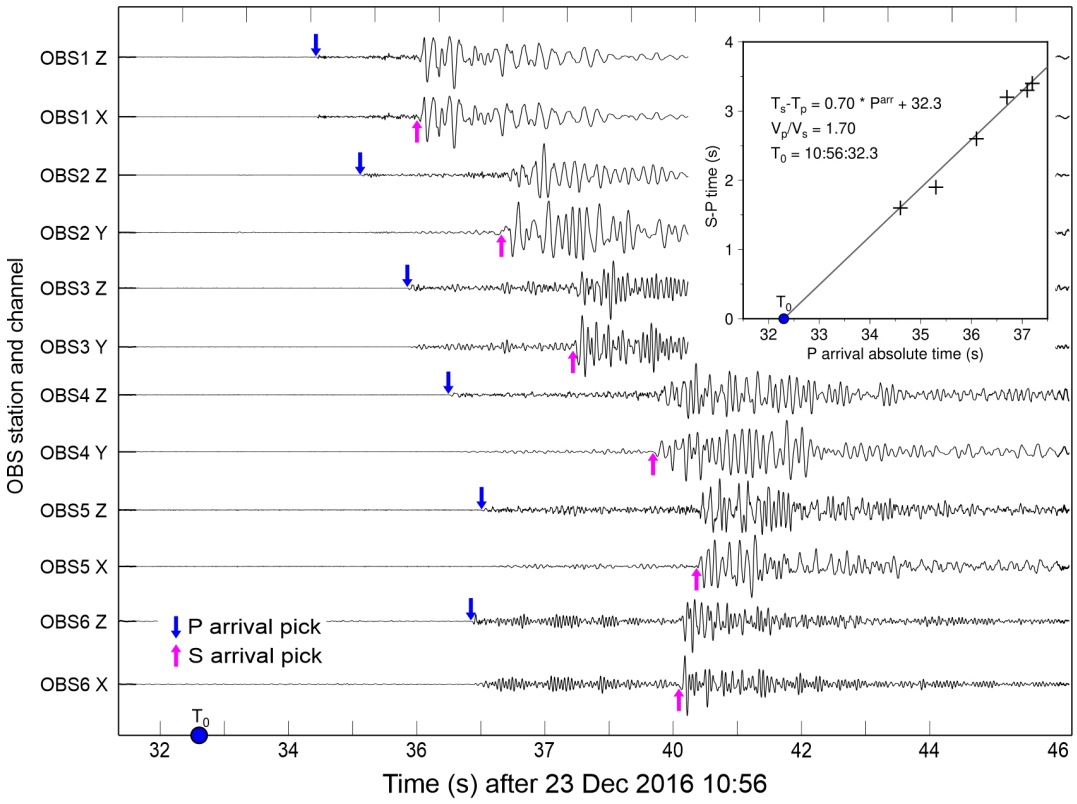
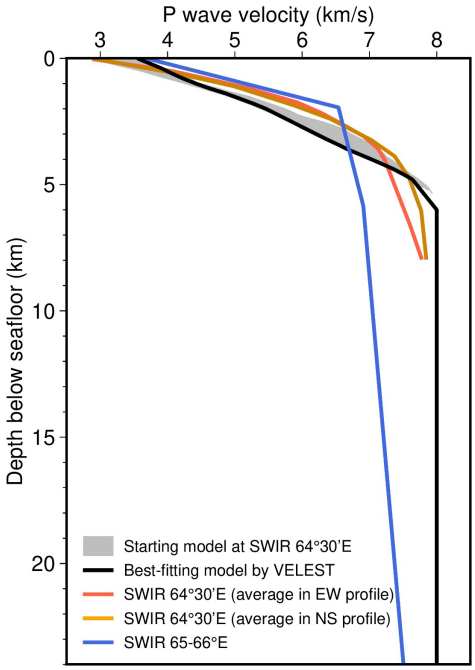


414

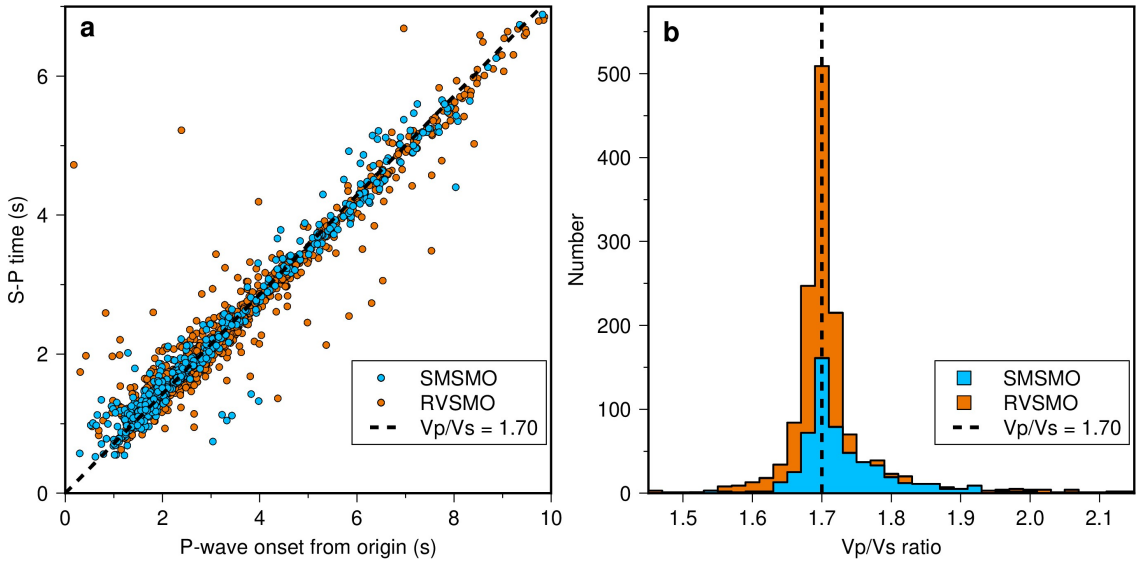
415 **Supplementary Fig. 1 | Typical event waveforms.** The event occurred at
416 64.394°E/27.883°S 11.7 km below seafloor with a local magnitude of 2.3, at 10:56, 23 Dec
417 2016 in RVSMO catalog. The inset shows the P-wave arrival absolute time versus arrival
418 time differences of P- and S-waves (S-P time), yielding the origin time (T0) of 10:56:32.3
419 and a Vp/Vs ratio of 1.7.

420



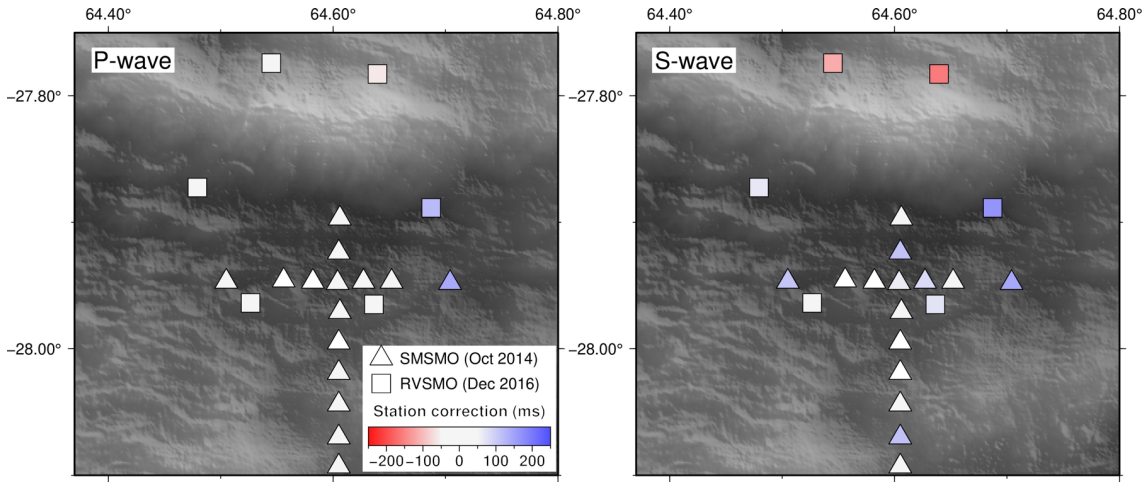
421

422 **Supplementary Fig. 2 | 1-D P wave velocity model.** Starting model (gray area) at the SWIR
423 64°30'E is extracted from a seismic refraction experiment[23]. The best-fitting model (black
424 line) is iteratively searched by the VELEST program[38]. Red and orange lines are average
425 velocity models in EW and NS profiles at the SWIR 64°30'E[39]. Blue line is the velocity
426 model at the SWIR 65-66°E[32].

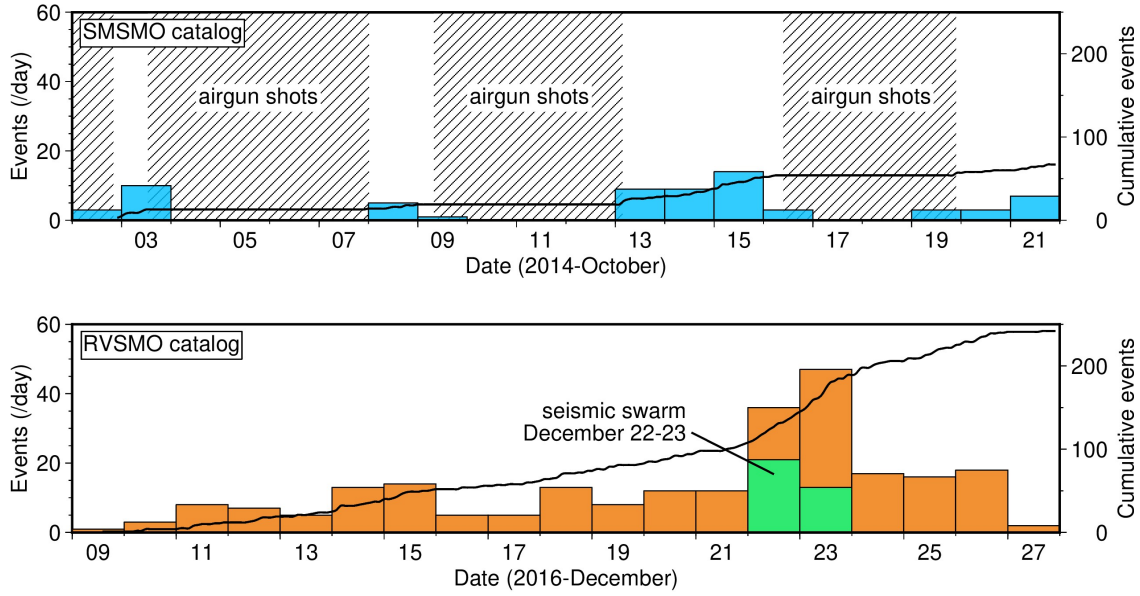


427

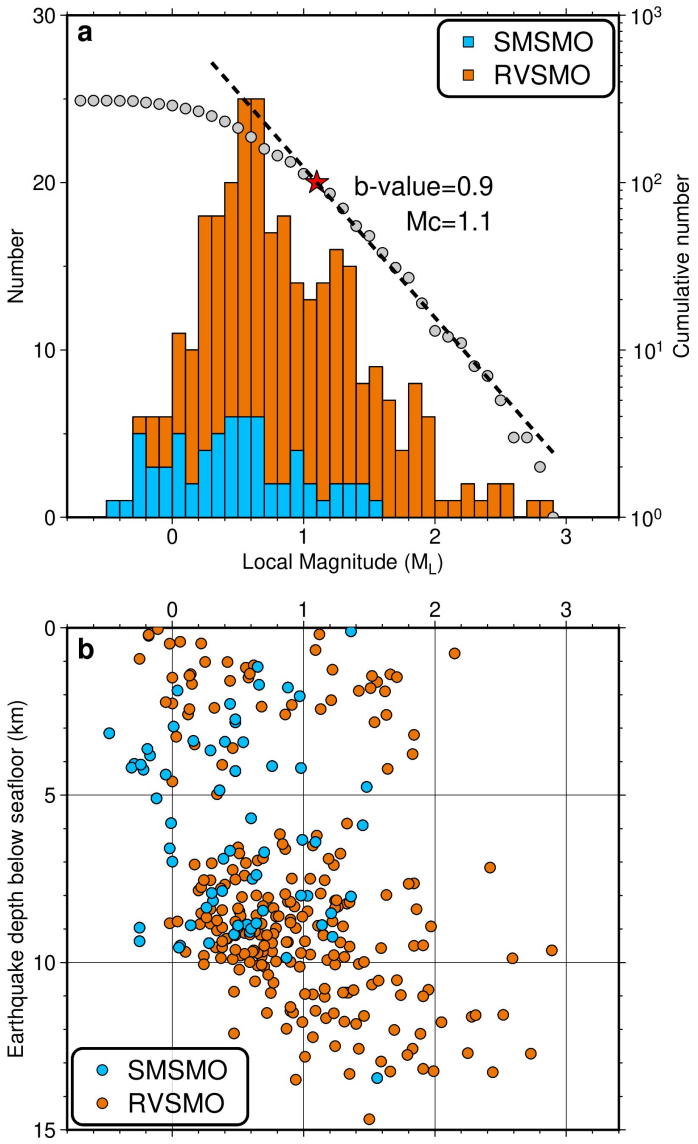
428 **Supplementary Fig. 3 | Wadati diagram**. (**a**) P-wave onset from origin versus S-P time
429 (Wadati diagram) for both SMSMO (orange) and RVSMO (blue) catalogs. (**b**) Histogram of
430 Vp/Vs ratio Vp/Vs ratio is calculated from the slopes of the Wadati diagram. The best-fitting
431 Vp/Vs ratio is 1.7.



Supplementary Fig. 4 | Station corrections of P- and S-wave returned by NonLinLoc.

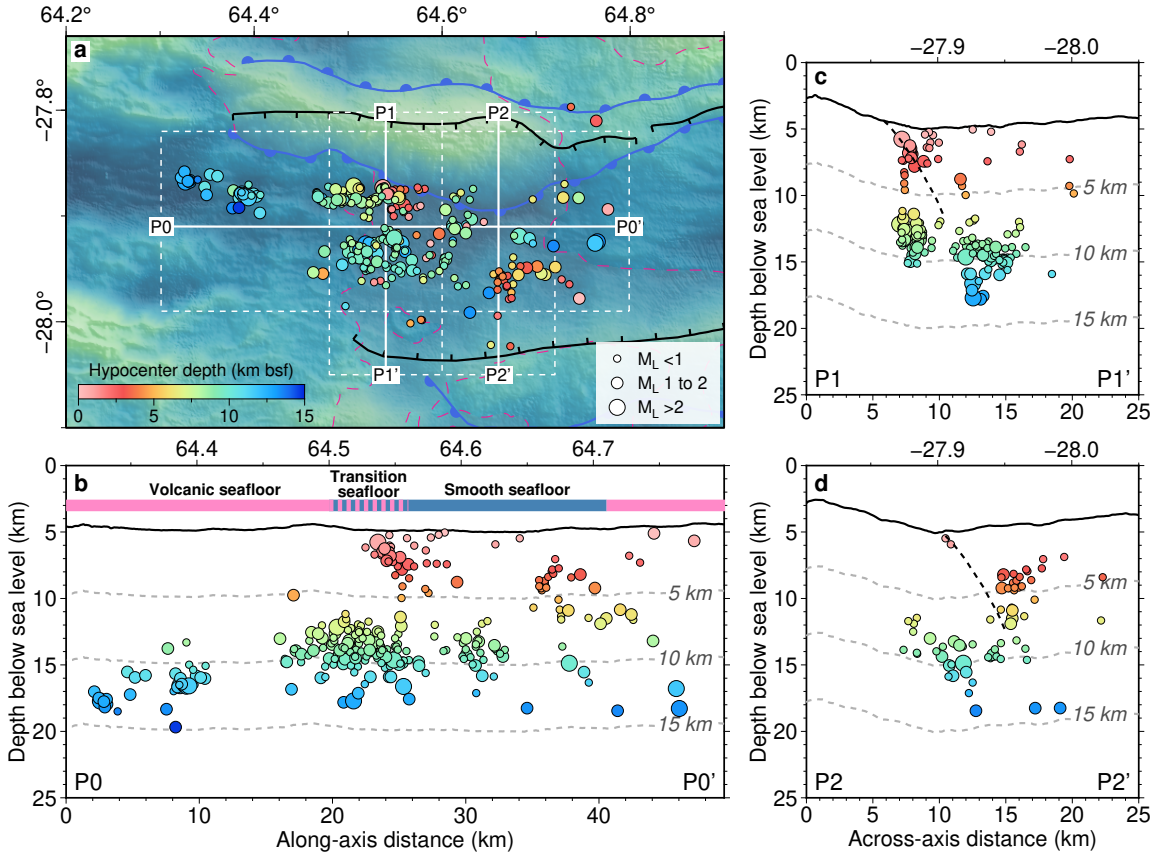


Supplementary Fig. 5 | Histogram and cumulative histogram of located earthquakes for the SMSMO and RVSMO catalogs.



438

439 **Supplementary Fig. 6 | Distribution of local magnitude (M_L).** (**a**) Histograms of local
440 magnitude for the SMSMO (blue) and RVSMO (orange) catalogs (left Y-axis). The
441 cumulative number of earthquakes for both catalogs (gray circles) as a function of local
442 magnitude (right Y-axis). Magnitude completeness (Mc) is determined as 1.1 (red star) using
443 the b-value stability approach[47], resulting in a b-value of 0.9 (slope of the dashed line). (**b**)
444 Local magnitude as a function of earthquake depth for the SMSMO (blue) and RVSMO
445 (orange) catalogs.

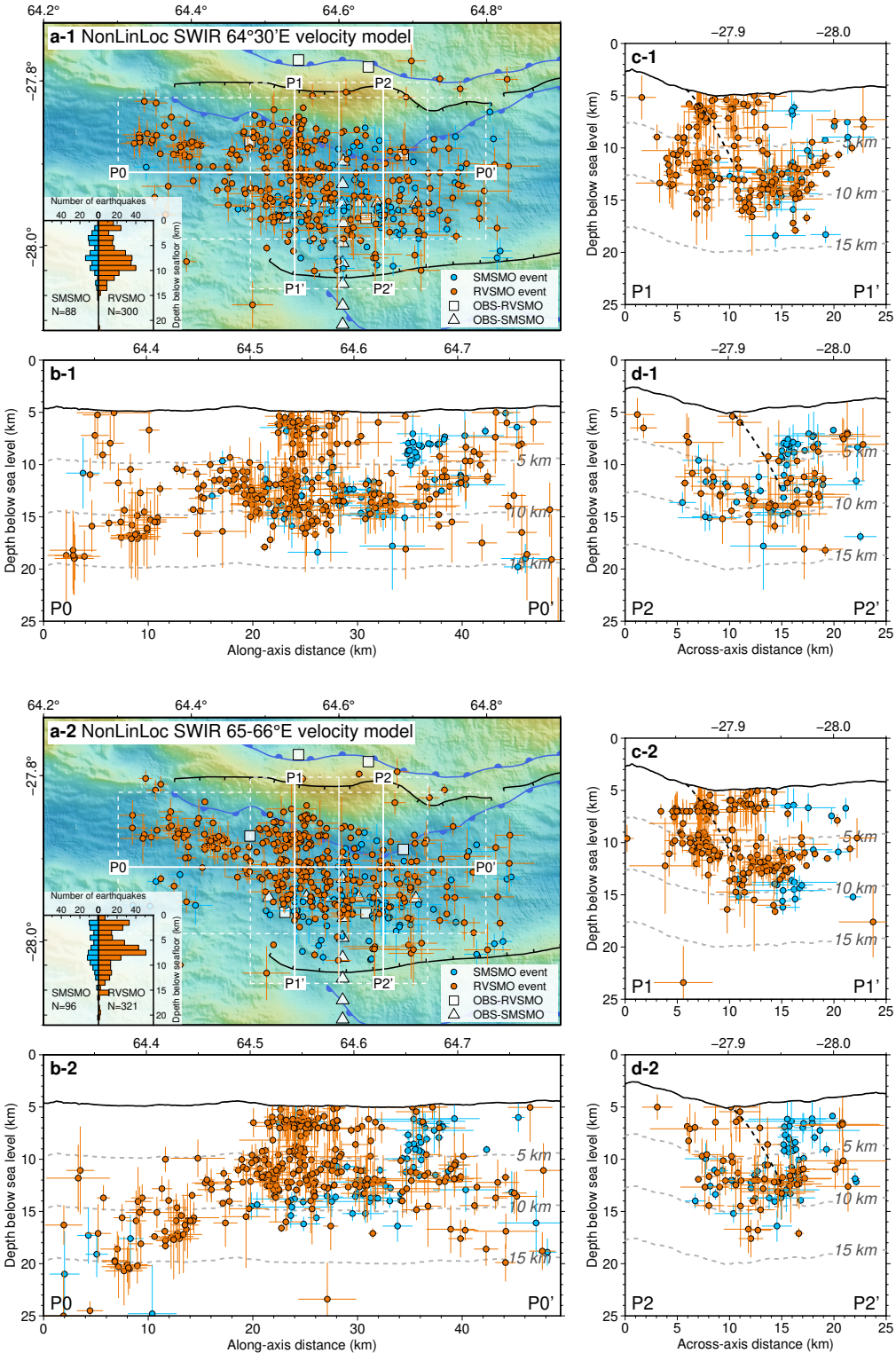


446

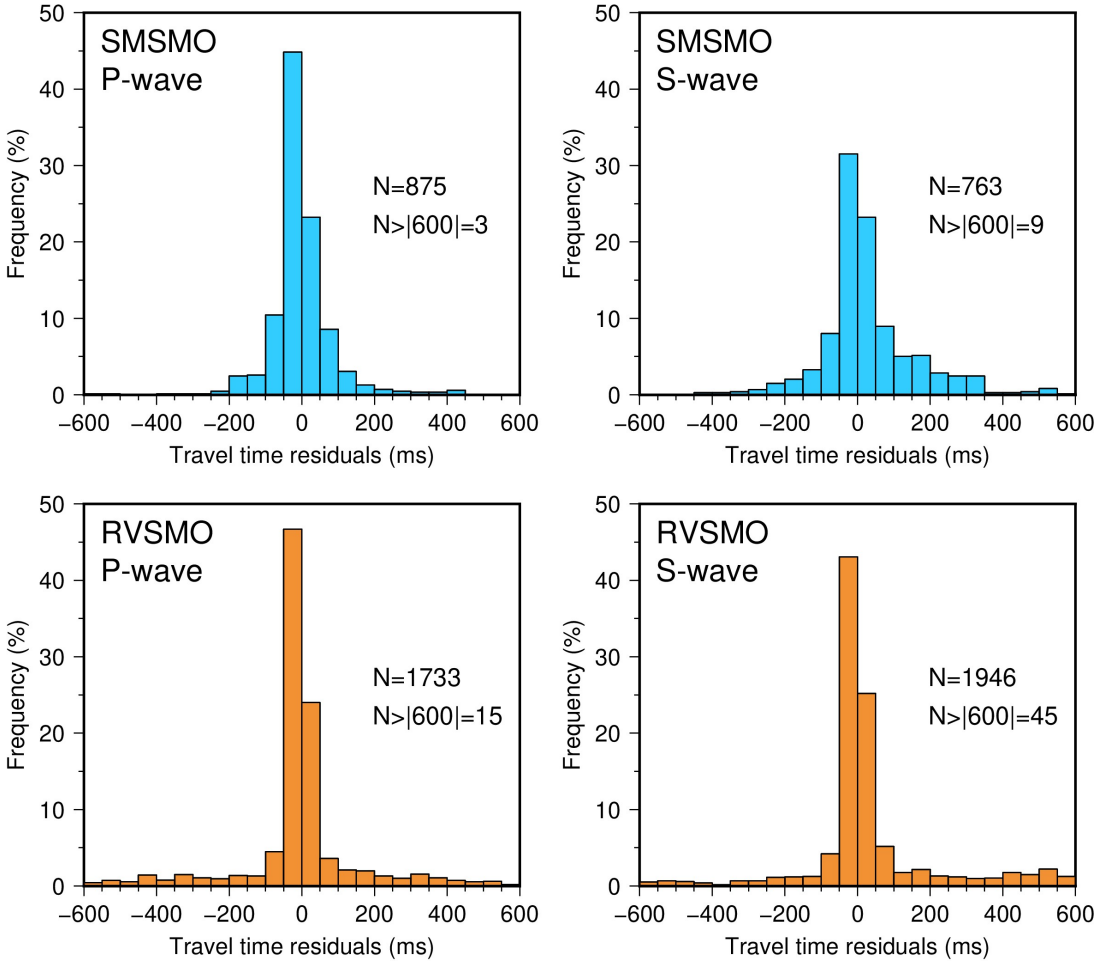
447 **Supplementary Fig. 7 | Earthquake relocations, color coded based on hypocenter depths**

448 **and circle size based on local magnitude (M_L).**

449

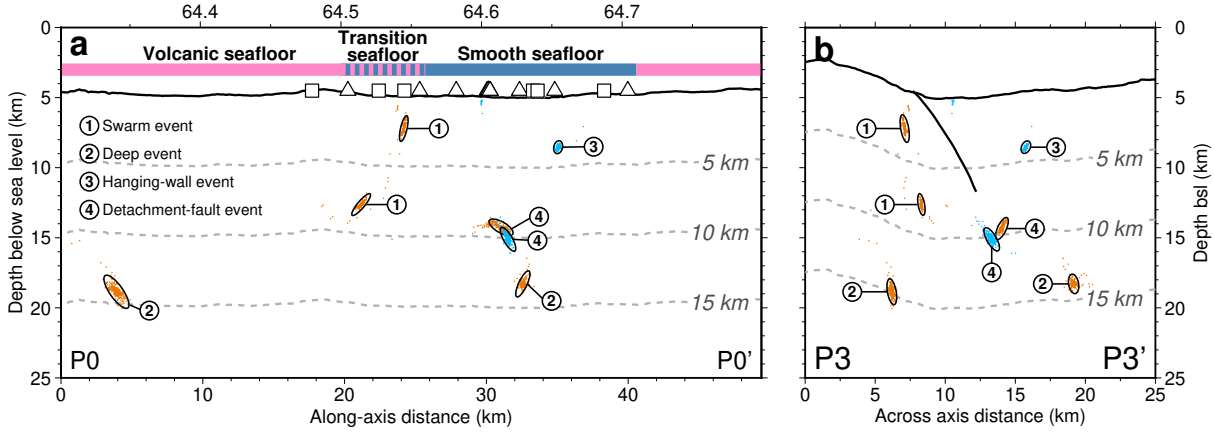


Supplementary Fig. 8 | Earthquake locations. See legend for symbols. Earthquake locations using the NonLinLoc with the SWIR 64°30'E velocity model (**a-1** to **d-1**). Earthquake locations using the NonLinLoc with the SWIR 65-66°E velocity model (**a-2** to **d-2**), compared with the NonLinLoc results with the SWIR 64°30'E velocity model (pale gray). Velocity models see Supplementary Fig. 2. Error bars represent absolute location errors.



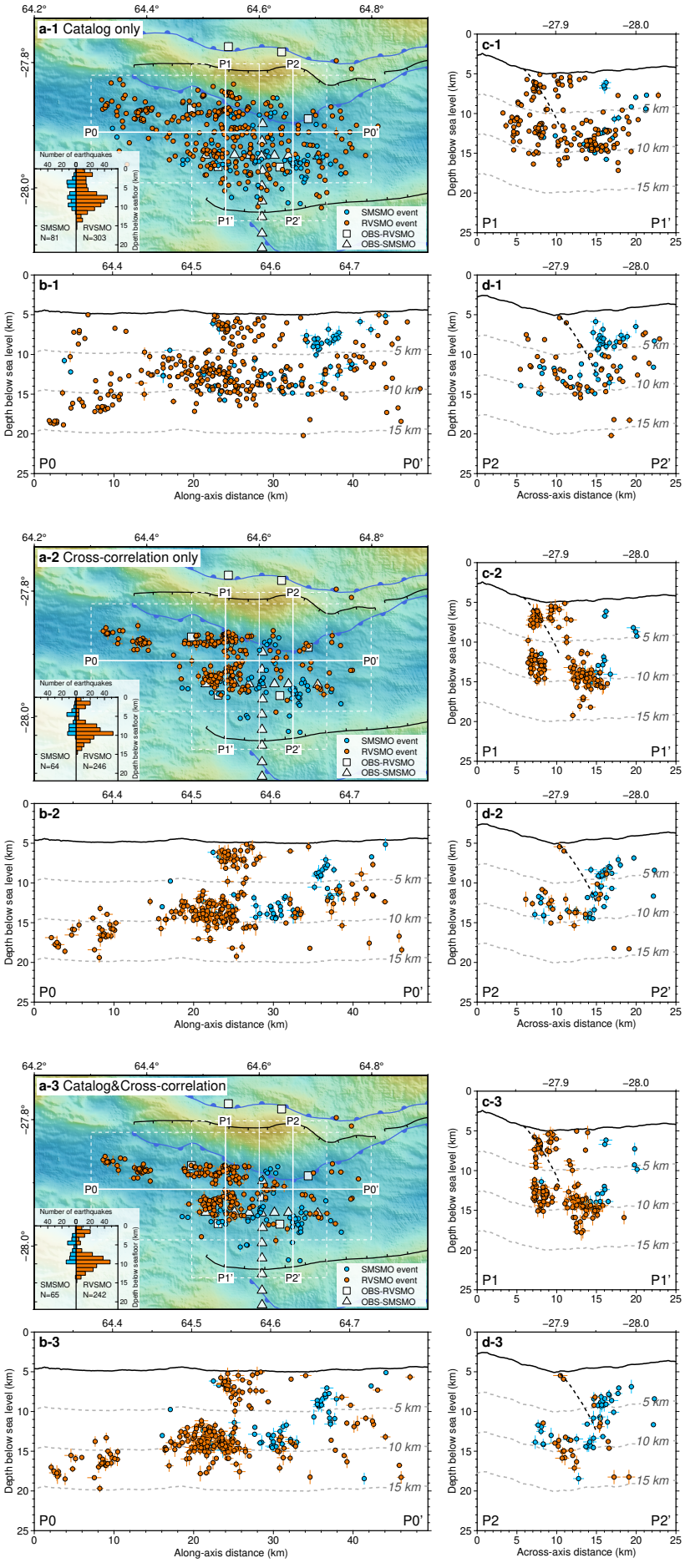
456

457 **Supplementary Fig. 9 | Frequency distribution of P- and S-wave travel time residuals**
458 **for the SMSMO (blue) and RVSMO (orange) catalogs.**

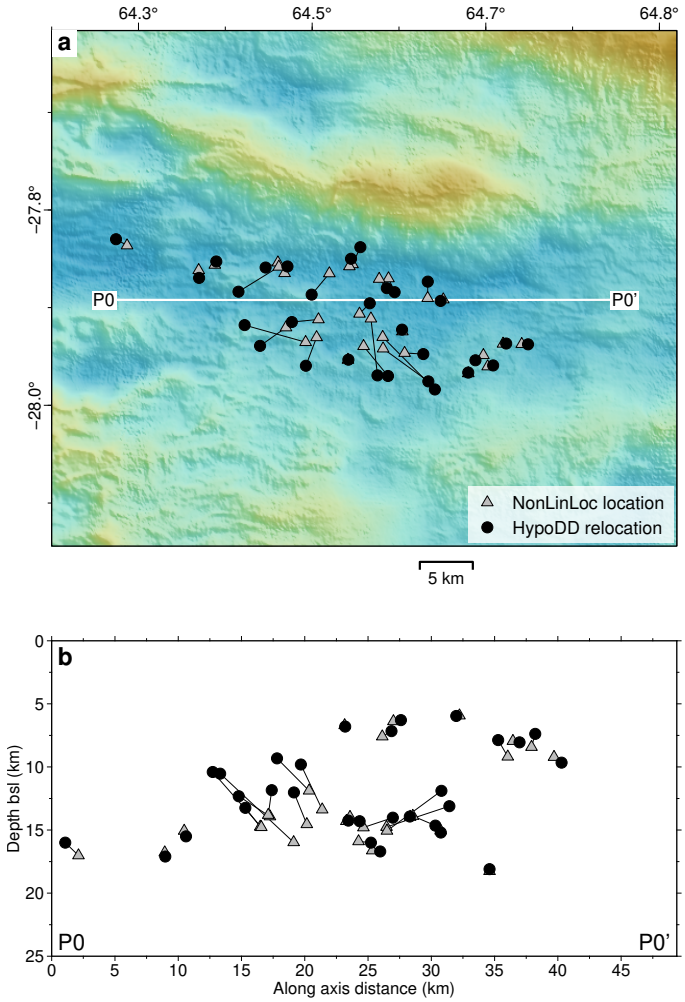


459

460 **Supplementary Fig. 10 | Bootstrap analysis of location errors for four chosen groups of**
461 **NonLinLoc located events.** Blue and orange dots represent events in the SMSMO and
462 RVSMO catalogs, respectively. Perturbations were randomly applied 300 times to P and S
463 arrivals, which were constrained by travel time residuals shown in Supplementary Fig. 9.


a-1 Catalog only
a-2 Cross-correlation only
a-3 Catalog&Cross-correlation
b-1
b-2
b-3
c-1
c-2
c-3
d-1
d-2
d-3
P0
P0'
P1
P1'
P2
P2'
SMSMO event
RVSMO event
OBS-RVSMO
OBS-SMSMO
Number of earthquakes
Depth below seafloor (km)
SMSMO N=81
RVSMO N=303
SMSMO N=64
RVSMO N=246
SMSMO N=65
RVSMO N=242
5 km
10 km
15 km
Depth below sea level (km)
Along-axis distance (km)
Across-axis distance (km)

Supplementary Fig. 11 | Earthquake relocations. See legend for symbols. Tests of earthquake relocation using the HypoDD with catalog only (**a-1** to **d-1**), cross-correlation only (**a-2** to **d-2**), and catalog&cross-correlation (**a-3** to **d-3**; same results as Fig. 2). Error bars represent relative location errors.



Supplementary Fig. 12 | Differences of NonLinLoc locations and HypoDD relocations for 30 randomly selected events. Each event is connected by a black line between the results of the NonLinLoc location and the HypoDD relocation (catalog&cross-correlation). (**a**) Map view. (**b**) events projected on the along-axis P0-P0' profile.