Permian aeolian sediments

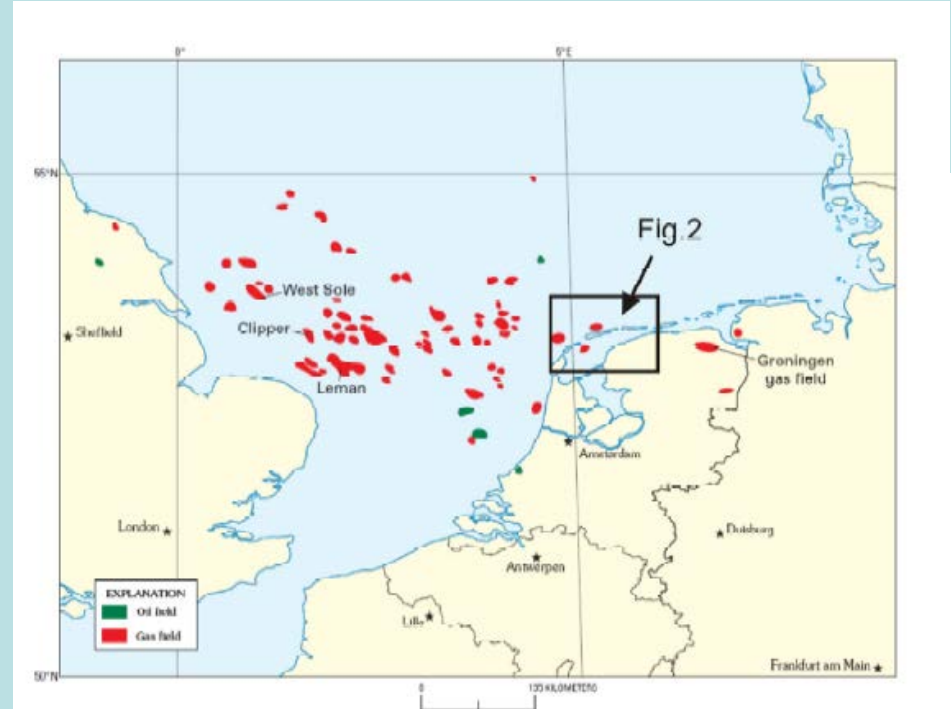
Velledits Felicitász

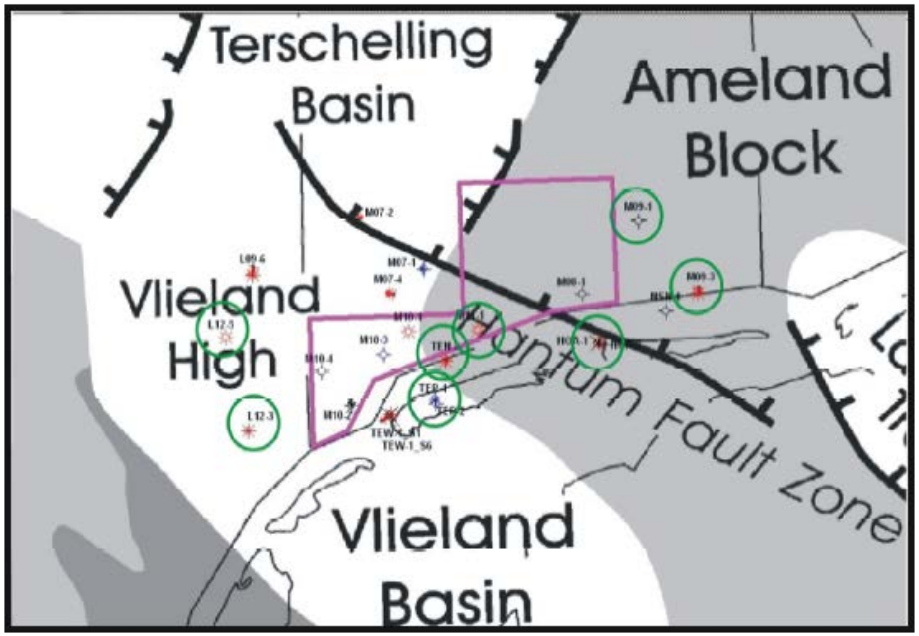
To build up a reservoir model

- Every good reservoir model is based on geological (sedimentological) model
- 1). Core logging: description, identify facies packages.
- 2). To tie facies packages to wireline log signals.
- 3). Regional correlation of facies packages and log signals
- 4). To build block-wide facies and reservoir property distribution maps.

- Regional setting

(where are we in the word?)





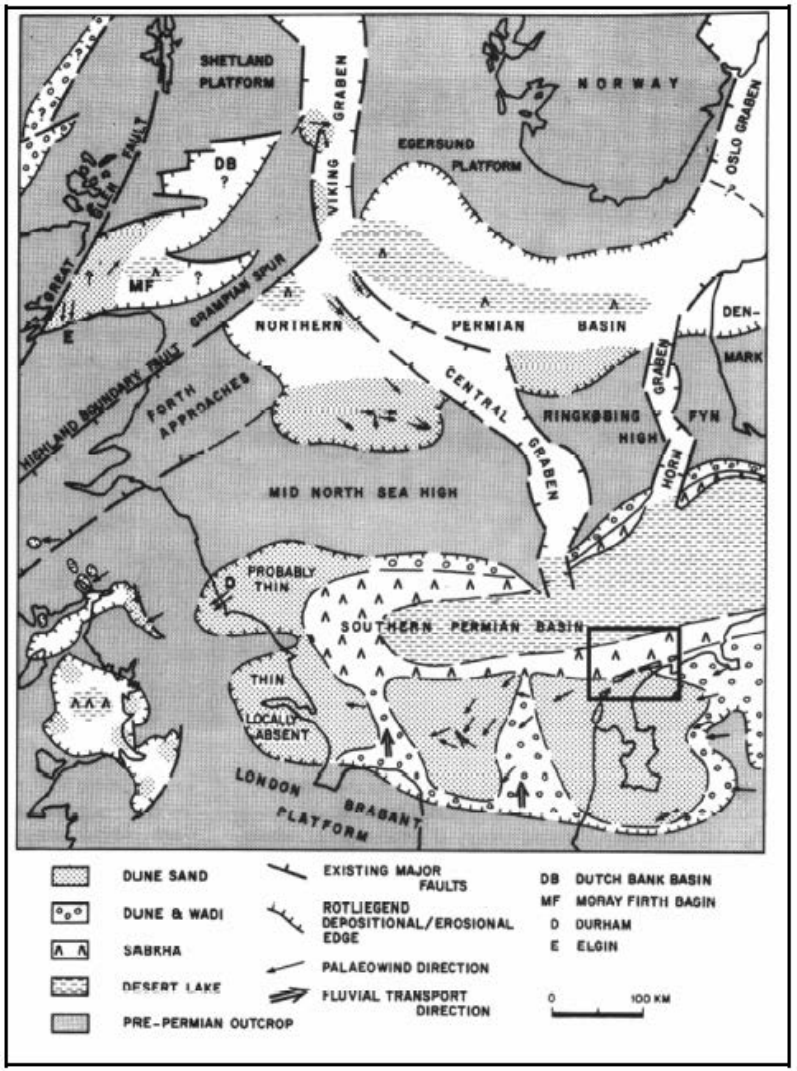


Figure 3 Palaeogeography of the Rotliegend in the southern Permian Basin (after Glennie 1998). The study area is indicated by the inset.

Stratigraphic position
(where are we in the time?)

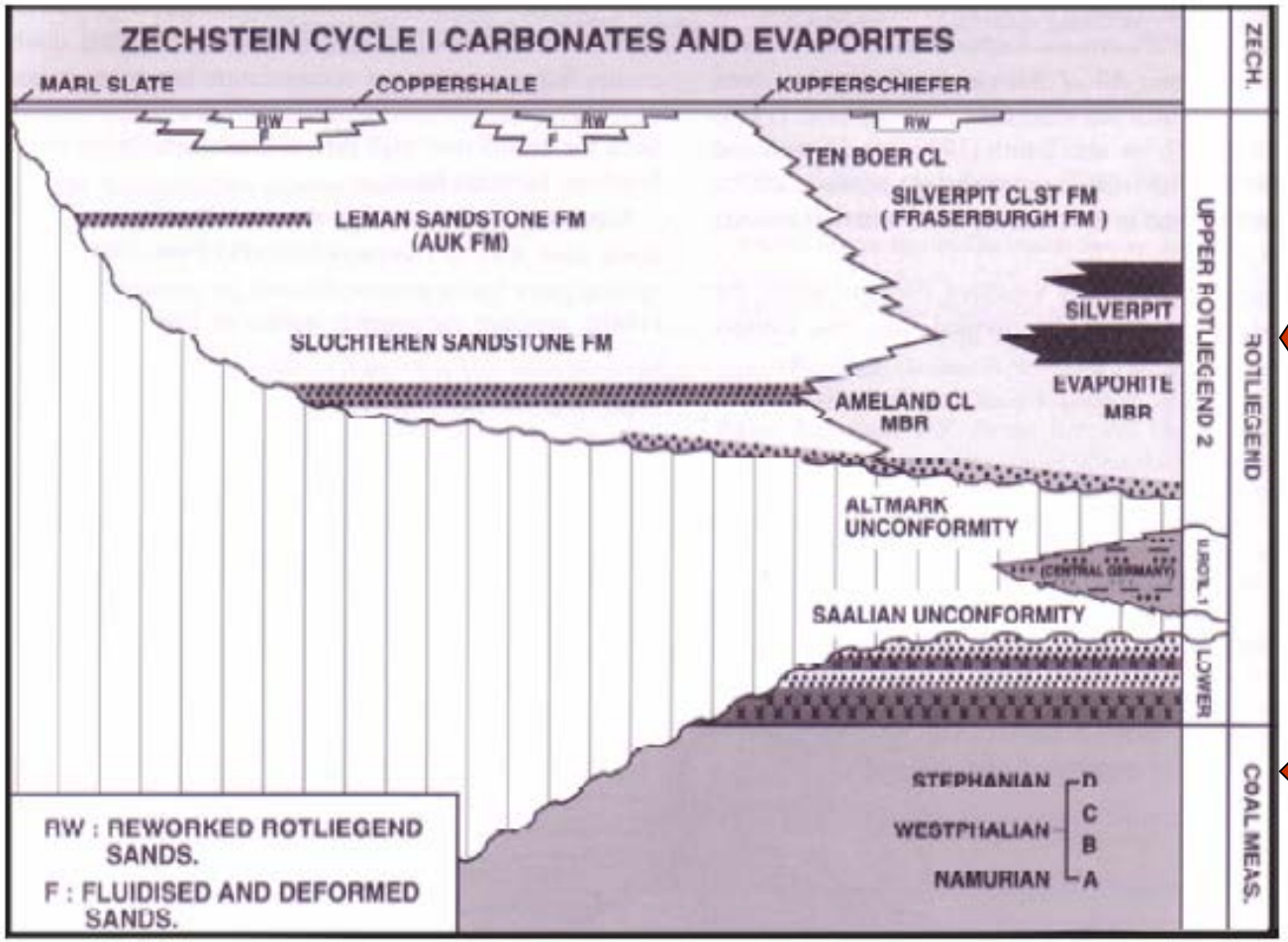


Figure 4 Stratigraphic relationships in the Rotliegend of the southern North Sea.

Seal

Pay zone

Source rock

Permian

Carboniferous

To built up a reservoir model

- 1). Core logging: description, identify facies packeges.

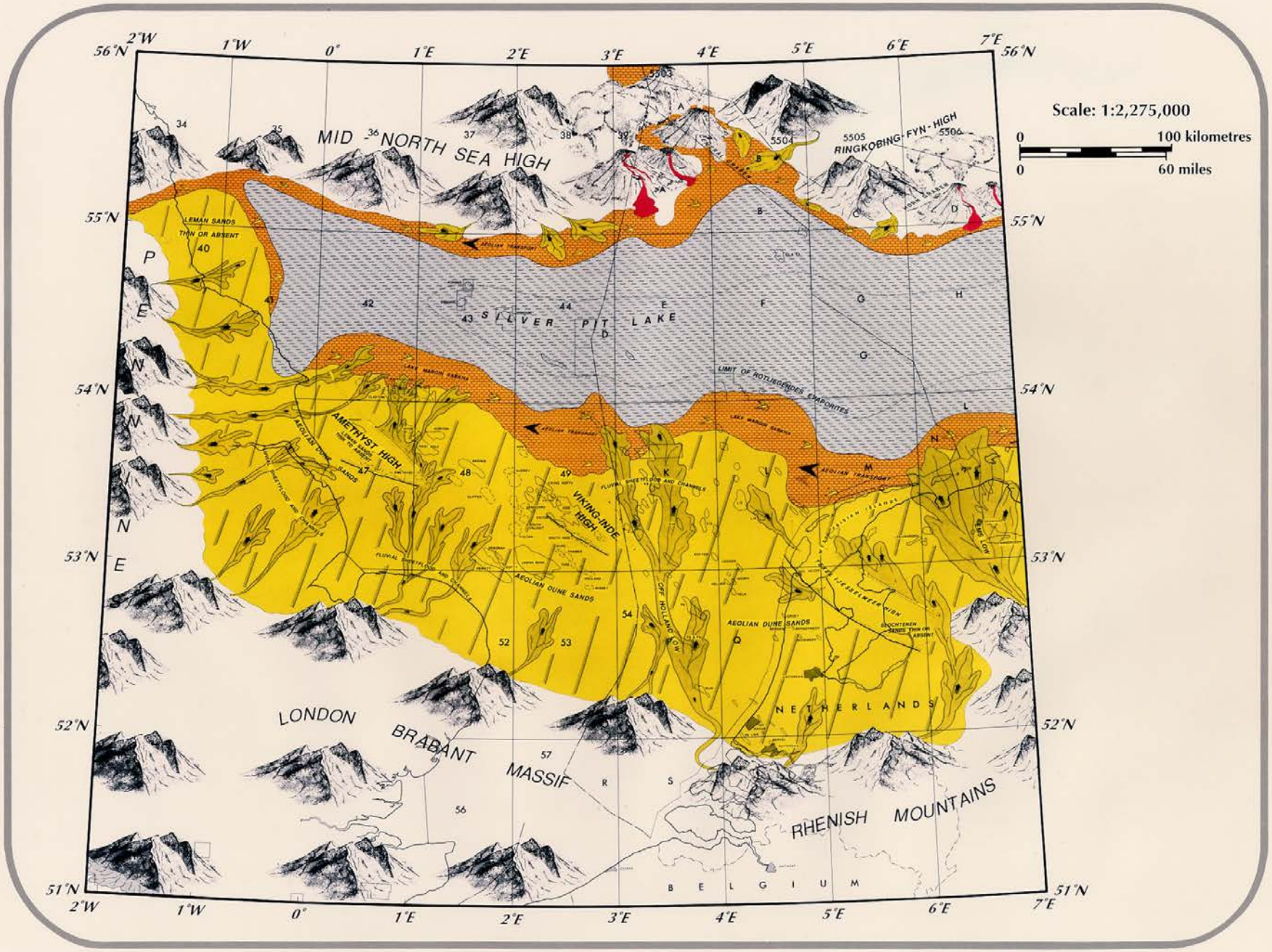
Cores were loged on a scale of 1:50

Recording

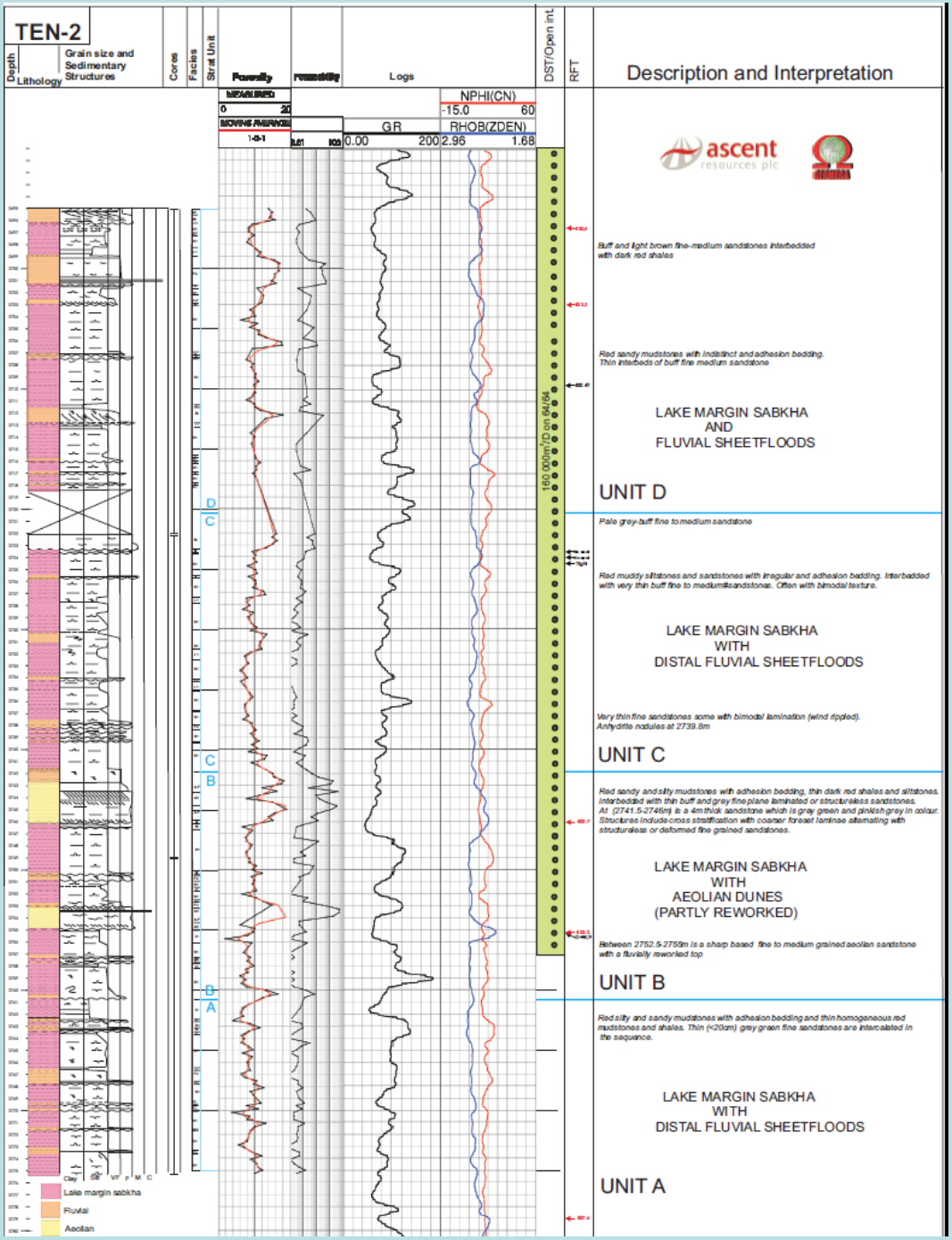
- lithology
- grain size
- sedimentary structures
- diagenetic features

Aeolian Dune	Dune top	A1
	Dune core	A2
	Dune base	A3
Aeolian Interdune	Dry interdune/interdune sheet	A4
	Damp interdune	A5
	Wet interdune	A6
Proximal fluvial	Alluvial fan	F1
	Alluvial channel	F2
Fluvial	Structured sheetflood	F3
	Dewatered sheetflood	F4
Sabkha	Lake margin sabkha	S1
	Inland sabkha	S2
Lacustrine	Playa Lake	L1
	Desert Lake (permanent)	L2
	Desert Lake (evaporative)	L3
Reworked	Fluvially reworked dunes	A-F
	Biogenically reworked:	
	Dunes	A*
	Fluvial	F*

Table 2 Facies scheme used in the core description (George and Berry, 1993).

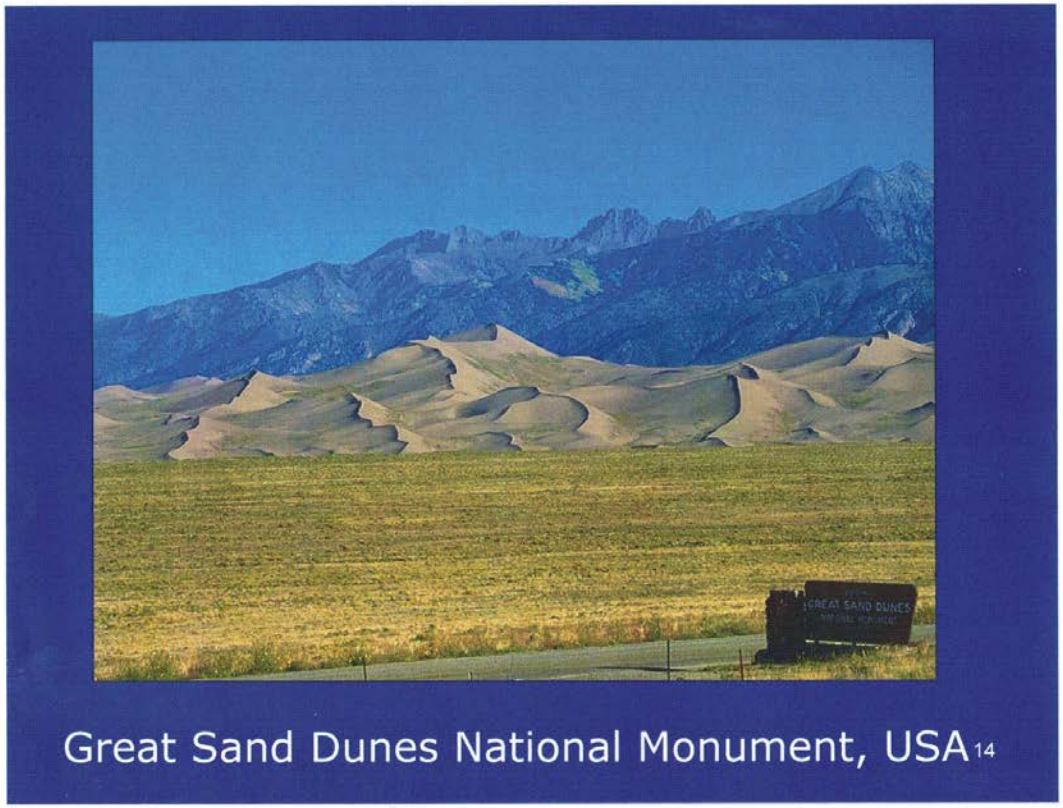


ROTLIEGENDES SLOCHTEREN / LEMAN SANDSTONE SCHEMATIC PALAEOGEOGRAPHY


TEN-2
Depth
Lithology
Grain size and Sedimentary Structures
Cores
Facies
Strat Unit
Porosity
Permeability
Logs
NPHI(CN)
-15.0 60
GR
RHOB(ZDEN)
0.00 200 2.96 1.68
DST/Open int.
RFT
Description and Interpretation
ascent resources plc
Buff and light brown fine-medium sandstones interbedded with dark red shales
Red sandy mudstones with indistinct and adhesion bedding. Thin interbeds of buff fine medium sandstone
LAKE MARGIN SABKHA AND FLUVIAL SHEETFLOODS
UNIT D
Pale grey-buff fine to medium sandstone
Red muddy siltstones and sandstones with irregular and adhesion bedding. Interbedded with very thin buff fine to medium sandstones. Often with bimodal texture.
LAKE MARGIN SABKHA WITH DISTAL FLUVIAL SHEETFLOODS
Very thin fine sandstones some with bimodal lamination (wind rippled). Anhydrite nodules at 2739.8m
UNIT C
Red sandy and silty mudstones with adhesion bedding, thin dark red shales and siltstones. Interbedded with thin buff and grey fine plane laminated or structureless sandstones. At (2741.5-2746m) is a 4m thick sandstone which is grey green and pinkish grey in colour. Structures include cross stratification with coarser foreset laminae alternating with structureless or deformed fine grained sandstones.
LAKE MARGIN SABKHA WITH AEOLIAN DUNES (PARTLY REWORKED)
Between 2752.5-2759m is a sharp based fine to medium grained aeolian sandstone with a fluvially reworked top
UNIT B
Red silty and sandy mudstones with adhesion bedding and thin homogeneous red mudstones and shales. Thin (<20cm) grey green fine sandstones are intercalated in the sequence.
LAKE MARGIN SABKHA WITH DISTAL FLUVIAL SHEETFLOODS
UNIT A
160 000m³/D on 64/64
Lake margin sabkha
Fluvial
Aeolian

Actualism

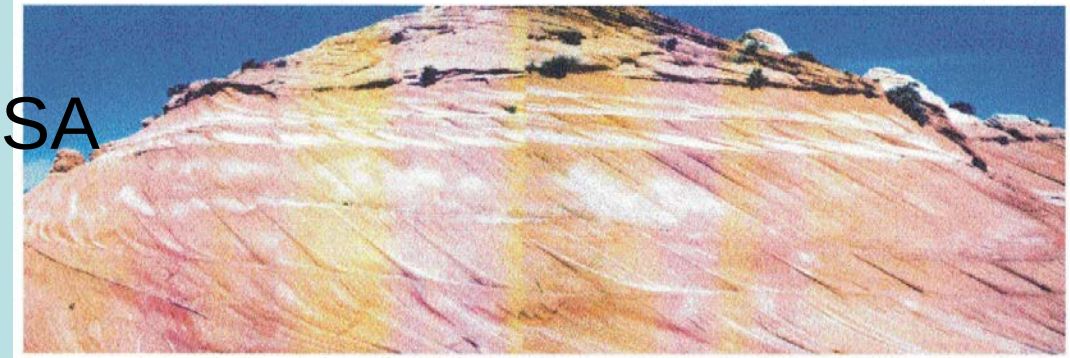
- **The principle that the same processes and natural laws that operated in the past are operating at present as well. The present is the key to the past.**



Great Sand Dunes National Monument, USA 14

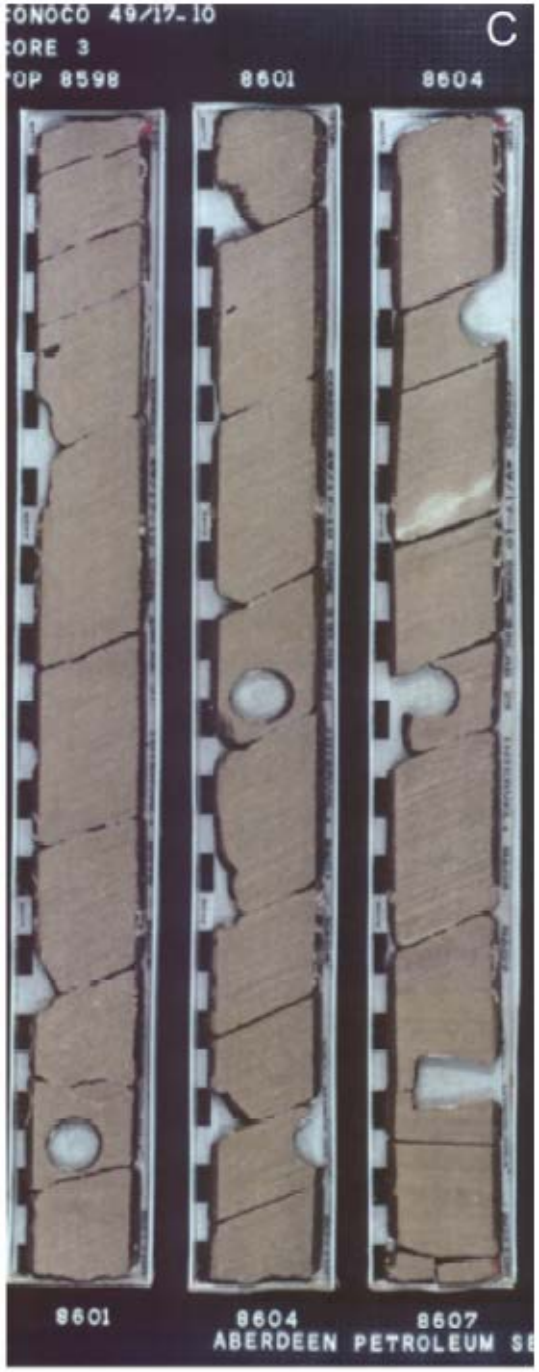
Present

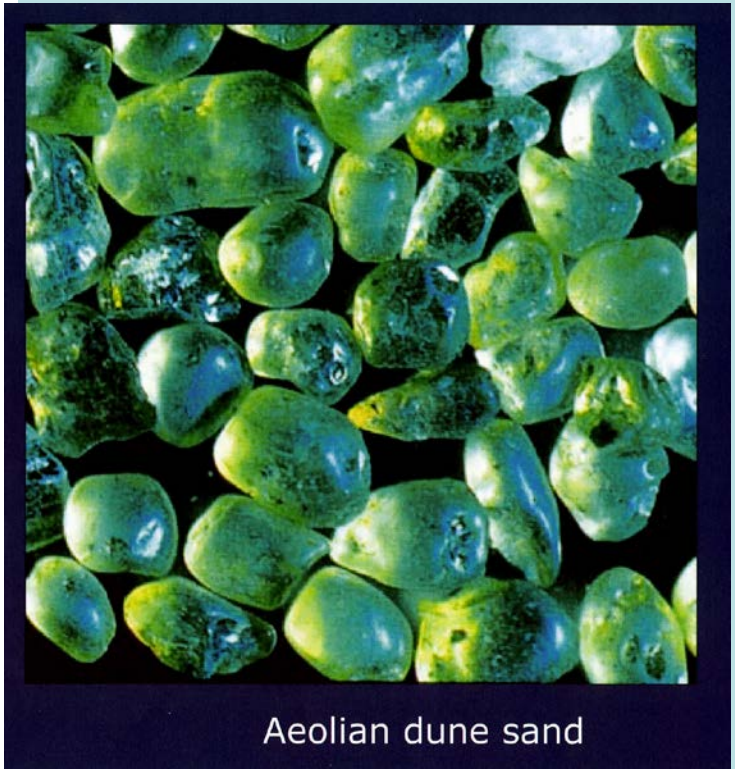
- Past: Jurassic Navajo Sandstone, western USA




A


B


C
8601
8604
8601
8604
8607
ABERDEEN PETROLEUM


Aeolian dune sand

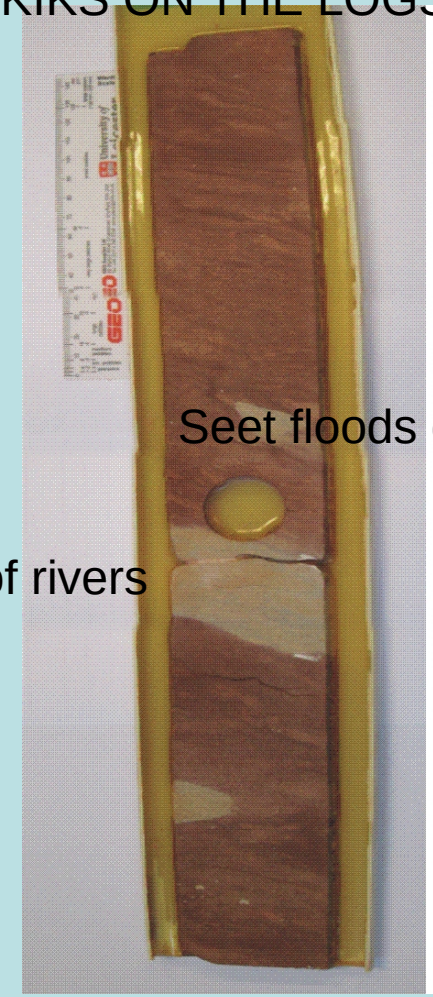
Interdune and sheet sand



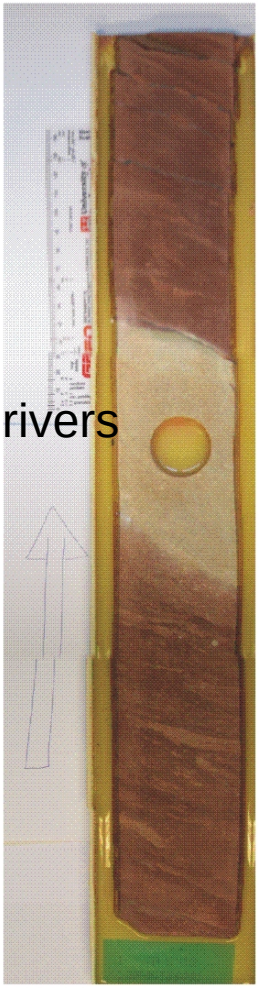
Figure 7 Isolated barchan dune field in the Wahiba sands of Oman. Note the large partially vegetated interdune surface with a coarse deflation lag.

Interdune sheet sand

- FINE ARGILLACEOUS SANDSTONE
- ADHESION STRUCTURES
- WELL CEMENTED
- DENSITY KIKS ON THE LOGS



Seet floods of rivers



Seet floods of rivers



Lake margin sabkha

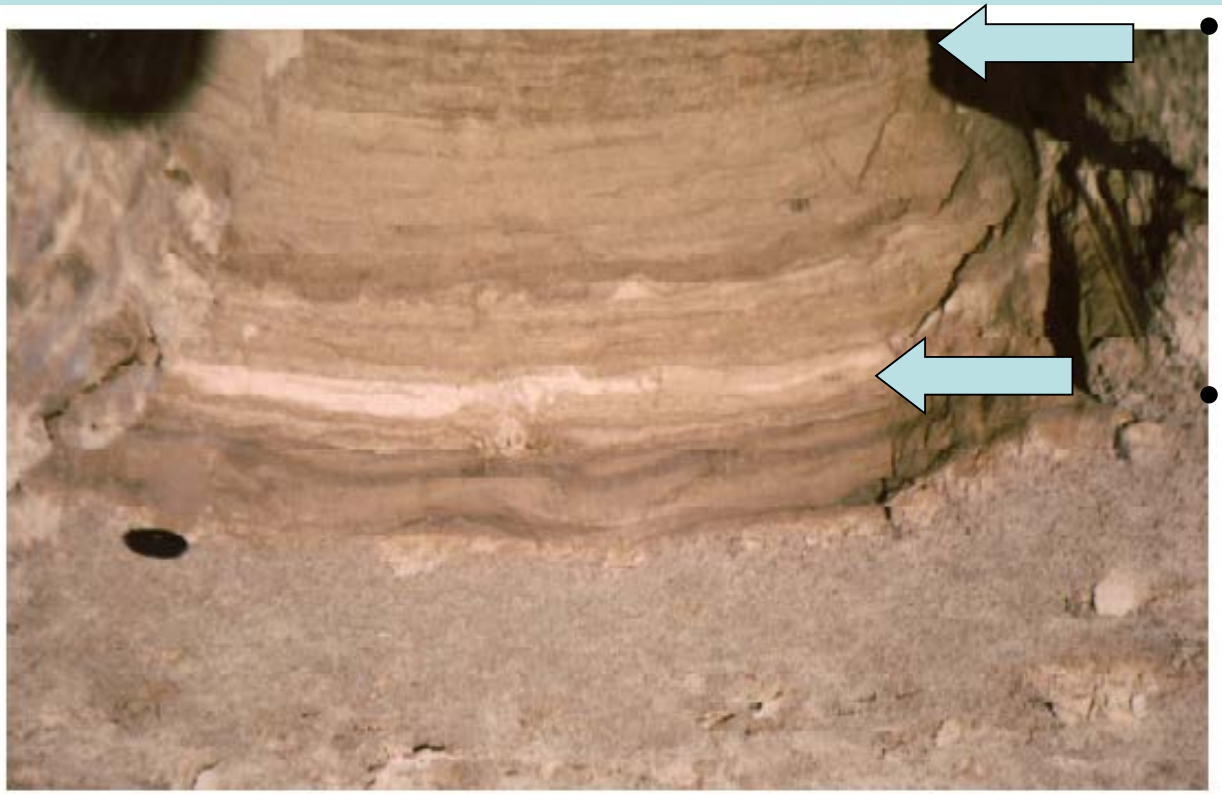


Figure 8 Lake margin sabkha deposits on the Chott-el Jherid, Tunisia. The upper part of the picture shows silty sediments with adhesion structure and in the lower part are gysum/anhydrite layers and nodules. Lens cap for scale.

- Adhesion structure
- Gypsum/anhydrite layers

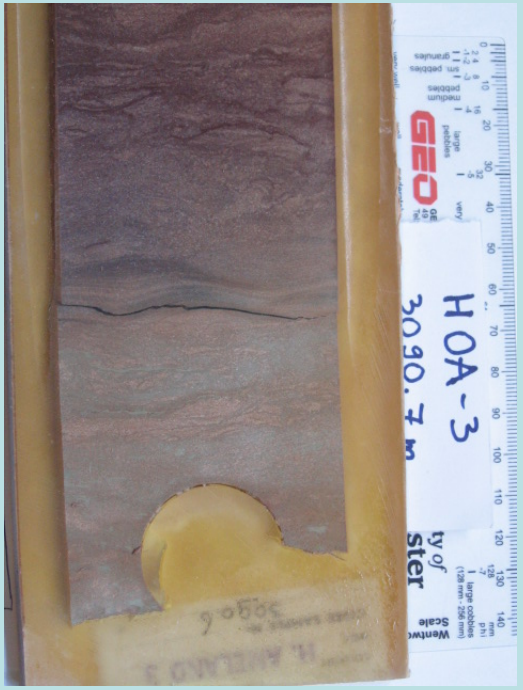
Fluviatile

Proximal (wadi deposits)
- aerially confined
- next to the faults



Distal
- sheet like
- fining upward packages
- can be followed ower some km
- poorly sorted, can be clay rich

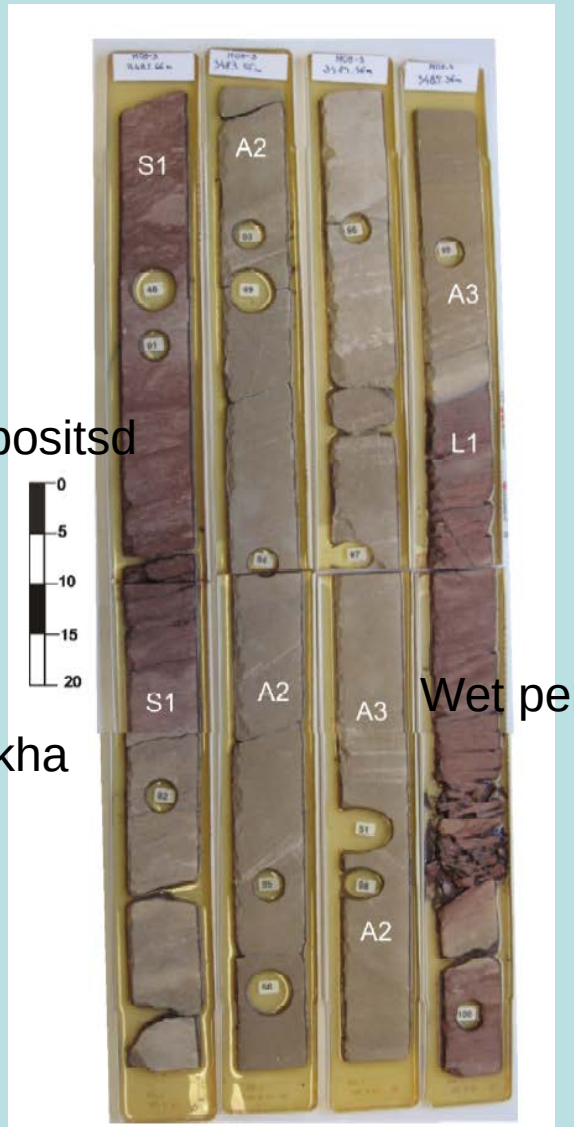




Desert lake deposits

Dry period: dune
-A3 dune base
-A2 dune core

Wet period: lake depositsd

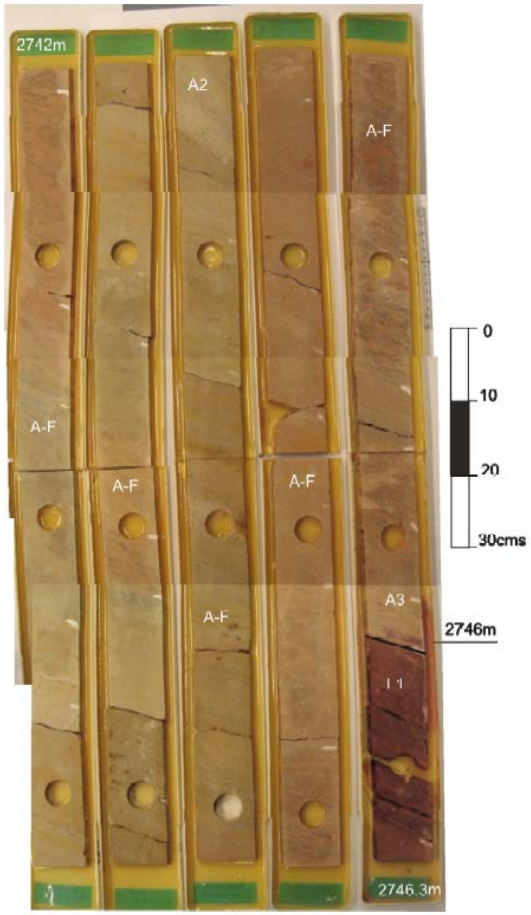


Wet period: lake deposits

Sabkha

Aeolian dune sequence at the top of Unit B in M9-3.

Dune reworked by fluvial sheet flood



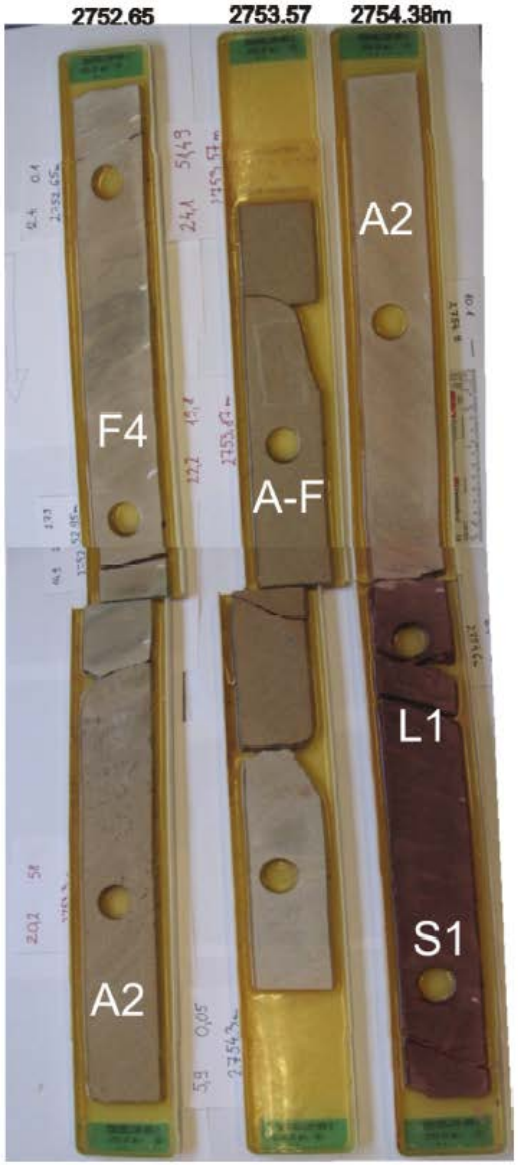
Reworked dune

Lake sediments

Figure 15 Core section between 2742-2746.3m (top Unit C) in TEN-2. The sequence is interpreted as an aeolian dune complex (A2/A3) partly reworked by a fluvial sheetflood.

Sheet flood deposites

Reworked dune sand



Dune sand was deposited

The lake dried out

Lake sediments

Sabkha

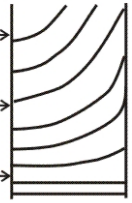
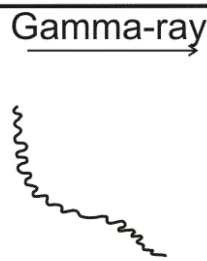
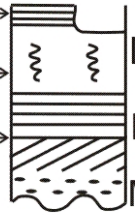
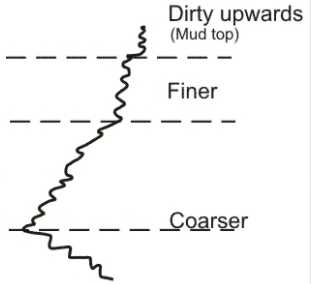
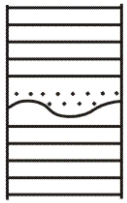
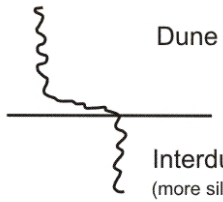
Figure 16 Aeolian dune sequence in lower part of Unit C (TEN-2). The dune initially developed on a dried up lake or pond (L1) and the dune deposits A2/A3 were reworked (A-F) by fluvial sheetfloods (F4).

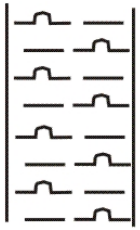
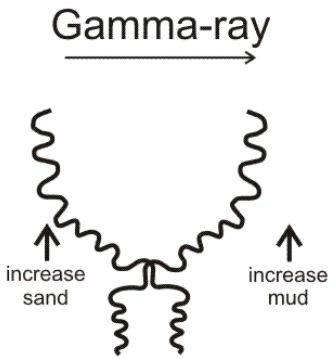
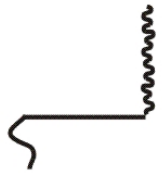
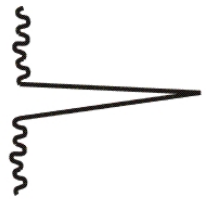
To built up a reservoir model

- 1). Core logging: description, identify facies packeges.
- 2). To tie facies packeges to wireline log signals.

Connection between sedimentary structures and log signals

Desert facies (see George and Berry 1993)

Facies	Subfacies	Sedimentary structure	Log signal	Remarks
Dune	Dune top Dune core Dune base			- Well sorted - Well rounded sand - Alternation of grain flow and grain fall lamination
Fluvial	Fine top Unstructured Structured			-Erosively based - Often contains intra-formational clasts - Thin low angle cross strata, cross lamination or plane bedding - Unstructured fluvial are formed by dewatering. May show “dish and pillar” and other soft sediment deformation -Reservoir quality there is very poor
Dry interdune= “Aeolian sandflats” (more extenseive areas)	Merges with dune base			-May include coarser deflation lags -Typical structure is bimodal lamination -Maybe more homogeneous

Facies	Subfacies	Sedimentary structure	Log signal	Remarks
Wet interdune = Inland sabkha	-Muddy -Sandy (varies much according to relative amount of sand/mud)	 Adhesion ripples Dessication cracks. (Anhydrite nodules. Salt pseudomorphs in evaporitic interdunes.		Log trends may be - upward fining or -upward coarsening. Depending on overall scenario.
Pond or desert lake	Mudstone	 Laminated, homogenous fissile (Sometimes very thin laminated)		Generally mudstone with anhydrite nodules. Small ponds represented by thin units of fissile mudstone.
		Wetting event		

To built up a reservoir model

- 1). Core logging: description, identify facies packeges.
- 2). To tie facies packeges to wireline log signals.
- 3). Regional correlation of facies packages and log signals

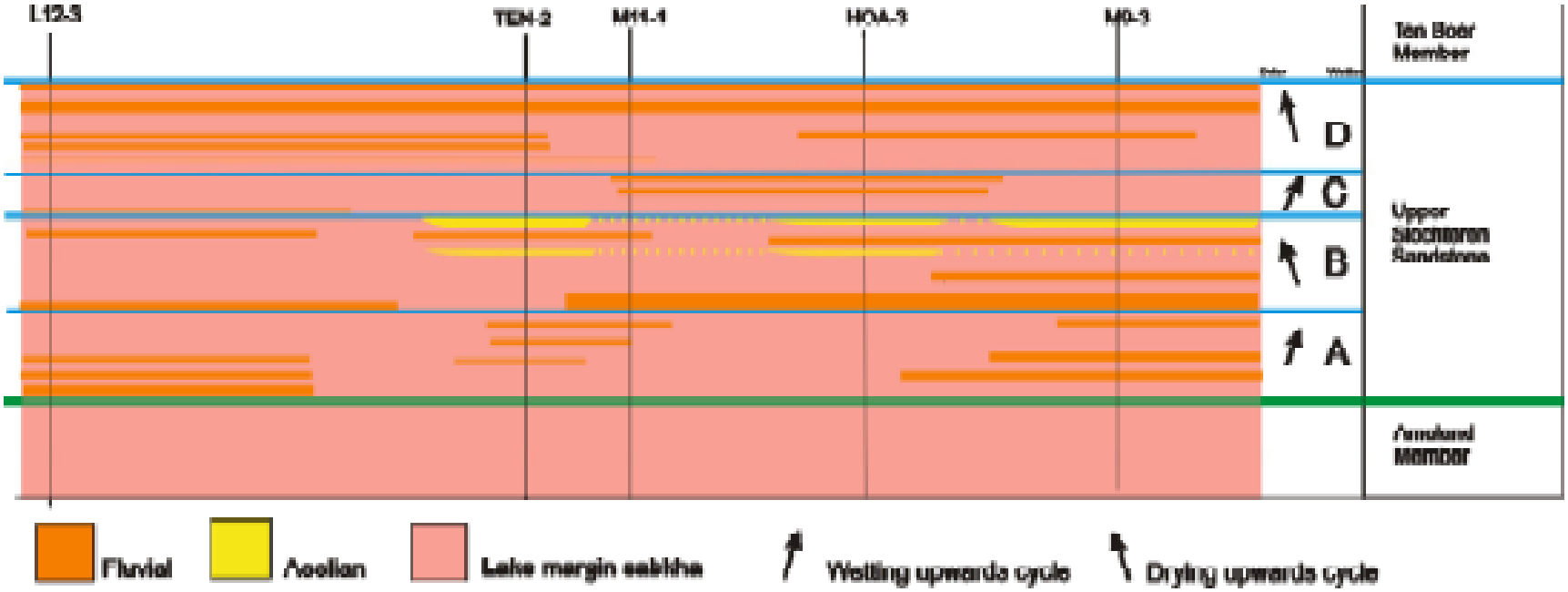


Figure 24 Schematic diagram showing the subdivision of the Upper Slochteren Sandstone into four Units based on upwards drying and upwards wetting cycles,

A: Lake margin shabka with sheetflood
B: Main aeolian sand development:
-Isolated small dune fields with fluvial reworking (wetter periods)

C: Thin wetting upward cycle
D: Drying upward cycle:
- Lower part: thin sandstones
- Upper part: thick sand bodies, regionally can be followed

To build up a reservoir model

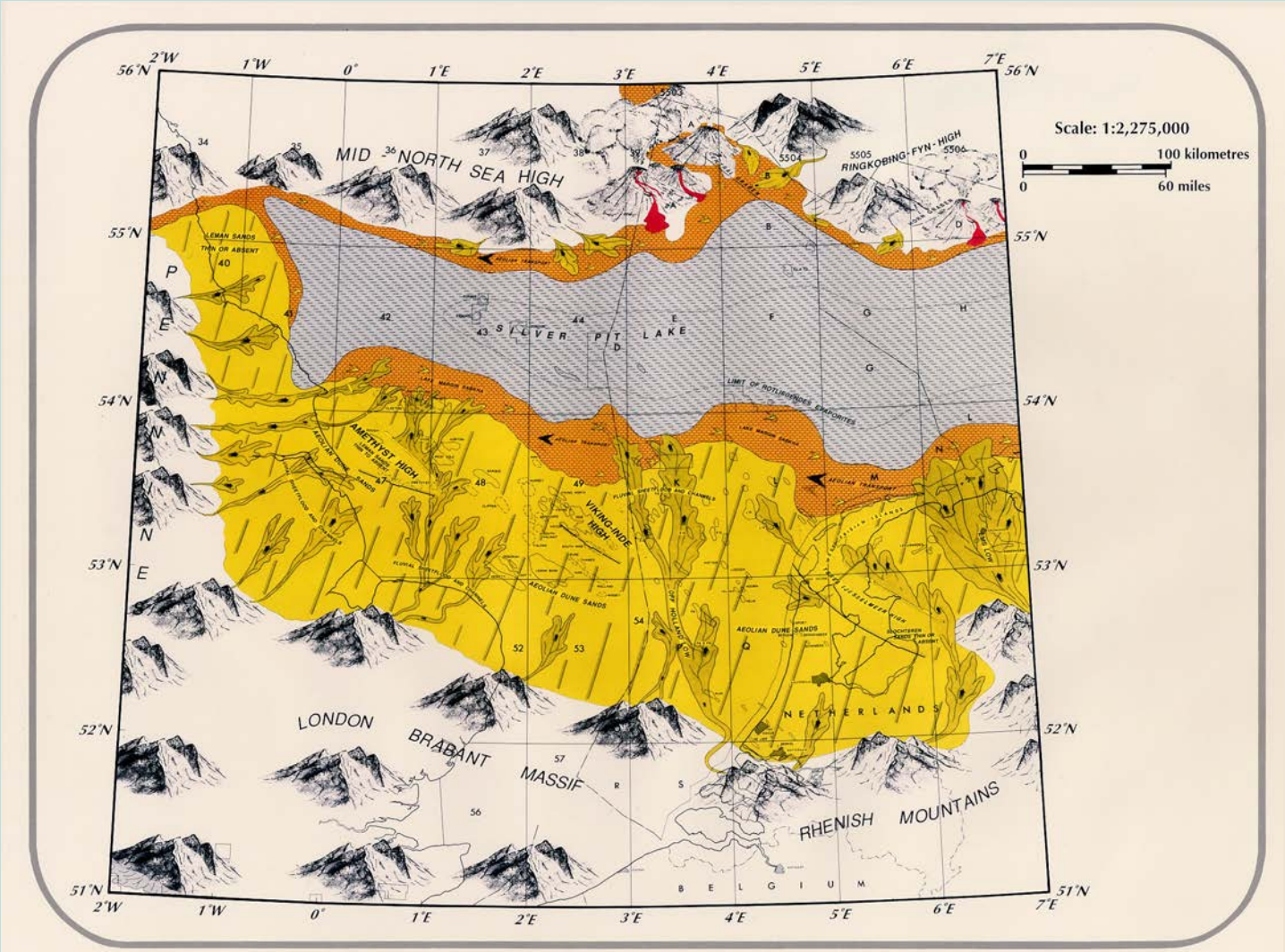
- 1). Core logging: description, identify facies packeges.
- 2). To tie facies packeges to wireline log signals.
- 3). Regional correlation of facies packages and log signals
- 4). To build block-wide facies and reservoir property distribution maps.

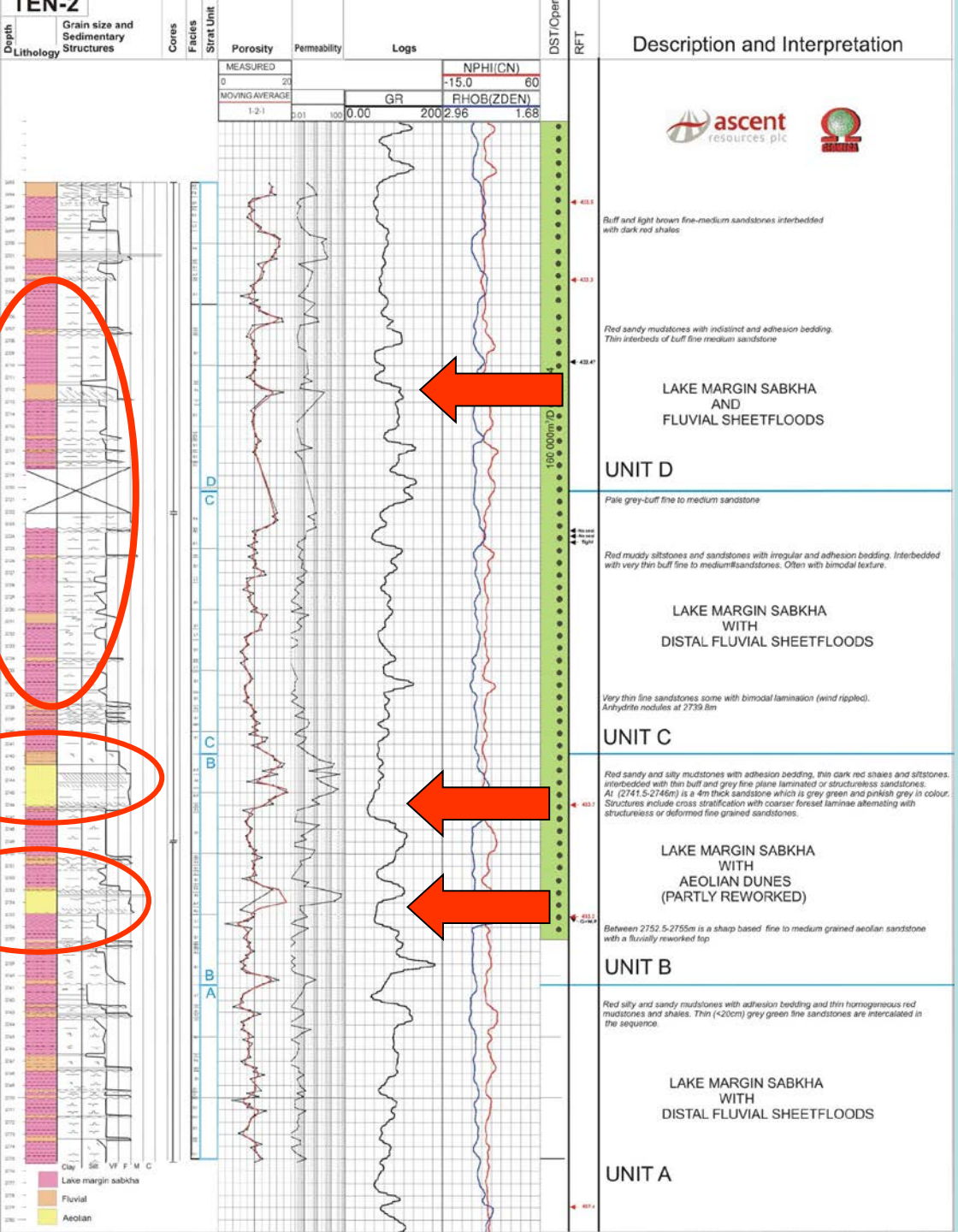
Reservoir properties (porosity, permeability) correspond to depositional facies

- A2>F3>F4>S1
- Dune core >Structured sheet flood> Dewatered sheet flood>Lake margin sabkha

Reservoir quality corresponds closely to depositional facies, but diagenetic processes, mainly dolomite cementation can strongly reduce the porosity!

Facies distribution map



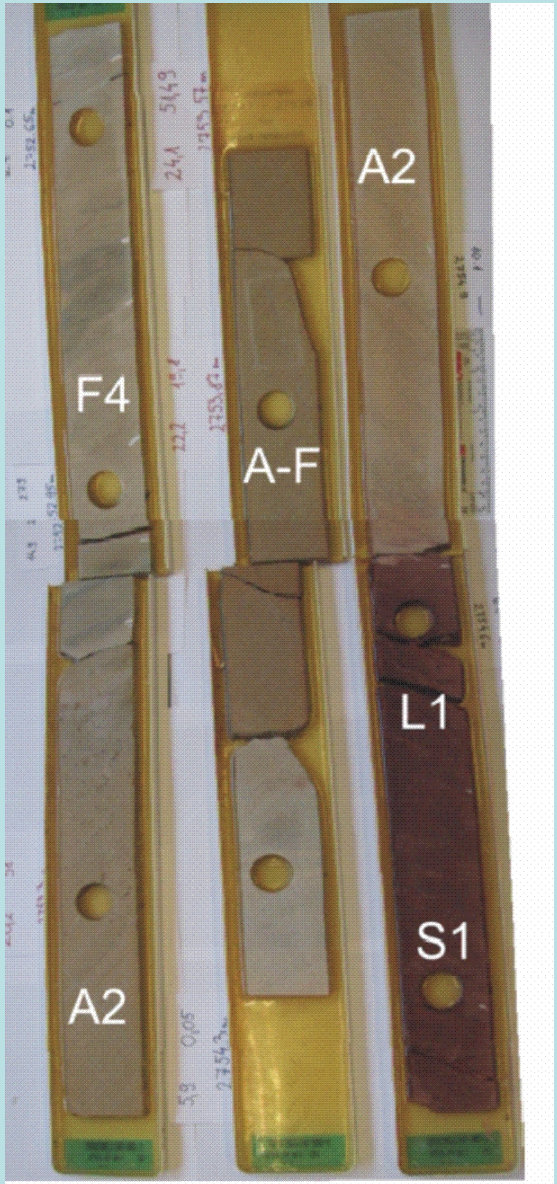


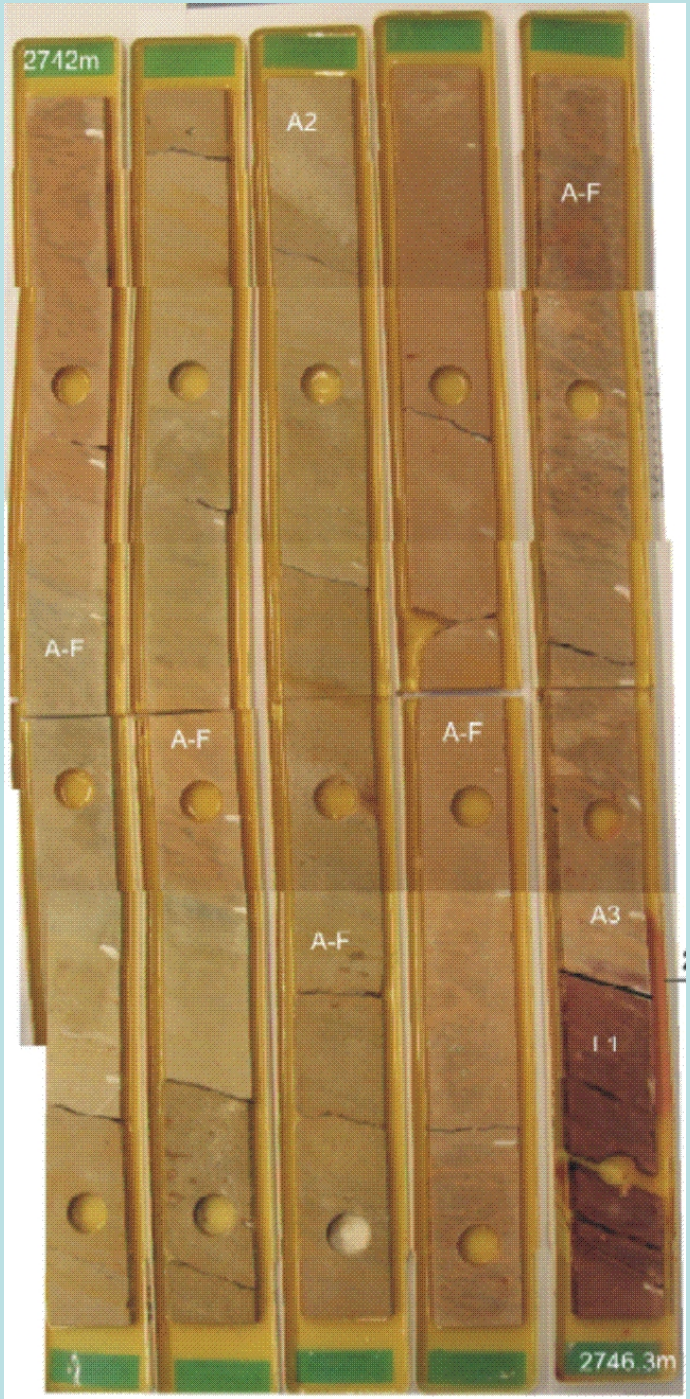
Sheet flood

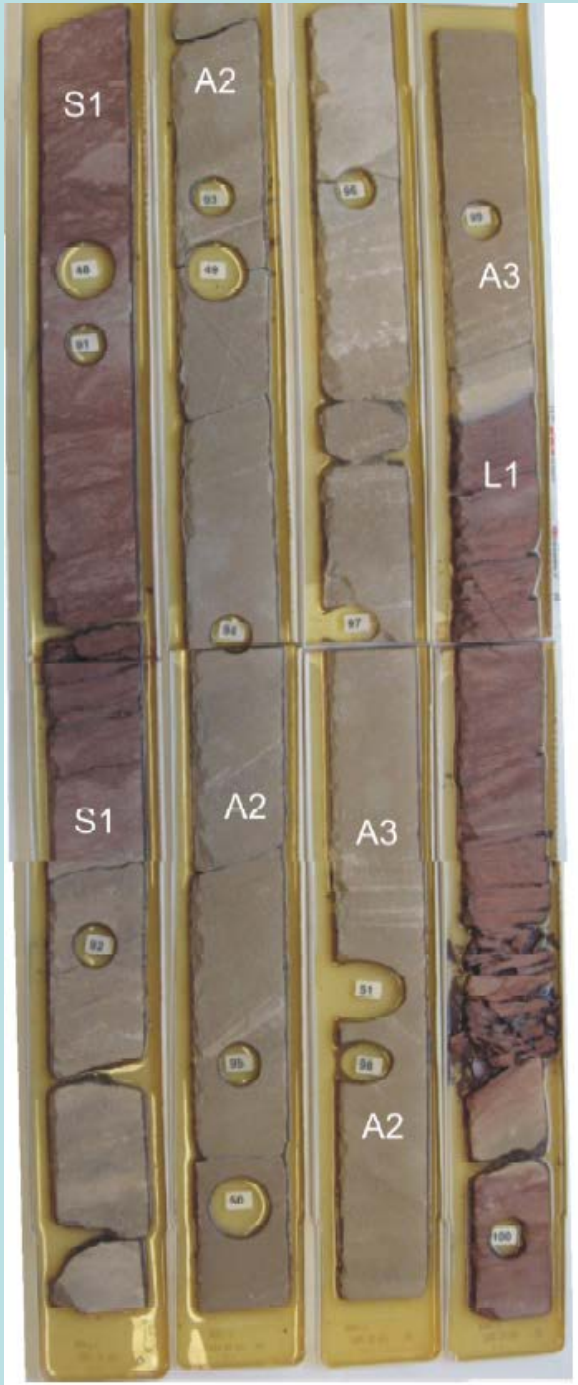
Reworked dune

Dune

Colour

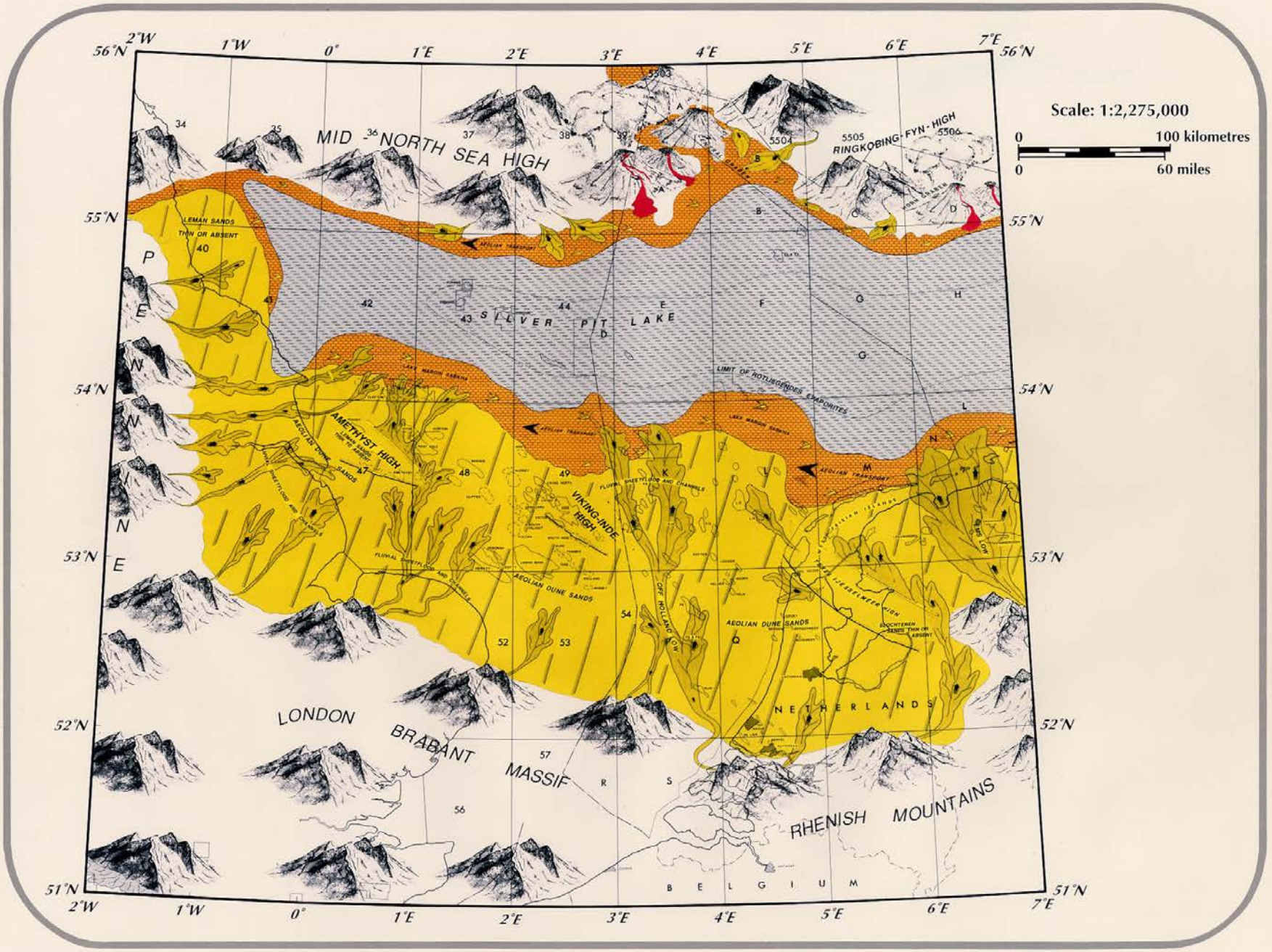

F4
A-F
A2
L1
S1
A2


2742m
A2
A-F
A-F
A-F
A-F
A-F
A3
2746.3m


S1
A2
A3
L1
S1
A2
A3
A2

Exercise:

- You are a manager in a company, which plan to buy a concession in the North Sea, where Permian Rotligend sediments are the reservoirs.
- 1. What kind of information would you ask from the geological team to decide where the best reservoirs are?
- 2. With the help of the Permian facies map make 3 suggestions, where to buy concessions. List your arguments.
- 3. Give a list: where the company must not buy a concession in no way.



ROTLIEGENDES SLOCHTEREN / LEMAN SANDSTONE SCHEMATIC PALAEOGEOGRAPHY

WELL SYMBOLS

- Drilling
- Suspended Well
- Junked & Abandoned
- Tight Hole
- Plugged & Abandoned (Dry Hole)
- Gas Well
- Oil Well
- Plugged & Abandoned with Gas shows
- Plugged & Abandoned with Oil Shows
- Plugged & Abandoned Gas Discovery
- Plugged & Abandoned Oil Discovery
- Plugged & Abandoned Oil & Gas Shows
- Gas Discovery with Oil shows
- Oil Discovery with Gas Shows
- Oil & Gas Well
- Suspended with Oil Shows
- Suspended Oil Well
- Gas & Condensate Well
- Water Injector
- Gas Injector

ISOCHORE LEGEND

- Restricted Area
- Outcrop of Horizon
- Area of Incomplete Section
- Limit of Horizon
- Faulted Out Section
- Axis of Inversion
- Salt Diapir
- Salt Removed

PALAEOGEOGRAPHY LEGEND

- Hamilton Acreage
- High Relief
- Low Relief
- Volcanos
- Contemporaneous Faulting
- Fluvial Transport Direction in Sheetflood Fans
- Fluvial Transport Direction in rivers
- Aeolian Transport Direction
- Direction of Marine Transgression
- Direction of Sediment Supply
- Transverse (Sief) Dunes
- Barchan Dunes
- Tidal Flat Sands
- Aeolian Sands
- Deltaic Sands
- Fluvial Channel Sands in Broad Floodplain (Shales, Coals & Sands)
- Crevasse Splays in Channels
- Proximal Braid Plain (Braided Channel Dominated)
- Distal Braid Plain (Sheetflood Dominated)
- Shoreline & Coastal Barrier Sands
- Paralic Sandstones Flanking Highs
- Fluvial Sheetflood Fans
- Alluvial Fans
- Marine Shales
- Lacustrine Deposits
- Lacustrine Deltas
- Lacustrine Playa & Lake Margin / Sabkha Facies
- Lake Margin Sabkha Facies
- Shallow Marginal Facies (Marine Carbonates & Clastics)
- Lagoonal Facies
- Oolitic Reefal Facies (Shallow Marine Carbonates)
- Z1 & Z2 Platform Carbonates & Anhydrites
- Z3 Platform Carbonates & Anhydrites
- Limit of Zechstein Salts with Basin Halites
- Hypersaline Lagoonal Facies (Shales,Marls,Anhydrites & Halites)
- Volcanic Lava Flows