The diverse challenges in a mining geophysics career

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The old saying "jack-of-all-trades but master of none" does not apply to mining geophysicists—we are expected to be "jack-of-all-trades and master of many." In other words, a mining geophysicist needs a broad background, extensive training, experience in many branches of geophysics, and the ability to communicate across disciplinary boundaries.

The path leading to my eventual career was accidental, turbulent, and chaotic. Sometimes out of chaos comes some order. The oil crises of the 1970s impacted many lives globally, but also created opportunities. It occurred during my formative years in high school and college. The Philippine government embarked on a program to subsidize the U.S. training of local physics graduates in nuclear physics because the country was building a nuclear power generation plant to lessen dependence on foreign oil.

While waiting for the bureaucratic wheels to engage, I completed my training in nuclear engineering and did astronomical research at the Manila Observatory. I applied to a dozen U.S. institutions, but SEG was the only one that responded. That SEG scholarship, first awarded in 1979, exposed me to exploration geophysics and the petroleum industry for the first time. The impact was positive such that I changed my career plans.

Employment opportunities in the petroleum and geophysical service industries had evaporated by the time I completed my graduate studies in 1982. Even though all aspects of the oil business were contracting, I went to Houston to look for a job. I managed to work for three companies and survived two layoffs in the next three years before I became a mining geophysicist.

This was similar to a path I took 25 years ago when I joined my high school track team. I had ability in several areas, but no overwhelming strengths. So I tried the sprints, middle distance, long distance, and jumping events. I constantly ended up "third best" in these events—good enough to get on the team but not good enough to even be eligible for top NCAA competition where a minimum of "second best" was required. The coach suggested that my strong combination of speed, endurance, and jumping ability might better fit the high and low hurdles. It also would involve an instant promotion since the team had only one runner in these events. My response was: "What's a hurdle?"

Even though I technically became "second best" overnight in the hurdles events, constant training and practice were necessary to develop the proper techniques to reach the top.

It was virtually déjà vu 14 years later when I came to CONSOL R&D in 1985 (then Conoco Coal Research Division) for a job interview after having recently been laid off from a major oil company. During the interview, I wondered: "What's coal-mining geophysics?"

The Conoco supervisor, however, offered me the job even though I had no experience in mining geophysics.

Editor's note: Deadlines forced the June 1998 issue on "Careers in Geophysics" to go to press without an article on mining geophysics. This article attempts to correct that omission.

Lawrence Gochioco is pictured (left) with two other geophysicists at the entrance to a coal mine.

Apparently, my diverse academic background, training, and experiences seemed to complement Conoco's planned expansion of its coal geophysics program. I believe this supervisor and my high school track coach made wise decisions for good reasons.

However, just as with my track experience, instant transformation into a mining geophysicist did not ensure success. Again, training and practice were needed.

Employment and career opportunities in mining geophysics hinge on the same business cycles as the petroleum industry. To survive and prosper in difficult and competitive environments, you need good defensive and offensive strategies. For a mining geophysicist, a good defense is built on a strong academic background in physics, math, geology, geophysics, and electrical engineering. A working knowledge of computer hardware and software programming is invaluable. Moreover, ample common sense, open-mindedness, and self-motivation are a must.

However, the more challenging work—developing a good offense—lies ahead because the field is not static, but dynamic. Your offensive tactics may change and/or evolve depending on the challenges. But certain things stand out constantly. Effective communication is critical. You will need to qualify and quantify the capabilities and limitations of each geophysical method in terms that a client can readily understand, because a lot is at stake. For example, a single lost production day from a longwall mining operation costs a coal company an average of $1 million. If geophysical methods can be employed to reduce the number of down days per year, the resultant savings would pay for the survey costs many times over.

The mining industry operates in a very competitive business environment that is result-driven and unyielding. Consequently, the mining geophysicist has to overcome adversity and skepticism. Mining engineers are usually the users of your data, and often in a position to subsequently influence and/or decide the fate of your career or future contracts. Therefore, it's imperative that you learn how to work with them, not against them. But engineers are only one group with whom you will interact. At CONSOL, I regularly interact with a wide spectrum of professionals—coal miners, engineers (mining, civil, and electrical), geologists, managers, and corporate executives, which has enriched my knowledge base.

Before a mine is opened and put into production, engineering and environmental issues related to upstream and downstream operations will also have to be addressed. Thus, the mining geophysicist, either as a hired consultant or in-house expert, will have to be competent in all aspects of several geophysical techniques because the problems or challenges can be diverse, varied, and unique.

Locations of most major coal basins around the world are well known. Coal exploration programs are conducted primarily to detect geologic anomalies (i.e., faults, sand-channel washout, rolls, and thin coal) and old mine workings that could adversely affect future mining operations rather than to find more coal.

High-resolution surface seismic reflection surveys are conducted to provide continuous subsurface profiles between exploratory drill holes that are usually spaced hundreds or a few thousand feet apart. In addition, shallow VSP surveys are also conducted to complement and improve the interpretations of geophysical logs and seismic data.

When geologic anomalies become too small and difficult to be detected by surface seismic, sources and receivers may be taken underground to improve its detection and mapping. Due to the large acoustic impedance contrasts of coal with respect to shales and sandstones, the coal seam acts like a waveguide to seismic energy. Underground in-seam seismic reflection is used to measure distances to old mine workings to ensure sufficient barrier thicknesses for safety considerations. In-seam seismic transmission-mode (tomography) surveys are conducted across longwall panels (from tailgate to headgate entries) to detect potential in-panel geologic anomalies that could slow down face advance.

Reconnaissance surveying for other minerals requires employment of various electromagnetic (EM) techniques such as magnetotellurics, induced polarization, electrical resistivity, ground conductivity, etc. Some of these tools measure or induce natural electric and/or magnetic properties to find localized anomalies that may indicate the presence of certain mineral deposits.

Many mining operations involve engineering and environmental issues which may relate to the short-term and long-term effects of the mine on the land, groundwater, and the environment. Construction of support facilities and processing plants may also require some engineering geophysics studies. Thus, various geophysical techniques such as seismic refraction, electrical resistivity, ground conductivity, magnetometer, ground-probing radar, and borehole imaging methods may also be employed.

Mining geophysicists generally experience high degrees of pride and satisfaction in their work because they get to conduct projects from point alpha to omega. They are involved in the planning, field design, acquisition, data processing, modeling, and interpretation of seismic and other geophysical data. The opportunity to go underground (Figure 1) to verify one's interpretation with actual geology is especially satisfying.

To determine if mining geophysics is suitable for you, the following simple test questions are provided. Are you the Indiana Jones-type person who seeks adventure, challenge, and pursuit of the Holy Grail? Do you feel stifled in your current job because you perform only one aspect of geophysics such as seismic data processing or interpretation? Do you seek to expand your knowledge about other geophysical techniques? Do you prefer to compete in an all-around event like the decathlon rather than in individual events? If you answered yes to all the above questions, then you may have the right stuff to pursue a career in mining geophysics. LE

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