Transgressive Shoreline Deposits of the Lower Cretaceous (Albian) Bluesky Formation in the Boyer and Steen Field Areas of Northwestern Alberta*

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Introduction

In northwestern Alberta, at the northern edge of the pre-Cretaceous Central Alberta Ridge, there is a 400-km-long series of gas fields that produce from the Lower Cretaceous Bluesky and Gething formations (Figure 1). The study area covers some 700 townships (T98 – T118; R10w5 – 13w6) and is centered on the Boyer and Steen fields, just to the east of the 6th meridian. Mapping is based on 3400 wells, with descriptions of over 100 cores.

Bluesky Formation

The Boyer and Steen field areas produce gas from Bluesky transgressive shoreline sands in the thickest part of a large NW-SE-trending Bluesky sub-basin (Figure 2). This basin abruptly terminates to the NW along a line that coincides with the Hay River basement fault zone. Within this basin the Bluesky Formation, which averages between 30m and 40m in thickness, onlaps the pre-Cretaceous ridge to the south and passes into marine shales in a northerly and westerly direction.

The Bluesky Formation in this area forms a progradational succession from a major marine flooding surface at the top of the underlying Gething Formation, to the overlying regional Moosebar marine transgression. A series of sandy, wave-dominated NW-SE-trending Bluesky shoreface units parallel the pre-Cretaceous ridge and prograde towards the NE. The Bluesky succession can be informally divided into three major depositional units; which are referred to here as the B3 to B1, in ascending order (Figure 3).Representative features of the Bluesky are illustrated in Figure 4 and core descriptions are shown graphically in Figures 5, 6, and 7.

B3

The lower part of the B3 is a marine shale unit up to 20m in thickness, containing flat-lying markers such as bentonites and concretionary siderite layers. The marine shales in the lower part of the B3 cycle contain indications of fresh-water influence, such as syneresis cracks and a sparse marine ichnology.

The lowermost sand body in the Bluesky is present at the top of the B3. This consists of a single, coarsening-upward, regressive shale to silty sand cycle. This succession represents a transition from offshore to lower shoreface deposits. The B3 unit is truncated to the south by the overlying B2 unit. To the north the B3 sands gradually thin and pass into offshore silty muds and shales.

B2

This unit is composed of a series of stacked transgressive shoreface deposits. These transgressive units are characterized by:
(i) Erosional bases accompanied by an extensive *Glossifungites* ichnofacies (Figure 4), usually consisting of large vertical *Diplocraterion* (Figure 4), and horizontal *Thallasinoides.*
(ii) Muddy, fine- to medium-grained sands with variable concentrations of glauconite, in some cases up to 30%.
(iii) Large terrestrial organic clasts within the sands, such as wood, bone and coal, along with quartz and chert granules and pebbles.
(iv) Sedimentary structures dominated by small wave-formed troughs and wave ripples passing upwards into low angle lamination, and rare HCS.
(v) Fining-upward depositional units, from medium-grained marine sands to marine shales, indicating an upward-deepening marine facies succession.
(vi) A high bioturbation index with assemblages dominated by *Macaronichnus segregatis* and *Chondrites*, and large vertical forms, such as *Diplocraterion*.

These characteristics indicate that the sands were deposited in a high-energy, wave-dominated nearshore environment, in which there was extensive reworking of glauconitic offshore marine deposits. The maximum preserved thickness of transgressive sediment in the B2 interval is 12m and contains multiple minor ravinement surfaces with erosional contacts and *Glossifungites* ichnofacies.

B1

The uppermost Bluesky unit consists of a progradational lower- to middle-shoreface succession that is incised by a single overlying transgressive shoreface unit (Figure 3). The Bluesky B1 to B3 succession is also characterized by the absence of channel deposits.

Depositional History

The B1 and B3 progradational units were deposited along NW-SE- trending shorelines that paralleled the northern edge of the pre-Cretaceous ridge. In contrast to this, the B2 transgressive sands have a NE-SW trend that is perpendicular to regional Bluesky shoreline trends (Figure 2).

The most extensive and mappable transgressive unit, the T1, is present at the base of the B2, overlying a regional transgressive surface of erosion (Figure 3). The T1 unit is between 1m and 3m thick and covers an area of some 70 townships.

The formation of minor ravinement surfaces within the B2 and the deposition of multiple, stacked transgressive deposits is related to fluctuations in the rate of transgression and corresponding sediment supply. These fluctuations may have given rise to local episodes of progradation and transgression. These minor ravinement surfaces cannot be correlated in the subsurface. The landward termination of the transgressive shorelines is not preserved due to erosion in a southerly direction, near to the tectonically stable pre-Cretaceous ridge.

The main anomalous characteristic of the B2 transgressive sands are the thickening of the sands within the basin in an offshore direction with a NE orientation (Figures 2 and 3). The geometry of transgressive deposits often reflects underlying topography, and the thickest transgressive deposits are preserved in areas with greater available accommodation space, such as tectonically subsiding areas. The B2 sands appear to have been deposited and preserved in an area of NE-SW trending tectonically enhanced subsidence, paralleling the nearby Hay River Fault Zone.

Acknowledgment

The author wishes to thank Talisman Energy for their support in carrying out much of this work.

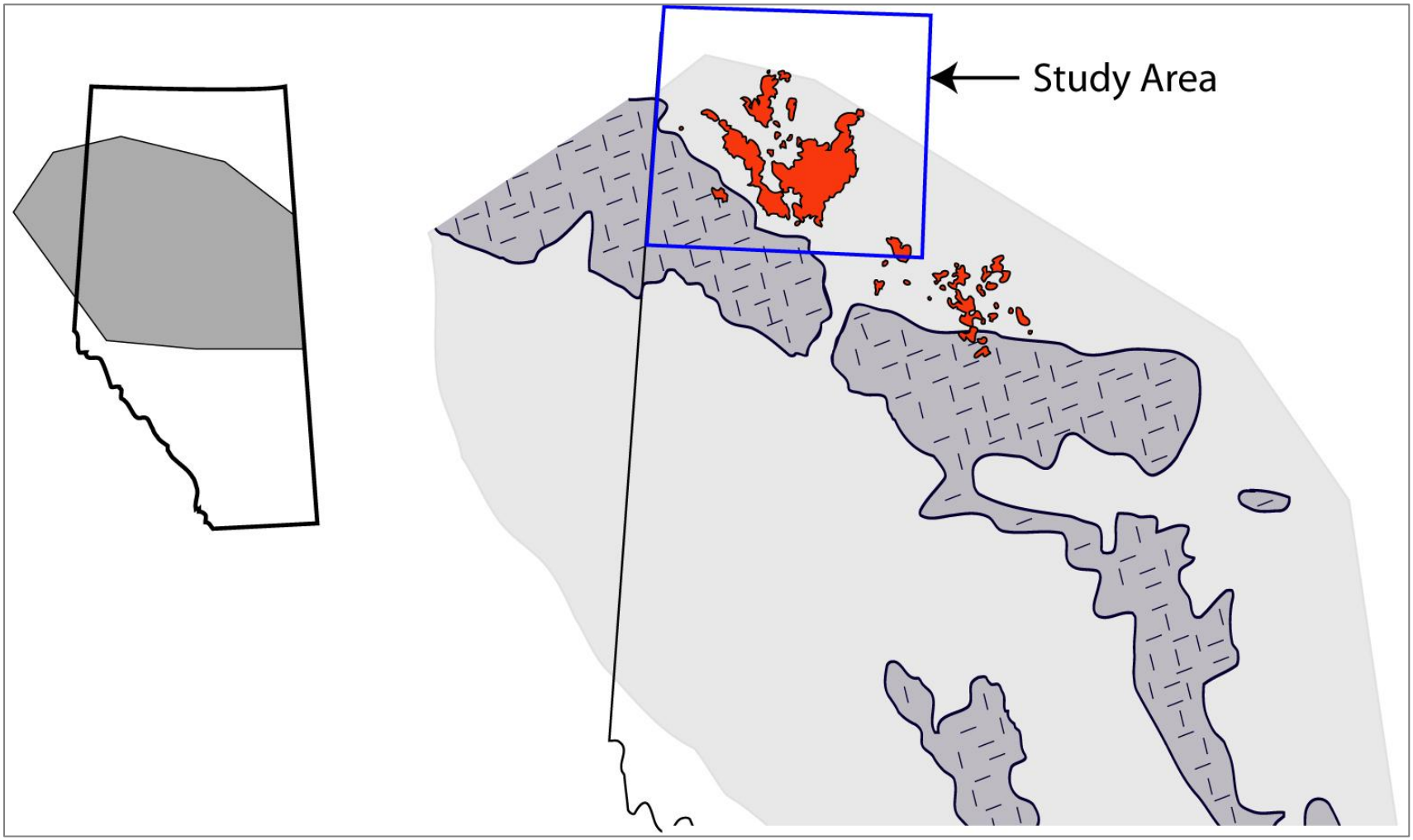

Figure 1. Location of the Central Alberta Ridge and study area. Bluesky/Gething production north of the ridge is shown in red.

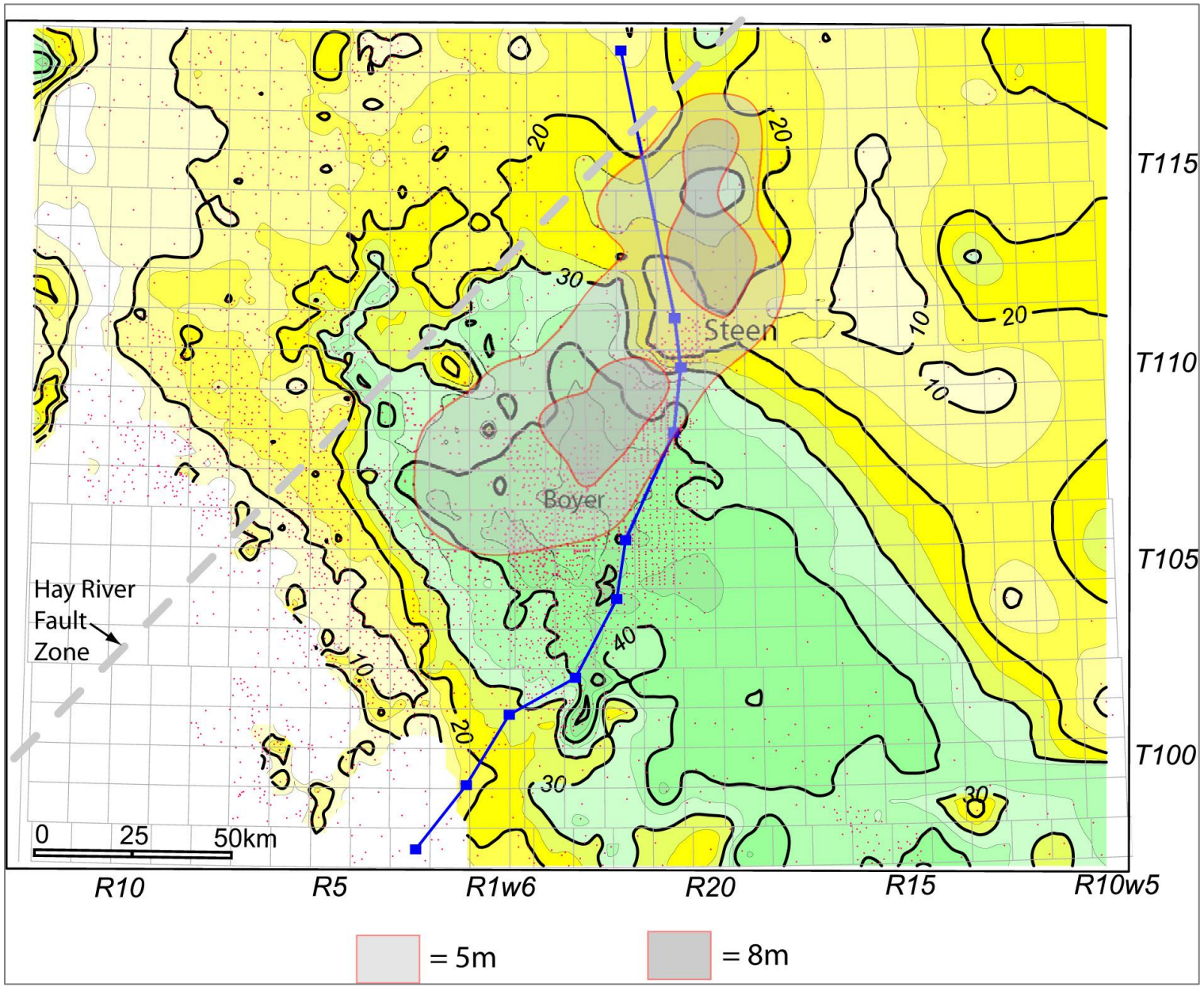

Figure 2. Bluesky and Gething Isopach, with data points Line of cross-section in Figure 3 is shown 0 25 50km Hay River Fault Zone. Transparent grey overlay is an isopach of the B2 transgressive sand.

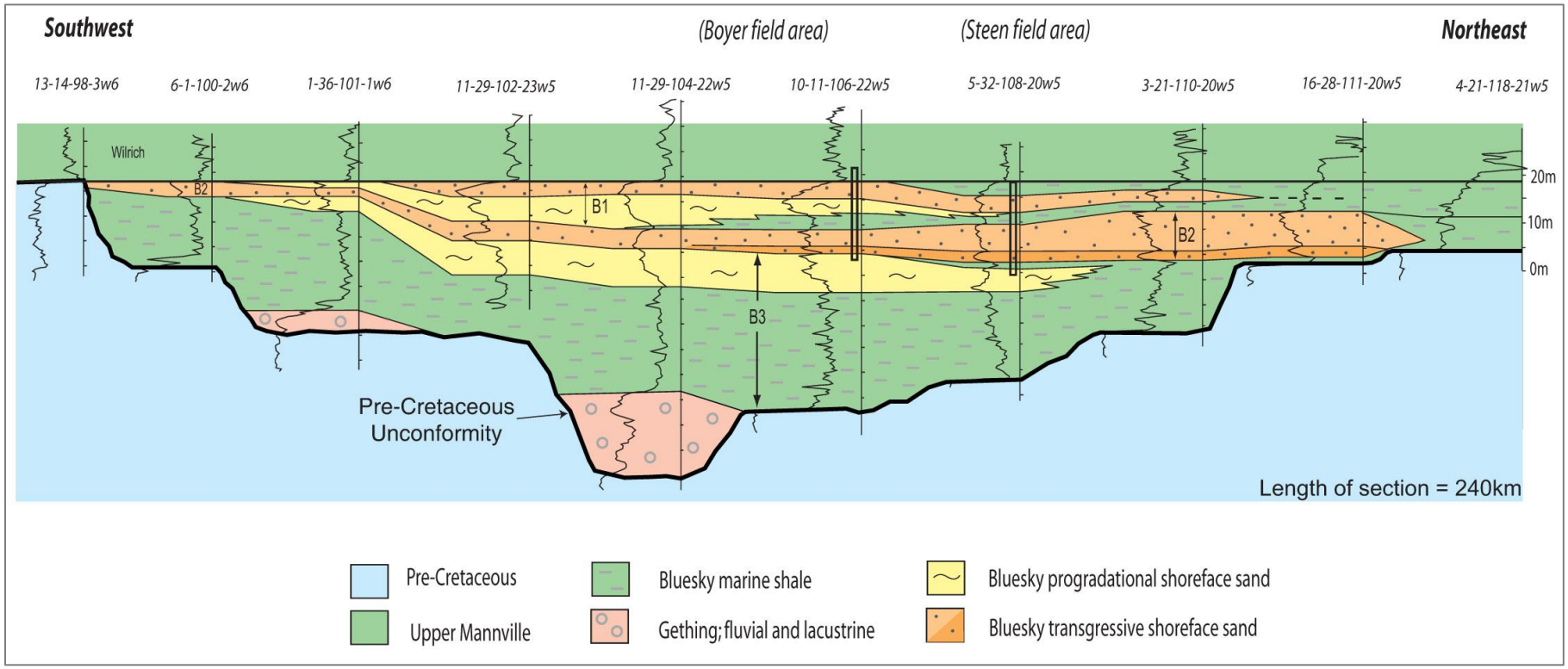

Figure 3 - Stratigraphic cross-section through Bluesky and Gething Formations, Boyer and Steen field areas. Location of cross-section is shown in Figure 2.

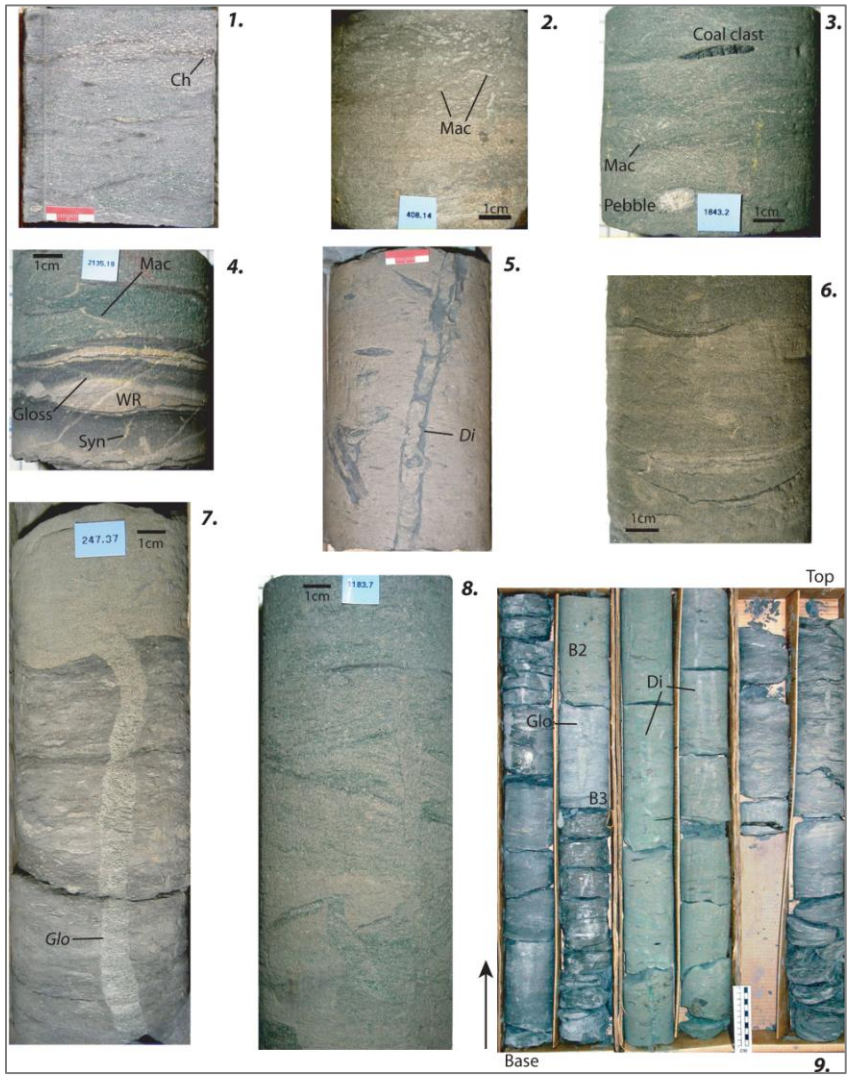

Figure 4. Transgressive sands: 1. *Chondrites* in fine-grained muddy sand. 2. *Macaronichnus segregatis* in fine-grained sand. 3. Highly glauconitic, fine-grained sand with quartz pebble, coal clast, and *M. segregatis*. 4. Contact between underlying B3, with syneresis and wave ripples and glauconitic B2 with *M. segregatis.* 5. *Diplocraterion.* 6.Wave-rippled fine- to medium-grained sand. 7.Vertical *Glossifungites* at base of B2. 8. Trough cross-stratified sands. 9. Transgressive T-sand unit; erosional base with *Glossifungites;* highly glauconitic green sand, fining upwards into marine shale. Ch = *Chondrites*; Mac = *Macaronichnus* ; Di = *Diplocraterion*; Glo = Glossifungites; Sy - syneresis cracks; Wr = wave ripple.

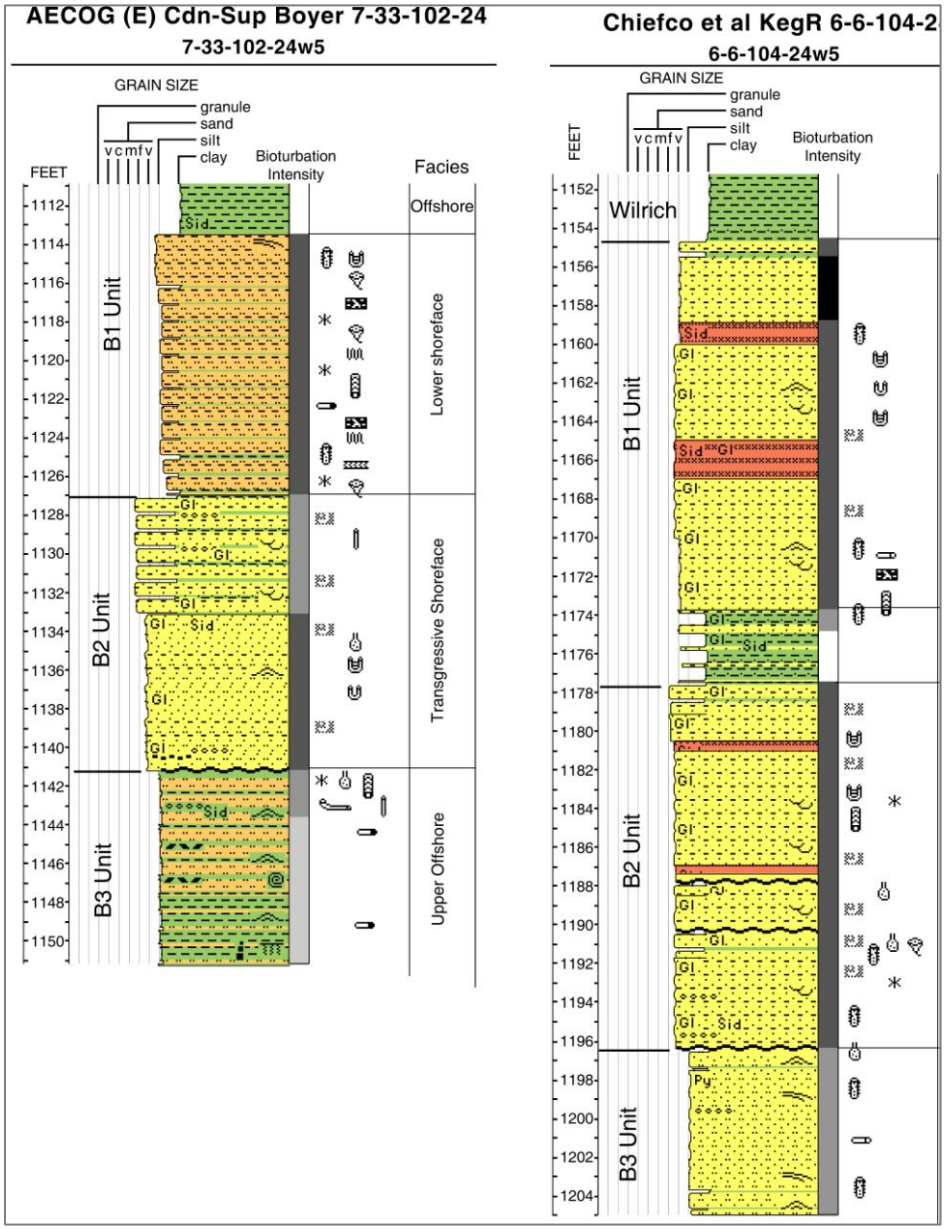

Figure 5. Bluesky core descriptions, AECOG (E) Cdn-Sup Boyer 7-33-102-24w5 and Chiefco et al. KegR 6-6-104-24w5.

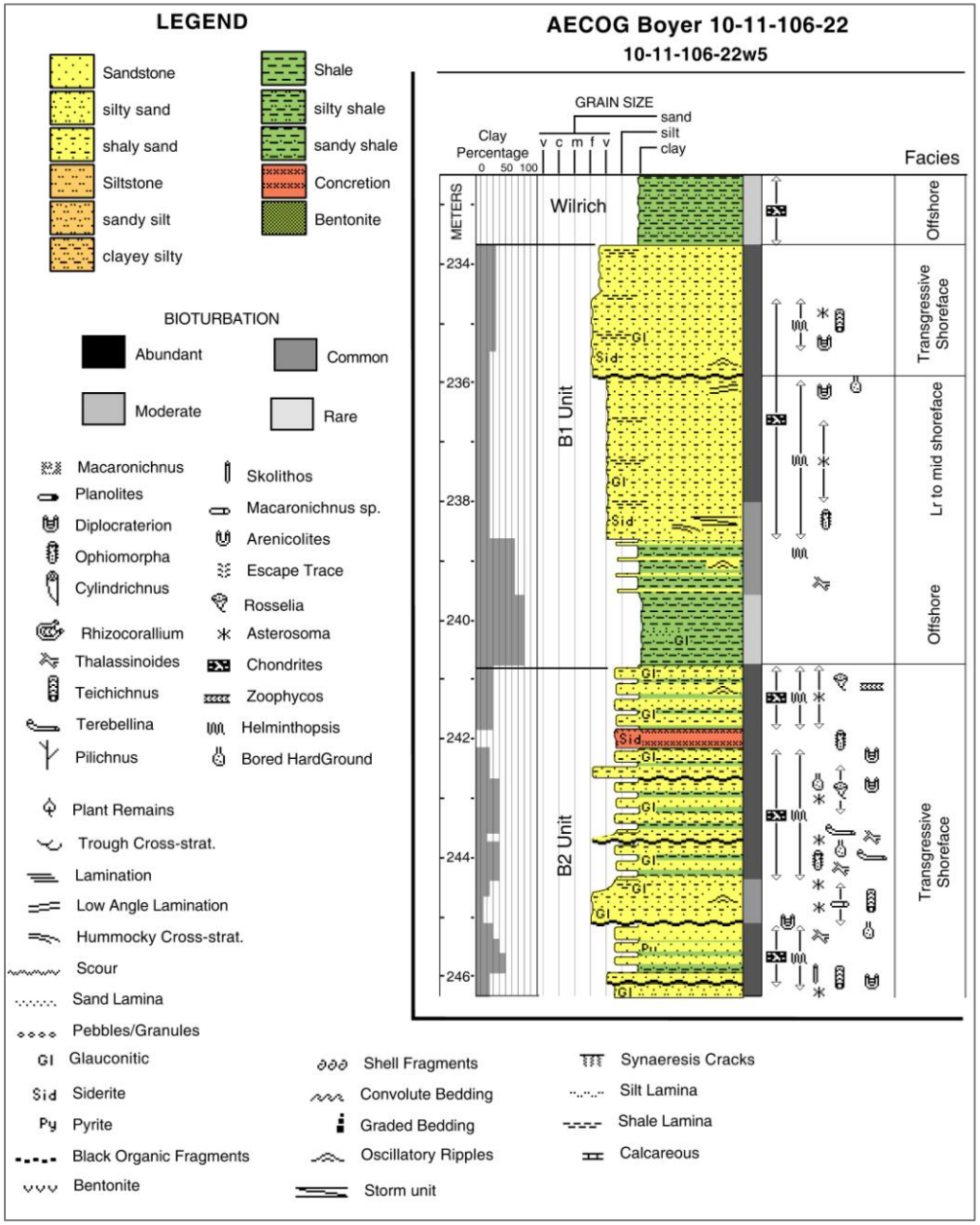

Figure 6. Bluesky core description, AECOG Boyer 10-11-106-22w5, with legend. Well log is in Figure 3.

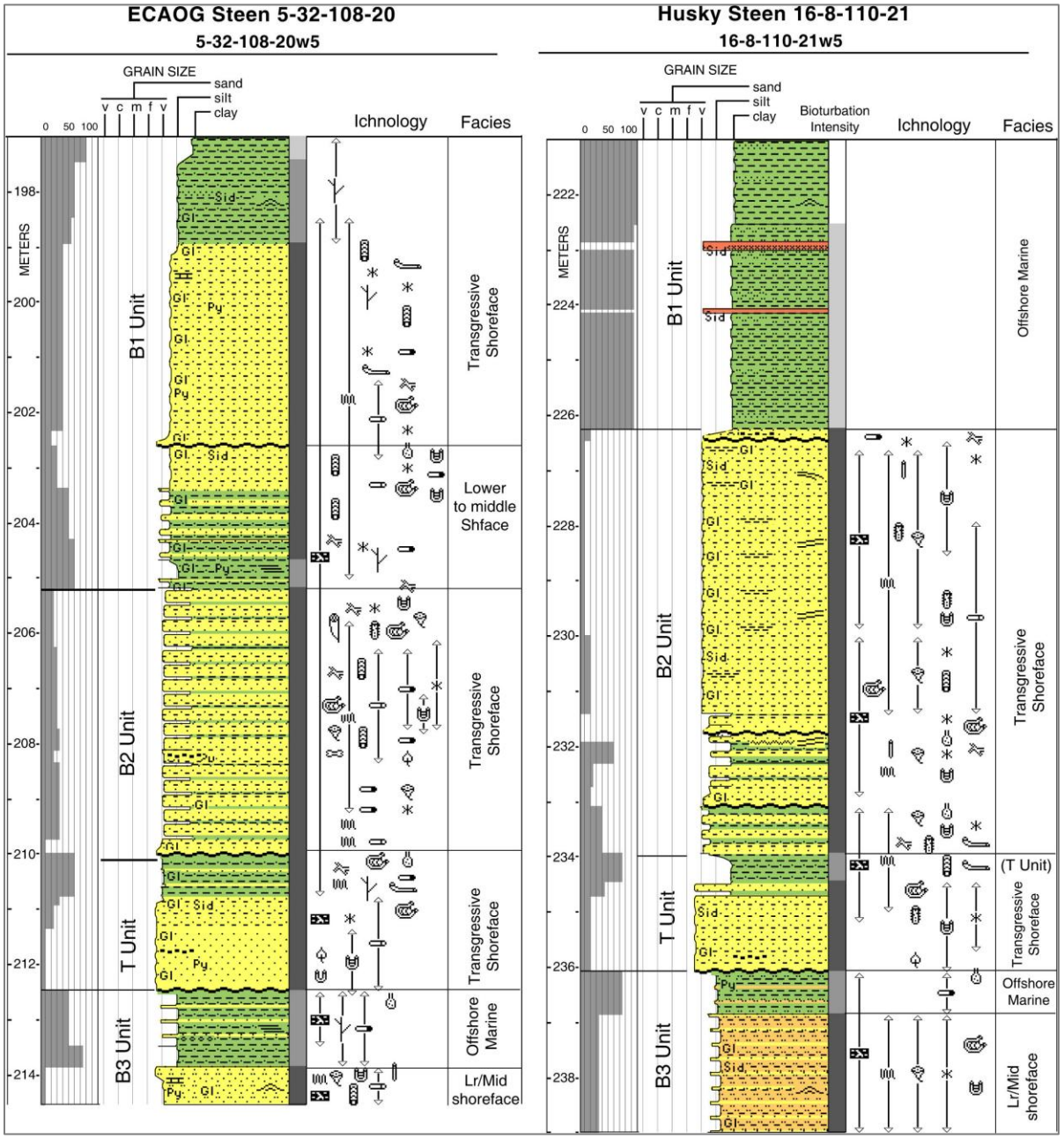

Figure 7. Bluesky core descriptions, ECAOG Steen 5-32-108-20w5 and Husky Steen 16-8-110-21w5. The well log of the former is in Figure 3.