

US coal geophysics expands and gains more support.

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SUMMARY

The US coal geophysics program was once the exclusive domain and best kept secret of one major coal company. The company was able to develop a full spectrum of remote-sensing technologies to address their complex upstream and downstream challenges. The program started in the mid-1970s, and greatly expanded a decade later with more robust and diverse applications. Innovative geophysical surveys were routinely conducted to enhance the company's coal exploration, engineering, and environmental programs.

As the largest operator of underground longwall mines in the country, Consol Energy was able to improve their mining productivity and mine safety by detecting and imaging potential geologic anomalies that could create adverse underground mining conditions prior to mine development. High-resolution surface seismic surveys were routinely conducted years in advance of mine development. Other geophysical methods were at times employed as part of internal multi-disciplinary (geology, geophysics, geohydrology, and ground control) studies to address environmental, engineering, and permitting issues.

Key words: US coal geophysics, high-resolution seismic, abandoned oil/gas well searches, and digital EM system.

INTRODUCTION

The coal geophysics program at Consol Energy started in the mid-1970s when Consol was still a subsidiary of Conoco Inc. Upstream and downstream oil field technologies were tested and transferred through the Conoco Coal Research Division which later became the Research and Development of Consol Energy. According to the former Consol Energy CEO, Bobby Brown, it costs the coal company more than \$1,000,000 USD/day in lost productivity when longwall mines are down. As the largest operator of underground longwall mines in the country, it was imperative that all necessary measures and innovative technologies be developed and employed to enhance mining productivity and mine safety. After successful field testing, the coal geophysics program greatly expanded in the mid-1980s to address its complex exploration, engineering, and environmental issues (Gochioco, 2005, 2000, 1992, 1991, and 1990, Gochioco and Cotten, 1989). The coal geophysics program unfortunately ended in April 2000 during a reorganization process under new management.

As a result of the high-profile underground coal mine accident at Que Creek Mine near Somerset, Pennsylvania, in late July 2002, the US coal industry was forced to examine and explore any available remote-sensing technologies that could be employed to detect and map abandoned old mine works. The investigative efforts were led by the Mine Safety and Health Administration (MSHA), US Department of Labor. It was through these investigations that MSHA learned more details about Consol's former coal geophysics program.

HIGH-RESOLUTION SURFACE SEISMIC METHODS

With funding from the US Congress, MSHA initiated a geophysical field demonstration program in which grants were provided to service providers, contractors and academic institutions in 2004 and 2005. LM Gochioco & Associates Inc. was a recipient of such a grant. Given the founder's diverse past experiences and expertise, and successful demonstration under the MSHA program, a new geophysical services company was established to assist the US coal industry.

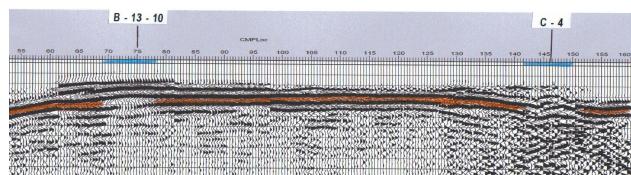


Figure 1. Coal seismic section highlights anomalous signature beneath B-13-10 indicating detection of abandoned old mine works.

Some recent examples of US coal seismic projects are presented. Figure 1 shows a coal seismic section in which abandoned old mine works were detected beneath B-13-10. The disturbance beneath C-4 is associated with a culvert (road drainage) which was backfilled with loose unconsolidated materials. The robust and continuous coal seam reflections between the two boreholes indicated uniform seam thickness. Figure 2 shows a disturbed zone near the middle of the section. The disturbance is interpreted to be abandoned old mine works. The robust reflections to the left and right of the disturbed zone indicate a uniformly thick coal seam.

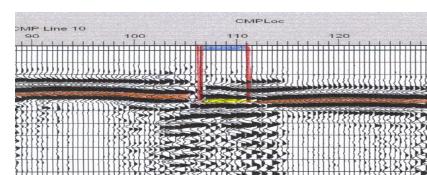


Figure 2. Disturbed zone near the middle of the seismic section is interpreted to be associated with detected old mine works.

ABANDONED OIL/GAS WELL SEARCH

In 1859, Colonel E. L. Drake was credited in supervising the drilling of the first recorded successful oil well in Oil Creek, Pennsylvania. This historic event heralded an era of oil exploration in the country that resulted in the drilling of thousands of wildcat wells in the next several decades. It occurred at a time when no government regulations were in place to document these drilling activities and laws requiring oil and drilling companies to remediate abandoned wells. As a result, there are thousands of poorly documented oil and gas wells scattered across various US coal basins, creating public safety and environmental problems.

By law, coal companies are required to find and plug these abandoned legacy oil/gas wells before mining permits are granted as a safety measure because these open holes could become conduits for hydrocarbons to migrate upward and into underground coal mines; thus, creating hazardous conditions. To compound its detection by geophysical methods, major recycling efforts during the WWII resulted in recovering steel pipes from abandoned wells without proper documentation. Despite these challenges, a digital multi-frequency source electromagnetic (EM) system was field tested and found to be effective in detecting the hard-to-find abandoned oil & gas wells in US coal basins (Gochioco and Ruev, 2006).

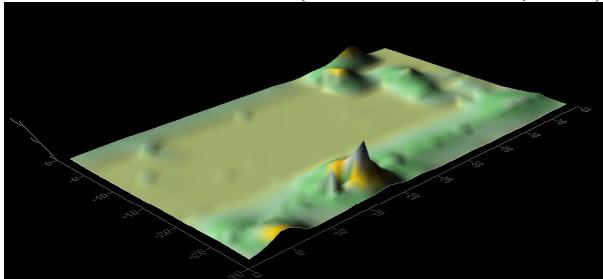
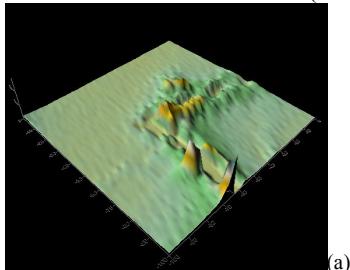


Figure 3. A 3D EM image of detected abandoned oil and water wells (larger and smaller peaks) near coordinate (15, -25) along a linear feature interpreted to be an old pipeline.

A 3D EM image is presented in Figure 3 of a study area in West Virginia conducted in 2005. The two orthogonal linear features are associated with buried pipelines. The larger peak detected near coordinate (15, -25) is the abandoned oil well and the smaller peak detected nearby is associated with a water well used to supply water while drilling the deeper well.

Figure 4a shows a 3D image of a 100' X 100' study area in SW Pennsylvania. A single pipeline was detected which made a 90-degree turn. A small disturbance was detected near coordinate (-30, -30) and is interpreted to be an abandoned well. The well location can easily be seen from a different perspective. Figure 4b is a map view of the study area but displayed at a different source frequency reading. It is more evident that the abandoned well is located at (-30, -30).



(a)

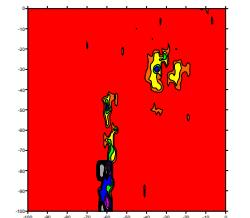


Figure 4. 3D and 2D different perspectives views of a study area showing detection of an abandoned oil well at (-30, -30) in SW Pennsylvania

(b)

CONCLUSIONS

For nearly two decades, the R&D Department of Consol Energy Inc. (the former Conoco Coal Research Division) kept their coal geophysics program close to their chest. The genie is now out of the bottle and is no longer the exclusive domain of any private entity. Through the internet, any end users can easily search and find numerous examples of geophysical technologies being employed in coal basins around the world. As a result, more US coal companies are adopting geophysical technologies into their upstream and downstream operations. In addition, federal and state regulatory agencies are aware of its capabilities and limitations from the MSHA-funded studies.

ACKNOWLEDGMENTS

The authors thank MSHA for providing the initial grant to bring about and resurrect the US coal geophysics program to benefit the entire coal industry. In addition, former Conoco and Consol management are acknowledged for their role in supporting the development of coal geophysical technologies in order to improve mining productivity and mine safety.

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