Marine and Petroleum Geology 67 (2015) 481–497

Contents lists available at ScienceDirect

Marine and Petroleum Geology

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

Research paper

Tectono-sedimentary evolution of the Paleogene succession offshore Northeast Greenland

T.G. Petersen [a, *], N.E. Hamann [b], L. Stemmerik [c, d]

[a] Department of Geosciences and Natural Resources Management, University of Copenhagen, Øster Voldgade 10, DK-1350 Copenhagen K, Denmark
[b] DONG Energy, Nesa Allé 1, DK- 2820 Gentofte, Denmark
[c] Natural History Museum of Denmark, University of Copenhagen, Øster Voldgade 5-7, DK-1350 Copenhagen K, Denmark
[d] University Centre in Svalbard, P. O Box 156, N-9171, Longyearbyen, Norway

ARTICLE INFO

Article history:
Received 21 July 2014
Received in revised form
27 April 2015
Accepted 19 May 2015
Available online 14 June 2015

Keywords:
Northeast Greenland
Paleogene
Tectonostratigraphy
North Atlantic
Break-up

ABSTRACT

The large-scale geological evolution of the Northeast Greenland shelf is interpreted on the basis of Cenozoic seismic mega-sequences, which are dated by comparison to the knowledge from onshore East Greenland. However, no detailed studies exist of the tectonostratigraphic development during the Paleogene period, when the break-up between Greenland and Eurassia occurred. In this study, we examine the details of the geological development by analysis of the available seismic data in a rift to drift margin context, and we give a detailed seismic stratigraphic interpretation of the deposited units. A threefold subdivision of the presumed Paleogene shelf succession is suggested based on correlation between strata geometries and the break-up history of the Northeast Greenland margin. Deposition took place in two basins, the Danmarkshavn Basin in the west and the Thetis Basin in the east, separated by the Danmarkshavn Ridge. The first recorded Paleogene sediments in the Danmarkshavn Basin are wedge/fan complex, Unit 1, which is referred to a pre-drift or pre-volcanic setting. The overlying, prograding Units 2–4 are interpreted to be deposited during the break-up phase and are inferred to form the syn-drift or syn-volcanic interval. The aggrading Units 5–6 display passive, thermal subsidence in a post-volcanic setting following continental break-up. Detailed seismic interpretation indicates that the pre-volcanic succession is dominated by a complex of highstand prograding wedges and lowstand basin floor fans. The syn-drift succession is interpreted to be shallow marine and relatively coarse grained due to dominance of prograding units with steep angles of the foresets constrained to the Danmarkshavn Basin. Finally, the post-volcanic succession is interpreted to primarily consist of fine-grained sediments deposited below wave base, in a deep, shelf-wide basin. The pre-volcanic units (Units 1–3) are only recognized in the Danmarkshavn Basin, and not until the syn-volcanic phase was the Danmarkshavn Ridgeoverstepped and sedimentation became coherent across the entire shelf. This pattern continued during the post-volcanic thermal cooling phase.

1. Introduction

The Northeast Greenland shelf covers the area from 70° N to 82° N along the Northeast Greenland coast, and it extends ca. 350 km east of the coastline (Fig. 1a). Paleogene deposits are present on the Northeast Greenland shelf, and at scattered localities onshore Northeast Greenland, but many uncertainties still exist regarding their distribution, age and depositional environment. The main reason is the extreme climatic and geographic conditions prevailing offshore Northeast Greenland, limiting the amount of collected data. A central shortcoming of the present database is the lack of any deep well bores on the Northeast Greenland shelf to provide stratigraphical control.

The early Cenozoic succession on the Northeast Greenland shelf is of primary interest as it records the structural and depositional evolution during continental break-up. It is, therefore, highly interesting to perform a seismic stratigraphic interpretation of the early Cenozoic sedimentary succession of this poorly described area, both in order to gain general knowledge of the rift-to-drift

* Corresponding author. Present address: Maersk Oil, Esplanaden 50, 1098 Copenhagen K, Denmark.
E-mail addresses: Thomas.petersen@geo.ku.dk (T.G. Petersen), niham@dongenergy.com (N.E. Hamann), lars.stemmerik@snm.ku.dk (L. Stemmerik).

http://dx.doi.org/10.1016/j.marpetgeo.2015.05.033
0264-8172/

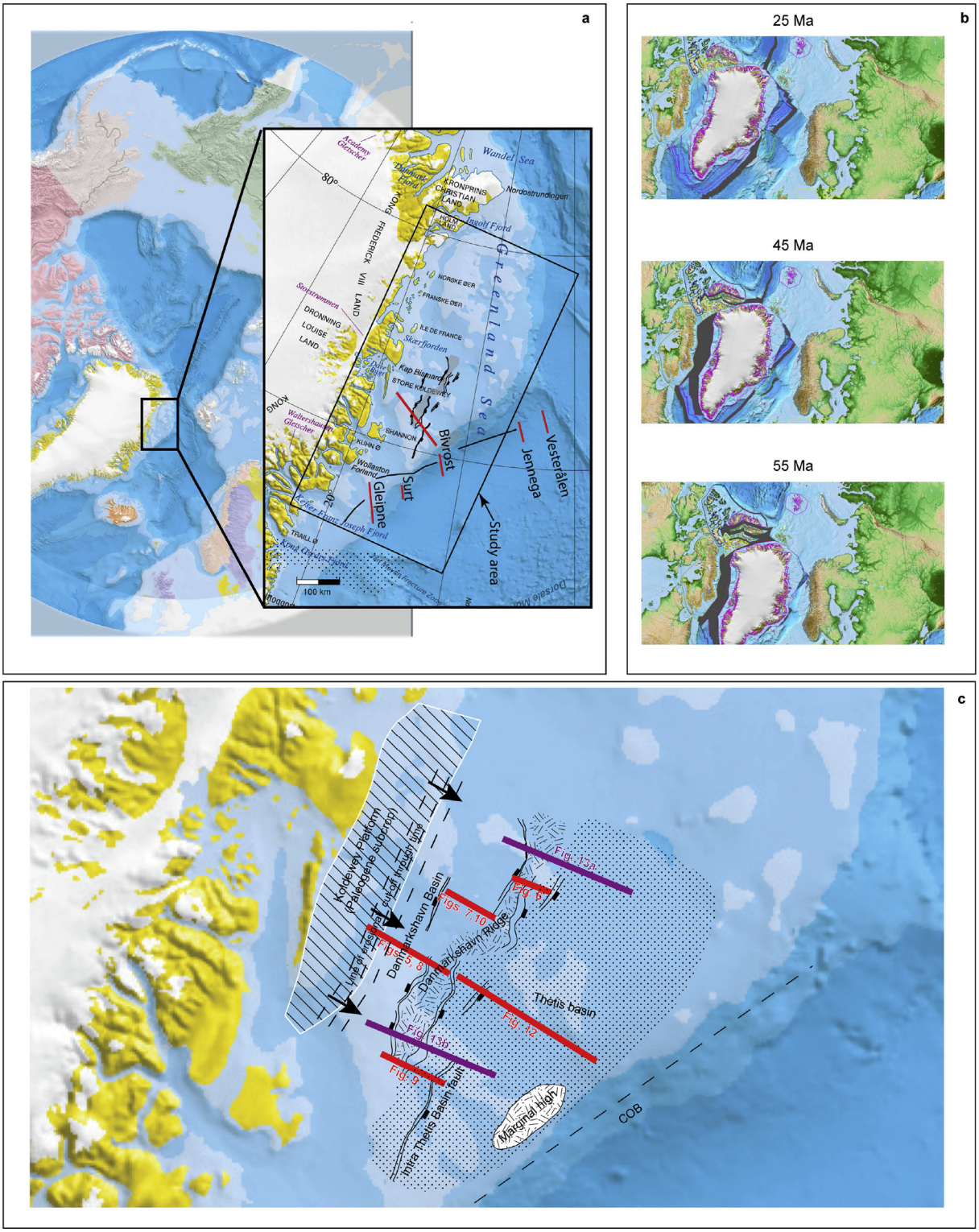

Fig. 1. a: Map of the study area with major faults and transfer zones displayed. Map modified from http://atlas.gc.ca/and transfer zones are modified from Tsikalas et al. (2005). Fig. 1b: Plate reconstructions based on Gplates software (www.gplates.org) during the pre-, syn- and post-volcanic phases. Fig. 1c: Overview map of the main Late Paleozoic and Mesozoic structural elements on the Northeast Greenland shelf. Note the eastwards migration of the maximum western extent of the Paleogene succession along the margin of the Danmarkshavn Basin. Seismic examples are marked by red lines, and continent-ocean boundary (COB) marked by dashed line. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

transition phase and the creation of passive margins, but also in order to tie the Northeast Greenland shelf with the conjugate West Barents Sea margin.

The seismic database consists of ca. 21000 line-km of 2D data from the KANUMAS (1991, 1994, 1995), TGS-NEG2008, GXT2009 and GXT2010 surveys. These datasets are not public domain, and