NOTES ON THE
PROCESSING AND PRESENTATION OF
U.S. GEOLOGICAL SURVEY
ALASKAN GRAVITY DATA

by

DAVID F. BARNES

UNITED STATES GEOLOGICAL SURVEY

Menlo Park, California

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PREPARED WITH SUPPORT OF

U.S. ARMY TOPOCOM

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Introduction

The author's techniques for handling Alaskan gravity data represent a series of preliminary attempts to adapt the peculiarities of Alaskan data to other formats designed primarily for gravity data collected by the Geological Survey in other parts of the United States. The Alaskan gravity surveys differ in important ways from most of the surveys in more southern latitudes. Each difference leads to several desirable changes in the methods of processing and presenting the data, but the expanding use of digital computers for reducing, storing and analysing the data has also made compatibility of formats between Alaskan and other U.S. data very desirable. The present card input formats for Alaskan gravity data grew out of those used by the Geological Survey's first digital gravity reduction program in the early 1960's, and the present card output format closely resembles a format adapted in conferences between Alaskan and Californian investigators in 1967. The printed outputs and data presentations are now very different, but many of the computation procedures and programming techniques are similar. Furthermore, the Alaskan techniques have generally been delayed until after the systems for handling other U.S. data were well established. These brief notes can thus reference previously well-established techniques, and concentrate on special features, which are considered desirable for the Alaskan data. The present procedures were initiated early in the 1960s, and have or probably will be used for all field data collected between 1958 and 1971, and perhaps for some earlier data collected by the Navy in the 1940s. A slightly improved input format and some changes in documentation may be adopted for the 1972 field data, but the present notes are designed to cover a large amount of earlier data. Before discussing specific procedures and formats, the three fundamental differences between the Alaskan surveys and most of those in more southern latitudes should be briefly mentioned.

First, the primary Alaskan objective is not a detailed study of specific geologic features but a reconnaissance survey of the whole state designed to stimulate and to provide a framework for future more-detailed surveys (Barnes, 1965 and 1969). Thus the Alaskan reconnaissance is designed to include a reasonable number of reoccupiable stations plus a basis for future upgrading of the data. Furthermore, the breadth of coverage and the necessity for using a variety of transportation techniques have prevented a systematic area-by-area approach and caused each area to be attacked first with low-cost transportation techniques and then with increasingly costly transportation systems until adequate coverage is obtained. Thus a simple chronological listing of station numbers would follow a bewildering geographical pattern.

Second, Alaskan geodetic control is still so limited that good elevations are difficult to obtain either by leveling or by photogrammetry between widely spaced control points. The topographic maps completed since World War II provide reasonable horizontal control, but their contour intervals are either 100 or 200 feet, Spot elevations are scarce and probably have accuracies of about half a contour interval. This scarcity of precise elevations has caused extensive use of altimetry, which has greatly complicated the data reduction and the detection of survey errors. Some method for indicating the source and estimated accuracy of the elevations was thus considered essential for the data presentation. Furthermore, the altimetry probably provides elevations consistent with the requirements of regional surveys, but in local areas, some users may consider photogrammetric elevations more precise. Thus much of the Alaskan gravity data presentation shows both the elevation and any available photogrammetry elevations, their resulting simple Bouguer anomalies, and a preliminary judgment of which elevations and which anomalies are considered preferable for the reconnaissance objectives. Furthermore, the Alaskan geodetic and topographic control is improving, and future maps may provide a basis for upgrading these reconnaissance gravity data at any places where the gravity data are referenced to surfaces which can be identified and given more accurate elevations on future topographic maps and surveys. The reconnaissance gravity survey has thus emphasized the use of transportation routes, water bodies, and aircraft landing sites where better elevations may later be available, and the data presentation shows how the station elevations differ from these reference surfaces.

Third, travel difficulties and the necessity for making many long water traverses has often prevented the looping procedures which are usually used to control and detect the drift of gravimeters. LaCoste meters, which have low drift, have been used for most long traverses since 1961, and aircraft have been used to establish control points along these long traverses. However, older, non-thermostated meters had to be used on a few of the earlier traverses, and inter-traverse control points have not always been recovered. The data presentation is thus designed to reveal the progress of the field work and any factors which might affect the accuracy of the gravimetry. Unusual meter drift, tares, questionable measurements or poor meter performance are specifically identified within the data which are made available to the public.

Data Processing Procedures

The processing of USGS Alaska gravity data involves about six basic steps and four frequently-used computer programs. In some ways the initial processing begins in the field where all observations are recorded on data sheets which can later be used for punching of cards for computer input. Most field locations are also recorded on 1:63,360 field maps or 1:250,000 maps if the former are not available. Each evening field compilation maps on a scale of 1:250,000 are also prepared so that the progress of the coverage is apparent and so that a separate record of locations is available. Some preliminary latitude measurements are also made, and these meter readings and elevations can be used with a specially designed circular slide rule to immediately calculate preliminary simple-Bouguer anomalies.

Soon after the return from the field, all base station observations are run through a base station reduction program which converts the meter readings to milligal differences according to the manufacturer's calibration curves and their USGS corrections (Barnes, 1969). This program also performs corrections for earth tide fluctuations according to slightly modified versions of Longman's (1959) formulas, calculates new observed gravities, calculates milligal differences between each station and selected base stations plus adjacent stations, and compares the new observed gravities with any previously established observed gravities. Even when few repeated readings or closed loops are included in a data set, the latter facility permits the computer to plot a preliminary drift curve for each one- to four-day period, so that the interpreter has a preliminary indication of meter performance. Then for each base station a list is prepared showing the dates of occupations, the durations of ties and the milligal differences to nearby stations. Base-station values are then established from these sheets and from the preliminary drift curves. Finally, all new base-station values are punched onto the computer cards, and the data are run through the same computer program to obtain final drift curves for each meter's performance. This plot also provides a good indication of any badly adjusted base-station values.

In the office, the original field sheets are also attached to supplementary sheets on which latitudes, longitudes, reference elevations, base-station references, source codes and weather data for reducing the altimeter observations are also recorded. Transparent templates are usually used for measuring latitudes and longitudes. Reference elevations are obtained either from maps, geodetic control summaries, special surveys, calculation of ocean tidal elevations, or plotting of river gradients. The curves of ocean-tide elevations are plotted according to the methods, data and predicted values given in annual editions of the West Coast Tide Tables (U.S. Dept. of Commerce), and the reference datum used is mean-tide level rather than mean sea level, which is used for geodetic data on land.

River-gradient graphs are prepared using mid-channel distances, all available spot elevations, all contour crossings, and all bench marks recovered along the river traverse. These various sources of river elevation data are not always consistent, and altimetry may suggest additional variations in river gradient, so the gradient plots involve several possibilities for human judgment and errors. The height-from-reference column of the gravity data sheet may thus be especially useful when including the river-traverse data in future surveys. Data for reducing the altimeter field observations include either readings of recording base stations or data for linear interpolation of barometric changes between readings at known elevations, plus air temperatures, wet-bulb depressions obtained with a sling psychrometer, and various special corrections. The techniques for handling the altimetry are still being perfected and are sufficiently complicated to be discussed in a separate paper at a later date.

These combined sheets of field and office data are then used for punching the gravity-altimetry input cards which are processed by a second Fortran computer program which provides a listing of all input data and preliminary calculations of simple Bouguer anomalies using both the map (or reference) elevations and the altimetry elevations. The sheets used to prepare the card input and the sheets giving the output of this computer program are bound opposite each other in loose-leaf notebooks and provide a good system for proof-reading and locating errors. Furthermore, all data are plotted on maps from these notebooks and this process provides another opportunity for error detection. Finally, this program provides an easy method of comparing the altimetry data with other elevation data, for evaluating its accuracy, and for deciding whether the altimetry or reference elevation is the more precise. As a result additional punches can be made in the input cards to specify the better elevation source, the estimated altimeter accuracy, and the estimated anomaly accuracy. These cards are then resubmitted for a final computer processing, which prepares a simplified output sheet that summarizes the data for public release.

Latitudes and longitudes are also checked by a transverse-mercator plotting program using the formulas of Plouff (1968), which reads all the reduction card decks, skips the lead cards, sorts the station data into arrays organized for efficient plotting, and then plots as many maps as desired showing: station locations, station identifications and anomaly values for each specified latitude and longitude range. Most Alaskan gravity data sets cover two to ten 1x2 or 1x3 degree 1:250,000 maps, and this scale is usually used for checking the latitudes and longitudes and will now be used for most preliminary data releases. The most common location errors occur when data on 1:63,360 field maps are transferred to the 1:250,000 maps, so xerox reduction techniques are being increasingly used to reduce this type of error.

The computer programs are still being revised and are not yet ready for publication, but the basic formulaes for the gravity reduction are those involving 1931 International Ellipsoid and the second-order latitude and elevation terms in the free-air correction. These gravity formulas are identical to those used for other releases of Geological Survey gravity data and have also been summarized by Sheibe & Howard (1964). The standard reduction density of 2.67 g/cc is always used and a supplementary reduction density is usually either 2.85 g/cc near coastlines or mafic rocks, or 2.20 g/cc for sedimentary basins. Most of the Alaskan elevation control does not justify terrain corrections but these have been made on a few stations, which were used for model studies and quantitative interpretations. Therefore Alaskan terrain corrections are usually considered part of the interpretation process and are not involved in data releases. Formulas for the correction and reduction of the altimetry data are either taken directly from or simplified from those of the Smithsonian Institute (1939).

Description of data tabulation sheets

The first two lines of the data tabulation sheets give the facts that apply to each sheet or data set plus some additional words which are added for explanation and reading clarity. These two lines are used to summarize the most important facts from data originally punched on the primary lead card plus as many as twenty supplementary gravity-base or altimetry-base lead cards. The lengths of some of the phrases are thus limited by available columns on the cards, so that abbreviations or shortened spellings appear in some places. Such column limitations are especially noticable on the traverse names which follow the convention of the original 1959 USGS gravity reduction program which restricted project and traverse names to ten characters. The Alaska project names (Southeast, North Interior, Peninsula, etc.) are arbitrarily assigned to large areas of the state which have convenient boundaries for dividing the gravity data and these boundaries were outlined in Figure 1 of the initial base station report (Barnes, 1968). Although the project names should be easily recognized, familiarity with local geography may be needed to understand such abbreviated traverse names as "KEND-HESSA," "PETB-RD-AL," or "N BEHM ENT," which represent "Kendrick Bay to Hessa Inlet," "Petersburg road altimetry," and "North entrance of Behm Canal" respectively. The project-chief name is fairly obvious and is recorded only so that a proper contact can be made at the Geological Survey to locate the man, who stores the original field and computation sheets, and who can best answer questions about the data. The datum statement references a report which describes the gravity base network and which lists the base station names, their descriptions and principal facts. The datum dates may, however, be a little confusing, because some may suggest an earlier release date for the base station report than actually took place. For example, when the southeast Alaska gravity cards were punched, a 1971 release date was planned for the base-station report, but the actual release will not occur until 1972.

The final item of the first line is a data-set code name, which is punched on all output cards, and which enables the card user to identify the data set from which the card originated. It can thus be used to determine the date of the measurement, the meter used, the observers, the bases occupied, the densities used in reduction and a variety of supplementary information which may be desired if the data appear questionable. If any user of Alaskan gravity data has specific questions about any of the data, he should contact the project chief and as a minimum specify the station number and data-set code. Desirable supplementary information might include: the project name, the traverse name, observation date, observation time, and meter name. All the USGS Alaskan data-set code names begin with the letter "A", but the letter "U" is being used as the first letter in code names for gravity data collected by the Navy and United Geophysical Corp. in the Naval Petroleum Reserve. The second letter is usually an indication of the year and/or area where the work was performed. Thus the prefixes "AM" and "AP" specify most of the data from small-boat traverses in southeast Alaska in 1968 and 1969 respectively, but "AN" and "AQ" refer to other 1968 and 1969 traverses which may have partly included southeast Alaskan data. The last two digits are basicly a chronological series with each number representing one day's work with one meter. The data releases may not include a continuous series of data set codes because traverses in other areas or which do not involve new stations are omitted from the releases; thus the data releases do not list all base-station observations or field-checking traverses.

The second line should also be understandable to the reader, but a few notes may clarify special conditions and conventions. The date is the date of the field work or more exactly the date on which the field work began; a few data sets include more than one day's work and may be identified by observation times which exceed 2400 in the tabulations. Meter names should also be easily recognized and follow the convention that the letters L, G, W, and WW indicate old LaCoste meters, LaCoste Geodetic meters, Worden meters and World Wide meters respectively.

Observers' names, like traverse names, must be limited to a specified number of letters and thus include abbreviated spellings. Most field parties begin the day with one man reading the meter and the second man recording and/or navigating, but the roles are usually reversed one to three times each day.

The "Main Base" specifies a four-letter name of a base station, which is described in the gravity base-station report referenced by the datum statement. The "main base" is that one of the bases occupied during the day, for which the base station data are given on the first of up to 9 base station cards. Each base station card gives one or two meter readings at that station, the times of these readings, the adjusted observed gravity at the station, and the location data necessary for calculating tidal corrections. The base selected for the first card is usually the first station occupied during the day, but it may also be another base occupied during the day which was listed first because it may have been the best established station, the best reading to use for that day's data, or included readings revealing drift or tares which were considered important in that day's data. If two readings were made at that station or if a second reading was computed on the basis of a later reading at another base station, this main-base drift is listed following the station's "Value" or observed gravity. If the main-base card does not include a second reading, the recorded "drift" will be zero even if drift or tares were revealed by readings at other base stations. Whenever, the data reveal drift or tares exceeding 0.10 mgal, an effort was made to show it either as drift or by a statement at the bottom of the data set. The present format provides for printing at the end of the second line the names of two other base stations which were occupied during that day. Other base or control stations occupied may appear in the listing but only three stations are listed in the second header line. Many Alaskan gravity traverses occupied several base or control stations each day, and a later version of the program may list all these occupations as header information and then list only newly read or established stations in the main listing. Users who would prefer this format should contact the author.

The station listing includes the names and data for all stations occupied during a day's field work unless the observation was discarded because it included an inaccurate measurement. Thus, base-station measurements may appear several times in the listing, but only one output card is supplied for each station. The base and control stations are included in the listing primarily because several potential users have stated that they would prefer a total listing of a day's data to an edited listing showing only new measurements.

The tabulation provides for two station numbers: a main number and an auxiliary number. The auxiliary number in some cases is an old number used for the station, and in other cases merely provides additional information about the station. Typical additional information includes identification of the station as a base, an indication of the type of field mark, or available reoccupation information. Thus typical phrases in the auxiliary number column may be "BASE" (for base stations), "MARK" (for USGS gravity marker), TBM1 (for tidal bench mark number 1), TB11 (for tidal bench mark number 11), FOTO (to indicate a photograph was taken), DESC (to indicate a description suitable for reoccupation is available), or a "/" followed by letters or numbers indicating the name of a vertical angle bench mark or triangulation station. A more complete list of station naming and description conventions is included at the end of these notes. Latitudes and longitudes are given in degrees plus minutes and hundredths of minutes. The location-type column gives a letter indicating the kind of map used for the field work and for the measurements of latitude and longitudes. The most common location type is a letter "A" indicating measurements from a modern inch-to-the-mile map, but users should be careful about letters "B" indicating doubtful locations on such maps. If such maps were used for latitude and longitude measurements of stations located in the field on smaller scale maps, the same letter "D" will be used if the transfer justifies the improved precision, but the letter "K" for 4-inch-per-mile maps would be used if these were the original field map and if this scale map seemed to control the precision of the location. Letters early in the alphabet usually indicate the use of better maps than later letters in the alphabet.

The next three columns give elevation data which are recorded in feet. No decimal or fractional parts of a foot have been listed because very few elevations are that well known in Alaska, where most of the bench marks on even first-order level lines have been influenced by frost action. The first column "HT-REF" is the altitude of the station above any nearby reference surface such as a lake, river, stream, roadway, bench mark or hill-top. This information is given even if the elevation of the surface is not known and an altimetry measurement is given in the next column. However, a zero does not necessarily mean that the station was right at the waterline, although a few measurements of this type are made on calm days. Most zeros in this column mean that no height-from-reference was measured, that the station elevation could not be referenced to a surface, or that the elevation was determined from other types of data or during previous occupations of the same station. The height-from-reference is generally estimated if the station is less than about 4 feet vertically and/or 20 feet horizontally away from the reference surface; hand levels are used when the station is farther away from the reference surface. The "elevation type" column gives a letter which indicates the source of the elevation. The Alaskan letter code for this column has been used since 1963 and was thus developed earlier than a similar code used in gravity surveys in California (Oliver and others, written communication, 1969, p. 40). The Alaskan code is not completely satisfactory, but has and will serve its special needs until a more useful and general code is established. For easy use the code is broken into four groups of letters in successive portions of the alphabet, and some of the letters have also been chosen for mnemonic purposes. A few clues can thus eliminate a lot of memorization and/or page turning for the user. The letters A through E indicate a decreasing quality of surveyed or listed elevations, with A representing the best tidal or surveyed elevations, C mnemonically representing sea level, and E representing a variety of reported elevations some of which turn out to be estimated. The next four letters (F through I) are for elevations printed on USGS topographic maps. The F is used for field-checked elevations which were printed in black on all the pre-1970 maps, but which has less meaning on the newer maps. The meaning of the letters G, H, and I should be fairly easy if the user remembers they stand for "ground (brown) spot elevations" "hydro (blue lake and river) elevations," and "interim or unpublished maps showing extra photogrammetric elevations." The third group of letters from J to Q include a variety of river gradient and contour interpolation processes which basicly depend on the contour interval of the map, and perhaps "P" for poor interpolation is the best and most common. The final group of letters are variations in altimetry techniques and distances which begin with "R" for repeated readings close to the base station. The complete list of symbols is printed at the end of these notes. The elevation and the type code printed in these columns may be either an altimetry elevation or a map or surveyed elevation, but it is always the elevation which the author considers the best available for the objectives of a regional survey. Data consistency sometimes makes the use of altimetry preferable even when some of the stations may be located at photogrammetric elevations.

The third group of three columns gives the observed gravity and two indicators of factors affecting its accuracy. The observation time usually has little importance, but it has been included primarily because long interruptions in the data collection can affect the accuracy of drift corrections. In the early river traverses which used non-thermostated meters, these interruptions were frequent and usually resulted from factors which prevented before- and after-readings of the meter. The observed gravity is given to the nearest 0.01 mgal, but perhaps 0.05 mgal is a better estimate of its precision. The computer program includes the calibration tables for LaCoste meters, a provision for correcting these tables by factors determined on the USGS calibration loops, and a tide correction subroutine. Drift corrections are also applied whenever the data suggest a drift of more than 0.10 mgal. The letter code for gravity-type indicates the type of meter, the number of ties, and the duration of time between base station readings.

The four columns for anomalies give the values for the free-air anomalies, a simple-Bouguer anomaly computed with an alternate specific gravity printed at the top of the column, a numerical code indicating the accuracy of the anomaly, and the standard simple-Bouguer based on a specific-gravity of 2.67. The numerical anomaly accuracy code is the same as one developed for the California gravity code and represents steps of approximately half an order of magnitude each. No USGS Alaskan gravity anomalies are believed to have an absolute precision better than ±0.1 mgal or accuracy code 4 which represents an elevation uncertainty of about 1½ feet. In most of the Alaska data the elevation uncertainty is significantly larger than possible location or gravity-measurement errors and thus controls the anomaly accuracy code. If the code is larger than 6 indicating an uncertainty of ±0.5 mgal, the anomalies are automatically rounded to the nearest milligal. The authors tend to be optimistic about their data, and some assigned accuracy codes may be one unit too low.

The main station number is repeated after the standard simple-Bouguer anomaly and the three columns on the extreme right edge of the tabulation are filled only when altimetry and supplementary elevation data are available or when terrain correction data are included. The latter facility has not yet been used in Alaskan data and will not be discussed in these notes. When altimetry data are involved, a supplementary elevation, a letter indicating its type, and a supplementary simple-Bouguer anomaly based on the standard 2.67 specific gravity are printed. The elevation type-code is the same as the one used in the previous elevation-type column. The supplementary elevation shows how the altimetry elevations may differ from surveyed map or spot elevations. In general, no supplementary elevations are printed for elevations based on bench marks, highway surveys or sea-level unless an altimetry elevation is printed as a supplementary indication of the altimetry control and precision for altimetry used at other stations in the data set. Altimetry elevations are easily spotted by letters R through Z in the type column.

At the bottom of each data set is a summary indicating the number of stations and the ranges of latitudes, longitudes, elevations, observed gravities and anomalies. The data used in these summaries include the base- and control-station readings.

The program also has a facility for printing notes and comments about individual stations or significant portions of the data set. Each line represents seventy-five characters printed on a single IBM card. The notes are used to flag tares or unusual operating conditions; they should all be self-explanatory.

Card output formats

The computer program also provides two types of output card which will be made available to the public if there is sufficient demand. The first card type is a data-set lead card, which gives information about the data set such as date, project, traverse, meter, etc. It is a duplicate of the lead card used in the primary reduction program and may or may not be useful to individual users. It contains a large number of alphanumeric characters and may be recognized by slashes in columns 30 and 33 of the date statements. These cards can be easily discarded if they are not needed. The format is listed below:

Columns	Contents
1-10	Project name
12-21	Traverse name
23-26	State abbreviation
27	Format control number
28 & 29	Month
30	/
31-32	Day of the month
33	/
34-35	Year
37-40	Meter name
42	Punch control number
43	Meter type indicator (0 for uncorrected LaCoste calibrations, 1 for Worden type meters, 2 for LaCoste calibrations requiring a correction)
44-49	Meter calibration or correction factor (F 6.5)
50-51	Constant to obtain Greenwich mean time for tide correction
52-54	The supplementary density. A reduction density of 2.67 is always used.
55-61	Project Chief name.
62-75	Observers names which are often abbreviated.
76-79	Data Set code (usually two letters and a number)
80	Blank

The station output cards are very nearly the same format as the 'Plouff' output cards used by the Geological Survey's California gravity program and were designed to be read by the same programs, although some minor differences developed after the initial format was chosen. Most users will find that the same format statements can be used to extract the data. The format listing shows all significant differences. Although the tabulated data show all station occupations including repeated readings at base and control stations, there is probably only one output card per station. Base stations cards appear either when first used as a base or when first occupied.

Columns	Contents
1-4	Main base number of identification.
4-8	Auxiliary base station name or information.
9-11	Latitude, degrees, negative if south of the equator.
12-15	Latitude minutes and hundredths of minutes (F 4.2).
16-19	Longitude degrees, negative if east of Greenwich.
20-23	Longitude minutes and hundredths of minutes (F 4.2).
24-28	Elevation in feet.
30-36	Observed gravity in hundredths of milligals minus 90,000,000 (F 7.2 for milligals)
37	A letter for position type.
38	A letter for gravity type.
39	A letter for elevation type.
40	A number representing the estimated anomaly accuracy.
41-45	Free-air anomaly in milligals and tenths (F 5.1).
47-51	Simple Bouguer anomaly in milligals and tenths (F 5.1) for a reduction density of 2.67 g/cc.
70-74	Simple Bouguer anomaly in milligals and tenths (F 5.1) for a second reduction density.
75-79	Data set code name usually two letters and two numbers.

Table 1

Preliminary List

Naming Conventions

Alaska Gravity Stations

Symbol etc.	Example	
B---	BF31	At bench mark (such as F31)
@---	@F31	At or near a bench mark location which may or may not have been found (such as F31)
/---	/LOO /GEB	Vertical angle or triangulation station followed by first three letters of name or initials in name (such as stations "Loon" or "Glen East Base)
TB-- TBM-	TB11 TBM2	Tidal bench marks (such as numbers 11 or 2)
BASE		U.S.G.S. gravity base station (probably marked with hexagonal tablet)
MARK		Marked with USGS hexagonal gravity marker
LITE		On base of lighthouse or navigation light
FOTO		Station photographed
BLM-		At a Bureau of Land Management marker
DESC		Station described
T---	TB31	On railway track opposite (such as BM B31)
MP--	MP12	Milepost (such as milepost 12)
M---	M292	Milepost (such as at milepost 292)
TM--	TM69	On track or highway opposite a milepost (such as opposite milepost 69)
A---		Stations in Arctic Alaska or near Anchorage
F---	FM65	Stations obtained on float or ski-plane flights (such as Minto Flat ski-plane station 65)
H---	HT15	Stations obtained on helicopter traverses (such as Takahula helicopter station 15)
---P	KETP	Station at Post Office (such as Ketchikan Post Office)
---A	WRNA	Station at airport (such as Wrangell airport)
---H	PETH	At harbor entrance (such as Petersburg harbor)
---D	HAND	At dock entrance (such as Haines small boat dock)
---F	MCGF	At Federal aviation building (such as McGrath FAA headquarters)
---F.	ANCR	At railroad station (such as Anchorage)
---?	TB5?	At a questionably identified or hard-to-read mark (such as Tidal bench mark 5)

Naming Conventions for Southeast Alaska

SA--,SB--,SC--,SO--,	Stations first read with Worden meter 226 in southeast Alaska in 1968
SZ--.SY--,SX--,SV--,ST--, SP--, SN--,	Stations first read with LaCoste meter G-08 in southeast Alaska in 1968
SW--,SU--,SQ--,SP--,SM--, SL--, SK--,	Stations first read with LaCoste meter G-17 in southeast Alaska in 1968
QA--, QB--,	Stations first read with Worden meter 226 in southeast Alaska in 1969
QZ--,QY--,QX--,QW--,QV--, QU--,QT--,QR--,QP--,QM--, QS--,QQ--,QN--,QL--,	Stations first read with LaCoste meter G-58 in southeast Alaska in 1969

Source or Type of Measurement

Codes for USGS Alaskan Gravity Data

Table 2

Position Codes

Map used for field work or for reading latitudes & longitudes or which controlled location precision	good location	poor location	transfer from photo	Transfer from smaller scale field map
Modern published maps, scale ≥ 1:63,360	A	B	C	D
Old or unpublished " " ≥ 1:63,360	F	G	H	I
Modern 1:250,000 maps	K	L	M	N
Reconnaissance 1:250,000 maps	P	Q	R	S
Coast Survey or special maps	U	V	W	X

Data from other agency - Y
Position from special survey - Z
No location - ?
Estimated or assumed location- #
Near a bench mark - @

Table 3

Gravity Codes

Type of meter	3 ties within 0.1 mgal	other multiple ties	ties or drift loops lasting <6 hours	6-24 hours	1-4 days	>4 days
LaCoste Geodetic meters	A	B	C	D	E	F
Worden or (loop drift control)	G	H	I	J	K	L
World-Wide (other drift ")	M	N	O	P	Q	R
meters (no drift control)	S	T	U			
Old LaCoste or other thermo-stated meters	V	W	X			

Data from other agencies - Y
Reasons to expect errors - Z

Table 4

Elevation Control Code

	Bench marks	Highway & Railway Surveys	Sea Level	Special Surveys	USWB FAA Wisc
Surveys etc.	A	B	C	D	E

	black	brown	blue	unpublished maps
Topo Map Elevations	F	G	H	I

Contour intervals	≤50 ft.		100 ft.	200 ft.
River gradient interpolation	J		K	L
good contour "	M		N	O
poor " "		P		Q

Altimetry

Base Distance	<15 miles	15-70 miles	>70 miles
Good-repeated readings	R	S	-
Alticorder or other good base control	T	U	-
Poor control	V	W	X

Altimetry involving special adjustments - Y
No data - ?
Elevation from nearby bench marks - @

Table 5

Anomaly Accurady Code

(similar to California USGS observed gravity code)

Code	Gravity Anomaly Accuracy milligals	Typical Gravity or Elevation Types
1	±0.01	Local surveys with special meters and leveling
2	±0.02	Multiple readings with LaCoste meters on hard, surveyed surfaces
3	±0.05	Average LaCoste data at stable bench marks
4	±0.10	Average LaCoste or Worden data at sea level or frost-affected bench marks
5	±0.2	Worden or LaCoste data with poor drift or closure errors, or average data at vertical angle bench marks
6	±0.5	Data from loops with closure errors this large, or good data using river gradients, good photogrammetric elevations or well controlled altimetry
7	±1.0	Most surveys based on reasonable altimetry
8	±2.0	Data using moderate-distance altimetry in variable weather or spot elevations on 100-foot contour interval maps
9	±5.0	Data using long-range altimetry in bad weather or contour interpolation on 200-foot contour interval maps
10	>5.0	Data from surveys using long-distance altimetry or altimetry with control failures or errors or some 500-foot-contour-interval reconnaissance maps

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