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Abstract

Drill cores from the southeastern Baffin Island shelf offer rare insights into the lower Paleozoic bedrock geology that underlies the northern Baffin-Labrador Seaway Mesozoic to Cenozoic rift stratigraphy. Six seabed drill cores (Cruise 75-009 Phase V, Stations 4, 5, 8A, 8B and Cruise 77027, Stations 026A, and 028) were recovered from offshore Baffin Island by the Geological Survey of Canada during marine cruises in the 1970s. The lithology (sedimentology and paleontology) of the drill cores and their associated thin sections is analyzed to provide information on the depositional environments that existed in the Iapetus Ocean during the Middle to Upper Ordovician. The drill cores are predominantly composed of fine, lime mud, with evidence of bioturbation observed in four of the six cores. The drill cores exhibit varying degrees of dolomitization, with the drill core from 75-009, Phase V Station 4 being the most diagenetically altered. Disseminated pyrite is found throughout the drill cores and thin sections, and the cores from Stations 8A and 8B contain finely macerated organic matter dispersed in the matrix. Fossils identified in the drill cores and thin sections include bivalves, trilobites, crinoids, sponge spicules, gastropods, brachiopods, corals, cephalopods, dasycladacean green algae, ostracods, bryozoans, and radiolarians, as well as possible calcispheres. Undifferentiated echinoderm and shell fragments are also common throughout the strata. Initial interpretations based on observations from the drill cores and thin sections suggest depositional milieus ranging from shallow, photic zone environments to deeper, open marine settings.

Table of Contents

1. Introduction

The Paleozoic strata from the Baffin-Labrador Seaway are said to represent deposition along the western margin of the Iapetus Ocean during the latter part of the Ordovician (Bell and Howie, 1990). A passive margin environment dominated the region during the Cambrian and into the Ordovician with eastward subduction occurring. The closure of the Iapetus Ocean initiated with the Taconic Orogeny in the Middle Ordovician when the North American margin collided with an island arc. The closing of the Iapetus Ocean and the eventual opening of the Atlantic Ocean has resulted in highly-altered and deformed Paleozoic rocks scattered throughout the Baffin-Labrador Seaway from the Labrador shelf to Baffin Bay. Paleozoic strata has been penetrated in a handful of wells in the Hopedale Basin along the Labrador margin (Bell and Howie, 1990). Outcrops of Paleozoic rocks also occur on Baffin and Akpatok (in Ungava Bay) islands, and shallow drill cores provide evidence for the existence of Paleozoic bedrock along the southeastern Baffin Island shelf between Frobisher Bay and Cumberland Sound (Fig. 1A; Jansa, 1976; MacLean and Srivastava, 1976; MacLean et al., 1977; Bell and Howie, 1990). Seismic refraction and reflection data, in tandem with gravity and magnetic data, suggest that Paleozoic rocks may underlie parts of the Hudson Strait, Davis Strait, and Ungava Bay, as well as be present locally along the western margin of Baffin Bay between Cape Dyer and Bylot Island (MacLean and Williams, 1983; Bell and Howie, 1990). Based on seismic data and submersible observations, Paleozoic strata is also inferred to outcrop along the seafloor in Frobisher Bay, outer Cumberland Sound, and extending towards Cape Dyer, however no physical evidence has been recovered to confirm this (MacLean et al., 1982; 1986; Bell and Howie, 1990). Upper Ordovician to Lower Silurian carbonate xenoliths have also been found contained within Upper Jurassic to Lower Cretaceous kimberlites on the Hall Peninsula suggesting the onshore presence of Lower Paleozoic strata in the region prior to the Early Cretaceous (Zhang and Pell 2013; 2014).

Due to a lack of sampling of Paleozoic strata in these regions, these sediments are largely identified and mapped via seismic, magnetic and gravity data, with limited subsurface bedrock samples to ground truth the data. The paucity of bedrock samples and the remote nature of known locations has resulted in the offshore Paleozoic of the region to be understudied and poorly constrained. Six upper Ordovician carbonate drill cores recovered from the southeastern Baffin Island shelf (Fig. 1B), and their associated thin sections, provide a rare opportunity to study the depositional environments that existed in the Iapetus Ocean under what is now the Baffin-Labrador Seaway. General descriptions of these drill cores have been published previously; however, no detailed core or thin section descriptions were available until now.

2. Geology of the area

The subsurface geology of the southeastern Baffin Island margin (Hudson Strait to Cape Dyer) was largely unknown until the 1970s when research cruises led by the Geological Survey of Canada collected magnetic and seismic data from the region (Bell and Howie, 1990). Using this newly acquired seismic data and magnetic profiling, Grant (1975) subdivided the subsurface of the region into six geophysical units that were

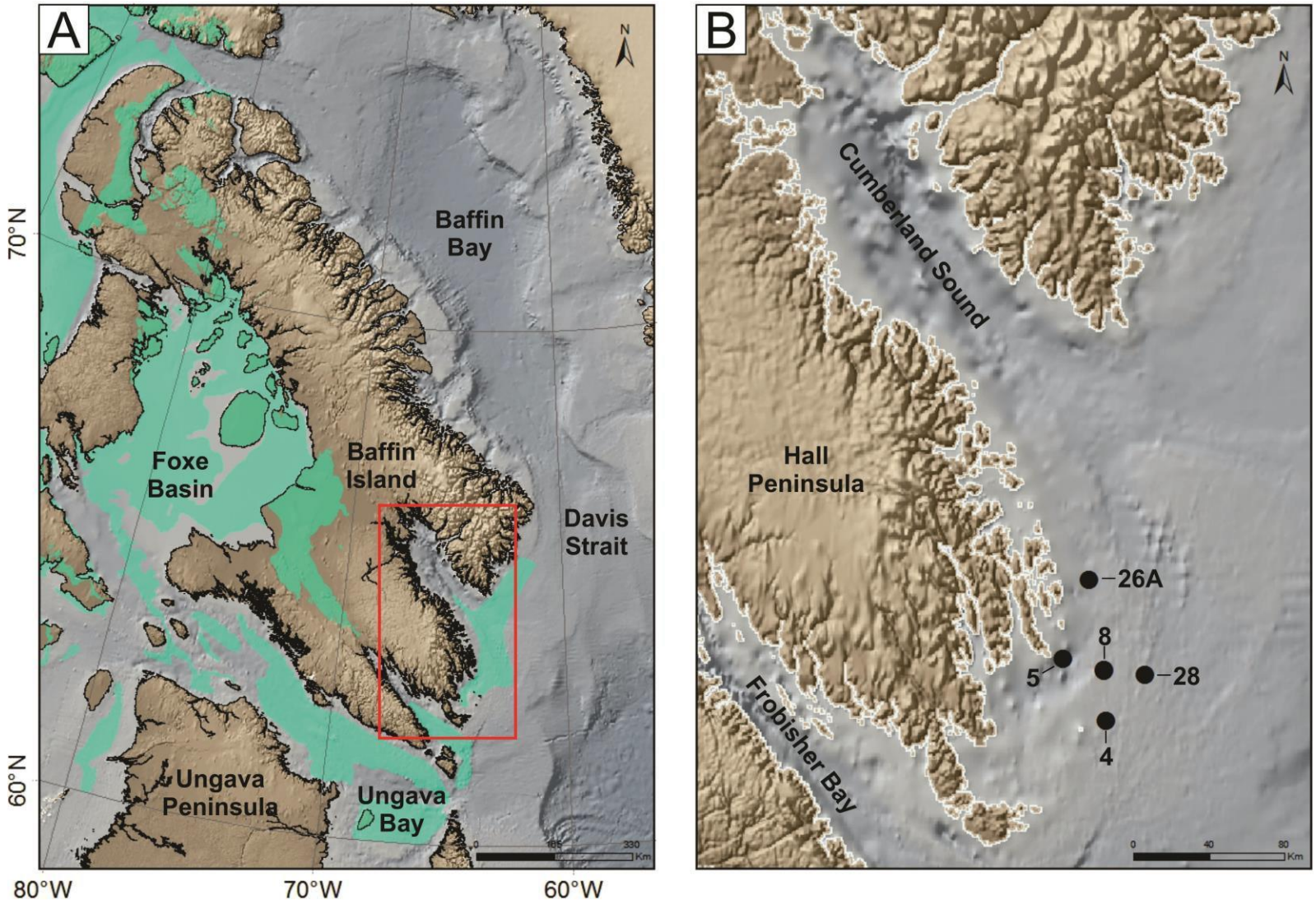

Figure 1: Location maps for the southeastern Baffin Island shelf drill cores. (A) Distribution map of Ordovician strata on and around Baffin Island with the location of the region of interest indicated by the red box (based on Harrison et al., 2011). (B) View of the study region of interest from (A) displaying the locations of the drill core recovery sites from the southeastern Baffin Island shelf.

grouped into Precambrian, Early Paleozoic, Late Paleozoic to Mesozoic, and Cretaceous to Tertiary intervals. The geophysical data suggested that the upper Paleozoic to Tertiary strata exhibited evidence of folding, faulting, and diaper-like intrusion, and that lower Tertiary basalts covered these sediments offshore of Cape Dyer (Grant, 1975). Based on the seismic and magnetic profiles, Grant (1975) concluded that the structure of the southeastern Baffin Island shelf was more complicated than that of the Labrador shelf to the south; however, no physical bedrock samples were available at this time north of the Labrador shelf Bjarni H-81 well, 512 km to the south (MacLean and Srivastava, 1976). Seismic data was later used to identify consolidated bedrock units in the region and determine drill targets for the 1975 and 1977 Geological Survey of Canada research cruises aboard the CSS Hudson (Cruise 75-009, Phase V and Cruise 77-027, respectively).

The newly collected seismic, drill core, and piston core data from the research cruises demonstrated that the offshore subsurface geology of the southeastern Baffin Island shelf is complex, as Grant (1975) had predicted. The subsurface is composed of semi-consolidated to consolidated sedimentary (limestone and semi-consolidated sandstone), igneous (granite and basalt), and metamorphic (gneiss) rocks dating from the Precambrian to Quaternary (Jansa, 1976; MacLean, 1978). The Paleozoic interval exposed offshore southeastern Baffin Island unconformably overlies Precambrian gneiss, migmatite, and schist in areas. It is, in turn, unconformably overlain to the north and seaward by strata interpreted from seismic to be of Mesozoic to Cenozoic in age (MacLean et al., 1977).

3. Paleozoic drill cores

Six Paleozoic limestone drill cores from the southeast Baffin Island shelf were recovered in the 1970s from Geological Survey of Canada led research cruises. Four drill cores located on the southeast Baffin Island shelf between Frobisher Bay and Cumberland Sound, were collected between September 15 and 17, 1975 aboard the CSS Hudson, Cruise 75-009, Phase V (Stations 4, 5, 8A, and 8B (Fig. 1B); MacLean and Srivastava, 1976). Fifteen drilling attempts were made during Phase V, at nine locations, with six drill cores being obtained from four locations; Stations 4 (limestone), 5 (limestone), 8A (limestone), 8B (limestone), 9A (gneiss), and 9B (gneiss; MacLean and Srivastava, 1976). Three of these locations (Stations 4, 5, 8A, and 8B) produced cores composed of Paleozoic limestones, as well as some Paleozoic limestone gravel (Station 8), which are described in this report. The drill cores from Station 9 are considered to be the only representation of metamorphic basement recovered during the 1975 cruise from the region (Jansa, 1976). All other occurrences of metamorphic or igneous rocks in the drill cores are deemed to be erratics, likely representing boulders. 137 cm of limestone was recovered from Station 4, which is located 46 km southeast of Brevoort Island and 15 km east-northeast of Lady Franklin Island (MacLean and Srivastava, 1976). Over a meter of drill core was obtained from Station 5, the top 65 cm of which is overburden consisting of garnet-biotite gneiss, and the remaining 54 cm is composed of limestone (MacLean et al., 1977). This station is located 6 km southeast of the southern tip of Brevoort Island, and is separated by a fault from Station 8 to the east (MacLean et al., 1977). Three drilling attempts were made at Station 8, the first of which only produced gneiss and limestone gravel; no bedrock was recovered. The

second and third attempts, Stations 8A and 8B respectively, both recovered Paleozoic limestone bedrock. Station 8 is located 24 km east-southeast of Station 5, and 27 km north of Station 4, in an area deformed by faults and small folds (MacLean et al., 1977).

The drill cores from the 1975 expedition, and associated thin sections, were described briefly by Jansa (1976) and MacLean et al. (1977), but no formal core logs or descriptions were published. Biostratigraphy studies by Jenkins (1976) and Bolton (1976) determined that all drill cores recovered during this cruise were Middle to Upper Ordovician in age. Jansa (1976) identified three lithostratigraphic units based solely on core and thin section descriptions: Unit 1 = Station 4, Unit 2 = Station 5, and Unit 3 = Station 8. MacLean and colleagues (1977), conversely, subdivided the strata of the region into two units based on lithological, seismic, and magnetic data. The first unit (Unit 1) occurs in a narrow band, up to 40 km wide, along the southeast coast of Baffin Island and includes Station 5 (MacLean et al., 1977). This unit is fault bounded to the east and is distinguished from the second unit by its greater acoustical hardness. The second unit (Unit 2) is composed of the remaining Ordovician strata and includes Stations 4 and 8 (MacLean et al., 1977).

The remaining two Paleozoic drill cores were collected off the southeastern edge of Hall Peninsula during cruise 77-027 from September 18 to October 13, 1977 (Atlantic Geoscience Centre, 1977). Sixteen localities and 26 drilling attempts resulted in 703 cm of core from six sites, two of which, Stations 026A and 028, intersect Paleozoic limestone. Approximately 83 cm of Paleozoic limestone was recovered from Station 026A, while Station 028 yielded 100 cm of Paleozoic core. Brief, general descriptions of these cores can be found in a MacLean (1978). These drill cores are assumed to be Upper Ordovician in age based on similarities in lithologies to the drill cores recovered from the 1975 expedition, however, no biostratigraphic analysis has been done.

The drill cores from both the 1975 and 1977 cruises were obtained using the Bedford Institute of Oceanography's underwater electric rock core drill which has a maximum penetration depth of up to 6 m below the sea floor and cuts 25 mm diameter drill core (MacLean and Srivastava, 1976; MacLean, 1978).

4. Methodology

Six Paleozoic limestone drill cores from the southeast Baffin Island shelf and their associated thin sections were examined and described. Details regarding the lithology, sedimentology, paleontology, and diagentic history of the drill cores were recorded and published for the first time in this report (Table 1; Appendix A). There may be some discrepancies between the length of drill core stated in the core descriptions and the original recovery length published in the cruise reports. The differences in length are likely due to the distribution of core in the box. Twenty-three thin sections (Table 2) were created in the 1970s from a combination of the six Paleozoic limestone drill cores (Stations 4, 5, 8A, 8B, 026A, and 028) and gravel (Station 8) and are described in terms of sedimentological and paleontological composition (Appendices B and C). The thin sections were analyzed using a Zeiss Axio Scope A1 petrographic microscope, photographed with an Axiocam 12 Mb camera, and captured digitally using the Zeiss ZEN software.

Table 1: Paleozoic drill cores in the Baffin Bay region.

Expedition	Year	Station #	Lat.	Long.	Water Depth	Recovery	Age	Age Reference
75-009, Phase V	1975	4	62° 58.2' N (62.9705)	63° 26.1' W (-63.43433)	157 m	137 cm core	Ordovician (Caradoc)	Jenkins, 1976; MacLean et al., 1977
75-009, Phase V	1975	5	63° 16.2' N (63.27017)	63° 54.6' W (-63.91067)	358 m	126 cm core	Ordovician (Caradoc)	Bolton, 1976; MacLean et al., 1977
75-009, Phase V	1975	8	63° 12.8' N (63.21333)	63° 27.2' W (-63.454)	165 m	Mainly gravel	Ordovician (assumed)	MacLean et al., 1977
75-009, Phase V	1975	8A	63° 12.9' N (63.21533)	63° 27.5' W (-63.45917)	165 m	70 cm core	Ordovician (Caradoc)	Jenkins, 1976; MacLean et al., 1977
75-009, Phase V	1975	8B	63° 13.2' N (63.22033)	63° 27.6' W (-63.45983)	165 m	89 cm core	Ordovician (Caradoc)	Jenkins, 1976; MacLean et al., 1977
77027	1977	026A	63° 39.5' N (63.65833)	63° 38.1' W (-63.635)	373 m	7 cm gravel; 83 cm core	Middle to Late Ordovician (assumed)	MacLean, 1978
77027	1977	028	63° 11.86' N (63.19767)	63° 00.9' W (-63.01583)	179 m	7 cm gravel; 100 cm core	Middle to Late Ordovician (assumed)	MacLean, 1978

Table 2: Thin sections of the southeastern Baffin Island shelf drill cores.

Cruise	Station #	Piece #	Sample depth (inches)
75-009, Phase V	4	6	15
		17	19
		11	30
		7	40
		7	42
75-009, Phase V	5	16	21
		10	31
		10	33
		5	6.5
		1	45.5
		1	47.5
75-009, Phase V	8	4	13
			20
75-009, Phase V	8A	13	2
		5	15
		1	27
75-009, Phase V	8B	20	3.5
		16	10
		16	10
		6	32
77027	026A	SPL5	
77027	028	3	
		10	

5. Drill cores

The following section includes a summary of previous work along with new drill core and thin section descriptions for each station. The drill core and thin section descriptions presented here are generalized; please refer to Appendix A for detailed drill core descriptions and Appendix B for thin section descriptions. Thin section descriptions below are based on the amalgamation of observations made from the thin sections associated with that station. Photographs of the thin sections can be found in Appendix C. Thin sections are referred to in the text by three numbers: station number – piece number – sample depth (if provided). Preliminary, generalized interpretations for each station, based on thin sections and drill core descriptions, are presented here. More in-depth interpretations and regional implications will be published separately.

5.1. 75-009, Phase V – Station 4

5.1.1. Previous work - Station 4

The reports from Jansa (1976) and MacLean et al. (1977) describe the drill core from Station 4 (Jansa's Unit 1; MacLean's Unit 2) as being composed of mottled, olive grey, dolomitic limestone with the mottling attributed to preferential dolomitization of burrows infilled with micrite (Jansa, 1976). Angular to rounded intraclasts occur

throughout the core and are typically oriented parallel to bedding with the exception of the intraclasts that are found in a pebble breccia (MacLean et al., 1977). Dolomitization is noted to increase towards the base of the drill core. Faunal elements identified in the core by Jansa (1976) include trilobite, mollusc, and crinoid fragments. Rare Chitinozoa and scolecodonts are found in the insoluble residue and provide a Middle to Late Ordovician age for the drill core (Jenkins, 1976; MacLean et al., 1977).

5.1.2. Drill core description – Station 4

Drill core 75-009, Phase V – Station 4 (Fig. 2) is 150 cm in length and is composed primarily of dolomite and limestone, with the bottom third of the core (50 cm) being predominantly dolomitic. Dolomitization increases with depth in the drill core, with preferential dolomitization observed in the upper section, transitioning into a heavily dolomitized mid-section, and finally into pervasive dolomitization in the bottom third of the core. Light and dark brown layers alternate between 60 and 100 cm, likely a product of preferential dolomitization of the siltier, lighter coloured layers, which may represent burrows. The darker brown mudstone layers are less dolomitized and contain several fossil fragments too small to macroscopically identify. Calcite cement and fractures are also more prevalent in the basal section (below 80 cm), but other diagenetic features, such as pyrite precipitation and stylolite formation, remain fairly consistent throughout the drill core.

Angular to sub-angular, centimeter-scale intraclasts are present throughout the upper 100 cm of the drill core and a pebble lag containing skeletal fragments occurs around 30 cm from the top (Fig. 2D). There are a few occurrences of argillaceous layers (silt stringers) between 40 and 60 cm, which tend to be preferentially dolomitized. A breccia is found around 55 cm and includes angular skeletal clasts and sub-rounded to rounded intraclasts, with smaller skeletal clasts and fragments in the matrix (Fig. 2E). There are also a few diagenetic sediment cavities located in the middle portion of the drill core, between 60 and 120 cm, which are predominantly filled with calcite cement and a minor amount of pyrite.

Mottling occurs throughout the drill core with definitive evidence of bioturbation (burrows; Fig. 2D) identified in the upper 100 cm. The bottom third of the drill core exhibits minor mottling, but the lack of fossils and pervasive dolomitization makes it difficult to confirm its origin. The upper section of the drill core is fossiliferous with abundant skeletal and shell fragments. Identifiable macro-fauna found throughout the upper 100 cm include echinoid (crinoid), bivalve, brachiopod, and trilobite fragments. A possible piece of branching coral (*Thamnopora?*) was noted at 57 cm depth, but could not be conclusively identified in the drill core. In addition to an increase in dolomite, the basal third of the drill core is noticeably lacking in regards to macrofossils, with possible microbial laminations (around 106 cm and 114 cm depth) and an altered crinoid (at 119 cm depth; Fig. 2A) documented. The paucity of fossils may be due, in part, to the presence of dolomite, which can alter preservation conditions and/or dissolve skeletal material.

5.1.3. Thin section descriptions – Station 4 (Appendix C, Plates 1-5)

Five thin sections at varying depths were made from the drill core taken at Station 4. The thin sections exhibit a wide range of lithologies with dolomite increasing with depth until pervasive dolomitization is present in thin sections 4-7-40 and 4-7-42. Large-scale, biological components are present at shallower depths and include bivalve

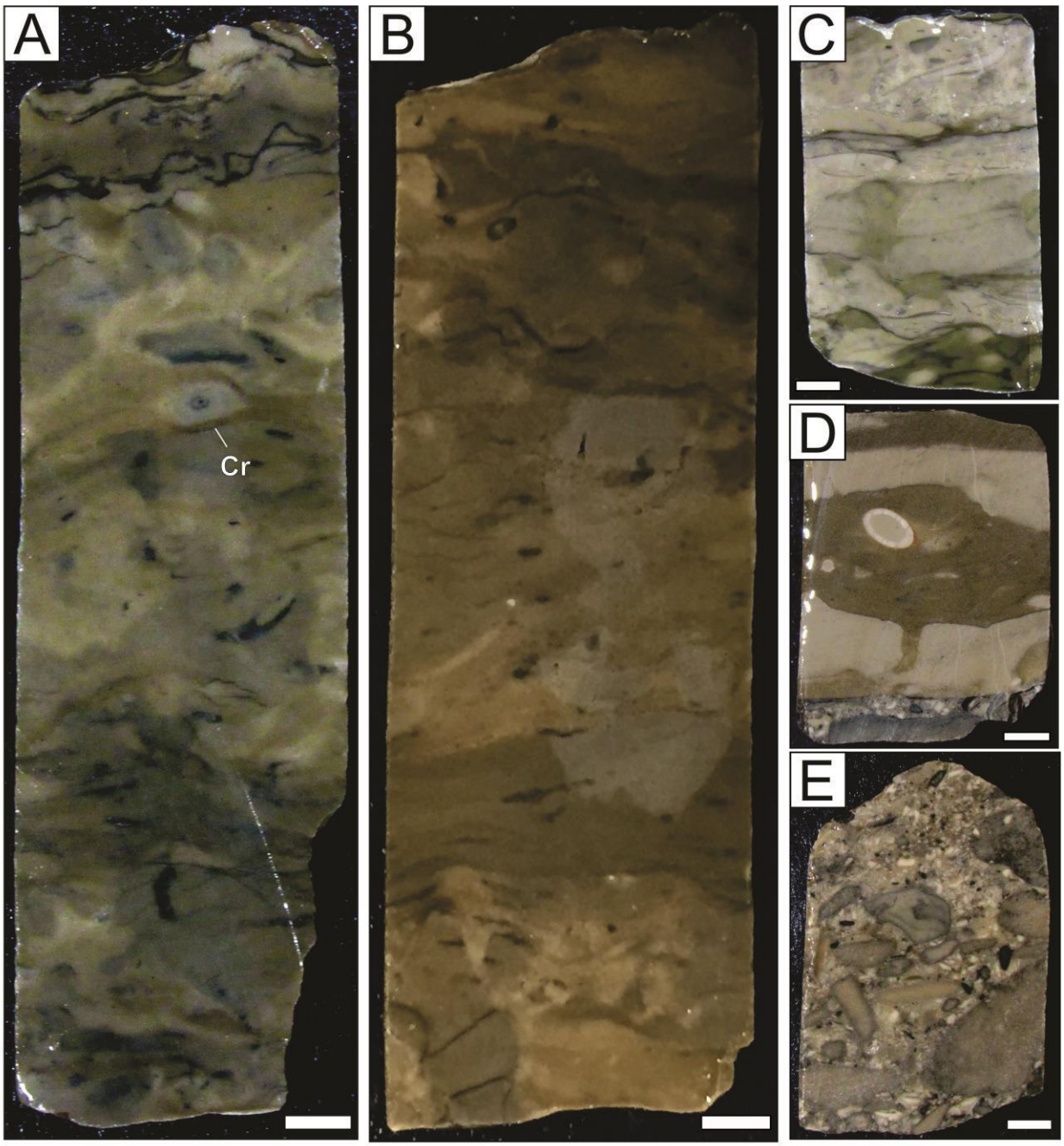

Figure 2: Drill core photographs from cruise 75-009, Phase V, Station #4. Scale bars = 1 cm, depths are given in centimetres from top of drill core. (A) Mottled dolostone with shell fragments, an altered crinoid (Cr), and possible macro algae (base at 121 cm). (B) Limestone and dolomite mudstone with shell and echinoderm fragments (base at 97.5 cm). (C) Mudstone composed of limestone and dolomite with bivalve and trilobite fragments in matrix (base at 65 cm). (D) Alternating medium brown and light brown mud layers with a burrow at the base of the medium brown layer. Unknown fossil in medium brown mud (possible algae or cephalopod in cross section) along with shell and crinoid fragments in the matrix. Pebble lag at base of piece (base at 30 cm). (E) Packstone of angular skeletal fragments (predominantly echinoderm fragments) (base at 58 cm).

shell fragments (4-6-15 and 4-17-19), trilobite fragments (4-6-15 and 4-17-19), as well as crinoid fragments (4-6-15 and 4-17-19). Peloids are also present in 4-17-19. Dolomite occurs in patches and discrete layers within these uppermost thin sections. Where not dolomitized, the matrix appears to be composed of micritic lime mud. Thin sections taken at greater depths (4-11-30, 4-7-40, and 4-7-42), show fossil content decreasing as dolomite increases. Skeletal fragments are rare at depth and often altered, but fragments of bivalves (4-11-30 and 4-7-40) and echinoderms (crinoids; 4-11-30 and 4-7-40) can be identified. The percentage of pyrite also increases with depth, and the replacement of skeletal components by pyrite is observed in the bottom half of the drill core (4-11-30 and 4-7-42).

5.1.4. Interpretations – Station 4

The drill core from Station 4 is interpreted as having been deposited in a shallow water environment, above storm wave base. Energy levels are interpreted as being moderate, based on the presence of fossil fragments, with breccias and lags representing isolated high-energy events.

5.2. 75-009, Phase V – Station 5

5.2.1. Previous work – Station 5

The drill core from Station 5 (Jansa's Unit 2; MacLean's Unit 1) is described by both Jansa (1976) and MacLean et al. (1977) as a massive, pale yellow to brown, skeletal wackestone that is lightly to moderately bioturbated and partially dolomitized (Jansa, 1976; MacLean et al., 1977). It consists of micrite with silt- to sand-sized bioclasts, which are found concentrated in thin laminae (MacLean et al., 1977). Identified skeletal particles included echinoderms, trilobites, articulate brachiopods, cephalopods (rare), corals, and bryozoans (Jansa, 1976). A massive colonial rugose coral comprises a section of the core and was identified by Bolton (1976) as the Ordovician *Favisitina sp.* The drill core from Station 5 resembles limestone outcrops on Akpatok Island, strata of the Churchill River Group in Hudson Bay, as well as Silliman's Fossil Mount on Baffin Island (Jansa, 1976). The strata at Station 5 is noted as being magnetically similar to the Paleozoic strata located at Stations 4 and 8, however, it is acoustically harder with higher measured seismic velocities (MacLean et al., 1977).

5.2.2. Drill core description – Station 5

The upper 82 cm of drill core 75-009, Phase V –Station 5 (Fig. 3) consists of a garnet gneiss overburden (boulder(s); Fig. 3A). The remaining 41 cm, of which 15 cm is missing, is composed of limestone, primarily wackestone to packstone. There are a few argillaceous layers (silt stringers) in the upper 10 cm of the limestone section. The drill core exhibits some evidence of diagenesis including the presence of developed fracture networks and stylolites in the middle section of the limestone (90 to 100 cm). Furthermore, calcite cement is observed infilling some fractures as well as fossils throughout the limestone portion of the drill core.

The first section of limestone (82 to 100 cm) is fossiliferous containing articulated and replaced bivalves, as well as trilobites, shelly fossils, brachiopods, and indistinguishable skeletal fragments (Fig. 3B). Additionally, small round, white fossils, interpreted as echinoderm fragments, occur from 82 to 88 cm, but are too small to accurately identify in core. A possible tabulate coral fragment is also noted amongst the fossil fragments around 90 cm and a cephalopod occurs at approximately 95 cm. Black, organic laminations are found near 90 cm that could be microbial or algal in

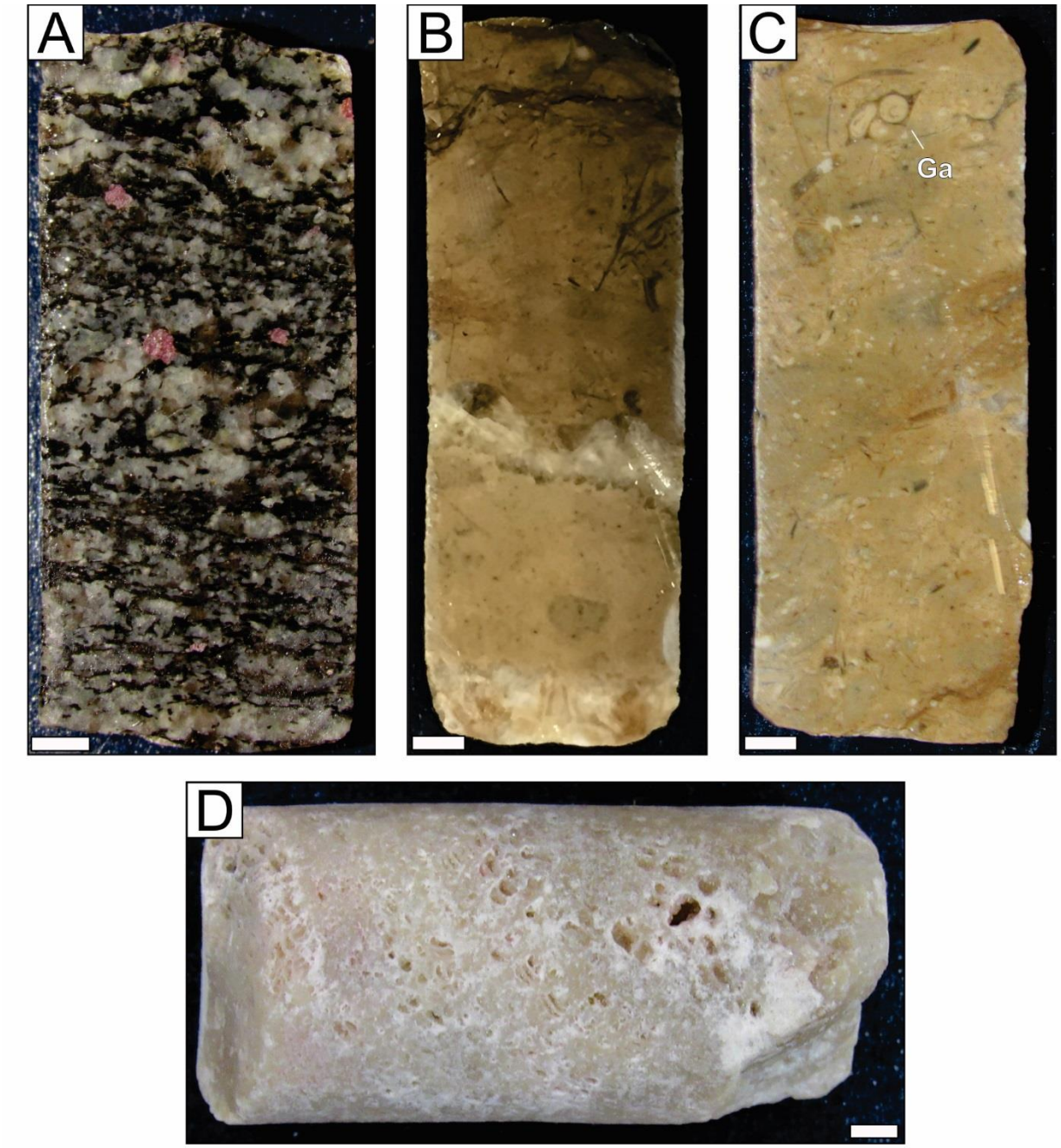

Figure 3: Drill core photographs from cruise 75-009, Phase V, Station #5. Scale bars = 1 cm, depths are given in centimetres from top of drill core. (A) Garnet-biotite gneiss overburden (base at 65 cm). (B) Fossiliferous wackestone with fragments of shells, echinoderms, trilobites, and cephalopods in matrix. Calcite cement in seams (base at 100 cm). (C) Fossiliferous wackestone with shell fragments, gastropods (Ga), ostracods, calcispheres, and echinoderm fragments (base at 123 cm). (D) Colonial rugose coral (base at 115 cm).

nature. A massive piece of colonial rugose coral comprises the drill core from 110 to 115 cm (Fig. 3D). The drill core returns to a fossiliferous wackestone for the bottommost 8 cm, and contains shelly fragments, a gastropod, as well as small, white, rounded to sub-rounded fossil fragments, again thought to be echinoderm fragments (Fig. 3C).

5.2.3. Thin section descriptions – Station 5 (Appendix C, Plates 6-11)

Four of the six thin sections made from the drill core recovered at Station 5 exhibit similar lithologies (5-10-21, 5-10-31, 5-10-45.5, and 5-10-47.5), representing a fossiliferous wackestone to packstone with a micritic, lime mud matrix. Identified fossil fragments are common and include bivalve shells, gastropods, echinoderms, sponge spicules, trilobites, brachiopods, bryozoans, corals, cephalopods, calcispheres, and dasycladacean green algae. A ribbed, articulated brachiopod shell is noted in thin section 5-10-33. Articulated bivalves (5-10-31, 5-10-33, 5-1-45.5, 5-1-47.5) and ostracods (5-10-31, 5-1-47.5) are also observed in the thin sections. Minor dolomite is present locally in some thin sections (5-10-31, 5-1-45.5, 5-1-47.5). Thin section 5-5-6.5 is from a section of the drill core that penetrated a colonial rugose coral. Coral septae and tabulae are present in the slide with isopachous and blocky calcite cement infilling the structural voids.

The final thin section, 5-16-21, is from the garnet-biotite gneiss overburden at the top of the drill core. Minerals identified in thin section include quartz (most common), biotite, garnet, and plagioclase (minor). Opaque minerals, some of which are elongated and tapered, account for less than 5% of the overall rock composition.

5.2.4. Interpretations – Station 5

The lithologies present in the drill core from Station 5 are tentatively thought to represent deposition in a low to moderate energy environment based on the fragmentary nature of the faunal material and the abundance of mud. The presence of dasycladacean green algae as well as possible calcispheres suggests deposition in a shallow, photic zone environment such as a back reef or lagoon.

5.3. 75-009, Phase V – Station 8

5.3.1. Previous work – Station 8

The initial shallow core drilling attempt at Station 8 retrieved mainly gravel (MacLean and Srivastava, 1976) including pieces of Paleozoic limestone that are largely considered to be erratics (Jansa, 1976). There is no drill core to go with Station 8, only two thin sections, which were made from the Paleozoic gravel recovered and are described here.

5.3.2. Thin section descriptions – Station 8 (Appendix C, Plates 12 and 13)

Thin section 8-4-13 has been pervasively dolomitized with the matrix having been completely replaced by finely crystalline dolomite. Skeletal fragments are thought to have originally occurred but have since been dissolved out leaving irregular shaped voids throughout the thin section. In contrast, thin section 8-13 contains abundant fossils that occur within a densely-packed, dominantly shell layer. Identified skeletal components include bivalve shells, gastropod shells, an ostracod, calcitized radiolarians, as well as fragments of trilobites and echinoderms (crinoids). All original shell mineralogy has been replaced. The matrix appears to have been recrystallized but only a few discrete dolomite rhombs are observed. Disseminated pyrite is noted in both thin sections and can occur in clusters.

5.3.3. Interpretations – Station 8

The high degree of alteration and recrystallization observed combined with the fact that these thin sections are produced from gravel interpreted as erratics, prevents meaningful interpretations on paleoenvironmental conditions to be made for Station 8.

5.4. 75-009, Phase V – Stations 8A and 8B

5.4.1. Previous work – Stations 8A and 8B

Drill cores from Stations 8A and 8B (Jansa's Unit 3; MacLean's Unit 2) are described in the literature as being composed of a dark yellowish brown, bituminous, micritic limestone that is slightly dolomitized (Jansa, 1976; MacLean et al., 1977). The limestone is further characterized as being lightly bioturbated with faint banding caused by alternating light and dark brown layers (MacLean et al., 1977). Finely disseminated organic matter is prevalent throughout the drill cores and occurs in between the micrite particles. Rounded, 0.14 mm diameter radiolarians are common in both drill cores and occur as poorly preserved casts filled by iron-rich calcite cement (Jansa, 1976). Additional skeletal components noted in the drill cores include fragments of trilobites, sponge spicules, and some graptolite pieces (Jansa, 1976). Chitinozoa and acritarchs are common in insoluble residue and constrain this drill core to the Middle to Late Ordovician (Jenkins, 1976; MacLean et al., 1977). The lithology at Stations 8A and 8B is thought to be comparable to that of the Red Head Rapids Formation of the Hudson Platform, as well as Member B of the Baillarge Formation (northwestern Baffin Island; Jansa, 1976).

5.4.2. Drill core description – Station 8A

Drill core 75-009, Phase V –Station 8A (Fig. 4, A-D) is 76 cm in length with the top 26 cm composed of granite overburden (Fig. 4A). The bottom 50 cm consists of a dark to medium brown mudstone to wackestone, the first piece of which (26-32 cm) has high-angled bedding. The remainder of the drill core exhibits normal horizontal bedding, potentially suggesting that the first piece is not in place. The drill core does not exhibit much in the way of diagenetic fabrics, but minor pyrite can be found in the top 6 cm of the limestone. There are some intraclasts noted just below 50 cm, and argillaceous layers (silt stringers) are observed between 50 and 67 cm. Disseminated pyrite and organic matter is dispersed throughout the drill core. There are two possible burrow clusters in the drill core at 55 cm (Fig. 4D) and 68 cm.

Macrofossils in this drill core are very difficult to identify as they are often small and/or highly fragmented. Small, millimeter-scale, white, round fossils are found throughout the drill core, (though their abundance varies over the length of the core) and are identified as radiolarian tests. Long, centimeter-scale, wavy, black layers are noted from 42 to 45 cm and are preliminarily identified as some sort of organic component, most likely macro algae. Narrow (1 to 2 mm thick), elongated tapered sponge spicules are found within the same interval as the potential macro-algae. There is also a thin (1 to 2 cm) fossil layer around 70 cm composed of small, highly fragmented skeletal fragments and shell pieces.

5.4.3. Thin section descriptions – Station 8A (Appendix C, Plates 14-16)

Three thin sections were made from the drill core recovered from Station 8A. The shallowest thin section, 8A-13-2, occurs within the granite overburden at the top of the drill core. Mineralogical components identified in this thin section include quartz, plagioclase, feldspars, and biotite. The other two thin sections, 8A-5-15 and 8A-1-27,

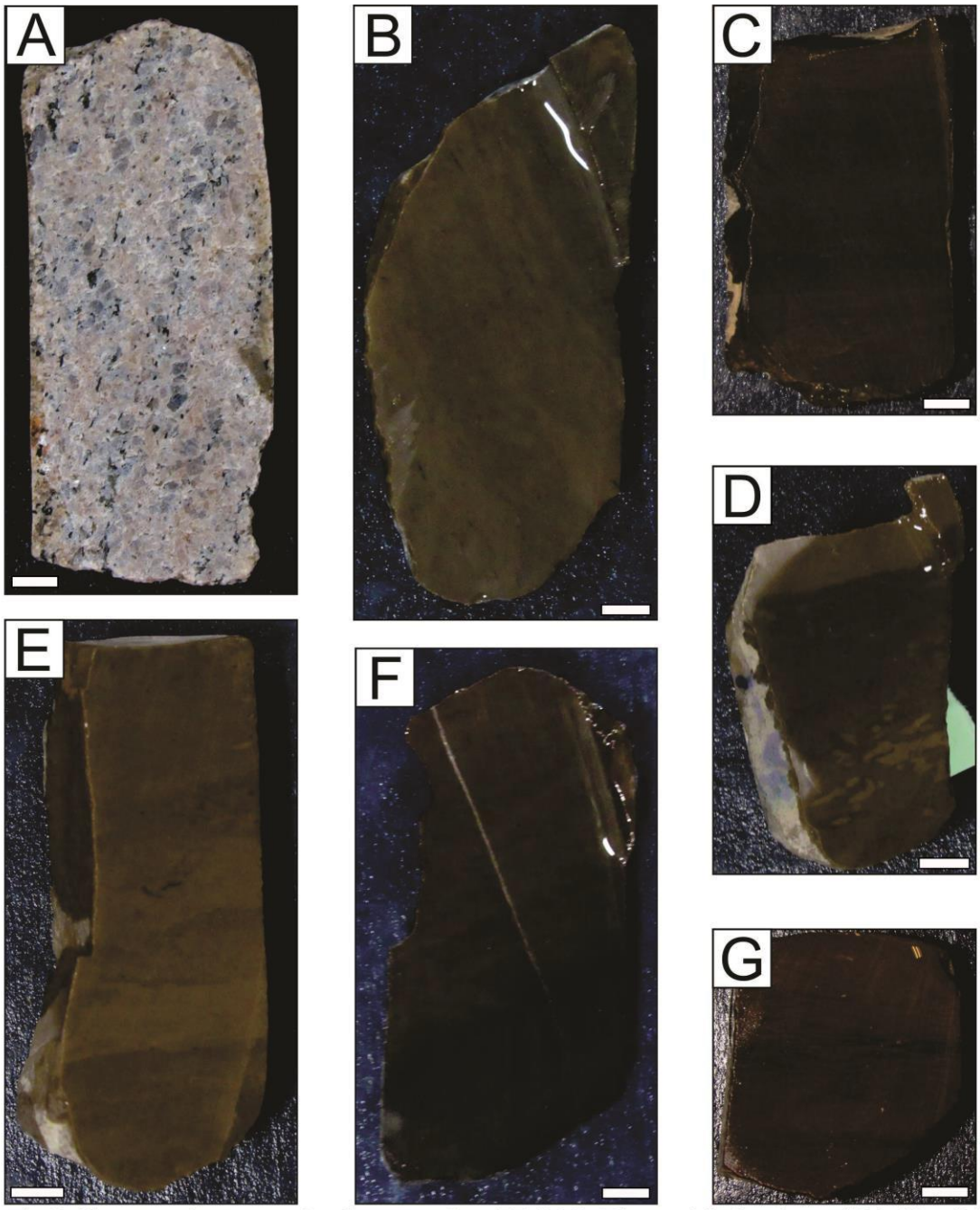

Figure 4: Drill core photographs from cruise 75-009, Phase V, Stations #8A (A - D) and #8B (E-G). Scale bars = 1 cm, depths are given in centimetres from top of drill core. (A) Granite overburden (base at 6.5 cm of 8A). (B) Lime mudstone exhibiting high-angled bedding (base at 50 cm of 8A). (C) Dark brown limestone with radiolarian tests, sponge spicules, and organic matter (base at 45 cm of 8A). (D) Burrow cluster in dark brown lime mudstone (base at 56 cm of 8A). (E) Mottled lime mudstone with radiolarian tests and fragments of trilobites in matrix (base at 38 cm of 8B). (F) Dark brown lime mudstone with a calcite cement-filled fracture (base at 12 cm of 8B). (G) Organic-rich mudstone with radiolarians (base at 69 cm of 8B).

are characterized by fine, lime-mud matrixes and the abundance of calcitized radiolarian tests. Other biological components include rare shell fragments (small to moderate-sized (millimetre-scale) bivalve shells), pieces of trilobites, and sponge spicules. Disseminated pyrite occurs in both thin sections, as does rare phosphate grains. The matrix of 8A-5-15 appears to be slightly crystalized, exhibiting a grainy texture.

5.4.4. Drill core description – Station 8B

Drill core 75-009, Phase V –Station 8B (Fig. 4, E-G) is 90 cm in length with the upper 8 cm consisting of granite overburden. The remaining drill core is composed of dark to medium brown, lime mudstone to wackestone with disseminated organic material found throughout the drill core. Silt stringers/argillaceous layers are present in the drill core, but are not abundant. A few vertical fractures are found in the upper 40 cm of the core. Calcite cement precipitation is common in the upper half of the drill core with calcite cement found in fractures and as infill in dissolved/replaced fossils. There is one occurrence of calcite cement in the bottom section of the core in a replaced bivalve shell at approximately 83 cm depth. Minor pyrite is found from 20 to 50 cm with a pyritized surface located just above 50 cm.

Minor mottling above 20 cm, expressed as alternating light and dark brown limestone, and additional, somewhat mottled areas around 33 cm, suggests the occurrence of bioturbation. Small, millimetre-scale, rounded, white radiolarian tests are common throughout the drill core. Thin (1-2 mm), elongated, tapered fossils, identified as sponge spicules, are found oriented parallel to bedding in the upper 2 cm of the limestone. Some shell fragments are found between 20 and 51 cm, and include identifiable brachiopod and bivalve shells. There are also dark, undulating organic laminations noted in the same section that may be microbial in nature. A fragment of a branching fossil, either a coral or bryozoan, occurs around 30 cm, and trilobite fragments were observed between 40 and 45 cm.

5.4.5. Thin section descriptions – Station 8B (Appendix C, Plates 17-20)

Four thin sections were made at three depths, with one oriented parallel to the bedding plane (8B-16-10X), from the drill core at Station 8B. The four thin sections all consist of a fine, lime mud matrix with abundant calcitized radiolarian tests. Disseminated pyrite and phosphate grains are also present in all thin sections from Station 8B. The shallowest thin section, 8B-20-3.5, has a grainy texture with the density of grains varying throughout the slide. Biological components, in addition to the radiolarians, include small bivalve shell fragments, sponge spicules, trilobite fragments, and organic matter (possibly algal related). The biological components in this thin section, specifically the organic matter and sponge spicules, tend to all be oriented parallel to the bedding plane. Thin section 8B-16-10 and its bedding plane counterpart (8B-16-10X), are less grainy (contain more mud) than 8B-20-3.5 and contain several large fossil fragments including bivalves and trilobites. Sponge spicules are also observed throughout the slide. Thin section 8B-6-32 also lacks the grainy matrix observed in 8B-20-3.5, and does not contain the larger fossil fragments characteristic of 8B-16-10. 8B-6-32 is dominated by calcitized radiolarian tests (some with spines intact) with rare, small fragments of bivalve shells and trilobites. Sponge spicules are also noted in this slide. Thin sections 8B-16-10, 8B-16-10X, and 8B-6-32 all lack the organic matter and alignment observed in 8B-20-3.5.

5.4.6. Interpretations – Stations 8A and 8B

The drill cores at Station 8A and 8B, are interpreted as having been deposited in a deeper water, open marine environment due to the paucity of large benthic fossils, the lack of photosynthetic organisms, and the abundance of pelagic radiolarians. The preservation of organic matter implies anoxic to dysoxic conditions at or below the sediment water interface. Evidence of benthic fauna (trilobite fragments and sponge spicules), though minor, would suggest that the low oxygen conditions required for organic matter preservation were either ephemeral with a weakly stratified water column, or that anoxia was prevalent and that benthic organisms were transported in during high energy events from more oxygenated regions on the shelf.

5.5. *77027 – Stations 026A and 028*

5.5.1. Previous work – Stations 026A and 028

Limited descriptions of the two Paleozoic limestone drill cores from cruise 77-027 were published in Maclean (1978). Drill core 026A is described as 83 cm of grey limestone composed of fine-grained crystalline calcite (MacLean, 1978). Drill core 028 is 100 cm in length and is comprised of dark brown micritic limestone with radiolarian casts and finely disseminated organic material (MacLean, 1978). Both drill cores are thought to be Middle to Late Ordovician in age based on lithological, seismic, and magnetic similarities with other Paleozoic cores located in the Baffin Bay region (MacLean, 1978).

5.5.2. Drill core description – Station 026A

Drill core 77027 – Station 026A (Fig. 5) is 92 cm in length and consists predominantly of lime mudstone with the exception of the upper 7 centimetres of overburden, which is composed of gneiss. The drill core is largely homogeneous in nature and is highly fractured. Stylolites are also present throughout the drill core, but are notably absent between 60 and 85 cm. Calcite precipitation has occurred within the fractures and stylolites, and calcite cement can also be found infilling cavities around 82 cm. Pyrite is present throughout the core disseminated in the matrix and within some fracture infills alongside calcite cement. There are rare skeletal fragments just below 20 cm that are likely echinoderm in nature; however the highly fractured nature of the drill core and the small size of the fragments hinders identification. The drill core is noticeably devoid of sedimentary structures and fossils when compared to the other cores in the region, with the exception of a few occurrences of radiolarians.

5.5.3. Thin section description – Station 026A (Appendix C, Plate 21)

Only one thin section was made from the drill core taken at Station 026A. The thin section is labeled as SPL #5, with no depth provided. The matrix is classified as a fine-grained lime mudstone and no dolomite is noted. Disseminated pyrite is common throughout and rare phosphate grains are observed. Calcitized radiolarian tests are the only fossils present in the thin section.

5.5.4. Interpretations – Station 026A

The drill core from Station 026A is interpreted as having been deposited in a deep-water, open marine setting. This drill core is lacking with respect to fossil content, compared to the other drill cores in the study area, with only a minor number of radiolarian fossils identifiable. Bottom waters appear to be oxygenated as organic matter is absent and the core is relatively light in colour. The near absence of benthic and pelagic fossils could indicate the presence of an environmental stressor. Station 026A is the farthest north of the stations studied and therefore, the drill core recovered

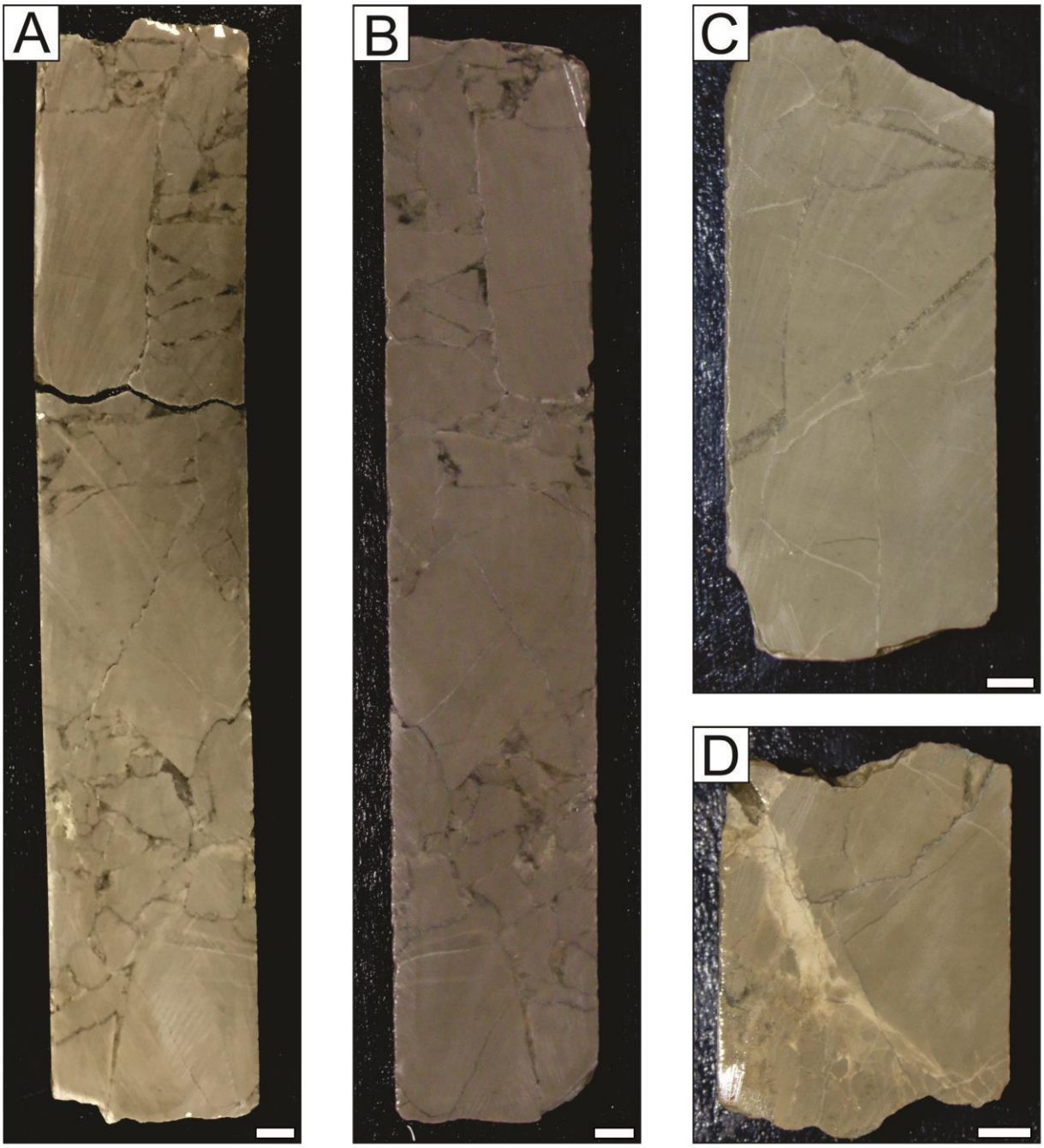

Figure 5: Drill core photographs from cruise 77027, Station #026A. Scale bars = 1 cm, depths are given in centimetres from top of drill core. (A and B) Highly fractured lime mudstone with fractures infilled with calcite cement (base at 32 cm). (C) Calcite cement filled fractures in a lime mudstone (base at 48 cm). (D) Fractured lime mudstone (base at 12 cm).

could potentially represent deposition in a different environment than that of the other four stations. It's location to the north could account for the discrepancies in lithology and paleontology noted in the drill core and associated thin section.

5.5.5. Drill core description – Station 028

Drill core 77027 –Station 028 (Fig. 6) is 100 cm in length with the top 6.5 cm consisting of igneous gravel (overburden) including pieces of granite and basalt. Directly underlying the overburden is approximately 4 cm of brown to grey lime mudstone that exhibits near-vertical bedding, indicating that it may not be in place. The remainder of the drill core is fairly homogeneous, being composed of medium to buff brown lime mudstone. Fractures are noted throughout, the majority of which have been infilled with calcite cement. Rounded skeletal clasts, interpreted to be radiolarian tests, are observed throughout the drill core. Other skeletal components are minor and include shell fragments, pieces of trilobites, bivalve shells fragments, as well as two articulated bivalve shells (at ~58 cm and ~94 cm from the top), both of which have been replaced. Distinct vertical and horizontal burrows are recognized 28-34 cm from the top of the drill core (Fig. 6A). Pyrite occurs disseminated throughout, as well as in burrows and in replaced skeletal components (shell fragments and radiolarian tests).

5.5.6. Thin section descriptions – Station 028 (Appendix C, Plates 22 and 23)

The thin sections from Station 028 (028-3 and 028-10), have no depths associated with them but are similar with respect to lithology. Both have a fine-grained, lime mud matrix, with no dolomite noted in either slide. Rare phosphate grains occur in the thin sections, and disseminated pyrite is common. Abundant calcitized radiolarian tests (some with spines intact) are the dominant fossil present. 028-3 has rare fossil fragments of bivalve shells and trilobites. Fossil fragments are more common in 028-10 with bivalve shell fragments being the most abundant. Other identifiable fragments in 028-10 include pieces of trilobites and sponge spicules. One large articulated bivalve shell is present in 028-10 with clusters of pyrite along its edges. This shell is also visible in the drill core at approximately 94 cm depth.

5.5.7. Interpretations – Station 028

The drill core from Station 028 is interpreted as having been deposited in a low energy, open marine environment, due to the presence of radiolarians and the abundance of mud. The absence of organic matter and the presence of benthic fossils and sediment burrowers, suggest that bottom waters were oxygenated.

6. Summary and Conclusions

Six Paleozoic drill cores and 23 thin sections from the southeastern Baffin Island shelf were analyzed and described in terms of sedimentology and paleontology. The six drill cores were obtained in the 1970s and have been described in general by Jansa (1976), MacLean et al. (1977), and MacLean (1978), however no detailed core logs or thin section descriptions have been published until now. The six drill cores are composed predominantly of limestone with only Station 4 containing a significant amount of dolomite. Recrystallization of the matrix and/or fossil components has occurred locally within some drill cores. Calcite cement along with disseminated pyrite is observed in almost every drill core and thin section, and the presence of phosphatic grains has been noted at all stations with the exception of Station 5.

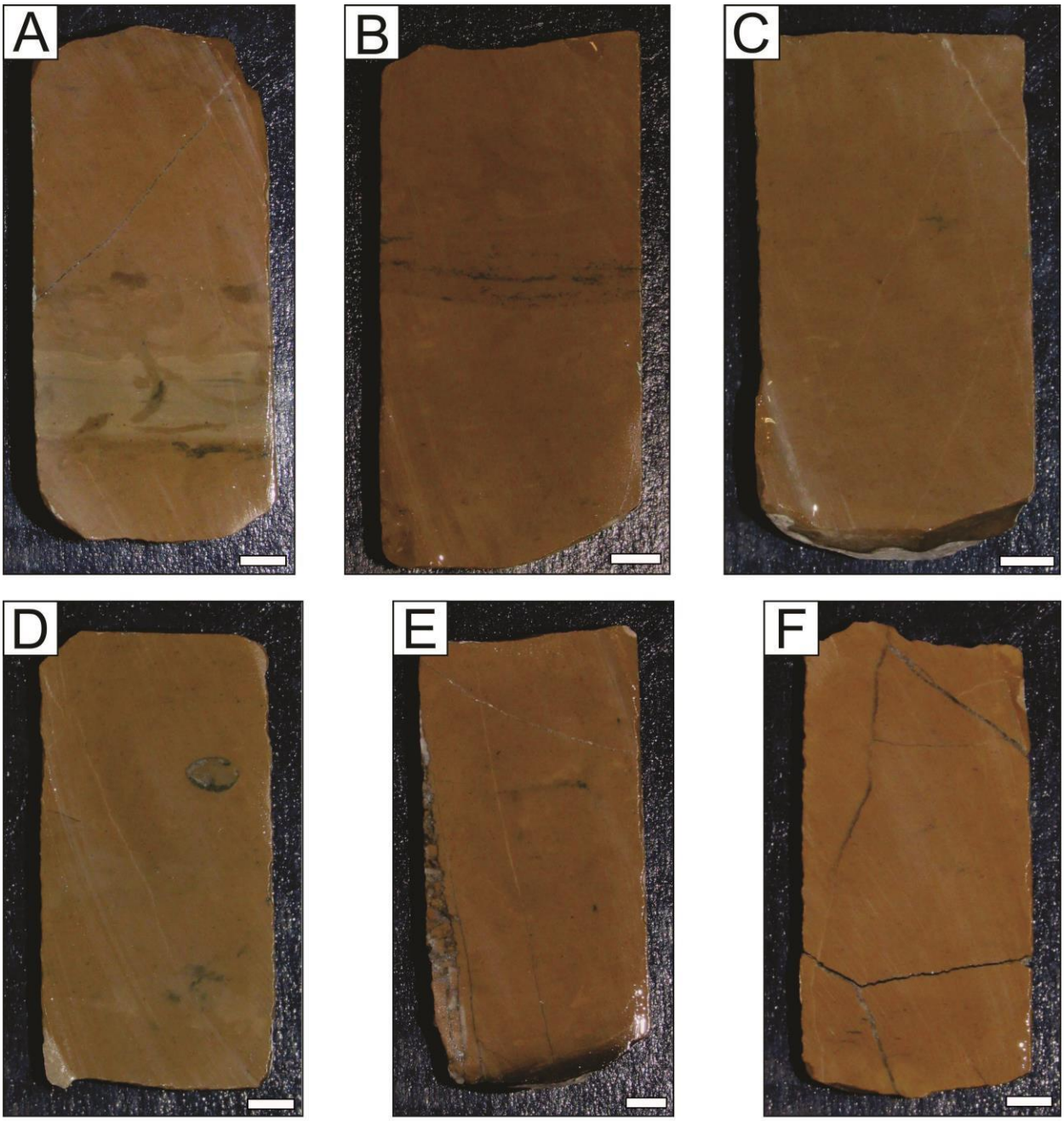

Figure 6: Drill core photographs from cruise 77027, Station #028. Scale bars = 1 cm, depths are given in centimetres from top of drill core. (A) A burrowed layer in a lime mudstone (base at 34 cm). (B) Layer containing shell and trilobite fragments (base at 44 cm). (C) Lime mudstone (base at 56.5 cm). (D) Replaced bivalve shell in a lime mud matrix (base at 61 cm). (E) Fracture network along left side infilled with calcite cement (base at 73 cm). (F) Calcite cement-filled fractures in a lime mudstone (base at 82.5 cm).

The Paleozoic strata of the southeastern Baffin Island shelf appear to reflect a low stressed Ordovician marine community with several fossil groups represented including molluscs, brachiopods, corals, echinoderms, algae, and radiolarians. Mud is prevalent in all drill cores suggesting an overall low to moderate energy setting. Water depth varies between drill core stations with Station 4 interpreted as having been deposited in the shallowest water, Station 5 deposited within the photic zone, and Stations 8A, 8B, 026A, and 028B representing deposition in deeper water environments where oxygen may have been limited, at least ephemerally (Stations 8A and 8B).

The drill cores from Cruise 77-009, Phase V have previously been determined to be of Middle to Late Ordovician in age based on the identification of chitinozoa, scolecodonts, and corals (Bolton, 1976; Jenkins, 1976; MacLean et al., 1977). The six lower Paleozoic drill cores from the southeastern Baffin Island shelf are assumed to be syndepositional; however given that they are located at sea floor in strata that shows clear indications of deformation (folding and faulting) it is impossible to determine their exact relationship to one another. If the assumption that the drill cores are syndepositional is correct, or if the difference in age between the cores is minor, then discrepancies in the interpreted depositional environments would indicate differences in the paleogeographic location of the drill cores within the basin (shallow versus deep water), as opposed to reflecting eustatic fluctuations.

Acknowledgements

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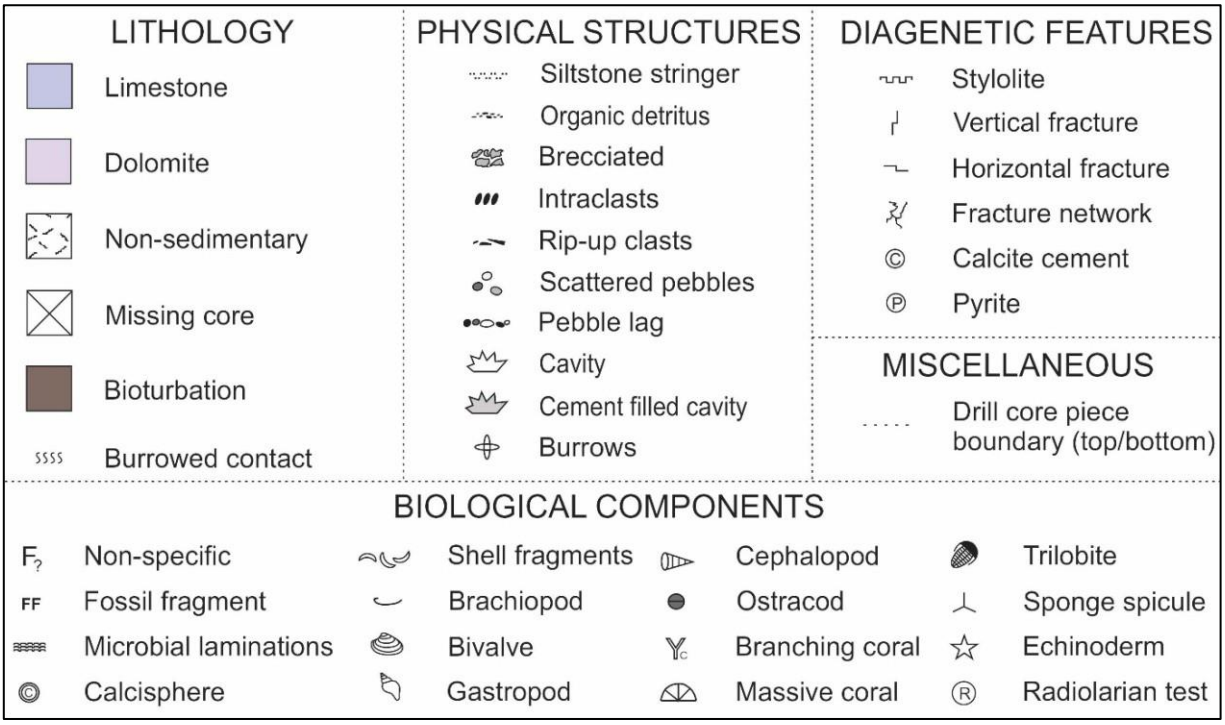
Appendices

Appendix A

Southeast Baffin Island shelf drill core descriptions



Well Location: Southeast Baffin Island Shelf | Fm/Strat. Unit: Ordovician | Page: 1/2

Well Name: 75-009, Phase V - Station 4 | Core interval: Drill Core - 150 cm | Name: Nikole Bingham | Date: Dec. 20 2016

THIN SECTIONS	DEPTH (CM)	LITHOLOGY (Dolomite, Limestone, Mudstone, Wackestone, Packstone, Floatstone, Rudstone, Grainstone, Framestone, Boundstone, Bafflestone)	PHYSICAL STRUCTURES	BIOTURBATION	BIOGENIC COMPONENTS	DIAGENETIC FEATURES	MISCELLANEOUS	DESCRIPTIONS
					FF	Ⓟ Ⓒ		Large, cm-scale, intraclasts. Partial, preferential dolomitization. A few fractures filled with blocky calcite cement. Minor pyrite. Some fossil fragments (crinoid and bivalves).
	10							
	20				FF			Partial dolomitization, angular fragments, mottled below dolomitization, clasts and mudstones above stylolite.
				?				Horizontal and vertical fractures, small vertical fractures are filled with calcite cement, some stylolites and argillaceous layers. Partial dolomitization, small (cm-scale) dolomitized burrows in bottom half, larger angular clasts at top.
	30				F? FF	Ⓟ		Unknown fossil - possible algae or cephalopod cross-section. Preferential dolomitization. Round fossils in darker siltier area. Possible burrow. Minor pyrite in dolomitized layers. Pebble lag at base - skeletal fragments (shells, crinoids, possible trilobite).
4-6-15	40					Ⓟ		Mostly dolomitized. Large sections, not a single burrow. Fine mud with trilobites, echinoid fragments and small bivalves in non-dolo sections. Intraclasts at top. Mottled look in dolomitized sections. Pyrite at base.
								Partially dolomitized. Silty/argillaceous layers with fine mud in between
								Mottled and dolomitized at end of piece
4-17-19	50				FF			Thin, cm-thick section with skeletal fragments (mostly shells).
					FF	Ⓟ		Silty, argillaceous layers at top of piece. Mostly dolomitized, few skeletal fragments most likely crinoids.
					FF Yc?			Packstone of skeletal fragments (largely crinoids) and large clasts. Skeletal clasts are angular, intraclasts are subrounded to angular. Smaller clasts in matrix, large in intraclasts. High energy event. Pebble breccia. Possible tabulate coral fragment - highly altered and rounded.
	60				F? FF	Ⓟ Ⓒ		Thin laminae (microbial or argillaceous), fine mud and mottled. Mud areas not as heavily dolomitized - mollusc and trilobite fragments as well as others. Partial dolomitization. Looks like alternating layers of fine mud/floatstone/wackestone and mudstone (might be due to preferential dolomitization). Small cement-filled cavities. Mud layers quite fossiliferous.
4-11-30	70							Rough, uncut core, no fresh face. Looks similar to above. Buff coloured. Muddy.
	80					Ⓟ Ⓒ		Very mottled; light and dark brown areas. Several small cavities filled with cement. One cavity had pyrite as well. A few bivalves at top.
					FF	Ⓒ		Similar to above. Cavities with mineral fill, large bivalve fragments, mottled, thin skeletal layer near base separates less silty/dolo brown mud from above. Angular, squared intraclasts. Skeletal fragments.
4-7-40	90					Ⓟ Ⓒ		Heavily dolomitized - much the same as above. Cement-filled cavities Shell (some brachiopod) and echinoid fragments. Increase in pyrite compared to above; mostly in fractures.

Well Location: Southeast Baffin Island Shelf
Fm/Strat. Unit: Ordovician
Page: 2/2
Name: Nikole Bingham
Well Name: 75-009, Phase V- Station 4
Core interval: Drill Core - 150 cm
Date: Dec. 20 2016

THIN SECTIONS	DEPTH (CM)	LITHOLOGY (Dolomite, Limestone, Mudstone, Wackestone, Packstone, Floatstone, Rudstone, Grainstone, Framestone, Boundstone, Bafflestone)	PHYSICAL STRUCTURES	BIOTURBATION	BIOGENIC COMPONENTS	DIAGENETIC FEATURES	MISCELLANEOUS	DESCRIPTIONS
4-7-42	110					Ⓒ Ⓟ		Small triangular piece of core. Buff-coloured. Dark, argillaceous layers. Some pyrite.
	120				?	Ⓟ Ⓒ		Black wavy layers at top - possibly microbial/macro algae. Very mottled. Light versus dark brown mudstone/dolostone. Dark looking areas filled with pyrite and cement; could be in-filled fractures, nodules/pores, or dissolved fossils. Light beige/off white nodules at top; possible altered fossils. One altered crinoid.
	130					Ⓟ Ⓒ		Angular piece of core similar to above piece: mottled with light and dark brown mud. Pyrite and cement-filled fractures.
	140					Ⓒ Ⓟ		Mottled with pyrite filled cavities/pores/fractures. Styolites.
	150							

Well Location: Southeast Baffin Island Shelf

Fm/Strat. Unit: Ordovician

Name: Nikole Bingham

Well Name: 75-009, Phase V- Station 5

Core interval: Drill Core - 123 cm

Date: Dec. 20 2016

THIN SECTIONS	DEPTH (CM)	LITHOLOGY	PHYSICAL STRUCTURES	BIOTURBATION	BIOGENIC COMPONENTS	DIAGENETIC FEATURES	MISCELLANEOUS	DESCRIPTIONS
								Garnet gneiss/Overburden
	10							
	20							
								Garnet gneiss/Overburden
	30							
	40							Garnet gneiss/Overburden
	50							
5-16-21	60							
	70							
	80							Large pebble
5-10-31					FF, $F_?$			Articulated bivalve. Echinoid fragments. Trilobite and shelly fossils. Larger, replaced bivalves. Silty, argilaceous layers near top.
5-10-33					?, FF, $F_?$, FF	©		Argillaceous layers near 90 cm. Dense shell section. Large calcite-filled seam/fracture on edge. Wackestone to mudstone matrix. Lots of small fossil fragments (predominantly echinoderms). Trilobites. Small crinoid pieces near 90 cm. Replaced bivalves. More skeletal fragments between 88 and 93 cm. Cephalopod. Stylolites. 2 calcite seams. Area between seams is clean lime mud with some small skeletal bits - nothing identifiable.
	90					©		

Well Location: Southeast Baffin Island Shelf

Fm/Strat. Unit: Ordovician

Name: Nikole Bingham

Well Name: 75-009, Phase V - Station 5

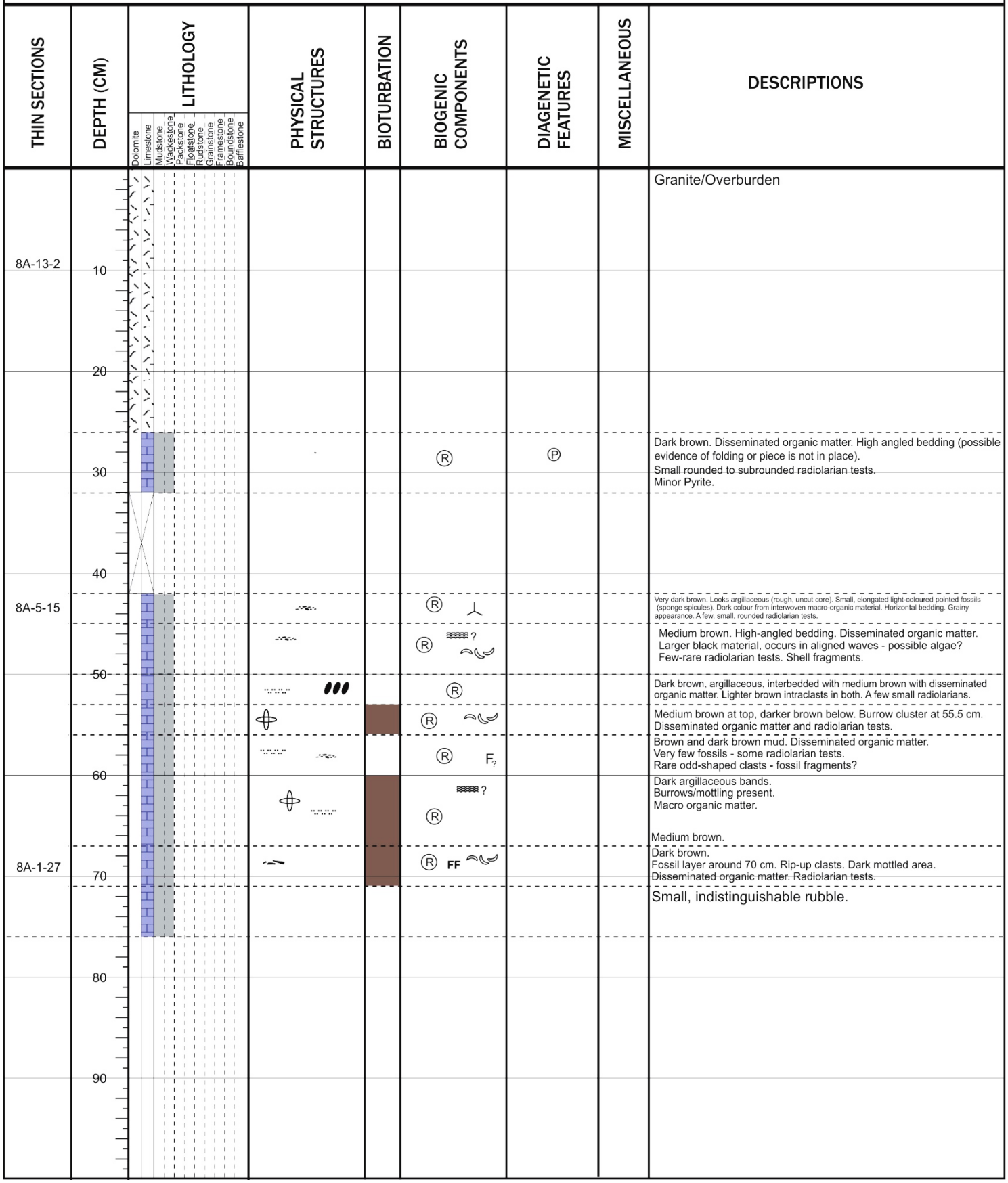
Core interval: Drill Core - 123 cm

Date: Dec. 20 2016

THIN SECTIONS	DEPTH (CM)	LITHOLOGY (Dolomite, Limestone, Mudstone, Wackestone, Packstone, Floatstone, Rudstone, Grainstone, Framestone, Boundstone, Bafflestone)	PHYSICAL STRUCTURES	BIOTURBATION	BIOGENIC COMPONENTS	DIAGENETIC FEATURES	MISCELLANEOUS	DESCRIPTIONS
								No smooth, flat, fresh surface (rough, uncut core). Light coloured. Mudstone to wackestone.
	110							
5-5-6.5								Large chunk of a colonial rugose coral.
5-1-45.5					FF	©		Lime mud matrix. Fossiliferous wackestone (some larger fragments). Large, blocky calcite cement. Shelly fragments, gastropods, ostracods, calcispheres, echinoid fragments. Large bivalve fragments.
5-1-47.5	120				©			

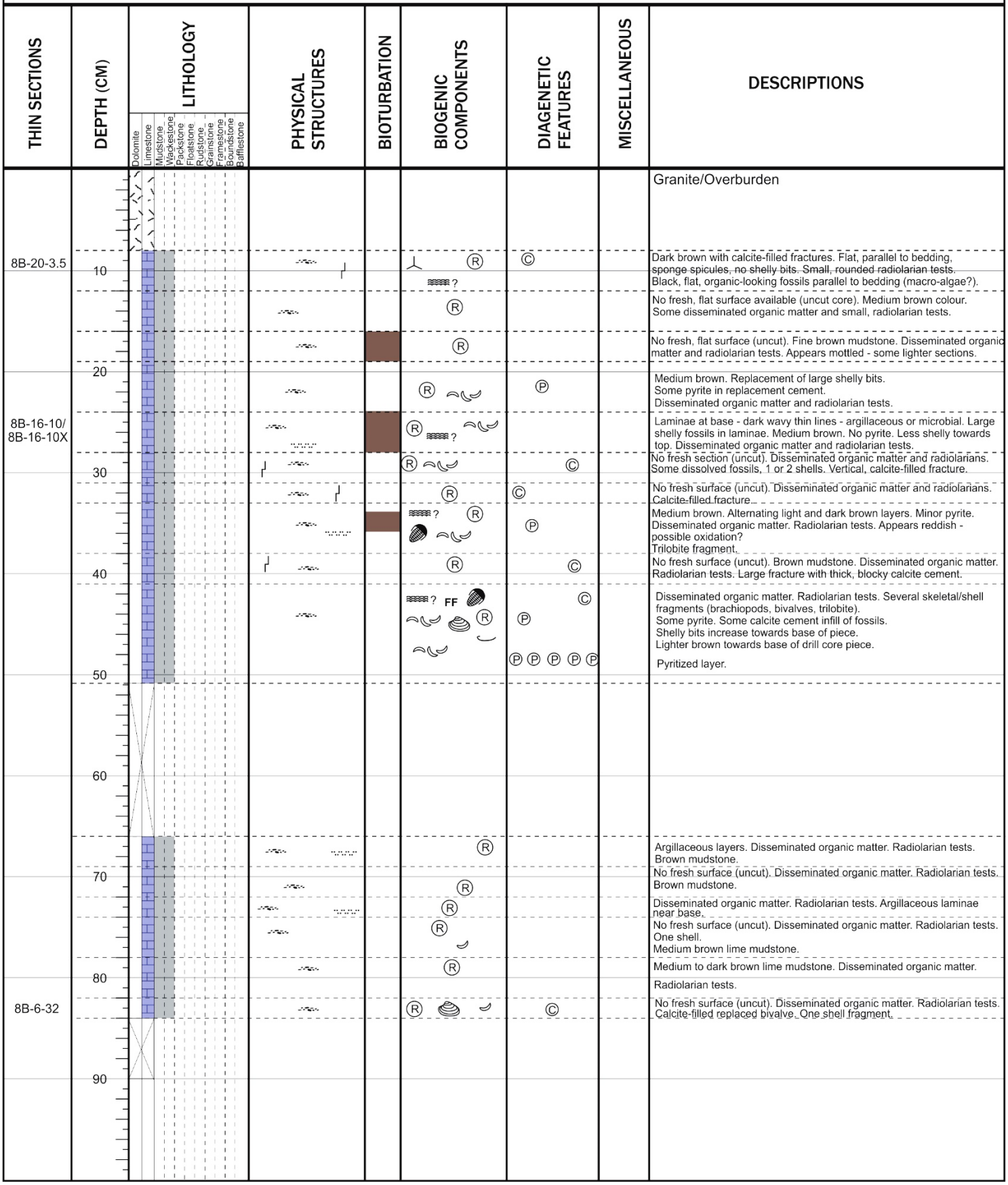
Well Location: Southeast Baffin Island Shelf | Fm/Strat. Unit: Ordovician | Page: 1/1

Well Name: 75-009, Phase V - Station 8A | Core interval: Drill Core - 76 cm | Name: Nikole Bingham | Date: Dec. 20 2016



Well Location: Southeast Baffin Island Shelf | Fm/Strat. Unit: Ordovician | Page: 1/1

Well Name: 75-009, Phase V - Station 8B | Core interval: Drill Core - 90 cm | Name: Nikole Bingham | Date: Dec. 20 2016



Well Location: Southeast Baffin Island Shelf

Fm/Strat. Unit: Ordovician?

Name: Nikole Bingham

Well Name: 77027 - Station 026A

Core interval: Drill Core - 92 cm

Date: Dec. 20 2016

THIN SECTIONS	DEPTH (CM)	LITHOLOGY (Dolomite, Limestone, Mudstone, Wackestone, Packstone, Floatstone, Rudstone, Grainstone, Framestone, Boundstone, Baffflestone)	PHYSICAL STRUCTURES	BIOTURBATION	BIOGENIC COMPONENTS	DIAGENETIC FEATURES	MISCELLANEOUS	DESCRIPTIONS
								Gneiss/Overburden
	10					Ⓟ Ⓒ		Limestone with stylolites. Disseminated pyrite. Calcite-filled fractures - predominantly vertical fractures, some horizontal. Large calcite-filled fracture on backside of piece - calcite cement in stylolites.
								Some pyrite in fractures.
						Ⓟ Ⓒ		Calcite-filled horizontal and vertical fractures. Minor pyrite. Grey lime mudstone with multiple fractures. Minor pyrite in fractures.
	20				Ⓡ FF	Ⓟ Ⓒ Ⓒ Ⓟ		Big solid piece of grey lime mudstone. Highly fractured - thin to wide fractures. Fractures give brecciated appearance. Fractures contain calcite cement, some pyrite. Small, rounded fossils (radiolarian tests) near top of piece - rare. Cement fill in larger fractures.
	30							Stylolites near base. Fracture filled with calcite cement and pyrite.
	40					Ⓒ Ⓟ		Grey lime mudstone. No fossils. Stylolites. Multiple, calcite cement-filled fractures. Pyrite occurs in clusters, as well as disseminated in matrix.
	50					Ⓟ Ⓒ		Multiple fractures, some filled with calcite cement. Grey lime mudstone. Minor pyrite. No stylolites.
						Ⓒ Ⓟ		Uncut, no fresh or flat surfaces. Calcite-filled fractures. Minor fractures. Grey-coloured lime mudstone.
	60					Ⓒ Ⓟ		Off-coloured darker spots - cement filled. Replacement of small, round fossils? Dissolution or something similar? Stylolites near top of piece.
						Ⓒ Ⓟ		Rubble.
	70					Ⓟ		Minor pyrite around 65 and 68 cm.
						Ⓟ Ⓒ		No flat, fresh surface. Drill core uncut. Pyrite in fractures and also throughout - minor amount. Grey lime mudstone. Calcite-filled fractures.
	80							Limestone rubble.
						Ⓒ Ⓟ		Minor, small disseminated pyrite. One thin fracture. Grey lime mudstone.
					Ⓡ	Ⓒ Ⓟ		Calcite-filled fractures. A stylolite. Minor pyrite. More possible small radiolarians. Grey lime mudstone.
	90							
26A-5								

Well Location: Southeast Baffin Island Shelf

Fm/Strat. Unit: Ordovician?

Page: 1/1

Name: Nikole Bingham

Well Name: 77027 - Station 028

Core interval: Drill Core - 100 cm

Date: August 2 2017

THIN SECTIONS	DEPTH (CM)	LITHOLOGY (Dolomite, Limestone, Mudstone, Wackestone, Packstone, Floatstone, Rudstone, Grainstone, Framestone, Boundstone, Baffflestone)	PHYSICAL STRUCTURES	BIOTURBATION	BIOGENIC COMPONENTS	DIAGENETIC FEATURES	MISCELLANEOUS	DESCRIPTIONS
								6 pieces of igneous rock - looks like 2 pieces of granite containing pink potassium feldspar, 2 pieces of white and dark minerals (diorite?), and two dark pieces that are likely basalt. Not in place.
	10				F?, FF, R	P		Angled bedding (tilting?). Brown to grey mudstone. Few to rare skeletal fragments in light section, disseminated organic material, pyrite (denser in middle of light). Round, white fossils in dark section (radiolarians), some possible shell fragments as well 2, small, uncut pieces. Lime mudstone.
	20				R, FF	P, C		Med to buff brown mudstone. Rounded, white fossils (radiolarians). Rare to few skeletal particles. Pyrite flecks throughout. Disseminated organic matter. Calcite-filled, small, narrow fracture.
					FF, R	P, C		Same as above - radiolarians, pyrite, disseminated organic matter. Some skeletal fragments.
	30				FF, R	P, C, P		Piece #13:Lighter layer in middle containing burrows - vertical and horizontal. Possible hard ground at top of light layer. Rest of piece is the same as above. Don't see any skeletal fragments in light layer with burrows. May be an event layer? Pyrite in burrows.
								Round, uncut piece. No fresh or flat surfaces. Piece #12 looks like average lithology - medium brown lime mudstone. No fossils visible at this scale.
	40				FF, R	P		Piece #11: Darker brown, layer in middle - wackestone with shells and radiolaria. Particles/fossils are aligned. Iron-rich cement present. Shell fragments and a piece of trilobite in layer. Rest of piece is similar to above: lime mudstone, rare skeletal fragments-shells, trilobites, rare pyrite.
					FF, R	P		Piece #10: Consists of 3 pieces. Pyrite-replaced fossil shell. Some larger shell fragments. Minor pyrite in matrix. Radiolarians. Some larger, off-white round fossils. Rare pyrite. Possible organic content.
	50							Piece #9: No fresh, flat surface (uncut). Brown lime mudstone.
					FF, R	C, P		Minor calcite-filled fractures. Pyrite, Disseminated organic matter. Very homogeneous. Some fossil/skeletal fragments. Shell fragments. Rounded fossil tests - Radiolarians.
	60				R, FF	C, P		Piece #28-7: Calcite fracture. Pyrite flecks throughout. Disseminated organic matter. Larger shell fragments - bivalves. Larger shell - 1 cm in diameter - shell replaced and contains pyrite. Radiolarians.
	70				R, FF	C, P		Piece #5: Vertical, calcite-filled fractures. Heavily fractured on left side. Small stylolites - pyrite in stylolites. Skeletal fossil fragments. Radiolarians. Disseminated organic matter.
					R			Appears mottled. Lime mudstone. Some replaced shells. Radiolarians. Minor disseminated organic matter. No visible pyrite. Siltier than average at base of piece.
	80				FF, R	P, C		Piece #3: Calcite-filled fractures. Trilobite fragments, shells, other skeletal, fossil fragments. Pyrite-filled round fossils (radiolarians?). Homogeneous throughout. Possible mottling. Disseminated organic matter throughout.
								Rubble - large chunks, no fresh or flat surfaces (uncut) Lime mudstone.
	90				FF, R	C, P		No fresh or flat surfaces. Round, uncut piece. Calcite-filled fractures. Large fossil clast - shell (bivalve), looks replaced, may contain pyrite. Some other fossil fragments noted. Brown lime mudstone.
028-10								
028-3								

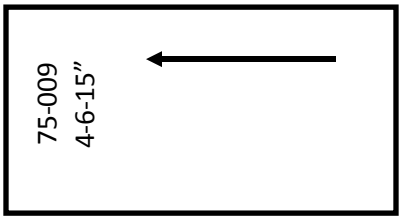
Appendix B

Thin section descriptions

Cruise	Station #	Piece (PCE) / Sample (SPL) #	Sample depth on slide label (inches)	Sample depth on core log (cm)
75-009, Phase V	4	6	15	39
		17	19	49
		11	30	76
		7	40	97.5
		7	42	107
75-009, Phase V	5	16	21	59
		10	31	83
		10	33	89
		5	6.5	112
		1	45.5	116
		1	47.5	119
75-009, Phase V	8	4	13	No core log
			20	No core log
75-009, Phase V	8A	13	2	9
		5	15	43
		1	27	69
75-009, Phase V	8B	20	3.5	9
		16	10	26
		16	10	26
		6	32	83
77027	026A	5	Not provided	Unknown
77027	028	3	Not provided	Unknown
		10	Not provided	58

75-009, Phase V – Station #4

A. 4-6-15



Cruise: Hudson 75-009, Phase V
Core/Station: 4
Piece/Depth as per slide label: PCE 6, 15”
Depth on core log: 39 cm
Lithology:

- Very heavily recrystallized
- Matrix: very fine-grained, lime mudstone

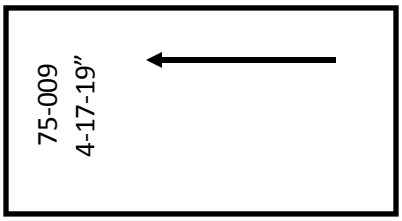
Composition:

- Intervals preferentially dolomitized
    - Possible argillaceous layers
    - Small, distinct dolomite rhombs present
- Layered, light orange, isotropic grain
    - Possible layered phosphate grain?

Organisms:

- Several small to large fossil fragments
    - Primarily looks to be composed of shells (bivalves)
- Fossil fragments in layers
    - Confined to argillaceous zones
- Trilobite and crinoid fragments

B. 4-17-19



Cruise: Hudson 75-009, Phase V
Core/Station: 4
Piece/Depth as per slide label: PCE 17, 19”
Depth on core log: 49 cm
Lithology:

- Peloidal – large, defined peloids that are darker than the surrounding matrix
    - Some grains present within peloids

    - Fossils may be present in peloids
        - Fossil fragments too small to identify
        - Small shell fragments
- Main matrix is a fine grained, lime mudstone

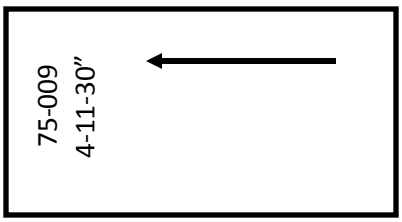
Composition:

- Dolomite present
    - Distinct dolomite rhombs (euhedral dolomite crystals), restricted
    - Patchy, in discrete intervals
    - Denser dolomite sections may be associated with argillaceous layers

Organisms:

- Large bivalve shells and fragments
    - Some blocky, calcite cement in corner of large shell
- Several trilobite fragments
    - Including trilobite spines
- Echinoderm fragments
- Other unidentified fossil fragments
    - Too small/fragmented to be identified –predominantly shell pieces
    - Possible sponge spicules

C. 4-11-30



Cruise: Hudson 75-009, Phase V
Core/Station: 4
Piece/Depth as per slide label: PCE 11, 30”
Depth on core log: 76 cm
Lithology:

- Limestone and dolomite

Composition:

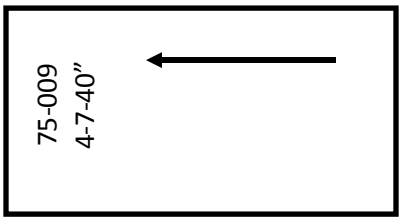
- Increase in dolomite
    - Pervasive through matrix
    - Small, euhedral to subhedral, dolomite rhombs
    - Density varies across thin section
        - Very dense to pervasive at the top and bottom of the slide
        - Original matrix still visible in centre of slide
- Disseminated pyrite throughout
    - Can occur in clusters – possible replacement of original fossil material
- One area of the thin section is mostly dolomite free
    - No indication as to why it has been less dolomitized than other areas
    - Matrix appears to have a bit of a granular/crystalline texture

    - Pyrite located throughout section
    - Rare dolomite rhombs
- Blocky calcite cement in fracture

Organisms:

- Shell fragments
- Echinoid fragments
- Fossils appear to be altered as edges are indistinct in areas

D. 4-7-40



Cruise Hudson 75-009, Phase V
Core/Station: 4
Piece/Depth as per slide label: PCE 7, 40”
Depth on core log: 97.5 cm
Lithology:

- Dolomite

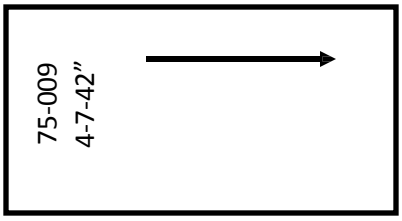
Composition:

- Pervasively dolomitized
    - Solid dolomite (euhedral to subhedral) with little to no matrix
    - Some faint original textures possible
- Disseminated pyrite occurs throughout
    - Sometimes occurs in clusters
        - Around edge of possible fossil
        - Possible replacement of original fossil material
        - Not framboidal
- One area not pervasively dolomitized
    - No obvious reason as to why matrix was not pervasively dolomitized
    - Fine lime mud matrix
    - Some euhedral dolomite rhombs present but occur floating in matrix
- Density of dolomite varies throughout slide from very dense/pervasive dolomite, to predominantly dolomite, to isolated dolomite rhombs in a lime mud matrix
    - In areas where dolomite is pervasive, dolomite occurs as subhedral to euhedral crystals

Organisms:

- Some shell fragments
    - Likely bivalve shells
- Echinoid fragment

E. 4-7-42



Cruise: Hudson 75-009, Phase V
Core/Station: 4
Piece/Depth as per slide label: PCE 7, 42”
Depth on core log: 107 cm
Lithology:

- Dolomite

Composition:

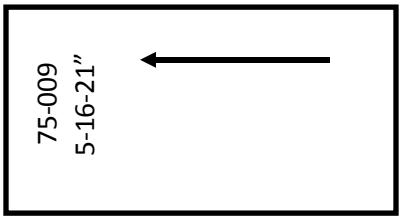
- Pervasively dolomitized
    - Dolomite is increasing with depth in the drill core from Station 4
    - Subhedral to euhedral dolomite crystals
- Very minor cement content
- Pyrite restricted to discrete congregations
    - Appears to be replacing original fossil material
    - Minor amount of disseminated pyrite throughout thin section

Organisms:

- Possible echinoid fragment

75-009, Phase V – Station #5

A. 5-16-21



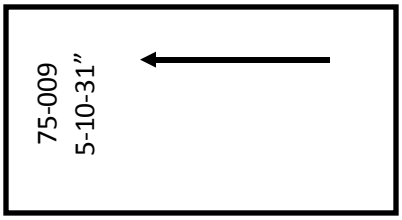
Cruise: Hudson 75-009, Phase V
Core/Station: 5
Piece/Depth as per slide label: PCE 16, 21”
Depth on core log: 59 cm
Lithology:

- Metamorphic rock
- Garnet biotite gneiss
- Overburden

Composition:

- Overall large crystals, coarse grained
- Biotite: beige/brown/orange/yellow phyllosilicate crystals in plane polarized light
- Garnet: isotropic, highly fractured, grey coloured in plane polarized light
- Black, opaque, thin/elongated/sometimes bladed minerals (possible tourmaline or rutile?)
- Quartz: blocky, anhedral crystals
- Minor plagioclase
- Quartz most common: 70-80%
- Biotite: 15-20%
- Garnet: <5%
- Opaques: <5%

B. 5-10-31



Cruise: Hudson 75-009, Phase V
Core/Station: 5
Piece/Depth as per slide label: PCE 10, 31”
Depth on core log: 83 cm
Lithology:

- Fine mud matrix with lots of fossil fragments

- Skeletal packstone

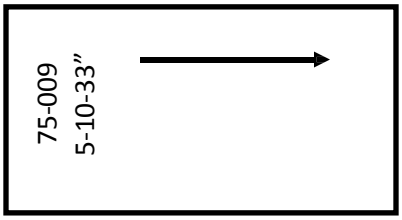
Composition:

- Minor dolomite (small rhombs) along seams/in argillaceous layers
- High diversity of fossils
- Muddy lime matrix
- Predominantly limestone (packstone) with minor dolomite
- Large dissolution feature
    - Blocky calcite cement
    - Likely a dissolved shell

Organisms:

- Echinoid fragments
- Gastropods
- Bivalves
- Brachiopods
- Coral fragments
- Crinoid fragments
- Cephalopods
- Dasycladacean green algae
- Sponge spicules
- Articulated shells (predominantly bivalves)
- Possible calcispheres
- Trilobites
- Ostracods
- Possible foraminifera
- Bryozoan fragment
- Ring fossils
    - Possible echinoid spines in cross section

C. 5-10-33



Cruise: Hudson 75-009, Phase V
Core/Station: 5
Piece/Depth as per slide label: PCE 10, 33”
Depth on core log: 89 cm
Lithology:

- Similar to PCE 5-10-31 though fragments seem to be less abundant and smaller overall
- Lime mudstone matrix

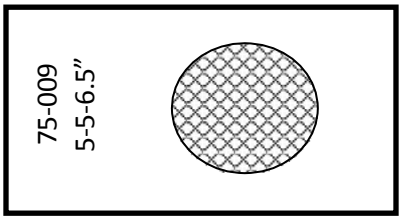
Composition:

- Skeletal wackestone: more mud than 10-31, with floating fossil fragments
- No dolomite observed

Organisms:

- Shell fragments
    - Bivalves
    - Ostracods
    - Brachiopods
- Thin ring fossils
    - Possible calcispheres
- Ribbed, articulated brachiopod
- Echinoid fragments
- Sponge spicules

D. 5-5-6.5



Cruise: Hudson 75-009, Phase V
Core/Station: 5
Piece/Depth as per slide label: PCE 5, 6.5” (cross-section of a colonial rugose coral)
Depth on core log: 116 cm
Lithology:

- Colonial rugose coral

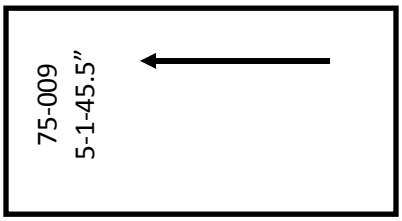
Composition:

- Colonial rugose coral
- Calcite, no evidence of dolomite
- Isopachous and blocky calcite cement present amongst coral components

Organisms:

- Colonial rugose coral
    - Septae are visible in the middle of the thin section and tabulae are observed towards the edges of the slide
    - Isopachous calcite cement around septae

E. 5-1-45.5



Cruise: Hudson 75-009, Phase V
Core/Station: 5
Piece/Depth as per slide label: PCE 1, 45.5”
Depth on core log: 119 cm
Lithology:

- Several fossil fragments in lime mud matrix
    - Size of fragments varies from small and indiscernible to large-scale pieces visible without magnification
- Skeletal wackestone to packstone
- Highly fragmented

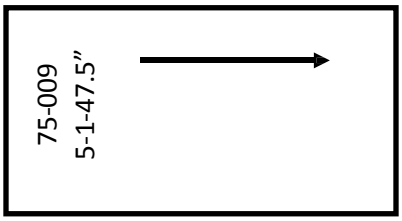
Composition:

- Dark, lime mud matrix
- Dolomite present in one corner of slide
    - Possibly within an argillaceous section
- Two phases of cement

Organisms:

- Large bivalve shells have been recrystallized
    - Possible smaller isopachous cement initially formed around edges and was then infilled with larger, blocky calcite cement
- Abundant echinoid fragments
- Bryozoan fragments
- Brachiopods
- Articulated bivalve shells
- Gastropods
- Coral fragments – not common, rare
- Trilobites
- Lacking sponge spicules
- Possible cephalopod
- Thin, ring-fossils
    - Possible calcispheres

F. 5-1-47.5



Cruise: Hudson 75-009, Phase V
Core/Station: 5
Piece/Depth as per slide label: PCE 1, 47.5”
Depth on core log: 112 cm
Lithology:

- Highly fragmented
    - Small to larger fossils in dark muddy matrix
    - Denser fossil fragments compared to 5-1-45.5

Composition:

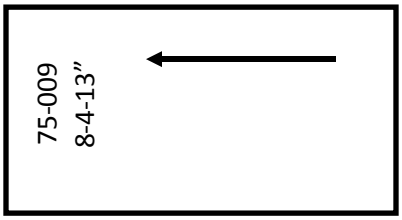
- Very minor amount of dolomite along an argillaceous seam
- Recrystallization in bivalve shells
- Some dolomite rhombs along top edge

Organisms:

- Dasycladacean green algae
- Echinoids
- Shell fragments
- Bivalves
- Gastropods
- Trilobites
- Ostracods
- Fenestrate bryozoan fragments
- Cephalopod
- Possible calcispheres
- Articulated bivalve shells

75-009, Phase V – Station #8

A. 8-4-13



Cruise: Hudson 75-009, Phase V
Core/Station: 8
Piece/Depth as per slide label: PCE 4, 13”
Depth on core log: No core log
Lithology:

- Very fine dolomite
- From limestone gravel/erratics

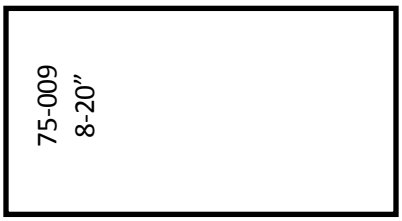
Composition:

- Completely dolomite/Pervasive dolomitization
    - Subhedral to anhedral dolomite crystals

Organisms:

- Small voids are present where fossils likely existed but have since been dissolved out
    - Possible echinoid fragments
    - Most appear rounded in shape
    - Some appear bladed – pointed at the ends
- Minor pyrite throughout

B. 8-20



Cruise: Hudson 75-009, Phase V
Core/Station: 8
Piece/Depth as per slide label: 20”
Depth on core log: no core log
Lithology:

- Lime mudstone matrix with a densely packed shell layer
- From limestone gravel/erratics

Composition:

- Matrix has been heavily recrystallized

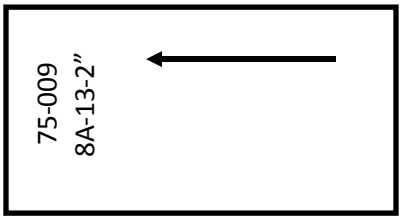
    - A few, discrete dolomite rhombs
- Minor to common disseminated pyrite
    - Can occur in clusters
- Rare phosphate grains
    - Isotropic
    - Light orange colour in plane polarized light

Organisms:

- Dense shell layer
- Some dissolved shells
- Molluscs
- Brachiopods
- Gastropods
- Ostracods
- Crinoid fragments
- All original shell material has been dissolved
- At least one trilobite fragment
- Radiolarians
- Ring fossils
    - Possible rugose corals?
    - Altered so difficult to see details

75-009, Phase V – Station #8A

A. 8A-13-2



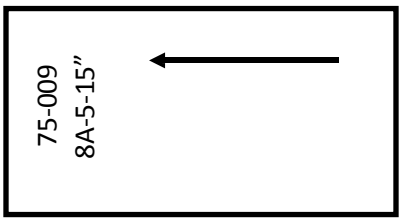
Cruise: Hudson 75-009, Phase V
Core/Station: 8A
Piece/Depth as per slide label: Piece 13, 2”
Depth on core log: 9 cm
Lithology:

- Erratic granite pebble (Jansa, 1976) – overburden

Composition:

- Large, blocky crystals
- Biotite present
- Large opaque crystals
- Quartz and plagioclase dominant – almost 50/50
- Unknown feature
    - Possible mineral
    - Possible alteration feature
    - Possible thin section artifact (bubble)
- Less biotite than in Drill Core #5
- No evidence of alignment
- Cross hatch mineral – feldspar

B. 8A-5-15



Cruise: Hudson 75-009, Phase V
Core/Station: 8A
Piece/Depth as per slide label: PCE 5, 15””
Depth on core log: 43 cm
Lithology:

- Fine lime mud matrix
- Mud is somewhat crystalized –calcite crystals can be resolved

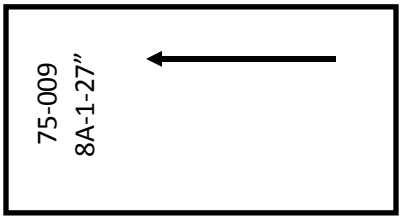
Composition:

- Disseminated pyrite throughout
- Disseminated organic matter throughout matrix
- Rare phosphate grains
    - Isotropic
    - Orange coloured in plane polarized light

Organisms:

- Abundant, small, replaced, rounded voids/clasts (calcitized radiolaria)
- Thin, elongated features – sponge spicules
- A few larger fossil fragments
    - Trilobite fragments
    - Shell (bivalve) fragments
- Shell fragments common
    - Mollusc (bivalve) fragments
- Unknown round, walled fossil

C. 8A-1-27



Cruise: Hudson 75-009, Phase V
Core/Station: 8A
Piece/Depth as per slide label: PCE 1, 27”
Depth on core log: 69 cm
Lithology:

- Fine lime mud matrix
    - Appears muddier than in 8A-5-15” (less crystalized) and overall fewer rounded fossil clasts (radiolaria)
- Matrix contains sponge spicules, radiolaria clasts, pyrite, and organic matter

Composition:

- Very similar to PCE 5-15”, but this thin section has a denser skeletal section that contains sponge spicules, trilobite fragments, and shell (bivalve) fragments
- A second, smaller patch of skeletal material occurs containing 1 definitive shell and sponge spicules
- Rare, but present, isotropic phosphate grains
- Disseminated organic material throughout
- No evidence of dolomite

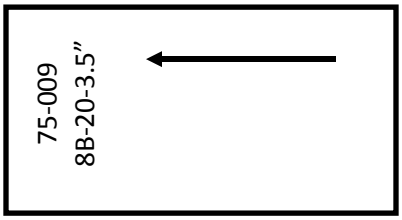
Organisms:

- Trilobite fragments
- Sponge spicules
- Shell fragments

    - Have been recrystallized
    - Mollusc (bivalve)
- Calcitized radiolaria
- One large shell void in matrix

75-009, Phase V – Station #8B

A. 8B-20-3.5



Cruise: Hudson 75-009, Phase V
Core/Station: 8B
Piece/Depth as per slide label: PCE 20, 3.5”
Depth on core log: 9 cm
Lithology:

- Fine lime mud matrix, becomes grainy towards the bottom
- Matrix: grainy
    - Phosphate grains, rounded radiolaria tests, and organic matter increase towards base of slide

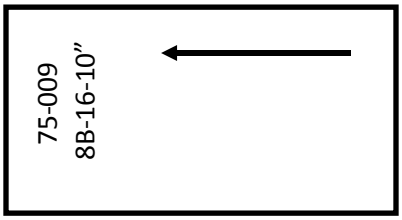
Composition:

- Phosphate grains present in matrix
    - Orange-coloured, isotropic rounded grains
    - More common than in 8A
- Linear, long, aligned, organic material in thin section
    - Possibly aligned due to compaction

Organisms:

- Very small fossil/shell fragments
    - Bivalves
- Small, rounded, calcitized radiolarian clasts/tests (similar to 8A)
    - Common, especially towards the bottom of the slide
- Sponge spicules
    - Aligned horizontally – same orientation as organic material, parallel to bedding

B. 8B-16-10



Cruise: Hudson 75-009, Phase V
Core/Station: 8B
Piece/Depth as per slide label: PCE 16, 10”

Depth on core log: 26 cm
Lithology:

- Matrix: fine mud
    - Less grainy/crystalline (more muddy) than 8B-20-3.5”
        - No alignment noted

Composition:

- Disseminated organic material present, though less than in 8B-20-3.5
- No alignment of organic matter present
- Disseminated pyrite present
- Small phosphate grains present
    - Isotropic
    - Rounded
    - Orange colour in plane polarized light

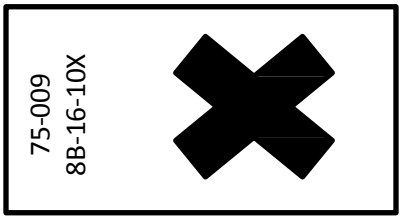
Organisms:

- Rounded, replaced clasts common (calcitized radiolaria)
- Other fossil fragments include shells (bivalves) and a possible trilobite fragment
- Larger fossil fragment cluster near bottom of slide
- A few shell fragments throughout
    - Primarily small and thin
- Sponge spicules throughout
- Possible echinoderm fragments

Sedimentary features and structures:

- Some thin, calcite-filled fractures

C. 8B-16-10X



Cruise: Hudson 75-009, Phase V
Core/Station: 8B
Piece/Depth as per slide label: PCE #16, 10”
Depth on core log: 26 cm
Lithology:

- Matrix: same as 8B-16-10; cross section of same core piece

Composition:

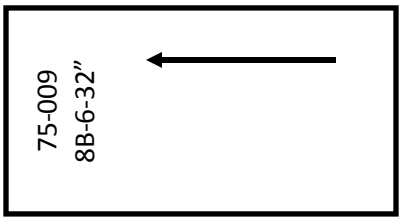
- Phosphate grains present
- Disseminated organic matter in matrix

Organisms:

- Some larger fossils: fragments and shells (bivalves)
- Abundant rounded, calcitized radiolaria

- Trilobite fragment
- Possible crinoid fragments
- Sponge spicules
- 1 round, walled fossil
    - Possible *Tentaculites?*
    - Possible cross section of an echinoid spine?
    - Cross-extinction pattern

D. 8B-6-32



Cruise: Hudson 75-009, Phase V
Core/Station: 8B
Piece/Depth as per slide label: PCE 6, 32”
Depth on core log: 83 cm
Lithology:

- Similar to the other 8B thin sections
    - Fine lime mud matrix
    - May be slightly more crystalline than 8B-16-10

Composition:

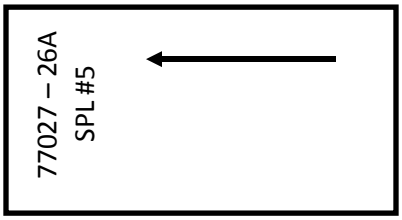
- Phosphate grains present
- Disseminated organic matter in matrix

Organisms:

- Rounded, fossil casts common (calcitized radiolarians)
    - Two radiolarian casts look like they have spines preserved
- Shell (bivalve) fragments and sponge spicules present
- Trilobite fragments
- A few larger fossil fragments (unidentified)

77027 – Station #026A

A. 026A-5



Cruise: Hudson 77, 77027
Core/Station: 26A
Piece/Depth as per slide label: SPL #5
Depth on core log: Unknown
Lithology:

- Very homogeneous looking
- Predominantly a fine lime mud

Composition:

- No dolomite
- Some damage to the thin section (dissolution and pitting)
- Rare to common disseminated pyrite
- Rare phosphate grains

Organisms:

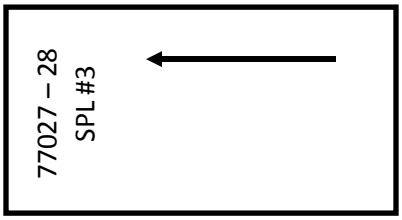
- Some small, rounded fossil casts present
    - Calcitized radiolarians

Sedimentary features and structures:

- A few, thin fractures filled with calcite cement
- Lots of artefacts on the edge of the slide: hair, bubbles, cracks, dissolution

77027 – Station #028

A. 028-3



Cruise: Hudson 77, 77027
Core/Station: 28
Piece/Depth as per slide label: SPL #3
Depth on core log: Unknown
Lithology:

- Matrix: fine lime mud, dark to medium grey (similar to other thin sections from the region)

Composition:

- Rare to few isotropic phosphate grains
    - Fairly small
- Disseminated pyrite throughout

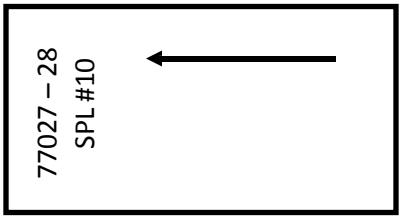
Organisms:

- Abundant, replaced, rounded clasts (calcitized radiolaria)
    - A few with spines intact
- A few significantly larger, rounded replaced fossils. Likely related to smaller, rounded clasts (radiolaria), just larger in size
    - Similar cement replacement
- Shell fragments present
    - Primarily small
    - Bivalves
    - Some larger pieces that display sweeping extinction
    - Common throughout thin section
- A few trilobite fragments

Sedimentary features and structures:

- Calcite-filled fractures

B. 028-10



Cruise: Hudson 77, 77027

Core/Station: 28
Piece/Depth as per slide label: SPL #10
Depth on core log: 58 cm
Lithology:

- Lime mud – fine grained matrix

Composition:

- Orange coloured, isotropic phosphate grains present
    - Appear more elongated and less rounded than previously encountered phosphate grains
- Disseminated pyrite throughout
- No dolomite noted
- Minor disseminated organic material in matrix
- Elongated (bladed)? opaques
    - Not sure if real or artefacts
    - Composition unknown, likely organic matter

Organisms:

- Small, round, replaced clasts common (calcitized radiolaria)
    - Variable in size and all replaced
- Fossil fragments common, primarily shell (bivalve) fragments
- One rounded, replaced clast (radiolarian) with spines
- Sponge spicules
- Majority of fossil fragments seem to be replaced
- Small to large shell fragments
    - Small shell fragments are common
- Some trilobite fragments
- Large, somewhat compacted bivalve shell
    - Concentration of pyrite inside and outside of shell
- Unknown fossil fragment - rounded
- A few rounded fossils
    - Larger than the radiolarians
    - Too altered/replaced and fragmented for identification

Appendix C

Thin section photographs

Cruise	Station #	Piece (PCE) / Sample (SPL) #	Sample depth on slide label (inches)	Sample depth on core log (cm)	Plate #
75-009, Phase V	4	6	15	39	1
		17	19	49	2
		11	30	76	3
		7	40	97.5	4
		7	42	107	5
75-009, Phase V	5	16	21	59	6
		10	31	83	7
		10	33	89	8
		5	6.5	112	9
		1	45.5	116	10
		1	47.5	119	11
75-009, Phase V	8	4	13”	No core log	12
			20”	No core log	13
75-009, Phase V	8A	13	2	9	14
		5	15	43	15
		1	27	69	16
75-009, Phase V	8B	20	3.5	9	17
		16	10	26	18
		16	10	26	19
		6	32	83	20
77027	026A	5	Not provided	Unknown	21
77027	028	3	Not provided	Unknown	22
		10	Not provided	58	23

PPL = Plane polarized light

XPL = Cross polarized light

Scale bar units = micrometres (µm)

Thin sections were photographed with an Axiocam 12 Mb camera and captured digitally using the Zeiss ZEN software

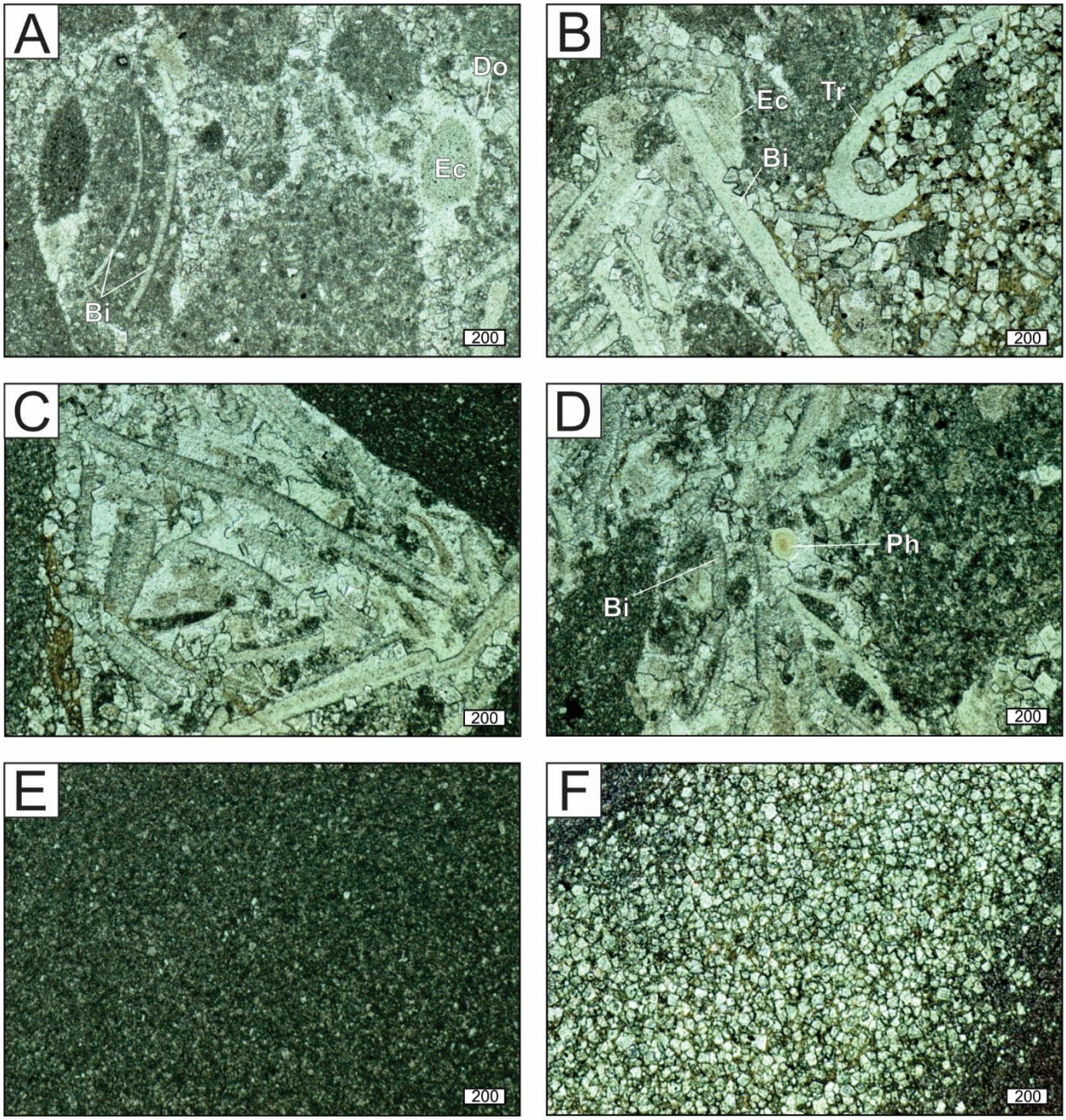


Plate 1: Thin section photographs from cruise 75-009, Phase V, Station #4, Piece #6, 15". (A) Bivalve shell fragments (Bi) and echinoderm pieces (Ec) in a mudstone matrix with rare dolomite rhombs (PPL, scale = 200 μm). (B) Bivalve (Bi), trilobite (Tr), and echinoderm (Ec) fragments in a mudstone matrix with dolomite rhombs (PPL, scale = 200 μm). (C) Bivalve shell fragments in a mudstone matrix with dolomite rhombs (PPL, scale = 200 μm). (D) Bivalve shell fragments (Bi) and a layered phosphate grain in a mudstone matrix with rare dolomite rhombs (PPL, scale = 200 μm). (E) Lime mudstone (PPL, scale = 200 μm). (F) Dolomite crystals (PPL, scale = 200 μm).

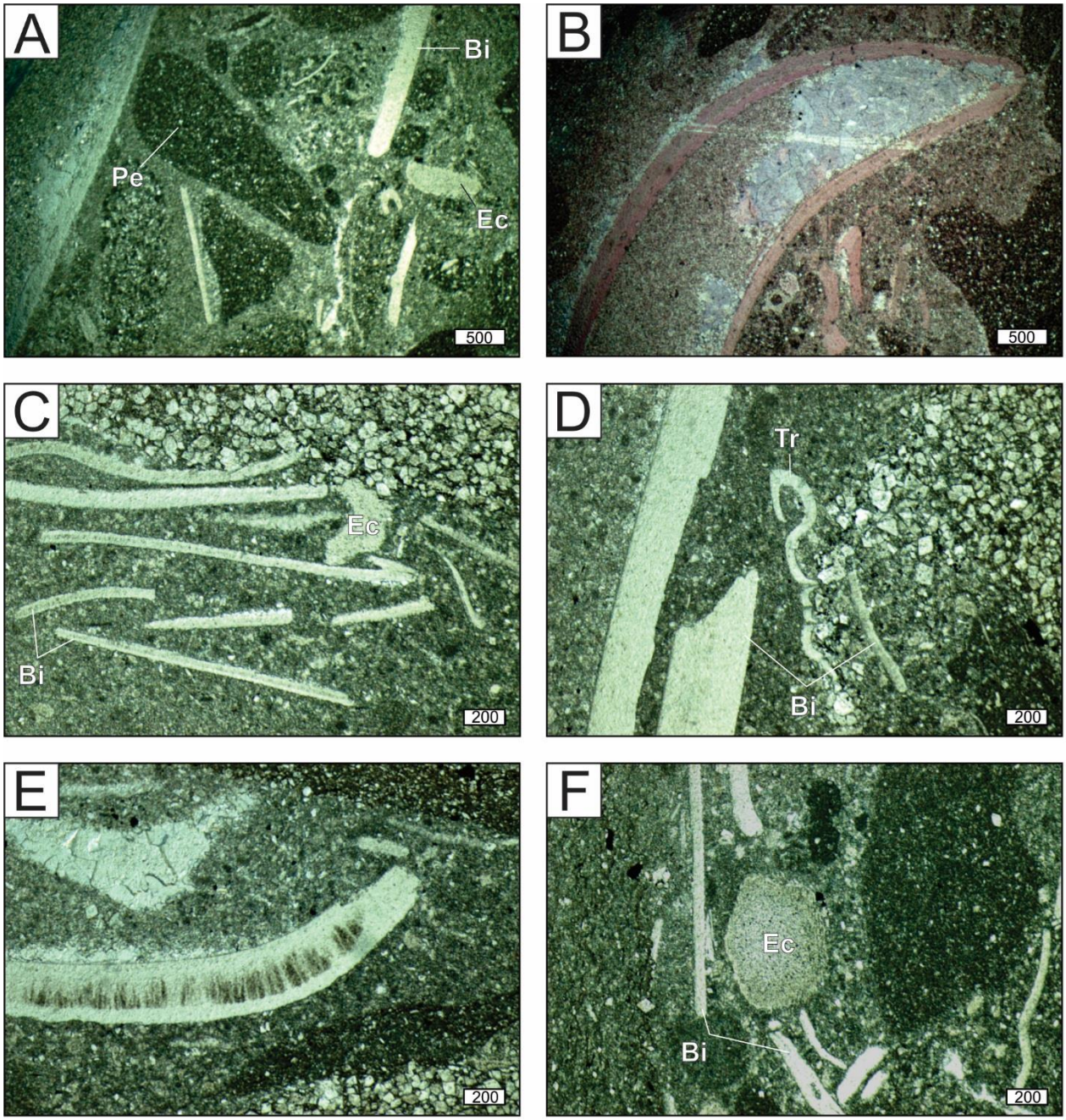


Plate 2: Thin section photographs from cruise 75-009, Phase V, Station #4, Piece #17, 19". (A) Peloids (Pe), bivalve shell fragments (Bi), and echinoderm pieces (Ec) in a mudstone matrix (PPL, scale = 500 μm). (B) Bivalve shell with blocky calcite cement in a mudstone matrix with peloids (PPL, scale = 500 μm). (C) Bivalve shell fragments (Bi) and a piece of echinoderm (Ec) in a mudstone matrix adjacent to a dolomitized section (PPL, scale = 200 μm). (D) Bivalve shell fragments (Bi) and a piece of trilobite (Tr) in a mudstone matrix with dolomite rhombs (PPL, scale = 200 μm). (E) A fragment of a bivalve shell (PPL, scale = 200 μm). (F) Bivalve shell fragments (Bi), and a piece of echinoderm (Ec) in a mudstone matrix with some dolomite rhombs (PPL, scale = 200 μm).

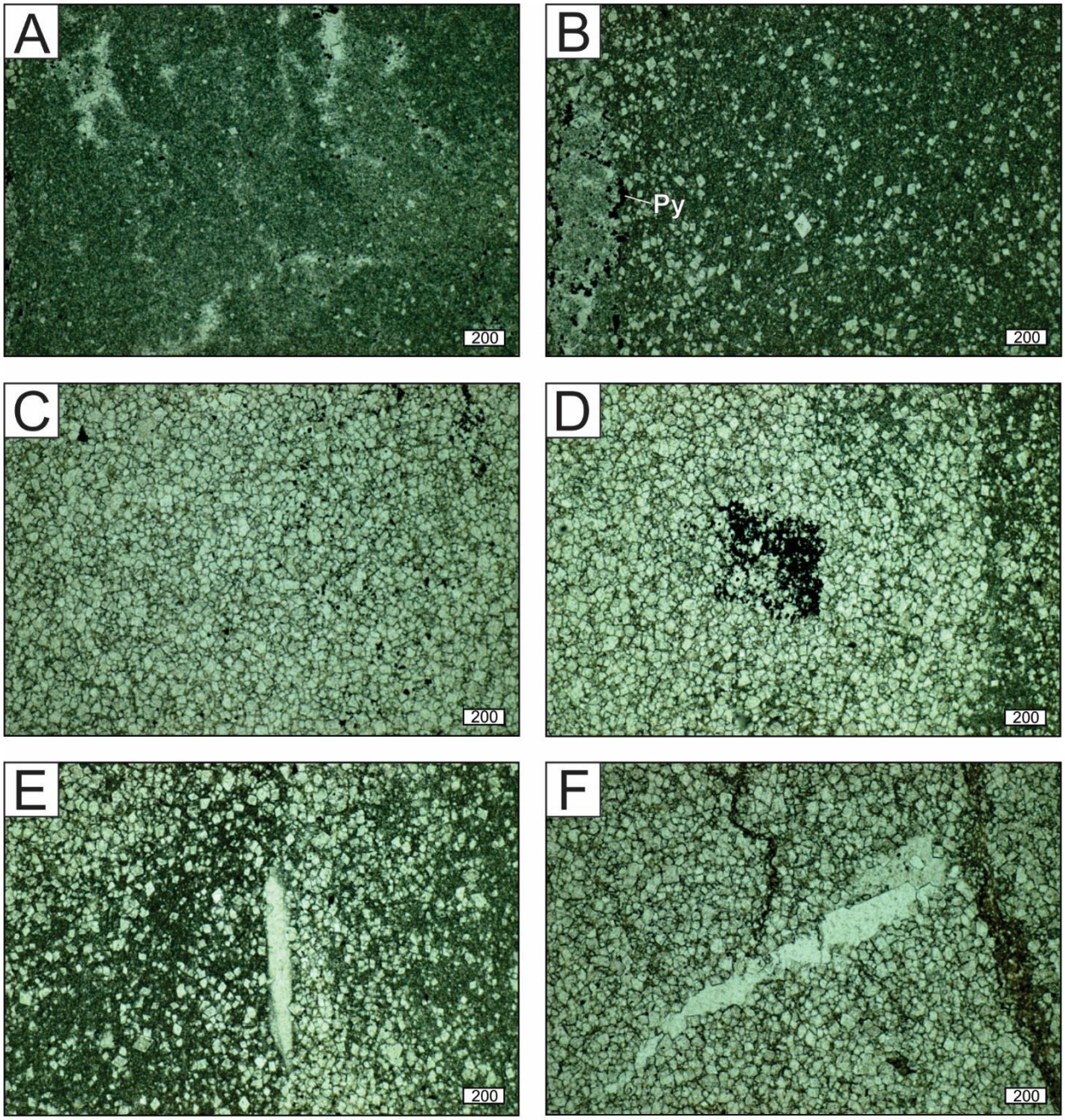


Plate 3: Thin section photographs from cruise 75-009, Phase V, Station #4, Piece #11, 30". (A) Lime mudstone matrix with a few dolomite rhombs (PPL, scale = 200 μm). (B) Dolomite rhombs in a mudstone matrix with some pyrite (Py) clusters (PPL, scale = 200 μm). (C) Pervasive dolomitization with disseminated pyrite (PPL, scale = 200 μm). (D) Pervasive dolomite with pyrite occurring in a cluster (PPL, scale = 200 μm). (E) An altered shell fragment surrounded by mudstone and dolomite (PPL, scale = 200 μm). (F) A possible altered fossil shell fragment in dolomite (PPL, scale = 200 μm).

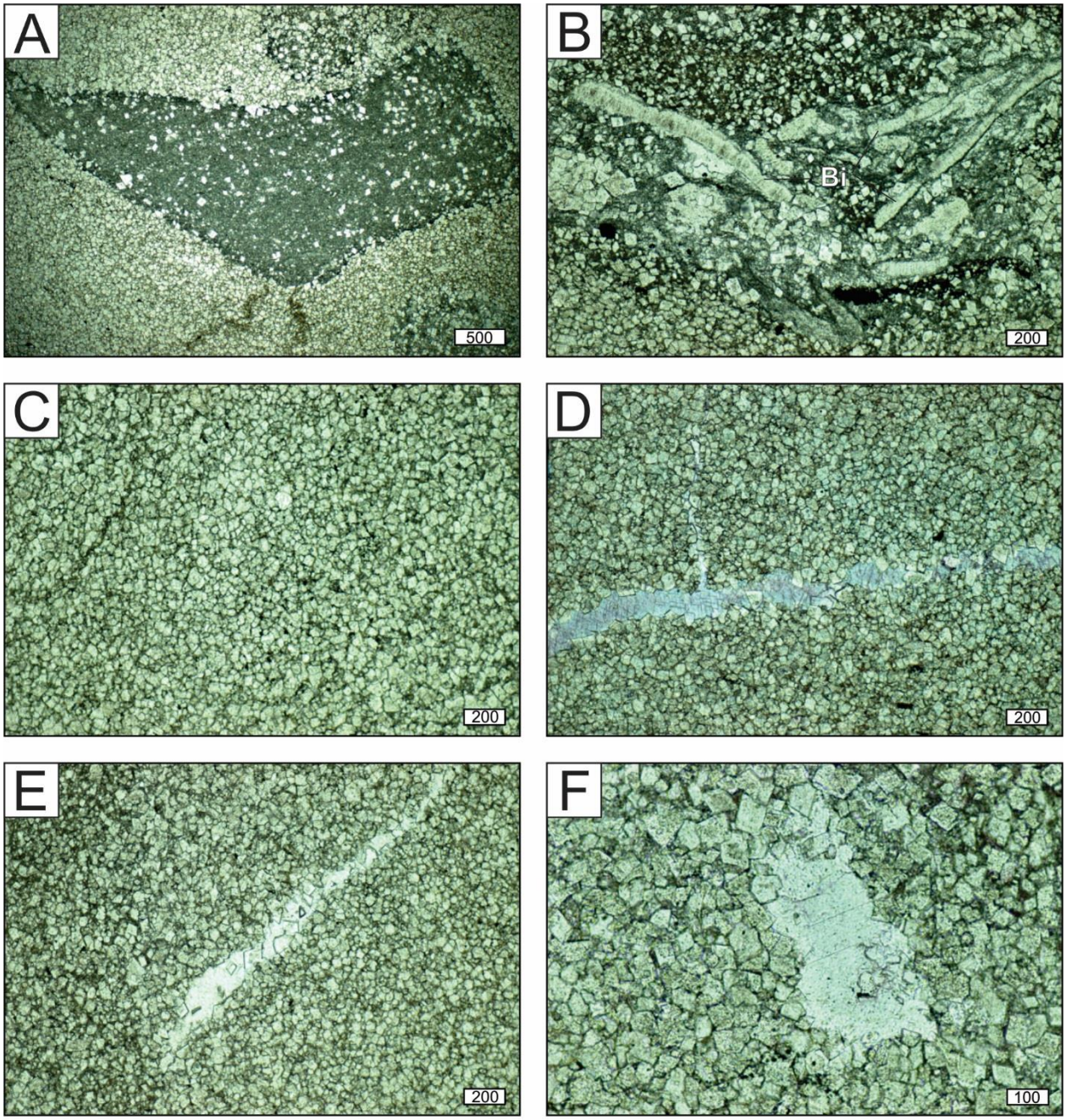


Plate 4: Thin section photographs from cruise 75-009, Phase V, Station #4, Piece #7, 40". (A) A section of lime mudstone in an otherwise dolomitized section (PPL, scale = 500 μm). (B) Bivalve shell fragments (Bi) in a predominantly dolomitized matrix (PPL, scale = 200 μm). (C) Pervasive dolomitization with disseminated pyrite (opaques; PPL, scale = 200 μm). (D) Pervasive dolomitization (PPL, scale = 200 μm). (E) Pervasive dolomitization (PPL, scale = 200 μm). (F) An echinoderm fragment in dolomite (PPL, scale = 100 μm).

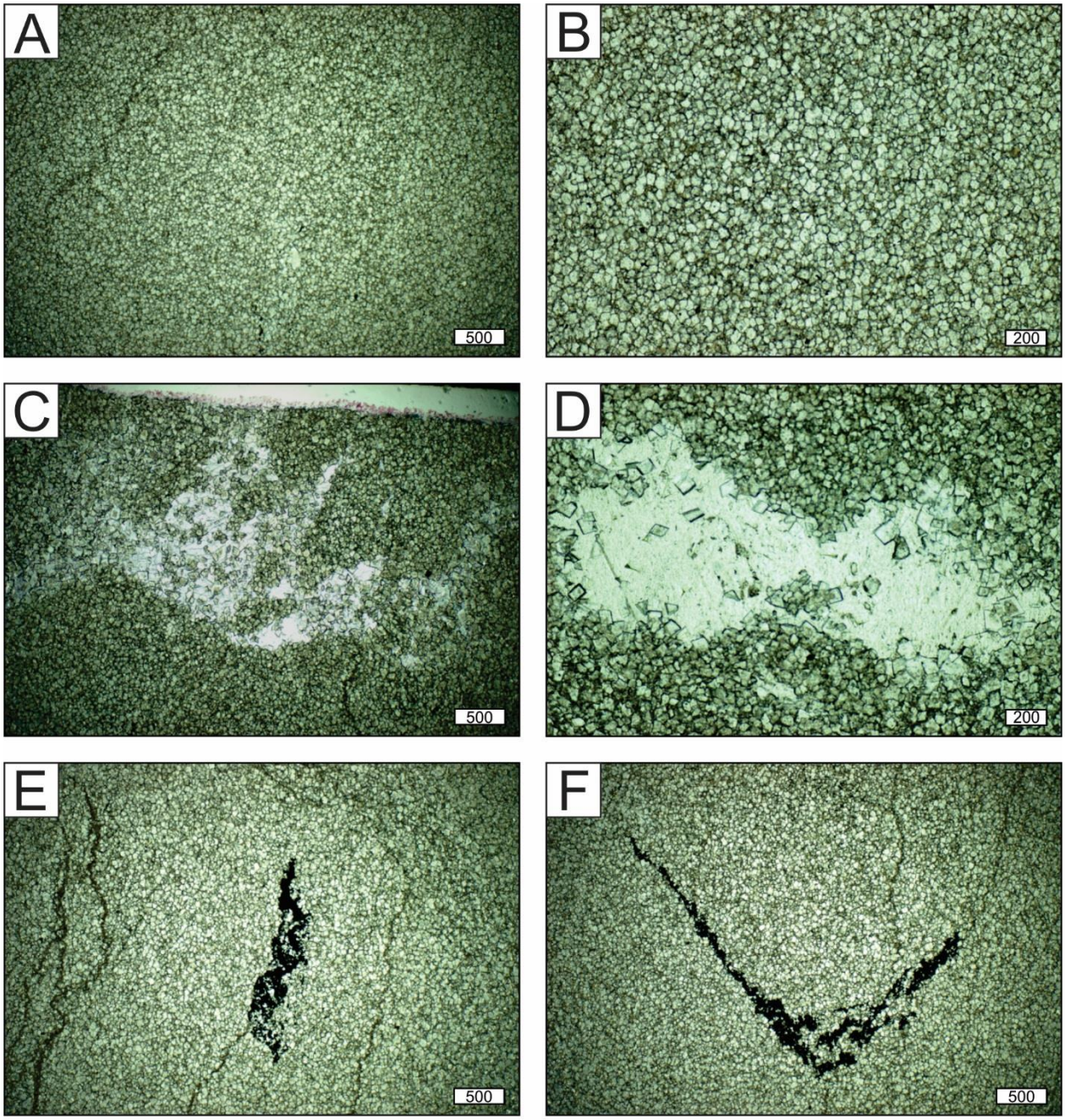


Plate 5: Thin section photographs from cruise 75-009, Phase V, Station #4, Piece #7, 42". (A) Pervasive dolomitization (PPL, scale = 500 μm). (B) Pervasive dolomitization (PPL, scale = 200 μm). (C) Calcite cement fill in dolomite (PPL, scale = 500 μm). (D) Possible altered echinoderm fragment in dolomite (PPL, scale = 200 μm). (E) A pyrite cluster (possible replacement of fossil fragment) in dolomite (PPL, scale = 500 μm). (F) A pyrite cluster (possible shell replacement) in dolomite (PPL, scale = 500 μm).

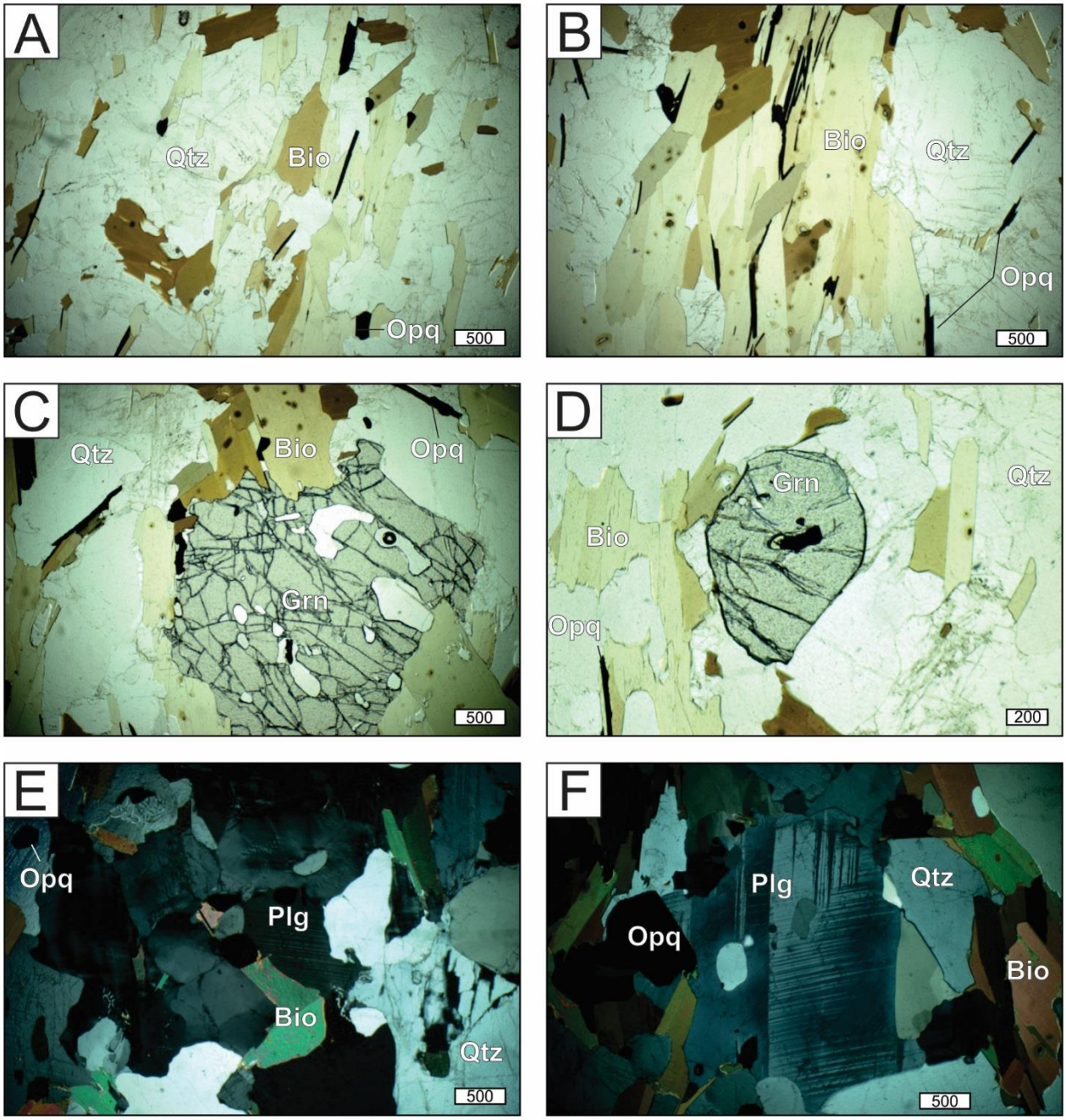


Plate 6: Thin section photographs from cruise 75-009, Phase V, Station #5, Piece 16, 21". (A) A garnet biotite gneiss composed of quartz (Qtz), biotite (Bio), and opaque (Opq) minerals (PPL, scale = 500 μm). (B) Quartz (Qtz), biotite (Bio), and opaque (Opq) minerals (PPL, scale = 500 μm). (C) Garnet (Grn), biotite (Bio), quartz (Qtz), and opaque minerals (PPL, scale = 500 μm). (D) Garnet (Grn), biotite (Bio), quartz (Qtz), and opaque minerals (PPL, scale = 200 μm). (E) Quartz (Qtz), biotite (Bio), plagioclase (Plg), and opaque minerals (XPL, scale = 500 μm). (F) Plagioclase (Plg), quartz (Qtz), biotite (Bio) and opaque minerals (Opq) (XPL, scale = 500 μm).

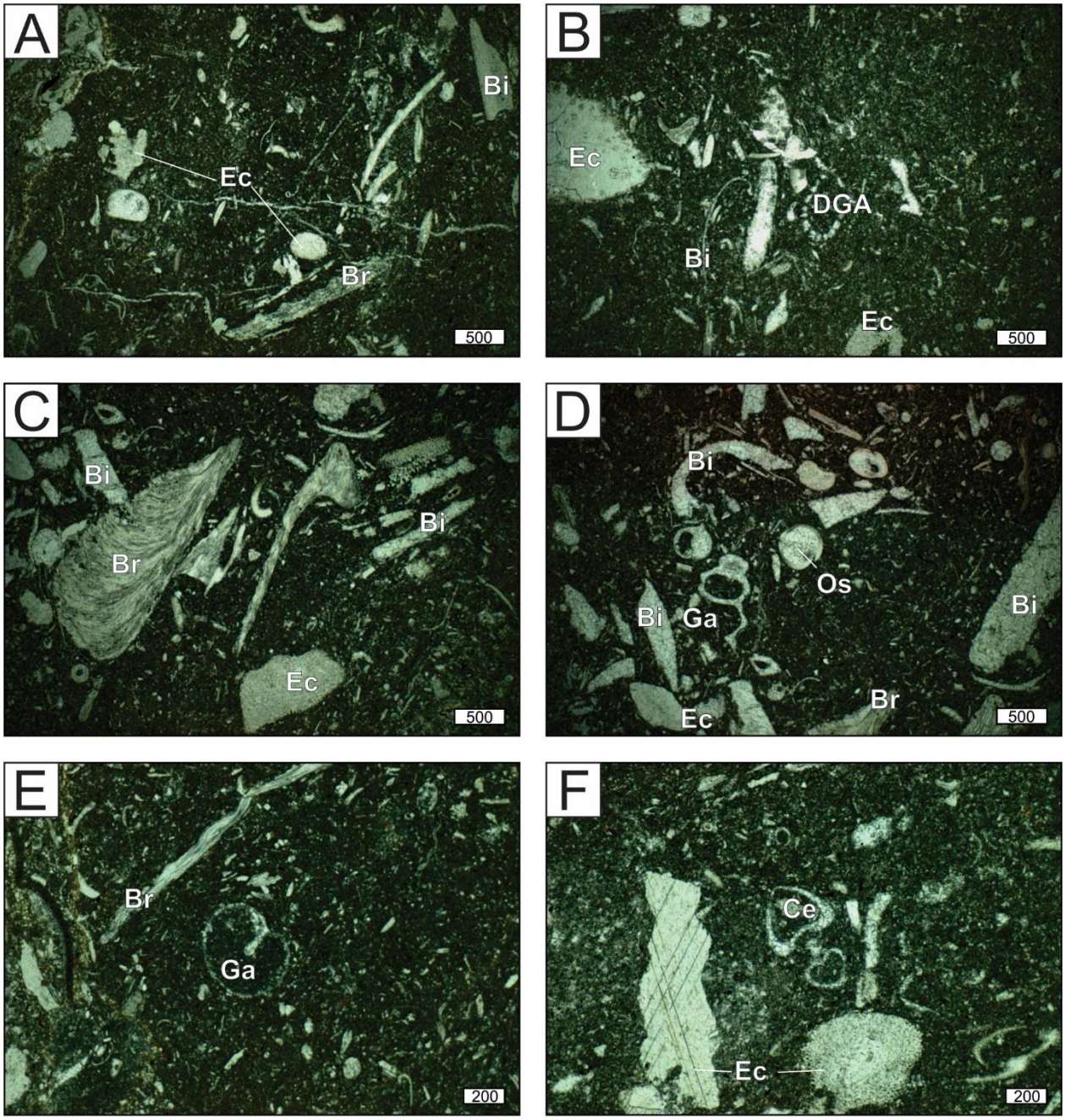


Plate 7: Thin section photographs from cruise 75-009, Phase V, Station #5, Piece 10, 31". (A) Fossiliferous wackestone with fragments of echinoderms (Ec), bivalves (Bi), and brachiopods (Br) (PPL, scale = 500 μm). (B) Fossiliferous wackestone with fragments of echinoderms (Ec), bivalves (Bi), and dasycladacean green algae (DGA) (PPL, scale = 500 μm). (C) Fossiliferous wackestone with fragments of brachiopods (Br), echinoderms (Ec), and bivalves (Bi) (PPL, scale = 500 μm). (D) Fossiliferous wackestone with fragments of bivalves (Bi), gastropods (Ga), ostracods (Os), brachiopods (Br), and echinoderms (Ec) (PPL, scale = 500 μm). (E) Fossiliferous wackestone with a brachiopod shell fragment (Br) and a gastropod (Ga) (PPL, scale = 200 μm). (F) Fossiliferous wackestone with shell and echinoderm (Ec) fragments and a cephalopod (Ce) (PPL, scale = 200 μm).

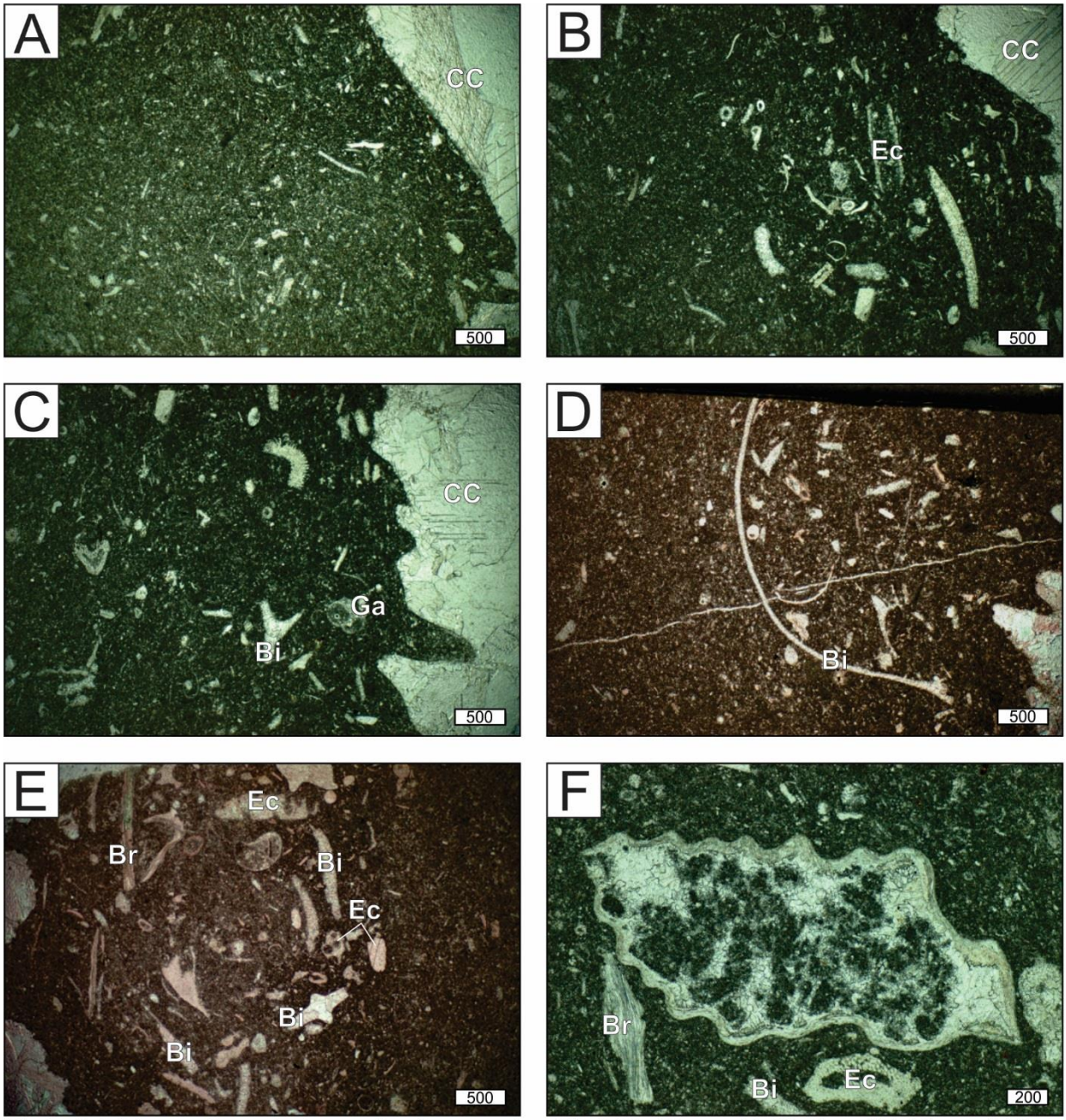


Plate 8: Thin section photographs from cruise 75-009, Phase V, Station #5, Piece #10, 33". (A) Fossiliferous wackestone with shell fragments and calcite cement (CC; PPL, scale = 500 μm). (B) Fossiliferous wackestone with shell fragments, pieces of echinoderms (Ec) and calcite cement (CC; PPL, scale = 500 μm). (C) Fossiliferous wackestone with fragments of bivalves (Bi), echinoderms (Ec), and gastropods (Ga). Calcite cement (CC) present (PPL, scale = 500 μm). (D) Fossiliferous wackestone with shell fragments and a bivalve (Bi) segment (PPL, scale = 500 μm).(E) Fossiliferous wackestone with fragments of echinoderms (Ec), bivalves (Bi), and brachiopods (Br) (PPL, scale = 500 μm). (F) Fossiliferous wackestone with an articulated brachiopod and fragments of brachiopods (Br), echinoderms (Ec), and bivalves (Bi) (PPL, scale = 200 μm).

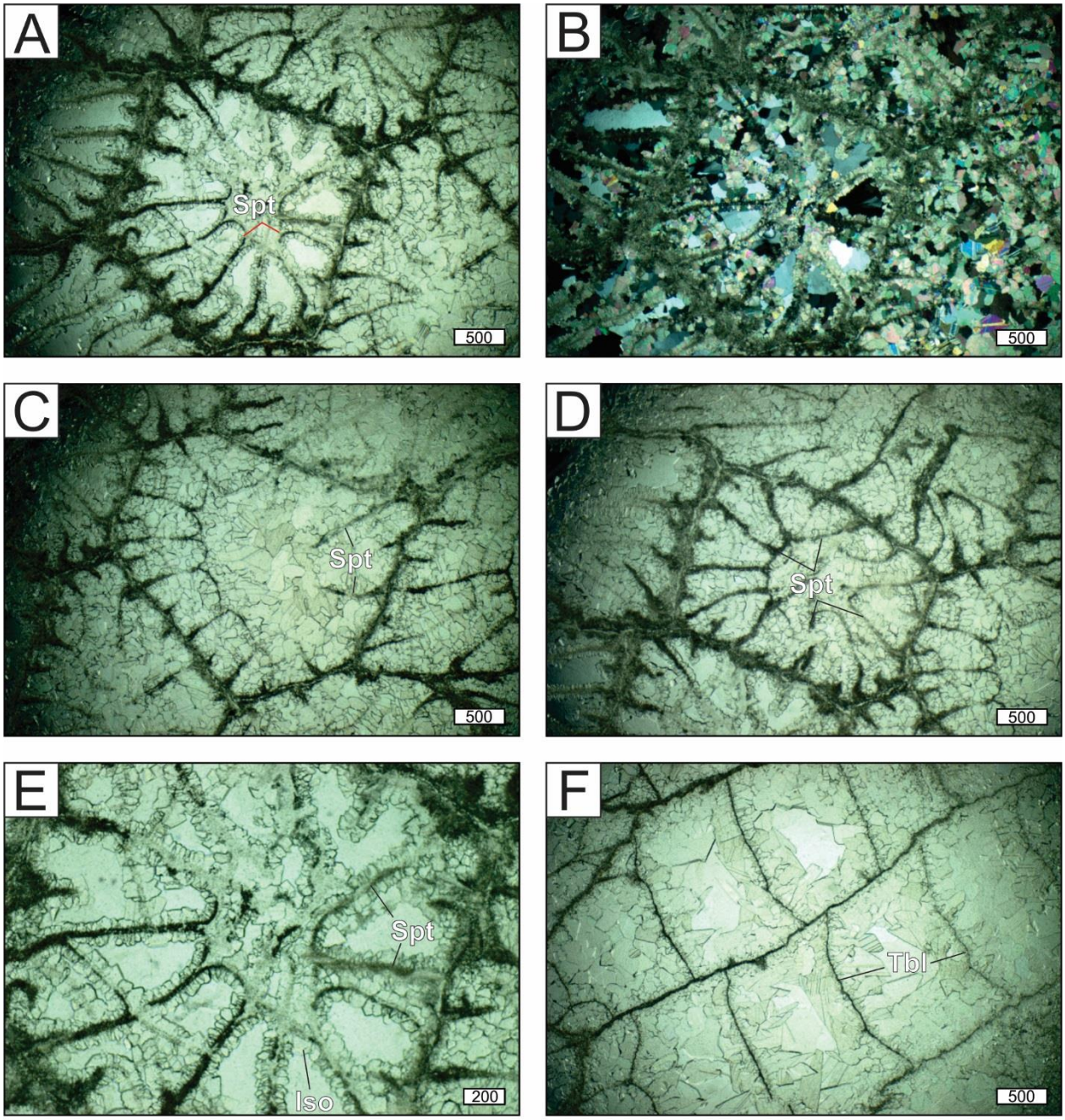


Plate 9: Thin section photographs of a colonial rugose coral from cruise 75-009, Phase V, Station #5, Piece #5, 6.5". (A) Corallites featuring septae (Spt) (PPL, scale = 500 µm). (B) Corallites featuring septae (XPL, scale = 500 µm). (C) Corallites featuring septae (Spt) (PPL, scale = 500 µm). (D) Corallites featuring septae (Spt) (PPL, scale = 500 µm). (E) Corralite with septae (Spt) and isopachous calcite cement (Iso) (PPL, scale = 200 µm). (F) Tabulae (Tbl) (PPL, scale = 500 µm).

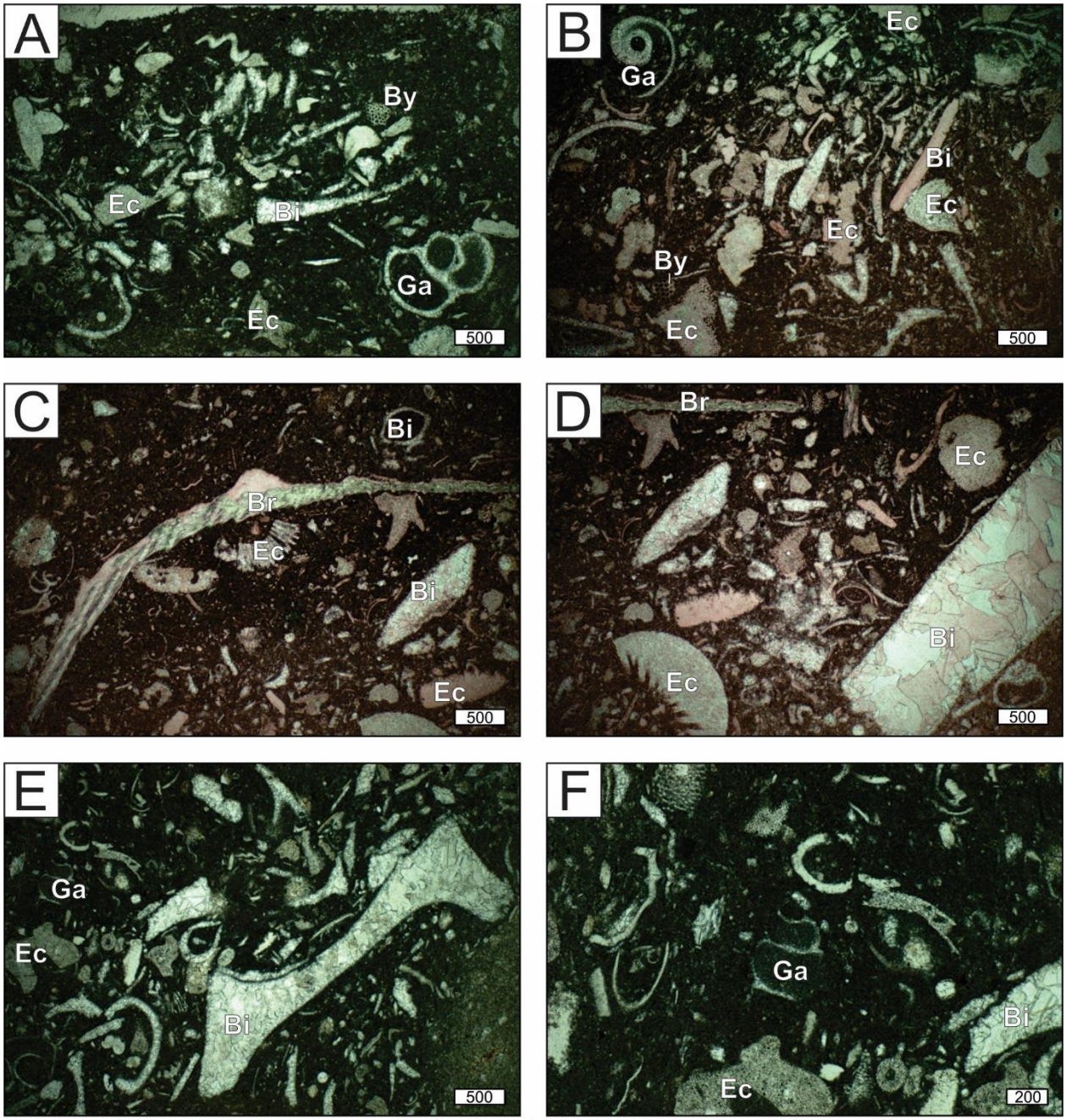


Plate 10: Thin section photographs from cruise 75-009, Phase V, Station #5, Piece #1, 45.5". (A) Fossiliferous wackestone to packstone composed of fragments of gastropods (Ga), bivalves (Bi), echinoderms (Ec) and bryozoans (By) (PPL, scale = 500 µm). (B) Fossiliferous wackestone to packstone composed of fragments of gastropods (Ga), bivalves (Bi), echinoderms (Ec) and bryozoans (By) (PPL, scale = 500 µm). (C) Fossiliferous wackestone with fragments of brachiopods (Br), echinoderms (Ec), and bivalves (Bi) (PPL, scale = 500 µm). (D) Fossiliferous wackestone to packstone composed of fragments of bivalves (Bi), echinoderms (Ec) and brachiopods (Br) (PPL, scale = 500 µm). (E) Fossiliferous wackestone to packstone composed of fragments of gastropods (Ga), bivalves (Bi), and echinoderms (Ec) (PPL, scale = 500 µm). (F) Fossiliferous wackestone consisting of fragments of gastropods (Ga), echinoderms (Ec), and bivalves (Bi) (PPL, scale = 200 µm).

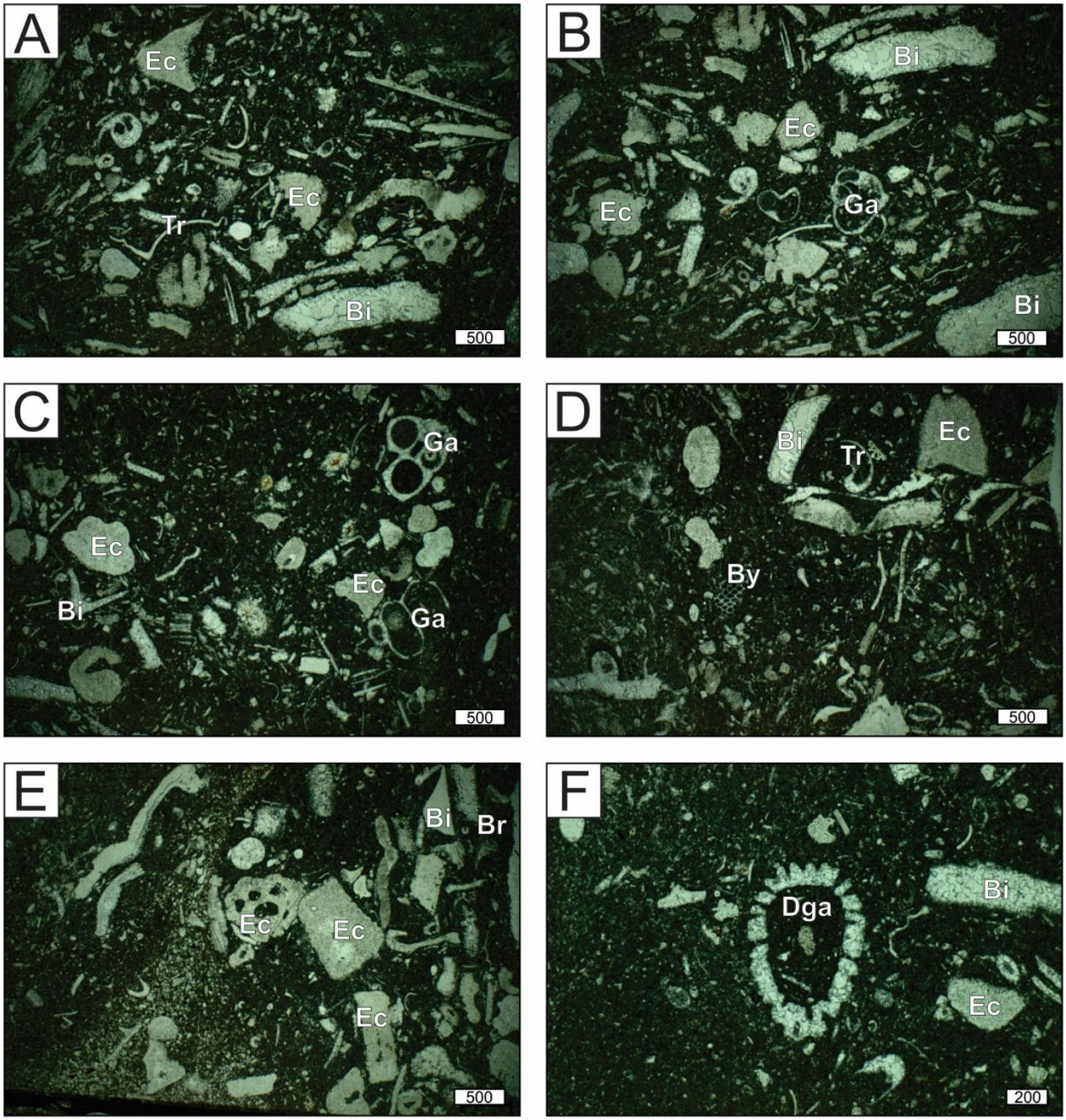


Plate 11: Thin section photographs from cruise 75-009, Phase V, Station #5, Piece #1, 47.5". (A) Fossiliferous wackestone to packstone composed of fragments of bivalves (Bi), trilobites (Tr), and echinoderms (Ec) (PPL, scale = 500 μm). (B) Fossiliferous wackestone to packstone with fragments of gastropods (Ga), bivalves (Bi), and echinoderms (Ec) (PPL, scale = 500 μm). (C) Fossiliferous wackestone with echinoderm (Ec), bivalve (Bi), and gastropod (Ga) fragments (PPL, scale = 500 μm). (D) Fossiliferous wackestone with fragments of bryozoans (By), echinoderms (Ec), bivalves (Bi), and trilobites (Tr) (PPL, scale = 500 μm). (E) Fossiliferous wackestone to packstone consisting of fragments of echinoderms (Ec), brachiopods (Br), and bivalves (Bi) with minor dolomite (PPL, scale = 500 μm). (F) Fossiliferous wackestone with bivalves (Bi), echinoderms and a piece of dasycladacean green algae (Dga) (PPL, scale = 200 μm).

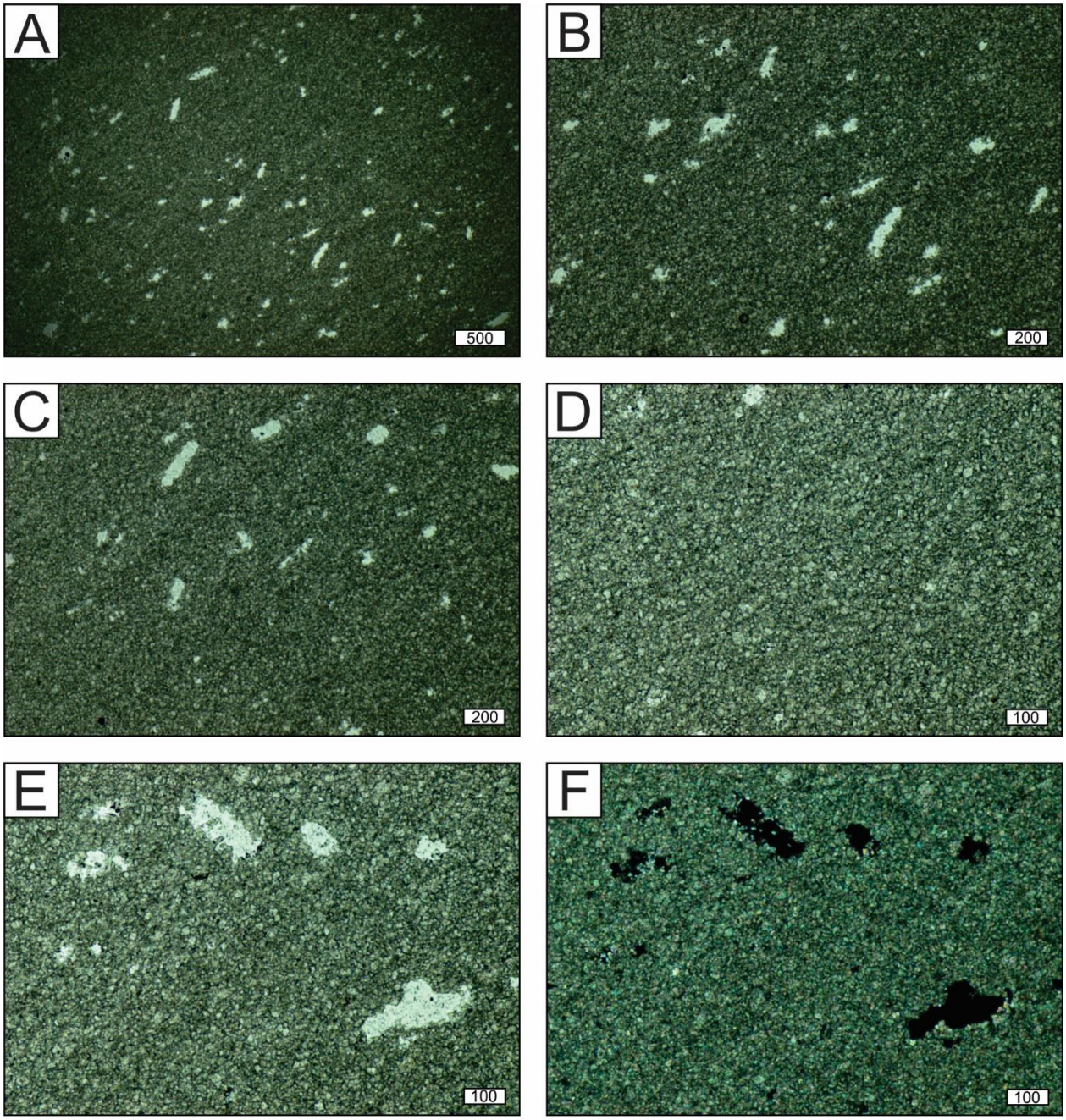


Plate 12: Thin section photographs from cruise 75-009, Phase V, Station #8, Piece #4, 13". (A) Finely crystalline dolo-mudstone with voids (possible dissolution of fossils) (PPL, scale = 500 µm). (B) Finely crystalline dolo-mudstone with voids (possible dissolution of fossils) (PPL, scale = 200 µm). (C) Finely crystalline dolo-mudstone with voids (possible dissolution of fossils) (PPL, scale = 200 µm). (D) Finely crystalline dolo-mudstone (PPL, scale = 100 µm). (E) Finely crystalline dolo-mudstone with voids (possible dissolution of fossils) (PPL, scale = 100 µm). (F) Finely crystalline dolo-mudstone with voids (possible dissolution of fossils) (XPL, scale = 100 µm).

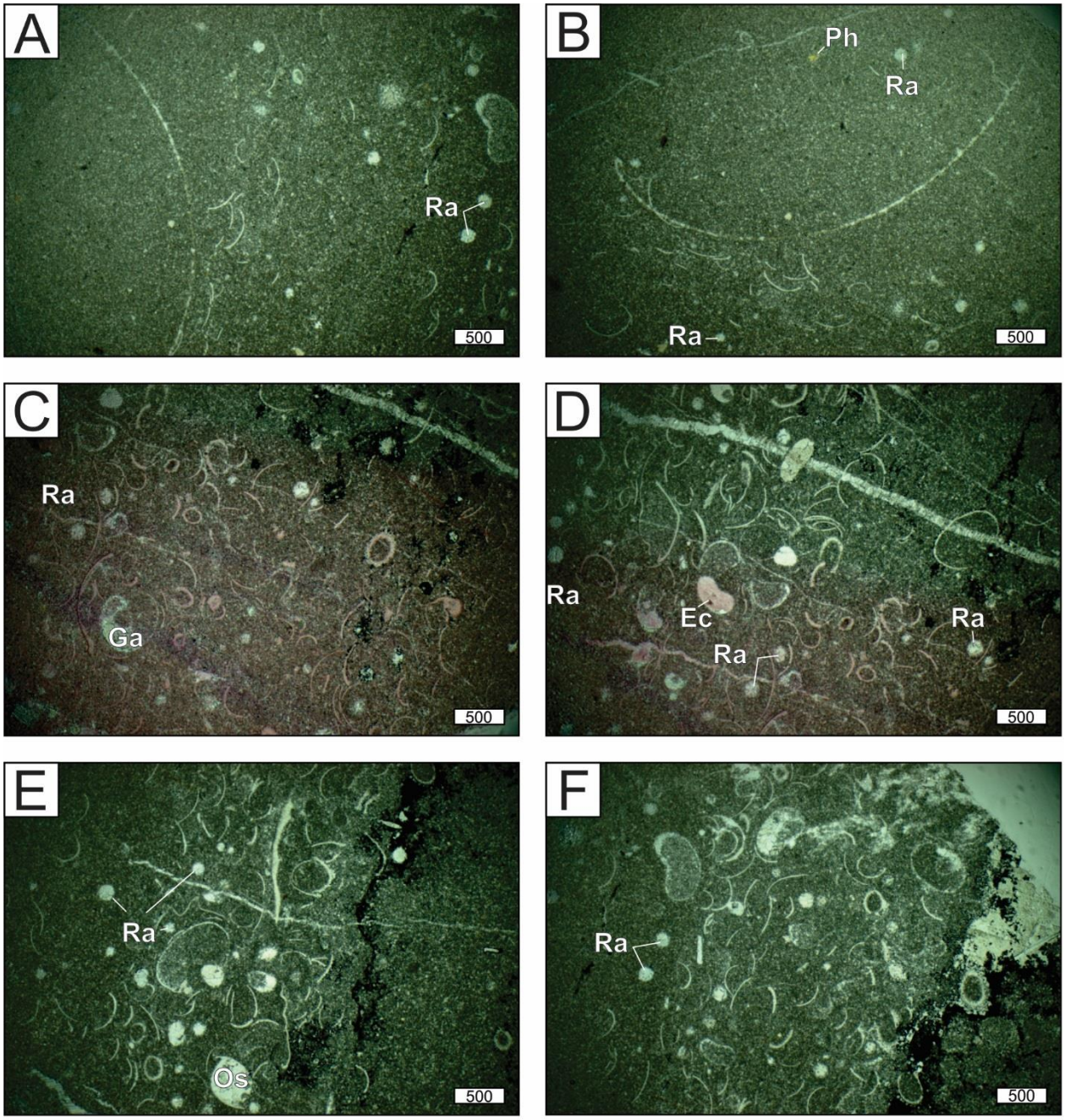


Plate 13: Thin section photographs from cruise 75-009, Phase V, Station, #8, 20". (A) Fossiliferous wackestone consisting of bivalve shell fragments and radiolarians (Ra) (PPL, scale = 500 µm). (B) Fossiliferous wackestone with bivalve shell fragments, radiolarians (Ra), and a phosphate grain (Ph) (PPL, scale = 500 µm). (C) Fossiliferous wackestone with bivalve shell fragments, gastropods (Ga), radiolarians (Ra), unknown ring fossils and disseminated pyrite (PPL, scale = 500 µm). (D) Fossiliferous wackestone dominated by bivalve shell fragments with minor pyrite, radiolarians (Ra) and pieces of echinoderms (Ec) (PPL, scale = 500 µm). (E) Fossiliferous wackestone composed of bivalve shell fragments, radiolarians (Ra), and an ostracod (Os) with disseminated pyrite in the matrix. (F) Fossiliferous wackestone consisting predominantly of bivalve shell fragments with disseminated pyrite and radiolarians (Ra) (PPL, scale = 500 µm).

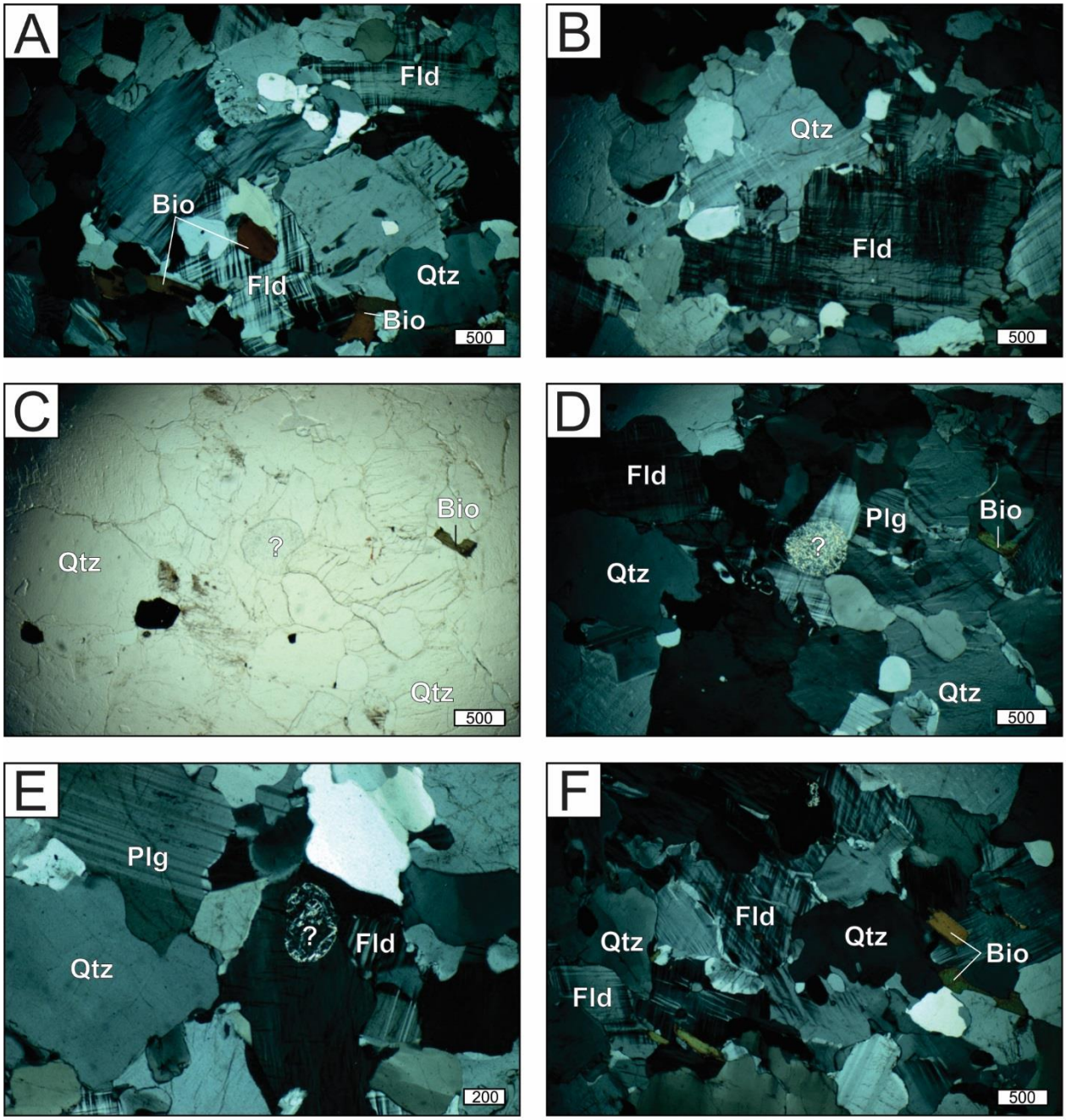


Plate 14: Thin section photographs of an igneous erratic from cruise 75-009, Phase V, Station #8A, Piece #13, 2". (A) Igneous rock composed of quartz (Qtz), feldspar (Fld), biotite (Bio) and opaque minerals (XPL, scale = 500 µm). (B) Quartz (Qtz), feldspar (Fld), and opaque minerals (XPL, scale = 500 µm). (C) Quartz (Qtz), biotite (Bio), opaque minerals, and an unknown mineral/artefact/bubble (?) (PPL, scale = 500 µm). (D) Quartz (Qtz), biotite (Bio), feldspar (Fld), plagioclase (Plg), opaque minerals, and an unknown mineral/artefact/bubble (?) (XPL, scale = 500 µm). (E) Quartz (Qtz), plagioclase (Plg), feldspar (Fld), and an unknown mineral/artefact (?) (XPL, scale = 200 µm). (F) Quartz (Qtz), biotite (Bio), feldspar (Fld) and opaque minerals (XPL, scale = 500 µm).

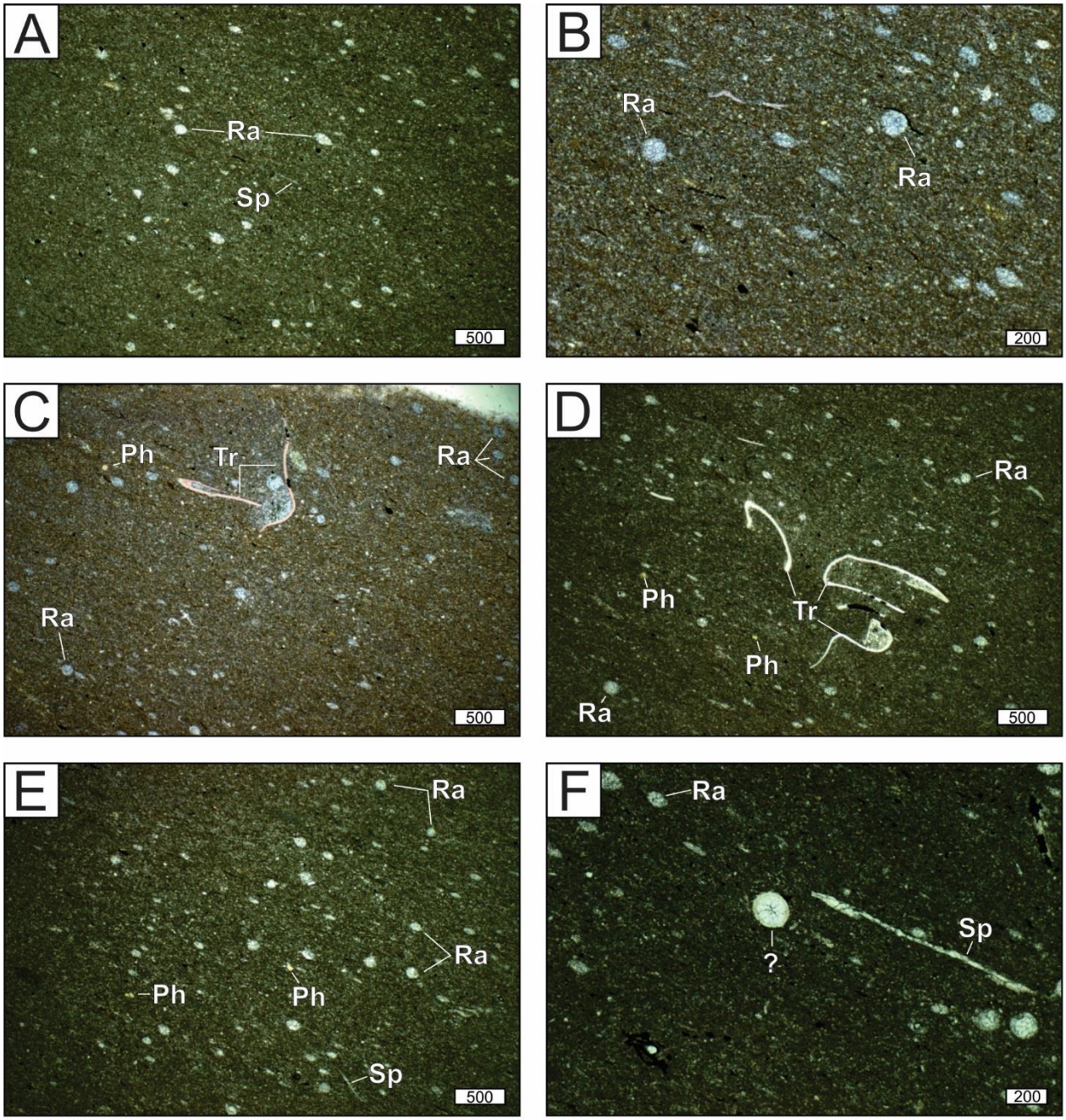


Plate 15: Thin section photographs from cruise 75-009, Phase V, Station #8A, Piece #5 15". (A) Lime mudstone with radiolarians (Ra), sponge spicules (Sp) and a minor amount of organic matter (PPL, scale = 500µm). (B) Lime mudstone with radiolarians (Ra) and fine organic matter (PPL, scale = 200 µm). (C) Lime mudstone with radiolarians (Ra), trilobite (Tr) fragments, organic matter and a phosphate grain (Ph) (PPL, scale = 500 µm). (D) Lime mudstone with radiolarians (Ra), trilobite pieces (Tr), shell fragments, organic matter, and phosphate grains (Ph) (PPL, scale = 500 µm). (E) Lime mudstone with radiolarians (Ra), sponge spicules (Sp), phosphate grains (Ph), and organic matter (PPL, scale = 500 µm). (F) Lime mudstone with radiolarians (Ra), a sponge spicule (Sp), organic matter, and an unknown, walled fossil (?) (PPL, scale = 200 µm).

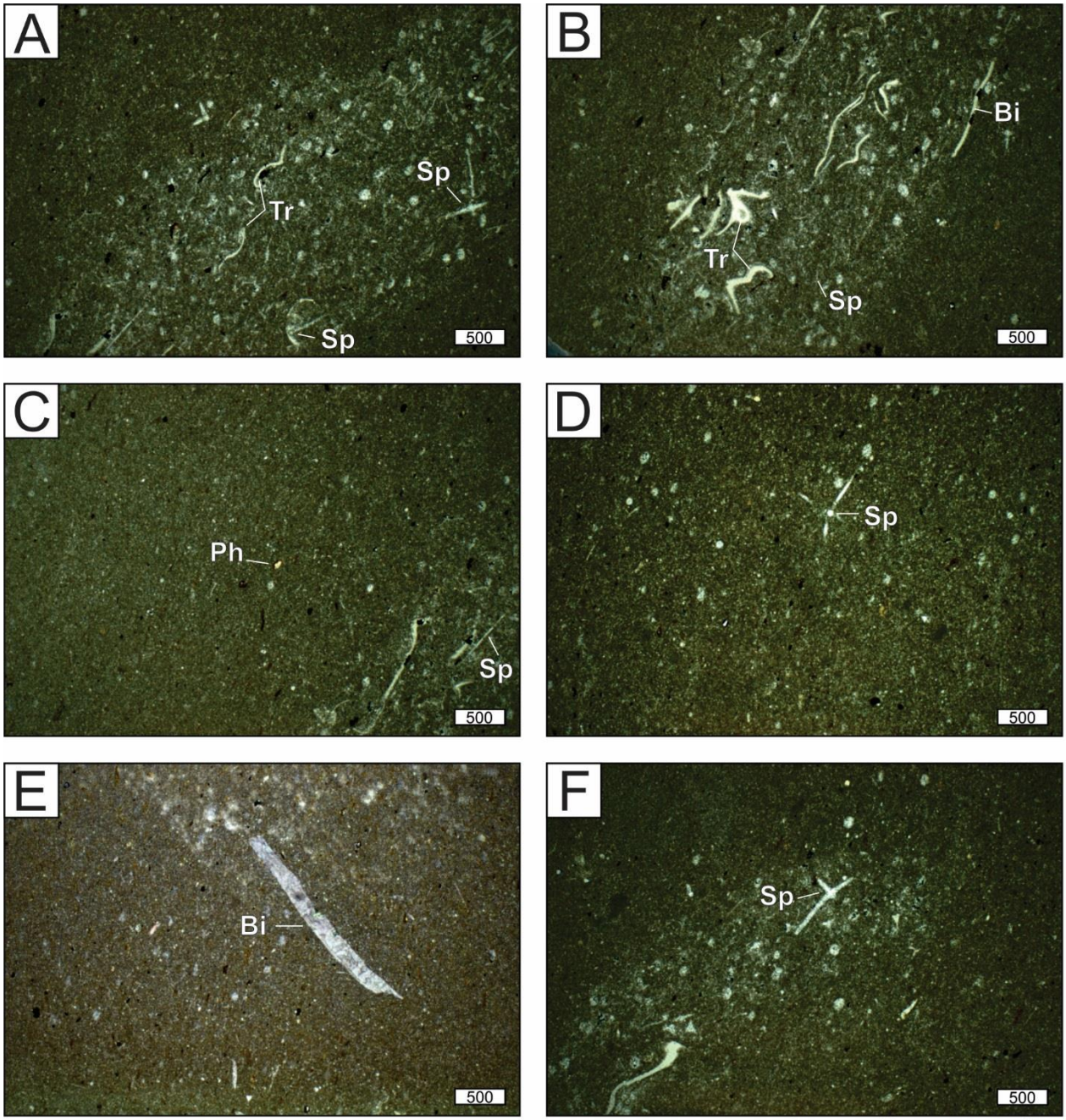


Plate 16: Thin section photographs from cruise 75-009, Phase V, Station #8A, Piece #1, 27". (A) Fossiliferous zone consisting of pieces of trilobites (Tr), shell fragments, radiolarians, and sponge spicules (Sp) with disseminated organic matter (PPL, scale = 500 µm). (B) Radiolarians, sponge spicules (Sp), bivalve shell fragments (Bi), and pieces of trilobites (Tr) (PPL, scale = 500 µm). (C) Lime mudstone to wackestone with sponge spicules (Sp), radiolarians, skeletal fragments, organic matter and a phosphate grain (Ph) (PPL, scale = 500 µm). (D) Fossiliferous wackestone with radiolarians, sponge spicules (Sp) and disseminated organic matter (PPL, scale = 500 µm). (E) Fossiliferous wackestone with bivalve shell fragments (Bi), radiolarians, sponge spicules, and organic matter (PPL, scale = 500 µm). (F) Fossiliferous section with radiolarians, sponge spicules (Sp), skeletal fragments and organic matter (PPL, scale = 500 µm).

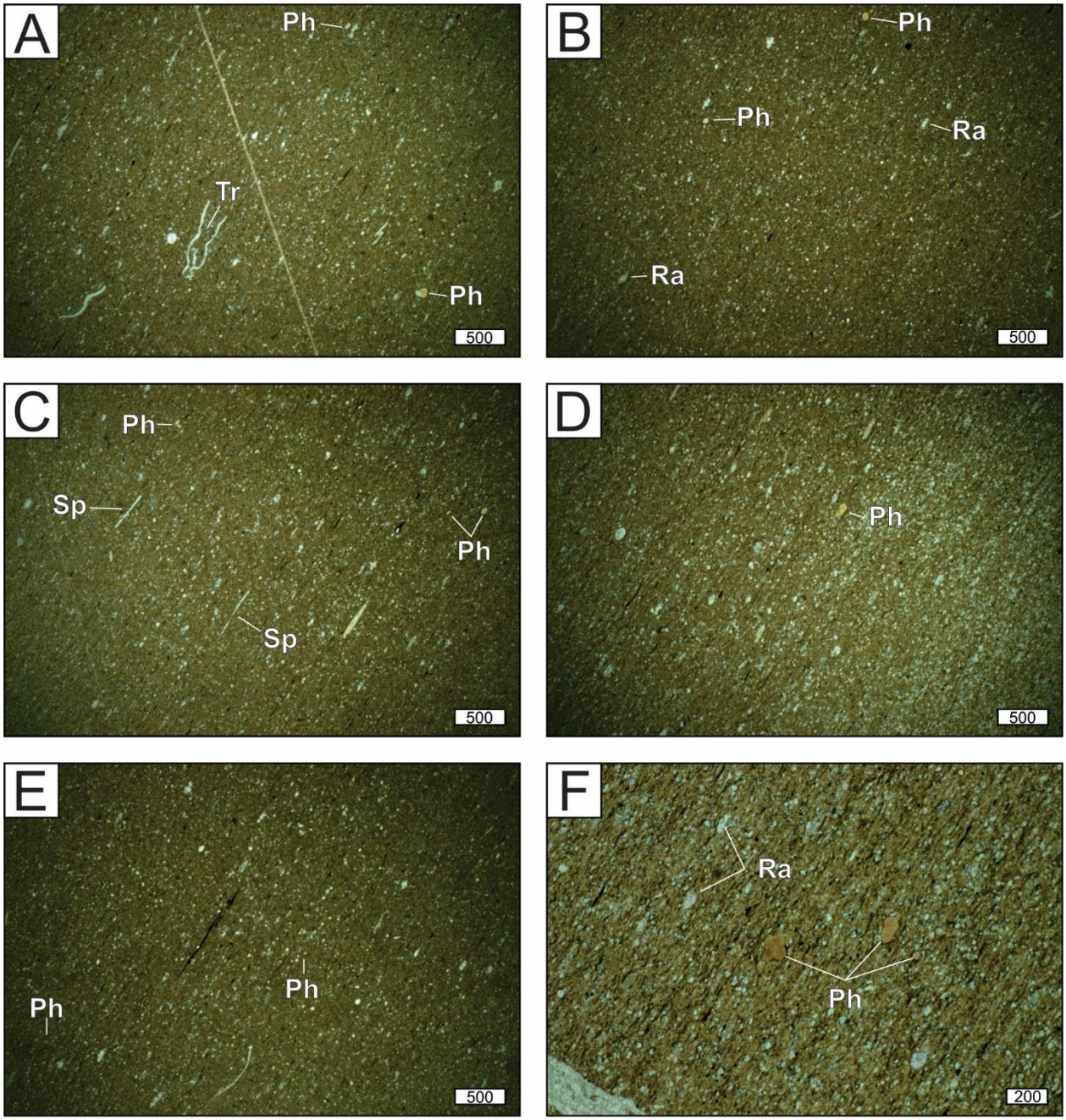


Plate 17: Thin section photographs from cruise 75-009, Phase V, Station #8B, Piece #20, 3.5". (A) Lime mudstone with radiolarians, trilobite fragments (Tr), shell pieces, phosphate grains (Ph), and organic matter (PPL, scale = 500 μm). (B) Lime mudstone consisting of radiolarians (Ra), phosphate grains (Ph), and organic matter (PPL, scale = 500 μm). (C) Sponge spicules (Sp), radiolarians, and phosphate grains (Ph) in a lime mud matrix with organic matter (PPL, scale = 500 μm). (D) Lime mud with radiolarians, phosphate grains (Ph), and organic matter (PPL, scale = 500 μm). (E) Lime mudstone composed of radiolarians, shell fragments, phosphate grains (Ph) and organic matter (PPL, scale = 500 μm). (F) Phosphate grains (Ph) and radiolarians (Ra) in a lime mud matrix with disseminated organic matter (PPL, scale = 200 μm).

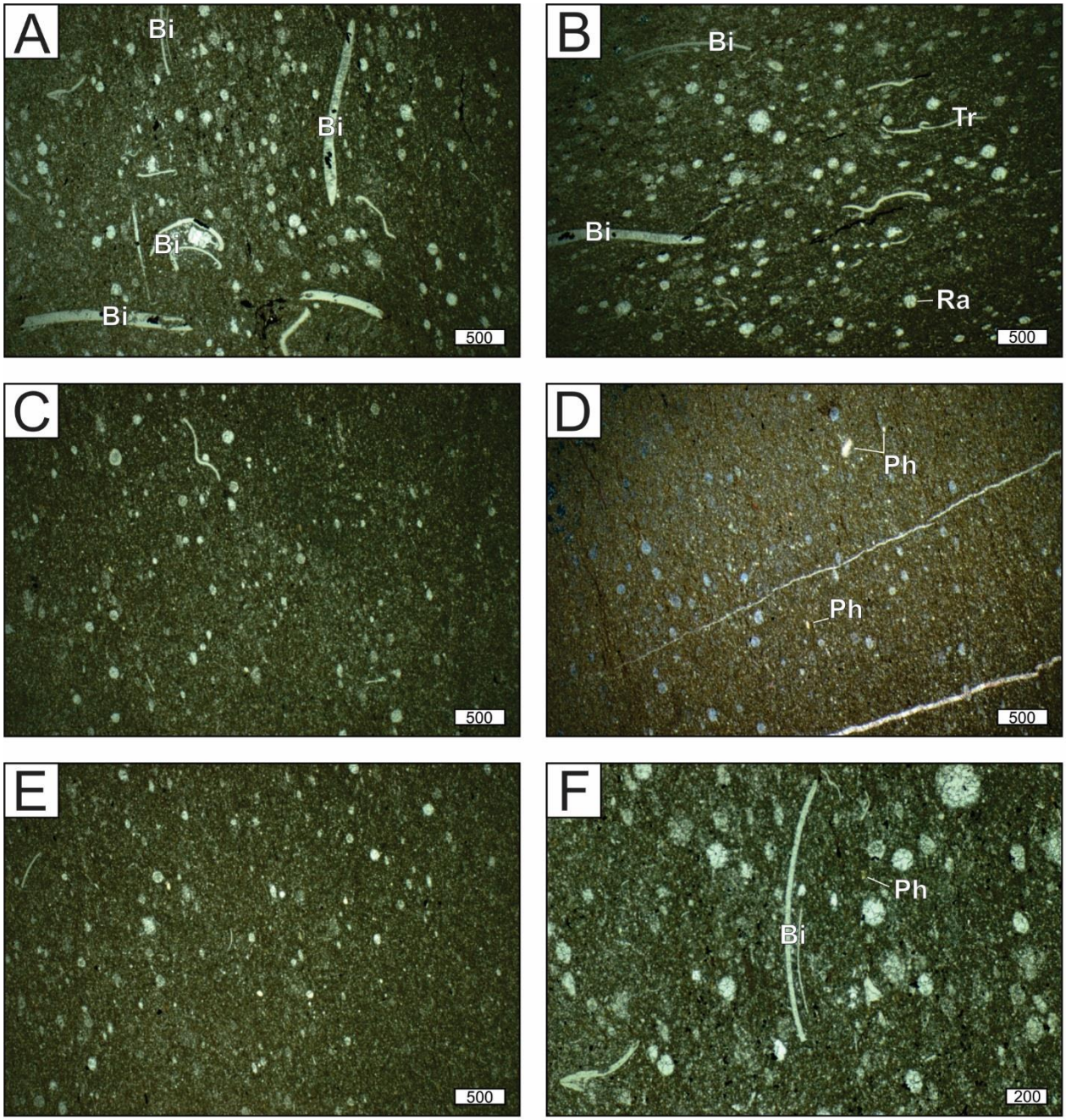


Plate 18: Thin section photographs from cruise 75-009, Phase V, Station #8B, Piece #16, 10". (A) Fossiliferous wackestone with bivalve shell fragments (Bi), radiolarians, and organic matter (PPL, scale = 500 µm). (B) Radiolarians (Ra), bivalve shell fragments (Bi), and trilobite pieces (Tr) in a lime mud matrix with organic matter (PPL, scale = 500 µm). (C) Mudstone with radiolarians, shell fragments, and organic matter (PPL, scale = 500 µm). (D) Radiolarians and phosphate grains (Ph) in a lime mud matrix with organic matter (PPL, scale = 500 µm). (E) Lime mud with radiolarians, shell fragments, and organic matter (PPL, scale =500 µm). (F) Fossiliferous mudstone to wackestone with radiolarians, bivalve shell fragments (Bi) and phosphate grains (Ph) (PPL, scale = 200 µm).

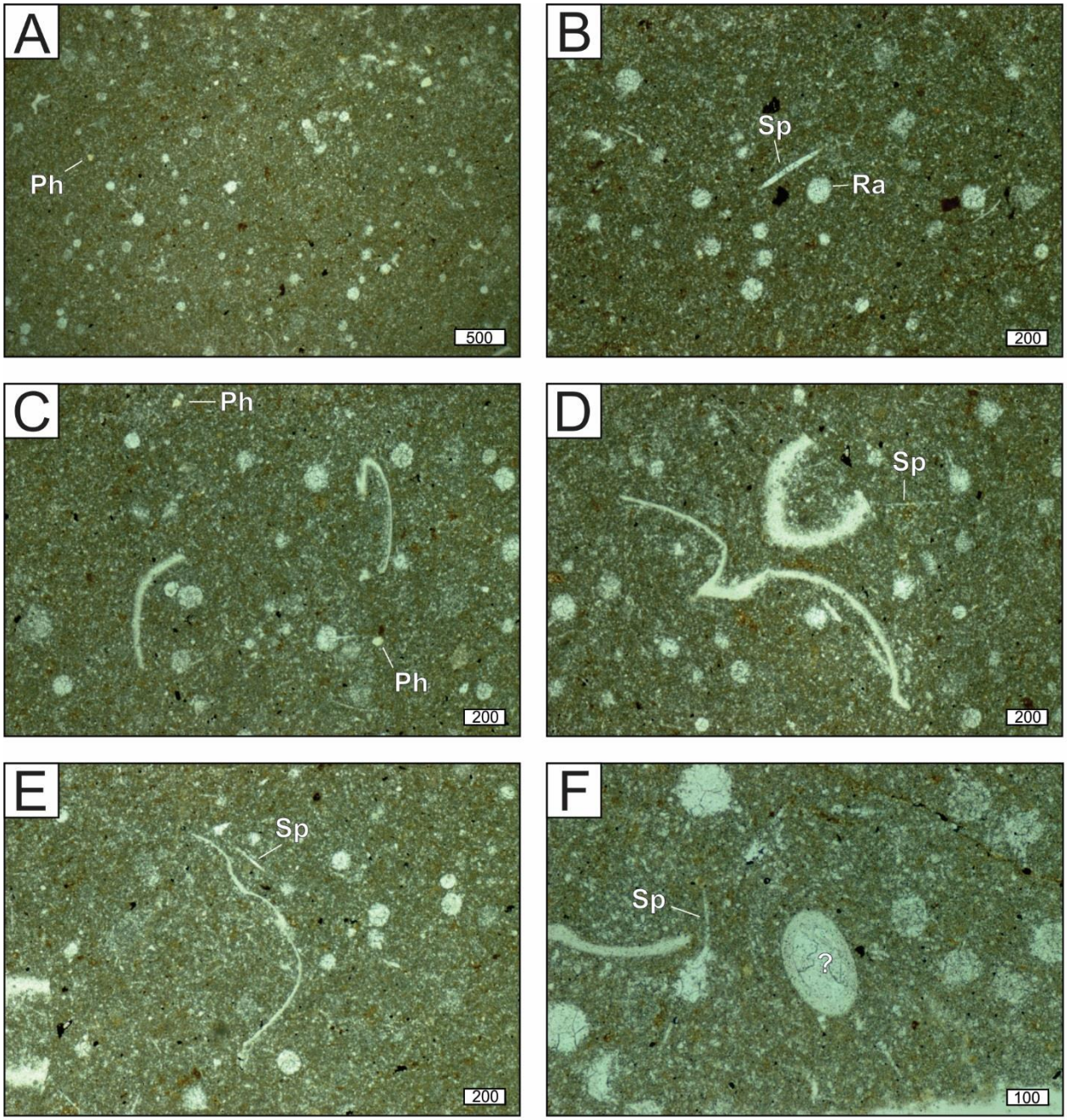


Plate 19: Thin section photographs from cruise 75-009, Phase V, Station #8B, Piece #16, 10", parallel to bedding plane. (A) Lime mudstone with radiolarians, skeletal fragments, phosphate grains (Ph), and organic matter (PPL, scale = 500 μm). (B) Radiolarians (Ra) and sponge spicules (Sp) in a lime mud matrix with organic matter (PPL, scale = 200 μm). (C) Lime mud with radiolarians, shell fragments, phosphate grains (Ph), and organic matter (PPL, scale = 200 μm). (D) Radiolarians, sponge spicules and skeletal fragments in a lime mud matrix (PPL, scale = 200 μm). (E) Lime mudstone (Sp), consisting of radiolarians, sponge spicules (Sp), shell fragments, and organic matter (PPL, scale = 200 μm). (F) Skeletal fragments, sponge spicules (Sp), radiolarians, and an unknown fossil (?) in a lime mud matrix with organic matter (PPL, scale = 100 μm).

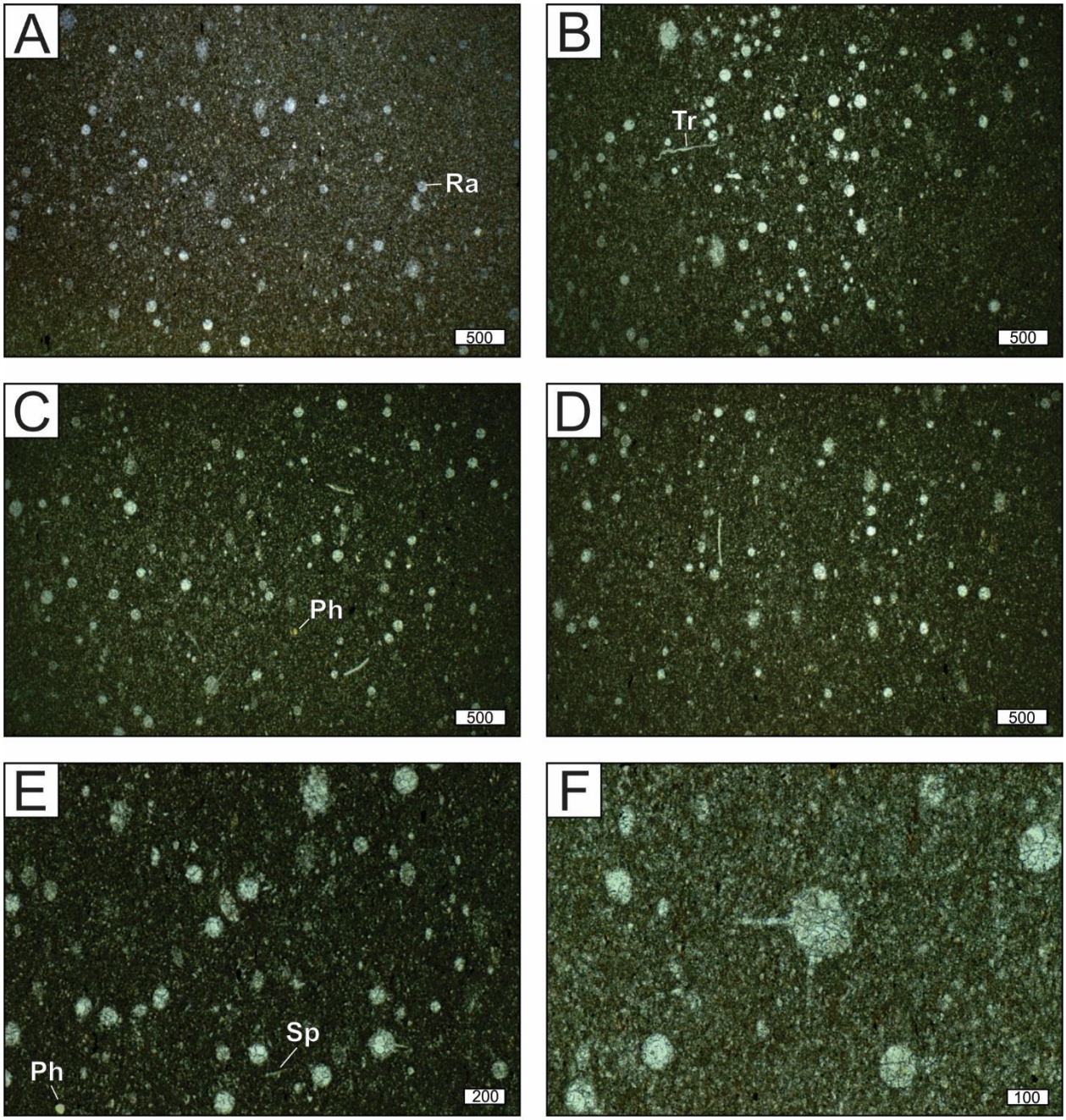


Plate 20: Thin section photographs from cruise 75-009, Phase V, Station #8B, Piece #6, 32". (A) Lime mudstone with radiolarians (Ra) and small phosphate grains (PPL, scale = 500 µm). (B) Radiolarians and a piece of trilobite (Tr) in a lime mud matrix (PPL, scale = 500 µm). (C) Lime mud with radiolarians, shell fragments, and phosphate grains (Ph) (PPL, scale = 500 µm). (D) Radiolarians and shell fragments in a lime mud matrix (PPL, scale = 500 µm). (E) Lime mudstone consisting of radiolarians, sponge spicules (Sp), phosphate grains (Ph), and organic matter (PPL, scale = 200 µm). Radiolarians, including one with spines in a lime mud matrix with disseminated organic matter (PPL, scale = 100 µm).

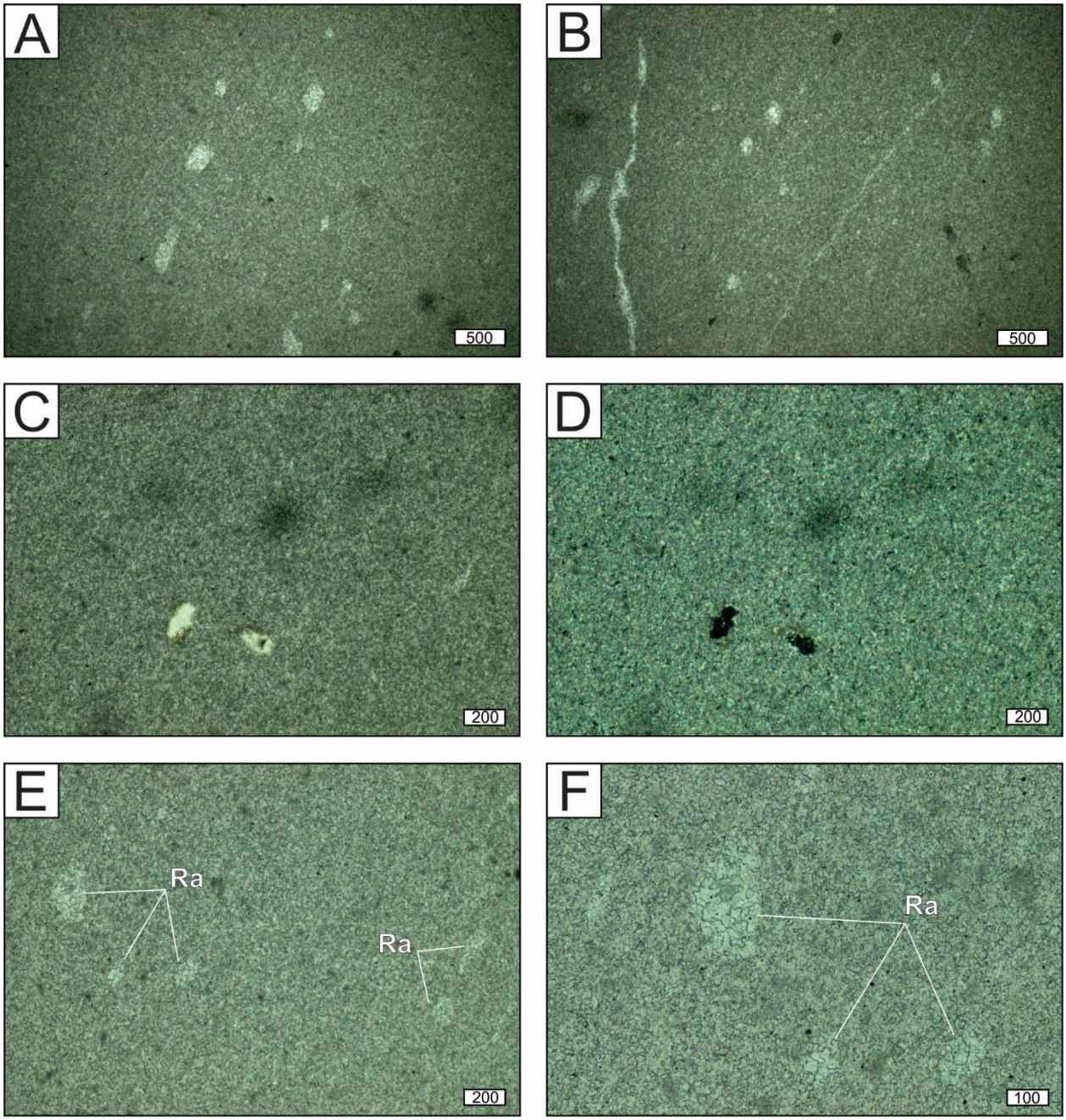


Plate 21: Thin section photographs from cruise 77027, Station #26A, SPL #5. (A) Lime mudstone with radiolarians and other possible fossil voids (PPL, scale = 500 µm). (B) Mudstone with radiolarians (PPL, scale = 500 µm). (C) Phosphate grains in a lime mud matrix (PPL, scale = 200 µm). (D) Phosphate grains in a lime mud matrix (XPL, scale = 200 µm). (E) Lime mudstone with radiolarians (Ra) (PPL, scale = 200 µm). (F) Lime mudstone with radiolarians (Ra) (PPL, scale = 100 µm)

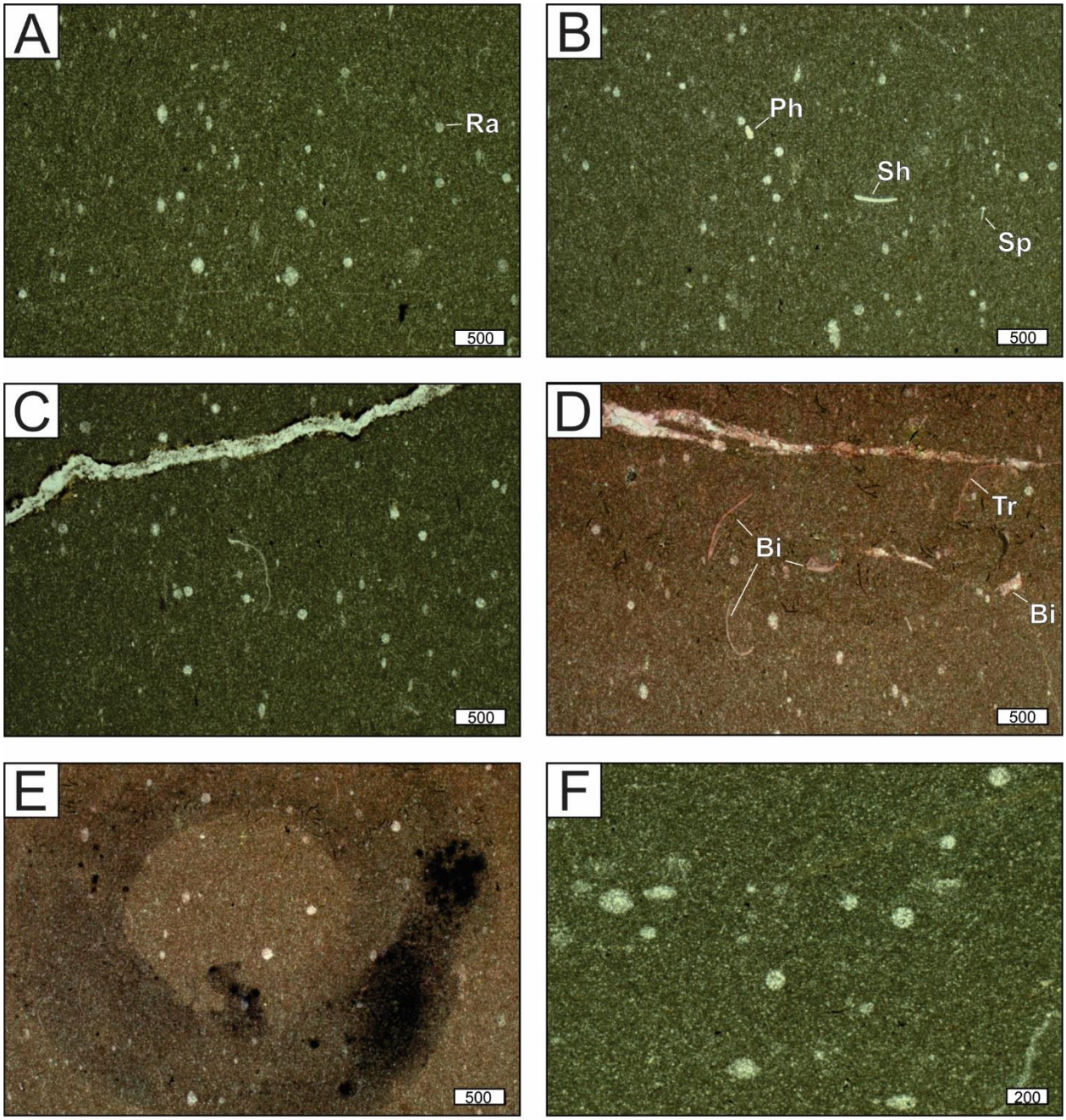


Plate 22: Thin section photographs from cruise 77027, Station #28, SPL #3. (A) Lime mudstone with radiolarians (Ra) and shell fragments (PPL, scale = 500 µm). (B) Radiolarians, sponge spicules (Sp), shell fragments (Sh), and phosphate grains (Ph) in a lime mud matrix (PPL, scale = 500 µm). (C) Radiolarians and skeletal fragments in a mud matrix (PPL, scale = 500 µm). (D) Lime mudstone consisting of radiolarians, bivalve shell fragments (Bi), trilobite pieces (Tr) and small phosphate grains (PPL, scale = 500 µm). (E) Radiolarians (some with their spines intact) and shell fragments in a lime mud matrix (PPL, scale = 500 µm). (F) Lime mudstone with radiolarians (PPL, scale = 200 µm).

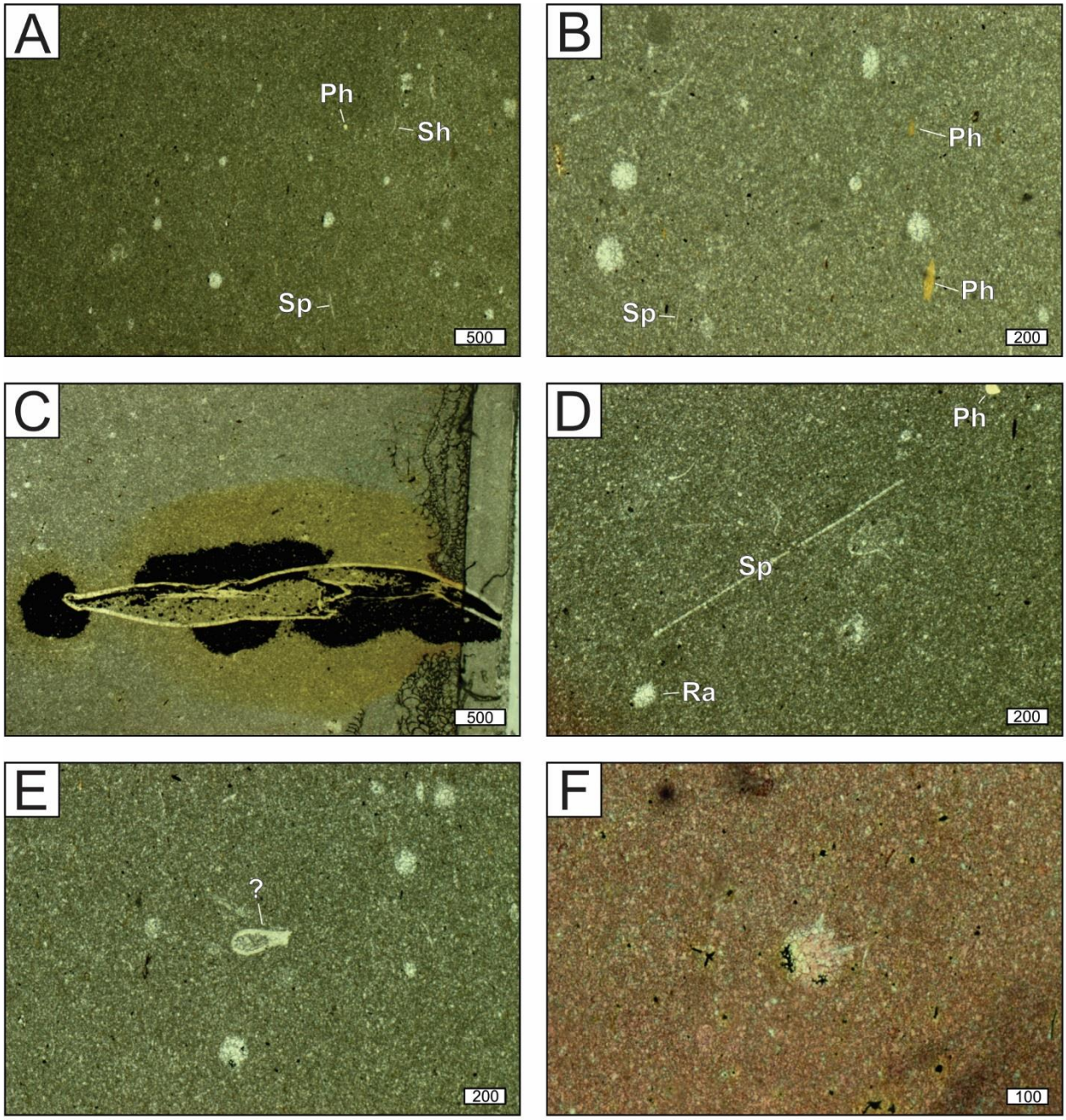


Plate 23: Thin section photographs from cruise 77027, Station #28, SPL #10. (A) Lime mudstone with radiolarians, phosphate grains (Ph), sponge spicules (Sp) and shell fragments (Sh) (PPL, scale = 500 µm). (B) Radiolarians, sponge spicules (Sp), shell pieces, and phosphate grains (Ph) in a lime mud matrix (PPL, scale = 200 µm). (C) Bivalve shell with pyrite precipitation in a lime mud matrix containing radiolarians and shell fragments (PPL, scale = 500 µm). (D) Lime mudstone with radiolarians (Ra), sponge spicules (Sp), shell fragments, and phosphate grains (Ph). (E) Radiolarians, shell pieces, and an unknown fossil fragment (?) in a lime mud matrix (PPL, scale = 200 µm). (F) Radiolarian with a few spines preserved in a lime mud matrix (PPL, scale = 100 µm).