A Gravity Collapse Origin for the Hampshire Basin, U.K.*

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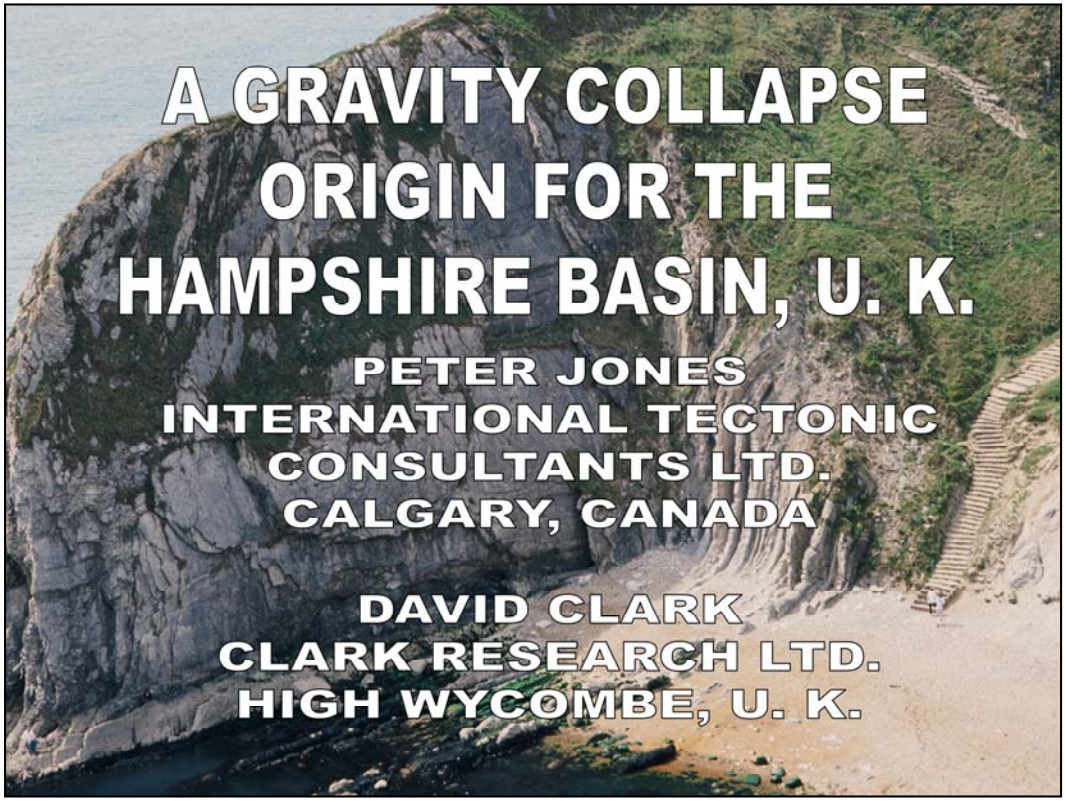
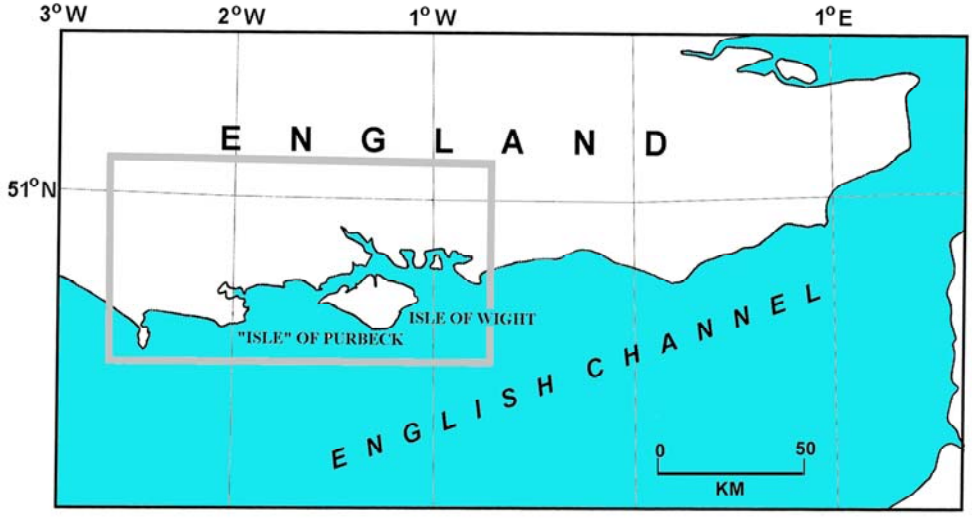
Abstract

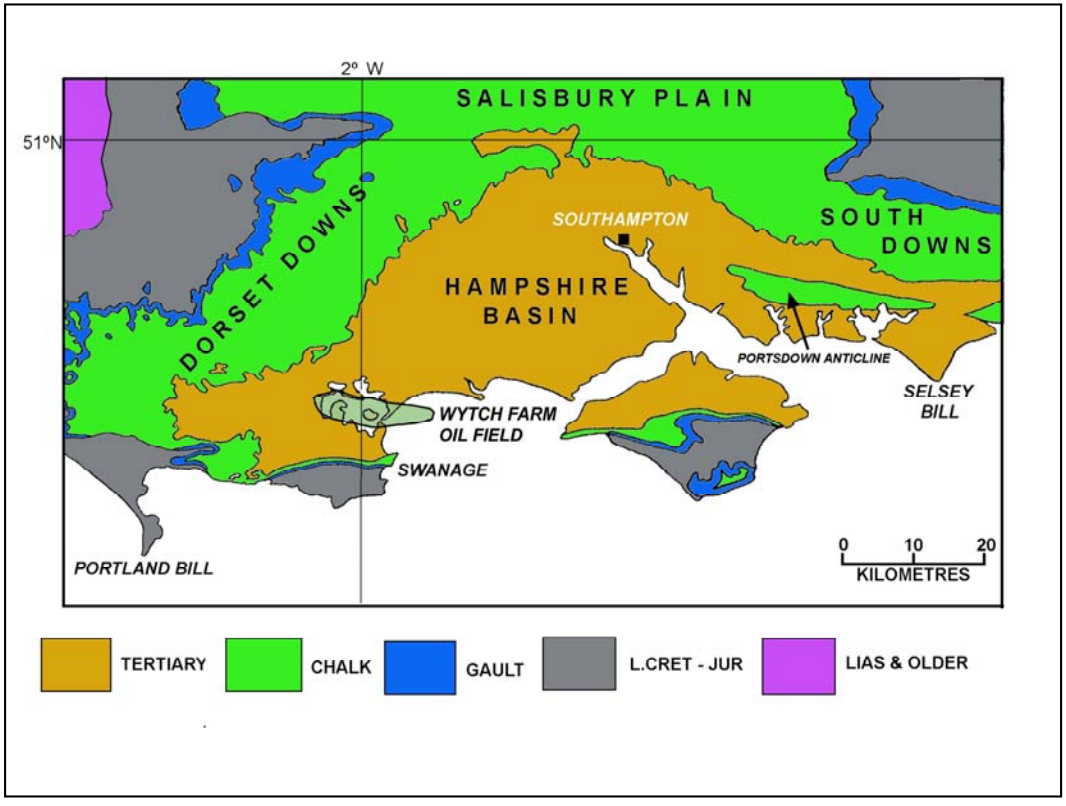
Hampshire Basin is a topographic depression in southern England, some 3500 km^2 in area. It extends about 140 km from west to east and up
n from north to south. Geologically it is a half-graben, with normal faulting along its north edge, and the Purbeck monocline forming a
ngwall rollover fold along the south edge. Starting in the 19th century, the structural history of the region had been described in terms of M
ceous rifting followed by Tertiary (Alpine) compression. The 1973 discovery of the Wytch Farm oilfield in Mesozoic sediments provided v
eismic data leading to a new model for the evolution of the area through the mechanism of inversion tectonics. That model postulated
ceous rifting with normal faults that became inverted during the Tertiary to form supposedly Alpine-related folds, reverse, and thrust faults

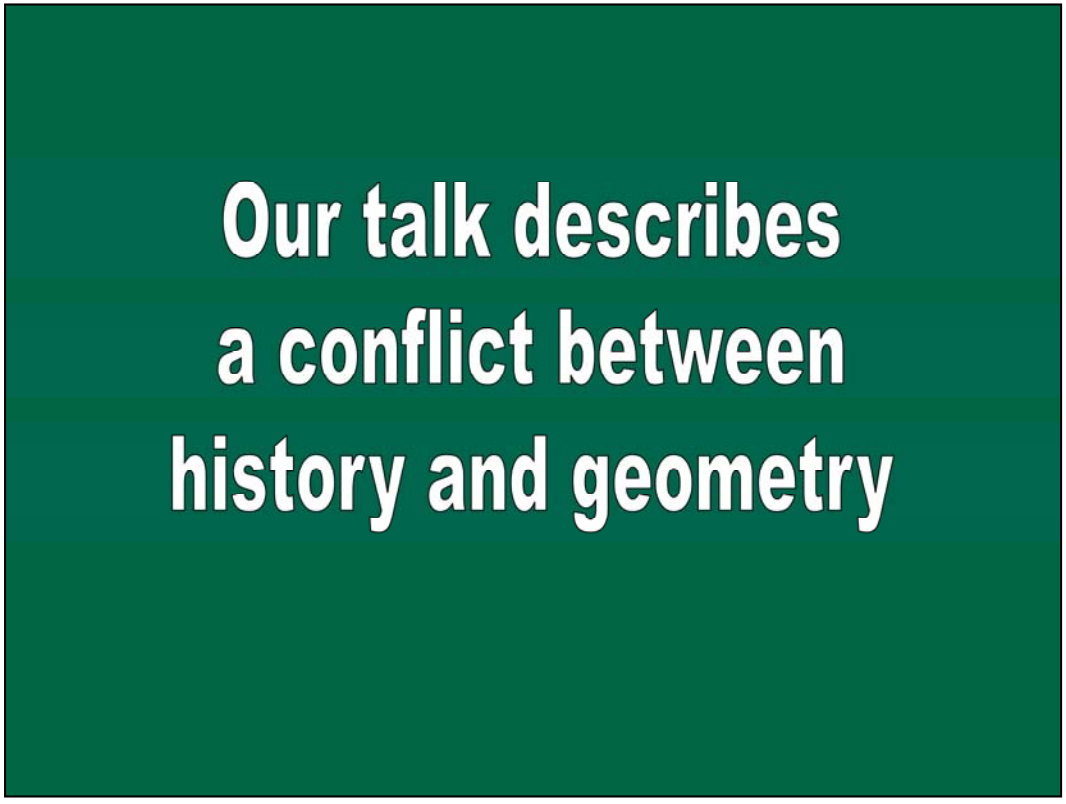
tudy supports neither the original interpretation nor the inversion tectonic model. There is no evidence for compressive folding and repetiti
allow basin section nor evidence that Cretaceous normal faults in the deeper reservoir section became reactivated and inverted in the Tertia
"Alpine" compressional structures in the shallow section. Instead, we propose that the present-day structure is a result of large-scale sub-
ontal southward movements along blind bedding-plane detachments in overpressured and mobile Upper Cretaceous and Jurassic clays and
sic salt, with emphasis, on the vital role of the Upper Cretaceous Gault Clay as a lubricant for large-scale bedding-plane slippage. This



The Hampshire basin also known as the Wessex basin has been the subject of fierce geological debate since 1816, with argument, still current, centred on the nature of a solitary fault in a cliff near the resort town of Swanage, on the south coast of England.


3°W
2°W
1°W
1°E
51°N
ENGLAND
ISLE OF WIGHT
"ISLE" OF PURBECK
ENGLISH CHANNEL
0
50
KM


2º W
51ºN
SALISBURY PLAIN
DORSET DOWNS
SOUTHAMPTON
SOUTH DOWNS
HAMPSHIRE BASIN
PORTSDOWN ANTICLINE
SELSEY BILL
WYTCH FARM OIL FIELD
SWANAGE
PORTLAND BILL
0 10 20
KILOMETRES
TERTIARY
CHALK
GAULT
L.CRET - JUR
LIAS & OLDER



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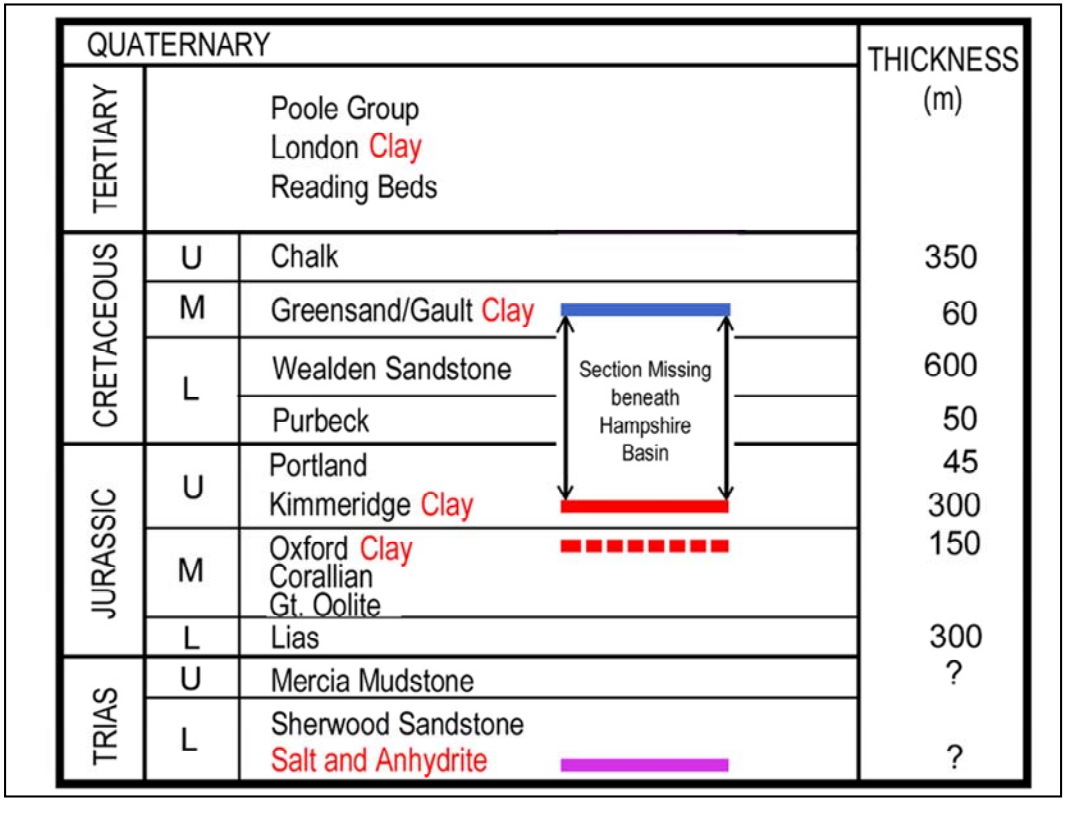
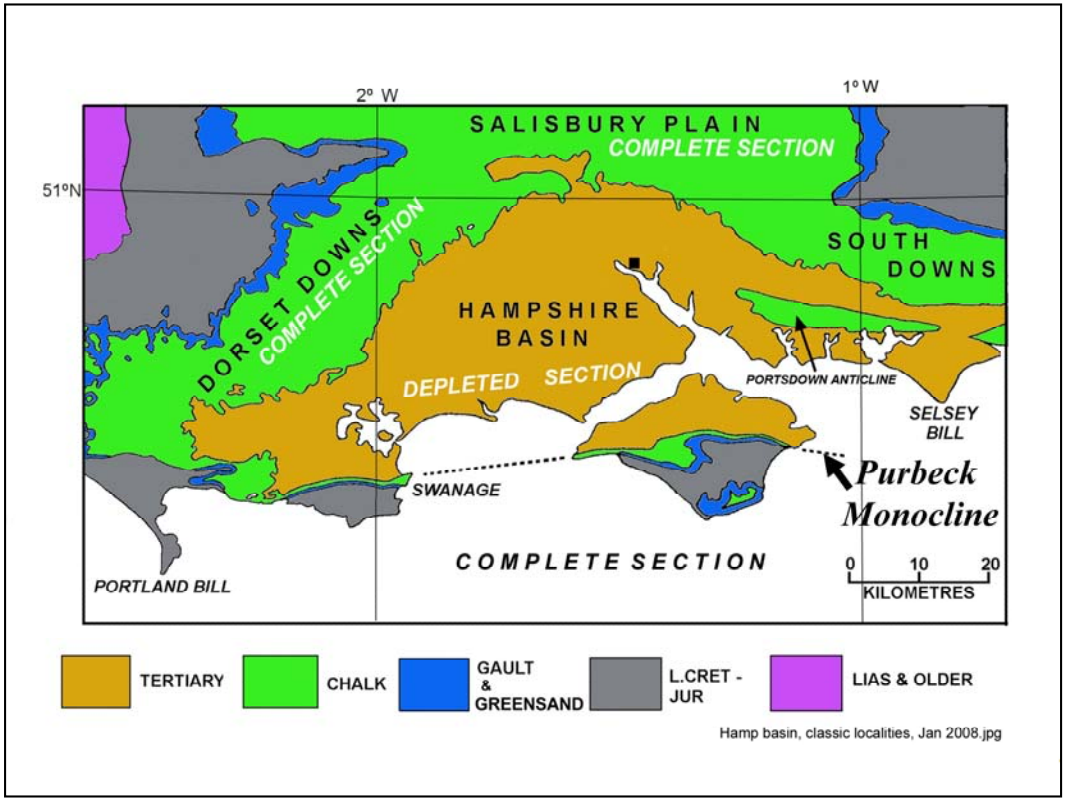
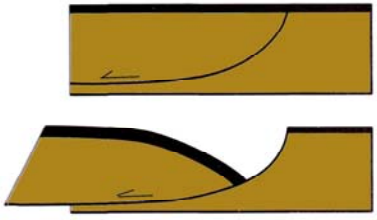
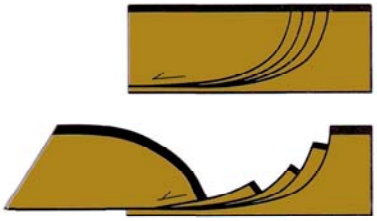
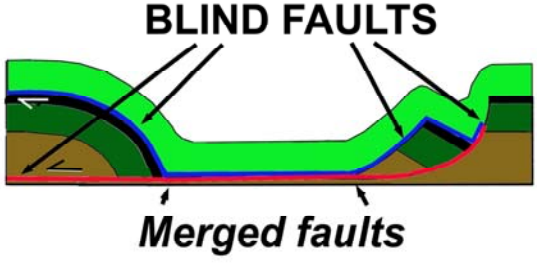

QUATERNARY
THICKNESS (m)
TERTIARY
Poole Group
London Clay
Reading Beds
CRETACEOUS
U
Chalk
350
M
Greensand/Gault Clay
60
L
Wealden Sandstone
600
Purbeck
50
Section Missing beneath Hampshire Basin
JURASSIC
U
Portland
45
Kimmeridge Clay
300
M
Oxford Clay
150
Corallian
Gt. Oolite
L
Lias
300
TRIAS
U
Mercia Mudstone
?
L
Sherwood Sandstone
Salt and Anhydrite
?



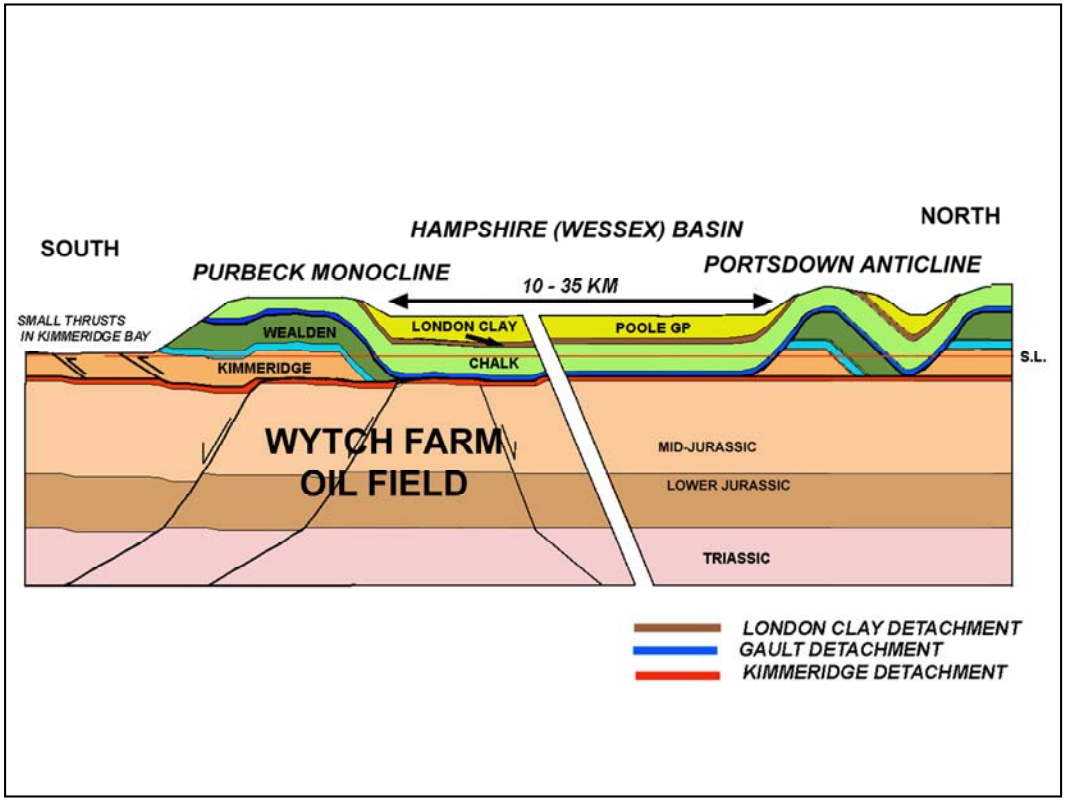
For generations geologists had regarded the Purbeck monocline as an anomalous “high”, formed by compression and sought to explain it. Instead, we suggest that the Hampshire basin is an anomalous “low” whose origin we shall attempt to explain through the removal from the subsurface of more than a kilometre of Lower Cretaceous and Jurassic sediments, formerly deposited over the entire region. How??

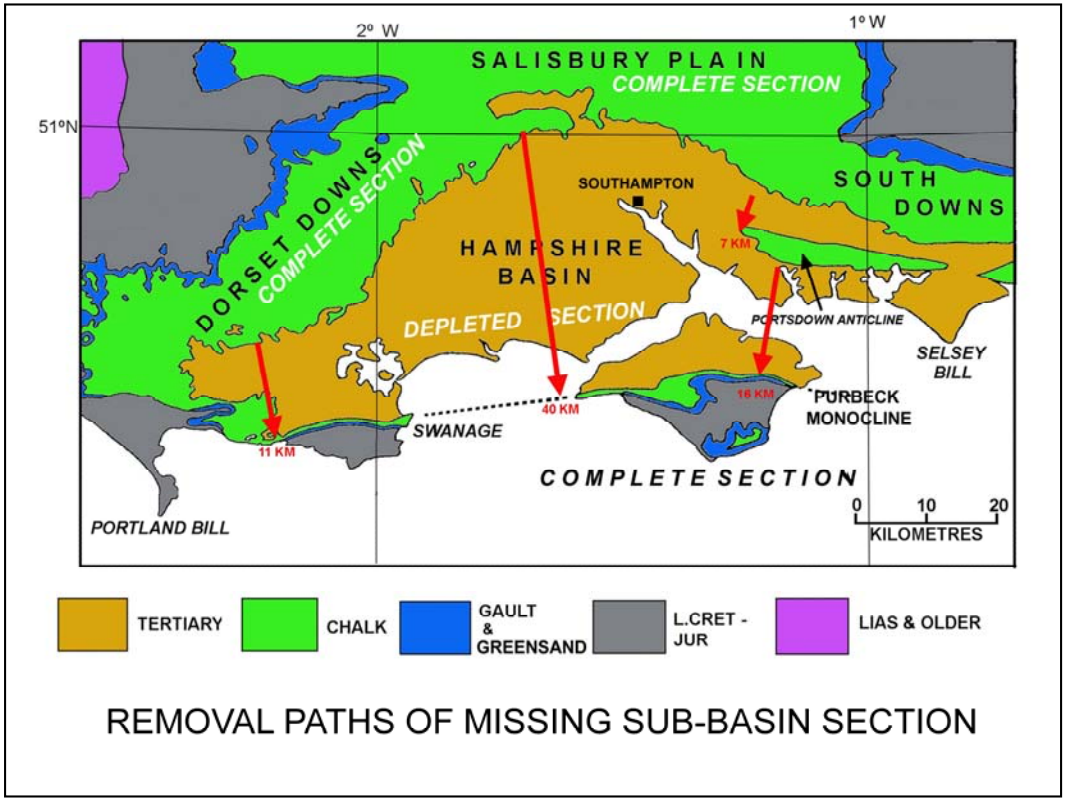




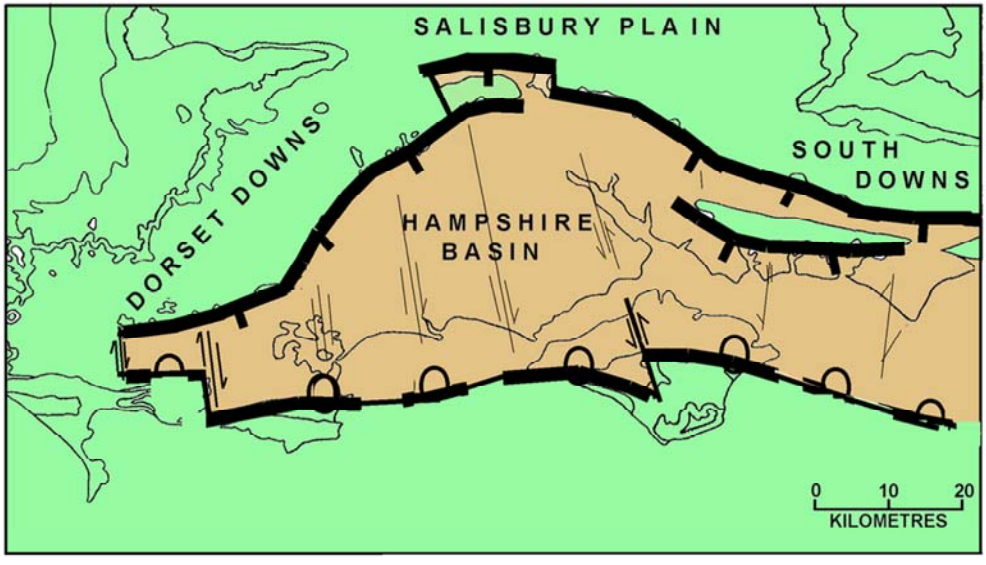


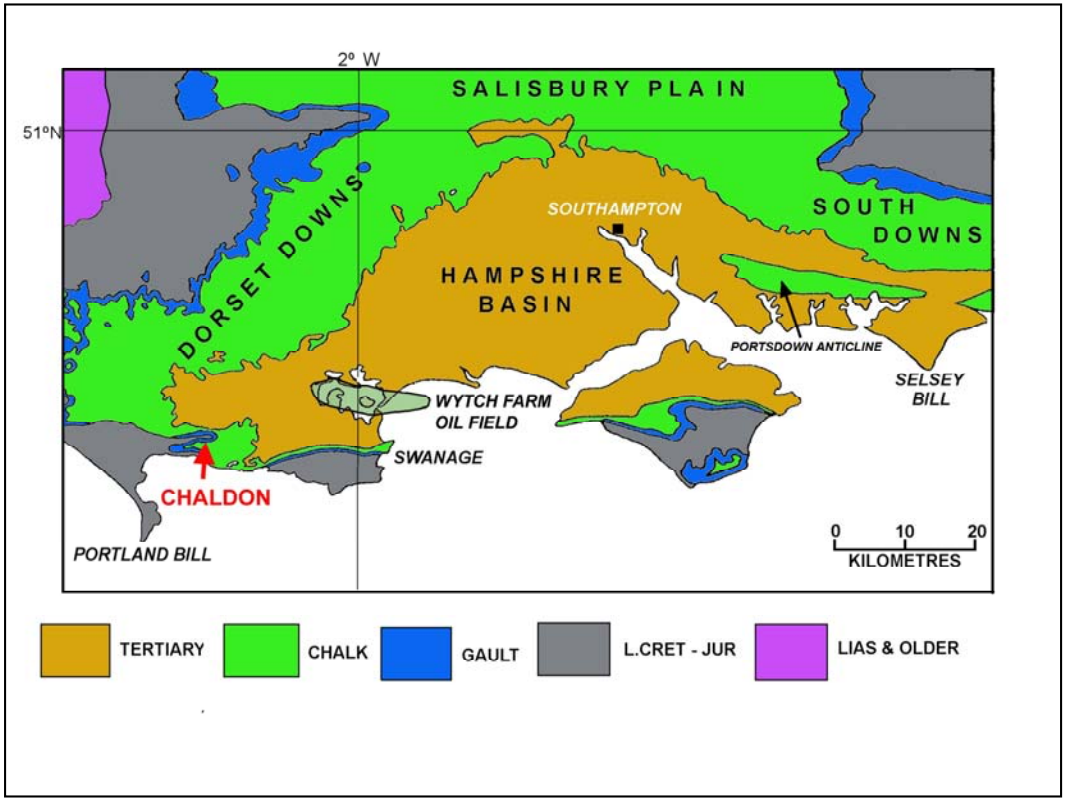
Modified from Wernicke & Burchfiel, 1982

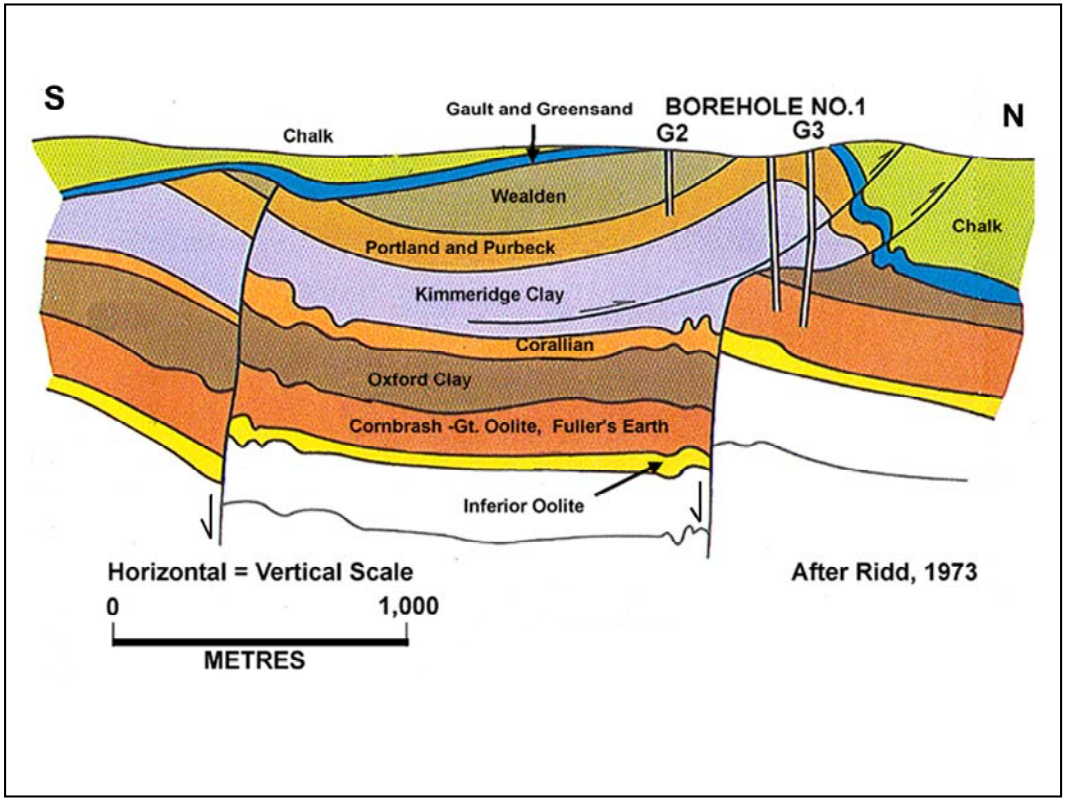

SOUTH
HAMPSHIRE (WESSEX) BASIN
NORTH
PURBECK MONOCLINE
PORTSDOWN ANTICLINE
10 - 35 KM
SMALL THRUSTS
IN KIMMERIDGE BAY
WEALDEN
LONDON CLAY
POOLE GP
KIMMERIDGE
CHALK
S.L.
WYTCH FARM
OIL FIELD
MID-JURASSIC
LOWER JURASSIC
TRIASSIC
LONDON CLAY DETACHMENT
GAULT DETACHMENT
KIMMERIDGE DETACHMENT



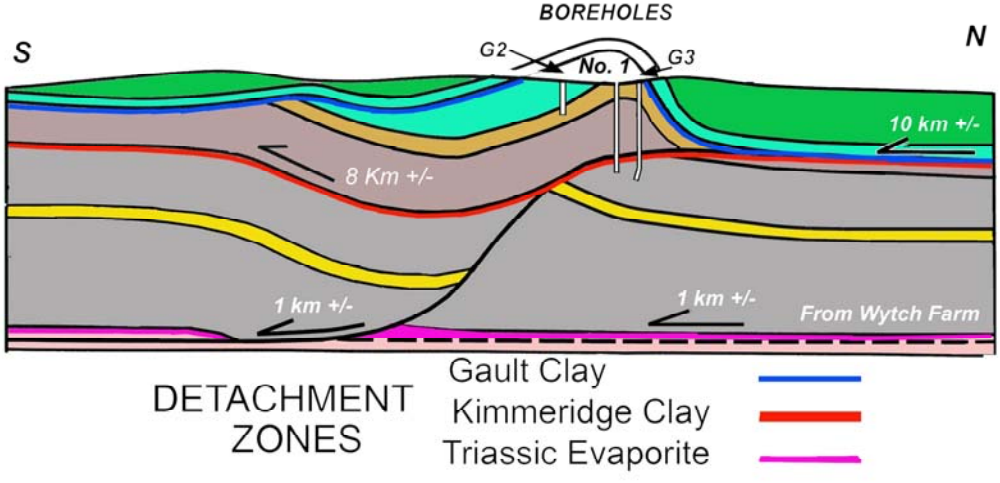
REMOVAL PATHS OF MISSING SUB-BASIN SECTION


SALISBURY PLAIN
DORSET DOWNS
SOUTH DOWNS
HAMPSHIRE BASIN
0 10 20
KILOMETRES

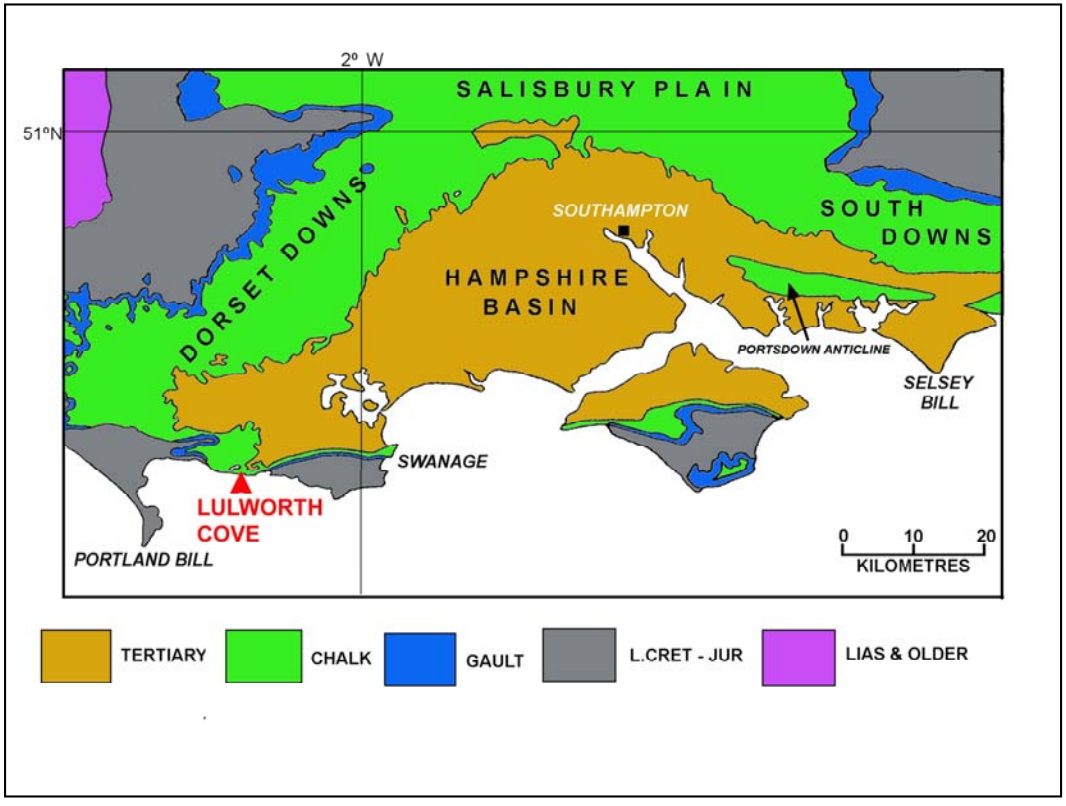

2° W
51°N
SALISBURY PLAIN
DORSET DOWNS
SOUTHAMPTON
SOUTH DOWNS
HAMPSHIRE BASIN
PORTSDOWN ANTICLINE
SELSEY BILL
WYTCH FARM OIL FIELD
SWANAGE
CHALDON
PORTLAND BILL
0 10 20
KILOMETRES
TERTIARY
CHALK
GAULT
L.CRET - JUR
LIAS & OLDER



This cross-section is typical of several such folds in the Purbeck monocline, originally misinterpreted as compression (therefore Alpine - therefore Tertiary). This misunderstanding led to the inversion tectonic model to explain this and similar structures as products of mid-Cretaceous rifting, followed by Tertiary compression. This cross-section shows wells penetrating a fault that places younger beds over older- by definition a sub-horizontal normal fault,. having no connection with imaginary thrust faults interpreted to cut the overlying chalk.

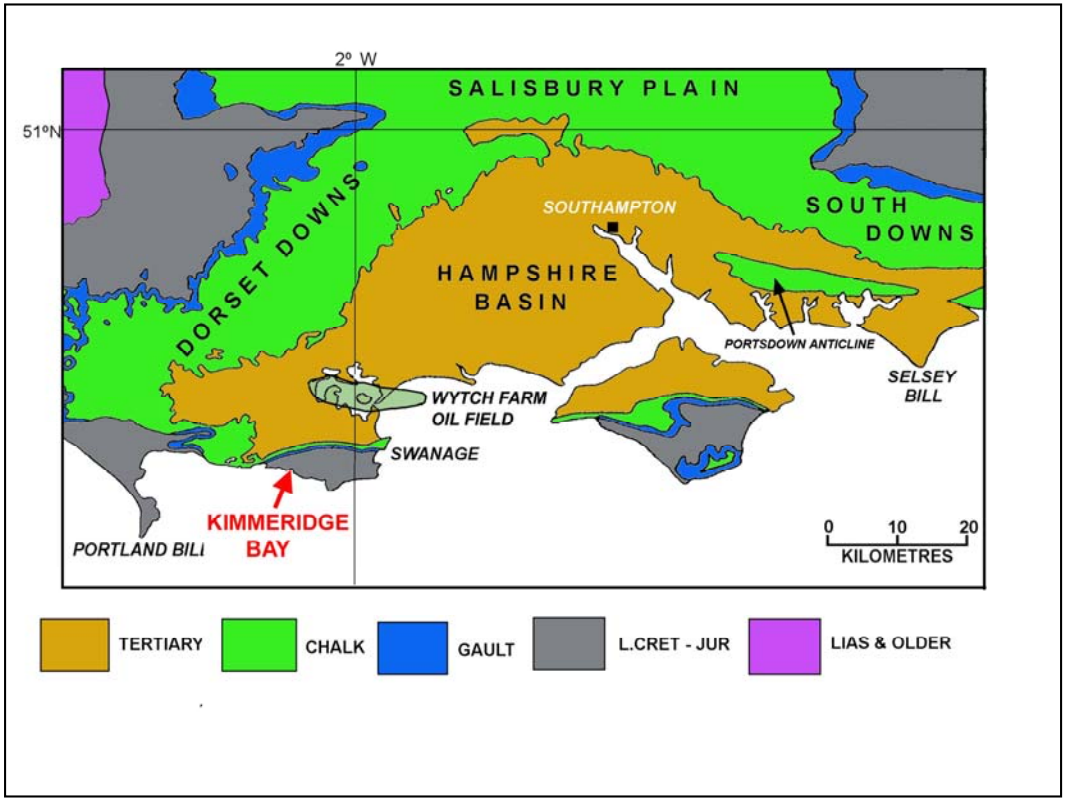


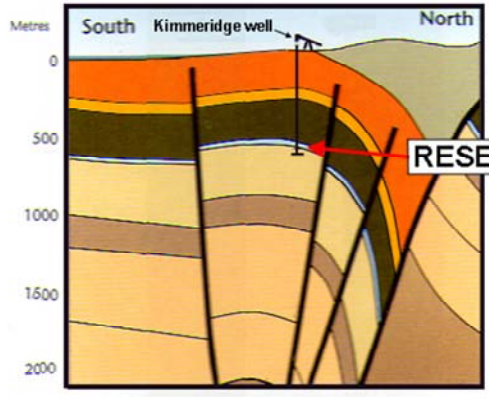
Modified after Ridd, 1973

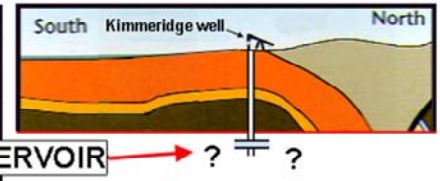

2º W
51ºN
SALISBURY PLAIN
DORSET DOWNS
SOUTHAMPTON
SOUTH DOWNS
HAMPSHIRE BASIN
PORTSDOWN ANTICLINE
SELSEY BILL
SWANAGE
LULWORTH COVE
PORTLAND BILL
0 10 20
KILOMETRES
TERTIARY
CHALK
GAULT
L.CRET - JUR
LIAS & OLDER

VERTICAL LIMB OF THE PURBECK MONOCLINE

The steep limb of the Purbeck monocline at Durdle Door, west of Swanage, south coast of Dorset. View SW of Jurassic strata dipping north.


2° W
51°N
SALISBURY PLAIN
SOUTHAMPTON
SOUTH DOWNS
DORSET DOWNS
HAMPSHIRE BASIN
PORTSDOWN ANTICLINE
SELSEY BILL
WYTCH FARM OIL FIELD
SWANAGE
KIMMERIDGE BAY
PORTLAND BILL
0 10 20
KILOMETRES
TERTIARY
CHALK
GAULT
L.CRET - JUR
LIAS & OLDER





RESERVOIR → ? ?

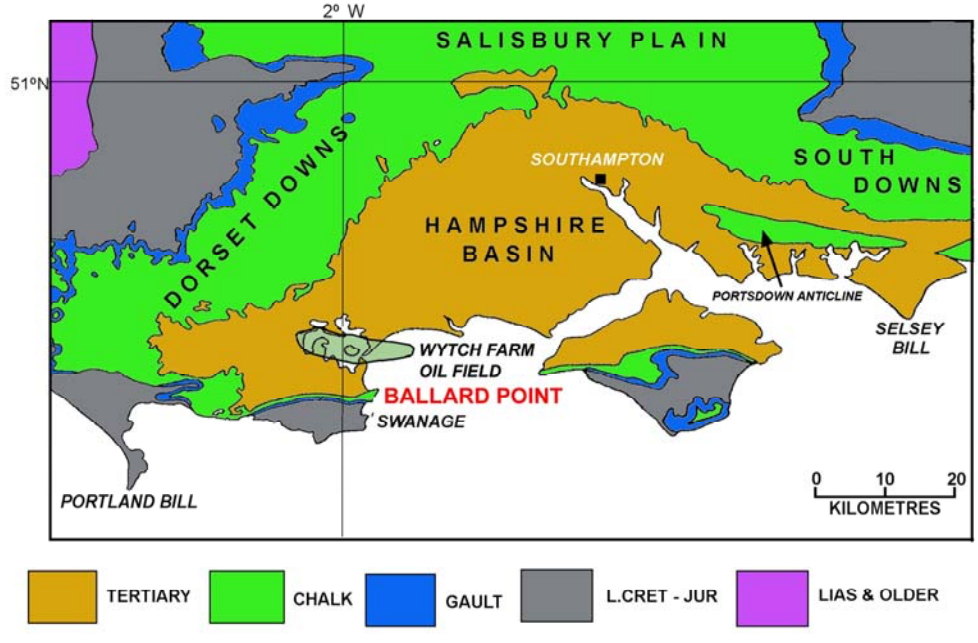
STRUCTURE UNKNOWN

- Portland, Wealden, Chalk
- Kimmeridge Clay Formation
- Corallian Group
- Oxford Clay Formation
- Cornbrash
- Middle Jurassic
- Bridport Sands
- Lias/Mercia Mudstone Group

Q. Why did the Kimmeridge Well produce more than expected?

A. Because the geology beneath the Kimmeridge detatchment is different from the surface geology.

From: JURASSIC COAST. D. Brunsden, ed. 2005


2º W
51ºN
SALISBURY PLAIN
DORSET DOWNS
SOUTHAMPTON
SOUTH DOWNS
HAMPSHIRE BASIN
PORTSDOWN ANTICLINE
SELSEY BILL
WYTCH FARM OIL FIELD
BALLARD POINT
SWANAGE
PORTLAND BILL
0 10 20
KILOMETRES
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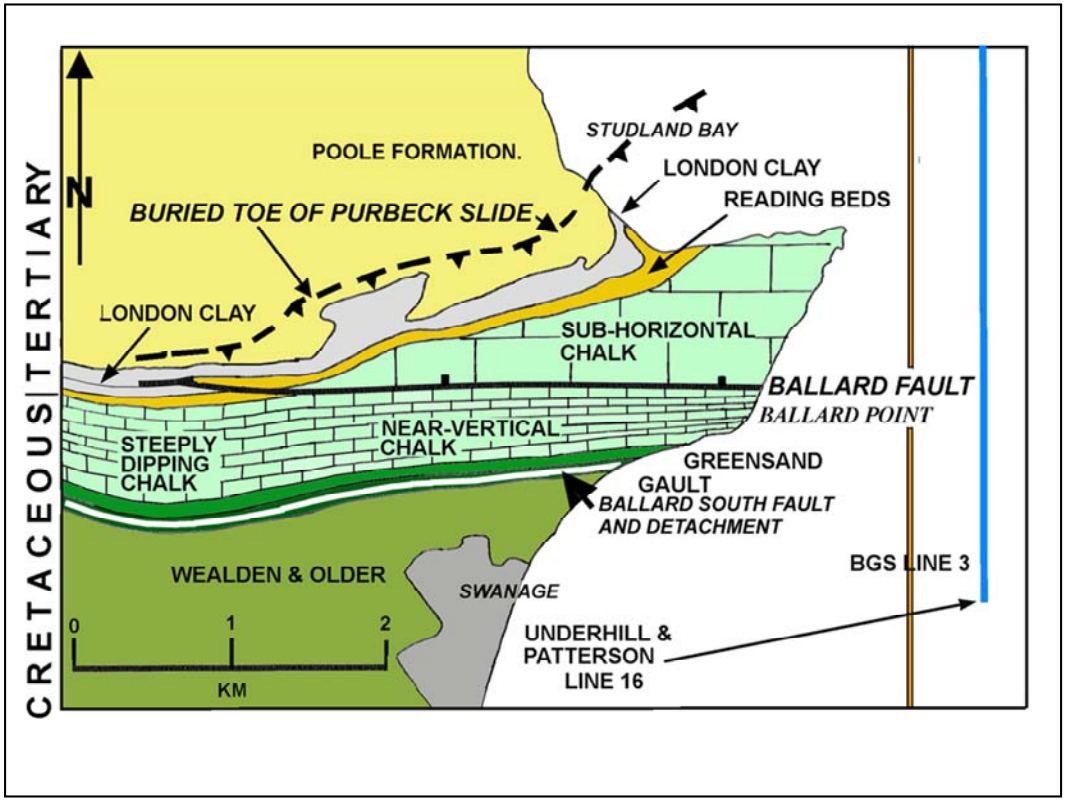
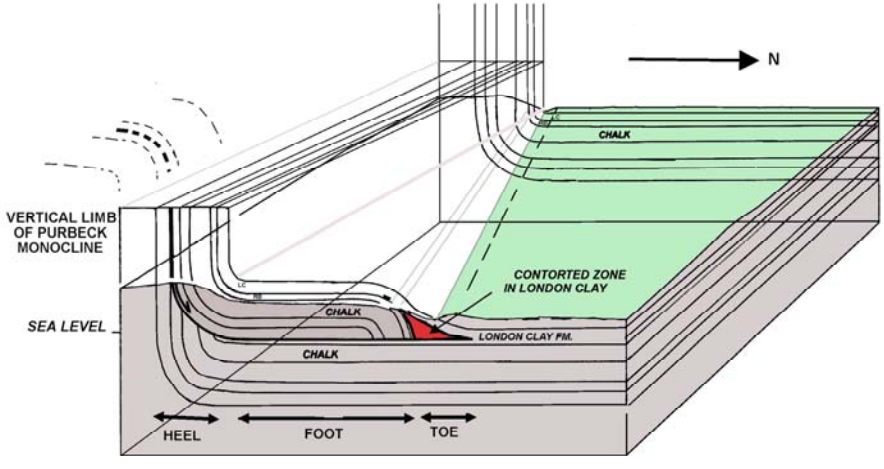
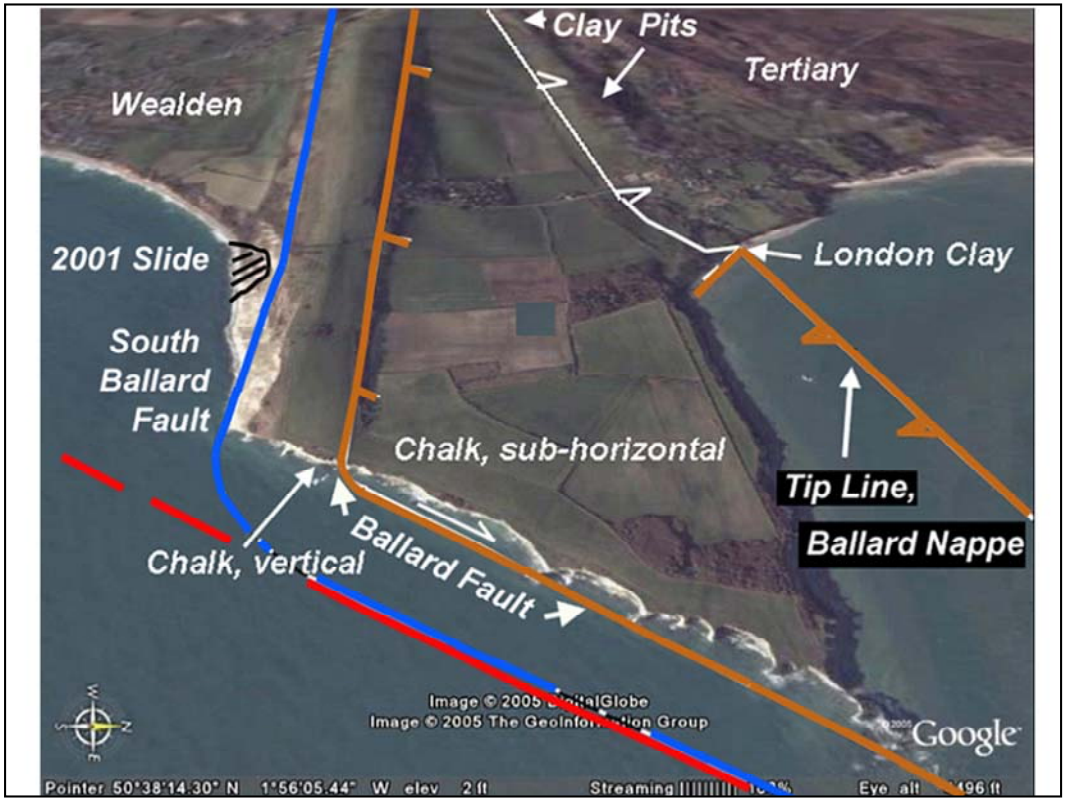

CRETACEOUS|TERTIARY
N
POOLE FORMATION.
STUDLAND BAY
LONDON CLAY
READING BEDS
BURIED TOE OF PURBECK SLIDE
LONDON CLAY
SUB-HORIZONTAL CHALK
BALLARD FAULT
BALLARD POINT
NEAR-VERTICAL CHALK
STEEPLY DIPPING CHALK
GREENSAND
GAULT
BALLARD SOUTH FAULT AND DETACHMENT
WEALDEN & OLDER
SWANAGE
BGS LINE 3
0
1
2
KM
UNDERHILL & PATTERSON LINE 16


Image © 2005 DigitalGlobe
Image © 2005 The GeoInformation Group
Google
Pointer 50°38'14.30" N 1°56'05.44" W elev 2 ft
Streaming 100%
Eye alt 4496 ft


BALLARD DOWN FAULT



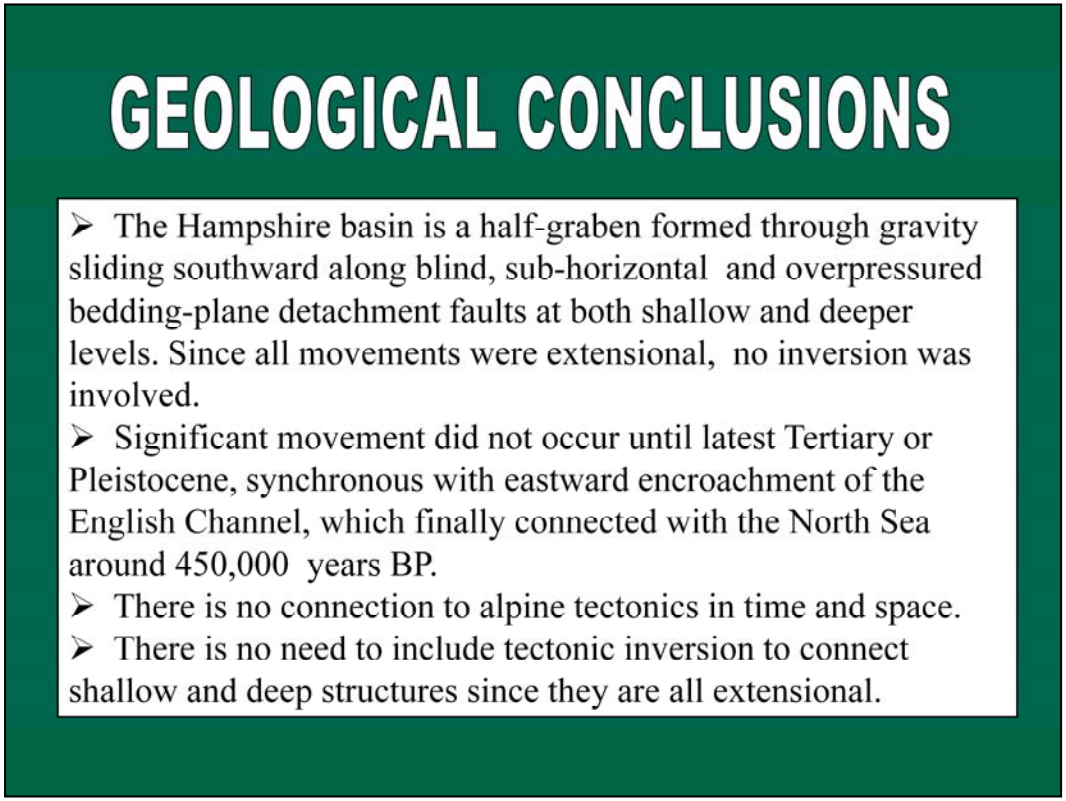
THE BALLARD DOWN FAULT- SOLE FAULT OF A REGIONAL-SCALE GRAVITY SLIDE, THE BALLARD NAPPE


Clay Pits
Tertiary
Wealden
2001 Slide
London Clay
South
Ballard
Fault
Chalk, sub-horizontal
Tip Line,
Ballard Nappe
Chalk, vertical
Ballard Fault
Image © 2005 DigitalGlobe
Image © 2005 The GeoInformation Group
Google
Pointer 50°38'14.30" N 1°56'05.44" W elev 2 ft
Streaming
Eye alt 196 ft

CONSEQUENCES FOR OIL & GAS

- Stratigraphy and sedimentation are all affected because it had been assumed that all sediments were autochthonous, moved little or not at all from their sites of deposition and movements were predominantly vertical.
- All critical localities, outcrops and wells, need to be restored to their sites of deposition to construct usable isopach, facies, and other paleogeographic maps.
- Removal of the mid-Cretaceous unconformity means that sedimentation was continuous through the Mesozoic and Tertiary until the Plio-Pleistocene resulting in increased maturation of section - in particular - the Kimmeridge clay falls within the oil window.
- Prospects for the area are dramatically improved. It is now a new frontier!

The Hampshire basin also known as the Wessex basin has been the subject of fierce geological debate since 1816, with argument, still current, centred on the nature of a solitary fault in a cliff near the resort town of Swanage, on the south coast of England.



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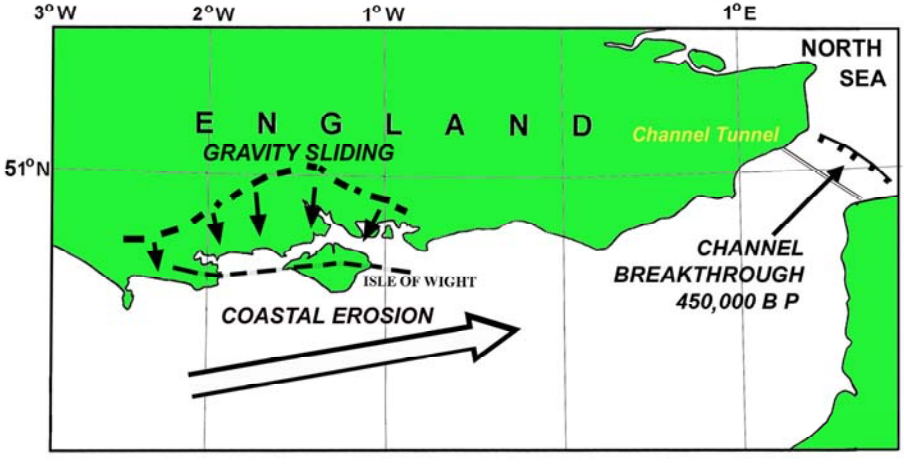

Eastward advance of the future English Channel with coastal erosion of contemporaneous gravity sliding in the Hampshire Basin.