Rejuvenation of Mature Plays
Granite Wash Reborn

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ABOUT THE AUTHORS

SURYA RAJAN, IHS CERA Director, is an expert on North American natural gas supply. Mr. Rajan has more than 20 years of energy industry experience across the value chain in many sectors, including upstream exploration and production, completion technologies, tight gas operations, downstream commercial supply chain, project management, information technology, corporate management, and strategy. In addition Mr. Rajan is actively connected with the gas industry through ongoing research, analysis, publications and presentations, and participation in industry forums. His interests and analyses have included strategic workforce issues, international corporate alliance models, country entry risk assessment, and the digital oil field. Before joining IHS CERA he held senior posts with Marathon Oil Corporation and Schlumberger. Mr. Rajan is a certified Project Management Professional. He is an active member of the Society of Petroleum Engineers where he serves on the Digital Energy Program Committee for the Annual Technical Conference and Exhibitions. Mr. Rajan holds a BS from the Indian School of Mines, Dhanbad, and an MS from the University of Kansas.

WALTER MOODY, IHS CERA Associate, specializes in supply modeling for North American natural gas, including production and rig outlooks. Mr. Moody is responsible for the supply analysis of North American natural gas markets. He has extensive experience in exploration geology, including in log analysis, prospect evaluation, decline curve analysis, reserve calculations, and subsurface map creation and interpretation. Before joining IHS CERA Mr. Moody was an independent consulting geologist. Previously he was Exploration Geologist for Mull Drilling Company and with the Kansas Corporation Commission was a regulatory geologist. Mr. Moody holds a BA and an MS from Wichita State University, Kansas.

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REJUVENATION OF MATURE PLAYS: GRANITE WASH REBORN

KEY IMPLICATIONS

Operators have recently demonstrated remarkable success in applying unconventional well practices that originally unlocked the “shale gale” in North America to tight oil and gas formations other than shale. For some plays in production plateau or in decline, that can mean a virtual rebirth of the play. In the United States the Granite Wash play in the Texas Panhandle and western Oklahoma is an example of such a “tight oil” rebirth. After over 50 years in operation, this mature oil and gas play is registering dramatic production growth, transforming it into a significant emerging source of crude oil, natural gas liquids (NGLs), and natural gas.

- **Tight oil and gas plays have responded dramatically to application of unconventional well technologies including horizontal wellbores and multistage hydraulic fracture stimulation treatments.** The productive life of mature tight reservoirs such as the Granite Wash can be extended significantly by applying these techniques.

- **Production from the Granite Wash could exceed 3 billion cubic feet of dry gas per day, 140,000 barrels of oil per day, and 2 billion cubic feet equivalent per day of NGLs by 2025, according to estimates by IHS CERA.**

- **The value of liquids is driving increasing amounts of associated gas into an already oversupplied market at negligible incremental cost.** Associated and nonassociated gas production from oil plays (including the Granite Wash) could exceed 10 percent of North American supply by 2020.

- **Regional spikes in liquids production may test the limits of handling capacity.** Increased NGLs production will drive infrastructure investments for expanded liquids processing as well as gas handling capacity.

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REJUVENATION OF MATURE PLAYS:
GRANITE WASH REBORN

by Surya Rajan and Walter Moody

NEW HORIZONS FOR UNCONVENTIONAL TECHNOLOGIES

Successful application of unconventional drilling and completion technologies is at the heart of the renaissance of onshore oil production in the United States. Tight oil plays using these techniques have contributed to making the United States the single most important source of growth in global oil production—by far—in 2009 and 2010.

Besides shale, other tight formations also respond positively to horizontal wellbores with long reach laterals and to multistage hydraulic fractures (fracs). The Granite Wash play in the states of Texas and Oklahoma may be just the first of many such mature tight oil and gas plays waiting in the wings to be revisited with a new arsenal of technology.* Tight oil refers to crude extracted from shale and other tight, fine-grained rocks such as sandstones and carbonates. With established production-handling networks, mature tight oil plays have the potential to ramp up rapidly and cost effectively, competitive with newer, more prolific plays. Along with oil production growth, gas output from oil plays, both associated and nonassociated, could exceed 10 percent of North American supply by 2020. The Granite Wash play is located in North Texas and western Oklahoma (see Figure 1). It has been producing oil and gas since 1956, primarily as a modest oil play with vertical wells targeting fairly tight reservoir rock and stimulated with traditional single stage hydraulic fracs where necessary. Promising results from unconventional well technologies such as horizontal wellbores with long reach laterals, and multistage hydraulic fracturing have sparked renewed interest among operators. Activity in the Granite Wash play has grown steadily in recent months. High productivity from the recent unconventional-style wells and the potential for liquids production, both crude oil and natural gas liquids (NGLs), have boosted confidence in the profitability of this play.

Gas production in the Granite Wash has increased fourfold over levels of about ten years ago. Crude production has grown even more dramatically, from 3,000 barrels per day (bd) to 36,000 bd over the same ten-year period. Nearly 95 percent of all wells being drilled in the area at this time are either horizontal or directional.

Operators have recently reported average 30-day initial production (IP) rates of between 5 and 8 million cubic feet (MMcf) per day and estimated ultimate recovery (EUR) volumes close to 6 billion cubic feet (Bcf) per well. Over the past year and a half drilling activity has steadily grown. From January 2010 to June 2011 daily production in the play has grown from 680 MMcf to 750 MMcf of dry gas, 450 MMcfe-equivalent (MMcfe) to 500 MMcfe of NGLs, and 21,000 barrels to 36,000 barrels of crude oil (see Figure 2). With these recent increases, the Granite Wash is emerging as a significant source of crude, NGLs, and natural gas. IHS CERA projects that by 2025 the production from the Granite Wash will exceed 3 Bcf gas per day, 140,000 barrels of oil per day, and 2 billion cubic feet equivalent (Bcfe)

*See the IHS CERA Private Report The Shale Gale Goes Oily.
per day of NGLs.* More broadly, the Granite Wash is further evidence that tight oil could lead to significant new production in the United States—and perhaps, over time, globally as well.

HISTORY OF THE GRANITE WASH PLAY

The panhandle areas of Texas and Oklahoma have been exploited for other target zones since the middle of the 20th century. In 1956 the first two discovery wells were drilled in the Granite Wash—the Phillips Petroleum Company Price F No. 1 in Hutchinson County, Texas, and the Union Oil Company of California Lard No. 1–3 in Roberts County, Texas.

*See the IHS CERA Multiclient Study NGLs Analytics and Insight: Rebalancing NGLs in an Unconventional North America.
These two wells were drilled vertically to depths of 8,070 feet (ft) and 9,362 ft, respectively, but being exploratory wells, both were completed to depths shallower than total depth. The Price F No. 1 well produced 81 bd of oil and 4 barrels of salt water per day. The Lard No. 1 well produced less, with an IP of 39 bd of oil. Other major players in the early development of the Granite Wash were Standard Oil, Stanolind Oil and Gas, and Sinclair Oil Company.

**PRODUCTION AND PERFORMANCE GROWTH STEADY**

Gas production from the primary Granite Wash development steadily grew from the 1960s and reached about 180–190 MMcf per day by 2003 (see Figure 3). From 2003 to 2008 high gas prices allowed relatively lower value or expensive plays to flourish. Tight sand in particular produced a windfall, leading to the term “tight sand boom years” for that period of time.

Through 2008, production from the Granite Wash grew rapidly, primarily by means of vertical drilling. By the end of the year volumes reached 725 MMcf per day of gas, 500 MMcfe per day of NGLs, and over 20,000 bd of oil (see Figures 4 and 5). Typically production from vertical wells would reach a plateau and then ultimately decline. In about 2008, however, development using horizontal wells with multistage hydraulic fractures began in this formation, with great success. Production growth response in NGLs has been similar to that for gas, but growth in oil production from the Granite Wash has been nothing short of remarkable. Currently Penn Virginia, for example, reports average well IP of 720 bd
The Granite Wash derives its name from the weathering process that created the reservoir rock. Uplifted granite rocks from the southwestern foothills, where the Rocky Mountains are now located, eroded over time, depositing sands in subaqueous fans. These sands eventually compacted to what is known today as the Granite Wash formation (see Figure 6). Geologically, this play is a combination of the Virgilian, Missourian, Desmoinean, and Atokan formations. The Pennsylvanian-age Granite Wash consists of a wedge of discontinuous sandstones and siltstones deposited as lobes that were shed off the north flank of the Wichita–Amarillo Uplift. The Granite Wash thins northward and has interbedded marine sands and shales in the Anadarko Basin. The main body of this play is located in the northern Texas panhandle and in western Oklahoma, also extending into southwestern Kansas.

The primary mature Granite Wash layers are nonmarine fluvial sands found primarily in the Atokan and Desmoinesian stages of the Pennsylvanian Granite Wash at drilling depths between 7,000 and 15,000 ft. Granite Wash in mature producing areas sometimes occurs in 100 to 200 ft thick sandstone packages separated by gray shale. Porosity varies from less than 0.1 percent to 16 percent, and permeability varies from 0.005 to 100 millidarcies. As a result, individual well performance varies widely across the play. Granite Wash wedges near the northern depositional limit are targeted with directional and horizontal wells. There can be up to 11 stacked wedges of sandstone, and liquid content occurs in the upper three of these.
Figure 4
Granite Wash NGL Production by Well Type

Source: IHS CERA.
10802-17

Figure 5
Granite Wash Oil Production by Well Type

Source: IHS CERA.
10802-16
of oil with 8 MMcf associated gas per day; EUR for the average well is calculated at 4.1 Bcf and 350 million barrels of oil (6.2 Bcfe).* Penn Virginia has been completing its wells with a 4,000 foot lateral section completed by means of 10–15 stage hydraulic fracture stimulation treatments.

The Granite Wash historically has been liquids-rich in the earlier vertical well developments, with average yields of 0.03 barrels of oil per 1 Mcf gas. The same yield ratio also holds true for newer horizontal wells in the play. However, total EURs have been significantly improved with horizontal drilling, increasing from an average of 0.67 Bcf for vertical wells to nearly 3.0 Bcf for horizontal wells, a fivefold increase. IP rates also increased fivefold (see Figure 7). Total gas production from the Granite Wash was about 750 MMcf per day in June 2011, despite a steep decline in production from vertical wells.

The upside in this play will be based on the horizontal development of stacked sand wedges. At this point IHS CERA expects the production from the play to exceed 3 Bcf of gas per day, 140,000 bd of oil, and 2 Bcfe per day of NGLs by 2025. The reemergence of this play is still in its early stages, however, and there may be much more to learn. Given the likelihood of stacked horizontal laterals producing from the multiple sand

bodies, there is a possibility that these production estimates could be revised significantly upward in the future.

Evolving Trends in the Granite Wash Play

There is a strong case for the price differential between crude oil and US natural gas to remain much wider than in the past. The price differential between crude oil and Henry Hub natural gas hit record levels throughout 2010 and into 2011. West Texas Intermediate crude averaged around $9 per million British thermal units (MMBtu) higher than Henry Hub gas, up from the 1996–2005 differential of $1 per MMBtu. In our Global Redesign scenario, which represents the current IHS CERA view, this differential is expected to be higher during 2011–20 than in 2000–08.* This wide oil–US gas price differential will continue to encourage liquids production—and thus give wet gas production an advantage over dry gas. This trend is reflected in the US lower-48 rig count as well: in April 2011, for the first time since 1995, the gas-directed rig count fell below the oil-directed rig count. Since April, this trend has maintained a gentle but steady growth trajectory.

The total gas- and oil-directed rig count in the Granite Wash has grown from 55 rigs in January 2010 to 107 rigs as of June 2011 (see Figure 8). As a result, the Granite Wash play, which is rich in NGL content, has piqued the interest of many operators. But this

*See the IHS CERA Private Report Mind the Gap: Gas versus Oil Prices.
is a recent phenomenon. Until May 2010, there were no oil-directed rigs working on the Oklahoma side of the play.

Since January 2010, the total rig count on the Texas side of Granite Wash in Hemphill, Lipscomb, Ochiltree, Roberts, and Wheeler counties has increased from 39 to 76, most of them gas directed. However, the proportion of gas rigs has decreased from 85 percent to 72 percent as a result of greater interest in liquids-directed drilling. Over the course of 2010, drilling more than doubled on the Oklahoma side of the play in the Ellis, Roger Mills, and Washita counties, and peaked at 39 oil and gas rigs in December. Since then, the rig count has fallen to 31, most of the drop consisting of gas-directed rigs that have moved west into Texas.

In another trend emerging since January 2010, the small decline in vertical drilling has been more than offset by the increase in horizontal drilling (see Figure 9). The percentage of nonvertical (horizontal and directional) rigs operating in the area rose from 80 percent to 94 percent from January 2010 to June 2011. During that same period, the nonvertical rig count more than doubled, increasing from 44 to 100, while the vertical rig count in the play dropped from 11 rigs to 7 rigs. The overall growth in rig activity is remarkable for the play, which may previously have been considered mature and on plateau or in decline.

The initial 3,500 ft long horizontal section of the typical Granite Wash well has now been stretched to about 4,500 ft, and hydraulic fracturing is in 12–15 stages treated with about 1.5 million pounds of proppant for each well. IP rates in the play have also been improving as the design is fine tuned. Although the average horizontal rate is slightly greater than 5
MMcf per day, some operators have started reporting IP rates approaching 20 MMcf per day in the sweet spots. Total Granite Wash gas production neared 750 MMcf per day in June 2011.

The established sweet spot for horizontal wells has been in the Colony Granite Wash field in Washita County, Oklahoma. However, a new sweet spot appears to be emerging in Wheeler and Hemphill counties, Texas, at the Buffalo Wallow, Stiles Ranch, and West Park fields, judging by increased drilling activity in these areas.

**NEW PRODUCTION FROM ONCE MATURE PLAYS**

Application of unconventional well drilling and completion practices has been the key to rejuvenation of mature plays such as the Granite Wash. Drilling horizontal wells with long reach laterals and hydraulically fracturing in multiple stages has been the game changer for operators in this play. The broader significance of the Granite Wash is that it is another example—following in the steps of the Bakken and Eagle Ford plays—of the potential for growth in tight oil production.

Drilling activity has risen steadily in this play, but there is also a marked shift in emphasis from dry gas to wet gas and oil. Consistent with the rest of the North American oil and gas industry, portions of the play that produce mostly dry gas seem to be at a plateau or gently declining, whereas wet and oily portions of the play appear to be gradually gaining strength.
The Granite Wash is in a region of mature oil and gas development, and enjoys easy access to well services and pipeline infrastructure for handling produced hydrocarbons. Proximity to the large Texas demand hubs allows low-cost access to ready markets with an established distribution network. The presence of abundant NGLs in addition to crude and natural gas makes the production even more lucrative for operators. Chemical plants along the Texas Gulf Coast present a ready market for produced NGLs. Indeed, regional spikes in liquids production may test the limits of handling capacity. IHS CERA expects production growth in the Granite Wash to drive future capacity additions for liquid processing as well as production gathering and transportation.