Sand Distribution Within a Topographically Complex Basin — From Channelized Sheets to Onlap Margins: Grès D'Annot, SE France*

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Abstract

Common stratigraphic-trap reservoirs in the Gulf of Mexico and along the margins of the Atlantic, often in salt-provinces, are found within channelized (e.g. Tahoe) or basin margin settings (e.g. Auger, Mars). Frequently within the same topographically complex mini-basin, high net:gross channel and lower net:gross basin-margin environments occur concurrently. Deciphering the lateral and distal relationships between these environments is key to understanding reservoir connectivity.

The Grand Coyer Sub-Basin (Grès d'Annot, SE France) outcrops demonstrate lateral and distal facies changes in a confined basin with complex paleotopography from a relatively thin-bedded unit, the Marnes Brunes Inférieures, to the thicker-bedded Grès d'Annot. The relationship between these two units in this confined, topographically complex sub-basin has implications for subsurface reservoir characterization:

1) High net:gross sandstone bodies terminate rapidly with little draping onto palaeoslopes. Lower net:gross sandstone bodies tend to drape onto palaeoslopes,
2) Cyclical, ~50m thick, high- and low- net:gross sedimentary intervals appear to be unpredictable in both their repetition and in their distribution in the sub-basin,
3) Channel sinuosity tends to increase as the basin is progressively filled,
4) All formations erode underlying intervals and have implications for reservoir seal,
5) Steep slopes in the underlying palaeoslopes result in remobilized, chaotically deposited material creating complex palaeotopography later in-filled with turbidity-current derived sediment.

Selected References

Apps, G.M., F.J. Peel, and T. Elliott, 2004, The Structural Setting and Palaeogeographical Evolution of the Grès d'Annot Basin: Geological Society, London, Special Publications, 221, p. 65-96. doi:10.1144/GSL.SP.2004.221.01.05

Pickering, K.T., and V.C. Hilton, 1998, Turbidite Systems of Southeast France: Vallis Press, London, 229 p.

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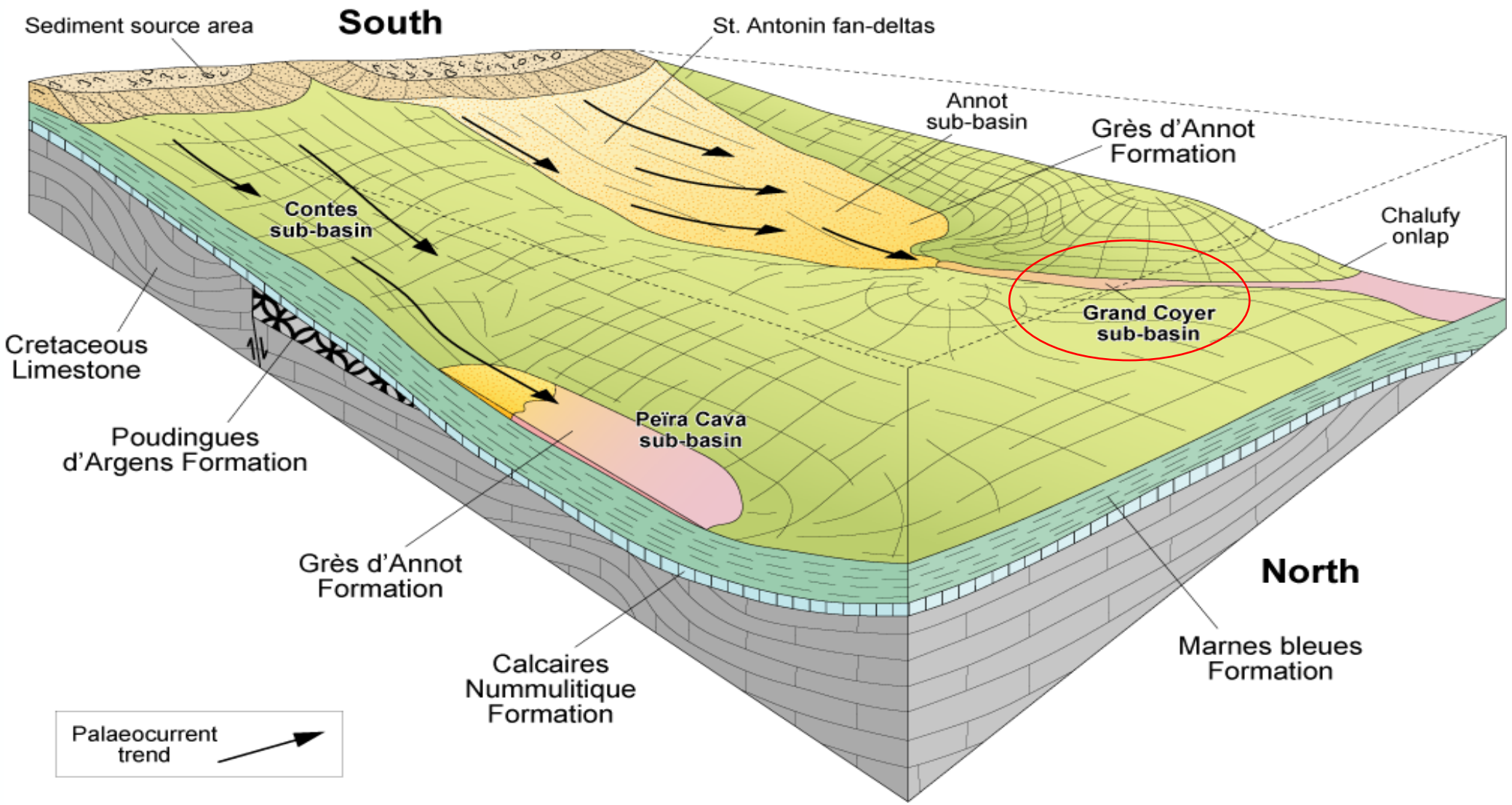
Objectives

- *Briefly introduce the Grand Coyer basin setting and key formations*

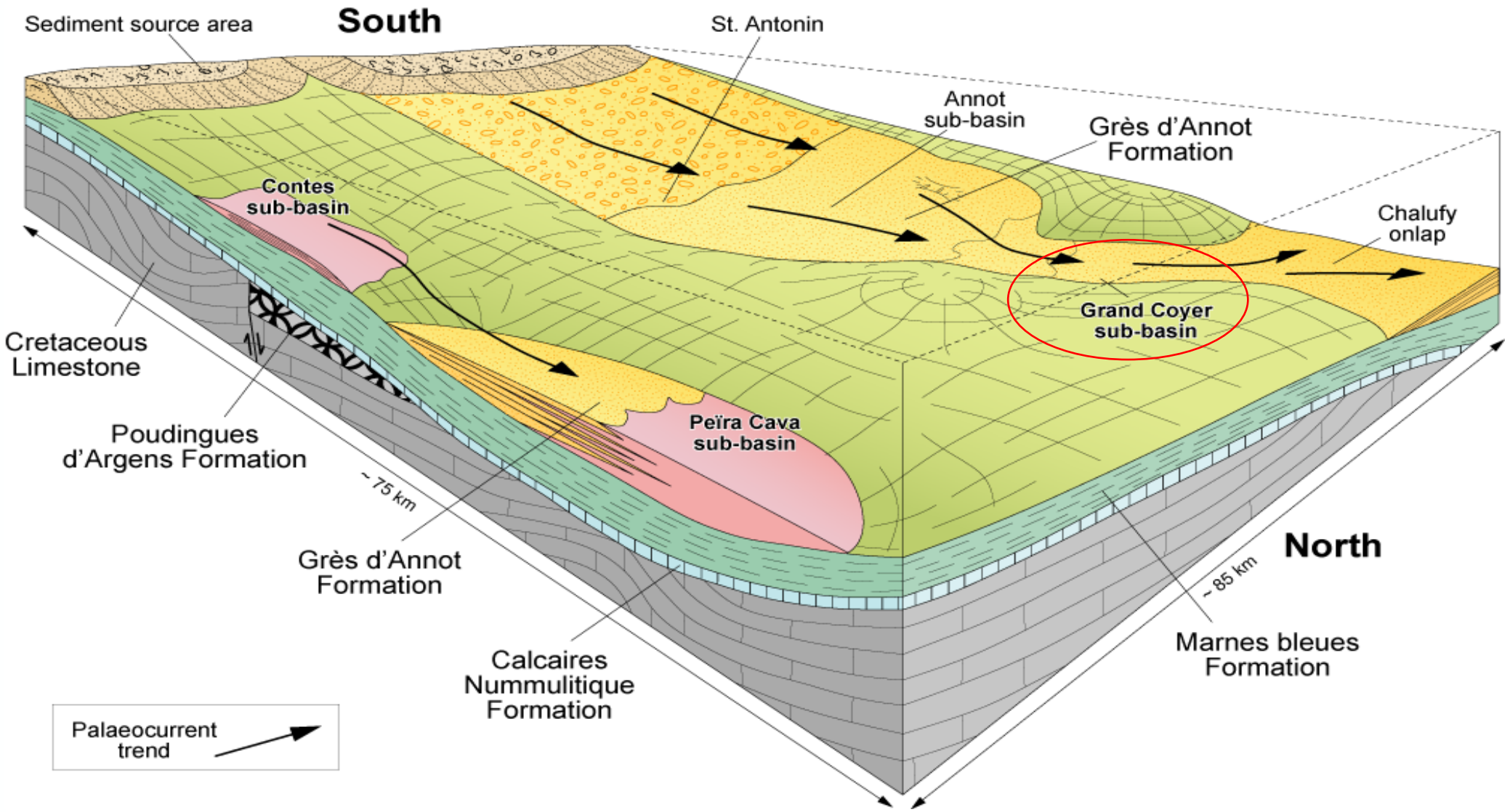
1. *Character of sand distribution on a steep leeward slope down-dip of spill-point*
2. *Onlap facies character in different areas of the basin*
3. *Channel sinuosity trends and basin fill*
4. *Stratigraphic character of a confined basin*

Grand Coyer basin setting



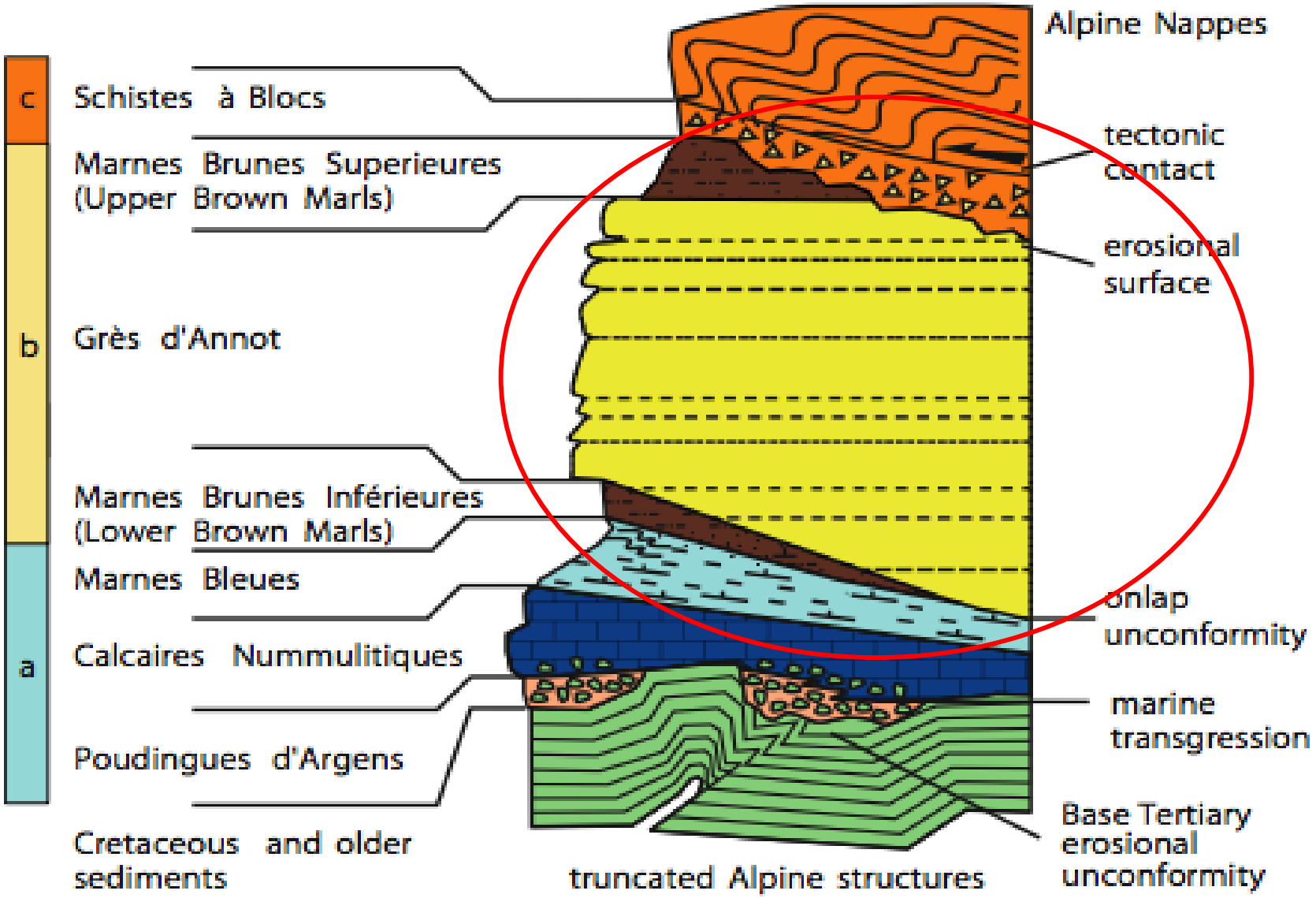
Pickering & Hilton 1987

Grand Coyer basin setting



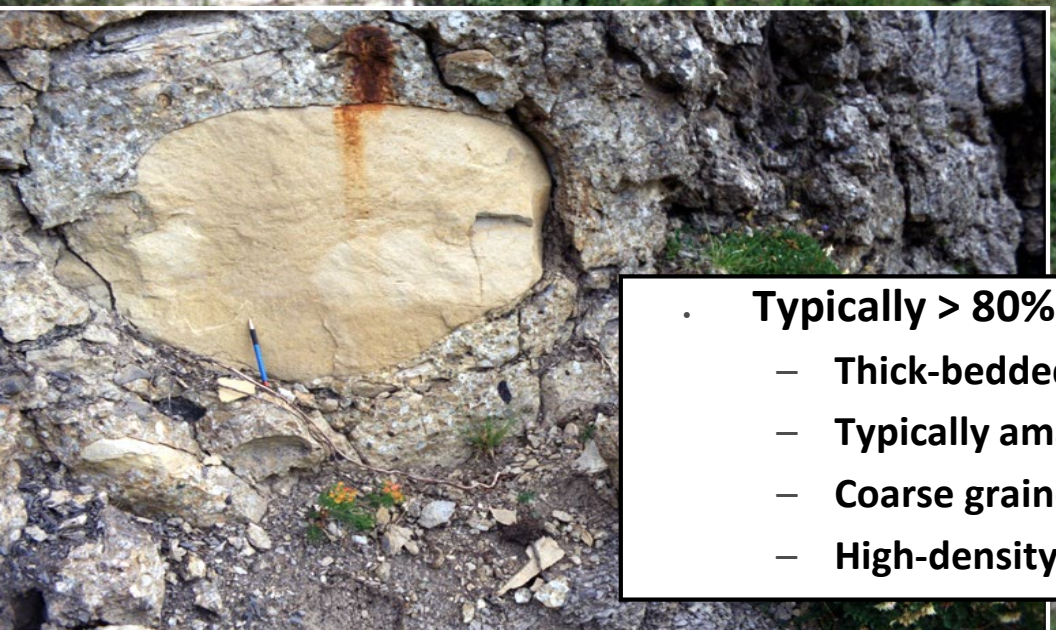
Pickering & Hilton 1987

Key formations



Apps et al 2004

Basin axis deposits

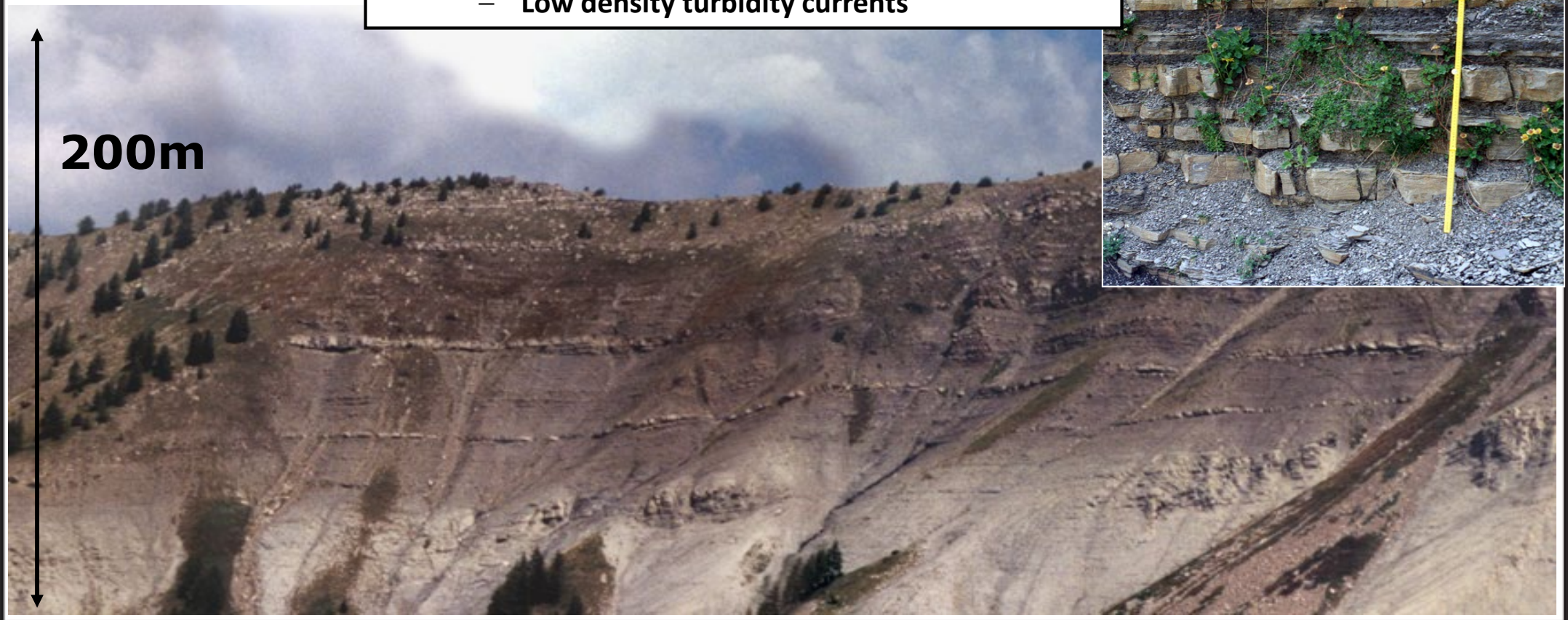


200m

- **Typically > 80% Net:Gross**
  - **Thick-bedded, often several metres**
  - **Typically amalgamated**
  - **Coarse grained conglomerate and gravely sandstones**
  - **High-density flows**

Basin margin deposits

- **Typically below 40% net:gross**
  - **Thin sands, average 5-10cm**
  - **Rarely above fine sand grade**
  - **Higher order of sedimentary structures**
  - **Low density turbidity currents**



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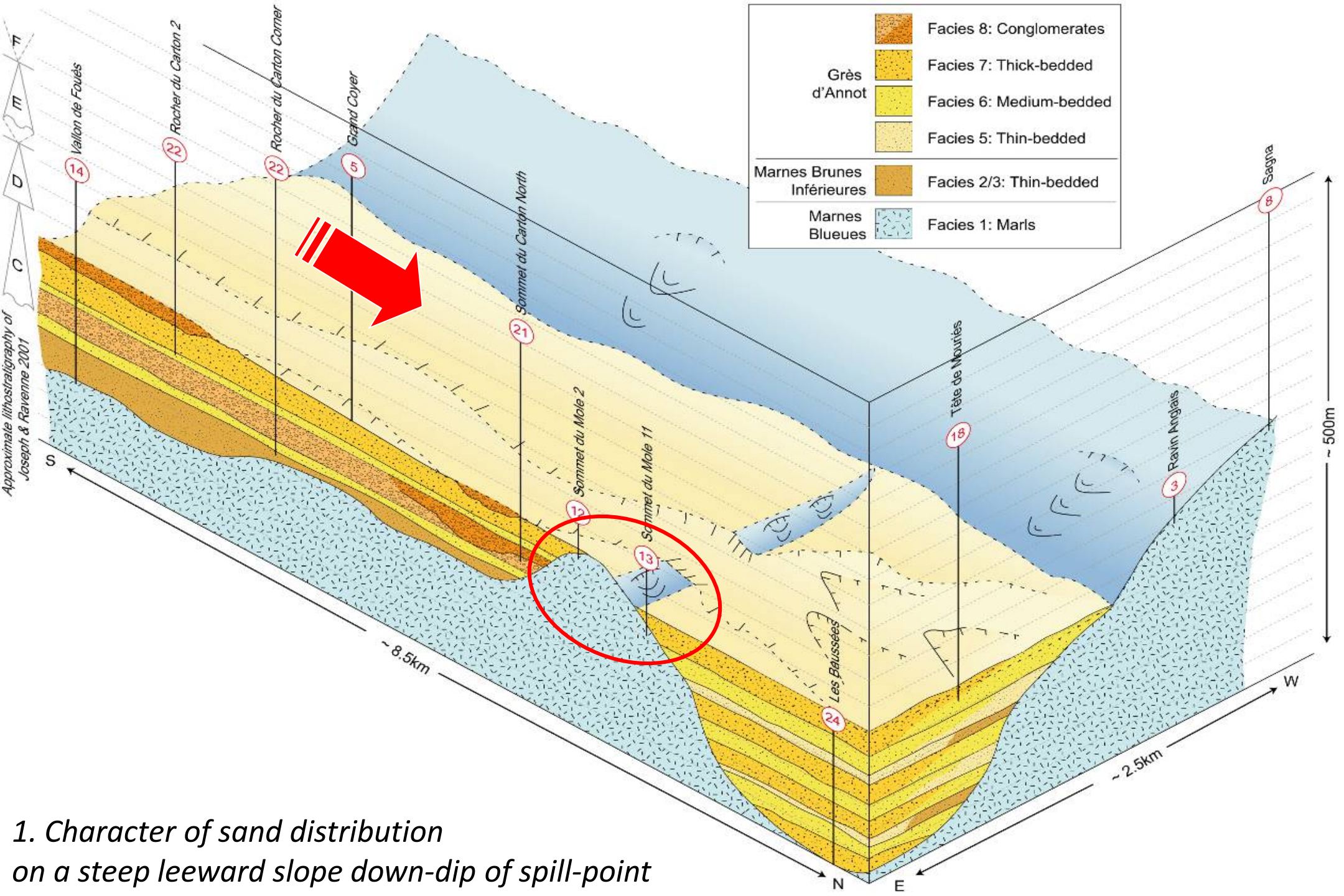
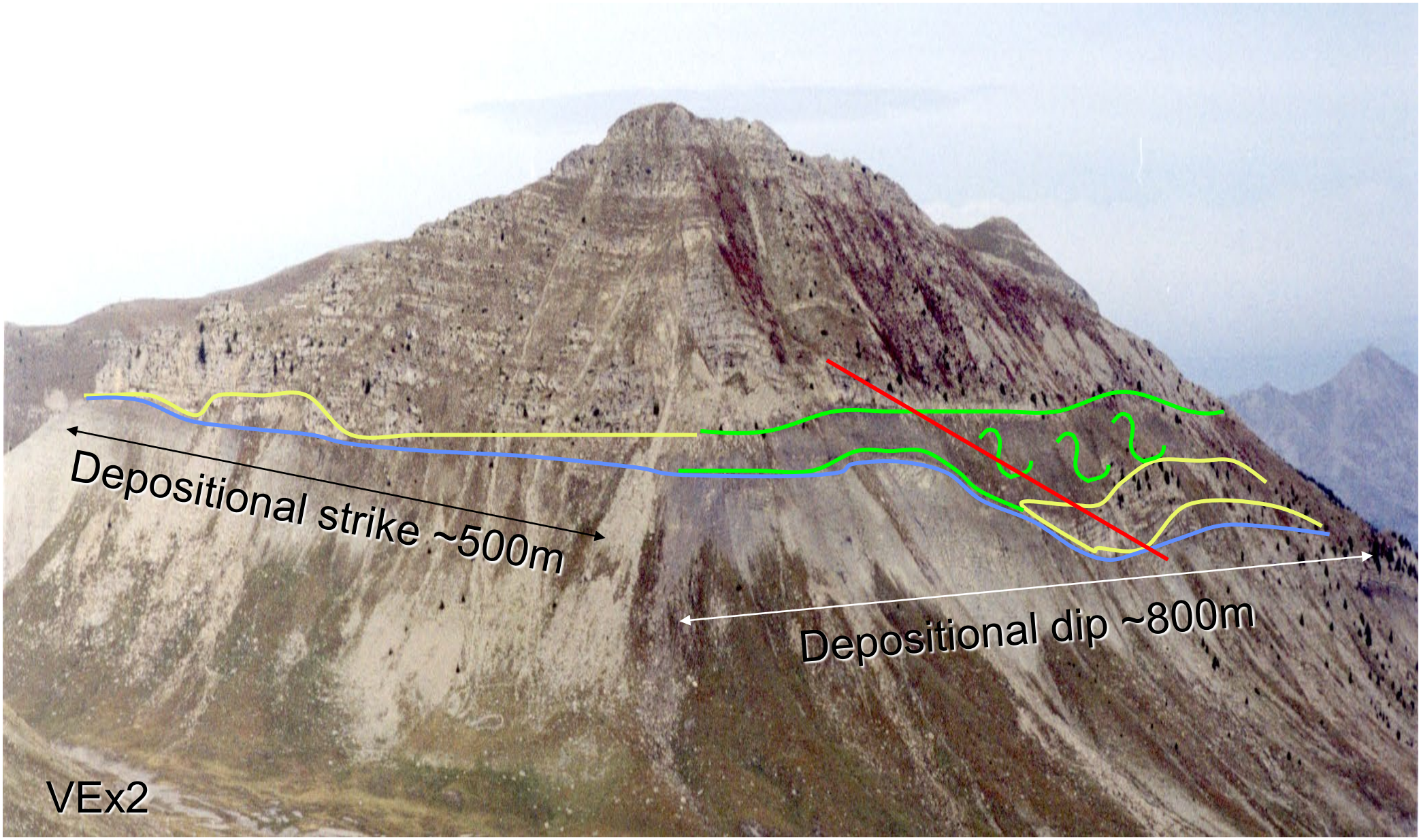


1. Character of sand distribution on a steep leeward slope down-dip of spill-point



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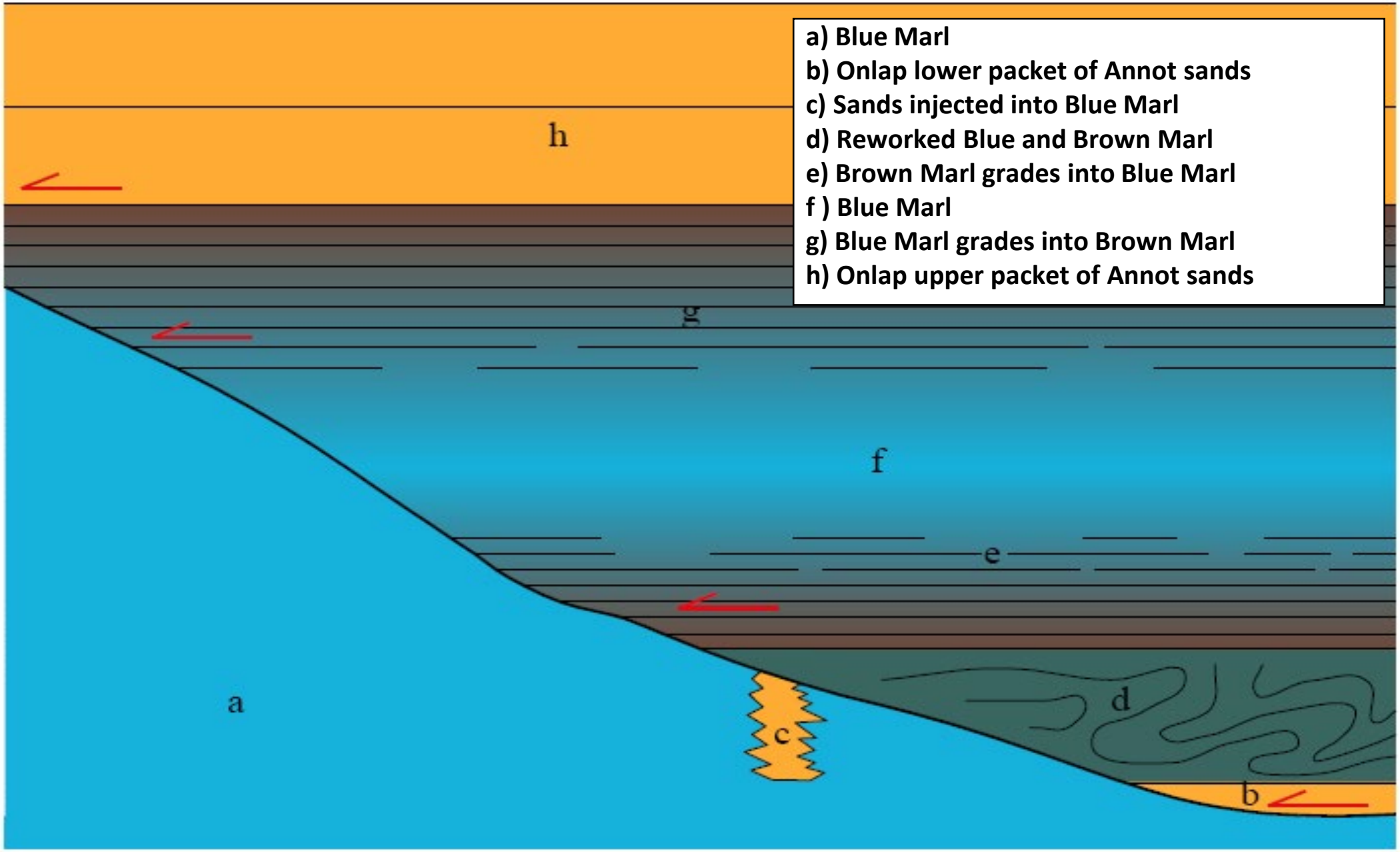
Sand distribution within a topographically complex basin-from channelized sheets to onlap margins: Grès d'Annot, SE France

AAPG October 2008



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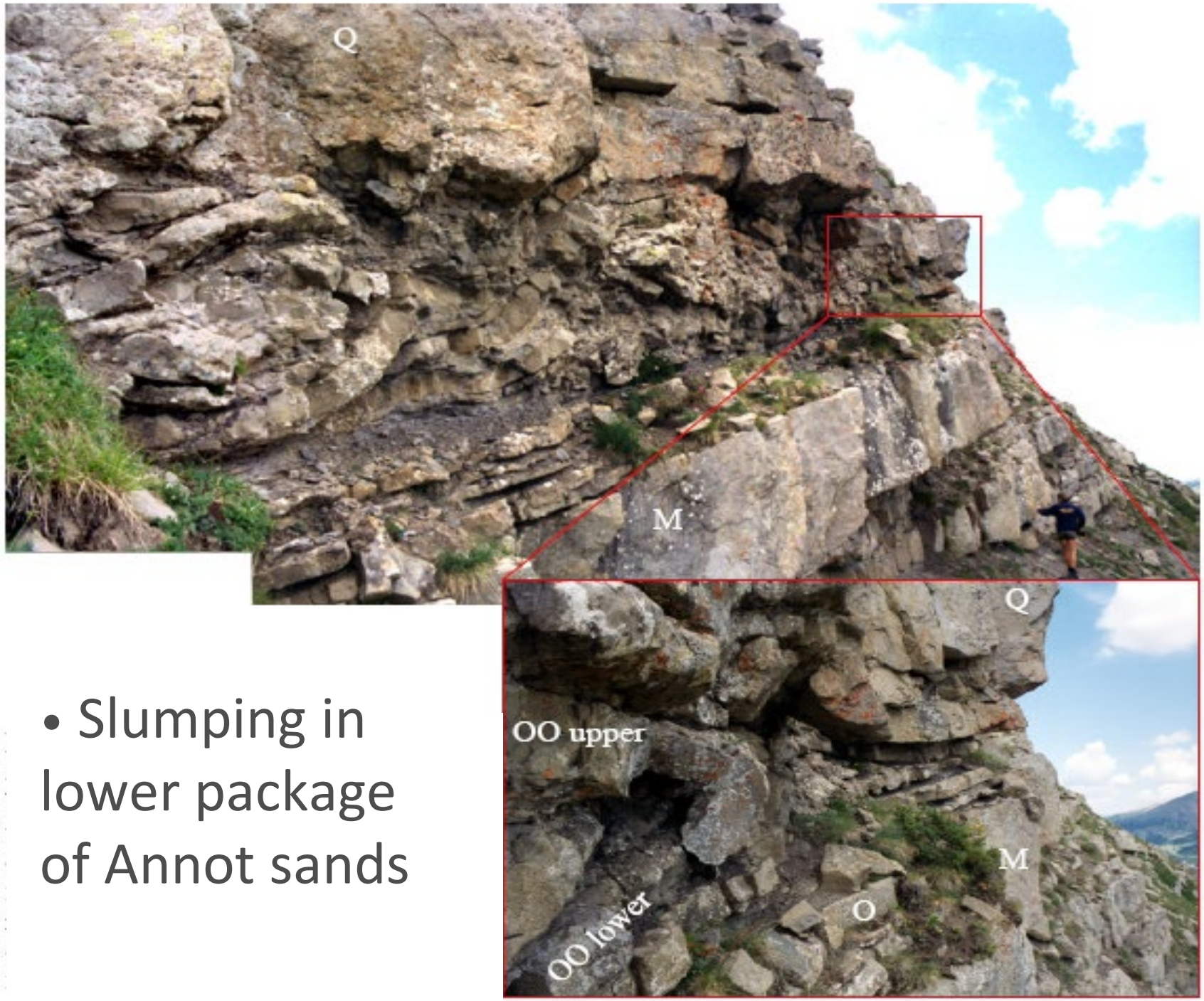

- Slumping in lower package of Annot sands

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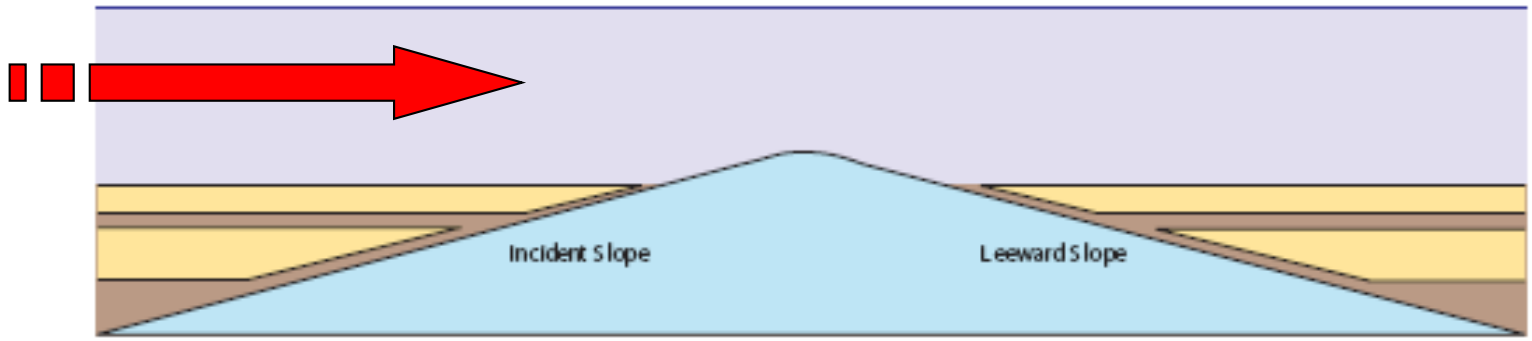
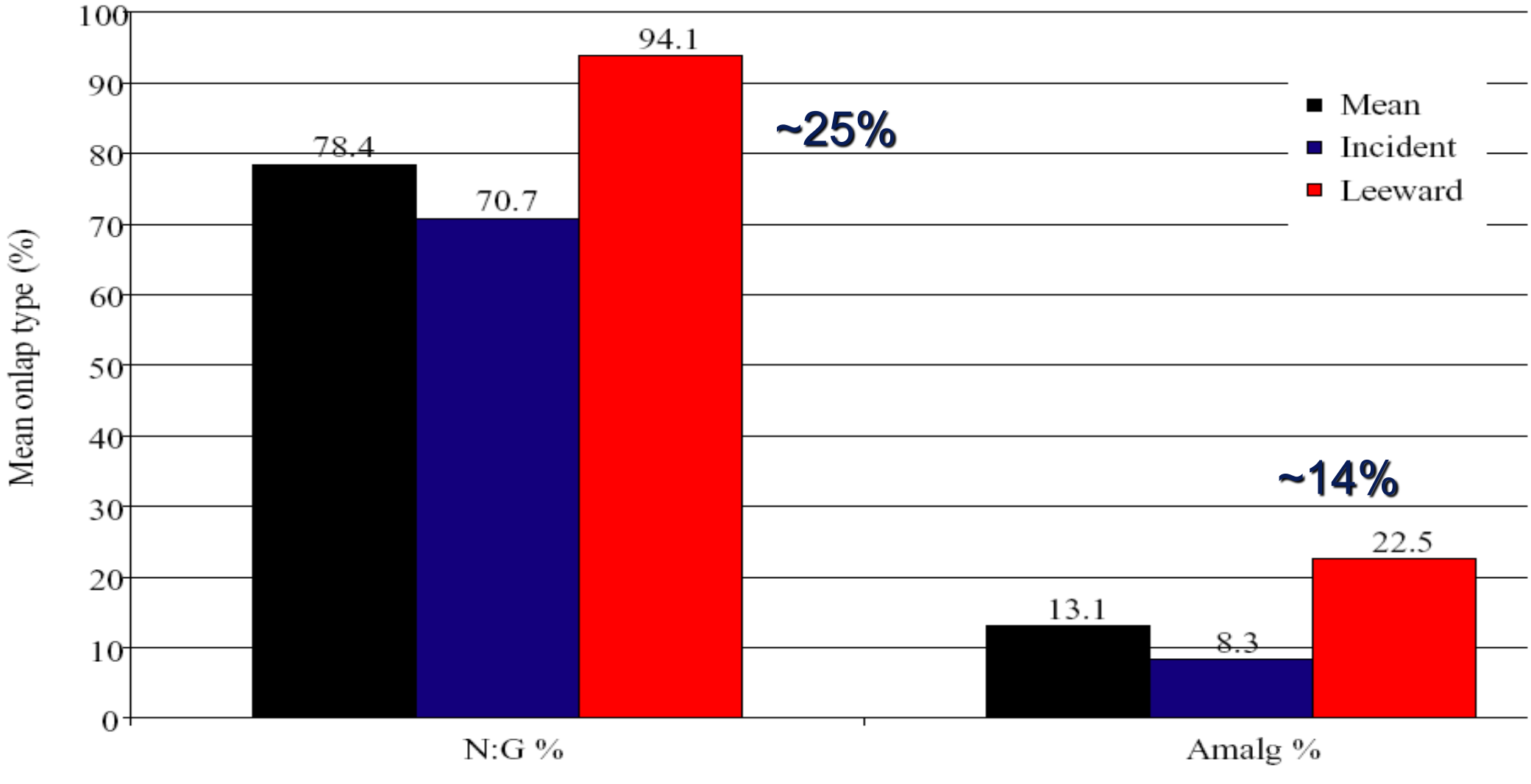
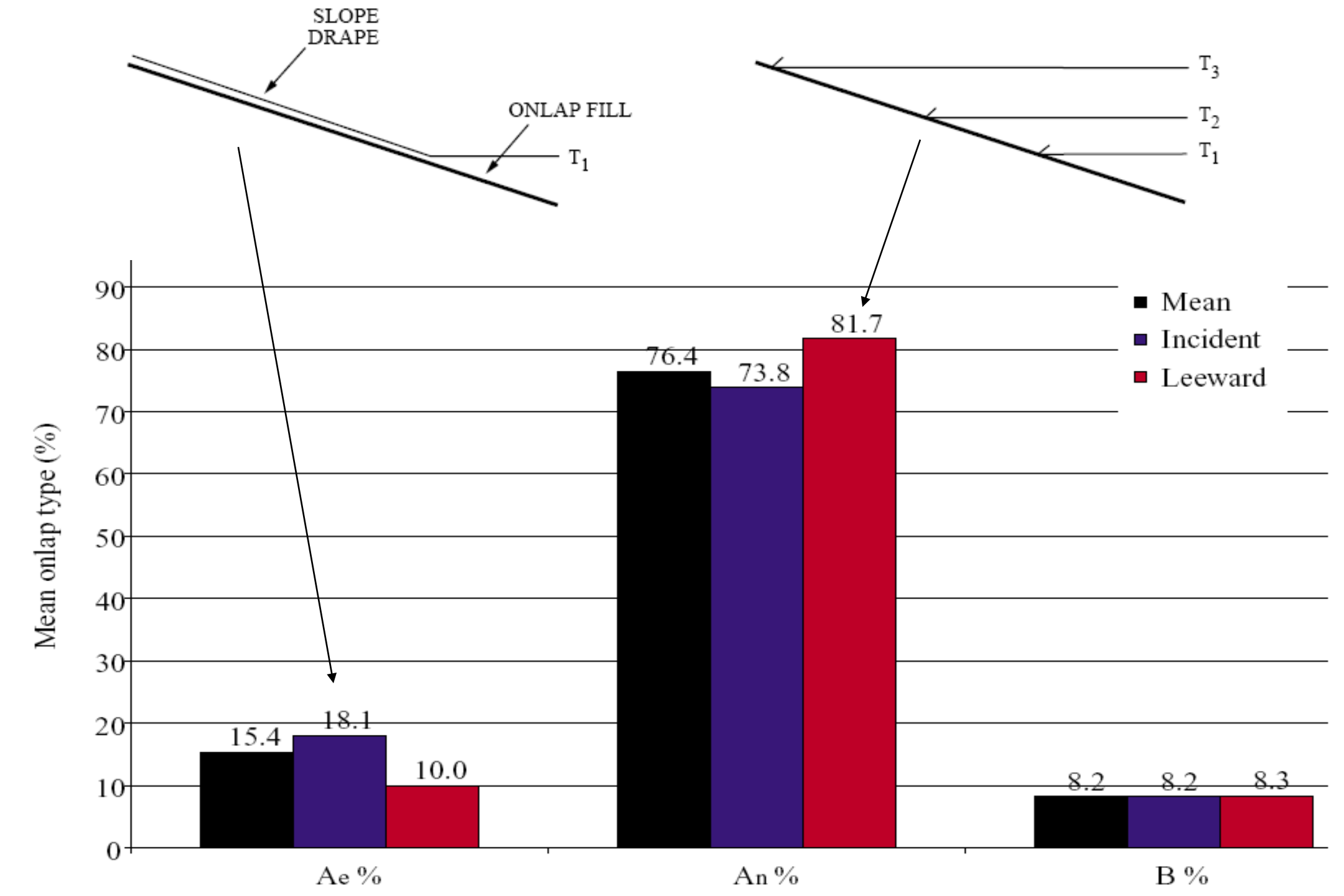
Record of events immediately down dip of a spill point

- Deposition on a leeward slope
- Complex depositional history
- Early trapping of sands but slump prone
- Prolonged periods of shutdown/bypass
- Reworking/slumping prominent

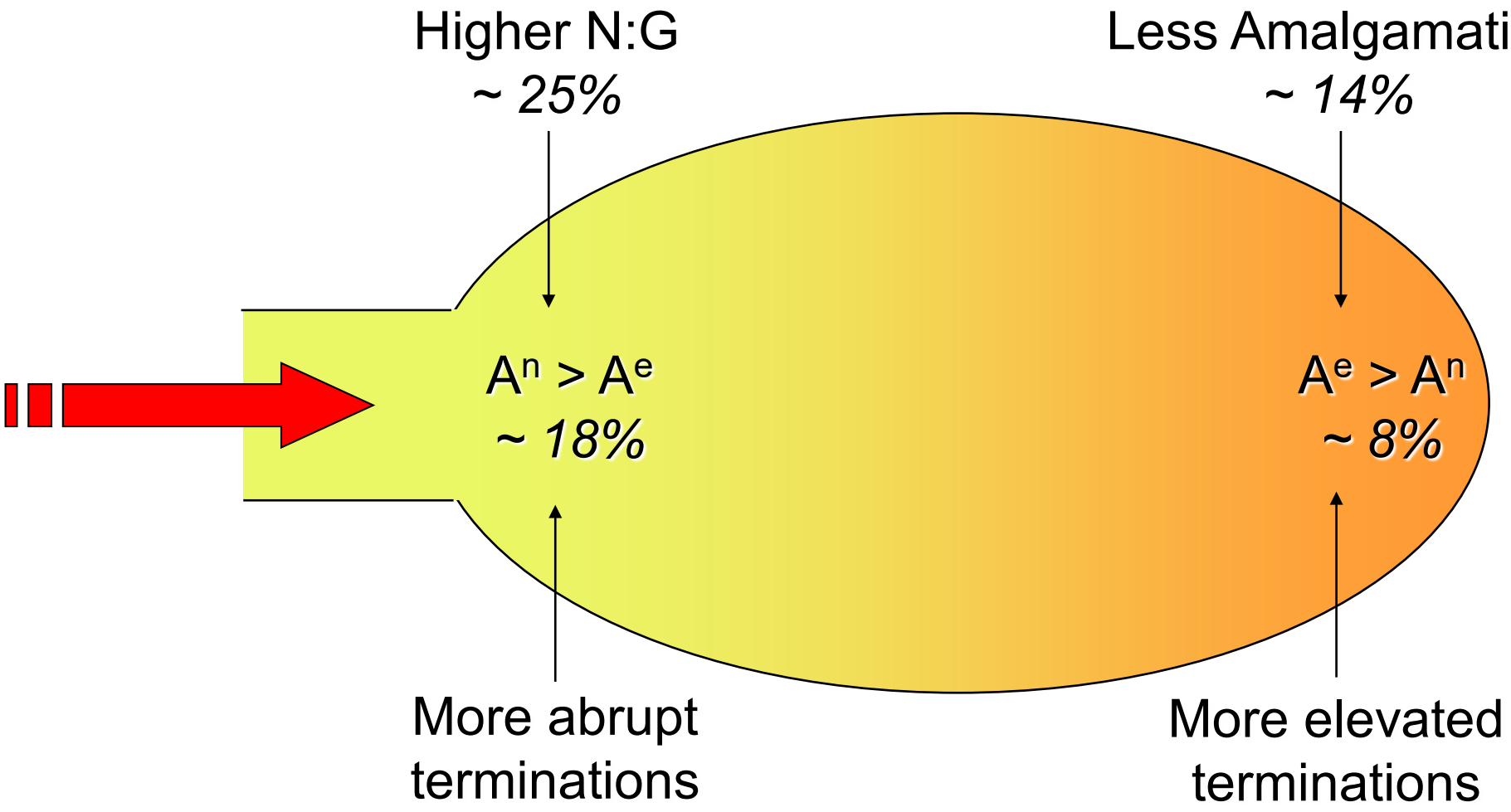
2.Onlap facies character in different areas of the basin

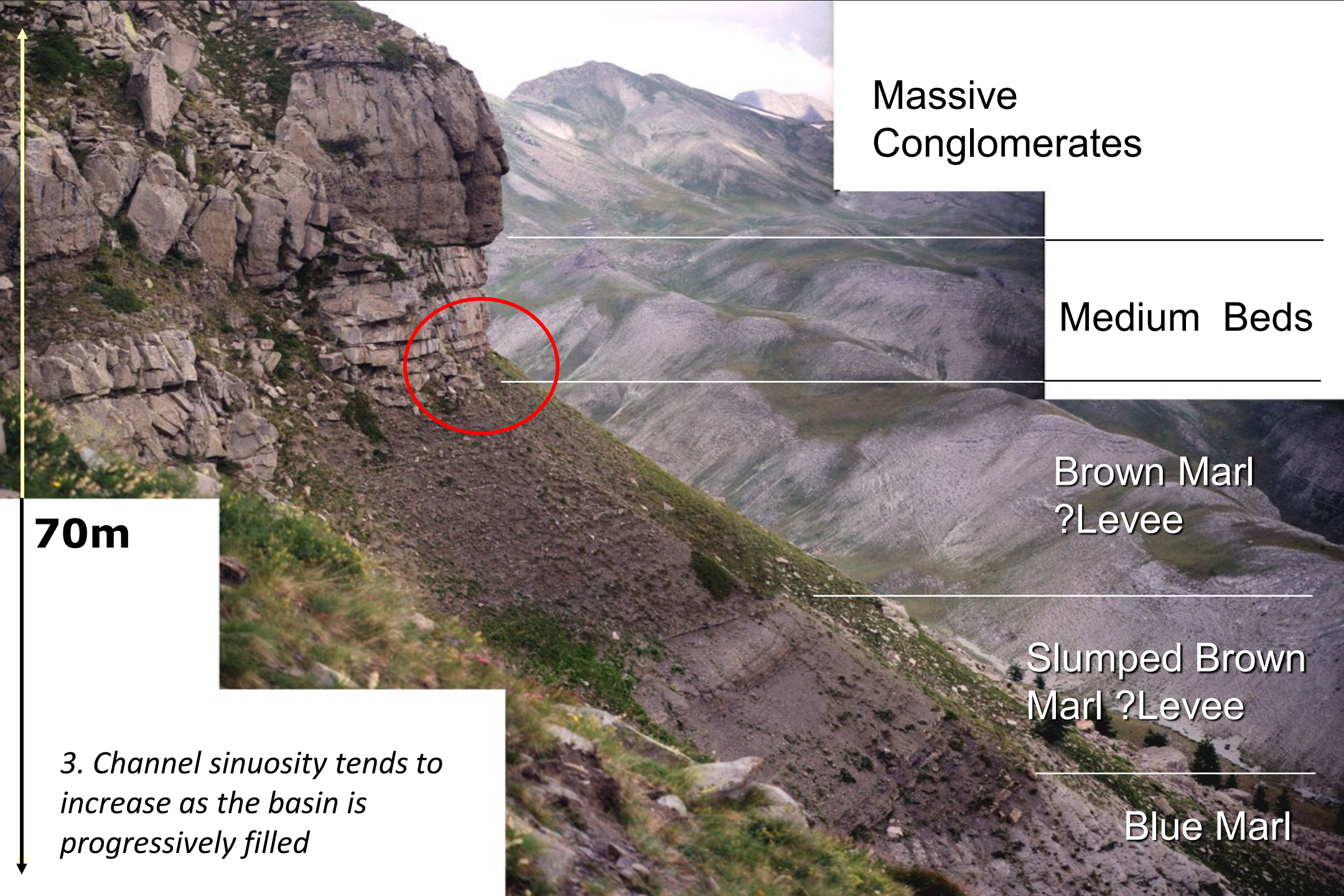





SLOPE
DRAPE
ONLAP FILL
T1
T3
T2
T1
Mean onlap type (%)
90
80
70
60
50
40
30
20
10
0
Mean
Incident
Leeward
15.4
18.1
10.0
76.4
73.8
81.7
8.2
8.2
8.3
Ae %
An %
B %

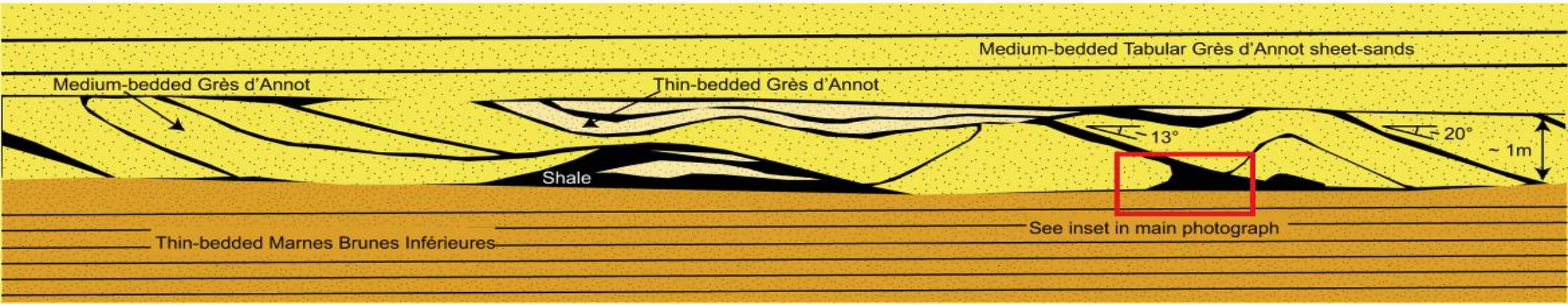
Onlap type in relation to basin position

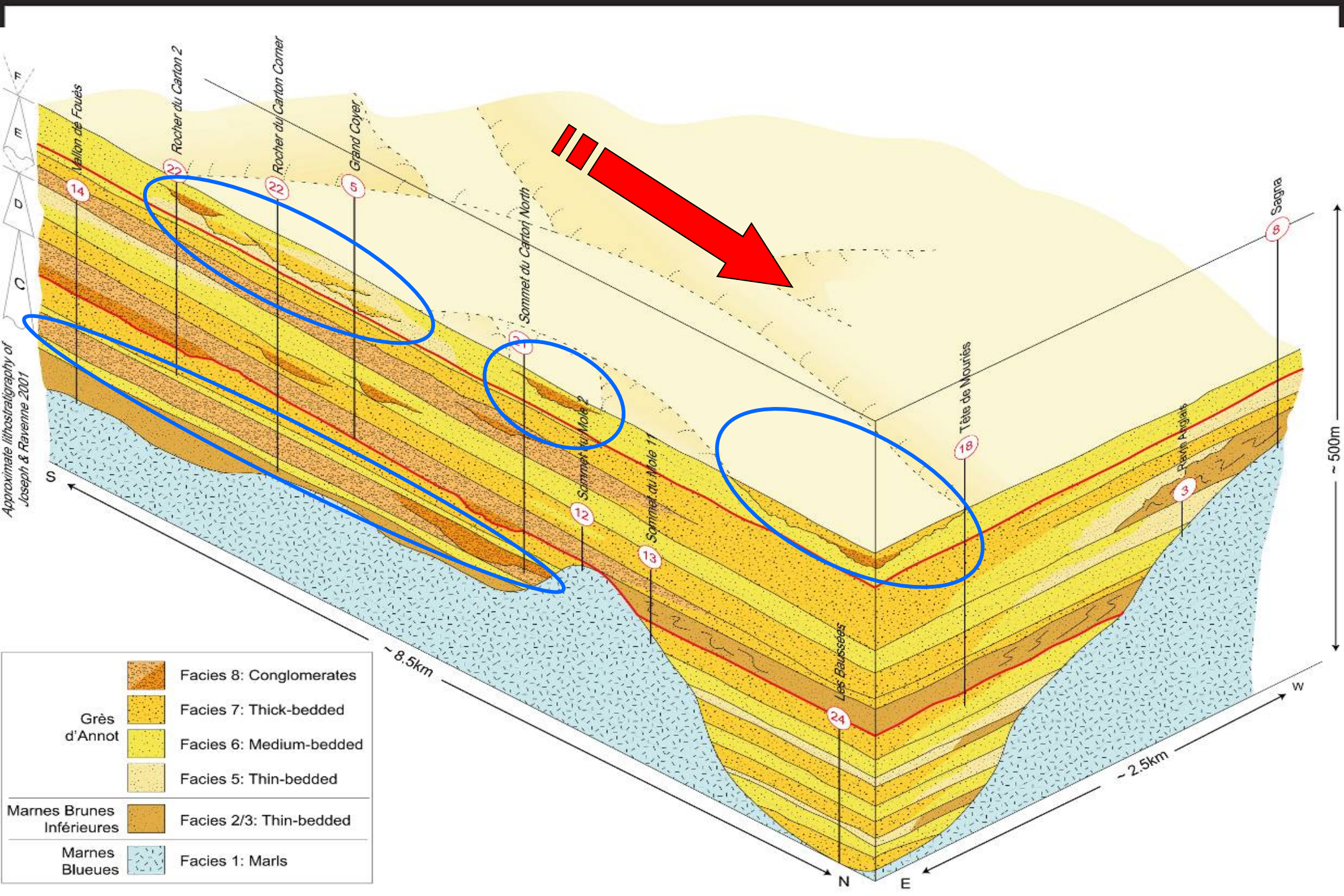




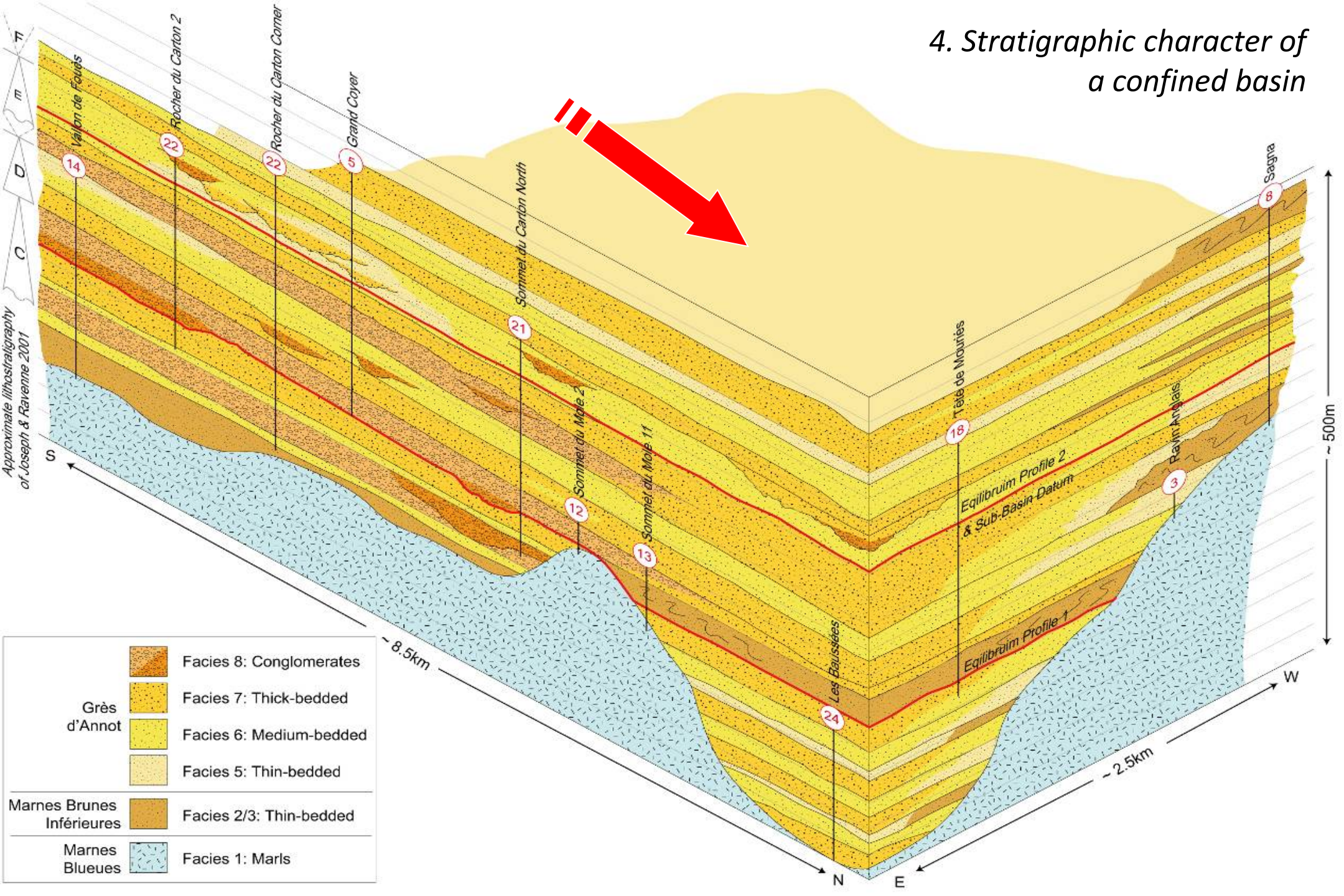
3. Channel sinuosity tends to increase as the basin is progressively filled


352° Mean
E.I., n=6
005° Mean
D.I., n=12
14
A
A'


Medium-bedded Tabular Grès d'Annot sheet-sands
Medium-bedded Grès d'Annot
Thin-bedded Grès d'Annot
~ 13°
~ 20°
~ 1m
Shale
See inset in main photograph
Thin-bedded Marnes Brunes Inférieures
A
~ 22m
A'


Vallon de Foués
Rocher du Carton 2
Rocher du Carton Corner
Grand Coyer
Sommet du Carton North
Sommet du Mole 2
Sommet du Mole 11
Les Bausseas
Tête de Mouriès
Roche Anglais
Sagna
14
22
22
5
2
12
13
24
18
3
8
S
N
E
W
~ 8.5km
~ 2.5km
~ 500m
Approximate lithostratigraphy of Joseph & Ravenne 2001
Grès d'Annot
Facies 8: Conglomerates
Facies 7: Thick-bedded
Facies 6: Medium-bedded
Facies 5: Thin-bedded
Marnes Brunes Inférieures
Facies 2/3: Thin-bedded
Marnes Blueues
Facies 1: Marls

4. Stratigraphic character of a confined basin



Hang on a minute….

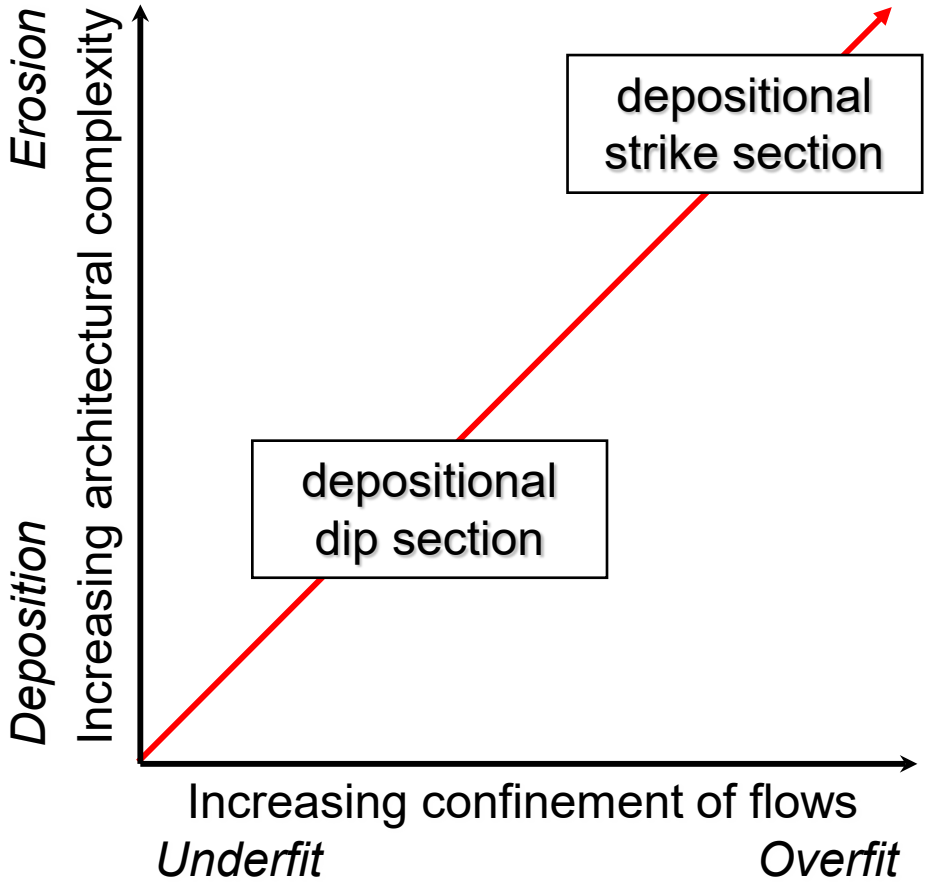
- In the middle of a confined basin / spill basin
  - Should expect high energy as flows become constricted and ‘forced’ though narrow topography
  - That should give rise to cross cutting architectures
- Yet we find:
  - Predominantly sheet like sandbodies
  - Packages of c50m thickness
  - Channelization restricted to two main intervals

So what's going on?

- If the basin acts as a conduit then it represents a zone of bypass
- However bypass is characterised by non-deposition
- To be recorded in the stratigraphic record deposition is required
- The entire preserved sequence represents the 'non-characteristic' depositional episodes

Proximal-Distal & Axial-Marginal relationships

- The relationship from proximal to distal is markedly simpler than that of axial to marginal in this confined basin
- It is the confinement of flows (at all scales) that gives rise to erosion and therefore complex architectural patterns
- Basin geometry can be used a proxy to condition bed lengths in geologic models



Summary

- Leeward slopes (esp. spill-points) is characterized by slumping & instability
- Leeward onlap are characterized by higher N:G, greater amalgamation and more abrupt terminations than incident onlap
- Confinement controls channel sinuosity
- Scaling of flows in relation to basin size has an empirical relationship to architecture

Thanks: Original fieldwork done with the Genetic Units Project at Heriot-Watt University with assistance from BSRG, IAS & AAPG. Nautilus for use of some drafted materials.