

# University of Alaska, U.S. Geological Survey, Pacific Rim Geological Consulting, Queens University

## REGIONAL EARTH SCIENCE FOR THE LAYPERSON THROUGH PROFESSIONAL LEVELS

### E-Book on Dynamic Geology of the Northern Cordillera (Alaska and Western Canada) and Adjacent Marine Areas: Tectonics, Hazards, and Resources

*The E-Book describes, explains, and illustrates the nature, origin, and geological evolution of the amazing mountain system that extends through the Northern Cordillera (Alaska and Western Canada), and the intriguing geology of adjacent marine areas. Other objectives are to describe geological hazards (i.e., volcanic and seismic hazards) and geological resources (i.e., mineral and fossil fuel resources), and to describe the scientific, economic, and social significance of the earth for this region. As an example, the figure on the last page illustrates earthquakes belts for this dangerous part of the globe.*

#### What is the Northern Cordillera?

The Northern Cordillera is comprised of Alaska and Western Canada. Alaska contains a series of parallel mountain ranges, and intervening topographic basins and plateaus. From north to south, the major mountain ranges are the [Brooks Range](#), [Kuskokwim Mountains](#), [Aleutian Range](#), [Alaska Range](#), [Wrangell Mountains](#), and the [Chugach Mountains](#). Western Canada also contains a series of parallel mountain ranges and intervening topographic basins and plateaus. From east to west, the major mountain ranges are the [Rocky Mountains](#), [Mackenzie Mountains](#), [Selwyn Mountains](#), [Cassiar Mountains](#), [Columbia Mountains](#), and [Coast Mountains](#).

#### Why Are Adjacent Marine Areas Included?

In order to understand the earth science of the continental Northern Cordillera, learning about the geology, bathymetry, and tectonics of the Adjacent Marine Areas is essential. Vast parts of these areas have interacted through geologic time with the continental Northern Cordillera. For instance, major ocean plates, composed of [oceanic crust](#) and [oceanic lithosphere](#), have been [subducted](#) underneath [continental margins](#), thereby forming major [continental-margin arcs](#). [Oceanic ridges](#) have been overridden by [continental plates](#) with resultant rifting of plates. And in a few cases, entire oceanic plates

have been subducted and have disappeared under the Northern Cordillera.

In alphabetical order, the marine areas adjacent to the Northern Cordillera are the [Arctic Ocean](#), [Beaufort Sea](#), [Bering Sea](#), [Chukchi Sea](#), [Gulf of Alaska](#), and the [Pacific Ocean](#).



Photo of south side of [Denali](#). This mountain is the highest mountain peak in North America, with a summit elevation of 20,310 feet (6,190 meters) above sea level. With a large [topographic prominence](#) and [topographic isolation](#), Denali is the third most prominent and third most isolated peak after [Mount Everest](#) and [Aconcagua](#). Denali, which occurs a few kilometers north of the Denali Fault, and the containing Alaska Range, have formed from [transpression](#), a combination of strike-slip and thrust faulting. Photo by W.J. Nokleberg.

## E-Book Contents

In alphabetical order, the chapters of the E-Book are:

**Alaska Road Guides**

**Canada Road Guides**

**Earth Science Atlas**

**Geologic Sources of Energy**

**Geologic Sources of Minerals**

**How the Solid Earth Works**

**Introduction**

**Landscapes and Seascapes and Tectonics**

**Natural Hazards and Neotectonics**

**Marine Geology and Tectonics**

**Regional Geology and Tectonics**

**Slicing the Earth**

**Tectonic Evolution**



Photo of Mount Saint Elias towards the east. This mountain is the second highest peak in both Canada and the United States, being situated on the [Yukon](#) and [Alaska](#) border. It lies about 40 kilometers (25 miles) southwest of [Mount Logan](#), the highest mountain in Canada. Mount Saint Elias is notable for its immense vertical relief. Its summit rises 18,008 feet (5,489 meters) vertically in just 10 miles (16 kilometers) horizontal distance from the head of [Taan Fjord](#), off of [Icy Bay](#). Mount Saint Elias is forming from the active [subduction](#) of the [Yakutat Terrane](#) under Southern Alaska. Photo from NOAA Photo Library.

## Level of Knowledge

The E-Book is primarily designed for laypeople who have a strong interest in [earth science](#). We hope the reader will understand science at the level of [Scientific American](#), a popular science magazine, and/or has taken one or two earth science courses at the college level. Because the E-Book contains new syntheses and new interpretations of the dynamic geology of the Northern

Cordillera and Adjacent Marine Areas, the E-Book should be quite useful for earth science teachers from the secondary school through college levels, and also useful to earth science majors and professional earth scientists.

## Interactive Nature of E-Book

With interactive features, the E-Book is not simply a scanned image of black print on a white page. Instead, the E-Book is a powerful vehicle that employs a new style of interactive learning. This method of learning is analogous to modern learning by surfing the Web.

A major aid to understanding the dynamic geology, hazards, and tectonics of the region is learning earth science terms. These words have Hot Links ([hyperlinks](#)) to [Wikipedia](#), (in this underlined, blue font), the free encyclopedia, that provides excellent descriptions and definitions. The E-Book also contains Hot Links (in a red font) to other chapters, to figures in other chapters, and to other Web sites. With this capability, the reader can hop to multiple Web sites in the [Cloud](#).

With the use of Bookmarks in chapters, that are all in [Adobe Acrobat PDF](#) format, one can skip to headings and related text in chapters. (Bookmarks are listed in the left-hand panel of PDF Windows.)

## Interactive Features for Figures and Maps

With the use of Layers for figures and maps, that are all in [Adobe Acrobat PDF](#) format, one can expose or hide layers of spatial data in various combinations, thereby revealing relationships between map layers. (Layers are listed in the left-hand panel of PDF Windows.) And with zooming into smaller areas on maps and figures, one can examine complicated areas.

## Interactive Features for Road Guides

The Alaska Road Guides and Canada Road Guides provide interactive geologic field trips along major highways in Eastern Alaska and southern Western Canada. After selecting a Geologic Road Guide, by clicking on Hot Spots for sites on the geologic maps for each region, one can read descriptions of the major geologic features for sites along the major highways.

With the use of Google Earth Street View for the Alaska Road Guides and Canada Road Guides, by entering listed decimal latitudes and longitudes for sites, one can view outcrops at sites along the Geologic Road Guides.

With the use of Google Earth, one can partake of so-called helicopter-style (fly-by) tours along the Geologic Road Guides that parallel major highways.

## System Requirements

All the text and static graphics files that comprise the E-Book are in [Adobe Acrobat Reader](#) (Portable Document Format (PDF)). Version 8 or higher of the software is required. Adobe Acrobat Reader for various computer operating systems (Windows, Mac, and others) can be

downloaded from the Web at:  
<http://get.adobe.com/reader/otherversions/>

Connection to the [Internet](#) is needed for viewing Hot Links to Web sites.

Installation of [Google Earth](#) is needed to view dynamic graphics images of either static images or fly-by tours across regions. To view these images, a recent version of Google Earth is needed. The Google Earth files are in [KMZ](#) format. Connection to the Internet is needed for employing Google Earth.

Use of a computer with a monitor that can display two or more overlapping or separate windows is required.



Photo shows a view to the south of the [Matanuska River](#) and associated flood plain, and the northwestern [Chugach Mountains](#) in the distance. The Matanuska River and associated gorge formed during huge megafloods that occurred repeatedly during several Pleistocene Ice Ages. The drainings down the Matanuska River, and the [Susitna River](#) to the west, poured abundant sediment and glacial debris (ranging from mud to silt to sand to cobbles to boulders) to form the extensive glaciofluvial deposits that cover the [Matanuska-Susitna Valley](#) to the west, and [Knik Arm](#), [Cook Inlet](#), and the Anchorage coastal plain to the south. Photo by W.J. Nogleberg.

## Availability

The E-Book is available for free downloading from the Web at [ScholarWorks@UA](#). In addition, for a free DVD containing the E-Book, send an E-Mail message with your name and mailing address to Warren J. Nogleberg, E-Book Editor, at [wnogleberg@usgs.gov](mailto:wnogleberg@usgs.gov).

The E-Book, that is not copyrighted, is a donation by the authors to the greater earth science community. Users are encouraged to give free copies of parts, or the entire E-Book to others. Because of extensive use of Wikipedia, Google Earth, and other Web sites, the E-Book may not be sold for profit.

## Authors and Editor

The E-Book authors are veteran earth scientists, each with many years of field and laboratory experience in Alaska and Western Canada, for a combined total of over 200 person years. The authors are:

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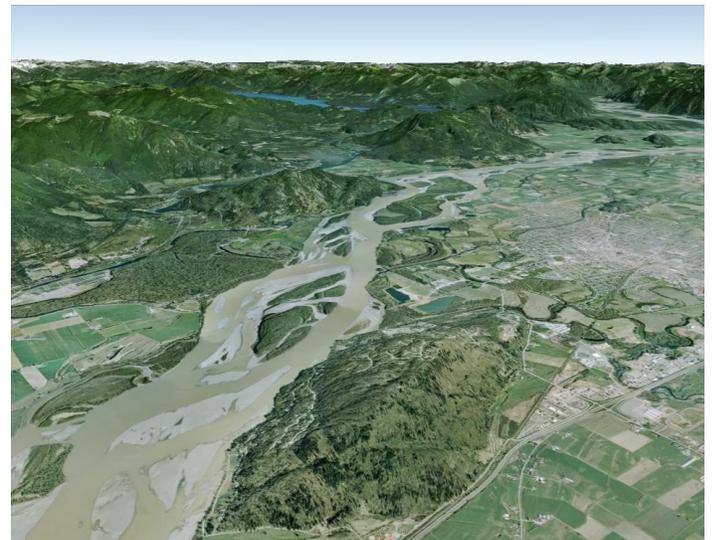
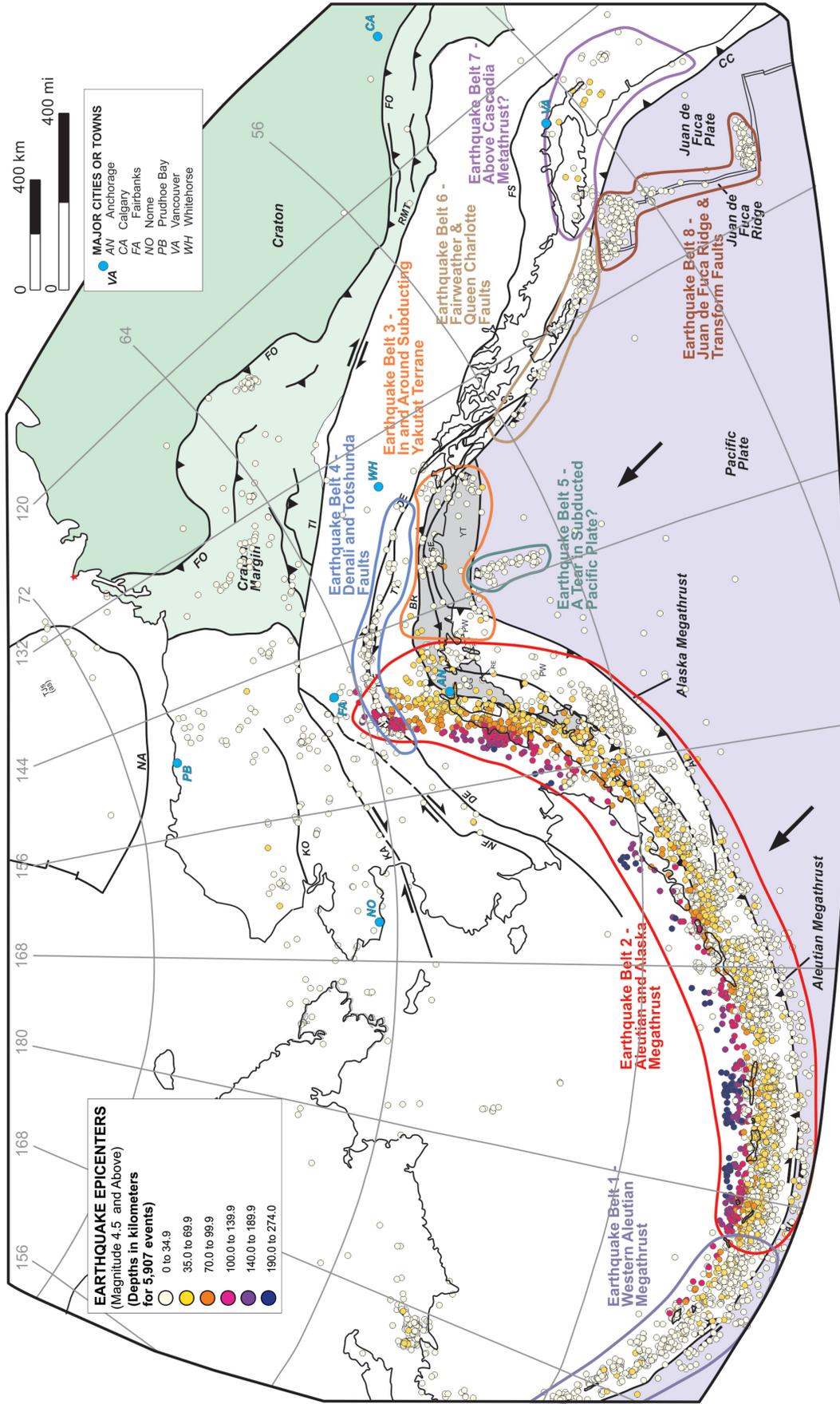


Image is an oblique view to the northeast of the braided channels of the Fraser River. The main features in the photo are: (1) southwest-flowing Fraser River; (2) the intricate braided channels; (3) areas of oxbow lakes, formed from abandoned, older drainages or floods; (4) in the far distance the beginning of the Fraser Delta; and (5) the fertile flood plains adjacent to the river.

The lowland formed from both glacial and alluvial deposits laid down more than 10,000 years ago as a delta at the mouth of a much larger, postglacial, Fraser River. Following postglacial uplift of the land and erosion into the deposits by the modern Fraser River, the older delta deposits are now about 100 meters above sea level. Lower-level lowlands, almost at sea level, are the result of recent alluvial deposition along the floodplain of present Fraser River channels, and are protected from flooding by dikes.

Image adapted from Google Earth.



**Earthquake Belts in the Northern Cordillera and Adjacent Marine Areas**