David Piper and Atika Karim ABSTRACT

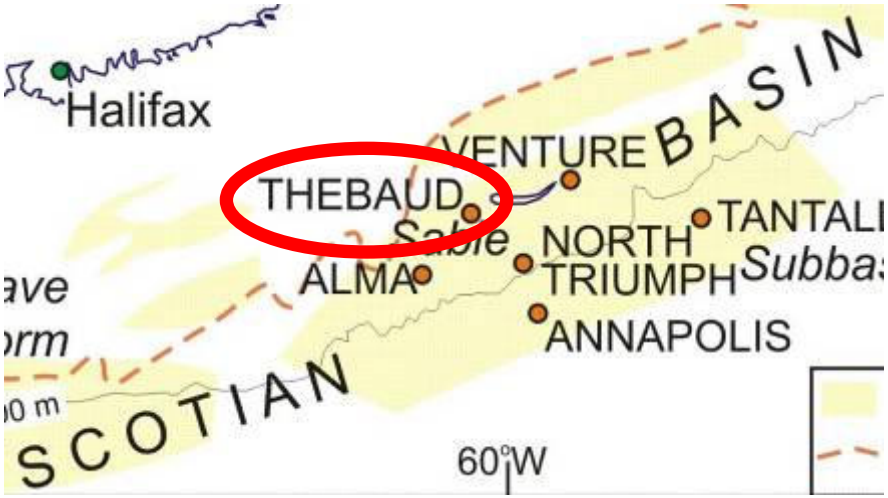
Hyperpycnal flow deposits, or “delta-front turbidites”, are becoming increasingly recognised as important components of some deltaic systems. The presence of Bouma Tabce or Tbce sequences in sandstones, with unidirectional climbing current ripples and basal flute marks are the most diagnostic sedimentological evidence of prodeltaic hyperpycnal flows (Bhattacharya and Tye, 2004; Hampson and Howell, 2005; Myrow et al. 2006). Such beds may be capped by wave-generated oscillatory ripples and the tops are commonly strongly bioturbated. Laminae of phytodetritus are common in the sandstones and the Te division commonly has a high organic content (Rice et al. 1986). Delta-front turbidites show distinctive ichnological suites (MacEachern et al. 2005) as a result of rapid event deposition and changes in oxygenation and salinity. Some coarse-grained cross-bedded sandstones have been interpreted as deposits of predominantly by-passing prodeltaic hyperpycnal flows (Edwards et al. 2005) and turbidite channels and lobes are interpreted as significant components of shelf facies models (Pattison, 2007). Hyperpycnal mud turbidites are also recognised in prodelta settings (Leithold and Dean, 1998), with sedimentological characteristics summarized by Piper and Stow (1991). Delta-front turbidites show many similarities to sandstone beds termed tempestites, that are interpreted to result from storm resuspension of littoral sand. Myrow et al. (2002) have demonstrated that well sorted sandstone beds showing Bouma sequences and basal unidirectional flute marks have climbing ripples with convex-up and sigmoidal foresets that are characteristic of mixed wave and current motion.

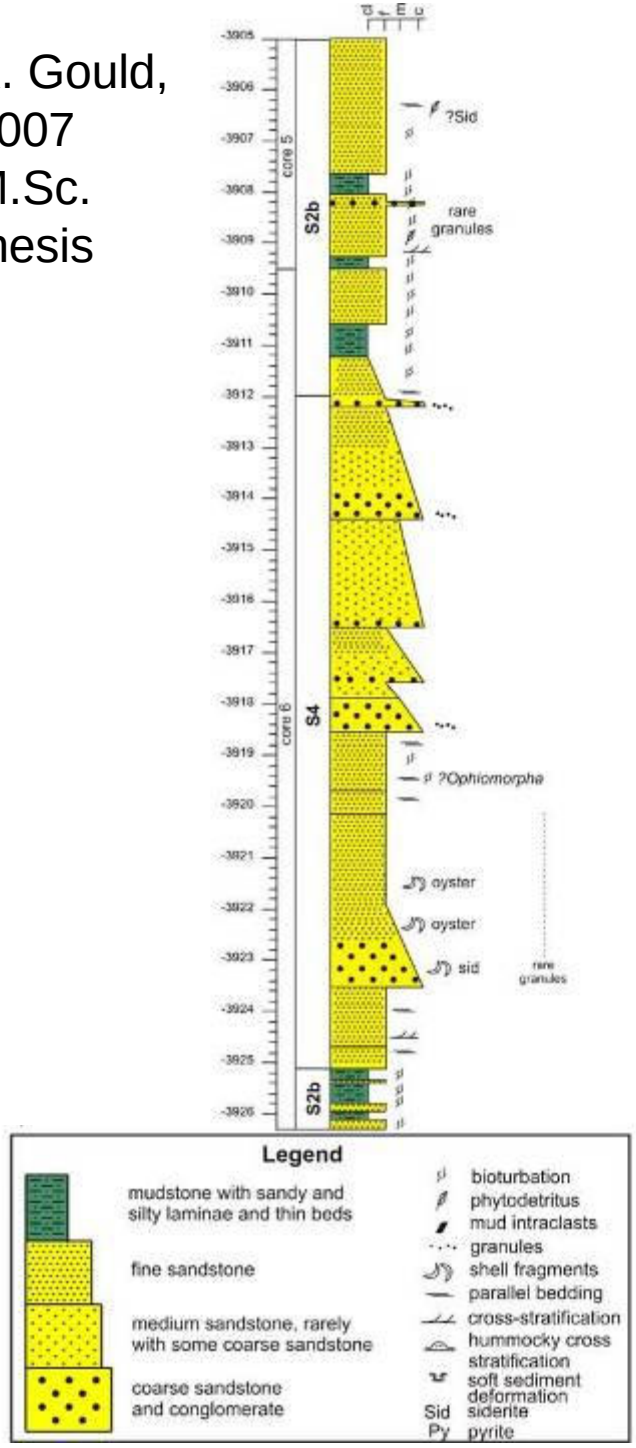
These concepts will be illustrated by selected core, principally from the Thebaud field. Thick bedded reservoir sandstones from fields such as Thebaud appear to be inner shelf hyperpycnal deposits (facies 9), forming graded sandstone beds decimeters to metres thick, with Bouma Ta-Tc sequences, abundant phytodetritus, detrital intraclasts of mudstone and siderite, and minor bioturbation at the top of beds. This facies passes stratigraphically upward into tidally influenced river-mouth and river-channel sandstones (facies 4) and downward into thinner graded sandstone beds with interbedded mudstone (facies 0). More highly bioturbated thin bedded sandstones (facies 2) in places show hummocky cross-stratification, concentration of shells at the base of beds, and wave-ripples, suggestive of storm reworking. In the Glenelg field, tidally-influenced hypopyncal silts interbed with hyperpycnal sands and both change character distally.

The recognition of hyperpycnal flow deposits has important implications for reservoir geometry and diagenesis.

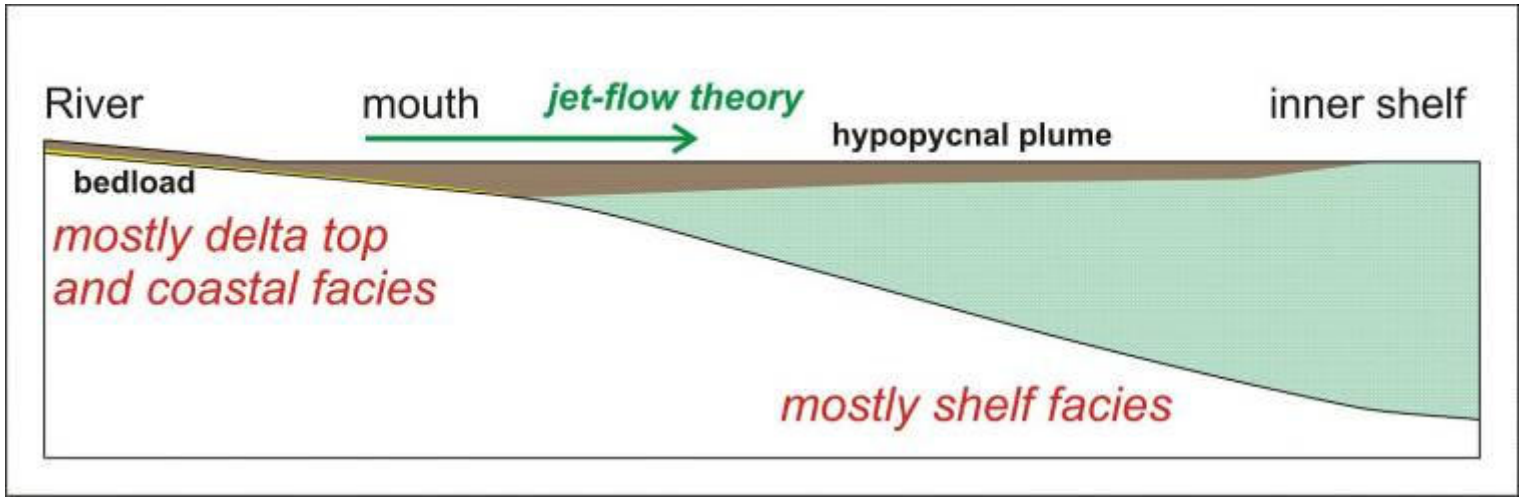
Hyperpycnal flow deposits from the Thebaud field

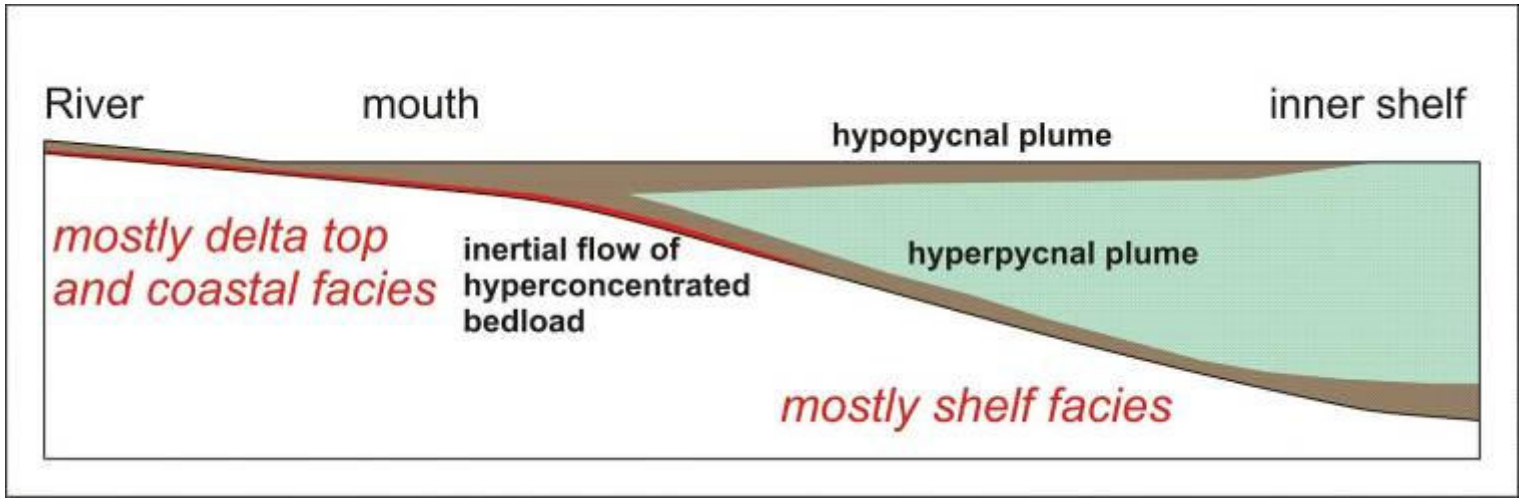
K. Gould, 2007 M.Sc. thesis

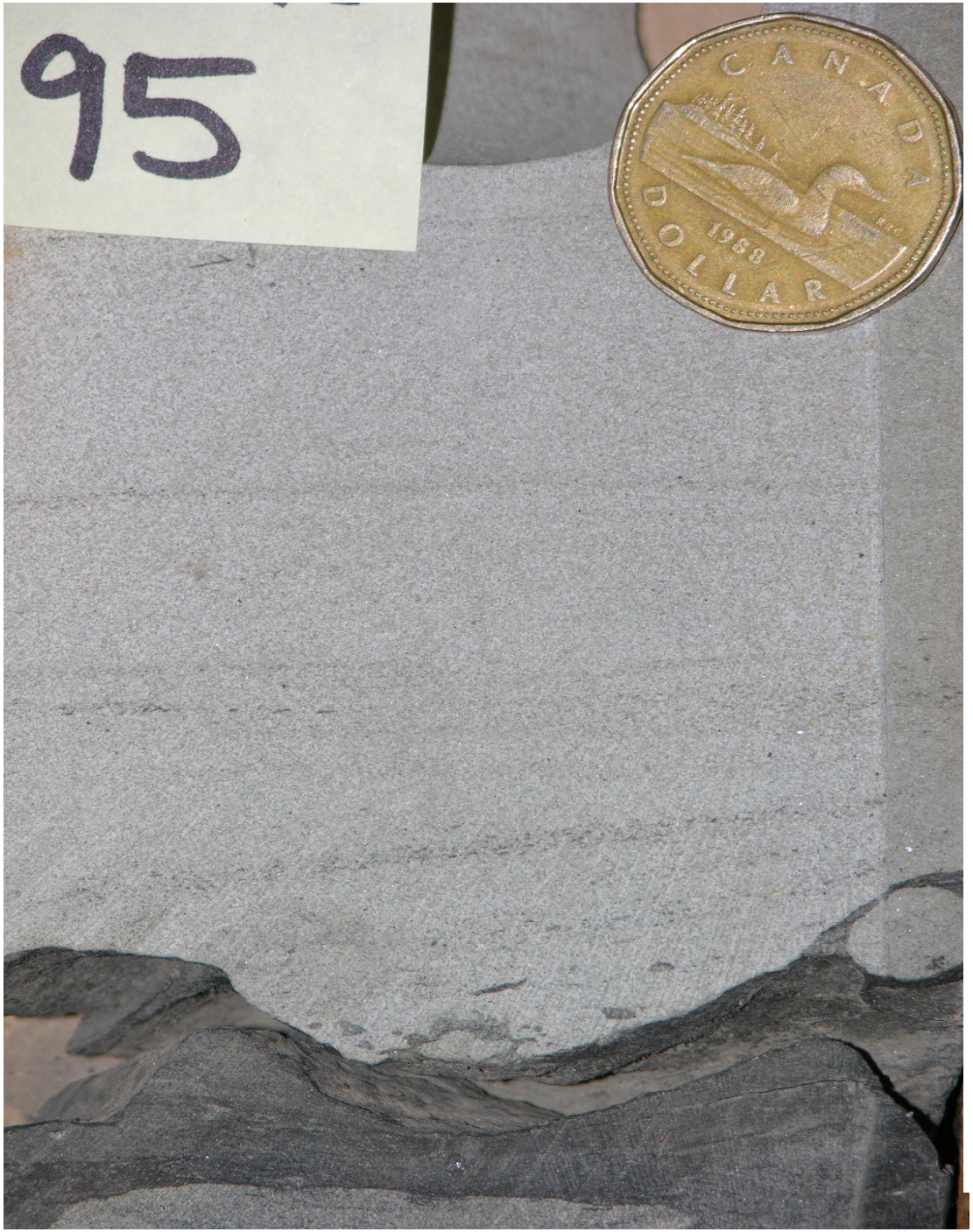




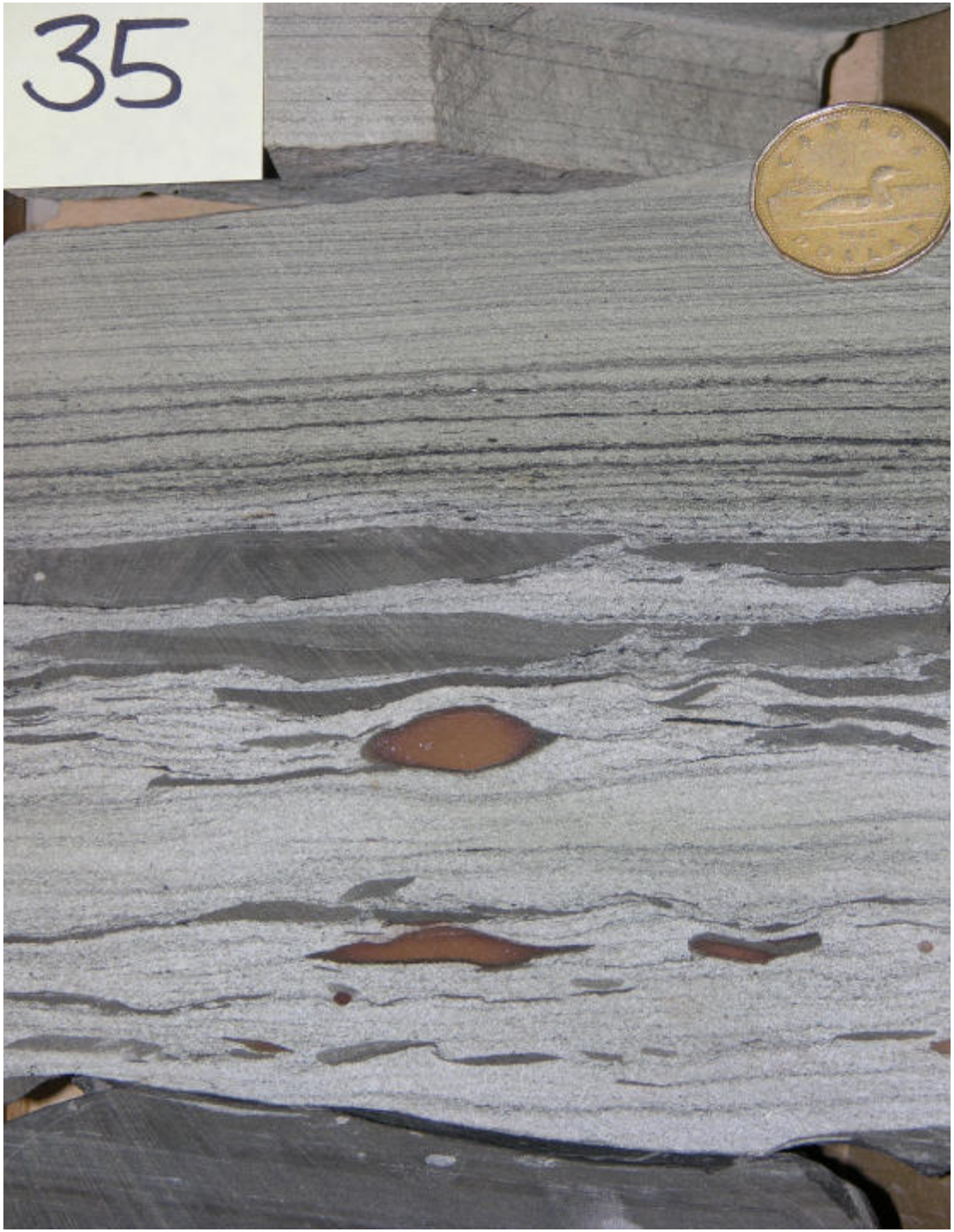
– 2 m thick event beds interbedded with marine facies


River
mouth
jet-flow theory
inner shelf
hypopycnal plume
bedload
mostly delta top
and coastal facies
mostly shelf facies


River
mouth
inner shelf
hypopycnal plume
mostly delta top
and coastal facies
inertial flow of
hyperconcentrated
bedload
hyperpycnal plume
mostly shelf facies



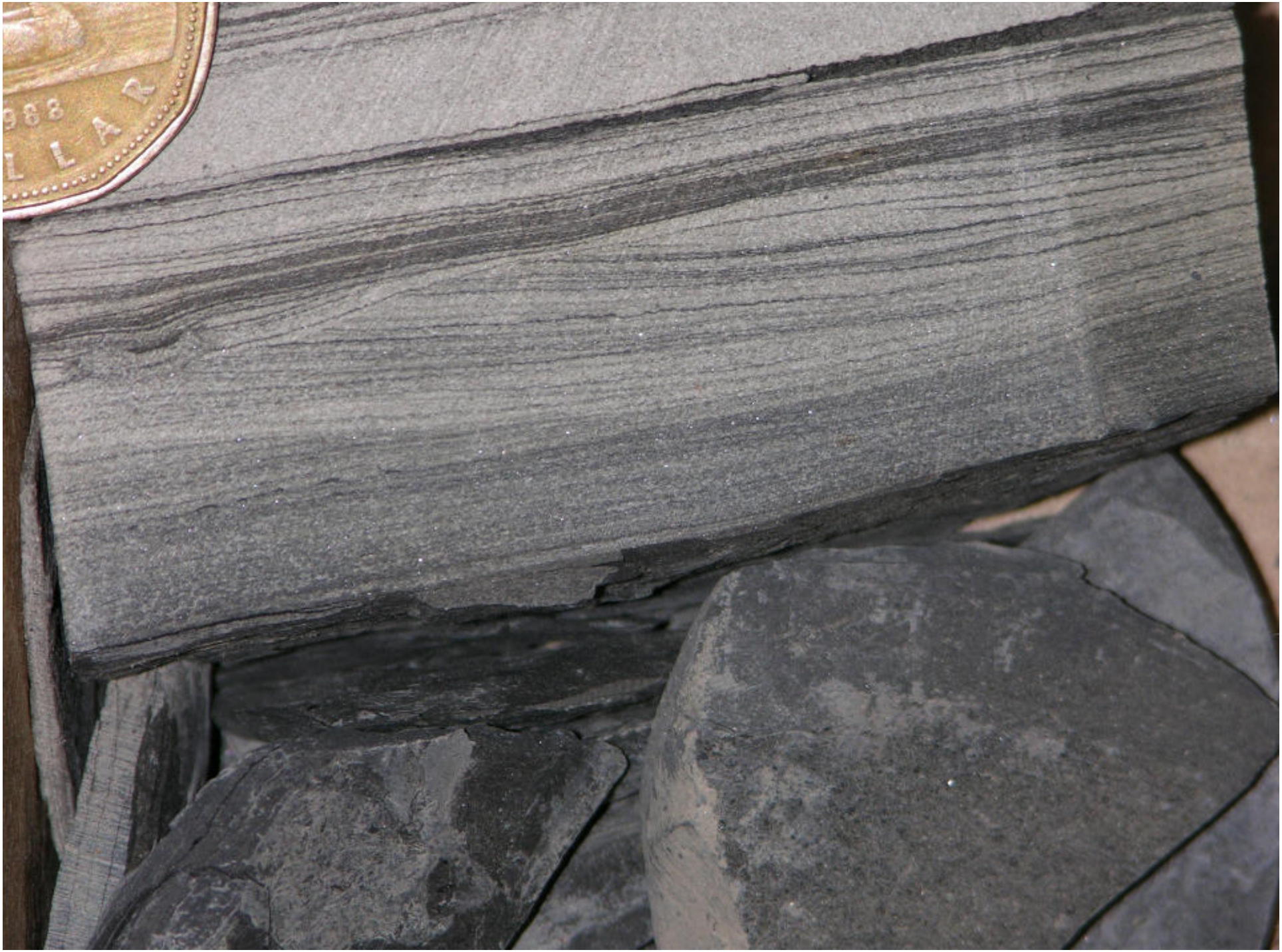
Graded beds with abundant detrital wood and siderite or black mudstone intraclasts, flute-like erosion at base of bed, interbedded with variably bioturbated black mudstones. These beds are interpreted to be deposited from prodeltaic hyperpycnal flows from high gradient rivers.



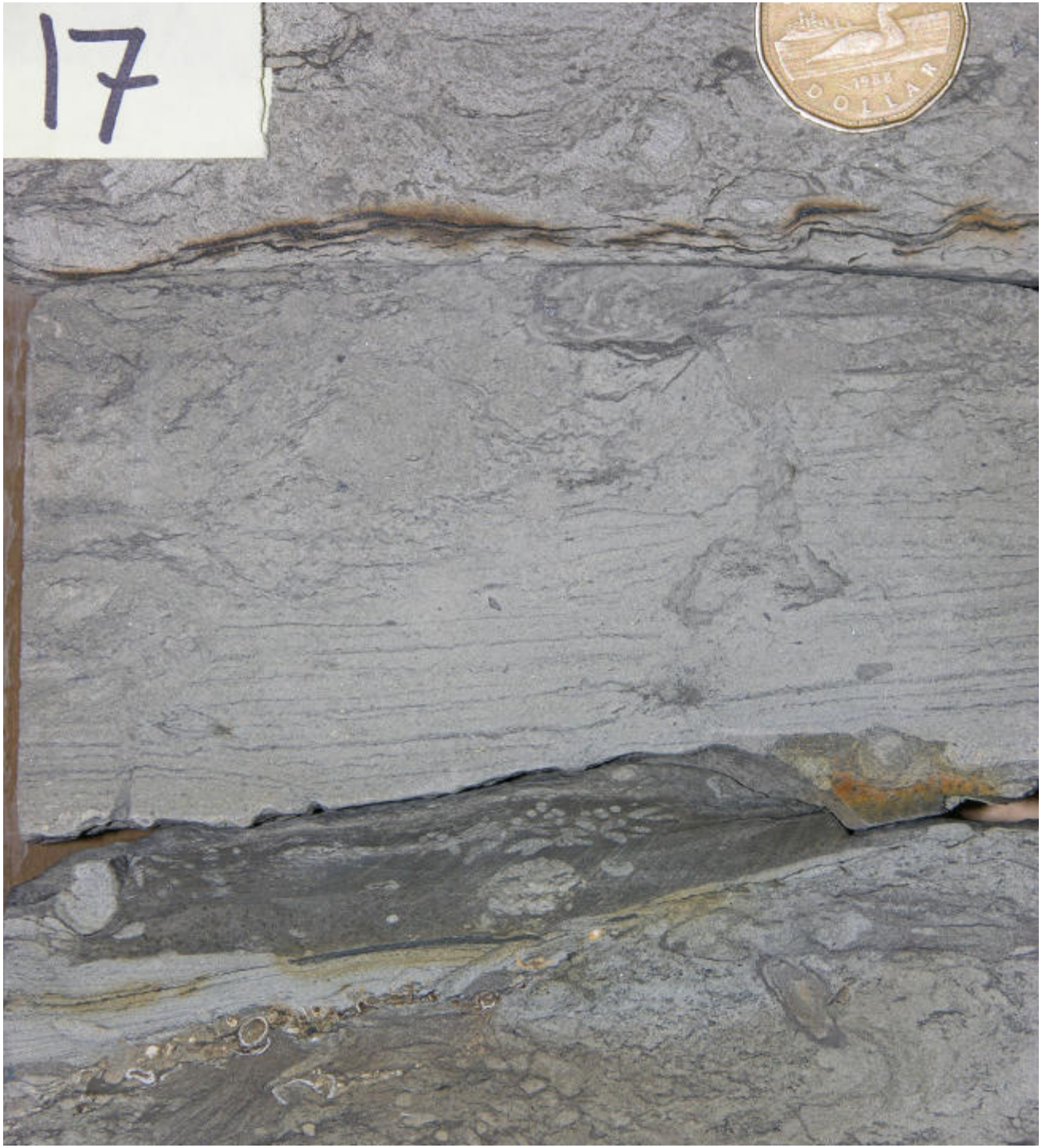
Sharp based graded bed with siderite intraclasts and phytodetritus, suggestive of river supply.

Interpreted as a hyperpycnal bed within a bioturbated marine prodeltaic sequence.

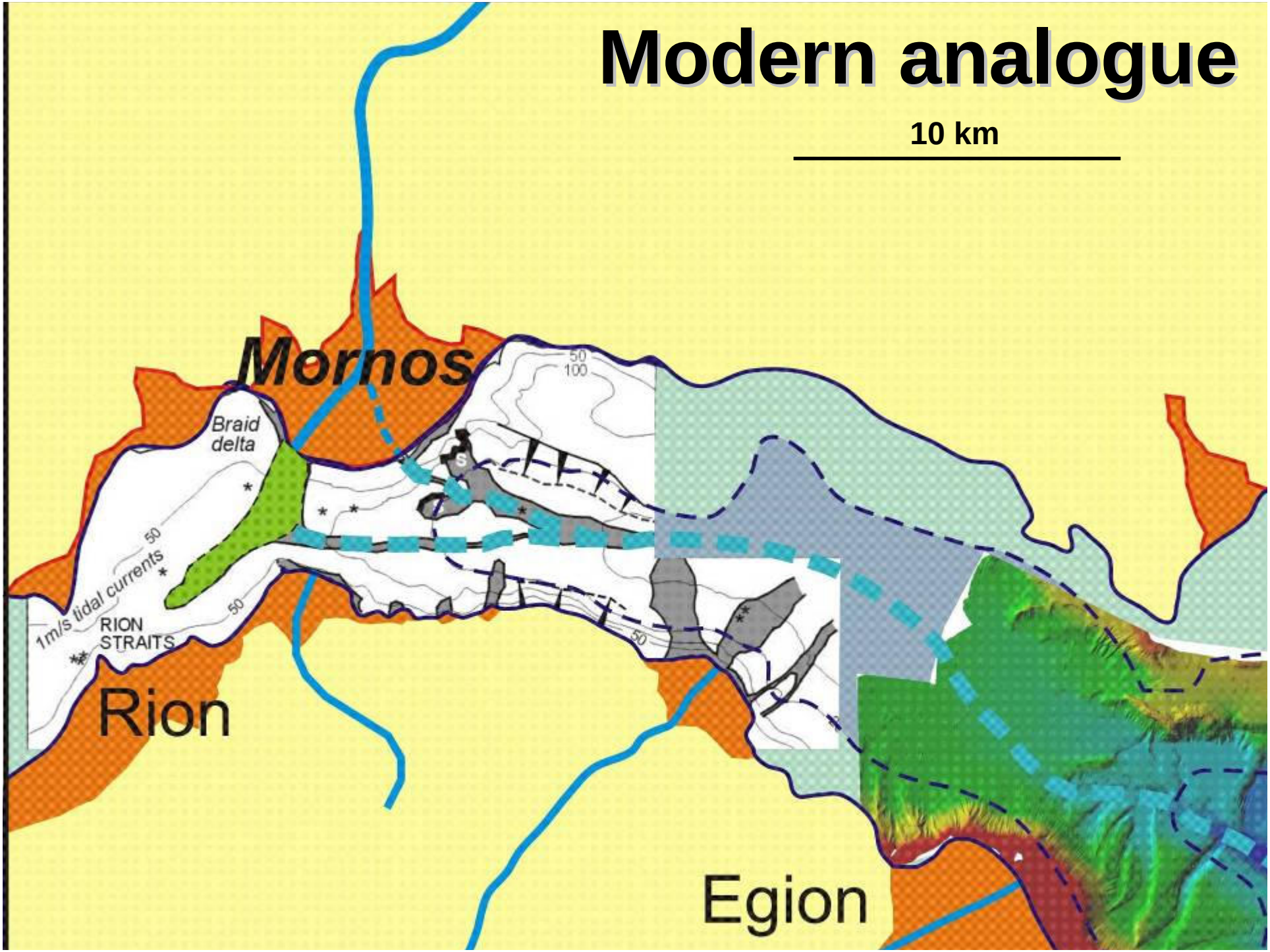
Thebaud field.



Abrupt transitions from very coarse to fine sandstone and to mudstone. May represent inertial bedload flow followed by hyperpycnal wash load, then hypopycnal plume deposit.
Thebaud field.



Bioturbated graded bed, large plant fragments near top. Below, concentrated shelly fossils. Interpreted as a hyperpycnal bed overlying a storm-reworked layer.
Thebaud field.


Modern analogue
10 km
Mornos
Braid
delta
50
100
50
1m/s tidal currents
RION
STRAITS
50
50
Rion
Egion

Ancient analogue

- Book Cliffs

all from Pattison et al. 2007 Sedimentology