

Marty Stetzer: Hi, everyone and welcome. I'm Marty Stetzer, president of EKT interactive in Houston. We are proud to be the podcast sponsor with the Society of Petroleum Engineers, Gulf Coast Section. The section was founded in 1935 and now has over 11,000 members. It is a volunteer organization that provides member forums to upgrade and maintain professional competency. This podcast is one of a series and another learning resource available to the members. Numerous on-demand webinars can be accessed at www.spegcs.org.

Today our topic is "Letting the Genie out of the Bottle" — the importance of understanding geo pressure to avert drilling challenges. I'll be speaking with Dr. Selim Shaker, with over 40 years of resolving these types of drilling and exploration issues. His company, Geo Pressure Analysis Services, accomplished numerous pressure prediction and analysis projects, especially in the Gulf of Mexico and South America. He has taught risk assessment and drilling challenges related to this topic both in-house and in public forums for the AAPG, SEG, and SCA.

He has over 45 papers relating to this topic, and more information can be reached by looking at his website www.geopressure.analysis.com. We're really happy to have his input on this topic at this time of unprecedented challenges in our industry, as more wells go deeper into more complex and high-pressure formations. Selim, thanks so much for taking the time today.

Selim: Thank you, Marty. Good to be here.

Marty Stetzer: Selim, your topic title is intriguing. Letting the genie out of the bottle... What does it mean?

Selim: Well, Marty, it is... let the genie out of the bottle. I will explain that. There are a lot of natural disasters... as volcanoes, earthquakes, and these natural disasters... is a spontaneous response to the stress within the earth itself and increases in pressure and temperature. However, man can do the same thing. He can create his own hazard and death.

This has happened sometimes when the drill bit penetrates a sequence of layers... when their steel pipes can penetrate uncontrollable subsurface pressure compartment during the exploring for oil and gas, and all hell can break loose. This is what my title reflects.

Marty Stetzer: Selim, can you first share with our audience how you got interested in this topic in the first place?

Selim: Sure. I started as a hard rock geologist in Egypt. This is in the '70s, and when I switched, in the '80s, to oil and gas exploration in the Gulf of Mexico, I have discovered the importance of evaluating pore pressure and geo pressure for explorationists and drilling engineers as well. It is not an easy job. It's not an easy discipline. It is an intricate and complex process to find oil and gas. It is not in a gas station. It is a long and complex process.

So, the geologist finds a prospect and we referred to a prospect as potentially deep, buried oil trap. So we refer to it as a prospect... using multiple tools from... start from seismic, well correlation, analysis of petrophysics, and then the engineer comes and designs the wellbore to test and reach that trap to produce the oil and gas we use. It is a dual effort for both sides.

Pressure plays an essential role in finding and producing hydrocarbon from the source to the wellhead. And that's why I became really intrigued by it.

Marty Stetzer: Selim, to get into some of the specifics, what are the main driving mechanisms in accelerating pressure with depth?

Selim: Marty, simply three words: stressed, fluids, and pores. Stressed, fluids, and pores. For pressure buildup, what we need: fluids, mainly formation water, porosity to host that fluid, and the fluid needs to be stressed to generate fluid compressibility. That's how pressures generate as fluid resisting to the stress, the compressibility. It's exactly like a human being. The blood pressure increases when the artery becomes narrow and have a stress.

So this is the same thing, or similar to it. The sediments compaction take place in the subsurface with increasing depth until the formation water does not respond to the sediments fluid — which is the stress, the main stress, and is no longer escaping to the sea floor. That's where and why and how the excess permission forms. The fluid gets trapped and is fighting the stress.

And at that depth, we call this zone a pressure cap or seal. And in general, for a long time, we called it the top of the geo pressure. That top, or that zone, that depth and attributes of this zone help... assisting the prospect drilling challenges and the overall project economic feasibility. So most of the money is going to spend on exploring and producing that oil and gas and is... dependent or contingent on how that pressure system will behave in the subsurface.

Marty Stetzer: Thanks, Selim. That was very helpful. Can you let our listeners know just what is the risk assessment of a prospect, in relation to the top of the geo pressure depth that you just described.

Selim: Marty, this is a good question. The four pillars of any successful prospect include the presence of hydrocarbon source, that's number one; presence of a reservoir, that's number two; and that reservoir should be able to contain and deliver hydrocarbon under a differential pressure.

Number three, which is very important, a presence of seal. That seal, or the pressure cap, will prevent the hydrocarbons from escape to the sea floor. Number four, which is... this is going to be the manmade process. Something drillable, not too deep, not too risky. This is the four pillars, and all these four pillars are supported by the pressure system behavior. And this is another good reason why I became intrigued by pore pressure prediction and analysis. Go figure.

Marty Stetzer: Thanks, Selim, that was a great overview. But now, what are some of the causes of pressure surges and anomalies that can cause serious drilling challenges for the operator?

Selim: Here are some of the possible causes. Number one, inherited causes, and we cannot do anything about it... such as drilling boundaries, geologic compartmentalization, salt and shale dampers, which is like a dome, a large fault. These features, geological features, we can't do anything about it. The only thing we can do... during building that model, the pore pressure model, we can mark along the borehole trajectory until the toolpusher, that you are going to see here... you're going to see, probably, a little flow here. You're going to see probably a loss of circulation here.

Another reason also — the modeling. Some of the software or some... the users or the operator just rely on a single software without modifying the model to adapt to the subsurface geology.

So... third reason, which is the most frequent to happen during drilling... the operation... during the operation watch out for how the well breathes, how the well will go up and down. Send some guys up, reduce the mud level down... that's called well breathing. Mudcuts... one of the examples — connection gas, volume, cutting. So during the drilling operation monitoring and maneuvering the mud weight is very, very important.

Marty Stetzer: Can you continue the conversation on the importance of the mud system in managing open borehole pressure?

Selim: This is great. Thank you. In the subsurface there are four fluids we're dealing with in the borehole. There are three natural subsurface fluids... mainly the formation water, oil, and gas. That's the three. And we are looking for oil and gas, which is a very minor, very minor fluid in the subsurface.

The main fluid is formation water. That's the one to cause the troubles, the pressure surge... and with increasing the depths, all these natural... three natural fluids have a different pressure gradient control by density and depth. The human being cannot do anything about it.

On the other hand, the number four fluid, or fourth fluid, in the borehole is the mud. The mud, in addition to lubricating the drilling bit and moving the cutting to the surface, it is capping that increase in pressure with depth. That's why one of the main functions of the mud is capping the pressure increase in the subsurface.

The rule of thumb — we need to keep that mud pressure in balance — that is, where the imbalance is, means... usually we have a quarter or three-quarters of PPG, pound per gallon, excess weight than the formation pressure... so we can keep the mud pressure above the formation pressures.

This range, one quarter to three-quarters, is contingent on the borehole breathing. If the borehole is sending a lot of fluids out, and gas, we need to increase that amount of the balance. So, now borehole breathing... and the industry regulated that amount of the balance between the mud pressure and the formation pressure.

Here in the US we have BSEE. It is a relatively new organization. The BSEE stands for Bureau of Safety and Environment Enforcement, previously known as MMS. This organization regulates and supervises this process, which is balancing the mud to the formation. I think this is probably the easy way to explain the mud function and the borehole. Is that satisfactory?

Marty Stetzer: It is, but there's kind of two situations. One would be underbalance. The other would be overbalance. Can we first talk about the symptoms of mud weight underbalance that can cause a well flow or a strong kick during drilling?

Selim: Marty, this is a good question, and we should not ignore these symptoms. Some of these symptoms are very subtle. It doesn't show a lot of indications for underbalance. The way that we worry about the underbalance, we call it underbalance. It means the formation pressure is higher than the mud pressure, so the mud... the mud cannot keep the pressure in the borehole. So the borehole tries to come out. So this is the underbalance. The subtle part of it is... can be seen on the mud logging tools. We can see a mudcut — mudcut means less density of the mud coming out than going in.

However, this symptom really becomes obvious and becomes really dangerous for the underbalance when connection pipes are made. Connections pipes... every 30 feet, we add a pipe to that drilling stem. So when we add the pipe, we need to shut off the pump. When you shut off the pump, the pressure of the mud gets less... or gets reduced. If the formation pressure is getting close to the mud pressure, here you're going to see a lot of indications that the flow... the wellhead would keep flowing, and then the gas and chloride records will sound an alarm, so, they need to be treated... need to increase the mud weight to balance the system or balance the pressure in the formation versus the pressure in the mud.

Marty Stetzer: Selim, that was a great story on the underbalance situation. How about overbalance? Can loss of circulation cause a strong kick or blowout as well?

Selim: This is a great, interesting question. The thought... that losing mud and the formation was overbalance and runout of mud returned to the rig floor due to overbalance... is not as dangerous as the underbalance is false, is erroneous. Because overbalance can cause more dangerous situations and more devastating results than the underbalance... because if you overbalance and the mud escapes in the formation and the borehole becomes, say, empty. So you didn't have anything to combat the pressure in the borehole.

And this is a problem. You have to be ready to replenish the loss of circulation as soon as possible, as you see a loss of circulation. So the answer to your question — yes, it is dangerous. Overbalance is as dangerous as underbalance, or more.

Marty Stetzer: Selim, thank you so much for your insights. They will definitely be valuable to the SPEGCS audience and our own community of 10,000 EKT interactive listeners. Finally, what advice do you have for today's young petroleum and drilling engineers?

Selim: Well, Marty, I want to divide this into two parts. For petroleum engineers in general: The consumption of oil and gas will not end overnight. Planes, trains, and automobiles need fuels. Even look around and find out... old, countless petroleum products are in use... from agriculture, construction, to medicine. So your career, petroleum engineers, whatever you are — drilling, production, chemicals — your career is not in jeopardy.

For our friends, the drilling engineers: We need to avoid cutting corners. This is some of the problem with our industry — the drilling part of it — cutting corners. You cannot save a few thousands of dollars, but then the consequence is catastrophic. Let us remember a mudcut can lead to wellhead flow, and the flow can lead to a hard kick, and the kick can lead to a blowout. So let's tackle the problem from the initial stage. Let's treat the mudcut as soon we see it and saving money is not an issue. The issue is the consequences.

Recently, about 12 years ago, there is a case history... the infamous Deepwater Horizon explosion is a classic example of cutting corners. A lot of questions have not been answered yet, but the cause of this disaster... maybe... the incorrect pore pressure model has been applied to drilling that well. The deep well was 18,000 feet in the Mississippi mini-basin. Mini salt basins... because salt basins, modeling in the salt basins is very hard... because the stress drastically changes in salt basins, and using the correct model is the right answer.

Another possible case... that gas in the mud was too much, and they did not take the time to separate the gas out of the mud and... cleaning the hole. And the one obvious... everybody was talking about... is the cement integrity due to borehole instability. If any cave-in takes place in the borehole so that when you put in cement, you need more cement than the actual volume. And according to the reports, there are no CBL, which is casing — a cement bond log has been run.

The most important... My advice: Keep the genie at bay. Don't let it out. And also, we need to remember that the blowout preventer — this is the last line of defense against the subsurface sleeping giant. Be careful.

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Marty Stetzer: Selim, are there other SPE resources or papers where our audience can find out more about this topic?

Selim: Yes, a lot. Drilling manuals, textbooks, and published papers... mainly dealing with this issue of balancing the pressure in the borehole versus the mud pressure. Yes, sir. In my classes, I have one of the classes, a deal was for safety and drilling, formation pressure prediction, and application for drillers. This is... you're going to find it in my website under Training.

I hope I gave you a dose of how the pore pressure behaves in the subsurface. Drilling and exploring for oil and gas has a lot of issues and relies... and is contingent on how that pore pressure behaves in the subsurface.

Marty Stetzer: Selim, that was terrific. Thanks again.

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