U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

DOCUMENTATION FOR GEOGRAPHIC INFORMATION SYSTEMS (GIS) COMPILATION OF GEOPHYSICAL, GEOLOGIC, AND TECTONIC DATA FOR THE CIRCUM-NORTH PACIFIC

***By* Mark L. Greninger* and Simon L. Klemperer**
(Department of Geophysics, Stanford University, Stanford, California 94305-2215), *and*
Warren J. Nokleberg (U.S. Geological Survey, Menlo Park, California 94025)
*Now at: Anteon Corporation, PMD-10, 75 Hawthorne Street, San Francisco, CA 94105

Warren J. Nokleberg *and* Michael F. Diggles, Editors

Open-File Report 99-422
Version 1.0

With Contributions From (listed alphabetically):

Douglas S. Aitken (U.S. Geological Survey, Menlo Park, California, USA)	Boris Khlebnikov (Research Information Center, GlavNIC, Russian Ministry of Natural Resources, Moscow, Russia)
Brian S. Bennett (U.S. Geological Survey, Menlo Park, California, USA)	D. Paul Mathieux (U.S. Geological Survey, Reston, Virginia, USA)
Keri L. Brennan (Chapleau, Ontario, Canada)	James W. H. Monger (Geological Survey of Canada, Vancouver, Canada)
Ronald W. Buhmann (National Geophysical Data Center, NOAA, Boulder, Colorado, USA)	Boris A. Natalin (Russian Academy of Sciences, Khabarovsk, Russia)
Stanislav G. Byalobzhesky (Russian Academy of Sciences, Magadan, Russia)	Leonid M. Parfenov (Russian Academy of Sciences, Yakutsk, Russia)
Steven P. Gordey (Geological Survey of Canada, Vancouver, Canada)	Richard W. Saltus (U.S. Geological Survey, Denver, Colorado, USA)
Roger A. Hansen (University of Alaska, Fairbanks)	D.T. Sandwell (University of California San Diego, San Diego, California, USA)
Paul P. Hearn, Jr. (U.S. Geological Survey, Reston, Virginia, USA)	Thomas Simkin (Smithsonian Institution, Washington, DC 20560)
Thomas G. Hildenbrand (U.S. Geological Survey, Menlo Park, California, USA)	Gregory Ulmishek (U.S. Geological Survey, Reston, Virginia, USA)
Allen M. Hittelman (National Geophysical Data Center, NOAA, Boulder, Colorado, USA)	Frederic H. Wilson (U.S. Geological Survey, Anchorage, Alaska, USA)
J. Murray Journeay (Geological Survey of Canada, Vancouver, Canada)	
Alexander I. Khanchuk (Russian Academy of Sciences, Vladivostok, Russia)	

With Data Made Available By (listed alphabetically):

Alaska Biological Science Center	National Ocean Service
Alaska Division of Oil and Gas	National Oceanic and Atmospheric Administration (NOAA)
Defense Mapping Agency	Naval Research Laboratory (NRL)
Eros Data Center	Research Information Center (GlavNIVC), Russian Ministry of Natural Resources (RMNR)
European Space Agency	Russian Academy of Sciences
Exxon Production Research Company	Scripps Institution of Oceanography
Geological Society of America (GSA)	Smithsonian Institution, Global Volcanism Program
Geological Survey of Canada (GSC)	Society of Exploration Geophysicists
Geological Survey of Japan	Stanford University
International Seismological Centre (ISC)	United Nations Environment Programme/Global Resource Information Database (UNEP/GRID)
Japan Oceanographic Data Center	U.S. Agency for International Development (USAID)
Lamont-Doherty Earth Observatory	United States Geological Survey (USGS)
Ministry of Geology, U.S.S.R.	University of Alaska, Fairbanks
National Aeronautics and Space Administration (NASA)	
National Earthquake Information Center (NEIC)	
National Geophysical Data Center (NGDC)	

1999

ABSTRACT

The accompanying CD-ROM contains a Geographic Information Systems (GIS) compilation of geophysical, geological, and tectonic data for the Circum-North Pacific. This area includes the Russian Far East, Alaska, the Canadian Cordillera, linking continental shelves, and adjacent oceans. This GIS compilation extends from 120°E to 115°W, and from 40°N to 80°N. This area encompasses: (1) to the south, the modern Pacific plate boundary of the Japan-Kuril and Aleutian subduction zones, the Queen Charlotte transform fault, and the Cascadia subduction zone; (2) to the north, the continent-ocean transition from the Eurasian and North American continents to the Arctic Ocean; (3) to the west, the diffuse Eurasian-North American plate boundary, including the probable Okhotsk plate; and (4) to the east, the Alaskan-Canadian Cordilleran fold belt. This compilation should be useful for: (1) studying the Mesozoic and Cenozoic collisional and accretionary tectonics that assembled this continental crust of this region; (2) studying the neotectonics of active and passive plate margins in this region; and (3) constructing and interpreting geophysical, geologic, and tectonic models of the region.

Geographic Information Systems (GIS) programs provide powerful tools for managing and analyzing spatial databases. Geological applications include regional tectonics, geophysics, mineral and petroleum exploration, resource management, and land-use planning. This CD-ROM contains thematic layers of spatial data-sets for geology, gravity field, magnetic field, oceanic plates, overlap assemblages, seismology (earthquakes), tectonostratigraphic terranes, topography, and volcanoes. The GIS compilation can be viewed, manipulated, and plotted with commercial software (ArcView and ARC/INFO) or through a freeware program (ArcExplorer) that is included on this CD-ROM, or can be downloaded from the internet/Web at http://www.esri.com for both Unix and Windows computers. This report is for sale by U.S. Geological Survey, Information Services, ESIC Open-File Reports, PO Box 25286, Denver, CO 80225 (Telephone: 303-202-4210).

INTRODUCTION

In order to facilitate geological understanding of a tectonically complex region this Geographical Information Systems (GIS) compilation of the Circum-North Pacific is presented on the companion CD-ROM. Geologically and politically, the Circum-North Pacific is a complex region that is partially marine, straddles the Russia/U.S.A./Canada political boundaries, crosses the International Dateline and 180° longitude, and includes a major part of the Arctic. This GIS compilation contains thematic layers of spatial data-sets for geology, gravity field, magnetic field, oceanic plates, overlap assemblages, seismology (earthquakes), tectonostratigraphic terranes, topography, and volcanoes.

Several problems exist in studying the earth science of this region. (1) The political boundaries of many geologic maps disguises the fact that a large part of the North American plate is in Russia. As examples, the current geological map of Alaska shows Russia as a white outline; the converse occurs for the geological map of Russia. (2) Traditional geological tools permits mapping land areas but not marine areas. As a result, the geology of the vast area of the submerged Bering and Chukchi continental shelves, extending over 500 km offshore between mainland Alaska and Chukotka (Russian Northeast), is even less well known than Siberia, even though the coastline over much of this region is an accidental manifestation of modern-day sea-level rather than a fundamental geological boundary. (3) For high latitudes, the most common map projection (Mercator) introduces large distortion. To solve this problem, Polar and Lambert projections are often used, creating the necessary but difficult task of transforming data between projections. And (4) many digital data-sets are stored from 180°W (-180°) to 180°E (+180°) and many querying routines do not allow access of data-sets straddling the 180° longitude. To address these four difficulties - political boundaries, coastlines, variable projections, and an arbitrary longitude reference system - a GIS compilation (initially presented by Greninger and others, 1996, 1999) is herein presented to advance crustal studies of the Bering and Chukchi Seas, and adjacent onshore areas of Alaska and Chukotka. The centerpiece of these studies was two month-long geophysical cruises in 1994 that collected the first deep seismic reflection transects across this region. In offshore areas, interpretation of reflection data requires considerable input from onshore geology and regional potential field data which are not always readily available. To assist the studies of adjacent regions, the GIS compilation is extended to include the entire Circum-North Pacific area from 120°E to 115°W and from 40°N to 80°N. This area coincides with that of a previously published terrane and overlap assemblage map of the Circum-North Pacific (Nokleberg and others, 1994b).

This GIS compilation includes digital datasets which will assist geological and geophysical research in the fields of: geology, gravity field, magnetic field, oceanic plates, overlap assemblages, seismology (earthquakes), tectonics, tectonostratigraphic terranes, topography, volcanoes, environmental studies, resource management, and land-use planning. A huge amount of GIS data exists for the Circum-North Pacific. As a result, important data was chosen for publication on this single CD-ROM. Although this GIS study is a compilation and not a synthesis, three sample views are included of the datasets in order to illustrate the type and quality of data available, and some different ways in which data may be combined by utilizing the ability of GIS software to permit spatial queries. The data can be interactively analyzed, viewed, and printed using ArcView, ARC/INFO, ArcExplorer, or other GIS programs. The explanations for the digital cartographic data and companion datasets are provided in several formats. The many individuals and organizations who have contributed data and assistance in preparing that data at listed as contributors.

METHOD OF GIS COMPILATION

The digital data consist of vector, raster, and point data. (1) Vector data (e.g. the geographic base map) have a location precision that depends upon the scale of the original map and the density of the digitization points. Because of the large area covered, no datasets or maps originally compiled at scales greater than 1:250,000, and some datasets compiled at scales as small as 1:10,000,000, are included. (2) Raster data (gridded data) have a resolution that depends upon the grid spacing and cell size. Our raster datasets range from less than 1 km to greater than 5 km spacing. And (3) point data (e.g. trackline shot locations or earthquake epicenter locations) are only limited by their location precision. All datasets are recorded in the Lambert azimuthal projection with a center of projection at 165°W, 70°N as originally utilized for the terrane and overlap assemblage map of the Circum-North Pacific (Nokleberg and others, 1994b) that forms the principal geologic base this GIS compilation. It is common for digital data releases to be prepared as unprojected data, i.e., as data referenced to a geographic (latitude/longitude) co-ordinate system, with no assigned map projection. In contrast, all datasets in this GIS compilation are projected to a single chosen map projection in order to avoid problems associated with datasets that straddle the longitude of 180°E/180°W.

This GIS compilation is also designed to be accessible to customers who lack proprietary GIS software and who will be using the freeware ArcExplorer GIS program provided on this CD-ROM. If unprojected, ArcExplorer would display the spatial datasets centered on the Greenwich, or zero meridian, split into separate far western and far eastern sections. Advanced users, i.e. those using programs such ArcView or ARC/INFO, have the option and ability to unproject and reproject the spatial data to a chosen projection. This procedure may lead to some loss of precision (due to a data conversion within ESRI software from double-precision to single-precision coordinates) but this loss of precision is not significant for datasets at scales of 1 million and smaller. The geological or geophysical potential-field datasets on this CD-ROM are not intended for use at scales larger than 1:1 million.

All cartographic datasets for this GIS compilation are in ARC/INFO coverage or GRID format. Various text files, including explanatory README files, this detailed explanation and reference list, and detailed explanations to the terrane and overlap assemblage map of the Circum-North Pacific, are available in text (***.txt), Word 6 (***.doc), and Adobe Acrobat PDF formats. In addition, a suite of 178 stratigraphic columns for the terrane and overlap assemblage map of Circum-North Pacific are included in Adobe Acrobat format. The digital cartographic data for this compilation were compiled with ARC/INFO 7.0.3 on a Sun Microsystems SPARC Station 20 computer running with Solaris OpenWindows version 5.4 (Sun OS 2.4).

The map-making software most commonly used by academic geophysicists is probably Generic Mapping Tools (GMT) (Wessel and Smith, 1995) and the newer Interactive Generic Mapping Tools (iGMT) (Becker and Braun, 1998). Both programs are free software packages for Unix computers. GMT is widely used to create images of superimposed point datasets (e.g. hypocenters) and raster datasets (e.g. topography). GMT has been used to create many of the datasets compiled for this study (e.g., ETOPO5, GTOPO30, satellite-derived free-air gravity). Despite the widespread use of GMT and iGMT, the ESRI ARC/INFO and ArcView programs are used for this GIS compilation for three reasons. (1) These programs permit database queries that are not available in GMT and iGMT. (2) Use of ARC/INFO and ArcView will hopefully encourage new, innovative ways of working with multiple geophysical and geological datasets such as geologic maps of the Russian Far East, Alaska, and the Canadian Cordillera. And (3) because ESRI software is available for both Windows and Unix computers, a greater opportunity exists for scientists in the former Soviet Union to have access to this GIS compilation.

Users of this publication should note that this CD-ROM consists of two separate products: (1) a compilation of datasets in ARC/INFO format; and (2) two collection of displays (views) of combinations of these datasets in ArcView and ArcExplorer projects. The datasets in the ARC/INFO format are available to any GIS user for further manipulation and analysis. The ArcView or ArcExplorer projects can be used as displays for interpretation without any additional GIS manipulation of interpretation. Users of this publication should also note that it is beyond the

scope of this publication to provide a GIS tutorial. Training is available online, for example through ESRI at the internet address of http://campus.esri.com/campus/catalog/courses.cfm, or in readily available textbooks (e.g. ESRI, 1997; Hutchinson and Daniel, 1997).

ARC/INFO

ARC/INFO is a full-featured GIS software program sold by Environmental Systems Research Institute, Inc. (ESRI), and is generally used on Unix-based servers and workstations and for Windows NT. A separate software package, PC ARC/INFO, is available for Windows (3.x, 95, 98, and NT), as well as DOS. For this GIS compilation, the data are in ARC/INFO 7.1.2, utilizing both coverage and GRID formats. ARC/INFO can be utilized to view and manipulate the data sets on the CD-ROM exactly as compiled.

ArcView

ArcView (version 3.1) is a desktop GIS software program sold by Environmental Systems Research Institute, Inc. (ESRI). Although ArcView does not have all the features of ARC/INFO, it is easier to learn; and some recent ArcView extensions (e.g. 3D Analyst) are not available in ARC/INFO 7.1.2. ArcView 3.1 runs on Unix- computers and on Windows computers (3.x, 95, 98, or NT).

ArcExplorer

ArcExplorer is a freeware GIS-viewing program created by and available from Environmental Systems Research Institute, Inc. (ESRI). The directory */norpac/setup/arcexplo* contains installers for ArcExplorer 1.1 for Windows 95/98/NT. NT machines must have Service Pack 3 installed. In addition to viewing GIS data in ARC/INFO, ArcView, and other digital formats, ArcExplorer permits GIS data queries. ArcExplorer is currently only available for Windows computers (95, 98, or NT 4.0). ArcExplorer can access the GIS data contained in ARC/INFO 7.1.2 coverages on this CD-ROM. But because ArcExplorer can not display gridded datasets, images of these datasets are created as ****.bil* files which are displayed for the following datasets: (1) three raster topographic datasets (*/norpac/data/topogrfy/raster/etopo5*, */gtopo2* and */gtopo30);* (2) three gravity datasets (*/norpac/data/gravity/dgrav*, */geosat* and */sea-surf*); and (3) five magnetic datasets (*/norpac/data/magnetic/ak_mag*, */arct_mag*, */asia_mag*, */dnag_mag* and */russ_mag*). Please refer to the section below on "Contents and Description of /norpac/data".

SYSTEM REQUIREMENTS

The data and text on this CD-ROM require a computer and software able to read ESRI (Environmental Systems Research Institute) data formats. Appropriate software packages include ARC/INFO version 7.1.2 or higher, ArcView 3.1 or higher, and ArcExplorer. Full system requirements for each software package can be found at the internet (Web) homepage for ESRI, http://www.esri.com. In order to run ArcView 3.1, a Windows computer is required with a Pentium processor with 24 Mb of RAM (32 Mb recommended). A Pentium-II processor with a speed ≥ 200 MHz is recommended for handling the large data files. All systems require a color monitor that can display 256 colors. This CD-ROM was produced in accordance with the ISO 9660 and Macintosh HFS standards. All ASCII text on this CD-ROM file can be accessed from DOS, Windows, Macintosh, and Unix computers.

USE OF GIS COMPILATION ON UNIX, MACINTOSH, AND DOS/WINDOWS COMPUTERS

Depending on system configuration and user needs, the data can be viewed directly from the CD-ROM, or the data can be downloaded onto a computer hard drive for viewing, manipulation, and plotting.

Unix

To mount this CD-ROM on a Unix-based computer, become the root user, then: *% su* - (not necessary for a Silicon Graphics workstation).

If a */cdrom* directory does not exist, create one:

 # cd/
#mkdir cdrom

Use the command appropriate to the UnixTM host:
DG AViiON: *mount -o noversion,ro -t cdrom /<dev> /cdrom*
DEC ALPHA: *mount -t cdfs -r -o nodefperm,noversion /<dev> /cdrom*
DECstation: *mount -t cdfs -r -o nodefperfm /<dev> /cdrom*
HP 700/8x7: *mount -rt cdfs /<dev> /cdrom* (or use *sam*)
IBM RS/6000: *mount -v 'cdrfs' -p' ' -r' ' /<dev> /cdrom* (or use *smit*)
Silicon Graphics: *mount -o setx -t iso9660 /dev/ssi/<dev> /cdrom*
Sun Solaris 1.x: *mount -rt hsfs /<dev> /cdrom*
Sun Solaris 2.3: Use volume management software to mount and access the CD-ROM. Sun Workstations running the Common Desktop Environment will auto-mount the CD-ROM.

Macintosh

ArcView 3.1 and ArcExplorer are not available for the Macintosh computer. The document, Adobe Acrobat PDF, and readme files can be view, manipulated, and printed with a Macintosh computer. ArcView 3.0 for Macintosh can be used to create new ArcView project files. ArcView 3.0 for Macintosh can be used to create new ArcView project files.

DOS/Windows

To mount this CD-ROM on a DOS/Windows-based computer, insert the CD-ROM into a drive, and open the CD-ROM window. Follow the below instructions in the next section.

OPENING THE DATA SETS AND EXAMPLES OF GIS COMPILATION

In the directory */norpac/setup*, two ArcView projects (*norpac1.apr*, *norpac2.apr*) and one ArcExplorer project (*norpac.aep*) are provided to give users easy access to data on the CD-ROM. *norpac1.apr* requires that Spatial Analyst, an ArcView Extension which allows advanced manipulation and analysis of raster or point data (such as aeromagnetic, gravity, and earthquake data) compiled in ARC/INFO GRID format, be installed as well as ArcView 3.1. Use of *norpac2.apr* is designed for ArcView users who do not also have Spatial Analyst. Use of the ArcExplorer 1.1 file, norpac.aep, requires installation of the ArcExplorer program that is provided on the CD-ROM.

Use of GIS Compilation with ArcView 3.1

If ArcView 3.1 or higher is installed on your computer:

1. Place the CD-ROM in the CD Drive. Open the CD-ROM window.

2. Find the ArcView project *setup.apr* located in the directory */norpac/setup*.

3. Open the ArcView project by clicking on *setup.apr*, either from a file manager or from within ArcView.

4. ArcView should start with a small window with the title, “Cannot find the NorPac Data” followed by the sentence, “Enter the location of the NorPac Data”. In the white box, replace “Drive Name” with the drive name and directory, “N:/norpac/” where “N” is the letter or name of the CD or hard drive. Next click “OK”. A new window will appear with the title, “Found Spatial Analyst!” followed by the sentence, “Select a Project to load:” In the white box, select either “Norpac1.apr (Spatial Analyst)”, if your computer has both ArcView 3.1 and Spatial Analyst installed, or select “Norpac2.apr (non-Spatial Analyst)”, if your computer has only ArcView 3.1 installed. The selected ArcView project should load automatically. (Please note that if Spatial Analyst is not installed, Norpac2.apr will automatically load.) A window will appear with the title norpac1.apr or norpac2.apr, depending on the preceding selection. In the white box on the left side of the window will be a list of views that can be opened, viewed, manipulated, or printed within ArcView. Each view is a digital map of part of the GIS compilation. Each view has one or more themes (layers) that can be selected (made visible) or deselected (made invisible).

The views are:

Active Earth Example
Magnetic – Lithologic Correlation Example

Topographic Example
Cultural Features
Geology - Alaska
Geology – Russia
Gravity – DGRAV
Gravity – Geosat
Gravity – Seasurface
Magnetics – Alaska
Magnetics – Arctic
Magnetics - DNAG
Magnetics – East Asia
Magnetics – Russia
Reflection Profile Tracklines
Seismicity
Terranes – Alaska
Terranes – Canadian Cordillera
Terranes – Circum-North Pacific
Topography – Raster
Topography – Vector
Volcanoes – Active

A more detailed description of the views in given in the below section on Description of Views. Please note that if new themes and views are added to either *norpac1.apr* or to *norpac2.apr* and the ArcView project is saved, the ArcView project file needs to be edited before subsequent use of *setup.a*pr. Using a text editor such as WordPad, the path name *N:/norpac/* (where N is the designator of the CD drive) in either *norpac1.apr* or *norpac2.apr* (as appropriate) will need to be replaced by *$norpac/.*

Use of GIS Compilation with ArcExplorer 1.1

If ArcExplorer 1.1 is installed on your computer:

1. Place the CD-ROM in the CD Drive. Open the CD-ROM window.

2. Find the ArcView project "*norpac.aep"* located in the directory */norpac/setup*.

3. Copy the ArcExplorer project, "*norpac.aep"* into a directory on your hard drive. Deselect the Read-only box for the properties of this file. In order to accomplish this on a Windows computer, right-click on the file name and select "Properties".

4. Open the *norpac.aep* file in a word processor program, such as WordPad. Substitute the text string, *D:\norpac* with *N:\norpac* where "N" is the letter or name of the CD drive. Save the file as a text file with a new file name. Please note that a back slash ("\") is used in the substitution**.**

5. Start the ArcExplorer project by clicking on the new file name. The ArcExplorer project will start. In the gray box on the left side will be a list of pre-selected themes that can be opened (by selecting), viewed, and printed. Each theme is one part of the GIS compilation. Other themes can be added from the GIS compilation by referring to the below data descriptions. The themes consist of the basic ARC/INFO files contained in the GIS compilation. The theme names and their "translated" names are:

THEME NAME	"TRANSLATED NAME"
Circum-North Pacific Terrane and Overlap Assemblage Map	
basins.aat	Mesozoic and Cenozoic basins for Circum-North Pacific terrane and overlap assemblage map
coast.aat	Coastline for Circum-North Pacific terrane and overlap assemblage map
flts_lnd.aat	Onshore (land) faults for Circum-North Pacific terrane and overlap assemblage map
flts_ocn.aat	Offshore faults for Circum-North Pacific terrane and overlap assemblage map
flts_pos.aat	Post-accretionary faults, onshore and offshore, for Circum-North Pacific terrane and overlap assemblage map
mag_lins.aat	Magnetic lineaments for Circum-North Pacific terrane and overlap assemblage map
nor_pac.pat	Topography for Circum-North Pacific terrane and overlap assemblage map
ocn_geol.aat	Oceanic geology for Circum-North Pacific terrane and overlap assemblage map
rivers.aat	River drainages from Circum-North Pacific terrane and overlap assemblage map
terr_lnd.pat1	Onshore terranes for Circum-North Pacific terrane and overlap assemblage map
terr_ocn.pat	Offshore terranes for Circum-North Pacific terrane and overlap assemblage map
sea_mnts.pat	Seamounts for Circum-North Pacific terrane and overlap assemblage map
Geologic Map of Russian Far East	
rus_flts.aat	Faults for geologic map of Russia
rus_geol.pat	Geologic units of Russian Far East
rus_geol.patimpac	Impactite areas for geologic map of Russia
Terrane and Geologic Maps of Alaska and Canadian Cordillera	
ak_geol.pat	Geologic map of Alaska
assemblg.pat	Terrane and tectonic-assemblage maps of the Canadian Cordillera
terr_lnd.pat	Detailed terrane map of Alaska at 1:2.5 M scale
Gravity and Magnetic Maps	
ak_mag (image)	Magnetic map of Alaska (mainly onshore)
arct_mag (image)	Magnetic map of the Arctic (mainly offshore).
asia_mag (image)	Magnetic map of Far East Asia
dgrav (image)	Onshore Bouguer gravity anomalies and offshore free-air gravity anomalies for Alaska and adjacent offshore area
dnag_mag (image)	Magnetic map of North America, onshore and offshore
geosat (image)	Satellite-derived free-air gravity for offshore areas only.
russ_mag (image)	Magnetic map of Russia
sea_surf (image)	Satellite-derived sea-surface heights
Seismicity	
ak_seis.pat	Seismicity for Alaska, 1888-1998
isc_cat.pat	Global seismicity, 1964-1991

Topography and Bathymetry	
ak_shelf.pat	Bathymetry for US waters shallower than 200 m, Beaufort Sea to the Aleutians
ber_chuk.pat	Bathymetry for Chukchi Sea and Bering Straits, US and Russian waters
chukchi.pat	Bathymetry for Chukchi Sea
etopo5 (image)	5'-sampled land topography and marine bathymetry.
gtopo2 (image)	2'-sampled land topography and marine bathymetry (only available to 70°N)
gtopo30 (image)	30"-sampled topography (land only)
Cultural Features	
boundary.pat	International boundaries for Circum-North Pacific
cities.pat	Major cities for Circum-North Pacific
features.pat	Cultural features for Circum-North Pacific
latlong5.aat	Latitude and longitude grid at 5 degree spacing for Circum-North Pacific
latlon12.pat	Latitude and longitude grid at 12° spacing for Circum-North Pacific
Tracklines	
ew94_09.pat	Ship trackline for geophysical cruise EW94-09
ew94_10.pat	Ship trackline for geophysical cruise EW94-10

Please note that for the geologic and terrane maps, unique colors can be added to polygons (units) and lines (faults or contacts), and map unit abbreviations can be displayed. (Please refer to the ArcExplorer documentation included on the CD.)

PORTABLE DOCUMENT FORMAT (PDF) FILES

This publication makes use of Adobe Acrobat PDF files that are viewed with Adobe Acrobat Reader (versions 3.01 and 4.0 provided on this CD-ROM in the */norpac/setup/Acrobat* folder). To make best use of this CD-ROM, you will need to develop some familiarity with Acrobat Reader; an on-line guide is available within Acrobat Reader under "Help." The Acrobat directory contains installers for Adobe Acrobat Reader 3.01 (ACROBAT3 subdirectory) and 4.0 (ACROBAT4 subdirectory) for both 32-bit Windows (PC directories) and Macintosh (MAC directories). Acrobat 3.01 will run on the minimum system requirements for this disc given above. To use Acrobat Reader 4.0 under Windows, you need an 80486 or Pentium processor-based personal computer, Microsoft Windows 95, Windows 98, or Windows NT 4.0 with Service Pack 3 or later, 8 MB of RAM on Windows 95 and Windows 98 (16 MB recommended), or 16 MB of RAM on Windows NT (24 MB recommended). To use Acrobat Reader 4.0 on a Macintosh, you need a Power Macintosh computer. This CD-ROM contains a full-text index (index.pdx and associated files in the "index" directory) that is for use in searching the PDF files for words or sets of words, using the search tool in Acrobat Reader. You can use the installers provided on this disc or download the latest version of Adobe Acrobat Reader free via the World Wide Web from the Adobe homepage at http://www.adobe.com/.

DIRECTORY ORGANIZATION

The */norpac* directory of this CD-ROM contains four directories, */data*, */readme*, and */setup* plus the */index* directory used for Acrobat Search. In all tables, directories, sub-directories and filenames are listed alphabetically. Please note, however, that the ArcView windows with the available views for the projects *norpac#.apr* are listed alphabetically by "theme name", as listed in the contents of */data*.

Directory	Description of Files
data	GIS data in ARC/INFO 7.1.2 coverage and GRID formats. Data directories are organized by data type in the following sub-directories: *cultural*; *geology*; *gravity*; *magnetic*; *seismcty*; *shiptrax*; *terranes*; *topogrfy*; and *volcano*. Each of these contains a sub-directory for each dataset which in turn contains all necessary files for use of the data with ESRI Arc software. All the vector datasets are presented as ARC/INFO coverages accessible by ArcView and ARC/INFO. Because ARC/INFO GRID format files are not accessible by ArcExplorer, these datasets are represented as ***.*bil* images which can be opened in ArcExplorer. Sub-directories within *geology* and *terranes* also contain explanatory texts and figures, in ***.*txt*, ***.*doc*, and ***.*pdf* formats, within sub-sub-directories called /*explanat*. All data directories act as ARC/INFO work spaces and include an ARC/INFO files. Two additional sub-directories exist. The directory */norpac/data/examples* contains shape files for new coverages created from this CD-ROM that are used to produce example views of data compilations. The directory */norpac/data/legends* contains suggested color tables and legends for different data-sets. The directories /*examples* and */legends* are not ARC/INFO work-spaces and have no ARC/INFO files.
readme	Information files for this CD-ROM in multiple file formats, text (***.*txt*), Word (***.*doc*), Rich-Text Format *(***.*rtf*), and portable document format (***.*pdf*). (***.*pdf* files can be read with Adobe Acrobat Reader 4.0, freeware contained in */norpac/setup/Acrobat*) *readme.*** contains brief ASCII information about this CD-ROM. *document.*** (this file) contains full documentation for all data-sets on this CD-ROM. Subdirectory *cpyright* contains copyright notices associated with multiple-generation data.
setup	Installation files for ArcExplorer, the freeware software for users of this CD-ROM who lack access to the proprietary ArcView and ARC/INFO GIS software. The files are contained in the sub-directory */norpac/setup/explorer*. Files for Acrobat, freeware text-viewing software for PDF files are contained in the sub-directory */norpac/setup/Acrobat*. Project files for use with ArcView (*norpac1.apr* for users with the extension Spatial Analyst installed; and *norpac2.apr* for those without and for use with ArcExplorer (*norpac.aep*).

CONTENTS AND DESCRIPTION OF */norpac/setup*

The directory */norpac/setup* contains sub-directories /*explorer* and /*Acrobat*, which hold the freeware programs ArcExplorer and Adobe Acrobat, respectively.

The directory */norpac/setup/Acrobat* contains installers for Adobe Acrobat Reader 3.01 and 4.0 for both Windows 95/98/NT and Macintosh. The latest version of Adobe Acrobat Reader can also be downloaded free via the Internet from the Adobe homepage on the World Wide Web at http://www.adobe.com.

The directory */norpac/setup* also contains the files *norpac.aep*, *norpac1.apr* and *norpac2.apr*. The ***.*aep* and ***.*apr* files are project files for ArcExplorer and ArcView, respectively. If either ArcView and/or ArcExplorer are installed, the ***.*apr* and ***.*aep* files can be loaded from within these programs, using the instructions given in the above section on "OPENING THE DATASETS…" to display preset examples of the data. In general, users need not modify these files, but will rather wish to create new project files for individual needs.

SUMMARY CONTENTS OF */norpac/data*

Data directory	**Sub-direc-tory**	**Filename (data-set name) in GIS**	**Theme name used in views presented in projects *norpac1.apr* & *norpac2.apr***	**Brief description of data**	**Layer size (Mb)**
cultural		*boundary*	International/state boundaries	International, provincial and state boundaries	1
		cities	Cities	Significant population centers	0.6
		features	Manmade features	Other socio-cultural features, such as airports amd golf-courses	1.6
		latlong5	Latitude/longitude grid (5°)	Latitude and longitude grid at 5° spacing	< 0.1
		latlon12	Latitude/longitude grid (12°)	Latitude and longitude grid at 12° spacing	< 0.3
examples				Shape files used in constructing the example views. "Active Earth and Magnetic-Lithologic correlation, examples" discussed in text	37
geology		*ak_geol*	Geologic map of Alaska	Geologic map of Alaska	8
		rus_flts	Fault map of Russia	Fault map of Russia	1
		rus_geol	Geologic map of Russia	Geologic map of Russia	26
gravity		*dgrav*	Onshore Bouguer and offshore free-air gravity (mGal)	Onshore Bouguer gravity anomalies and offshore free-air gravity anomalies. Blank areas in regions offshore Southwestern Alaska, in interior Alaska, and in Canadian Cordillera have not data. †Note that *dgrav.bil* has been created	< 0.3
		geosat	Satellite free-air gravity (mGal)	Satellite-derived free-air gravity, offshore areas only. †Note that *geosat.bil* has been created.	6
		sea_surf	Satellite sea-surface height (m)	Satellite-derived sea-surface heights. †Note that *sea_surf.bil* has been created.	1
legends				Contains suggested color-bars and contour information for each data-set as ***.*avl* files; automatically accessed by ArcView as needed; contains sub-directories for each of the other sub-directories to */norpac/data* [i.e. *cultural*, *geology*, *gravity*, etc.]	1

magnetic		*ak_mag*	Magnetic map of Alaska (nT)	Magnetic map of Alaska (mainly onshore) †Note that *ak_mag.bil* has been created	2
		arct_mag	Magnetic map of the Arctic (nT)	Magnetic map of the Arctic (largely offshore). †Note that *arct_mag.bil* has been created	< 0.2
		asia_mag	Magnetic map of Far East Asia (nT)	Magnetic map of Far East Asia. †Note that *asia_mag* has been created	2
		dnag_mag	Magnetic map of North America (nT)	Magnetic map of North America, onshore and offshore. †Note that *dnag_mag.bil* has been created	44
		russ_mag	Magnetic map of Russia (nT)	Magnetic map of Russia. †Note that *russ_mag.bil* has been created	1
seismcty		*isc_cat* *ak_seis*	Global seismicity, 1964-1991 Alaskan seismicity, 1898-1998	Catalog of global seismicity, 1964-1991 Alaska State Seismicity, 1898-1998	5 7
shiptrax		*ew94_09*	Ship trackline, EW94-09	Ship trackline for geophysical cruise EW94-09	< 0.5
		ew94_10	Ship trackline, EW94-10	Ship trackline for geophysical cruise EW94-10	< 0.5
terranes	*alaska*	*explanat*		*mapexpln.*** (map explanations)	< 0.6
		terr_lnd	Alaska terrane map, 1:2.5M	Tectonostratigraphic terrane and overlap map of Alaska (scale, 1:2.5 M)	2
	canada	*assemblg*	Canadian Cordillera - terranes / tectonic assemblages	Terrane and tectonic-assemblage maps of the Canadian Cordillera. Note that useful hotlinks exist.	22
	nor_pac		Circum-North Pacific Terrane Map	Circum-North Pacific Tectonostratigraphic Terrane Map. Note that useful hotlinks exist.	n/a
		basins	Circum-North Pacific basins	Outlines of Mesozoic and Cenozoic basins	< 0.2
		coast	Circum-North Pacific coastline	Coastline; same as *topogrfy/vector/contours*, but presented as sea-level contour only	2
		explanat		*assemb* (text files for assemblage descriptions; *columns* (stratigraphic columns); *terranes* (text files for terrane descriptions); *mapexpln.*** (map explanation)	10
		flts_lnd	Circum-North Pacific onshore faults	Onshore faults	1
		flts_ocn	Circum-North Pacific offshore faults	Offshore faults	< 0.5

		flts_pos	Circum-North Pacific post-accretionary faults	Post-accretionary faults, onshore and offshore	< 0.3
		mag_lins	Circum-North Pacific magnetic lineaments	Magnetic lineaments	< 0.3
		ocn_geol	Circum-North Pacific oceanic geology	Oceanic geology	< 0.2
		sea_mnts	Circum-North Pacific seamounts	Seamounts	< 0.2
		terr_lnd	Circum-North Pacific onshore terranes - terranes / overlap abbreviations / overlap assemblages	Onshore terranes	9
		terr_ocn	Circum-North Pacific offshore terranes	Offshore terranes	3
topogrfy	*raster*			*raster* contains gridded topographic data	n/a
		etopo5	5' topography/bathy-metry (m)	5'-sampled land topography and marine bathymetry. †Note that *etopo5.bil* has been created	< 0.3
		gtopo2	2' topography/bathy-metry (m)	2'-sampled land topography and marine bathymetry (only available to 70°N). †Note that *gtopo2.bil* has been created	15
		gtopo30	30" land topography (m)	30"-sampled topography (land only). †Note that *gtopo30.bil* has been created	23
		hillshad	hillshade of 30" land topography	30"-sampled topography illuminated by sun from 315° at 45° elevation	12
	vector			*vector* contains contours (elevation or bathymetry) and hence polygons lying between fixed contour values	n/a
		ak_shelf	US shelf bathymetry (m) (1:0.25M)	Bathymetry for US waters shallower than 200m, Beaufort Sea to the Aleutians (most detailed, 1:0.25M)	17
		ber_chuk	Bering/Chukchi Seas bathymetry (m) (1:2.5M)	Bathymetry for Bering and Chukchi Seas, US and Russian waters (intermediate detail, 1:2.5M)	4
		chukchi	Chukchi Sea/Bering Straits bathymetry (m) (1:1M)	Bathymetry for Chukchi Sea and Bering Straits, US and Russian waters (more detailed, 1:1M)	1
		nor_pac	1:10M topography/bathyme try (m)	Circum-North Pacific topography and bathymetry (least detailed, 1:10M)	4
		rivers	Rivers	Major drainages, circum-North Pacific	< 0.3

		shorline	World Vector Shoreline (1:0.25M)	World Vector Shoreline, designed for use at scales of up to 1:250,000	4
volcano		*volcano*	Volcanoes	Historically active volcanoes	< 0.1

†Note: For some gridded datasets, an image file, */data/data-directory/data-subdirectory/filename.bil,* is created to for viewing of these datasets in the freeware ArcExplorer program which otherwise cannot display these data-sets.

†Note: For some datasets, hotlinks are created to link features in views to other data sources, typically text descriptions of geologic units. When the linked feature is clicked with the Hot Link tool, ArcView opens the linked data source. Hotlinks are created for the map explanations for the Circum-North Pacific tectonostratigraphic terrane map and for the terrane and tectonic assemblage maps of the Canadian Cordilleran. Refer to ArcView manuals for use of the hotlink tool.

DETAILED DESCRIPTION OF */norpac/data*

General Form of Metadata

For each of the datasets, the relevant metadata are presented in tabular form. The first table is generic and lists the various type of metadata.

Filename: (in the format *sub-directory/filename*)	**Summary title / Brief description of data**
(Additional filename)	**Additional title(s) in bold imply all these data share the same source and similar metadata**
Data type:	Information contained in the dataset [e.g., "Bouguer gravity anomalies"]
Geographic extent:	The north, west, south and east limits of the dataset; if the dataset extends to the full area of coverage (120°E, 80°N, 115°W, 40°N) the annotation *full coverage* is used
Projection:	The projection of the original map or data source. This projection may affect the spacing of grid-points or accuracy of arcs and polygons. The accuracy is usually a function of latitude; and is not normally relevant for point data.
Source scale: *or* Source grid interval:	Scale of original map or scale of compilation of original data source. This section provides a measure of spatial accuracy of the data. Where data are digitized from paper maps, this section provides, when known, the spacing of digitizing vertices. Such information is not normally applicable to point data.
Data documentation:	Documentation files are included on this CD-ROM, are described herein. These files are usually presented in three formats, ASCII (***.*txt*), Word (***.*doc*), and Adobe Acrobat Reader (***.*pdf*).
Arc attributes, polygon attributes, or point attributes:	For vector data, a list of the attributes (data types) stored for the data-set for each arc and each polygon [e.g. "Lithology"] [in arc attribute tables, ***.*aat*, and in polygon attribute tables, ***.*pat*, respectively] are stated. Also stated are region attributes for datasets where regions (subsets of a single coverage) are defined. The names of attribute fields are listed as [name], and for attribute names that are not immediately obvious, a definition is listed, As an example, for the field value, all possible values are listed. For raster (gridded) data and point data are listed the attributes (data values) stored for the data-set for each point [in point attribute tables, ***.*pat*], and the units of measurement [e.g. "Bouguer anomaly, units of mGal"].
Range:	Where appropriate, the maximum and minimum values contained in the dataset are listed. Knowledge of the full range can assist in choosing display scales. Note that some datasets are truncated (e.g. topographic datasets that only extend to the shelf edge) other datasets include specially coded values to indicate missing data.

Resolution: *&/or* Error estimates:	Where appropriate data on resolution are included, for example "Contour interval 200 m", or "±3 mGal". This type of data may not be applicable to vector coverages, e.g. Geology.
Legends:	For customized legends available within the projects *norpac#.apr*, the name (****.avl*) and the relevant details are provided herein.
Primary reference:	Source of dataset, to which reference should be made when any derivative maps or products are presented or published. Original sources that contain significant additional datasets are noted herein.
Further information:	Publisher or developer of the dataset; included to provide further credit to the providers of the datasets, and as a source for further information

Note that additional notes are provided for some datasets.

Cultural Datasets

cultural/boundary	**International, provincial and state boundaries**
cultural/cities	**Significant population centers**
cultural/features	**Other socio-cultural features, such as airports amd golf-courses**
cultural/latlong5	**Latitude and longitude grid at 5° spacing**
cultural/latlon12	**Latitude and longitude grid at 12° spacing**
Data type:	Various, see above
Geographic extent:	Full coverage
Projection:	Decimal Degrees
Source scale:	Boundary: 1:5 million Cities: n/a Features: 1:1 million
Point attributes:	**cultural/cities** /norpac/data/cultural/info/cities.pat contains attributes: [Name] = city name; spellings are based on Board of Geographic Names standards and commercial atlases [Country] = abbreviated country name [Population] = total population for the entire metropolitan area; values are from recent census or estimates; attributes of -99 are null values (data not available) [Capital] = indicates whether a city is a national capital (possible values are Y and N) **cultural/features** /norpac/data/cultural/info/features.pat contains attributes: [Text] = feature name, e.g. Laptev Sea, Denali; spellings based on DMA Operational Navigation Charts [Type] = the type of feature to which the name pertains (possible values: Administrative name, Airport, Country name, Cultural landmark, Desert name, Drainage feature, Island name, Land place name, Mountain name, Ocean name, Populated place)
Arc attributes:	**cultural/latlong5** */norpac/data/cultural/info/latlong5.aat* contains attributes: [Value] = degree value and the latitude or longitude directional reference of the grid line [Degree10] = indicates whether a grid line is part of the 10 by 10 degree grid (Y/N) [Degree15] = indicates whether a grid line is part of the 15 by 15 degree grid (Y/N) [Degree20] = indicates whether a grid line is part of the 20 by 20 degree grid (Y/N) [Degree30] = indicates whether a grid line is part of the 30 by 30 degree grid (Y/N)

Polygon attributes:	**cultural/boundary** */norpac/data/cultural/info/boundary.pat* contains attributes: [Fips_admin] = two-letter, two-number United States Federal Information Processing Standards (FIPS) code for a first-level administrative unit; for countries without administrative units, this field contains only the two-letter country code [Gmi_admin] = three -letter country code combined with a three-letter code for a first-level administrative unit created by Global Mapping International [Admin_Name] = name of a first-level administrative unit [Fips_cntry] = two-letter country code from the United States Federal Information Processing Standards (FIPS) coding scheme [Gmi_cntry] = three-letter country code from Global Mapping International [Cntry_Name] = country name; shortened and not necessarily official [Region] = name of the world region; data is grouped into 25 commonly recognized regions to permit selection of a small multicountry area for display or study [Continent] = continent name [Pop_admin] = population of a first level administrative unit (from NCGIA: The Global Demography Project; 1994 estimated population); –99999 indicates population figures unavailable [Sqkm_admin] = total area of a first level administrative unit in square km [Sqmi_admin] = total area of a first level administrative unit in square mi [Type_eng] = English name for the type of administrative unit [Type_loc] = local name for the type of administrative unit
Primary reference:	**cultural/boundary** ESRI's ArcWorld database **cultural/cities** ESRI's ArcWorld database supplemented with other data from the Rand McNally New International Atlas, 1991 **cultural/features** Digital Chart of the World (DCW), from the United States Defense Mapping Agency (DMA) Operational Navigation Charts (ONC) **cultural/latlong5** mathematically generated by ESRI using ARC/INFO software and converted to an ESRI shapefile
Further information:	Environmental Systems Research Institute, Inc., http://www.esri.com

Geology Datasets

geology/ak_geol	**Geologic map of Alaska**
Data type:	Geologic data separated by lithology and age. [Faults present in the source map are not contained in our database.]
Geographic extent:	State of Alaska
Projection:	The original map (Beikman, 1980) is based upon two base maps of different unknown projections which have been combined at unknown locations to create the final product.
Source scale:	1:2,500,000; digitized with 500 m vertices
Data documentation:	A description of the map units is contained in files */explanat/mapexpln.****
Arc attributes:	*ak_geol.aat* contains: [Type] = Contact information (Visible, Non-visible, Ice)
Polygon attributes:	*/norpac/data/geology/info/ak_geol.pat* contains: [Code] = Lookup code for the geologic unit; the unit description is also appended [Mapunit_ab] = Geologic Unit, e.g. DVM for Devonian mafic volcanics, after Beikman (1980)
Legends:	*ak_geol.avl* is modelled as closely as possible on the colors and patterns of the Beikman (1980) map. Due to limitations in available ArcView color palettes and patterns, the matching is not exact, and some distinct units are mapped by identical colors and patterns. Note also that, typically, screen colors are not faithfully reproduced by plotters.

Primary reference:	Geologic Map of Alaska, Beikman (1980); digital version prepared by F.R. Wilson (USGS).
Further information:	F.R. Wilson, U.S. Geological Survey, Anchorage, Alaska 99508

geology/rus_flts	**Fault map of Russia**
geology/rus_geol	**Geologic map of Russia**
Data type:	Geologic data separated by lithology and age
Geographic extent:	Eastern Former Soviet Union and adjacent marine areas
Projection:	Geographic (decimal degrees); original coverage was split across 180° longitude; the regions west and east of 180° have been merged but not formally joined so affected polygons are split into two parts by a line along 180°
Source scale:	1:2,500,000
Data documentation:	A description of the map is contained in files */explanat/mapexpln.doc* and *explanat/mapexpln.pdf;* and look-up tables for the numeric attributes are contained in *explanat/attribut.doc* and *explanat/attribut.pdf*
Arc attributes:	*/norpac/data/geology/info/rus_geol.aat* contains: [Numleg] = lookup code for geoleg, the geologic legend (see */explanat/attribut.doc*) [Line-type] = all line work, including e.g. 'Proved faults', 'Shoreline', 'Boundaries between facies varieties of rocks'
Polygon attributes:	*/norpac/data/geology/info/rus_geol.pat* contains: [Numleg] = legend number for plotting [Numl] = legend number for plotting [Err] = errors in the printed map (see */explanat/mapexpln.doc*) [Priz] = special features (see *explanat/mapexpln.doc*) [Agecod] = lookup code for agesleg, the age legend (see */explanat/attribut.doc*) [GeoCod] = lookup code for geoleg, the geologic legend (see */explanat/attribut.doc*) [Geo_unit] = rock type, e.g. 'Continental deposits' [*sic*], 'Granite' [AgeIndex] = abbreviated geologic age, e.g. 'AR' for Archean, J1 for Lower Jurassic [Age] = geologic age, e.g. 'Archean', 'Lower Jurassic'
Region attributes:	*Acoust* No values; "Acoustic Basement" includes basement uplifts determined geophysically in offshore areas *Impac* No values; "Impactite" includes rocks with characteristics of metamorphism but chemical characteristics of primary rocks *Diaph* No values; "Diaphthorite Rocks" includes rocks changed by retrogressive metamorphism
Legends:	*rus_age.avl* is derived from the polygon attribute [Numleg] and contains a distinct color/pattern for each geologic age [Age] *rus_arcs.avl* contains a separate line symbol for every value of the arc attribute [Line-type], including various types of tectonic boundaries as well as coastlines, state boundaries, etc. *rus_flts.avl* contains line symbols for tectonic contacts *rus_geol.avl* contains distinct color/pattern combinations for each value of the polygon attribute [Geo_unit], i.e. for separate rock types
Primary references:	Nalivkin (1994); GlavNIVC (1998). GlavNIVC team: Boris L. Khlebnikov, Paul P. Hearn, Jr., Gregory Ulmishek, Michael P.Nemynov, Elena M. Nuzhdenova, Svetlana A. Goryushina, Galina I.Bogolyubova, Andrew P. Gilbershteyn, Valeriy A. Medvedev, Aleksey A. Polishchu, Paul G. Schruben, Walter Bawiec, Nina Y. Lebedeva, and Andrew V. Korotkov. Original data compilation also includes topographic base maps, mineral deposits map and petroleum basins/gas fields map.
Further information:	Boris Khlebnikov (GlavNIVC, RMNR, boris@glavnivc.msk.su); and Paul P. Hearn (USGS, phearn@usgs.gov). Russian Far East part of geologic map of Russia compiled herein with permission of Boris Khlebnikov and Paul P. Hearn.

Gravity Datasets

gravity/dgrav	**Onshore Bouguer gravity anomalies and offshore free-air gravity anomalies**
Data type:	Bouguer gravity on land; free-air gravity over oceans. Computation of gravity anomalies based on the International Gravity Standardization Net 1971 and the Geodetic Reference System 1967. Bouguer anomalies calculated using a crustal density of 2670 $kg.m^{-3}$. Data for "high-relief areas of Canada and the United States" have been terrain corrected; elsewhere data are generally not terrain corrected. Data were originally compiled from surface, airborne, and satellite measurements. For Alaska, Chukchi Sea, Western Beaufort Sea, and Norton Sound, where surface data could not be readily obtained in digital form, synthetic point gravity values were created from contour maps: Childs and others (1985) for the Bering Sea, Fisher and others (1982) for the Norton Basin, Barnes (1977) for Alaska, May (1985) for the Chukchi and Beaufort Seas and Arctic Ocean. Over the oceans, up to about 70°N, satellite-derived free-air values filled in areas where surface data were unavailable or sparse. Satellite data provided on a 15-minute geographic grid were gridded at a 24-km interval to remove the short-wavelength components at higher latitudes and then combined with the surface data. The resultant data set was then interpolated to a 6-km grid.
Geographic extent:	full coverage east of 170°E
Projection:	Regridded into latitude and longitude from an original spherical transverse Mercator projection. Decade of North American (DNAG) 6-km gravity grid was regridded by NGDC using a grid cell dimension of 2.5' of longitude and latitude and a Brigg's minimum curvature algorithm which allowed generation of grids from randomly distributed data. The 2.5' grid cell dimension leads to a high degree of spatial distortion at very high latitudes, so the latitude-longitude grids have been truncated above 80°N. [Because regridding the potential field data from km on a map projection into latitude and longitude introduced some gradient distortions at all latitudes it is recommended that anyone attempting to do quantitative work with the potential field grids use the original 6-km gravity grids.]
Source grid interval:	2.5 minute (from original 6-km spacing)
Point attributes:	values are milligals
Range:	-284 to +204 mGal
Spatial resolution:	field data were often sampled along a traverse or along a ship track; the grids produced often generate solutions several grid cells wide, and so will appear on color raster images as narrow bands of color-coded information rather than as lines
Error estimates:	estimated rms error for land, surface marine, and airborne data ranges from +/- 1 to +/- 5 mGal; satellite data have an estimated rms error of +/- 8 mGal
Primary reference:	NGDC Gravity CD-ROM: Hittelman (1994); Committee for the Gravity Anomaly Map of North America (1987)

gravity/geosat	**Satellite-derived free-air gravity, offshore areas only**
Data type:	Satellite-derived free-air gravity over oceans; low-pass filtered with 0.5 gain at a wavelength of 20 km, gridded on a Mercator projection (method of Sandwell, 1992); derived from the following sources: Geosat/ERM - average of 62 Geosat Exact Repeat Mission profiles; Geosat/GM – declassified Geosat Geodetic mission data for all ocean areas; ERS-1 -ERS-1 OPR GDR's from the first 16 repeat cycles of the 35-day repeat orbit were averaged to improve their accuracy and resolution; ERS-1/GM - ERS-1 OPR GDR's from the first 200 days of the ERS-1 Geodetic mission
Geographic extent:	full coverage below 72°N (marine areas only)

Projection:	latitude and longitude grid
Source grid interval:	2 minute; but effective resolution is only about 10 km (ERS-1 provided 8-km-spaced profiles, and Geosat 6-km-spaced profiles). Source data includes values over land areas, presumably an artifact of the contouring or extrapolation method, so we used the coastline from the Circum-North Pacific Terrane map, */topogrfy/vector/nor_pac*, to mask out all land areas
Point attributes:	values are milligals
Range:	-3329 to +3211 mGal
Error estimates:	> 3 mGal
Primary reference:	Smith and Sandwell (1997)
Further information:	http://topex.ucsd.edu/marine_grav/mar_grav.html

A similarly gridded data-set that extends to 80° N over the polar ice-cap (Laxon and McAdoo, 1998) is available from http://msslsp.mssl.ucl.ac.uk:80/people/swl/polar-gravity.html.

gravity/sea_surf	**Satellite-derived sea-surface heights**
Data type:	Sea-surface height computed on a 0.125-degree grid in the ocean areas from a combined GEOS3/SEASAT/GEOSAT altimeter data set to provide the long-wavelength component of the gravity field.
Geographic extent:	Full coverage below 72°N (marine areas only)
Projection:	latitude and longitude grid
Source grid interval:	0.125°
Point attributes:	Values are meters
Range:	-36 to +41
Primary reference:	NGDC Gravity CD-ROM: Hittelman (1994)

Magnetic Datasets

magnetic/ak_mag	**Magnetic map of Alaska (largely onshore)**
Data type:	Aeromagnetic, compilation of 85 previous surveys conducted between 1945 and 1982 with varying attributes (note that large regions of Alaska are covered only by very coarse surveys); upward or downward continued and converted from level to drape as necessary to produce a consistent survey specification of 1000 ft above ground; the Definitive Geomagnetic Reference Field (DGRF) has been applied for the date of each original survey
Geographic extent:	Alaska and immediate offshore areas only
Projection:	Latitude and longitude grid
Source grid interval:	1 km, regridded from original surveys
Data documentation:	An index map stored as a gif image showing data sources is contained in the file *ak_mag.gif*. Click on the ? ikon in the view to display a gif image of the data.
Point attributes:	Values are nanoteslas
Range:	-1867 to +4640 nT
Primary reference:	Saltus and Simmons (1997), Saltus et al. (1999)
Further information:	http://minerals.cr.usgs.gov/publications/ofr/97-520/alaskamag.html

magnetic/arct_mag	**Magnetic map of the Arctic (largely offshore)**
Data type:	Short and medium-wavelength (< 400 km) magnetic anomaly over the Arctic and adjacent land areas; numerous datasets merged to develop a digital data base of coherent magnetic observations suitable for quantitative tectonic interpretations
Geographic extent:	Full coverage above 60°N (but only patchy coverage of the Bering Straits region)

Projection:	Original dataset was Transverse Mercator, a projection not supported by ARC/INFO. Therefore the source grid was converted to an ARC/INFO point coverage with entries of type latitude, longitude, data value; and the ARC/INFO command POINTGRID was then used to create the final GRID coverage in our standard Lambert-Azimuthal projection. Because the equi-spaced sampling of the grid points in orthogonal co-ordinates does not translate to equi-spaced sampling in latitude-longitude co-ordinates, although the data coverage appears continuous at lower latitudes, increasing numbers of data-points near the poles contain no data value and appear as "holes" in the coverage at high latitudes.
Source grid interval:	5 km, reduced to 12 km in creating this coverage
Point attributes:	Values are nanoteslas
Spatial resolution:	Isolated data profiles, e.g. In the Bering Sea, appear as swaths 15 km wide
Range:	-2573 to +1748 nT
Primary reference:	GAMMAA5 (Gridded Aeromagnetic and Marine Magnetics of the north Atlantic and Arctic, 5 km) Magnetic Anomalies of the Arctic and North Atlantic Oceans and Adjacent Land Areas CD-ROM: Verhoef and others (1996); Macnab and others (1995) [original data compilation also includes a separate grid defining the long-wavelength (> 400 km) anomalies, and ancillary grids containing a quantitative indication of the quality and accuracy of the final data set]
Further information:	Jacob Verhoef, verhoef@agc.bio.ns.ca; Ron Macnab, macnab@agc.bio.ns.ca; http://agcwww.bio.ns.ca/index.html.

magnetic/asia_mag	**Magnetic map of Far East Asia**
Data type:	Aeromagnetic and marine magnetic data for East Asia
Geographic extent:	West = 120°E North = 50°N East = 150°E South = 40°N
Projection:	XY values of geographic co-ordinates are calculated using Lambert azimuthal equal-area projection with central point 15°N, 120°E; a spherical earth with radius 6377 km has been assumed. Locations in Latitude and longitude in units of 10^{-4}° inversely projected from the X and Y co-ordinates.
Source grid interval:	2 km; original map scale was 1:4,000,000
Point attributes:	values are nanoteslas
Range:	-770.6 to +1278.4 nT
Primary reference:	Magnetic Anomaly Map of East Asia, 1:4,000,000, CD-ROM: Geological Survey of Japan and CCOP (1996).
Further information:	Information and Publication Office, Geological Survey of Japan fukyu@gsjnet.gsj.go.jp CCOP Technical Secretariat, Thailand ccop@external.ait.ac.th

magnetic/dnag_mag	**Magnetic map of North America, onshore and offshore**
Data type:	Merged land and marine magnetic anomalies gravity for the western hemisphere part of our area, created from the Magnetic Anomaly Map of North America with x and y step intervals of 2.0 km in a Spherical Transverse Mercator projection, with reference meridian 100°W and earth radius 6371.204 km, using the Definitive Geomagnetic Reference Field (DGRF)
Geographic extent:	Full coverage east of 170°E
Projection:	Geographic (decimal degrees)

Source grid interval:	2 km; data were originally compiled at an interval appropriate for contour intervals of 100 nT (gamma); attempts to produce contour intervals less than 100 nT may reveal discontinuities between some data sets used in compiling the map
Point attributes:	Values are nanoteslas
Spatial resolution:	field data were often sampled along a traverse or along a ship track; the grids produced often generate solutions several grid cells wide, and so will appear on color raster images as narrow bands of color-coded information rather than as lines
Error estimates:	Joins between the data sets were largely free of major discrepancies, though adjustment was necessary in the panhandle of Alaska where the data were lowered approximately 150 nT (Hittelman and others, 1989)
Range:	-3580 to + 4278 nT
Primary reference:	Committee for the Magnetic Anomaly Map of North America, (1987); Hittelman and others (1989); unpublished contributions by Tom Hildenbrand (USGS).
Further information:	Tom Hildenbrand (USGS), thildenbrand@usgs.gov

magnetic/russ_mag	**Magnetic map of Russia**
Data type:	Magnetic data for the Russian Far East; magnetic maps of the land and offshore areas of China and Former Soviet Union originally published (1974) at 1:2.5 million scale, from which digitized contours were extracted and a 1 arc-minute grid prepared (1980) by U.S. Naval Oceanographic Office; some data spikes, data errors, and data omissions corrected by Conoco, Inc., and the entire dataset reduced to IGRF 1980 and merged to produce a composite grid with a spacing of 5 km for publication by GSC. The data set has been high-pass filtered to remove long-wavelength components greater than 400 km.
Geographic extent:	Full coverage west of 170°W
Projection:	Geographic (decimal degrees); the data were warped to match the geographic boundaries of Russia present in our topography datasets. The warping process results in a resampling of the original data, so the warp we performed on russ_mag (second-order using bilinear interpolation) attempted to minimize the change in the data while maximizing the spatial correlation between the dataset and the rest of this GIS compilation. Warping the data in the opposite direction will give users the original data. The links (start and end points) used in the polynomial transformation follow, measured in meters from the zero point of our Lambert Azimuthal projection at 165°W, 70°N: FromX, FromY, ToX, ToY -216917.74665, -557259.82339, -262657.03815, -467793.08008 -351321.53412, -649351.26631, -362506.63694, -596866.94939 -891425.24825, -709086.26153, -903155.52350, -691845.80497 -1318354.49763, -843782.70439, -1348161.08791, -839295.42439 -1268575.33967, 348428.11170, -1272665.05031, 356464.22264 -3690477.54461, -965302.33514, -3710012.77456, -994272.58564 -3563540.77141, -1358557.69744, -3585809.70113, -1366881.90032 -1773248.38155, 1212828.44935, -1787853.37859, 1219243.57022 -1696090.66104, 1416923.10222, -1714792.71517, 1426248.63379 -1815560.66822, 1663329.96941, -1834125.11242, 1647866.06602 -1235633.40954, 493519.50358, -1254510.70082, 491072.49600 -3071605.57077, -496939.04713, -3106487.58154, -509194.14353 -3400148.00418, -698544.66635, -3423083.69172, -716199.31972 -3123873.77287, -365024.33190, -3143017.94007, -367943.59381 -2118920.66639, -501477.84139, -2132566.99217, -485061.94724 -2539554.48655, -145556.91664, -2546577.33383, -146547.55909 -1735838.89182, -1287415.70477, -1746339.61803, -1283420.28833 -2261874.12690, -1214115.69280, -2271713.18177, -1201182.97012 -1377962.56550, 803790.20963, -1412303.98862, 789149.13093 -1511627.12488, 1058184.32338, -1540739.78304, 1046584.95009 -3266515.28444, 75101.88353, -3284529.34896, 52187.30721
Source grid interval:	5 km
Point attributes:	Values are nanoteslas

Range:	-1059 to + 1380 nT
Primary reference:	Racey and others (1996)
Further information:	The dataset included on this CD-ROM was transformed by the National Geophysical Data Center (NGDC) into a 3 arc-minute dataset that is available from R.W. Buhmann, rwb@ngdc.noaa.gov, National Geophysical Data Center (E/GC1), 325 Broadway, Boulder Colorado, 80303, U.S.A.

Seismic Datasets

seismcty/isc_cat	**Catalog of global seismicity, 1964-1991**
Data type:	Earthquake hypocenters for 1964-1991, probably complete for teleseismic events with body-wave magnitude $m_b > 5.0$
Geographic extent:	Full coverage
Projection:	Geographic (decimal degrees)
Point attributes:	*/norpac/data/seismcty/info/isc_cat.pat* contains attributes: [Isc_cat-id], [Year], [Month], [Day], [Hour], [Minute], [Second], [Depth], [Magnitude]
Legends:	Two separate legends are available, *isc_cat.avl*, and *mag##.avl*. *isc_cat.avl* displays earthquakes color-coded by depth, not by magnitude (since many earthquakes in the ISC catalog have no assigned magnitude). *mag##.avl* is a series of eight legends designed respectively for use with earthquakes of magnitudes in the range (## to ##+5)/10 (for example, *mag40.avl* refers to earthquakes with 4.0 $\leq$ magnitude < 4.5), in which symbol size increases with increasing magnitude range but earthquakes are also color-coded by depth as in *isc_cat.avl*. The eight *mag##.avl* legends together provide a bivariate legend, simultaneously coding for size and depth, when applied to the shape files */norpac/data/examples/mag##.shp* which contain all earthquakes for which magnitudes are assigned.
Primary reference:	Whiteside and others (1996)
Further information:	R.J. Willemann, International Seismological Centre, United Kingdom, RG 19 4NS http://www.isc.ac.uk/

Notes for seismcty/isc_cat

Earthquake focal-plane solutions ("beach-ball" diagrams) are available for individual earthquakes from http://www.seismology.harvard.edu/CMTsearch.html We lack software to plot focal mechanisms within ESRI software packages.

seismcty/ak_seis	**Alaska state seismicity, 1898-1998**
Data type:	Earthquake hypocenters for 1898-1998
Geographic extent:	Alaska
Projection:	Geographic (decimal degrees)

Point attributes:	*/norpac/data/seismcty/info/ak_seis.pat* contains attributes: [Lat] = Latitude of hypocenter [Lon] = Longitude of hypocenter [Depth] = Depth of hypocenter [Date] = Date of Earthquake [Doy] = Julian day of a year [Time_utc] = UTC time of earthquake origin [ML] = Local (or Richter)magnitude, or the best etimate magnitude for events prior to 1988 [Mb] = Body wave magnitude (1 second period) [Ms] = Surface wave magnitude (20 second period) [Mw} = Moment magnitude (more robust energy at high magnitude)
Legends:	The ISC legend, *isc_cat.avl*, can be applied to this dataset. *isc_cat.avl* displays earthquakes color-coded by depth, not by magnitude.
Primary reference:	Hansen and others (1999)
Further information:	Roger Hansen, State Seismologist, State Seismologists Office, Alaska Earthquake Information Center, University of Alaska Geophysical Institute, Fairbanks, Alaska.

Ship Trackline Datasets

shiptrax/ew94_09	**Ship trackline for geophysical cruises EW94-09**
shiptrax/ew94_10	**Ship trackline for geophysical cruises EW94-10**
Data type:	Tracklines for marine non-proprietary deep-crustal seismic reflection profiles recorded in July and August 1994 by the UNOLS vessel R/V Ewing in the Bering and Chukchi seas and around the Aleutians; latitude and longitude co-ordinates for every 10th seismic source position (variously every 500 m or 750 m along the track-line)
Geographic extent:	Full coverage
Projection:	Point data
Error estimates:	Dataset contains every 10th source-point; original dataset contains every datapoint, measured with single-station GPS
Primary reference:	Bering-Chukchi Working Group (1999); Brocher and others (1995); Fliedner and Klemperer (1999); Holbrook and others (1999) [original datasets also include underway deep seismic reflection profiling; gravity; magnetic; 3.5 kHz profiler; occasional sonobuoy recordings; and recordings by on-land refraction seismographs and by ocean-bottom seismographs (OBS)]
Further information:	Simon Klemperer, sklemp@geo.stanford.edu; http://geo.stanford.edu/~sklemp/bering_chukchi/alaska.overview.html; http://www.gg.uwyo.edu/faculty/holbrook/aleut/aleut.html

Terrane and Tectonic Assemblage Datasets

terranes/alaska/terr_lnd	**Terrane map of Alaska**
Data type:	Terrane and overlap assemblage map derived from extensive geologic mapping and associated tectonic studies suggesting that most of the region can be interpreted as a collage of fault-bounded tectonostratigraphic terranes accreted onto continental margins around the Circum-North Pacific mainly during the Mesozoic and Cenozoic
Geographic extent:	Alaska onshore only
Projection:	Lambert Azimuthal; center of projection at 165°W, 70°N
Source scale:	1:2,500,000 (i.e. the same scale as *geology/ak_geol* but properly projected)
Data documentation:	A description of the terranes is contained in files *terranes/alaska/explanat/mapexpln.***

Polygon attributes:	[Unit] = Map Unit Abbreviation [Age] = Geologic Age
Legend:	The legend, contained in the file *data/legends/terranes/alaska/terrane.avl*, is colored according to tectonic environment for terranes and according to age for overlap assemblages.
Primary reference:	Nokleberg and others (1994b)
Further information:	Compiled in ARC/INFO format by Keri L. Brennan

terranes/canada/assemblg	**Tectonic assemblage map of the Canadian Cordillera**
Data type:	Tectonic assemblages, plutonic suites, and terranes for the western part of Canada, originally compiled at 1:1,000,000 scale by Wheeler and McFeeley (1991) from published geologic maps, reports, university theses, and unpublished data of the GSC, the British Columbia Geological Survey, the Department of Indian and Northern Affairs, and the U.S. Geological Survey
Geographic extent:	West = 145°W; North = 72°N; East = 108°W; South = 48°N
Projection:	Lambert, standard parallels 49° and 77°N, central meridian 95°W, Y-shift 6,585,000
Source scale:	1:1,000,000
Data documentation:	A description of each terrane or tectonic assemblage is contained in multiple ASCII files */terranes/canada/explana/tectonic/***.txt* and */terranes/canada/explana/terrane/***.txt*, where *** corresponds to the map-unit identifying abbreviation; an overview of data on the source CD-ROM is contained in */terranes/canada/explanat/cdexpln.doc*
Polygon attributes:	*/norpac/data/terranes/canada/info/assemblg.pat* contains attributes: [Tecunit] A tectonic unit apart from terrane [Terunit] e.g. KTN. [Name] e.g. Nanaimo [Rock_clas] e.g. sedimentary [Rock_type] e.g. sandstone/conglomerate/shale [Descript] e.g. non-marine calc-alkaline arc volcanics [Belt] e.g. Insular/Coast [Terrane] e.g. Admiralty [Era_epoch] e.g. Neogene [Age_max] [Age_min] [Textfile] e.g. ntp.txt (text for Neogene Pemberton volcanics) [Vmunit] e.g. CAV [Superterr] e.g. Insular [Subterr] e.g. Okanagan [Tertype] e.g. Oceanic island arc [Description] e.g. Amalgamated by latest Triassic time and accreted to Ancestral North America in the Jurassic [Assemblage] e.g. lPmv (undifferentiated, lower Paleozoic, craton-related metavolcanic rocks) [Plutons] e.g. Epnt (Early Paleozoic Tochieka orthogneiss)
Primary reference:	GIS Map Library: A Window on Cordillera Geology CD-ROM: Journeay and Williams (1995)
Further information:	

Notes for /terranes/canada/assemblg

Each terrane of the Canadian Cordillera is an assemblage or assemblages of rocks whose paleogeographic setting with respect to adjacent terranes is known or suspected to be a major fault. Terranes are categorized according to their relationship to the ancestral North American craton and flanking miogeoclinal strata present along the continental margin in early Paleozoic time. Displaced continental margin terranes have a stratigraphic record similar to that of Ancestral North America. Pericratonic terranes represent rocks that were originally contiguous with, but distal to, the North American Continental Margin. Accreted terranes represent oceanic and/or island arc assemblages of unknown or uncertain paleogeographic origin, which are clearly allochthonous with respect to Ancestral North America. Pre-accretionary plutonic assemblages are included in the terranes, whereas post-accretionary plutons are

shown separately. Plutonic suites are subdivided on the basis of age and composition and are grouped into magmatic episodes.

terranes/nor_pac	**Terrane and Overlap Assemblage Map of the Circum-North Pacific**
terranes/nor_pac/basins	**Outlines of Mesozoic and Cenozoic basins**
terranes/nor_pac/coast	**Coastline**
terranes/nor_pac/flts_lnd	**Onshore faults**
terranes/nor_pac/flts_ocn	**Offshore faults**
terranes/nor_pac/flts_pos	**Post-accretionary faults, onshore and offshore**
terranes/nor_pac/mag_lins	**Magnetic lineaments**
terranes/nor_pac/ocn_geol	**Oceanic geology**
terranes/nor_pac/sea_mnts	**Seamounts**
terranes/nor_pac/terr_lnd	**Onshore terranes**
terranes/nor_pac/terr_ocn	**Offshore terranes**
Data type:	Terrane and overlap assemblage map, and major offshore geologic features, along with map explanation and stratigraphic columns; derived from extensive geologic mapping and associated tectonic studies suggesting that most of the region can be interpreted as a collage of fault-bounded tectonostratigraphic terranes accreted onto continental margins around the Circum-North Pacific mainly during the Mesozoic and Cenozoic
Geographic extent:	Full coverage
Projection:	Lambert Azimuthal; center of projection at 165°W, 70°N
Source scale:	1:10,000,000 with vertices at about 1 km
Data documentation:	A lengthy text explanation for the entire terrane map, including cited references, is provided in the files */terranes/nor_pac/explanat/mapexpln.***;* a brief description of each terrane or overlap assemblage is contained in files */terranes/nor_pac/explanat/assemblg/***.txt* or */terranes/nor_pac/explanat/terranes/***.txt*; and a summary characteristic stratigraphic column for each terrane or overlap assemblage in files */terranes/nor_pac/explanat/columns/***.pdf*, where ***** corresponds to the map-unit identifying abbreviation, ****.doc* are Word documents, ****.pdf* are Adobe Acrobat files, and ****.txt* are ASCII text files
Arc attributes:	**terranes/nor_pac/flts_lnd** - */norpac/data/terranes/nor_pac/flts_lad* contains the attribute: [Ltype] = Fault Name and Type, e.g. “Thrust fault, certain”

Polygon attributes:	**terranes/nor_pac/flts_lnd** - */norpac/data/terranes/nor_pac/info/terr_lnd.pat* contains the attributes*:* [terrane_abbrev] = map abbreviation (typically three letters) for each tectonostratigraphic terrane (individual polygons can be either a terrane or an overlap assemblage, but not both) [overlap_abbrev] = map abbreviation (typically three letters) for each overlap assemblage [overlap_name] = geologic abbreviation summarizing age and lithology of each overlap assemblage, e.g. Czs for Cenozoic sedimentary rocks [terrane_igneous] = geologic abbreviation summarizing age and lithology of pre-accretionary plutonic units, e.g. Kpfi for a Cretaceous plutonic felsic intrusive [terrane_name] = terrane name spelled out in full, e.g. Endicott Mountains terrane, Arctic Alaska Superterrane" [tectonic_environ] = tectonic environment of formation of each terrane, e.g. "island arc" terranes/nor_pac/flts_ocn - */norpac/data/terranes/nor_pac/info/terr_ocn.pat* contains the attributes*:* [Tectonicterranes] = map abbreviation for each tectonostratigraphic terrane [Mapunits] = geologic abbreviation summarizing age and lithology of each overlap assemblage, e.g. Czs for Cenozoic sedimentary rocks [Assemblages] e.g. Kw for Kuskokwim Group [Land/ocean] is set as OCEAN
Legends:	The complete legend (explanation) is contained in the directory /norpac/data/terranes/nor_pac/explanat in the files mapexpln.doc and mapexplan.pdf.
Primary reference:	Nokleberg and others (1994b)
Further information:	Warren J. Nokleberg (USGS), wnokleberg@usgs.gov

Notes for terranes /nor_pac

A key definition for the map is *tectonostratigraphic terrane.* A tectonostratigraphic terrane (hereafter referred to as *terrane*) is a fault-bounded, stratigraphically coherent assemblage that formed before accretion, i.e. tectonic juxtaposition, to adjacent units. A few terranes are fault-bounded structural complexes, mainly subduction zone or accretionary-wedge complexes. The terranes are bounded by various types of major faults or fault zones, termed sutures.

Terranes are interpreted according to inferred tectonic environments: (1) cratonal; (2) passive continental margin; (3) metamorphosed continental margin; (4) continental-margin arc; (5) island arc; (6) oceanic crust, seamount, and ophiolite; (7) accretionary wedge and subduction zone; (8) turbidite basin; and (9) metamorphic for terranes that are too highly-deformed and metamorphosed to determine the original tectonic environment. For terranes with complex geologic histories, the assignation indicates the tectonic environment most prevalent during this history of the terrane.

Tectonic environments inferred for igneous rocks are both temporal (pre-accretion and post-accretion) and genetic (subduction-related, rift-related, and collision (anatectic)-related).

Post-accretion units that include: (1) Cenozoic and Mesozoic overlap assemblages of sedimentary and volcanic rocks that are deposited across two or more terranes that formed generally after accretion of most terranes in the region; (2) Cenozoic and Mesozoic basinal deposits that occur within a terrane or on the craton; and (3) plutonic rocks. Post-accretion igneous units are identified by age-lithologic abbreviations and by name. Some Cenozoic and Mesozoic overlap assemblages and basinal deposits, as well as fragments of terranes, are extensively offset by movement along post-accretion faults.

Onshore, the map depicts major pre-accretion plutonic rocks that are limited to individual terranes. Offshore, the map depicts major oceanic plates, ocean-floor magnetic lineations, oceanic spreading ridges, and seamounts. Significant differences exist between the representation of onshore and offshore geology: (1) the offshore part is depicted in a more schematic fashion because of more limited data and because the offshore terranes and early Cenozoic and older overlap assemblages generally are obscured by extensive late Cenozoic sedimentary cover that is not shown unless thicker than about 2 km; (2) marginal contacts of offshore Cenozoic and Cretaceous sedimentary basins do not match contacts of onshore Cenozoic and Cretaceous sedimentary units because offshore basins are limited to those regions with sediment thicknesses greater than two km; (3) stratigraphic columns are provided only for onshore terranes because the geology of offshore terranes is generally less well-known; and (4) for simplicity, the major onshore Cenozoic sedimentary basins are generally not defined and described separately.

Topographic Datasets (Raster)

topogrfy/raster/etopo5	**5'-sampled land topography and marine bathymetry**
Data type:	Raster land topography and marine bathymetry from ETOPO5, a global digital elevation model (DEM) with a horizontal grid spacing of 5 arc minutes; data sources include: ocean Areas: U.S. Naval Oceanographic Office; U.S.A. and Japan: U.S. Defense Mapping Agency; other land masses: U.S. Navy Fleet Numerical Oceanographic Center.
Geographic extent:	Full coverage
Projection:	Latitude and longitude grid
Source grid interval:	5 arc-minutes (c. 9 km); in some areas true resolution may be lower
Point attributes:	Elevations in meters representing the elevation of the center of each cell
Range:	-9067 to +3657 m
Spatial resolution:	Resolution of the gridded data varies from true 5-minute for the ocean floors, the U.S.A. and Japan, to 1 degree in data-deficient parts of Asia and northern Canada
Error estimates:	In general, the dataset for the USA is most precise, having a vertical resolution of 1 m. Data for Asia vary in resolution from +/- a few meters to only representing every 150m, depending on the available source data. Very little detail is contained in the oceanic data shallower than 200m; the interpolation algorithm used by the US Navy to create the oceanic grid from contour charts was set to an arbitrary cutoff of -10m wherever the algorithm would have "overshot" and marked points as above sea level. Because the pixel size in ETOPO5 is about 9 km, one should anticipate discrepancies of this magnitude when comparing ETOPO5 to higher-resolution products, e.g. GTOPO30.
Primary reference:	Hittelman and others (1994); NOAA (1988)
Further information:	http://web.ngdc.noaa.gov/mgg/global/etopo5.HTML; psloss@ngdc.noaa.gov

topogrfy/raster/gtopo2	**2'-sampled land topography and marine bathymetry**
Data type:	Raster topography (land areas only) from GTOPO30. See below description. Bathymetry has been resampled from ship tracks
Geographic extent:	Full coverage to 70°N
Projection:	Mercator
Source grid interval:	2 arc-minutes (c. 4 km)
Point attributes:	Decimal degrees of latitude and longitude referenced to WGS84; vertical units are meters.
Range:	-9561 to +5625 m
Primary reference:	Smith and Sandwell (1997)
Further information:	http://topex.ucsd.edu/marine_grav/mar_grav.html

topogrfy/raster/gtopo30	**30"-sampled topography (land only)**

topogrfy/raster/hillshad	30”-sampled topography illuminated by sun from 315° at 45° elevation
Data type:	Raster topography (land areas only) from GTOPO30, a global digital elevation model (DEM) with a horizontal grid spacing of 30 arc seconds; the major data source for Asia and Canada is Digital Terrain Elevation Data, a raster topographic base with a horizontal grid spacing of 3 arc-seconds, produced by National Imagery and Mapping Agency (formerly DMA); the major data source for the USA is USGS “1-degree DEMs” (Digital Elevation Models distributed in 1° blocks), also with a horizontal grid spacing of 3 arc-seconds; one representative elevation value was selected (by median value for Asia and by systematic subsampling for North America) to represent the area covered by 100 full-resolution cells (10 by 10 matrix). The effect of illumination with a sun angle of 45° from the northwest (315°) was computed using the ESRI Spatial Analyst module, and this derived dataset saved as */raster/hillshad.*
Geographic extent:	Full coverage
Projection:	Latitude and longitude grid
Source grid interval:	30 arc-seconds (c. 1 km)
Point attributes:	Decimal degrees of latitude and longitude referenced to WGS84; vertical units are elevation above sea-level in meters; ocean values are masked as “no data” and have been assigned a value of -9999
Range:	+1 to +6009 m
Error estimates:	±18 m root mean square error, with higher relative accuracy
Primary reference:	GTOPO30: U.S. Geological Survey (1997)
Further information:	http://edcwww.cr.usgs.gov/landdaac/gtopo30/gtopo30.html

Topographic Datasets (Vector)

topogrfy/vector/ak_shelf	Bathymetry for US waters shallower than 200 m, Beaufort Sea to the Aleutians (1:0.25M)
Data type:	Bathymetric contours for offshore Alaska (from the Alaska-Yukon border to Unimak Island in the Aleutian Chain) to 200 m water depth; derived from over 90 digitized NOAA-NOS maps (90%) and point soundings from the NOS Hydrographic CD-ROM (10%).
Geographic extent:	West = 178°W North = 74°N East = 138°W South = 53°N
Projection:	geographic units, -180°/0°/+180°, NAD 1927
Source scale:	1:250,000
Arc attributes:	[Elevation] = depth below sea level, in negative meters +999 = arc defining boundary, holiday area, or used to clip dangling contours to next shallowest contour [Methods] = method used to develop contours DIGITIZE = digitized from paper NOS maps GENERATE = generated from NOS digital survey point data
Polygon attributes:	*/norpac/data/topogrfy/vector/info/ak_shelf.pat* contains the attribute: [Elevation] = mid-value between arc values (-5m to -195m) +999 = "holiday areas" where no data were collected -999 = polygons deeper than 200m +998 = enclosed polygons outside map area +5 = land polygons
Range:	0m to -200m
Depth resolution:	10 m
Primary reference:	Alaska Biological Science Center (1998)
Further information:	http://www.absc.usgs.gov/research/bering/bathy/index.htm

topogrfy/vector/ber_chuk	**Bathymetry for Bering and Chukchi Seas, US and Russian waters (1:2.5M)**
Data type:	Bathymetric contours for Chukchi Sea and Bering Straits; a single Bering/Chukchi Sea coverage was created by joining two USGS Open File Report maps: The Bathymetric Map of the Chukchi Sea and Arctic Ocean (USGS OFR 76-823) and The Bathymetric Map of the Aleutian Trench and Bering Sea (USGS OFR 76-821)
Geographic extent:	West = 206°W North = 76°N East = 130°W South = 48°N
Projection:	Geographic units, 0°/-360°, NAD 1927 The USGS Bering and Chukchi Sea coverage crosses the 180th meridian - a situation ARC/INFO does not cope with well. To avoid this problem, it is stored with longitudes in 0°/-360° format instead of the usual -180°/0°/+180° format. This allows the coverage to be reprojected normally using the PROJECT command and standard projection files. Note that reprojection may split arcs along the 180th meridian; inspect the coverage before use (note: ArcView may not be able to reproject from this format into certain projections.)
Source scale:	1: 2,500,000
Arc attributes:	[Depth] = depth below sea level, in positive meters [Class] = function of arc 0 = digitized bathymetric contours 8 = arcs added to close polygons 9 = coastlines
Polygon attributes:	*/norpac/data/topogrfy/vector/info/ber_chuk.pat* contains the attributes: [Mid-depth] = mid-value between arc values (25 m to 8,000 m) [Mid-elevation] = mid-value between arc values, as a negative number (-25 m to –8,000 m)
Range:	0 to 8,000 m
Depth resolution:	varies, 10-400 m
Primary reference:	Schumacher (1976a & b); Alaska Biological Science Center (1998)
Further information:	http://www.absc.usgs.gov/research/bering/bathy/index.htm

topogrfy/vector/chukchi	**Bathymetry for Chukchi Sea and Bering Straits, US and Russian waters (1:1M)**
Data type:	Bathymetric contours for Chukchi Sea and Bering Straits
Geographic extent:	West = 176°W North = 74.5°N East = 153°W South = 65.5°N; Chukchi Sea from Smith Bay, Alaska (east of Point Barrow) to Herald Island, Russia (east of Wrangel Island) and south to the Bering Strait
Projection:	geographic units, -180°/0°/+180°, NAD 1927
Source scale:	1:1,000,000
Arc attributes:	[Depth] = depth below sea level, in positive meters -999 = arc defining boundary, holiday area, or used to clip dangling contours to next shallowest contour [Class] = method used to develop contours 0 = digitized bathymetric contours 8 = arcs added to close polygons 9 = coastlines
Polygon attributes:	*/norpac/data/topogrfy/vector/info/chukchi.pat* contains the attributes: [Mid-depth] = mid-value between arc values (5m to 3500m) [Mid-elevation] = mid-value between arc values, as a negative number (-5m to -3500m)
Range:	0 m to 3000 m
Depth resolution:	Varies with depth: 10 m (10-100 m); 100 m (100-1000 m); 1000 m (>1000 m)

Primary reference:	Hill and others (1984); Alaska Biological Science Center (1998)
Further information:	http://www.absc.usgs.gov/research/bering/bathy/index.htm

topogrfy/vector/nor_pac	**Circum-North Pacific topography and bathymetry (1:10M)**
topogrfy/vector/rivers	**Major drainages, circum-North Pacific**
Data type:	Contour areas as polygons for the circum-North Pacific Region
Geographic extent:	Full coverage
Projection:	Lambert azimuthal; center of projection at 165°W, 70°N
Source scale:	1: 10,000,000 with 10 km digitizing vertices; coastline from printed map was hand-inked on mylar and scanned
Polygon attributes:	topogrfy/vector/nor_pac */norpac/data/topogrfy/vector/info/nor_pac.pat* contains the attribute: [Meters] = height of the lower contour line of the polygon.
Range:	-9000 to +4000 m
Depth resolution:	Topography, from –9000 to +4000 m, at 1000 m increments, with additional contours at ±200 m
Errors:	These contours, coastline and drainages are internally consistent, and were used as a base for the Circum_North Pacific Terrane map (see /*terranes/nor_pac*); however, they are collectively offset from the coastlines in GTOPO30 (see /*topogrfy/raster/gtopo30*) and the World Vector Shoreline (see /*topogrfy/vector/shorline*) by up to several km, with magnitude and direction of the discrepancy varying systematically across the coverage. The magnitude of the discrepancy, about 5 km, is equivalent to a 0.5 mm error in drafting and digitizing the source 1:10M map. Note also several islands are missing from this coverage (including Nunivak, about 50,000 km^2!) and at least a few polygons are miscoded (see e.g. apparent landmass east of the Shumagin Islands).
Primary reference:	Moore (1990); digitized and compiled by D.S. Aitken, B.S. Bennett, and W.J. Nokleberg (USGS, Menlo Park); in Nokleberg and others (1994a).

topogrfy/vector/shorline	**World Vector Shoreline (WVS), designed for use at scales of up to 1:250,000**
Data type:	Coastline for our entire Circum-North Pacific area as arcs; originally created by Defense Mapping Agency (now NIMA). The source material for WVS was DMA's Digital Landmass Blanking (DLMB) data 3 arc-second raster grid, which in turn was derived primarily from the Joint Operations Graphics and coastal nautical charts produced by DMA
Geographic extent:	Full coverage
Projection:	Latitude and longitude (decimal degrees); horizontal datum is WGS84; for vertical datum, shoreline is based on Mean High Water
Source grid interval:	WVS consists of vectors derived from a 3 arc-second raster grid
Horizontal accuracy:	500 m: 90% of all identifiable shoreline features are located within 500 m (2.0 mm at 1:250,000) circular error of their true geographic positions with respect to the preferred datum (WGS 84).
Primary reference:	Soluri and Woodson (1990)
Further information:	http://www.tmpo.nima.mil/guides/dtf/wvs_vpf.html

Volcano Datasets

volcano	**Historically active volcanoes**
Data type:	Basic geographic and geologic information for volcanoes thought to have been active in the last 10,000 years (Holocene)
Geographic extent:	Full coverage
Projection:	Point data

Point attributes:	*/norpac/data/volcano/info/volcano.pat* contains the attributees: [Number]= Unique identification number based on the scheme established for the "Catalog of Active Volcanoes of the World" (CAVW) [Name] [Location] Geographical and/or political area, e.g. Russia-NE [Elevation] = Summit elevation in m [Type] = Volcano morphology e.g. "Stratovolcano" or "Calderas" LOCATION: [Status] = Type of evidence for Holocene activity [Time frame] = Code indicating whether dated eruptions have been recorded, and the time period of the volcano's last known eruption
Primary reference:	Simkin and others (1994b) and unpublished contributions by Thomas Simkin and Paul Mathieux, Smithsonian Institution, Global Volcanism Program
Further information:	Simkin and others (1994a); http://www.volcano.si.edu/gvp/

DESCRIPTION OF VIEWS

Views Contained in *./norpac/setup/norpac#.apr*

The following "views" have been created in the ArcView "projects" *norpac1.apr* and *norpac2.apr*. Each view contains one or more superimposed datasets, with the higher-numbered layers above and partly concealing the lower-numbered layers. Most of these views contain, as their top two layers, a latitude-longitude grid (*/norpac/data/cultural/latlon12*), and the World Vector Shoreline (*/norpac/data/topogrfy/vector/shorline*). Because these fiducial layers are often repeated, their details are only shown in the summary table. All these views have map units and distance units set to kilometers.

View name as appearing in the project *./norpac/setup/norpac#.apr*			
layer #	Theme name as it appear on-screen	Dataset location in */norpac/data*	Legend location in */norpac/data/legends*

Active Earth Example - discussed below, see "Active Earth Example"

Magnetic - Lithologic Correlation Example - discussed below, see "Magnetic - Lithologic Correlation Example"

Topography Example - discussed below, see "Topography Example"

Cultural Features			
5	Latitude/longitude grid (5°)	*cultural/latlong5*	Latitude and longitude grid at 5° spacing
4	Latitude/longitude grid (12°)	*cultural/latlon12*	Latitude and longitude grid at 12° spacing
3	Manmade features	*cultural/features*	Other socio-cultural features, such as airports and golf-courses
2	Cities	*cultural/cities*	Significant population centers
1	International/state boundaries	*cultural/boundary*	International, provincial and state boundaries

Geology - Alaska			
1	Geologic map of Alaska	*geology/ak_geol*	Geologic map of Alaska

Geology - Russia			
5	Impactites	*geology/rus_geol*	"Impactite" includes rocks with characteristics of metamorphism but chemical characteristics of primary rocks
4	Diaphthoritic rocks	*geology/rus_geol*	"Diaphthorite Rocks" includes rocks changed by retrogressive metamorphism
3	Acoustic basement	*geology/rus_geol*	"Acoustic Basement" includes basement uplifts determined geophysically in offshore areas
2	Fault map of Russia	*geology/rus_flts*	Fault map of Russia
1	Geologic map of Russia	*geology/rus_geol*	Geologic map of Russia

Gravity - DGRAV			
1	Onshore Bouguer and offshore free-air gravity (mGal)	*gravity/dgrav*	Onshore Bouguer gravity anomalies and offshore free-air gravity anomalies

Gravity - Geosat			
1	Satellite free-air gravity (mGal)	*gravity/geosat*	Satellite-derived free-air gravity, offshore areas only

Gravity - Seasurface			
1	Satellite sea-surface height (m)	*gravity/sea_surf*	Satellite-derived sea-surface heights

Magnetics - Alaska			
1	Magnetic map of Alaska (nT)	*magnetic/ak_mag*	Magnetic map of Alaska (largely onshore)

Magnetics - Arctic			
1	Magnetic map of the Arctic (nT)	*magnetic/arct_mag*	magnetic map of the Arctic (largely offshore)

Magnetics - DNAG			
1	Magnetic map of North America (nT)	*magnetic/dnag_mag*	Magnetic map of North America, onshore and offshore

Magnetics - East Asia			
1	Magnetic map of Far East Asia (nT)	*magnetic/asia_mag*	Magnetic map of Far East Asia

Magnetics - Russia			
1	Magnetic map of Russia (nT)	*magnetic/russ_mag*	Magnetic map of Russia

Reflection Profile Tracklines			
2	Ship trackline, EW94-10	*shiptrax/ew94_10*	Ship trackline for geophysical cruise EW94-10
1	Ship trackline, EW94-09	*shiptrax/ew94_09*	Ship trackline for geophysical cruise EW94-09

Seismicity			
1	Alaska state seismicity 1898-1998	*seismcty/ak_seis*	Alaska state seismicity, 1898-1998
2	Global seismicity, 1964-1991	*seismcty/isc_cat*	Catalog of global seismicity, 1964-1991

Terranes - Canadian Cordillera			
2	Canadian Cordillera - terranes	*terranes/canada/assemblg*	Terrane maps of the Canadian Cordillera
1	Canadian Cordillera - tectonic assemblages	*terranes/canada/assemblg*	Tectonic-assemblage maps of the Canadian Cordillera

Terranes - Circum-North Pacific			
12	Circum-North Pacific oceanic geology	*terranes/nor_pac/ocn_geol*	Oceanic geology from the Circum-North Pacific Terrane Map
11	Circum-North Pacific offshore terranes	*terranes/nor_pac/terr_ocn*	Offshore terranes from the Circum-North Pacific Terrane Map
10	Circum-North Pacific onshore terranes	*terranes/nor_pac/terr_lnd*	Onshore terrane names from the Circum-North Pacific Terrane Map
9	Circum-North Pacific onshore terranes	*terranes/nor_pac/terr_lnd*	Map abbreviations from the Circum-North Pacific Terrane Map
8	Circum-North Pacific onshore terranes	*terranes/nor_pac/terr_lnd*	Age and lithology for onshore geology from the Circum-North Pacific Terrane Map
7	Circum-North Pacific seamounts	*terranes/nor_pac/sea_mnts*	Seamounts from the Circum-North Pacific Terrane Map
6	Circum-North Pacific magnetic lineaments	*terranes/nor_pac/mag_lins*	Magnetic lineaments from the Circum-North Pacific Terrane Map
5	Circum-North Pacific post-accretionary faults	*terranes/nor_pac/flts_pos*	Post-accretionary faults, onshore and offshore from the Circum-North Pacific Terrane Map
4	Circum-North Pacific offshore faults	*terranes/nor_pac/flts_ ocn*	Offshore faults from the Circum-North Pacific Terrane Map
3	Circum-North Pacific onshore faults	*terranes/nor_pac/flts_ lnd*	Onshore faults from the Circum-North Pacific Terrane Map
2	Circum-North Pacific coastline	*terranes/nor_pac/coast*	Coastline from the Circum-North Pacific Terrane Map
1	Circum-North Pacific basins	*terranes/nor_pac/basins*	Outlines of Mesozoic and Cenozoic basins from the Circum-North Pacific Terrane Map

Topography - Raster			
2	30" land topography (m)	*topogrfy/raster/gtopo30*	30"-sampled topography (land only)
1	2' topography/bathymetry (m)	*topogrfy/raster/gtopo2*	2'-sampled land topography and marine bathymetry (only available to 70° N)

Topography - Vector			
5	US shelf bathymetry (m) (1:0.25M)	*topogrfy/vector/ak_shelf*	Bathymetry for US waters shallower than 200 m, Beaufort Sea to the Aleutians (most detailed, 1:0.25 M)
4	Bering/Chukchi Seas bathymetry (m) (1:2.5M)	*topogrfy/vector/ber_chuk*	Bathymetry for Bering and Chukchi Seas, US and Russian waters (intermediate detail, 1:2.5 M)
3	Chukchi Sea/Bering Straits bathymetry (m) (1:1 M)	*topogrfy/vector/chukchi*	Bathymetry for Chukchi Sea and Bering Straits, US and Russian waters (more detailed, 1:1 M)
2	1:10 M topography/bathymetry (m)	*topogrfy/vector/nor_pac*	Circum-North Pacific topography and bathymetry (least detailed, 1:10 M)
1	Rivers	*topogrfy/vector/rivers*	Major drainages, circum-North Pacific

Volcanoes - Active			
1	Volcanoes	*volcano*	Historically active volcanoes

Example Compilations (Coverages) of Individual Datasets (Themes)

In order to display some features (and limitations) of the available data-sets, and to illustrate some ways in which this GIS compilation might stimulate data analysis, the following three example 'views' of various combinations of datasets are created using ArcView or ArcExplorer projects. (1) The Topography example shows the different resolution raster and vector data available for different sub-areas, and high-lights both the range of data availability and also data problems for a single data type. (2) The Active Earth example combines tectonic information (faults, volcanoes, earthquake locations) with topographic and gravity data in order to show the relationship between these features and to synthesize the neo-tectonic activity of our region. And (3) the 'Magnetic-Lithologic Correlation' example shows overlays of lithologic data on onshore aeromagnetic data, suggesting a correlation between high-frequency magnetic signature and igneous rocks that may then allow recognition of different geologic provinces offshore.

These three views are only a few examples of other possible visualizations of various combinations of the spatial data in this GIS compilation. For all three examples, the CD-ROM contains specific views and color-scales that highlight features of interest. Users are encouraged to experiment with their own views, to zoom into different areas, and to select different display styles, in order to emphasize different features and to portray different and new geological relationships.

Topography Example

The following datasets are superimposed in the Topography example, with the higher-numbered layers above and partly concealing the lower-numbered layers.

	Dataset location	**Legend location in *<u>/norpac/data/legends/topog_ex</u>* (locations of the form ****2.avl* are for use with *norpac2.apr*)**	**Data description**
9	*shiptrax/ew94_09*	*ew94_09.avl*	Ship trackline for geophysical cruise EW94-09
8	*shiptrax/ew94_10*	*ew94_10.avl*	Ship trackline for geophysical cruise EW94-10
7	*topogrfy/vector/ak_shelf*	*ak_shelf.avl (ak_shelf2.avl)*	Bathymetry for US waters shallower than 200 m, Beaufort Sea to the Aleutians (1:250,000)
6	*topogrfy/vector/chukchi*	*topovect.avl (topovect2.avl)*	Bathymetry for Chukchi Sea and Bering Straits, US and Russian waters (1:1,000,000)
5	*topogrfy/vector/ber_chuk*	*topovect.avl (topovect2.avl)*	Bathymetry for Bering and Chukchi Seas, US and Russian waters (1:2,500,000)
4	*topogrfy/vector/nor_pac*	*n_p_eror.avl (n_p_eror2.avl)*	Circum-North Pacific region (1:10,000,000), as topographic contours and a single polygon coded in error (see text)
3	*topogrfy/vector/rivers*	*rivers.avl*	Major drainages, circum-North Pacific region
2	*topogrfy/raster/gtopo30*	*gtopo30.avl*	30”-sampled land topography, color-shaded topography
1	*topogrfy/vector/nor_pac*	*topovect.avl (topovect2.avl)*	Circum-North Pacific region (1:10,000,000), color-shaded bathymetry

Topography, the departure of the land and sea-floor elevation from the geoid, is the most basic geophysical dataset; however data availability and quality vary widely. The coverages in the above examples are chosen to show the range of various raster and vector topographic datasets that are publicly available, for both land (onshore) and marine (offshore), and also to display typical data quality and expose reliability issues.

In the Topography example, the base layer is low-resolution (1:10M) vector bathymetry with contours at 1000 m intervals, plus the -200 m isobath. The land areas for this layer are obscured by layer 2, the best global raster topography available, GTOPO30. This nominal 30-arc-second topography has points at about 900 m spacing, corresponding to a vector map of scale about 1:1 M, which for this raster data-set provides a data-point every 1 mm. Superimposed on GTOPO30 is low-resolution drainages for geographic reference (layer 3), and more importantly contour lines (layer 4) from the low-resolution basal layer. Layers 1 and 4 are the same dataset displayed with different legends, the former with color-shaded bathymetry (using the same legend as layers 5, 6 and 7), and the latter with only line contours with no shading. Comparison of these contour lines with the raster GTOPO30 shows how the low-resolution contour data matches well, but generalizes the more-detailed raster data. For example, the narrow drainages dissecting the south flank of the Brooks Range are visible in the raster data (the chosen color-scale emphasizes the change from 200 m contour, with a change from green to very pale green), but not in the 200 m contour-line.

Layers 5, 6 and 7 of the Topography example are successively more detailed bathymetric coverages (1:2.5 M; 1:1 M; 1:0.25 M, respectively) (compare layers 1 and 4, 1:10M), with each dataset encompassing a successively smaller area (Bering and Chukchi Seas; Chukchi Sea and Bering Straits; U.S. continental shelf (waters shallower than 200 m)) (compare layer 1 with full coverage). Depth resolution increases correspondingly, from 1000 m throughout (layer 1), to 10 m in shallow water to 1000 m in deep water (layer 5), to 10 m throughout (layer 7). An identical color bar has been chosen to shade layers 1, 5, 6, and 7, so that the boundaries between the datasets are only visible where dense contours give way to sparse contours, due to a thin outline drawn for each layer. The nesting of these four layers shows clearly how topographic resolution increases in more intensively studied countries (U.S. waters) and in shallow, near-shore waters. The uppermost of these bathymetric layers is used to illustrate a typical problem with digital data-sets used uncritically. Some coastal regions of shallow tidal waters exist for which /*topogrfy/vector/ak_shelf* is lacking data (“holiday areas”). The polygons are attributed with the elevation value +999 in contrast to the true but unknown negative value. When shaded uncritically, these areas may appear as land in a display. See for example the proximal regions of the Yukon Delta entering into Norton Sound which in reality have depths -9 to -1 m but are coded as positive values and shaded light green by the legend /*legends/topog_ex/ak_shelf.avl*.

The relative agreement of different datasets is tested by comparing their coastlines with excellent results with respect to the World Vector Shoreline. The 0 m (sea level) contour derived from GTOPO30 is consistent to within 1 pixel (900 m) at St. Lawrence Island in the approximate center of our coverages. Note that although GTOPO30 is sampled at a 30 arc-second interval, in some areas, this represents an over-sampling of originally coarser data. This

over-sampling is interpreted as the cause of some artifacts, e.g. sharp boundaries in the elevation samples, both north-south and east-west, bounding the northern promontory of the Seward Peninsula. Athough barely visible in this Topography example, these artifacts are clearly seen in the Active Earth example. A complete 1-km-sampled digital elevation model of land areas of the earth (NOAA's Global Land One-kilometer Base Elevation (GLOBE) Project) is under development at internet site at http://web.ngdc.noaa.gov/seg/topo/globe.html.

With respect to the World Vector Shoreline, the vector coverage /*topogrfy/vector/nor_pac* (layers 1 and 4 in the Topography example) is: (1) offset by between 0 and 4 km around St. Lawrence Island; (2) appears consistent, around Kamchatka; (3) is displaced about. 8 km north near Barrow; and (4) is displaced about 4 km SW near Anchorage. These errors presumably arose during the process of hand-tracing the coastline from the 1:10M paper map (Moore, 1990) onto mylar, followed by scanning: a mere 1 mm error at the 1:10 M scale results in 10 km relative displacement. Displacements of these magnitudes should also be anticipated in the other coverages of the Circum-North Pacific Terrane Map, and represent the limits of useful accuracy in our database. Other errors present in /*topogrfy/vector/nor_pac* include several missing islands (including both the Diomede Islands and Nunivak, about 50,000 km^2. At least a few polygons are miscoded (e.g., the closed contour/apparent landmass east of the Shumagin Islands, highlighted in bright yellow by the legend /*legends/topog_ex/n_p_eror.avl* designed for this purpose). The other, higher-resolution vector coverages (/*topogrfy/vector/ak_shelf*, /*topogrfy/vector/chukchi* and /*topogrfy/vector/ber_chuk*), all appear consistent with the World Vector Shoreline. The Canadian terrane map /*terranes/canada/assemblg* appears to be very well registered with the World Vector Shoreline, and the Alaska terrane map /*terranes/alaska/terr_lnd* seems to be offset by only about 3 km to the SW, an error probably acquired during hand-digitization from a Decade-of-North-American-Geology (DNAG) map with its center-of-projection at about 100° W, well outside the present coverage.

Finally, layers 8 and 9, ship-tracks, are included in the Topography example as a visual centerpiece and to remind users of the original purpose of this GIS database, to support interpretations of seismic profiles acquired along these tracklines.

Although this example is designed only to illustrate features of the GIS database, many uses exist for such topographic data. One obvious example is using the surface elevation model to study surface hydrology. For instance, the HYDRO1k geographic database (not included here for lack of space on this CD-ROM) includes a hydrologically correct digital elevation model, a slope dataset, an aspect (or slope-direction) dataset, a flow-direction dataset, a compound-topographic (or wetness) index, and a flow-accumulation dataset as six raster grids directly derived from the GTOPO30 grid (http://edcsnw3.cr.usgs.gov/topo/hydro/).

Active Earth Example

The following datasets are superimposed in Active Earth example, with the higher-numbered layers above and partly concealing the lower-numbered layers:

	Dataset location	**Legend location in */norpac/data/legends/act_erth***	**Data description**
14	*terranes/nor_pac/flts_pos*	*flts.avl*	Post-accretionary faults, onshore and offshore onshore faults
13	*terranes/nor_pac/flts_lnd*	*flts.avl*	Onshore faults
12	*terranes/nor_pac/flts_ocn*	*flts.avl*	Offshore faults
11	*volcano*	*volcano.avl*	Volcanoes active during the Holocene
10	*examples/mag35* derived from *seismcty/isc_cat*	*mag35.avl*	Earthquakes of 3.5 ≤ magnitude ≤ 4.0, extracted from Catalog of global seismicity, 1964-1991
9	*examples/mag40* derived from *seismcty/isc_cat*	*mag40.avl*	Earthquakes of 4.0 ≤ magnitude ≤ 4.5, extracted from Catalog of global seismicity, 1964-1991
8	*examples/mag45* derived from *seismcty/isc_cat*	*mag45.avl*	Earthquakes of 4.5 ≤ magnitude ≤ 5.0, extracted from Catalog of global seismicity, 1964-1991

7	*examples/mag50* derived from *seismcty/isc_cat*	*mag50.avl*	Earthquakes of 5.0 ≤ magnitude ≤ 5.5, extracted from Catalog of global seismicity, 1964-1991
6	*examples/mag55* derived from *seismcty/isc_cat*	*mag55.avl*	Earthquakes of 5.5 ≤ magnitude ≤ 6.0, extracted from Catalog of global seismicity, 1964-1991
5	*examples/mag60* derived from *seismcty/isc_cat*	*mag60.avl*	Earthquakes of 6.0 ≤ magnitude ≤ 6.5, extracted from Catalog of global seismicity, 1964-1991
4	*examples/mag65* derived from *seismcty/isc_cat*	*mag65.avl*	Earthquakes of magnitude ≥ 6.5, extracted from Catalog of global seismicity, 1964-1991
3	*topogrfy/raster/hillshad*	*hillshad.avl*	30”-sampled topography illuminated by sun from 315° at 45° elevation
2	*topogrfy/vector/nor_pac*	*nor_pac.avl*	Circum-North Pacific region (1:10,000,000)
1	*gravity/geosat*	*geosat.avl*	Satellite-derived free-air gravity, offshore areas only

The above datasets are chosen to show how a map can be created from the GIS database to illustrate the relations between active seismicity, mapped faults, volcanoes, and topography. This view illustrates the neotectonic setting of the study area.

Although topography is the most basic dataset for studying tectonics, because marine gravity is shown in the Topography Example, for the base layer in this example we display the satellite-derived free-air gravity, /*gravity/geosat* using a standard blue-to-red dichromatic color-bar (blue represents gravity lows; red gravity highs). On land, the GTOPO30 dataset is used, as in the Topography example, and because the marine gravity data-set (which had its land areas masked using the *nor_pac* coastline) has “no data values” shaded black, the offset between *nor_pac* and GTOPO30 appears as a black rim wherever the *nor_pac* coastline is outside (seaward of) the GTOPO30 coastline. This black margin, for example adjacent to northern Alaska, represents the discrepancy between the *nor_pac* coastline and the *gtopo30* coastline, rather than a discrepancy between *nor_pac* and *gravity/geosat*.

Subsurface density variations are important to the gravity field, but the most significant features are the major changes in water depth at the Aleutian trench, and across the Beringian margin and the Arctic shelf edge, as made clear by the superimposition of the second layer, bathymetric contours from /*topogrfy/vector/nor_pac*. Abrupt bathymetric features correspond well with corresponding features of the gravity field, for example, the topographic promontory of the Bering Shelf edge, just west of Zemchug Canyon (location of a magnitude 6.5 earthquake; southwest of St. Matthew Island), and the Kodiak Seamounts of the northeast Pacific.

For layer 3, rather than simply repeat the color-scale bar used for the GTOPO30 layer in the Topography example, a “hillshade” is applied to provide a real sense of the topography. The hillshade was created using the ESRI Spatial Analyst (ARC GRID has an equivalent program) with a sun-angle of 45° elevation from the northwest. This sun-angle highlights the data-errors in GTOPO30 on the northern Seward Peninsula (described in the above Topography Example), but, of more geological interest, highlights (as dark lineaments) the topographic lineaments and valleys corresponding to the southwest-northeast family of faults that transect southern and western Alaska.

Earthquake epicenters are overlaid as seven different themes from the ISC catalog, *seismcty/isc_cat*. In order to capture both the depth and magnitude information on a single view, seven subsets of the catalog are derived corresponding to magnitude ranges of one-half unit, from 3.5 ≤ magnitude < 4.0 to magnitude ≥ 6.5. The earthquakes of each magnitude range are displayed with a different size circle, and these symbols are color-coded by hypocentral depth (dichromatic yellow-to-blue representing shallow to deep sources). This color variation clearly shows the northward dip of the Benioff zone beneath the Alaskan Peninsula and the Aleutian Islands. There is no easy way to use the focal mechanism of individual earthquakes as an individual symbol within ArcView. Therefore focal-plane solutions are not included in the data-base. For further reference, the Harvard centroid-moment tensor (CMT) catalog provides solutions for individual earthquakes at the internet site at *http://www.seismology.harvard.edu/CMTsearch.html*. Other catalogs are also available.

Layers of volcano and fault locations complete this example. The volcanoes (black spots on red circles) depict not only the Pacific “Ring of Fire” but also the young centers of Bering Straits basaltic province, in association with sparse crustal seismicity in the Seward Peninsula. The locations of earthquakes can be compared with topography, for example, the Denali fault that is visible as a deep valley. For instance, the Kaltag Fault plots about 5 km southeast of the Unalakleet River and associated topographic lineament where they and the fault enter Norton Sound. The Togiak-Tikchik strand of the Denali Fault plots about 5 km southeast of its associated topographic lineament and Togiak Lake occurs close to its entry into Bristol Bay near Hagemeister Island. These discrepancies are consistent with the aforementioned errors in the digitized /*topogrfy/vector/nor_pac* contours.

Magnetic-Lithologic Correlation Example

The following datasets are superimposed in the Magnetic-Lithologic Correlation example, with the higher-numbered layers above and partly concealing the lower-numbered layers:

	Dataset location	**Legend location in */norpac/data/legends/mag_lith***	**Data description**
9	*cultural/latlong5*	*shorline.avl*	Latitude and longitude grid
8	*topogrfy/vector/shorline*	*shorline.avl*	World Vector Shoreline
7	*examples/rus_geol.shp*	*igneous.avl*	Geologic map of Russia with igneous lithologies selected
6	*examples/ak_geol.shp*	*igneous.avl*	Geologic map of Alaska with igneous lithologies selected
5	*magnetic/russ_mag*	*russ_mag.avl*	Magnetic map of Russia
4	*magnetic/ak_mag*	*ak_mag.avl*	Magnetic map of Alaska (largely onshore)
3	*topogrfy/vector/nor_pac*	*nor_pac.avl*	Circum-North Pacific region (1:10,000,000)
2	*magnetic/dnag_mag*	*dnag_mag.avl*	Magnetic map of North America, onshore and offshore
1	*magnetic/arct_mag*	*arct_mag.avl*	Magnetic map of the Arctic (largely offshore)

These datasets are chosen as examples of the possible use of GIS databases to correlate different datasets, and then to use these correlations to interpret other areas. This example attempts to correlate rocks with magnetic anomalies. Though not a ubiquitous relation, igneous rocks, particularly mafic and ultramafic varieties, generally contain more magnetite and other magnetic minerals than sedimentary rocks, and are therefore associated with high magnetic anomalies. Although more-magnetic lithologies may exist at depth beneath sedimentary basins, their associated anomalies are attenuated by a greater distance from the sensor. Mid-crustal rocks lose their magnetic signature due to temperatures being above the Curie limit of magnetization.

Layers 1, 2, 4 and 5 in this example are all magnetic coverages, displayed with data of higher quality and higher resolution towards the top of the list of views. As a result, the shallowest magnetic layers, 4 and 5, are the land coverages for Alaska and Russia, typically derived from dense flight-line coverages. The deeper layers, 1 and 2, have their lower-resolution land parts obscured by the upper layers, but provide offshore coverage which is typically less well-sampled by sparse marine geophysical tracklines. Placing topographic contours (*/topogrfy/vector/nor_pac)* above the marine magnetic coverages, but below the land magnetic coverages, provides bathymetric contours that identify the location of the shelf edge, without obscuring or confusing the land areas on which geology is overlain. Because both *russ_mag* and *ak_mag* obscure the coastlines and some near-shore bathymetry, the World Vector Shoreline is displayed as layer 7. Note that where offshore data were sampled along a single ship track, even though the information is strictly correct only along that line, the grids typically show data that are several grid cells wide, and so appear on our image as narrow bands of color-coded information rather than as lines. For instance, the outer Bristol Bay and the northeast Pacific Ocean provide are areas where the magnetic information comes from sparse ship tracks. For all four magnetic coverages, a dichromatic red-blue color-scale is used, as for the gravity coverage in Active Earth Example. In order to visually match the different coverages where they abut, because each magnetic coverage has a slightly different mean and range, four different legends are defined in which identical colors correspond to identical ranges of standard deviations away from the specific data mean.

In order to compare geology with magnetic data two areal coverages are displayed that are both visible simultaneously. Hence the onland part of the geological map of Russia (polygons in */geology/rus_geol* with attribute *agecod* $\leq$ 256), and the entire geological map of Alaska (*/geology/ak_geol*), are shown as transparent overlays over the magnetic grids. Because it is not possible to label individual geological units without further obscuring the magnetic display, igneous lithologies were highlighted in yellow; other lithologies were not highlighted and are shaded gray. This example does not present well in *norpac2.apr* for which Spatial Analyst is not available to provide the dichromatic red-blue color-scale for the magnetic field. The Russian geology and Alaskan geology data-sets are exported as shape files, then igneous units (intrusive, volcanic and ophiolitic) were selected by Boolean query of the legends, and given the value "True" for the new polygon attribute [Igneous] in attribute files *ak_geol.dbf* and *rus_geol.dbf*. These igneous units are, on the Alaska map, any unit identifier (attribute [mapunit_ab]) containing the letter "i", except units identified as "Ice" (i.e. all intrusives), and any identifier containing the letter "v" (i.e. volcanics), or ending in the letter "u" (i.e., ultramafics, but avoiding abbreviations for time periods, "Upper ***"), and on the Russia map, lithologic units that did not contain the label "acoustic" (corresponding to undifferentiated offshore acoustic basement) or the label "continential" (sic) (corresponding to platform deposits); all other units are labeled "False".

When the igneous outcrop areas in the southern Brooks Ranges or in Chukotka are examined, this example shows that igneous rocks in these regions indeed correlate with high-spatial-frequency, high-intensity magnetic anomalies. In contrast areas underlain by sedimentary rocks, such as the North Slope of Alaska, show more quiet signatures. Can this correlation be taken offshore, into regions that are poorly mapped geologically? On the Bering Shelf, the style of magnetic anomalies varies quite widely, and has been described both as showing a fairly simple pattern, low-high-low from north to south (Marlow and others, 1976), with the high anomaly zone marking a submarine, Late Cretaceous-early Tertiary volcanic belt (Worrall, 1991), and as a more complex pattern of magnetic domains interpretable as a group of accreted terranes (McGeary and Ben-Avraham, 1981). However, the degree of sedimentary burial of the basement also contributes significantly to the observed magnetic signature. Thus Worrall (1991) identifies as "volcanics" the zone from the Anadyr Basin, including the St. Matthew-Nunivak arch and broadening eastwards to include the Goodnews Arch and much of Bristol Bay. McGeary and Ben-Avraham (1981) interpret the same data in more detail, for example describing a small region of lower anomalies within the high anomaly zone midway between Nunivak Island and the Pribilof Islands. Marlow and others (1976) note that the northern boundary of the region of high-amplitude, high-frequency magnetic anomalies lies close to the southern boundary of the St. Matthew Basin-Hall Basin, whereas the southern limit of the high-intensity magnetic belt generally coincides with the northern boundaries of the large outer-shelf basins such as St. George and Navarin, raising the possibility that any simple magnetic-lithologic correlation in this region is incorrect in detail. A GIS database and display such as ours cannot of themselves resolve such uncertainties, but they can make it easier to understand the limits of the available data and to test the possibilities.

ASSOCIATED STUDIES

This GIS compilation on this CD-ROM is part of a project on the major mineral deposits, metallogenesis, and tectonics of the Russian Far East, Alaska, and the Canadian Cordillera. The project provides critical information for collaborators and customers on bedrock geology and geophysics, tectonics, major metalliferous mineral resources, metallogenic patterns, and crustal origin and evolution of mineralizing systems for the Russian Far East, Alaska, and the Canadian Cordillera.

The major scientific goals and benefits of the project are to: (1) provide a comprehensive international data base on the mineral resources of the region that is the first, extensive knowledge available in English; (2) provide major new interpretations of the origin and crustal evolution of mineralizing systems and their host rocks, thereby enabling enhanced, broad-scale tectonic reconstructions and interpretations; and (3) promote trade and scientific and technical exchanges between North America and Eastern Asia. Products from the project are providing sound scientific data and interpretations for commercial firms, governmental agencies, universities, and individuals that are developing new ventures and studies in the project area, and for land-use planning studies that deal with mineral resource issues. The Russian Far East part of the project (as well as Alaska and the Canadian Cordillera) has vast potential for known and undiscovered mineral deposits.

Published major companion studies for the project are: (1) a report on the metallogenesis of mainland Alaska and the Russian Northeast (Nokleberg and others, 1993); (2) a tectono-stratigraphic terrane map of the Circum-North Pacific at 1:5 million scale with a detailed explanation of map units and stratigraphic columns (Nokleberg and others, 1994b); (3) a tectono-stratigraphic terrane map of Alaska at 1:2.5 million scale (Nokleberg and others, 1994a); (4) a summary terrane map of the Circum-North Pacific at 1:10 million scale (Nokleberg and others, 1997a); (5) detailed tables of mineral deposits and placer districts for the Russian Far East, Alaska, and the Canadian Cordillera in paper format (Nokleberg and others, 1996) and in CD-ROM format (Nokleberg and others, 1997b); (6) a GIS presentation of a summary terrane map, mineral deposit maps, and metallogenic belt maps of the Russian Far East, Alaska, and the Canadian Cordillera (Nokleberg and others, 1998b); and (7) a study of the Phanerozoic tectonic evolution of the Circum-North Pacific (Nokleberg and others, 1998a).

ACKNOWLEDGMENTS

We thank the many organizations which contributed data, directly or indirectly, to this compilation. We particularly thank the contributors for their providing data, assistance in compiling, and reviewing of the GIS compilation. We thank V.J.S. Grauch (U.S. Geological Survey, Denver, Colorado, USA) for assistance in obtaining the aeromagnetic data set of the former Soviet Union from the National Geophysical Data Center. Support for compilation of the digital data sets was obtained from *Research Experience for Undergraduate Funds* from the National Science Foundation (award EAR-93-17087 from the Continental Dynamics program). We thank Jeffrey C. Wynn and Frances R. Mills for their constructive scientific reviews.

DISCLAIMERS

REFERENCES CITED

Alaska Biological Science Center, 1998, Bering and Chukchi Sea Ecosystem Database, Bathymetry Coverages http://www.absc.usgs.gov/research/bering/bathy/index.htm

Anonymous, 1995, Magnetic anomalies and tectonic elements of Northeast Eurasia, 1:10,000,000. Geological Survey of Canada, Open File 2574, and http://agcwww.bio.ns.ca/pubprod/eurasia.gif

Balmino, G., Moynot, B., Sarrailh, M., and Vales, N, 1987, Free-air gravity anomalies over the oceans from Seasat and GEOS 3 altimeter data: EOS, v. 68, no. 2, p. 17-18.

Barnes, D.F., 1977, Bouguer gravity map of Alaska: U.S. Geological Survey Geophysical Investigations Map GP-913, scale 1:2,500,000.

Becker, T.W., and Braun, A., 1998, New program maps geoscience datasets interactively. EOS, v. 79, p. 505, 508; and http://www.seismology.harvard.edu/~becker/igmt/

Beikman, H.M., 1980, Geologic map of Alaska: U. S. Geological Survey, 2 sheets, 1:2,500,000.

Bering-Chukchi Working Group, 1999, Crustal structure of the Bering and Chukchi shelves from deep seismic reflection profiling. Geological Society of America Special Paper, submitted; and at http://geo.stanford.edu/~sklemp/bering_chukchi/alaska.overview.html

Brocher, T.M., Allen, R.M., Stone, D.B., Wolf, L.W., and Galloway, B.K., 1995, Data report for onshore-offshore wide-angle seismic recordings in the Bering-Chukchi Sea, western Alaska and eastern Siberia: U.S. Geological Survey Open-File Report 95-0650, 57 p.; and at http://geo.stanford.edu/~sklemp/bering_chukchi /alaska.overview.html

Childs, J.R., Magistrale, H.W., and Cooper, A.K., 1985, Free-air gravity anomaly map of the Bering Sea: U.S. Geological Survey Miscellaneous Field Studies Map MF-1728, scale 1:2,500,000.

Committee for the Gravity Anomaly Map of North America, 1987, Gravity anomaly map of North America, Geological Society of America, Boulder, Colorado, scale 1:5,000,000, 5 sheets.

Committee for the Magnetic Anomaly Map of North America, 1987, Magnetic anomaly map of North America: Geological Society of America, Boulder, Colorado, 5 sheets, scale 1:5,000,000.

ESRI, 1997, Getting to know ArcView GIS, 2nd ed., Environmental Systems Research Institute, Inc., Redlands CA, 29 chapters.

Fisher, M.A., Childs, J.R., and Magistrale, H.W., 1982, Free-air gravity map, Norton Basin, Alaska: U.S. Geological Survey, Miscellaneous Field Studies Map MF-1460, scale 1:250,000.

Fliedner, M.M., and Klemperer, S.L., 1999, Structure of an island-arc: wide-angle seismic studies in the eastern Aleutian islands, Alaska. Journal of Geophysical, v. 104, p. 10,667-10,694.

Geological Survey of Japan and Coordinating Committee for Coastal and Offshore Geoscience Programmes in East and Southeast Asia (CCOP), 1996, Magnetic Anomaly Map of East Asia, 1:4,000,000, CD-ROM version: Geological Survey of Japan Digital Geoscience Map 2 (P-1).

GlavNIVC, 1998, Natural resources GIS of Russia: American Geological Institute, Washington, D.C., 1 CD-ROM.

Godson, R.H., and Scheibe, D.M., 1982, Description of magnetic tape containing conterminous U.S. gravity data in a gridded format: U.S. Department of Commerce National Technical Information Service, PB82-254798. (Digital data provided by U.S. Geological Survey, Denver, Colorado).

Greninger, M.L., Klemperer, S.L., and Nokleberg, W.J., 1996, Geographic Information System (GIS) Database of the geology, geophysics, deep-crustal structure and tectonics of the Russian Far East, Alaska, Canadian Cordillera and adjacent offshore regions [abs.]: American Geophysical Union 1996 Fall Meeting Program, v. 77, no. 46, F669; and http://pangea.stanford.edu/ ~wabs/index.html

Greninger, M.L., Klemperer, S.L., and Nokleberg, W.J., 1999, Geographic information systems (GIS) compilation of geophysical, geological, and tectonic data for the Circum-North Pacific region [abs.]: Geological Society of America Abstracts with Programs, v. 31, p. A-59.

Hansen, R.A., Rowe, C.R., Fogelman, Kent, and Staff, Alaska Earthquake Information Center, 1999, Catalog for seismic events in Alaska: 1898 through 1998: Earthquake Information Center, Geophysical Institute, University of Alaska, Fairbanks, 1 internet file.

Hill, E.R., Grantz, A., May, S.D.; Smith, M. 1984, Bathymetric Map of the Chukchi Sea: U.S. Geological Survey Miscellaneous Investigations Map I-1182-D.

Hittelman, A.M., Kinsfather, J.O., and Meyers, H., 1989, Geophysics of North America CD-ROM and Users Manual: National Oceanic and Atmospheric Administration, National Geophysical Data Center, Boulder, Colorado.

Hittelman, A.M., Dater, D.T., Buhmann, R.W., and Racey, S.D., 1994, Gravity CD-ROM and User's Manual (1994 Edition): National Oceanic and Atmospheric Administration, National Geophysical Data Center, Boulder, Colorado.

Holbrook, W.S., D. Lizarralde, S. McGeary, and N. Bangs, 1999, Structure and composition of the Aleutian island arc and implications for continental crustal growth, Geology, v. 27, p. 31-34; and at http://www.gg.uwyo.edu /faculty/holbrook /aleut/aleut.html

Hutchinson, S., and L. Daniel, 1997, Inside ArcView GIS, 2nd ed., Onword Press, Santa Fe, NM, pp. 474.

Journeay, J.M., and Willimas, S.P., 1995, GIS map library, a window on Cordilleran geology: Computer data and programs. Geological Survey, Canada Open file 2948, CD-ROM.

Laxon, S., and McAdoo, D. 1998. Satellites provide new insights into Polar geophysics: EOS, v. 79 (6), p. 69, 72-73.

Macnab, R., Verhoef, J., Roest, W., and Arkani-Hamed, J., 1995, New database documents the magnetic character of the Arctic and North Atlantic: EOS, v. 76, p. 449, 458.

Marlow, M.S., Scholl, D.W., Cooper, A.K., and Buffington, E.C., 1976, Structure and evolution of Bering Sea shelf south of St. Lawrence Island: Am. Assoc. Pet. Geol., Bull., v. 60, p. 161-183.

May, S.D., 1985, Free-air gravity anomaly map of the Chukchi and Alaskan Beaufort seas, Arctic Ocean: U.S. Geological Survey Miscellaneous Investigations Series Map I-1182E, scale 1:1,000,000.

McGeary, S.E., and Ben-Avraham, Z., 1981, Allochthonous terranes in Alaska; implications for the structure and evolution of the Bering Sea shelf: Geology, v. 9, p. 608-614.

Moore, G.W., 1990, Geographic map of the Circum-Pacific region, Arctic Sheet: Circum-Pacific Council for Energy and Mineral Resources, scale 1:10,000,000.

Nalivkin, D.V., editor, 1994, Geologic Map of Russia: U.S.S.R. Research Geological Institute (VSEGEI) in collaboration with institutes, research institutes and manufacturing associates of the U.S.S.R. Ministry of Geology, 16 sheets. scale 1:2,500,000.

NOAA, 1998, Data Announcement 88-MGG-02, Digital relief of the Surface of the Earth. NOAA, National Geophysical Data Center, Boulder, CO; and at http://web.ngdc.noaa.gov/mgg/global/etopo5.HTML

Nokleberg, W.J., Bundtzen, T.K., Dawson, K.M., Eremin, R.A., Goryachev, N.A., Koch, R.D. Ratkin, V.V., Rozenblum, I.S., Shpikerman, V.I., Frolov, Y.F., Gorodinsky, M.E., Melnikov, V.D., Ognyanov, N.V., Petrachenko, E.D., Petrachenko, R.I., Pozdeev, A.I., Ross, K.V., Wood, D.H., Grybeck, Donald, Khanchuk, A.I., Kovbas, L.I., Nekrasov, I.Ya., and Sidorov, A.A., 1996, Significant metalliferous lode deposits and placer districts for the Russian Far East, Alaska, and the Canadian Cordillera U.S. Geological Survey Open-File Report 96-513-A (paper format), 385 p.

Nokleberg, W.J., Bundtzen, T.K., Dawson, K.M., Eremin, R.A., Goryachev, N.A., Koch, R.D., Ratkin, V.V., Rozenblum, I.S., Shpikerman, V.I., Frolov, Y.F., Gorodinsky, M.E., Melnikov, V.D., Ognyanov, N.V., Petrachenko, E.D., Petrachenko, R.I., Pozdeev, A.I., Ross, K.V., Wood, D.H., Grybeck, Donald, Khanchuk, A.I., Kovbas, L.I., Nekrasov, I.Ya., and Sidorov, A.A., 1997b, Significant metalliferous lode deposits and placer districts for the Russian Far East, Alaska, and the Canadian Cordillera: U.S. Geological Survey Open-File Report 96-513-B, CD-ROM.

Nokleberg, W.J., Bundtzen, T.K., Grybeck, Donald, Koch, R.D., Eremin, R.A., Rozenblum, I.S., Sidorov, A.A., Byalobzhesky, S.G., Sosunov, G.M., Shpikerman, V.I., and Gorodinsky, M.E., 1993, Metallogenesis of mainland Alaska and the Russian Northeast: Mineral deposit maps, models, and tables, metallogenic belt maps and interpretation, and references cited: U.S. Geological Survey Open-File Report 93-339, 222 pages, 1 map, scale 1:4,000,000; 5 maps, scale 1:10,000,000.

Nokleberg, W.J., Moll-Stalcup, E.J., Miller, T.P., Brew, D.A., Grantz, A., Reed, J.C., Jr., Plafker, G., Moore, T.E., Silva, S.R., Patton, W.R., Jr., 1994a, Tectonostratigraphic terrane and overlap assemblage map of Alaska. USGS Open-File Report 94-194, scale 1:2,500,000, 26 p.

Nokleberg, W.J., Parfenov, L.M., and Monger, J.W.H., and Baranov, B.V., Byalobzhesky, S.G., Bundtzen, T.K., Feeney, T.D., Fujita, Kazuya, Gordey, S.P., Grantz, Arthur, Khanchuk, A.I., Natal'in, B.A., Natapov, L.M., Norton, I.O., Patton, W.W., Jr., Plafker, George, Scholl, D.W., Sokolov, S.D., Sosunov, G.M., Stone, D.B., Tabor, R.W., Tsukanov, N.V., Vallier, T.L. and Wakita, Koji, 1994b, Circum-North Pacific tectono-stratigraphic terrane map: U.S. Geological Survey Open-File Report 94-714, 2 sheets, scale 1:5,000,000; 2 sheets, scale 1:10,000,000, 211 p.

Nokleberg, W.J., Parfenov, L.M., and Monger, J.W.H., Baranov, B.V., Byalobzhesky, S.G., Bundtzen, T.K., Feeney, T.D., Fujita, Kazuya, Gordey, S.P., Grantz, Arthur, Khanchuk, A.I., Natal'in, B.A., Natapov, L.M., Norton, I.O., Patton, W.W., Jr., Plafker, George, Scholl, D.W., Sokolov, S.D., Sosunov, G.M., Stone, D.B., Tabor, R.W., Tsukanov, N.V., and Vallier, T.L., 1997a, Summary Circum-North Pacific tectono-stratigraphic terrane map: Geological Survey of Canada Open-File 3428, scale 1:10,000,000 and U.S. Geological Survey Open-File Report 96-727, scale 1:10,000,000.

Nokleberg, W.J., Parfenov, L.M., Monger, J.W.H., Norton, I.O., Khanchuk, A.I., Stone, D.B., Scholl, D.W., and Fujita, K., 1998a, Phanerozoic Tectonic Evolution of the Circum-North Pacific: U.S. Geological Survey Open-File Report 98-574, 125 p.

Nokleberg,W.J., West, T.D., Dawson, K.M., Shpikerman, V.I. Bundtzen, T.K., Parfenov, L.M., Monger, J.W.H., Ratkin, V.V., Baranov, B.V., Byalobzhesky, S.G., Diggles, M.F., Eremin, R.A., Fujita, Kazuya, Gordey, S.P., Gorodinskiy, M.E., Goryachev, N.A., Frolov, Y.F., Grantz, Arthur, Khanchuck, A.I., Koch, R.D., Natalín, B.A., Natapov, L.M., Norton, I.O., Patton, W.W., Jr., Plafker, George, Pozdeev, A.I., Rozenblum, I.S., Scholl, D.W., Sokolov, S.D., Sosunov, G.M., Stone, D.B., Tabor, R.W., Tsukanov, N.V., and Vallier, T.L., 1998b, Summary terrane map, mineral deposit maps, and metallogenic belt maps of the Russian Far East, Alaska, and the Canadian Cordillera: U.S. Geological Survey Open-File Report 98-136 (CD-ROM).

Pratt, R.M., and Walton, F.W., 1974, Bathymetric map of the Bering Shelf: Geological Society of America Map and Chart Series MC-7, scale ca. 1:1,539,000.

Racey, S.D., McLean, S.J., Davis, W.M., Buhmann, R.W., and Hittelman, A.M., 1996: Magnetic anomaly data of the Former Soviet Union, version 1.0: NOAA, National Geophysical Data Center, Boulder, Colorado, 1 CD-ROM.

Saltus, R.W., and Simmons, G.C., 1997, Composite and Merged Aeromagnetic Data for Alaska: A Web Site for Distribution of Gridded Data and Plot Files: U.S. Geological Survey Open-File Report 97-520, pp. 14; and at http://minerals.cr.usgs.gov/publications/ofr/97-520/alaskamag.html

Saltus, R.W., Hudson, T.L., and Connard, G.G., 1999, A new magnetic view of Alaska: GSA Today, v. 9, no. 3, p. 1-6.

Sandwell, D. T., 1992, Antarctic marine gravity field from high-density satellite altimetry: Geophysical Journal International, v. 109, p. 437-448.

Schumacher, G., 1976a, Bathymetric map of the Aleutian Trench and Bering Sea: U.S. Geological Survey Open-File Report 76-0821, 2 sheets.

Schumacher, G., 1976b, Bathymetric map of Chukchi Sea and Arctic Ocean: U.S. Geological Survey Open-File Report 76-0823, 2 sheets.

Simkin, T., L. Siebert, R. Blong, J. Dehn, C. Newhall, R. Pool and T.C. Stein, 1994a, Volcanoes of the world; a regional directory, gazetteer, and chronology of volcanism during the last 10,000 years. Geoscience Press, Tucson, AZ, 349 p.

Simkin, T., Unger, J.D., Tilling, R.I., Vogt, P.R., and Spall, H., 1994b, This dynamic planet: world map of volcanoes, earthquakes, impact craters, and plate tectonics. Scale 1:30,000,000: U.S. Geological Survey, Denver, CO.; and at http://www.volcano.si.edu/gvp/

Smith, W.H.F., and Sandwell, D.T., 1997, Global Seafloor Topography from Satellite Altimetry and Ship Depth Soundings: Science, v. 277, p. 1956-1962; and at http://topex.ucsd.edu/marine_grav/mar_grav.html

Soluri, E.A., and Woodson, V.A., 1990, World Vector Shoreline: International Hydrographic Review, v. 67, no. 1, p. 28-35.

U.S. Geological Survey, 1997, GTOPO30 Global 30 Arc Second Elevation Data Set, available at http://edcwww.cr.usgs.gov/landdaac/gtopo30/gtopo30.html

Verhoef, J., Roest, W.R., Macnab, R., Arkani-Hamed, J., and Members of the Project Team, 1996, Magnetic Anomalies of the Arctic and North Atlantic Oceans and Adjacent Land Areas: Geological Survey of Canada Open File 3125a (CD-ROM); and at http://agcwww.bio.ns.ca/pubprod/of3125etc.html

Wessel, P., and Smith, W.H.F, 1995, New version of the Generic Mapping Tools released: EOS, v. 76, p. 329.

Wheeler, J.O., and McFeeley, P., 1991, Tectonic assemblage map of the Canadian Cordillera and adjacent parts of the United States of America: Geological Survey of Canada Map 1712A, 3 sheets, scale 1:2,000,000.

Whiteside, L.S., Dater, D.T., Dunbar, P.K., Racey, S.D., Buhmann, R.W., and Hittelman, A.M., 1996, Earthquake Seismicity Catalog volumes 1 and 2, Volume 2: Global and Regional, 2150 B.C. - 1996 A.D.: National Geophysical Data Center, Boulder, CO.

Worrall, D.M., 1991, Tectonic history of the Bering Sea and the evolution of Tertiary strike-slip basins of the Bering shelf: Geological Society of America Special Paper 257, pp. 120.