## *Detailed studies of mid-ocean ridge volcanism at the Mid-Atlantic Ridge (45N) and elsewhere*

YEO, ISOBEL,ALICE,L

**Volume Calculations for Pillow Ridges on CoAxial, Cleft, and Gorda**

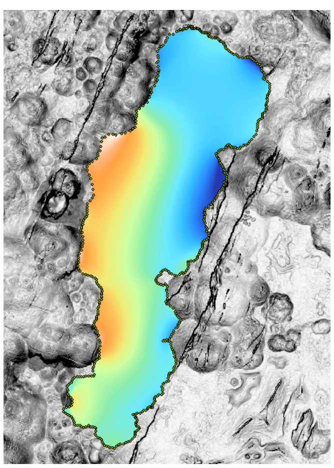
**Methods:**
AUV bathymetry data were gridded at 1 and 1.5 m resolution and all gaps in these data were filled by data interpolation.  An interpolated surface was created based using natural neighbor interpolation based on depths extracted from each bounding outline of the pillow ridges.  This interpolated surface was assumed to be the pre-eruption surface.  The volume of the flow was calculated by subtracting the pre-eruption interpolated surface from the observed bathymetry.

To compare differences that could result form the interpolation process, a planer surface was created using trend interpolation based on depths extracted from each bounding outline, creating a flat plain as the pre-eruption surface.   Volumes were calculated for CoAxial using both methods.

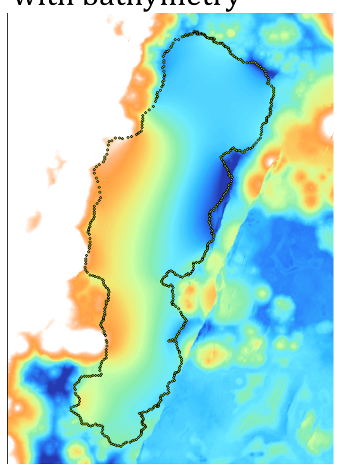
Additional Comparisons were made to volumes calculated at Axial.  Axial has before and after eruption surveys so it can be used to ground truth the methods used.  All pre-eruption surfaces were generated using the Natural Neighbor.  North Axial flows were compared using high resolution (1.5m) AUV pre and post eruption surveys.  South Axial flows were compared using low resolution (5 m) surveys.  The southern flows are pillow ridges where the northern flows are sheet flows

Examples of pre-eruptive surfaces created for the Volume calculations at CoAxial:

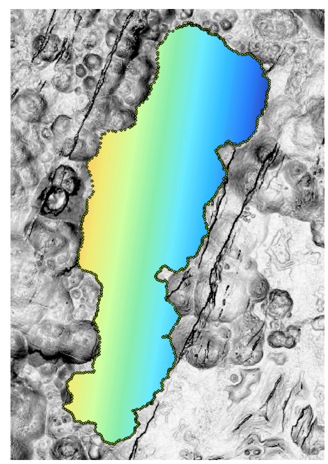
Natural Neighbor



Natural Neighbor with bathymetry



Trend



**Results:**
**See the attached excel spreadsheet for volumes.**

Volumes calculated using this method varied from both the volumes published by Chadwick and calculated by Yeo.  These variations were not consistent.  Part of the large difference noted in the Cleft eruption could be due to differences in the flow boundary outline.  A large southern pillow may have been included in Yeo calculation that was not included in Martin calculation.

Volumes calculated using the 1 m vs the 1.5 m grid were not significantly different.  Volumes calculated using the Trend surface were lower.

All Axial volume calculations greatly underestimated the flow volumes by 30-60%.  These differences could be reduced by carefully picking the lowest bathymetry points near the boundary to generate the interpolated pre-eruptive surface. However, this process was highly subjective. This suggests that interpolating a correct pre-eruptive surface may impossible. Clague suggested that these volume underestimations could be result from the behavior of the flow. If a flow fills in the low portion of the topography and stops when it runs into a higher region of topography, the edges of the flow will always be bounded by these higher regions. This means that all attempts to estimate the pre-eruptive surface will be too high.

**Cookbook-style Methods:**

1. Create 1 m and 1.5 meter grids in UTM coordinate system using MBsystem. Forced interpolation of all grid squares.

```
mbgrid -I datalistp.mb-1 \
        -R -126.799/-126.768/42.656/42.693 \
        -A2 -JU -F5 -N -E1/0! -C10/3 -V \
        -O GordaVol-UTM_1m
```

2. Convert to arc-ready ascii file:

```
mbm_grd2arc -I GordaVol-UTM_1m.grd -V -O GordaVol-UTM_1m.asc
```

3. Convert to arc-grid (bathy-grid):
    ArcToolbox → Conversion Tools → To Raster → ASCII to Raster (Float)

4. Convert the vertices of the Pillow mound shapefile outline created by Yeo in 2010 and modified by Clague et al in 2012 to point file (flow-points):
    ArcToolbox → Data Management Tools → Features → Feature Vertices to Points

5. Find the depth value at each of the flow-points (depth-points):
    ArcToolbox → Spatial Analyst Tools → Extraction → Extract Values to Points

6. Create a “fake” bathymetry surface based on the depth-points. This surface is assumed to be the pre-eruptive surface in the volume calculation (base-surface):
    ArcToolbox → 3D Analyst Tools → Raster Interpolation → Natural Neighbor
        Z value field = RASTERVALU
        Output cell size = 1/1.5 (depending on bathy-grid resolution)

7. Make a raster with a grid value of 1 within the flow outline and a grid value of 0 outside the flow outline, to be used to clip the bathy-grid and base-surface to just include the flow regions (clip-area):
    ADD RastVal column to the attribute table of the original polygon flow outline shapefile.
        Assign a value of 1 for all features.
    ArcToolbox → Conversion Tools → To Raster → Feature to Raster
        Input = polygon flow outline
        Field = RastVal
        Output Cell size = 1/1.5 (depending on bathy-grid resolution)

8. Clip bathy-grid and base-surface to the include only the flow region (bathy-clip & base-clip)
    ArcToolbox → Spatial Analyst Tools → Map Algebra → Raster Calculator
        clip-area * bathy-grid
        clip-area * base-surface

9. Calculate the volume between the tow surfaces
    ArcToolbox → Spatial Analyst Tools → Surface → Cut Fill
        To get positive Volumes: Input Before = bathy-clip; Input After = base-clip

10. Sum all of the values in Volume Attribute column and all the values in the Area column