Docket #: S08-357

Mapping Underground Geological Structures Using Lightning-Induced Electromagnetic Pulses in the VLF Frequency Range

A new method for underground mapping and imaging allows the use of the underground reflections of electromagnetic pulses caused by lightning (occurring up to thousands of miles away) to be used for geologic imaging. These electromagnetic pulses, known as 'sferics,' travel between the earth and the ionosphere for great distances and scatter off of underground features- a phenomenon that can be measured with the proper equipment in order to provide sub-surface data. Stanford researchers have developed a 3-antenna array that detects the original atmospheric pulse on two channels, and the underground, scattered pulse on a third channel. This information is then stored as a 3 channel, very low frequency waveform that can then be processed to obtain an image or representation of the underground features that caused the pulse to scatter. This method can be used to find mineral, gas, or oil deposits, as well as to image man-made underground features.

Applications

- Mapping, imaging, and discovery of underground structures and features
- Geological and geophysical exploration
- Oil and natural gas exploration
- Precious and non-precious mineral deposit discovery
- Locating man-made underground features, such as tunnels
- Mapping earthquake fault zones

Advantages

- Use of lightning produced electromagnetic pulses reduces equipment complexity (no transmitter required)
- Resolution and quality of images is increased compared to standard methods
- Image errors and distortion (artifacts) are reduced
- Less ambiguity in the data due to the increase in imaging quality
- Precisely determines pulse waveform shape, as well as the direction and elevation of arrival of the pulse to increase information quality

Publications

- US patent 8,633,699: Techniques for determining physical properties of underground structures using lightning
- David Strauss. Electromagnetic subsurface imaging at VLF using distributed optimization. Dissertation, Stanford University. 2013.

Patents

- Published Application: 20110095763

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