Earth's physical resources: extracting coal & oil

The North Sea oil bonanza

Dr Hilary Irwin, Technical Advisor, Basin Modelling & Geochemistry, Statoil
The scientists believe, generally, that the conditions in the late Jurassic were, worldwide, rather unusual: they don't think there was very much circulation in the seas. From time to time there will have been algal blooms in the surface waters, and algae create a huge amount of organic material which then sinks down in the water column. When you closely at the kindred shale, it is often laminated on a millimetre scale, and this shows us that there were no organisms living on the bottom, churning it up. So that shows that conditions were not conducive to life on the bottom. If we look at thin sections of the shale in fluorescent light, then the organic material fluoresces and we can identify some of the organisms. Here we have an example of Ammonites, which is one of the most commonly identifiable algae in the upper Jurassic shale.

Presenter
So what sort of thickness of, of organic shale accumulated in the late Jurassic time?

Dr Hilary Irwin
Well, down here we've got one and a half kilometres: 1500 metres.

Presenter
That's a fantastic amount of algae settling out.

Dr Hilary Irwin
Yes. Yes, we… It was buried by about 2,000 metres of Cretaceous, and then about 2,000 metres of Tertiary.

Presenter
When did it start to actually produce hydrocarbons?

Dr Hilary Irwin
Well, what I marked on here is that the top of what we call the oil window, that's when the temperature's high enough for the organic material to start breaking down, so these huge macromolecules of organic material start to crack, and we get smaller molecules coming off. If we go down to about 4,000 metres, then the temperatures are so high that oil that's produced is not stable any more; the molecules in the oil begin to crack down into smaller and smaller molecules, because oil is not firmly stable. I know that we burn it.

Presenter
Yes, okay. And we get gas coming off instead of oil.

Dr Hilary Irwin
Yeah. So eventually we get gas coming off. Here I've marked the interval where oil cracks to gas, and beneath that we just get gas in the sediments.

Presenter
Just what was the likelihood of finding such a mature source rock in the North Sea? Look at the onshore geology of either Scotland or Norway, and the prospects of finding any mature source rocks are bleak indeed. The ancient crystalline rocks of both countries are quite unsuitable, either to source oil, or to host it. But were the rocks under the North Sea likely to be any different?

Dr Myles Bowen, Consultant, Former Exploration Geologist, Shell, UK
Of course the company sent out a seismic boat and it carried out seismic surveys admittedly, and rather primitive ones, right over the whole of the North Sea. In fact, the Brent barrier was first covered in 1966, and you could see a lot; I mean, you could see that there were thick sedimentary sequences. So the fact that you had, if you like, crystalline rocks in Scotland and crystalline rocks in Norway, it was irrelevant; you, you had some sort of a sedimentary basin in between.

Presenter
Here's one of those features on the seismic profile: a series of tilted fault-blocks.

Dr Myles Bowen
A Norwegian gentleman I think, or a Danish gentleman, called Halle, produced a, a book on eastern Greenland, and he, he published a section which looked remarkably like the… if you like, the structures that we saw – the tilted fault-block arrangement – that we saw on the seismic.

Presenter
But this was in Greenland. What made you think it was going on our side of the Atlantic?

Dr Myles Bowen
Well, this was early days of plate tectonics, Continental Drift we used to call it, but it got renamed as plate tectonics.

Presenter
150 million years ago, the geography of north-west Europe was very different from todays. Shallow, sub-tropical seas covered the area where Brent field now lies. Conditions in those warm seas were ideal for organisms to flourish and organic material to accumulate. In late Jurassic times, there was no Atlantic here, simply an arm of some distant northern ocean extending down between Greenland and Norway.

Dr Myles Bowen
And of course looking at that, and then looking at where the Brent well was going to be drilled, we could see that it was actually quite close to the east coast of Greenland, or would have been at that time, and therefore it seemed not unreasonable to suppose that, since we saw the same tectonic appearance – admittedly an outcrop in Greenland, but buried in, in the northern North Sea – that we might be looking at the same thing. And in Greenland it was indeed Jurassic, and with good reservoir rocks, so we just hoped that it would be the same where, where we were going to drill.

Presenter
And did you feel excited about that as a prospect?

Dr Myles Bowen
Oh, it was tremendously exciting. Well, I actually went out to the rig and I was one of four people who extracted the core from the core barrel. Everybody else was ushered away [laughs], and we, we… the four of us boxed up the core, and we had it almost immediately on a helicopter to the Shetlands, and then on a plane the same evening down to London.

Presenter
That borehole established not only that there were mature Jurassic source rocks in the northern North Sea, but also that there were Jurassic sandstones that could hold billions of barrels of oil. Other finds told the same story. The North Sea oil bonanza had begun.