Earth-Science Reviews 91 (2008) 27–76

Contents lists available at ScienceDirect

Earth-Science Reviews

journal homepage: www.elsevier.com/locate/earscirev

Geologic evolution of the Gulf of Maine region

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ARTICLE INFO

Article history:
Received 10 March 2008
Accepted 2 September 2008
Available online 6 October 2008

Keywords:
Gulf of Maine
Georges Bank
Paleozoic–Mesozoic rift basins
Mesozoic carbonate banks
Tertiary fluvial erosion
Pleistocene glaciations

ABSTRACT

In this study we reconstruct the evolution of the northern New England passive margin whose development has been influenced by Pleistocene glaciations. The morphology of the northern New England shelf is rather unique consisting of a inner lowland, the Gulf of Maine, with an average depth of 150 m and an area of 90,700 km^2 and Georges Bank, a high whose crest is less than 40 m deep and has an area of 27,000 km^2. The bank's northern slope, facing the Gulf of Maine, has a maximum relief of 377 m. On the seaward side of Georges Bank is the 2000 m high continental slope deeply cut by canyons. Two channels, Northeast and Great South Channels, east and west of Georges Bank, provide passageways from the Gulf of Maine to the open sea. This morphology was acquired by a combination of Tertiary fluvial erosion, Pleistocene glacial erosion/deposition and Pleistocene/Holocene marine processes. Fluvial/glacial erosion in the Gulf of Maine was so extensive as to expose basement, thus making it possible to map the various terranes making up this foundation. These terranes include the pre-Carboniferous Avalon and Meguma units, a Carboniferous–Permian rift basin formed by the oblique continental collision during the closure of the Paleozoic proto-Atlantic and a Late Triassic–Early Jurassic rift system created during the opening of the present Atlantic. Basement in the Gulf of Maine remained above sea level from the opening of the Atlantic 190 Ma (Early Jurassic) to the Eocene 55 Ma. That the Gulf of Maine remained a high for so long may have been due to igneous activity along the northwest-trending Boston–Ottawa Lineation extending from the vicinity of the St. Lawrence River, Canada to Gulf of Maine from Late Triassic to Early Cretaceous. The northwest-trending New England Seamounts south of Georges Bank may represent a seaward extension of this lineation. On Georges Bank, rising hundreds of meters above the Gulf of Maine, the basement exposed in the gulf is mantled by sediments thousands of meters thick. Included in these sediments are Early Jurassic- to earliest Cretaceous reefs along the continental slope and carbonates north of the reefs grading landward into continental sediments, Cretaceous–Cenozoic continental/marine terrigenous sediments and Pleistocene glacial deposits. The continental slope on the seaward flank of Georges Bank has a complex history of early to mid Mesozoic carbonate accretion, mid to late Mesozoic and Cenozoic calcareous/terrigenous sediments and canyon erosion, burial and exhumation going back to Early Cretaceous.

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doi:10.1016/j.earscirev.2008.09.002

Come let us sail the endless ocean of time and see how it all came to be.

1. Introduction

The continental shelf described in this report is that segment of the eastern United States shelf off northern New England. This segment is characterized by a deep embayment, the Gulf of Maine, near the coast and a shallow bank, Georges Bank, offshore. The gulf is so deep that it provides a window to the basement forming the foundation of the shelf making it possible to map the geologic events responsible for its construction. In contrast, on Georges Bank are preserved the sediments deposited during the formation of the present Atlantic that provide a geologic record of the processes responsible for the construction of a segment of the passive North Atlantic margin. No such condition exists on the rest of the United States east coast shelf. In this paper we will use results from studies of the regional geology inshore, charts published by NOAA/NOS and papers published by others and us on the offshore geology to reconstruct the pre and Quaternary geologic history of the region. This geologic base has reached such a degree that this may be the appropriate time to offer an overview of the geologic evolution of the region. We hope that with this report we will provide the reader with a historical perspective on the development of the Gulf of Maine region. From this history we will map the past and such mapping in turn will allow us to determine how events were initiated and how they in turn set in motion other events that ultimately led to the creation of the present morphology, a mélange of various elements.

2. Onshore morphology

2.1. New England Upland

The major morphologic element of New England is the New England Upland, a northeast extension of the Piedmont, Blue Ridge and Ridge and Valley provinces of Appalachia. It rises northwestward from an altitude of 100 m along the inboard side of the Seaboard Lowland to 600 m at its northwest end (Figs. 1–4; Thornbury, 1965). Rising above the general level of the New England Upland, a plateau-like high, are mountain ranges (Green, Taconic, White), lesser highs (Hoosac and Berkshire Hills in western Massachusetts) and individual peaks (Mount Monadnock in New Hampshire and Mount Katahdin in Maine). Some geologists have ascribed the upland surface to a single-cycle of fluvial erosion in Late Cretaceous (the so called Schooley Peneplain) with the mountains and peaks rising above its surface representing monadnocks (Davis, 1896).