

169-1035A-01H-05, 104-105 cm**Thin section:** # 35 NB: Polished slab**ROCK NAME:** Sulfide sand

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Total percentage of section: 40</i>				
Pyrrhotite	47	0.005-1.0	Subhedral to euhedral, laths or blades.	
Sphalerite	10	0.01-0.1	Anhedral to subhedral.	Some with partly hexagonal morphology.
Chalcopyrite	8	0.02-0.05	Anhedral.	Mottled or rippled surface, elongate minute grains in sphalerite (0.001-0.005 mm).
Isocubanite	2	0.005-0.01	Anhedral.	Associated with chalcopyrite.
NON-OPAQUE MINERALOGY				
<i>Total percentage of section: 20</i>				
Silicates	33	≤ 0.05		Controlled by pyrrhotite network.
VOID SPACE				
Note: Void space is not considered as part of mineral percentage given above.				
	40	0.02-0.4		Mainly controlled by pyrrhotite network.

COMMENTS: Dominantly open interlocking network of hexagonal pyrrhotite. Chalcopyrite, sphalerite, and silicates (mainly quartz?) occur interstitial to pyrrhotite crystals. Sphalerite often has inclusions of larger grains of anhedral chalcopyrite with minor isocubanite. Sphalerite also has minute elongated inclusions of crystallographically oriented, as well as occasional small blebs (chalcopyrite disease), of chalcopyrite. Some grains of sphalerite have a partly preserved hexagonal outline, which suggests that the original zinc sulfide was wurtzite. Irregular grains of isocubanite occur in chalcopyrite. No exsolution lamellae are found (maybe too fine for detection in light microscope?).

169-1035C 5X-CC, Piece 6 (42-47 cm)**Thin section:** #36**ROCK NAME:** Vuggy and colloform massive pyrite-marcasite.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Total percentage of section: 95</i>				
Marcasite	50	<0.01-0.02		Crystalline, twinned; colloform layers (interlayered with unidentified extremely fine-grained and fibrous gangue), framboids, granoblastic (120° grain boundaries); partly replaced by pyrite.
Pyrite	50	<0.01-1		Fine-grained massive; colloform layers (interlayered with unidentified extremely fine-grained and fibrous gangue), framboids, granoblastic (120° grain boundaries); partly replacing the marcasite.
NON-OPAQUE MINERALOGY				
Anhydrite	Trace	0.1	Subhedral.	In vugs in pyrite and marcasite.
VOID SPACE				
Note: Void space is not considered as part of the mineral percentage.				
Vugs	5		Irregular.	

COMMENTS: Recrystallized pyrite and marcasite; colloform in some, and vuggy in other places. Rare anhydrite in vugs. Marcasite occurs predominantly in colloform layers as epitaxial growths on predominantly granoblastic pyrite.

169-1035D-2H-1, (95-96 cm)**Thin section:** # 37 (Polished slab)**ROCK NAME:** Sulfide sand

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 10</i>				
Pyrrhotite	3	0.005-0.2	Typically euhedral to subhedral and lath-shaped.	Partly to totally replaced by pyrite.
Pyrite	4	<0.001-0.04	Anhedral to euhedral.	Partly replacing pyrrhotite in extremely fine-grained aggregates. Often larger anhedral grains associated with marcasite. Euhedral grains are either pyritohedrons or pseudomorphs after hexagonal pyrrhotite.
Sphalerite	2	<0.01-0.07	Anhedral in very fine-grained aggregates.	Rimmed by chalcopyrite, or in larger grains sometimes with a hexagonal outline, suggesting that the original zinc sulfide was wurtzite. Chalcopyrite disease is common in larger grains. Other grains have inclusions of pyrite. One grain shows a well developed zonation, from light core to dark rim.
Chalcopyrite	Trace	0.005-0.04	Anhedral grains.	Typical with a mottled surface, occasionally with inclusions of isocubanite.
Isocubanite	Trace	≤0.01		Inclusions in chalcopyrite, too fine-grained to see any lamellae.
Galena	Trace	≤0.005		Numerous small inclusions in an aggregate of larger sphalerite crystals.
Marcasite	1-2	≤0.01		In larger aggregates, sometimes twinned, often smaller grains associated with pyrite.

NON-OPAQUE MINERALOGY*Percentage of section: 90*

Not possible to determine, because of thickness of slab.

VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
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Note: Void space is not considered in mineral percentages given above.

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COMMENTS: Weak impregnation of various sulfides in random orientation, suggesting a clastic origin, though no oxidation can be seen in any of the sulfide grains.

169-1035D-9X-1, Piece 2B (25-30 cm)**Thin section:** # 38**ROCK NAME:** Clastic sulfide.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 70</i>				
Pyrite	42	<0.001-0.02	Anhedral.	Extremely fine-grained colloform with dark bands (clay?) and, in more coarse-grained aggregates, forming pseudomorphs after elongate pyrrhotite grains. A few small subhedral to euhedral cubes, sometimes with equant faces. Chalcopyrite disease, mainly following crystallographic directions in the sphalerite.
Sphalerite	14	0.005-0.5	Anhedral to subhedral.	Exsolution, less isocubanite than chalcopyrite.
Chalcopyrite + Isocubanite	7	0.02-0.1	Lamellar intergrowth.	
Pyrrhotite (?)	7	<0.0005-0.002	Anhedral aggregates.	Intergrown with dark material (clay?). Could also be very fine-grained pyrite.

NON-OPAQUE MINERALOGY*Percentage of section: 30*

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Sericite	15	0.01-0.05	Fibrous, felty mass.	Typically radiating out from the sulfides.
Quartz	6	0.02-0.1		Aggregates of anhedral grains between sulfides.
Anhydrite	6	0.1-0.7	Equant grains.	Controlled by sulfide morphology.
Barite	3	0.1-0.5	Equant grains.	Controlled by sulfide morphology.

VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
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Note: Void space is not considered in the mineral percentage given above.

25-30

COMMENTS: Pyrite forms partly an open interlocking network texture with interstitial chalcopyrite, sphalerite, silicates and sulfates, obviously replacing earlier formed network of coarse grained pyrrhotite. Pyrite also occur in colloform banding with dark material (clay?), maybe together with minor pyrrhotite.

169-1035D-10X-1, Piece 15 (80-84 cm)**Thin section:** # 39 (polished slab)**ROCK NAME:** Massive sulfide with sediment

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 60</i>				
Pyrite	43.8	0.05-3.0 and ≤0.002	Euhedral, Anhedral	Lath-shaped as pseudomorphs. Extremely fine-grained in intergrowth with dark material (clay?) and magnetite.
Magnetite	9	0.05-0.1 and ≤0.002	Anhedral to euhedral.	Lath-shaped as pseudomorphs. Extremely fine-grained in intergrowth with dark material (clay?) and pyrite.
Chalcopyrite +	6	0.02-0.2	Anhedral.	Extremely fine-grained in intergrowth, but color suggests less isocubanite than chalcopyrite.
Isocubanite				
Sphalerite	1.2	0.02-0.05	Anhedral grains.	
Pyrrhotite	Trace			Very few inclusions in pyrite
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 40</i>				
Anhydrite				Can be detected from crystal shapes, otherwise unknown, because of thickness of slab.
Quartz				Can be detected from crystal shapes, otherwise unknown, because of thickness of slab.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
	0			

COMMENTS: Mainly an interlocking, open network of pyrite laths and minor magnetite laths with interstitial chalcopyrite, magnetite, and silicates. Both pyrite and magnetite can be seen replacing anhydrite, probably also earlier formed pyrrhotite has been replaced. Locally, patches with interlocking network of magnetite can be seen with interstitial sphalerite. Some remnants of earlier banding with very fine-grained dark material can be seen overgrown by the pyrite network. Pyrite has also overgrown chalcopyrite-isocubanite grains. In places pyrite and magnetite occur in very fine-grained intergrowth, suggesting co-precipitation, maybe due to oxidation of pyrrhotite.

169-1035D-17X-1, Piece 5B (33-37 cm)**Thin section:** # 40**ROCK NAME:** Silicified coarse-grained sandstone with minor sulfide impregnations.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Pyrrhotite	2	<0.1 to 0.4	Interlocking euhedral to anhedral grains and clusters (blebs).	Some hexagonal plates; disseminated.
Magnetite	Trace	0.1	Anhedral grains.	Disseminated and on sulfides.
Hematite	Trace	0.1	Anhedral grains.	Disseminated and on sulfides.
Chalcopyrite	Trace	0.01	Anhedral.	Disseminated, isolated grains.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Smectite/Clay	54	<0.0001		Fine-grained groundmass, interstitial to quartz.
Quartz	44	0.1 to 0.3	Subhedral to euhedral grains within clay matrix.	
Chlorite	Trace	0.1 to 0.2		Rare, disseminated, well formed fibrous books, deep green, mainly anomalous Berlin blue birefringence indicative of high Fe content.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Note: Voids space is not considered in mineral percentages above.	<2%			

COMMENTS: Quartz is predominantly recrystallized and contains numerous two-phase fluid inclusions along healed and some isolated fractures.

169-1035D-20X-1, (65-68 cm)**Thin section: # 41****ROCK NAME: Sulfide-veined siltstone**

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 25</i>				
Pyrrhotite	21	0.03-0.25	Anhedral, fractured grains.	Granoblastic
Chalcopyrite	3	0.04-0.1	Anhedral.	Fine lamellae of isocubanite
Sphalerite	1	0.02-0.1	Anhedral, fractured grains.	
Isocubanite	trace	0.001-0.1		Mainly as fine lamellae in chalcopyrite, a few larger single grains.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 75</i>				
<i>Associated with pyrrhotite vein:</i>				
Quartz	trace	0.02-0.15	Euhedral.	Partly double terminated.
Zoisite	2	0.05-0.5		In aggregates, interstitial to the sulfides, partly elongated and prismatic, with well developed cleavage.
Ti-oxides	trace	≤ 0.05		Very fine-grained, small aggregates as inclusions in zoisite, sometimes needle-shaped (rutile or anatase).
<i>Matrix (siltstone):</i>				
Quartz	24	0.01-0.04	Anhedral.	Rounded grains, some euhedral larger grains associated with muscovite aggregates.
Clay minerals	37	<0.005		Felty groundmass, surrounding the quartz grains.
Chlorite	2	0.02		A few thin lamellae in the groundmass.
Muscovite	10	0.01-0.02		Felty aggregates, partly peculiar amoeboid to more rectangular equant shapes. Some quartz and chlorite associated. Could it be replacement of some mineral, e.g., feldspar?

COMMENTS: Pyrrhotite vein crosscutting a clay-rich siltstone. No particular chlorite selvage is seen around the vein, and no later alteration of the siltstone or grain growth.

169-1035D-24X-CC, Piece 1 (10-11 cm)**Thin section: # 42****ROCK NAME: Epidotized and silicified siltstone**

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Pyrrhotite	2-3	0.1	Anhedral blebs and clusters of crystals.	Disseminated in groundmass of epidote and quartz.
Hematite	trace	0.01-0.05	Anhedral grains.	Disseminated.
Pyrite	trace	0.01	Euhedral.	Very small, and disseminated.
Chalcopyrite	trace	0.01	Subhedral.	Very small, and disseminated.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Epidote	45-50	0.05-0.3	Euhedral.	Disseminated in matrix.
Quartz	45-50	0.05-0.3	Interlocking anhedral grains.	Interstitial to epidote.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
	0			

COMMENTS: Strongly epidotized and silicified mudstone with minor fragments of disseminated sulfides.

169-1035F 4R-1, Piece 4D (36-38 cm)**Thin section:** #44**ROCK NAME:** Colloform massive sulfide.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percent of section: 55%</i>				
Pyrite	70	0.005-0.3	Colloform.	Replacing marcasite(?).
Marcasite	20	0.005-0.3	Colloform.	Intergrown with pyrite.
Sphalerite	10	0.3- 2	Ragged anhedral grains.	Possibly two generations of sphalerite. Later fills interstices between some colloform layers.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percent of section: Trace</i>				
Anhydrite	<1	0.5-2	Laths and as void infill.	Laths in pyrite occur in clusters.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Note: Void space is not considered in mineral percentage above.				
	49		Irregular.	Voids occur in between colloform layers.

COMMENTS: Massive colloform sulfide.**169-1035F 5R-1, Piece 2B (23-24 cm)****Thin section:** # 45**ROCK NAME:** Colloform and vuggy massive pyrite/marcasite.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Total percentage of sulfide in section: 70</i>				
Pyrite	80	0.01-0.2	Colloform.	
Marcasite	20	0.05	Colloform.	
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Anhydrite	Trace	0.01	Infill or line voids.	White.
Clay?	Trace	0.01		Interstitial to adjacent colloform layers.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Note: Void space is not considered in mineral percentage above.				
	30		Irregular.	

COMMENTS: Fluid channelway structure. Coarse-grained marcasite lines the channelway walls.

169-1035F-5R-2, Piece 22 (134-137 cm)**Thin section:** # 46 (polished Slab)**ROCK NAME:** Colloform and vuggy pyrite.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 100</i>				
Pyrite	85	0.02-0.1	Anhedral	With partially straight grain boundaries, especially against chalcopyrite. Granoblastic texture.
Chalcopyrite	10	0.01-0.25	Anhedral.	Small inclusions of sphalerite
Marcasite	5	0.03-0.15		Aggregates and veinlets associated with void spaces, some twinning.
Sphalerite	Trace	0.005-0.02	Anhedral.	Associated with chalcopyrite.
Pyrrhotite	Trace	0.01	Anhedral.	Inclusions in pyrite.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: Trace</i>				
Clay/smectite	Trace	<0.001		Very fine-grained. Partly lines and fills some vugs.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Note: Void space is not considered in mineral percentages above.				
	20			

COMMENTS: Totally recrystallized, nearly monomineralic pyrite. Old grain boundaries in the pyrite can be seen by dark inclusions, forming trails.**169-1035F-6R-1, Piece 24 (129-135 cm)****Thin section:** # 47 (polished Slab)**ROCK NAME:** Colloform and vuggy pyrite.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 100</i>				
Pyrite	40	0.2-2.0	Anhedral, colloform.	Often with "dusty" dark inclusions.
Marcasite	25	0.05-0.25	Anhedral.	Straight boundaries, granoblastic. Twinning is common.
Sphalerite	35	0.2-1.5	Anhedral to subhedral.	Partially with cubic outline, mostly colloform.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: not determined</i>				
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Note: Void space is not considered in mineral percentages above.				
	15			

COMMENTS: Colloform banding of nearly monomineralic pyrite alternating with bands of marcasite and bands of sphalerite, as well as bands with dark material partially intergrown with the pyrite. Multiple stages of veining can be seen in the section. The main vein shows a sequence as follows: Pyrite-sphalerite-pyrite-marcasite-sphalerite-marcasite-pyrite-marcasite.

169-1035F 7R-1, Piece 1 (23-24 cm)**Thin section:** # 48**ROCK NAME:** Colloform and vuggy massive pyrite

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Total percentage of sulfide in section: 80				
Marcasite	70	0.1-1	Crystalline.	Elongate blades arranged perpendicular to growth surfaces in colloform bands.
Pyrite	30	0.01-0.1	Colloform.	Botryoidal layers and spheres, and framboids. Very fine-grained.
Sphalerite stage.	<1	(layer) 0.02	Subhedral.	Lines and partly fills interstices in vugs in iron sulfides. Late stage.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Clay(?) minerals	Trace	?	Infill of vugs.	Cannot determine because it is a polished slab.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Note: Void space is not considered in mineral percentages above.				
	20	0.01-100	Irregular.	

COMMENTS: Complex alternating mineral layers: first formed is very fine-grained, interlocking marcasite crystals in layers. Upon these were nucleated colloform, botryoidal pyrite layers (up to 15 or 20) stacked on each other (defined by ultrafine gangue), and finally, upon this was nucleated a very coarse-grained, bladed colloform marcasite. Alternating pyrite and marcasite layers may be due to rapidly changing physico-chemical conditions.

169-1035F 8R-1, Piece 8 (48-52 cm)**Thin section:** #49**ROCK NAME:** Vuggy massive pyrite.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Total [percentage of sulfide in section: 90				
Pyrite	70	0.05-0.2		Replacing marcasite(?).
Marcasite	2	0.05-0.2	Colloform spheres and layers.	
Sphalerite	20	0.1-0.4		Possibly two generations, one Cu/Fe rich co-precipitating pyrite (heavily dusted with chalcopyrite), with pyrite, and a later sphalerite that cross cuts pyrite.
Chalcopyrite	2	0.025		Ultra-fine dustings in sphalerite.
Pyrrhotite	3	0.1		In late crosscutting veinlet.
Isocubanite	3	0.025		In late crosscutting veinlet; fills fracture in pyrite.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Clay minerals(?)	Trace	?		Brown and grungy.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Note: Void space is not considered in mineral percentages above.				
	10		Irregular	

COMMENTS: Possible paragenesis marcasite-pyrite-sphalerite-chalcopyrite-sphalerite-pyrrhotite/isocubanite. Heavily chalcopyrite-diseased sphalerite areas are localized around pyrite grains in contact with sphalerite.

169-1035F-11R-1, Piece 17 (112-119 cm)**Thin section:** # 52**ROCK NAME:** Sulfide-veined and disseminated, silicified mudstone.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Pyrrhotite	20	0.05-0.2		Disseminations, blebs, veins.
Chalcopyrite	Trace	0.05-0.2		Mutual boundaries with pyrrhotite.
Magnetite	Trace	0.05-0.1		Small, anhedral grains on other sulfides.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Quartz	40	0.05-0.3	Euhedral microlites.	
Smectite/clay	40	0.001		Matrix, interstitial to quartz.
Anhydrite sulfides.	Trace	0.05	Euhedral.	Small grains and fibers clustered in blebs with quartz and
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
	0			

COMMENTS: Highly silicified and clay altered mudstone with >10% sulfide blebs/impregnations and veins. Quartz has comb texture in veins and vuggy texture in groundmass. The cores of the "vugs" are sulfides. Quartz contains abundant two-phase fluid inclusions.

169-1035F-11R-1, Piece 4 (29-34 cm)**Thin section:** # 50**ROCK NAME:** Semi-massive banded sulfide with clay altered sediment.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Pyrrhotite	40	0.01-0.05		Interlocking anhedral grains and small inclusions in pyrite.
Pyrite	15	4		Either replaces pyrrhotite or vice versa; also crosscuts earlier pyrrhotite in late veinlet.
Sphalerite	5	0.05		Mutual boundaries with pyrrhotite.
Isocubanite	5	0.01-0.05		Mutual boundaries with pyrrhotite.
Chalcopyrite	3	0.001		Exsolution lamellae in isocubanite.
Hematite	Trace	0.01		Microlites and colloform layers as epitaxial growths on sulfides.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Smectite/clay	30	0.001		Very fine-grained matrix (replaces sediment), also interstitial to sulfides.
Anhydrite	2	0.1-0.3		Large, interlocking crystals in <1 mm, late vein crosscutting sulfides and also interstitial to sulfides in pockets.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Note: Void space is not considered in mineral percentages above.				
	3			

COMMENTS: Sulfide bands/veins are predominantly bedding/lamination parallel, although a later sulfide vein (same mineralogy) cuts these bands as a high angle. Pyrite later than/replaces pyrrhotite? Anhydrite vein is later than all the sulfides.

169-1035F-11R-1, Piece 12 (83-86 cm)**Thin section:** # 51**ROCK NAME:** Sulfide-veined mudstone.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Pyrrhotite	25	0.05-0.1		Intergrowth of laths in blebs and veins.
Chalcopyrite	Trace	0.05-0.1		Disseminated, isolated blebs.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Anhydrite	12	0.1-2		Coarse-grained, interlocking subhedral crystals in 1-3 mm wide vein which crosscuts the pyrrhotite.
Clays/smectite	60	0.01		Green-brown, very fine-grained matrix. More abundant nearest vein (envelope) and decreasing away from it.
Quartz	2-3	0.05-0.1		Euhedral, hexagonal cross sections. Lines vugs which are infilled by pyrrhotite.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
	0			

COMMENTS: Sulfide-veined mudstone crosscut by monomineralic anhydrite vein (later than all sulfides).**169-1035F-13R-2, Piece 1 (112-116 cm) (113-116 sic)****Thin section:** # 53**ROCK NAME:** Sandstone with disseminated sulfide impregnations.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Isocubanite?	1-2	<0.01		Authigenic; partly replaces earlier pyrite.
Chalcopyrite	Trace to 1	0.01		Exsolution lamellae in isocubanite.
Pyrite	Trace to 1	0.5		Authigenic; partly replaced by isocubanite/chalcopyrite.
Pyrrhotite	Trace	0.01		Overgrowths/rims on chalcopyrite/isocubanite, with which it displays mutual boundaries.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Quartz	47	0.5	Subhedral to anhedral.	Grains in groundmass intergrown with clay/smectite; extensive overgrowths; original detrital outlines are visible. In places, hexagonal quartz is surrounded by sulfides.
Clay/smectite	42	0.5		Groundmass; intergrown with hydrothermal quartz; interstitial to quartz grains from alteration of feldspars.
Epidote	Trace to 1		Anhedral.	Small grains in clay/smectite groundmass.
Feldspar	10	0.5		Highly altered
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
	0			

COMMENTS: Very silicified sediment with Cu-Fe sulfides in blebs. Medium-grained sandstone (cross and parallel laminated) with feldspars almost completely altered to clay minerals. All the quartz grains show syntaxial quartz overgrowths. Fine-grained volcanic rock fragments are still detectable although intensively altered. Former lithic arkose. Quartz has excellent primary and numerous secondary two-phase inclusions. Sulfides are interstitial to euhedral, hexagonal quartz.

169-1035F-19R-1, Piece 16 (105-108 cm)

Thin section: # 54

ROCK NAME: Epidotized sandstone.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 0</i>				
NON-OPAQUE MINERALOGY				
<i>Percentage of section: 100</i>				
Quartz	55	0.025	Anhedral.	Interlocking grains. Intergrown with clay/smectite.
Clay/smectite	40	<0.001		Groundmass, felted interlocking; intergrown with quartz.
Epidote	5	0.025	Subhedral to euhedral.	Disseminated in groundmass.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
	0			

COMMENTS: Fine-grained epidotized and clay altered sandstone.

169-1035G 2R-1, Piece 10 (60-64 cm)

Thin section: # 55

ROCK NAME: Massive vuggy pyrite.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Marcasite	60	0.01-0.2	Euhedral.	Vuggy intergrowth of marcasite with minor pyrite. Coarsest marcasite occurs as colloform crystalline bands around vugs and apparently following veins or cracks. Marcasite crystals line some anhydrite-filled vugs.
Pyrite	20	0.05-0.3	Euhedral.	In fine-grained cores of sulfide; remote from vugs.
NON-OPAQUE MINERALOGY				
Anhydrite	20	0.1-1		Orthorhombic crystals. Irregular large crystals of anhydrite fill vugs-usually polycrystalline masses. Single crystals sometimes fill non-connected (in 2D) vugs (i.e., are in optical continuity).
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Note: Void space is not considered in mineral percentages above.				
	10	0.1-0.5	Irregular.	Most pore space filled by anhydrite.

COMMENTS: Initial pyrite, replaced by marcasite, followed by marcasite crystals lining vugs, and lastly by anhydrite infilling. In some places the FeS₂ masses appear to pseudomorph a (now gone) hexagonal mineral (pyrrhotite, or possibly, but unlikely wurtzite). Two possible generations of marcasite however, an earlier one pre-pyrite and a later one lining vugs. (Pyrrhotite)-marcasite-pyrite-marcasite paragenesis. Also, sulfides could be overgrowing and replacing anhydrite in places.

169-1035G 4R-1, Piece 4 (20-25 cm)**Thin section:** # 56**ROCK NAME:** Massive vuggy pyrite/marcasite filled with anhydrite.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 25</i>				
Marcasite	20	0.01-0.03	Euhedral.	Crystalline network pseudomorphing tabular crystals, probably pyrrhotite.
Pyrite	5	0.01-0.02	Subhedral to euhedral.	Fine-grained, partly replacing marcasite.
Chalcopyrite	Trace	0.1	Anhedral.	Patches in marcasite; replaces marcasite.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 75</i>				
Anhydrite	75	4-6	Subhedral.	Crystalline masses infilling open space in vuggy marcasite/pyrite.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Note: Void space is not considered in mineral percentages above.				
	5-10			

COMMENTS: Open, sometimes interconnected network of tabular crystals, probably pyrrhotite, with a wood-grain texture replaced and overgrown by euhedral marcasite, giving the rock a vuggy/lacy texture. Minor pyrite replaces marcasite, and patches of later chalcopyrite occur within marcasite.

169-1035G 7R-1 (113-117 cm)**Thin section:** # 57**ROCK NAME:** Sandstone.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Fe-Ti oxides	18	0.063		Blebs.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Quartz	50	0.063		
Clay minerals, chlorite, Sericite	30	0.063		
Muscovite	2	0.033		Concentrated in laminae.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
	0			

COMMENTS: Parallel laminated fine-grained sandstone, very altered. Fine-grained texture of quartz with a "matrix" of clay minerals, chlorite and sericite. Fe-Ti oxides are randomly disseminated.

169-1035G-10R-1, Piece 6 (33-36 cm)**Thin section:** # 58**ROCK NAME:** Highly clay altered sediment(?)

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Magnetite	Trace	0.1		Disseminated
Hematite	Trace	0.1		Disseminated
Pyrrhotite	2-3	0.1-2		Disseminated and one 2-mm bleb.
Chalcopyrite	Trace	0.1		Disseminated.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Smectite/chlorite	95	<0.001		Predominant groundmass
Anhydrite	Trace to 1	0.05		Very fine euhedral tabular crystals, disseminated.
Epidote	Trace	0.05		Small, isolated subhedral crystals in smectite.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
	0			

COMMENTS: Highly clay altered mudstone with minor, very fine-grained, dispersed disseminations.**169-1035H-2R-1, Piece 6 (32-35 cm)****Thin section:** # 59 (polished slab)**ROCK NAME:** Sulfide breccia.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 50</i> Variable grain sizes, percentage, morphologies in different clasts, see comments below.				
Pyrite				
Marcasite				
Sphalerite				
Chalcopyrite				
Isocubanite				
Hematite +				
Fe-hydroxides				
Magnetite				
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 50</i>				
				Polished slab: too thick to determine mineralogy.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
				Note: Void space is not considered in mineral percentages.
	5			

COMMENTS: Roughly two different clast-types in the section, subrounded and with different content of sulfide minerals:

1) Sphalerite-pyrite-marcasite clast: Size of clast is 2 x 1 cm (cut by slab). Content is 55% sphalerite, 30% pyrite, 10% marcasite 5% chalcopyrite, 5% isocubanite, about 25% silicates and voids. Sphalerite is partly pseudo-hexagonal (crystallized as wurtzite). Pyrite is anhedral, partly forming fine-grained, dusty, elongated aggregates after earlier pyrrhotite, together with minor marcasite. Later pyrite has overgrown and merged these "lath-shaped" aggregates. Some euhedral pyrite-hedrons are present. Chalcopyrite occurs partly as extremely fine-grained very delicate, "dusky" dendritic disease in sphalerite. Grain sizes: Pyrite and sphalerite: 0.02-0.1 mm, Chalcopyrite: 0.001-0.02 mm.

2) Pyrite-chalcopyrite clasts: Sizes of clast 5 to 7 mm. 60-70 % pyrite, 15-25% chalcopyrite, 10% marcasite, 5% magnetite, 0-5% hematite. Open network of pyrite with minor marcasite replacing probably pyrrhotite or anhydrite. Cloudy concentric aggregates of chalcopyrite with cores of isocubanite. Magnetite and hematite in fine-grained intergrowth in cores of pyrite-laths. Thin veins of pyrite crosscut the chalcopyrite-isocubanite assemblage. Grain sizes: Pyrite: 0.02-1 mm laths, chalcopyrite: 0.03-0.2 mm (aggregate size).

Interstitial: Aggregates and anhedral grains of pyrite with minor sphalerite (locally chalcopyrite-diseased), chalcopyrite-isocubanite, magnetite, hematite.

169-1035H-2R-2, Piece 10 (55-61 cm)**Thin section:** # 60 (polished slab)**ROCK NAME:** Massive sulfide

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 50</i>				
Pyrite	17.5	0.005-0.5	Anhedral to subhedral.	In aggregates, fine-grained when replacing pyrrhotite. Associated with marcasite.
Marcasite	12.5	0.01-0.05	Anhedral.	Somewhat elongated grains.
Sphalerite	7.5	0.005-0.3	Anhedral to subhedral.	Partly octahedrons, some "dusty" chalcopyrite-disease, and dendritic growth of isocubanite.
Chalcopyrite + isocubanite	5	0.02-0.1	Anhedral to subhedral.	With isocubanite in core of chalcopyrite or vice versa. Few lamellar intergrowths. Occasionally with dendritic inclusions of pyrite or a nonsulfide. More isocubanite than chalcopyrite (60:40).
Hematite + Fe-hydroxides	4			Hematite, small laths and globular aggregates
Galena	1.5	0.005-0.02	Anhedral.	Inclusions in sphalerite, partly very fine, irregular intergrowth in pyrite.
Pyrrhotite	1.5			A few inclusions in pyrite.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 50</i>				
				Polished slab, therefore cannot determine mineralogy.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS

COMMENTS: Open to irregular network texture of pyrite and marcasite. Pyrite and marcasite are both occurring in elongated aggregates, pseudomorphic after a lath-shaped mineral, probably pyrrhotite. Locally a colloform banding, consisting of very fine-grained pyrite and sphalerite is present, now overgrown by coarser grained pyrite.

169-1035H-5R-1, (94-96 cm)**Thin section:** # 61**ROCK NAME:** Sediment with sulfide veins(?)

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Sphalerite	20	0.1-0.3	Anhedral.	Intergrown with pyrrhotite and chalcopyrite in vein; partly replaced by chalcopyrite.
Pyrrhotite	20	0.1-0.3	Anhedral.	Intergrown with sphalerite and chalcopyrite in vein; mutual boundaries with chalcopyrite.
Chalcopyrite	3	0.1-0.2	Anhedral.	Intergrown with sphalerite and pyrrhotite in vein; partly replaces sphalerite; exsolution lamellae in isocubanite.
Isocubanite	1	0.01	Anhedral.	Disease in sphalerite.
Native lead	One grain	0.01		From polishing lap??!!
Hematite	1	0.001	Anhedral.	Associated with sulfides.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Clay/smectite	46%	0.001-0.01		Very fine-grained groundmass intergrown with anhedral authigenic quartz.
Anhydrite	3%	0.1-2		1) isolated 1 mm long, tabular crystals in matrix; 2) clusters of small euhedra in patches; 3) euhedral, large, part of pyrrhotite-sphalerite-chalcopyrite vein.
Chlorite	Trace	0.1-0.2		Fibers, part of same pyrrhotite-sphalerite-chalcopyrite-anhydrite vein.
Quartz	5	0.01-0.05	Anhedral to euhedral.	Crystals. Anhedral grains intergrown with clay/smectite in groundmass, and euhedral variety associated with sulfides.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
	0			

COMMENTS: Chalcopyrite as microveinlets which crosscut sphalerite. Groundmass is fine-grained clay/smectite, with isolated anhydrites.

169-1035H-9R-1, Piece 8 (34-38 cm)**Thin section:** # 62 (polished slab) Most of the section was lost during polishing!**ROCK NAME:** Massive sulfide.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 75</i>				
Sphalerite	45	0.01 -0.05	Anhedral.	
Pyrrhotite	20	0.01-0.8	Anhedral.	Partly, fine-grained intergrown with sphalerite.
Isocubanite	8	0.005-0.8	Anhedral.	Straight boundaries (governed by sphalerite).
Unknown white phase	2 grains	0.002-0.004	Anhedral.	Probably anisotropic, inclusions in sphalerite.

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 25?</i>				
	Polished slab: too thick to determine mineralogy.			

VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
	0			

COMMENTS: Only about 20% of the section is present. The remaining consists of variable sized grains of pyrrhotite and isocubanite in a groundmass of sphalerite. Locally there is fine-grained intergrowth of pyrrhotite and sphalerite (grain sizes 0.02-0.05).

169-1035H-12R-1, Piece 13 (80-84 cm)**Thin section:** # 67**ROCK NAME:** Silicified and clay/smectite altered sandstone.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Hematite	Trace	0.01-0.03		Scattered, finely disseminated anhedral to subhedral grains, some broken (corundum from polishing?).
Pyrite	Trace	0.005-0.01	Anhedral to subhedral.	Scattered grains

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Clay/smectite	55	0.01		Colorless to light gray, very fine-grained matrix, intergrown with quartz to which it is interstitial.
Quartz	40	0.1	Anhedral.	Ragged to predominantly euhedral elongate, hexagonal crystals. Authigenic; intergrown with clay/smectite in groundmass.
Chlorite	Trace	0.2		Deep green, fibrous bundle intergrown with clay/smectite in groundmass.
Plagioclase	3-5	0.1	Anhedral.	Somewhat elongated grains, few twins.

VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Note: Void space is not considered in mineral percentages above.				
	2-3			

COMMENTS: Quartz-rich sandstone, laminated, with variations in content of clay + chlorite, and with quartz-rich laminae at 0.4-2 mm scale.

169-1035H-16R-1, Piece 9 (44-48 cm)**Thin section:** # 63 (polished slab)**ROCK NAME:** Massive sulfide.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 80</i>				
Sphalerite	48	0.005	Subhedral.	Equant grains in fine-grained intergrowth with pyrrhotite, otherwise anhedral.
Pyrrhotite	20	0.005-0.15	Anhedral.	Partly in granoblastic aggregates.
Isocubanite	8	0.001-0.02	Anhedral to subhedral.	With pseudo-hexagonal outlines.
Pyrite	2	0.02-1.0	Anhedral.	Associated with and overgrowing pyrrhotite.
Marcasite (?)	2	0.001-0.01		Mainly as inclusions in sphalerite, often associated with isocubanite in the same inclusion. Strongly anisotropic, with greenish-gray and brownish anisotropy colors, white color, same reflectivity as pyrite, scratching hardness greater than isocubanite, lower than sphalerite.

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 20</i>				
				Polished slab: too thick to determine mineralogy.

VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
	20	0.02-20.0	Irregular rounded.	Controlled by the sphalerite and pyrrhotite grains.

COMMENTS: Massive sphalerite-pyrrhotite sulfide, where pyrrhotite and other sulfides occur in a matrix of sphalerite. Irregular sphalerite-dominated patches are surrounded by fine-grained sphalerite-pyrrhotite intergrowth at a scale of 0.5-1.0 cm. Isocubanite and marcasite (the latter too fine-grained for certain identification) occur as fine-grained aggregates in the sphalerite-rich areas. Some pyrite is replacing pyrrhotite.

169-1035H-16R-2, Piece 18 (122-126 cm)**Thin section:** # 64 (polished slab)**ROCK NAME:** Semi-massive sulfide.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 40</i>				
Pyrite	18	0.2-2.0	Anhedral to subhedral.	Partly aggregates and grains with ragged outline and numerous inclusions of other sulfides (i.e. poikiloblastic).
Sphalerite	10	0.01-0.05	Anhedral.	Lots of inclusions of chalcopyrite, isocubanite and marcasite.
Pyrrhotite	4	0.001-0.02	Anhedral.	
Magnetite	6	0.005-0.25		Fine-grained aggregates, partly recrystallized to poikiloblastic larger grains.
Isocubanite + Chalcopyrite	2	0.005-0.01		Inclusions in sphalerite.
Marcasite	0.4	0.005-0.01		Inclusions in sphalerite.
Hematite	Trace	0.001-0.003		Tiny inclusions, laths in magnetite.

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 60</i>				
Carbonate	54	0.02-0.15	Irregular aggregates and mottled grains, amoeboid grain boundaries	
Talc	6	0.03-0.05	Fibrous aggregates.	

VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS

COMMENTS: Semi-massive pyrite=sphalerite, where pyrite forms porphyroblasts overgrowing and including sphalerite, magnetite and pyrrhotite. The larger grains are fractured and infilled by late pyrrhotite.

169-1035H-16R-3, Piece 9A (72-76 cm)**Thin section:** # 68**ROCK NAME:** Completely altered, porphyritic basalt/Mg-metasomatized mudstone.**Texture:** Porphyritic(?)**Grain size:** Cryptocrystalline to glassy.

PRIMARY (Original) MINERALOGY PHENOCRYSTS	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Plagioclase(?)	5	0.5-2	Euhedral/prismatic.	Completely altered (actinolite). Shadowy relict outlines only.
Clinopyroxene (?)	2	0.5-4	Euhedral.	Completely altered, pyrite, white mica, actinolite, zoisite.
GROUNDMASS	93	<0.01	Glassy/cryptocrystalline.	Completely altered to interwoven orthogonal mat of actinolite.
SECONDARY MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Actinolite	85	<0.01-0.1	Interwoven mat.	Very low birefringence, complex intergrowth.
Zoisite (?)	3	0.1	Granular-ragged/corroded.	Very low birefringence, oscillatory extinction, high relief.
Epidote	5	0.1-0.5	Prismatic-granular.	Bright mucus-green; dispersed throughout groundmass.
White Mica	1	0.05-1	Platy.	Associated with pyrite after clinopyroxene phenocrysts. Speckled extinction.
OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Pyrite	5	0.2-4	Prismatic-subhedral.	After phenocrysts and disseminated throughout groundmass.
Sphalerite groundmass.	1	0.01-0.1	Anhedral-ragged.	In irregular trails and finely disseminated throughout

COMMENTS: NOTE - This is a very unusual and difficult rock to describe and argument continues as to whether the rocks in this interval (1035H-16R-3 through to 19R-1) include highly altered basalts as well as strongly metasomatized and hydrothermally recrystallized sediments. The principal evidence that the original protolith was basaltic is the presence of large (2-3 mm), white prismatic grains clearly visible in hand specimen and suspected to be phenocrysts (plagioclase (?)). None of the original minerals remain in thin section, being completely replaced by microscopic mats of intergrown actinolite, with only shadowy outlines of the original crystal outlines preserved. Other suspected phenocryst phases (clinopyroxene (?)) are replaced by pyrite and white mica. This white mica has speckled extinction, and may be also an intergrowth of fibrous amphibole. The groundmass comprises a tightly interwoven mat of cryptocrystalline amphibole (actinolite/tremolite-XRD confirmation). This material has unusually low birefringence and slightly inclined extinction. In areas surrounding dispersed sphalerite grains and where amphibole appears to have replaced relict "hoppers" of igneous plagioclase, the birefringence is slightly higher (upper 1st order) perhaps reflecting increased iron content. Granular colorless zoisite as well as bright mucus-green epidote coexist within this section and are dispersed throughout the groundmass, though where these minerals are intergrown textures suggest that the epidote post-dates the zoisite. XRF analyses of this rock type indicate a sedimentary protolith from immobile element ratios (see "Igneous and Metamorphic Petrology" section, "Site 1035" chapter, this volume).

169-1035H-17R-1, Piece 20 (124-126 cm)**Thin section:** # 66**ROCK NAME:** Semi-massive sulfide.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Pyrite	60	<0.01-0.5	Anhedral to euhedral.	Cores in pyrite (partly replaces pyrite). Fills fractures in pyrite; partly replaces sphalerite and pyrite.
Pyrrhotite	5	0.01 to 0.1		
Sphalerite	10	<0.01-0.5	Anhedral to euhedral.	Rimmed by sphalerite. Overgrowths and partial replacements of pyrite. Contains exsolution lamellae of isocubanite.
Isocubanite	Trace	0.002-0.02	Anhedral.	Displays mutual boundaries with sphalerite; disease in sphalerite.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Fe-Actinolite?	25%	0.01-0.02		Very low to moderate birefringence, colorless to light grey-green; interwoven mats in colloform layers interlayered with colloform layers of sphalerite and lesser isocubanite and pyrrhotite; also as interwoven mats interstitial to sulfides.
Epidote	1-2	0.01-0.25		Bright green, colloform layers, pseudomorphs chlorite/smectite (interstitial to sulfides). Also as euhedral crystals with oscillatory zoning.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
	0			

COMMENTS: Sphalerite has pale yellow-orange cores and dark orange/brown rims. Actinolite matrix interstitial to sulfides. Identical mineral to that noted in thin section #68. No discernible sediment matrix or fragments. Large, euhedral epidotes have sulfide inclusions and also overgrow sulfides and, therefore, postdate them.

169-1035H-17R-1, Piece 6 (27-31 cm)**Thin section:** # 69**ROCK NAME:** Epidote-rich, sphalerite mineralized, hydrothermally altered mudstone or basalt.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Sphalerite	20	0.04-3	Granular to prismatic.	Exsolved blebby brown mineral. In veins and disseminated.
Isocubanite	1	0.01-0.4	Blebby, subhedral.	Exsolved and within sphalerite ("disease").
Pyrrhotite	3	0.04-3	Granular to prismatic.	Minor phase with sphalerite.
Marcasite	<1	3	Prismatic(?).	Uncommon coarse grains.

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Clay/Silt Groundmass	50	<0.001	Submicroscopic.	Hydrothermally altered and recrystallized siltstone-actinolite.
Epidote	26	0.04-0.5	Granular to prismatic.	Very bright mucus-green. Epidote-rich region comprises 60% of slide.

VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS

COMMENTS: Strongly hydrothermally altered, well-indurated siltstone. The submicroscopic groundmass is difficult to discern but comprises tightly intergrown chlorite and quartz. Relict sedimentary layering is present and these laminae are exploited by hydrothermal phases (epidote and sulfides). The thin section is divided by a sharply delineated infiltration/reaction front across which bleached light gray baked siltstone (40% of slide) is altered bright green and becomes epidote-rich (60% of slide). Within the light gray zone, epidote is sparsely present (5%), but dispersed, granular to prismatic, mucus-green epidote is abundant (30%) in the neighboring green zone. Epidote is regularly dispersed throughout the green region, though more concentrated along relict sedimentary layers. Epidote-rich tongues protrude into the gray zone along relict sedimentary layers. Epidote is most commonly present as scattered grains, but epidotic, clottish-concentrations are present, albeit rarely. Sphalerite (avec disease) is abundant (>20%) throughout the slide and is present in veins or concentrated along relict sedimentary layers. Blebs of isocubanite are exsolved from many of the coarser sphalerite grains. Minor pyrrhotite is present with sphalerite, within veins and layers. Sphalerite is red-brown in transmitted light indicating a moderate iron content. There is an intimate association between epidote alteration and sphalerite mineralization though this appears to represent two different though interacting and closely contemporaneous processes. Epidote developed in relation to a porous media process; sphalerite mineralization was generally along veins or layers (channels). Both minerals are intimately intergrown with sphalerite islands or inclusions within coarser grains of epidote and vice versa. The sphalerite distribution however, is not sharply delineated by the epidote-front and sub-vertical veins and mineralized layers cut across this boundary. These textures and mineral relations suggest that the epidote alteration and the sphalerite mineralization were either contemporaneous or that sphalerite precipitated at a slightly later stage of the same alteration event. XRF analyses of this rock type indicate a sedimentary protolith from immobile element ratios (see "Igneous and Metamorphic Petrology" section, "Site 1035" chapter, this volume).

169-1035H-17R-1, Piece 9 (48-51 cm)**Thin section:** # 65**ROCK NAME:** Sulfide-veined sediment.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Pyrrhotite	40	0.01-1	Anhedral.	Interlocking grains and anhedral inclusions in pyrite; pseudomorphs large pyrite cubes in places.
Sphalerite	10-15	0.05-0.1	Anhedral grains.	Late veins which crosscut pyrrhotite; displays mutual boundaries with pyrrhotite.
Pyrite	Trace	0.05-0.7	Anhedral to euhedral cubes.	
Isocubanite	Trace to 2	0.001-0.005		Disease and blebs in sphalerite, also at sphalerite grain boundaries.
Galena(?)	Trace	0.3		(White with blue cast) inclusion in sphalerite.

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Chlorite/clay/smectite	40-50	0.001		Matrix, interstitial.
Epidote	5-7	0.1-0.2		Large clots, interstitial to sphalerite.
Quartz	1-2	0.025-0.05	Anhedral grains.	Intergrown with clay/smectite groundmass.

VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
	0			

COMMENTS: Predominantly fine-grained pyrrhotite crosscut by later 1- to 2-mm-wide moderately high-Fe sphalerite veinlets. Sphalerite has high Fe cores, with lower, transparent middle zones, and darker, Fe-rich rims.

169-1035H-17R-3, Piece 17B (137-140 cm)**Thin section:** # 71**ROCK NAME:** Massive to semi-massive sulfide.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 60</i>				
Pyrite	33	0.5-5	Anhedral to subhedral.	Large porphyroblasts, partly poikiloblastic. Inclusions of magnetite and all the sulfides that otherwise occur in this section.
Isocubanite	6	0.001-0.5	Anhedral.	Large aggregates and small inclusions in sphalerite, partly like a "disease".
Magnetite	9	0.02-0.1	Anhedral to subhedral.	Lath-shaped partly in globular aggregates, replacing hematite. A few remnants of hematite are present in some of the magnetite laths.
Sphalerite	9	0.05-0.35	Anhedral to euhedral.	With cubic outline, partly with isocubanite "disease" which occasionally are surrounded by inclusion-free sphalerite
Pyrrhotite	3	0.01-0.15	Skeletal.	Poikiloblastic grains and aggregates, a few hexagonal grains.
Hematite	3	0.02-0.05	Lath- to wedge-shaped grains.	Mostly replaced by magnetite.
Chalcopyrite	Trace	0.001-0.01		Few inclusions in sphalerite, which is included in a large pyrite grain.

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 40</i>				
Chlorite	40	0.01-0.08		Laths and fibrous aggregates in a reticulated boxwork pattern, weak greenish color and pleochroism, anomalous blue to normal gray interference colors, optical (-) implies chlorite.
Fe-rich Carbonate or Anhydrite	Trace	0.005-0.01		Few scattered, anhedral, rounded grains (too small to identify with certainty).

VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Note: Void space is not considered in mineral percentages above.				
	5			

COMMENTS: Porphyroblastic pyrite dominates the section. Both sphalerite and pyrrhotite show grain growth. Hematite is replaced by magnetite. All are features suggesting prograde metamorphic conditions, e.g., increasing temperature, maybe accompanied by hot fluids.

169-1035H-17R-3, Piece 9 (60-64 cm)**Thin section:** # 70**ROCK NAME:** Massive sulfide.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 75</i>				
Sphalerite	50	0.005-0.08		Deep red-brown color, anhedral to subhedral with partially hexagonal outline, generally occurring in a granoblastic texture.
Pyrrhotite	8	0.2-1.0	Anhedral, skeletal to poikiloblastic grains and aggregates.	Inclusions of sphalerite, magnetite and chlorite.
Pyrite	7	0.2-0.8	Anhedral, poikiloblastic.	With small inclusions of sphalerite and minor magnetite.
Magnetite	5	0.02-0.15		Scattered anhedral to subhedral grains, partially diamond shaped, poikiloblastic with inclusions of pyrrhotite, sphalerite inclusions.
Isocubanite	3	0.004-0.2		Scattered anhedral grains in sphalerite.
Chalcopyrite	2	0.004-0.01		Scattered grains in sphalerite.

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 25</i>				
Chlorite	23	0.01-0.05		Reticulate boxwork, normal gray interference colors, optical (-) implies Fe-rich.
Carbonate	2	0.2-0.5		An aggregate of three grains.

VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Note: Void space is not considered in mineral percentages above.				
	7			

COMMENTS: Partially recrystallized granoblastic matrix of sphalerite, in which pyrrhotite, pyrite and magnetite form poikiloblastic grains. Typical of rapid grain growth, metamorphic.

169-1035H-19R-1, Piece 12 (58-62 cm)**Thin section:** # 72 (Polished Slab)**ROCK NAME:** Massive to semi-massive sulfide.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 80</i>				
Pyrrhotite	25	0.01-0.05	Anhedral.	Mainly granoblastic aggregates.
Isocubanite	55	0.01	Aggregates.	Recrystallized.
Bi-telluride (probably Tetradymite)	one grain	0.02	Anhedral.	Very high reflectance, white with a yellowish tinge, soft (lots of scratches), anisotropic, with brown to blue anisotropy colors (distinctive!).
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 20</i>				
Chlorite	5	0.02-0.05	Laths, lepidoblastic.	Anomalous blue interference colors, optical (-)implies Fe-rich.
Clinoamphibole	15	0.01-0.03	Needles and fibrous.	High 1st to 2nd order interference colors, probably Mg-rich.
Quartz	Trace		Euhedral crystals.	
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
	0			

COMMENTS: Massive pyrrhotite-isocubanite, recrystallized into a granoblastic assemblage, partly pseudomorphing a coarse-grained elongated, lath-shaped mineral. Somewhat ragged outlines of the sulfides against silicate patches.

169-1035H-21R-1, Piece 19 (94-99 cm)**Thin section:** # 73**ROCK NAME:** Massive to semi-massive sulfide.

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 50</i>				
Chalcopyrite	10	0.05-0.5 0.002-0.02		Lamellae in isocubanite.
Isocubanite	35	0.05-0.5		Aggregates of anhedral grains, seems to have recrystallized or replaced former elongated large crystals (size 0.5-1.5 mm)
Anatase (+ rutile?)	5	0.02-0.05		Small needles, often forming inclusions in quartz (rutile?), some more irregular aggregates (anatase).
Ilmenite	Trace	0.03-0.05	Elongated grains.	(Cut plates).
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Percentage of section: 50</i>				
Quartz	20	0.01-1.0	Euhedral.	Sometimes doubly terminated.
Clinoamphibole	30	0.02-0.1	Fibrous.	Needle shaped in felted aggregates. Very weak green pleochroism, Z ^c about 10 degrees suggest cummingtonite.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
	0			

COMMENTS: Semi-massive Cu-sulfides, at least partly recrystallized or replacing an former phase with elongate grain shape. The matrix is well recrystallized to euhedral quartz and clinoamphibole.

169-856H-19R-01, Piece 10 (60-64 cm)**Thin section: # 1****ROCK NAME:** Massive sulfide (pyrrhotite-chalcopyrite)

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Pyrrhotite	55	0.05-0.1	Anhedral.	Equant grains, pseudo-granoblastic texture. In places occurs as vestigial inclusions in pyrite.
Chalcopyrite	20	0.1-0.5	Anhedral.	Exsolution lamellae of isocubanite.
Pyrite	8	<0.01-0.1	Anhedral to subhedral.	Partially fine-grained aggregates of "zwischen-produkt"(?), grayish, mottled. In some places incipiently replaces pyrrhotite along fractures and veins (in areas almost completely). Can see pyrite reentrants along crystal planes (cleavages) in pyrrhotite. Lamellae in chalcopyrite and also in cores of large chalcopyrite grains.
Isocubanite	9			
Magnetite	2	<0.01-0.1	Anhedral to euhedral.	
Hematite	1	<0.01-0.03	Subhedral.	Bladed, in aggregates, rare globules; ragged, incipient alteration of magnetite grains.
Marcasite	?	?	Euhedral.	Grains.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Anhydrite	a few grains	< 0.01	Anhedral.	Single grains (lower interference colors than carbonate).
Carbonate	< 1	≤ 0.01	Anhedral.	Aggregates with granoblastic texture.
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
	5			

COMMENTS: Generally monomineralic fields of pyrrhotite and chalcopyrite with some pyrite. Pyrite is typically found along the boundaries of the fields, replacing pyrrhotite. Aggregates of less reflective, grayish, very fine-grained pyrite, is first formed and crystallizes to more coarse grains (Ramdohr: "zwischen-produkt"). Magnetite and hematite are generally contemporaneous with the pyrite replacement. Pyrite also occurs in late veins, typically crosscutting the "granoblastic" pyrrhotite texture. Chalcopyrite is exsolved in isocubanite, forming a "tartan" or grating pattern, locally filling 30%-40% of the chalcopyrite grains. The isocubanite in places is almost totally replaced by chalcopyrite.

169-856H-20R-1, Piece 3b (32-36 cm)**Thin section: #2****ROCK NAME:** Sulfide-veined and impregnated siltstone

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Total percentage of section: 15-20</i>				
Pyrrhotite	60	<0.05-0.2	Subhedral to euhedral laths.	Elongate crystals.
Chalcopyrite	15	0.05	Anhedral.	
Isocubanite	25	0.05	Anhedral.	
Hematite	<1		Subhedral to euhedral, laths.	
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Total percentage of section: 80-85</i>				
VEIN:				
Quartz	-	0.05-0.15	Euhedral.	
Chlorite	-	0.01-0.05	Anhedral to subhedral.	Orbicular, fibrous aggregates, weak yellow, 1st order yellow interference colors. Less than 1 mm selvage around vein. Same chlorite as in siltstone.
SILTSTONE:				
Quartz	55 (Q+P)	0.02-0.05	Anhedral to subhedral.	Partially recrystallized.
Plagioclase		0.03-0.05	Subhedral.	Carlsbad twinning.
Chlorite	45	0.02-0.03	Anhedral to subhedral.	Orbicular, fibrous aggregates, weak yellowish color, 1st order yellow interference colors.
Sphene, anatase or leucoxene	1-2	<0.05 (aggregates)		Weak brown very fine-grained aggregates.

COMMENTS: Few mm-wide veins and impregnations of isocubanite/chalcopyrite and pyrrhotite in siltstone. The siltstone consists mainly of quartz and chlorite, with minor plagioclase and scattered grains of Ti-oxides. Chlorite typically forms orbicular aggregates. Quartz in the siltstone is partially recrystallized (some equant grains), especially close to the veins and impregnations of sulfide. Close to veins the chlorite content increases and a 0.5 -1.0 mm-thick, mainly chlorite selvage is formed. In the sulfide veins local zonation is observed with isocubanite/chalcopyrite in the middle and pyrrhotite at the edges. Also this assemblage seems to be pseudomorphic after rhombic or monoclinic elongated crystals, possibly early formed pyrrhotite. Intergrowths of isocubanite and chalcopyrite (chalcopyrite lamellae in isocubanite) mimic crystallographic orientations. Quartz is generally euhedral, suggesting hydrothermal recrystallization. Planes of very small (<4 µm) two phase fluid inclusions crosscut some euhedral quartz grains. (NB! section too thick)

169-856H-21R-1, Piece 5b (54-58 cm)

Thin section: #3

ROCK NAME: Sulfide-veined siltstone

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Total percentage of section: 35</i>				
Chalcopyrite	40	<0.01-0.3	Anhedral.	Exsolution texture with isocubanite.
Isocubanite	20	<0.01-0.3	Anhedral.	Exsolution texture with chalcopyrite, distinct pinkish tinge compared to pyrrhotite, isotropic.
Pyrrhotite	30	<0.01-0.3	Anhedral to subhedral.	Few twins.
Pyrite	10	<0.001-2 to 3	Anhedral to euhedral.	Cubes.
Hematite	<1	0.01-0.5		Orbicular aggregates.
NON-OPAQUE MINERALOGY				
MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Total percentage of section: 65</i>				
SEDIMENT:				
Feldspar-plagioclase	50	<0.01-0.05	Anhedral.	Some albite twinning.
Clays and chlorite	50	?		Very fine-grained aggregates, colorless to light greenish gray.
Epidote	Trace to 1	0.01-0.03	Euhedral.	Prismatic crystals in clays and chlorite.
VEIN:				
Chlorite	85% of vein	<0.001-0.03		Around vein; occurs with quartz; anhedral, green brown, with anomalous blue birefringence.
Quartz	10% of vein	0.05-0.15	Euhedral.	Around vein, occurs with chlorite.
Carbonate (calcite(?))	5% of vein	0.5		Uniaxial, 2nd order interference (section not true thickness); 1) concentrically zoned sphere, interbanded with pyrite; 2) clusters of euhedral grains in veins.
Epidote(?)	Trace	0.01	Prismatic needle.	Colorless, second order interference colors.
Barite(?)	1% of vein	0.05	Anhedral.	Mottled extinction, very low 1st order interference colors, biaxial(+).

COMMENTS: Generally a network of chalcopyrite-isocubanite veins, with lesser amounts of pyrrhotite and pyrite. In isocubanite-dominant parts of veins, chalcopyrite forms thin exsolution lamellae in the isocubanite and occurs along fractures and grain boundaries at the expense of isocubanite, together with larger grains of pyrrhotite and often pyrite. In chalcopyrite-dominant parts of veins, large subhedral grains of pyrrhotite occupy the central parts, surrounded by chalcopyrite, the latter with lamellae of isocubanite in the central part of the grains, again following crystallographic directions. Small, very irregular aggregates of pyrrhotite occur along the grain boundaries to the chalcopyrite, but also as inclusions in the grains, sometimes difficult to distinguish from the isocubanite, because of the small grain size. Often the smaller pyrrhotite grains are found close to the larger pyrrhotite grains. Pyrite is less commonly associated with this assemblage than with the isocubanite dominant one. A few late veins of pyrite crosscut the earlier chalcopyrite-isocubanite veins. Late hematite is formed along grain boundaries at the expense of iron sulfides. The veins have formed in a siltstone, original mineralogy of quartz, feldspar, clays, and chlorite are preserved, as well as bedding shown by mineralogical variations (viz., quartz-feldspar and clay minerals). Close to veins a fibrous partially radiating selvage of green to dark brown chlorite has formed at the expense of siltstone, as well as overprinting earlier euhedral quartz crystals (euhedral shapes preserved in chlorite aggregates). Selvage thickness varies with quartz content in siltstone (0.2 to 0.5 mm). Sulfide impregnations develop mainly in the quartz-feldspar rich layers.

169-856H-21R-1, 80-84 cm**Thin section: #4****ROCK NAME:** Chalcopyrite-isocubanite mineralization/sulfide-veined siltstone

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Total percentage of section: 85</i>				
Chalcopyrite	35	0.01-0.5	Anhedral.	Ragged to straight boundaries, lamellae in isocubanite.
Isocubanite	30	0.01-0.5	Anhedral.	Ragged to straight boundaries, lamellae in chalcopyrite.
Pyrrhotite	15	0.02-0.6	Anhedral to subhedral.	
Pyrite	10	0.01-0.6	Anhedral to euhedral.	
Magnetite	3	<0.001-0.05	Anhedral.	In small blebs, aggregates to single grains, often intergrown or replaced by hematite. Also very fine grains intergrown with pyrite.
Hematite	7	<0.001-0.03	Anhedral to euhedral.	Aggregates, blebs, partly in globular aggregates of euhedral lath-shaped crystals.
Marcasite	<1	0.01	Subhedral.	Inclusions in pyrite, distinct greenish reflection pleochroism and bluish strong anisotropy.
NON-OPAQUE				
MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Total percentage of section: 10</i>				
Chlorite I or clay-min?	30	0.005-0.01		Very fine-grained, felty aggregates, very low first order blue-gray interference colors.
Chlorite II	70	<0.005		Very fine-grained, felty aggregates, first order gray-yellow interference colors.
Sphene	1	-	Subhedral to euhedral.	Biaxial, colorless, weak brown color.
Epidote/(prob. clinozoisite)	Trace	-	Anhedral.	Occurs in veins.
Quartz	Pockets	-	Anhedral.	
Carbonate	Few grains	0.02	Anhedral.	
Barite	< 1	0.01-0.02	Anhedral.	Aggregates of several grains, mottled, low first order interference colors, biaxial(+), low angle.
VOID				
SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
	5			Occurs in massive sulfide veins.

COMMENTS: Generally a massive chalcopyrite-isocubanite vein with minor amounts of pyrite, pyrrhotite, magnetite, and hematite. Chalcopyrite and isocubanite are exsolved in each other, following crystallographic orientations. Larger grains of pyrrhotite and pyrite occur in chalcopyrite dominant parts of the section. Chalcopyrite is formed at the expense of isocubanite along grain boundaries and fractures. Generally pure chalcopyrite around pyrrhotite and pyrite grains. Hematite is found along fractures and grain boundaries in the isocubanite-chalcopyrite assemblage, replacing magnetite, and may have formed contemporaneously with chalcopyrite, as well as replacing chalcopyrite. The chalcopyrite-isocubanite-hematite-magnetite assemblage is overgrown by later pyrrhotite, as well as late stage pyrite. Pyrite replacement of pyrrhotite often occurs along cleavage planes, forming "fingers" in the pyrrhotite. Two types of chlorite occur. Chlorite II is a felty mass with first order gray-yellow colors, replacing an earlier chlorite (chlorite I) with extremely low first order blue gray color, which could indicate a clay mineral.

169-856H-22R-2, Piece 7B (57-60 cm)

Thin section: #5

ROCK NAME: Sulfide-veined siltstone

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Total percentage of section: 40</i>				
Chalcopyrite	45	≤0.2	Anhedral.	
Isocubanite	10	≤0.01-0.05	Anhedral.	Exsolved in chalcopyrite in irregular patches.
Pyrite	5	≤0.02	Anhedral to subhedral.	
Pyrrhotite	40	0.01-0.4	Anhedral to subhedral.	
Magnetite	Trace		Anhedral.	Associated with pyrrhotite.
Ilmenite	1	0.02	Subhedral.	In veins crosscutting sulfide assemblage.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Total percentage of section: 60</i>				
Chlorite I	45	≤0.01		Felty to fibrous aggregates, green yellow, pseudomorphic replacement of equant-grained mineral (quartz?).
Chlorite II	5	≤0.02		Fibrous, in veinlets, colorless.
Quartz	50 (Q+P)	≤0.02	Anhedral to euhedral.	Euhedral close to and in sulfide veins/disseminations.
Plagioclase		≤0.02	Anhedral to subhedral.	Albite twinning.
Sphene/rutile	Trace		Euhedral.	In sulfide veins.
Epidote(?)	Trace		Anhedral	

COMMENTS: Cm-wide vein and mm-wide veinlets of chalcopyrite with minor exsolution of isocubanite and grains of pyrrhotite crosscut siltstone. Pyrrhotite overgrows an earlier chalcopyrite-isocubanite assemblage, together with pyrite. Thin veins of ilmenite partially replaced by sphene(?) crosscut the sulfide assemblage. The siltstone comprises mainly quartz and chlorite or clay minerals with minor plagioclase. Selvages of brownish green chlorite with some epidote(?) are present adjacent to major veins. Chlorite is also replaces a euhedral mineral, probably quartz (less likely amphibole or pyroxene), according to crystal shape. Thinner veins and veinlets are rimmed by euhedral fine-grained quartz, which grows into the veins (cockade structure), indicating open space filling.

169-856H-23R-1, Piece 18 (94-98 cm)

Thin section: #6

ROCK NAME: Sulfide-veined siltstone

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Total percentage of section: 20</i>				
Chalcopyrite	65	0.02-0.06	Anhedral.	Ragged, ratty grains interstitial to quartz and albite; finely disseminated throughout groundmass of host rock along grain boundaries and fractures in chalcopyrite.
Isocubanite	15	<0.01		Partly strongly anisotropic, anhedral to euhedral lath shaped.
Pyrrhotite	15	0.01-0.02		Cubes, skeletal intergrowth with quartz in places.
Pyrite	5	0.01-1.0	Subhedral to euhedral.	Cubes and laths, anisotropic; occurs 1) in late fractures in chalcopyrite/isocubanite vein; 2) as inclusions in chalcopyrite/isocubanite vein.
Marcasite	Trace to 1%		Euhedral.	Rounded anhedral blebs along incipient fractures in chalcopyrite/isocubanite vein.
Magnetite	Trace			Ragged anhedral grains lining fractures which crosscut chalcopyrite/isocubanite vein.
Hematite				Interstitial to quartz; deep red orange tarnish, contains exsolution lamellae.
Bornite(?)	Trace		Anhedral.	
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Total percentage of section: 80</i>				
Quartz	40 of all section			1) Ragged, anhedral subequant grains; 2) hexagonal crystals in veins.
Chlorite				Clear to orange, brown, and yellow ragged felted patches and radiating bundles of fibers; anomalous Berlin blue birefringence indicates Fe-rich nature; occurs with chalcopyrite blebs.
Sphene with leucoxene	2-5 of all section			Ragged clusters of agglomerated anhedral grains with leucoxene scum, often surrounding chalcopyrite grains. Veinlets in sulfide veins.
Epidote	2 of all section			Ragged patches of clusters or anhedral grains; occurs as overgrowths on chalcopyrite; high relief, yellowish brown green.
Carbonate(?) or is it all sphene				Ragged, anhedral patches in groundmass.
Rutile	?		Needles.	
Albite(?) or quartz	5-7 of all section		Tabular laths.	Replacement of detrital feldspars(?).

COMMENTS: <1-mm to 4- or 5-mm-wide veins (rectilinear) in altered sediments. Vein fill consists of rare hexagonal quartz (open space filling) with chalcopyrite, pyrrhotite, and isocubanite. Contains primary two-phase, 2-4 μm fluid inclusions in subhedral quartz crystals in the groundmass. Thin section slightly too thick. Hematite veins crosscut marcasite-lined veins. Skeletal, fine-grained intergrowth between pyrite and quartz, adjacent to veins.

169-856H-24R-2, Piece 10 (77-80 cm)**Thin section: #7**

ROCK NAME: Hydrothermally altered siltstone with minor sulfide veins and disseminations

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Total percentage of section: (not provided)</i>				
Chalcopyrite	Trace to 1	0.01-0.1	Anhedral.	Grains displaying mutual boundaries with pyrrhotite. Interstitial to quartz.
Pyrrhotite	1 to 2	0.01-0.1	Anhedral.	Grains displaying mutual boundaries with chalcopyrite. Interstitial to quartz.
Magnetite	Trace	0.02-0.03	Anhedral.	Inclusions in pyrrhotite.
Hematite	Trace	0.02		1) Fine needles occurring at the periphery of chalcopyrite and pyrite which occur in patches or drusy pockets with quartz; 2) anhedral grains incipiently replacing pyrrhotite along grain boundaries and fractures.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Total percentage of section: (not provided)</i>				
Quartz	25-30 of section	0.05 - 0.1		1) Ragged, anhedral grains intergrown with clays; 2) isolated euhedral tabular crystals and intergrowths of crystals in patches, likely replaced after original detrital feldspars; patches may be small original lithic fragments. Certain laminae are particularly quartz rich; 3) euhedral, hexagonal, elongate crystals in drusy pockets with sulfides.
Chlorite I	60-70			Extremely fine-grained, very light gray, translucent, intergrown with quartz in groundmass.
Chlorite II	1 to 3	0.05		Yellow-brown, anhedral grains and fibers interstitial to sulfides.

COMMENTS: Hydrothermally altered, fine-grained sediment with narrow crosscutting microveinlets of sulfide and fine-grained disseminations of sulfide. Contains relatively large (10 µm) two-phase inclusions in quartz.

169-856H-31R-1, Piece 7a (48-52 cm)**Thin section: #8**

ROCK NAME: Sulfide-banded sandstone

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Total percentage of section: 40</i>				
Unknown Cu-Fe sulfide	65	0.5-2.0	Anhedral to subhedral.	Lath or blade-shaped, lamellae of chalcopyrite along crystallographic orientation. Isotropic, cream yellow (as pyrite), reflectivity as chalcopyrite.
Chalcopyrite	35	<0.01-0.05		Lamellae in unknown phase (width of lamellae).
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Total percentage of section: (not provided)</i>				
Rutile	1-2	<0.00.1-0.2	Anhedral.	Aggregates to euhedral needles, twinning.
Quartz	12-13	0.2-0.4	Euhedral.	Inclusions of rutile common, associated with sulfides. Anhedral in chlorite matrix, mottled, deformed?
Chlorite	85	≤0.4		Fibrous aggregates, colorless, 1st order gray interference colors.
Muscovite	1	0.01-0.1		Fibrous aggregates and grains, 3rd order interference colors. Forms from chlorite.
Barite	1-2	0.2-0.6	Euhedral.	Barrel-shaped crystals, colorless, low birefringence similar to quartz, one good cleavage, with abundant, elongate, two-phase fluid inclusions; surrounded by sulfides.
Epidote	1	0.01-0.1	Anhedral.	Grains in chlorite.
Calcite	Trace	0.15		Patch of intergrown anhedral grains in chlorite.
Brookite	Trace	0.1	Anhedral.	Irregular grains interstitial to sulfides.
Anatase	Trace	0.1	Anhedral.	Irregular grains interstitial to sulfides.
Apatite	Trace	0.05		Clusters of tabular, euhedral crystals in late quartz within chlorite; very low birefringence, uniaxial negative.

COMMENTS: Veins and veinlets of Cu-Fe sulfides in matrix of mainly chlorite with minor quartz and lesser barite. Sulfides composed of primarily unknown isotropic, cream-white phase with lamellae of chalcopyrite along crystallographic directions. Mg-rich chlorite comprises 85% of the matrix. Euhedral quartz crystals, typically with inclusions of rutile, are associated with the sulfides. Quartz in the matrix has irregular grain shapes and is mottled under cross polars which suggests deformation. Some muscovite is overgrowing the chlorite forming aggregates. Barite crystals have excellent, needle-like, elongate, two-phase fluid inclusions along cleavages.

169-856H-31R-2, Piece 1 (1-5 cm)**Thin section:** #9**ROCK NAME:** Sulfide banded sandstone

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Total percentage of section: 40</i>				
Unknown Cu-Fe sulfide	80	≤0.02-0.4	Anhedral.	Rounded, lobate grains with exsolution lamellae of chalcopyrite, width of lamellae ≤0.02 mm following crystallographic directions in the mineral. Isotropic, cream yellow (as pyrite), reflectivity as chalcopyrite. Lamellae in unknown phase.
Chalcopyrite	20			
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
<i>Total percentage of section: 55</i>				
Chlorite	97-98	0.02-0.1		Felty, fibrous aggregates, 1st order gray, colorless.
Sphene	1	1	Anhedral.	Colorless.
Quartz	Trace to 1			Authigenic, hexagonal.
Anatase	1-2		Anhedral.	Colorless to brown, partly needly to euhedral.
Rutile	Trace		Needles.	
K-feldspar	Trace			

COMMENTS: Veinlets and rich impregnation of sulfides in a matrix of chlorite with trace amounts of quartz and accessory anatase and sphene (based on optical properties). Unknown isotropic cream-white phase is the major sulfide with exsolution lamellae of chalcopyrite.

169-856H-35R-1, Piece 17 (107-110 cm)**Thin section:** # 10**ROCK NAME:** Chloritized arkose

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Chalcopyrite, Pyrite	Trace	<0.015	Anhedral.	Chalcopyrite included in quartz grains.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Quartz	50	0.06-0.10	Anhedral.	Recrystallized grains.
Chlorite/smectite	40			"Groundmass" interstitial to quartz replacing feldspar and/or protomatrix(?). Scattered.
Chlorite	Single crystals			
Ti oxides (Anatase(?))	Trace		Anhedral to euhedral.	

COMMENTS: Fine parallel/cross laminated texture. Chlorite more abundant in silty-clayey laminae whilst quartz is more abundant in fine-grained sand laminae. Quartz, although affected by extensive overgrowths, is the only primary detrital mineral preserved. The fine-grained dull "groundmass" with scattered bluish (crossed nicols) chlorite crystals likely consists of a chlorite smectite mixture probably derived from alteration of detrital feldspar grains and matrix.

169-856H-39R-1 Piece 9 (82-85 cm)**Thin section:** # 11**ROCK NAME:** Chloritized arkose

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Pyrite, Chalcopyrite, Pyrrhotite	Few grains	<0.02	Anhedral.	Associated with quartz.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Quartz	40	0.06-0.1		Clastic, with preserved quartz overgrowths.
Chlorite/smectite	60			Surrounds quartz grains muscovite/sericite.
Anatase	2	<0.05	Anhedral to euhedral.	??

COMMENTS: See thin section 169-856H-35R-1, 107-110 cm (#10). The only difference is that muscovite/sericite microlamellae are present in the "groundmass".

169-856H-43R-1, Piece 6c (70-75 cm)

Thin section: # 12

ROCK NAME: Arkose

OPAQUE MINERALOGY				
MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Pyrite	1	0.1	Euhedral, cubes.	
Chalcopyrite	Trace	0.01	Anhedral.	
NON-OPAQUE MINERALOGY				
MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Quartz	30-40	0.06-0.125		Clastic, subrounded with chlorite overgrowths.
Muscovite	15-20	0.06-0.125		Coarse-grained lamellae, generally felty, rounded aggregates, that suggest pseudomorphs after clastic feldspar grains.
Chlorite	5	0.05-0.2		Lamellar with blue 1st order interference colors, interstitial to quartz and feldspar.
Clay mineral/chlorite(?)	40-45	≤0.01		Very fine-grained felty aggregates, low 1st order gray interference colors.
Rutile, Anatase	1	<0.05	Anhedral.	Cloudy, some euhedral grains.

COMMENTS: Very homogeneous siltstone, without any recognizable lamination. Quartz is the only detrital phase. Aggregates of felty muscovite and clay minerals may have replaced detrital feldspar in the matrix.

169-856H-47R-2, Piece 5 (40-43 cm)

Thin section: # 13

ROCK NAME: Arkose

OPAQUE MINERALOGY				
MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Pyrite	Trace	<0.02	Anhedral.	Small grains associated with a quartz aggregate.
Chalcopyrite	Trace	<0.01	Anhedral.	Few scattered grains.
NON-OPAQUE MINERALOGY				
MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Quartz	30-40	0.125-0.25		Clastic with quartz overgrowths.
Sericite	35-45	0.125-0.25		Clastic, altered. After feldspar.
Chlorite	10	0.125-0.25	Pseudomorphic.	After plagioclase(?).
Matrix	5-10	<0.06	Interstitial.	Epimatrix (Dickinson, 1970).

COMMENTS: Detrital quartz grains show quartz overgrowths. Feldspar grains, although strongly sericitized, are in some places still recognizable as plagioclase. Chlorite is present in two forms, as bluish pseudomorphous crystals and, as thin continuous rims around detrital grains. [Reference: Dickinson, W.R., 1970. Interpreting detrital modes of graywacke and arkose. *J. Sediment. Petrol.*, 40:695-707.]

169-856H-54R-1, Piece 4 (12-16 cm)

Thin section: # 14

ROCK NAME: Mudstone

OPAQUE MINERALOGY				
MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Pyrrhotite	Trace			
Leucoxene	Trace			
Chalcopyrite	Trace			
NON-OPAQUE MINERALOGY				
MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Quartz	30	0.01-0.02	Anhedral.	Rounded grains.
Chlorite I	30	<0.005		Extremely, fine-grained unoriented, felty mass, 1st order gray interference color.
Chlorite II	20	0.01-0.04		Lamellar, deep blue interference colors suggests high Fe-content, (maybe some trace elements too)? Associated with pyrrhotite.
Clay mineral(?)	20	<0.005		Extremely fine-grained masses, 1st order yellow interference colors.

COMMENTS: Generally a mudstone, with quartz partially overgrown by chlorite and clay as only detrital mineral. Irregular patches of more coarse-grained, well-crystallized chlorite with a deep blue abnormal interference color, make up approximately one third of the section.

169-856H-55R-1, Piece 4 (22-26 cm)**Thin section:** #15**ROCK NAME:** Very highly altered, aphyric, fine-grained basalt**GRAIN-SIZE:** Fine-grained**TEXTURE:** Subophitic to variolitic

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Pyrrhotite	Trace	≤0.05	Subhedral laths.	
Ilmenite	<1	≤0.01	Subhedral to anhedral laths.	
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
PHENOCRYSTS	None			
GROUNDMASS (Primary)				
Clinopyroxene(?)	Trace	0.2	Stubby to subhedral.	Completely replaced by chlorite (± mixed layer clays?) and microgranular quartz.
Plagioclase	50	0.2-1	Acicular laths.	Completely altered to chlorite, and quartz.
Titanomagnetite	10	≤0.02	Irregular granules.	Replaced by titanite.
Mesostasis	40			Completely altered to quartz, chlorite, and titanite.
SECONDARY MINERALS				
Quartz (± albite)	35	0.2-1		Plagioclase laths pseudomorphically replaced by quartz (± albite) and chlorite.
Chlorite	50	0.2-1		Chlorite also replaces titanite of the primary groundmass with abundant microgranular titanite.
Titanite	15			

COMMENTS: Very highly altered, fine-grained basalt, almost completely replaced by secondary minerals (chlorite, quartz, and titanite) though a relict igneous texture is preserved due to the pseudomorphic replacement of the plagioclase lath framework by chlorite and quartz. The mesostasis comprises a cryptocrystalline intergrowth of nearly indistinguishable microgranular quartz, chlorite, and titanite. Secondary plagioclase may be present (recognized by rare albitic twins) but this may also be quartz pseudomorphs after plagioclase. The thin section is crosscut by a 2 mm barren chlorite vein that includes slithers of basaltic wall rock in progressive stages of silicification and chloritization. Basalt is more highly altered (chloritized) along the vein margins (>2 mm halo). 15-mm-wide quartz + chlorite + titanite (+ rare chalcopyrite) region developed on one side of chlorite vein. Primary igneous texture in this region obliterated due to replacement by granular quartz-rich and other chlorite-rich patches. Slide contains abundant bubbles in epoxy.

169-856H-55R-1, Piece 19 (134-138 cm)**Thin section:** #16**ROCK NAME:** Completely aphyric, fine-grained basalt**GRAIN-SIZE:** Fine-grained**TEXTURE:** Intersertal to subophitic

OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Ilmenite	1-2	≤0.25	Subhedral laths.	Replaced by microgranular titanite.
NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
PHENOCRYSTS	None.			
GROUNDMASS (Primary)				
Plagioclase	50	0.2-1	Laths to stubby.	Completely altered to chlorite, and quartz.
Clinopyroxene (+ mesostasis(?))	40	0.2-1	Subhedral-irregular.	Completely altered to chlorite + quartz + brown clay + titanite.
Titanomagnetite	8	0.1	Subhedral.	Rimmed and replaced by microgranular titanite.
SECONDARY MINERALS				
Quartz	60	0.05-1		Plagioclase laths pseudomorphically replaced by chlorite and quartz. Altered mesostasis/clinopyroxene comprises a microgranular mass of irregular quartz, chlorite, brown clay, and titanite.
Chlorite	30	0.1-1		
Brown Clay	10	0.5		
Titanite	10	0.1		
VOID SPACE	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Vesicles	2	0.5	Subrounded.	Filled with brown clay (Mg-smectite/chlorite mixed layer(?)).

COMMENTS: Completely altered. Very difficult to locate any primary minerals, though a relict igneous texture is preserved. The chlorite has extremely intense anomalous colors in crossed polars. Microgranular titanite is disseminated throughout the groundmass. Slide contains abundant bubbles in epoxy.

169-856H-57R-1, Piece 16 (76-80 cm)**Thin section:** #17 and #18**ROCK NAME:** Completely altered, moderately clinopyroxene-phyric basalt**GRAIN-SIZE:** Microcrystalline to cryptocrystalline**TEXTURE:** Variolitic to intersertal

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
PHENOCRYSTS				
Clinopyroxene	5	0.5-2	Stubby prisms.	Completely replaced by brown clay, chlorite, quartz, and titanite.
Plagioclase(?)	1	0.5-1.2	Subhedral laths.	Replaced by pyrrhotite.
GROUNDMASS (Primary)				
Plagioclase	30	0.05-1	Acicular laths.	Completely altered to quartz and chlorite.
Mesostasis (+ clinopyroxene)	53		Intersertal.	Completely altered to microcrystalline quartz, chlorite + titanite.
Ilmenite/titanomagnetite	10	0.02-0.5	Subhedral to acicular.	Commonly rimmed by microgranular titanite.
SECONDARY MINERALS				
Quartz (+ albite)	20	0.01-1		Groundmass of granular quartz and fibrous aggregates of chlorite and a ubiquitous dusting of titanite. Relict igneous texture preserved.
Chlorite	60	0.1-1		
Titanite	15	0.02-0.5		
OPAQUE MINERALOGY				
Pyrrhotite	1	0.1-1.2	Subhedral laths.	Coarse grains. Habit suggest replacement of plagioclase phenocrysts though no primary phase remains. Halos of iron-oxyhydroxide staining.

COMMENTS: Some 3-4 mm patches of chlorite replace glomerocrystic clinopyroxene (\pm plagioclase). Groundmass comprises a complex intergrowth of granular quartz, chlorite, and a dusting of microgranular titanite. Chlorite commonly pseudomorphs acicular groundmass plagioclase but plagioclase is also replaced by multiple subgrains of irregular quartz. Irregular variolitic texture preserved by the replacement products of feldspar. Slide contains abundant bubbles in epoxy.

169-856H-59R-1, Piece 3a (15-17 cm)**Thin section:** # 28**ROCK NAME:** Siltstone

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
Quartz	35-40	0.04	Anhedral.	
Chlorite/smectite	55-60			Very fine-grained dull groundmass.

COMMENTS: Parallel- and cross-laminated siltstone. Cross lamination visible due to alternation of laminae with different proportions of the coarse quartzose silt and mud.

169-856H-59R-1, Piece 20 (138-143 cm)

Thin section: #19

ROCK NAME: Highly plagioclase-phyric basalt

GRAIN-SIZE: Glassy to cryptocrystalline

TEXTURE: Micro-porphyrific-variolitic groundmass

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
PHENOCRYSTS				
Plagioclase	15	0.2-2	Acicular-hopper car to equant.	Fresh plagioclase-hopper car and open boxy habits.
Clinopyroxene	2	0.5-1	Stubby, subhedral.	Mostly altered to clay and chlorite, though rare fresh clinopyroxene occurs.
GROUNDMASS				
Plagioclase	15	0.04-0.2	Acicular-radiating.	Precipitating within sheaf-spherical glassy groundmass. Sheaf-spherical/plumose. Spherically arranged radial, acicular plagioclase with interstitial glass.
Mesostasis	60		Variolitic.	
SECONDARY MINERALS				
Chlorite				Replace clinopyroxene phenocrysts, particularly near the crosscutting brown clay vein.
Brown clay				
VOID SPACE				
Vesicles	1	1	Rounded.	Filled with brown clays.
OPAQUE MINERALOGY				
Chalcopyrite	Trace	≤0.01	Anhedral.	

COMMENTS: Corner of thin section cut by 2-3 mm barren quartz vein. Simple filling of dilational crack with pieces of broken acicular plagioclase preserved on either side of vein. Also irregular 0.5 mm brown clay-filled vein. Rare, fine veinlets of carbonate replace interiors of plagioclase phenocrysts.

169-856H-59R-1, Piece 10 (66-68 cm)

Thin section: #29

ROCK NAME: Highly altered, porphyritic basalt

GRAIN-SIZE: Cryptocrystalline

TEXTURE: Porphyritic, variolitic

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
PHENOCRYSTS				
Plagioclase	4	0.5-2	Prismatic.	Plucked, or replaced by pyrrhotite ± coarse euhedral titanite. Brown clay + titanite.
Clinopyroxene	1	0.5	Subhedral.	
GROUNDMASS (Primary)				
Plagioclase	25	0.2-0.5	Acicular.	Replaced by titanite. Completely altered.
Mesostasis	69		Glassy, variolitic.	
SECONDARY MINERALS				
Quartz	20	0.05		Groundmass completely replaced by chlorite, quartz, and titanite. Titanite replaces laths of plagioclase that form a variolitic texture. Plagioclase phenocrysts are replaced by large euhedral single grains of titanite + pyrrhotite.
Chlorite	54	0.1-1		
Titanite	20	0.05-2		
Brown clay	3	1		
Epidote	1	0.1		
VOID SPACE				
Vesicles	1	0.5-1	Rounded.	Brown clay infill.
OPAQUE MINERALOGY				
Pyrrhotite	<1	3-4		

COMMENTS: Most phenocrysts are plucked from the slide and only prismatic holes remain. Unplucked plagioclase feldspars are replaced by large, euhedral pinkish titanites. Variolitic groundmass totally replaced by secondary minerals (chlorite, quartz, titanite) but ghosts of plumose/radiating sheafs remain.

169-856H-60R-1, Piece 4a (12-18 cm)**Thin section:** #20**ROCK NAME:** Highly altered, highly vesicular, fine-grained basalt**GRAIN-SIZE:** Fine-grained to microcrystalline**TEXTURE:** Intersertal

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
PHENOCRYSTS				
Plagioclase	<1	0.5-1	Prismatic.	Open voids remain.
Clinopyroxene	<1	0.5-1	Stubby.	Phenocrysts may have been removed by alteration or during thin section preparation.
GROUNDMASS (Primary)				
Plagioclase	42	0.05-1	Acicular.	Quartz + chlorite.
Mesostasis/clinopyroxene	43		Intersertal.	Completely altered to quartz, chlorite, and titanite.
Titanomagnetite	5	0.1	Subhedral to bladed.	Altered to titanite.
SECONDARY MINERALS				
Quartz	40	0.05-1		Microcrystalline aggregate of chlorite > quartz. Faint outlines of primary phases/textures.
Chlorite	45	0.05-1		
Titanite	5	0.01-0.1		Dusty-microgranular.
VOID SPACE				
Vesicles	10	0.5-2	Subrounded to rounded.	Brown clay, quartz.
OPAQUE MINERALOGY				
Pyrrhotite	Trace	1	Euhedral to prismatic.	After plagioclase(?).
Chalcopyrite	Trace	0.05		

COMMENTS: Microcrystalline aggregate of chlorite, quartz and dusty titanite. Secondary minerals pseudomorphically overprint primary phases and a faint relict texture is preserved by ghost outlines of igneous phases. 1-2 mm irregular brown clay ± quartz veins. One brown clay vein changes to a quartz + chlorite vein. Vesicles intersected by this latter vein are filled by quartz > brown clay. Slide contains abundant bubbles in epoxy.

169-856H-60R-2, Piece 6 (58-60 cm)**Thin section:** #30**ROCK NAME:** Diabase**GRAIN-SIZE:** Medium grained**TEXTURE:** Subophitic to ophitic

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
PHENOCRYSTS				
Plagioclase	40	0.5-4	Prismatic.	Brown clay along cracks.
Pyroxene	30-35	0.5-2	(Sub+)ophitic.	Mostly fresh. Some altered to chlorite.
Olivine	10-20	0.6	Isodiametric.	Altered into serpentine cellular texture; difficult to estimate modal proportion.
GROUNDMASS				
Mesostasis	5		Anhedral.	Altered to chlorite.
Magnetite/ilmenite	10	0.1	Anhedral.	Titanite rims.
SECONDARY MINERALS				
Quartz	3			Quartz, chlorite and brown clay replace mesostasis, some pyroxene, olivine, and plagioclase along internal cracks.
Chlorite	3			
Brown clay	2			
Titanite	2			Rims titanomagnetite.
OPAQUE MINERALOGY				
Chalcopyrite	Trace	0.01-0.5	Anhedral.	Scattered.

COMMENTS: Mostly crystalline and fresh. Possible olivine phenocrysts completely altered to chlorite and quartz. Pyroxene (augitic) and plagioclase (about An₈₀) are only locally altered into chlorite. Plagioclase commonly shows oscillatory zoning, altered to brown clay along fractures.

169-856H-62R-1, Piece 20 (120-124 cm)**Thin section:** #21**ROCK NAME:** Sparsely plagioclase-clinopyroxene-phyric basalt**GRAIN-SIZE:** Cryptocrystalline to glassy**TEXTURE:** Porphyritic, intersertal

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
PHENOCRYSTS				
Plagioclase	3	0.5-2	Squat to acicular.	Fresh. Glomerocrystic or single grains. Some zoned.
Clinopyroxene	1	0.5-1	Stubby.	Completely altered to brown clay and chlorite ± titanite.
GROUNDMASS (Primary)				
Plagioclase	30	0.01-1	Acicular.	Altered to quartz(?).
Mesostasis	62		Glassy.	
Titanomagnetite	5	0.1	Subhedral.	Replaces by titanite.
SECONDARY MINERALS				
Quartz	40	0.01-1		Groundmass comprises a highly altered lattice of semi-crystallized plagioclase with intersertal glass. Glass recrystallized to chlorite, quartz, and titanite.
Chlorite	50	0.01-1		
Titanite	10	0.01-0.1		

COMMENTS: Darker patches in groundmass with no plagioclase may be altered varioles. The rest of the groundmass comprises a framework of fine acicular plagioclase with intersertal glass replaced by quartz and chlorite. Glass-rich areas display plumose and sheaf-spherical quench textures. Slide contains abundant bubbles in epoxy.

169-856H-63R-1, Piece 4 (16-20 cm)**Thin section:** #22**ROCK NAME:** Chloritized glassy margin of pillow basalt**GRAIN-SIZE:** Glassy**TEXTURE:** Hyaloclastic

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
PHENOCRYSTS				
Plagioclase	<1	0.5-1.5	Squat to prismatic.	Replaced by quartz + chlorite ± sulfides.
GROUNDMASS (Primary)				
Basaltic glass	90	1-10	Angular fragments.	Completely altered to chlorite.
Quenched varioles	10	1-2	Flattened elliptical.	Chilled margin.
SECONDARY MINERALS				
Chlorite	80		Intergrown.	Individual crystals unresolvable.
Epidote	5	0.5	Granular.	
Quartz	10	0.05-0.1	Anhedral.	After plagioclase.
Titanite	5	0.05	Microgranular.	Ubiquitous dusting.
VOID SPACE				
Vesicles	<1	0.4	Rounded.	Quartz ± chlorite.
OPAQUE MINERALOGY				
Pyrite	Trace	0.01-0.05	Subhedral to cubic.	Rare scattered grains.
Chalcopyrite	Trace	0.01	Anhedral.	Rare scattered grains.

COMMENTS: Completely recrystallized glassy margin of pillow lava with variolitic chilled margin. Glass fragmented to subhorizontal (to core), irregular zones and altered to chlorite. Internal alteration of larger glassy areas commonly siliceous and altered in "Mandelbrot Set"-shaped patterns. Varioles commonly formed around plagioclase (micro-) phenocrysts. These plagioclase grains are completely recrystallized to microgranular irregular quartz ± chlorite ± chalcopyrite ± pyrite. Glassy fragments separated by subhorizontal, anastomosing 0.5-1 mm veins of irregular and microgranular quartz, chlorite, epidote and titanite. Upper part of slide is the variolitic chilled margin of the host pillow. This region comprises coalesced elliptical varioles flattened subparallel to the horizontal. Varioles become more common within the glassy fragments toward the top of the slide. Subhorizontal fractures, glass and altered phenocrysts and crosscut and slightly offset by narrow, (<0.5 mm) discontinuous, chlorite > quartz-filled fractures.

169-856H-63R-1, Piece 11e (127-130 cm)**Thin section:** #23**ROCK NAME:** Cryptocrystalline to microcrystalline aphyric basalt**GRAIN-SIZE:** Cryptocrystalline to microcrystalline**TEXTURE:** Microvariolitic

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
PHENOCRYSTS				
Clinopyroxene	<1	1	Stubby-equant.	Altered to clay + chlorite.
Plagioclase	<1	1	Acicular.	Altered to quartz and chlorite.
GROUNDMASS (Primary)				
Plagioclase	5	0.1	Acicular.	Altered to quartz, and chlorite.
Mesostasis	85		Quenched.	Chlorite, quartz, epidote, and titanite.
Titanomagnetite	10	0.0	Subhedral.	Altered to titanite.
SECONDARY MINERALS				
Quartz	45	0.01-0.5		Groundmass comprises radiating laths of altered plagioclase with a plumose or sheaf-spherical texture; with highly altered interstitial glass replaced by chlorite, quartz, brown clay, and titanite.
Chlorite	35	0.1-1		
Brown clay	10			
Titanite	10	0.05		
VOID SPACE				
Vesicles	<1	0.8	Rounded.	Filled with brown clay.
OPAQUE MINERALOGY				
Pyrrhotite	<1	2.5	Prismatic.	With chlorite + titanite.

COMMENTS: Highly altered groundmass comprises microcrystalline quartz, chlorite and titanite. Primary or secondary plagioclase difficult to confirm due to fine grain size. Relict igneous texture preserved within groundmass by pseudomorphic replacement of acicular plagioclase by quartz and chlorite. One edge of slide cut by 1-2 mm quartz >> chlorite + brown clay vein, with en echelon discontinuous veinlets.

169-856H-63R-2, Piece 12 (68-70 cm)**Thin section:** #24**ROCK NAME:** Sparsely plagioclase-clinopyroxene-phyric basalt**GRAIN-SIZE:** Cryptocrystalline to microcrystalline**TEXTURE:** Microporphyric to intersertal

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
PHENOCRYSTS				
Plagioclase	1	0.5-2	Prismatic to acicular.	Some fresh, but many replaced by quartz + chlorite. Altered to chlorite + quartz, commonly with rims of cryptocrystalline quenched basalt.
Clinopyroxene	<1	0.5	Prismatic to stubby.	
Olivine(?)	<1	0.5	Prismatic.	Completely replaced by chlorite, quartz, and titanite.
GROUNDMASS (Primary)				
Plagioclase	40	0.05-0.5	Acicular framework.	A nearly indistinguishable groundmass after plagioclase and mesostasis comprising intergrown quartz, chlorite in plumose or radiating arrangements with a ubiquitous dusting of microgranular titanite.
Mesostasis	60		Intersertal.	
SECONDARY MINERALS				
Chlorite	45			A nearly indistinguishable groundmass after plagioclase and mesostasis comprising intergrown quartz, chlorite in plumose or radiating arrangements with a ubiquitous dusting of microgranular titanite.
Quartz	45			
Titanite	10			

COMMENTS: Numerous subrounded 2 mm blobs of cryptocrystalline basalt, commonly around the rims of altered phenocrysts. Chilled margin present along one edge of the slide. This comprises a cryptocrystalline glassy basalt with fine acicular plagioclase and is very highly chloritized (chlorite: 80%; quartz: 10%; titanite: 10%).

169-856H-64R-2, Piece 1 (9-11 cm)**Thin section:** #25**ROCK NAME:** Sparsely plagioclase phyric basalt**GRAIN-SIZE:** Cryptocrystalline**TEXTURE:** Microporphyric to intersertal

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
PHENOCRYSTS				
Plagioclase	4	0.5-1.5	Acicular to squat.	Zoned, altered core into bluish chlorite (pennine), quartz or brown clay.
Clinopyroxene	1	0.8-1.5	Stubby, prismatic.	Completely altered to chlorite > quartz ± pyrite.
GROUNDMASS (Primary)				
Plagioclase (microliths)	30	0.1-0.5	Needles, thin laths.	Zoned, altered cores mostly replaced by quartz, chlorite (75%).
Mesostasis	70		Intersertal.	Highly altered-quartz, chlorite, and titanite.
SECONDARY MINERALS				
Quartz	40	0.01-0.1		Throughout groundmass and after plagioclase.
Chlorite	30	0.01		Fine-grained, bluish lamellae (bluish pennine(?)).
Smectite	5	0.001		Minute dull brown spots and patches.
Titanite	15	0.01		Microgranular dusting throughout groundmass.
OPAQUE MINERALOGY				
Chalcopyrite	<1	0.1-0.5	Subhedral.	Scattered in groundmass.

COMMENTS: Plagioclase microliths have a central canal altered into bluish very low birefringent chlorite or are completely transformed into brown smectite. Coarser scattered plagioclase phenocrysts are commonly fully replaced by bluish, very low birefringent, chlorite. The groundmass is made up by 2nd-3rd order birefringent elongated microcrysts, probably titanite (or epidote(?)), with dull cryptocrystalline smectite and bluish very low birefringent chlorite (pennine?). A chilled margin is present with the same structure but with ghost of feldspars microliths fully replaced by chlorite and smectite.

169-856H-65R-1, Piece 4 (34-38 cm)

Thin section: #26

ROCK NAME: Altered sparsely plagioclase phyric basalt

GRAIN-SIZE: Fine-grained

TEXTURE: Subophitic

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
PHENOCRYSTS				
Plagioclase	20	0.5 to 3	Acicular to prismatic.	Mostly fresh, some replaced by chlorite, actinolite, quartz, rare carbonate and clinozoisite. Commonly glomerocrystic. Altered to chlorite + quartz.
Clinopyroxene (Olivine(?))	<1	0.8	Stubby to prismatic.	
GROUNDMASS (Primary)				
Plagioclase	25	0.05-0.5	Acicular laths.	Mostly fresh, some altered to quartz, chlorite, and clinozoisite. Chlorite (+ actinolite), quartz, titanite.
Mesostasis	55		Subophitic.	
SECONDARY MINERALS				
Chlorite(+ actinolite)	40	0.05-0.1		Chlorite(+ actinolite(?)) and quartz replaces mesostasis between variably altered plagioclase.
Quartz	20	0.05-0.2		
Titanite	10	0.05		Ubiquitous dusting of titanite.
Epidote/clinozoisite	1	0.1		In veins or near margins.
Calcite	1	0.2		In veins or replaces plagioclase near vein margins.
VOID SPACE				
Vesicles	<1	1	Rounded.	
OPAQUE MINERALOGY				
Pyrrhotite and Chalcopyrite	<1	1	Subhedral.	Filling vein with chalcopyrite.
Sphalerite	<1		Anhedral.	

COMMENTS: Mesostasis altered to fibrous mineral plus quartz and titanite. Fibrous mineral displays upper first order birefringence, and lacks anomalous colors. May be chlorite, but possibly fibrous actinolite. Phenocrystic and larger groundmass plagioclase are mostly fresh. **VEINS:** Fine-grained drusy quartz lines the fracture walls. Bluish fine-grained chlorite (pennine(?)), subhedral quartz and pyrite + pyrrhotite fill the vein fractures; late anhedral to subhedral patchy calcite replaces chlorite. Vein walls exhibit a microcrystalline groundmass halo with secondary fine-grained quartz.

169-856H-65R-2, Piece 1 (10-13 cm)

Thin section: # 27

ROCK NAME: Sparsely plagioclase-phyric seriate basalt

GRAIN-SIZE: Fine-grained

TEXTURE: Subophitic

NON-OPAQUE MINERALOGY	PERCENT	SIZE (mm)	MORPHOLOGY	COMMENTS
PHENOCRYSTS				
Plagioclase	29	1.0-3.0		Fresh, thin, twinned phenocrysts.
GROUNDMASS (Primary)				
Plagioclase	25	0.1-1.0	Acicular lattice.	Fresh and acicular needles, hopper/open box-shapes. Fresh augite
Clinopyroxene	44	0.1-1.0	Subophitic.	
Titanomagnetite	5	0.05	Anhedral.	
SECONDARY MINERALS				
Chlorite	3	1-2		Patches (1-2 mm) of pennine-replacing plagioclase.
Brown clay	2	0.5-1		Mg-saponite(?) replacing plagioclase.
Titanite	5	0.05		Microgranular in groundmass.

COMMENTS: Fresh, twinned, coarse plagioclase phenocrysts within a fine-grained crystalline groundmass of intergrown plagioclase and clinopyroxene (augite: C-Gamma 40-45 degrees). Plagioclase composition is labradorite/bytownite. Some patches of positive chlorite (pennine) replacing plagioclase.