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The Marcellus Shale has triggered a natural gas rush in the Appalachian Basin as developers race to extract the relatively inexpensive hydrocarbon and deliver it to the nearby Northeast United States, where energy demands are among the highest in the nation. With many trillions of cubic feet of recoverable gas in the ground beneath more than half a dozen states, boom towns already are springing up in West Virginia, Ohio and Pennsylvania.

Predictably, the modern day gold rush has touched off a frenzy in the mapping business, too. For a cubic foot of natural gas to find its way from the Marcellus formation nearly 9,000 feet below the surface to the furnaces of regional energy customers, maps are needed—and in some states legally required—in every phase of development, from exploration and land leasing to well pad siting and pipeline construction.

“This is a classic energy boom—the oil and gas companies that get there first are going to grab the golden egg,” says Ken Scruggs, President of Midwest Aerial Photography. “In terms of mapping, the demand is intense because the development activities are changing the area so fast that maps are out of date after four or five months.”

Midwest Aerial has experienced the relentless request for timely imagery since April 2011, when the firm was first contracted by Blue Mountain Aerial Mapping to fly collections over the basin. Since then, these companies have had to push their respective aerial acquisition and map generation capabilities to the limit—and beyond—as Marcellus success is increasingly tied to economic recovery. Both firms credit digital technologies with helping them stay ahead of the nonstop demand for maps.

**Based in Columbus, Ohio,** Midwest Aerial focuses exclusively on airborne imaging and data collection. Leaving the map production to its partners and clients, the firm has intentionally built its reputation on getting an aircraft over the target site when and where the end user needs it. Reliability is such an integral part of the company’s business model that it formed an aircraft maintenance shop.
several years ago to ensure its planes are always first in line for repairs and seldom grounded by mechanical issues.

Midwest Aerial made the transition from analog photography to digital imaging in 2010 with the purchase of the Z/I Imaging DMC II sensor. Prior to that, the firm relied solely on four Zeiss RMK TOP film cameras, which it still uses for some projects. The switch to digital, however, was driven by the need to stay competitive as more and more project specifications began requiring digital equipment. The firm bought a second identical sensor a year later. “Digital sensors have accelerated the entire aerial mapping procedure primarily because there’s no film to process and scan,” says Scruggs, “and secondly, digital sensors can collect suitable imagery in adverse light conditions.”

Scruggs selected the DMC II digital mapping camera for several reasons. First was its reputation for rare downtime due to maintenance problems. The second was the quality of its images. The sensor has a rigid square frame and single pixel array that result in very high-quality geometric resolution. The sharpness of the imagery, along with the square image that mimics traditional 9x9 film, played a role in Midwest Aerial’s selection for the Marcellus project in 2011. “It’s hard to show a client something analog after they’ve seen the digital products,” says Doug Six, president of Blue Mountain Aerial Mapping.

From its headquarters in Burton, W. Va., near Morgantown, Blue Mountain takes a proactive approach to serving the mapping needs of the regional energy business. For years, it has specialized in providing highly accurate topographic maps, terrain models, orthomages and digital contours to energy companies involved in coal, oil and gas extraction in the region. When Marcellus shale gas leases opened, the firm was ideally positioned to serve the market.

As local Marcellus activity was heating up in the spring of 2011, Blue Mountain received requests for mapping over a large block of land, primarily in West Virginia and Pennsylvania. Two engineering firms that had done business previously with Blue Mountain were working with energy companies preparing to drill into the shale.

Doug Six saw that several other open leases were nearby as well as active coal mining operations. He decided to fly 4 million contiguous acres to fulfill the existing requests and to speculate on future map needs.

The project became a race against time as the spring progressed and trees were ready to bud. All the while, another important factor was adding a sense of fierce urgency—the competition among energy developers. “We had clients looking for map information from the flight before we could even get the imagery in our hands,” says Craig Fry, Blue Mountain vice president. “It was quite trying, to say the least.”

Blue Mountain contracted Midwest Aerial to perform the acquisition and specifically requested use of the digital mapping camera. The participants agreed that digital collection was their only hope of covering the target area before the leaves popped. But then another challenge arose—bad weather. Daily overcast skies and frequent rain storms dominated the local weather patterns, as they often
do at that time of year there. “There weren’t many ideal flying days during that spring,” Fry says.

At the time, Midwest Aerial had been operating its digital camera for a year and had already noticed an unanticipated benefit of its use—the DMC II could be operated in lower light conditions than film cameras could handle. Traditionally, aerial photography occurs when the sun is greater than 30 degrees above the horizon, which leaves a very short or even non-existent daily collection window at some latitudes for up to half the year. “We had blatantly violated the 30-degree sun angle rule on several projects [with the digital camera] and still collected extremely sharp and detailed imagery,” says Midwest’s Scruggs.

He explains that two key features of the digital camera make low-light imaging possible. First, the DMC II’s pixel array is extremely sensitive to light and collects in 14-bit radiometric resolution, giving it a broader dynamic range than film. In addition, Z/1 Imaging integrated electronic forward motion compensation technology into the sensor to shift pixel value information from one row of pixels to the next during the exposure. This allows the shutter to stay open a fraction of a second longer at high aircraft speeds and low altitudes without blurring the image. “If it worked at low sun angles, we figured it would work in low light conditions caused by overcast skies and storm clouds,” Scruggs says.

For most of April 2011, Midwest Aerial had an aircraft over the target area dodging rain clouds and collecting imagery whenever it was safe enough to fly. Before each collect, the pilot flew over that day’s site while the sensor technician took light meter readings with the camera. The average reading was used to set the exposure for all frames planned to be shot on that flight, unless there was a significant change in external lighting conditions. “This ensured a consistent and natural appearance of light throughout the mosaicked imagery once it was processed,” says Scruggs. “The last thing you want is different exposures from one frame to the next down the flight line.”

Project specifications from Blue Mountain called for natural-color imagery at a 10-centimeter ground sample distance (GSD) with 60 percent forward and 30 percent side overlap. To accomplish this, the flights were conducted at 4,200 feet above ground level. Minimal ground control points had to be surveyed because the digital camera is integrated with a tightly coupled GPS/IMU (inertial measurement unit) in the aircraft that collects extremely precise location and attitude coordinates of the camera during imaging. The DMC II automatically collects red, green, blue and near-infrared bands with each image.

After each day’s collection, the Midwest Aerial aircraft returned to its base near Columbus, where technicians used the Z/1 Imaging software delivered with the sensor to post-process and radiometrically correct the raw digital imagery. The GPS/IMU data was post-processed using undifferenced GPS data precise point positioning technology from NovAtel/Waypoint Consulting using a tightly coupled filter. “We typically shipped the post-
processed imagery on hard drives overnight for delivery the next day, and the corrected GPS/IMU points were available the next evening,” says Scruggs.

Blue Mountain didn’t waste any time deriving high-quality map products from the image data. Once it was delivered, the mapping firm’s technicians used the Vr photogrammetric mapping software suite from Cardinal Systems LLC to generate maps. Working in order of customer priority, they performed digital terrain model extraction, orthorectified the natural color bands and generated two-foot contour maps. Some clients also asked for planimetric feature maps. “For most of our clients [in this project], the contour map is the primary deliverable,” says Blue Mountain’s Doug Six. “They need engineering grade topographic maps for logistics related to the shale gas production—designing drill pads, grading roads, and installing gas and water pipelines.”

Despite the acquisition under less-than-ideal lighting conditions, Blue Mountain encountered no difficulties generating its various end products from the digital camera imagery at the accuracy specifications of their clients. End users who received the digital orthoimagery were impressed, as usual, with the sharpness and information content, according to Six. And they were especially pleased the mapping firm was delivering finished products within three days of the aerial acquisition. “The quality of the orthoimages we’ve received [from Blue Mountain] has been nothing short of excellent,” says Chris Dieffenbauch, president of Dieffenbauch & Hritz LLC, a Morgantown, W.Va., engineering firm. “Without it, we just simply wouldn’t have the success we’ve had.”

Since completing map work on the original 4-million-acre block, Blue Mountain has made numerous requests for Midwest Aerial to fly back into the basin and collect smaller targets, sometimes with as little as 24 hours notice. Several flights have had to dodge thunderheads and rain showers, but none has been canceled due to equipment failures. Nor have any sites had to be rescheduled due to poor image quality.

“The energy industry is extremely demanding for quick response,” says Scruggs. “The bottom line on this project is that we’re collecting geometrically precise and high-fidelity color imagery in the timeframe demanded by the end user, which makes everybody look good all the way down the line.”

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Additional information about Blue Mountain Aerial Mapping is at www.bluemountainairmaiming.com, and more details about Z/I Imaging technology are at www.zimaging.com.