DISCUSSION

FACIES AND STRUCTURAL CONTRASTS ACROSS BONNE BAY CROSS-STRIKE DISCONTINUITY, WESTERN NEWFOUNDLAND

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Cawood and Botsford (1991) present structural and sedimentological arguments for a major "cross-strike discontinuity" across the Humber zone of western Newfoundland coincident with and extending southeastward of Bonne Bay. We argue here that the structural interpretation presented in their figure 5 is kinematically improbable and that an alternative explanation involving substantial allochthoneity of both the Long Range massif and the carbonate platform rocks to the southwest is fully consistent with the sedimentary and structural observations they summarize.

Figure 1 is a perspective view of the structural sections of Cawood and Botsford (apparently based on the similar sections of Cawood and Williams (1988), Cawood and others (1988), and Williams and Cawood (1989)), combining their figures 2 and 5. The kinematic improbability of the interpreted structure becomes apparent with scrutiny of their section D-D'. On the southwest side of the proposed Bonne Bay cross-strike discontinuity (BBCSD), Grenville basement rocks are shown transported to the northwest in a passive-roof duplex or tectonic wedge, above a northwest-vergent detachment at depth. Above the tectonic wedge, carbonate platform cover rocks occur in the "passive roof," separated from underlying Grenville basement along a southeast-directed thrust. Comparison with their section B-B' shows that, relative to *autochthonous* basement at depth, this cover succession has suffered predominantly *vertical* displacement, having been peeled upward above the tectonic wedge, but has not been transported a significant distance horizontally.

Contrast the situation northeast of the proposed cross-strike discontinuity. Here the platform succession is in stratigraphic contact with the basement of the Long Range massif (their sec. D-D', and as discussed in their text and shown in their fig. 2). If the massif has been transported significantly to the northwest above the Long Range thrust, as shown in their section A-A' and discussed on page 750 of their text, then the unconformably overlying cover succession must have been transported as well. Therefore, the proposed steep fault along the BBCSD shown at depth in their section D-D' must crop out at the surface, as in their section C-C', separating transported platform (to the northeast) from essentially autochthonous platform (to the southwest). No such feature has been recognized in this area (Nyman and others, 1984; Williams and others, 1984). Furthermore, the suggestion (p. 750) that the East Arm of Bonne

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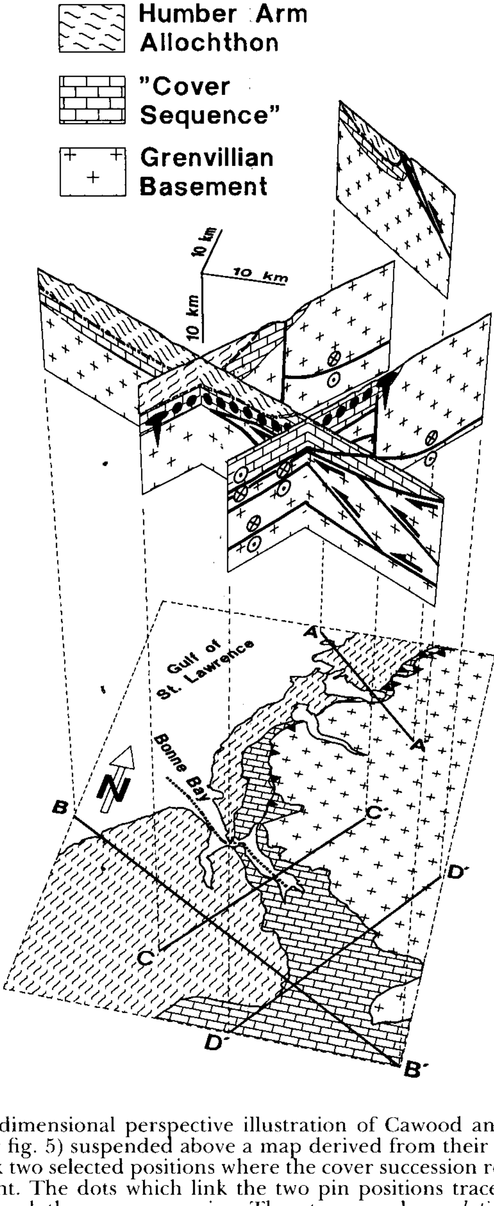

Fig. 1. Three-dimensional perspective illustration of Cawood and Botsford's structural sections (their fig. 5) suspended above a map derived from their figure 2. The large "pin" symbols mark two selected positions where the cover succession rests in stratigraphic contact on basement. The dots which link the two pin positions trace a continuous and unbroken path through the cover succession. Thrust arrows show *relative* sense of displacement. Circles adjacent to thrusts in sections C-C' and D-D' indicate *relative* displacement sense: circle with dot = "toward," circle with 'x' = "away." Dotted line on map in Bonne Bay is the inferred trace of the cross-fault shown to crop out on the sea floor in section C-C'.

Bay marks the trace of the proposed cross-fault (their section C-C') is at odds with the map of Williams (1985) which shows continuity of platform stratigraphy across "The Tickle" (the narrow strait connecting Bonne Bay proper with the East Arm). A strike-slip offset of up to 2 km could be accommodated if the isthmus to Norris Point (immediately north of The Tickle) is cut by such a cross-fault, but no hint of such a feature was recognized by Williams (1985).

In figure 1, "pin" symbols show two locations where the cover sequence is shown by Cawood and Botsford to rest with stratigraphic contact on basement; large dots trace a continuous and unbroken path from the autochthonous cover succession (on sec. C-C') to the cover succession on the Long Range massif (on sec. D-D'). As drawn by Cawood and Botsford, with the cross-fault along the BBCSD confined to depth in section D-D', the Long Range must be autochthonous, contrary to their arguments for northwestward motion on the Long Range thrust (and as shown in their sec. A-A'). It is kinematically unreasonable that "East of the head of Bonne Bay the fracture (cross-fault) is confined to basement and concealed under the drape of cover lithologies" (p. 750). Perhaps this kinematic problem would have been evident if balanced and restored cross sections had been constructed corresponding to sections A-A' and B-B'. It would also have been apparent if the map in figure 2 of Cawood and Botsford had been expanded to show how the trace of the upper detachment of the inferred basement passive-roof duplex (which projects to the surface immediately off the southeast end of their sec. B-B') should structurally link with the trace of the Long Range thrust; such a linkage would be required to transfer shortening from the duplex to the Long Range thrust.

A more realistic and kinematically admissible interpretation of the structural data presented by Cawood and Botsford would involve northwestward transport and structural duplication of the entire cover succession (plus basement where it is in contact stratigraphically) above autochthonous cover rocks at depth. Such a model would be consistent with the presence and configuration of the Acadian thrust front offshore to the west of North Arm Mountain, as interpreted by Stockmal and Waldron (1990) and Waldron and Stockmal (1991), and with new deep seismic reflection data (Quinlan and others, 1991; Stockmal and Waldron, 1991). The "BBCSD" would then reflect a lateral ramp at depth in the hanging wall of the detachment, as suggested by Waldron and Milne (1991, fig. 10, p. 408), and the basement duplex wedge postulated by Cawood and Botsford in their section D-D' would no longer be required.

Such a geometry could also explain the facies contrasts noted by Cawood and Botsford. In the structural depression southwest of the lateral ramp, structurally high slices of the Humber Arm Supergroup occur at the surface. Such slices would have originated in a relatively distal, off-margin position prior to Taconian emplacement of the Humber Arm Allochthon. In contrast, to the northeast only the most "proximal," structurally low slices (Cow Head Group) crop out in the narrow belt preserved to the west of the Long Range massif. These display a more continuous record of platform-derived sedimentation and a stratigraphically higher basal detachment, consistent with a more "proximal" origin on the pre-Taconian continental slope.

In conclusion, we maintain that the structural geometry proposed by Cawood and Botsford is internally inconsistent, and that the sedimentary data presented by them are compatible with alternative structural models. One of us (GSS) finds himself in a somewhat difficult position in writing this Discussion, because he formally reviewed this paper for the American Journal of Science in October 1989. At that time, he pointed out the problems with the structural interpretation discussed above. These critical comments have not been addressed in the published paper, resulting in this Discussion.

References

Cawood, P. A., and Botsford, J. W., 1991, Facies and structural contrasts, across Bonne Bay cross-strike discontinuity, western Newfoundland: American Journal of Science, v. 291, p. 737–759.

Cawood, P. A., and Williams, H., 1988, Acadian basement thrusting, crustal delamination, and structural styles in and around the Humber Arm Allochthon, western Newfoundland: Geology, v. 16, p. 370–373.

Cawood, P. A., Williams, H., O'Brien, S. J., and O'Neill, P. P., 1988, A geologic cross-section of the Appalachian Orogen: Geological Association of Canada, Mineralogical Association of Canada, and Canadian Society of Petroleum Geologists, Joint Annual Meeting, Field Excursion Guidebook, 160 p.

Nyman, M., Quinn, L., Reusch, D. N., and Williams, H., 1984, Geology of Lomond map area, Newfoundland: Gelogical Survey of Canada, Current Research, Part A Paper 84-1A, p. 157–164.

Quinlan, G. M., Hall, J., Williams, H., Wright, J. A., Colman-Sadd, S. P., O'Brien, S. J., Stockmal, G. S., and Marillier, F., 1991, Onshore seismic reflection transects across the Newfoundland Appalachians: Lithoprobe East Transect Meeting, November 29–30, 1991, St. John's, Newfoundland, Lithoprobe Report No. 23, p. 3–15.

Stockmal, G. S., and Waldron, J. W. F., 1990, Structure of the Appalachian deformation front in western Newfoundland: Implications of multichannel seismic reflection data: Geology, v. 18, p. 765–768.

———— 1991, Interpretations of western Newfoundland and Lithoprobe East lines: problems and possibilities for Humber zone tectonics: Lithoprobe East Transect Meeting, November 29–30, 1991, St. John's, Newfoundland, Lithoprobe Report 23, p. 63–68.

Waldron, J. W. F., and Milne, J. V., 1991, Tectonic history of the central Humber Zone, western Newfoundland Appalachains: post-Taconian deformation in the Old Man's Pond area: Canadian Journal of Earth Sciences, v. 28, p. 398–410.

Waldron, J. W. F., and Stockmal, G. S., 1991, Mid-Paleozoic thrusting at the Appalachian deformation front: Port au Port Peninsula, western Newfoundland: Canadian Journal of Earth Sciences, v. 28, p. 1992–2002.

Williams, H., 1985, Geology of Gros Morne area, 12H/12 (West Half), western Newfoundland: Geological Survey of Canada, Open File 1134, scale 1:50,000.

Williams, H., and Cawood, P. A., 1989, Geology, Humber Arm Allochthon, Newfoundland: Geological Survey of Canada, Map 1678A, scale 1:250,000.

Williams, H., Quinn, L., Nyman, M., and Reusch, D. N., 1984, Geology of Lomond map area, 12H/5, western Newfoundland: Geological Survey of Canada, Open File 1012, scale 1:50,000.