NEW APPLICATIONS OF SEISMIC IMAGING IN RESOURCES EXPLORATION BASED ON SEISMIC ATTRIBUTES ANALYSIS AND SEISMIC INTERFEROMETRY

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論 文 名：**NEW APPLICATIONS OF SEISMIC IMAGING IN RESOURCES EXPLORATION BASED ON SEISMIC ATTRIBUTES ANALYSIS AND SEISMIC INTERFEROMETRY**
（サイスミックアトリビュート解析と地震波干渉法に基づく資源探査における地震探査の新規適用先の開拓）

区　　分　：甲

論 文 内 容 の 要 旨

Geophysics has been essential in appraisal, reservoir characterization, drilling, well completion, and production since early stages of the exploration of resources. However, the effectiveness of using the geophysical technologies varies and is still facing many challenges such as data collection from the topographic areas and data analysis for imaging of complicated structures and deep sophisticated reservoirs. A wide frequency of signal, amplitude preservation, high precision and data integration are also challenges and key concerns in the seismic approach. Seismic exploration is the use of seismic energy to investigate the earth's subsurface not only for commercial oil, gas, or mineral reserves, but also for other engineering, archeological, and scientific research. The main objective of seismic exploration is to obtain high-precision seismic imaging, which ensures the accuracy of geological interpretations. With the development of seismic exploration, the targets of the seismic survey become more complex. Imaging on complex media like subsalt and small-scale, steeply-dipping structures, and heterogeneous structures brings a great challenge to the imaging techniques. In this study, I applied seismic-based approach for the complex geological imaging based on seismic attributes analysis and seismic interferometry approach. In the seismic attribute analysis, I used the seismic reflection data acquired from the active seismic surveys using the air gun and data recorded from the boreholes for structural mapping and imaging purposes. In the seismic interferometry approach, I utilized mainly the artificial blast mining signals to image the shallow subsurface structures of a minefield, beside using the other passive sources (i.e., natural earthquakes and ambient noise) to compare the results from different sources. This dissertation contains four chapters, and their descriptions are as follows.

Chapter 1 explains the research background, motivation, and objectives. In this chapter, I introduce some previous studies on the seismic attributes and the seismic interferometry methods used to

image the subsurface structures associated with the resources.

In Chapter 2, the Ras El Ush field (Gulf of Suez, Egypt) characterized by complex geologic setting, which results in difficulties in terms of high-resolution seismic interpretation, was investigated. This study interpreted post-stacked reflection seismic and well data comprising the check shot velocity data to obtain and investigate detailed information about the structural fault orientation and dip of the Ras El Ush field. Seismic attributes were employed to improve the fault attributes by eliminating noise and residue of non-faulting events. Detailed enhanced structural modeling was achieved by integrating explicit faults, horizons, and selected zones into a three-dimensional grid. The models helped define geological discontinuities and structural traps, which would help develop the field and nearby similar hydrocarbon fields in the Gulf of Suez (Egypt).

In Chapter 3, the seismic data from natural earthquakes, ambient noise and mine blasts were analyzed to map P-wave reflection profiles at the Hishikari mine area by autocorrelation analysis. Because fissure-filled gold veins are dominant in this area, the potential of autocorrelation analysis for investigating the shallow subsurface was evaluated, including the ore deposits. Seismic interferometry is commonly performed based on the autocorrelation of ambient noise or natural earthquake signals; here, blasting in the mine was used instead since blast events include high-frequency signals that boost the spatial resolution of the imaging. Auto-correlograms were successfully obtained showing high-resolution seismic reflectors at shallow formation depths (< 500 m depth). A comparison with profiles obtained from ambient noise and earthquake data showed that blasting signals yielded highly spatially consistent reflections that would not be achievable with natural or ambient seismic sources. This study highlights the potential of using blast autocorrelation seismic analysis which can be done for short survey periods. By using a single blast shot and dense distribution of seismic stations, higher resolution 3D reflection images of lithological interfaces were successfully achieved, possibly including heterogeneities associated with ore veins.

Chapter 4 summarizes the results, key findings, and conclusion of this thesis, and a possible future vision is described. The results derived from the proposed methods demonstrate that further processing techniques and seismic attributes for the pre-stacked and post stacked data can resolve the distortion and the masking of seismic energy especially by the evaporite layers and complex structures. Also, using the blast as a source of seismic waves for the minefields in a short time survey could be a low-cost option to provide high-resolution information and images of the shallow subsurface structures of minefields.