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1. SCIROCCO Project

The geophysical research cruise SO301 (22 Nov. 2023 - 4 Jan. 2024) aimed to image the first segment of the Central Indian Ridge at depth in order to investigate the structure and evolution of the prominent 25° S Oceanic Core Complex (OCC) and the Kairei Hydrothermal Field. This poster is focused on the Kairei Hydrothermal Vent Field.

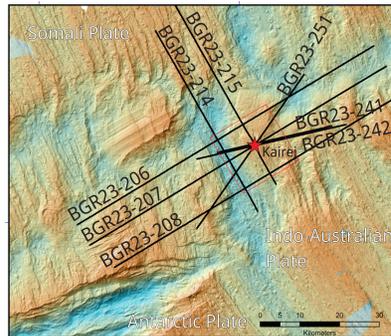


Fig.2: Bathymetry derived from cruise SO301 with selected seismic profiles. The red box marks the 3D tomography model.

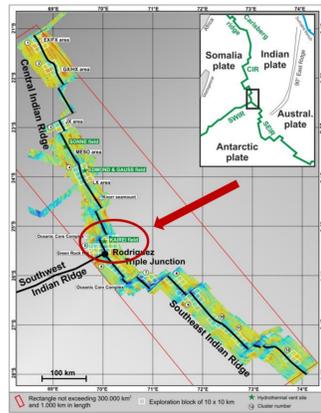


Fig.1: Research area in the vicinity of the BGR contract area for massive sulphides.

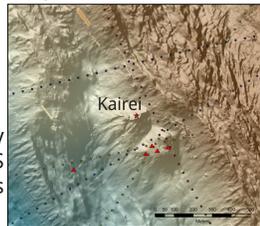


Fig.3: High-resolution bathymetry data of the Kairei area with OBS station (triangles) and shotpoints (dots).

2. Data and Methods

- Towed streamer of 7800 m active length
- Seismic G-sources array (volume of 50 l) triggered every 50 m
- 5 OBS (4 were deployed video-controlled on an inactive Kairei sulphide mound, 2 instruments per dive)
- High-resolution bathymetry data of the Kairei area (INDEX project)
- OBS processing: relocation, bandpass, drift correction
- MCS processing: bandpass, FxSwell, linear Radon, FK Filter, PSDM, mute, stacking, prestack depth migration



Fig.4: RV Sonne hosting three streamer winches and two airgun arrays (upper Fig.). Video-controlled deployment gear to carry OBS (bottom Fig.).

3. 3D Seismic Tomography and Multichannel Seismic Data

- 3D Tomography generated with FAST based on OBS data (Zelt & Barton, 1998; 14 x 14 x 5 km, cell size 50 m, RMS 18.06 ms, χ^2 1.008)
- Increased seismic velocities can be traced toward the ridge valley (serpentinization by water circulation)
- Low velocities near the surface can indicate increased porosity caused by the hydrothermal vent field (disseminated sulphides)

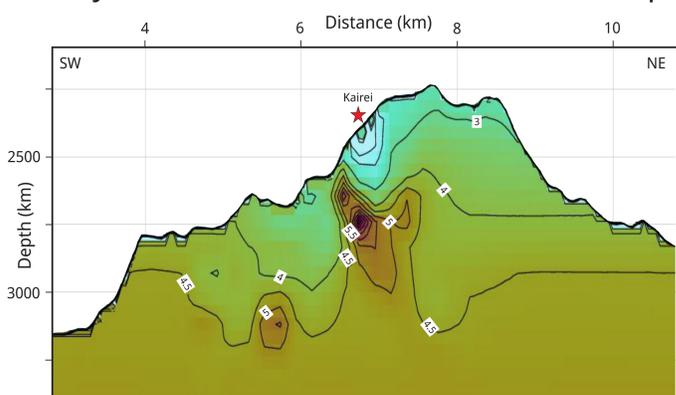


Fig.5: Crosssection of the resulting tomography along the profile BGR23-207 crossing Kairei Hydrothermal Vent Field. The red star marks the location of the Kairei Hydrothermal Vent Field.

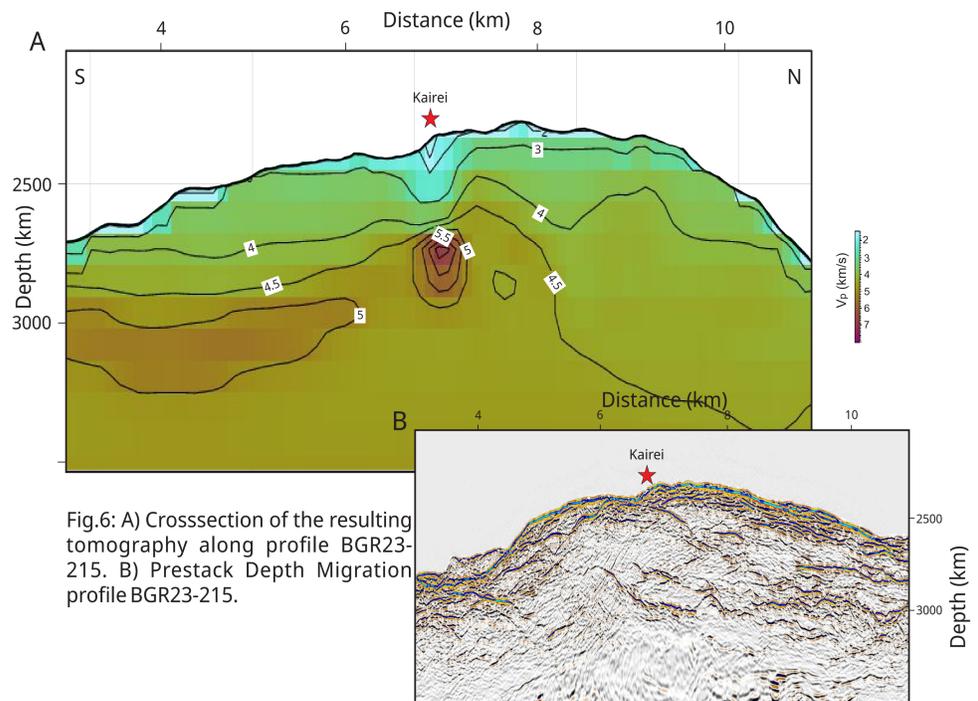


Fig.6: A) Crosssection of the resulting tomography along profile BGR23-215. B) Prestack Depth Migration profile BGR23-215.

4. Tomography after Wavefield Downward Continuation

- The 8 km long streamer allows to analyse refracted phases
- Downward continuation after Jimenez-Tejero et al. (2022)
- To build a 2D p-wave tomography based on streamer and OBS data, we used Tomo2D (Korenaga et al. 2000)
- Combination of OBS and streamer data provides high ray coverage and deep refractions

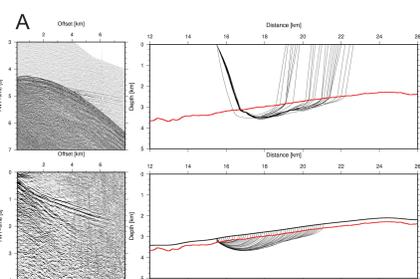
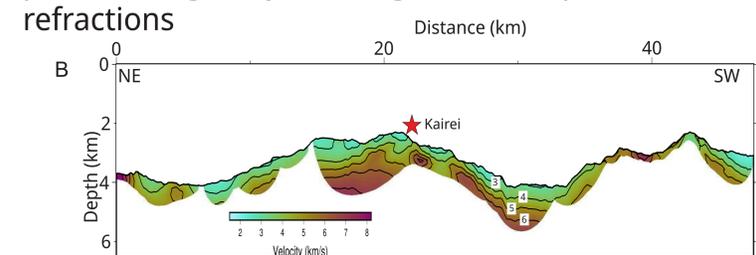


Fig.6: A) Shot gather and corresponding raypaths according to the tomography model for the original streamer data (top row) and after source and receiver wavefield downward continuation close to the seafloor. B) Resulting tomography model of Profile BGR23-251. The red star marks the location of the Kairei field.



5. Conceptual FD-Models

Finite-Difference (FD) Modeling of conceptual model shall distinguish side reflections. The models were generated within a FD-modelling code from Li et al. (2021).

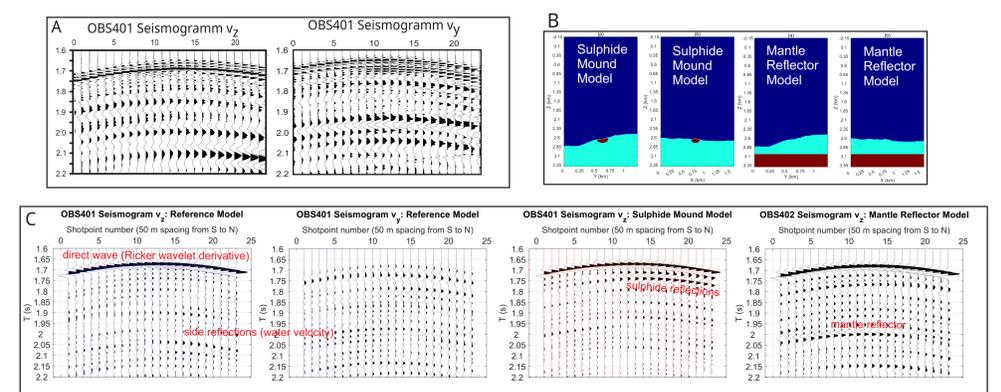


Fig.7: A) Data example of profile BGR23-215. B) Sulphide mound and mantle reflector model. C) Seismogram of the reference model with side reflections emphasized in the y-component of the velocity field; Sulphide mound model with signals shortly after the direct wave; Mantle reflector model with an inverted signal (opposite direction) at 2 s travel time.

6. Results

- Tomography models indicate uplifted deep rocks which might be the ultramafic setting required for the hydrothermal circulation (H_2 -rich fluids)
- Low velocities near the surface indicate high porosity and more disseminated sulphides
- Only combination and integration of multiple geophysical datasets enable the resolution to investigate smaller areas in the complex geological area

References:

Jimenez-Tejero et al. (2011): Downward continuation of marine seismic reflection data: an undervalued tool to improve velocity models, GJI, Vol. 230(2); Korenaga, J., et al. (2000): Crustal structure of the southeast Greenland margin from joint refraction and reflection seismic tomography, J. Geophys. Res.-Sol. Ea., Li et al. (2021): FDwave3D: a MATLAB solver for the 3D anisotropic wave equation using the finite-difference method, Computational Geosciences 25.; Zelt & Barton (1998): Three-dimensional seismic refraction tomography: a comparison of two methods applied to data from the Faeroe Basin, JGR.