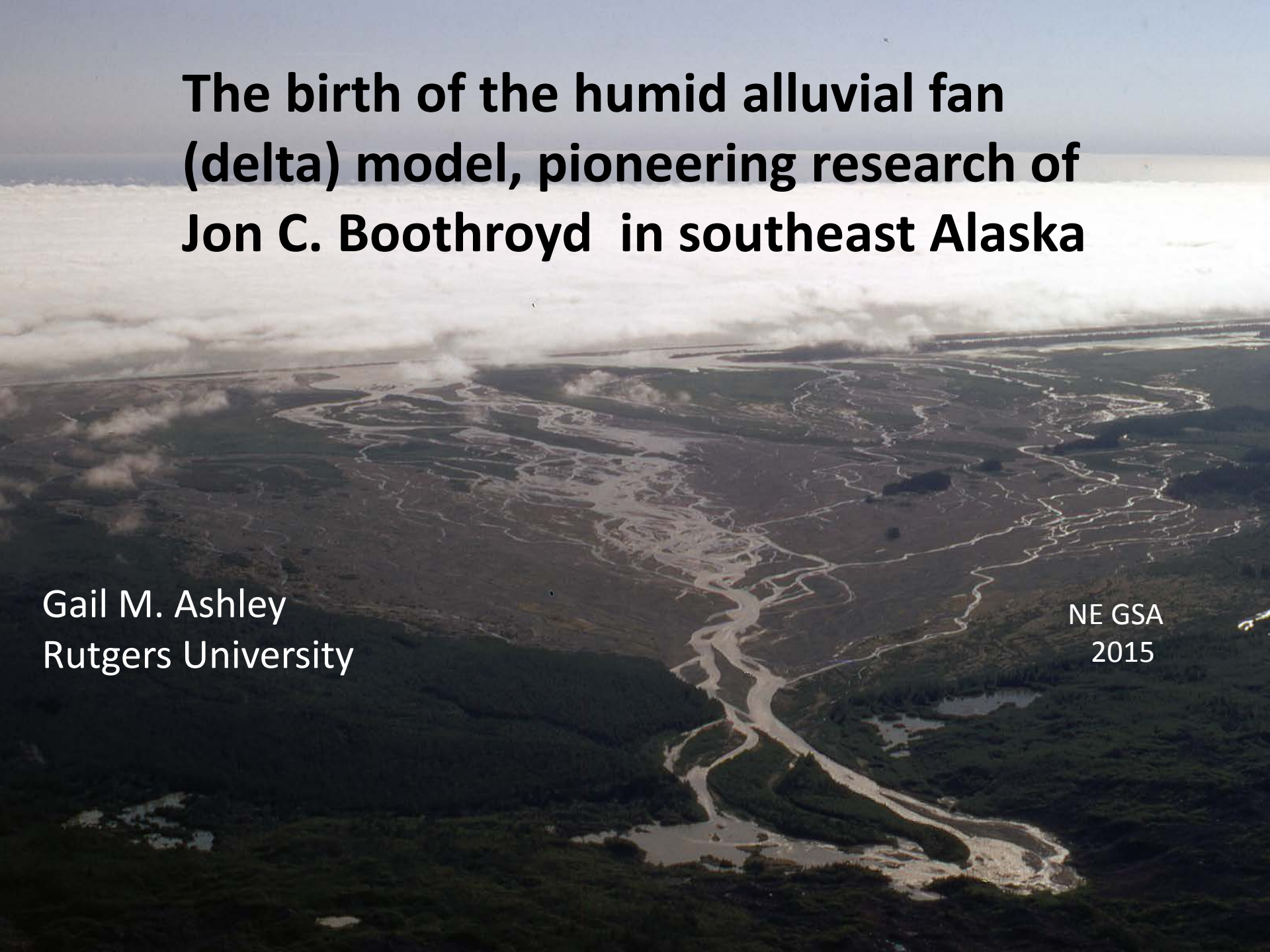
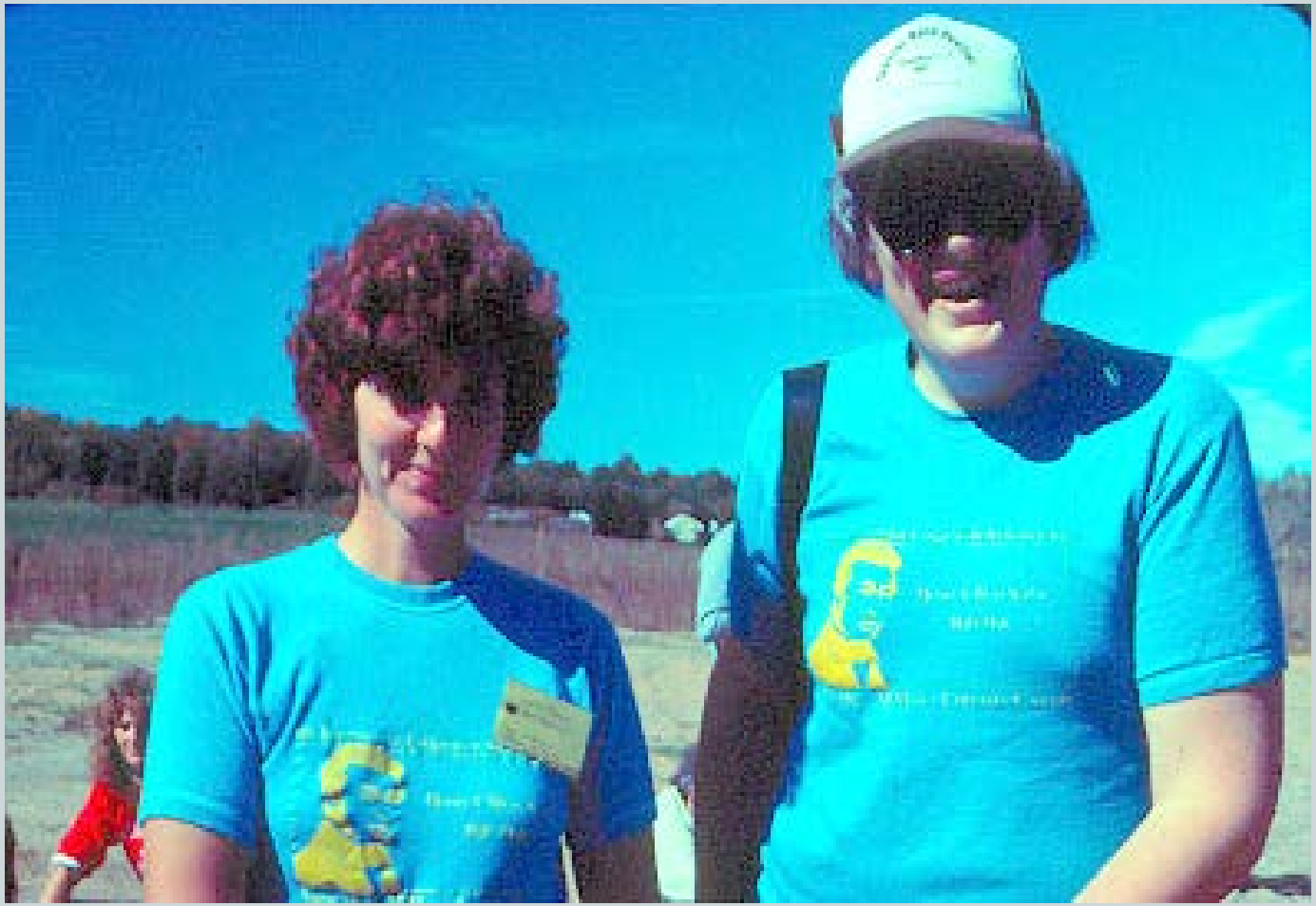
The birth of the humid alluvial fan (delta) model, pioneering research of Jon C. Boothroyd in southeast Alaska



Gail M. Ashley
Rutgers University

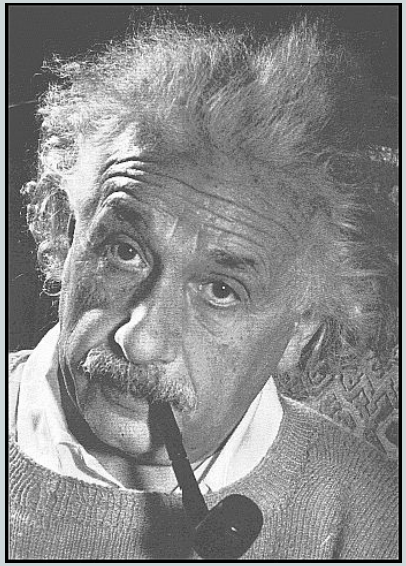
NE GSA
2015



In the beginning…… 1960's

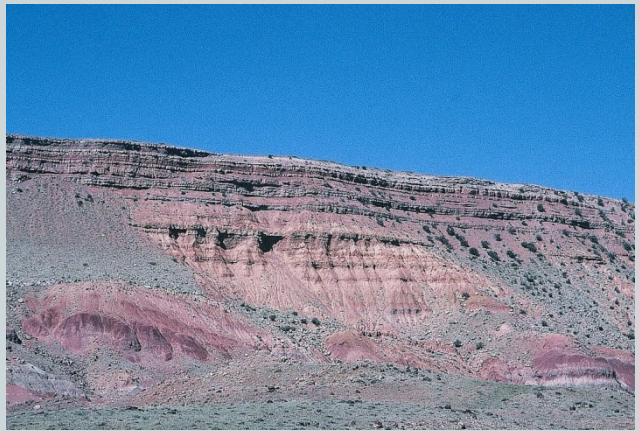
Sedimentology as its own discipline was progressing along a number of separate tracks

studies of modern environments



theory

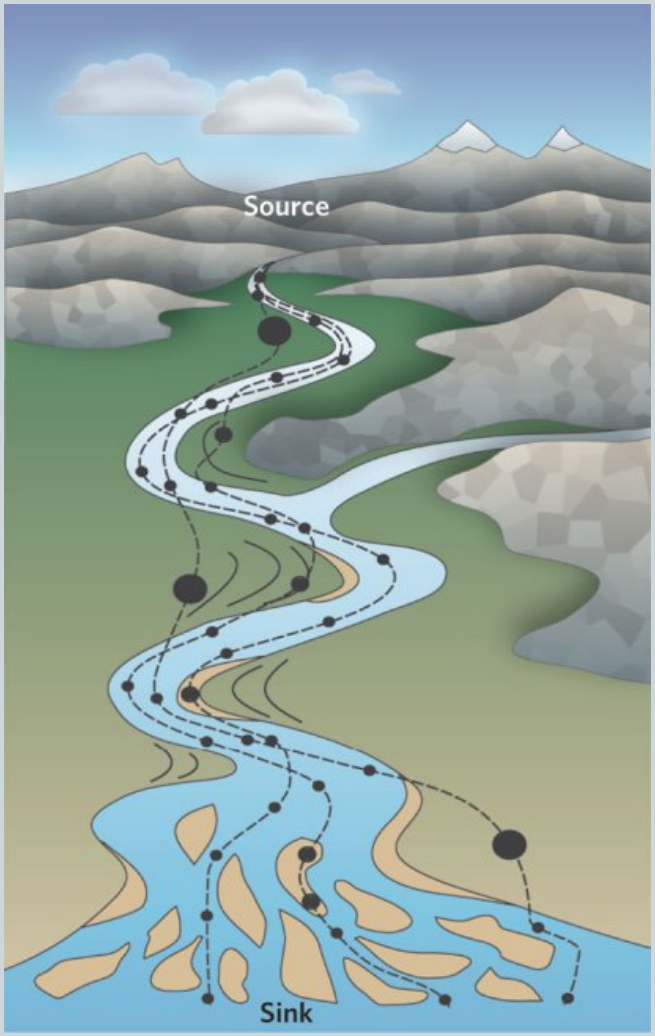
experimental studies



studies of ancient environments

“Source to sink” sedimentology

was in need of some fresh ideas and connections between separate lines of investigation.



Laboratory (flume) studies: fluid mechanics sediment transport , and sedimentary structures

Geomorphologists (field):
fluvial processes, deposits , sedimentary structures channel patterns and architectural elements

Geologists (outcrop & cores):
- stratification & sedimentary structures
- sedimentary petrology & composition
- sandstone geometry & facies

Phillip Allen

Theory & Experimental Studies

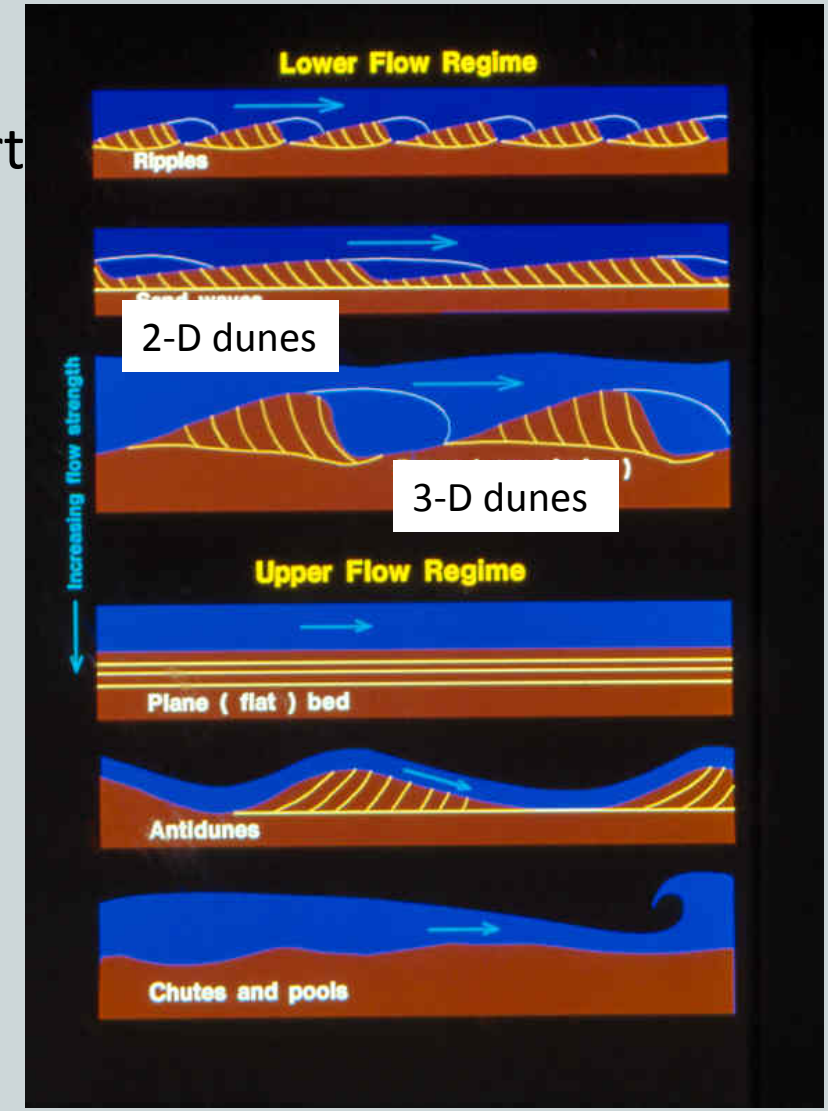
civil engineers & geologists

- Fluid mechanics & sediment transport

H.A. Einstein, 1942, 1950
Sneed & Folk, 1958
J.F. Kennedy, 1961
M.S. Yalin, 1964
J.R.L. Allen, 1965
A.V. Jopling, 1965
Harms & Fahnestock, 1965
G.P. Williams, 1967
C.R. Neill, 1968

- Bed forms & sedimentary structures

J.R.L. Allen, 1963; 1970
Pettijohn & Potter, 1964
Simons et al. 1961, 1965
G.V. Middleton, 1965
Roger Walker, 1965
J.C. Harms, 1975
John B. Southard, 1975



Geomorphologists – field studies

processes, deposits, fluvial channel patterns

- Leopold & Wolman, 1957
- S.A. Schumm, 1960
- A. Krigstrom, 1962
- J.M. Coleman, 1969
- N.D. Smith, 1970
- J. D. Collinson, 1970
- Brian Rust, 1972
- Michael Church, 1972
- R. Hooke, 1967-1969

Troy Pewe

Geologists

Research was divided into:

(1) Those working on surface processes and deposits were mainly **sub-aerial alluvial fan** systems)…and

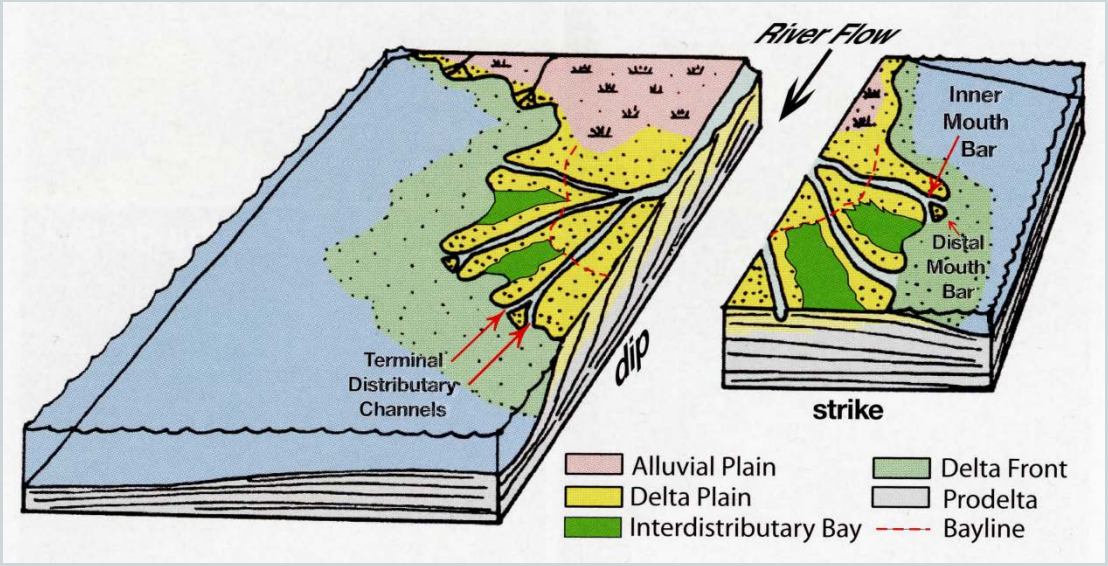
Badwater Alluvial fan, Death Valley

Beaty 1963; 1970
Blissenbach, 1954
Bull, 1962-1971
Bluck, 1964
Denny, 1965
Legget et al., 1965
Melton, 1965
Ruhe, 1964
Hooke 1967;1968

(2) Those working on the rock record (outcrop & core) focused on **deltas**…motivated by the potential of fossil fuels.

J.M. Colman
C.C. Bates
A.G. Fischer
H.N. Fisk
R. L. Folk
J.C. Harms
W.C. Krumbein
P.D. Krynine
F.J. Pettijohn
P.E. Potter
L.L. Sloss
R. G. Walker

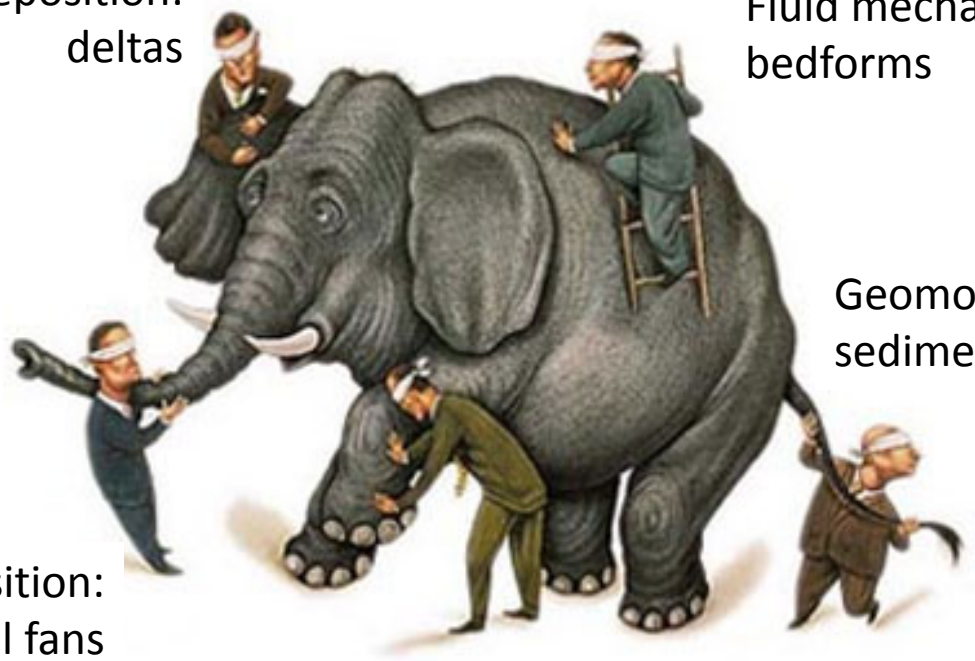
The Mississippi delta was a favorite.



Source to sink investigations were like the 5 blind men and the elephant

Sediment deposition: deltas

Fluid mechanics & bedforms

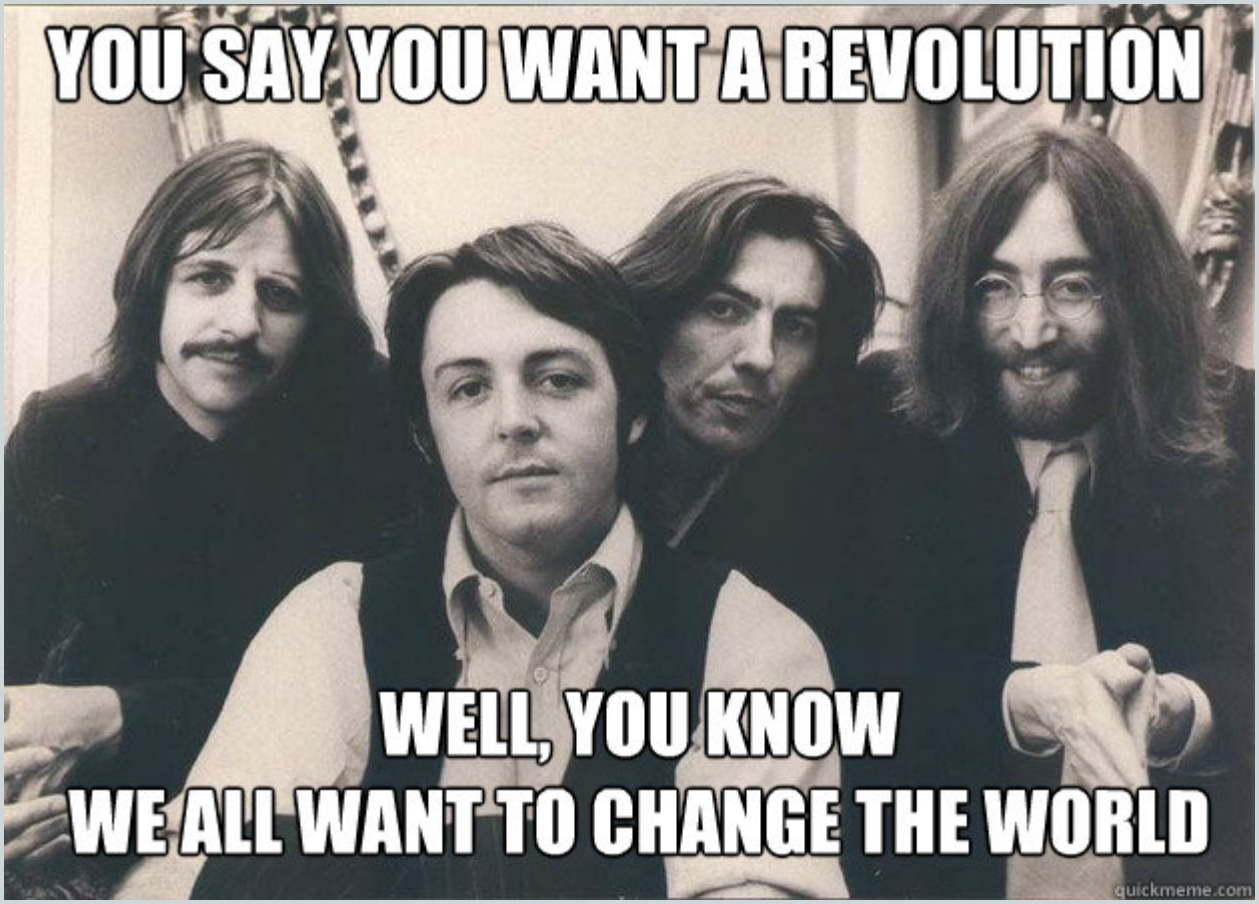


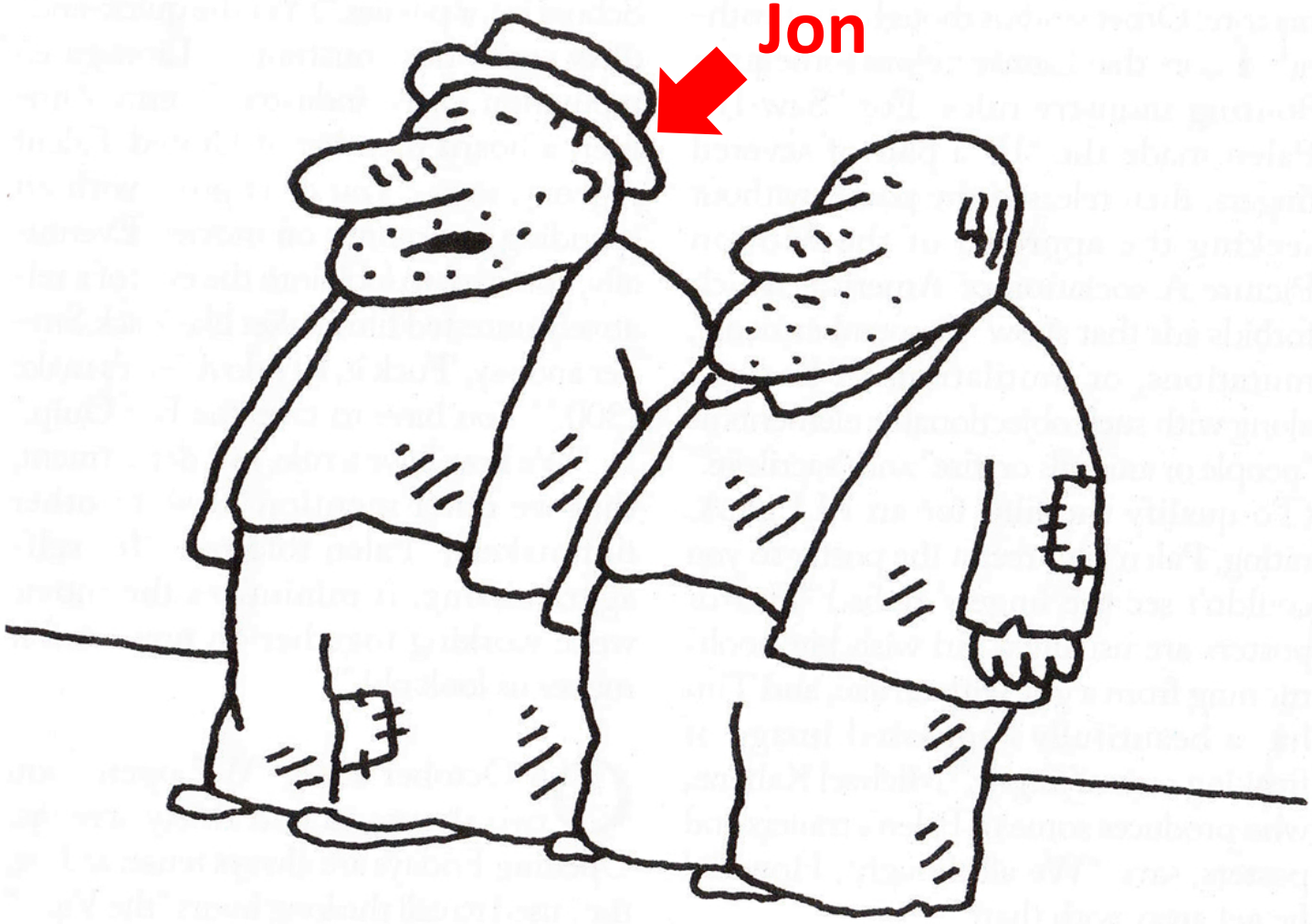
Geomorphology & sedimentary structures

Sediment deposition: alluvial fans

Sediment transport & fluvial patterns

Sedimentology in the 1960's was ready for a revolution



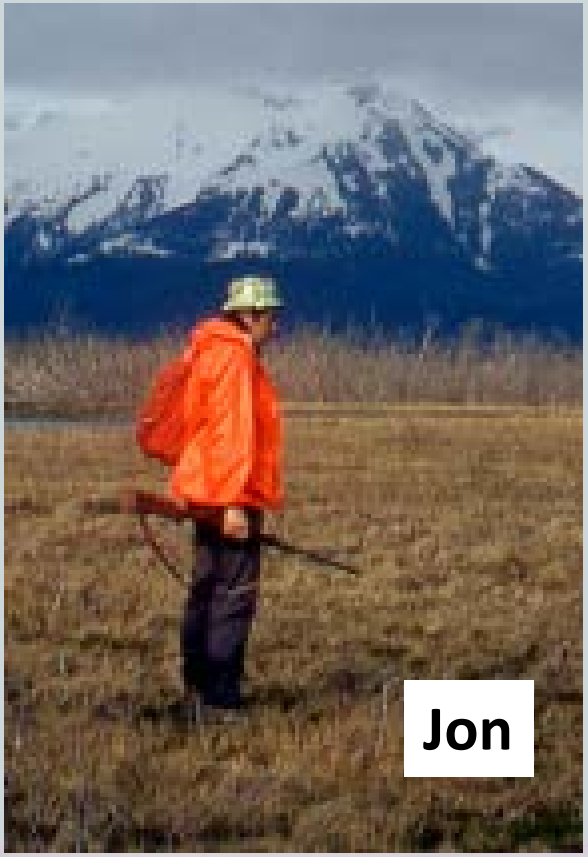


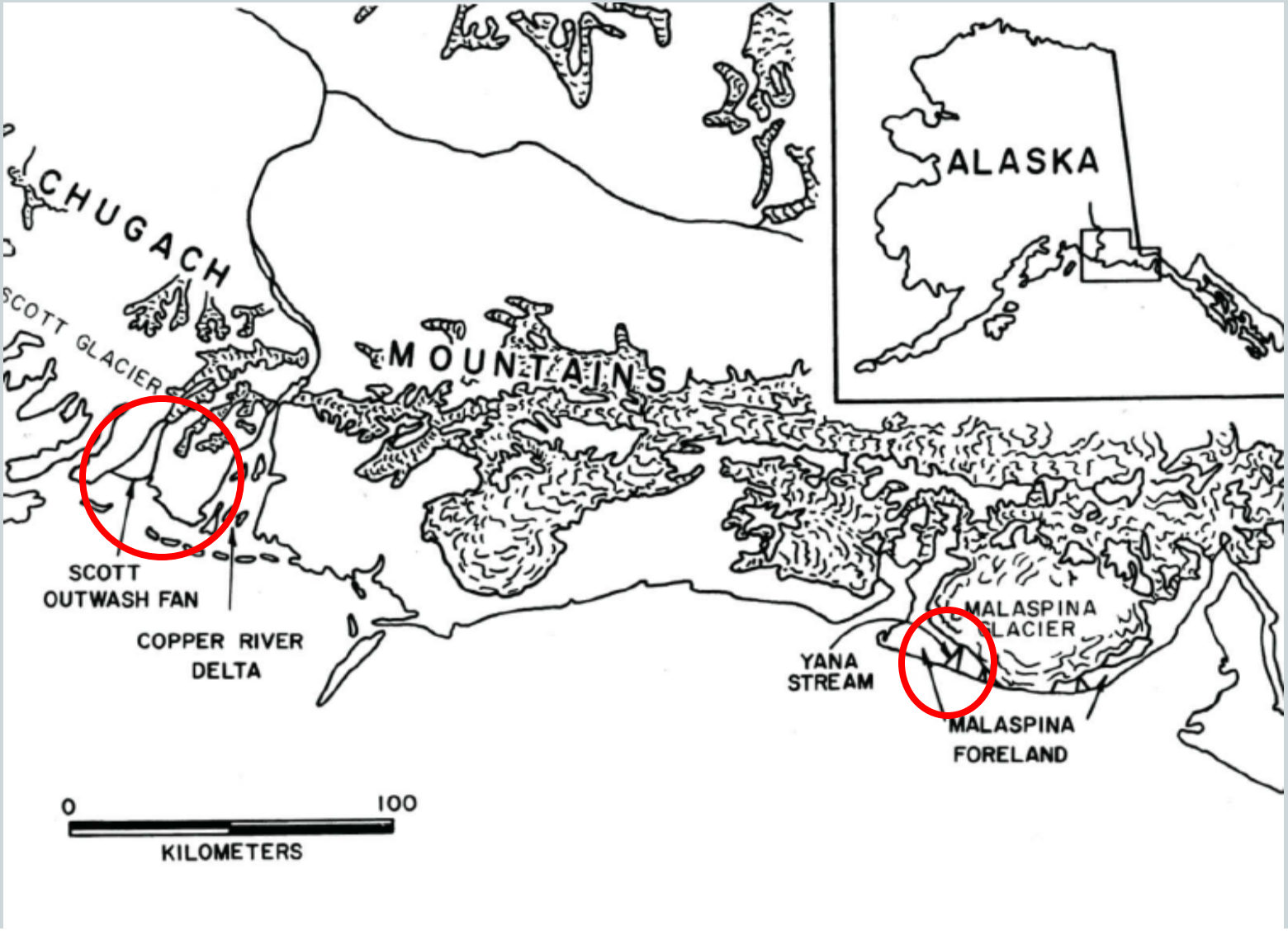
"Good news—I hear the paradigm is shifting."


CRC reunion at the celebration in honor of former
UMass Prof. Miles Hayes
2011

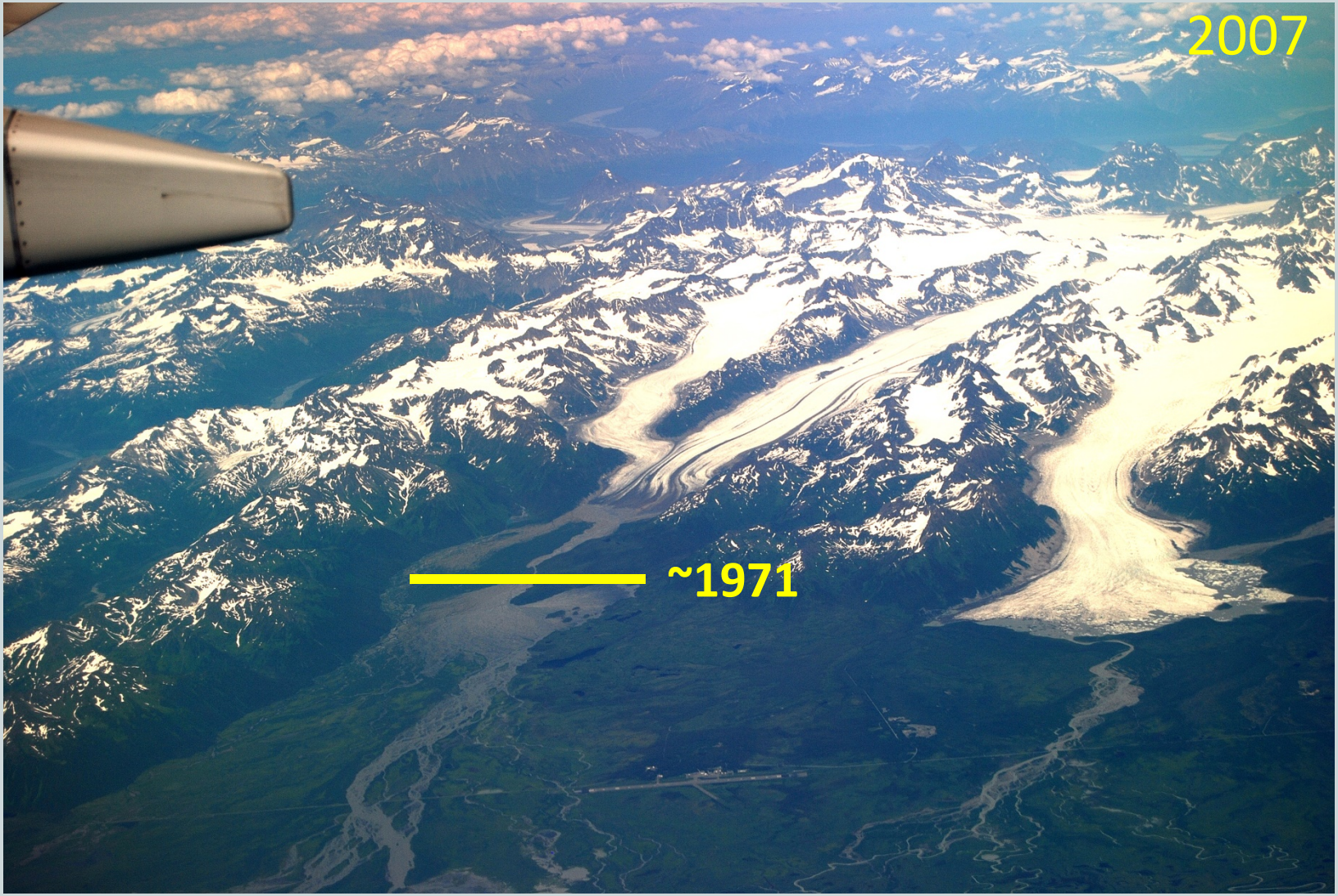
Southeast Alaska ….active glaciers…..
meltwater streams draining to the coast

1971



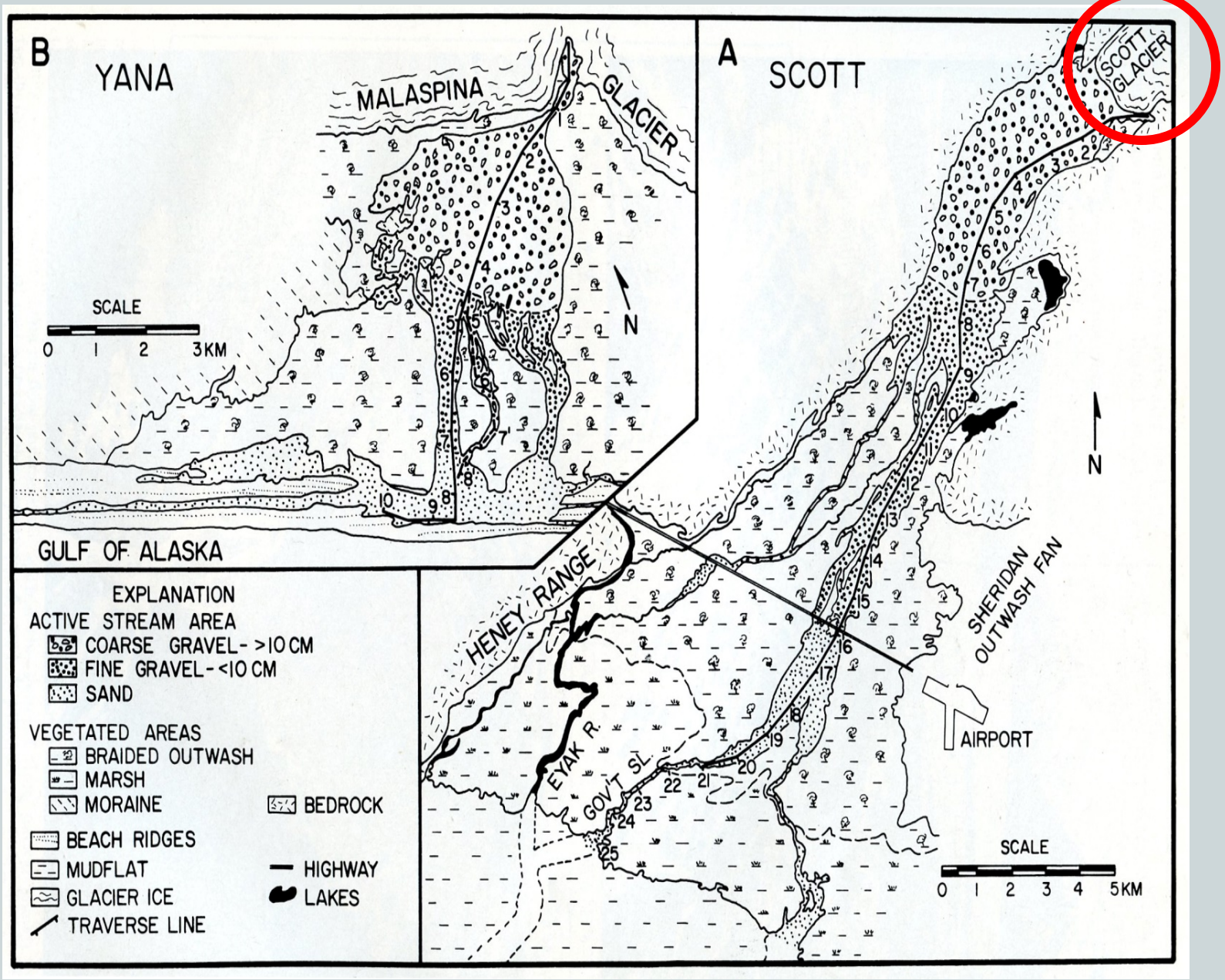


Boothroyd and Ashley 1975, SEPM Special Publication



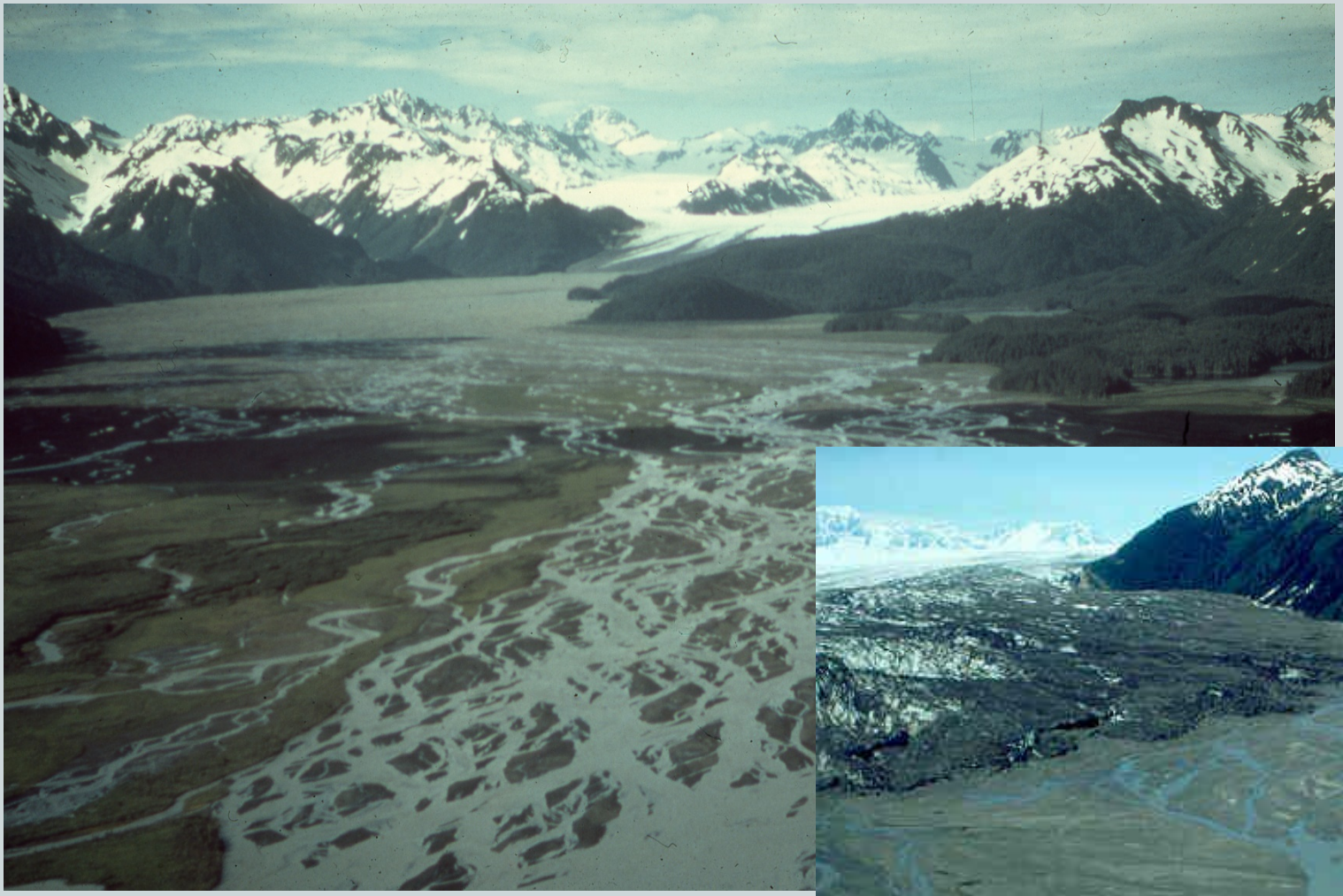
Scott Glacier

Sheridan Glacier


B
YANA
MALASPINA
GLACIER
SCALE
0 1 2 3KM
N
GULF OF ALASKA
A
SCOTT
SCOTT GLACIER
N
HENEY RANGE
SHERIDAN OUTWASH FAN
EYAK R.
GOVT SL
AIRPORT
SCALE
0 1 2 3 4 5KM
EXPLANATION
ACTIVE STREAM AREA
COARSE GRAVEL- >10 CM
FINE GRAVEL- <10 CM
SAND
VEGETATED AREAS
BRAIDED OUTWASH
MARSH
MORAINE
BEDROCK
BEACH RIDGES
MUDFLAT
GLACIER ICE
TRAVERSE LINE
HIGHWAY
LAKES

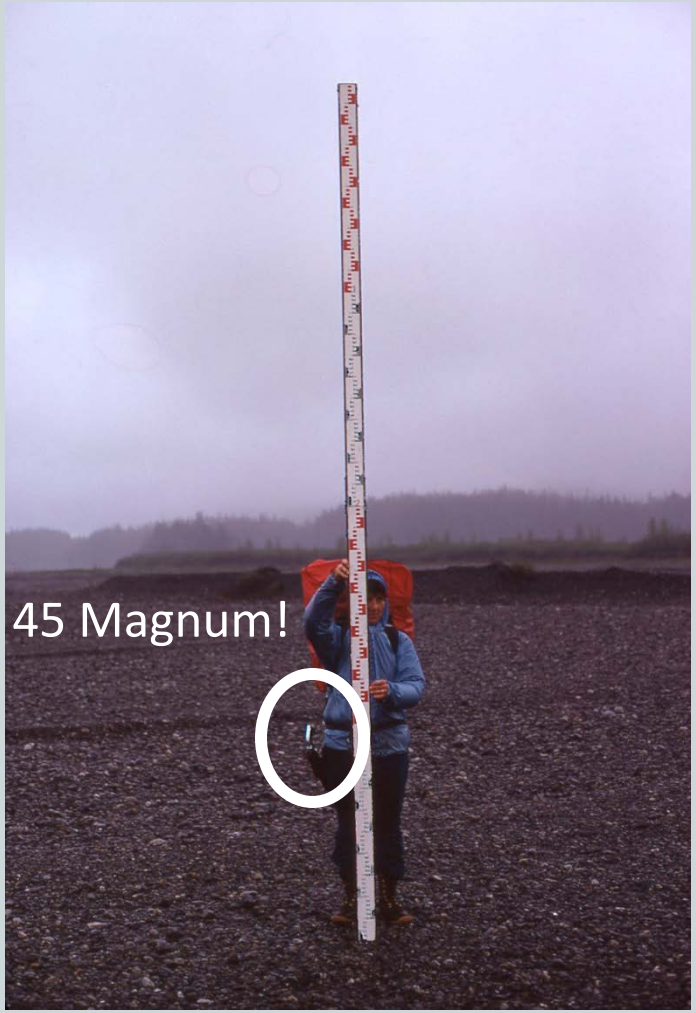
Upper Scott Fan, sourced by meltwater

(24 km long



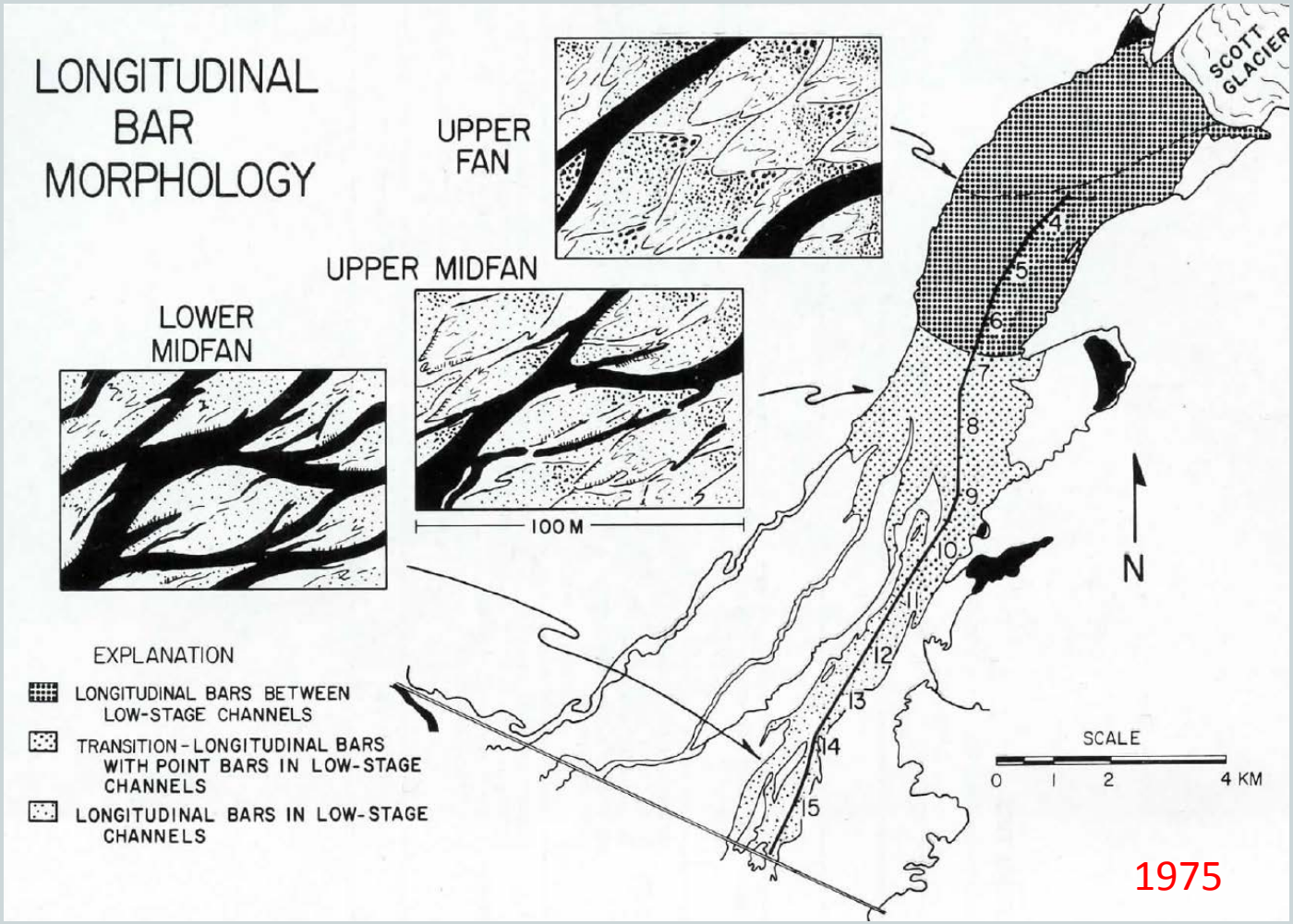
Data, Data, Data…….. Clast size

Measuring slope and temperature



Scott Fan Model

Miall (1977 onward) used the Scott as 1 of 3 types of facies models for braided-river deposits



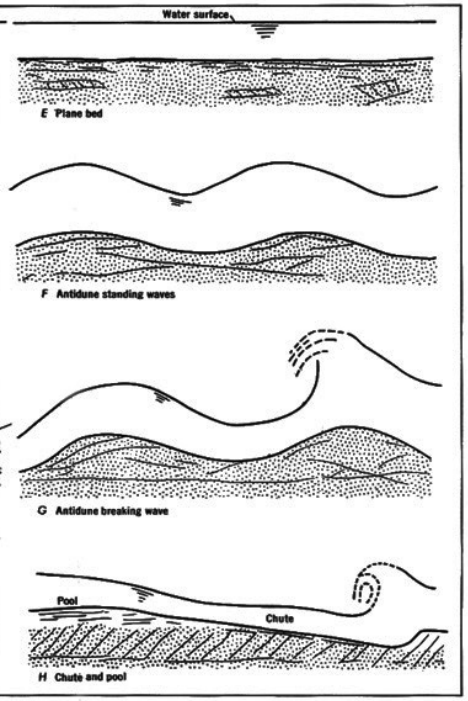
Upper Scott fan - gravel, braided

type area for longitudinal bars

Longitudinal bar

Upper Yana Fan

Transverse ribs

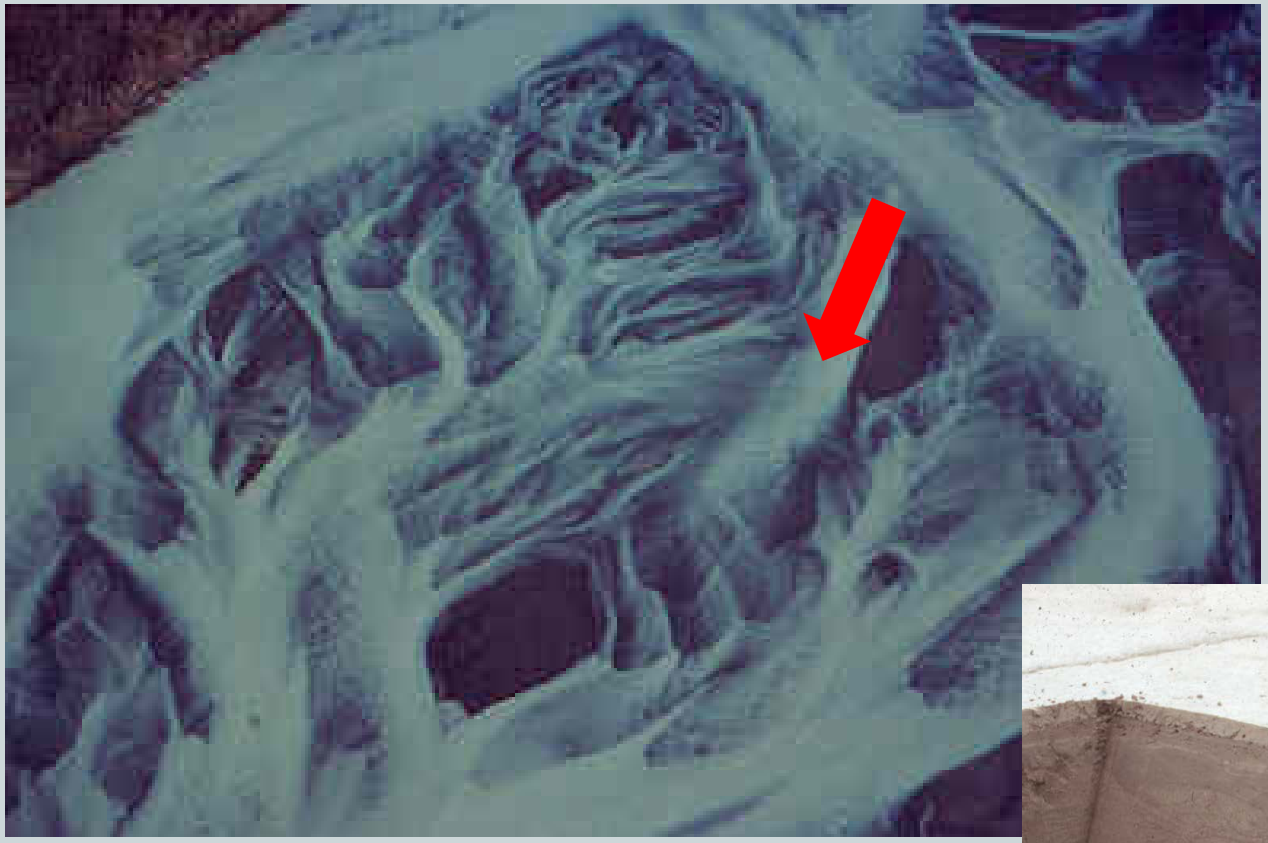


Upper flow regime gravel bedforms

Middle Scott fan - sandy, braided

(overbank flooding (splays) and type area for linguoid bars)

Linguoid Bars



Mid-Lower Scott Fan

Lower Yana Fan

Internal structure - Dune crossbedding and ripple-drift cross-lamination

Lower Scott Fan – low gradient, silt & clay

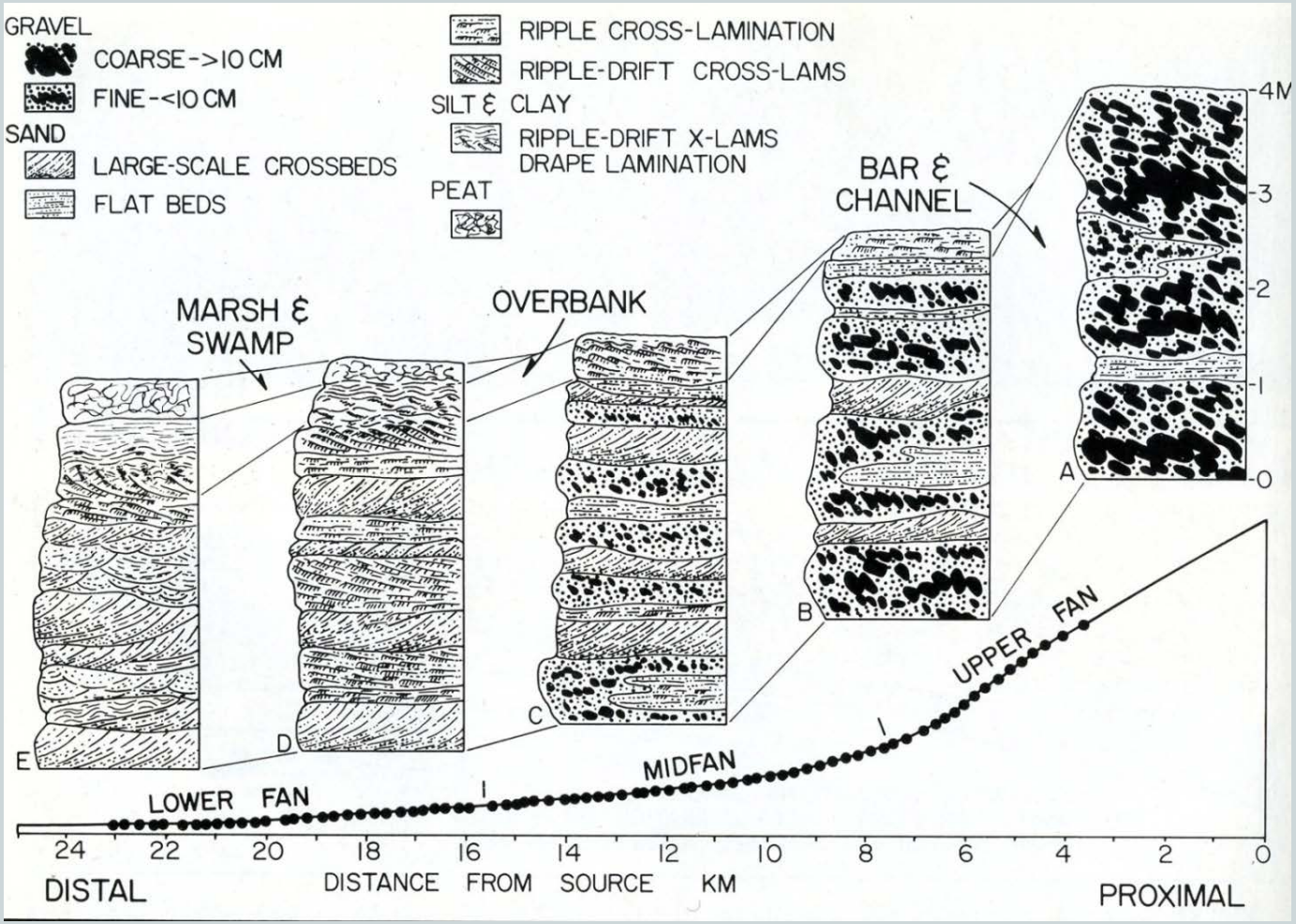
(ends in intertidal mudflats behind barrier islands of the Copper River Delta

Meandering channel

in stable, vegetated swamp in interdistributary areas

Delta ← **24 km** → **Glacial Source**

Copper River Delta

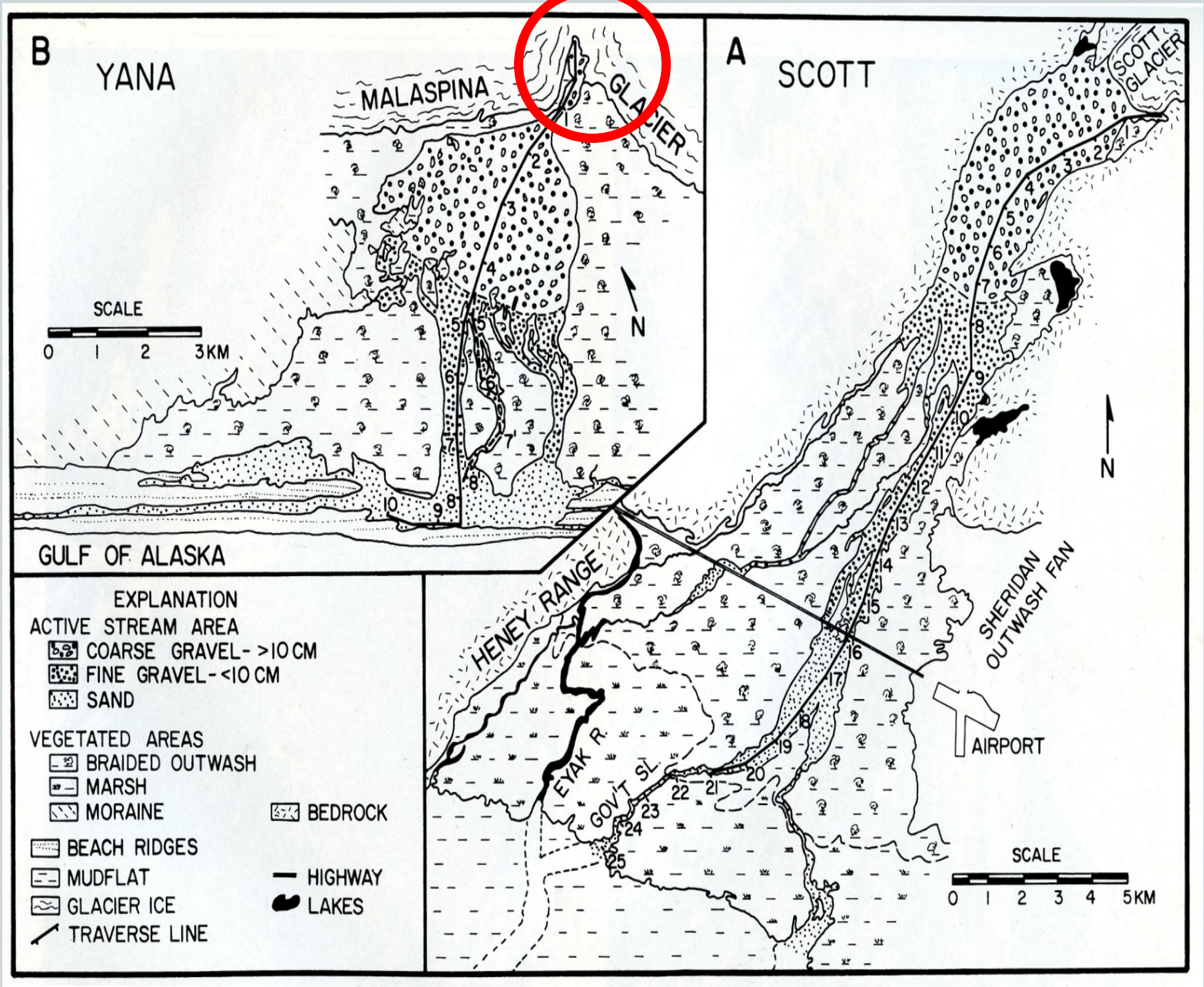


-clast size

-slope

-bar type

-sedimentary structures


B
YANA
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MORAINE
BEDROCK
BEACH RIDGES
MUDFLAT
GLACIER ICE
TRAVERSE LINE
HIGHWAY
LAKES

Yana Source

Cessna 39 Victor beach landing Yana Fan


YANA
INTERNATIONAL

Pilot John Davis
Gulf Air Taxi

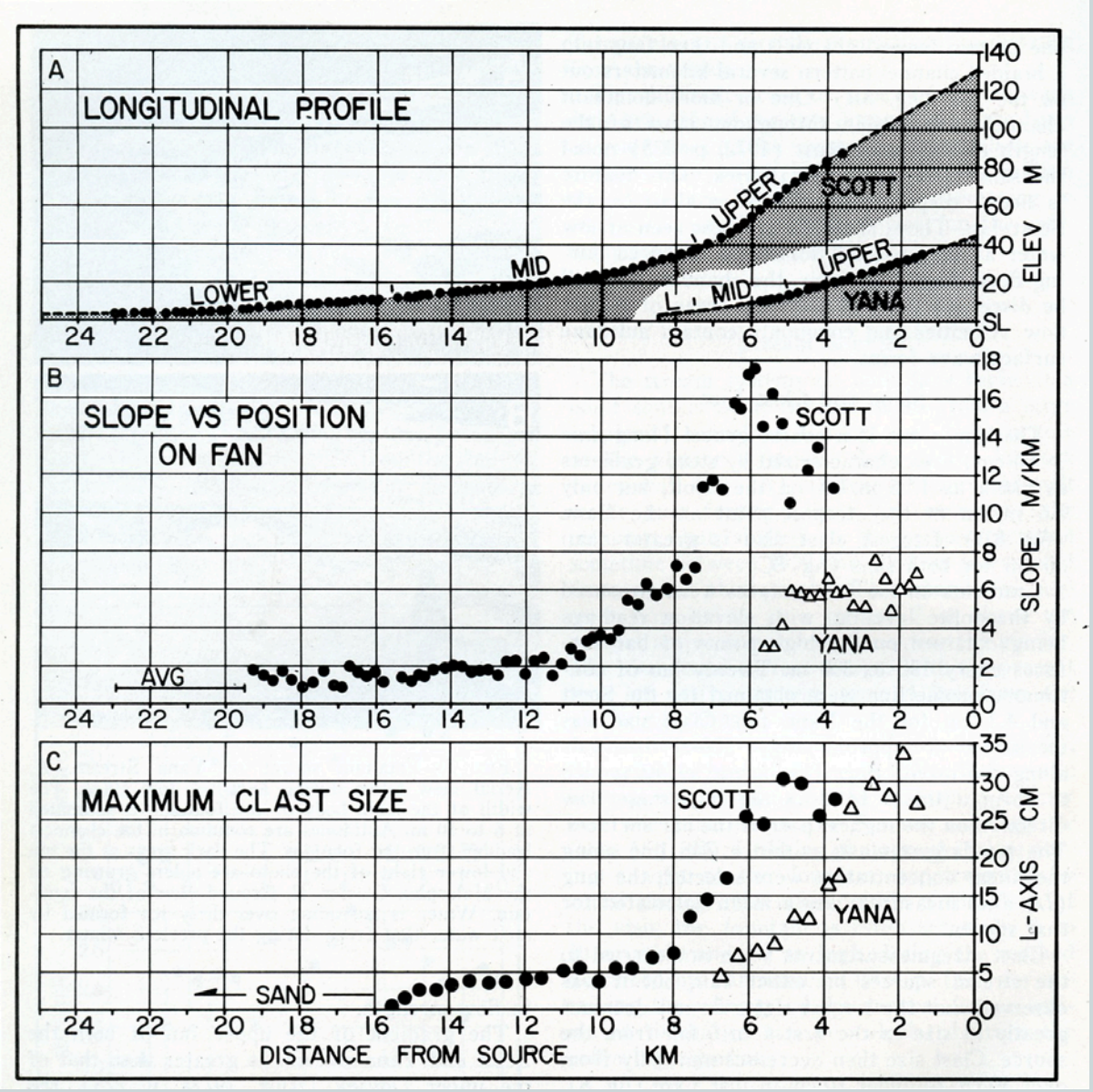
Air sick

Yana fountain -- artesian water & sediment source

Middle Yana Fan, longitudinal gravel bars

(8. 5 km long, but same facies as the Scott Fan)

Compiled data – Scott Fan and Yana Fan



What has happened to humid alluvial fan science since 1971?

Subaerial humid alluvial fans

1975 Boothroyd & Ashley **fan delta**

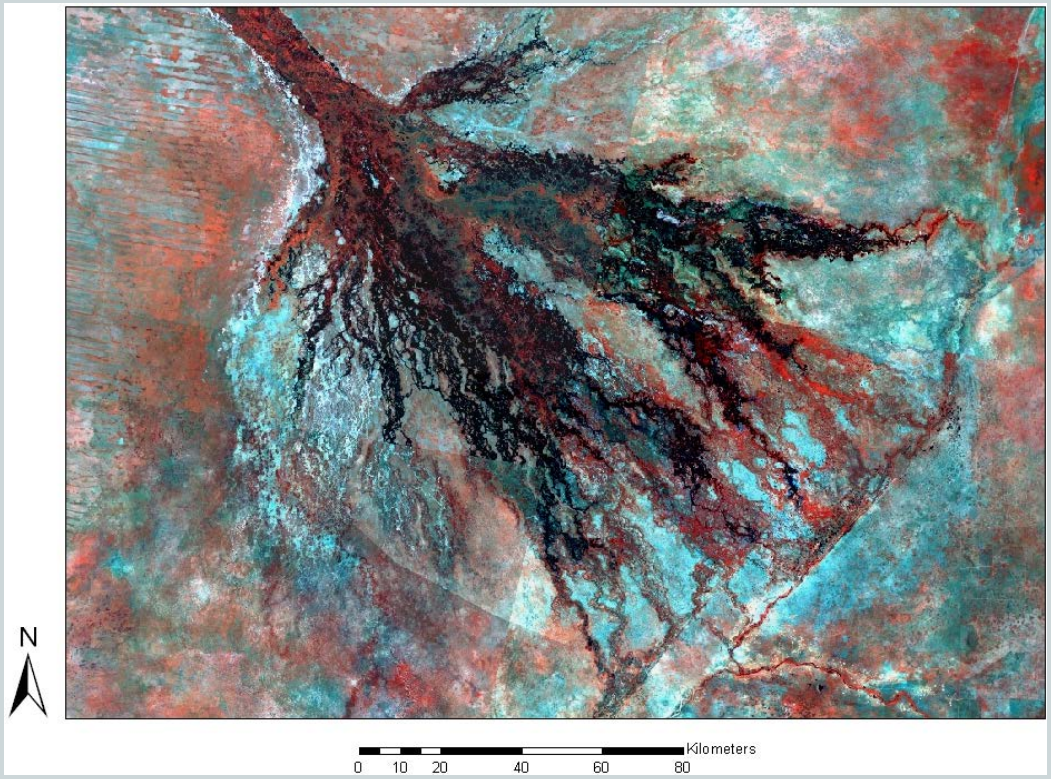
1977 Miall **Scott "type"** of braided-river deposits

1978 Boothroyd & Nummedal **humid alluvial fan**

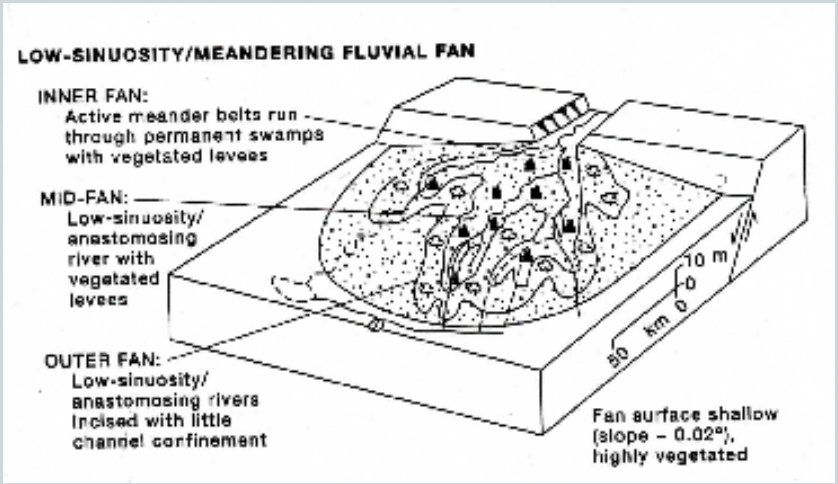
1978 Friend **terminal fan**

1993 Stanistreet & McCarthy, 1993 **subaerial fan system**

Okavango, Botswana



1993 Stanistreet & McCarthy, subaerial fan system



Losimean Fan

Subaerial humid alluvial fans

1973 Boothroyd & Ashley **fan delta**

1978 Boothroyd & Nummedal **humid alluvial fan**

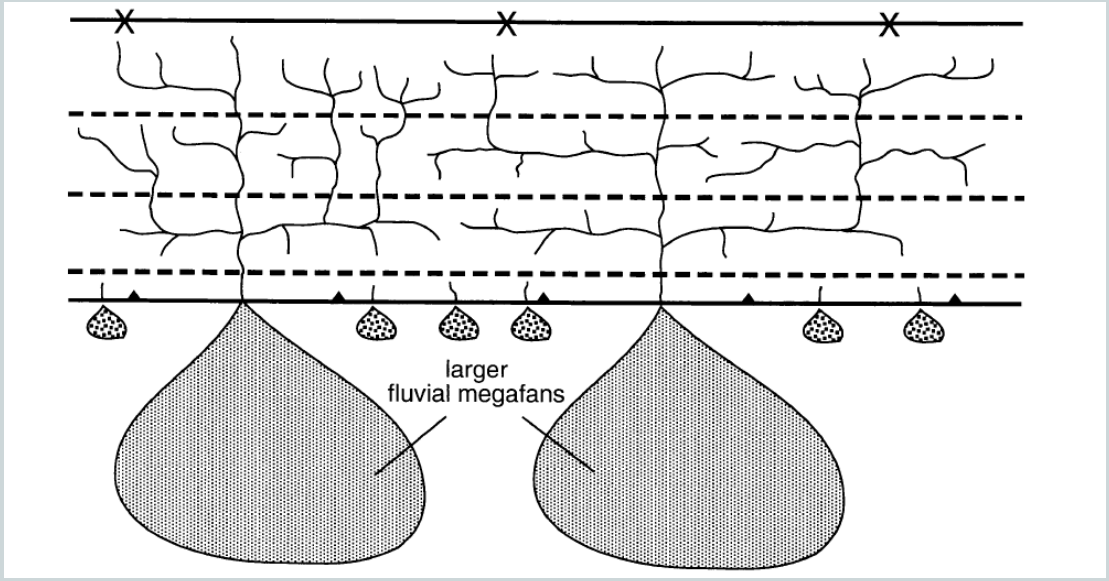
1978 Friend **terminal fan**

1993 Stanistreet & McCarthy **subaerial fan system**

2001 Shukla et al. 2001 **megafan**

2001 Horton and DeCelles **megafan**

The perfect storm
-tectonics
-climate



Late stage fluvial development (fold & thrust Belt, Bolivia)

Subaerial humid alluvial fans

1973 Boothroyd & Ashley **fan delta**

1978 Boothroyd & Nummedal **humid alluvial fan**

1978 Peter Friend **terminal fan**

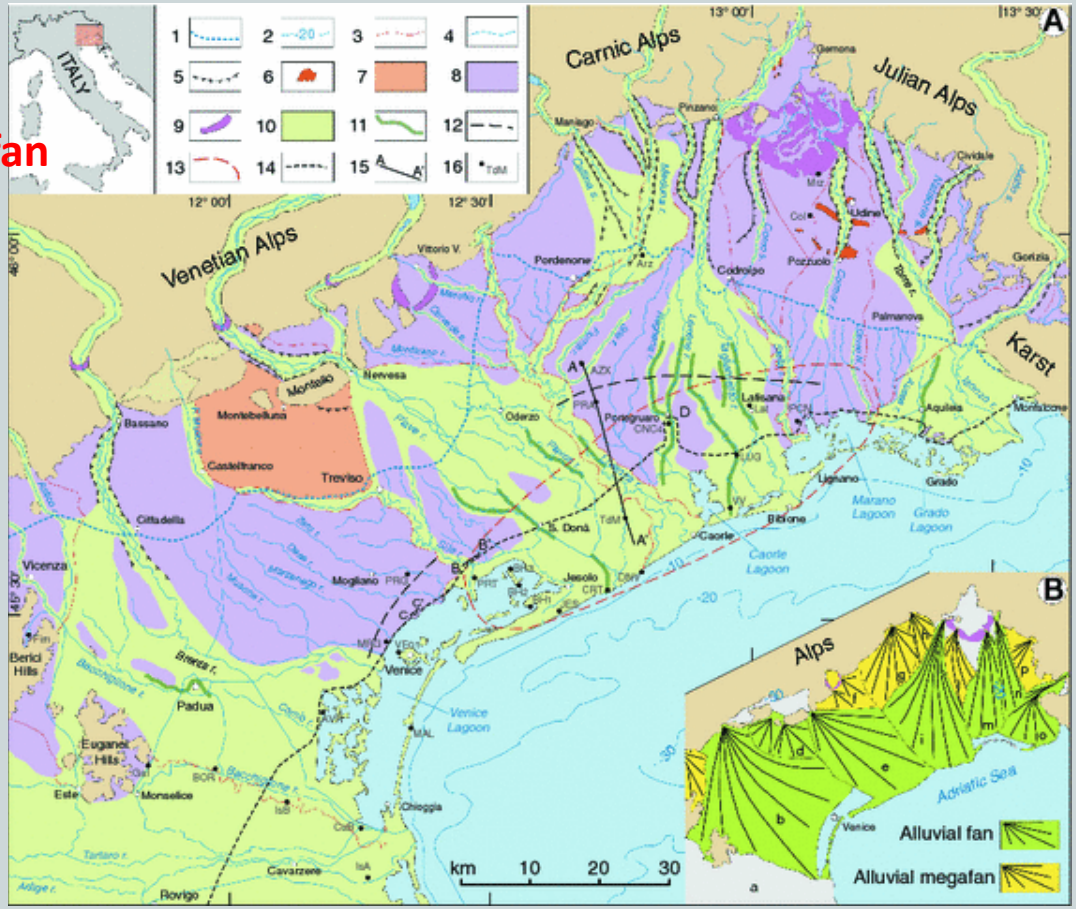
1993 Stanistreet & McCarthy, **subaerial alluvial fan**

2001 Horton and DeCelles **megafan**

2001 Shukla et al. 2001 **megafan**

2008 Fontana et al. **alluvial megafan**

Venetian-Friulian Plain
(Fontana et al. 2008)



Subaerial humid alluvial fans

1973 Boothroyd & Ashley **fan delta**

1978 Boothroyd & Nummedal **humid alluvial fan**

1978 Friend **terminal fan**

1993 Stanistreet & McCarthy **subaerial alluvial fan**

2001 Horton and DeCelles **megafan**

2001 Shukla et al. 2001 **megafan**

2005 Weissmann et al. **fluvial fan**

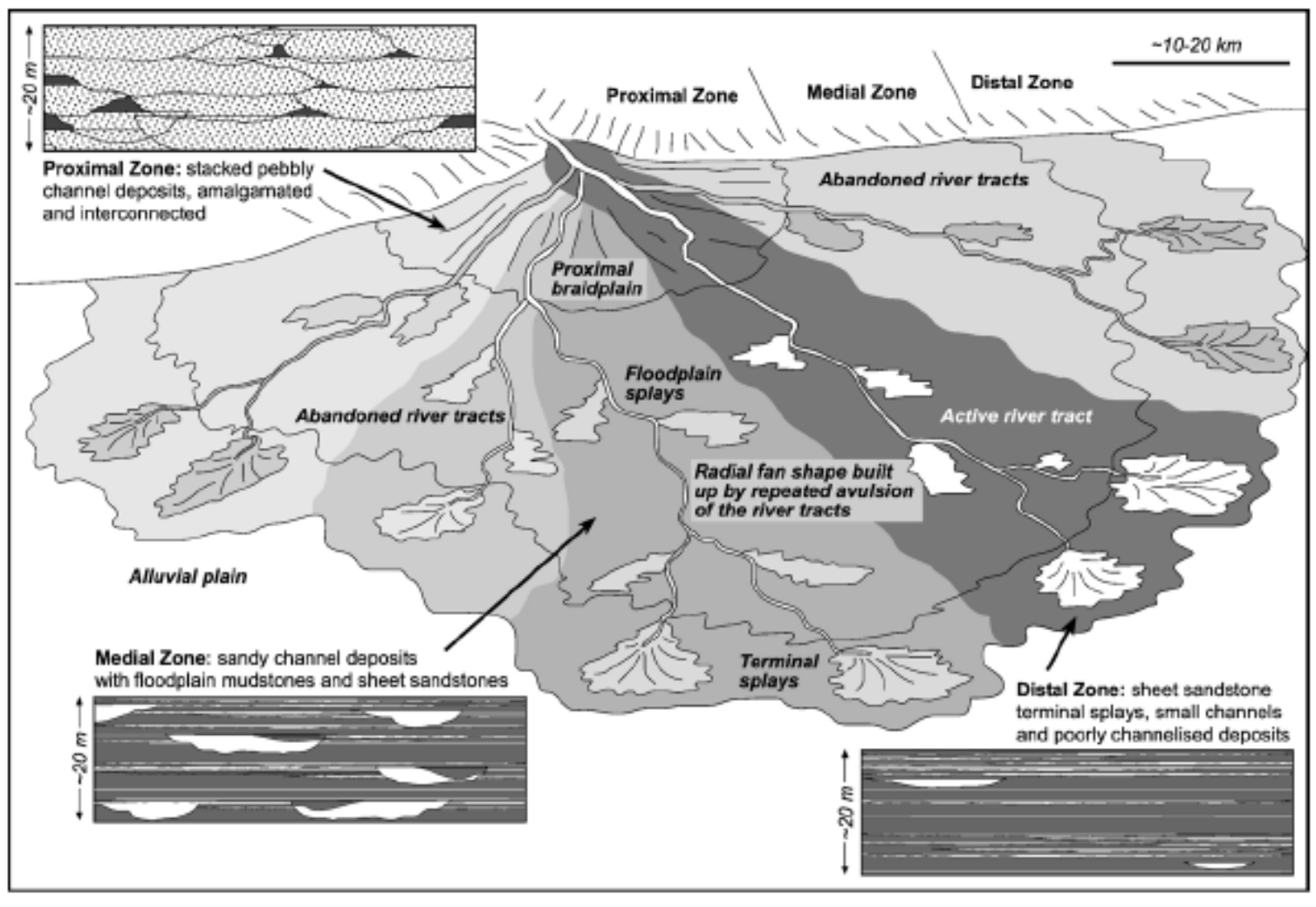
2007 Nichols & Fisher **fluvial distributary system**

2008 Fontana et al. **alluvial megafan**

2013 Weissmann et al. **distributary fluvial system**

DFS

2007 Nichols & Fisher fluvial distributary system

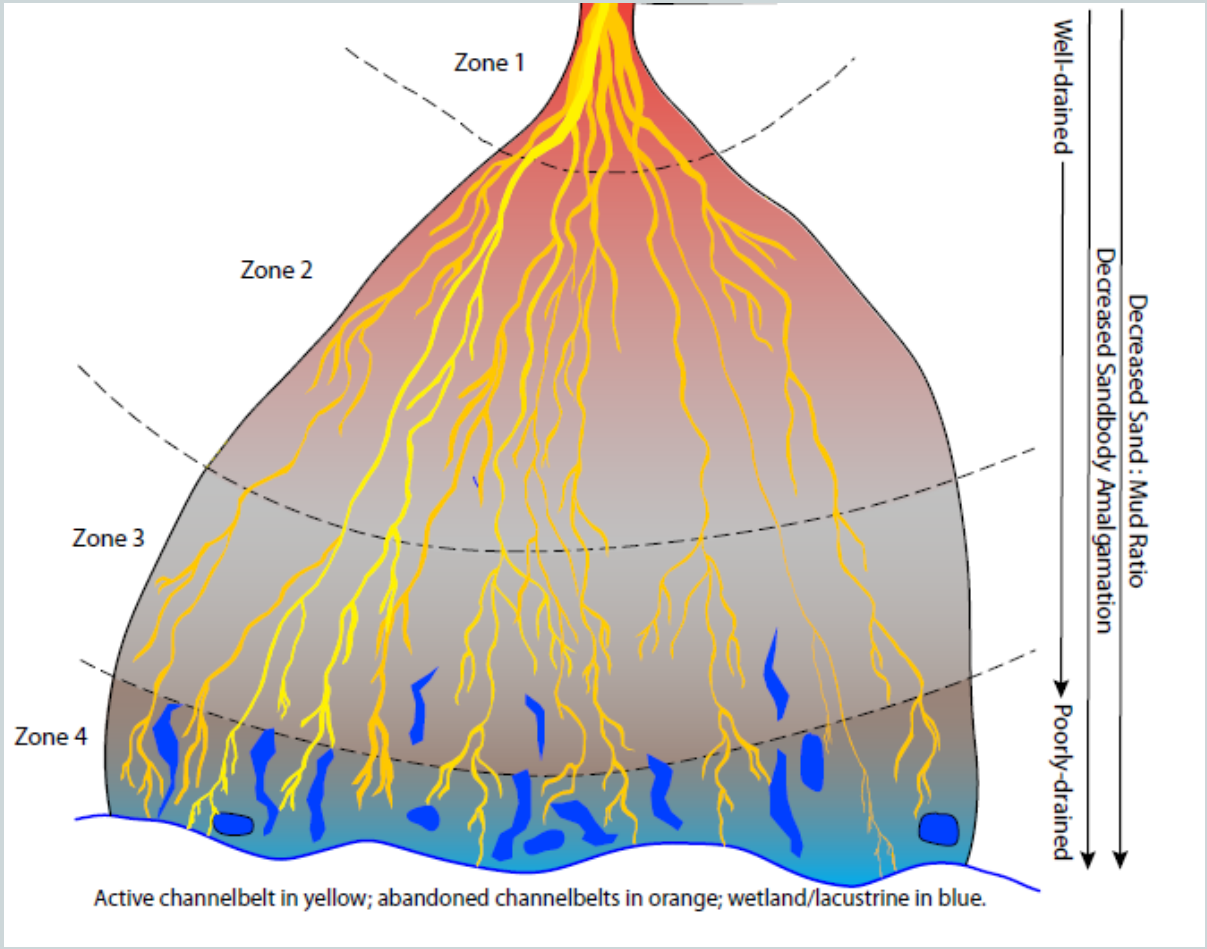


DFS (Distribuary Fluvial System

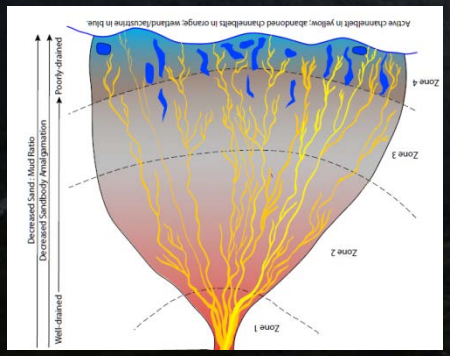
Tarim Basin, China

Courtesy of Gary Weissmann

Distributive Fluvial System Weissmann et al. 2013



Humid alluvial fan – we have come full circle



Yana Fan

Jon, always curious, always thinking