The Oil Drum: Europe
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

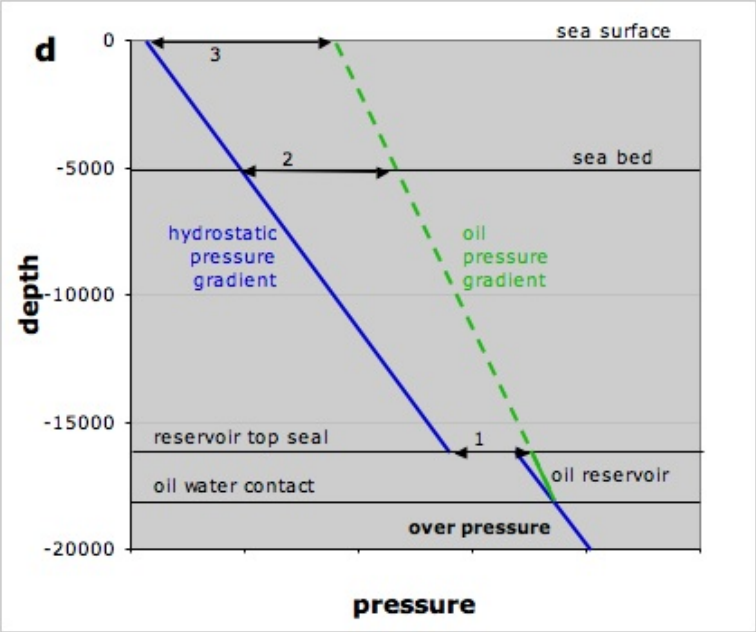
Deepwater Oil Spill - Pressure Tutorial - and Open Thread

Posted by Euan Mearns on June 6, 2010 - 7:00am in The Oil Drum: Europe
Topic: Miscellaneous
Tags: blow out, bp, deepwater horizon, macondo, oil spill, over pressure, pressure [list all tags]

Because of the large number of comments, this discussion is being moved to http://europe.theoildrum.com/node/6568.

There has been much debate about pressure in relation to the Macondo blow out and I thought it might be helpful to explain the origins of sub-surface pressure differentials in as simple terms as possible.

Note that I am a geologist, not an engineer. The diagrams are intended to be cartoons to illustrate simple concepts.



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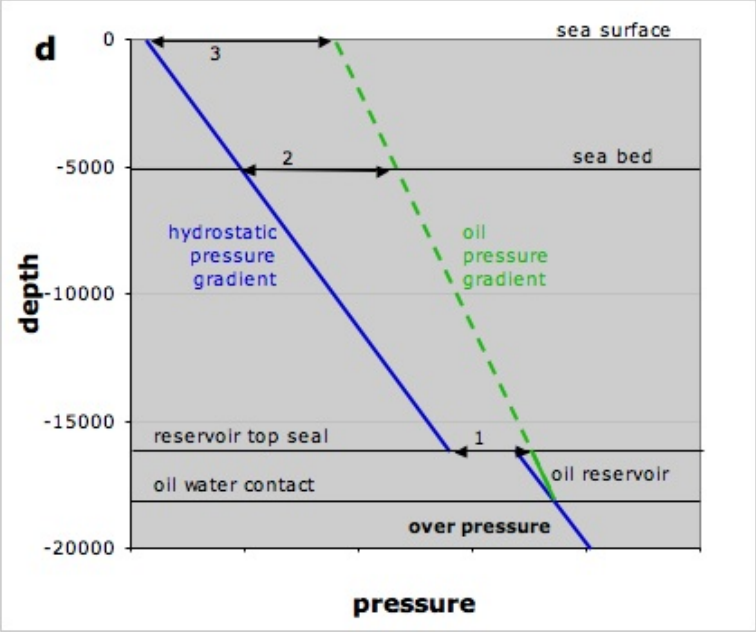
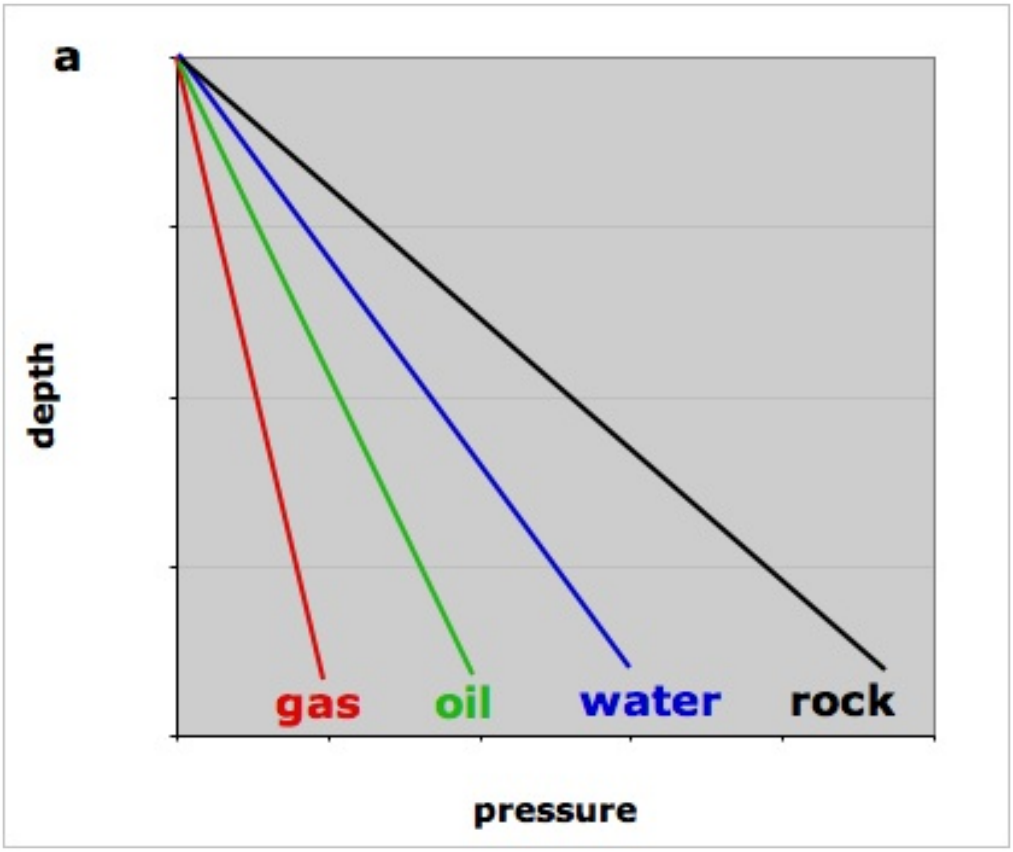


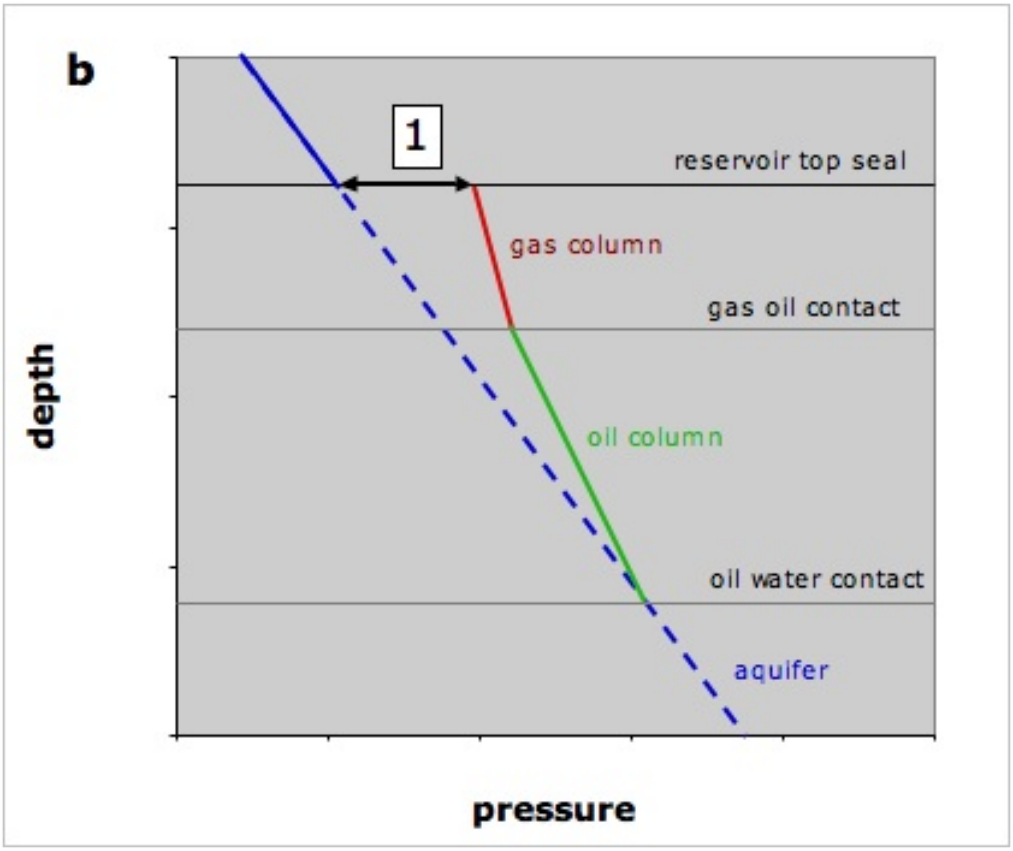
(a) Basic concepts

Pressure increases with depth in the sub-surface proportinal to the density of material. The lowest density material encountered is normally gas which has the shalowest pressure gradient, followed by oil, water and then rock. Normally pressured water is called the hydrostatic pressure gradient. But in the sub-surface, the presence of regional rock seals may produce over pressure in water caused by rock pressing on water (see example d). The rock pressure gradient is referred to as the lithostatic pressure gradient.



(b) Common configuration in reservoir

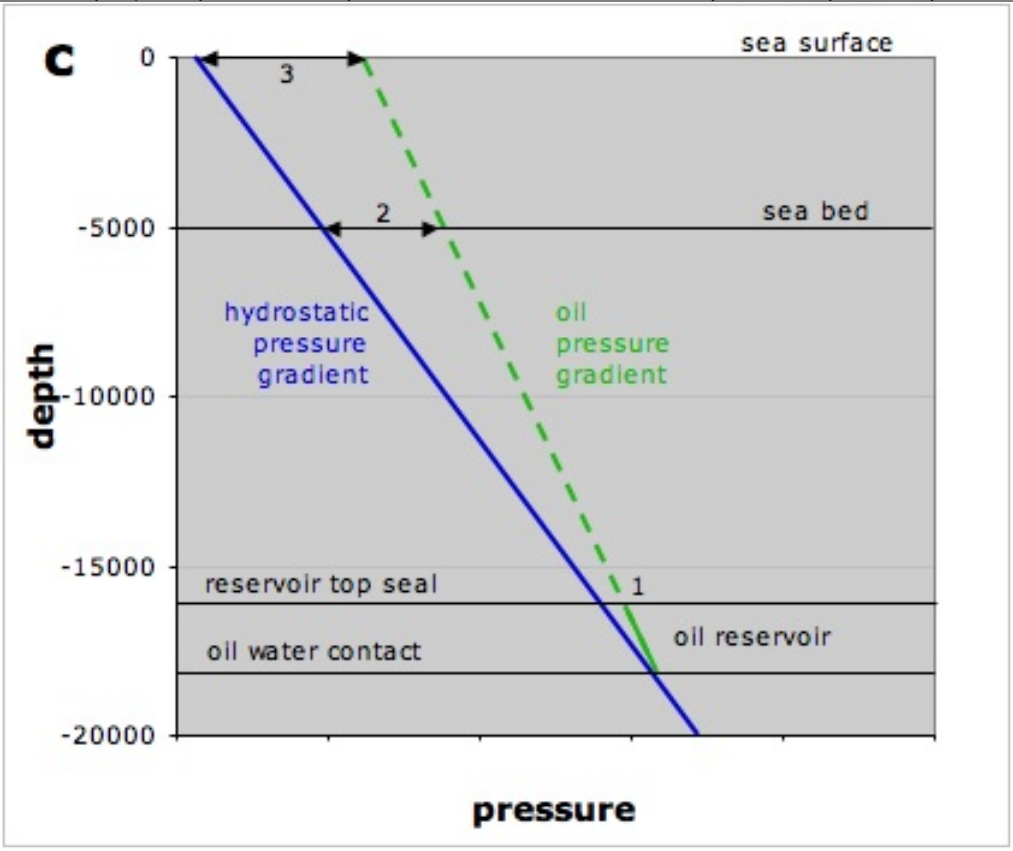
In an oil / gas reservoir the oil essentially floats on water and the gas floats on oil. The top seal prevents the oil and gas escaping giving rise to the pressure configuration as shown. The "pressure kick" at the top seal (1) is contained when drilling by the drilling mud.



(c) Common configuration in production tubing

If oil (± gas) are allowed to enter production tubing then a column of oil ± gas may exist all the way to the surface. This long column of low density material creates large positive pressure differentials that need to be contained by the production infrastructure. Note how the pressure difference grows up the well.

Pressure difference on the sea bed (2) is lower than on the sea surface (3). In the case of Macondo, the 5000 ft column of water exerts some useful pressure, limiting the flow of oil from the well.



(d) Over pressure

Deep reservoirs such as Macondo are often over pressured. That means that regional rock seals prevent subsurface water escaping. The rocks above can then exert some pressure on the water.

Note how over pressure can create a much larger pressure differential at the top seal. These are the large pressure kicks that are of great concern to drillers in this type of environment. Note how over pressure gets transmitted to surface through oil and gas in production tubing.