1. Introduction

Rodrigues Island is located at the eastern end of the Rodrigues Ridge, approximately 650 km east of Mauritius in the South-West Indian Ocean. Rodrigues Ridge connects the Reunion hotspot track with the Central Indian Ridge (CIR) and has been suggested to represent the surface expression of a sub-lithospheric flow channel. From global earthquake catalogues, the seismicity around Rodrigues Island has been generally associated with events related to the fracture zones at and off the CIR.

Here, we report on the seismicity recorded at a temporary array of ten seismic stations operating on Rodrigues Island from Sept. 2014 until June 2016 with a focus on the possible seismic activity along Rodrigues Ridge.

2. Beamforming

The slowness and the backazimuth of an event are determined from beamforming: Assuming a plane wavefront of horizontal slowness $s_x$ moving across the array with an apparent velocity $v_x$, the waveform at station $j$ is given by

$$w_j(t) = v_x(t - r_j/s_x),$$

where $r_j$ defines the position of the station.

For an array consisting of $M$ stations, the beam energy is calculated from the trace amplitudes within a suitable time window defined by $t_1$ and $t_2$.

$$E = \int_{t_1}^{t_2} \int_{j=1}^{M} w_j(t)^2 \, dt_2 \, dt_1,$$

where $s$ denotes the (trial) slowness for the current beam. The beam energy reaches a maximum, if $s = s_x$. The backazimuth is then obtained from $\tan^{-1}(\phi / \lambda)$. For regional earthquakes, the slowness cannot be used to determine the epicentral distance of an event. We therefore use the arrival time difference between the S and P waves (see Figure 4).

3. Array analysis

Figure 2. Based on our initial estimates on earthquake distance and frequency content, the aperture of the array was set to about 5 km (a). The 10 stations were arranged such as to minimize the influence of side lobes of the array response function (b).

Conventional array analyses are performed in the frequency domain, which is computationally advantageous as the amplitude stacking can be limited to the dominant frequency or a narrow frequency band. This approach usually requires selection of a common time window for all traces. However, in cases of significantly different arrival times of the phase to be analyzed, a large common time window has to be chosen such that the cut waveforms of individual traces may be significantly different. In the time domain, we can time-shift the traces before stacking, which is then performed within a much narrower time window. This approach ensures that only the relevant waveform is contained within the stack, provided that the correct time shift has been applied. The time-domain analysis corresponds to a broad-band frequency stack, without the described disadvantages.

4. Results

Figure 5. Locations of new events (red) detected and located using the array analysis and earthquakes from the USGS catalogue (yellow) during the same time period (from 09/2014 to 06/2016), CCFZ: Marie-Celeste fracture zone and EFZ: Egeria fracture zone.

5. Conclusions

- We detected and located 62 new events, which were not reported by the global networks. Most of the events are located off the CIR and can be classified as intraplate events. Local magnitudes of the events varied between 1.6 and 3.7.
- Most of the events were localized in the north-east of Rodrigues at distance of about 140 km from the reference station of the array. The Rodrigues Ridge appeared aseismic during the period of operation.
- Three seismic clusters were observed around the island. A distinguishable swarm of earthquakes was observed to the west of the spreading segment of the CIR during the period from March to April 2015.