



Tupi, the new kid in town

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On the morning of November 12th a friend called me saying that the largest oil field in the world had just been found off Brasil. I then explained to him what the largest oil field in the world was like, and how implausible that information was.

In fact since the late hours of the previous day the media was reporting "the largest world oil find in the last 20 years". Once again our energy problems were over, goodbye 90 dollar oil and so on.



Déjà vu? Didn't this all happen last year with the [Jack field](#) in the Gulf of Mexico?

Jack was a media stunt that mistaken an assessment of an entire layer corresponding to the Lower Tertiary with a single field. Fireworks came and went, oil prices came down and went up to stay one year later 20 dollars above the price just prior to Jack's announcement. As of now it is unknown when production from that layer will start.

Last week the name was Tupi, a field found by Petrobras in the Campos Basin off Brasil; with prospects of 5 to 8 Gb of intermediate gravity oil (28° API) and gas, it boosted the country's reserves of hydrocarbons by 50%. A remarkable find (for today's standards) announced again in a period of high prices.

It took some days for the dust to settle down and for a clear picture to emerge from the various and sometimes contradictory reports circling in the press; something reminiscent of the lack of preparation by some journalists to deal with this kind of information.

What is it?

First of all, does 5 to 8 Gb refer to oil in place or recoverable reserves? During the first reports the field was given as capable of producing 100 Kb/d, a number that indicated lower reserves making those 8 Gb sound like oil in place. Later in the week the production target was given as high as 4 Mb/d then settling at 400 Kb/d, reassuring that the numbers given were in fact recoverable reserves. Petrobras' officials were stated as directly using those terms.

Is Tupi a single field? The information available at the moment and the quotes from Petrobras' geologists point to that. Tupi is either a single field or a complex of closely lying reservoirs in an area some 800 Km long by 200 Km wide of pre-salt rock formations under a column of water ranging from 2000 to 3000 meters deep.

What's the oil to gas ratio? An important question, given the field's depth the temperatures could

be high enough to form gas, and most media reports refer to "oil and gas reserves". It is likely that at this stage the company itself may not know exactly what's this ratio and hence the large reserves interval given.

As for the production schedule, first oil is placed in different places in time by different media sources, but none points to earlier than 2011. There's an obligatory two year gap to get the equipment from the current tight rig market and at least two more years to get commercial oil flows. A possible calendar:

First drilling	2009
First production at 100 Kb/d	2011 - 2013
Peak/plateau production at 400 Kb/d	2015

At some point there were reports of production reaching 4 Mb/d, which were likely confusing the overall company targets with the field's target. Recent reports state a company target of 4.5 Mb/d and 400 Kb/d for Tupi in 2015. Khebab made the following calculations using the [Pickering relation](#):

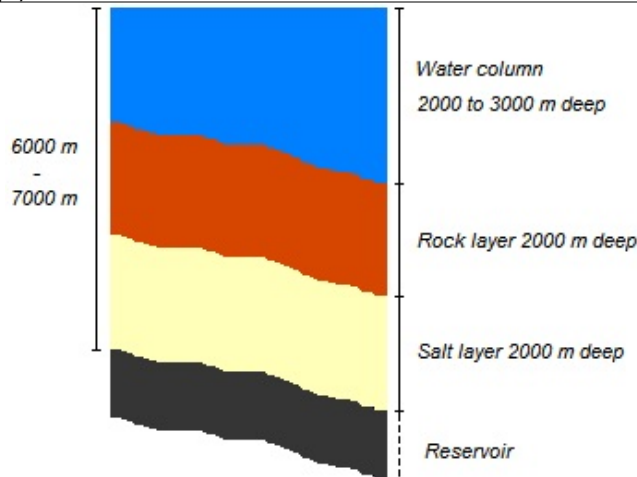
Region	Parameters	Max. Production (Kb/d)
World (Small Fringe)	0.0435 / 0.0418	260 - 390
Cantarell (Mexico)	2.1 / 11	1000 - 1500
Statfjord (Norway)	0.637 / 5.53	580 - 920
Ekofisk (Norway)	0.299 / 5.10	290 - 470

These numbers put in perspective what Tupi represents globally, at its peak the field will produce less than half a percent of the world oil production. Even if the higher estimate of 8 Gb is confirmed, the field's reserves represent 14 weeks of world oil consumption.

The Challenge

Nonetheless, with the information gathered Tupi looks for real and not just another media stunt. A major piece of insight was published in the journal *O Estado de São Paulo* this weekend, where several experts were interviewed. Tupi is a real technological challenge, lying in a geological setting never before approached in Brasil.

The pre-salt layer is found under water depths that vary between 2000 and 3000 meters, after which there's a layer of 2000 meters of rock. The salt layer itself is also some 2000 meters deep and only after that is found the reservoir.



Sketch of the pre-salt layer setting.

Petrobras is today exploring fields over 5000 meters deep from water line to the reservoir; Tupi's depth by itself does not frighten the world leader in offshore exploration. The problem is the salt layer through which it has to be drilled. Nelson Ebecken from the Coordination of Post-Doctoral Engineering Programmes (COPPE) of the Federal University of Rio de Janeiro (UFRJ) had this to say:

We have to develop that technology. [...] If that layer was onshore it would be difficult. Imagine then at three or four thousand meters deep.

Drilling through layers of salt has been done in other places, but not at that depth, neither through such thickness.

At such depths, under immense pressure and warmed by the planet's internal heat the salt behaves more like a fluid than a rock. It is like drilling through jelly, a hole is opened but closes immediately after. Well maintenance in these conditions can be problematic; Edison Prates de Lima, also from the UFRJ:

The rock is hard but stable. The salt isn't as hard but it's unstable.

A difficult task, but at the reach of Brazilian engineering. Giuseppe Bacocolli from COPPE's Laboratory of Computational Methods in Engineering put it this way:

I don't see a paradigm break, it is another evolution.

But there's a problem: cost, that grows exponentially with depth. Bacocolli again:

We may reach the conclusion that we can, but we shouldn't. Defeating the salt layer implies a considerable additional cost.

at depths up to 6000 meters, were the equipment used in drilling is tested. A fourth chamber that will be able to replicate operating conditions up to 7000 meters deep is being built, that will start operating by the beginning of 2009. Drilling at the mentioned depths has to be made entirely by robots operated remotely. "It's like driving a Formula 1 car entirely from the pit box" said Segen Estefan also from COPPE.

Other problems include the thermal shock oil endures when it gets out of the rock layer, in the reservoir temperatures could be close to 100 ° C and at the ocean floor crude meets temperatures as low as 4 ° C. The crude can create high density bulbs that block the flow to the surface. This problem can be mitigated with pipe heating or insulation. The pipes themselves can be problematic due to their weight in steel, making the experts from COPPE contemplate the use of titanium.

The question comes down to cost, as Segen Estefan puts it:

We are operating in the limits of technology. The problem is cost, if it will be too expensive or not.

The first well drilled in the Tupi field cost 240 million dollars, a number that fell to 60 million in later field assessments. A total of 15 wells were drilled through the salt layer with 8 of these reaching the hydrocarbon reservoir. Giuseppe Bacocolli expects the costs to fall even further to 30 million dollars per well during commercial operation. Still a number that implies a base price of at least 30 dollars per barrel of oil produced, four times Petrobras' present cost of deep offshore production and not factoring in equipment costs. Bacocolli thinks that the operations will require between 6 and 12 [FPSO](#) platforms, each connected to 10 to 15 wells.

Also according to Giuseppe Bacocolli further volumes of recoverable reserves can be confirmed, depending on new assessments to be made on the remaining of the pre-salt layer where Tupi was found.

Conclusion

All things considered, Tupi seems a markedly different case from last year's announcement of Jack. Scrutinizing the information circulated by the media leads to a sound picture of a field buried at the current technological offshore exploration frontier. Judging by the Brazilian academics' excitement, cost can in fact be the limiting factor but not technology by itself.

A final question should be answered, was Petrobras needing this kind of media attention? In reality it doesn't look so. Petrobras is the most profitable private company (of all commercial sectors) in South America, posting almost 9 billion dollars solely in the first nine months of this year.

Current reliable world 2P crude reserves lay somewhere around 800 Gb; given that:

- a) 1000 Gb of crude have already been produced and
- b) most reliable models point to a crude URR of 2000 Gb or higher,

there are still at least 200 Gb of crude oil yet to find. This implies that entire oil regions the size of the North Sea are yet to be discovered. The pre-salt layer of the Campos Basin off Brasil, where Tupi was found, may well be one of those.

The press release by Petrobras can be read [here](#).

Further information in the brasilian media (in portuguese):

[O Estado de São Paulo](#)

[Cosmo On Line](#)

[A Tarde](#)

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