Application of True Reflective Tomography and 2-D and 3-D Seismic Tomographic Imaging to Location of Mine Works

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ABSTRACT

Geotechnical engineers have struggled for years with the difficult task of characterizing geologic and past mining conditions that affect the design, stability, and safety of both civil and mining constructions/operations. Commonly, underground developments (mines, tunnels, foundations, etc.) are based on surface or underground investigative drilling programs that may not characterize the true character or three-dimensional continuity of the material/strata present, and may also not detect the presence of prior excavations (old mine works) or localized structural discontinuities (faults, shear zones, etc.). Geophysical techniques such as seismic reflection, seismic refraction, and ground penetrating radar have been used with some success to expand the knowledge of subsurface conditions prior to excavation; however, these techniques often interfere with the construction process and are time-intensive in terms of data collection and interpretation.

To improve the quality, continuity, and timeliness of geotechnical data for site characterization, NSA Engineering, Inc., has developed an imaging system known as TRT™ ("True Reflective Tomography"). Whereas past structure mapping applications relied on seismic velocity and/or attenuation tomography within an enclosed seismic source and receiver array, recent developments in TRT™ have expanded the application of this technology considerably. For example, in-seam TRT™ seismic reflection may now be used to image structures and/or old workings from within an active mine (e.g. face areas of mains and panel developments) well ahead of planned developments – potentially eliminating the need to probe-drill on regular intervals.

Seismic tomographic imaging, based on the same principles as a medical CAT (Computer Aided Tomography) scan, has been used for many years in the oil industry for large-scale subsurface stratigraphic characterization, and has been applied to various structure- and stress-related problems in the coal industry.

This presentation demonstrates the application of 2-D and 3-D seismic tomographic imaging to (1) the location of old works in Appalachian room-and-pillar operations, and (2) the identification of anomalous zones ahead of mining/tunneling developments. These applications demonstrate the state-of-the-art in seismic ground imaging using reflective, velocity, and attenuation techniques (and combinations thereof), and further illustrate the flexibility of data acquisition from a variety of mining and tunneling settings. Recent examples are presented from projects in the United States, Europe, and Japan.