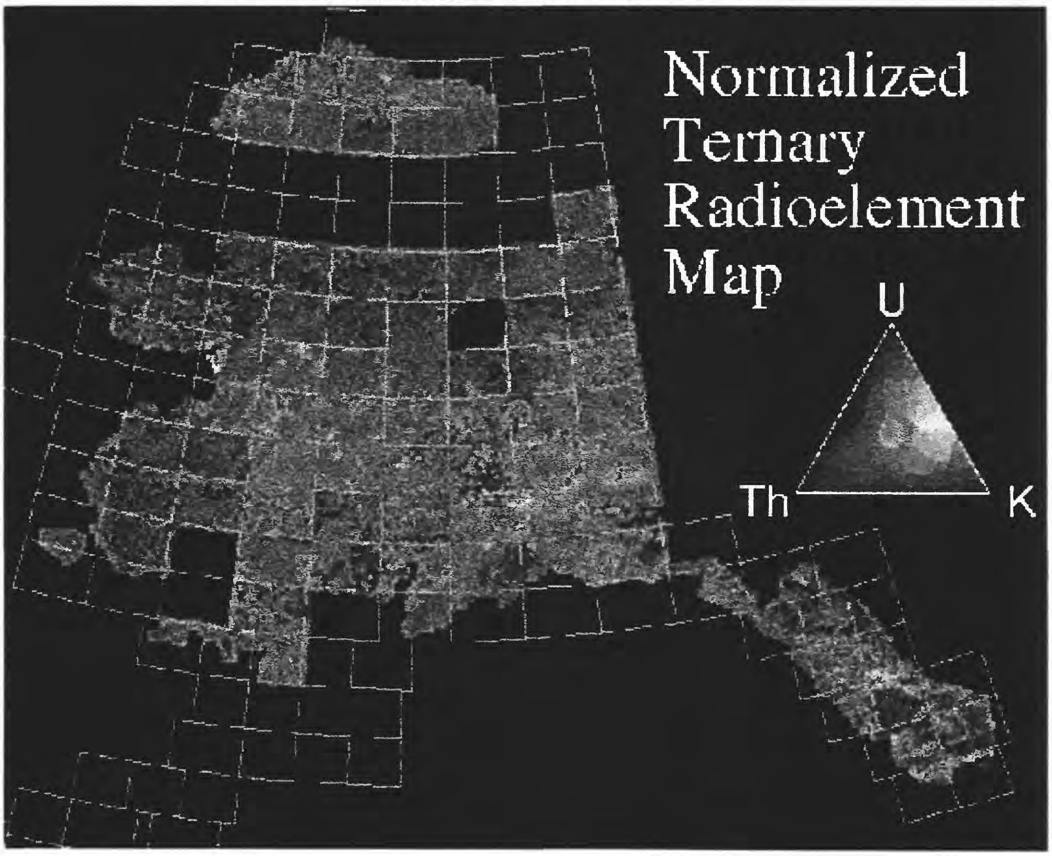
Merged Aeroradiometric Data for Alaska:

A Web Site for Distribution of Gridded Data and Plot Files

by
R.W. Saltus, F.E. Riggle, B.T. Clark, and P.L. Hill
Open-File Report 99-0016



1999

Abstract

This report is a listing of the primary information pages in the following web site:

http://greenwood.cr.usgs.gov/pub/open-file-reports/ofr-99-0016/alaskarad.html

This web site describes the results of a USGS project to merge NURE aeroradiometric data into consistent 2-km grids spanning the state of Alaska. The website allows users to download (via FTP) data files (in several formats) and plot files. The anonymous FTP sites are:

ftp://greenwood.cr.usgs.gov/pub/open-file-reports/ofr-99-0016/data.html

and

ftp://greenwood.cr.usgs.gov/pub/open-file-reports/ofr-99-0016/plots.html

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THE NATIONAL URANIUM RESOURCE EVALUATION

The National Uranium Resource Evaluation (NURE) program was conducted by the U.S. Government between 1974 and 1983. The NURE program was administered by the Grand Junction, CO, office of the Department of Energy. The program included airborne gamma-ray spectrometry and magnetic data collection as well as extensive geochemical sample collection and processing. Aeroradiometric and aeromagnetic surveys of 98 1° by 3° quadrangles were flown in Alaska between 1975 and 1980. The data were flown in 15 surveys by Texas Instruments (T.I.), Lockwood, Kessler, and Bartlett (LKB), and AeroServices (Aero) under contract to the U.S. Government. A series of contractor reports document the surveys on a quadrangle by quadrangle basis. We list references to these reports on the detailed survey index pages accessible through the Survey Info page.

NURE AERORADIOMETRIC DATA SPECIFICATIONS

The Alaska NURE aeroradiometric surveys were flown with the following specifications:

1. Flight height: 400 ft (122 m) above ground.
2. Flight line spacing: 6 mi (10 km).
3. Direction of flight lines: E-W.

The data were measured using sensors containing 30-50 L of thallium activated sodium iodide crystals. The data were processed by the contractors to correct for aircraft background contamination, cosmic rays, altitude variations, airborne Bi-214, and Compton scattering. The sensors were calibrated using test pads maintained at Grand Junction, CO, and Lake Mead, AZ. The data are reported in four data channels:

1. Total count (energy between 0.4 and 2.8 MeV).
2. Equivalent Uranium (energy between 1.66 and 1.86 MeV) in ppm.
3. Equivalent Thorium (energy between 2.4 and 2.8 MeV) in ppm.
4. Potassium (energy between 1.37 and 1.57 MeV) in percent (%).

Because of the low flight height (400 ft) and relatively wide data spacing (6 mi), less than 4% of the ground surface was actually sampled by the measurements in the quadrangles surveyed. The measurements typically sample only the upper 2 ft (50 cm) of the Earth (Duval and others, 1971).

DATA PROCESSING

The aeroradiometric grids were produced from the raw NURE radiometric data tapes as follows:

1. Data were read and reformatted into a standard line format.
2. Data lines with gaps were identified and renumbered.
3. A 3-point median filter was passed over the data (to remove one-point spikes).
4. A Gaussian filter was run over the data (to reduce multi-point noise).
5. Data points exceeding minimum and maximum criteria for each channel (uranium, thorium, potassium, and total count) were eliminated.
6. 2.5 km grids were constructed from each data channel using the minimum curvature gridding algorithm.

This procedure was performed on 6 blocks spanning Alaska. The resulting grids were then merged together to produce the final data grids. As part of the merging process datum levels were adjusted between surveys to minimize obvious data shifts at survey boundaries. This process does not correct for all the discrepancies between the surveys. These differences are particularly noticeable in the normalized RGB maps because these maps amplify small variations in the data values. Care should be taken when interpreting the patterns on these maps to avoid attaching geologic significance to boundaries between surveys.

UTILITY OF AERORADIOMETRIC DATA

In addition to directly sensing surface uranium, radiometric data can be used to locate intrusive rocks or to map any rock unit with a distinctive radiometric signature. Potassium is commonly found in potash feldspars, microcline, and orthoclase or in micas such as muscovite and biotite. Uranium and thorium in igneous and metamorphic rocks are usually found in accessory minerals such as apatite, sphene and zircon or in the rarer allanite, monazite, pyrochlore, thorite, uraninite, and xenotime (Hoover and others, 1992). Uranium tends to be highly mobile in the near surface whereas thorium is relatively stable. Uranium is chemically active over a broad range of temperature and pH and moves readily in the groundwater. Thorium is much less soluble than uranium and potassium and does not move except by mechanical means such as wind and erosion processes. Both thorium and uranium content tend to be greater in felsic rocks and to also increase with alkalinity (Hoover and others, 1992).

The ratio between potassium and thorium is rather constant in most rocks, typically varying from 0.17 to 0.2 (K/Th in %/ppm, Hoover and others, 1992). Rocks with K/Th ratios significantly outside this usual range have been called potassium or thorium specialized (Portnov, 1987). Igneous rocks with potassium specialization have been related to gold-silver, silver-polymetallic, molybdenum, and bismuth deposits. Thorium specialized rocks are identified with tin, tungsten, rare-earth, and rare-metal deposits (Portnov, 1987).

Ternary radioelement maps are a useful way to display uranium, thorium, and potassium data (Broome and others, 1987). In many cases, particular rock types will have characteristic ratios of the three elements and this type of map display can highlight useful geologic trends and patterns. In addition to distinguishing lithologic variations, because of the contrasting chemical properties of the radioactive elements, radiometric data can provide information relevant to understanding of various geochemical and physical processes, including alteration and weathering (Duval, 1989). Aero*magnetic* maps provide good complementary information for use in geologic interpretations.

REFERENCES

Broome, J., Carson, J.M., Grant, J.A., Ford, K.L., 1987, A modified ternary radioelement mapping technique and its application to the south coast of Newfoundland: Geological Survey of Canada Paper 87-14, 1 sheet, scale 1:500,000.

Duval, J.S., 1989, Radioactivity and some of its applications in geology, in "Proceedings of the Symposium on the Application of geophysics to Engineering and Environmental Problems", SAGEEP 89, March 13-16, Golden, Colorado, p. 1-61.

Duval, J.S., Cook, B., and Adams, J.A.S., 1971, Circle of investigation of an air-borne gamma-ray spectometer: Journal of Geophysical Research, v. 76, n. 35, p. 8466-8470.

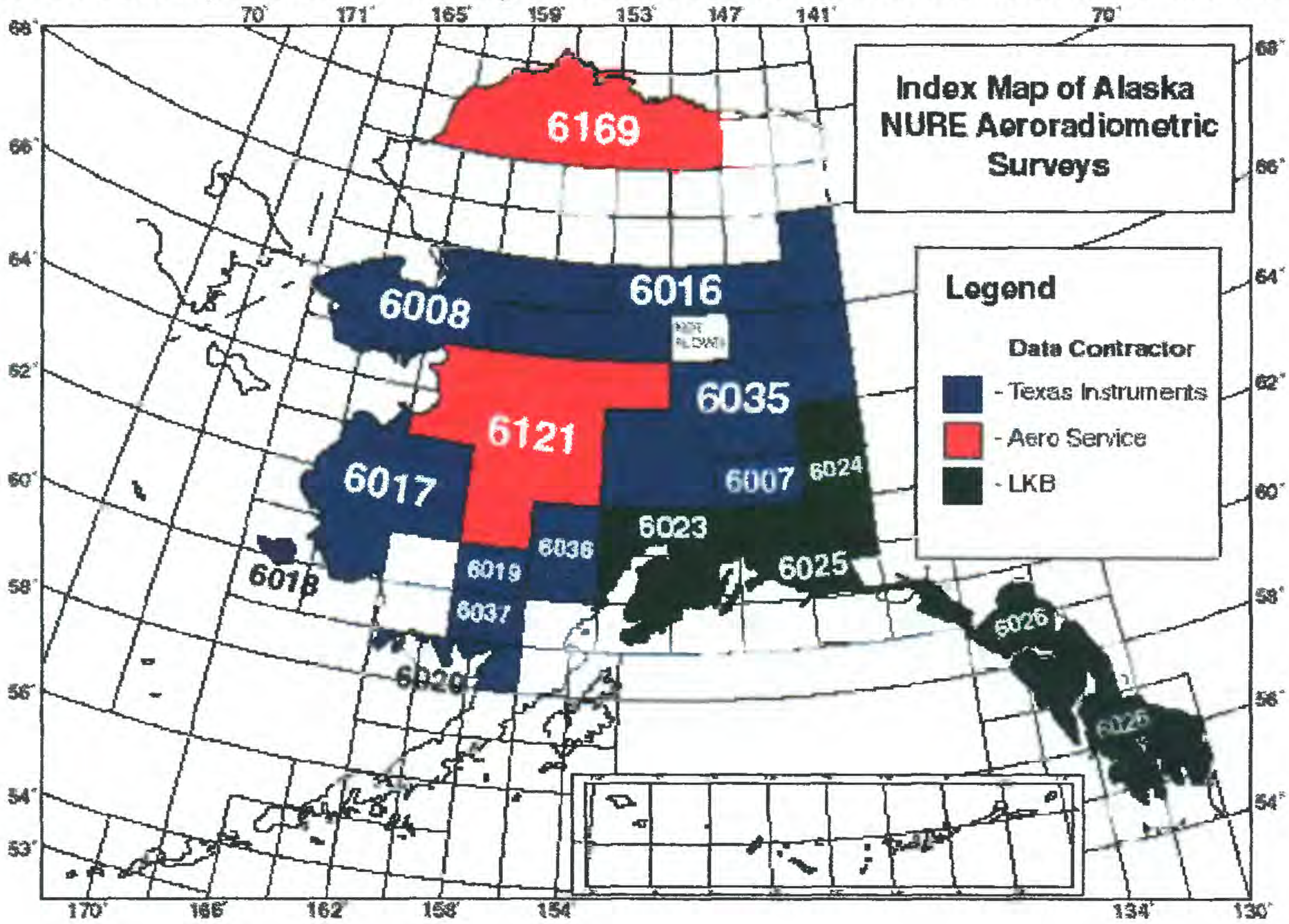
Hoover, D.B., Heran, W.D., and Hill, P.L., 1992, The geophysical expression of selected mineral deposit models: U.S. Geological Survey Open-File report 92-557, 129 p.

Portnov, A.M., 1987, Specialization of rocks toward potassium and thorium in relation to mineralization: International Geology Review, v. 29, p. 326-344.

Riehle, J.R., Fleming, M.D., Molnia, B.F., Dover, J.H., Kelley, J.S., Miller, M.L., Nokleberg, W.J., Plafker, George, and Till, A.B., 1996, Digital shaded-re lief image of Alaska: U.S. Geological Survey Map I-2585, 1 sheet plus 11 p. text , scale 1:2,500,000.

Aeroradiometric Survey Index Map

Click on a Survey *Number* in the map below to zoom in and find out more about that survey.



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Alaska NURE Data Table

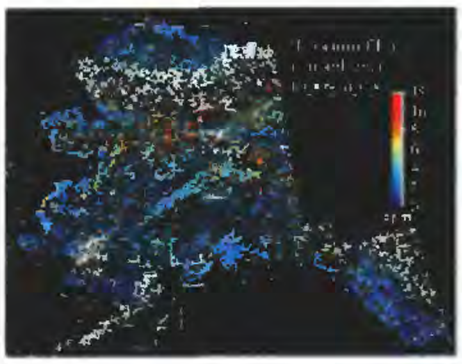
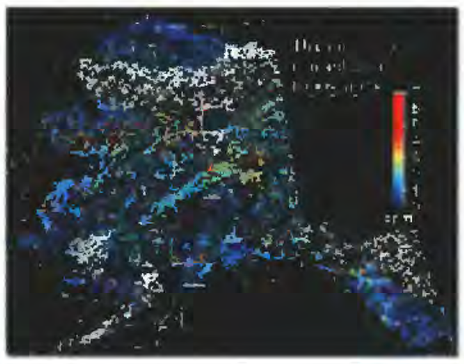
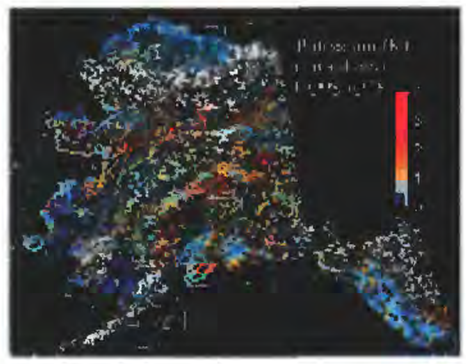
ID #	Name	CO	Dates	Flt	Dir	Height	LnMi	Publication
6007	Copper River	T.I.	06/75-07/75	6 mi.	E-W	400 AG	1950	GJO-1653
6008	Seward-Selawik	T.I.	06/75-07/75	6 mi.	E-W	400 AG	7630	GJO-1653
6016	Yukon	T.I.	05/76-08/76	6 mi.	E-W	400 AG	9700	GJBX-005(77)
6017	Bethel	T.I.	05/76-08/76	6 mi.	E-W	400 AG	7700	GJBX-005(77)
6018	Nunivak Island	T.I.	05/76-08/76	6 mi.	E-W	400 AG	250	GJBX-005(77)
6019	Taylor Mountains	T.I.	05/76-08/76	6 mi.	E-W	400 AG	1400	GJBX-005(77)
6020	Nushagak Bay	T.I.	05/76-08/76	6 mi.	E-W	400 AG	1100	GJBX-005(77)
6023	Cook Inlet	LKB	06/76-07/77	6 mi.	E-W	400 AG	5753	GJBX-108(78)
6024	Eastern Alaska	LKB	07/76-08/76	6 mi.	E-W	400 AG	4037	GJBX-091(78)
6025	Chugach-Yakutat	LKB	08/76-08/77	6 mi.	E-W	400 AG	3680	GJBX-127(78)
6026	Southeastern Alaska	LKB	08/76-09/77	6 mi.	E-W	400 AG	7683	GJBX-048(79)
6035	Eagle-Talkeetna	T.I.	06/77-09/77	6 mi.	E-W	400 AG	12392	GJBX-113(78)
6036	Lime Hills-Lake Clark	T.I.	06/77-09/77	6 mi.	E-W	400 AG	2775	GJBX-113(78)
6037	Dillingham	T.I.	06/77-09/77	6 mi.	E-W	400 AG	1509	GJBX-113(78)
6121	West-Central Alaska	Aero	07/79-09/79	6 mi.	E-W	400 AG	13273	GJBX-072(80)+
6169	Northern Alaska	Aero	07/80-08/80	6 mi.	E-W	400 AG	8835	GJBX-295(81)+

Explanation of columns: ID # = Pat Hill survey index number; Name = survey name; CO = contractor; Dates = dates flown; Flt = flightline spacing; Dir = flightline direction; Height = flight height above ground (ft); LnMi = approximate number of line miles in survey; Publication = NURE report reference (see detailed reference lists on individual survey index pages in this report).

Aeroradiometric Map Image Thumbnails

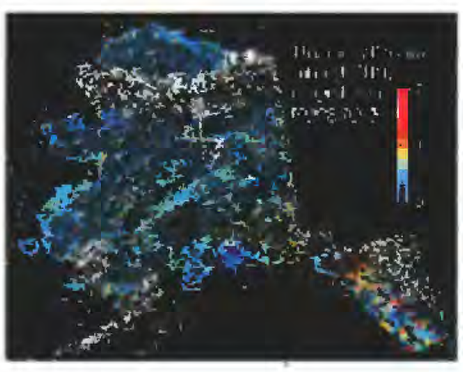
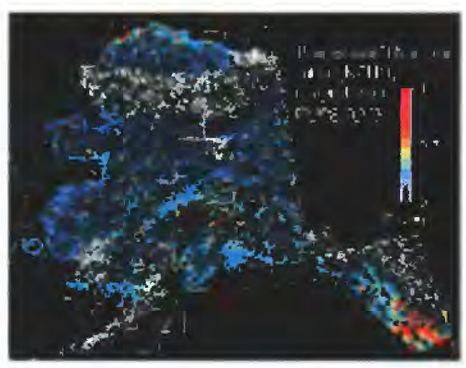
Individual Element Maps:

Thorium (Th) || Uranium (U) || Potassium (K)

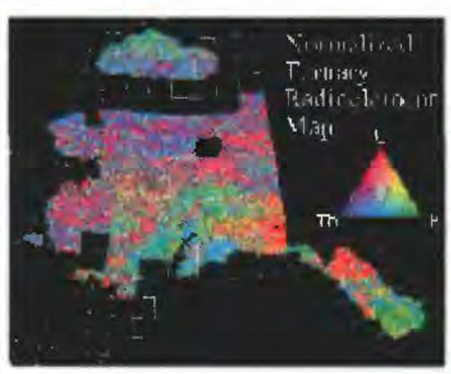
Ratio Maps:

Uranium over Thorium || Potassium over Thorium

RGB Composite Maps:

Non-Normalized || Normalized



Get Plots: File Type Explanation

Rick Saltus
13 August 1998

The following directory contains binary HPGL format plot files for aeroradiometric maps that span the state of Alaska. See the web site for a look at the maps and more information. These plot files will plot on plotters such as the HP750. The resulting maps are about 2 ft x 3 ft. The maps are at 1:2,500,000 scale.

These plot files have been compressed using the "gzip" public-domain utility. Before plotting these files you will need to uncompress them. Information on gzip is available at:

http://www.maths.lancs.ac.uk/~smithdml/GNU/GNUWeb/gzip.html
(unix and PC DOS versions)

http://www.winzip.com/
(PC windows version)

http://www.1source.com/tools/compress.html
(contains link to download Mac gzip)

Listing of plot files:

1. K - Potassium map draped over topography
2. U - Equivalent uranium map draped over topography
3. Th - Equivalent thorium map draped over topography
4. KdivTh - Potassium/Thorium ratio map draped over topography
5. UdivTh - Uranium/Thorium ratio map draped over topography
6. RGB - Ternary radioelement map
7. RGBnorm - Normalized ternary radioelement map draped over topography

Get Data: File Type Explanation

Rick Saltus
13 August 1998

The following directory contains ASCII and binary gridded files for the Alaska aeroradiometric data. Each data grid is available in four different data formats:

1. GeoSoft GXF format (an ASCII grid transfer format)(nure_*.gxf)
2. ER Mapper grid format (a two-part transfer format)(nure_* & nure_*.ers)
3. ARC/INFO grid export format (a binary format)(nure_*.e00)
4. USGS ODDF grid format (a binary format)(nure_*.gd)

Each of these formats is discussed briefly below.
If none of these formats are directly readable by software on your system, then your best bet is probably to write a program to input and translate the GXF format. Extensive description of this format is given below.

The data grids in this directory have been compressed using the public-domain "gzip" compression utility. Information on gzip is available at:

http://www.maths.lancs.ac.uk/~smithdm1/GNU/GNUWeb/gzip.html
(unix and PC DOS versions)

http://www.winzip.com/
(PC windows version)

http://www.1source.com/tools/compress.html
(contains link to download Mac gzip)

To avoid file name problems on older PC systems, I have replaced the original "." in the filenames with an "_" (underscore) character.
For example:

original filename: nure_k.e00
changed to: nure_k_e00
compressed file name: nure_k_e00.gz

After you transfer and uncompress the files, you should rename them to replace the "_" with a "." again.

BASIC GRID STATISTICS (All Grids)

```
Cell Size =             2000.000 meters  Data Type: Floating Point
Number of Rows    =         855
Number of Columns =         1110

           BOUNDARY

Xmin =               -904000.000 meters
```

Xmax =	1316000.000 meters
Ymin =	120000.000 meters
Ymax =	1830000.000 meters

COORDINATE SYSTEM DESCRIPTION

Projection	ALBERS		
Units	METERS	Spheroid	CLARKE1866
Parameters:			
1st standard parallel			55 0 0.000
2nd standard parallel			65 0 0.000
central meridian			-151 0 0.00
latitude of projection's origin			55 0 0.000
false easting (meters)			0.00000
false northing (meters)			0.00000

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1. Grid eXchange Format (nure_*.gxf)

GXF (Grid eXchange File) is a standard ASCII file format for exchanging gridded data among different software systems. Software that supports the GXF standard will be able to import properly formatted GXF files and export grids in GXF format.

Grid Description:
A grid is a rectangular array of points at which single data values define a two dimensional function. Grid point locations are related to a Grid Coordinate System (GCS), which is a right handed Cartesian system with X and Y axis defined by the bottom and left sides of a grid array. The grid point at the bottom, left corner of the array is the origin of the GCS. All distances are in meters.

GCS coordinates are related to a Base Coordinate System (BCS) through a plane translation and rotation. (For these Alaska grids, the base coordinate system is the Albers conical equal-area projection with standard parallels of 55 and 65 degrees, a base latitude of 55 degrees north, a central meridian of 151 degrees west, a semi-major axis of ellipsoid of 6378206.400 meters, an eccentricity of 0.0067686579973.) The origin of the GCS is located at point (x0,y0) in the BCS, and the X and Y grid indices are related to BCS units through the separation between points in the GCS X and Y directions.

Labeled Data Objects and Comments

A GXF file is an ASCII file made up of a number of labeled data objects and comments. Each labeled data object has a label line followed by one or more data lines. A label line is identified by a '#' character in the first column followed immediately by an upper-case label. The data associated with that label are found on one or more lines that follow the label.

Lines

All lines in a GXF file must be less than or equal to 80 characters in length. Any lines that are not part of a labeled data object are ignored and can be used to place comments within a GXF file. Programs that read GXF files will skip such comment lines while they search for the next GXF data object.

GXF Object Definitions

#TITLE
A one line descriptive title of the grid. Some grid formats include textual descriptions of the grid, and this information can be placed in a #TITLE

object.
Default: blank title

#POINTS
The number of points in each grid row (horizontal or vertical as defined by the #SENSE object).
Default: no default - this object is required.

#ROWS
The number of rows in the grid. A grid row (or vector) is a collection of consecutive grid points that represent the grid values along a horizontal or vertical line in the grid. The complete grid is then defined by a consecutive sequence of grid rows.
Default: no default - this object is required.

#PTSEPARATION
The separation between points in the grid. This should be in Base Coordinate System units (ground units for geographically based grids).
Default: 1.0

#RWSEPARATION
The separation between rows in the grid. These should be in Base Coordinate System units (ground units for geographically based grids).
Default: 1.0

#XORIGIN
The X location of the bottom left corner of the grid in the Base Coordinate System.
Default: 0.0

#YORIGIN
The Y location of the bottom left corner of the grid in the Base Coordinate System.
Default: 0.0

#ROTATION
The rotation angle of the grid. This is the counter-clockwise angle of the bottom edge of the grid with respect to the Base Coordinate System X axis. Rotation only has meaning for Base Coordinate Systems that use the same units on the X and Y axis.
Default: 0.0

#SENSE
The first point of the first row of the stored grid can be at any corner of the grid rectangle, and the grid rows can be run vertically or horizontally. The SENSE object defines this storage sense as follows:

- ±1 first point at bottom left of grid
- ±2 first point at upper left of grid
- ±3 first point at upper right of grid
- ±4 first point at bottom right of grid

A positive SENSE stores rows in a right-handed sense; a negative SENSE stores rows in a left-handed sense. This means that if you were standing at the first grid point and looking into the grid, the first grid row would extend to your right for a right handed grid (positive sense), or to your left for a left handed sense (left-handed grid):
(All grids on this CD have SENSE=+1.)
Default: 1 (first point at bottom left, rows left to right)

#TRANSFORM
This keyword is followed by two numbers on the same line: SCALE and OFFSET, which are used to transform the grid data to desired units:

```
Z = G * SCALE + OFFSET
where
        Z       grid value in the desired unit
        G       are grid values as specified in the #GRID object
Default:        SCALE = 1.0,  OFFSET = 0.0
```

#DUMMY
The grid must be rectangular (every row must have the same number of points). The dummy value defined by this object is used to define blank areas of the grid. Any grids that include blank areas must define a dummy value.
Default: no dummy value.

#GRID
The grid data is listed point by point and row by row. The #GRID object and data is always the last object in a GXF file.
The first data point is at the location indicated by #SENSE, and is followed by successive points in that row of points (either horizontal or vertical), then the points in the next row, and so on. The points in a row can follow on to the next data line, although each new row must start on a new data line. A GXF reading program can expect #ROWS of #POINTS for a total of #ROWS times

#POINTS data values.
Default: none, must be included as the last object in a GXF file.

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2. ER Mapper grid format (nure_k & nure_k.ers)

The ER Mapper grid format consists of two files: a binary data file (no file suffix) and a ASCII header file (*.ers). These files can be read directly by the ER Mapper software or by other packages such as ERDAS IMAGINE. Note that the header files refer to the projection called "ALINTAK1". This is not a standard ER Mapper projection. To register the grid properly within ER Mapper you must create a projection entry that corresponds to the parameters listed above for the projection of these data.

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3. ARC/INFO Grid Export format (nure_k.e00)

This format is readable by ARC/INFO, ERDAS IMAGINE, and other packages. When imported into ARC/INFO, this file will unpack into a directory containing all the components of the registered grid coverage.

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4. USGS ODDF binary grid format (nure_k.gd)

This is a binary format with an included ASCII header. This format is used by the USGS Geophysics Group within the Minerals Program of the Geologic Division.
