A PETROLOGIC ANALYSIS OF THE ORDOVICIAN LOWVILLE LIMESTONE FROM INGHAM MILLS, NEW YORK

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INTRODUCTION

The study described here began with field work during June 1991 and will be completed as part of a year long senior honors thesis. The outcrops that I studied were located along East Canada Creek, northwest of Canojaharie, at Ingham Mills, Herkimer County, New York. My field work consisted of taking detailed notes, measuring stratigraphic sections, taking photographs of the individual units and collecting hand samples. A detailed petrographic analysis was conducted to supplement the field work and create a comprehensive study of the diagenetic history, paleodepositional environments and depositional cycles. From observations made in the field, it seems likely that there are small scale cycles present in the Lowville Formation at this site.

GEOLOGIC SETTING

Originally proposed by Kay (1929), the Black River Group consisted of three units, the lower Pamelia Formation, the middle Lowville Formation, and the upper Chaumont Formation. At the Ingham Mills locality, the Lowville lies between two disconformities: below lies the Little Falls Dolomite (Cambrian), above, the Napanee Limestone of the Trenton Group (Upper Ordovician).

The Black River Group spans from Tennessee into Ontario, Canada (Cameron and Mangion, 1977). There has been much debate as to whether the formations that comprise the Black River Group are time-stratigraphic or facies of one another. Cameron and Mangion (1977) point out that the outcrop belt in the Black River Valley, just north of the Mohawk Valley, more or less parallels the ancient strandline, and feel that it is reasonable that the contacts of the formations are time lines. Additionally, by following Walther's Rule, all the facies exhibited by the Black River Group should be laterally equivalent in a direction perpendicular to the paleoshoreline.

FIELD WORK

Two stratigraphic sections were measured and a detailed stratigraphic column was created. Eight informal units were described and labeled A-H. (See Fig. 1)

<u>Units A & B</u>

This first unit is characterized by a grey to buff lime mudstone of variable thickness with bedding usually defined by wavy/algal laminations. Mudcracks, bird's eye texture, intraclasts, vertical and horizontal burrows, ostracodes, brachiopods, trilobites, echinoderms and mollusks are present. Ostracodes are the most abundant bioclast and all of the bioclasts are very small.

<u>Unit C</u>

This unit is a more massive, medium-light grey lime mudstone. The lower part is dominated by bird's eye texture, wavy/algal laminations, ostracodes, brachiopods, echinoderms, mollusks, trilobites, and vertical and horizontal burrows. The upper portion of unit C shows a layering and stratification of features, i.e., the bioclasts and bird's eye texture are concentrated into distinct and separate laminar zones. Mudcracks are common in this unit and higher in the unit the lime mud becomes more homogenous. Neither bioclasts nor vertical burrows occur in the upper portion.

Unit D

Unit D is characterized by a medium grey lime mudstone with dense laminar algal accumulations and an abundance of upwardly branching vertical burrows. Bird's eye texture and mudcracks are also present.

Units E & F

These units consist of a medium grey, massive lime mudstone. This rock has a very distinct mottled pattern possibly formed through bioturbation. In both units, there are zones of fossil debris, e.g., nautiloids, gastropods, crinoids, *Hedstroemia*, and rugose (horn) corals, concentrated in horizontal bands. Vertical burrows are also present. In the base of Unit F, there is a convoluted and contorted zone which is characteristic of soft sediment deformation. A channel cuts into the upper portion of Unit F. Wavy/algal laminations are present but less common and spaced farther apart than in lower units.

Unit G

This thin unit consists of a light grey to buff lime mudstone with bird's eye texture and intraclasts. Very characteristic of this unit are the large vertical burrows which are filled with anthraxolite. Also found in this unit are mudcracks and thick concentrations of alternating grey and buff laminae.

Unit H

Unit H is characterized in the upper half by a light to dark grey lime mudstone with bird's eye texture and mudcracks. It has a wide diversity of bioclasts and includes two separate beds of *Tetradium*; one has *Tetradium* in growth position and the other is dominantly *Tetradium* fragments. Algal layers are present in most beds and anthraxolite filled vertical burrows occur in the uppermost part of the unit. The upper bed also shows strong evidence of brecciation and may represent a paleosol.

PETROGRAPHIC ANALYSIS

The majority of the laboratory work done in this project was extensive petrographic analysis of the limestone samples from Ingham Mills (See Fig. 2). Over 50 thin sections were examined to determine the grain composition and the types of carbonate cements that are present. The dominant cement is a ferroan spar which occurs intragranually and intergranually. The ferroan spar tends to be coarse, euhedral and in several places exhibits a drusy fabric. In many instances it is difficult to distinguish between ferroan cement and neomorphic spar. However, there are sections with good evidence of neomorphic microspar and pseudospar fabrics. Several of the samples have an earlier non ferroan spar which exhibits a blocky and euhedral mosaic. Additionally, all of the sections were looked at under cathodoluminescence. Interestingly, the earlier non ferroan spar commonly displayed luminescence. Likewise, there is a patchy distribution of zoned luminescent coarse, ferroan spar. Finally, zoned and euhedral dolomite rhombs are present throughout all the units.

Several microfacies are represented throughout the Lowville Formation. The most common is a biomicrite. Second in abundance are biopelmicrite and peldismicrite. Also recognized are pelmicrite, biopelsparite, intrabiomicrite, intrapelsparite, dismicrite and biopeldismicrite. A wide diversity of bioclasts are represented including, brachiopods, ostracodes, corals, bryozoans, pelmatazoans, mollusks, calcareous algae and trilobites. Euhedral and zoned dolomite rhombs, and silt and sand sized quartz grains are common in the lower half of the section and decrease in abundance higher up in the section.

DISCUSSION

It has been proposed that the Black River Group represents a transgressive phase, (Fisher 1962, Textoris 1968) and that the Lowville limestone particularly represents a supratidal to intertidal deposit in the lower half and a shallow subtidal environment in the upper half. Considering the data and observations made thus far, several conclusions can be made. First of all, polygonally shaped mudcracks caused by shrinkage of carbonate mud are often associated with the supratidal environment. However they are also observed in the modern intertidal setting, but there is little evidence that they are preserved in this environment. Consequently, the considerable information available suggests that mudcracks are best preserved in the supratidal and possibly the upper part of the intertidal zones (Shinn, 1983). Therefore, it seems reasonable to suggest that each layer of mudcracks represents a period of subaerial exposure in either the supratidal zone or the upper intertidal zone. Secondly, bird's-eye structures are also considered reliable indicators of supratidal deposition when they occur in predominantly muddy rocks (Shinn, 1983). These features are small millimeter-sized vugs that form in supratidal sediments as a result of shrinkage and expansion, gas bubble formation, air escape during flooding, or wrinkles in algal mats (Shinn, 1968). Bird's-eye structures may form in intertidal and even subtidal sediments, but evidence that they are preserved in these environments is lacking. The features are preserved, however, in the upper part of intertidal sediments and increase in abundance through the transition to supratidal sediments (Shinn, 1968). Supratidal bird's-eye vugs are preserved because they form in an active diagenetic environment, where early lithification is common and voids can be quickly filled with carbonate cement, internal sediment or evaporites. The presence of bird's-eye vugs in ancient limestones is therefore considered evidence of both supratidal deposition and early cementation (Shinn et al, 1969). Intraclasts are another sedimentary feature that have been suggested to commonly occur on supratidal flats. Likewise, the presence of wavy/algal-laminated sediments and dolomite suggests deposition in the upper intertidal to supratidal zone.

Staining a limestone with poatssium ferricyanide and alizarin red S will give an indication of the iron content of the calcite (Dickson, 1966). It is not uncommon to find that cement crystals are zoned, implying changes in the chemistry of the pore-waters from which the calcite was precipitated, i.e., ferroan calcite represents reducing conditions and non-ferroan calcite represents oxidizing conditions. Moreover, cathodoluminescence can be used to distinguish the Mn content, i.e., bright luminescence represents manganese-rich calcites and faint or absence of luminescence represents manganese-poor calcites (Tucker, 1981). The Lowville Formation has a very complex diagentic history and shows evidence for both oxidizing and reducing conditions as well as the presence of manganese.

Taking into consideration the data collected thus far, the Lowville Formation contains significant evidence for a supratidal to intertidal environment in the lower portion getting progressively deeper into a shallow subtidal environment in the upper portion. However, from field observations such as the proposed paleosol at the top of the sequence and reoccurrence of supratidal and intertidal features also at the top of the sequence, I have reason to believe that there is a more complicated story to be told here. The finer details of small depositional cycles superimposed on the proposed larger transgressive cycle are still under investigation.

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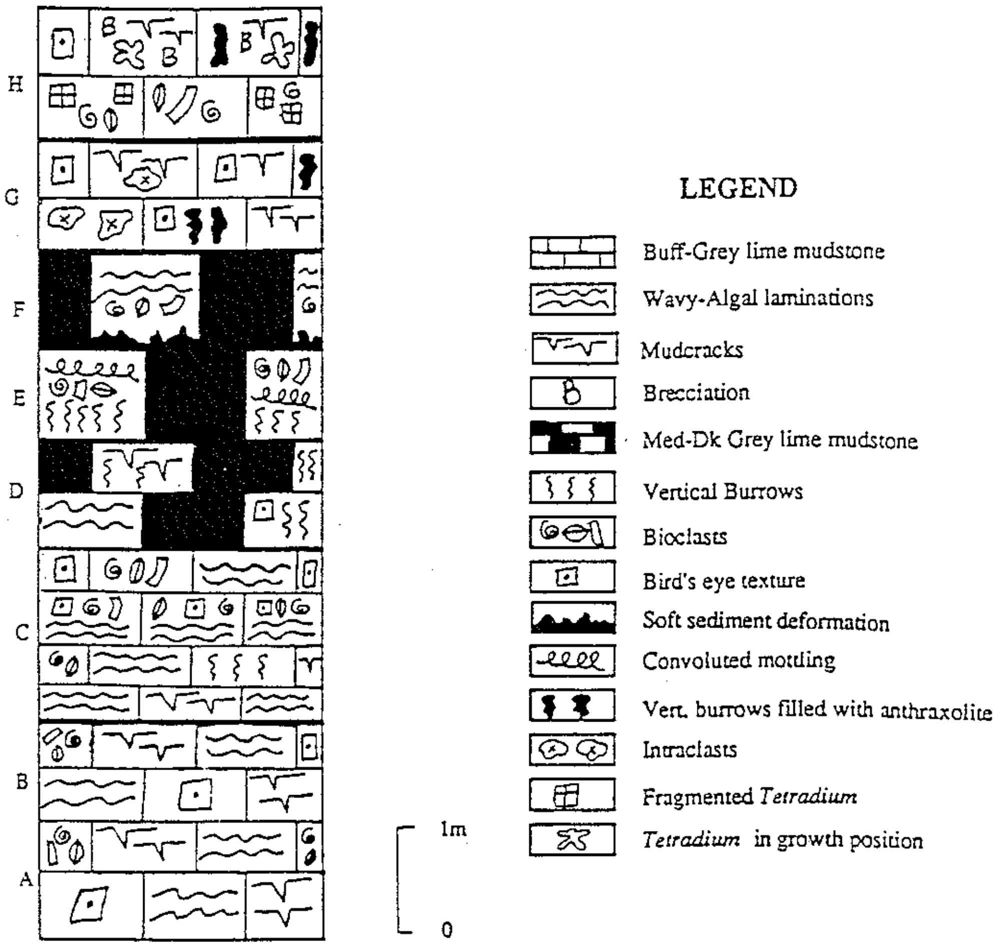
Fig. 1- Stratigraphic column for Lowville Formation



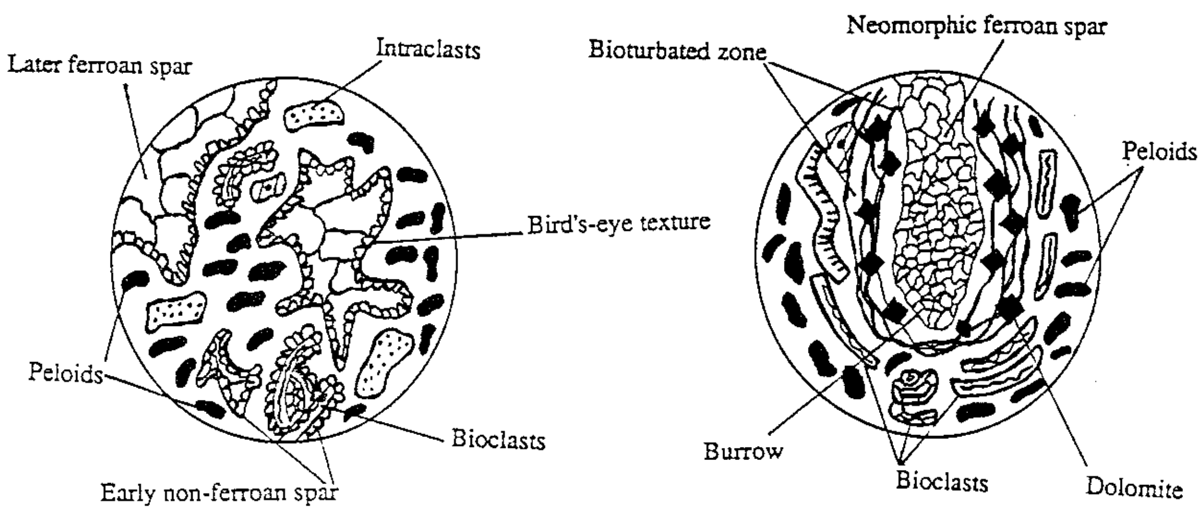


Fig. 2- Lowville Formation Petrography