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Sedimentary Geology 178 (2005) 75–97

Sedimentary Geology

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Sedimentary environment and diagenesis of the Lower Cretaceous Chaswood Formation, southeastern Canada: The origin of kaolin-rich mudstones

Georgia Pe-Piper[a], Lila Dolansky[a], David J.W. Piper[b,*]

[a]*Department of Geology, Saint Mary's University, Halifax, NS, Canada B3H 3C3*
[b]*Geological Survey of Canada (Atlantic), Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia, Canada B2Y 4A2*

Received 3 August 2004; received in revised form 3 April 2005; accepted 6 April 2005

Abstract

The Lower Cretaceous fluvial sandstone–mudstone succession of the Chaswood Formation is the proximal equivalent of offshore deltaic rocks of the Scotian Basin that are reservoirs for producing gas fields. This study interprets the mineralogical consequences of Cretaceous weathering and early diagenesis in a 130-m core from the Chaswood Formation in order to better understand detrital and diagenetic minerals in equivalent rocks offshore. Mineralogy was determined by X-ray diffraction, electron microprobe analysis and scanning electron microscopy. The rocks can be divided into five facies associations: light gray mudstone, dark gray mudstone, silty mudstone and muddy sandstone, sorted sandstone and conglomerate, and paleosols. Facies transitions in coarser facies are related to deposition in and near fluvial channels. In the mudstones, they indicate an evolutionary progression from the dark gray mudstone facies association (swamps and floodplain soils) to mottled paleosols (well-drained oxisols and ultisols following syntectonic uplift). Facies transitions and regional distribution indicate that the light gray mudstone facies association formed from early diagenetic oxidation and alteration of the dark gray mudstone facies association, probably by meteoric water. Principal minerals in mudstones are illite/muscovite, kaolinite, vermiculite and quartz. Illite/muscovite is of detrital origin, but variations in abundance show that it has altered to kaolinite in the light gray mudstone facies association and in oxisols. Vermiculite developed from the weathering of biotite and is present in ultisols. The earliest phase of sandstone cementation in reducing conditions in swamps and ponds produced siderite nodules and framboidal pyrite, which were corroded and oxidized during subsequent development of paleosols. Kaolinite is an early cement, coating quartz grains and as well-crystallized, pore-filling booklets that was probably synchronous with the formation of the light gray mudstone facies association. Later illite and barite cement indicate a source of abundant K and Ba from formation water. This late diagenesis of sandstone took place when the Chaswood Formation was in continuity with the main

* Corresponding author. Tel.: +1 902 426 6580; fax: +1 902 426 4104.
E-mail addresses: gpiper@smu.ca (G. Pe-Piper), ldolansky@yahoo.ca (L. Dolansky), dpiper@nrcan.gc.ca (D.J.W. Piper).

doi:10.1016/j.sedgeo.2005.04.002

Scotian Basin, prior to Oligocene uplift of the eastern Scotian Shelf. Findings of this study are applicable to other mid-latitude Cretaceous weathering and early diagenetic environments.

Keywords: Fluvial; Paleosol; Clay minerals; Kaolinite; Sandstone; Early diagenesis; Mudrock diagenesis

1. Introduction

1.1. Background and purpose

The Lower Cretaceous Chaswood Formation of southeastern Canada (Stea and Pullan, 2001) is the proximal equivalent of thick deltaic units that are reservoir rocks for gas and oil in the offshore Scotian Basin. The Chaswood Formation is best preserved in a series of fault-bound basins in central Nova Scotia, with minor outliers in northern Nova Scotia and southern New Brunswick (Fig. 1a). Chaswood For-

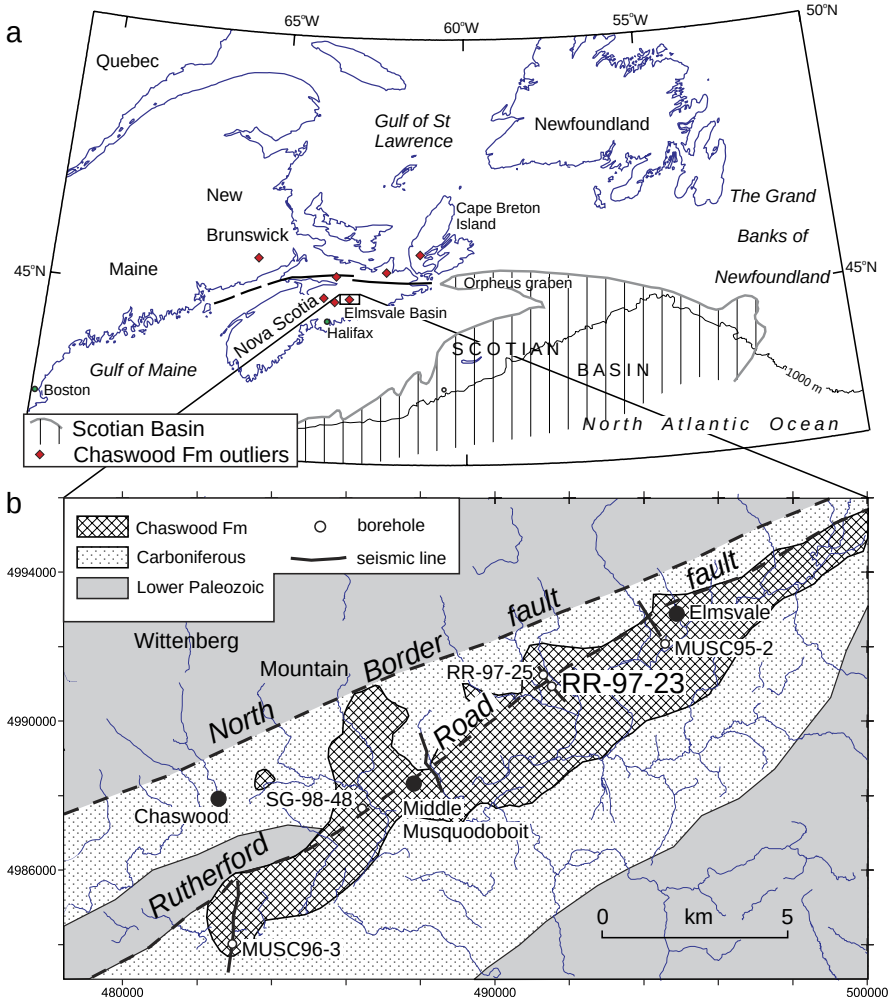

Fig. 1. (a) Map of southeastern Canada showing the offshore Scotian Basin and its onshore equivalent, the outliers of the Cretaceous Chaswood Formation. (b) Detail of Elmsvale Basin, showing location of boreholes discussed in text (geology from Stea and Pullan, 2001).