Subsurface Mine Void and Karst Imaging Using 3D Seismic Methods; Adapting Oil and Gas Seismic Advancements to Develop 3D Integrated Site Characterization Models[1]

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Abstract: Subsurface voids (both karst and mining related) pose significant risk to human health, the environment, infrastructure, and mining operations worldwide. Innovations in 3D seismic acquisition and processing have provided technological advancements in site characterization applications. Detailed void network imaging and mapping of void networks can be accomplished using shallow high-resolution dense sourcing and receivers acquisition specifications with customized processing workflows. Multi-component seismic acquisition with swept-frequency active sourcing provides full 3D azimuthal coverage to successfully delineate water- and air-filled subsurface voids from 3 to 3000-foot depths using 3D seismic acoustic velocity structure, signal attenuation, and resonance constraints. These data provide enough resolution of subsurface characteristics to: guide targeted drilling investigations, monitor real-time mining and drilling, map karst systems and aquifer flow paths, identify potential sinkhole locations, and manage risk during placement of critical infrastructure such as stacks, mining equipment, pipelines, flowlines, horizontal directional drill paths, tanks, bridge foundations, dams, and tailings. These data are applicable to accurately mapping unknown historic hard rock and soft rock mine workings and are most valuable when tied to empirical borehole data and provide continuous data for interpolation between borings. 2D seismic methods do not work for these applications, and 3D multicomponent sensors and processing continue to become more affordable, and much more effective for sufficient data resolution.

Additional Key Words: Geohazard, subsidence, modeling, engineering inputs, construction design.

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