

APPENDIX 9. DESCRIPTIONS OF SELECTED SAMPLES FROM GHN. DESCRIPTION OF SAMPLE GHN-JRM-0001 LOCATION

Sample GHN-JRM-0001 was collected from Unit J, trench LFG-009, bench 22 (UTM 4062136.8, 453642.2E, elevation 9602 ft). The sample was located approximately 61 ft east of the outer edge of the rock pile (Fig. A9-1).



FIGURE A9-1. Bench 22N and 23N, Units I, J, and N. Sample GHN-JRM-0001 (GHN-LFG-009-H007) was collected at green flag below sample number. Note Bruton compass for scale.

HANDSAMPLE DESCRIPTION

Sample GHN-JRM-0001 is a bulk sample that consists of soil matrix and rock fragments that vary in size from 3 inches to less than 1 mm (Fig. A9-2). It is pale yellow (25Yr 8/3), oxidized, poorly-sorted, of firm consistency and low to medium plasticity. The clasts are subangular. It has a SWI (Simple Weathering Index) of 4. The sample reacts slightly with HCl.

PETROGRAPHIC DESCRIPTION (using binocular scope of soil sample)

Sample GHN-JRM-0001 is highly altered andesite, mostly QSP (~90%) and propylitic (~2%) alteration. There is approximately 10% cement that consists of jarosite, illite, and gypsum. Gypsum is found as primarily rounded milky grains with some euhedral clear crystals. Pyrite is found as rounded cubes 1.44 mm to 0.18 mm in diameter.



FIGURE A9-2. Euhedral tarnished pyrite on detrital gypsum in soil matrix (GHN-JRM-001-T002). Field of view 1.5 mm (plane light).

MICROPROBE DESCRIPTION

This is a highly altered sample in which much of the feldspar has been hydrothermally altered to clay minerals. The sample consists of rock and mineral fragments within abundant soil matrix. The majority of rock fragments are highly altered to illite (or illite/smectite) with some remnant quartz and feldspar (dominantly K-feldspar) present in the rock matrix and as rounded grains within the soil matrix. Localized areas of the sample contain pure jarosite cement (Fig. A9-3). Euhedral bladed aggregates of gypsum (up to 100 micron blades) occur along edges of adhered soil matrix and intergrown within the illite/jarosite soil matrix (Fig. A9-4). The soil matrix is predominantly composed of illitic clay and large areas of the sample appear cemented by an illite/jarosite mixture (Fig. A9-5). Slightly dissolved, embayed pyrite cubes occur as isolated grains within the matrix and within some rock fragments (Fig. A9-6). Some pyrite grains contain numerous tiny inclusions.

LABORATORY ANALYSES

Laboratory analyses are in Tables A9-1 and A9-2. The QMWI (Questa Mineralogy Weathering Index) is 4. ABA results are in Figure A9-7.

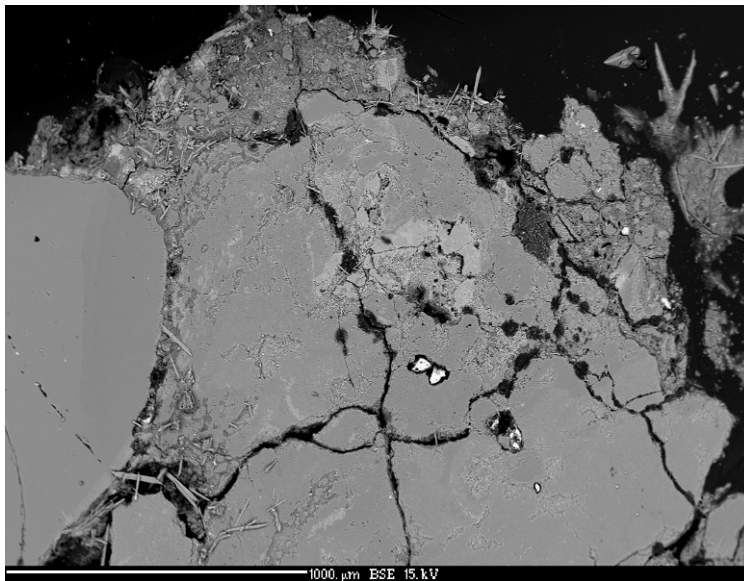


FIGURE A9-3. Backscattered electron microprobe (BSE) image of altered rock fragment with adhered illite/jarosite matrix showing intergrown euohedral bladed gypsum aggregates (GHN-JRM-0001-30-04). Note eroded pyrite crystals (bright grains in center of image).

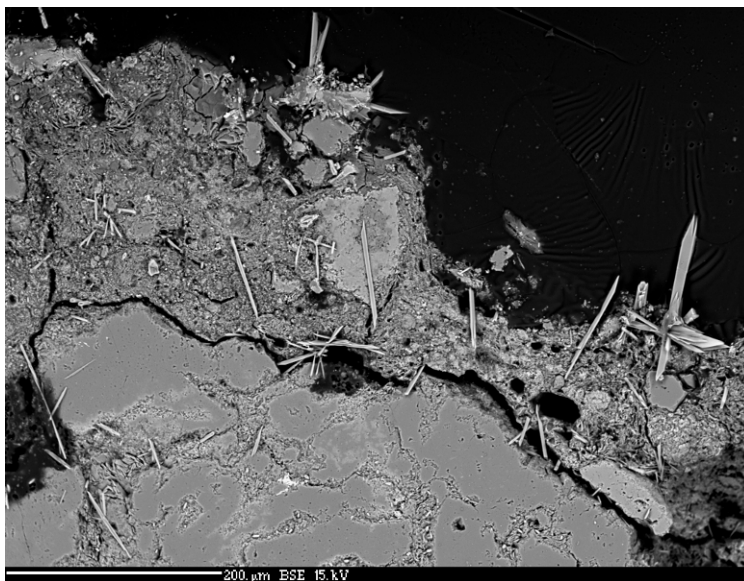


FIGURE A9-4. Backscattered electron microprobe image of altered rock fragment with illite/jarosite matrix and intergrown euohedral bladed gypsum aggregates (GHN-JRM-0001-30-05).



FIGURE A9-5. Backscattered electron microprobe image of altered rock fragments containing illite and illite/jarosite matrix with intergrown euhedral bladed gypsum aggregates (GHN-JRM-0001-30-06).

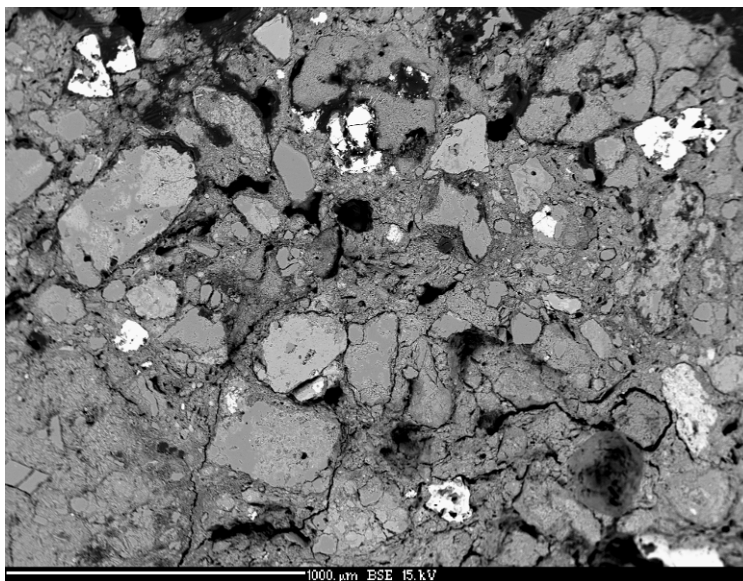


FIGURE A9-6. Backscattered electron microprobe image of eroded pyrite grains in soil matrix (GHN-JRM-0001-30-10).

TABLE A9-1. Various laboratory analyses for sample GHN- JRM-0001.

Atterberg Limits	
LL	37.35
PL	19.94
PI	17.71
Paste pH	2.14
Paste Conductivity	6.31
Slake Index	93.99
Point Load	3.3
Friction Angle	45.61

Residual Friction Angle	38.5
Specific Gravity	3
ABA data	
NAG pH	2.87
NAG value	28.03
AP	26.42
NP	0
Net NP	-26.42
NPAP	0

TABLE A9-2. Chemical and mineralogical analysis for sample GHN-JRM-0001.

Chemistry	GHN-JRM-0001	Mineralogy	GHN-JRM-0001
SiO ₂	61.64	quartz	35
TiO ₂	0.53	K-spar/orthoclase	7
Al ₂ O ₃	13.65	plagioclase	15
Fe ₂ O ₃ T	5.24	albite	
FeOT	4.76	anorthite	
FeO	2.86	biotite	
Fe ₂ O ₃	2.09	clay	
MnO	0.08	illite	27
MgO	1.28	chlorite	3
CaO	0.98	smectite	2
Na ₂ O	1.87	kaolinite	1
K ₂ O	3.91	mixed layered	
P ₂ O ₅	0.19	epidote	0.0001
S	2.01	magnetite	
SO ₄	1.12	Fe oxides	0.0001
C	0.07	goethite	
LOI	8.81	hematite	
Total	101.38	rutile	0.5
Trace elements		apatite	0.3
Ba	832	pyrite	3
Rb	134	calcite	0.4
Sr	136	gyp	
Pb	153	detrit gyp	1.1
Th	11	auth gyp	0.1
U	5	zircon	0.03
Zr	163	sphalerite	
Nb	16	molybdenite	
Y	25	fluorite	
Sc	9	jarosite	4
V	74	copiapite	
Ni	30	chalcopyrite	
Cu	172		
Zn	92		
Ga	21		
Cr	57		
F	1646		
REE			
La	49		
Ce	96		

Chemistry	GHN-JRM-0001	Mineralogy	GHN-JRM-0001
Nd	40.3		
Sm	7.3		
Eu	1.15		
Gd	5.3		
Yb	1.18		
Lu	.88		

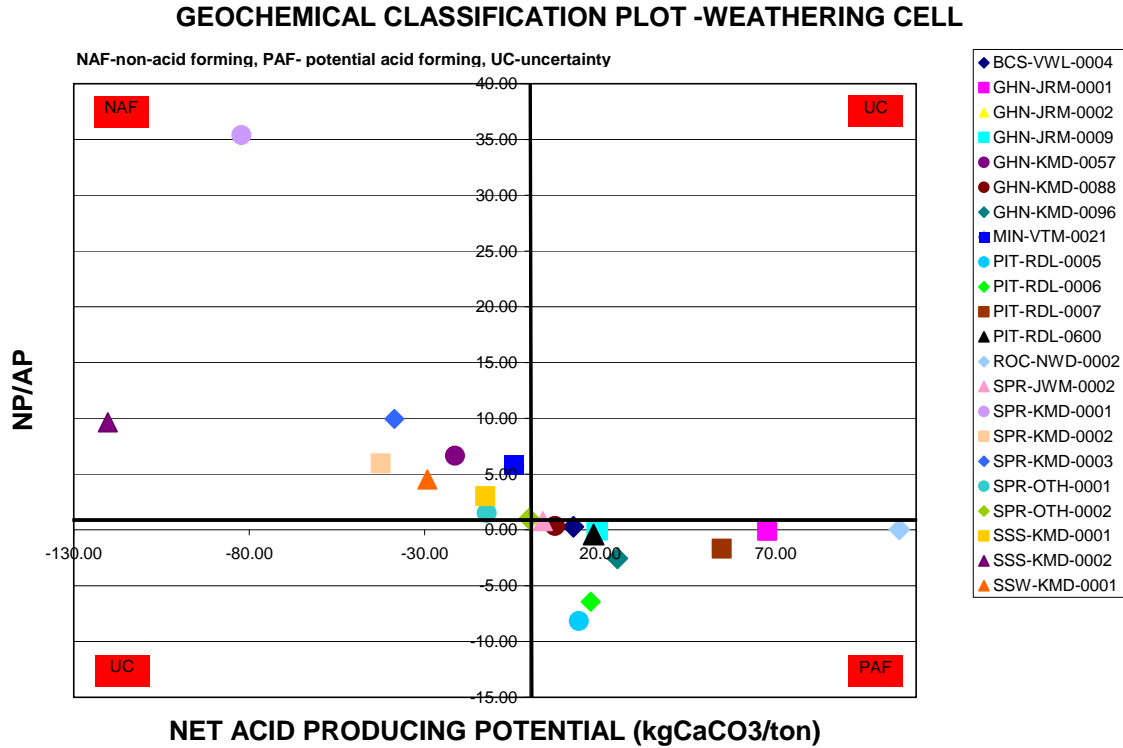


FIGURE A9-7. NP/AP vs Net Acid Producing Potential for weathering cell samples.

DESCRIPTION OF SAMPLE GHN-JRM-0002
LOCATION

Sample GHN-JRM-0002 was collected from Unit N, trench LFG-009, bench 22 (UTM 4062136.8N, 453642.4E, elevation 9601 ft). The sample was located approximately 61.5 ft east of the outer edge of the rock pile (Fig. A9-8).

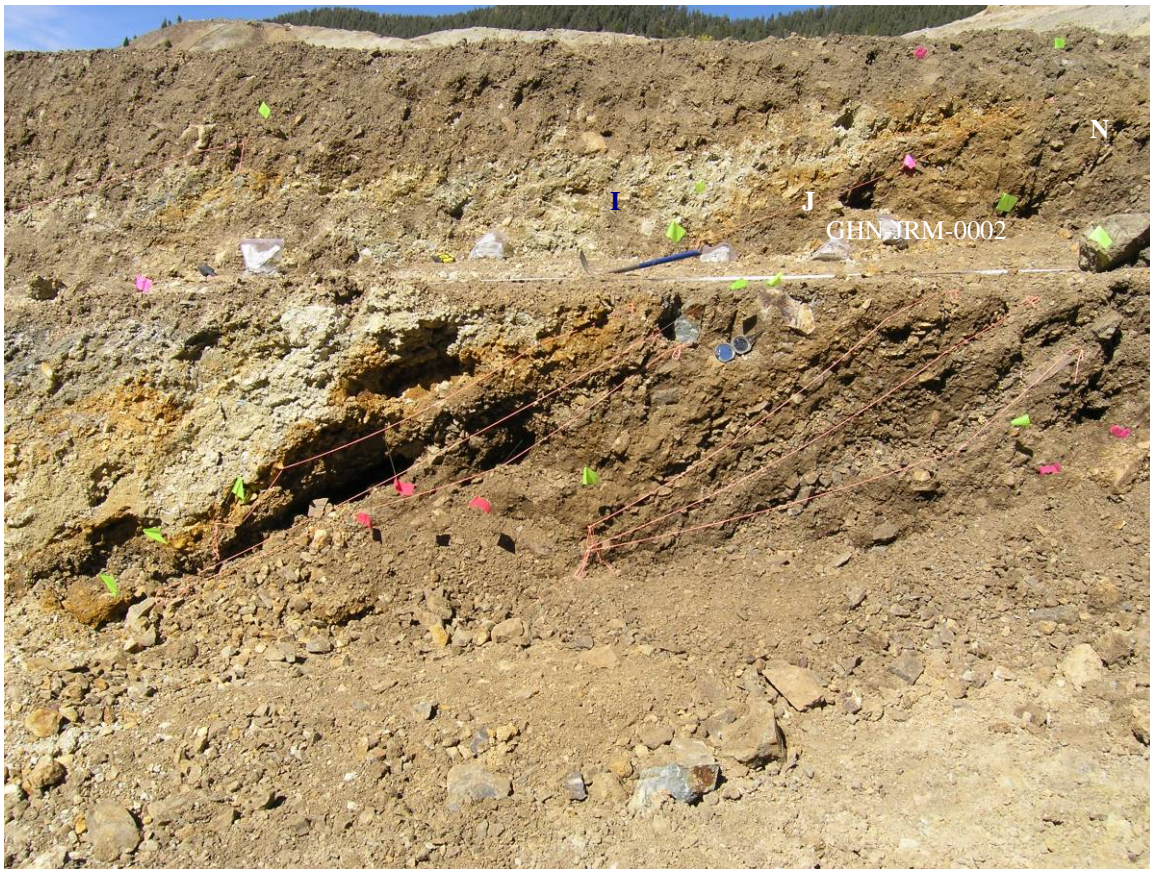


FIGURE A9-8. Bench 22N and 23N, Units I, J, and N. Sample GHN-JRM-0002 (GHN-LFG-009-H007) was collected to the right of the green flag. Note Bruton compass for scale.

HANDSAMPLE DESCRIPTION

Sample GHN-JRM-0002 is a bulk sample that consists of soil matrix and rock fragments that vary in size from 3 inches to less than 1 mm. It is brown (10Yr, 7/3), poorly-sorted, of firm consistency, and low to medium plasticity. The clasts are subangular. It has a SWI (Simple Weathering Index) of 2. The sample reacts slightly with HCl.

PETROGRAPHIC DESCRIPTION (using binocular scope of soil sample)

Sample GHN- JRM-0002 is highly altered andesite (98%) with minor fragments of intrusion (2%), mostly QSP (70%) and propylitic (7%) alteration. There is approximately 5% cement that consists of gypsum. Gypsum is found primarily as rounded euhedral clear crystals. Pyrite occurs as rounded cubes 1.44 mm to 0.18 mm in diameter and is coated with Fe oxides.

MICROPROBE DESCRIPTION

The sample consists of variably altered andesitic rock fragments. Many rock fragments are pervasively altered to illite/smectite with some chlorite. Epidote is present as a replacement phase within altered phenocrysts. Many rock fragments are rimmed by P-S (+/- Mn) bearing goethite (Fig. A9-9). Relict pyrite cubes are typically oxidized to P-S bearing goethite. Within some rock fragments relict pyrite cubes have been partially replaced by jarosite (Fig. A9-10). Jarosite also occurs as cement along the edges of some rock fragments (Fig. A9-11).

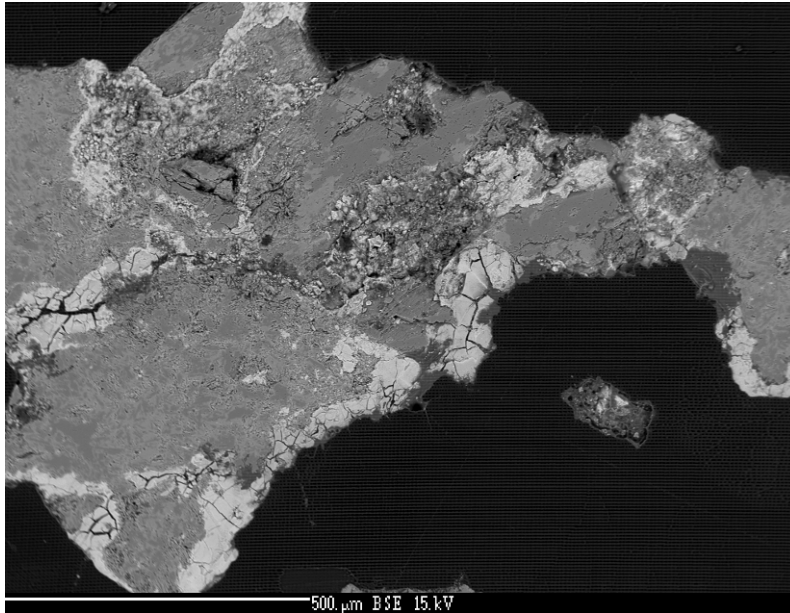


FIGURE A9-9. Backscattered electron microprobe image of altered rock fragment with P-S-Mn bearing goethite cement (GHN-JRM-0002-90-02).

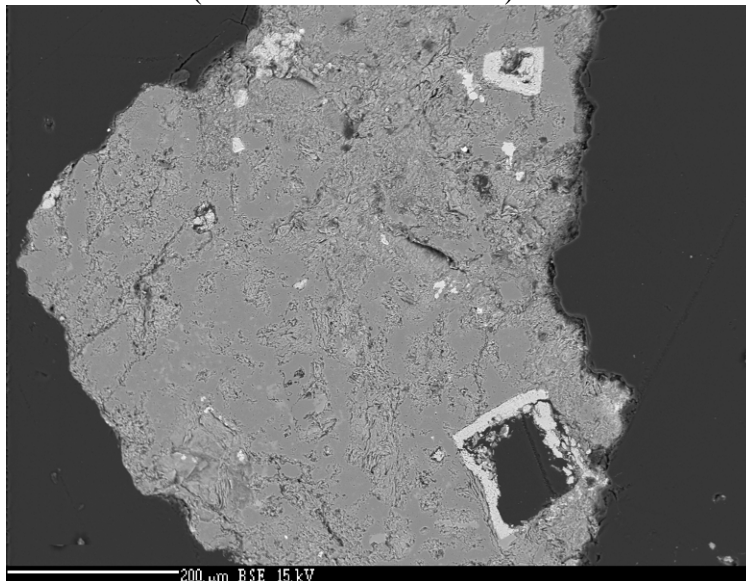


FIGURE A9-10. Backscattered electron microprobe image showing relict pyrite cube partially replaced by jarosite. The rock matrix is pervasively altered to illite/smectite clay (GHN-JRM-0002-90-07).

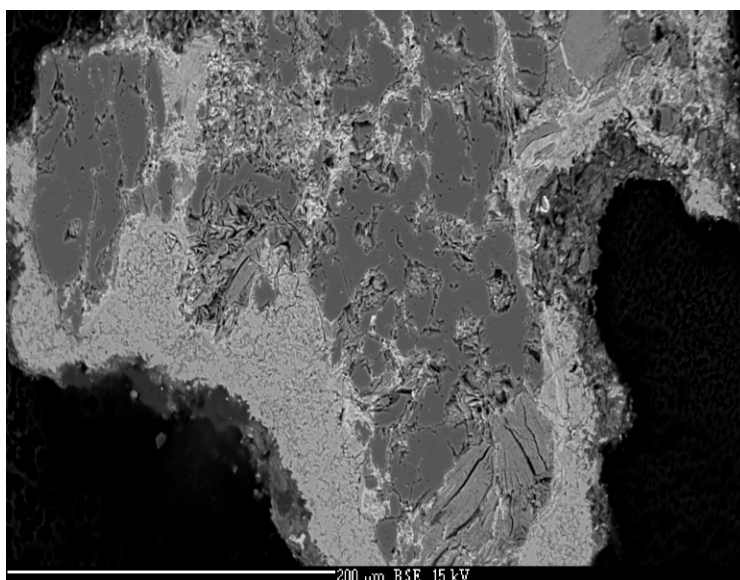


FIGURE A9-11. Backscattered electron microprobe image of altered rock fragment containing chlorite alteration clay and rimmed by jarosite cement (GHN-JRM-0002-90-06).

LABORATORY ANALYSES

Laboratory analyses are in Tables A9-3 and A9-4. The QMWI (Questa Mineralogy Weathering Index) is 4. ABA results are in Figure A9-12. The QMWI (Questa Mineralogy Weathering Index) is 6.

TABLE A9-3. Various laboratory analyses for sample GHN- JRM-0002.

Atterberg Limits	
LL	36.14
PL	24.34
PI	11.8
Paste pH	2.15
Paste Conductivity	5.46
Slake Index	97.6
Point Load	4.48
Density	1.91
ABA data	
NAG pH	3.8
NAG value	12.78
AP	3.27
NP	4.3
Net NP	1.03
NPAP	1.31

TABLE A9-4. Chemical and mineralogical analysis for sample GHN-JRM-0002.

Chemistry	GHN-JRM-0001	Mineralogy	GHN-JRM-0001
SiO ₂	61.64	quartz	35
TiO ₂	0.53	K-spar/orthoclase	7
Al ₂ O ₃	13.65	plagioclase	15

Chemistry	GHN-JRM-0001	Mineralogy	GHN-JRM-0001
Fe2O3T	5.24	albite	
FeOT	4.76	anorthite	
FeO	2.86	biotite	
Fe2O3	2.09	clay	
MnO	0.08	illite	27
MgO	1.28	chlorite	3
CaO	0.98	smectite	2
Na2O	1.87	kaolinite	1
K2O	3.91	mixed layered	
P2O5	0.19	epidote	0.0001
S	2.01	magnetite	
SO4	1.12	Fe oxides	0.0001
C	0.07	goethite	
LOI	8.81	hematite	
Total	101.38	rutile	0.5
Trace elements		apatite	0.3
Ba	832	pyrite	3
Rb	134	calcite	0.4
Sr	136	gyp	
Pb	153	detrit gyp	1.1
Th	11	auth gyp	0.1
U	5	zircon	0.03
Zr	163	sphalerite	
Nb	16	molybdenite	
Y	25	fluorite	
Sc	9	jarosite	4
V	74	copiapite	
Ni	30	chalcopyrite	
Cu	172		
Zn	92		
Ga	21		
Cr	57		
F	1646		
REE			
La	49		
Ce	96		
Nd	40.3		
Sm	7.3		
Eu	1.15		
Gd	5.3		
Yb	1.18		
Lu	.88		

GEOCHEMICAL CLASSIFICATION PLOT -WEATHERING CELL

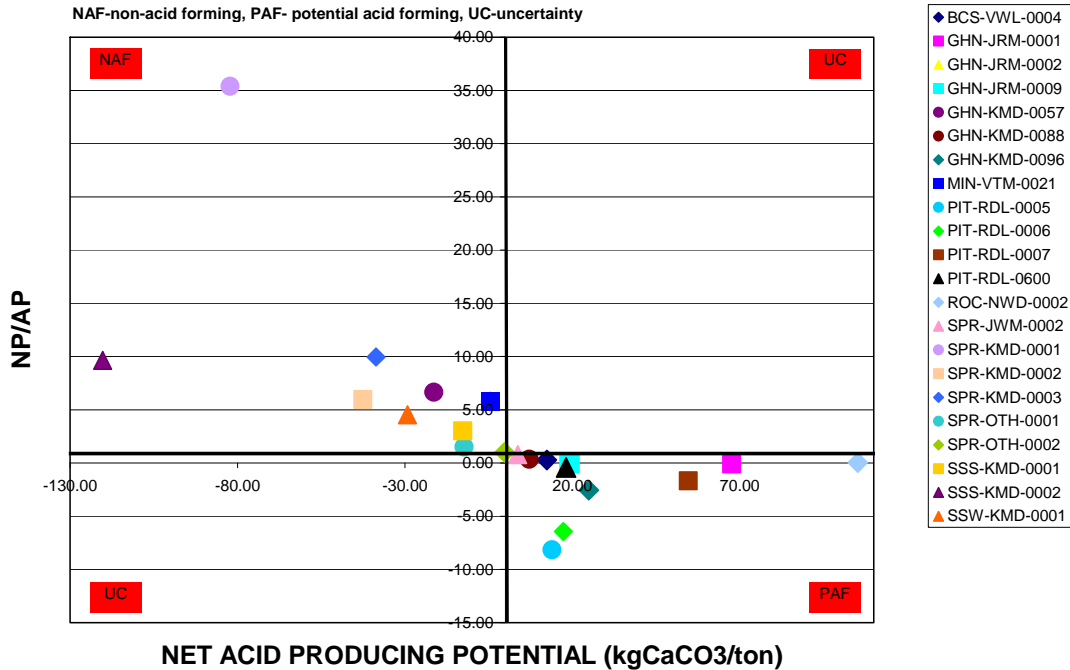


FIGURE A9-12. NP/AP vs Net Acid Producing Potential for weathering cell samples. Sample GHN-JRM-0001 (pink square) is potentially acid producing.

DESCRIPTION OF SAMPLE GHN-KMD-0016

LOCATION

This sample was collected at the Goathill North rock pile. The UTM coordinates of sample collection are 13N4062141, 453725.1E, and the sample was collected 9736.107 ft above sea level.

HAND SAMPLE DESCRIPTION

In hand sample the sample is grey to tan in color before rinsing and grey after rinsing; the cement is completely removed by rinsing. There is orange oxide staining as well as black Fe/Mn oxide rinds around on many rock fragments (Fig. A9-13). The rock fragments range in size from sand to boulders, and are sub-rounded in shape. Many of the smaller rock fragments are cemented together before rinsing. Epidote is present in the sample as green and brown grains (Fig. A9-13). Carbonate minerals appear as sub-rounded, individual grains, up to 0.25 mm in size, although much of the carbonate appears in the matrix. No pyrite was observed because all of the pyrite has been replaced, however some pseudomorphs are visible in areas of QSP alteration. Particle size distribution is shown in Figure A9-15.

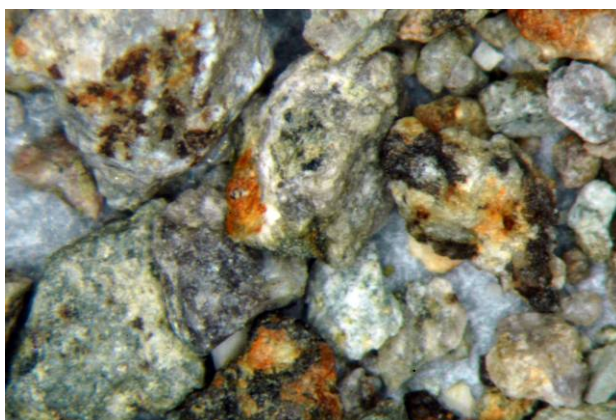


FIGURE A9-13. Figure shows rinsed rock fragments displaying orange and black Mn/Fe-oxide staining. Field of view is 5 cm.

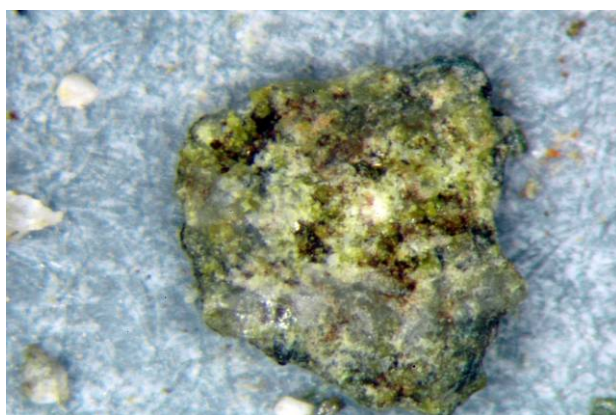


FIGURE A9-14. Figure shows a rock fragment with epidote. Field of view is 2 cm.

LABORATORY ANALYSES

TABLE A9-5. Various laboratory analyses for sample GHN-KMD-0016.

Atterberg Limits	
LL	28.11
PL	20.94
PI	7.17
Paste pH	5.74
Paste Conductivity	2.46
Specific Gravity	2.8
NAG pH	8.36
NAG value	0

TABLE A9-6. Chemical and mineralogical analysis for sample GHN-KMD-0016.

Chemistry	Weight Percent	Mineralogy	Weight Percent
SiO ₂	61.88	Quartz	24
TiO ₂	0.79	K-spar/orthoclase	22
Al ₂ O ₃	14.44	Plagioclase	22
Fe ₂ O ₃ T	5.51	Albite	-
FeOT	-	Anorthite	-

Chemistry	Weight Percent	Mineralogy	Weight Percent
FeO	3	Biotite	-
Fe2O3	2.21	Clays/groundmass	-
MnO	0.31	Illite	4
MgO	2.83	Chlorite	7
CaO	2.97	Smectite	5
Na2O	3.36	Kaolinite	0.9
K2O	3.12	Mixed layered	-
P2O5	0.29	Epidote	12
S	-	Magnetite	-
SO4	-	Fe oxides	0.5
C	-	Goethite	0.04
LOI	3.42	Hematite	0.3
Total	100.71	Rutile	0.7
Trace elements	ppm	Apatite	0.7
Ba	1174	Pyrite	0.2
Rb	76	Calcite	0.01
Sr	579	Gypsum	-
Pb	186.2	Detrital gypsum	-
Th	7.82	Auth gypsum	-
U	2.52	Zircon	0.03
Zr	164	Sphalerite	-
Nb	15	Molybdenite	-
Y	16.3	Fluorite	0.2
Sc	-	Jarosite	-
V	126	Copiapite	-
Ni	49	Other S minerals	-
Cu	59		
Zn	451		
Ga	35.1		
Cr	88		
F	993		

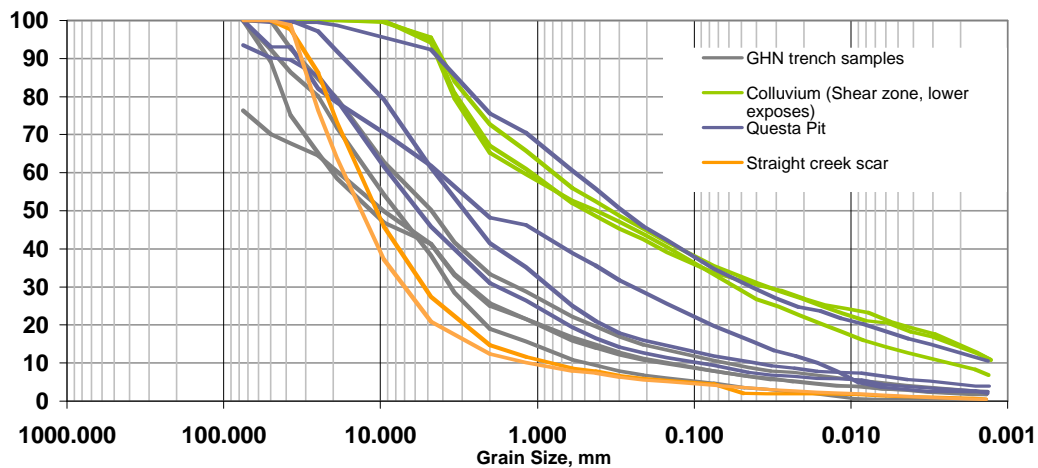


FIGURE A9-15. Particle size distribution for colluvium, the GHN rock pile, the Straight Creek scar, and the open pit at Questa.

**DESCRIPTION OF SAMPLE GHN-KMD-0018
LOCATION**

Sample GHN-KMD-0018 was collected from Unit J, trench LFG-006, bench 9 (UTM 4062143.2N, 453698.2E, zone 13, elevation 9730.5 ft). The sample was located approximately 10 ft east of the outer edge of the rock pile (Fig. A9-16).



FIGURE A9-16. GHN-LFG-006-H007. Bench 9, Unit J. Sample GHN-KMD-0018 was collected at location X.

HAND SAMPLE DESCRIPTION

Sample GHN-KMD-0018 is a bulk sample that consists of soil matrix and rock fragments that vary in size from 8 cm to less than 1 mm. It is yellowish brown (10YR 5/4), slightly oxidized, poorly-sorted, moderate consistency, low to medium plasticity clayey gravel. The clasts are subangular to angular. There is no reaction to HCl after rinsing, and possibly there are rare carbonates as fine-grained material in rock fragments. Rock fragments are primarily andesite but rhyolite (Amalia Tuff) is also present. Epidote is rare and is found as small green grains associated with rock fragments. There are Mn and Fe rinds on many clasts with associated orange staining from these oxides. There is no pyrite observed in the sample although there is evidence that the pyrite has been replaced by goethite. It has a SWI (Simple Weathering Index) of 3.

PETROGRAPHIC DESCRIPTION (using petrographic scope of soil sample)

Sample GHN-KMD-0018 consists of orange-stained (Fig. A9-17), altered andesite (65%) and rhyolite (Amalia tuff, 35%), mostly QSP (~20%) and propylitic (~8%) alteration (Fig. A9-18). Mn/Fe oxide rinds on some rock fragments. Chlorite is found as rare subangular green crystals. Epidote is found as rare small green grains associated with rock fragments. Gypsum is found as clear, euhedral, crystals (Fig. A9-19); milky rounded grains; and fuzzy gypsum adhering to clasts. Pyrite is partially replaced by goethite. Particle size distribution is shown in Figure A9-20.



FIGURE A9-17. Subangular orange-stained rock fragments (GHN-KMD-018-T001). Field of view is 6 mm.

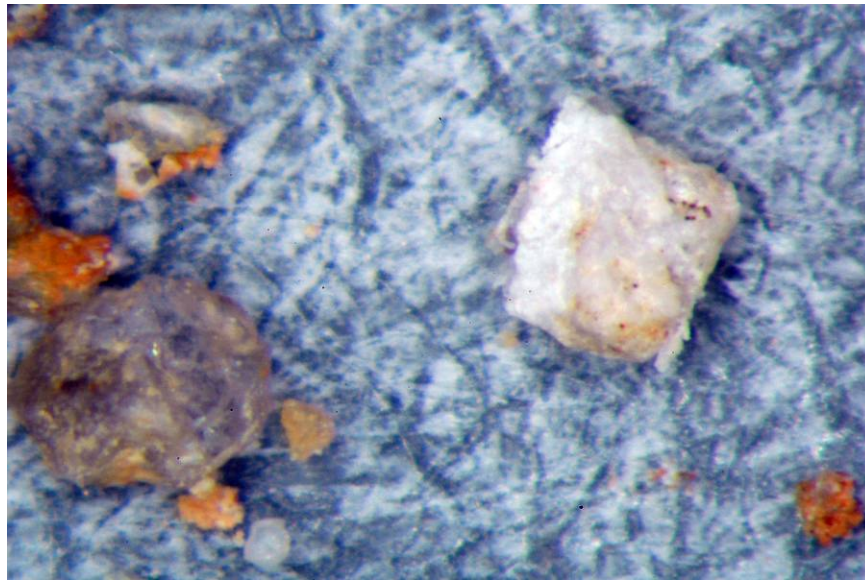


FIGURE A9-18. Quartz (left) and milky detrital gypsum (right) (GHN-KMD-018-T004). Field of view is 2 mm.

LABORATORY ANALYSES

TABLE A9-7. Various laboratory analyses for sample GHN-KMD-0018.

Atterberg Limits	
LL	30.93
PL	17.55
PI	13.4
Paste pH	3.5
Paste Conductivity	7.98
Specific Gravity	2.65
NAG pH	3.88
NAG value	0.5

TABLE A9-8. Chemical and mineralogical analysis for sample GHN-KMD-0018.

Chemistry	Weight Percent	Mineralogy	Weight Percent
SiO ₂	70.45	Quartz	39
TiO ₂	0.36	K-spar/orthoclase	25
Al ₂ O ₃	12.95	Plagioclase	4
Fe ₂ O ₃ T	3.48	Albite	-
FeOT	-	Anorthite	-
FeO	1.73	Biotite	-
Fe ₂ O ₃	1.58	Clays/groundmass	-
MnO	0.22	Illite	19
MgO	1.23	Chlorite	3
CaO	0.81	Smectite	3
Na ₂ O	1.29	Kaolinite	0.9
K ₂ O	4.81	Mixed layered	-
P ₂ O ₅	0.08	Epidote	0.4

Chemistry	Weight Percent	Mineralogy	Weight Percent
S	-	Magnetite	-
SO4	-	Fe oxides	1.7
C	0	Goethite	0.1
LOI	4.2	Hematite	0.07
Total	98.99	Rutile	0.3
Trace elements	ppm	Apatite	0.2
Ba	712	Pyrite	0.4
Rb	149	Calcite	0
Sr	197	Gypsum	-
Pb	154	Detrital gypsum	0.6
Th	10.45	Auth gypsum	0.6
U	4.31	Zircon	0.04
Zr	240	Sphalerite	-
Nb	32	Molybdenite	-
Y	38	Fluorite	0.3
Sc	-	Jarosite	1.4
V	51	Copiapite	0.06
Ni	0	Other S minerals	-
Cu	105		
Zn	502		
Ga	39		
Cr	76		
F	1217		

Particle Size Distribution

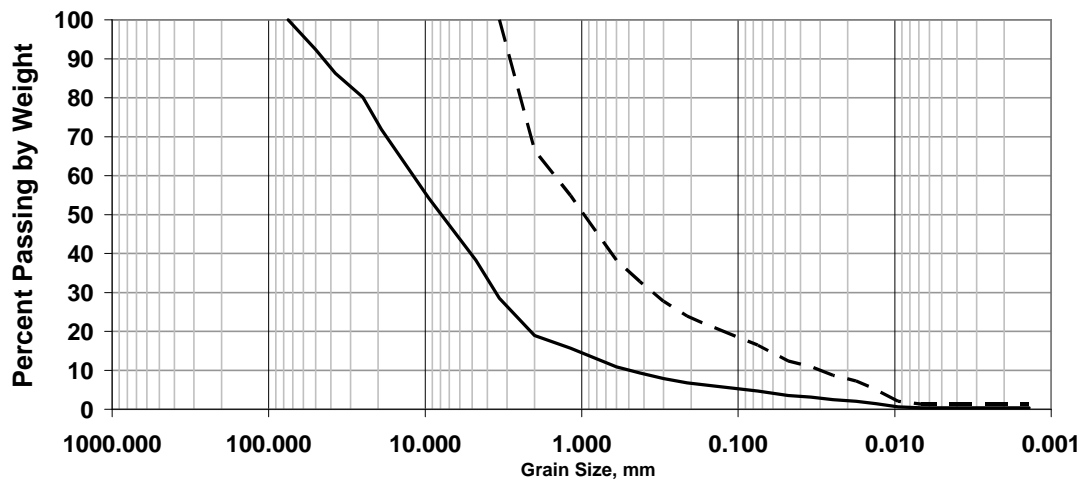


FIGURE A9-19. Particle size distribution graph for sample GHN-KMD-0018. The solid line represents the whole sample as collected from the field and the dashed line represents the scalped sample that was used to measure friction angle in the NMIMT laboratory.

DESCRIPTION OF SAMPLE GHN-KMD-0051

LOCATION

Sample GHN-KMD-0051 was collected from Unit O, trench LFG-007, bench 12 (UTM 4062145.8N, 453695.1E, zone 13, elevation 9698 ft). The sample was located approximately 54 ft east of the outer edge of the rock pile (Fig. A9-20).

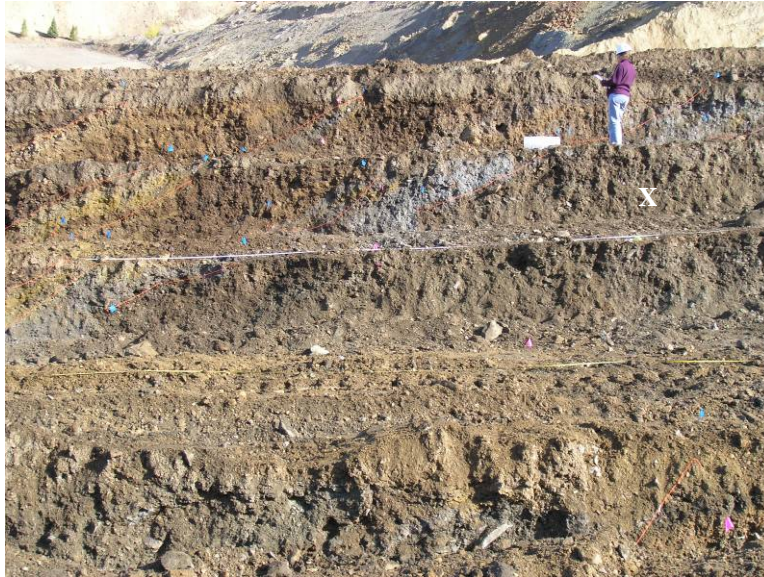


FIGURE A9-20. GHN-LFG-007–H008. Bench 12, in Unit O. Sample GHN-KMD-0018 was collected at location X.

HAND SAMPLE DESCRIPTION

Sample GHN-KMD-0051 is a bulk sample that consists of soil matrix and rock fragments that vary in size from 8 cm to less than 1 mm. It is light olive brown (2.5Y 5/3), Fe-oxide stained, poorly-sorted, low to medium plasticity gravel with clay. Rock fragments are sand to gravel sized, sub-angular, and smaller rock fragments are cemented together by the matrix. Epidote can be seen in the matrix and on grains (Fig. A9-21) but pyrite and gypsum are not visible. Mn and Fe-oxides are present in the sample forming in fractures and on rock fragments (Fig. A9-22). It has a SWI (Simple Weathering Index) of 2.

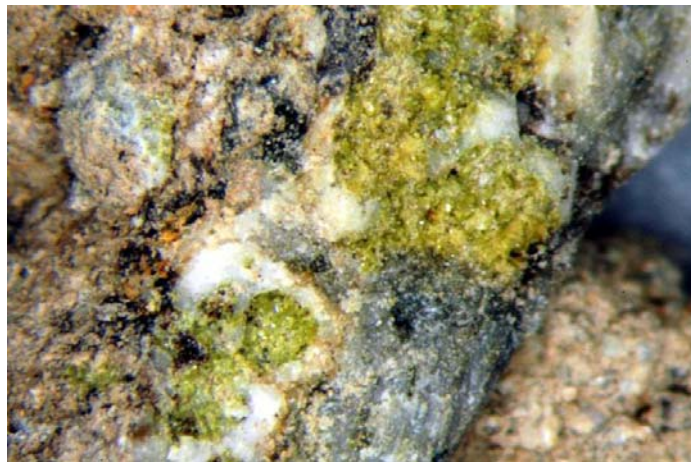


FIGURE A9-21. Epidote and quartz in rock fragments (GHN-KMD-051-T001). Field of view is 4 mm.

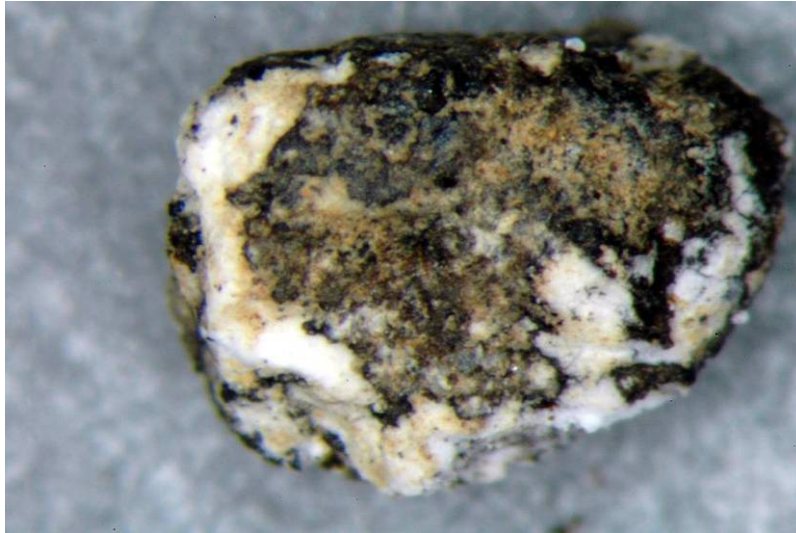


FIGURE A9-22. Rock fragment with Fe/Mn oxide with platy, detrital gypsum (GHN-KMD-051-T007). Field of view is 4 mm.

PETROGRAPHIC DESCRIPTION (using petrographic scope of soil sample)

Sample GHN-KMD-0051 consists of orange Fe-oxide stained, altered andesite (40%) and rhyolite (Amalia tuff, 60%), mostly QSP (~25%) and propylitic (~15%) alteration. Mn/Fe oxide rinds on some rock fragments. Chlorite is found as rare small green to black-green grains (up to 1mm). Epidote is found as rare small green crystals adhering to rock fragments and in vugs. There are small white calcite grains present in the sample. Gypsum is found as clear, euhedral, crystals; milky rounded grains; and fuzzy gypsum adhering to clasts. Pyrite is completely replaced by Fe oxides.

ELECTRON MICROPROBE DESCRIPTION

Sample GHN-KMD-0051 consists of variably altered rock fragments (andesite and Amalia Tuff). Matrix is clast-supported with clasts up to 500 microns. Quartz is abundant and seen as sub-rounded clasts, up to 300 microns in size, and often found with fine K-spar intergrowths. Some quartz grains are associated with albite and others are rarely found intergrown with epidote. K-spar and albite are common. Albite is seen as euhedral to subhedral grains, some with K-spar intergrowths (up to 100 microns in size). K-spar is observed as sub-rounded grains (up to 120 microns in size), some with small albite inclusions, and rarely seen with epidote and Fe-oxide inclusions; intergrown K-spar and quartz are common. Clay matrix is sparse and clasts are locally in contact. Most clasts are subrounded with some euhedral albite. Relatively abundant epidote and Fe-oxides; epidote is seen as subhedral to anhedral grains, up to 25 microns in size, and is found intergrown with K-spar and quartz grains. Rare Mn nodules observed. No carbonate or gypsum observed. Pyrite is very rare as tiny (<2 micron) grains. Matrix has mottled texture (Fig. A9-23). Altered rhyolite rock fragments (probably Amalia Tuff) contain abundant primary igneous textures and phenocrysts, and also contain clay minerals in sample groundmass. There is a moderate amount of clay present in groundmass and it is intergrown with Fe oxide in some places. Clays observed are primarily illite and chlorite. In addition to clay alteration, Fe-oxide veins cut the sample and along the outside edge of the rock fragment (Fig. A9-24). Cementation by Fe oxide is observed. Clay is present in a number of fractures in the rock fragments. Fe oxide is found as bladed forms in fractures (Fig. A9-

24). Quartz veining is present in sample and is crosscut by Fe oxide veining. Fe oxide grains show zoning (Fig. A9-25). In the sample rare rutile (~20 microns) and apatite grains are observed. Particle size distribution is shown in Figure A9-26.

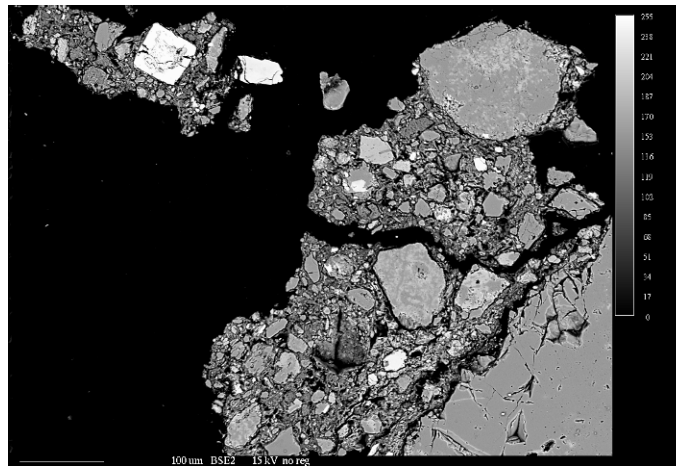


FIGURE A9-23. Backscattered electron microprobe image (BSE) showing clay matrix and Fe-oxides (GHN-KMD-0051-30-02).

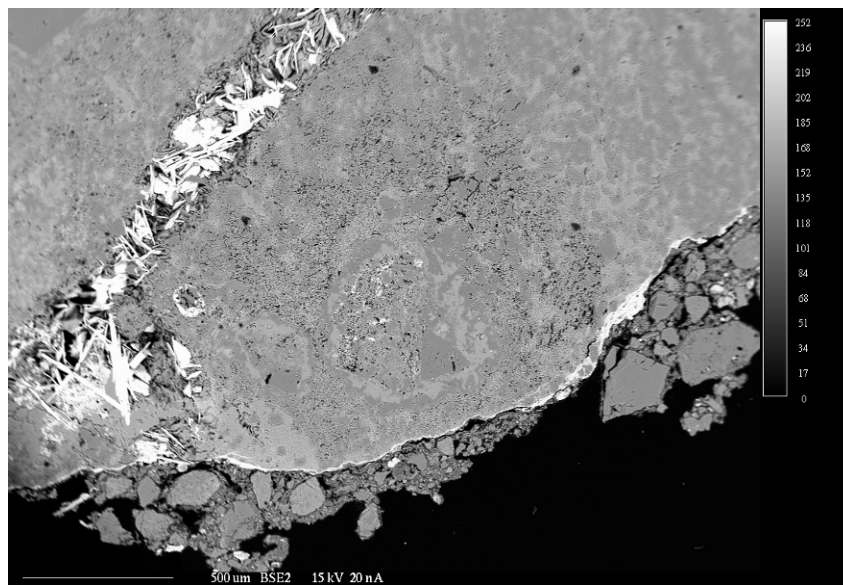


FIGURE A9-24. Backscattered electron microprobe image (BSE) showing Fe oxide veining along the edge and interior of rock fragment (GHN-KMD-0051-31-07).

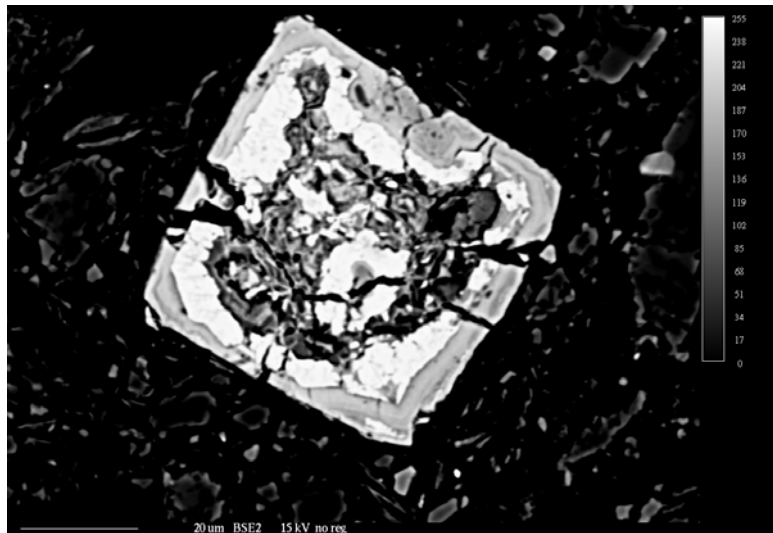


FIGURE A9-25. Backscattered electron microprobe image (BSE) showing altered iron oxide with zoned core and rim (GHN-KMD-0051-30-04).

LABORATORY ANALYSES

TABLE A9-9. Various laboratory analyses for sample GHN-KMD-0051.

Atterberg Limits	
LL	31.67
PL	17.37
PI	14.29
Paste pH	7.19
Paste Conductivity	2.94
NAG pH	8.51
NAG value	0

TABLE A9-10. Chemical and mineralogical analysis for sample GHN-KMD-0051.

Chemistry	Weight Percent	Mineralogy	Weight Percent
SiO ₂	67.83	Quartz	27
TiO ₂	0.59	K-spar/orthoclase	25
Al ₂ O ₃	14.44	Plagioclase	19
Fe ₂ O ₃ T	4.32	Albite	-
FeOT	-	Anorthite	-
FeO	2.22	Biotite	-
Fe ₂ O ₃	1.88	Clays/groundmass	-
MnO	0.29	Illite	8
MgO	1.8	Chlorite	4
CaO	1.94	Smectite	4
Na ₂ O	3.22	Kaolinite	2
K ₂ O	3.96	Mixed layered	-
P ₂ O ₅	0.16	Epidote	4
S	-	Magnetite	-
SO ₄	-	Fe oxides	2
C	-	Goethite	-
LOI	2.72	Hematite	-

Chemistry	Weight Percent	Mineralogy	Weight Percent
Total	102.65	Rutile	0.5
Trace elements	ppm	Apatite	0.4
Ba	963	Pyrite	0.2
Rb	99	Calcite	1.8
Sr	436	Gypsum	-
Pb	150.5	Detrital gypsum	0.01
Th	9.02	Auth gypsum	1.8
U	3.22	Zircon	0.04
Zr	204	Sphalerite	-
Nb	23	Molybdenite	-
Y	33.5	Fluorite	0.1
Sc	-	Jarosite	-
V	80	Copiapite	-
Ni	14	Other S minerals	-
Cu	54		
Zn	403		
Ga	33.8		
Cr	78		
F	709		

Particle Size Distribution

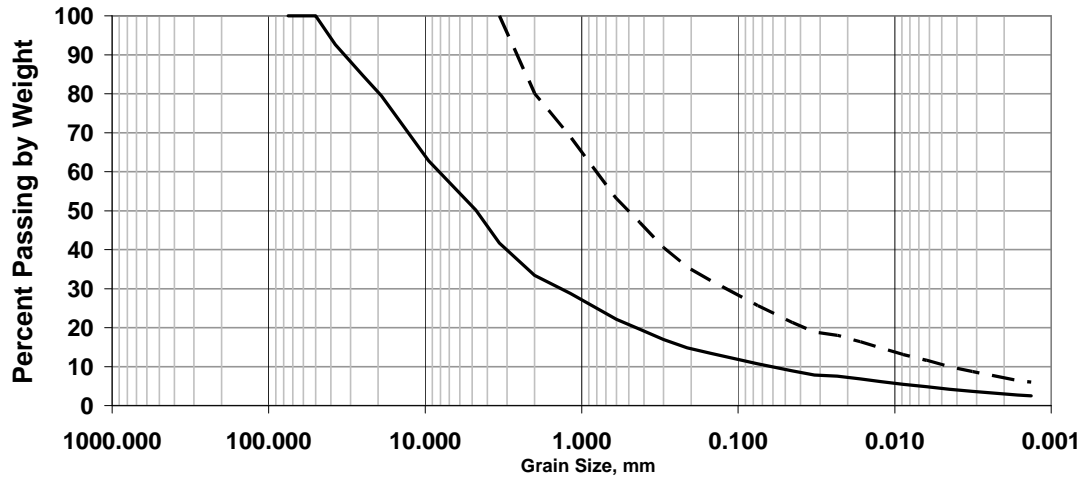


FIGURE A-26. Particle size distribution graph for sample GHN-KMD-0051. The solid line represents the whole sample as collected from the field and the dashed line represents the scalped sample that was used to measure friction angle in the NMIMT laboratory.

DESCRIPTION OF SAMPLE GHN-KMD-0053

LOCATION

This sample was collected at the Goathill North rock pile. The UTM coordinates of sample collection are 13N4062146, 453684.7E, and the sample was collected 9694 ft above sea level.

HAND SAMPLE DESCRIPTION

In hand sample the sample is tan to yellow to orange before rinsing and grey to brown to white to grey after rinsing; the cement is completely removed by rinsing. Orange Fe-oxide staining common, and some black Fe/Mn oxide rinds are visible as well. Rock fragments are composed of rhyolite (Amalia Tuff), range in sized from sand to boulder, and are sub-rounded to sub-angular; smaller rock fragments are well cemented together (Fig. A-27). Pyrite is not seen in hand sample but blades of authigenic gypsum are present (Fig. A-28).



FIGURE A9-27. Figure shows a well cemented rock fragments with Fe-oxide staining. Field of view is 2 cm.



FIGURE A9-28. Figure shows authigenic gypsum crystal in a rinsed matrix. Field of view is 1.5 cm.

MICROPROBE DESCRIPTION

Under the microprobe the sample is composed of moderately to highly altered Amalia Tuff rock fragments with little original igneous texture remaining. Quartz is present within Amalia rock fragments and as abundant individual matrix clasts; occasionally there are large quartz phenocrysts up to 1000+ microns in size. Feldspar is seen as finely intergrown K-spar and albite grains in matrix; some large relict K-spars are partially altered to clay and albite partially rims other K-spar phenocrysts. Epidote is rare, but is observed as small crystals adhering to rock fragments. The soil matrix appears to be dominantly composed of abundant clasts of Amalia Tuff, quartz, albite, K-spar fragments, and abundant tiny Fe-rich particles. There is a moderate amount of chlorite alteration within the groundmass and large K-spar phenocrysts are partially kaolinized. The matrix also contains some clusters and rare single crystals of pyrite, as well as some crystalline magnetite. There is some Fe-oxide cementation within the matrix and within quartz-rich clasts (Fig. A9-29). There is a moderate amount of Mn-oxide cement present along edge of

rock and as fracture filling (Fig. A9-30); some Mn-cement has a popcorn-like texture. Calcite is possibly present in the cement due to a weak reaction to HCl prior to rinsing. Pyrite is rare, but is seen as fine clusters within the matrix or as slightly altered, 50-micron large single grains in matrix. Abundant goethite is seen as tiny grains within the soil matrix with some larger granular clusters (to 100 microns), and a few crystalline grains up to 500 microns in size. The sample also contains several large euhedral magnetite phenocrysts with intricately zoned interiors (due to variable oxidization and hydration?). Rutile occurs as small isolated anhedral grains, as inclusions within K-spar phenocrysts, and some appear as needle-like clusters. Particle size distribution is shown in Figure A-31.

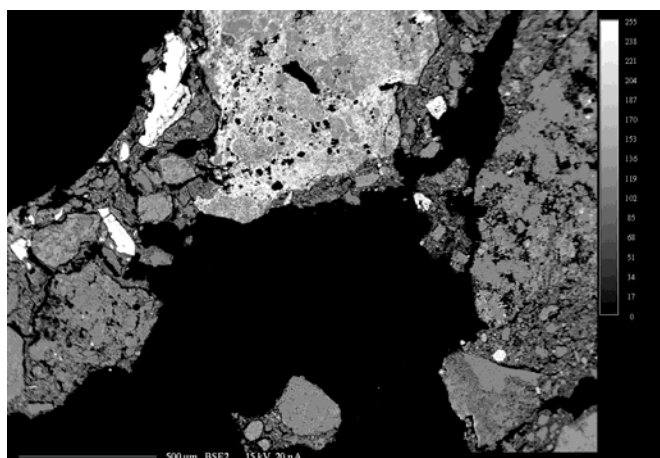


FIGURE A9-29. Microprobe image of Fe-rich cement supporting a clast-based matrix.

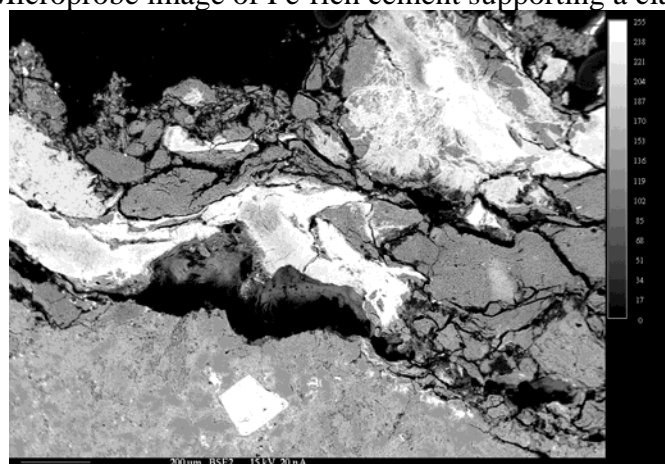


FIGURE A9-30. Microprobe image of Mn-rich cement (bright) running through a chloritized matrix. Euhedral magnetite is in bottom center.

LABORATORY ANALYSES

TABLE A9-11. Various laboratory analyses for sample GHN-KMD-0053.

Atterberg Limits	
LL	35.2
PL	17.96
PI	17.24
Paste pH	4.32
Paste Conductivity	2.84

NAG pH	6.26
NAG value	0

TABLE A9-12. Chemical and mineralogical analysis for sample GHN-KMD-0053.

Chemistry	Weight Percent	Mineralogy	Weight Percent
SiO ₂	70.62	Quartz	38
TiO ₂	0.33	K-spar/orthoclase	27
Al ₂ O ₃	12.82	Plagioclase	8
Fe ₂ O ₃ T	3.73	Albite	-
FeOT	-	Anorthite	-
FeO	1.9	Biotite	-
Fe ₂ O ₃	1.64	Clays/groundmass	-
MnO	0.3	Illite	15
MgO	0.91	Chlorite	2
CaO	0.53	Smectite	2
Na ₂ O	1.78	Kaolinite	2
K ₂ O	4.54	Mixed layered	-
P ₂ O ₅	0.06	Epidote	0.9
S	0.06	Magnetite	-
SO ₄	0.2	Fe oxides	3
C	0.07	Goethite	-
LOI	3.65	Hematite	-
Total	99.49	Rutile	0.2
Trace elements	ppm	Apatite	0.09
Ba	583	Pyrite	0.09
Rb	136	Calcite	0.6
Sr	165	Gypsum	-
Pb	67.1	Detrital gypsum	0.2
Th	15.87	Auth gypsum	0.4
U	4.31	Zircon	0.06
Zr	264	Sphalerite	-
Nb	33	Molybdenite	-
Y	56.4	Fluorite	0.2
Sc	-	Jarosite	0.5
V	42	Copiapite	-
Ni	0	Other S minerals	-
	Cu	86	
	Zn	416	
	Ga	37.1	
	Cr	34	
	F	961	

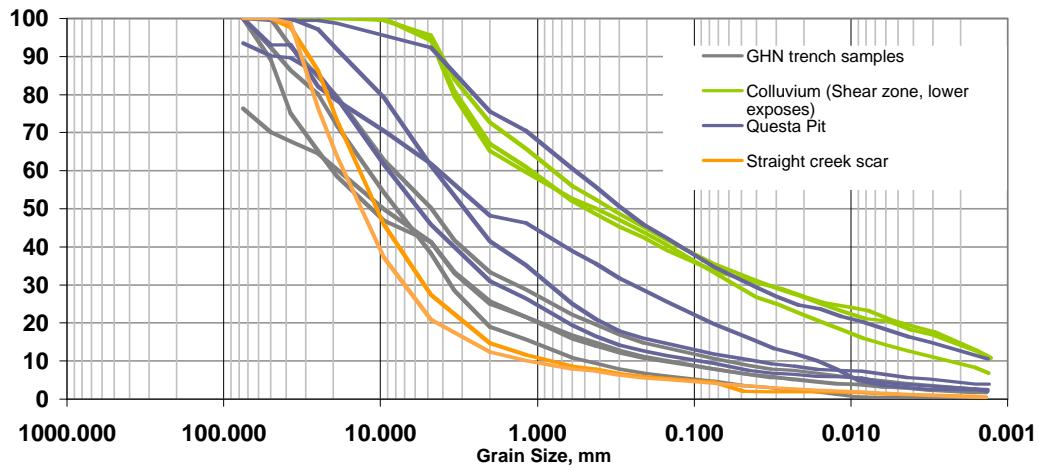


FIGURE A9-31. Particle size distribution for colluvium, the GHN rock pile, the Straight Creek scar, and the open pit at Questa.

DESCRIPTION OF SAMPLE GHN-KMD-0054

LOCATION

Sample GHN-KMD-0054 was collected from trench LFG-007, bench 12 in the Goathill North rock pile at UTM coordinates N4062146.3, 453682E, zone 13, elevation 9692.6 ft (Fig. A9-32). It was 18 ft from the outer edge of the rock pile.



FIGURE A9-32. Location of samples GHN-KMD-0054 and GHN-KMD-0055, bench 12, trench LFG-007, GHN rock pile.

HANDSAMPLE DESCRIPTION

The sample was from Unit J and was orange brown, poorly sorted, and angular to subangular grains.

PETROGRAPHIC DESCRIPTION

In thin section the sample appears as a slightly altered andesite rock that is clast dominated with a matrix of fine rock particles (Figs. A9-33, A9-34). Original igneous textures are present, but the groundmass has been altered. Quartz is present in the groundmass and as phenocrysts, it is also seen as large patches and veins. Sometimes the quartz is associated with epidote and rims some albite phenocrysts. There is abundant finely intergrown K-spar and albite in the matrix and some large albite phenocrysts (500+ microns). Some isolated epidote grains (50 microns) are seen within the matrix; there are also localized pockets of abundant epidote weathering out along edges of andesite rock fragments. The sample is typically fractured and partially altered. Some epidote occurs as inclusions within large albite phenocrysts. The matrix appears to consist of fine rock particles with a moderate amount of clay throughout groundmass (dominantly chlorite); in some areas large relic phenocrysts have been completely replaced by clay. In some areas chlorite forms a network and acts to cement framework grains. Some subhedral magnetite grains up to 100 microns are present in the sample, they are typically pitted, and some display a swiss cheese appearance (goethite). Some magnetites show intricate zonation, likely due to variable Fe-valance or partial silicification. The sample also contains a few isolated subhedral apatite grains (50 microns). Minor fractures are observed, and some are lined with clay minerals. The matrix contains some Fe and Fe/Mn oxide cements, and there is a network of chlorite filled fractures present in some areas.

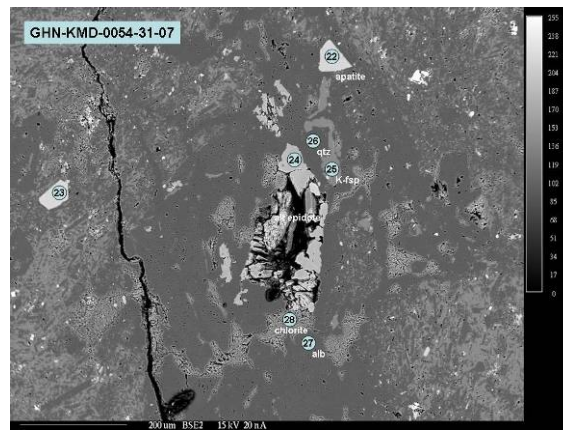


FIGURE A9-33. Electron microprobe backscatter image shows partially dissolved epidote phenocrysts and apatite.

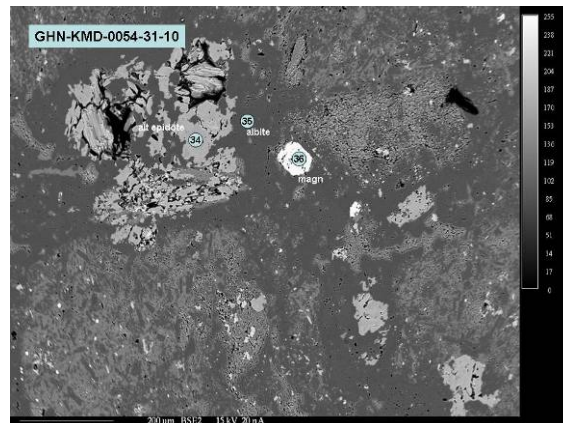


FIGURE A9-34. Electron microprobe backscatter image shows altered epidote phenocrysts and euhedral magnetite.

LABORATORY ANALYSES

The laboratory results for mineralogy and chemistry are summarized in Tables A9-13 and A9-14.

TABLE A9-13. Various laboratory analyses for sample GHN-KMD-0054.

Paste pH	3.93
Paste Conductivity	6.05
Paste TDS	3.03
AP	4.94
NP	7.99
Net NP	3.05
NPAP	1.62
QMWI	5
SWI	4
LL	37.9
PL	23.4
PI	14.4

TABLE A9-14. Chemical and mineralogical analysis for sample GHN-KMD-0054.

Element	Weight %	Mineralogy	Weight %
SiO ₂	62.74	description	Unit J
TiO ₂	0.73	quartz	28
Al ₂ O ₃	14.19	K-feldspar/orthoclase	24

Element	Weight %	Mineralogy	Weight %
FeOT	4.74	plagioclase	17
MnO	0.24	illite	12
MgO	2.33	chlorite	6
CaO	2.19	smectite	1
Na2O	2.7	kaolinite	1
K2O	3.64	epidote	5
P2O5	0.32	magnetite	
S	0.25	Fe oxides	3
SO4	0.23	goethite	
C	0.05	hematite	
LOI	4.2	rutile	0.6
Total	99.02	apatite	0.8
Trace elements	Parts per million	pyrite	0.5
Ba	1180	calcite	0.5
Rb	98	gypsum	1
Sr	496	detrit gypsum	
Pb	242	auth gypsum	
Th	9	zircon	0.03
U	4	sphalerite	
Zr	181	molybdenite	
Nb	14	fluorite	

Y	23
Sc	9
V	87
Ni	48
Cu	61
Zn	374
Ga	20
Cr	71
F	1013
La	44
Ce	100
Nd	54

DESCRIPTION OF SAMPLE GHN-KMD-0055

LOCATION

Sample GHN-KMD-0055 was collected from trench LFG-007, bench 12 in the Goathill North rock pile at UTM coordinates N4062146.5, 453676.5E, zone 13, elevation 9691.3 ft (Fig. A9-35). It was 1 ft from the outer edge of the rock pile.

HANDSAMPLE DESCRIPTION

The sample was from Unit I and was yellow brown, poorly sorted, and angular to subangular grains. There is limited cohesion prior to rinsing.

PETROGRAPHIC DESCRIPTION

Sample is pale yellow, with coatings, and consists of 100% andesite with 50% QSP alteration (Figs. A9-36, A9-37). Sample is dominantly clast supported, which are variably altered. Some quartz and pyrite essentially unaltered. Quartz is fairly abundant in the sample as is seen as subangular to subrounded clasts up to 500 microns in size; quartz is also present in the groundmass. Some large clasts of intergrown quartz and K-spar are present as well as some K-spar clasts. Albite and potassic feldspar are both present in the matrix. Abundant epidote is present in the sample and in a number of places epidote is surrounded by potassic feldspar, however little to no epidote or mafic silicates were noted in the groundmass. The soil matrix dominantly consists of fine rock fragments and clay. Clay is present as phenocryst replacements and is finely dispersed in the groundmass. Clay is mostly chloritic, with some illite in a few places. There are tabular voids present in the matrix, which may be relict gypsum casts. Minor apatite is seen as tiny isolated grains in matrix. Minor Mn oxides are seen in the sample as tiny dispersed particles. The sample is unfractured. There is no carbonate or gypsum cement, and the majority of the matrix consists of fine rock fragments with some clay. The edge of the sample shows evidence of Fe deposition, which is likely Fe oxide. The sample itself contains clay, but it is finely dispersed and is not very abundant. No carbonate was noted in the sample. Pyrite is fairly abundant and is seen in the sample as somewhat pitted and fractured but otherwise appear unaltered. Pyrite grain shapes appear as irregular, slightly rounded and euhedral. Individual pyrite grains are seen as large grains grown together in clusters, or as individual crystals up to 400 microns in size.

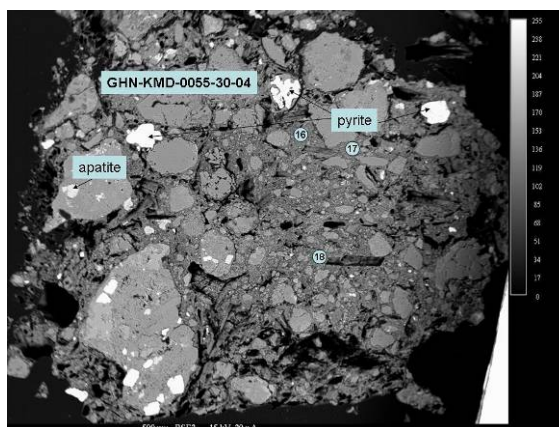


FIGURE A9-35. Electron microprobe backscatter image shows clay matrix and possible gypsum clasts.

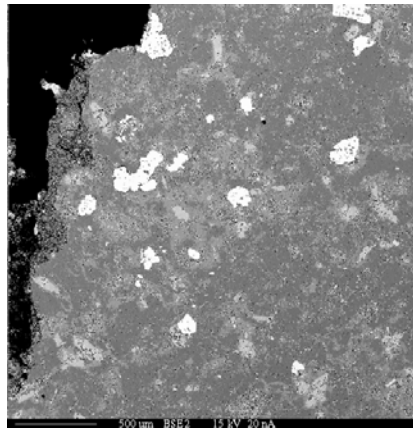


FIGURE A9-36. Electron microprobe backscatter image shows clay matrix with pyrite (GHN-KMD-0055-31BSE2).

CLAY MINERALOGY

The clay mineralogy was obtained by XRD on an oriented glass slide (Moore and Reynolds, 1989; Hall, 2004) and represents the soil matrix only. The clay mineral composition of sample GHN-KMD-0055 in parts per ten (ppt) consist of 1 ppt kaolinite, 1 ppt chlorite, 4 ppt illite, 1 ppt smectite, and 3 ppt mixed layered clays. The actual abundance of clay minerals in the entire sample (rock fragments and soil matrix is in Table 1-10.

LABORATORY ANALYSES

The laboratory results for mineralogy and chemistry are summarized in Tables A9-15 and A9-16.

TABLE A9-15. Various laboratory analyses for sample GHN-KMD-0055.

Paste pH	4.27
Paste Conductivity	5.84
Paste TDS	2.93
AP	15.03
NP	0
Net NP	-15.03
NPAP	0
QMWI	5
SWI	4
LL	30
PL	24.7
PI	5.3

TABLE A9-16. Chemical and mineralogical analysis for sample GHN-KMD-0055.

Element	Weight %	Mineralogy	Weight %
SiO ₂	71.86	description	Unit I
TiO ₂	0.27	quartz	48
Al ₂ O ₃	12.19	K-feldspar/orthoclase	14
FeOT	3.17	plagioclase	-
MnO	0.06	illite	28
MgO	0.63	chlorite	2
CaO	0.76	smectite	1
Na ₂ O	0.38	kaolinte	1

Element	Weight %	Mineralogy	Weight %
K2O	3.88	epidote	-
P2O5	0.1	magnetite	-
S	1.97	Fe oxides	0.7
SO4	0.46	goethite	
C	0.06	hematite	
LOI	5.04	rutile	0.3
Total	101.15	apatite	0.2
Trace elements		pyrite	3
Ba	238	calcite	0.5
Rb	127	gypsum	1
Sr	51	detrit gypsum	
Pb	102	auth gypsum	
Th	15	zircon	0.04
U	4	sphalerite	
Zr	255	molybdenite	
Nb	26	fluorite	0.03
Y	51	jarosite	1

Sc	4
V	37
Ni	18
Cu	146
Zn	137
Ga	19
Cr	24
F	2445
La	58
Ce	112
Nd	50

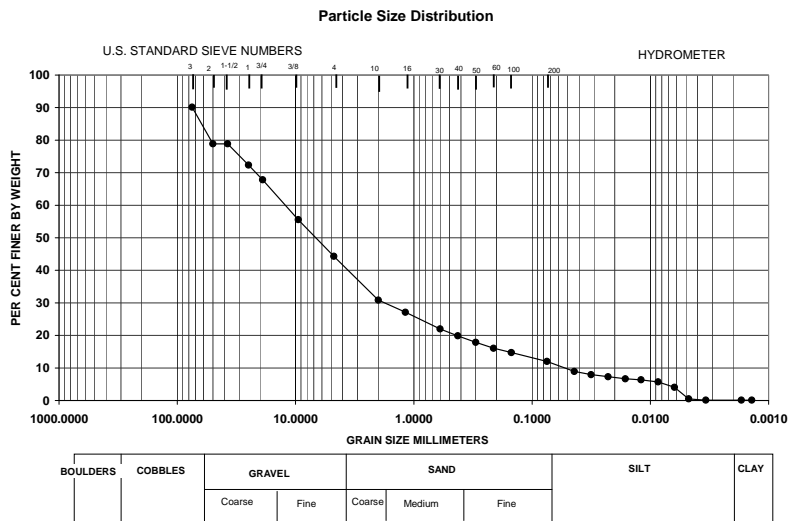


FIGURE A9-37. Gradation curve for sample GHN-KMD-0055.

DESCRIPTION OF SAMPLE GHN-KMD-0062

LOCATION

Sample GHN-KMD-0062 was collected from trench LFG-007, bench 14 in the Goathill North rock pile at UTM coordinates N4062140.5, 453682.4E, zone 13, elevation 9689.8 ft (Fig. A9-38). It was 23 ft from the outer edge of the rock pile.



FIGURE A9-38. Location of sample GHN-KMD-0062, bench 14, trench LFG-007, GHN rock pile.

HANDSAMPLE DESCRIPTION

The sample was from Unit N and was brown, poorly sorted, sandy gravel with clay, and angular to subangular grains. It consisted of andesite grains.

PETROGRAPHIC DESCRIPTION

Sample is mainly composed of rock fragments 10-500 microns in size in a sparse clay matrix with some larger rock fragments (Figs. A9-39, A9-40). Clay matrix has mottled appearance and abundant clasts. Quartz is present as subangular grains up to 250 microns in size, quartz is also seen finely intergrown with K-spar, and it is abundant in the matrix. Feldspar is also seen as intergrown albite and K-spar in grains up to 500 microns in size; there are also some large (1000+ microns) relic K-spar phenocrysts that have largely altered to clay. Fe/Mg silicates and Fe silicates are common as grains up to 150 microns in size. No epidote was seen in the sample. Clay is abundant throughout the matrix and replacing portions of large relict K-spar phenocrysts; most of the clay is adhering to rock fragments. Fe/Mn oxides are present as anhedral altered grains up to 20 microns in size.

Apatite is present as small (up to 100 micron) isolated euhedral to subeuhedral crystals. In the sample there is a moderate degree of fracturing. Fractures are largely void, but there are rare instances where fractures are filled by Fe-oxides. The sample is cemented

by abundant clay dispersed throughout the matrix along with fine rock fragments. No carbonate was observed in the sample. Pyrite is rare in the sample, but when present it is normally 10-30 microns in size and subhedral to anhedral in shape; some pyrite appears altered but has retained its sulfur. In the sample there are also some Fe and Ti oxides present, mainly as small isolated grains, and there are a few larger Fe oxides crystals with inclusions of apatite as well.

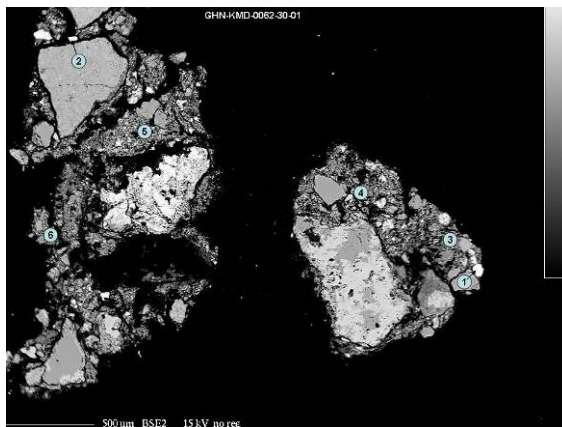


FIGURE A9-39. Electron microprobe backscatter image shows clay matrix.

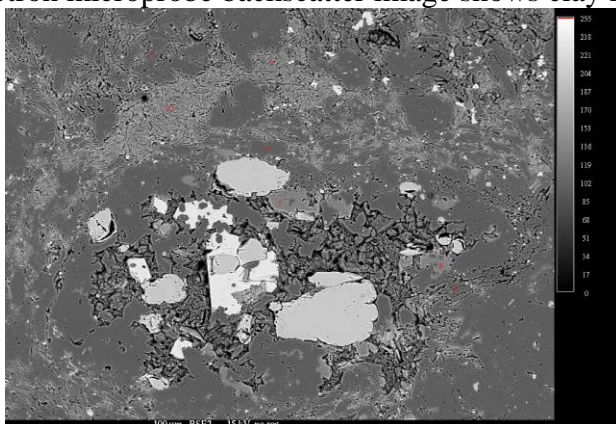


FIGURE A9-40. Electron microprobe backscatter image shows clay matrix and pyrite grain (bright area) (GHN-KMD-0062-31-05).

CLAY MINERALOGY

The clay mineralogy was obtained by XRD on an oriented glass slide (Moore and Reynolds, 1989; Hall, 2004) and represents the soil matrix only. The clay mineral composition of sample GHN-KMD-0062 in parts per ten (ppt) consist of 1 ppt kaolinite, 3 ppt chlorite, 2 ppt illite, 2 ppt smectite, and 2 ppt mixed layered clays. The actual abundance of clay minerals in the entire sample (rock fragments and soil matrix is in Table A9-16.

LABORATORY ANALYSES

The laboratory results for mineralogy and chemistry are summarized in Tables A9-17 and A9-18.

TABLE A9-17. Various laboratory analyses for sample GHN-KMD-0062.

Paste pH	4.43
Paste Conductivity	3.79

Paste TDS	1.89
AP	2.97
NP	1.95
Net NP	-1.02
NPAP	0.66
QMWI	6
SWI	3
LL	35.6
PL	20.4
PI	15.1

TABLE A9-18. Chemical and mineralogical analysis for sample GHN-KMD-0062.

Element	Weight %	Mineralogy	Weight %
SiO ₂	67.01	description	Unit N
TiO ₂	0.49	quartz	35
Al ₂ O ₃	13.66	K-feldspar/orthoclase	21
FeOT	4.79	plagioclase	10
MnO	0.442	illite	20
MgO	1.35	chlorite	3
CaO	0.51	smectite	2
Na ₂ O	1.8	kaolinite	1
K ₂ O	4.18	epidote	
P ₂ O ₅	0.2	magnetite	
S	0.02	Fe oxides	5
SO ₄	0.24	goethite	
C	0.12	hematite	
LOI	4.72	rutile	0.3
Total	100.01	apatite	0.2
Trace elements		pyrite	0.01
Ba	833	calcite	1
Rb	129	gypsum	0.1
Sr	222	detrit gypsum	
Pb	118	auth gypsum	
Th	10	zircon	0.04
U	4	sphalerite	
Zr	25	molybdenite	
Nb	22.1	fluorite	
Y	46	jarosite	1
Sc			5
V			54
Ni			33
Cu			123
Zn			386
Ga			21
Cr			41
F			1032
La			59
Ce			121
Nd			66

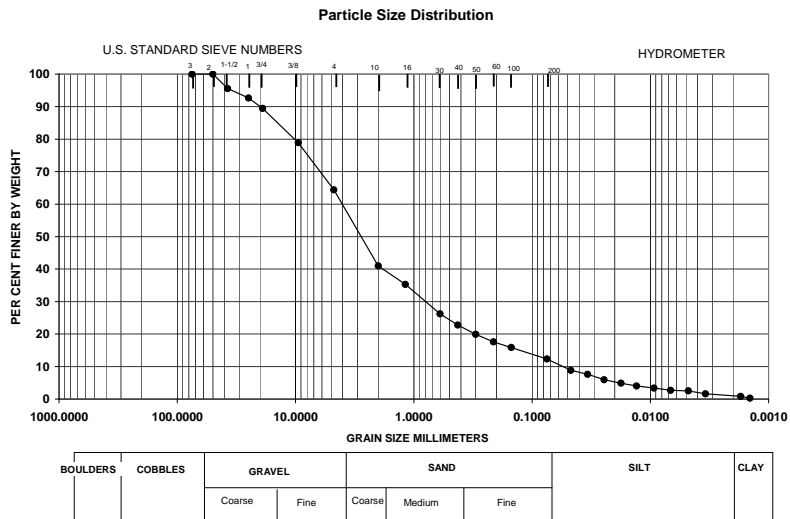


FIGURE A9-41. Gradation curve for sample GHN-KMD-0062.

DESCRIPTION OF SAMPLE GHN-KMD-0063

LOCATION

Sample GHN-KMD-0063 was collected from trench LFG-007, bench 14 in the Goathill North rock pile at UTM coordinates N 4062140.7, 453677.2E, zone 13, elevation 9688.1 ft (Fig. A9-42). It was 6 ft from the outer edge of the rock pile.



FIGURE A9-42. Location of sample GHN-KMD-0063 (X), bench 14, trench LFG-007, GHN rock pile.

HANDSAMPLE DESCRIPTION

The sample was from Unit J and was orange brown, poorly sorted, clayey gravel with sand, and angular to subangular grains. It consisted of andesite grains.

PETROGRAPHIC DESCRIPTION

This is a matrix-poor soil sample consisting of rock fragments with some surrounding clay-rich matrix (Fig. A9-43, A9-44). The most notable thing about this sample is that it contains large clusters of Fe-oxides as part of individual grains. Some clusters are up to 500 microns in size. The sample is a highly altered andesitic rock sample. Quartz is present in rock fragments and as particles in the groundmass. Feldspar is present in rock fragments and as particles in the groundmass; both albite and potassic feldspar are present. Moderately abundant epidote is present in rock fragments and in the matrix as granular clusters associated with clay minerals. Clay is present in matrix and consists of either chlorite, a chlorite-illite mix, or as a mixture of clay and Fe-oxides. Clay also occurs in relict phenocrysts and is associated with epidote. Gypsum is seen as lathes that are 100-200 microns in length. There is a low degree of fracturing, fractures are small with no apparent clay infilling. Abundant Fe oxide is present in some grains, and this appears to cause cementation of associated clays, but does not cause extensive cementation of the sample as a whole. When observed in BSE, the Fe oxide areas exhibit variable composition.

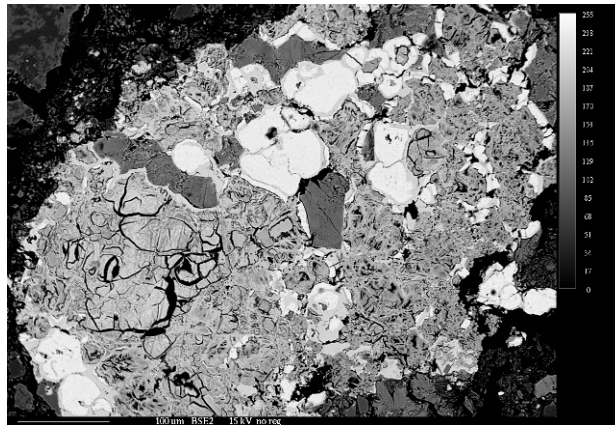


FIGURE A9-43. Electron microprobe backscatter image shows Fe oxide and clay matrix (GHN-KMD-0063-30-07).

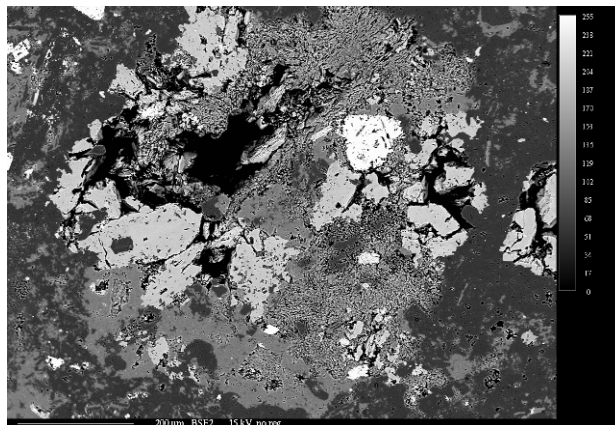


FIGURE A9-44. Electron microprobe backscatter image shows clay matrix and epidote crystal (GHN-KMD-0063-31-06).

CLAY MINERALOGY

The clay mineralogy was obtained by XRD on an oriented glass slide (Moore and Reynolds, 1989; Hall, 2004) and represents the soil matrix only. The clay mineral composition of sample GHN-KMD-0063 in parts per ten consist of 1 kaolinite, 2 chlorite, 3 illite, 2 smectite, and 2 mixed layered clays. The actual abundance of clay minerals in the entire sample (rock fragments and soil matrix is in Table A9-18.

LABORATORY ANALYSES

The laboratory results for mineralogy and chemistry are summarized in Tables A9-19 and A9-20.

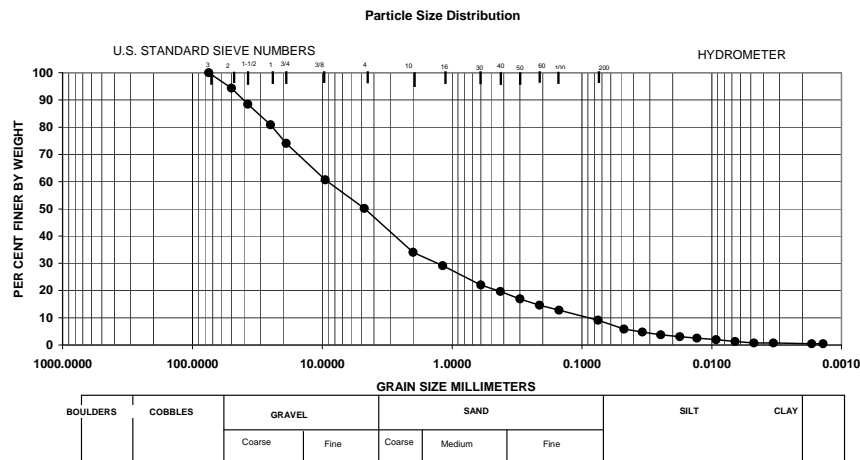
TABLE A9-19. Various laboratory analyses for sample GHN-KMD-0063.

Paste pH	3.95
Paste Conductivity	5.24
Paste TDS	2.63
AP	10.78
NP	3.92
Net NP	-6.96
NPAP	0.36
QMWI	6
SWI	4
LL	38.4
PL	22.1
PI	16.4

TABLE A9-20. Chemical and mineralogical analysis for sample GHN-KMD-0063.

Element	Weight %	Mineralogy	Weight %
SiO ₂	64.27	Description	Unit J
TiO ₂	0.62	Quartz	33
Al ₂ O ₃	13.64	K-feldspar/orthoclase	16
FeOT	5.38	plagioclase	13
MnO	0.166	illite	20
MgO	1.89	chlorite	5
CaO	1.25	smectite	2
Na ₂ O	2	kaolinite	2
K ₂ O	3.79	epidote	0.1
P ₂ O ₅	0.22	magnetite	
S	0.55	Fe oxides	4
SO ₄	0.75	goethite	
C	0.04	hematite	
LOI	5.97	rutile	0.5
Total	101.07	apatite	0.3
Trace elements		pyrite	1
Ba	977	calcite	0.2
Rb	118	gypsum	2
Sr	295	detrit gypsum	
Pb	117	auth gypsum	
Th	9	zircon	0.03
U	3	sphalerite	
Zr	185	molybdenite	

Element	Weight %	Mineralogy	Weight %
Nb	16	fluorite	
Y	27	jarosite	1.6
	Sc	8	
	V	80	
	Ni	32	
	Cu	42	
	Zn	213	
	Ga	21	
	Cr	61	
	F	1318	
	La	52	
	Ce	99	
	Nd	44	



clays have replaced all the pyrite. Calcite is possibly present in the sample in a very small amount associated with the cement, but there was no reaction to HCl after rinsing.



FIGURE A9-46. Figure shows grains of authigenic gypsum and magnetite. Field of view is 5 mm.

MICROPROBE DESCRIPTION

Under the microprobe the sample is a pervasively altered andesite rock. Quartz is abundant in groundmass and is finely intergrown with feldspar. Albite occurs in groundmass, and some areas of albite concentration may be the remains of large feldspar phenocrysts. Epidote is present throughout the sample as large clots in some places, and is intergrown with clay and Fe-oxides in other areas. Large gypsum crystals are observed in sample, but there is no apparent gypsum cementation (Fig. A9-47). Abundant clay is present within the matrix. There are large areas of intense alteration that may be relict phenocrysts; epidote, clay minerals, Fe-oxides, and some rutile replace these phenocrysts. Several compositions of clay appear to be present. Geochemically, the clay minerals represented appear to be illite and chlorite. Some areas appear to be end-member concentrations, but many areas represent a mixture between the phases. Minor fracturing occurs within the sample. There is little cementation of the sample except around the very margin of sample where some Mn mineralization, or where rare Fe-oxide cementation is observed (Fig A9-48). A small amount of apatite is seen, and rutile is intergrown with Fe-oxide grains. Particle size distribution is shown in Figure A9-49.

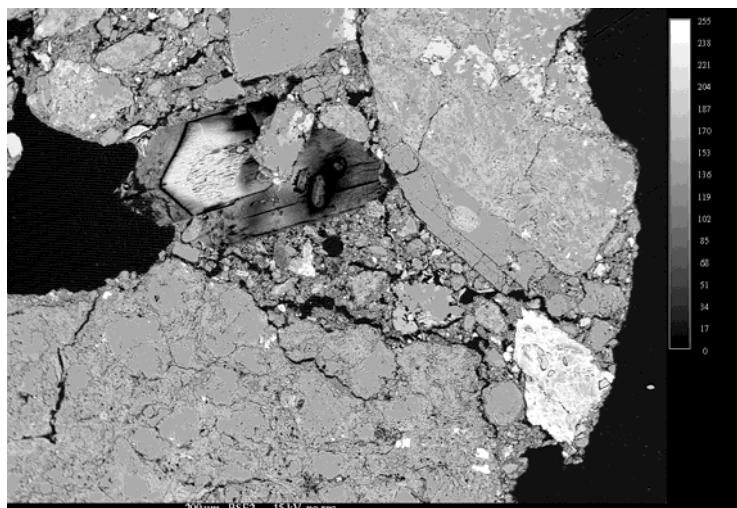


FIGURE A9-47. Figure shows authigenic gypsum crystal in upper center of the image, which is cemented in between two rock fragments.

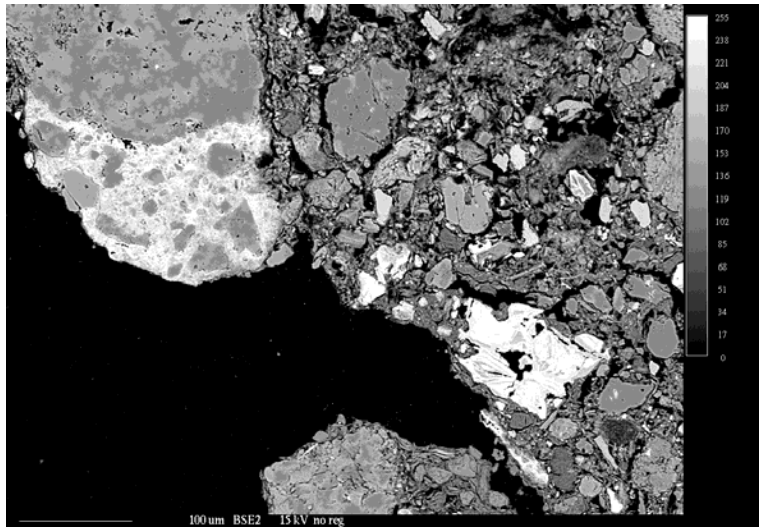


FIGURE A9-48. Figure shows rock fragments cemented together with Fe-oxides (bright areas) and clay matrix.

LABORATORY ANALYSES

TABLE A9-21. Various laboratory analyses for sample GHN-KMD-0065.

Atterberg Limits	
LL	35.34
PL	18.36
PI	16.98
Paste pH	5.77
Paste Conductivity	1.45

TABLE A9-22. Chemical and mineralogical analysis for sample GHN-KMD-0065.

Chemistry	Weight Percent	Mineralogy	Weight Percent
SiO ₂	66.82	Quartz	29
TiO ₂	0.66	K-spar/orthoclase	22
Al ₂ O ₃	14.69	Plagioclase	17
Fe ₂ O ₃ T	6.12	Albite	-
FeOT	-	Anorthite	-
FeO	3.4	Biotite	0.01
Fe ₂ O ₃	2.38	Clays/groundmass	-
MnO	0.52	Illite	14
MgO	2.15	Chlorite	5
CaO	1.29	Smectite	2
Na ₂ O	2.76	Kaolinite	2
K ₂ O	3.73	Mixed layered	-
P ₂ O ₅	0.2	Epidote	3
S	0.05	Magnetite	-
SO ₄	0.06	Fe oxides	5
C	0.03	Goethite	-
LOI	3.59	Hematite	-
Total	104.86	Rutile	0.4
Trace elements	ppm	Apatite	0.5
Ba	1124	Pyrite	0.09
Rb	99	Calcite	0.4
Sr	376	Gypsum	-
Pb	121.8	Detrital gypsum	0.2
Th	9.9	Auth gypsum	0.1
U	2.91	Zircon	0.04
Zr	194	Sphalerite	-
Nb	20	Molybdenite	-
Y	35.6	Fluorite	0.2
Sc		Jarosite	-
V	87	Copiapite	-
Ni	46	Other S minerals	-
	Cu	190	
	Zn	552	
	Ga	40.7	
	Cr	79	
	F	1206	

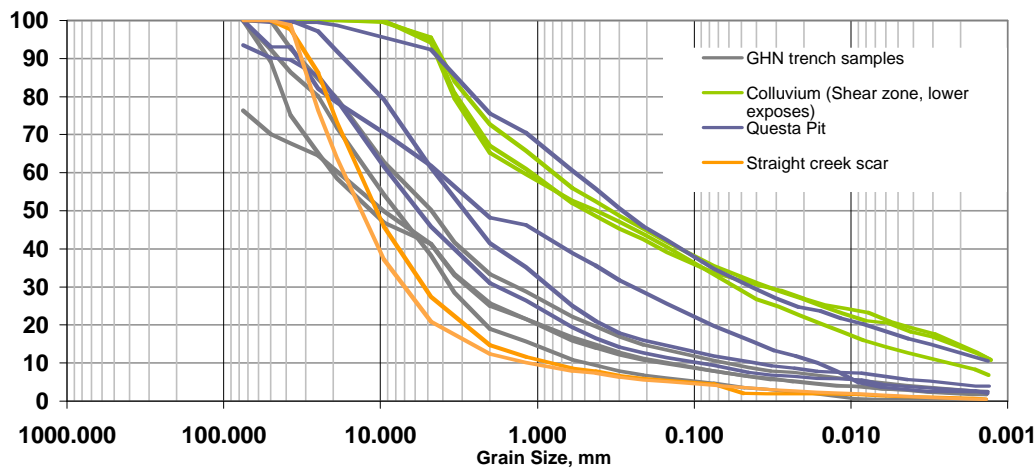


FIGURE A9-49. Particle size distribution for colluvium, the GHN rock pile, the Straight Creek scar, and the open pit at Questa.

DESCRIPTION OF SAMPLE GHN-KMD-0076

LOCATION

This sample was collected at the Goathill North rock pile. The UTM coordinates of sample collection are 13N4062134, 453671.7E, and the sample was collected 9644 ft above sea level. No petrographic data was collected for this sample.

DESCRIPTION OF SAMPLE GHN-LFG-0001

LOCATION

This sample was collected at the Goathill North rock pile. The UTM coordinates of sample collection are 13N4062510, 453253E, and the sample was collected 9020 ft above sea level. No petrographic data was collected for this sample.

LABORATORY ANALYSES

TABLE A9-23. Various laboratory analyses for sample GHN-LFG-0001.

Atterberg Limits	
LL	35.43
PL	20.05
PI	15.38
Paste pH	3.2
Paste Conductivity	1.419

TABLE A9-24. Chemical and mineralogical analysis for sample GHN-LFG-0001.

Chemistry	Weight Percent	Mineralogy	Weight Percent
SiO ₂	67.64	Quartz	41

Chemistry	Weight Percent	Mineralogy	Weight Percent
TiO2	0.63	K-spar/orthoclase	6
Al2O3	15.63	Plagioclase	-
Fe2O3T	1.65	Albite	-
FeOT	1.50	Anorthite	-
FeO	0.39	Biotite	-
Fe2O3	1.22	Clays/groundmass	-
MnO	0.01	Illite	44
MgO	0.55	Chlorite	1
CaO	0.79	Smectite	0.9
Na2O	0.10	Kaolinite	0.9
K2O	4.38	Mixed layered	-
P2O5	0.08	Epidote	-
S	0.01	Magnetite	-
SO4	0.75	Fe oxides	0.9
C	0.08	Goethite	-
LOI	5.17	Hematite	-
Total	97.46	Rutile	0.6
Trace elements	ppm	Apatite	0.09
Ba	879.3	Pyrite	0.02
Rb	103.9	Calcite	0.6
Sr	34	Gypsum	-
Pb	17.7	Detrital gypsum	0.9
Th	12.9	Auth gypsum	-
U	3.7	Zircon	0.04
Zr	252	Sphalerite	-
Nb	27.5	Molybdenite	-
Y	19	Fluorite	0.3
Sc	6	Jarosite	3
V	56	Copiapite	-
Ni	2.7	Other S minerals	-
	Cu	8.8	
	Zn	16.7	
	Ga	20	
	Cr	8.2	
	F	1130	
	REE	ppm	
	La	51.6	
	Ce	89.6	
	Nd	34.4	

DESCRIPTION OF SAMPLE GHN-KMD-0079

LOCATION

Sample GHN-KMD-0079 was collected from trench LFG-008, bench 18 in the Goathill North rock pile at UTM coordinates N 4062137.5, 453679.3E, zone 13, elevation 9651.9 ft (Fig. A9-50). It was 99 ft from the outer edge of the rock pile.

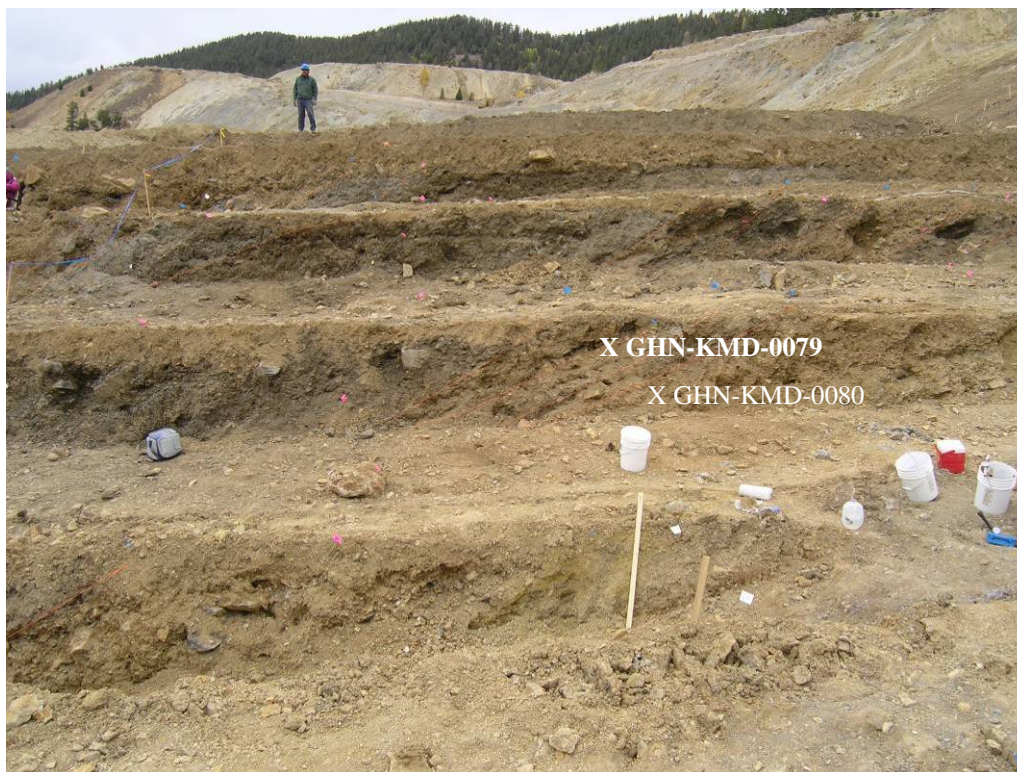


FIGURE A9-50. Location of samples GHN-KMD-0079 and GHN-KMD-0080, bench 18, trench LFG-008, GHN rock pile (photograph GHN-LFG-008-H011).

HANDSAMPLE DESCRIPTION

The sample was from Unit U and was medium brown to orange, poorly sorted, clay to large cobble, and angular to subangular grains. It consisted of andesite grains.

PETROGRAPHIC DESCRIPTION

The sample is light olive brown, abundant staining, and contains 80% andesite and 20% rhyolite (Amalia Tuff) with 50% QSP, 7% prophyllitic, and 3% argillic alteration (Fig. A9-51, A9-52). It is a clast rich sample and the soil matrix is composed of a mixture of fine particles with localized clay rich areas. Quartz is abundant within the groundmass of andesite rock fragments, as well as phenocrysts within Amalia Tuff clasts, veins, and as loose fragments in the soil matrix. Feldspar is mainly seen as intergrown albite and K-spar laths, as well as large albite phenocrysts within andesite rock fragments. Some feldspar fragments are seen in the soil matrix. There are large micaceous mafic silicates (1+mm) in the sample with inclusions of altered pyrite and apatite within Amalia rock fragments. Moderate amount of Fe-oxides (goethite) is present as grains in soil matrix, as vein filling and coatings on rock fragments, and as replacements within euhedral cubic crystals (possibly relict pyrite or magnetite), particularly within the Amalia rock fragments. Epidote and jarosite present in some rock fragments and as loose grains in soil matrix.

Minor large mica phenocrysts within some rock fragments. No pyrite or carbonate was observed in the sample.

CLAY MINERALOGY

The clay mineralogy was obtained by XRD on an oriented glass slide (Moore and Reynolds, 1989; Hall, 2004) and represents the soil matrix only. The clay mineral composition of sample GHN-KMD-0079 in parts per ten consist of 1 kaolinite, 3 chlorite, 3 illite, 3 smectite, and 0 mixed layered clays. The actual abundance of clay minerals in the entire sample (rock fragments and soil matrix is in Table 1-20).

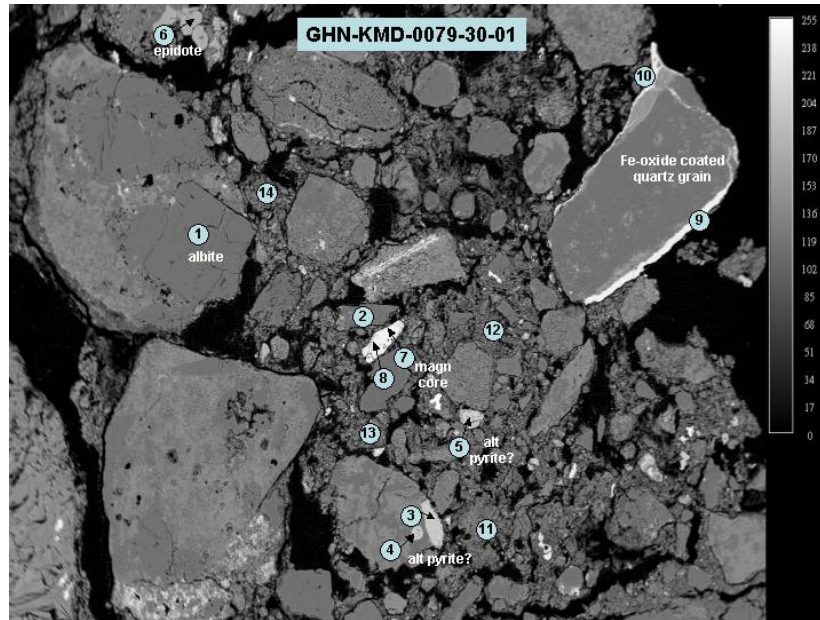


FIGURE A9-51. Electron microprobe backscatter image of soil matrix of sample GHN-KMD-0079-30-01.

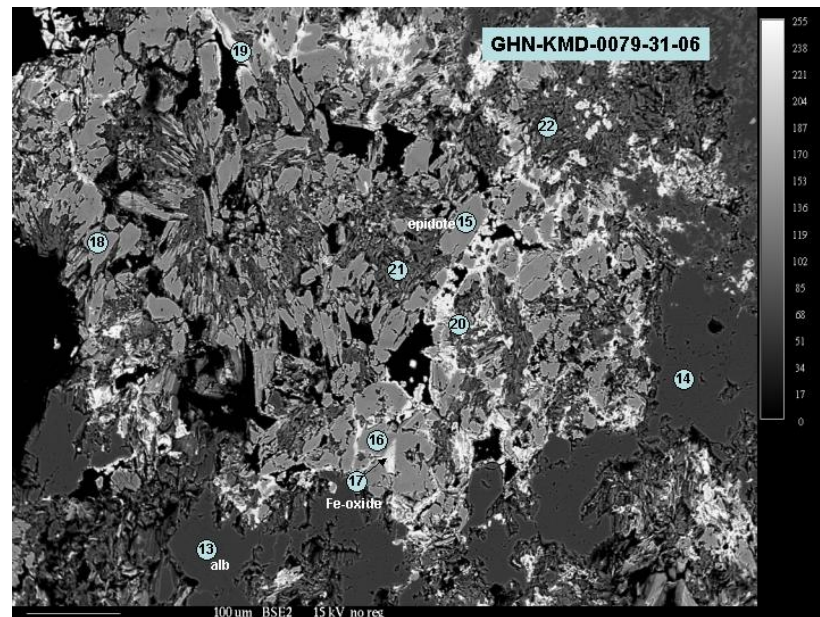


FIGURE A9-52. Electron microprobe backscatter image of sample GHN-KMD-0079-31-06 showing epidote and clay minerals replacing phenocrysts.

LABORATORY ANALYSES

The laboratory results for mineralogy and chemistry are summarized in Tables A9-25 and A9-26.

TABLE A9-25. Various laboratory analyses for sample GHN-KMD-0079.

Paste pH	3.07
Paste Conductivity	3.98
Paste TDS	1.99
AP	4.79
NP	9.6
Net NP	4.81
NPAP	2
QMWI	6
SWI	2
LL	32.7
PL	18.3
PI	14.4

TABLE A9-26. Chemical and mineralogical analysis for sample GHN-KMD-0079.

Element	Weight %	Mineralogy	Weight %
SiO ₂	67.58	Description	Unit U
TiO ₂	0.55	quartz	31
Al ₂ O ₃	14.22	K-feldspar/orthoclase	23
FeOT	4.14	plagioclase	17
MnO	0.23	illite	13
MgO	1.49	chlorite	4
CaO	1.26	smectite	3
Na ₂ O	2.8	kaolinite	1
K ₂ O	3.82	epidote	2
P ₂ O ₅	0.16	magnetite	
S	0.15	Fe oxides	4
SO ₄	0.17	goethite	
C	0.05	hematite	
LOI	3.21	rutile	0.4
Total	100.25	apatite	0.4
Trace elements		pyrite	0.3
Ba	1027	calcite	0.5
Rb	109	gypsum	0.8
Sr	305	detrit gypsum	0.5
Pb	53	auth gypsum	0.3
Th	13	zircon	0.04
U	3	sphalerite	
Zr	215	molybdenite	
Nb	22	fluorite	
Y	31	jarosite	0.01
		Sc	
		V	75
		Ni	2
		Cu	67
		Zn	256
		Ga	28
		Cr	61

Element	Weight %	Mineralogy	Weight %
	F	1126	
	La		
	Ce		
	Nd		

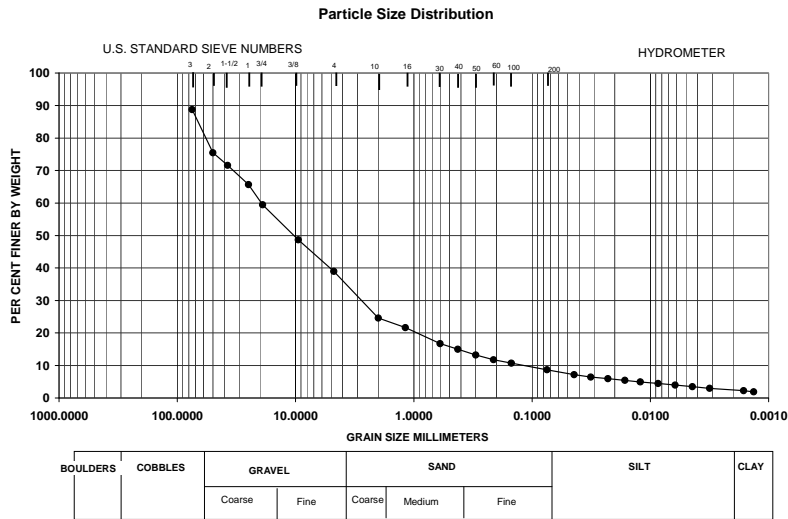


FIGURE A9-53. Gradation curve for sample GHN-KMD-0079.

DESCRIPTION OF SAMPLE GHN-KMD-0080

LOCATION

Sample GHN-KMD-0080 was collected from trench LFG-008, bench 18 in the Goathill North rock pile at UTM coordinates N 4062137.5, 453677.5E, zone 13, elevation 9650.7 ft (Fig. A9-50). It was 93 ft from the outer edge of the rock pile.

HANDSAMPLE DESCRIPTION

The sample was from Unit S and was dark brown to orange, poorly sorted, clay to large cobble, and angular to subangular grains. It consisted of andesite grains.

PETROGRAPHIC DESCRIPTION

This is a matrix supported sample and is composed of fine rock fragments with little or no clay (Figs. A9-51, A9-52). Clasts are primarily andesite. Fragments of epidote are moderately abundant within the matrix. Tiny dispersed euhedral jarosite is abundant within localized areas of the matrix. Some andesite clasts contain large euhedral casts of remnant pyrite. The casts are partially void of material, with some goethite. Fe oxide is present as nodules within the matrix and as veins or coatings on clasts. The sample contains a moderate amount of Fe cement.

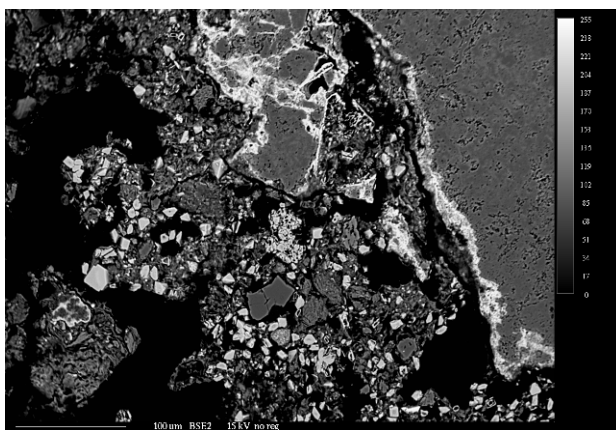


FIGURE A9-51. Electron microprobe backscatter image of tiny dispersed jarosite crystals and Fe oxide coating and veining (GHN-KMD-0080-30-03).

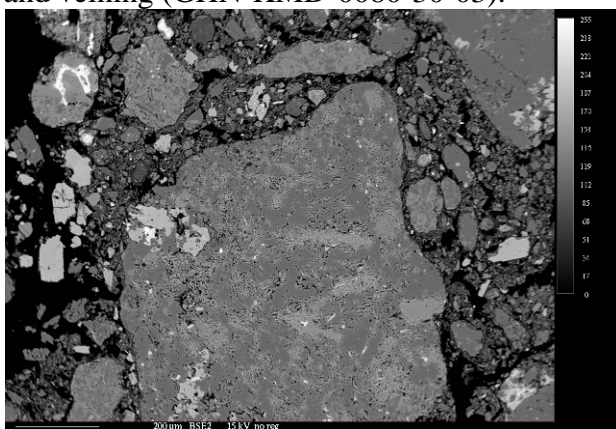


FIGURE A9-52. Electron microprobe backscatter image of matrix and crystalline epidote (GHN-KMD-0080-30-10).

CLAY MINERALOGY

The clay mineralogy was obtained by XRD on an oriented glass slide (Moore and Reynolds, 1989; Hall, 2004) and represents the soil matrix only. The clay mineral composition of sample GHN-KMD-0080 in parts per ten consist of 1 kaolinite, 3 chlorite, 2 illite, 3 smectite, and 1 mixed layered clays. The actual abundance of clay minerals in the entire sample (rock fragments and soil matrix is in Table 1-10.

LABORATORY ANALYSES

The laboratory results for mineralogy and chemistry are summarized in Tables A9-271 and A9-28.

TABLE A9-27. Various laboratory analyses for sample GHN-KMD-0080.

Paste pH	6.36
Paste Conductivity	2.59
Paste TDS	1.3
AP	2.13
NP	
Net NP	-2.13
NPAP	0
QMWI	1
SWI	2

TABLE A9-28. Chemical and mineralogical analysis for sample GHN-KMD-0080.

Element	Weight %	Mineralogy	Weight %
SiO ₂	64.18	description	Unit S
TiO ₂	0.68	quartz	24
Al ₂ O ₃	14.57	K-feldspar/orthoclase	23
FeOT	4.72	plagioclase	23
MnO	0.375	illite	4
MgO	2.37	chlorite	7
CaO	2.35	smectite	3
Na ₂ O	3.36	kaolinite	3
K ₂ O	3.4	epidote	10
P ₂ O ₅	0.309	magnetite	
S	0.1	Fe oxides	2
SO ₄	0.1	goethite	
C	0.082	hematite	
LOI	3.09	rutile	0.7
Total	100.16	apatite	0.7
Trace elements		pyrite	0.1
Ba	1085	calcite	0.4
Rb	82	gypsum	0.1
Sr	555	detrit gypsum	
Pb	74	auth gypsum	
Th	10	zircon	0.04
U	2	sphalerite	
Zr	194	molybdenite	
Nb	14	fluorite	
Y	37	jarosite	
	Sc	8	
	V	66	
	Ni	47	
	Cu	60	
	Zn	521	
	Ga	21	
	Cr	58	
	F	982	
	La	62	
	Ce	121	
	Nd	60	

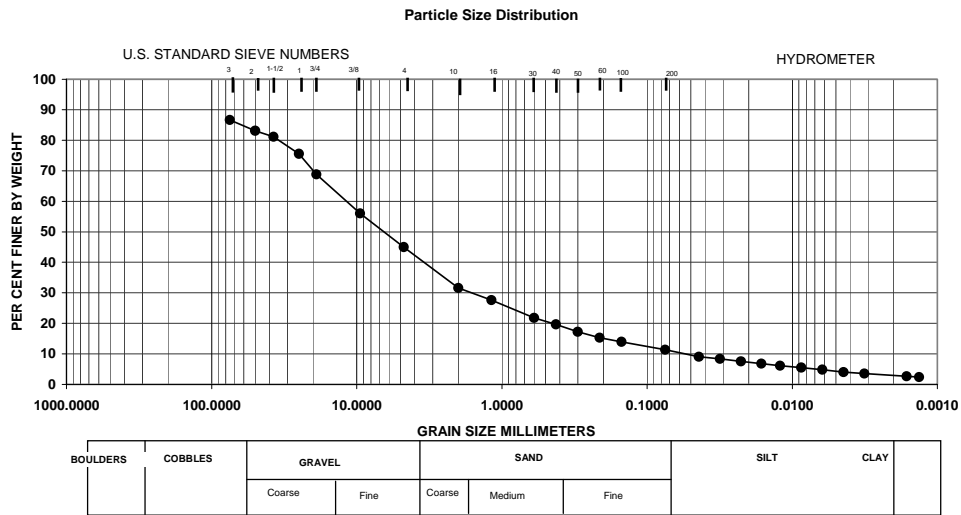


FIGURE A9-53. Gradation curve for sample GHN-KMD-0080.

**DESCRIPTION OF SAMPLE GHN-KMD-0088
LOCATION**

Sample GHN-KMD-0088 was collected from Unit O, trench LFG-008, bench 20 (UTM 4062127.1N, 453657.4E, zone 13). The sample was located approximately 36 ft east of the outer edge of the rock pile (Fig. A9-54).



FIGURE A9-54. GHN-LFG-008-H019. Bench 20, south wall showing tension crack in Unit O. Sample GHN-KMD-0088 was collected at location X.

HANDSAMPLE DESCRIPTION

Sample GHN-KMD-0088 is a bulk sample that consists of soil matrix and rock fragments that vary in size from 8 cm to less than 1 mm. It is yellow-orange (8/8 10Yr), oxidized, poorly-sorted, firm consistency, and low plasticity. The clasts are subrounded to subdiscoidal. It has a SWI (Simple Weathering Index) of 2.

PETROGRAPHIC DESCRIPTION (using petrographic scope of soil sample)

Sample GHN-KMD-0088 is highly altered andesite, mostly QSP (~60%) and propylitic (~10%) alteration (Fig. A9-55). A few rock fragments of rhyolite tuff (Amalia Tuff) are present. There is approximately 5% cement that consists of Fe-stained clay minerals. Chlorite is found as soapy green individual grains and green sheets. Gypsum is found as primarily rounded milky grains with some euhedral clear crystals.



FIGURE A9-55. GHN-KMD-0088. Iron oxides coating rock fragments (field of view is 4 mm).

ELECTRON MICROPROBE DESCRIPTION

Sample GHN-KMD-0088 consists of variably altered rock fragments (andesite and some Amalia Tuff) within a relatively minor amount of soil matrix that appears to be a mixture of clay and fine rock and mineral particles (Fig. A9-56, A9-57). Sample contains notably few mineral phases (dominantly quartz and feldspar). Clay is present in both the soil matrix and within the groundmass of some rock fragments. Some sericitic material is present, along with areas of illitic and chloritic material, although some areas appear to represent mixtures. Small crystals of rutile are found in the groundmass. Rare pyrite is present in rock fragments.

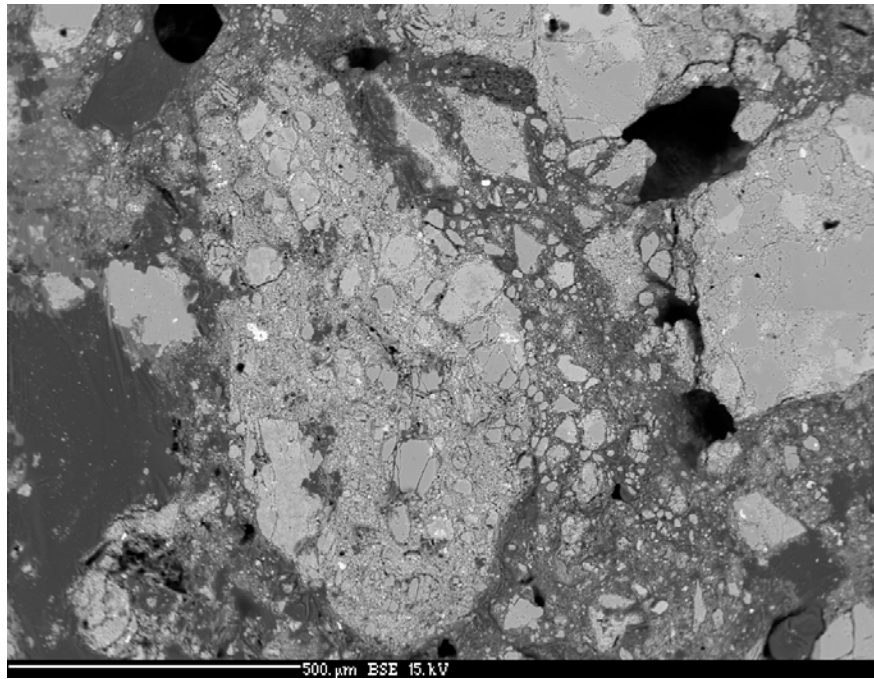


FIGURE A9-56. Backscattered electron microprobe image (BSE) GHN-KMD-0088-30-04 showing area of clay-rich matrix that is loosely cementing rock and mineral fragments.

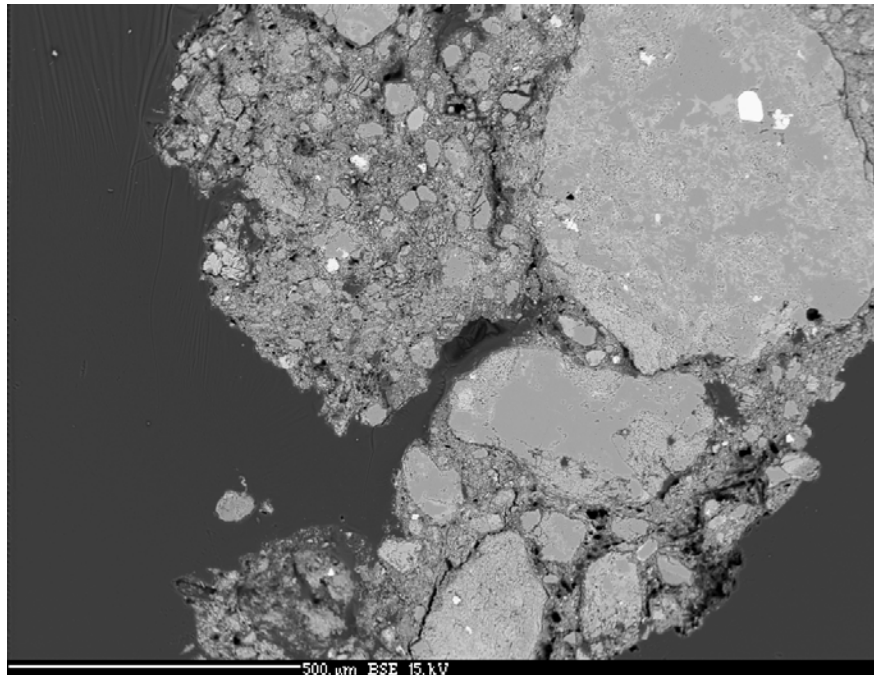


FIGURE A9-57. GHN-KMD-0088-30-05 is a BSE image showing rock fragments and soil matrix. Note the relatively fresh pyrite crystal(bright white phase) in the rock fragment, indicating little if any weathering or oxidation.

LABORATORY ANALYSES

TABLE A9-29. Various laboratory analyses for sample GHN-KMD-0088.

Particle Size (%)	
Gravel	37.19

Sand	48.41
Silt	14.4
Clay	0.01
Fines	14.41
D10	0.041
D30	0.52
D60	4.1
Atterberg Limits	
LL	40.96
PL	20.67
PI	20.3
Paste pH	2.63
Paste Conductivity	6.09
Slake Index (%)	96.21
Friction Angle (degrees)	45.83
Ultimate Friction Angle (degrees)	38.87
Specific Gravity	2.75

Particle Size Distribution

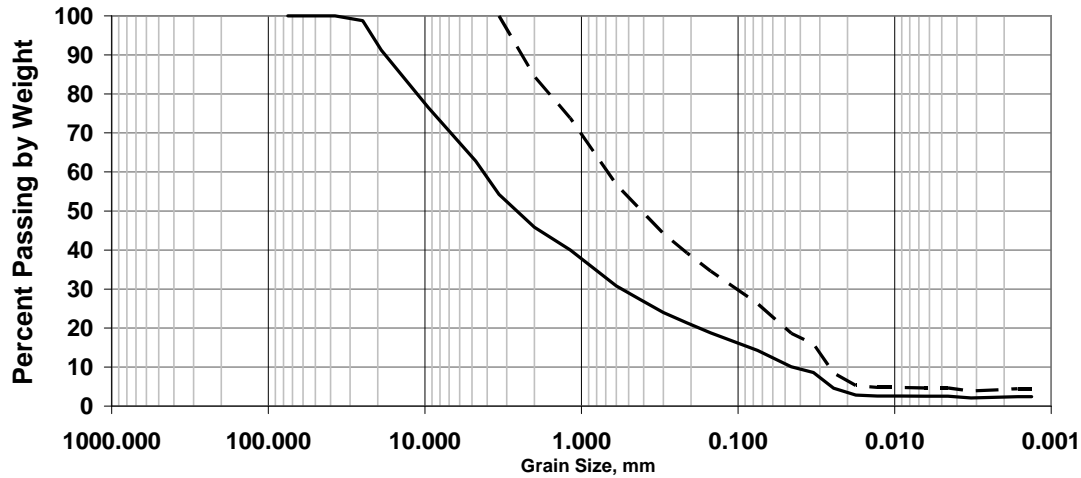


FIGURE A9-58. Particle size distribution graph for sample GHN-KMD-0088. The solid line represents the whole sample as collected from the field and the dashed line represents the scalped sample that was used to measure friction angle in the laboratory.

TABLE A9-30. Chemical and mineralogical analysis for sample GHN-KMD-0088. Mineralogy and major oxides are in percent. Trace elements are in parts per million.

Chemistry	GHN-KMD-0088	Mineralogy	GHN-KMD-0088
SiO2	64.35	quartz	34
TiO2	0.49	K-spar/orthoclase	7
Al2O3	14.19	plagioclase	23

Fe2O3T	4.19	albite	
FeOT	3.81	anorthite	
FeO	2.14	biotite	
Fe2O3	1.84	clay	
MnO	0.16	illite	21
MgO	1.51	chlorite	4
CaO	1.13	smectite	2
Na2O	2.92	kaolinite	2
K2O	3.8	mixed layered	
P2O5	0.21	epidote	
S	0.55	magnetite	
SO4	0.41	Fe oxides	3
C	0.04	goethite	
LOI	5.14	hematite	
Total	99.09	rutile	0.4
Trace elements		apatite	0.2
Ba	1216	pyrite	1
Rb	102	calcite	0.2
Sr	374	gyp	
Pb	60	detrit gyp	1.7
Th	7	auth gyp	0.1
U	4	zircon	0.03
Zr	176	sphalerite	
Nb	13	molybdenite	
Y	25.6	fluorite	
Sc	6	jarosite	0.1
V	60	copiapite	
Ni	31	chalcopyrite	
Cu	40		
Zn	221		
Ga	20		
Cr	47		
F	1015		
REE			
La	41		
Ce	102		
Nd	53.8		
Sm	10.2		
Eu	1.07		
Gd	8.09		
Yb	1.81		
Lu	1.32		

DESCRIPTION OF SAMPLE GHN-KMD-0095

LOCATION

Sample GHN-KMD-0095 was collected from trench LFG-008, bench 18 in the Goathill North rock pile at UTM coordinates N 4062118.6, 453656E, zone 13, elevation 9638.6 ft (Fig. A9-59). It was 15 ft from the outer edge of the rock pile.



FIGURE A9-59. Location of sample GHN-KMD-0095, bench 18, trench LFG-008, GHN rock pile (photograph GHN-LFG-008-H14).

HANDSAMPLE DESCRIPTION

The sample was from Unit C and was yellow gray, poorly sorted, clay to gravel, and angular to subangular grains. It consisted of andesite grains.

CLAY MINERALOGY

The clay mineralogy was obtained by XRD on an oriented glass slide (Moore and Reynolds, 1989; Hall, 2004) and represents the soil matrix only. The clay mineral composition of sample GHN-KMD-0095 in parts per ten (ppt) consist of 2 ppt kaolinite, 1 ppt chlorite, 4 ppt illite, 2 ppt smectite, and 1 ppt mixed layered clays. The actual abundance of clay minerals in the entire sample (rock fragments and soil matrix is in Table 1-10.

LABORATORY ANALYSES

The laboratory results for mineralogy and chemistry are summarized in Tables A9-31 and A9-32.

TABLE A9-31. Various laboratory analyses for sample GHN-KMD-0095.

Paste pH	2.73
Paste Conductivity	2.88
Paste TDS	1.44
AP	2.77
NP	
Net NP	-2.77
NPAP	0
QMWI	7
SWI	4

LL	32.2
PL	17.9
PI	14.3

TABLE A9-32. Chemical and mineralogical analysis for sample GHN-KMD-0095.

Element	Weight %	Mineralogy	Weight %
SiO2	75.4	description	Unit C
TiO2	0.16	quartz	48
Al2O3	11.65	K-feldspar/orthoclase	25
FeOT	1.57	plagioclase	
MnO	0.025	illite	20
MgO	0.39	chlorite	1
CaO	0.14	smectite	2
Na2O	0.47	kaolinite	2
K2O	4.81	epidote	
P2O5	0.032	magnetite	
S	0.18	Fe oxides	0.7
SO4	0.28	goethite	
C	0.04	hematite	
LOI	3.51	rutile	0.1
Total	98.81	apatite	0.01
Trace elements		pyrite	0.3
Ba	179	calcite	0.3
Rb	157	gypsum	0.2
Sr	52	detrit gypsum	
Pb	109	auth gypsum	
Th	10	zircon	0.06
U	6	sphalerite	
Zr	288	molybdenite	
Nb	34	fluorite	
Y	57	jarosite	1
		Sc	1
		V	13
		Ni	7
		Cu	38
		Zn	41
		Ga	24
		Cr	8
		F	1066
		La	51
		Ce	101
		Nd	44

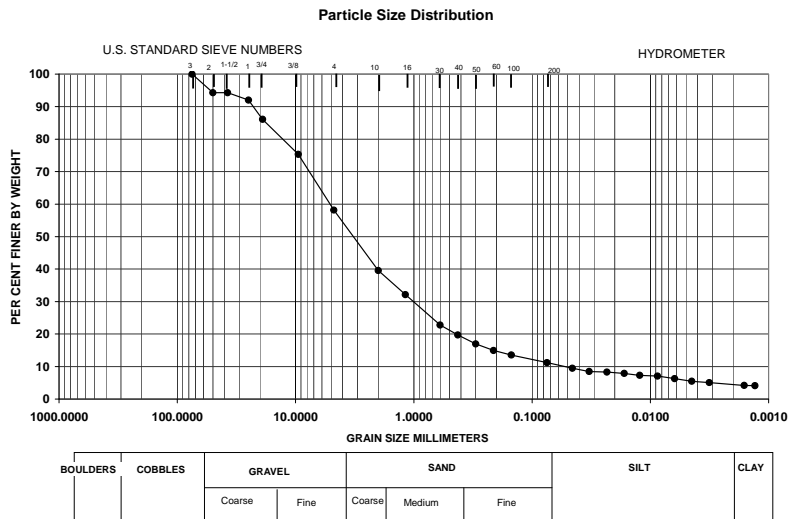


FIGURE A9-60. Gradation curve for sample GHN-KMD-0095.

DESCRIPTION OF SAMPLE GHN-KMD-0100

LOCATION

Sample GHN-KMD-0100 was collected from trench LFG-008, bench 19 in the Goathill North rock pile at UTM coordinates N 4062131.6, 453631E, zone 13, elevation 9632 ft (Fig. A9-60). It was 58 ft from the outer edge of the rock pile.



FIGURE A9-60. Sample GHN-KMD-0100 (X) from Unit O on bench 19, trench LFG-008.

HANDSAMPLE DESCRIPTION

The sample was from Unit O and was brown, poorly sorted, clay to gravel, and angular to subangular grains. It consisted of andesite grains.

CLAY MINERALOGY

The clay mineralogy was obtained by XRD on an oriented glass slide (Moore and Reynolds, 1989; Hall, 2004) and represents the soil matrix only. The clay mineral composition of sample GHN-KMD-0100 in parts per ten consist of 3 kaolinite, 1 chlorite, 3 illite, 2 smectite, and 1 mixed layered clays. The actual abundance of clay minerals in the entire sample (rock fragments and soil matrix is in Table 1-10.

LABORATORY ANALYSES

The laboratory results for mineralogy and chemistry are summarized in Tables A9-33 and A9-34.

TABLE A9-33. Various laboratory analyses for sample GHN-KMD-0100.

Paste pH	3.42
Paste Conductivity	3.25
Paste TDS	1.63
AP	2.64
NP	
Net NP	-2.64
NPAP	0
QMWI	7
SWI	2
LL	34.2
PL	17.5
PI	16.7

TABLE A9-34. Chemical and mineralogical analysis for sample GHN-KMD-0100.

Element	Weight %	Mineralogy	Weight %
SiO ₂	67.74	description	Unit O
TiO ₂	0.48	quartz	34
Al ₂ O ₃	13.19	K-feldspar/orthoclase	25
FeOT	4.28	plagioclase	11
MnO	0.311	illite	15
MgO	1.47	chlorite	4
CaO	0.93	smectite	2
Na ₂ O	2.05	kaolinite	3
K ₂ O	4.15	epidote	
P ₂ O ₅	0.211	magnetite	
S	0.01	Fe oxides	4
SO ₄	0.2	goethite	
C	0.06	hematite	
LOI	3.91	rutile	0.3
Total	99.42	apatite	0.4
Trace elements		pyrite	0.01
Ba	780	calcite	0.5
Rb	126	gypsum	1
Sr	282	detrit gypsum	
Pb	116	auth gypsum	
Th	10	zircon	0.04
U	4	sphalerite	
Zr	226	molybdenite	
Nb	23	fluorite	

Element	Weight %	Mineralogy	Weight %
Y	44	jarosite	
	Sc	6	
	V	54	
	Ni	31	
	Cu	66	
	Zn	320	
	Ga	23	
	Cr	41	
	F	1047	
	La	45	
	Ce	88	
	Nd	38	

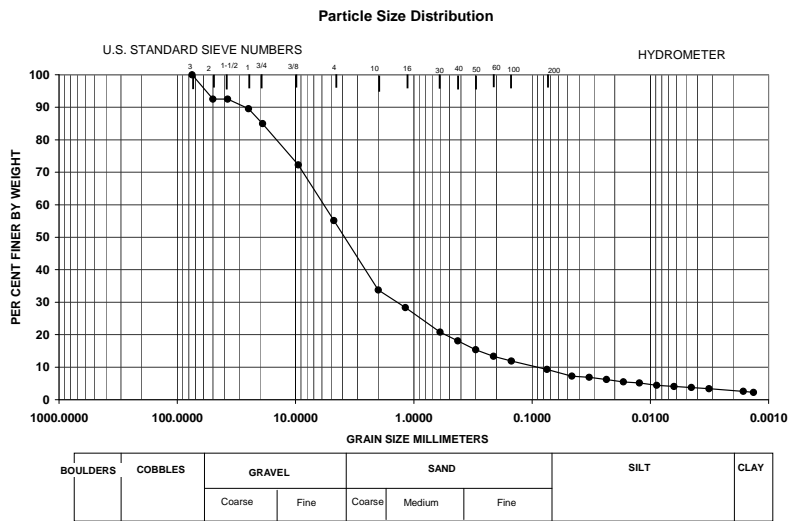




FIGURE A9-62. Photograph of rinsed hand sample showing various rock lithologies. Field of view is 3.5 cm.

Microprobe Description

Under the microprobe this is a matrix-dominated sample consisting of clasts within a matrix of illite, minor chlorite, and jarosite cement; these cementing agents are intergrown with fine bladed gypsum (Fig. A9-63). Clasts and rock fragments mainly consist of quartz, albite, and andesite. The sample contains some large andesite clasts that are significantly altered to illite and secondary K-spar; jarosite, epidote, and gypsum are present within altered andesite clasts as well. Large K-mica grains (to 500+ microns) are present in the soil matrix; some appear to be growing along fractures. Abundantly dominant illite clay with minor chlorite is within the soil matrix and significantly replacing the matrix of large andesite clasts. Jarosite cement is intermixed with illite throughout the soil matrix and is present as veins and coatings within altered andesite clasts (Fig. A9-64). No pyrite or carbonate was observed in the sample.

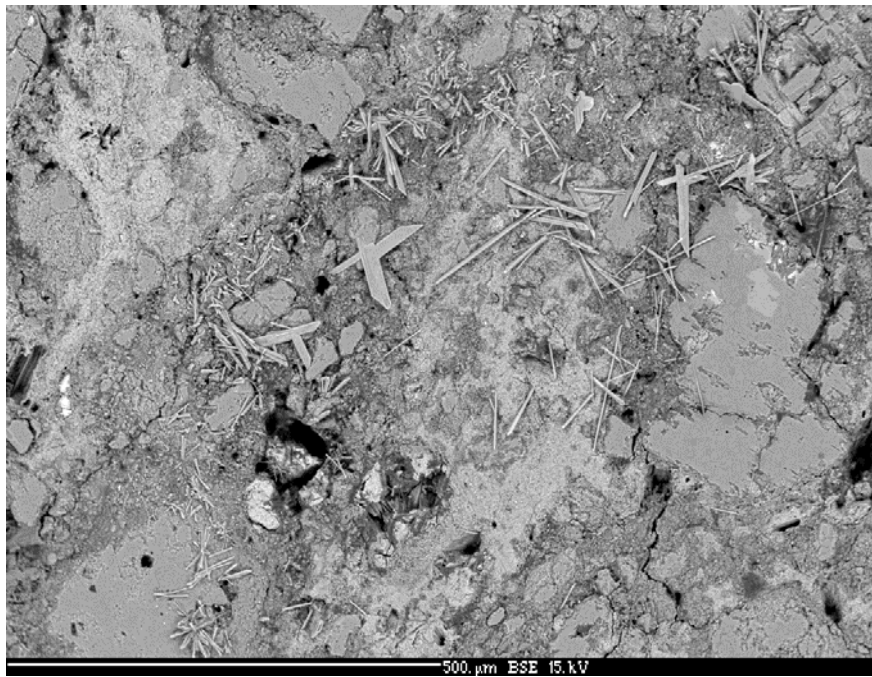


FIGURE A9-63. Microprobe image showing bladed gypsum formed in a clay matrix in between altered rock fragments.

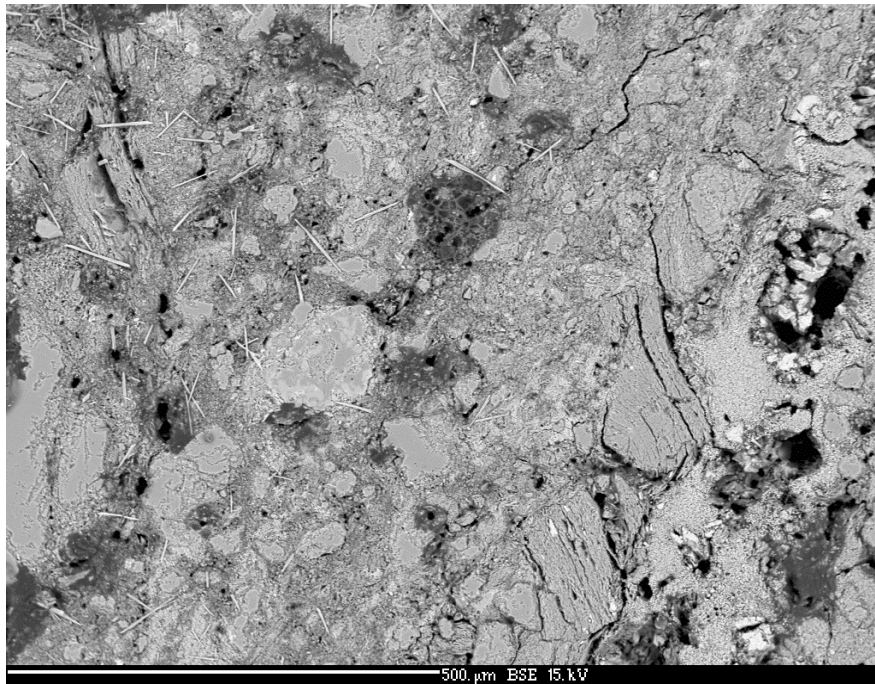


FIGURE A9-64. Overview image of altered andesite rock fragments showing jarosite along edges and intergrown gypsum has been formed on the left side of the image.

Laboratory Analyses

Laboratory analyses are in Tables A9-35 and A9-36.

TABLE A9-35. Various laboratory analyses for sample GHN-JRM-0009.

Atterberg Limits	
LL	
PL	
PI	
Paste pH	3.97
Paste Conductivity	5.45
Specific Gravity	
NAG pH	
NAG value	

TABLE A9-36. Chemical and mineralogical analysis for sample GHN-JRM-0009.

Chemistry	Weight Percent	Mineralogy	%
SiO ₂	70.87	Quartz	50
TiO ₂	0.37	K-spar/orthoclase	2
Al ₂ O ₃	11.96	Plagioclase	5
Fe ₂ O ₃ T	3.79	Albite	-
FeOT	3.45	Anorthite	-
FeO	1.98	Biotite	-
Fe ₂ O ₃	1.62	Clays/groundmass	-
MnO	0.18	Illite	31
MgO	1.22	Chlorite	3
CaO	0.93	Smectite	1
Na ₂ O	0.62	Kaolinite	1

Chemistry	Weight Percent	Mineralogy	%
K2O	2.71	Mixed layered	-
P2O5	0.18	Epidote	0.01
S	1.3	Magnetite	-
SO4	0.55	Fe oxides	1
C	0.07	Goethite	-
LOI	5.42	Hematite	-
Total	100.18	Rutile	0.4
Trace elements	ppm	Apatite	0.5
Ba	506.3	Pyrite	2
Rb	94.9	Calcite	0.7
Sr	65.5	Gypsum	-
Pb	132.2	Detrital gypsum	1
Th	11.2	Authigenic gypsum	0.1
U	5.7	Zircon	0.04
Zr	207.9	Sphalerite	-
Nb	18.3	Molybdenite	-
Y	42.6	Fluorite	-
Sc	6.7	Jarosite	1.9
V	53	Copiapite	-
Ni	27.5	Other S minerals	-

Cu	99.3
Zn	252.1
Ga	16.6
Cr	48.2
F	1016
REE	ppm
La	42
Ce	93
Nd	47
Sm	9.1
Eu	0.94
Gd	6.46
Yb	1.42
Lu	1.11

DESCRIPTION OF SAMPLE GHN-KMD-0057

Location

This sample was collected at the Goathill North rock pile. The UTM coordinates of sample collection are 13N4062140, 453695.8E, and the sample was collected 9694 ft above sea level.

Handsample Description

In hand sample the sample is light grey in color with limited cohesion prior to rinsing (Fig. A9-65) and dark grey to yellow to white after rinsing (Fig. A9-66). The rock fragments are mainly andesite, although few rhyolite fragments are also present; the rock fragments are sub-angular to sub-rounded. Trace amounts of epidote are seen as small crystals associated with rock fragments. Calcite was detected by a fizz test, although there does not seem to be a lot in the sample. Pyrite is seen as small, 0.2 mm, cubic clusters; some exhibit extreme oxidation.



FIGURE A9-65. Photograph of unrinsed hand sample. Field of view is 5 cm.



FIGURE A9-66. Photograph of rinsed hand sample. Field of view is 5 cm.

Microprobe Description

Under the microprobe the sample is a moderately altered andesite rock that is clast dominated within a soil matrix. The clasts are mainly andesite, although there are some Mg-Fe rich clasts, and minor Amalia Tuff rhyolite clasts. Groundmass consists largely of quartz, feldspar, and albite, which is all finely intergrown. Large plagioclase phenocrysts are present in the sample. Epidote is common in the sample, can occur in large pockets, and is mainly intergrown with quartz and K-spar. There are localized Mn-oxide nodules and veining within clasts. Minor small apatite is seen as isolated grains up to 50 microns in size. Few fractures are present within the sample. Clay is present throughout the sample, but in abundance of well less than 30%. Clay mostly replaces relict phenocrysts, and is dispersed in the groundmass; clay is not present in fractures. Fe oxides act as a cementing agent in some instances (Fig. A9-67). Calcium carbonate, up to 50 microns in size, is present as sparse grains adhering to the outside of the sample; few minor altered grains are associated with epidote. No pyrite is noted in the sample. Some magnetite, up to 500 microns in size, is compositionally zoned with inclusions of other minerals; some magnetites are euhedral.

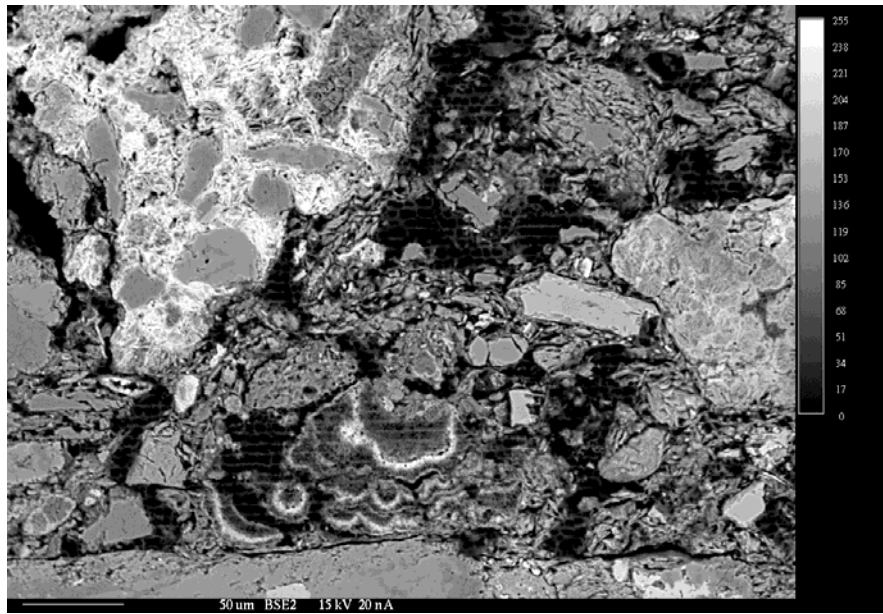


FIGURE A9-67. Microprobe image of Fe oxides (bright areas) cementing together altered andesite clasts.

Laboratory Analyses

Laboratory analyses are in Tables A9-27 and A9-38.

TABLE A9-37. Various laboratory analyses for sample GHN-KMD-0057.

Atterberg Limits	
LL	32.75
PL	18.06
PI	14.69
Paste pH	7.96
Paste Conductivity	0.18
Specific Gravity	
NAG pH	7.94
NAG value	0

TABLE A9-38. Chemical and mineralogical analysis for sample GHN-KMD-0057.

Chemistry	Weight Percent	Mineralogy	%
SiO ₂	62.67	Quartz	26
TiO ₂	0.71	K-spar/orthoclase	17
Al ₂ O ₃	14.99	Plagioclase	25
Fe ₂ O ₃ T	5.19	Albite	-
FeOT	4.72	Anorthite	-
FeO	2.77	Biotite	-
Fe ₂ O ₃	2.15	Clays/groundmass	-
MnO	0.35	Illite	11
MgO	2.62	Chlorite	7
CaO	2.56	Smectite	2
Na ₂ O	3.05	Kaolinite	1
K ₂ O	3.52	Mixed layered	-
P ₂ O ₅	0.33	Epidote	7
S	0.09	Magnetite	0.01

Chemistry	Weight Percent	Mineralogy	%
SO4	0.01	Fe oxides	2
C	0.13	Goethite	-
LOI	3.38	Hematite	-
Total	99.6	Rutile	0.6
Trace elements	ppm	Apatite	0.8
Ba	1243	Pyrite	0.2
Rb	101	Calcite	1
Sr	613	Gypsum	0.05
Pb	141	Detrital gypsum	-
Th	9	Authigenic gypsum	-
U	3	Zircon	0.03
Zr	182	Sphalerite	-
Nb	12.5	Molybdenite	-
Y	19	Fluorite	-
Sc	10	Jarosite	-
V	89	Copiapite	-
Ni	52	Other S minerals	-

Cu	63
Zn	319
Ga	21
Cr	73
F	910
REE	ppm
La	43
Ce	87
Nd	39
Sm	-
Eu	-
Gd	-
Yb	-
Lu	-

DESCRIPTION OF SAMPLE GHN-KMD-0096

Location

This sample was collected at the Goathill North rock pile. The UTM coordinates of sample collection are 13N4062119, 453658.4E, and the sample was collected 9640 ft above sea level.

Handsample Description

In hand sample there were many differences between the rinsed and unrinsed sample. There was no orange Fe staining prior to rinsing and limited orange staining after rinsing. Ninety percent of the cement was removed by rinsing, although some yellow clay material remains adhering to rock fragments after rinsing. There was a reaction to HCl prior to rinsing, but no carbonate grains were identified after rinsing. No epidote or pyrite was observed in the sample, although a small euhedral muscovite was observed in the sample (Fig. A9-68). Bladed gypsum was also observed adhering to the outside of rock fragments prior to rinsing as well (Fig. A9-69).

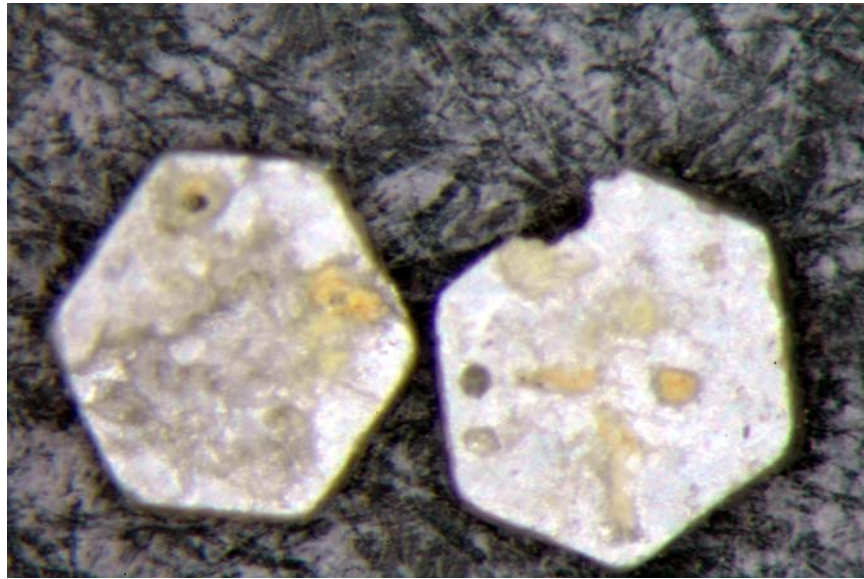


FIGURE A9-68. Small euhedral muscovite crystals. Field of view is 1 cm.

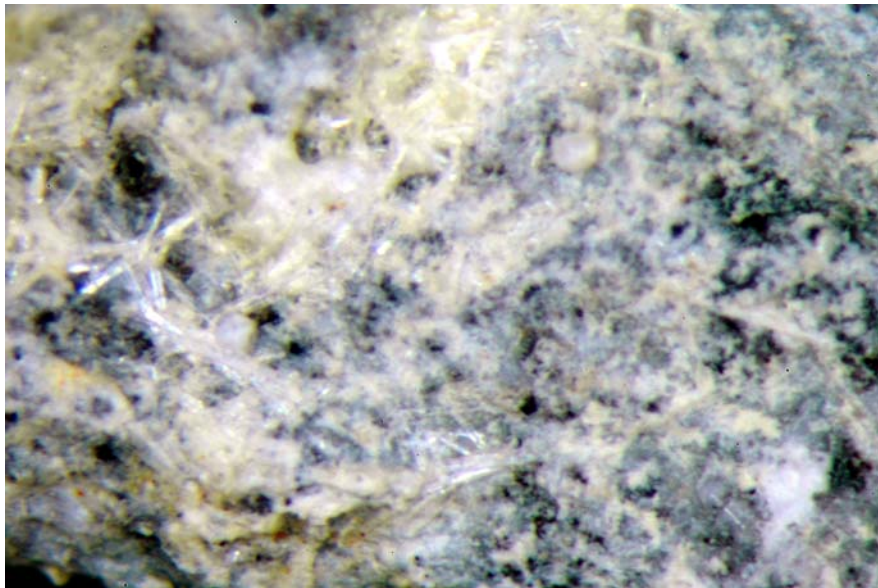


FIGURE A9-69. Bladed gypsum is observed prior to rinsing the hand sample (seen left of center). Field of view is 1 cm.

Microprobe Description

Under the microprobe the sample is composed mainly of Amalia Tuff fragments with matrix material adhering around the fragments (Fig. A9-70). Nice igneous textures are preserved, although some alteration to clay minerals appears to have taken place. Large quartz crystals are seen as well as fine-grained quartz in the groundmass. Large igneous feldspar crystals were observed, and some have been exsolved. No carbonate was seen. A relict mica crystal and apatite were observed, although this is not common in the sample. Clay minerals are preserved in many fragments, largely as replacements of pre-existing phases and as pockets and veins in the sample. The sample is relatively unfractured. Rare pyrite fragments are seen in the sample as well.

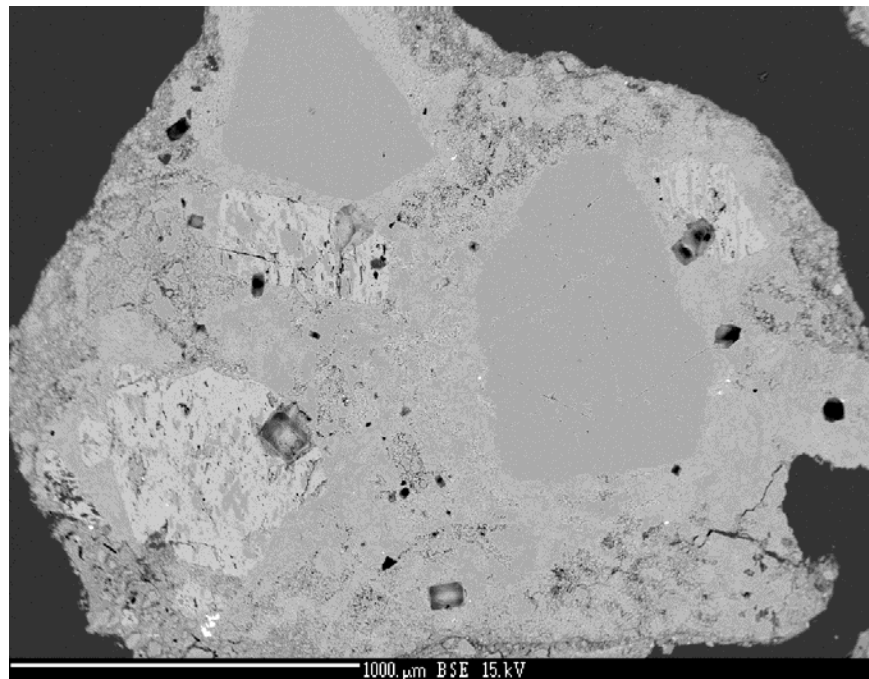


FIGURE A9-70. Microprobe image shows large feldspar crystals in a matrix of clay.

Laboratory Analyses

Laboratory analyses are in Tables A9-39 and A9-40.

TABLE A9-39. Various laboratory analyses for sample GHN-KMD-0096.

Atterberg Limits	
LL	33.91
PL	18.72
PI	15.18
Paste pH	2.56
Paste Conductivity	3.04
Specific Gravity	2.66
NAG pH	2.75
NAG value	3.08

TABLE A9-40. Chemical and mineralogical analysis for sample GHN-KMD-0096.

Chemistry	Weight Percent	Mineralogy	%
SiO ₂	72.29	Quartz	46
TiO ₂	0.23	K-spar/orthoclase	19
Al ₂ O ₃	11.91	Plagioclase	2
Fe ₂ O ₃ T	2.31	Albite	-
FeOT	2.1	Anorthite	-
FeO	1	Biotite	0.01
Fe ₂ O ₃	1.21	Clays/groundmass	-
MnO	0.04	Illite	23
MgO	0.63	Chlorite	2
CaO	0.66	Smectite	1
Na ₂ O	0.77	Kaolinite	2
K ₂ O	4.57	Mixed layered	-
P ₂ O ₅	0.05	Epidote	

Chemistry	Weight Percent	Mineralogy	%
			0.01
S	0.16	Magnetite	-
SO4	0.66	Fe oxides	0.4
C	0.06	Goethite	-
LOI	4.84	Hematite	-
Total	99.17	Rutile	0.2
Trace elements	ppm	Apatite	0.1
Ba	274	Pyrite	0.3
Rb	146	Calcite	0.5
Sr	89	Gypsum	-
Pb	121	Detrital gypsum	1
Th	10	Authigenic gypsum	0.01
U	5	Zircon	0.06
Zr	266	Sphalerite	-
Nb	31	Molybdenite	-
Y	51	Fluorite	-
Sc	2	Jarosite	2.5
V	22	Copiapite	-
Ni	11	Other S minerals	-

Cu	30
Zn	53
Ga	24
Cr	16
F	1069
REE	ppm
La	56
Ce	113
Nd	13.1
Sm	9.6
Eu	0.41
Gd	7.26
Yb	2.15
Lu	2.19