

**THIN SECTION:** 345-U1415E-1R-1-W 21/23-TSB\_Piece\_3-TS\_01  
**Rock name:** orthopyroxene-bearing gabbro  
**Rock comment:** with patches of coarser grained oxide-bearing gabbronorite, moderately altered  
**Lithologic interval:** 3  
**Piece No.:** #3  
**Billet request comment:** Ig. Pet: primary minerals; Struct: Ig. fabric dev

**Thin Section no.:** 1

**Authors:** TH, AM

**PRIMARY MINERALOGY**

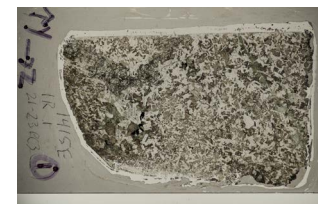
**No. of igneous domains:** 2

**Nature of ign. domains:** two lithologies and textures

**Igneous domain number:** 1

**Domain grain size:** medium grained  
**Domain texture:** granular to subophitic  
**Domain comment:** In part, textures show granoblastic features

**Domain lithology:** orthopyroxene-bearing gabbro  
**Grain size distribution:** equigranular  
**Relative abundance (%):** 75



	Present (%)	Original (%)	Vol. repl. (%)	Size mode (mm)	Shape	Habit	Zoning	Color	Special features	Comment
Olivine	0	1	1	0.4	subhedral to anhedral	equant				totally altered
Plagioclase	20	50	30	0.4	subhedral	tabular	oscillatory zoning		zoning	some exist as chadacrysts in clinopyroxene; some plagioclases are extremely elongated implying fast crystal growth
Clinopyroxene	44	47	3	1	anhedral	irregular		colorless	twinnings	some are subophitic; interstitial in plagioclase framework
Orthopyroxene	2	2	0	1.5	anhedral	irregular		colorless		
Oxide	0.1	0.1	0	0.2	anhedral	irregular				
Apatite (no. of grains)	0.01	N/A	N/A		euohedral to subhedral	included in interstitial clinopyroxene				

**Igneous domain number:** 2

**Domain grain size:** medium grained  
**Domain texture:** granular to subophitic  
**Domain comment:**

**Domain lithology:** disseminated oxide gabbronorite  
**Grain size distribution:** inequigranular  
**Relative abundance (%):** 25

	Present (%)	Original (%)	Vol. repl. (%)	Size mode (mm)	Shape	Habit	Zoning	Color	Special features	Comment
Plagioclase	35	35	0	1	subhedral	tabular	oscillatory zoning		inclusion-bearing	plagioclase near or in orthopyroxene has oxides and multiphase inclusion.
Clinopyroxene	18	18	0	1.5	anhedral	irregular		colorless	twinnings	some are subophitic; interstitial in plagioclase framework
Orthopyroxene	30	35	5	6.2	anhedral	irregular		colorless		some are oikocrysts enclosing plagioclase
Amphibole	5	10	5	1	anhedral	interstitial		green to brownish	associated with oxide	interpreted as primary, but with secondary overprint
Oxide	2	2	0	0.8	anhedral	irregular				
Apatite (no. of grains)	0.01	N/A	N/A		euohedral to subhedral					

**ALTERATION / METAMORPHISM**

**Alteration domain number:** 1

**No. of alteration domains:** 2  
**Domain type:** background

**Domain rel. abund %:** 70

**Estimated total % alteration:** 50

SECONDARY MINERALOGY	%	REPLACING / FILLING	PRIMARY MINERAL REPLACED	% ORIGINAL	% ALTERED	REPLACEMENT MINERAL	ALTERATION COMMENTS
clay minerals	0.2	orthopyroxene 0.2%	Plagioclase	40	40	green amphibole 30%, secondary plagioclase 70%	Patchy net vein alteration to both secondary plagioclase and pale green amphibole.
green amphibole	38.4	clinopyroxene 32%, orthopyroxene 1.6%, plagioclase 4.8%	Clinopyroxene	50	80	green amphibole 80%, oxide 2%, secondary clinopyroxene 18%	turbid to fine grained secondary cpx is followed by amphibole
oxide	0.8	clinopyroxene 0.8%	Orthopyroxene	10	20	green amphibole 80%, pale/colorless amphibole 10%, clay minerals 10%	Large grains with fluid inclusion arrays and both marginal and net-vein alteration to green amphibole.
pale/colorless amphibole	0.2	orthopyroxene 0.2%					
secondary clinopyroxene	7.2	clinopyroxene 7.2%					
secondary plagioclase	11.2	plagioclase 11.2%					

**domain total alteration %:** 58

**Vein summary**

vein 1 Thin transgranular green amphibole veins, fibrous when crossing amphibole, appear to localize more intense alteration (not described as a separate halo).

**ALTERATION COMMENT:**

Moderately to strongly altered rock with clinopyroxene altered to secondary clinopyroxene + oxides, then to green amphibole. Plagioclase altered to secondary plagioclase and green amphibole. Disseminated sulfide and some larger grain boundary patches (up to 1mm) are associated with secondary amphibole after pyroxenes, which are also dusted with tiny oxides, probably ilmenite.

**ALTERATION / METAMORPHISM**

**Alteration domain number:** 2

**No. of alteration domains:** 2  
**Domain type:** background

**Domain rel. abund %:** 30

**Estimated total % alteration:** 30

SECONDARY MINERALOGY	%	REPLACING / FILLING	PRIMARY MINERAL REPLACED	% ORIGINAL	% ALTERED	REPLACEMENT MINERAL	ALTERATION COMMENTS
green amphibole	6	clinopyroxene 6%	Plagioclase	50	20	secondary plagioclase 100%	Protogranoblastic texture; extent of plagioclase alteration uncertain.
secondary clinopyroxene	14	clinopyroxene 14%	Clinopyroxene	50	40	green amphibole 30%, secondary clinopyroxene 70%	grain boundaries have migrated but not true granoblastic texture. Extent of secondary cpx very uncertain.
secondary plagioclase	10	plagioclase 10%					

**domain total alteration %:** 30

**Vein summary**

vein 1 A few thin amphibole veins.

**ALTERATION COMMENT:**

Finer grained possible inclusion in gabbronorite shows possible protogranoblastic texture in clinopyroxene and plagioclase with relatively little amphibole alteration. Disseminated sulfide and some larger grain boundary patches (up to 1mm) are associated with secondary amphibole after pyroxenes, which are also dusted with tiny oxides, probably ilmenite.

**STRUCTURE COMMENT:**

Magmatic: Very weak foliation defined by plagioclase SPO. Rare submagmatic deformation twins and/or bent grains of plagioclase.  
 Crystal Plastic: None.  
 Brittle: Very minor fracturing; no significant brittle deformation.  
 Veins/alteration: Thin chlorite-serpentine veins appear restricted to clinopyroxene. One prehnite vein cuts pyroxene and plagioclase.  
 Cross-cutting Relationships (as apparent in thin section):  
 1) Minor magmatic fabric development.  
 2) Minor fracturing.  
 3) Static alteration.

**PHOTOMICROGRAPHS:**

345\_U1415E\_1R\_1\_TS\_01.JPG  
 345\_U1415E\_1R\_1\_TS\_01-2.JPG

**THIN SECTION:** 345-U1415E-1R-1-W 30/33-TSB\_Piece\_4-TS\_02  
**Rock name:** clinopyroxene-bearing troctolite  
**Rock comment:** strongly altered  
**Lithologic interval:** 4  
**Piece No.:** #4  
**Billet request comment:** Ig. Pet: primary minerals; Struct: ig. fabric dev

**Thin Section no.:** 2

**Authors:** MMJ, TN

**PRIMARY MINERALOGY** No. of igneous domains: 1

**Nature of ign. domains:**

**Igneous domain number:** 1

**Domain grain size:** Medium grained  
**Domain texture:** granular  
**Domain comment:** totally altered

**Domain lithology:** troctolite  
**Grain size distribution:** equigranular  
**Relative abundance (%):** 100



	Present (%)	Original (%)	Vol. repl. (%)	Size mode (mm)	Shape	Habit	Zoning	Color	Special features	Comment
Olivine	1	35	34	0.3	anhedral				overgrowth	100% alteration of olivine; can observe outlines of former olivine
Plagioclase	20	50	30	1.5	anhedral to subhedral	tabular	patchy zoning			secondary plagioclase
Clinopyroxene	5	15	10	9	subhedral to euhedral	prismatic		pale green		
Amphibole				1	subhedral	prismatic, short		colorless to pale green		
Oxide	0.1	0.1	0	0.5	subhedral	granular				

**ALTERATION / METAMORPHISM** No. of alteration domains: 1 Domain type: background Domain rel. abund %: 100 Estimated total % alteration: 90

ALTERATION domain number:	%	REPLACING / FILLING	PRIMARY MINERAL REPLACED	% ORIGINAL	% ALTERED	REPLACEMENT MINERAL	ALTERATION COMMENTS
1	6.2	clinopyroxene 1.8%, plagioclase 4.4%	Olivine	30	100	pale/colorless amphibole 3%, clay minerals 10%, oxide 5%, sulfide 1%, serpentine 50%, talc 30%, other 1%	Other: granitic garnet in mesh center with talc
	3	olivine 3%	Plagioclase	55	80	chlorite 10%, prehnite 90%	
	1.5	olivine 1.5%	Clinopyroxene	10	90	pale/colorless amphibole 30%, chlorite 20%, secondary clinopyroxene 30%, other 20%	Other: talc along cleavage surface with chlorite. Secondary clinopyroxene looks to form intergrowth with talc/chlorite.
	3.6	olivine 0.9%, clinopyroxene 2.7%					
	39.6	plagioclase 39.6%					
	2.7	clinopyroxene 2.7%					
	15	olivine 15%					
	0.3	olivine 0.3%					
	9	olivine 9%					
	2.1	olivine 0.3%, clinopyroxene 1.8%					
<b>domain total alteration %:</b>	<b>83</b>						

**Vein summary**  
 vein 1 Zeolite  
 vein 2 Clay, cross fiber.

**ALTERATION COMMENT:** Pervasive pseudomorphic alteration of olivine to serpentine, talc, clay minerals, magnetite, and amphibole. Plagioclase is highly altered to prehnite and chlorite. Clinopyroxene is highly altered to colorless prismatic amphibole, chlorite, secondary clinopyroxene, and talc. Formation of tremolitic amphibole and chlorite between olivine and plagioclase. Talc and garnet replacing olivine is restricted to mesh-center of serpentinization texture. Magnetite/ilmenite and possibly pyrrhotite are disseminated in secondary amphibole after pyroxene. Sulfide and oxide are very heterogeneously developed within mesh texture serpentine after olivine with magnetite rimming pyrite. No sulfides are associated with prehnite or chlorite.

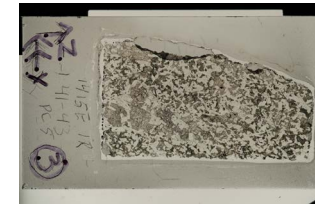
**STRUCTURE COMMENT:** Magmatic: No magmatic microstructures.  
 Crystal Plastic: Weak serpentine foliation of olivine.  
 Brittle: No significant brittle deformation.  
 Veins/alteration: Minor prehnite and serpentine veins cut all minerals and serpentine foliation.  
 Cross-cutting Relationships (as apparent in thin section):  
 1) Serpentine foliation in olivine, and veinlets in pyroxene.  
 2) Prehnite veins.

**PHOTOMICROGRAPHS:** 345\_U1415E\_1R\_1\_TS\_02.JPG 345\_U1415E\_1R\_1\_TS\_02-3.JPG  
 345\_U1415E\_1R\_1\_TS\_02-2.JPG 345\_U1415E\_1R\_1\_TS\_02-4.JPG

**THIN SECTION:** 345-U1415E-1R-1-W 41/43-TSB\_Piece\_5-TS\_03  
**Rock name:** gabbro  
**Rock comment:** moderately altered, weak magmatic foliation  
**Lithologic interval:** 5  
**Piece No.:** #5  
**Billet request comment:** Ig. Pet: primary minerals; Struct: ig. fabric dev

**Thin Section no.:** 3  
**Authors:** JM, MP

**PRIMARY MINERALOGY**  
**No. of igneous domains:** 1  
**Nature of ign. domains:**  
**Igneous domain number:** 1  
**Domain grain size:** medium grained  
**Domain texture:** granular  
**Domain comment:** Large orthopyroxene grains are rather concentrated  
**Domain lithology:** gabbro  
**Grain size distribution:** seriate  
**Relative abundance (%):** 100



	Present (%)	Original (%)	Vol. repl. (%)	Size mode (mm)	Shape	Habit	Zoning	Color	Special features	Comment
Plagioclase	60	60	0	1.8	subhedral to euhedral	tabular	continuous zoning			In some grains, core & margin are slightly discontinuous
Clinopyroxene	17	20	3	1.1	anhedral	irregular		colorless	twinnings	interstitial in plagioclase framework
Orthopyroxene	17	20	3	2.5	anhedral	irregular		colorless		oikocrystic, including plagioclase grains
Oxide	0.1	0.1	0	0.1	anhedral	irregular				
Other										A completely altered small round grain in orthopyroxene may be primarily olivine?
Apatite	0.05	N/A	N/A		euhedral					

**ALTERATION / METAMORPHISM**  
**Alteration domain number:** 1  
**No. of alteration domains:** 1  
**Domain type:** background  
**Domain rel. abund %:** 100  
**Estimated total % alteration:** 10

SECONDARY MINERALOGY	%	REPLACING / FILLING	PRIMARY MINERAL REPLACED	% ORIGINAL	% ALTERED	REPLACEMENT MINERAL	ALTERATION COMMENTS
chlorite	1.7	clinopyroxene 0.5%, orthopyroxene 0.6%, plagioclase 0.6%	Plagioclase	55	2	chlorite 50%, secondary plagioclase 50%	Rare replacement by clay minerals.
green amphibole	2.3	clinopyroxene 1.9%, orthopyroxene 0.4%	Clinopyroxene	25	10	green amphibole 76%, chlorite 20%, oxide 2%, sulfide 2%	Clinopyroxene altered to amphibole + chlorite in some places, totally fresh in other places
oxide	0.1	clinopyroxene 0.1%	Orthopyroxene	20	15	green amphibole 13%, pale/colorless amphibole 65%, chlorite 20%, sulfide 2%	Alteration of orthopyroxene along cracks and as coronae.
pale/colorless amphibole	2	orthopyroxene 2%					
secondary plagioclase	0.6	plagioclase 0.6%					
sulfide	0.1	clinopyroxene 0.1%, orthopyroxene 0.1%					
<b>domain total alteration %:</b>	<b>6.8</b>						

**Vein summary**  
 vein 1 One thin vein of zeolite with sharp boundaries and no halo cross-cutting plagioclase and other minerals.

**ALTERATION COMMENT:** Relatively low background alteration with presence of thin veins of zeolite. Minor pyrite and magnetite in olivine mesh textures and in plagioclase. Rare chalcopyrite is association with pyrite.

**STRUCTURE COMMENT:** Magmatic: Weak magmatic foliation defined by plagioclase SPO. Common submagmatic deformation twins and/or bent grains of plagioclase, bent around a common axis in the plane of foliation.  
 Crystal Plastic: Minor undulose extinction, subgrain formation, and kink bands in several clinopyroxene grains.  
 Brittle: Minor cracking of large orthopyroxene; no significant brittle deformation.  
 Veins/alteration: Rare filled cracks extend through the remainder of the section.  
 Cross-cutting Relationships (as apparent in thin section):  
 1) Magmatic foliation development likely synchronous with weak magmatic/ crystal plastic deformation of plagioclase and clinopyroxene.  
 2) Low temperature cracking and alteration/vein formation.

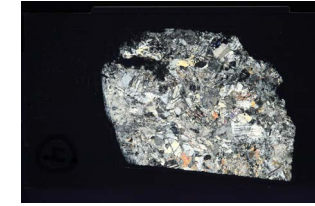
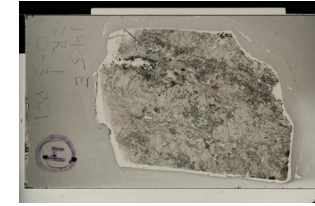
**PHOTOMICROGRAPHS:** 345\_U1415E\_1R\_1\_TS\_03.JPG  
 345\_U1415E\_1R\_1\_TS\_03-2.JPG

**THIN SECTION:** 345-U1415E-2R-1-W 0/3-TSB\_Piece\_1-TS\_04  
**Rock name:** anorthositic gabbro  
**Rock comment:** strongly altered  
**Lithologic interval:** 8  
**Piece No.:** #1  
**Billet request comment:** Ig Pet: primary minerals

**Thin Section no.:** 4  
**Authors:** JK, RW

**PRIMARY MINERALOGY**  
**No. of igneous domains:** 1  
**Nature of ign. domains:**  
**Igneous domain number:** 1  
**Domain grain size:** medium grained  
**Domain texture:** granular  
**Domain comment:** It was macroscopically described as olivine-bearing; but no olivine or pseudomorphs after olivine in the thin section; seems to be metamorphosed in the lower amphibolite facies

**Domain lithology:** anorthositic gabbro  
**Grain size distribution:** equigranular  
**Relative abundance (%):** 100



	Present (%)	Original (%)	Vol. repl. (%)	Size mode (mm)	Shape	Habit	Zoning	Color	Special features	Comment
Olivine										no indication for primary olivine
Plagioclase	40	90	50	1.5	subhedral	tabular	continuous zoning			
Clinopyroxene	0	10	10	1.5						not clear, what the primary mafic mineral was. If there was any primary clinopyroxene it is now completely altered. Note that macroscopically olivine was also detected.

**ALTERATION / METAMORPHISM**  
**Alteration domain number:** 1  
**No. of alteration domains:** 1  
**Domain type:** background  
**Domain rel. abund %:**  
**Estimated total % alteration:** 29

SECONDARY MINERALOGY	%	REPLACING / FILLING	PRIMARY MINERAL REPLACED	% ORIGINAL	% ALTERED	REPLACEMENT MINERAL	ALTERATION COMMENTS
chlorite	8.2	olivine 2%, plagioclase 6.2%	Olivine	5	100	pale/colorless amphibole 60%, chlorite 40%	
epidote/zoisite	1.8	plagioclase 1.8%	Plagioclase	89	20	pale/colorless amphibole 15%, chlorite 35%, prehnite 40%, epidote/zoisite 10%	
green amphibole	6	clinopyroxene 6%	Clinopyroxene	6	100	green amphibole 100%	
pale/colorless amphibole	5.7	olivine 3%, plagioclase 2.7%					
prehnite	7.1	plagioclase 7.1%					
<b>domain total alteration %:</b>	<b>28.8</b>						

**Vein summary**  
 vein 1 A vein 200 to 300 micrometers wide cuts the altered gabbro in an arcuate shape. Contacts with the altered host gabbro are sharp and follow and locally follow crystal boundaries in the host. The vein contains approximately 85 % pale green amphibole as subhedral crystals locally intergrown with approximately 15% chlorite. Amphibole in chlorite-rich regions is subhedral to euhedral.

**ALTERATION COMMENT:** Moderately altered. Plagioclase is moderately altered to prehnite, chlorite, colorless amphibole and epidote/clinozoisite; clinopyroxene is completely altered to green amphibole; olivine is completely altered to pale/colorless amphibole and chlorite. Virtually no sulfide or oxide - a few <5 micron grains of each.

**STRUCTURE COMMENT:** Magmatic: No recognizable magmatic fabric.  
 Crystal Plastic: Minor undulose extinction and/or bent grains of plagioclase.  
 Brittle: Minor cracking of plagioclase and pyroxene, with no grain size reduction.  
 Veins/alteration: Pervasive, static alteration.  
 Cross-cutting Relationships (as apparent in thin section):  
 1) Very weak crystal plastic deformation of plagioclase.  
 2) Static cracking and alteration.

**PHOTOMICROGRAPHS:** 345\_U1415E\_2R\_1\_TS\_04.JPG  
 345\_U1415E\_2R\_1\_TS\_04-2.JPG