Supporting Information for “Statistical Analysis of the Preparatory Phase of the $M_w$ 8.1 Iquique earthquake, Chile”
F. Aden-Antoniów$^{1,2}$, C. Satriano$^2$, P. Bernard$^2$, N. Poiata$^{2,3}$, E-M. Aissaoui$^2$, J-P. Vilotte$^2$, W.B. Frank$^{1,4}$

1 Department of Earth Sciences, University of Southern California, Los Angeles, CA, USA
2 Équipe de Sismologie, Institut de Physique du Globe de Paris, CNRS, UMR 7154, 75238 Paris, France
3 National Institute for Earth Physics, 12 Calugareni, Magurele, 077125 Ilfov, Romania
4 Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA, USA

Contents of this file

1. Figures S1 to S14
Figure S1. Automated detection and location with BackTrackBB. (a) 3D representation of the Source Location Function (SLF) (equation 3.10) in the three perpendicular planes passing through the maximum. The 68% confidence ellipsoid is yellow and the stations used are represented by the black triangles. The values len1, len2 and len3 correspond to the values of the semi-axes of the ellipsoid. The maximum value of the SLF, at the location of the hypocenter, is indicated in red. (b) Same as (a) but the SLF is brought to the power of 18. (c) The filtered traces (highpass at 5Hz) and the corresponding characteristic functions are gray and blue, respectively. The blue vertical lines mark the arrival time of P-waves given by BackTrackBB, while the dashed blue line represents the theoretical arrival time of P-waves given the location of the maximum and the velocity model.
Figure S2. Attempt to detect and locate in a window of random ambient noise.

Same as Figure S1
Figure S3. Application of the Rosenberger polarization filter. (a) Raw signals (gray) and filtered signals for P waves (blue) and S waves (red) for station PB11 on the three components. (b) Polarization filter $U_n[0, 0]$ from the Singular Value Decomposition.
Figure S4. Detection and location of an event by combining the P waves and the S waves. (a) and (b) are the 3D representation of the Source Location Function (SLF) resulting respectively from the correlation of the P waves and S-P in the three perpendicular planes passing through the maximum. The 68% confidence ellipsoid is yellow and the stations used are represented by the black triangles. The maximum value of the SLF, at the hypocenter, is written in red. (c) 3D representation of the multiplication of the grids in (a) and (b). (d) The filtered traces (highpass at 5Hz), the CFs characteristic functions corresponding to the P and S waves are respectively gray, blue and red. The solid vertical lines represent the point obtained for the associated wave type while the theoretical point is represented by the dotted lines.
Figure S5. Final location of an event detected by BackTrackBB with NonLinLoc. 
(a) 3D representation of the Source Location Function (SLF) resulting from the combination of SLF obtained from P waves and of the correlation of the waves P and S in the three perpendicular planes passing by the maximum. The 68% confidence ellipsoid is yellow and the stations used are represented by the black triangles. (b) 3D representation of the probability density function (red dots) obtained with NonLinLoc using the picks from BackTrackBB for the same event. The yellow dot corresponds to the maximum likelihood. The location is similar but the dimensions of the error ellipsoid are significantly different.
Figure S6. Example of rejected detection. Same as Figure S5.
Figure S7. 3D-68% error ellipsoid for magnitude 3.0+ earthquakes, projected on the XY-plane. This map represents the error ellipsoid for Ml 3.0+. Black ellipsoids mark the event kept in the final catalog while the white ellipsoids are discarded. Profiles A and B are shown in Figure S8.
Figure S8. 3D-68% error ellipsoid for magnitude 3.0+ earthquakes along -20N and -21.2N profiles.

Figure S9. Declustered catalogs with the nearest-neighbor-approach. (a, b) comparison between the clustered (black curves) and the background seismicity (color coded curves) for the interface and the intermediate-depths, respectively. The two dashed lines represent the linear fit of the background seismicity during the time period: February 1st - July 23rd 2013. The vertical light blue lines mark the beginning of the three precursory clusters. The gray areas correspond to the period of the missing stations.
Figure S10. Kolmogorov-Smirnov one-sample test for the reference period. (a, b) probability density functions of the theoretical distributions (orange) and the reference periods distributions (green and red) for the interface and intermediate-depths background seismicity. The black dashed lines correspond to the 95% probability limit of $P_{\text{ref}}$. (c, d) corresponding cumulative density functions. The dotted-black line is the difference between $P_{\text{ref}}$ and $F_{\text{obs}}$. The light-grey, dark-grey and black contour lines represents the level of significance respectively at 68%, 95% and 99.9%. Both null hypothesis cannot be rejected.
Figure S11. Kolmogorov-Smirnov one-sample test for different reference periods with $T = 0.5$ days. (a, b) evolution of the event excess or deficit $D_n$ by changing $T_{ref}$ respectively for the interface (green) and intermediate-depths (red) background catalogs. The lighter colors represent the 95% confidence intervals estimated by bootstrapping (2000 resampling). The light-grey, dark-grey and black contour lines represent the level of significance respectively at 68%, 95% and 99.9% while the grey area represents the region of no significance. The vertical blue line marks the first cluster of July 23$^{rd}$ 2013.
Figure S12. Kolmogorov-Smirnov one-sample test for different reference periods with $T = 2$days. Same as Figure S11

Figure S13. Kolmogorov-Smirnov one-sample test for different reference periods with $T = 5$days. Same as Figure S11
Figure S14. Bootstrap distribution for two points of the interface. (a, b) Bootstrap resampling distribution (2000 populations) in green for a point in the area of significant event excess on the interface while. (c, d) Bootstrap resampling distribution for a point in the quiescence area. (a) and (c) correspond to a $T_{ref}$ of May 20th 2013 and (b) and (d) correspond to a $T_{ref}$ of July 23rd 2013. The red vertical line is the measured event excess $D_n$ defined in the main text. The light green area corresponds to the 95% confidence interval of the bootstrap resampling.