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The structure and stratigraphy of the sedimentary succession in the Swedish sector of the Baltic Basin: New insights from vintage 2D marine seismic data

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ABSTRACT

We present five interpreted regional seismic profiles, describing the full sedimentary sequence across the Swedish sector of the Baltic Sea. The data for the study are part of an extensive and largely unpublished 2D seismic dataset acquired between 1970 and 1990 by the Swedish Oil Prospecting Company (OPAB). The Baltic Basin is an intracratonic basin located in northern Europe. Most of the Swedish sector of the basin constitutes the NW flank of a broad synclinal depression, the Baltic Basin. In the SW of the Swedish sector lies the Hanö Bay Basin, formed by subsidence associated with inversion of the Tornquist Zone during the Late Cretaceous.

The geological history presented here is broadly consistent with previously published works. We observe an area between the Hanö Bay and the Baltic Basin where the Palaeozoic strata has been affected by transpression and subsequent inversion, associated with the Tornquist Zone during the late Carboniferous–Early Permian and Late Cretaceous, respectively. We propose that the Christiansø High was a structural low during the Late Jurassic, which was later inverted in the Late Cretaceous. We suggest that a fan shaped feature in the seismic data, adjacent to the Christiansø Fault within the Hanö Bay Basin, represents rapidly deposited, coarse-grained sediments eroded from the inverted Christiansø High during the Late Cretaceous. We identify a number of faults within the deeper part of the Baltic Basin, which we also interpret to be transpressional in nature, formed during the Caledonian Orogeny in the Late Silurian–Early Devonian. East of Gotland a number of sedimentary structures consisting of Silurian carbonate reefs and Ordovician carbonate mounds, as well as a large Quaternary glacial feature are observed. Finally, we use the seismic interpretation to infer the structural and stratigraphic history of the Baltic and Hanö Bay basins within the Swedish sector.

1. Introduction

The framework of the bedrock geology in the southern Baltic Sea is dominated by four main structural elements, the Baltic Basin, the Hanö Bay Basin, the Tornquist Zone and the Danish–Polish Basin. The structural elements reflect a transition from an intracratonic platform, to a plate margin, to a rift basin setting in a NE–SW direction (Fig. 1). The up to 2 km thick sedimentary succession in the Swedish sector of the south Baltic Sea, representing the north and western flanks of the Baltic Basin and Hanö Bay Basin, was during the 1970s and 1980s explored by the Swedish Oil Prospecting Company (OPAB) for its hydrocarbon potential. As part of their exploration program they drilled 14 offshore wells and acquired a relatively dense coverage of 2D seismic profiles south of the island of Gotland and in the Hanö Bay area. The seismic data provide information, primarily, on the Lower Palaeozoic platform. However, they also give information on the transition zone between the Palaeozoic succession in the Baltic Basin and the Mesozoic succession in the Hanö Bay Basin.

The bedrock geology and subsurface maps of the area are largely based on the extensive work of Flodén (1980) and Kumpas (1978, 1980). They primarily used single channel seismic profiling to map the Central Baltic Sea and Hanö Bay area, respectively. This single channel seismic, although high in resolution, has poor penetration, which generally limits the interpretation to the upper 50–300 ms (Flodén, 1980), corresponding to a maximum depth of approximately 400 m. Information about the complete sedimentary succession has been provided by a number of deep seismic profiles (EUGENO-S Working group, 1988; Meissner et al., 1992; DEKORP-BASIN Research group, 1999). However,

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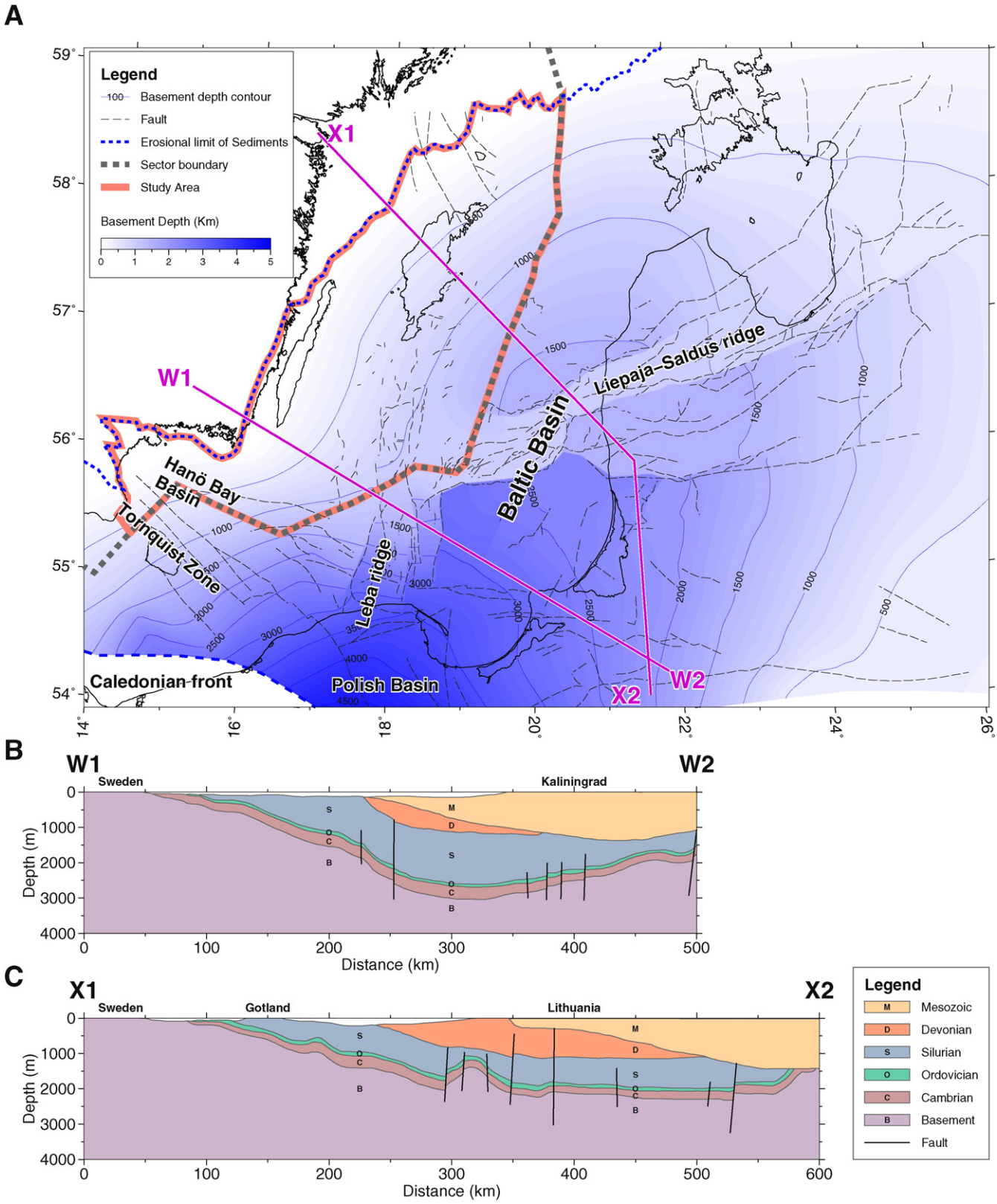

Fig. 1. A) Structural map of the Baltic Basin showing the structural elements, the Swedish marine border (sector boundary), fault network and present day extent of sedimentary rocks within the various sedimentary basins. Thick black lines on map denote the coastline. The location of the two schematic regional profiles (W1–W2 and X1–X2) are shown. Map is modified from Sopher et al. (2014). The projection used for this map is WGS84. B). Shows schematic regional profile W1–W2. C). Shows schematic regional profile X1–X2. The schematic regional profiles are modified from depth cross sections provided by Ulf Sivhed to Daniel Sopher (pers. comm.).

the data acquisition, processing and interpretation in these studies focused on the structure of the deeper crust and did not address the sedimentary successions in detail. As a result, the current maps detailing the sedimentary successions and structures within the Swedish sector of the basin, below approximately 400 m depth, are poorly constrained and largely based on the sparse well data.