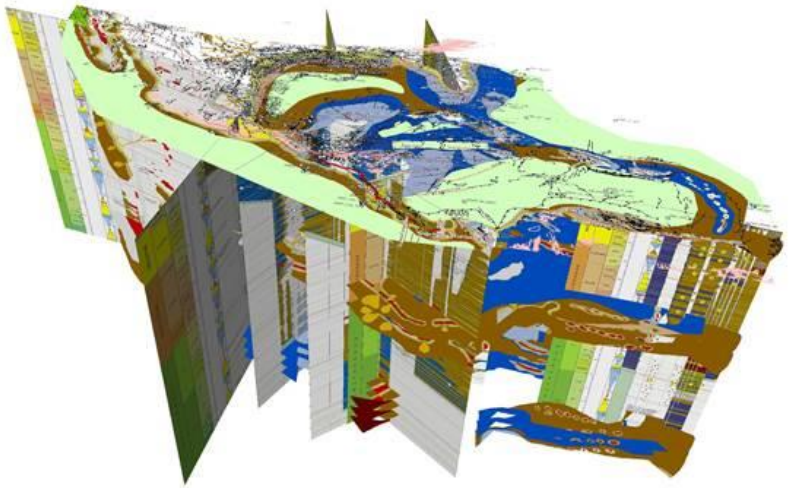
Natural Resources Seminar Series

Date	Name	Title	Abstract
Jan 28th	Dr Anna Korre	CO2 storage site characterisation, monitoring and risk assessment	In recent years, field and pilot CO2 Capture and Storage (CCS) projects around the world have demonstrated the feasibility to mitigate climate change by storing CO2 in the subsurface. A number of UK Research Council, EU and industry funded research projects carried out at Imperial College have looked at, amongst others, the issues surrounding CO2 storage site characterisation, monitoring and risk assessment. This presentation will introduce different aspects of this work discussing • the methods developed in devising key performance indicators of CO2 storage performance in the Rotliegendes depleted gas fields of the North Sea; • the use of remote sensing monitoring techniques in identifying CO2 leakage targets at natural analogue sites (Latera, Italy and Laacher See, Germany), and • the development of risk a methodology to quantify the influence of geological uncertainties in performing a site-specific risk assessment for the post-closure period of CO2 storage sites, using the Ketzin CO2 pilot as an example.
Feb 4th	Guy Plint	Dynamic linkages between subsidence, stratal geometry, facies distributions and Cordilleran deformation: Cretaceous of Western Canada Foreland Basin.	Regional stratigraphic mapping using thousands of wells over 200,000 km2 of the Western Canada foreland basin has revealed that flexural depocentres evolve and migrate over time scales of a few myr and length scales of a few hundred km. Lateral shifts in depocentres may be linked to changes in the locus of active deformation in the Rocky Mountain accretionary wedge. Individual depocentres typically show an upward change from wedge-shaped to sheet-shaped rock units, with a corresponding change from aggrading, mud-dominated rocks to prograding sandstone and conglomerate-dominated rocks. These stratal and facies patterns are readily reconciled with numerical models of foreland basin behaviour.
Feb 11th	Bruce Levell	Oil, Glaciation and Salt dissolution : Oman and Michigan	Permo-Carboniferous glacial sediments in Oman host major oil fields. The oil is derived from Neoproterozoic source rocks matured as early as the Ordovician. The depositional geometry of the glacial sediments, the structure of the traps, the occurrence of the seals and the release of oil from the Neoproterozoic were all controlled by salt mobilisation and dissolution. Specifically meltwater from ice sheets was ponded in large ribbon-like lakes along a salt dissolution front. This lake hosted ice marginal deltas and diamictites (both true tillites and debris flows). In the Middle Silurian of the Michigan Basin hundreds of large pinnacle reefs act as oil reservoirs and traps sealed by interbedded evaporate and carbonate sequences which also provide the source rocks. The effects of vadose and artesian water in these reefs at times of evaporative drawdown both control local facies development around the pinnacle refs and also cause the formation of salt dissolution craters filled from above by collapsing intra evaporate carbonate units. The resulting craters filled with collapse breccias resemble the pinnacle reefs on seismic data but are non-prospective With these examples the role of salt dissolution as a phenomenon is highlighted and the detective work needed to unravel the geological evolution and explore successfully will be explained.

Feb 25th	Mike Simmons	Hydrocarbon Exploration Creativity – Have We Lost our Mojo? And If So, Can We Get It Back?	One of the oldest clichés in the oil industry is that oil is found in the minds of men and women. This implies that the oil industry geologist needs to be continuously creative and innovative. The economic drivers for this are clear – securing energy supply is an obvious need, but for individual companies their success is measured against reserves replacement and carrying this out in an efficient, cost effective manner. So how are we doing? Whilst within the last decade or so there have been some notable new discoveries, exploration success currently runs at about 30% of all exploration wells drilled. With well costs between $200-300M for deep-water wells there are some expensive dry wells being drilled. Moreover, those successes that are reported are typically extensions of known plays - no bad thing – but not entirely new geological concepts as were the "wow factor" discoveries of the likes of Tupi/Lula offshore Brazil, Tamar offshore Israel and Windjammer offshore East Africa. In the last 2 years genuine frontier exploration wells drilling entirely new geological concepts have met mostly with failure. To add other factors to the mix, "the big crew change" means that the industry knowledge base is retiring, as costs are rising and as data volumes and staff workloads increase. The new generation of explorers take time to learn the skills and gain the experience to be truly creative. At the same time volumes of heritage data – both company archive data and publicly available geoscience data, which should be an important component of their information set, are growing at an exponential rate. So the next generation of geologists needs to be as creative as possible, efficiently using all the data and past experience and use workflows to do this smartly. The good news is that technology and joined-up geological thinking allow us to tackle these problems. Good old stratigraphy is the key to joining-up vast amounts of geological data through modern sequence stratigraphic approaches. This data can then be held within a 3D software platform that allows rapid manipulation of interpretations to ask the "what if" questions that a geologist needs to ask to be truly creative. The interpretations can be kept evergreen as new data arrives. Bringing such approaches to bear means that the exploration geologist of tomorrow has the tools at their disposal to find the next game changing discoveries.

			 3D capture of geological data and sequence stratigraphy based interpretations for the whole of Central America in DecisionSpace from Landmark.
March 4th	Guy Plint	Mudstone is the new sandstone, - and it needs our love!	Marine mudrocks form about 70% of the ~ 5 km thick Cretaceous succession in the Western Canada foreland basin. Until recently, publications have described these rocks using terms like 'monotonous' 'deep-water' 'basinal' 'quiet-water'. Microscopic examination of mudstones deposited on 100 km long prodelta clinoforms reveals distinctive microfacies indicative of lateral flows of fluid mud in which silt micro-ripples indicate consistent down-slope flow driven by a combination of wave-generated turbulence and gravity. Mudstones deposited 100-200 km offshore on ramps with negligible slope show no evidence of gravity-driven flow and instead graded, wave-rippled silt and clay record waning, storm-generated geostrophic flows in a few tens of metres of water. Centimetre-scale scour structures and micron-scale aggregates of clay raise puzzling questions about the cohesive behaviour of clays at very shallow burial depth.
March 11th	Bruce Levell	Oil from the Ediacaran of Oman	Ediacaran to Early Cambrian intra-salt reservoirs, mostly carbonates but also silica rich units, form reservoirs for oil in South Oman. The "Ara Stringers" are highly overpressured (near lithostatic) and float within salt which has been mobilised by overburden load, consequently they have been broken into isolated slabs, folded and thrust. In order to explore and develop efficiently both an exploration model of the original carbonate platforms and local facies models of the mostly microbial facies (thrombolites, stromatolites) are needed. Building such models requires a correlation framework. This was done using Carbon isotope data, U contents, and U/Pb dating of ash layers which, together with the palaeontology of the Ediacaran fauna resulting in establishing the current best date for the Precambrian Cambrian boundary. The oil derived from

			the microbial facies bears biomarkers which may inform theories of sponge evolution. Analogue outcrop studies in Namibia suggested the widespread occurrence of both bioherms and biostromes (Microbialites and *Cloudina* grainstones) in the Neoproterozoic which were also drilled in Oman, and also provided quantified reservoir models. As well as providing a new source of oil for Oman, the work demonstrates the diversity of techniques and expertise needed to successfully explore for “difficult oil” as well as the fascinating academic spin-offs that can arise.