

## Middle Ordovician conodonts from the Buchans Group, central Newfoundland, and their significance for regional stratigraphy of the Central Volcanic Belt:<sup>1</sup> Discussion

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Nowlan and Thurlow have recently reported a conodont fauna of latest Arenig – early Llanvirn age from the Buchans Group, central Newfoundland, and have suggested that this demonstrates that all volcanogenic massive sulfide deposits and, hence, associated volcanism in the Canadian Appalachians are of Caradocian or older Ordovician age. They go on to state that this requires substantial revisions of tectonic models for the northern Appalachians.

We welcome this important contribution to the knowledge regarding the age of Roberts Arm Volcanic Belt (which includes the Buchans Group; Dean 1977) but find their suggestion that current tectonic models for central Newfoundland are inadequate or erroneous to be somewhat misleading. Perhaps this is the case if the "tectonic" models they are referring to are those, for instance, of Dean (1977, 1978), Strong (1977), or Dean and Kean (1980). However, their results strongly support the tectonic models set out by Kidd *et al.* (1977),

Nelson (1979, 1981), Nelson and Kidd (1979), and Dewey *et al.* (1983). These authors have clearly stated their view that Ordovician island-arc related volcanism in central Newfoundland terminated by the Caradocian; in other words, the Roberts Arm and equivalents (Buchans Group included) are pre-Caradocian in age, in contrast to the views of Dean (1977, 1978). The cessation of arc-type volcanism by (or in) the Caradocian led to widespread thermal subsidence and the deposition of cherts and black carbonaceous, graptolitic shales over the flanking volcanoclastics of the island arc in the Exploits Zone.

Although the Buchans Group was previously regarded as Silurian by some workers, available age information from the rest of the Roberts Arm Belt indicates that it is pre-Caradocian in age, supporting the views of Nowlan and Thurlow. Specifically, Bostock *et al.* (1979) reported a Rb–Sr age of approximately 455 Ma from silicic volcanics and a genetically related pluton from the Roberts Arm Group near Halls Bay. Because

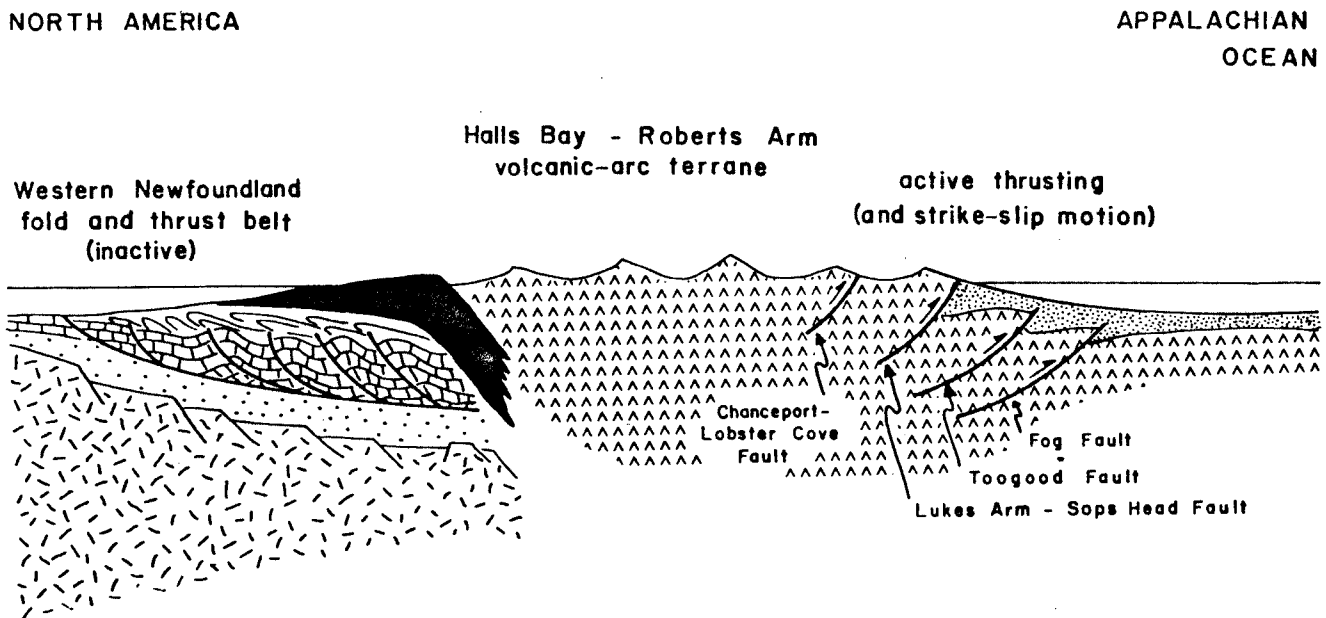


FIG. 1. Schematic Late Ordovician – Early Silurian reconstruction showing back thrusting in what is now central Newfoundland. This event accommodated continued convergence between the Taconic modified margin of North America and the Appalachian Ocean and commonly emplaced rocks of island-arc–back-arc basin affinity over similar rocks and a contemporaneous flysch sequence generally known as the Sansom Graywacke (fine stipple). Several examples of these thrust faults are shown, including the Fog Fault (new), which separates the Frozen Ocean Group from Sansom-equivalent rocks in the New Bay Pond area (modified after Nelson 1981).

<sup>1</sup>Paper by G. S. Nowlan and J. G. Thurlow. 1984. Canadian Journal of Earth Sciences, 21, pp. 284–296.

these samples came from the upper part of the Roberts Arm Group and Rb–Sr age determinations commonly yield ages that are younger than those obtained by using other methods, we regard this as a minimum age for the Roberts Arm Group and consider it most probable that the Roberts Arm Group was deposited over a long period of time, possibly beginning as early as Late Cambrian – Early Ordovician if the Tremadocian volcanics reported by Kay (1972) for the Exploits Zone on New World Island are equivalents. Elsewhere on New World Island the Cobbs Arm Limestone represents fossil atolls that formed around volcanic islands related to the Roberts Arm volcanism (Fåhræus and Hunter 1981). The volcanism was waning at the time of deposition of these limestones, and their Llandeilian age (Bergström *et al.* 1974; Fåhræus and Hunter 1981) also suggests that all island-arc related volcanism in central Newfoundland ended by the Caradocian. Thus, the Early to Middle Ordovician age that Nowlan and Thurlow report for the Buchans Group is entirely reasonable and consistent with the now well established age of the correlative Roberts Arm volcanics to the north. These new data imply that there was not a diachronous migration of active volcanism towards the southwest, as suggested by Strong (1977), Dean (1977, 1978), Dean and Kean (1980), and others.

There remains one area in central Newfoundland where island-arc-type volcanics have been stated to lie conformably over Caradocian and younger sediments (Dean 1977, 1978; Dean and Kean 1980). The rocks are the so-called Frozen Ocean Group (Dean 1977) and are found in the Frozen Ocean Lake – New Bay Pond area. Recent and as yet unpublished fieldwork by us in this area has revealed that the Frozen Ocean Group does NOT conformably overlie medial Ordovician sediments as previously suggested but is everywhere in demonstrable thrust fault contact with them (Fog Fault in Fig. 1). The thrust faulting was directed towards the southeast, although in this area too the fault has been subsequently folded and rotated into a vertical position (Kusky and Kidd 1985). This situation is similar to that reported by Nowlan and Thurlow for the Buchans area and by Nelson (1979, 1981) for the Notre Dame Bay area and appears to be generally true for all of central Newfoundland. As Nelson (1981) pointed out, this geometry is a result of Early Silurian southeastward-directed back thrusting and was apparently related to a continued component of convergence between the Taconic modified margin of North America and what is now the Exploits Terrane of central Newfoundland (Dewey *et al.* 1983; Kusky and Kidd, in preparation). Figure 1 is a schematic representation of the tectonic situation suggested for western and central Newfoundland in Early Silurian times.

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We are pleased that the data and interpretations presented in the discussion by Kusky and Kidd agree with those in our original paper (Nowlan and Thurlow 1984). We did not argue that the tectonostratigraphic interpretations of Nelson and Kidd (1979) and Nelson (1981) required revision; indeed we cited the former paper's interpretation of the age of the Roberts Arm Group as circumstantial support for a pre-Caradoc age of the Buchans Group. We emphasized Dean's (1977) model because it is a comprehensive stratigraphic compilation from the earliest ophiolites to Carboniferous sediments and, as such, it has been a standard with which the results of each detailed local study have been compared. There can be little doubt, as witnessed by

this discussion, that the model focussed subsequent research into key areas.

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