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Proterozoic tectonic evolution of the Grenville orogen in North America: An introduction

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As illustrated by many papers in this volume, the fundamental tools used in geologic analysis of the complex igneous and metamorphic rocks constituting the Grenville Province and its various outliers include many traditional pursuits such as detailed field mapping, petrologic and geochemical analysis, and geochronologic investigation. However, continuous refinement of these tools and application of new strategies in protolith studies have provided novel avenues to improve understanding of the pre-orogenic nature of many of the gneiss- and granitoid-dominated terranes. Moreover, the techniques involved in such analysis have benefited significantly from recent technical advances, including the high spatial resolution available for isotopic analyses utilizing ion microprobe techniques, elemental mapping obtained through electron microprobe analysis, and the increased resolution of crustal seismic profiling. The numerous multiauthored papers in this volume underscore the importance of interdisciplinary studies in developing an improved understanding of Grenvillian and related rocks, and the geologic processes involved in their genesis.

In this volume, the term *Grenville orogen* is used to refer to all areas affected by dominantly convergent-style orogenesis during the interval ca. 1.3–1.0 Ga. From the outset, this project was designed to include contributions concerned with the entire historical span of the Grenville orogen, including those (1) identifying geological precursors to terrane accretion, (2) deciphering the sequence of tectonic events involved in creation of the orogen, and (3) documenting its eventual geologic destruction. Most papers focus on aspects of the ca. 1.3–1.0 Ga time frame, which represents an important period of convergent tectonics along the southeastern margin of Laurentia. Because of the protracted nature of this convergence and the various geologic entities involved, these papers cover a broad range of topics that collectively illustrate the complexity of the orogen and the processes involved in its creation. Such papers present results from studies located throughout the geographic extent of the Grenville orogen and related outliers in North America (Fig. 1). A subset of papers concerns the Late Neoproterozoic rifting of Rodinia and the subsequent breakup of the Grenville orogen. The geographic focus of these latter papers is centered on the southern Appalachians and the Blue Ridge Province of Virginia, where the geologic record of Neoproterozoic extension is well preserved. Individually, these papers involve topics related to the three main stages in the regional Neoproterozoic extensional regime, including (1) failed rifting at ca. 750 Ma, (2) successful rifting at ca. 570 Ma, and (3) subsequent establishment of a passive tectonic margin.

TEMPORAL SUBDIVISIONS AND NOMENCLATURE

Many of the studies concerned with Grenvillian (*sensu lato*) orogenesis utilize results from detailed mapping and U-Pb isotopic analysis to calibrate the chronology of geologic events on both local and regional scales. Such temporal calibrations and broad correlations are elements critical to developing a firm understanding of local geological evolution, which is, in turn, an essential requirement for establishing regional plate tectonic models. In these pursuits, clear communication of geologically constrained time intervals and potentially correlatable events is extremely important. Nevertheless, recent advances in geological knowledge and analytical technology have resulted in sev-

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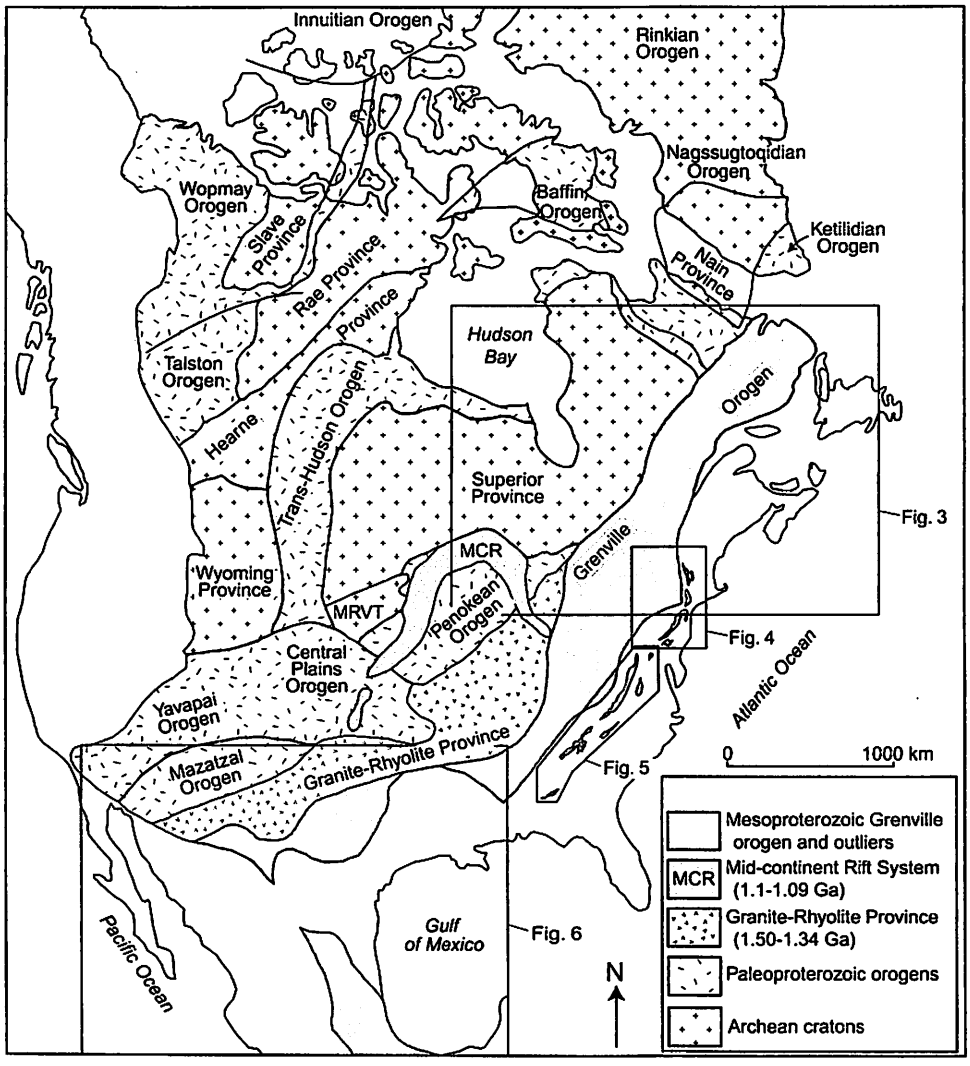

Figure 1. Generalized map showing the location of the Grenville orogen, including both its subsurface extent and the location of exposed outliers occurring within the Appalachians and its continuation in Texas and Mexico, in relation to other principal Precambrian lithotectonic elements of North America. Areas of younger orogens and rocks are unpatterned. Abbreviations include MCR—Mid-continent Rift System; MRVT—Minnesota River Valley terrane. Map modified from Rankin et al. (1990), Wheeler et al. (1996), Rivers (1997), Card and Poulsen (1998), and Davidson (1998a).

eral competing time scales and nomenclature schemes for tectonic events in the Grenville Province of Canada and the Adirondacks (Fig. 2). Some of the key contributions in this regard are summarized below.

The nature and timing of geological events that resulted in the development of the Canadian Grenville Province serve as a benchmark for interpretation of similar rocks throughout North America, and as a linchpin for reconstruction of plate tectonic configurations during the Mesoproterozoic. Identification and interpretation of the timing and sequence of events in the Canadian Grenville have evolved over time as (1) new field-based information has become available, (2) geophysical crustal mapping techniques have improved, (3) modeling of plate tectonic processes has become more sophisticated, and (4) new, high-precision isotopic age information for both igneous and metamorphic and/or deformational events has been obtained. The following brief synopsis of published syntheses regarding the timing and nature of Grenvillian orogenesis is presented on the following pages to provide readers with a reference frame in which to better understand the geologic context and nomenclature used to define orogenies in the papers included within this volume. Davidson (1998a) and Gower and Krogh (2002) provide more detailed historical perspectives and additional background on the evolution of geological knowledge in this province. Considering the present uncertainty with regard to the merits of various models, we did not request that contributors of papers to this volume (references noted in italics) conform to any particular scheme.

Wynne-Edwards (1972) and Moore and Thompson (1980) were among the first researchers to recognize multiple episodes of orogenesis within the Grenville Province. Moore and Thompson (1980) noted that deposition of the Flinton Group, which they constrained to the interval 1080–1050 Ma, occurred after arc-related magmatism, uplift, and erosion, and prior to major regional metamorphism. On this basis, they proposed the term "Elzevirian orogeny" to denote the period of activity that pre-