Potential Seamount Estimation from Predicted Bathymetry

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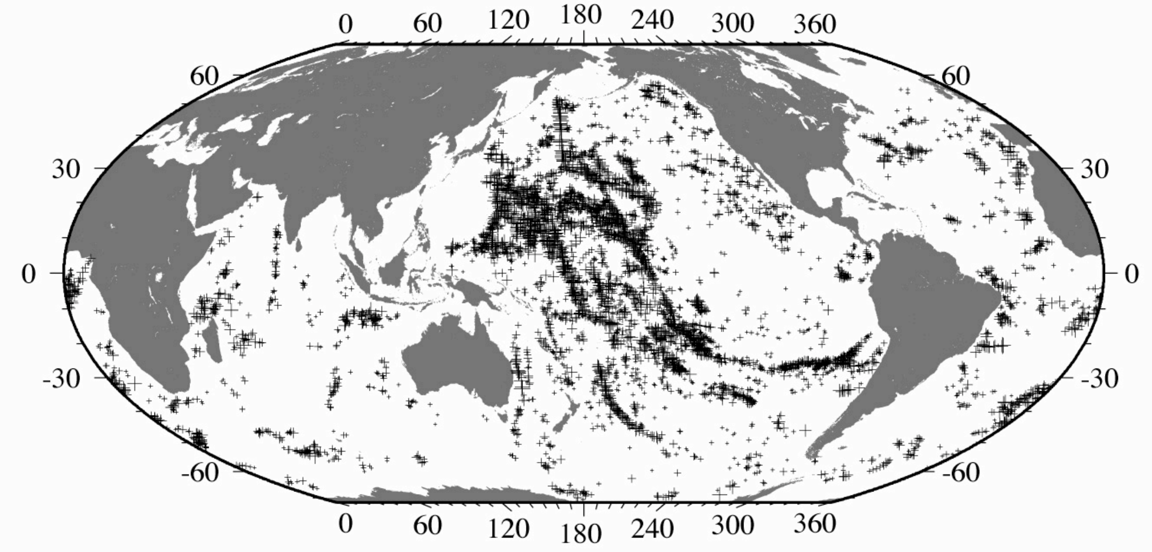
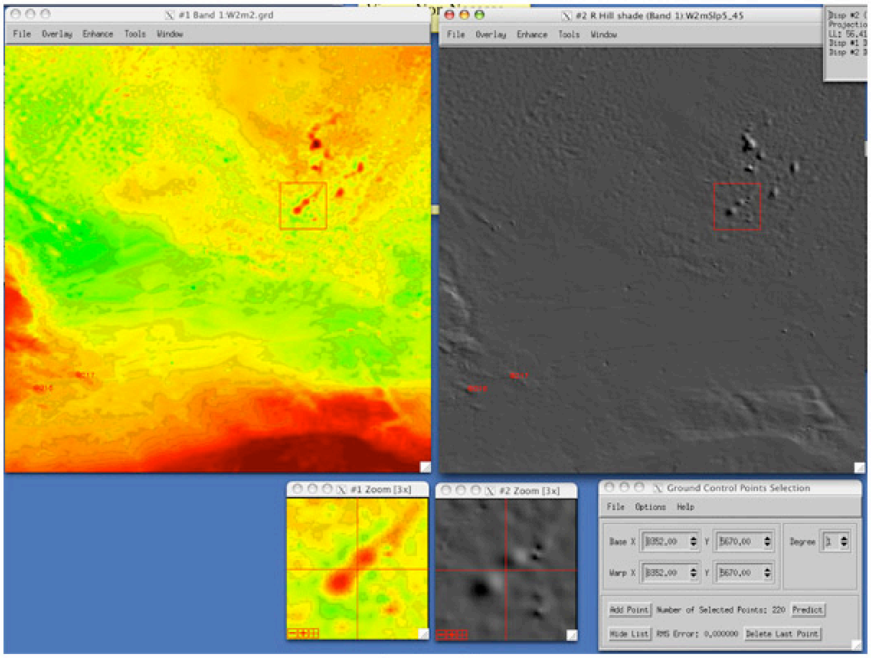


The Merriam-Webster dictionary defines a seamount as a submarine mountain rising above the deep-sea floor. Geologically, seamounts are usually considered to be volcanic in origin and characterized by a circular planform and conical morphology. Identification of potential seamounts in satellite gravity and/or predicted bathymetry data is complicated by the limited spatial resolution (typically 2 arc minutes or lower) of these datasets and the attenuation of detail in the sea surface topography from which these data are derived. For the purposes of this task, potential seamounts are identified on the basis of 1) circular planform, 2) slope continuity and 3) geologic intuition with respect to tectonic setting. All three of these factors are more easily considered when interpretation is based on both elevation and slope images. Figure 1 provides an example of two closely spaced potential seamounts discriminated on the basis of distinct slopes. The color images show depth while the gray shade images show slope as a false illumination from the northeast. The larger windows show the regional view at 1:1 pixel resolution while the smaller windows allow interactive zooming at greater than 1:1 resolution. Both elevation and slope color and shading can be adjusted interactively as necessary. Figure 2 provides an example of grid artifacts.

The smaller the amplitude of the potential seamount, the greater the likelihood of misidentification. When digitizing potential seamount locations from predicted bathymetry, the most likely error is a false positive related to shiptrack bathymetry profiles. Because bathymetry profiles resolve the full amplitude of seafloor topography at scales finer than grid resolution, isolated cases of large amplitude abyssal hill topography can resemble narrow, high amplitude seamounts. These can be distinguished from true seamounts on the basis of slope continuity. Real seamounts have circular bathymetric and gravitational expression over areas considerably wider than shiptrack artifacts. Shiptrack artifacts have discontinuous slopes and lack the larger circular planform and gentle slope breaks that are characteristic of true seamounts. Figure 3 shows an example of each. The peak in the lower left corner of the zoom window is a bathymetric artifact and the peak in the upper right corner of the zoom window is an actual seamount. The shiptrack causing the artifact is apparent as the linear “tear” in the slope window. The seamount in the upper right corner is also crossed by a shiptrack but the slope image shows the larger more continuous circular anomaly resolved by the sea surface gravity field from which the predicted bathymetry is derived. Even though the two peaks look similar in the color depth image, the difference is apparent in the slope image as there is no larger circular feature associated with the peak at the lower left. Figure 4 shows a more obvious shiptrack error.

In many cases, multiple seamounts have grown to the extent that their bases overlap and coalesce into a linear ridge. Individual summits can generally be resolved within these features. In these cases, each summit is digitized as a separate seamount as illustrated in Figure 5. In some cases, volcanic edifices have grown much larger than what is typically considered a seamount. Some of these have been included in the dataset for consistency with established convention. Figure 6 provides an example of a much larger volcanic edifice in the Iberian Basin. Although features of similar size are often referred to as banks and knolls, this feature is identified on Gebco charts as the Charcot seamount. In such cases, geologic setting determines inclusion. If the feature is known to be volcanic in origin, then it is included. If it is tectonic it is omitted.

After the seamounts have been manually identified and picked, estimates of summit depth and relief are generated. Summit depth is interpolated directly from the predicted bathymetry grid at the pick location. Relief is estimated as the difference between the summit depth and the regional median depth. When interpreting the depth and relief estimates it is important to consider the constraints imposed by the satellite gravity field from which the predicted bathymetry is derived. The marine gravity field is subject to upward continuation from the seafloor to the sea surface producing wavelength-dependent attenuation of amplitude at scales between ~50 and ~25 km (Small and Sandwell, 1993). As a result, the amplitude of the gravity anomaly of most seamounts is significantly reduced so that small seamounts are not resolved above background noise and larger seamounts are imaged at lower than true amplitudes. The short wavelength filter applied to the gravity field prior to downward continuation in the bathymetric prediction procedure further attenuates smaller features. The net result is that relief tends to be underestimated more severely for smaller seamounts while the largest seamounts are less severely affected. In spite of the detection limit imposed by these factors, the size-frequency distribution (Fig. 7) shows a preponderance of smaller (~1000 m) seamounts with the number of larger seamounts diminishing almost monotonically.



Base X 8352.00 Y 5670.00 Degree 1
Warp X 8352.00 Y 5670.00
Number of Selected Points: 220
RMS Error: 0.000000

Fig. 1 - Seamounts

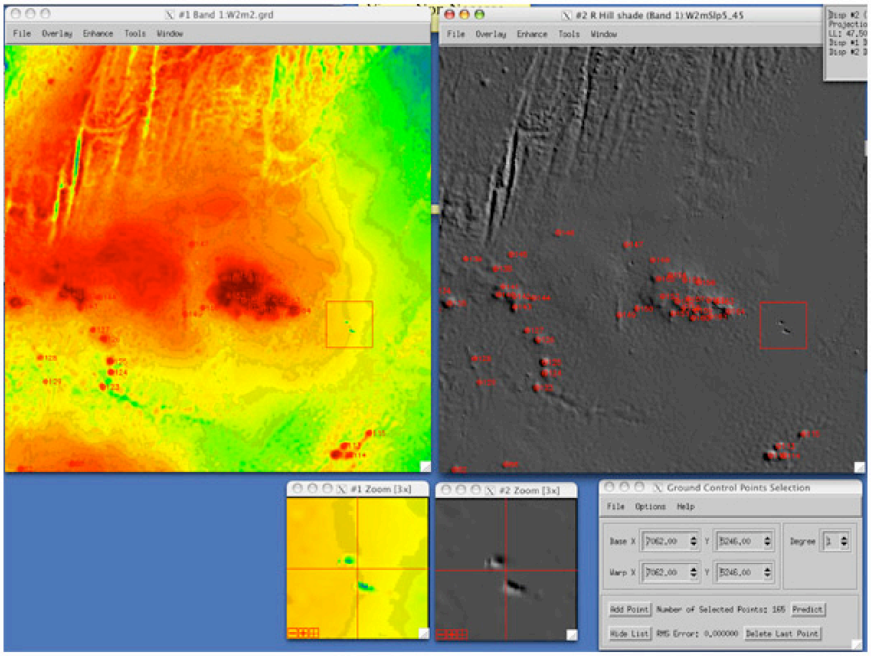


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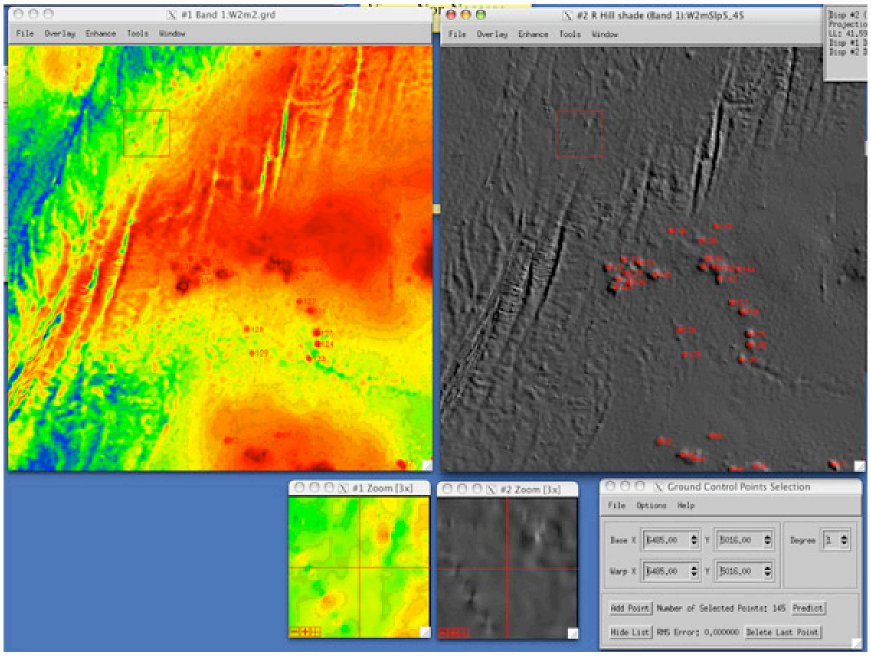
Fig. 2 - Not Seamounts



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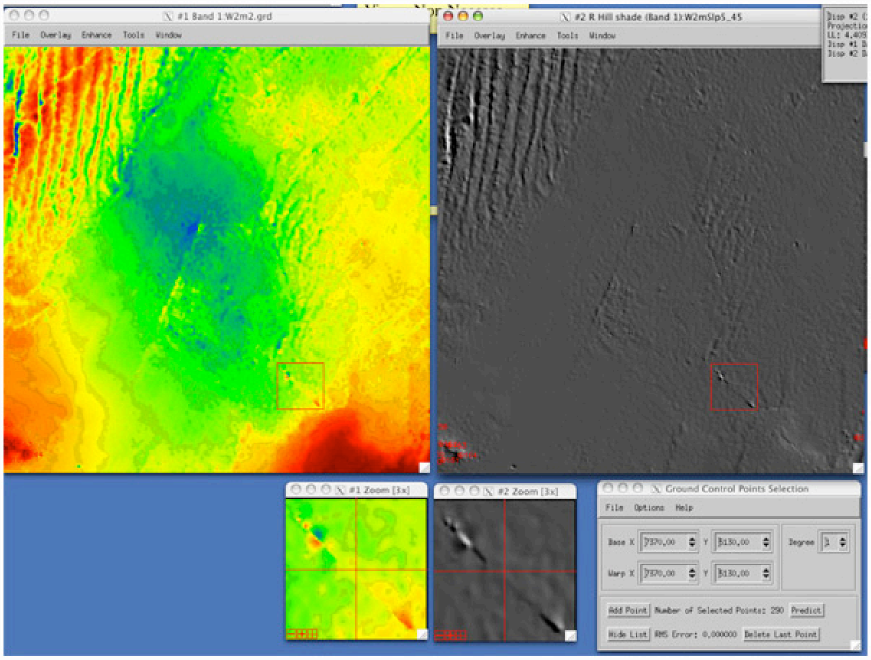
Warp X 6405,00 Y 5016,00
Number of Selected Points: 145
RMS Error: 0,000000

Fig. 3 - Shiptrack depth spikes



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Warp X 7370,00 Y 5130,00
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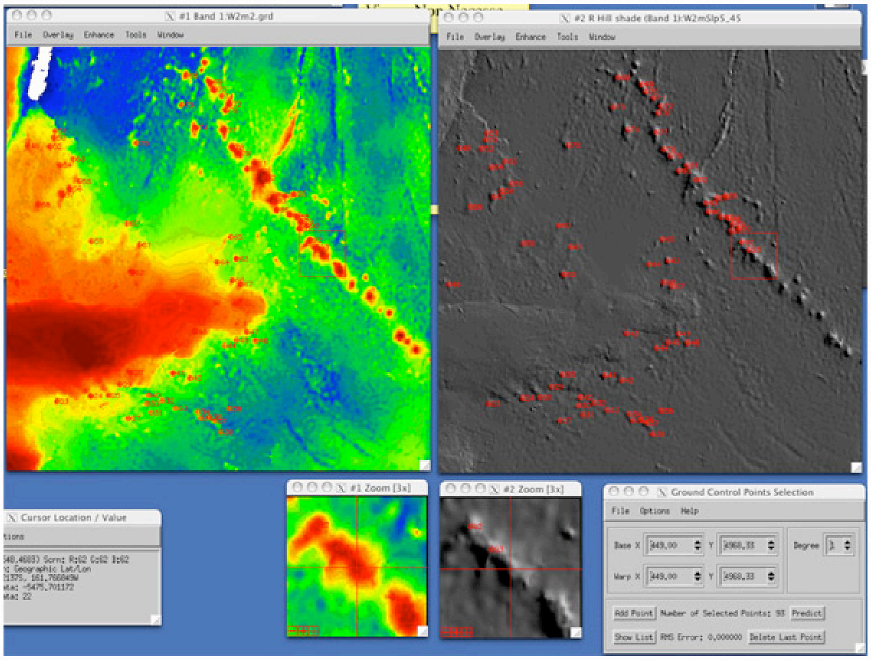
Fig. 4 - More shiptrack depth spikes



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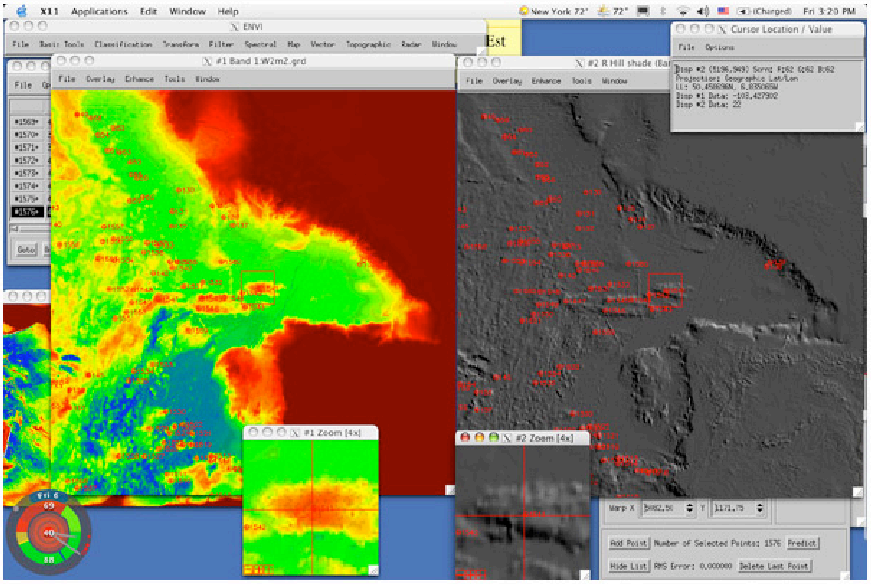
Warp X 449,00 Y 4968,33
Degree 1
Number of Selected Points: 93
RMS Error: 0,000000

Fig. 5 - Volcanic ridge with distinct summits



Disp #2 (5196,949) Scrn: R:62 G:62 B:62
Projection: Geographic Lat/Lon
Disp #1 Data: -103,427902
Disp #2 Data: 22

Warp X 5082,50 Y 1171,75
Number of Selected Points: 1576
RMS Error: 0,000000

Fig. 6 - Seamount in name (Charcot) but not morphology

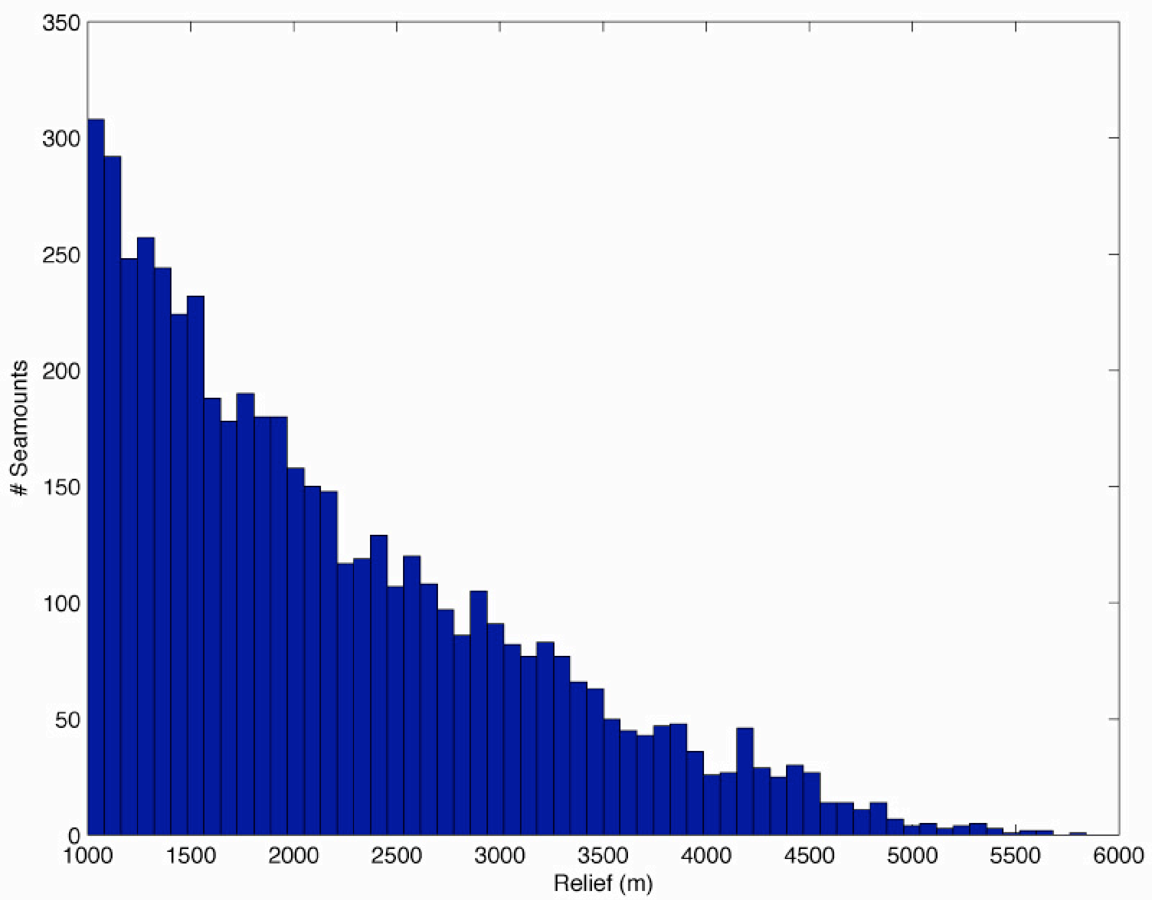


Fig. 7 Size-frequency distribution of seamount relief estimates.