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C. Sawatzky and G. Pe-Piper

2012

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Provenance identification of detrital quartz using hot-cathode cathodoluminescence: An atlas of source rocks

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2012

doi:10.4095/291336

This publication is available from the Geological Survey of Canada Bookstore (http://gsc.nrcan.gc.ca/bookstore_e.php).
It can also be downloaded free of charge from GeoPub (http://geopub.nrcan.gc.ca/).

Recommended citation:
Sawatzky, C., and Pe-Piper, G., 2012. Provenance identification of detrital quartz using hot-cathode cathodoluminescence: An atlas of source rocks; Geological Survey of Canada, Open File 7060, 149 p. doi:10.4095/291336

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Preface

This study forms part of a joint project between the Geological Survey of Canada and Saint Mary's University to investigate the provenance and diagenesis of reservoir sandstones in the offshore Scotian Basin. This report documents the optical and hot-cathode cathodoluminescence (CL) character of quartz from a suite of crystalline rocks. Most of these rocks are from potential bedrock sources to the Scotian Basin; a few archived rock samples from elsewhere were selected to characterize particular types of quartz without the expense of collecting samples in the field from throughout Atlantic Canada. A subsequent publication will apply the optical and CL properties documented here to sandstones in the Scotian Basin.

The Atlas proper summarizes the CL colours and petrographic characteristics from each of six groups of source rocks, and then presents key data from each of the rocks examined in that group. The Appendix provides additional information on each rock sample. The six groups of quartz types based on source rocks are:

- Plutonic and hypabyssal intrusions
- Volcanic rocks
- Aplites and quartz vein
- Low grade metamorphic rocks
- Medium and high-grade metamorphic rocks
- High-pressure metamorphic rocks

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Provenance Identification of Detrital Quartz: An Atlas of Source Rocks

Cynthia Sawatzky and Georgia Pe-Piper

Introduction

Cathodoluminescence is a technique of interest for the study of quartz because it can provide information that cannot be obtained by other analytical methods. It is useful in the study of composition, structure, genetic characteristics and typomorphic properties of quartz (Marfunin, 1979; Remond et al., 1992; Pagel et al., 2000). For example, the identification of growth zoning in quartz crystals and distinguishing quartz grains of different generations of crystallization are made possible through the use of cathodoluminescence (Ramseyer et al., 1988, Ramseyer and Mullis, 1990; Watt et al., 1997).

Defects in the crystal lattice, especially point defects, of quartz affect the degree of luminescence produced during irradiation by the CL beam (Götze et al., 2000). The type and frequency of such point defects reflects the thermodynamic and physico-chemical conditions under which the quartz was formed (Götze et al., 2000). Spectroscopic data of CL emissions of quartz combined with electron paramagnetic resonance (EPR) measurements and spatially resolved trace-element analysis have been used to relate the different emission bands to specific lattice defects in the structure of quartz (Götze et al., 2000). Aluminum is the most frequent trace element in quartz, which can be explained by its natural abundance in the earth's crust and similar ionic radii to Si^{4+} (Götze et al., 2000). This substitution results in a point defect due to the difference in charge between Si^{4+} and Al^{3+} and can result in varying degrees of lattice distortion. This substitution also allows for the incorporation of interstitial cations (most commonly H^{+}, Na^{+}, Li^{+} and K^{+}) (Götze et al., 2000). CL observations, microprobe analysis, and heat- and electrodiffusion experiments have revealed that the CL properties of quartz can be related to the uptake of these positively charged interstitial cations (Götze et al., 2000). Amorphous SiO_2 samples show a positive correlation between Al content and the intensity of the 500nm (blue in the visible light spectrum) emission band (Götze et al., 2000). A similar correlation was observed in samples of volcanic quartz and quartz xenocrysts through ion microprobe analysis; although results of these analyses suggest that other factors, including the effect of growth rate on defect density, may affect CL intensity to some degree (Watt et al., 1997).

One of the first developed classification schemes of CL colors of quartz in sandstones included three groups: 1) igneous and high-grade metamorphic quartz which have undergone relatively fast cooling and exhibit a blue or violet luminescence, 2) low-grade metamorphic or slowly cooled high-grade metamorphic rocks which exhibit a brown luminescence and 3) non-luminescent quartz of authigenic (sedimentary) or hydrothermal origin (Zinkernagal, 1978). It has, however, been shown through numerous investigations of a wide array of quartz-bearing rocks that a genetic correlation of quartz grains based on CL color alone is not always possible. This is because multiple samples of quartz that formed under varying genetic conditions may exhibit the same CL color (Götze et al., 2000). General genetic classification of quartz by CL color is nevertheless often carried out using the following classification scheme: 1) blue to violet: plutonic quartz and also quartz phenocrysts in volcanic rocks and high grade metamorphic quartz, 2) red: matrix quartz and quartz phenocrysts in volcanic rocks, 3) brown: quartz from regional metamorphic rocks, 4) non or weakly luminescent: authigenic quartz, 5) short-lived blue green: hydrothermal and pegmatitic quartz (Ramseyer et al. 1988; Götze, 1996). There are some detailed observations that should be considered when employing this general classification scheme. For example, quartz from extrusive igneous rocks commonly exhibits a more intense blue luminescence than intrusive igneous quartz and may also display concentric zoning made visible by varying shades of blue to violet CL (Götze et al., 2000). Trace element analysis of zones of varying CL color has confirmed a relationship between the Al content of quartz and varying CL colors of quartz, specifically the intensities of blue and red CL emissions (Schneider, 1993; Watt et al., 1997; Müller et al., 2000). Al content between zones varies because of varying degrees of trace element uptake during crystal growth.

Another observation to be considered is that metamorphic quartz that recrystallized at high temperatures exhibits a blue luminescence comparable to the characteristic blue CL color of plutonic quartz. Also, the CL color of quartz will evolve toward a uniform brownish-red CL color through high-grade levels of metamorphism (Sprunt et al., 1978; Götze et al., 2000). It has been speculated that this uniform reddish-brown CL color is achieved by quartz in metamorphic rocks which are classified to be above the garnet zone within high-grade metamorphism (Owen, 1984). Also, luminescence of hydrothermal quartz is highly variable, with almost every color having been reported; this may result from disequilibrium conditions during crystal growth (Götte and Richter, 2006). In addition to the quartz types mentioned above, low-grade metamorphic quartz has been observed to have an initial CL color of dark blue to dark violet and to undergo a strong color shift comprising mainly an increase in the red component of RGB color (Götte and Richter, 2006). It has been also been observed that quartz crystals which formed under high temperatures from a melt show a more stable luminescence than those formed from hydrothermal solutions (Götze et al., 2000).

It was assumed for some time that all authigenic quartz overgrowths have a non-luminescent character, however secondary quartz rims have since then been observed to exhibit variable luminescence colors including stable reddish-brown and blue, and a short-lived blue-green and yellow luminescence (Burley et al., 1989; Neuser et al., 1989; Ramseyer and Mullis, 1990; Morad et al., 1991; Götze and Walther, 1995; Bruhn et al., 1996). In general the stable luminescence is interpreted to be the result of burial diagenesis, whereas the short-lived luminescence is thought to be the result of deposition from basinal brines or hydrothermal solutions (Götze et al., 2000). Differences in CL colors of authigenic quartz have in fact been used to distinguish several types of silica cements not discernable by polarizing microscopy (Walther and Götze, 1993; Götze and Walther, 1995; Walther et al., 1996).

CL color has also been used to investigate the chemical composition and structure of silicate glasses and fused silica (Götze, 1996). This can further be applied to identifying intrinsic defects in high purity SiO_2 glasses and films used for high-tech applications (Skuja and Entzian, 1986).

A completely conclusive correlation between intensities of wavelengths bands for CL colors of quartz and specific trace elements or lattice defects does not exist. It is, therefore, difficult to interpret the origin of luminescence bands in quartz (Luff and Townsend, 1990, Itoh et al., 1988). The decrease in intensity of the blue luminescence emission (500 nm emission band) after a period of electron bombardment can, however, be related to ionization-enhanced diffusion of luminescence centers (Ramseyer and Mullis, 1990). A decrease in emission from the blue region of the spectrum coupled with a simultaneous increase in emission from the red region of the spectrum has been determined to be the result of the production of non-bridging oxygen hole centers from precursor defects (Stevens Kalceff MA and Phillips MR, 1995).

Due to the variance in CL color that results from the physico-chemical conditions at the time of formation, determining provenance of detrital quartz in sandstone based on CL color is possible to some degree, provided the CL color of quartz grains remains unchanged from its original source rock. Since it is not possible to ensure that no change has occured, and since overlap between CL colors of various source rocks is also possible, it is necessary to combine the use of other analytical methods with CL provenance studies (Götze and Zimmerle, 2000).

In this atlas, the cathodoluminesce (CL) colors and petrographic features of quartz grains from six main provenance rock groups are documented. The provenance groups include plutonic and hypabyssal, volcanic, aplites and vein quartz, low grade metamorphic, medium to high grade metamorphic and high pressure metamorphic rocks. Determining characteristic petrographic features of potential source rocks will aid in deducing the provenance of quartz of unknown origin since distinguishing provenance based on CL colors and color shift alone is not possible. As previously stated, overlap in possible CL color of quartz between provenance groups make the analysis of petrographic features of grains of unkown origin necessary in order to determine provenance. For example, in the samples analyzed, both low grade metamorphic quartz and plutonic quartz, in some cases, exhibited an initial color of medium or medium-dark blue and underwent only a slight color shift. In these same samples, low grade metamorphic quartz often exhibited sutured sub-grain boundaries, chlorite inclusions, and irregular grain margins, whereas plutonic quartz usually had embayed or rounded grain margins, tourmaline, apatite, and/or zircon inclusions, and smooth sub-grain boundaries in the case of polycrystalline grains (Table 1). These differences in petrographic features can be used to discern provenance in scenarios where variable sources for quartz are possible based on CL color alone.

It was observed in this study that quartz grains generally exhibit their most intense luminescence after about three seconds of being exposed to the CL beam. Luminescence decreases in intensity over time with continued exposure, and reaches a final CL color after around twelve second of exposure.

CL properties recorded for provenance groups include initial and final CL colors, degree of CL color shift, and the homogeneity of CL color. CL color was assigned using the quartz CL bar which is provided in this atlas. An inhomogeneous CL color may be patchy, may be caused by microfractures within grains, or may be the result of diagenetic quartz surrounding detrital quartz. Petrographic features recorded for provenance groups include: degree of undulose extinction, whether grains are monocrystalline or polycrystalline, nature of sub-grains boundaries (sutured or smooth), types of mineral inclusions, the presence or absence of deformation banding or lineations, whether microfractures are present and whether they are conchoidal, and whether fluid inclusions are plentiful, large, or form trails. A summary of the collected characteristic CL and petrographic features of each provenance group is provided in this atlas (Table 1).

Most samples exhibited in this atlas are from Atlantic Canada as this is the area of study; however, some samples are from other regions.

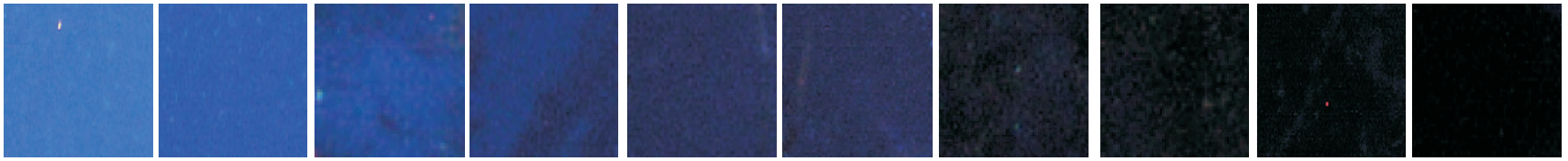
RGB color data was collected and included for samples which were photographed after exactly three and twelve seconds exposure to the CL beam. Grain numbers in RGB graphs represent grain numbers in the appendix of this atlas. Samples for which an RGB graph is not included were photographed approximately the time of maximum luminescence and upon the completion of the color shift, however not at exactly three and twelve seconds exposure time to the CL beam. Exposure times can be viewed in the appendix for all grains.

Quartz Provenance Groups

	Plutonic and Hypabyssal Quartz	Volcanic Quartz	Aplites and Vein Quartz	Low Grade Metamorphic Quartz	Medium and High Grade Metamorphic Quartz	High Pressure Metamorphic Quartz
Most Common Initial CL Color(s)	ranges from bright to medium-dark blue	ranges from bright to medium blue	dark blue	medium to dark blue or medium to dark brownish blue	bright to bright-medium blue	either dark grey, dark reddish brown, or not luminescent
Most Common Final CL Color(s)	ranges from bright-medium to dark blue	ranges from medium to medium-dark blue	very dark blue	medium-dark to very dark blue or medium-dark to very dark brownish blue	medium to medium-dark blue	very dark, or not luminescent
Other Possible CL Color(s)	violet	violet	bright to bright-medium blue initial color shifting to a final color of medium-dark blue, olive green brown	brown		
Magnitude of CL Color Shift	slight to moderate (strong color shift is possible but not common)	moderate to strong (slight color shift possible in the case of violet CL color)	usually slight color shift (moderate to strong color shift possible in the case of an initial color ranging from bright to bright-medium blue and a final color of medium-dark blue)	slight to moderate	moderate to strong	either no color shift, or one that is very slight
Microfractures	may be present and are often conchoidal	may be present and are often conchoidal	rarely may contain conchoidal fractures	microfractures are present and may be oriented in a common direction indicating deformation	microfractures may or may not be conchoidal	microfractures are present and may be conchoidal
Grain Margins	embayed or rounded, may be euhedral if hypabyssal	embayed or rounded, may be euhedral	embayed or rounded	irregular margins are characteristic although rounded margins are also possible	embayed or rounded	irregular grain margins
Nature of Sub-Grain Boundaries	smooth boundaries are characteristic, sutured boundaries have been observed in some cases		smooth but may be poorly defined	sutured boundaries are characteristic	boundaries may or may not be sutured	boundaries are sutured
Characteristics of Fluid Inclusions	inclusions forming trails are characteristic	fluid and melt inclusions are present	many inclusions as well as large inclusions are characteristic, inclusions often form trails	inclusions are present	inclusions are present	inclusions are present
Mono/ Polycrystallinity	monocrystalline or polycrystalline (usually < 3 sub-grains)	monocrystalline	monocrystalline or polycrystalline	monocrystalline or polycrystalline	monocrystalline or polycrystalline	polycrystalline with many sub-grains
Possible Mineral Inclusions	apatite, zircon, and tourmaline		tourmaline, muscovite, hydrothermal chlorite, and opaque mineral inclusions	metamorphic mineral inclusions (mainly chlorite)	metamorphic mineral inclusions	metamorphic mineral inclusions
Other Characteristics		rounded concentric zoning	euhedral zoning may be observed in CL photos, zoning was observed in grains with olive green brown, and bright to medium blue initial CL colors	inhomogeneous CL color is characteristic, deformation lamellae, deformation banding	deformation lamellae, deformation banding	

Table 1: Shows characteristic CL and petrographic features for provenance groups described in atlas.

Quartz CL Color Bar



	BB		BMB		MB	MDB			DB	VDB
Red	42	38	38	26	29	32	22	17	8	4
Green	85	64	54	37	33	32	21	16	13	4
Blue	252	184	126	90	72	69	33	21	18	5

→ Slight color shift = 1-2 square shift

→ Moderate color shift = 3 square shift

→ Strong color shift = 4 or more square shift

BB- Bright Blue
BMB- Bright-Medium Blue
MB- Medium Blue
MDB- Medium-Dark Blue
DB- Dark Blue
VDB- Very Dark Blue

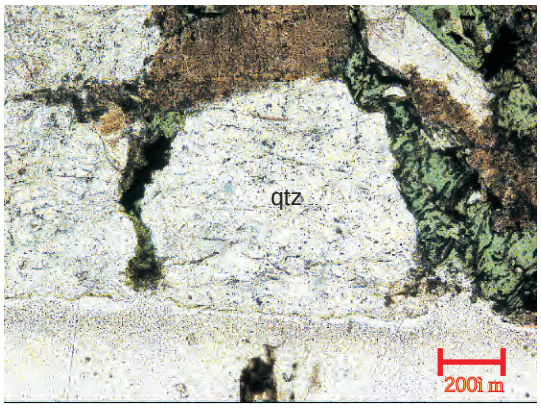
Plutonic and Hypabyssal Quartz

General Characteristics

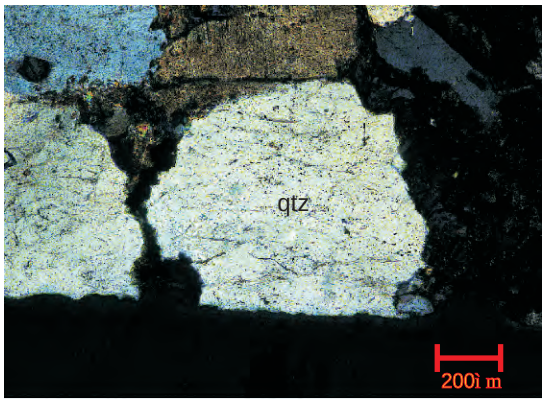
Quartz grains exhibit a slight to moderate color shift. Initial CL colors usually range from bright blue to medium-dark blue. Final CL color of grains usually ranges from bright-medium to dark blue. A violet CL color is also possible. Conchoidal fractures are characteristic of plutonic quartz. Grains usually are embayed and contain mineral inclusions of apatite, zircon and tourmaline. Fluid inclusions often form trails. Grains may be monocrystalline or polycrystalline while polycrystalline grains usually contain three or less subgrains. Smooth sub-grain boundaries are characteristic, but sutured sub-grain boundaries are also possible.

In this and all subsequent pages, photomicrographs on the right of the page display quartz grains with CL features characteristic of the discussed group.

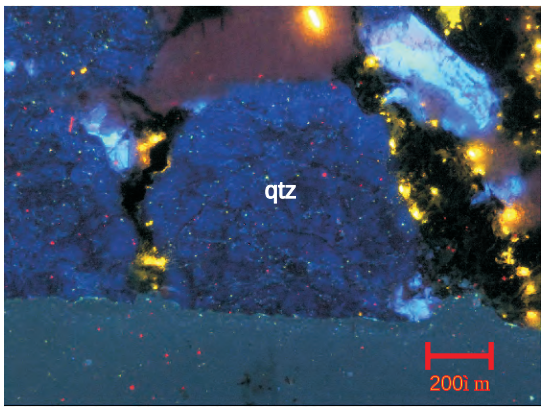
Sample: 3119
Source: G. Pe-Piper



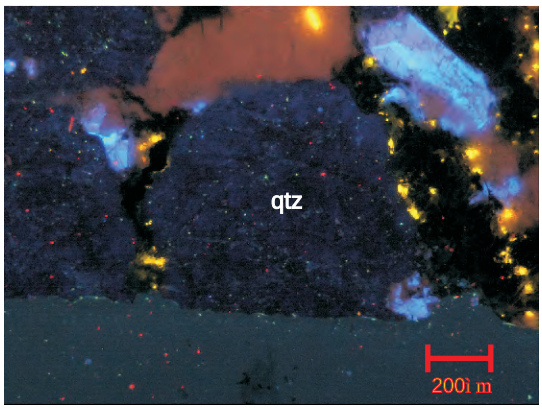
Plane polarized light



Crossed polarized light



Initial CL color



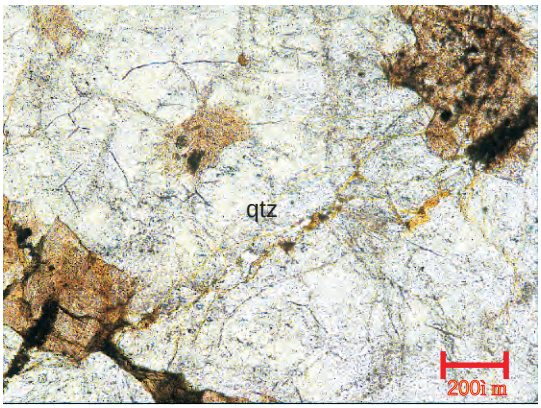
Final CL color

Granite, Gamble Lake, Cobequid Highlands, NS

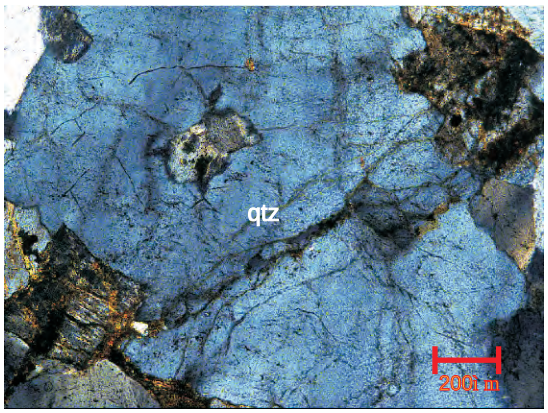
Samples: 4685, 4689
Source: G. Pe-Piper

Quartz grains exhibit a slight to moderate color shift. Initial colors range from bright-medium to medium blue. Final colors range from medium to medium dark blue. CL color is inhomogeneous. Quartz grains have mineral inclusions of chlorite and apatite, have embayed grain margins, and have many fluid inclusions. Fluid inclusion trails were observed in some grains. Quartz grains are microfractured and have moderate to strong undulose extinction. Some grains exhibit deformation lineations. Grains may be monocrystalline or polycrystalline. Polycrystalline grains generally do not contain more than three sub-grains.

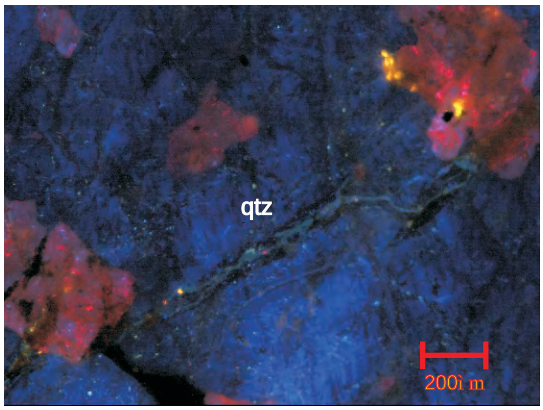
Sample: 4685



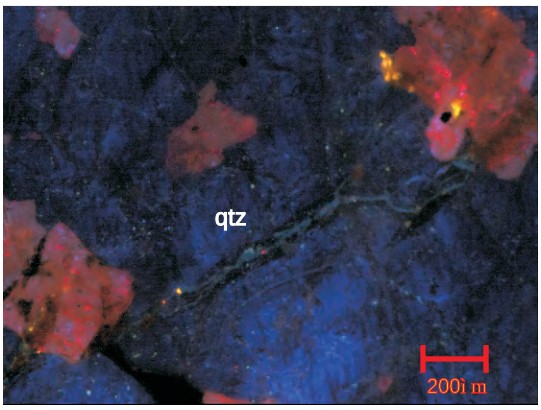
Plane polarized light



Crossed polarized light



Initial CL color

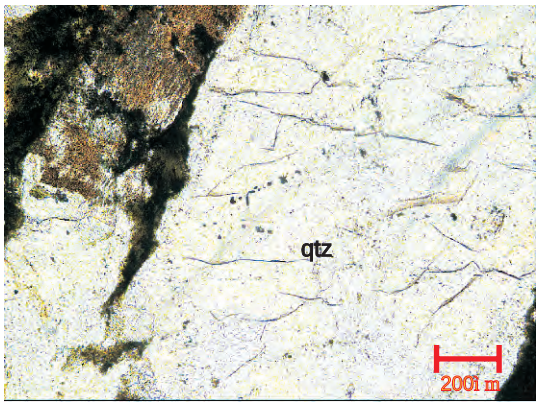


Final CL color

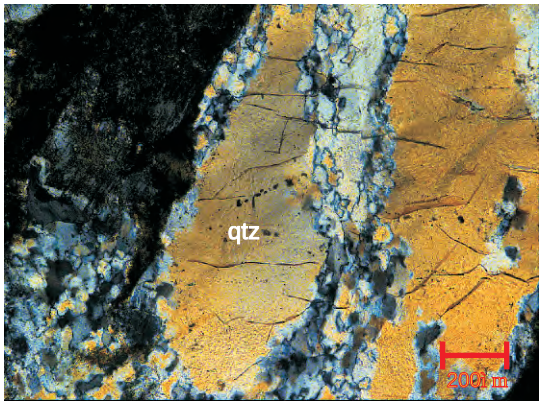
Granite (with mylonitic areas), SW of Economy Lake, Cobequid Highlands, NS

Sample: 4701
Source: G. Pe-Piper

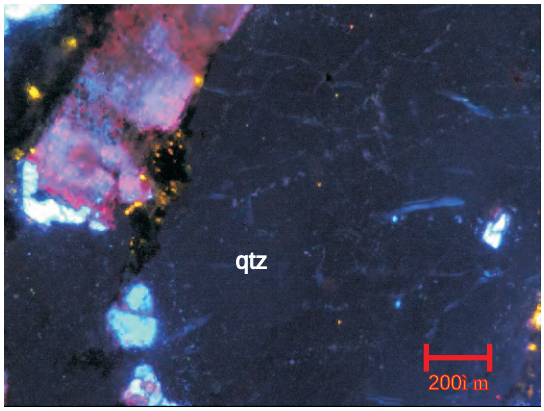
Quartz grains exhibit a slight to strong color shift. Initial colors range from bright-medium blue to medium-dark blue. Final colors range from medium-dark blue to dark blue. Grains have mineral inclusions of feldspar, tourmaline and zircon. Fluid inclusions form trails. Quartz grains have irregular grain margins and exhibit moderate to strong undulose extinction. Grains are polycrystalline and sub-grain boundaries are sutured. Grains are microfractured; some microfractures are conchoidal.



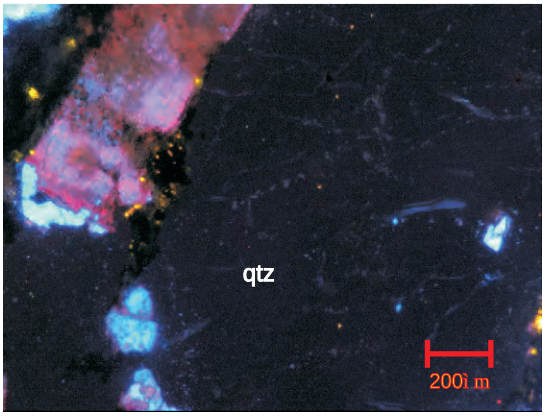
Plane polarized light



Crossed polarized light



Initial CL color



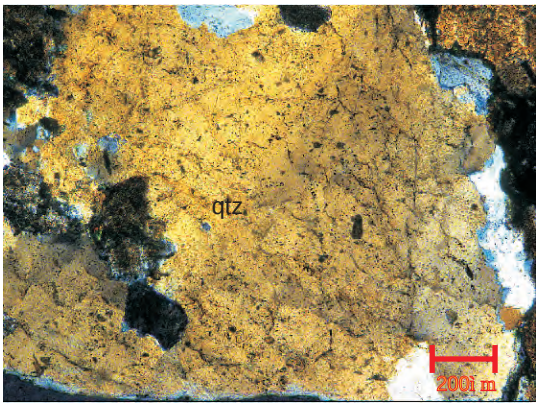
Final CL color

Granite, Chiganois River, Cobequid Highlands, NS

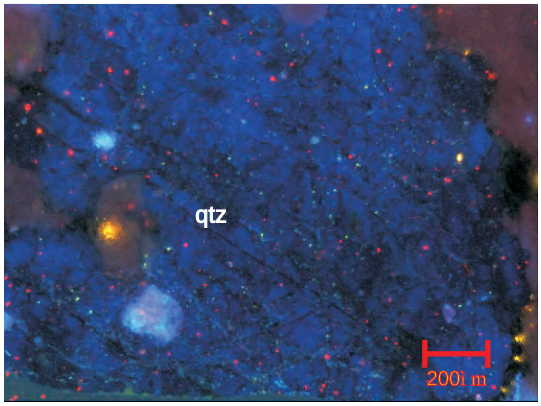
Sample: 3119
Source: G. Pe-Piper

Quartz grains exhibit a slight to moderate color shift. Initial colors range from bright-medium blue to medium blue. Final colors range from medium-dark blue to dark blue. Grains have mineral inclusions of chlorite, feldspar, and very small needles of apatite. Fluid inclusions form trials in some grains. Most grains are polycrystalline, have sutured sub-grain boundaries, are microfractured and have moderate to strong undulose extinction.

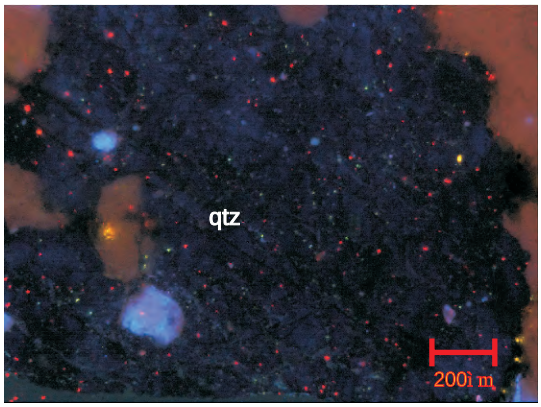
Plane polarized light



Crossed polarized light



Initial CL color



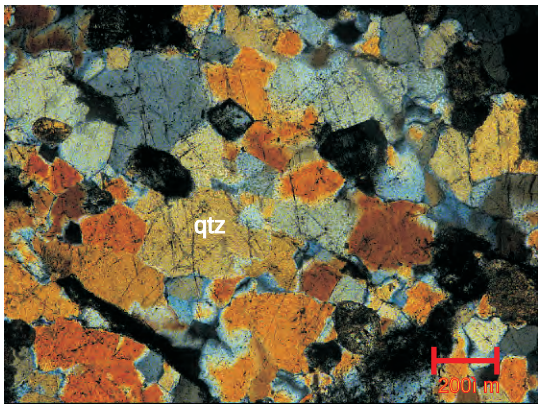
Final CL color

Pegmatitic Granite, Frog Lake Quarry, Cobequid Highlands, NS

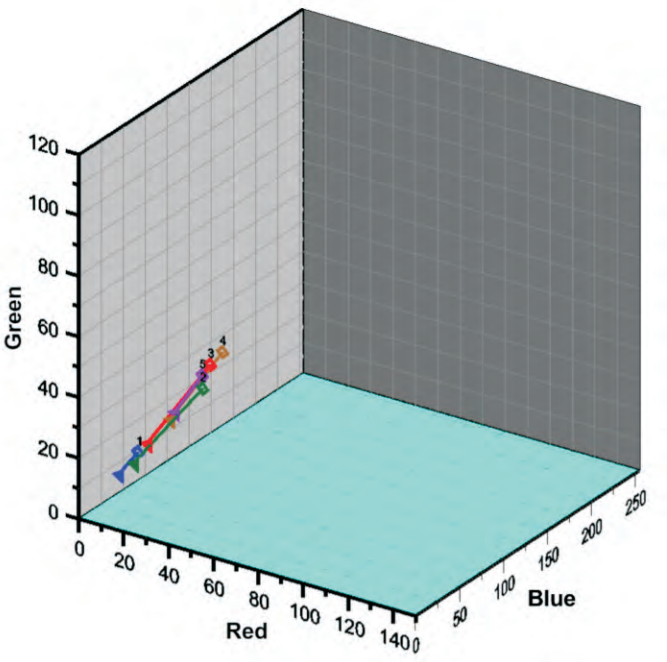
Sample: 4190
Source: G. Pe-Piper

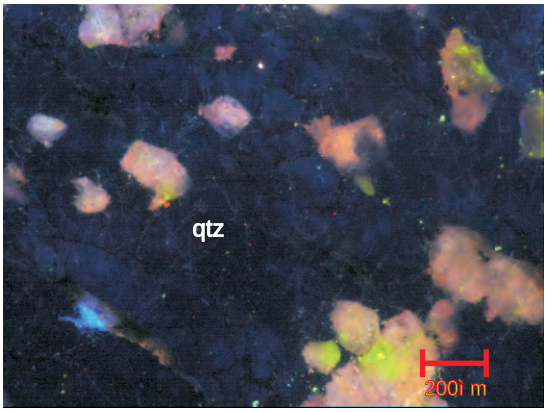
Plane polarized lightl

Quartz grains exhibit a slight to moderate color shift. Initial colors range from medium blue to medium-dark blue. Final color of quartz grains is dark blue. Grains have mineral inclusions of zircon, apatite and feldspar. Fluid inclusions form trails. Grains are polycrystalline and have embayed grain margins. Sub-grains boundaries are often not well defined but do not appear to be sutured. Grains have weak to moderate undulose extinction and are microfractured. Some microfractures are conchoidal.



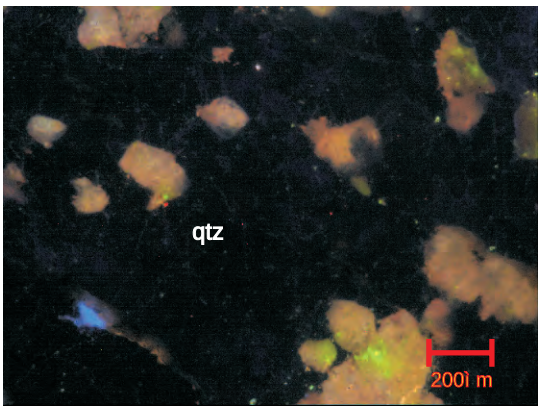
Crossed polarized light





Initial CL color

	Initial Red	Initial Green	Initial Blue	Final Red	Final Green	Final Blue
Grain 1	13.31	18.56	33.34	9.66	12.73	19.87
Grain 2	28.24	36.01	68.82	13.98	16.30	25.45
Grain 3	24.33	39.49	87.64	15.59	20.90	36.85
Grain 4	25.31	41.75	98.91	19.50	26.71	52.46
Grain 5	24.59	37.87	77.62	21.17	29.27	53.56



Final CL color

Microgranite, Powerlines at Henry Brook, Cobequid Highlands, NS

Sample: 2109
Source: G. Pe-Piper

There are two types of quartz in this sample; quartz grains in the matrix and quartz phenocrysts.

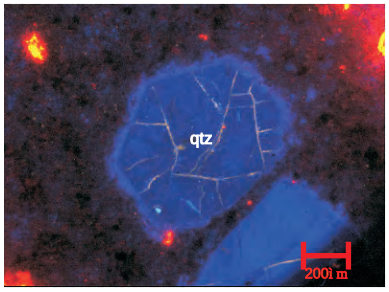
Quartz phenocrysts exhibit a slight to moderate color shift. Initial colors of the phenocrysts range from bright blue to bright-medium blue, and their final color is medium blue. They have mineral inclusions of chlorite and apatite (very few). Fluid inclusions form trails. Quartz phenocrysts have embayed or rounded grain margins and exhibit weak to non-undulose extinction. They are either monocrystalline or polycrystalline (only a few sub-grains). Phenocrysts have conchoidal fractures.

Quartz grains in the matrix exhibit a slight color shift from an initial color ranging from medium-dark blue to dark blue, and a final color ranging from dark blue to very dark blue. Grains have mineral inclusions of chlorite, have irregular grain margins and exhibit weak to moderate undulose extinction. Grains in the matrix may be monocrystalline or polycrystalline (only a few grains).

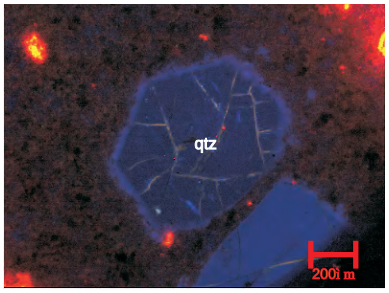
Type 1: Quartz phenocryst

Plane polarized light

Crossed polarized light

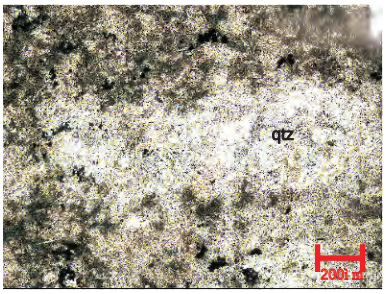


Initial CL color

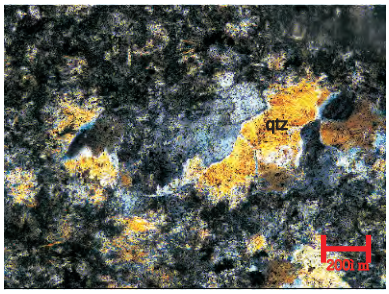


Final CL color

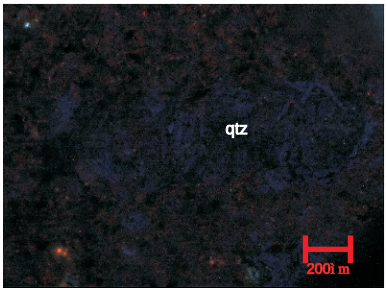
Type 2: Quartz in matrix



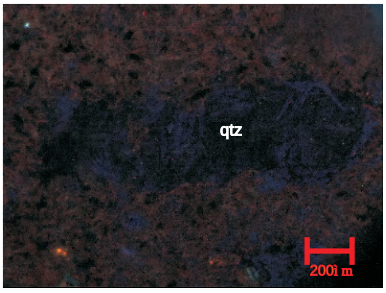
Plane polarized light



Crossed polarized light



Initial CL color

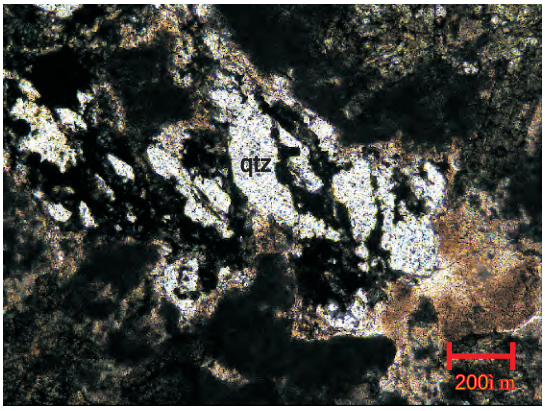


Final CL color

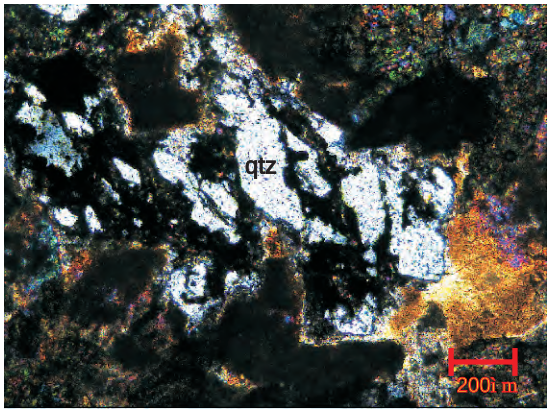
Undeformed Hornblende Pegmatitic Gabbro, Frog Lake Quarry, Cobequid Highlands, NS

Sample: 2649b
Source: G. Pe-Piper

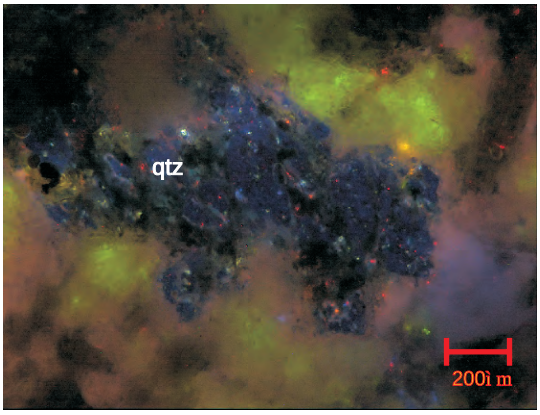
Quartz exhibits a slight to moderate color shift from an initial color of medium or medium-dark blue to a final color of dark blue. Grain margins can be either embayed or irregular. Grains have mineral inclusions of chlorite and apatite (abundant), and many large fluid inclusions. Most grains are monocrystalline, exhibit moderate undulose extinction and have large open microfractures.



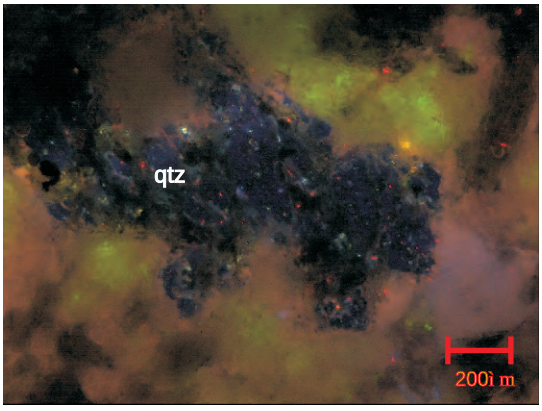
Plane polarized light



Crossed polarized light



Initial CL color

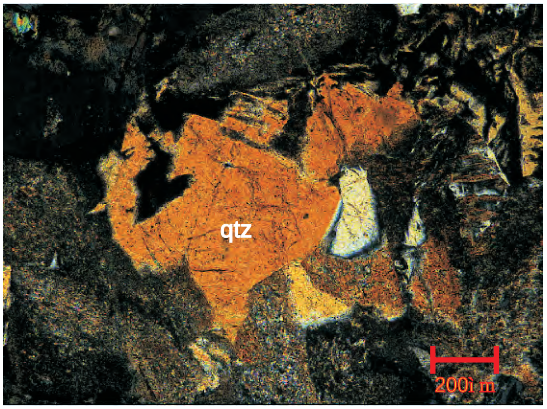


Final CL color

Granophyric Granite, East of Amphisa, Greece

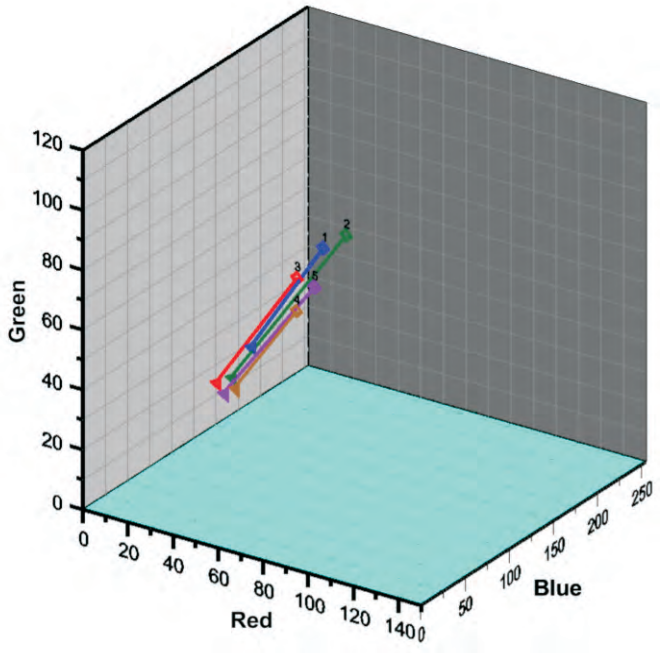
Sample: A42
Source: G. Pe-Piper

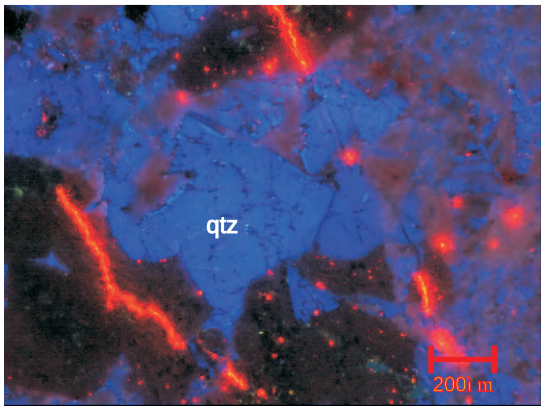
Plane polarized light



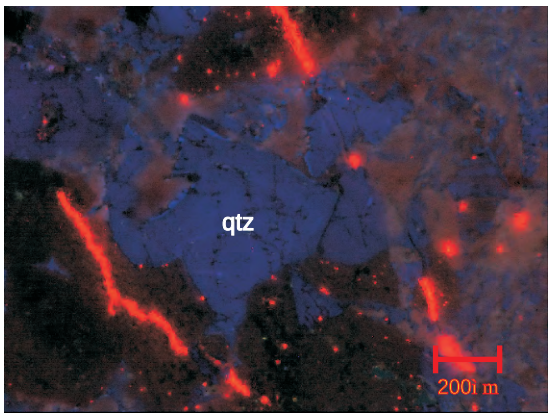
Crossed polarized light

Quartz grains exhibit a moderate to strong color shift with an initial color ranging from bright blue to bright-medium blue, and a final color ranging from medium blue to medium-dark blue. Grains have mineral inclusions of altered feldspar, apatite and chlorite. Areas of some quartz grains have myrmekitic texture. Fluid inclusions form trails. Quartz grains have irregular grain margins and exhibit weak to non-undulose extinction. Grains may be monocrystalline or polycrystalline (only a few sub-grains), and are microfractured.





Initial CL color



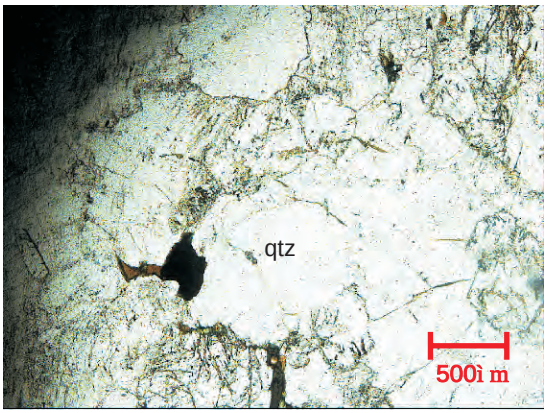
Final CL color

	Initial Red	Initial Green	Initial Blue	Final Red	Final Green	Final Blue
Grain 1	34.43	60.02	184.15	33.89	42.07	102.62
Grain 2	40.08	63.32	195.81	33.90	36.08	80.44
Grain 3	33.15	54.71	157.86	28.81	34.00	76.46
Grain 4	43.18	50.77	131.64	39.02	35.33	70.84
Grain 5	43.07	54.86	152.24	35.39	33.44	68.05

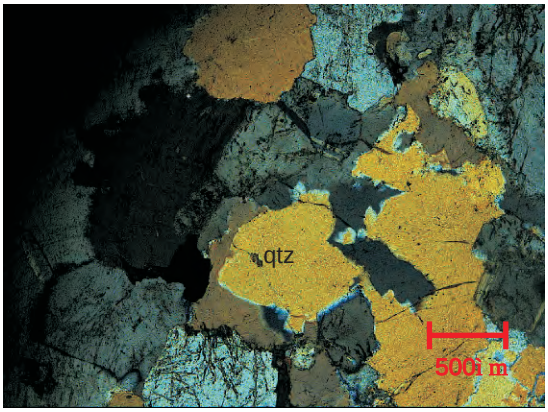
Granite, Quarry on SE Coast of Delos Island, Greece

Sample: DL31a
Source: G. Pe-Piper

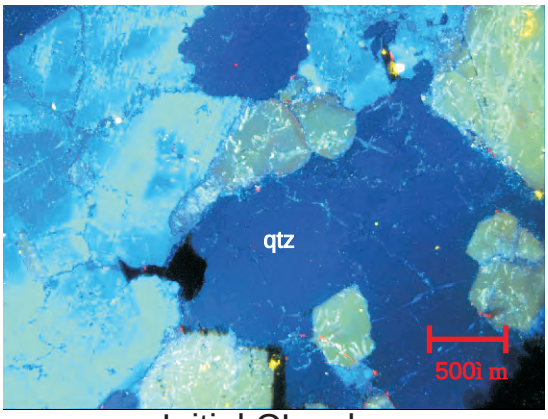
Quartz grains exhibit a slight to moderate color shift with an initial color of bright-medium blue and a final color ranging from medium blue to medium-dark blue. Grains have mineral inclusions of tourmaline and zircon. Fluid inclusions form trails. Grains exhibit weak to moderate undulose extinction and may be monocrystalline or polycrystalline. Monocrystalline grains have embayed grain margins while polycrystalline grains have sutured sub-grain boundaries and have filled intergranular space. Grains are microfractured; some microfractures are conchoidal.



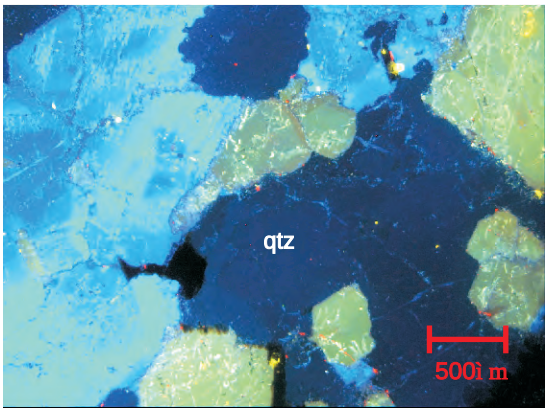
Plane polarized light



Crossed polarized light



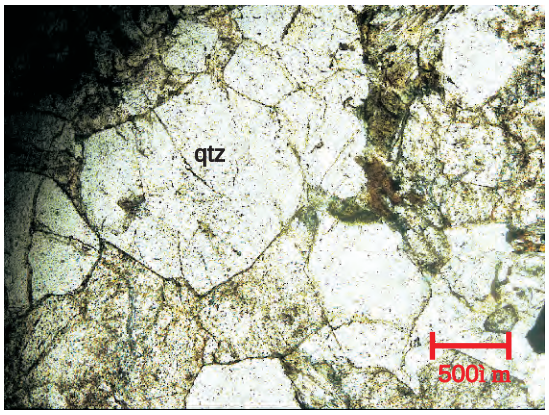
Initial CL color



Final CL color

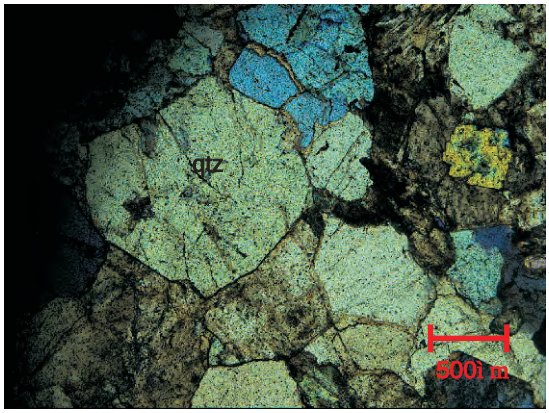
Granite, Coast at Fourni, Delos Island, Greece

Sample: DL16
Source: G. Pe-Piper

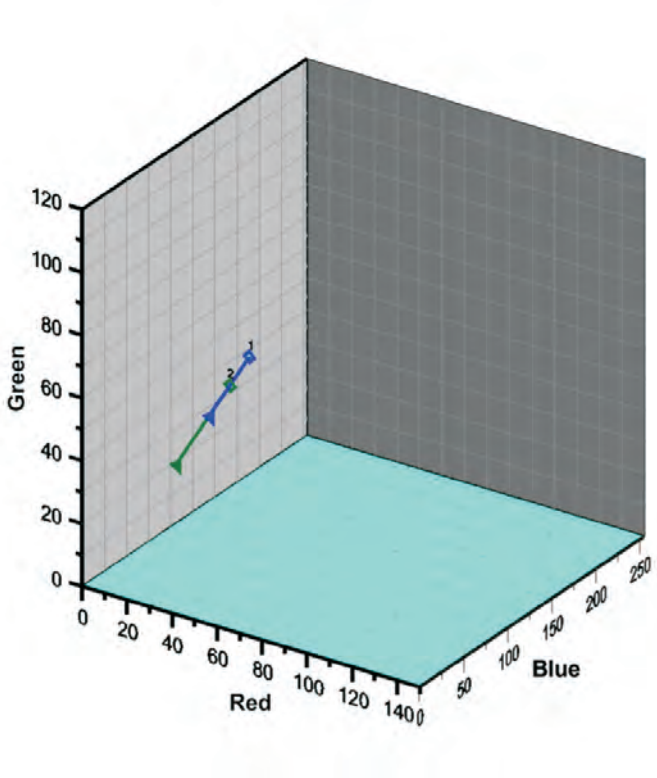


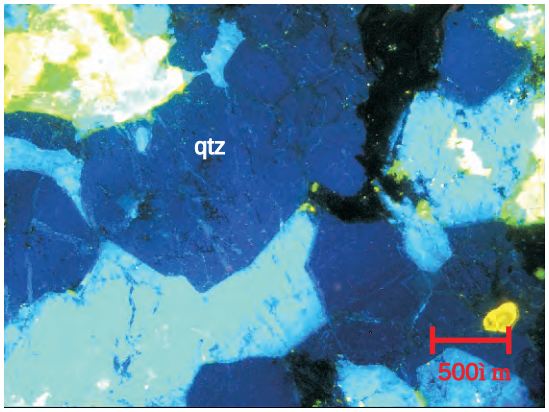
Plane polarized light

Quartz grains exhibit a slight color shift with an initial color ranging from bright-medium blue to medium blue to a final color ranging from medium blue to medium-dark blue. Grains have mineral inclusions of zircon, feldspar and tourmaline. Fluid inclusions form trails. Quartz grains are microfractured, have embayed grain margins, and exhibit weak to moderate undulose extinction. Both monocrystalline and polycrystalline grains are present in the sample. Polycrystalline grains contain smooth sub-grains boundaries.



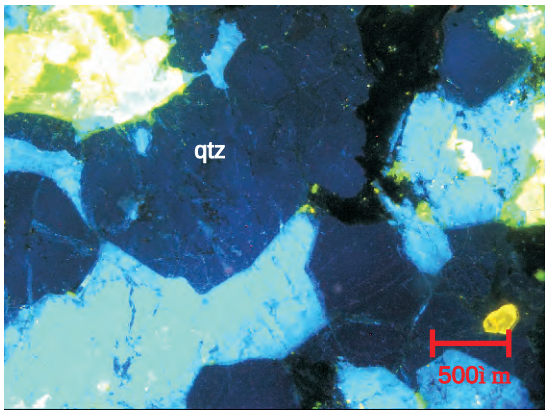
Crossed polarized light





Initial CL color

	Initial Red	Initial Green	Initial Blue	Final Red	Final Green	Final Blue
Grain 1	26.07	55.42	123.20	24.86	44.26	79.68
Grain 2	25.23	49.89	103.40	20.28	32.67	53.87



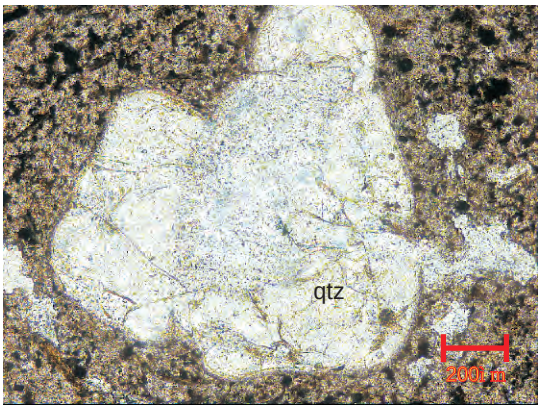
Final CL color

Volcanic Quartz

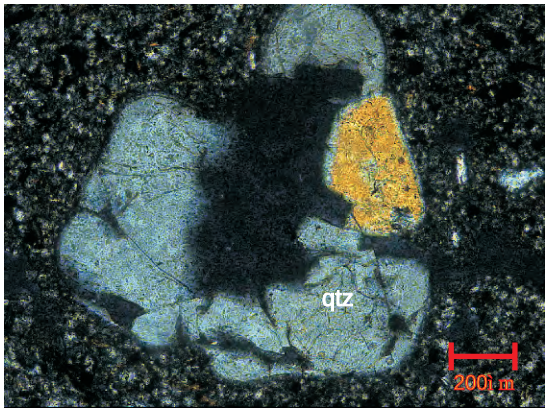
General Characteristics

Quartz grains exhibit a moderate to strong color shift. Initial CL colors usually range from bright blue to medium blue. Final CL color of grains usually ranges from medium to medium-dark blue. A violet CL color is also possible. Conchoidal fractures and melt inclusions are characteristic of volcanic quartz. Grains are monocrystalline and grain margins are embayed or smooth.

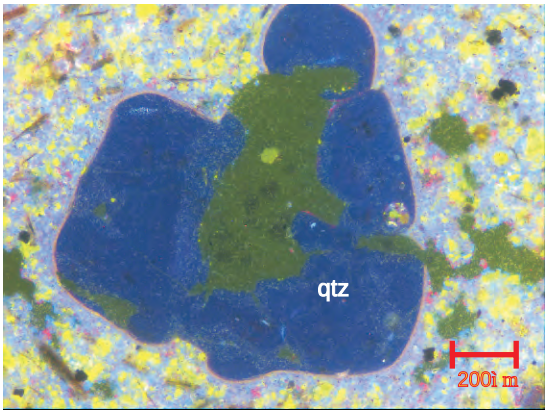
Sample: C9
Source: G. Pe-Piper



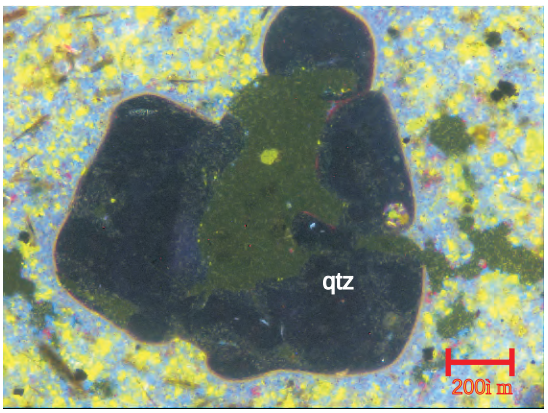
Plane polarized light



Crossed polarized light



Initial CL color



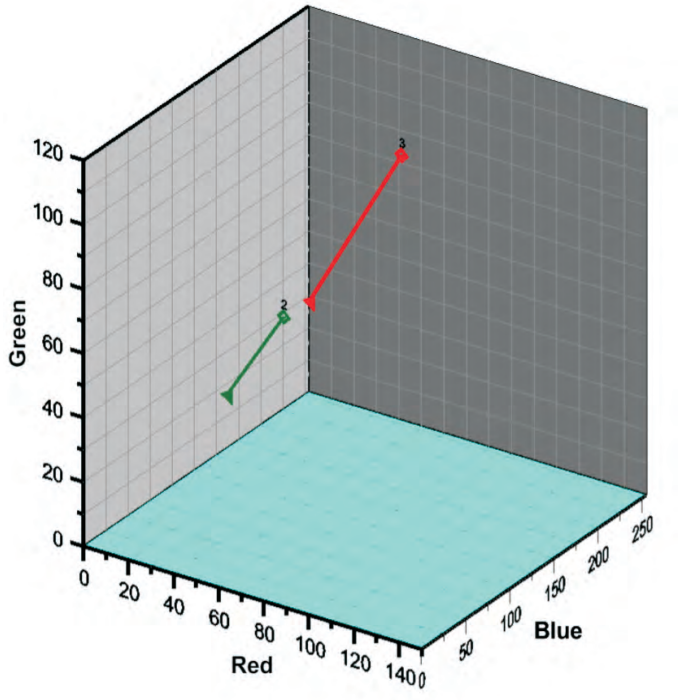
Final CL color

Rhyodacite, Crommyonia, near Corinthos, Greece

Samples: C22, C9
Source: G. Pe-Piper

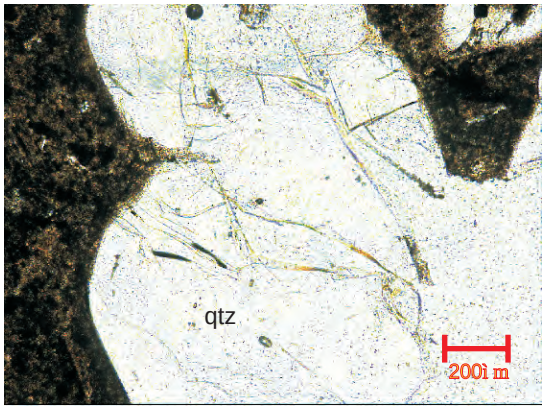
Quartz grains exhibit a moderate to strong color shift. Initial colors range from bright blue to medium blue. Final colors range from medium blue to dark blue. Grains have mineral inclusions of apatite and tourmaline. Grains have embayed margins and exhibit weak to non-undulose extinction. Grains may be monocrystalline or polycrystalline (only a few sub-grains), and are conchoidally fractured.

RGB Color Values for Sample: C9

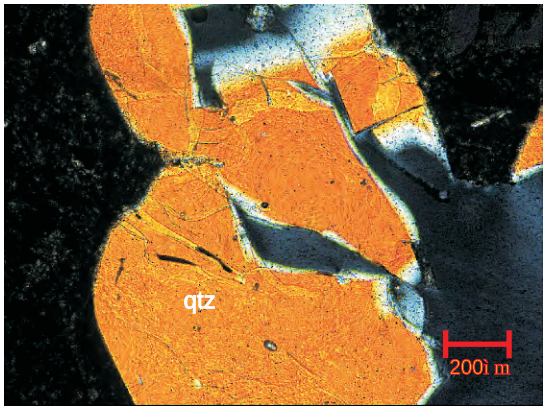


	Initial Red	Initial Green	Initial Blue	Final Red	Final Green	Final Blue
Grain 2	44.24	59.35	113.93	42.34	45.78	53.95
Grain 3	62.62	97.21	200.47	60.65	69.97	100.64

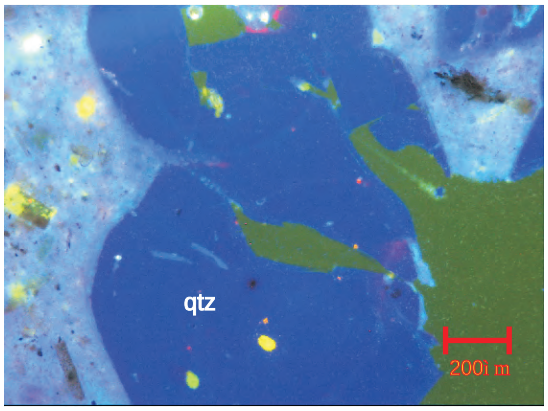
Sample: C22



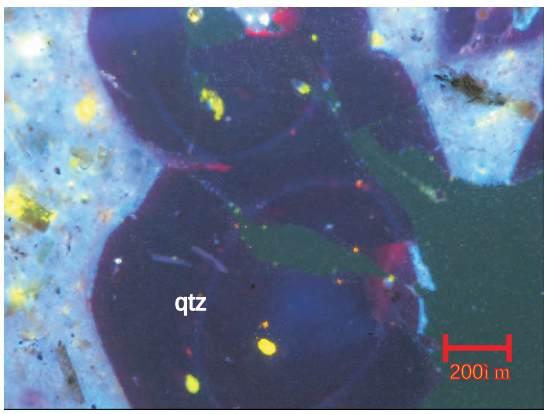
Plane polarized light



Crossed polarized light



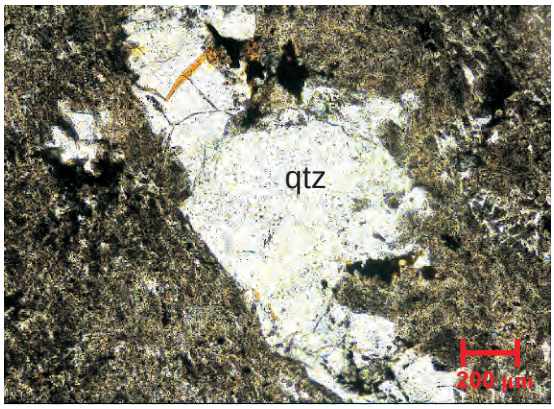
Initial CL color



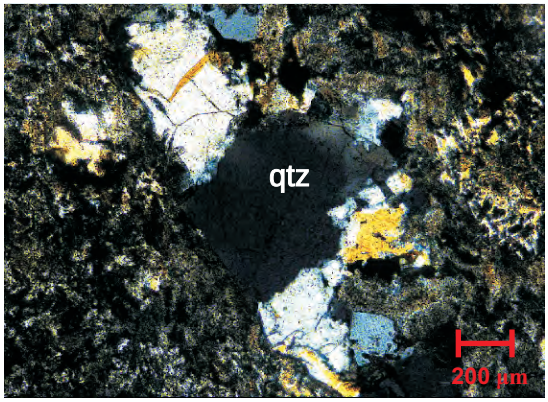
Final CL

Rhyodacite, Ambelos, Samos Island, Greece

Sample: SV10
Source: G. Pe-Piper

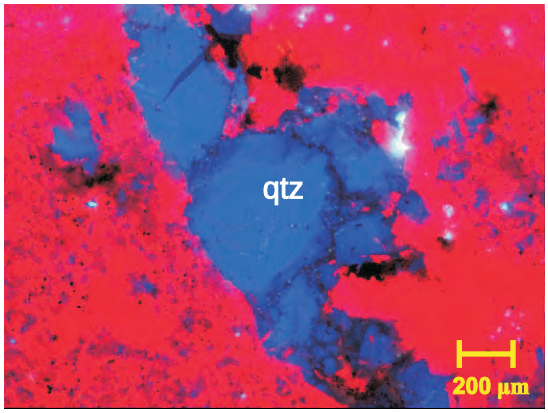


Plane polarized light

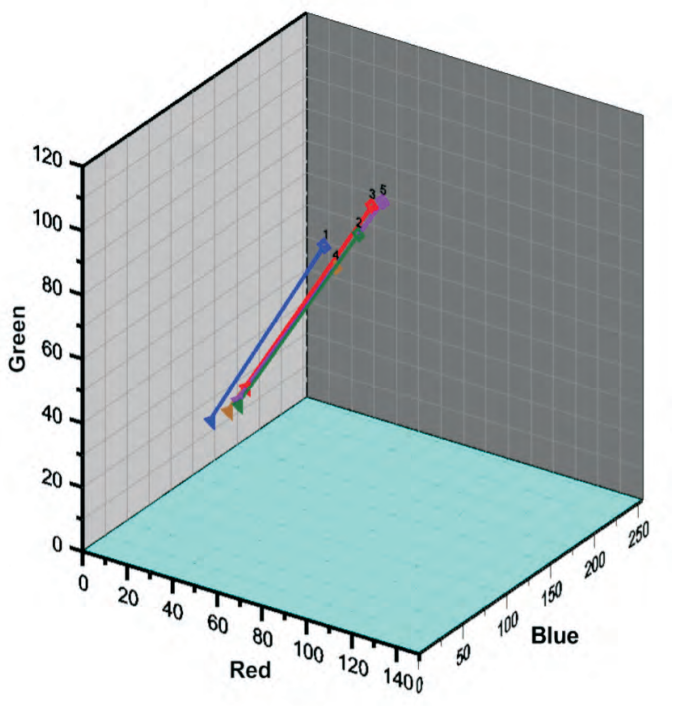


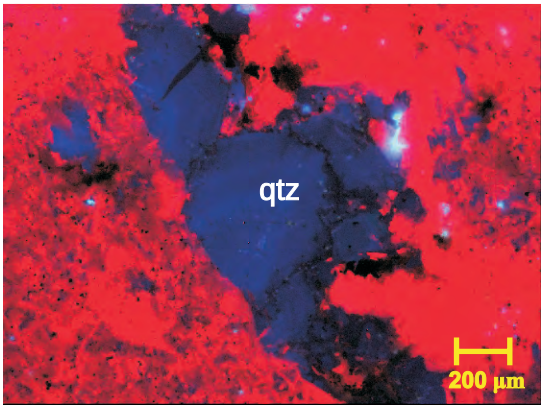
Crossed polarized light

Quartz grains exhibit a strong color shift from an initial color of inhomogeneous bright blue to a final color of medium-dark blue. Inhomogeneity is caused by non-luminescent fractures in grains. The CL color of the groundmass quartz in this sample is red. Grains have mineral inclusions of altered feldspar and opaque minerals. Fluid inclusions form trails. Quartz grains have irregular grain margins and exhibit weak undulose extinction. Grains are polycrystalline; sub-grain boundaries are often sutured or not well defined. Grains have conchoidal fractures.



Initial CL color





Final CL color

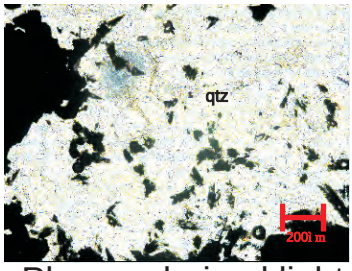
	Initial Red	Initial Green	Initial Blue	Final Red	Final Green	Final Blue
Grain 1	28.15	63.03	203.07	27.24	32.51	74.71
Grain 2	36.39	64.97	221.09	35.01	36.80	86.29
Grain 3	33.75	69.13	243.07	32.42	38.91	101.51
Grain 4	34.84	58.65	198.91	31.10	34.50	84.40
Grain 5	35.76	69.54	250.36	32.94	37.01	90.94

Aplites and Vein Quartz

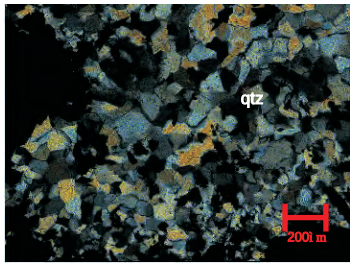
General Characteristics

Quartz grains may exhibit a slight to strong color shift although color shift is usually slight. Initial CL color most often ranges from medium-dark to dark blue. Final CL color most often ranges from dark blue to very dark blue. Brownish olive green CL color is also possible. Some grains underwent a moderate to strong color shift from an initial CL color ranging from bright blue to bright-medium blue to a final CL color ranging from medium-dark to dark blue. Sharp angled sector zoning has been observed in some samples. Grains usually are embayed and contain mineral inclusions of opaque minerals, tourmaline and muscovite, and are sometimes fractured. Microfractures may or may not be conchoidal. It is characteristic of vein quartz to have large fluid inclusions. Fluid inclusions are often abundant and/ or form trails. Grains may be monocrystalline or polycrystalline.

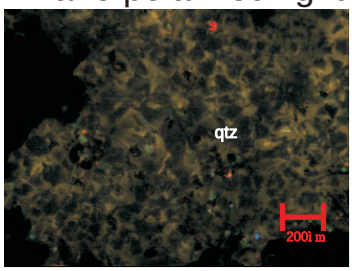
Sample: 8237



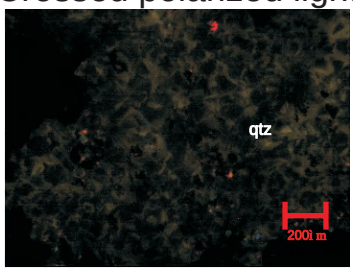
Plane polarized light



Crossed polarized light



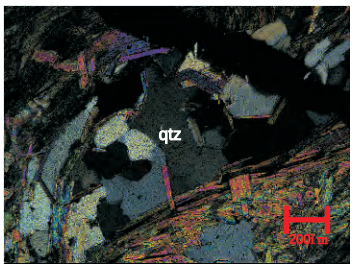
Initial CL color



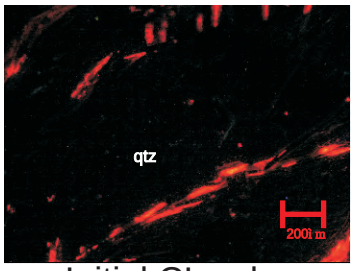
Final CL color

Sample: GL115

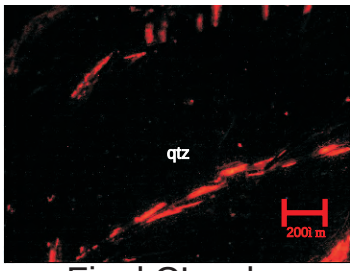
polarized light



Crossed polarized light



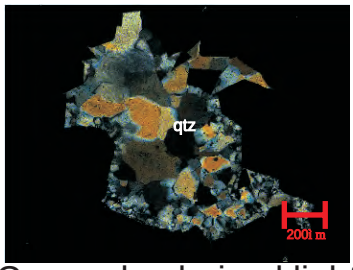
Initial CL color



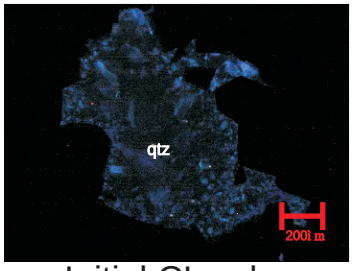
Final CL color

Sample: 8237

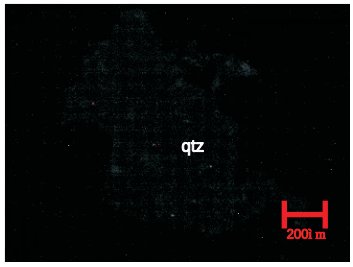
Plane polarized light



Crossed polarized light



Initial CL color



Final CL color

Aplite, Beechville overpass, Highway 103, Halifax, NS

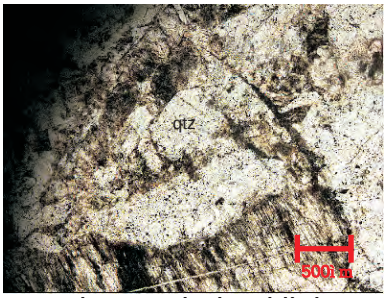
Samples: 9811, 9812, 9813
Source: G. Pe-Piper

Two types of quartz are observed in these samples. The first type exhibits a moderate-strong color shift from an initial color ranging from bright blue to bright-medium blue and a final color of medium-dark blue. This type can easily be identified by its abundant fractures that are not luminescent (see CL images). Grains of this first type have mineral inclusions of tourmaline and chlorite, and contain fluid inclusion trails. Their grain margins are embayed and grains are microfractured. A few microfractures are conchoidal. Grains may be monocrystalline or polycrystalline with only a few sub-grains.

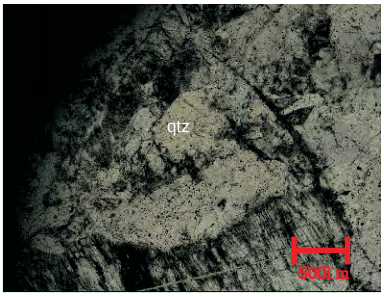
The second type of quartz observed exhibits a inhomogeneous luminescence. Small patches exhibit a color shift from bright-medium blue to a final color of medium dark blue, while most of the grain is only very weakly luminescent. This quartz has mineral inclusions of chlorite and altered tourmaline. All quartz grains in these samples are polycrystalline. Quartz grains of the second type have many sub-grains and appear to be deformed.

Based on petrographic features corresponding to type one, it appears that nearly all quartz grains in the slides belong to the first type, whereas quartz of the second type is fairly rare.

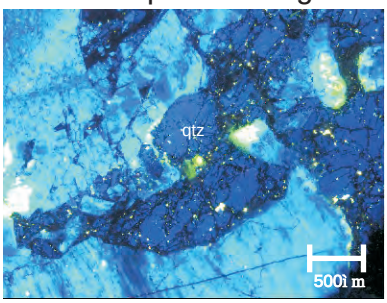
Type 1
Sample: 9812



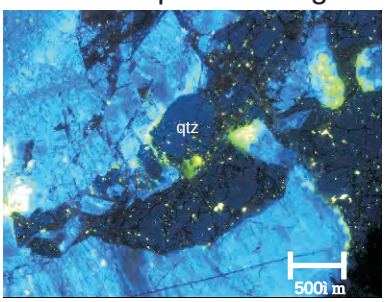
Plane polarized light



Crossed polarized light

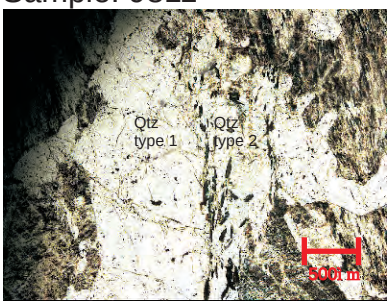


Initial CL color

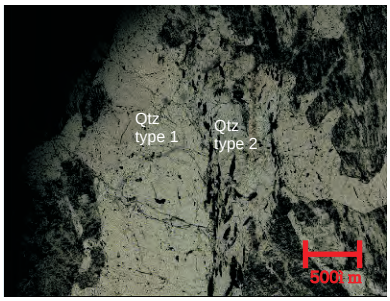


Final CL color

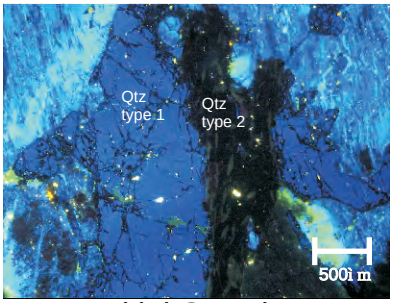
Type 1 and 2
Sample: 9811



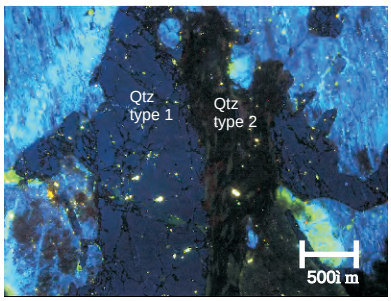
Plane polarized light



Crossed polarized lightl



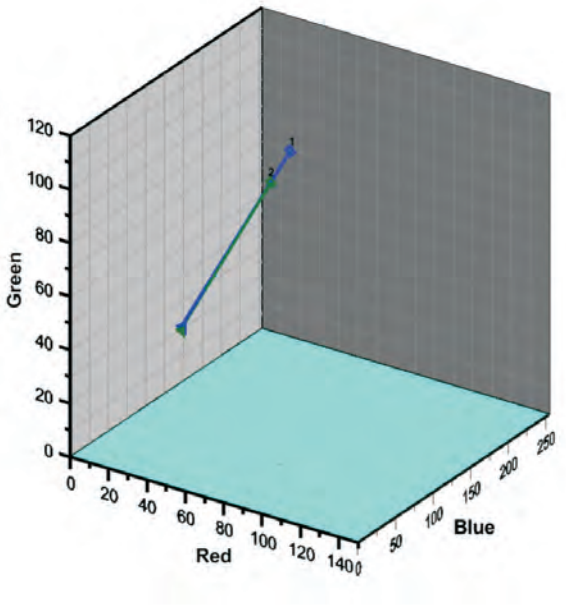
Initial CL color



Final CL color

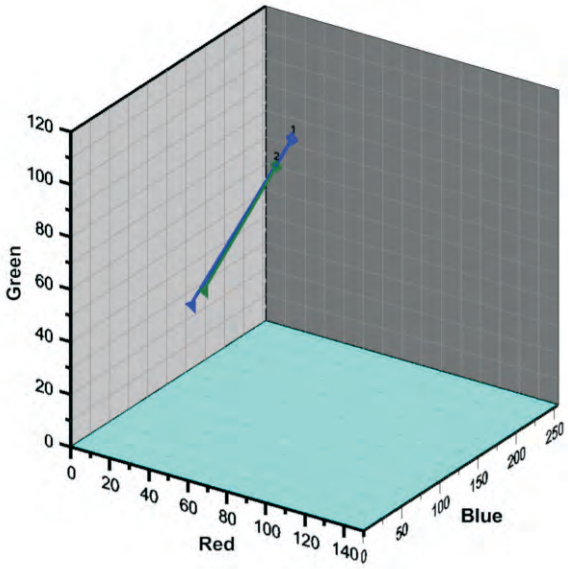
RGB Color Values for Sample: 9811

	Initial Red	Initial Green	Initial Blue	Final Red	Final Green	Final Blue
Grain 1	25.94	77.29	226.58	28.40	40.65	74.77
Grain 2	27.24	71.31	197.36	28.73	39.69	72.91



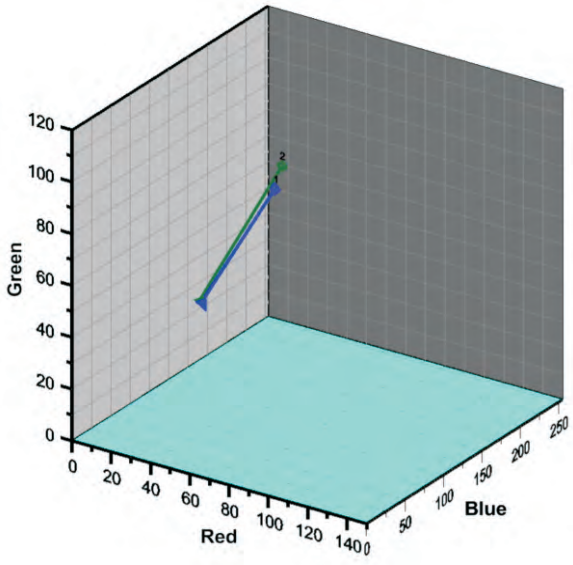
RGB Color Values for Sample: 9812

	Initial Red	Initial Green	Initial Blue	Final Red	Final Green	Final Blue
Grain 1	25.87	80.86	223.34	28.88	44.65	82.78
Grain 2	28.36	76.12	196.38	32.78	49.59	89.37



RGB Color Values for Sample: 9813

	Initial Red	Initial Green	Initial Blue	Final Red	Final Green	Final Blue
Grain 1	30.72	69.07	185.08	34.15	45.33	80.18
Grain 2	27.87	74.16	201.80	32.63	45.53	81.90



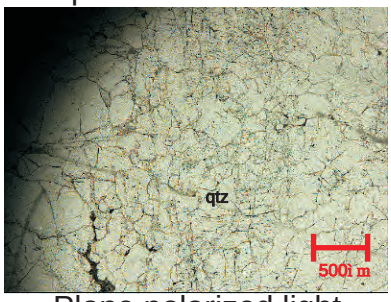
Quartz Veins in Meguma Supergroup, Kearney Lake Road, Halifax, NS (9814), and Highway

Samples: 9814, 9815
Source: G. Pe-Piper

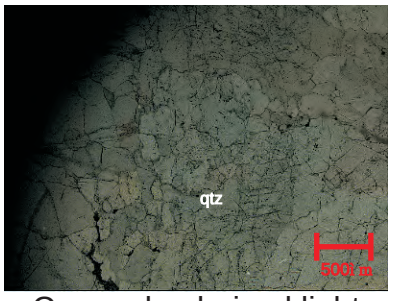
Vein quartz exhibits a moderate to strong color shift from an initial color of either bright blue or medium blue to a final color of medium blue or medium-dark blue. CL color is inhomogeneous. Grains are conchoidally fractured, contain abundant fluid inclusion trails, and have mineral inclusions of muscovite, chlorite and apatite. Muscovite appears to be in the process of altering to chlorite. There are no inclusions of tourmaline in this sample setting it apart from quartz grain in the host sediment, which contain abundant tourmaline inclusions.

There are two types of quartz grains in the sediments. Type 1 exhibits a slight color shift from medium blue to medium-dark blue. Type 2 exhibits a moderate color shift from medium brownish blue to medium grayish brown. Quartz grains in the host sediments have embayed to irregular grain margins.

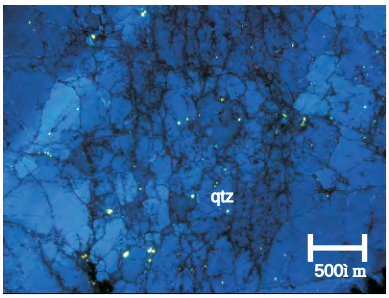
Vein quartz
Sample: 9814



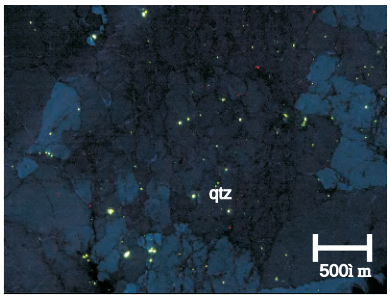
Plane polarized light



Crossed polarized light

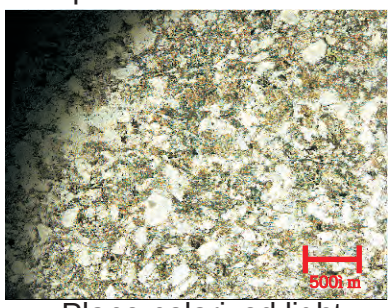


Initial CL color

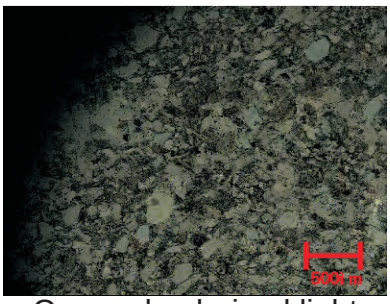


Final CL color

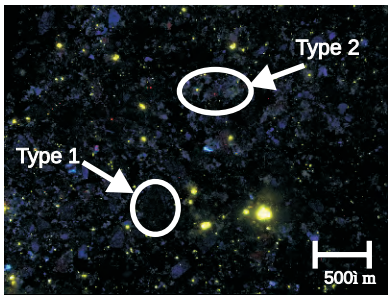
Quartz in host sediments
Sample: 9814



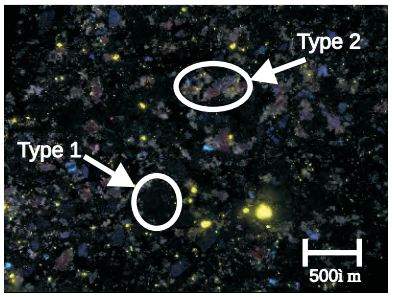
Plane polarized light



Crossed polarized light



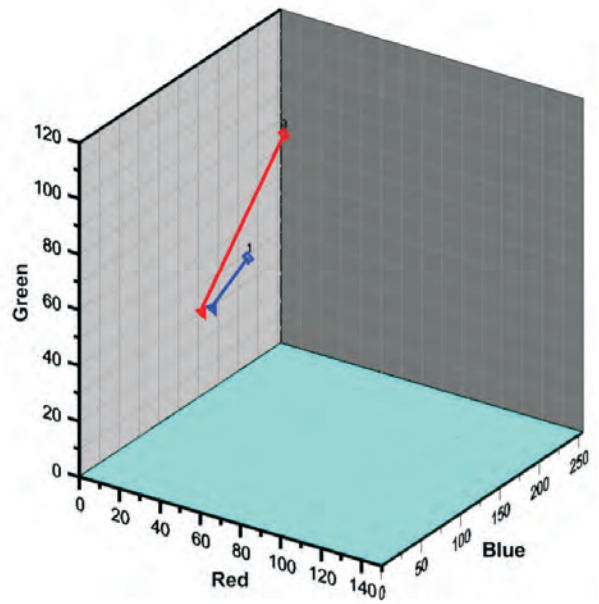
Initial CL color



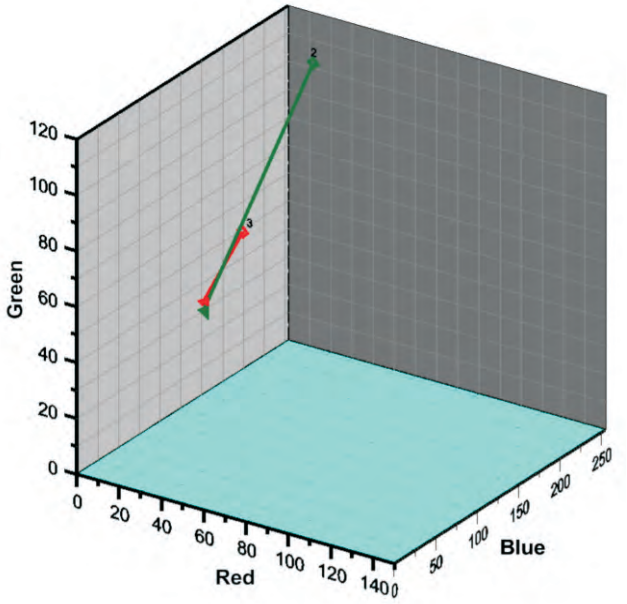
Final CL color

-CL images have been enhanced to better display CL color

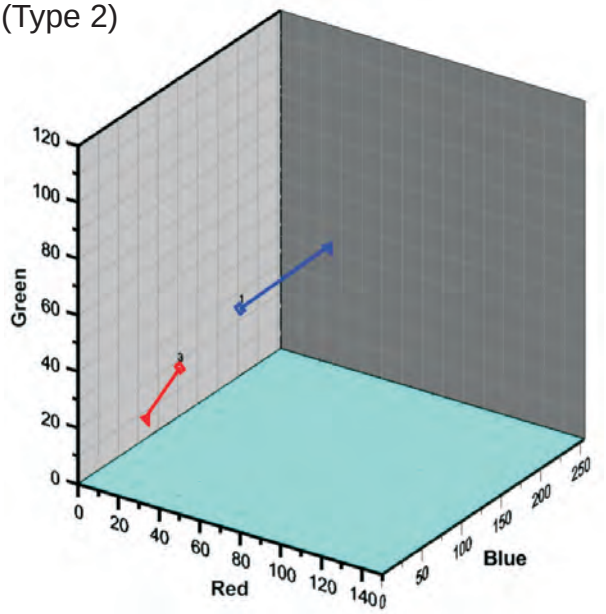
RGB Color Values for Sample: 9814
Blue quartz in host sediments (Type 1)



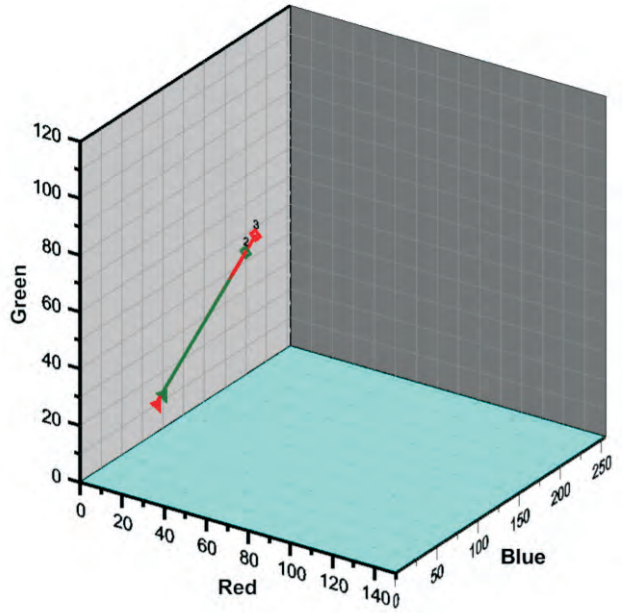
RGB Color Values for Sample: 9814 -
Bright blue vein quartz



RGB Color Values for Sample: 9814 -
Brownish blue quartz in host sediments
(Type 2)



RGB Color Values for Sample: 9814 -
Medium blue vein quartz



RGB Color Data for Sample: 9814

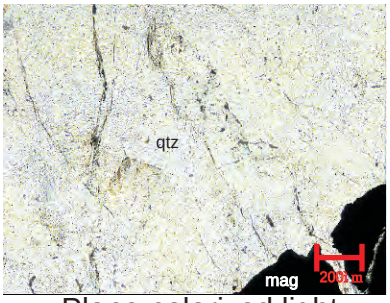
	Initial Red	Initial Green	Initial Blue	Final Red	Final Green	Final Blue
Blue Quartz in Host Sediments						
Photomicrograph 1	27.50	57.68	143.30	27.20	48.24	97.30
Photomicrograph 3	26.09	92.38	192.74	30.12	51.36	76.31
Brownish Blue Quartz in Host Sediments						
Photomicrograph 1	46.76	56.29	84.57	86.91	85.28	91.51
Photomicrograph 3	28.67	37.04	55.09	22.05	22.81	27.50
Bright Blue Vein Quartz						
Photomicrograph 2	20.96	108.20	231.59	29.62	50.31	76.58
Photomicrograph 3	26.63	67.72	132.09	28.15	52.44	80.43
Medium Blue Vein Quartz						
Photomicrograph 2	27.26	62.14	131.34	22.93	28.29	39.85
Photomicrograph 3	27.80	66.30	141.91	22.38	25.70	34.25

Quartz Vein, Gerrish Mountain Magnetite Mine, Economy, NS

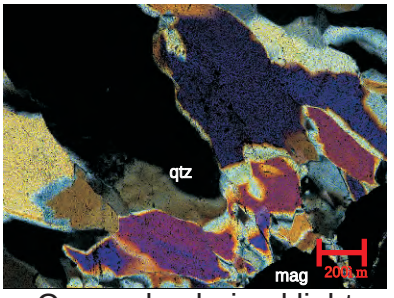
Samples: 8237, 8242
Source: G. Pe-Piper

There are two main types of vein quartz in these rocks. The first type, type 1, exhibits a slight to moderate color shift from an initial color of light-medium olive green brown to a final color of medium olive green brown. The second type, type 2, exhibits a moderate to strong color shift with an initial color ranging from bright to medium blue to a final color of dark blue. All samples show sector zoning with sharp angles or irregular zoning in CL photos, and as a result all have an inhomogeneous CL color. Veinlets of quartz of the second type have been observed cutting quartz of the first type, which shows they are of a younger generation of vein quartz. Deformation lamellae and a few microfractures have been observed in some grains suggesting deformation. Some microfractures are conchoidal. Individual grain margins are embayed. Fluid inclusions are not abundant and do not form trails.

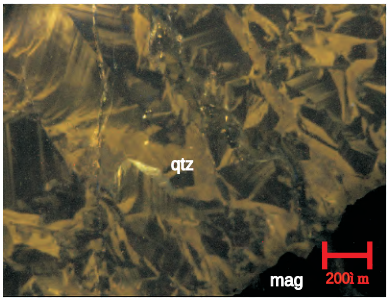
Type 1
Sample: 8242



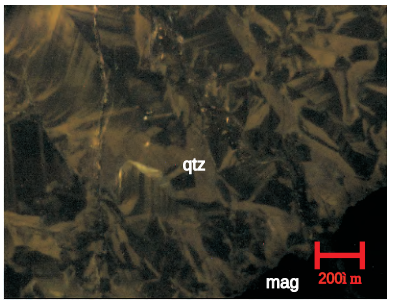
Plane polarized light



Crossed polarized light



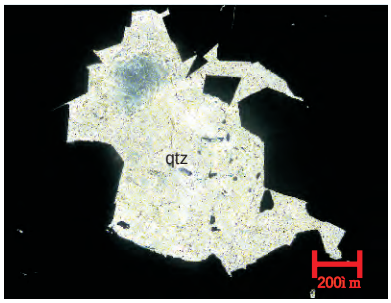
Initial CL color



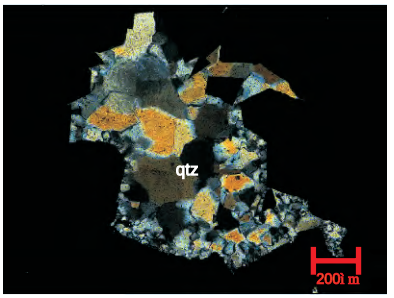
Final CL color

-CL images have been enhanced to better display CL color

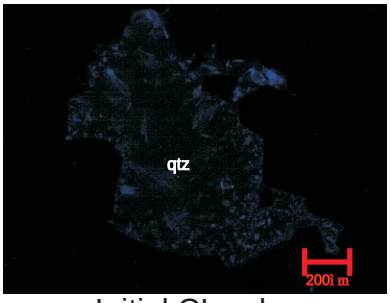
Type 2
Sample: 8237



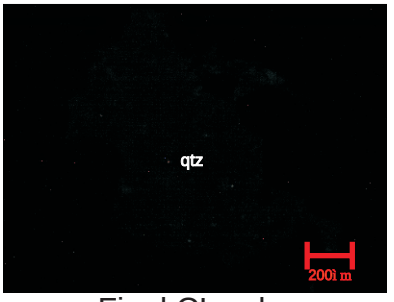
Plane polarized light



Crossed polarized light



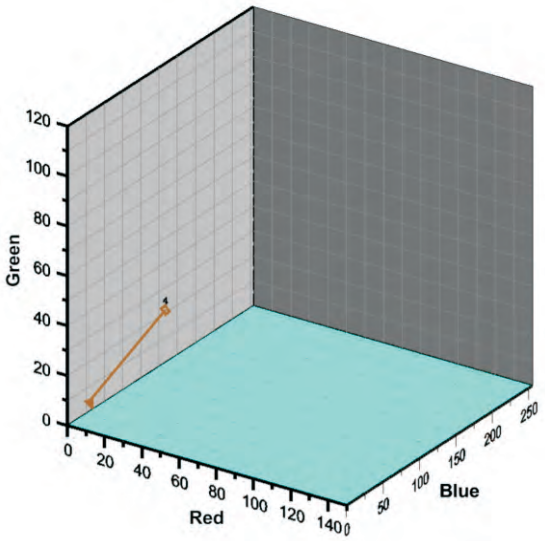
Initial CL color



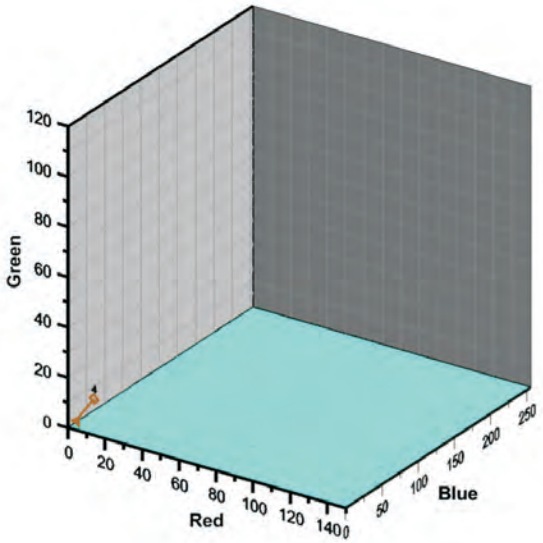
Final CL color

-CL images have been enhanced to better display CL color

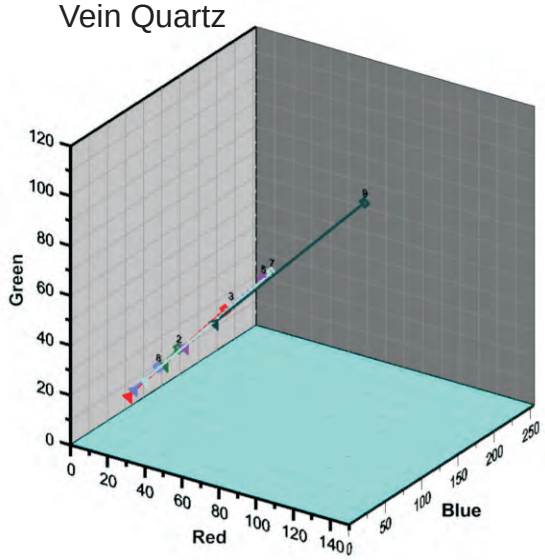
RGB Color Values for Sample: 8237 Vein Quartz with Bright Blue Initial Color



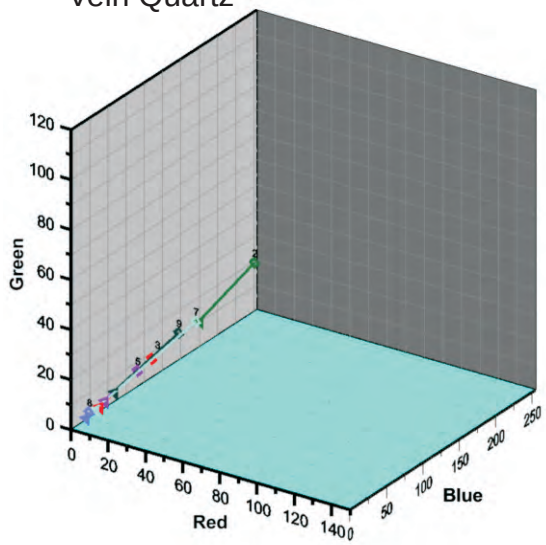
RGB Color Values for Sample: 8237 Vein Quartz with Medium-Dark Blue Initial Color



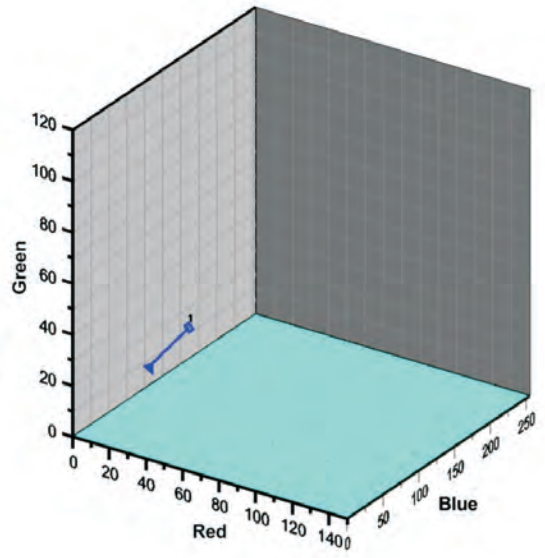
RGB Color Values for Sample: 8237 Light Olive Green Intervals of Zoning in Vein Quartz



RGB Color Values for Sample: 8237 Dark Olive Green Intervals of Zoning in Vein Quartz



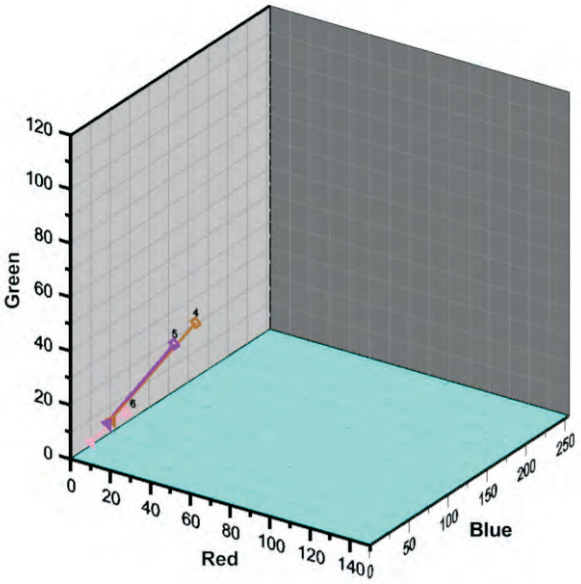
RGB Color Values for Sample: 8237 Homogeneous Olive Green Vein Quartz



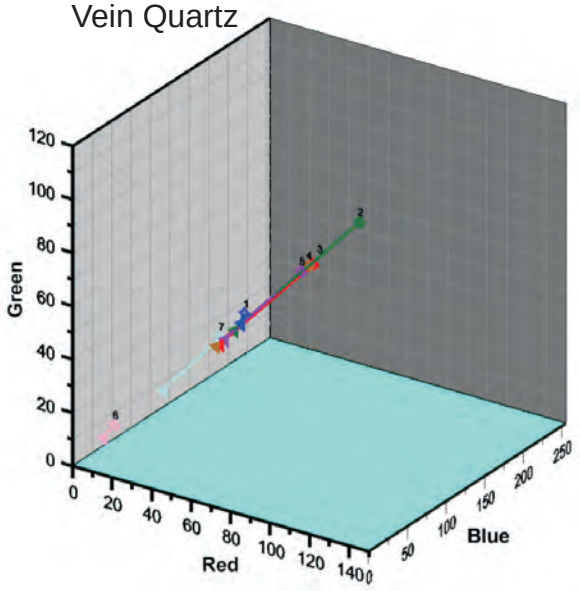
RGB Color Data for Sample: 8237

	Initial Red	Initial Green	Initial Blue	Final Red	Final Green	Final Blue
Homogeneous Olive Green Vein Quartz						
Grain 1	48.56	45.90	38.27	31.49	29.17	24.90
Light Olive Green Intervals of Zoning in Vein Quartz						
Grain 2	43.29	40.90	38.10	38.13	34.56	29.88
Grain 3	65.43	59.57	45.59	23.46	21.12	17.67
Grain 5	85.59	76.15	46.40	48.37	43.53	31.49
Grain 7	89.71	79.48	47.39	30.95	28.33	21.24
Grain 8	37.02	34.18	26.03	26.24	24.19	18.37
Grain 9	138.46	117.18	51.03	62.95	55.57	35.49
Dark Olive Green Intervals of Zoning in Vein Quartz						
Grain 2	77.22	72.98	54.58	54.28	47.90	36.28
Grain 3	32.01	29.75	28.99	11.00	9.67	8.96
Grain 5	27.18	25.28	21.74	13.19	12.20	10.33
Grain 7	53.03	47.89	35.95	9.72	8.76	7.14
Grain 8	7.18	7.32	6.44	5.37	4.87	4.27
Grain 9	44.58	41.83	33.99	17.11	15.96	13.51
Bright Blue Vein Quartz						
Grain 4	21.72	36.15	78.70	6.70	8.52	11.64
Medium-Dark Blue Vein Quartz						
Grain 4	8.33	10.58	14.46	2.87	2.72	2.75

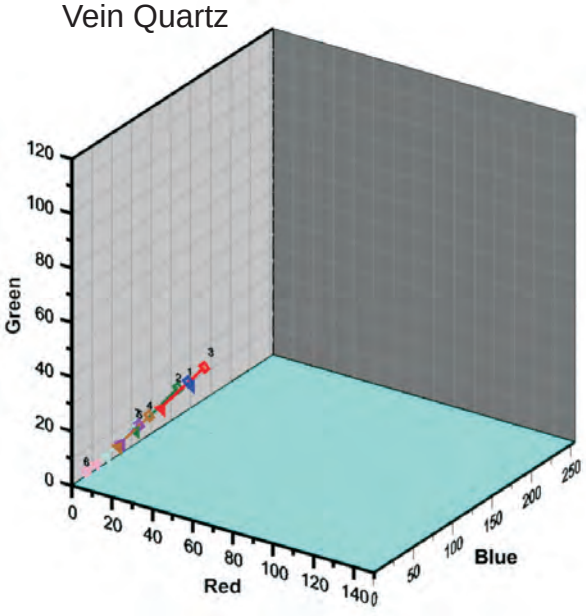
RGB Color Values for Sample: 8242
Vein Quartz with Blue CL Color



RGB Color Values for Sample: 8237
Light Olive Green Intervals of Zoning in Vein Quartz



RGB Color Values for Sample: 8237
Dark Olive Green Intervals of Zoning in Vein Quartz



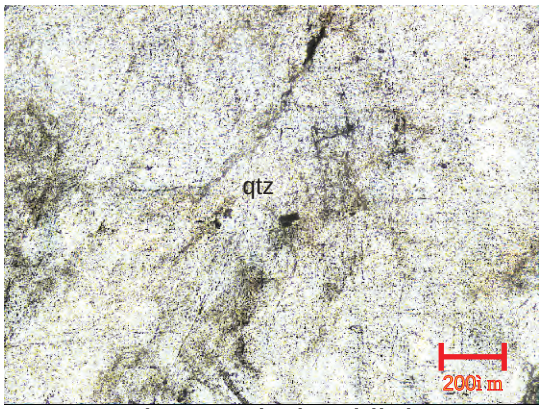
RGB Color Data for Sample: 8242

	Initial Red	Initial Green	Initial Blue	Final Red	Final Green	Final Blue
Light Olive Green Interval of Zoning of Vein Quartz						
Grain 1	70.94	64.44	41.57	69.14	60.63	39.39
Grain 2	123.66	107.25	56.08	65.63	57.35	39.57
Grain 3	101.67	87.62	52.18	59.41	51.16	37.38
Grain 4	99.89	86.96	50.60	57.25	50.19	36.64
Grain 5	96.94	84.47	48.79	61.67	53.42	37.60
Grain 6	16.41	15.05	12.82	11.04	10.60	10.00
Grain 7	59.32	53.45	40.34	35.29	31.16	24.79
Dark Olive Green Interval of Zoning in Vein Quartz						
Grain 1	44.68	41.37	33.38	45.40	40.38	32.93
Grain 2	38.57	37.31	36.19	23.02	21.14	20.20
Grain 3	50.43	46.84	39.34	33.48	30.53	25.93
Grain 4	28.87	27.19	24.49	16.85	15.33	13.42
Grain 5	24.98	23.61	21.47	17.87	16.46	14.52
Grain 6	5.11	4.94	4.92	7.80	7.83	9.26
Grain 7	23.84	23.73	21.91	12.27	11.33	10.49
Blue Vein Quartz						
Grain 4	26.86	39.03	91.57	12.70	13.63	18.30
Grain 5	24.67	34.84	69.54	11.08	12.27	17.26
Grain 6	12.92	18.53	38.60	5.77	6.74	9.07

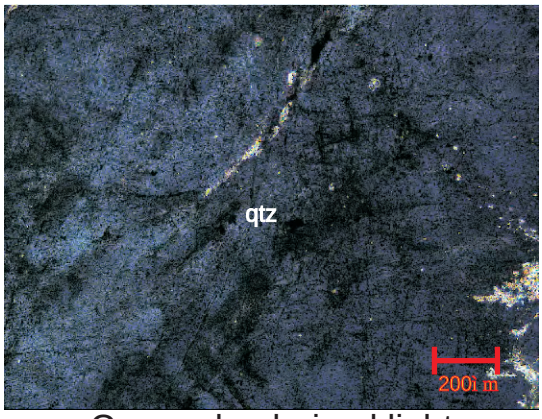
Quartz Vein in Horton Group, Boyd Brook, near Bass River of Five

Sample: 8053A
Source: G. Pe-Piper

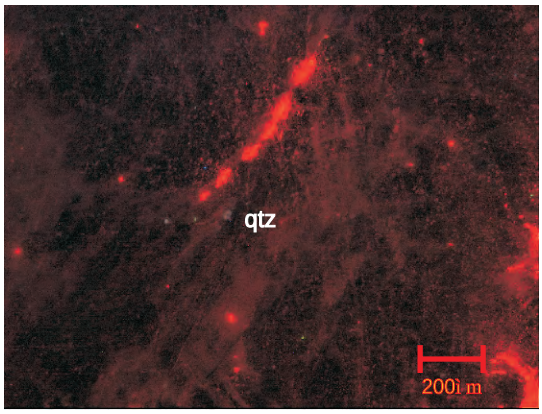
Quartz exhibits either no color shift or one that is very small. The majority of quartz is not visibly luminescent, although some small areas with dark blue luminescence were observed in some grains from this sample. Grains contain mineral inclusions of chlorite and tourmaline. Tourmaline inclusions are scarce and very small. Grains have embayed to irregular grain margins and contain fluid inclusion trails which are oriented in a common direction in some grains. All quartz grains have many fluid inclusions. Grains are monocrystalline and contain large microfractures.



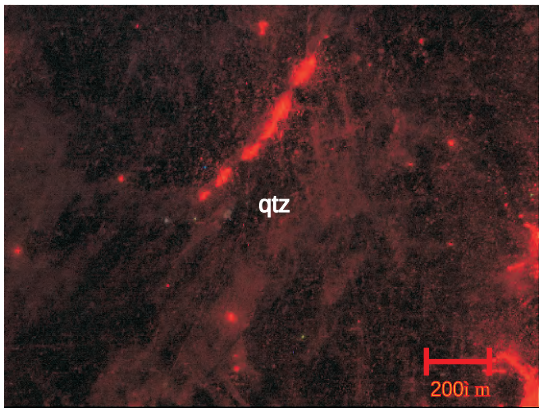
Plane polarized light



Crossed polarized light



Initial CL color



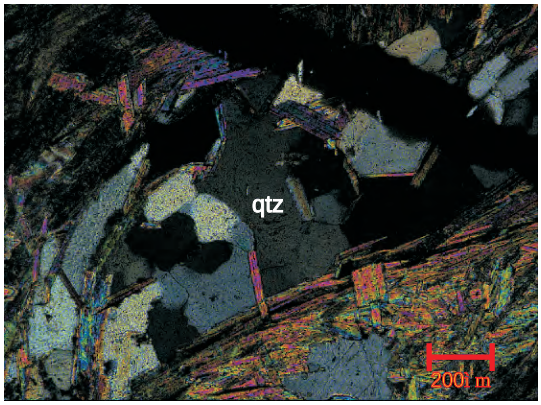
Final CL color

Vein Quartz in Metapelite, Grand Lake, NL

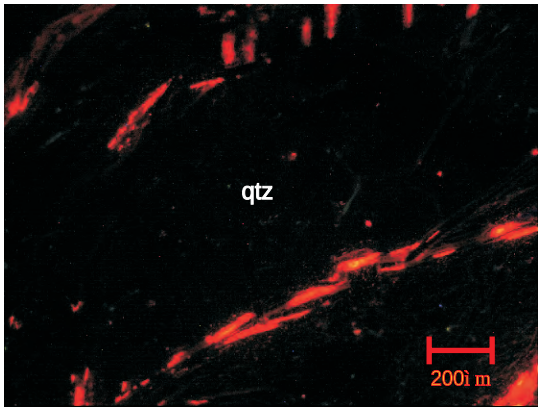
Sample: GL115
Source: V.Owen

CL color of quartz is very dark and quartz exhibits either no color shift or one that is very slight. Initial colors range from dark blue to very dark blue. Final color of grains ranges from very dark blue to seemingly non-luminescent. A few microfractures have been observed in some grains. Grains are polycrystalline and contain only a few sub-grains; grain margins are embayed. Quartz grains have inclusions of opaque minerals, muscovite, apatite and tourmaline. Fluid inclusions form trails in some grains.

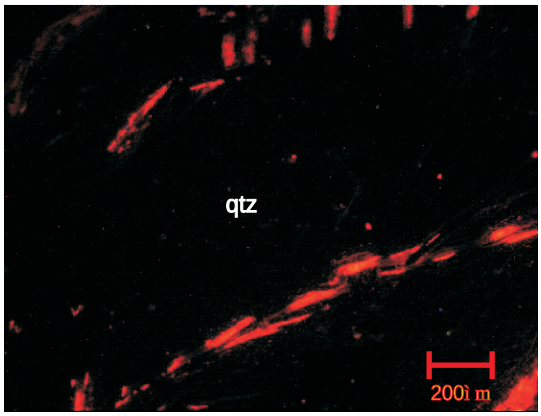
Plane polarized light



Crossed polarized light



Initial CL color



Final CL color

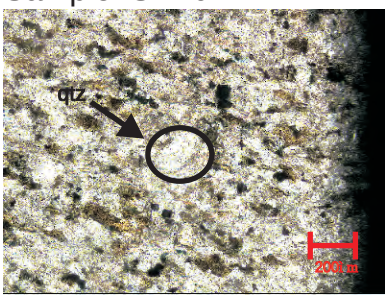
Low Grade Metamorphic Quartz

General Characteristics

Quartz grains exhibit a slight to moderate color shift. Initial CL colors usually range from medium to dark blue or brown. Final CL color of grains usually ranges from medium-dark blue to very dark blue or brown. Often quartz with brown CL color is inhomogenous and contains patches of blue CL color; an inhomogeneous CL color is characteristic of this group. Grains are microfractured. Some grains contain microfractures with a preferred orientation, which is diagnostic of regional deformation. Grains may be monocrystalline or polycrystalline; polycrystalline grains often have many sub-grains with sutured sub-grain boundaries. Mineral inclusions in grains mainly consist of chlorite, although inclusions of more stable pre-metamorphic minerals and metamorphic minerals are possible.

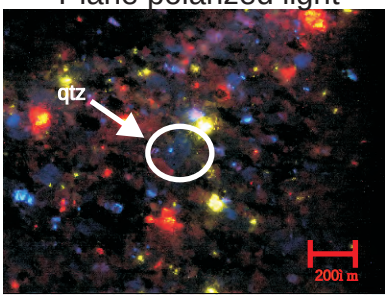
Photomicrographs of sample SH8 exhibit quartz with an inhomogeneous brown and blue luminescence, while all quartz grains in sample SH10 have only a blue luminescence.

Sample: SH10

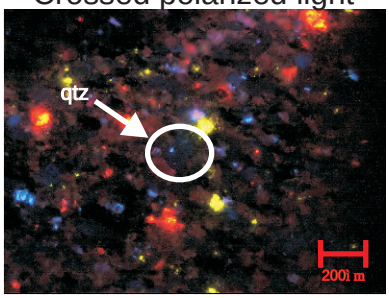


Plane polarized light

Crossed polarized light



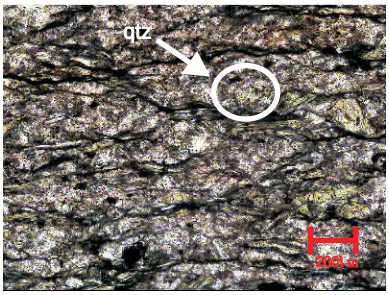
Initial CL color



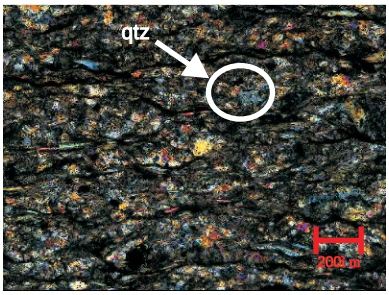
Final CL color

-CL images have been enhanced to better display CL color

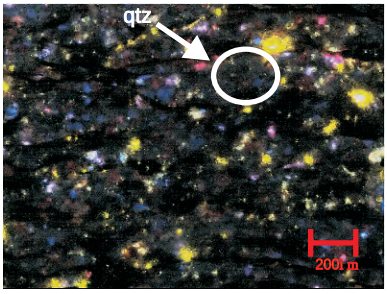
Sample: SH 08



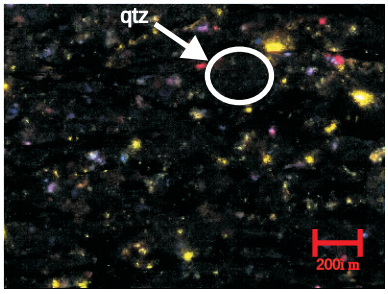
Plane polarized light



Crossed polarized light



Initial CL color

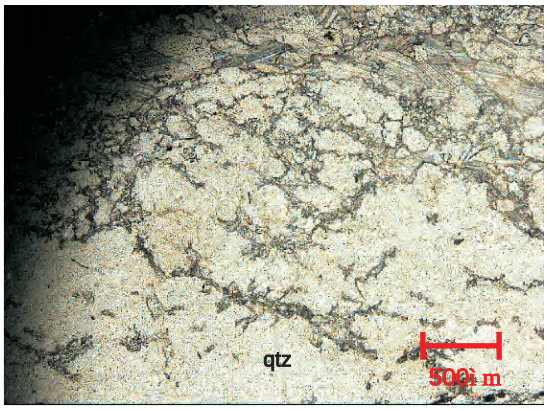


Final CL color

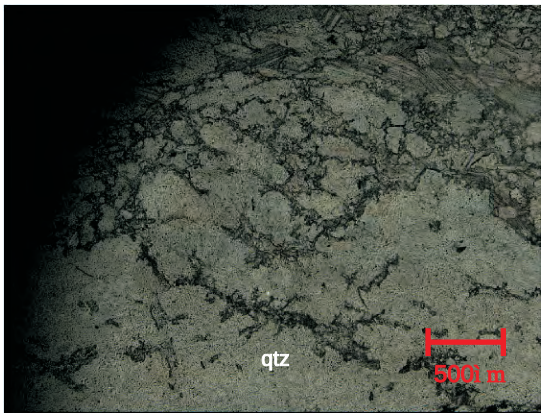
-CL images have been enhanced to better display CL color

Quartz Vein in meta-basalt, Jeffers Group, Lynn Road, Five Islands, NS

Sample: 9804
Source: G. Pe-Piper

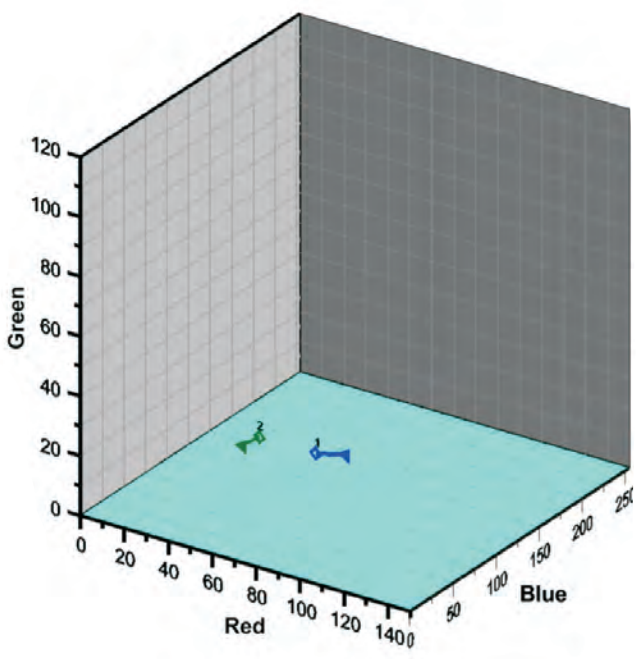


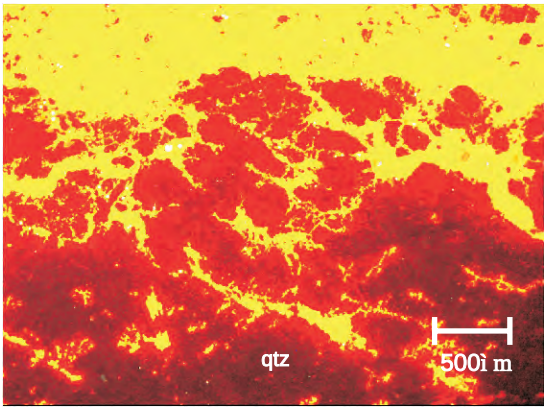
Plane polarized light



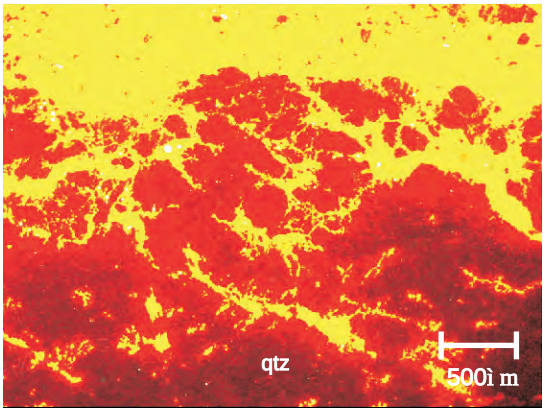
Crossed polarized light

Quartz grains do not exhibit a color shift in CL images. The CL color of quartz grains is being affected by surrounding bright orange luminescent calcite. Grains are polycrystalline, microfractured, and exhibit strong undulose extinction. Calcite is infilling large fractures in quartz. Grains have irregular grain margins and have sutured sub-grain boundaries. Mineral inclusions of tourmaline and chlorite, and also deformation lineations were observed in grains.





Initial CL color



Final CL color

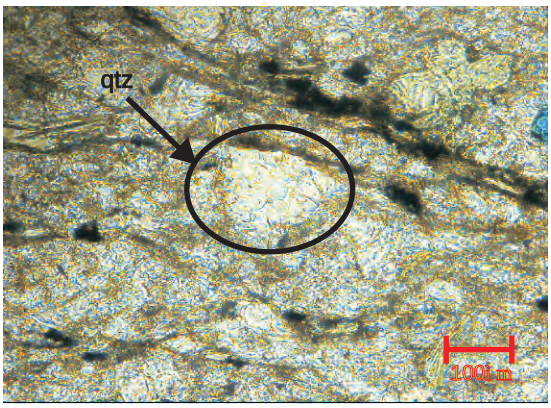
	Initial Red	Initial Green	Initial Blue	Final Red	Final Green	Final Blue
Grain 1	93.97	34.55	33.60	106.53	36.63	34.05
Grain 2	67.30	33.88	36.18	60.63	30.49	30.99

Slate, Halifax Group, Gore, Hants Co., NS

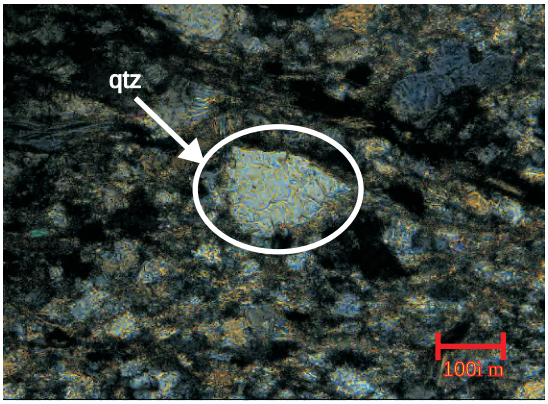
Sample: SH8
Source: G. Pe-Piper

Quartz grains exhibit a slight to moderate color shift. Initial color either ranges from medium blue to dark blue, or is inhomogeneous dark bluish brown. Final color ranges from medium-dark blue to very dark blue, or is brown. Grains are very small (~50-100ì m), monocrystalline, have weak undulose extinction, and may or may not have irregular grain margins. Grains contain mineral inclusions of tourmaline, amphibole and chlorite.

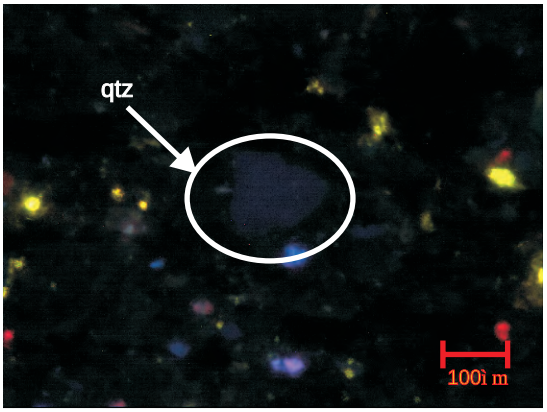
Quartz in this example underwent a slight color shift from an initial color of medium blue to a final color of medium-dark blue.



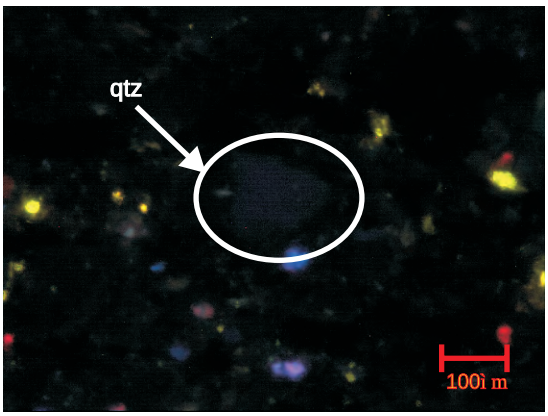
Plane polarized light



Crossed polarized light

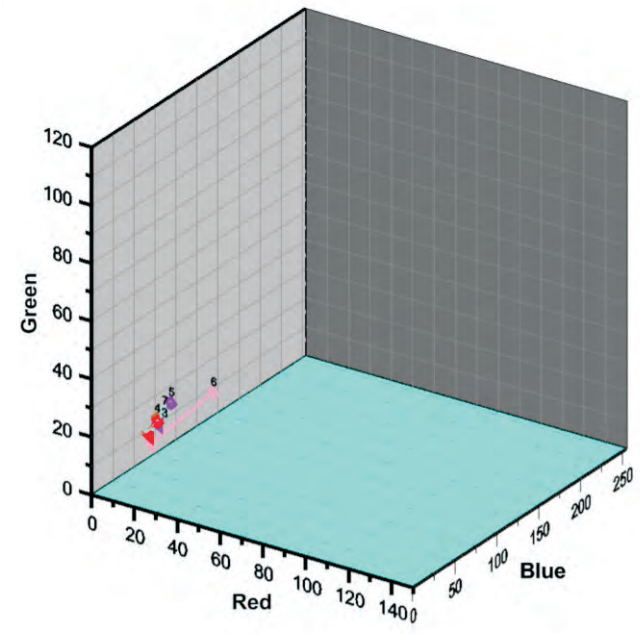


Initial CL color

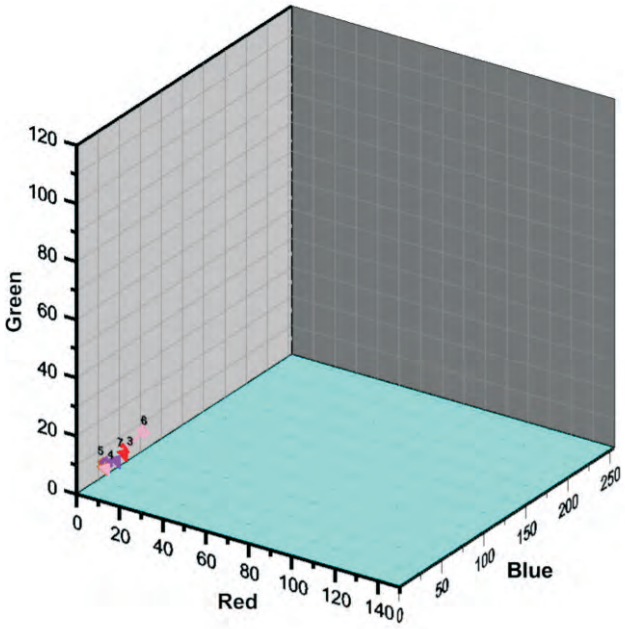


Final CL color

RGB Color Data for Sample: SH8 - Quartz with Blue CL Color



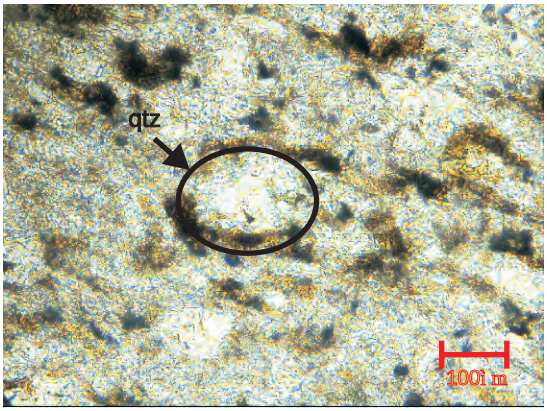
RGB Color Data for Sample: SH8 - Quartz with Dark Bluish Brown Initial CL Color



	Initial Red	Initial Green	Initial Blue	Final Red	Final Green	Final Blue
Blue Quartz						
Photomicrograph 3	17.07	22.28	35.36	15.77	18.53	26.62
Photomicrograph 4	14.28	21.43	41.78	12.73	17.84	33.07
Photomicrograph 5	16.81	25.64	51.82	16.23	20.58	36.45
Photomicrograph 6	26.05	38.07	78.68	14.27	18.48	32.51
Photomicrograph 7	17.61	24.68	42.02	15.01	19.05	29.91
Quartz with Dark Bluish Brown Initial CL Color						
Photomicrograph 3	15.22	15.35	16.15	15.20	14.38	15.01
Photomicrograph 4	8.14	10.11	11.55	7.83	8.91	9.89
Photomicrograph 5	9.90	10.79	10.12	13.14	12.19	11.70
Photomicrograph 6	21.61	23.00	24.22	8.97	9.42	9.45
Photomicrograph 7	14.07	14.19	15.11	12.67	12.12	12.35

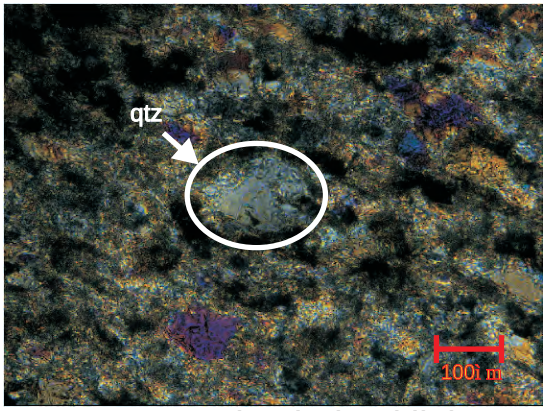
Quartzite, Goldenville Group, Beaverbank Road, Upper Rawdon,

Sample: SH10
Source: G. Pe-Piper



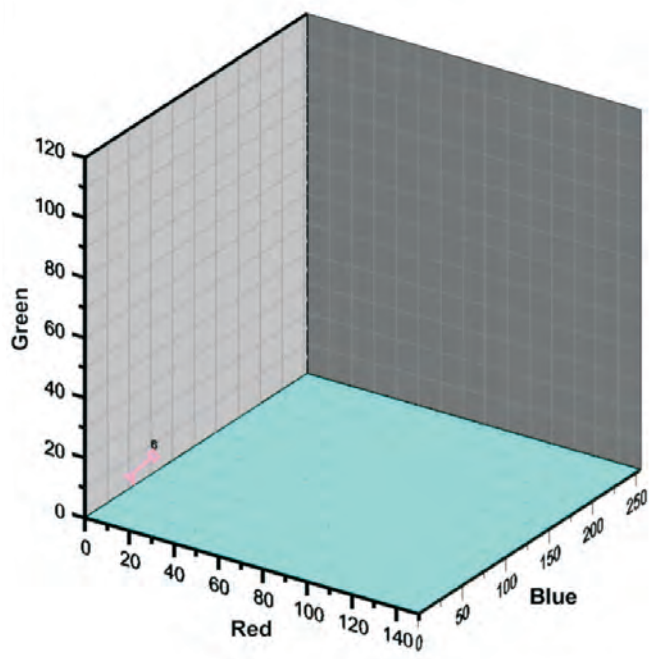
Plane polarized light

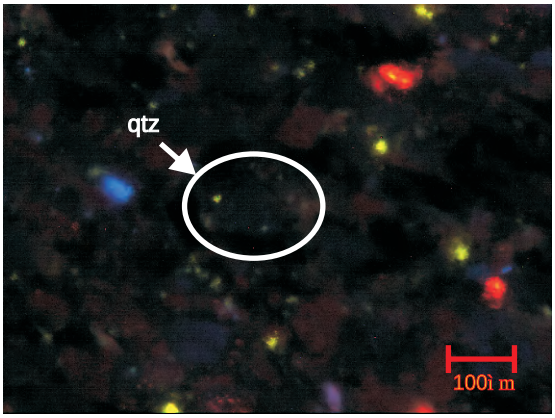
Quartz exhibits either no color shift of one that is slight. Initial color ranges from medium blue to dark blue or is brown. Final color ranges from medium-dark blue to very dark blue or is brown. Grain margins may either be irregular or rounded. Grains contain a few small microfractures. Analyzed sample was mildly foliated. Most grains are monocrystalline, very small (~50-100 ì m), and have chlorite and tourmaline inclusions. Grains have weak undulose extinction.



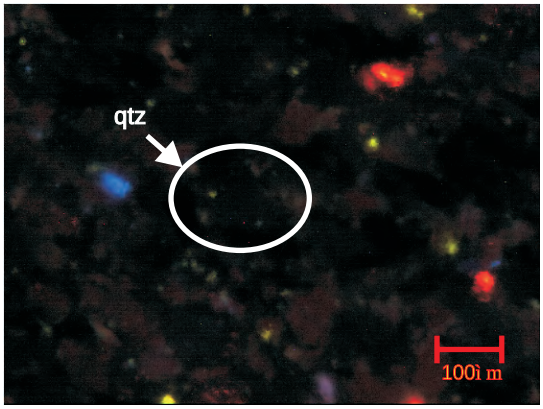
Crossed polarized light

Quartz in this example underwent a slight color shift from an initial color of dark blue to a final color of very dark blue.





Initial CL color



Final CL color

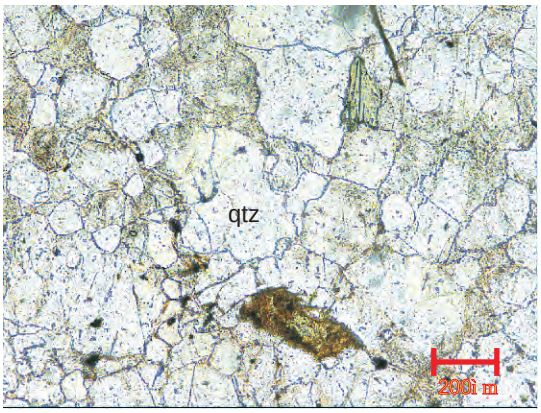
	Initial Red	Initial Green	Initial Blue	Final Red	Final Green	Final Blue
Grain 6	19.03	20.50	30.13	13.20	12.90	16.94

Medium and High Grade Metamorphic

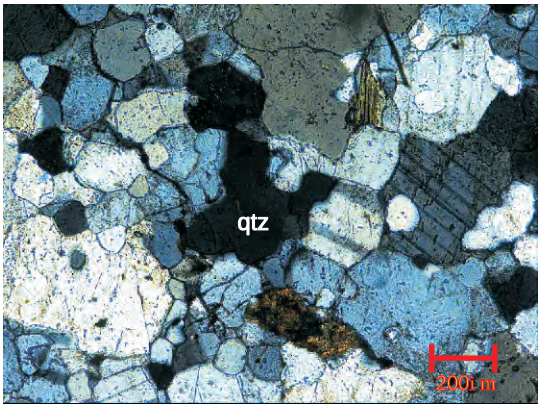
General Characteristics

Quartz grains exhibit a moderate to strong color shift. Initial CL colors usually range from bright blue to bright-medium blue. Final CL color of grains usually ranges from medium to medium-dark blue. Grains may be monocrystalline or polycrystalline. Sutured sub-grain boundaries, deformation lamellae and deformation banding are characteristic of metamorphic quartz. Mineral inclusions in analyzed grains mainly consist of chlorite and more stable pre-metamorphic inclusions. Other metamorphic mineral inclusions are possible, but have not been observed.

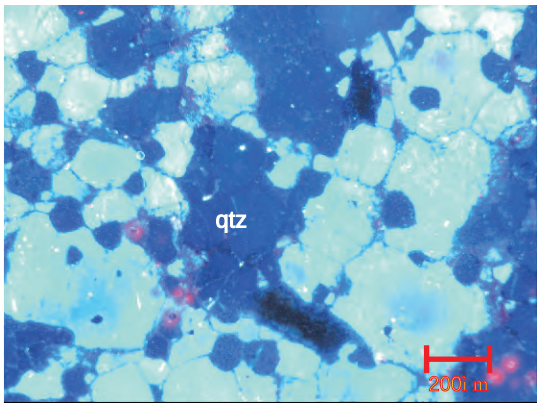
Sample: CL 32-6



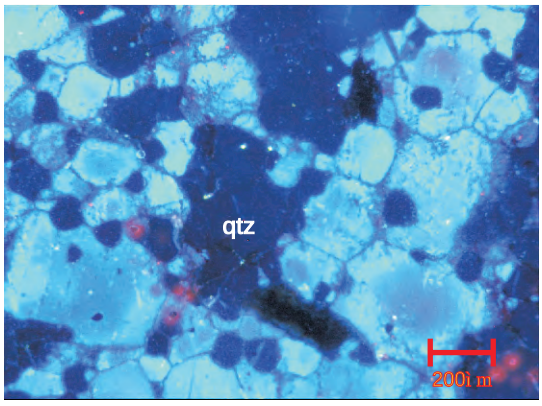
Plane polarized light



Crossed polarized light



Initial CL color

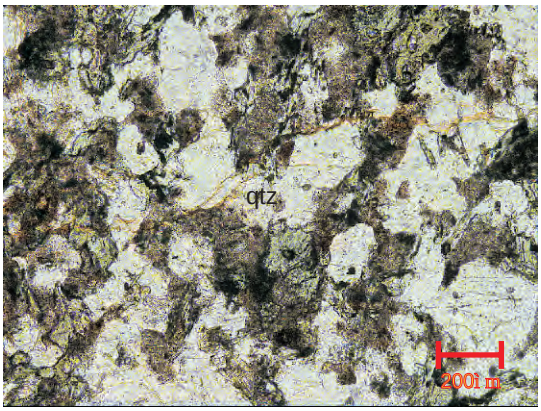


Final CL color

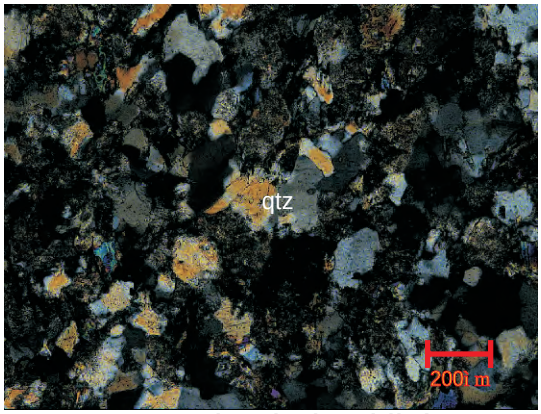
Quartzite, Gamble Brook Formation, Quarry S of Folly Lake, Cobequid

Sample: HG30
Source: G. Pe-Piper

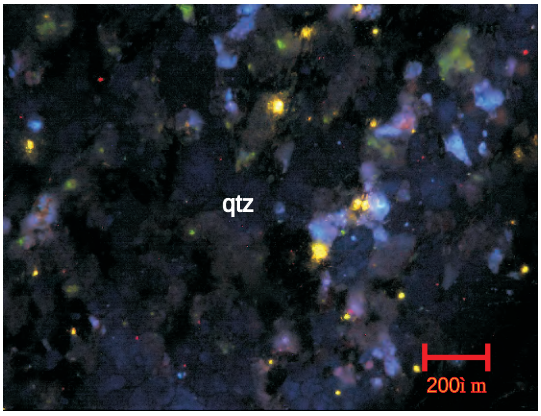
Quartz exhibits a slight to moderate color shift. Initial colors range from medium blue to dark blue. Final colors range from dark blue to very dark blue. CL color of quartz grains is inhomogeneous. Grain margins are irregular and grains have a few microfractures. Quartz grains are polycrystalline and sub-grain boundaries are sutured. Mineral inclusions of tourmaline, chlorite and feldspar are present in quartz grains. Fluid inclusions form trails in some grains. Grains have moderate to strong undulose extinction.



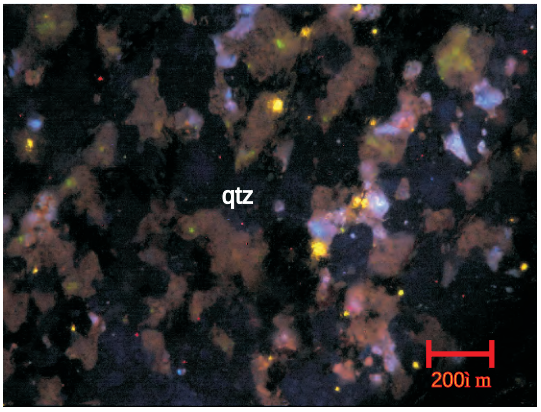
Plane polarized light



Crossed polarized light



Initial CL color

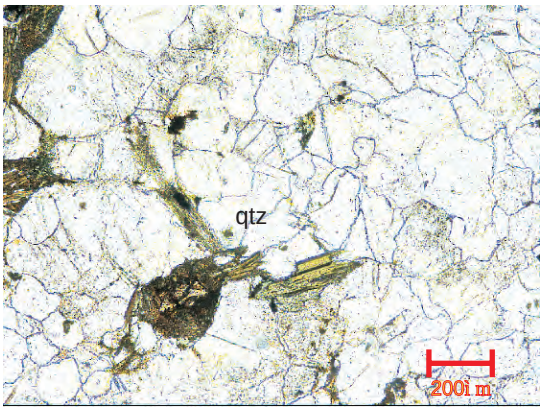


Final CL color

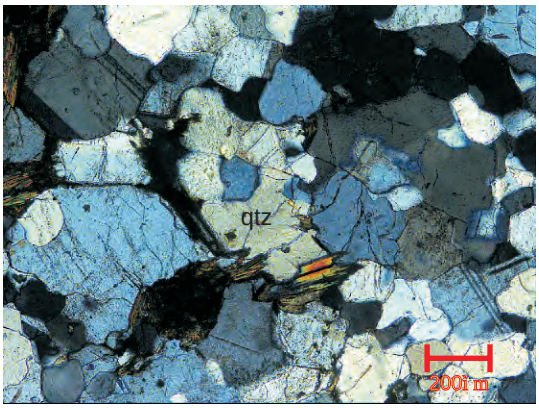
Leucocratic Gneiss, Cormacks Lake, central NL

Sample: CL 32-6
Source: V. Owen

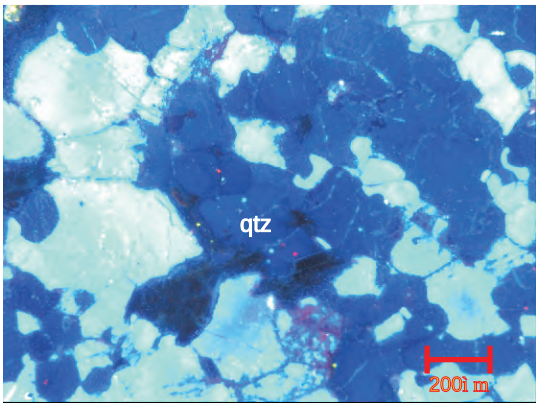
Quartz grains exhibit a moderate to strong color shift. Initial colors range from bright blue to bright-medium blue. Final colors range from medium blue to medium-dark blue. Quartz grains have mineral inclusions of tourmaline, feldspar and chlorite. Some quartz grains contain fluid inclusion trails. Grains are monocrystalline and are abundantly fractured; most fractures are conchoidal. Grain margins are embayed.



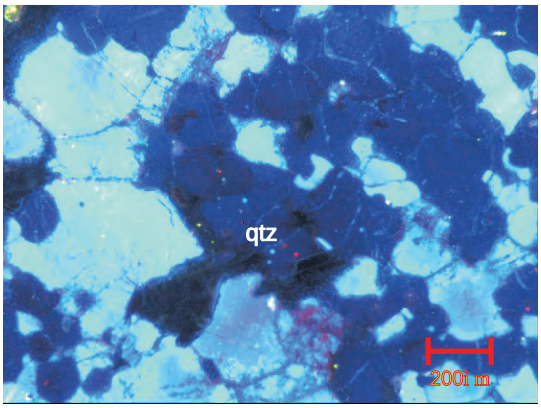
Plane polarized light



Crossed polarized light



Initial CL color

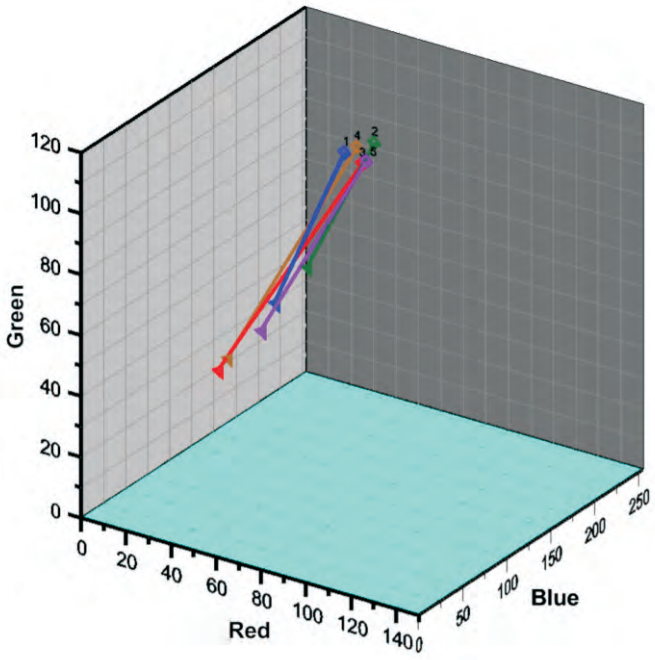


Final CL color

Garnetiferous Tonalitic Gneiss, Western Brook Pond, Gros Morne NL

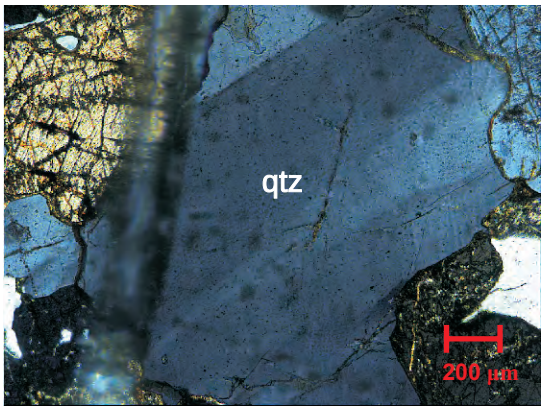
Sample: VO-86-113-2
Source: V. Owen

Quartz grains exhibit a strong color shift from an initial color of bright blue to a final color ranging from medium to medium-dark blue. Chlorite, apatite, tourmaline and feldspar mineral inclusions, as well as fluid inclusions are present; fluid inclusions form trails in some grains. Grains are microfractured; some microfractures are conchoidal. Grains are monocrystalline and have embayed grain margins. Grains exhibit deformation banding and have moderate undulose extinction.

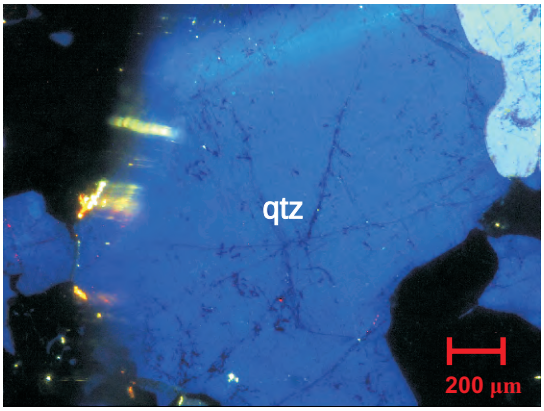


	Initial Red	Initial Green	Initial Blue	Final Red	Final Green	Final Blue
Grain 1	25.32	81.46	234.10	33.71	52.63	132.79
Grain 2	34.44	84.62	244.61	44.77	65.05	141.22
Grain 3	32.12	78.71	236.61	29.90	39.99	78.28
Grain 4	26.32	81.29	245.90	30.18	42.16	88.14
Grain 5	40.69	84.63	219.47	39.00	50.15	103.61

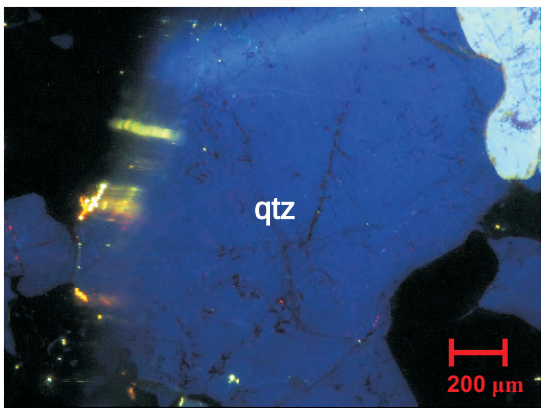
Plane polarized light



Crossed polarized light



Initial CL color

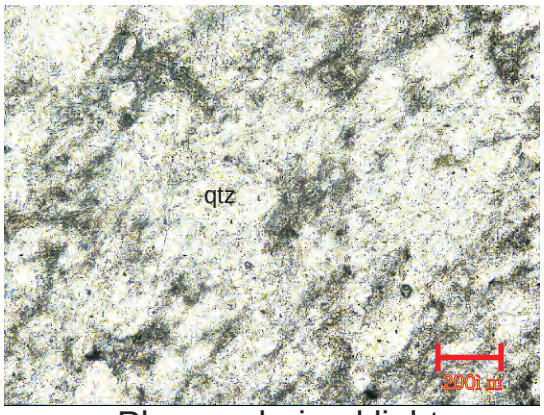


Final CL color

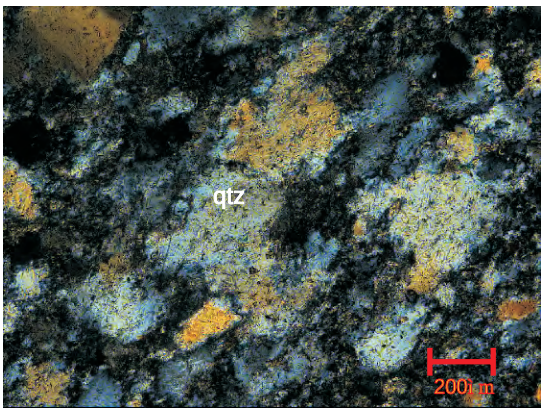
Quartzite,Gamble Brook Formation, Frog Lake Quarry, Cobequid

Sample: 4066
Source: G. Pe-Piper

Quartz exhibits a slight color shift from an initial color of dark reddish blue to a final color of very dark reddish blue. Grains are polycrystalline and have irregular margins; sub-grain boundaries are sutured. Grains exhibit a few microfractures. Quartz grains have mineral inclusions of zircon, tourmaline, apatite, calcite and feldspar. Fluid inclusions in grains are form trails, and grains have moderate undulose extinction. This sample is medium grade metamorphic, however has a darker CL color than is characteristic of this group.



Plane polarized light



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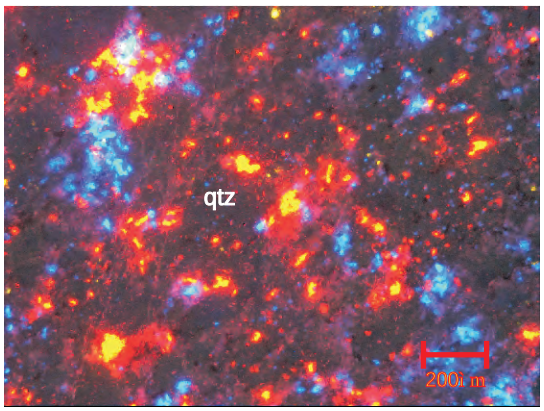
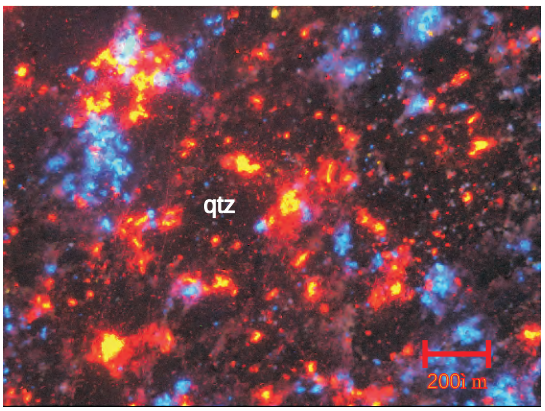


Initial CL color



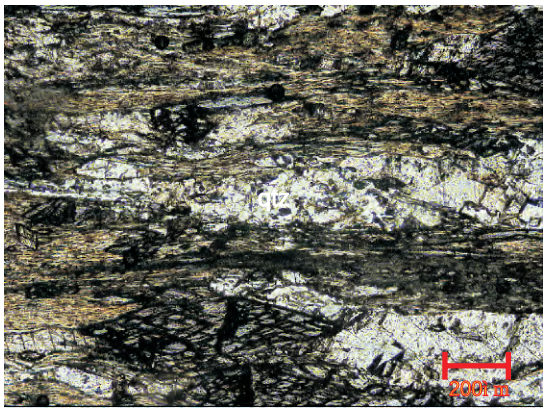
Final CL color

High Pressure Metamorphic Quartz

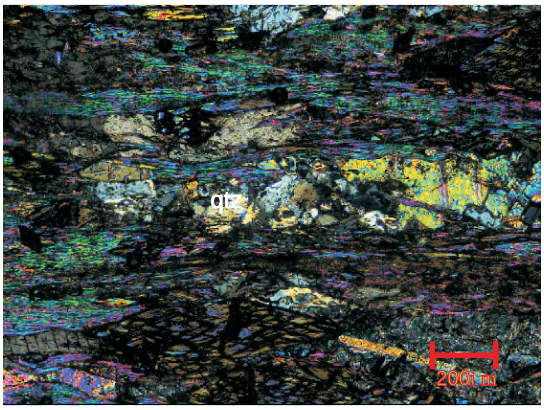
General Characteristics

Quartz grains exhibit either no color shift, or one that is very slight. CL color is very dark. Samples examined have initial CL colors that include dark grey, dark reddish brown, or are not luminescent. Quartz either exhibits very weak luminescence or is not luminescent after the color shift is complete. Grains are polycrystalline and have many sub-grains with sutured boundaries. Samples examined contains inclusions of toumaline, chlorite and muscovite. Grains are microfractured; some microfractures are conchoidal.

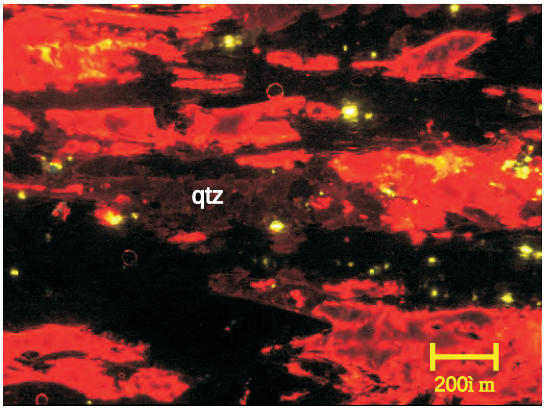
Sample: ALF5



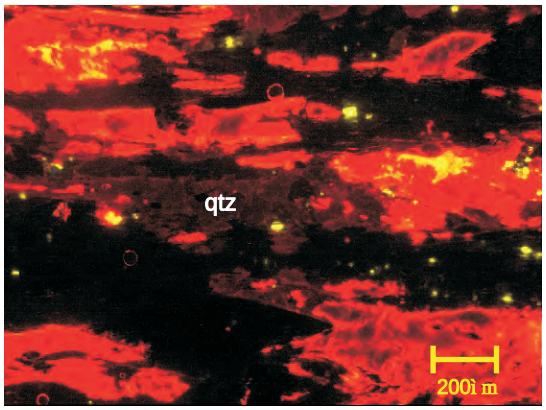
Plane polarized light



Crossed polarized light



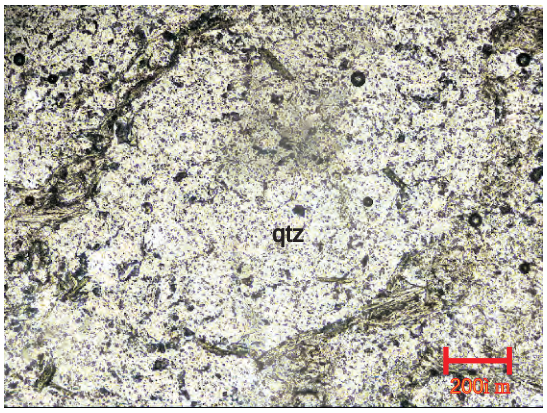
Initial CL color



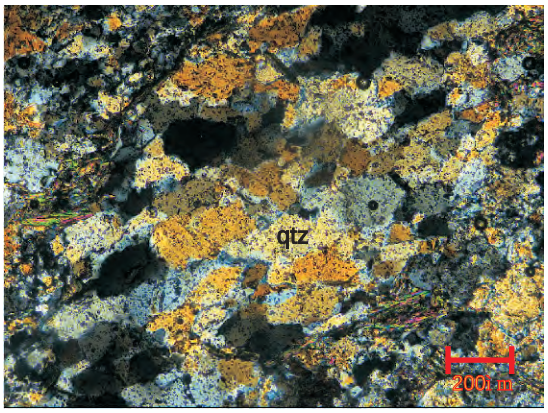
Final CL color

Foliated metasandstone (metaflysch), Petries, Evia, Greece

Sample: ALF1
Source: G. Pe-Piper

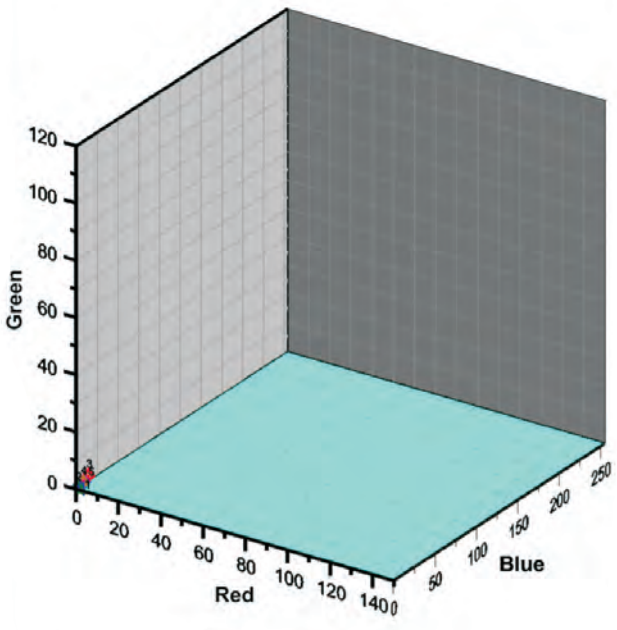


Plane polarized light



Crossed polarized light

Quartz grains exhibit either no color shift, or one that is very slight. Grains that do not display a color shift do not appear to be luminescent. Grains that display a color shift have an initial color of very dark grey and are no longer luminescent after twelve seconds exposure to the CL beam. Grains have irregular margins, are polycrystalline and contain many sub-grains with sutured boundaries. Inclusions of amphibole, tourmaline, muscovite and chlorite have been observed. Grains are microfractured and exhibit weak to moderate undulose extinction.



Initial CL color

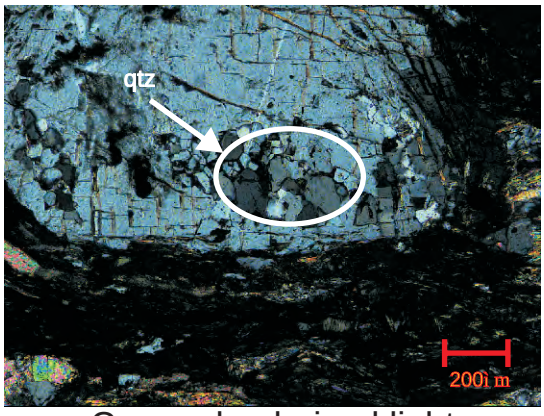
Final CL color

	Initial Red	Initial Green	Initial Blue	Final Red	Final Green	Final Blue
Grain 1	1.27	1.25	1.08	0.95	0.78	0.68
Grain 2	0.80	0.69	0.63	0.84	0.69	0.61
Grain 3	4.12	4.98	5.01	1.02	0.92	0.81
Grain 4	2.53	2.81	2.71	1.17	1.00	0.90
Grain 5	2.80	3.10	3.04	0.99	0.86	0.77

Metasandstone (metaflysch), Petries, Evia, Greece

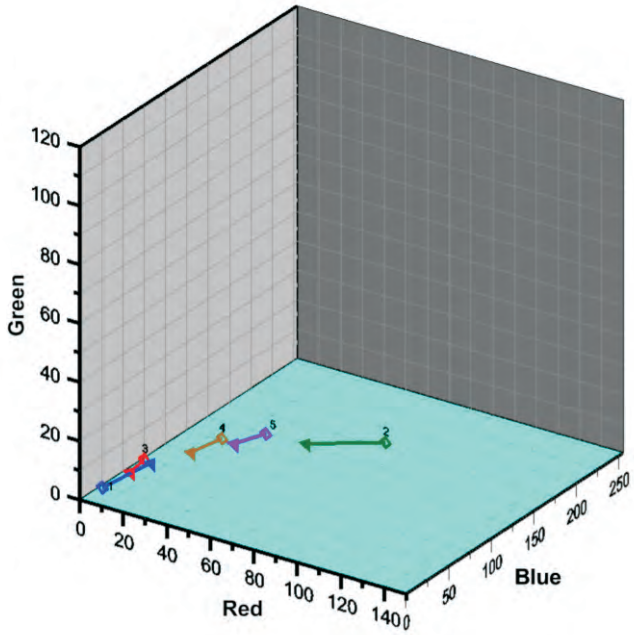
Sample: ALF3
Source: G. Pe-Piper

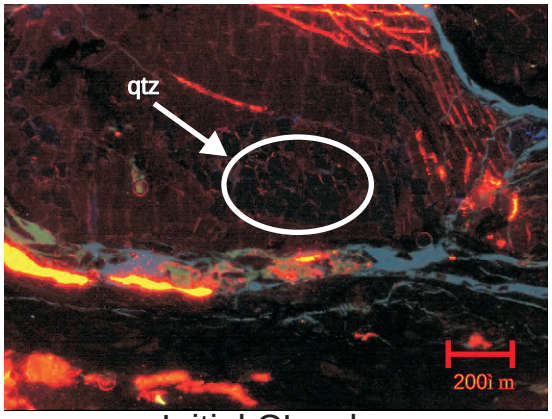
Plane polarized light



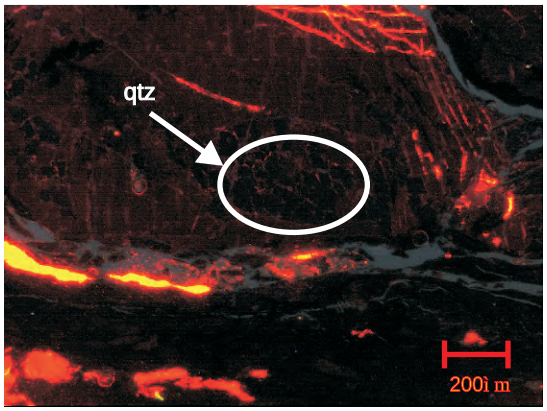
Crossed polarized light

Quartz grains are weakly luminescent or non-luminescent. No visible color shift occurs during exposure to the CL beam. Quartz grains are polycrystalline and have many small sub-grains. Grains have irregular grain margins and contain inclusions of calcite, apatite, tourmaline and chlorite. Grains are microfractured; some fractures are conchoidal.





Initial CL color

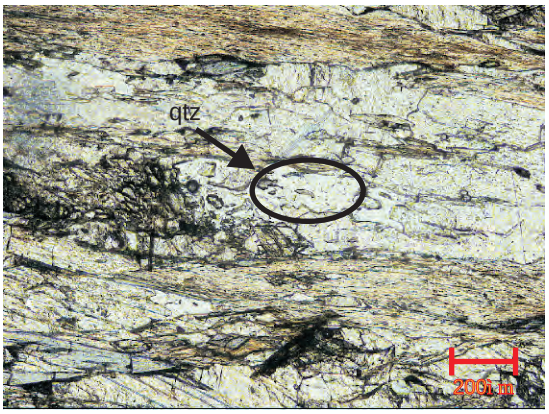


Final CL color

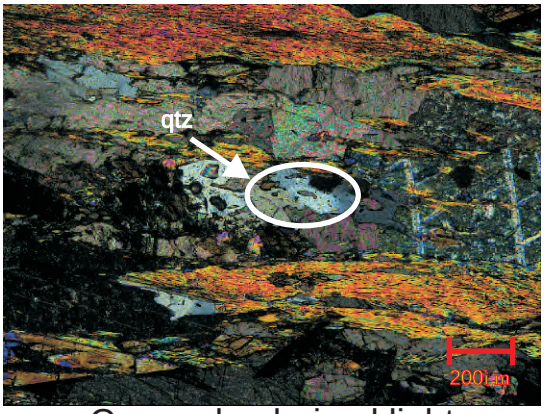
	Initial Red	Initial Green	Initial Blue	Final Red	Final Green	Final Blue
Grain 1	8.43	5.04	4.91	26.02	14.98	15.62
Grain 2	125.34	38.90	39.06	91.12	32.67	30.98
Grain 3	23.02	15.30	17.29	18.11	10.96	11.58
Grain 4	54.14	26.98	28.79	42.17	21.01	21.07
Grain 5	72.67	31.78	32.97	59.81	26.74	26.47

Glaucophane schist, Petries, Evia, Greece

Sample: ALF5
Source: G. Pe-Piper

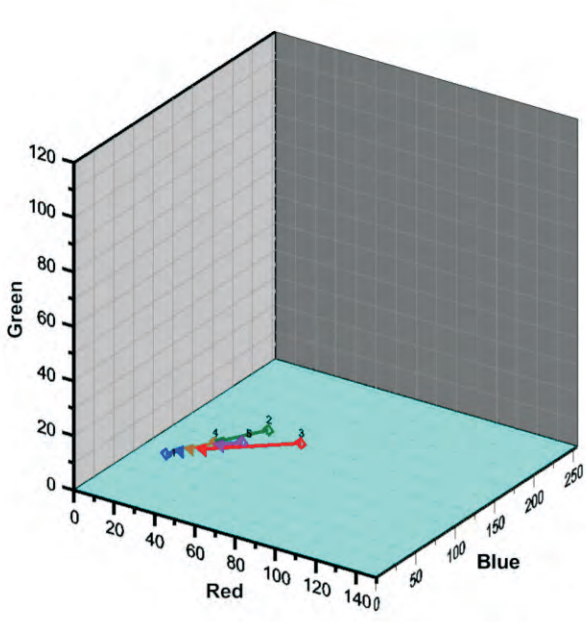


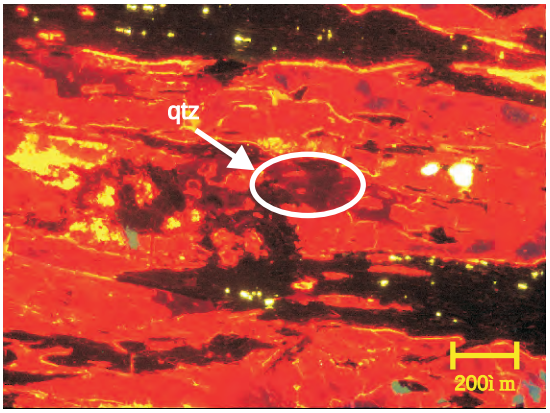
Plane polarized light



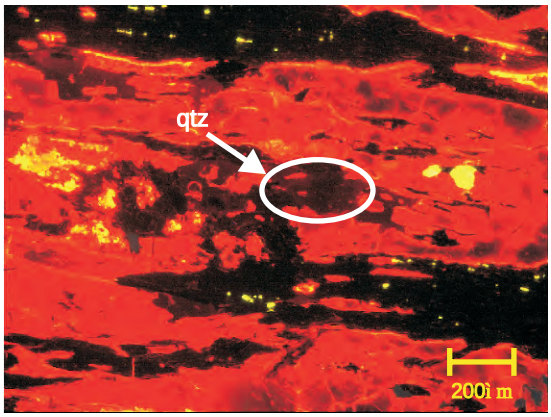
Crossed polarized light

Quartz grains exhibit either no color shift, or one that ranges from slight to moderate. Grains that do not undergo a color shift exhibit a dark reddish brown luminescence. Grains that display a color shift have an initial color ranging from medium to dark reddish brown, and a final color of dark reddish brown or very dark reddish brown. Grains have irregular margins and contain many sub-grains; sub-grains are small and have sutured boundaries. Quartz grains have mineral inclusions of tourmaline and amphibole, and contain microfractures; microfractures are conchoidal. Grains exhibit weak undulose extinction.





Initial CL color



Final CL color

	Initial Red	Initial Green	Initial Blue	Final Red	Final Green	Final Blue
Grain 1	38.62	18.13	18.12	43.99	20.09	19.91
Grain 2	83.62	33.65	33.23	62.06	26.33	25.82
Grain 3	99.46	32.03	33.78	54.46	22.57	21.78
Grain 4	59.97	25.32	25.94	48.50	21.59	21.04
Grain 5	73.11	28.16	26.98	62.44	25.42	23.88

Appendix

Notes:

1) -explains color shift in quartz grain(s) in CL photos

2) -comments on other colors seen in CL photos

3) -states any inclusions in quartz grain(s)

4) -states physical features of quartz grain(s)

5) -additional notes

Abbreviations:

xpl - crossed polarized light

ppl – plane polarized light

CL - cathodoluminescence

qtz - quartz

sec - seconds

Color Shift in Quartz Grains:

Color shift in quartz grain when exposed to the hot cathodoluminescent beam depends on the defect structure of the quartz and is caused by the creation and destruction of luminescence centers (Götte and Ritcher, 2006). Quartz exhibits maximal luminescence after about three seconds exposure to the CL beam and completes its color shift after about twelve seconds exposure time. It was thus our goal to photograph grains once after three seconds and again after twelve seconds exposure to the CL beam; however, some technical difficulties with the imaging software resulted in many photographs which were not taken at these exact times. This issue is explained in depth in this appendix. Exposure times are listed for each individual grain for all CL photomicrographs. If the color shift was not completed after about twelve seconds exposure time, an additional picture of the final color may be provided.

Variation in CL Exposure

Photomicrographs were taken using the Kappa DX40C Peltier cooled camera equipped with the Kappa Camera Control: DX40C-285FW software package. Prior to identifying an issue with the exposure times to the CL beam at which the samples were photographed, photomicrographs were captured as a series of five images at what was thought to be 0, 3, 6, 9, and 12 seconds exposure to the CL beam. However, there was a large variation in the brightness of the first two images between photo series. The picture taken at what was thought to be 0 seconds exposure time to the CL beam was sometimes black, sometimes dark although grain boundaries could be seen, sometimes partially luminescent and sometimes maximally luminescent. In some cases, the first two pictures were completely black and the third picture would exhibit the maximum luminescence of the sample. This raised the question of whether the time recorded for the images reflected the actual time the sample was exposed to the CL beam.

During the period when these photos were taken, the camera was in the “free-running” mode with an exposure time set to 3 seconds. Through experimenting with camera exposure times and latency times (the time gap between pictures), while still using the “free running” mode, it was discovered that the “start” time was not synchronized with the exposure time. Thus, if you click “start” under the “time” tab to begin taking a series of photos, the first photo will not be taken until the camera's exposure time has reached its next 3 second interval and it is ready to refresh the picture on the screen. When the camera's exposure time is set to the free running mode, the screen will continuously refresh after every 3 seconds regardless of when the “start” button is pressed to commence taking a series of photos. Therefore the first picture, which was meant to have been taken at 0 seconds, could have been exposed to CL anywhere between 0-3 seconds, as the CL was turned on at the same time the “start” button was pressed. If the CL beam is turned on, and the “start” button pressed simultaneously in order to take a series of photos when the camera has nearly completed a cycle of 3 seconds exposure time, the first picture will be dark (if not black) because the CL was on for only a fraction of the time the camera was collecting light to take the picture. But if the “start” button is pressed and CL turned on when the camera had just began one 3 second exposure time cycle, then the picture will be maximally luminescent because the CL beam

would have been on for nearly the whole 3 seconds exposure time cycle of the camera. Therefore, the brightness of the first picture is dependent on how far along the camera was in a 3 seconds exposure time cycle on the free running mode when the CL was turned on and the “start” button was pressed. It is therefore not possible to state exact CL exposure times for any of the pictures taken before this issue was identified. Exposure times for these photos will be recorded as approximations with a maximum variance of 3 seconds.

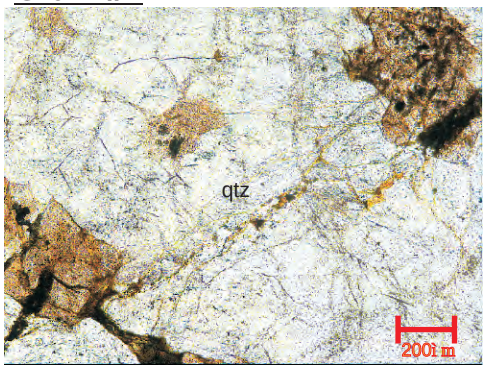
To solve this problem and more accurately record CL exposure times in the future, the exposure time under the “settings” tab was changed to “internal trigger” mode, which allows the camera to begin progressing toward the desired exposure time at the exact time at which the “start” button is pressed under the “time” tab to begin taking a series of photos. In this setting it is important to note that the exposure time will be added to the latency time and their sum will equal total exposure time to the CL beam if the CL beam is turned on at the same time the “start” button under the “time” tab is pressed. The latency time and the number of consecutive pictures taken can be selected under the “time” tab. Pictures should be taken at 2 seconds exposure time and 1 second latency. Sets of four consecutive pictures are taken, the first of which is exposed to CL beam for 3 seconds, the second for 6 seconds, the third for 9 seconds and the fourth for 12 seconds. The first and last picture will be used to exhibit initial and final colors of quartz grains and to record the color shift.

Plutonic and Hypabyssal Quartz

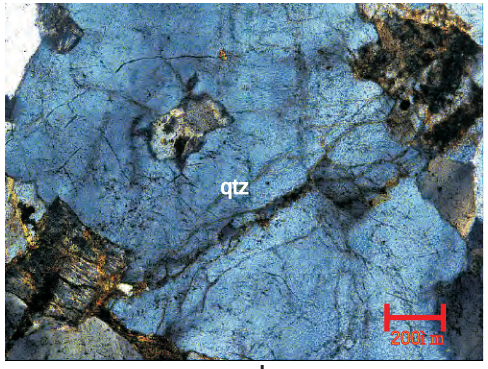
Sample

4685 Granite, Gamble Lake, Cobequid Highlands, NS

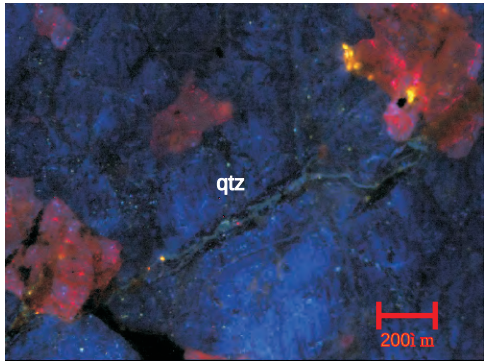
Grain #1



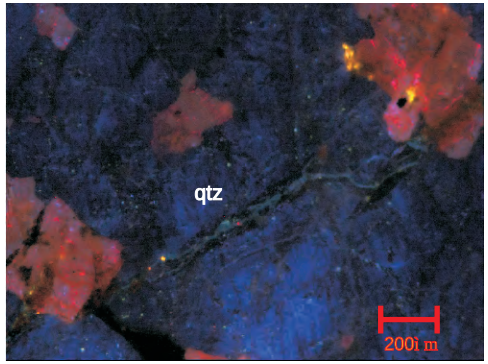
ppl



xpl



after ~3 sec exposure to CL

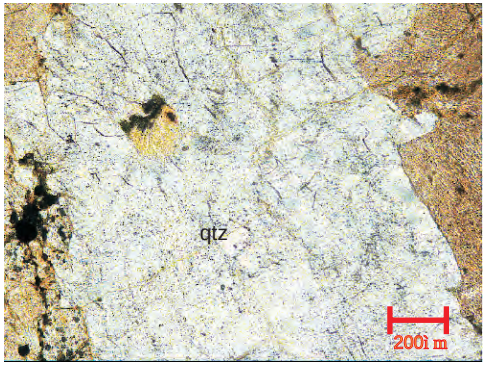


after ~13 sec exposure to CL

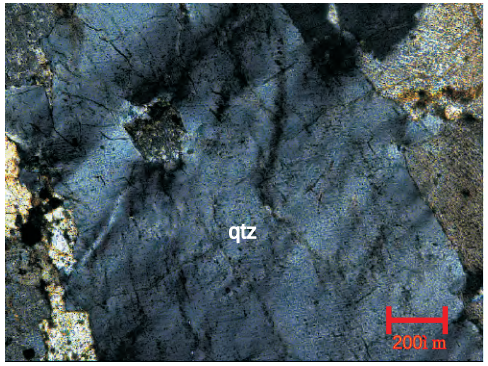
Notes

1) -slight color shift from inhomogeneous, bright-medium-dark at ~3 sec exposure to CL to inhomogeneous medium blue at ~13 sec exposure to CL
2) -reddish luminescent grains are feldspar, yellow luminescent grains are apatite
3) -feldspar mineral inclusions, and fluid inclusions can be seen
4) -embayments and microfractures can be seen, grain is monocrystalline

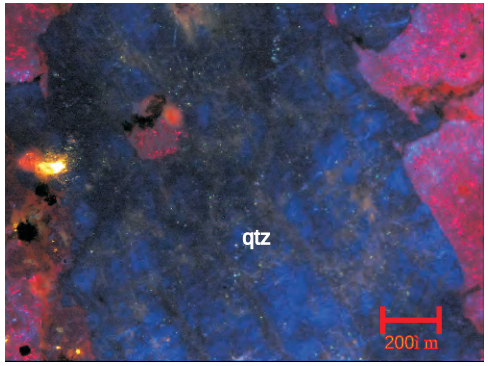
Grain #2



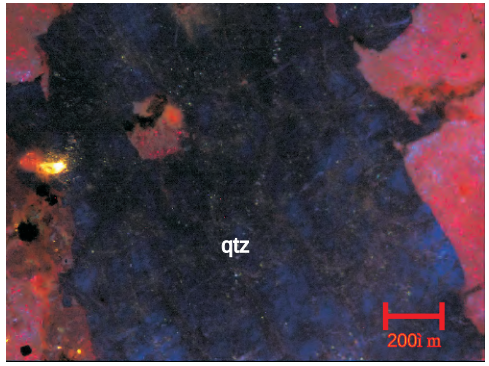
ppl



xpl



after ~3 sec exposure to CL



after ~18 sec exposure to CL

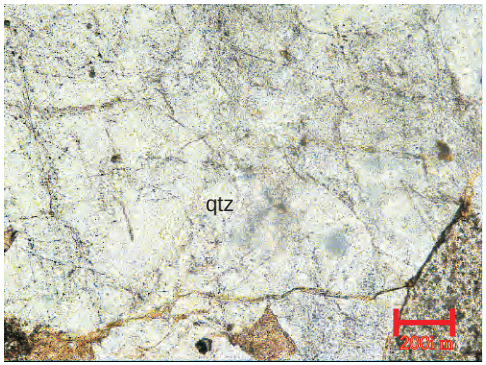
Notes

1) -moderate color shift from inhomogeneous, bright-medium blue at ~3 sec exposure to CL to inhomogeneous medium- dark blue at ~18 sec exposure to CL
2) -red luminescent grains are feldspar, yellow luminescent grain is apatite
3) -altered feldspar mineral inclusion, and also fluid inclusions can be seen
4) -embayments and microfractures can be seen, grain is monocrystalline

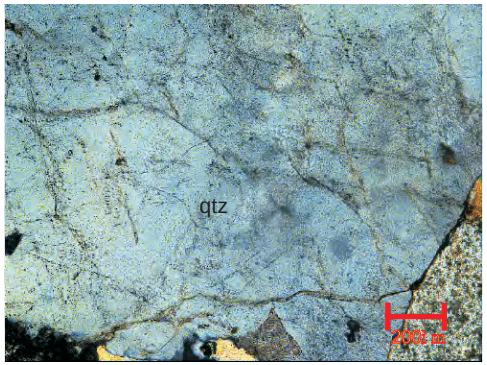
Sample

4685 Granite, Gamble Lake, Cobequid Highlands, NS

Grain #3



ppl



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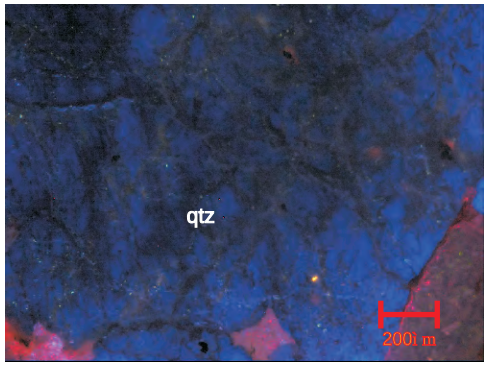
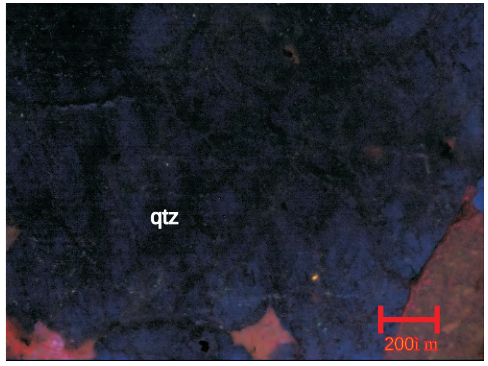


after ~6 sec exposure to CL

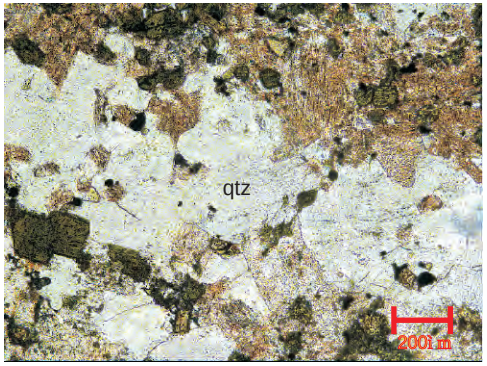


after ~15 sec exposure to CL

Notes

1) -moderate color shift from inhomogeneous, bright-medium blue at ~6 sec exposure to CL to inhomogeneous medium-dark blue at ~15 sec exposure to CL
2) -reddish luminescent grains are feldspar, yellow luminescent inclusion is apatite
3) -biotite and apatite mineral inclusions, and also fluid inclusions are present in grain
4) -embayments, and small microfractures can be seen, grain is monocrystalline

Grain #4



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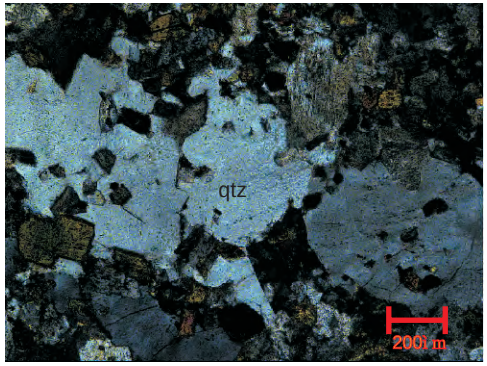

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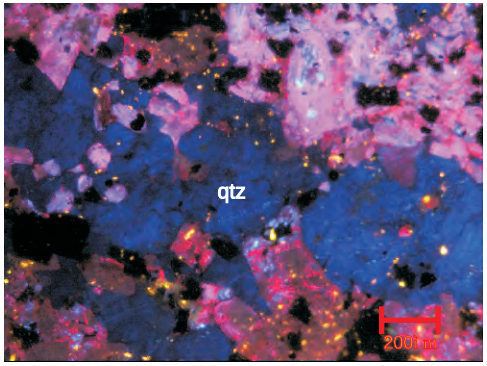
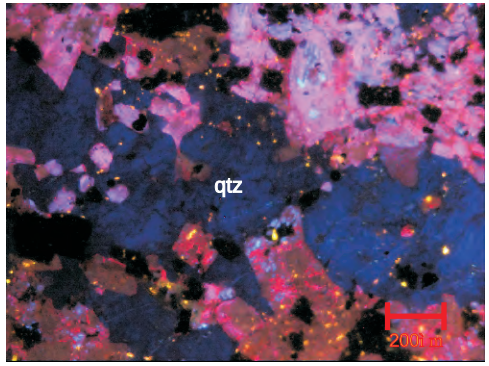


after ~6 sec exposure to CL



after ~15 sec exposure to CL

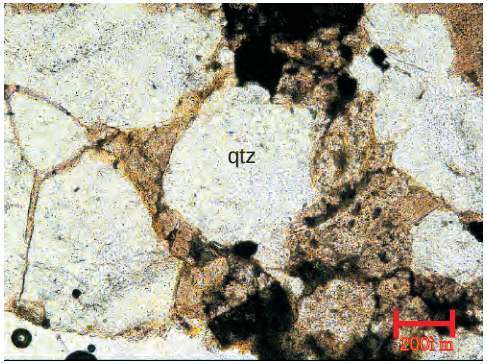
Notes

1) -slight color shift from inhomogeneous bright-medium blue at ~3 sec exposure to CL to inhomogeneous medium blue at ~15 sec exposure to CL
2) -bright blue/pink, and reddish luminescent grains are feldspar, bright yellow luminescent inclusions are apatite
3) -biotite, feldspar, and apatite mineral inclusions, and also fluid inclusions are present in quartz grains
4) -embayments, microfractures, and a few cooling cracks (conchoidal fractures) can be seen, grain is polycrystalline

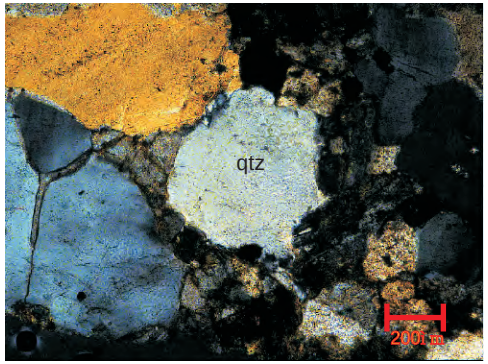
Sample

4685 Granite, Gamble Lake, Cobequid Highlands, NS

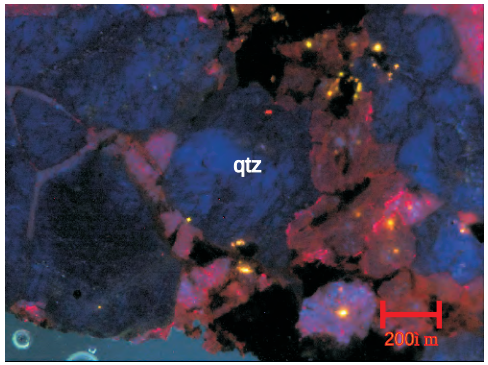
Grain #5



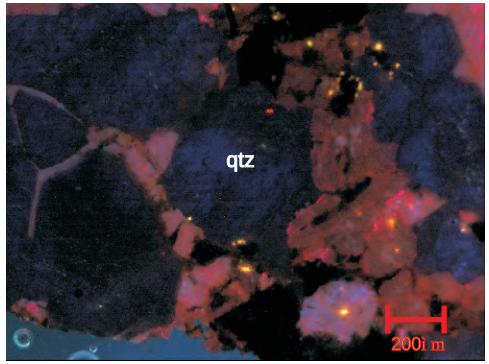
ppl



xpl



after ~3 sec exposure to CL



after ~19 sec exposure to CL

Notes

1) -slight color shift from inhomogeneous medium blue at ~3sec exposure to CL to inhomogeneous medium-dark blue at ~19 sec exposure to CL
2) -reddish luminescent grains are feldspar, bright yellow luminescent inclusions are apatite
3) -zircon mineral inclusions and also fluid inclusions are present in grain
4) -a few microfractures can be seen, grain is monocrystalline

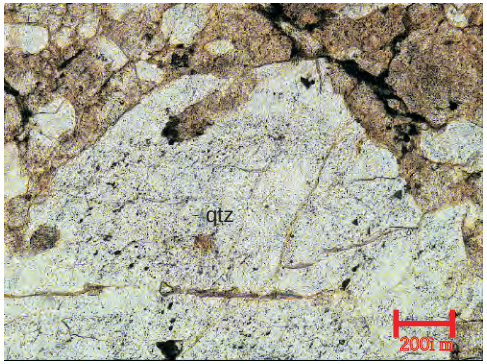
Summary

A slight to moderate color shift is observed in qtz grains in this slide. Initial colors of grains range from bright-medium to medium blue. Final colors of grains range from of medium to medium-dark blue. All photographed qtz grains in this slide have an inhomogenous CL color.

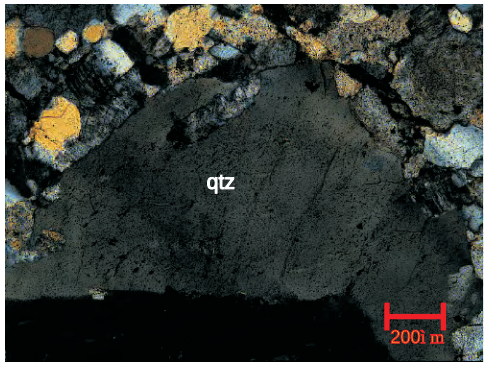
Sample

4689 Granite, Gamble Lake, Cobequid Highlands, NS

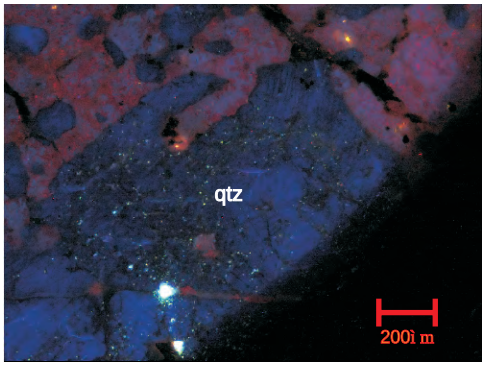
Grain #1



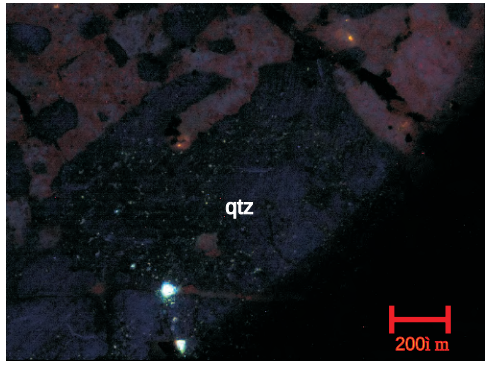
ppl



xpl



after ~3 sec exposure to CL

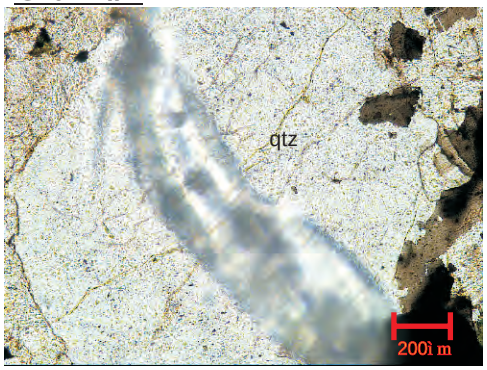


after ~12 sec exposure to CL

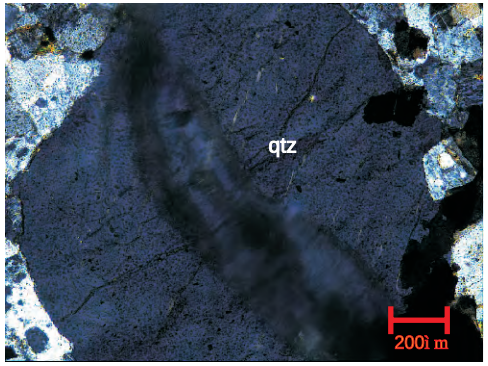
Notes

1) -moderate color shift from inhomogeneous medium blue at ~3 sec exposure to CL to inhomogeneous dark blue at ~12 sec exposure to CL
2) -reddish luminescent mineral is feldspar, bright light blue luminescent mineral was not identified
3) -feldspar and biotite mineral inclusions, and also fluid inclusions are present in grain
4) -embayments, and microfractures can be seen, grain is monocrystalline

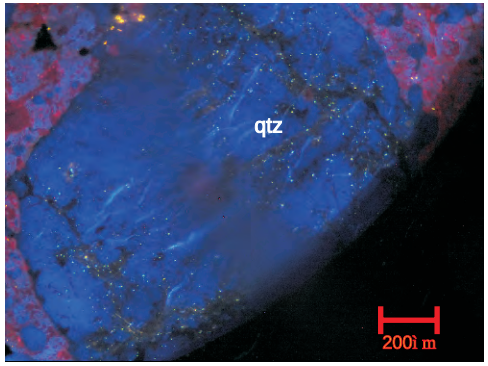
Grain #2



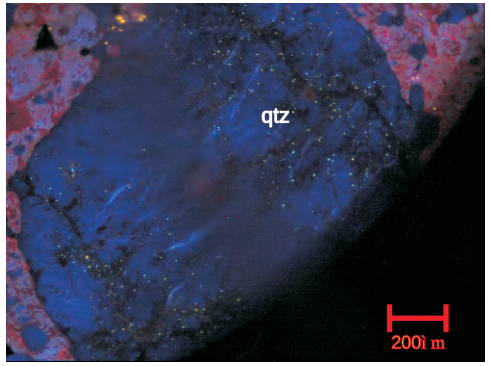
ppl



xpl



after ~9 sec exposure to CL



after ~18s sec exposure to CL

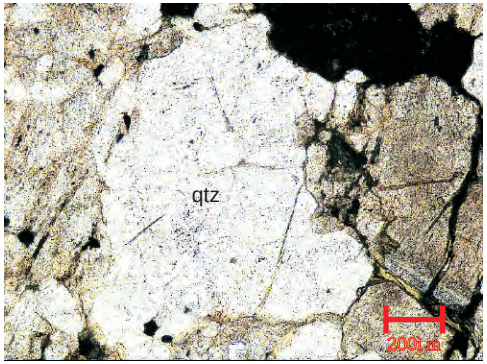
Notes

1) -slight color shift from bright-medium blue at ~9 sec exposure to CL to medium blue with light blue in fractures at ~18 sec exposure to CL
2) -bright yellow luminescent grains are apatite, red/violet luminescent grains are feldspar
3) -feldspar, chlorite and opaque mineral inclusions, and also fluid inclusions are present in grain
4) -microfractures can be seen, grain is monocrystalline

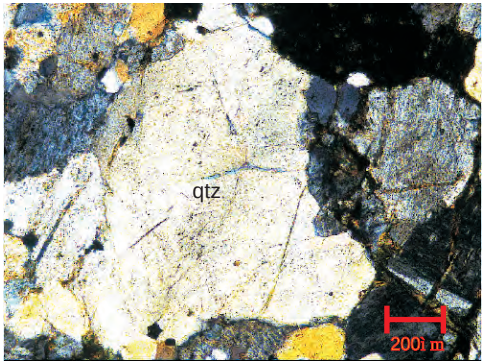
Sample

4689 Granite, Gamble Lake, Cobequid Highlands, NS

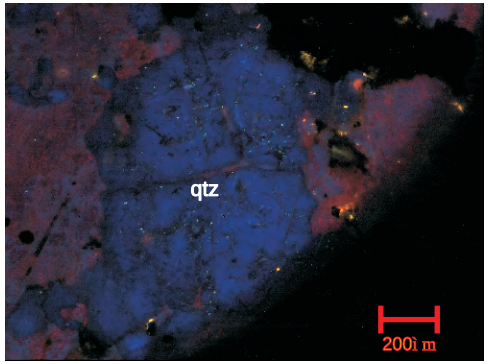
Grain #3



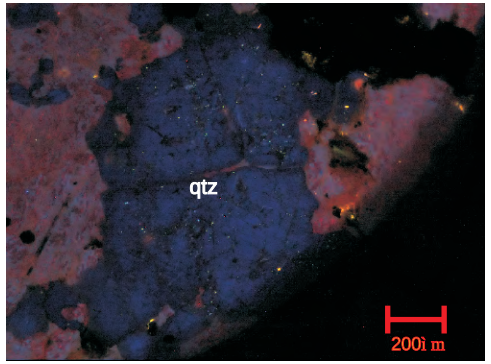
ppl



xpl



after ~6 sec exposure to CL

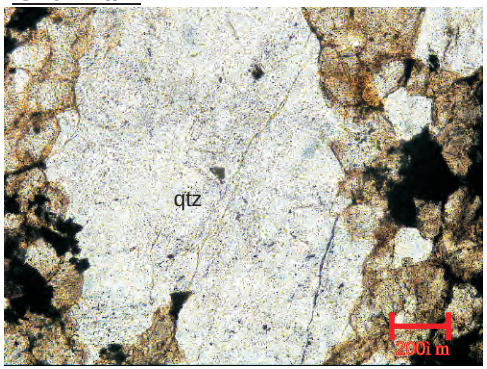


after ~19 sec exposure to CL

Notes

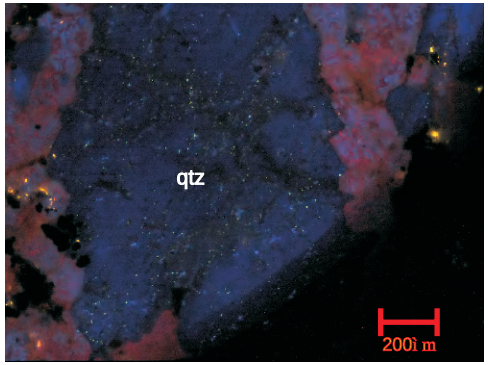
1) -slight color shift from inhomogeneous medium blue at ~6 sec exposure to CL to inhomogeneous medium-dark blue at ~19 sec exposure to CL
2) -reddish luminescent mineral is feldspar, yellow luminescent inclusions are apatite, flecks of light blue can be seen on grain
3) -feldspar and opaque mineral inclusions, and also fluid inclusions are present in grain, feldspar filling some cracks in grain
4) -embayments, microfractures and a few cooling cracks (conchoidal fractures) can be seen

Grain #4

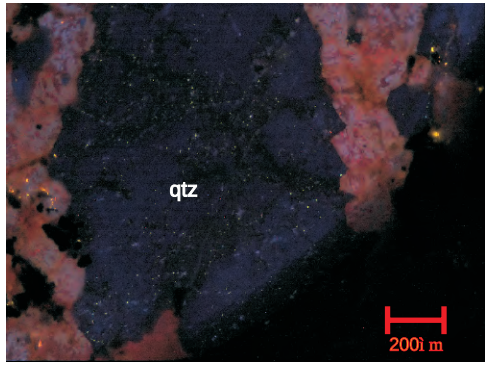


ppl

xpl



after ~12 sec exposure to CL



after ~18 sec exposure to CL

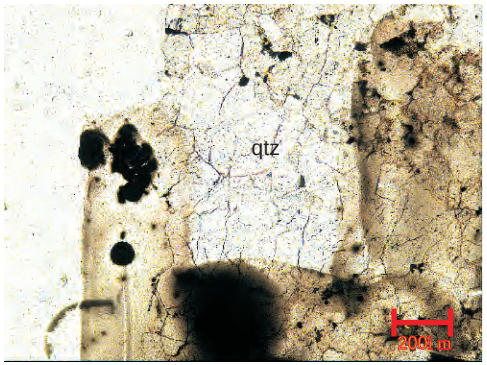
Notes

1) -slight color shift from inhomogeneous medium blue at ~12 sec exposure to CL to medium-dark blue at ~18 sec exposure to CL
2) -bright yellow luminescent inclusions are apatite, reddish/violet luminescent grains are feldspar
3) -chlorite and biotite mineral inclusions, and also fluid inclusions are present in grain
4) -embayments and microfractures can be seen

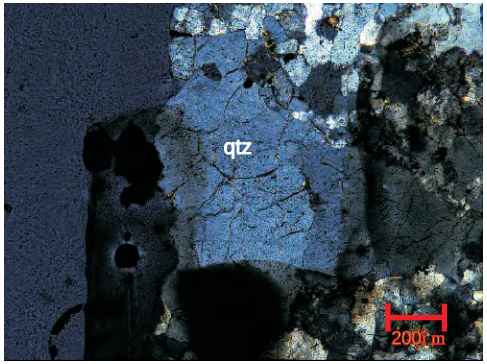
Sample

4689 Granite, Gamble Lake, Cobequid Highlands, NS

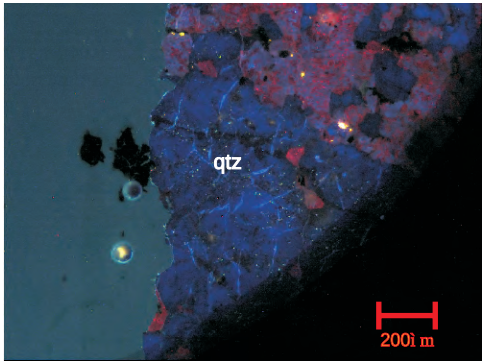
Grain #5



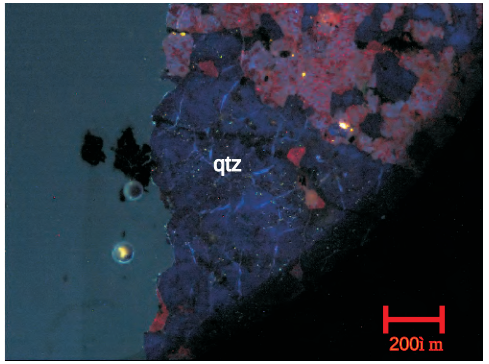
ppl



xpl



after ~9 sec exposure to CL



after ~15 sec exposure to CL

Notes

1) -slight color shift from inhomogeneous medium blue with light blue in fractures at ~9 sec exposure to CL to inhomogeneous medium-dark blue with light blue in fractures at ~15 sec exposure to CL
2) -very small bright yellow luminescent grains are apatite, reddish/violet luminescent grains are feldspar, flecks of light blue can be seen on qtz grain
3) -feldspar, and mica mineral inclusions, and also fluid inclusions can be seen
4) -microfractures can be seen, grain is polycrystalline

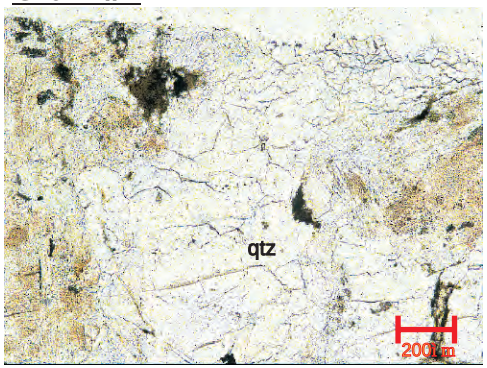
Summary

A slight to moderate color shift is observed in quartz grains in this thin section. Initial colors range from bright-medium to medium blue. Final colors range from medium to dark blue. CL color of qtz grains is inhomogeneous. The first CL picture of Grain#4 was taken after 12 sec of exposure to the CL beam and so it is expected that the color shift had already began before the picture was taken therefore this color of the quartz grain in the initial CL photo could not be considered the initial color.

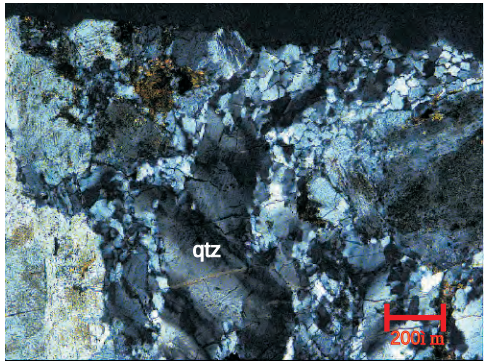
Sample

4701 Granite (with mylonitic areas), SW of Economy Lake, Cobequid Highlands, NS

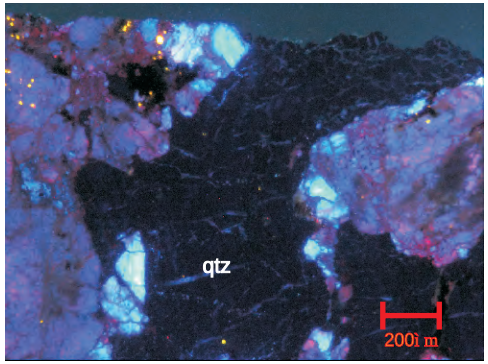
Grain #1



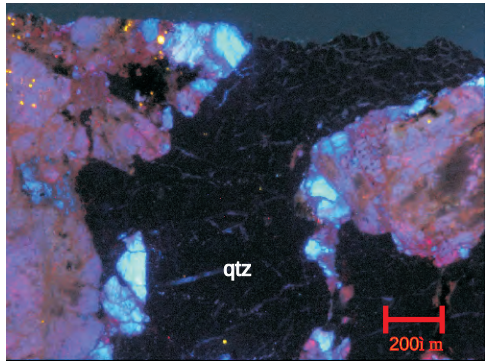
ppl



xpl



after ~3 sec exposure to CL



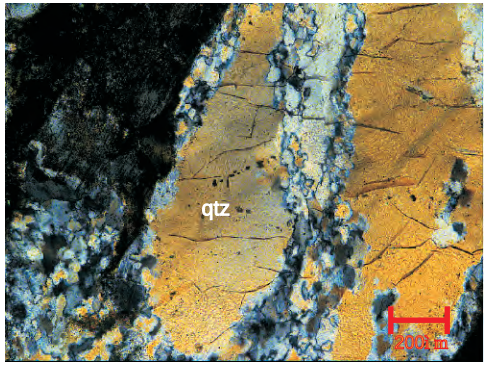
after ~16 sec exposure to CL

Notes

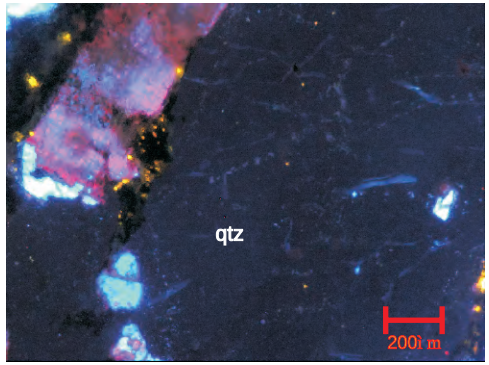
1) -slight color shift from medium-dark blue with light blue in some cracks at ~3 sec exposure to CL to dark blue with light blue in some cracks at ~16 sec exposure to CL
2) -bright blue, and reddish/violet luminescent grains are feldspar, smaller bright yellow luminescent grains are apatite
3) -feldspar mineral inclusions, and also fluid inclusions are present in grain
4) -embayments and microfractures can be seen, grain is polycrystalline, sub-grain boundaries are sutured

Grain #2

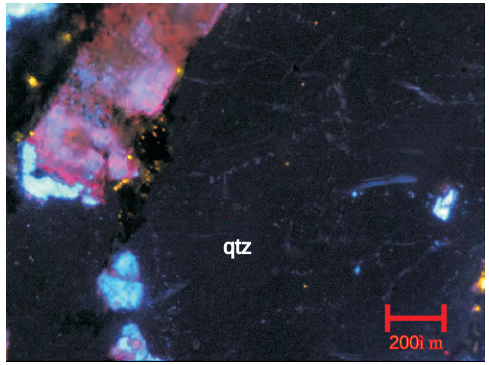
ppl



xpl



after ~6 sec exposure to CL



after ~16 sec exposure to CL

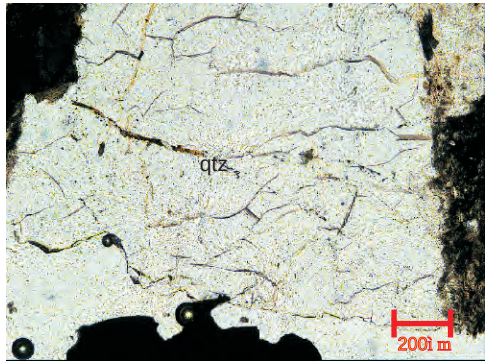
Notes

1) -slight color shift from medium-dark blue with light blue in some cracks at ~6 sec exposure to CL to dark blue at ~16 sec exposure to CL
2) -reddish/violet, and light blue luminescent grains are feldspar, small bright yellow luminescent grains are apatite
3) -feldspar mineral inclusions, and also fluid inclusions are present in grain
4) -cooling cracks (conchoidal fractures) can be seen, grain is polycrystalline, sub-grain boundaries are sutured

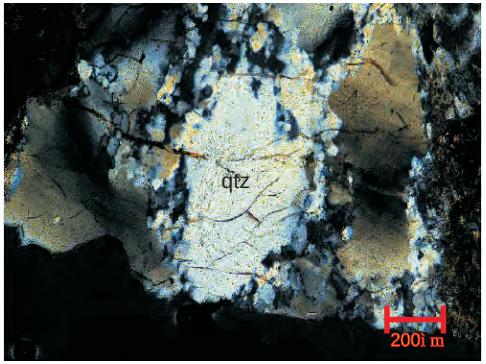
Sample

4701 Granite (with mylonitic areas), SW of Economy Lake, Cobequid Highlands, NS

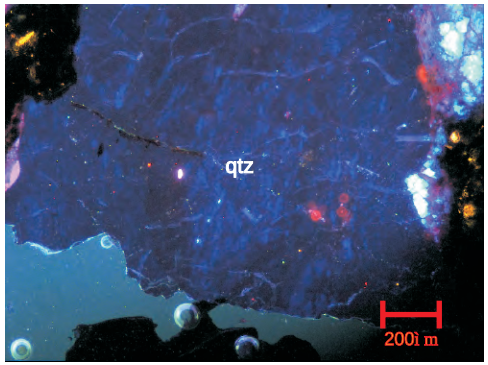
Grain #3



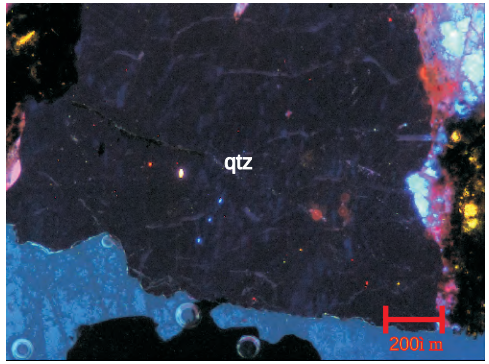
ppl



xpl



after ~6 sec exposure to CL

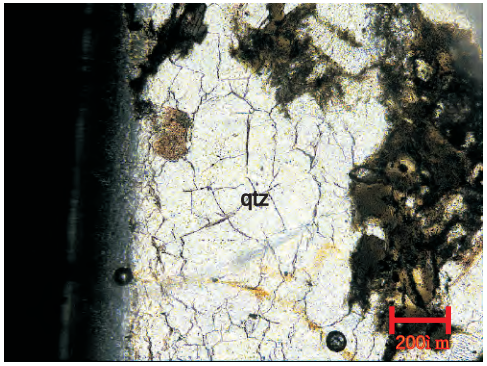


after ~18 sec exposure to CL

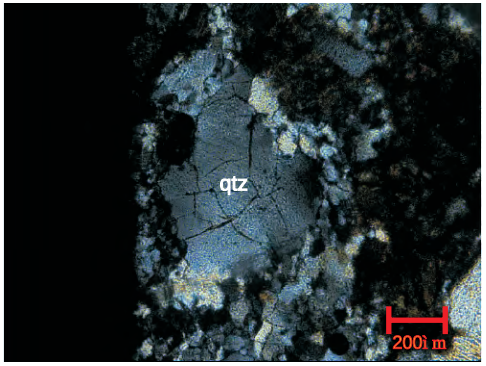
Notes

1) -strong color shift from bright-medium blue with light blue luminescence in cracks at ~6 sec exposure to CL to medium-dark blue with at ~18 sec exposure to CL (cracks still visible but not exhibiting light blue luminescence at ~18 sec exposure to CL)
2) -light blue, and reddish/violet luminescent grains are feldspar, yellow luminescent grains are apatite
3) -fluid inclusions present in grain
4) -irregular grain margins and cooling cracks (conchoidal fractures) can be seen, grain is polycrystalline and has sutured sub-grain boundaries

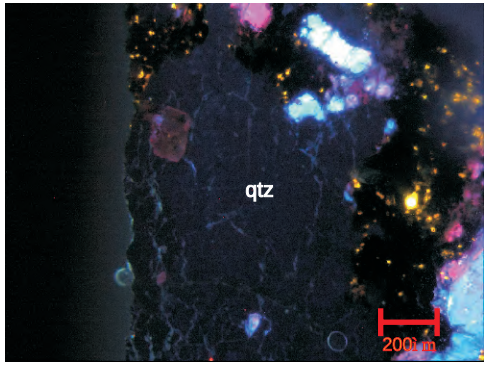
Grain #4



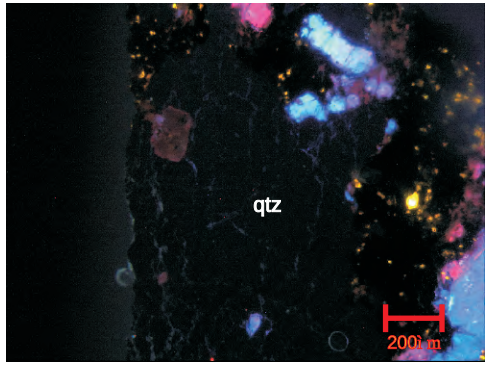
ppl



xpl



after ~12 sec exposure to CL



after ~18 sec exposure to CL

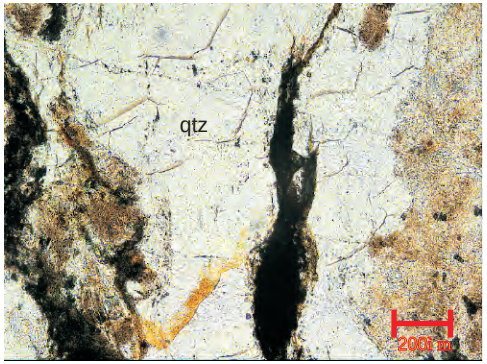
Notes

1) -moderate color shift from medium-dark blue with light blue in cracks at ~12 sec exposure to CL to dark blue at ~18 sec exposure to CL
2) -light blue and light pink luminescent grains are feldspar, bright yellow luminescent grains are apatite
3) -feldspar and very small biotite mineral inclusions, and also fluid inclusions are present in grain
4) -irregular grain margins and cooling cracks (conchoidal fractures) can be seen, grain is polycrystalline and has sutured sub-grain boundaries

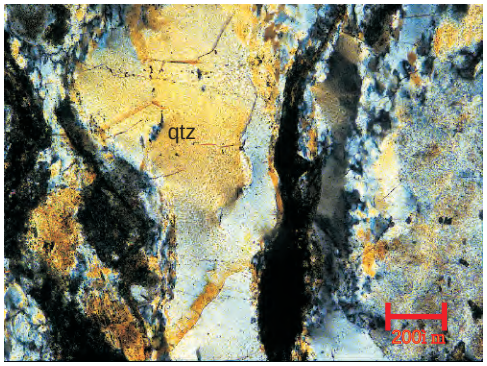
Sample

4701 Granite (with mylonitic areas), SW of Economy Lake, Cobequid Highlands, NS

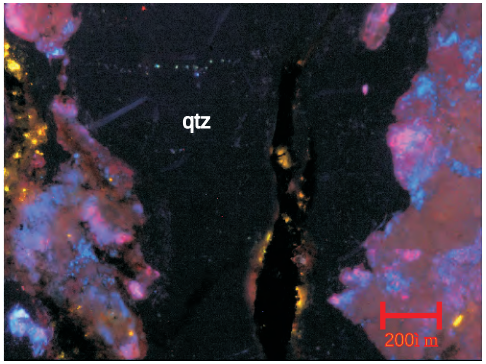
Grain #5



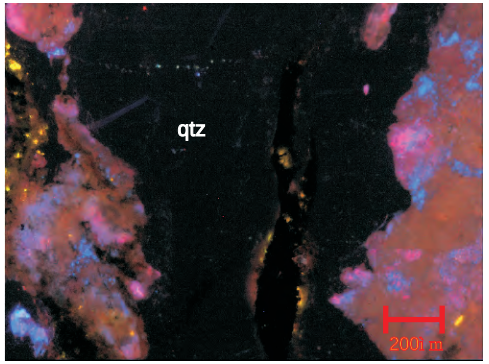
ppl



xpl



after ~3 sec exposure to CL



after ~18 sec exposure to CL

Notes

1) -slight color shift from medium-dark blue at ~3 sec exposure to CL to dark blue at ~18 sec exposure to CL
2) -reddish/ violet/ light blue luminescent grains are feldspar, bright yellow luminescent grains are apatite
3) -opaque mineral inclusions, and also fluid inclusions are present in grain
4) -irregular grain margins and cooling cracks (conchoidal fractures) can be seen, grain is polycrystalline and has sutured sub-grain boundaries

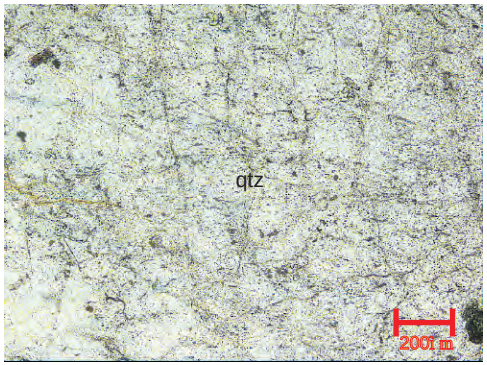
Summary

A slight to strong color shift is observed in qtz grains in this thin section. Initial colors of grains range from bright-medium to medium-dark blue. Final colors of grains range from medium-dark blue to dark blue. Light blue luminescence can be seen in some cracks in qtz grains. In general mylonitization does not seem to affect the CL color, however in Grain #3 a slightly darker CL color is seen in mylonitized areas.

Sample

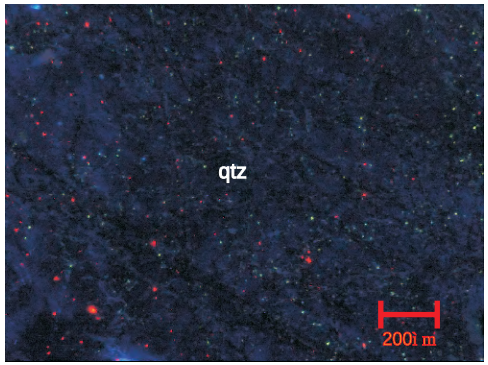
3119 Granite, Chiganois River, Cobequid Highlands, NS

Grain #1

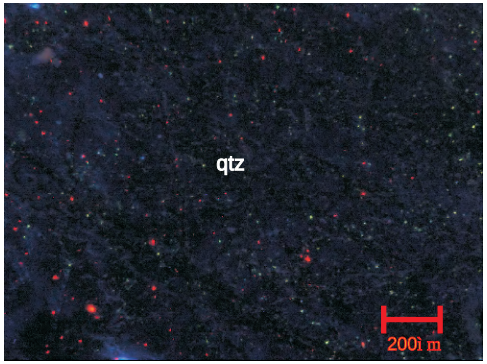


ppl

xpl



after ~6 sec exposure to CL

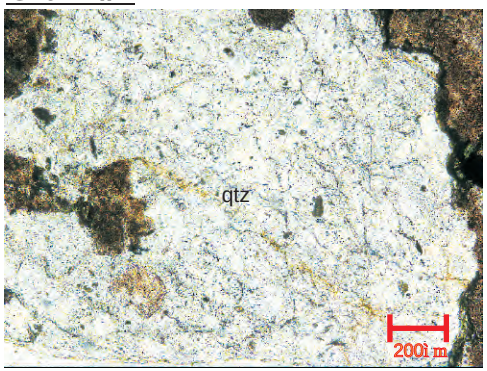


after ~22 sec exposure to CL

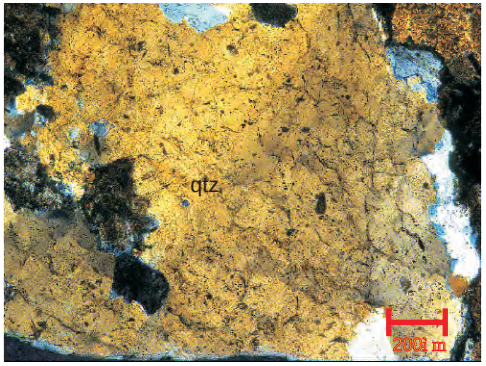
Notes

1) -slight color shift from inhomogeneous medium blue at ~6 sec exposure to CL to inhomogeneous medium-dark blue at ~22 sec exposure to CL
2) -many flecks of color (red, light blue, light green) can be seen on quartz, could be very small mineral inclusions or debris from materials used to polish thin section
3) -chlorite mineral inclusions, and also fluid inclusions are present in grain
4) -microfractures can be seen, grain has embayments and is polycrystalline but these features cannot be seen in photos

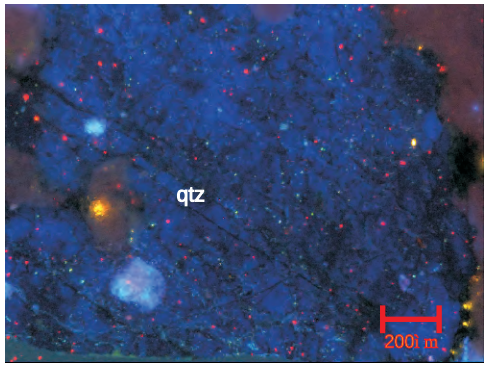
Grain #2



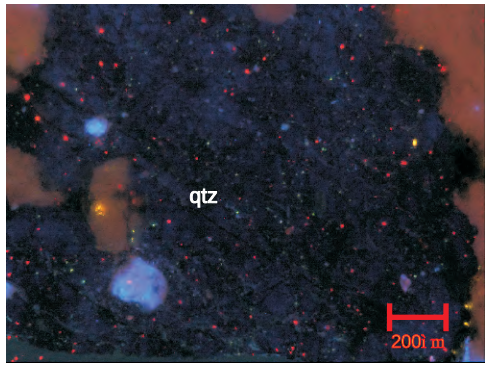
ppl



xpl



after ~3 sec exposure to CL



after ~18 sec exposure to CL

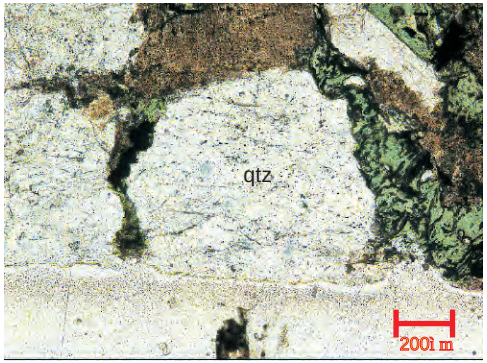
Notes

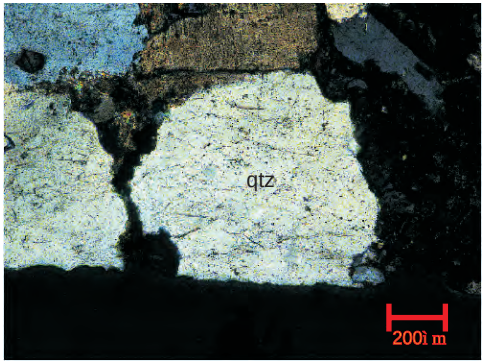
1) -moderate color shift from inhomogeneous bright-medium blue at ~3 sec exposure to CL to inhomogeneous medium-dark blue at ~18 sec exposure to CL
2) -many flecks of color (red, light blue, light green) can be seen on quartz, could be very small mineral inclusions or debris from materials used to polish thin section, light blue and reddish brown inclusions are feldspar
3) -feldspar mineral inclusions, and also fluid inclusions are present in grain
4) -embayments and microfractures can be seen, grain is polycrystalline, sub-grain boundaries are sutured

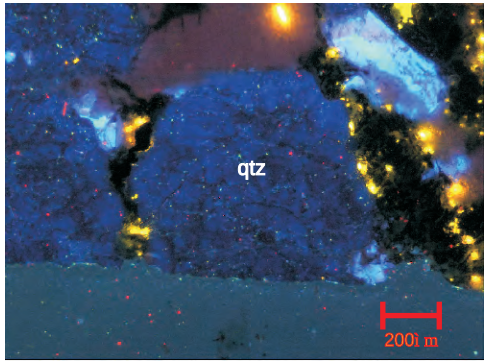
Sample

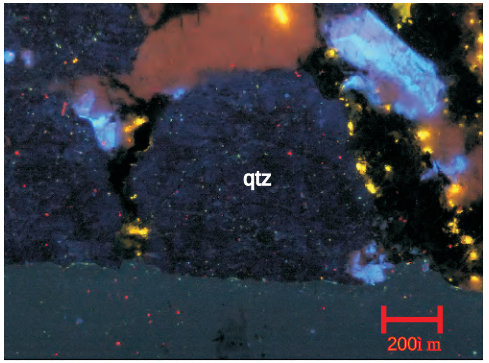
3119 Granite, Chiganois River, Cobequid Highlands, NS

Grain #3





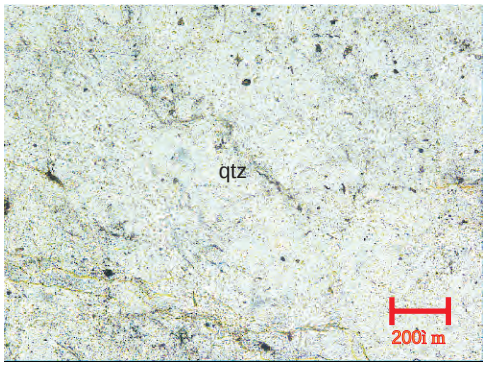


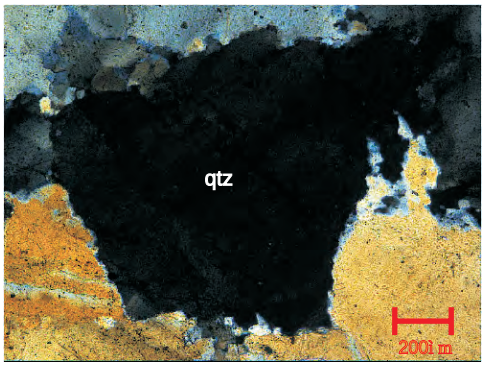


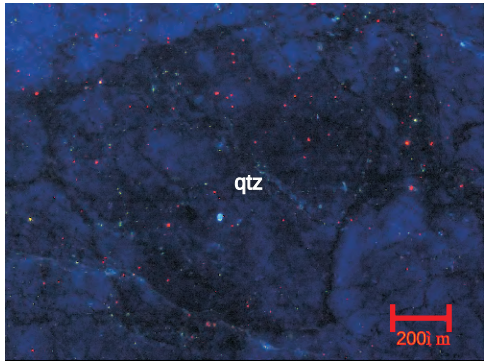
Notes ppl xpl after ~3 sec exposure to CL after ~18 sec exposure to CL

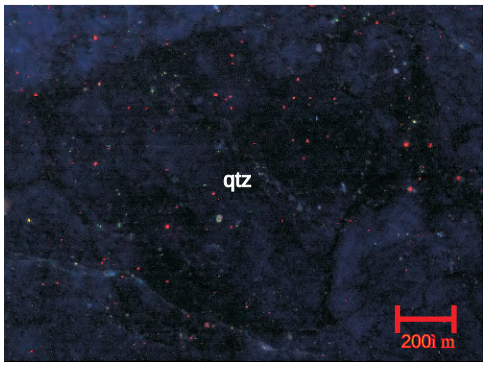
1) -moderate color shift from inhomogeneous bright-medium blue at ~3 sec exposure to CL to inhomogeneous medium-dark blue at ~18 sec exposure to CL
2) -many flecks of color (red, light blue, light green) can be seen on quartz grain, could be very small mineral inclusions or debris from materials used to polish thin section -light blue, and reddish brown luminescent grains are feldspar, bright yellow luminescent grains are apatite
3) -mineral inclusions too small to identify (looks like mica), and also fluid inclusion are present in grain
4) -microfractures can be seen, grain is monocrystalline

Grain #4









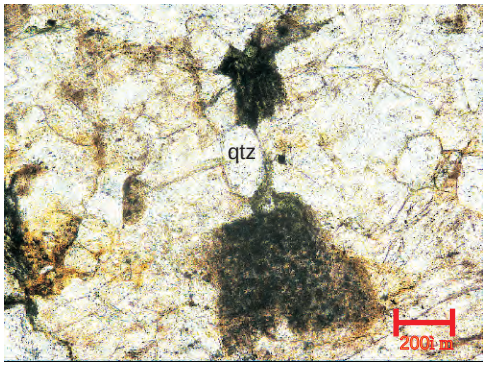
Notes ppl xpl after ~3 sec exposure to CL after ~19 sec exposure to CL

1) -slight color shift from inhomogeneous medium blue at ~3 sec exposure to CL to inhomogeneous medium-dark blue at ~19 sec exposure to CL
2) -many flecks of color (red, light blue, light green, pink, yellow) can be seen on quartz grain, could be very small mineral inclusions or debris from materials used to polish thin section
3) -mineral inclusions too small to identify (biotite?), and also fluid inclusions are present in grain
4) -microfractures can be seen, grain is polycrystalline and subgrain boundaries are sutured

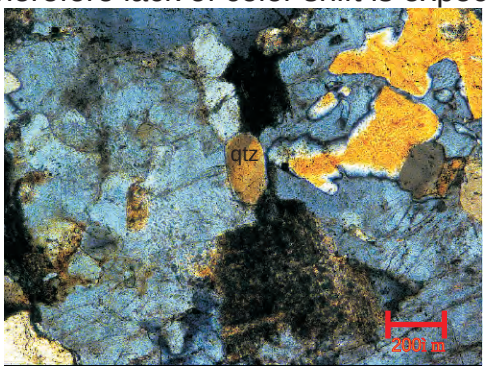
Sample

3119 Granite, Chiganois River, Cobequid Highlands, NS

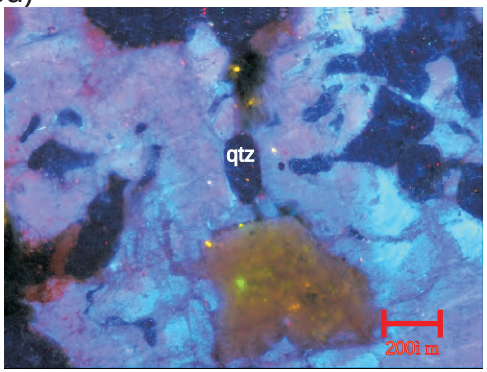
Grain #5 (second exposure to CL therefore lack of color shift is expected)



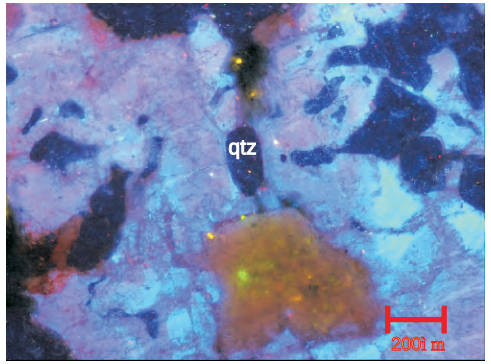
ppl



xpl



after ~7 sec exposure to CL



after ~19 sec exposure to CL

Notes

1) -no color shift, grain is medium-dark blue
2) -light blue/violet luminescent mineral is feldspar, dark yellow luminescent mineral was not identified
3) -unknown mineral inclusion (too small to identify), and also fluid inclusion are present in grain
4) -grain exhibits deformation banding and is monocrystalline

Summary

Slight-moderate color shift in quartz grains in this slide going from an initial color of bright-medium to medium blue to a final color of medium-dark blue (Grain #5 exhibits no color shift because pictures shown are of the grains second exposure to the CL beam). Grains have an inhomogenious CL color, and have many flecks of color on them (possibly mineral inclusions that are too small to identify or debris from polishing materials).

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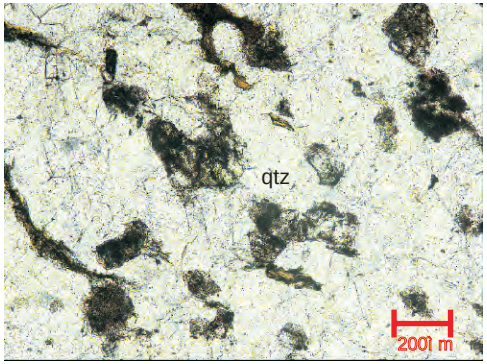
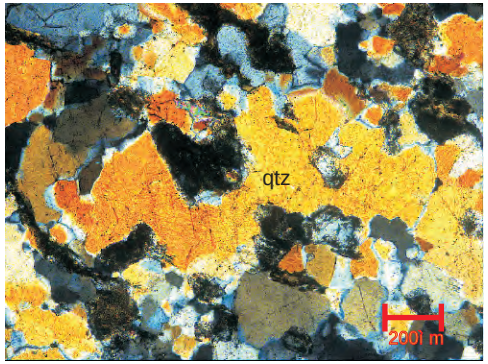
Sample

4190 Pegmatitic Granite, Frog Lake Quarry, Cobequid Highlands, NS

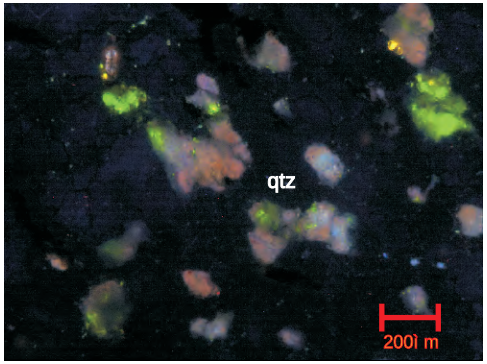
Grain #1



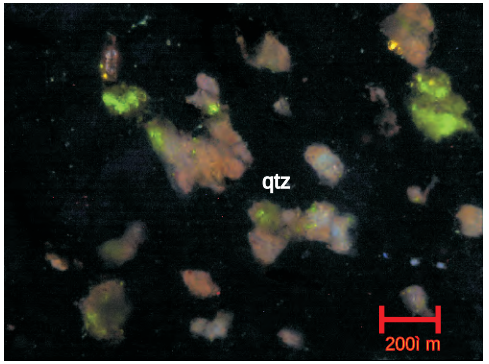
ppl



xpl



after 3 sec exposure to CL

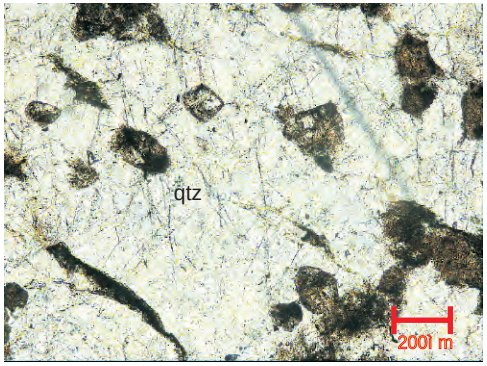


after 12 sec exposure to CL

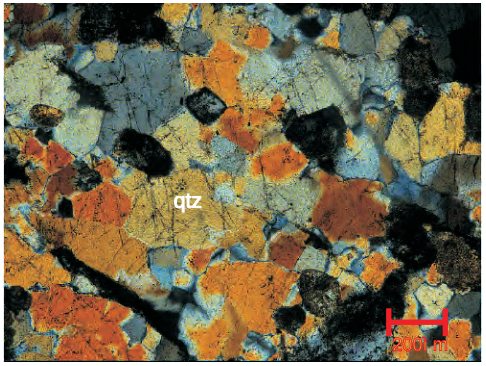
Notes

1) -moderate color shift from medium-dark blue at 3 sec exposure to CL to dark blue at 12 sec exposure to CL, CL color is slightly inhomogeneous
2) -pale blue/pink and bright green luminescent grains are feldspar, a few flecks of color can be seen on grain, could be very small mineral inclusions or debris from materials used to polish thin section
3) -altered feldspar mineral inclusions, and also fluid inclusions are present in grain
4) -embayments and microfractures can be seen, grain is polycrystalline, sub-grain boundaries are not well defined

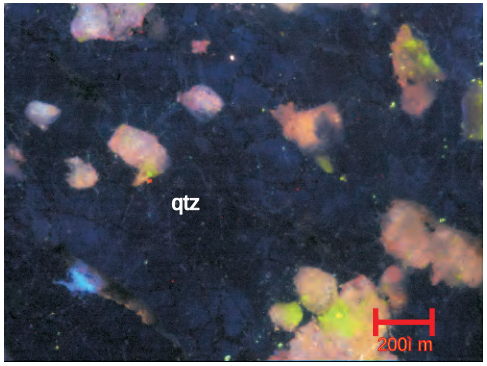
Grain #2



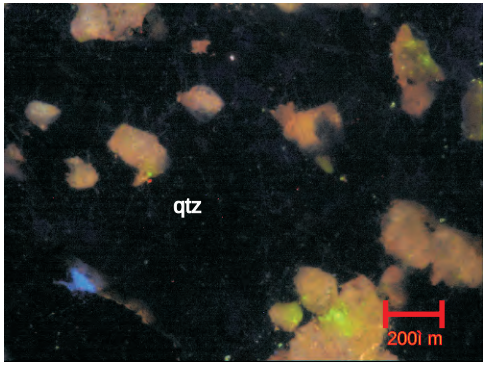
ppl



xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

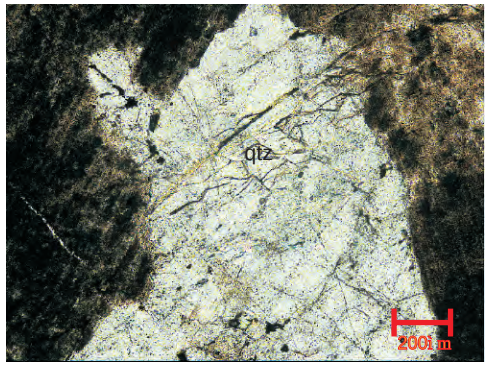
Notes

1) -moderate color shift from medium blue at 3 sec exposure to CL to dark blue at 12 sec exposure to CL, CL color is slightly inhomogeneous
2) -pale pink, light blue, and bright green luminescent grains are feldspar, a few flecks of color can be seen on grain, could be very small mineral inclusions or debris from materials used to polish thin section
3) -altered feldspar mineral inclusions, and also fluid inclusions are present in grain
4) -embayments, and microfractures can be seen, grain is polycrystalline, sub-grain boundaries are not well defined

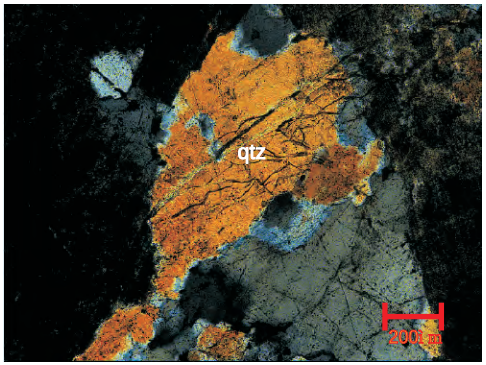
Sample

4190 Pegmatitic Granite, Frog Lake Quarry, Cobequid Highlands, NS

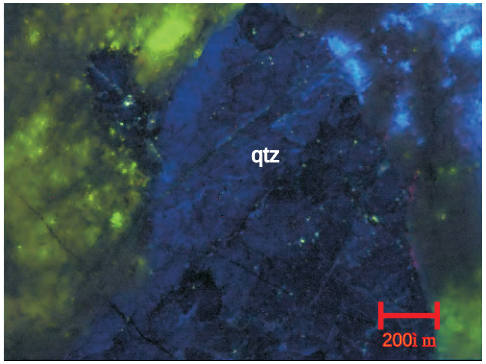
Grain #3



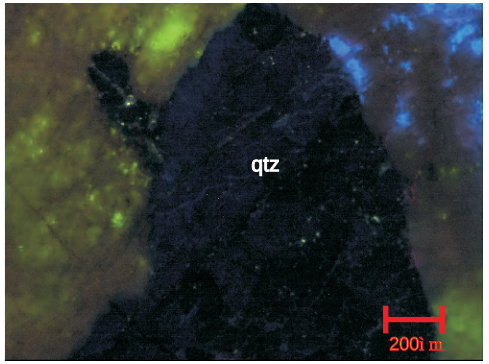
ppl



xpl



after 3 sec exposure to CL

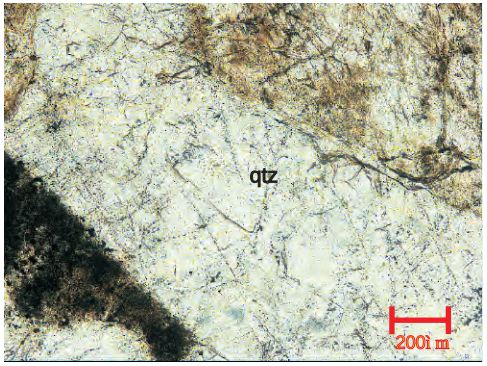


after 12 sec exposure to CL

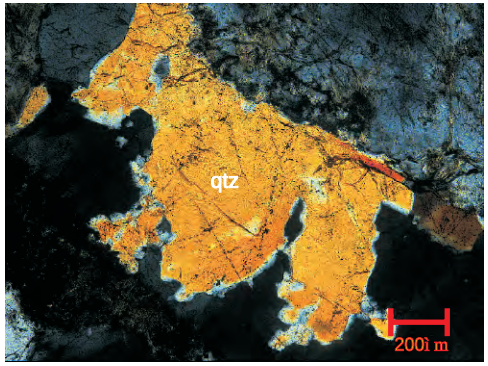
Notes

1) -moderate color shift from medium blue at 3 sec exposure to CL to dark blue at 12 sec exposure to CL, CL color is inhomogeneous
2) -light blue luminescent mineral is feldspar, green luminescent mineral not identified (altered feldspar?), some flecks of color (light blue and green) can be seen on quartz grain, could be very small mineral inclusions or debris from materials used to polish thin section
3) -apatite mineral inclusions, and also fluid inclusions are present in grain
4) -embayments, cooling cracks (conchoidal fractures), and microfractures can be seen, grain is polycrystalline, sub-grain boundaries not well defined

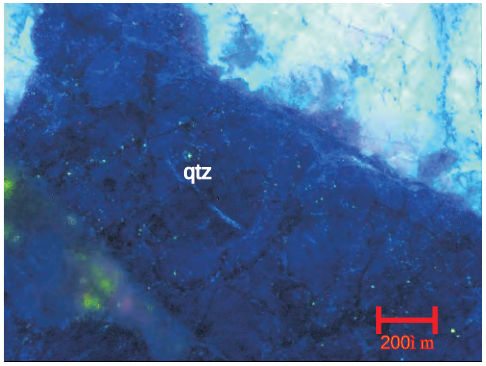
Grain #4



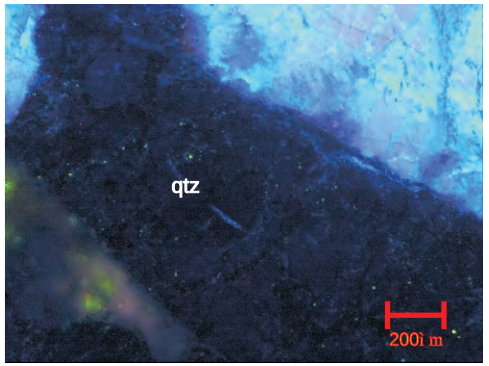
ppl



xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

Notes

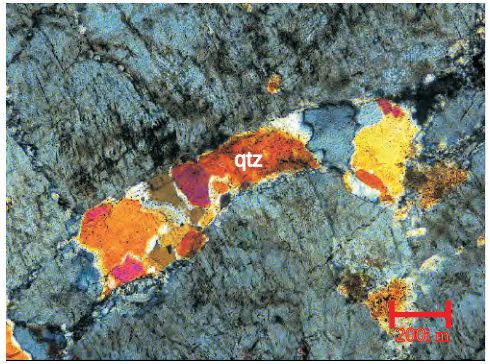
1) -moderate color shift from medium blue at 3 sec exposure to CL to dark blue at 12 sec exposure to CL, CL color is inhomogeneous, light blue luminescence present in some fractures
2) -light blue luminescent mineral is feldspar, green luminescent areas not identified (altered feldspar?), some flecks of color (light blue and green) can be seen on quartz grain, could be very small mineral inclusions or debris from materials used to polish thin section
3) -apatite mineral inclusions, and also fluid inclusions are present in grain
4) -embayments, and microfractures can be seen, grain is polycrystalline, sub-grain boundaries are not well defined

Sample

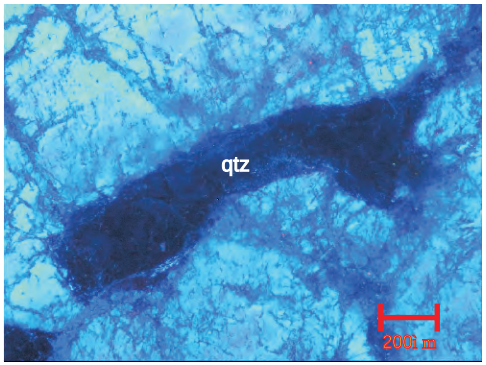
4190 Pegmatitic Granite, Frog Lake Quarry, Cobequid Highlands, NS

Grain #5

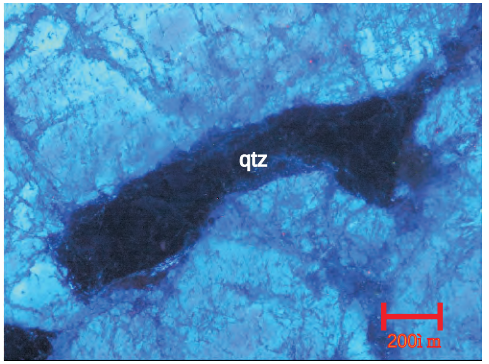
ppl



xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

Notes

1) -slight color shift from medium-dark blue at 3 sec exposure to CL to dark blue at 12 sec exposure to CL, CL color is inhomogeneous, grain is light blue in some fractures
2) -light blue luminescent mineral is feldspar
3) -opaque and feldspar mineral inclusions, and also fluid inclusions are present in grain
4) -a few very small microfractures can be seen
5) -qtz appears to be part of a small vein, grain is polycrystalline

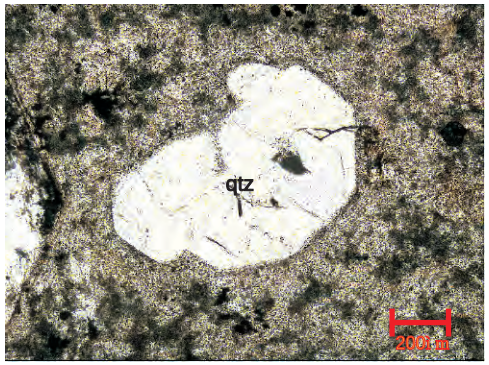
Summary

Slight to moderate color shifts were seen in qtz grains in this slide with initial colors ranging from medium blue to medium-dark blue, and a final color of dark blue. CL color of qtz grains is inhomogenous.

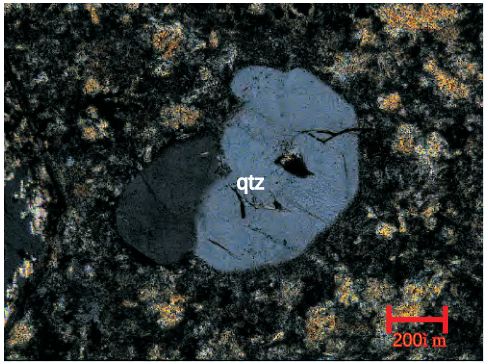
Sample

2109 Microgranite, Powerlines at Henry Brook, Cobequid Highlands, NS

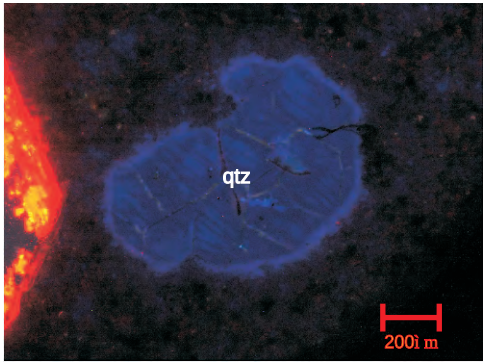
Grain #1



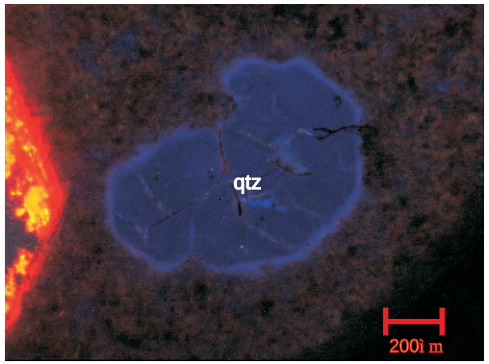
ppl



xpl



after ~3 sec exposure to CL

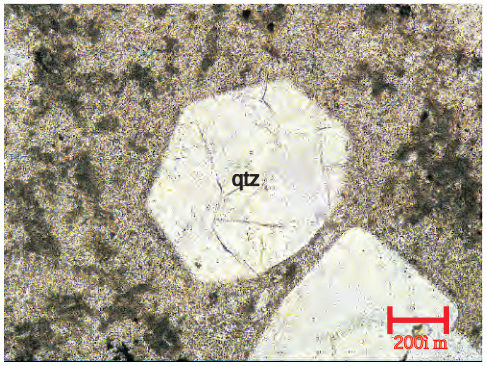


after ~18 sec exposure to CL

Notes

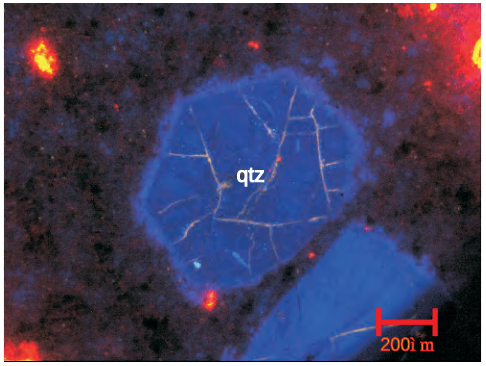
1) -slight color shift from bright-medium blue at ~3 sec exposure to CL to medium blue at ~18 sec exposure to CL
2) -bright orange luminescent mineral is calcite
3) -opaque, and chlorite mineral inclusions, and also fluid inclusions are present in grain
4) -a few microfactures and cooling cracks (conchoidal fractures) can be seen

Grain #2

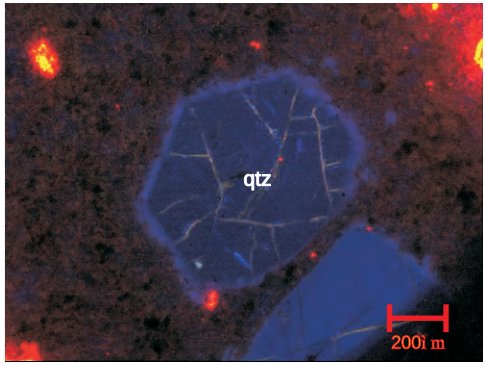


ppl

xpl



after ~3 sec exposure to CL



after ~16 sec exposure to CL

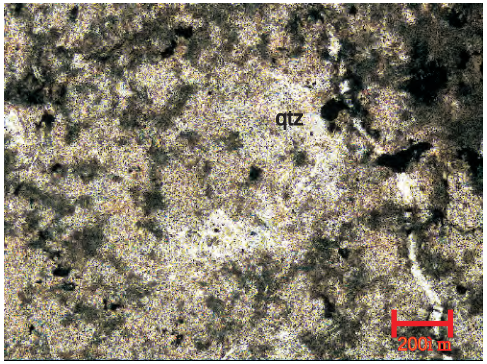
Notes

1) -strong color shift from bright blue with lighter blue patches at ~3 sec exposure to CL to a medium-dark blue at ~16 sec exposure to CL, white in cracks
2) -yellow crystal in xpl photo that becomes bright blue under CL is feldspar, orange luminescent mineral is calcite
3) -mineral inclusions that are too small to identify, and also fluid inclusions are present in grain
4) -microfractures, and also a few cooling cracks (conchoidal fractures) can be seen

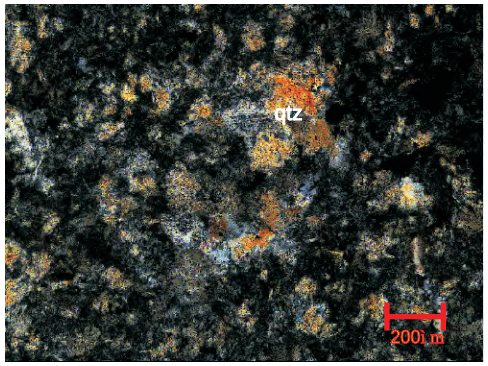
Sample

2109 Microgranite, Powerlines at Henry Brook, Cobequid Highlands, NS

Grain #3



ppl



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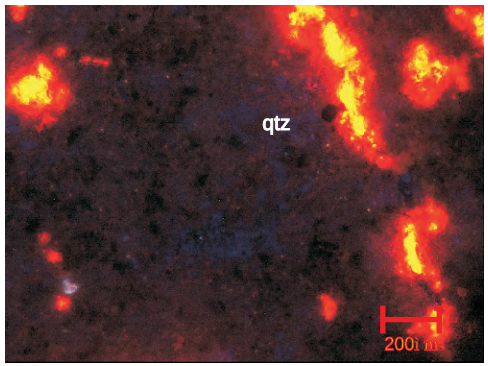
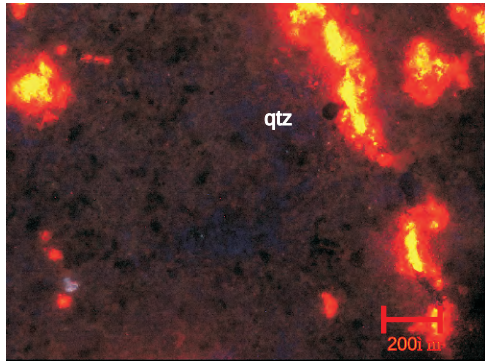


after ~7 sec exposure to CL

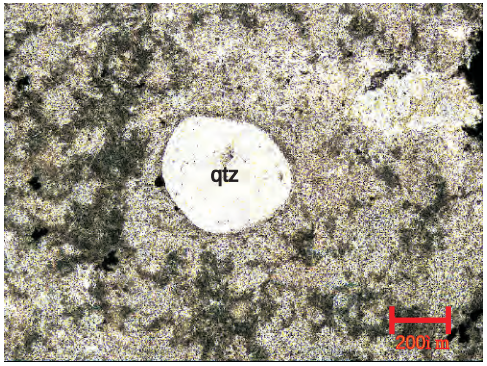


after ~19 sec exposure to CL

Notes

1) -slight color shift from dark blue and violet at ~7 sec exposure to CL to dark blue with more violet at ~19 sec exposure to CL
2) -bright orange luminescent mineral is calcite
3) -chlorite and opaque mineral inclusions, and also fluid inclusions are present in grain
4) -grain margins are irregular, microfractures can be seen

Grain #4



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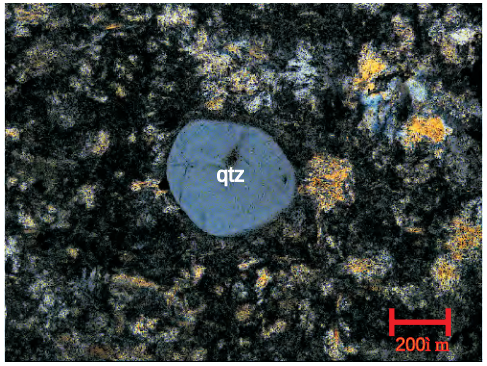

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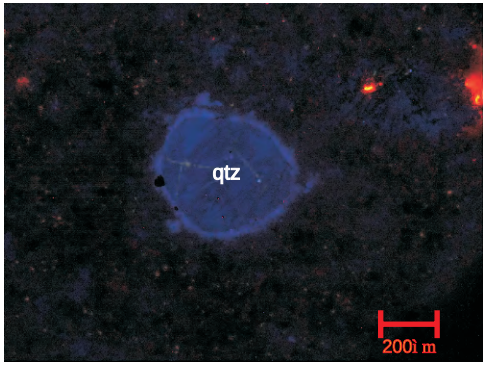
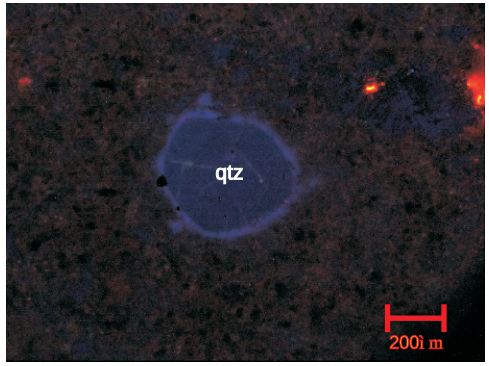


after ~6 sec exposure to CL



after ~12 sec exposure to CL

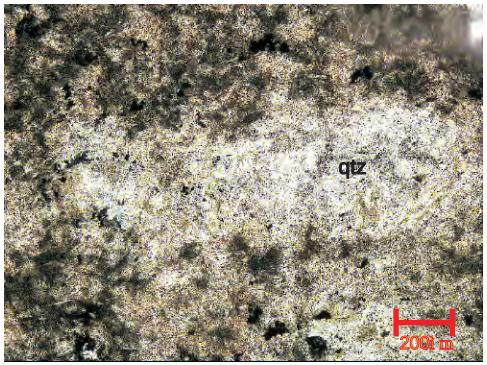
NOtes

1) -slight color shift from inhomogeneous bright-medium blue at ~6 sec exposure to CL to homogeneous medium blue at ~12 sec exposure to CL
2) -bright orange luminescent mineral is calcite
3) -apatite mineral inclusions, mineral inclusions that are too small to identify, and also fluid inclusions are present in grain
4) -a few very small microfractures seen

Sample

2109 Microgranite, Powerlines at Henry Brook, Cobequid Highlands, NS

Grain #5



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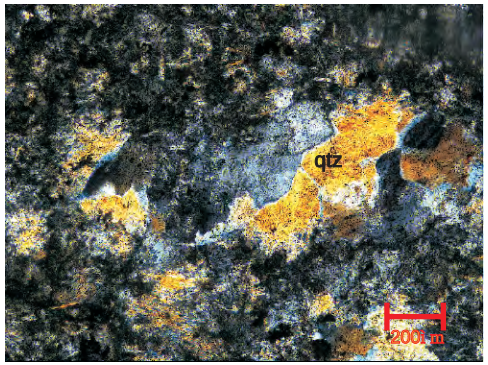

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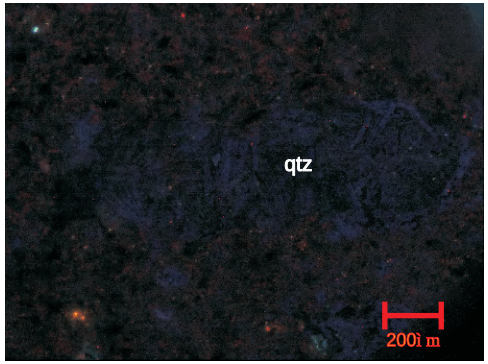
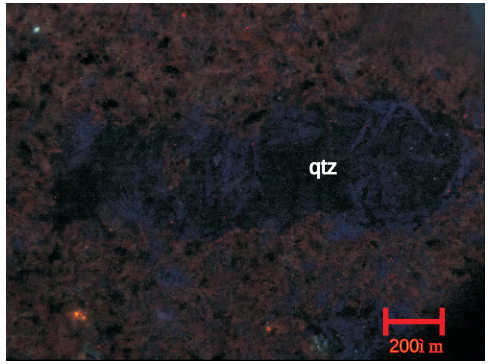


after ~3 sec exposure to CL



after ~18 sec exposure to CL

Notes

1) -slight color shift from medium-dark blue at ~3 sec exposure to CL to dark blue at ~18 sec exposure to CL
2) -groundmass is dark violet to brown
3) -chlorite mineral inclusion, and also fluid inclusions are present in grain
4) -irregular grain margins and a few microfractures can be seen

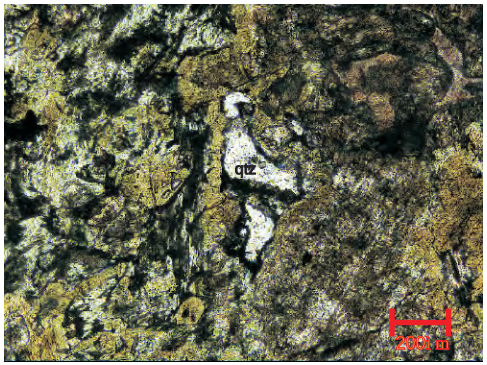
Summary

A slight to moderate color shift is exhibited by quartz phenocrysts. Initial CL colors of phenocrysts range from bright to bright-medium and have a final color of medium blue. Quartz in groundmass exhibits a slight color shift from an initial color ranging from medium-dark blue to dark blue and a final color ranging from dark blue to very dark blue.

Sample

2649b Undeformed Hornblende Pegmatitic Gabbro, Frog Lake Quarry, Cobequid Highlands, NS

Grain #1



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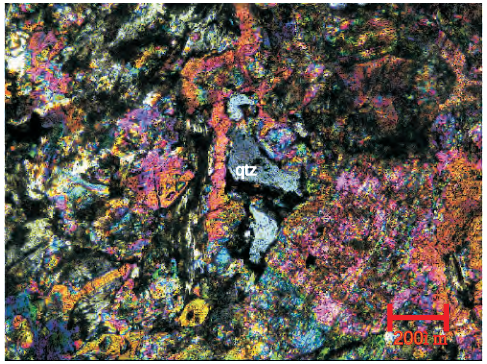

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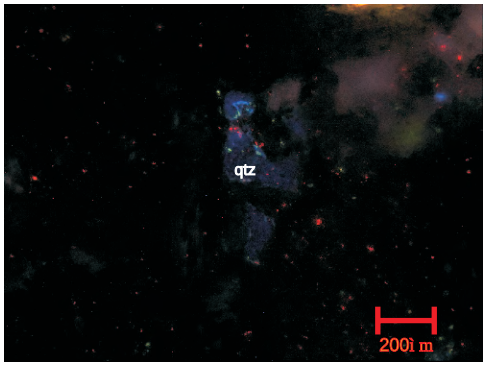
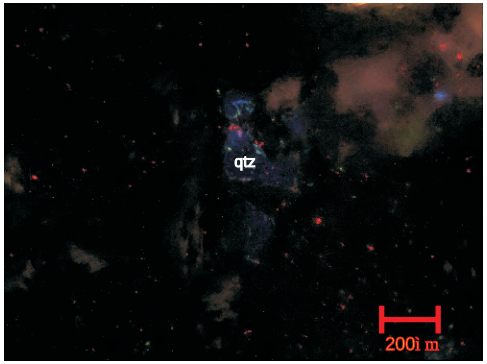


after ~6 sec exposure to CL

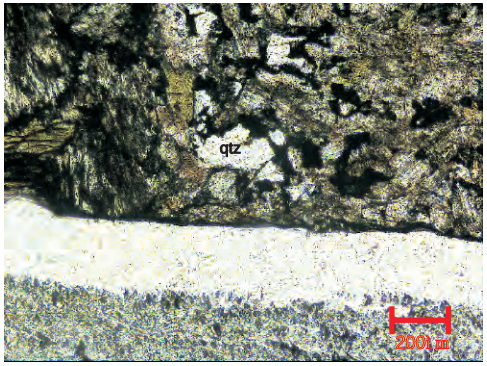


after ~21 sec exposure to CL

Notes

1) -slight color shift from medium blue at ~6 sec exposure to CL to medium-dark blue at ~21 sec exposure to CL
2) -small red and green flecks of color can be seen on grain in CL photos
3) -mineral inclusions of amphibole and apatite, and also fluid inclusions present in grain
4) -grain has embayed grain margins and is monocrystalline, small microfractures can be seen

Grain #2



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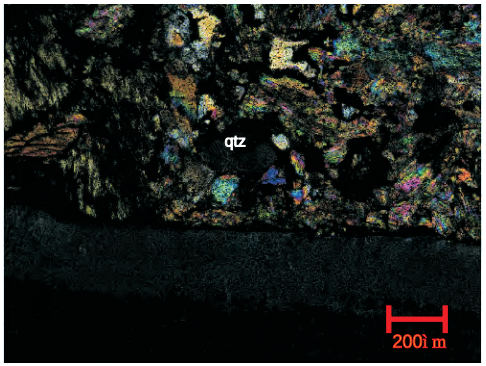

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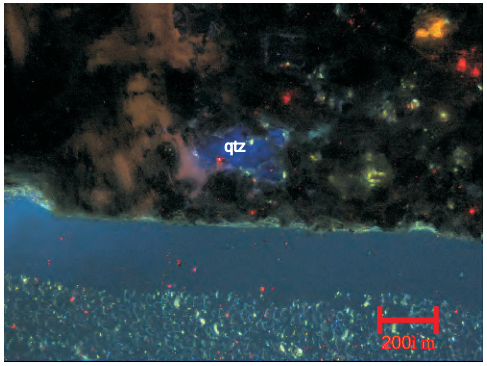
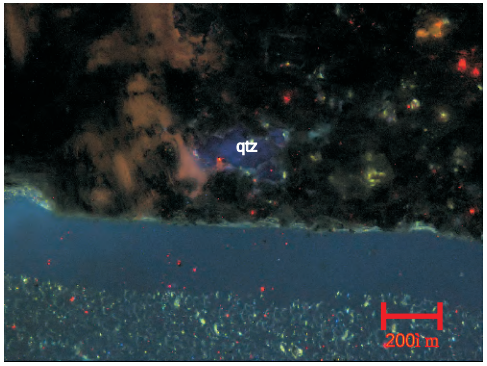


after ~4 sec exposure to CL



after ~16 sec exposure to CL

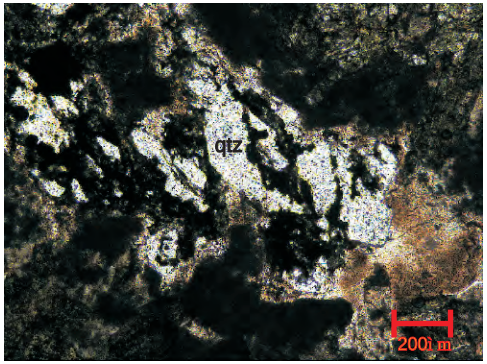
Notes

1) -slight color shift from medium blue at ~4 sec exposure to CL to medium-dark blue at ~16 sec exposure to CL
2) -small red and green flecks of color can be seen on grain in CL photos (possibly mineral inclusions or residue from polishing materials)
3) -mineral inclusions of chlorite and apatite, and also fluid inclusions present in grain
4) -grain has irregular grain margins and is monocrystalline, microfractures can be seen

Sample

2649b Undeformed Hornblende Pegmatitic Gabbro, Frog Lake Quarry, Cobequid Highlands, NS

Grain #3



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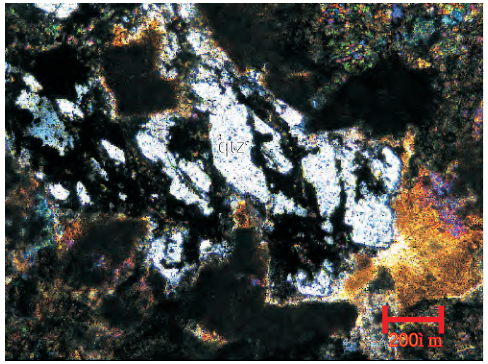

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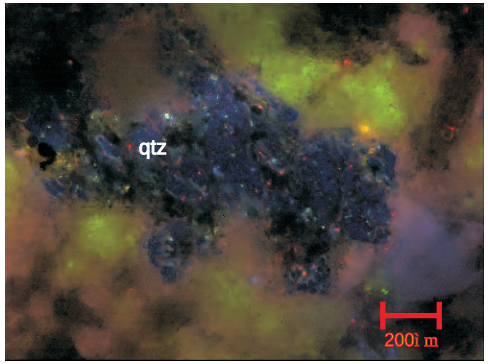
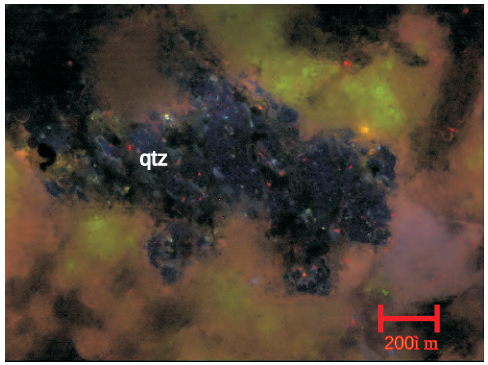


after ~3 sec exposure to CL



after ~18 sec exposure to CL

Notes

1) -slight color shift from inhomogeneous medium blue at ~3 sec exposure to CL to inhomogeneous medium-dark blue at ~18 sec exposure to CL
2) -flecks of red and light blue can be seen (possibly mineral inclusions or residue from polishing materials)
3) -apatite and toumaline mineral inclusions, and also fluid inclusions present in grain
4) -grain is monocrystalline and has irregular grain margins, microfractures can be seen

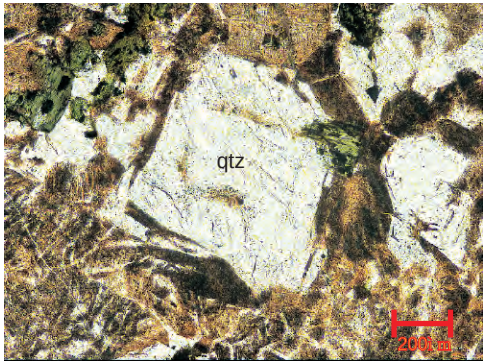
Summary

A slight color shift was observed in quartz grains in this thin section going from an initial color of medium blue to a final color of medium-dark. Grains are monocrystalline.

Sample

A42 Granophyric Granite, East of Amphisa, Greece

Grain #1



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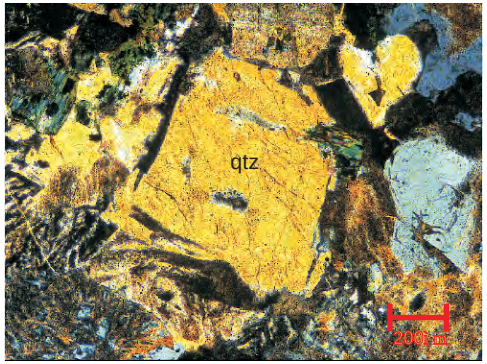

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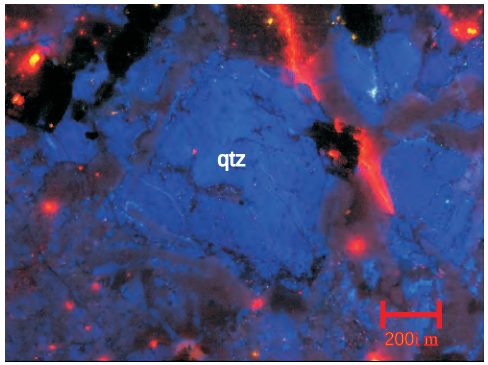
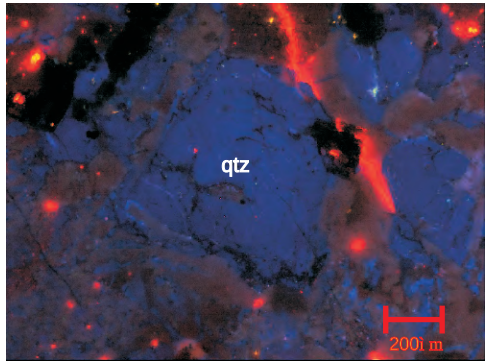


after 3 sec exposure to CL

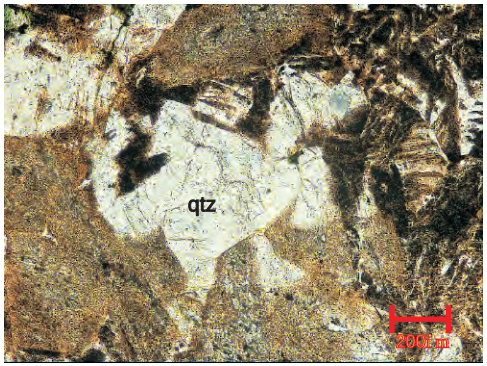


after 12 sec exposure to CL

Notes

1) -moderate color shift from bright blue at 3 sec exposure to CL to medium blue at 12 sec exposure to CL, CL color of grain is inhomogeneous, fractures appear dark in CL photos
2) -bright orange luminescent grains are calcite, purplish brown luminescent grains are altered feldspar
3) -altered feldspar and chlorite mineral inclusions, and also fluid inclusions are present in grain
4) -microfractures can be seen, grain is monocrystalline

Grain #2



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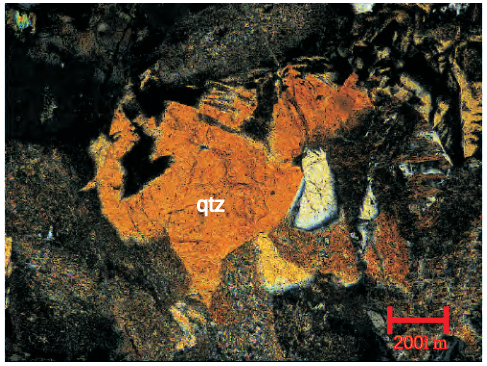

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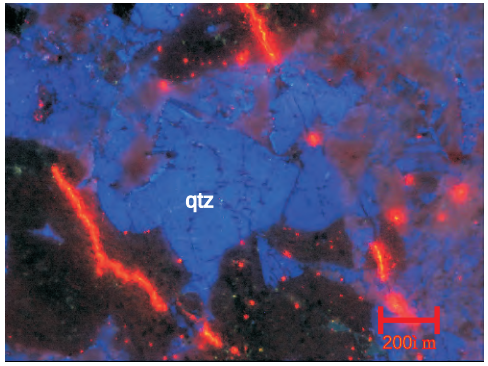
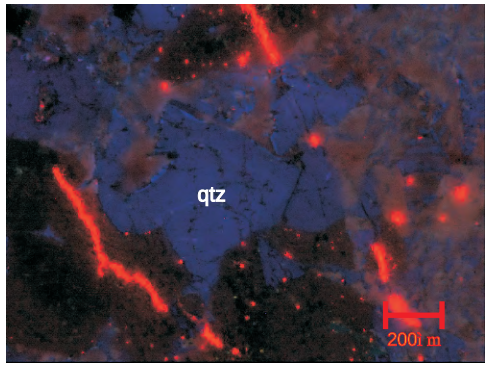


after 3 sec exposure to CL



after 12 sec exposure to CL

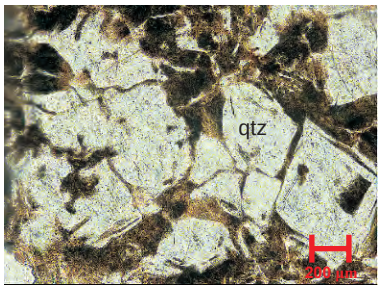
Notes

1) -strong color shift from bright blue at 3 sec exposure to CL to medium blue at 12 sec exposure to CL, CL color of grain is inhomogeneous, fractures appear dark in CL photos
2) -bright orange luminescent grains are calcite, dark purplish brown luminescent grains are altered feldspar
3) -altered feldspar chlorite mineral inclusions, one small unknown mineral inclusion (too small to identify), and also fluid inclusions are present in grain
4) -embayments and microfractures can be seen, grain is polycrystalline

Sample

A42 Granophyric Granite, East of Amphisa, Greece

Grain #3



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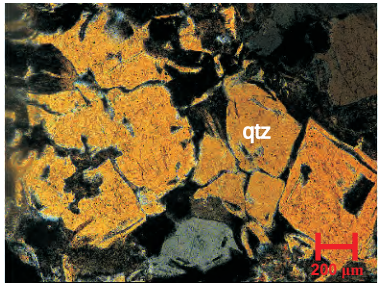

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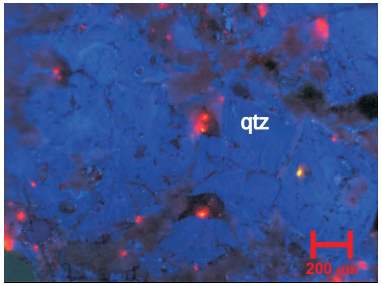
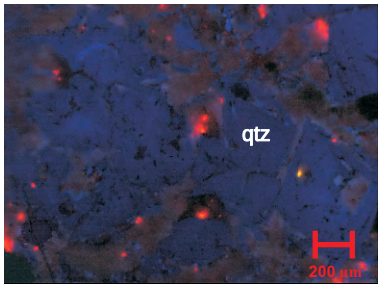


after 3 sec exposure to CL

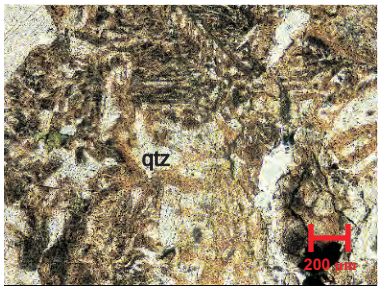


after 12 sec exposure to CL

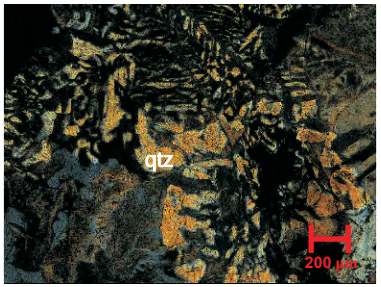
Notes

1) -strong color shift from bright blue at 3 sec exposure to CL to medium-dark blue at 12 sec exposure to CL, CL of grain is slightly inhomogeneous, fractures appear dark in CL photos
2) bright orange luminescent grains are calcite, bright yellow luminescent inclusion is apatite, dark purplish brown luminescent grains are altered feldspar
3) -altered feldspar, calcite, and apatite mineral inclusions, and also fluid inclusions are present in grain
4) -microfractures can be seen, grain margins are irregular

Grain #4



ppl



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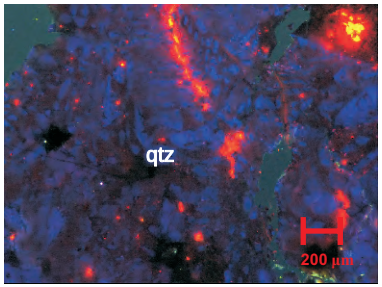
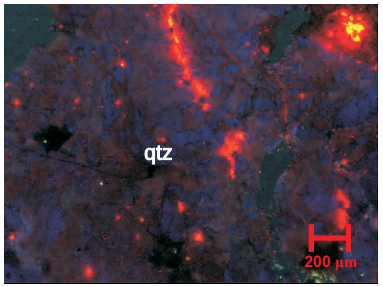
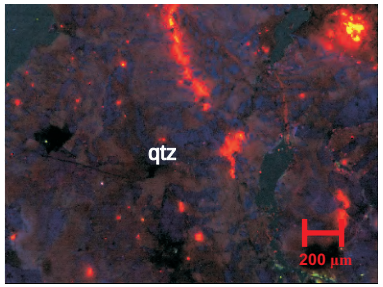


after 3 sec exposure to CL



after 12 sec exposure to CL



after 21 sec exposure to CL

Notes

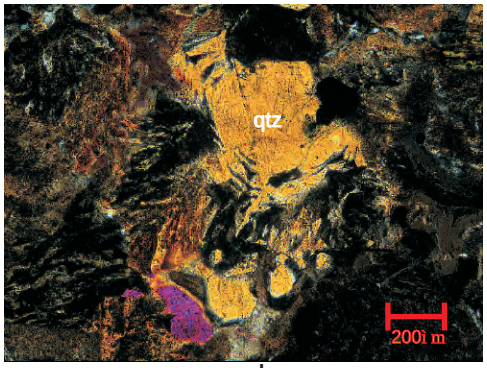
1) -moderate color shift from inhomogeneous bright-medium blue at 3 sec exposure to CL to medium-dark blue at 21 sec exposure to CL, fractures appear dark in CL photos
2) -bright orange luminescent mineral is calcite, dark purplish brown luminescent mineral is feldspar
3) -fluid inclusions are present in grain
4) -microfractures can be seen, grain margins are irregular

Sample

A42 Granophyric Granite, East of Amphisa, Greece

Grain #5

ppl



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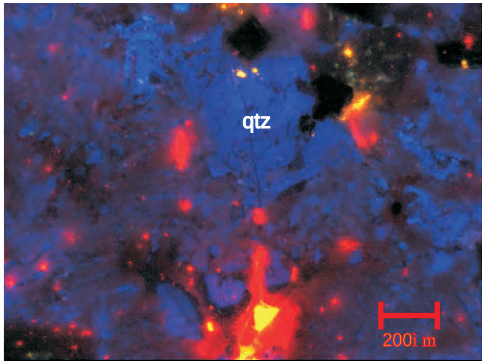
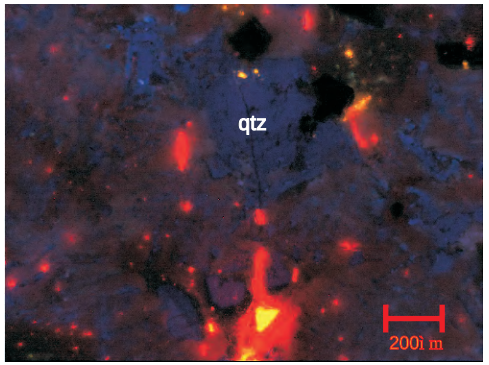


after 3 sec exposure to CL



after 12 sec exposure to CL

Notes

1) -strong color shift from bright blue at 3 sec exposure to CL to medium-dark blue at 12 sec exposure to CL, CL color of grain is slightly inhomogenous
2) -bright orange luminescent mineral is calcite, bright yellow luminescent mineral is apatite, dark purplish brown luminescent mineral is altered feldspar
3) -calcite, apatite, and opaque mineral inclusions, and also fluid inclusions are present in grain
4) -microfractures can be seen, grain margins are irregular

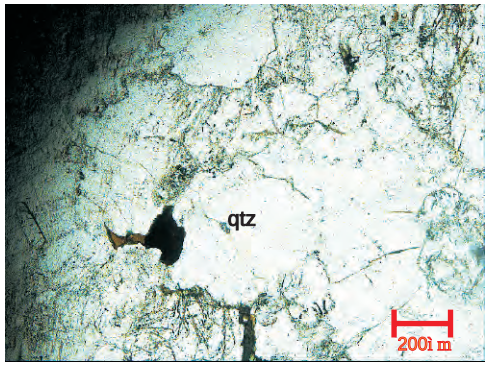
Summary

Moderate to strong color shift can be seen in qtz grain in this thin section going from and initial color ranging from bright to bright-medium blue to a final color ranging from medium to medium-dark blue. CL of grains is slightly inhomogeneous , and many fractures in grain appear dark in CL photos.

Sample

DL31a Granite, Quarry on SE Coast of Delos Island, Greece

Grain #1



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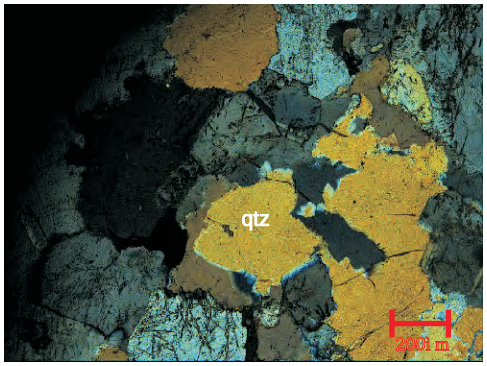
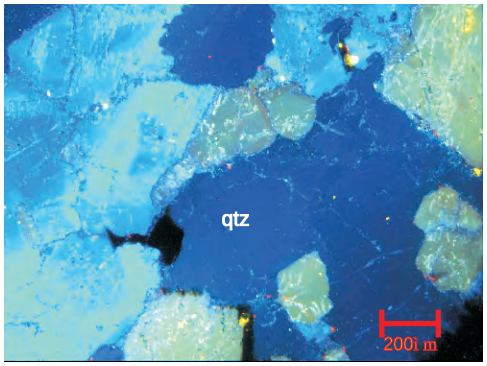
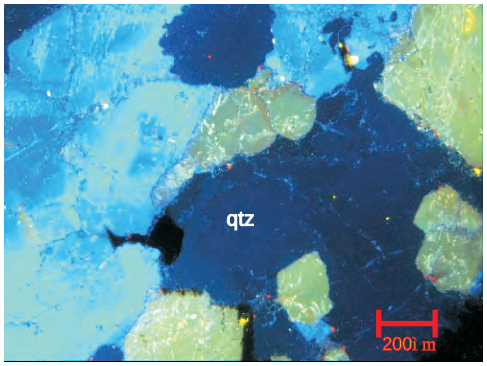


xpl



after 3 sec exposure to CL



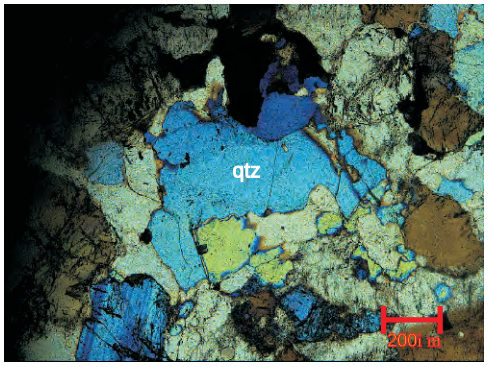
after 12 sec exposure to CL

Notes

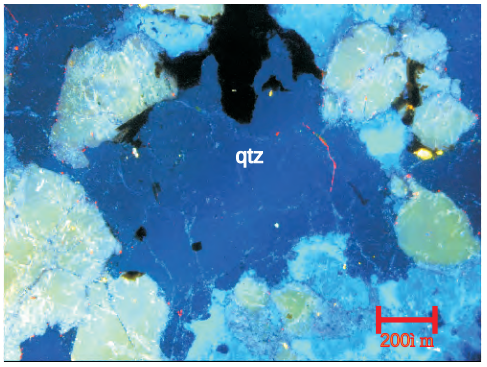
1) -slight color shift from an initial color of bright-medium blue at 3 sec exposure to a final color of CL to medium blue at 12 sec exposure to CL
2) -light blue and green luminescent grains are feldspar
3) -mineral inclusions of tourmaline, and also fluid inclusions are present in grain
4) -grain is filling intergranular space and is polycrystalline, sub-grain boundaries are sutured, a few microfactures and cooling cracks (conchoidal fractures) can be seen

Grain #2

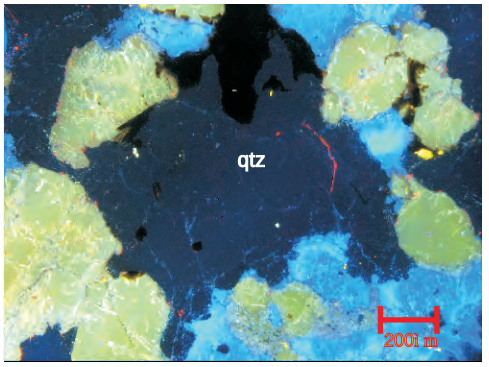
ppl



xpl



after 3 sec exposure to CL



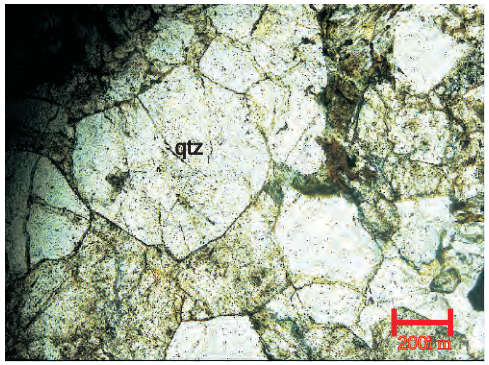
after 12 sec exposure to CL

1) -moderate color shift from an initial color of bright-medium blue at 3 sec exposure to a final color of CL to medium-dark blue at 12 sec exposure to CL
2) -light blue and green luminescent grains are feldspar
3) -mineral inclusions of tourmaline and zircon, and also fluid inclusions are present in grain
4) -grain is filling intergranular space and is polycrystalline, sub-grain boundaries are sutured, a few microfactures and cooling cracks (conchoidal fractures) can be seen

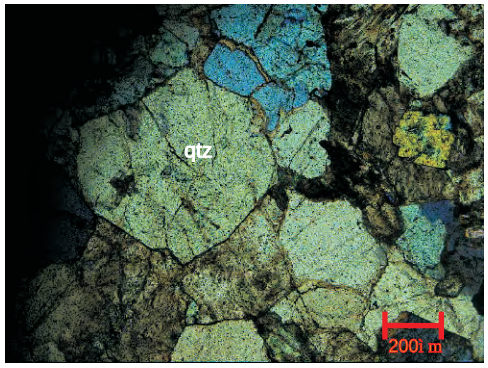
Sample

DL16 Granite, Coast at Fourni, Delos Island, Greece

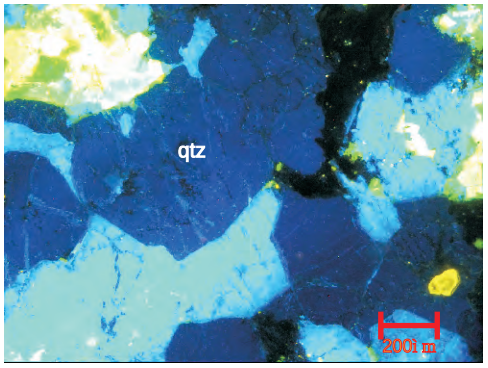
Grain #1



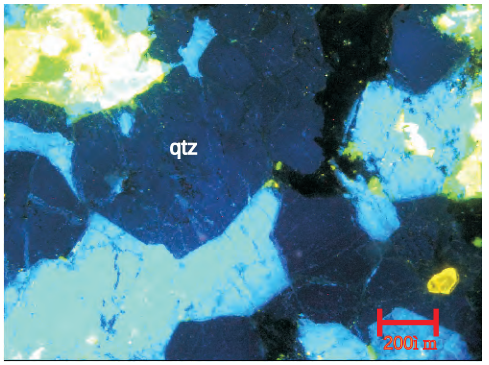
ppl



xpl



after 3 sec exposure to CL

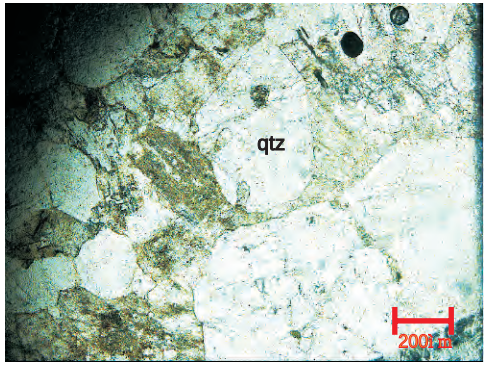


after 12 sec exposure to CL

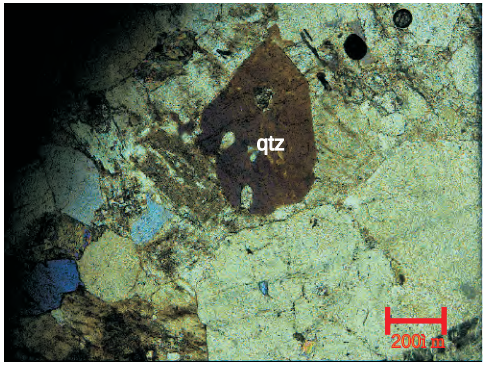
Notes

1) -slight color shift from an initial color of bright-medium blue at 3 sec exposure to a final color of CL to medium blue at 12 sec exposure to CL
2) -light blue and bright green luminescent grains are feldspar
3) -mineral inclusions of tourmaline and also fluid inclusions are present in grain
4) -grain is monocrystalline, a few microfactures can be seen

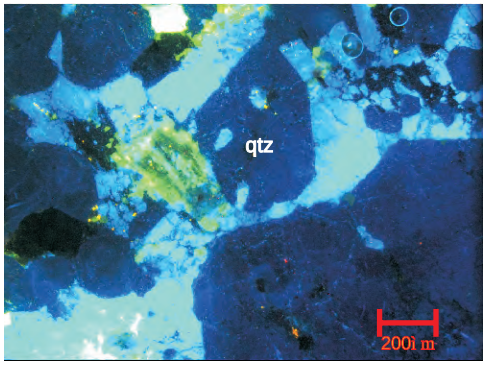
Grain #2



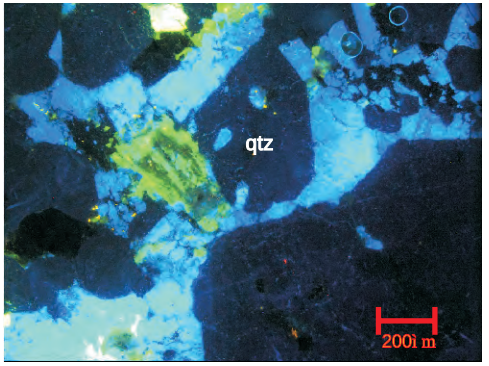
ppl



xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

Notes

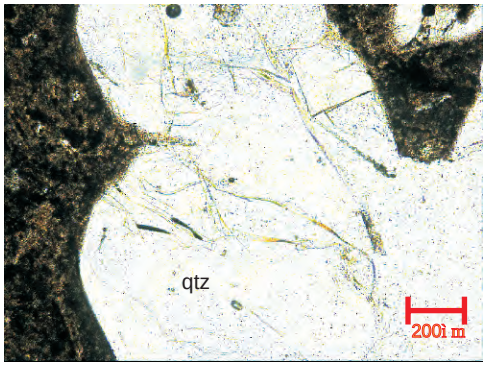
1) -slight color shift from an initial color of medium blue at 3 sec exposure to a final color of CL to medium-dark blue at 12 sec exposure to CL
2) -light blue and bright green luminescent grains are feldspar
3) -mineral inclusions of tourmaline and feldspar, and also fluid inclusions are present in grain
4) -grain is monocrystalline, a few microfactures can be seen

Volcanic Quartz

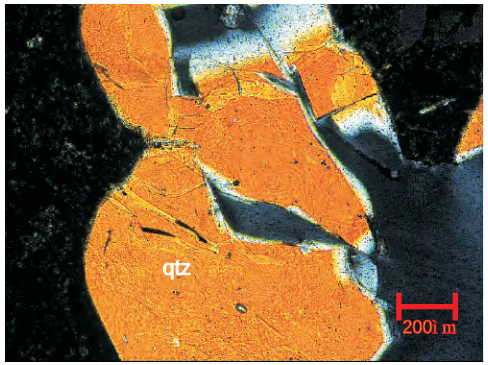
Sample

C22 Rhyodacite, Crommyonia, near Corinthos, Greece

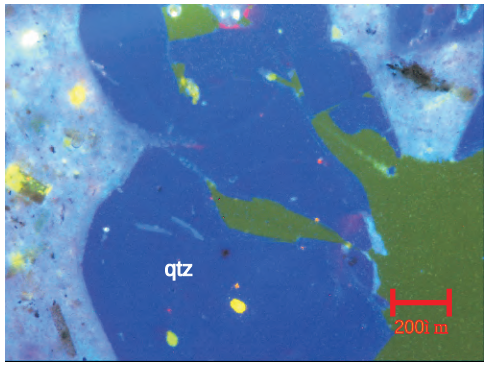
Grain #1



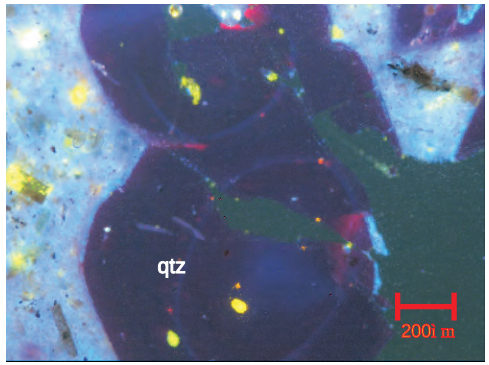
ppl



xpl



after 0-3 sec exposure to CL



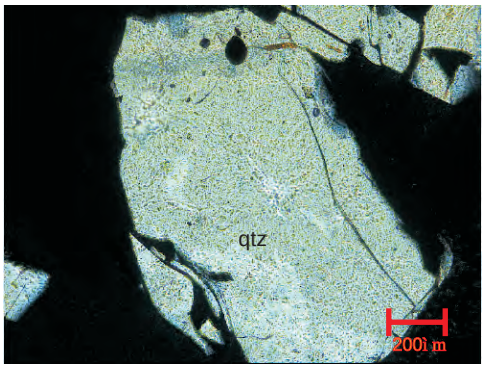
after ~19 sec exposure to CL

Notes

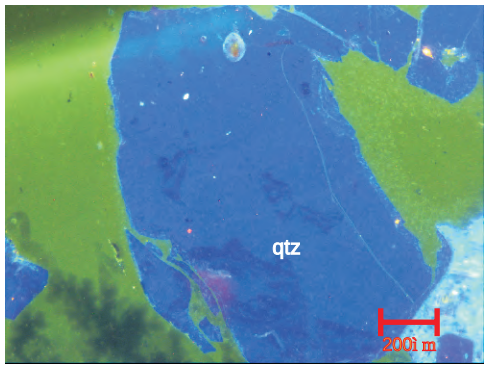
1) -strong color shift from bright blue after between 0-3 sec exposure to CL to medium-dark blue at ~19 sec exposure to CL
2) -bright yellow luminescent inclusions are apatite, olive green luminescent areas are Canada balsam, light blue luminescence in groundmass is glass
3) -zircon, apatite and feldspar mineral inclusions, and also fluid inclusions are present in grain
4) -embayments, cooling cracks (conchoidal fractures), and microfractures can be seen, grain is monocrystalline

Grain #2

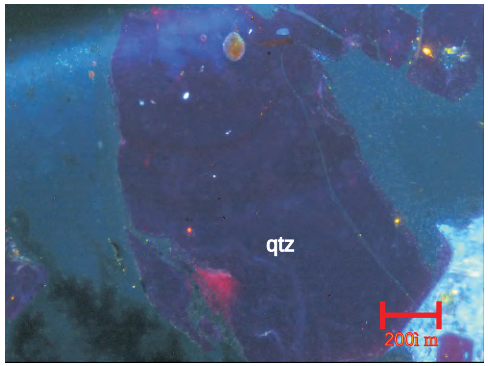
ppl



xpl



after (0-3) sec exposure to CL



after ~18 sec exposure to CL

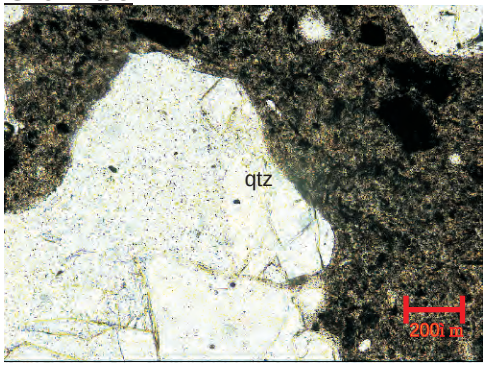
Notes

1) -strong color shift from bright blue with darker blue patches after between 0-3 sec exposure to CL to medium-dark blue at ~18 sec exposure to CL
2) -bright yellow luminescent inclusions are apatite, olive green luminescent areas are Canada balsam, pale blue luminescence in groundmass is glass, brownish orange luminescent inclusion at ~18 sec exposure to CL is opaque minera
β) -zircon, apatite, altered mica and opaque mineral inclusions, and also fluid inclusions are present in grain
4) -embayments, cooling cracks (conchoidal fractures), and microfractures can be seen, grain is monocrystalline

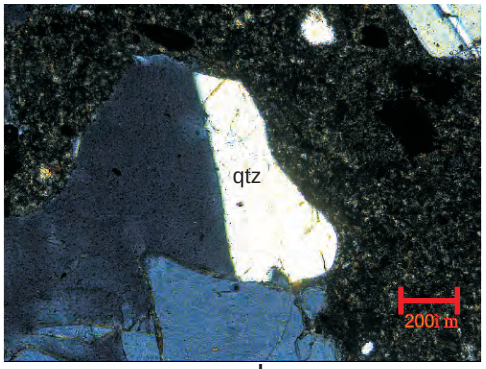
Sample

C22 Rhyodacite, Crommyonia, near Corinthos, Greece

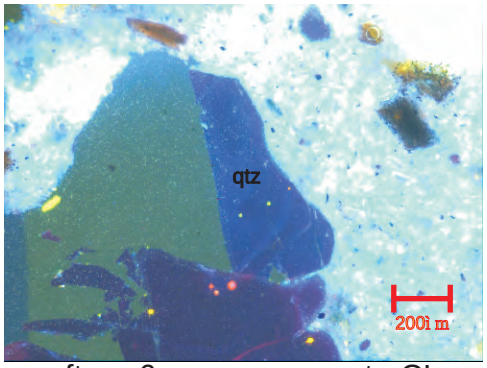
Grain #3



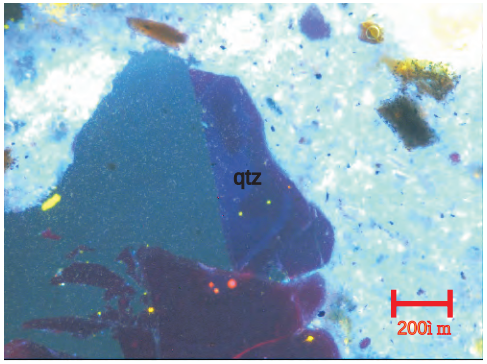
ppl



xpl



after ~6 sec exposure to CL



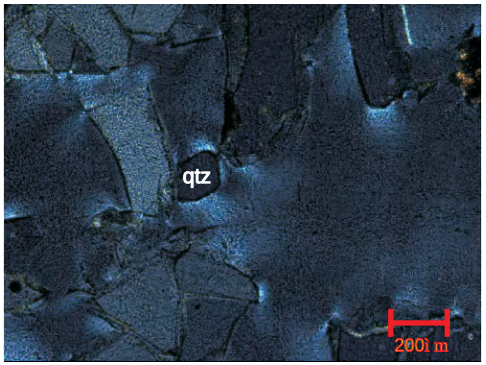
after ~18 sec exposure to CL

Notes

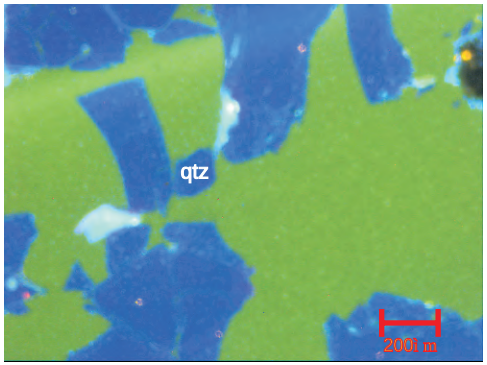
1) -slight color shift from bright-medium blue at ~6 sec exposure to CL to medium blue at ~18 sec exposure to CL
2) -bright yellow luminescent inclusions are apatite, pale blue luminescence in groundmass is glass, pale yellow luminescent mineral at ~18 sec exposure to CL in top right corner is feldspar, red luminescent inclusions not identified (possibly lead from polishing?), olive green luminescent areas at ~6 sec exposure to CL are Canada balsam
3) -biotite and apatite mineral inclusions, and also fluid inclusions are present in grain
4) -cooling cracks (conchoidal fractures) and microfractures can be seen, grain is monocrystalline
5) -color shift has already begun before ~6 sec exposure to CL, therefore, the two CL micrographs do not capture the full color shift

Grain #4

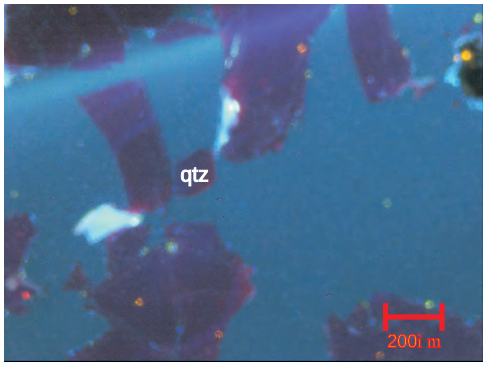
ppl



xpl



after (0-3) sec exposure to CL



after ~18 sec exposure to CL

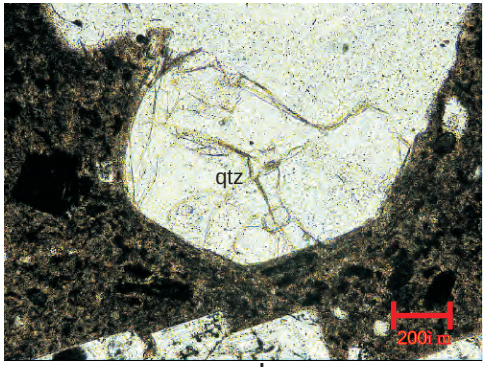
Notes

1) -strong color shift from bright blue at between 0-3 sec exposure to CL to medium-dark blue at ~18 sec exposure to CL
2) -olive green luminescent areas at 0-3 sec exposure to CL are Canada balsam, pale blue luminescent grains are feldspar
3) -biotite and apatite mineral inclusions, and also fluid inclusions are present in grain
4) -cooling cracks (conchoidal fractures) can be seen, grain is monocrystalline

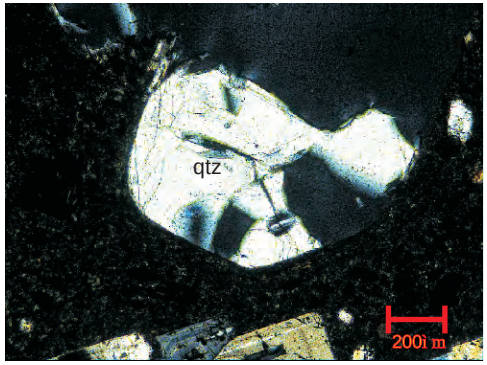
Sample

C22 Rhyodacite, Crommyonia, near Corinthos, Greece

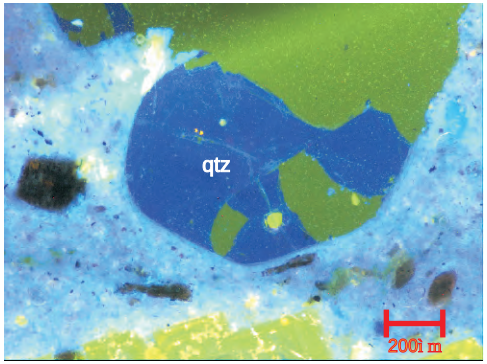
Grain #5



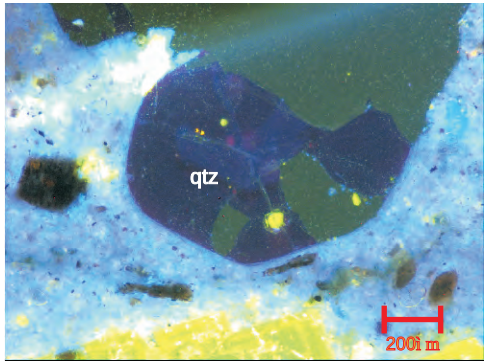
ppl



xpl



after (0-3) sec exposure to CL



after ~16 sec exposure to CL

Notes

1) -strong color shift from bright blue with some lighter blue in cracks at between 0-3 sec exposure to CL to medium-dark blue at ~16 sec exposure to CL
2) -lime green/yellow luminescent grains/ inclusions are feldspar, olive green luminescent areas are Canada balsam, dark brown luminescent grains are biotite
3) -apatite, feldspar, and tourmaline mineral inclusions, and also fluid inclusions can be seen
4) -embayments and cooling cracks (conchoidal fractures) can be seen, grain is monocrystalline

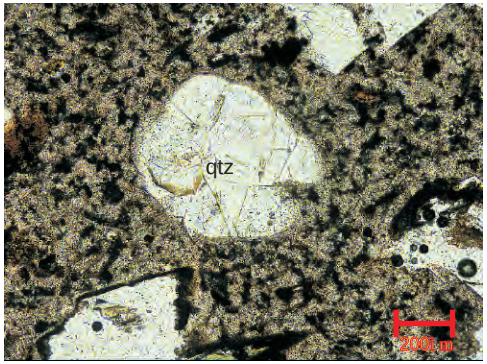
Summary

Moderate to strong color shift can be seen in qtz grains in this thin section going from an initial color ranging from bright to medium blue to a final color ranging from medium to medium- dark blue. Color shift in grain #3 is not representative if the CL properties of this sample as the color shift had already commenced when the first CL micrograph was taken at ~6 sec exposure to CL.

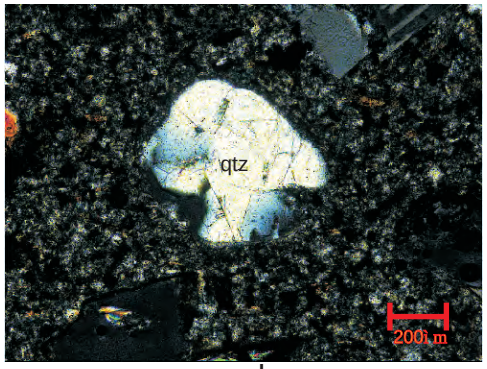
Sample

C9 Rhyodacite, Crommyonia, near Corinthos, Greece

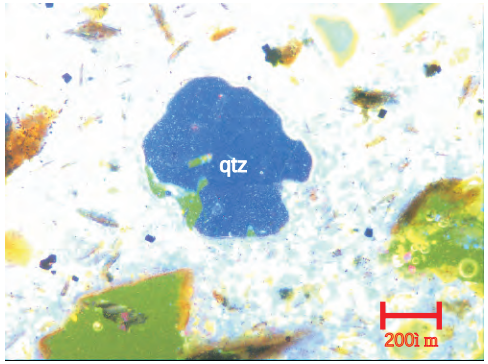
Grain #1



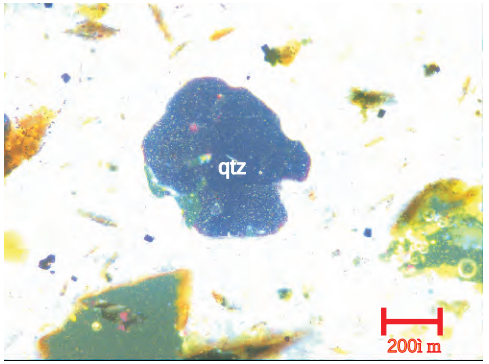
ppl



xpl



after ~9 sec exposure to CL

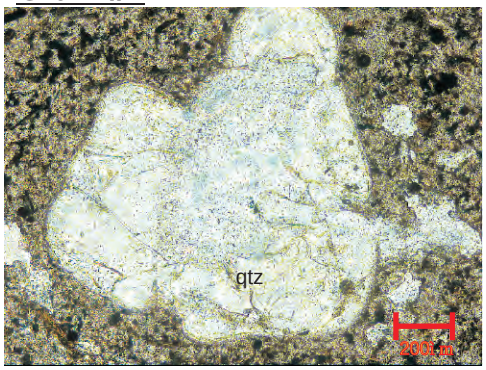


after ~15 sec exposure to CL

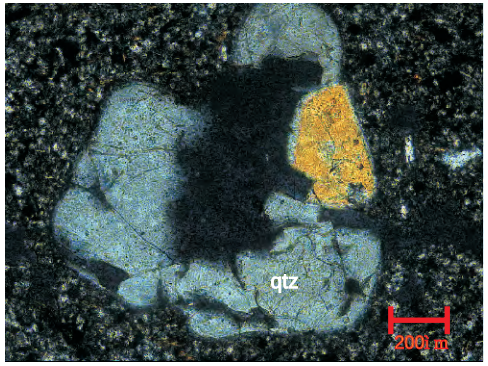
Notes

1) -moderate color shift from bright blue at ~9 sec exposure to CL to medium blue at ~15 sec exposure to CL
2) -olive green luminescent areas are Canada balsam, lime green/yellow luminescent grains are feldspar, brown luminescent grains are biotite, light blue luminescent areas in groundmass are glass
3) -apatite mineral inclusions and also fluid inclusions are present in grain
4) -embayments, cooling cracks, and microfractures can be seen, grain is monocrystalline

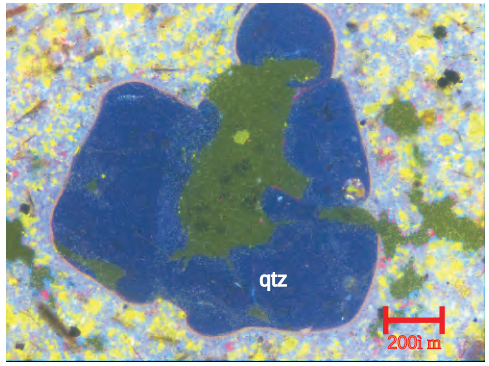
Grain #2



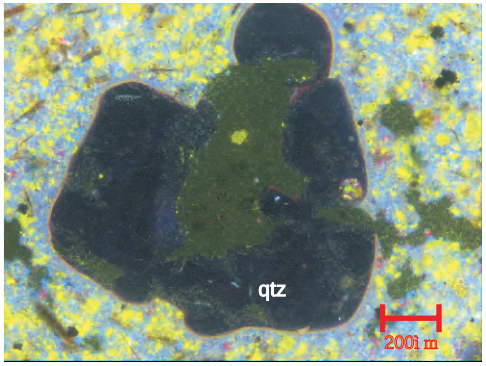
ppl



xpl



after ~3 sec exposure to CL



after ~12 sec exposure to CL

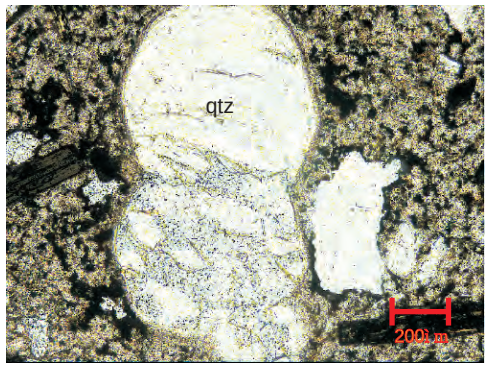
Notes

1) -strong color shift from bright-medium blue at ~3 sec exposure to CL to dark blue at ~12 sec exposure to CL, there are areas with an inhomogenous CL color around holes in grains throughout color shift
2) -olive green luminescent areas are Canada balsam, brown luminescent grains are biotite, groundmass has a bright yellow, pink, and pale blue luminescence, light blue luminescent areas are glass
3) -apatite mineral inclusions and also fluid inclusions are present in grains
4) -embayments and cooling cracks (conchoidal fractures) can be seen, grain is polycrystalline

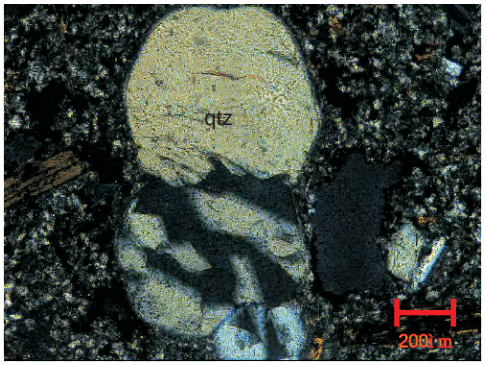
Sample

C9 Rhyodacite, Crommyonia, near Corinthos, Greece

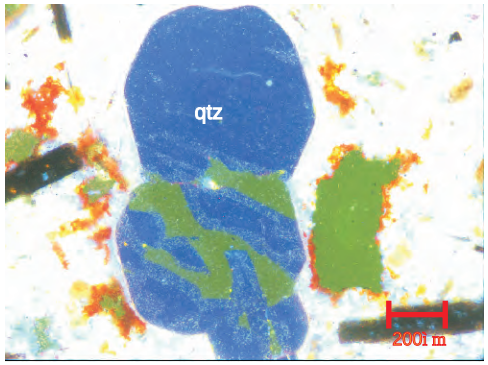
Grain #3



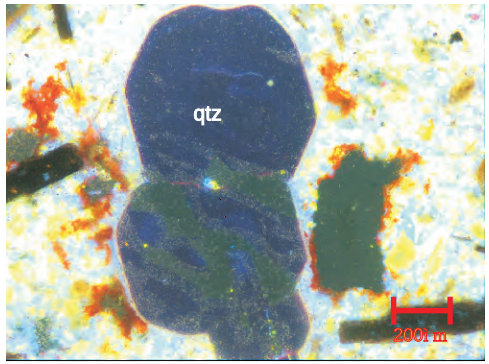
ppl



xpl



after ~3 sec exposure to CL

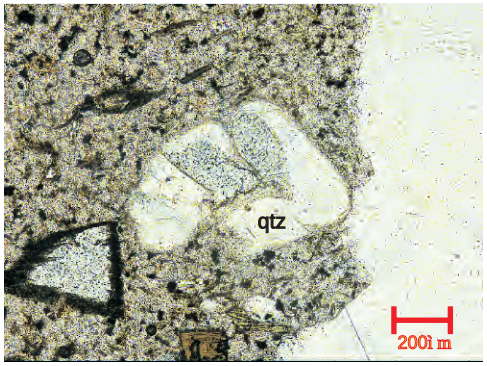


after ~12 sec exposure to CL

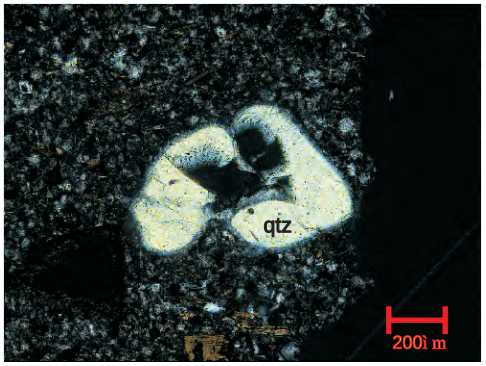
Notes

1) -strong color shift from from bright blue at ~3 sec exposure to CL to medium-dark blue at ~12 sec exposure to CL, there are areas with an inhomogenous CL color around large holes in grains throughout color shift
2) -olive green luminescent areas are Canada balsam, orange luminescent mineral is lead (from polishing), very dark brown luminescent grains are biotite, light blue luminescent areas in groundmass are glass
3) -apatite and tourmaline mineral inclusions, and also fluid inclusions are present in grain
4) -embayments, cooling cracks (conchoidal fractures), and microfractures can be seen, grain is polycrystalline

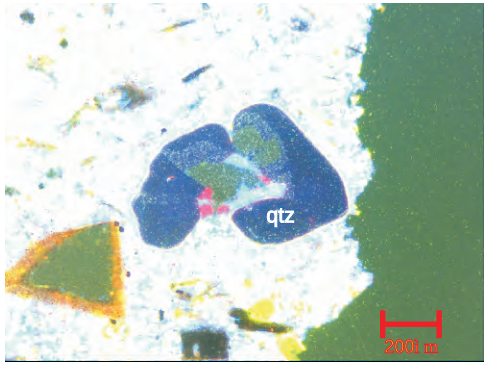
Grain #4



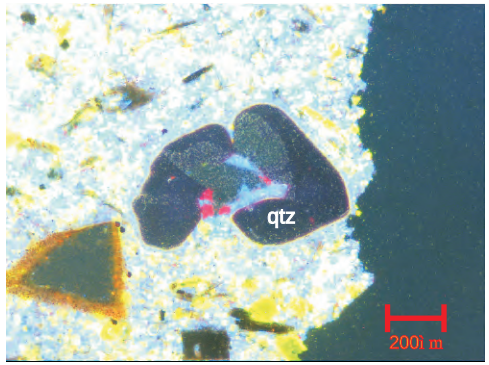
ppl



xpl



after ~6 sec exposure to CL



after ~19 sec exposure to CL

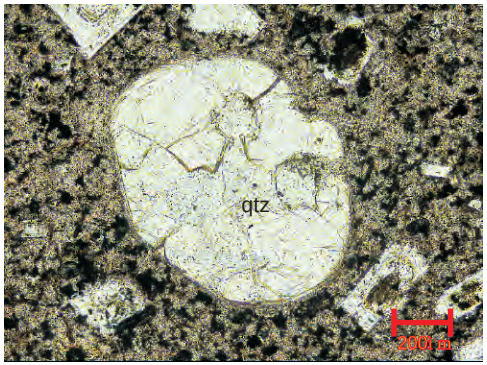
Notes

1) -moderate color shift from medium blue at ~6 sec exposure to CL to dark blue at ~19 sec exposure to CL, there are areas with an inhomogenous CL color around holes in grains throughout color shift
2) -unknown pink luminescent mineral, pale blue luminescent grains are feldspar, olive green luminescent areas are Canada balsam, orange brown luminescent mineral is lead (from polishing), light blue luminescent areas in groundmass are glass
3) -apatite and tourmaline mineral inclusions and also fluid inclusions are present in grains
4) -embayments, cooling cracks (conchoidal fractures), and microfractures can be seen, grain is monocrystalline
5) -CL color at ~6 sec exposure to the CL beam is not representative of the initial CL color of this sample as the color shift has already commenced prior to ~6 sec exposure time

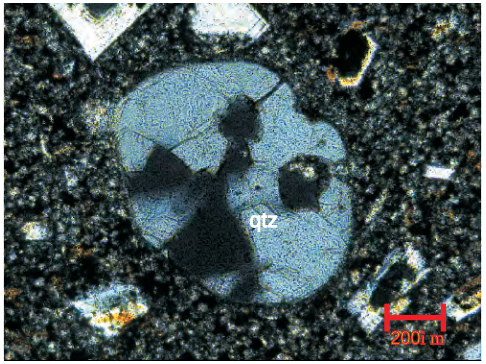
Sample

C9 Rhyodacite, Crommyonia, near Corinthos, Greece

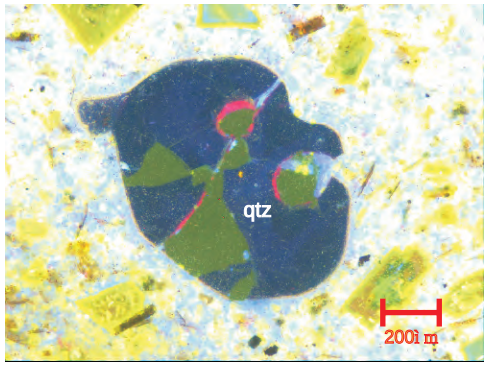
Grain #5



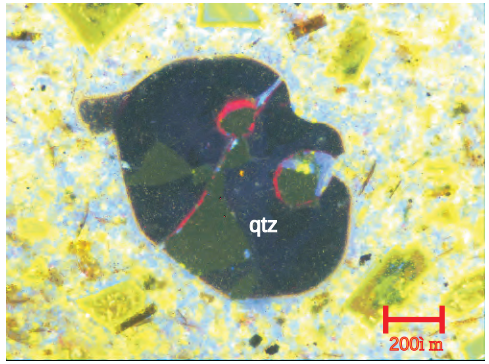
ppl



xpl



after ~3 sec exposure to CL



after ~15 sec exposure to CL

Notes

1) -moderate color shift from medium blue at ~3 sec exposure to CL to dark blue at ~15 sec exposure to CL
2) -olive green luminescent areas are Canada balsam, lime green/yellow luminescent grains and light blue luminescent inclusions are feldspar, unknown pink luminescent mineral, light blue luminescent areas in groundmass are glass
3) -feldspar and apatite mineral inclusions, and also fluid inclusions are present in grain
4) -embayments and cooling cracks (conchoidal fractures) can be seen, grain is monocrystalline

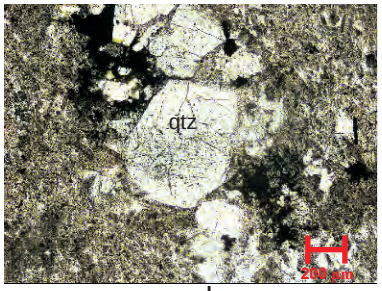
Summary

Moderate to strong color shift can be seen in qtz grains in this thin section going from an initial color ranging from bright to medium blue to a final color ranging from medium to dark blue. CL color of grains are inhomogeneous around large holes in grains (holes filled in with Canada balsam).

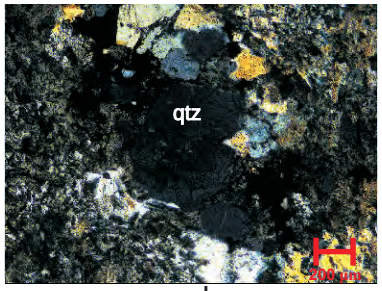
Sample

SV10 Rhyodacite, Ambelos, Samos Island, Greece

Grain #1



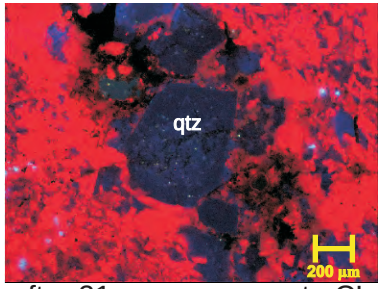
ppl



xpl

after 3 sec exposure to CL

after 12 sec exposure to CL

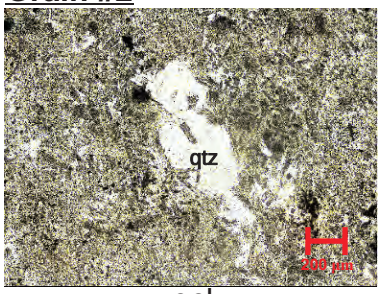


after 21 sec exposure to CL

Notes

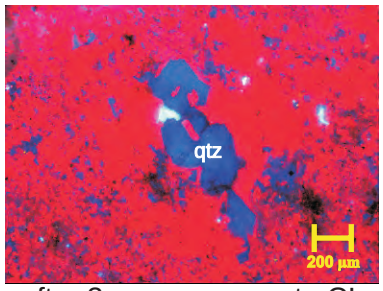
1) -strong color shift from bright blue at 3 sec exposure to CL to medium-dark blue at 21 sec exposure to CL, fractures appear dark in CL photos, slight color shift in groundmass from bright red to slightly darker red
2) -small light blue luminescent grains are feldspar
3) -unknown mineral inclusions (too small to identify), and also fluid inclusions are present in grain
4) -embayments and microfractures can be seen, grain is polycrystalline

Grain #2

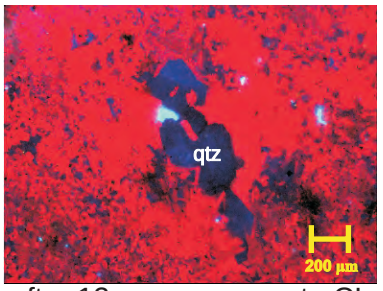


ppl

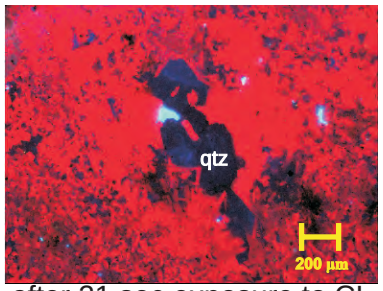
xpl



after 3 sec exposure to CL



after 12 sec exposure to CL



after 21 sec exposure to CL

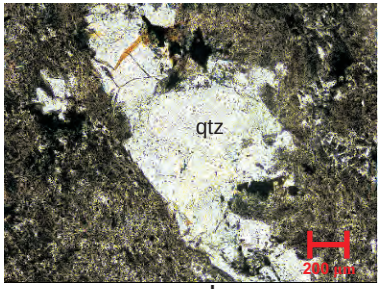
Notes

1) -strong color shift from inhomogeneous bright blue at 3 sec exposure to CL to inhomogeneous dark blue at 21 sec exposure to CL, slight color shift in groundmass from bright red to slightly darker red
2) -light blue luminescent mineral is feldspar
3) -altered biotite and altered feldspar mineral inclusions, and also fluid inclusions are present in grain
4) -embayments, a few cooling cracks (conchoidal fractures), and microfractures can be seen, grain is polycrystalline

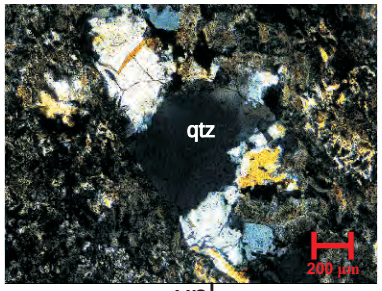
Sample

SV10 Rhyodacite, Ambelos, Samos Island, Greece

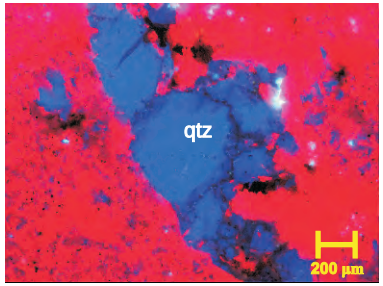
Grain #3



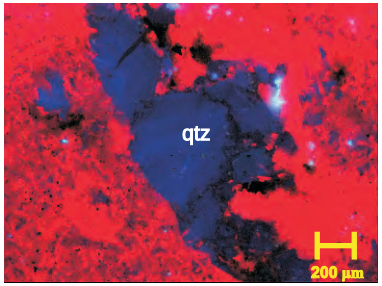
ppl



xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

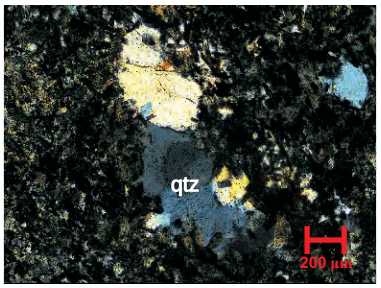
after 21 sec exposure to CL

Notes

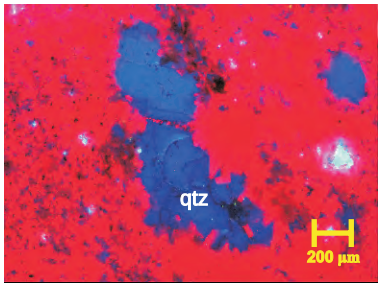
1) -strong color shift from inhomogeneous bright blue at 3 sec exposure to CL to inhomgeneous medium-dark blue at 21 sec exposure to CL, slight color shift in groundmass from bright red to slightly darker red
2) -light blue lluminescent grains are feldspar
3) -altered feldspar mineral inclusions and also fluid inclusions are present in grain
4) -embayments, a few cooling cracks (conchoidal fractures) and microfractures can be seen, grain is polycrystalline, sub-grain boundaries are sutured

Grain #4

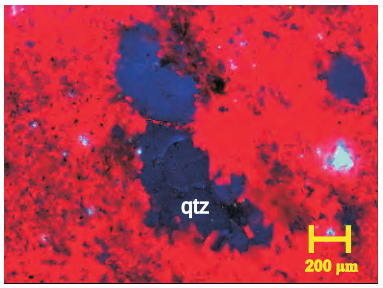
ppl



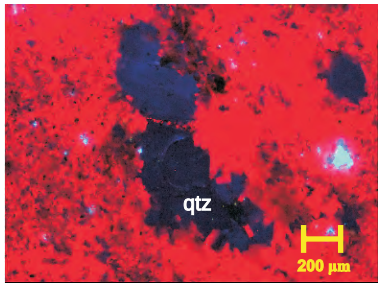
xpl



after 3 sec exposure to CL



after 12 sec exposure to CL



after 21 sec exposure to CL

Notes

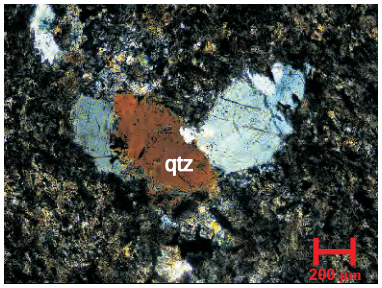
1) -strong color shift from slightly inhomogeneous looking bright blue at 3 sec exposure to CL to slightly inhomgeneous medium-dark blue at 21 sec exposure to CL, slight color shift in groundmass from bright red to sligthly darker red
2) -light blue luminescent grains are feldspar
3) -altered feldspar mineral inclusions and also fluid inclusions are present in grain
4) -embayments, a few cooling cracks (conchoidal fractures), and microfractures can be seen, grain is polycrystalline, sub-grain boundaries are not well defined

Sample

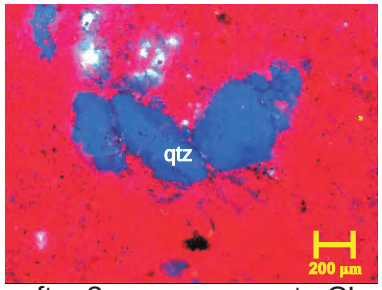
SV10 Rhyodacite, Ambelos, Samos Island, Greece

Grain #5

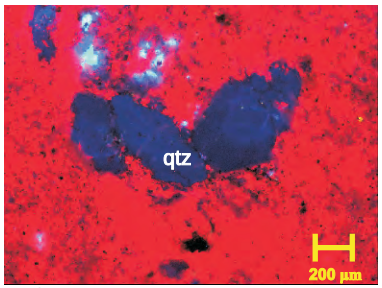
ppl



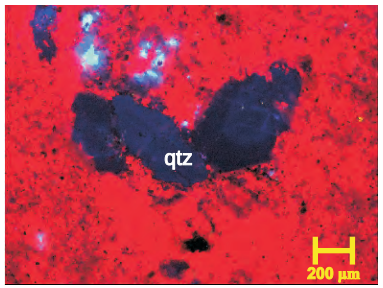
xpl



after 3 sec exposure to CL



after 12 sec exposure to CL



after 21 sec exposure to CL

Notes

1) -strong color shift from inhomogeneous bright blue at 3 sec exposure to CL to inhomogeneous medium-dark blue at 21 sec exposure to CL, slight color shift in groundmass from bright red to slightly darker red
2) -light blue luminescent grains are feldspar
3) -altered feldspar mineral inclusions and also fluid inclusions are present in grain
4) -embayments, a few cooling cracks (conchoidal fractures), and microfractures can be seen, grain is polycrystalline, sub-grain boundaries are sutured

Summary

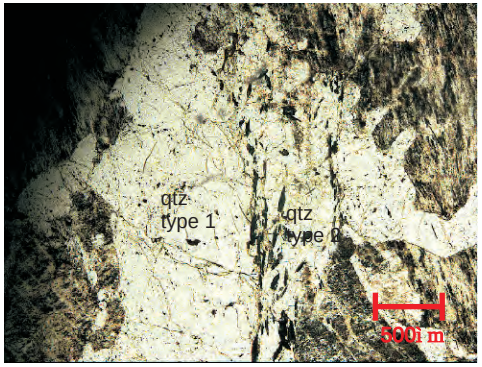
Strong color shift in qtz grains in this thin section going from an initial color of bright blue to a final color of medium-dark blue. Luminescence in qtz grains is inhomogeneous. Fractures appear dark in CL photos.

Aplites and Vein Quartz

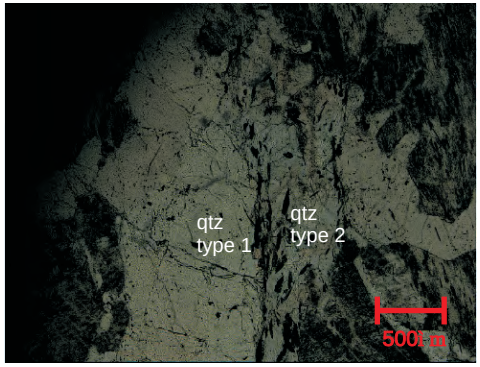
Sample

9811 Aplite, Beechville overpass, Highway 103, Halifax, NS

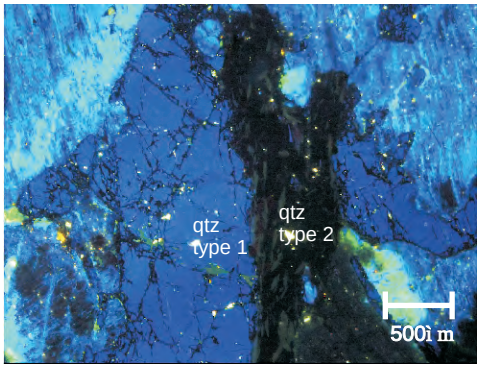
Grain #1



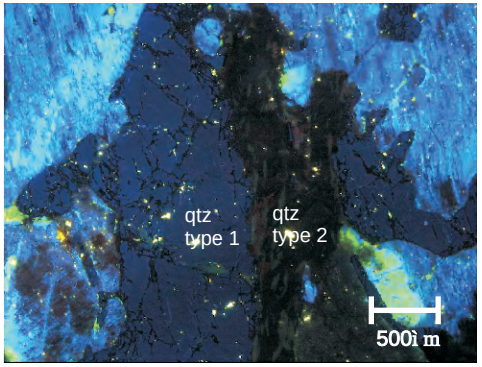
ppl



xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

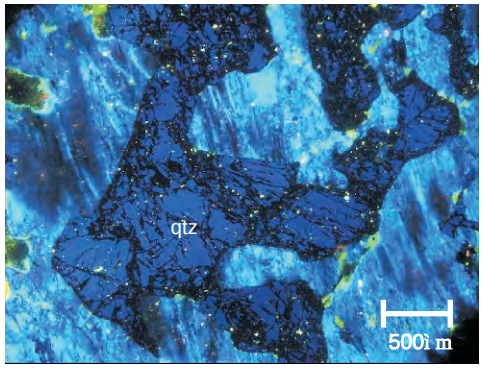
Notes

1) -two types or quartz: the first type exhibits a strong color shift from bright blue to medium-dark blue, the second type exhibits a slight colour shift an from inhomogeneous very dark color with medium-dark brown patches to an inhomogeneous very dark color with dark brown patches
2) -bright blue and bright green luminescent grains are feldspar, bright yellow luminescent grains are apatite, unknown brown luminescent mineral
3) -apatite mineral inclusions in the first type of quartz, fluid inclusions are present in grains
4) -embayments and microfractures can be seen, grains is monocrystalline

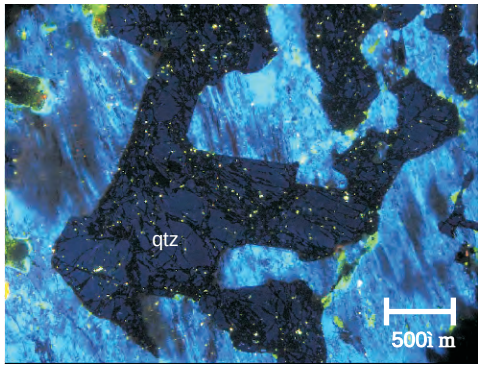
Grain #2

ppl

xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

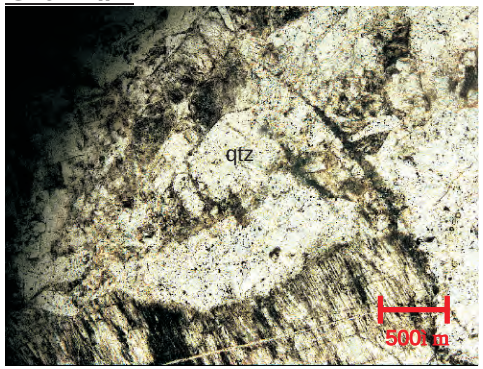
Notes

1) -strong color shift from bright blue to medium-dark blue, quartz is very fractured, fractures are not luminescent
2) -bright blue and bright green luminescent grains are feldspar, bright yellow luminescent grains are apatite, unknown brown luminescent mineral
3) -apatite mineral inclusions and also fluid inclusions present in grain
4) -embayments and microfractures can be seen, grain is monocrystalline

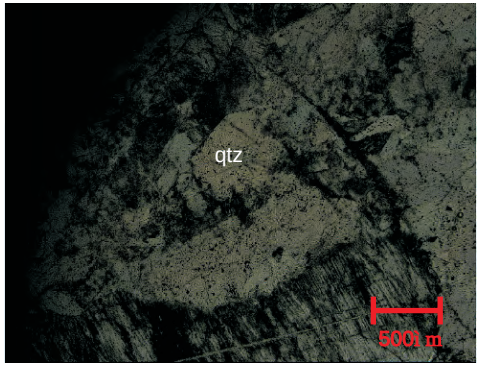
Sample

9812 Aplite, Beechville overpass, Highway 103, Halifax, NS

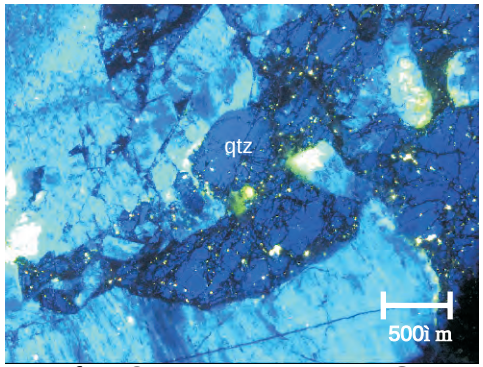
Grain #1



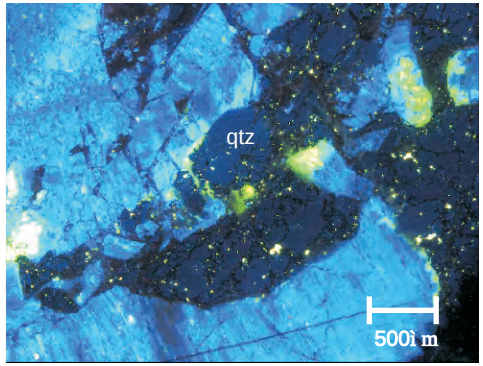
ppl



xpl



after 3 sec exposure to CL

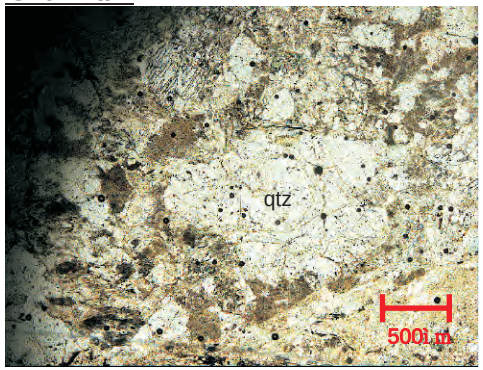


after 12 sec exposure to CL

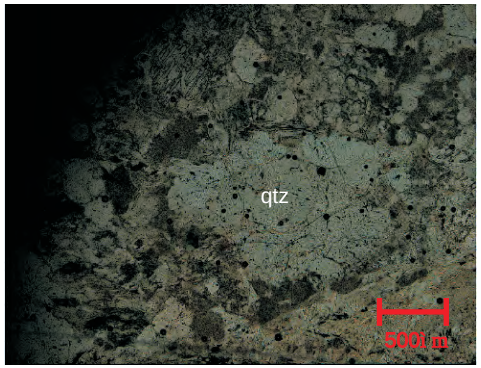
Notes

1) -moderate color shift from bright blue at 3 sec exposure to CL to medium-dark blue at 12 sec exposure to CL, quartz is very fractured, microfractures are not luminescent
2) -bright light blue and bright green luminescent grains are feldspar, yellow luminescent grains are apatite
3) -apatite, chlorite and tourmaline mineral inclusions and also fluid inclusions are present in grains
4) -microfractures can be seen, grain has irregular grain margins and is monocrystalline

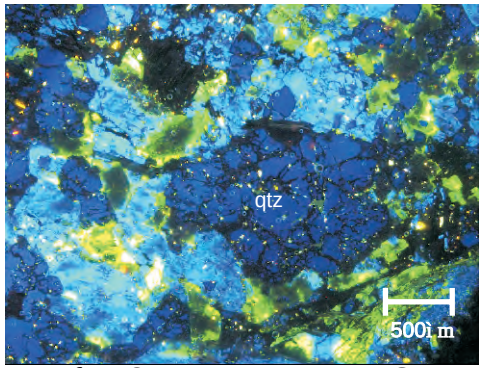
Grain #2



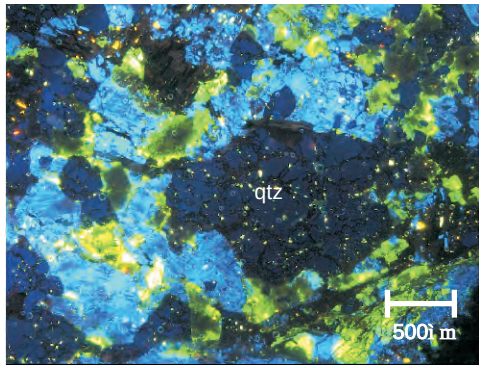
ppl



xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

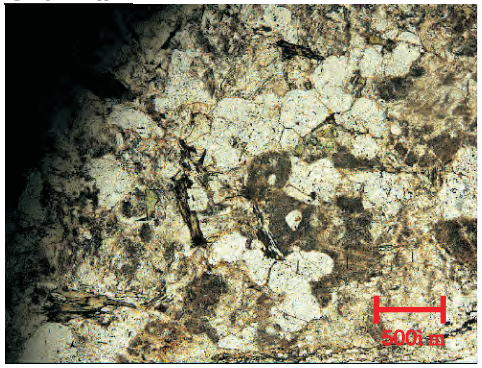
Notes

1) -strong color shift from bright-medium blue at 3 sec exposure to CL to medium-dark blue at 12 sec exposure to CL, quartz is very fractured, microfractures are not luminescent
2) -bright light blue and bright green luminescent grains are feldspar, yellow luminescent grains are apatite
3) -apatite and chlorite mineral inclusions and also fluid inclusions are present in grains
4) -microfractures can be seen, grain is monocrystalline and has irregular grain margins

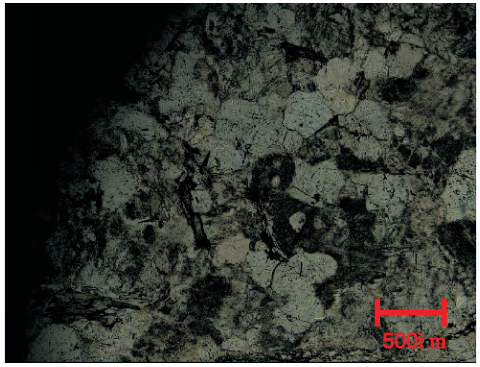
Sample

9813 Aplite, Beechville overpass, Highway 103, Halifax, NS

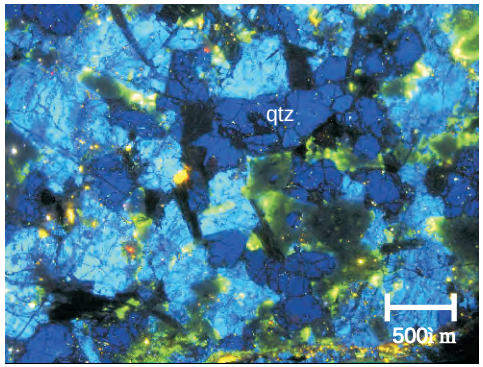
Grain #1



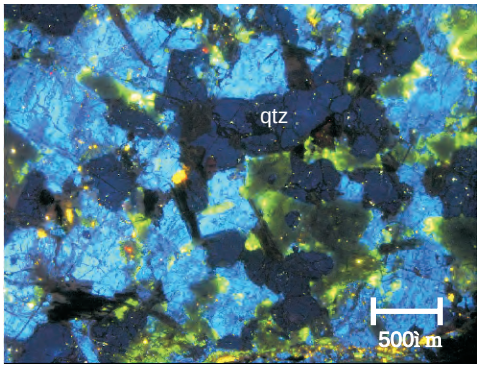
ppl



xpl



after 3 sec exposure to CL

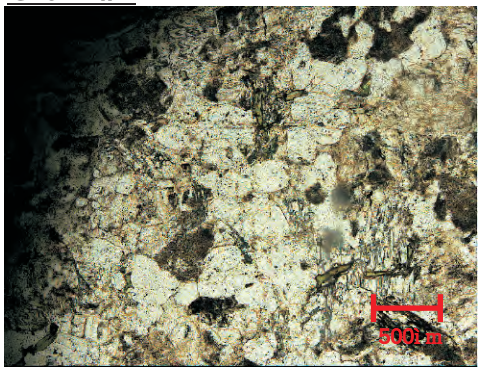


after 12 sec exposure to CL

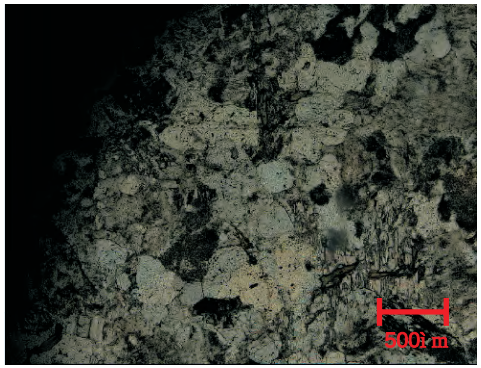
Notes

1) -moderate color shift from an initial color of bright-medium blue to a final color of medium-dark blue, quartz grains are very fractured, microfractures are not luminescent
2) -bright green and bright light blue luminescent grains are feldspar, bright yellow luminescent grains are apatite
3) -apatite and chlorite mineral inclusions, and also fluid inclusions are present in grains
4) -microfractures can be seen, grain is polycrystalline

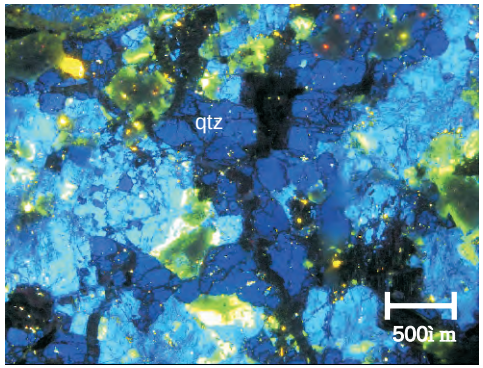
Grain #2



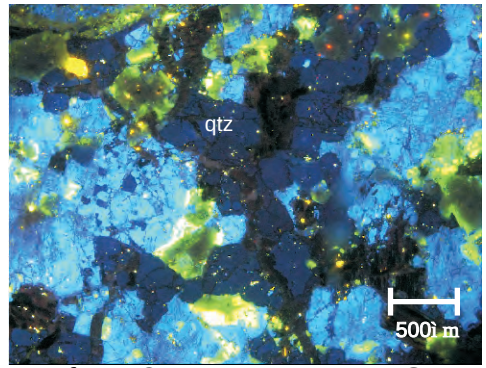
ppl



xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

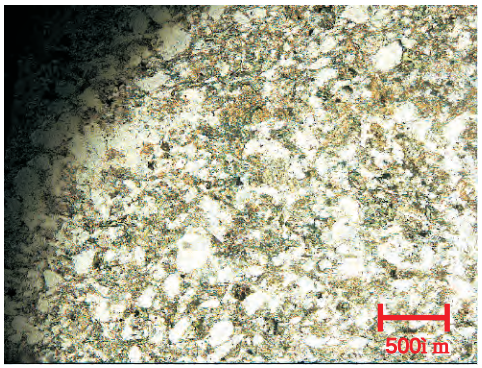
Notes

1) -moderate color shift from an initial color of bright-medium blue to a final color of medium-dark blue
2) -bright green and blue luminescent grains are feldspar, bright yellow luminescent grains
3) -apatite and chlorite mineral inclusions, and also fluid inclusions are present in grains
4) -microfractures can be seen, grain is polycrystalline

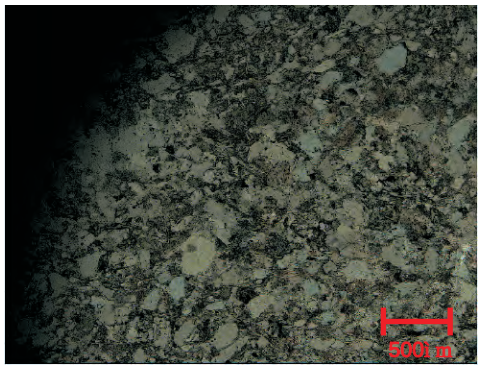
Sample

9814 Quartz Vein, Kearney Lake Road, Halifax, NS

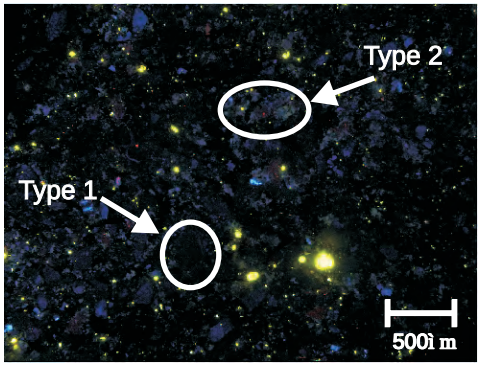
Grain # 1



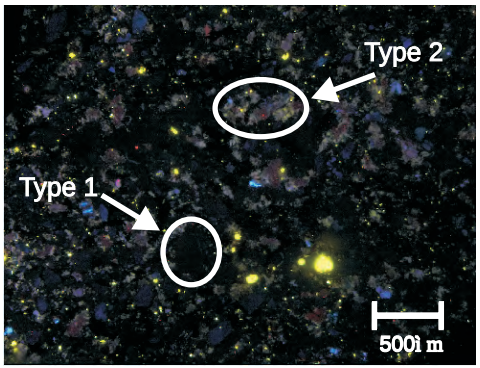
ppl



xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

Notes

1)-two types of quartz grains in sediment: type 1 exhibits a moderate color shift from bright-medium blue at 3 sec exposure to CL to medium-dark blue at 12 sec exposure to CL, type 2 exhibits a moderate color shift from inhomogeneous medium blue at 3 sec exposure to CL to medium greyish brown at 12 sec exposure to CL

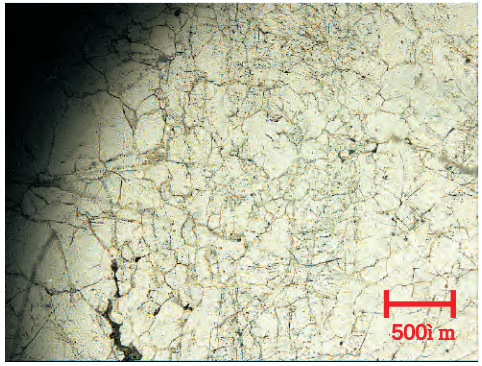
2) -bright light blue luminescent grains are feldspar, bright yellow luminescent grains are apatite

3) -inclusions of tourmaline and also fluid inclusions are present in grains

4) -grains are either monocrystalline or polycrystalline and have either irregular or rounded grain margins

5) -grains with more irregular grain boundaries have a color shift from medium-dark blue to brown, rounded grain have a color shift from medium to medium-dark blue

Grain # 2



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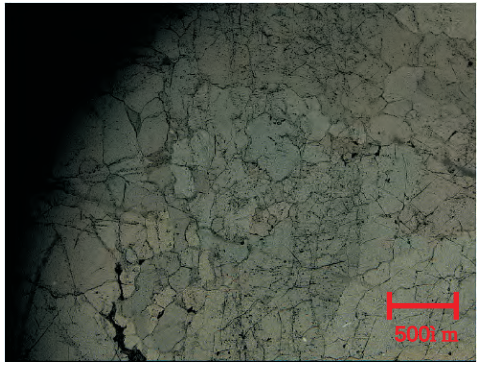

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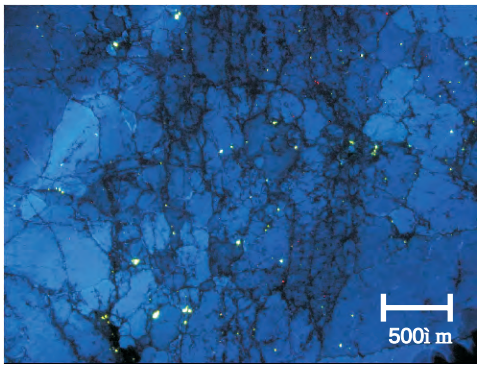
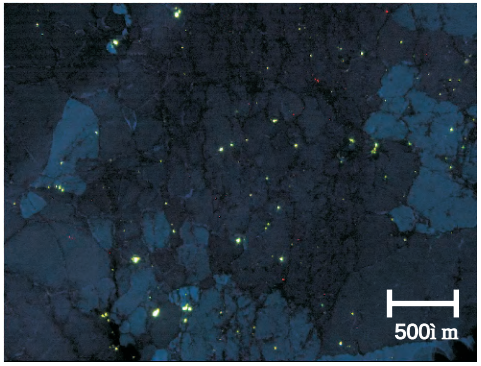


after 3 sec exposure to CL



after 12 sec exposure to CL

Notes

1) -strong color shift from and initial color of bright blue at 3 sec exposure to CL to medium blue & medium-dark blue after 12 sec exposure to CL, CL color is inhomogeneous (patchy), abundant fractures in grain also causes inhomogenous CL color

2) -bright yellow luminescent mineral is apatite

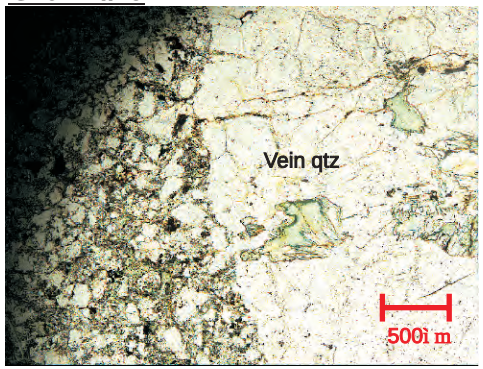
3) -inclusions of apatite are present in grains

4) -grain is very fractured

Sample

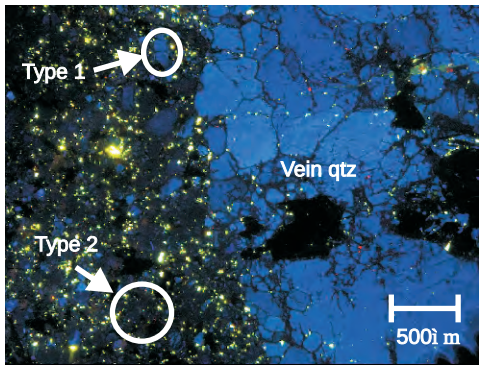
9814 Quartz Vein, Kearney Lake Road, Halifax, NS

Grain # 3

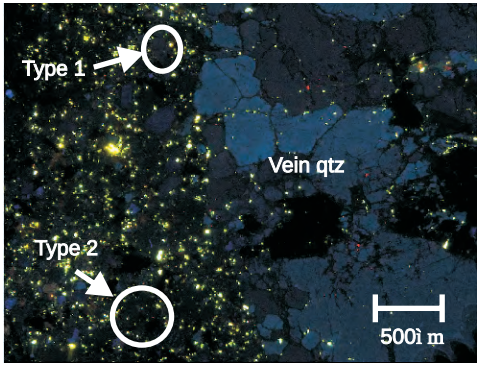


ppl

xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

Notes

1) -strong color shift in vein quartz from an initial color of inhomogenous bright blue at 3 sec exposure to a final color of inhomogeneous medium and medium-dark blue (patchy CL color) at 12 seconds exposure. There are two types of quartz grains in sediment: type 1 exhibits a moderate color shift from bright-medium blue at 3 sec exposure to CL to medium-dark blue at 12 sec exposure to CL, type 2 exhibits a moderate color shift from inhomogeneous medium blue at 3 sec exposure to CL to medium dark blue at 12 sec exposure to CL

3) -mineral inclusions of apatite and chlorite, and also fluid inclusions are present in grains

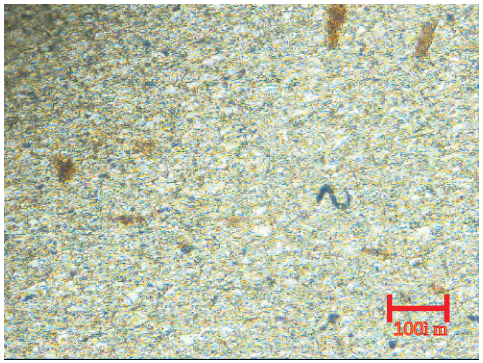
4) -quartz grains are fractured

5) -grains with more irregular grain boundaries have a darker initial CL color than grains with rounded grain boundaries

Sample

9815 Quartz Vein, Highway 101, Upper Sackville, NS

Grain #1



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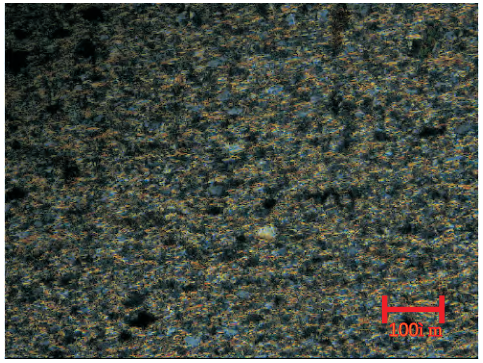
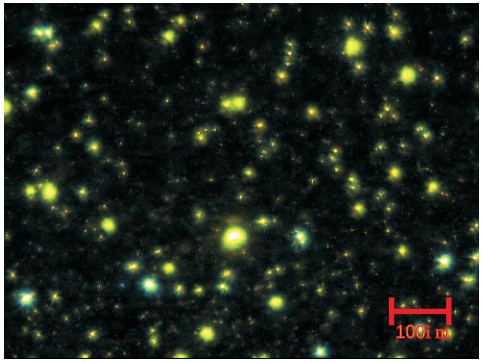
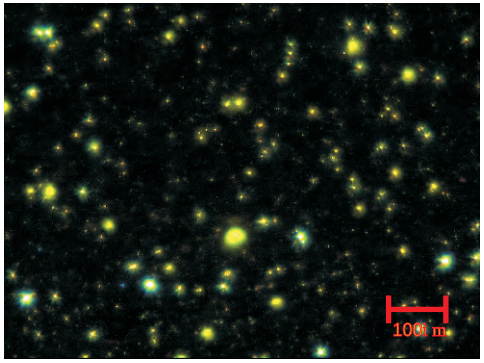


xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

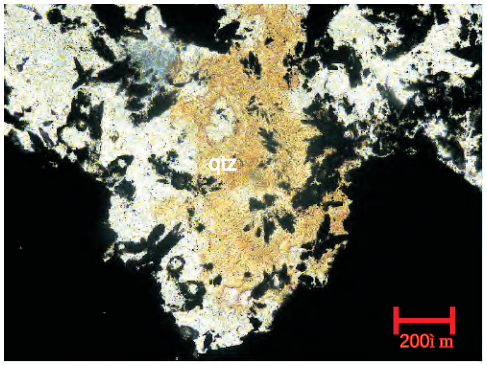
Notes

1) - slight color shift from an initial color of brown at 3 sec exposure to CL to a final color of dark brown at 12 sec exposure to CL
2) -bright yellow luminescent grains are apatite
3) -grains contain fluid inclusions
4) -grains are too small to easily identify physical features

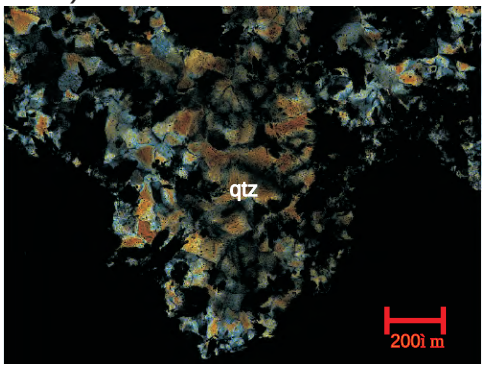
Sample

8237 Quartz Vein, Gerrish Mountain Magnetite Mine, Economy, NS

Grain #1 (quartz cluster in magnetite ore)



ppl



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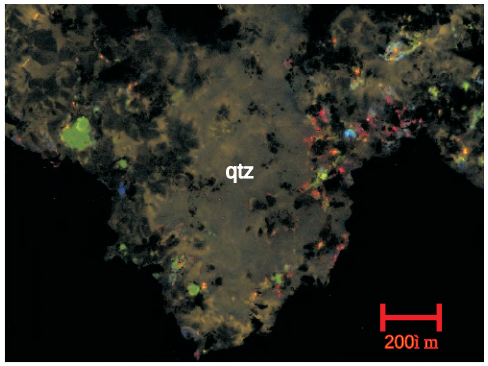
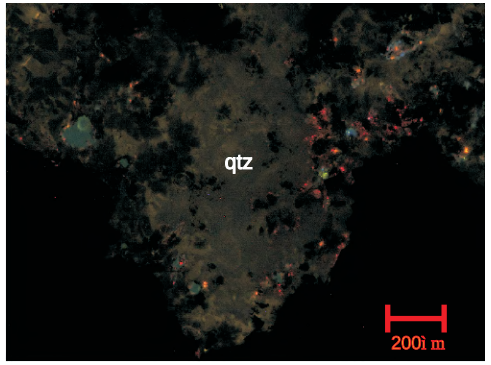


after 3 sec exposure to CL

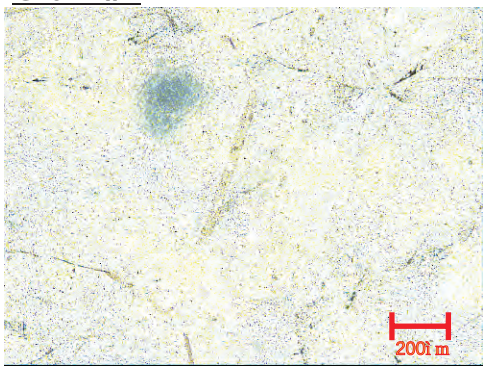


after 12 sec exposure to CL

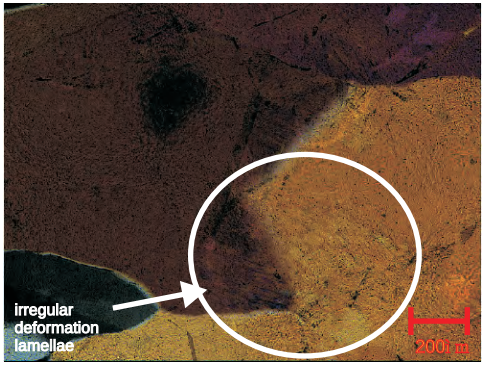
Notes

1) -slight color shift from inhomogeneous light olive green/brown at 3 sec exposure to CL to inhomogeneous medium olive greenish grey at 12 sec exposure to CL
2) -unknown mineral with green luminescence, blue luminescent grain is qtz, unknown mineral with red luminescence (carbonate?)
3) -mineral inclusions of magnetite, and also fluid inclusion are present in grains
4) -embayments can be seen, fabric of grains appears oriented (looks like a feather)

Grain #2



ppl



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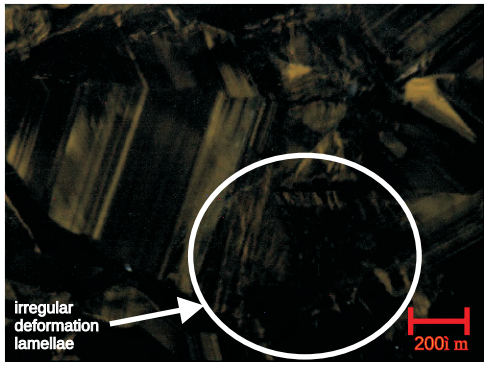
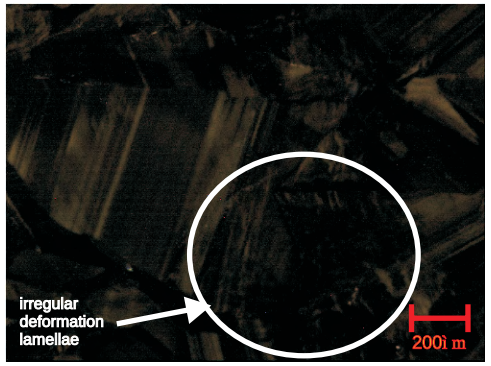


after 3 sec exposure to CL



after 12 sec exposure to CL

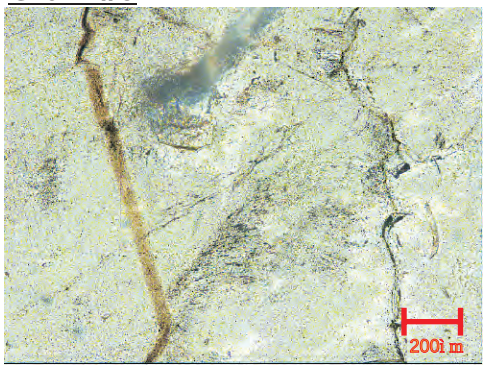
Notes

1) -slight color shift from light-medium olive green/brown at 3 sec exposure to CL to medium olive green brown at 12 sec exposure to CL, sector zoning can be seen in CL photos that could not be seen under xpl, individual grains have different CL colors
2) -only qtz present in photos therefore no other CL colors can be seen
3) -fluid inclusions are present in grains
4) -irregular deformation lamellae can be seen under xpl

Sample

8237 Quartz Vein, Gerrish Mountain Magnetite Mine, Economy, NS

Grain #3



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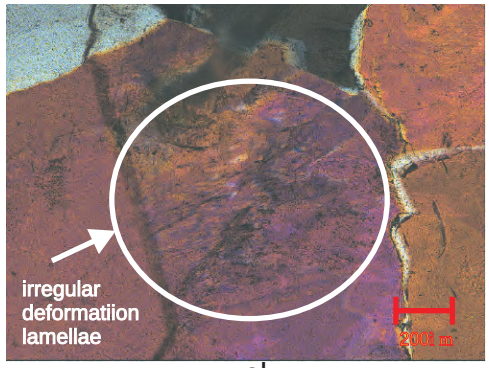
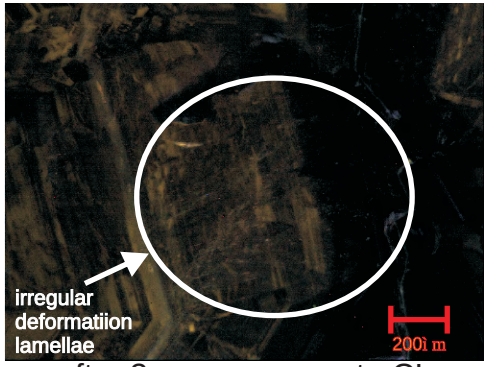
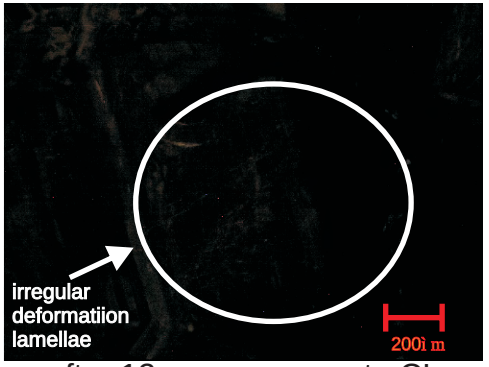


xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

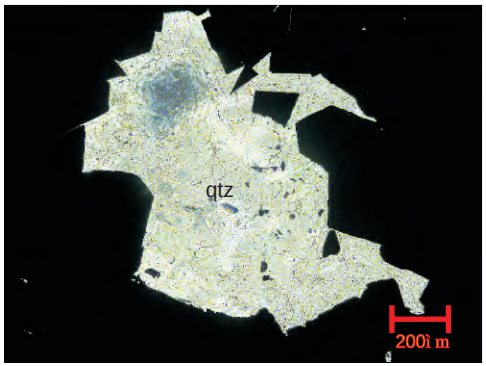
Notes

1) -moderate color shift from an initial color of light-medium olive green/brown with a few blue zones at 3 sec exposure to CL to a final color of medium-dark olive green/brown with blue zones shifted to brown at 12 sec exposure to CL, sector zoning can be seen in CL photos that could not be seen under ppl or xpl

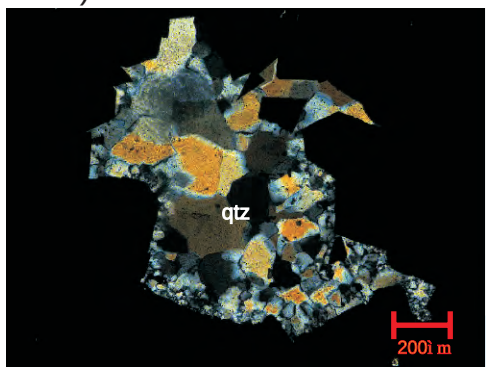
3) -fluid inclusions are present in grains

4) -embayments, a few small microfractures, and irregular deformation lamellae can be seen (seen xpl and CL photomicrographs)

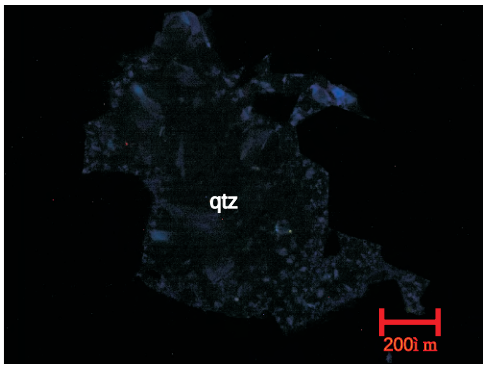
Grain #4 (quartz cluster in magnetite ore)



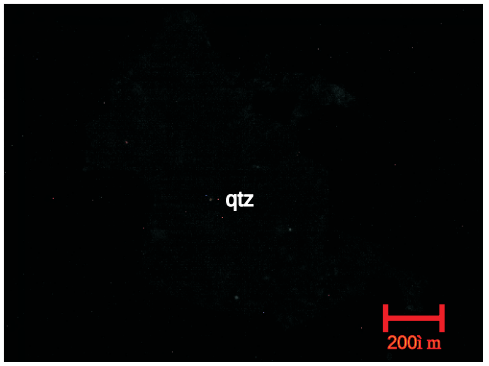
ppl



xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

Notes

1) -strong color shift from a mixture of inhomogeneous medium at 3 sec exposure to CL to inhomogeneous dark blue at 12 sec exposure to CL, individual grains have different CL colors

2) -non-luminescent area is composed of magnetite

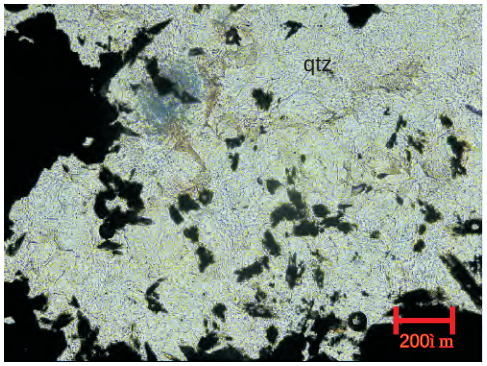
3) -mineral inclusions of magnetite, and also fluid inclusions are present in grain

4) -embayments can be seen, quartz filling intergranular space

Sample

8237 Quartz Vein, Gerrish Mountain Magnetite Mine, Economy, NS

Grain #5 (quartz cluster in magnetite ore)



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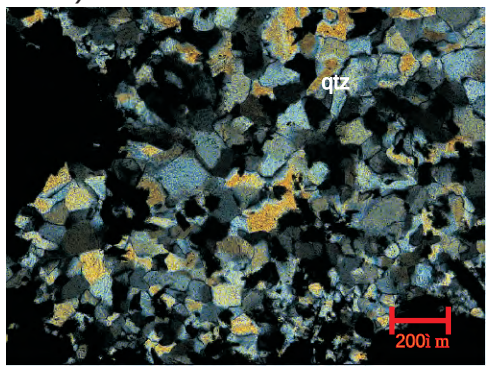
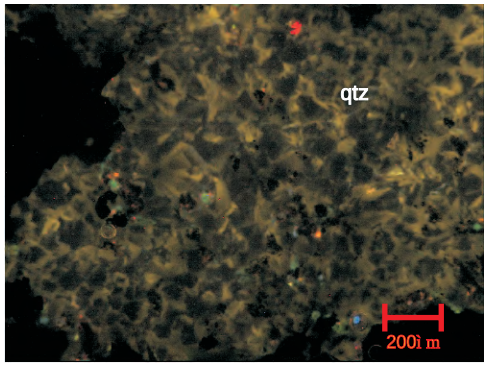
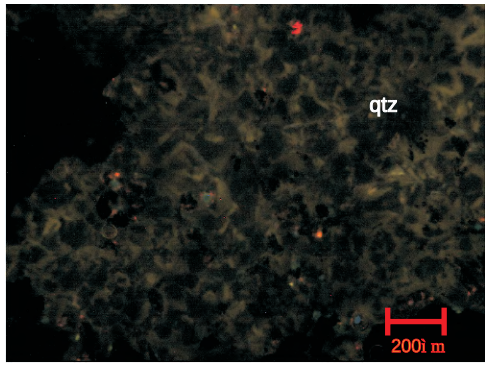


xpl



after 3 sec exposure to CL



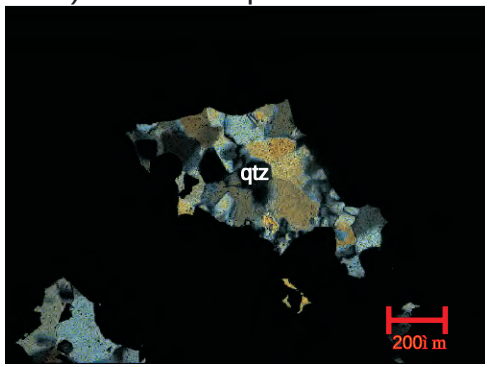
after 12 sec exposure to CL

Notes

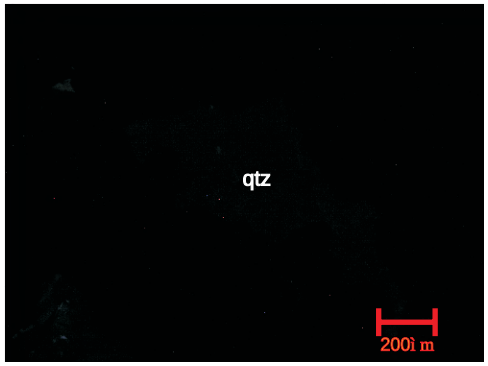
1) -moderate color shift from inhomogeneous light-medium olive green/brown at 3 sec exposure to CL to inhomogeneous medium-dark olive green brown at 12 sec exposure to CL, individual qtz grains have different CL colors
2) -unknown blue, red, green, and orange/yellow luminescent mineral inclusions (some may be epoxy or debris from polishing?)
3) -magnetite grains included among qtz grains in cluster, fluid inclusions present in grains
4) -embayments and microfractures can be seen, quartz filling intergranular space

Grain #6 (quartz cluster in magnetite ore) -second exposure to CL beam

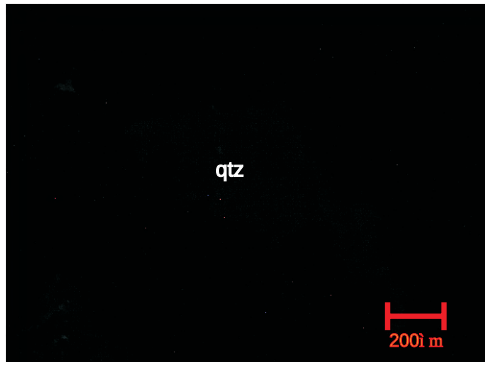
ppl



xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

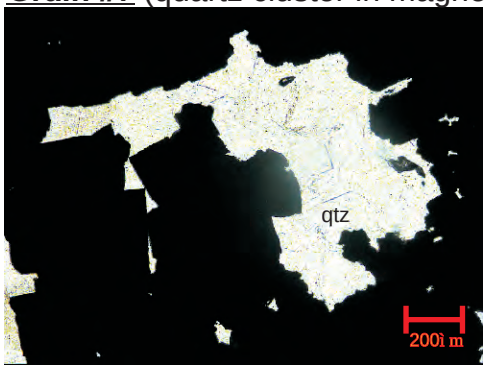
Notes

1) -no color shift, grain to close to grain#4 and so had previously been exposed to CL beam, grains exhibit dark blue luminescence
2) -non-luminescent areas are magnetite
3) -magnetite grains included among qtz grains in cluster, fluid inclusions present in grains
4) -embayments and microfractures can be seen, quartz filling intergranular space

Sample

8237 Quartz Vein, Gerrish Mountain Magnetite Mine, Economy, NS

Grain #7 (quartz cluster in magnetite ore)



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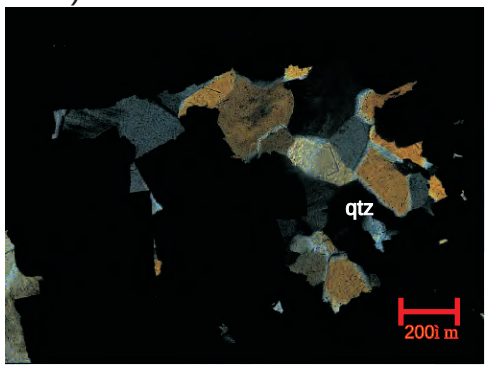

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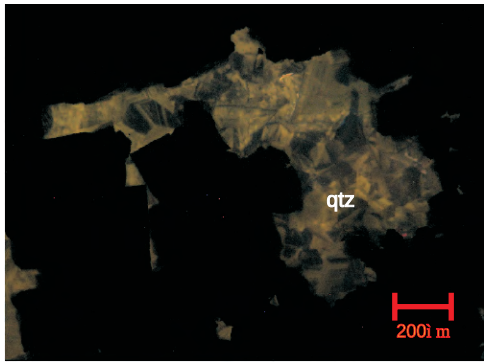
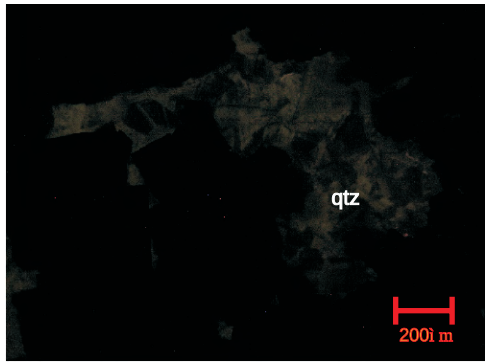


after 3 sec exposure to CL

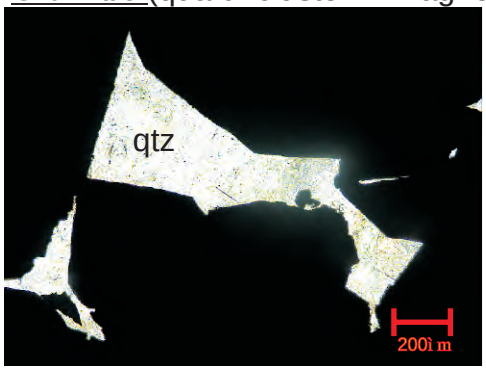


after 12 sec exposure to CL

Notes

1) -moderate color shift from an initial color of inhomogeneous light-medium olive green/brown at 3 sec exposure to CL to a final color of inhomogeneous medium-dark olive green/brown at 12 sec exposure to CL, sector zoning can be seen in CL photomicrographs that could not be seen in ppl or xpl photomicrographs, individual qtz grains have different CL colors
2) -non-luminescent areas are composed of magnetite
3) -magnetite grains included among qtz grains in cluster, fluid inclusions present in grains
4) -embayments and also deformation lamellae can be seen (deformation lamellae seen under xpl), quartz filling intergranular space

Grain #8 (quartz cluster in magnetite ore)



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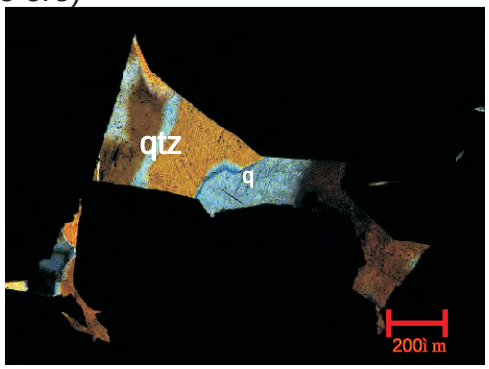

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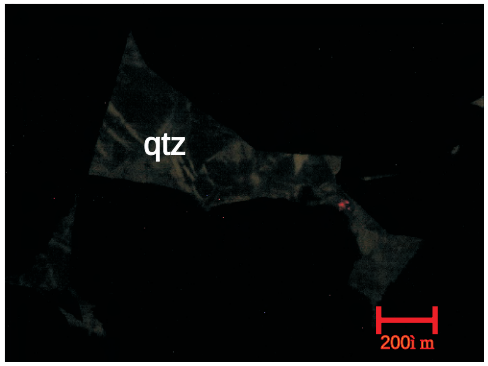


after 3 sec exposure to CL

after 12 sec exposure to CL

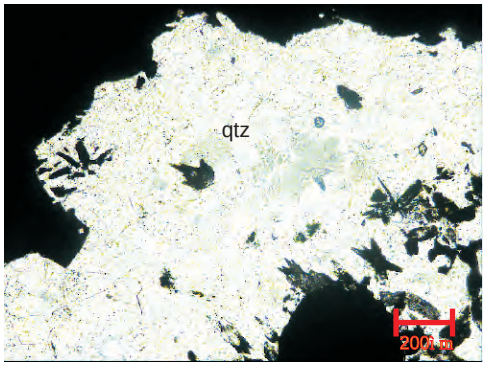
Notes

1) -slight color shift from an initial color of inhomogeneous medium olive green/brown at 3 sec exposure to CL to a final color of inhomogeneous medium-dark olive green/brown at 12 sec exposure to CL, sector zoning can be seen in CL photomicrographs that could not be seen in ppl or xpl photomicrographs, individual grains have different CL colors
2) -non-luminescent areas are composed of magnetite
3) -magnetite mineral inclusions, and also fluid inclusions present in grains
4) -embayments and a few small microfractures can be seen, quartz filling intergranular space

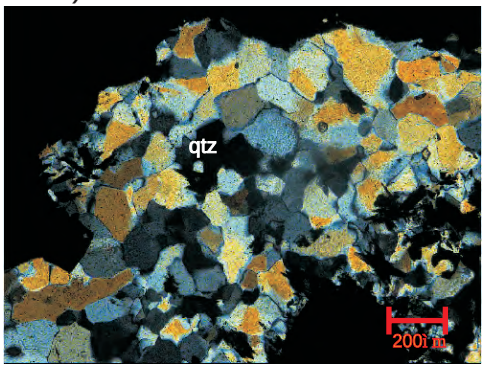
Sample

8237 Quartz Vein, Gerrish Mountain Magnetite Mine, Economy, NS

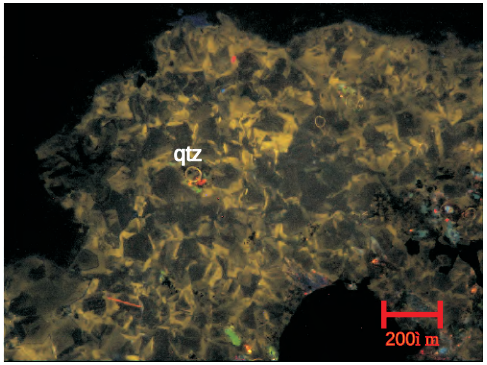
Grain #9 (quartz cluster in magnetite ore)



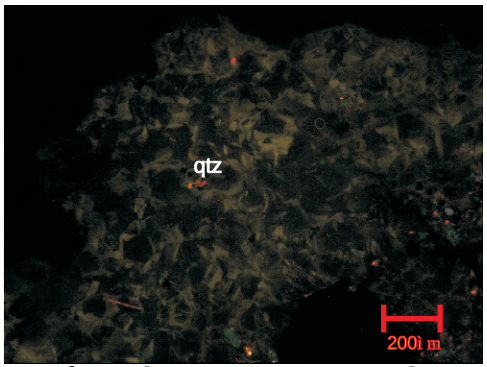
ppl



xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

Notes

1) -moderate color shift from inhomogeneous light olive green/brown to inhomogeneous medium olive green/brown, individual mineral grains have different CL colors
2) -unknown red (carbonate?), and green (epoxy?) luminescent mineral inclusions
3) -mineral inclusions of magnetite, and also fluid inclusions present in grains
4) -embayments can be seen, some grain margins are not well defined, quartz filling intergranular space

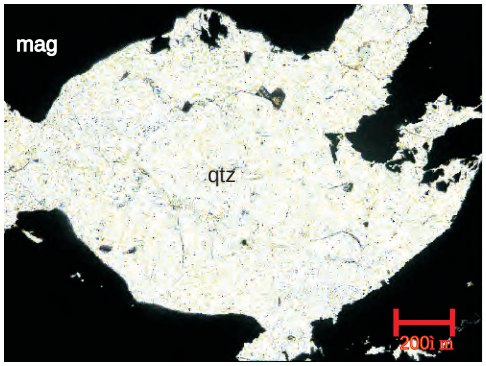
Summary

Color shift ranges from slight to moderate in qtz grains in this thin section. Initial colors range from light to medium olive green/brown, and also bright blue while final colors range from medium to dark olive green/brown, and also dark blue. Two generations of quartz are present in this thin section; one with olive green/brown luminescence, and one with blue luminescence. Deformation lamellae can be seen in some CLphotomicrographs that could not be seen in ppl or xpl photomicrographs. All CL colors of qtz in this thin section are inhomogeneous.

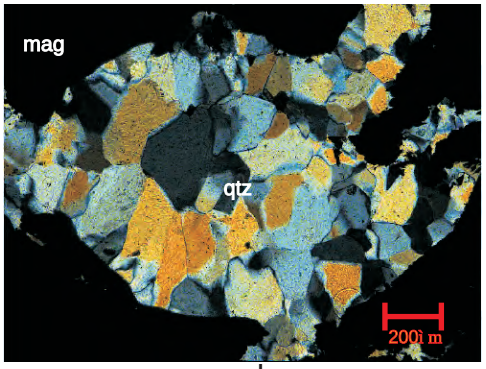
Sample

8242 Quartz Vein, Gerrish Mountain Magnetite Mine, Economy, NS

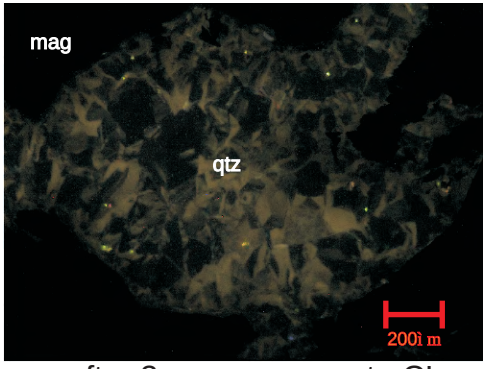
Grain #1 (quartz cluster in magnetite ore)



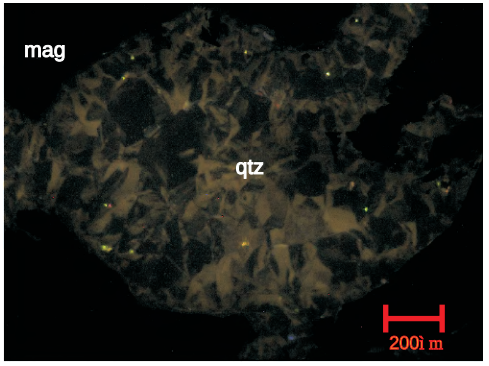
ppl



xpl



after 3 sec exposure to CL

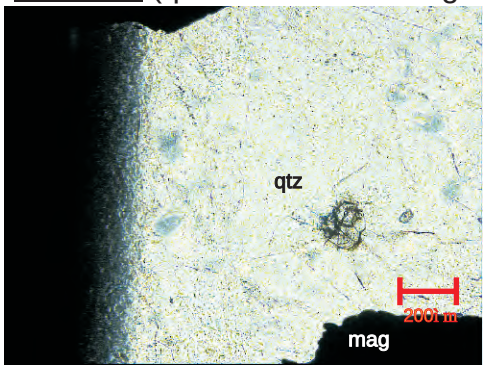


after 12 sec exposure to CL

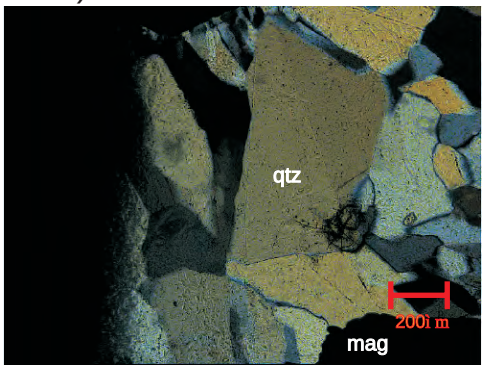
Notes

1) -no visible color shift between 3 sec and 12 sec exposure to CL, luminescence of qtz is medium olive green/brown, individual grains have different CL colors
2) -a few bright green luminescent mineral inclusions can be seen, non-luminescent areas surrounding qtz grains is magnetite
3) -mineral inclusion of magnetite and also fluid inclusions present in grains
4) -embayments and a few microfractures can be seen, some microfractures are conchoidal, quartz filling intergranular space

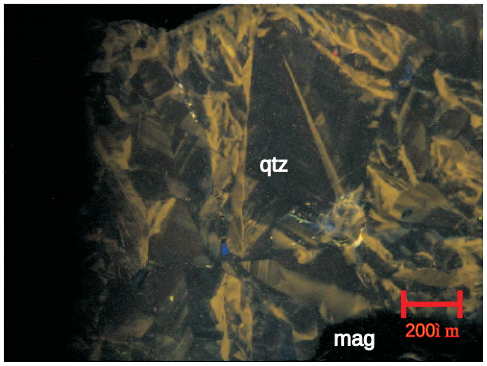
Grain #2 (quartz cluster in magnetite ore)



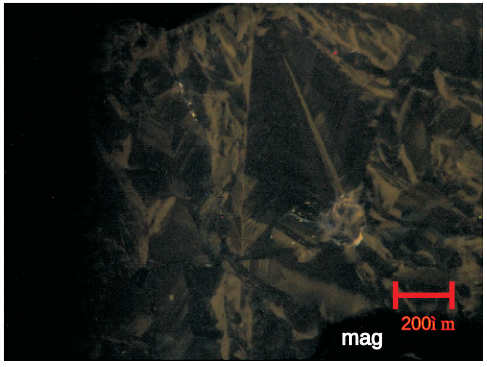
ppl



xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

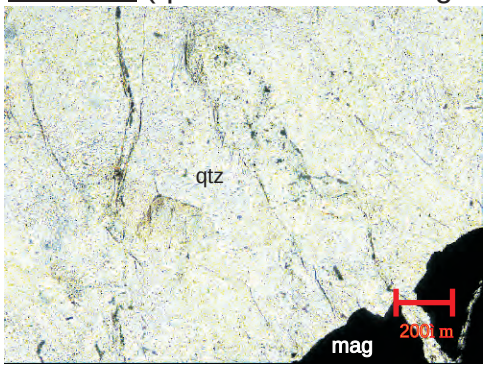
Notes

1) -moderate color shift from inhomogeneous light-medium olive green/brown with a few bright blue grains at 3 sec exposure to CL to inhomogeneous medium-dark olive green/brown, small grains with an initial color of bright blue grains have a final color of brown at 12 sec exposure to CL, individual qtz grains have different CL colors, sector zoning can be seen in CL photomicrographs that could not be seen in ppl or xpl photomicrographs
2) -non-luminescent area in the bottom right corner of CL photos is composed of magnetite
3) -fluid inclusions present in grains
4) -embayments and a few microfractures can be seen, quartz filling intergranular space

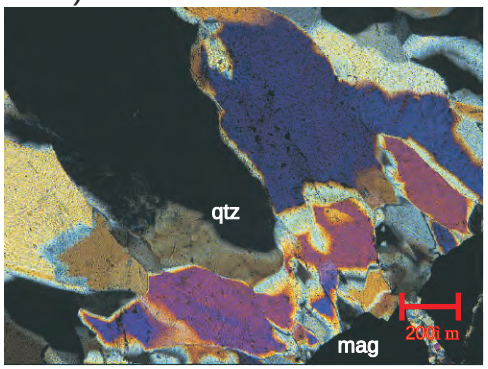
Sample

8242 Quartz Vein, Gerrish Mountain Magnetite Mine, Economy, NS

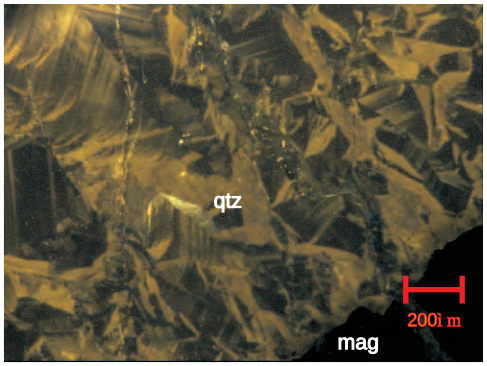
Grain #3 (quartz cluster in magnetite ore)



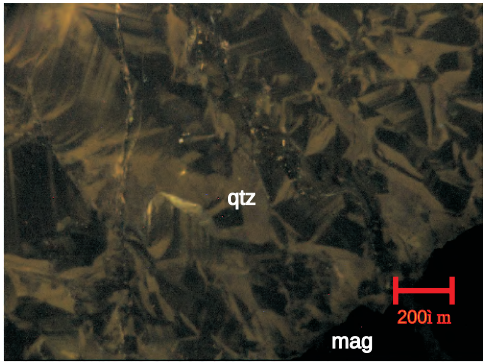
ppl



xpl



after 3 sec exposure to CL

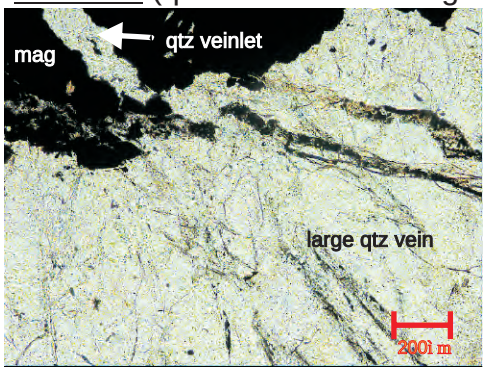


after 12 sec exposure to CL

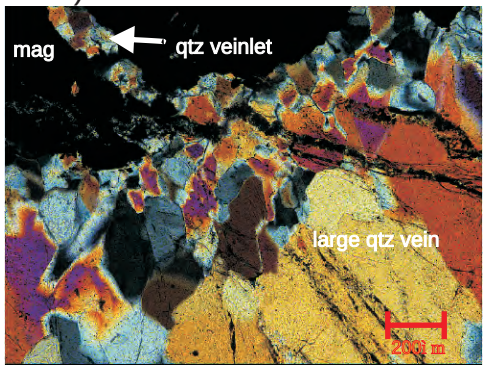
Notes

1) -moderate color shift from inhomogenous light olive green/brown at 3 sec exposure to CL to inhomogenous medium olive green/brown at 12 sec exposure to CL, sector zoning can be seen in CL photomicrographs that could not be seen ppl or xpl photomicrographs
2) -non-luminescent areas in the bottom right hand corner of CL photos is magnetite
3) -fluid inclusions present in grains
4) -embayments and a few microfractures can be seen, individual grain margins are not well defined

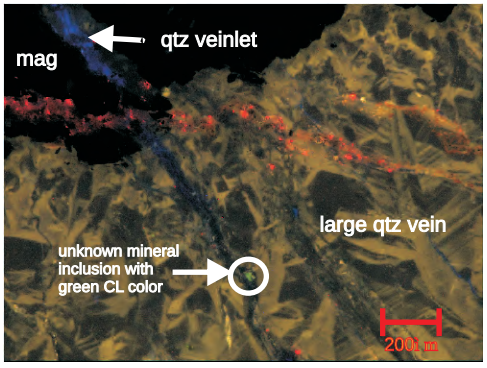
Grain #4 (quartz cluster in magnetite ore)



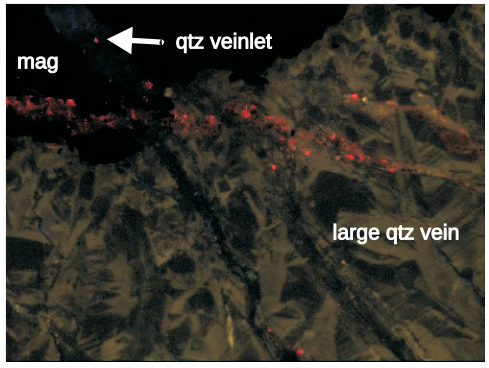
ppl



xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

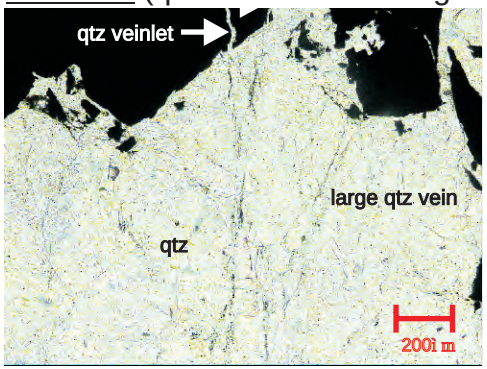
Notes

1) -moderate color shift in qtz in larger vein from inhomogenous light-medium olive green/brown at 3 sec exposure to CL to inhomogenous medium-dark olive green/brown at 12 sec exposure to CL, sector zoning can be seen in CL photomicrographs that could not be seen in ppl or xpl photomicrographs, strong color shift in qtz veinlet from bright blue at 3 sec exposure to CL to dark blue at 12 sec exposure to CL
2) -unknown red luminescent vein (could be dirt containing lead and iron, or epoxy, as per SEM testing), unknown green luminescent mineral
3) -fluid inclusions present in grains
4) -embayments and microfractures can be seen, individual grain margins are not well defined

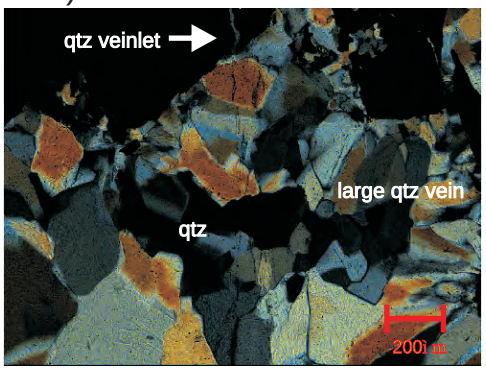
Sample

8242 Quartz Vein, Gerrish Mountain Magnetite Mine, Economy, NS

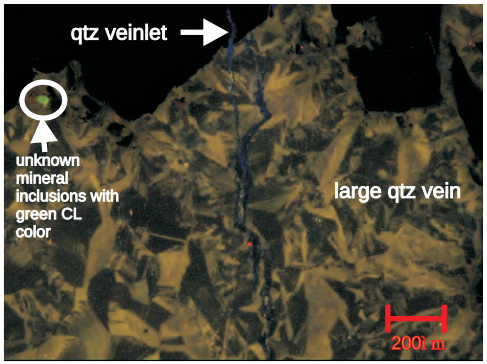
Grain #5 (quartz cluster in magnetite ore)



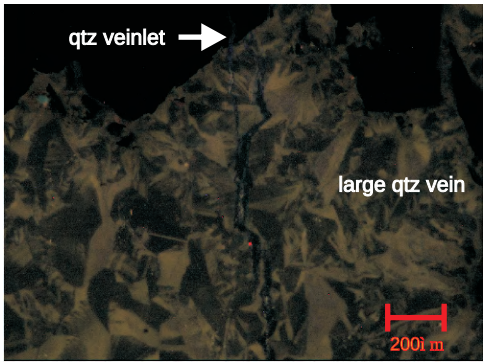
ppl



xpl



after 3 sec exposure to CL

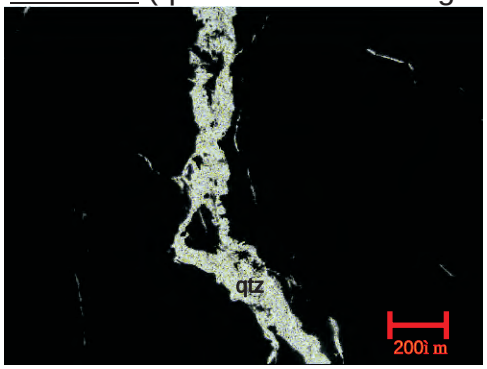


after 12 sec exposure to CL

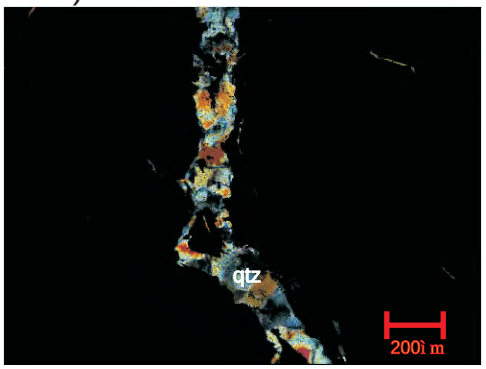
Notes

1) -moderate color shift from inhomogeneous light-medium olive green/brown at 3 sec exposure to CL to inhomogeneous medium-dark olive green/brown at 12 sec exposure to CL in qtz in larger vein, strong color shift in veinlet from bright blue at 3 sec exposure to CL to medium-dark blue at 12 sec exposure to CL, individual grains have different CL colors
2) -a few very small red luminescent inclusions (calcite?), and an unknown green luminescent mineral grain can be seen
3) -fluid inclusions present in grain
4) -embayments can be seen, quartz filling intergranular space, individual grain margins not well defined

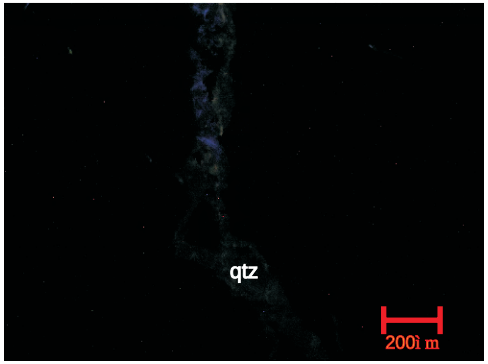
Grain #6 (quartz cluster in magnetite ore)



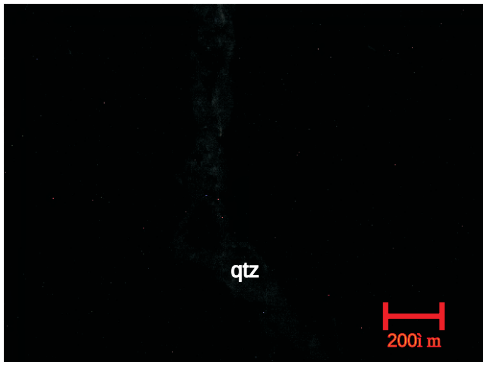
ppl



xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

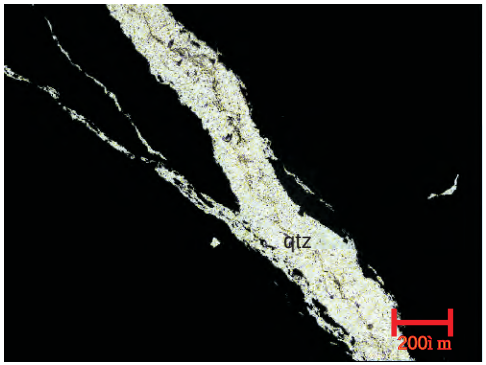
Notes

1) -moderate color shift from a mixture of medium blue and dark olive green/brown at 3 sec exposure to CL to a mixture of dark blue and dark olive green/brown at 12 sec exposure to CL, individual grains have different CL colors
2) -non-luminescent areas are composed of magnetite
3) -mineral inclusions of magnetite in quartz veinlet, fluid inclusions present in grains
4) -irregular grain margins can be seen, individual grains margins not well defined

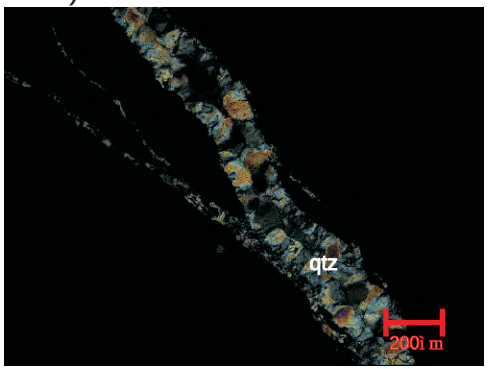
Sample

8242 Quartz Vein, Gerrish Mountain Magnetite Mine, Economy, NS

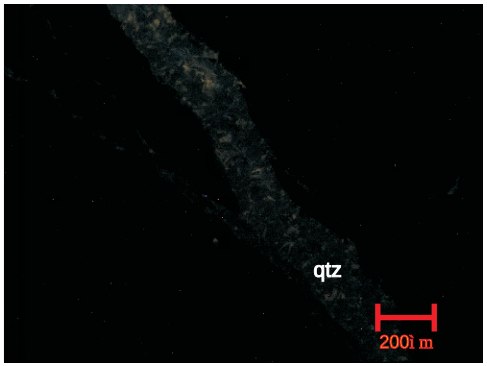
Grain #7 (quartz cluster in magnetite ore)



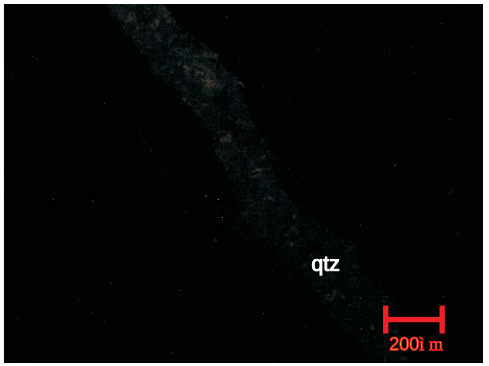
ppl



xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

Notes

1) -slight color shift from inhomogeneous dark olive green/brown at 3 sec exposure to CL to inhomogeneous very dark olive green brown at 12 sec exposure to CL, individual qtz grains have different CL colors
2) -non-luminescent areas are composed of magnetite
3) -magnetite grains included in quartz vein, also fluid inclusions can be seen
4) -embayments can be seen, individual grain margins are not well defined
5) -CL photomicrographs have been altered in order to see luminescence, quartz grains are less luminescent than they appear

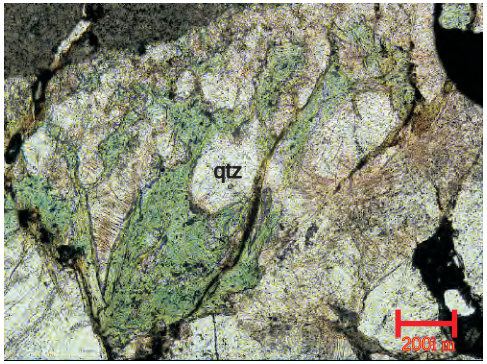
Summary

Color shift in qtz in this sample ranges from no color shift to a strong color shift. In the larger veins, the initial color or qtz ranges from light to dark olive green/brown, whereas final colors range from medium to very dark olive green/brown. Qtz in the very small veins (veinlets) has an initial color of bright blue and a final color of medium-dark blue, or brown. The CL color of all qtz in this thin section is inhomogenious.

Sample

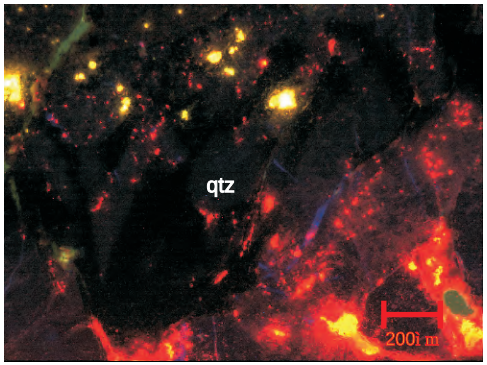
8053A Quartz Vein, Boyd Brook, near Bass River of Five Islands, NS

Grain #1

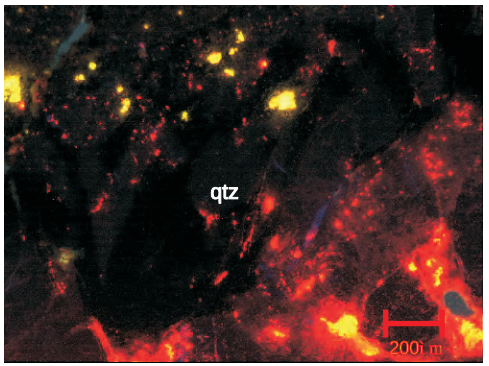


ppl

xpl



after ~6 sec exposure to CL

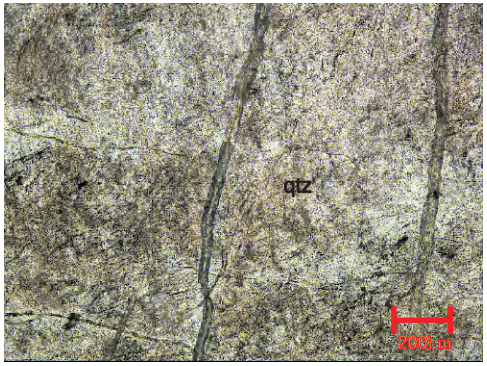


after ~18 sec exposure to CL

Notes

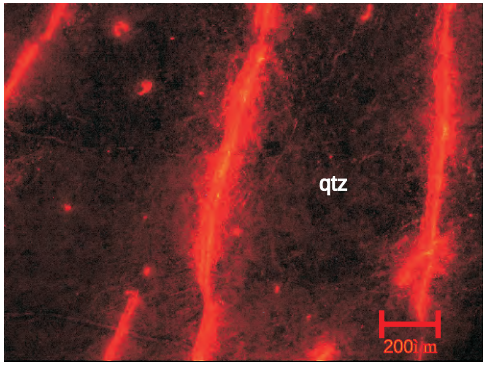
1) -slight color shift from dark blue at ~6 sec exposure to CL to very dark blue at ~18 sec exposure to CL
2) -bright orange luminescent mineral is calcite, bright yellow luminescent mineral is apatite
3) -mineral inclusions of chlorite and also fluid inclusions present in grain
4) -very small microfractures can be seen, some grain margins are embayed while others are irregular, grains are monocrystalline

Grain #2

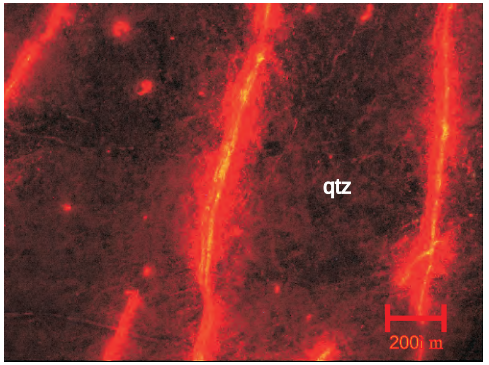


ppl

xpl



after ~6 sec exposure to CL



after ~15 sec exposure to CL

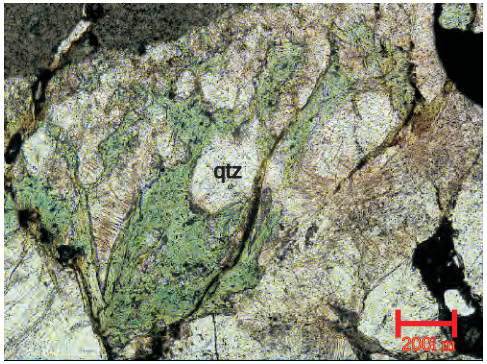
Notes

1) -slight color shift from dark reddish brown at ~6 sec exposure to CL to lighter reddish brown at ~15 sec exposure to CL (color may be being affected by bright orange luminescing veins)
2) -bright orange luminescent veins are calcite
3) -mineral inclusions of chlorite and also fluid inclusions present in grain
4) -large fractures can be seen, grain is monocrystalline

Sample

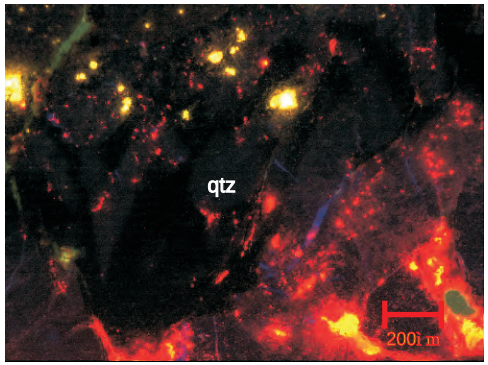
8053A Quartz Vein in Horton Group, Boyd Brook, near Bass River of Five Islands, NS

Grain #1

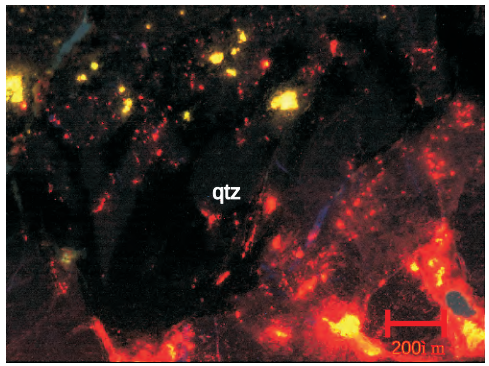


ppl

xpl



after ~6 sec exposure to CL

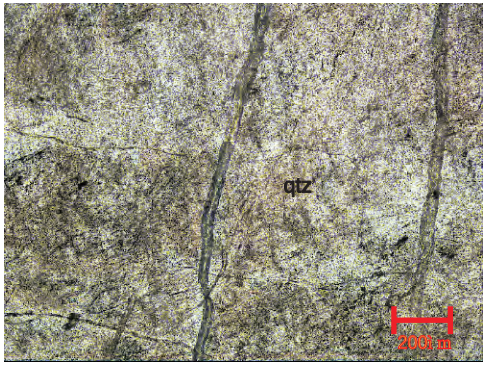


after ~18 sec exposure to CL

Notes

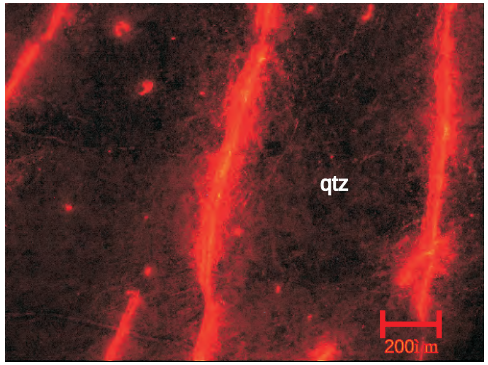
1) -slight color shift from dark blue at ~6 sec exposure to CL to very dark blue at ~18 sec exposure to CL
2) -bright orange luminescent mineral is calcite, bright yellow luminescent mineral is apatite
3) -mineral inclusions of chlorite and also fluid inclusions present in grain
4) -very small microfractures can be seen, some grain margins are embayed while others are irregular, grains are monocrystalline

Grain #2

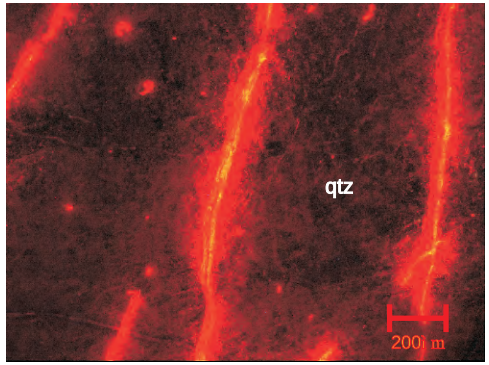


ppl

xpl



after ~6 sec exposure to CL



after ~15 sec exposure to CL

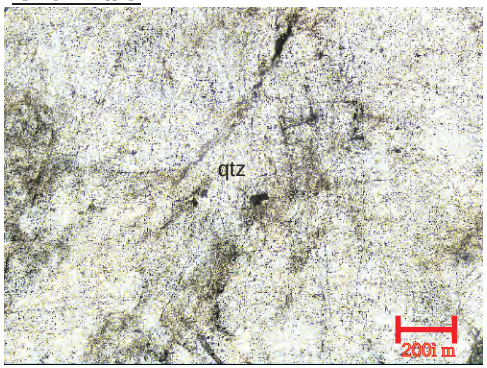
Notes

1) -slight color shift from dark reddish brown at ~6 sec exposure to CL to lighter reddish brown at ~15 sec exposure to CL (color may be being affected by bright orange luminescing veins)
2) -bright orange luminescent veins are calcite
3) -mineral inclusions of chlorite and also fluid inclusions present in grain
4) -large fractures can be seen, grain is monocrystalline

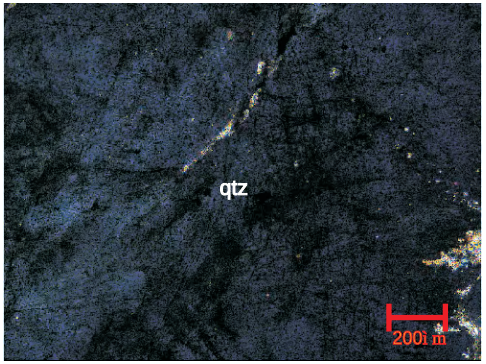
Sample

8053A Quartz Vein in Horton Group, Boyd Brook, near Bass River of Five Islands, NS

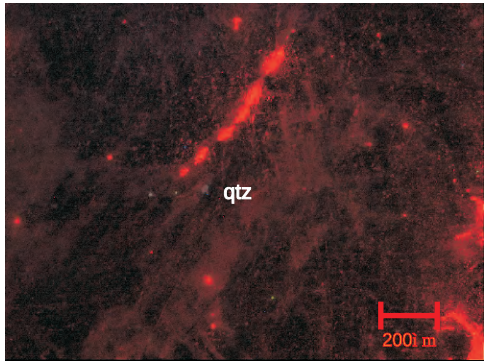
Grain #3



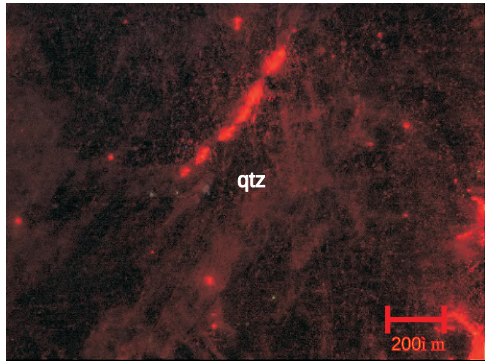
ppl



xpl



after ~3 sec exposure to CL

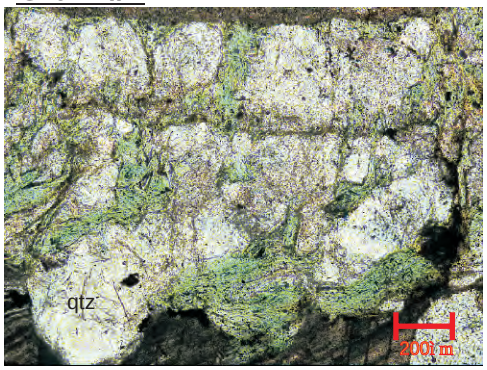


after ~15 sec exposure to CL

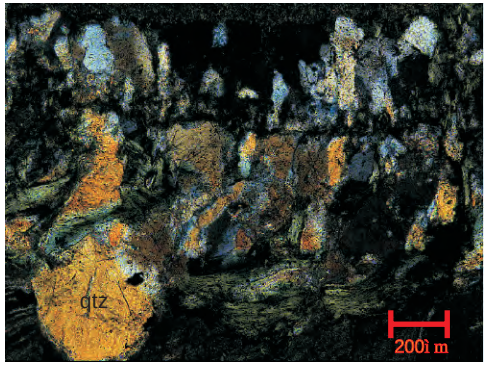
Notes

1) -no visible color shift between ~3 sec and ~15 sec exposure to CL, grain exhibits reddish brown luminescence
2) -bright orange luminescent mineral is calcite
3) -chlorite and calcite mineral inclusions and also fluid inclusions present in grains
4) -microfractures can be seen, grain is monocrystalline

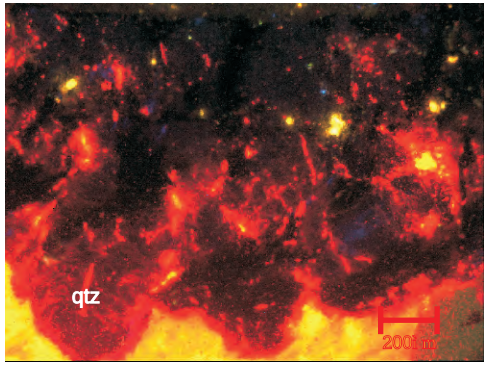
Grain #4



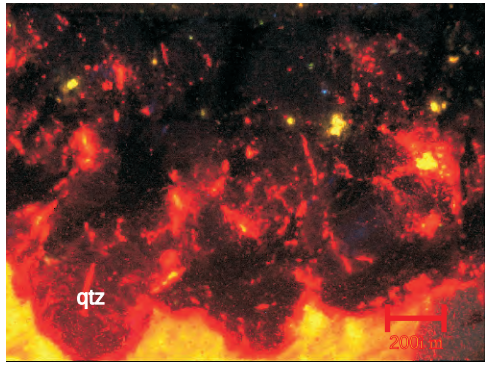
ppl



xpl



after ~6 sec exposure to CL



after ~19 sec exposure to CL

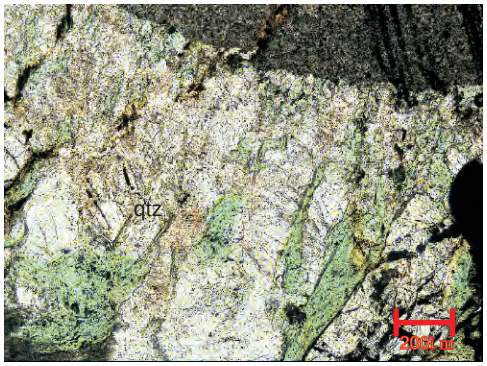
Notes

1) -some areas of qtz cluster appear dark blue with medium-dark blue patches while some qtz appears brownish possibly because of adjacent bright orange luminescent calcite, areas of medium-dark blue at ~6 sec exposure to CL experience a slight color shift and are dark blue at ~19 sec exposure to CL, brownish areas do not exhibit a color shift
2) -bright orange luminescent mineral is calcite, bright yellow luminescent grains are apatite
3) -chlorite, calcite and tourmaline mineral inclusions and also fluid inclusions present in grains
4) -microfractures can be seen, grain margins are embayed or irregular, grains are monocrystalline

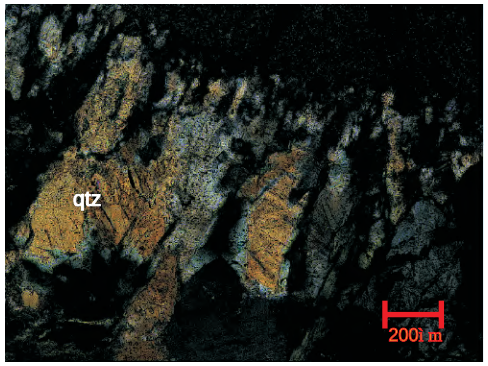
Sample

8053A Quartz Vein in Horton Group, Boyd Brook, near Bass River of Five Islands, NS

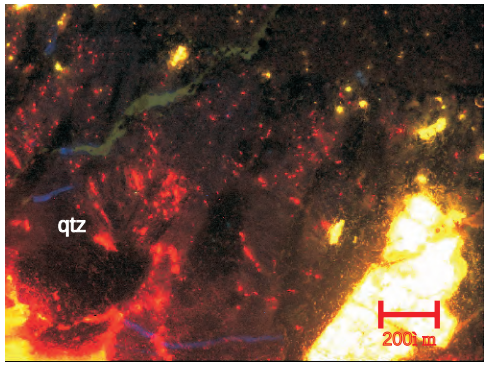
Grain #5



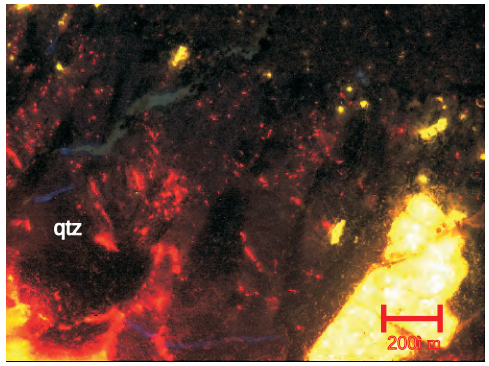
ppl



xpl



after ~6 sec exposure to CL



after ~16 sec exposure to CL

Notes

1) -no visible color shift between ~6 sec and ~16 sec exposure to CL, quartz has dark bluish brown luminescence with medium blue luminescence in a few microfractures
2) -bright orange luminescent mineral is calcite, bright yellow luminescent grains are apatite
3) -chlorite, calcite and tourmaline mineral inclusions and also fluid inclusions present in grains
4) -microfractures can be seen, grains have irregular grain margins and are monocrystalline

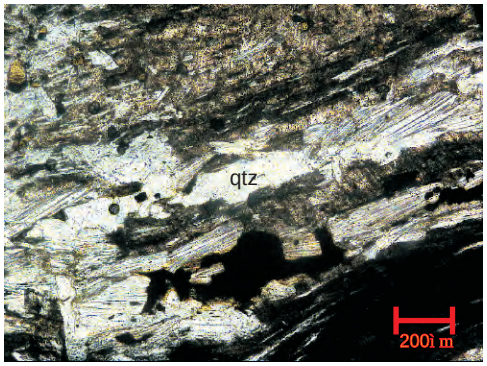
Summary

Either no color shift or a slight color shift has been observed in qtz grains in this thin section. Dark blue, very dark blue and reddish brown luminescence have all been seen in CL photos of grains. For grain #2, an initial color of dark reddish brown and a final color a slightly lighter reddish brown was observed; bright orange calcite luminescence is interfering with the observed CL color of the grain.

Sample

GL115 Vein Quartz in Metapelite, Grand Lake, NL

Grain #1



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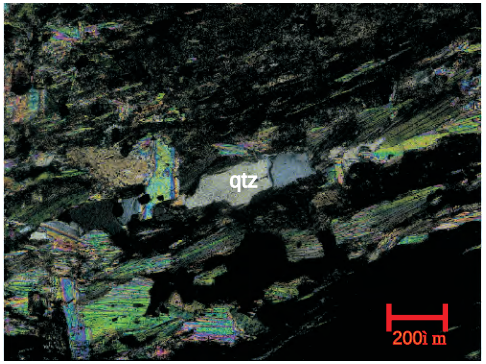
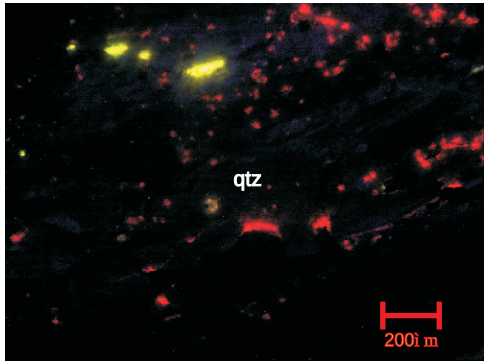
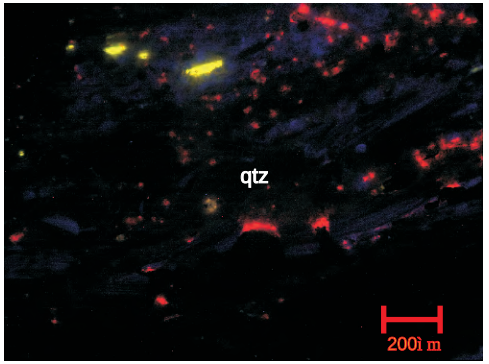


xpl



after ~3 sec exposure to CL

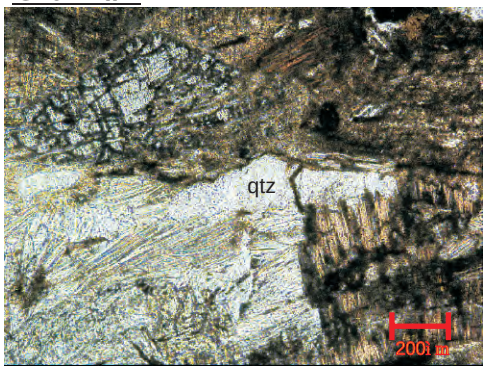


after ~15 sec exposure to CL

Notes

1) -no color shift between ~3 sec and ~15 sec exposure to CL, qtz very dark (could be very dark blue)
2) -bright orange luminescent grains are calcite, bright yellow luminescent grains are apatite
3) -fluid inclusions present in grain
4) -grain has embayed grain margins and is polycrystalline

Grain #2



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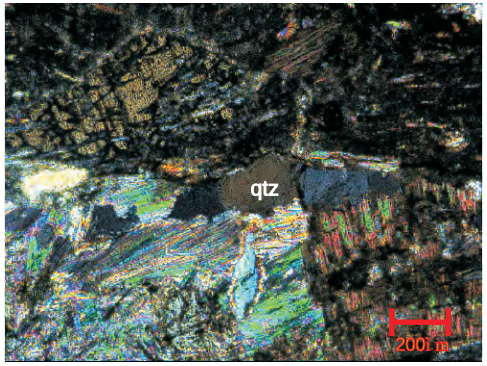

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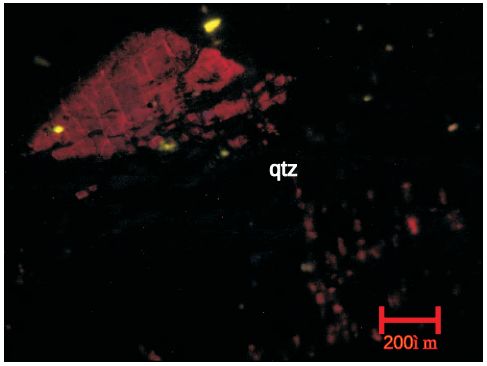
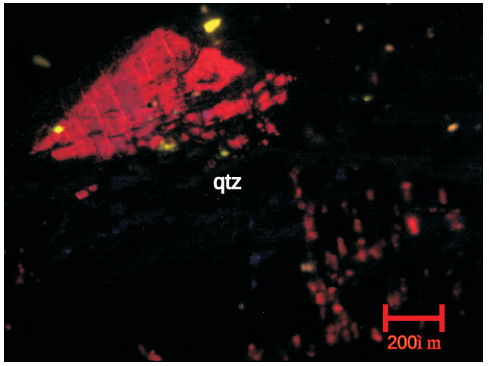


after ~3 sec exposure to CL



after ~18 sec exposure to CL

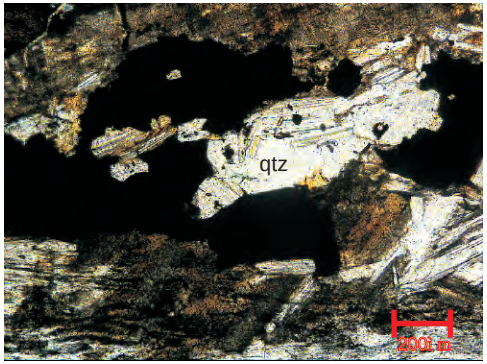
Notes

1) -no color shift between ~3 sec and ~18 sec exposure to CL, qtz very dark (could be very dark blue), overall picture brighter at ~18 sec exposure to CL
2) -bright orange luminescent grain not identified (calcite?), bright yellow luminescent grains are apatite
3) -mica (phlogopite?)and opaque mineral inclusions, and also fluid inclusions present in grains
4) -grain had embayed grain margins and is polycrystalline

Sample

GL115 Vein Quartz in Metapelite, Grand Lake, NL

Grain #3



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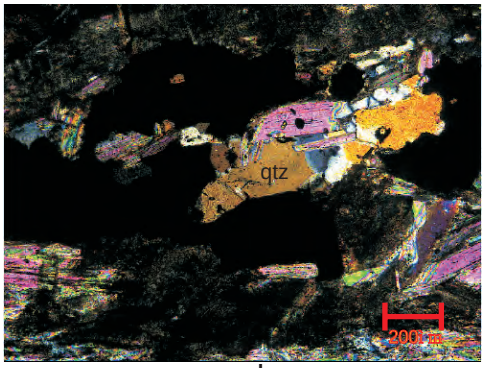
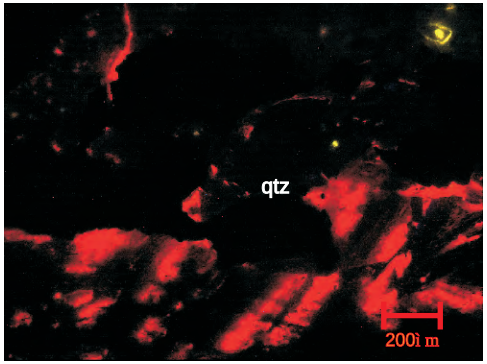
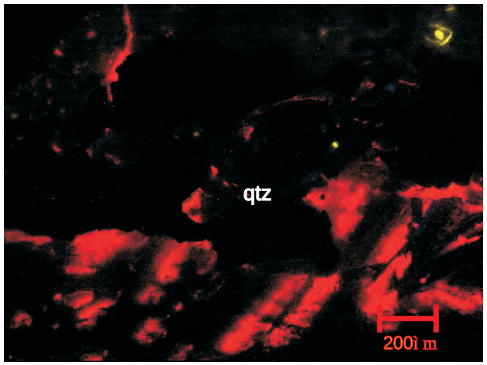


xpl



after ~7 sec exposure to CL

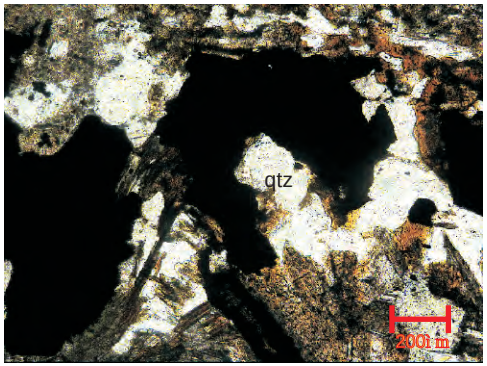


after ~19 sec exposure to CL

Notes

1) -no color shift between ~7 sec and ~19 sec exposure to CL, qtz very dark (could be very dark blue)
2) -bright orange luminescent grains are calcite, bright yellow luminescent grain is apatite
3) -opaque mineral and also fluid inclusions present in grains
4) -grain has embayed grain margins and is polycrystalline, microfractures can be seen

Grain #4



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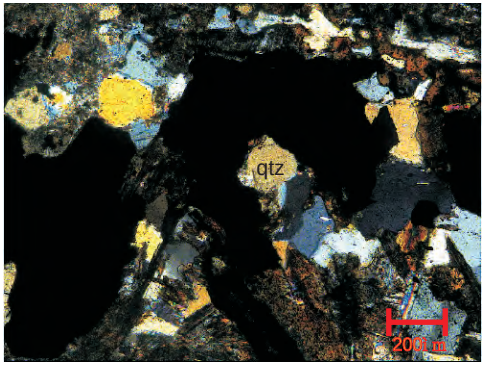

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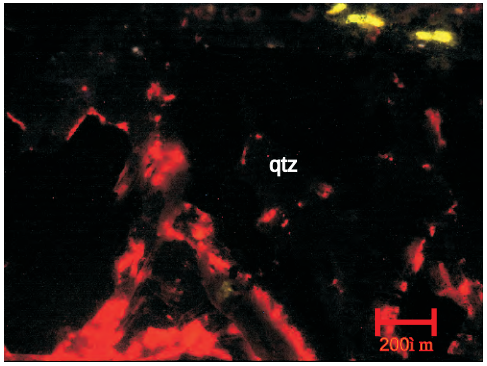
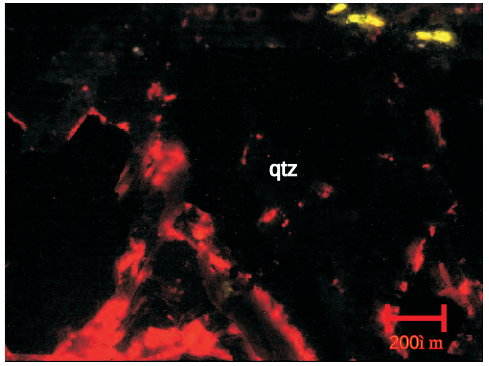


after ~6 sec exposure to CL



after ~19 sec exposure to CL

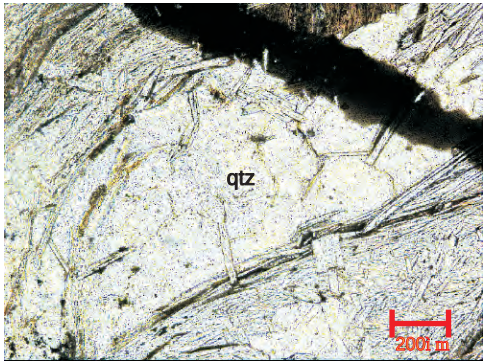
Notes

1) -no color shift between ~6 sec and ~19 sec exposure to CL, qtz very dark (could be very dark blue)
2) -bright orange luminescent grains are calcite, bright yellow luminescent grains are apatite
3) -fluid inclusions present in grain
4) -grain has embayed grain margins and in polycrystalline

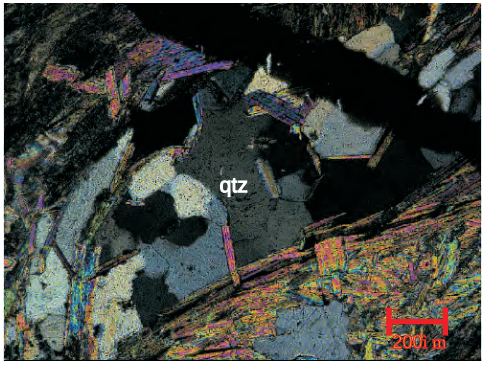
Sample

GL115 Vein Quartz in Metapelite, Grand Lake, NL

Grain #5



ppl



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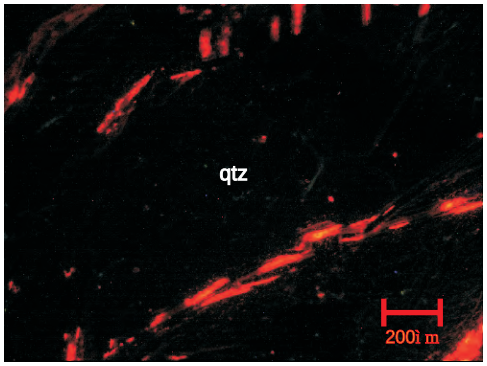
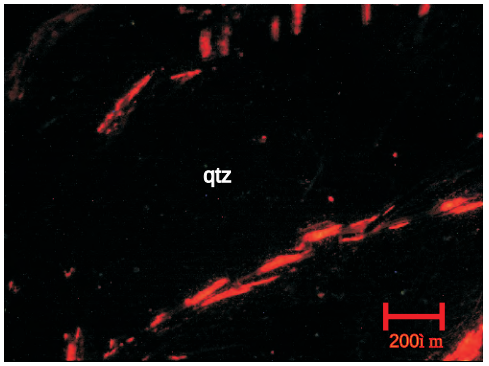


after ~3 sec exposure to CL



after ~14 sec exposure to CL

Notes

1) -no color shift between ~3 sec and ~14 sec exposure to CL, qtz very dark (could be very dark blue)
2) -bright orange luminescent mineral is calcite
3) -fluid inclusions present in grain
4) -grain has embayed grain margins and is polycrystalline, a few microfractures can be seen

Summary

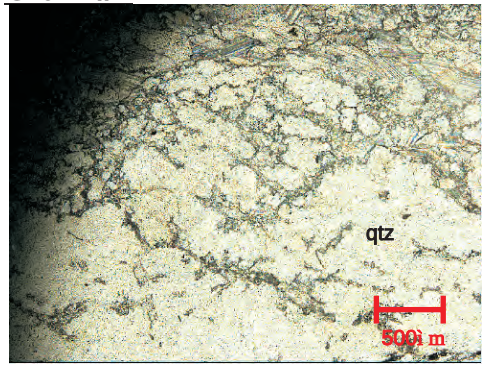
No color shift can be seen in qtz grain in this thin section, grains all appear very dark (could be very dark blue, but too dark to be sure).

Low Grade Metamorphic Quartz

Sample

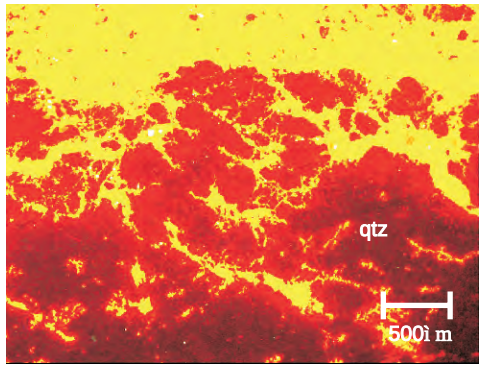
9804 Quartz Vein in meta-basalt, Jeffers Group, Lynn Road, Five Islands, NS

Grain #1

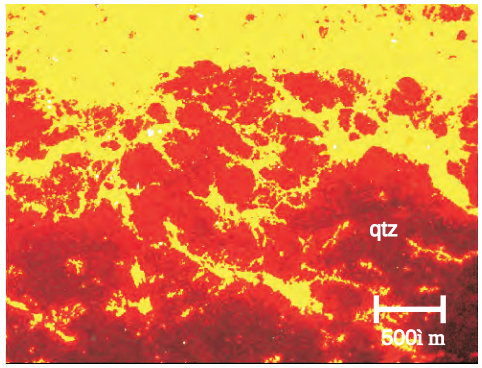


ppl

xpl



after 3 sec exposure to CL

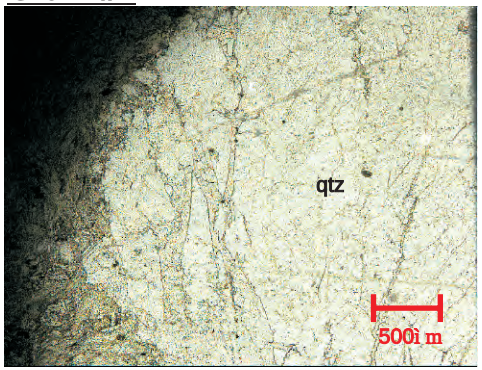


after 12 sec exposure to CL

Notes

1) -quartz is very dark, no visible color shift, bright orange luminescent calcite is affecting color of quartz
2) -bright orange luminescent grains are calcite
3) -calcite mineral inclusions and also fluid inclusions are present in grain
4) -grains are microfractured, some microfractures are infilled with calcite, grains are polycrystalline with sutured sub-grain boundaries (not easily seen in photomicrographs)

Grain #2



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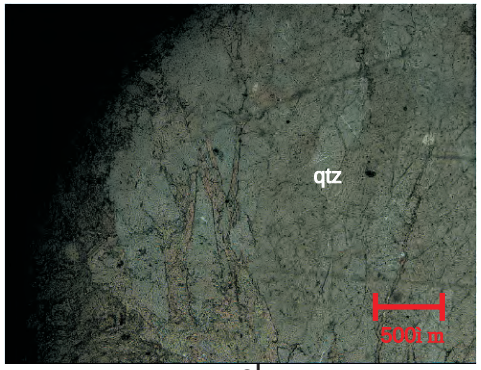
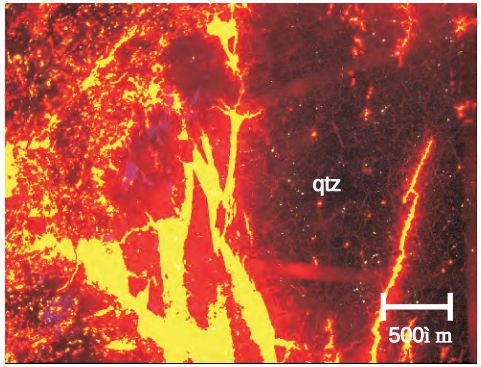
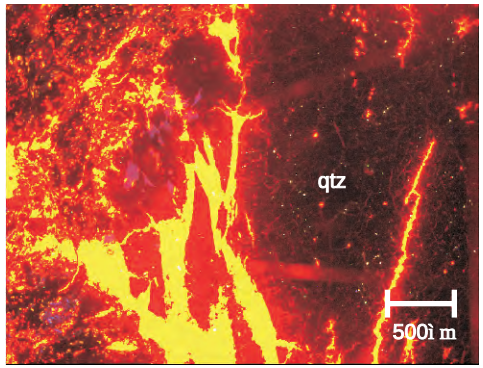


xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

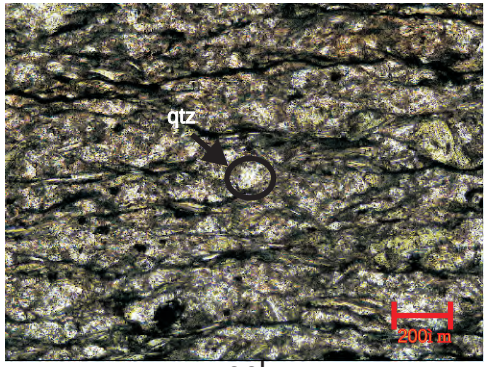
Notes

1) -quartz is very dark, no visible color shift, bright orange luminescent calcite is affecting color of quartz
2) -bright orange luminescent grains are calcite
3) -calcite mineral inclusions and also fluid inclusions are present in grain
4) -grains are microfractured, some microfractures are infilled with calcite, grains are polycrystalline with sutured sub-grain boundaries (not easily seen in photomicrographs)

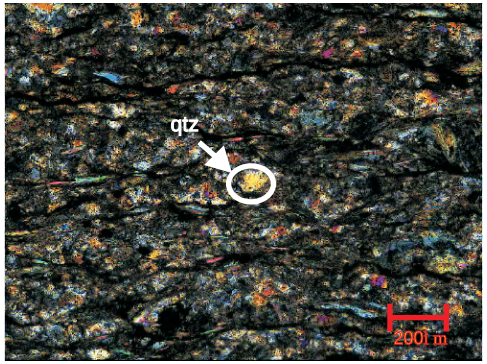
Sample

SH8 Slate, Halifax Group, Gore, Hants Co., NS

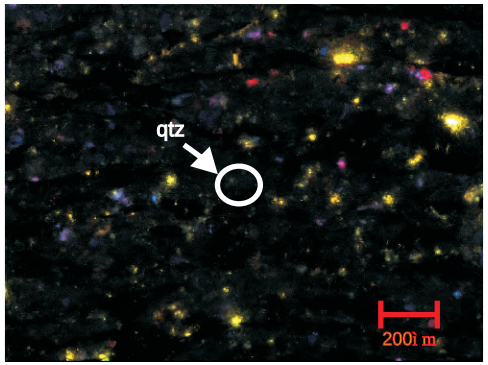
Grain #1



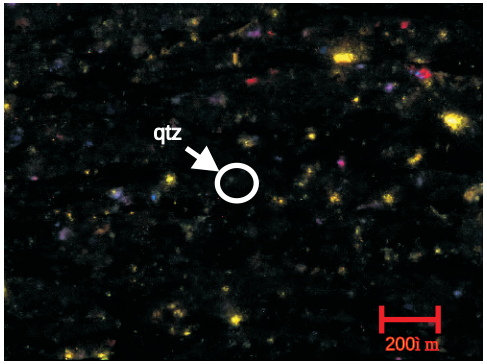
ppl



xpl



after ~6 sec exposure to CL

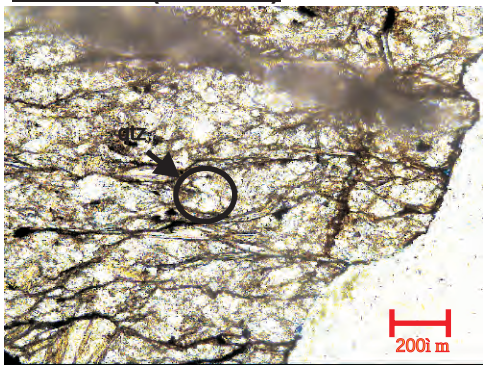


after ~18 sec exposure to CL

Notes

1) -slight color shift from an initial color of dark bluish brown at ~6 sec exposure to CL to a final color of brown at ~18 sec exposure to CL
2) -light blue and reddish luminescent grains are feldspar, bright yellow luminescent grains are apatite
3) -fluid inclusions are present in grains
4) -grain has irregular grain margins and is monocrystalline
5) -foliation can be seen

Grain #2 (Cluster)



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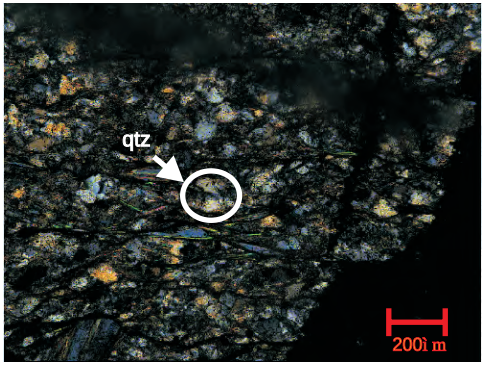

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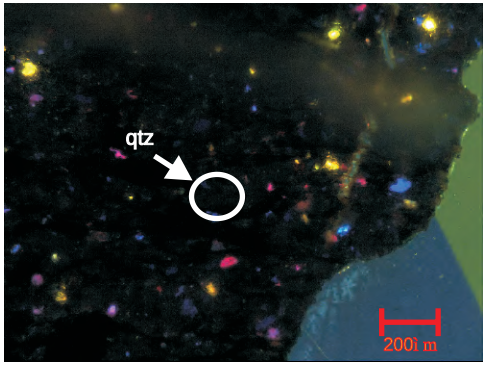
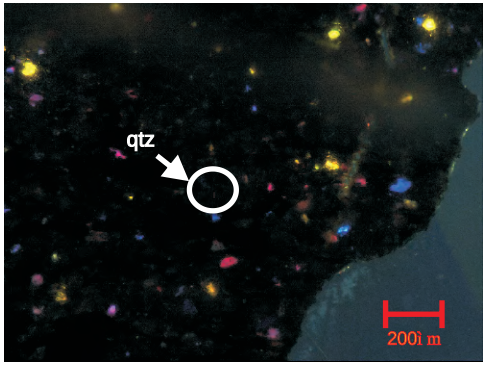


after ~6 sec exposure to CL



after ~19 sec exposure to CL

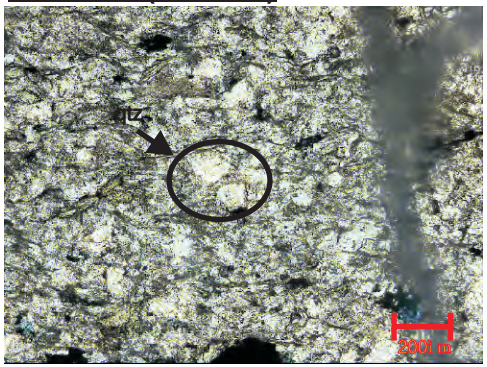
NOtes

1) -no color shift between ~6 sec and ~19 sec exposure times to CL, qtz has brown luminescence
2) -reddish and light blue luminescent grains are feldspar, bright yellow luminescent grains are apatite
3) -unknown mineral inclusion (too small to identify), and also fluid inclusions present in grain
4) - grain has irregular grain margins and is monocrystalline, small microfractures can be seen
5) -foliation can be seen, quartz grains may have exhibited a color shift had the first CL photomicrograph been captured at a shorter exposure time to the CL beam

Sample

SH8 Slate, Halifax Group, Gore, Hants Co., NS

Grain #3 (Cluster)



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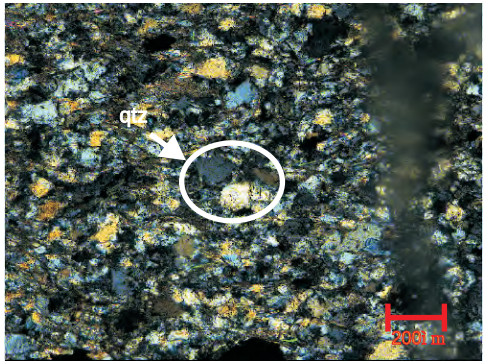
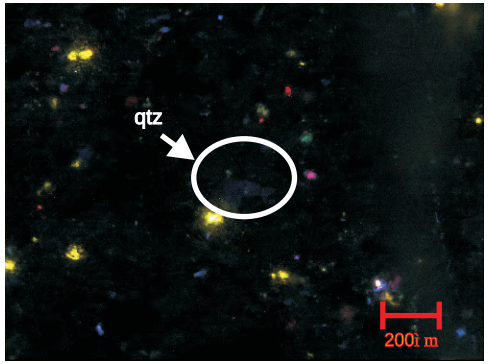
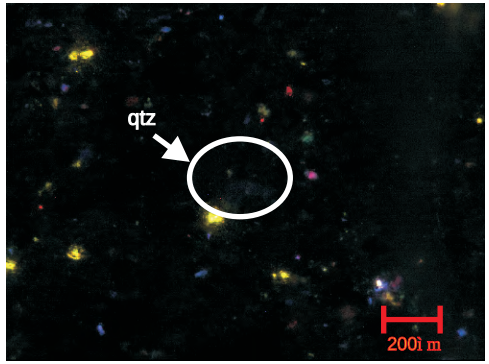


xpl



after 3 sec exposure to CL

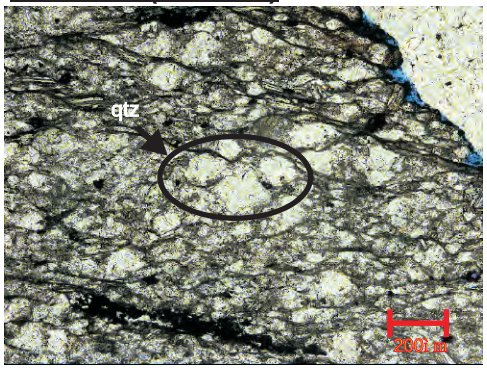


after 12 sec exposure to CL

Notes

1) -slight color shift from an initial color of dark blue at 3 sec exposure to CL to a final color of very dark blue at 12 sec exposure to CL
2) -bright yellow luminescent grains are apatite, light blue, and reddish luminescent grains are feldspar
3) -chlorite and tourmaline mineral inclusions, and also fluid inclusions present in grains
4) -grains have irregular grain boundaries and are monocrystalline, a few small microfractures can be seen

Grain #4 (Cluster)



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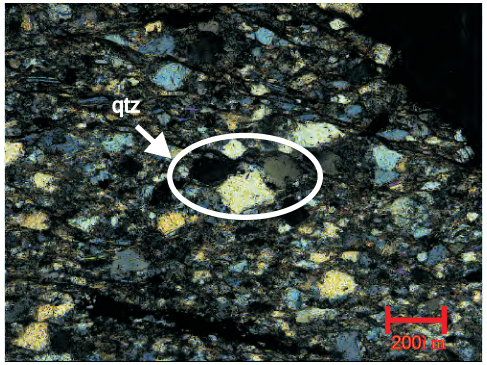

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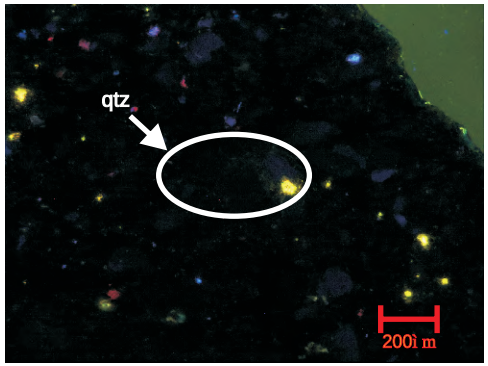
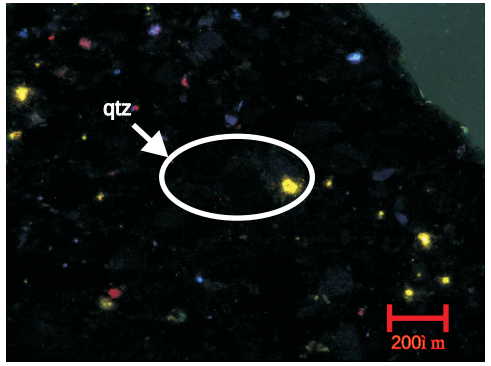


after 3 sec exposure to CL



after 12 sec exposure to CL

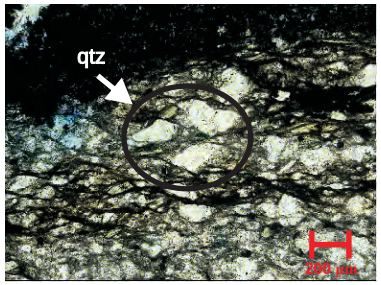
NOtes

1) -slight color shift from an initial color of medium-dark blue at 3 sec exposure to CL to a final color of dark blue at 12 sec exposure to CL
2) -bright yellow luminescent grains are apatite, light blue and reddish luminescent grains are feldspar
3) -chlorite mineral inclusions and also fluid inclusions present in grains
4) -grain have irregular grain boundaries and are monocrystalline, a few small microfractures can be seen

Sample

SH8 Slate, Halifax Group, Gore, Hants Co., NS

Grain #5 (Cluster)



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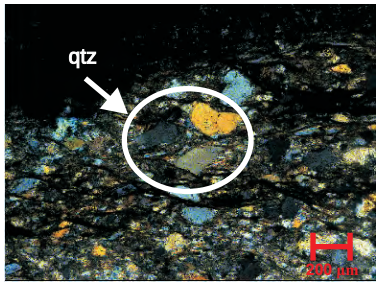

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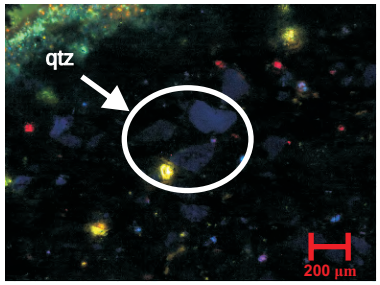
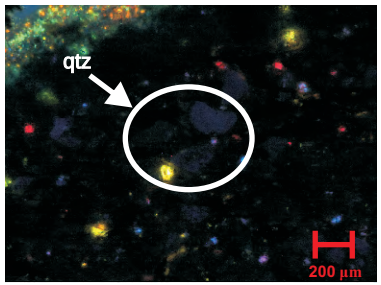
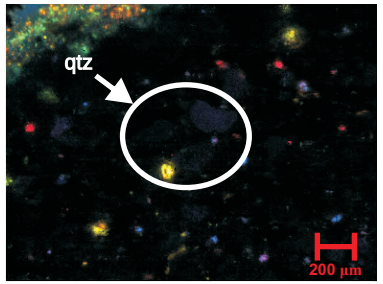


after 3 sec exposure to CL



after 12 sec exposure to CL

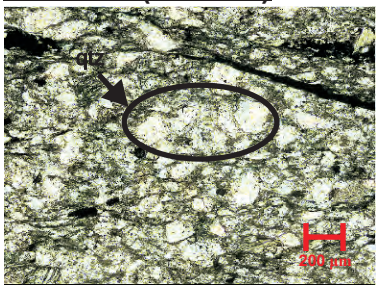


after 21 sec exposure to CL

Notes

1) -moderate color shift from an initial color of medium blue at 3 sec exposure to CL to a final color of dark blue at 21 sec exposure to CL
2) -light blue and reddish luminescent grains are feldspar, bright yellow luminescent grains are apatite
3) -amphibole mineral inclusion and also fluid inclusions are present in grains
4) -grains have embayed grain margins and are monocrystalline, small microfractures can be seen

Grain #6 (Cluster)



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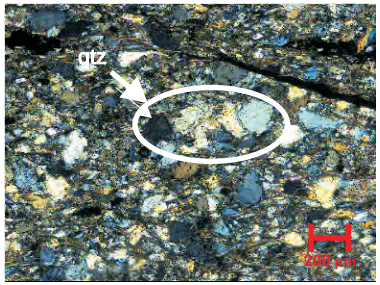
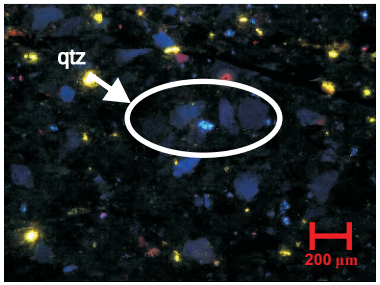
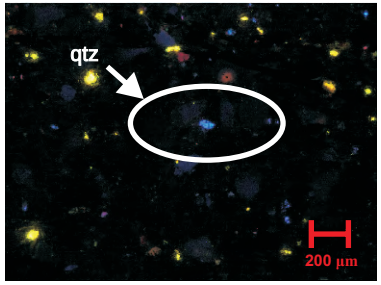


xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

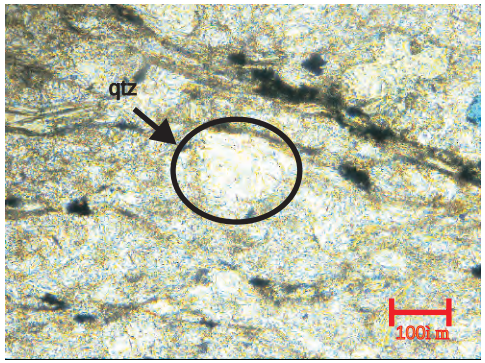
Notes

1) -moderate color shift from an initial color of medium-dark blue at 3 sec exposure to CL to a final color of dark blue at 12 sec exposure to CL
2) -light blue and reddish luminescent grains are feldspar, bright yellow luminescent grains are apatite
3) -unknown mineral inclusion (too small to identify), tourmaline inclusions , and also fluid inclusions can be seen
4) -grains are monocrystalline and have irregular grain boundaries

Sample

SH8 Slate, Halifax Group, Gore, Hants Co., NS

Grain #7



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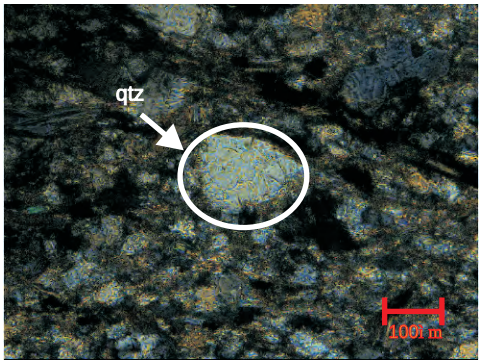

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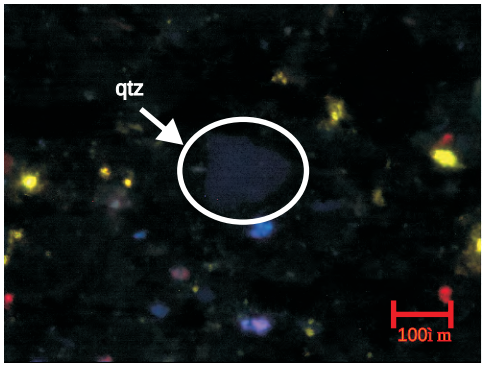
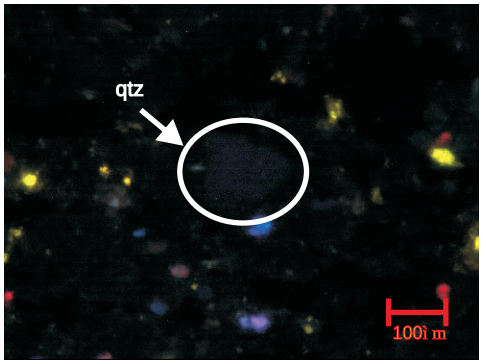


after 3 sec of exposure



after 12 sec exposure to CL

Notes

1) -slight color shift from an initial color of medium blue to a final color of medium-dark blue
2) -bright yellow luminescent grains are apatite, bright light blue and pinkish luminescent grains are feldspar
3) -mineral inclusions of tourmaline and also fluid inclusions present in grains
4) -grains are very small (~50-100ì m)

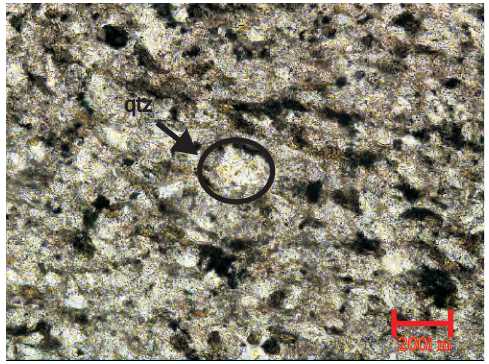
Summary

Quartz in this sample exhibits a slight to moderate color shift going from initial colors of dark bluish brown or ranging from medium to dark blue to a final color of brown or dark blue.

Sample

SH10 Quartzite, Goldenville Group, Beaverbank Road, Upper Rawdon, Hants Co., NS

Grain #1



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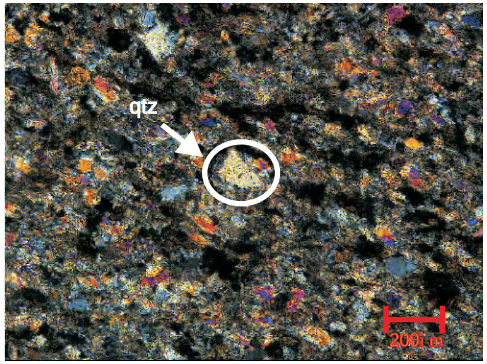

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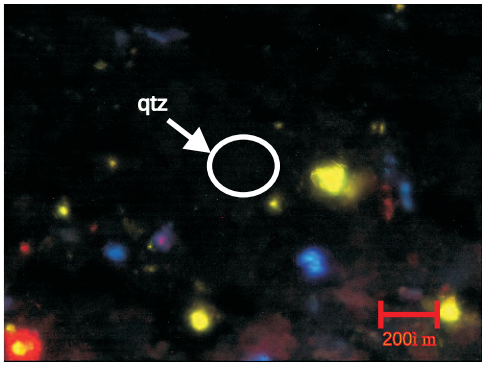
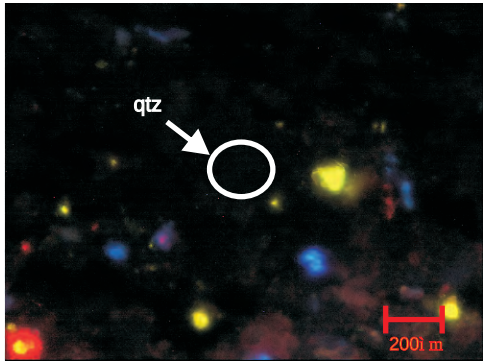


after ~6 sec exposure to CL



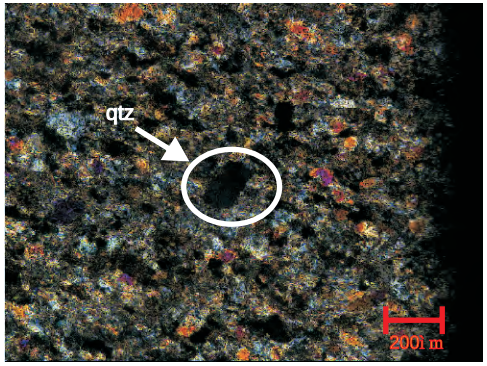
after ~19 sec exposure to CL

Notes

1) -no visible color shift between ~6 sec and ~19 sec of exposure to CL, quartz has very dark blue luminescence
2) -dark reddish brown, and light blue luminescent grains are feldspar, bright yellow luminescent grains are apatite, bright orange luminescent grain is calcite
3) -fluid inclusions can be seen
4) -grain has irregular grain margins and is monocrystalline, small microfractures can be seen

Grain #2

ppl



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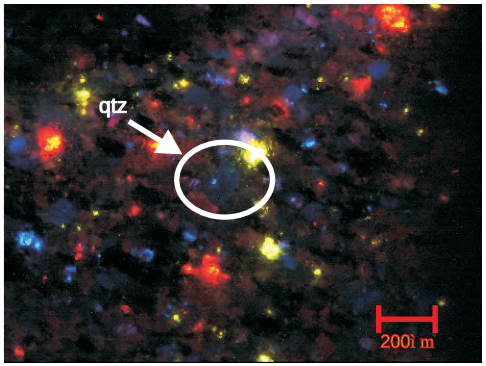
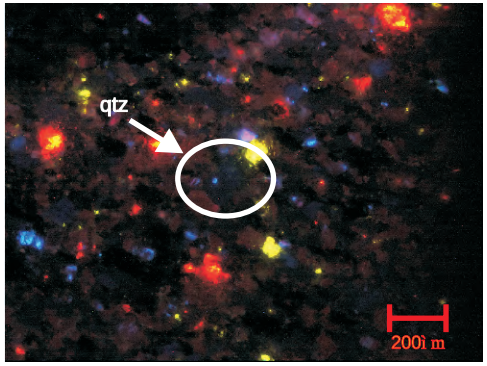


after ~3 sec exposure to CL



after ~16 sec exposure to CL

Notes

1) -slight color shift from an initial color of dark blue at ~3 sec exposure to CL to a final color of very dark blue at ~16 sec exposure to CL
2) -bright orange luminescent grains are calcite, light blue/violet luminescent grains are feldspar, bright yellow luminescent grains are apatite
3) -fluid inclusions present in grain
4) -small microfractures can be seen, grain is monocrystalline

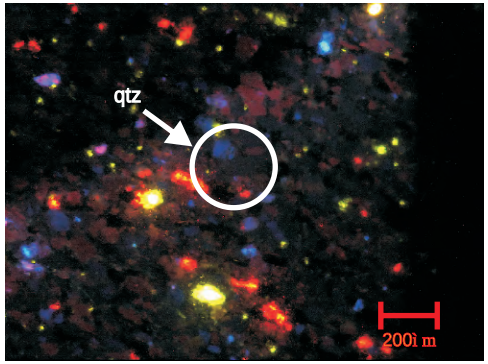
Sample

SH10 Quartzite, Goldenville Group, Beaverbank Road, Upper Rawdon, Hants Co., NS

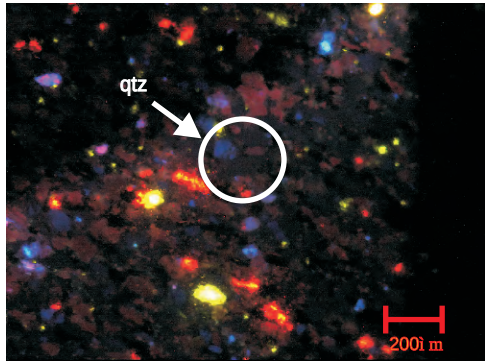
Grain #3 (Cluster)

ppl

xpl



after ~10 sec exposure to CL

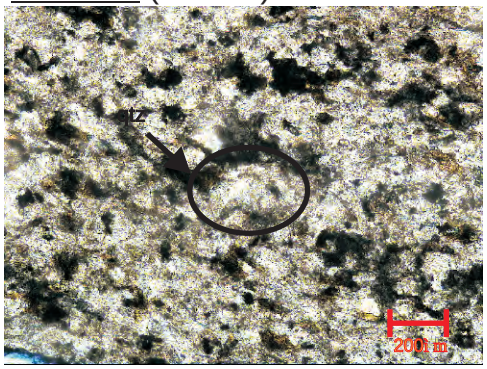


after ~19 sec exposure to CL

Notes

1) -slight color shift from medium-dark blue at ~10 sec exposure to CL to dark medium-dark blue at ~19 sec exposure to CL
2) -reddish and also blue/violet luminescent grains are feldspar, bright yellow and bright orange luminescent grains are apatite and calcite respectively
3) -mineral inclusions of tourmaline and also fluid inclusions are present in grains
4) -grains have rounded grain margins and are monocrystalline, small microfractures can be seen

Grain #4 (Cluster)



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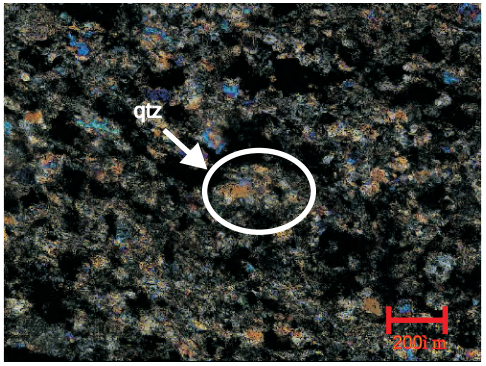

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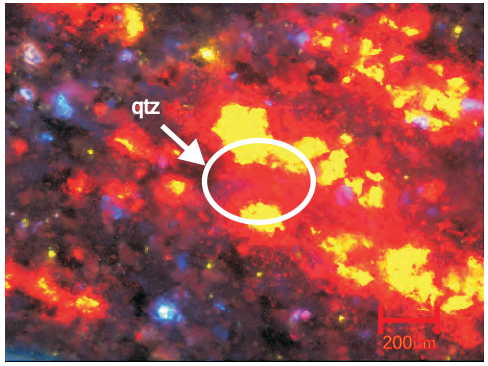
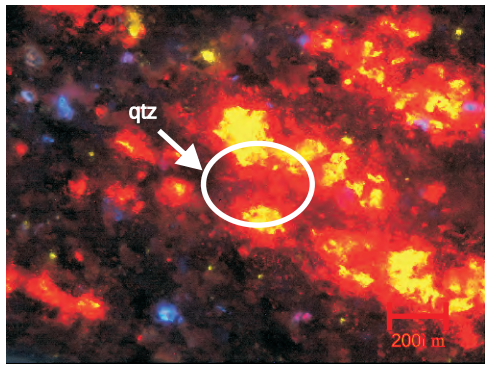


after ~6 sec exposure to CL



after ~19 sec exposure to CL

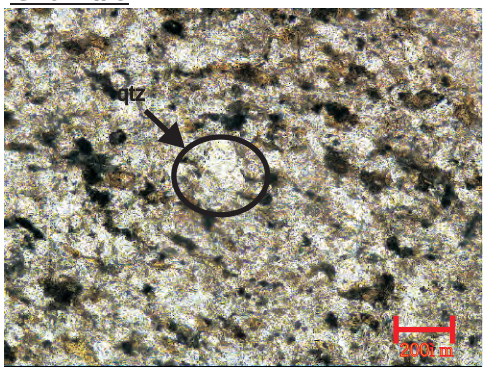
Notes

1) -color shift of qtz could not be determined because of bright orange luminescent calcite grains interfering with color
2) -bright orange luminescent mineral is calcite, reddish brown, and light blue luminescent grains are feldspar
3) -mineral inclusions of chlorite and also fluid inclusions present in grains
4) -grains have irregular grain margins and are monocrystalline
5) -weak foliation can be seen in photographed area of sample

Sample

SH10 Quartzite, Goldenville Group, Beaverbank Road, Upper Rawdon, Hants Co., NS

Grain#5



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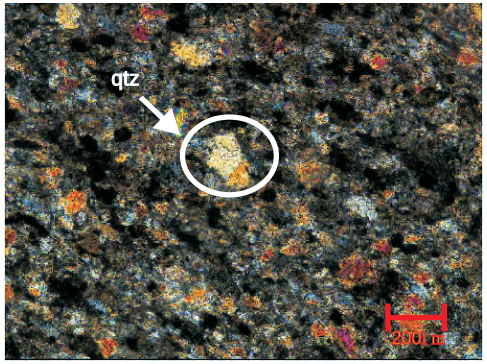

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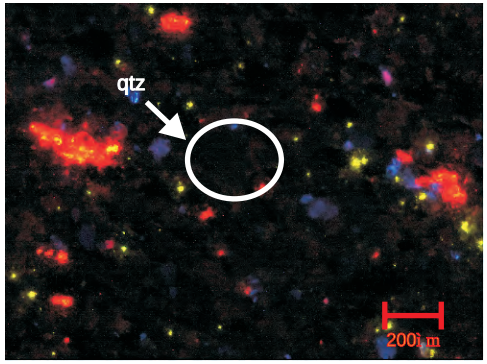
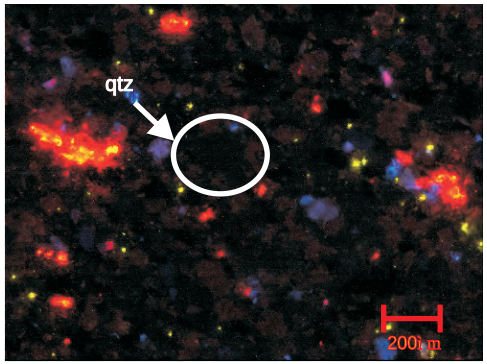


after ~4 sec exposure to CL

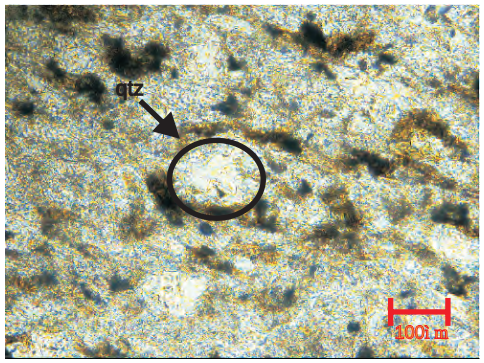


after ~16 sec exposure to CL

Notes

1) -no visible color shift between ~4 sec and ~16 sec exposure to CL, qtz has very dark blue luminescence
2) -bright orange luminescent grains are calcite, bright yellow luminescent grains are apatite, light blue/violet luminescent grains are feldspar
3) -mineral inclusions of toumaline and also fluid inclusions are present in grain
4) -a few microfractures present in grains, grain is polycrystalline
5) -weak foliation can be seen in photographed area of the sample

Grain #6



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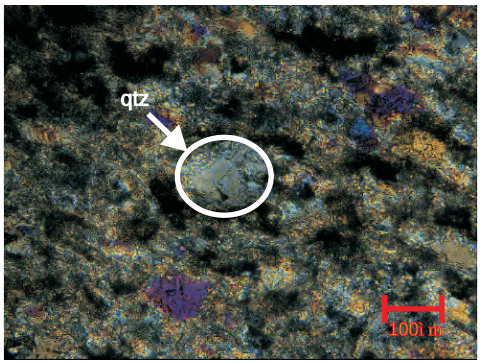

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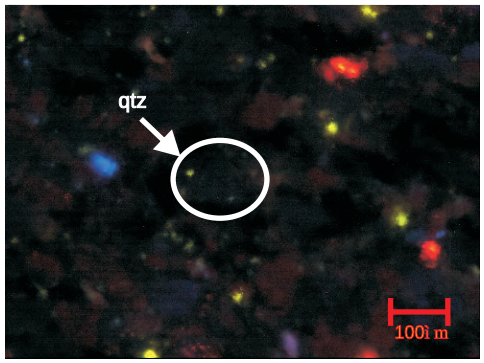
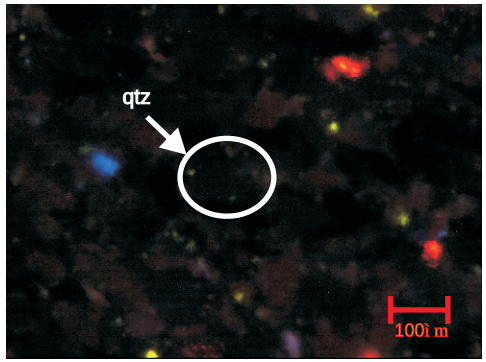


after 3 sec exposure to CL



after 12 sec exposure to CL

Notes

1) -slight color shift from an initial CL color of dark blue after 3 sec exposure to CL to a final color of very dark blue after 12 seconds exposure to CL
2) -bright blue luminescent mineral is feldspar, bright yellow luminescent mineral is apatite, bright orange luminescent mineral is calcite, brownish luminescent mineral was not identified (altered feldspar?)
3) -mineral inclusions of chlorite and tourmaline, and also fluid inclusions present in grain
4) -grains margins are irregular, grain is monocrystalline

Sample

SH10 Quartzite, Goldenville Group, Beaverbank Road, Upper Rawdon, Hants Co., NS

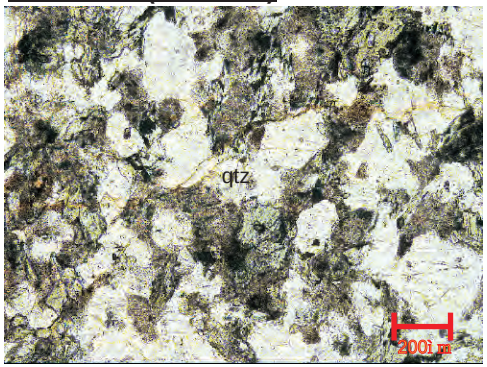
Summary
Quartz grains in this sample exhibit either no color shift or one that is very slight. Initial colors range from medium-dark to very dark blue. Final colors range from dark blue to very dark blue. No color shift could be recorded for grain #7 because the bright luminescent color of surrounding calcite affected its color.

Medium and High Grade Metamorphic Quartz

Sample

HG30 Quartzite, Gamble Brook Formation, Quarry S of Folly Lake, Cobequid Highlands, NS

Grain #1 (Cluster)



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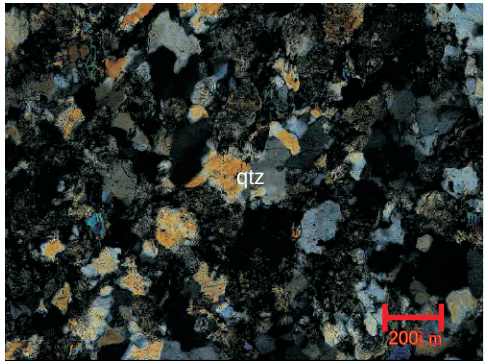

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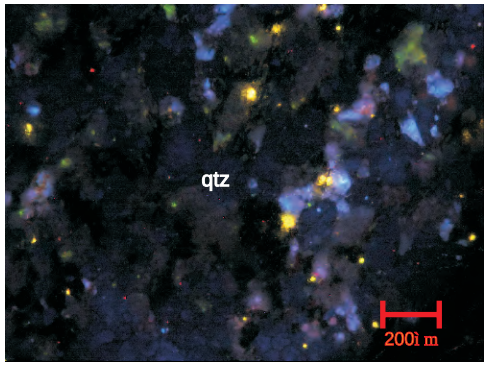
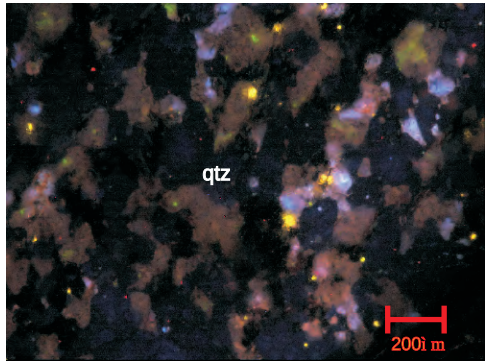


after ~3 sec exposure to CL

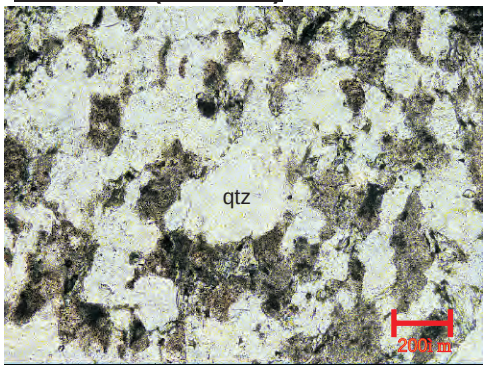


after ~16 sec exposure to CL

Notes

1) -slight color shift from an initial color of inhomogeneous dark blue at ~3 sec exposure to CL to a final color of inhomogeneous very dark blue at ~16 sec exposure to CL
2) -reddish/violet luminescent grains are feldspar, yellow luminescent grains are apatite, green luminescent grains were not identified
3) -tourmaline, chlorite and feldspar mineral inclusions, and also fluid inclusions present in grains
4) -grains have irregular grain margins and are polycrystalline, sub-grain boundaries are sutured, microfractures can be seen

Grain #2 (Cluster)



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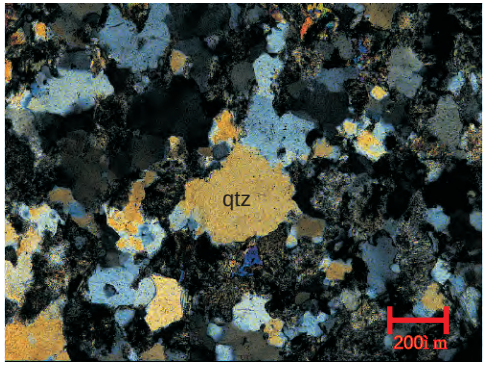
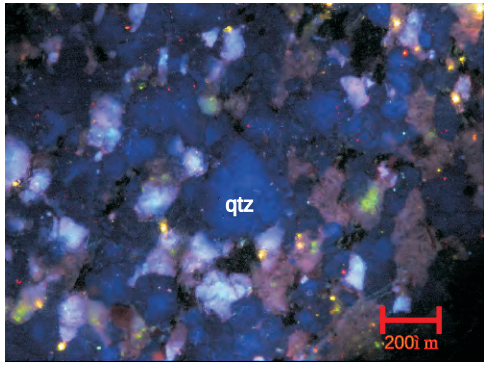
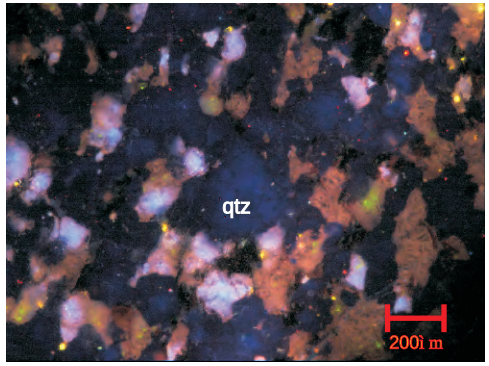


xpl



after ~3 sec exposure to CL



after ~16 sec exposure to CL

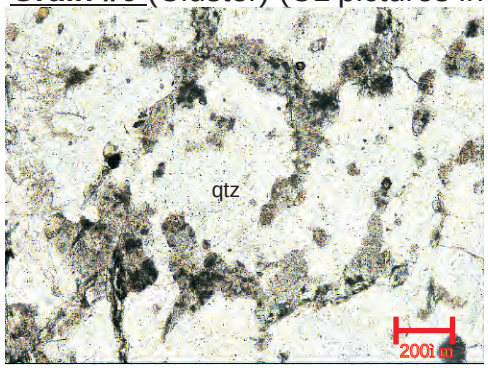
Notes

1) -moderate color shift from an initial color of inhomogeneous medium blue at ~3 sec exposure to CL to a final color of inhomogeneous dark blue at ~16 sec exposure to CL
2) -reddish and violet luminescent grains are feldspar, bright yellow luminescent grains are apatite, flecks of light blue and red can be seen
3) -feldspar and chlorite mineral inclusions, and also fluid inclusions present in grains
4) -grains have irregular grain margins and are polycrystalline, sub-grain boundaries are sutured, a few microfractures can be seen

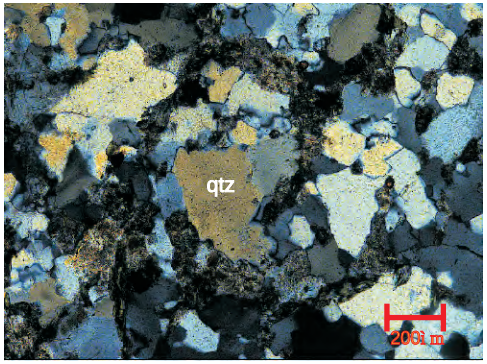
Sample

HG30 Quartzite, Gamble Brook Formation, Quarry S of Folly Lake, Cobequid Highlands, NS

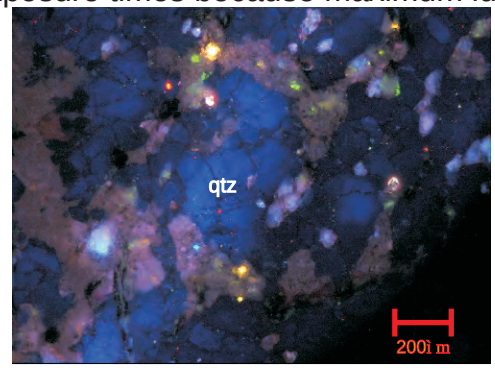
Grain #3 (Cluster) (CL pictures included are at ~12 sec and ~19 sec exposure times because maximum luminescence occured at ~12 sec)



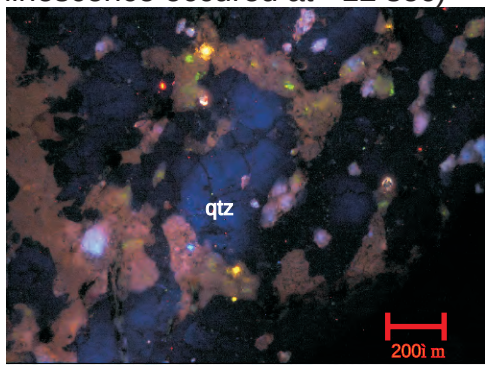
ppl



xpl



after ~12 sec exposure to CL

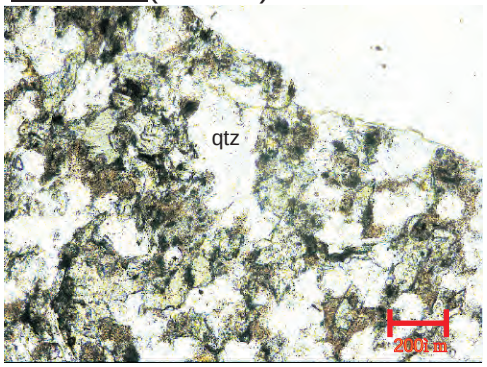


after ~19 sec exposure to CL

Notes

1) -moderate color shift from inhomogeneous medium-dark blue at ~12 sec exposure to CL to inhomogeneous dark blue at ~19 sec exposure to CL
2) -reddish/violet luminescent grains are feldspar, yellow luminescent inclusions are apatite, green luminescent mineral not identified
3) -feldspar, tourmaline and chlorite mineral inclusions, and also fluid inclusions present in grains
4) -grains have irregular grain margins and are polycrystalline, sub-grain boundaries are sutured, a few very small microfractures can be seen

Grain #4 (Cluster)



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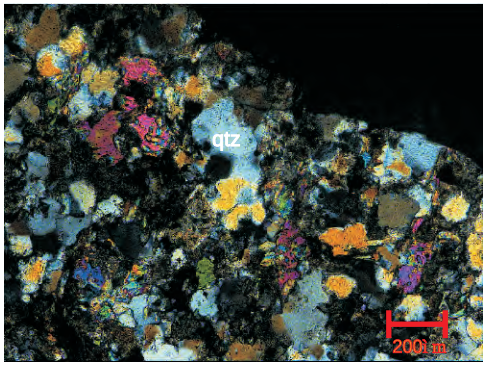
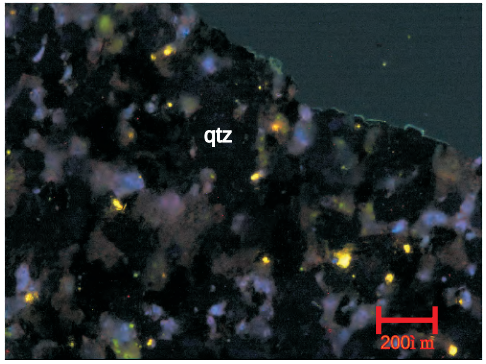
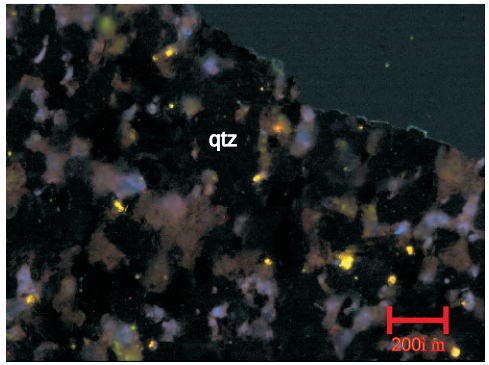


xpl



after ~6 sec exposure to CL



after ~15 sec exposure to CL

NOtes

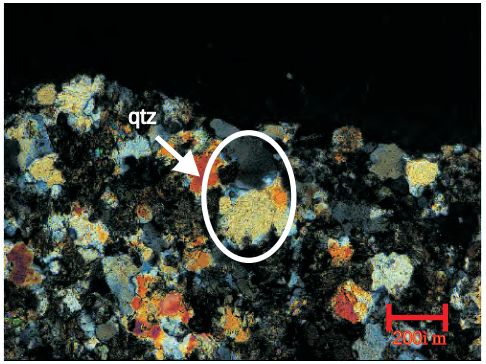
1) -slight color shift from dark blue at ~6 sec exposure to CL to very dark blue at ~15 sec exposure to CL
2) -reddish/violet luminescent grains are feldspar, bright yellow luminescent grains are apatite
3) -tourmaline mineral inclusions, and also fluid inclusions present in grains
4) -grains have irregular grain margins and are polycrystalline, sub-grain boundaries are sutured, microfractures can be seen

Sample

HG30 Quartzite, Gamble Brook Formation, Quarry S of Folly Lake, Cobequid Highlands, NS

Grain #5 (Cluster)

ppl



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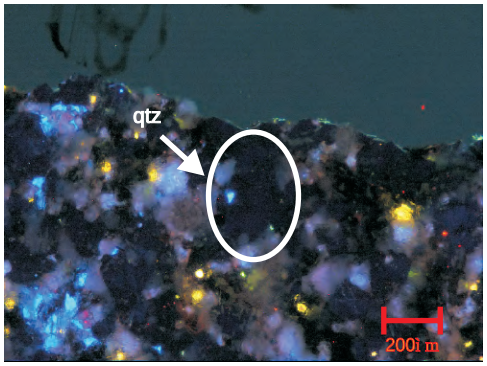
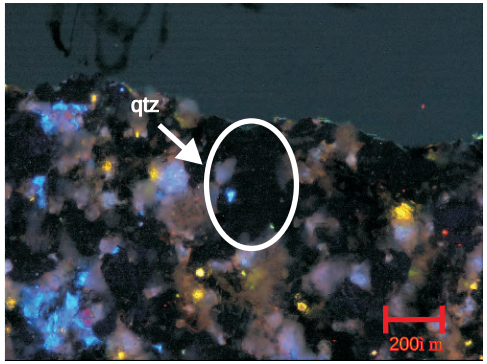


after ~6 sec exposure to CL



after ~15 sec exposure to CL

Notes

1) -slight color shift from very dark blue at ~6 sec exposure to CL to even darker blue at ~15 sec exposure to CL
2) -light blue and reddish/violet luminescent grains are feldspar, bright yellow luminescent grains are apatite
3) -unknown mineral inclusion (too small to identify), and also fluid inclusions can be seen
4) -irregular grain boundaries, and microfractures seen

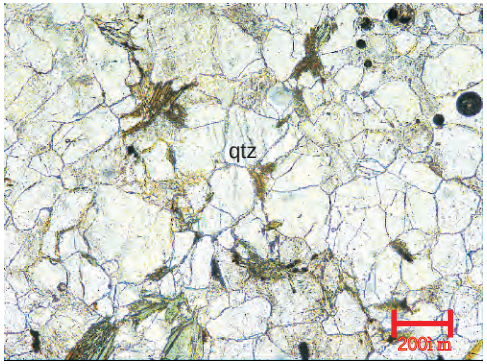
Summary

A slight to moderate color shift is observed in qtz grains in this thin section going from an initial color ranging from medium to dark blue to a final color ranging from dark to very dark blue. Luminescence of qtz grains is inhomogeneous.

Sample

CL 32-6 Leucocratic Gneiss, Cormacks Lake, central NL

Grain #1



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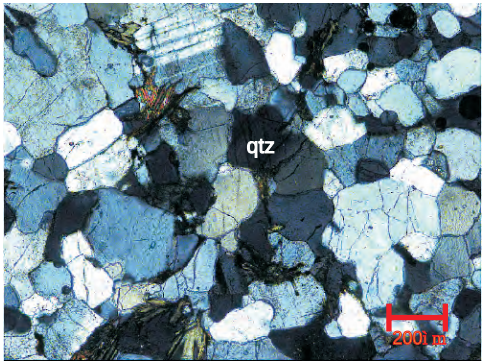
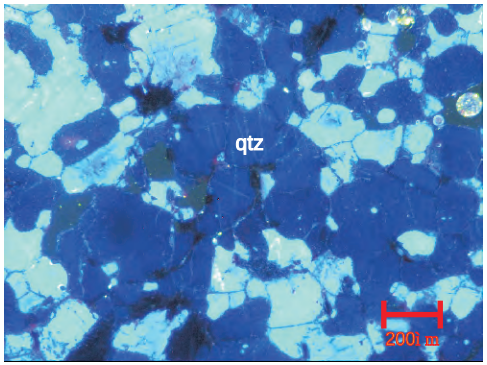
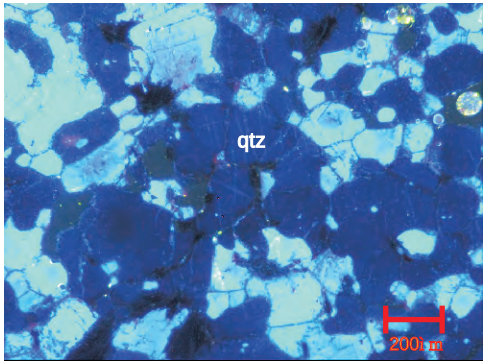


xpl



after ~6 sec exposure to CL

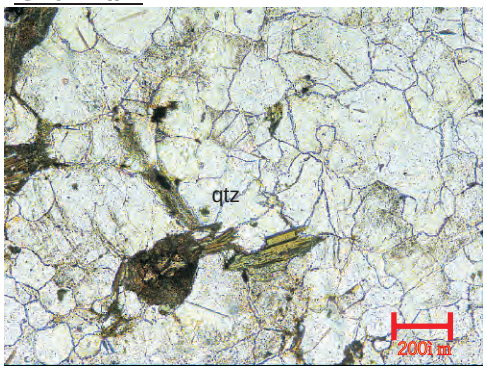


after ~22 sec exposure to CL

Notes

1) -moderate color shift from bright blue with light blue in fractures at ~6 sec exposure to CL to medium blue with light blue in fractures at ~22 sec exposure to CL
2) -light blue luminescent grains are feldspar
3) -chlorite and feldspar mineral inclusions, and also fluid inclusions present in grains
4) -grains have embayed grain margins and are monocrystalline, cooling cracks (conchoidal fractures) can be seen

Grain #2



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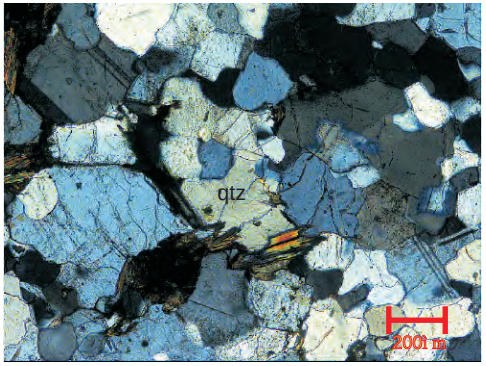

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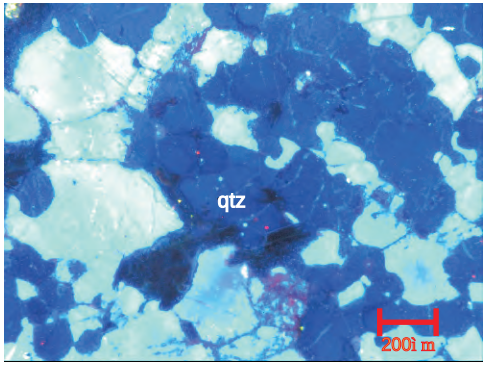
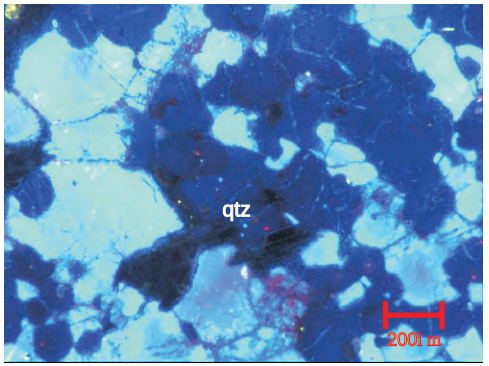


after ~3 sec exposure to CL



after ~19 sec exposure to CL

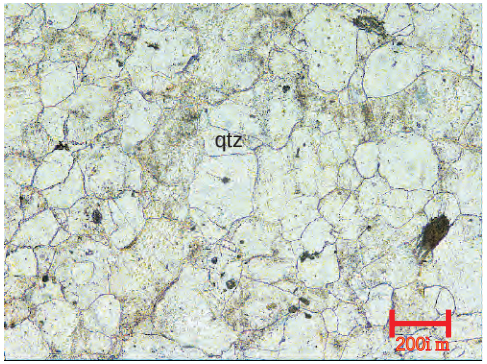
Notes

1) -moderate color shift from an initial color of bright blue with light blue in fractures at ~3 sec exposure to CL to a final color of medium-dark blue with light blue in fractures at ~19 sec exposure to CL
2) -light blue luminescent grains are feldspar
3) -chlorite and feldspar mineral inclusions, and also fluid inclusion present in grains
4) -grains have irregular grain margins and are monocrystalline, cooling cracks (conchoidal fractures) can be seen

Sample

CL 32-6 Leucocratic Gneiss, Cormacks Lake, central NL

Grain #3



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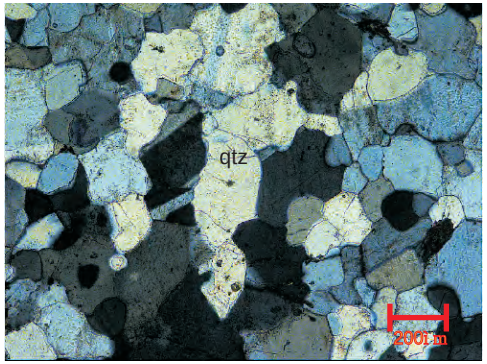

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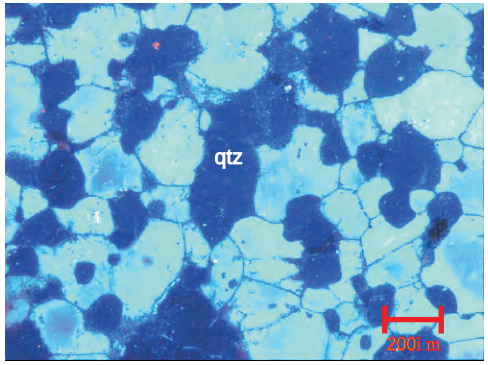
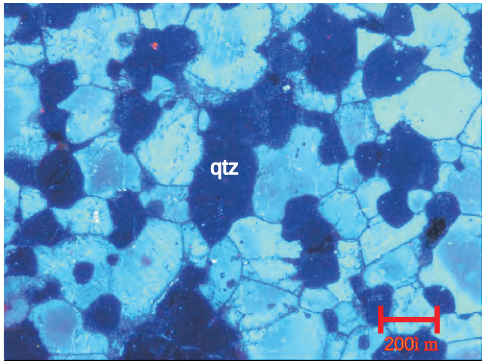


after ~6 sec exposure to CL

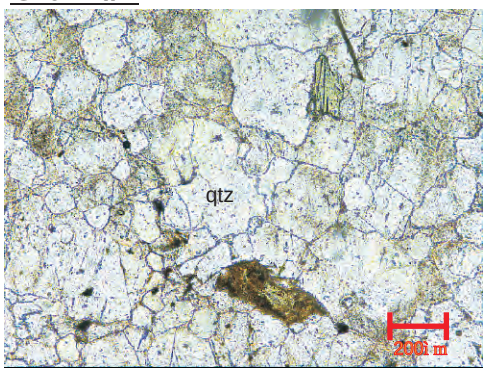


after ~15 sec exposure to CL

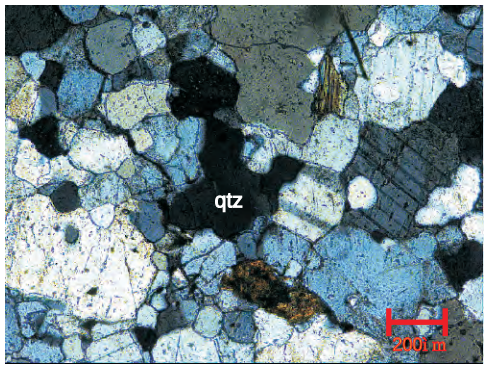
Notes

1) -moderate color shift from bright-medium blue with light blue in fractures ~6 sec exposure to CL to medium-dark blue with light blue in fractures at ~15 sec exposure to CL
2) -light blue luminescent grains are feldspar
3) -chlorite and unknown mineral inclusions (too small to identify with petrographic microscope), and also fluid inclusions present in grains
4) -grains have embayed grain margins and are monocrystalline, cooling cracks (conchoidal fractures) and a few microfractures can be seen

Grain #4



ppl



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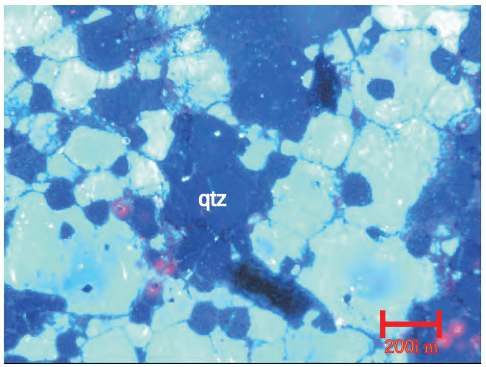
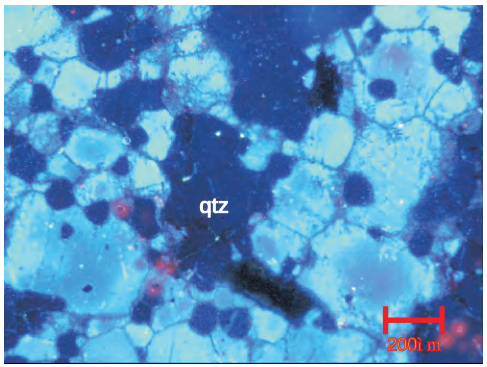


after ~3 sec exposure to CL



after ~19 sec exposure to CL

NOtes

1) -strong color shift from bright blue with light blue in fractures at ~3 sec exposure to Cl to medium-dark blue with light blue in fractures at ~19 sec exposure to CL
2) -light blue luminescent mineral is feldspar, red luminescent areas not identified
3) -unknown mineral inclusions (too small to identify with petrographic microscope), and also fluid inclusions present in grains
4) -grains have embayed grain margins and are monocrystalline, cooling cracks (conchoidal fractures) and a few microfractures can be seen

Sample

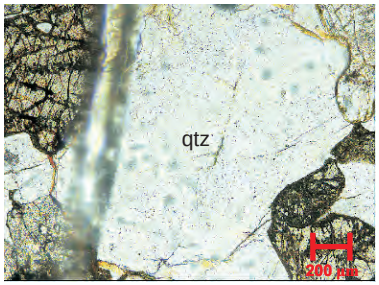
CL 32-6 Leucocratic Gneiss, Cormacks Lake, central NL

Summary
Moderate to strong color shift in quartz grains in this thin section going from an initial color of bright to bright-medium blue to a final color of medium to medium-dark blue. Grains also exhibit a light blue luminescence in fractures.

Sample

VO-86-113-2 Garnetiferous Tonalitic Gneiss, Western Brook Pond, Gros Morne NL

Grain #1



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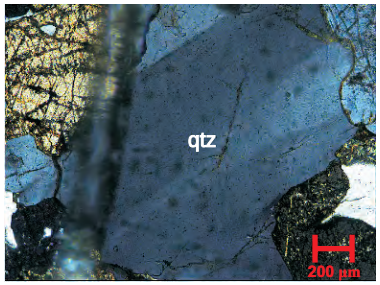

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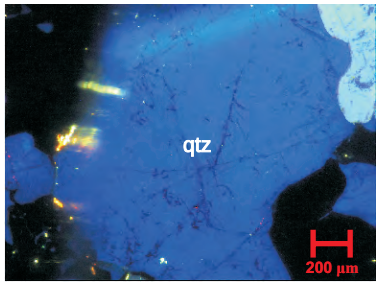
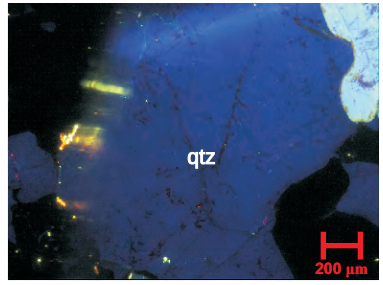


after 3 sec exposure to CL

after 12 sec exposure to CL

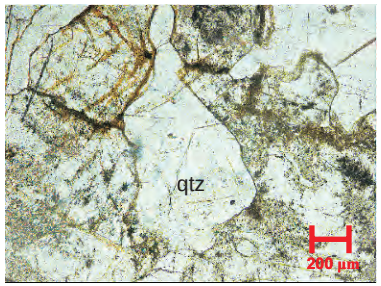


after 21 sec exposure to CL

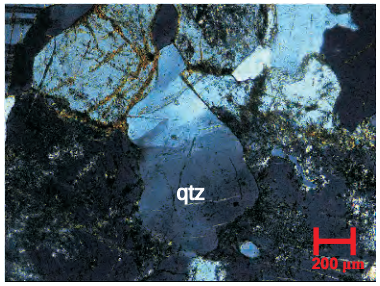
Notes

1) -strong color shift from an initial color of bright blue at 3 sec exposure to CL to a final color of medium-dark blue at 21 sec exopsure to CL
2) -bright yellow luminescent grains are apatite, light blue luminescent grain is feldspar
3) -mineral inclusions of tourmaline, and also fluid inclusions present in grain
4) -grain has embayed grain margins and is monocrystalline, microfractures can be seen

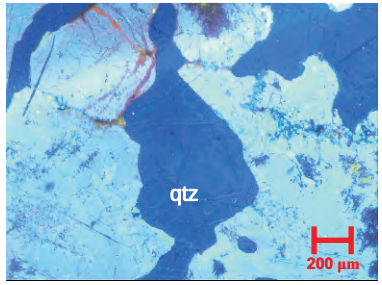
Grain #2



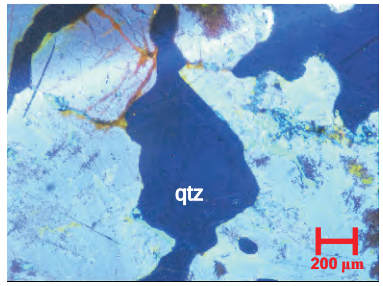
ppl



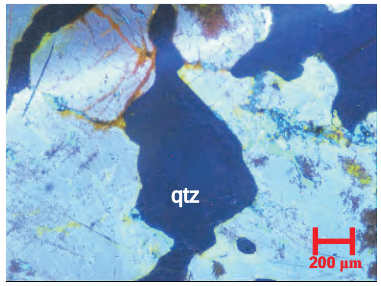
xpl



after 3 sec exposure to CL



after 12 sec exposure to CL



after 21 sec exposure to CL

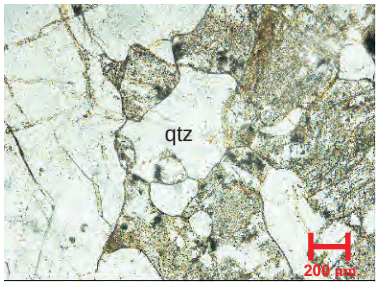
NOtes

1) -strong color shift from an initial color of bright blue at 3 sec exposure to CL to a final color of medium-dark blue at 21 sec exposure to CL
2) -light blue luminescent grains are feldspar
3) -mineral inclusions of chlorite and also fluid inclusions present in grain
4) -grain has embayed grain margins and is monocrystalline, microfractures can be seen

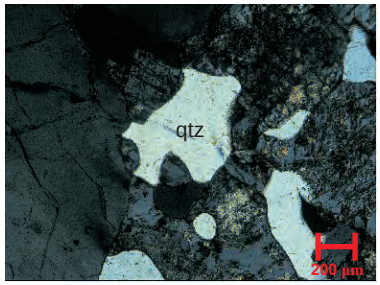
Sample

VO-86-113-2 Garnetiferous Tonalitic Gneiss, Western Brook Pond, Gros Morne NL

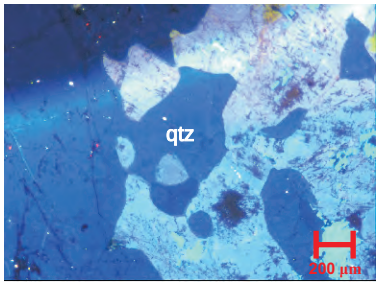
Grain #3



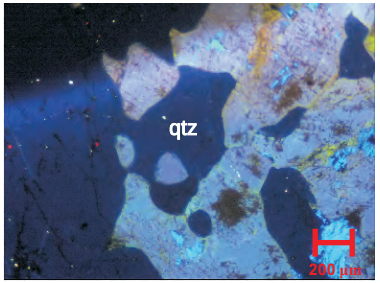
ppl



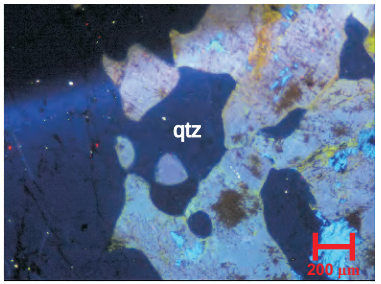
xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

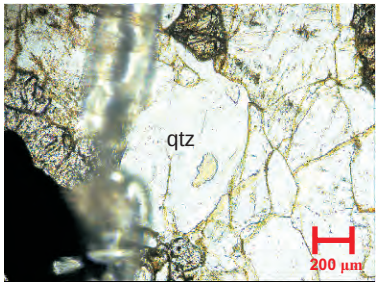


after 21 sec exposure to CL

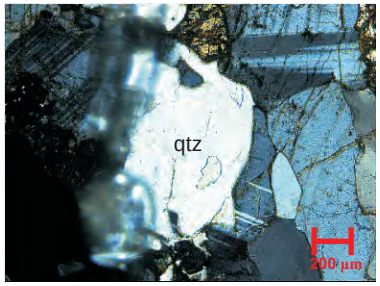
Notes

1) -strong color shift from an initial color of bright blue at 3 sec exposure to CL to a final color of dark blue at 12 sec exposure to CL, no color shift observed between 12 sec and 21 sec exposure
2) -light blue luminescent mineral is feldspar
3) -chlorite, tourmaline and feldspar mineral inclusions and also fluid inclusions present in grain
4) -grain has embayed grain margins and is monocrystalline, microfractures can be seen

Grain #4



ppl



xpl

after 3 sec exposure to CL

after 12 sec exposure to CL

after 21 sec exposure to CL

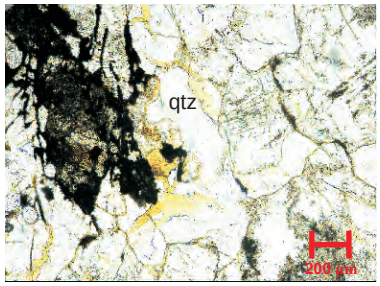
NOtes

1) -strong color shift from an initial color of bright blue at 3 sec exposure to CL to a final color of dark blue at 21 sec exposure to CL
2) -light blue luminescent grains are feldspar, bright yellow luminescent mineral is apatite
3) -mineral inclusions of feldspar and also fluid inclusions present in grain
4) -grain has embayed grain margins and is monocrystalline, microfractures can be seen

Sample

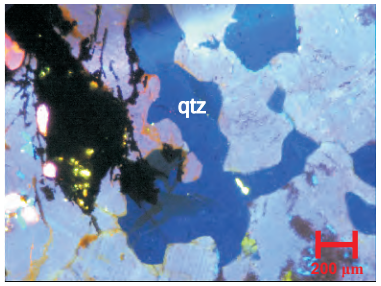
VO-86-113-2 Garnetiferous Tonalitic Gneiss, Western Brook Pond, Gros Morne NL

Grain #5

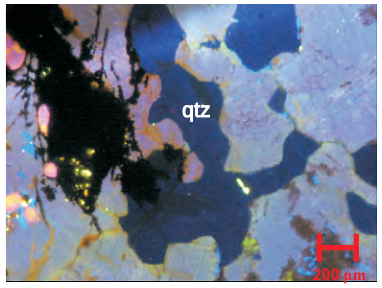


ppl

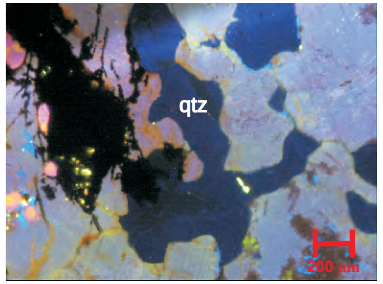
xpl



after 3 sec exposure to CL



after 12 sec exposure to CL



after 21 sec exposure to CL

Notes

1) -strong color shift from an initial color of inhomogeneous bright blue at 3 sec exposure to CL to a final color of dark blue at 12 sec exposure to CL, no color shift between 12 sec and 21 sec exposure to CL
2) -light pinkish/blue luminescent grains are feldspar, bright yellow luminescent mineral is apatite, unknown bright pink luminescent mineral
3) -apatite, toumaline and feldspar mineral inclusions, and also fluid inclusions present in grain
4) -grain has embayed grain margins and is monocrystalline, microfractures can be seen

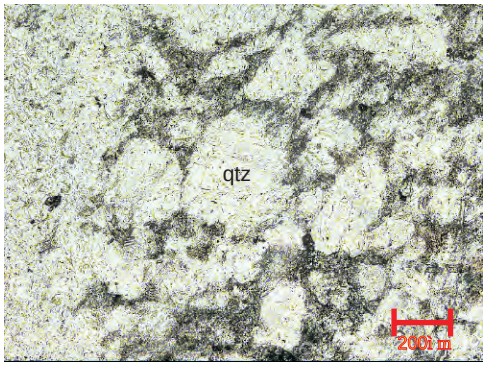
Summary

Strong color shift can be seen in qtz grains in this thin section going from an initial color of bright blue to a final color of medium-dark to dark blue. Grains have embayed grain margins, are microfractured and are monocrystalline.

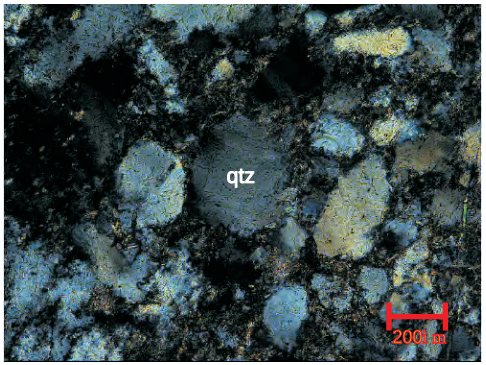
Sample

4066 Quartzite, Gamble Brook Formation, Frog Lake Quarry, Cobequid Highlands, NS

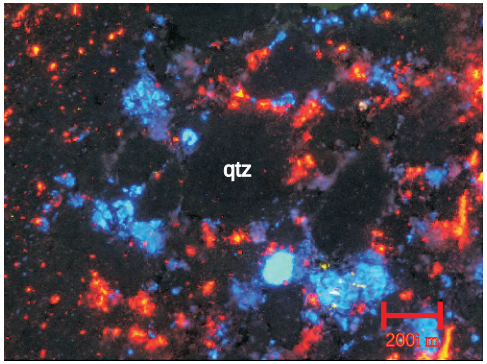
Grain #1



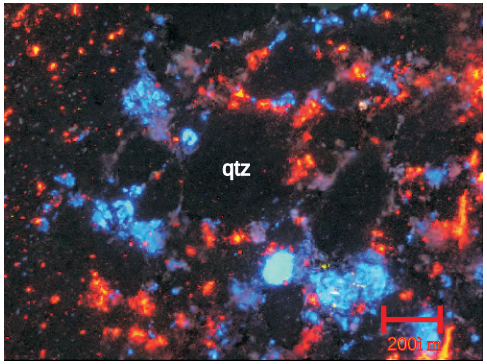
ppl



xpl



after ~6 sec exposure to CL

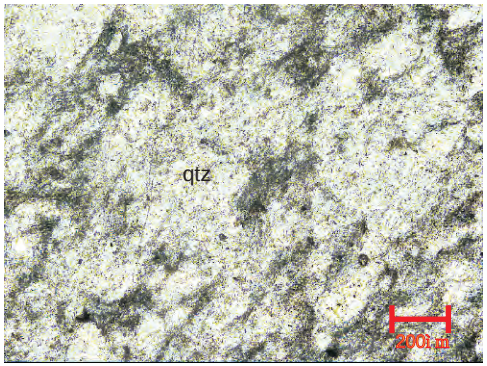


after ~16 sec exposure to CL

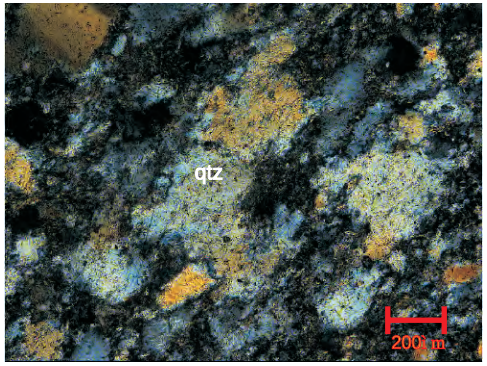
Notes

1) -slight color shift from dark blue/reddish brown at ~6 sec exposure to CL to very dark blue/reddish brown at ~16 sec exposure to CL
2) -bright orange luminescent grains are calcite, light blue luminescent grains are feldspar
3) -mineral inclusions of apatite and tourmaline, and also fluid inclusions present in grain
4) -grain is polycrystalline and has irregular grain margins, microfractures can be seen

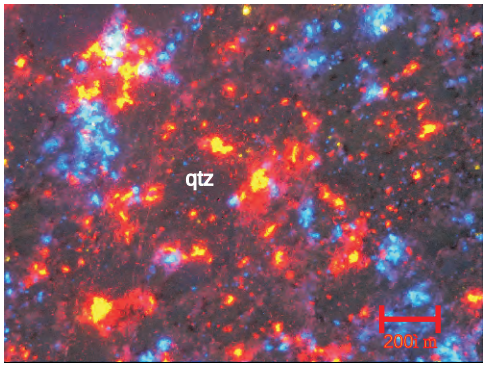
Grain #2



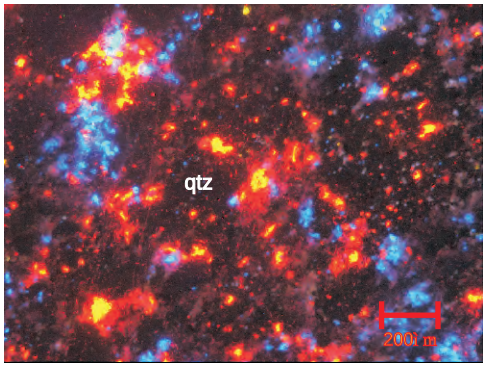
ppl



xpl



after ~3 sec exposure to CL



after ~16 sec exposure to CL

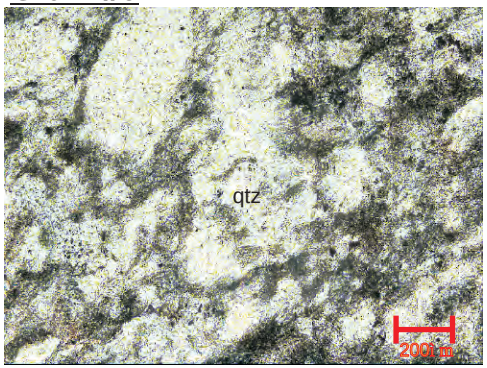
Notes

1) -slight color shift from and initial color of inhomogeneous dark blue/reddish brown at ~3 sec exposure to CL to a final color of inhomogeneous very dark blue/reddish brown at ~16 sec exposure to CL
2) -bright orange luminescent grains are calcite, light blue luminescent grains are feldspar
3) -many calcite mineral inclusions, and also fluid inclusion can be seen
4) -grain is polycrystalline and has irregular grain margins, microfractures can be seen

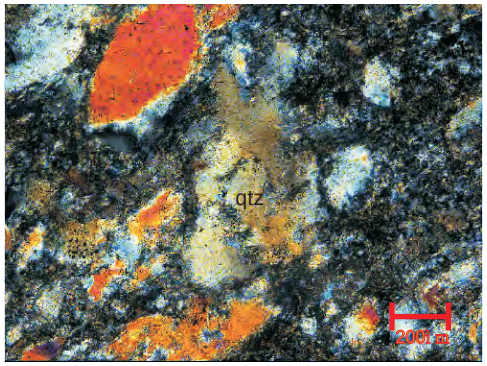
Sample

4066 Quartzite, Gamble Brook Formation, Frog Lake Quarry, Cobequid Highlands, NS

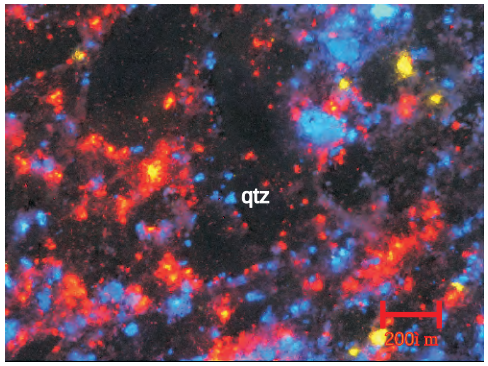
Grain #3



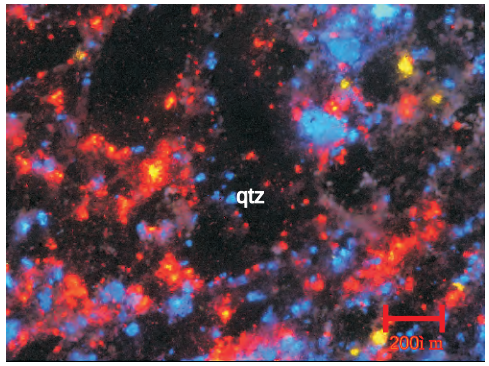
ppl



xpl



after ~6 sec exposure to CL

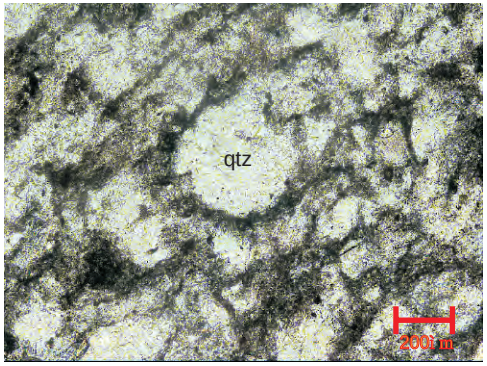


after ~19 sec exposure to CL

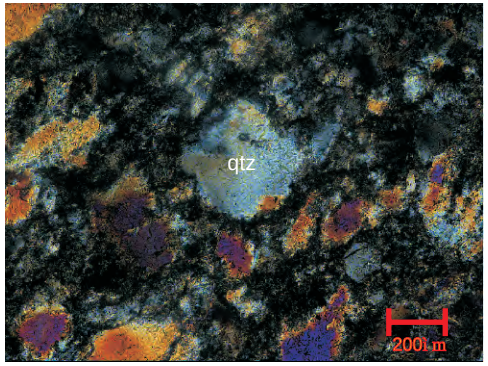
Notes

1) -slight color shift from dark blue/reddish brown at ~6 sec exposure to CL to very dark blue/reddish brown at ~19 sec exposure to CL
2) -bright blue luminescent grains are feldspar, bright orange luminescent grains are calcite, and bright yellow luminescent grains are apatite
3) -calcite, feldspar, and apatite mineral inclusions, and also fluid inclusions present in grain
4) -grain is polycrystalline and has irregular grain margins, a few small microfractures can be seen

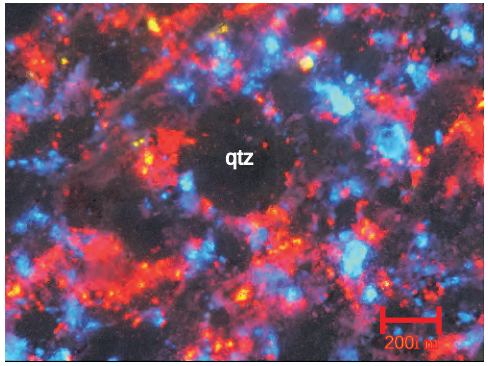
Grain #4



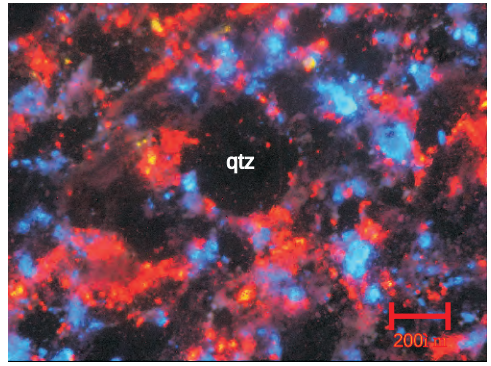
ppl



xpl



after ~4 sec exposure to CL



after ~16 sec exposure to CL

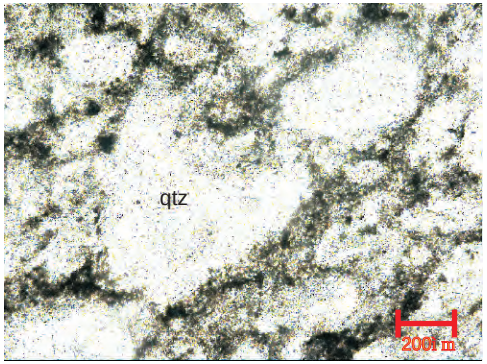
Notes

1) -slight color shift from dark blue/reddish brown at ~4 sec exposure to CL to very dark blue/reddish brown at ~16 sec exposure to CL
2) -bright orange luminescent grains are calcite, light blue luminescent grains are feldspar, and yellow luminescent grains are apatite
3) -calcite, feldspar, and tourmaline mineral inclusions, and also fluid inclusions present in grain
4) -grain is polycrystalline and has irregular grain margins, a few small microfractures can be seen

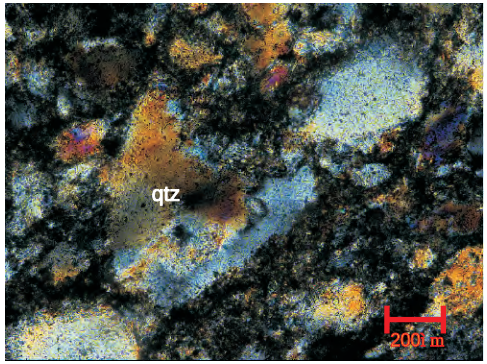
Sample

4066 Quartzite, Gamble Brook Formation, Frog Lake Quarry, Cobequid Highlands, NS

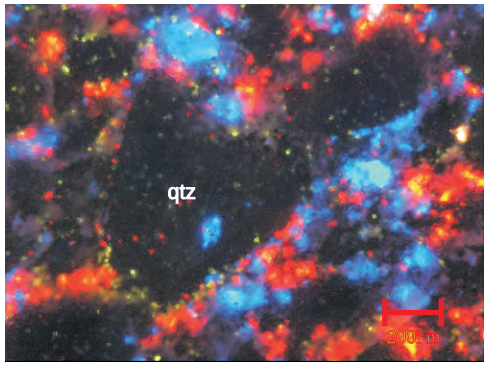
Grain #5



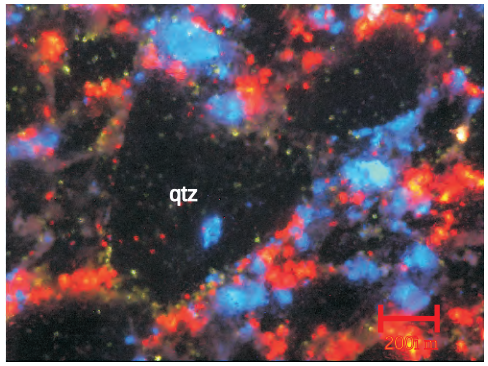
ppl



xpl



after ~7 sec exposure to CL



after ~19 sec exposure to CL

Notes

1) -slight color shift from dark blue/brown at ~7 sec exposure to CL to very dark blue/brown at ~19 sec exposure to CL
2) -flecks of light green, light blue, and bright orange on grain (possibly very small mineral inclusions or residue from polishing materials), bright orange luminescent grains are calcite, light blue luminescent grains are feldspar
3) -feldspar, apatite, and tourmaline mineral inclusion, and also fluid inclusions present in grain
4) -grain is polycrystalline and has irregular grain margins, a few small microfractures can be seen

Summary

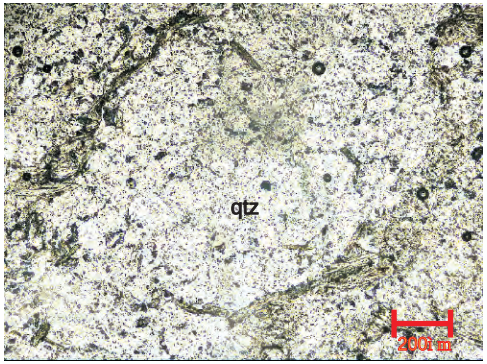
Slight color shift in qtz grains in this slide from an initial color of dark blue/reddish brown or blue/brown to a final color of very dark blue/reddish brown or blue/brown. CL color of quartz grains is slightly inhomogenious.

High-Pressure Metamorphic Quartz

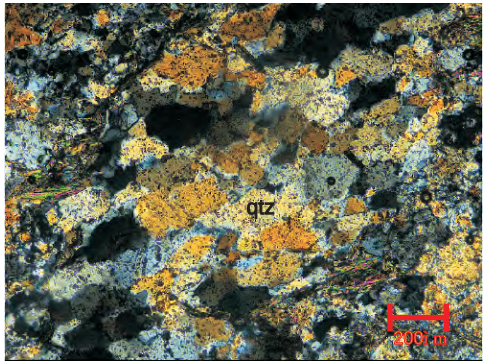
Sample

ALF1 Foliated metasandstone (metaflysch), Petries, Evia, Greece

Grain #1



ppl



xpl

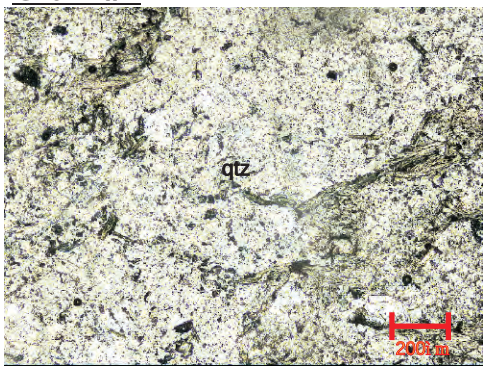
after 3 sec exposure to CL

after 12 sec exposure to CL

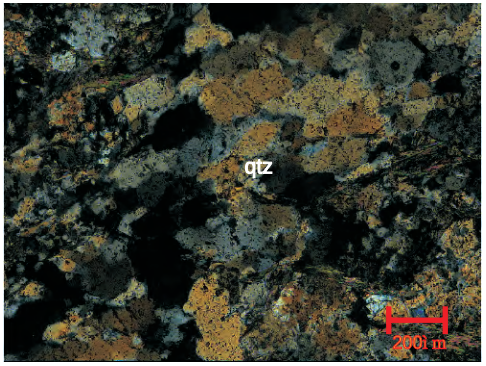
Notes

1) -no color shift between 3 sec and 12 sec exposure to CL, quartz does not appear to be luminescent
2) -the few very small bright orange luminescent grains are calcite
3) -muscovite and tourmaline mineral inclusions, and also fluid inclusions present in grains
4) -grains have irregular grain margins and are polycrystalline, sub-grain boundaries are sutured, and a few small microfractures can be seen
5) -weak foliation can be seen in photographed area of sample

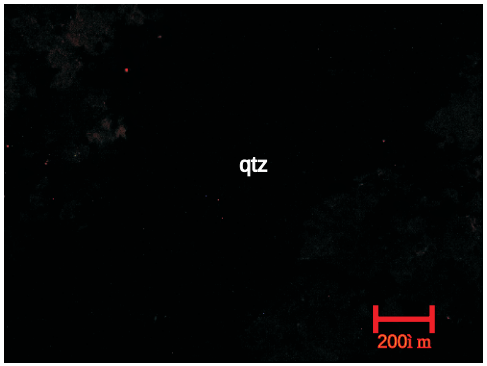
Grain #2



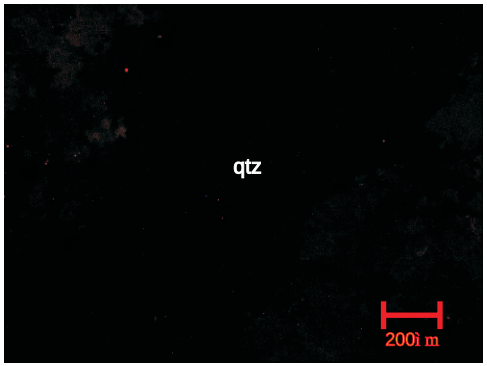
ppl



xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

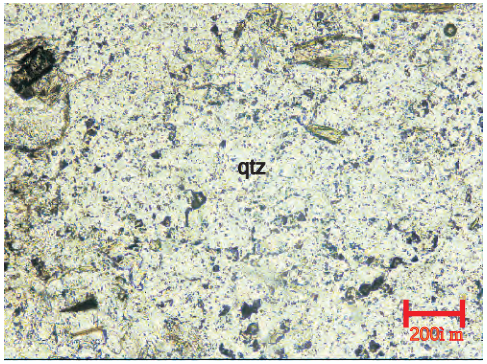
NOtes

1) -no color shift between 3 sec and 12 sec exposure to CL, qtz does not appear to be luminescent
2) -the few very small bright orange luminescent grains are calcite
3) -amphibole and chlorite mineral inclusion, and also fluid inclusions present in grains
4) -grains have irregular grain margins and are polycrystalline, sub-grain boundaries are sutured, microfractures can be seen
5) -weak foliation can be seen in photographed area of sample

Sample

ALF1 Foliated metasandstone (metaflysch), Petries, Evia, Greece

Grain #3



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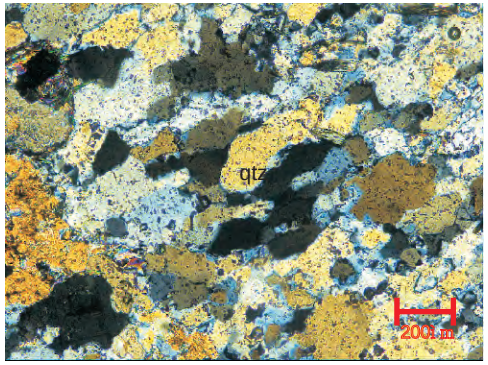
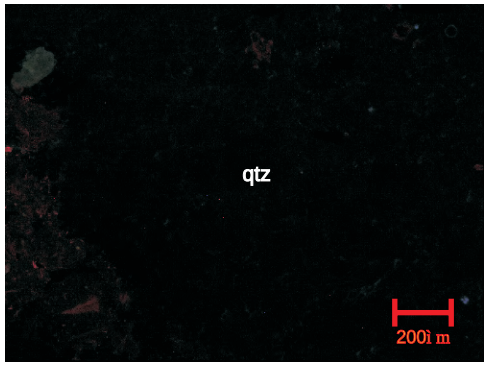


xpl



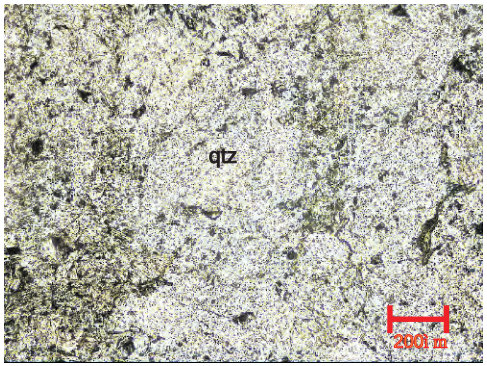
after 3 sec exposure to CL

after 12 sec exposure to CL

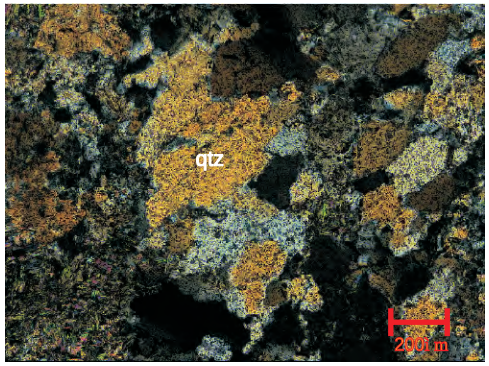
Notes

1) -slight color shift from an initial color of very dark grey at 3 sec exposure to CL to a final color of even darker grey/black (qtz does not appear to be luminescent) at 12 sec exposure to CL
2) -dark reddish luminescent grains were not identified (feldspar?)
3) -muscovite mineral inclusion, and also fluid inclusions present in grain
4) -grain has irregular grain margins and is polycrystalline, sub-grain boundaries are sutured
5) foliation can be seen in photographed area of sample

Grain #4



ppl



xpl

after 3 sec exposure to CL

after 12 sec exposure to CL

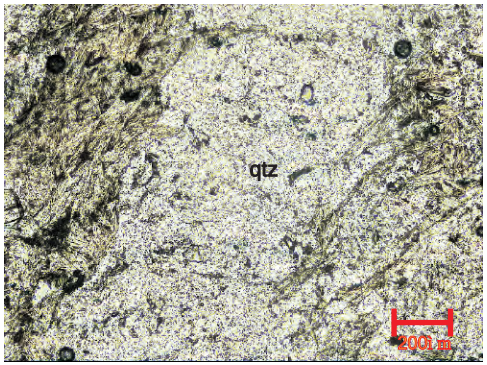
Notes

1) -slight color shift from an initial color of very dark grey at 3 sec exposure to CL to a final color of even darker grey/black (qtz does not appear to be luminescent) at 12 sec exposure to CL
2) -no other luminescent grains seen in CL photos
3) -amphibole and chlorite mineral inclusions, and also fluid inclusions present in grain
4) -grain has irregular grain margins and is polycrystalline, sub-grain boundaries are sutured
5) -foliation can be seen in photographed area of sample

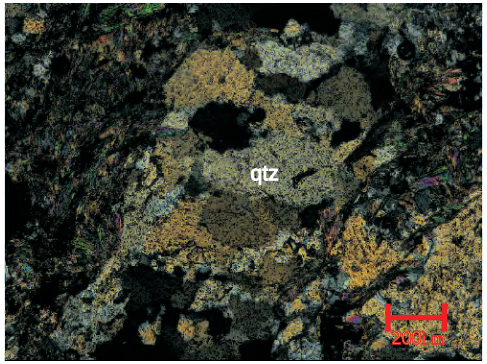
Sample

ALF1 Foliated metasandstone (metaflysch), Petries, Evia, Greece

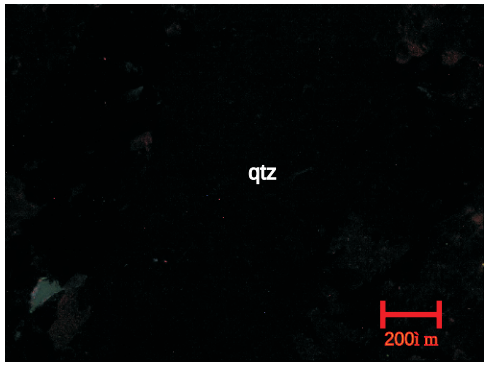
Grain #5



ppl



xpl



after 3 sec exposure to CL

after 12 sec exposure to CL

Notes

1) -slight color shift from an initial color very dark grey at 3 sec exposure to CL to a final color of even darker grey/black (qtz does not appear to be luminescent) at 12 sec exposure to CL
2) -no other luminescent grains seen in CL photos
3) -amphibole mineral inclusions, and also fluid inclusions can be seen
4) -grain has irregular grain margins and is polycrystalline, sub-grain boundaries are sutured, a few microfractures present in grain
5) -foliation can be seen in photographed area of sample

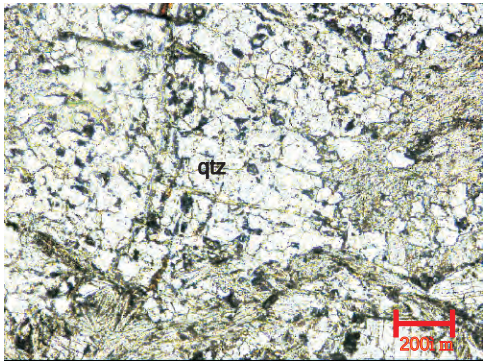
Summary

Color shift in qtz grain in this slide is slight to non-existent. Grains that do not display a color shift do not appear to be luminescent at all, however grains that display a color shift have an initial color of very dark grey and a final color that is so dark the grain no longer appears to be luminescent.

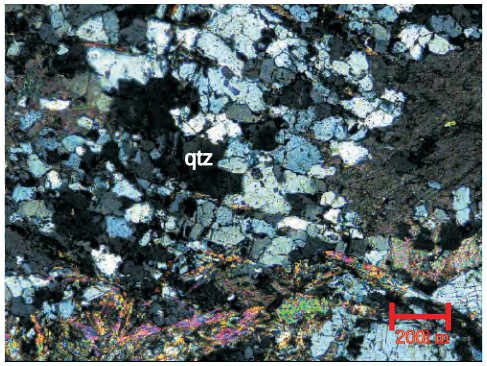
Sample

ALF3 Metasandstone (metaflysch), Petries, Evia, Greece

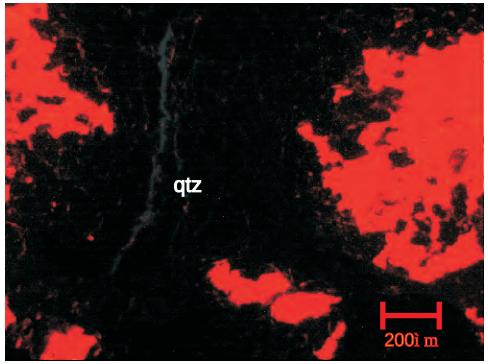
Grain #1



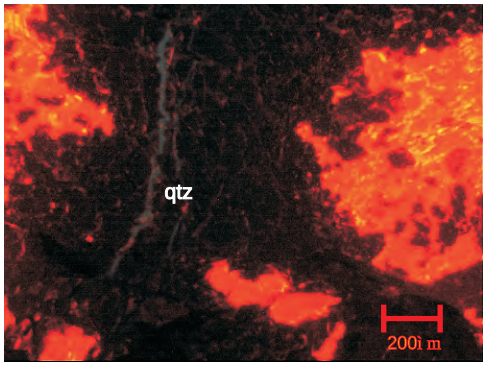
ppl



xpl



after 3 sec exposure to CL

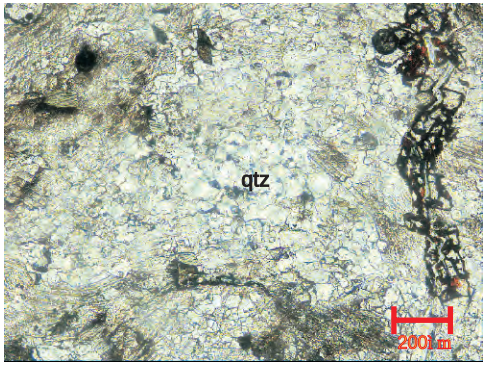


after 12 sec exposure to CL

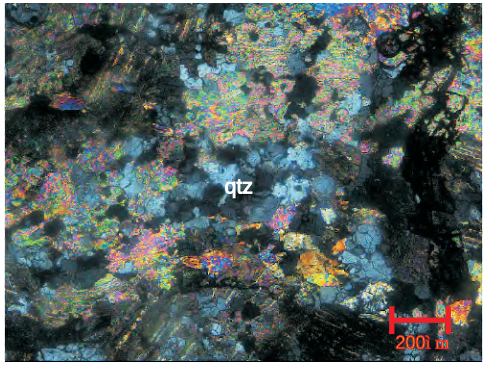
Notes

1) -grain appears almost black (luminescence of qtz is too dark to determine color) at 3 sec exposure to CL and reddish brown at 12 sec exposure to CL, slight color shift
2) bright orange luminescent mineral is calcite
3) -mineral inclusions of tourmaline and chlorite, and also fluid inclusions present in grain
4) -grains have irregular grain margins and are polycrystalline, individual sub-grains are small and have sutured boundaries

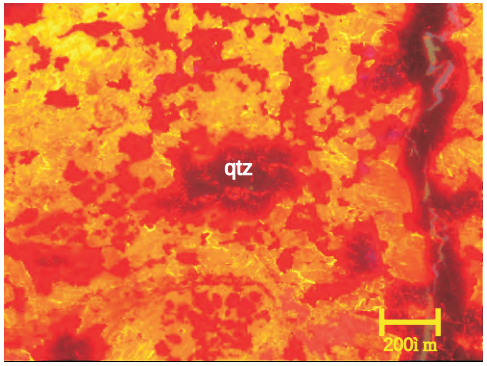
Grain #2



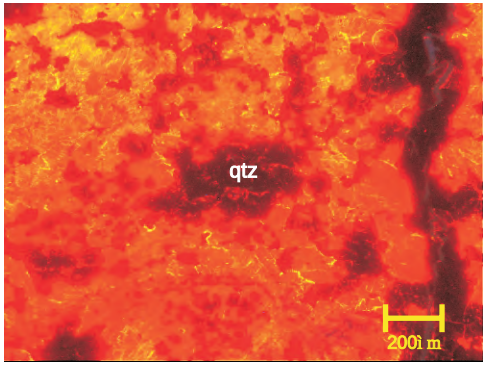
ppl



xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

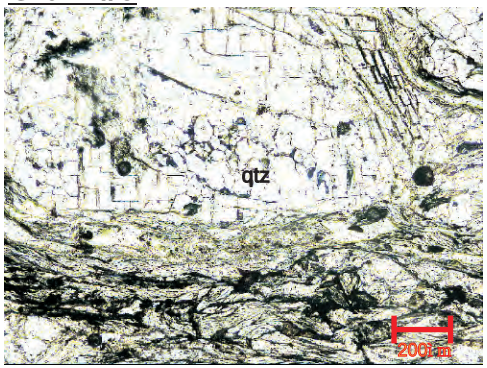
NOtes

1) -slight color shift from lighter to darker around edges of grain from 3 sec to 12 sec exposure to CL because of color shift darker in surrounding calcite, otherwise no visible color change in quartz grain, bright orange luminescent calcite filling fractures in quartz
2) -bright orange luminescent mineral is calcite
3) -tourmaline mineral inclusions and also fluid inclusion present in grain
4) -grain has irregular grain margins and is polycrystalline, sub-grains are small and have sutured boundaries, microfractures can be seen

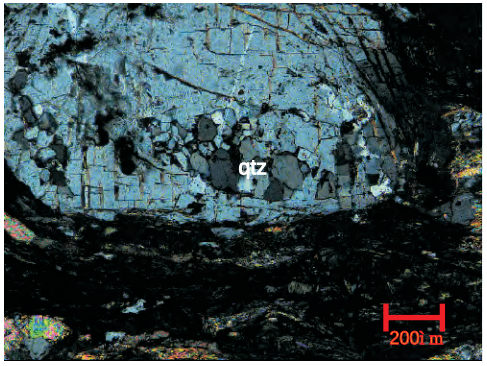
Sample

ALF3 Metasandstone (metaflysch), Petries, Evia, Greece

Grain #3



ppl



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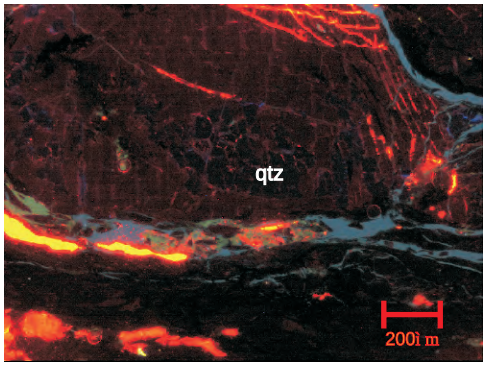
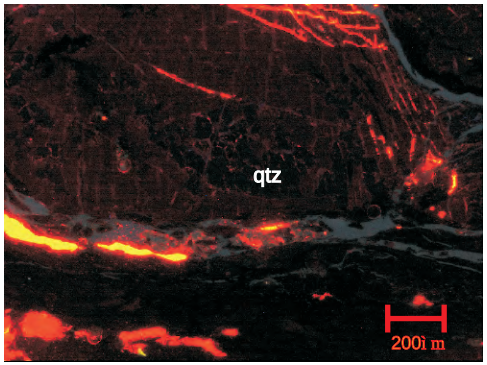


after 3 sec exposure to CL

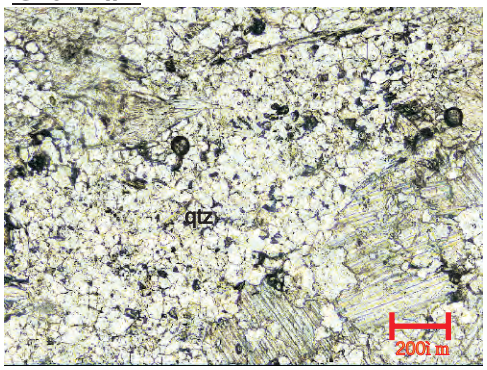


after 12 sec exposure to CL

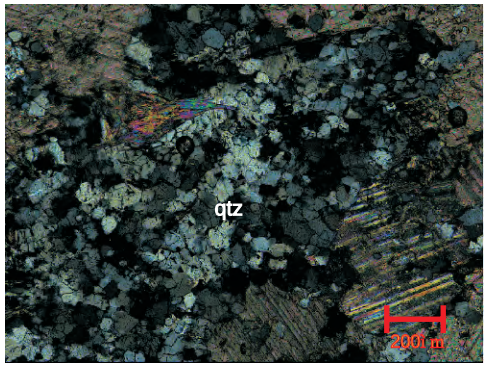
Notes

1) -luminescence of qtz grains is too dark to determine a color, however there is a slight color shift darker between 3 sec and 12 sec exposure to CL
2) -dark red luminescent mineral is feldspar, bright orange luminescing mineral is calcite
3) -tourmaline and chlorite mineral inclusions, and also fluid inclusions present in grain
4) -grain has irregular grain boundaries and is polycrystalline, a few microfractures can be seen

Grain #4



ppl



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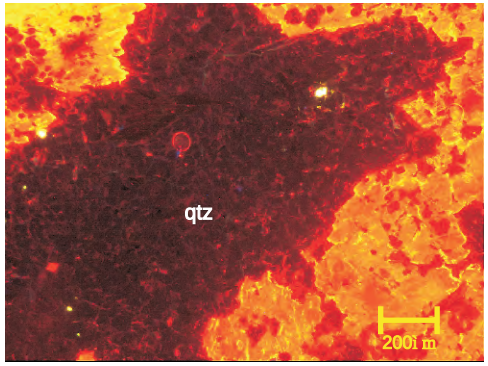
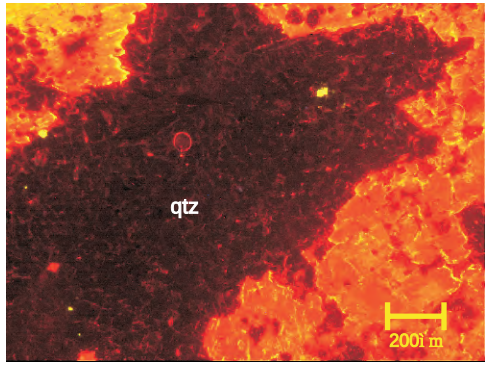


after 3 sec exposure to CL



after 12 sec exposure to CL

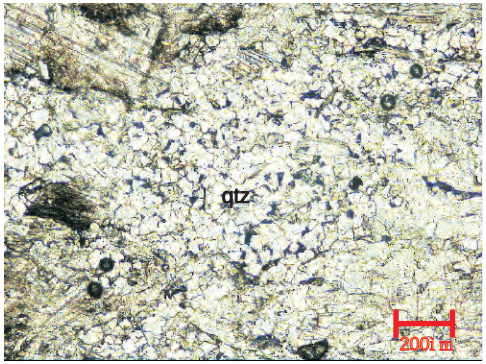
NOtes

1) -slight color shift from an initial color of dark reddish brown at 3 sec exposure to CL to a final color of very dark reddish brown at 12 sec exposure to CL
2) -bright orange luminescent mineral is calcite, bright yellow luminescent inclusions are apatite
3) -apatite and calcite grains included in quartz, fluid inclusions present in grain
4) -grains have irregular grain boundaries and are polycrystalline, microfractures can be seen

Sample

ALF3 Metasandstone (metaflysch), Petries, Evia, Greece

Grain #5



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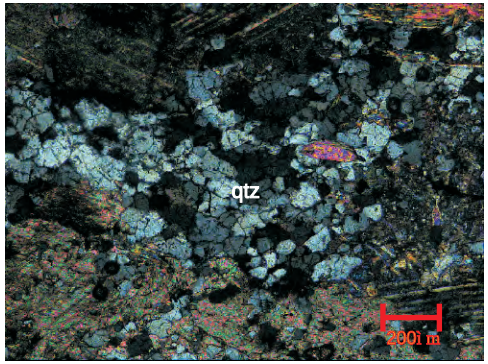

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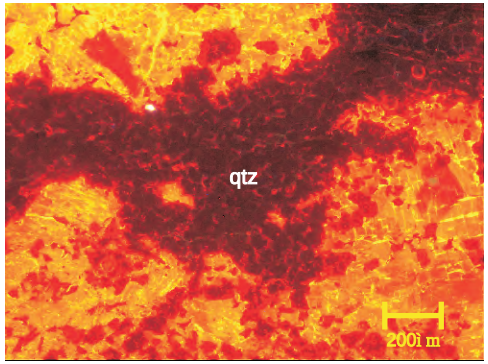
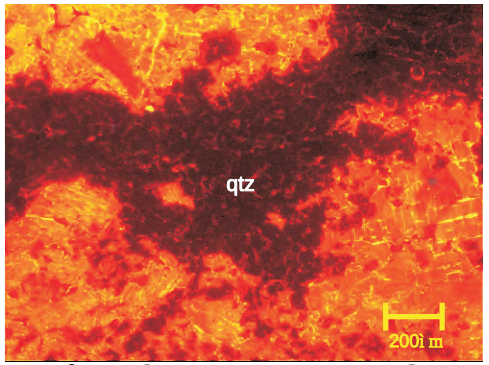


after 3 sec exposure to CL



after 12 sec exposure to CL

Notes

1) -no visible color shift in quartz grains between 3 sec and 12 sec exposure to CL, quartz grains are very dark reddish brown
2) -bright orange luminescent mineral is calcite
3) -calcite grains included in quartz, fluid inclusions also present in grain
4) -grain has irregular grain boundaries and is polycrystalline, sub-grain margins are sutured, microfractures can be seen

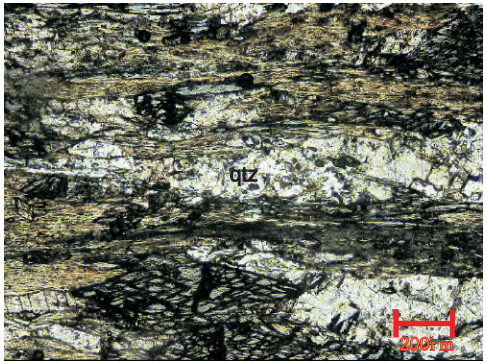
Summary

Qtz grain in this slide exhibit a slight to non-existant color shift. In grains #2, and #4 a slight color shift can be seen going from an initial color of dark reddish brown to a final color of an even darker reddish brown. In grain #1 there is a also a slight color shift, however grain becomes lighter with increased exposure to CL. In grain #3, the luminescence of the quartz is not bright enough to distinguish what color it is (not quite black though), however it does shift darker between its initial and final colors. Grain#5 exhibits very dark reddish brown luminescence and does not shift in color.

Sample

ALF5 Glaucophane schist, Petries, Evia, Greece

Grain #1



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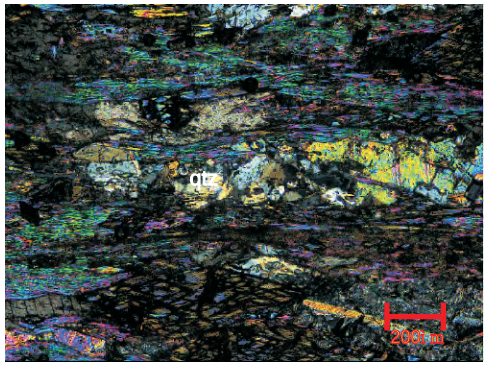

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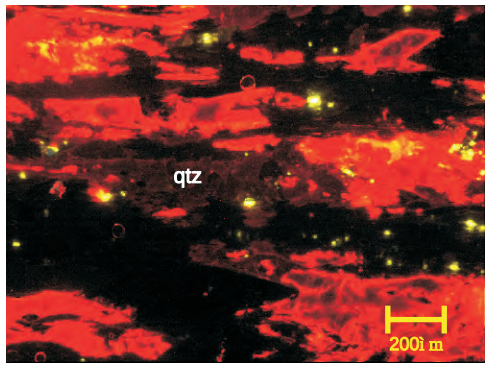
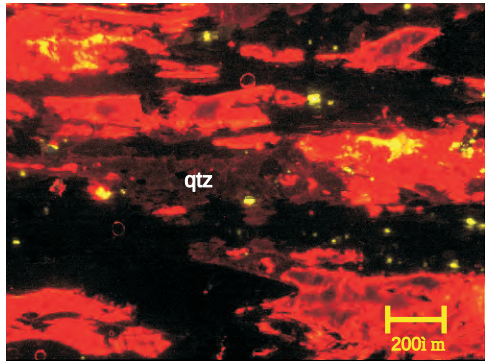


after 3 sec exposure to CL

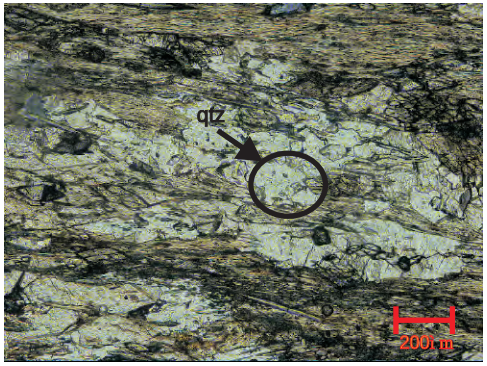


after 12 sec exposure to CL

Notes

1) -no color shift between 3 sec and 12 sec exposure to CL, luminescence of qtz is dark reddish brown
2) -bright orange luminescent mineral is calcite, bright yellow luminescent grains are apatite
3) -amphibole mineral inclusion and also fluid inclusions present in grain
4) -grains have irregular grain boundaries and are polycrystalline, sub-grain boundaries are sutured, microfractures can be seen
5) -foliation can be seen in photographed area of sample

Grain #2



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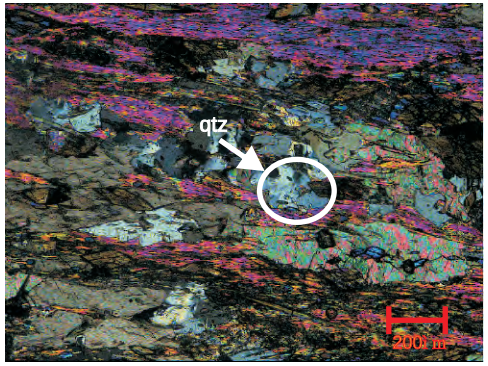
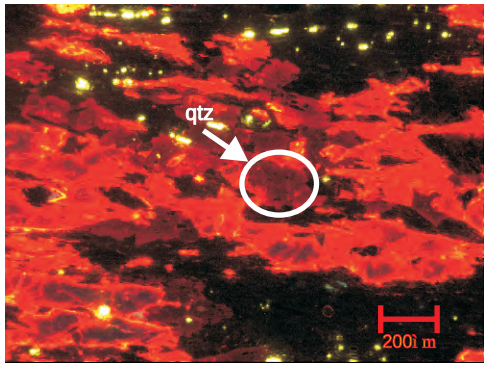
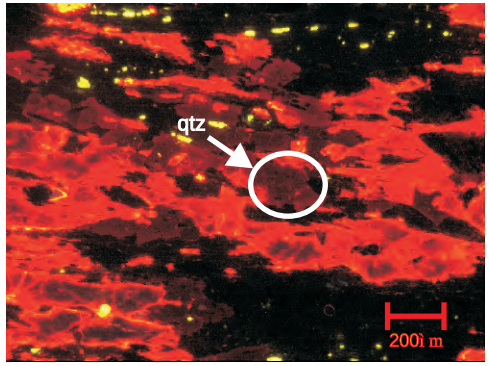


xpl



after 3 sec exposure to CL



after 12 sec exposure to CL

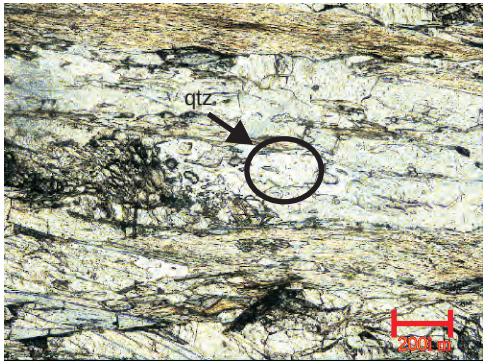
NOtes

1) -slight color shift from an initial color of dark reddish brown at 3 sec exposure to CL to a final color of very dark reddish brown at 12 sec exposure to CL
2) -bright orange luminescent mineral is calcite, bright yellow luminescent grains are apatite
3) -amphibole and tourmaline mineral inclusions, and also fluid inclusions present in grain
4) -grain has irregular grain boundaries and is polycrystalline, sub-grain boundaries are sutured, a few very small microfractures can be seen
5) -foliation can be seen in photographed area of sample

Sample

ALF5 Glaucophane schist, Petries, Evia, Greece

Grain #3



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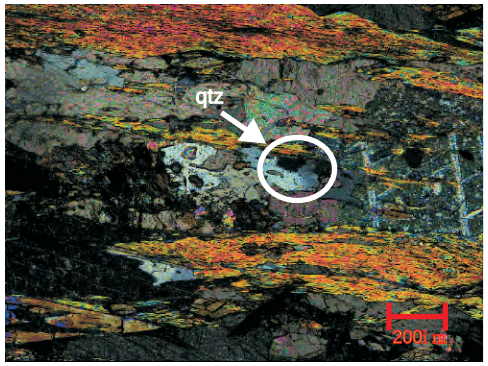

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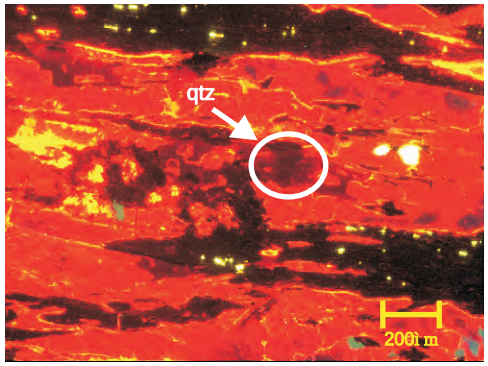
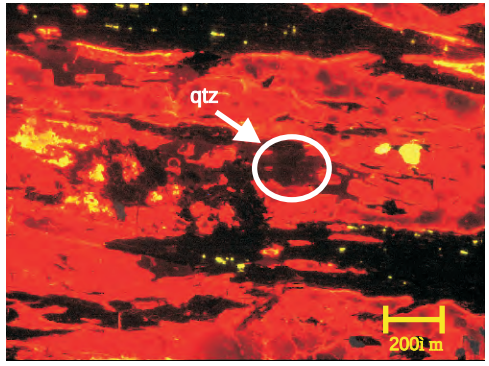


after 3 sec exposure to CL

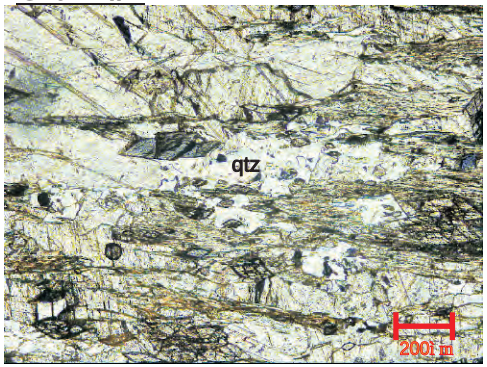


after 12 sec exposure to CL

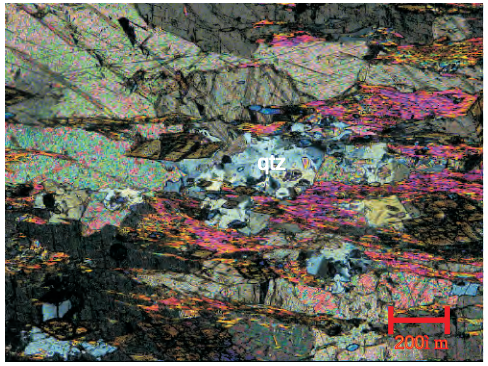
Notes

1) -moderate color shift from an initial color of medium reddish brown at 3 sec exposure to CL to a final color of dark reddish brown at 12 sec exposure to CL
2) -bright orange luminescent mineral is calcite, bright yellow luminescent mineral is apatite
3) -amphibole and calcite mineral inclusions, and also fluid inclusions present in grain
4) -grain has irregular grain boundaries and is polycrystalline, sub-grain boundaires are sutured
5) -foliation can be seen in photographed area of grain

Grain #4



ppl



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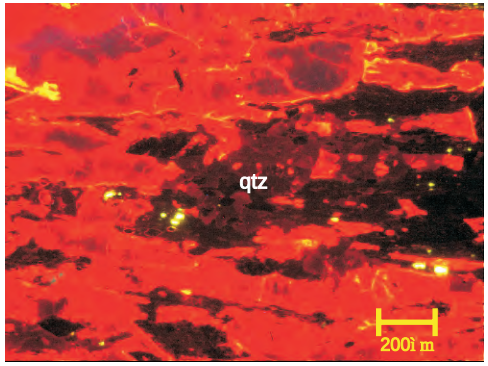
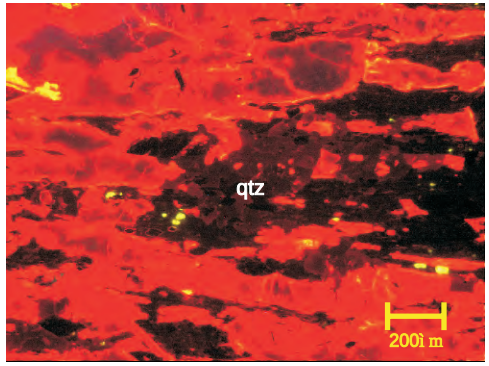


after 3 sec exposure to CL



after 12 sec exposure to CL

NOtes

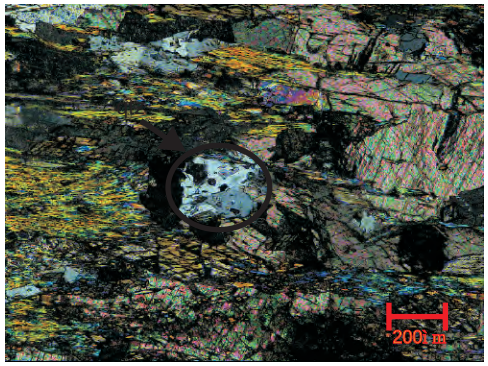
1) -slight color shift from an initial color of dark reddish brown at 3 sec exposure to CL to final color of very dark reddish brown at 12 sec exposure to CL
2) -bright orange luminescent mineral is calcite, bright yellow luminescent mineral is apatite
3) -calcite mineral inclusions and also fluid inclusions present in grain
4) -grain has irregular grain boundaries and is polycrystalline, sub-grain boundaries are sutured
5) -foliation can be seen in photographed area of sample

Sample

ALF5 Glaucophane schist, Petries, Evia, Greece

Grain#5

ppl



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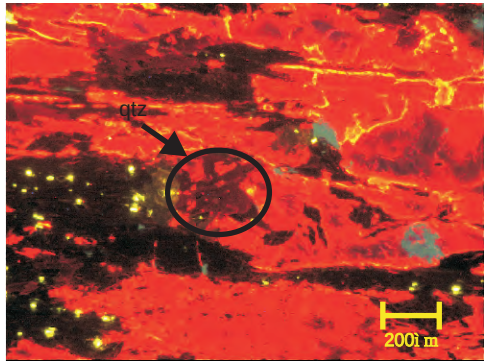
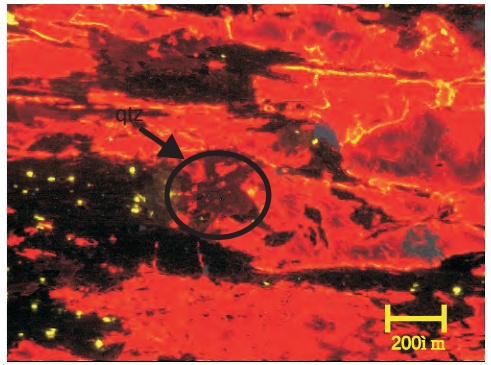


after 3 sec exposure to CL



after 12 sec exposure to CL

Notes

1) -no visible color shift between 3 sec and 12 sec exposure to CL, luminescence of quartz is dark reddish brown
2) -bright orange luminescing mineral is calcite, bright yellow luminescing mineral is apatite
3) -amphibole and calcite mineral inclusions, and also fluid inclusions present in grain
4) -grain has irregular grain boundaries and is polycrystalline

Summary

Quartz grains in this thin section exhibit a moderate to non-existant color shift. Grains that do not display a color shift show a dark reddish brown luminescence. Grains that display a color shift have an initial color of medium to dark reddish brown, and a final color of very dark reddish brown.

Sample List with Localities and Literature

Lithology	Sample	Rock Type	Locality	UTM (E and N) or Latitude & Longitude		Rock Unit	Initial CL Color	Final CL Color
Granite	4685	Plutonic	Gamble Lake, Cobequid Highlands, NS	437371	5037129	Devono-Carboniferous Pleasant Hills Pluton, Avalon Terrane	bright-medium to medium blue	medium to medium-dark blue
Granite	4689	Plutonic	Gamble Lake, Cobequid Highlands, NS	437371	5037132	Devono-Carboniferous Pleasant Hills Pluton, Avalon Terrane	bright-medium to medium blue	medium to medium-dark blue
Granite (with mylonitic areas)	4701	Plutonic	SW of Economy Lake, Cobequid Highlands, NS	433539	5034590	Devono-Carboniferous Pleasant Hills Pluton, Avalon Terrane	bright-medium blue to medim-dark blue	medium-dark blue to dark blue
Granite	3119	Plutonic	Chiganois River, Cobequid Highlands, NS	472958	5039406	Neoproterozoic Frog Lake Pluton, Avalon Terrane	bright-medium to medium blue	medium to dark blue
Pegmatitic Granite	4190	Plutonic	Frog Lake Quarry, Cobequid Highlands, NS	468842	5039285	Neoproterozoic Frog Lake Pluton, Avalon Terrane	medium blue to medium-dark blue	dark blue
Microgranite	2109	Hypabyssal	Powerlines at Henry Brook, Cobequid Highlands, NS	396098	5038378	Minor Carboniferous intrusions north of Parrsboro, Avalon Terrane	Phenocrysts: bright to bright-medium blue, Quartz in matrix: medium-dark blue to dark blue	Phenocrysts: medium blue, Quartz in matrix: dark blue to very dark blue
Undeformed Hornblende Pegmatitic Gabbro	2649b	Plutonic	Frog Lake Quarry, Cobequid Highlands, NS	468842	5039285	Neoproterozoic Frog Lake Pluton, Avalon Terrane	medium to medium-dark blue	dark blue
Granophyric Granite	A42	Plutonic	East of Amphisa, Greece			Jurassic ophiolite clast in Paleocene flysch	bright to bright-medium blue	medium to medium-dark blue
Granite	DL31a	Plutonic	Quarry on SE coast of Delos Island, Greece			Miocene Cyclades granites	bright-medium blue	medium blue to medium-dark blue
Granite	DL16	Plutonic	Coast at Fourni, Delos Island, Greece			Miocene Cyclades granites	bright-medium to medium blue	medium to medium-dark blue
Rhyodacite	C22	Volcanic	Crommyonia, near Corinthos, Greece	~37 55.1 N	~23 06.2 E	Pliocene volcanics, South Aegean Arc	bright to medium blue	medium to dark blue
Rhyodacite	C9	Volcanic	Crommyonia, near Corinthos, Greece	~37 55.1 N	~23 06.2 E	Pliocene volcanics, South Aegean Arc	bright to medium blue	medium to dark blue
Rhyodacite	SV10	Volcanic	Ambelos, Samos Island, Greece			Miocene trachytic volcanics	bright blue	medium-dark blue
Aplite	9811	Vein	Beechville overpass, Highway 103, Halifax, NS	44 38.110 N	63 39.861 W	Cuts the South Mountain Batholith	either bright to bright-medium blue, or very weak luminescence	either medium-dark blue, or very weak luminescence
Aplite	9812	Vein	Beechville overpass, Highway 103, Halifax, NS	44 38.110 N	63 39.861 W	Cuts the South Mountain Batholith	either bright to bright-medium blue, or very weak luminescence	either medium-dark blue, or very weak luminescence
Aplite	9813	Vein	Beechville overpass, Highway 103, Halifax, NS	44 38.110 N	63 39.861 W	Cuts the South Mountain Batholith	either bright to bright-medium blue, or very weak luminescence	either medium-dark blue, or very weak luminescence
Quartz Vein	9814	Vein	Kearney Lake Road, Halifax, NS	44 43.727 N	63 42.738 W	Cuts Meguma Supergroup metasediments	bright blue	medium to medium-dark blue
Quartz Vein	9815	Vein	Highway 101, Upper Sackville, NS	44 48.755 N	63 46.171 W	Cuts Meguma Supergroup metasediments	bright blue	medium to medium-dark blue

Quartz Vein	8237	Vein	Gerrish Mountain magnetite mine	421770	5028385	Cuts Triassic North Mountain Basalt, NS	either light-medium olive green brown, or bright to medium blue	either medium olive green brown, or dark blue
Quartz Vein	8242	Vein	Gerrish Mountain magnetite mine, Economy, NS	421770	5028385	Cuts Triassic North Mountain Basalt, NS	either light-medium olive green brown, or bright to medium blue	either medium olive green brown, or dark blue
Quartz Vein	8053A	Vein	Boyd Brook, near Bass River of Five Islands, NS	412852	5031870	Cuts Horton Group, Avalon Terrane, NS	either not visibly luminescent, or dark blue	either not visibly luminescent, or dark blue
Quartz Vein in meta-basalt	9804	Low Grade Metamorphic	Lynn Road, Five Islands, NS	45 26.557 N	64 06.772 W	cuts Jeffers Group, Avalon Terrane, NS	quartz is not visibly luminescent	quartz is not visibly luminescent
Quartzite	HG30	Medium-High Grade Metamorphic	Quarry S of Folly Lake, Cobequid Highlands, NS	45 31.35 N	63 32.37 W	Gamble Brook Fm., Avalon Terrane, NS	medium to dark blue	dark blue to very dark blue
Quartzite adjacent to gabbro intrusion	4066	Medium-High Grade Metamorphic	Frog Lake Quarry, Cobequid Highlands, NS	468842	5039285	Gamble Brook Fm., Avalon Terrane	dark reddish blue	very dark reddish blue
Vein Quartz in Metapelite	GL115	Vein Quartz	Grand Lake, NFLD				dark blue to very dark blue	very dark blue or not luminescent
Slate	SH08	Low Grade Metamorphic	Gore, Hants Co., NS	45 05.09 N	63 42.63 W	Halifax Group, Meguma Terrane, NS	medium to dark blue, or dark blue/brown	medium-dark blue to dark blue, or brown
Quartzite	SH10	Low Grade Metamorphic	Beaverbank Road, Upper Rawdon, Hants Co., NS	45 02.02 N	63 43.27 W	Goldenville Group, Meguma Terrane, NS	medium blue to dark blue, or brown	medium-dark blue to dark blue, or brown
Leucocratic Gneiss	CL 32-6	Medium-High Grade Metamorphic	Cormacks Lake, central Newfoundland			Cormacks Lake Complex, Central Gneiss (Dashwoods) subzone	bright blue to bright-medium blue	medium blue to medium-dark blue
Garnetiferous Tonalitic Gneiss	VO-86-113-2	Medium-High Grade Metamorphic	Western Brook Pond, Gros Morne, NL			Grenville granitoids, Long Range	bright blue	medium to medium-dark blue
Foliated Metasandstone (metaflysch)	ALF1	High Pressure Metamorphic Quartz	Petries, Evia, Greece	38 23.87 N	24 08.86 E	Krieza metaflysch	either very dark grey, or not luminescent	not luminescent
Metasandstone (metaflysch)	ALF3	High Pressure Metamorphic Quartz	Petries, Evia, Greece	38 23.87 N	24 08.86 E	Krieza metaflysch	weakly luminescent or not luminescent	not luminescent
Glaucophane Schist	ALF 5	High Pressure Metamorphic Quartz	Petries, Evia, Greece	38 22.99 N	24 09.01 E	Krieza metaflysch	medium to dark reddish brown, or not luminescent	dark to very dark reddish brown, or not luinescent

Table 2: Samples used in this atlas and the localities from which they were collected.

References

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