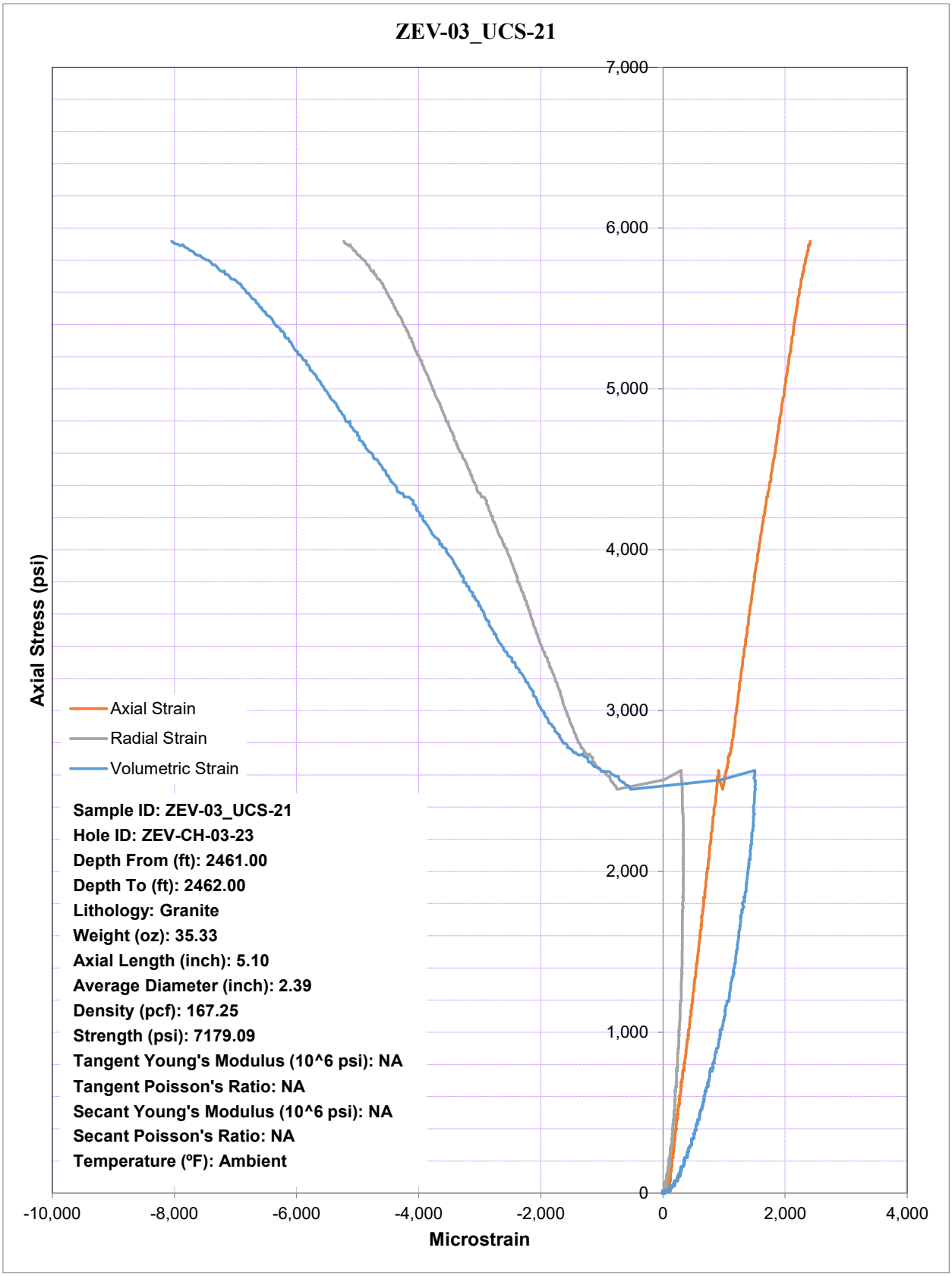

ZEV-03_UCS-16
Axial Stress (psi)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-500
0
500
1,000
1,500
2,000
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-16
Hole ID: ZEV-CH-03-23
Depth From (ft): 2321.00
Depth To (ft): 2322.00
Lithology: Granite
Weight (oz): 38.00
Axial Length (inch): 5.39
Average Diameter (inch): 2.39
Density (pcf): 169.54
Strength (psi): 25541.29
Tangent Young's Modulus (10^6 psi): 11.10
Tangent Poisson's Ratio: 0.23
Secant Young's Modulus (10^6 psi): 9.96
Secant Poisson's Ratio: 0.11
Temperature (ºF): Ambient

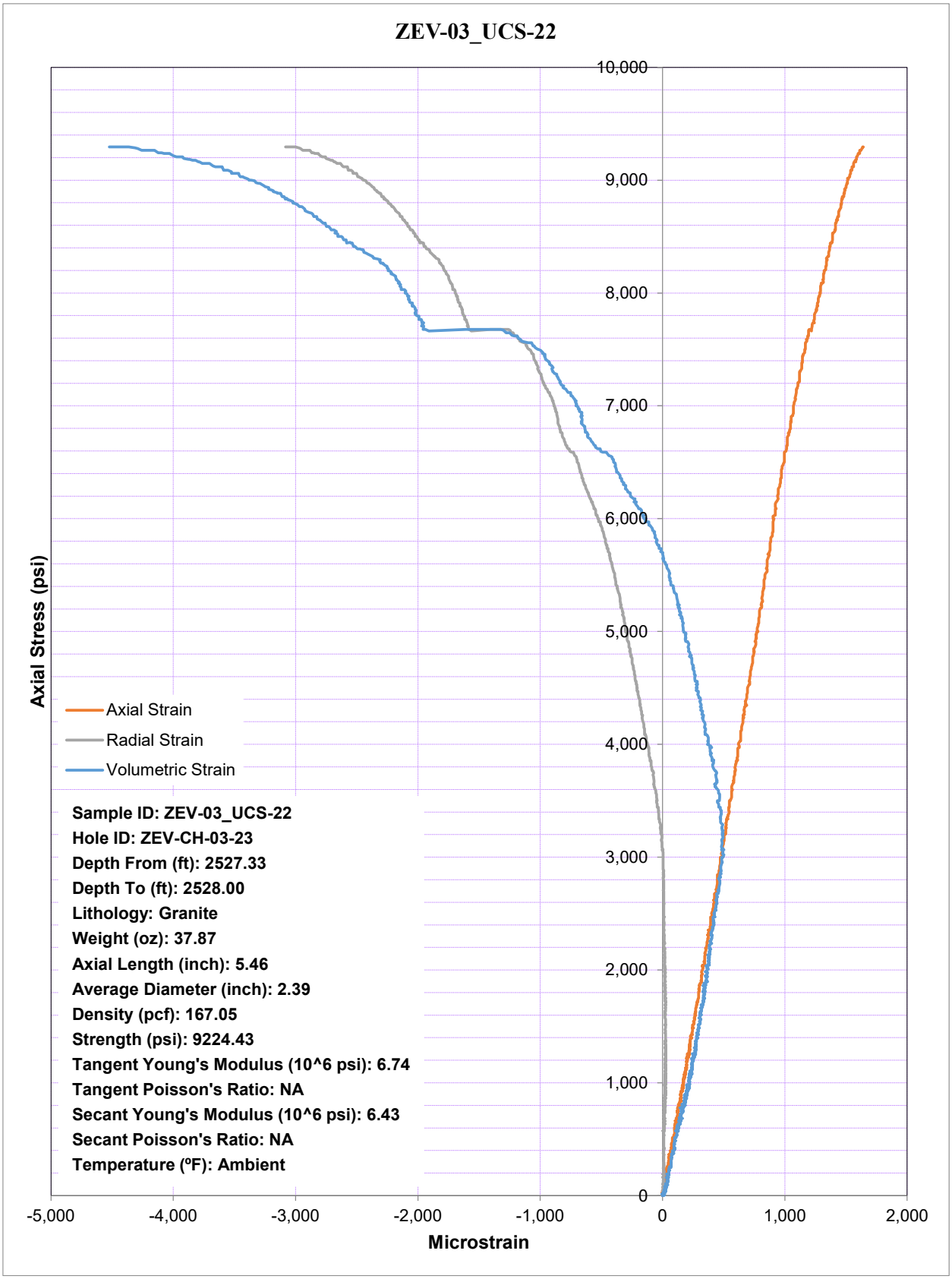

ZEV-03_UCS-17
Axial Stress (psi)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-400
-200
0
200
400
600
800
1,000
1,200
1,400
1,600
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-17
Hole ID: ZEV-CH-03-23
Depth From (ft): 2352.50
Depth To (ft): 2354.00
Lithology: Granite
Weight (oz): 38.34
Axial Length (inch): 5.46
Average Diameter (inch): 2.39
Density (pcf): 169.22
Strength (psi): 18181.49
Tangent Young's Modulus (10^6 psi): 10.66
Tangent Poisson's Ratio: 0.18
Secant Young's Modulus (10^6 psi): 10.73
Secant Poisson's Ratio: 0.08
Temperature (ºF): Ambient

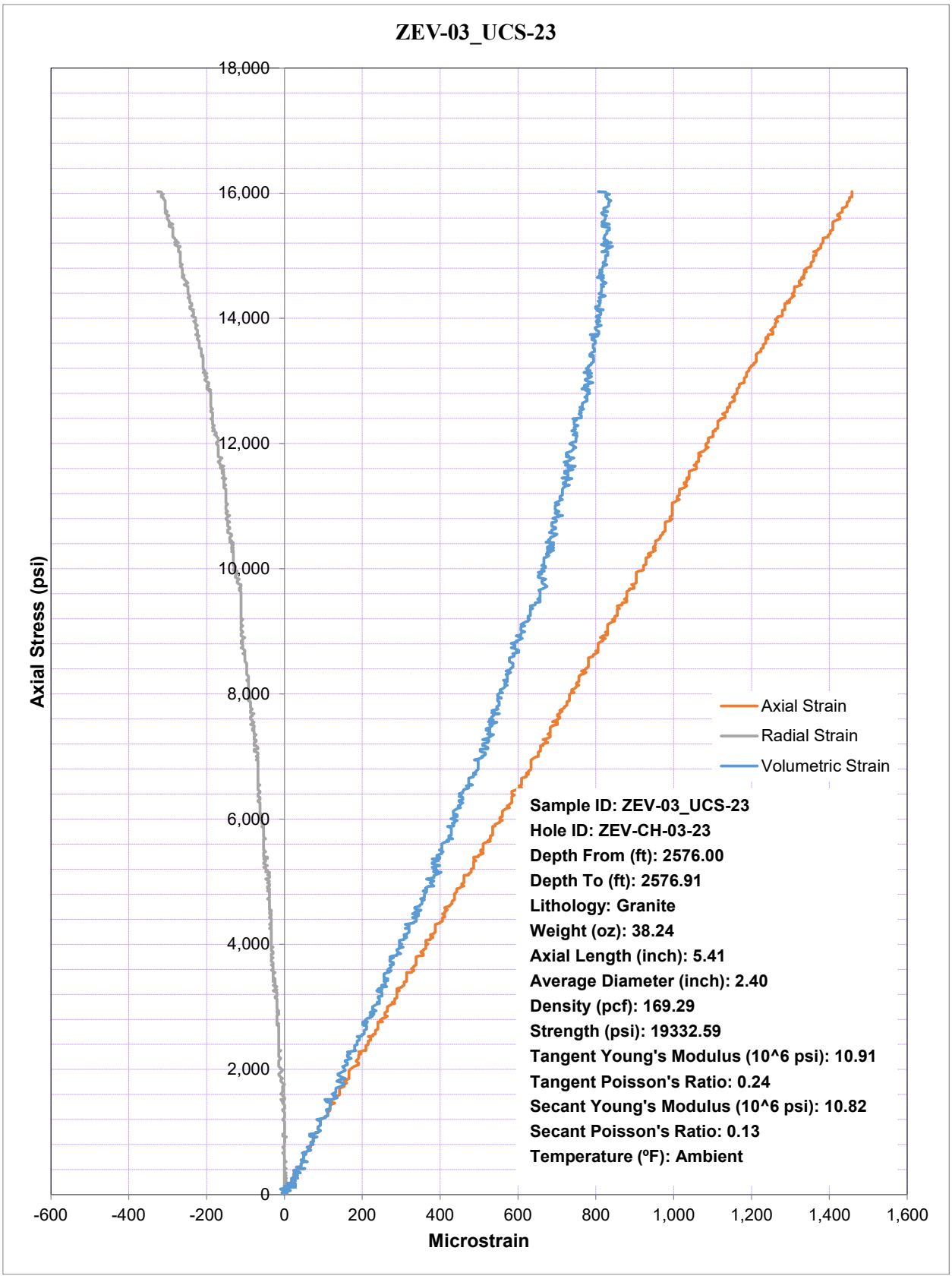

ZEV-03_UCS-18
Axial Stress (psi)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-500
0
500
1,000
1,500
2,000
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-18
Hole ID: ZEV-CH-03-23
Depth From (ft): 2384.50
Depth To (ft): 2386.00
Lithology: Granite
Weight (oz): 38.46
Axial Length (inch): 5.46
Average Diameter (inch): 2.39
Density (pcf): 169.09
Strength (psi): 17944.67
Tangent Young's Modulus (10^6 psi): 9.84
Tangent Poisson's Ratio: 0.24
Secant Young's Modulus (10^6 psi): 8.76
Secant Poisson's Ratio: 0.08
Temperature (ºF): Ambient

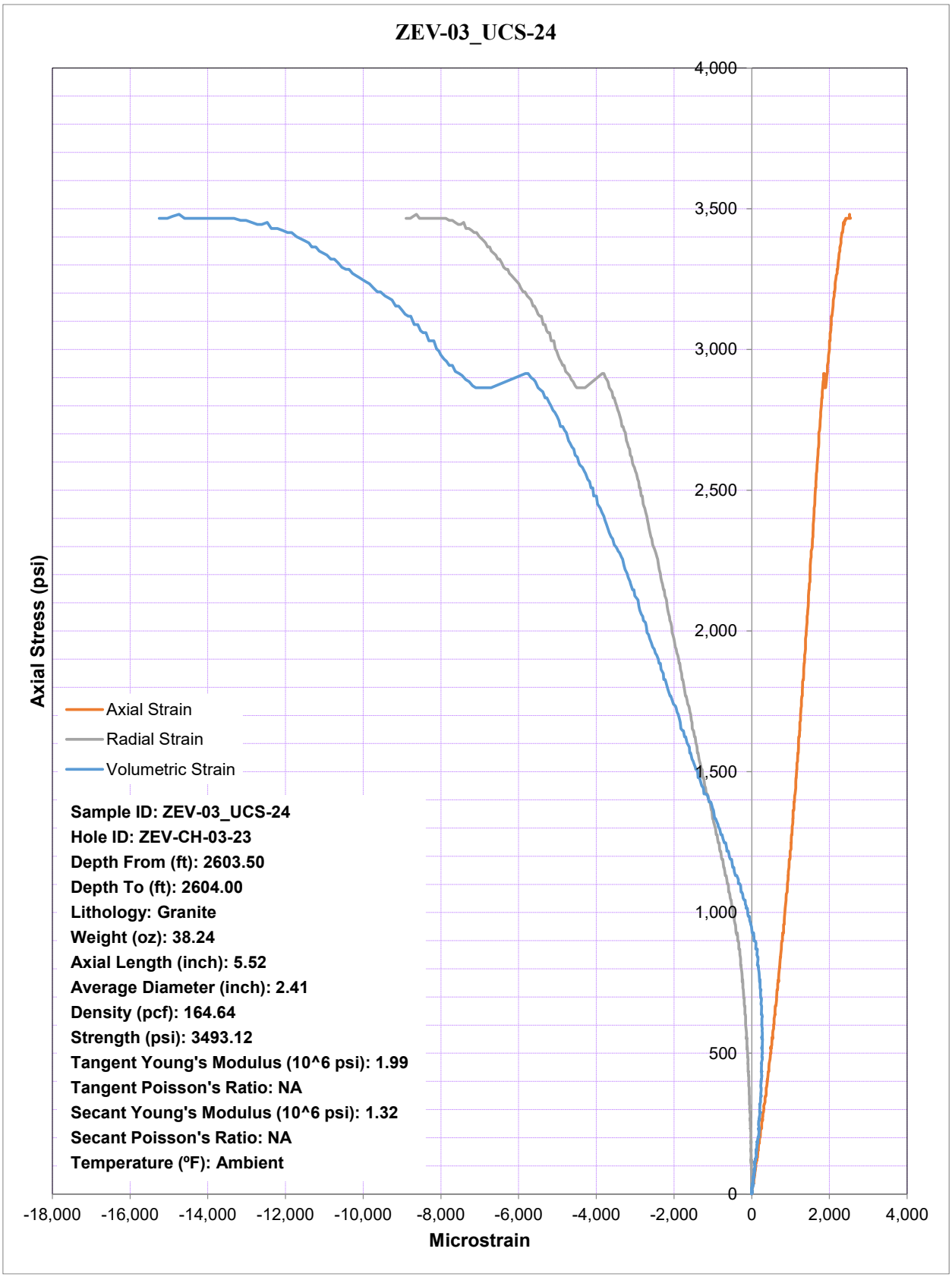

ZEV-03_UCS-19
Axial Stress (psi)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-500
0
500
1,000
1,500
2,000
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-19
Hole ID: ZEV-CH-03-23
Depth From (ft): 2412.40
Depth To (ft): 2414.00
Lithology: Granite
Weight (oz): 38.73
Axial Length (inch): 5.52
Average Diameter (inch): 2.39
Density (pcf): 168.34
Strength (psi): 15660.98
Tangent Young's Modulus (10^6 psi): 9.72
Tangent Poisson's Ratio: 0.25
Secant Young's Modulus (10^6 psi): 9.03
Secant Poisson's Ratio: 0.08
Temperature (ºF): Ambient

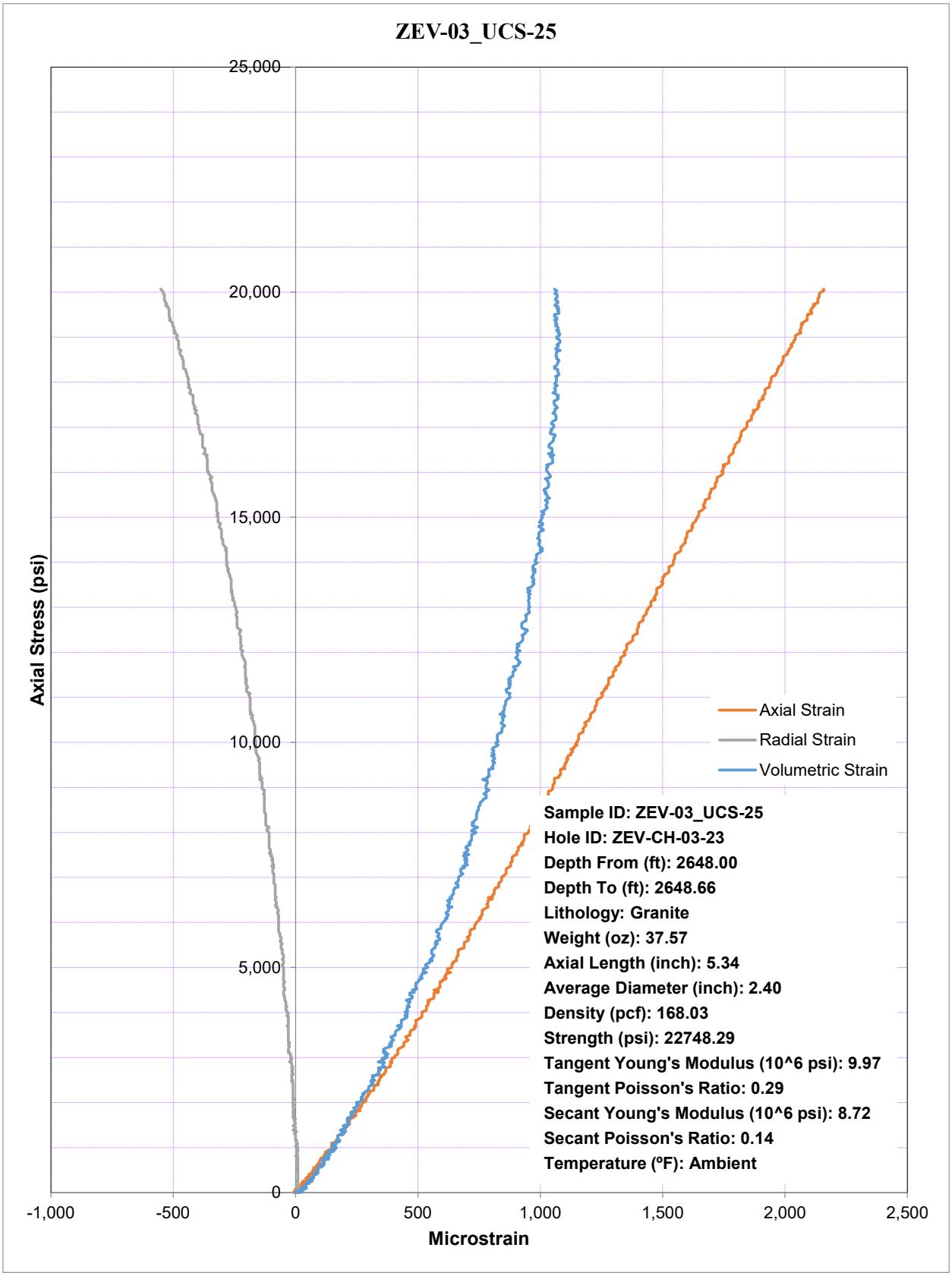

ZEV-03_UCS-20
Axial Stress (psi)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-500
0
500
1,000
1,500
2,000
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-20
Hole ID: ZEV-CH-03-23
Depth From (ft): 2444.00
Depth To (ft): 2445.50
Lithology: Granite
Weight (oz): 37.27
Axial Length (inch): 5.32
Average Diameter (inch): 2.39
Density (pcf): 168.76
Strength (psi): 14005.66
Tangent Young's Modulus (10^6 psi): 10.25
Tangent Poisson's Ratio: 0.19
Secant Young's Modulus (10^6 psi): 8.28
Secant Poisson's Ratio: 0.07
Temperature (ºF): Ambient

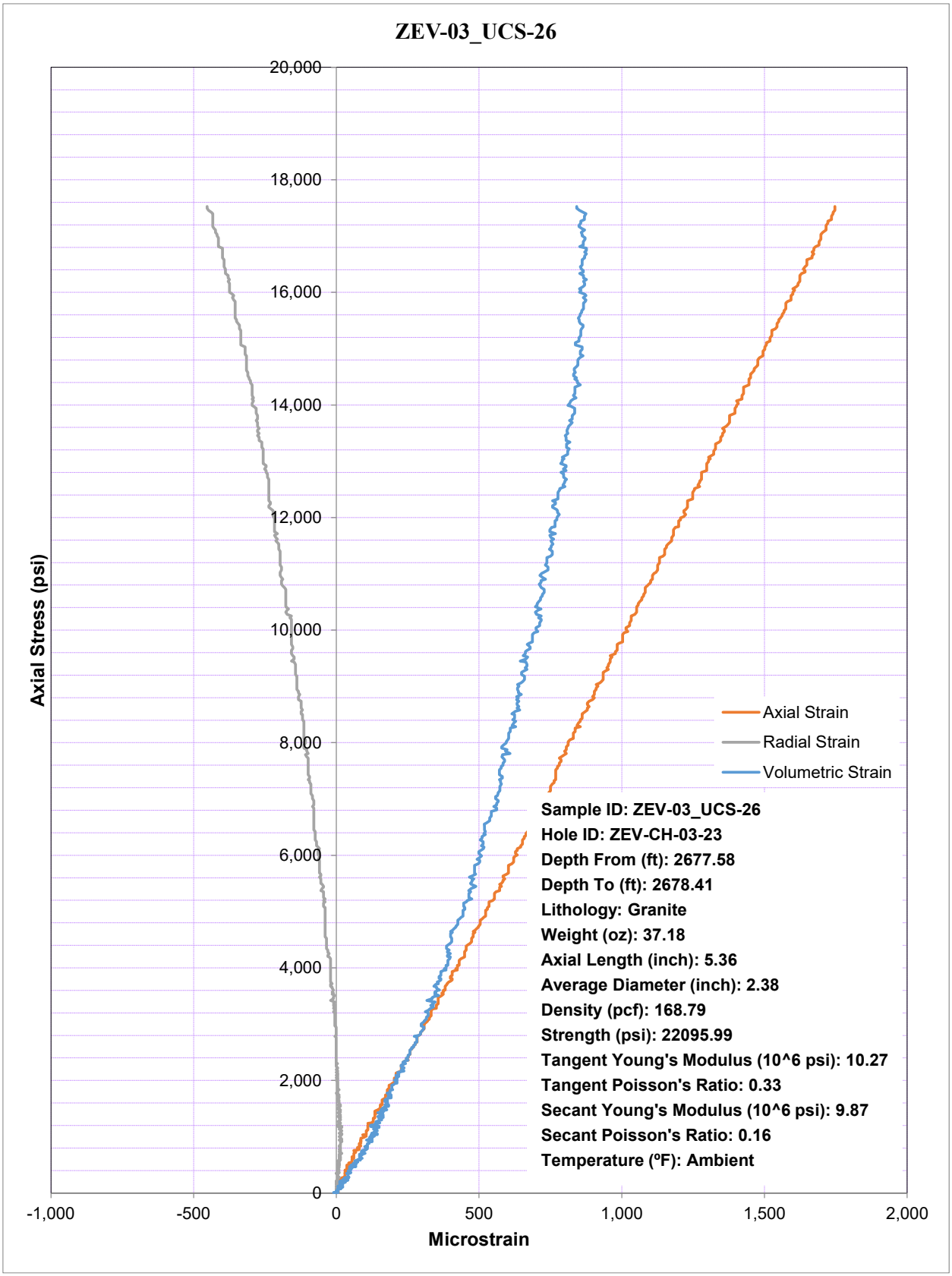

ZEV-03_UCS-21
Axial Stress (psi)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
-10,000
-8,000
-6,000
-4,000
-2,000
0
2,000
4,000
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-21
Hole ID: ZEV-CH-03-23
Depth From (ft): 2461.00
Depth To (ft): 2462.00
Lithology: Granite
Weight (oz): 35.33
Axial Length (inch): 5.10
Average Diameter (inch): 2.39
Density (pcf): 167.25
Strength (psi): 7179.09
Tangent Young's Modulus (10^6 psi): NA
Tangent Poisson's Ratio: NA
Secant Young's Modulus (10^6 psi): NA
Secant Poisson's Ratio: NA
Temperature (ºF): Ambient

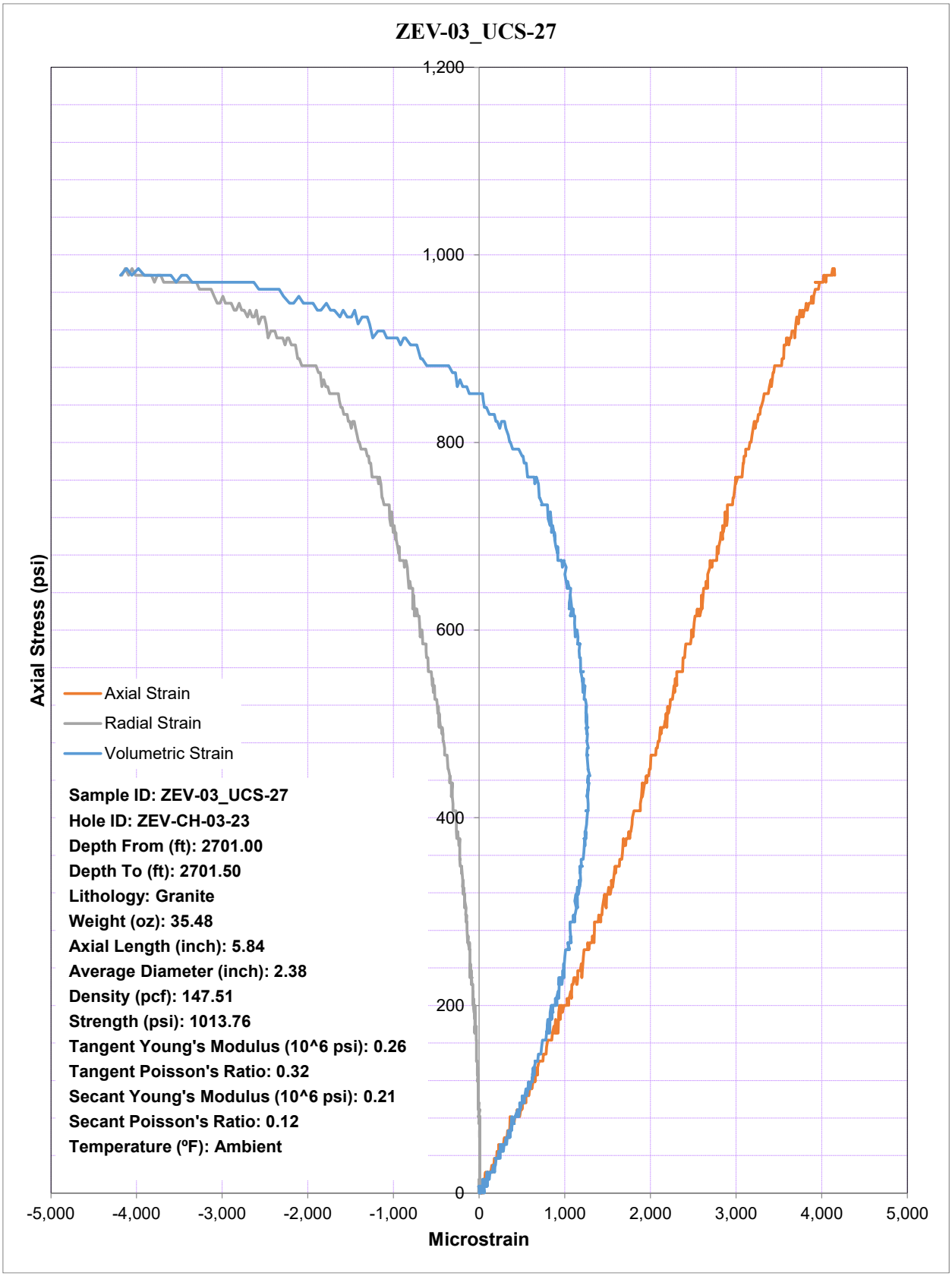

ZEV-03_UCS-22
Axial Stress (psi)
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
-5,000
-4,000
-3,000
-2,000
-1,000
0
1,000
2,000
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-22
Hole ID: ZEV-CH-03-23
Depth From (ft): 2527.33
Depth To (ft): 2528.00
Lithology: Granite
Weight (oz): 37.87
Axial Length (inch): 5.46
Average Diameter (inch): 2.39
Density (pcf): 167.05
Strength (psi): 9224.43
Tangent Young's Modulus (10^6 psi): 6.74
Tangent Poisson's Ratio: NA
Secant Young's Modulus (10^6 psi): 6.43
Secant Poisson's Ratio: NA
Temperature (ºF): Ambient

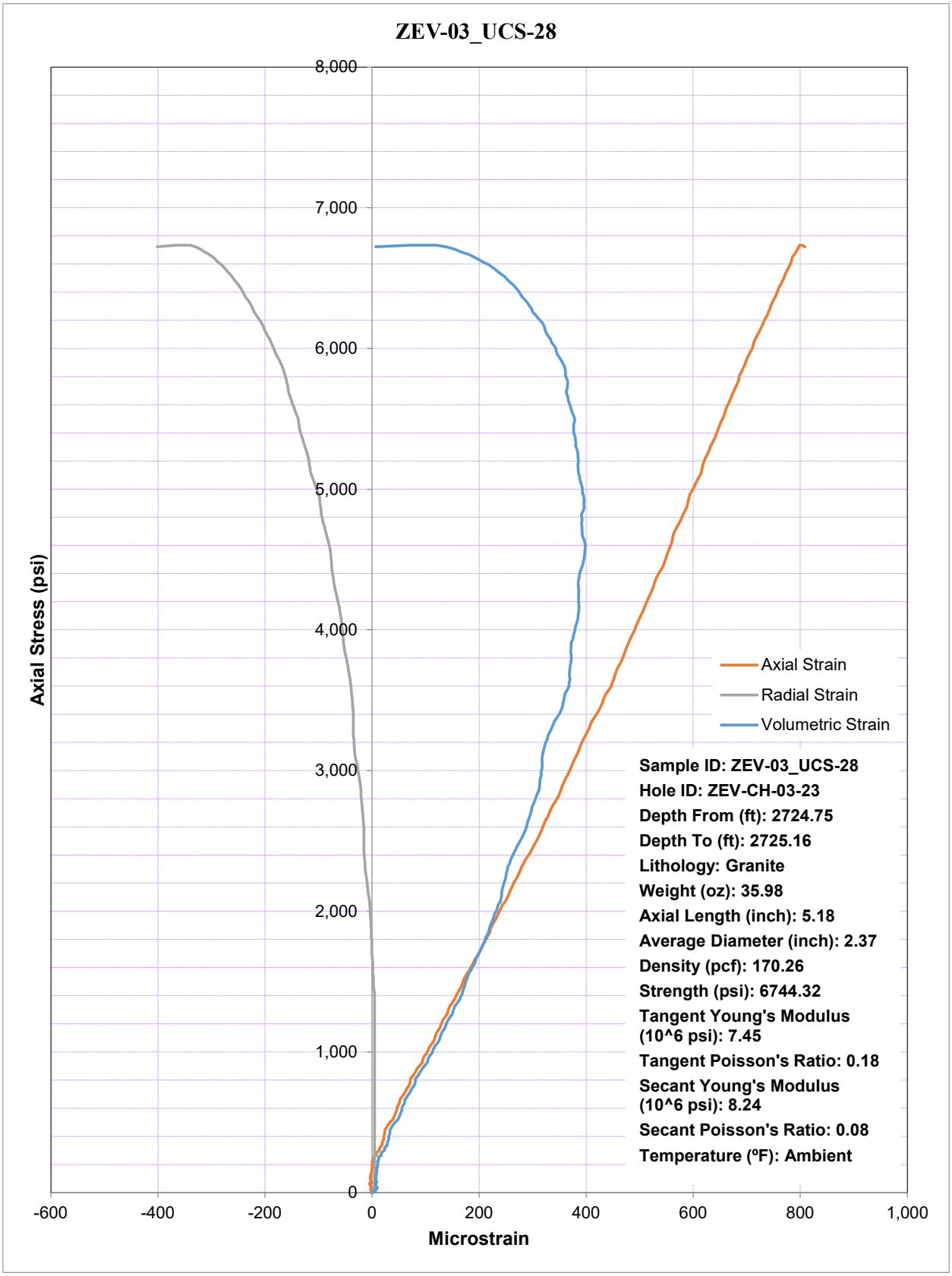

ZEV-03_UCS-23
Axial Stress (psi)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-600
-400
-200
0
200
400
600
800
1,000
1,200
1,400
1,600
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-23
Hole ID: ZEV-CH-03-23
Depth From (ft): 2576.00
Depth To (ft): 2576.91
Lithology: Granite
Weight (oz): 38.24
Axial Length (inch): 5.41
Average Diameter (inch): 2.40
Density (pcf): 169.29
Strength (psi): 19332.59
Tangent Young's Modulus (10^6 psi): 10.91
Tangent Poisson's Ratio: 0.24
Secant Young's Modulus (10^6 psi): 10.82
Secant Poisson's Ratio: 0.13
Temperature (ºF): Ambient

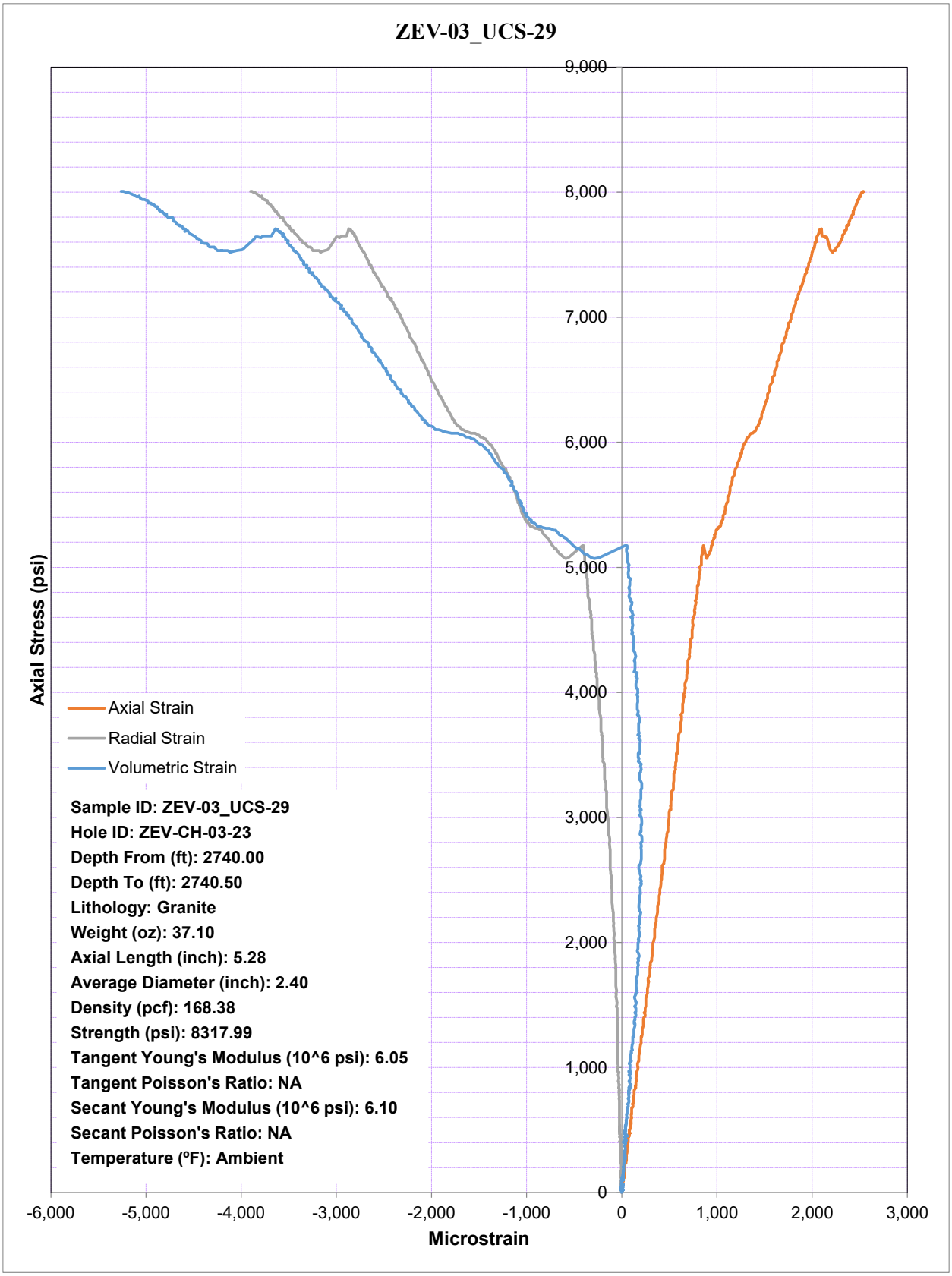

ZEV-03_UCS-24
Axial Stress (psi)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
-18,000
-16,000
-14,000
-12,000
-10,000
-8,000
-6,000
-4,000
-2,000
0
2,000
4,000
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-24
Hole ID: ZEV-CH-03-23
Depth From (ft): 2603.50
Depth To (ft): 2604.00
Lithology: Granite
Weight (oz): 38.24
Axial Length (inch): 5.52
Average Diameter (inch): 2.41
Density (pcf): 164.64
Strength (psi): 3493.12
Tangent Young's Modulus (10^6 psi): 1.99
Tangent Poisson's Ratio: NA
Secant Young's Modulus (10^6 psi): 1.32
Secant Poisson's Ratio: NA
Temperature (ºF): Ambient

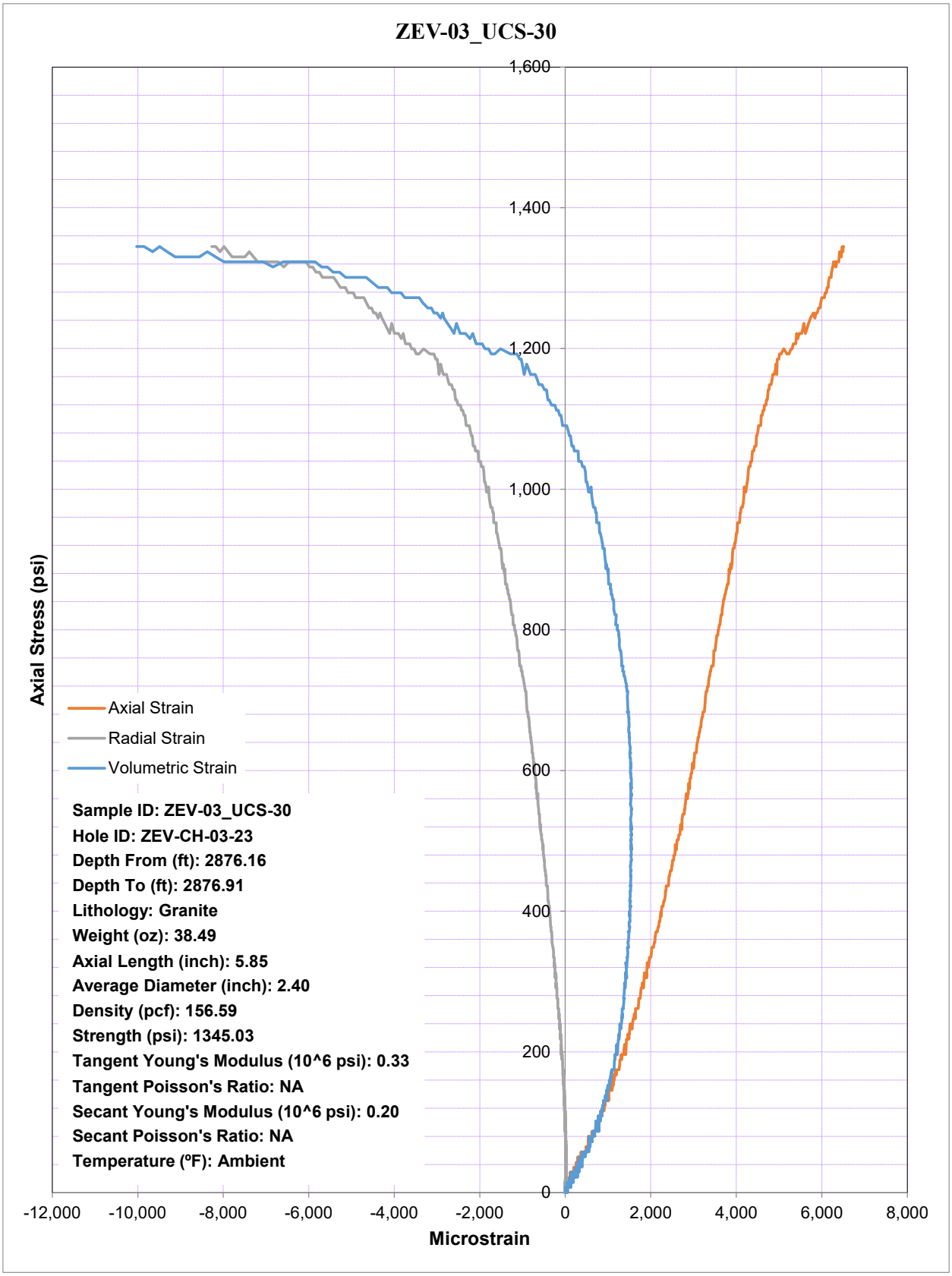

ZEV-03_UCS-25
Axial Stress (psi)
25,000
20,000
15,000
10,000
5,000
0
-1,000
-500
0
500
1,000
1,500
2,000
2,500
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-25
Hole ID: ZEV-CH-03-23
Depth From (ft): 2648.00
Depth To (ft): 2648.66
Lithology: Granite
Weight (oz): 37.57
Axial Length (inch): 5.34
Average Diameter (inch): 2.40
Density (pcf): 168.03
Strength (psi): 22748.29
Tangent Young's Modulus (10^6 psi): 9.97
Tangent Poisson's Ratio: 0.29
Secant Young's Modulus (10^6 psi): 8.72
Secant Poisson's Ratio: 0.14
Temperature (ºF): Ambient

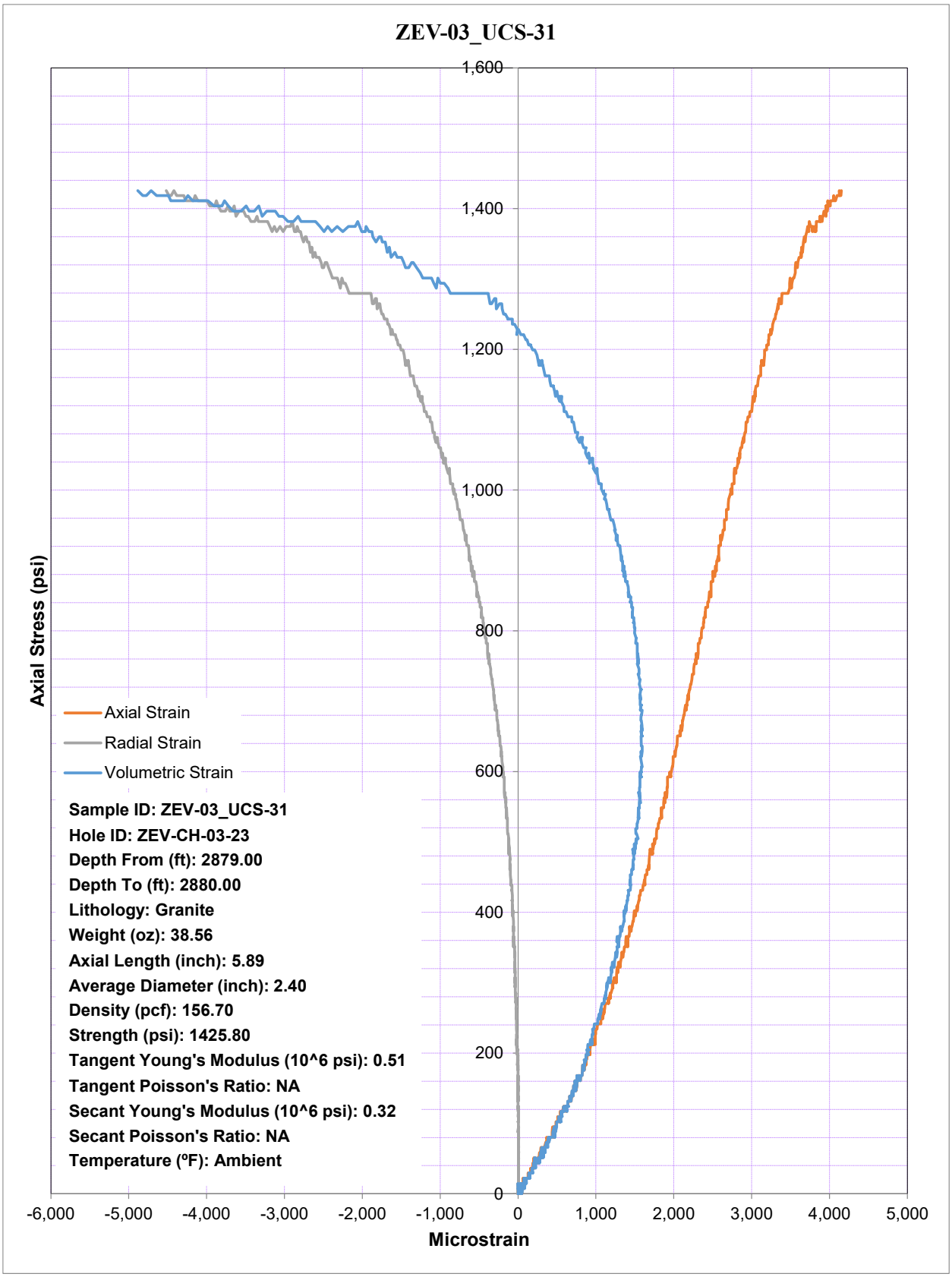

ZEV-03_UCS-26
Axial Stress (psi)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-1,000
-500
0
500
1,000
1,500
2,000
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-26
Hole ID: ZEV-CH-03-23
Depth From (ft): 2677.58
Depth To (ft): 2678.41
Lithology: Granite
Weight (oz): 37.18
Axial Length (inch): 5.36
Average Diameter (inch): 2.38
Density (pcf): 168.79
Strength (psi): 22095.99
Tangent Young's Modulus (10^6 psi): 10.27
Tangent Poisson's Ratio: 0.33
Secant Young's Modulus (10^6 psi): 9.87
Secant Poisson's Ratio: 0.16
Temperature (ºF): Ambient

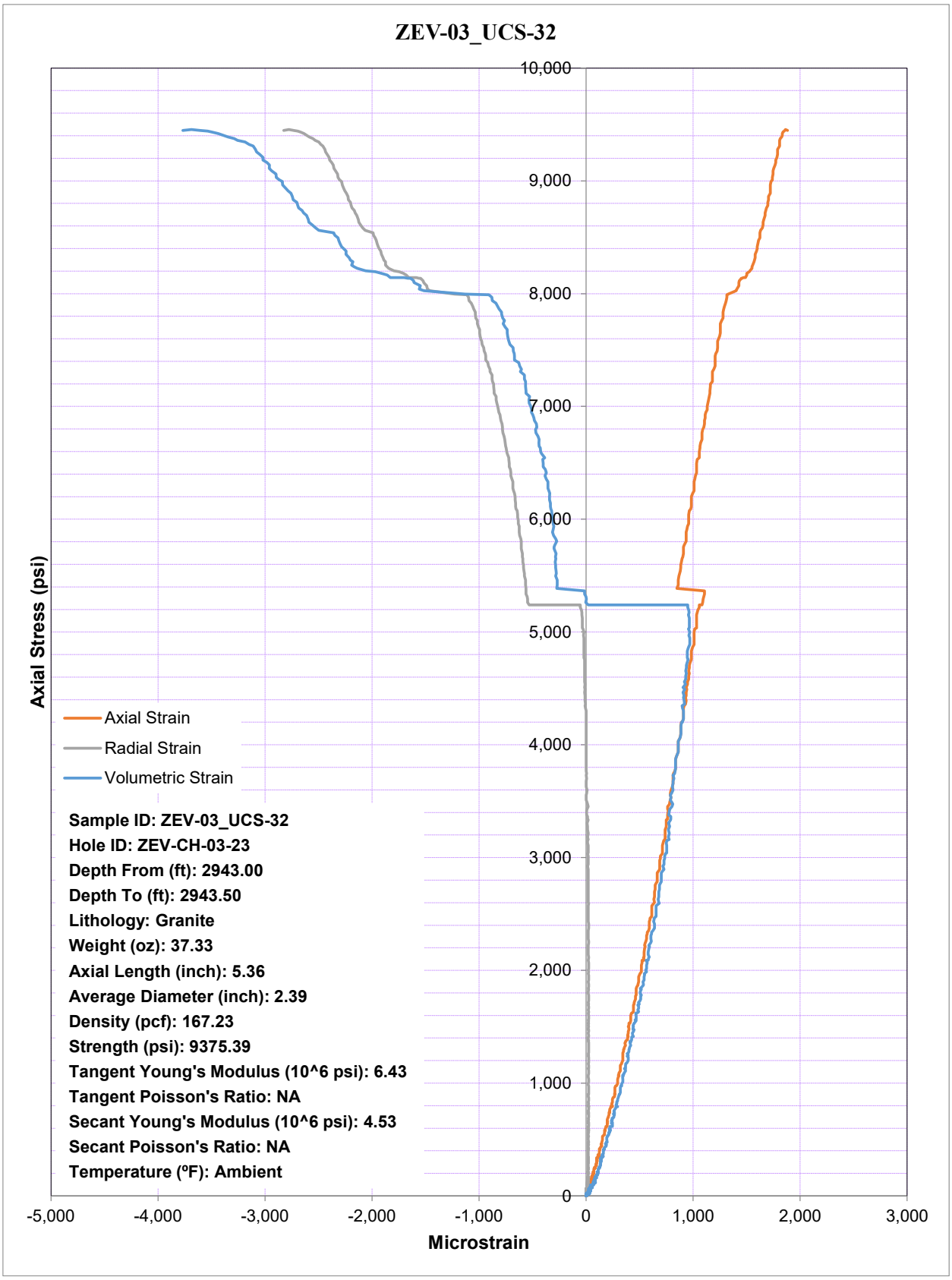

ZEV-03_UCS-27
Axial Stress (psi)
1,200
1,000
800
600
400
200
0
-5,000
-4,000
-3,000
-2,000
-1,000
0
1,000
2,000
3,000
4,000
5,000
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-27
Hole ID: ZEV-CH-03-23
Depth From (ft): 2701.00
Depth To (ft): 2701.50
Lithology: Granite
Weight (oz): 35.48
Axial Length (inch): 5.84
Average Diameter (inch): 2.38
Density (pcf): 147.51
Strength (psi): 1013.76
Tangent Young's Modulus (10^6 psi): 0.26
Tangent Poisson's Ratio: 0.32
Secant Young's Modulus (10^6 psi): 0.21
Secant Poisson's Ratio: 0.12
Temperature (ºF): Ambient

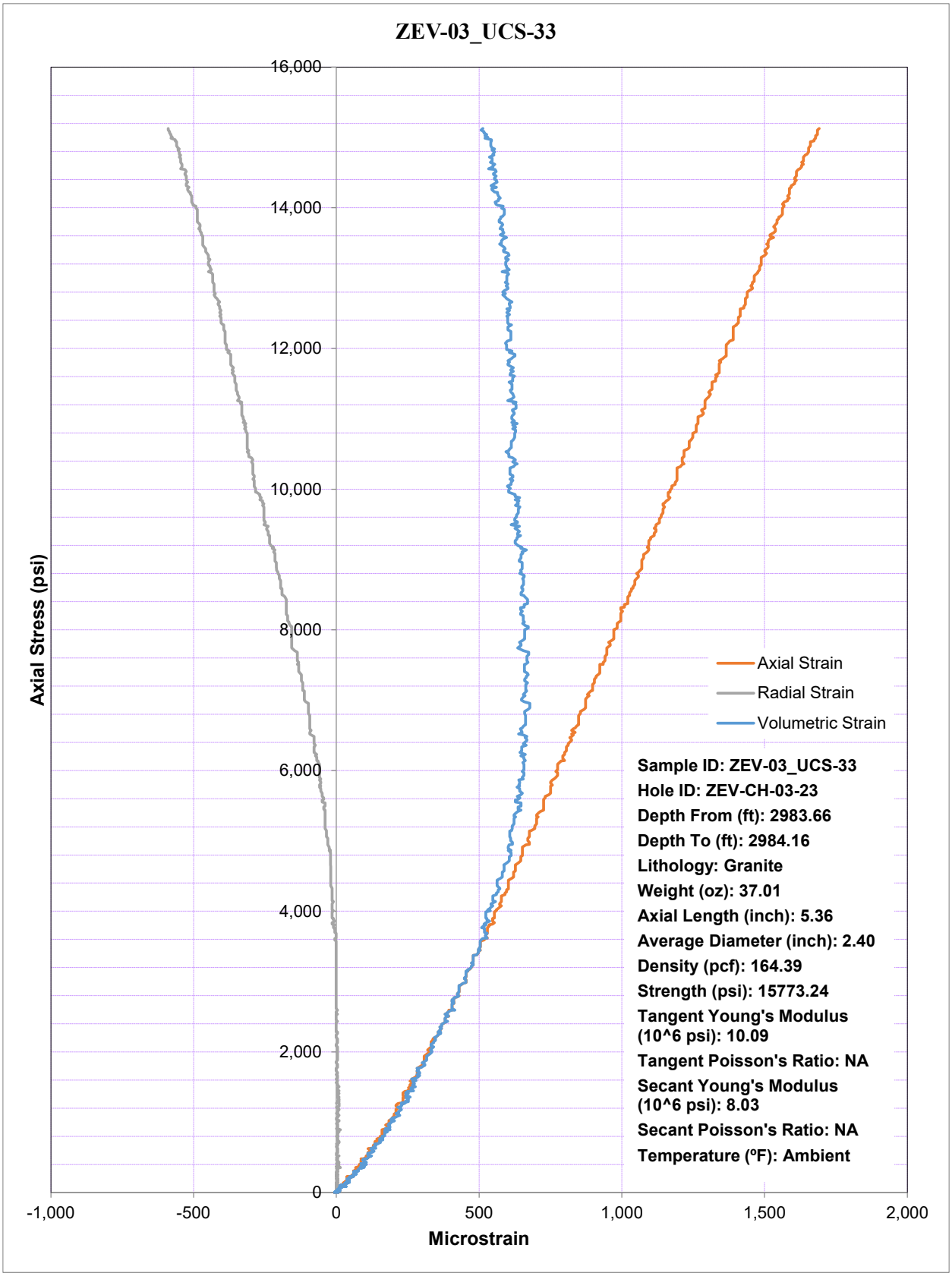

ZEV-03_UCS-28
Axial Stress (psi)
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
-600
-400
-200
0
200
400
600
800
1,000
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-28
Hole ID: ZEV-CH-03-23
Depth From (ft): 2724.75
Depth To (ft): 2725.16
Lithology: Granite
Weight (oz): 35.98
Axial Length (inch): 5.18
Average Diameter (inch): 2.37
Density (pcf): 170.26
Strength (psi): 6744.32
Tangent Young's Modulus (10^6 psi): 7.45
Tangent Poisson's Ratio: 0.18
Secant Young's Modulus (10^6 psi): 8.24
Secant Poisson's Ratio: 0.08
Temperature (ºF): Ambient


ZEV-03_UCS-29
Axial Stress (psi)
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
-6,000
-5,000
-4,000
-3,000
-2,000
-1,000
0
1,000
2,000
3,000
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-29
Hole ID: ZEV-CH-03-23
Depth From (ft): 2740.00
Depth To (ft): 2740.50
Lithology: Granite
Weight (oz): 37.10
Axial Length (inch): 5.28
Average Diameter (inch): 2.40
Density (pcf): 168.38
Strength (psi): 8317.99
Tangent Young's Modulus (10^6 psi): 6.05
Tangent Poisson's Ratio: NA
Secant Young's Modulus (10^6 psi): 6.10
Secant Poisson's Ratio: NA
Temperature (ºF): Ambient


ZEV-03_UCS-30
Axial Stress (psi)
1,600
1,400
1,200
1,000
800
600
400
200
0
-12,000
-10,000
-8,000
-6,000
-4,000
-2,000
0
2,000
4,000
6,000
8,000
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-30
Hole ID: ZEV-CH-03-23
Depth From (ft): 2876.16
Depth To (ft): 2876.91
Lithology: Granite
Weight (oz): 38.49
Axial Length (inch): 5.85
Average Diameter (inch): 2.40
Density (pcf): 156.59
Strength (psi): 1345.03
Tangent Young's Modulus (10^6 psi): 0.33
Tangent Poisson's Ratio: NA
Secant Young's Modulus (10^6 psi): 0.20
Secant Poisson's Ratio: NA
Temperature (ºF): Ambient


ZEV-03_UCS-31
Axial Stress (psi)
1,600
1,400
1,200
1,000
800
600
400
200
0
-6,000
-5,000
-4,000
-3,000
-2,000
-1,000
0
1,000
2,000
3,000
4,000
5,000
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-31
Hole ID: ZEV-CH-03-23
Depth From (ft): 2879.00
Depth To (ft): 2880.00
Lithology: Granite
Weight (oz): 38.56
Axial Length (inch): 5.89
Average Diameter (inch): 2.40
Density (pcf): 156.70
Strength (psi): 1425.80
Tangent Young's Modulus (10^6 psi): 0.51
Tangent Poisson's Ratio: NA
Secant Young's Modulus (10^6 psi): 0.32
Secant Poisson's Ratio: NA
Temperature (ºF): Ambient


ZEV-03_UCS-32
Axial Stress (psi)
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
-5,000
-4,000
-3,000
-2,000
-1,000
0
1,000
2,000
3,000
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-32
Hole ID: ZEV-CH-03-23
Depth From (ft): 2943.00
Depth To (ft): 2943.50
Lithology: Granite
Weight (oz): 37.33
Axial Length (inch): 5.36
Average Diameter (inch): 2.39
Density (pcf): 167.23
Strength (psi): 9375.39
Tangent Young's Modulus (10^6 psi): 6.43
Tangent Poisson's Ratio: NA
Secant Young's Modulus (10^6 psi): 4.53
Secant Poisson's Ratio: NA
Temperature (ºF): Ambient


ZEV-03_UCS-33
Axial Stress (psi)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-1,000
-500
0
500
1,000
1,500
2,000
Microstrain
Axial Strain
Radial Strain
Volumetric Strain
Sample ID: ZEV-03_UCS-33
Hole ID: ZEV-CH-03-23
Depth From (ft): 2983.66
Depth To (ft): 2984.16
Lithology: Granite
Weight (oz): 37.01
Axial Length (inch): 5.36
Average Diameter (inch): 2.40
Density (pcf): 164.39
Strength (psi): 15773.24
Tangent Young's Modulus (10^6 psi): 10.09
Tangent Poisson's Ratio: NA
Secant Young's Modulus (10^6 psi): 8.03
Secant Poisson's Ratio: NA
Temperature (ºF): Ambient

APPENDIX C

BEFORE AND AFTER PHOTOGRAPHS OF UNIAXIAL COMPRESSIVE STRENGTH TEST SPECIMENS

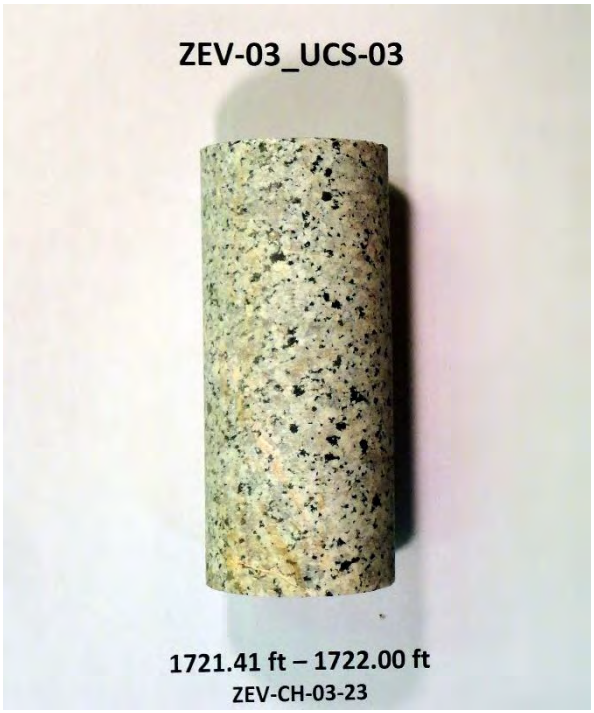
ZEV-03_UCS-01—Before

ZEV-03_UCS-01—After

ZEV-03_UCS-02—Before

ZEV-03_UCS-02—After

Figure C-1. Before and After Photographs of Uniaxial Compressive Strength Test Specimens



ZEV_03-UCS-03—Before

ZEV-03_UCS-03—After

ZEV-03_UCS-04—Before

ZEV-03_UCS-04—After

Figure C-1. Before and After Photographs of Uniaxial Compressive Strength Test Specimens *(continued)*

ZEV-03_UCS-05—Before

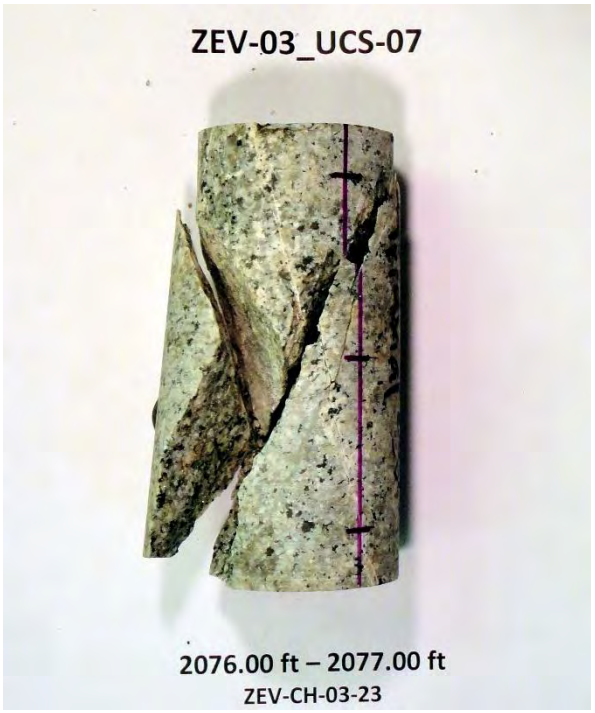
ZEV-03_UCS-05—After

ZEV-03_UCS-06—Before

ZEV-03_UCS-06—After

Figure C-1. Before and After Photographs of Uniaxial Compressive Strength Test Specimens *(continued)*

ZEV-03_UCS-07—Before



ZEV-03_UCS-07—After

ZEV-03_UCS-08—Before

ZEV-03_UCS-08—After

Figure C-1. Before and After Photographs of Uniaxial Compressive Strength Test Specimens *(continued)*

ZEV-03_UCS-09—Before

ZEV-03_UCS-09—After

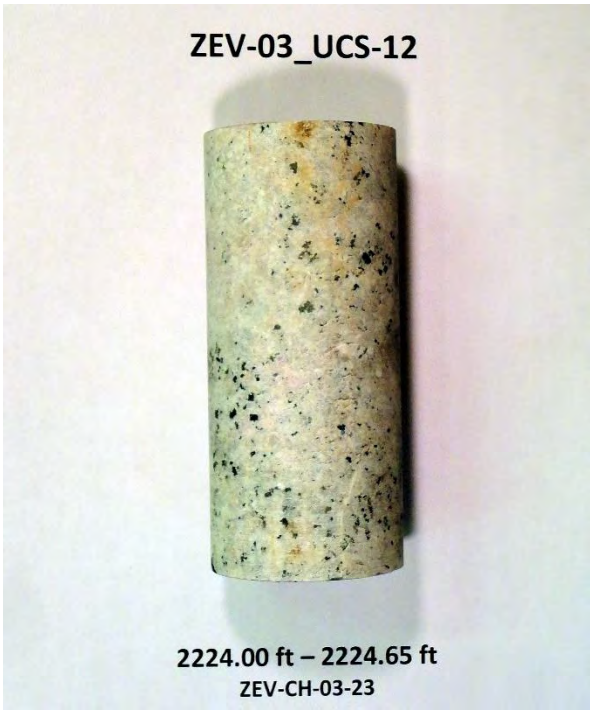
ZEV-03_UCS-10—Before

ZEV-03_UCS-10—After

Figure C-1. Before and After Photographs of Uniaxial Compressive Strength Test Specimens *(continued)*

ZEV-03_UCS-11—Before

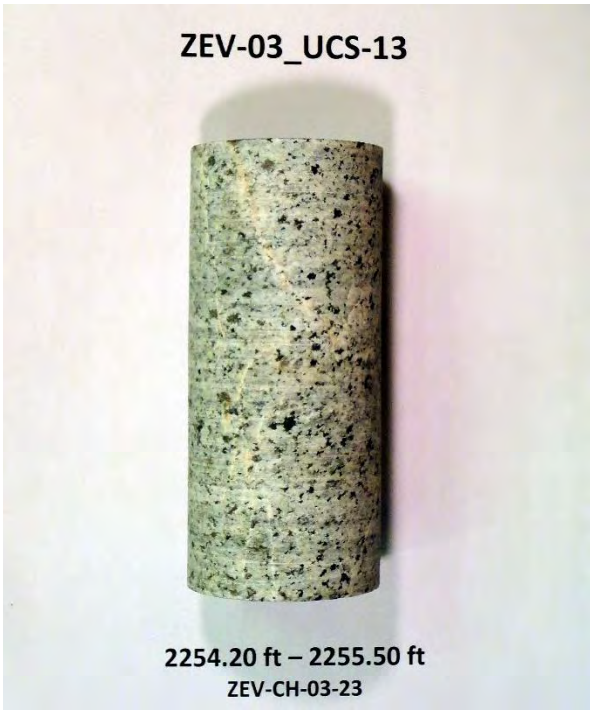
ZEV-03_UCS-11—After



ZEV-03_UCS-12—Before

ZEV-03_UCS-12—After

Figure C-1. Before and After Photographs of Uniaxial Compressive Strength Test Specimens *(continued)*



ZEV-03_UCS-13—Before

ZEV-03_UCS-13—After

ZEV-03_UCS-14—Before

ZEV-03_UCS-14—After

Figure C-1. Before and After Photographs of Uniaxial Compressive Strength Test Specimens

ZEV-03_UCS-15—Before

ZEV-03_UCS-15—After

ZEV-03_UCS-16—Before

ZEV-03_UCS-16—After

Figure C-1. Before and After Photographs of Uniaxial Compressive Strength Test Specimens *(continued)*

ZEV-03_UCS-17—Before

ZEV-03_UCS-17—After

ZEV-03_UCS-18—Before

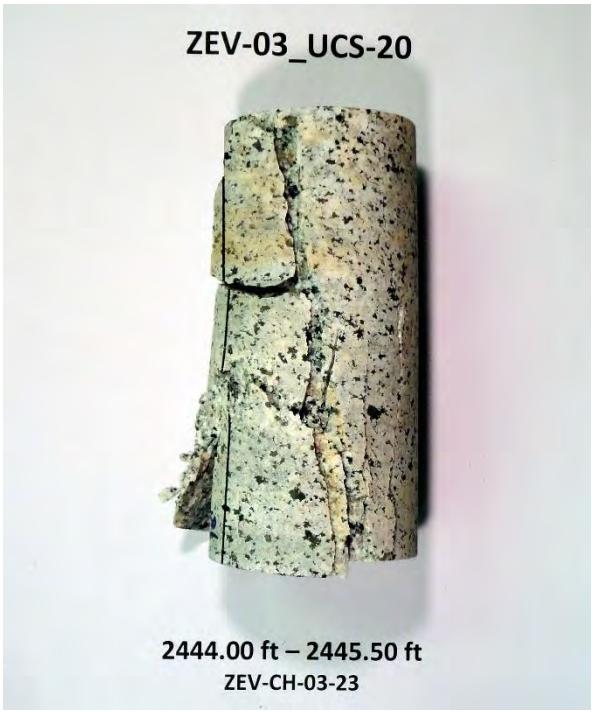
ZEV-03_UCS-18—After

Figure C-1. Before and After Photographs of Uniaxial Compressive Strength Test Specimens *(continued)*

ZEV-03_UCS-19—Before

ZEV-03_UCS-19—After

ZEV-03_UCS-20—Before



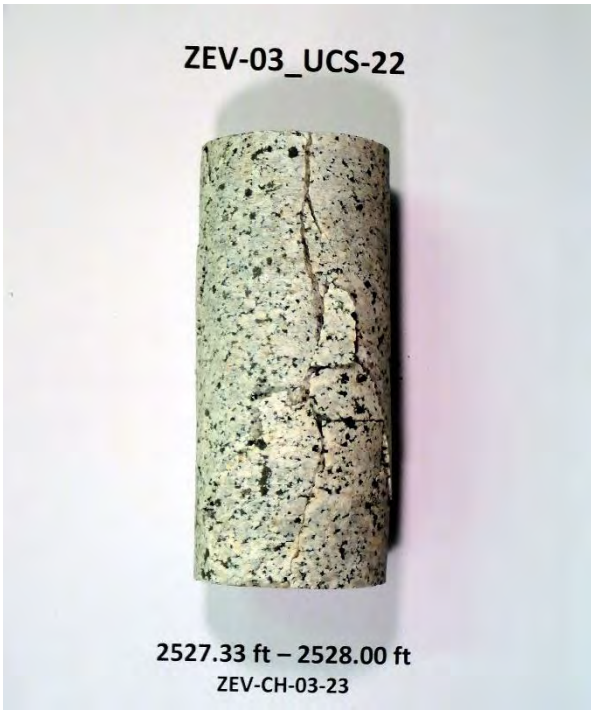
ZEV-03_UCS-20—After

Figure C-1. Before and After Photographs of Uniaxial Compressive Strength Test Specimens *(continued)*

ZEV-03_UCS-21—Before

ZEV-03_UCS-21—After

ZEV-03_UCS-22—Before



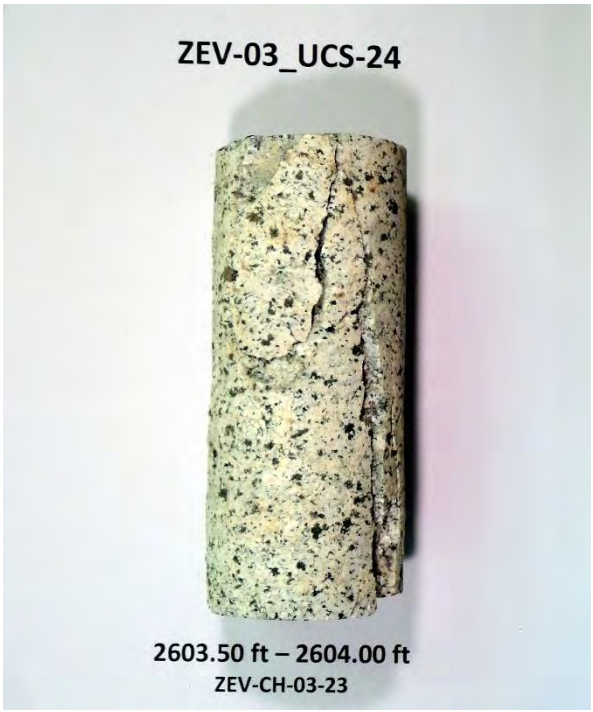
ZEV-03_UCS-22—After

Figure C-1. Before and After Photographs of Uniaxial Compressive Strength Test Specimens *(continued)*

ZEV-03_UCS-23—Before

ZEV-03_UCS-23—After

ZEV-03_UCS-24—Before



ZEV-03_UCS-24—After

Figure C-1. Before and After Photographs of Uniaxial Compressive Strength Test Specimens *(continued)*

ZEV-03_UCS-25—Before

ZEV-03_UCS-25—After

ZEV-03_UCS-26—Before

ZEV-03_UCS-26—After

Figure C-1. Before and After Photographs of Uniaxial Compressive Strength Test Specimens *(continued)*

ZEV-03_UCS-27—Before

ZEV-03_UCS-27—After

ZEV-03_UCS-28—Before

ZEV-03_UCS-28—After

Figure C-1. Before and After Photographs of Uniaxial Compressive Strength Test Specimens *(continued)*

ZEV-03_UCS-29—Before

ZEV-03_UCS-29—After

ZEV-03_UCS-30—Before

ZEV-03_UCS-30—After

Figure C-1. Before and After Photographs of Uniaxial Compressive Strength Test Specimens *(continued)*

ZEV-03_UCS-31—Before

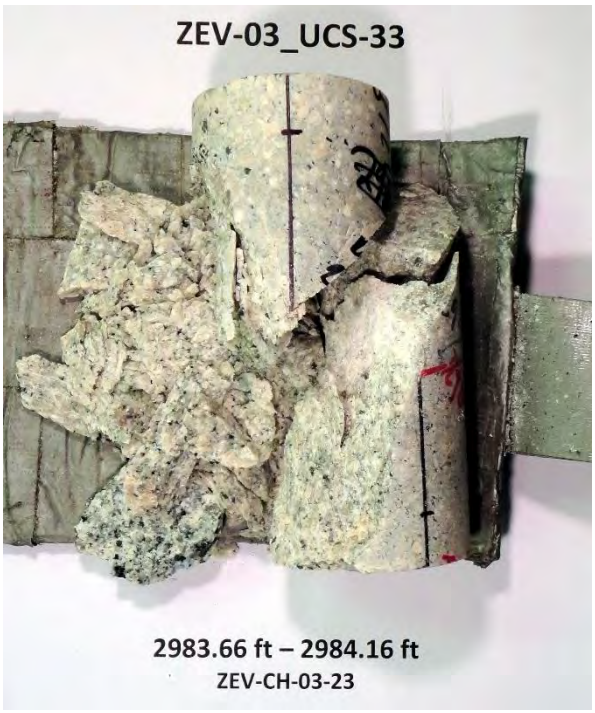
ZEV-03_UCS-31—After

ZEV-03_UCS-32—Before

ZEV-03_UCS-32—After

Figure C-1. Before and After Photographs of Uniaxial Compressive Strength Test Specimens *(continued)*

ZEV-03_UCS-33—Before



ZEV-03_UCS-33—After

Figure C-1. Before and After Photographs of Uniaxial Compressive Strength Test Specimens *(concluded)*

APPENDIX D

TRIAXIAL COMPRESSION TEST DATASHEET

AGAPITO ASSOCIATES, INC.
2913 Hill Avenue, #B
Grand Junction, CO 81504 USA
970-242-4220

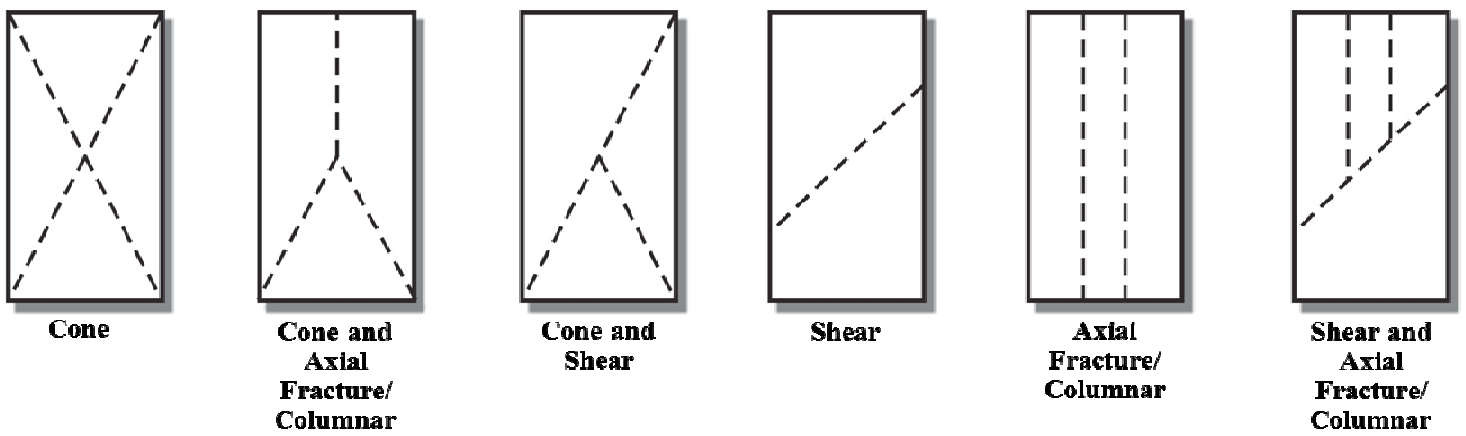
TRIAXIAL COMPRESSION TESTS

CLIENT	Lane PES	**HOLE NUMBER**	ZEV-CH-03-23
JOB NUMBER	951-20	**MOISTURE CONDITION**	As received
DATE	October 4, 2023	**TEMPERATURE**	Ambient

Specimen No.	Hole No.	Interval From (ft)	Interval To (ft)	Length of Interval (ft)	Weight (oz)	Diameter D_1 (in)	Diameter D_2 (in)	Axial Length (in)	Length-to-Diameter Ratio	Area (in^2)	Volume (in^3)	Density (pcf)	Specific Gravity
ZEV-03_TRI-01	ZEV-CH-03-23	1,898.70	1,899.70	1.00	36.87	2.38	2.38	5.35	2.3	4.43	23.71	168	2.69
ZEV-03_TRI-02	ZEV-CH-03-23	1,901.20	1,902.00	0.80	36.31	2.38	2.38	5.24	2.2	4.44	23.25	169	2.70
ZEV-03_TRI-03	ZEV-CH-03-23	1,902.00	1,902.80	0.80	34.88	2.37	2.38	5.04	2.1	4.43	22.34	169	2.70
ZEV-03_TRI-04	ZEV-CH-03-23	2,246.00	2,247.70	1.70	35.41	2.40	2.40	5.16	2.2	4.51	23.25	164	2.64
ZEV-03_TRI-05	ZEV-CH-03-23	2,246.00	2,247.70	1.70	34.89	2.40	2.40	5.08	2.1	4.51	22.93	164	2.63
ZEV-03_TRI-06	ZEV-CH-03-23	2,246.00	2,247.70	1.70	36.11	2.40	2.40	5.24	2.2	4.51	23.64	165	2.64
ZEV-03_TRI-07	ZEV-CH-03-23	2,468.70	2,470.00	1.30	34.06	2.39	2.39	4.97	2.1	4.48	22.27	165	2.65
ZEV-03_TRI-08	ZEV-CH-03-23	2,468.70	2,470.00	1.30	34.58	2.39	2.39	4.99	2.1	4.49	22.41	167	2.67
ZEV-03_TRI-09	ZEV-CH-03-23	2,468.70	2,470.00	1.30	33.90	2.39	2.39	5.00	2.1	4.48	22.37	164	2.62
ZEV-03_TRI-10	ZEV-CH-03-23	2,689.00	2,689.75	0.75	37.86	2.39	2.39	5.39	2.3	4.48	24.14	169	2.71
ZEV-03_TRI-11	ZEV-CH-03-23	2,684.00	2,685.00	1.00	37.32	2.39	2.39	5.38	2.3	4.48	24.09	167	2.68
ZEV-03_TRI-12	ZEV-CH-03-23	2,694.75	2,695.25	0.50	38.09	2.39	2.39	5.44	2.3	4.49	24.42	168	2.70
ZEV-03_TRI-13	ZEV-CH-03-23	2,722.50	2,723.00	0.50	41.10	2.40	2.42	5.82	2.4	4.55	26.50	167	2.68
ZEV-03_TRI-14	ZEV-CH-03-23	2,723.33	2,724.16	0.83	37.14	2.40	2.40	5.29	2.2	4.52	23.91	168	2.69
ZEV-03_TRI-15	ZEV-CH-03-23	2,723.33	2,724.16	0.83	36.65	2.40	2.40	5.19	2.2	4.52	23.47	169	2.70
ZEV-03_TRI-16	ZEV-CH-03-23	2,777.66	2,778.33	0.67	33.39	2.40	2.40	5.19	2.2	4.53	23.52	153	2.46

Specimen No.	Lithological Description	Confining Pressure (psi)	Failure Load (lb)	Failure Stress (psi)	Failure Mode Notes	Comments
ZEV-03_TRI-01	Granite	1,500	120,410	27,157	Shear	
ZEV-03_TRI-02	Granite	2,500	202,450	45,641	Axial / Shear	
ZEV-03_TRI-03	Granite	1,500	153,620	34,683	Shear	
ZEV-03_TRI-04	Granite	2,500	227,815	50,516	Shear	
ZEV-03_TRI-05	Granite	1,500	213,135	47,212	Axial / Shear	
ZEV-03_TRI-06	Granite	2,500	269,100	59,658	Axial	
ZEV-03_TRI-07	Granite	1,500	135,535	30,236	Shear	
ZEV-03_TRI-08	Granite	2,500	167,430	37,313	Shear	
ZEV-03_TRI-09	Granite	1,500	144,955	32,387	Axial	
ZEV-03_TRI-10	Granite	2,500	170,725	38,095	Axial	
ZEV-03_TRI-11	Granite	1,500	133,270	29,762	Shear	Sample failed mostly along pre-existing fracture
ZEV-03_TRI-12	Granite	2,500	133,840	29,827	Shear	
ZEV-03_TRI-13	Granite	1,500	-	-	-	Sample broken during preparation
ZEV-03_TRI-14	Granite	2,500	77,475	17,136	Shear	Sample failed mostly along pre-existing fracture
ZEV-03_TRI-15	Granite	1,500	109,320	24,185	Shear	Sample failed mostly along pre-existing fracture
ZEV-03_TRI-16	Granite	2,500	12,370	2,732	Axial	Sample had many pre-existing fractures and was partially decomposed

Failure Mode Sketches



APPENDIX E

BEFORE AND AFTER PHOTOGRAPHS OF TRIAXIAL COMPRESSION TEST SPECIMENS

ZEV-03_TRI-01—Before

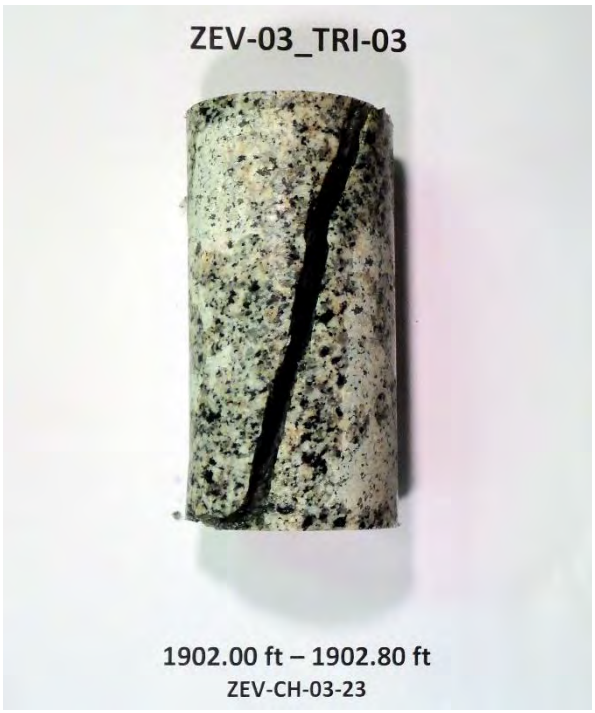
ZEV-03_TRI-01—After

ZEV-03_TRI-02—Before

ZEV-03_TRI-02—After

Figure E-1. Before and After Photographs of Triaxial Compressive Strength Test Specimens

ZEV-03_TRI-03—Before



ZEV-03_TRI-03—After

ZEV-03_TRI-04—Before

ZEV-03_TRI-04—After

Figure E-1. Before and After Photographs of Triaxial Compressive Strength Test Specimens *(continued)*

ZEV-03_TRI-05—Before

ZEV-03_TRI-05—After

ZEV-03_TRI-06—Before

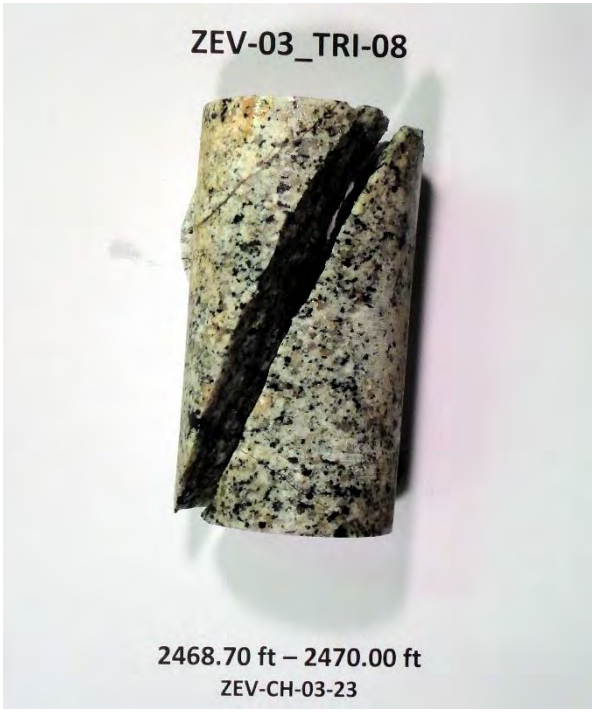
ZEV-03_TRI-06—After

Figure E-1. Before and After Photographs of Triaxial Compressive Strength Test Specimens *(continued)*

ZEV-03_TRI-07—Before

ZEV-03_TRI-07—After

ZEV-03_TRI-08—Before



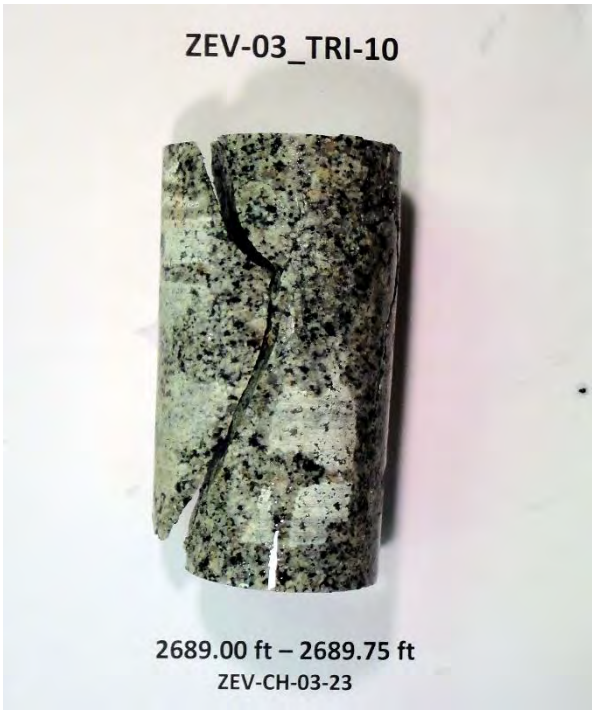
ZEV-03_TRI-08—After

Figure E-1. Before and After Photographs of Triaxial Compressive Strength Test Specimens *(continued)*

ZEV-03_TRI-09—Before

ZEV-03_TRI-09—After

ZEV-03_TRI-10—Before



ZEV-03_TRI-10—After

Figure E-1. Before and After Photographs of Triaxial Compressive Strength Test Specimens *(continued)*

ZEV-03_TRI-11—Before

ZEV-03_TRI-11—After

ZEV-03_TRI-12—Before

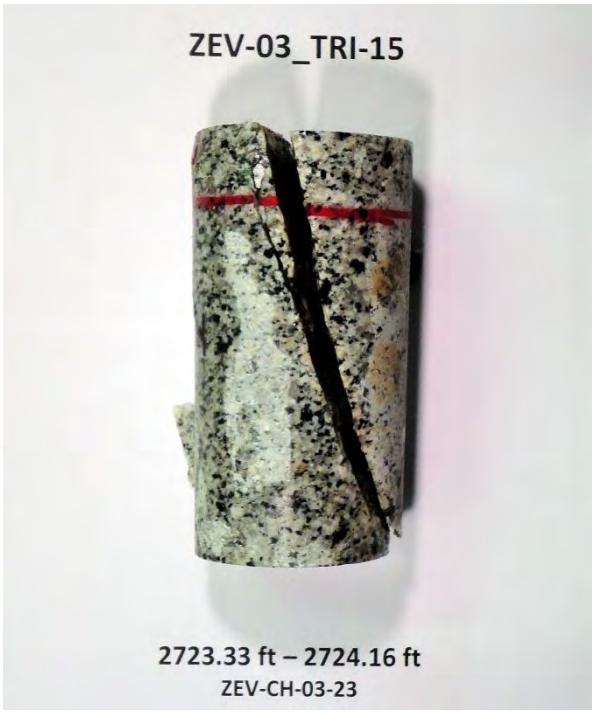
ZEV-03_TRI-12—After

Figure E-1. Before and After Photographs of Triaxial Compressive Strength Test Specimens *(continued)*

ZEV-03_TRI-14—Before

ZEV-03_TRI-14—After

ZEV-03_TRI-15—Before



ZEV-03_TRI-15—After

Figure E-1. Before and After Photographs of Triaxial Compressive Strength Test Specimens *(continued)*

ZEV-03_TRI-16—Before

ZEV-03_TRI-16—After

Figure E-1. Before and After Photographs of Triaxial Compressive Strength Test Specimens *(concluded)*

APPENDIX F

SPLITTING TENSILE STRENGTH (BRAZILIAN) TEST DATASHEET

AGAPITO ASSOCIATES, INC.
2913 Hill Avenue, #B
Grand Junction, CO 81504 USA
970-242-4220

INDIRECT TENSILE STRENGTH (BRAZILIAN) TESTS

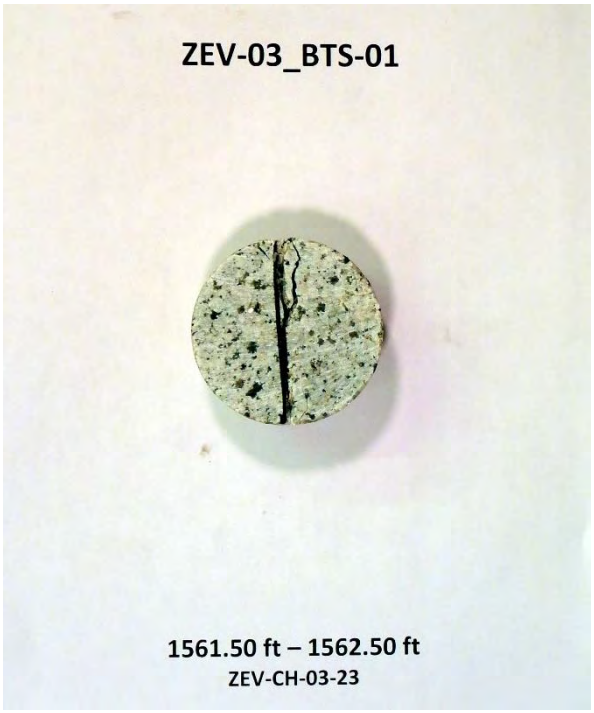
CLIENT	Lane PES	**HOLE NUMBER**	ZEV-CH-03-23
JOB NUMBER	951-20	**MOISTURE CONDITION**	As Received
DATE	October 4, 2023	**TEMPERATURE**	Ambient

Specimen No.	Hole No.	Depth From (ft)	Depth To (ft)	Length of Interval (ft)	Weight (oz)	Diameter D_1 (in)	Diameter D_2 (in)	Axial Length (inch)	Area (inch^2)	Density (pcf)	Specific Gravity
ZEV-03_BTS-01	ZEV-CH-03-23	1,561.50	1,562.50	1.00	9.09	2.39	2.39	1.33	4.49	165	2.6
ZEV-03_BTS-02	ZEV-CH-03-23	1,633.08	1,634.41	1.33	9.06	2.37	2.37	1.32	4.43	167	2.7
ZEV-03_BTS-03	ZEV-CH-03-23	1,722.08	1,723.16	1.08	8.81	2.36	2.36	1.33	4.38	164	2.6
ZEV-03_BTS-04	ZEV-CH-03-23	1,878.70	1,879.60	0.90	9.11	2.38	2.37	1.35	4.43	164	2.6
ZEV-03_BTS-05	ZEV-CH-03-23	1,913.80	1,914.60	0.80	8.94	2.37	2.37	1.31	4.40	168	2.7
ZEV-03_BTS-06	ZEV-CH-03-23	2,019.90	2,020.40	0.50	8.46	2.40	2.40	1.21	4.51	168	2.7
ZEV-03_BTS-07	ZEV-CH-03-23	2,074.60	2,076.00	1.40	8.92	2.40	2.40	1.28	4.51	166	2.7
ZEV-03_BTS-08	ZEV-CH-03-23	2,092.70	2,093.80	1.10	9.38	2.40	2.40	1.34	4.51	168	2.7
ZEV-03_BTS-09	ZEV-CH-03-23	2,111.40	2,112.00	0.60	8.32	2.40	2.40	1.19	4.52	167	2.7
ZEV-03_BTS-10	ZEV-CH-03-23	2,175.20	2,176.00	0.80	8.89	2.40	2.40	1.28	4.52	166	2.7
ZEV-03_BTS-11	ZEV-CH-03-23	2,193.50	2,195.00	1.50	8.63	2.40	2.40	1.27	4.51	162	2.6
ZEV-03_BTS-12	ZEV-CH-03-23	2,218.00	2,219.00	1.00	8.55	2.39	2.39	1.25	4.49	164	2.6
ZEV-03_BTS-13	ZEV-CH-03-23	2,254.20	2,255.50	1.30	8.79	2.39	2.40	1.28	4.50	165	2.6
ZEV-03_BTS-14	ZEV-CH-03-23	2,276.40	2,277.00	0.60	8.73	2.40	2.40	1.25	4.51	167	2.7
ZEV-03_BTS-15	ZEV-CH-03-23	2,306.60	2,308.20	1.60	7.86	2.39	2.39	1.15	4.49	165	2.6
ZEV-03_BTS-16	ZEV-CH-03-23	2,321.00	2,322.00	1.00	8.54	2.39	2.39	1.22	4.49	168	2.7
ZEV-03_BTS-17	ZEV-CH-03-23	2,352.50	2,354.00	1.50	8.99	2.39	2.39	1.30	4.49	167	2.7
ZEV-03_BTS-18	ZEV-CH-03-23	2,384.50	2,386.00	1.50	9.10	2.39	2.39	1.30	4.50	168	2.7
ZEV-03_BTS-19	ZEV-CH-03-23	2,412.40	2,414.00	1.60	8.10	2.39	2.40	1.17	4.50	166	2.7
ZEV-03_BTS-20	ZEV-CH-03-23	2,438.40	2,440.60	2.20	8.82	2.38	2.38	1.30	4.45	164	2.6
ZEV-03_BTS-21	ZEV-CH-03-23	2,482.83	2,483.25	0.42	9.20	2.39	2.39	1.35	4.48	164	2.6
ZEV-03_BTS-22	ZEV-CH-03-23	2,526.83	2,527.25	0.42	8.99	2.39	2.39	1.30	4.48	166	2.7
ZEV-03_BTS-23	ZEV-CH-03-23	2,559.83	2,560.00	0.17	9.64	2.40	2.40	1.38	4.51	167	2.7
ZEV-03_BTS-24	ZEV-CH-03-23	2,578.83	2,579.58	0.75	9.19	2.40	2.40	1.31	4.51	168	2.7
ZEV-03_BTS-25	ZEV-CH-03-23	2,654.00	2,654.50	0.50	8.91	2.39	2.39	1.28	4.49	167	2.7
ZEV-03_BTS-26	ZEV-CH-03-23	2,677.58	2,678.41	0.83	8.80	2.38	2.38	1.30	4.44	165	2.6
ZEV-03_BTS-27	ZEV-CH-03-23	2,707.00	2,707.50	0.50	8.52	2.38	2.39	1.26	4.47	164	2.6
ZEV-03_BTS-28	ZEV-CH-03-23	2,740.00	2,740.50	0.50	8.96	2.40	2.40	1.30	4.51	165	2.6
ZEV-03_BTS-29	ZEV-CH-03-23	2,759.91	2,760.33	0.42	8.82	2.40	2.40	1.29	4.53	163	2.6
ZEV-03_BTS-30	ZEV-CH-03-23	2,939.58	2,940.00	0.42	8.63	2.38	2.39	1.26	4.46	165	2.6
ZEV-03_BTS-31	ZEV-CH-03-23	2,946.50	2,947.00	0.50	9.39	2.40	2.40	1.35	4.51	167	2.7

Specimen No.	Lithological Description	Failure Load (lb)	Splitting Tensile Strength (psi)	Failure Mode Notes
ZEV-03_BTS-01	Granite	6,815	1,366	Tensile - Center
ZEV-03_BTS-02	Granite	6,602	1,338	Tensile - Center
ZEV-03_BTS-03	Granite	4,563	927	Tensile - Center
ZEV-03_BTS-04	Granite	1,935	384	Shear - Along pre existing fractures
ZEV-03_BTS-05	Granite	5,655	1,163	Tensile - Center, Secondary along pre-existing fracture
ZEV-03_BTS-06	Granite	4,677	1,028	Tensile - Center
ZEV-03_BTS-07	Granite	5,449	1,127	Tensile - Center
ZEV-03_BTS-08	Granite	5,651	1,122	Tensile - Center
ZEV-03_BTS-09	Granite	5,653	1,258	Tensile - Off center, Partially along pre existing fracture
ZEV-03_BTS-10	Granite	2,894	600	Tensile - Off center, Partially along pre existing fracture
ZEV-03_BTS-11	Granite	2,292	478	Tensile - Center, Partially along pre existing fractures
ZEV-03_BTS-12	Granite	6,432	1,370	Tensile - Center
ZEV-03_BTS-13	Granite	5,632	1,172	Tensile - Center
ZEV-03_BTS-14	Granite	3,843	816	Tensile - Center
ZEV-03_BTS-15	Granite	5,999	1,393	Tensile - Center
ZEV-03_BTS-16	Granite	5,475	1,194	Tensile - Center
ZEV-03_BTS-17	Granite	6,151	1,265	Tensile - Center
ZEV-03_BTS-18	Granite	7,440	1,521	Tensile - Center
ZEV-03_BTS-19	Granite	2,157	491	Tensile - Failed partially along pre existing fracture
ZEV-03_BTS-20	Granite	6,288	1,293	Tensile - Center
ZEV-03_BTS-21	Granite	-	-	Sample broke before testing
ZEV-03_BTS-22	Granite	5,114	1,047	Tensile - Center
ZEV-03_BTS-23	Granite	8,503	1,640	Tensile - Slight off center. Multiple secondary fractures alo
ZEV-03_BTS-24	Granite	6,083	1,232	Tensile - Slight off center.
ZEV-03_BTS-25	Granite	7,396	1,535	Tensile - Slight off center
ZEV-03_BTS-26	Granite	6,800	1,405	Tensile - Center
ZEV-03_BTS-27	Granite	6,987	1,481	Tensile - Center
ZEV-03_BTS-28	Granite	5,150	1,053	Tensile - Slight off center
ZEV-03_BTS-29	Granite	2,639	542	Tensile - Center
ZEV-03_BTS-30	Granite	3,887	822	Tensile - Center; Secondary failure along PE fracture
ZEV-03_BTS-31	Granite	7,537	1,485	Tensile - Slight off center

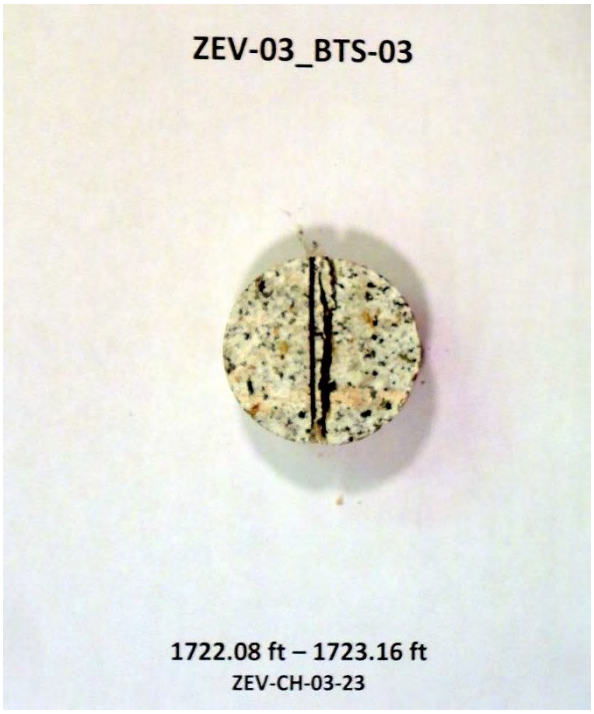
APPENDIX G

AFTER PHOTOGRAPHS OF BRAZILIAN TEST SPECIMENS

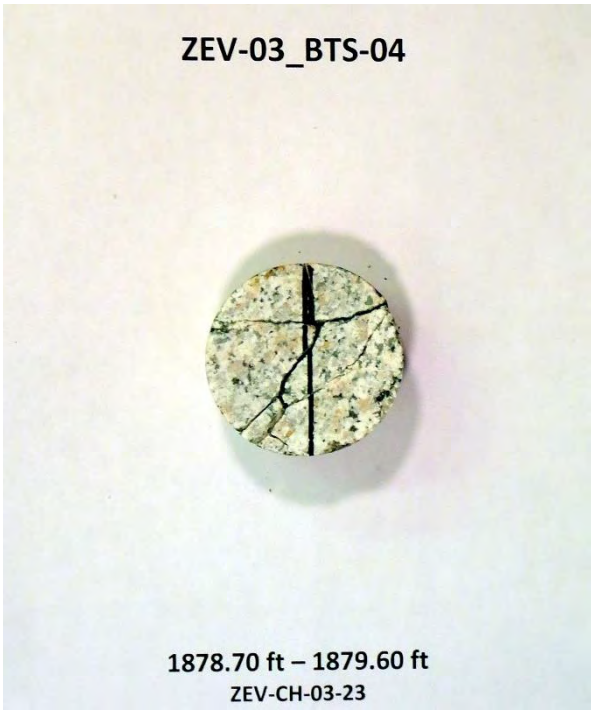


ZEV-03_BTS-01—After

ZEV-03_BTS-02—After



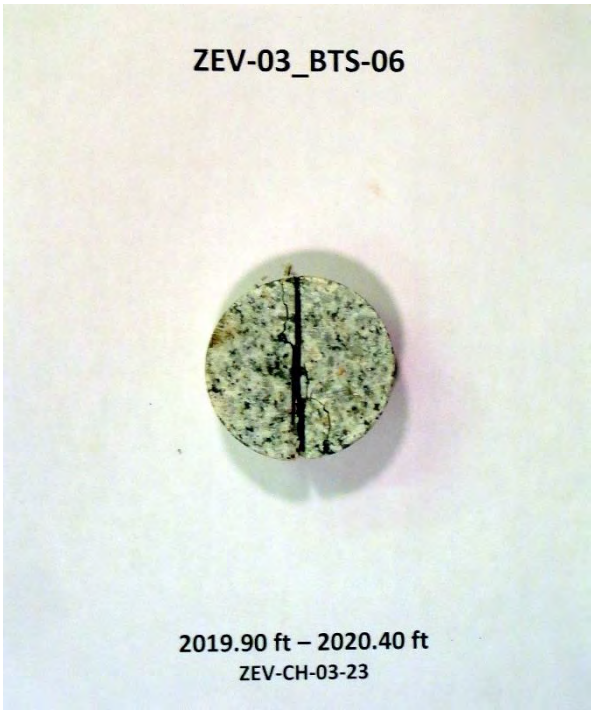
ZEV-03_BTS-03—After



ZEV-03_BTS-04—After

Figure G-1. After Photographs of Brazilian Test Specimens

ZEV-03_BTS-05—After

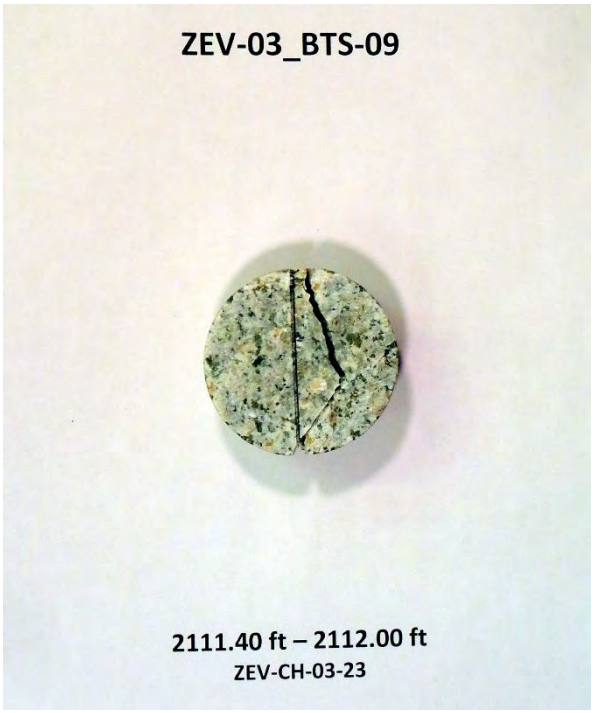


ZEV-03_BTS-06—After

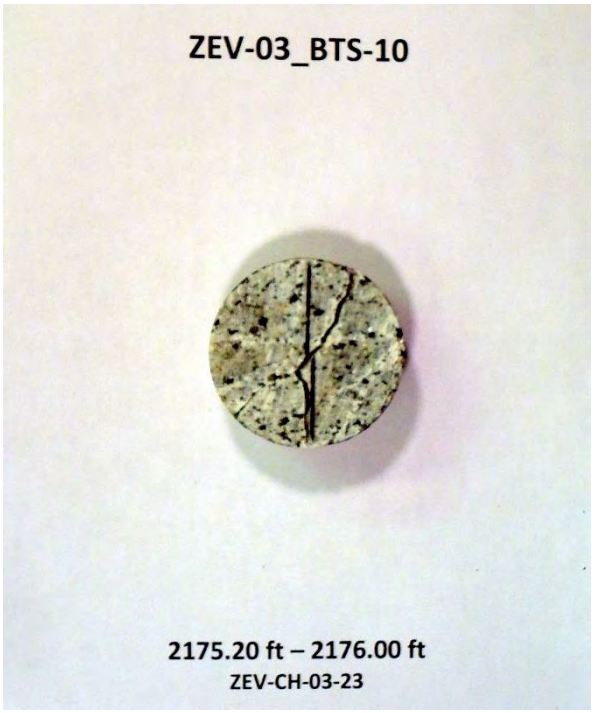
ZEV-03_BTS-07—After

ZEV-03_BTS-08—After

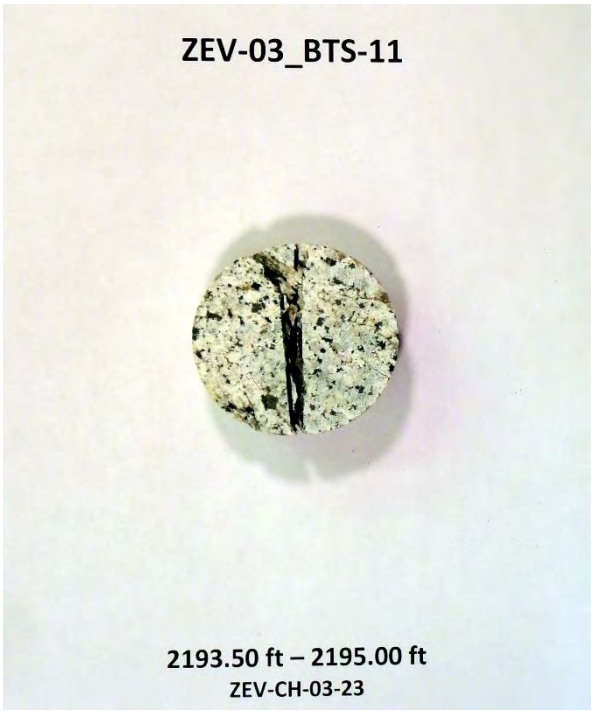
Figure G-1. After Photographs of Brazilian Test Specimens *(continued)*



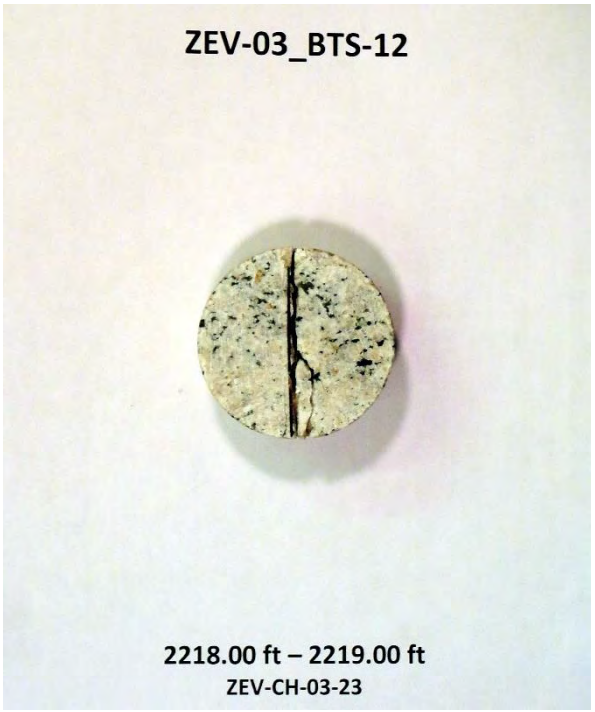
ZEV-03_BTS-09—After



ZEV-03_BTS-10—After



ZEV-03_BTS-11—After



ZEV-03_BTS-12—After

Figure G-1. After Photographs of Brazilian Test Specimens *(continued)*

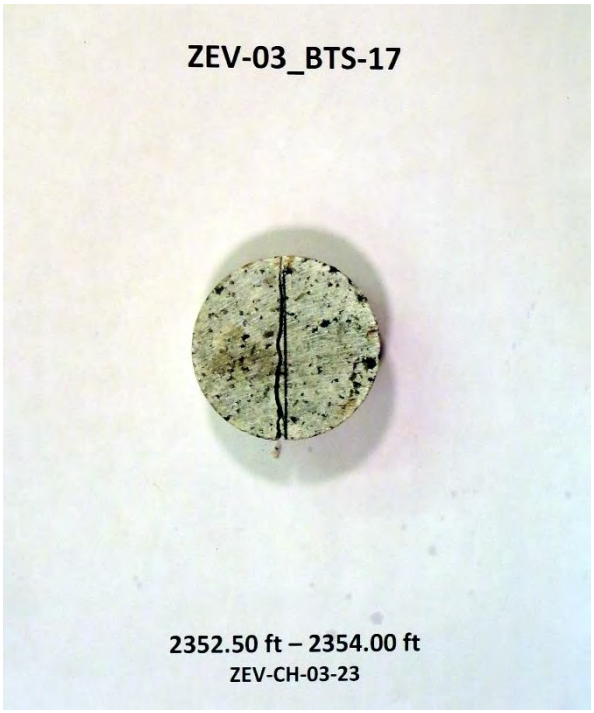
ZEV-03_BTS-13—After

ZEV-03_BTS-14—After

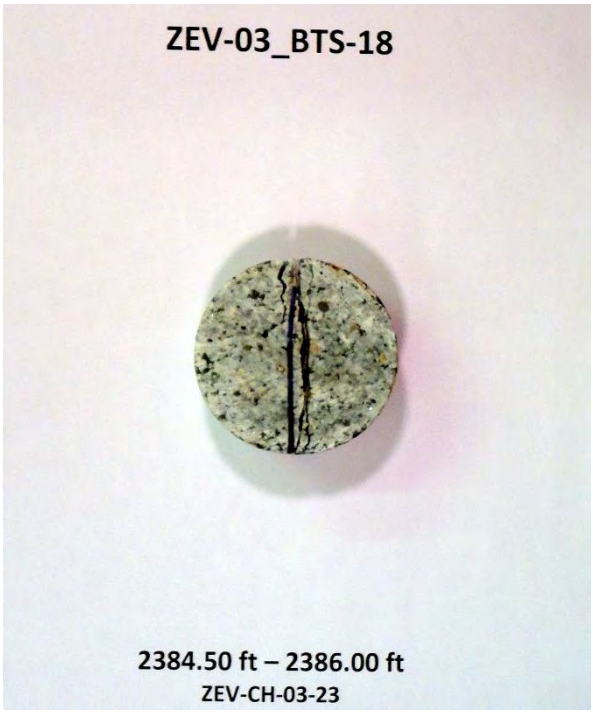
ZEV-03_BTS-15—After

ZEV-03_BTS-16—After

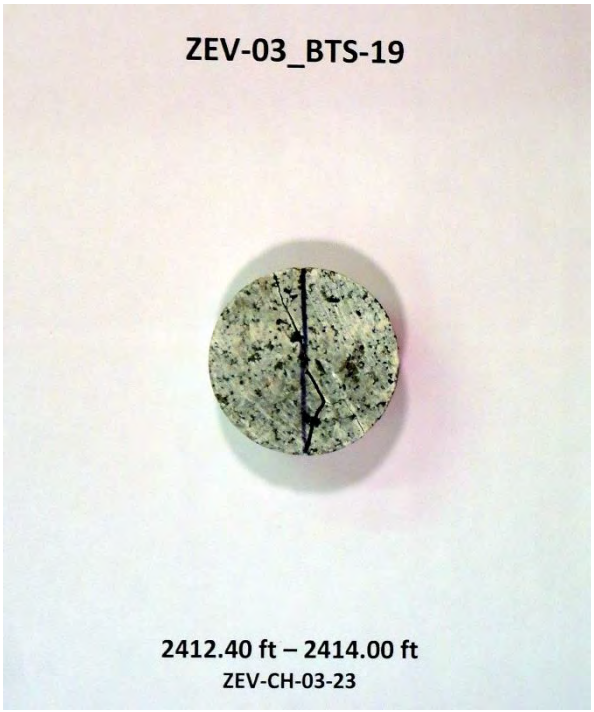
Figure G-1. After Photographs of Brazilian Test Specimens *(continued)*



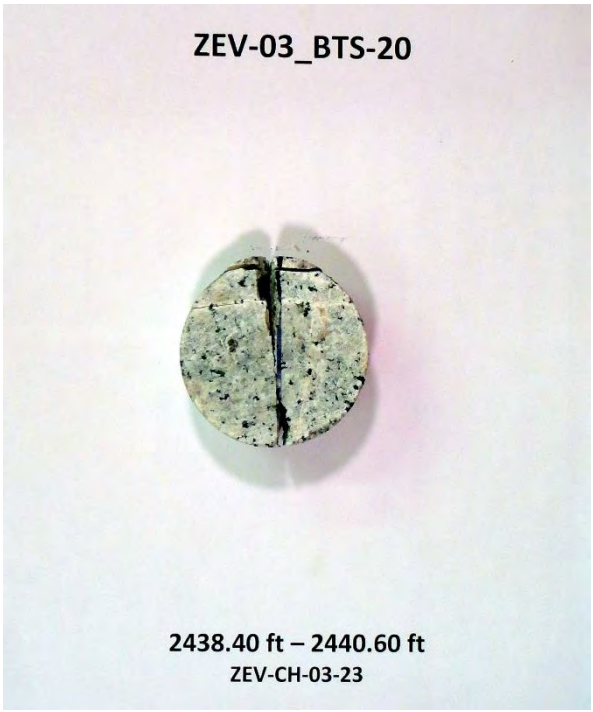
ZEV-03_BTS-17—After



ZEV-03_BTS-18—After

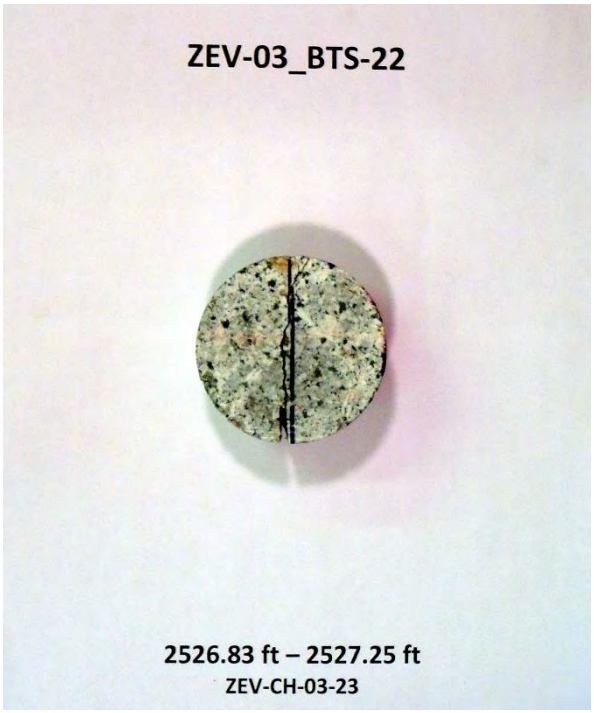


ZEV-03_BTS-19—After

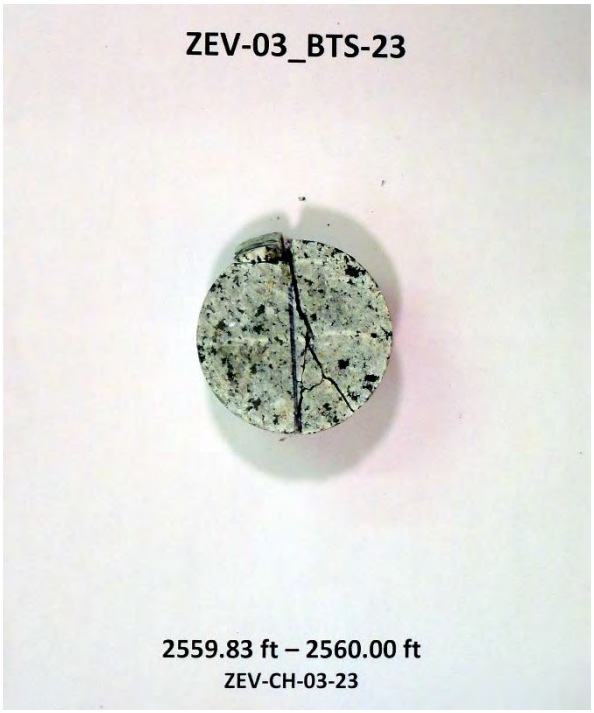


ZEV-03_BTS-20—After

Figure G-1. After Photographs of Brazilian Test Specimens *(continued)*

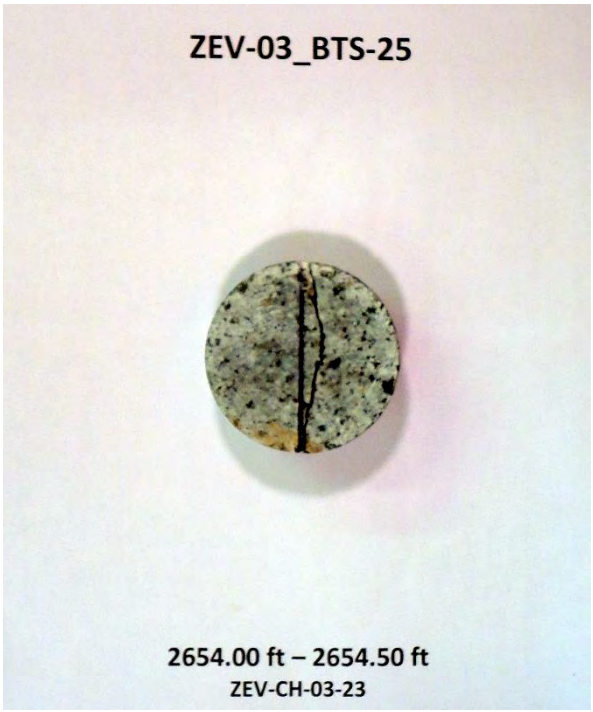


ZEV-03_BTS-22—After



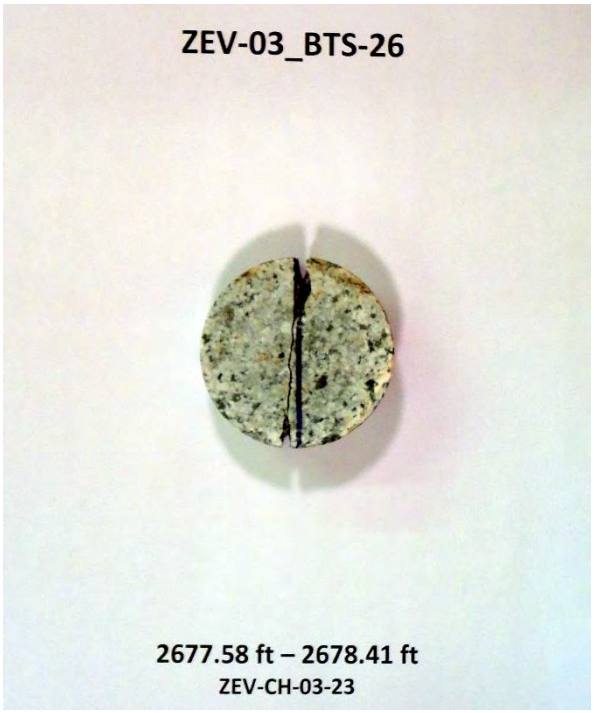
ZEV-03_BTS-23—After

ZEV-03_BTS-24—After



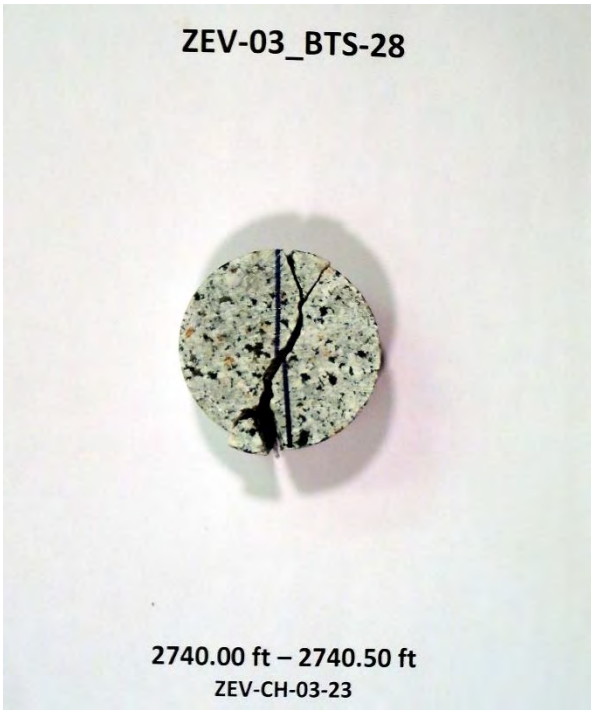
ZEV-03_BTS-25—After

Figure G-1. After Photographs of Brazilian Test Specimens *(continued)*



ZEV-03_BTS-26—After

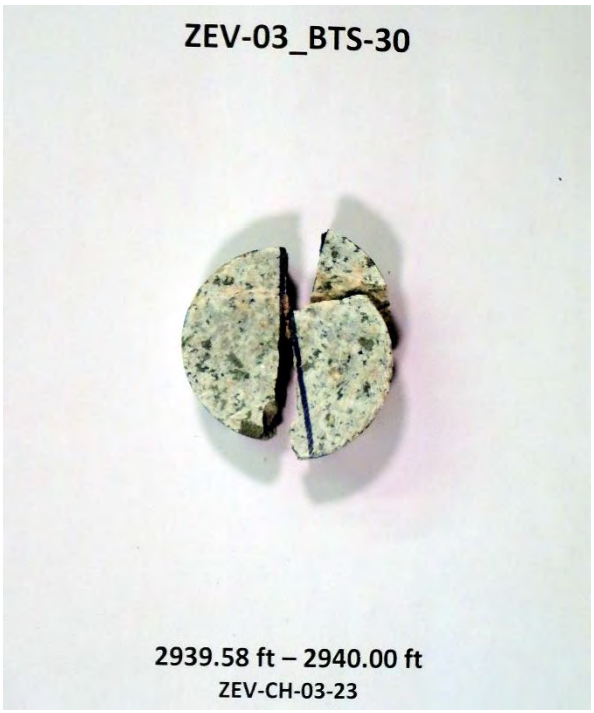
ZEV-03_BTS-27—After



ZEV-03_BTS-28—After

ZEV-03_BTS-29—After

Figure G-1. After Photographs of Brazilian Test Specimens *(continued)*



ZEV-03_BTS-30—After

ZEV-03_BTS-31—After

Figure G-1. After Photographs of Brazilian Test Specimens *(concluded)*

APPENDIX H

POINT LOAD TEST DATASHEET

AGAPITO ASSOCIATES, INC.
2913 Hill Avenue, #B
Grand Junction, CO 81504 USA
970-242-4220

POINT LOAD TESTS

CLIENT	Lane PES
JOB NUMBER	951-20
DATE	October 4, 2023

HOLE NUMBER	ZEV-CH-03-23
MOISTURE CONDITION	As Received
TEMPERATURE	Ambient

Sample No.	Hole ID	Depth From (ft)	Depth To (ft)	Failure Gauge Pressure (psi)	"Failure Load" P (lb)	Test Orientation (A/D)	D (inch)	W (inch)	D_e (inch)	D_e^2 (inch^2)	Uncorrected Point Load Index, I_s (psi)	Size Correction Factor, F	Corrected Point Load Index, $I_{S(50)}$ (psi)	UCS (psi)	Lithology
ZEV-03_PLT-01	ZEV-CH-03-23	1539.25	1540.50	196	340	A	2.40	1.02	1.77	3.13	109	0.95	104	2,175	Granite
ZEV-03_PLT-02	ZEV-CH-03-23	1576.00	1577.00	2,574	4,463	A	2.39	1.10	1.83	3.35	1,331	0.97	1,288	27,051	Granite
ZEV-03_PLT-03	ZEV-CH-03-23	1598.75	1599.66	1,755	3,043	A	2.38	1.20	1.91	3.64	835	0.99	824	17,300	Granite
ZEV-03_PLT-04	ZEV-CH-03-23	1616.33	1617.00	2,405	4,170	A	2.39	1.18	1.90	3.60	1,160	0.98	1,140	23,946	Granite
ZEV-03_PLT-05	ZEV-CH-03-23	1617.08	1618.00	2,276	3,946	A	2.39	1.16	1.88	3.54	1,116	0.98	1,093	22,956	Granite
ZEV-03_PLT-06	ZEV-CH-03-23	1618.18	1619.00	1,043	1,808	A	2.39	1.20	1.91	3.65	495	0.99	488	10,256	Granite
ZEV-03_PLT-07	ZEV-CH-03-23	1701.25	1701.75	2,686	4,657	A	2.37	1.18	1.89	3.56	1,307	0.98	1,282	26,928	Granite
ZEV-03_PLT-08	ZEV-CH-03-23	1701.83	1702.33	1,443	2,502	A	2.37	1.12	1.84	3.39	739	0.97	717	15,056	Granite
ZEV-03_PLT-09	ZEV-CH-03-23	1778.16	1779.00	1,875	3,251	A	2.35	1.18	1.88	3.54	919	0.98	900	18,906	Granite
ZEV-03_PLT-10	ZEV-CH-03-23	1851.00	1851.70	924	1,602	A	2.39	1.18	1.90	3.60	445	0.98	438	9,194	Granite
ZEV-03_PLT-11	ZEV-CH-03-23	1869.30	1869.70	1,929	3,344	A	2.39	1.18	1.90	3.60	930	0.98	914	19,201	Granite
ZEV-03_PLT-12	ZEV-CH-03-23	1869.70	1870.10	1,881	3,261	A	2.39	1.20	1.91	3.66	892	0.99	880	18,484	Granite
ZEV-03_PLT-13	ZEV-CH-03-23	1921.60	1922.00	2,295	3,979	A	2.37	1.14	1.86	3.45	1,153	0.97	1,123	23,586	Granite
ZEV-03_PLT-14	ZEV-CH-03-23	1922.00	1922.40	3,021	5,238	A	2.37	1.16	1.87	3.51	1,492	0.98	1,459	30,638	Granite
ZEV-03_PLT-15	ZEV-CH-03-23	1922.40	1922.80	2,567	4,451	A	2.37	1.24	1.94	3.75	1,188	0.99	1,179	24,755	Granite
ZEV-03_PLT-16	ZEV-CH-03-23	2020.40	2021.00	2,212	3,835	A	2.39	1.20	1.91	3.66	1,047	0.99	1,034	21,717	Granite
ZEV-03_PLT-17	ZEV-CH-03-23	2077.00	2077.60	2,190	3,797	A	2.40	1.16	1.88	3.54	1,072	0.98	1,050	22,056	Granite
ZEV-03_PLT-18	ZEV-CH-03-23	2105.50	2106.00	1,330	2,306	A	2.40	1.20	1.92	3.67	629	0.99	621	13,041	Granite
ZEV-03_PLT-19	ZEV-CH-03-23	2111.40	2112.00	1,827	3,168	A	2.40	1.10	1.83	3.37	941	0.97	912	19,145	Granite
ZEV-03_PLT-20	ZEV-CH-03-23	2175.20	2176.00	737	1,278	A	2.40	1.18	1.90	3.61	354	0.98	349	7,322	Granite
ZEV-03_PLT-21	ZEV-CH-03-23	2196.00	2196.60	397	688	A	2.40	1.16	1.88	3.54	194	0.98	190	3,999	Granite
ZEV-03_PLT-22	ZEV-CH-03-23	2218.00	2219.00	2,293	3,976	A	2.39	1.18	1.90	3.60	1,105	0.98	1,086	22,816	Granite
ZEV-03_PLT-23	ZEV-CH-03-23	2237.00	2237.70	3,001	5,203	A	2.40	1.22	1.93	3.72	1,398	0.99	1,385	29,088	Granite
ZEV-03_PLT-24	ZEV-CH-03-23	2254.20	2255.50	1,653	2,866	A	2.39	1.20	1.91	3.66	783	0.99	773	16,231	Granite
ZEV-03_PLT-25	ZEV-CH-03-23	2271.60	2272.65	631	1,094	A	2.40	1.18	1.90	3.60	304	0.98	299	6,275	Granite
ZEV-03_PLT-26	ZEV-CH-03-23	2306.60	2308.20	1,427	2,474	A	2.39	1.14	1.86	3.48	712	0.98	695	14,585	Granite
ZEV-03_PLT-27	ZEV-CH-03-23	2321.00	2322.00	2,292	3,974	A	2.39	1.14	1.86	3.47	1,144	0.98	1,116	23,433	Granite
ZEV-03_PLT-28	ZEV-CH-03-23	2352.50	2354.00	2,138	3,707	A	2.39	1.18	1.90	3.59	1,031	0.98	1,014	21,295	Granite
ZEV-03_PLT-29	ZEV-CH-03-23	2389.20	2390.00	2,521	4,371	A	2.39	1.20	1.91	3.66	1,195	0.99	1,180	24,770	Granite
ZEV-03_PLT-30	ZEV-CH-03-23	2417.00	2418.50	2,119	3,674	A	2.37	1.18	1.89	3.56	1,033	0.98	1,013	21,271	Granite
ZEV-03_PLT-31	ZEV-CH-03-23	2451.60	2453.00	354	614	A	2.39	1.24	1.94	3.78	162	0.99	161	3,391	Granite
ZEV-03_PLT-32	ZEV-CH-03-23	2478.00	2478.40	2,672	4,633	A	2.39	1.24	1.94	3.78	1,227	0.99	1,220	25,618	Granite
ZEV-03_PLT-33	ZEV-CH-03-23	2533.41	2533.83	669	1,160	A	2.40	1.26	1.96	3.85	302	1.00	301	6,323	Granite
ZEV-03_PLT-34	ZEV-CH-03-23	2577.83	2578.33	3,018	5,233	A	2.40	1.28	1.98	3.91	1,339	1.00	1,342	28,174	Granite
ZEV-03_PLT-35	ZEV-CH-03-23	2602.75	2603.33	470	815	A	2.40	1.24	1.95	3.80	215	1.00	214	4,488	Granite
ZEV-03_PLT-36	ZEV-CH-03-23	2631.83	2632.33	944	1,637	A	2.40	1.20	1.91	3.67	447	0.99	441	9,261	Granite
ZEV-03_PLT-37	ZEV-CH-03-23	2654.66	2655.25	1,975	3,424	A	2.39	1.22	1.93	3.72	922	0.99	913	19,171	Granite
ZEV-03_PLT-38	ZEV-CH-03-23	2684.00	2685.00	1,397	2,422	A	2.39	1.20	1.91	3.65	664	0.99	655	13,760	Granite
ZEV-03_PLT-39	ZEV-CH-03-23	2721.16	2721.66	2,408	4,175	A	2.40	1.14	1.87	3.48	1,198	0.98	1,170	24,567	Granite
ZEV-03_PLT-40	ZEV-CH-03-23	2751.75	2752.25	170	295	A	2.40	1.30	1.99	3.97	74	1.01	75	1,569	Granite
ZEV-03_PLT-41	ZEV-CH-03-23	2835.58	2836.00	2,295	3,979	A	2.40	1.26	1.96	3.85	1,034	1.00	1,033	21,688	Granite
ZEV-03_PLT-42	ZEV-CH-03-23	2853.00	2853.58	1,819	3,154	A	2.40	1.24	1.95	3.79	833	0.99	828	17,398	Granite
ZEV-03_PLT-43	ZEV-CH-03-23	2879.00	2880.00	83	144	A	2.40	1.36	2.04	4.15	35	1.02	35	740	Granite
ZEV-03_PLT-44	ZEV-CH-03-23	2939.58	2940.00	1,220	2,115	A	2.38	1.22	1.92	3.70	571	0.99	565	11,870	Granite
ZEV-03_PLT-45	ZEV-CH-03-23	2949.25	2949.50	660	1,144	A	2.40	1.20	1.91	3.67	312	0.99	308	6,475	Granite

APPENDIX I

SLAKE DURABILITY TEST DATASHEET

AGAPITO ASSOCIATES, INC.
2913 Hill Avenue, #B
Grand Junction, CO 81504 USA
970-242-4220

SLAKE DURABILITY TESTS

CLIENT	Lane PES	**HOLE NUMBER**	ZEV-CH-03-23
JOB NUMBER	951-20	**MOISTURE CONDITION**	As Received
DATE	October 4, 2023	**OVEN TEMPERATURE**	230 ± 10 °F

SYMBOLS:

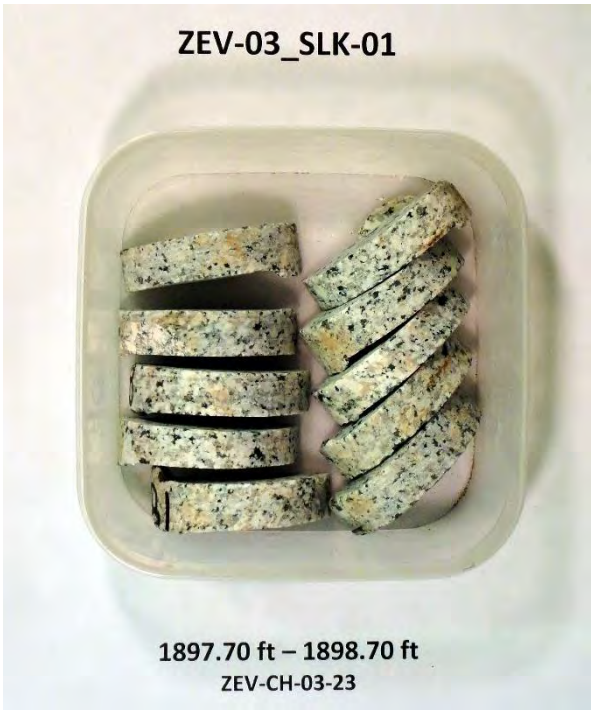
A	Weight of drum plus sample at natural moisture content (oz)	**D**	Weight of drum plus oven-dried sample before second cycle (oz)
B	Weight of drum plus oven-dried sample before first cycle (oz)	**W_F**	Weight of drum plus oven-dried sample after second cycle (oz)
C	Weight of drum (oz)		

Specimen No.	Hole ID	Interval		Length of Interval (ft)	A (oz)	B (oz)	C (oz)	D (oz)	Water Temperature Cycle 1		W_F (oz)	Water Temperature Cycle 2		Moisture Content (%)	Slake Durability Index $I_d(2)$	Retained Materials Description	
		From (ft)	To (ft)						Before (°F)	After (°F)		Before (°F)	After (°F)			Lithology	Type*
ZEV-03_SLK-01	ZEV-CH-03-23	1,897.70	1,898.70	1.00	70.86	70.80	53.49	70.75	68.5	71.6	70.74	70.4	76.0	0.3%	99.7	Granite	I
ZEV-03_SLK-02	ZEV-CH-03-23	2,021.70	2,023.10	1.40	71.00	70.96	53.50	70.92	68.5	71.6	70.90	70.4	76.0	0.3%	99.7	Granite	I
ZEV-03_SLK-03	ZEV-CH-03-23	2,074.60	2,076.00	1.40	69.91	69.87	52.76	69.82	68.5	71.6	69.80	70.4	76.0	0.2%	99.6	Granite	I
ZEV-03_SLK-04	ZEV-CH-03-23	2,092.70	2,093.80	1.10	69.75	69.70	53.74	69.62	70.2	72.5	69.6	72.5	77.8	0.3%	99.5	Granite	I
ZEV-03_SLK-05	ZEV-CH-03-23	2,112.00	2,113.00	1.00	74.04	74.00	55.00	73.95	70.2	72.5	73.93	72.5	77.8	0.2%	99.7	Granite	I
ZEV-03_SLK-06	ZEV-CH-03-23	2,151.00	2,151.60	0.60	71.81	71.76	55.41	71.70	70.2	72.5	71.66	72.5	77.8	0.3%	99.4	Granite	I
ZEV-03_SLK-07	ZEV-CH-03-23	2,187.00	2,188.04	1.04	72.64	72.60	55.49	71.81	71.6	72.0	71.46	72.8	74.6	0.2%	93.4	Granite	II
ZEV-03_SLK-08	ZEV-CH-03-23	2,245.00	2,246.00	1.00	69.45	69.42	53.49	69.38	63.8	73.7	69.36	68.6	73.2	0.2%	99.7	Granite	I
ZEV-03_SLK-09	ZEV-CH-03-23	2,277.50	2,279.00	1.50	70.84	70.80	53.49	70.67	63.8	73.7	70.63	68.6	73.2	0.3%	99.0	Granite	I
ZEV-03_SLK-10	ZEV-CH-03-23	2,306.60	2,308.20	1.60	70.51	70.48	52.76	70.43	63.8	73.7	70.40	68.6	73.2	0.2%	99.6	Granite	I
ZEV-03_SLK-11	ZEV-CH-03-23	2,335.00	2,335.80	0.80	72.36	72.32	53.73	72.21	64.4	67.7	72.17	73.2	77.5	0.2%	99.2	Granite	I
ZEV-03_SLK-12	ZEV-CH-03-23	2,359.70	2,360.50	0.80	72.68	72.65	55.00	72.58	64.4	67.7	72.55	73.2	77.5	0.2%	99.4	Granite	I
ZEV-03_SLK-13	ZEV-CH-03-23	2389.20	2390.00	0.80	73.20	73.17	55.41	73.13	64.4	67.7	73.11	73.2	77.5	0.2%	99.7	Granite	I
ZEV-03_SLK-14	ZEV-CH-03-23	2,417.00	2,418.50	1.50	72.25	72.21	55.50	72.17	67.5	68.9	72.16	77.5	77.8	0.2%	99.7	Granite	I
ZEV-03_SLK-15	ZEV-CH-03-23	2,451.60	2,453.00	1.40	71.24	71.21	53.49	71.08	65.8	71.8	71.02	68.3	74.3	0.2%	98.9	Granite	I
ZEV-03_SLK-16	ZEV-CH-03-23	2,486.00	2,487.00	1.00	70.11	70.07	53.50	69.96	65.8	71.8	69.92	68.3	74.3	0.3%	99.1	Granite	I
ZEV-03_SLK-17	ZEV-CH-03-23	2,532.00	2,532.75	0.75	70.03	69.92	52.76	69.22	65.8	71.8	68.96	68.3	74.3	0.6%	94.4	Granite	II
ZEV-03_SLK-18	ZEV-CH-03-23	2,562.83	2,563.58	0.75	72.08	72.05	53.74	71.97	71.8	75.0	71.93	74.3	77.4	0.2%	99.3	Granite	I
ZEV-03_SLK-19	ZEV-CH-03-23	2,604.50	2,605.41	0.91	72.21	72.10	55.00	71.09	71.8	75.0	70.55	74.3	77.4	0.6%	90.9	Granite	II
ZEV-03_SLK-20	ZEV-CH-03-23	2,648.00	2,648.66	0.66	73.82	73.74	55.41	73.47	71.8	75.0	73.36	74.3	77.4	0.4%	97.9	Granite	I
ZEV-03_SLK-21	ZEV-CH-03-23	2,674.50	2,675.50	1.00	72.29	72.26	55.49	72.22	74.5	74.5	72.20	77.4	77.6	0.1%	99.6	Granite	I
ZEV-03_SLK-22	ZEV-CH-03-23	2,717.08	2,717.58	0.50	70.84	70.80	53.49	70.76	63.3	68.9	70.72	64.2	70.8	0.2%	99.5	Granite	I
ZEV-03_SLK-23	ZEV-CH-03-23	2,757.00	2,758.00	1.00	71.14	71.08	53.50	70.82	63.3	68.9	70.64	64.2	70.8	0.3%	97.5	Granite	I
ZEV-03_SLK-24	ZEV-CH-03-23	2,798.58	2,799.58	1.00	70.51	70.39	52.76	69.78	63.3	68.9	69.13	64.2	70.8	0.7%	92.8	Granite	II
ZEV-03_SLK-25	ZEV-CH-03-23	2,867.00	2,867.58	0.58	70.66	70.55	53.73	64.04	68.8	72.1	61.23	70.8	74.2	0.7%	44.6	Granite	II
ZEV-03_SLK-26	ZEV-CH-03-23	2,917.77	2,918.33	0.56	72.60	72.26	55.01	60.98	68.8	72.1	59.13	70.8	74.2	2.0%	23.9	Granite	III
ZEV-03_SLK-27	ZEV-CH-03-23	2,983.66	2,984.16	0.50	71.97	71.92	55.41	71.81	68.8	72.1	71.75	70.8	74.2	0.3%	99.0	Granite	I

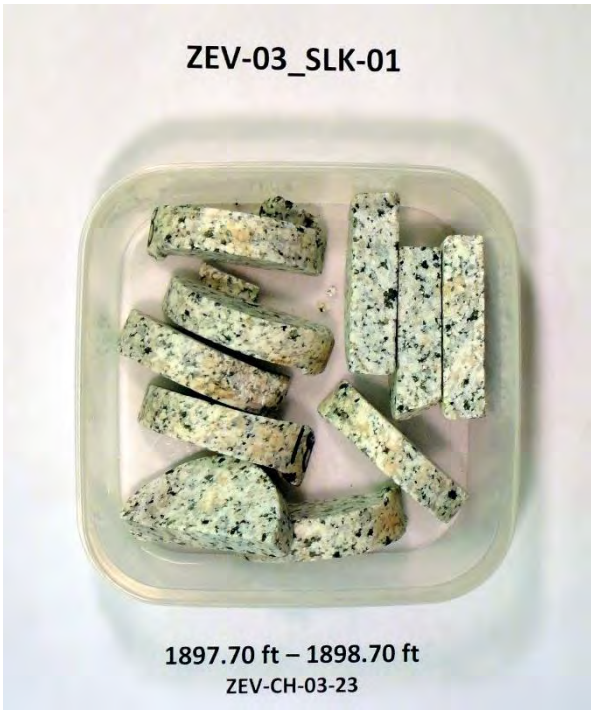
* Type I = Retained pieces remained virtually unchanged
II = Retained materials consist of large and small pieces
III = Retained materials is exclusively small fragments

APPENDIX J

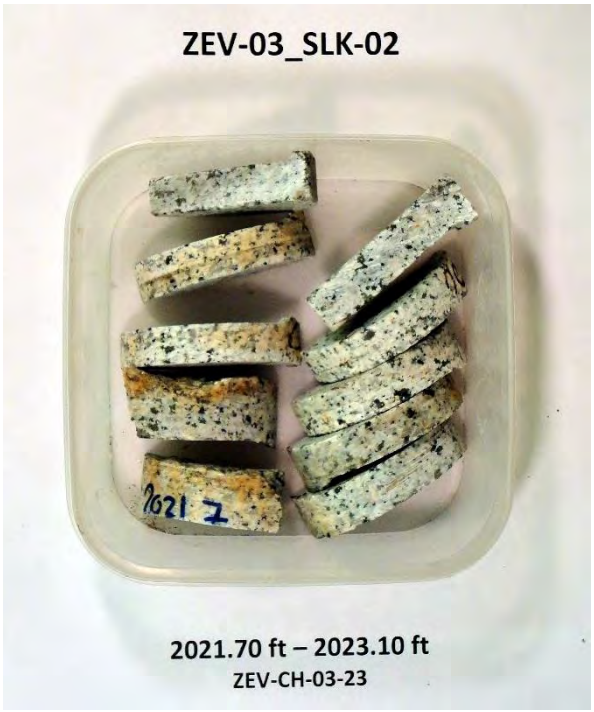
BEFORE AND AFTER PHOTOGRAPHS OF SLAKE DURABILITY TEST SPECIMENS



ZEV-03_SLK-01—Before



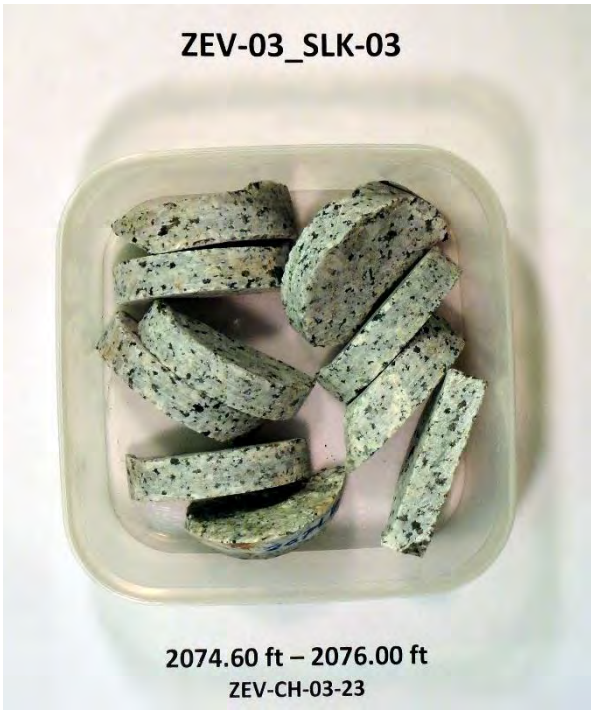
ZEV-03_SLK-01—After



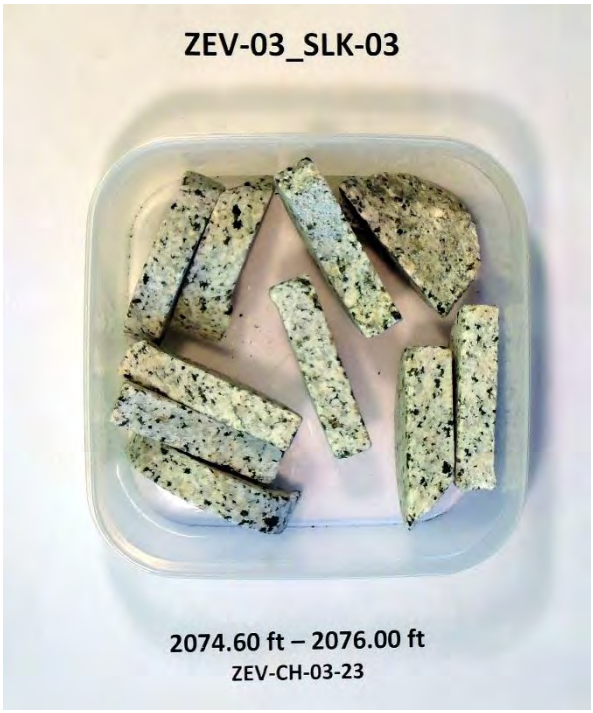
ZEV-03_SLK-02—Before

ZEV-03_SLK-02—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens

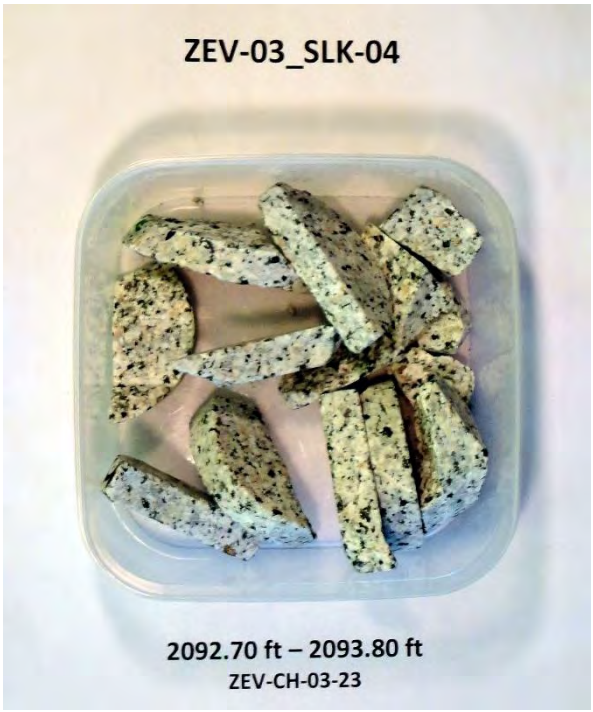


ZEV-03_SLK-03—Before



ZEV-03_SLK-03—After

ZEV-03_SLK-04—Before



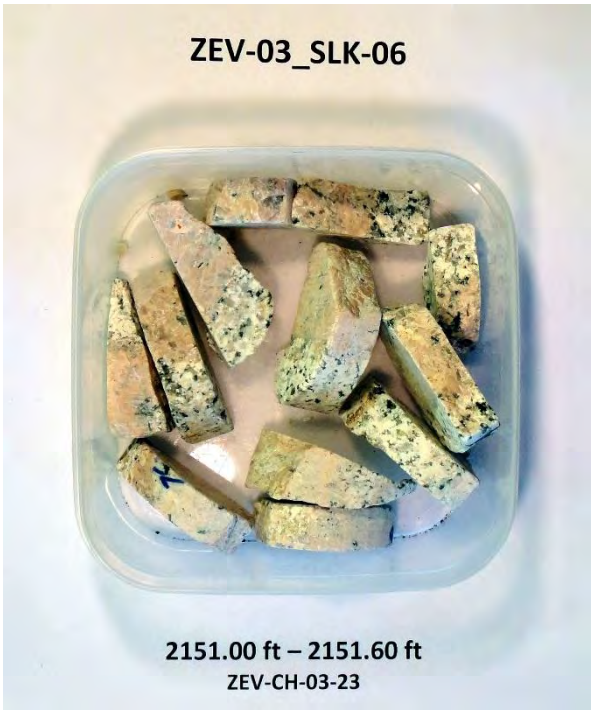
ZEV-03_SLK-04—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-03_SLK-05—Before

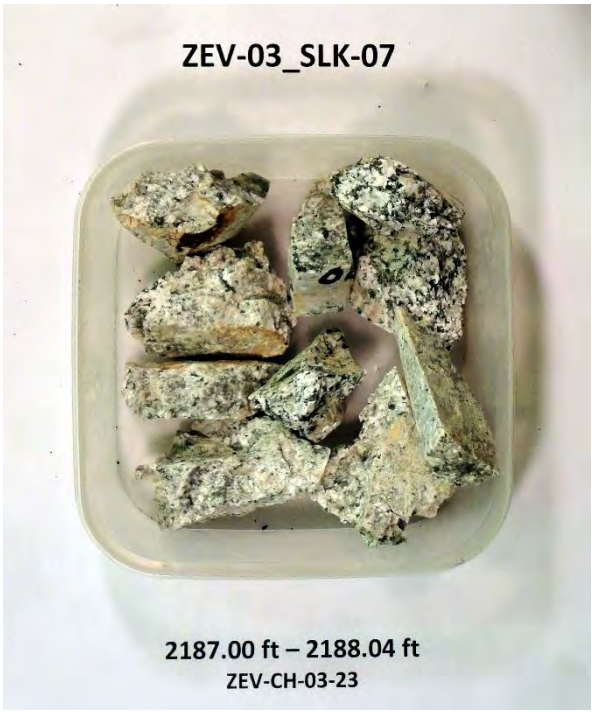
ZEV-03_SLK-05—After

ZEV-03_SLK-06—Before



ZEV-03_SLK-06—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*



ZEV-03_SLK-07—Before

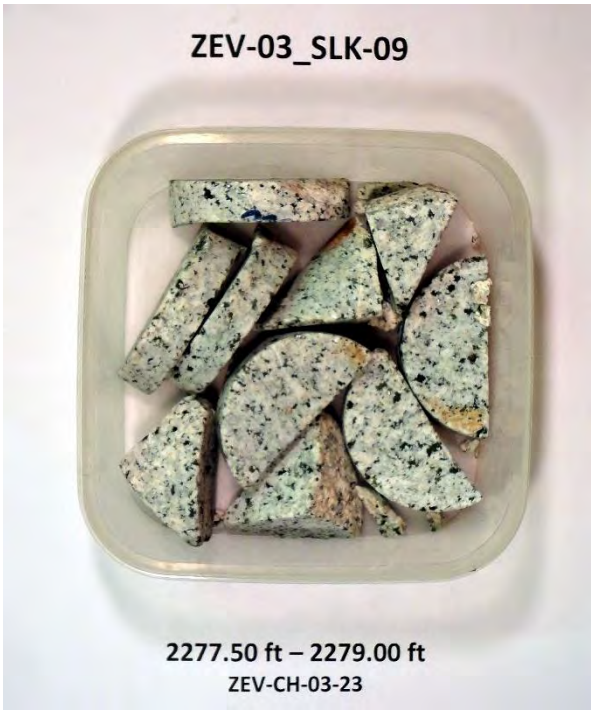
ZEV-03_SLK-07—After

ZEV-03_SLK-08—Before

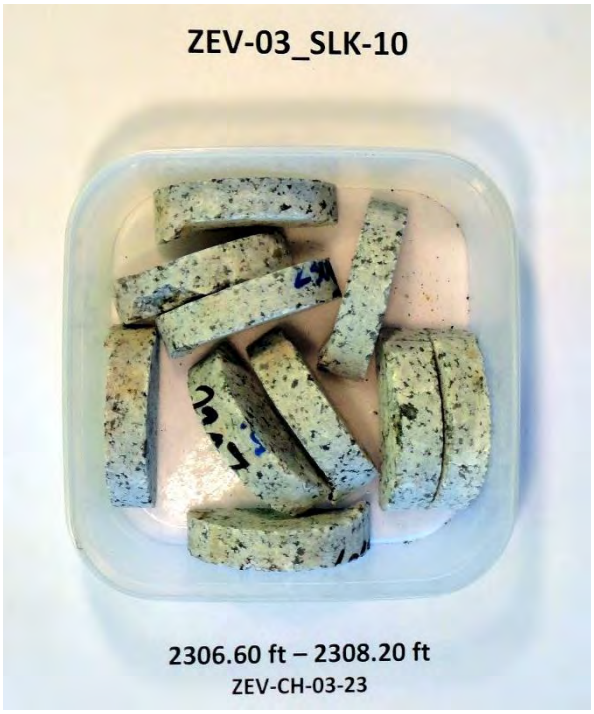
ZEV-03_SLK-08—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

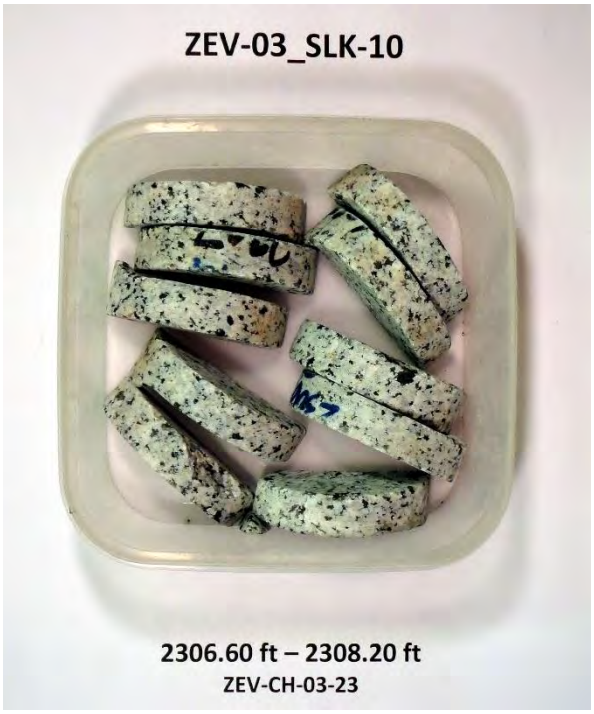
ZEV-03_SLK-09—Before



ZEV-03_SLK-09—After

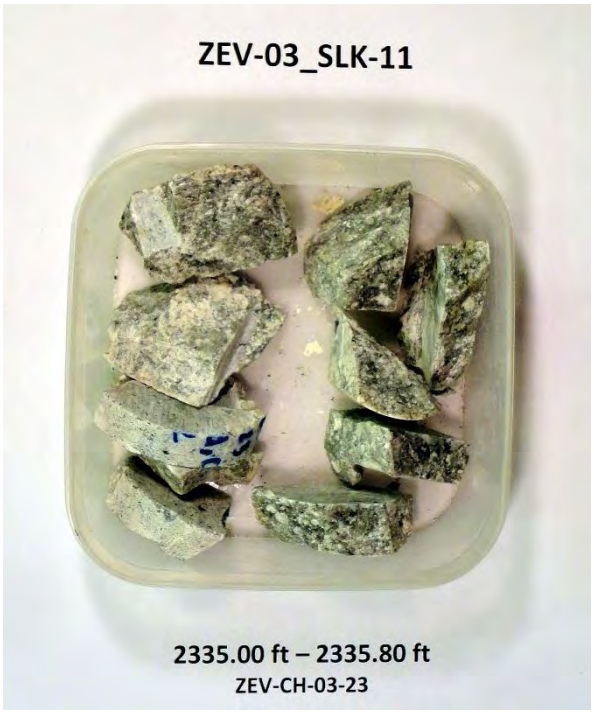


ZEV-03_SLK-10—Before

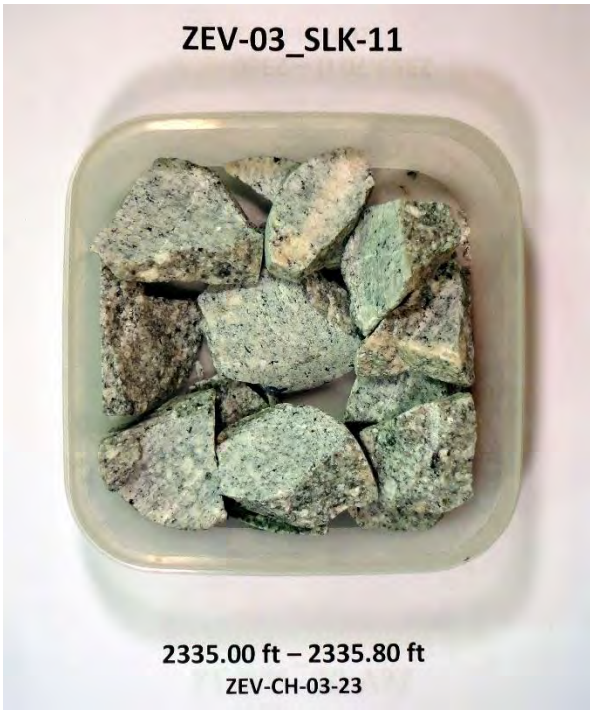


ZEV-03_SLK-10—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

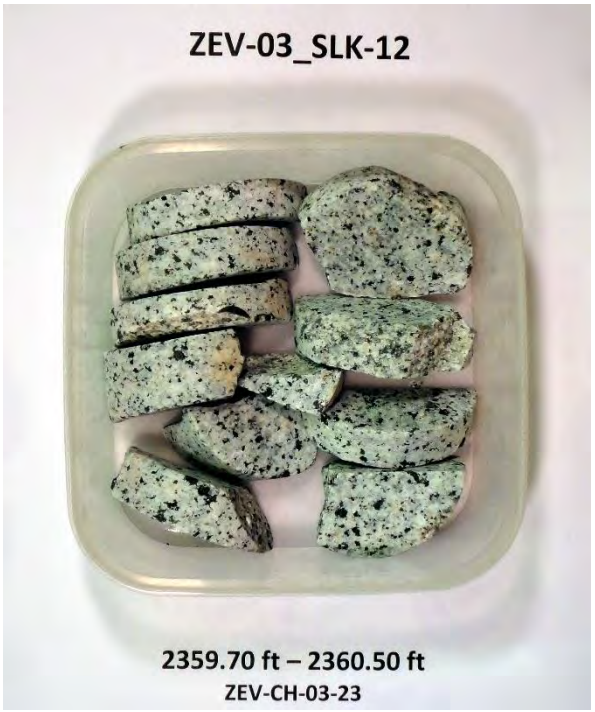


ZEV-03_SLK-11—Before



ZEV-03_SLK-11—After

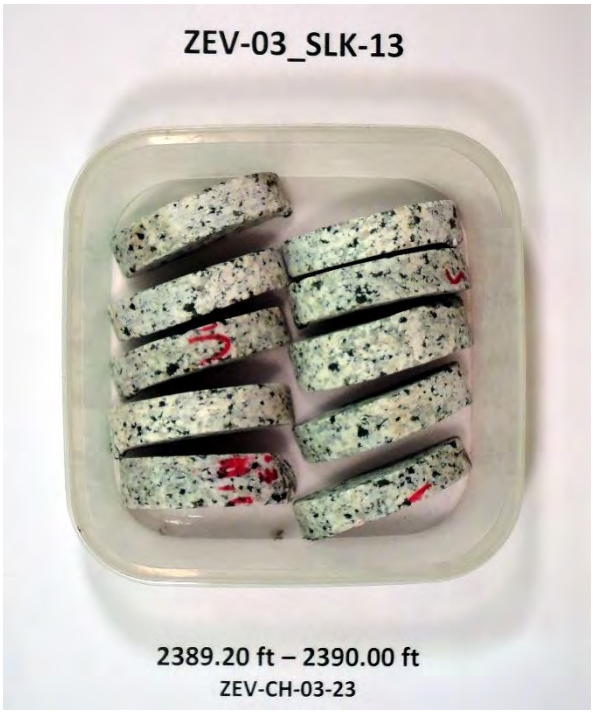
ZEV-03_SLK-12—Before



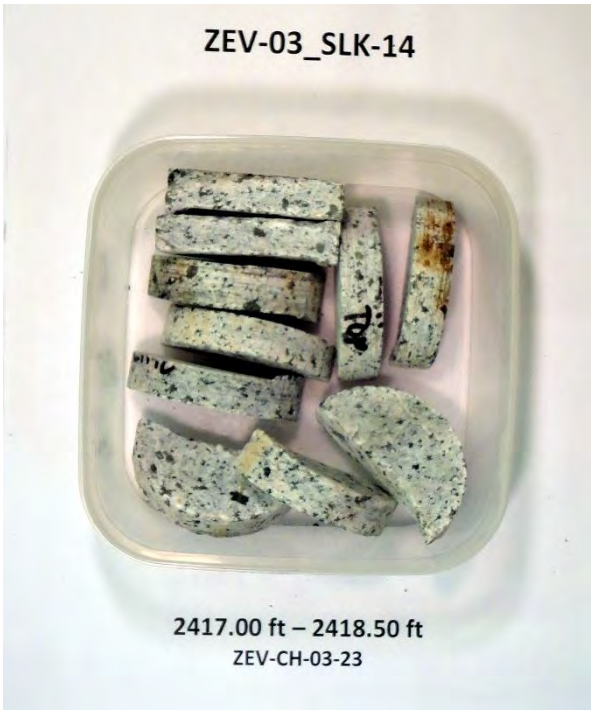
ZEV-03_SLK-12—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

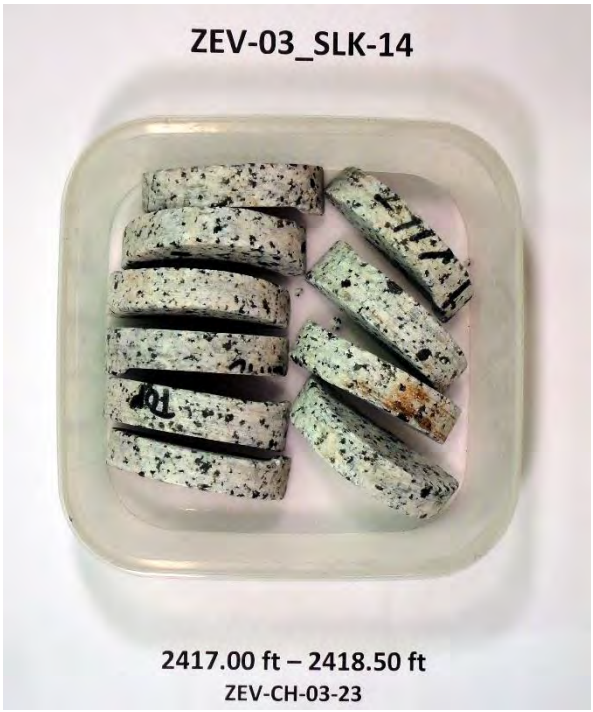
ZEV-03_SLK-13—Before



ZEV-03_SLK-13—After

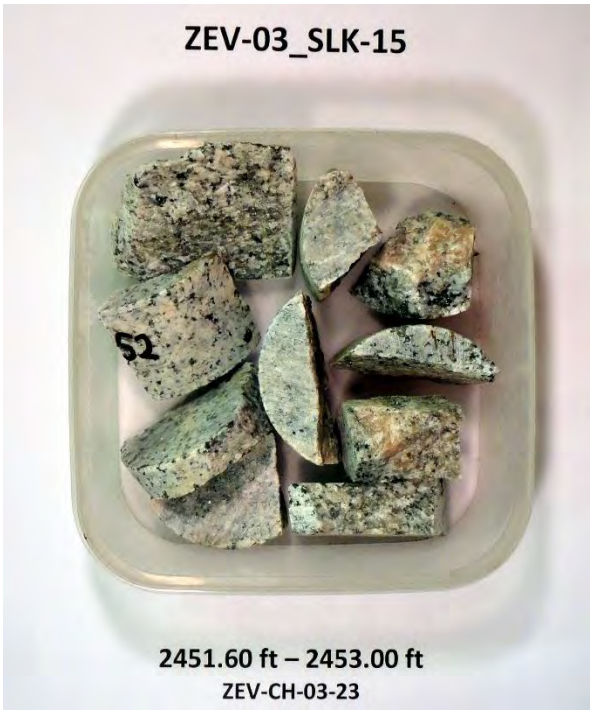


ZEV-03_SLK-14—Before

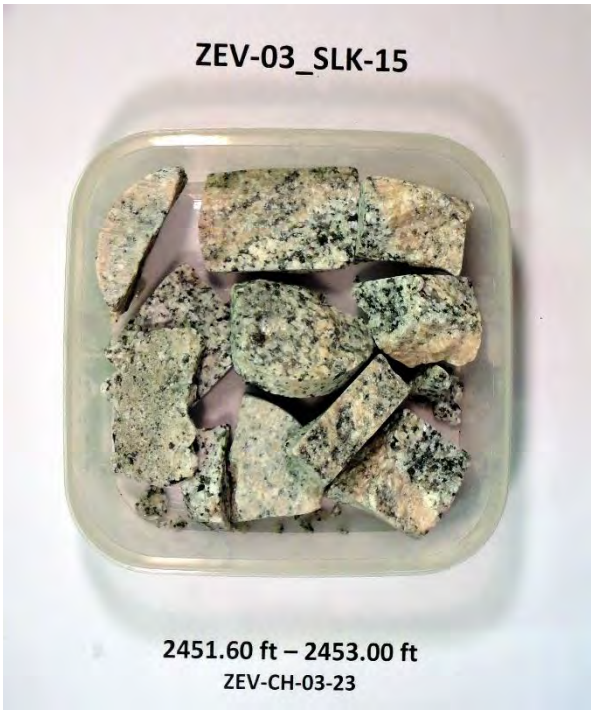


ZEV-03_SLK-14—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

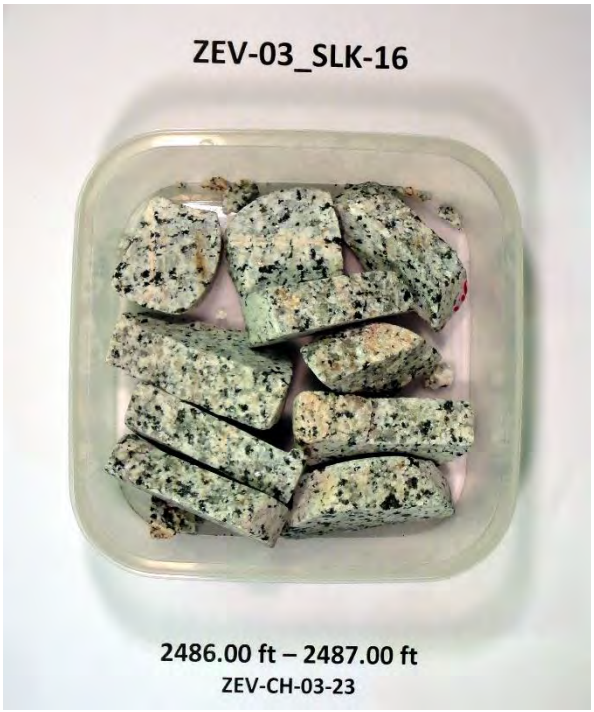


ZEV-03_SLK-15—Before



ZEV-03_SLK-15—After

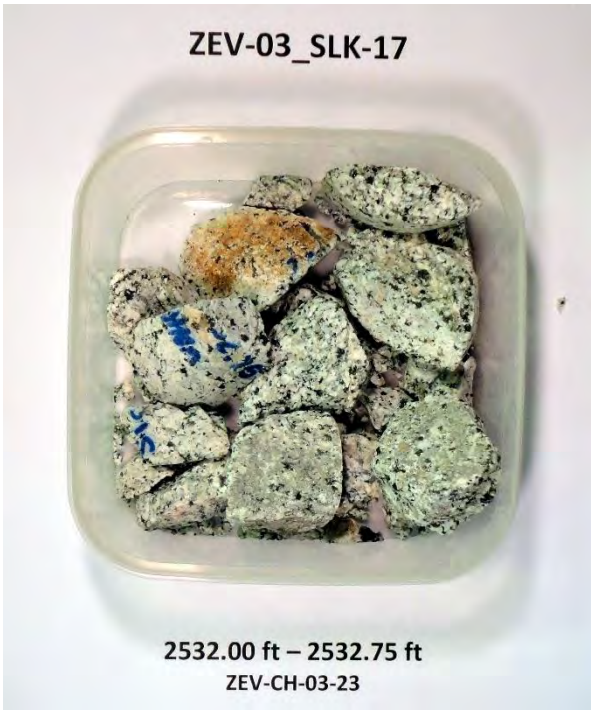
ZEV-03_SLK-16—Before



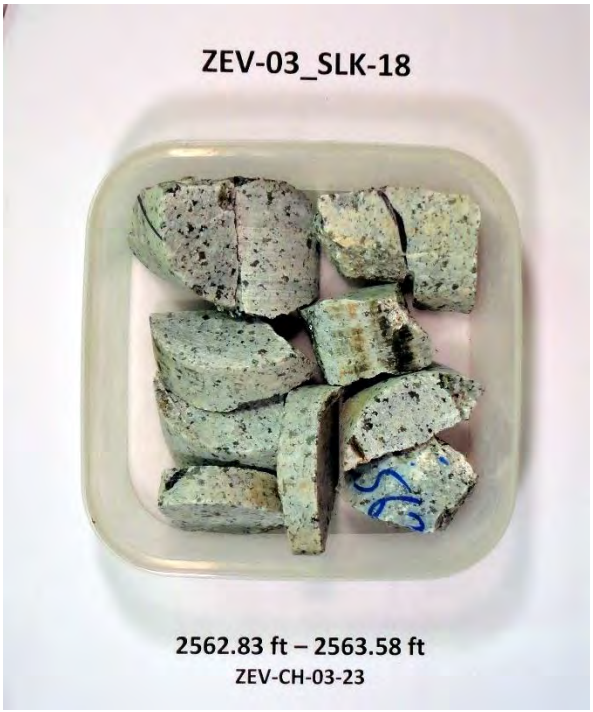
ZEV-03_SLK-16—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

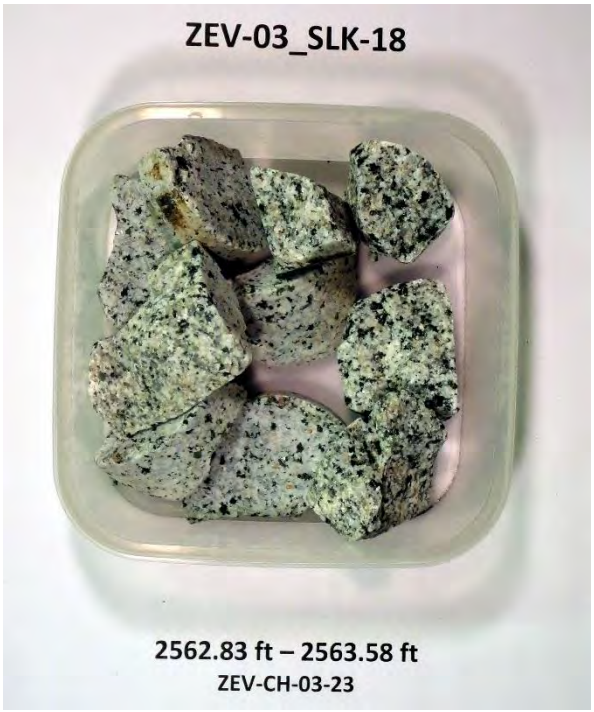
ZEV-03_SLK-17—Before



ZEV-03_SLK-17—After

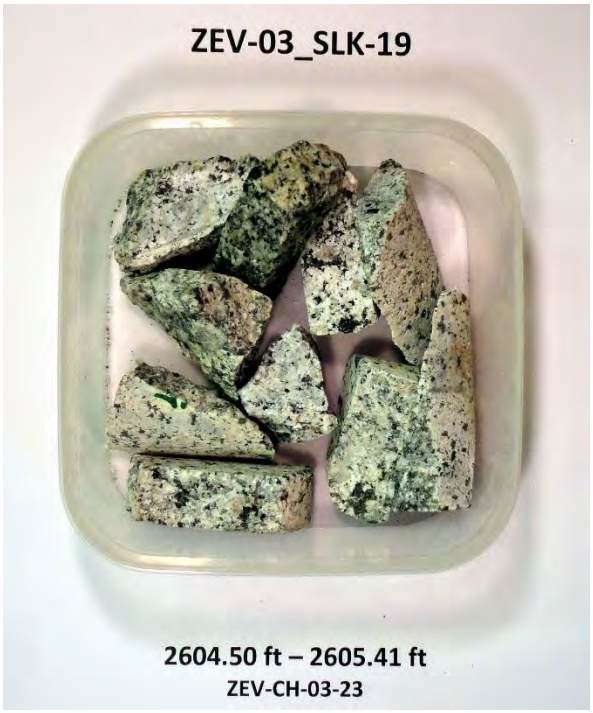


ZEV-03_SLK-18—Before

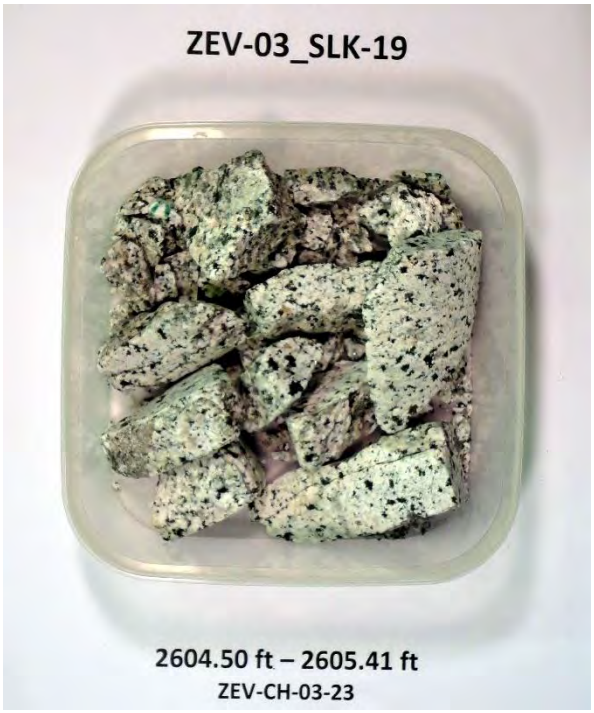


ZEV-03_SLK-18—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*



ZEV-03_SLK-19—Before

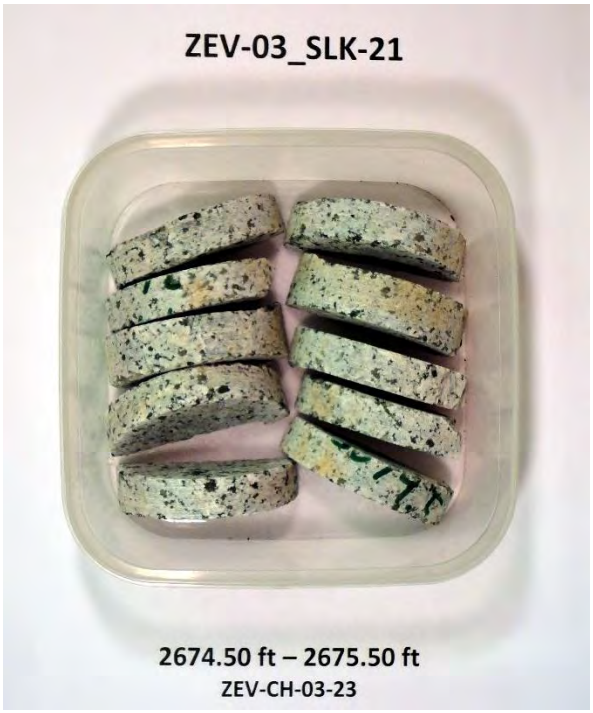


ZEV-03_SLK-19—After

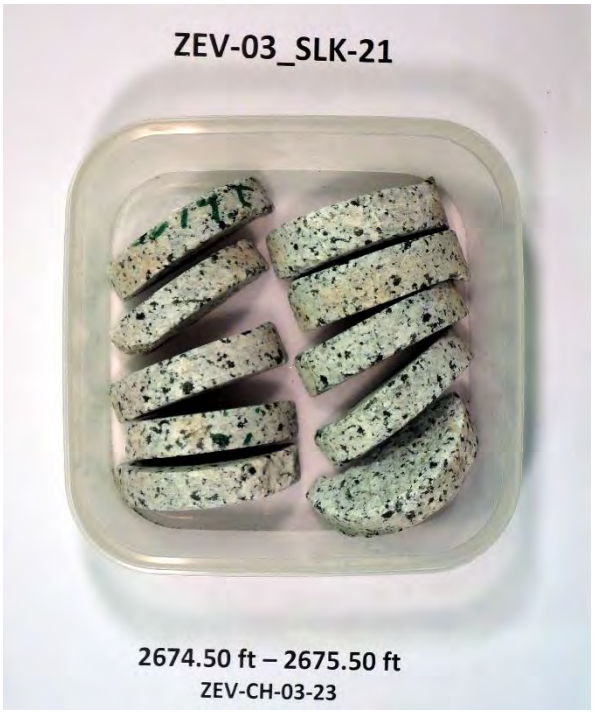
ZEV-03_SLK-20—Before

ZEV-03_SLK-20—After

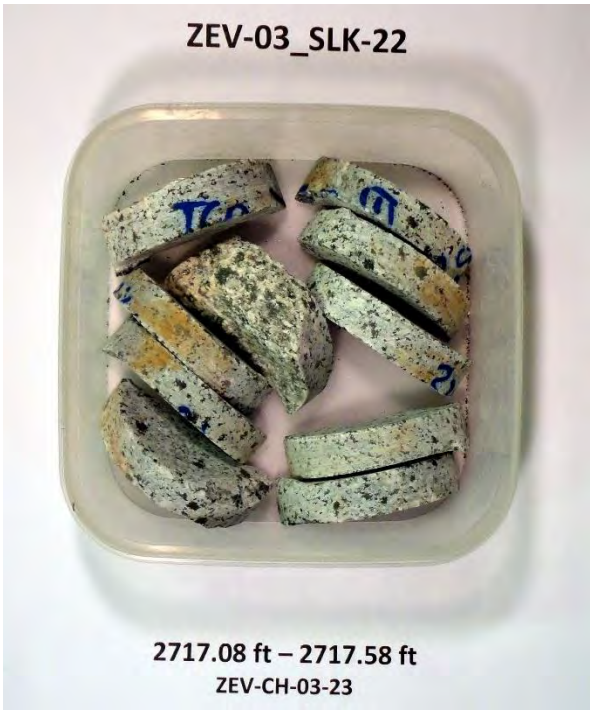
Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*



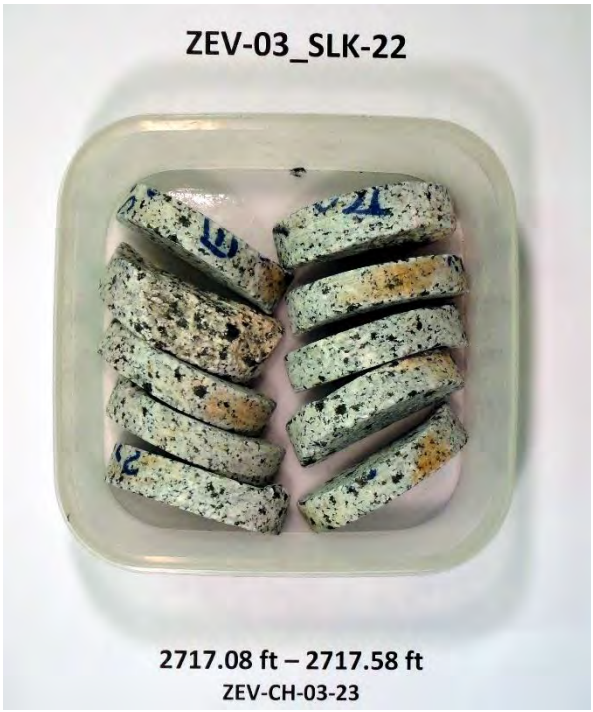
ZEV-03_SLK-21—Before



ZEV-03_SLK-21—After



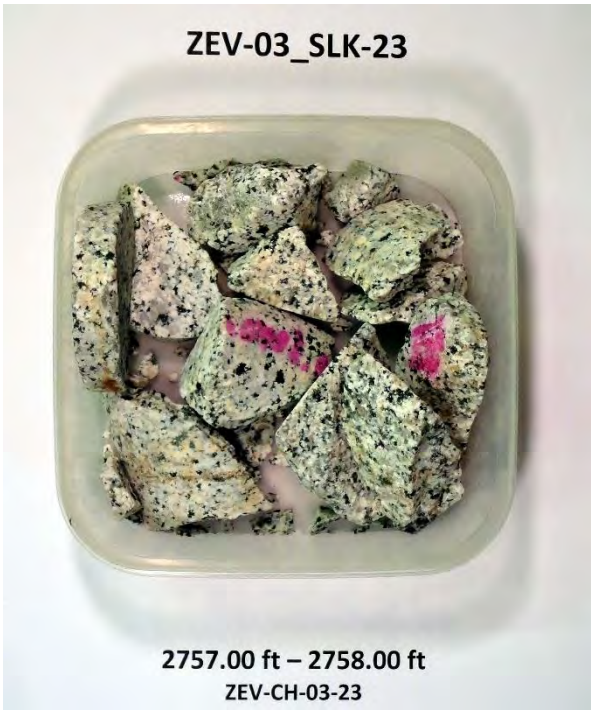
ZEV-03_SLK-22—Before



ZEV-03_SLK-22—After

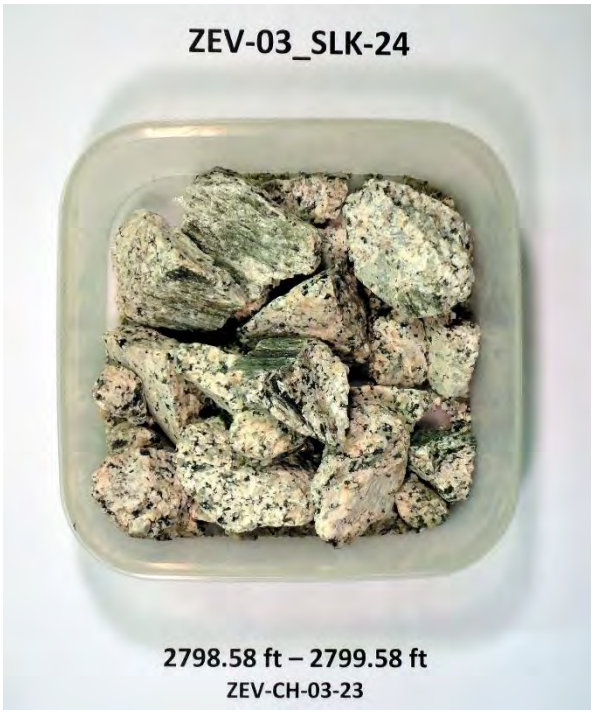
Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-03_SLK-23—Before



ZEV-03_SLK-23—After

ZEV-03_SLK-24—Before

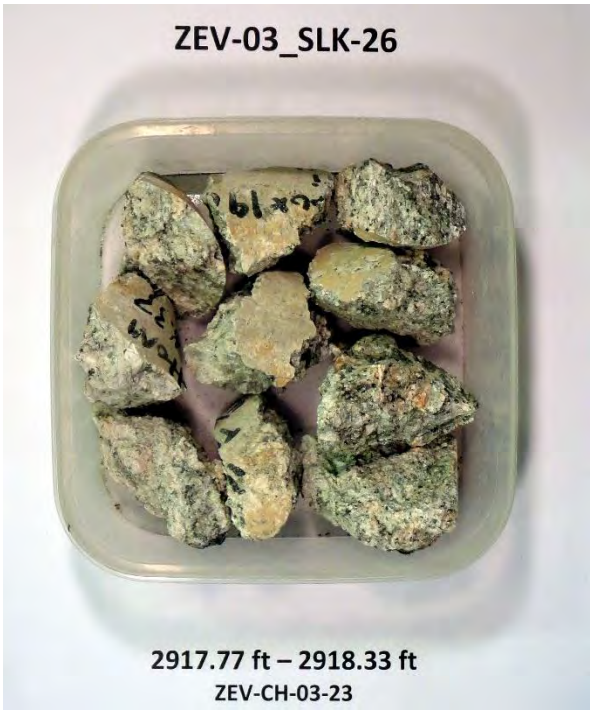


ZEV-03_SLK-24—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*

ZEV-03_SLK-25—Before

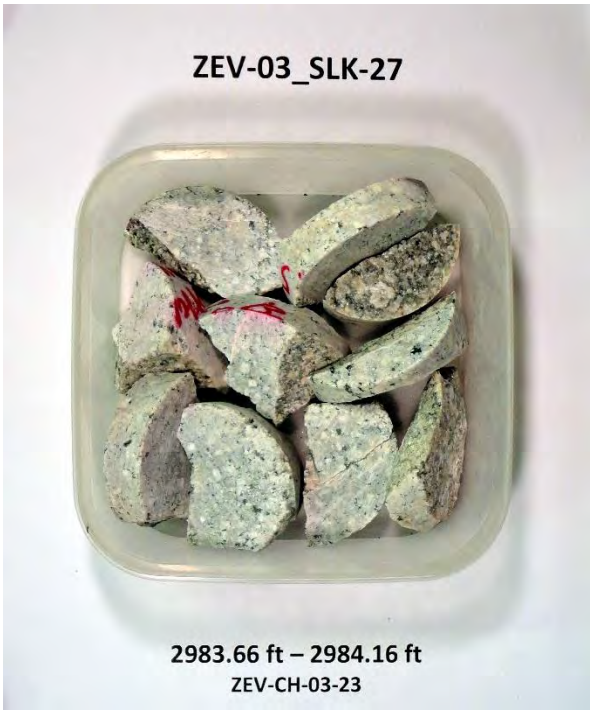
ZEV-03_SLK-25—After



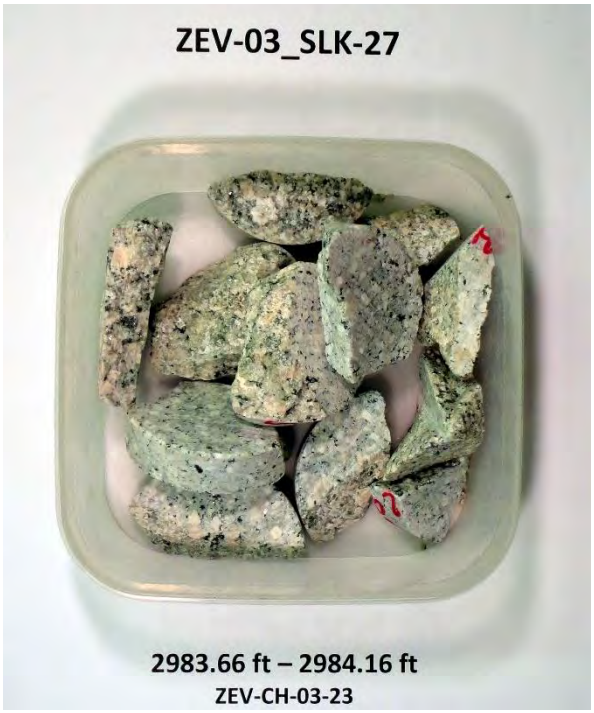
ZEV-03_SLK-26—Before

ZEV-03_SLK-26—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(continued)*



ZEV-03_SLK-27—Before



ZEV-03_SLK-27—After

Figure J-1. Before and After Photographs of Slake Durability Test Specimens *(concluded)*

APPENDIX D

ROCK MASS RATINGS

Depth		Elevation (MSL)		Interval Thickness (ft)	Lithology	Strength of Intact Rock (psi)	Estimated Strength of Intact Rock	Estimated Strength of Intact Rock (psi)	Rock Quality Designation (RQD)	Fracture Spacing (ft)	Number of Joint Sets	Condition of Discontinuities							Joint Water (Q)	Groundwater Conditions
From (ft)	To (ft)	From (ft)	To (ft)									Discontinuity Length (ft)	Aperture Thickness (mm)	Joint Roughness (Q)	Roughness (RMR)	Joint Alteration (Q)	Infilling (RMR)	Weathering / Alteration		
1752	1762	808	798	10	Qtz Monzonite	9,966			52	0.63	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1762	1772	798	788	10	Qtz Monzonite		R4	10,875	39	0.37	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1772	1782	788	778	10	Qtz Monzonite	17,820			69	0.83	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Softening or low friction clay	Soft filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1782	1792	778	768	10	Qtz Monzonite		R4	10,875	42	0.63	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1792	1802	768	758	10	Qtz Monzonite		R4	10,875	56	0.40	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Tightly healed, hard	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1802	1812	758	748	10	Qtz Monzonite		R4	10,875	24	0.33	Two joint sets plus random joints	10	2	Smooth, planar	Smooth	Tightly healed, hard	Hard filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1812	1822	748	738	10	Qtz Monzonite		R4	10,875	74	0.38	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1822	1832	738	728	10	Qtz Monzonite	10,296			61	0.56	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1832	1842	728	718	10	Diorite	12,474			15	0.43	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1842	1852	718	708	10	Diorite / Qtz Monzonite		R5	25,375	29	0.20	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1852	1862	708	698	10	Qtz Monzonite		R4	10,875	25	0.38	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1862	1872	698	688	10	Qtz Monzonite	18,920			50	0.45	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1872	1882	688	678	10	Qtz Monzonite		R4	10,875	34	0.25	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1882	1892	678	668	10	Qtz Monzonite		R4	10,875	16	0.33	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1892	1902	668	658	10	Qtz Monzonite		R3	4,550	10	0.56	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1902	1912	658	648	10	Qtz Monzonite		R3	4,550	41	0.59	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Medium inflow, occasional outwash of joint fillings (many drips/"rain")	Wet
1912	1922	648	638	10	Qtz Monzonite		R4	10,875	51	0.33	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	Hard filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1922	1932	638	628	10	Qtz Monzonite		R4	10,875	71	0.77	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1932	1942	628	618	10	Qtz Monzonite	17,783			61	0.53	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	Hard filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1942	1952	618	608	10	Qtz Monzonite		R4	10,875	56	0.56	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	Hard filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1952	1962	608	598	10	Qtz Monzonite		R4	10,875	34	0.20	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Tightly healed, hard	Hard filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1962	1972	598	588	10	Qtz Monzonite	8,654			11	0.22	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1972	1982	588	578	10	Qtz Monzonite		R4	10,875	30	0.20	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1982	1992	578	568	10	Qtz Monzonite		R4	10,875	52	0.67	Two joint sets plus random joints	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1992	2002	568	558	10	Qtz Monzonite		R4	10,875	82	0.77	Three joint sets	10	Closed	Smooth, planar	Smooth	Tightly healed, hard	Hard filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2002	2012	558	548	10	Qtz Monzonite	20,405			80	0.83	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	Hard filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2012	2022	548	538	10	Qtz Monzonite		R4	10,875	77	0.43	Three joint sets	10	Closed	Smooth, planar	Smooth	Tightly healed, hard	Hard filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2022	2032	538	528	10	Qtz Monzonite		R4	10,875	70	0.77	Three joint sets	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	Hard filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2032	2042	528	518	10	Qtz Monzonite	12,102			100	2.00	Three joint sets	10	Closed	Smooth, planar	Smooth	Tightly healed, hard	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2042	2052	518	508	10	Qtz Monzonite		R4	10,875	96	1.11	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2052	2062	508	498	10	Qtz Monzonite	20,834			94	1.43	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2062	2072	498	488	10	Qtz Monzonite	17,449			78	0.91	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2072	2082	488	478	10	Qtz Monzonite		R4	10,875	78	0.67	Three joint sets	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	Soft filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2082	2092	478	468	10	Qtz Monzonite		R4	10,875	81	0.59	Three joint sets	10	Closed	Smooth, planar	Smooth	Tightly healed, hard	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2092	2102	468	458	10	Qtz Monzonite	16,552			77	1.25	Three joint sets	10	Closed	Smooth, planar	Smooth	Tightly healed, hard	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2102	2112	458	448	10	Qtz Monzonite		R4	10,875	79	0.71	Three joint sets	10	Closed	Slickensided, planar	Slickensided	Slightly altered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2112	2122	448	438	10	Qtz Monzonite		R5	25,375	51	0.38	Three joint sets	10	Closed	Smooth, planar	Smooth	Tightly healed, hard	Hard filling <5mm	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2122	2132	438	428	10	Qtz Monzonite		R4	10,875	64	0.53	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2132	2142	428	418	10	Qtz Monzonite	24,510			80	0.71	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2142	2152	418	408	10	Qtz Monzonite		R4	10,875	48	0.67	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2152	2162	408	398	10	Qtz Monzonite		R4	10,875	41	0.34	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2162	2172	398	388	10	Qtz Monzonite	15,267			21	0.29	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2172	2182	388	378	10	Qtz Monzonite	5,610			68	0.40	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2182	2192	378	368	10	Qtz Monzonite		R4	10,875	74	0.40	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2192	2202	368	358	10	Qtz Monzonite	13,136			91	0.67	Three joint sets	10	Closed	Smooth, undulating	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2202	2212	358	348	10	Qtz Monzonite		R4	10,875	84	0.77	Three joint sets	10	Closed	Smooth, undulating	Slightly rough	Slightly altered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2212	2222	348	338	10	Qtz Monzonite	13,570			94	1.00	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2222	2232	338	328	10	Qtz Monzonite		R4	10,875	92	0.71	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2232	2242	328	318	10	Qtz Monzonite	18,172			41	0.53	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2242	2252	318	308	10	Qtz Monzonite	19,149			81	1.11	Three joint sets	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	Hard filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2252	2262	308	298	10	Qtz Monzonite		R3	4,550	72	0.59	Three joint sets	10	Closed	Smooth, undulating	Slightly rough	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2262	2272	298	288	10	Qtz Monzonite	6,820			38	0.33	Three joint sets	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	Hard filling <5mm	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2272	2282	288	278	10	Qtz Monzonite		R4	10,875	18	0.43	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2282	2292	278	268	10	Qtz Monzonite		R4	10,875	84	0.67	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2292	2302	268	258	10	Qtz Monzonite	582			56	0.71	Three joint sets	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	Hard filling <5mm	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2302	2312	258	248	10	Qtz Monzonite		R4	10,875	71	0.56	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2312	2322	248	238	10	Qtz Monzonite	2,442			68	0.25	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2322	2332	238	228	10	Qtz Monzonite	2,990			56	0.91	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2332	2342	228	218	10	Qtz Monzonite	3,805			51	0.56	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2342	2352	218	208	10	Qtz Monzonite	16,170			64	0.33	Three joint sets	10	Closed	Smooth, undulating	Slightly rough	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2352	2362	208	198	10	Qtz Monzonite	22,117			39	0.48	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2362	2372	198	188	10	Qtz Monzonite	20,900			51	0.48	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly weathered	Dry excavations or minor inflow (humid or a few drips)	Damp
2372	2382	188	178	10	Qtz Monzonite		R4	10,875	17	0.29	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2382	2392	178	168	10	Qtz Monzonite	12,604			71	0.40	Three joint sets	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	Hard filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2392	2402	168	158	10	Qtz Monzonite		R4	10,875	42	0.40	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2402	2412	158	148	10	Qtz Monzonite		R4	10,875	59	0.34	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2412	2422	148	138	10	Qtz Monzonite	5,349			70	0.83	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2422	2432	138	128	10	Qtz Monzonite	28,182			67	0.91	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2432	2442	128	118	10	Qtz Monzonite		R4	10,875	85	0.63	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2442	2452	118	108	10	Qtz Monzonite	27,060			80	0.77	Three joint sets	10	Closed	Rough, irregular, planar	Slightly rough	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2452	2462	108	98	10	Qtz Monzonite	11,914			56	0.36	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2462	2472	98	88	10	Qtz Monzonite		R4	10,875	49	0.43	Three joint sets	10	Closed	Smooth, planar	Smooth	Tightly healed, hard	Hard filling <5mm	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2472	2482	88	78	10	Qtz Monzonite	19,778			42	0.43	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2482	2492	78	68	10	Qtz Monzonite		R4	10,875	51	0.40	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2492	2502	68	58	10	Qtz Monzonite		R4	10,875	31	0.59	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2502	2512	58	48	10	Qtz Monzonite		R4	10,875	16	0.29	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2512	2522	48	38	10	Qtz Monzonite	23,472			49	0.56	Three joint sets	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp

Depth From (ft)	Depth To (ft)	Rock Mass Rating (RMR) Classification: Strength of Intact Rock Rating	Strength of Intact Rock Rating	RQD Rating	Spacing of Discontinuities Rating	Discontinuity Length Rating	Aperture Thickness Rating	Discontinuity Roughness Rating	Discontinuity Filling Rating	Weathering / Alteration Rating	Groundwater Rating	Rock Mass Rating (RMR)	RMR Classification
1752	1762	7	0	13	8	2	6	1	6	5	10	**58**	**Fair Rock**
1762	1772	0	7	8	8	2	6	1	6	5	10	**53**	**Fair Rock**
1772	1782	12	0	13	10	2	6	1	2	5	10	**61**	**Good Rock**
1782	1792	0	7	8	8	2	6	1	6	5	10	**53**	**Fair Rock**
1792	1802	0	7	13	8	2	6	1	6	5	10	**58**	**Fair Rock**
1802	1812	0	7	3	8	2	1	1	4	5	10	**41**	**Fair Rock**
1812	1822	0	7	13	8	2	6	1	6	5	10	**58**	**Fair Rock**
1822	1832	7	0	13	8	2	6	1	6	5	10	**58**	**Fair Rock**
1832	1842	7	0	3	8	2	6	1	6	6	10	**49**	**Fair Rock**
1842	1852	0	12	8	8	2	6	1	6	5	10	**58**	**Fair Rock**
1852	1862	0	7	8	8	2	6	1	6	5	10	**53**	**Fair Rock**
1862	1872	12	0	13	8	2	6	1	6	5	10	**63**	**Good Rock**
1872	1882	0	7	8	8	2	6	1	6	5	10	**53**	**Fair Rock**
1882	1892	0	7	3	8	2	6	1	6	5	10	**48**	**Fair Rock**
1892	1902	0	4	3	8	2	6	1	6	3	10	**43**	**Fair Rock**
1902	1912	0	4	8	8	2	6	1	6	6	7	**48**	**Fair Rock**
1912	1922	0	7	13	8	2	6	1	4	5	10	**56**	**Fair Rock**
1922	1932	0	7	13	10	2	6	1	6	5	10	**60**	**Fair Rock**
1932	1942	12	0	13	8	2	6	1	4	5	10	**61**	**Good Rock**
1942	1952	0	7	13	8	2	6	1	4	5	10	**56**	**Fair Rock**
1952	1962	0	7	8	8	2	6	1	4	5	10	**51**	**Fair Rock**
1962	1972	7	0	3	8	2	6	1	6	6	10	**49**	**Fair Rock**
1972	1982	0	7	8	8	2	6	1	6	5	10	**53**	**Fair Rock**
1982	1992	0	7	13	10	2	6	1	6	5	10	**60**	**Fair Rock**
1992	2002	0	7	17	10	2	6	1	4	5	10	**62**	**Good Rock**
2002	2012	12	0	17	10	2	6	1	4	5	10	**67**	**Good Rock**
2012	2022	0	7	17	8	2	6	1	4	5	10	**60**	**Fair Rock**
2022	2032	0	7	13	10	2	6	1	4	5	10	**58**	**Fair Rock**
2032	2042	7	0	20	15	2	6	1	6	5	10	**72**	**Good Rock**
2042	2052	0	7	20	10	2	6	1	6	5	10	**67**	**Good Rock**
2052	2062	12	0	20	10	2	6	1	6	5	10	**72**	**Good Rock**
2062	2072	12	0	17	10	2	6	1	6	5	10	**69**	**Good Rock**
2072	2082	0	7	17	10	2	6	1	2	5	10	**60**	**Fair Rock**
2082	2092	0	7	17	8	2	6	1	6	5	10	**62**	**Good Rock**
2092	2102	12	0	17	10	2	6	1	6	5	10	**69**	**Good Rock**
2102	2112	0	7	17	10	2	6	0	6	5	10	**63**	**Good Rock**
2112	2122	0	12	13	8	2	6	1	4	6	10	**62**	**Good Rock**
2122	2132	0	7	13	8	2	6	1	6	5	10	**58**	**Fair Rock**
2132	2142	12	0	17	10	2	6	1	6	5	10	**69**	**Good Rock**
2142	2152	0	7	8	10	2	6	1	6	5	10	**55**	**Fair Rock**
2152	2162	0	7	8	8	2	6	1	6	5	10	**53**	**Fair Rock**
2162	2172	12	0	3	8	2	6	1	6	5	10	**53**	**Fair Rock**
2172	2182	4	0	13	8	2	6	1	6	5	10	**55**	**Fair Rock**
2182	2192	0	7	13	8	2	6	1	6	5	10	**58**	**Fair Rock**
2192	2202	7	0	20	10	2	6	3	6	5	10	**69**	**Good Rock**
2202	2212	0	7	17	10	2	6	3	6	5	10	**66**	**Good Rock**
2212	2222	7	0	20	10	2	6	1	6	5	10	**67**	**Good Rock**
2222	2232	0	7	20	10	2	6	1	6	5	10	**67**	**Good Rock**
2232	2242	12	0	8	8	2	6	1	6	5	10	**58**	**Fair Rock**
2242	2252	12	0	17	10	2	6	1	4	5	10	**67**	**Good Rock**
2252	2262	0	4	13	8	2	6	3	6	6	10	**58**	**Fair Rock**
2262	2272	4	0	8	8	2	6	1	4	6	10	**49**	**Fair Rock**
2272	2282	0	7	3	8	2	6	1	6	6	10	**49**	**Fair Rock**
2282	2292	0	7	17	10	2	6	1	6	6	10	**65**	**Good Rock**
2292	2302	1	0	13	10	2	6	1	4	3	10	**50**	**Fair Rock**
2302	2312	0	7	13	8	2	6	1	6	6	10	**59**	**Fair Rock**
2312	2322	2	0	13	8	2	6	1	6	6	10	**54**	**Fair Rock**
2322	2332	2	0	13	10	2	6	1	6	6	10	**56**	**Fair Rock**
2332	2342	4	0	13	8	2	6	1	6	6	10	**56**	**Fair Rock**
2342	2352	12	0	13	8	2	6	3	6	6	10	**66**	**Good Rock**
2352	2362	12	0	8	8	2	6	1	6	6	10	**59**	**Fair Rock**
2362	2372	12	0	13	8	2	6	1	6	5	10	**63**	**Good Rock**
2372	2382	0	7	3	8	2	6	1	6	6	10	**49**	**Fair Rock**
2382	2392	7	0	13	8	2	6	1	4	5	10	**56**	**Fair Rock**
2392	2402	0	7	8	8	2	6	1	6	5	10	**53**	**Fair Rock**
2402	2412	0	7	13	8	2	6	1	6	5	10	**58**	**Fair Rock**
2412	2422	4	0	13	10	2	6	1	6	6	10	**58**	**Fair Rock**
2422	2432	12	0	13	10	2	6	1	6	6	10	**66**	**Good Rock**
2432	2442	0	7	17	8	2	6	1	6	6	10	**63**	**Good Rock**
2442	2452	12	0	17	10	2	6	3	6	6	10	**72**	**Good Rock**
2452	2462	7	0	13	8	2	6	1	6	6	10	**59**	**Fair Rock**
2462	2472	0	7	8	8	2	6	1	4	6	10	**52**	**Fair Rock**
2472	2482	12	0	8	8	2	6	1	6	5	10	**58**	**Fair Rock**
2482	2492	0	7	13	8	2	6	1	6	5	10	**58**	**Fair Rock**
2492	2502	0	7	8	8	2	6	1	6	5	10	**53**	**Fair Rock**
2502	2512	0	7	3	8	2	6	1	6	5	10	**48**	**Fair Rock**
2512	2522	12	0	8	8	2	6	1	6	5	10	**58**	**Fair Rock**

Depth From (ft)	Depth To (ft)	Q-system: Joint Set Number (J_n)	Joint Roughness Number (J_r)	Joint Alteration Number (J_a)	Joint Water Reduction (J_w)	Estimated Vertical Stress (psi)	Stress Condition	Stress Reduction Factor (SRF)	Q-value	Q-value Classification	Rock Mass Rating (RMR_{89})	Geological Strength Index (GSI)
1752	1762	6	1	1	1	2021	High Stress, Jointed Rock	4	**2.167**	**Poor**	**63**	**58**
1762	1772	6	1	1	1	2032	High Stress, Jointed Rock	4	**1.625**	**Poor**	**58**	**53**
1772	1782	6	1	4	1	2044	High Stress, Jointed Rock	2	**1.438**	**Poor**	**66**	**61**
1782	1792	6	1	1	1	2055	High Stress, Jointed Rock	4	**1.750**	**Poor**	**58**	**53**
1792	1802	6	1	0.75	1	2067	High Stress, Jointed Rock	4	**3.111**	**Poor**	**63**	**58**
1802	1812	6	1	0.75	1	2078	High Stress, Jointed Rock	4	**1.333**	**Poor**	**46**	**41**
1812	1822	6	1	1	1	2090	High Stress, Jointed Rock	4	**3.083**	**Poor**	**63**	**58**
1822	1832	6	1	1	1	2101	High Stress, Jointed Rock	4	**2.542**	**Poor**	**63**	**58**
1832	1842	6	1	1	1	2113	High Stress, Jointed Rock	4	**0.625**	**Very Poor**	**54**	**49**
1842	1852	6	1	1	1	2124	Medium Stress	1	**4.833**	**Fair**	**63**	**58**
1852	1862	6	1	1	1	2136	High Stress, Jointed Rock	4	**1.042**	**Poor**	**58**	**53**
1862	1872	6	1	1	1	2147	High Stress, Jointed Rock	2	**4.167**	**Fair**	**68**	**63**
1872	1882	6	1	1	1	2159	High Stress, Jointed Rock	4	**1.417**	**Poor**	**58**	**53**
1882	1892	6	1	1	1	2170	High Stress, Jointed Rock	4	**0.667**	**Very Poor**	**53**	**48**
1892	1902	6	1	2	1	2182	High Stress, Jointed Rock	14	**0.060**	**Extremely Poor**	**48**	**43**
1902	1912	6	1	1	0.66	2193	High Stress, Jointed Rock	14	**0.322**	**Very Poor**	**56**	**51**
1912	1922	6	1	2	1	2205	High Stress, Jointed Rock	4	**1.063**	**Poor**	**61**	**56**
1922	1932	6	1	1	1	2216	High Stress, Jointed Rock	4	**2.958**	**Poor**	**65**	**60**
1932	1942	6	1	2	1	2228	High Stress, Jointed Rock	2	**2.542**	**Poor**	**66**	**61**
1942	1952	6	1	2	1	2239	High Stress, Jointed Rock	4	**1.167**	**Poor**	**61**	**56**
1952	1962	6	1	0.75	1	2251	High Stress, Jointed Rock	4	**1.889**	**Poor**	**56**	**51**
1962	1972	6	1	1	1	2262	High Stress, Jointed Rock	6	**0.306**	**Very Poor**	**54**	**49**
1972	1982	6	1	1	1	2274	High Stress, Jointed Rock	4	**1.250**	**Poor**	**58**	**53**
1982	1992	6	1	1	1	2285	High Stress, Jointed Rock	4	**2.167**	**Poor**	**65**	**60**
1992	2002	9	1	0.75	1	2297	High Stress, Jointed Rock	4	**3.037**	**Poor**	**67**	**62**
2002	2012	9	1	1	1	2308	High Stress, Jointed Rock	2	**4.444**	**Fair**	**72**	**67**
2012	2022	9	1	0.75	1	2320	High Stress, Jointed Rock	4	**2.852**	**Poor**	**65**	**60**
2022	2032	9	1	2	1	2331	High Stress, Jointed Rock	4	**0.972**	**Very Poor**	**63**	**58**
2032	2042	9	1	0.75	1	2343	High Stress, Jointed Rock	4	**3.704**	**Poor**	**77**	**72**
2042	2052	9	1	1	1	2354	High Stress, Jointed Rock	4	**2.667**	**Poor**	**72**	**67**
2052	2062	9	1	1	1	2366	High Stress, Jointed Rock	2	**5.222**	**Fair**	**77**	**72**
2062	2072	9	1	1	1	2377	High Stress, Jointed Rock	2	**4.333**	**Fair**	**74**	**69**
2072	2082	9	1	2	1	2389	High Stress, Jointed Rock	4	**1.083**	**Poor**	**65**	**60**
2082	2092	9	1	0.75	1	2400	High Stress, Jointed Rock	4	**3.000**	**Poor**	**67**	**62**
2092	2102	9	1	0.75	1	2412	High Stress, Jointed Rock	2	**5.704**	**Fair**	**74**	**69**
2102	2112	9	0.5	2	1	2423	High Stress, Jointed Rock	4	**0.549**	**Very Poor**	**68**	**63**
2112	2122	9	1	0.75	1	2435	Medium Stress	1	**7.556**	**Fair**	**67**	**62**
2122	2132	9	1	1	1	2446	High Stress, Jointed Rock	4	**1.778**	**Poor**	**63**	**58**
2132	2142	9	1	1	1	2458	High Stress, Jointed Rock	2	**4.444**	**Fair**	**74**	**69**
2142	2152	9	1	1	1	2469	High Stress, Jointed Rock	4	**1.333**	**Poor**	**60**	**55**
2152	2162	9	1	1	1	2481	High Stress, Jointed Rock	4	**1.139**	**Poor**	**58**	**53**
2162	2172	9	1	1	1	2492	High Stress, Jointed Rock	2	**1.167**	**Poor**	**58**	**53**
2172	2182	9	1	1	1	2504	High Stress, Jointed Rock	12	**0.630**	**Very Poor**	**60**	**55**
2182	2192	9	1	1	1	2515	High Stress, Jointed Rock	4	**2.056**	**Poor**	**63**	**58**
2192	2202	9	2	1	1	2527	High Stress, Jointed Rock	4	**5.056**	**Fair**	**74**	**69**
2202	2212	9	2	2	1	2538	High Stress, Jointed Rock	4	**2.333**	**Poor**	**71**	**66**
2212	2222	9	1	1	1	2550	High Stress, Jointed Rock	4	**2.611**	**Poor**	**72**	**67**
2222	2232	9	1	1	1	2561	High Stress, Jointed Rock	4	**2.556**	**Poor**	**72**	**67**
2232	2242	9	1	1	1	2573	High Stress, Jointed Rock	2	**2.278**	**Poor**	**63**	**58**
2242	2252	9	1	2	1	2584	High Stress, Jointed Rock	2	**2.250**	**Poor**	**72**	**67**
2252	2262	9	2	1	1	2596	High Stress, Jointed Rock	16	**1.000**	**Poor**	**63**	**58**
2262	2272	9	1	2	1	2607	High Stress, Jointed Rock	10	**0.211**	**Very Poor**	**54**	**49**
2272	2282	9	1	1	1	2619	High Stress, Jointed Rock	6	**0.333**	**Very Poor**	**54**	**49**
2282	2292	9	1	1	1	2630	High Stress, Jointed Rock	6	**1.556**	**Poor**	**70**	**65**
2292	2302	9	1	2	1	2642	High Stress, Jointed Rock	20	**0.156**	**Very Poor**	**55**	**50**
2302	2312	9	1	1	1	2653	High Stress, Jointed Rock	6	**1.315**	**Poor**	**64**	**59**
2312	2322	9	1	1	1	2665	High Stress, Jointed Rock	20	**0.378**	**Very Poor**	**59**	**54**
2322	2332	9	1	1	1	2676	High Stress, Jointed Rock	20	**0.311**	**Very Poor**	**61**	**56**
2332	2342	9	1	1	1	2688	High Stress, Jointed Rock	20	**0.283**	**Very Poor**	**61**	**56**
2342	2352	9	2	1	1	2699	High Stress, Jointed Rock	2	**7.111**	**Fair**	**71**	**66**
2352	2362	9	1	1	1	2711	High Stress, Jointed Rock	2	**2.167**	**Poor**	**64**	**59**
2362	2372	9	1	1	1	2722	High Stress, Jointed Rock	2	**2.833**	**Poor**	**68**	**63**
2372	2382	9	1	1	1	2734	High Stress, Jointed Rock	6	**0.315**	**Very Poor**	**54**	**49**
2382	2392	9	1	2	1	2745	High Stress, Jointed Rock	4	**0.986**	**Very Poor**	**61**	**56**
2392	2402	9	1	1	1	2757	High Stress, Jointed Rock	6	**0.778**	**Very Poor**	**58**	**53**
2402	2412	9	1	1	1	2768	High Stress, Jointed Rock	6	**1.093**	**Poor**	**63**	**58**
2412	2422	9	1	1	1	2780	High Stress, Jointed Rock	14	**0.556**	**Very Poor**	**63**	**58**
2422	2432	9	1	1	1	2791	Medium Stress	1	**7.444**	**Fair**	**71**	**66**
2432	2442	9	1	1	1	2803	High Stress, Jointed Rock	6	**1.574**	**Poor**	**68**	**63**
2442	2452	9	1.5	1	1	2814	High Stress, Jointed Rock	2	**6.667**	**Fair**	**77**	**72**
2452	2462	9	1	1	1	2826	High Stress, Jointed Rock	6	**1.037**	**Poor**	**64**	**59**
2462	2472	9	1	0.75	1	2837	High Stress, Jointed Rock	6	**1.210**	**Poor**	**57**	**52**
2472	2482	9	1	1	1	2849	High Stress, Jointed Rock	2	**2.333**	**Poor**	**63**	**58**
2482	2492	9	1	1	1	2860	High Stress, Jointed Rock	6	**0.944**	**Very Poor**	**63**	**58**
2492	2502	9	1	1	1	2872	High Stress, Jointed Rock	6	**0.574**	**Very Poor**	**58**	**53**
2502	2512	9	1	1	1	2883	High Stress, Jointed Rock	6	**0.296**	**Very Poor**	**53**	**48**
2512	2522	9	1	1	1	2895	High Stress, Jointed Rock	2	**2.722**	**Poor**	**63**	**58**

Depth		Elevation (MSL)		Interval Thickness (ft)	Lithology	Strength of Intact Rock (psi)	Estimated Strength of Intact Rock	Estimated Strength of Intact Rock (psi)	Rock Quality Designation (RQD)	Fracture Spacing (ft)	Number of Joint Sets
From (ft)	To (ft)	From (ft)	To (ft)								
1750	1760	820	810	10	Qtz Monzonite	24,860			72	1.25	Two joint sets plus random joints
1760	1770	810	800	10	Qtz Monzonite		R4	10,875	78	1.00	Two joint sets plus random joints
1770	1780	800	790	10	Qtz Monzonite	14,036			69	0.71	Two joint sets plus random joints
1780	1790	790	780	10	Qtz Monzonite		R4	10,875	71	0.63	Two joint sets plus random joints
1790	1800	780	770	10	Dolerite/ Qtz Monazite		R4	10,875	36	0.29	Two joint sets plus random joints
1800	1810	770	760	10	Qtz Monazite		R4	10,875	30	0.43	Two joint sets plus random joints
1810	1820	760	750	10	Qtz Monazite		R4	10,875	65	0.37	Two joint sets plus random joints
1820	1830	750	740	10	Qtz Monazite		R4	10,875	30	0.45	Two joint sets plus random joints
1830	1840	740	730	10	Qtz Monazite		R4	10,875	14	0.42	Two joint sets plus random joints
1840	1850	730	720	10	Qtz Monazite		R4	10,875	45	0.24	Two joint sets plus random joints
1850	1860	720	710	10	Qtz Monazite	15,752			35	0.45	Two joint sets plus random joints
1860	1870	710	700	10	Qtz Monazite	4,686			27	0.33	Two joint sets plus random joints
1870	1880	700	690	10	Qtz Monazite	16,610			48	0.63	Two joint sets plus random joints
1880	1890	690	680	10	Qtz Monazite	17,182			52	0.91	Two joint sets plus random joints
1890	1900	680	670	10	Qtz Monazite		R4	10,875	19	0.56	Two joint sets plus random joints
1900	1910	670	660	10	Qtz Monazite		R4	10,875	10	0.25	Two joint sets plus random joints
1910	1920	660	650	10	Qtz Monazite		R4	10,875	10	0.25	Two joint sets plus random joints
1920	1930	650	640	10	Qtz Monazite		R4	10,875	10	0.29	Two joint sets plus random joints
1930	1940	640	630	10	Qtz Monazite		R4	10,875	10	0.32	Two joint sets plus random joints
1940	1950	630	620	10	Qtz Monazite		R4	10,875	43	0.36	Two joint sets plus random joints
1950	1960	620	610	10	Qtz Monazite	18,272			23	0.40	Two joint sets plus random joints
1960	1970	610	600	10	Qtz Monazite	19,250			80	0.42	Two joint sets plus random joints
1970	1980	600	590	10	Qtz Monazite	14,146			55	1.11	Two joint sets plus random joints
1980	1990	590	580	10	Qtz Monazite	25,410			87	0.48	Two joint sets plus random joints
1990	2000	580	570	10	Qtz Monazite		R4	10,875	95	0.83	Three joint sets
2000	2010	570	560	10	Qtz Monazite	26,655			92	0.77	Three joint sets
2010	2020	560	550	10	Qtz Monazite		R4	10,875	50	0.50	Three joint sets
2020	2030	550	540	10	Qtz Monazite		R4	10,875	74	0.56	Three joint sets
2030	2040	540	530	10	Qtz Monazite		R4	10,875	55	0.34	Three joint sets
2040	2050	530	520	10	Qtz Monazite	27,231			100	0.83	Three joint sets
2050	2060	520	510	10	Qtz Monazite		R4	10,875	100	0.59	Three joint sets
2060	2070	510	500	10	Qtz Monazite	22,671			100	3.33	Three joint sets
2070	2080	500	490	10	Qtz Monazite	25,454			95	1.43	Three joint sets
2080	2090	490	480	10	Qtz Monazite		R4	10,875	92	2.00	Three joint sets
2090	2100	480	470	10	Qtz Monazite	16,566			100	1.67	Three joint sets
2100	2110	470	460	10	Qtz Monazite	18,128			100	5.00	Three joint sets
2110	2120	460	450	10	Qtz Monazite		R3	4,550	100	1.25	Three joint sets
2120	2130	450	440	10	Qtz Monazite		R3	4,550	80	0.91	Three joint sets
2130	2140	440	430	10	Qtz Monazite	25,939	R3	4,550	90	0.91	Three joint sets
2140	2150	430	420	10	Qtz Monazite		R3	4,550	100	1.11	Three joint sets
2150	2160	420	410	10	Qtz Monazite		R3	4,550	95	1.43	Three joint sets
2160	2170	410	400	10	Qtz Monazite	23,626			80	0.91	Three joint sets
2170	2180	400	390	10	Qtz Monazite		R4	10,875	60	0.77	Three joint sets
2180	2190	390	380	10	Qtz Monazite	29,590			100	3.33	Three joint sets
2190	2200	380	370	10	Qtz Monazite	26,290			100	2.50	Three joint sets
2200	2210	370	360	10	Qtz Monazite		R4	10,875	100	1.43	Three joint sets
2210	2220	360	350	10	Qtz Monazite/ Monzonite	20,384			78	1.25	Three joint sets
2220	2230	350	340	10	Qtz Monzonite	7,084			50	0.71	Three joint sets
2230	2240	340	330	10	Qtz Monzonite		R3	4,550	40	1.00	Three joint sets
2240	2250	330	320	10	Qtz Monzonite		R3	4,550	30	0.71	Three joint sets
2250	2260	320	310	10	Qtz Monzonite	3,872			53	0.63	Three joint sets
2260	2270	310	300	10	Qtz Monzonite		R3	4,550	40	0.32	Three joint sets
2270	2280	300	290	10	Qtz Monzonite		R3	4,550	58	0.40	Three joint sets
2280	2290	290	280	10	Qtz Monzonite	1,628			37	0.56	Three joint sets
2290	2300	280	270	10	Qtz Monzonite		R3	4,550	41	0.63	Three joint sets
2300	2310	270	260	10	Qtz Monzonite		R4	10,875	35	0.38	Three joint sets
2310	2320	260	250	10	Qtz Monzonite	21,714			21	0.36	Three joint sets
2320	2330	250	240	10	Diorite		R4	10,875	19	0.42	Three joint sets
2330	2340	240	230	10	Qtz Monzonite		R4	10,875	67	0.38	Three joint sets
2340	2350	230	220	10	Qtz Monzonite	21,408			62	0.77	Three joint sets
2350	2360	220	210	10	Qtz Monzonite/ Diorite		R4	10,875	61	0.45	Three joint sets
2360	2370	210	200	10	Qtz Monzonite		R4	10,875	38	0.56	Three joint sets
2370	2380	200	190	10	Qtz Monzonite	3,146			70	0.45	Three joint sets
2380	2390	190	180	10	Qtz Monzonite/ Diorite	9,099			62	0.83	Three joint sets
2390	2400	180	170	10	Qtz Monzonite	3,344			57	0.63	Three joint sets
2400	2410	170	160	10	Qtz Monzonite		R4	10,875	45	0.67	Three joint sets
2410	2420	160	150	10	Qtz Monzonite		R4	10,875	38	0.32	Three joint sets
2420	2430	150	140	10	Qtz Monzonite		R4	10,875	10	0.29	Three joint sets
2430	2440	140	130	10	Qtz Monzonite		R4	10,875	12	0.40	Three joint sets
2440	2450	130	120	10	Qtz Monzonite	20,262			25	0.45	Three joint sets
2450	2460	120	110	10	Qtz Monzonite		R3	4,550	25	0.59	Three joint sets
2460	2470	110	100	10	Qtz Monzonite	3,410			10	0.33	Three joint sets
2470	2480	100	90	10	Qtz Monzonite		R3	4,550	10	0.40	Three joint sets
2480	2490	90	80	10	Qtz Monzonite		R3	4,550	18	0.36	Three joint sets
2490	2500	80	70	10	Qtz Monzonite	3,760			8	0.33	Three joint sets
2500	2510	70	60	10	Qtz Monzonite	4,136			30	0.20	Three joint sets
2510	2520	60	50	10	Qtz Monzonite	11,075			10	0.29	Three joint sets
2520	2530	50	40	10	Qtz Monzonite	4,720			10	0.20	Three joint sets

Depth From (ft)	Condition of Discontinuities								
	Discontinuity Length (ft)	Aperture Thickness (mm)	Joint Roughness (Q)	Roughness (RMR)	Joint Alteration (Q)	Infilling (RMR)	Weathering / Alteration	Joint Water (Q)	Groundwater Conditions
1750	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	Soft filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1760	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1770	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1780	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1790	10	Closed	Smooth, planar	Smooth	Tightly healed, hard	Hard filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1800	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1810	10	Closed	Rough, irregular, planar	Slightly rough	Tightly healed, hard	Hard filling <5mm	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1820	10	Closed	Smooth, planar	Smooth	Tightly healed, hard	Hard filling <5mm	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1830	10	Closed	Smooth, planar	Smooth	Tightly healed, hard	Hard filling <5mm	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1840	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1850	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1860	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Decomposed	Dry excavations or minor inflow (humid or a few drips)	Damp
1870	10	Closed	Smooth, undulating	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1880	10	Closed	Slickensided, undulating	Slickensided	Slightly altered joint walls	Soft filling <5mm	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1890	10	Closed	Smooth, undulating	Smooth	Slightly altered joint walls	Hard filling <5mm	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1900	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	Hard filling <5mm	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1910	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1920	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	Hard filling <5mm	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1930	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1940	10	Closed	Slickensided, undulating	Slickensided	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1950	10	Closed	Rough or irregular, undulating	Slightly rough	Slightly altered joint walls	Hard filling <5mm	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1960	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1970	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1980	10	Closed	Smooth, undulating	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1990	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	Hard filling <5mm	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2000	10	Closed	Smooth, undulating	Smooth	Slightly altered joint walls	Hard filling <5mm	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2010	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2020	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2030	10	Closed	Smooth, undulating	Smooth	Slightly altered joint walls	Soft filling <5mm	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2040	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	Soft filling <5mm	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2050	10	Closed	Smooth, undulating	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2060	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2070	10	Closed	Smooth, undulating	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2080	10	Closed	Rough or irregular, undulating	Slightly rough	Slightly altered joint walls	Soft filling <5mm	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2090	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2100	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2110	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2120	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Highly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2130	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	Soft filling <5mm	Highly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2140	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Highly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2150	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Highly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2160	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	Hard filling <5mm	Highly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2170	10	Closed	Smooth, undulating	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2180	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2190	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2200	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2210	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2220	10	Closed	Smooth, undulating	Smooth	Slightly altered joint walls	Soft filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2230	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2240	10	Closed	Smooth, undulating	Smooth	Unaltered joint walls	None	Highly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2250	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	Soft filling <5mm	Highly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2260	10	Closed	Smooth, undulating	Smooth	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2270	10	Closed	Smooth, undulating	Smooth	Tightly healed, hard	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2280	10	Closed	Slickensided, planar	Slickensided	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2290	10	Closed	Smooth, planar	Smooth	Tightly healed, hard	Soft filling <5mm	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2300	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2310	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2320	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2330	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2340	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2350	10	Closed	Smooth, planar	Smooth	Tightly healed, hard	Soft filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2360	10	Closed	Slickensided, planar	Slickensided	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2370	10	Closed	Slickensided, planar	Slickensided	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2380	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2390	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2400	10	Closed	Discontinuous joints	Smooth	Tightly healed, hard	Hard filling <5mm	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2410	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2420	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2430	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2440	10	Closed	Rough or irregular, undulating	Slightly rough	Slightly altered joint walls	Soft filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2450	10	Closed	Smooth, undulating	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2460	10	Closed	Slickensided, undulating	Slickensided	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2470	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2480	10	Closed	Smooth, undulating	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2490	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2500	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2510	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2520	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp

Depth From (ft)	Rock Mass Rating (RMR) Classification											
	Strength of Intact Rock Rating	Strength of Intact Rock Rating	RQD Rating	Spacing of Discontinuities Rating	Discontinuity Length Rating	Aperture Thickness Rating	Discontinuity Roughness Rating	Discontinuity Filling Rating	Weathering / Alteration Rating	Groundwater Rating	Rock Mass Rating (RMR)	RMR Classification
1750	12	0	13	10	2	6	1	2	5	10	**61**	**Good Rock**
1760	0	7	17	10	2	6	1	6	5	10	**64**	**Good Rock**
1770	7	0	13	10	2	6	1	6	5	10	**60**	**Fair Rock**
1780	0	7	13	8	2	6	1	6	5	10	**58**	**Fair Rock**
1790	0	7	8	8	2	6	1	4	5	10	**51**	**Fair Rock**
1800	0	7	8	8	2	6	1	6	6	10	**54**	**Fair Rock**
1810	0	7	13	8	2	6	3	4	6	10	**59**	**Fair Rock**
1820	0	7	8	8	2	6	1	4	6	10	**52**	**Fair Rock**
1830	0	7	3	8	2	6	1	4	6	10	**47**	**Fair Rock**
1840	0	7	8	8	2	6	1	6	6	10	**54**	**Fair Rock**
1850	12	0	8	8	2	6	1	6	6	10	**59**	**Fair Rock**
1860	4	0	8	8	2	6	1	6	0	10	**45**	**Fair Rock**
1870	12	0	8	8	2	6	1	6	6	10	**59**	**Fair Rock**
1880	12	0	13	10	2	6	0	2	6	10	**61**	**Good Rock**
1890	0	7	3	8	2	6	1	4	6	10	**47**	**Fair Rock**
1900	0	7	3	8	2	6	1	4	6	10	**47**	**Fair Rock**
1910	0	7	3	8	2	6	1	6	3	10	**46**	**Fair Rock**
1920	0	7	3	8	2	6	1	4	3	10	**44**	**Fair Rock**
1930	0	7	3	8	2	6	1	6	6	10	**49**	**Fair Rock**
1940	0	7	8	8	2	6	0	6	3	10	**50**	**Fair Rock**
1950	12	0	3	8	2	6	3	4	6	10	**54**	**Fair Rock**
1960	12	0	17	8	2	6	1	6	6	10	**68**	**Good Rock**
1970	7	0	13	10	2	6	1	6	6	10	**61**	**Good Rock**
1980	12	0	17	8	2	6	1	6	6	10	**68**	**Good Rock**
1990	0	7	20	10	2	6	1	4	6	10	**66**	**Good Rock**
2000	12	0	20	10	2	6	1	4	6	10	**71**	**Good Rock**
2010	0	7	13	8	2	6	3	6	6	10	**61**	**Good Rock**
2020	0	7	13	8	2	6	3	6	6	10	**61**	**Good Rock**
2030	0	7	13	8	2	6	1	2	6	10	**55**	**Fair Rock**
2040	12	0	20	10	2	6	1	2	6	10	**69**	**Good Rock**
2050	0	7	20	8	2	6	1	6	6	10	**66**	**Good Rock**
2060	12	0	20	15	2	6	1	6	6	10	**78**	**Good Rock**
2070	12	0	20	10	2	6	1	6	6	10	**73**	**Good Rock**
2080	0	7	20	15	2	6	3	2	6	10	**71**	**Good Rock**
2090	12	0	20	10	2	6	1	6	6	10	**73**	**Good Rock**
2100	12	0	20	15	2	6	1	6	6	10	**78**	**Good Rock**
2110	0	4	20	10	2	6	3	6	3	10	**64**	**Good Rock**
2120	0	4	17	10	2	6	1	6	1	10	**57**	**Fair Rock**
2130	12	4	20	10	2	6	1	2	1	10	**68**	**Good Rock**
2140	0	4	20	10	2	6	1	6	1	10	**60**	**Fair Rock**
2150	0	4	20	10	2	6	1	6	1	10	**60**	**Fair Rock**
2160	12	0	17	10	2	6	1	4	1	10	**63**	**Good Rock**
2170	0	7	13	10	2	6	1	6	6	10	**61**	**Good Rock**
2180	12	0	20	15	2	6	1	6	6	10	**78**	**Good Rock**
2190	12	0	20	15	2	6	1	6	6	10	**78**	**Good Rock**
2200	0	7	20	10	2	6	1	6	6	10	**68**	**Good Rock**
2210	12	0	17	10	2	6	3	6	6	10	**72**	**Good Rock**
2220	4	0	13	10	2	6	1	2	5	10	**53**	**Fair Rock**
2230	0	4	8	10	2	6	1	6	3	10	**50**	**Fair Rock**
2240	0	4	8	10	2	6	1	6	1	10	**48**	**Fair Rock**
2250	4	0	13	8	2	6	1	2	1	10	**47**	**Fair Rock**
2260	0	4	8	8	2	6	1	6	3	10	**48**	**Fair Rock**
2270	0	4	13	8	2	6	1	6	3	10	**53**	**Fair Rock**
2280	2	0	8	8	2	6	0	6	3	10	**45**	**Fair Rock**
2290	0	4	8	8	2	6	1	2	3	10	**44**	**Fair Rock**
2300	0	7	8	8	2	6	1	6	3	10	**51**	**Fair Rock**
2310	12	0	3	8	2	6	3	6	3	10	**53**	**Fair Rock**
2320	0	7	3	8	2	6	1	6	6	10	**49**	**Fair Rock**
2330	0	7	13	8	2	6	3	6	5	10	**60**	**Fair Rock**
2340	12	0	13	10	2	6	3	6	5	10	**67**	**Good Rock**
2350	0	7	13	8	2	6	1	2	5	10	**54**	**Fair Rock**
2360	0	7	8	8	2	6	0	6	5	10	**52**	**Fair Rock**
2370	2	0	13	8	2	6	0	6	5	10	**52**	**Fair Rock**
2380	7	0	13	10	2	6	1	6	5	10	**60**	**Fair Rock**
2390	2	0	13	8	2	6	3	6	5	10	**55**	**Fair Rock**
2400	0	7	8	10	2	6	1	4	3	10	**51**	**Fair Rock**
2410	0	7	8	8	2	6	1	6	5	10	**53**	**Fair Rock**
2420	0	7	3	8	2	6	1	6	5	10	**48**	**Fair Rock**
2430	0	7	3	8	2	6	1	6	5	10	**48**	**Fair Rock**
2440	12	0	8	8	2	6	3	2	5	10	**56**	**Fair Rock**
2450	0	4	8	8	2	6	1	6	5	10	**50**	**Fair Rock**
2460	2	0	3	8	2	6	0	6	5	10	**42**	**Fair Rock**
2470	0	4	3	8	2	6	3	6	5	10	**47**	**Fair Rock**
2480	0	4	3	8	2	6	1	6	5	10	**45**	**Fair Rock**
2490	4	0	3	8	2	6	1	6	5	10	**45**	**Fair Rock**
2500	4	0	8	8	2	6	1	6	6	10	**51**	**Fair Rock**
2510	7	0	3	8	2	6	1	6	5	10	**48**	**Fair Rock**
2520	4	0	3	8	2	6	1	6	5	10	**45**	**Fair Rock**

Depth From (ft)	Q-system										
	Joint Set Number (J_n)	Joint Roughness Number (J_r)	Joint Alteration Number (J_a)	Joint Water Reduction (J_w)	Estimated Vertical Stress (psi)	Stress Condition	Stress Reduction Factor (SRF)	Q-value	Q-value Classification	Rock Mass Rating (RMR_{89})	Geological Strength Index (GSI)
1750	6	1	2	1	2018	Medium Stress	1	**6.000**	**Fair**	**66**	**61**
1760	6	1	1	1	2030	High Stress, Jointed Rock	4	**3.250**	**Poor**	**69**	**64**
1770	6	1	1	1	2041	High Stress, Jointed Rock	2	**5.750**	**Fair**	**65**	**60**
1780	6	1	1	1	2053	High Stress, Jointed Rock	4	**2.958**	**Poor**	**63**	**58**
1790	6	1	0.75	1	2064	High Stress, Jointed Rock	4	**2.000**	**Poor**	**56**	**51**
1800	6	1	1	1	2076	High Stress, Jointed Rock	4	**1.250**	**Poor**	**59**	**54**
1810	6	1.5	0.75	1	2087	High Stress, Jointed Rock	4	**5.417**	**Fair**	**64**	**59**
1820	6	1	0.75	1	2099	High Stress, Jointed Rock	4	**1.667**	**Poor**	**57**	**52**
1830	6	1	0.75	1	2110	High Stress, Jointed Rock	4	**0.778**	**Very Poor**	**52**	**47**
1840	6	1	1	1	2122	High Stress, Jointed Rock	4	**1.875**	**Poor**	**59**	**54**
1850	6	1	1	1	2133	High Stress, Jointed Rock	2	**2.917**	**Poor**	**64**	**59**
1860	6	1	1	1	2145	High Stress, Jointed Rock	12	**0.375**	**Very Poor**	**50**	**45**
1870	6	2	1	1	2156	High Stress, Jointed Rock	2	**8.000**	**Fair**	**64**	**59**
1880	6	1.5	2	1	2168	High Stress, Jointed Rock	2	**3.250**	**Poor**	**66**	**61**
1890	6	2	2	1	2179	High Stress, Jointed Rock	4	**0.792**	**Very Poor**	**52**	**47**
1900	6	1	2	1	2191	High Stress, Jointed Rock	4	**0.208**	**Very Poor**	**52**	**47**
1910	6	1	1	1	2202	High Stress, Jointed Rock	4	**0.417**	**Very Poor**	**51**	**46**
1920	6	1	2	1	2214	High Stress, Jointed Rock	4	**0.208**	**Very Poor**	**49**	**44**
1930	6	1	1	1	2225	High Stress, Jointed Rock	4	**0.417**	**Very Poor**	**54**	**49**
1940	6	1.5	1	1	2237	High Stress, Jointed Rock	4	**2.688**	**Poor**	**55**	**50**
1950	6	3	2	1	2248	High Stress, Jointed Rock	2	**2.875**	**Poor**	**59**	**54**
1960	6	1	1	1	2260	High Stress, Jointed Rock	2	**6.667**	**Fair**	**73**	**68**
1970	6	1	1	1	2271	High Stress, Jointed Rock	2	**4.583**	**Fair**	**66**	**61**
1980	6	2	1	1	2283	Medium Stress	1	**29.000**	**Good**	**73**	**68**
1990	9	1	2	1	2294	High Stress, Jointed Rock	4	**1.319**	**Poor**	**71**	**66**
2000	9	2	2	1	2306	Medium Stress	1	**10.222**	**Good**	**76**	**71**
2010	9	3	1	1	2317	High Stress, Jointed Rock	4	**4.167**	**Fair**	**66**	**61**
2020	9	3	1	1	2329	High Stress, Jointed Rock	4	**6.167**	**Fair**	**66**	**61**
2030	9	2	2	1	2340	High Stress, Jointed Rock	4	**1.528**	**Poor**	**60**	**55**
2040	9	1	2	1	2352	Medium Stress	1	**5.556**	**Fair**	**74**	**69**
2050	9	2	1	1	2363	High Stress, Jointed Rock	4	**5.556**	**Fair**	**71**	**66**
2060	9	1	1	1	2375	High Stress, Jointed Rock	2	**5.556**	**Fair**	**83**	**78**
2070	9	2	1	1	2386	Medium Stress	1	**21.111**	**Good**	**78**	**73**
2080	9	3	2	1	2398	High Stress, Jointed Rock	4	**3.833**	**Poor**	**76**	**71**
2090	9	1	1	1	2409	High Stress, Jointed Rock	2	**5.556**	**Fair**	**78**	**73**
2100	9	1	1	1	2421	High Stress, Jointed Rock	2	**5.556**	**Fair**	**83**	**78**
2110	9	3	1	1	2432	High Stress, Jointed Rock	16	**2.083**	**Poor**	**69**	**64**
2120	9	1	1	1	2444	High Stress, Jointed Rock	16	**0.556**	**Very Poor**	**62**	**57**
2130	9	1	2	1	2455	Medium Stress	1	**5.000**	**Fair**	**73**	**68**
2140	9	1	1	1	2467	High Stress, Jointed Rock	16	**0.694**	**Very Poor**	**65**	**60**
2150	9	1	1	1	2478	High Stress, Jointed Rock	16	**0.660**	**Very Poor**	**65**	**60**
2160	9	1	2	1	2490	High Stress, Jointed Rock	2	**2.222**	**Poor**	**68**	**63**
2170	9	2	1	1	2501	High Stress, Jointed Rock	4	**3.333**	**Poor**	**66**	**61**
2180	9	1	1	1	2513	Medium Stress	1	**11.111**	**Good**	**83**	**78**
2190	9	1	1	1	2524	Medium Stress	1	**11.111**	**Good**	**83**	**78**
2200	9	1	1	1	2536	High Stress, Jointed Rock	4	**2.778**	**Poor**	**73**	**68**
2210	9	3	1	1	2547	High Stress, Jointed Rock	2	**13.000**	**Good**	**77**	**72**
2220	9	2	2	1	2559	High Stress, Jointed Rock	10	**0.556**	**Very Poor**	**58**	**53**
2230	9	1	1	1	2570	High Stress, Jointed Rock	16	**0.278**	**Very Poor**	**55**	**50**
2240	9	2	1	1	2582	High Stress, Jointed Rock	16	**0.417**	**Very Poor**	**53**	**48**
2250	9	1	2	1	2593	High Stress, Jointed Rock	20	**0.147**	**Very Poor**	**52**	**47**
2260	9	2	1	1	2605	High Stress, Jointed Rock	16	**0.556**	**Very Poor**	**53**	**48**
2270	9	2	0.75	1	2616	High Stress, Jointed Rock	16	**1.074**	**Poor**	**58**	**53**
2280	9	0.5	1	1	2628	High Stress, Jointed Rock	20	**0.103**	**Very Poor**	**50**	**45**
2290	9	1	0.75	1	2639	High Stress, Jointed Rock	16	**0.380**	**Very Poor**	**49**	**44**
2300	9	1	2	1	2651	High Stress, Jointed Rock	6	**0.324**	**Very Poor**	**56**	**51**
2310	9	3	1	1	2662	High Stress, Jointed Rock	2	**3.500**	**Poor**	**58**	**53**
2320	9	1	1	1	2674	High Stress, Jointed Rock	6	**0.352**	**Very Poor**	**54**	**49**
2330	9	3	1	1	2685	High Stress, Jointed Rock	6	**3.722**	**Poor**	**65**	**60**
2340	9	3	1	1	2697	High Stress, Jointed Rock	2	**10.333**	**Good**	**72**	**67**
2350	9	1	0.75	1	2708	High Stress, Jointed Rock	6	**1.506**	**Poor**	**59**	**54**
2360	9	0.5	1	1	2720	High Stress, Jointed Rock	6	**0.352**	**Very Poor**	**57**	**52**
2370	9	0.5	1	1	2731	High Stress, Jointed Rock	20	**0.194**	**Very Poor**	**57**	**52**
2380	9	1	1	1	2743	High Stress, Jointed Rock	8	**0.861**	**Very Poor**	**65**	**60**
2390	9	3	1	1	2754	High Stress, Jointed Rock	20	**0.950**	**Very Poor**	**60**	**55**
2400	9	4	0.75	1	2766	High Stress, Jointed Rock	6	**4.444**	**Fair**	**56**	**51**
2410	9	1	1	1	2777	High Stress, Jointed Rock	6	**0.704**	**Very Poor**	**58**	**53**
2420	9	1	1	1	2789	High Stress, Jointed Rock	6	**0.185**	**Very Poor**	**53**	**48**
2430	9	1	1	1	2800	High Stress, Jointed Rock	6	**0.222**	**Very Poor**	**53**	**48**
2440	9	3	2	1	2812	High Stress, Jointed Rock	2	**2.083**	**Poor**	**61**	**56**
2450	9	2	1	1	2823	High Stress, Jointed Rock	18	**0.309**	**Very Poor**	**55**	**50**
2460	9	1.5	1	1	2835	High Stress, Jointed Rock	20	**0.083**	**Extremely Poor**	**47**	**42**
2470	9	3	1	1	2846	High Stress, Jointed Rock	18	**0.185**	**Very Poor**	**52**	**47**
2480	9	2	1	1	2858	High Stress, Jointed Rock	18	**0.222**	**Very Poor**	**50**	**45**
2490	9	1	1	1	2869	High Stress, Jointed Rock	20	**0.044**	**Extremely Poor**	**50**	**45**
2500	9	1	1	1	2881	High Stress, Jointed Rock	20	**0.167**	**Very Poor**	**56**	**51**
2510	9	1	1	1	2892	High Stress, Jointed Rock	6	**0.185**	**Very Poor**	**53**	**48**
2520	9	1	1	1	2904	High Stress, Jointed Rock	18	**0.062**	**Extremely Poor**	**50**	**45**

Depth From (ft)	Depth To (ft)	Elevation (MSL) From (ft)	Elevation (MSL) To (ft)	Interval Thickness (ft)	Lithology	Strength of Intact Rock (psi)	Estimated Strength of Intact Rock	Estimated Strength of Intact Rock (psi)	Rock Quality Designation (RQD)	Fracture Spacing (ft)	Number of Joint Sets
1751	1761	819	809	10	Qtz Monzonite		R3	4,550	16	0.40	Two joint sets plus random joints
1761	1771	809	799	10	Qtz Monzonite		R4	10,875	20	0.42	Two joint sets plus random joints
1771	1781	799	789	10	Qtz Monzonite	19,800			24	0.34	Two joint sets plus random joints
1781	1791	789	779	10	Qtz Monzonite		R4	10,875	22	0.33	Two joint sets plus random joints
1791	1801	779	769	10	Qtz Monzonite		R4	10,875	17	0.33	Two joint sets plus random joints
1801	1811	769	759	10	Qtz Monzonite		R4	10,875	12	0.33	Two joint sets plus random joints
1811	1821	759	749	10	Qtz Monzonite		R4	10,875	18	0.38	Two joint sets plus random joints
1821	1831	749	739	10	Qtz Monzonite		R4	10,875	33	1.00	Two joint sets plus random joints
1831	1841	739	729	10	Qtz Monzonite	14,797			47	0.71	Two joint sets plus random joints
1841	1851	729	719	10	Qtz Monzonite		R4	10,875	23	0.63	Two joint sets plus random joints
1851	1861	719	709	10	Qtz Monzonite	9,636			15	0.59	Two joint sets plus random joints
1861	1871	709	699	10	Qtz Monzonite	20,108			21	0.42	Two joint sets plus random joints
1871	1881	699	689	10	Qtz Monzonite	19,360			14	0.48	Two joint sets plus random joints
1881	1891	689	679	10	Diorite/ Qtz Monzonite		R4	10,875	36	0.59	Two joint sets plus random joints
1891	1901	679	669	10	Diorite/ Qtz Monzonite		R4	10,875	10	0.48	Two joint sets plus random joints
1901	1911	669	659	10	Qtz Monzonite	7,909			56	0.53	Two joint sets plus random joints
1911	1921	659	649	10	Qtz Monzonite		R4	10,875	28	0.56	Two joint sets plus random joints
1921	1931	649	639	10	Qtz Monzonite	32,098			30	0.48	Two joint sets plus random joints
1931	1941	639	629	10	Qtz Monzonite		R3	4,550	57	0.83	Two joint sets plus random joints
1941	1951	629	619	10	Qtz Monzonite		R4	10,875	10	0.45	Two joint sets plus random joints
1951	1961	619	609	10	Qtz Monzonite		R4	10,875	10	0.48	Two joint sets plus random joints
1961	1971	609	599	10	Qtz Monzonite		R4	10,875	40	0.91	Two joint sets plus random joints
1971	1981	599	589	10	Qtz Monzonite		R4	10,875	90	1.67	Two joint sets plus random joints
1981	1991	589	579	10	Qtz Monzonite		R4	10,875	67	0.83	Two joint sets plus random joints
1991	2001	579	569	10	Qtz Monzonite		R4	10,875	47	0.67	Three joint sets
2001	2011	569	559	10	Qtz Monzonite		R4	10,875	10	0.29	Three joint sets
2011	2021	559	549	10	Qtz Monzonite	20,362			30	0.32	Three joint sets
2021	2031	549	539	10	Qtz Monzonite		R4	10,875	50	1.00	Three joint sets
2031	2041	539	529	10	Qtz Monzonite		R3	4,550	50	1.00	Three joint sets
2041	2051	529	519	10	Qtz Monzonite		R4	10,875	10	0.31	Three joint sets
2051	2061	519	509	10	Qtz Monzonite		R4	10,875	10	0.33	Three joint sets
2061	2071	509	499	10	Qtz Monzonite		R4	10,875	17	0.43	Three joint sets
2071	2081	499	489	10	Qtz Monzonite	23,100			32	0.67	Three joint sets
2081	2091	489	479	10	Qtz Monzonite		R4	10,875	10	0.34	Three joint sets
2091	2101	479	469	10	Qtz Monzonite		R3	4,550	11	0.34	Three joint sets
2101	2111	469	459	10	Qtz Monzonite	13,662			39	0.48	Three joint sets
2111	2121	459	449	10	Qtz Monzonite	27,676			27	0.50	Three joint sets
2121	2131	449	439	10	Qtz Monzonite		R4	10,875	10	0.45	Three joint sets
2131	2141	439	429	10	Qtz Monzonite		R4	10,875	30	0.53	Three joint sets
2141	2151	429	419	10	Qtz Monzonite		R4	10,875	10	0.37	Three joint sets
2151	2161	419	409	10	Qtz Monzonite		R3	4,550	10	0.25	Three joint sets
2161	2171	409	399	10	Qtz Monzonite		R3	4,550	10	0.29	Three joint sets
2171	2181	399	389	10	Qtz Monzonite		R3	4,550	13	0.29	Three joint sets
2181	2191	389	379	10	Qtz Monzonite		R4	10,875	13	0.38	Three joint sets
2191	2201	379	369	10	Qtz Monzonite	4,180			10	0.37	Three joint sets
2201	2211	369	359	10	Qtz Monzonite		R4	10,875	10	0.56	Three joint sets
2211	2221	359	349	10	Qtz Monzonite	16,257			51	0.40	Three joint sets
2221	2231	349	339	10	Qtz Monzonite	18,589			50	0.33	Three joint sets
2231	2241	339	329	10	Qtz Monzonite	30,470			35	0.33	Three joint sets
2241	2251	329	319	10	Qtz Monzonite		R4	10,875	29	0.53	Three joint sets
2251	2261	319	309	10	Qtz Monzonite	17,006			67	0.83	Three joint sets
2261	2271	309	299	10	Qtz Monzonite		R4	10,875	40	0.71	Three joint sets
2271	2281	299	289	10	Qtz Monzonite	19,470			37	0.56	Three joint sets
2281	2291	289	279	10	Qtz Monzonite		R4	10,875	32	0.48	Three joint sets
2291	2301	279	269	10	Qtz Monzonite		R4	10,875	14	0.40	Three joint sets
2301	2311	269	259	10	Qtz Monzonite	15,290			30	1.00	Three joint sets
2311	2321	259	249	10	Qtz Monzonite		R4	10,875	42	0.59	Three joint sets
2321	2331	249	239	10	Qtz Monzonite	24,552			30	0.59	Three joint sets
2331	2341	239	229	10	Qtz Monzonite		R4	10,875	38	0.53	Three joint sets
2341	2351	229	219	10	Qtz Monzonite		R4	10,875	35	0.56	Three joint sets
2351	2361	219	209	10	Qtz Monzonite	22,308			71	1.00	Three joint sets
2361	2371	209	199	10	Qtz Monzonite		R4	10,875	45	0.91	Three joint sets
2371	2381	199	189	10	Qtz Monzonite		R4	10,875	62	1.43	Three joint sets
2381	2391	189	179	10	Qtz Monzonite	25,960			77	1.25	Three joint sets
2391	2401	179	169	10	Qtz Monzonite		R4	10,875	84	1.25	Three joint sets
2401	2411	169	159	10	Qtz Monzonite		R4	10,875	67	1.11	Three joint sets
2411	2421	159	149	10	Qtz Monzonite	22,286			63	0.83	Three joint sets
2421	2431	149	139	10	Qtz Monzonite		R4	10,875	45	0.67	Three joint sets
2431	2441	139	129	10	Qtz Monzonite		R4	10,875	91	1.25	Three joint sets
2441	2451	129	119	10	Qtz Monzonite	14,006			68	0.71	Three joint sets
2451	2461	119	109	10	Qtz Monzonite	3,542			62	0.71	Three joint sets
2461	2471	109	99	10	Qtz Monzonite	7,179			47	0.83	Three joint sets
2471	2481	99	89	10	Qtz Monzonite	26,840			25	0.48	Three joint sets
2481	2491	89	79	10	Qtz Monzonite		R4	10,875	17	0.43	Three joint sets
2491	2501	79	69	10	Diorite/ Qtz Monzonite		R4	10,875	10	0.33	Three joint sets
2501	2511	69	59	10	Diorite			24,587	10	0.25	Three joint sets
2511	2521	59	49	10	Diorite			24,587	10	0.20	Three joint sets
2521	2531	49	39	10	Diorite			24,587	10	0.20	Three joint sets

Depth From (ft)	Depth To (ft)	Condition of Discontinuities: Discontinuity Length (ft)	Aperture Thickness (mm)	Joint Roughness (Q)	Roughness (RMR)	Joint Alteration (Q)	Infilling (RMR)	Weathering / Alteration	Joint Water (Q)	Groundwater Conditions
1751	1761	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1761	1771	10	Closed	Rough, irregular, planar	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1771	1781	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1781	1791	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1791	1801	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1801	1811	10	Closed	Rough, irregular, planar	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1811	1821	10	Closed	Rough or irregular, undulating	Slightly rough	Slightly altered joint walls	Soft filling <5mm	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1821	1831	10	Closed	Rough, irregular, planar	Slightly rough	Slightly altered joint walls	Soft filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1831	1841	10	Closed	Rough, irregular, planar	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1841	1851	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1851	1861	10	Closed	Rough or irregular, undulating	Slightly rough	Slightly altered joint walls	Soft filling <5mm	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1861	1871	10	Closed	Smooth, undulating	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1871	1881	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1881	1891	10	Closed	Smooth, undulating	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1891	1901	10	Closed	Smooth, undulating	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1901	1911	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1911	1921	10	Closed	Smooth, planar	Smooth	Tightly healed, hard	Hard filling <5mm	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1921	1931	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1931	1941	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	Hard filling <5mm	Highly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1941	1951	10	Closed	Discontinuous joints	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1951	1961	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1961	1971	10	Closed	Smooth, undulating	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
1971	1981	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1981	1991	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
1991	2001	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2001	2011	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2011	2021	10	Closed	Rough, irregular, planar	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2021	2031	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2031	2041	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Highly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2041	2051	10	Closed	Discontinuous joints	Slightly rough	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2051	2061	10	Closed	Discontinuous joints	Slightly rough	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2061	2071	10	Closed	Smooth, undulating	Smooth	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2071	2081	10	Closed	Rough, irregular, planar	Slightly rough	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2081	2091	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2091	2101	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Highly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2101	2111	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2111	2121	10	Closed	Discontinuous joints	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2121	2131	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2131	2141	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2141	2151	10	Closed	Discontinuous joints	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2151	2161	10	Closed	Discontinuous joints	Slightly rough	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2161	2171	10	Closed	Discontinuous joints	Slightly rough	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2171	2181	10	Closed	Discontinuous joints	Slightly rough	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2181	2191	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2191	2201	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2201	2211	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2211	2221	10	Closed	Rough or irregular, undulating	Slightly rough	Tightly healed, hard	Hard filling <5mm	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2221	2231	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2231	2241	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp
2241	2251	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2251	2261	10	Closed	Rough or irregular, undulating	Slightly rough	Slightly altered joint walls	Soft filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2261	2271	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2271	2281	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2281	2291	10	Closed	Smooth, undulating	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2291	2301	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2301	2311	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2311	2321	10	Closed	Smooth, undulating	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2321	2331	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2331	2341	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2341	2351	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2351	2361	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2361	2371	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2371	2381	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2381	2391	10	Closed	Rough or irregular, undulating	Slightly rough	Slightly altered joint walls	Soft filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2391	2401	10	Closed	Smooth, planar	Smooth	Slightly altered joint walls	Soft filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2401	2411	10	Closed	Smooth, undulating	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2411	2421	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2421	2431	10	Closed	Smooth, undulating	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2431	2441	10	Closed	Rough or irregular, undulating	Slightly rough	Tightly healed, hard	Soft filling <5mm	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2441	2451	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2451	2461	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2461	2471	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2471	2481	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2481	2491	10	Closed	Rough or irregular, undulating	Slightly rough	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2491	2501	10	Closed	Discontinuous joints	Slightly rough	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2501	2511	10	Closed	Smooth, planar	Smooth	Unaltered joint walls	None	Slightly altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2511	2521	10	Closed	Rough, irregular, planar	Slightly rough	Unaltered joint walls	None	Moderately altered	Dry excavations or minor inflow (humid or a few drips)	Damp
2521	2531	10	Closed	Smooth, undulating	Smooth	Unaltered joint walls	None	Unaltered	Dry excavations or minor inflow (humid or a few drips)	Damp

Depth From (ft)	Depth To (ft)	Rock Mass Rating (RMR) Classification: Strength of Intact Rock Rating	Strength of Intact Rock Rating	RQD Rating	Spacing of Discontinuities Rating	Discontinuity Length Rating	Aperture Thickness Rating	Discontinuity Roughness Rating	Discontinuity Filling Rating	Weathering / Alteration Rating	Groundwater Rating	Rock Mass Rating (RMR)	RMR Classification
1751	1761	0	4	3	8	2	6	1	6	5	10	45	Fair Rock
1761	1771	0	7	3	8	2	6	3	6	5	10	50	Fair Rock
1771	1781	12	0	3	8	2	6	3	6	5	10	55	Fair Rock
1781	1791	0	7	3	8	2	6	1	6	3	10	46	Fair Rock
1791	1801	0	7	3	8	2	6	3	6	5	10	50	Fair Rock
1801	1811	0	7	3	8	2	6	3	6	5	10	50	Fair Rock
1811	1821	0	7	3	8	2	6	3	2	3	10	44	Fair Rock
1821	1831	0	7	8	10	2	6	3	2	5	10	53	Fair Rock
1831	1841	12	0	8	10	2	6	3	6	5	10	62	Good Rock
1841	1851	0	7	3	8	2	6	3	6	6	10	51	Fair Rock
1851	1861	7	0	3	8	2	6	3	2	6	10	47	Fair Rock
1861	1871	12	0	3	8	2	6	1	6	6	10	54	Fair Rock
1871	1881	12	0	3	8	2	6	1	6	6	10	54	Fair Rock
1881	1891	0	7	8	8	2	6	1	6	6	10	54	Fair Rock
1891	1901	0	7	3	8	2	6	1	6	6	10	49	Fair Rock
1901	1911	7	0	13	8	2	6	3	6	6	10	61	Good Rock
1911	1921	0	7	8	8	2	6	1	4	6	10	52	Fair Rock
1921	1931	12	0	8	8	2	6	3	6	6	10	61	Good Rock
1931	1941	0	4	13	10	2	6	1	4	1	10	51	Fair Rock
1941	1951	0	7	3	8	2	6	3	6	5	10	50	Fair Rock
1951	1961	0	7	3	8	2	6	1	6	5	10	48	Fair Rock
1961	1971	0	7	8	10	2	6	1	6	6	10	56	Fair Rock
1971	1981	0	7	20	10	2	6	3	6	5	10	69	Good Rock
1981	1991	0	7	13	10	2	6	3	6	3	10	60	Fair Rock
1991	2001	0	7	8	10	2	6	1	6	3	10	53	Fair Rock
2001	2011	0	7	3	8	2	6	1	6	5	10	48	Fair Rock
2011	2021	12	0	8	8	2	6	3	6	5	10	60	Fair Rock
2021	2031	0	7	13	10	2	6	1	6	3	10	58	Fair Rock
2031	2041	0	4	13	10	2	6	1	6	1	10	53	Fair Rock
2041	2051	0	7	3	8	2	6	3	6	3	10	48	Fair Rock
2051	2061	0	7	3	8	2	6	3	6	3	10	48	Fair Rock
2061	2071	0	7	3	8	2	6	1	6	3	10	46	Fair Rock
2071	2081	12	0	8	10	2	6	3	6	3	10	60	Fair Rock
2081	2091	0	7	3	8	2	6	1	6	3	10	46	Fair Rock
2091	2101	0	4	3	8	2	6	3	6	1	10	43	Fair Rock
2101	2111	7	0	8	8	2	6	3	6	3	10	53	Fair Rock
2111	2121	12	0	8	8	2	6	3	6	5	10	60	Fair Rock
2121	2131	0	7	3	8	2	6	1	6	5	10	48	Fair Rock
2131	2141	0	7	8	8	2	6	3	6	5	10	55	Fair Rock
2141	2151	0	7	3	8	2	6	3	6	5	10	50	Fair Rock
2151	2161	0	4	3	8	2	6	3	6	3	10	45	Fair Rock
2161	2171	0	4	3	8	2	6	3	6	3	10	45	Fair Rock
2171	2181	0	4	3	8	2	6	3	6	3	10	45	Fair Rock
2181	2191	0	7	3	8	2	6	1	6	6	10	49	Fair Rock
2191	2201	4	0	3	8	2	6	3	6	6	10	48	Fair Rock
2201	2211	0	7	3	8	2	6	1	6	6	10	49	Fair Rock
2211	2221	12	0	13	8	2	6	3	4	3	10	61	Good Rock
2221	2231	12	0	13	8	2	6	1	6	5	10	63	Good Rock
2231	2241	12	0	8	8	2	6	3	6	6	10	61	Good Rock
2241	2251	0	7	8	8	2	6	1	6	5	10	53	Fair Rock
2251	2261	12	0	13	10	2	6	3	2	5	10	63	Good Rock
2261	2271	0	7	8	10	2	6	3	6	5	10	57	Fair Rock
2271	2281	12	0	8	8	2	6	1	6	5	10	58	Fair Rock
2281	2291	0	7	8	8	2	6	1	6	5	10	53	Fair Rock
2291	2301	0	7	3	8	2	6	1	6	5	10	48	Fair Rock
2301	2311	12	0	8	10	2	6	1	6	5	10	60	Fair Rock
2311	2321	0	7	8	8	2	6	1	6	5	10	53	Fair Rock
2321	2331	12	0	8	8	2	6	3	6	5	10	60	Fair Rock
2331	2341	0	7	8	8	2	6	3	6	5	10	55	Fair Rock
2341	2351	0	7	8	8	2	6	3	6	5	10	55	Fair Rock
2351	2361	12	0	13	10	2	6	3	6	5	10	67	Good Rock
2361	2371	0	7	8	10	2	6	1	6	5	10	55	Fair Rock
2371	2381	0	7	13	10	2	6	3	6	5	10	62	Good Rock
2381	2391	12	0	17	10	2	6	3	2	5	10	67	Good Rock
2391	2401	0	7	17	10	2	6	1	2	5	10	60	Fair Rock
2401	2411	0	7	13	10	2	6	1	6	5	10	60	Fair Rock
2411	2421	12	0	13	10	2	6	1	6	5	10	65	Good Rock
2421	2431	0	7	8	10	2	6	1	6	5	10	55	Fair Rock
2431	2441	0	7	20	10	2	6	3	2	5	10	65	Good Rock
2441	2451	7	0	13	10	2	6	3	6	5	10	62	Good Rock
2451	2461	2	0	13	10	2	6	1	6	5	10	55	Fair Rock
2461	2471	4	0	8	10	2	6	3	6	5	10	54	Fair Rock
2471	2481	12	0	8	8	2	6	3	6	5	10	60	Fair Rock
2481	2491	0	7	3	8	2	6	3	6	5	10	50	Fair Rock
2491	2501	0	7	3	8	2	6	3	6	3	10	48	Fair Rock
2501	2511	0	0	3	8	2	6	1	6	5	10	41	Fair Rock
2511	2521	0	0	3	8	2	6	3	6	3	10	41	Fair Rock
2521	2531	0	0	3	8	2	6	1	6	6	10	42	Fair Rock

Depth From (ft)	Depth To (ft)	Q-system: Joint Set Number (J_n)	Joint Roughness Number (J_r)	Joint Alteration Number (J_a)	Joint Water Reduction (J_w)	Estimated Vertical Stress (psi)	Stress Condition	Stress Reduction Factor (SRF)	Q-value	Q-value Classification	Rock Mass Rating (RMR_{89})	Geological Strength Index (GSI)
1751	1761	6	1	1	1	2019	High Stress, Jointed Rock	12	0.222	Very Poor	50	45
1761	1771	6	1.5	1	1	2031	High Stress, Jointed Rock	4	1.250	Poor	55	50
1771	1781	6	3	1	1	2042	High Stress, Jointed Rock	2	6.000	Fair	60	55
1781	1791	6	1	1	1	2054	High Stress, Jointed Rock	4	0.917	Very Poor	51	46
1791	1801	6	3	1	1	2065	High Stress, Jointed Rock	4	2.125	Poor	55	50
1801	1811	6	1.5	1	1	2077	High Stress, Jointed Rock	4	0.750	Very Poor	55	50
1811	1821	6	3	2	1	2088	High Stress, Jointed Rock	4	1.125	Poor	49	44
1821	1831	6	1.5	2	1	2100	High Stress, Jointed Rock	4	1.031	Poor	58	53
1831	1841	6	1.5	1	1	2111	High Stress, Jointed Rock	2	5.875	Fair	67	62
1841	1851	6	3	1	1	2123	High Stress, Jointed Rock	4	2.875	Poor	56	51
1851	1861	6	3	2	1	2134	High Stress, Jointed Rock	4	0.938	Very Poor	52	47
1861	1871	6	2	1	1	2146	High Stress, Jointed Rock	2	3.500	Poor	59	54
1871	1881	6	1	1	1	2157	High Stress, Jointed Rock	2	1.167	Poor	59	54
1881	1891	6	2	1	1	2169	High Stress, Jointed Rock	4	3.000	Poor	59	54
1891	1901	6	2	1	1	2180	High Stress, Jointed Rock	4	0.833	Very Poor	54	49
1901	1911	6	3	1	1	2192	High Stress, Jointed Rock	6	4.667	Fair	66	61
1911	1921	6	1	0.75	1	2203	High Stress, Jointed Rock	4	1.556	Poor	57	52
1921	1931	6	3	1	1	2215	Medium Stress	1	15.000	Good	66	61
1931	1941	6	1	2	1	2226	High Stress, Jointed Rock	14	0.339	Very Poor	56	51
1941	1951	6	4	1	1	2238	High Stress, Jointed Rock	4	1.667	Poor	55	50
1951	1961	6	1	1	1	2249	High Stress, Jointed Rock	4	0.417	Very Poor	53	48
1961	1971	6	2	1	1	2261	High Stress, Jointed Rock	4	3.333	Poor	61	56
1971	1981	6	3	1	1	2272	High Stress, Jointed Rock	4	11.250	Good	74	69
1981	1991	6	3	1	1	2284	High Stress, Jointed Rock	4	8.375	Fair	65	60
1991	2001	9	1	1	1	2295	High Stress, Jointed Rock	4	1.306	Poor	58	53
2001	2011	9	1	1	1	2307	High Stress, Jointed Rock	4	0.278	Very Poor	53	48
2011	2021	9	1.5	1	1	2318	High Stress, Jointed Rock	2	2.500	Poor	65	60
2021	2031	9	1	1	1	2330	High Stress, Jointed Rock	4	1.389	Poor	63	58
2031	2041	9	1	1	1	2341	High Stress, Jointed Rock	14	0.397	Very Poor	58	53
2041	2051	9	4	1	1	2353	High Stress, Jointed Rock	4	1.111	Poor	53	48
2051	2061	9	4	1	1	2364	High Stress, Jointed Rock	4	1.111	Poor	53	48
2061	2071	9	2	1	1	2376	High Stress, Jointed Rock	4	0.944	Very Poor	51	46
2071	2081	9	1.5	1	1	2387	High Stress, Jointed Rock	2	2.667	Poor	65	60
2081	2091	9	1	1	1	2399	High Stress, Jointed Rock	4	0.278	Very Poor	51	46
2091	2101	9	3	1	1	2410	High Stress, Jointed Rock	14	0.262	Very Poor	48	43
2101	2111	9	3	1	1	2422	High Stress, Jointed Rock	4	3.250	Poor	58	53
2111	2121	9	4	1	1	2433	Medium Stress	1	12.000	Good	65	60
2121	2131	9	1	1	1	2445	High Stress, Jointed Rock	4	0.278	Very Poor	53	48
2131	2141	9	3	1	1	2456	High Stress, Jointed Rock	4	2.500	Poor	60	55
2141	2151	9	4	1	1	2468	High Stress, Jointed Rock	4	1.111	Poor	55	50
2151	2161	9	4	1	1	2479	High Stress, Jointed Rock	16	0.278	Very Poor	50	45
2161	2171	9	4	1	1	2491	High Stress, Jointed Rock	16	0.278	Very Poor	50	45
2171	2181	9	4	1	1	2502	High Stress, Jointed Rock	16	0.361	Very Poor	50	45
2181	2191	9	1	1	1	2514	High Stress, Jointed Rock	4	0.361	Very Poor	54	49
2191	2201	9	3	1	1	2525	High Stress, Jointed Rock	18	0.185	Very Poor	53	48
2201	2211	9	1	1	1	2537	High Stress, Jointed Rock	4	0.278	Very Poor	54	49
2211	2221	9	3	0.75	1	2548	High Stress, Jointed Rock	2	11.333	Good	66	61
2221	2231	9	1	1	1	2560	High Stress, Jointed Rock	2	2.778	Poor	68	63
2231	2241	9	3	1	1	2571	Medium Stress	1	11.667	Good	66	61
2241	2251	9	1	1	1	2583	High Stress, Jointed Rock	6	0.537	Very Poor	58	53
2251	2261	9	3	2	1	2594	High Stress, Jointed Rock	2	5.583	Fair	68	63
2261	2271	9	3	1	1	2606	High Stress, Jointed Rock	6	2.222	Poor	62	57
2271	2281	9	1	1	1	2617	High Stress, Jointed Rock	2	2.056	Poor	63	58
2281	2291	9	2	1	1	2629	High Stress, Jointed Rock	6	1.185	Poor	58	53
2291	2301	9	1	1	1	2640	High Stress, Jointed Rock	6	0.259	Very Poor	53	48
2301	2311	9	1	1	1	2652	High Stress, Jointed Rock	4	0.833	Very Poor	65	60
2311	2321	9	2	1	1	2663	High Stress, Jointed Rock	6	1.556	Poor	58	53
2321	2331	9	3	1	1	2675	High Stress, Jointed Rock	2	5.000	Fair	65	60
2331	2341	9	3	1	1	2686	High Stress, Jointed Rock	6	2.111	Poor	60	55
2341	2351	9	3	1	1	2698	High Stress, Jointed Rock	6	1.944	Poor	60	55
2351	2361	9	3	1	1	2709	High Stress, Jointed Rock	2	11.833	Good	72	67
2361	2371	9	1	1	1	2721	High Stress, Jointed Rock	6	0.833	Very Poor	60	55
2371	2381	9	3	1	1	2732	High Stress, Jointed Rock	6	3.444	Poor	67	62
2381	2391	9	3	2	1	2744	High Stress, Jointed Rock	2	6.417	Fair	72	67
2391	2401	9	1	2	1	2755	High Stress, Jointed Rock	6	0.778	Very Poor	65	60
2401	2411	9	2	1	1	2767	High Stress, Jointed Rock	6	2.481	Poor	65	60
2411	2421	9	1	1	1	2778	High Stress, Jointed Rock	2	3.500	Poor	70	65
2421	2431	9	2	1	1	2790	High Stress, Jointed Rock	6	1.667	Poor	60	55
2431	2441	9	3	0.75	1	2801	High Stress, Jointed Rock	6	6.741	Fair	70	65
2441	2451	9	3	1	1	2813	High Stress, Jointed Rock	4	5.667	Fair	67	62
2451	2461	9	1	1	1	2824	High Stress, Jointed Rock	20	0.344	Very Poor	60	55
2461	2471	9	3	1	1	2836	High Stress, Jointed Rock	10	1.567	Poor	59	54
2471	2481	9	3	1	1	2847	High Stress, Jointed Rock	2	4.167	Fair	65	60
2481	2491	9	3	1	1	2859	High Stress, Jointed Rock	6	0.944	Very Poor	55	50
2491	2501	9	4	1	1	2870	High Stress, Jointed Rock	6	0.741	Very Poor	53	48
2501	2511	9	1	1	1	2882	High Stress, Jointed Rock	2	0.556	Very Poor	46	41
2511	2521	9	1.5	1	1	2893	High Stress, Jointed Rock	2	0.833	Very Poor	46	41
2521	2531	9	2	1	1	2905	High Stress, Jointed Rock	2	1.111	Poor	47	42

APPENDIX E

IST2D STRESS MEASUREMENTS

951-20

DRAFT

IN-SITU STRESS TESTING
CORE HOLE ZEV-CH-03-23

WILLOW ROCK - DAWN ROAD PROJECT SITE, ROSAMOND CALIFORNIA

Prepared for:

Lane Power and Energy Solutions

February 12, 2024

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DRAFT

IN-SITU STRESS TESTING
CORE HOLE ZEV-CH-03-23

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DISCLAIMER: *This report contains professional opinions based on information provided by the Owner. Agapito Associates, Inc. makes no warranties, either expressed or implied, as to the accuracy or completeness of the information herein. Opinions are based on subjective interpretations of geotechnical data; other equally valid interpretations may exist. Identification and control of hazardous conditions are the responsibilities of the Owner.*

1 INTRODUCTION

In September 2023, Agapito Associates, Inc. (Agapito) performed downhole in-situ stress testing for Lane Power and Energy Solutions at the Willow Rock – Dawn Road Project site near Rosamond, California. The purpose of the work was to measure the in-situ stress field within the quartz monzonite rock at target cavern construction horizons. A total of four tests were attempted in the quartz monzonite. Two of the tests were unsuccessful, owing to one oversized pilot hole and one attempt, in which the IST tool did not set into the pilot hole correctly; two of the tests were successful and provided usable stress relief data.

Testing was conducted in core hole ZEV-CH-03-23 between the depths of 2,027.4 and 2,037.4 feet (ft). The overcore testing was conducted by Agapito in cooperation with Crux Subsurface, Inc. drilling personnel, who performed the core drilling for all the stress tests.

The measurements were obtained using the in-situ stress measurement tool (IST2D) and downhole technique developed by Sigra, Pty. (Sigra) of Brisbane, Australia. The IST technique measures the rock stresses in the plane perpendicular to the core hole, and because core holes are generally vertical, this technique provides the principal stresses in the horizontal plane at the testing depth.

Rock samples from the two successful overcores were tested in Agapito's laboratory in Grand Junction, Colorado, to determine the unconfined compressive strength (UCS), Young's modulus € (in the axial direction), and Poisson's ratio (v). The horizontal stresses were determined based on the elastic properties and the measured changes in hole diameter resulting from stress relief during overcoring.

The effects of horizontal stress on structural stability have been identified as potentially important design factors at the project site. The orientation, magnitude, and ratio of the maximum and minimum components of the pre-mining stress field, along with the intact rock mass strength and jointing characteristics, determine the extent of the impacts of horizontal stress.

2 TESTING METHODOLOGY

The IST2D tool is a pilot hole overcoring device that automatically measures the deformation across the diameter of a 25 to 27 mm pilot hole at six locations during overcoring. It is used with the Boart Longyear HQ wireline coring system. The tool's orientation is determined by triaxial magnetometers and accelerometers which are read when the tool is locked in the pilot hole and the drill rods are withdrawn 6 meters (m) above the tool, so as to free it from the effects of magnetic field.

The overcore samples are tested to determine the core's mechanical properties relating to Young's Moduli and Poisson's Ratios as well as uniaxial compressive strength. The analysis is in terms of axisymmetric anisotropic elastic, though not necessarily linearly elastic behavior. The derivation of core properties is described by Gray, Zhao, and Liu (2018).

There is one solution for six diameter change measurements, six solutions for five diameter change measurements, fifteen solutions for four diameter change measurements, and twenty solutions for three diameter change measurements. Thus, there exists forty-two potential solutions. The best

solution is one that uses the most diameter change measurements, provided the traces of diameter changes are consistent throughout the overcore process.

The solution to the sets of equations describing the stress and deformation is arrived at by using a least squares procedure. A value of the RMS (Root Mean Square) error between the theoretical best fit and actual measurements is presented with each solution.

3 FIELD TESTING PROGRAM

Testing was conducted using a specially modified set of wireline coring components (setting tools) and the IST stress tool. The setting tools were brought to the site in conjunction with Agapito's field work and assembled immediately prior to testing. Testing was conducted by one Agapito employee with the assistance of the drillers and other project personnel.

The data measured by the IST and used for analysis consisted of the measurement time and voltages for the six measurement pins, three magnetometers, and three inclinometer accelerometers. The datalogger contained within the IST was configured to record the hole diameter at 4-second intervals and orientation data at 20-second intervals for each overcore test. The response of the stress tool measurement pins was calibrated prior to the field program to determine the (linear) relationship between voltage and diameter. The pin response was checked periodically to verify proper operation. The magnetometers and accelerometers determined the orientation of the tool with respect to Magnetic North and the tool inclination within the hole. Each overcore test was performed in the following sequence, as shown in Figure 1.

1. After coring proceeded to a pre-determined depth (Figure 1 [a]), the core was pulled and a special counterbore assembly was lowered down the hole by wireline (Figure 1 [b]). The counterbore bit grinds any core stump left at the bottom of the hole and makes a counterbore to center the 25-mm-diameter pilot hole within the HQ (100-mm) bore. The counterbore bit is locked into the outer barrel such that thrust is transmitted to the bit, and an adapter, installed in the drill string, permits the counterbore bit to rotate with the rods.

2. Once the counterbore was drilled, the counterbore assembly was removed from the hole by wireline, and the pilot hole assembly (thruster) was lowered down the hole (Figure 1 [c]). Thrust on the pilot hole bit is provided by a water-pressure-actuated piston within the assembly, and rotation is transmitted to the assembly through the special adapter installed in Step 1. Thus, the rods rotate during drilling of the pilot hole, but do not provide thrust. Completion of the 500-mm-deep pilot hole is accompanied by a drop in water pressure as the piston advances past water-bypass ports at the end of its stroke.
3. Upon completion of the pilot hole, the hole was flushed for several minutes to clear cuttings. The thruster assembly was then removed, and the IST tool was carefully lowered down the hole by wireline (Figure 1 [d]). The IST was guided into the pilot hole by the shape of the counterbore, and wedges on the end of the IST secured it within the pilot hole as the downward load of hydraulic pressure acted on the IST. The launching tool was then pulled out of the hole, and the inner core barrel lowered down the hole by wireline.
4. After the inner core barrel latched, the rods were pulled up 20 ft so that magnetometers within the IST could stabilize without magnetic interference from the metallic rods

(Figure 1 [e]). The rods were held in this position for a minimum of 5 minutes to ensure that a satisfactory data sample was recorded.

5. With the inner barrel latched in and directional orientation assured, overcoring of the IST proceeded (Figures 1 [f] and 1 [g]). Rotation and feed rate were somewhat lower than in normal coring operations to minimize vibration as the IST was overcored.
6. At the completion of the overcore run, the inner barrel was pulled out of the hole by wireline, and with it, the core and IST. The core was extracted from the inner barrel into a core tray, and the core around the IST pins was photographed. Finally, the IST was removed from the core and the battery powering the IST was removed. The IST was then connected to a laptop computer and the pin, magnetometer, and accelerometer data were downloaded and reviewed (Figure 1 [h]). Depending on the expected competence of the strata in the next core run, the process was immediately repeated, or further coring was undertaken to locate a suitable test horizon.

Stress testing in core hole ZEV-CH-03-23 began on September 4, 2023, at a depth of 2027.4 ft. A total of four tests were attempted in the core hole to a depth of 2037.0 ft. A summary of the overcoring test attempts is given in Table 1. Two tests were successful: overcores 0052-70 and 0054-70. When possible, the recovered cores for each test were photographed to document rock type and condition, particularly cores that contained fractures which may have influenced the overcore data. Photographs of the recovered core for the two successful tests, including the relative location of the measurement pins are shown in Figures 2 and 3.

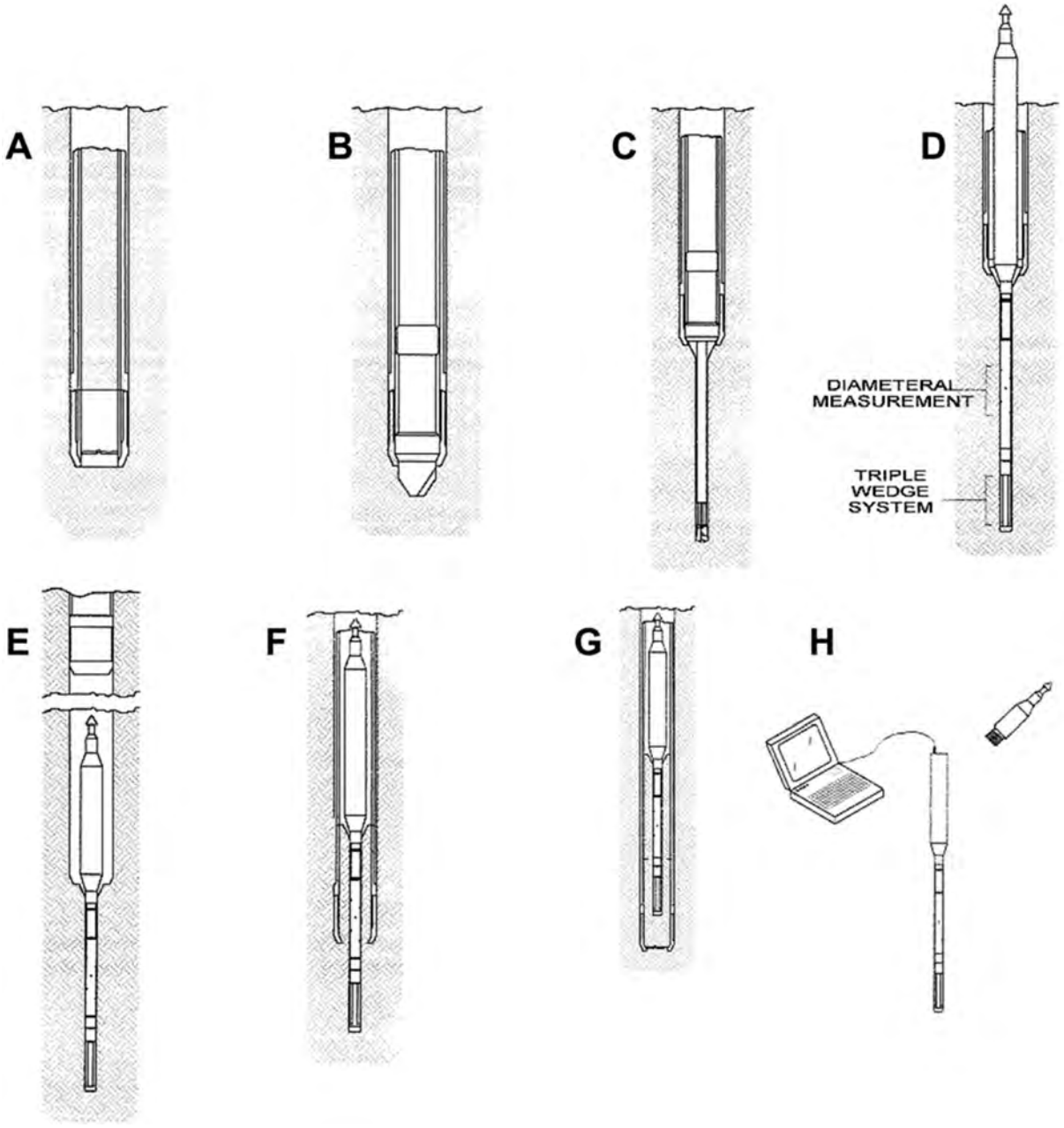

Figure 1. IST Field Stress Testing Sequence

Table 1. Summary of IST Test Attempts

Test Number	Overcore Number	Test Date	Successful Unsuccessful	Rock Condition	Depth (ft)
1	0036-076	9/5/2023	Unsuccessful	Solid	2027.4
2	0052-070	9/5/2023	Successful	Solid	2030.0
3	0054-070	9/5/2023	Successful	Solid	2033.4
4	0056-070	9/6/2023	Unsuccessful	Solid	2037.0

Figure 2. Photograph of Recovered Core from Overcore 0052-070

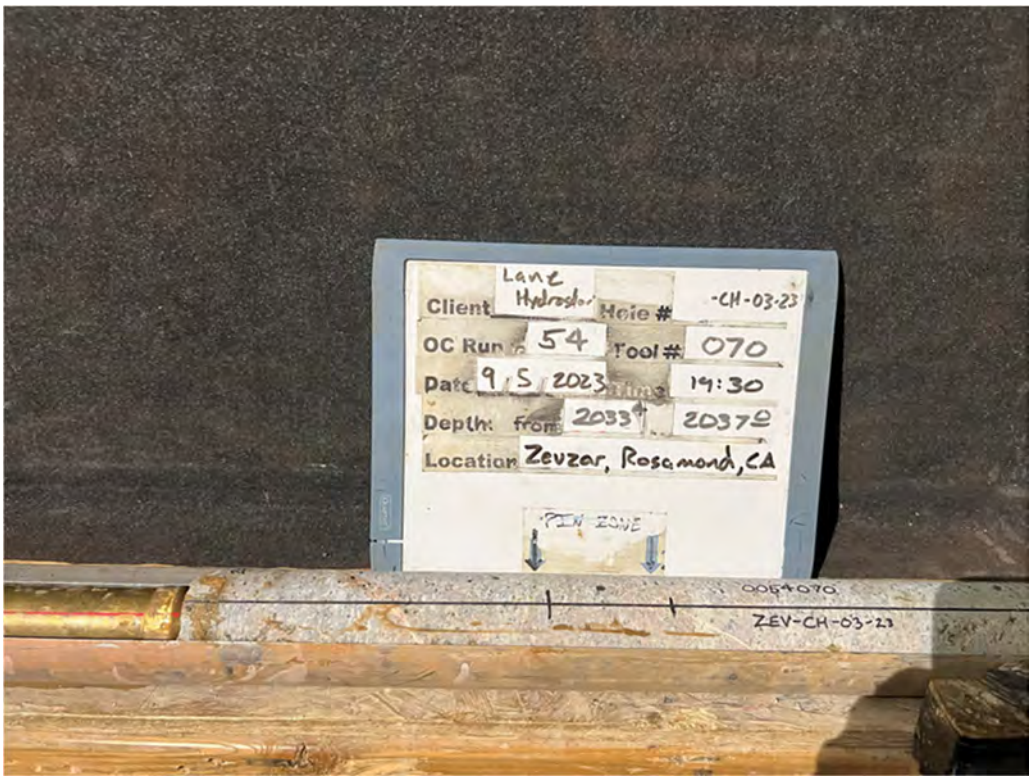

Figure 3. Photograph of Recovered Core from Overcore 0054-070

4 PHYSICAL PROPERTY TESTING

4.1 Physical Property Testing

Rock samples from both successful overcores were tested in Agapito's laboratory in Grand Junction, Colorado, to determine unconfined compressive strength (UCS), Young's modulus, and Poisson's ratio (in the axial direction).

4.2 Axial Testing

A summary of the laboratory test results is included in the Appendix following this report. The Appendix also contains the stress-strain plots for each test. Tests Run-0052-070 and Run-0054-070 correspond to overcores 0052-070 and 0054-070, respectively. The calculated values of Young's modulus (E) were 10.38×10^6 psi for overcore 0052-070, and 9.31×10^6 psi for overcore 0054-070. The Poisson's ratio was 0.32 for overcore 0052-070 and 0.19 for overcore 0054-070. The UCS was 26,468 psi for overcore 0052-070 and 12.696 psi for overcore 0054-070.

4.3 Radial Testing

Ideally, the value of E should be determined in the plane (generally horizontal) of the measurement direction, perpendicular to the borehole axis. However, because of the core size and geometry, samples used for conventional compression tests in the laboratory must be loaded along the borehole (vertical) axis. Additionally, the granitic rock being tested is presumed to be isotropic, with similar elastic properties in directions parallel and perpendicular to the plane of testing. Therefore, it was determined that radial testing was unnecessary for this project.

5 CALCULATION OF HORIZONTAL STRESSES

Plots of the pin data versus time were examined to determine the change in diameter that occurred during overcoring. In general, the diameter decreases slightly just before overcoring due to a stress concentration ahead of the core bit, then increases significantly and stabilizes as the bit relieves the horizontal stress acting on the core. The diametral change is calculated as the difference between the diameter measured just before the stress concentration decreases and the stable diameter just after the stress relief increases. Because the pins are offset, the overcore responses for the six pins occur in sequence at different times, depending upon the bit advance speed. Most of the pin traces for the successful tests showed normal response during the approximately 5-minute interval, while the core bit drilled past the pins, and could be used to calculate the stresses. The data for some pins were inconsistent and were excluded from the calculations.

Periodically, dummy runs were conducted on the surface to ensure that the tool, communication box, and laptop computer were all functioning properly. During dummy runs, data was collected while an aluminum standard cylinder was fitted over the pin zone. The data was downloaded and reviewed to confirm each pin was recording the correct diameter. In this manner, typical problems such as sticking pins and poor battery connections could be identified and corrected before lowering the IST tool into the pilot hole and attempting the actual overcore test.

The elastic properties and changes in the pilot hole diameter during overcoring are used to calculate the rock stresses in the plane (horizontal) normal to the borehole axis. The stresses can be

determined using data from a minimum of three pins; however, the additional data obtained using all six pins provides a measure of redundancy and permits the evaluation of the relative accuracy of the measurement. The stress calculation software, provided by Sigra, evaluates each combination of three or more pins and calculates an error value, or goodness-of-fit measure, for those combinations with four or more pins. An exact solution can be determined for any three-pin combination; however, a least-squares curve-fit technique is required to solve the combinations involving four or more pins.

The analysis software determines values for the mean effective stress (σ_m) and the deviatoric stress (σ_d). The major (σ_1) and minor (σ_2) principal stresses in the horizontal plane are calculated as follows:

$$\sigma_1 = \sigma_m + \sigma_d \quad \text{(Eqn. 1)}$$

$$\sigma_2 = \sigma_m - \sigma_d \quad \text{(Eqn. 2)}$$

For gravitational loading, the vertical stress (σ_v) is based on the density of the rock and the depth of the test. The stress gradient of the overburden material was calculated assuming a specific gravity of 2.69, or 1.17 psi-per-foot of depth (psi/ft). Assuming elasticity and that the rock is laterally constrained so there is no allowable strain in the horizontal plane, the lithostatic stress, or horizontal stress due to self-loading (σ_{hsw}) caused by the Poisson's effect, is:

$$\sigma_{hsw} = \sigma_v \times \frac{v}{(1-v)} \quad \text{(Eqn. 3)}$$

Recent research (Mark and Gadde 2008) into the expected levels of horizontal stress worldwide has shown the classic assumption of passive pressure (σ_{hsw}) may not be applicable and horizontal stresses are typically much higher. It was found that horizontal stresses varied linearly with depth and rock stiffness, and a constant excess stress was present, regardless of depth.

Figures 4 and 5 show plots of the best-fit stress calculations for each successful test (overcore runs 0052-070 and 0054-070). The data is considered valid and provides clear indications of stress relief and accurate relief displacements. The least-squares curve fits are generally good, and the stress orientations are consistent. Overcore 0052-070 was slightly biaxial, though overcore 0054-070 showed minimum and maximum horizontal stresses with similar magnitudes. This low biaxiality in the two overcore results means further testing may be required to determine a more accurate bearing of maximum horizontal stress at depth at the project site. The orientation of the instrument and the calculated principal stresses relative to Magnetic North are determined using the magnetometer and inclinometer data recorded by the IST. The data obtained during the measurement periods when the rods were raised were stable and are considered valid.

Using the axial modulus values derived from the laboratory tests, the average maximum horizontal stress (σ_1) is 1.2 times the minimum horizontal stress (σ_3) and 1.62 times the estimated vertical stress (σ_v). Thus, the ratio between the major maximum horizontal stress and vertical stress indicates a reasonably high horizontal stress regime. The successful tests were located at similar depths, so it was not possible to predict the variation of stress with depth. However, since the increase in vertical stress is typically linear, vertical stress levels should be expected to increase with depth. The horizontal stresses are presumed to be caused by the tectonic stresses related to the San Andreas Fault system and, therefore, not a function of the depth.

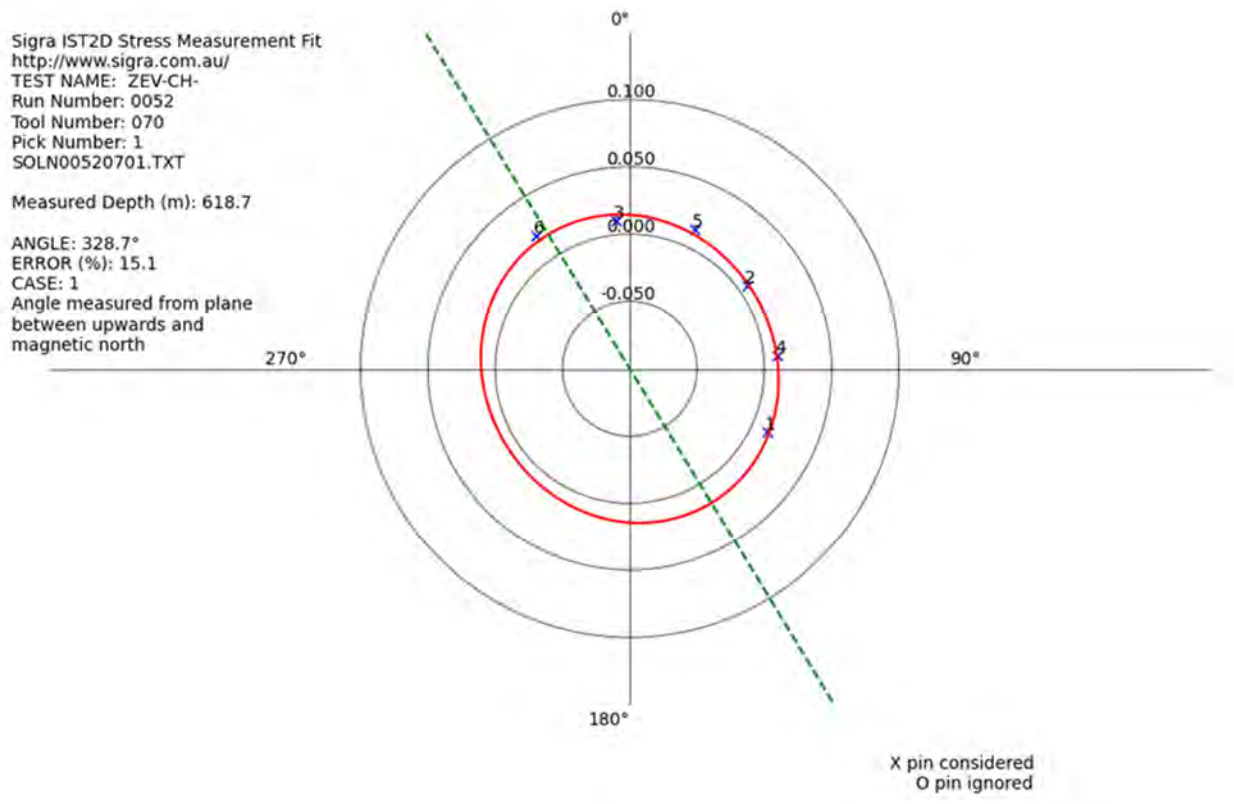

Figure 4. Best-Fit Stress Calculation for Overcore 0052-070

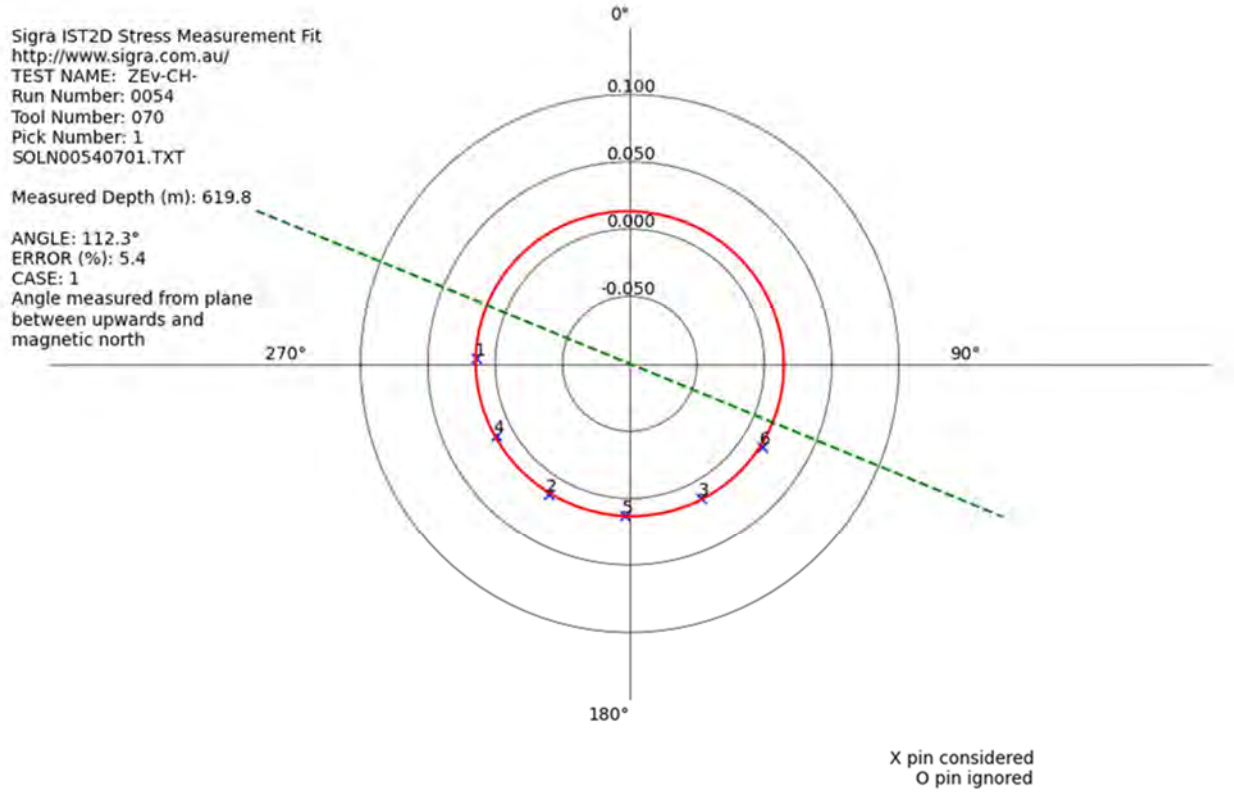

Figure 5. Best-Fit Stress Calculation for Overcore 0054-070

Table 2. Calculated Principal Stresses in ZEV-CH-03-23

Hole Name	ZEV-CH-03-23	
Overcore Number	**0052-070**	**0054-070**
Date Tested	9/5/2022	9/5/2022
Depth (ft)	2,030.0	2,033.4
Unconfined Compresive Strength (psi)	26,468	12,696
Young's Modulus ($\times 10^6$ psi)†	10.38	9.31
Poisson's Ratio †	0.32	0.19
Estimated Vertical Stress (psi)	2,368	2,373
Self-loading Horizontal Stress σ_{hsw} (psi)	1,114	557
Maximum Horizontal Stress σ_1 (psi)	4,098.8	3,611
Minimum Horizontal Stress σ_3 (psi)	3,115.4	3,446
σ_1:σ_3 Ratio	1.3	1.0
True Bearing of Maximum Horizontal Stress	340.38°	303.98°
Maximum Horizontal Strain ϵ_1 (microstrain)	226.8	269.8
Minimum Horizontal Strain ϵ_2 (microstrain)	101.6	248.6

psi = pounds per square inch; ° = degree; E = East
† Tangent Calculation Method
magnetic declination of 11.68° E

6 DISCUSSION AND CONCLUSIONS

The testing program resulted in two successful tests out of four attempts. The first unsuccessful attempt was caused by an unforeseen incompatibility between the rock and the type of drill bit used to drill the pilot hole for the tool. This caused the pilot hole diameter to be oversized and outside of the measurable range of the tool for run 0036-076. The cause of the second failed attempt was unclear. Upon retrieval of the core run containing the deployed tool for test 0056-070, the tool was set approximately 4 inches into the pilot hole instead of the ~16 inches required for a proper deployment. The tool's pins were not placed inside the pilot hole in the rock and, therefore, recorded no usable data. The successful overcores generally produced consistent results with respect to stress levels and orientation. The variability between stress magnitudes is attributed to the typical variations associated with geological materials and environments.

The calculated magnitudes and orientation of the stresses are considered reasonable and indicate the tectonic strain of the San Andreas Fault system influences the in-situ horizontal stress of the project area.

The average maximum horizontal stress was 3,855.1 psi and the average minimum stress was 3,280.1 psi. Of the two successful tests run, 0052-070 provided an azimuth of the maximum horizontal stress of 340.4° (clockwise from North). Run 0054-070 provided maximum and minimum horizontal stresses of similar magnitude, causing lower confidence in the azimuthal data for run 0054-070.

7 REFERENCES

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APPENDIX A

LABORATORY COMPRESSION TESTING

Table A-1. Uniaxial Compressive Strength Test Results

Specimen No.	Hole ID	Depth From (ft)	Depth To (ft)	Rock Type	Weight (oz)	Average Diameter (inch)	Axial Length (inch)	Density (pcf)	Failure Load (lb)	UCS (psi)	Young's Modulus† ($\times 10^6$ psi)	Poisson's Ratio†	Young's Modulus‡ ($\times 10^6$ psi)	Poisson's Ratio‡
Run-0052-070	ZEV-CH-03-23	2026.30	2026.75	Granite - IST Test at 2030.0 ft	37.10	2.39	5.29	168	118,940	26,468	10.38	0.32	10.64	0.17
Run-0054-070	ZEV-CH-03-23	2036.30	2036.75	Granite - IST Test at 2033.4 ft	38.37	2.40	5.49	168	57,195	12,696	9.31	0.19	8.94	0.05

†Tangent calculation method.

‡Secant calculation method.

Run-0052-070—Before

Run-0052-070—After

Run-0054-070—Before

Run-0054-070—After

Figure A-1. Before and After Photographs of Uniaxial Compressive Strength Test Specimens

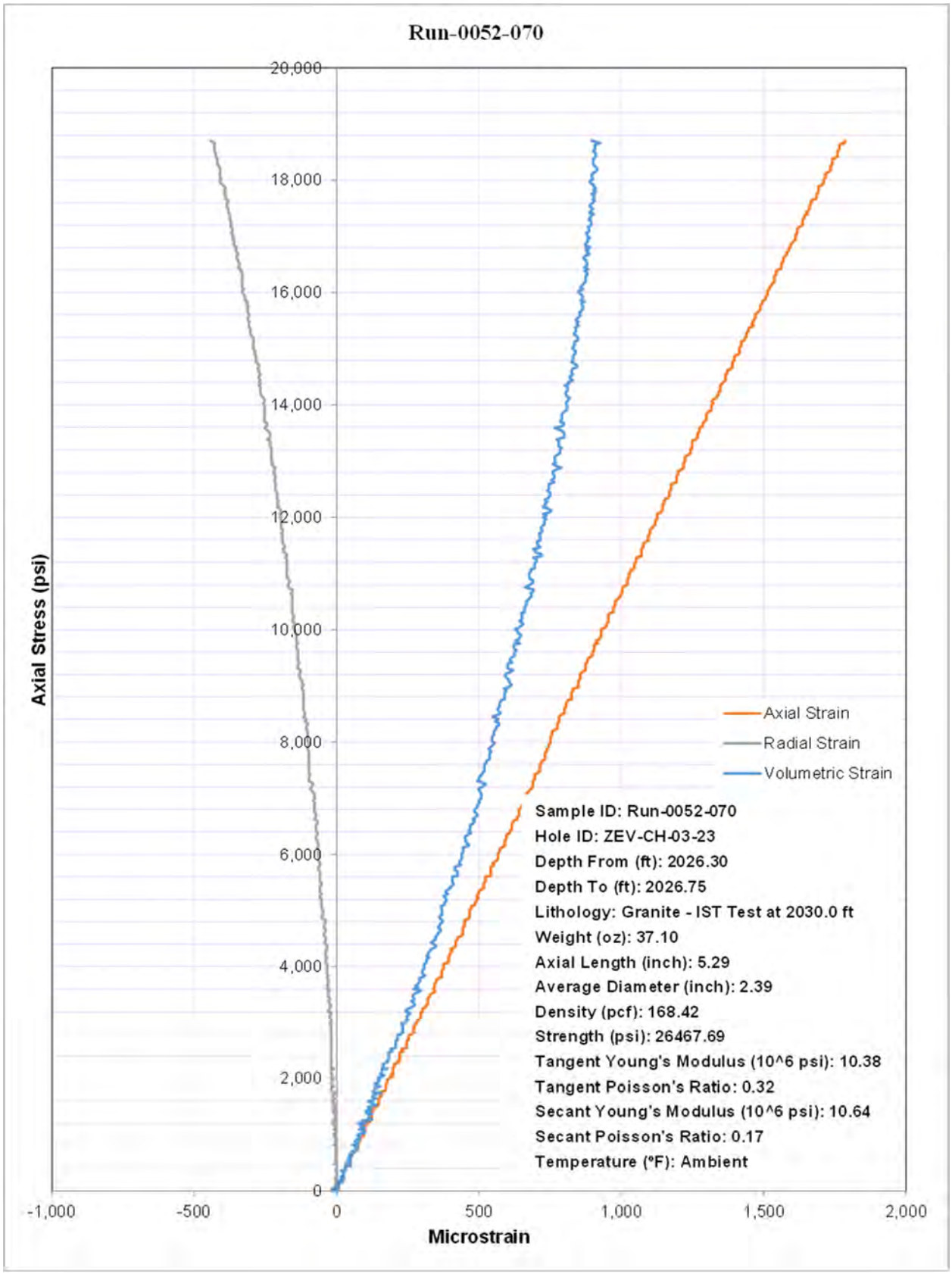

Figure A-2. Stress-Strain Plots of Uniaxial Compressive Strength Test Specimens

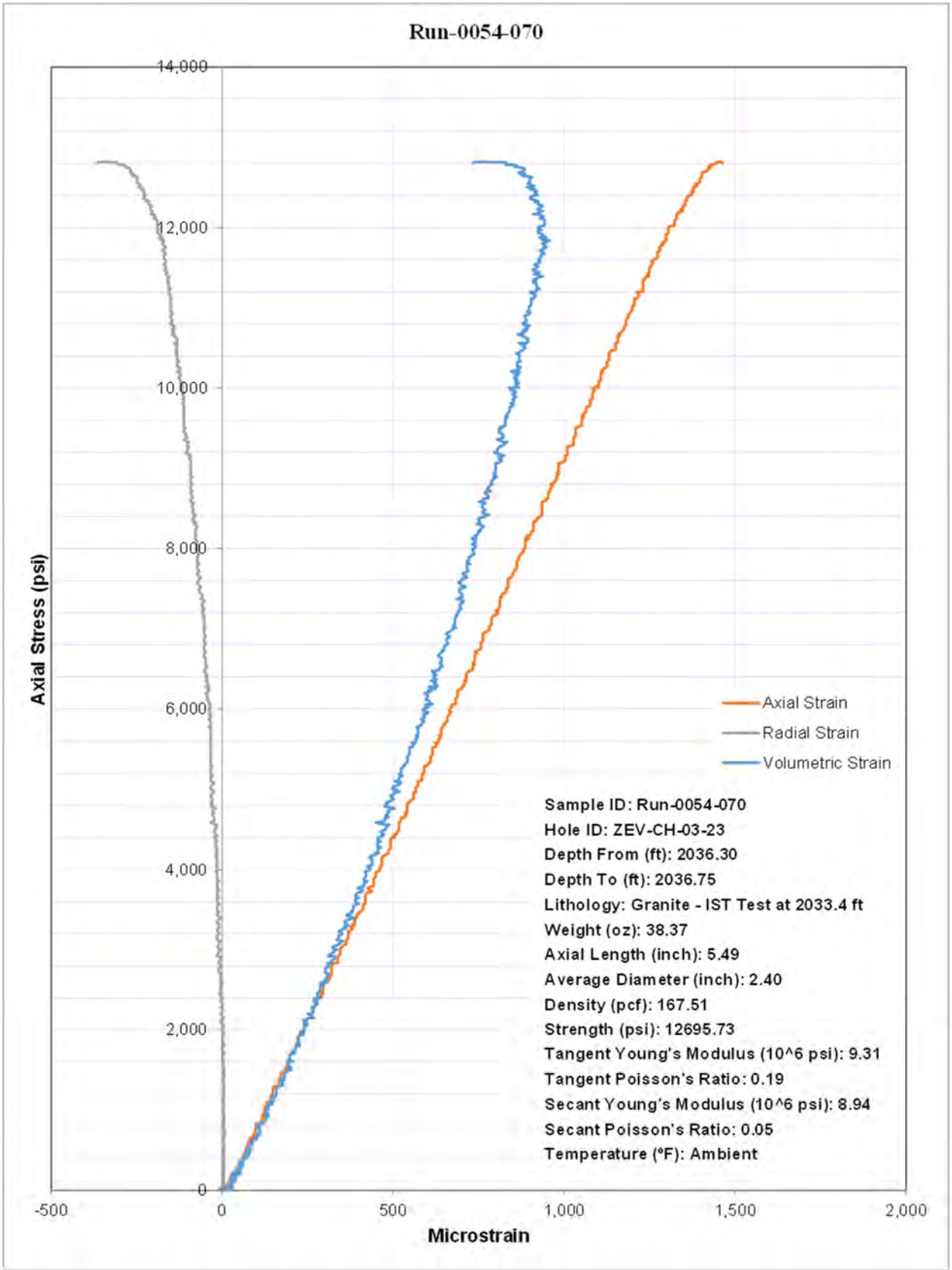

Figure A-2. Stress-Strain Plots of Uniaxial Compressive Strength Test Specimens