Carboniferous Research in the Cumberland Basin, Northern Nova Scotia

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Introduction

The work summarized here represents field research conducted mainly during 1999 and 2000, and in many cases represents continuing projects. In 2000, the Cumberland Basin of northern Nova Scotia was the main focus of field work and related research. Studies described below, in particular a modern sedimentological description of the Joggins coastal section and the revision and documentation of the macrofloral record of the Cumberland Group, contribute to the scientific accredition of Joggins as a prospective UNESCO World Heritage site (UNESCO, 1972).

Sedimentology and Stratigraphy

Joggins Section (NTS 21H/09)

Research in 2000 focused on specific aspects of the Joggins section, in order to publish the results of projects carried out in collaboration with colleagues Sarah Davies (University of Leicester) and Martin Gibling (Dalhousie University). These projects include: (1) the first comprehensive documentation of the fossil record and its paleoecology since the pioneering work of Dawson (1855, and many others); and (2) the first detailed account of the sedimentology and paleoecology of the renowned fossil lycopsid forests for which Joggins is famous. In addition, the writer entered into formal collaboration as a committee member for M.Sc. thesis research at Dalhousie University by Michael Rygel. This current research centres on the evolution of fluvial architecture recorded in the Joggins Formation.

The focus of field work during 2000, however, was a detailed sedimentological description of the problematic redbeds exposed at Lower Cove, intervening between the Boss Point Formation and overlying coal measures of the Joggins Formation, to which these strata are currently assigned.

Lower Cove Redbeds

The bed-by-bed measurement of strata exposed in the wave-cut platform and bluffs in the 2 km long section of redbeds at Lower Cove, north and south of Little River, was completed in October 2000. This interval, measuring 645 m in thickness, corresponds almost precisely with Division V of Sir William Logan's section (Logan, 1845). The lithologic log of this interval was recorded in the field at a scale of 1:100 and will be digitally transcribed in 2001. The section log adjoins a similar log of the overlying Joggins Formation undertaken by Sarah Davies, University of Leicester, and Martin Gibling, Dalhousie University, thus providing a continuous reference log of the Joggins Formation from South Reef at the upper contact of the Boss Point Formation, to the contact, as presently mapped south of MacCarrons Creek, with the overlying Springhill Mines Formation. This is the first comprehensive log of the 'classic' Joggins section to have been completed since the work of Logan (1845).

Implications

The author concurs with Logan (1845) in according the Lower Cove redbeds a distinct stratigraphic unit (see Calder, 1998, for a review of the history of stratigraphic interpretation of this unit). The Lower Cove redbeds, currently included in the Joggins Formation (Ryan *et al.*, 1990, 1991), are lithologically distinct from overlying strata (Division IV of Logan) which constitute the Joggins coal measures on the strength of numerous attributes including: (1) the absence of coal beds, (2) the virtual absence of grey mudrocks, and (3) the absence of bivalve-bearing limestone beds, all of which are definitive for the Joggins Formation (Ryan *et al.*, 1991). Similarly, they differ from the underlying Boss Point Formation (Division VI of Logan), with its distinctive thick, well sorted, green-grey sandstone bodies, which were quarried for grindstone in the Nineteenth Century.

A proposal to recognize the Lower Cove redbeds as a distinct unit will be made formally in the literature as prescribed by the North American Code of Stratigraphic Nomenclature. Pending demonstration of their regional mapability, these strata may be assigned formation status, which would necessitate redefinition of the Joggins Formation. The Lower Cove beds exhibit many similarities with strata exposed to the west on Marangouin Peninsula, New Brunswick, assigned by New Brunswick workers to the Grande Anse Formation, as confirmed in reconnaissance during the past field

season with Susan Johnson of the New Brunswick Department of Natural Resources. Application of this name at Lower Cove may be problematic, however, due to uncertainties in the stratigraphic relationship of the Grand Anse Formation in the type section with neighbouring geologic units, rendered by faulted contacts.

Brule (NTS 11E/14)

Field work at the Brule fossil walchian forest and vertebrate trackway site during 2000 was supported by a grant to the author from the National Geographic Society Research and Exploration Committee, Washington, DC. These funds permitted continued work at the site by colleague Howard van Allen (independant researcher). Our chief focus in the field was the procurement of a reference section cut with a portable rock saw that will be preserved for future study once the site has been eroded, a process well underway. Favourable results revealed aspects of the sedimentology and casting of walchian tree stumps that offer important complementary insight to the plan view, bedding-plane exposures that typify the site.

National Geographic Society funds further permitted continuing curation of bedding-plane mosaics lifted from the site, as well as casting of problematic sections difficult to retrieve. The site continues to be productive, yielding important additional trackway specimens and walchian foliage. Additional finds during the past field season include a second large dragonfly wing and new, enigmatic traces of uncertain plant or animal origin. A field trip to the site by the Canadian Paleontology Conference held at Saint Francis Xavier University in August 2000 provided valuable interpretive insight into the paleo-ecology of this unique locality . Further rock cutting of reference sections is planned for the coming field season.

Biostratigraphy

Waugh River, Tatamagouche (NTS 11E/11)

An important macrofloral site was discovered in 2000 by Tatamagouche resident Jennifer Black on the Waugh River at Tatamagouche. The productive strata, redbeds assigned (Ryan *et al.,* 1990) to the Tatamagouche Formation of the Pictou Group, yield as well a significant record of invertebrate and vertebrate trackways. A long-standing biostratigraphic problem in Maritimes Basin geology has been the assignment of a definitive age to redbeds of the Pictou Group, due in particular to the paucity of palynomorphs and to the general scarcity of fossil sites. The Waugh River site provides a diverse macrofloral compression-impression record comprising ferns, pteridosperms, and walchian conifers, unusual in its state of preservation, which allows taxonomic diagnosis at the species level.

Preliminary assessment of the Waugh River macrofloral collection (Table 1) was undertaken by R H. Wagner, Jardin Paleobotanico de Cordoba, during a visit to Nova Scotia in November 2000, and further work is currently underway on specimens forwarded to Spain. The flora include taxa common to the Dunkard Group flora of the Appalachian and Interior United States and to the mid-Rotliegend flora of Thuringia, Europe. The recorded taxa constrain the age of the strata most closely to the upper Stephanian, specifically the Stephanian B *sensu* the Ste. Etienne type locality, France (R. H. Wagner, personal communication, 2000).

Confirmation of the age of the Tatamagouche Formation redbeds at Waugh River has implications for interpretations of regional stratigraphy and basin history. An upper Stephanian age for the Waugh River redbeds lends support to the inferred age of the Brule fossil locality, near the Carboniferous-Permian boundary, and the probability that redbeds of the Pictou Group extend into the Permian. The definitive age for rocks mapped as the Tatamagouche Formation at Tatamagouche and the utility of the Waugh River floral record enhances the possibility of testing the existenee of an intra-Stephanian hiatus in the Maritimes Basin. Although such an unconformity has been demonstrated in western Europe and may be present in North America (Wagner and Winkler Prins, 1991; Wagner and Lyons, 1997), palynostratigraphic studies in Nova Scotia have been unable to resolve adequately the Stephanian stages in Nova Scotia (Graham Dolby, personal communication, 1995). Field reconnaissance of mapped macrofloral localities, particularly within the underlying Balfron Formation, may allow its critical evaluation.

Macrofloral Analysis

Macrofloral collections from the Joggins section (including Don Reid's collection at the Joggins Fossil Centre and the author's (JHC) at NSDNR, Halifax), Spicers Cove section (Fundy Geological Museum, collected by Brian Hebert, and the JHC collection at NSDNR) and the Springhill coalfield (JHC collection at NSDNR) were evaluated by R. H. Wagner for their biostratigraphic potential. Several taxa unrecorded by Bell (1944 and others) and specimens superior to those published in the literature (Bell, 1944, 1966) are represented in these collections. Select specimens are

Table 1. Preliminary floral list from the Waugh River macroflora locality.

Ferns		
	Zygopteridales	
		Danaeites emersonii Lesquereux
	Marattiales	
		Pecopteris lepidorachis Brongniart *P.* of group *arborescens*
Gymnosperms		
	Pteridospermales	
		Alethopteris cf *bohemica* or *zeilleri* *Dicksonites plueckenetii* (von Schlotheim) Sterzel
	Voltziales	
		walchian conifer

being forwarded to Wagner's paleobotanical lab in Cordoba, Spain, for further study and possible inclusion in his report and forthcoming revision of the Riversdale and Cumberland floras, to be published by the Geological Survey of Canada.

The macroflora collections mentioned above have proved important in resolving an important and contentious difficulty in assigning ages to the Carboniferous strata of Nova Scotia, which has had serious implications for the interpretation of basinal history in the Maritimes. These findings will be reported fully by Wagner to the Geological Survey of Canada, but the macroflora are largely consistent with age assignments determined earlier by Dolby (1991 and others; see Calder, 1998 for a full discussion of the biostratigraphic issues involved) and confirm the presence of early Westphalian strata in the Maritimes Basin.

References

Bell, W. A. 1944: Carboniferous rocks and fossil floras of Nova Scotia; Geological Survey of Canada, Memoir 238, 277 p.

Bell, W. A. 1966: Carboniferous plants of eastern canada; Geological Survey of Canada, Paper 66-11, 76 p.

Calder, J. H. 1998: The Carboniferous evolution of Nova Scotia; *in* D. J. Blundell and A. C. Scott (editors), Lyell: the Past is the Key to the Present; Geological Society, London, Special Publication No. 143, p. 261-302.

Dawson, J. W. 1855 (and Supplements, 1868, 1878, 1891): Acadian Geology: an Account of the Geological Structure and Mineral Resources of Nova Scotia, and Portions of the Neighbouring Provinces of British America; Oliver and Boyd, Edinburgh, 694 p.

Dolby, G. 1991: The palynology of the western Cumberland Basin, Nova Scotia; Nova Scotia Department of Mines and Energy, Open File Report 91-006, 39 p.

Logan, W. E. 1845: A section of the Nova Scotia coal measures as developed at Joggins on the Bay of Fundy, in descending order, from the neighbourhood of the west Ragged Reef to Minudie, reduced to vertical thickness; Geological Survey of Canada, Report of Progress for 1843, Appendix, p. 92-153.

Ryan, R. J., Boehner, R. C. and Calder, J. H. 1991: Lithostratigraphic revision of the Upper Carboniferous to Lower Permian strata in the Cumberland Basin, Nova Scotia, and the regional implications for the Maritimes Basin in Atlantic Canada; Canadian Society of Petroleum Geologists Bulletin, v. 39, p. 289-314.

Ryan, R. J., Boehner, R. C., Deal, A. and Calder, J. H. 1990: Cumberland Basin geology, Amherst, Springhill and Parrsboro, Cumberland County; Nova Scotia Department of Mines and Energy, Map 90-12, scale 1:50 000.

UNESCO, 1972: Nomination of properties for inclusion on the World Heritage list. Explanatory notes; Convention Concerning the Protection of the World

Cultural and Natural Heritage, United Nations Educational Scientific and Cultural Organization, Paris.

Wagner, R. H. and Lyons, P. C. 1997: A critical analysis of the higher Pennsylvanian megafloras of the Appalachian region; Review of Palaeobotany and Palynology, v. 95, p. 255-283.

Wagner, R. H. and Winkler Prins, C. F. 1991: Major subdivisions of the Carboniferous System; Comptes Rendu, 11e Congrès Carbonifère, Beijing, 1987, v. 1, p. 213-245.