REPLY

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I thank Drs. Cousineau and Pollock for their comments.

1. I endorse their argument that the origin and evolution of orogenic belts as complex as the Quebec-Maine Appalachians cannot be deciphered using a single method of analysis. While framework mineralogy of the sandstone samples I studied is more compatible with deposition along a broad distended continental crustal block east of the Ascot-Weedon arc complex, my data cannot independently convincingly single out a definitive tectonic model for this region in Early Paleozoic time. In the Dunnage zone, segments of ocean crust, volcanic arcs, and melange belts whose existence is clearly indicated by other data can be unobvious sedimentologically for several reasons, including sampling. And inferring plate tectonic setting east of the Dunnage zone based only on the framework mineralogy (especially that of accretionary prism sands) is even more tenuous.

2. I believe the provocative points raised by Coisineau and Pollack about some of my specific conclusions further underscore shortcomings of this approach.

A. I support their view that sandstones of the Cambrian (?) Caldwell Group accumulated along a distended continental margin characterized by initial rifting and subsequent passive drifting. Unpublished data on sandstone of the Caldwell Group (Tawadros, ms), presumably counted using the Dickinson-Gazzi technique and apparently not extensively altered by metamorphic recrystallization, evidently suggests ongoing rifting and the existence of an offshore (basement?) horst northeast of the area studied by me. Though active rifting is not apparent based on the samples I studied, six out of eight samples contained more than 20 percent matrix and were disregarded after counting because metamor-

phism may have skewed sandstone framework mineralogy toward a deceptively quartz-rich and rock fragment- and feldspar-poor content. The remaining two quartz-rich matrix-poor samples contain only 5 to 6 percent feldspar and no rock fragments. I doubt that sandstone mineralogy alone can determine whether the offshore horst(?) of continental crust suggested by Tawadros was a continuous feature, or a discontinuous peninula (like Kamchatka) or microcontinental block (like Sakhalin).

B. Saint-Daniel Melange. My apparently cumbersome wording aside, I regard this as an orogen-scale unit, largely the relict of an Early to Late Ordovician accretionary prism that stratigraphically overlies ophiolite representing oceanic crust. I do not disagree with models showing an ocean basin, the Saint-Daniel accretionary wedge, a subjacent fore-arc basin (in which the Magog Group accumulated), and the Ascot-Weedon magmatic arc (all of which appear on both my cross sections). My study simply shows that accretionary wedges in particular poorly preserve the record of precise tectonic setting.

C. I did not include samples from the Middle to Late Ordovician Magog Group. I do not question a fore-arc setting for this assemblage. Interestingly, while sandstones at the base clearly signal volcanic sources, they apparently become less obvious in upper portions of the succession as erosion of Taconian nappes becomes dominant (Pinet and Tremblay, 1995).

D. Samples collected east of the Dunnage zone from melanges adjacent to the Boundary Mountain terrane (Jim Pond and Hurricane Mountain Formations), from the Grand Pitch Formation (perhaps deposited on and adjacent to various islands of the Celtic archipelago), and from stratigraphic units within the Maine Coastal Lithotectonic Belt strengthen the case for using sandstone framework mineralogy with great care.

3. Why are precautions so necessary?

A. Because recrystallization and alteration typically blur the distinctions among detrital matrix, secondary matrix, rock fragments, and feldspar, results of many sandstone counts cannot be used with confidence. For example, of a half dozen samples counted from the Saint Daniel Melange, all but one were discarded as too altered. Seventeen samples counted from the Maine Coastal Lithotectonic Block (arguably representing sands deposited in an accretionary prism adjacent to the Avalon microcontinent) suggest a rifted continental block provenance (Qt75-85%Ft10-25%L0%), but all were disregarded because high matrix content together with clast shape and roundness characteristics indicate that recrystallization was extensive.

B. Sandstones in accretionary prisms and fore-arc basins classically illustrate how tenuous the link can be between sandstone petrography, source composition, the tectonics of sediment source areas, and the tectonic setting of depositional basins (Velbel, 1980, 1985). Mack (1984) previously concluded that the mineralogy of sand accumulating in accretionary prisms can either be derived from relict source rocks that survive

during the temporal transition between tectonic regimens or can be compositionally "cleaned up" by alteration during weathering, transport, and burial. And Ingersoll and Suczek (1979) showed that modern sands derived from the Himalayas (a "recycled orogen" provenance) deposited in the modern Bengal and Nicobar Fans have the potential to be introduced both sedimentologically (by longitudinal transport) and tectonically (by off-scraping from the downgoing slab) into the Sunda fore-arc complex. Unhappily, it is sandstone suites for which the tectonic setting is most tightly constrained that seem to be best "behaved" compositionally. In more complicated orogenic belt interiors, especially those that may be collages of far-travelled terranes, inferring tectonic setting based only on sandstone framework mineralogy is risky, and better done using all data available, including structural geology, fossil provinciality, and heavy mineral content.

References

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