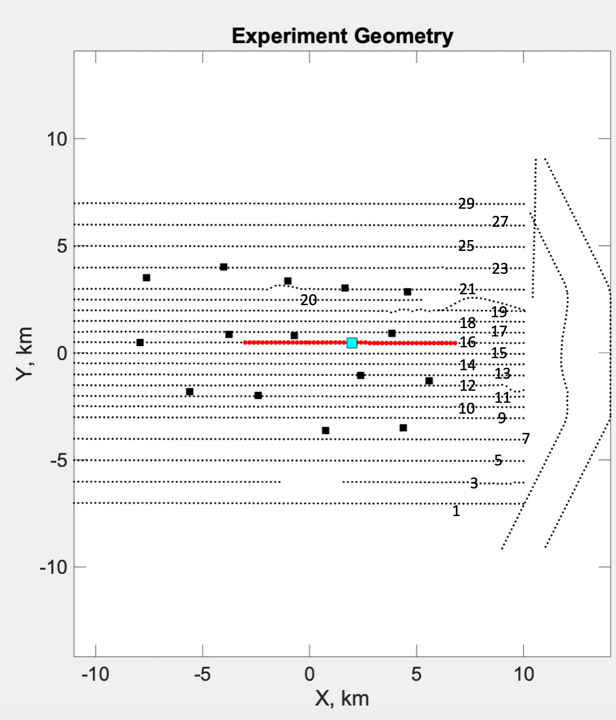
**Relocating Ocean Bottom Seismographs by Inversion of Water Wave Arrival Times**

*Updated by Maleen Kidiwela on June 25th 2020*

Ocean Bottom Seismographs are relocated using the water wave picks identified and picked using the tlPicker. Before proceeding with the inversion results, it’s important to understand the station bathymetry.

*A close up of a map

Description automatically generatedFigure A Figure B*

The figure A to the left showcases the numbering of the Lines with respect to the station geometry. The red line on this figure is a potion of selected tomography picks along line 16 that are located within a 5km radius of the station 21. The figure B to the right is a representation of all the tomography shots and the respective station locations near the orca volcano.

The figure C below shows this set of water waves generated along Line 16 station 21 as a record section. Each onset of the water waves is denoted by a red line picked by setting the wiggle option to -1 within tlPicker. To generate this record plot, a clip of 1 was used with 1e-05 scale on the channel 3. Using tlPicker, the water wave arrivals originated 5 km laterally from each station were picked and used within the inversion

*A picture containing fence

Description automatically generatedFigure C*

The Figure below is the result of the inversion performed on all stations. As shown here, the RMS residuals observed in each station is less than 8 x10-3 seconds.

A screenshot of a cell phone

Description automatically generated

*Figure D*

The figure E is a representation of how the RMS residuals of change in each station for each constant velocity (1445-1465 m/s) within the inversion. The labels indicate the velocity at its local minimum.

*Figure E*

A picture containing drawing

Description automatically generated

When visualizing which events are recorded in multiple station the figure F below shows that a significant portion of tomography shots are recorded in 3 or more stations. This allows us to conduct a joint inversion to correct event locations.

A close up of a logo

Description automatically generated

*Figure F*

The figure G is a Misfit histogram between the Observed Travel Time and the Predicted trave time for each event used in the inversion. From this figure it can be noted that the errors are gaussian and there are some outliers within the data that needs to be evaluated

A close up of a map

Description automatically generated

*Figure G >*

*A screenshot of a cell phone

Description automatically generated*A close up of a map

Description automatically generated

*Figure H Figure I*

The figures H and I above are showing how the best velocity (Determined by Figure E) varies through the station geometry. While we initially hypothesized that the best velocity might vary from east to west, the above figure debunks this to show that the velocity varies pretty randomly across stations.

Figures K denotes which tomography shots are excluded from the inversion while Figure J shows the map view of the histogram figure F. Here, most shots in the mid portion of the station geometry contains 3 or more stations recording the same event. Red dots on figure J are the events which 2 or 1 stations recording them.

A close up of a map

Description automatically generated

Figure J

A close up of a map

Description automatically generated

Figure K

Now that Initial Analysis of parameters are conducted, let’s proceed through the inversion figures that were generated by the obsloc code.

*Figure L*

A close up of a map

Description automatically generated

Figure L shows how the total RMS residuals are minimized over 5 iterations. This iterative approach to resolving the station locations is necessary because of the station location is a nonlinear inverse problem.

A screenshot of a cell phone

Description automatically generated

*Figure M*

This figure shows the variability in the x, y, z directions in each station with respect to its assumed original station position. While the station Index 12 shows significant variability in the x, y, z direction, this station: BRA25 was found to be relocated correctly when comparing the relocated depths to bathymetric depths.

*Figure N*

A screenshot of a social media post

Description automatically generated

*Figure O*

A screenshot of a cell phone

Description automatically generated

Figure N and O are similar figures denoting the misfit (Observed arrival times – predicted arrival times) and the normalized misfit (Uncertainty = 0.005). Here we can see that certain stations contain 4 or 6 times the picking uncertainty. This means that either these picks are bad or there is some other error associated with the data. So, it’s important to check what these water wave picks look like.

*Figure P*

A screenshot of text

Description automatically generated

*Figure Q*

A close up of a map

Description automatically generated

Figure R

A picture containing text, map

Description automatically generated

Figures P, Q, R are showing how the initial position of the station changed to the final location iteratively. Figure P shows the relocation in the XY plane, Figure Q shows the relocation in the XZ plane while the figure R shows the relocation in the YZ plane.

From looking at these 3 figures, it is evident how the events are well distributed along the y axis and is sparsely located along the x axis in intervals due to the event geometry. These events were denoted on the top of the figure as red dots. Final iteration is denoted by red squares and the blue squares are the initial station location before the inversion. Most significant jump in depth was observed in station 25 located on the north eastern slope of the caldera. With even a small lateral variation, the depth is expected to change much more.

The figure S below is a comparison of depths of stations between the inverted depths and bathymetric depths. Here this comparison shows that these two values are similar but still is larger than the variabilities of values observed before. These values show how well the inversion is doing in its ability to relocate the stations.

Figure S

A close up of a map

Description automatically generated

Figure T

A picture containing computer

Description automatically generated

Figure T is another record section plot but plotted with a velocity reduction of 5. This emphasizes how the orca volcano interferes with the body waves travelling through the ground. The interference is seen between 4 < x < 6 in the above record section.