Current Research (1988) Newfoundland Department of Mines, Mineral Development Division, Report 88-1, pages 183-188

MIDDLE ORDOVICIAN GRAPTOLITES FROM CENTRAL NEWFOUNDLAND

S. Henry Williams
Department of Earth Sciences
Memorial University of Newfoundland

ABSTRACT

The Middle Ordovician black shales of the Shoal Arm Formation and Lawrence Harbour Shale of central Newfoundland are well known for their rich and biostratigraphically useful graptolite fauna. The present study involves detailed systematic collecting and full taxonomic treatment of the assemblages. A new set of graptolite zones will be subsequently erected for the late Llandeilo to early Ashgill(?) argillites. Conodont collections from associated nodular limestones should permit integration of the scheme with the standard British Middle Ordovician chronostratigraphy.

Poorly preserved graptolites have been recovered from one locality in the Victoria Lake Group near Grand Falls and may suggest an early Llandeilo age. It is anticipated that other black shale units recorded previously as unfossiliferous or non-graptolitic will also yield graptolites useful in biostratigraphic correlation.

INTRODUCTION

The author commenced a study of graptolites from the Dunnage Zone of central Newfoundland in the summer of 1987. The project initially involved identification and systematic collection of relatively unbroken sections through the Lawrence Harbour Shale and Shoal Arm Formation, with detailed mapping and section measuring where necessary. This was followed by collecting from less complete, comparitive localities (Figure 1). Further aims include the location of graptolitic horizons within the Victoria Lake Group and possible recovery of biostratigraphically useful faunas from other 'non-graptolitic' or 'unfossiliferous' strata such as the Boones Point Complex of Notre Dame Bay.

LAWRENCE HARBOUR SHALE AND SHOAL ARM FORMATION

Previous Study

The ubiquitous Middle Ordovician black shale of Notre Dame Bay has been variously referred to as the 'Caradocian argillites' (e.g., Dean, 1979) and the Exploits Group (e.g., Erdtmann, 1976), but was first defined as the Shoal Arm Formation (Espenshade, 1937) and the Lawrence Harbour Shale (Heyl, 1936) and 'unnamed argillite' (Helwig, 1967, 1969) of the Exploits Group. Other lateral equivalents appear to include the Rodgers Cove Shale and Dark Hole Formation of New World Island and several other formations within Notre Dame Bay and the Gander Lake area (see Dean, 1979).

Graptolites have been widely collected from the shale for much of this century; early collections received published reviews by Schuchert and Dunbar (1934) and by Ruedemann (1947). A series of more recent studies was initiated by Helwig (1967, 1969) and Horne (1968). A thorough review of graptolite localities and their correlation was made by Bergström *et al.* (1974), but they failed to include any taxonomic descriptions or figures of graptolites and relied mainly on previous collections. The lack of systematic paleontological study was remedied in part by Erdtmann (1970, 1976), but this material was restricted both numerically and spatially and lacked critical, systematic collecting. Erdtmann attempted to 'force' the central Newfoundland succession into the 'standard' North American scheme (Berry, 1960; Ross and Berry, 1963; Riva, 1969, 1974) with limited success, and his revisions have not since been utilized. The most recent comprehensive review was by Dean (1979), who included zonal assemblages from numerous localities; his identifications were made primarily by Riva, with additional studies by Erdtmann, Skevington and Cumming.

Results

Inspection of the most important sections through the Middle Ordovician black shale (localities supplied by S. Swinden, P. Dean and J. Meyer) revealed their inadequacy with respect to employing ideal biostratigraphic procedures. The only two localities studied to date with any kind of coherent stratigraphy are those at Little Red Indian Falls on the Exploits River south of Badger (studied briefly by Erdtmann, 1976) and at Lawrence Harbour in Notre Dame Bay (Figure 1). Even at these localities the unit is badly deformed, the sections broken and generally, graptolites have suffered some degree of tectonic distortion.

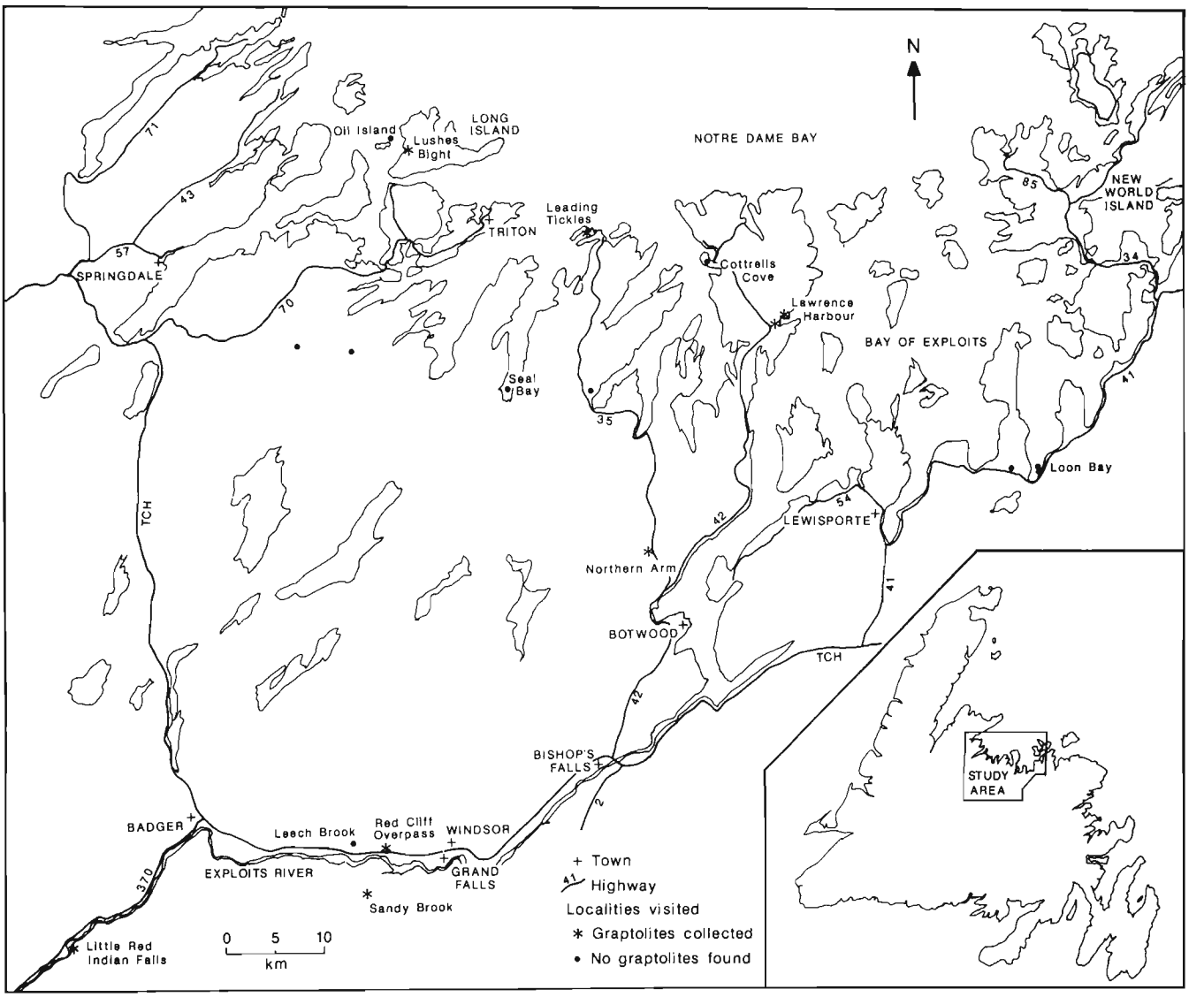

Figure 1. *Map of central Newfoundland showing localities visited during the summer of 1987.*

It is evident that no one section in central Newfoundland will yield a continuous stratigraphic succession spanning more than about one graptolite zone. Even cursory observation of samples while being collected in the field shows, however, that the currently employed division, merely borrowed from the British scheme, is unsuitable for Newfoundland and has diminished the quality of biostratigraphic resolution. Furthermore, the zones proposed by Erdtmann, based on a cursory look at the biostratigraphy, have proved unhelpful.

To improve the situation and permit stratigraphic refinement, a new graptolite zonal scheme will be erected for the region. Because of the lack of continuous, structurally simple sequences, a rather different approach will need to be employed from that used by the author elsewhere (e.g., Williams and Bruton, 1983). In order to erect a new set of zones, samples have been (and will be) collected from very narrow intervals up to only 10 cm thick in order to guard against any structurally induced mixing of graptolite taxa. Once all species have been identified, the many assemblages will then be compared and diagnostic zonal criteria developed using numerical computer analyses. These will be subsequently employed to erect a new biostratigraphy, which although never seen in any one section, should permit refined correlation and assist interpretation of regional data.

First inspection suggests that division into four or five zones will be possible, although a final decision must await study of both this and next summer's collections. For the purpose of this report, I include reference to four biostratigraphic intervals, informally termed zones 1 to 4. Zone 1 essentially correlates with the widespread *gracilis* Zone, yielding common *Nemagraptus gracilis* together with the latest species of *Didymograptus (Expansograptus)*. Zone 2 lacks *N. gracilis*, but has abundant *Climacograptus bicornis*

and *Corynoides*. Zone 3 is characterized by *Climacograptus caudatus*, abundant *Dicellograptus pumilus* and *Climacograptus tubuliferus*. These zones are broadly equivalent to their British counterparts (*gracilis*, *multidens*, *clingani* and *linearis* zones respectively), and will almost certainly be revised before the completion of the present study.

It must be reiterated that use of the term 'Caradoc black shale' is inapt and should be discontinued. Based on correlations from outside Newfoundland, Zone 1 is at least partially Llandeilo in age, whereas Zone 4 (found in the 'unnamed argillite' of Helwig, 1967, equivalent to the basal Point Leamington Greywacke of Bergström *et al.*, 1974) may well be Ashgill (see Williams and Bruton, 1983; Williams, 1987). It is hoped that conodont collections from limestone nodules within the argillites will confirm correlation with the shelly-based British chronostratigraphy, and with that of North America.

Little Red Indian Falls. It was found necessary to make a detailed geological map at 1:200 using tape and compass in order to accurately locate graptolite samples and deduce the stratigraphy and structure (Figure 2). A gradational passage from greywacke through chert, and into black shale, occurs in the basal part of the section. It is presently unclear whether the greywackes belong to the Exploits Group or to the underlying Victoria Lake Group. The earliest graptolites found in siliceous shales overlying the chert belong to Zone 1 and are commonly well preserved, some horizons displaying three-dimensional, pyritized specimens. The top of the unit shows a gradational contact with the overlying greywacke; graptolites from this gradational passage indicate Zone 3. Unfortunately the stratigraphy between the base and top of the black shale appears incomplete, as at all other recorded localities. Approximately 30 precisely located graptolite collections were made, and several samples for conodont processing were taken from the basal greywacke–chert and from nodular limestone directly underlying the first thick greywacke bed in the upper part of the section.

Lawrence Harbour. Relatively well preserved and abundant graptolites may be collected, but this locality proved somewhat disappointing. No unbroken sections of any thickness occur, and although an approximate stratigraphy may be deduced, it is of limited potential for graptolite biostratigraphy. The lowest faunas as listed by previous authors belong to Zone 1 (Bergström *et al.*, 1974; Dean, 1979), and the latest graptolites from the transitional passage to greywacke are Zone 4 (i.e., later than at Little Red Indian Falls). No intervening zonal assemblages appear to be present in the harbour section, although the shale pit adjacent to the main road at Lawrence Harbour may show a transition to Zone 2. The latter locality yielded far better preserved material than the harbour section and has been mapped and sampled in detail. In addition, the author collected several samples for conodonts at Lawrence Harbour.

Other sections. Sections through Middle Ordovician black shale that yielded relatively good graptolites include the Red Cliff overpass section west of Grand Falls and Leading Tickles in Notre Dame Bay (Figure 1). The intervals yielding useful graptolites at these localities are, however, restricted to Zone 2? and Zone 3 respectively. A fairly rich, but badly deformed and weathered assemblage was collected from a roadcut just outside Northern Arm; the assemblage suggests a likely Zone 2 age. Many additional localities were inspected, but the vast majority were either highly cleaved or poorly fossiliferous.

Long Island–Oil Island, Notre Dame Bay. G. Dunning recently obtained a radiometric date suggesting a Llanvirn age for felsic volcanic rocks overlying a shale unit of supposedly Caradoc age (both belonging to the Cutwell Group) on Oil Island. The age of this latter unit was deduced by S. Swinden and others, due to a supposed correlation with a black shale on Long Island yielding '*gracilis* Zone' graptolites (Dean, 1979). Re-examination of Dean's faunal list does not, however, suggest a diagnostic zonal assemblage. Three exposures of black shale on Long Island were collected in conjunction with A. Sebinski. The fauna is sparse and of low diversity, although preliminary inspection does appear to confirm zones 1 or 2 (one species, however, seems to resemble a sinograptid, typical of Llanvirn and older strata). A visit to the shale on Oil Island immediately following the work on Long Island revealed a totally different lithology; that of Oil Island is much paler in colour, more siliceous, coarser grained and has common pyroclastic layers. Lithostratigraphic correlation with the black shale on Long Island is therefore unjustifiable. Because of its pale colour and presence of a well-developed cleavage, it is extremely unlikely that graptolites would be preserved within the shale on Oil Island. Two samples were collected from nodular limestones for conodont processing, which will hopefully confirm the unpublished 'Llanvirn' age deduced by C.R. Barnes based on a meagre conodont collection.

OTHER STRATIGRAPHIC UNITS

Results

Victoria Lake Group. Attempts to collect from this unit were largely thwarted by the perfect summer weather experienced throughout the field season, as forest areas were closed for all but a few days during this time. Two visits were, however, made to a section along Sandy Brook just below a dam, 12 km west-southwest of Grand Falls. One badly preserved, unidentifiable graptolite was recorded previously from this locality on the 1:50,000 Grand Falls geological map of Kean and Mercer (1981), but neither the exact bed nor identification exist. The exposure is an impressive but heavily faulted section through the Victoria Lake Group, here composed of volcaniclastic greywackes and dark to medium grey shale intervals up to 2 m thick. Unfortunately the ubiquitous cross-cutting cleavage rules out all the thicker shale units in terms of graptolite preservation. Following detailed bed-by-bed examination, a narrow, dark grey shale with cleavage running parallel to bedding was found on the second day, and a few badly deformed graptolites recovered. Preliminary study suggests a distinct similarity to '*Glyptograptus*' *teretiusculus*, a species characteristic of the early Llandeilo immediately preceding the *gracilis* Zone in

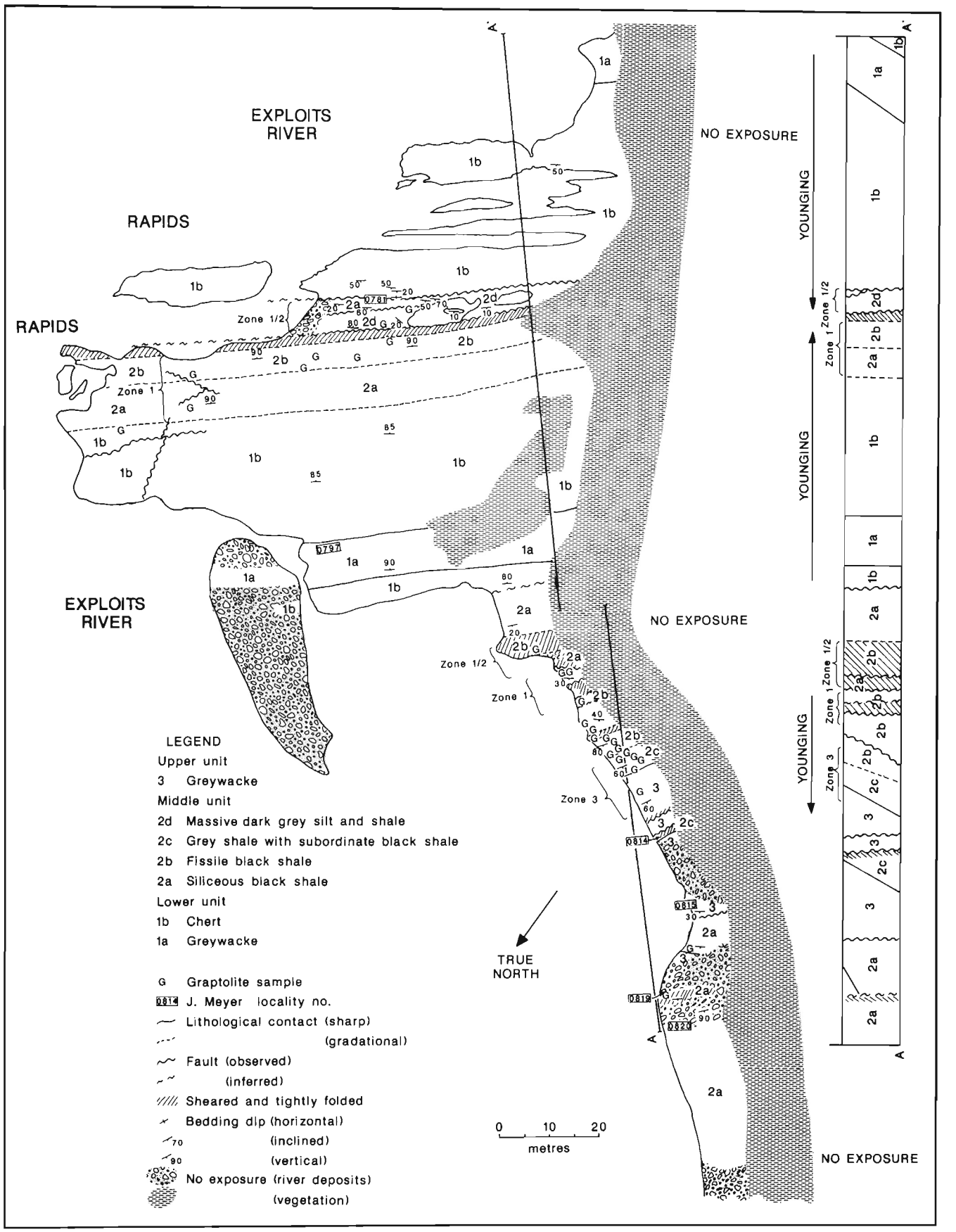

Figure 2: *Geological map and simplified cross section of Little Red Indian Falls, on the Exploits River 19 km southwest of Badger.*

Britain and Scandinavia. Should this identification prove correct, it would indicate little or no hiatus between the Victoria Lake Group and the overlying black shale. Recovery of additional graptolites bodes well for future age refinement of the Victoria Lake Group through utilization of this fossil group.

A drill core through supposed Victoria Lake Group from an old boring about 5 km south of the dam at Millertown (40 km southwest of Badger) was examined with abundant deformed graptolites including *Climacograptus bicornis, Dicellograptus salopiensis* and *Climacograptus brevis.* This assemblage demonstrates an unequivocal Zone 2 age, and indicates the presence of the Middle Ordovician black shale, rather than the Victoria Lake Group.

Wild Bight Group. S. Swinden guided myself and G. Dunning to an outcrop of shale on a small island in Seal Bay (Figure 1), where the lowest known rocks of the Wild Bight Group are exposed. Unfortunately the so-called 'black shale' is rather pale and cut obliquely by a strong cleavage; it is therefore very unlikely that graptolites are present.

Boones Point Complex. Brief inspection of the black shale matrix surrounding pillow lavas at Cottrells Cove, Notre Dame Bay, revealed a few silvery markings that almost certainly represent very poorly preserved graptolites. It is considered that further detailed investigation will probably lead to the discovery of graptolites, hopefully improving on the resolution of the 'Llanvirn' age suggested by rare conodonts in limestone blocks (see Swinden *et al.*, 1985).

ACKNOWLEDGMENTS

Financial assistance for the initial year of the project was given by Memorial University of Newfoundland through a President's NSERC Award, and fieldwork was supported by the Newfoundland Department of Mines. I also thank Paul Dean, Baxter Kean, Jamie Meyer, Scott Swinden and Adam Sebinski for guidance to localities, and my wife Kathleen Grebneff for help with mapping Little Red Indian Falls.

REFERENCES

Bergström, S.M., Riva, J. and Kay, M.
1974: Significance of conodonts, graptolites, and shelly faunas from the Ordovician of western and north-central Newfoundland. Canadian Journal of Earth Sciences, Volume 11, pages 1625-1660.

Berry, W.B.N.
1960: Graptolite faunas of the Marathon region, West Texas. Bureau of Economic Geology, University of Texas, Publication 6005, 179 pages.

Dean, P.L.
1979: The volcanic stratigraphy and metallogeny of Notre Dame Bay, Newfoundland. Memorial University of Newfoundland, Geology Report 7, 206 pages.

Erdtmann, B.-D.
1970: Morphometrie und computerstatistik am beispiel der graptolithengattung *Dicellograptus.* Neues Jahrbuch für Geologie und Paläontologie, Volume 134, pages 235-266.

1976: Die graptolithenfauna der Exploits Gruppe (Oberes Ordovizium, Caradoc) von zentral Newfoundland. Mitteilungen aus dem Geologisch-Paläontologischen Institut der Universität Hamburg, Volume 45, pages 65-140.

Espenshade, G.H.
1937: Geology and mineral resources of the Pilley's Island area. Newfoundland Department of Natural Resources, Geology Section, Bulletin 6, 56 pages.

Helwig, J.A.
1967: Stratigraphy and structural history of the New Bay area, north central Newfoundland. Unpublished Ph.D. thesis, Columbia University, New York, 211 pages.

1969: Redefinition of Exploits Group, Lower Paleozoic, northeast Newfoundland. *In* North Atlantic Geology and Continental Drift. *Edited by* M. Kay. American Association of Petroleum Geologists, Memoir 12, pages 408-413.

Heyl, G.R.
1936: Geology and mineral deposits of the Bay of Exploits area. Geological Survey of Newfoundland, Bulletin 3, 66 pages.

Horne, G.S.
1968: Stratigraphy and structural geology of southwestern New World Island area, Newfoundland. Unpublished Ph.D. thesis, Columbia University, 280 pages.

Kean, B.F. and Mercer, N.L.
1981: Grand Falls map area (2D/13), Newfoundland. Newfoundland Department of Mines and Energy, Mineral Development Division, Map 8199 (with descriptive notes).

Riva, J.
1969: Middle and Upper Ordovician graptolites in the St. Lawrence Lowlands and of Anticosti Island. American Association of Petroleum Geologists, Memoir 12, pages 513-556.

1974: A revision of some graptolites from North America. Palaeontology, Volume 17, pages 1-40.

Ross, R.J. and Berry, W.B.N.
1963: Ordovician graptolites of the Basin Ranges in California, Nevada, Utah and Idaho. United States Geological Survey, Bulletin 1134, 177 pages.

Ruedemann, R.
1947: Graptolites of North America. Geological Society of America, Memoir 19, 652 pages.

Schuchert, C. and Dunbar, C.O.
1934: Stratigraphy of western Newfoundland. Geological Society of America, Memoir 1, 123 pages.

Swinden, S., Dean, P. and Meyer, J.
1985: Ordovician and Silurian volcanism and sedimentation in central Newfoundland. Geological Association of Canada, Newfoundland Section, Fall Field Trip Guide, 15 pages.

Williams, S.H.
1987: Upper Ordovician graptolites from the *D. complanatus* Zone of the Moffat and Girvan districts and their significance for correlation. Scottish Journal of Geology, Volume 23, pages 65-92.

Williams, S.H. and Bruton, D.L.
1983: The Caradoc-Ashgill boundary in the central Oslo Region and associated graptolite faunas. Norsk Geologisk Tidsskrift, Volume 63, pages 147-191.