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情報地球学から拓く AI for Science／Engineering

海域火山デジタルツインの構築に向けて
― データ駆動型解析と物理モデリングの融合 ―

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Toward a Digital Twin of Marine Volcanoes: Integrating Data-Driven Analysis and Physical Modeling

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和文要旨

近年，地球科学では，多様な観測データと物理モデル，AI・機械学習を融合し，複雑な地球内部・表層現象の理解と予測につなげる研究が進展している．我々はこれまで，地球物理観測データに基づく地下深部の物質・流体分布の推定，地球化学データを用いたテフラ対比や地層対比，海流データと粒子シミュレーションに基づく漂流軽石の予測など，データ駆動型解析と逆問題を軸とした研究に取り組んできた．本講演では，これらの研究事例とその方法論を紹介するとともに，観測，物理モデル，データ同化，AI を統合し，地下深部のマグマ・流体移動から噴火，噴出物の海洋漂流までを一体的に理解・予測する「海域火山デジタルツイン」の構想と今後の展望について議論する．

English Abstract

Recent advances in Earth sciences have increasingly focused on integrating diverse observational data, physical models, and artificial intelligence (AI) and machine learning to better understand and predict complex processes occurring within and on the surface of the Earth. We have been developing data-driven and inverse modeling approaches for various geoscientific problems, including the estimation of subsurface material properties and fluid distributions from geophysical observations, tephra identification and stratigraphic correlation using geochemical data, and the prediction of pumice drift based on ocean current data and numerical simulations. In this presentation, we will introduce these research examples and their underlying methodologies. We will also discuss our vision and future perspectives for developing a "Digital Twin of Marine Volcanoes" that integrates observations, physical models, data assimilation, and AI to achieve a comprehensive understanding and prediction of interconnected volcanic processes, ranging from deep subsurface magma and fluid migration to volcanic eruptions and the subsequent oceanic transport of erupted materials.