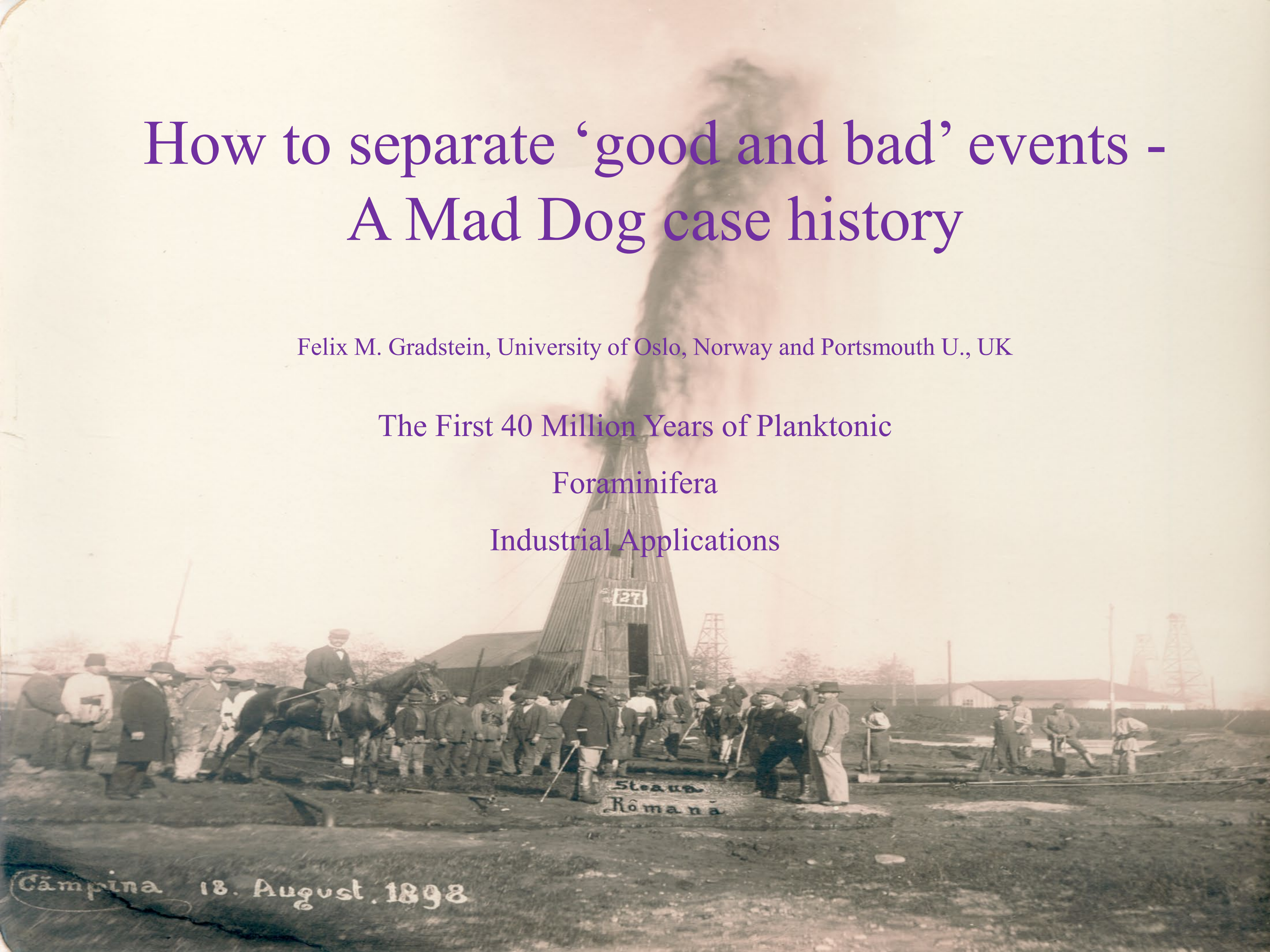
How to separate ‘good and bad’ events - A Mad Dog case history

Felix M. Gradstein, University of Oslo, Norway and Portsmouth U., UK

The First 40 Million Years of Planktonic

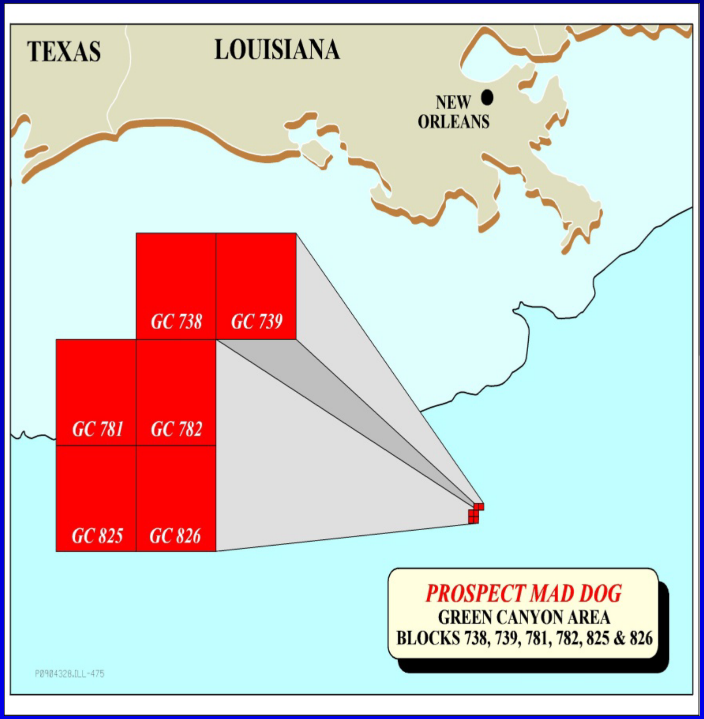
Foraminifera

Industrial Applications



Mad Dog (GOM) Miocene prospects below Jurassic evaporites

1500 – 2000m WD; 5 billion barrels OE



Deep water drilling

Ultra deep wells (> 9 km)

Poor seismic resolution to identify turbidite fairways

Identify sand prone strat levels with microfossils

Garry Jones †

Mardi Gras 1993

Data

1600+ Miocene nannofossil and foraminifer occurrences in 13 wells

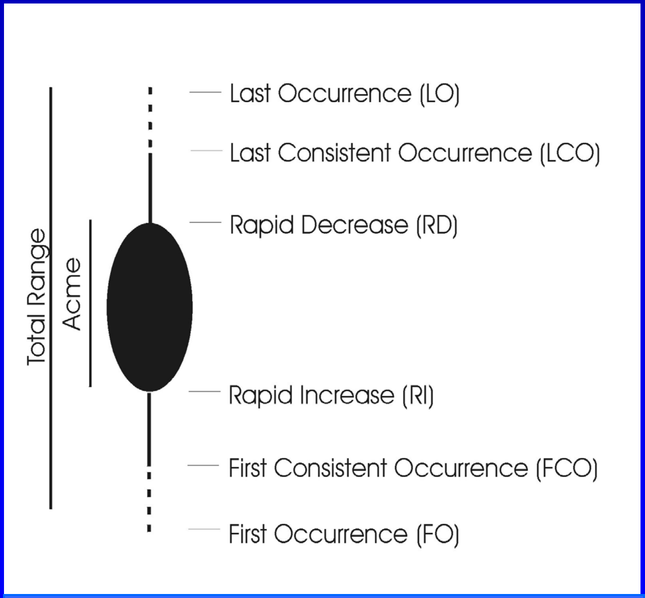
LO (top)

LCO

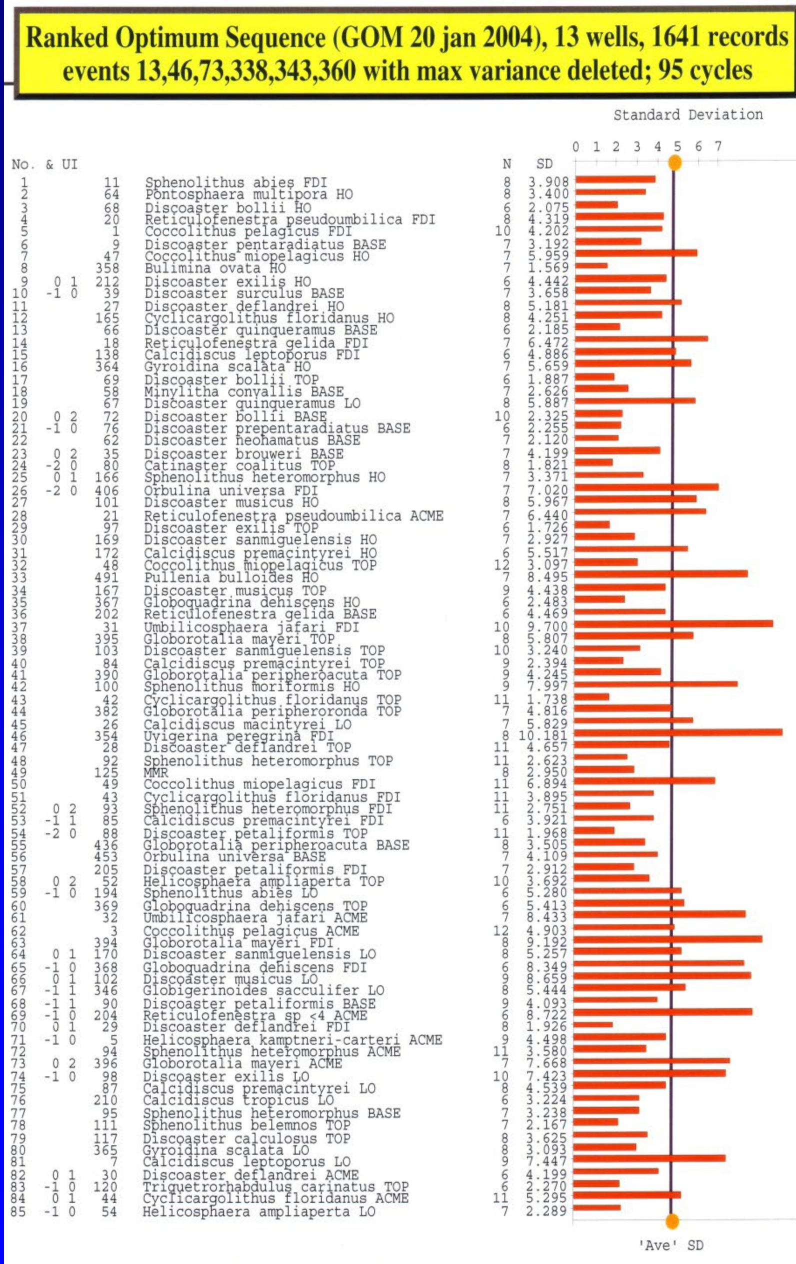
Acme

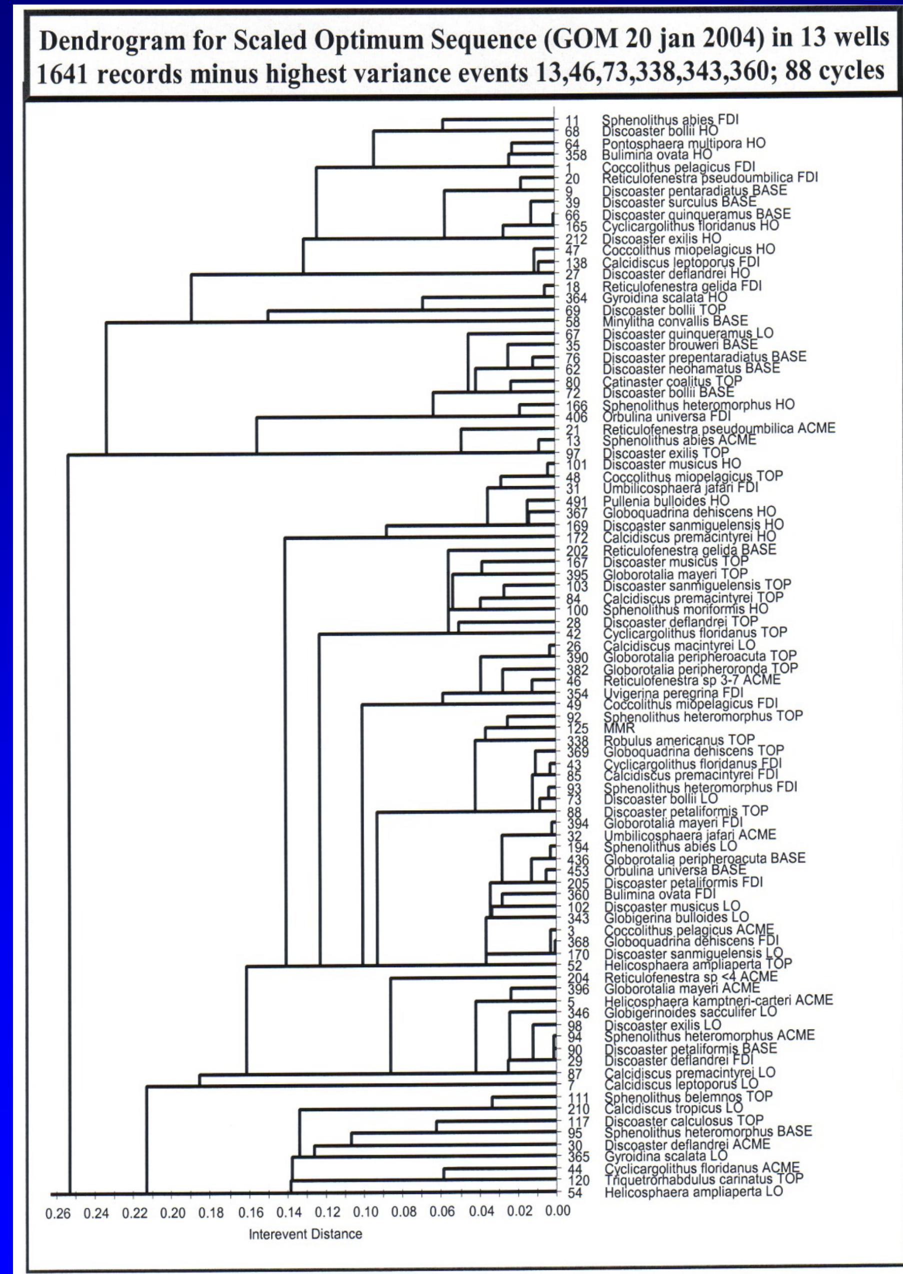
FCO

FO



Mad Dog Miocene Optimum Sequence and Zonation





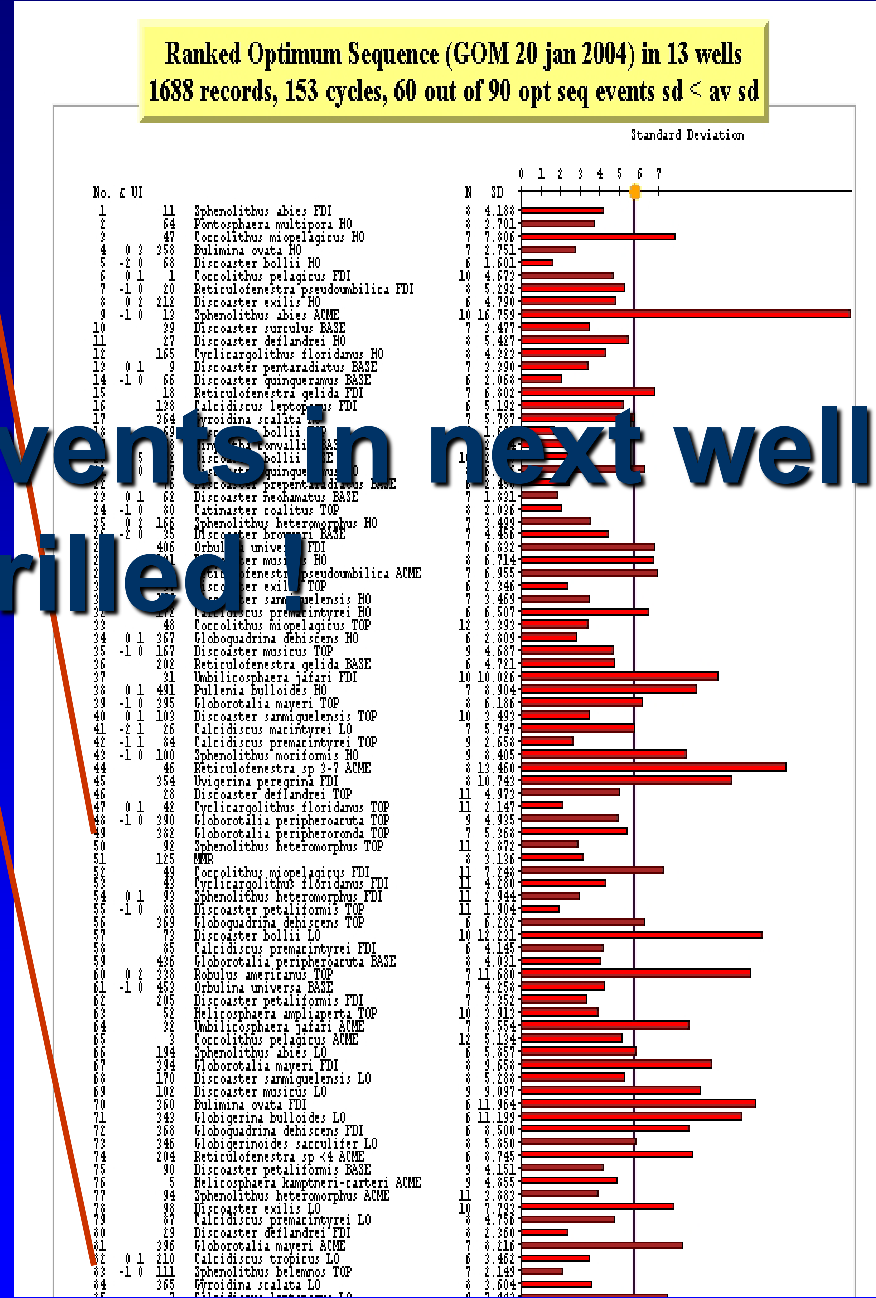
GOM – Foraminifera and Nannofossil Events

Lower – Middle Miocene

MM65	C. FLORIDANUS		13.19
MM68	C. FLORIDANUS INCREASE		13.30
MM70	S. HETEROMORPHUS		13.59
MM80	G. FOHSI PERIPHERORONDA		14.61
MM90	D. PETALIFORMIS		14.69
MM94	RARE, SMALL H. AMPLIAPERTA		14.74
MM98	RARE, SMALL H. AMPLIAPERTA INCREASE		14.78
MM100	H. AMPLIAPERTA		14.80
MM103	VERY LARGE H. AMPLIAPERTA		14.90
MM105	GLOB. IN[illegible]ETA		[illegible]
[illegible]		[illegible]	[illegible].44
MM120	D. DEFLANDREI ACME	CIB. 38	15.76
Middle / Early Miocene Boundary			16.4
ME10		ROB. MAYERI	17.31
ME15		ROB CHAMBE[illegible]	[illegible].28
ME19	NANNOS INCR. W/ RETICULO. SPP.		18.60
ME20	S. BELEMNOS		18.71
ME23	H. MEDITERRANEA		18.75
ME40		DISCORBIS B	18.92
ME50	D. CALCULOSUS	MARG. A	19.35
ME55	S. DISSIMILIS		19.78
ME59	D. SAUNDERSI		20.15
ME60		SIPH. DAVISI	20.21
ME61	T. CARINATUS		20.25
ME70		PLAN. PALM.	20.43
ME80		LENTIC. HAN.	20.86
ME81	S. CAPRICORNUTUS		20.91
ME90	C. ABISECTUS INCREASE	LENTIC. JEFF.	21.07
ME100	GLOB. KUGLERI	ABBEVILLE FAUNA	21.68
ME110		DISC. RESTRICTED / ROB. A	22.01
ME120	H. RECTA/ S. DISSIMILIS ACME / REWK K NANNOS ACME	D. GRAVELLI/GYR. HANNAI	22.52
ME130	T. CARINATUS ACME	HET SP/CIB. JEFF.	22.9
ME 140	S. DELPHIX	BOL. PERC.	23.2

EARLY

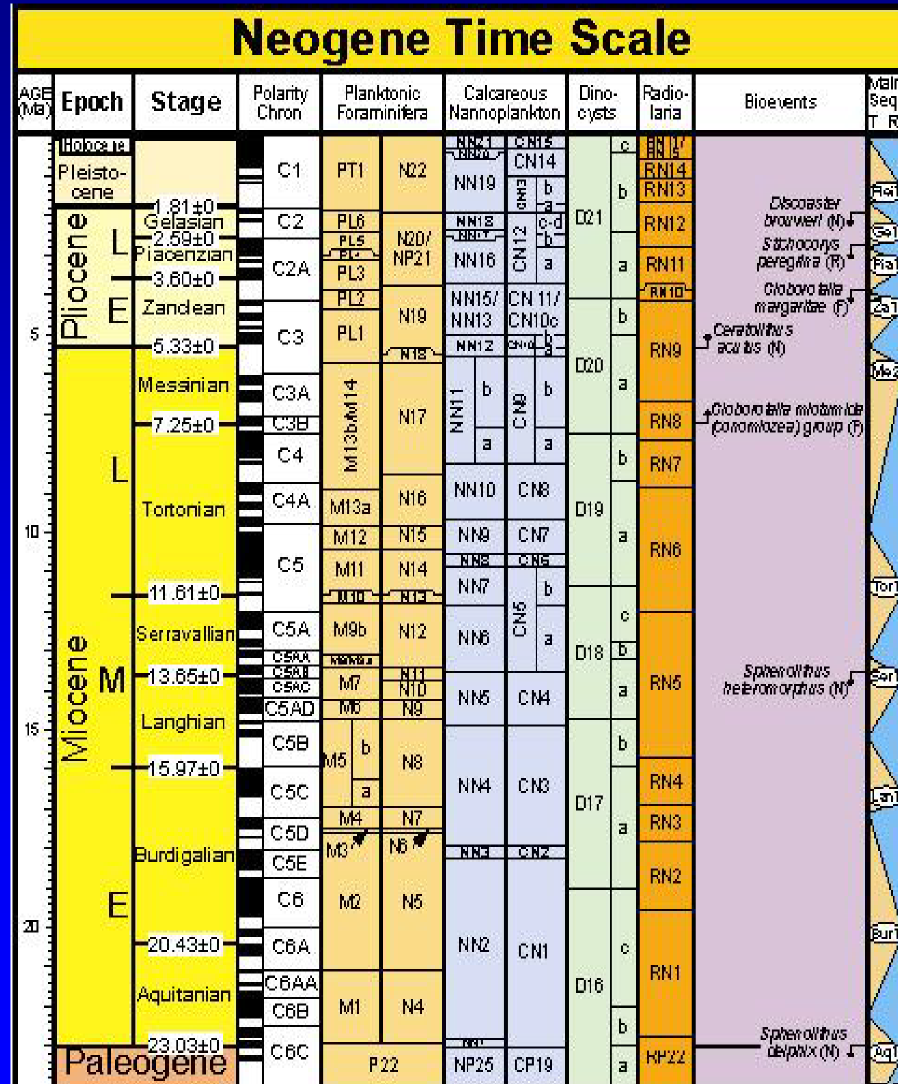
RASC Optimum Sequence



Predicts order of events in next well to be drilled !

Astronomically Tuned Neogene Time Scale 2004 Applied to GOM

Langhian - Serravallian	**13.654 Ma**	
top Sphenolithus heteromorphus	CN4-CN5a, NN5-NN6, MNN5b-MNN6	13.53
top Helicosphaera ampliaperta	CN3-CN4, NN4-NN5	14.91
top abundant Discoaster deflandrei		15.80
Burdigalian – Langhian	**15.974 Ma**	
bottom (common) Sphenolithus heteromorphus		17.71
top (common) Sphenolithus belemnos	CN2-CN3, NN3-NN4	17.95
top Triquetrorhabdulus carinatus	CN1-CN2, NN2-NN3	18.28
bottom Sphenolithus belemnos		19.03
Aquitanian – Burdigalian	**20.428 Ma**	
bottom Helicopontosphaera ampliaperta		20.43
bottom common Helicosphaera carteri		22.03
bottom Sphenolithus disbelemnos		22.76
bottom Discoaster druggi	NN1-NN2	
OLIGOCENE - MIOCENE / Chattian – Aquitanian	**23.030 Ma**	
top Sphenolithus delphix		23.11
bottom Sphenolithus delphix		23.21



The RASC and CONOP methods yield results that complement each other

RASC - Optimum sequence of events with event variances
CONOP - Composite standard with penalty (misfit) of events

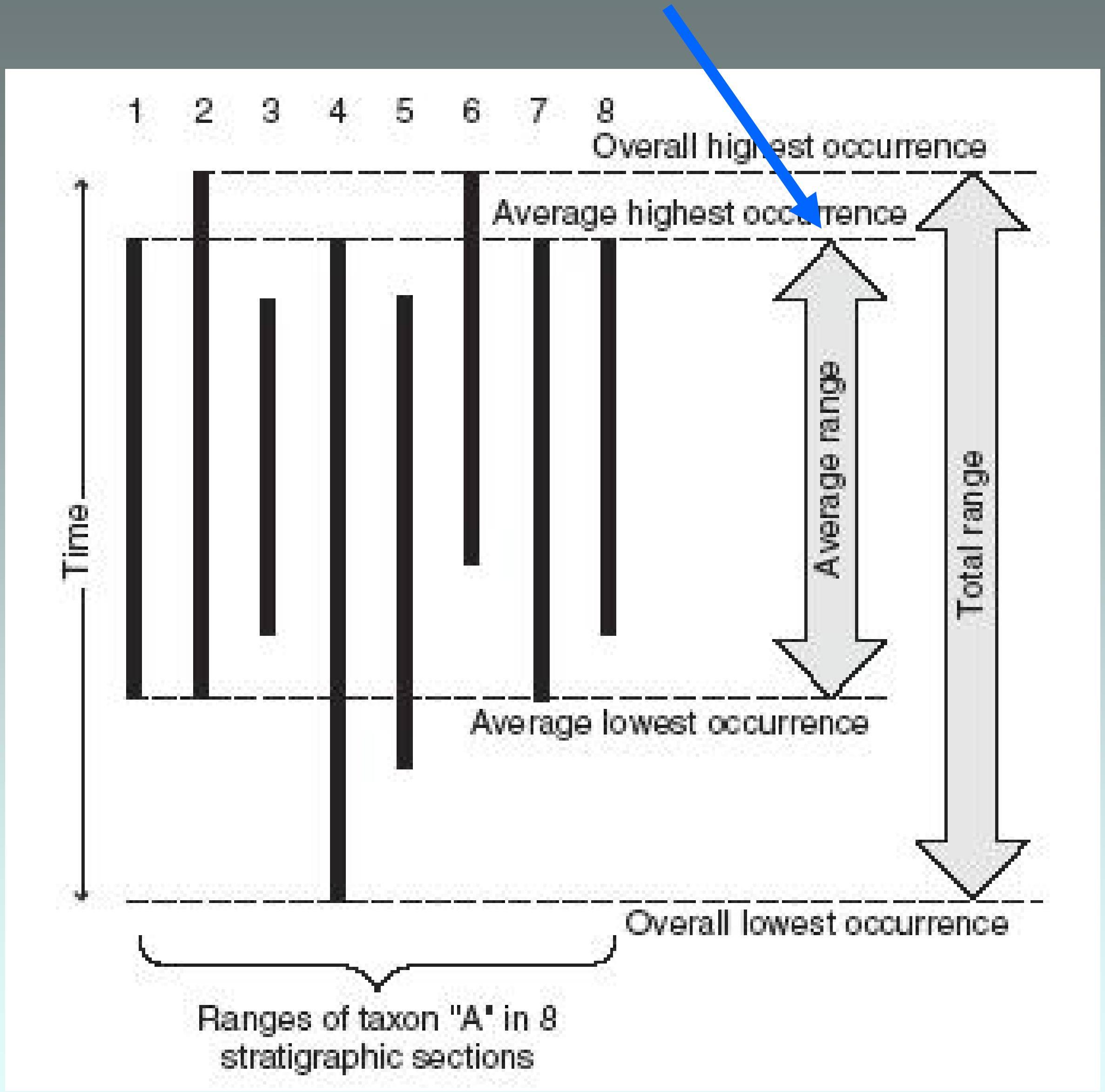
CONOP allows three strategies:

1. Event positions in the composite are unconstrained and can move either up or down, not unlike RASC

2. Event positions in the composite are maximized, = stratigraphically upwards (for tops) or downwards (for bases)

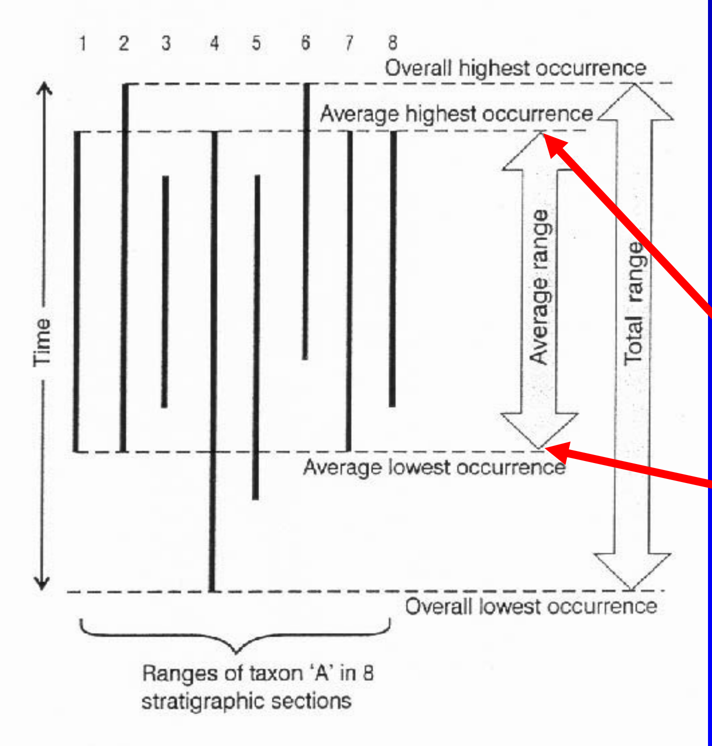
3. Event positions do not move (= Unique Events in RASC)

RASC generates average tops and average bases



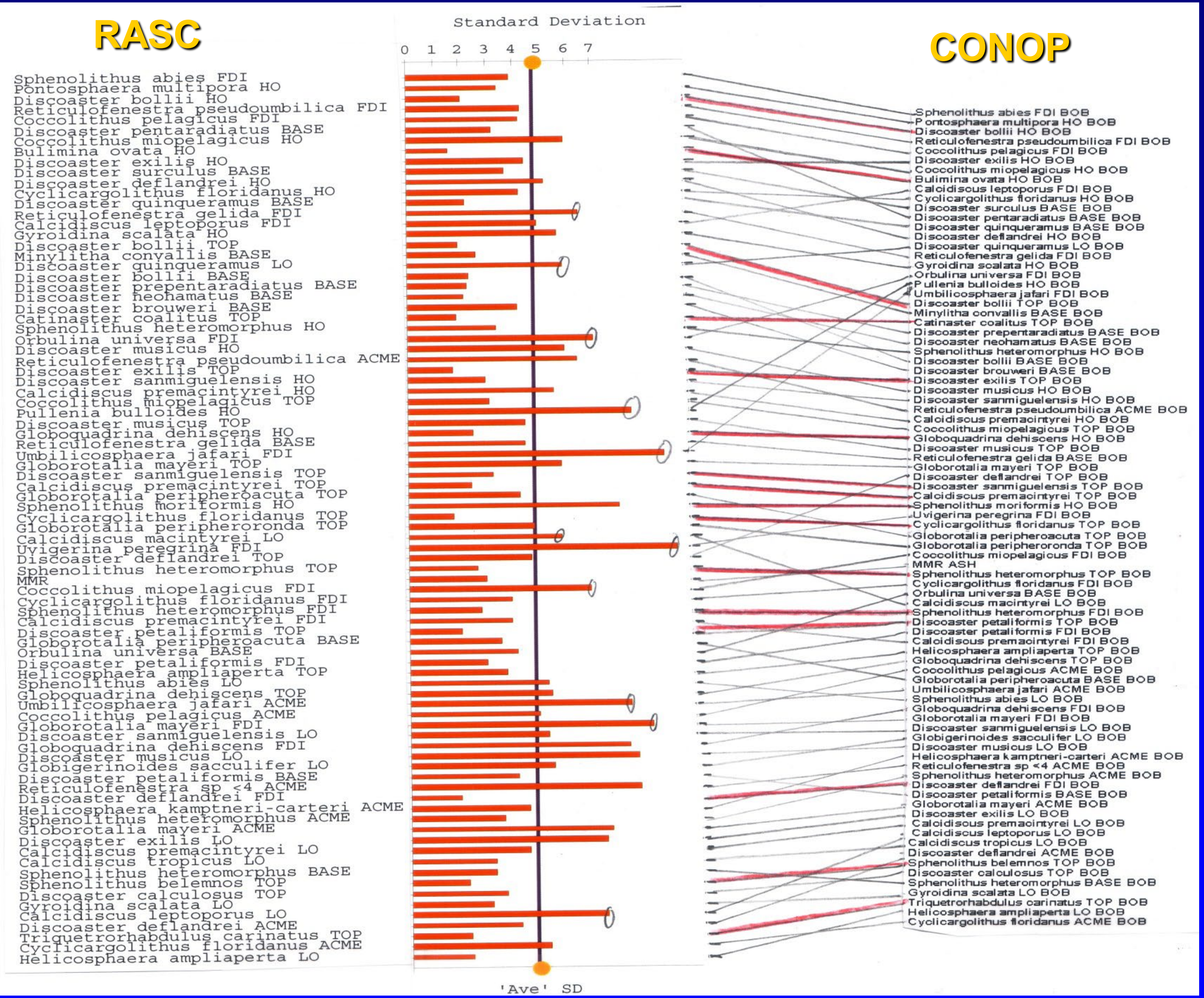
The average 'top' may seem 'non-biological',
but it certainly has attractive stratigraphic properties.

RUN 1 of RASC and CONOP

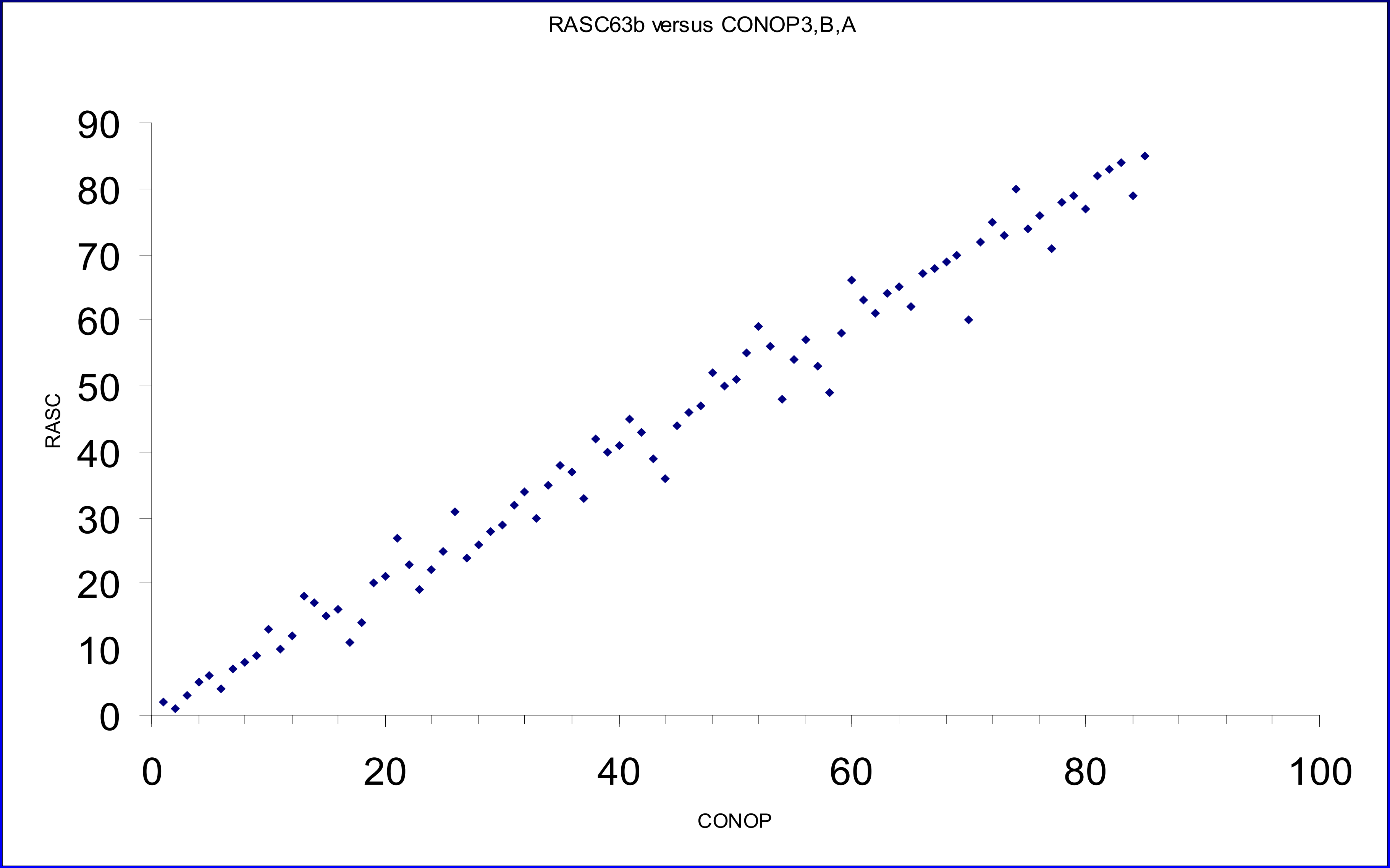


RUN 1
Ranking and Scaling
+
Unconstrained Optimization

Correlation of Run 1 Optimum Sequences with RASC and CONOP

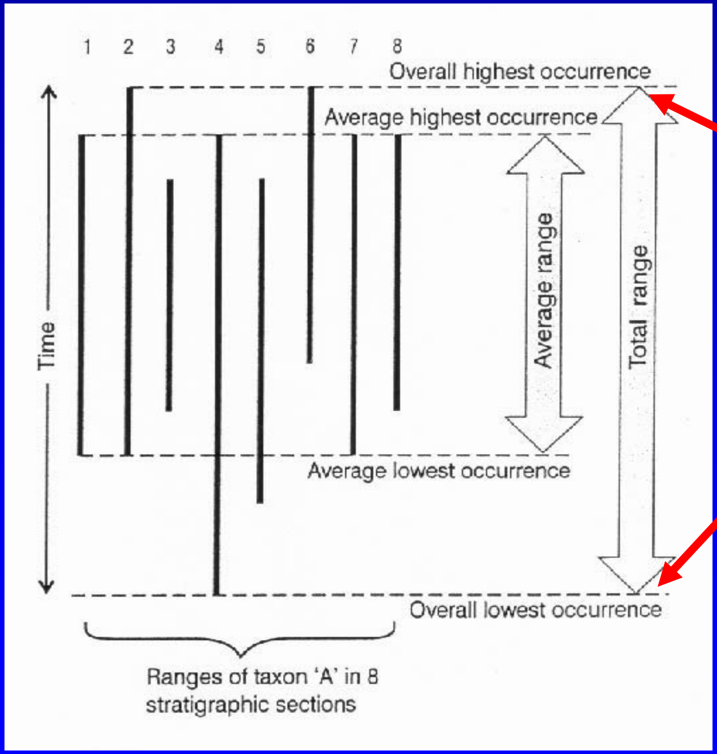


Run 1 - Average StratigraphicPositions of Events



Zonal convergence of RASC and CONOP

RUN 2 of RASC and CONOP



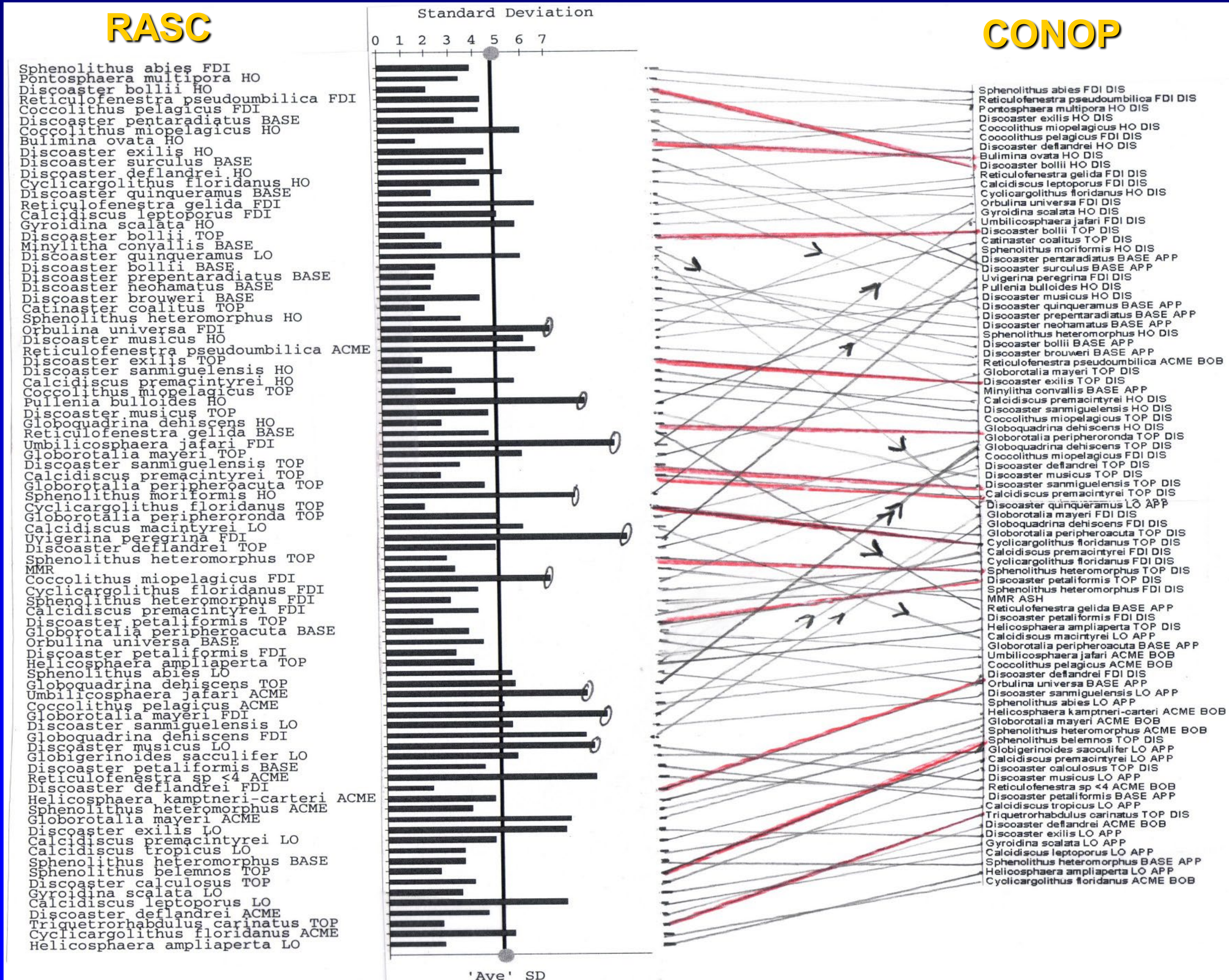
RUN 2

Constrained Optimization

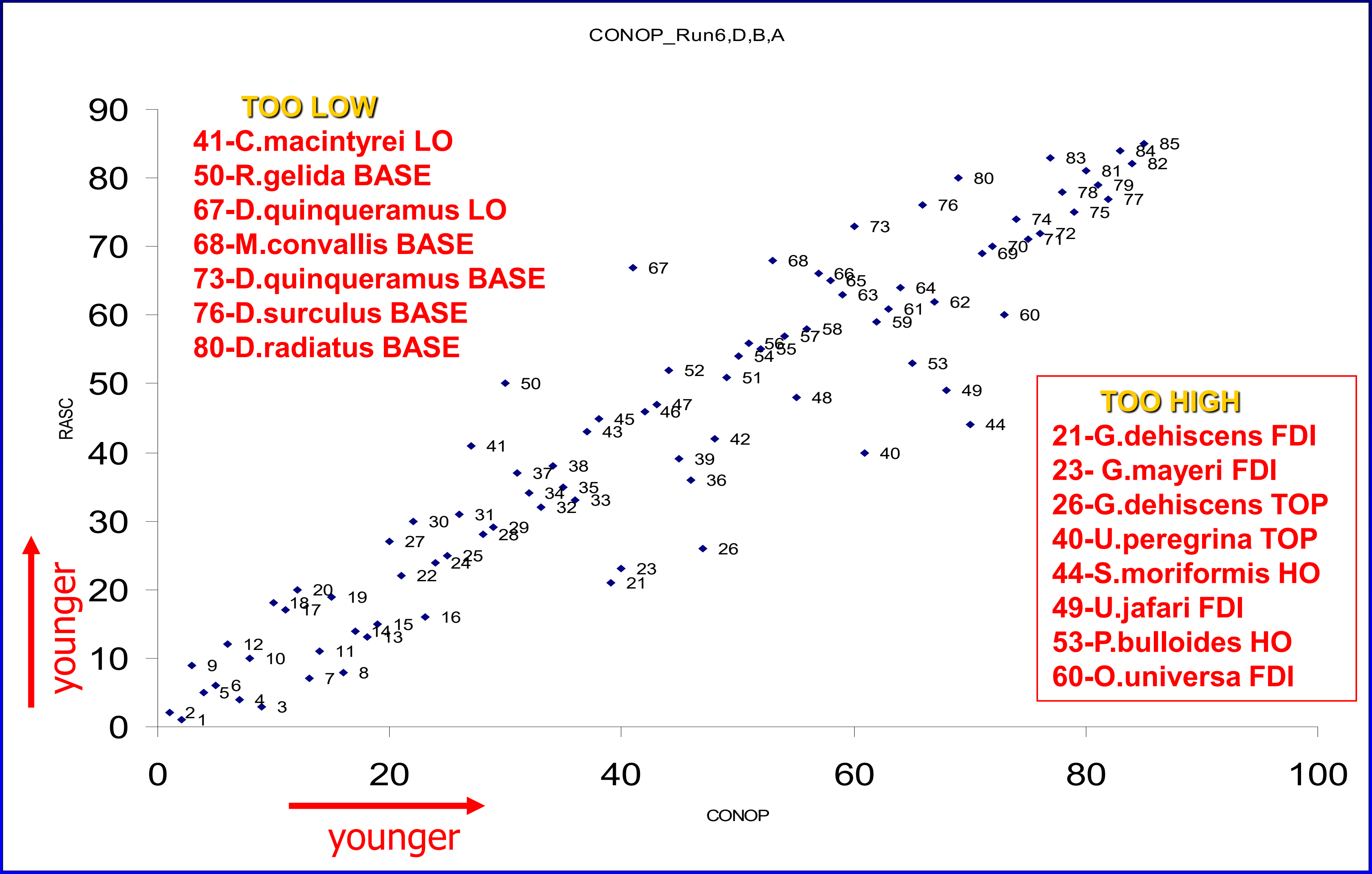
+

Ranking and Scaling as Run1

Correlation of RUN 2 Optimum Sequences with RASC and CONOP



Run 2 Average Event Occurrences with RASC Overall Lowest or Highest Occurrences with CONOP



Conclusions

Neogene Gulf of Mexico

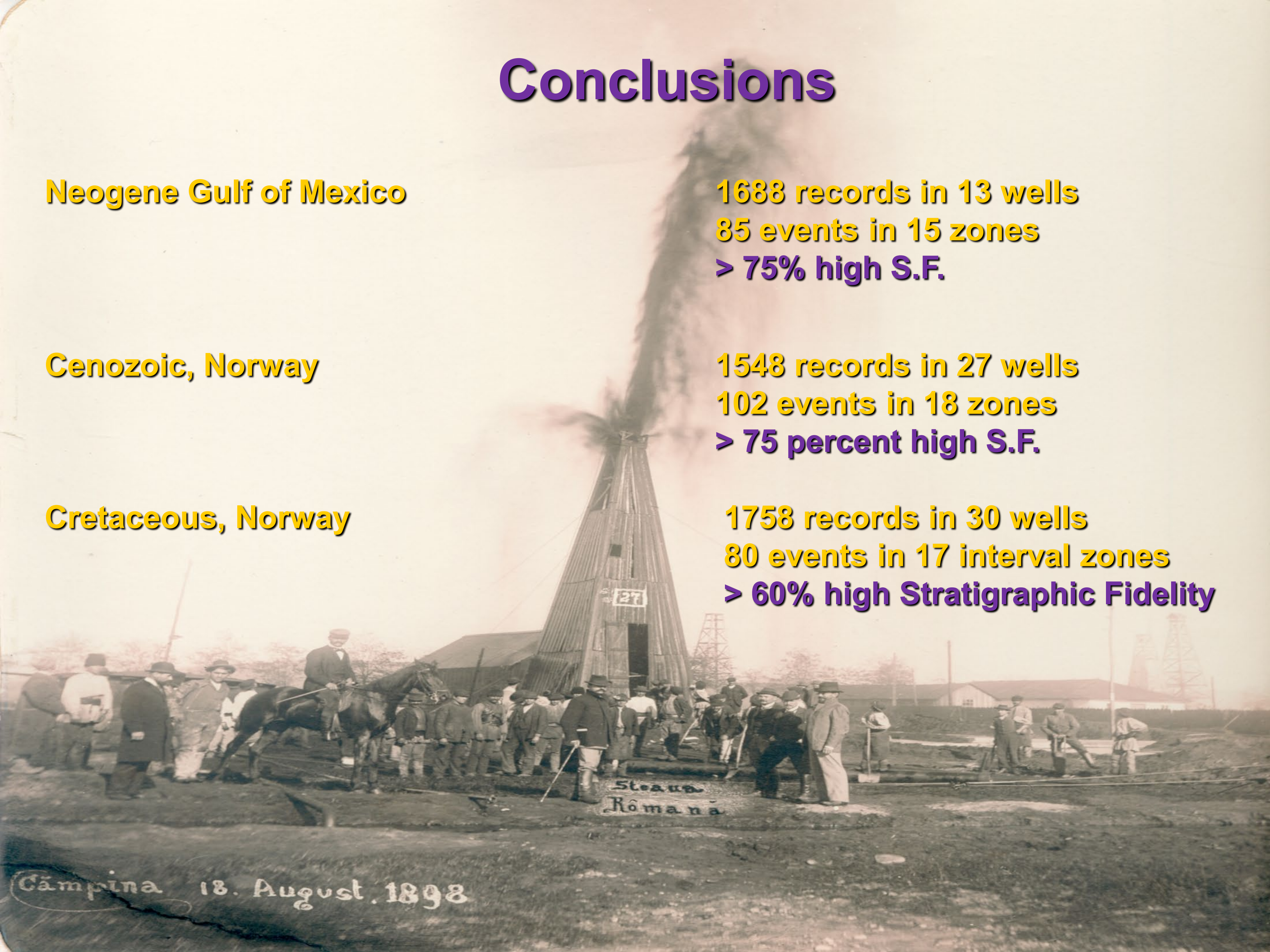
1688 records in 13 wells
85 events in 15 zones
> 75% high S.F.

Cenozoic, Norway

1548 records in 27 wells
102 events in 18 zones
> 75 percent high S.F.

Cretaceous, Norway

1758 records in 30 wells
80 events in 17 interval zones
> 60% high Stratigraphic Fidelity



Conclusions

The RASC and CONOP methods yield results that complement each other and objectively separate 'good and bad' events