LATE PALEOZOIC STRIKE SLIP TECTONICS OF THE NORTHERN APPALACHIANS

by

Dwight Culver Bradley

A dissertation
Submitted to the Faculty of the
State University of New York at Albany
in Partial Fulfillment
of the Requirements for the Degree of
Doctor of Philosophy

College of Science and Mathematics
Department of Geological Sciences

1984

LATE PALEOZOIC STRIKE SLIP TECTONICS OF THE NORTHERN APPALACHIANS

by

Dwight Culver Bradley

ABSTRACT

During the interval between Devonian collision and Triassic rifting, the Northern Appalachians were the site of a wide, strike-slip plate boundary zone. Episodic motion on northeast- and east-trending faults resulted in the relative displacement of the Avalon and Meguma Terranes with respect to North America, and at the same time caused the subsidence and later deformation of about 25 more-or-less distinct sedimentary basins. The result is an exceedingly complex rock record characterized by along- and across-strike variations through regimes of pure strike slip, rapid and continuous basin subsidence, and local, compressional deformation.

A large body of geologic evidence (first synthesized by Webb, 1969) shows that during Carboniferous times, the sense of displacement was dextral, and its magnitude was in the range of a few hundred kilometers. On the other hand, recent paleomagnetic work (e.g. Kent and Opdyke, 1978) has suggested that about 2000 km of sinistral motion occurred in the Northern Appalachians during this interval. Accordingly, the first purpose of this study was to reexamine the geologic evidence bearing on the sense-of-motion question. Results of this analysis (Chapter 2) show (as Webb believed) that displacement (1) was dominantly dextral and (2) probably amounted to a few hundred kilometers. These dextral faults were moving precisely during that interval when the paleomagnetic evidence implies sinistral faulting. Furthermore, although Kent and Opdyke's interpretation of the paleomagnetic data absolutely requires the existence of a major left lateral fault, geologic links across all known faults in Newfoundland and New Brunswick show that none can have accomo-

dated even a significant fraction of the required left-lateral motion. Another explanation of the paleomagnetic data must therefore be sought.

One of the most striking features of this transform is the extent to which strike slip faulting was accompanied by basin subsidence. A survey of the 25 major sedimentary basins (Chapter 3 and Appendix 1) reveals a population of (1) pull-apart basins, including those that underwent late thermal subsidence (Magdalen), and those disrupted by later strike slip (Moncton); (2) basins bounded in part by thrust faults (Cumberland); (3) basins at strike slip fault intersections (Deer Lake); and (4) basins of unknown origin (Narragansett).

Field studies of two Carboniferous sedimentary basins in Cape Breton Island (Chapters 4 and 5) are consistent with regional evidence that basin subsidence was driven by dextral faulting. Mapping at 1:10,000 in the Big Pond Basin indicates that it is a dextral pull apart that formed during Visean times at a right step in the newly recognized Big Pond fault zone. Although the origin of the Bay St. Lawrence Basin is less obvious, 1:12,000 mapping along the eastern margin shows that subsidence in early and medial Carboniferous was associated with at least 3 km of dextral slip on the St. Lawrence fault.

The ultimate goal in a strike slip system such as this is the construction of a set of palinspastic, paleogeographic maps illustrating the evolving relationships between faulting and sedimentation (Chapter 6). While the displacement histories of most faults in the Canadian Appalachians are still inadequately understood, this goal will be within reach after a few well focussed field seasons.

PREFACE

This dissertation on the late Paleozoic tectonics of the Northern Appalachians is divided into six chapters, some parts of which have previously been published as follows. Chapter 1 is a general introduction to the regional geology, stratigraphy, and review of previous works. Plate 1.1, a tectonic/geologic map introduced in that chapter, was previously exhibited in poster form at the National GSA in Cincinnati (Bradley, 1981). The second chapter deals with the sense-of-motion problem; some of the ideas in this chapter were presented in poster form at the Northeastern GSA in Monticello by Bradley and Rowley (1983). An early form of Chapter 3 dealt with Carboniferous basins of Atlantic Canada (Bradley, 1982); it has been cannibalized and restructured so that much of its introductory material now lives in Chapter 1. The discussion of basins has also been expanded to include in Appendix 1 a summary of most of the late Paleozoic basins now recognized in the Northern Appalachians. A few observations from this strike slip plate boundary zone were presented by Mann, Hempton, Bradley, and Burke (1983) in a paper on pull-apart basins. Chapter 4 presents the results of a 1982 field study in one such basin; the key findings were presented by Bradley and Bradley (1983) at the National GSA in Indianapolis. Chapter 5 is devoted to the results of the major field study of this project, conducted in 1980-1981 in the Bay St. Lawrence Basin. Bradley and Bradley (1984) reported the results of one aspect of this study at the Northeastern GSA in Providence. Finally, Chapter 6 presents a new interpretation of the late Paleozoic

paleogeographic development of the Northern Appalachians in the context of oblique convergence, continental collision (as described in Bradley, 1983, J. Geol.), and escape.

ACKNOWLEDGMENTS

It was John Dewey who initially suspected that this would be a worthwhile project; Kevin Burke, Bill Kidd, Win Means, and Ed Belt, served as formal advisors. Lauren Bradley assisted with mapping (sacrificing her own field time), during parts of four summers. Field visits to Bay St. Lawrence by Bruce Idleman, Katrina Idleman, Bill Kidd, and the SUNYA motorboat helped to speed mapping. A long list of geologists provided unpublished information and opinions. Among them, Ed Belt, the late Greg Webb, Dick Hyde, Lauren Bradley, Tim Kusky, Peter Giles, and Dwight Ball were most helpful. Fellow graduate students Dave Rowley, Paul Mann, A. M. C. Sengor, Andy Bobyarchick, Mark Swanson, Bruce Idleman, Steve Tanski, and Jane Kozinski each made valuable contributions toward the completion of the dissertation. I wish to thank all of the above people for their efforts on my behalf. I am also grateful to Rhubarb for providing a scale (55 cm shoulder height) in many field photographs.

I also owe thanks to my parents Bill and Paula Bradley, my wife Lauren Bradley, and friends William Woodruff, Dykstra Eusden, Tad Pfeffer, John H. Boothman and Don and Barbara Wilson for encouragement and support.

This research was funded in part by grants from the Geological Society of America (1981 and 1982), American Association of Petroleum Geologists (1981), Sigma Xi (1982), and the Department of Geological Sciences, SUNYA (1982).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

Plate Number