Thin Section Analysis Report

Sample ID:	WD-11		4710701266
Formation/Member Name:	Oriskany Sandstone Wood County, WV		
Lithologic Classification:	Sandstone		
Depth/Depth Range:	4225 ft		Observed @ 10x
Date of Analysis:		6/1/2017	
Analyzed by:	Eric Hirschfeld		

Texture		Comments
Grain Size	avg size 250 microns	Clastic
Rounding	subangular-subrounded	Inequigranular
Sorting	moderate- well-sorted	

Composition/Detrital Minerals		Comments
Quartz		
Polycrystalline	n/a	
	95% composition;predominantly undulose quartz; high relief; intergrown and deformed quartz grains; XN: black/white, PL: transparent	Figure 11.1 through Figure 11.6
Monocrystalline		
Microcrystalline	grains are easily observed via petroscope	
Feldspar		
Plagioclase	<1% composition; albite twinning, subhedral-anhedral; XN: black/white, PL: transparent; subangular grains.	Figure 11.1 and Figure 11.2
Orthoclase	n/a	
Microcline	n/a	
Carbonate		
Calcite	subangular fragments; 5% composition; some grains elognated, some slightly globular; XPL: tan-pink, PPL: transparent	Figure 11.1 through Figure 11.6
Dolomite	n/a	
Aragonite	n/a	
Clay		
Illite	n/a	
Smectite	n/a	
Kaolinite	n/a	
Muscovite	small oblate grains; <1% composition; subhedral; high birefringence, <1% composition; XN: green, pink, blue,orange, PL: transparent	no figure
Chlorite	n/a	
Glauconite	n/a	
Rock Fragments		
Sedimentary	Predominantly consisted of detrital sedimentary fragments	
Volcanic	possible volcanic fragments present	
Metamorphic		
Other (Accessory Minerals)		

Cementing Materials		Comments
Quartz	quartz intergrowth apply cementing	Figure 11.1 through Figure 11.6
Feldspar	n/a	
Carbonate	Calcite present and fills in spacing between quartz grains	Figure 11.1 through Figure 11.6
Clay	n/a	
Iron Oxide, Hydoxide and/or Sulfide	n/a	
Other	n/a	

Visual Porosity Estimate		Comments
Visual Porosity Estimate of total thin section	Porosity= 11%	Figure 11.7 through Figure 11.11

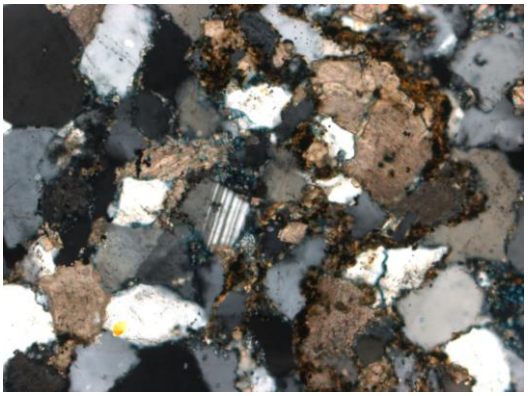


Figure 11.1 Observed at 10x magnification. In XN, intergrown , anhedral and deformed quartz and calcite grains. Also present is a small piece of plagioclase.

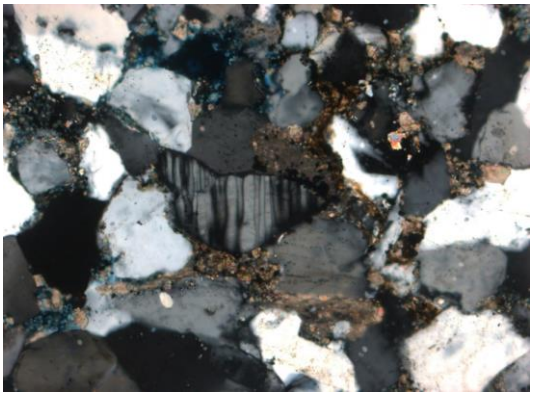


Figure 11.2 Observed at 10x magnification. In XN, anhedral quartz grain with intergrown calcite cementing material. Also present is a anhedral grain of plagioclase exhibiting albite twinning.

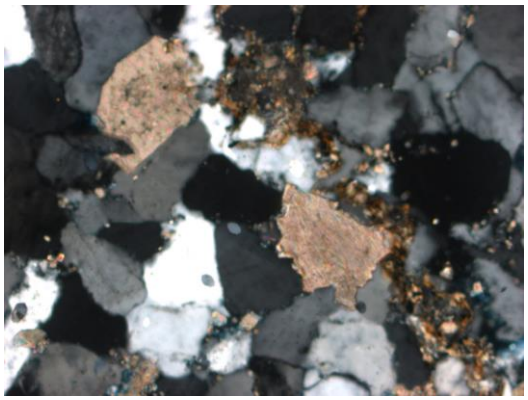


Figure 11.3 Observed at 10x magnification. In XN, anhedral to subhedral, quartz grains with subhedral calcite grains and intergrown calcareous cementing material

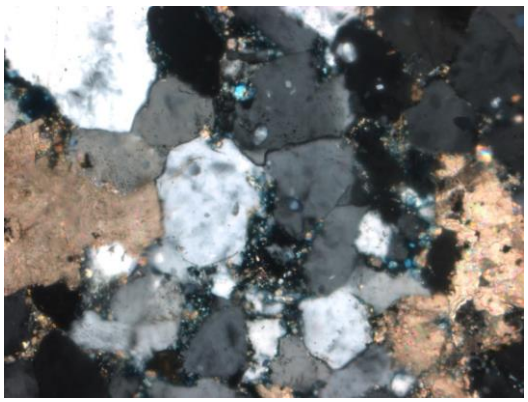


Figure 11.4 Observed at 10x magnification. In XN, subhedral quartz grains grown with anhedral and slightly deformed calcite grains and calcareous cementing material.

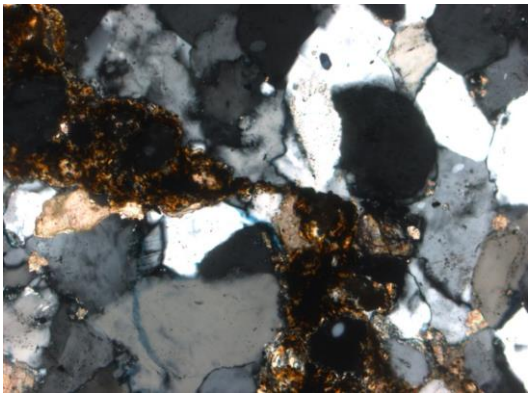


Figure 11.5 Observed at 10x magnification. In XN, interspersed, subhedral to anhedral unduloose quartz grains that are cement calcareous cementing material

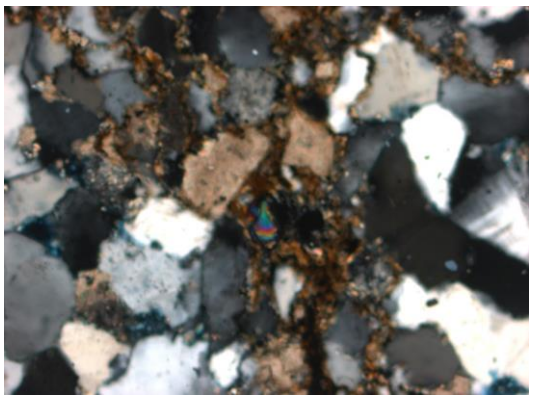


Figure 11.6 Observed at 10x magnification. In XN, subhedral undulose quartz grains overgrown and cemented with calcareous material and calcite in between.

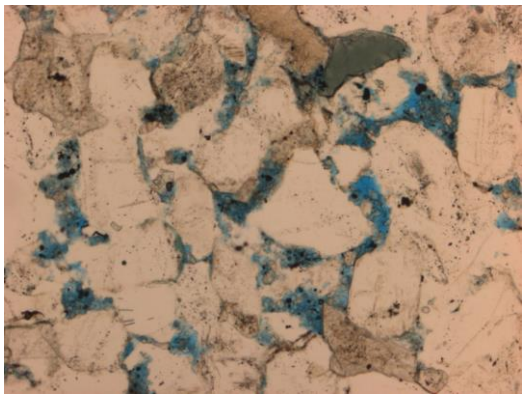


Figure 11.7 Observed at 10x magnification. In PL, the blue dye represents the open pore spaces in the thin section, estimating about 11% porous overall.

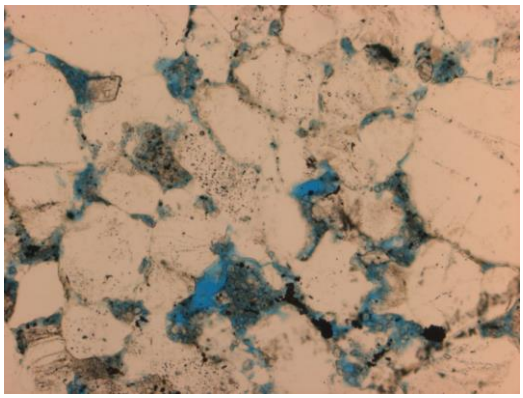


Figure 11.8 Observed at 10x magnification. In PL, the blue dye represents the open pore spaces in the thin section, estimating about 11% porous overall.

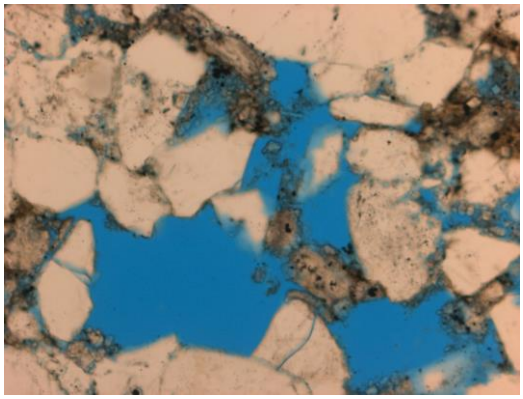


Figure 11.9 Observed at 10x magnification. In PL, the blue dye represents the open pore spaces in the thin section, estimating about 11% porous overall.

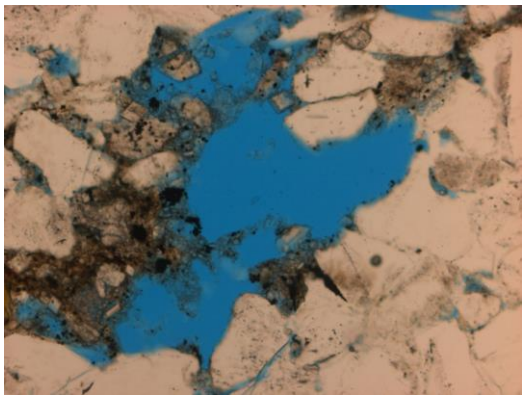


Figure 11.10 Observed at 10x magnification. In PL, the blue dye represents the open pore spaces in the thin section, estimating about 11% porous overall.

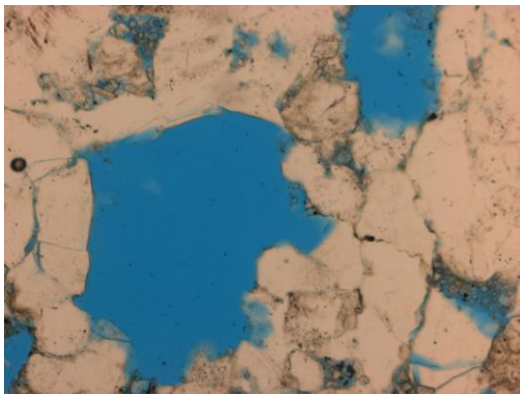


Figure 11.11 Observed at 10x magnification. In PL, the blue dye represents the open pore spaces in the thin section, estimating about 11% porous overall.

Thin Section Analysis Report

Sample ID:	WD-10		4710701266
Formation/Member Name:	Oriskany Sandstone Wood County, WV		
Lithologic Classification:	Sandstone		
Depth/Depth Range:	4222.5 ft		Observed @ 10x
Date of Analysis:		6/2/2017	
Analyzed by:	Eric Hirschfeld		

Texture		Comments
Grain Size	average grain size is approx 0.5 mm or less	non-homogeneous, Clastic,
Rounding	subangular- subrounded	
Sorting	moderately sorted	

Composition/Detrital Minerals		Comments
Quartz		
Polycrystalline	n/a	
Monocrystalline	75% composition; deformed grains; subhedral; evidence of quartz overgrowth	Figure 10.1 through Figure 10.6
Microcrystalline	grains are easily observed via petroscope	
Feldspar		
Plagioclase	1% or less of composition; albite twinning; subangular; XN: black/white, PL: transparent	no figure
Orthoclase		
Microcline		
Carbonate		
Calcite	24% composition; massive, globular grains; scattered smaller subangular grains; some lamellar twinning is present; XN: tan/pink, PL: transparent	Figure 10.2 through Figure 10.4, Figure 10.6
Dolomite	n/a	
Aragonite	n/a	
Clay		
Illite	n/a	
Smectite	n/a	
Kaolinite	n/a	
Muscovite	1% or less composition; high birefringence, rounded oblate grains; XN: pink, blue, green, orange PL: transparent	Figure 10.5
Chlorite	n/a	
Glauconite	n/a	
Rock Fragments		
Sedimentary	Detrital sedimentary fragments is predominant	
Volcanic	miniscule amount of volcanic fragments	
Metamorphic		
Other (Accessory Minerals)		

Cementing Materials		Comments
Quartz	Quartz overgrowth acts as a cememnting material for grains; well cemented	Figure 10.1, Figure 10.3, Figure 10.5
Feldspar	n/a	
Carbonate	Clcite fills in pores between grains as globular cement; moderately cemented	Figure 10.4 and Figure 10.6
Clay	n/a	
Iron Oxide, Hydoxide and/or Sulfide	n/a	
Other	n/a	

Visual Porosity Estimate		Comments
Visual Porosity Estimate	10% porosity	Figure 10.7 through Figure 10.11

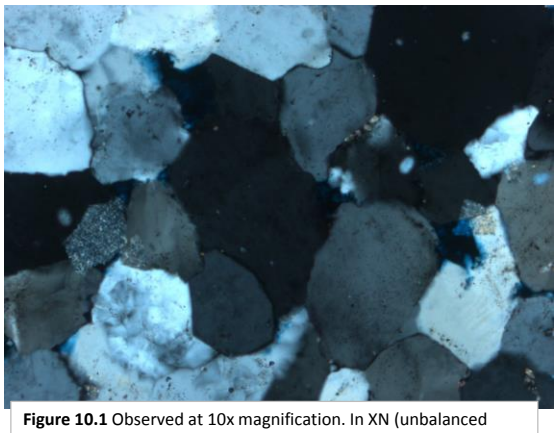


Figure 10.1 Observed at 10x magnification. In XN (unbalanced light), subhedral undulose quartz grains grown and cemented together.

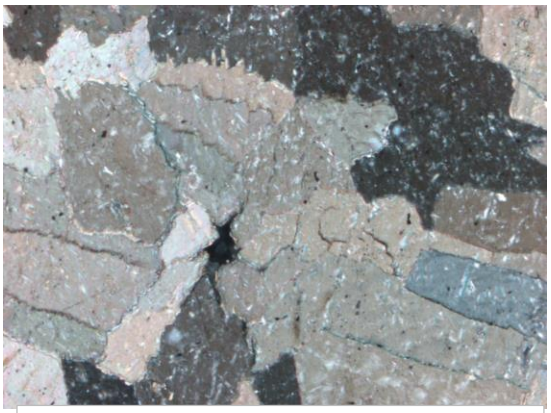


Figure 10.2 Observed at 10x magnification. In XN, elongated and anhedral calcite grains. Grown together acting as cementing material.

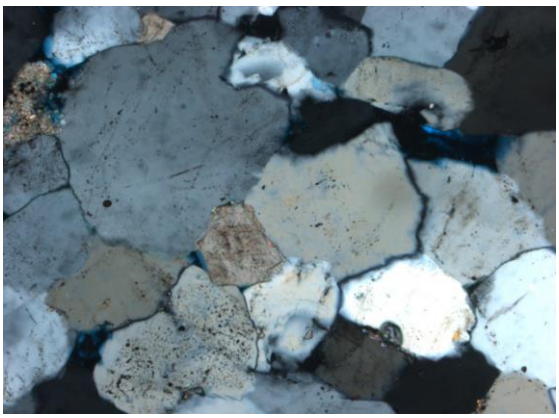


Figure 10.3 Observed at 10x magnification. In XN, subhedral, undulose quartz grains grown and cemented together.

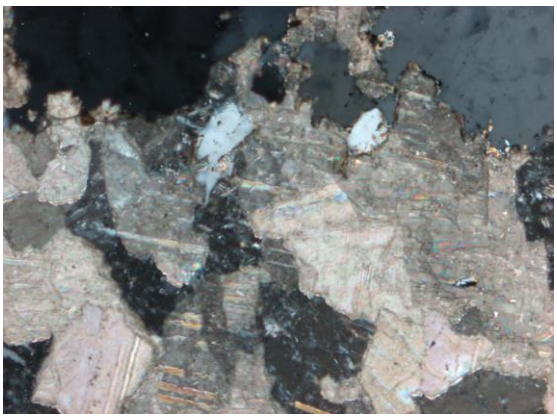


Figure 10.4 Observed at 10x magnification. In XN, globular calcite with lamellar twinning with a few overgrown quartz grains.

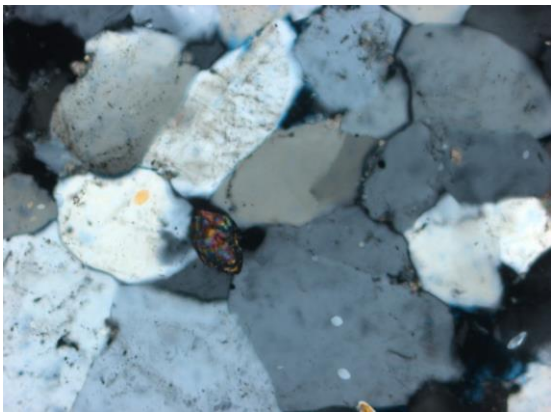


Figure 10.5 Observed at 10x magnification. In XN, subhedral and slightly intergrown quartz grains with a small grain of deformed

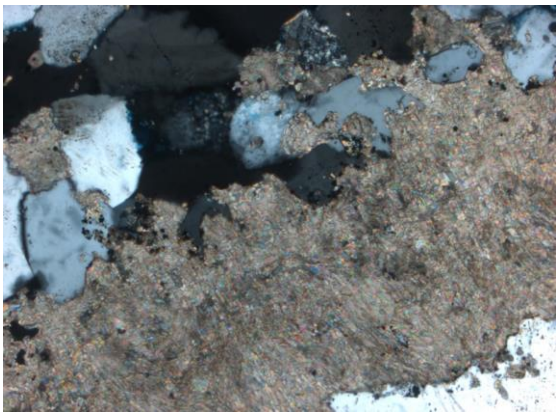


Figure 10.6 Observed at 10x magnification. In XN, globular calcite overgrown and interspersedwith subhedral quartz.

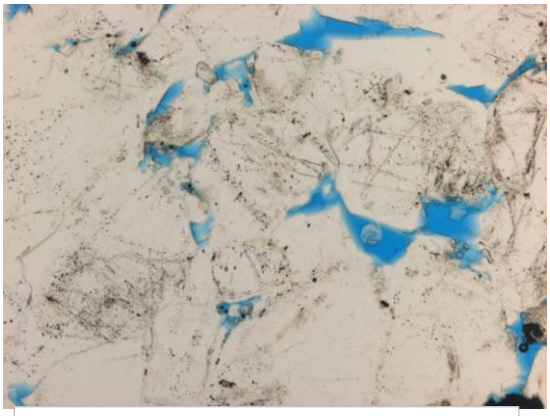


Figure 10.7 Observed at 10x magnification. In PL, the blue dye represents the open pore spaces in the thin section, estimating

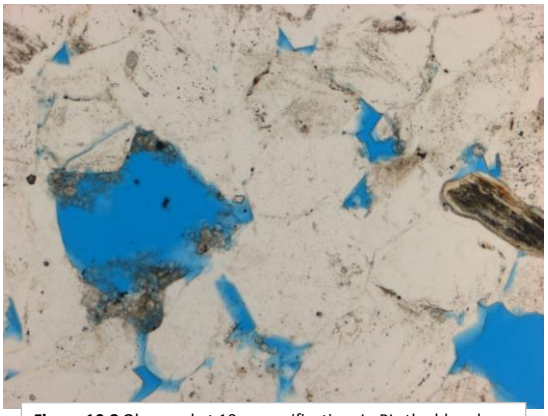


Figure 10.8 Observed at 10x magnification. In PL, the blue dye represents the open pore spaces in the thin section, estimating to about 10% porous overall.

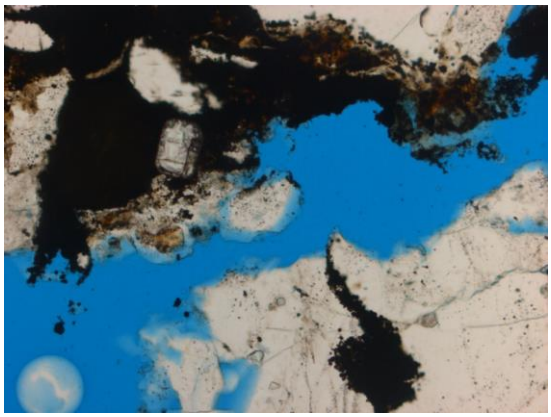


Figure 10.9 Observed at 10x magnification. In PL, the blue dye represents the open pore spaces in the thin section, estimating to about 10% porous overall.

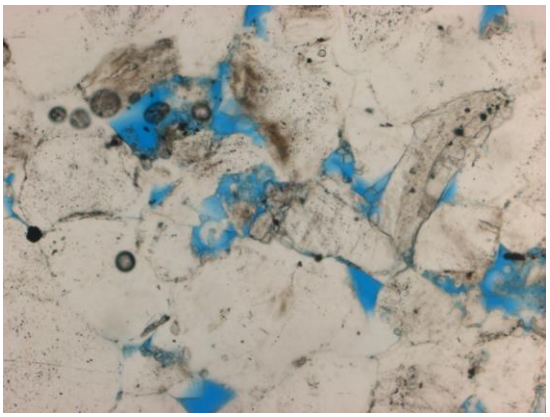


Figure 10.10 Observed at 10x magnification. In PL, the blue dye represents the open pore spaces in the thin section, estimating to about 10% porous overall.

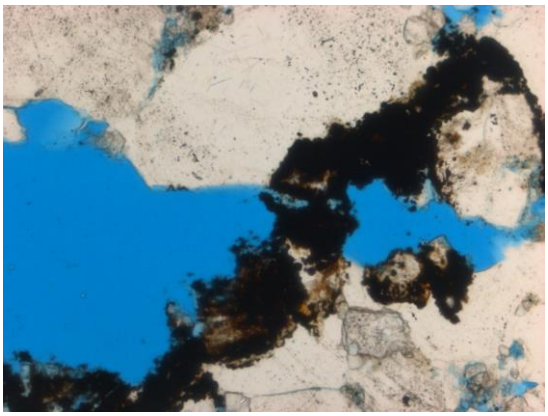


Figure 10.11 Observed at 10x magnification. In PL, the blue dye represents the open pore spaces in the thin section, estimating to about 10% porous overall.

Thin Section Analysis Report

Sample ID:	WD-9		4710701266
Formation/Member Name:	Oriskany Sandstone Wood County, WV		
Lithologic Classification:	Sandstone		
Depth/Depth Range:	4220.1 ft		Observed @ 10x
Date of Analysis:		6/2/2017	
Analyzed by:	Eric Hirschfeld		

Texture		Comments
Grain Size	average grain size 50 to 600 microns	inequigranular; subhedral; clastic
Rounding	subangularto subrounded	
Sorting	moderately-well sorted	

Composition/Detrital Minerals		Comments
Quartz		
Polycrystalline	5% composition; Polycrystalline quartz is less obvious; <50 microns; possibly just quartz overgrowth	
Monocrystalline	70% composition; undulose quartz; XN: black/white, PL: transparent	Figure 9.1, Figure 9.4, Figure 9.6, Figure 9.7
Microcrystalline	grains are easily observed via petroscope	
Feldspar		
Plagioclase	1% or less composition; subangular; albite twinning, subhedral	no figure
Orthoclase	n/a	
Microcline	n/a	
Carbonate		
Calcite	25% composition; elongated, fibrous, and globular texture; especially in areas of intergrowth; some massive cumulates of calcite; subangular grains; XN: tan/pink, PL: Tan, transparent	Figure 9.2 through 9.7
Dolomite	n/a	
Aragonite	n/a	
Clay		
Illite	n/a	
Smectite	n/a	
Kaolinite	n/a	
Muscovite	< 1% composition; olbate shape grains; <100 microns in size; XPL: pink, blue,green,orange, PPL: transparent	no figure
Chlorite	n/a	
Glauconite	n/a	
Rock Fragments		
Sedimentary	Predominantly detrital sedimentary rock fragments	
Volcanic	n/a	
Metamorphic	n/a	
Other (Accessory Minerals)		
Biotite?	noticed a few grainsof biotite; deformed; subrounded grain; 450 microns in size; XN: orange, PL: brown	no figure

Cementing Materials		Comments
Quartz	Quartz intergrowth acts as a cementing material; moderately cemented	Figure 9.1 through Figure 9.7
Feldspar	n/a	
Carbonate	Calcite filling in many of open pores spaces and in between quartz grains; moderately cemented	Figure 9.1 through Figure 9.7
Clay	n/a	
Iron Oxide, Hydoxide and/or Sulfide	n/a	
Other	n/a	

Visual Porosity Estimate		Comments
Visual Porosity Estimate	10% porosity	Figure 9.8 through Figure 9.12

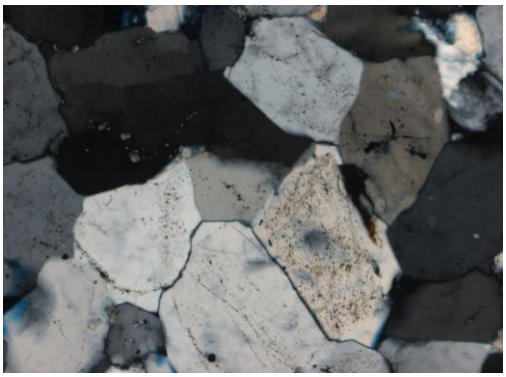


Figure 9.1 Observed at 10x magnification. In XN, subhedral undulose quartz that is also acting as cementing material from growth.

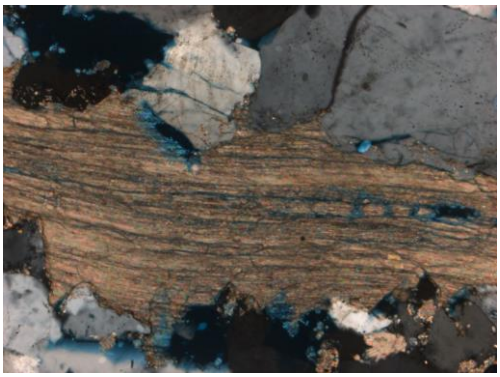


Figure 9.2 Observed at 10x magnification. In XN, deformed elongated grain of calcite grown in between subhedral quartz grains.

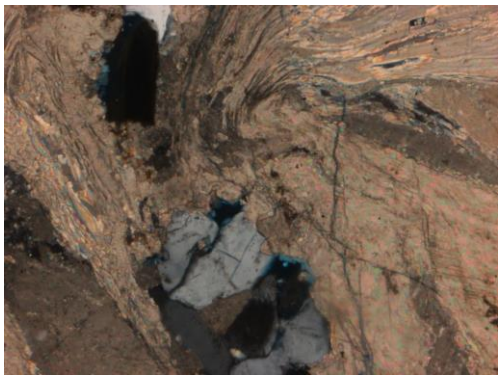


Figure 9.3 Observed at 10x magnification. In XN, large cumulate of deformed clacite, overgrown on quartz grains.

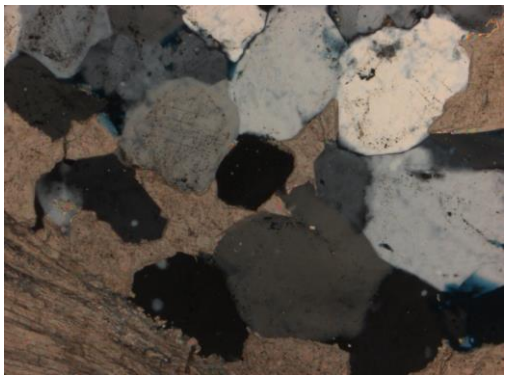


Figure 9.4 Observed at 10x magnification. In XN, grown calcite cementing together subhedral undulose quartz.

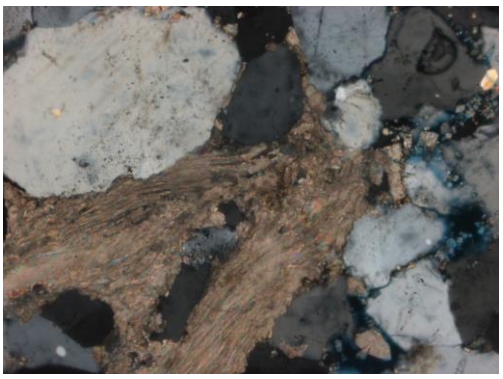


Figure 9.5 Observed at 10x magnification. In XN, interspersed calcite cementing together subhedral undulose quartz.

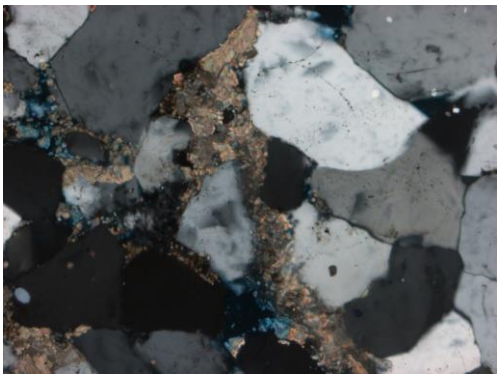


Figure 9.6 Observed at 10x magnification. In XN, intergrown calcite cementing together subhedral undulose quartz. Also quartz overgrowth, cementing grains together.

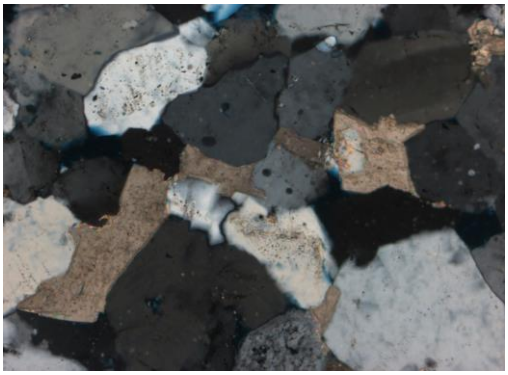


Figure 9.7 Observed at 10x magnification. In XN, interspersed subhedral quartz and calcite grains. Both acting as cementing material.

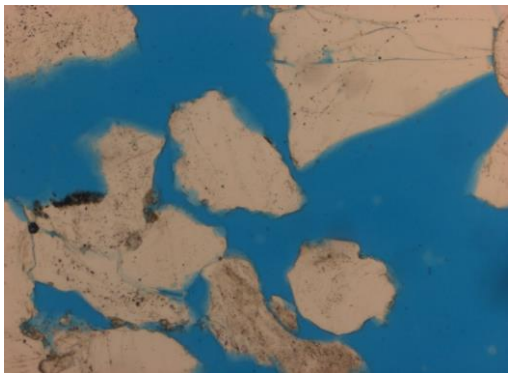


Figure 9.8 Observed at 10x magnification. In PL, blue dye represents the open pore spaces in the thin section, estimating about 10% porous overall

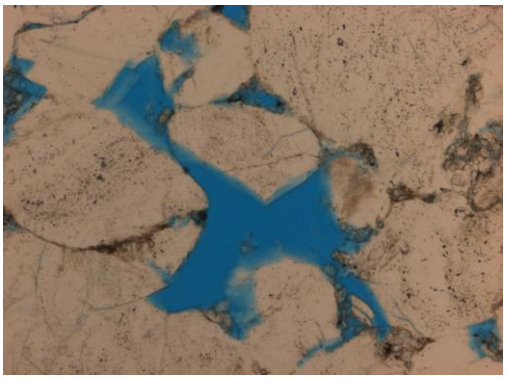


Figure 9.9 Observed at 10x magnification. In PL, blue dye represents the open pore spaces in the thin section, estimating about 10% porous overall

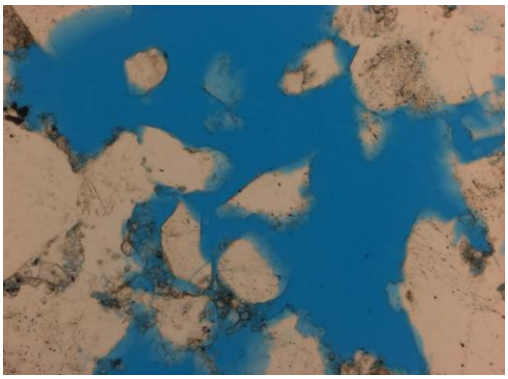


Figure 9.10 Observed at 10x magnification. In PL, blue dye represents the open pore spaces in the thin section, estimating about 10% porous overall

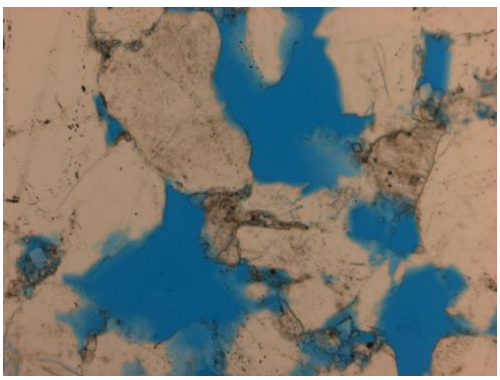


Figure 9.11 Observed at 10x magnification. In PL, blue dye represents the open pore spaces in the thin section, estimating about 10% porous overall

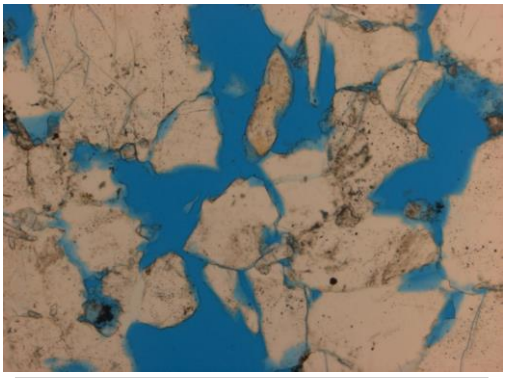


Figure 9.12 Observed at 10x magnification. In PL, blue dye represents the open pore spaces in the thin section, estimating about 10% porous overall

Thin Section Analysis Report

Sample ID:	WD-8		4710701266
Formation/Member Name:	Oriskany Sandstone Wood County, WV		
Lithologic Classification:	Sandstone		
Depth/Depth Range:	4218.7 ft		Observed @ 10x
Date of Analysis:		6/5/2017	
Analyzed by:	Eric Hirschfeld, Ellen Davis		

Texture		Comments
Grain Size	average grain size is approximately 100 microns	Inequigranular; Non-Homogeneous; clastic
Rounding	subangular- subrounded	
Sorting	moderately to well sorted	

Composition/Detrital Minerals		Comments
Quartz		
Polycrystalline		
Monocrystalline	70% composition; intergrown grains;subangular to subrounded; subhedral	Figures 8.1 through 8.8
Microcrystalline	grains are easily observed via petroscope	
Feldspar		
Plagioclase	albite twinning; subangular grains; <1% composition; approx. 100 microns in size; subhedral	no figures
Orthoclase		
Microcline	Tartan twinning; subangular grains; <1% composition; approx. 100 microns in size; subhedral	no figures
Carbonate		
Calcite	Intergrown and interspersed grains; subangular; some elongated grains; slightly deformed; approx. 30% composition	Figures 8.3 through 8.7
Dolomite		
Aragonite		
Clay		
Illite		
Smectite		
Kaolinite		
Muscovite	small oblated grains; approximately 50 microns in size; XN: green, orange, pink, blue, PL: transparent; <0.5% composition	no figures
Chlorite		
Glauconite		
Rock Fragments		
Sedimentary	Predominantly sedimentary detrital rock fragments	
Volcanic	n/a	
Metamorphic	n/a	
Other (Accessory Minerals)		

Cementing Materials		Comments
Quartz	Intergrown and cemented quartz grains that are evenly distributed	Figure 8.1 through 8.6
Feldspar	n/a	
Carbonate	Deformed calcite acting as cementing material between subhedral calcite grains and quartz grains	Figure 8.3 through 8.7
Clay	n/a	
Iron Oxide, Hydoxide and/or Sulfide	n/a	
Other	n/a	

Visual Porosity Estimate		Comments
Visual Porosity Estimate	5% porosity	Figure 8.8 through 8.11

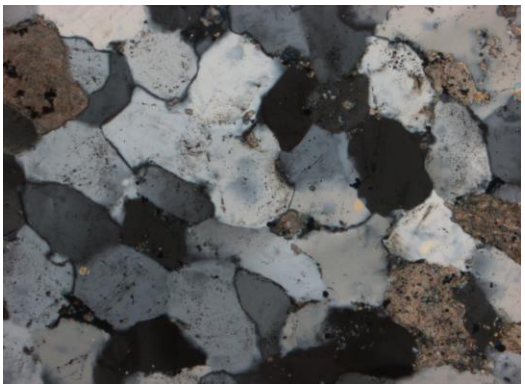


Figure 8.1 Observed at 10x magnification. In XPN subhedral and slightly deformed, undulose quartz. Slightly intergrown.

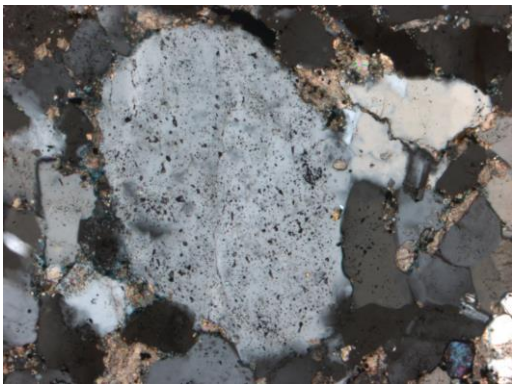


Figure 8.2 Observed at 10x magnification. In XN, large subhedral quartz grain surrounded by anhedral to subhedral quartz and small amounts of deformed calcite.

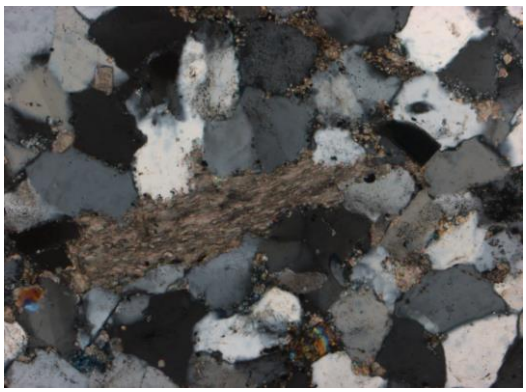


Figure 8.3 Observed at 10x magnification. In XN, deformed elongated calcite surrounded by subhedral quartz.

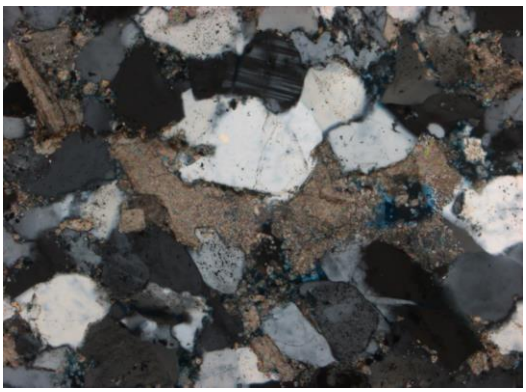


Figure 8.4 Observed at 10x magnification. In XN, deformed calcite grain grown between deformed and subhedral quartz grains.



Figure 8.5 Observed at 10x magnification. In XN, large, elongated, deformed calcite intergrown between subhedral quartz grains.

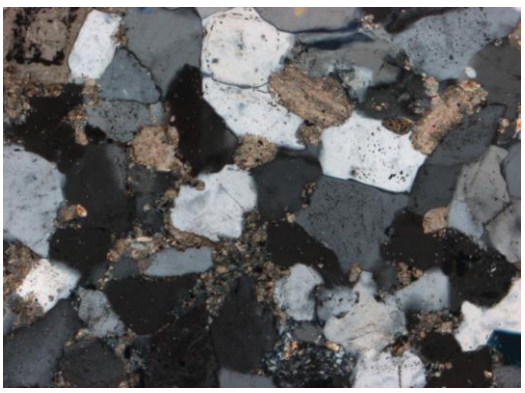


Figure 8.6 Observed at 10x magnification. In XN, subhedral undulose quartz with intergrown deformed calcite grains acting as cementing material.

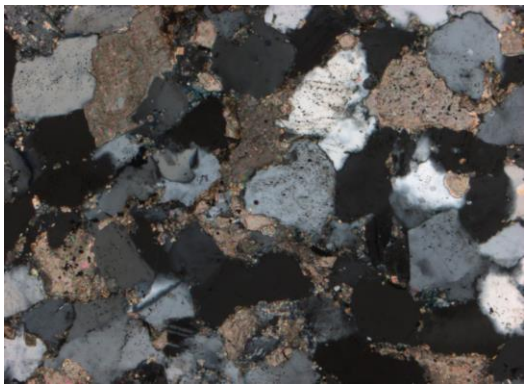


Figure 8.7 Observed at 10x magnification. In XN, deformed calcite grains in between quartz, acting as cementing material. quartz appears to be anhedral to subhedral.

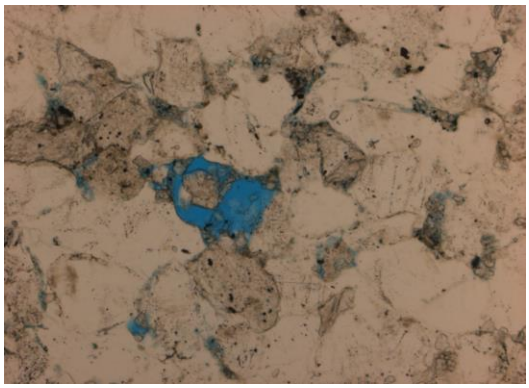


Figure 8.8 Observed at 10x magnification. In PL, blue dye represents the open pore spaces in the thin section, estimating 5% porosity overall.

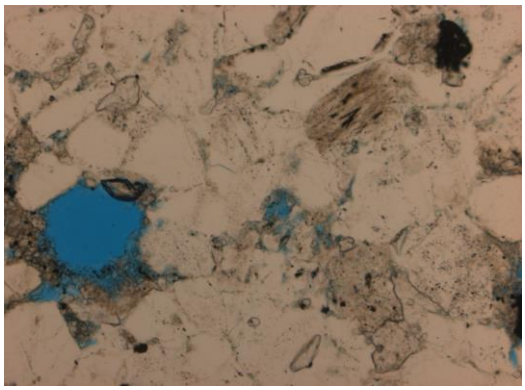


Figure 8.9 Observed at 10x magnification. In PL, blue dye represents the open pore spaces in the thin section, estimating 5% porosity overall.

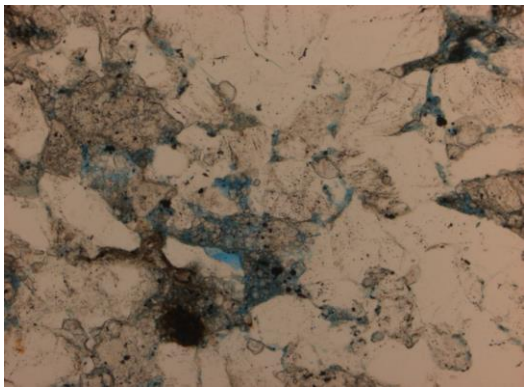


Figure 8.10 Observed at 10x magnification. In PL, blue dye represents the open pore spaces in the thin section, estimating 5% porosity overall.

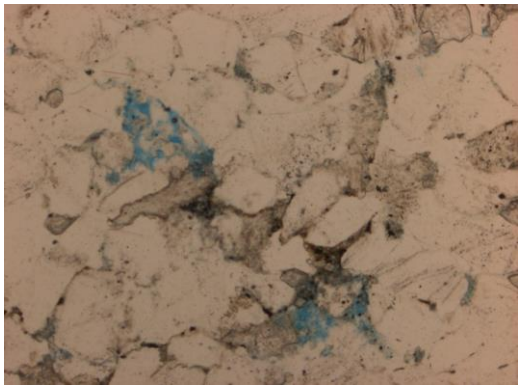


Figure 8.11 Observed at 10x magnification In PL, blue dye represents the open pore spaces in the thin section, estimating 5%

Thin Section Analysis Report

Sample ID:	WD-7		4710701266
Formation/Member Name:	Oriskany Sandstone Wood County, WV		
Lithologic Classification:	Sandstone		
Depth/Depth Range:	4215.8 ft		Observed @ 10x
Date of Analysis:		6/5/2017	
Analyzed by:	Eric Hirschfeld		

Texture		Comments
Grain Size	Average grain size is apporximately 300-400 microns	Inequigranular; Non-homogeneous; Clastic;
Rounding	subangular to subrounded	
Sorting	moderately sorted	

Composition/Detrital Minerals		Comments
Quartz		
Polycrystalline	n/a	
Monocrystalline	70% composition; undulose quartz; subhedral; intergrown grains; deformed sub-grains but still monocrystalline; few polycrystalline grains but are insignificant to total composition	Figures 7.1 through 7.7
Microcrystalline	grains are easily observed via petroscope	
Feldspar		
Plagioclase	sunangular grain; albite twinning, <1% composotion; XN: black/white	no figures
Orthoclase	n/a	
Microcline	subangular grain; tartan twinning: <1% composition; XN: black/white	no figures
Carbonate		
Calcite	29-30% composition; deformed grains; globular, elgongated, intergrown grains between quartz; XN: tan/pink, PL: transparent	Figures 7.4 through 7.7
Dolomite	n/a	
Aragonite	n/a	
Clay		
Illite	n/a	
Smectite	n/a	
Kaolinite	n/a	
Muscovite	<1% composition; small, oblate grains; XN: green, orange, blue, pink PL: transparent	no figures
Chlorite	n/a	
Glauconite	n/a	
Rock Fragments		
Sedimentary	Predominantly sedimentary detrital fragments	
Volcanic	n/a	
Metamorphic	n/a	
Other (Accessory Minerals)		

Cementing Materials		Comments
Quartz	very well cemented intergrown quartz grains;	Figures 7.4 through 7.6
Feldspar	n/a	
Carbonate	Calcite fills in some of the pores spaces and acts as a secondary cementing material	Figures 7.4 through 7.6
Clay	n/a	
Iron Oxide, Hydoxide and/or Sulfide	n/a	
Other	n/a	

Visual Porosity Estimate		Comments
Visual Porosity Estimate	8% porosity	Figures 7.8 thorugh 7.10

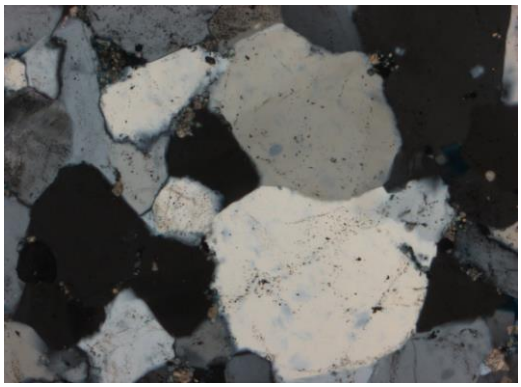


Figure 7.1 Observed at 10x magnification. In XN, subhedral, intergrown undulose quartz grains. Quartz is acting as cementing material. Some deformed grains.

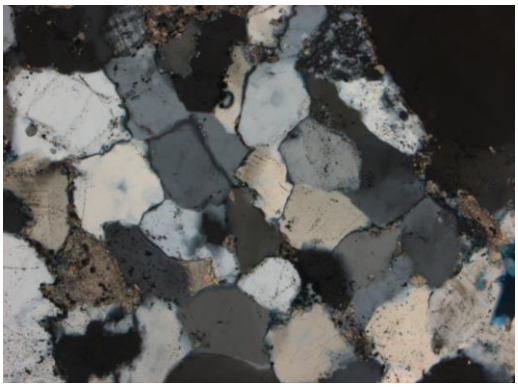


Figure 7.2 Observed at 10x magnification. In XN, subhedral , undulose quartz grains. Overgrown quartz grains. Also present, subhedral to euhedral calcite grains.

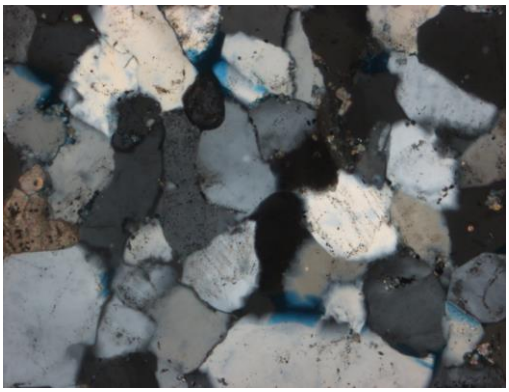


Figure 7.3 Observed at 10x magnification. In XN, anhedral to subhedral , undulose quartz grains. Quartz is the cementing

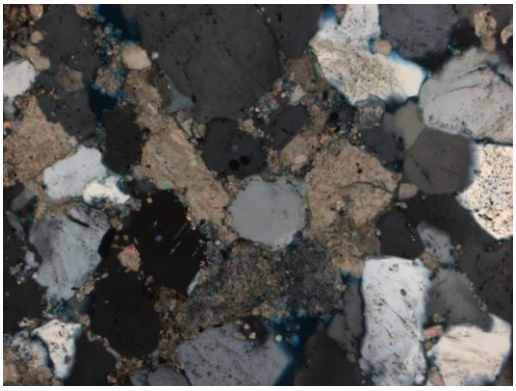


Figure 7.4 Observed at 10x magnification. In XN, Subhedral quartz and slightly globular calcite that is interspersed between quartz grains acting as a cementing material.

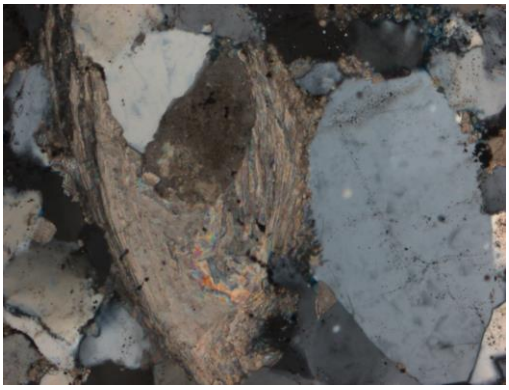


Figure 7.5 Observed at 10x magnification. In XN, globular, deformed calcite grain surrounded by subhedral grains of quartz.

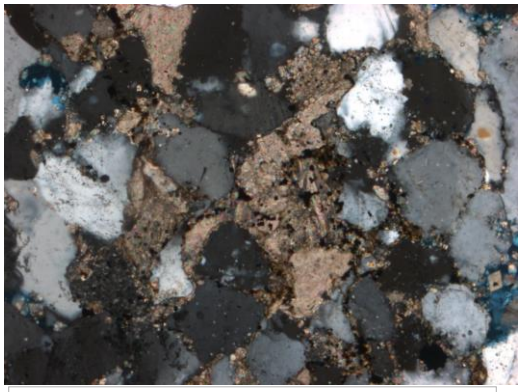


Figure 7.6 Observed at 10x magnification. In XN, interspersed calcite in between quartz grains. Subhedral quartz grains with calcite cement.

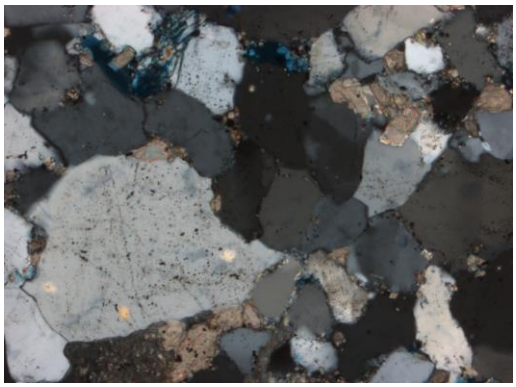


Figure 7.7 Observed at 10x magnification. In XN, anhedral to subhedral quartz grains. some slight deformation from quartz growth.

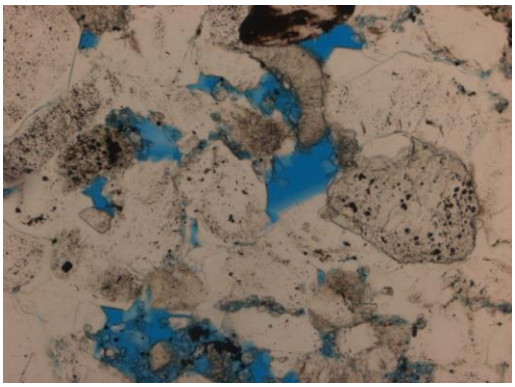


Figure 7.8 Observed at 10x magnification. In PL, the blue dye represents the open spaces in the thin section, estimating to about 8% porosity overall.

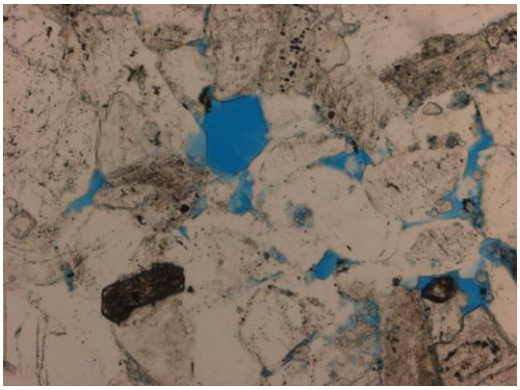


Figure 7.9 Observed at 10x magnification. In PL, the blue dye represents the open spaces in the thin section, estimating to about 8% porosity overall.

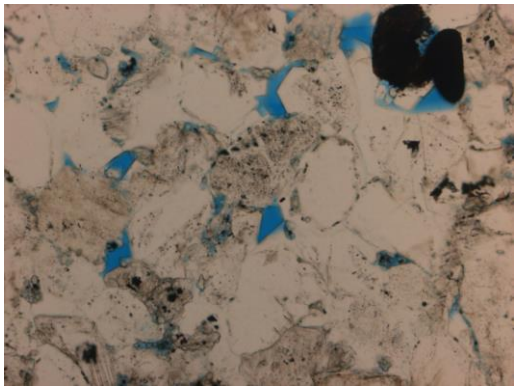


Figure 7.10 Observed at 10x magnification. In PL, the blue dye represents the open spaces in the thin section, estimating to about 8% porosity overall.

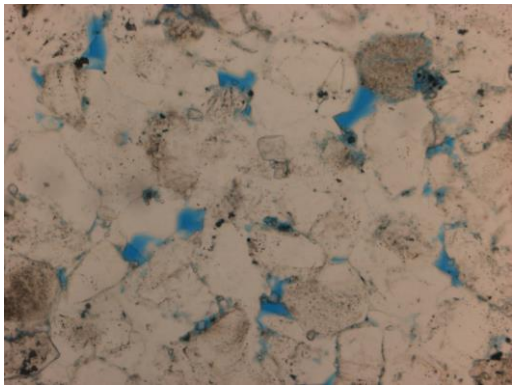


Figure 7.11 Observed at 10x magnification. In PL, the blue dye represents the open spaces in the thin section, estimating to about 8% porosity overall.

Thin Section Analysis Report

Sample ID:	WD-6		4710701266
Formation/Member Name:	Oriskany Sandstone Wood County, WV		
Lithologic Classification:	Sandstone		
Depth/Depth Range:	4213.5 ft		Observed @ 10x
Date of Analysis:		6/6/2017	
Analyzed by:	Eric Hirschfeld		

Texture		Comments
Grain Size	average grain size= approx. 0.5 to 0.75 mm	clastic; Homogeneous
Rounding	subangular to subrounded; mostly subrounded	
Sorting	moderately to well sorted	

Composition/Detrital Minerals		Comments
Quartz		
Polycrystalline	n/a	
Monocrystalline	80% composition; undulose quartz; subhedral; intergrown grains; some deformed grains; moderate relief; most grains are large ranging from 0.5 to 1mm	Figure 6.1
Microcrystalline	grains are easily observed via petroscope	
Feldspar		
Plagioclase	n/a	
Orthoclase	n/a	
Microcline	<0.1% composition, tartan twinning, subrounded; subhedral	no figure
Carbonate		
Calcite	20% composition; globular texture; anhedral but some grains appear to be subhedral; moderate birefringence; XN: tan/pink	Figure 6.2 through Figure 6.5 and Figure 6.7
Dolomite	n/a	
Aragonite	n/a	
Clay		
Illite	n/a	
Smectite	n/a	
Kaolinite	n/a	
Muscovite	<0.1% composition; approx <100 microns in size; deformed grains; XPL: green, blue,ornage	no figure
Chlorite	n/a	
Glauconite	n/a	
Rock Fragments		
Sedimentary	Predominantly sedimentary rock fragements	
Volcanic	n/a	
Metamorphic	n/a	
Other (Accessory Minerals)		

Cementing Materials		Comments
Quartz	Quartz intergrowth present are the cementing material; moderate to well cemented	
Feldspar	n/a	
Carbonate	calcite deformed between grains also acts as cementing material in between quartz grains; moderate to well cemented	Figure 6.4, Figure 6.6, Figure 6.7
Clay	n/a	
Iron Oxide, Hydoxide and/or Sulfide	n/a	
Other	n/a	

Visual Porosity Estimate		Comments
Visual Porosity Estimate	9% porosity	Figure 6.8 through Figure 6.12

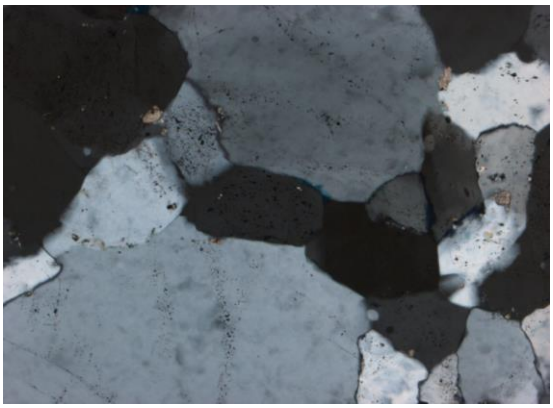


Figure 6.1 Observed at 10x magnification. In XPN subhedral, intergrown, undulose quartz grains. Quartz is the acting cementing material.

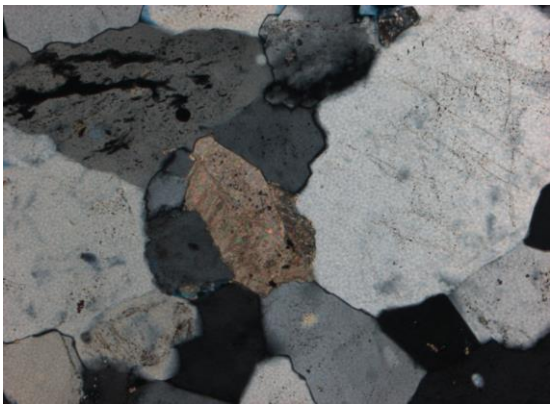


Figure 6.2 Observed at 10x magnification. In XPL, subhedral undulose quartz grains and a subhedral calcitee grain.

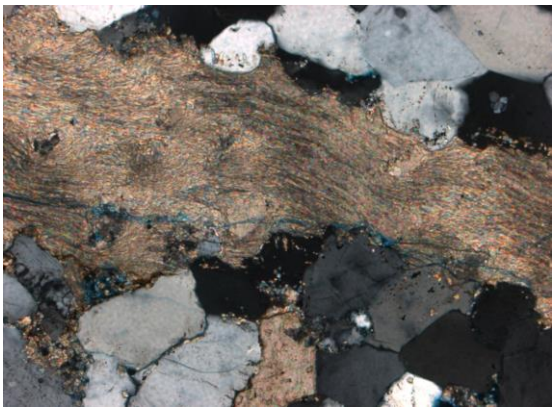


Figure 6.3 Observed at 10x magnification. In XN, globular grain of calcite with subhedral, subrounded undulose quartz grains.

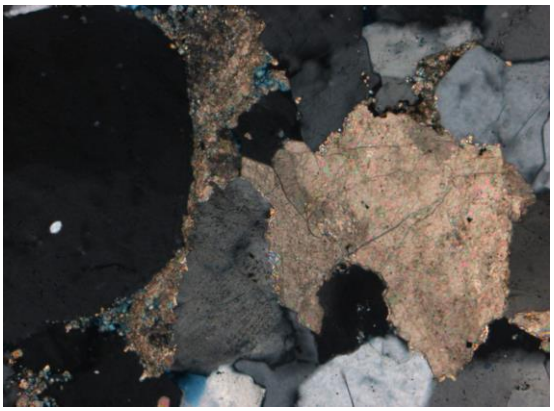


Figure 6.4 Observed at 10x magnification. In XN, globular calcite grain and calcite cementing material in between subhedral quartz grains.

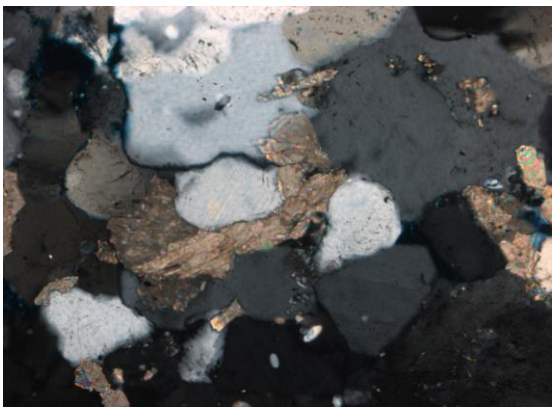


Figure 6.5 Observed at 10x magnification. In XN, Deformed quartz grains with some globular calcite grains.

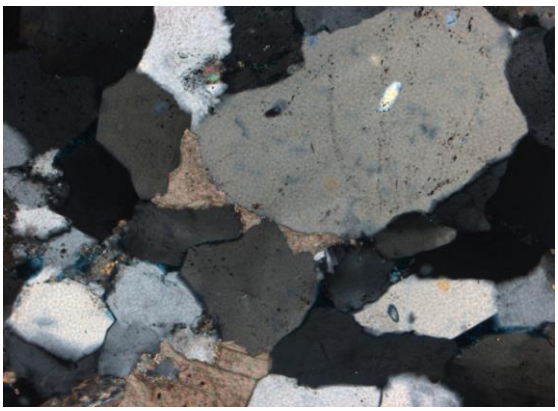


Figure 6.6 Observed at 10x magnification. In XN, quartz grains being cemented by both quartz growth and carbonate material calcite.

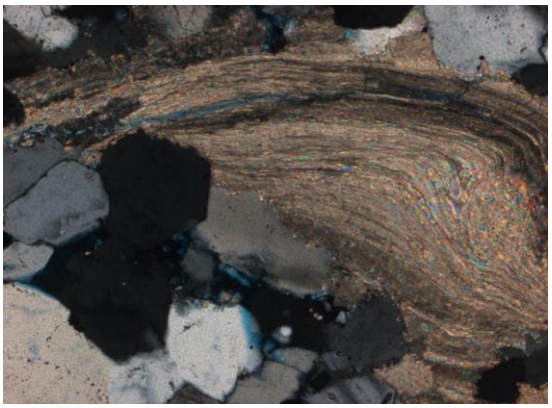


Figure 6.7 Observed at 10x magnification. In XN, massive globular calcite grain with some slightly deformed undulose quartz grains.

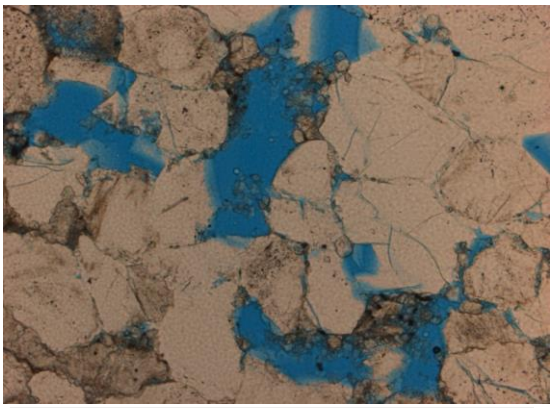


Figure 6.8 Observed at 10x magnification.In PL, the blue dye indicates the open pores spaces in the thin section. This thin section has an estimated 9% porosity overall.

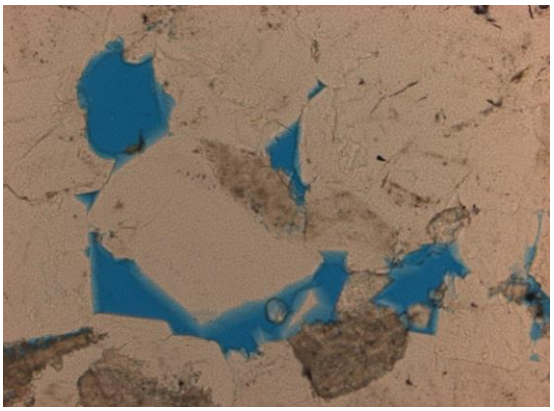


Figure 6.9 Observed at 10x magnification. In PL, the blue dye indicates the open pores spaces in the thin section. This thin section has an estimated 9% porosity overall.

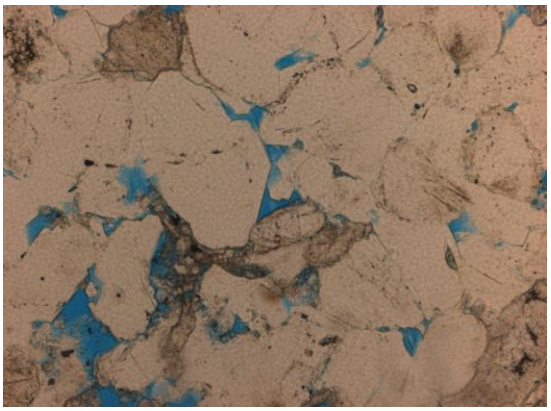


Figure 6.10 Observed at 10x magnification. In PL, the blue dye indicates the open pores spaces in the thin section. This thin section has an estimated 9% porosity overall.

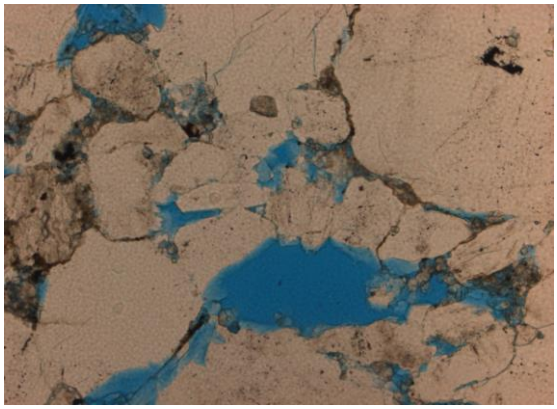


Figure 6.11 Observed at 10x magnification. In PL, the blue dye indicates the open pores spaces in the thin section. This thin section has an estimated 9% porosity overall.

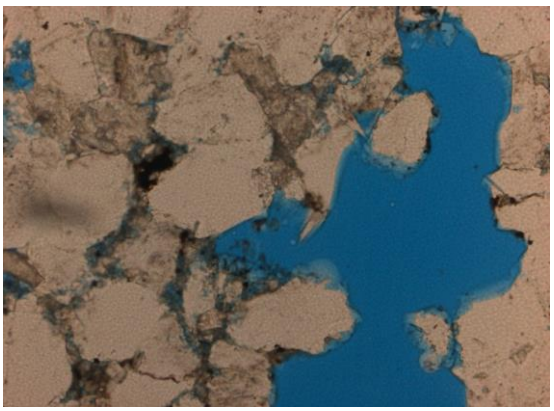


Figure 6.12 Observed at 10x magnification. In PL, the blue dye indicates the open pores spaces in the thin section. This thin section has an estimated 9% porosity overall

Thin Section Analysis Report

Sample ID:	WD-5		4710701266
Formation/Member Name:	Oriskany Sandstone Wood County, WV		
Lithologic Classification:	Sandstone		
Depth/Depth Range:	4212.1 ft		Observed @ 10x
Date of Analysis:		6/8/2017	
Analyzed by:	Eric Hirschfeld		

Texture		**Comments**
Grain Size	range of grain size = approx. 0.01 mm to 1mm	clastic
Rounding	subangular	
Sorting	moderately sorted	

Composition/Detrital Minerals		**Comments**
Quartz		
Polycrystalline	n/a	
Monocrystalline	75% composition; undulose quartz; anhedral to subhedral; interspersed grains; deformed grains	Figure 5.1 through Figure 5.6
Microcrystalline	grains are easily observed via petroscope	
Feldspar		
Plagioclase	albite twinning; small; subhedral; <0.1% composition	no figure
Orthoclase	n/a	
Microcline	tartan twinning; small; subhedral; <0.1% composition	no figure
Carbonate		
Calcite	25% composition; globular texture; fills in pores in between quartz grains; some subangular grains; semi-elongated texutre on some grains; deformation structures	Figure 5.1 through Figure 5.6
Dolomite	n/a	
Aragonite	n/a	
Clay		
Illite	n/a	
Smectite	n/a	
Kaolinite	n/a	
Muscovite	n/a	
Chlorite	n/a	
Glauconite	n/a	
Rock Fragments		
Sedimentary	Predominantly sedimentary rock fragments; detrital sediments of quartz	Figure 5.1 through Figure 5.6
Volcanic	n/a	
Metamorphic	n/a	
Other (Accessory Minerals)		
???	WD5_0036, WD5_0037	

Cementing Materials		**Comments**
Quartz	Quartz normal Growth and intergrowth of grains act as cementing material; moderately to well cemented	
Feldspar	n/a	
Carbonate	Calcite acts as carbonate cement material, fillin in pore spaces between quartz grains; globular texture; irregularshaped, possibly from deformation	Figure 5.1 through Figure 5.6
Clay	n/a	
Iron Oxide, Hydoxide and/or Sulfide	n/a	
Other	n/a	

Visual Porosity Estimate		**Comments**
Visual Porosity Estimate	11% porosity	Figure 5.7 through 5.12

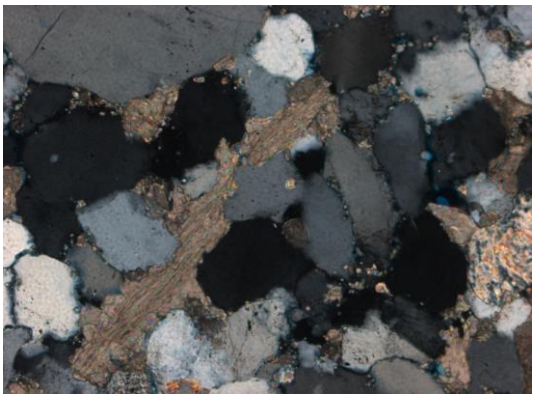


Figure 5.1 Observed at 10x magnification. In XN, Slightly deformed undulose quartz grains with semi-elongated calcite grain

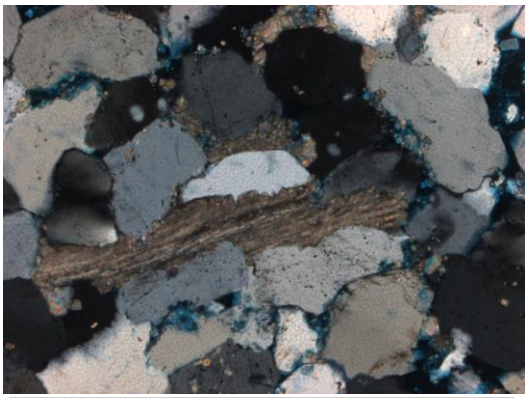


Figure 5.2 Observed at 10x magnification. In XN, anhedral and slightly deformed undulose quartz with a elongated calcite grain deformed from quartz growth, acting as cementing material.

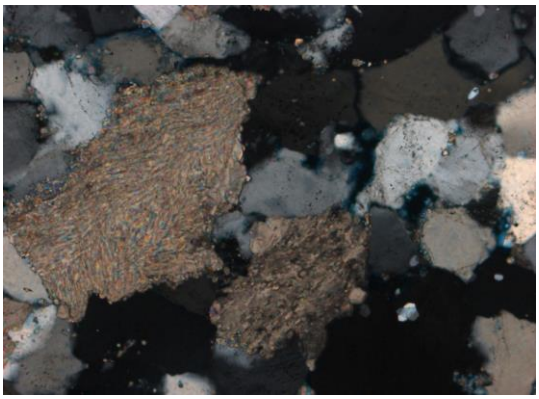


Figure 5.3 Observed at 10x magnification. In XN, anhedral calcite grain with anhedral to subhedral undulose quartz grains. Quartz intergrowth is evident

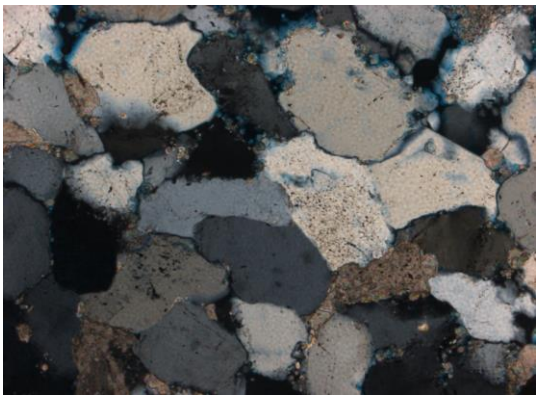


Figure 5.4 Observed at 10x magnification. In XN, subhedral and slightly deformed undulose quartz. Some interspersed grains.

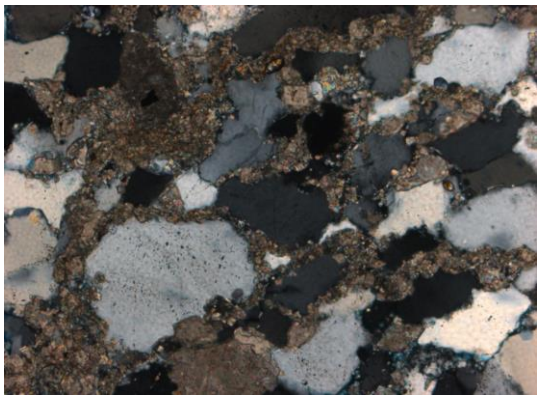


Figure 5.5 Observed at 10x magnification. In XN, subhedral undulose quartz grains cemented together by deformed calcite

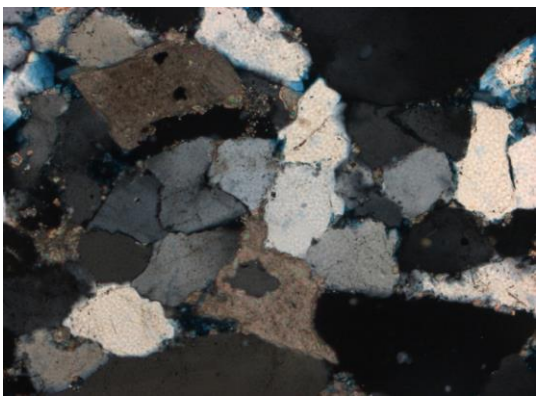


Figure 5.6 Observed at 10x magnification. In XPL, subhedral and slightly deformed quartz grains with quartz cementing. Also a few deformed calcite grains.

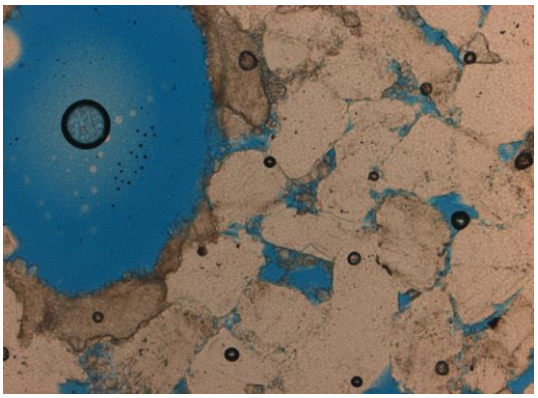


Figure 5.7 Observed at 10x magnification. In PL, blue dye exhibts the open pore spaces in the thin section. the estimated porosity of the thin section is 11% overall

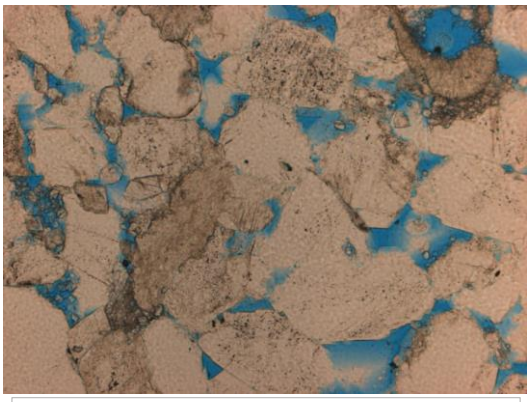


Figure 5.8 Observed at 10x magnification. In PL, blue dye exhibts the open pore spaces in the thin section. the estimated porosity of the thin section is 11% overall

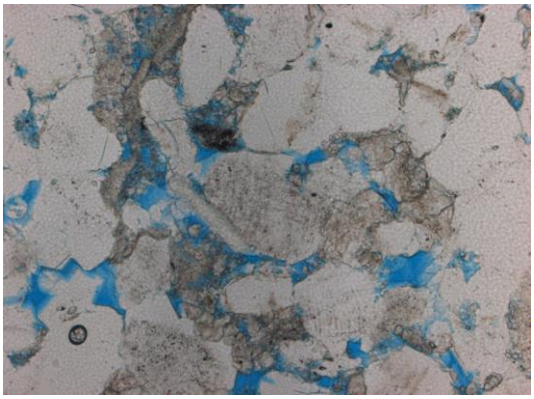


Figure 5.9 Observed at 10x magnification. In PL, blue dye exhibts the open pore spaces in the thin section. The estimated porosity of the thin section is 11% overall.

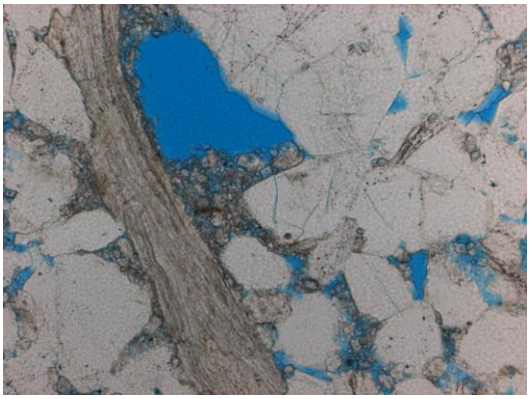


Figure 5.10 Observed at 10x magnification. In PL, blue dye exhibts the open pore spaces in the thin section. The estimated porosity of the thin section is 11% overall.

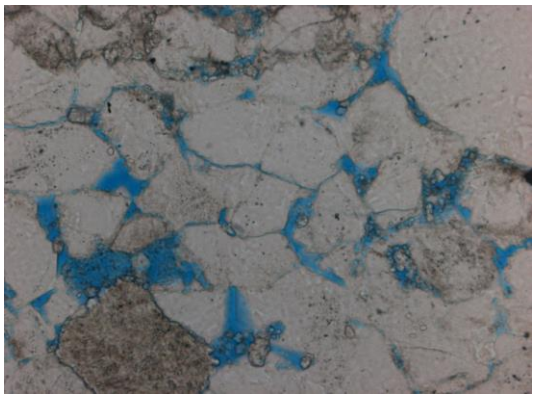


Figure 5.11 Observed at 10x magnification. In PL, blue dye exhibts the open pore spaces in the thin section. The estimated porosity of the thin section is 11% overall

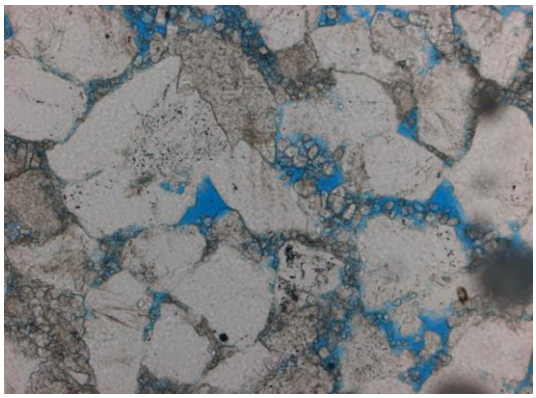


Figure 5.12 Observed at 10x magnification. In PL, blue dye exhibts the open pore spaces in the thin section. The estimated porosity of the thin section is 11% overall

Thin Section Analysis Report

Sample ID:	WD-4		4710701266
Formation/Member Name:	Oriskany Sandstone Wood County, WV		
Lithologic Classification:	Sandstone		
Depth/Depth Range:	4209 ft		Observed @ 10x
Date of Analysis:		6/9/2017	
Analyzed by:	Eric Hirschfeld		

Texture		Comments
Grain Size	average grain size= approx. 150 microns	clastic
Rounding	subangular to subrounded	
Sorting	moderately sorted	

Composition/Detrital Minerals		Comments
Quartz		
Polycrystalline	n/a	
Monocrystalline	80% composition; anhedral to subhedral grains; deformed grains from growth, undulose quartz	Figure 4.1 through Figure 4.8
Microcrystalline	grains are easily observed via petroscope	
Feldspar		
Plagioclase	<1% composition; subhedral; subangular; albite twinning	no Figure
Orthoclase	n/a	
Microcline	n/a	
Carbonate		
Calcite	20% composition; anhedral, deformed grains; XPL; pink/tan, PPL: transparent; moderate birfringence	Figure 4.3 through Figure 4.8
Dolomite	n/a	
Aragonite	n/a	
Clay		
Illite	n/a	
Smectite	n/a	
Kaolinite	n/a	
Muscovite	n/a	
Chlorite	n/a	
Glauconite	n/a	
Rock Fragments		
Sedimentary	Detrital sedimentary fragements are dominant in the thin section and is mostly quartz	
Volcanic	n/a	
Metamorphic	n/a	
Other (Accessory Minerals)		
	n/a	

Cementing Materials		Comments
Quartz	Normal quartz growth, overgrowth, and intergrowth of the grains cement each other together; moderately cemented	Figure 4.3 through Figure 4.8
Feldspar	n/a	
Carbonate	calcite deformations and globular textured grains act as cementing materials	Figure 4.3 through Figure 4.8
Clay	n/a	
Iron Oxide, Hydoxide and/or Sulfide	n/a	
Other	n/a	

Visual Porosity Estimate		Comments
Visual Porosity Estimate	13% porosity	Figure 4.9 through Figure 4.12

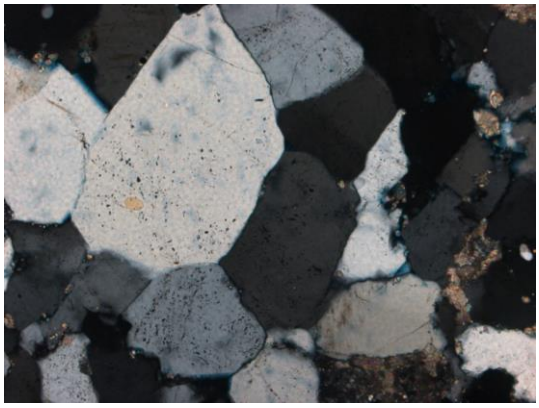


Figure 4.1 Observed at 10x magnification. In XPL, subhedral, undulose quartz gains. Exhibits quartz growth that results in slight deformation.

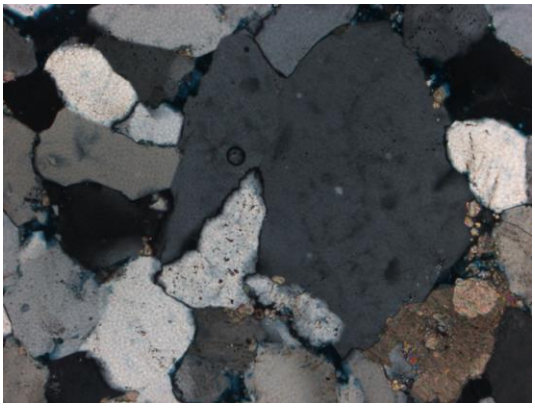


Figure 4.2 Observed at 10x magnification. In XPL, anhedral to subhedral, undulose quartz. Exhibits quartz intergrowth. Also some deformed calcite grains.

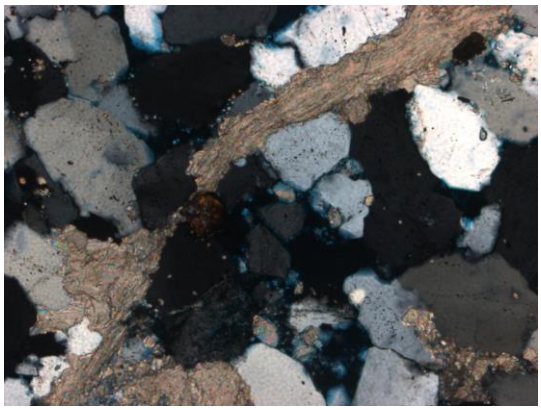


Figure 4.3 Observed at 10x magnification. In XPL, Anhedral and subhedral undulose quartz . some deform grains from interspersion. Elongated and deformed calcite grains.

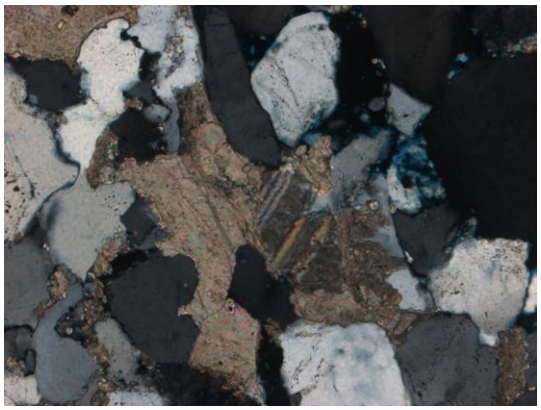


Figure 4.4 Observed at 10x magnification. Deformed undulose quartz grains with deformed calcite grains acting as cementing material. Calcite exhibits some lamellar twinning.

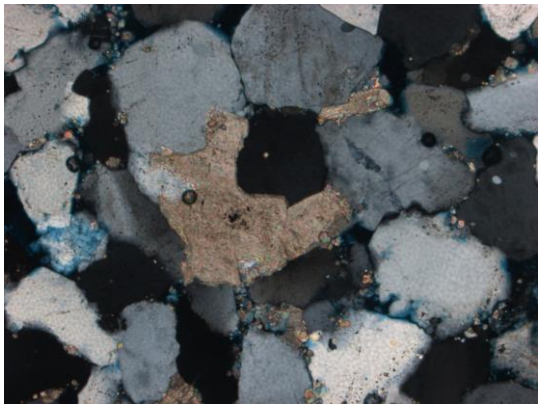


Figure 4.5 Observed at 10x magnification. In XPL, subhedral undulose quartz grains with some deformation growth with a few deformed calcite grains. Exhibits both quartz and carbonate

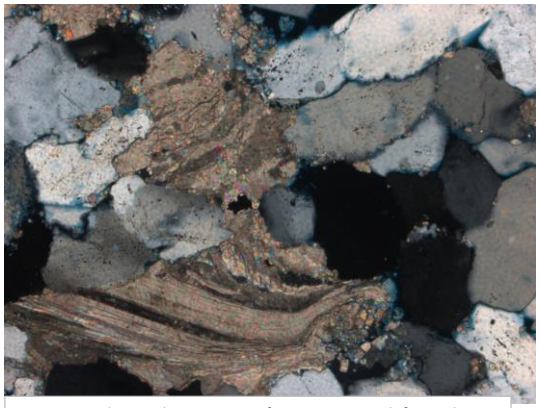


Figure 4.6 Observed at 10x magnification. In XPL, deformed, globular calcite grain cementing together subhedral, undulose quartz grains..

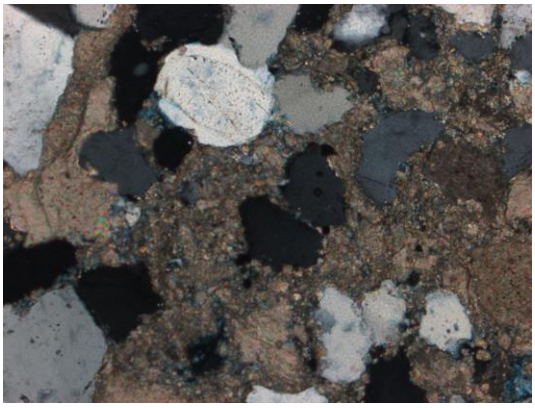


Figure 4.7 Observed at 10x magnification. In XPL, deformed calcite grain and calcareous cement with subrounded, subhedral, undulose quartz grains. Some grains are slightly deformed from growth.

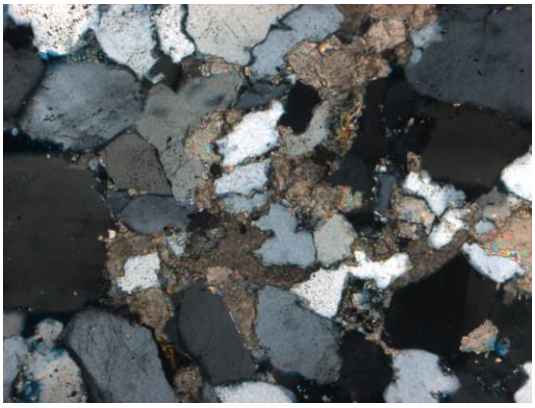


Figure 4.8 Observed at 10x magnification. In XPL, Deformed, undulose quartz grains with calcareous cementing materials.

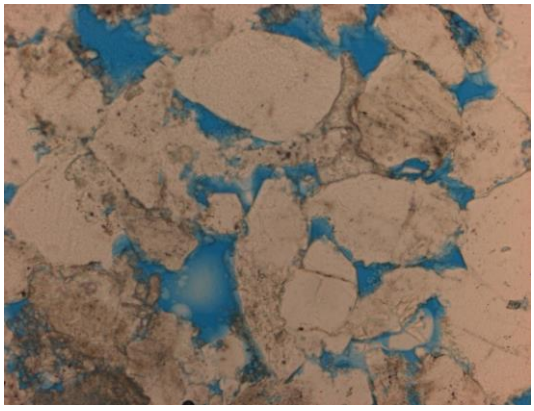


Figure 4.9 Observed at 10x magnification. In PPL, the blue dye exhibits the open pore spaces in the thin section. Visual estimate

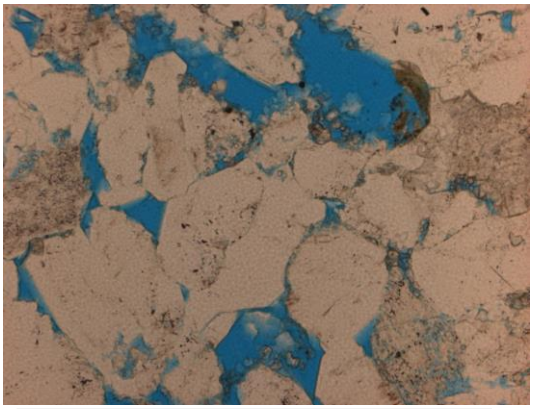


Figure 4.10 Observed at 10x magnification. In PPL, the blue dye exhibits the open pore spaces in the thin section. Visual estimate of porosity is 13% porous.

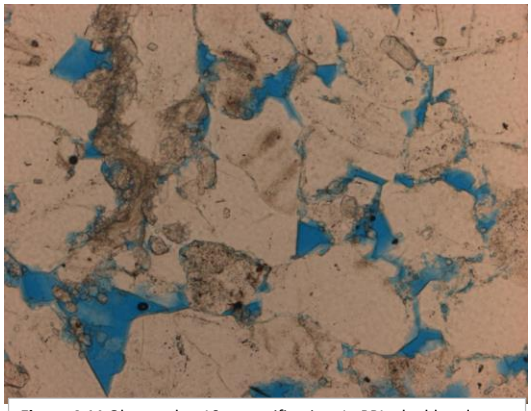


Figure 4.11 Observed at 10x magnification. In PPL, the blue dye exhibits the open pore spaces in the thin section. Visual estimate of porosity is 13% porous.

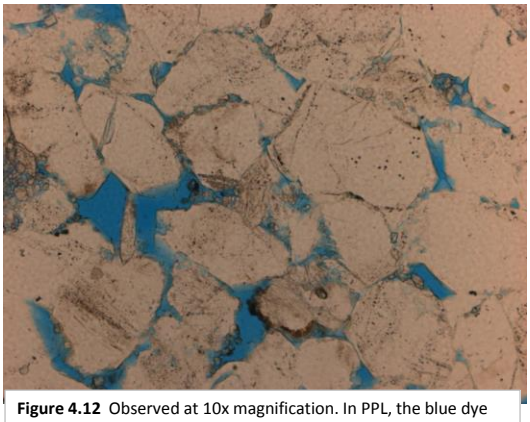


Figure 4.12 Observed at 10x magnification. In PPL, the blue dye exhibits the open pore spaces in the thin section. Visual estimate of porosity is 13% porous.

Thin Section Analysis Report

Sample ID:	WD-3		4710701266
Formation/Member Name:	Oriskany Sandstone Wood County, WV		
Lithologic Classification:	Sandstone		
Depth/Depth Range:	4206 ft		Observed @ 10x
Date of Analysis:		6/9/2017	
Analyzed by:	Eric Hirschfeld		

Texture		Comments
Grain Size	average grain size ranges from 50 microns to 2 mm	clastic
Rounding	subangular to subrounded	
Sorting	poorly sorted	

Composition/Detrital Minerals		Comments
Quartz		
Polycrystalline	n/a	
Monocrystalline	60% composition; anhedral to subhedral; undulose quartz; quartz overgrowth and intergrowth; deformed grains	Figure 3.1 and Figure 3.2
Microcrystalline	grains are easily observed via petroscope	
Feldspar		
Plagioclase	n/a	
Orthoclase	n/a	
Microcline	n/a	
Carbonate		
Calcite	40% composition; deformed grains; semi-fibrous; some subangular grains; anhedral to euhedral; texture in some locations appear to be lamellar twinning; mostly deformed globular grains; one massive deforemed grain of calcite, >3mm	Figure 3.3 through Figure 3.9
Dolomite	n/a	
Aragonite	n/a	
Clay		
Illite	n/a	
Smectite	n/a	
Kaolinite	n/a	
Muscovite	n/a	
Chlorite	n/a	
Glauconite	n/a	
Rock Fragments		
Sedimentary	Predominantly sedimentary detrital minerals and rock fragments with a miniscule traces of volcanic fragments	Figure 3.9
Volcanic		
Metamorphic	n/a	
Other (Accessory Minerals)		
???	unidentifiable mineral	Images: WD3_0011 and WD3_0012

Cementing Materials		Comments
Quartz	Some quartz cementing of grains; moderately cemented	Figure 3.1 through Figure 3.8
Feldspar	n/a	
Carbonate	Predominantly calcite cementing material; calcite fills in pores between quartz grains; acting as main cementing material; moderately to well cemented	Figure 3.1 through Figure 3.8
Clay	n/a	
Iron Oxide, Hydoxide and/or Sulfide	n/a	
Other	n/a	

Visual Porosity Estimate		Comments
Visual Porosity Estimate	7 to 10% porosity	Figure 3.10 through Figure 3.12

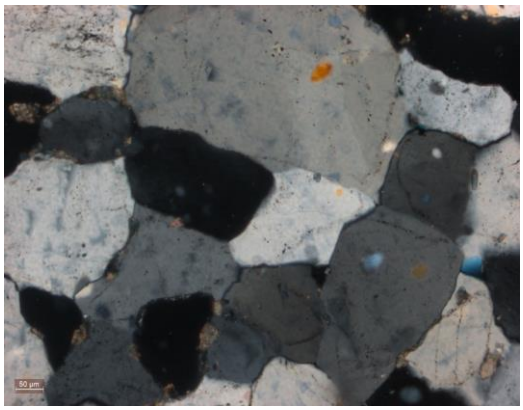


Figure 3.1 Observed at 10x magnification. In XN, subhedral undulose quartz grains cemented together by quartz growth

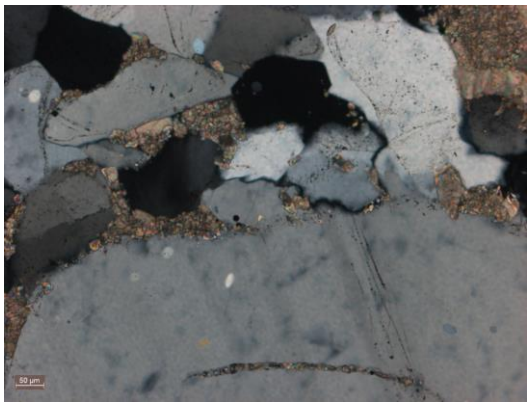


Figure 3.2 Observed at 10x magnification. In XN, anhedral, undulose quartz grains that is calcareously cemented. Also quartz grains show example of overgrowth.

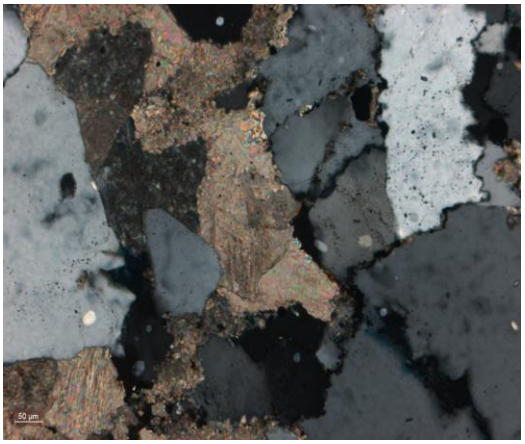


Figure 3.3 Observed at 10x magnification. In XN, Anhedral, undulose quartz grains grown with and cemented by anhedral, deformed calcite grains. Also quartz grains exhibit quartz intergrowth. Slight

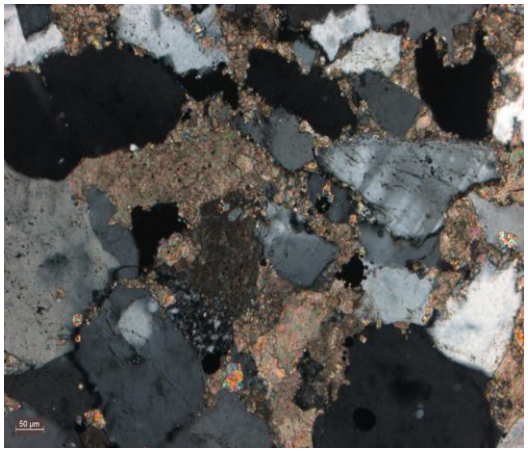


Figure 3.4 Observed at 10x magnification. In XN, anhedral, deformed undulose quartz grains cemented together by both quartz growth and deformed calcite or calcareous material.

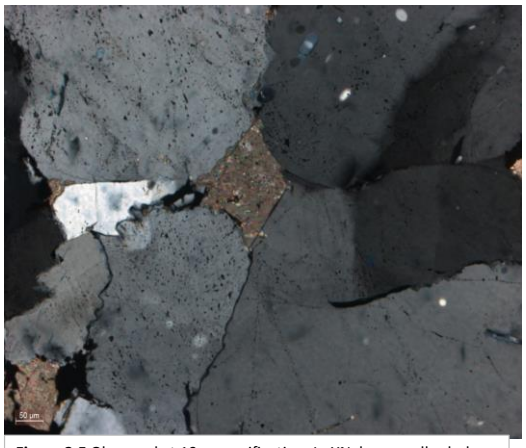


Figure 3.5 Observed at 10x magnification. In XN, large andhedral, undulose quartz grains that are cemented together by quartz growth. Also an euhedral clacite grain.

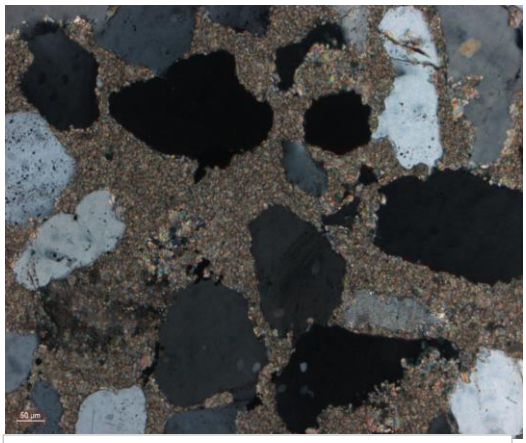


Figure 3.6 Observed at 10x magnification. In XN,subrounded, anhedral quartz grains in a calcareous cement material.

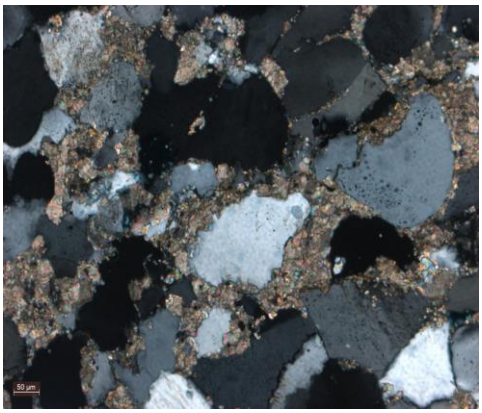


Figure 3.7 Observed at 10x magnification. In XN, anhedral, slighlty deformed quartz grains that are cemented mostly by deformed calcite.

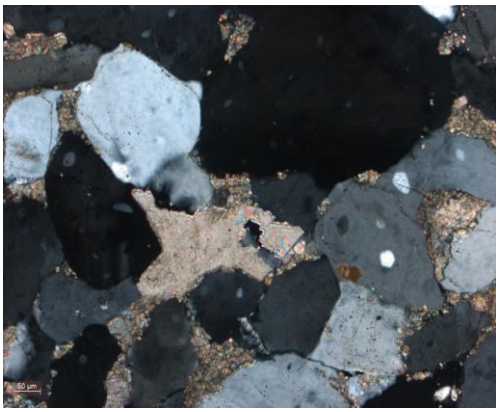


Figure 3.8 Observed at 10x magnification. In XN, subhedral undulose monocrystalline quartz grains cemented together along with cemented of deformed calcite grains.

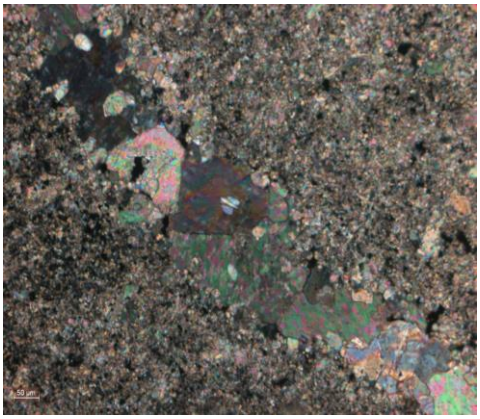


Figure 3.9 Observed at 10x magnification. In XN, portion of massive deformed calcite grain. Exhibits small sedimentary rock fragments and anhedral to subhedral calcite grains.

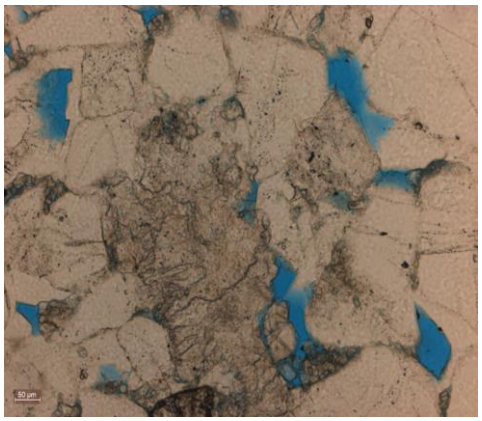


Figure 3.10 Observed at 10x magnification. In PL, blue dye represents the open pores spaces in the thin section,

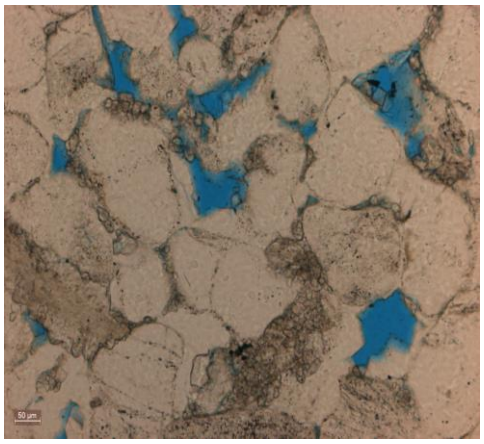


Figure 3.11 Observed at 10x magnification. In PL, blue dye represents the open pores spaces in the thin section, estimating of about 7% porous

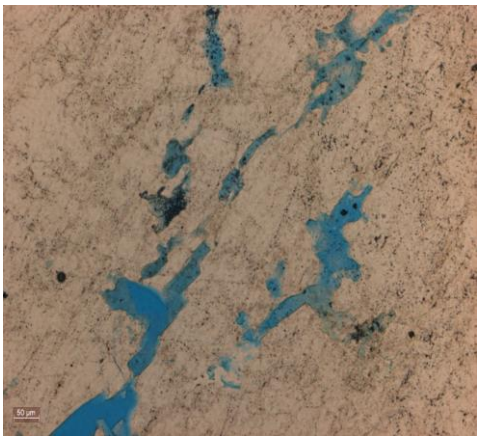


Figure 3.12 Observed at 10x magnification. In PPL blue dye represents the open pores spaces in the thin section, estimating of about 7% porous

Thin Section Analysis Report

Sample ID:	WD-2		4710701266
Formation/Member Name:	Oriskany Sandstone Wood County, WV		
Lithologic Classification:	Sandstone		
Depth/Depth Range:	4200.2 ft		Observed @ 10x
Date of Analysis:		6/9/2017	
Analyzed by:	Eric Hirschfeld		

Texture		Comments
Grain Size	grain size range = approx 50 microns to 500 microns	homogeneous; massive texture; clastic
Rounding	subangular	
Sorting	very well sorted	

Composition/Detrital Minerals		Comments
Quartz		
Polycrystalline	n/a	
Monocrystalline	1% composition; subrounded; subhedral; undulose quartz	Figure 2.1 through Figure 2.3 and Figure 2..8
Microcrystalline	most grains are visible under the petroscope	
Feldspar		
Plagioclase	n/a	
Orthoclase	n/a	
Microcline	n/a	
Carbonate		
Calcite	97% composition; massively grained, some elongated grains; deformation structures; Euhedral to anhedral; grain size 500 microns to 500 microns; dominant mineral in thin section	Figure 2.6, Figure 2.7
Dolomite	n/a	
Aragonite	n/a	
Clay		
Illite	n/a	
Smectite	n/a	
Kaolinite	n/a	
Muscovite	n/a	
Chlorite	n/a	
Glauconite	2% composition; small subangular; anhedral to subhedral; XN: dark green, PL: light green/light olive	
Rock Fragments		
Sedimentary	Predominantly sedimentary fragments of detrital rocks	Figure 2.6, Figure 2.9 through Figure 2.12
Volcanic	some volcanic rock fragments dispersed	
Metamorphic		
Other (Accessory Minerals)		

Cementing Materials		Comments
Quartz	n/a	
Feldspar	n/a	
Carbonate	completely carbonate cementing; entire smaple is deformed calcite with some residual grains	
Clay	n/a	
Iron Oxide, Hydoxide and/or Sulfide	n/a	
Other	n/a	

Visual Porosity Estimate		Comments
Visual Porosity Estimate	0% Porosity	

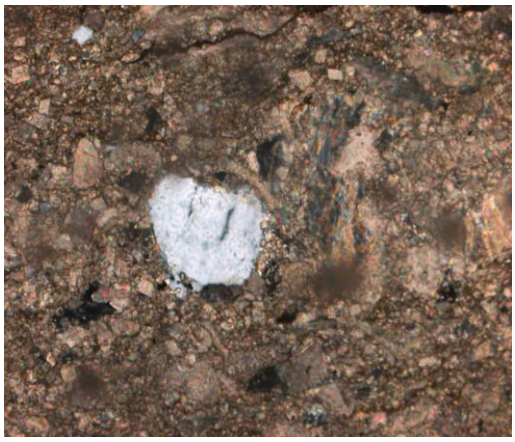


Figure 2.1 Observed at 10x magnification. In XN (unbalanced lighting), subhedral, undulose quartz grain surrounded by deformed calcite grains and calcareous cement

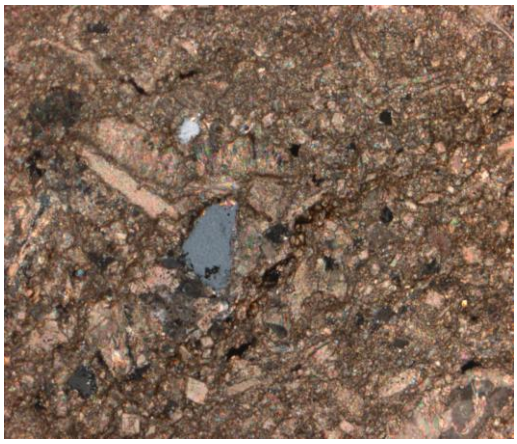


Figure 2.2 Observed at 10x magnification. In XN (unbalanced lighting), subhedral, undulose quartz grain surrounded by elongated, defromed calcite grains, subhedral calcite grains and calcareous cement

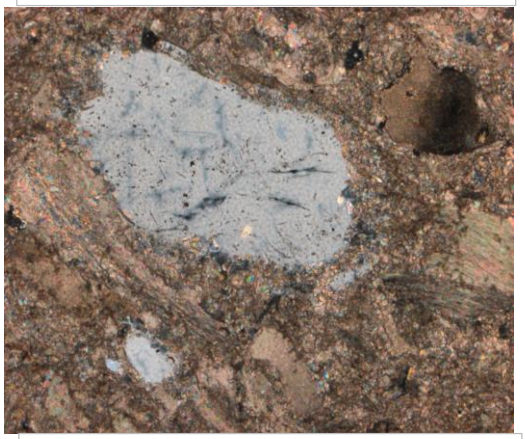


Figure 2.3 Observed at 10x magnification. In XN (unbalanced lighting), anhedral, undulose quartz grain surrounded by anhedral and deformed calcite grains.

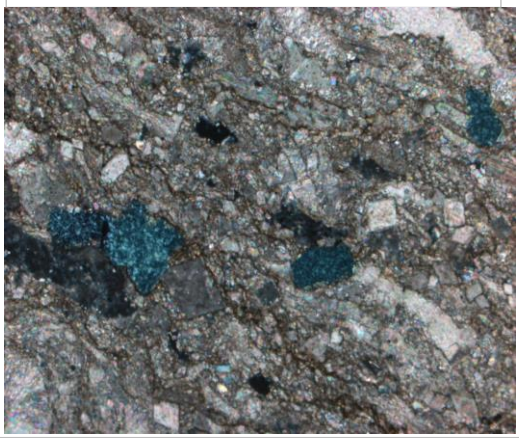


Figure 2.4 Observed at 10x magnification. In XN (balanced lighting), anhedral, greenish glauconite grains with deformed calcite growth and some euhedral calcite grains.

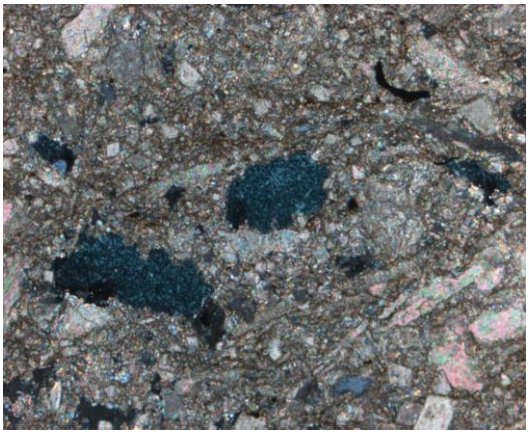


Figure 2.5 Observed at 10x magnification. In XN (balanced lighting), anhredal grains of greenish glauconite grown with deformed calcite grains and a few anhedral calcite grains all within a calcareous cement.

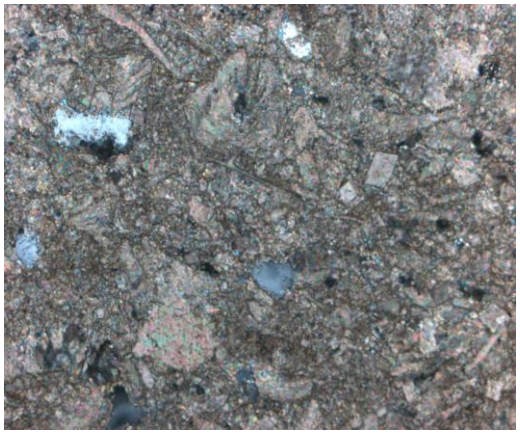


Figure 2.6 Observed at 10x magnification. In XN (balanced lighting), few euhedral calcite grains, deformed calcite growths and the black dots are detrital sedimentary rock fragments.

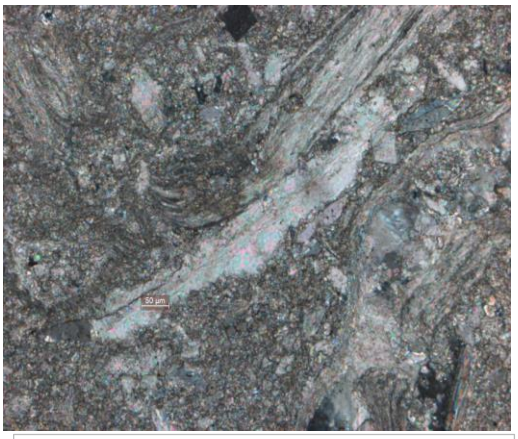


Figure 2.7 Observed at 10x magnification. In XN (balanced lighting) elongated, deformed calcite grains within a calcareous cement



Figure 2.8 Observed at 10x magnification. In XN (unbalanced lighting), anhedral, undulose quartz grain surrounded by multiple euhedral to anhedral calcite grains, all within a calcareous cement.

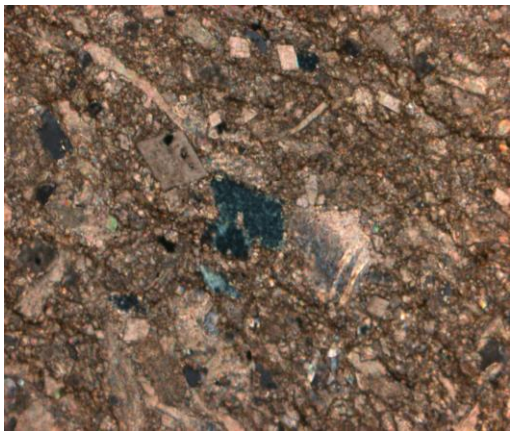


Figure 2.9 Observed at 10x magnification. In XN (unbalanced light) deformed glauconite, black sedimnetary rock fragments, and euhedral and deformed calcite grains winth a calcareous cement.

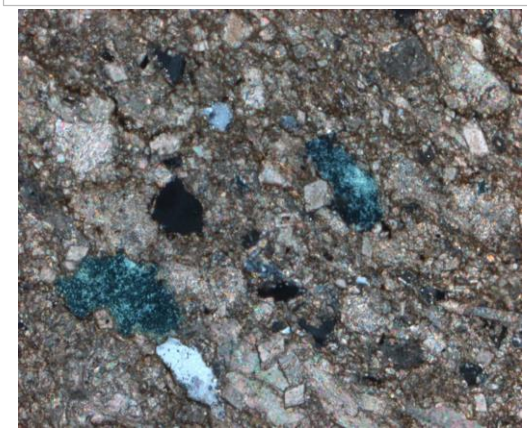


Figure 2.10 Observed at 10x magnification. In XN (balanced lighting), anhedral grains of glauconite (green), sedimentary rock fragments (black) and calcite, all in a calcareous

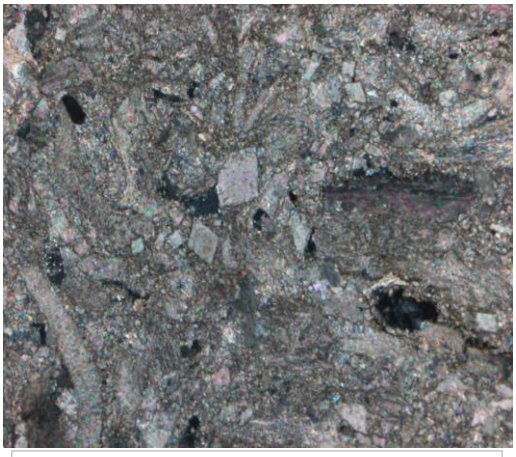


Figure 2.11 Observed at 10x magnification. In XN (balanced lighting) subedral to eudhedral calcite grains, deformed, slightly elongated calcite grains and sedimentary rock fragments.

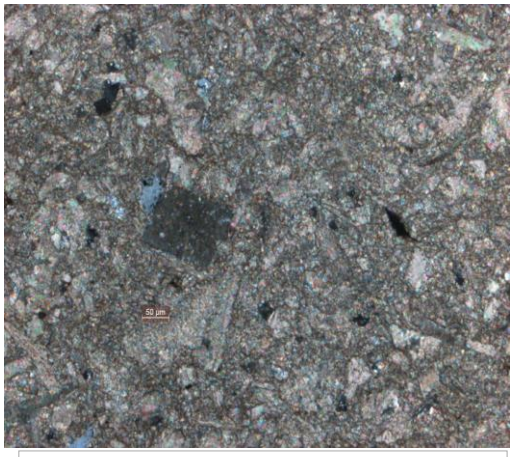


Figure 2.12 Observed at 10x magnification. In XN (balanced lighting), euhedral clacite grain surounded by deformed calcite growth, sedimnetary rock fragments and calcareous

Thin Section Analysis Report

Sample ID:	WD-1		4710701266
Formation/Member Name:	Oriskany Sandstone Wood County, WV		
Lithologic Classification:	Sandstone		
Depth/Depth Range:	4197.1 ft		Observed @ 10x
Date of Analysis:		6/9/2017	
Analyzed by:	Eric Hirschfeld		

Texture		Comments
Grain Size	average grain size= Approx. 50 microns	homogeneous; massive texure
Rounding	angular to subangular	
Sorting	well sorted	

Composition/Detrital Minerals		Comments
Quartz		
Polycrystalline	n/a	
Monocrystalline	n/a	
Microcrystalline	most grains are visible under petroscope	
Feldspar		
Plagioclase	n/a	
Orthoclase	n/a	
Microcline	n/a	
Carbonate		
Calcite	100% composition; low birefringence; euhedral to anhedral grains; deformation structures of calcite grains; some grains globular; some grains semi-fibrous; XN: tan-pink, light brown, PL: light brown, tan white	Figures 1.1 through 1.12
Dolomite	n/a	
Aragonite	n/a	
Clay		
Illite	n/a	
Smectite	n/a	
Kaolinite	n/a	
Muscovite	n/a	
Chlorite	n/a	
Glauconite	n/a	
Rock Fragments		
Sedimentary	Multiple remnants of detrital sedimentary rock fragments	Figures 1.1 through 1.12
Volcanic	n/a	
Metamorphic	n/a	
Other (Accessory Minerals)		
	n/a	
	n/a	
	n/a	

Cementing Materials		Comments
Quartz	n/a	
Feldspar	n/a	
Carbonate	Deformed calcite grains; calcareous mud acting as the cementing material; entire sample is calcite; very well cemented	Figures 1.1 through 1.12
Clay	n/a	
Iron Oxide, Hydoxide and/or Sulfide	n/a	
Other	n/a	

Visual Porosity Estimate		Comments
Visual Porosity Estimate	0% porosity	Images: WD1_0001 through WD1_0020

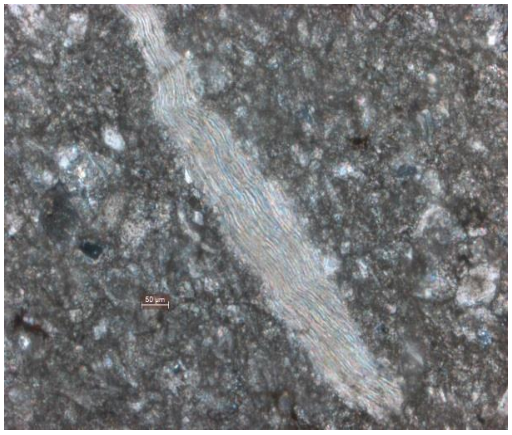


Figure 1.1 Observed at 10x magnificationIn XN, deformed calcite grains, calcite cement semi-fibrous texture.

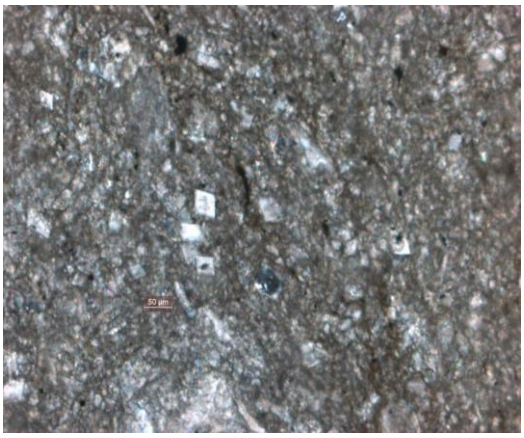


Figure 1.2 Observed at 10x magnification. In XN, euhedral calcite grains and deformed calcite grains in a calcareous cement.



Figrue 1.3 Observed at 10x magnification. In XN, highly deformed calcite grains intergrown and some subhedral calcite grains

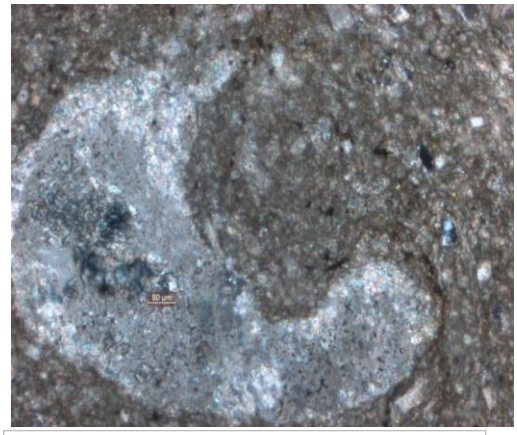


Figure 1.4 Observed at 10x magnification. In XN, masssive, globular calcite grain, some anhedral calcite grains

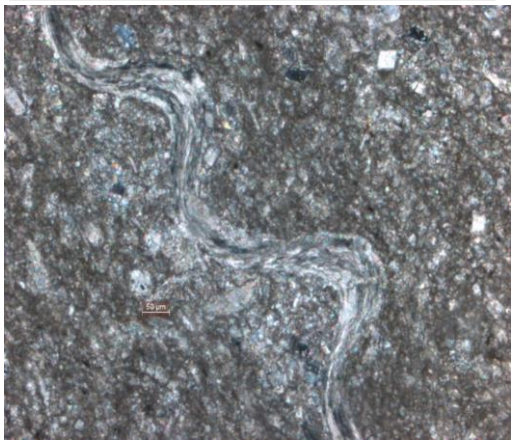


Figure 1.5 Observed at 10x magnification. In XN, deformed semi-fibrous calcite grain, anhedral and subhedral calcite grains. Calcareous cement

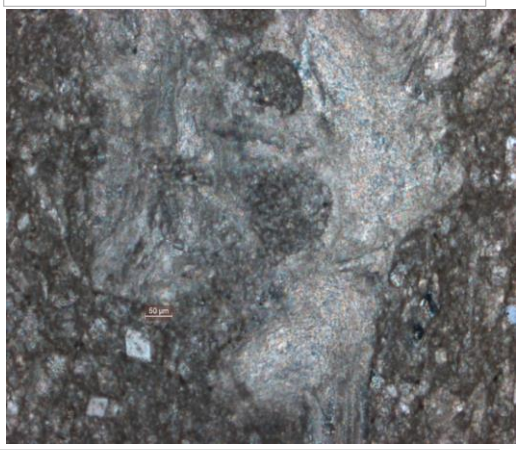


Figure 1.6 Observed at 10x magnification. In XN, massive, deformed calcite growth. Euhedral and subhedral calcite grains. Few remnants of detrital sedimnetray rock fragments

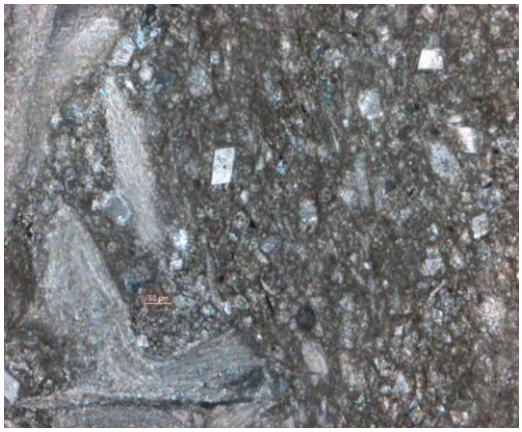


Figure 1.7 Observed at 10x magnification. In XN, massive, semi-globular, deformed calcite growth, euhedral and subhedral clacite grains, calcareous cement.

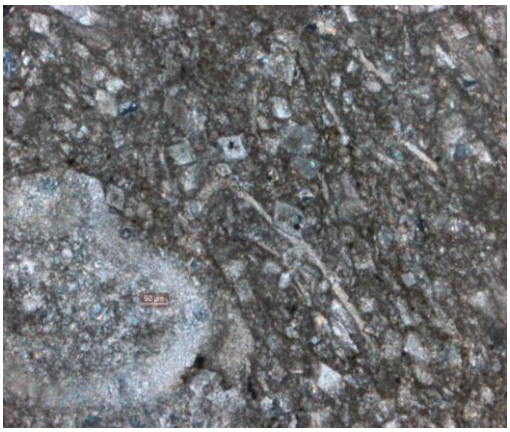


Figure 1.8 Observed at 10x magnification. In XN,many euhedral to anhedral calcite grains. Large deformed calcite growth

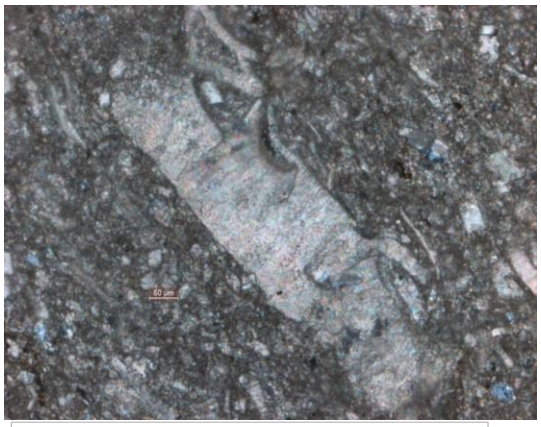


Figure 1.9 Observed at 10x magnification. In XN**,** massive, subhedral calcite grain surrounded by smaller anhedral to subhedral calcite grains. All within a calcareous cement.

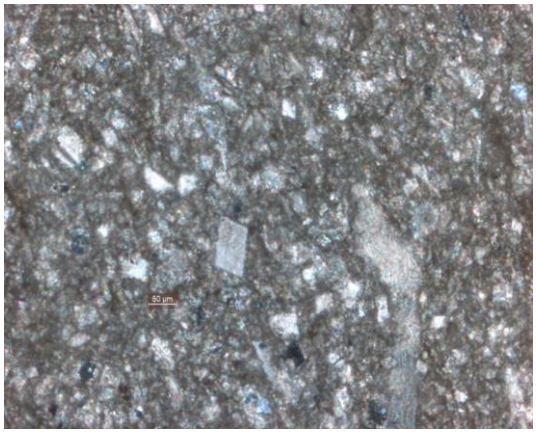


Figure 1.10 Observed at 10x magnification. In XN, subhedral to euhedral calcite grains. Some deformation of grains within calcareous cement

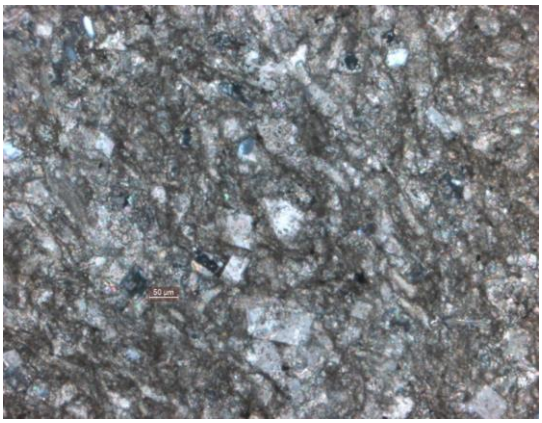


Figure 1.11 Observed at 10x magnification.In XN**,** anhedral to subhedral grains of calcite in calcareous cement. Few sedimentary rock fragments

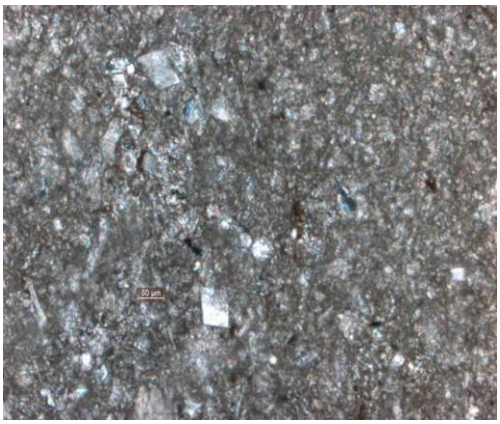


Figure 1.12 Observed at 10x magnification. In XN, euhedral calcite grains and deformed grains within calareous cement. Also present is a few sedimentary rock fragments.