Testimony for the U.S. Senate Energy and Natural Resources Committee

Hearing on "New developments in upstream oil and gas technologies"

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Seismic Technology – A Transformation

Good Morning and Thank you Chairman Bingaman and Ranking Member Murkowski for this opportunity to come and speak to you today in this hearing about recent advances to upstream oilfield technologies. I will be speaking to you today about new developments in the area of seismic technologies and its importance to finding, developing, and eventually producing oil and gas.

Let me begin with a brief explanation of what seismic data is. Seismic data are acquired by "listening" to motion related to seismic waves. Seismic waves are vibrations within the Earth induced naturally or artificially. The devices used to listen are seismic sensors that transform Earth motion into impulses that are recorded by seismic recording systems. After the data is recorded, the data is processed and used to get a better understanding, or a "picture", in two or three dimensions of what the rock below the Earth's surface looks like, as well as any potential oil and gas that might be contained within those rocks.

There are exciting new developments in seismic technology that will create greater efficiency in oil and gas exploration with an increased emphasis on the environment with a greater transparency in the upstream petroleum industry going forward. The main development has been in new seismic acquisition systems creating higher definition and greater productivity. The transformation involves new wireless recording systems. The systems can record actively as well as passively, meaning that they can record with an active source or they can "listen" to the natural seismicity of the Earth. It is equivalent to putting "cell phones" as monitoring stations on the ground.

These devices can record various kinds of seismic waves. The most widely used waves are acoustic waves, or sound waves, but other waves propagate within the Earth. Detecting different types of waves gives us additional information about the subsurface including: the strength or integrity of the substrate, stresses within the subsurface, fluid

pressures and even the fluids themselves. Combined recording of different seismic waves enables us to characterize the subsurface to optimally target wells, provide guidance on well drilling, and to monitor well completions and to monitor well and completion integrity. As a result, the petroleum industry is being transformed and the seismic industry is leading the transformation of the upstream oil and gas sector as we know it.

New seismic recording systems are being used to conduct monitoring of enhanced oil recovery projects in the US and Canada including carbon dioxide flooding and sequestration. The results have enabled scientists and regulators to work together to assess environmental safety associated with these projects. They have been used recently in resource plays in the US and Canada to determine “sweet spots” that are more economical to develop through horizontal drilling and hydraulic fracturing. The combined use of new seismic, drilling and completions technology is changing the landscape of the petroleum industry to lessen the environmental footprint and to create greater transparency.

Seismic technology is traditionally used for oil and gas exploration, but is capable of being used for much more. Recent uses include advanced reservoir characterization to increase the recovery factor of oil and gas reservoirs. Reservoir characterization is basically the methodology to document the heterogeneity, or complexities, naturally associated with reservoirs. Geology is complex and reservoirs are too. In the past about 25% to 33% of a resource has been recoverable. Through improved integrated reservoir characterization technology we have been able to increase recovery to 50 %, but we are not done. Enhanced recovery methods will enable us to improve the recovery factor even further. In resources, or unconventional plays where the oil and gas is generated and contained in-situ, recovery factors are generally low (10%), but the potential to increase recoveries through integrated reservoir characterization technologies is substantial.

Technology is the single most important factor in finding and developing energy resources to fuel our economy in an environmentally responsible manner. New seismic technologies will enable us to find new resources, to develop old ones more efficiently, and to open up exciting new growth opportunities here in the US for current and future generations.

I have provided some examples of sensors and recording devices that are shown in the attached figures. The equipment is getting smaller and more sophisticated to the point that high definition images of the subsurface can be made with relatively little intrusion on the environment. The instruments can be left in place to monitor the subsurface over relatively long periods of time- like motion sensors that are used for in-home security systems. These systems allow us to listen to our reservoirs and to take proactive rather than reactive in the management of our reservoirs.


Seismic Technology – A Transformation
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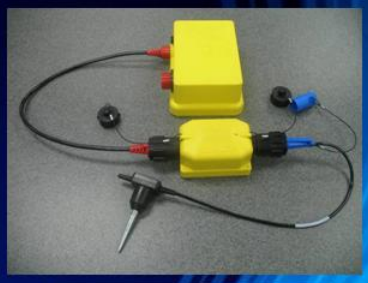
Seismic Exploration Products
Geospace Seismic Recorder (GSR)

- **Nodal Seismic Data Acquisition System**
  - Increases productivity and decreases cost
  - Permits new multi-source acquisition techniques
  - Decreases footprint easing access into environmental sensitive areas
  - Increases total channel count
- **Applications**
  - Seismic Exploration Market
  - Seismic Reservoir Market
  - Vibration Monitoring Market
  - Homeland security



Available in 1, 2, 3 and 4 channel configurations

OYO GEOSPACE

Seismic Exploration Products
Ocean Bottom Recorder (OBR)

- **Ocean Bottom Nodal Seismic Data Acquisition System**
  - Corrected GPS Clock Synchronized
  - Unlimited Channel Count
  - GSR and OBR Can Be Used Together
- **Expanding into Environmentally Sensitive Areas**
  - Seismic Exploration
  - Seismic Reservoir Monitoring

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Seismic Reservoir Characterization

- Permanent Seismic Reservoir Monitoring
- Ocean Bottom Data Acquisition Systems
  - Retrievable & Permanent
- Borehole Data Acquisition Systems
  - Retrievable & Permanent

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