

Evolution of the Hampshire Pull-Apart Basin, the Wytch Farm Oilfield within it, and the Dynamic Role of the Cretaceous Gault Clay in Southeastern England and the English Channel

Peter B. Jones, International Tectonic Consultants Ltd.

Introduction

This study presents evidence from local and international sources leading to major revisions of the timing and kinematics of Dorset coast structures. These revisions include reinterpretation of the Hampshire basin as a post-Alpine graben or pull-apart basin formed initially through southward gravity sliding on bedding-plane extensional faults in the Gault Clay and Triassic salt. This movement with up to 16 kilometres of sub-horizontal offset lead to gravitational redistribution of large areas of Mesozoic sediments. The effect of this was to set the Wytch Farm oilfield in the deepest part of the basin axis, while overlain by the minimum possible overburden, closely resembling a structural system documented in the Canyonlands region of Utah, U. S. A., where depletion of overburden by canyon erosion gave rise to lateral canyon-directed migration of salt and associated fluids. In the Hampshire basin, such fluids may have included oil and gas migrating into an incipient Wytch Farm oilfield. Other foreign background material is derived from compressional mountain belts, where contemporary concepts including "blind" and folded thrust faults, normal faults, thrust duplex structures, and folded unconformities are commonplace elements of deformation in similar packages of layered Phanerozoic sedimentary rocks .

Commonly known as the Hampshire Basin, the Hampshire Pull-Apart Basin is an east-west trending structural trough or graben, roughly triangular in plan extending for more than about 140 kilometres from the Weymouth region eastward through the Isle of Wight, between longitudes 3°W. and 1°W., before passing southeastward into the English Channel. The Hampshire basin is outlined on geological maps by the Cretaceous-Tertiary boundary (Figure 1).

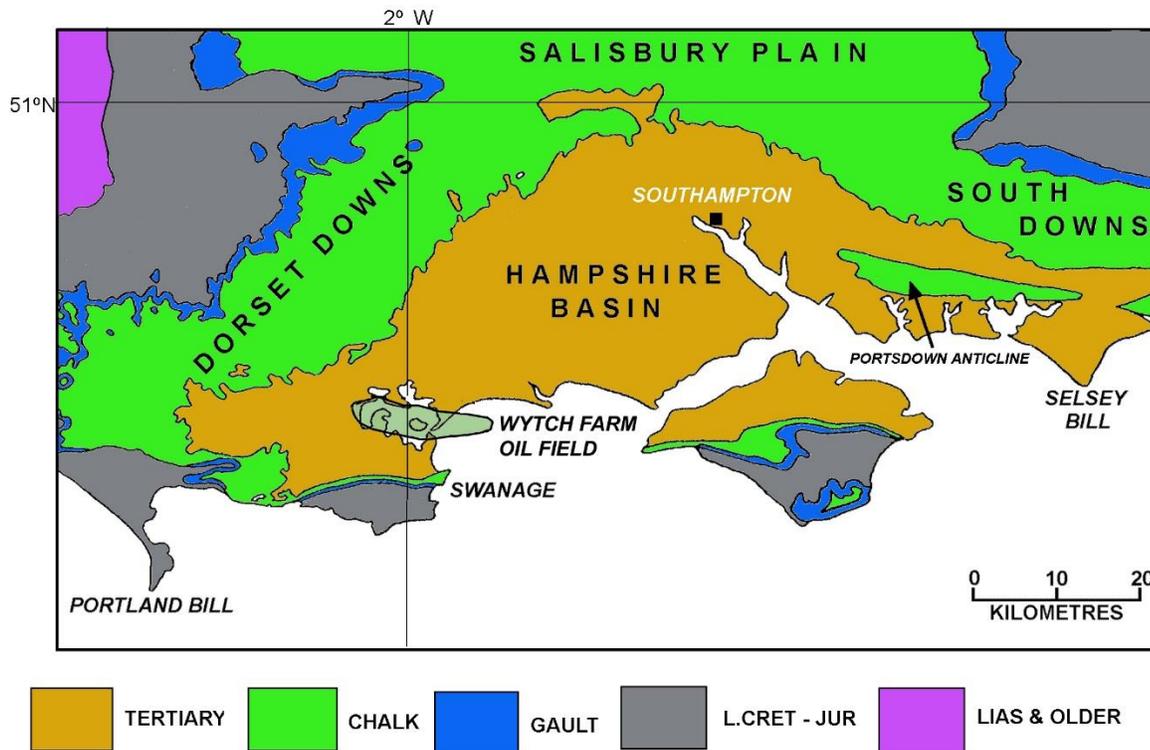


Figure 1. Map of Southern England and the English Channel.

Stratigraphy

The regional stratigraphy is based on published data from the BGS and other published sources. It involves two primary levels of bedding-plane detachment: the Gault Clay which, apart from its role as a major unconformity, is the most incompetent formation in the Mesozoic, and Triassic salt. Between those structural boundaries, the Gault cuts down-section to an intermediate level removing about 1500m of Jurassic and Lower Cretaceous section from the overburden section overlying of the Wytch Farm oil field.

The Ballard down Fault is a major distraction in interpretation of the structure of the Dorset Coast, it is an “Elephant in the Room”, a superficial post-tectonic gravity slide down the north face of the Purbeck-Isle of Wight monocline.

QUATERNARY		THICKNESS (m)
TERTIARY		Poole Group
		London Clay
		Reading Beds
CRETACEOUS	U	Chalk
	M	Greensand/Gault Clay
	L	Wealden Sandstone
		Purbeck
JURASSIC	U	Portland
		Kimmeridge Clay
	M	Oxford Clay
		Corallian
TRIAS	L	Gt. Oolite
		Lias
	U	Mercia Mudstone
	Sherwood Sandstone	
	Salt and Anhydrite	

Table 1. Summary of the regional stratigraphy of the regional-scale Wessex Basin and surroundings, showing detachment levels and the Albian/Aptian unconformity in the Gault clay.

The origin and structural setting of the Wytch Farm oil field

The new Wytch Farm structural model is based on similar structures in the Canyonlands region of Utah, U. S. A ., where removal of hundreds of metres overburden from canyon walls has led to lateral migration of a basal Permian salt towards valley floors under the influence of differential overburden loading. In the Dorset region, salt at the base of the Mesozoic section, combined with an upper bedding-plane detachment (the Gault Clay) to form the extensional duplex structure that hosts the Wytch Farm Oilfield in the deepest part of the Hampshire Basin

The Gault clay and the Channel Tunnel

Implicit in the understanding of the Hampshire graben is the recognition of the role played by the Gault Clay, facilitating approximately 16 kilometres of southward opening of the Hampshire Basin resulting from gravity sliding, shown by BGS cross-sections between Portsmouth and the Purbeck-Isle of Wight –Monocline on the Isle of Wight. Given the propensity of the Gault clay for kilometre-scale bedding-

plane slippage, the fact that it underlies the “Chunnel” by only twelve metres, might adversely affect the operational working life of the “Chunnel”.

Conclusions

The Purbeck-Isle of Wight monocline, commonly regarded as the leading edge of a north-verging thrust sheet is re-interpreted as the trailing edge of a southward-retreating gravity slide which removed up to approximately 1 ½ kilometres of Lower Cretaceous - Jurassic sediments from above the axis of the Hampshire graben. There by establishing the Wytch Farm oilfield as an unloading structure in the deepest part of the basin axis, close to the south edge of the graben, and buried beneath an abnormally small thickness of overburden. This resulted in sub-horizontal movement of the Triassic salt section that underlies the Mesozoic section, setting the oilfield in the situation of maximum overburden deficiency and resultant target of reservoir fluids and salt migration.

The removal of overburden can be attributed to southward gravity sliding of the Lower Cretaceous-Jurassic section southward, itself a consequence of the initial regional southward tilt of the entire region. The location of the Wytch farm oilfield and its setting beneath the axis of maximum overburden deficiency can be compared with the situation in the Canyonlands region of Utah, U. S. A., described for several decades by authors who have explained how in the Neogene, canyon erosion has resulted in basin floor salt flowage towards the canyon axes. It is also similar to the Vienna Basin in Europe.

The key to the replication of this kinematic process in the Dorset coast structures lies in the lithology and detachments along two principal bedding planes, the Gault Clay (Upper detachment) and the Triassic salt (Lower detachment) of an extensional duplex structure which includes the Wytch Farm reservoirs between the detachments. The location of the oilfield beneath the deepest part of the basin overlain by the minimum overburden loading in the floor of the basin facilitates the lateral migration of hydrocarbons into the reservoir rocks.