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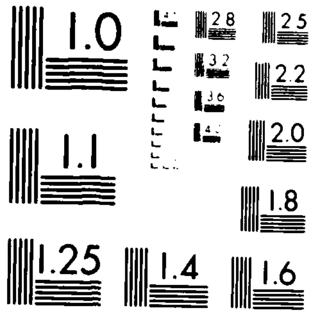

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>This report documents a computer program that augments an already operational automatic seamount detector. Featured again are a digital filter, a modified roughness indicator, a physical model accounting for the effect of seamount gravitation on the sea surface, as well as the algorithm performing the actual model parameter estimation. While the existing seamount detector calculates the seamount peak submergence depth in the

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process of solving for the seamount base width, it is now assumed that the latter quantity may be readily deduced from the altimetry pattern. It becomes then possible to simultaneously compute the seamount peak depth and the slope angle. Included once more are an error analysis program segment and an appendix listing the numerical checkout data.

FOREWORD

An experimental, automatic seamount survey technique for satellite radar altimetry has been developed and evaluated during the past two years. It was based on an empirical formula inferring the seamount slope from the maximal vertical deflection values on the sea surface. Adjustment of the maximal geoid elevation calculated from an idealized, theoretical seamount model to the maximal geoid elevation observed on the altimetry track permitted the seamount peak depth to be estimated. Subsequently, a new seamount model became available. Being much more detailed than the one just mentioned, it made possible a computer study investigating the exact details of the seamount slope angle estimation. The new insights into the nature of seamount parameter estimation then led to the development of a second detector algorithm documented in the present report. It is anticipated that the new algorithm will augment rather than replace the first.

Dr. B. Zondek of the Space and Surface Systems Division contributed the matched filter as well as the potential theory involved in the interaction of the seamount and its root with the sea surface. John Ellis of the Physical Sciences Software Branch performed the computer coding and computer program checkout. The author is responsible for the computer program formulation. To verify the numerical computer program checkout, the author also programmed the algorithm for use on an electronic calculator and made a large number of checkout calculations.

The work documented here was done in the Space and Surface Systems Division and was funded as part of the development of computer programs connected with the evaluation of seamount survey techniques.

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CONTENTS

	Page
INTRODUCTION	1
SPECIFICATION OF THE ONE-PARAMETER SOLUTION FOR SEAMOUNT SLOPE	3
SATELLITE RADAR ALTIMETRY DATA FORMAT	3
MATCHED FILTER	5
ROUGHNESS DETECTOR	6
SEAMOUNT LOCATOR	8
CALCULATION OF INITIAL SEAMOUNT PARAMETERS	13
OCEAN DEPTH ALGORITHM	14
ESTIMATION OF PEAK DEPTH	14
ANALYSIS OF DATA DISPERSION	26
AUTOMATIC ANALYSIS OF SATELLITE ALTIMETRY	29
REFERENCES	30
APPENDIXES	
A TRIAL DATA FOR ISOSTATIC COMPENSATION	31
B TRIAL DATA FOR A TYPICAL CASE OF GENERAL COMPENSATION	43
C TRIAL DATA FOR ABSENCE OF ROOT	55
DISTRIBUTION	

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INTRODUCTION

An experimental computer program for seamount model parameter estimation[1] became available last year. It is an automatic routine designed for application to SEASAT-A satellite radar altimetry and is capable of performing seamount surveys with a minimum of human intervention. This computer program is based on an empirical formula that infers the seamount slope from the maximal vertical deflection values on the sea surface above the seamount. It estimates the seamount peak depth in the process of adjusting the maximal geoid elevation calculated from an idealized, theoretical seamount model to the maximal geoid elevation observed above the seamount on the satellite track. Seamount peak geographical coordinates are a byproduct. Upon successful completion of the numerical checkout, the new computer program was subjected to a preliminary test and evaluation involving several SEASAT-A altimetry tracks for each of a number of geophysically diverse ocean areas. That study was severely limited by the vast gaps in the coverage of the globe by the SEASAT-A tracks. Nevertheless, the results of this first attempt at generating quantitative data measuring the performance of the experimental seamount detector[2] indicated that this computer program can be expected to become a useful device for satellite altimetry data analysis.

The principal weakness of the just-mentioned experimental seamount detector is not the simplicity of the seamount model employed (this being capable of calculating the geoid deflection resulting from the presence of the seamount on the seamount's symmetry axis only) but rather the empirical formula that relates the slope of the seamount to that of the sea surface above. This formula had been devised by scrutinizing a number of GEOS-3 radar altimetry data tracks passing over seamounts in the New England seamount province. The study had been confined to that part of the world because a rather dense net of altimetry tracks and reliable bathymetry were both available there. As part of the work preparatory to the design of an improved detector algorithm, the validity of the slope angle formula was reinvestigated[3] under more general conditions than those prevailing in the Western North Atlantic. Although an equally useful combination of reliable bathymetry and sufficiently dense ground tracks still could not be found elsewhere in the oceans, the renewed slope angle study became feasible because of the completion of a new seamount model. The new model permitted simulation of the geoid shape above the seamount-seamount root system as the combined effect of a collection of gravitating disks, the center coordinates, dimensions, and densities of which could be individually specified. Most importantly, this new computer routine was able to reproduce geoid height and vertical deflection above the seamount along specified straight surface tracks intersecting the seamount symmetry axis or offset from it. To obtain a detailed relationship between seamount slope and maximal vertical deflection, four drastically differing values of ocean depth, five seamount peak submergence depths, and various typical slope angles were now assumed. For each of altogether 60 different model seamounts, each consisting of 20 disks plus a corresponding number of disks representing the roots, the maximal signature slopes were calculated and compared with the assumed slope angles. Additionally, the postulated widths of the seamounts at their base were compared to the associated signature widths. The result was that the original empirical relationship between seamount slope and signature slope proved to be inaccurate under the variety of conditions considered. On the other hand, it was realized that the ratio of signature width to seamount width at the base is fairly insensitive to changes in the seamount parameters and ocean depth. The signature width being known from the altimetry data track, it now became possible to calculate the seamount width at the base, prior to the actual seamount parameter estimation, very simply and rather accurately.

It then appeared advisable that a second seamount detector should be developed, starting with the new relationship connecting the signature width and the seamount base width and subsequently proceeding to the seamount model parameter estimation in the course of which the predicted geoid elevation would be matched to the observed geoid height above the seamount. In spite of the usefulness of the seamount disk model for the purpose of the new slope angle study, no particular advantage could be realized by incorporating it into the new estimator algorithm. The original seamount model was thus retained. In its major outlines, the new seamount detector is similar to the experimental computer algorithm described in Reference 1. Specifically, it features the digital filter necessary to recognize and enhance the seamount signatures concealed among the radar altimetry data, the basic model[4] containing the seamount related potential theory, and a mathematical estimator for the physical seamount parameters. The latter estimator adjusts the characteristic properties of the radar altimetry signature predicted from the theoretical model to the corresponding quantities among the empirical data. The present and the experimental seamount detectors differ mainly in this latter computer program segment. While the previous algorithm performs at this point a one-parameter solution for the seamount base width, the present version of the seamount detector first calculates the seamount base width from the signature width and then iteratively varies the remaining seamount dimensions (in particular, slope angle and peak submergence depth) until the computed maximal geoid elevation above the seamount matches the altimetry signature height within a specified margin, subsequently attributing the resulting peak depth and slope angle to the actual seamount. Again, because of the imperfections inherent in our present knowledge of seamount compensation, this estimation is done twice per detection, separately for the cases of perfect isostasy and absence of root, with an option to prescribe arbitrary compensation if desired. The actual depth value is once more assumed to be bracketed by the depth values resulting from the isostatically compensated and uncompensated cases.

It should be noted that a change was specified for the experimental seamount detector after it was documented,[1] largely as a result of the work leading to the present algorithm. This change concerns the computer program segment "Roughness Detector" (pages 8 and 9 of Reference 1), in particular, the definition of the "maximum-SN_v-window." This segment of the algorithm has been deleted. It was replaced by a new version that is identical to the "Roughness Detector" specified below as part of the present "One-Parameter Solution for Seamount Slope."

SPECIFICATION OF THE ONE-PARAMETER SOLUTION FOR SEAMOUNT SLOPE

SATELLITE RADAR ALTIMETRY DATA FORMAT

The satellite altimetry data to be processed by the seamount detector can be recalled from permanent storage in the format indicated in Tables 1 and 2 (G. B. West, unpublished data, 1978). Extract from the data file header the time interval, Δt, in seconds and the subsatellite velocity, vs, in km/sec. From each segment of the altimetry data record, obtain for each data point (time instant, t_i, in seconds) the filtered geoid height, $N_i = N(t_i)$, in meters, the deflection of the vertical, $\delta_i = \delta(t_i)$, in arc seconds, the latitude, $\varphi_i = \varphi(t_i)$, in radians, and the longitude East, $\lambda_i = \lambda(t_i)$, in radians. Convert φ_i and λ_i to decimal fractions of degrees. Note that the altimetry data serving as input to this seamount detector are not the raw altimetry data tracks but result themselves from a filtering process explained in References 22 and 23 of NSWC TR 81-200.[1] Here and in the following we shall refer to N_i and δ_i as "filtered" when wishing to emphasize their origin, by Kalman smoothing, from the raw satellite radar altimetry. With reference to the present seamount detector, N_i and δ_i will usually be considered "unfiltered" and named so because they serve as input data to the matched filter.

TABLE 1. SEASAT-A FILTERED GEOID HEIGHT DATA FILE (TYPE FGD) HEADER RECORD (COMMON HEADER)

Word	Type	Approximate Range of Significance	Description
1	I	XXXX	Number of points in file
2	I	XXXXX	Rev number
3	I	XX	Starting year of segment
4	I	XXX	Starting day of segment
5	R	XXXXX.XXX	Starting seconds of segment (sec)
6	R	.XXXXXX	Time interval (sec)
7	A	YYDDD	Year and Julian day (right adjusted)
8	I	XXX	Altimeter mode
9	R	XXXX	Autocorrelation distance (km)
10	R	XX.XX	Standard deviation of data (m)
11	R	XX.XX	Standard deviation of geoid heights (m)
12	R	XX.XX	Standard deviation of vertical deflections (arc sec)
13	R	X.XX	RMS of filtered-raw differences (m)
14	R	±XXX	Maximum vertical deflection (arc sec)
15	R	X.XXX	Average velocity (km/sec)
16	R	X.XX	Antenna distance from satellite center of gravity (m)
17	R	XX.X	Radar instrument delay distance equivalent (cm)
18	R	±.XXX	Time correction (sec)
19	R		Spare

TABLE 2. SEASAT-A FILTERED GEOID HEIGHT DATA FILE (TYPE FGD) DATA RECORD (COMMON DATA)

Word	Type	Approximate Range of Significance	Description
1	R	±X.XXXXX	Latitude (rad)
2	R	X.XXXXX	Longitude (rad)
3	R	±XXX.XX	Geoid height (m)
4	R	±XXX.XX	Vertical deflection (arc sec)
5	R	±XXX.XX	Raw geoid height (m)
6	R	X.XX	Geoid height confidence bound (m)
7	R	XX.XX	Vertical deflection confidence bound (arc sec)
8	R	X.XX	Orbit uncertainty in geoid heights (m)
9	R	.XXX	Orbit uncertainty in vertical deflections (arc sec)
10	I	i_1 - - i_{14}	Flag word
11	R	XX.X	Significant wave height (m)
12	R	XX.X	σ - SWH (m)
13	R	XX	Automatic gain control (dB)
14	R	XX	σ - AGC (dB)
15	R	±.XX	Tilt SWH correction (m)
16	R	X.XXX	Tilt (rad)
17	R	XX.X	Ionospheric correction (cm)
18	R	XXX	Atmospheric pressure (mb)
19	R	XXX.X	Dry tropospheric correction (cm)
20	R	XX.X	Wet tropospheric correction (cm)
21	R	±XX.XX	Tide (m)
22	R	X.XX	Barotropic correction (m)
23	R	XX	Wind speed (kn)
24	R	X.X	Wind direction (rad)
25	R	±X.XX	Sea state (SWH) correction (m)
26	R	XX.X	Alternate wet tropospheric correction (cm)
27	R	XX.X	Rain rate (mm/hr)
28	R	XXX.X	Steric correction (cm)
29	R		Spare
30	R		Spare

MATCHED FILTER

The matched filter is an optimized, digital, high-pass filter permanently stored on the local computer system. Its application to the Kalman filtered SEASAT-A altimetry data base for the purposes of the seamount detector is controlled by the SEASAT-A revolution number, the device set number associated with the particular revolution number, and by the filter constant ρ. The latter is related to the cutoff wavelength λ_c of the filter and the length I of the sampling interval,

$$\rho = \tan \frac{\pi I}{\lambda_c} \tag{20}$$

λ_c and I are specified in terms of km. A typical value for SEASAT-A data is $I \approx 3.32$ km. typical value pairs for λ_c and ρ are

$$\lambda_c = 50 \text{ km} \quad \cdots\cdots \quad \rho = 0.212$$
$$\lambda_c = 100 \text{ km} \quad \cdots\cdots \quad \rho = 0.1047$$
$$\lambda_c = 150 \text{ km} \quad \cdots\cdots \quad \rho = 0.0696 \; .$$

Adopt the following terminology: N_i are the "unfiltered geoid height" values, and δ_i are the "unfiltered vertical deflection" values. Application of the matched filter to N_i and δ_i will result in the $\hat{N}_i$ and $\hat{\delta}_i$ data tracks. $\hat{N}_i$ are the "filtered geoid heights" (in m) and $\hat{\delta}_i$ are the "filtered vertical deflections" (in arc sec). The index "i" is related to the time value t_i associated with the data values.

Note that, because of the nature of the filter algorithm, no filtered data values will be associated with the first few and the last few unfiltered data points. Thus, the first "data window" (see below for definition) on a data track shall start with the first available filtered geoid height and vertical deflection and the last data window shall end with the last available pair of filtered data values. Further, the description of the control card deck and data cards on pages 6 and 7 of Reference 1 are now obsolete and must be replaced by the cards listed in Table 3.

TABLE 3. CONTROL CARDS FOR MATCHED FILTER

```
JOB CARD (P4, T110)
ACCOUNT CARD
ATTACH, JCL, ID=NBZ.
BEGIN, BHPSA, JCL, REV=XXXX,SN=NU####,0=OUT,FC=CC,RHOF=YYY,N=3,PLOT=NO.
6 7 8 9
```

XXXX	·····	Four-digit revolution number (Examples: 0747, 1234, etc.)
NU####	·····	Device set number associated with SEASAT file FGD0XXXX1
YYY	·····	Fractional part of the input parameter "rho"

These control cards will produce the data file "DATBINXXXXRHOYYYN3" identified by the ID specified on the job card. When intending to run the seamount detector, this file is attached as "TAPE1." "FC=CC" in the fourth control card means that the printed output generated by the filter algorithm will be reproduced on microfiche.

ROUGHNESS DETECTOR

Input Data

$\hat{N}_i$	Data track (filtered geoid heights)	m
$\hat{\delta}_i$	Data track (filtered vertical deflections)	arc sec
Δt	Data step width, Δt = [illegible]	sec
vs	Subsatellite velocity	km sec
L	Data window width (specified by user)	km
deln	Threshold parameter (specified by user)	m
F	Data window width factor (user specified)	
	Default value: F = 1.3	dimensionless

Algorithm

Consider the filtered data tracks $\hat{N}_i$ and $\hat{\delta}_i$. Assign the value zero to all $\hat{N}_i$ that are negative. Specify data track "windows." The number of the data points within each window is

$$n = \mathrm{INT}\left(\frac{L}{vs\ \Delta t}\right) + 1 \tag{301}$$

Eliminate all data track portions that, after application of the matched filter, have a number of points that is less than 1.5 to 2.0 times the number n of data points within the window. Start the first window at the first data point not omitted by the filter, t_k, and calculate

$$SN_k = \sqrt{\frac{1}{n} \sum_{i=1}^{n} \left(\hat{N}_{k-1+i}\right)^2} \tag{302}$$

Do the same for the next window, $N_{k+1}, N_{k+2}, \ldots, N_{k+n}$, obtaining

$$SN_{k+1} = \sqrt{\frac{1}{n} \sum_{i=2}^{n+1} \left(\hat{N}_{k-1+i}\right)^2} \tag{303}$$

and for each following window, obtaining

$$SN_{k+\nu} = \sqrt{\frac{1}{n}\sum_{i=\nu+1}^{n+\nu}\left(\hat{N}_{k-1+i}\right)^2} \qquad (304)$$

until the data track N_i is exhausted.

From now on, consider only those data windows for which $SN \geq deln$. Note that the latter requirement divides the new data track (consisting of the SN_i values) into "islands." For each data island, calculate the center of gravity.

$$SN_i = SN\ (t_i) \qquad (305)$$

$$t_{COG} = \frac{\Sigma t_i\ SN_i}{\Sigma\ SN_i} \qquad (306)$$

where the summation extends over the island under consideration. Note that t_{COG} will generally not exactly coincide with a t_i data value. Once t_{COG} has been found, substitute for it the t_i value directly preceding it or, if more convenient, the t_i value nearest to t_{COG}: $t_{COG} \rightarrow t^*_{COG}$. From all data windows associated with the data island, select then that window that is characterized by t^*_{COG} (the first data point of which has the time value t^*_{COG}).

Extend finally the thus-chosen data windows (one for each data island) to the left by m data points and to the right by m data points (i.e., by data points taken from among the just-calculated SN_i values). The number m is

$$m = INT\left(\frac{(F-1)\ n}{2}\right) . \qquad (307)$$

Output Data

For each of the latter, extended windows, store and print out

$$\begin{array}{llll}
t_\mu & t_{\mu+1} & \cdots\cdots & t_{\mu+n-1} \\
\hat{N}_\mu & \hat{N}_{\mu+1} & \cdots\cdots & \hat{N}_{\mu+n-1} \\
\hat{\delta}_\mu & \hat{\delta}_{\mu+1} & \cdots\cdots & \hat{\delta}_{\mu+n-1} \\
SN_\nu & & & \\
N_\mu & N_{\mu+1} & \cdots\cdots & N_{\mu+n-1} \\
\delta_\mu & \delta_{\mu+1} & \cdots\cdots & \delta_{\mu+n-1}
\end{array}$$

SEAMOUNT LOCATOR

Subroutine "EXTR"

Known are three data points, $i = 1, 2, 3$, on a data track $y_i = y(x_i)$. Assume that these points bracket a maximum or minimum of the y_i values. The abscissa value, x_p, associated with the extremum of y_i is then

$$x_p = x_1 - \frac{bd}{2cd} \tag{401}$$

$$bd = \begin{vmatrix} y_2 - y_1 & (x_2 - x_1)^2 \\ y_3 - y_1 & (x_3 - x_1)^2 \end{vmatrix} \tag{402}$$

$$cd = \begin{vmatrix} x_2 - x_1 & y_2 - y_1 \\ x_3 - x_1 & y_3 - y_1 \end{vmatrix} \tag{403}$$

Subroutine "INTERPOL-1"

Known are three data points, $i = 1, 2, 3$, on a data track $y_i = y(x_i)$. Find, for a specified abscissa value, x_p, the ordinate value $y_p = y(x_p)$.

$$y_p = a + b\,(x_p - x_1) + c(x_p - x_1)^2 \tag{404}$$

$$a = y_1 \tag{405}$$

$$b = \frac{1}{d} \begin{vmatrix} y_2 - y_1 & (x_2 - x_1)^2 \\ y_3 - y_1 & (x_3 - x_1)^2 \end{vmatrix} \tag{406}$$

$$c = \frac{1}{d} \begin{vmatrix} x_2 - x_1 & y_2 - y_1 \\ x_3 - x_1 & y_3 - y_1 \end{vmatrix} \tag{407}$$

$$d = (x_2 - x_1)\,(x_3 - x_1)\,(x_3 - x_2) \tag{408}$$

Subroutine "INTERPOL-2"

Known are four data points, i = 1, 2, 3, 4, on a data track $y_i = y(x_i)$. Calculate, for a specified abscissa value, x_p, the ordinate value $y_p = y(x_p)$.

$$y_p = e + f(x_p - x_1) + g(x_p - x_1)^2 + h(x_p - x_1)^3 \tag{409}$$

$$e = y_1 \tag{410}$$

$$f = \frac{1}{\Delta}\begin{vmatrix} y_2 - y_1 & (x_2 - x_1)^2 & (x_2 - x_1)^3 \\ y_3 - y_1 & (x_3 - x_1)^2 & (x_3 - x_1)^3 \\ y_4 - y_1 & (x_4 - x_1)^2 & (x_4 - x_1)^3 \end{vmatrix} \tag{411}$$

$$g = \frac{1}{\Delta}\begin{vmatrix} x_2 - x_1 & y_2 - y_1 & (x_2 - x_1)^3 \\ x_3 - x_1 & y_3 - y_1 & (x_3 - x_1)^3 \\ x_4 - x_1 & y_4 - y_1 & (x_4 - x_1)^3 \end{vmatrix} \tag{412}$$

$$h = \frac{1}{\Delta}\begin{vmatrix} x_2 - x_1 & (x_2 - x_1)^2 & y_2 - y_1 \\ x_3 - x_1 & (x_3 - x_1)^2 & y_3 - y_1 \\ x_4 - x_1 & (x_4 - x_1)^2 & y_4 - y_1 \end{vmatrix} \tag{413}$$

$$\Delta = \begin{vmatrix} x_2 - x_1 & (x_2 - x_1)^2 & (x_2 - x_1)^3 \\ x_3 - x_1 & (x_3 - x_1)^2 & (x_3 - x_1)^3 \\ x_4 - x_1 & (x_4 - x_1)^2 & (x_4 - x_1)^3 \end{vmatrix} \tag{414}$$

Note Concerning the Subroutines

Optionally, the computer programmer may implement the above subroutines by any of the classical interpolation schemes. If desired, the polynomial coefficients can be evaluated by a least-squares fit method. Irrespective of the method chosen, it must however be kept in mind that rather frequently along the altimetry track, the argument values (time or distance - depending on the interpretation of x_i) will be large compared to the time required for a seamount overflight or to the seamount width, implying $x_i \gg (x_k - x_j)$. To avoid loss of significant digits during the evaluation of the determinants, it is advisable to first transform the x_i values to corresponding x'_i values so that the origin of the x' system coincides with x_1, $x'_i = (x_i - x_1)$, implying $x'_1 = 0$. The particular interpolation method chosen may then be executed. Subsequently, the results must be transformed back into the x/y coordinate system. Note that this precaution is unnecessary if the subroutines are applied in the form specified above.

Input for Seamount Locator Algorithm

For each data window, have available

$N_i(t_i)$	Unfiltered geoid height	m
$\delta_i(t_i)$	Unfiltered vertical deflection	arc sec
t_i	Time argument	sec
λ_i	Longitude East from altimetry file	deg
φ_i	Latitude from altimetry file	deg

Seamount Locator Algorithm

For each of the specified data windows, now consider the unfiltered geoid heights, N_i, and the unfiltered deflections of the vertical, δ_i. Also keep in mind that it is possible to associate with the discrete number sets $N_i(t_i)$ and $\delta_i(t_i)$, the continuous functions $N(t)$ and $\delta(t)$ representing the geoid height and vertical deflection in the "real world" or simply being assumed to be suitable functions adapted to $N_i(t_i)$ and $\delta_i(t_i)$ by least-squares fit or other meaningful methods. For the present purpose, it is sufficient to postulate that $N(t)$ and $\delta(t)$ may be realized mathematically if needed. Perform the following calculations.

1. When traversing the window from the left to the right (proceeding from lower values of t_i to higher ones), expect to encounter negative δ_i values and, among them, an absolute minimum value. Consider the data point $\delta_i(t_i)$ associated with this minimum value plus the data point to the left and the data point to the right of it. Apply to these three data points the subroutine "EXTR" to find the abscissa value t_A belonging to the minimum of the curve $\delta(t)$ associated with the just specified three data points.

2. In the same manner, find the time value t_B associated with the absolute maximum value of $\delta_i(t_i)$ that will occur further down the data track but still within the data window.

3. Within the window, the data track $N_i(t_i)$ may be expected to have an absolute maximum. Find the data value representing this maximum. Also find the neighboring data points to the left and to the right of this maximum. Apply subroutine "EXTR" to find the time value t_{SM} of the maximum of $N(t)$ related to the just-defined three data points.

4. Now apply subroutine "INTERPOL-1" to t_{SM} and the three data points on the N_i track from which t_{SM} was determined in step 3, obtaining $N(t_{SM}) = N_{SM}$.

5. Next, determine the four data points on the N_i track that are nearest to the time value t_A. Apply to them subroutine "INTERPOL-2" to evaluate the N value associated with t_A, $N(t_A) = N_A$.

6. Further, proceed as in step 5 to find $N(t_B) = N_B$.

7. Proceed as in step 5 to find $\delta(t_A) = \delta_A$.

8. Proceed as in step 6 to find $\delta(t_B) = \delta_B$.

9. Consider now the data tracks N_i and δ_i in the neighborhood of t_{SM}, in particular, the time value $t_i = t^-_{SM}$ just to the left of (prior to) t_{SM} and the time value $t_i = t^+_{SM}$ to the right of (following) t_{SM}. Note that $t^-_{SM} < t_{SM}$ and $t^+_{SM} > t_{SM}$. In the radar files, t^-_{SM} and t^+_{SM} are associated with the values of longitude East and latitude on the subsatellite track.

$t^-_{SM} \leftrightarrow \lambda^-_{SM}$ and φ^-_{SM}

$t^+_{SM} \leftrightarrow \lambda^+_{SM}$ and φ^+_{SM}

Evaluate the longitude East and the latitude of the "signature peak,"

$$\lambda_{SM} = \lambda^-_{SM} + \frac{\lambda^+_{SM} - \lambda^-_{SM}}{t^+_{SM} - t^-_{SM}} (t_{SM} - t^-_{SM}) \qquad (415)$$

$$\varphi_{SM} = \varphi^-_{SM} + \frac{\varphi^+_{SM} - \varphi^-_{SM}}{t^+_{SM} - t^-_{SM}} (t_{SM} - t^-_{SM}) \qquad (416)$$

10. Note that above the data were postulated to conform to the typical seamount altimetry pattern illustrated in Figure 1. If the data fail, altogether or in any essential detail to match this pattern, reject the data window.

Seamount Locator Output

For each data window successfully processed, store and list the following.

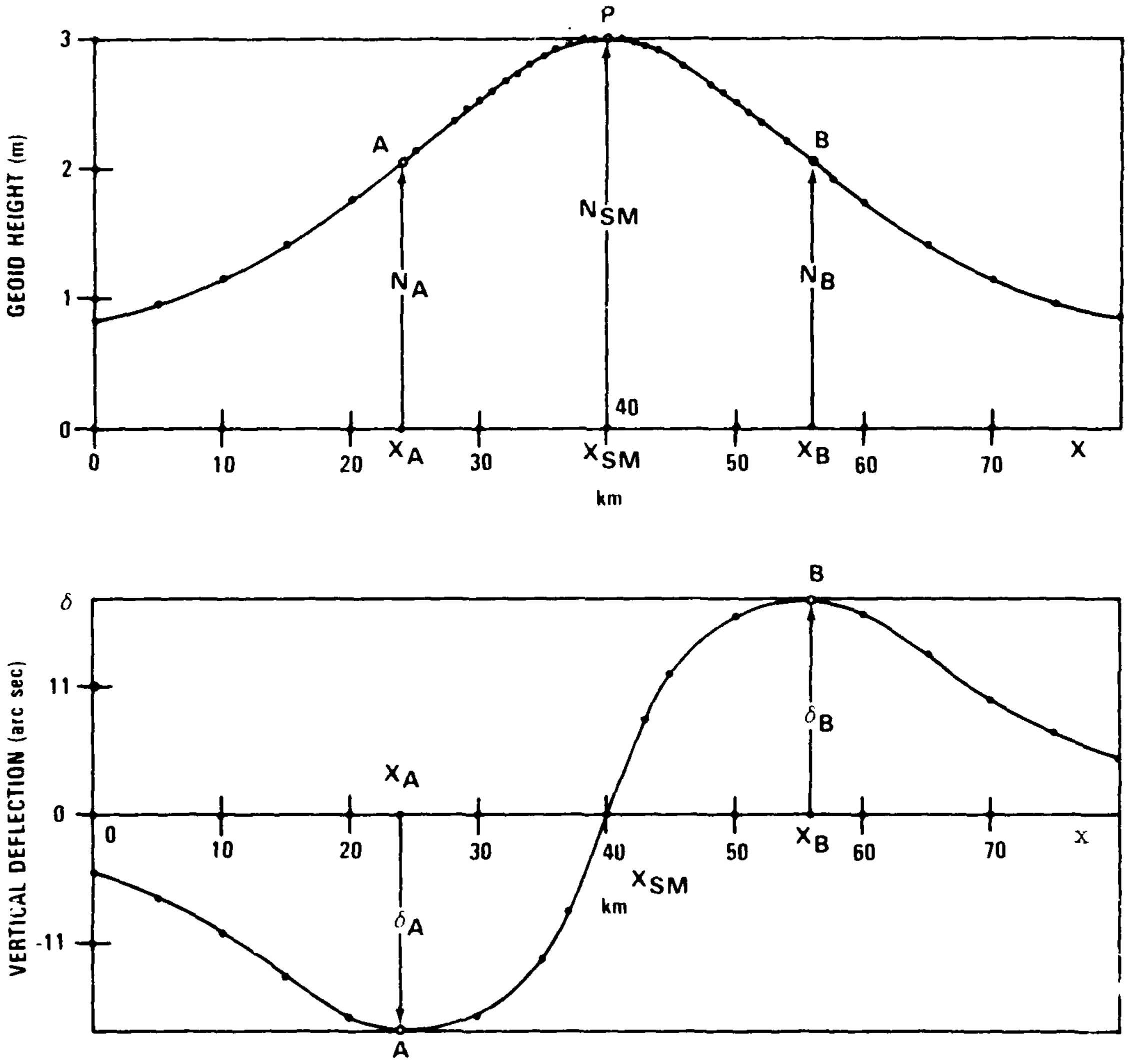

FIGURE 1. TYPICAL GEOID HEIGHT PATTERN AND VERTICAL DEFLECTION ABOVE A SEAMOUNT

t_A	N_A	δ_A		
t_B	N_B	δ_B		
t_{SM}	N_{SM}		λ_{SM}	φ_{SM}

Seamount longitude and latitude are to be specified in decimal degrees as well as in degree - minute - second format.

CALCULATION OF INITIAL SEAMOUNT PARAMETERS

Input Data

t_A	sec
t_B	sec
N_A	m
N_B	m
N_{SM}	m
δ_A	arc sec
δ_B	arc sec
k_3	User-defined constant Default value: $k_3 = 1.74$
k_5	User-defined constant Default value: $k_5 = 2.00$
vs	km/sec
D	m (for definition, see algorithm segment "OCEAN DEPTH ALGORITHM"

Algorithm

$$N_c = 1.7 \left[N_{SM} - \frac{1}{2} (N_A + N_B) \right] \tag{50l}$$

$$K_D = k_3 + \frac{k_5 - k_3}{2000}(D - 3000) \quad (502)$$

$$B_S = 500 \ vs \ (t_B - t_A) K_D \quad (503)$$

$$\varphi_{S0} = (1.5E + 05) \frac{\pi}{180 \times 3600} \frac{|\delta_A| + |\delta_B|}{2} \quad (504)$$

Output Data

N_C	Geoid elevation "observed" at the seamount center to be matched by the calculated geoid elevation during parameter adjustment	m
B_S	Estimate of seamount half width at the base	m
φ_{SO}	Initial estimate of seamount slope angle	deg

OCEAN DEPTH ALGORITHM

For each data window successfully processed, the ocean depth, D, at the seamount perimeter is required. Suitable ocean depth data (Reference 25 in NSWC TR 81-200)[1] are available as averages over one-by-one degree surface area elements, as a permanent data file on the local computer system. If necessary, convert D to meters.

ESTIMATION OF PEAK DEPTH

Subroutine "DN" - Input Data

D	*Ocean depth at seamount perimeter*	m
d_S or d	Depth of seamount peak	m
φ_S	Seamount slope angle	deg
H_S	Seamount height	m
T	Crustal thickness	m

B_R	Half width of seamount root as base	m
H_R	Depth, below crust, of seamount root	m
ρ_S	Seamount density	gr/m^3
ρ_W	Water density	gr/m^3
ρ_R	Root density	gr/m^3
ρ_M	Mantle density	gr/m^3
G/g	Ratio of Newton's constant to surface gravity	m^2/gr

If not otherwise specified, assume

ρ_S = 2.60 E+06 gr/m^3

ρ_W = 1.03 E+06 gr/m^3

ρ_R = 2.95 E+06 gr/m^3

ρ_M = 3.40 E+06 gr/m^3

G/g = 0.68024 E-14 m^2/gr

Subroutine "DN" - Algorithm

Reference is made to Figure 2. Perform the following calculations.

$$\alpha_S = \tan \varphi_S \qquad (701)$$

$$\beta_S = d/H_S \qquad (702)$$

$$\alpha_R = H_R/B_R \qquad (703)$$

$$\beta_R = (D + T + H_R)/H_R \qquad (704)$$

evaluate $FU(\alpha_S, \beta_S)$ (Subroutine "FU") (705)

evaluate $FI(\alpha_R, \beta_R)$ (Subroutine "FI") (706)

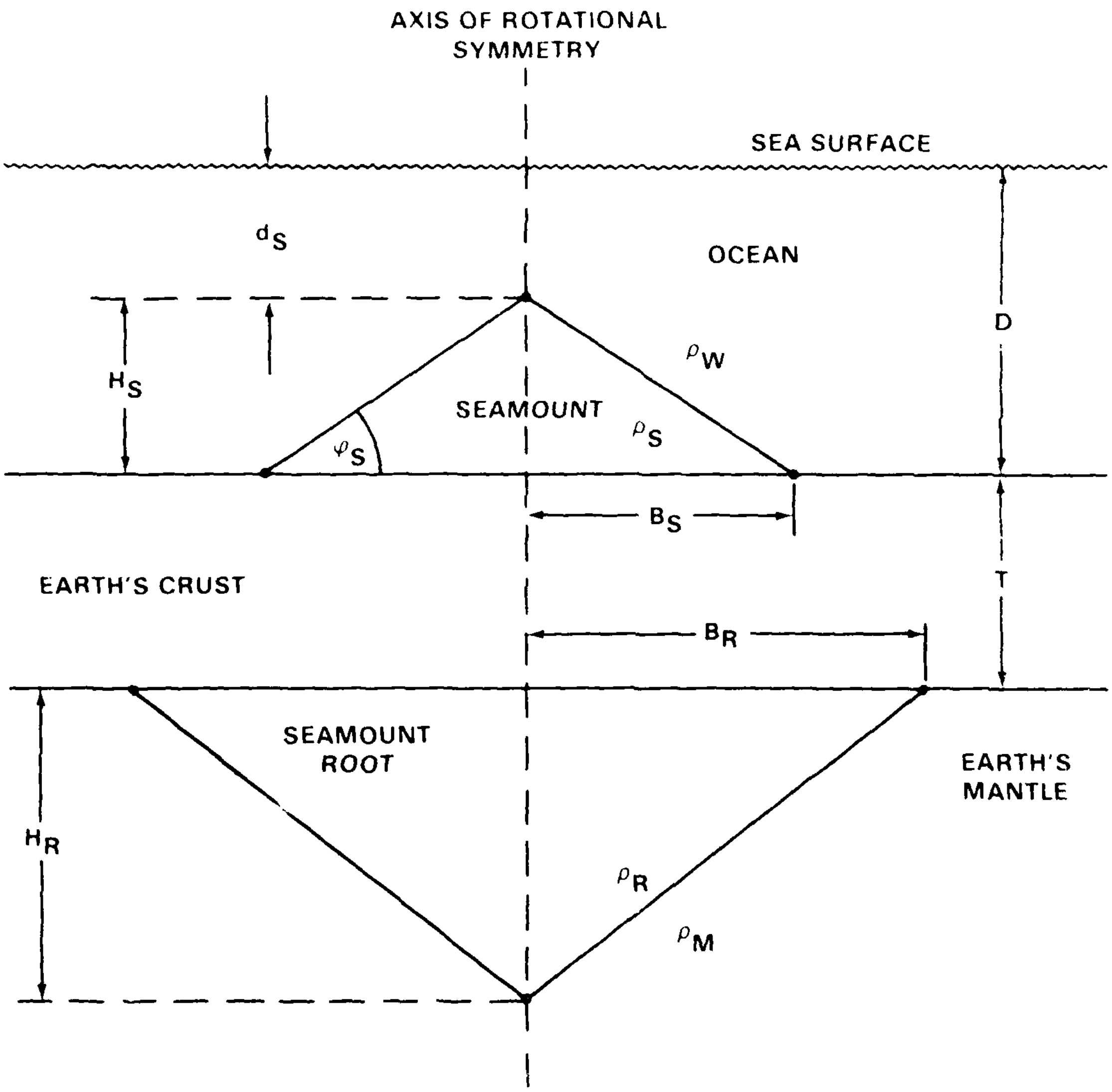

FIGURE 2. GEOMETRY OF SEAMOUNT MODEL

$$DNS = (\rho_S - \rho_W)\, H_S^2 \, \frac{G}{g} \, FU(\alpha_S, \beta_S) \qquad (707)$$

$$DNR = (\rho_M - \rho_R)\, H_R^2 \, \frac{G}{g} \, FI(\alpha_R, \beta_R) \qquad (708)$$

$$DN = DNS - DNR \qquad (709)$$

Subroutine "DN" - Output

DNS in m

DNR in m

DN in m

Subroutine "FU"

$FU(\alpha, \beta) =$

$$= 2\pi \left[\frac{-\alpha^2 \beta^2}{2(1+\alpha^2)} + \frac{1+\alpha^2(1+\beta)}{2\alpha(1+\alpha^2)} \sqrt{1+\alpha^2(1+\beta)^2} \right.$$

$$\left. + \frac{\alpha\beta^2}{2(1+\alpha^2)^{3/2}} \ln\left(\frac{\alpha\beta(\sqrt{1+\alpha^2} - \alpha)}{\sqrt{1+\alpha^2}\,\sqrt{1+\alpha^2(1+\beta)^2} - 1 - \alpha^2(1+\beta)} \right) - \beta - \frac{1}{2} \right] \qquad (710)$$

Subroutine "FI"

$FI(\alpha, \beta) =$

$$= 2\pi \left[\frac{\alpha^2 \beta^2}{2(1+\alpha^2)} + \frac{1-\alpha^2(\beta-1)}{2\alpha(1+\alpha^2)} \sqrt{1+\alpha^2(\beta-1)^2} \right.$$

$$\left. + \frac{\alpha\beta^2}{2(1+\alpha^2)^{3/2}} \ln\left(\frac{\alpha\beta(\sqrt{1+\alpha^2} + \alpha)}{\sqrt{1+\alpha^2}\,\sqrt{1+\alpha^2(\beta-1)^2} - 1 - \alpha^2(\beta-1)} \right) - \beta + \frac{1}{2} \right] \qquad (711)$$

Estimation of Peak Depth for Isostatically Compensated Seamount—Input Data

$G\cdot g$	m^2/gr
ρ_S	gr/m^3
ρ_W	gr/m^3
ρ_R	gr/m^3
ρ_M	gr/m^3
D	m
T	m
φ_{SO}	deg
B_S	m
N_C	m

If not otherwise specified, assume for $G\cdot g$ and the four densities the nominal values listed under "Subroutine 'DN' Input Data."

Estimation of Peak Depth for Isostatically Compensated Seamount—Removal of Ill-Conditioned Cases

Reference is made to Figure 2. Execute the following test. This test assumes that the seamount is as large as the estimated seamount half width at the base and the local ocean depth permit (seamount peak to be near surface · · · · · $d_S^* = 10$ m), thus producing the largest maximal geoid elevation DN* consistent with the particular B_S and D values. If DN* is smaller than the observed maximal geoid elevation N_C, the next program segment will be unable to perform the depth estimation unless certain corrective measures are taken as prescribed below.

$$B_S^* = B_S \tag{712}$$

$$d_S^* = 10 \text{ m} \tag{713}$$

$$\varphi_S^* = \tan^{-1}\left(\frac{D-d_S^*}{B_S^*}\right) \tag{714}$$

$$H_S^* = D - 10\ \text{m} \qquad (715)$$

$$B_R^* = B_S^* \qquad (716)$$

$$H_R^* = \frac{\rho_S - \rho_W}{\rho_M - \rho_R}\ H_S^* \qquad (717)$$

$$DN^* = DN(D, d_S^*, \varphi_S^*, H_S^*, F, B_R^*, H_R^*) \qquad (718)$$

$$DN^* > N_C\ ? \qquad (719)$$

If yes, proceed with the next computer program segment. Otherwise, print out "CAUTION: ILL-CONDITIONED CASE," perform the assignment $N_C = DN^*$, and consider the just-calculated parameters marked with a "*" to be the estimated seamount parameters.

Estimation of Peak Depth for Isostatically Compensated Seamount Algorithm

Perform the following calculations.

$$d_0 = D - B_S \tan \varphi_{S0} \qquad (720)$$

$$d_0 \leq ? \qquad (721)$$

If yes, continue. If no, go to (723).

$$d_0 = 10\ \text{m} \qquad (722)$$

$$\varphi_{S0} = \tan^{-1}\left(\frac{D - d_0}{B_S}\right) \qquad (723)$$

$$H_{S0} = D - d_0 \qquad (724)$$

$$B_R = B_S \qquad (725)$$

$$H_{R0} = \frac{\rho_S - \rho_W}{\rho_M - \rho_R}\ H_{S0} \qquad (726)$$

$$DN_0 = DN(D, d_0, \varphi_{S0}, H_{S0}, F, B_R, H_{R0}) \qquad (727)$$

$$\varphi_{S1} = 0.8 \times \varphi_{S0} \qquad (728)$$

$$d_1 = D - B_S \tan \varphi_{S1} \qquad (729)$$

$$H_{S1} = D - d_1 \qquad (730)$$

$$B_R = B_S \qquad (731)$$

$$H_{R1} = \frac{\rho_S - \rho_W}{\rho_M - \rho_R} H_{S1} \qquad (732)$$

$$DN_1 = DN(D, d_1, \varphi_{S1}, H_{S1}, T, B_R, H_{R1}) \qquad (733)$$

Reference is made to Figure 3. Using the above parameters with indices "0" and "1" as *initial* values, enter now the following iterative loop:

$$\varphi_{Si+2} = \varphi_{Si} + \frac{N_C - DN_i}{DN_{i+1} - DN_i} (\varphi_{Si+1} - \varphi_{Si}) \qquad (734)$$

$$d_{i+2} = D - B_S \tan \varphi_{Si+2} \qquad (735)$$

$$d_{i+2} \leq 0 \ ? \qquad (736)$$

If yes, continue. If no, go to (738).

$$d_{i+2} = 10 \text{ m} \qquad (737)$$

$$\varphi_{Si+2} = \tan^{-1} \left(\frac{D - d_{i+2}}{B_S} \right) \qquad (738)$$

$$H_{Si+2} = B_S \tan \varphi_{Si+2} \qquad (739)$$

$$B_R = B_S \qquad (740)$$

$$H_{Ri+2} = \frac{\rho_S - \rho_W}{\rho_M - \rho_R} H_{Si+2} \qquad (741)$$

$$DN_{i+2} = Dn(D, d_{i+2}, \varphi_{Si+2}, H_{Si+2}, T, B_R, H_{Ri+2}) \qquad (742)$$

$$\varepsilon = 0.00001 \text{ m} \tag{43}$$

$$\varepsilon_{i+2} = |N_C - DN_{i+2}| \tag{44}$$

$$\varepsilon_{i+2} \leq \varepsilon \text{ ?} \tag{45}$$

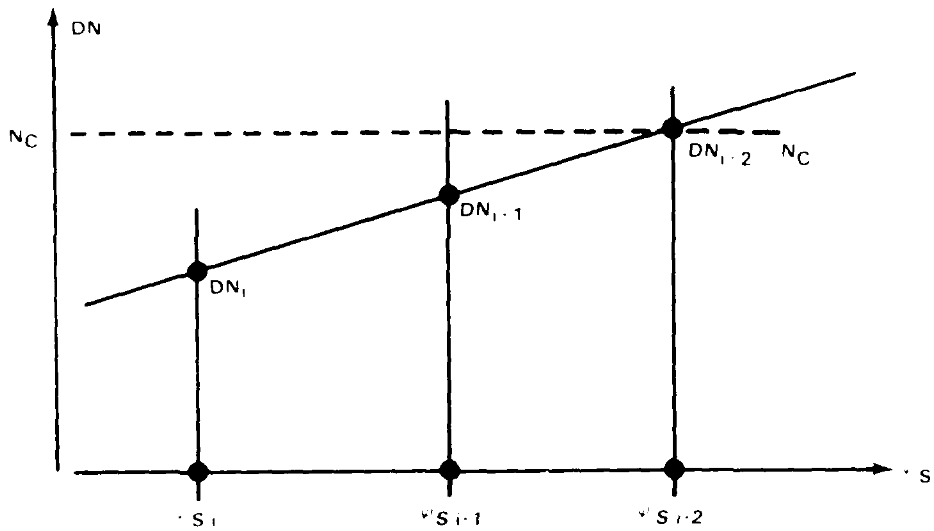

FIGURE 3. ILLUSTRATION OF ITERATION

If yes, stop the iteration. Call the parameters associated with the index i + 2 the estimated seamount parameters. In particular,

$$d_S = d_{S\,i+2}$$

$$\varphi_S = \varphi_{S\,i+2}$$

If no, reenter the iterative loop with the "i + 1" and "i + 2" parameters as the initial values.

Estimation of Peak Depth for Isostatically Compensated Seamount Output Data

$d_S = d_{S\,i+2}$	Estimated peak depth in m
$\varphi_S = \varphi_{S\,i+2}$	Estimated slope angle in deg

B_S	Estimated seamount width at base in m
$H_S = H_{S,i+2}$	Estimated seamount height in m
$B_R = B_S$	Estimated width of root in m
$H_R = H_{R,i+2}$	Estimated height of root in m

In case the parameter estimation is terminated at Equation 719, assign values to the estimated seamount parameters as specified in that latter equation.

Estimation of Peak Depth for the Generally Compensated Seamount Input Data

G/g	m^2/gr
ρ_S	gr/m^3
ρ_W	gr/m^3
ρ_R	gr/m^3
ρ_M	gr/m^3
D	m
T	m
φ_{S0}	deg
B_S	m
N_C	m
sk	
H_R	m

If not otherwise specified, assume for G·g and the four densities the nominal values listed under "Subroutine 'DN' Input Data."

Estimation of Peak Depth for Generally Compensated Seamount Removal of Ill-Conditioned Cases

Reference is made to Figure 2. Execute the following test. This test assumes that the seamount is as large as the estimated seamount half width at the base and the local ocean depth permit (seamount peak to be near surface ····· $d_S^* = 10$ m), thus producing the largest maximal geoid elevation DN* consistent with the particular B_S and D values. If DN* is smaller than the observed maximal geoid elevation N_C, the next program segment will be unable to perform the depth estimation unless certain corrective measures are taken as prescribed below.

$$B_S^* = B_S \tag{746}$$

$$d_S^* = 10 \text{ m} \tag{747}$$

$$\varphi_S^* = \tan^{-1}\left(\frac{D - d_S^*}{B_S^*}\right) \tag{748}$$

$$H_S^* = D - 10 \text{ m} \tag{749}$$

$$B_R^* = sk \times B_S \tag{750}$$

$$H_R^* = H_R \tag{751}$$

$$DN^* = DN(D,\ d_S^*,\ \varphi_S^*,\ H_S^*,\ T,\ B_R^*,\ H_R^*) \tag{752}$$

$$DN^* \geqslant N_C? \tag{753}$$

If yes, proceed with the next computer program segment. Otherwise, print out "CAUTION: ILL-CONDITIONED CASE," perform the assignment N_C = DN*, and consider the just calculated parameters marked with a "*" to be the estimated seamount parameters.

Estimation of Peak Depth for the Generally Compensated Seamount - Algorithm

Perform the following calculations.

$$d_0 = D - B_S \tan \varphi_{S0} \quad (754)$$

$$d_0 \leq 0 \; ? \quad (755)$$

If yes, continue. If no, go to (757).

$$d_0 = 10 \text{ m} \quad (756)$$

$$\varphi_{S0} = \tan^{-1}\left(\frac{D - d_0}{B_S}\right) \quad (757)$$

$$H_{S0} = D - d_0 \quad (758)$$

$$B_R = sk \times B_S \quad (759)$$

$$DN_0 = DN(D, d_0, \varphi_{S0}, H_{S0}, T, B_R, H_R) \quad (760)$$

$$\varphi_{S1} = 0.8 \times \varphi_{S0} \quad (761)$$

$$d_1 = D - B_S \tan \varphi_{S1} \quad (762)$$

$$H_{S1} = D - d_1 \quad (763)$$

$$B_R = sk \times B_S \quad (764)$$

$$DN_1 = DN(D, d_1, \varphi_{S1}, H_{S1}, T, B_R, H_R) \quad (765)$$

Using the above parameters with indices "0" and "1" as initial values, enter now the following iterative loop:

$$\varphi_{Si+2} = \varphi_{Si} + \frac{N_C - DN_i}{DN_{i+1} - DN_i} \; (\varphi_{Si+1} - \varphi_{Si}) \quad (766)$$

$$d_{i+2} = D - B_S \tan \varphi_{Si+2} \tag{767}$$

$$d_{i+2} \leq 0 \ ? \tag{768}$$

If yes, continue. If no, go to (770).

$$d_{i+2} = 10 \text{ m} \tag{769}$$

$$\varphi_{Si+2} = \tan^{-1}\left(\frac{D - d_{i+2}}{B_S}\right) \tag{770}$$

$$H_{Si+2} = B_S \tan \varphi_{Si+2} \tag{771}$$

$$B_R = sk \times B_S \tag{772}$$

$$DN_{i+2} = DN(D, d_{i+2}, \varphi_{Si+2}, H_{Si+2}, T, B_R, H_R) \tag{773}$$

$$\epsilon = 0.00001 \text{ m} \tag{774}$$

$$\epsilon_{i+2} = |N_C - DN_{i+2}| \tag{775}$$

$$\epsilon_{i+2} \leq \epsilon \ ? \tag{776}$$

If yes, stop the iteration. Call the parameters associated with the index i + 2 the estimated seamount parameters. In particular,

$$d_S = d_{Si+2}$$

$$\varphi_S = \varphi_{Si+2}$$

If no, reenter the iterative loop with the "i + 1" and "i + 2" parameters as the initial values.

Estimation of Peak Depth for the Generally Compensated Seamount--Output Data

$d_S = d_{Si+2}$ Estimated peak depth in m

$\varphi_S = \varphi_{S1+2}$	Estimated slope angle in deg
B_S	Estimated seamount width at base in m
$H_S = H_{S1+2}$	Estimated seamount height in m
$B_R = sk \times B_S$	Estimated width of root in m
H_R	Specified height of root in m

In case the parameter estimation is terminated at Equation 753, assign values to the estimated seamount parameters as specified in that latter equation.

ANALYSIS OF DATA DISPERSION

Input Data

Obtain the following from the SEASAT-A data track and/or data track header (Tables 3 and 4 of TR-81-200).[1]

$\bar{\sigma}_N$	Calculated average of all σ_N (Word 6, Table 2) on data track under consideration. This is the average geoid height confidence bound.	m
$\bar{\sigma}_\delta$	Calculated average of all σ_δ (Word 7, Table 2) on data track under consideration. This is the average vertical deflection confidence bound.	arc sec
vs	Satellite subtrack velocity	m/sec
Δt	Time interval between data points	sec

Further, have available

R_E	Earth's "radius" (R_E = 6378000 m)	m
G/g, ρ_S, ρ_W, ρ_R, ρ_M, as specified above.		
D	Ocean depth	m

ΔD	Uncertainty in ocean depth (user input). Normally, use the value of 10% of D.	m
T	Crustal thickness (user input)	m
ΔT	Uncertainty in crustal thickness (user input)	m
φ_{S0}	Initial estimate of slope angle	deg
N_C	"Observed" geoid elevation above seamount center	m
B_S	Seamount half width at base	m
sk	Geometry factor for generally compensated cases	
H_R	"Height" of root for generally compensated cases	m

Error Estimates

$$\Delta t_{SM} \approx \Delta t \tag{801}$$

$$\Delta N_{SM} \approx \bar{\sigma}_N \tag{802}$$

$$\Delta \delta \approx \bar{\sigma}_\delta \tag{804}$$

$$\Delta t_A \approx \Delta t_B \approx \Delta t \tag{805}$$

$$\Delta \varphi_S \approx (1.5E+05) \frac{\pi}{180 \times 3600} \Delta \delta \text{ deg} \tag{806}$$

$$\Delta N_A \approx \Delta N_B \approx \Delta N_{SM} \approx \bar{\sigma}_N \tag{807}$$

$$\Delta N_C \approx -0.3\, N_C \tag{808}$$

$$\Delta \lambda_{SM} \approx \Delta \varphi_{SM} \approx \frac{vs\ \Delta t}{R_E} \frac{180}{\pi} \text{ deg} \tag{809}$$

$$\Delta B_S \approx 1.4\ vs\ \Delta t\ 1000 \text{ m} \tag{810}$$

Data Dispersion for Isostatically Compensated Seamounts

Symbolize the computer routine that performs the peak depth and slope estimation for isostatically compensated seamounts by

$$d_{isostat.\ comp.} = u(D, T, \varphi_S, B_S, N_C) \tag{811}$$

Let

$$(d_{isostat.\ comp.})_{p+\Delta p}$$

symbolize an evaluation of the above function (computer routine) u (...) with all arguments nominal except the parameter indicated by "p." The latter shall enter the routine with a value perturbed by its error increment.

Calculate now

$$(d_{isostat.\ comp.})_{D+\Delta D}$$

$$(d_{isostat.\ comp.})_{T+\Delta T}$$

$$(d_{isostat.\ comp.})_{\varphi_S+\Delta\varphi_S}$$

$$(d_{isostat.\ comp.})_{B_S+\Delta B_S}$$

$$(d_{isostat.\ comp.})_{N_C+\Delta N_C}$$

and

$$(\Delta d)_{\Delta D} \approx (d_{isostat.\ comp.})_{D+\Delta D} - d_{isostat.\ comp.} \tag{812}$$

$$(\Delta d)_{\Delta T} \approx (d_{isostat.\ comp.})_{T+\Delta T} - d_{isostat.\ comp.} \tag{813}$$

$$(\Delta d)_{\Delta\varphi_S} \approx (d_{isostat.\ comp.})_{\varphi_S+\Delta\varphi_S} - d_{isostat.\ comp.} \tag{814}$$

$$(\Delta d)_{\Delta B_S} \approx (d_{isostat.\ comp.})_{B_S+\Delta B_S} - d_{isostat.\ comp.} \tag{815}$$

$$(\Delta d)_{\Delta N_C} \approx (d_{isostat.\ comp.})_{N_C+\Delta N_C} - d_{isostat.\ comp.} \tag{816}$$

Data Dispersion Analysis for Generally Compensated Seamounts

Symbolize the computer routine that performs the peak depth and slope estimation for generally compensated seamounts by

$$d_{\text{general comp.}} = v(D,\ T,\ \varphi_S,\ B_S,\ N_C) \tag{817}$$

and calculate

$$(\Delta d)_{\Delta D} \approx (d_{\text{general comp.}})_{D+\Delta D} - d_{\text{general comp.}} \tag{818}$$

$$(\Delta d)_{\Delta T} \approx (d_{\text{general comp.}})_{T+\Delta T} - d_{\text{general comp.}} \tag{819}$$

$$(\Delta d)_{\Delta \varphi_S} \approx (d_{\text{general comp.}})_{\varphi_S+\Delta \varphi_S} - d_{\text{general comp.}} \tag{820}$$

$$(\Delta d)_{\Delta B_S} \approx (d_{\text{general comp.}})_{B_S+\Delta B_S} - d_{\text{general comp.}} \tag{821}$$

$$(\Delta d)_{\Delta N_C} \approx (d_{\text{general comp.}})_{N_C+\Delta N_C} - d_{\text{general comp.}} \tag{822}$$

Additional Details Concerning the Data Dispersion Analysis

Note that the two algorithms indicated by Equations 811 and 817 depend on additional, unlisted, parameters. Not specifically mentioned, for example, are the densities. Also, sk and H_R are omitted from Equation 817. All these quantities were disregarded because the necessary quantitative data concerning the structure of the seamount root system and the seamount composition were not available with the degree of accuracy that would make inclusion into the data dispersion study meaningful.

AUTOMATIC ANALYSIS OF SATELLITE ALTIMETRY

To perform an automatic seamount survey on SEASAT-A altimetry, first specify the desired data track per device set number and revolution number. Be aware that a SEASAT-A altimetry track is likely to consist of several distinct track segments. For each of these track segments, the present seamount detector will automatically perform the Matched Filter, the Roughness Detector, the Seamount Locator, and the Calculation of Initial Seamount Parameters. For each track segment, indicate the cases rejected and those retained for further processing. For the cases rejected as well as for those retained, print out the longitude λ_{SM} and the latitude φ_{SM} resulting from Equations 415 and 416.

For the valid detections, execute the Estimation of Peak Depth for Isostatically Compensated Seamounts plus the associated Analysis of Data Dispersion. Then execute the uncompensated subcase (sk = 2 and H_R = 0.000001 m) of the Estimation of Peak Depth for Generally Compensated Seamounts plus the associated Analysis of Data Dispersion.

Make provision for the user to execute, automatically for the entire data track or, optionally, for selected individual detections, the Estimation of Peak Depth for Generally Compensated Seamounts and the associated Analysis of Data Dispersion for arbitrarily specified values of sk and H_R.

Arrange the operational computer printout of the input data and results as indicated by the experimental data printouts reproduced in Appendixes A through C, for which credit is due to John Ellis of the Physical Sciences Software Branch.

REFERENCES

1. W. J. Groeger, ***An Experimental Computer Algorithm for Seamount Model Parameter Estimation Based on SEASAT-A Satellite Radar Altimetry***, NSWC TR 81-200 (Dahlgren, Va., September 1981).

2. S. L. Smith III and W. J. Groeger, "Preliminary Evaluation of an Experimental Seamount Detector and First Collection of Trial Cases," Unpublished Working Notes (Dahlgren, Va., June 1981).

3. W. J. Groeger, ***Notes on Estimating the Seamount Slope from Vertical Deflection***, NSWC TR 81-202 (Dahlgren, Va., September 1981).

4. B. Zondek, ***Maximal Geoidal Elevation due to Simulated Seamounts***, NSWC/DL TR-3915 (Dahlgren, Va., November 1978).

APPENDIX A

TRIAL DATA FOR ISOSTATIC COMPENSATION

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```
                              S E A M O U N T   D E T E C T O R
                                         VERSION EE
                              ------------------------------

      USER INPUT
      ----------

TYPE OF COMPENSATION = ISOSTATIC

CRUST THICKNESS =     5000.00 M

L     =  70.00 KM
DELN =  .0200 M

G/G    =    .66024000E-14  M**2/GR
RHO.M  =    3400000.0      GR/M**3
RHO.R  =    2950000.0      GR/M**3
RHO.S  =    2600000.0      GR/M**3
RHO.W  =    1030000.0      GR/M**3

K3  =  1.740
K5  =  2.000

COG ROUGHNESS DETECTOR WILL BE USED WITH
F (DATA WINDOW WIDTH FACTOR) =  1.30

REJECT DATA SEGMENTS NOT INSIDE THE AREA BOUNDED BY:
LATITUDE   =    30    60
LONGITUDE  =  285   330

** NOTE - ANY DATA SEGMENT WITH FEWER THAN
          80 DATA POINTS WILL BE REJECTED.


          >>>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<<


     HEADER RECORD
     -------------

REV NUMBER      = 1375
RHO             =    .2120
N               = 3
DELTA TIME      =  .490024 SEC
SATELLITE VEL.=   6.7840 KM/SEC
NO. OF DATA POINTS =  141

***** DATA SEGMENT NOT IN DEFINED AREA, SKIP IT.
```

```
>>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<

     HEADER RECORD
     -------------

REV NUMBER       = 1375
RHO              =    .2120
N                = 3
DELTA TIME       =  .490024 SEC
SATELLITE VEL.=    6.7660 KM/SEC
NO. OF DATA POINTS =  156

***** DATA SEGMENT NOT IN DEFINED AREA, SKIP IT.

>>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<

     HEADER RECORD
     -------------

REV NUMBER       = 1375
RHO              =    .2120
N                = 3
DELTA TIME       =  .490024 SEC
SATELLITE VEL.=    6.7660 KM/SEC
NO. OF DATA POINTS =     8

***** NOT ENOUGH DATA POINTS IN SEGMENT, SKIP IT.

>>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<

     HEADER RECORD
     -------------

REV NUMBER       = 1375
RHO              =    .2120
N                = 3
DELTA TIME       =  .490024 SEC
SATELLITE VEL.=    6.7790 KM/SEC
NO. OF DATA POINTS = 1645

NUMBER OF DATA POINTS IN EACH WINDOW = 22

NUMBER OF DATA POINTS IN EACH "COG" DERIVED WINDOW = 28
```

```
-----------------------------------------------------------------------
WINDOW NO.    1

FIRST:  LATITUDE =   49   20    2 DEG,MIN,SEC
        LONGITUDE= 306   54   36 DEG,MIN,SEC

LAST :  LATITUDE =   48   38   18 DEG,MIN,SEC
        LONGITUDE= 306   17   32 DEG,MIN,SEC

*** REJECTED, MIN. VERT. DEFL. IS LAST  PT.  OF WINDOW ***

-----------------------------------------------------------------------


          >>>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<


     HEADER RECORD
     -------------

REV NUMBER      = 1375
RHO             =    .2120
N               = 3
DELTA TIME      =  .490024 SEC
SATELLITE VEL.=    6.7840 KM/SEC
NO. OF DATA POINTS =  994

NUMBER OF DATA POINTS IN EACH WINDOW = 22

NUMBER OF DATA POINTS IN EACH "COG" DERIVED WINDOW = 28
```

```
--------------------------------------------------------------------
WINDOW NO.    1

FIRST:  LATITUDE =   46   49   38 DEG,MIN,SEC
        LONGITUDE=  304   45   49 DEG,MIN,SEC

LAST :  LATITUDE =   46    7   21 DEG,MIN,SEC
        LONGITUDE=  304   11   49 DEG,MIN,SEC

*** REJECTED, MIN. VERT. DEFL. IS FIRST PT.  OF WINDOW ***

--------------------------------------------------------------------
WINDOW NO.    2

FIRST:  LATITUDE =   39   16   57 DEG,MIN,SEC
        LONGITUDE=  299   21   24 DEG,MIN,SEC

LAST :  LATITUDE =   38   33   28 DEG,MIN,SEC
        LONGITUDE=  298   54    0 DEG,MIN,SEC

ACCEPTED FOR FURTHER ANALYSIS

--------------------------------------------------------------------
WINDOW NO.    3

FIRST:  LATITUDE =   32   45   59 DEG,MIN,SEC
        LONGITUDE=  295   32   21 DEG,MIN,SEC

LAST :  LATITUDE =   32    1   50 DEG,MIN,SEC
        LONGITUDE=  295    8   35 DEG,MIN,SEC

ACCEPTED FOR FURTHER ANALYSIS

--------------------------------------------------------------------
```

```
RESULTS OF ANALYSIS ON WINDCW NO.  2
------------------------------------

GEOPHYSICAL CONSTANTS:

G/G    =  .68024000E-14 M**2/GR
RHO.S  =  2600000.0      GR/M**3
RHO.W  =  1030000.0      GR/M**3
RHO.R  =  2950000.0      GR/M**3
RHO.M  =  3400000.0      GR/M**3

OCEAN DEPTH AND CRUST THICKNESS:

C          =  4900.0000      M
T          =  5000.0000      M

RESULTS FROM SEAMOUNT LOCATCR:

T.A        =  145.74795      SEC
T.B        =  151.85393      SEC
T.SM       =  148.80395      SEC
N.A        = -35.552558      M
N.B        = -35.802828      M
N.SM       = -34.796667      M
DELTA.A    = -11.436224      ARC SEC
DELTA.B    =  15.777345      ARC SEC
LONG.SM    =  299.14165      DEG
              299  8 30      DEG,MIN,SEC
LAT.SM     =  38.942604      DEG
              38 56 33       DEG,MIN,SEC

INITIAL ESTIMATES:

B.S     =  41153.715     M
N.C     =  1.4977448     M
PHI.SC  =  9.8951328     DEG

ESTIMATED SEAMOUNT PARAMETERS:
ISOSTATIC COMPENSATION

D.S    =  1093.2883     M
PHI.S  =  5.2848116     DEG
B.S    =  41153.715     M
H.S    =  3806.7117     M
B.R    =  41153.715     M
H.R    =  13281.194     M
```

DATA DISPERSION ANALYSIS ON WINDOW NO. 2

```
AVG. GEOID HT.    =  .41243731E-01 M
AVG. VERT. DEFL. =  .33135406      ARC SEC

SATELLITE VEL. =  6.7840000      KM/SEC
TIME INTERVAL  =         .490024 SEC

EARTH RADIUS =       6378000.0 M
```

UNPERTURBED INPUT PARAMETERS:

```
D      =  4900.0000      M
T      =  5000.0000      M
PHI.S0=  9.8951328      DEG
B.S    =  41153.715      M
N.C    =  1.4977448      M
```

ERROR ESTIMATES:

```
DELTA D      =  490.00000      M
DELTA T      =  500.00000      M
DELTA PHI.S0=  .60457773      DEG
DELTA B.S    =  4654.0519      M
DELTA N.C    = -.44932343      M
```

RESULTS

PARAMETER CHANGED	NEW VALUE	D.S (M)	PHI.S (DEG)	H.S (M)	B.R (M)	H.R (M)	CHANGE IN D.S (M)
D	5390.000	1491.	5.412	3899.	41154.	13604.	397.50
T	5500.000	1171.	5.177	3729.	41154.	13009.	78.154
PHI.S0	10.500	1093.	5.285	3807.	41154.	13281.	0.
B.S	45807.767	1239.	4.569	3661.	45808.	12772.	146.09
N.C	1.048	1919.	4.143	2981.	41154.	10400.	825.81

```
RESULTS OF ANALYSIS ON WINDCW NC.  3
------------------------------------


***** WARNING - ILL-CONCITICNEO CASE *****


GEOPHYSICAL CONSTANTS:

G/G    =  .68024000E-14 M**2/GR
RHO.S =  2600000.0      GR/M**3
RHO.W =  1030000.0      GR/M**3
RHO.R =  2950000.0      GR/M**3
RHO.M =  3400000.0      GR/M**3


OCEAN DEPTH AND CRUST THICKNESS:

D        =  4000.0000     M
T        =  5000.0000     M


RESULTS FROM SEAMOUNT LOCATCR:

T.A      =  265.53176     SEC
T.B      =  270.70577     SEC
T.SM     =  268.05602     SEC
N.A      = -42.206865     M
N.B      = -42.330503     M
N.SM     = -40.359934     M
DELTA.A  = -33.073740     ARC SEC
DELTA.B  =  33.362081     ARC SEC
LONG.SM  =  295.31811     DEG
            295 19  5     DEG,MIN,SEC
LAT.SM   =  32.357068     DEG
            32  21 25     DEG,MIN,SEC


INITIAL ESTIMATES:

B.S     =  32818.998     M
N.C     =  1.5232942     M
PHI.S0 =  24.156746     DEG


ESTIMATED SEAMOUNT PARAMETERS:
ISOSTATIC COMPENSATION

D.S    =  10.000000     M
PHI.S =  6.9317687     DEG
B.S    =  32818.998     M
H.S    =  3990.0000     M
B.R    =  32818.998     M
H.R    =  13920.667     M
```

DATA DISPERSION ANALYSIS ON WINDOW NO. 3

AVG. GEOID HT. = .41243731E-01 M
AVG. VERT. DEFL. = .83135406 ARC SEC

SATELLITE VEL. = 6.7840000 KM/SEC
TIME INTERVAL = .490024 SEC

EARTH RADIUS = 6378000.0 M

UNPERTURBED INPUT PARAMETERS:

D = 4000.0000 M
T = 5000.0000 M
PHI.S0= 24.156746 DEG
B.S = 32818.998 M
N.C = 3.2448749 M

ERROR ESTIMATES:

DELTA D = 400.00000 M
DELTA T = 500.00000 M
DELTA PHI.S0= .60457773 DEG
DELTA B.S = 4654.0519 M
DELTA N.C = -.97346246 M

RESULTS

PARAMETER CHANGED	NEW VALUE	D.S (M)	PHI.S (DEG)	H.S (M)	B.R (M)	H.R (M)	CHANGE IN D.S (M)
D	4400.000	10.	7.619	4390.	32819.	15316.	0.
***** WARNING - ILL-CONDITIONED CASE *****							
T	5500.000	10.	6.932	3990.	32819.	13921.	0.
***** WARNING - ILL-CONDITIONED CASE *****							
PHI.S0	24.761	10.	6.932	3990.	32819.	13921.	0.
***** WARNING - ILL-CONDITIONED CASE *****							
B.S	37473.050	10.	6.078	3990.	37473.	13921.	0.
***** WARNING - ILL-CONDITIONED CASE *****							
N.C	2.271	10.	6.932	3990.	32819.	13921.	0.
***** WARNING - ILL-CONDITIONED CASE *****							

```
            >>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<


      HEADER RECORD
      -------------

REV NUMBER     = 1375
RHO            =    .2120
N              = 3
DELTA TIME     =  .490024 SEC
SATELLITE VEL.=    6.7800 KM/SEC
NO. OF DATA POINTS =  226

***** DATA SEGMENT NOT IN DEFINED AREA, SKIP IT.


            >>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<


      HEADER RECORD
      -------------

REV NUMBER     = 1375
RHO            =    .2120
N              = 3
DELTA TIME     =  .490024 SEC
SATELLITE VEL.=    6.7480 KM/SEC
NO. OF DATA POINTS = 3048

***** DATA SEGMENT NOT IN DEFINED AREA, SKIP IT.


            >>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<


      HEADER RECORD
      -------------

REV NUMBER     = 1375
RHO            =    .2120
N              = 3
DELTA TIME     =  .490024 SEC
SATELLITE VEL.=    6.7800 KM/SEC
NO. OF DATA POINTS = 2206

***** DATA SEGMENT NOT IN DEFINED AREA, SKIP IT.


***********           NBZSE50  //// END OF LIST ////
***********           NBZSE50  //// END OF LIST ////
```

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APPENDIX B

TRIAL DATA FOR A TYPICAL CASE OF GENERAL COMPENSATION

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```
                    S E A M O U N T   D E T E C T O R
                                VERSION EE
                    ------------------------------

          USER INPUT
          ----------

TYPE OF COMPENSATION = GENERAL

CRUST THICKNESS =      5000.00 M

SK =   2.00
HR =    3200.0000       M

L     =  70.00 KM
DELN =   .0200 M

G/G     =    .68024000E-14  M**2/GR
RHO.M =    3400000.0       GR/M**3
RHO.R =    2950000.0       GR/M**3
RHO.S =    2600000.0       GR/M**3
RHO.W =    1030000.0       GR/M**3

K3 =   1.740
K5 =   2.000

COG ROUGHNESS DETECTOR WILL BE USED WITH
F (DATA WINDOW WIDTH FACTOR) =  1.30

REJECT DATA SEGMENTS NOT INSIDE THE AREA BOUNDED BY:
LATITUDE  =    30   60
LONGITUDE =  285  330

** NOTE - ANY DATA SEGMENT WITH FEWER THAN
          80 DATA POINTS WILL BE REJECTED.


          >>>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<


      HEADER RECORD
      -------------

REV NUMBER       = 1375
RHO              =    .2120
N                = 3
DELTA TIME       =  .490024 SEC
SATELLITE VEL.=    6.7840 KM/SEC
NO. OF DATA POINTS =  141

***** DATA SEGMENT NOT IN DEFINED AREA, SKIP IT.
```

```
          >>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<


     HEADER RECORD
     -------------

REV NUMBER     = 1375
RHO            =    .2120
N              = 3
DELTA TIME     =  .490024 SEC
SATELLITE VEL.=   6.7660 KM/SEC
NO. OF DATA POINTS =  156

***** DATA SEGMENT NOT IN DEFINED AREA, SKIP IT.


          >>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<


     HEADER RECORD
     -------------

REV NUMBER     = 1375
RHO            =    .2120
N              = 3
DELTA TIME     =  .490024 SEC
SATELLITE VEL.=   6.7660 KM/SEC
NO. OF DATA POINTS =    8

***** NOT ENOUGH DATA POINTS IN SEGMENT, SKIP IT.


          >>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<


     HEADER RECORD
     -------------

REV NUMBER     = 1375
RHO            =    .2120
N              = 3
DELTA TIME     =  .490024 SEC
SATELLITE VEL.=   6.7790 KM/SEC
NO. OF DATA POINTS = 1645

NUMBER OF DATA POINTS IN EACH WINDOW = 22

NUMBER OF DATA POINTS IN EACH "COG" DERIVED WINDOW = 28
```

```
------------------------------------------------------------------------
WINDOW NO.    1

FIRST:  LATITUDE =   49   20    2 DEG,MIN,SEC
        LONGITUDE= 306   54   36 DEG,MIN,SEC

LAST :  LATITUDE =   48   38   18 DEG,MIN,SEC
        LONGITUDE= 306   17   32 DEG,MIN,SEC

*** REJECTED, MIN. VERT. DEFL. IS LAST  PT.  OF WINDOW ***

------------------------------------------------------------------------


          >>>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<


     HEADER RECORD
     -------------

REV NUMBER      = 1375
RHO             =    .2120
N               = 3
DELTA TIME      =  .490024 SEC
SATELLITE VEL.=    6.7840 KM/SEC
NO. OF DATA POINTS =  994

NUMBER OF DATA POINTS IN EACH WINDOW = 22

NUMBER OF DATA POINTS IN EACH "COG" DERIVED WINDOW = 28
```

```
----------------------------------------------------------------
WINDOW NO.    1

FIRST:  LATITUDE =   46   49   38 DEG,MIN,SEC
        LONGITUDE= 304   45   49 DEG,MIN,SEC

LAST :  LATITUDE =   46    7   21 DEG,MIN,SEC
        LONGITUDE= 304   11   49 DEG,MIN,SEC

*** REJECTED, MIN. VERT. DEFL. IS FIRST PT.  OF WINDOW ***

----------------------------------------------------------------
WINDOW NO.    2

FIRST:  LATITUDE =   39   16   57 DEG,MIN,SEC
        LONGITUDE= 299   21   24 DEG,MIN,SEC

LAST :  LATITUDE =   38   33   28 DEG,MIN,SEC
        LONGITUDE= 298   54    0 DEG,MIN,SEC

ACCEPTED FOR FURTHER ANALYSIS

----------------------------------------------------------------
WINDOW NO.    3

FIRST:  LATITUDE =   32   45   59 DEG,MIN,SEC
        LONGITUDE= 295   32   21 DEG,MIN,SEC

LAST :  LATITUDE =   32    1   50 DEG,MIN,SEC
        LONGITUDE= 295    8   35 DEG,MIN,SEC

ACCEPTED FOR FURTHER ANALYSIS

----------------------------------------------------------------
```

```
RESULTS OF ANALYSIS ON WINDOW NO.  2
------------------------------------

GEOPHYSICAL CONSTANTS:

G/G    =   .00024000E-14  M**2/GR
RHO.S =   2600000.0       GR/M**3
RHO.W =   1030000.0       GR/M**3
RHO.K =   2950000.0       GR/M**3
RHO.M =   3400000.0       GR/M**3


OCEAN DEPTH AND CRUST THICKNESS:

D          =   4900.0000      M
T          =   5000.0000      M


GENERAL COMPENSATION DATA:

SK   =   2.0000000
H.R =   3200.0000       M


RESULTS FROM SEAMOUNT LOCATOR:

T.A        =   145.74795      SEC
T.B        =   151.85393      SEC
T.SM       =   148.80395      SEC
N.A        =  -35.552558      M
N.B        =  -35.802828      M
N.SM       =  -34.796667      M
DELTA.A =  -11.436224      ARC SEC
DELTA.B =   15.777345      ARC SEC
LONG.SM =   299.14165      DEG
               299   8 30      DEG,MIN,SEC
LAT.SM    =   38.942604      DEG
               38 56 33       DEG,MIN,SEC


INITIAL ESTIMATES:

B.S       =   41153.715      M
N.C       =   1.4977448      M
PHI.S0 =   9.8951328      DEG


ESTIMATED SEAMOUNT PARAMETERS:
GENERAL    COMPENSATION

D.S     =   1932.4862      M
PHI.S =   4.1243482      DEG
B.S     =   41153.715      M
H.S     =   2967.5138      M
B.R     =   82307.429      M
H.R     =   3200.0000      M
```

DATA DISPERSION ANALYSIS ON WINDOW NO. 2

AVG. GEOID HT. = .41243731E-01 M
AVG. VERT. DEFL. = .83135406 ARC SEC

SATELLITE VEL. = 6.7840000 KM/SEC
TIME INTERVAL = .490024 SEC

EARTH RADIUS = 6378000.0 M

UNPERTURBED INPUT PARAMETERS:

D = 4900.0000 M
T = 5000.0000 M
PHI.SO= 9.8951328 DEG
B.S = 41153.715 M
N.C = 1.4977448 M

ERROR ESTIMATES:

DELTA D = 490.00000 M
DELTA T = 500.00000 M
DELTA PHI.SO= .60457773 DEG
DELTA B.S = 4654.0519 M
DELTA N.C = -.44932343 M

RESULTS

PARAMETER CHANGED	NEW VALUE	D.S (M)	PHI.S (DEG)	H.S (M)	B.R (M)	H.R (M)	CHANGE IN D.S (M)
D	5390.000	2378.	4.186	3012.	82307.	3200.0	445.70
T	5500.000	1948.	4.103	2952.	82307.	3200.0	15.330
PHI.SO	10.500	1932.	4.124	2968.	82307.	3200.0	0.
B.S	45807.767	2063.	3.544	2837.	91616.	3200.0	130.09
N.C	1.048	2296.	3.620	2604.	82307.	3200.0	363.78

RESULTS OF ANALYSIS ON WINDOW NO. 3

***** WARNING - ILL-CONDITIONED CASE *****

GEOPHYSICAL CONSTANTS:

```
G/G    =  .66024000E-14 M**2/GR
RHO.S  =  2600000.0     GR/M**3
RHO.W  =  1030000.0     GR/M**3
RHO.R  =  2950000.0     GR/M**3
RHO.M  =  3400000.0     GR/M**3
```

OCEAN DEPTH AND CRUST THICKNESS:

```
D         =  4000.0000     M
T         =  5000.0000     M
```

GENERAL COMPENSATION DATA:

```
SK  =  2.0000000
H.R =  3200.0000     M
```

RESULTS FROM SEAMOUNT LOCATOR:

```
T.A       =  265.53176     SEC
T.B       =  270.70577     SEC
T.SM      =  268.05602     SEC
N.A       = -42.206865     M
N.B       = -42.330503     M
N.SM      = -40.359934     M
DELTA.A   = -33.073740     ARC SEC
DELTA.B   =  33.362081     ARC SEC
LONG.SM   =  295.31811     DEG
             295 19  5     DEG,MIN,SEC
LAT.SM    =  32.357068     DEG
             32 21 25      DEG,MIN,SEC
```

INITIAL ESTIMATES:

```
B.S     =  32018.998     M
N.C     =  2.3492570     M
PHI.S0  =  24.156746     DEG
```

ESTIMATED SEAMOUNT PARAMETERS:
GENERAL   COMPENSATION

```
D.S    =  10.000000     M
PHI.S  =  6.9317687     DEG
B.S    =  32018.998     M
H.S    =  3990.0000     M
B.R    =  65637.996     M
H.R    =  3200.0000     M
```

DATA DISPERSION ANALYSIS ON WINDOW NO. 3

AVG. GEOID HT. = .41243731E-01 M
AVG. VERT. DEFL. = .83135406 ARC SEC

SATELLITE VEL. = 6.7840000 KM/SEC
TIME INTERVAL = .490024 SEC

EARTH RADIUS = 6378000.0 M

UNPERTURBED INPUT PARAMETERS:

D	=	4000.0000	M
T	=	5000.0000	M
PHI.SO	=	24.156746	DEG
B.S	=	32818.998	M
N.C	=	3.2448749	M

ERROR ESTIMATES:

DELTA D	=	400.00000	M
DELTA T	=	500.00000	M
DELTA PHI.SO	=	.60457773	DEG
DELTA B.S	=	4654.0519	M
DELTA N.C	=	-.97346246	M

RESULTS

PARAMETER CHANGED	NEW VALUE	D.S (M)	PHI.S (DEG)	H.S (M)	B.R (M)	H.R (M)	CHANGE IN D.S (M)
D	4400.000	10.	7.619	4390.	65638.	3200.0	0.
***** WARNING - ILL-CONDITIONED CASE *****							
T	5500.000	10.	6.932	3990.	65638.	3200.0	0.
***** WARNING - ILL-CONDITIONED CASE *****							
PHI.SO	24.761	10.	6.932	3990.	65638.	3200.0	0.
***** WARNING - ILL-CONDITIONED CASE *****							
B.S	37473.050	10.	6.078	3990.	74946.	3200.0	0.
***** WARNING - ILL-CONDITIONED CASE *****							
N.C	2.271	82.	6.809	3918.	65638.	3200.0	71.523

```
            >>>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<<


      HEADER RECORD
      -------------

REV NUMBER      = 1375
RHO             =    .2120
N               = 3
DELTA TIME      =  .490024 SEC
SATELLITE VEL.=    6.7800 KM/SEC
NO. OF DATA POINTS =  226

***** DATA SEGMENT NOT IN DEFINED AREA, SKIP IT.


            >>>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<<


      HEADER RECORD
      -------------

REV NUMBER      = 1375
RHO             =    .2120
N               = 3
DELTA TIME      =  .490024 SEC
SATELLITE VEL.=    6.7480 KM/SEC
NO. OF DATA POINTS = 3048

***** DATA SEGMENT NOT IN DEFINED AREA, SKIP IT.


            >>>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<<


      HEADER RECORD
      -------------

REV NUMBER      = 1375
RHO             =    .2120
N               = 3
DELTA TIME      =  .490024 SEC
SATELLITE VEL.=    6.7600 KM/SEC
NO. OF DATA POINTS = 2206

***** DATA SEGMENT NOT IN DEFINED AREA, SKIP IT.


***********            NBZSE5N  //// END OF LIST ////
***********            NBZSE5N  //// END OF LIST ////
```

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APPENDIX C

TRIAL DATA FOR ABSENCE OF ROOT

```
                                        S E A M O U N T   D E T E C T O R
                                                     VERSION EF
                                        ---------------------------------


            USER INPUT
            ----------

TYPE OF COMPENSATION = GENERAL - UNCOMPENSATED

CRUST THICKNESS =    5000.00 M

SK =  2.00
HR =   .10000000E-05 M

L    =  70.00 KM
DELN =  .0200 M

G/G    =   .68024000E-14 M**2/GR
RHO.M =   3400000.0      GR/M**3
RHO.R =   2950000.0      GR/M**3
RHO.S =   2600000.0      GR/M**3
RHO.W =   1030000.0      GR/M**3

K3 =  1.740
K5 =  2.000

COG ROUGHNESS DETECTOR WILL BE USED WITH
F (DATA WINDOW WIDTH FACTOR) =  1.30

REJECT DATA SEGMENTS NOT INSIDE THE AREA BOUNDED BY:
LATITUDE  =   30   60
LONGITUDE =  285   330

** NOTE - ANY DATA SEGMENT WITH FEWER THAN
          80 DATA POINTS WILL BE REJECTED.


          >>>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<


     HEADER RECORD
     -------------

REV NUMBER       = 1375
RHO              =    .2120
N                = 3
DELTA TIME       =  .490024 SEC
SATELLITE VEL.=    6.7840 KM/SEC
NO. OF DATA POINTS =  141

***** DATA SEGMENT NOT IN DEFINED AREA, SKIP IT.
```

```
>>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<

      HEADER RECORD
      -------------

REV NUMBER     = 1375
RHO            =    .2120
N              = 3
DELTA TIME     =  .490024 SEC
SATELLITE VEL.=    6.7660 KM/SEC
NO. OF DATA POINTS =  156

***** DATA SEGMENT NOT IN DEFINED AREA, SKIP IT.

          >>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<

      HEADER RECORD
      -------------

REV NUMBER     = 1375
RHO            =    .2120
N              = 3
DELTA TIME     =  .490024 SEC
SATELLITE VEL.=    6.7660 KM/SEC
NO. OF DATA POINTS =     8

***** NOT ENOUGH DATA POINTS IN SEGMENT, SKIP IT.

          >>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<

      HEADER RECORD
      -------------

REV NUMBER     = 1375
RHO            =    .2120
N              = 3
DELTA TIME     =  .490024 SEC
SATELLITE VEL.=    6.7790 KM/SEC
NO. OF DATA POINTS = 1645

NUMBER OF DATA POINTS IN EACH WINDOW = 22

NUMBER OF DATA POINTS IN EACH "COG" DERIVED WINDOW = 28
```

```
---------------------------------------------------------------------
WINDOW NO.    1

FIRST:   LATITUDE =   49   20    2 DEG,MIN,SEC
         LONGITUDE= 306   54   36 DEG,MIN,SEC

LAST :   LATITUDE =   48   38   18 DEG,MIN,SEC
         LONGITUDE= 306   17   32 DEG,MIN,SEC

*** REJECTED, MIN. VERT. DEFL. IS LAST  PT.  OF WINDOW ***

---------------------------------------------------------------------


          >>>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<<


     HEADER RECORD
     -------------

REV NUMBER     = 1375
RHO            =    .2120
N              = 3
DELTA TIME     =   .490024 SEC
SATELLITE VEL.=    6.7840 KM/SEC
NO. OF DATA POINTS =  994

NUMBER OF DATA POINTS IN EACH WINDOW = 22

NUMBER OF DATA POINTS IN EACH "COG" DERIVED WINDOW = 28
```

```
------------------------------------------------------------------------
WINDOW NO.   1

FIRST:  LATITUDE =   46   49   38 DEG,MIN,SEC
        LONGITUDE= 304   45   49 DEG,MIN,SEC

LAST :  LATITUDE =   46    7   21 DEG,MIN,SEC
        LONGITUDE= 304   11   49 DEG,MIN,SEC

*** REJECTED, MIN. VERT. DEFL. IS FIRST PT.  OF WINDOW ***

------------------------------------------------------------------------
WINDOW NO.   2

FIRST:  LATITUDE =   39   16   57 DEG,MIN,SEC
        LONGITUDE= 299   21   24 DEG,MIN,SEC

LAST :  LATITUDE =   38   33   28 DEG,MIN,SEC
        LONGITUDE= 298   54    0 DEG,MIN,SEC

ACCEPTED FOR FURTHER ANALYSIS

------------------------------------------------------------------------
WINDOW NO.   3

FIRST:  LATITUDE =   32   45   59 DEG,MIN,SEC
        LONGITUDE= 295   32   21 DEG,MIN,SEC

LAST :  LATITUDE =   32    1   50 DEG,MIN,SEC
        LONGITUDE= 295    8   35 DEG,MIN,SEC

ACCEPTED FOR FURTHER ANALYSIS

------------------------------------------------------------------------
```

```
RESULTS OF ANALYSIS ON WINDOW NC.  2
------------------------------------

GEOPHYSICAL CONSTANTS:

G/G    =  .68024000E-14 M**2/GR
RHO.S =  2600000.0      GR/M**3
RHO.W =  1030000.0      GR/M**3
RHO.R =  2950000.0      GR/M**3
RHO.M =  3400000.0      GR/M**3


OCEAN DEPTH AND CRUST THICKNESS:

D         =  4900.0000      M
T         =  5000.0000      M


GENERAL COMPENSATION DATA:

SK  =  2.0000000
H.R =  .10000000E-05 M


RESULTS FROM SEAMOUNT LOCATOR:

T.A       =  145.74795      SEC
T.B       =  151.85393      SEC
T.SM      =  148.80395      SEC
N.A       = -35.552558      M
N.B       = -35.802828      M
N.SM      = -34.796667      M
DELTA.A = -11.436224      ARC SEC
DELTA.B =  15.777345      ARC SEC
LONG.SM =  299.14165      DEG
             299  8 30      DEG,MIN,SEC
LAT.SM  =  38.942604      DEG
             38 56 33       DEG,MIN,SEC


INITIAL ESTIMATES:

B.S     =  41153.715      M
N.C     =  1.4977448      M
PHI.S0 =  9.3951328      DEG


ESTIMATED SEAMOUNT PARAMETERS:
GENERAL    COMPENSATION - NO ROOT

D.S    =  3588.2760       M
PHI.S =  1.8256144      DEG
B.S    =  41153.715       M
H.S    =  1311.7240       M
B.R    =  82307.429       M
H.R    =  .10000000E-05 M
```

DATA DISPERSION ANALYSIS ON WINDOW NO. 2

AVG. GEOID HT. = .41243731E-01 M
AVG. VERT. DEFL. = .83135406 ARC SEC

SATELLITE VEL. = 6.7840000 KM/SEC
TIME INTERVAL = .490024 SEC

EARTH RADIUS = 6378000.0 M

UNPERTURBED INPUT PARAMETERS:

D	=	4900.0000	M
T	=	5000.0000	M
PHI.SO	=	9.8951328	DEG
B.S	=	41153.715	M
N.C	=	1.4977448	M

ERROR ESTIMATES:

DELTA D	=	490.00000	M
DELTA T	=	500.00000	M
DELTA PHI.SO	=	.60457773	DEG
DELTA B.S	=	4654.0519	M
DELTA N.C	=	-.44932343	M

RESULTS

PARAMETER CHANGED	NEW VALUE	D.S (M)	PHI.S (DEG)	H.S (M)	B.R (M)	H.R (M)	CHANGE IN D.S (M)
D	5390.000	4052.	1.862	1338.	82307.	.10000E-05	464.07
T	5500.000	3588.	1.826	1312.	82307.	.10000E-05	.54133E-08
PHI.SO	10.500	3588.	1.826	1312.	82307.	.10000E-05	0.
B.S	45807.767	3740.	1.450	1160.	91616.	.10000E-05	151.81
N.C	1.048	3976.	1.287	924.	82307.	.10000E-05	387.39

RESULTS OF ANALYSIS ON WINDOW NO. 3

GEOPHYSICAL CONSTANTS:

```
G/G    =  .66024000E-14 M**2/GR
RHO.S =  2600000.0      GR/M**3
RHO.W =  1030000.0      GR/M**3
RHO.P =  2950000.0      GR/M**3
RHO.M =  3400000.0      GR/M**3
```

OCEAN DEPTH AND CRUST THICKNESS:

```
D         =  4000.0000      M
T         =  5000.0000      M
```

GENERAL COMPENSATION DATA:

```
SK  =  2.0000000
H.R =  .10000000E-05 M
```

RESULTS FROM SEAMOUNT LOCATOR:

```
T.A       =  265.53176      SEC
T.B       =  270.70577      SEC
T.SM      =  268.05602      SEC
N.A       = -42.206865      M
N.B       = -42.330503      M
N.SM      = -40.359934      M
DELTA.A   = -33.073740      ARC SEC
DELTA.B   =  33.362081      ARC SEC
LONG.SM   =  295.31811      DEG
             295 19  5      DEG,MIN,SEC
LAT.SM    =  32.357068      DEG
             32 21 25       DEG,MIN,SEC
```

INITIAL ESTIMATES:

```
B.S      =  32818.998     M
N.C      =  3.2448749     M
PHI.S0   =  24.156746     DEG
```

ESTIMATED SEAMOUNT PARAMETERS:
GENERAL   COMPENSATION - NO ROOT

```
D.S    =  613.88354      M
PHI.S  =  5.8906771      DEG
B.S    =  32818.998      M
H.S    =  3386.1165      M
B.R    =  65637.996      M
H.R    =  .10000000E-05  M
```

DATA DISPERSION ANALYSIS ON WINDOW NO. 3

AVG. GEOID HT. = .41243731E-01 M
AVG. VERT. DEFL. = .83135406 ARC SEC

SATELLITE VEL. = 6.7840000 KM/SEC
TIME INTERVAL = .490024 SEC

EARTH RADIUS = 6378000.0 M

UNPERTURBED INPUT PARAMETERS:

D = 4000.0000 M
T = 5000.0000 M
PHI.SO= 24.156746 DEG
B.S = 32818.998 M
N.C = 3.2448749 M

ERROR ESTIMATES:

DELTA D = 400.00000 M
DELTA T = 500.00000 M
DELTA PHI.SO= .60457773 DEG
DELTA B.S = 4654.0519 M
DELTA N.C = -.97346246 M

RESULTS

PARAMETER CHANGED	NEW VALUE	D.S (M)	PHI.S (DEG)	H.S (M)	B.R (M)	H.R (M)	CHANGE IN D.S (M)
D	4400.000	943.	6.013	3457.	65638.	.10000E-05	329.17
T	5500.000	614.	5.891	3386.	65638.	.10000E-05	.58208E-08
PHI.SO	24.761	614.	5.891	3386.	65638.	.10000E-05	1.
B.S	37473.050	1055.	4.494	2945.	74946.	.10000E-05	440.70
N.C	2.271	1571.	4.232	2429.	65638.	.10000E-05	957.46

```
          >>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<

     HEADER RECORD
     -------------

REV NUMBER     = 1375
RHO            =    .2120
N              = 3
DELTA TIME     =  .490024 SEC
SATELLITE VEL.=    6.7800 KM/SEC
NO. OF DATA POINTS =  226

***** DATA SEGMENT NOT IN DEFINED AREA, SKIP IT.

          >>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<

     HEADER RECORD
     -------------

REV NUMBER     = 1375
RHO            =    .2120
N              = 3
DELTA TIME     =  .490024 SEC
SATELLITE VEL.=    6.7480 KM/SEC
NO. OF DATA POINTS = 3048

***** DATA SEGMENT NOT IN DEFINED AREA, SKIP IT.

          >>>>>>>>>> PROCESS NEW DATA SEGMENT <<<<<<<<<<

     HEADER RECORD
     -------------

REV NUMBER     = 1375
RHO            =    .2120
N              = 3
DELTA TIME     =  .490024 SEC
SATELLITE VEL.=    6.7800 KM/SEC
NO. OF DATA POINTS = 2206

***** DATA SEGMENT NOT IN DEFINED AREA, SKIP IT.

***********          NBZSE5L  //// END OF LIST ////
***********          NBZSE5L  //// END OF LIST ////
```

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