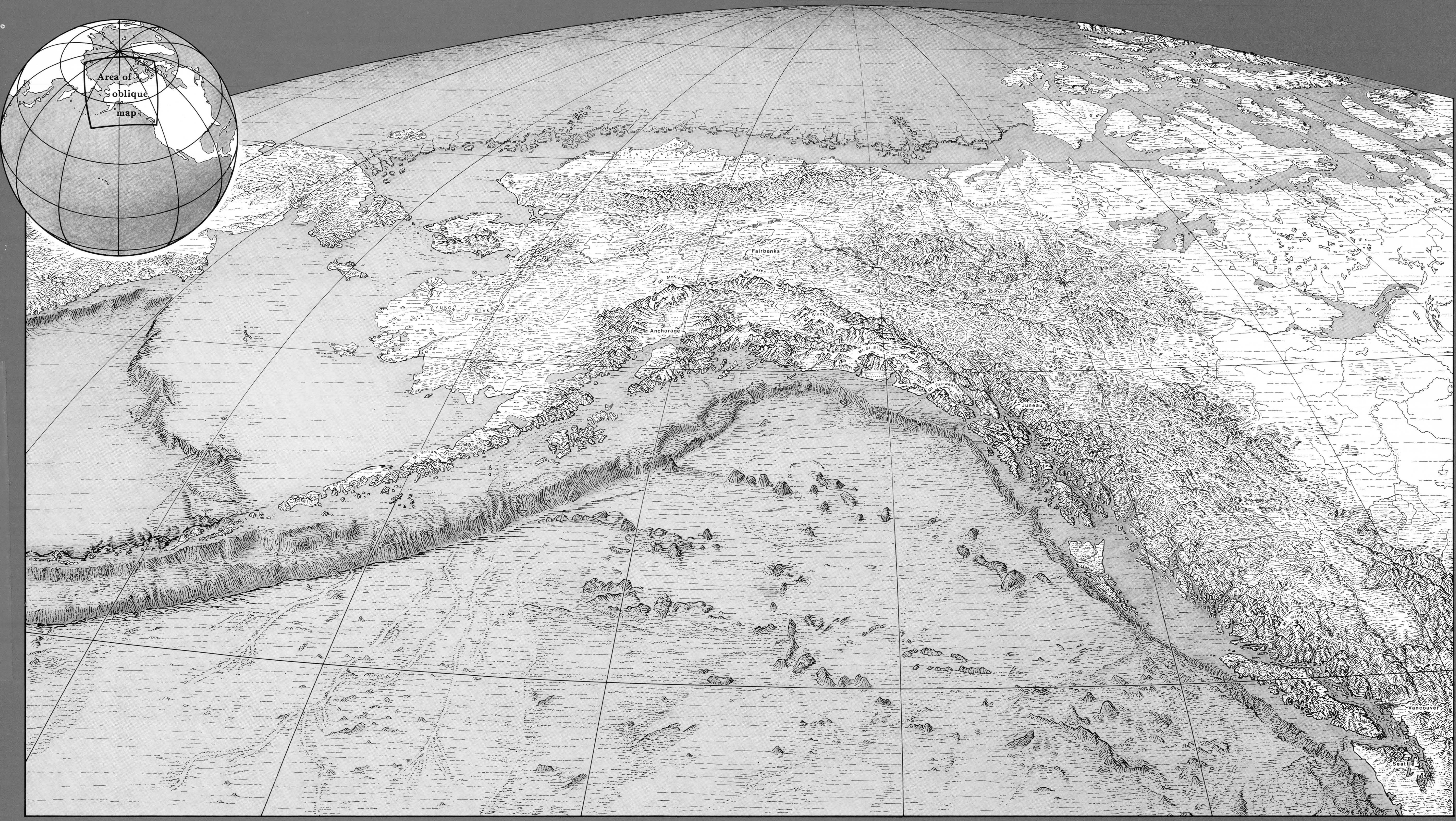
Atlas of Oblique Maps:

A COLLECTION OF LANDFORM PORTRAYALS OF SELECTED AREAS OF THE WORLD



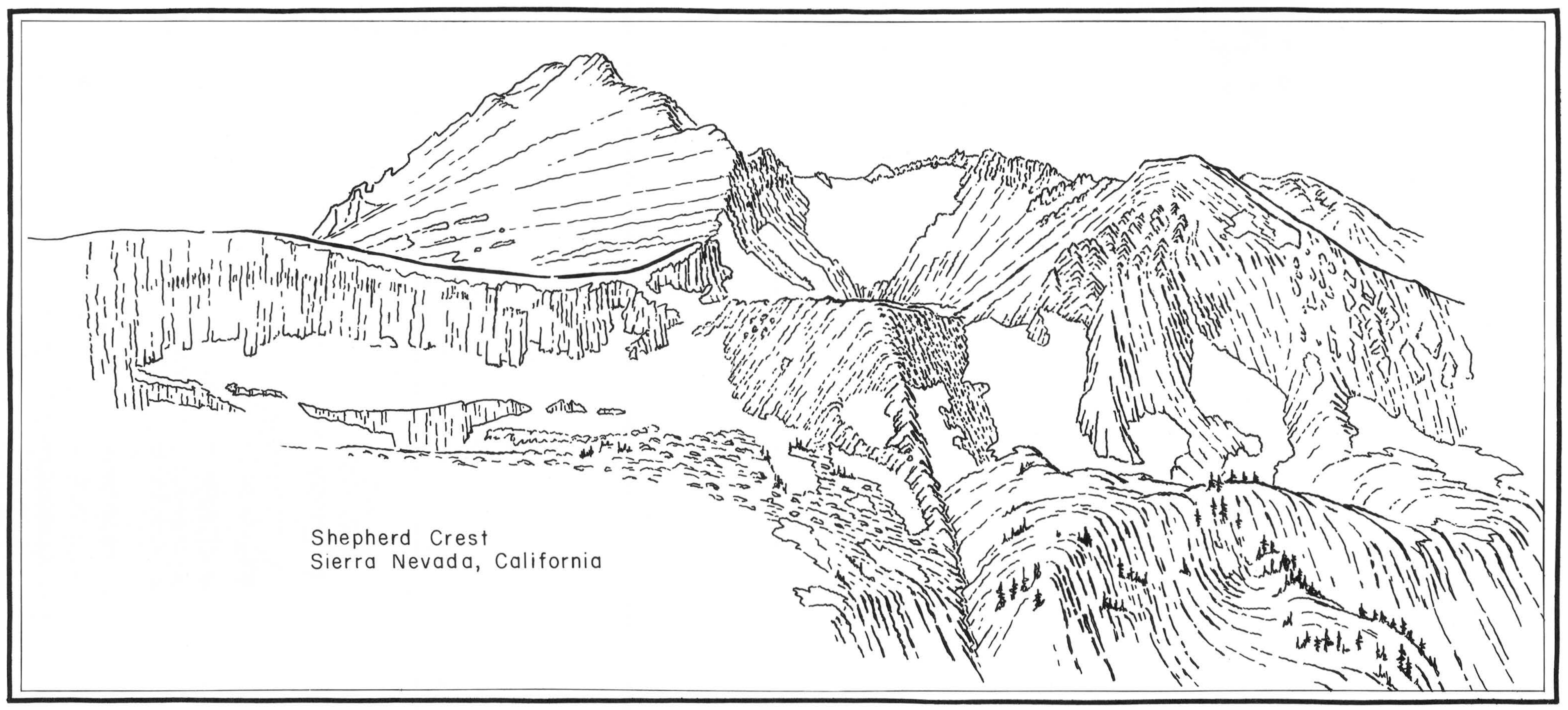
U.S. Geological Survey Miscellaneous Investigations Series I-1799

Atlas of Oblique Maps:

A COLLECTION OF LANDFORM PORTRAYALS OF SELECTED AREAS OF THE WORLD

By Tau Rho Alpha, Janis S. Detterman, and James M. Morley

This folio comprises scale-accurate, obliquely viewed maps compiled from 1961 to 1986 that portray the physiography of selected areas of the ocean floor and continents.



U.S. GEOLOGICAL SURVEY MISCELLANEOUS INVESTIGATIONS SERIES I–1799

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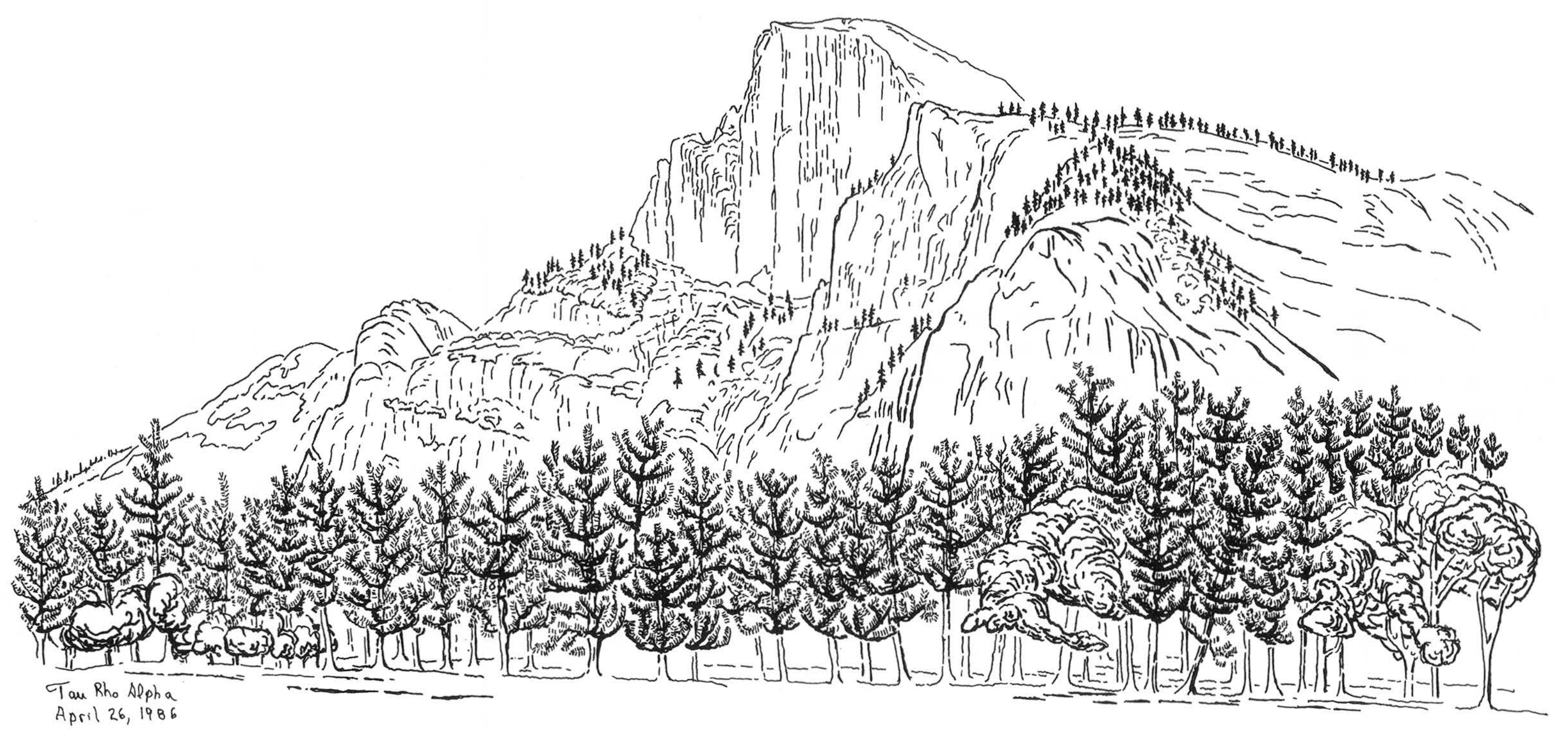
PREFACE

Oblique maps portray the surface of the Earth as if viewed from above at an oblique angle (usually about 30°). This atlas is a collection of more than 100 oblique maps that were compiled from 1961 to 1986. In cooperation with scientists of the U.S. Geological Survey, all but one of these maps were designed for a specific scientific purpose and publication, and the geographic area, orientation, angle of view, scale, and size of the area portrayed in each map differed with each intended purpose. Some of these maps show the physiography of a large regional area, while others focus on just a few landforms.

The purpose of this atlas is to present these oblique maps in one publication with a common format, to provide a history and explanation of the techniques used to make these maps, and to supply a bibliography for the individually published maps.



Half Dome from Stoneman Meadows
Yosemite National Park, California

CONTENTS

INTRODUCTION

We are a consequence of our environment: the sun, the air, the water, the earth. We have always been close to the earth; we feel the ground, we value the land, and we are familiar with the landscape around us. As observers of our environment, we know the landscape, and we know when the landscape is well represented by a painting or a map.

The challenge for cartographers is to portray landforms realistically. Usually the landscape is portrayed from above in a vertical view, but a more understandable approach is to portray the landscape as it is normally observed, from an angle that is oblique to the surface of the Earth. These oblique maps show the surface of the Earth in terms of landforms, their dimensions, relative relief, slopes, and surface materials. Specific oblique maps may be called physiographic diagrams, landform maps, or orthographic drawings. A physiographic diagram emphasizes the origin, or geologic structure, of landforms, a landform map emphasizes a realistic portrayal of surface features, and an orthographic drawing refers to the method of projecting the Earth's surface onto a map.

The oblique portrayal of landforms requires the representation of three dimensions upon a flat surface. This representation includes the interpretation and portrayal of the shape, form (volume), continuity, and surface material of the landforms. Surface features shown on an oblique map are more interpretative and descriptive than those shown on a contour map at the same scale. Geologic cross sections can be drawn on the sides of an oblique map, making correlations possible between the geologic structure and the landforms. One disadvantage of any oblique portrayal is that the far side of the landform is not seen, just as only the front-facing slopes are actually seen when viewed from the ground.

Oblique maps generally fit into one of two categories: (1) the portrayal of a specific area of the Earth's surface at a specific time and (2) the representation of a natural process through time. An oblique map of a specific area at a specific time is usually a single map, while a map portraying a natural process through time usually requires a series of interpretative oblique maps accompanied by a supporting text. Areas with historically active processes, such as volcanoes, sand dunes, and coastlines, can be effectively portrayed by a series of oblique maps that help the viewer understand the geologic process that is involved.

The techniques used to create the oblique maps in this atlas are a combination of the methods of Armin K. Lobeck, Erwin J. Raisz, and Philip B. King, all of whom greatly influenced the portrayal of landforms. The techniques used to create the oblique maps in this atlas are a combination of their methods. The maps and their supporting texts are presented in alphabetical order within regional collections. Each region includes an index map. The cognitive drawings are grouped together because they illustrate a concept or process that is based on research, and they may not portray a specific geographic location.

CHARACTERISTICS OF OBLIQUE MAPS

Oblique maps have several advantages over vertically viewed maps. They are more realistic in appearance, and the overall setting or physiography is as easy to comprehend as the individual components or landforms. Oblique maps are more expressive than other kinds of maps at the same scale; they give more information and leave less to the imagination. All of these attributes are effective in a black and white publication.

The main disadvantage of oblique maps is that the landforms are planimetrically displaced: on land, the top of a mountain is displaced; on the floor of the ocean, the base of a seamount is displaced. The planimetric displacement allows the front-facing slopes of the landform to be realistically portrayed while the back slopes are hidden from view. Oblique maps do not portray exact elevations; precise locations and elevations are best obtained from vertically viewed contour maps.

The most important factor in landform interpretation is the outline or shape of the landform. Other factors are form, continuity, surface material, and depth (fig. 1). Shape relates to the outline features of the landform (fig. 1*A*). Form describes the volume of the landform (fig. 1*B*). If an oblique map lacks form, each landform appears flat. Continuity prescribes that there is no interruption from one part of a landform to another part, or from one landform to another landform (fig. 1*C*). If there is no continuity, the individual parts of the oblique map do not make a whole map. Surface material includes the rock types (such as soft sedimentary rocks or harder metamorphic or igneous rocks) and cover material (alluvium) of the landform (fig. 1*D*). Depth in the oblique map is the distance away from the viewer. Several methods can be used to develop depth in an oblique map: direction of view, use of angular perspective, overlapping of landforms, and the use of thicker lines in the foreground.

Portrayal of the physiography is accomplished with variations in the character of form lines (fig. 1). The form lines that compose landform portrayal are lines that represent the direction of maximum slope, and the thickness and spacing of these lines indicate relief. Form lines are used to develop light and dark slopes (a form of shading) by assuming an imaginary light source from above, usually from the upper left corner of the oblique map. This results in slopes that reflect light if they face the upper left and slopes that are in the shadow if they face the lower right. Attached shadows (shadows attached to the landform) are used because a cast shadow may fall on a neighboring landform, making its depiction difficult. Contrast in an oblique map can be developed by use of light and shadow, textural differences in surface material, thick and thin lines, and orientation and direction of form lines.

In the past, Armin K. Lobeck called oblique maps "physiographic diagrams" (Raisz, 1962, p. 97) because he considered the major structural and surface-material differences to be the main core of the oblique map. Erwin Raisz coined the phrase "physiographic method" (Raisz, 1931, p. 297), which is the process of compiling oblique maps, and he called the result "landform portrayal maps". Physiographic diagrams emphasize the origin, or geologic structure, of landforms, and landform maps emphasize the shape and form of the landforms. In compiling the oblique maps in this atlas, we attempted to underscore the geologic structure and to portray the landforms realistically.

Two principal types of perspective methods are used to project a vertically viewed map into an oblique map: (1) angular perspective and (2) parallel perspective. Angular perspective results when parallel lines on the oblique map converge toward vanishing points on the horizon. Objects that are the same size are portrayed larger in the foreground and smaller in the background. Parallel perspective results when parallel lines on the oblique map are truly parallel, and objects that are the same size are portrayed the same size in foreground and background. Angular perspective allows a realistic portrayal because this is how we actually view the landscape; however, measuring (scaling) is difficult because the foreground is foreshortened less than the background. Parallel perspective allows uniform scaling throughout the oblique map but is less realistic in appearance. For further information see the section on measuring horizontal distances.

Four main steps are necessary to produce an oblique map that is compiled to scale: (1) transfer of horizontal contours from vertically viewed maps onto a perspective base; (2) interpretation of landforms; (3) inking of the physiography; and (4) printing.

The easiest way to transfer a standard vertically viewed contour map to a parallel-perspective oblique map is with a machine called an isometrograph (Dufour, 1917). This tool produces a framework of foreshortened contours faster than other transfer methods and preserves all of the minute detail of the original contour map. In the future, improvements in programming may enable the computer to produce a detailed framework of contours.

The next step is to interpret the landforms, and data for this interpretation are obtained in several ways. On land, the data are collected from contour maps, aerial photographs, satellite images, geologic maps, and fieldwork. For the underwater features, the data usually come from bathymetric maps, precision depth recorders, acoustic profiles, and geologic structure maps. These data are interpreted to identify the dimension, orientation, shape, form, structure, and surface materials of each landform. With this knowledge and the framework of foreshortened contours produced by the isometrograph, the inking of the oblilque map begins. Landforms are portrayed by controlling the direction, thickness, density, and character of the lines. The finished oblique map is an ink drawing that can be printed in black and white or further enchanced by color.

On all oblique maps, objects that appear to be vertical, in reality, are vertical, and objects that appear to be horizontal, in reality, are horizontal. It is paradoxical that the up direction on the oblique map represents elevation and depth (distance away from the viewer; fig. 2). Oblique maps seem realistic, but little is known about why. Research data and knowledge on this facet of cartography are lacking.

HISTORY

The earliest known oblique maps (2800 B.C.) were recorded on clay tablets on which mountains were portrayed in outline (Raisz, 1962, p. 3 and 4). During the great western surveys in the latter part of the last century, a landmark of landscape sketching was achieved by artist-geologist W. H. Holmes (Dutton, 1982). His landscape sketches have simplicity and boldness that emphasizes realism. The evolution from landscape sketches to oblique maps that have a geologic cross section was first accomplished by G. K. Gilbert, a geologist with the U.S. Geological Survey (Gilbert, 1877, frontispiece).

As a teacher of geomorphology (the study of the configuration and evolution of landforms), W. M. Davis compiled oblique maps of specific landforms and used oblique maps of hypothetical landforms to communicate ideas or geomorphic processes (Davis, 1909). He effectively used a series of oblique maps to depict changes in landforms through time. This technique is oriented more toward depicting erosional processes than toward showing surface material or geologic structure.

With the acceptance of W. M. Davis' publications, oblique maps became an integral part of earth science. As the use of oblique maps increased, D. W. Johnson, a student of W. M. Davis, influenced two of his own students, A. K. Lobeck, a geologist, and E. J. Raisz, a geographer. These two, along with P. B. King of the U.S. Geological Survey, were instrumental in developing and using the technique of oblique maps. Lobeck related the outline and volume of landforms to simple geometric solids and developed a geometric system by which landforms could be portrayed. He excelled in depicting geologic structure and surface material in his physiographic diagrams (Lobeck, 1958). As a teacher of geography, E. J. Raisz systematically organized small-scale or regional oblique maps by treating landforms as symbols; that is, he showed like features in a similar way. He strived for realism in his regional oblique maps and referred to them as landform maps (Raisz, 1959). King compiled oblique maps with the aid of an isometrograph and used landscape sketches to convey geologic concepts in his professional papers.

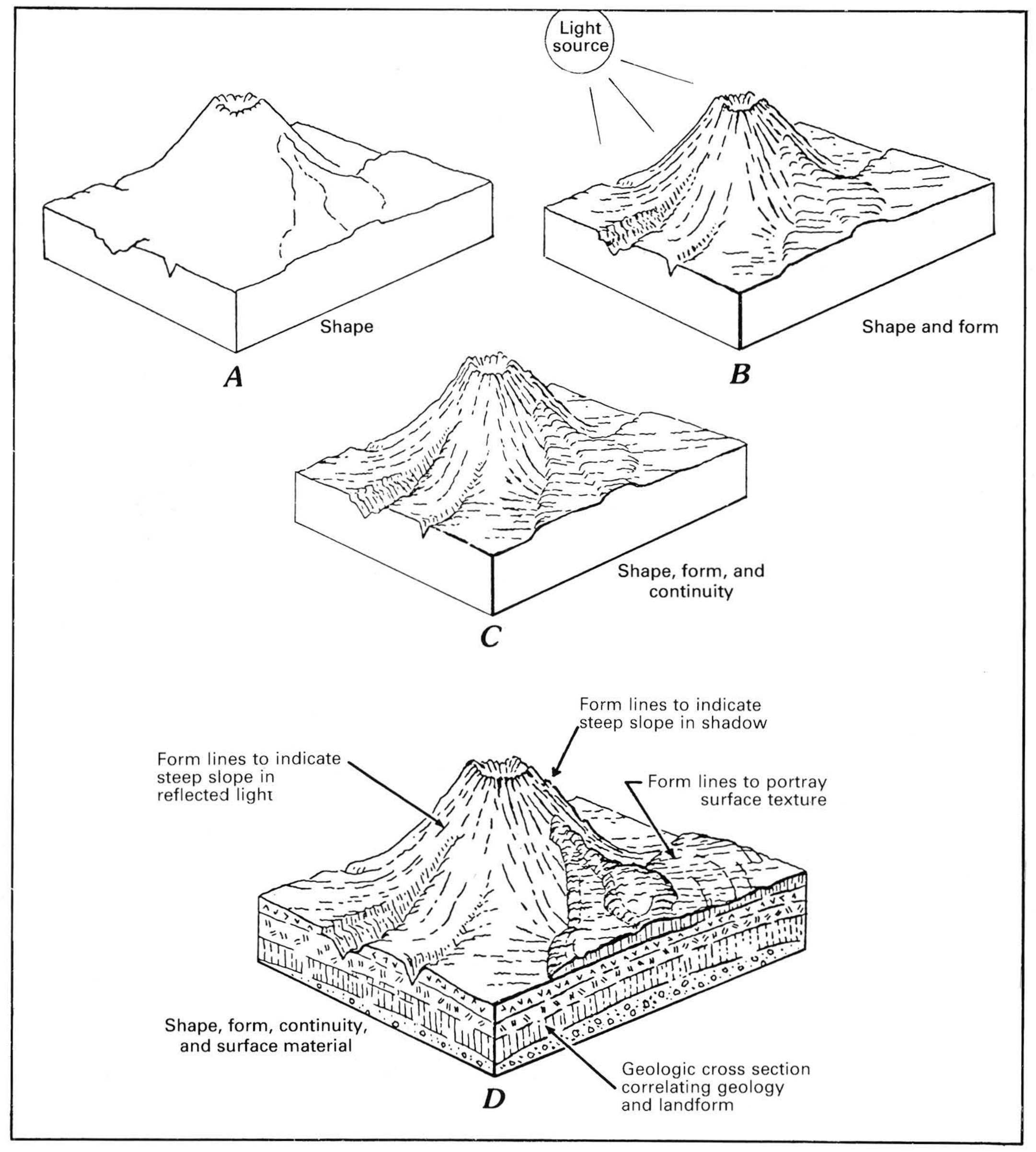


Figure 1. — Form lines are used to develop the landforms of an oblique map. ***A*** to ***D*** are discussed in text.

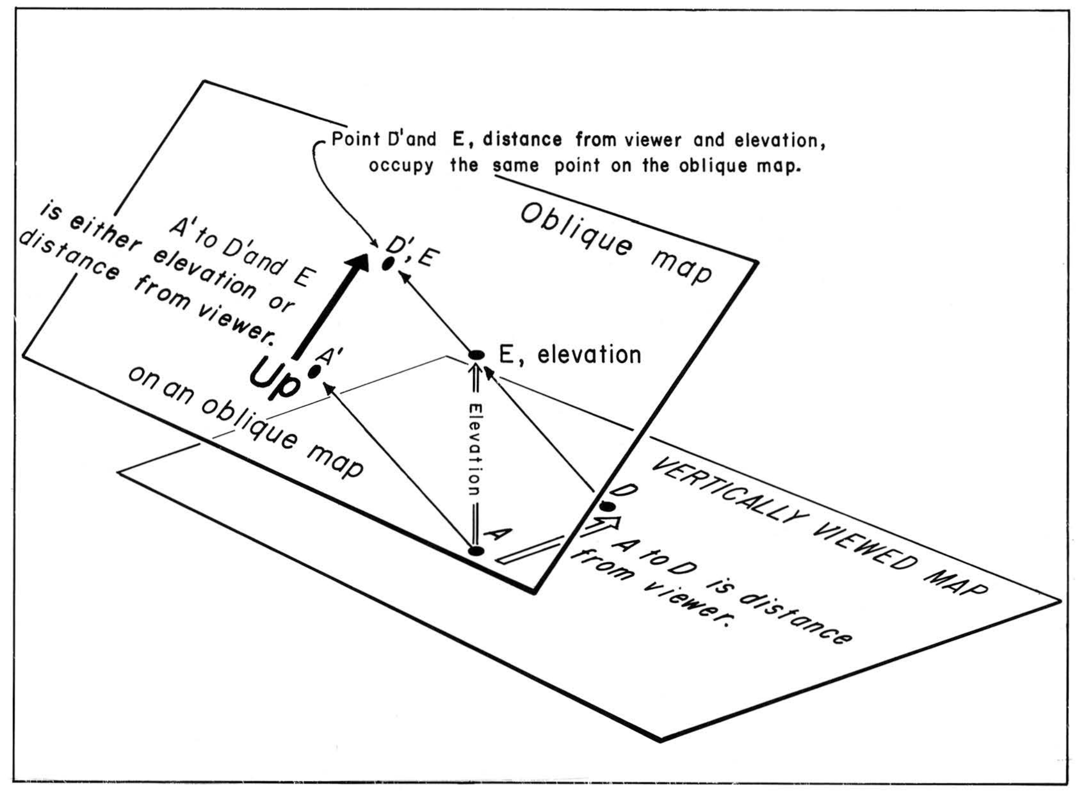
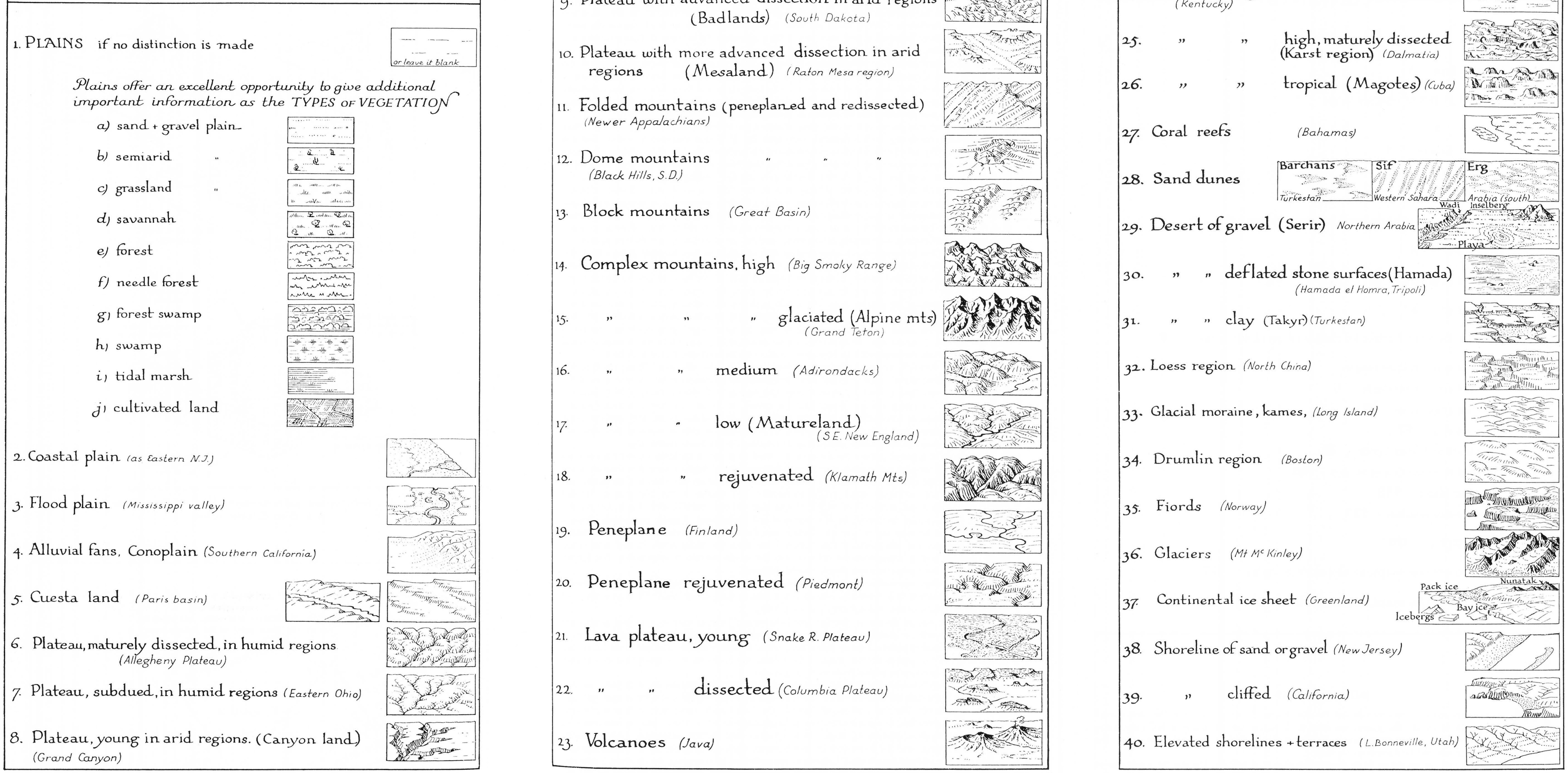


Figure 2. — The up direction on an oblique map may represent either elevation or distance from the viewer.

ARMIN K. LOBECK

In the realm of oblique maps, the most comprehensive book on the techniques of landform portrayal is *Block Diagrams* by Armin K. Lobeck (1958). This book enables the student to understand the concepts of shape and form by relating them to simple geometric solids and then progressing from these simple forms to complex landforms. Lobeck's theme is that the knowledge of geology, physiography, and geomorphology should be equal to the knowledge of drawing techniques, a marriage of geology and draftsmanship.

Figure 3. — Physiographic symbols from Raisz (1931).



Each map author is encouraged to develop his own individual landform technique. The book includes chapters on constructional landforms, plains and plateaus, dome mountains, and destructional landforms developed by streams, glaciers, and waves and shows examples from North America and Europe.

In the technique developed by Lobeck for his physiographic diagrams at small scales (large areas), the landforms are portrayed by symbols and are based on spot elevations (Lobeck, 1958, p. 151–155). At large scales (small areas), his diagrams are based on spot elevations or a framework of contours (Lobeck, 1958, p. 139–145). Shape, form, depth, and continuity within the landform are developed by the use of form lines that represent the geologic structure or rock type. Lobeck's use of angular perspective (parallel lines that converge toward vanishing points on the horizon) to create blocks of earth adds depth to his oblique maps. Other techniques of landform portrayal usually use an imaginary light source from the upper left corner of the map to enhance shape, form, and depth by the use of shadows. This results in thick, closely spaced lines on the slopes that in the shadow and thin, widely spaced lines on the slopes that reflect light. In the landform technique that Lobeck developed, the thickest lines are used to portray steep slopes, regardless of their orientation to the light source. Contrast in this landform technique is used to differentiate between surface materials, which are portrayed with form lines, and horizontal plains, which are portrayed without lines. Patterns (ruled or stippled) are highly developed to represent surface structure. Crystalline rocks are represented by crinkly lines drawn freehand, and sedimentary rocks are represented by ruled horizontal lines (Lobeck, 1948).

ERWIN J. RAISZ

Erwin J. Raisz named his approach to landform portrayal the "physiographic method". He systematically categorized landform symbols (fig. 3). The symbols were developed to appear as if they are viewed from 45° above the horizon, were scaled to spot elevations, and located on a vertically viewed map. Raisz's symbols illustrate the general landform types and do not claim to delineate every landform. They vary in size because the symbols are used in a logarithmic proportion that emphasizes the smaller landforms. This technique was successfully applied both to well-known areas of the world and to areas covered only by reconnaissance surveys.

Assuming a light source from the upper left corner, Raisz's physiographic method portrays the outline of the landform with fine lines on the slopes that reflect light and with dark areas on the slopes that have attached shadows facing away from the light. The dark areas enhance the form of the landform and make a bold representation, but at the cost of descriptive line that could portray surface material or texture (see fig. 3, No. 15).

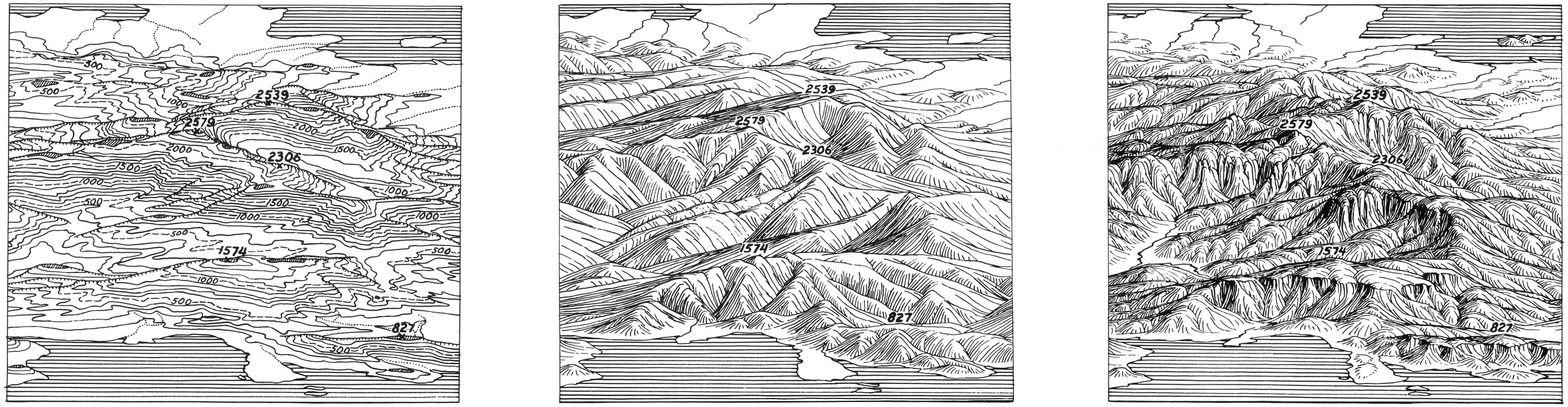
Continuity exists in the physiographic symbols by the use of form lines. In his regional oblique maps, flat plains are left blank without form lines (fig. 3, No. 13). Patterns and line texture are used mainly to develop drainage patterns rather than surface texture (Raisz, 1957). Raisz does develop surface texture, but not to the extent that is found in Lobeck's technique. On several regional oblique maps, depth was indicated by using blocks on the side of the oblique maps.

Raisz was a strong advocate of realism and believed that drawing oblique maps was the highest form of cartographic art. He tended to frown on using lettering on a map since it interfered with that realism. With this technique he was able to compress an astounding amount of information into an easily read and attractive map.

PHILIP B. KING

As a geologist for the U.S. Geological Survey, Philip B. King made field sketches and oblique maps of his study areas and used them as integral parts of his publications (King, 1968, p. 5, 17, 20). During the Second World War, King compiled many oblique maps, and a collection of them was published by the U.S. Department of the Army (1960). His maps emphasize knowledge of geology and terrain features and show the care King used in compiling oblique maps. Most of these oblique maps are oriented with north at the top. An isometrograph framework was used for maps at large scales, and spot elevations were used for maps at small scales.

A major departure of King's technique from that of others is the location of the light source in the upper right corner. King developed the shape of a landform by using lines of varying texture, using thicker outlines in the foreground. He achieved form with few lines, and even fewer lines on light-reflecting slopes. Continuity was achieved in field sketches and large-scale oblique maps by unbroken form lines on the landforms and by stream patterns in small-scale oblique maps. Surface texture in the large-scale oblique maps resulted from patterns and form lines, while surface texture in small-scale maps was portrayed with descriptive lines, dots, and dashes. In landscape sketching, depth was achieved by wide, solid lines in the foreground, grading to thin, broken lines toward the horizon.



A B C

Figure 4. — The value of knowledge of geology and terrain features. The same framework of adjusted contours (*A*) can produce two very different large-scale oblique maps: one shows no geologic interpretation (*B*) and one combines knowledge of geology with the presentation of relief (*C*). From U.S. Department of the Army (1960).

The techniques used by King for drawing landforms are organized into "An Album of Terrain Types" (U.S. Department of the Army, 1960), which contains examples of underwater features, shoreline features, lowlands, and highlands. Figure 4 is an example from that album and illustrates how the same framework of adjusted contours (*A*) can produce two very different large-scale oblique maps: one which shows no geologic interpretation (*B*) and one which combines knowledge of geology with the presentation of relief (*C*). When the framework of contours is interpreted geologically, knowledge of the types of rocks underlying the surface of the ground allows different surface textures to be portrayed, which results in a more complete portrayal.

King (U.S. Department of the Army, 1960) also illustrates with the use of six oblique maps some unsatisfactory techniques for drawing landforms: monotonous repetition, lack of quality, insufficient detail, stereotyped technique, excessive shading in lowlands, and excessive use of horizontal lines. Comparison of these unsatisfactory examples with the satisfactory oblique maps is an excellent way to develop a technique of landform portrayal.

OBLIQUE-MAP METHODS USED FOR MAPS IN THIS ATLAS

The technique of landform portrayal used on the maps in this atlas is based on a combination of the methods of Lobeck, Raisz, and King. This technique is still evolving as we strive for realism through the use of a minimum of form lines. In our experience, the ability to draw is not paramount in developing a realistic landform-portrayal technique. Excellent oblique maps can be produced if a minimal effort is made to learn drawing skills in addition to acquiring some knowledge of geology.

All but one of the oblique maps in this atlas were compiled between 1962 and 1986 for the U.S. Geological Survey. The early oblique maps were based on angular perspective, and the landform technique is weak in continuity, form, and surface texture (see oblique map of Mount Whitney and vicinity). The technique improved with time, particularly in the decreased number of form lines needed to show the continuity, form, and surface texture of the landform.

Most of the maps in this atlas focused initially on a particular study of a U.S. Geological Survey scientist. The optimum angle of view was chosen to portray a single landform of the study area, such as a submarine canyon or a volcano. Oblique maps are easier to understand if the direction of view allows the higher landforms to be located in the background.

This up-slope orientation gives landforms strong outlines and profiles and means that the convention of placing north at the top of the map was not always adhered to. The optimum orientation depends on the landform to be portrayed, although the process that developed the landform must often be considered. The selection of horizontal scale depends on the size of the area to be included. Generally, more area is portrayed than just the landform of interest because the regional geologic environment is important to the description of that landform. If possible, offshore oblique maps included the shoreline to help the reader to locate the area.

Vertical scales are important in compiling oblique maps. Regional maps at small scales require more vertical exaggeration than do large-scale maps in order to develop realistic physiography. The angle of view from the horizon also effects vertical scale. The lower angles of view require less vertical exaggeration for a realistic portrayal. As an example, in the portrayal of an Hawaiian shield volcano, a low (20°) angle of view requires little vertical exaggeration. Generally, oblique maps are drawn at a viewing angle of 30° above the horizon, and most of the oblique maps in this atlas are from that angle. One of the advantages in compiling oblique maps with the isometrograph is that the angle of view can be changed for different oblique maps.

The isometrograph develops a parallel-perspective framework from a vertically viewed contour map by (1) foreshortening the contours front-to-back in the direction of view and (2) changing the distance or space between contours. Starting with a vertically viewed contour map, and given the angle of view from the horizon, and the direction of view, the machine can be set up to produce an oblique contour map with the contours foreshortened without reproducing the hidden back slopes. At the same time the distance between the contours (vertical scale) is either left the same or is vertically exaggerated.

In setting up the isometrograph, the vertical scale is positioned on a calibrated bar (fig. 5). A vertically viewed contour map of the area to be portrayed is oriented so that the direction of view is parallel to the calibrated bar. The angle of view from the horizon is adjusted by the placement of the bars that hold the pencil (fig. 5). The stylus is moved along the highest contour of the vertically viewed contour map, and at the same time the pencil is activated to draw a foreshortened contour. The isometrograph is moved on the vertical scale to the next lower contour, and the process is repeated until all of the contours have been traced. We estimate that a framework of foreshortened contours by the isometrograph is produced in half the time as one based on angular perspective.

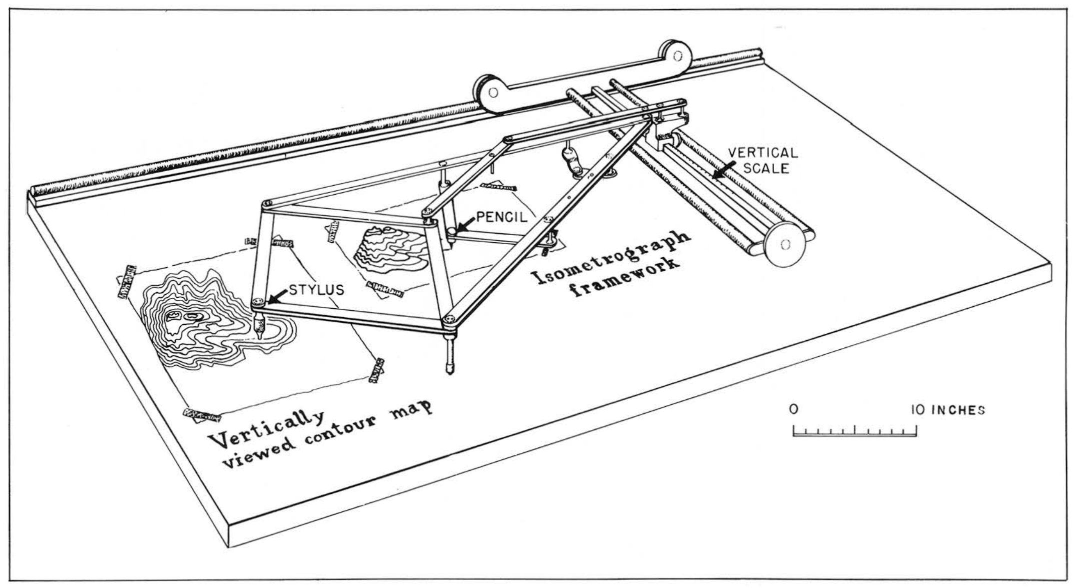


Figure 5. — Isometrograph.

All pertinent data are assembled before an oblique map is prepared. In the ideal case, the cartographers can visit the area and take photographs from the chosen angle of view. Unfortunately, this is not always the case, particularly when the subject is an underwater feature or an inaccessable area on land. For example, during the initial compilation of oblique maps of Mount St. Helens (included in this atlas) only the observations of geologists and newspaper photographs were available. For specific data on elevation, dimension, relative relief, slopes, and surface material, the best sources are maps and photographs, but for some data experts on the area need to be consulted.

The landform-portrayal techniques used in this atlas depend on the use of form lines, which are drawn individually with ink to represent shape, form, depth, and surface texture. The use of line is also the use of space. In the figure-ground relation the form line is the figure and the space that surrounds the figure is the ground. The ground reflects the traits that make up the form lines. If the form lines lack character, direction, and density, then the ground lacks definition, and it predominates. The ground is most noticeable when there is a lack of continuity in the landform-portrayal technique. A realistic portrayal technique represents the landforms by using a minimum number of expressive lines and letting the ground support the expressive lines.

This figure-ground relation is affected when the oblique map is printed in color. Although printing costs are higher, color can be applied to form lines and the ground. Contrast is lost when the form lines and the ground are printed in color (sometimes called relief shading), a process that results in a less descriptive landform technique.

CONCLUSION

Because oblique maps are instructive and easy to read, they help the scientist communicate with the layman concerning our environment, especially those areas, such as the sea floor, that are not easily accessible. With increasing population and all its attendant stresses on the planet, the need for this communication will become ever greater. Fortunately, in the near future, with new techniques and with the use of computers, the cartographer will be able to respond to this demand and to create oblique maps more quickly and more economically.

ACKNOWLEDGMENTS

This unusual atlas was a joy to compile. Its uniqueness, however, required a flexible and understanding publication system. We are very thankful to all of the U.S. Geological Survey scientists who, since 1962, have seen the value of oblique maps and used them in studies and publications. Helpful discussions and constructive ideas for this atlas were provided by John Aaron, Peter W. Barnes, May Lou Callas, Pat Earnest, Arthur B. Ford, Ralph E. Hunter, David McCulloch, Willis H. Nelson, Jim Pinkerton, Paula Quinterno, Erk Reimnitz, Larry Rooney, William Sanders, Catherine Rieser, and Rose Trombley.

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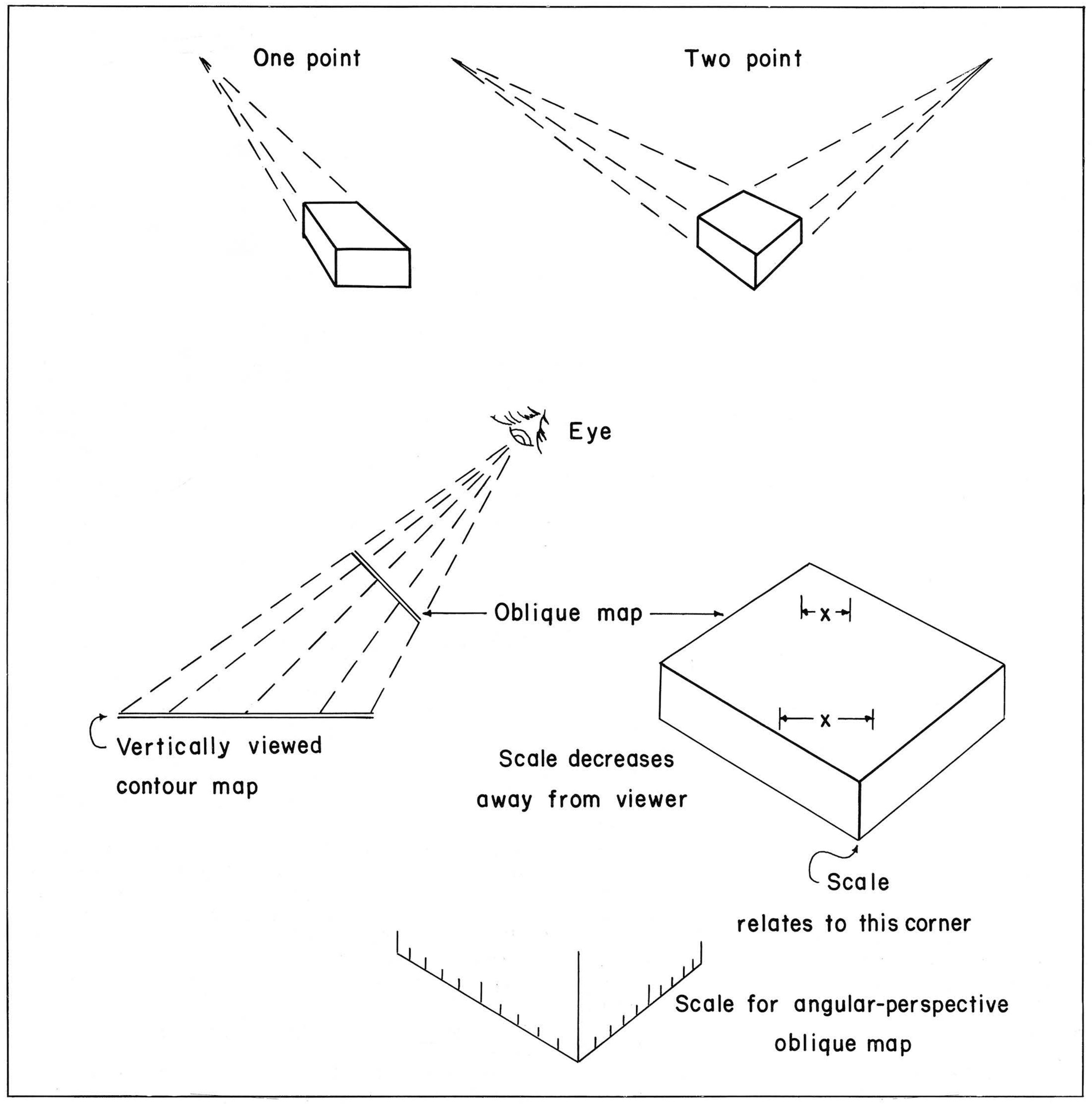
HOW TO MEASURE HORIZONTAL DISTANCES ON THESE OBLIQUE MAPS

Two types of oblique maps are shown in this atlas: (1) angular perspective, based on one- or two-point perspectives, and (2) parallel perspective, produced by the isometrograph (see text for description of the isometrograph).

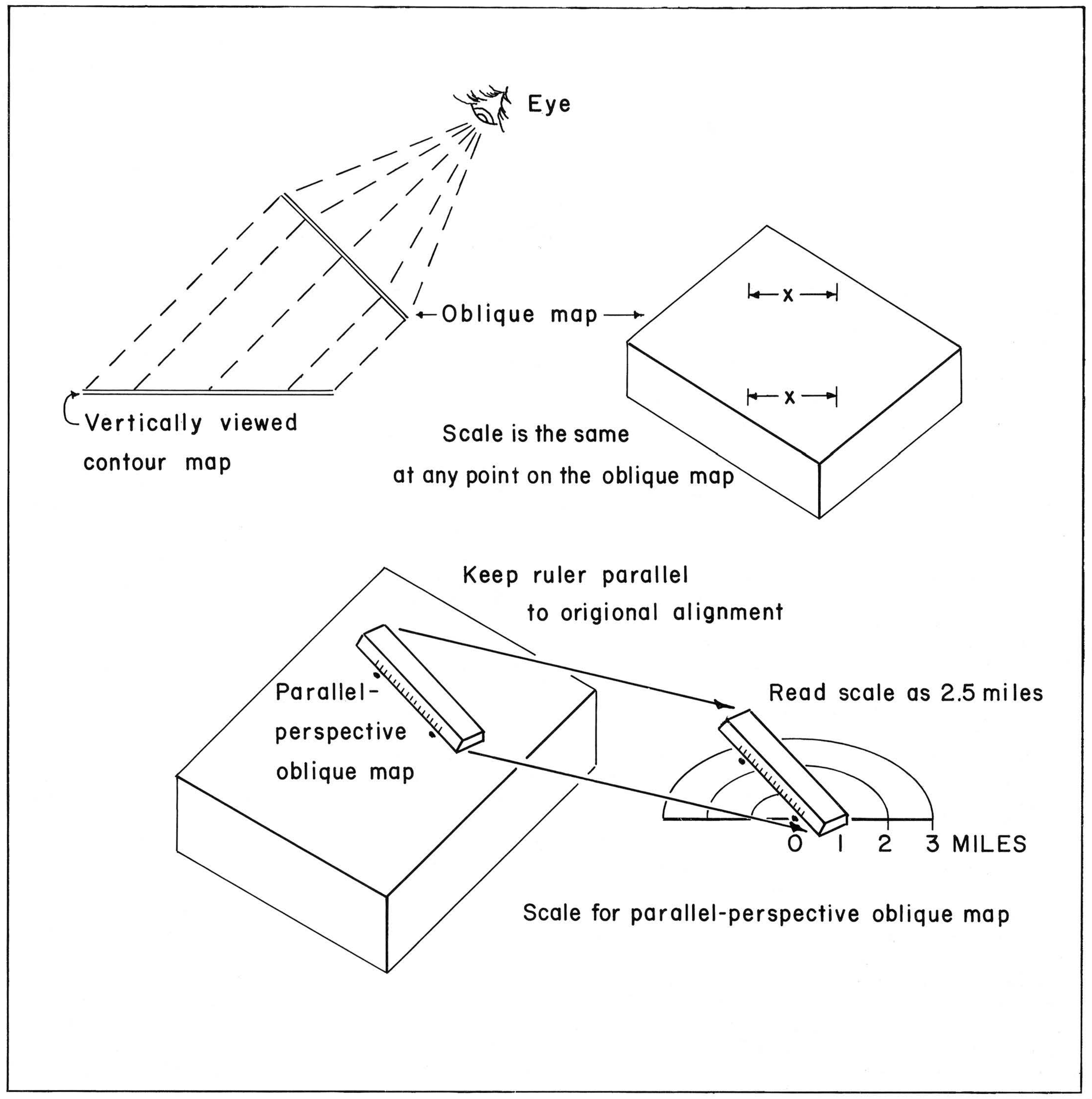
ANGULAR PERSPECTIVE

Measuring horizontal distances on an oblique map that is based on an angular perspective is difficult because the scale decreases away from the viewer. Often a scale accompanies this kind of map, but this scale represents only one location on the oblique map, usually the corner nearest the viewer.

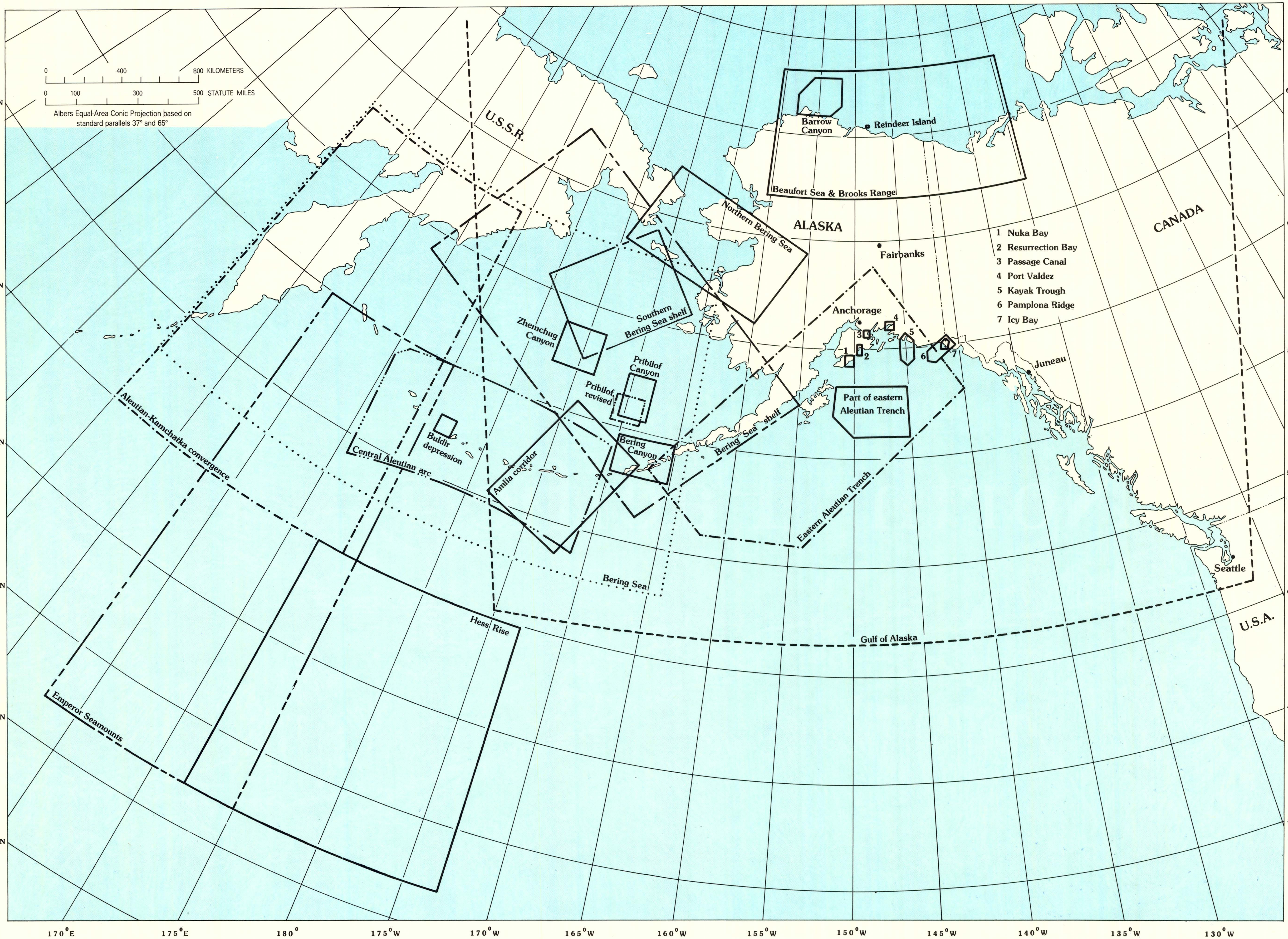


PARALLEL PERSPECTIVE

Measuring horizontal distances on an oblique map that is based on a parallel perspective is not difficult because the scale is consistent throughout the map. The scale that accompanies a parallel-perspective map is an elliptical scale; the front-to-back scale is foreshortened and the left-to-right scale remains unchanged. To use the elliptical scale, place a scaling instrument (ruler) on the map, note the number of units between the two points of interest, and then move it to the zero point on the elliptical scale, keeping the instrument parallel to its original alignment on the two map points. Read the distance from the elliptical scale.



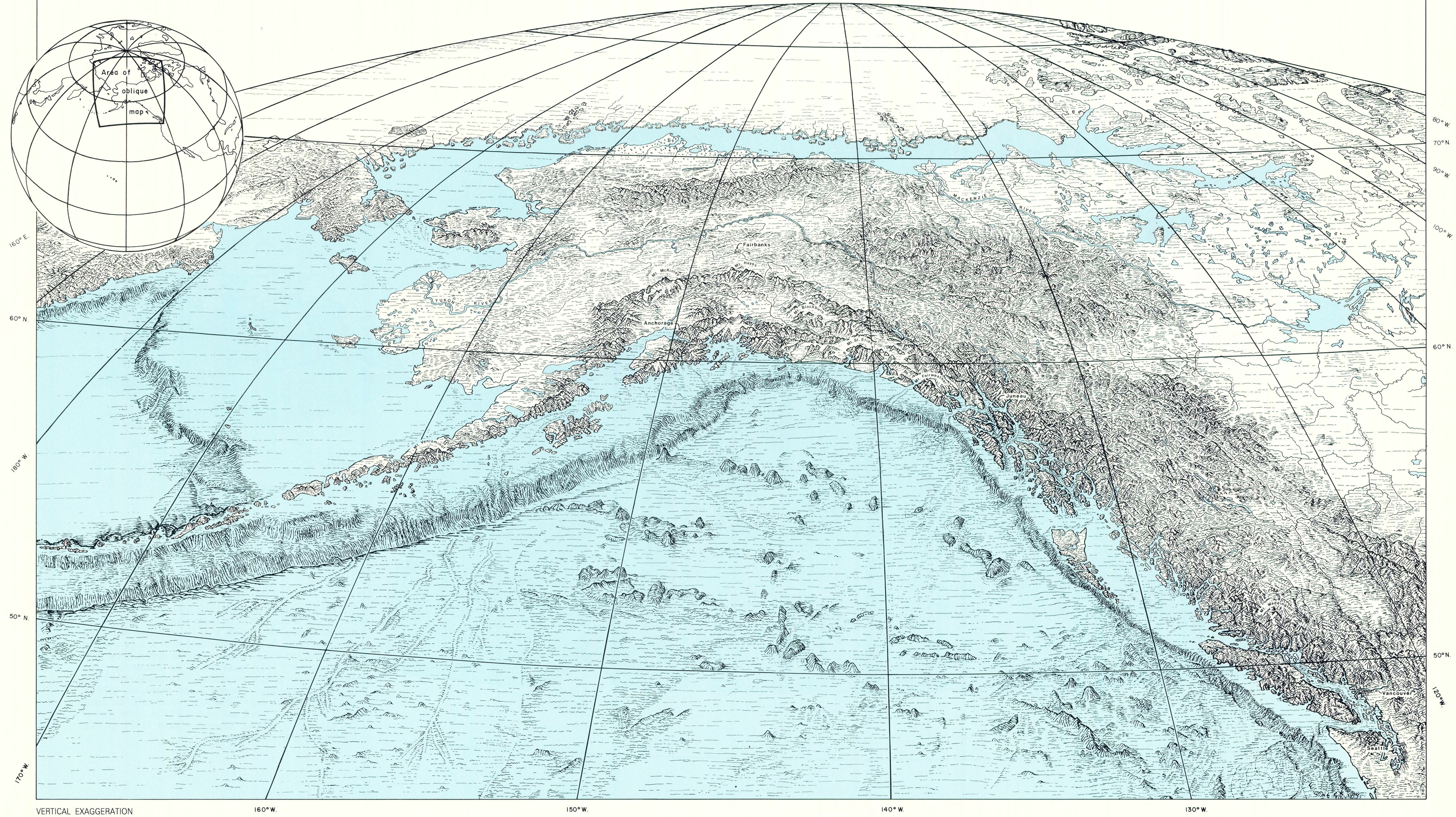
Alaska and North Pacific



6

LOCATION OF OBLIQUE MAPS IN ALASKA AND THE NORTH PACIFIC

This regional oblique map of the Gulf of Alaska is based on an orthographic map projection, which allows the Earth to be portrayed as if viewed from space. This map was compiled to compare the submarine and subaerial topography of the Gulf of Alaska and northwestern North America. The physiography of both areas is the result, in part, of plate tectonics: the Pacific plate is colliding with and sliding under the North American plate (Howell and others, 1980, p. 43). This knowledge was used to emphasize the topography and the sediment depicted in the adjacent basins, slopes, fans, and trenches. This map has been published in Alpha, Gerin, and Joyce (1980); Howell and others (1980, p. 48, 49).



VERTICAL EXAGGERATION
APPROXIMATELY X20

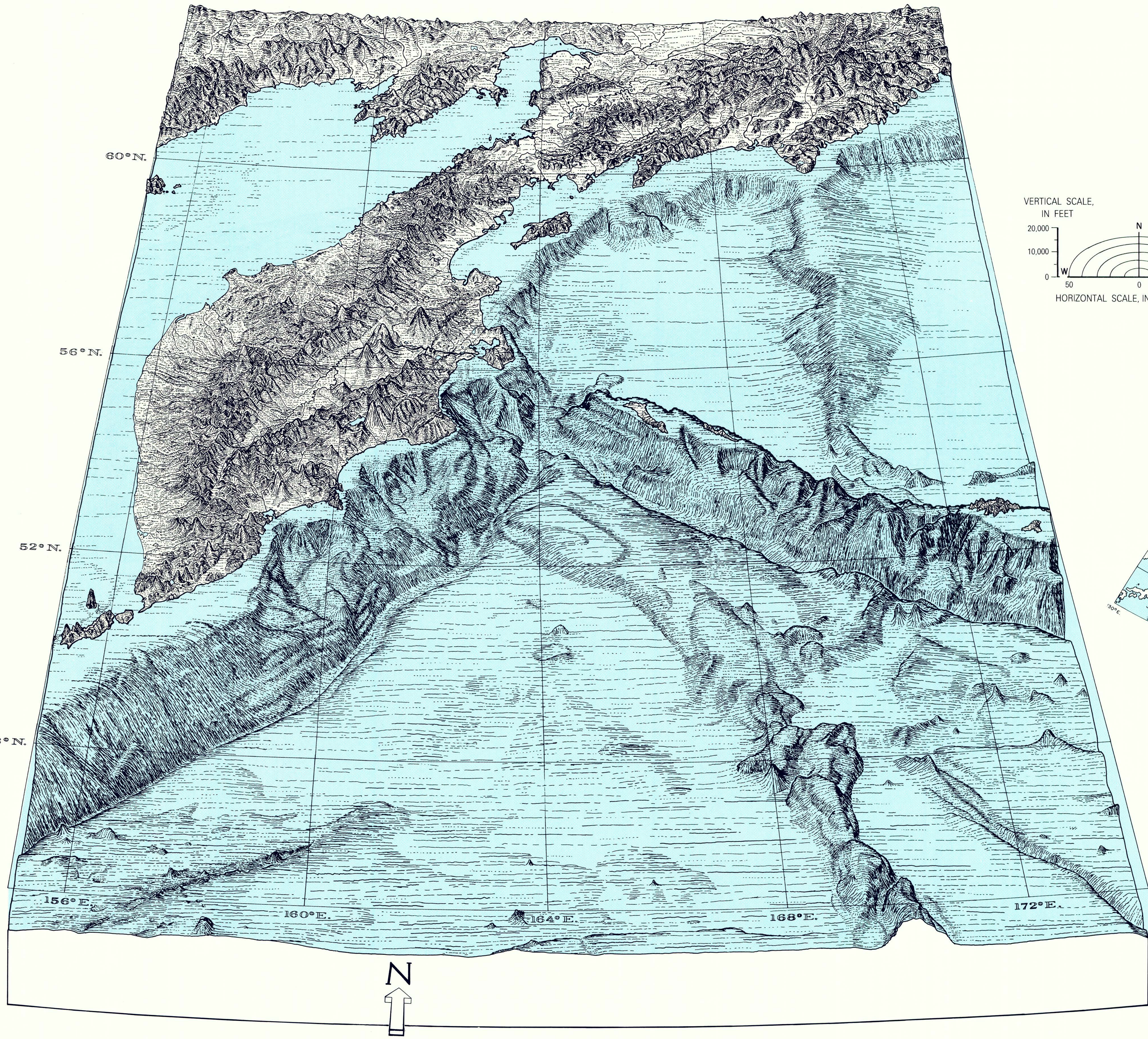
OBLIQUE MAP OF THE GULF OF ALASKA

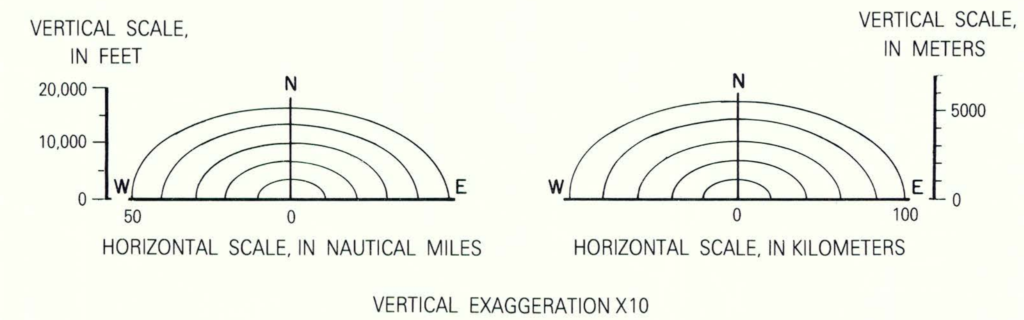
By

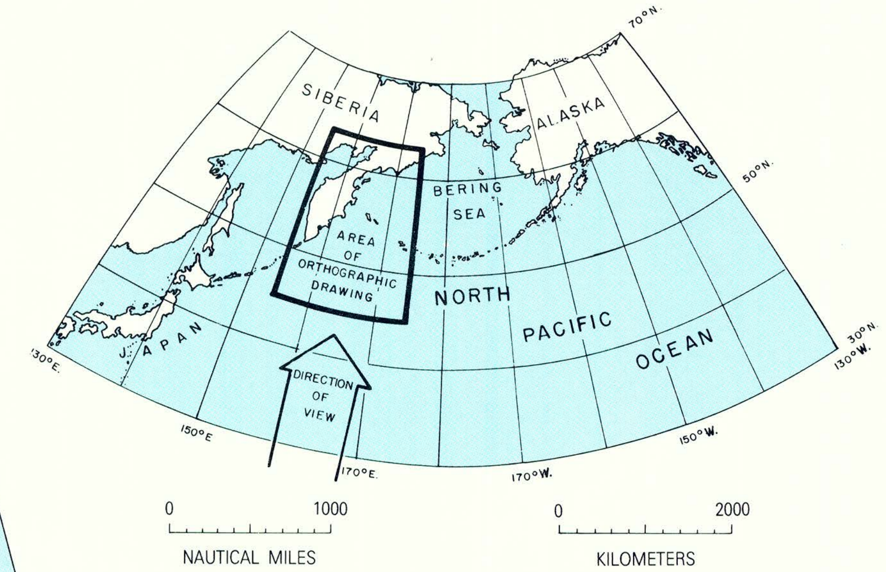
Tau Rho Alpha, Marybeth Gerin, and James M. Joyce

1980

8







INDEX MAP

The Kamchatka Peninsula in Asia is located in the northwest part of this oblique map. The Pacific Ocean (shaded) and the northeast-trending Kuril Trench is to the south and next to the Kamchatka Peninsula, the Aleutian Island chain is to the east, and the northern arm of the Emperor Seamount chain is to the south along long 168°E. The topography of the Aleutian-Kamchatka convergence may partly be the result of the converging of the Pacific plate and the Eurasian continental margin (Buffington, 1973, p. 1980). This map has been published in Alpha (1972); Buffington (1973, frontispiece); Scholl and others (1977, p. 1570); Stewart (1977, p. 193); National Research Council (1979, p. 30); Gnibidenko and others (1980, p. 14).

THE ALEUTIAN-KAMCHATKA CONVERGENCE, NORTH PACIFIC OCEAN

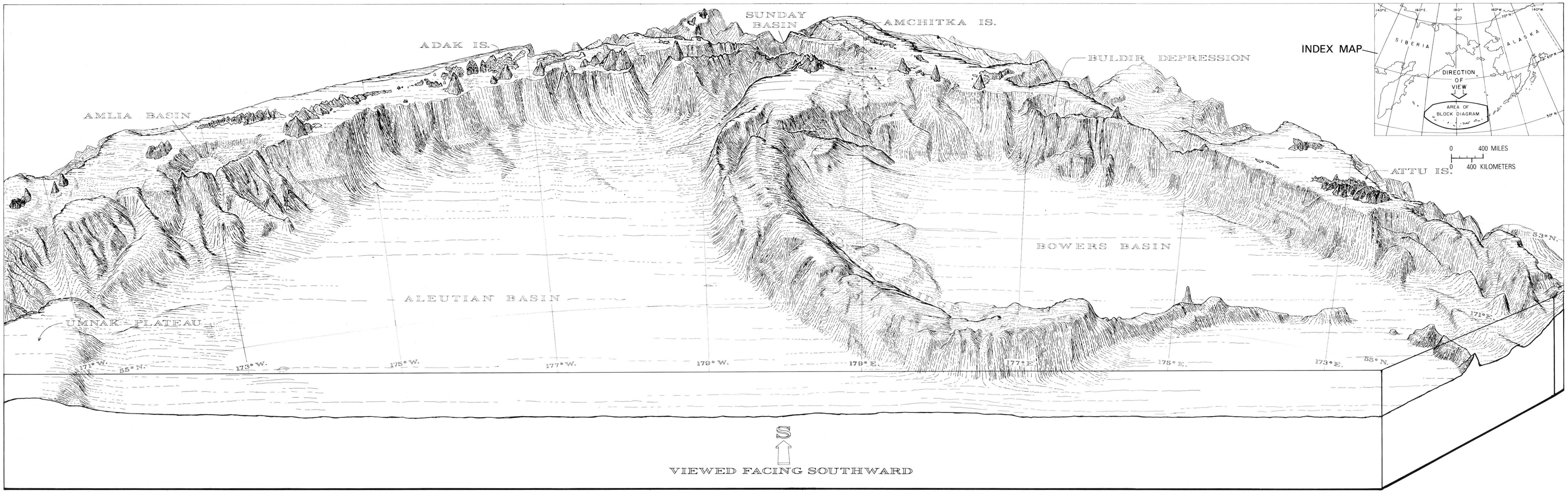
By

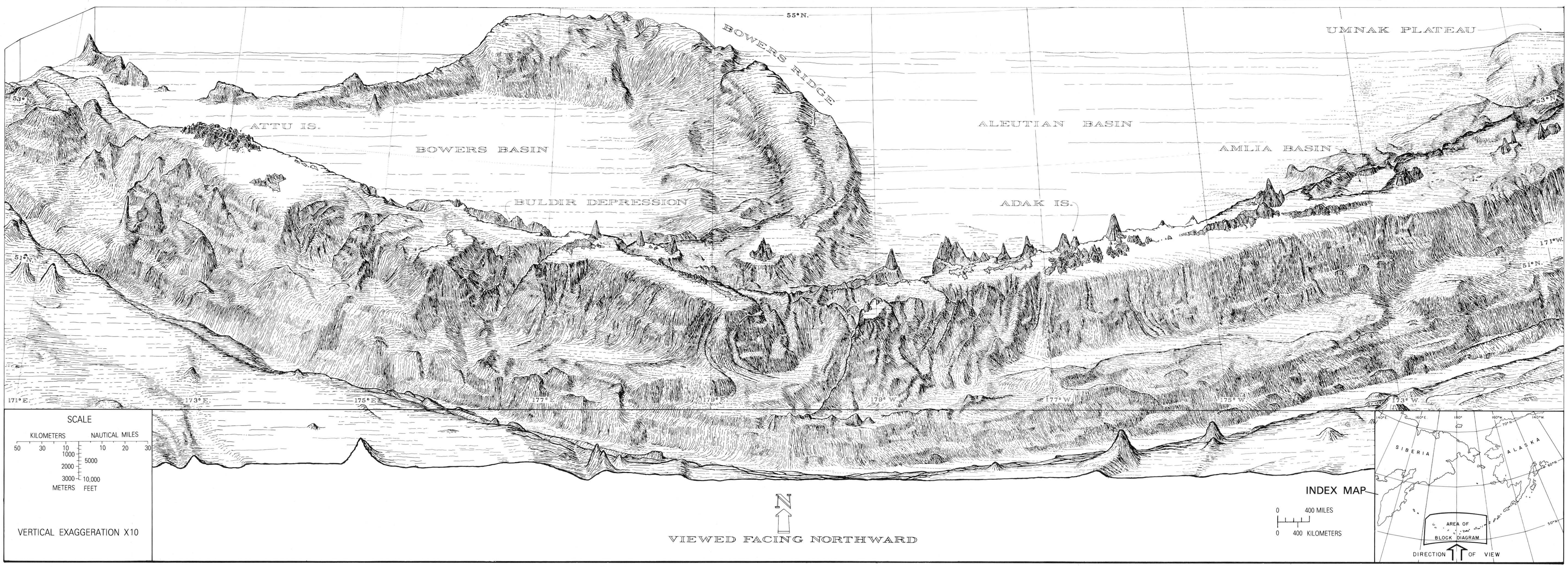
Tau Rho Alpha

1972

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

ATLAS OF OBLIQUE MAPS
I–1799





9

This oblique map covers the Aleutian Islands from Unalaska Island on the east to Attu Island on the west and from the Pacific seafloor and Aleutian Trench on the south to Bowers Ridge on the north. This dual map is unique because it was drawn to view both the north and south sides of the Aleutian Island arc. The Aleutian Islands are tops of volcanoes that sit on a submarine platform that lies only about 200 feet (61 meters) beneath the surface of the ocean (Marlow, 1973, p. 1567). The northern and southern views of this map have been published in Alpha (1970) and Marlow and others (1973, fig. 1); the southern view in Shepard (1973, p. 245); part of the southern view in Stewart (1978, p. 88).

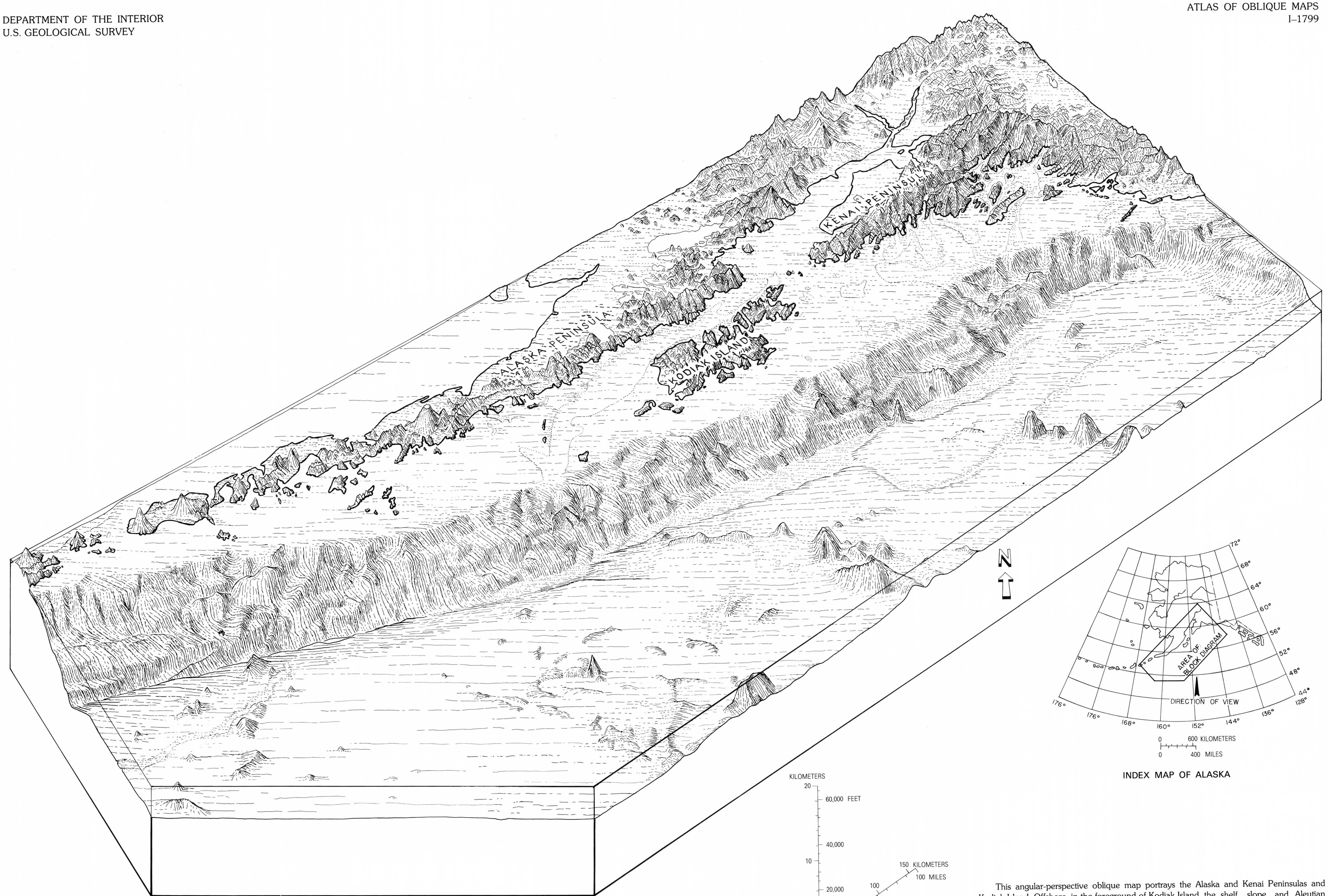
CENTRAL ALEUTIAN ARC, ALASKA

By

Tau Rho Alpha

1973

10



SCALE
VERTICAL EXAGGERATION X10

INDEX MAP OF ALASKA

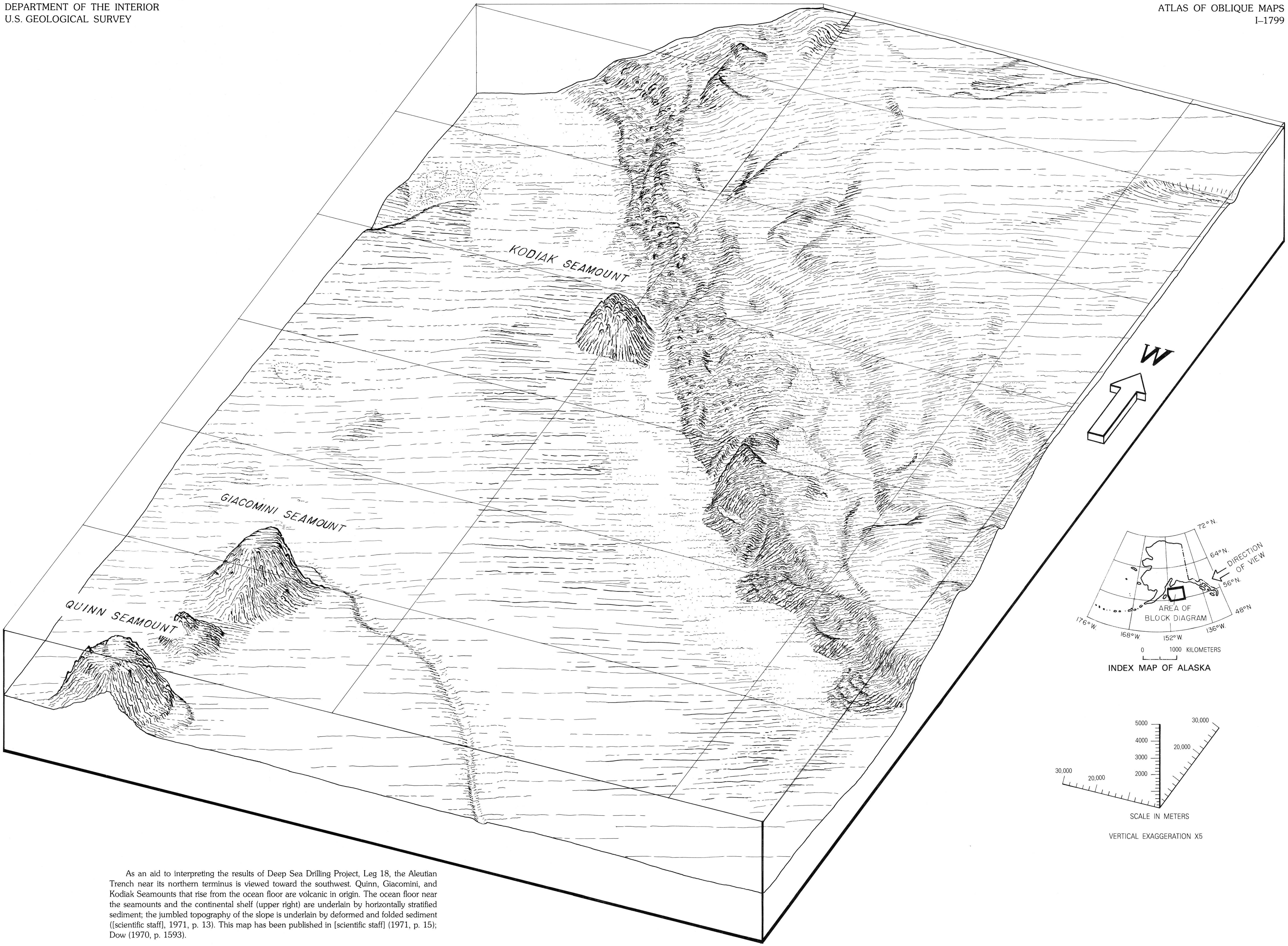
This angular-perspective oblique map portrays the Alaska and Kenai Peninsulas and Kodiak Island. Offshore, in the foreground of Kodiak Island, the shelf, slope, and Aleutian Trench trend from left to right in the center of the map. This oblique map helps to depict the morphology of the western Gulf of Alaska, which may possibly be underthrust and pushed up by the Pacific plate (von Huene and Shor, 1969, p. 1900). This map has been published in von Huene and Shor, (1969, pl. 2).

EASTERN ALEUTIAN TRENCH AND NORTHERN GULF OF ALASKA

By

Tau Rho Alpha and Charles I. Winegard

1969



INDEX MAP OF ALASKA

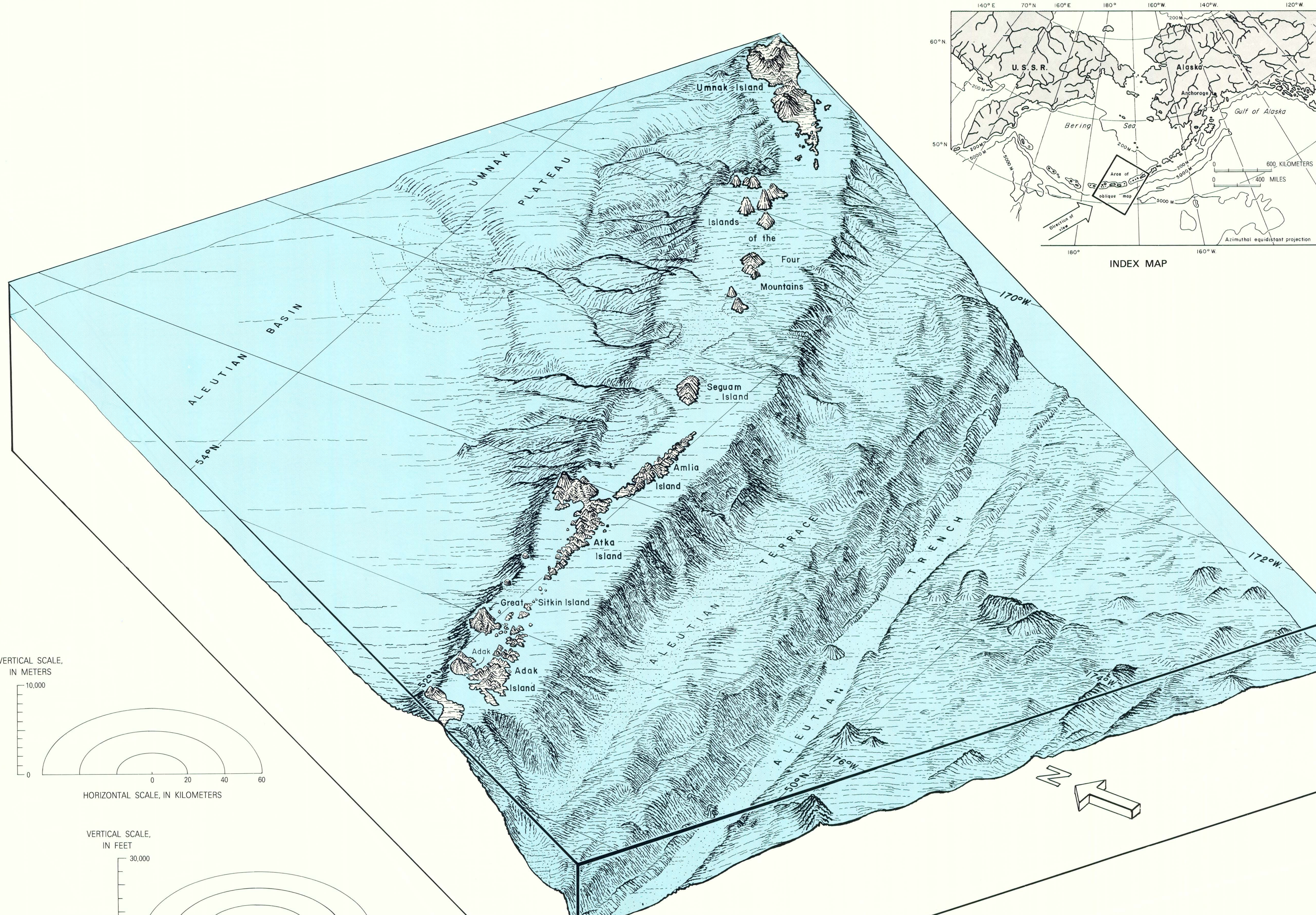
SCALE IN METERS

VERTICAL EXAGGERATION X5

As an aid to interpreting the results of Deep Sea Drilling Project, Leg 18, the Aleutian Trench near its northern terminus is viewed toward the southwest. Quinn, Giacomini, and Kodiak Seamounts that rise from the ocean floor are volcanic in origin. The ocean floor near the seamounts and the continental shelf (upper right) are underlain by horizontally stratified sediment; the jumbled topography of the slope is underlain by deformed and folded sediment ([scientific staff], 1971, p. 13). This map has been published in [scientific staff] (1971, p. 15); Dow (1970, p. 1593).

A PART OF THE EASTERN ALEUTIAN TRENCH

By
Tau Rho Alpha
1969



INDEX MAP

VERTICAL SCALE, IN METERS

HORIZONTAL SCALE, IN KILOMETERS

VERTICAL SCALE, IN FEET

HORIZONTAL SCALE, IN MILES

VERTICAL EXAGGERATION X 5

Northeast view of the Aleutian Islands near Amlia Island. The islands are tops of volcanoes located on a wavecut terrace (submarine plateau) that separates two bodies of water. The Bering Sea is on the upper left half of the map, where part of the Aleutian Basin is about 11,482 feet (3,500 meters) deep, and the Umnak Plateau is about 656 feet (200 meters) beneath the surface of the sea. The Pacific Ocean is on the right half of the map, where the Aleutian Terrace is about 15,419 feet (4,700 meters) beneath the surface, and the Aleutian Trench is about 24,278 feet (7,400 meters) deep.

The purpose of this map was to show the crest of the Aleutian Island arc, the Aleutian Terrace, and the Aleutian Trench. Offshore, the slope between the islands and the terrace has exposed rocks, and the slope between the terrace and the trench is underlain by ridges of folded sediments. In contrast, the terrace and the trench are underlain by undeformed, flat-lying sediments (Marlow and others, 1973, p. 1556). This map has been published in Alpha, Scholl, and Vallier (1981).

AMLIA CORRIDOR, ALASKA

By

Tau Rho Alpha, David W. Scholl, and T. L. Vallier

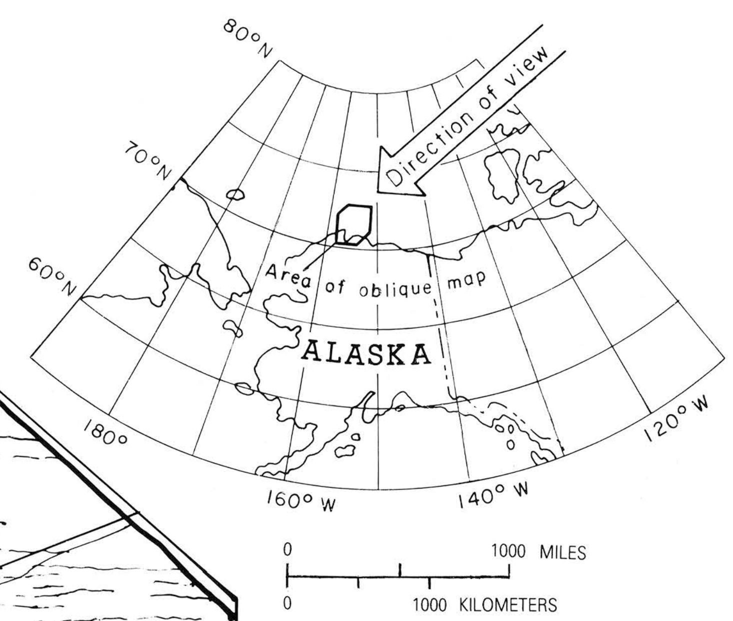
1981

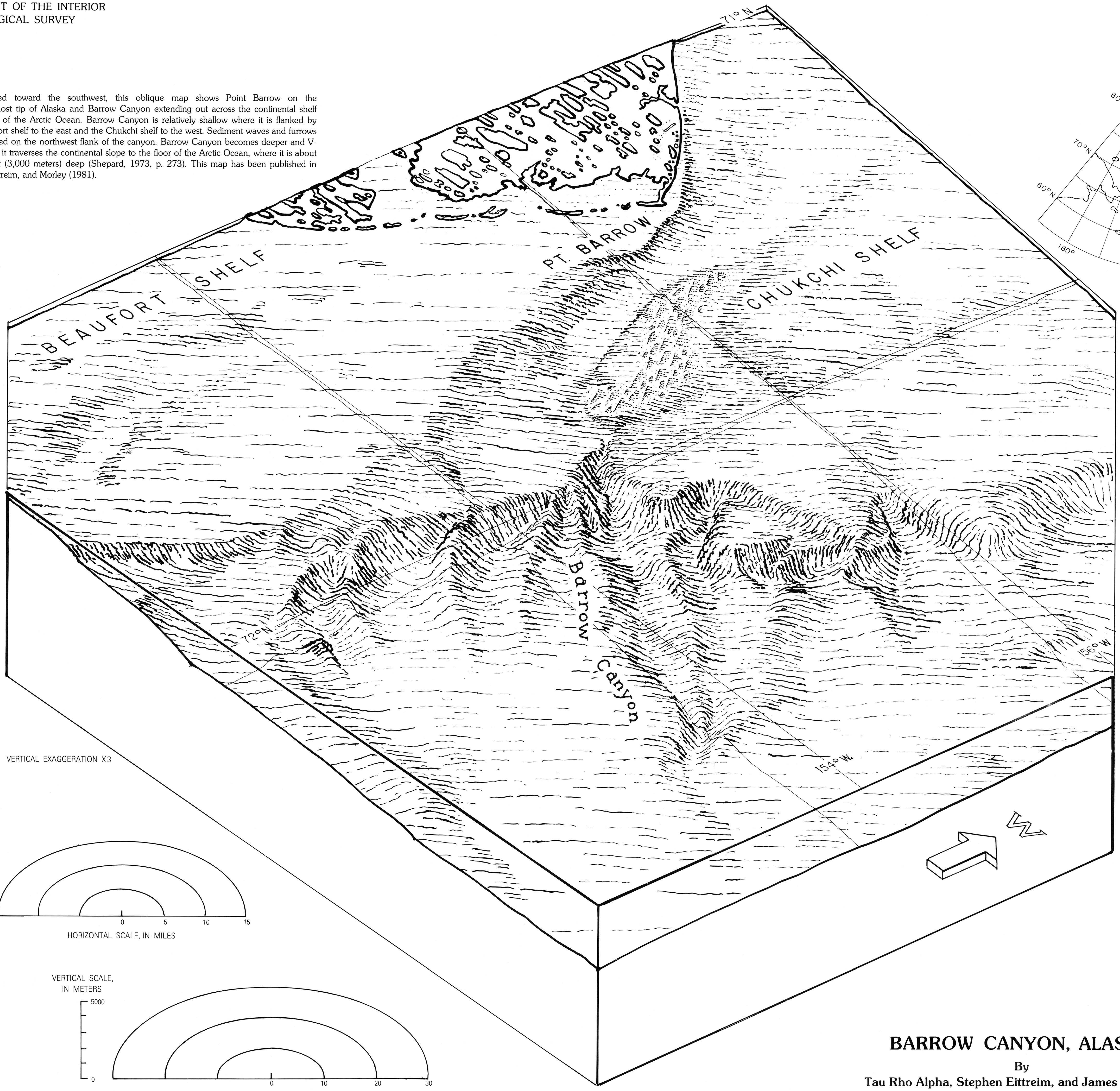
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

ATLAS OF OBLIQUE MAPS
I–1799

Viewed toward the southwest, this oblique map shows Point Barrow on the northernmost tip of Alaska and Barrow Canyon extending out across the continental shelf and slope of the Arctic Ocean. Barrow Canyon is relatively shallow where it is flanked by the Beaufort shelf to the east and the Chukchi shelf to the west. Sediment waves and furrows are depicted on the northwest flank of the canyon. Barrow Canyon becomes deeper and V-shaped as it traverses the continental slope to the floor of the Arctic Ocean, where it is about 9,482 feet (3,000 meters) deep (Shepard, 1973, p. 273). This map has been published in Alpha, Eittreim, and Morley (1981).

INDEX MAP





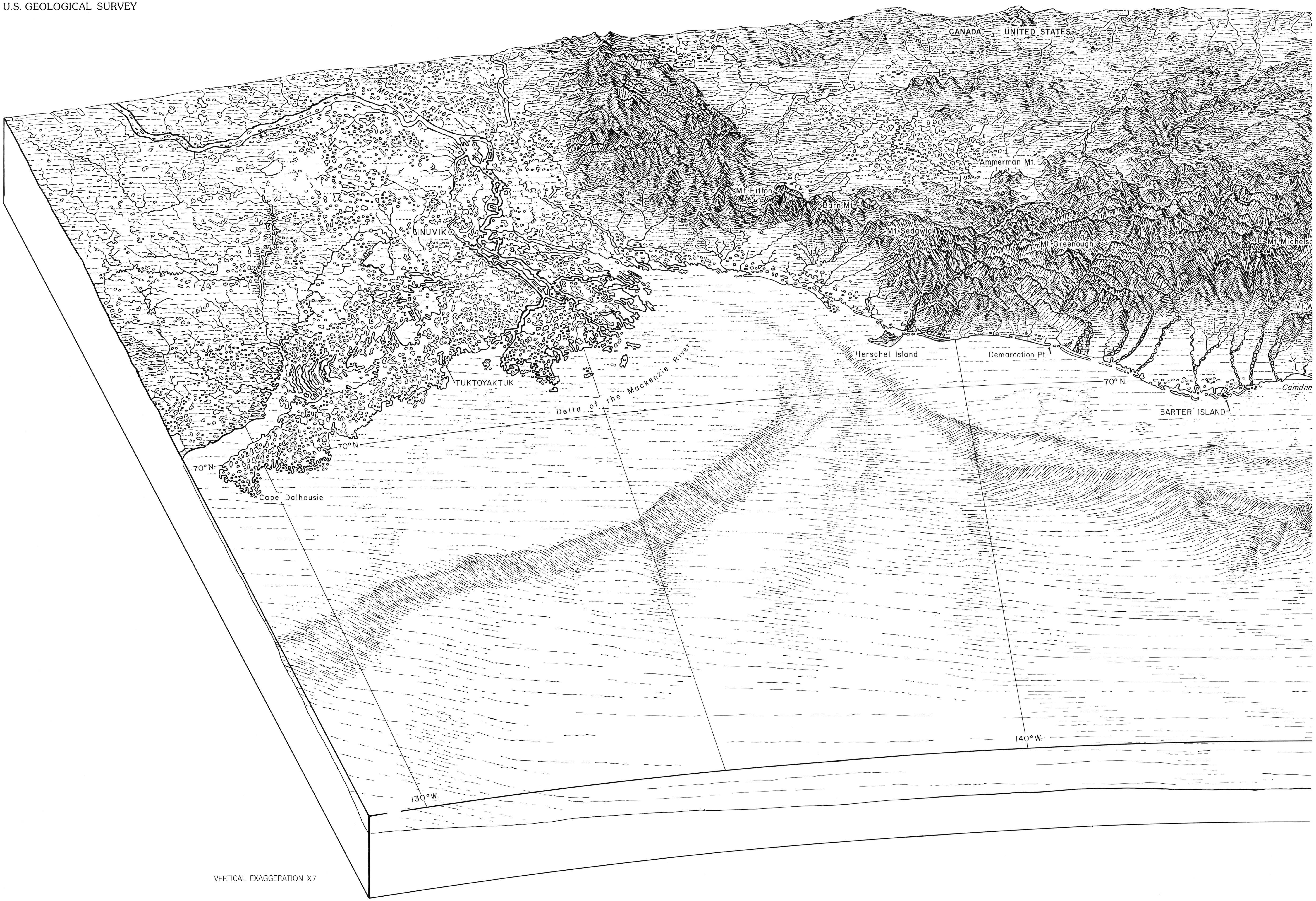
VERTICAL EXAGGERATION X3

VERTICAL SCALE, IN FEET
20,000
10,000
0
0
5
10
15
HORIZONTAL SCALE, IN MILES

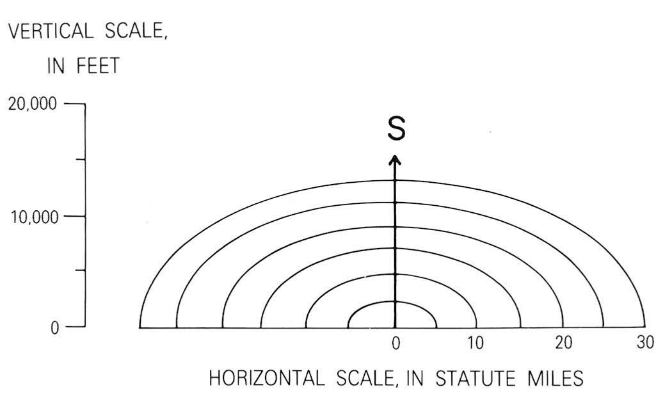
VERTICAL SCALE, IN METERS
5000
0
0
10
20
30
HORIZONTAL SCALE, IN KILOMETERS

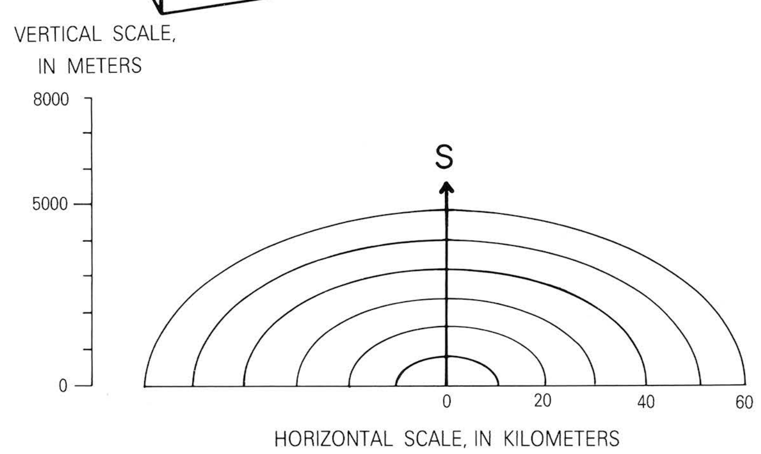
BARROW CANYON, ALASKA

By
Tau Rho Alpha, Stephen Eittreim, and James M. Morley
1981



14



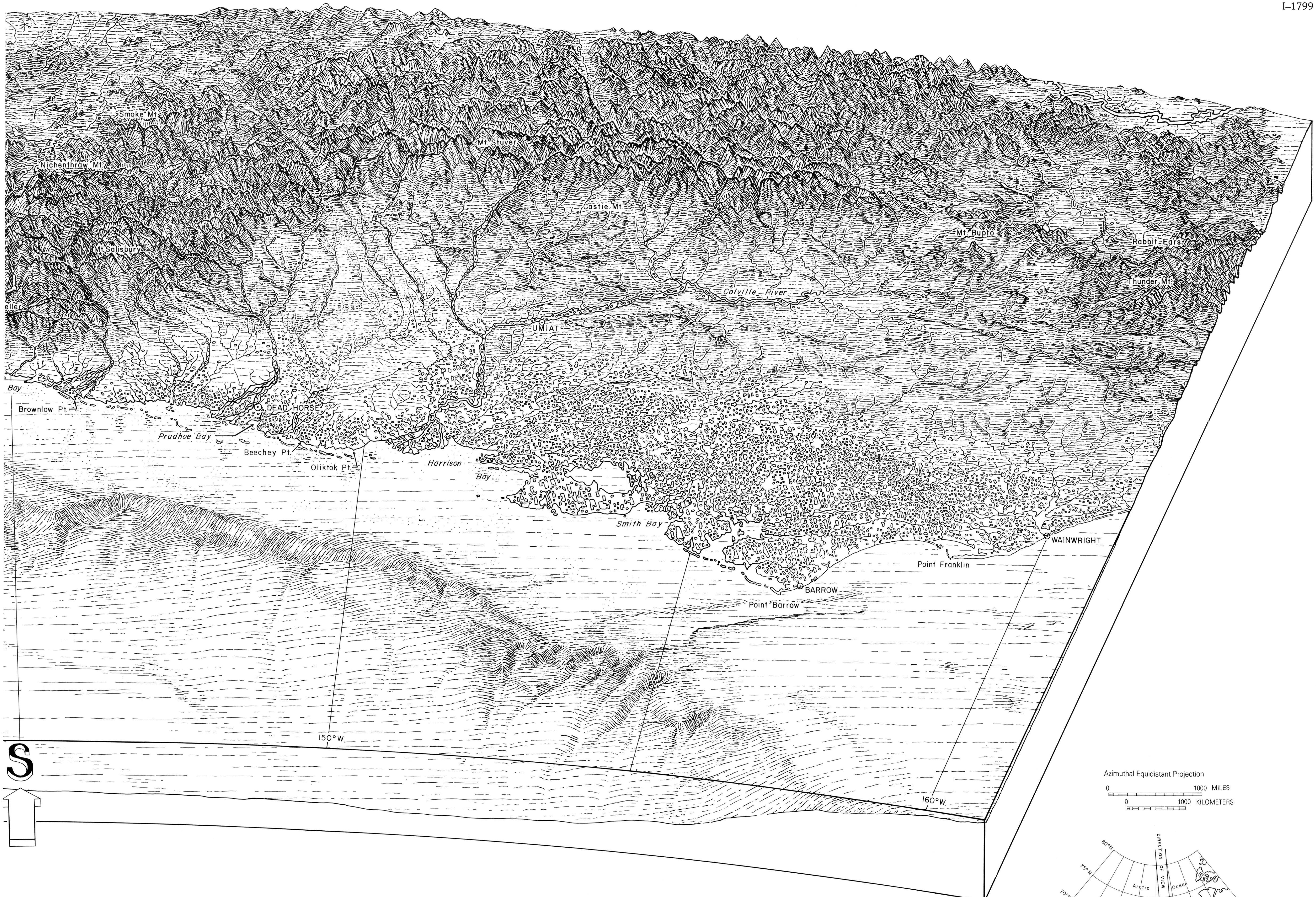


OBLIQUE MAP OF THE BEAUFORT SEA AND THE BROOKS RANGE OF ALASKA

By

Tau Rho Alpha and Marybeth Gerin

1980

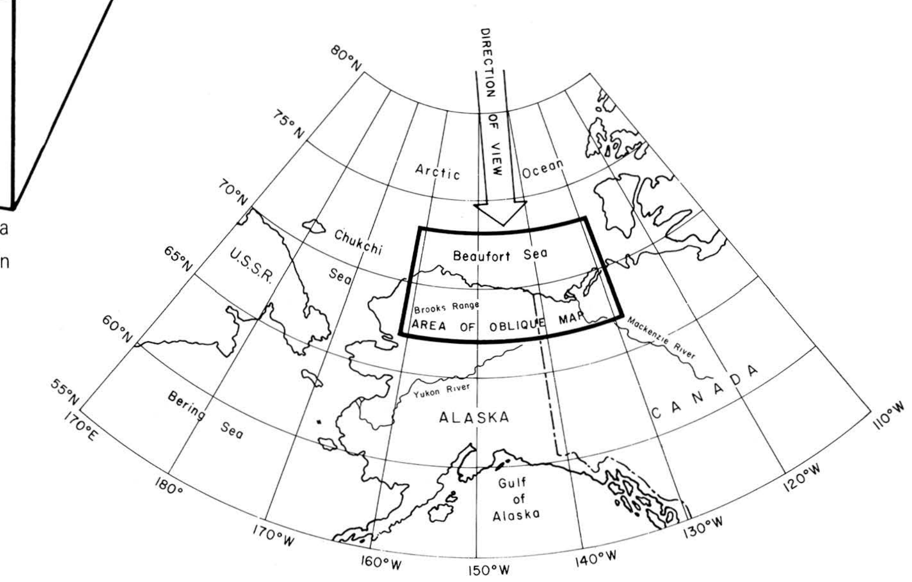


Azimuthal Equidistant Projection

0 1000 MILES

0 1000 KILOMETERS

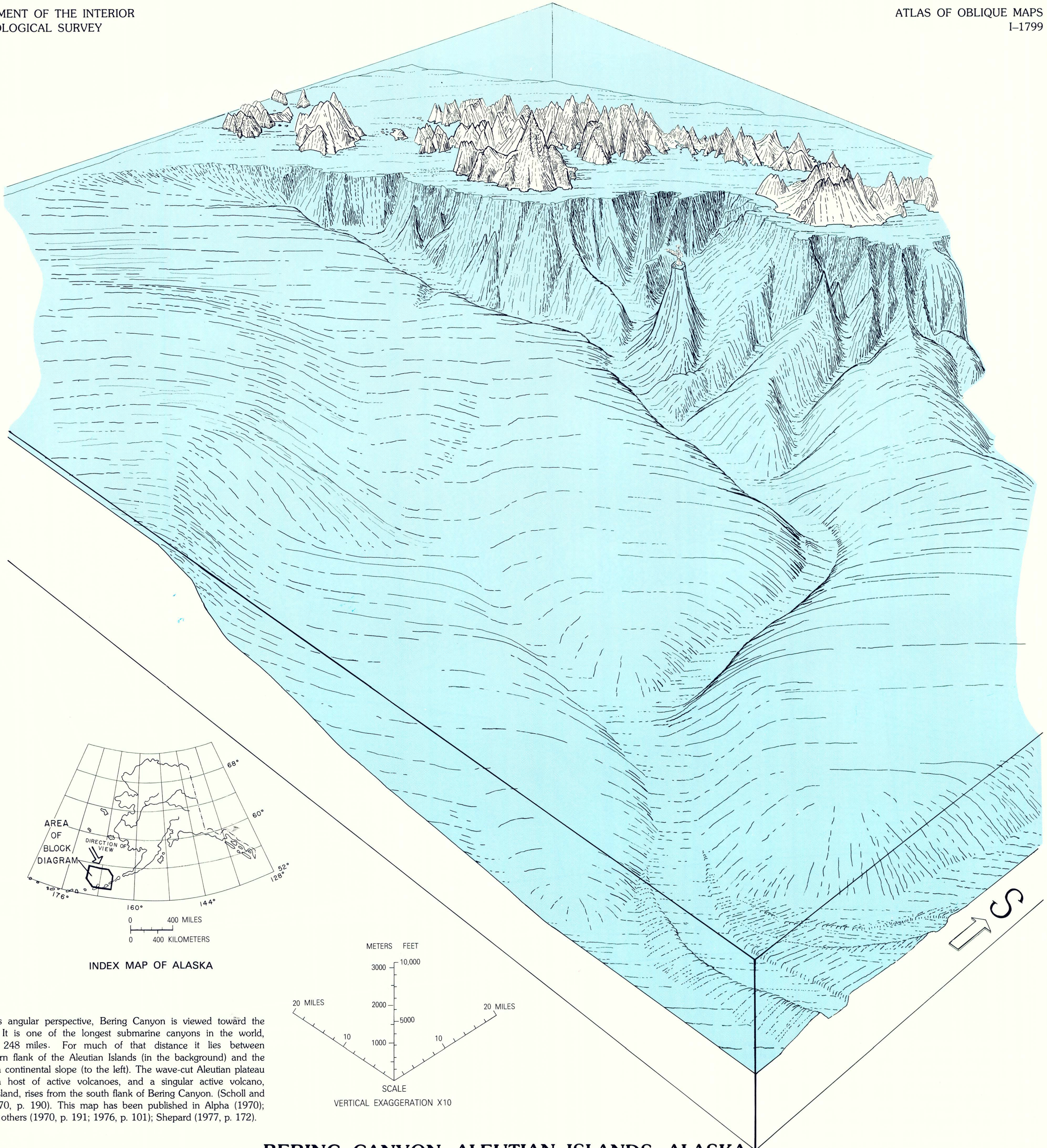
Onshore physiography by Tau Rho Alpha
Offshore physiography by Marybeth Gerin



INDEX MAP

This sweeping southerly view of the North Slope of Alaska and neighboring Canada includes the Mackenzie River, near the left edge of the map, and the Brooks Range, which extends from the center to the right edge of the map. The shelf and slope of the Beaufort Sea from the Mackenzie River delta to past Point Barrow and the Barrow submarine canyon are depicted in the foreground.

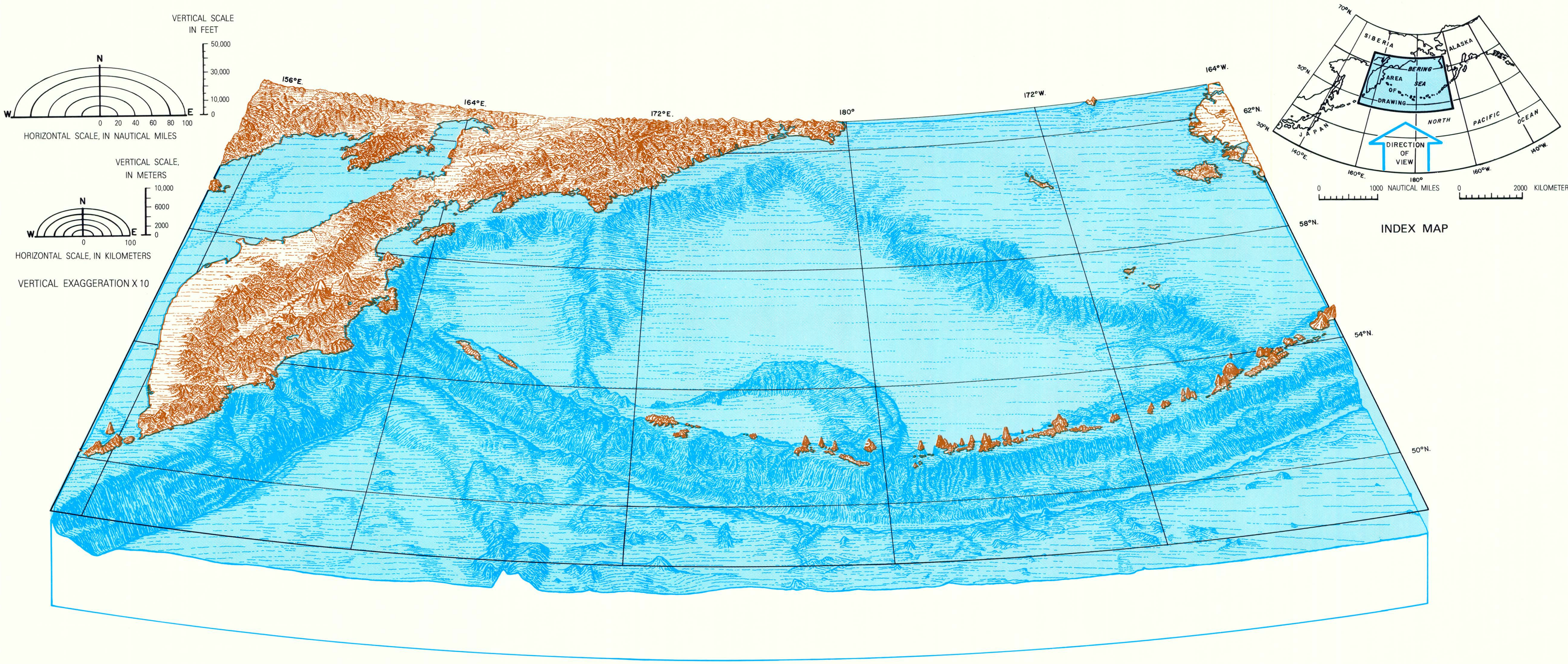
Thousands of rectangular lakes, which generally are oriented with the long axes approximately 10° west of north, dot the arctic coastal plain (Shepard and Wanless, 1971, p. 485). Behind them, sedimentary rocks are deformed into long linear folds to produce the arctic foothills. Dominating the scene are the rugged glaciated ridges of the Brooks Range, formed from belts of sedimentary and volcanic rocks. This map has been published in Alpha and Gerin (1980a).



In this angular perspective, Bering Canyon is viewed toward the southeast. It is one of the longest submarine canyons in the world, measuring 248 miles. For much of that distance it lies between the northern flank of the Aleutian Islands (in the background) and the Bering Sea continental slope (to the left). The wave-cut Aleutian plateau supports a host of active volcanoes, and a singular active volcano, Bogoslof Island, rises from the south flank of Bering Canyon. (Scholl and others, 1970, p. 190). This map has been published in Alpha (1970); Scholl and others (1970, p. 191; 1976, p. 101); Shepard (1977, p. 172).

BERING CANYON, ALEUTIAN ISLANDS, ALASKA

By
Tau Rho Alpha
1970



INDEX MAP

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This view of the Earth's crust takes in most of the Bering Sea, which is named for Vitus Bering, a Danish navigator who sailed on it in 1728. The sea is bounded on the south by the Aleutian Island arc and Aleutian Trench (foreground), on the west by Kamchatka Peninsula, to the north by Siberia, and on the east by Alaska. The delta of the Yukon River can be seen in the upper right corner. Offshore from the Siberia is Shirshov Ridge, which extends southward (left center) to nearly touch the tight curve of Bowers Ridge, which joins the Aleutian Island arc near the center of the map.

The Pacific plate, represented by the ocean floor south of the Aleutian Island arc and Aleutian Trench, is believed to underthrust the North American plate at the arc's east end (Marlow and others, 1973, p. 1555). At the arc's west end, however, the Pacific plate appears to be sliding west past the North American plate and to underthrust the Eurasian continental margin, resulting in the Kuril Trench (lower left corner) (Buffington, 1973, p. 180). This map has been published in Alpha (1974b); Scholl and others (1974).

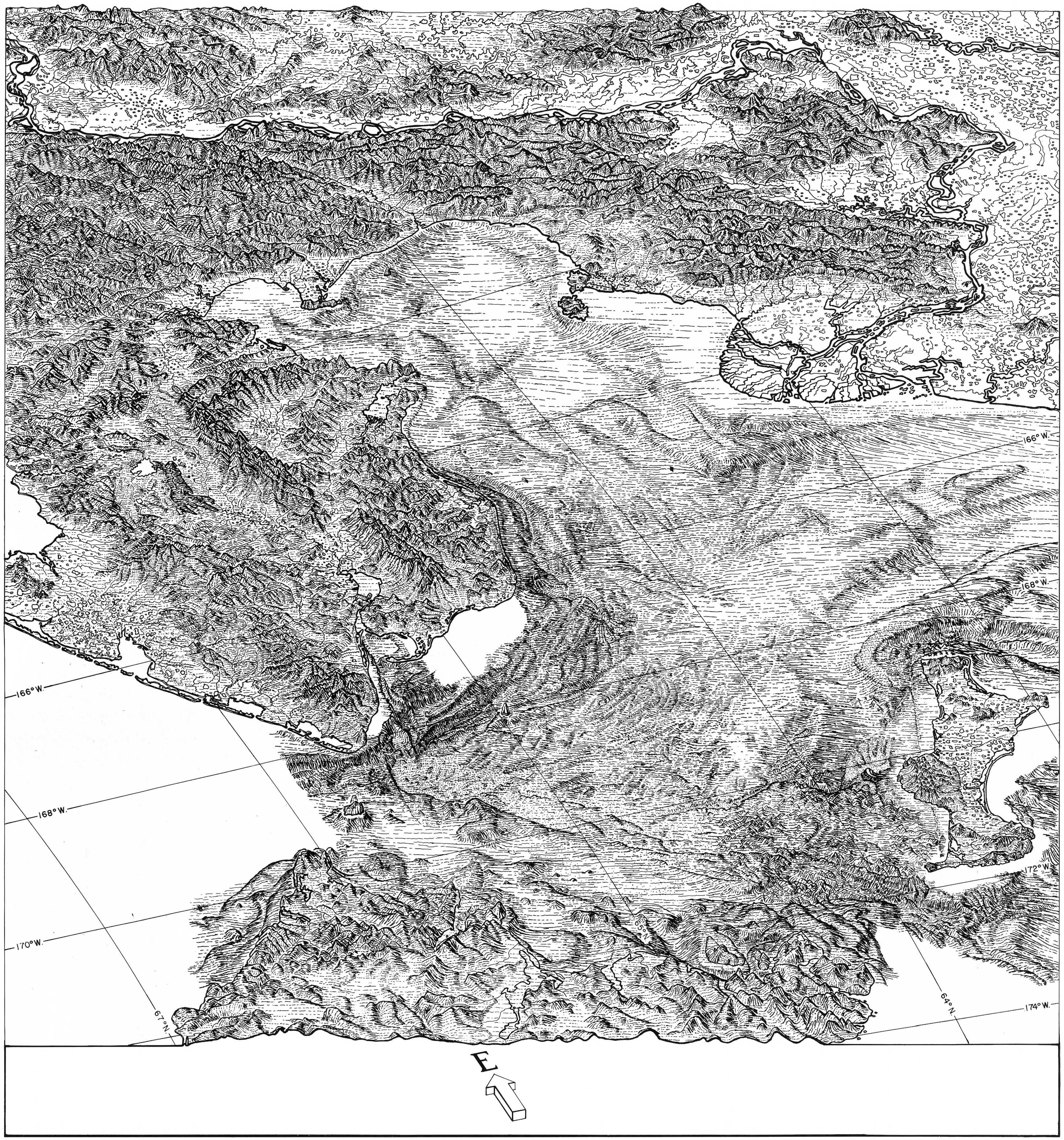
OBLIQUE MAP OF THE BERING SEA

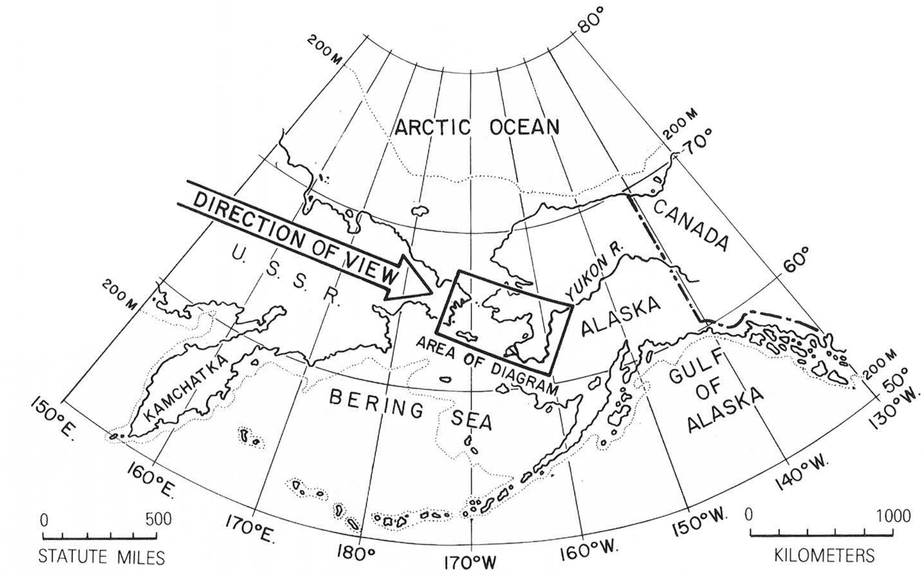
By

Tau Rho Alpha

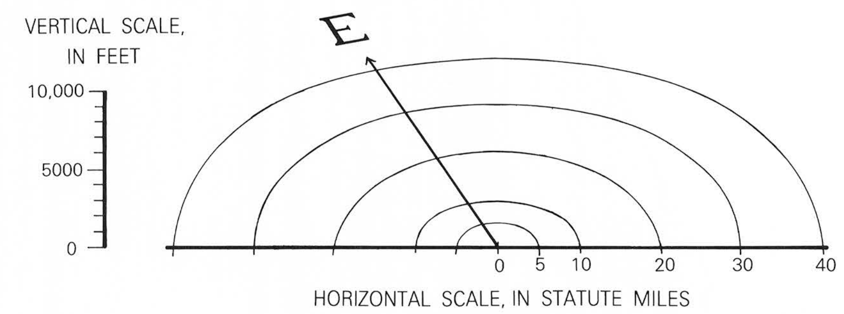
1974

18



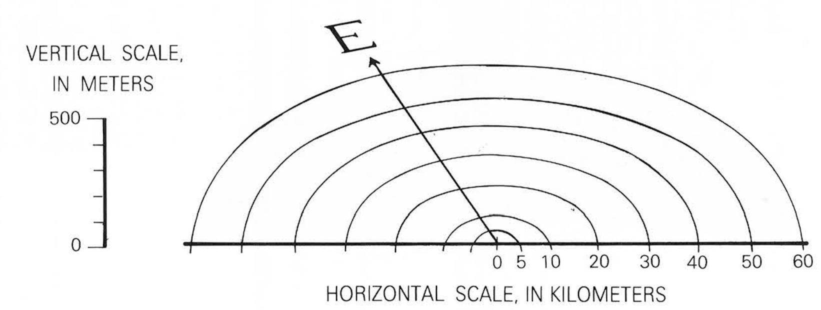


INDEX MAP



LAND

VERTICAL EXAGGERATION X 10



OCEAN

VERTICAL EXAGGERATION X 50

This oblique map is unique because of the extreme vertical exaggeration (X50) used for underwater features compared to the vertical exaggeration used for features on land (X10). The view is southeast over the tip of Siberia's Chukotka Peninsula toward the west coast of Alaska, where Norton Sound is located at the center of the map. At the left is the Seward Peninsula, at the upper right the Yukon River delta, and at the lower right St. Lawrence Island forms the southern end of the Chirikov Basin.

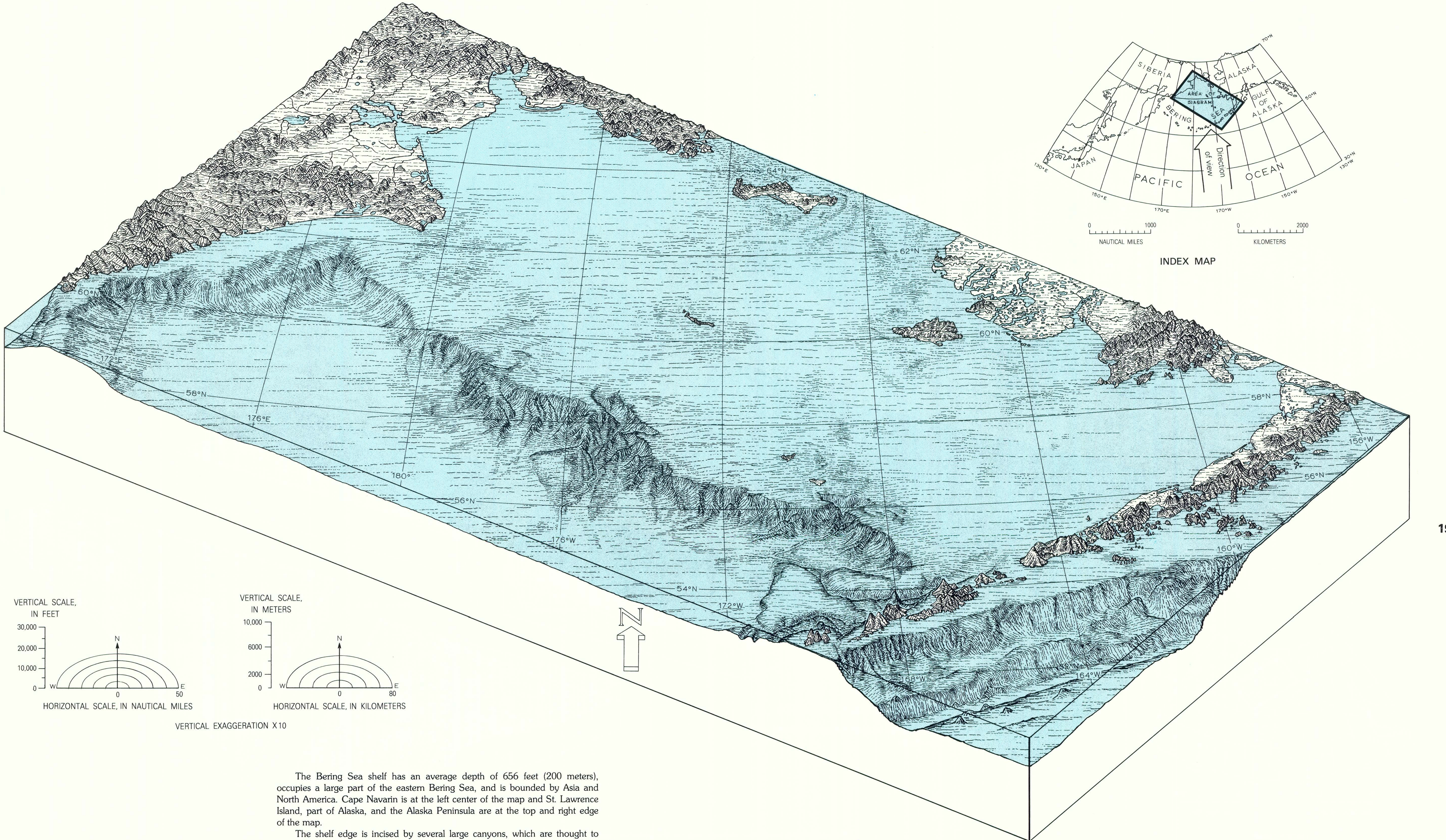
Uncharted offshore areas are blank regions on this oblique map. The offshore underwater features were formed by glacial erosion and depositional processes during periods of lower sea level, and now they are being changed by submarine erosion and deposition. During the last ice age approximately 20,000 years ago, land was exposed between the Chukotka and Seward Peninsulas, enabling migrations between North America and Asia to take place. This map represents how this area looked at that time (Hopkins and others, 1976, p. B6). It has been published in Alpha (1972); Hopkins and others (1976, pl. 2).

NORTHERN BERING SEA

By

Tau Rho Alpha

1972



INDEX MAP

VERTICAL EXAGGERATION X10

The Bering Sea shelf has an average depth of 656 feet (200 meters), occupies a large part of the eastern Bering Sea, and is bounded by Asia and North America. Cape Navarin is at the left center of the map and St. Lawrence Island, part of Alaska, and the Alaska Peninsula are at the top and right edge of the map.

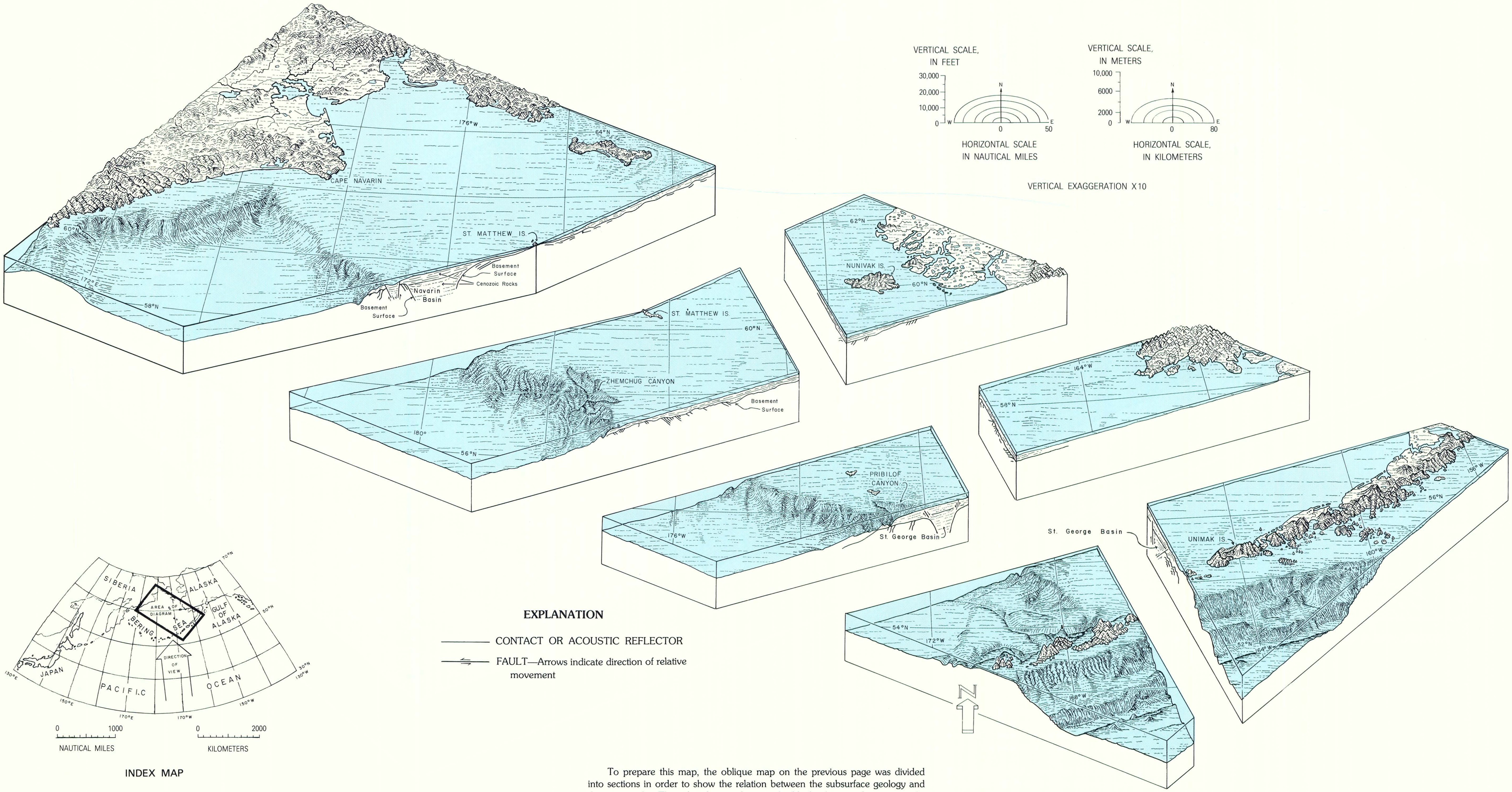
The shelf edge is incised by several large canyons, which are thought to have been eroded by ancestral rivers from Alaska during a time of lowered sea level (Scholl and others, 1970, p. 204).

This map was the basis for two derivative oblique maps of the Bering Sea shelf that are shown on the following two pages. This map has been published in Marlow and others (1975).

PHYSIOGRAPHY

BERING SEA SHELF, ALASKA

By
Tau Rho Alpha
1975



INDEX MAP

EXPLANATION

CONTACT OR ACOUSTIC REFLECTOR

FAULT—Arrows indicate direction of relative movement

To prepare this map, the oblique map on the previous page was divided into sections in order to show the relation between the subsurface geology and the topography. The subsurface geology on the blocks shows sedimentary rocks that are younger than 65 million years lying on top of older pre-Tertiary basement rocks (Marlow and others, 1975, sheet 2). See also the map on the next page. This map has been published in Marlow and others (1975).

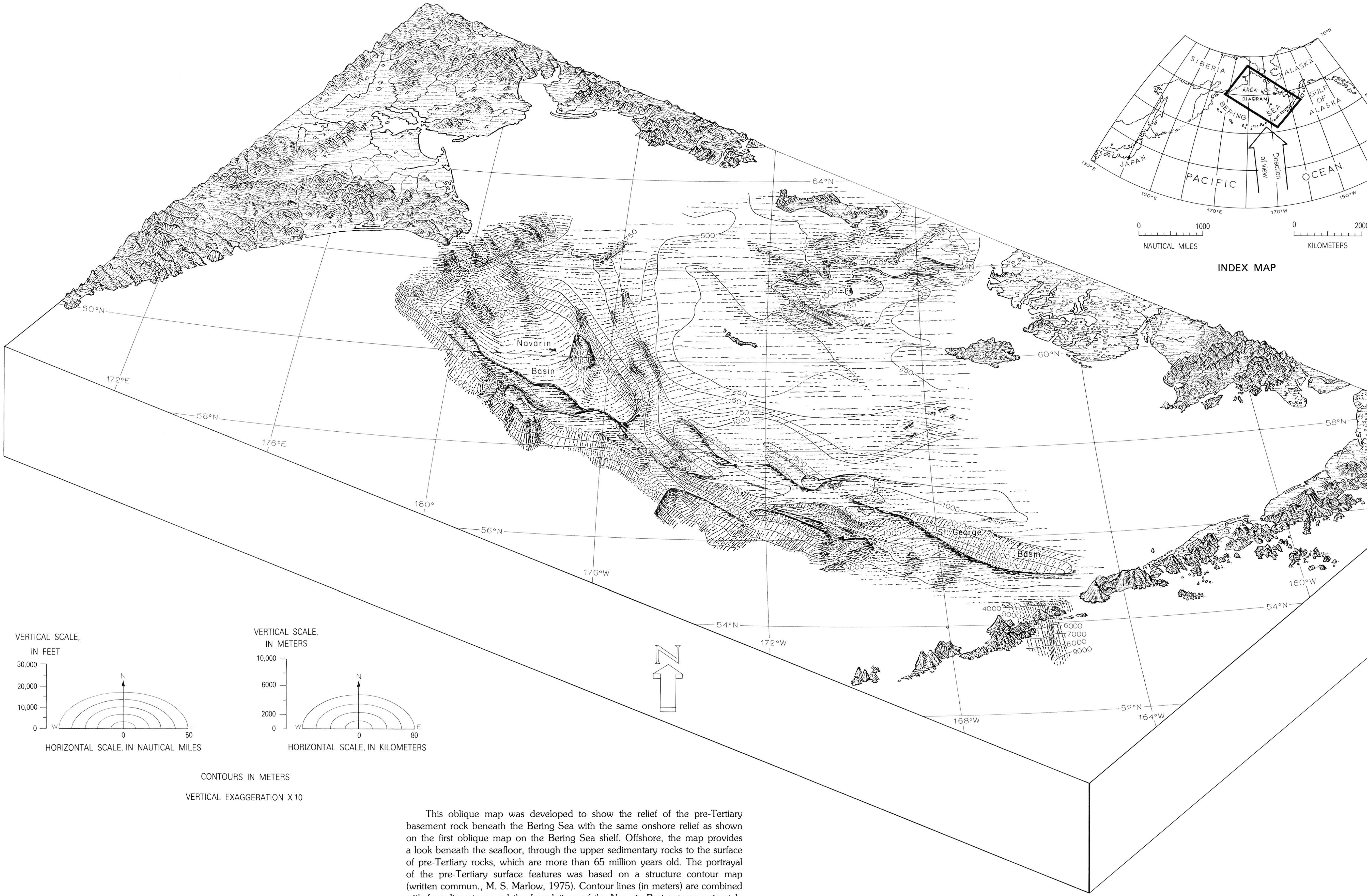
PHYSIOGRAPHY AND CROSS SECTIONS

BERING SEA SHELF, ALASKA

By

M. S. Marlow, T. R. Alpha, D. W. Scholl, and E. C. Buffington

1975



CONTOURS IN METERS

VERTICAL EXAGGERATION X 10

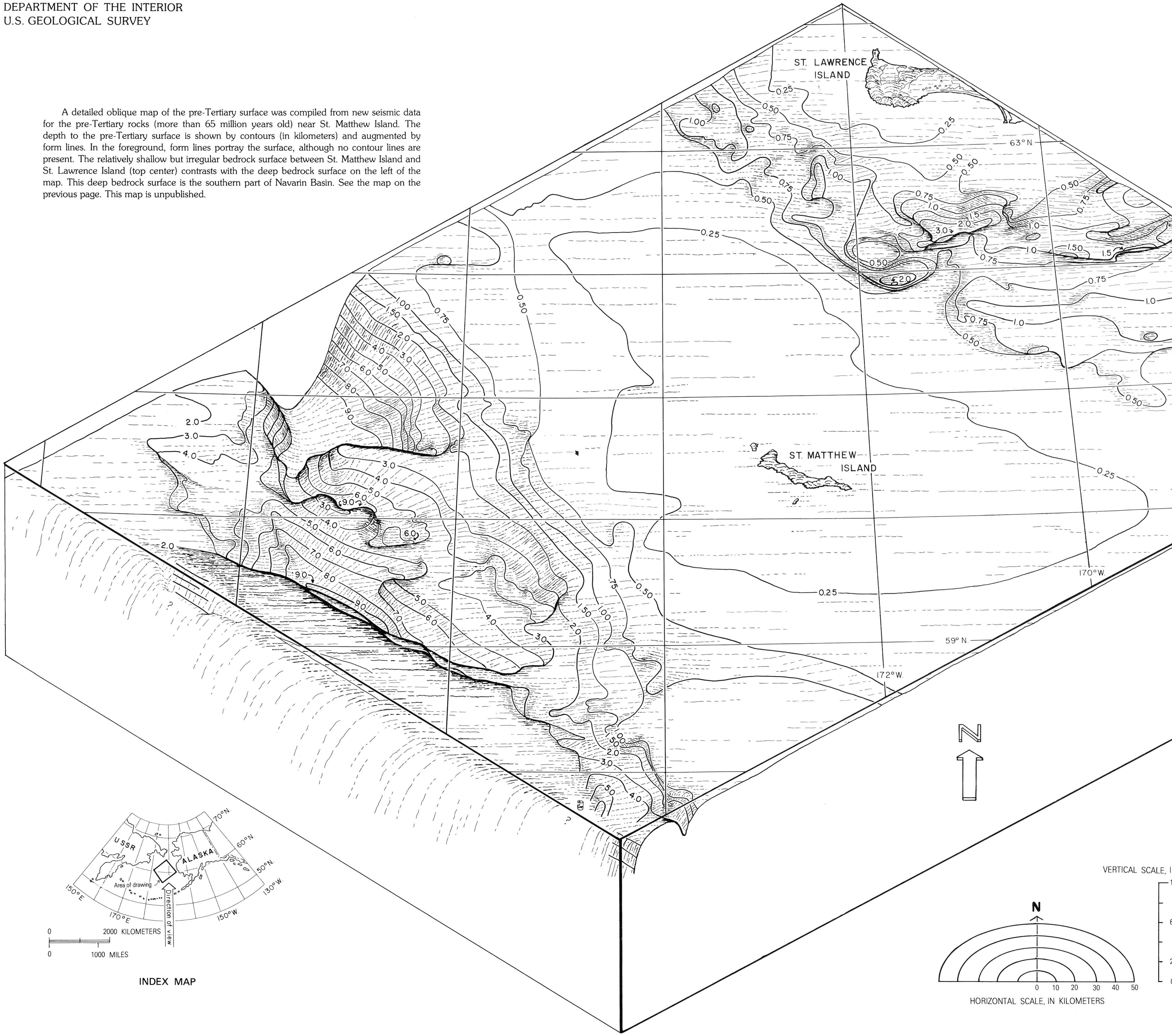
This oblique map was developed to show the relief of the pre-Tertiary basement rock beneath the Bering Sea with the same onshore relief as shown on the first oblique map on the Bering Sea shelf. Offshore, the map provides a look beneath the seafloor, through the upper sedimentary rocks to the surface of pre-Tertiary rocks, which are more than 65 million years old. The portrayal of the pre-Tertiary surface features was based on a structure contour map (written commun., M. S. Marlow, 1975). Contour lines (in meters) are combined with form lines to reveal the foundations of the Navarin Basin at approximately 19,678 feet (6,000 meters) and the St. George Basin at approximately 16,404 feet (5,000 meters) below sea level. For more information on the Navarin Basin see the oblique map on the following page. This map has been published in Marlow and others (1975).

PRE-TERTIARY ROCKS
BERING SEA SHELF, ALASKA

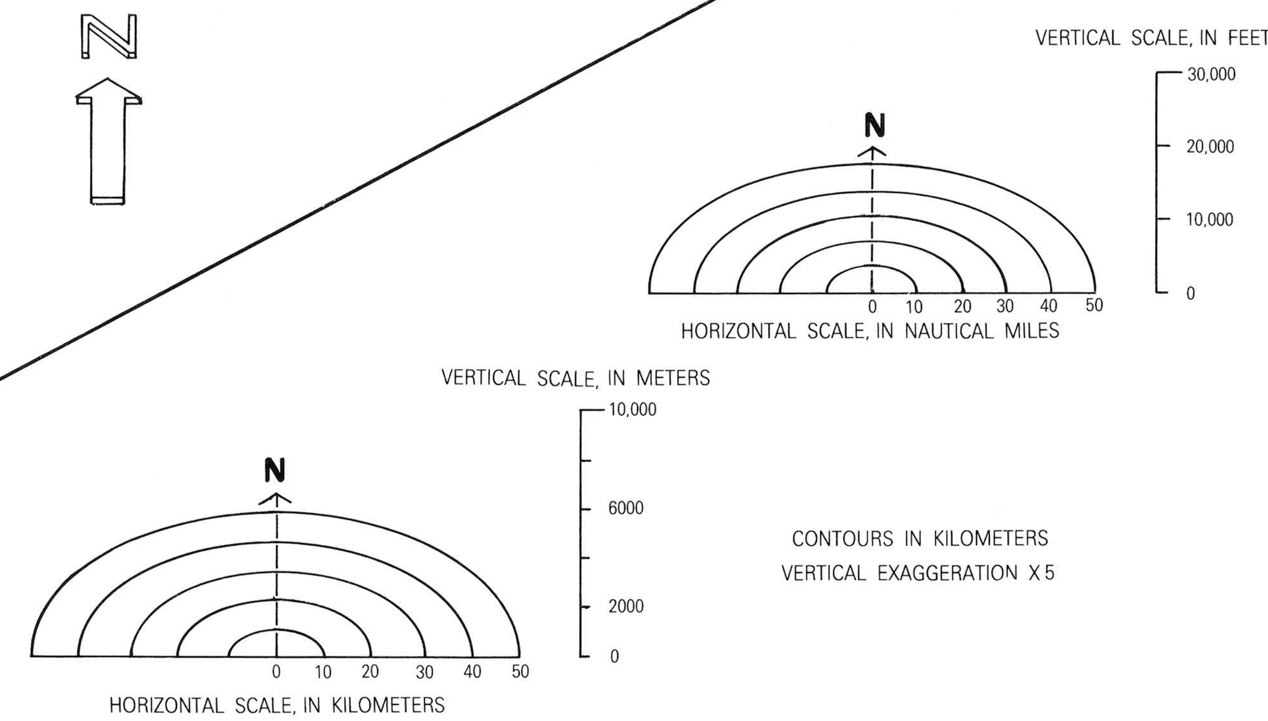
By
M. S. Marlow, T. R. Alpha, D. W. Scholl, and E. C. Buffington

1975

A detailed oblique map of the pre-Tertiary surface was compiled from new seismic data for the pre-Tertiary rocks (more than 65 million years old) near St. Matthew Island. The depth to the pre-Tertiary surface is shown by contours (in kilometers) and augmented by form lines. In the foreground, form lines portray the surface, although no contour lines are present. The relatively shallow but irregular bedrock surface between St. Matthew Island and St. Lawrence Island (top center) contrasts with the deep bedrock surface on the left of the map. This deep bedrock surface is the southern part of Navarin Basin. See the map on the previous page. This map is unpublished.



INDEX MAP



CONTOURS IN KILOMETERS
VERTICAL EXAGGERATION X5

PRE-TERTIARY ROCKS

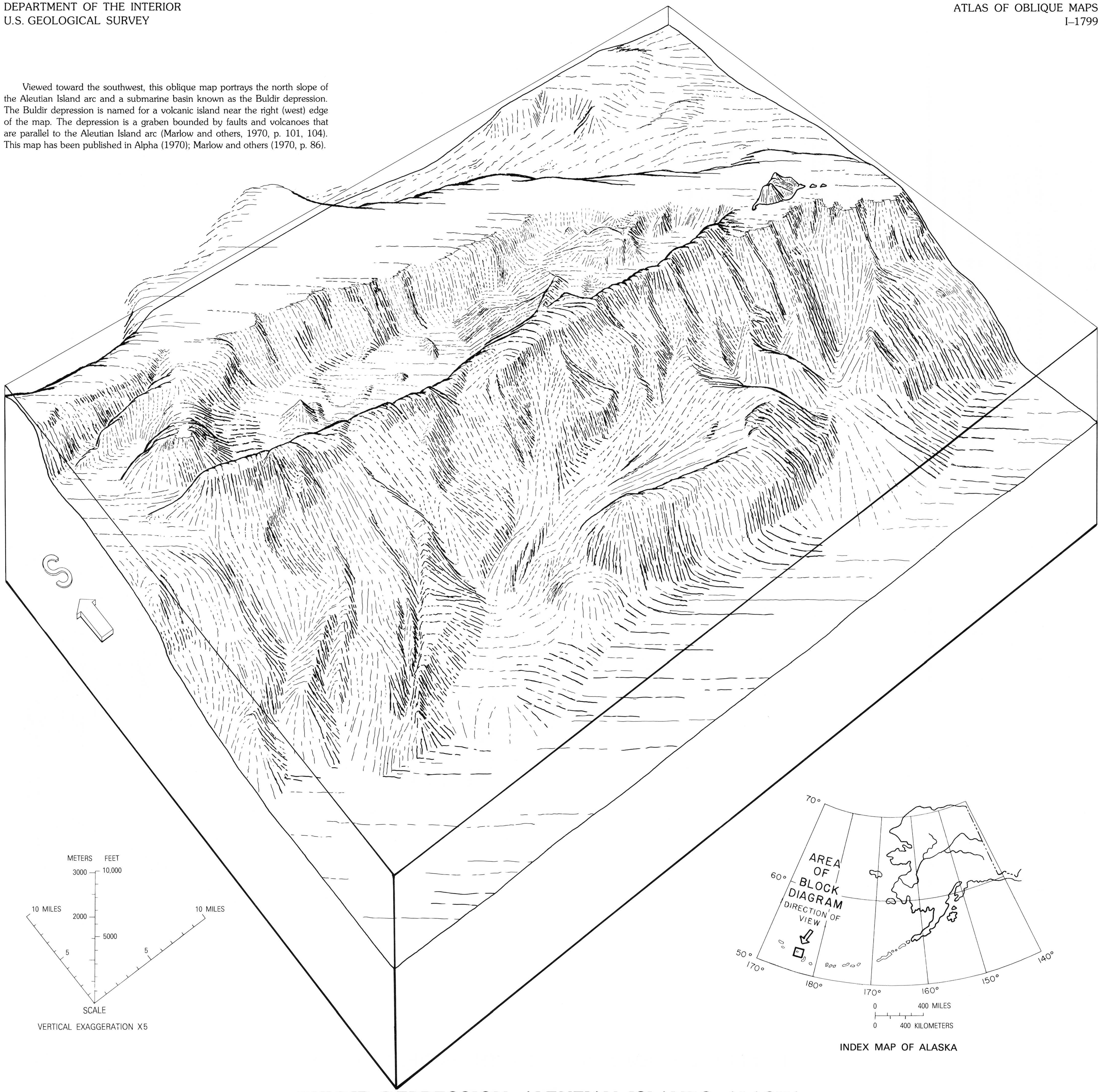
SOUTHERN BERING SEA SHELF, ALASKA

By

M. S. Marlow, Tau Rho Alpha, A. K. Cooper, and D. W. Scholl

1976

Viewed toward the southwest, this oblique map portrays the north slope of the Aleutian Island arc and a submarine basin known as the Buldir depression. The Buldir depression is named for a volcanic island near the right (west) edge of the map. The depression is a graben bounded by faults and volcanoes that are parallel to the Aleutian Island arc (Marlow and others, 1970, p. 101, 104). This map has been published in Alpha (1970); Marlow and others (1970, p. 86).

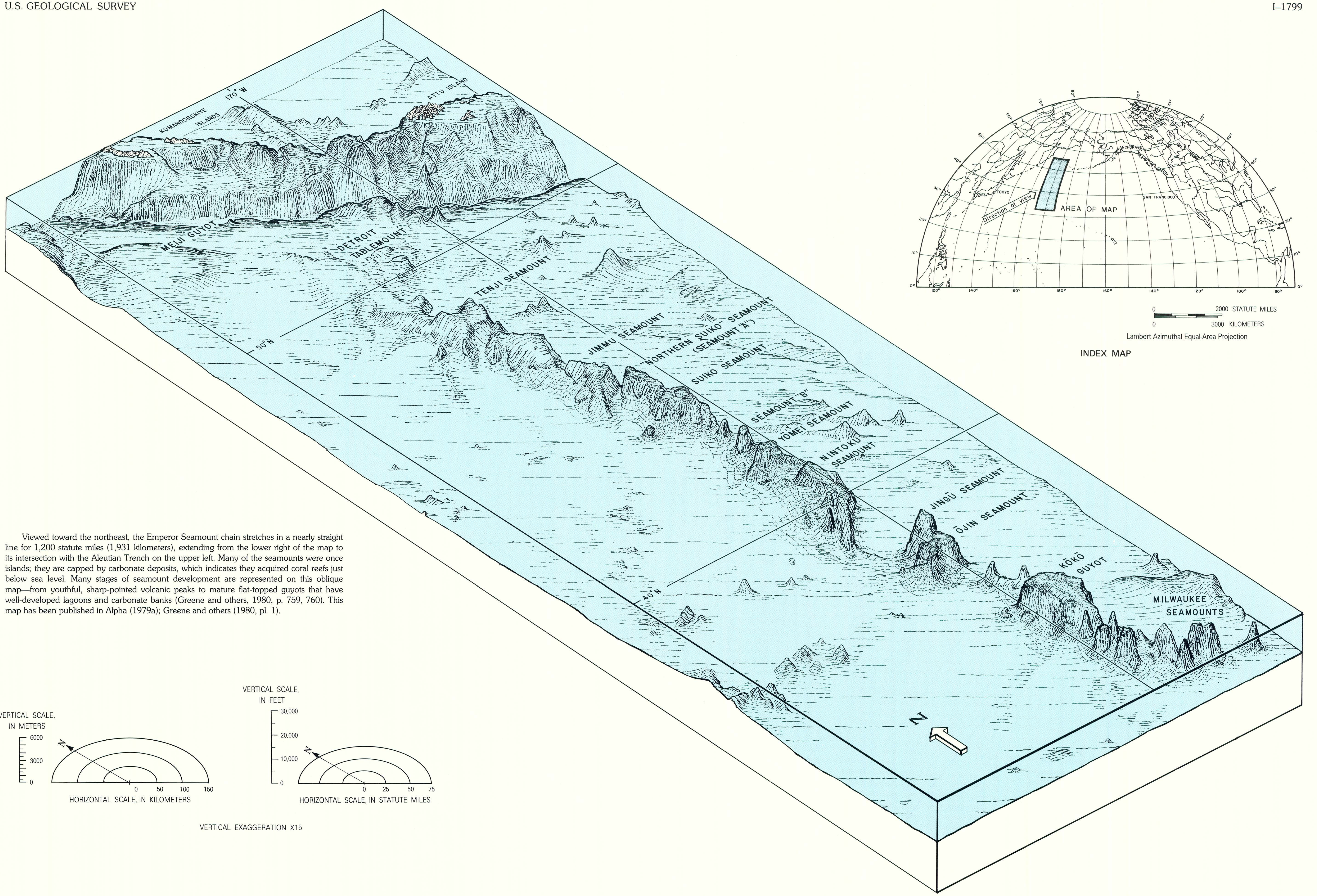


SCALE
VERTICAL EXAGGERATION X5

INDEX MAP OF ALASKA

BULDIR DEPRESSION, ALEUTIAN ISLANDS, ALASKA

By
Tau Rho Alpha
1970



INDEX MAP

Viewed toward the northeast, the Emperor Seamount chain stretches in a nearly straight line for 1,200 statute miles (1,931 kilometers), extending from the lower right of the map to its intersection with the Aleutian Trench on the upper left. Many of the seamounts were once islands; they are capped by carbonate deposits, which indicates they acquired coral reefs just below sea level. Many stages of seamount development are represented on this oblique map—from youthful, sharp-pointed volcanic peaks to mature flat-topped guyots that have well-developed lagoons and carbonate banks (Greene and others, 1980, p. 759, 760). This map has been published in Alpha (1979a); Greene and others (1980, pl. 1).

VERTICAL SCALE, IN METERS

6000 3000 0

0 50 100 150

HORIZONTAL SCALE, IN KILOMETERS

VERTICAL SCALE, IN FEET

30,000 20,000 10,000 0

0 25 50 75

HORIZONTAL SCALE, IN STATUTE MILES

VERTICAL EXAGGERATION X15

EMPEROR SEAMOUNTS, NORTH PACIFIC OCEAN

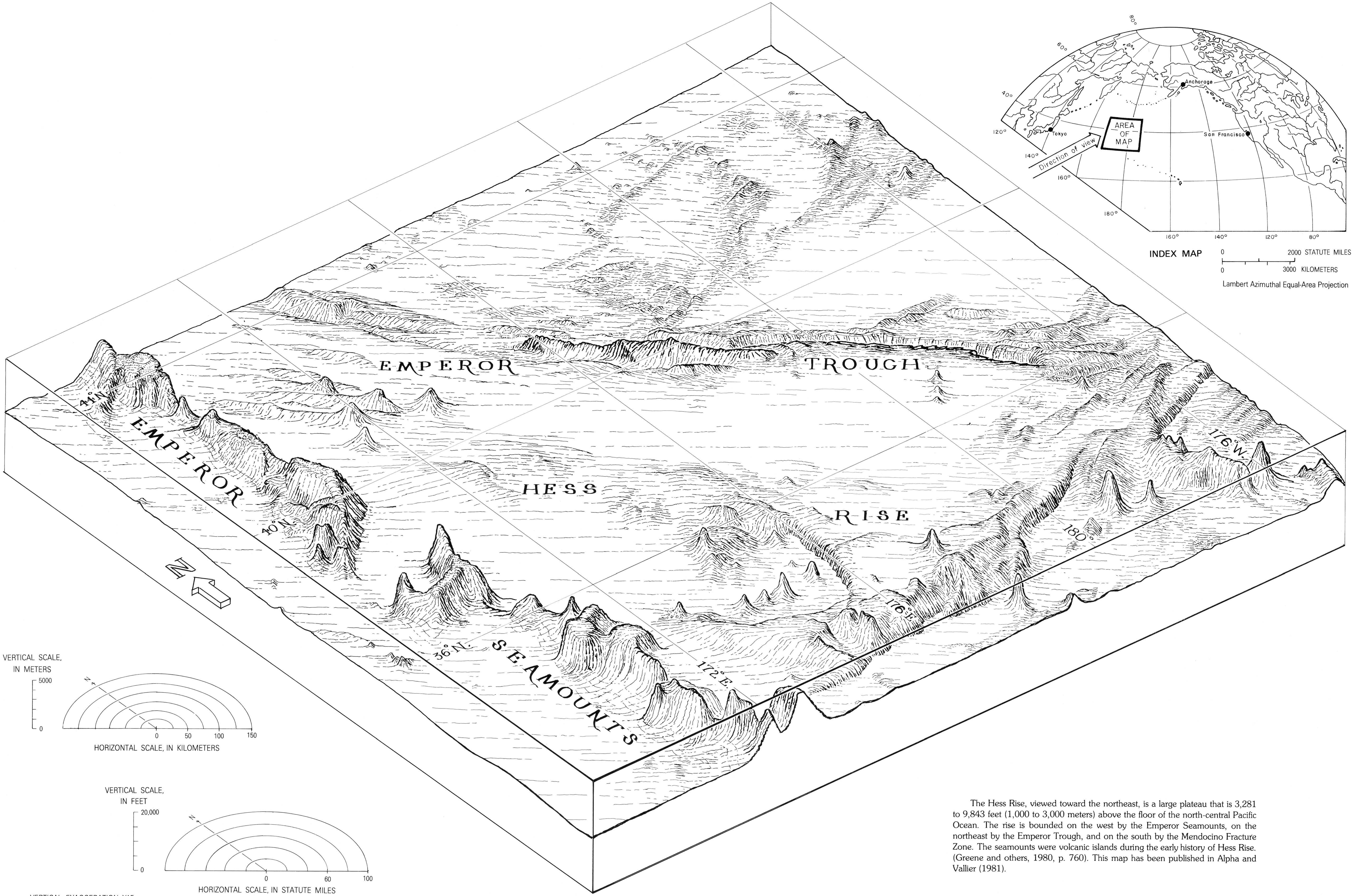
By

Tau Rho Alpha

1979

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

ATLAS OF OBLIQUE MAPS
I–1799



INDEX MAP

0 2000 STATUTE MILES
0 3000 KILOMETERS

Lambert Azimuthal Equal-Area Projection

25

VERTICAL SCALE,
IN METERS

HORIZONTAL SCALE, IN KILOMETERS

VERTICAL SCALE,
IN FEET

HORIZONTAL SCALE, IN STATUTE MILES

VERTICAL EXAGGERATION X15

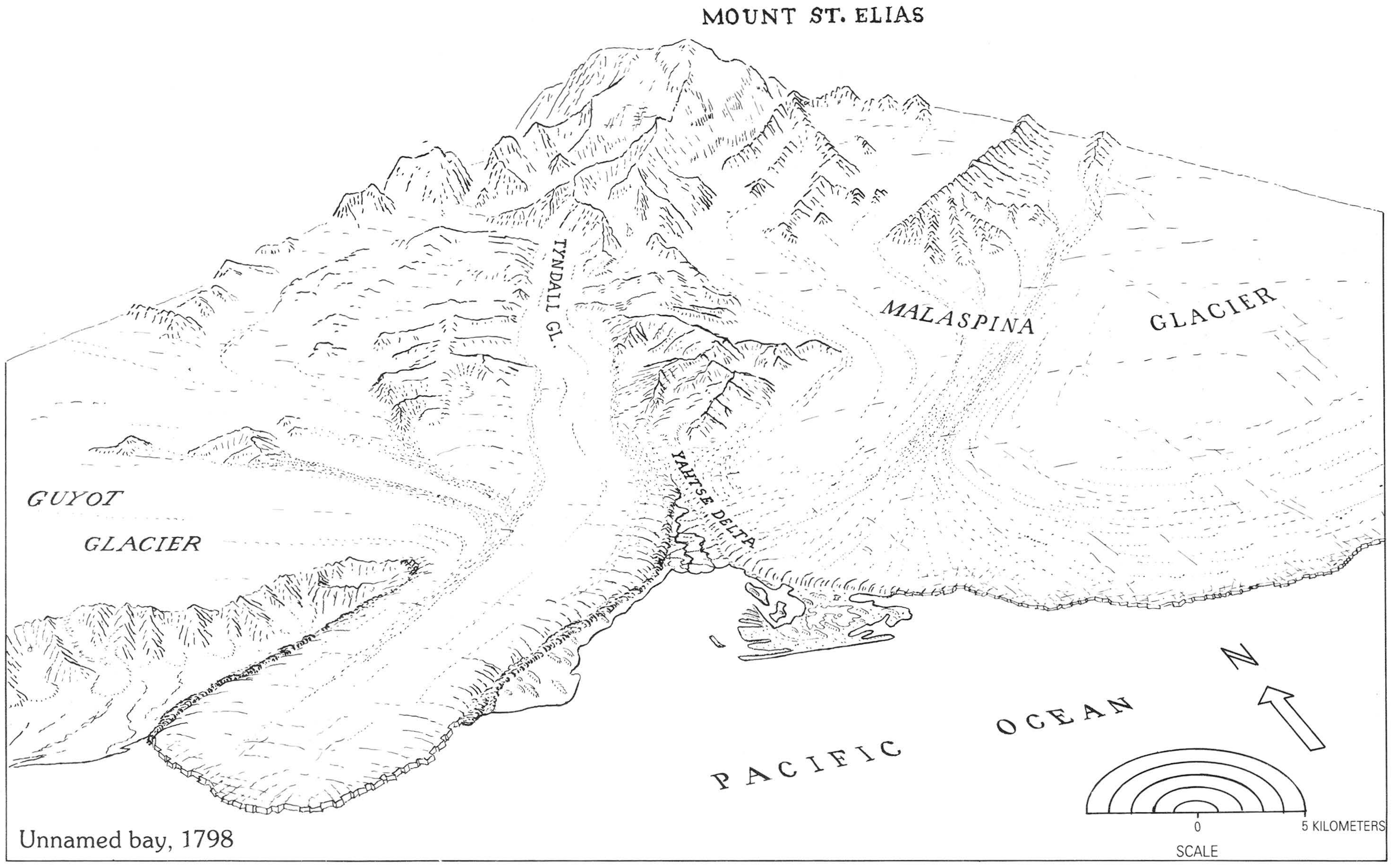
The Hess Rise, viewed toward the northeast, is a large plateau that is 3,281 to 9,843 feet (1,000 to 3,000 meters) above the floor of the north-central Pacific Ocean. The rise is bounded on the west by the Emperor Seamounts, on the northeast by the Emperor Trough, and on the south by the Mendocino Fracture Zone. The seamounts were volcanic islands during the early history of Hess Rise. (Greene and others, 1980, p. 760). This map has been published in Alpha and Vallier (1981).

OBLIQUE MAP OF HESS RISE AND VICINITY, NORTH-CENTRAL PACIFIC OCEAN

By
Tau Rho Alpha and T. L. Vallier

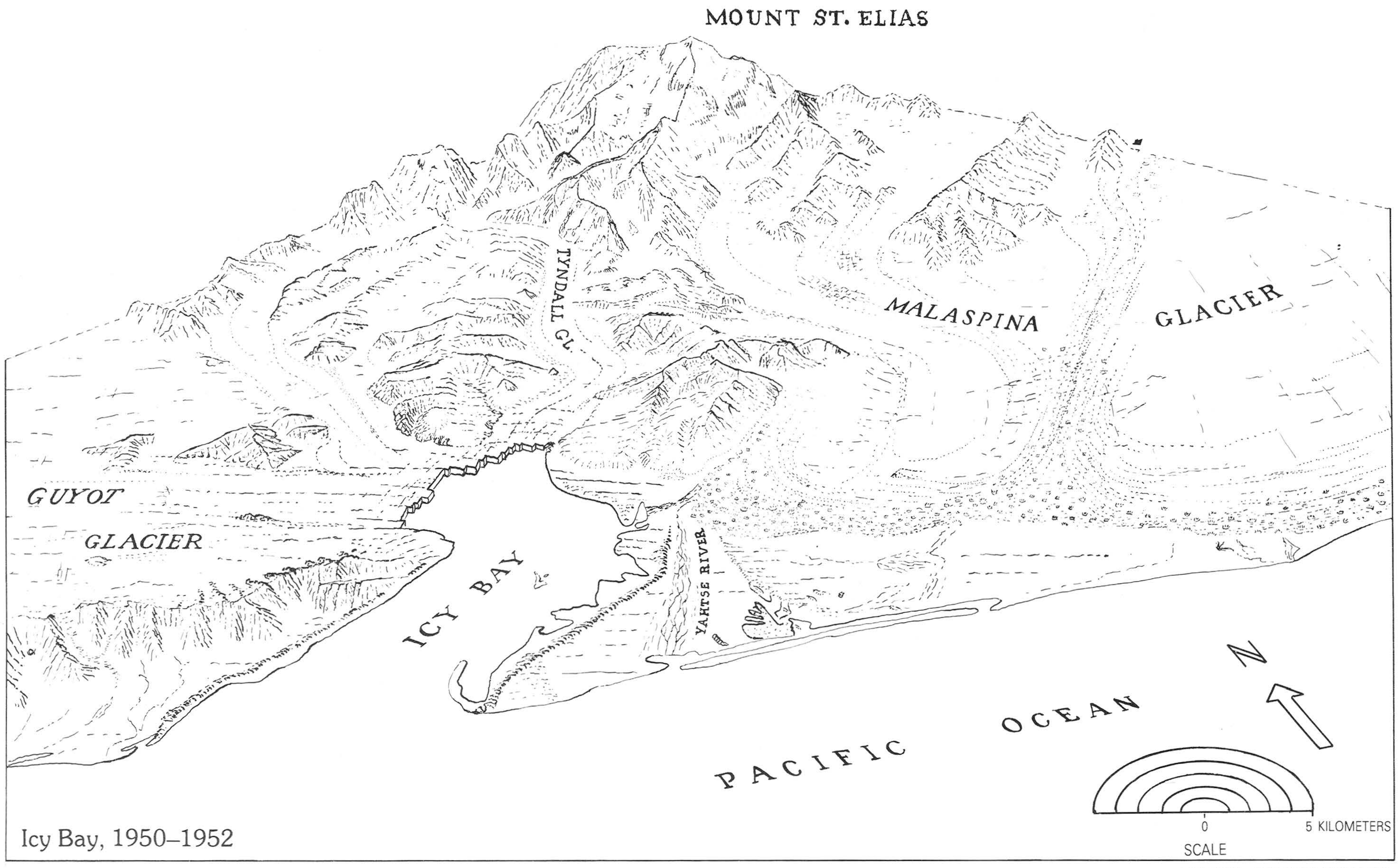
1981

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY



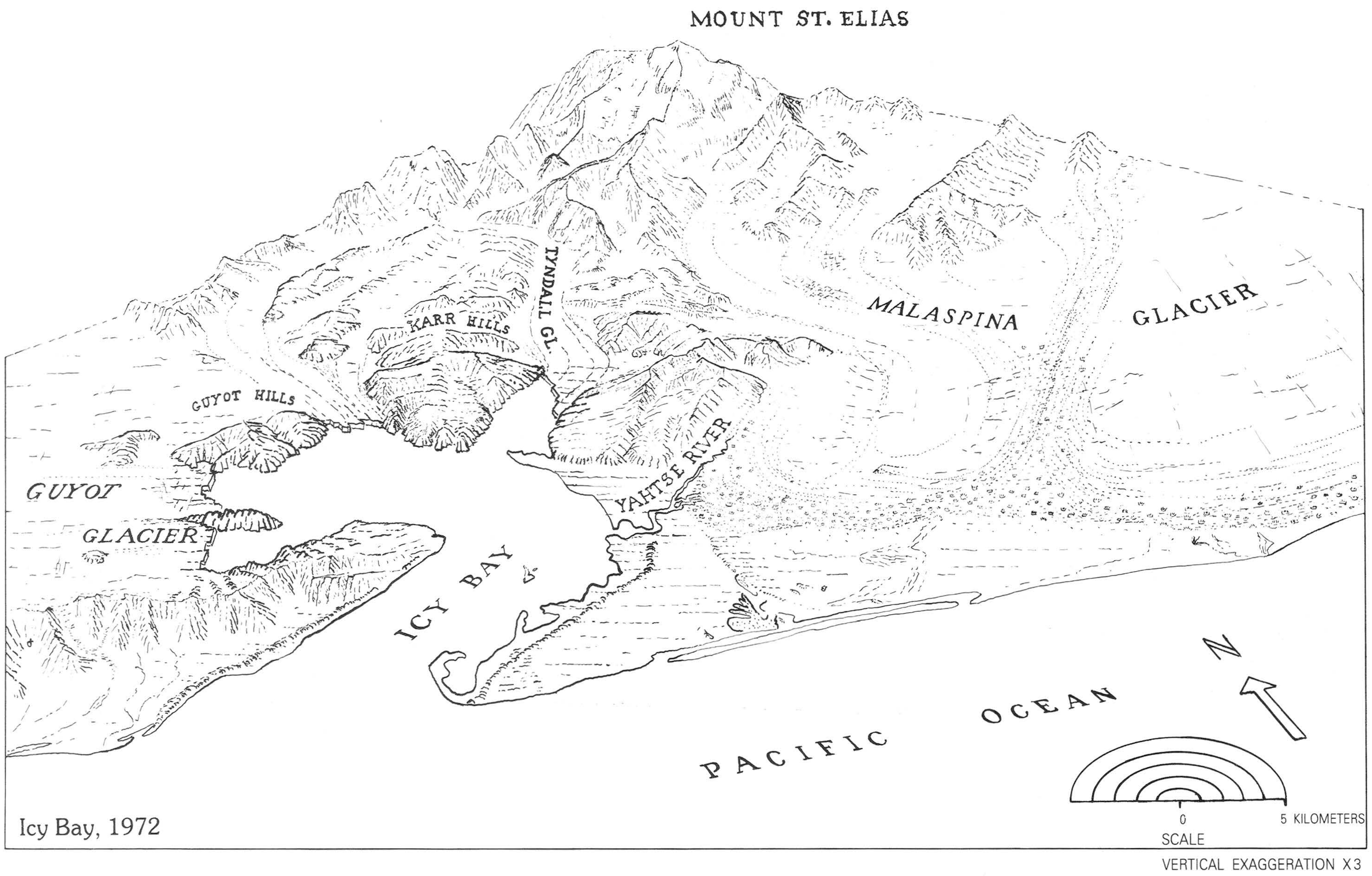
Unnamed bay, 1798

VERTICAL EXAGGERATION X3



Icy Bay, 1950–1952

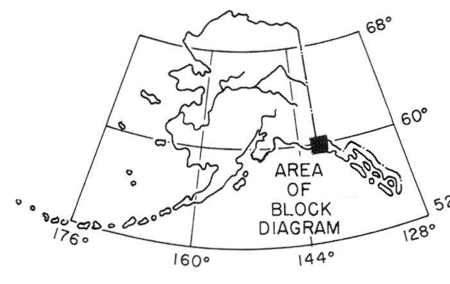
VERTICAL EXAGGERATION X3



Icy Bay, 1972

VERTICAL EXAGGERATION X3

This angular-perspective oblique map of Icy Bay and Mount St. Elias, viewed toward the northeast, demonstrates the use of oblique maps in a historical context. The coastline on the 1798 map is based on a sketch map made of George Vancouver's visit in 1794. Icy Bay in 1950–1952 is based on a U.S. Geological Survey 1:250,000-scale topographic map, and Icy Bay in 1972 shows the configuration of the bay as seen on LANDSAT imagery of September 21, 1972. These oblique maps illustrate the idea that Icy Bay developed in the past 175 years as the ice front of the Guyot an Tyndall glaciers receded. The maps also suggest that Vancouver observed a bay east of a glacier tongue that since has been filled with glacial outwash (Alpha, 1975, p. 4; Shepard and Wanless, 1971, p. 415). This map has been published in Alpha (1975, p. 6–7); Shepard (1977, p. 105); Shepard and Wanless (1971, p. 410).



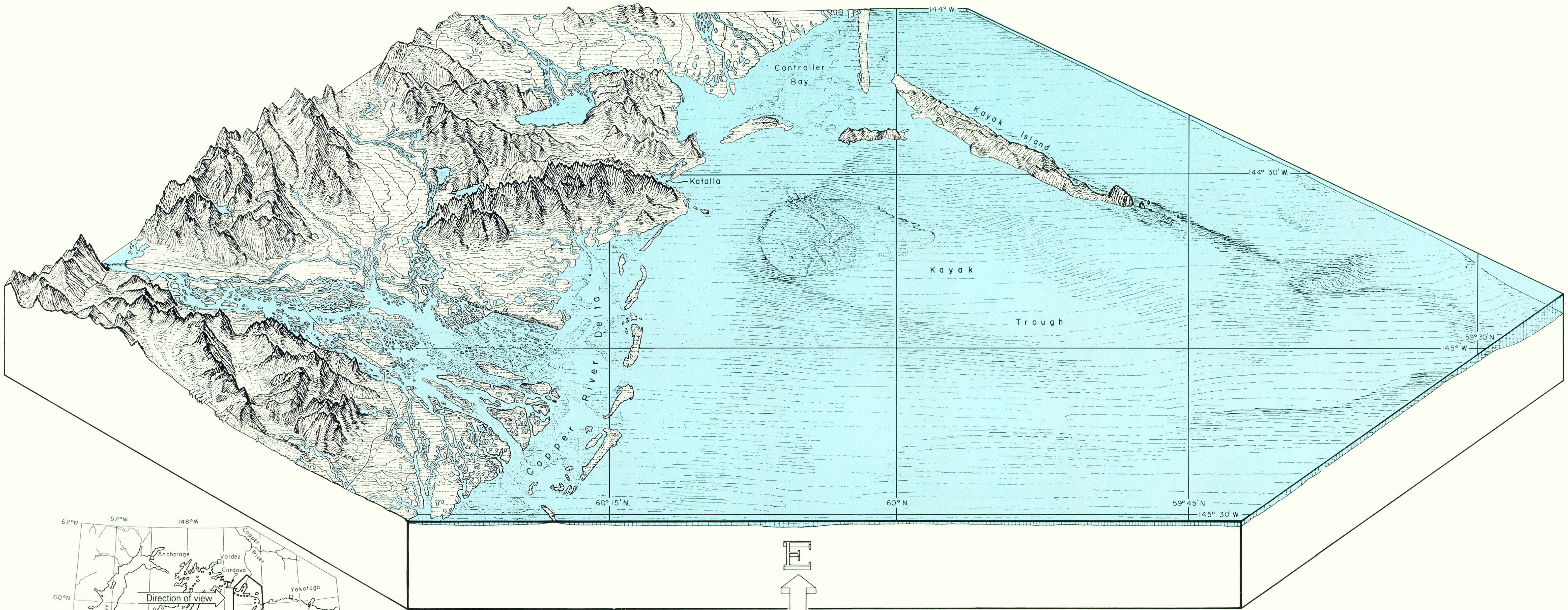
INDEX MAP OF ALASKA

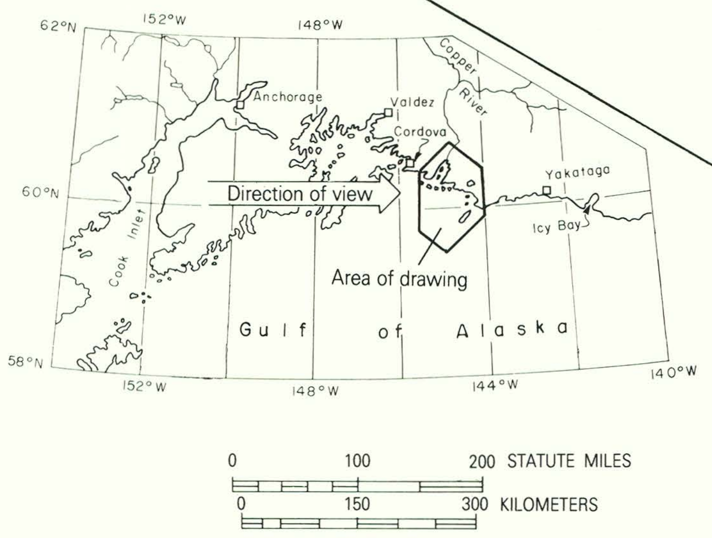
ICY BAY, ALASKA

By

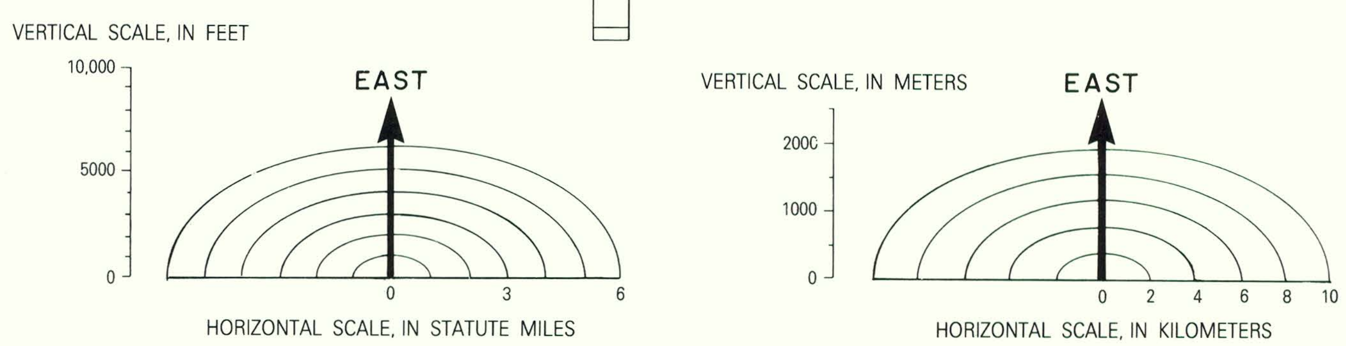
Tau Rho Alpha

1975





INDEX MAP



VERTICAL EXAGGERATION X4

Viewed toward the east, this oblique map shows the Copper River Delta, Kayak Island, and Kayak Trough. A large submarine slide is located at the northeast end of the Kayak Trough. The slide is 9 statute miles (15 kilometers) to 11 statute miles (18 kilometers) wide, the headwall is located to the north toward the town of Katalla, the center of the slide has an uneven surface, and the toe is located to the south toward Kayak Island. No sediment overlies the slide, which indicates the slide is a recent development. The slide could have been triggered by an earthquake or storm waves (Molnia and others, 1977, p. 147). This map has been published in Alpha (1978b); Cobb (1967, p. 56); Carlson and Molnia (1977, p. 287); Molnia and others (1977, p. 147); Quinterno and others (1980, p. 18).

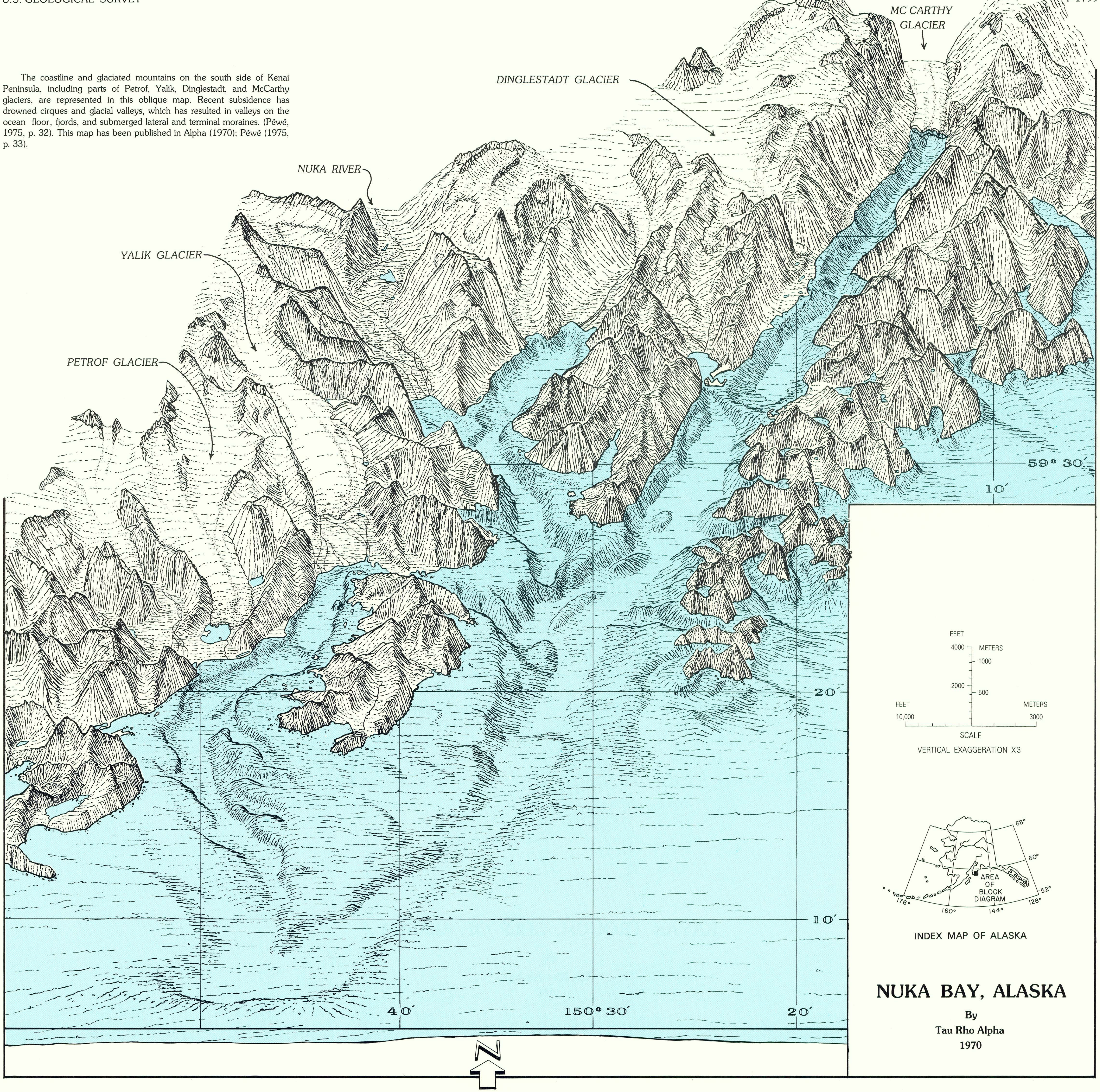
KAYAK TROUGH, GULF OF ALASKA

By

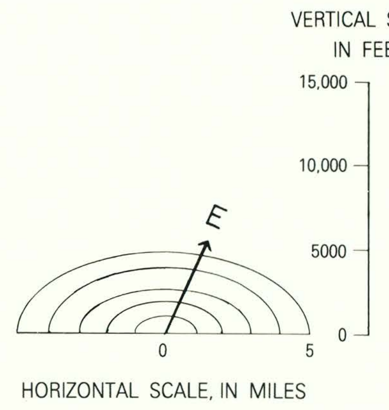
Tau Rho Alpha

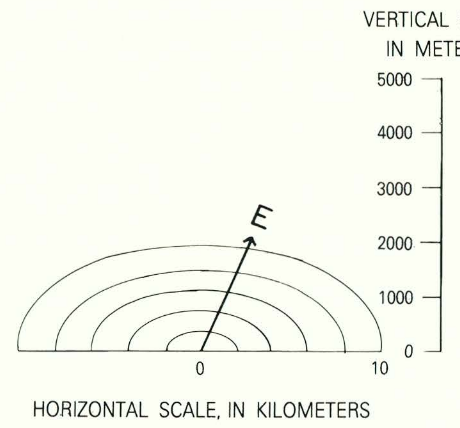
1978

The coastline and glaciated mountains on the south side of Kenai Peninsula, including parts of Petrof, Yalik, Dinglestadt, and McCarthy glaciers, are represented in this oblique map. Recent subsidence has drowned cirques and glacial valleys, which has resulted in valleys on the ocean floor, fjords, and submerged lateral and terminal moraines. (Péwé, 1975, p. 32). This map has been published in Alpha (1970); Péwé (1975, p. 33).

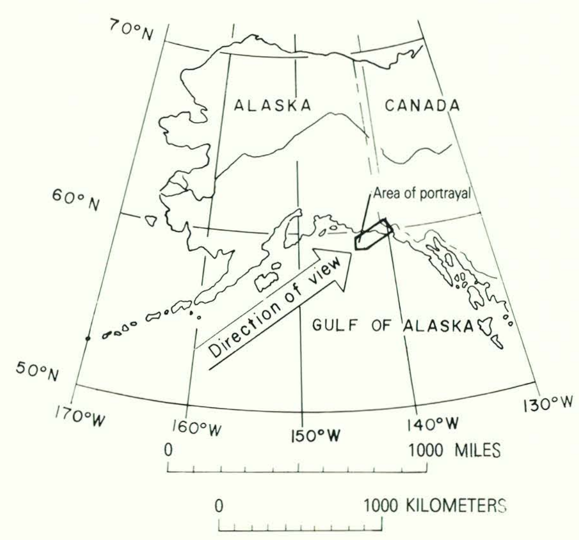


DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY





VERTICAL EXAGGERATION X3



INDEX MAP

Planimetrically adjusted contours by Paula Shryock

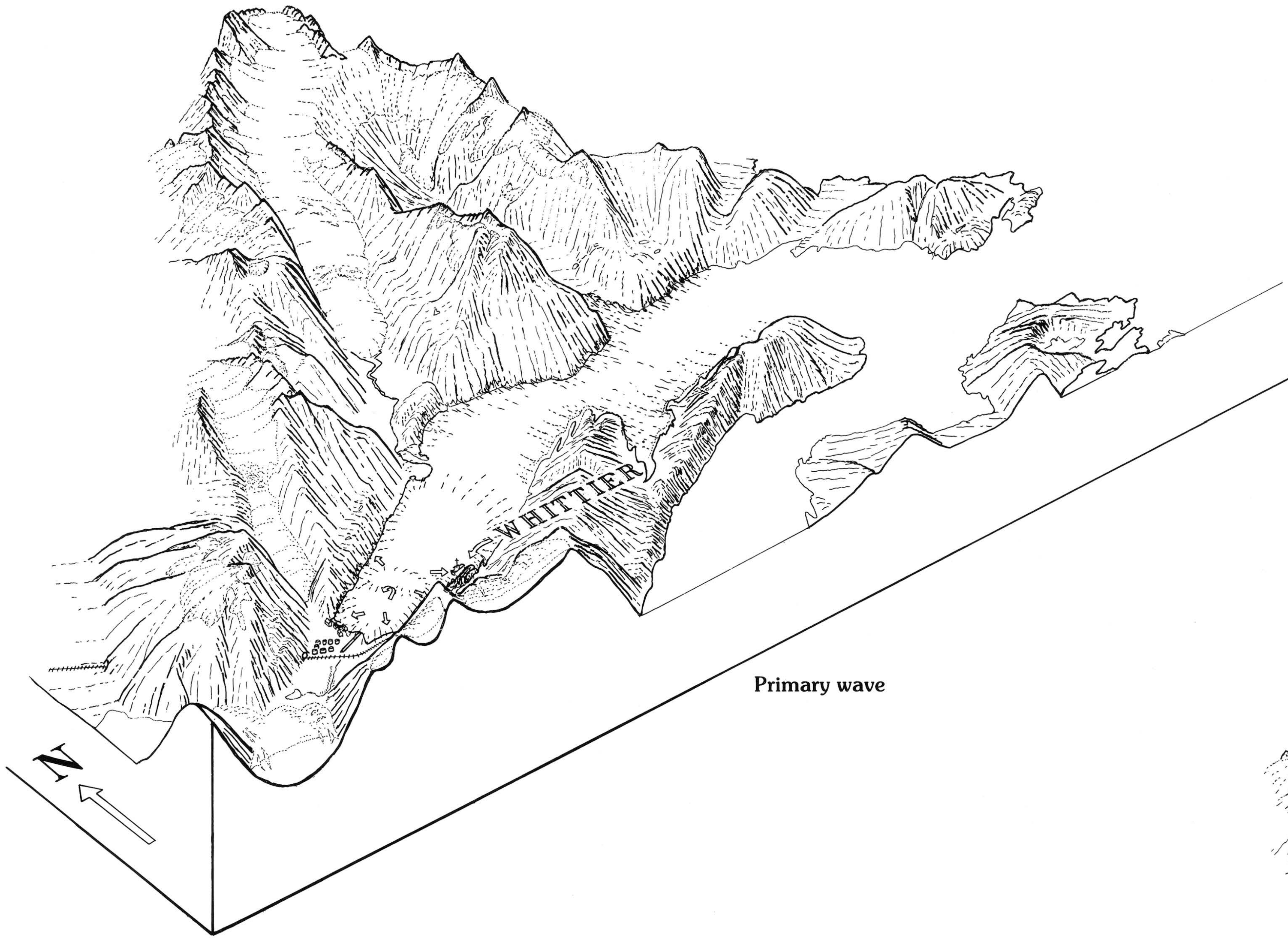
Viewed toward the northeast, this map shows Icy Bay, Mount St. Elias, part of the Malaspina Glacier, and Pamplona Ridge on the continental slope. A well-developed terminal moraine is located at the mouth of Icy Bay on the continental shelf. Different sedimentary deposits of clay, sand, and gravel are represented by various combinations of lines, textures, line weights, and dots (Quinterno and others, 1980, p. 13). This map has been published in Alpha (1978d); Quinterno and others (1980, p. 19).

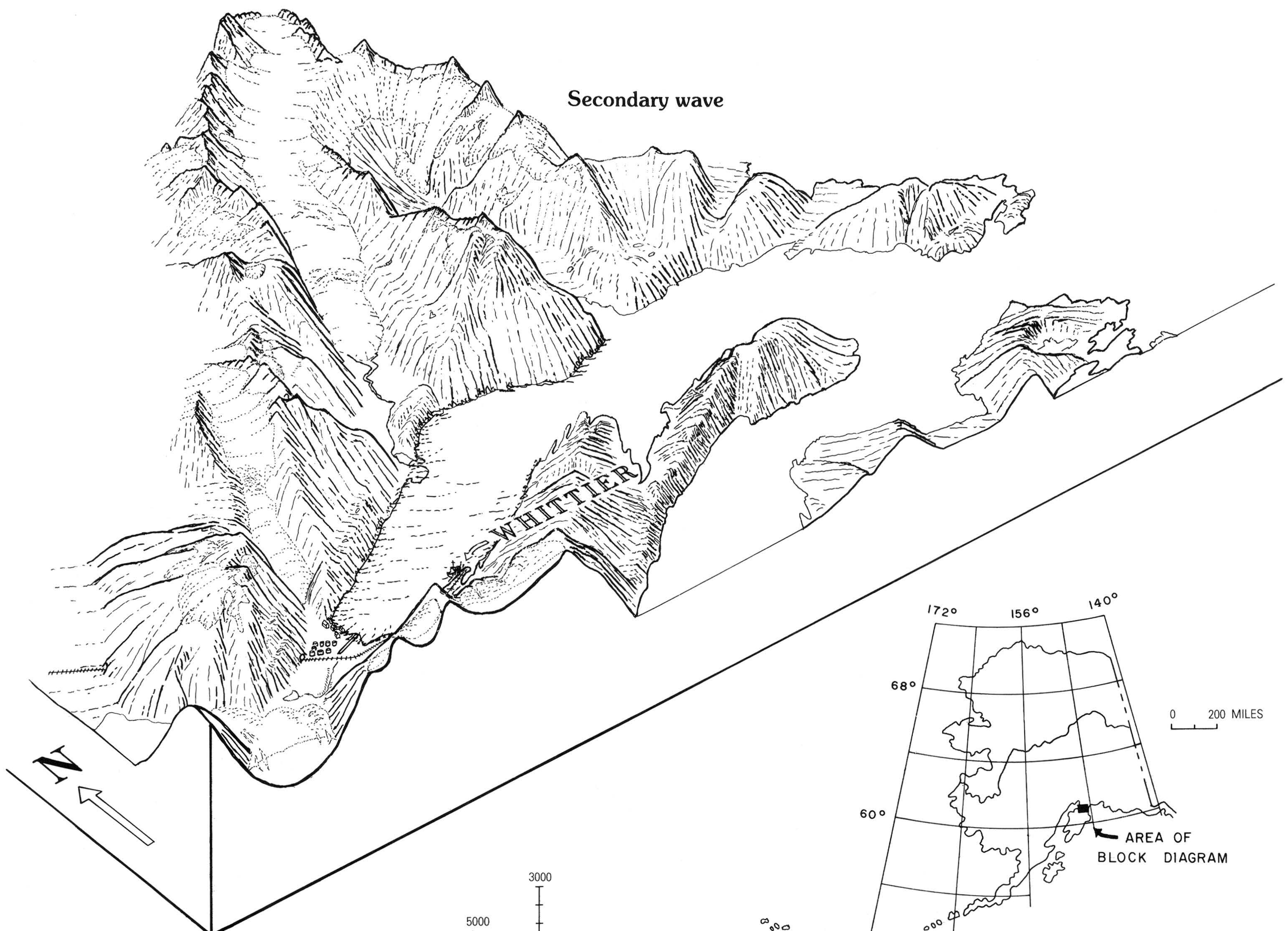
ATLAS OF OBLIQUE MAPS
I–1799

PAMPLONA RIDGE, GULF OF ALASKA

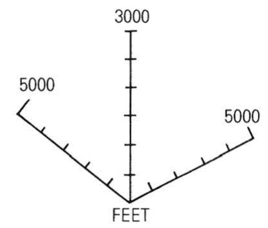
By

Tau Rho Alpha
1978





These angular-perspective drawings, viewed toward the northeast, are based on eyewitness accounts of the effect of the Alaska earthquake at Whittier, Alaska, in March 1964. The primary wave may have been caused by the slumping in the delta at the head of the fjord (Passage Canal) near Whittier, which caused a dome of water to form. As the dome flattened out, water flooded manmade structures in the town of Whittier. The secondary wave, which washed back and forth within the confines of Passage Canal and destroyed manmade structures the second time, may have been an oscillatory wave (seiche). This map is unpublished.



INDEX MAP OF ALASKA

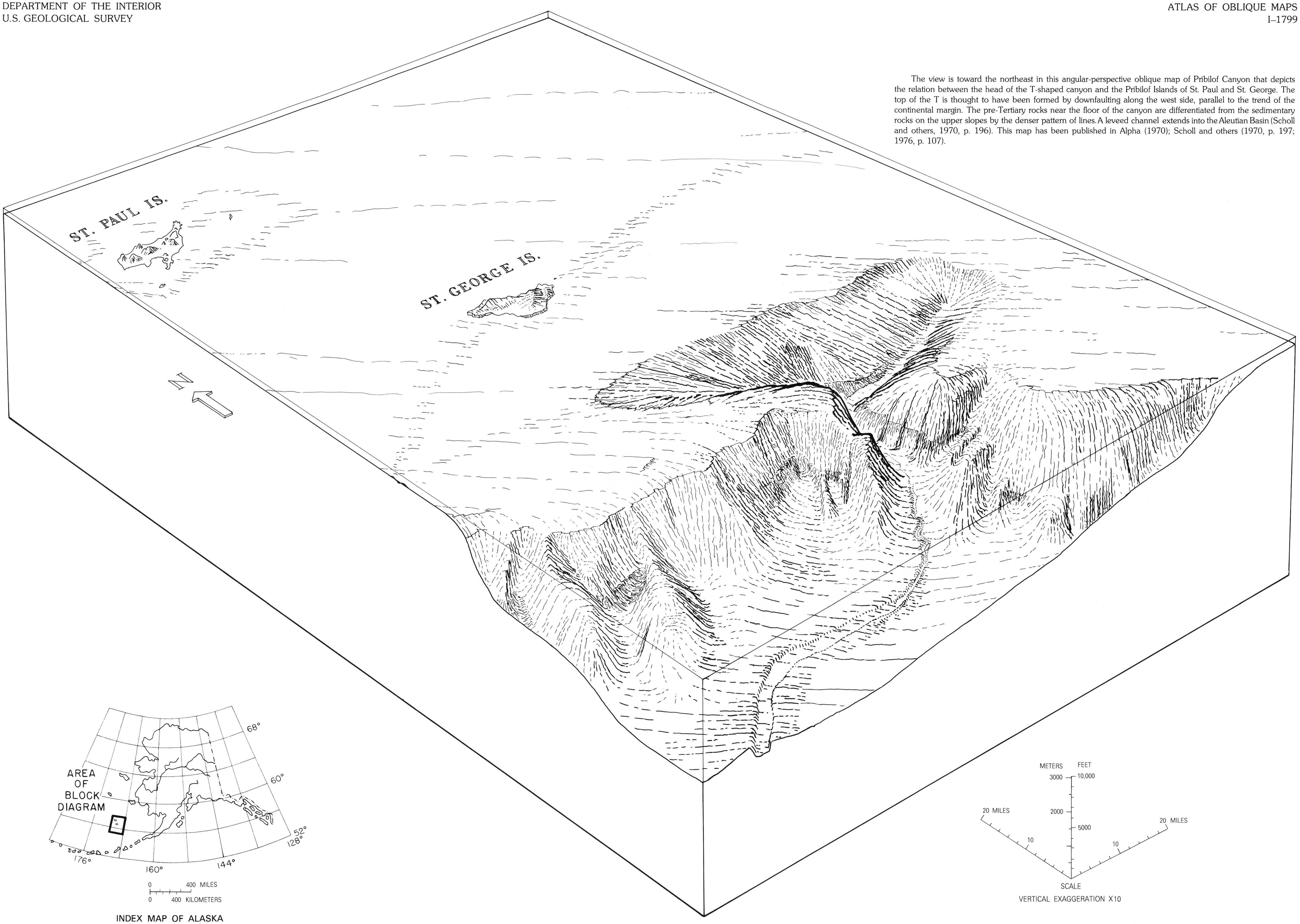
PASSAGE CANAL, ALASKA

By

Tau Rho Alpha

1964

The view is toward the northeast in this angular-perspective oblique map of Pribilof Canyon that depicts the relation between the head of the T-shaped canyon and the Pribilof Islands of St. Paul and St. George. The top of the T is thought to have been formed by downfaulting along the west side, parallel to the trend of the continental margin. The pre-Tertiary rocks near the floor of the canyon are differentiated from the sedimentary rocks on the upper slopes by the denser pattern of lines. A leveed channel extends into the Aleutian Basin (Scholl and others, 1970, p. 196). This map has been published in Alpha (1970); Scholl and others (1970, p. 197; 1976, p. 107).



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INDEX MAP OF ALASKA

SCALE
VERTICAL EXAGGERATION X10

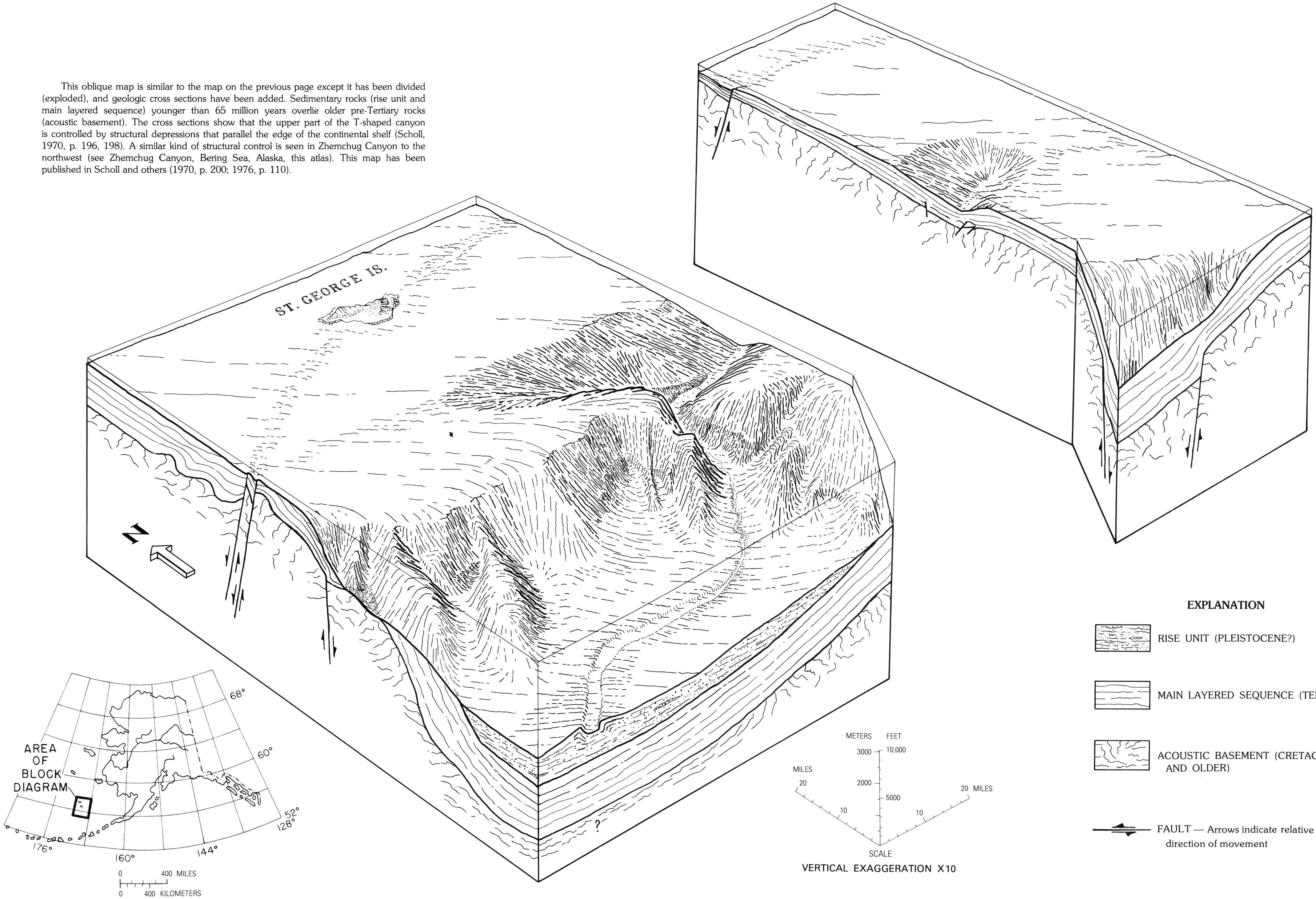
PRIBILOF CANYON, BERING SEA, ALASKA

By

Tau Rho Alpha

1970

This oblique map is similar to the map on the previous page except it has been divided (exploded), and geologic cross sections have been added. Sedimentary rocks (rise unit and main layered sequence) younger than 65 million years overlie older pre-Tertiary rocks (acoustic basement). The cross sections show that the upper part of the T-shaped canyon is controlled by structural depressions that parallel the edge of the continental shelf (Scholl, 1970, p. 196, 198). A similar kind of structural control is seen in Zhemchug Canyon to the northwest (see Zhemchug Canyon, Bering Sea, Alaska, this atlas). This map has been published in Scholl and others (1970, p. 200; 1976, p. 110).



VERTICAL EXAGGERATION X10

INDEX MAP OF ALASKA

EXPLANATION

RISE UNIT (PLEISTOCENE?)

MAIN LAYERED SEQUENCE (TERTIARY)

ACOUSTIC BASEMENT (CRETACEOUS AND OLDER)

FAULT — Arrows indicate relative direction of movement

EXPLODED DIAGRAM

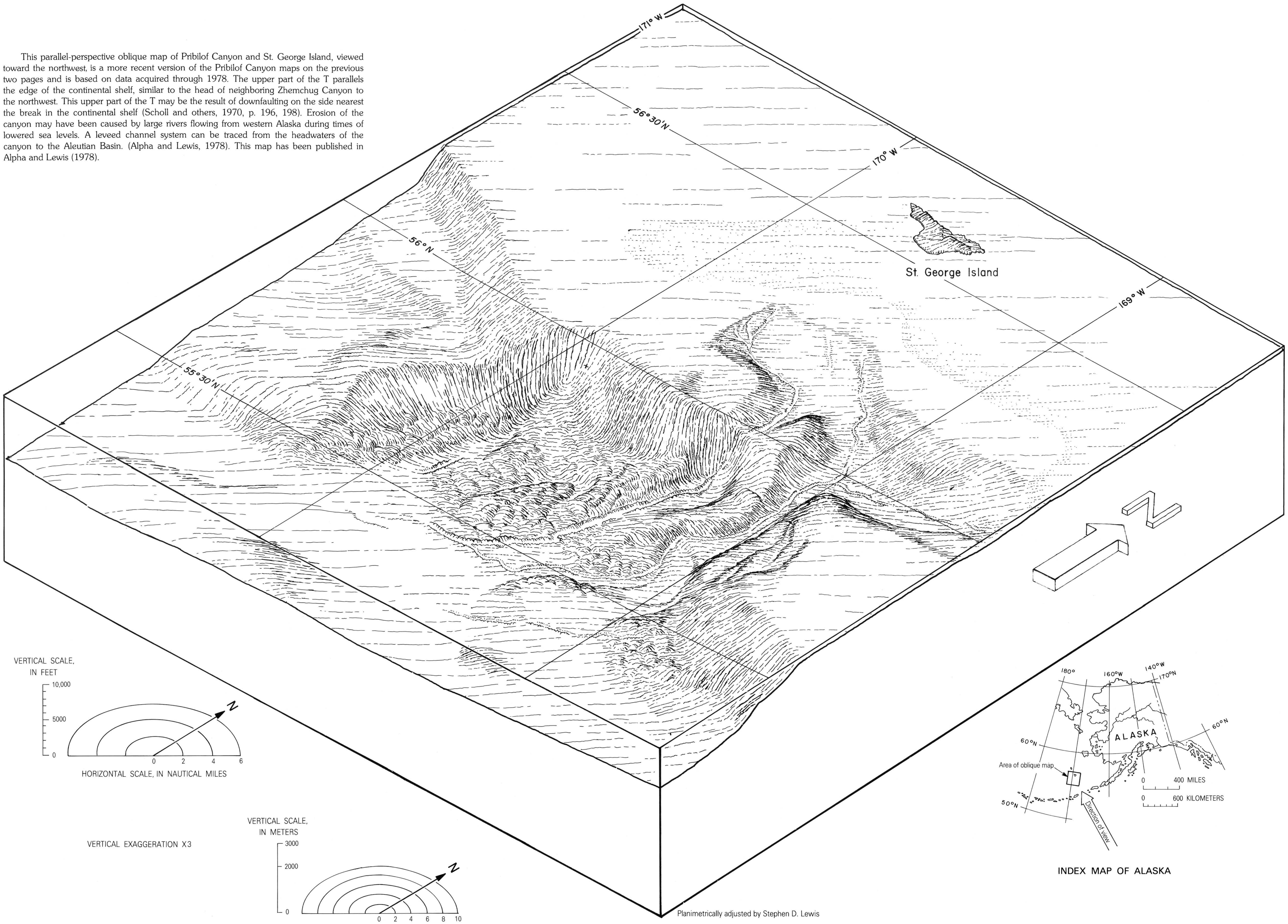
PRIBILOF CANYON, BERING SEA, ALASKA

By

Tau Rho Alpha

1970

This parallel-perspective oblique map of Pribilof Canyon and St. George Island, viewed toward the northwest, is a more recent version of the Pribilof Canyon maps on the previous two pages and is based on data acquired through 1978. The upper part of the T parallels the edge of the continental shelf, similar to the head of neighboring Zhemchug Canyon to the northwest. This upper part of the T may be the result of downfaulting on the side nearest the break in the continental shelf (Scholl and others, 1970, p. 196, 198). Erosion of the canyon may have been caused by large rivers flowing from western Alaska during times of lowered sea levels. A leveed channel system can be traced from the headwaters of the canyon to the Aleutian Basin. (Alpha and Lewis, 1978). This map has been published in Alpha and Lewis (1978).



Planimetrically adjusted by Stephen D. Lewis

VERTICAL SCALE, IN FEET

HORIZONTAL SCALE, IN NAUTICAL MILES

VERTICAL EXAGGERATION X3

VERTICAL SCALE, IN METERS

HORIZONTAL SCALE, IN KILOMETERS

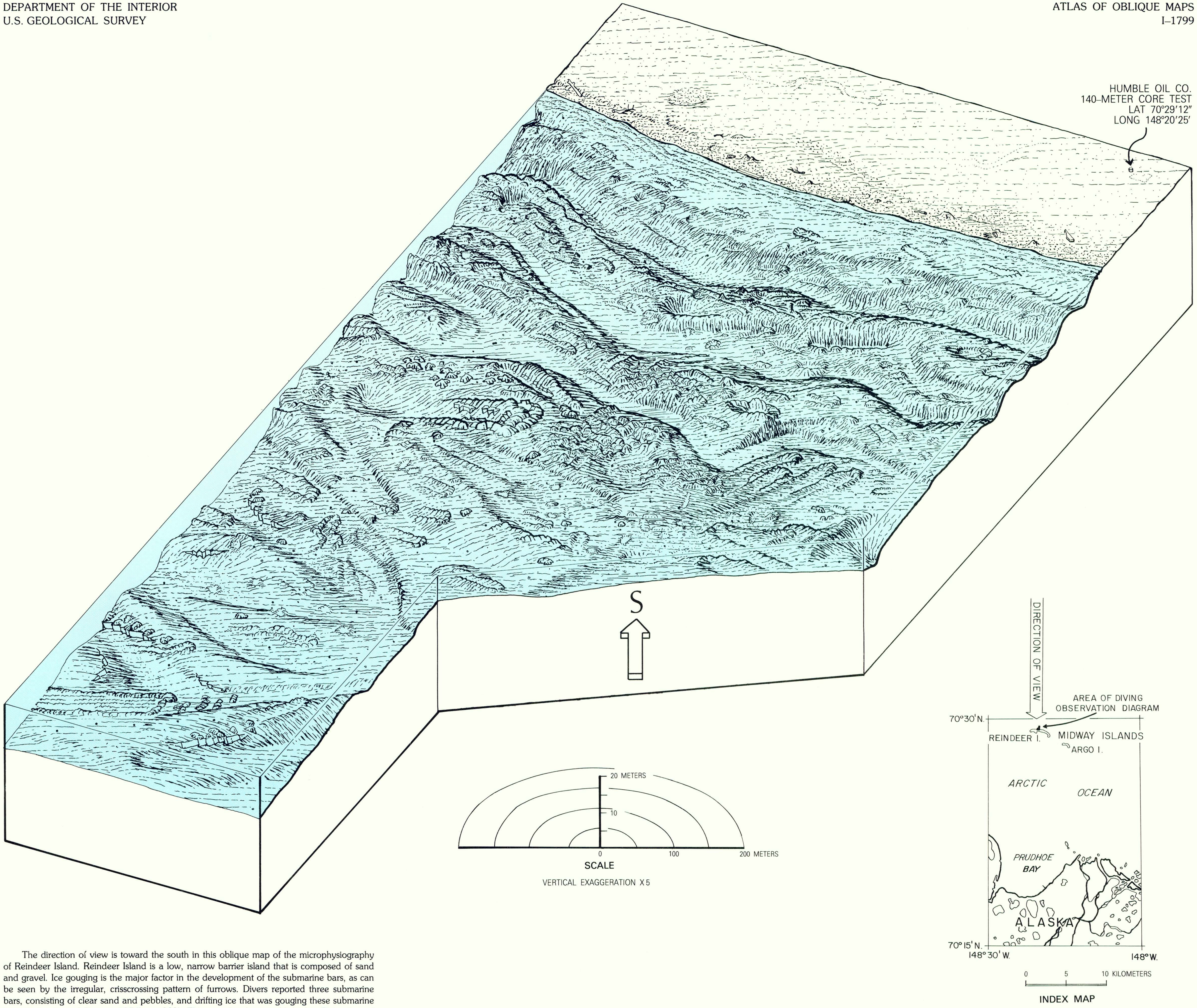
INDEX MAP OF ALASKA

REVISED
PRIBILOF CANYON, BERING SEA, ALASKA

By

Tau Rho Alpha

1978



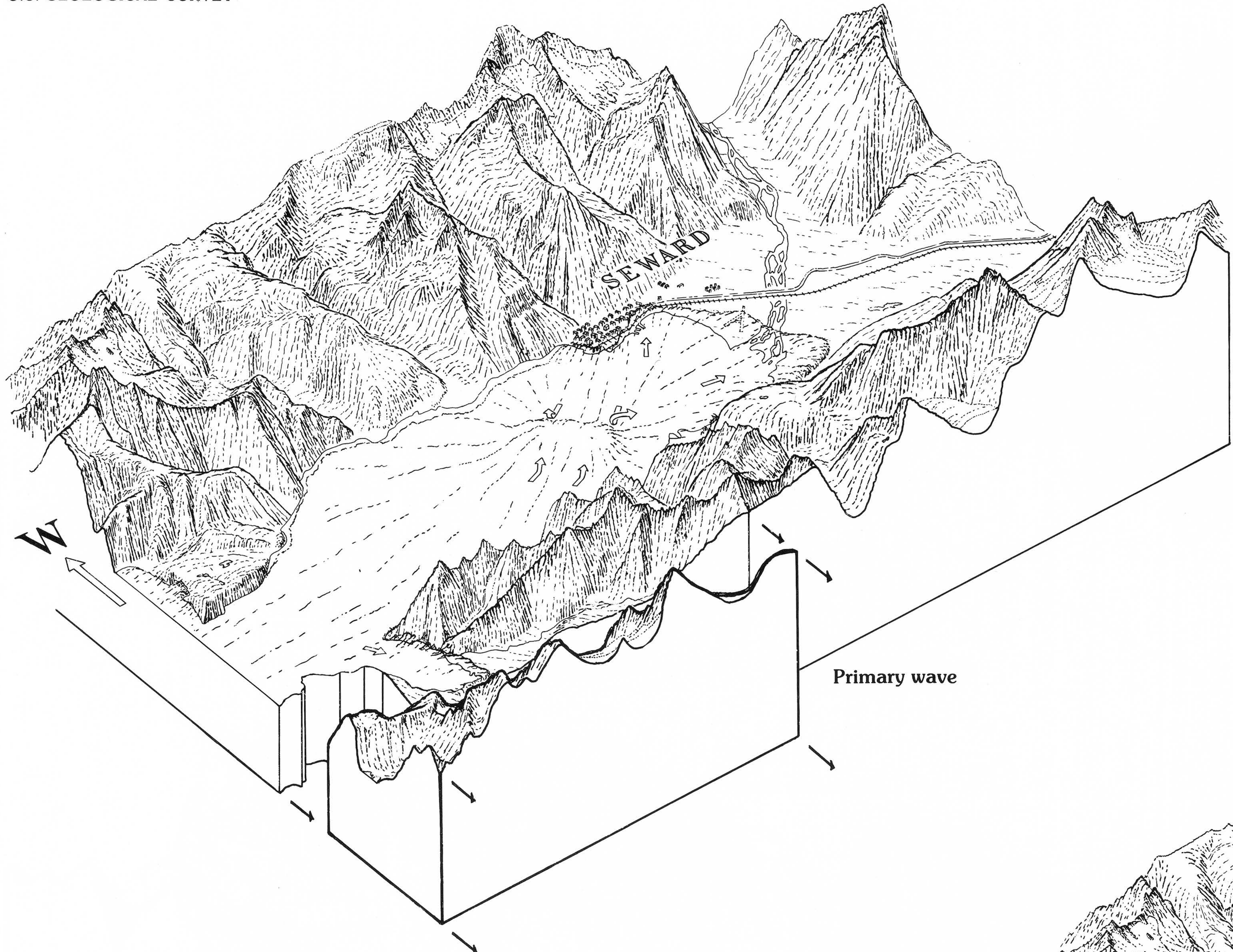
The direction of view is toward the south in this oblique map of the microphysiography of Reindeer Island. Reindeer Island is a low, narrow barrier island that is composed of sand and gravel. Ice gouging is the major factor in the development of the submarine bars, as can be seen by the irregular, crisscrossing pattern of furrows. Divers reported three submarine bars, consisting of clear sand and pebbles, and drifting ice that was gouging these submarine bars (Reimnitz and Barnes, 1974b, p. 323). This map has been published in Reimnitz and Barnes (1974b, p. 324).

DIVING OBSERVATION DIAGRAM OF REINDEER ISLAND, ALASKA

By

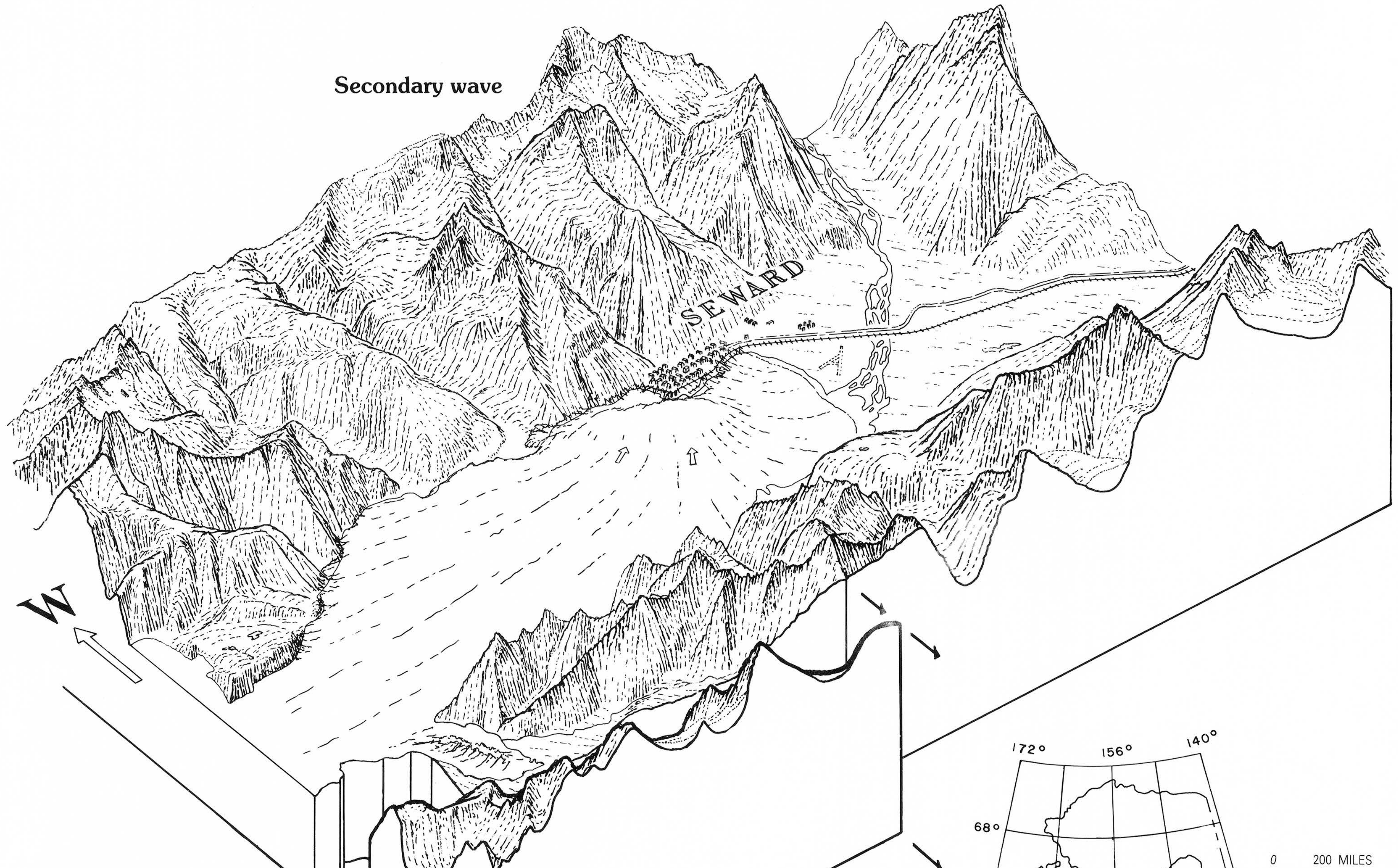
Tau Rho Alpha, Erk Reimnitz, Craig Rodeick, and Andrew D. Oesterle

1974

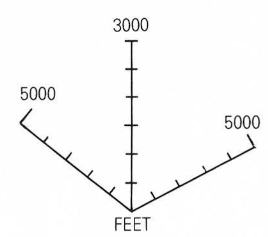


Primary wave

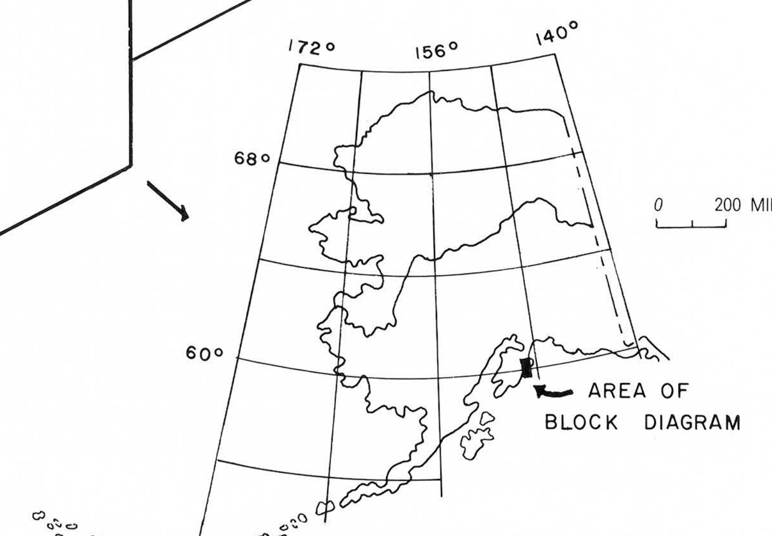
Secondary wave



These angular-perspective drawings, viewed toward the northwest, are based on contour maps for the onshore features and on eyewitness accounts of the effect of the March 1964 earthquake at Seward, Alaska, for the offshore features. Both the primary and secondary waves may have been caused by slumping on the front of the delta at the head of the fjord (Shepard and Wanless, 1971, p. 428). As a result of this mass movement, a water dome developed. As the water dome flattened out, the water flooded manmade structures and destroyed the waterfront of the city of Seward. The corner of the oblique map that includes Thumb Cove was moved out so the action of the waves in the cove can be seen. This map is unpublished.



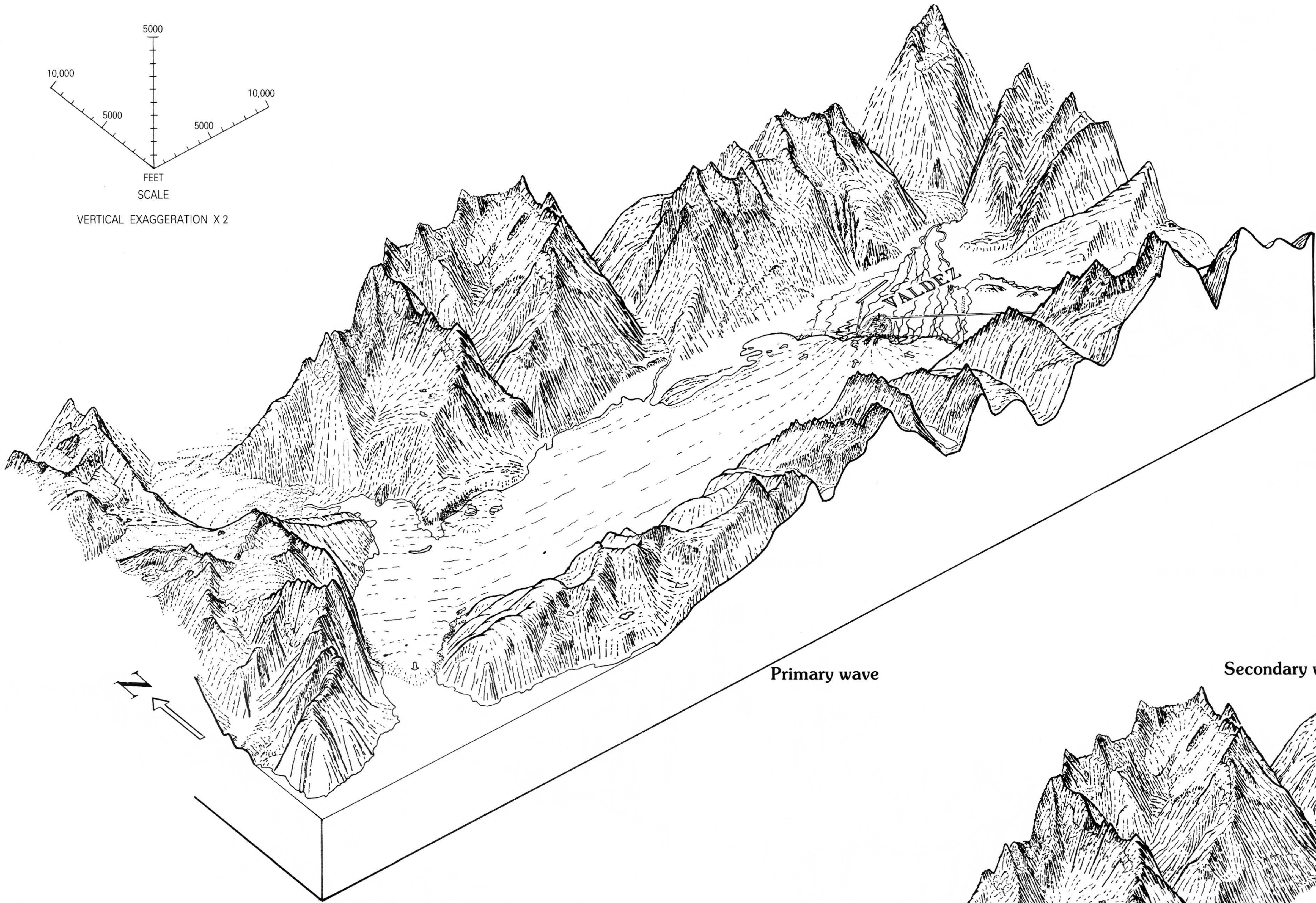
SCALE
VERTICAL EXAGGERATION X2



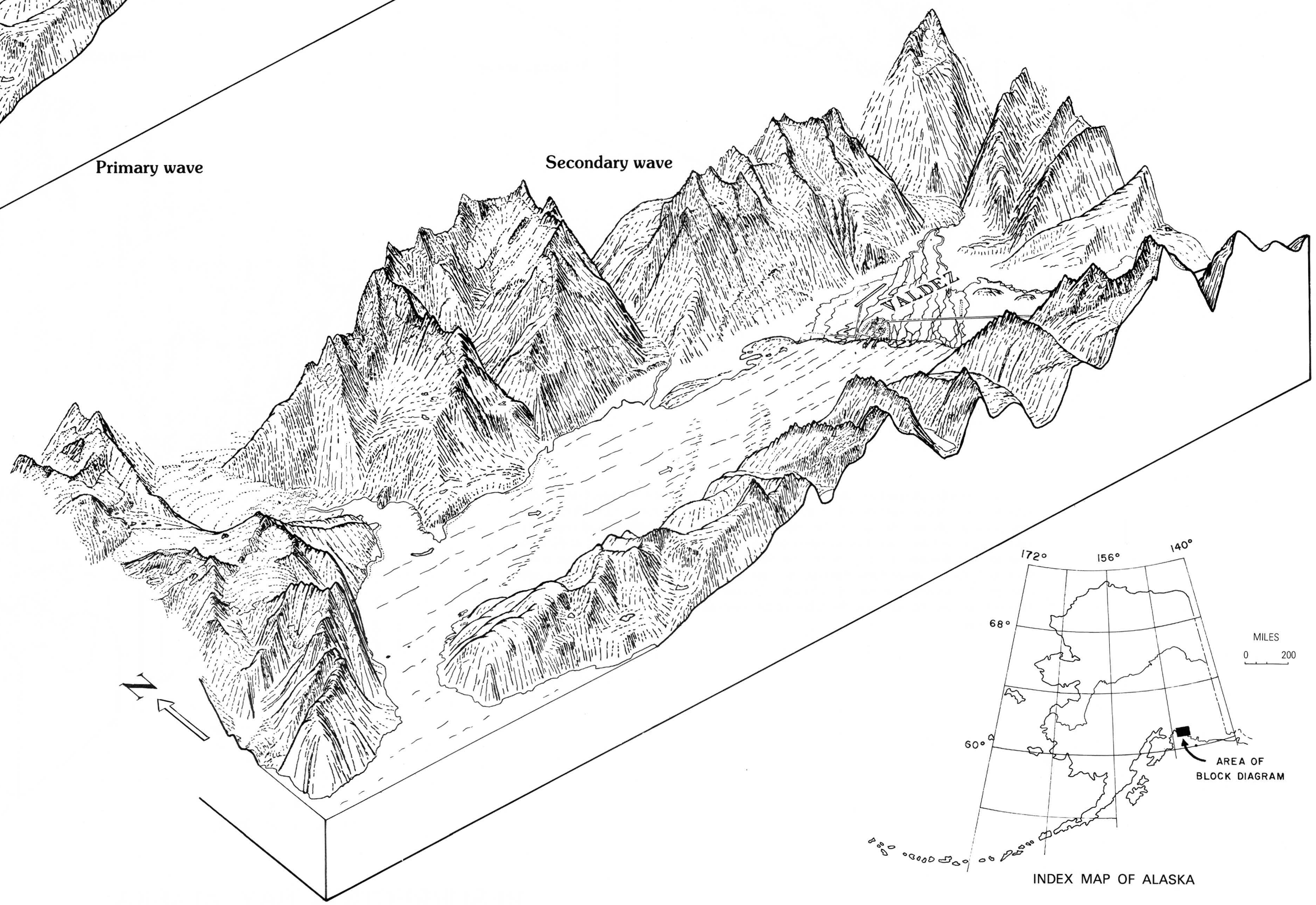
INDEX MAP OF ALASKA

RESURRECTION BAY, ALASKA

By
Tau Rho Alpha
1964



Primary wave



Secondary wave

INDEX MAP OF ALASKA

These angular-perspective drawings, viewed toward the northeast, are based on contour maps for the onshore features and on eyewitness accounts of the effect of the March 1964 earthquake at Seward, Alaska, for the offshore features. During the earthquake, the delta front near the city of Valdez moved downslope causing a water dome to form (Shepard and Wanless, 1971, p. 425). As the dome spread out, it produced the primary wave that destroyed manmade structures at Valdez. A secondary wave formed near the mouth of the fjord as another dome of water spread out. Most of this water flowed out of the fjord, but some flowed toward the head of the fjord and destroyed most of the Valdez waterfront. This map is unpublished.

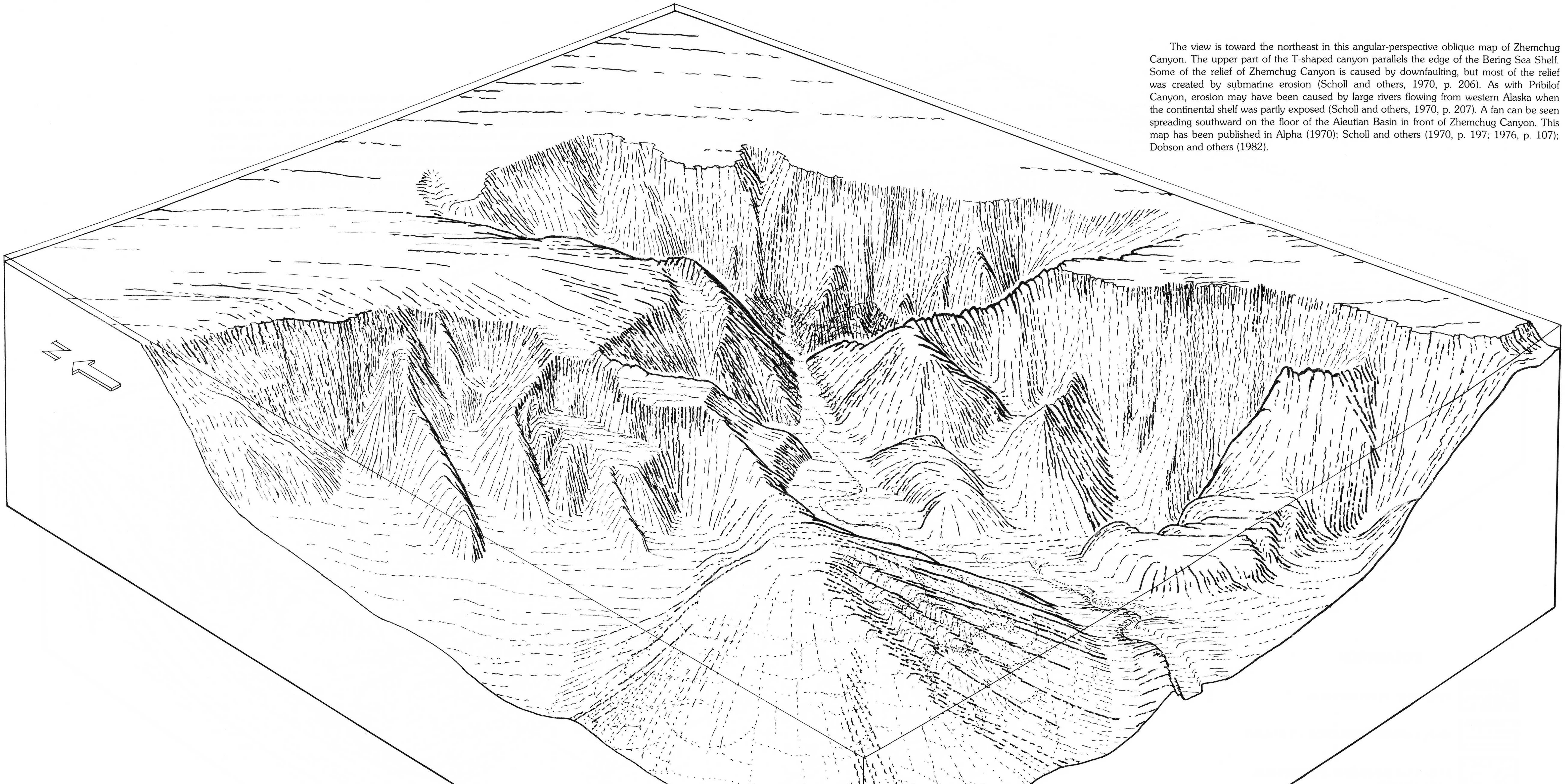
PORT VALDEZ, ALASKA

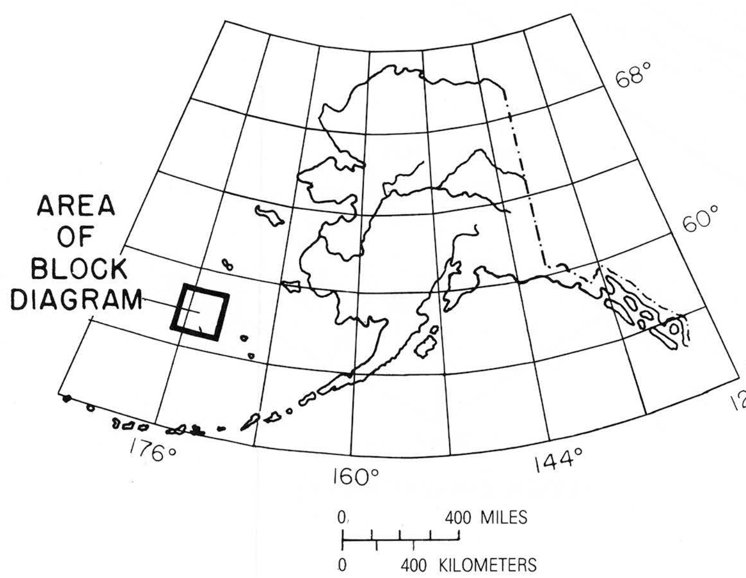
By

Tau Rho Alpha

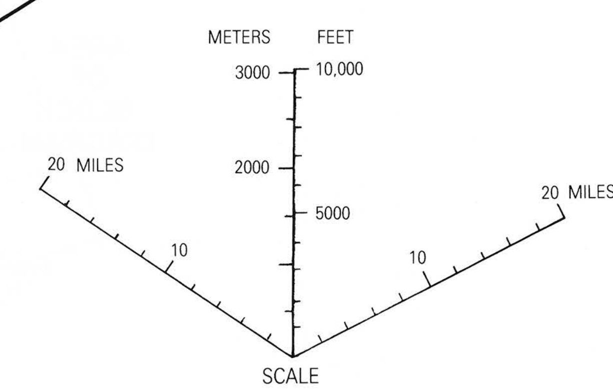
1964

The view is toward the northeast in this angular-perspective oblique map of Zhemchug Canyon. The upper part of the T-shaped canyon parallels the edge of the Bering Sea Shelf. Some of the relief of Zhemchug Canyon is caused by downfaulting, but most of the relief was created by submarine erosion (Scholl and others, 1970, p. 206). As with Pribilof Canyon, erosion may have been caused by large rivers flowing from western Alaska when the continental shelf was partly exposed (Scholl and others, 1970, p. 207). A fan can be seen spreading southward on the floor of the Aleutian Basin in front of Zhemchug Canyon. This map has been published in Alpha (1970); Scholl and others (1970, p. 197; 1976, p. 107); Dobson and others (1982).





INDEX MAP OF ALASKA



SCALE

VERTICAL EXAGGERATION X 10

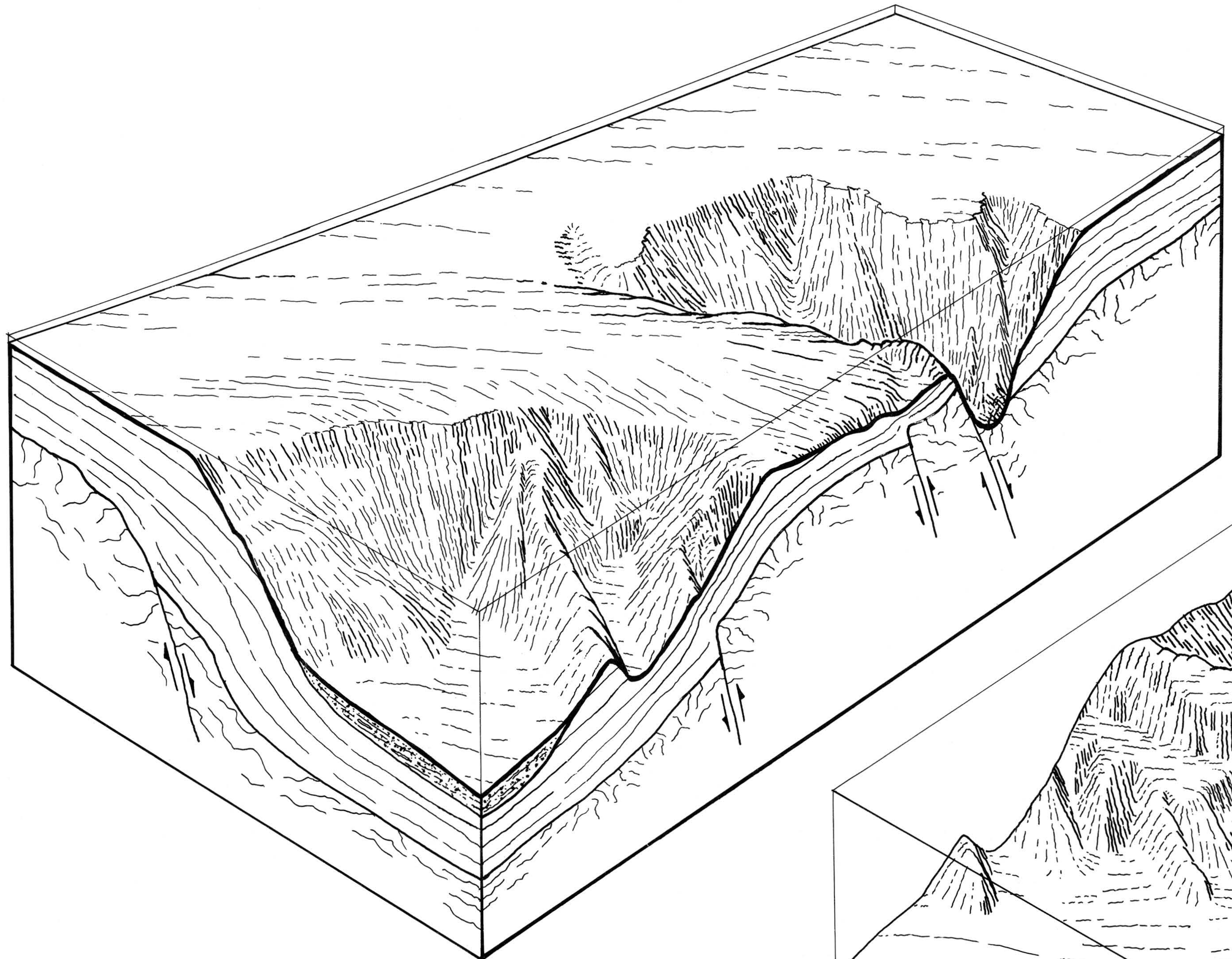
ZHEMCHUG CANYON, BERING SEA, ALASKA

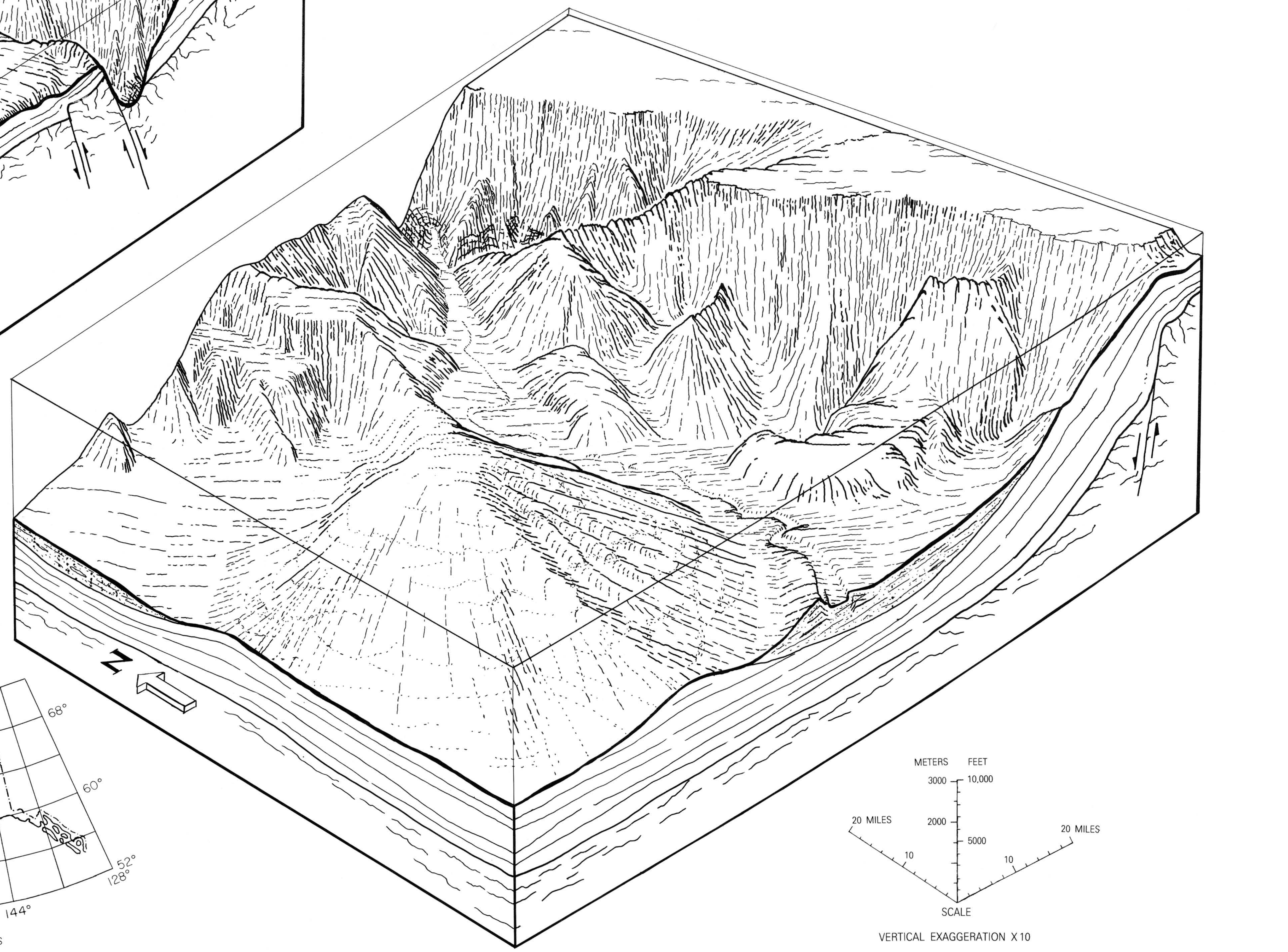
By

Tau Rho Alpha

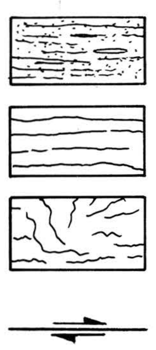
1970

This oblique map is similar to the map on the previous page except it has been divided (exploded) and geologic cross sections have been added. Sedimentary rocks (rise unit and main layered sequences) younger than 65 million years overlie older pre-Tertiary rocks (acoustic basement). The cross sections show that the upper part of the T-shaped canyon is controlled by structural depressions in pre-Tertiary rocks that parallel the edge of the continental shelf (Scholl and others, 1970, p. 206, fig. 8, p. 199). A similar kind of structural control is seen in Pribilof Canyon to the southeast (see Pribilof Canyon, Bering Sea, Alaska, this atlas). This map has been published in Scholl and others (1970, p. 203; 1976, p. 113).





EXPLANATION

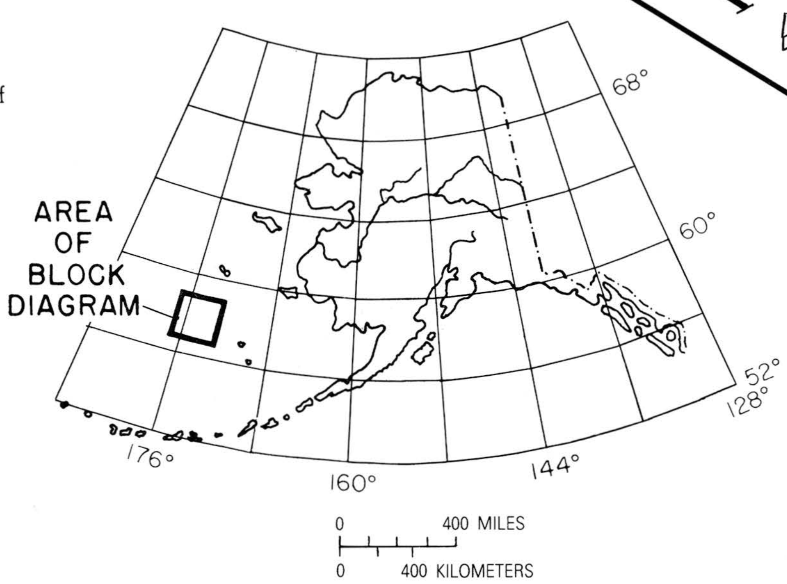


RISE UNIT (PLEISTOCENE?)

MAIN LAYERED SEQUENCE (TERTIARY)

ACOUSTIC BASEMENT (CRETACEOUS AND OLDER)

FAULT—Arrows indicate relative direction of movement



INDEX MAP OF ALASKA

SCALE

VERTICAL EXAGGERATION X 10

EXPLODED DIAGRAM

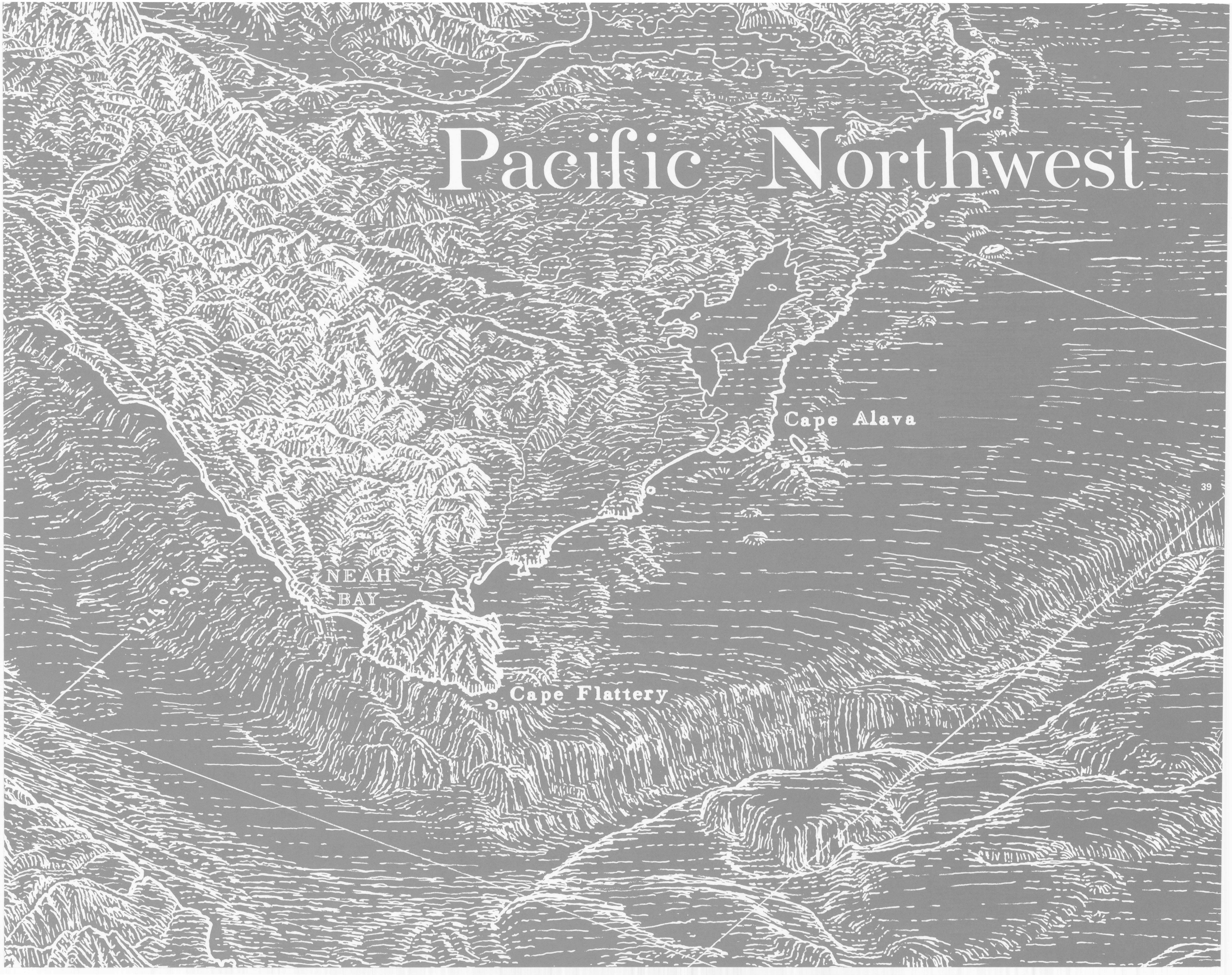
ZHEMCHUG CANYON, BERING SEA, ALASKA

By

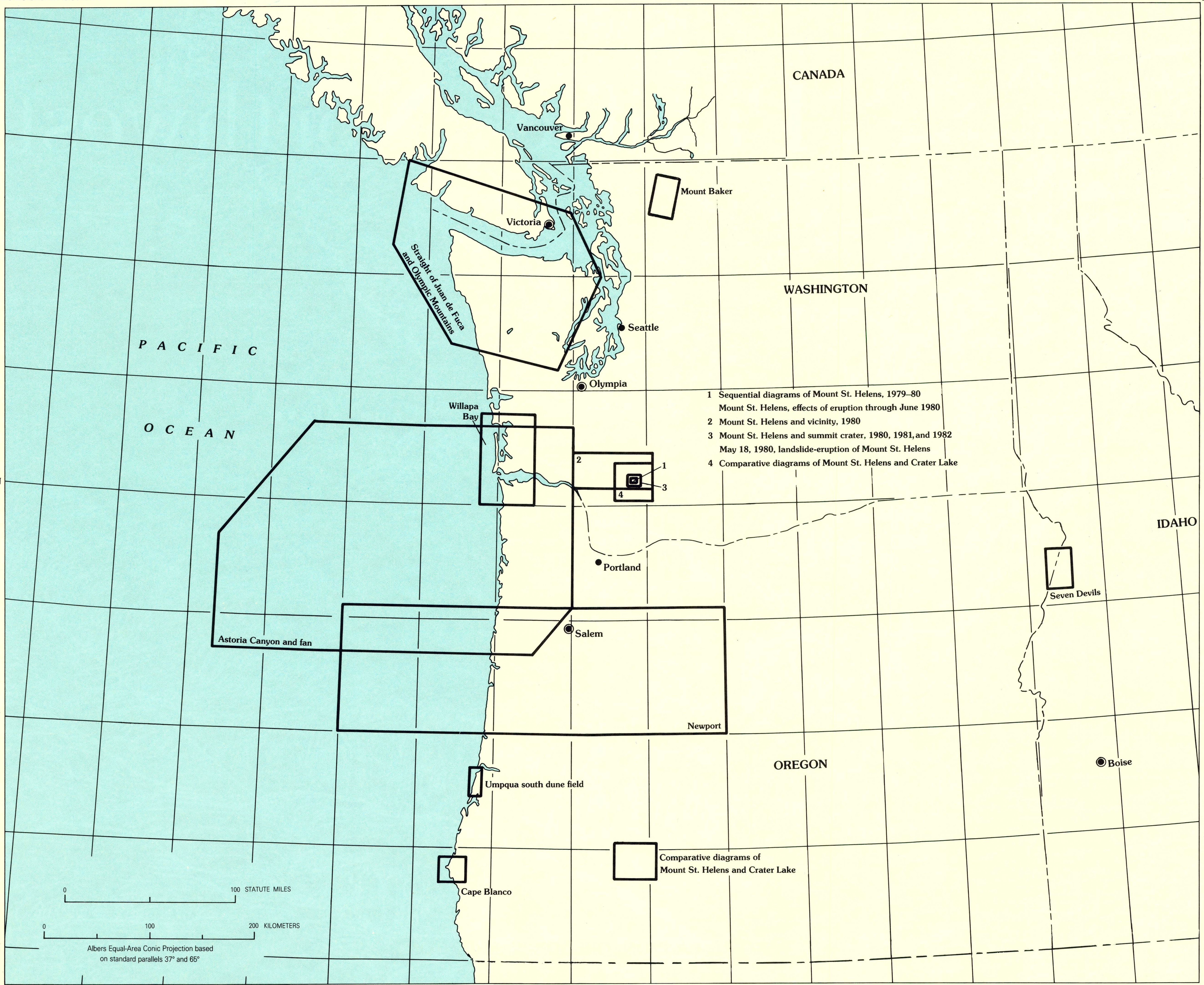
Tau Rho Alpha

1970

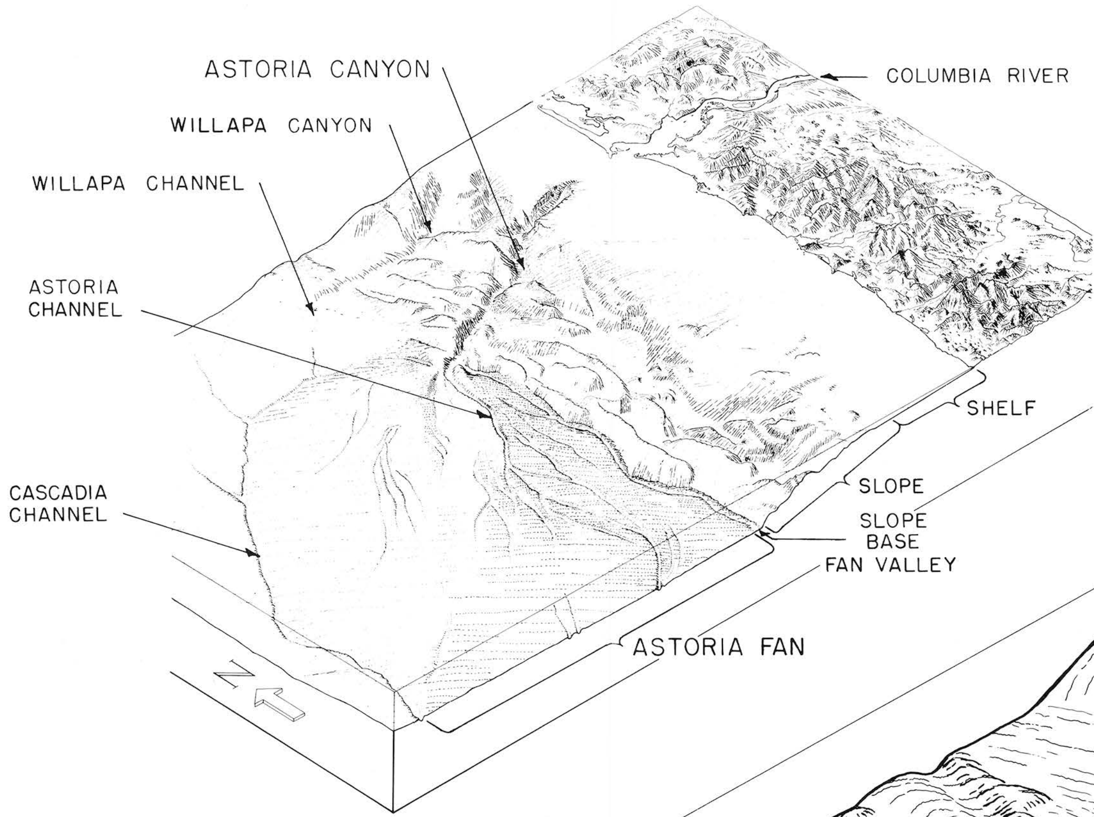
Pacific Northwest

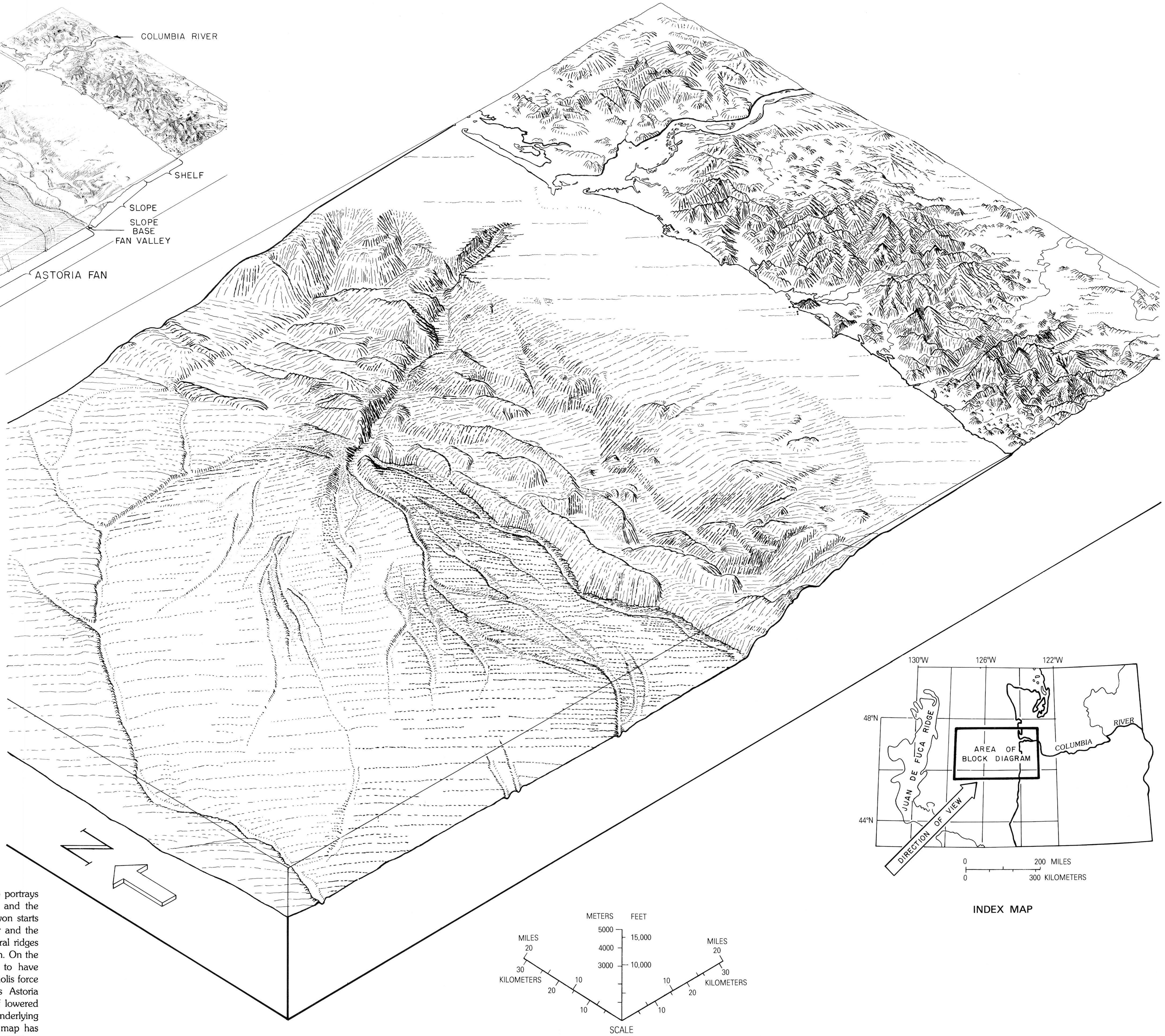


DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY



LOCATION OF OBLIQUE MAPS IN THE PACIFIC NORTHWEST





VERTICAL EXAGGERATION X5

Viewed toward the northeast, this oblique map portrays the coast ranges, the continental shelf and slope, and the Astoria Canyon and fan. The head of Astoria Canyon starts midway between the mouth of the Columbia River and the edge of the continental shelf and then crosses several ridges as it descends the continental slope to the Astoria fan. On the Astoria fan, ancient valleys and channels appear to have migrated southward, possibly in response to the Coriolis force (Nelson and others, 1970, p. 271). Or perhaps Astoria Canyon was developed by erosion during times of lowered sea level, and its course was influenced by the underlying structure (Nelson and others, 1970, p. 287). This map has been published in Alpha (1972); Nelson and others (1970, p. 260); Shepard (1973, p. 318); Nelson and Nilsen (1976, p. 390); National Research Council (1979, p. 41).

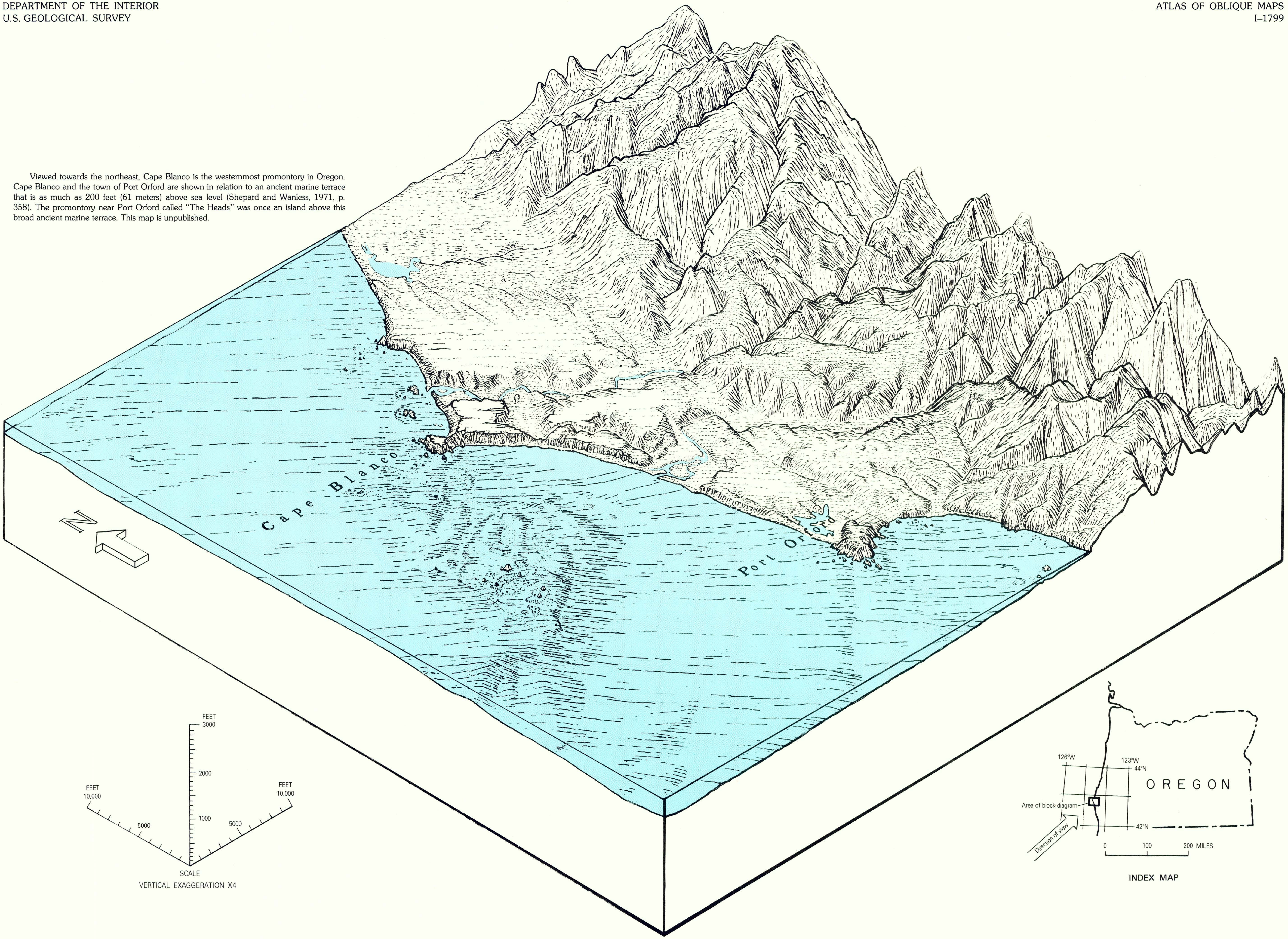
ASTORIA CANYON, OREGON-WASHINGTON

By

Tau Rho Alpha

1972

Viewed towards the northeast, Cape Blanco is the westernmost promontory in Oregon. Cape Blanco and the town of Port Orford are shown in relation to an ancient marine terrace that is as much as 200 feet (61 meters) above sea level (Shepard and Wanless, 1971, p. 358). The promontory near Port Orford called "The Heads" was once an island above this broad ancient marine terrace. This map is unpublished.



SCALE
VERTICAL EXAGGERATION X4

INDEX MAP

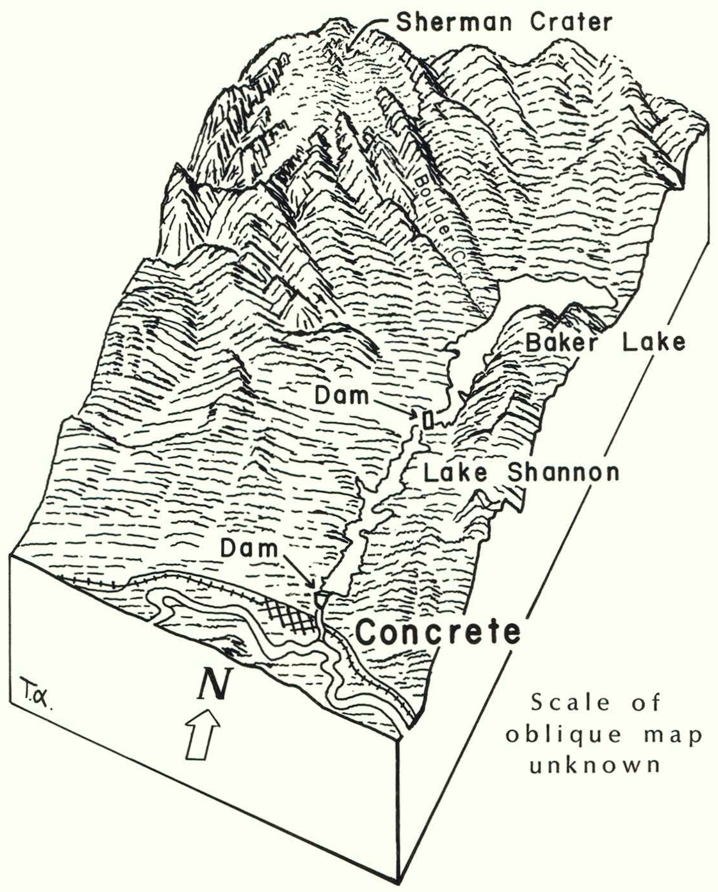
CAPE BLANCO, OREGON

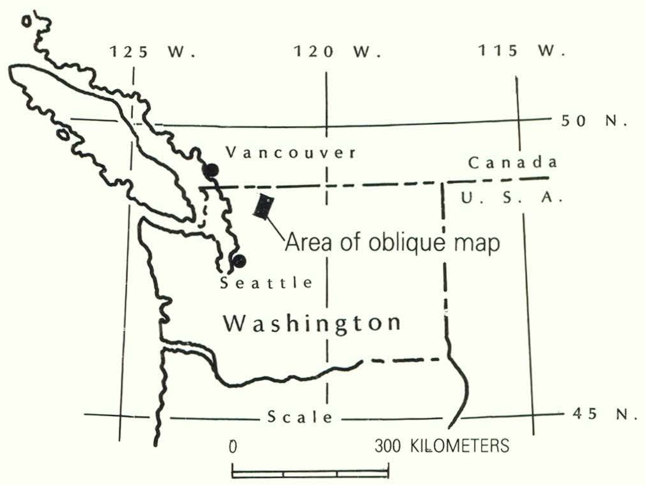
By

Tau Rho Alpha

1968

Mount Baker





INDEX MAP

This oblique map of Mount Baker and the town of Concrete was compiled rapidly for a newspaper press release on a potential mudflow issuing from Sherman Crater on the summit of Mount Baker. After a long dormancy, Sherman Crater began to emit heat and gas. The concern, which fortunately never developed, was that a mudflow would sweep down Boulder Creek into Baker Lake and thereby produce waves that would spill over or breach the dams of Baker Lake and Lake Shannon and destroy the town of Concrete (Alpha, 1975a, p. 1). This map has been published in Alpha (1975a, p. 3).

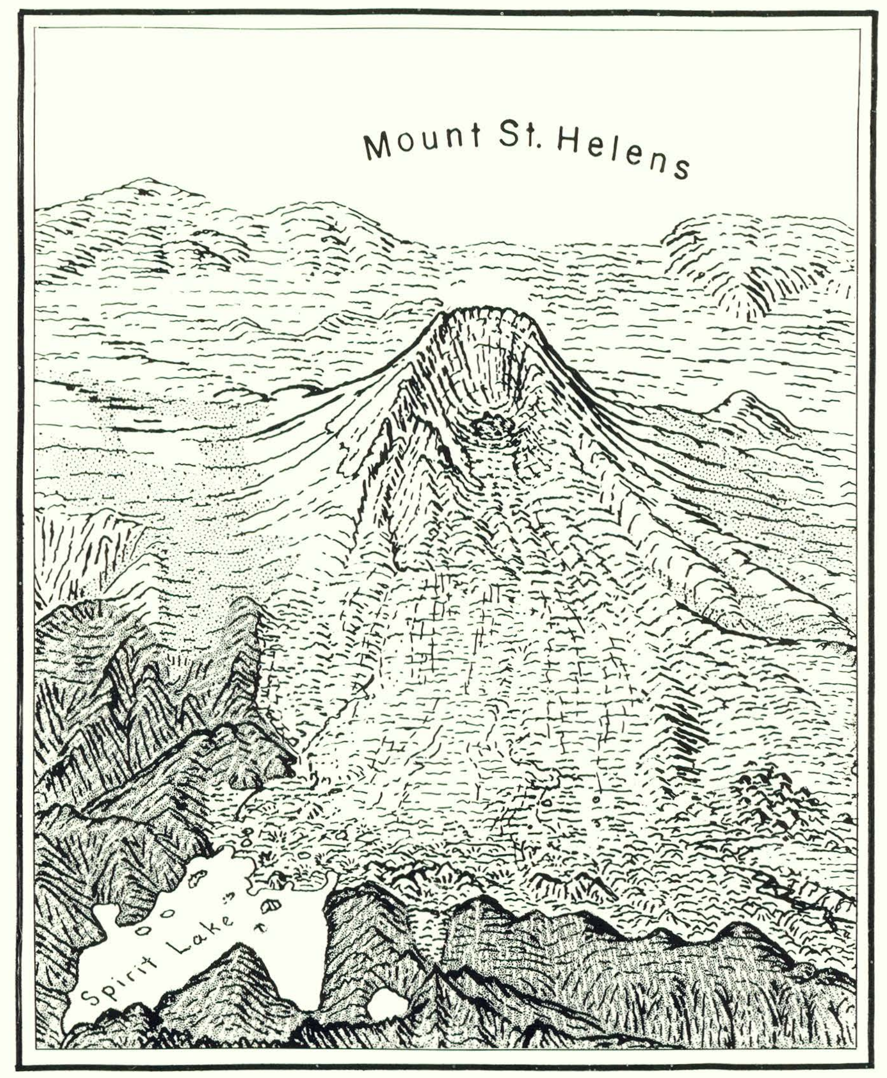
MOUNT BAKER, WASHINGTON

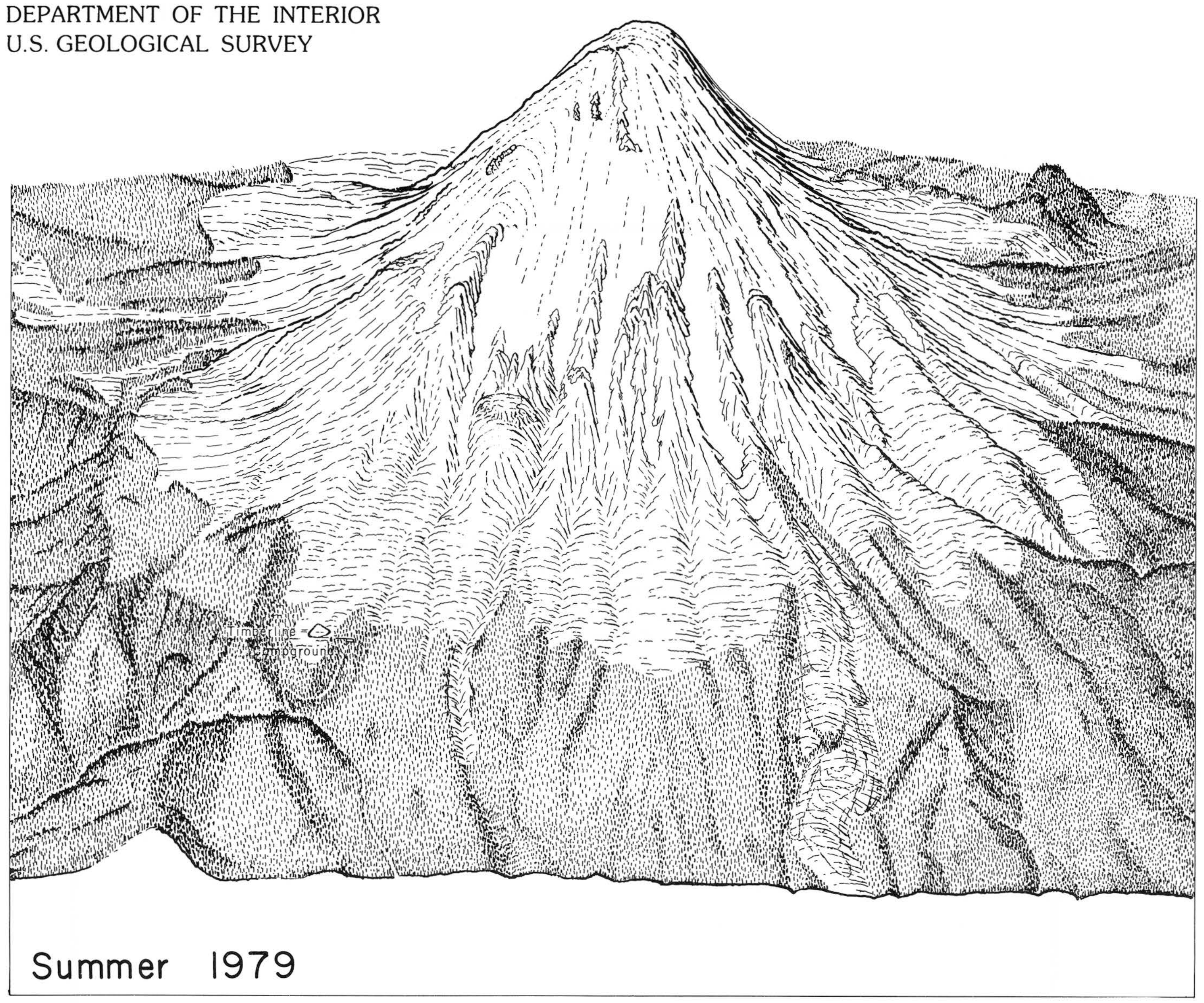
By
Tau Rho Alpha
1975

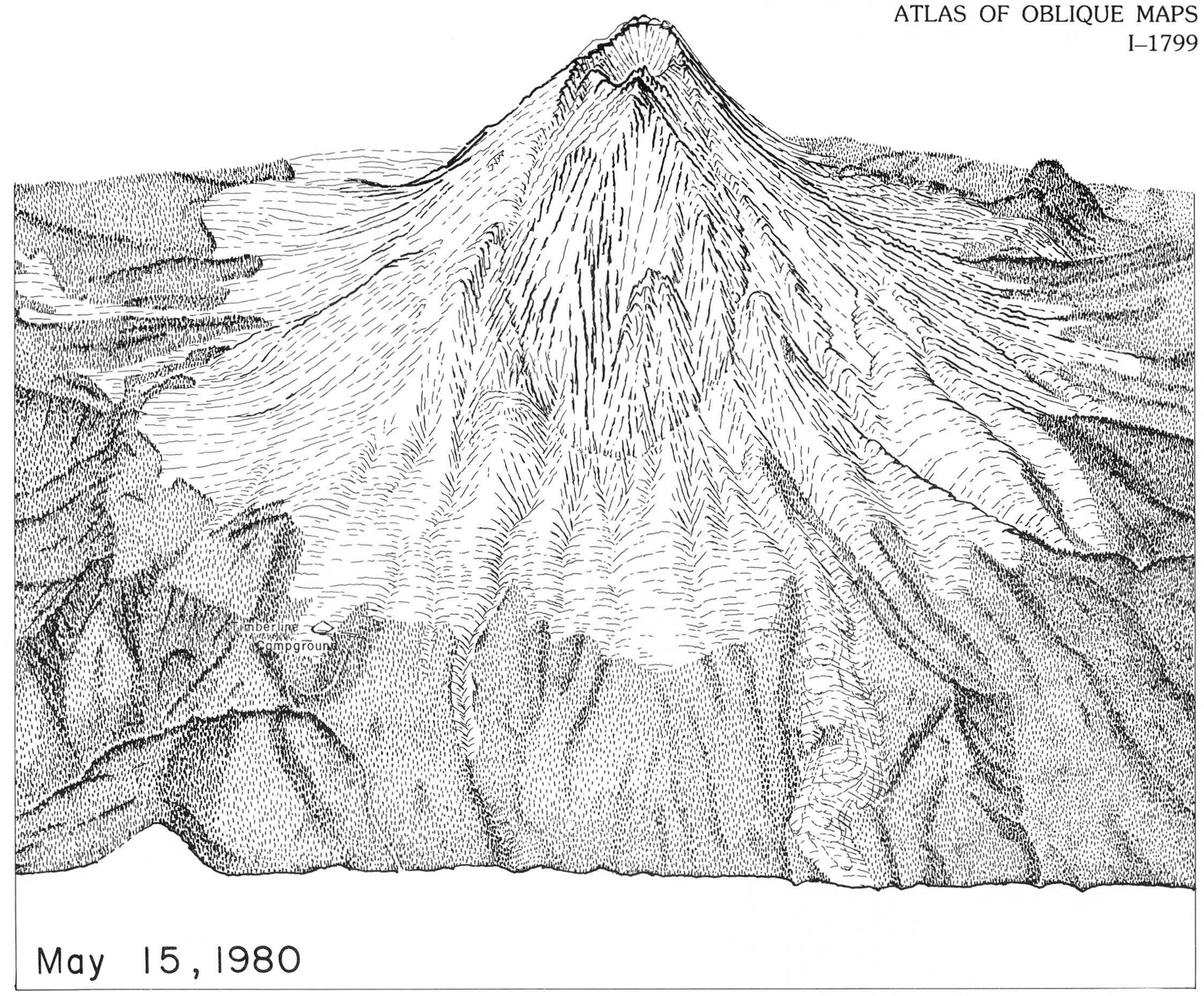
INTRODUCTION TO THE SERIES OF OBLIQUE MAPS THAT PORTRAY MOUNT ST. HELENS

The next series of physiographic diagrams portray Mount St. Helens from its eruption in 1980 to 1983. The maps may be divided into two groups: (1) those that show changes in the summit crater on a yearly basis, arranged chronologically, and (2) those that interpret the eruption and devastation, ending with a comparative study between Crater Lake, Oregon, and Mount St. Helens, Washington.

While most of the oblique maps in this atlas are based on contour maps, only sketch contour maps of the altered crater and debris avalanche were available when the oblique maps of Mount St. Helens were being compiled. These oblique maps of Mount St. Helens are based on the sketch contour maps, oblique and vertical aerial photographs, personal communication with experts on the area, and fieldwork.




Summer 1979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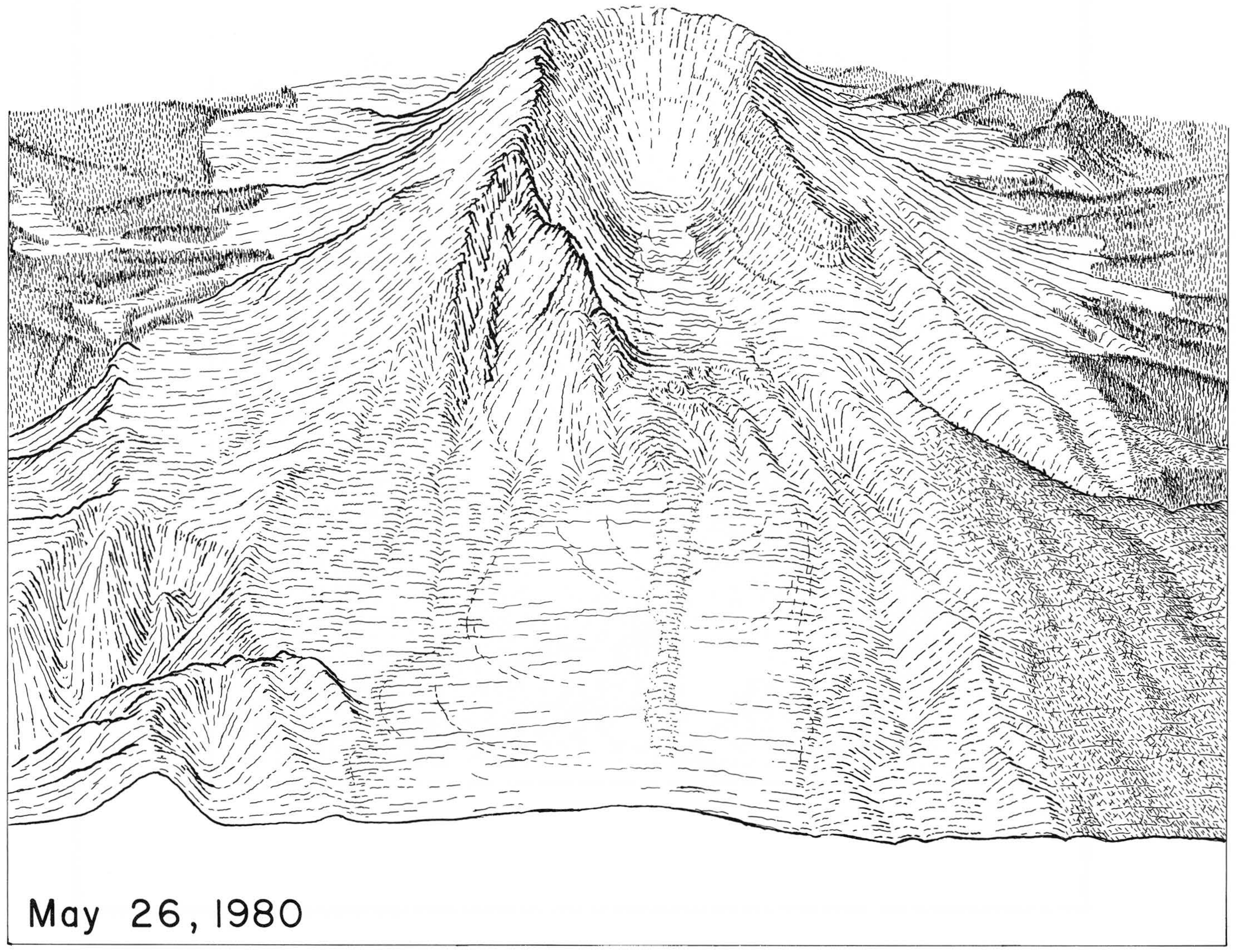
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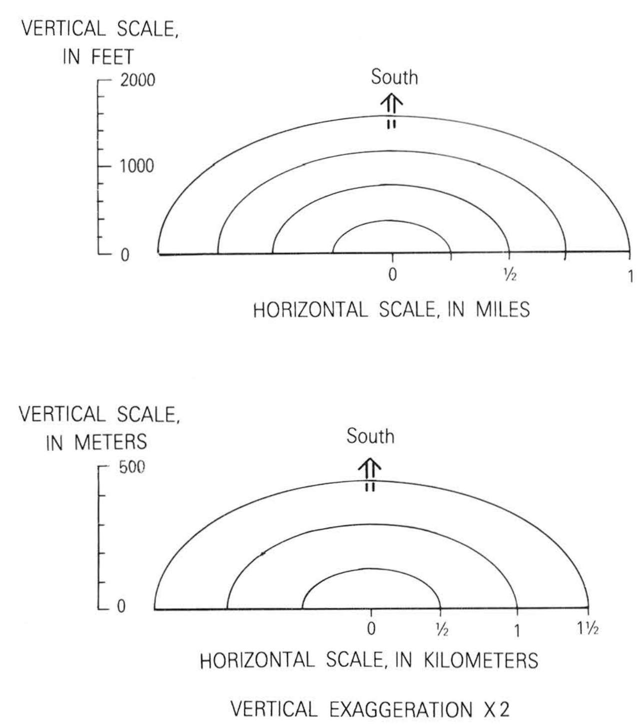
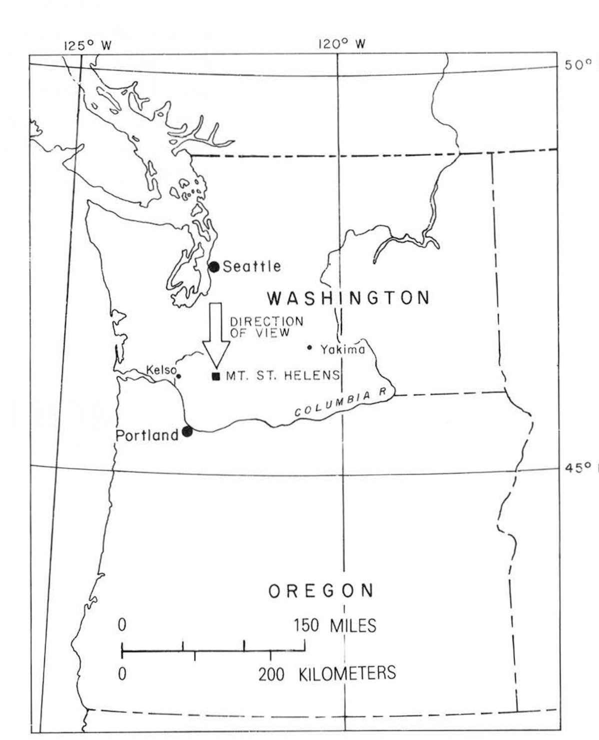


INDEX MAP



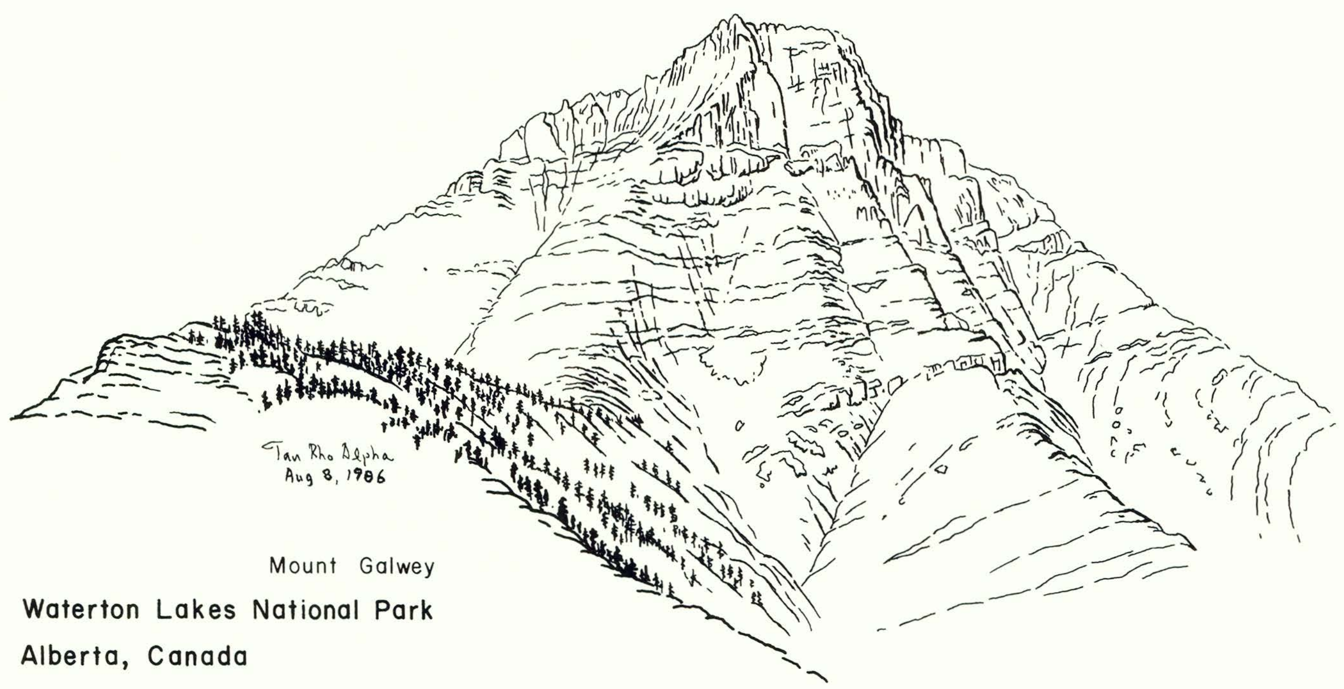
The view is toward the south in these three oblique maps of Mount St. Helens. The first represents the volcano in the summer of 1979 before the volcanic activity became visible. The second portrays the volcano on May 15, 1980, two days before the eruption. The summit phreatic crater (a crater formed by the explosion of steam, mud, or other material due to the heating and consequent expansion of water by an underlying heat source) and the extent of the growing bulge are emphasized (Rosenfeld and Cooke, 1982, p. 22). On May 18, 1980, Mount St. Helens erupted, devastating an area of 232 square miles (600 square kilometers). The third oblique map depicts the volcano eight days after the eruption. As sketch contour maps did not exist on May 26, 1980, this oblique map represents eyewitness accounts by geologists working on the volcano and media accounts, usually in the form of newspaper pictures. The third map was compiled in a short span of time, and these maps were on display during President Carter's briefing and tour of the devastated area. This map has been published in Alpha, Moore, and Jones (1980a, b, c).

SEQUENTIAL PHYSIOGRAPHIC DIAGRAMS OF MOUNT ST. HELENS, WASHINGTON 1979–80

By

Tau Rho Alpha, James G. Moore, and David R. Jones

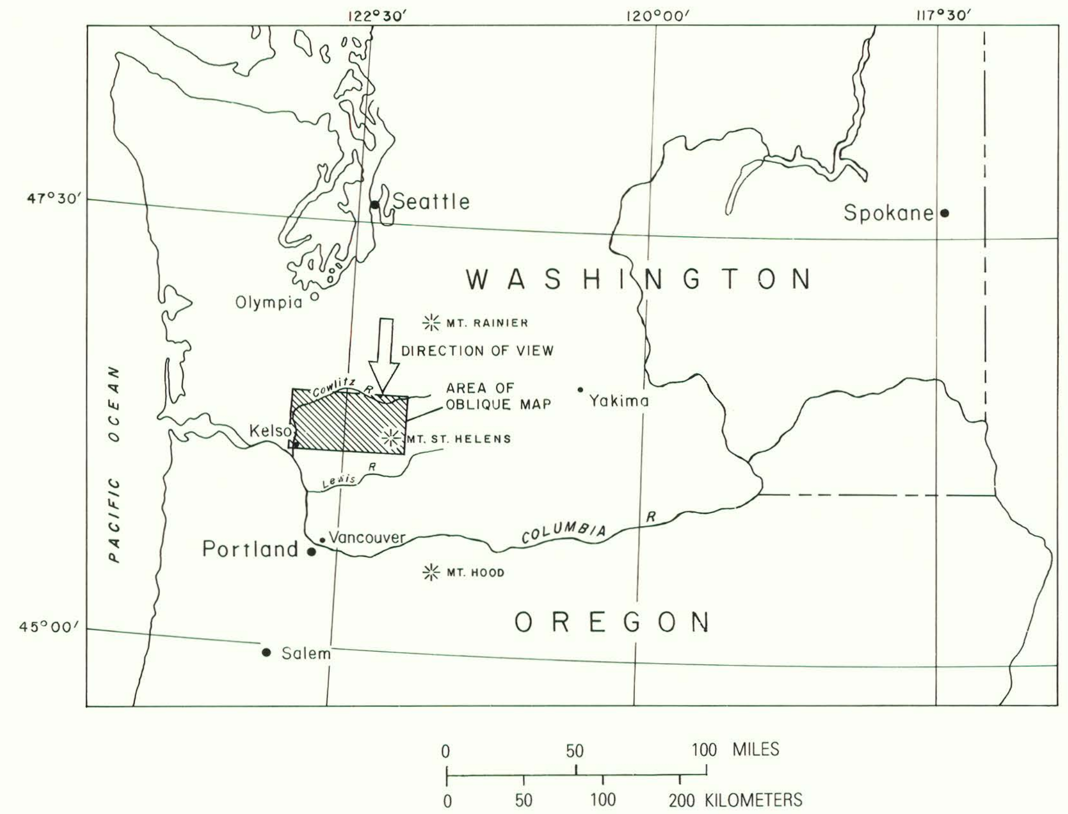
1980



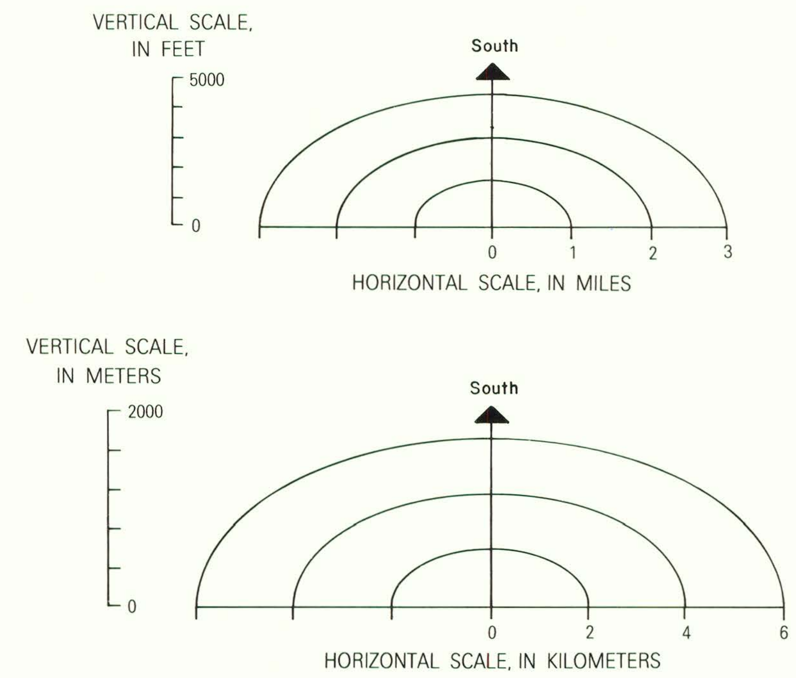
Mount Galwey

Waterton Lakes National Park

Alberta, Canada



INDEX MAP



VERTICAL EXAGGERATION X 2

EXPLANATION

EFFECTS OF ERUPTION

- Tree blowdown
- Mud flows
- Dead standing trees
- Rockslide avalanche

45

The view is toward the south in these two oblique maps of Mount St. Helens and vicinity. Each map includes Mount St. Helens, the Toutle River drainage, the lower Cowlitz River, and the cities of Castle Rock, Kelso, and Longview, Washington. The upper map represents the region before the eruption, and the lower map shows the effects of the eruption through June 1980, including the summit crater and dome, the debris avalanche, and the devastated area of blown down and scorched trees. The mudflow that rushed down the North and South Forks of the Toutle River, into the Cowlitz River, and on to the Columbia River at Longview, Washington, can be seen as a dot pattern along the flood plains of the rivers. The danger of large mudflows moving rapidly down the Toutle and Cowlitz Rivers still exists for people living along these flood plains (Rosenfeld and Cooke, 1982, p. 91). The area around Mount St. Helens that is depicted in the lower map is reproduced at the original scale on the next page in order to show the detail of the map. This map has been published in Alpha, Moore, and others (1980); Rosenfeld and Cooke (1982, p. 1).

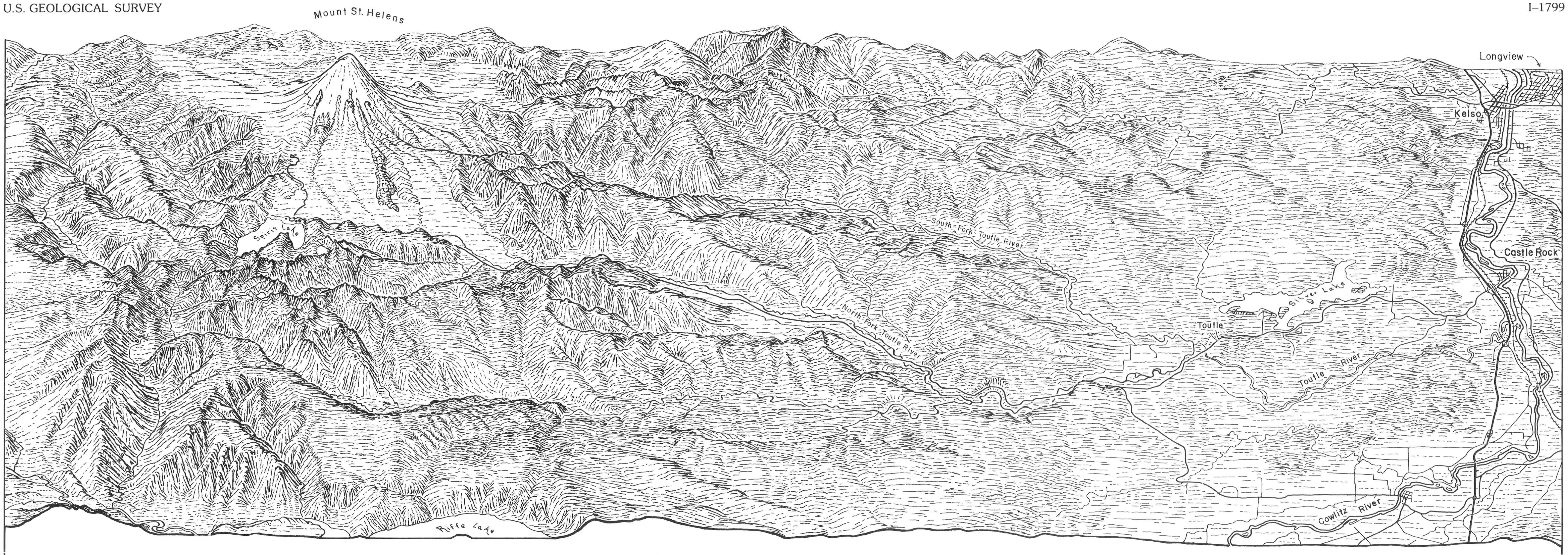
PHYSIOGRAPHIC DIAGRAMS OF MOUNT ST. HELENS AND VICINITY, WASHINGTON, 1980

By

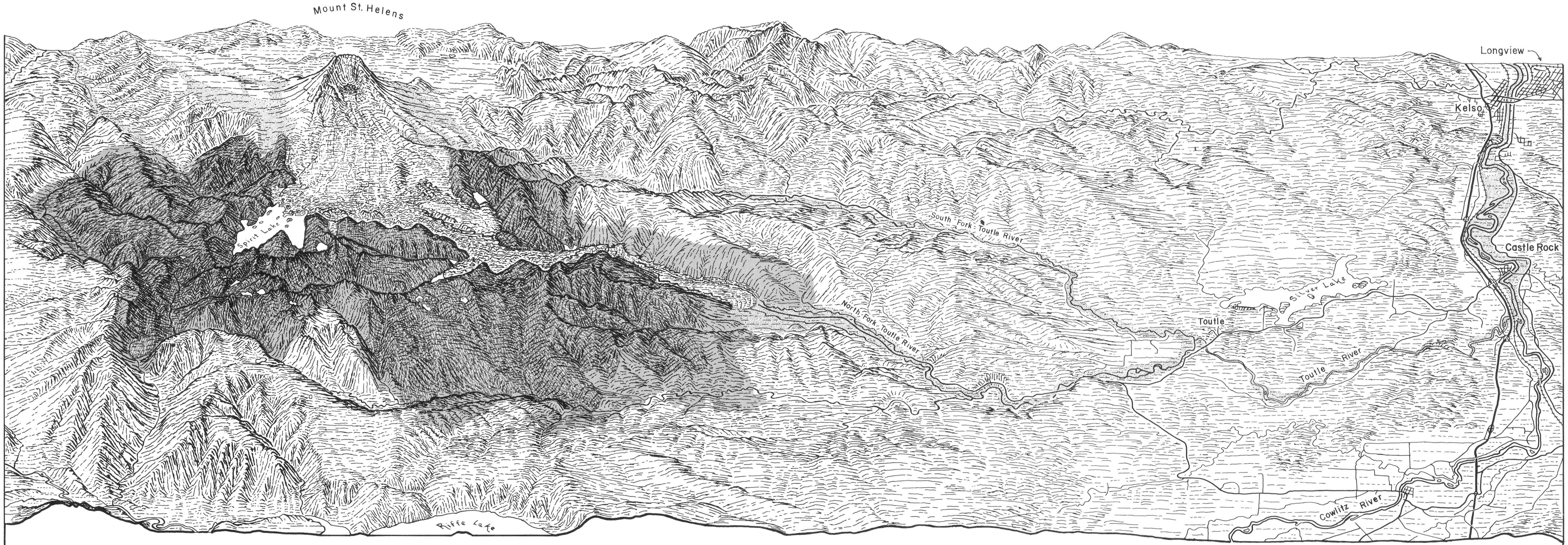
Tau Rho Alpha, James G. Moore, James M. Morley, and David R. Jones

1980

Maps on following page

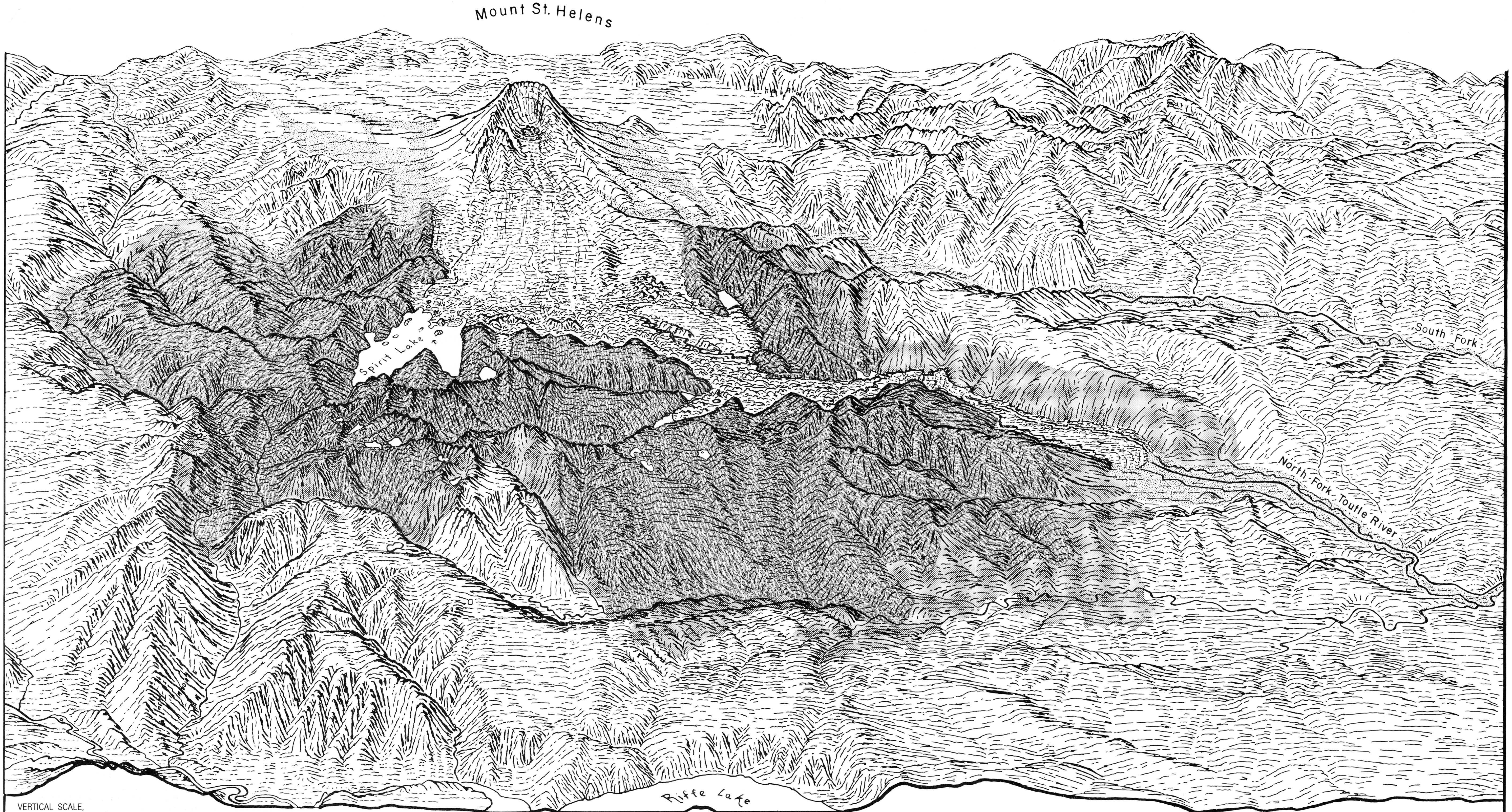


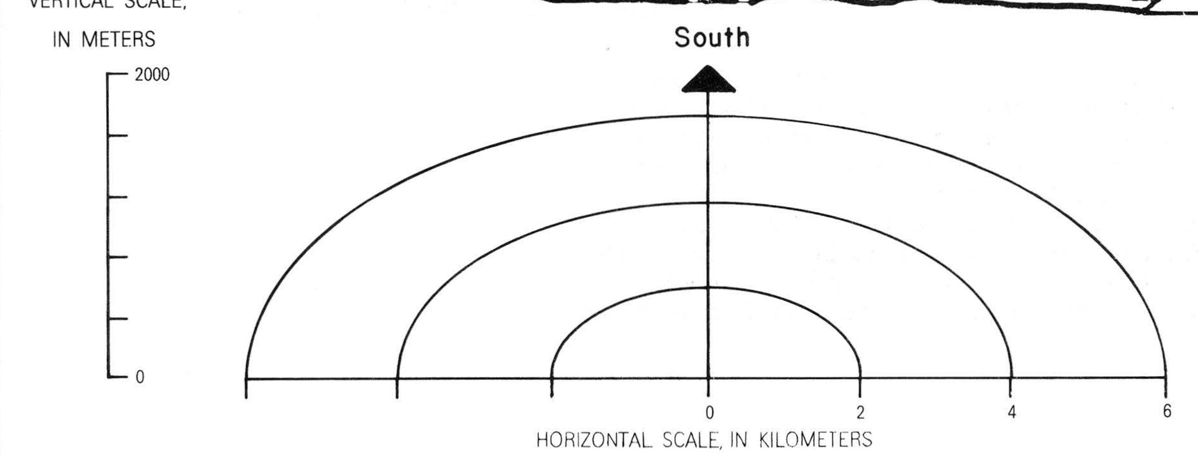
Pre-eruption



Effects of eruption through June 1980

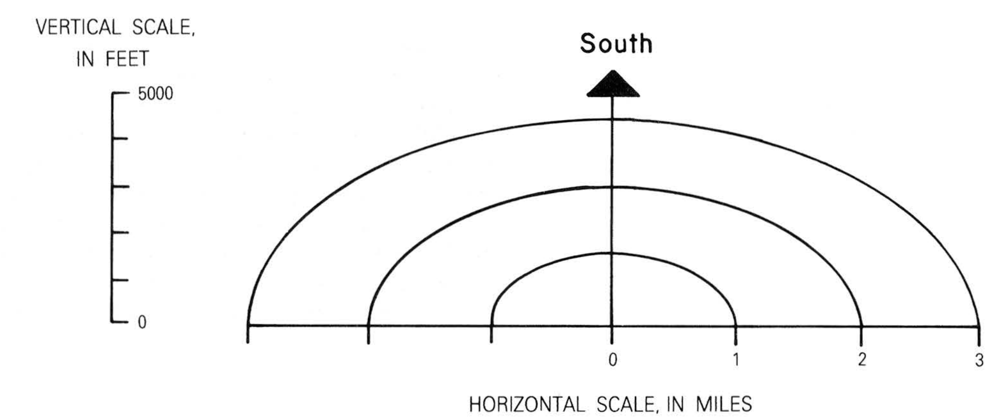
PHYSIOGRAPHIC DIAGRAMS OF MOUNT ST. HELENS AND VICINITY, WASHINGTON, 1980—*Continued*





EFFECTS OF ERUPTION THROUGH JUNE 1980

This physiographic diagram, a portion of the one on the previous page, is shown here at the original publication scale in order to show the techniques used to portray the effects of the eruption. Rockslide or debris avalanches are shown as hummocky and hilly surfaces, which can be seen at the base of the mountain. The symbol for mudflows is a dot pattern composed of large and small dots, as on the east and west flanks of the mountain. Dead standing trees are symbolized by a uniform dot pattern, as on the flanks of the North Fork Toutle River. The tree blowdown symbol is a random-dot pattern from which individual trees were cut out. The resulting symbols are white blowdown trees that indicate the direction of blowdown on a relatively dark random-dot pattern. This map has been published in Alpha, Moore, and others (1980); Rosenfeld and Cooke (1982, p. 1).



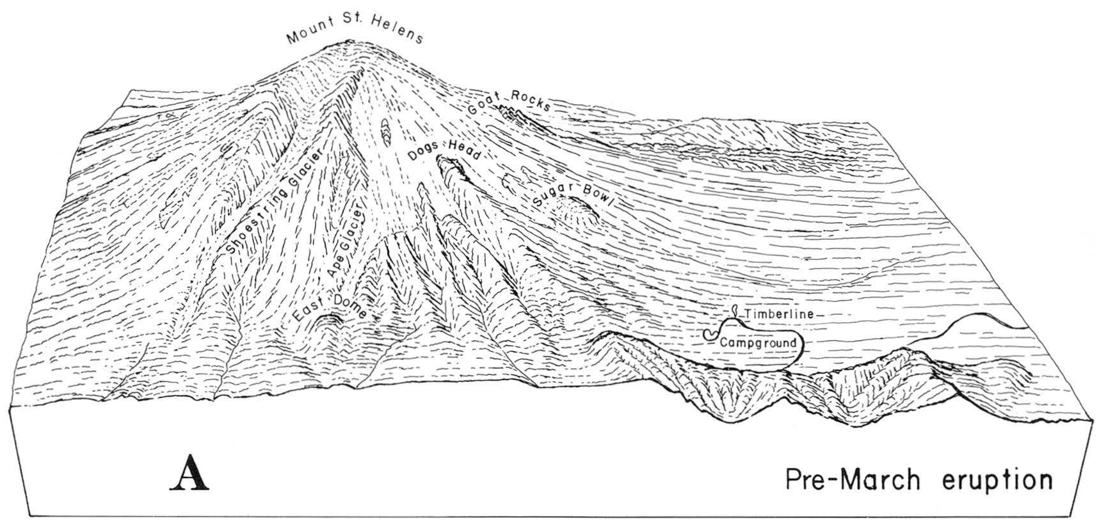
VERTICAL EXAGGERATION X 2

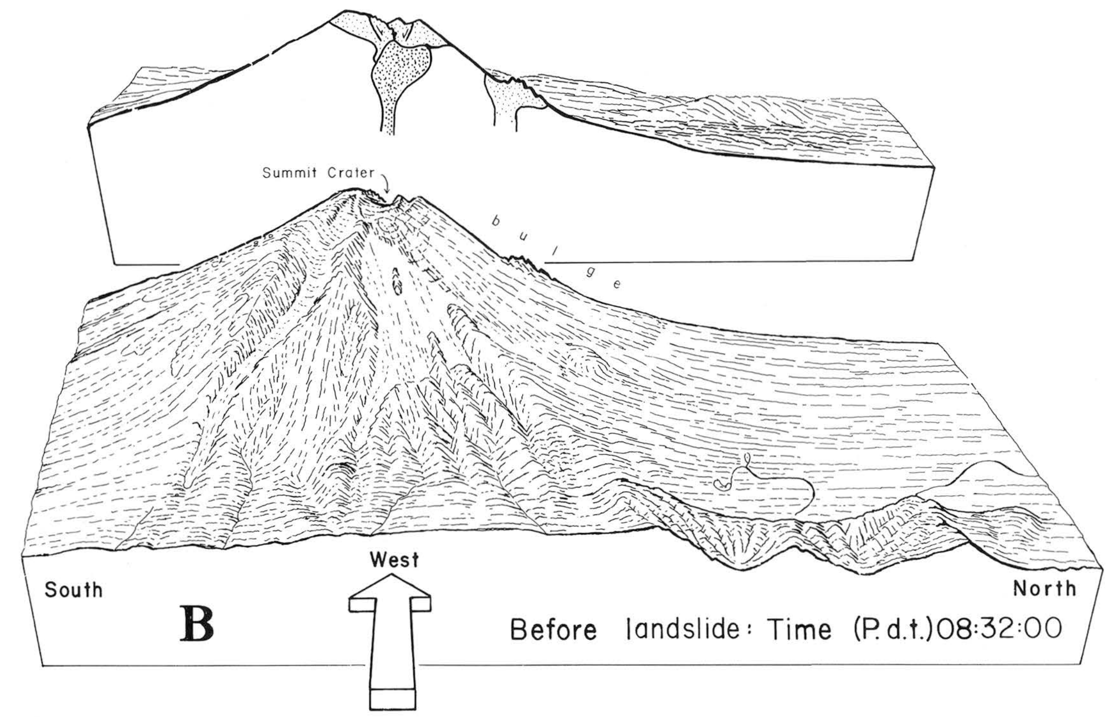
A PART OF THE PHYSIOGRAPHIC DIAGRAMS OF MOUNT ST. HELENS AND VICINITY, WASHINGTON, 1980

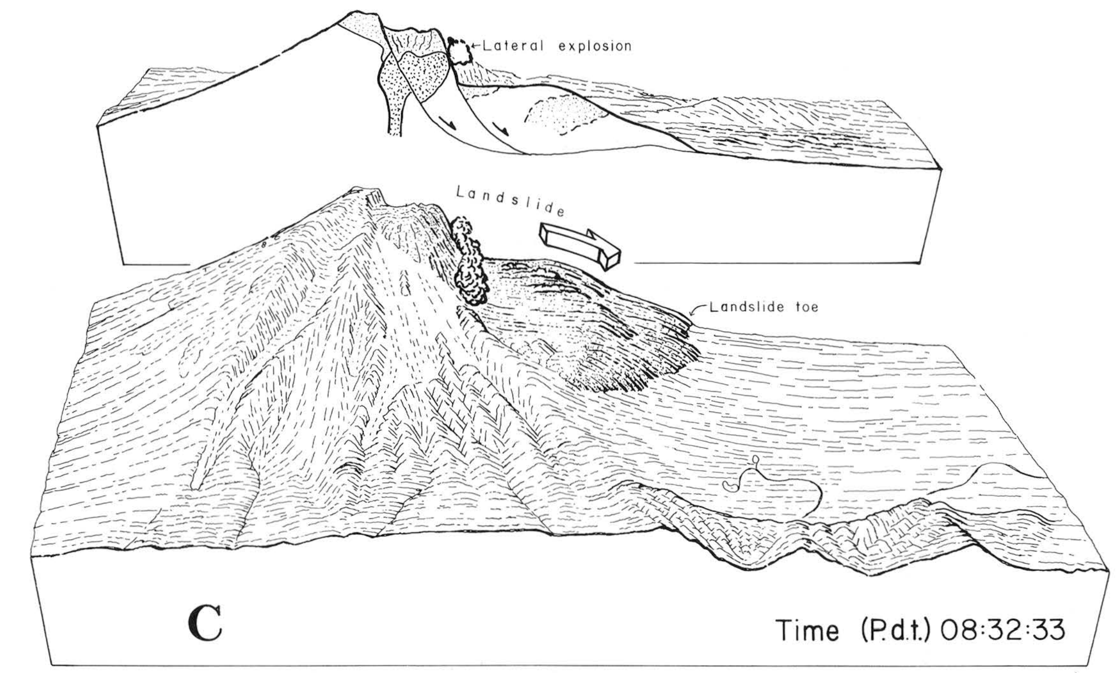
By
Tau Rho Alpha, James G. Moore, James M. Morley, and David R. Jones

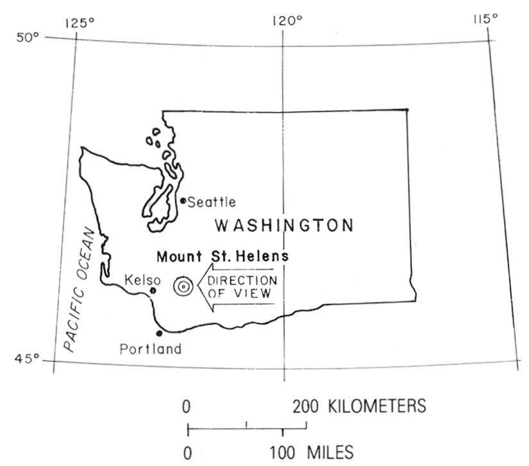
1980

See previous map for explanation









INDEX MAP

0 1 2 3 KILOMETERS

0 10,000 FEET

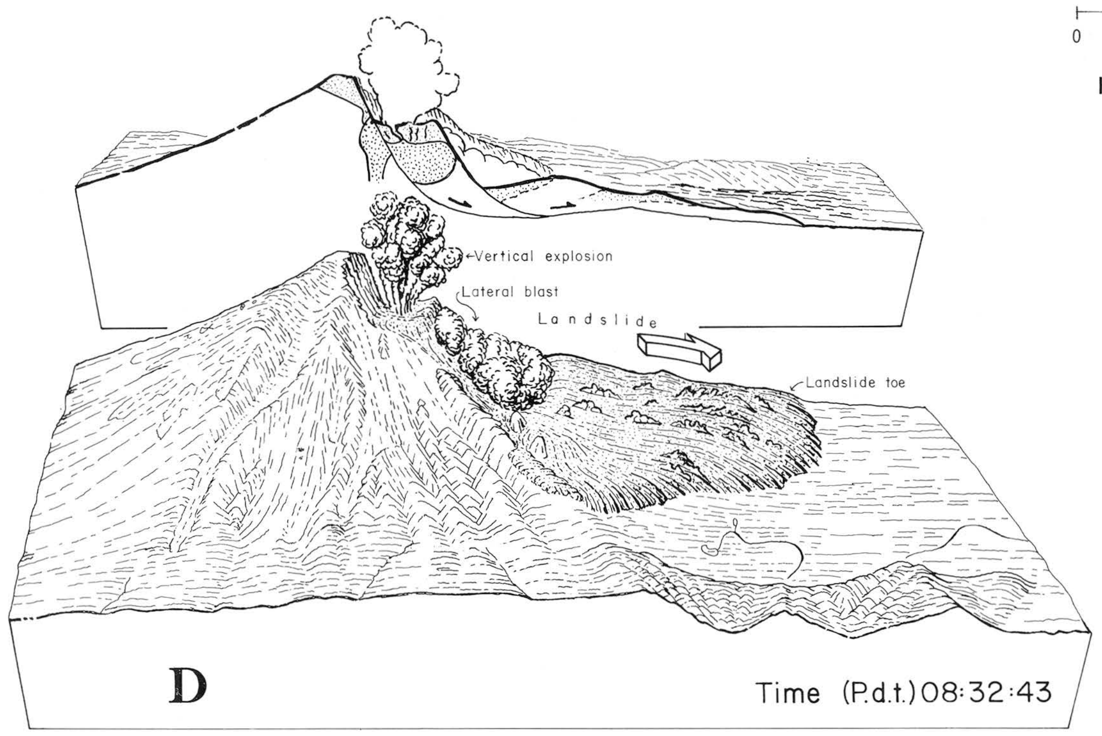
Approximate north-south scale 1:36 000
Angle of view 20° from horizon
Direction of view is toward the west

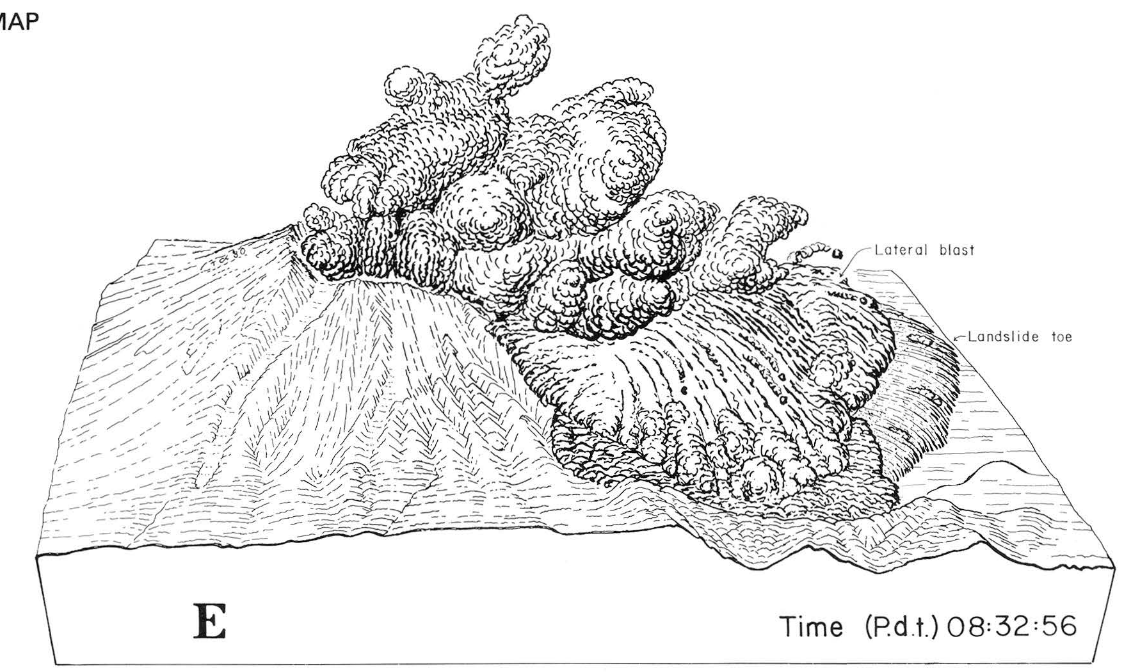
NO VERTICAL EXAGGERATION

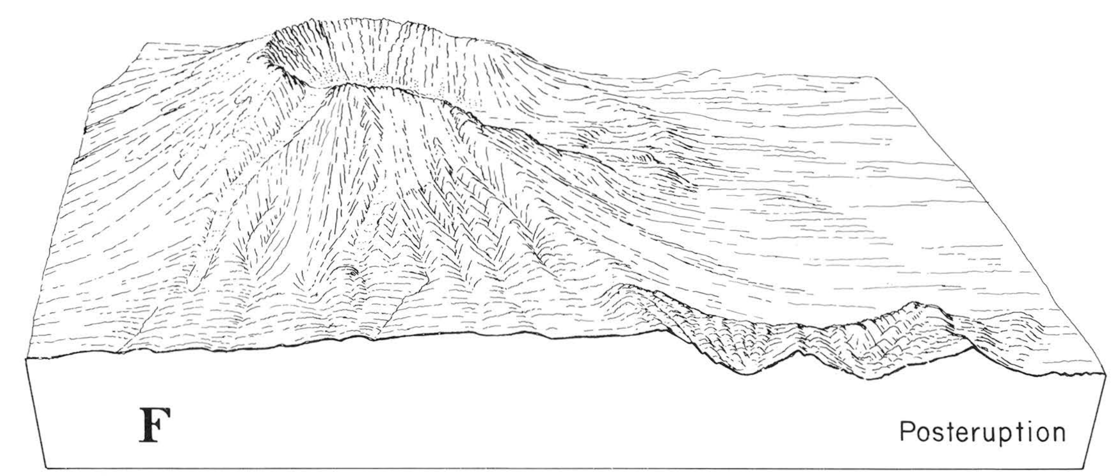
EXPLANATION

16th-CENTURY SUMMIT DOME AND 19th-CENTURY GOAT ROCKS DOME

DACITIC CRYPTODOME, 1980







Diagrams based in part on computer-generated digital terrain maps prepared by the National Mapping Division, U.S. Geological Survey.

Viewed toward the west, this sequence of diagrams illustrates the complex series of events that culminated in the catastrophic eruption of Mount St. Helens on the morning of May 18, 1980.

The volcano, dormant since the middle of the last century (A), began a series of small eruptions on March 27, 1980, which excavated a small summit crater (B). This crater grew slowly prior to May 18, as did a prominent bulge on the north flank, which rose as much as 492 feet (150 meters). The bulge was produced by intrusion of new igneous rock into a cryptodome (heavy stipple) beneath an old summit dome (light stipple). Immediately after an earthquake at 08:32:11 a.m. (P.d.t.), the oversteepened bulge failed and became a landslide composed of two giant blocks (C) (Alpha and Moore, 1981).

Removal of material by landsliding exposed and depressurized the cryptodome on the steep headwall between the blocks. This pressure reduction caused a massive explosion and a laterally directed blast to issue from the cryptodome system (C). A few seconds later, fracturing of the upper landslide block permitted explosions to rise vertically from the area of the previous summit crater (D). (Rosenfeld and Cooke, 1982, p. 5). The initial explosions from the exposed cryptodome combined to produce a second and much larger lateral blast that swept down the north flank (E), overtook the moving landslide, and eventually devastated an area of about 232 square miles (600 square kilometers) to the north of the mountain.

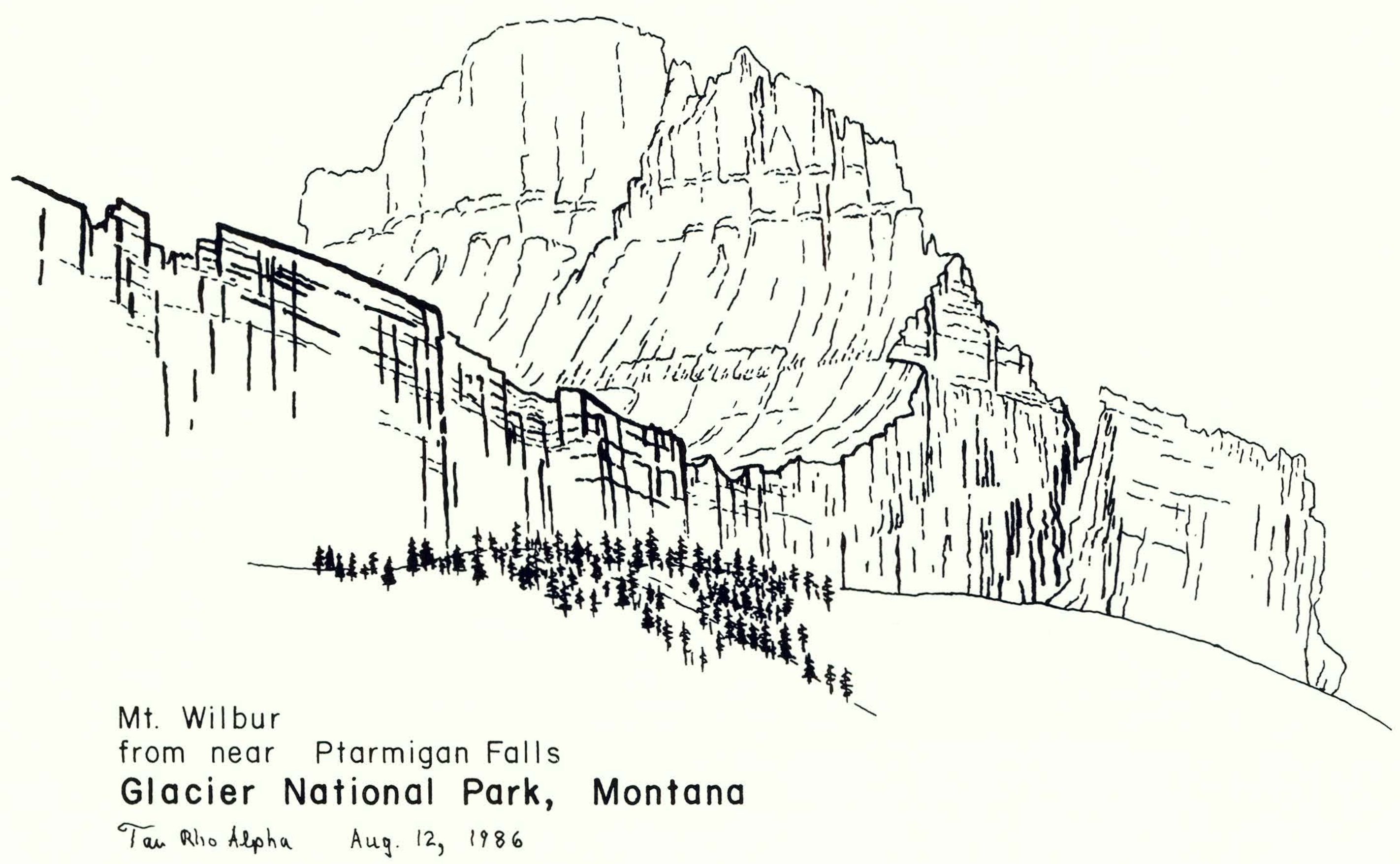
Landsliding and explosions eventually exposed the main volcanic conduit beneath the previous summit, and a massive column of steam, ash, and rock debris rose from it for several hours. By the afternoon of May 18, the removal of approximately 0.72 square miles (3 square kilometers) of material by the landslide and eruption had produced the large amphitheater crater (F). This map has been published in Alpha and Moore (1981).

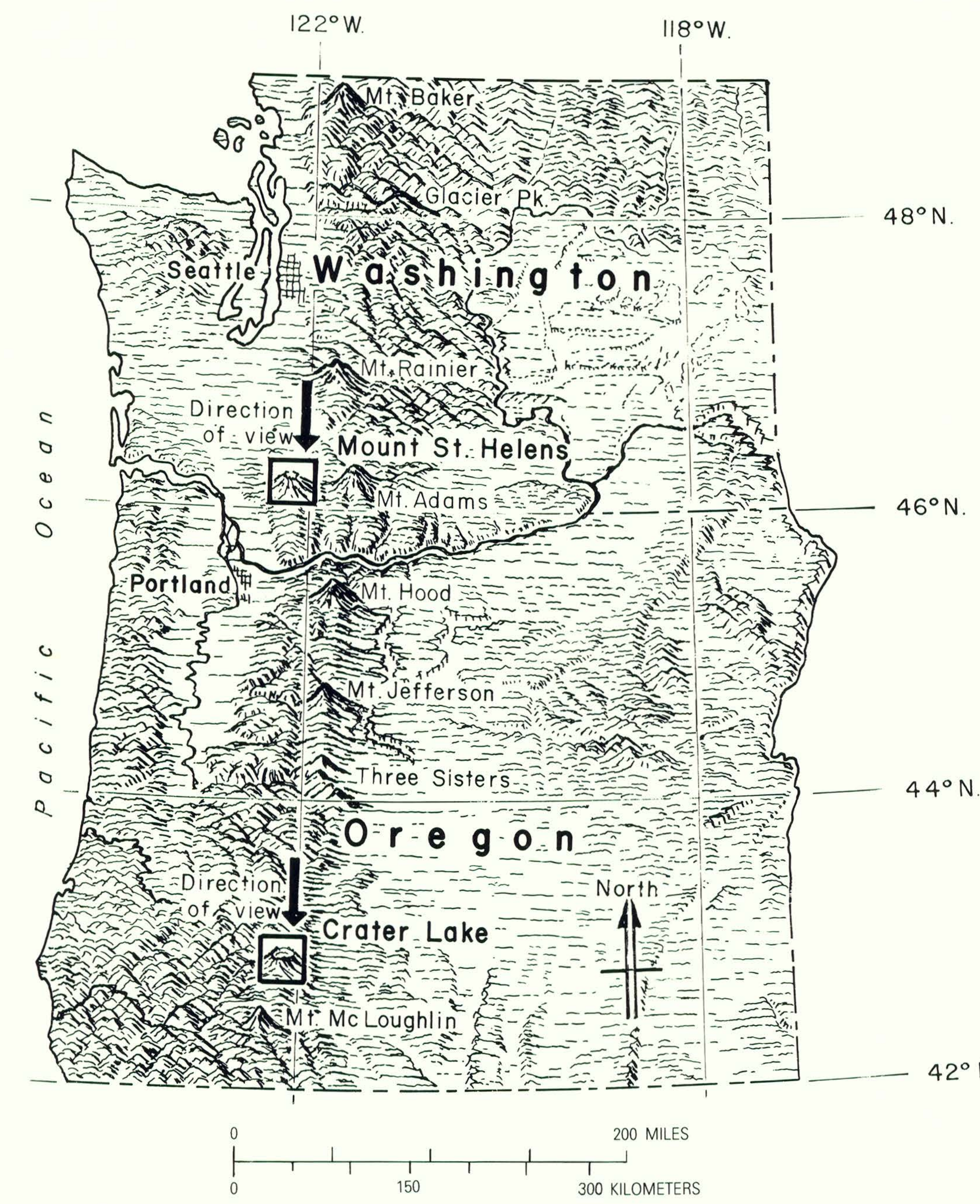
PHYSIOGRAPHIC DIAGRAMS OF THE MAY 18, 1980, LANDSLIDE-ERUPTION OF MOUNT ST. HELENS, WASHINGTON

By

Tau Rho Alpha and James G. Moore

1981





INDEX MAP

Viewed toward the south, these physiographic diagrams show two Cascade Range volcanoes that have had their summits destroyed—Mount St. Helens in 1980 and Mount Mazama (now occupied by Crater Lake) about 6,800 years ago.

The 1980 eruptions of Mount St. Helens began on May 18 when an earthquake triggered a huge landslide on the north side of the mountain. A violent, north-directed blast destroyed trees over a fan-shaped area covering more than 232 square miles (600 square kilometers). Following the landslide and blast, a vertical eruption threw ash into the air for more than 32 miles (20 kilometers), and winds carried it hundreds of miles to the east (Rosenfeld and Cooke, 1982, p. 5).

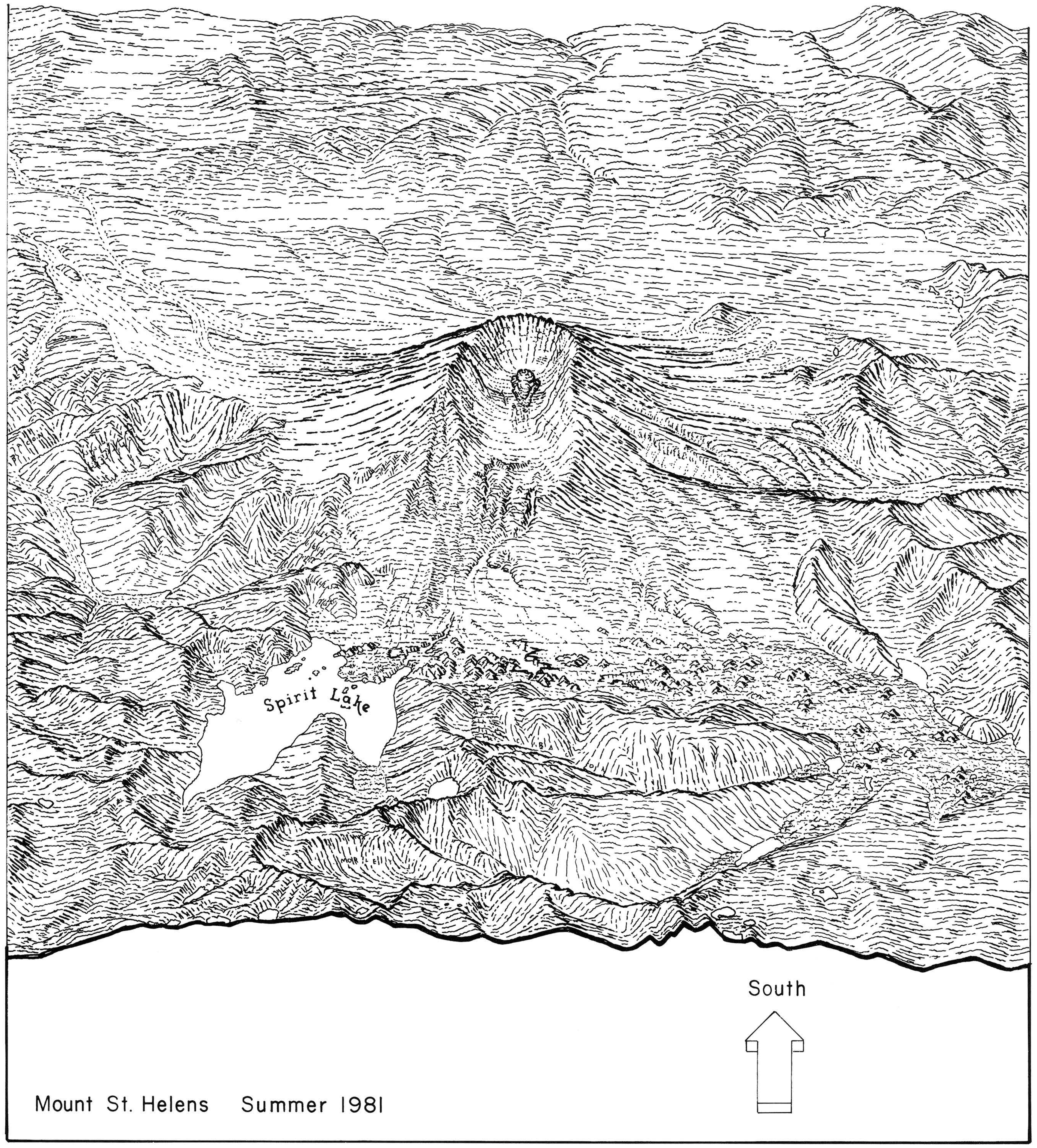
Crater Lake half fills the large, basin-shaped caldera of Mount Mazama, which was a volcano much larger than Mount St. Helens. During the climatic eruption of Mount Mazama, hot mudflows rushed down valleys, and pumice and ash were deposited over a large area. As magma was removed from the chamber beneath the volcano and ejected at the surface, Mount Mazama collapsed, forming a caldera (Rosenfeld and Cooke, 1982, p. 49). This caldera was flooded by rainwater and snowmelt and formed Crater Lake. As spectacular and devastating as the 1980 eruption of Mount St. Helens was, it was a minor event compared to the cataclysmic destruction of Mount Mazama (Alpha and Morley, 1982a). This map has been published in Alpha and Morley (1982a).

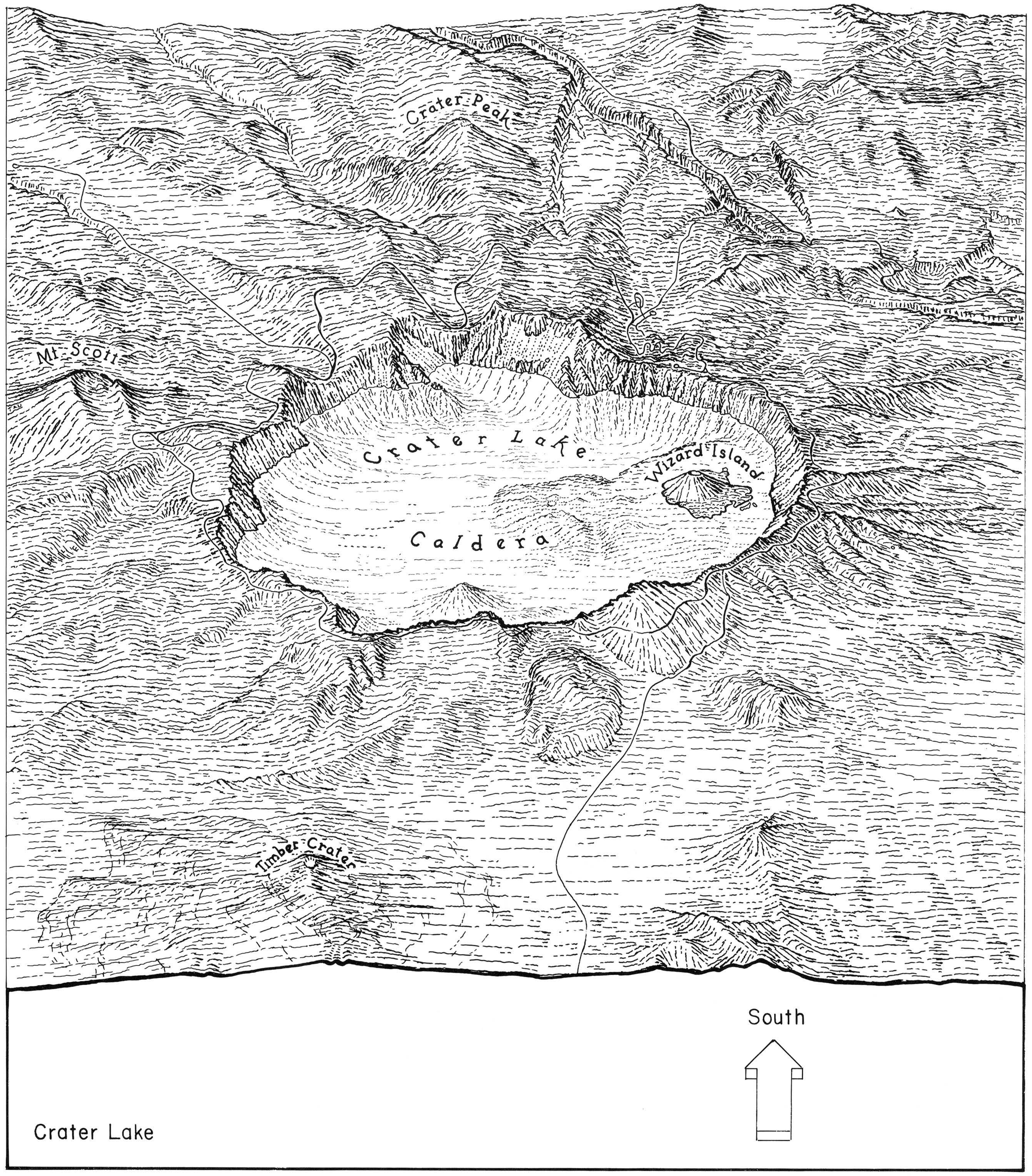
COMPARATIVE PHYSIOGRAPHIC DIAGRAMS OF MOUNT ST. HELENS, WASHINGTON, AND CRATER LAKE, OREGON

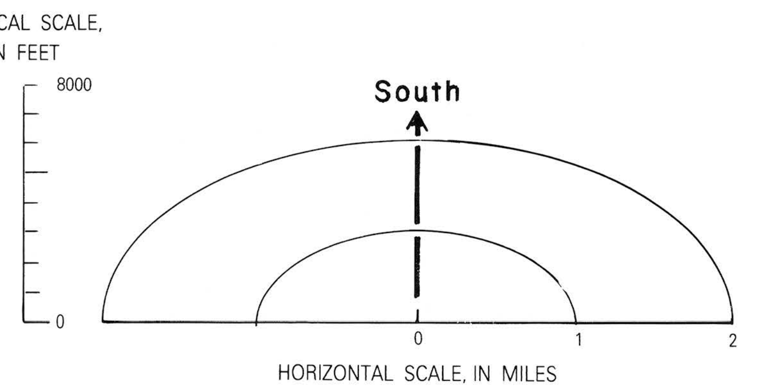
By
Tau Rho Alpha and James M. Morley

1982

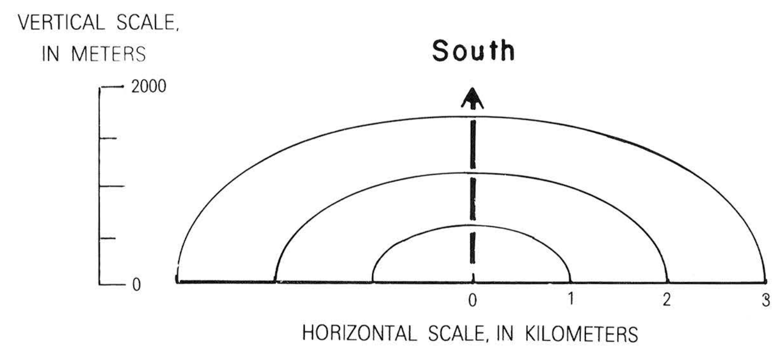
Maps on following page







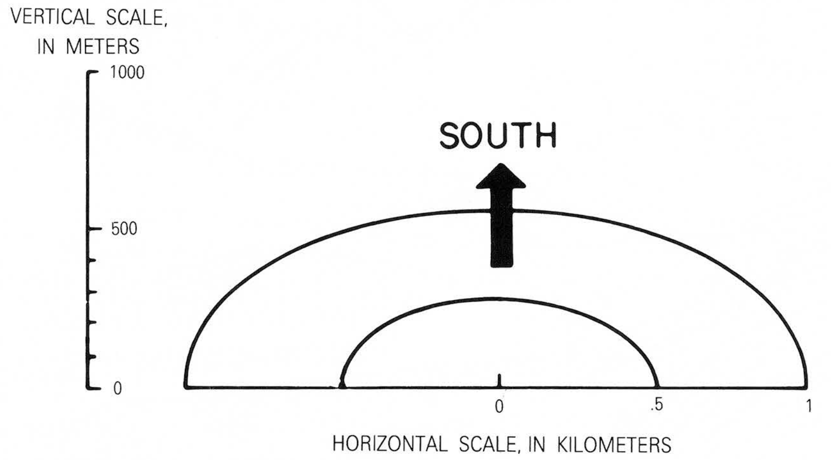
NO VERTICAL EXAGGERATION

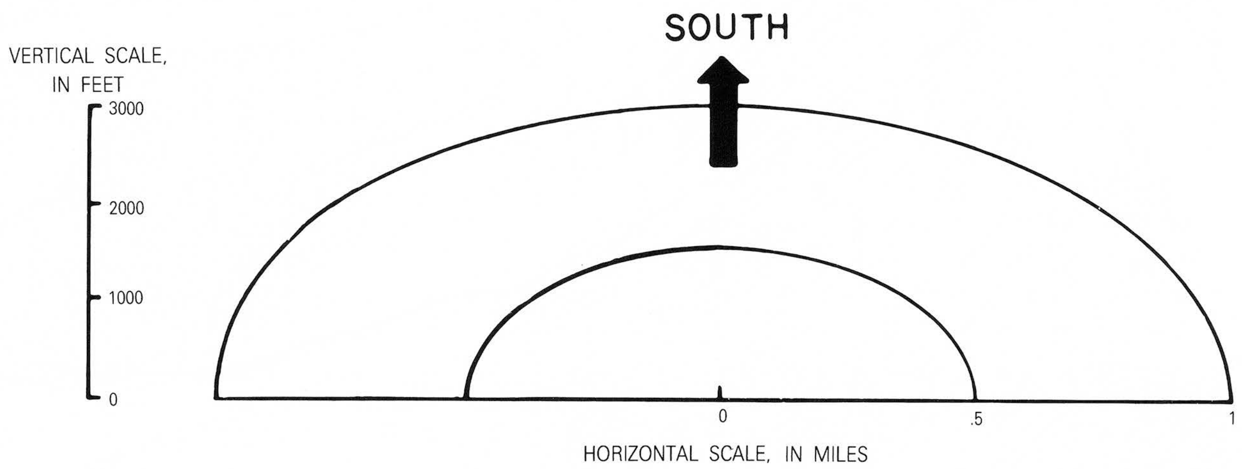


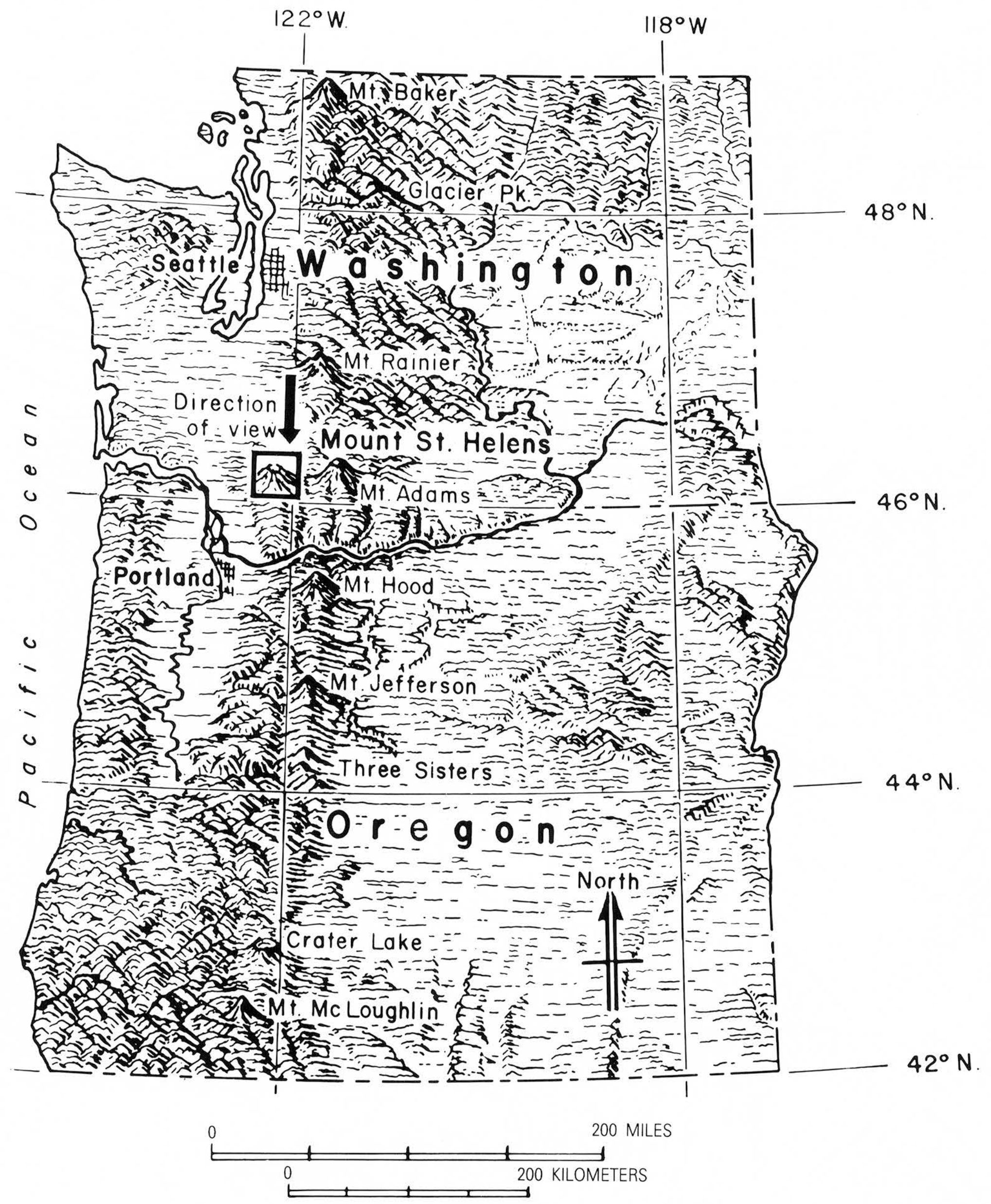
COMPARATIVE PHYSIOGRAPHIC DIAGRAMS OF MOUNT ST. HELENS, WASHINGTON, AND CRATER LAKE, OREGON—*Continued*

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

SCALES FOR LARGE OBLIQUE MAP
NO VERTICAL EXAGGERATION

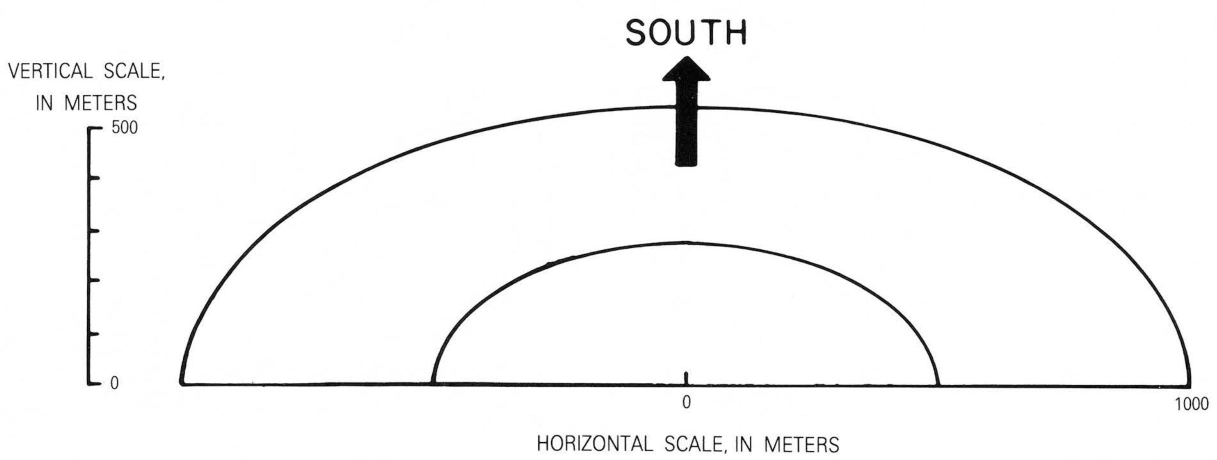


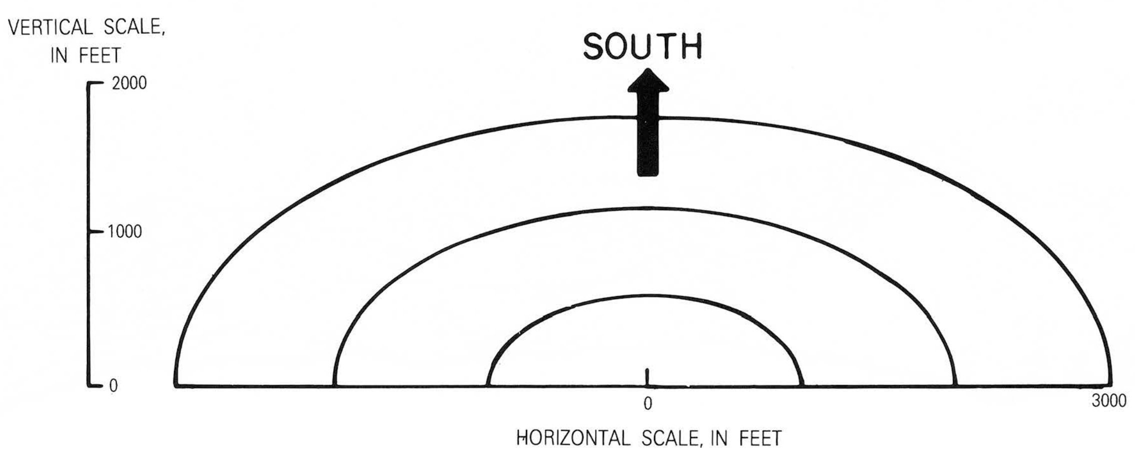




LOCATION MAP

SCALES FOR CRATERS
NO VERTICAL EXAGGERATION





The large oblique map, which is viewed toward the south, portrays Mount St. Helens and local landforms as they appeared on July 1, 1980. The dome and debris avalanche can be seen inside the crater. Spirit Lake, debris avalanche, and Coldwater Ridge are in the foreground. Two significant changes occurred in the crater after the eruption on May 18, 1980: (1) the development of the dome and (2) the erosion of the crater. These changes are portrayed at a larger scale on the accompanying four oblique maps of the summit crater. This map has been published in Alpha, Moore, and others (1981). Part of this map (the summit crater) has been published in Moore and others (1981, p. 543).

PHYSIOGRAPHIC DIAGRAMS OF MOUNT ST. HELENS, WASHINGTON, SHOWING CHANGES IN ITS SUMMIT CRATER, SUMMER 1980

By

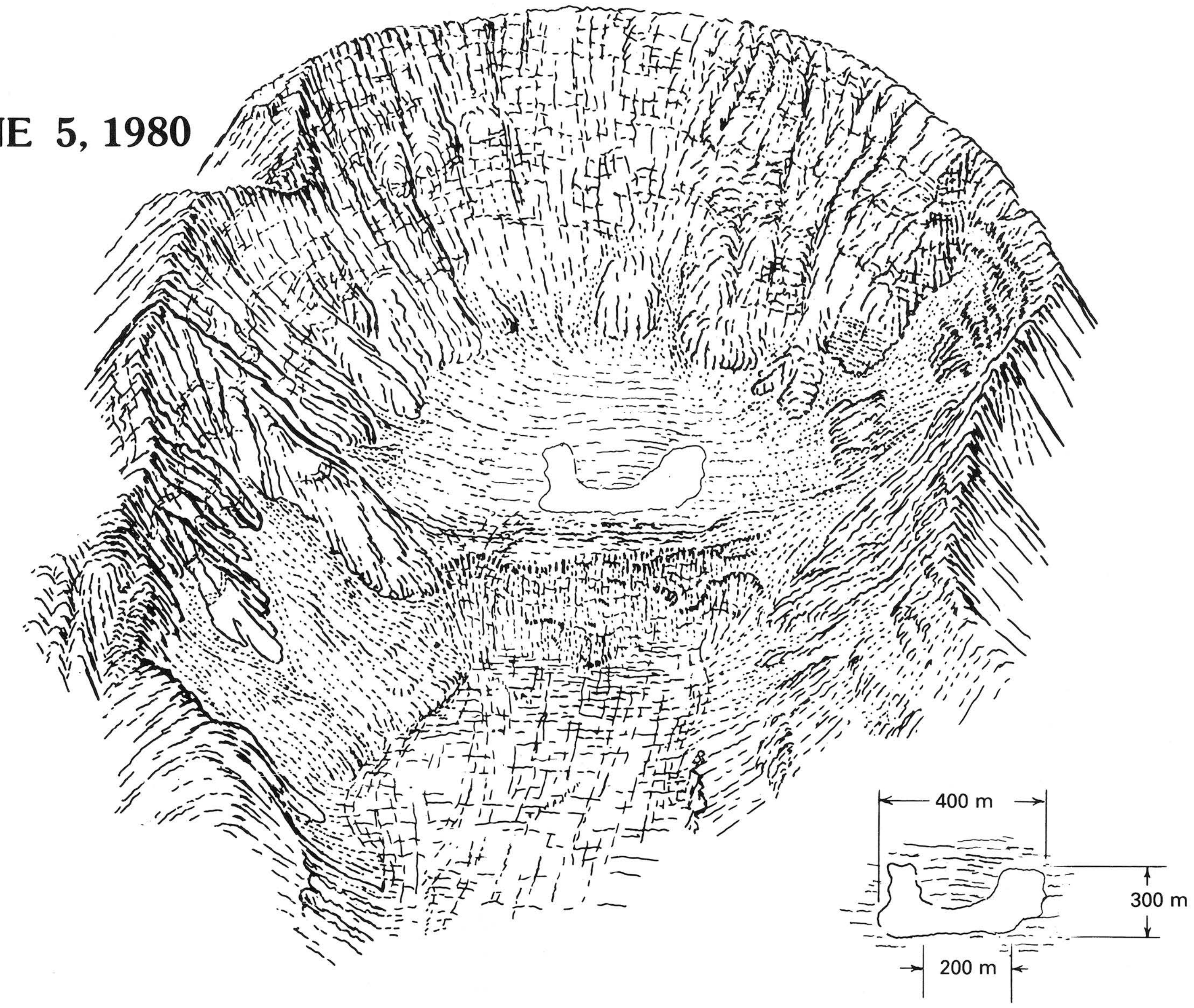
Tau Rho Alpha, James G. Moore, James M. Morley, and David R. Jones

1981

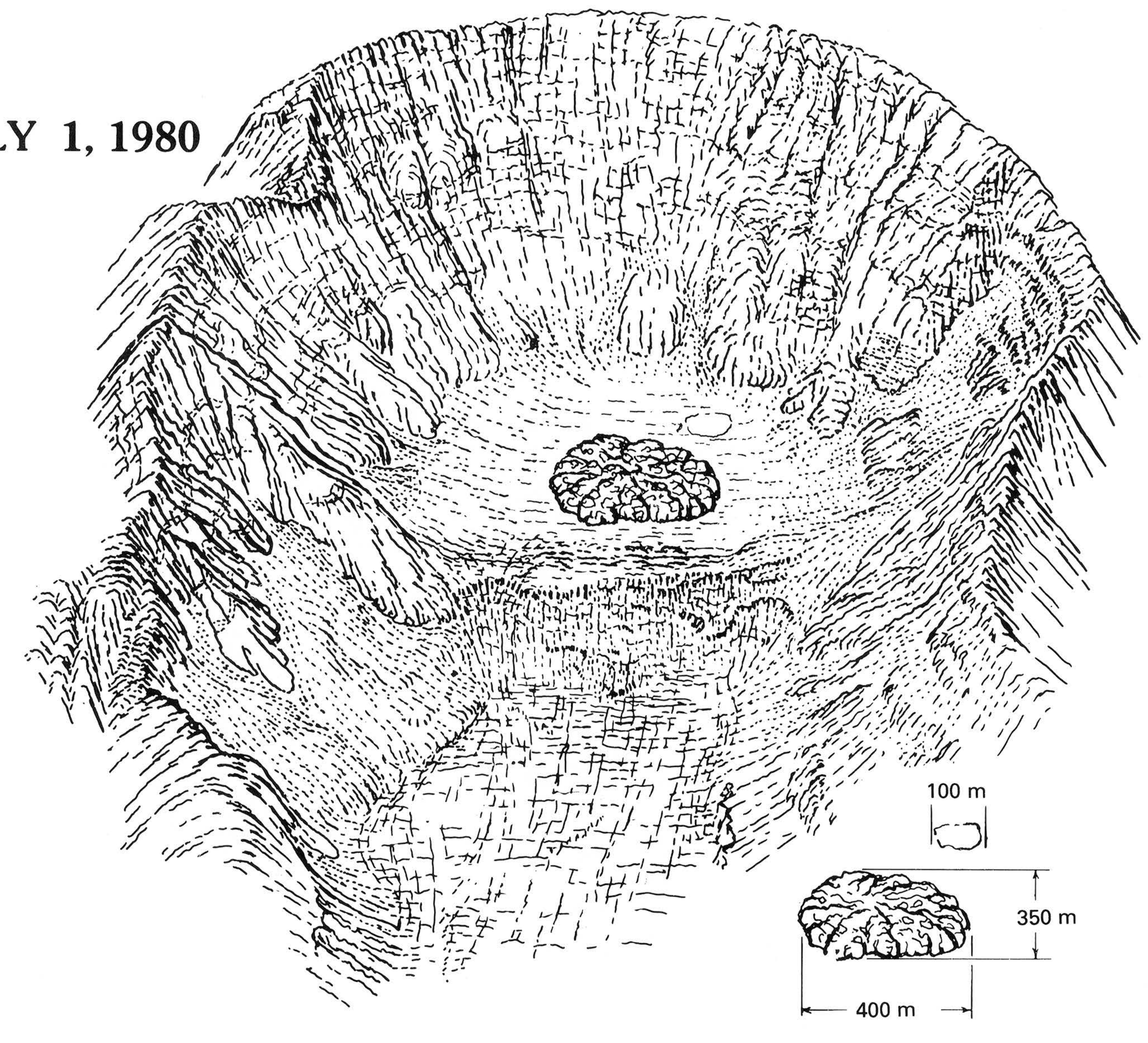
Maps are on following two pages

PHYSIOGRAPHIC DIAGRAMS OF MOUNT ST. HELENS, WASHINGTON, SHOWING CHANGES IN ITS SUMMIT CRATER, SUMMER 1980—*Continued*

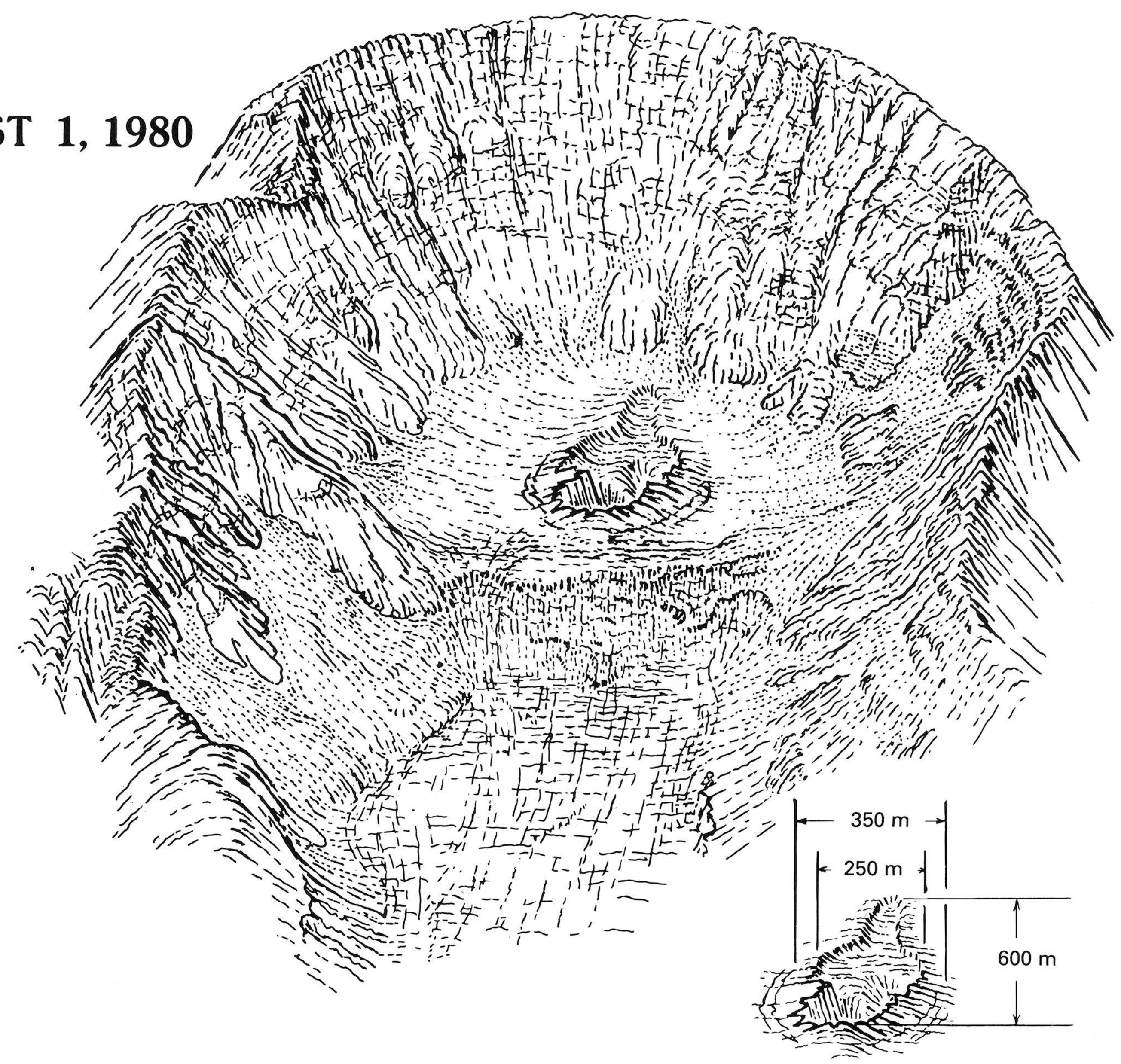
JUNE 5, 1980



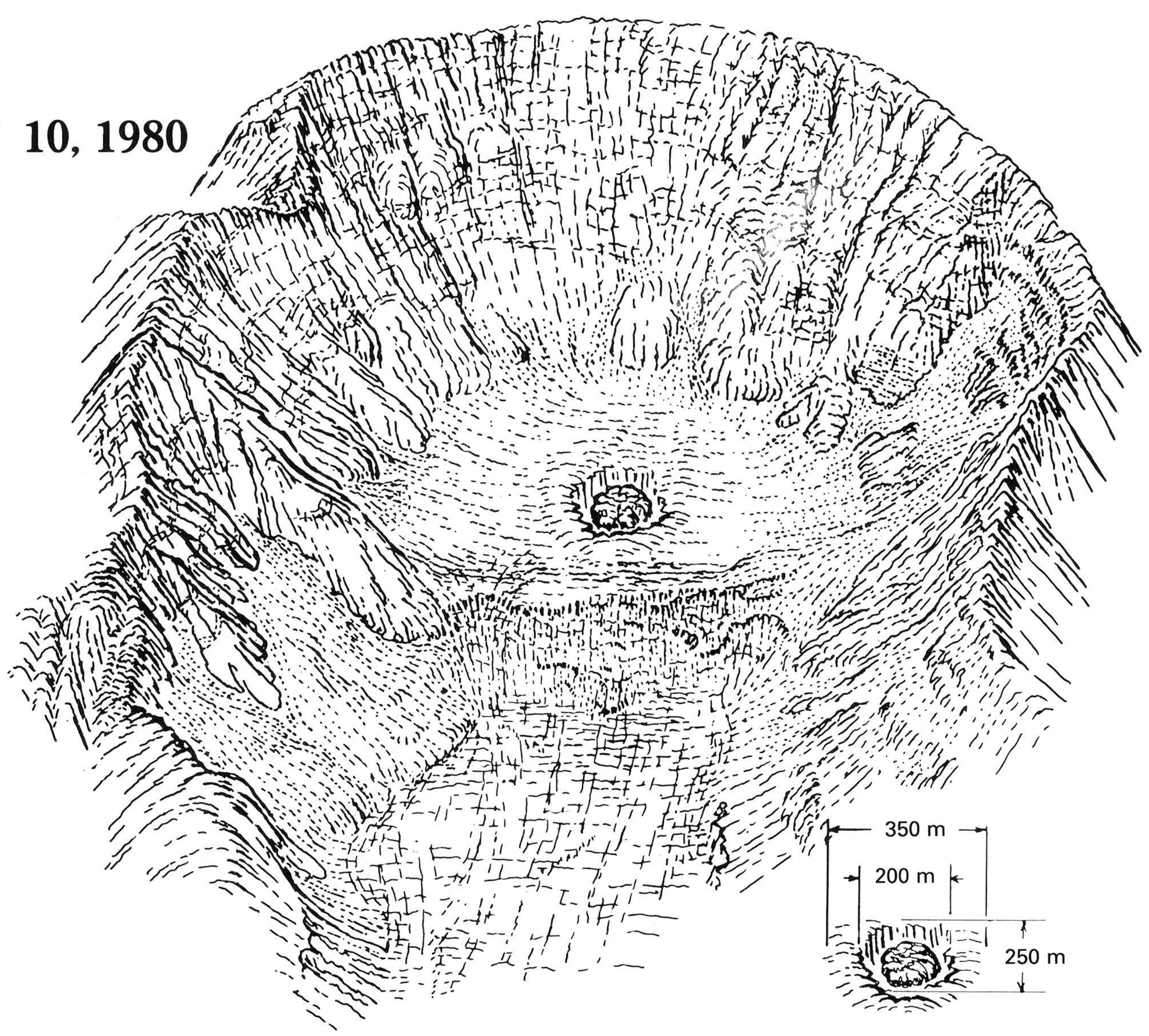
JULY 1, 1980



AUGUST 1, 1980



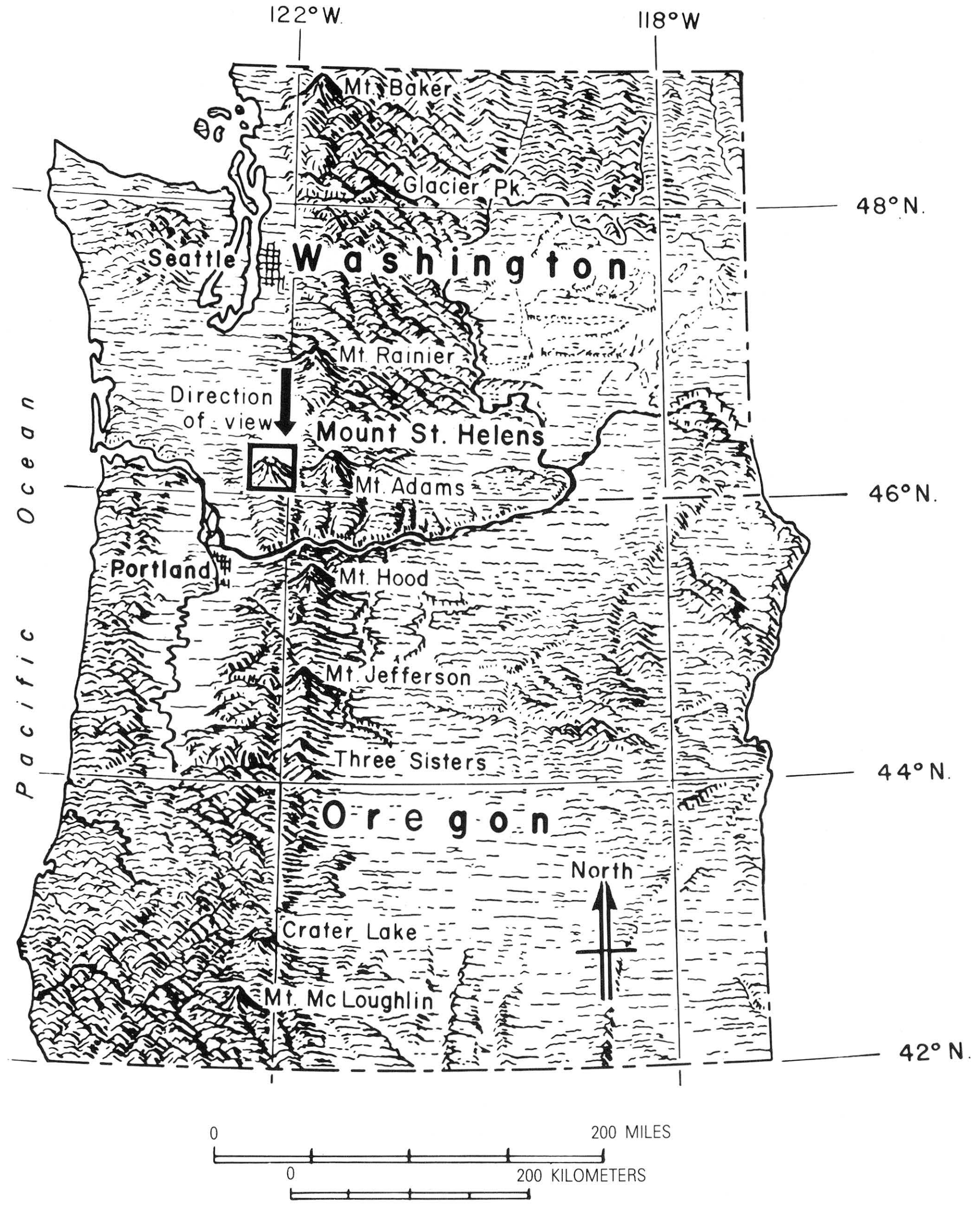
AUGUST 10, 1980



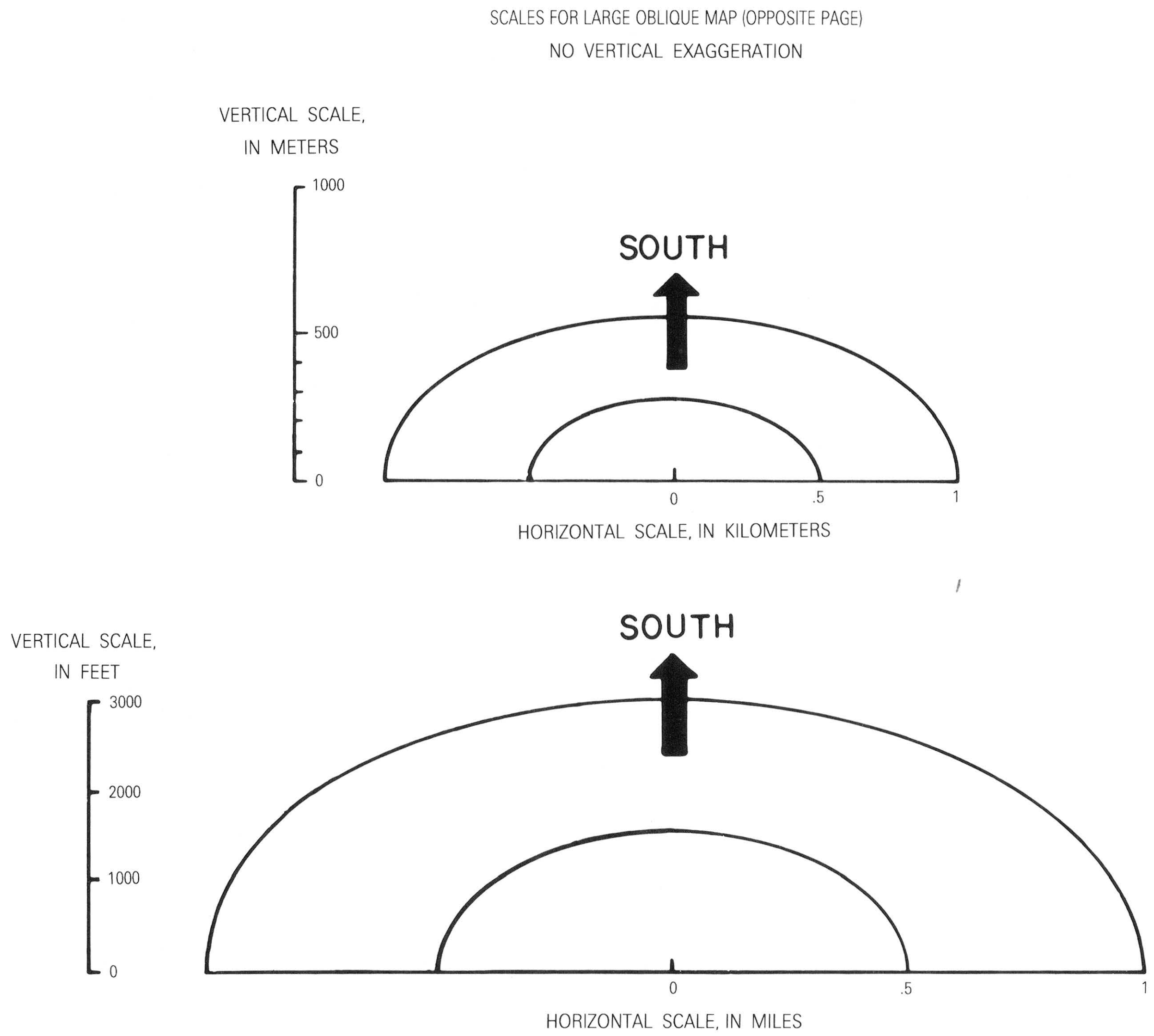
PHYSIOGRAPHIC DIAGRAMS OF MOUNT ST. HELENS, WASHINGTON, SHOWING CHANGES IN ITS SUMMIT CRATER, SUMMER 1980—*Continued*

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

ATLAS OF OBLIQUE MAPS
I–1799



LOCATION MAP



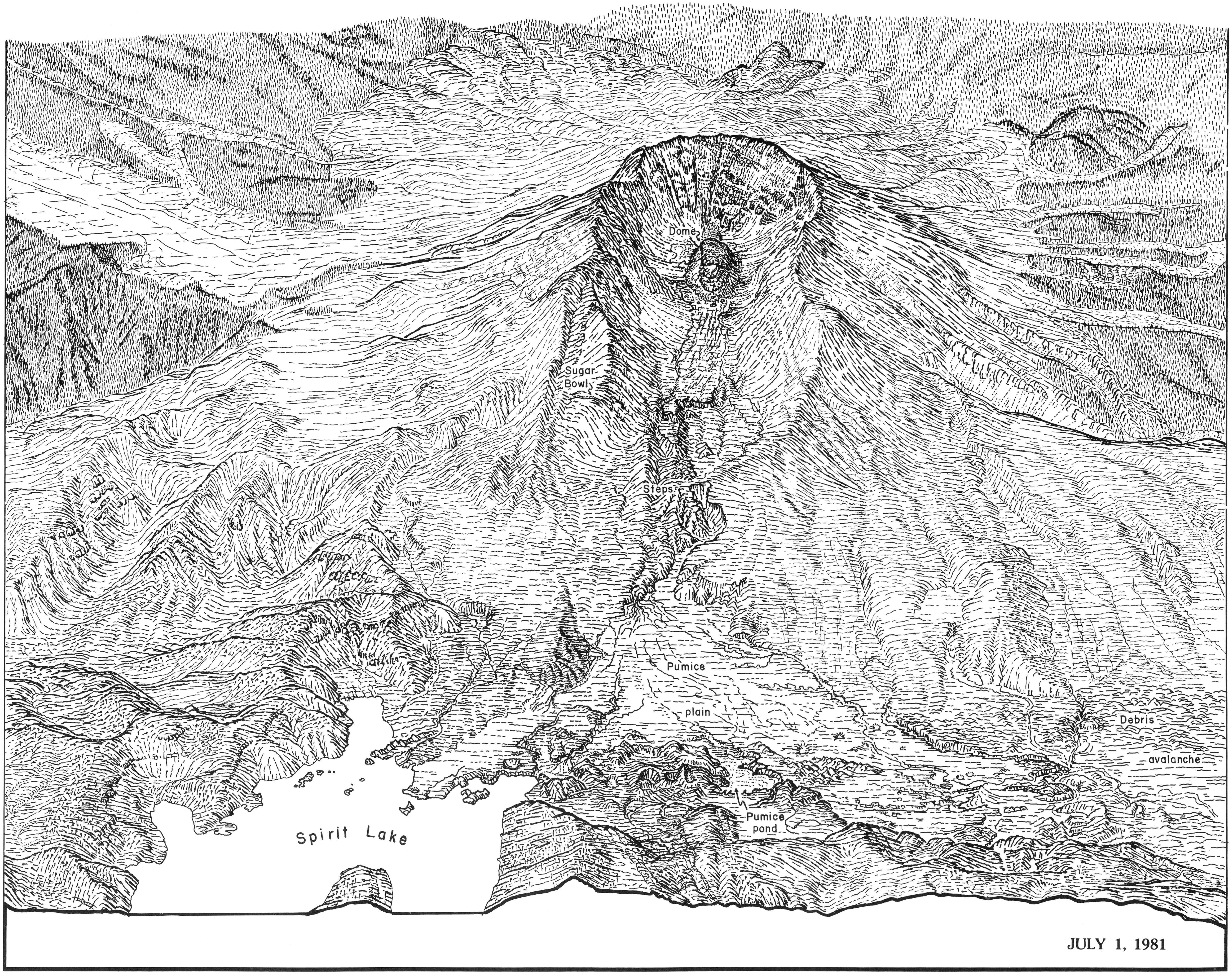
In a continuation of the 1980 oblique mapping, the large oblique map portrays Mount St. Helens and local landforms as they appeared on July 1, 1981, looking south into the crater. Many eruption-related features on Mount St. Helens now carry names: Dome, Steps, Pumice Plain, pumice pond, and Debris Avalanche. Comparison with the previous 1980 oblique map shows that the Dome is larger, the amphitheater and the Steps have eroded, and drainage patterns are developing on the Pumice Plain and Debris Avalanche. The south shore of Spirit Lake has encroached on the Debris Avalanche. The six larger scale oblique maps portray significant changes in the Dome and crater during 1981. This map has been published in Alpha, Morley, and others (1982).

PHYSIOGRAPHIC DIAGRAMS OF MOUNT ST. HELENS, WASHINGTON, SHOWING CHANGES IN ITS SUMMIT CRATER, SUMMER 1981

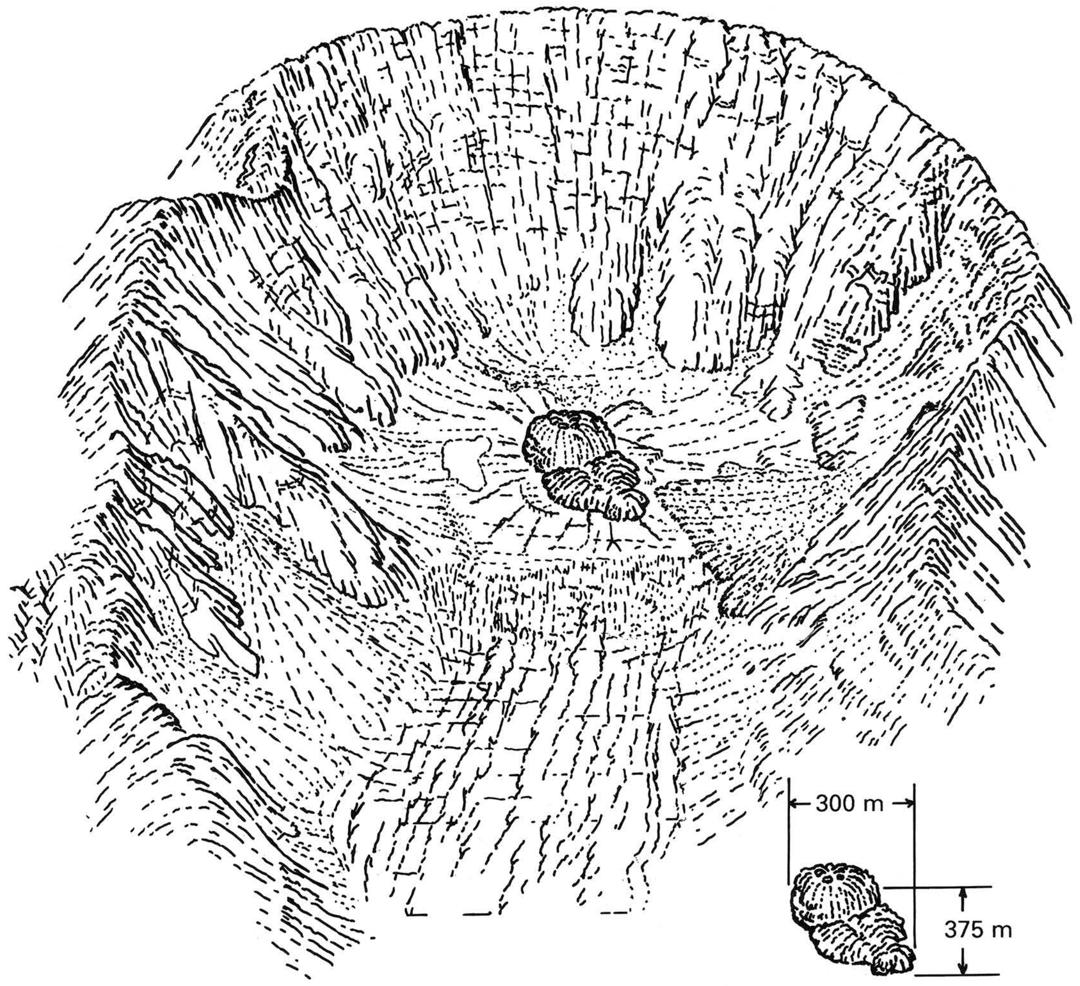
By
Tau Rho Alpha, James M. Morley, Bobbie Myers, and Terry Leighley

1982

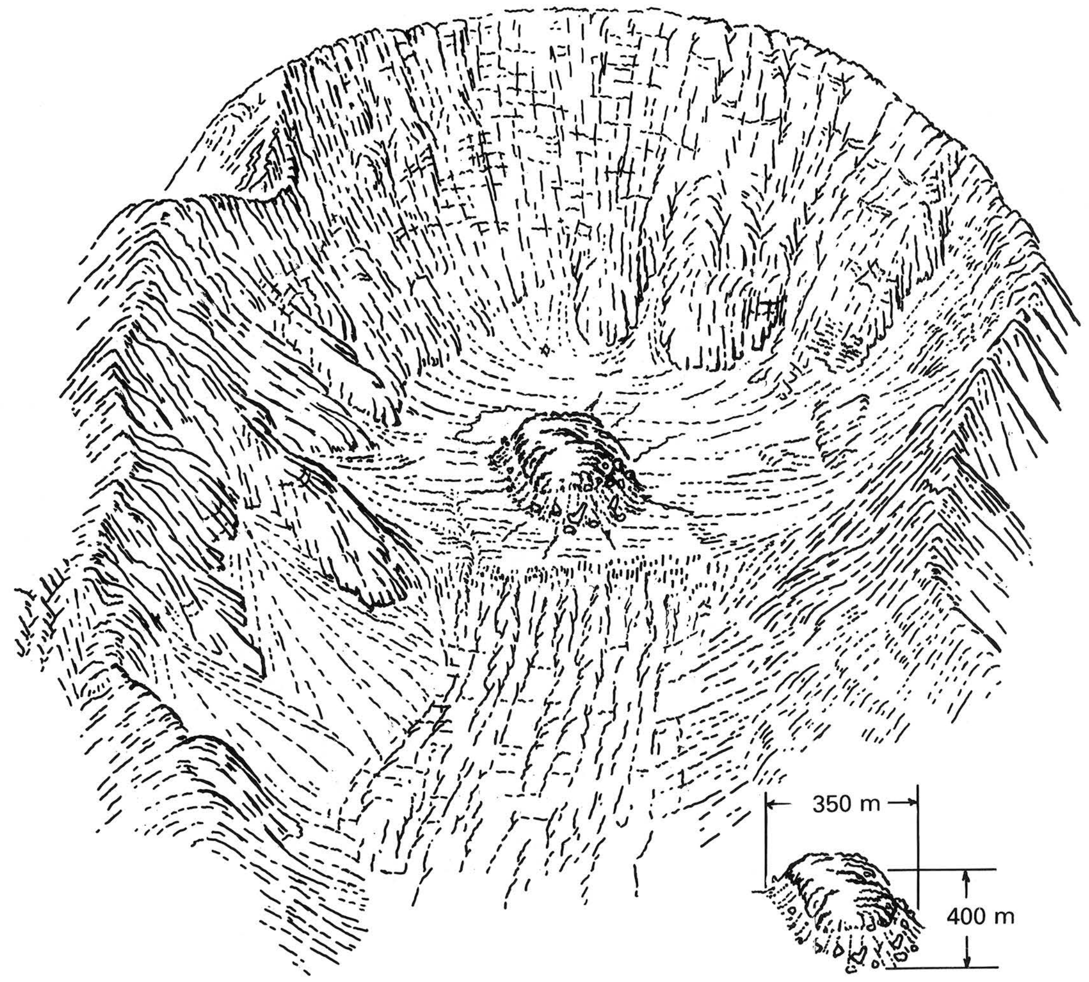
Maps are on following two pages



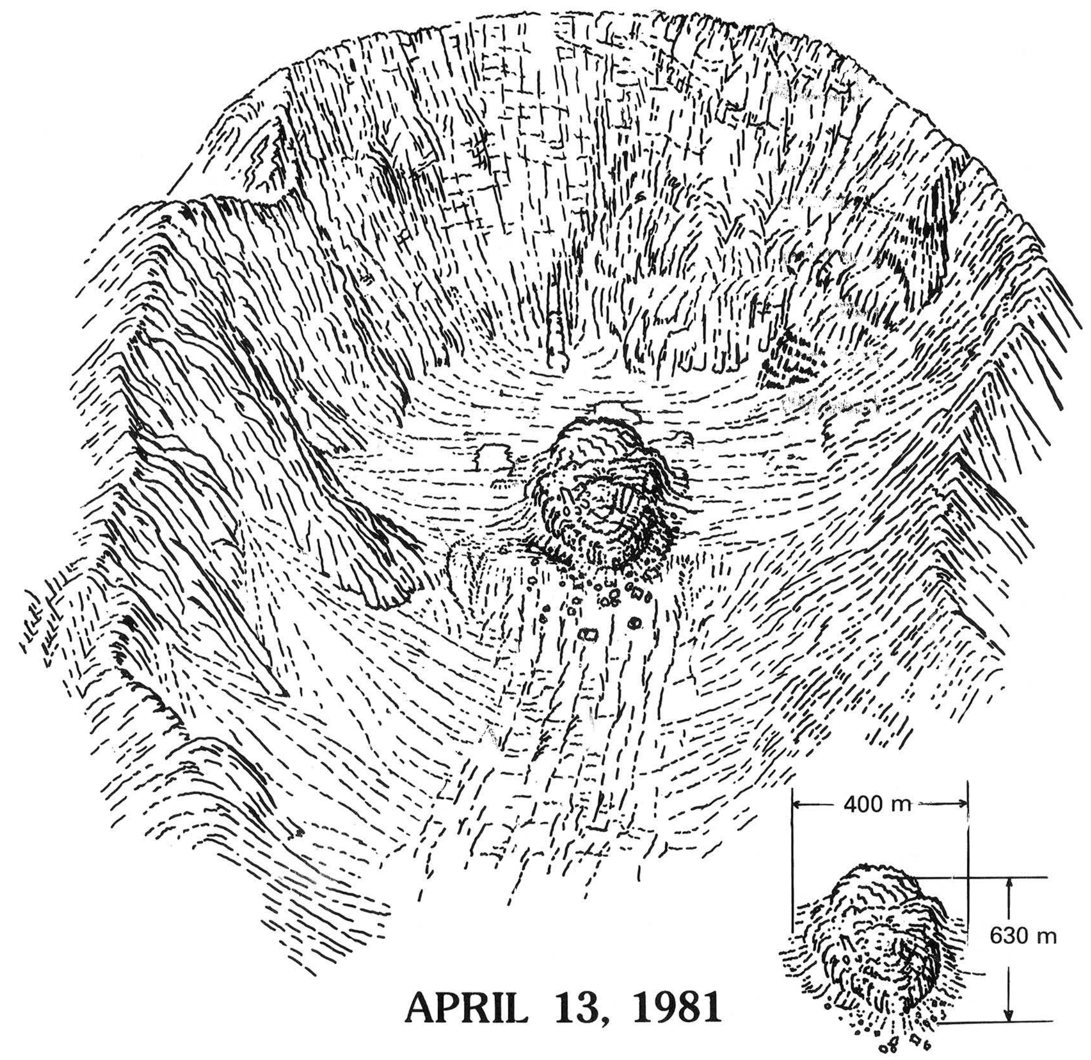
PHYSIOGRAPHIC DIAGRAMS OF MOUNT ST. HELENS, WASHINGTON, SHOWING CHANGES IN ITS SUMMIT CRATER, SUMMER 1981—*Continued*



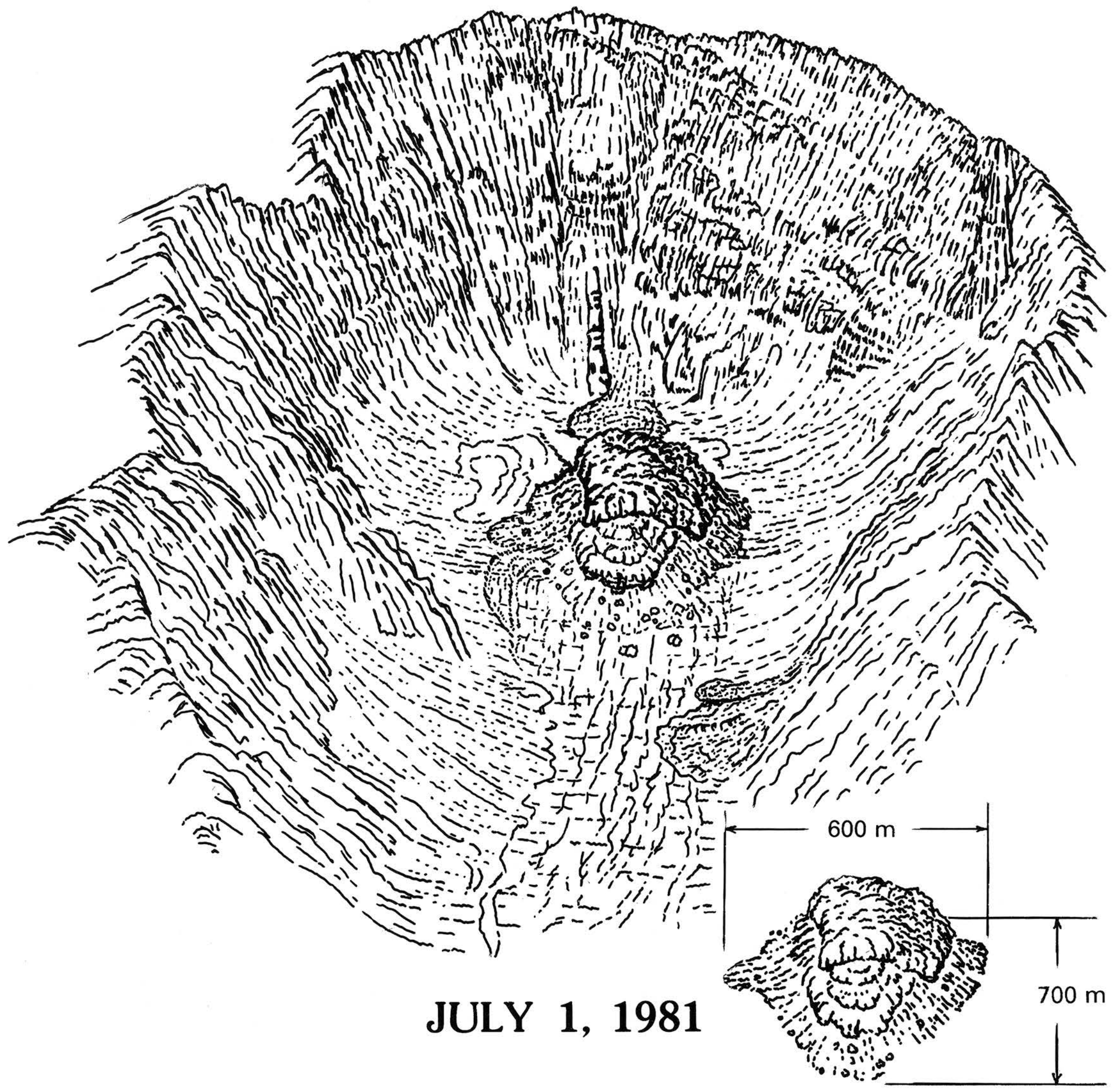
JANUARY 13, 1981



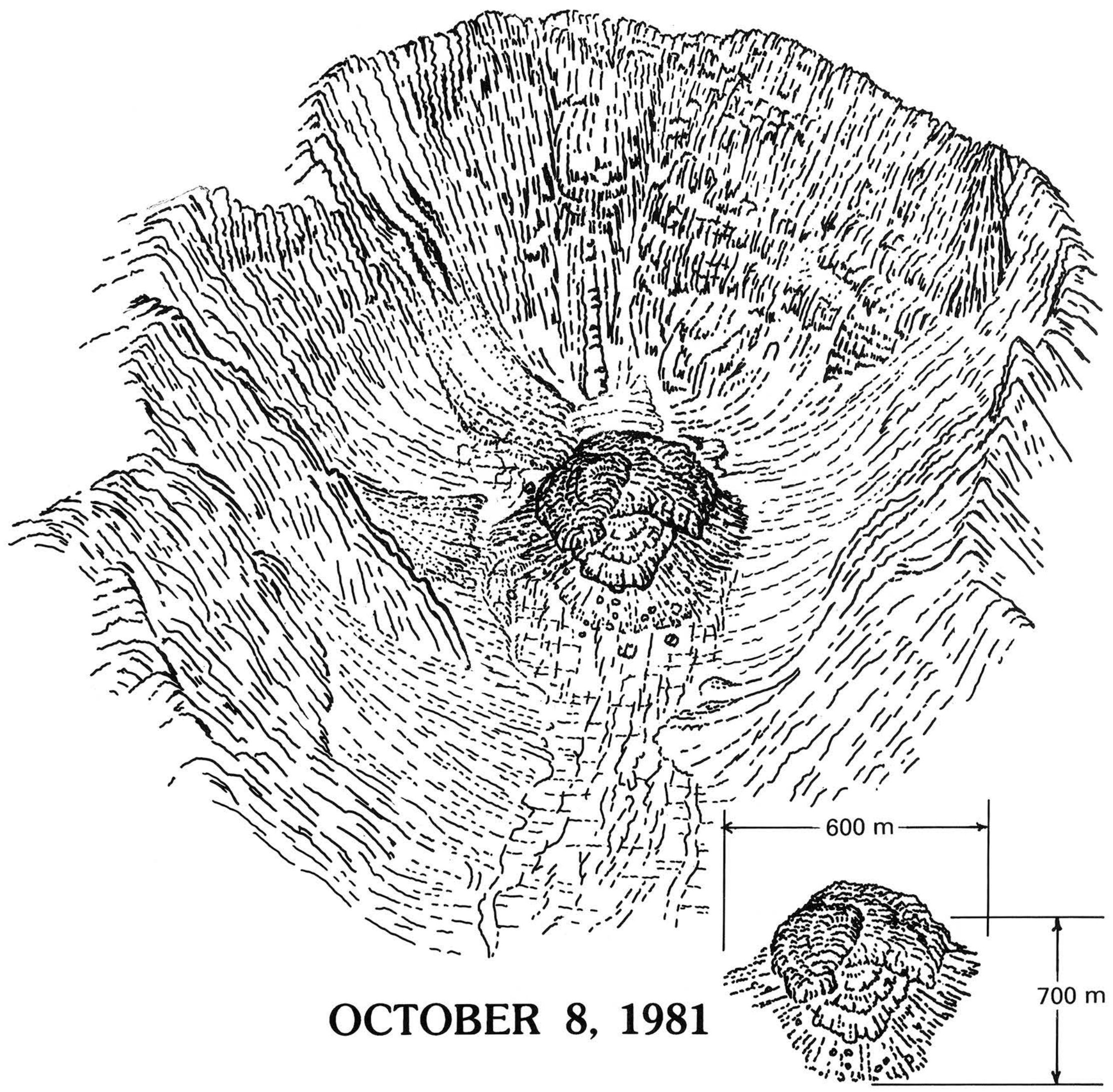
FEBRUARY 10, 1981



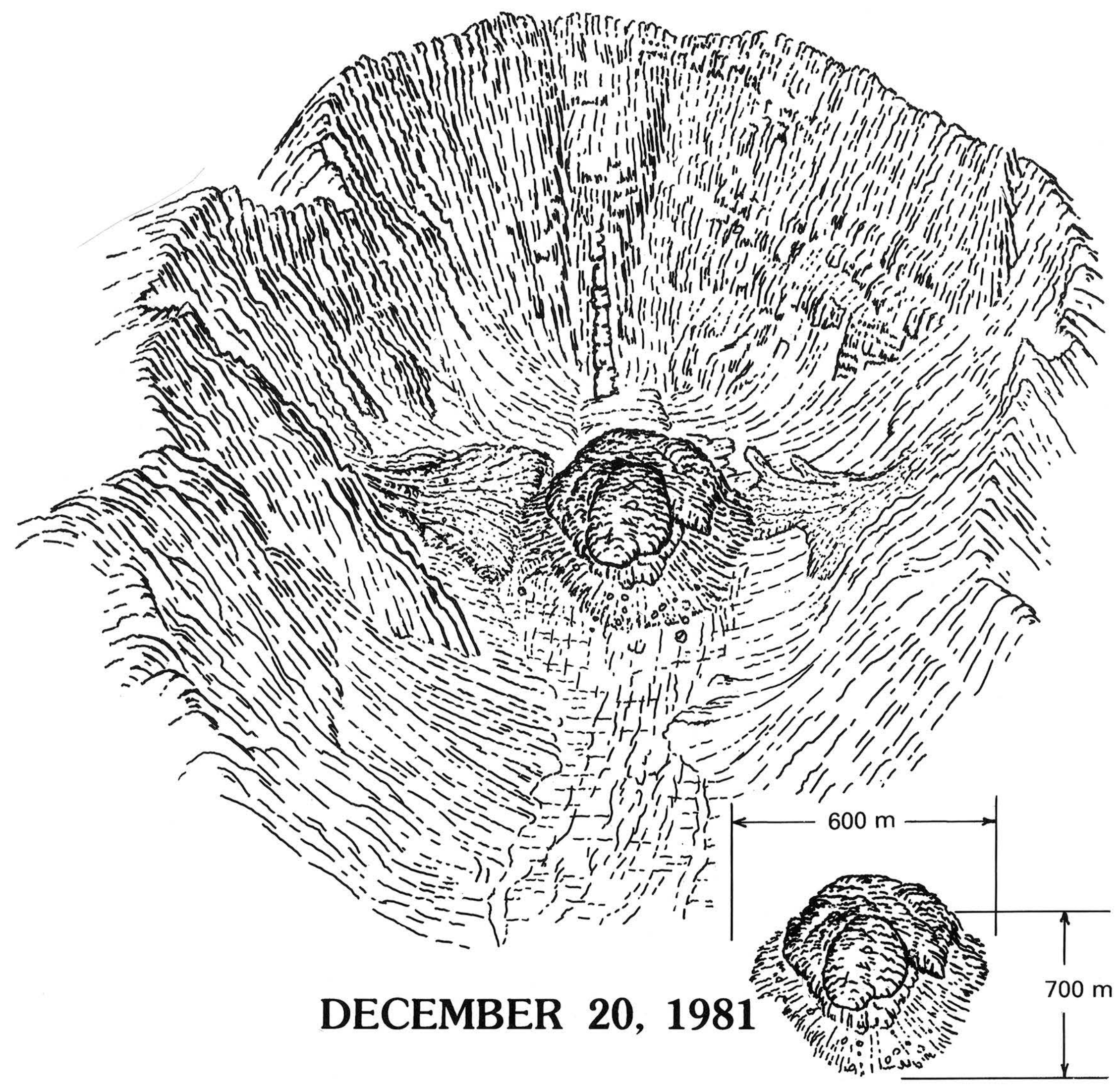
APRIL 13, 1981



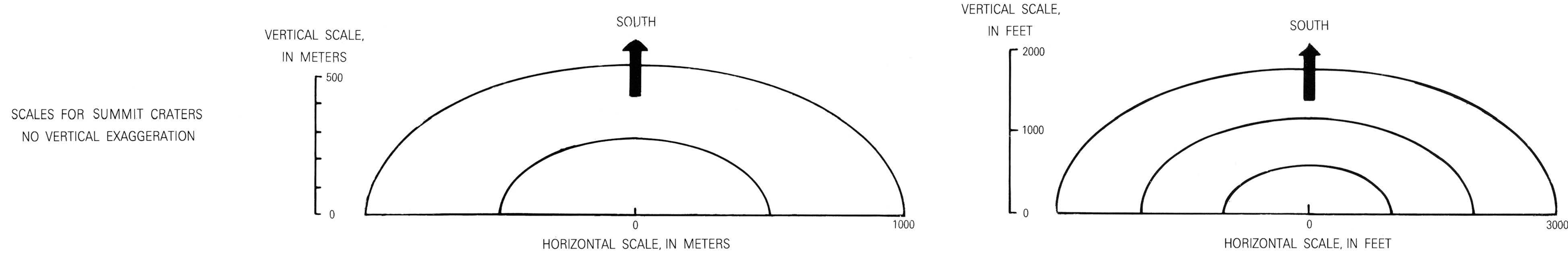
JULY 1, 1981



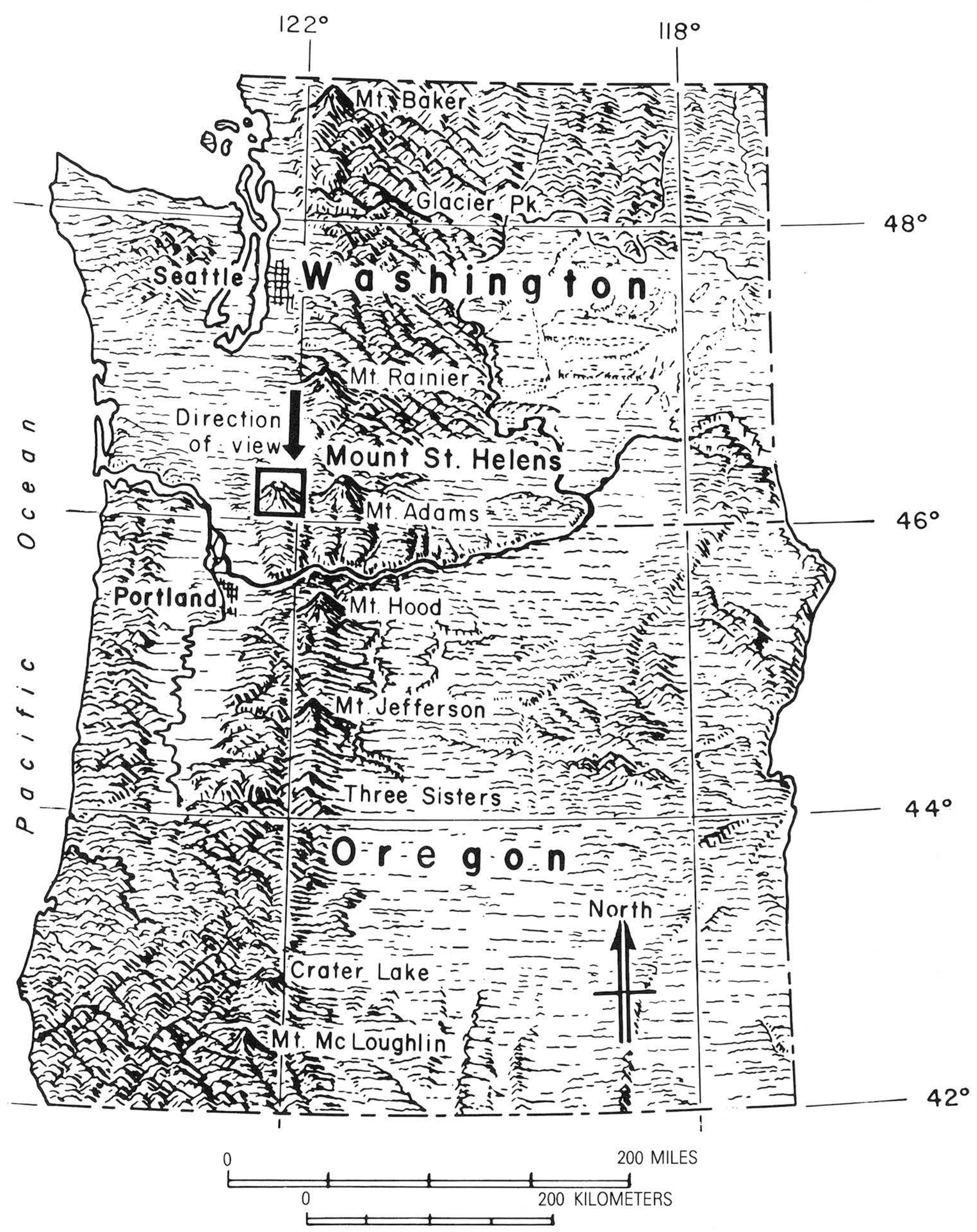
OCTOBER 8, 1981



DECEMBER 20, 1981

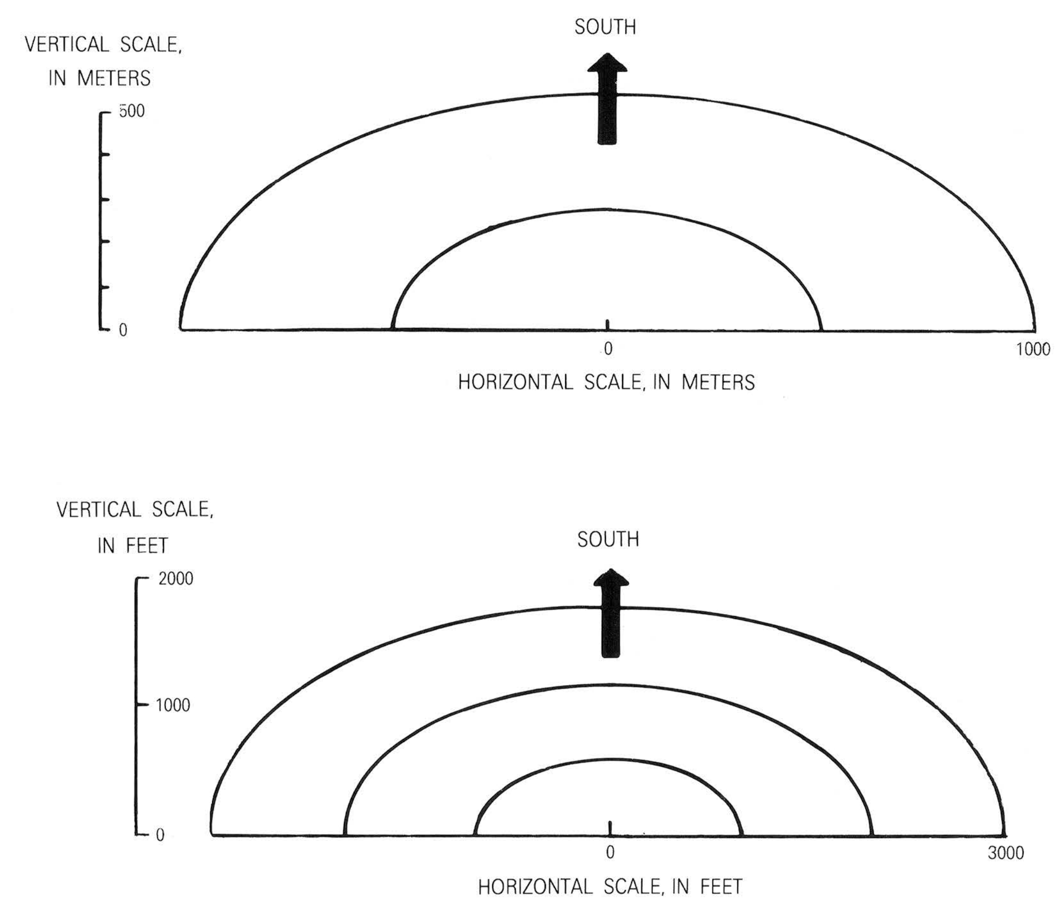


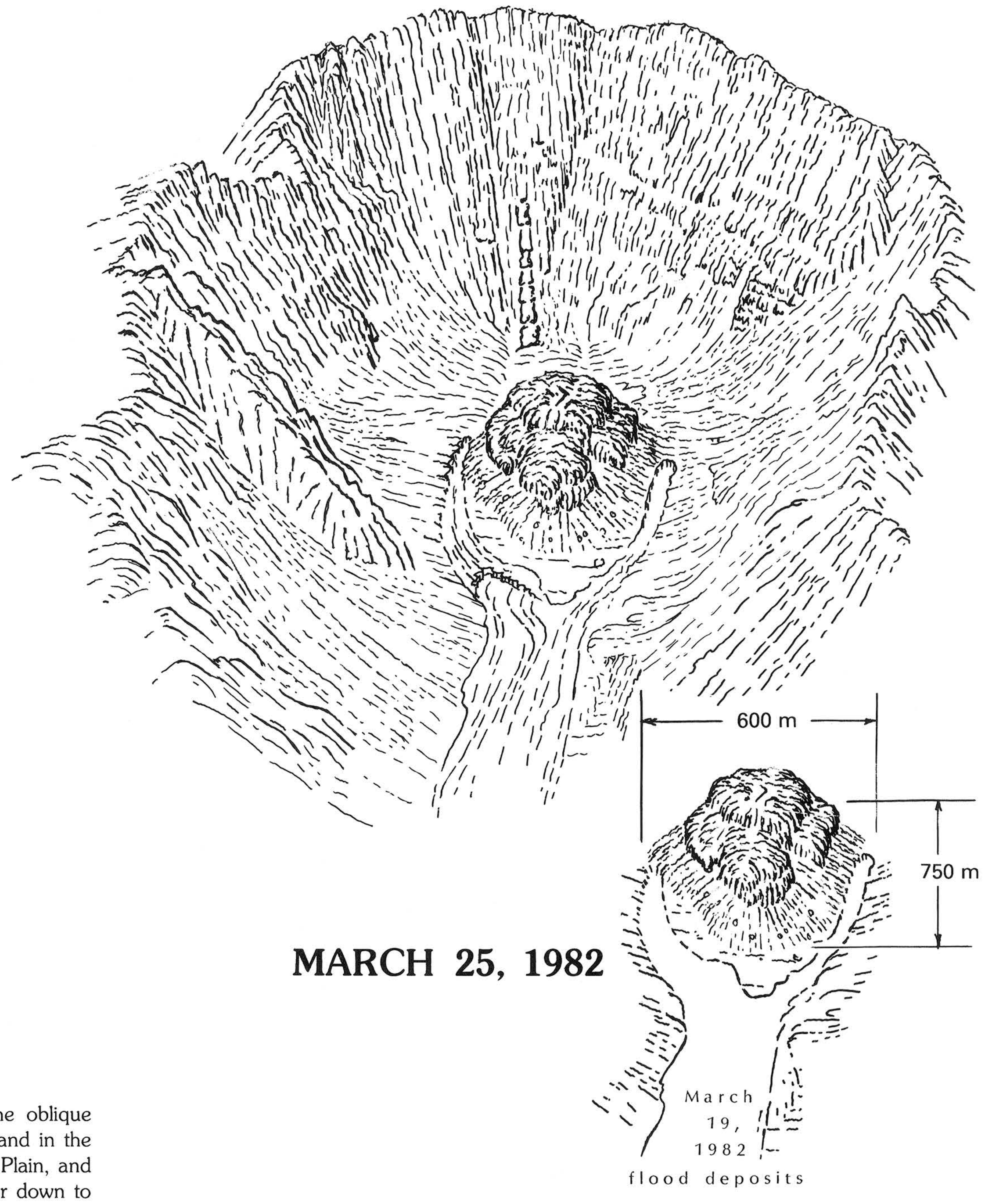
PHYSIOGRAPHIC DIAGRAMS OF MOUNT ST. HELENS, WASHINGTON, SHOWING CHANGES IN ITS SUMMIT CRATER, SUMMER 1981—*Continued*



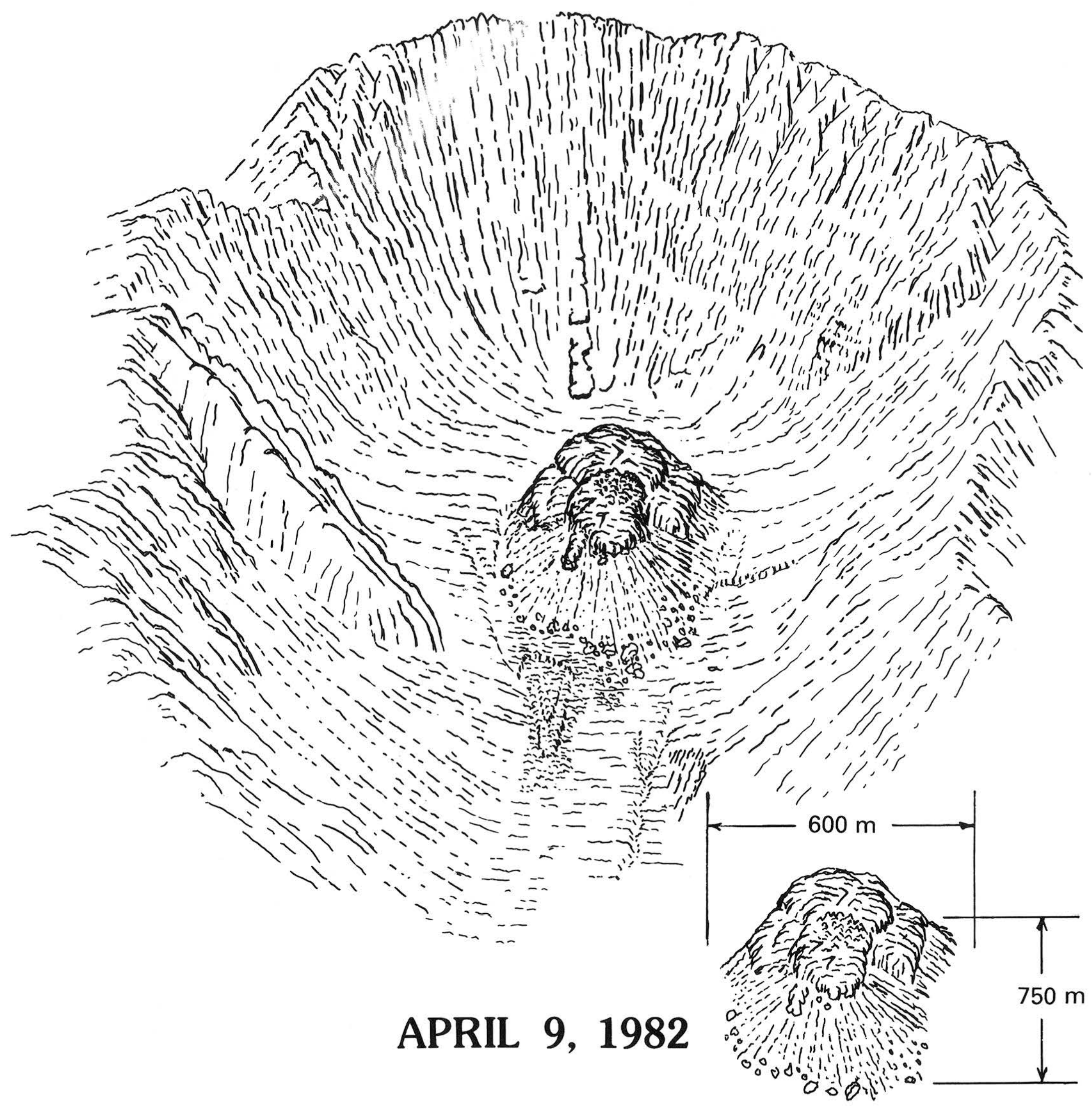
INDEX MAP

SCALES FOR SUMMIT CRATERS
NO VERTICAL EXAGGERATION





MARCH 25, 1982



APRIL 9, 1982

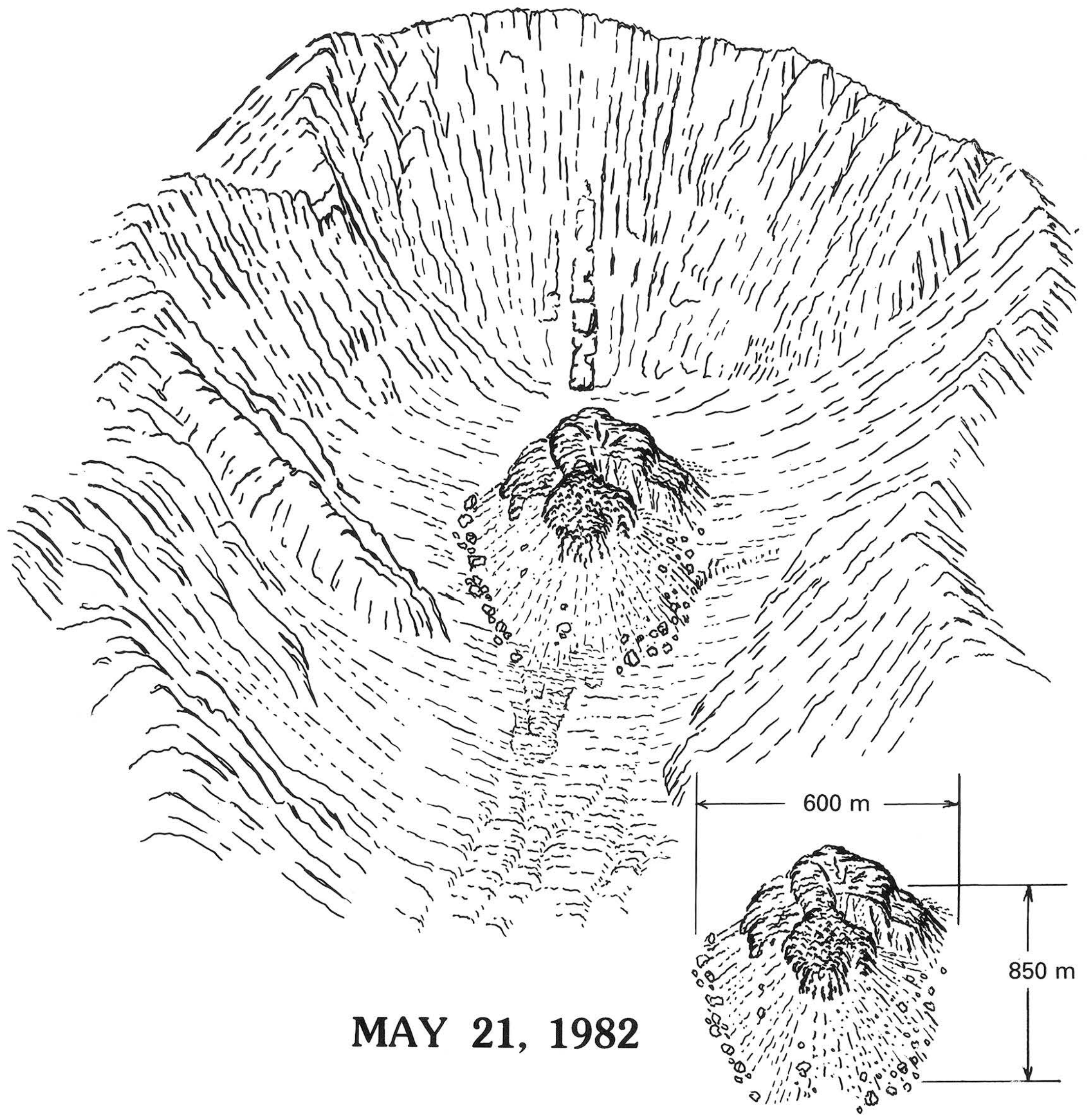
These 1982 oblique maps of Mount St. Helens are a continuation of the oblique mapping done in 1980 and 1981, portraying the same area at the same scale and in the same direction of view. Erosion continues its work on the crater, Steps, Pumice Plain, and Debris Avalanche. A well-defined drainage system has developed from the crater down to the Debris Avalanche, and the south shore of Spirit Lake has encroached farther toward Mount St. Helens. The five larger scale oblique maps portray significant changes in the dome and crater during 1982. The dome has grown in its longest dimension from 2,460 feet (750 meters) in March to 2,952 feet (900 meters) in August and has increased in its shortest dimension from 1,968 feet (600 meters) in March to 2,460 feet (750 meters) in August. This map has been published in Alpha (1983).

PHYSIOGRAPHIC DIAGRAMS OF MOUNT ST. HELENS, WASHINGTON, SHOWING CHANGES IN ITS SUMMIT CRATER, SUMMER 1982

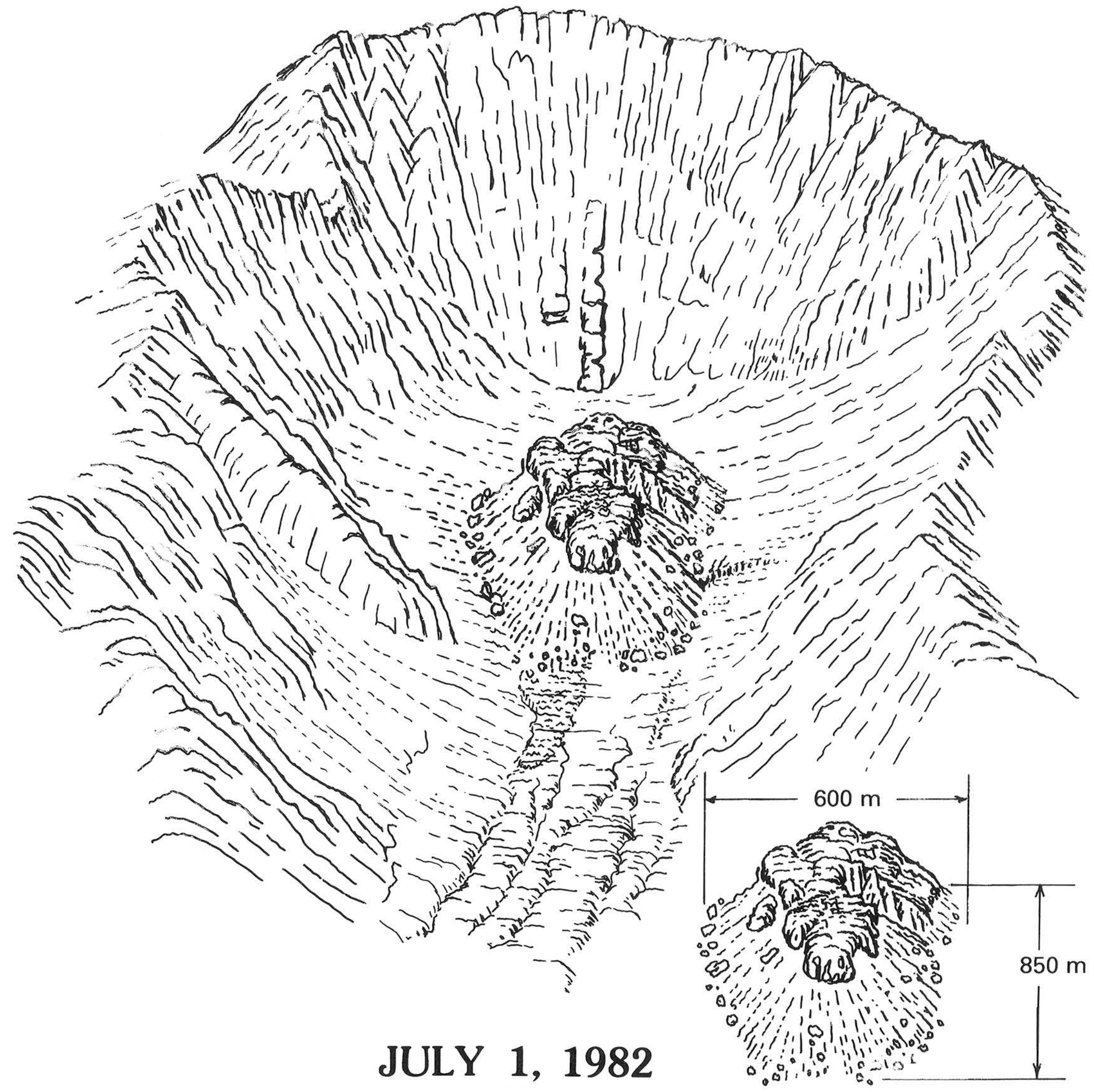
By
Tau Rho Alpha

1983

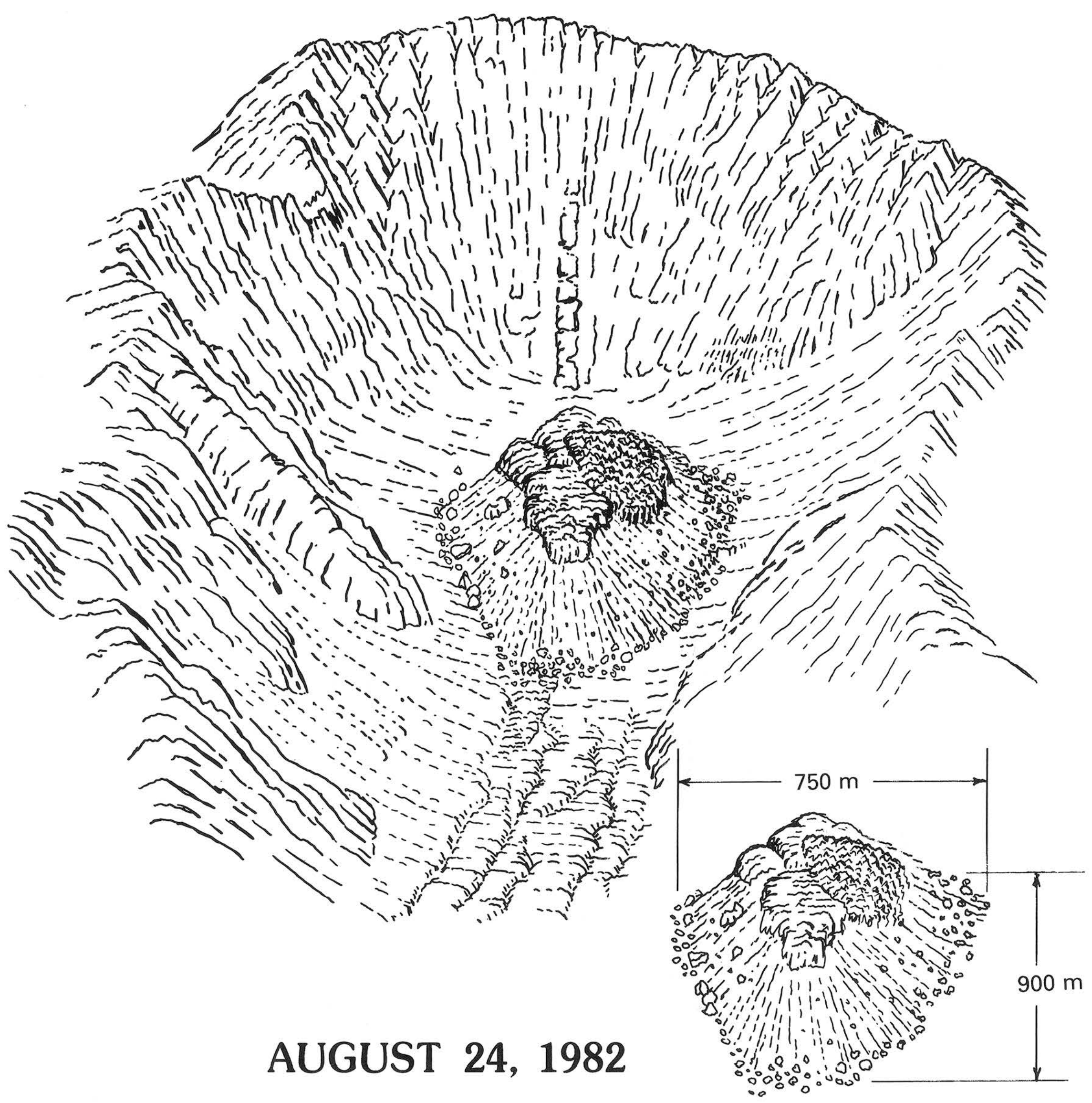
Maps are on following two pages



MAY 21, 1982

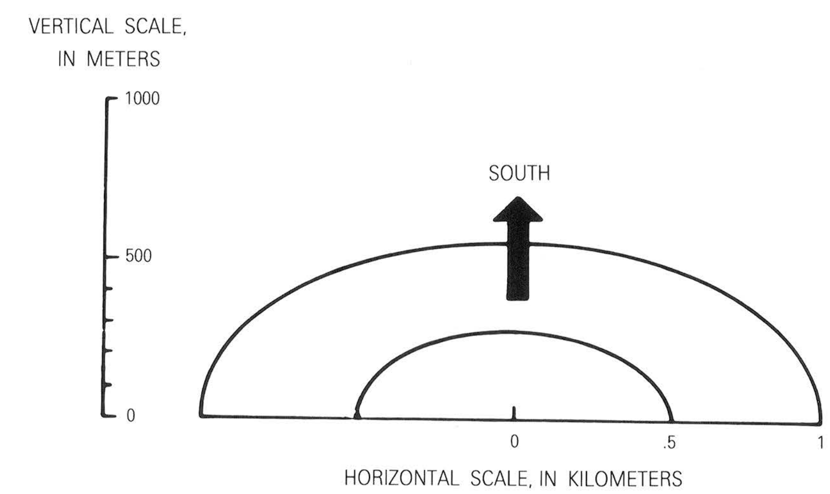


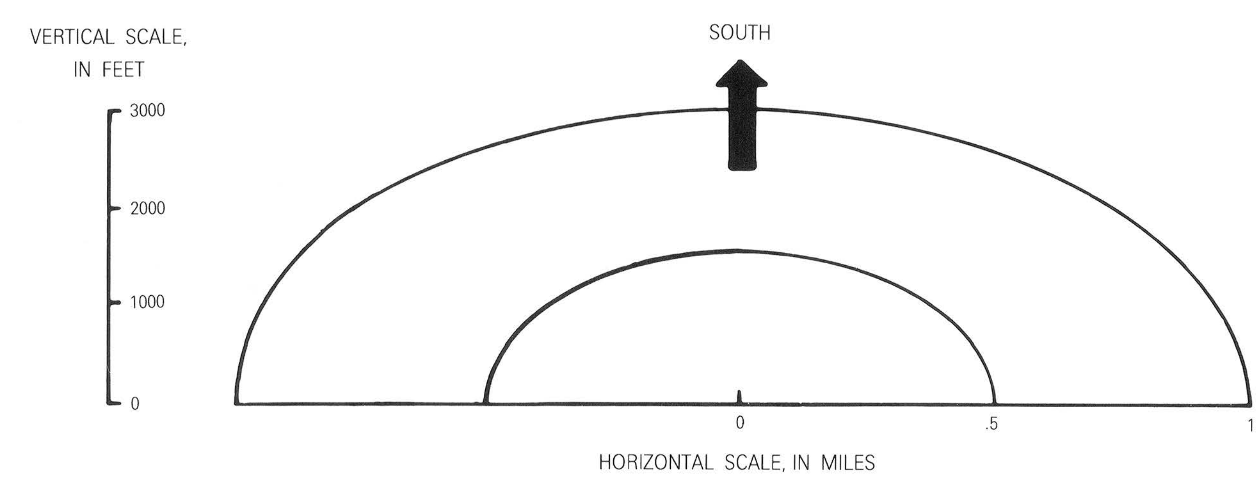
JULY 1, 1982



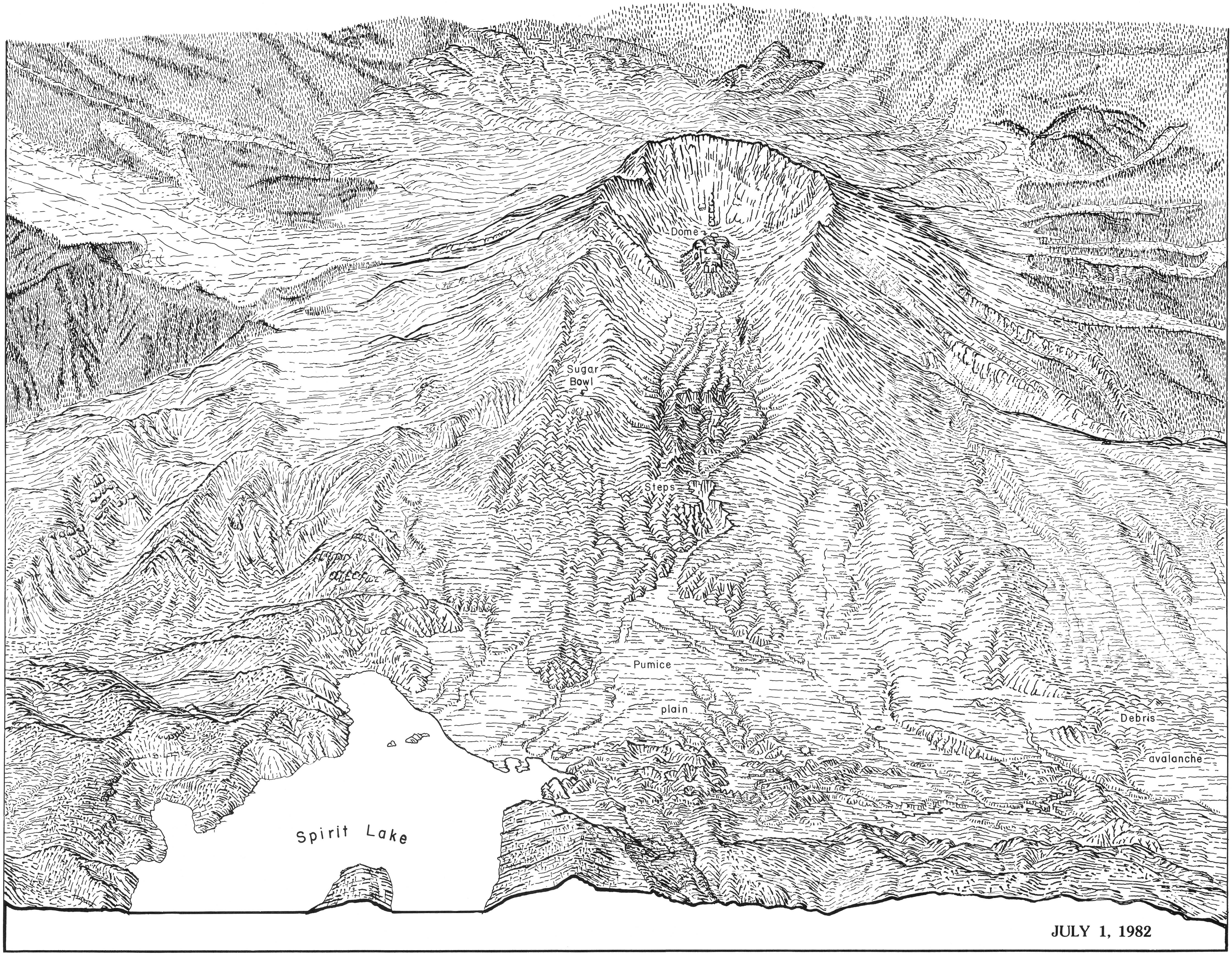
AUGUST 24, 1982

SCALES FOR LARGE OBLIQUE MAP (OPPOSITE PAGE)
NO VERTICAL EXAGGERATION

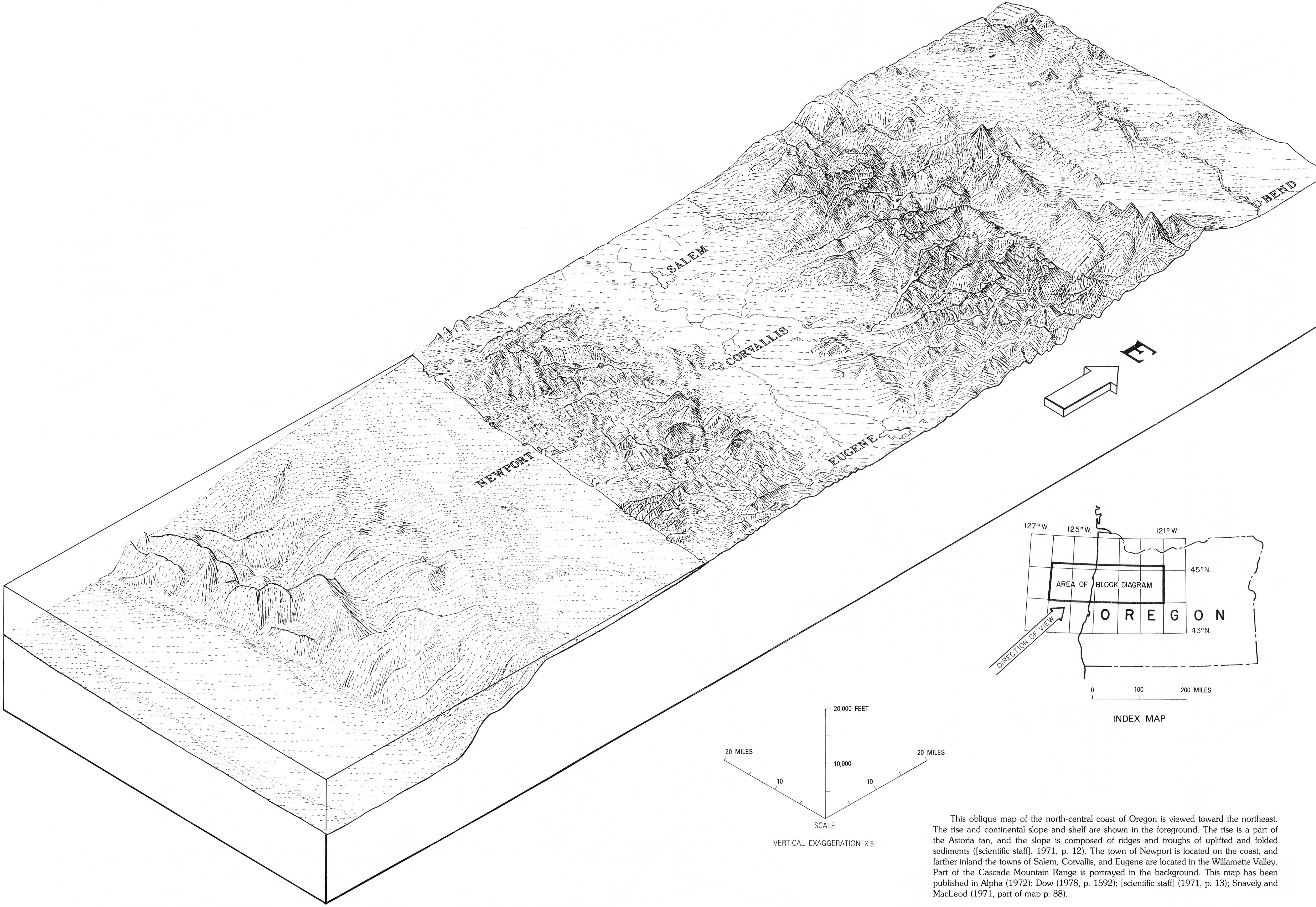




PHYSIOGRAPHIC DIAGRAMS OF MOUNT ST. HELENS, WASHINGTON, SHOWING CHANGES IN ITS SUMMIT CRATER, SUMMER 1982—*Continued*



PHYSIOGRAPHIC DIAGRAMS OF MOUNT ST. HELENS, WASHINGTON, SHOWING CHANGES IN ITS SUMMIT CRATER, SUMMER 1982—*Continued*



INDEX MAP

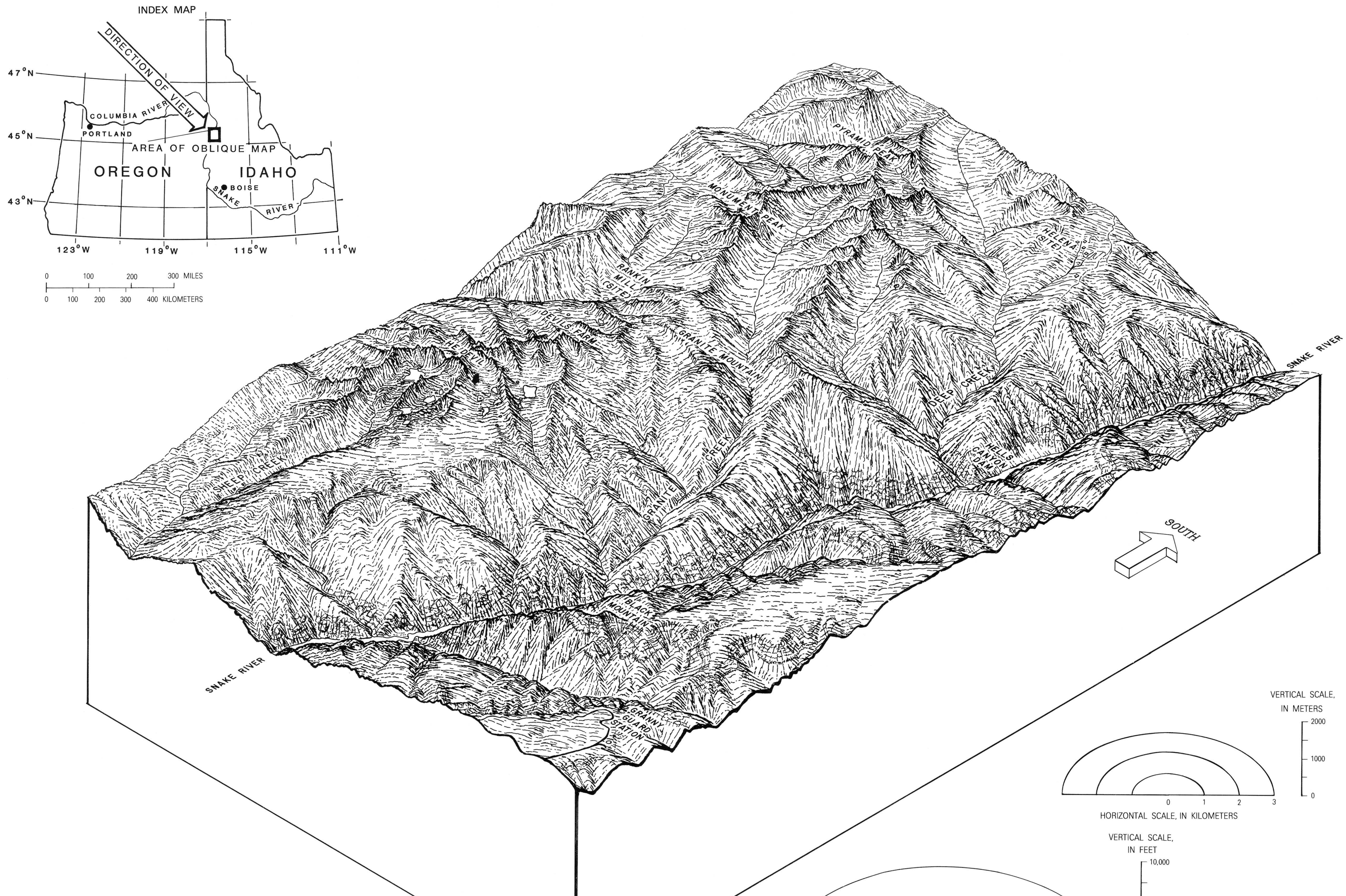
This oblique map of the north-central coast of Oregon is viewed toward the northeast. The rise and continental slope and shelf are shown in the foreground. The rise is a part of the Astoria fan, and the slope is composed of ridges and troughs of uplifted and folded sediments ([scientific staff], 1971, p. 12). The town of Newport is located on the coast, and farther inland the towns of Salem, Corvallis, and Eugene are located in the Willamette Valley. Part of the Cascade Mountain Range is portrayed in the background. This map has been published in Alpha (1972); Dow (1978, p. 1592); [scientific staff] (1971, p. 13); Snavely and MacLeod (1971, part of map p. 88).

NEWPORT, OREGON

By

Tau Rho Alpha

1972



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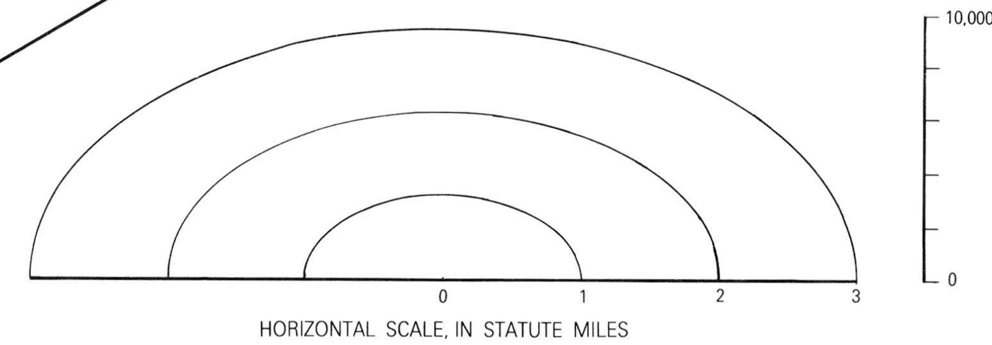


NO VERTICAL EXAGGERATION

Viewed toward the southeast, Hells Canyon is 8,000 feet (2,400 meters) deep in this gorge incised by the Snake River. On the Idaho side of the Snake River, the Seven Devils Mountains were sculptured by glaciers. Intrusive volcanic rocks can be seen along both sides of the Snake River, and layered basalts can be seen on the canyon walls in the foreground on the Oregon side of the river. A few of the mountains are named, and the Helena and Rankin Mill sites indicate abandoned mining locations. This map has been published in Alpha and Austin (1982).

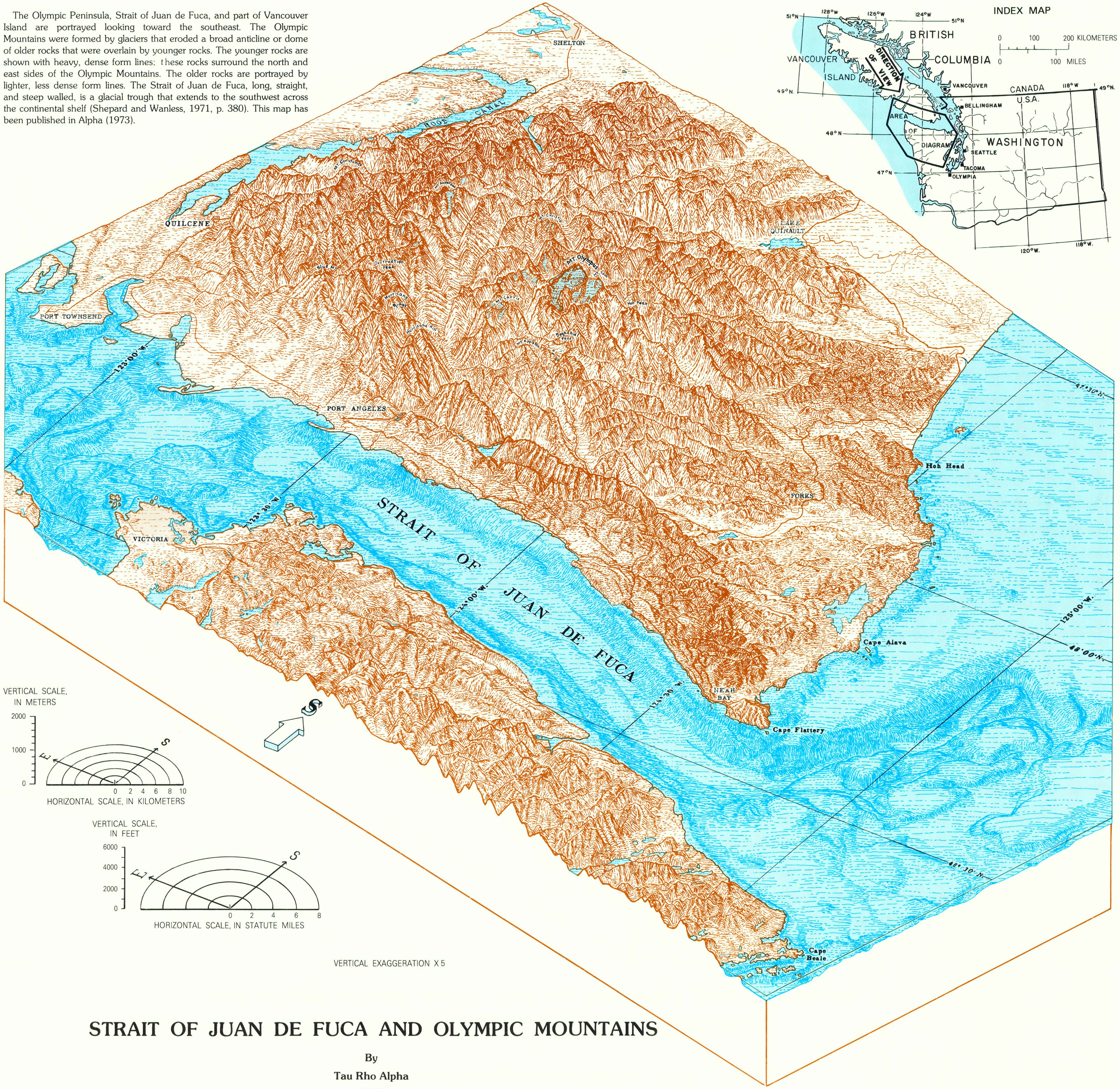
PHYSIOGRAPHIC DIAGRAM OF THE SEVEN DEVILS MOUNTAINS AND HELLS CANYON, IDAHO AND OREGON

By

Tau Rho Alpha and William A. Austin

1982

The Olympic Peninsula, Strait of Juan de Fuca, and part of Vancouver Island are portrayed looking toward the southeast. The Olympic Mountains were formed by glaciers that eroded a broad anticline or dome of older rocks that were overlain by younger rocks. The younger rocks are shown with heavy, dense form lines: these rocks surround the north and east sides of the Olympic Mountains. The older rocks are portrayed by lighter, less dense form lines. The Strait of Juan de Fuca, long, straight, and steep walled, is a glacial trough that extends to the southwest across the continental shelf (Shepard and Wanless, 1971, p. 380). This map has been published in Alpha (1973).



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VERTICAL EXAGGERATION X 5

STRAIT OF JUAN DE FUCA AND OLYMPIC MOUNTAINS

By

Tau Rho Alpha

1973

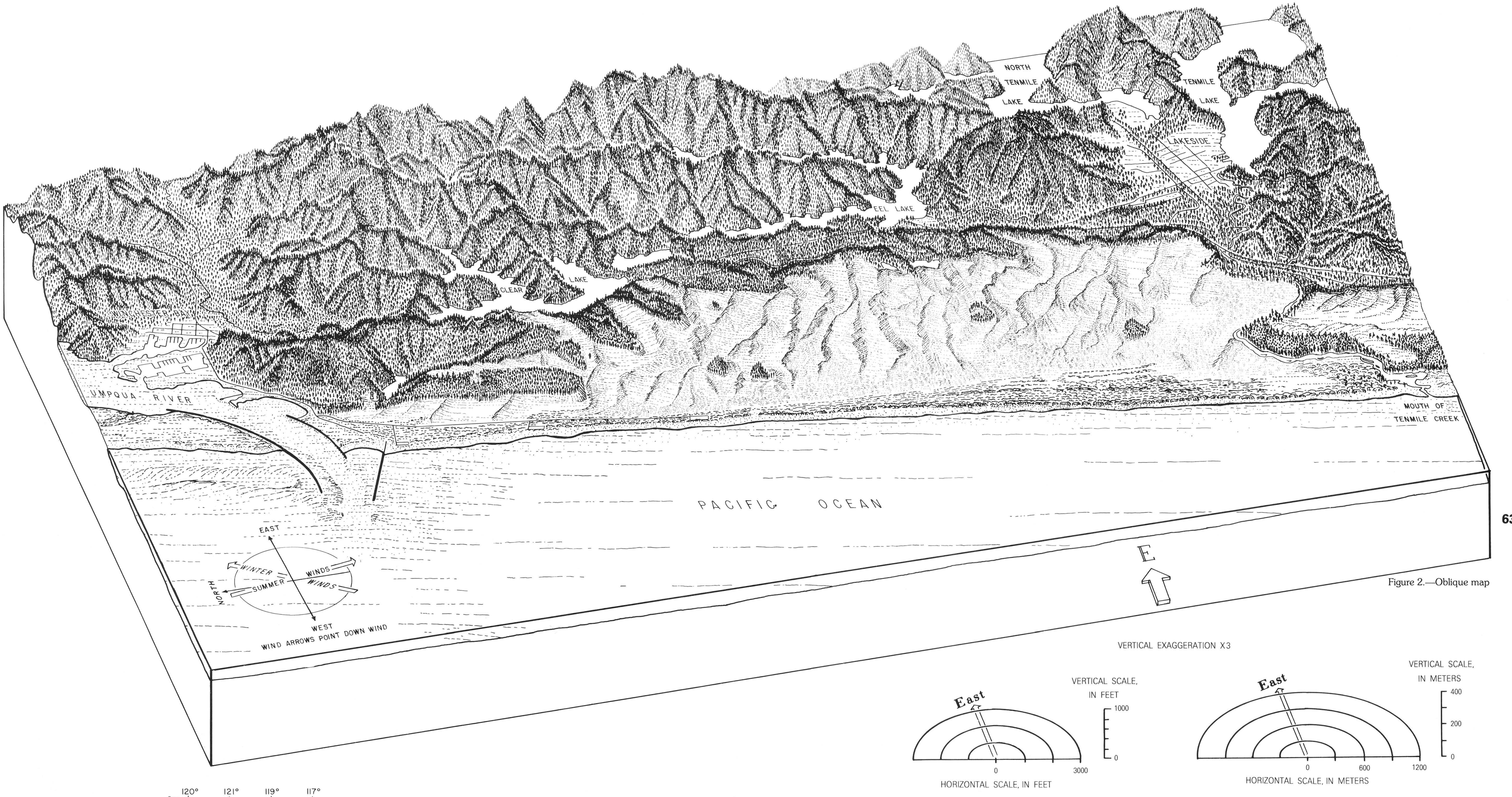


Figure 2.—Oblique map

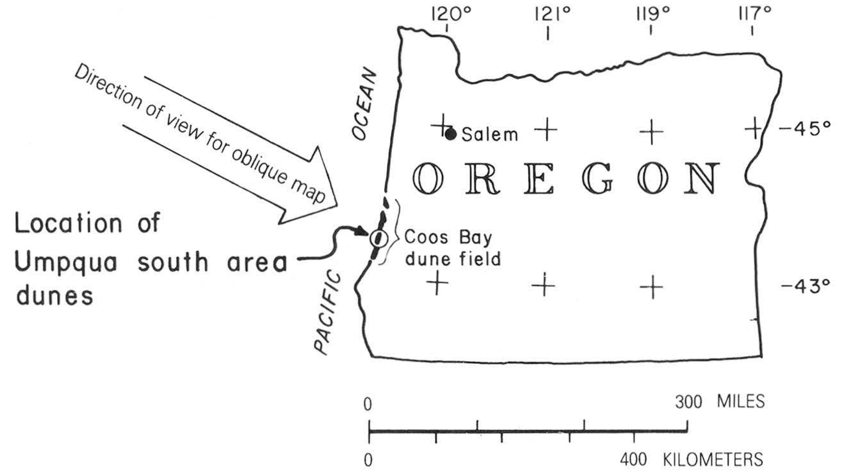


Figure 1.—Index map

This oblique map of sand dunes south of the Umpqua River on the Oregon Coast is viewed toward the southeast. These dunes are part of the Coos Bay dune field, which is the largest dune field on the west coast (fig. 1; Shepard and Wanless, 1971, p. 362). The dunes on the oblique map (fig. 2) are drawn by using form lines to represent the physiography, and the coastal mountains are portrayed by using the location and density of lines to represent trees. These large dunes move to the north at an average rate of 14.5 feet (55 meters) per year (Alpha, Hunter, and Richmond, 1980, sheet 2). The foredune ridge (fig. 3) is a grass-covered, hummocky ridge immediately inland from the beach. The transverse dunes (fig. 4) have long wavy crests and are oriented approximately at right angles to the winds that form them. They are too small (less than 10 feet (3 meters) in height) to be illustrated on the oblique map (fig. 2). The oblique dunes (fig. 5) rise as high as 180 feet (55 meters) above the adjacent interdune troughs. During the summer, a steep north-facing slope is a little less steep, and sand is deposited as small dunes on the south side.

The precipitation ridge (fig. 6) forms most of the dunes along the east edge of the dune field and stands 30–80 feet (9–24 meters) above the forested land to the east. Parabolic dunes (fig. 7) that are formed by the winter winds develop at the northeast edge of the dune field, and parabolic dunes that are formed by the summer winds develop at the southeast edge of the dune field. This map has been published in Alpha, Hunter, and Richmond (1980).

LANDFORMS OF THE UMPQUA SOUTH AREA, THE OREGON DUNES NATIONAL RECREATION AREA, OREGON

By

Tau Rho Alpha, Ralph E. Hunter, and Bruce M. Richmond

1980

Continued on following page

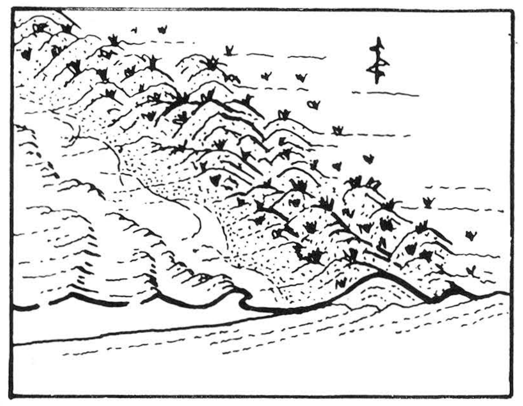


Figure 3.—Foredune ridge, formed in winter and summer along first beach ridge.

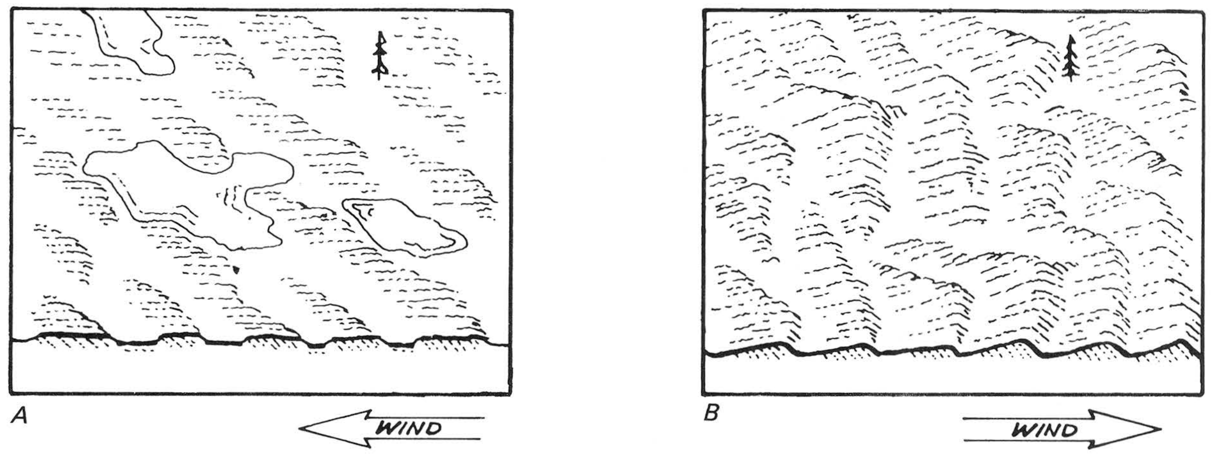


Figure 4.—Transverse dune field. *A*, Winter, dunes flatten. *B*, Summer, dunes grow.

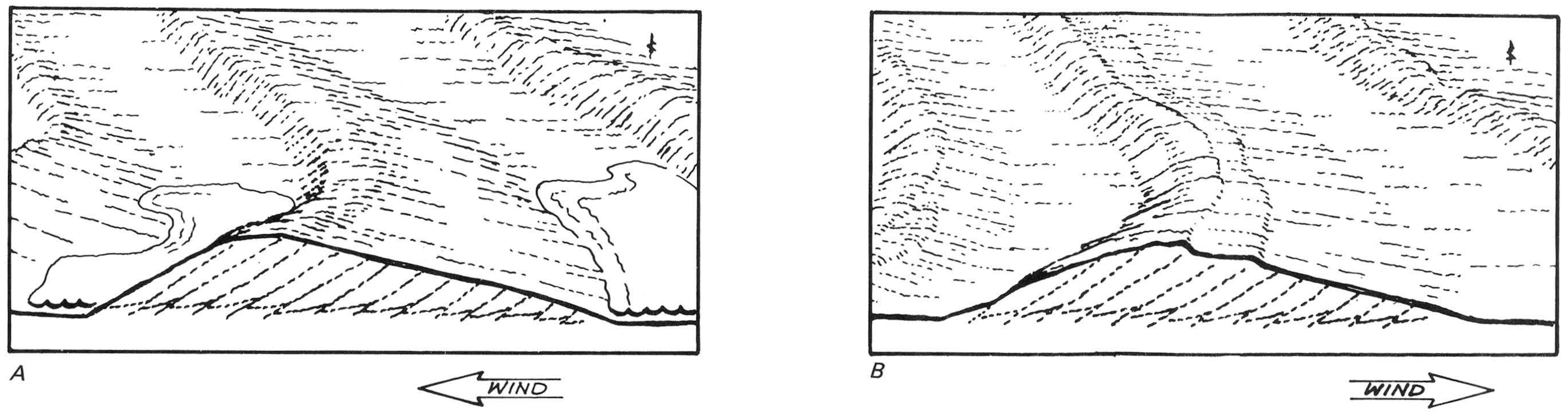


Figure 5.—Oblique dunes. *A*, Winter, dunes move north; slipface to left. *B*, Summer, crests of large dunes move south; slipface to right.

Note: Relative scale for figures 3–7 is indicated by size of trees

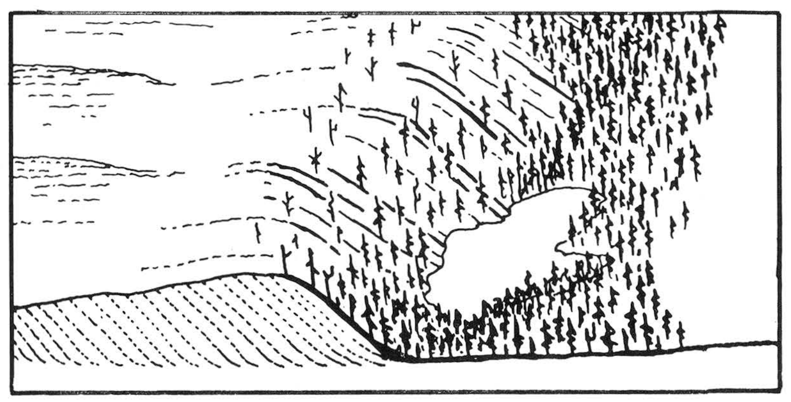


Figure 6.—Precipitation ridge.

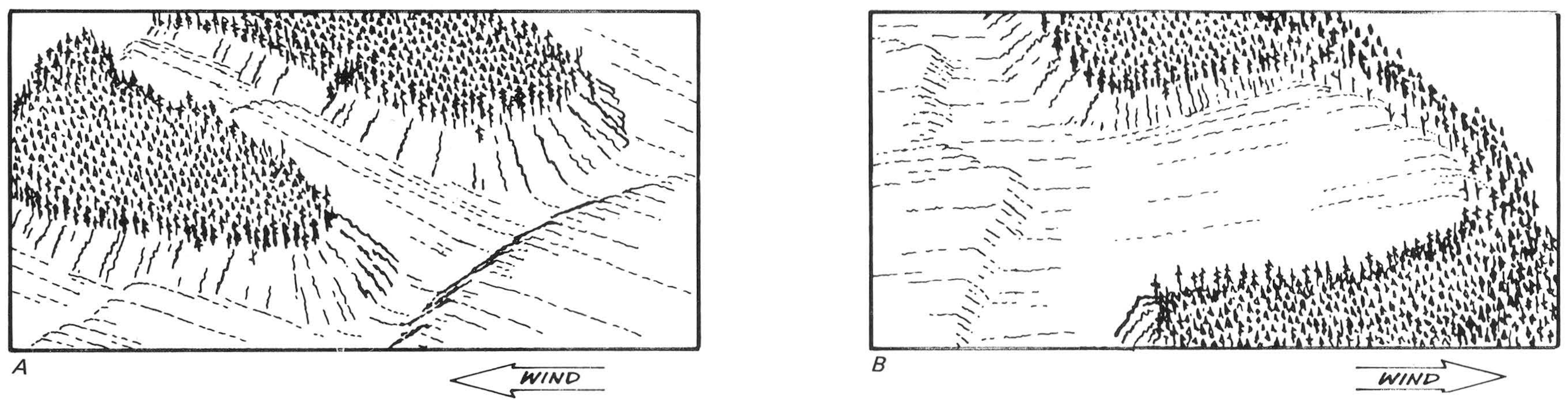
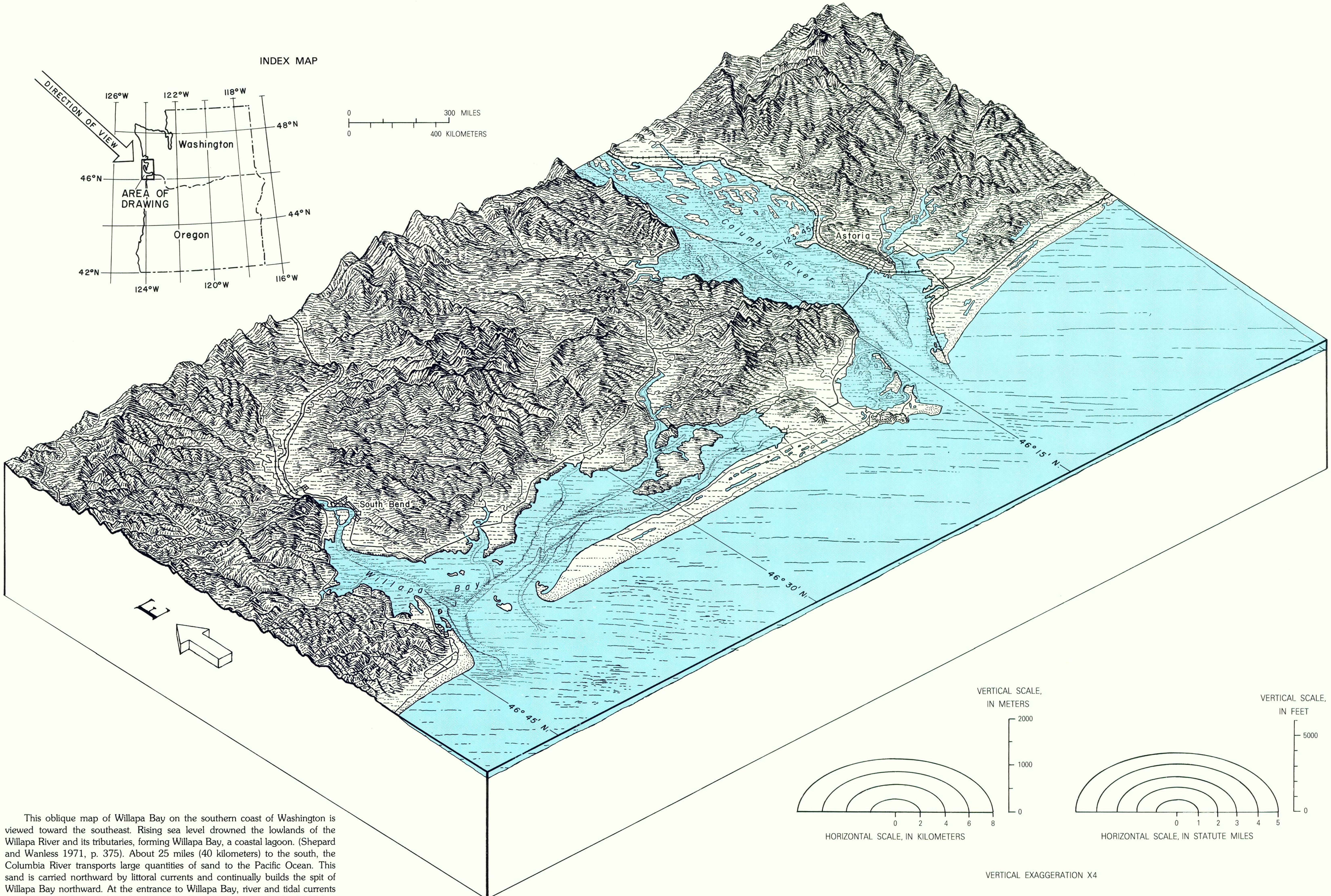


Figure 7.—Parabolic dunes. *A*, Formed by winter winds. *B*, Formed by summer winds.



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This oblique map of Willapa Bay on the southern coast of Washington is viewed toward the southeast. Rising sea level drowned the lowlands of the Willapa River and its tributaries, forming Willapa Bay, a coastal lagoon. (Shepard and Wanless 1971, p. 375). About 25 miles (40 kilometers) to the south, the Columbia River transports large quantities of sand to the Pacific Ocean. This sand is carried northward by littoral currents and continually builds the spit of Willapa Bay northward. At the entrance to Willapa Bay, river and tidal currents have maintained channels to the ocean that have a maximum depth of 100 feet (30 meters). This map has been published in Alpha (1978f).

OBLIQUE MAP OF WILLAPA BAY, WASHINGTON

By

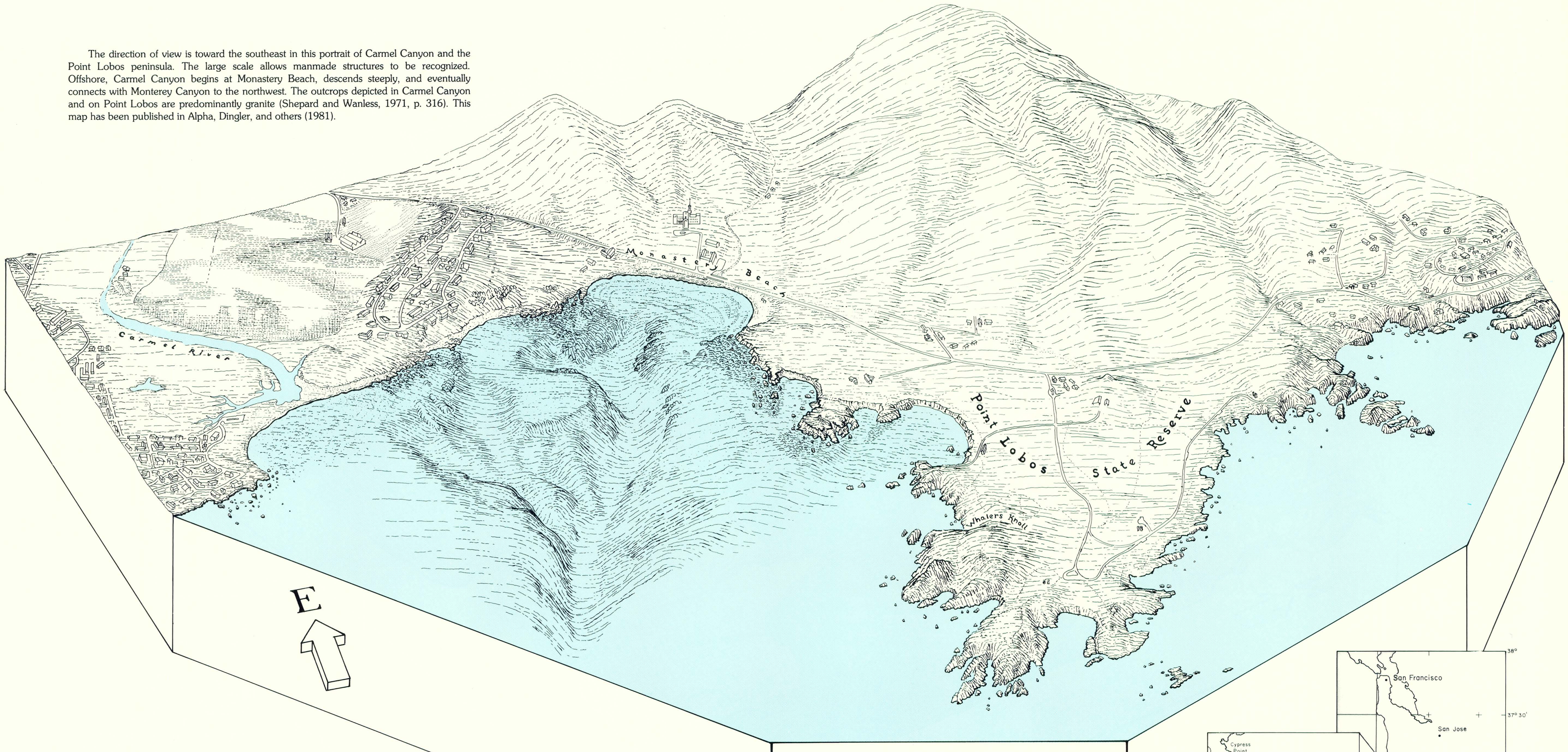
Tau Rho Alpha

1978


California

LOCATION OF OBLIQUE MAPS IN CALIFORNIA

The direction of view is toward the southeast in this portrait of Carmel Canyon and the Point Lobos peninsula. The large scale allows manmade structures to be recognized. Offshore, Carmel Canyon begins at Monastery Beach, descends steeply, and eventually connects with Monterey Canyon to the northwest. The outcrops depicted in Carmel Canyon and on Point Lobos are predominantly granite (Shepard and Wanless, 1971, p. 316). This map has been published in Alpha, Dingler, and others (1981).



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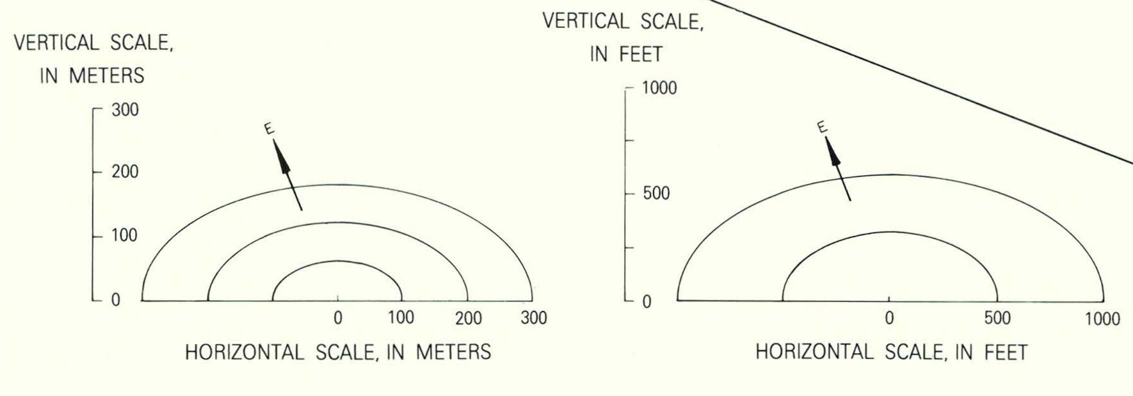
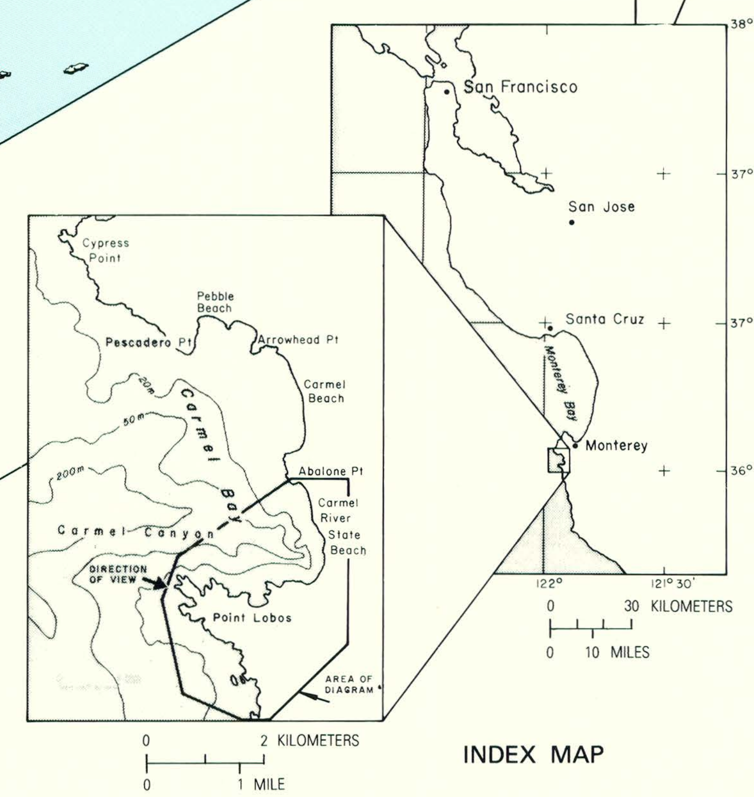


NO VERTICAL EXAGGERATION



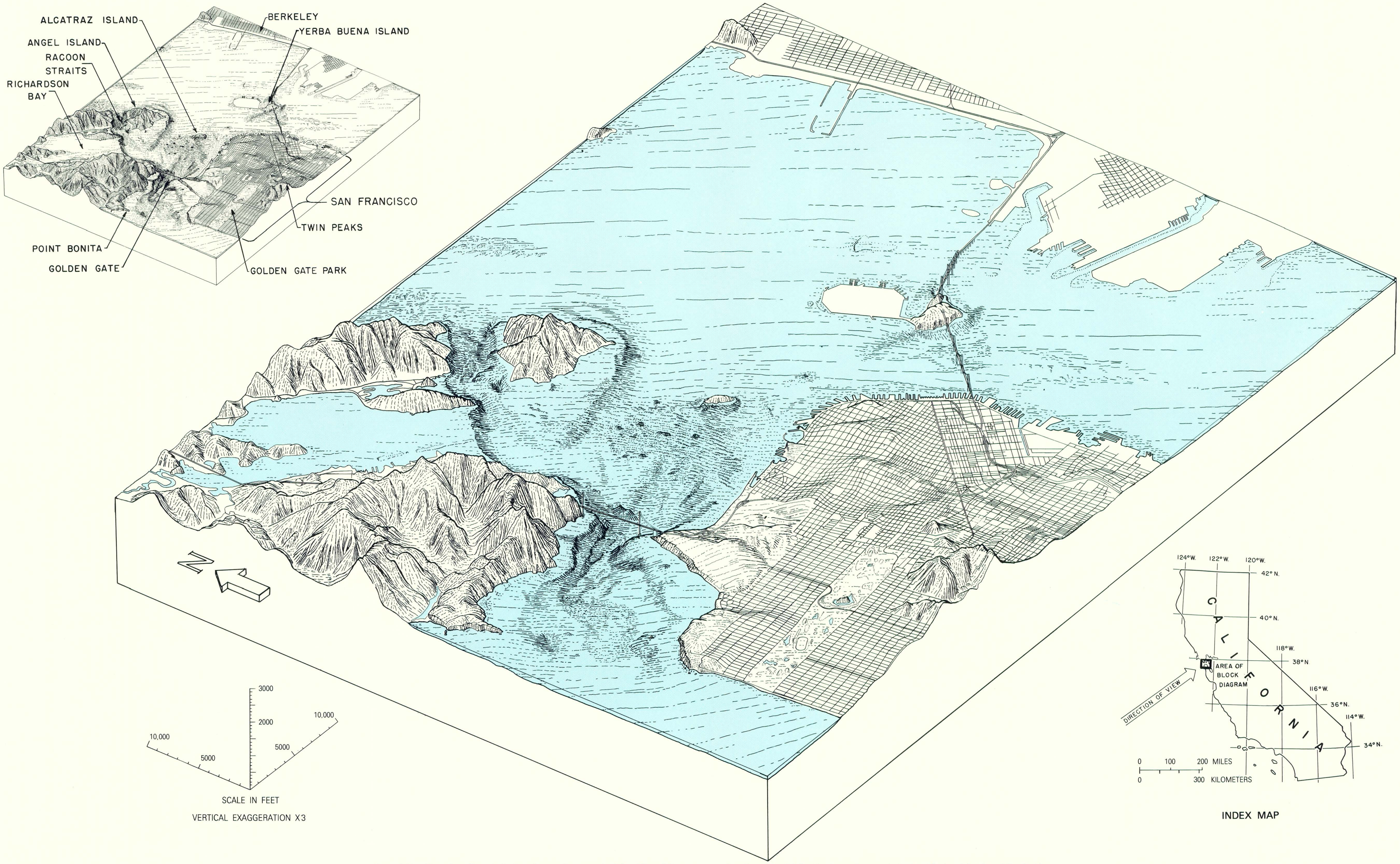
INDEX MAP

PHYSIOGRAPHIC DIAGRAM OF THE UPPER CARMEL CANYON AND POINT LOBOS, CALIFORNIA

By

Tau Rho Alpha, John R. Dingler, David R. Jones, David E. Molzan, Curt D. Peterson, and James M. Morley

1981



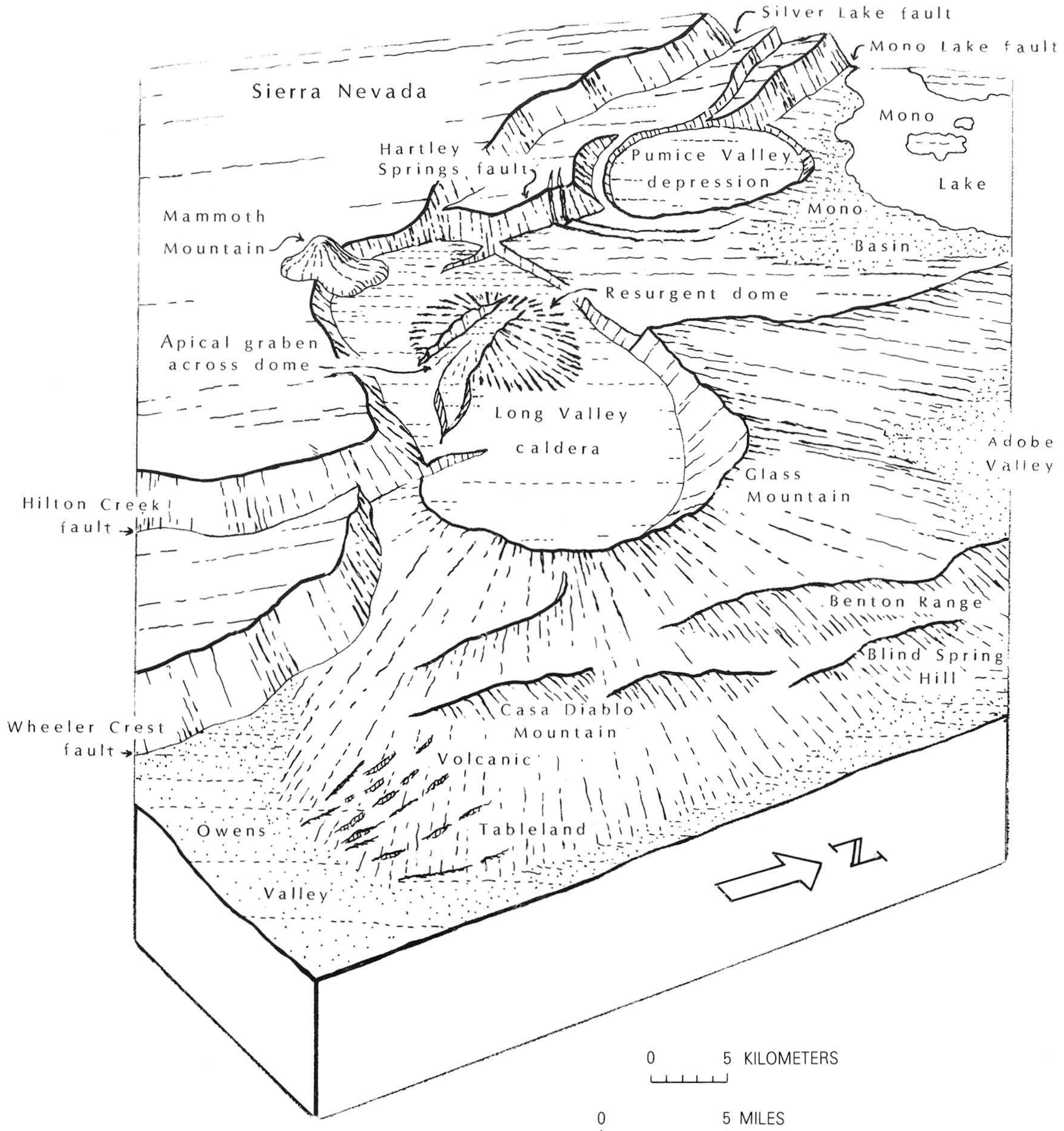
Central San Francisco Bay, including the northern part of the City of San Francisco, the Golden Gate, Richardson Bay, and Angel Island are seen in a view toward the northeast. The human imprint of street patterns, Golden Gate Park, the Golden Gate Bridge, the Bay Bridge, and shipping docks can be recognized. Underwater features include: the irregular depressions under the Golden Gate Bridge and in Racoon Straits (these depressions are swept clean of sediment by tidal action); sand waves between Alcatraz Island and the Golden Gate; and the sand and mud flats composing the rest of the submerged area (Carlson and others, 1970, p. 104–106). This map has been published in Alpha (1970); Magnan (1970, p. 21); Carlson and others (1970, p. 100, 101); Durrenberger and Johnson (1976, p. 18). Part of this map has been published in Alpha and Winter (1971, p. 132).

CENTRAL SAN FRANCISCO BAY

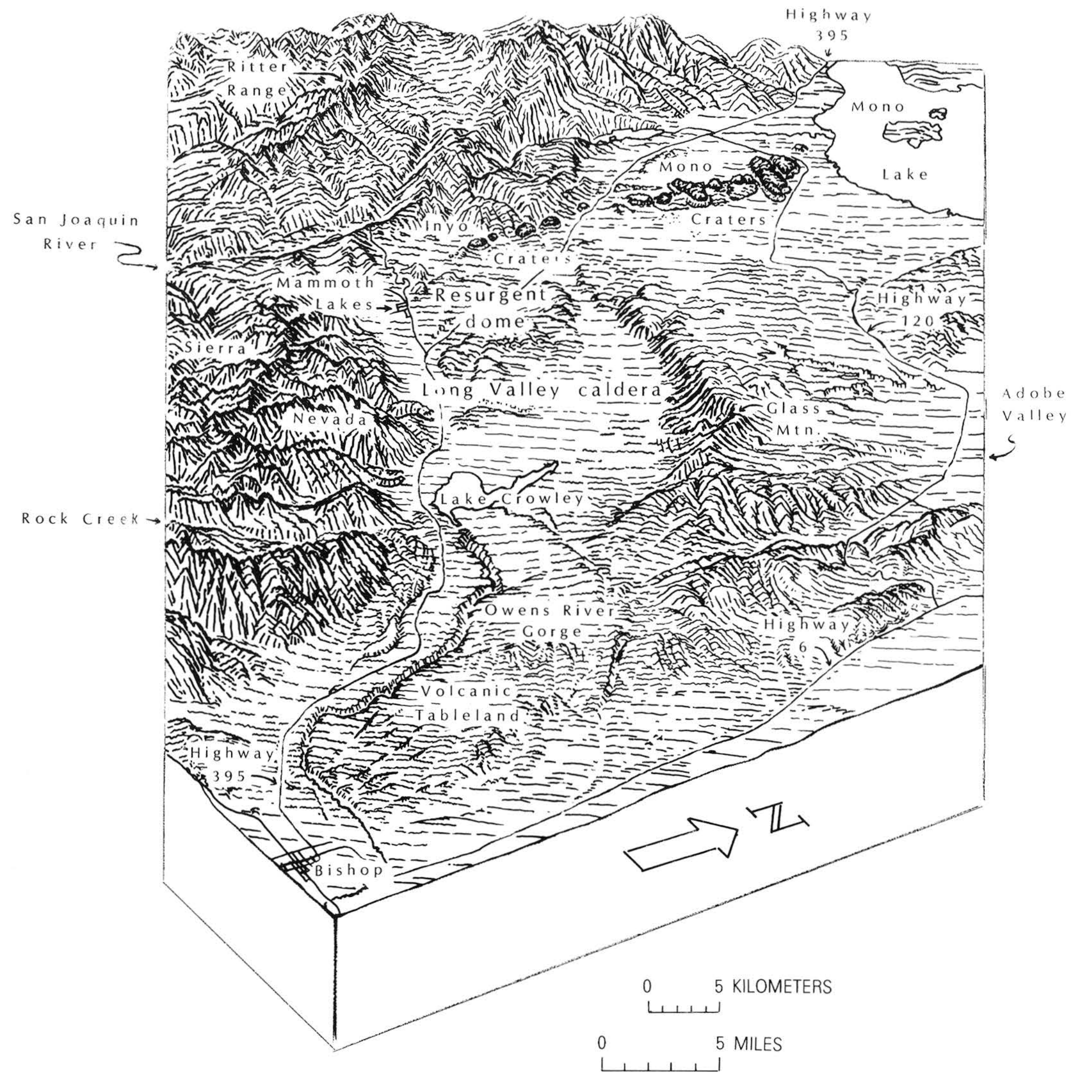
By

Tau Rho Alpha

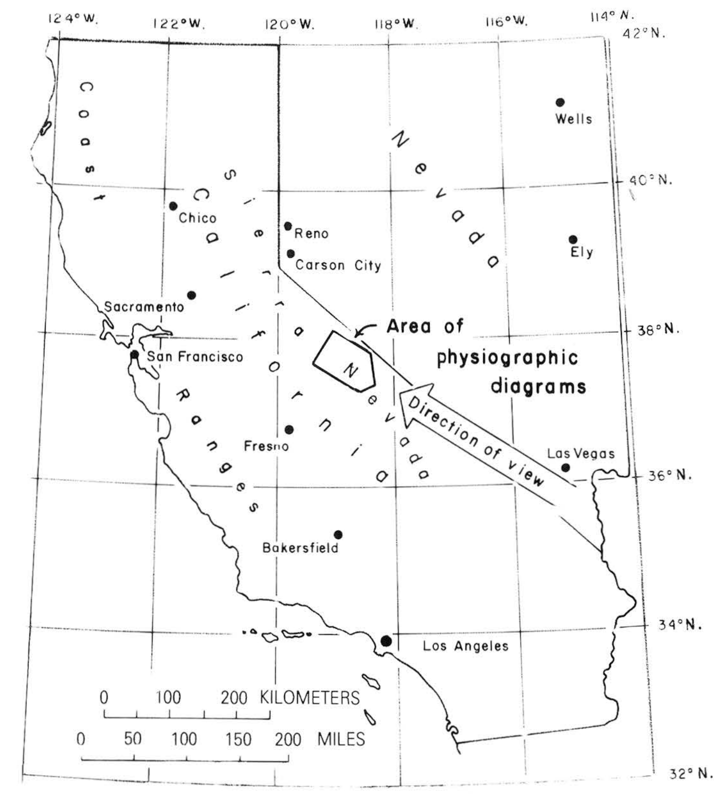
1970



SIMPLIFIED STRUCTURAL-PHYSIOGRAPHIC MAP OF LONG VALLEY, CALIFORNIA



IDENTIFICATION MAP OF LONG VALLEY, CALIFORNIA



INDEX MAP OF CALIFORNIA AND NEVADA

Viewed toward the northwest, Long Valley is located on the east side of the Sierra Nevada and on the west edge of the Basin and Range province. The town of Mammoth Lakes is a resort community that has a population of about 4,000 and a tourist population of 20,000 during the winter ski season. Long Valley is a volcanic depression called Long Valley caldera, which erupted about 700,000 years ago. The south and west edges of the caldera are defined by the faults of the eastern front of the Sierra Nevada, and the north and east edges are defined by the faults that flank Glass Mountain. Recently in the western part of the caldera near the town of Mammoth Lakes, a broad uplift called the Resurgent dome has been bulging upward, and several series of earthquakes have occurred. The second of these two maps shows a geologic cross section through the Long Valley caldera. An inferred new intrusion, which may be the cause of the earthquakes, can be seen toward the left side of the cross section. This map has been published in Alpha, Bailey, and others (1983).

PHYSIOGRAPHIC DIAGRAMS OF LONG VALLEY, MONO AND INYO COUNTIES, CALIFORNIA

By

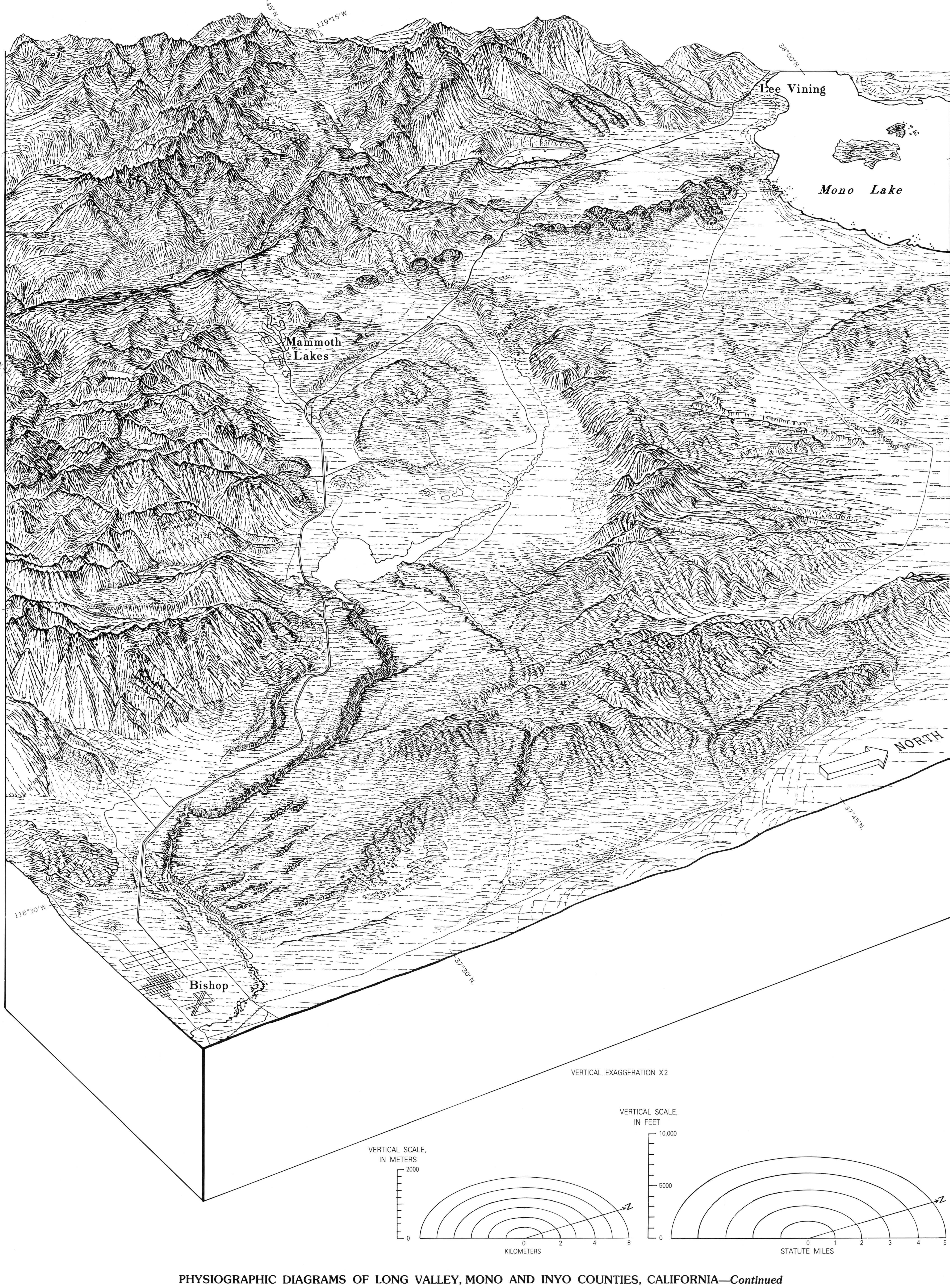
Tau Rho Alpha, Roy A. Bailey,

Kenneth R. Lojoie, and Malcolm M. Clark

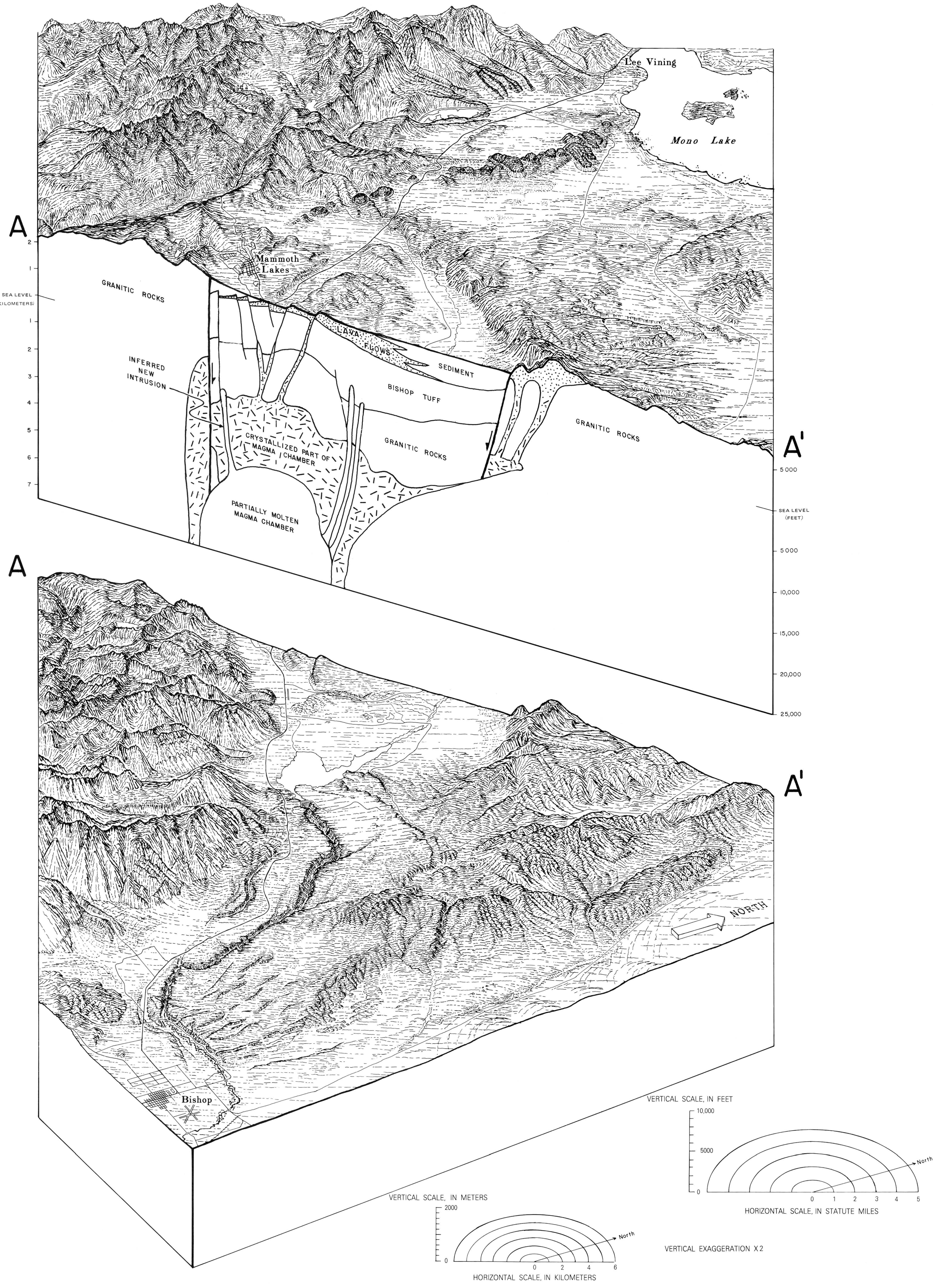
1983

Maps are on following two pages

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

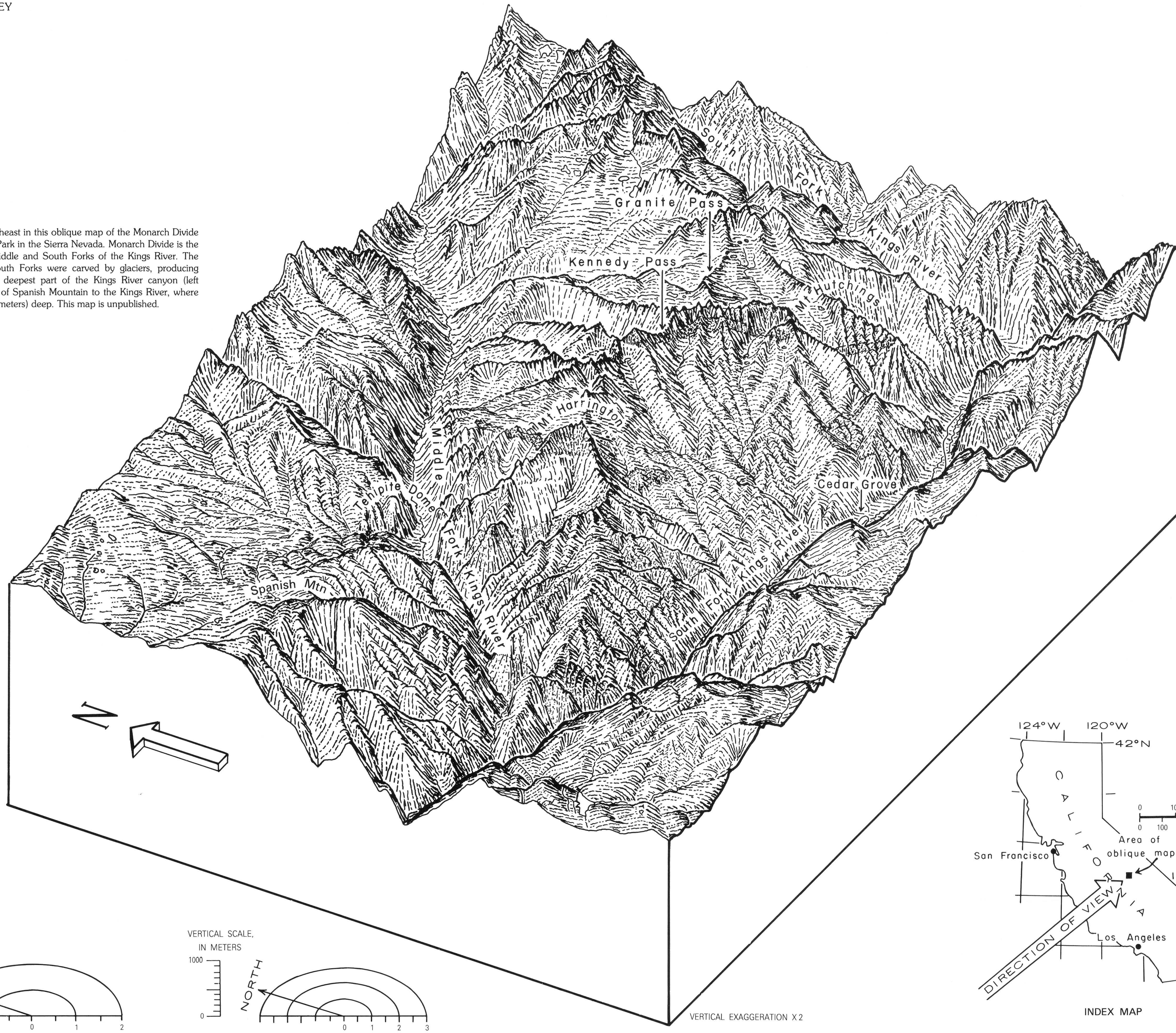


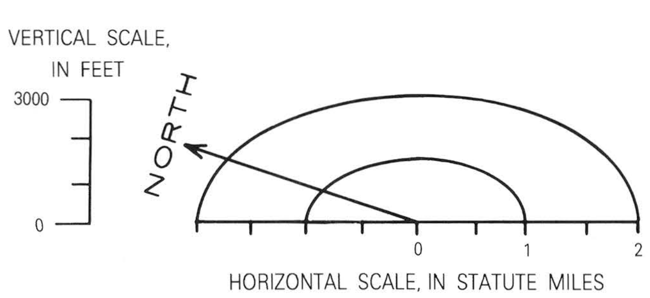
PHYSIOGRAPHIC DIAGRAMS OF LONG VALLEY, MONO AND INYO COUNTIES, CALIFORNIA—*Continued*



PHYSIOGRAPHIC DIAGRAMS OF LONG VALLEY, MONO AND INYO COUNTIES, CALIFORNIA—*Continued*

The view is toward the northeast in this oblique map of the Monarch Divide area of Kings Canyon National Park in the Sierra Nevada. Monarch Divide is the drainage divide between the Middle and South Forks of the Kings River. The canyons of the Middle and South Forks were carved by glaciers, producing canyons with steep sides. The deepest part of the Kings River canyon (left foreground) is from the summit of Spanish Mountain to the Kings River, where the canyon is 7,900 feet (2,400 meters) deep. This map is unpublished.





INDEX MAP

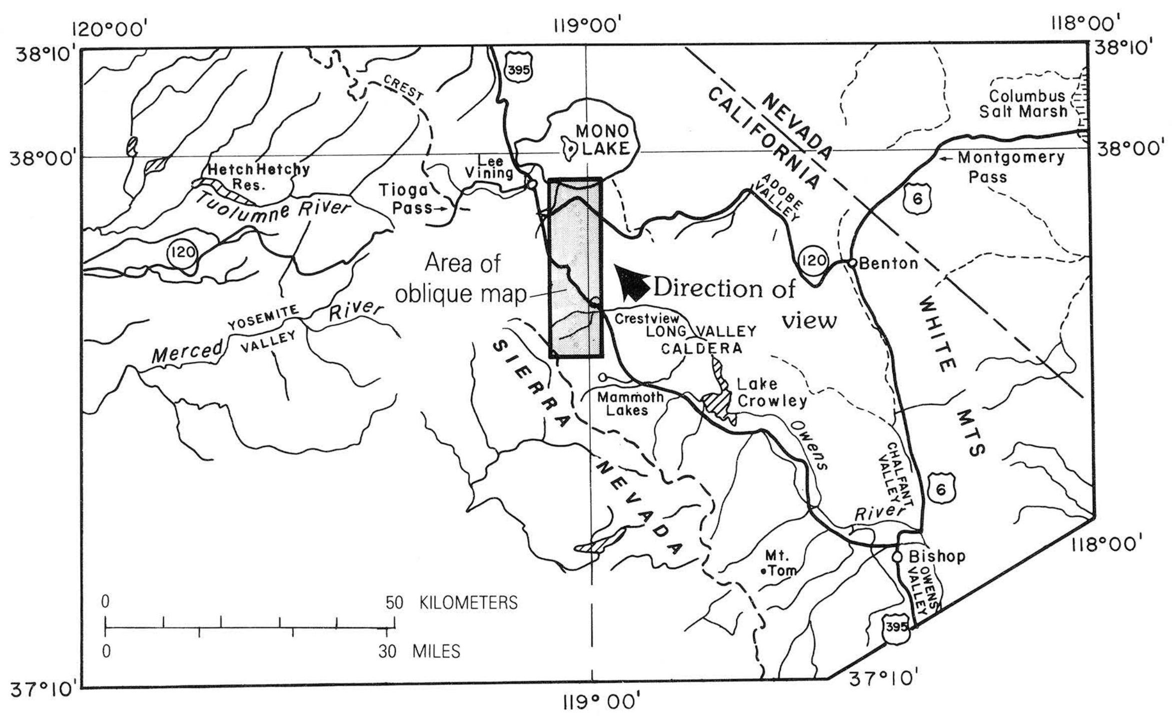
MONARCH DIVIDE

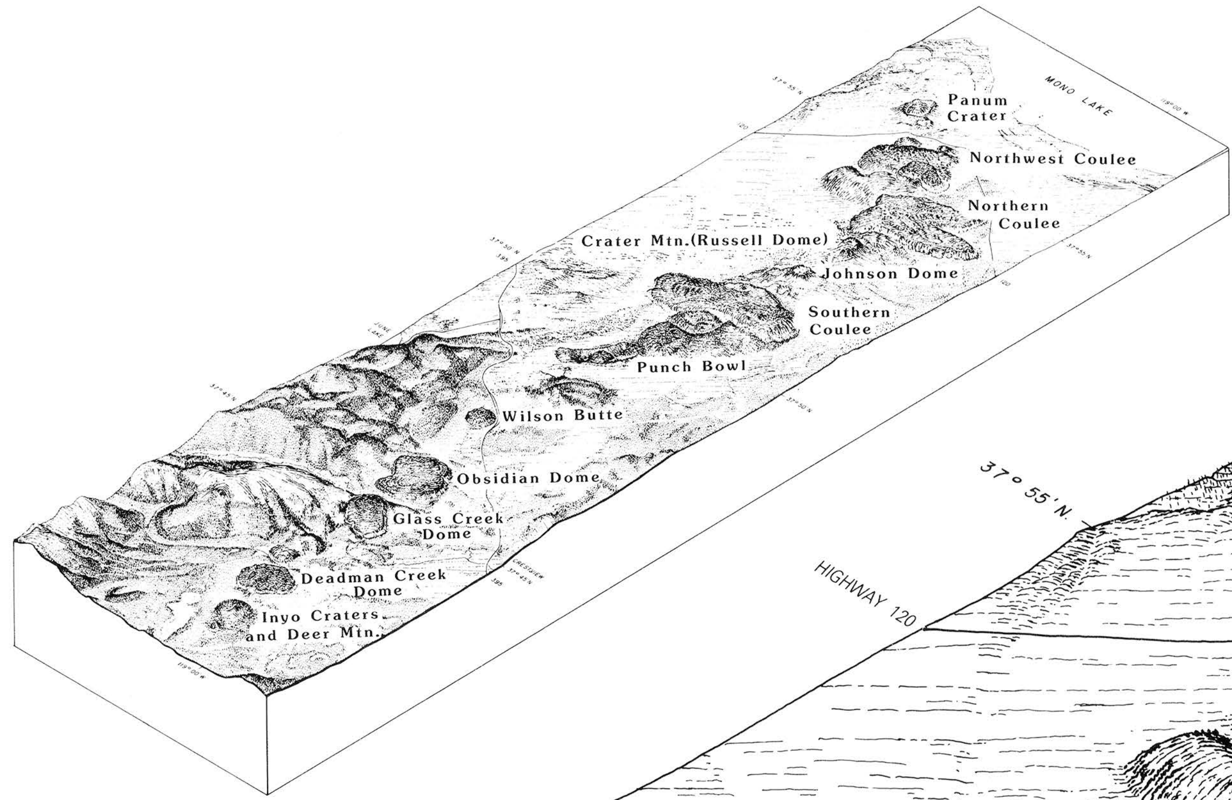
KINGS CANYON NATIONAL PARK

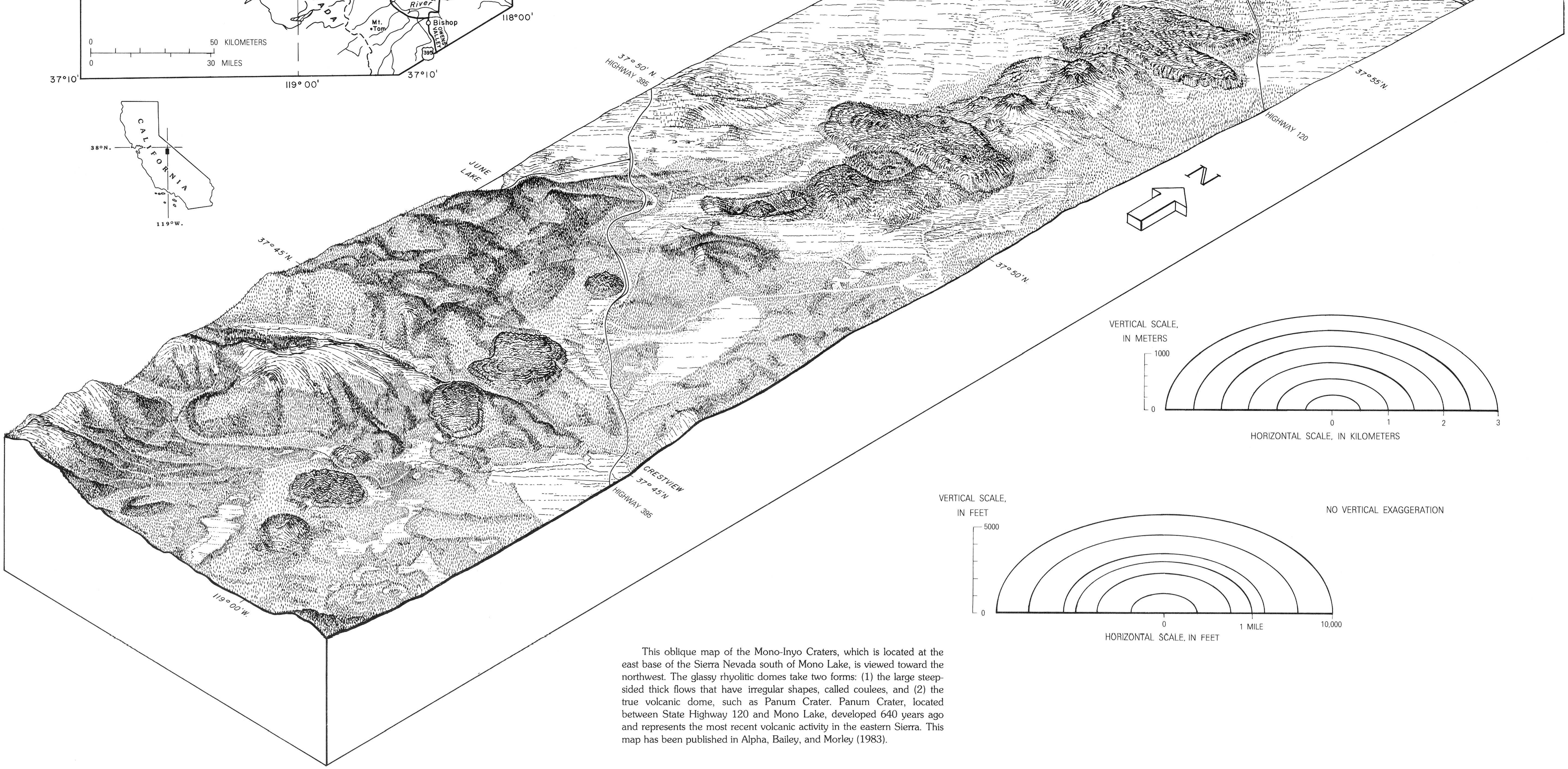
By

Tau Rho Alpha

1977







NO VERTICAL EXAGGERATION

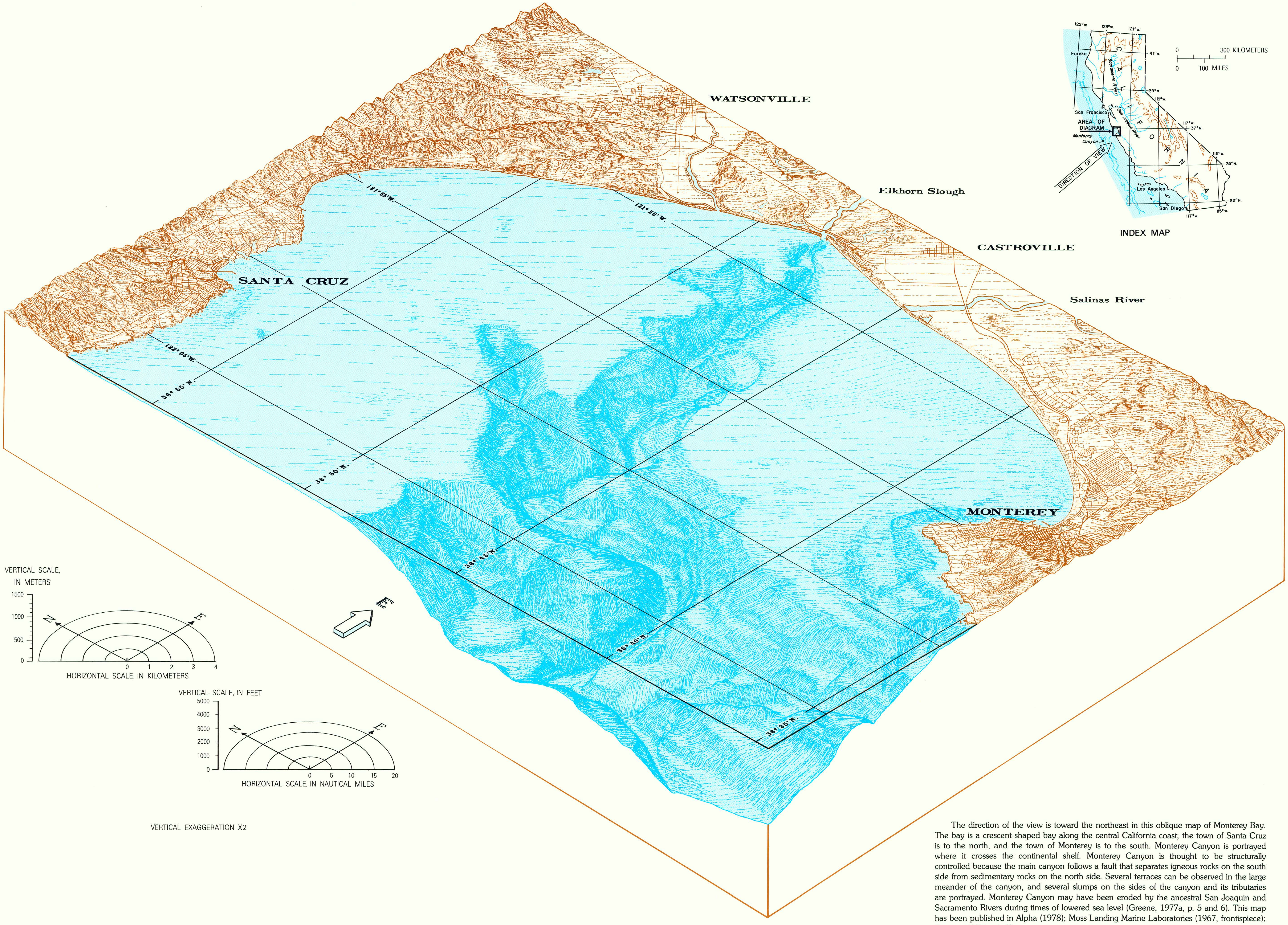
This oblique map of the Mono-Inyo Craters, which is located at the east base of the Sierra Nevada south of Mono Lake, is viewed toward the northwest. The glassy rhyolitic domes take two forms: (1) the large steep-sided thick flows that have irregular shapes, called coulees, and (2) the true volcanic dome, such as Panum Crater. Panum Crater, located between State Highway 120 and Mono Lake, developed 640 years ago and represents the most recent volcanic activity in the eastern Sierra. This map has been published in Alpha, Bailey, and Morley (1983).

OBLIQUE MAP OF MONO-INYO CRATERS, CALIFORNIA

By

Tau Rho Alpha, Roy A. Bailey, and James M. Morley

1983

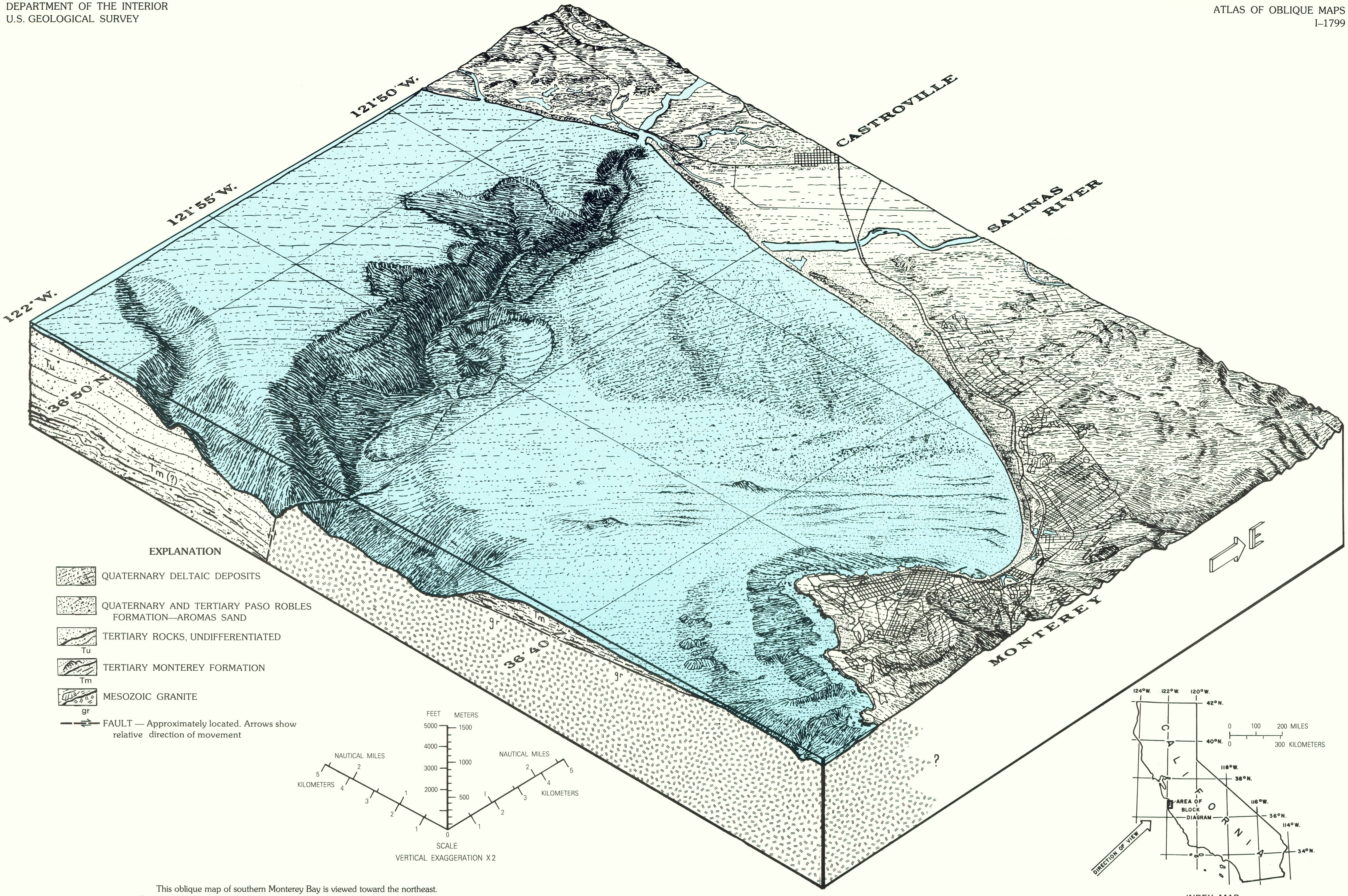


The direction of the view is toward the northeast in this oblique map of Monterey Bay. The bay is a crescent-shaped bay along the central California coast; the town of Santa Cruz is to the north, and the town of Monterey is to the south. Monterey Canyon is portrayed where it crosses the continental shelf. Monterey Canyon is thought to be structurally controlled because the main canyon follows a fault that separates igneous rocks on the south side from sedimentary rocks on the north side. Several terraces can be observed in the large meander of the canyon, and several slumps on the sides of the canyon and its tributaries are portrayed. Monterey Canyon may have been eroded by the ancestral San Joaquin and Sacramento Rivers during times of lowered sea level (Greene, 1977a, p. 5 and 6). This map has been published in Alpha (1978); Moss Landing Marine Laboratories (1967, frontispiece); Greene (1977a, pl. 2).

OBLIQUE MAP OF MONTEREY BAY

By
Tau Rho Alpha
1978

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY



INDEX MAP

This oblique map of southern Monterey Bay is viewed toward the northeast. The area includes the south half of Monterey Bay, the delta of the Salinas River, and Monterey Canyon. Several slumps can be noticed on both walls of the canyon (Shepard, 1973, p. 315). The softer sedimentary deposits that form the delta of the Salinas River and the harder resistant granitic rocks that form the Monterey Peninsula can be seen. The map and the geologic cross section show the two different types of rocks on each side of the canyon, which has been eroded along a fault. This map has been published in Alpha (1970); Greene (1970, pl. 5).

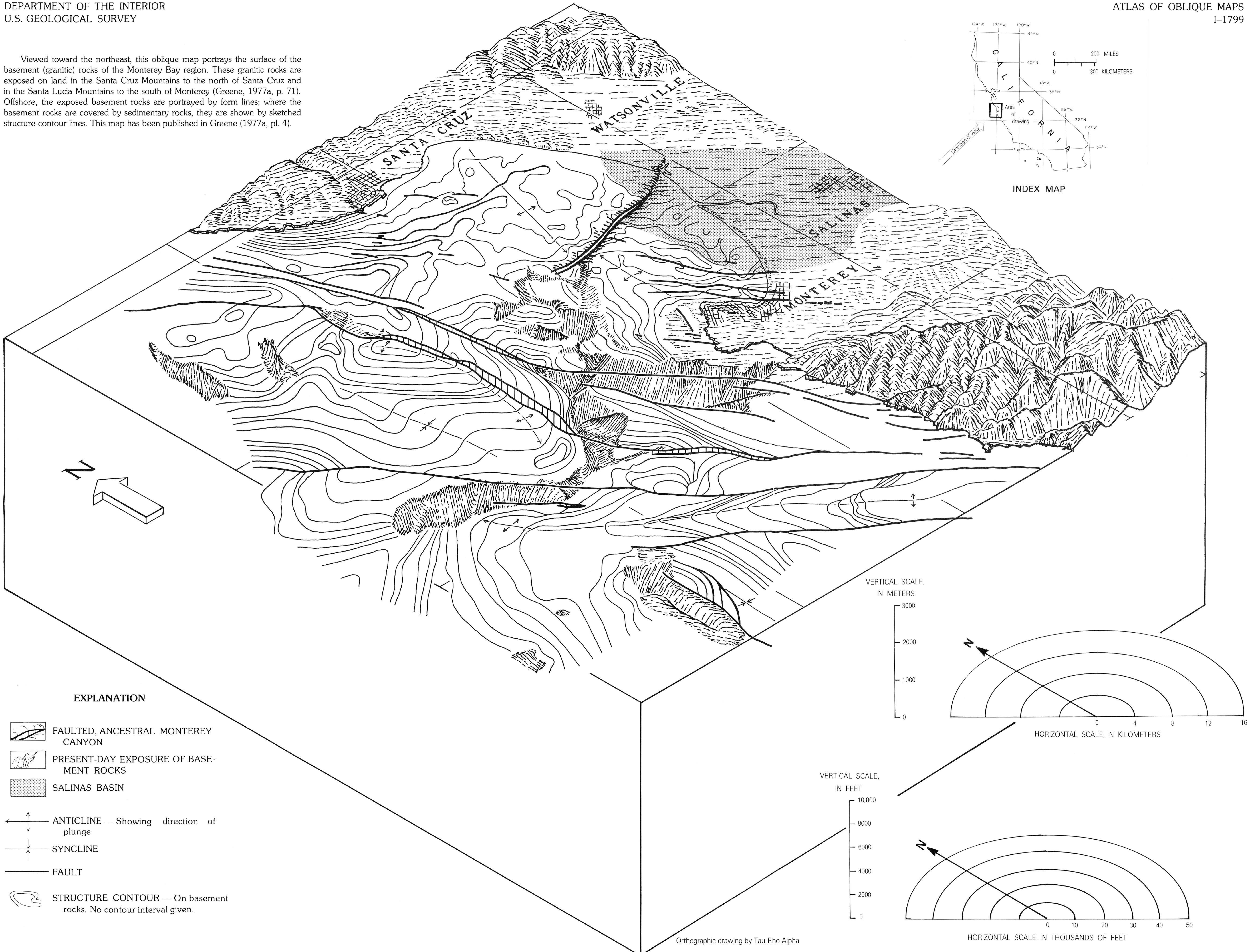
SOUTHERN MONTEREY BAY

Orthographic drawing by Tau Rho Alpha
Geologic interpretation by H. Gary Greene
1970

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

ATLAS OF OBLIQUE MAPS
I–1799

Viewed toward the northeast, this oblique map portrays the surface of the basement (granitic) rocks of the Monterey Bay region. These granitic rocks are exposed on land in the Santa Cruz Mountains to the north of Santa Cruz and in the Santa Lucia Mountains to the south of Monterey (Greene, 1977a, p. 71). Offshore, the exposed basement rocks are portrayed by form lines; where the basement rocks are covered by sedimentary rocks, they are shown by sketched structure-contour lines. This map has been published in Greene (1977a, pl. 4).



VERTICAL EXAGGERATION X4

Orthographic drawing by Tau Rho Alpha

EXPLANATION

FAULTED, ANCESTRAL MONTEREY CANYON

PRESENT-DAY EXPOSURE OF BASEMENT ROCKS

SALINAS BASIN

ANTICLINE — Showing direction of plunge

SYNCLINE

FAULT

STRUCTURE CONTOUR — On basement rocks. No contour interval given.

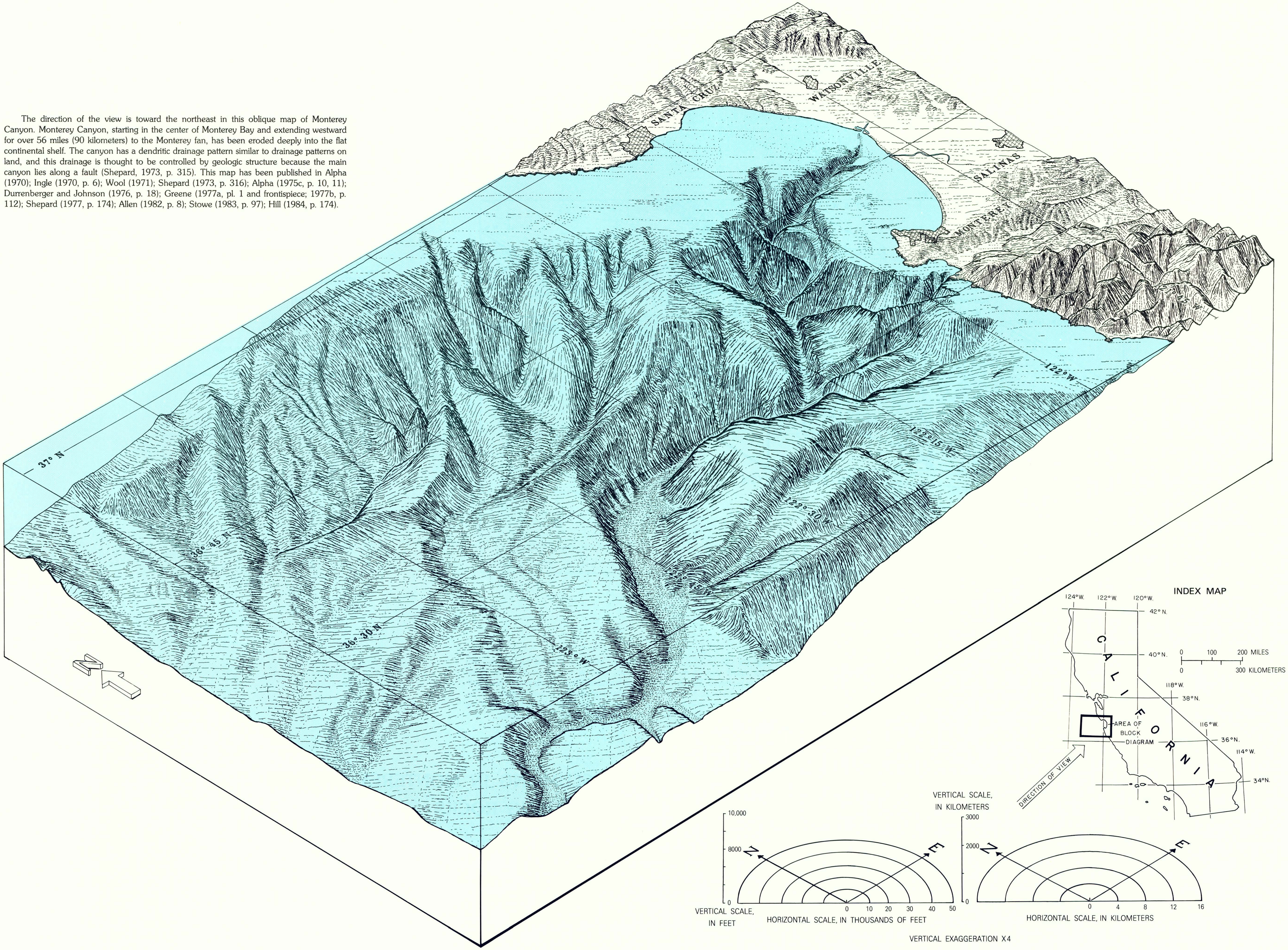
BASEMENT TOPOGRAPHY, MONTEREY BAY REGION, CALIFORNIA

By

H. Gary Greene

1977

The direction of the view is toward the northeast in this oblique map of Monterey Canyon. Monterey Canyon, starting in the center of Monterey Bay and extending westward for over 56 miles (90 kilometers) to the Monterey fan, has been eroded deeply into the flat continental shelf. The canyon has a dendritic drainage pattern similar to drainage patterns on land, and this drainage is thought to be controlled by geologic structure because the main canyon lies along a fault (Shepard, 1973, p. 315). This map has been published in Alpha (1970); Ingle (1970, p. 6); Wool (1971); Shepard (1973, p. 316); Alpha (1975c, p. 10, 11); Durrenberger and Johnson (1976, p. 18); Greene (1977a, pl. 1 and frontispiece; 1977b, p. 112); Shepard (1977, p. 174); Allen (1982, p. 8); Stowe (1983, p. 97); Hill (1984, p. 174).

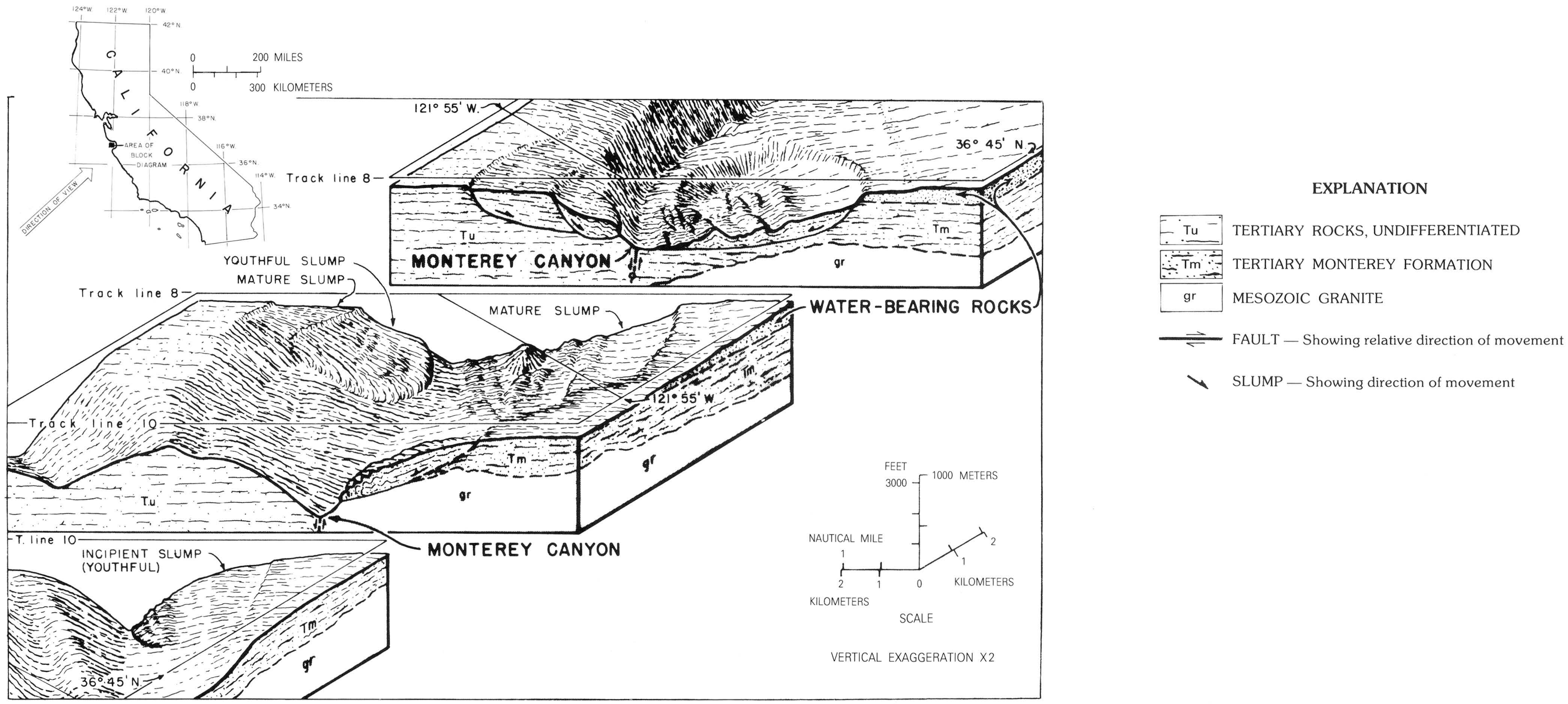


MONTEREY CANYON

By

Tau Rho Alpha

1970



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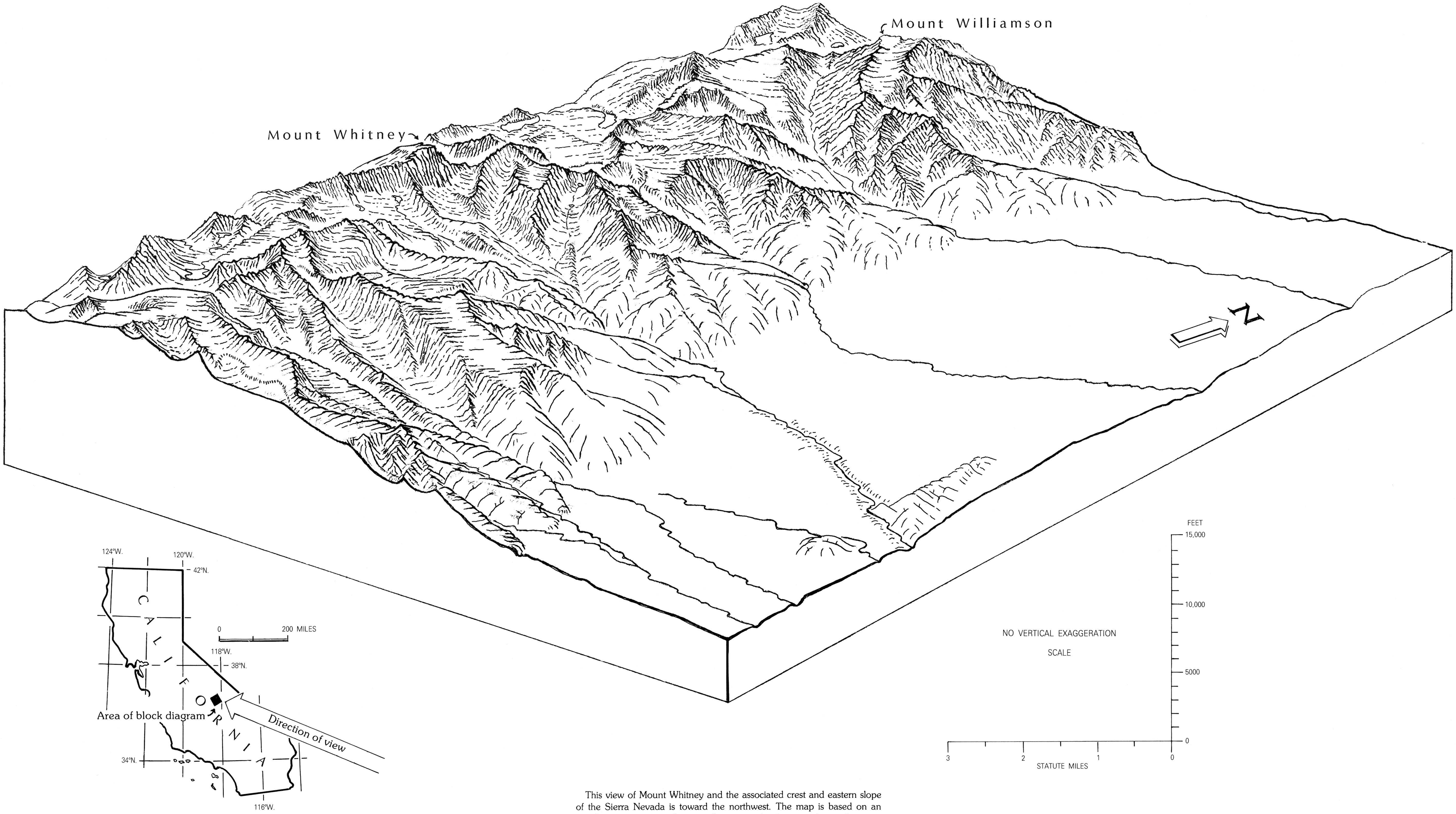
This page-size oblique map, viewed toward the northeast, displays the slumping that occurs in the upper part of Monterey Canyon. Youthful to mature stages of slump development are portrayed. The slumps that were interpreted from seismic profiles have well-developed headward scarps, hummocky topography, and identifiable toes (Greene, 1977a, p. 96). The cause of the numerous slumps may be due to undercutting and erosion of the canyon walls. This map has been published in Greene (1970, p. 42; 1977a, p. 99).

DIAGRAM SHOWING DIFFERENT STAGES OF SLUMPING IN MONTEREY CANYON AND RELATION TO WATER-BEARING ROCKS

By

Tau Rho Alpha

1970



INDEX MAP

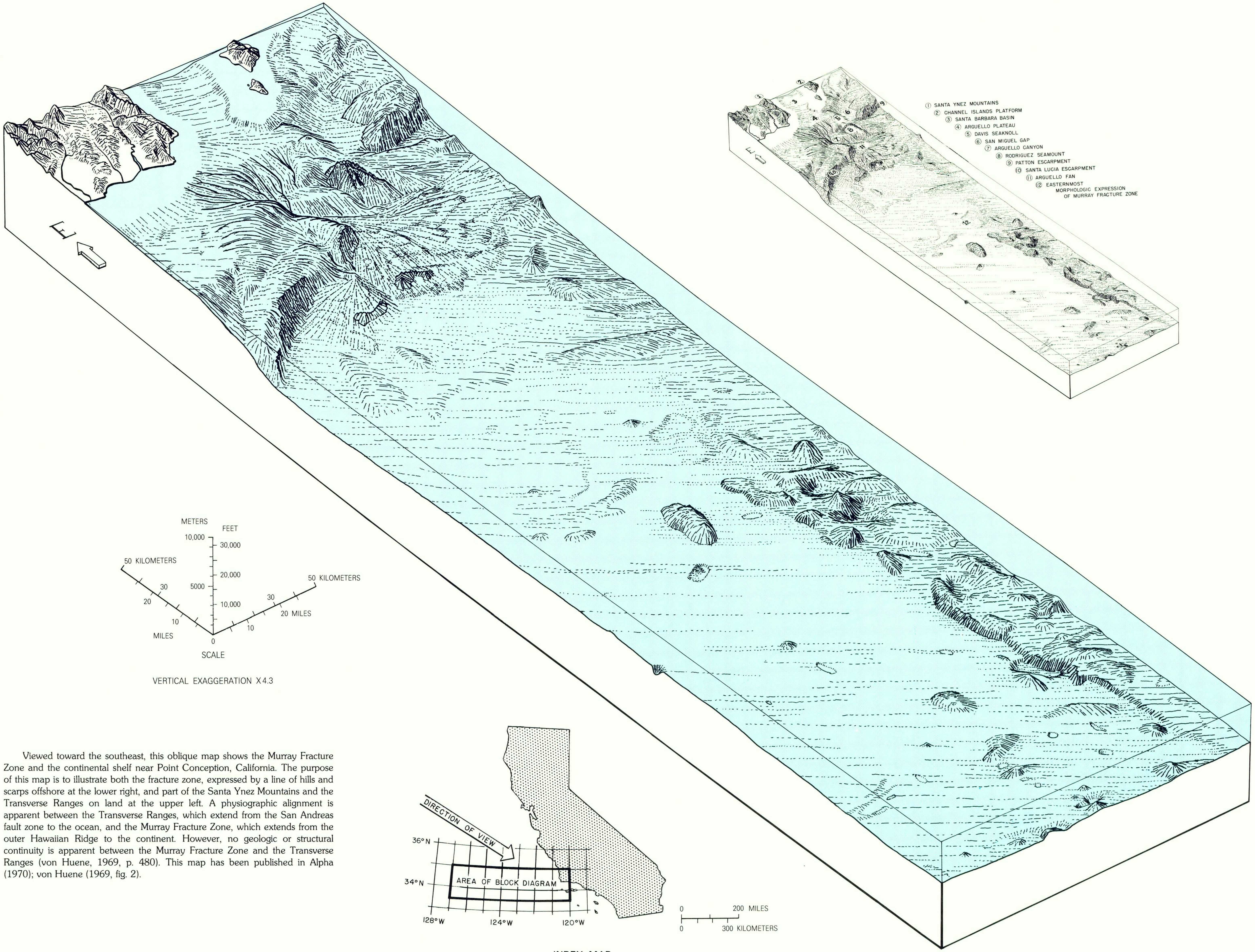
This view of Mount Whitney and the associated crest and eastern slope of the Sierra Nevada is toward the northwest. The map is based on an angular-perspective grid; spot elevations of ridges, peaks, and stream intersections are located on this grid and are vertically elevated using a common scale. These elevated spot elevations are the basis on which the physiography is drawn. This oblique map, compiled in 1961, is the oldest oblique map in this atlas and is unpublished.

MOUNT WHITNEY AND VICINITY, TULARE AND INYO COUNTIES, CALIFORNIA

By

Tau Rho Alpha

1961



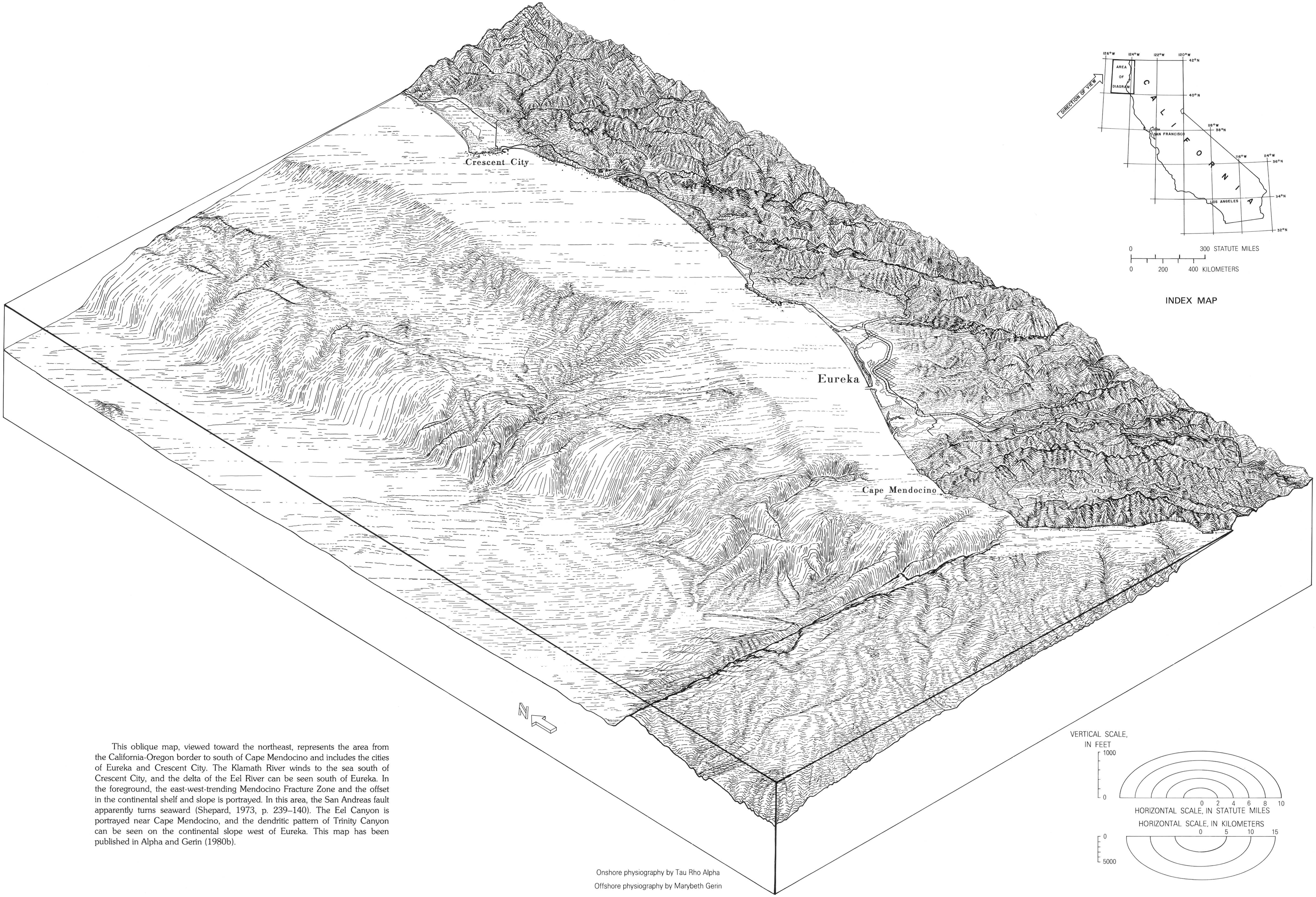
Viewed toward the southeast, this oblique map shows the Murray Fracture Zone and the continental shelf near Point Conception, California. The purpose of this map is to illustrate both the fracture zone, expressed by a line of hills and scarps offshore at the lower right, and part of the Santa Ynez Mountains and the Transverse Ranges on land at the upper left. A physiographic alignment is apparent between the Transverse Ranges, which extend from the San Andreas fault zone to the ocean, and the Murray Fracture Zone, which extends from the outer Hawaiian Ridge to the continent. However, no geologic or structural continuity is apparent between the Murray Fracture Zone and the Transverse Ranges (von Huene, 1969, p. 480). This map has been published in Alpha (1970); von Huene (1969, fig. 2).

EASTERN MURRAY FRACTURE ZONE AND TRANSVERSE RANGES

By

Tau Rho Alpha

1969



INDEX MAP

This oblique map, viewed toward the northeast, represents the area from the California-Oregon border to south of Cape Mendocino and includes the cities of Eureka and Crescent City. The Klamath River winds to the sea south of Crescent City, and the delta of the Eel River can be seen south of Eureka. In the foreground, the east-west-trending Mendocino Fracture Zone and the offset in the continental shelf and slope is portrayed. In this area, the San Andreas fault apparently turns seaward (Shepard, 1973, p. 239–140). The Eel Canyon is portrayed near Cape Mendocino, and the dendritic pattern of Trinity Canyon can be seen on the continental slope west of Eureka. This map has been published in Alpha and Gerin (1980b).

Onshore physiography by Tau Rho Alpha
Offshore physiography by Marybeth Gerin

VERTICAL EXAGGERATION X3

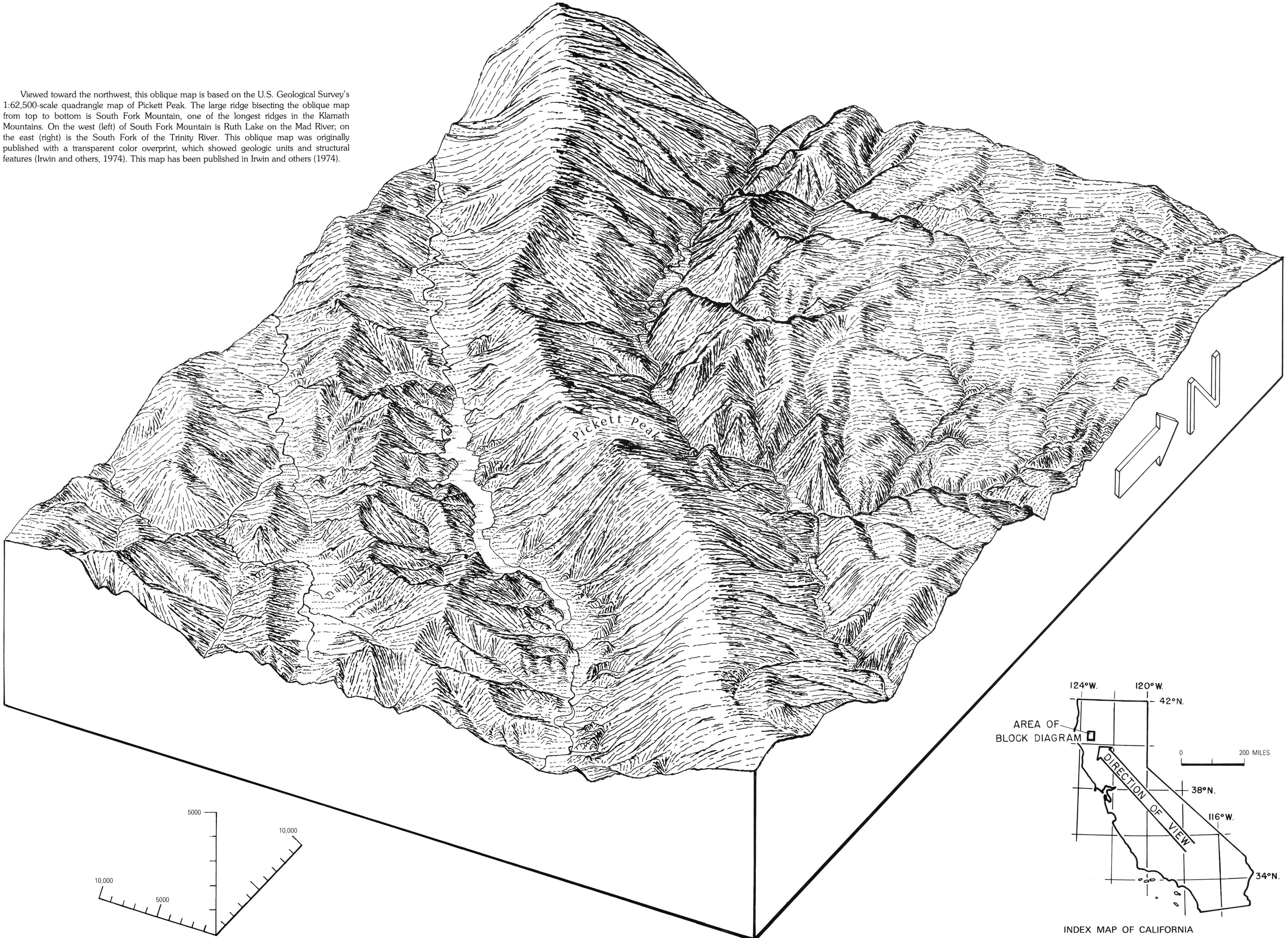
OBLIQUE MAP OF THE NORTHERN CALIFORNIA CONTINENTAL MARGIN

By

Tau Rho Alpha and Marybeth Gerin

1979

Viewed toward the northwest, this oblique map is based on the U.S. Geological Survey's 1:62,500-scale quadrangle map of Pickett Peak. The large ridge bisecting the oblique map from top to bottom is South Fork Mountain, one of the longest ridges in the Klamath Mountains. On the west (left) of South Fork Mountain is Ruth Lake on the Mad River; on the east (right) is the South Fork of the Trinity River. This oblique map was originally published with a transparent color overprint, which showed geologic units and structural features (Irwin and others, 1974). This map has been published in Irwin and others (1974).



SCALE IN FEET

VERTICAL EXAGGERATION X2

INDEX MAP OF CALIFORNIA

PICKETT PEAK QUADRANGLE, CALIFORNIA

By

Tau Rho Alpha

1974

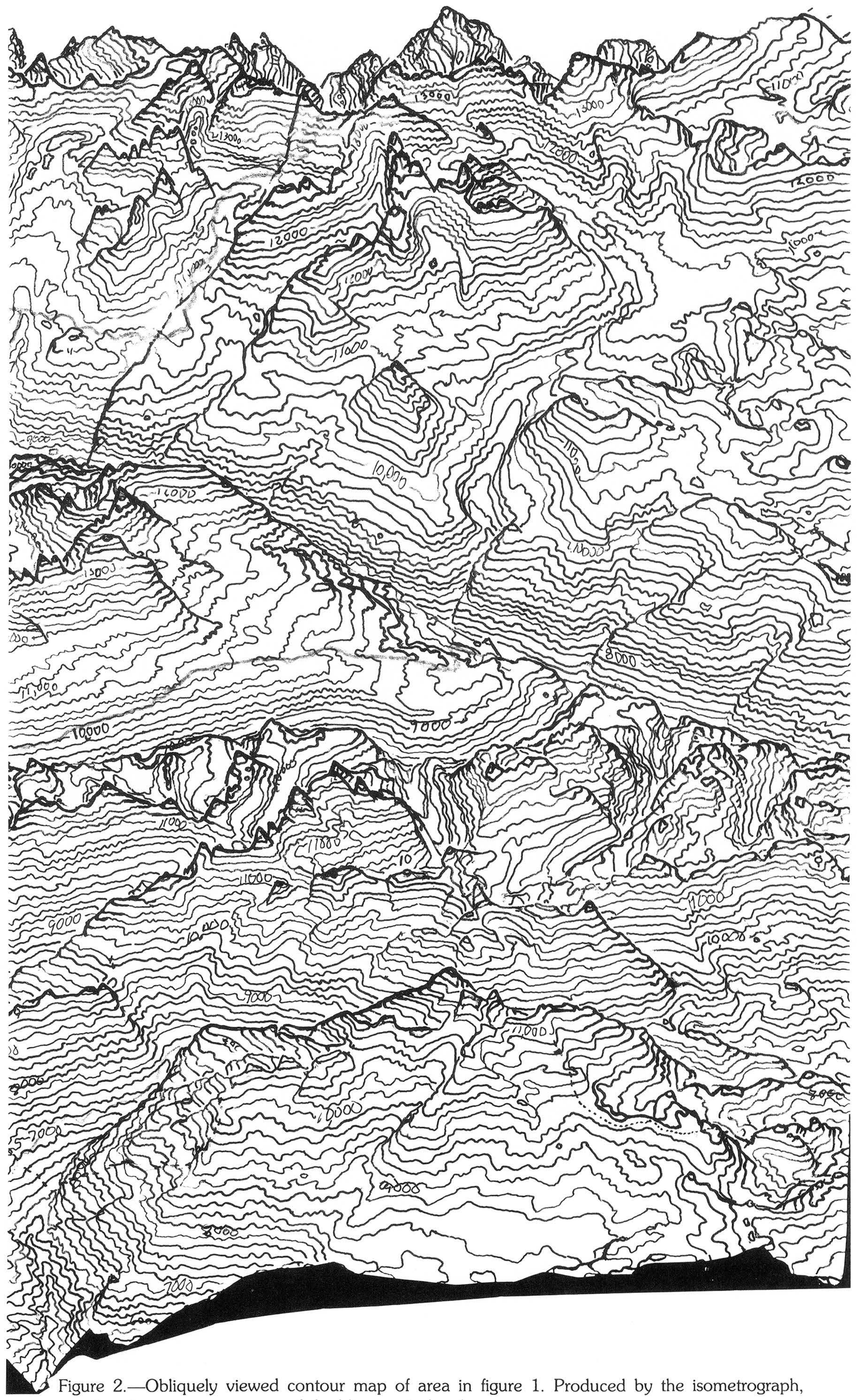


Figure 2.—Obliquely viewed contour map of area in figure 1. Produced by the isometrograph, foreshortening contours and doubling vertical scale.

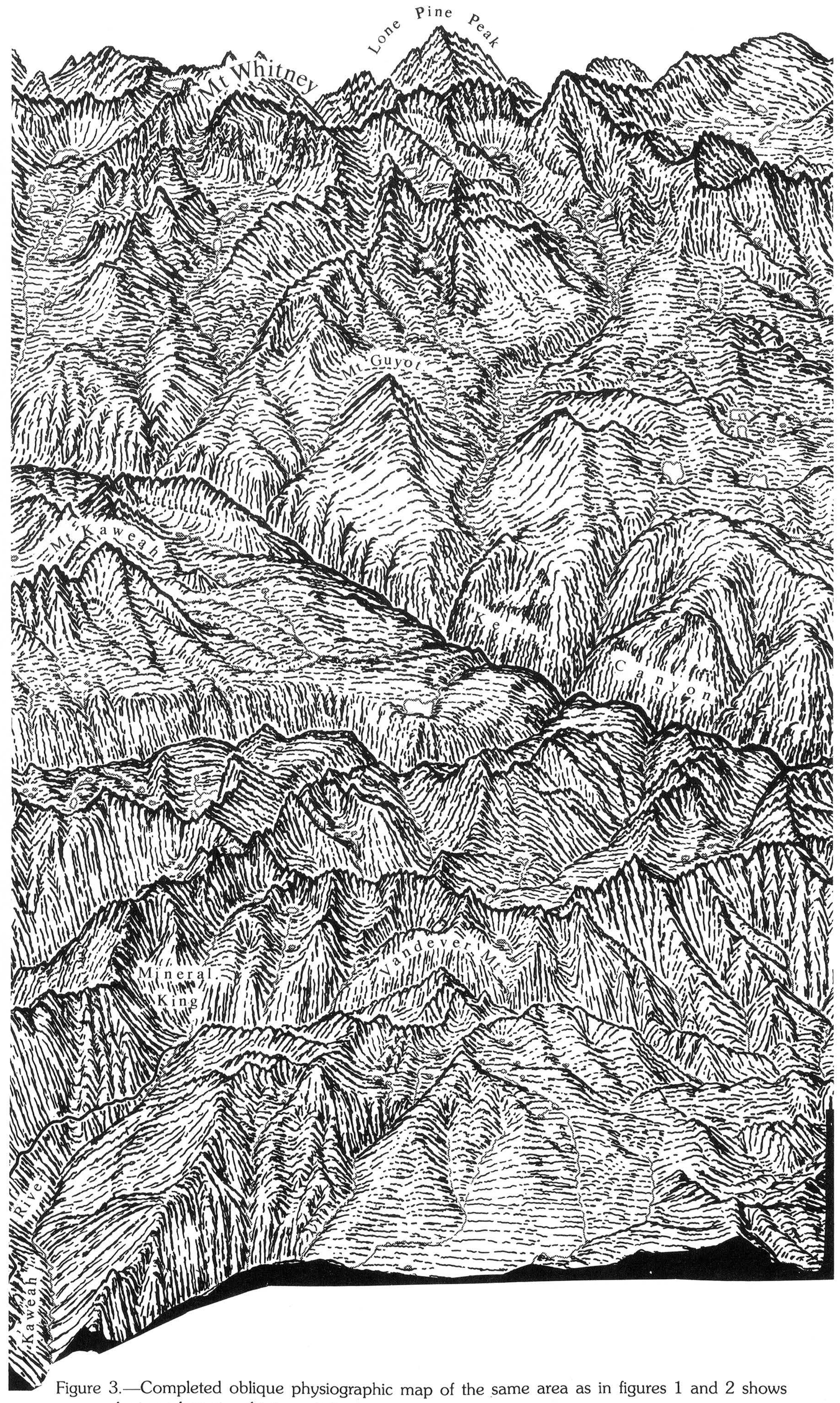


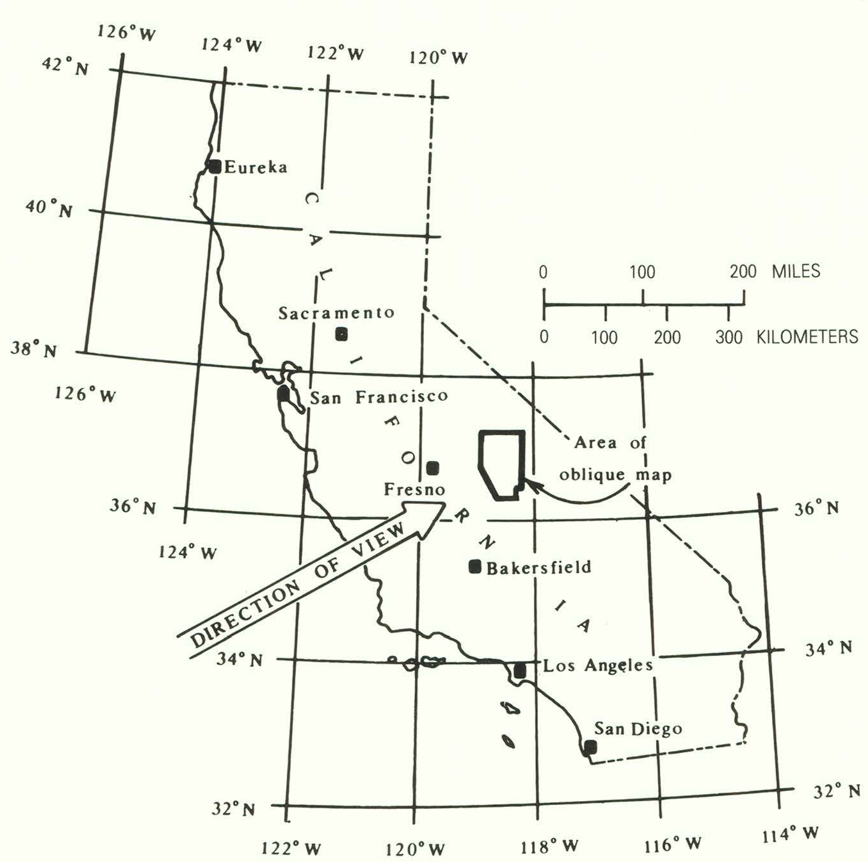
Figure 3.—Completed oblique physiographic map of the same area as in figures 1 and 2 shows geologic and erosional interpretations.

COMPILATION OF THE OBLIQUE MAP OF SEQUOIA AND KINGS CANYON NATIONAL PARKS

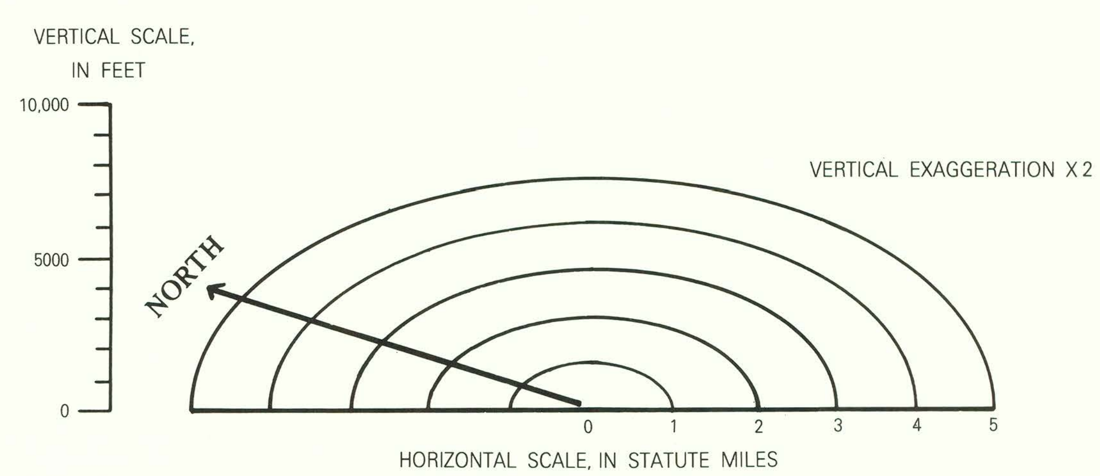
These three maps illustrate the procedure used to produce the oblique map of Sequoia and Kings Canyon National Parks that appears on the following pages. The isometgrograph was used to project the contours from the published contour map of the area (fig. 1) into a parallel-perspective framework of foreshortened contours (fig. 2). This contour map is viewed at an angle of 30° above the surface of the Earth, and the vertical scale has been doubled. Then, with the oblique contour map (fig. 2) as a quantitative base under a registered overlay, the geology and highly glaciated physiography of this area were interpreted with the aid of oblique aerial photographs, field visits, and consultations with experts on the area, producing the final oblique map (fig. 3). Please see page 3 for further discussion of these techniques.

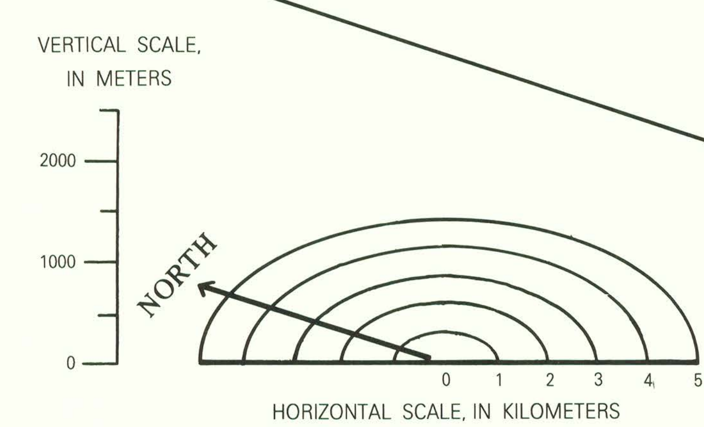
Figure 1.—Part of the vertically viewed, standard contour map of Sequoia and Kings Canyon National Parks. Published in four colors by U.S. Geological Survey, 1958. Scale 1:125,000.

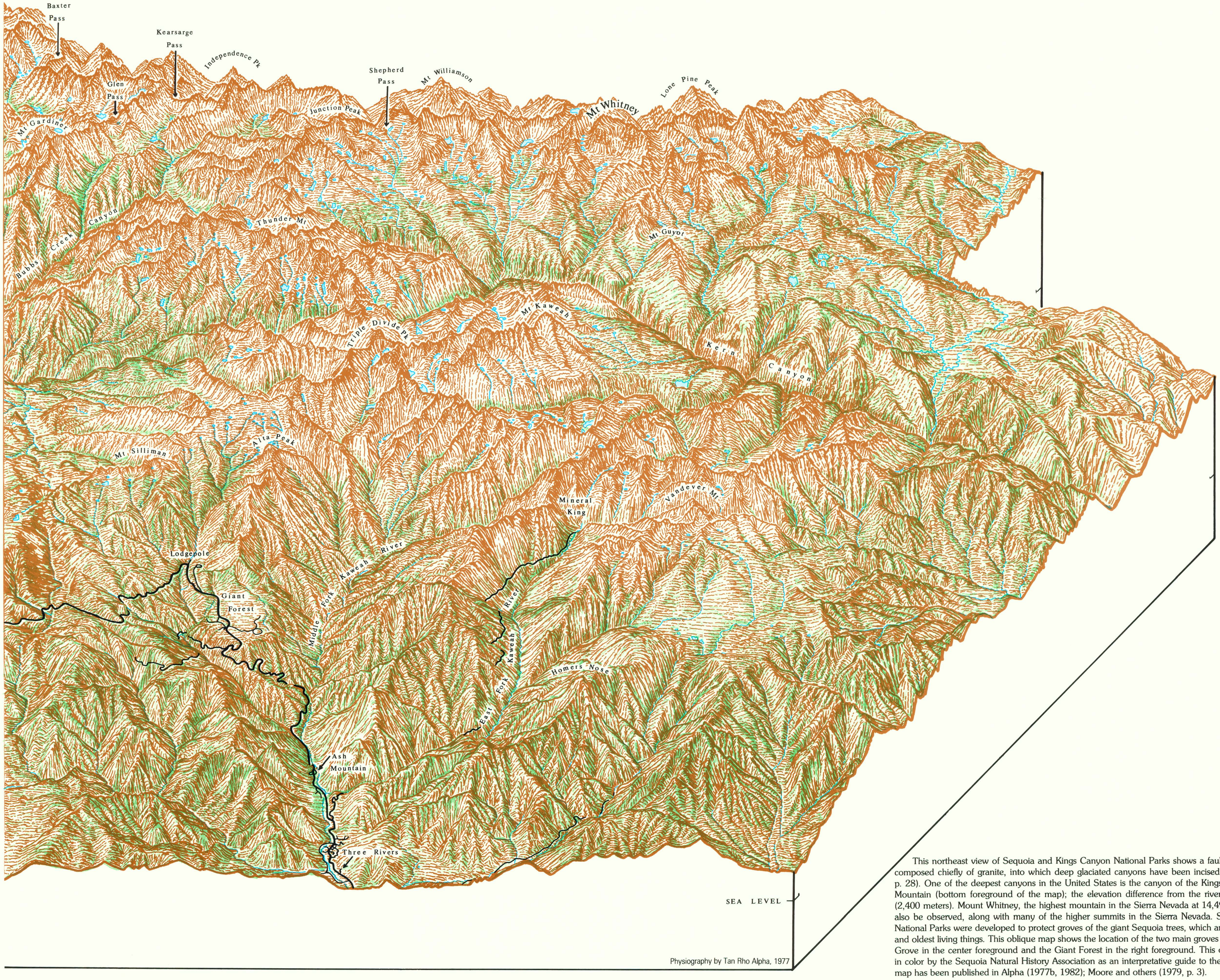
86



INDEX MAP OF CALIFORNIA

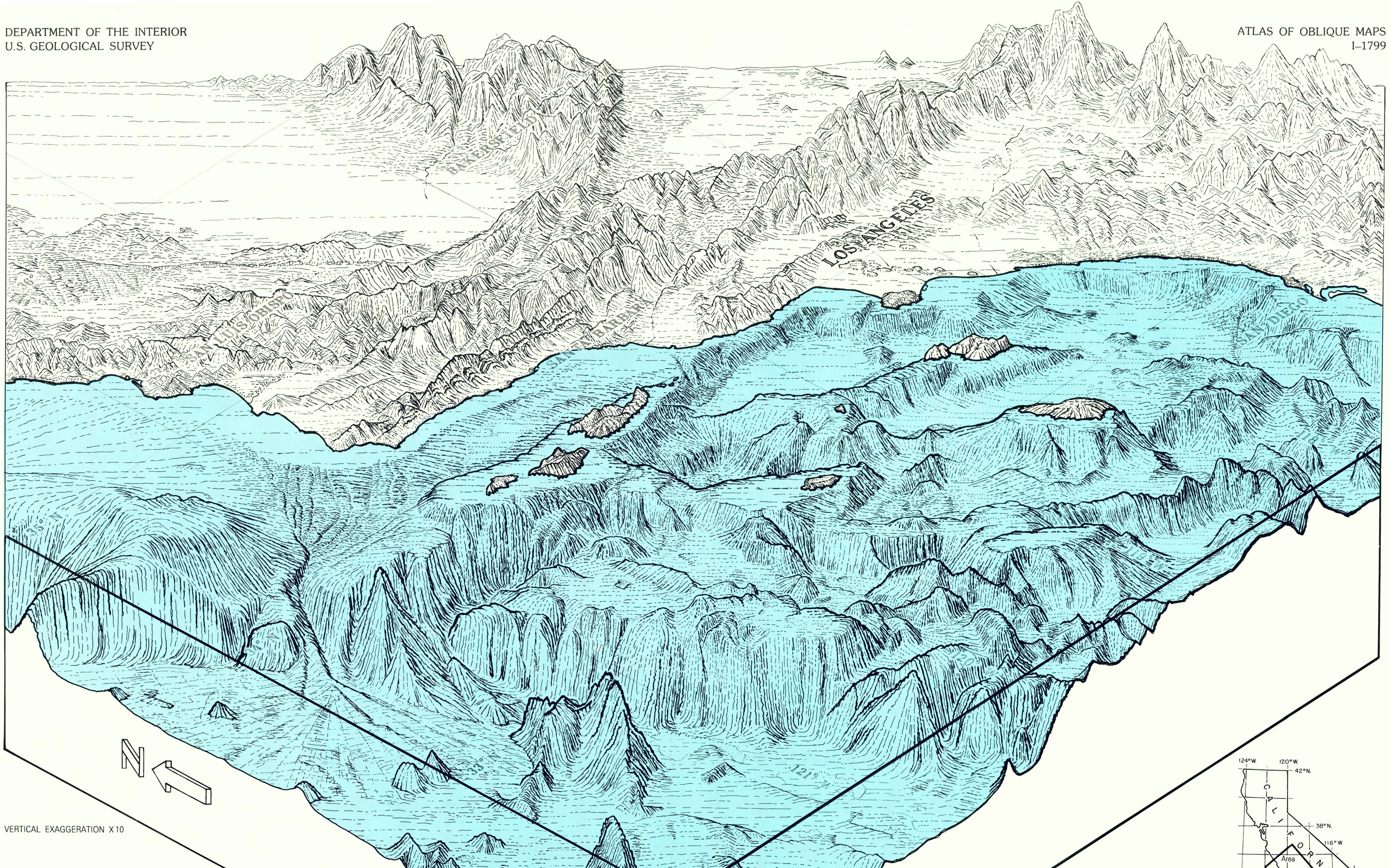




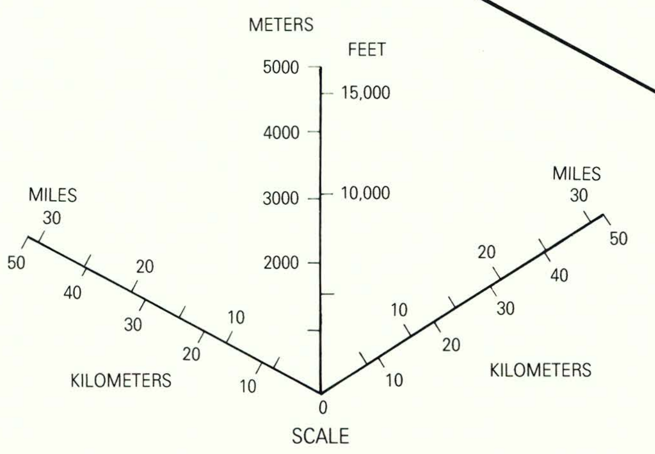


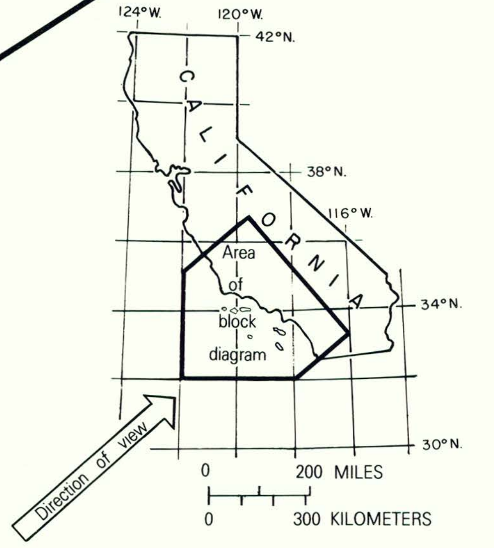
This northeast view of Sequoia and Kings Canyon National Parks shows a fault-block mountain complex, composed chiefly of granite, into which deep glaciated canyons have been incised (Moore and others, 1979, p. 28). One of the deepest canyons in the United States is the canyon of the Kings River adjacent to Spanish Mountain (bottom foreground of the map); the elevation difference from the river to the peak is 7,900 feet (2,400 meters). Mount Whitney, the highest mountain in the Sierra Nevada at 14,494 feet (2,404 meters), can also be observed, along with many of the higher summits in the Sierra Nevada. Sequoia and Kings Canyon National Parks were developed to protect groves of the giant Sequoia trees, which are among the world's largest and oldest living things. This oblique map shows the location of the two main groves of Sequoia trees: the Grant Grove in the center foreground and the Giant Forest in the right foreground. This oblique map was published in color by the Sequoia Natural History Association as an interpretative guide to these two national parks. This map has been published in Alpha (1977b, 1982); Moore and others (1979, p. 3).

OBLIQUE MAP OF SEQUOIA AND KINGS CANYON NATIONAL PARKS, FRESNO AND TULARE COUNTIES, CALIFORNIA



VERTICAL EXAGGERATION X10





INDEX MAP

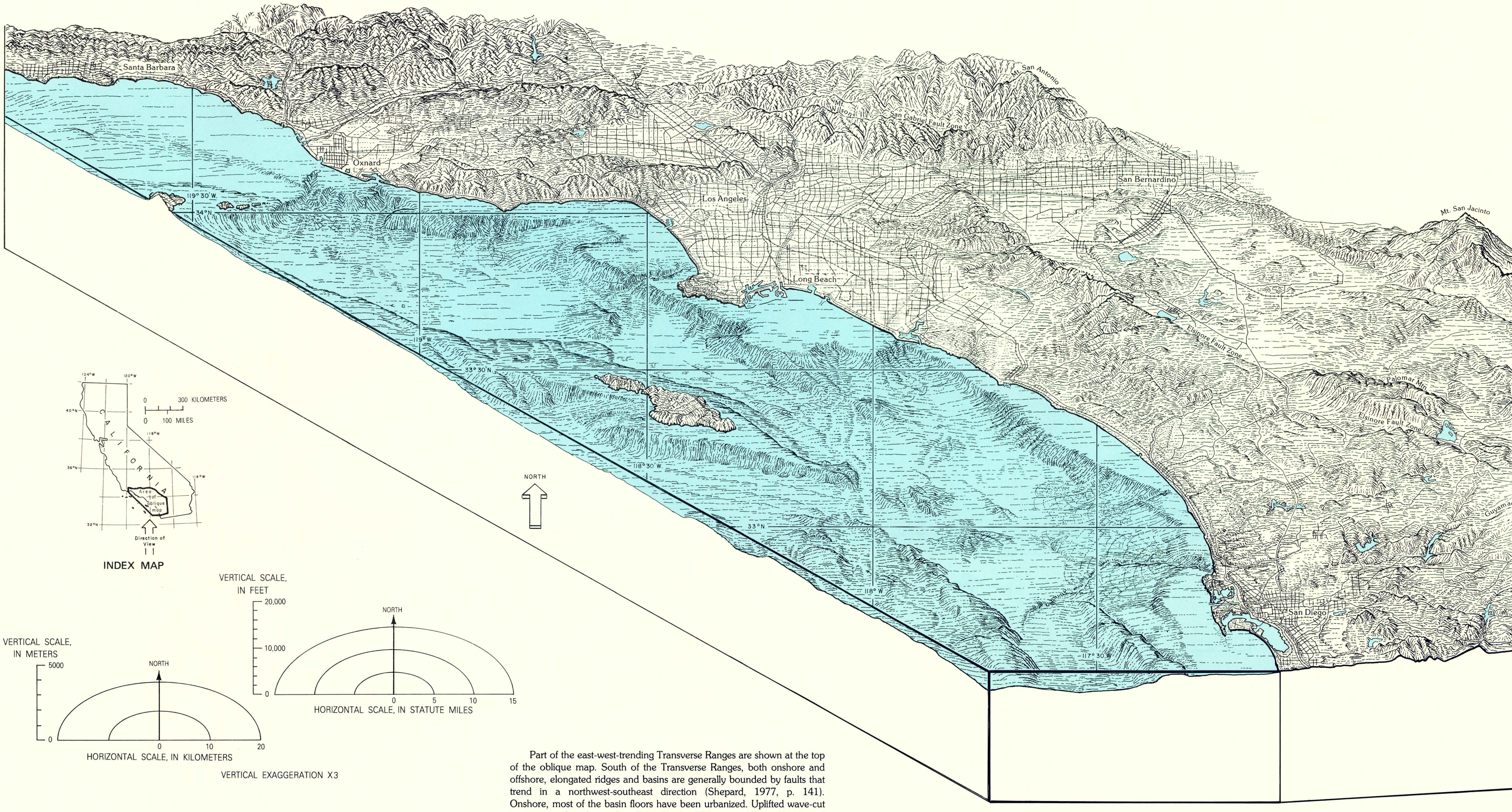
This oblique map of the southern California borderland has been published more often than any other oblique map appearing in this atlas. The reason is uncertain, but it could be either the very popular, highly populated area portrayed or the high interest in that area in offshore exploration for oil and gas, minerals, and sand and gravel. The direction of view is toward the northeast and shows the continental rise in the foreground, the basins and ridges that compose the borderland in the center, and the Coast, Transverse, and Peninsular Ranges in the background. This map has been published in Alpha (1970); Alpha (1971, cover and backplate); Shepard (1973, p. 234); Roberts (1975, cover); Rutledge (1975, p. 10–11); Salitore (1975, p. 168); Durrenberger and Johnson (1976, p. 19); Shepard (1977, part of map, p. 120; complete map, p. 140); Greene and others (1978, p. 2); National Research Council (1979, p. 31); Hill (1984, p. 170); Peck (1984, p. 64).

SOUTHERN CALIFORNIA BORDERLAND

By
Tau Rho Alpha
1970

INTRODUCTION TO THE OBLIQUE MAPS OF SOUTHERN CALIFORNIA

The southern California borderland is a continental shelf that is composed of a series of basins and ridges. The offshore islands are the summit areas of these ridges, and the basins located between the ridges have depths to about 1 mile (1.6 kilometers) (Shepard, 1977, p. 140). These basins and ridges are a result of faulting, which lowered the basins below the ridges (Shepard, 1977, p. 141). In the foreground, the continental slope is controlled by a steep fault scarp. Onshore north of the borderland, the east-west-trending Transverse Ranges are located between Bakersfield and Los Angeles. South of the Transverse Ranges and Los Angeles and east of the borderland are the Peninsular Ranges (Roberts, 1975, p. 1). The following five oblique maps portray various parts of the southern California borderland at different scales.



VERTICAL EXAGGERATION X3

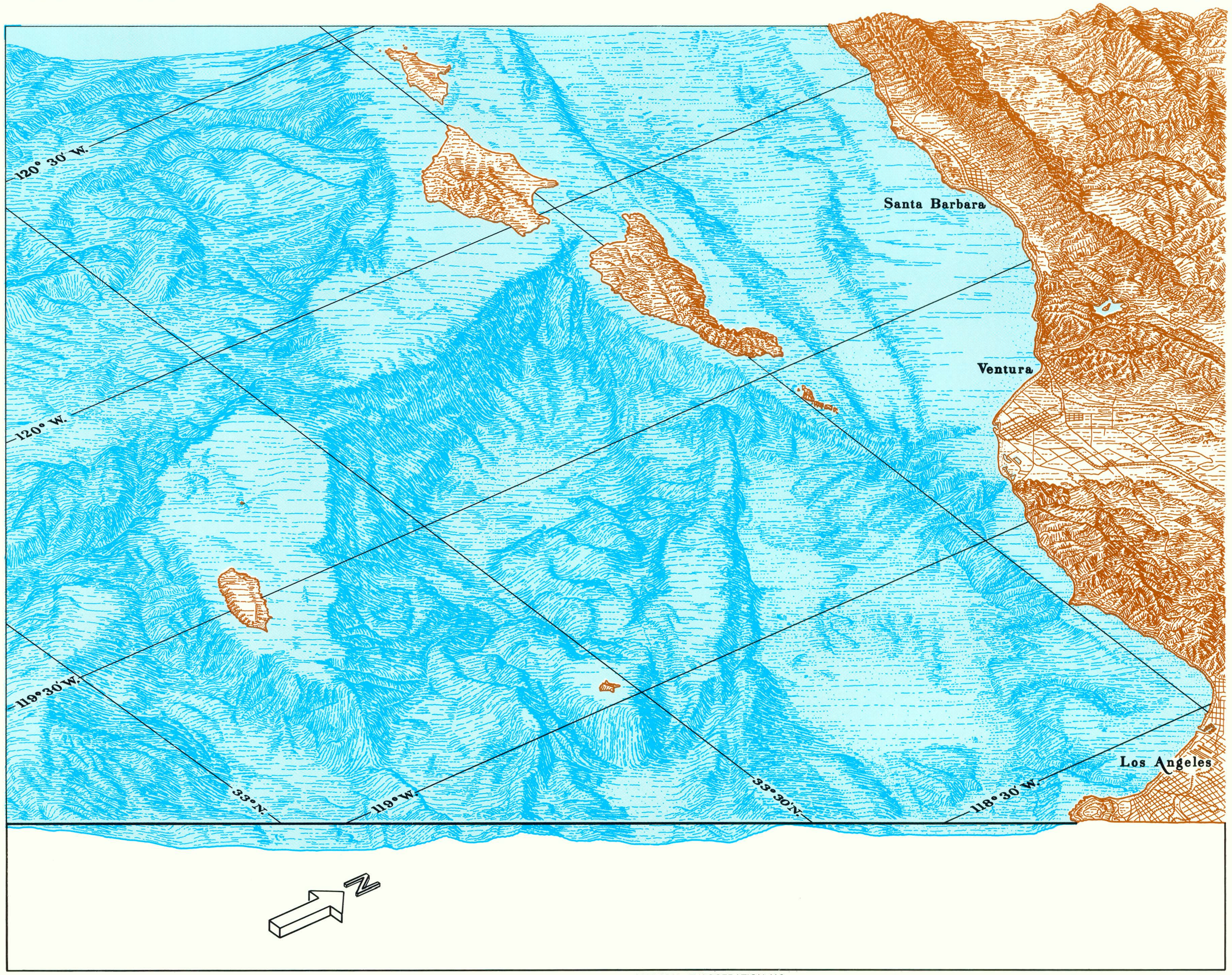
Part of the east-west-trending Transverse Ranges are shown at the top of the oblique map. South of the Transverse Ranges, both onshore and offshore, elongated ridges and basins are generally bounded by faults that trend in a northwest-southeast direction (Shepard, 1977, p. 141). Onshore, most of the basin floors have been urbanized. Uplifted wave-cut terraces can be observed at Palos Verdes Hills west of Long Beach and along the coastline north of San Diego. Offshore, steep fault scarps bound flat banks (wave-cut terraces) that are swept bare of sediments as sedimentation is occurring simultaneously in the basins (Shepard, 1973, p 238). This map is unpublished.

OBLIQUE MAP OF SOUTHERN CALIFORNIA, SANTA BARBARA TO SAN DIEGO

By

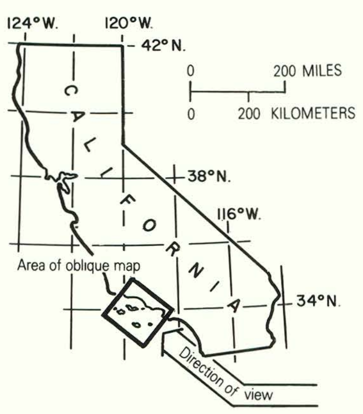
Tau Rho Alpha

1982

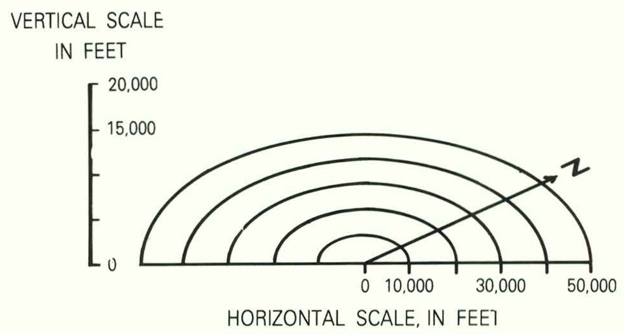


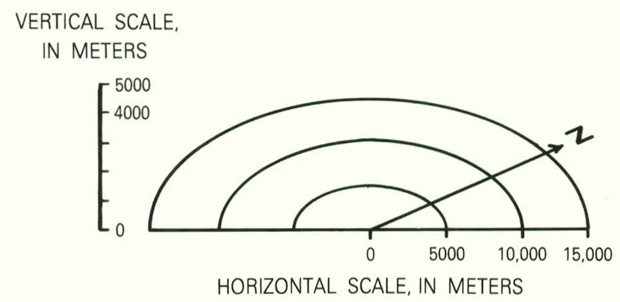
VERTICAL EXAGGERATION X 2

Planimetrically adjusted contours by W. C. Richmond and Theresa Hallinan



INDEX MAP



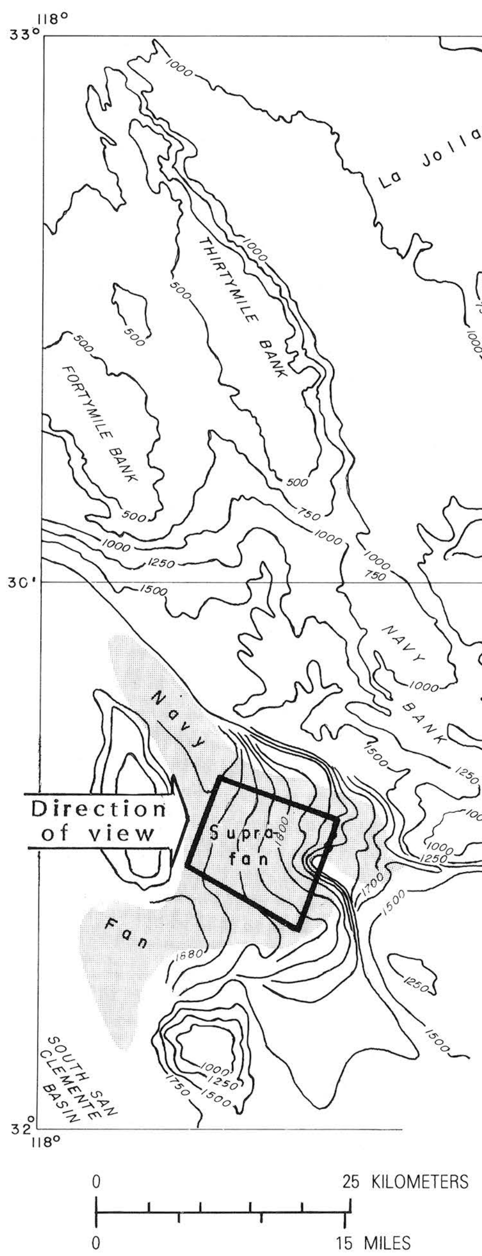


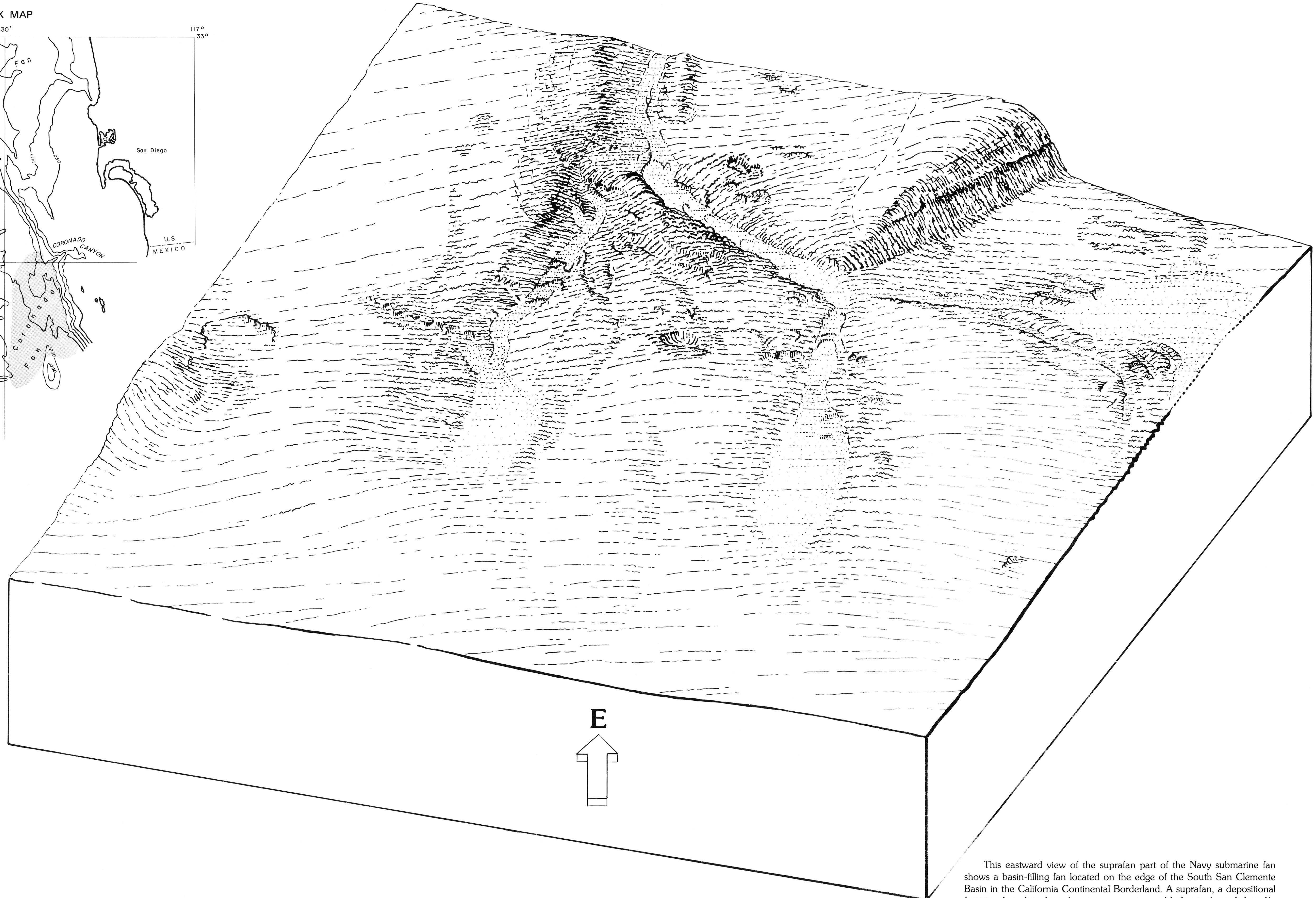
The direction of view of is toward the northwest in this map of the offshore area between Santa Barbara and Los Angeles. The delta and valley of the Santa Clara River near the city of Ventura is shown, bordered by mountains of the Transverse Ranges. Offshore, the distinctive pattern of the isolated banks and basins of the borderland are shown. Numerous canyons are portrayed cutting into the steep sides of the basins. These canyons are a major source for the sediment deposited on the floor of the basins (Field and Edwards, 1980, p. 183). This map has been published in Alpha (1978a); Field and Edwards (1980, p. 178).

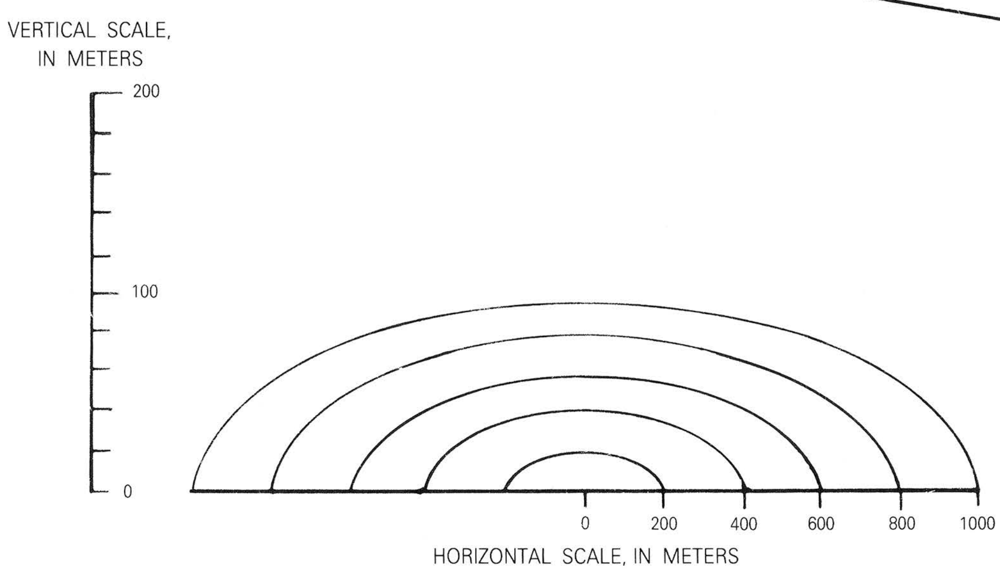
SOUTHERN CALIFORNIA BORDERLAND
OBLIQUE MAP OF THE NORTHWESTERN PART

By
Tau Rho Alpha
1978

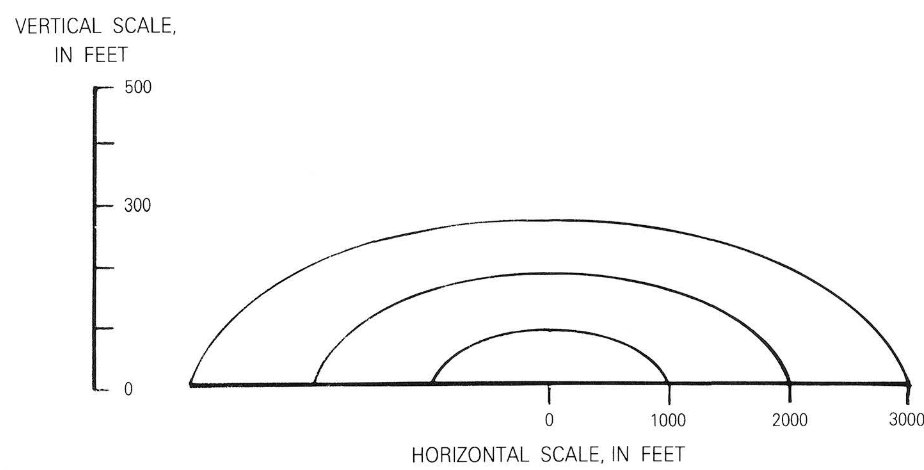
INDEX MAP







VERTICAL EXAGGERATION X5

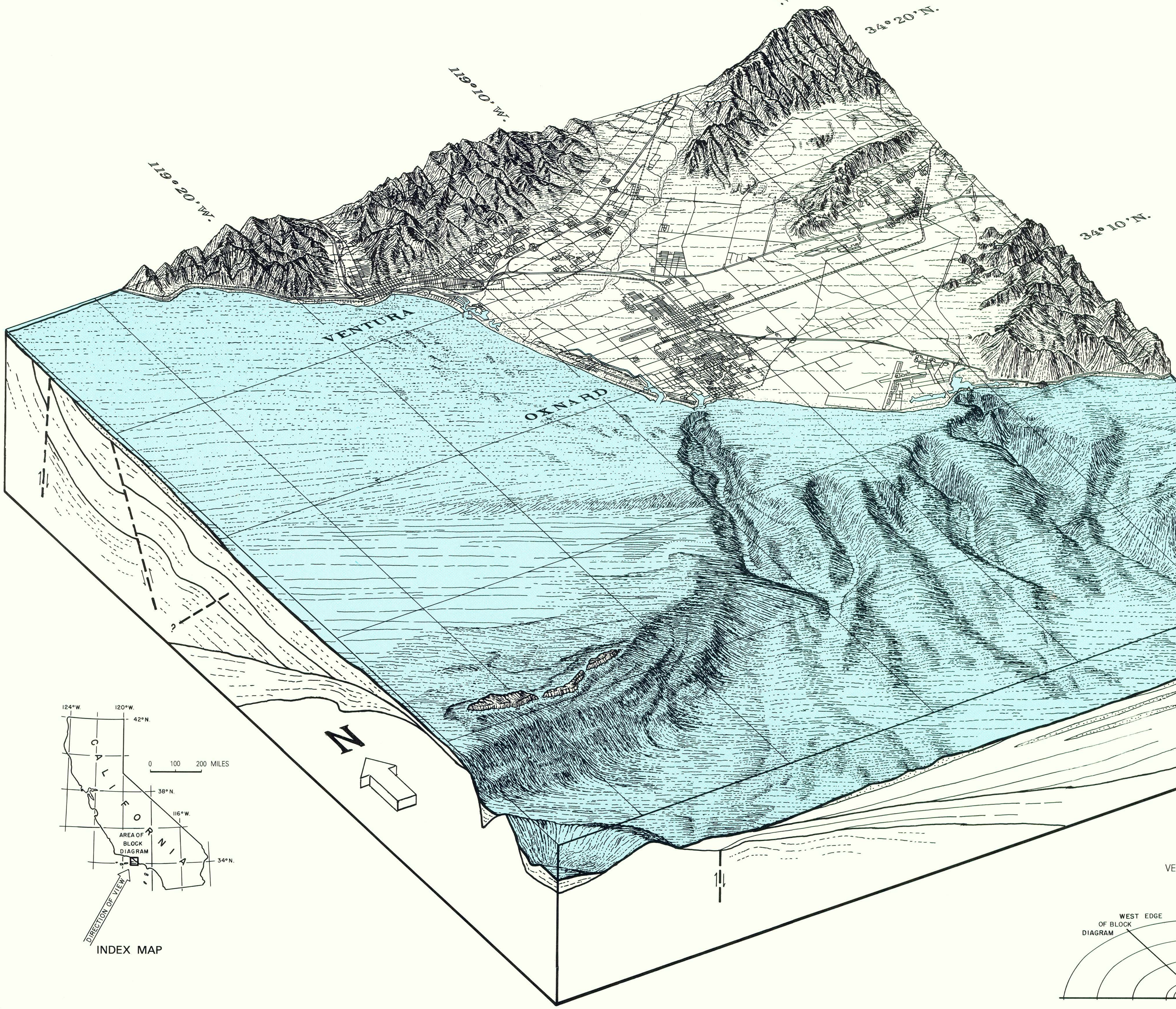


This eastward view of the suprafan part of the Navy submarine fan shows a basin-filling fan located on the edge of the South San Clemente Basin in the California Continental Borderland. A suprafan, a depositional feature of modern fans, forms a convex upward bulge in the radial profile of the fan. A leveed valley is shown near the apex of the fan, and a channel descends the fan. Two smaller distributary channels, which have small steps and terraces that terminate in smooth, featureless lobes at the base of the fan, and isolated scour depressions on the fan are shown (Normark and others, 1980). This map has been published in Normark and others (1979, p. 764); Normark and Hess (1980, p. 204); Howell and Normark (1982, p. 375).

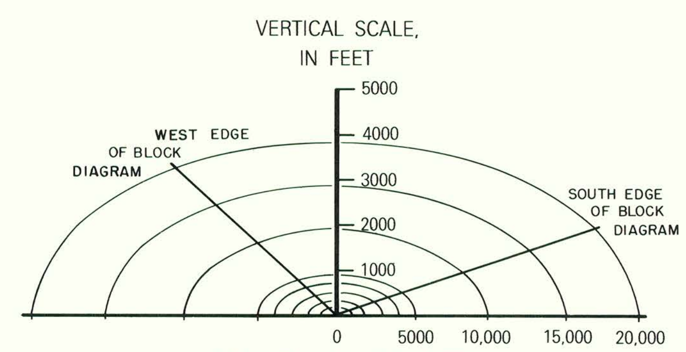
SUPRAFAN, PART OF THE NAVY SUBMARINE FAN, CALIFORNIA CONTINENTAL BORDERLAND

By
William R. Normark, Tau Rho Alpha, and Gordon R. Hess
1980

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY



INDEX MAP



EXPLANATION

——— CONTACT

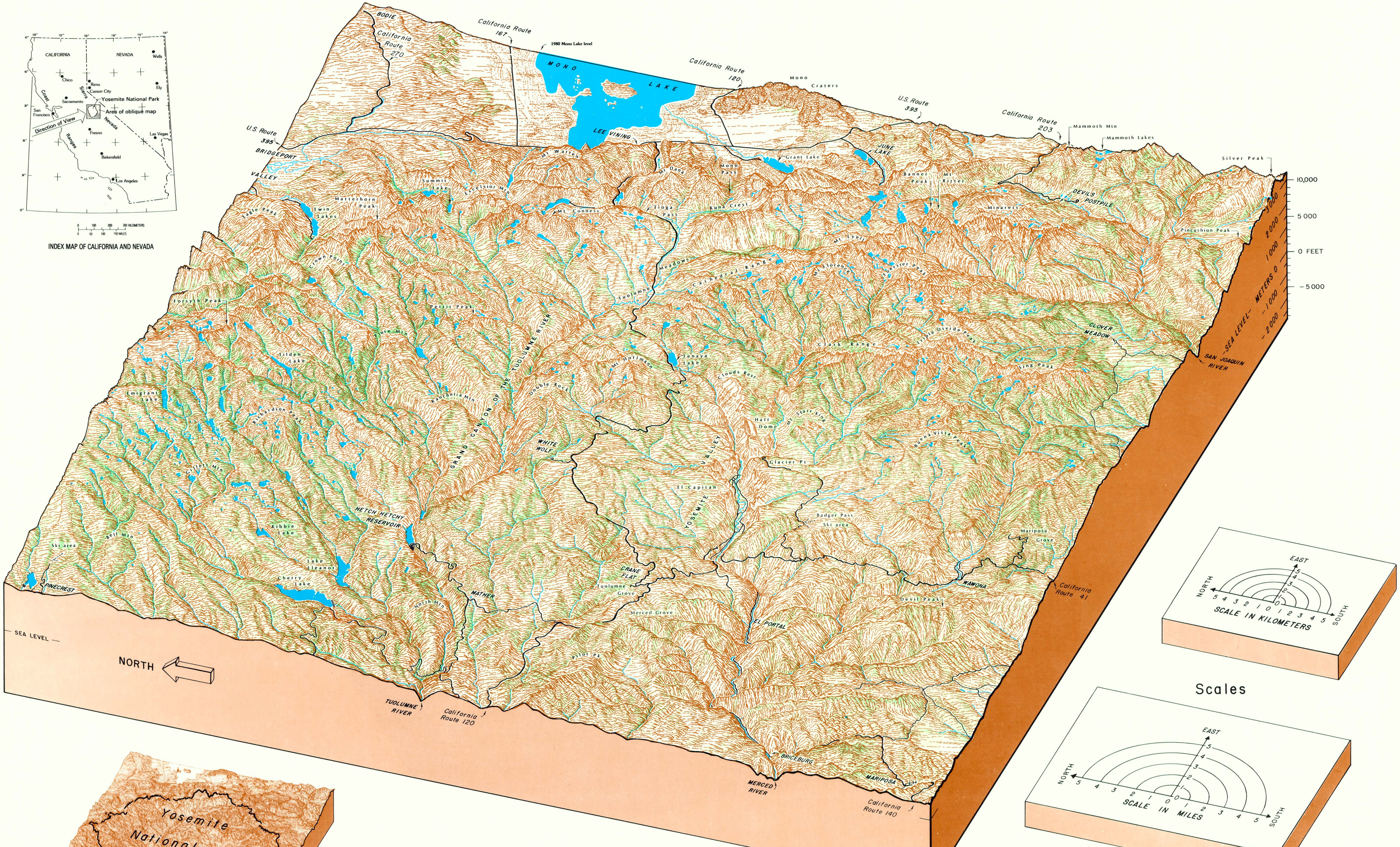
— — FAULT — Approximately located. Arrows indicate direction of relative movement

Viewed toward the northeast, the area portrayed by this oblique map is part of the east-west-trending Transverse Ranges physiographic province (Greene and others, 1978, p. 1). The Ventura-Oxnard plain is the delta of the Santa Clara River, which can be seen between the cities of Ventura and Oxnard. In the foreground, five submarine canyons with steep walls and flat floors are shown. This is one of the few oblique maps in this atlas that portrays geologic structure on the sides of the map. This map has been published in Alpha (1972); Durrenberger and Johnson (1976, p. 19); Greene and others (1978, p. 13).

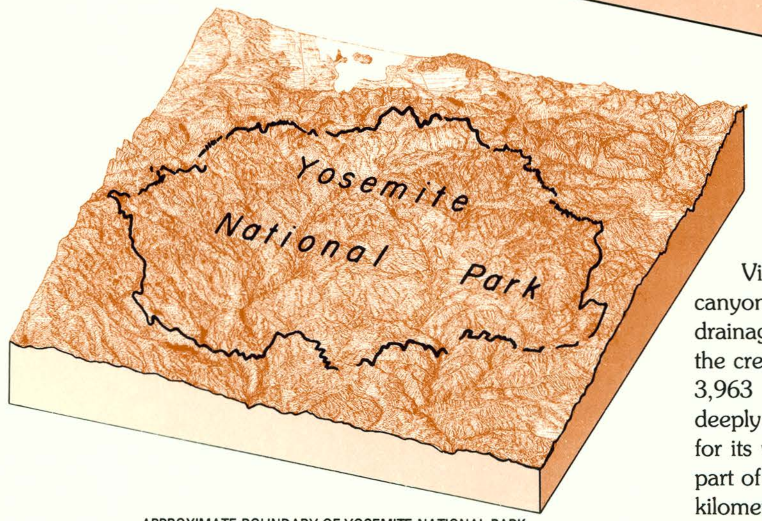
VENTURA-OXNARD OFFSHORE

By
Tau Rho Alpha

1972



Scale varies with direction in this obliquely viewed map.
Vertical scale is twice horizontal scale



APPROXIMATE BOUNDARY OF YOSEMITE NATIONAL PARK

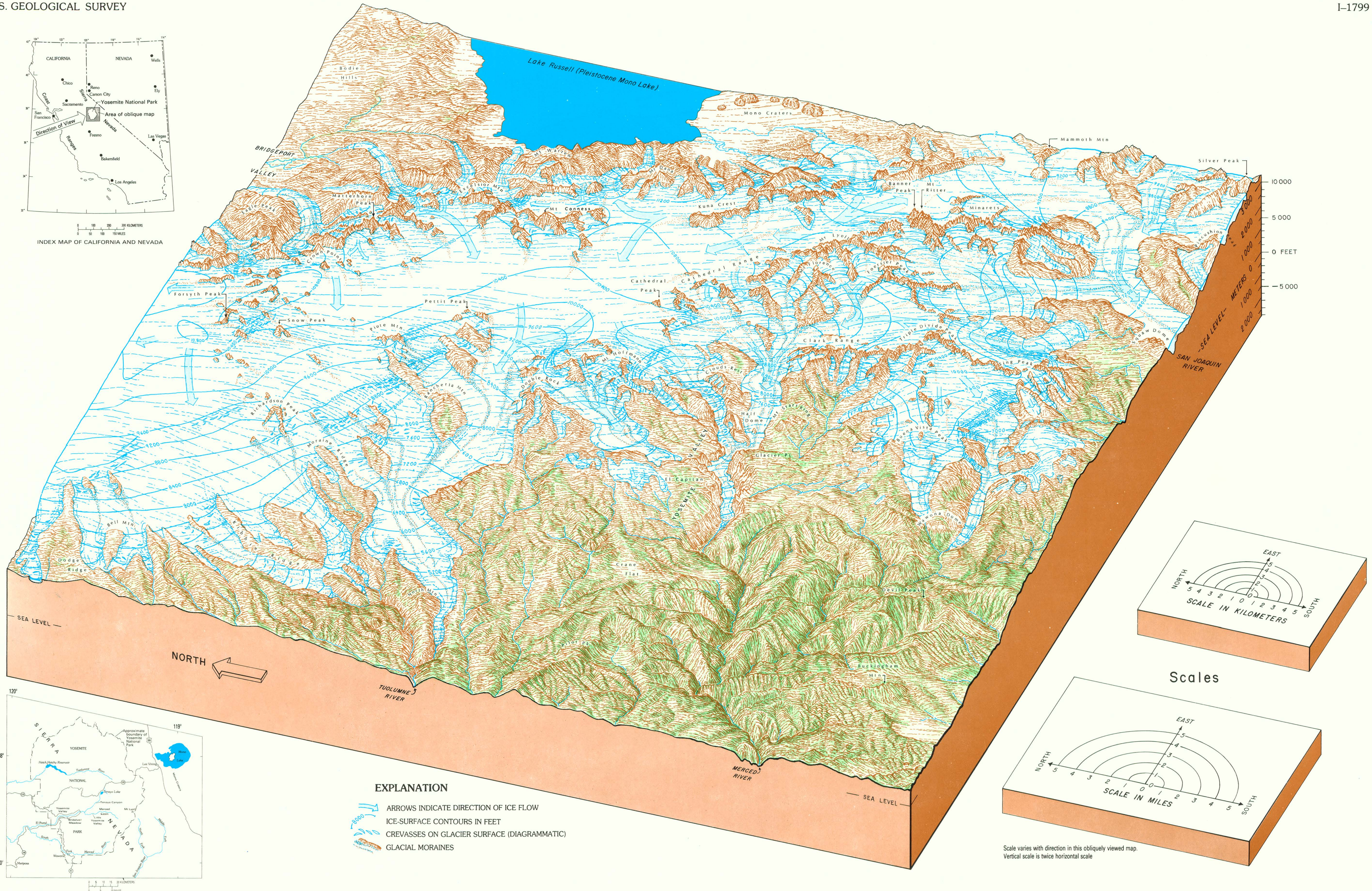
Viewed toward the northeast, this oblique map of Yosemite National Park looks directly into the parallel canyons of Hetch Hetchy and Yosemite Valley. The Hetch Hetchy canyon is part of the Tuolumne River drainage, and Yosemite Valley is part of the Merced River drainage. Both drainages have their headwaters on the crest of the Sierra Nevada and include numerous lakes. The high glaciated peaks (over 13,000 feet (over 3,963 meters)) can be seen in the background, as well as Mono Lake and Mono Craters. In the foreground, deeply incised drainages of the foothills of the Sierra Nevada can be seen. Yosemite National Park is known for its waterfalls and granite domes, which can be identified along the Merced River drainage. The domes are part of a large block of granite that forms much of the Sierra Nevada, which is approximately 400 miles (644 kilometers) long and 80 miles (129 kilometers) wide. The Sierra Nevada is rising faster than erosion by ice and water can wear it down. This map has been published in Alpha and others (1986).

OBLIQUE MAP OF YOSEMITE NATIONAL PARK, CENTRAL SIERRA NEVADA, CALIFORNIA

By

Tau Rho Alpha, N. King Huber, and Clyde Wahrhaftig

1986



INDEX MAP OF YOSEMITE NATIONAL PARK, CENTRAL SIERRA NEVADA, CALIFORNIA

EXPLANATION

ARROWS INDICATE DIRECTION OF ICE FLOW

ICE-SURFACE CONTOURS IN FEET

CREVASSES ON GLACIER SURFACE (DIAGRAMMATIC)

GLACIAL MORAINES

Scale varies with direction in this obliquely viewed map.
Vertical scale is twice horizontal scale

Viewed toward the northeast, this oblique map portrays Yosemite National Park as it might have looked during the last major glaciation in the Sierra Nevada 15,000 to 20,000 years ago. The geography in the foreground looks almost the same as it does today. The glacial ice is portrayed by surface contours, arrows indicate ice-flow direction, and form lines, including symbols for crevasses, portray the surface of the ice. The glaciers were interpreted from aerial photographs and field observations, and the ice-surface contours interpolated from ice-margin elevations and the physical constraints of glacier behavior. A large alpine icefield can be seen covering the crest of the Sierra Nevada, and the high 13,000-foot (3,963-meters) peaks appear as nunataks or isolated islands that are completely surrounded by ice. Ice flowed from the icefield through and over passes into previously eroded canyons where they formed valley glaciers. In the center of the map, two valley glaciers that originated in the icefield can be seen. One extends down the Merced River, terminating in Yosemite Valley. In the background, Lake Russell can be seen to be larger than the present-day Mono Lake. Nearby, Mono Craters can be seen to be much smaller in extent than they are today. This map has been published by Alpha and others (1987).

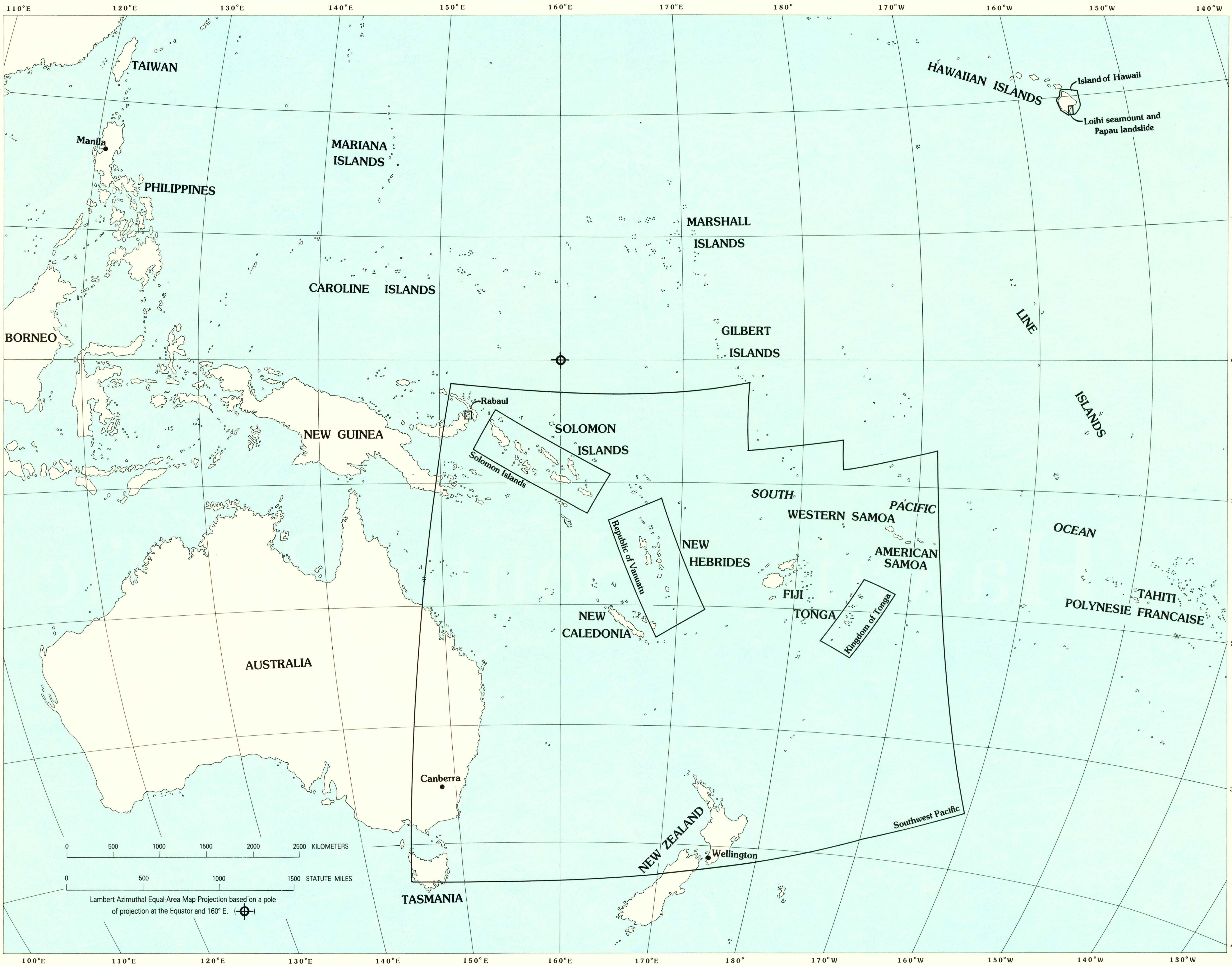
YOSEMITE NATIONAL PARK, TIOGA-AGED GLACIATION

By

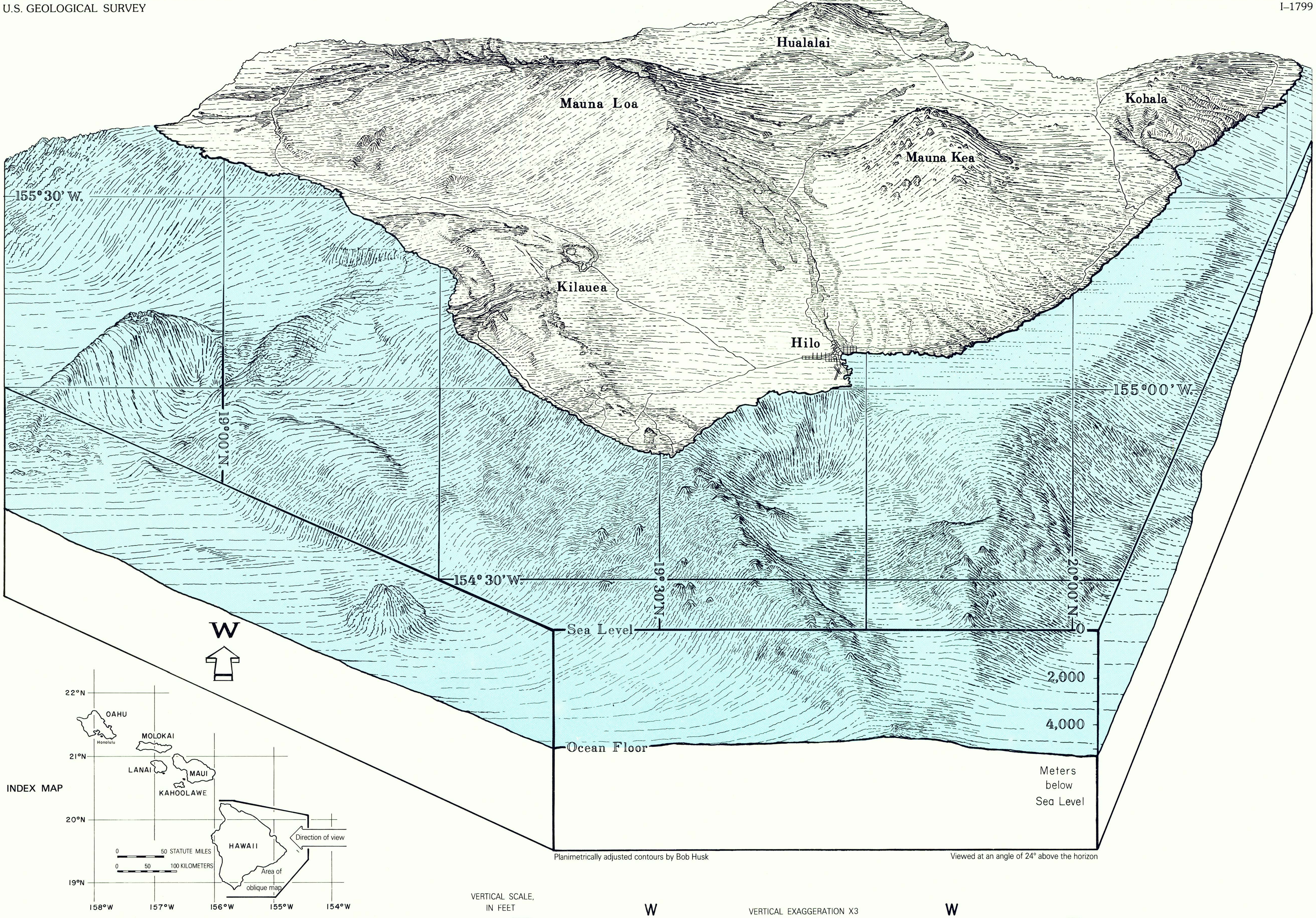
Tau Rho Alpha, Clyde Wahrhaftig, and N. King Huber

1987

Hawaii and South Pacific

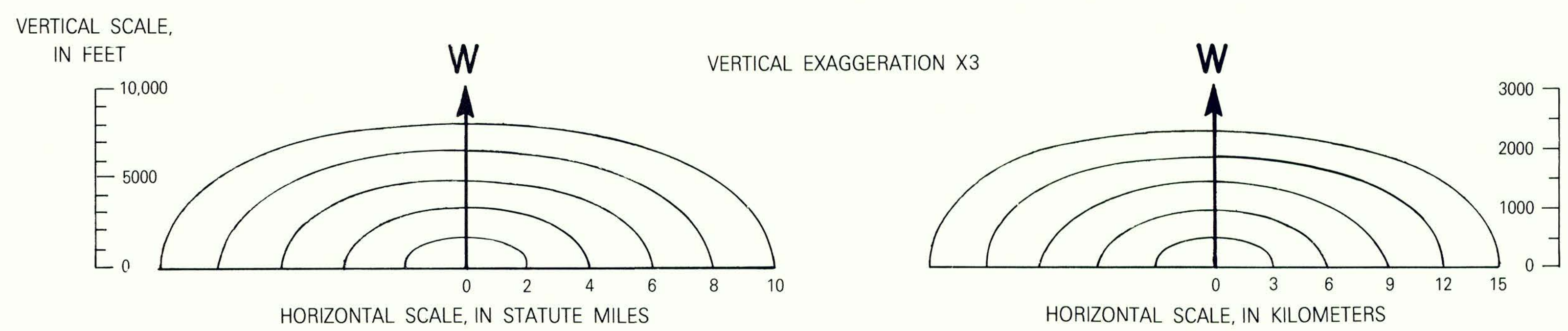


LOCATION OF OBLIQUE MAPS IN HAWAII AND THE SOUTH PACIFIC



Planimetrically adjusted contours by Bob Husk

Viewed at an angle of 24° above the horizon



A westward view of the Island of Hawaii and its submarine slopes. Loihi seamount, a submarine volcano, lies near the left edge of the map (see next plate for a description of Loihi). The Island of Hawaii is composed of five shield volcanoes. The most active volcanoes are Kilauea and Mauna Loa (Fornari, 1979, p. 239). The least active volcanoes are Mauna Kea, Hualalai, and Kohala. Mauna Kea is the highest volcano on the island and has evidence of glaciation on its upper slopes.

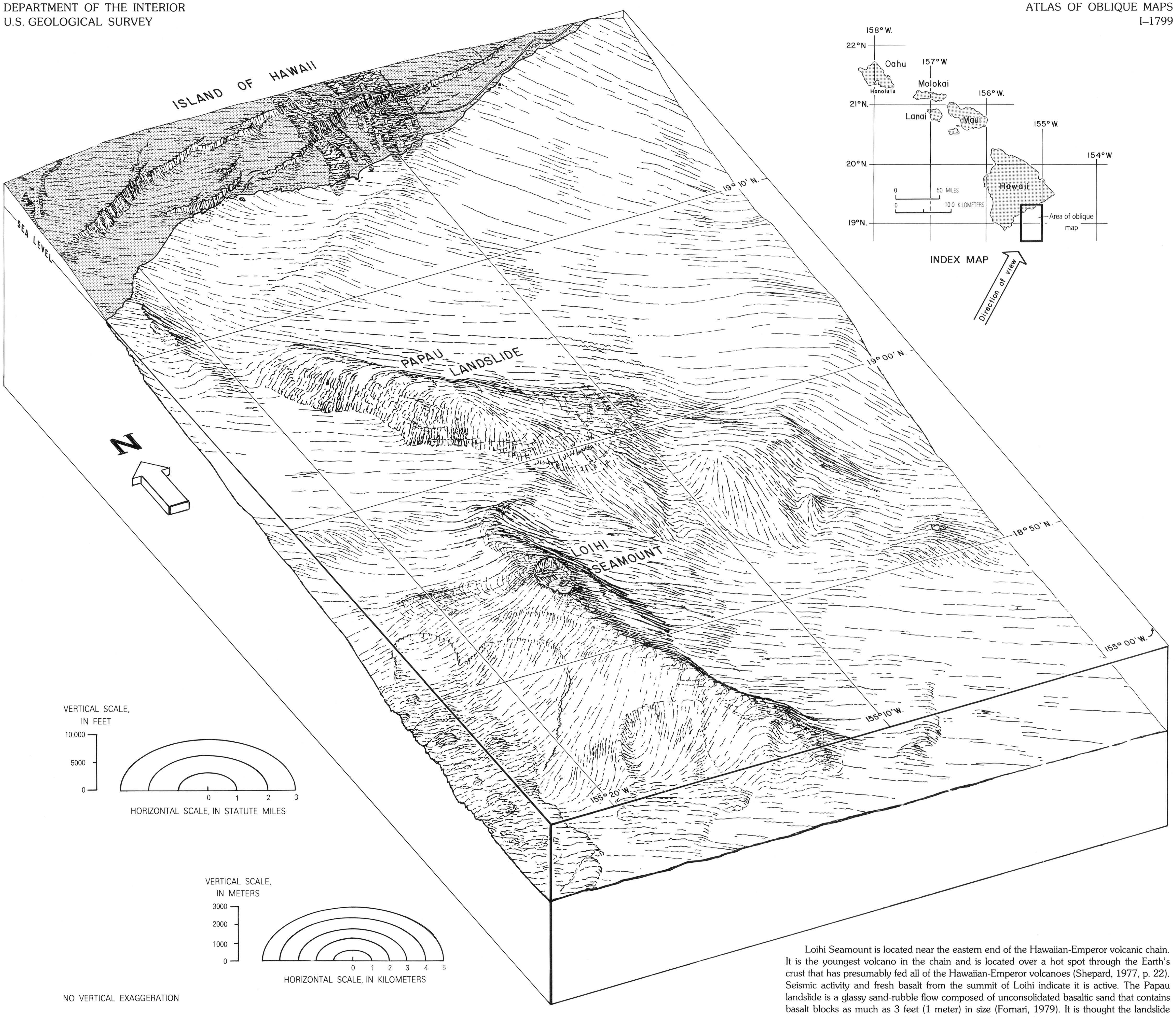
A lower angle of view was chosen to portray the shield volcanoes: an angle of 24° above the horizon was used rather than the usual angle of 30°. Relatively flat landforms, such as these shield volcanoes, are easier and hopefully better portrayed at this lower angle of view. This map has been published in Alpha (1972a); Fornari and others (1979, part of map p. 240); Tilling and others (1976, p. 31).

ISLAND OF HAWAII, HAWAII

By

Tau Rho Alpha

1977



NO VERTICAL EXAGGERATION

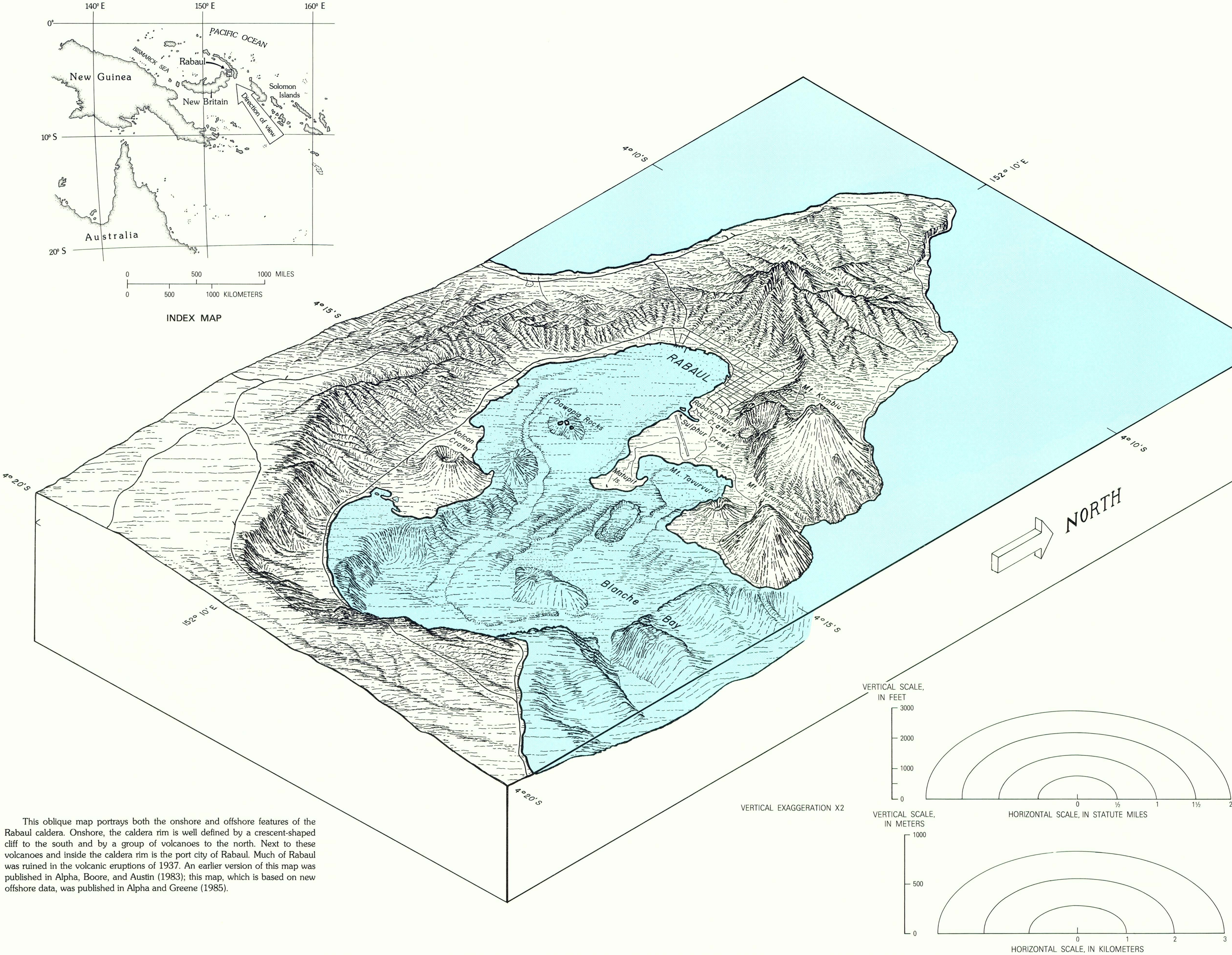
Loihi Seamount is located near the eastern end of the Hawaiian-Emperor volcanic chain. It is the youngest volcano in the chain and is located over a hot spot through the Earth's crust that has presumably fed all of the Hawaiian-Emperor volcanoes (Shepard, 1977, p. 22). Seismic activity and fresh basalt from the summit of Loihi indicate it is active. The Papau landslide is a glassy sand-rubble flow composed of unconsolidated basaltic sand that contains basalt blocks as much as 3 feet (1 meter) in size (Fornari, 1979). It is thought the landslide occurred as a massive, single flow event several thousand years ago. This map has been published in Alpha, Morley, and others (1982).

OBLIQUE MAP OF LOIHI SEAMOUNT AND PAPAU LANDSLIDE, HAWAII

By

Tau Rho Alpha, James M. Morley, Christina E. Gutmacher, and William A. Austin

1982



This oblique map portrays both the onshore and offshore features of the Rabaul caldera. Onshore, the caldera rim is well defined by a crescent-shaped cliff to the south and by a group of volcanoes to the north. Next to these volcanoes and inside the caldera rim is the port city of Rabaul. Much of Rabaul was ruined in the volcanic eruptions of 1937. An earlier version of this map was published in Alpha, Boore, and Austin (1983); this map, which is based on new offshore data, was published in Alpha and Greene (1985).

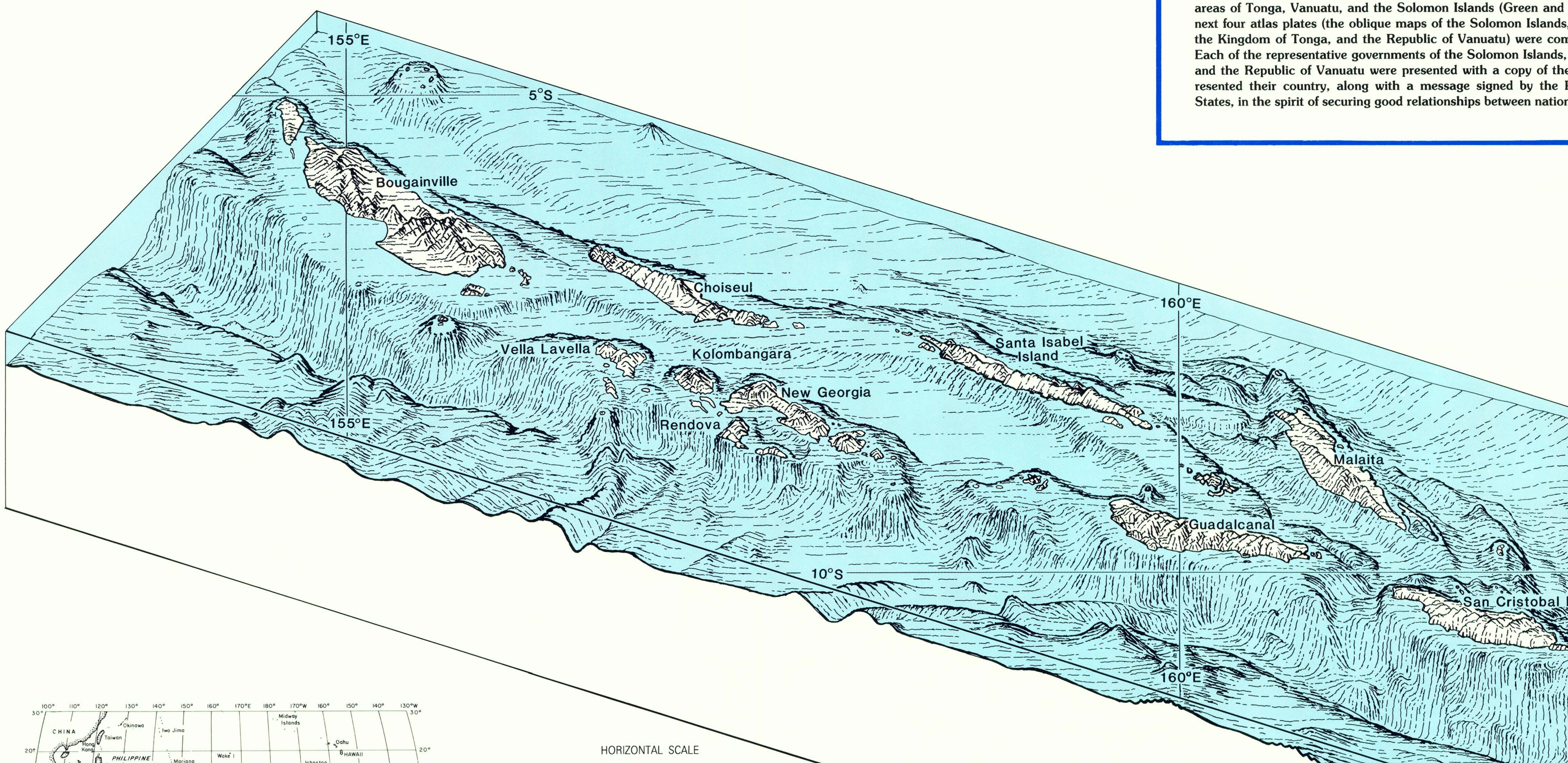
OBLIQUE MAP OF RABAUL, PAPUA NEW GUINEA

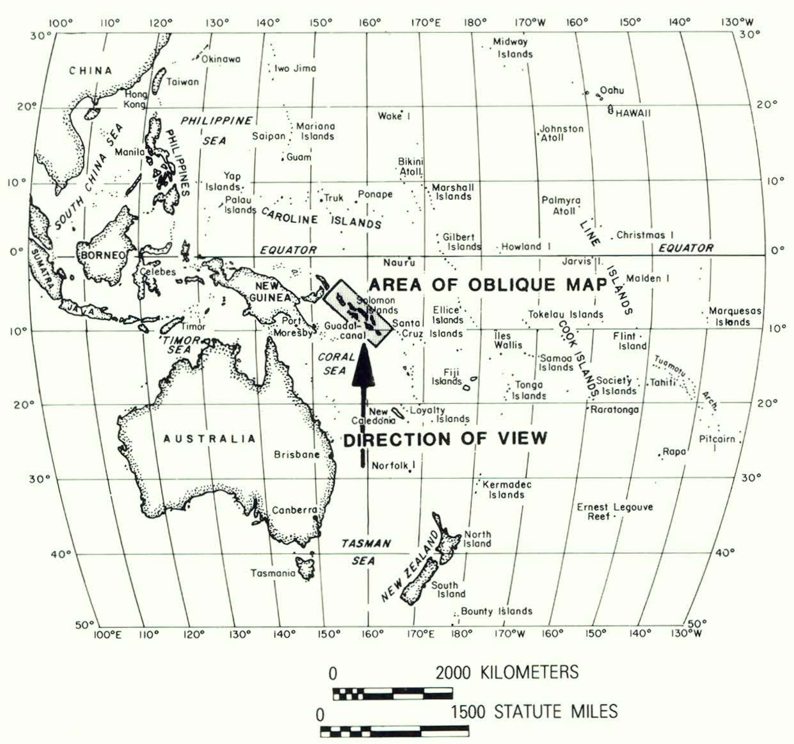
By
Tau Rho Alpha and H. Gary Greene

1985

AN INTRODUCTION TO THE SERIES OF OBLIQUE MAPS OF THE SOUTHWEST PACIFIC

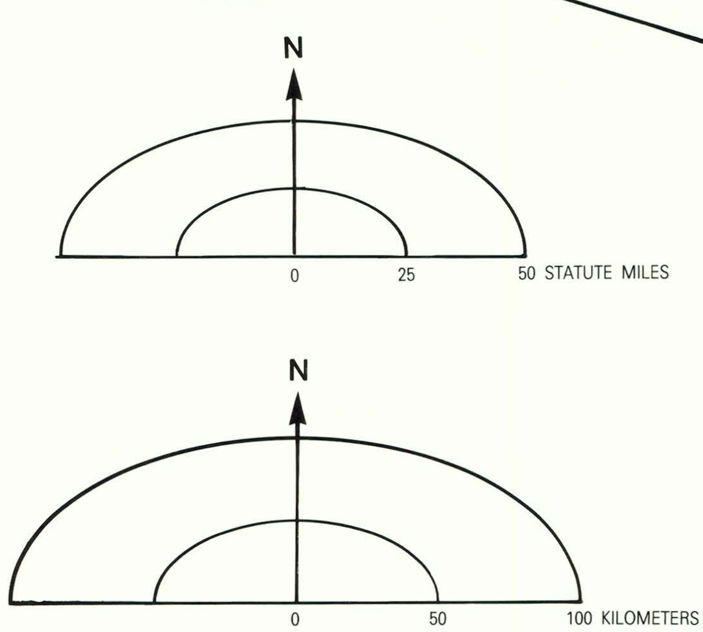
In 1982 the U.S. Geological Survey's program for marine geoscientific research and mineral resource studies included hydrocarbon resource investigations in the offshore areas of Tonga, Vanuatu, and the Solomon Islands (Green and Wong, 1983, p. 1). The next four atlas plates (the oblique maps of the Solomon Islands, the Southwest Pacific, the Kingdom of Tonga, and the Republic of Vanuatu) were compiled for this program. Each of the representative governments of the Solomon Islands, the Kingdom of Tonga, and the Republic of Vanuatu were presented with a copy of the oblique map that represented their country, along with a message signed by the President of the United States, in the spirit of securing good relationships between nations.



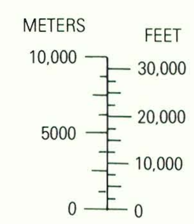


INDEX MAP OF THE SOUTHWEST PACIFIC

HORIZONTAL SCALE



VERTICAL SCALE



VERTICAL EXAGGERATION X5

This oblique map portrays the majority of the Solomon Islands, which are located in the western Pacific east of New Guinea. These islands are the summits of long ridges between submarine troughs and trenches. The eastern limit of the New Britain Trench is south of the Island of Bougainville, and the western end of the South Solomon Trench is south of the island of San Cristobal. This map has been published in Alpha and others (1982a).

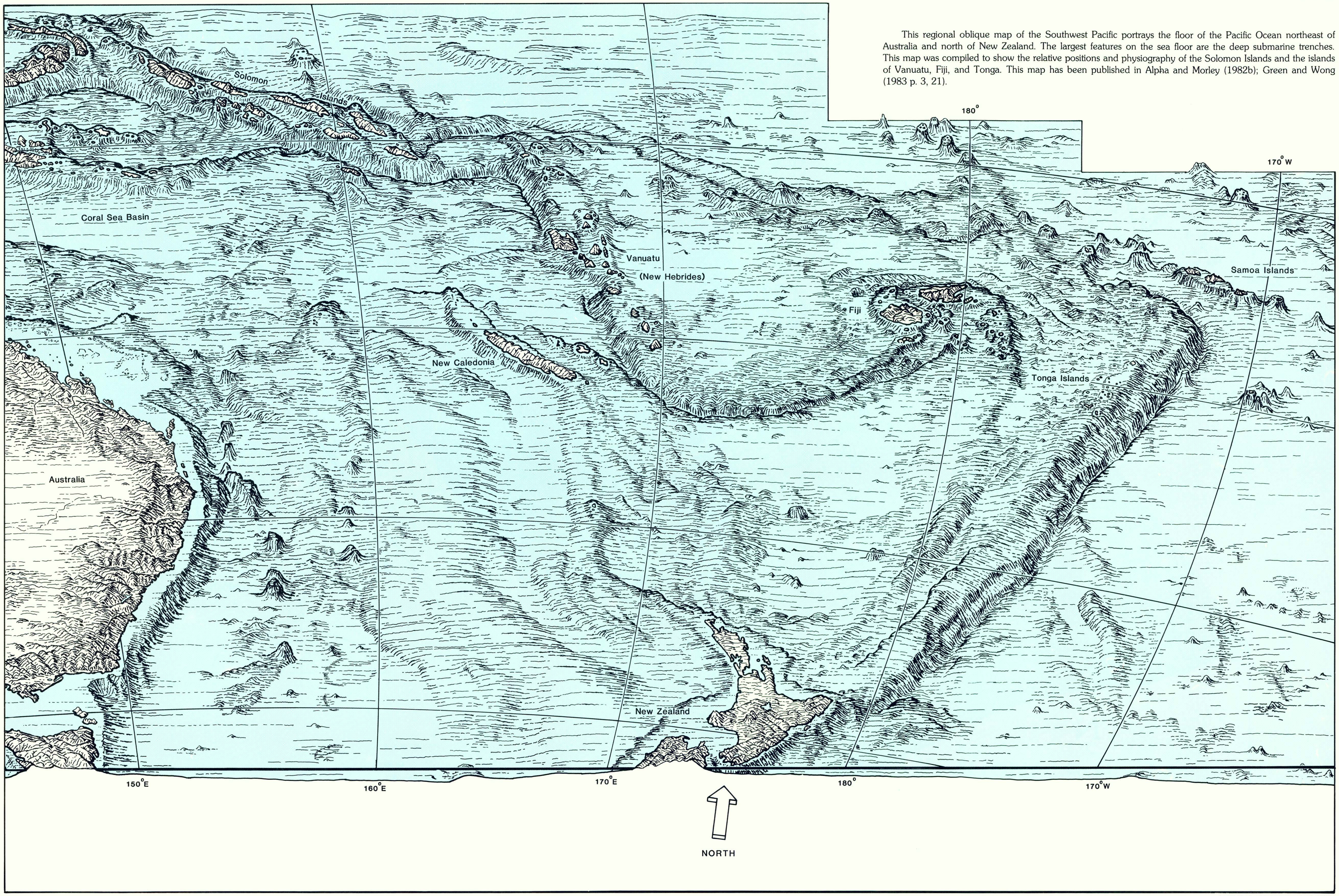
OBLIQUE MAP OF THE SOLOMON ISLANDS, SOUTHWEST PACIFIC

By

Tau Rho Alpha, William A. Austin, and James M. Morley

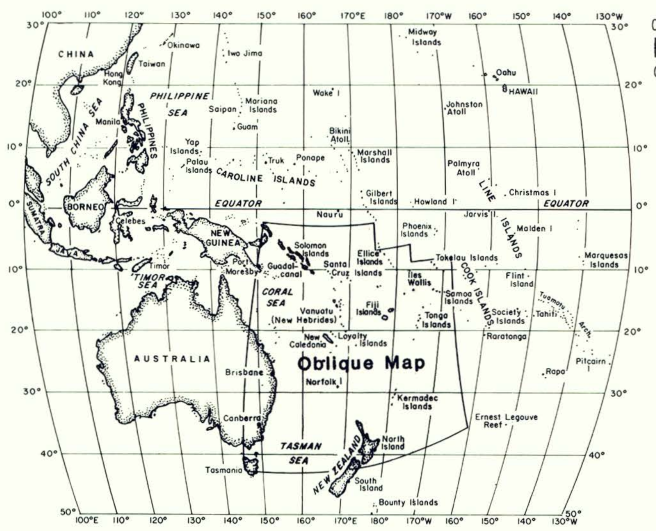
1982

This regional oblique map of the Southwest Pacific portrays the floor of the Pacific Ocean northeast of Australia and north of New Zealand. The largest features on the sea floor are the deep submarine trenches. This map was compiled to show the relative positions and physiography of the Solomon Islands and the islands of Vanuatu, Fiji, and Tonga. This map has been published in Alpha and Morley (1982b); Green and Wong (1983 p. 3, 21).

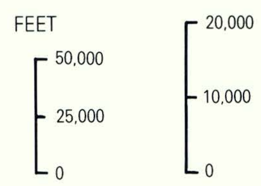


VERTICAL EXAGGERATION X10

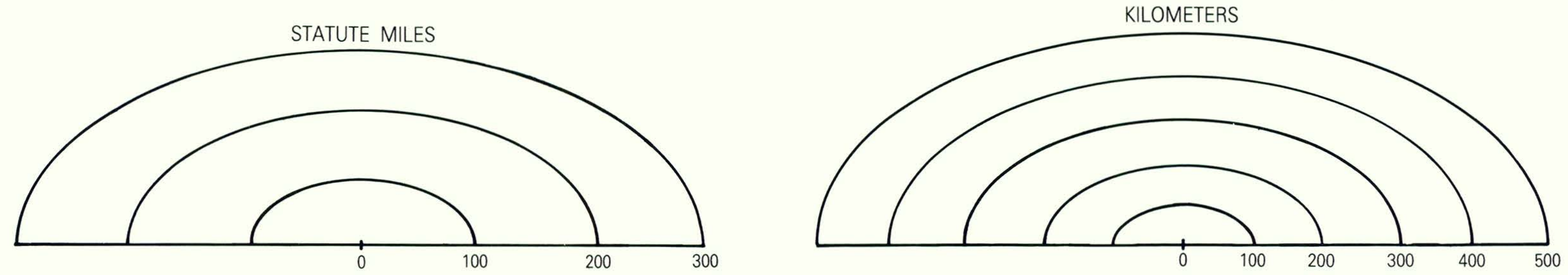
INDEX MAP OF THE SOUTHWEST PACIFIC



VERTICAL SCALE



HORIZONTAL SCALE



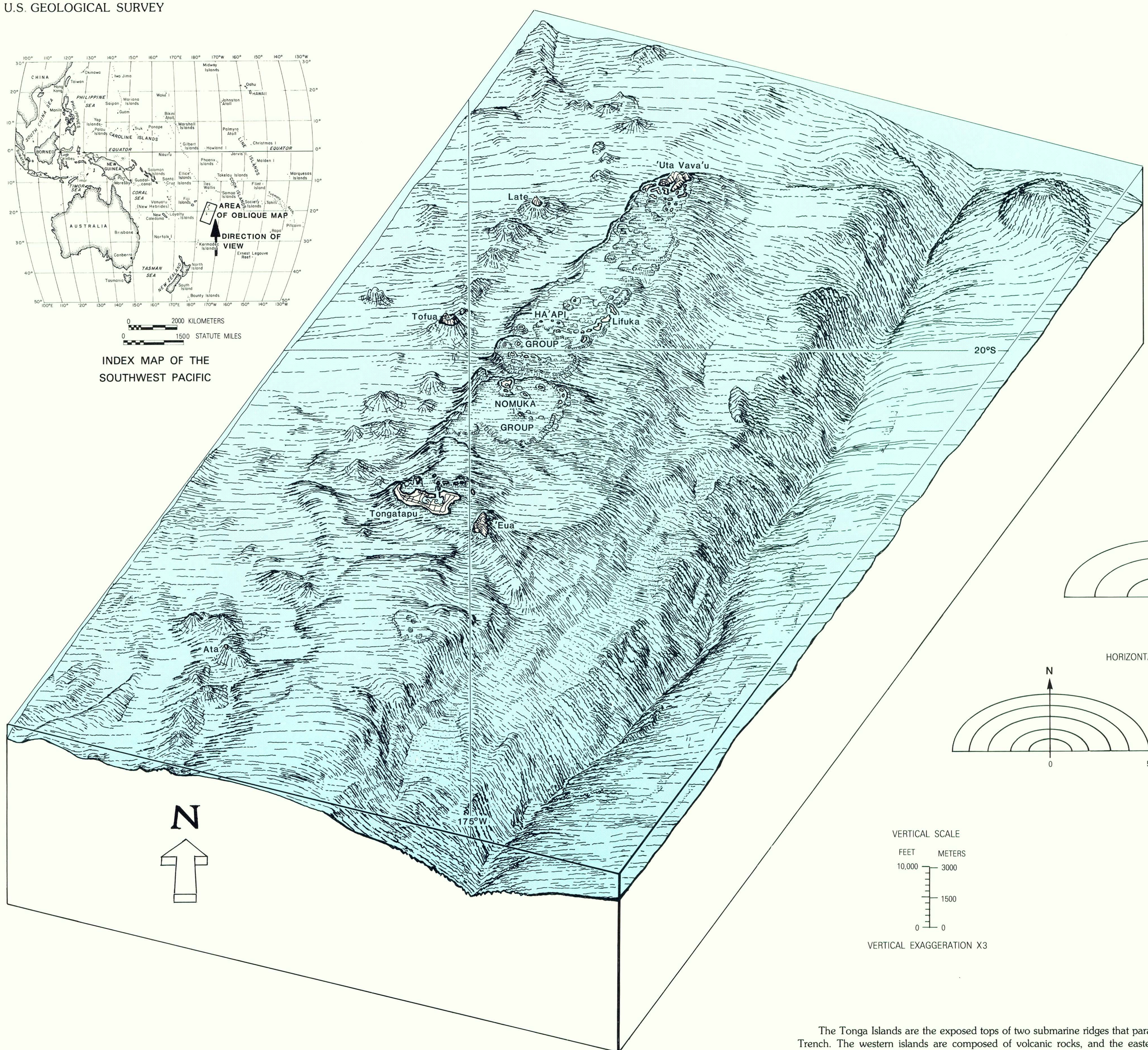
OBLIQUE MAP OF SOUTHWEST PACIFIC

By

Tau Rho Alpha and James M. Morley

1982

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY



N
0
3.5 MILES
HORIZONTAL SCALE
N
0
5 KILOMETERS

VERTICAL SCALE

FEET	METERS
10,000	3000
	1500
0	0

VERTICAL EXAGGERATION X3

The Tonga Islands are the exposed tops of two submarine ridges that parallel the Tonga Trench. The western islands are composed of volcanic rocks, and the eastern islands are composed of coral (Greene and Wong, 1983, p. 2). This map shows the Tonga Trench, one of the deepest in the world, on the right edge of the oblique map parallel to the Tonga Islands. This map has been published in Alpha and others (1982b).

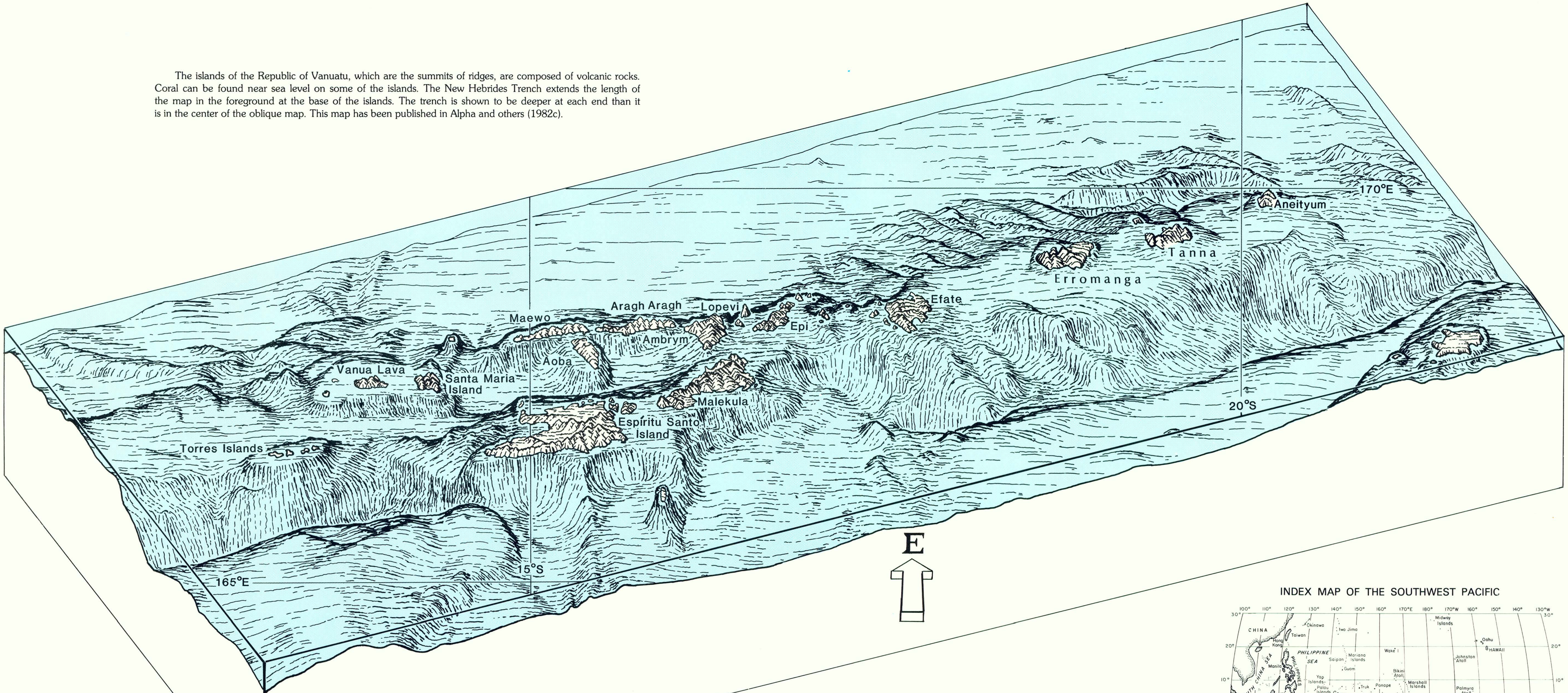
OBLIQUE MAP OF KINGDOM OF TONGA, SOUTHWEST PACIFIC

By

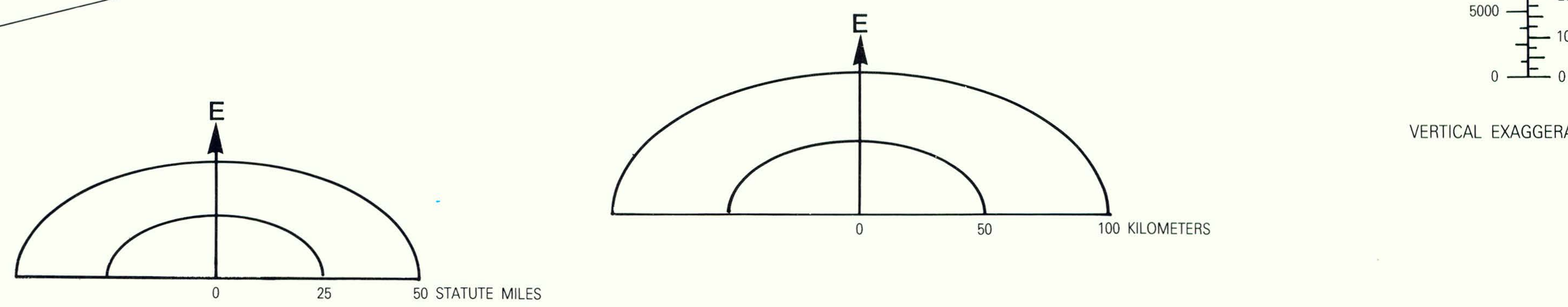
Tau Rho Alpha, William A. Austin, and James M. Morley

1982

The islands of the Republic of Vanuatu, which are the summits of ridges, are composed of volcanic rocks. Coral can be found near sea level on some of the islands. The New Hebrides Trench extends the length of the map in the foreground at the base of the islands. The trench is shown to be deeper at each end than it is in the center of the oblique map. This map has been published in Alpha and others (1982c).



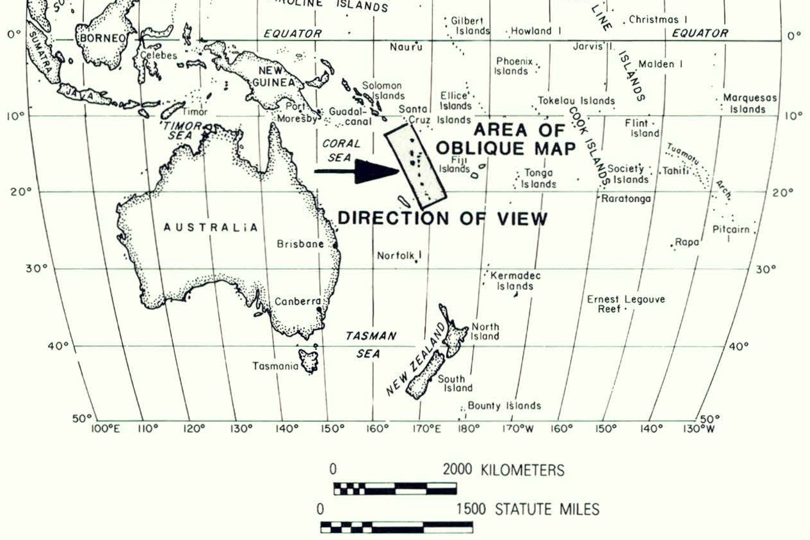
VERTICAL SCALE



VERTICAL EXAGGERATION X5

HORIZONTAL SCALE

INDEX MAP OF THE SOUTHWEST PACIFIC



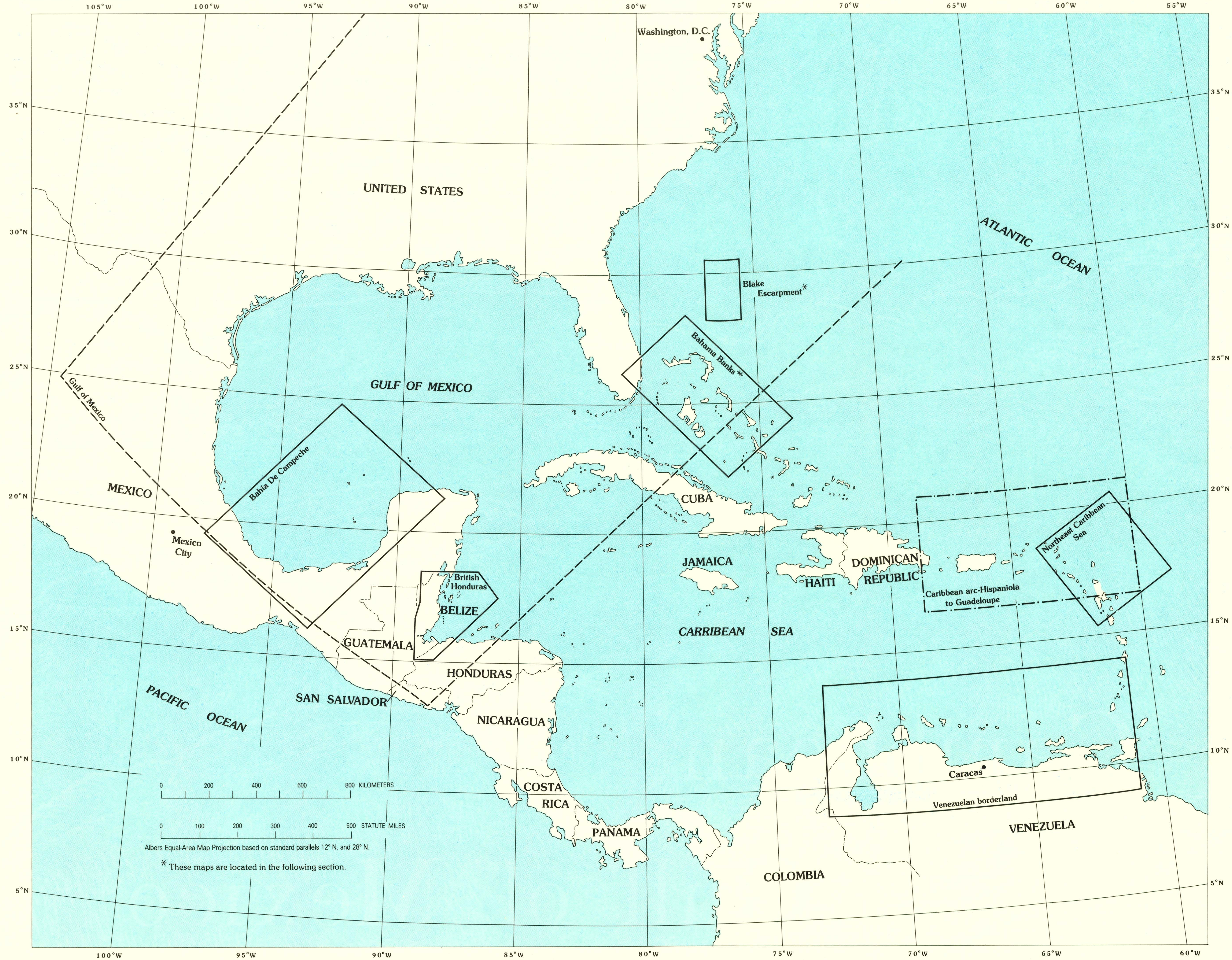
OBLIQUE MAP OF THE REPUBLIC OF VANUATU, SOUTHWEST PACIFIC

By

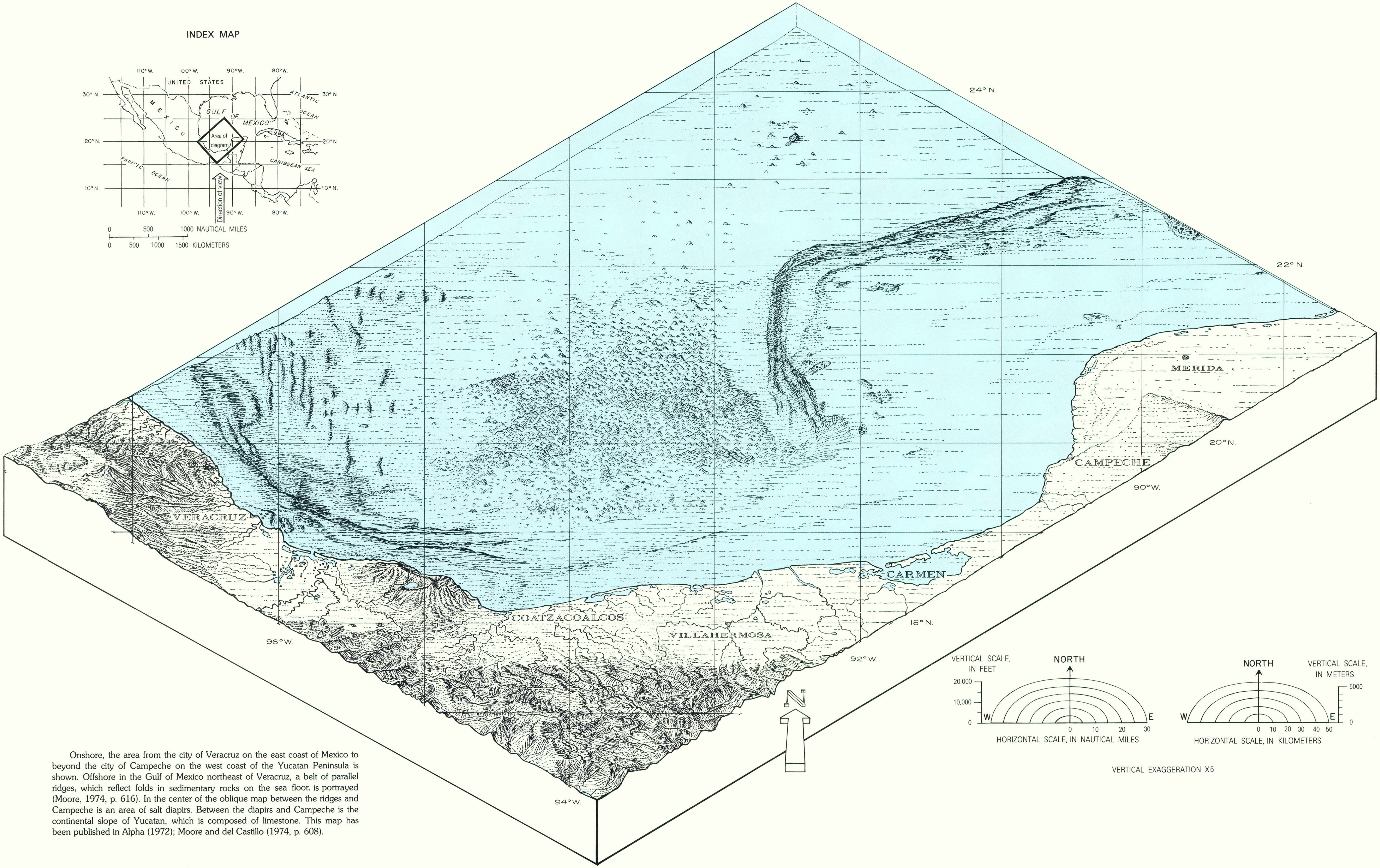
Tau Rho Alpha, William A. Austin, and James M. Morley

1982

Caribbean and Gulf of Mexico



LOCATION OF OBLIQUE MAPS IN THE CARIBBEAN AND GULF OF MEXICO



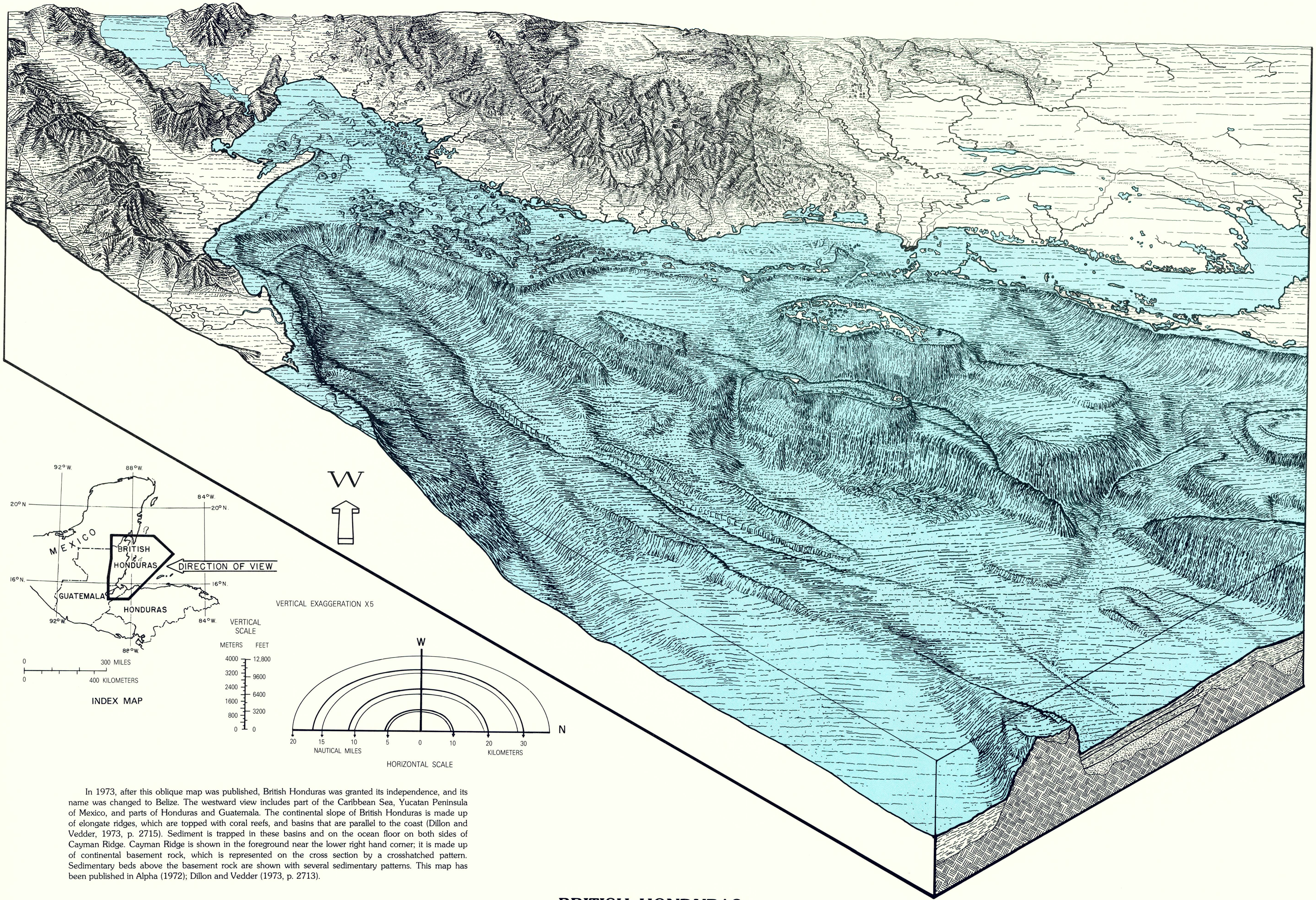
Onshore, the area from the city of Veracruz on the east coast of Mexico to beyond the city of Campeche on the west coast of the Yucatan Peninsula is shown. Offshore in the Gulf of Mexico northeast of Veracruz, a belt of parallel ridges, which reflect folds in sedimentary rocks on the sea floor, is portrayed (Moore, 1974, p. 616). In the center of the oblique map between the ridges and Campeche is an area of salt diapirs. Between the diapirs and Campeche is the continental slope of Yucatan, which is composed of limestone. This map has been published in Alpha (1972); Moore and del Castillo (1974, p. 608).

BAHÍA DE COMPECHE

By

Tau Rho Alpha

1972



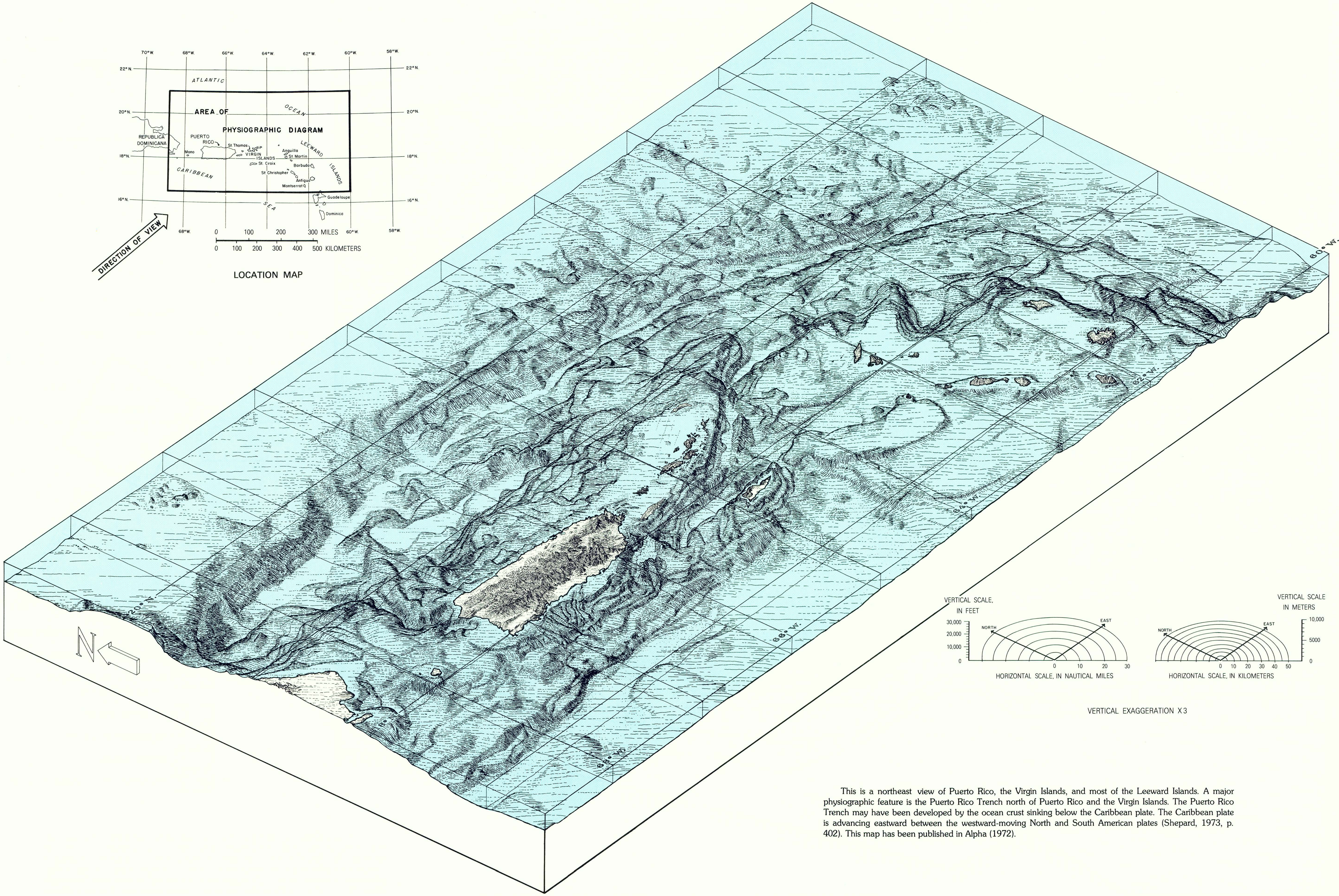
In 1973, after this oblique map was published, British Honduras was granted its independence, and its name was changed to Belize. The westward view includes part of the Caribbean Sea, Yucatan Peninsula of Mexico, and parts of Honduras and Guatemala. The continental slope of British Honduras is made up of elongate ridges, which are topped with coral reefs, and basins that are parallel to the coast (Dillon and Vedder, 1973, p. 2715). Sediment is trapped in these basins and on the ocean floor on both sides of Cayman Ridge. Cayman Ridge is shown in the foreground near the lower right hand corner; it is made up of continental basement rock, which is represented on the cross section by a crosshatched pattern. Sedimentary beds above the basement rock are shown with several sedimentary patterns. This map has been published in Alpha (1972); Dillon and Vedder (1973, p. 2713).

BRITISH HONDURAS

By

Tau Rho Alpha

1972



VERTICAL EXAGGERATION X3

This is a northeast view of Puerto Rico, the Virgin Islands, and most of the Leeward Islands. A major physiographic feature is the Puerto Rico Trench north of Puerto Rico and the Virgin Islands. The Puerto Rico Trench may have been developed by the ocean crust sinking below the Caribbean plate. The Caribbean plate is advancing eastward between the westward-moving North and South American plates (Shepard, 1973, p. 402). This map has been published in Alpha (1972).

CARIBBEAN ARC-HISPANIOLA TO GUADELOUPE

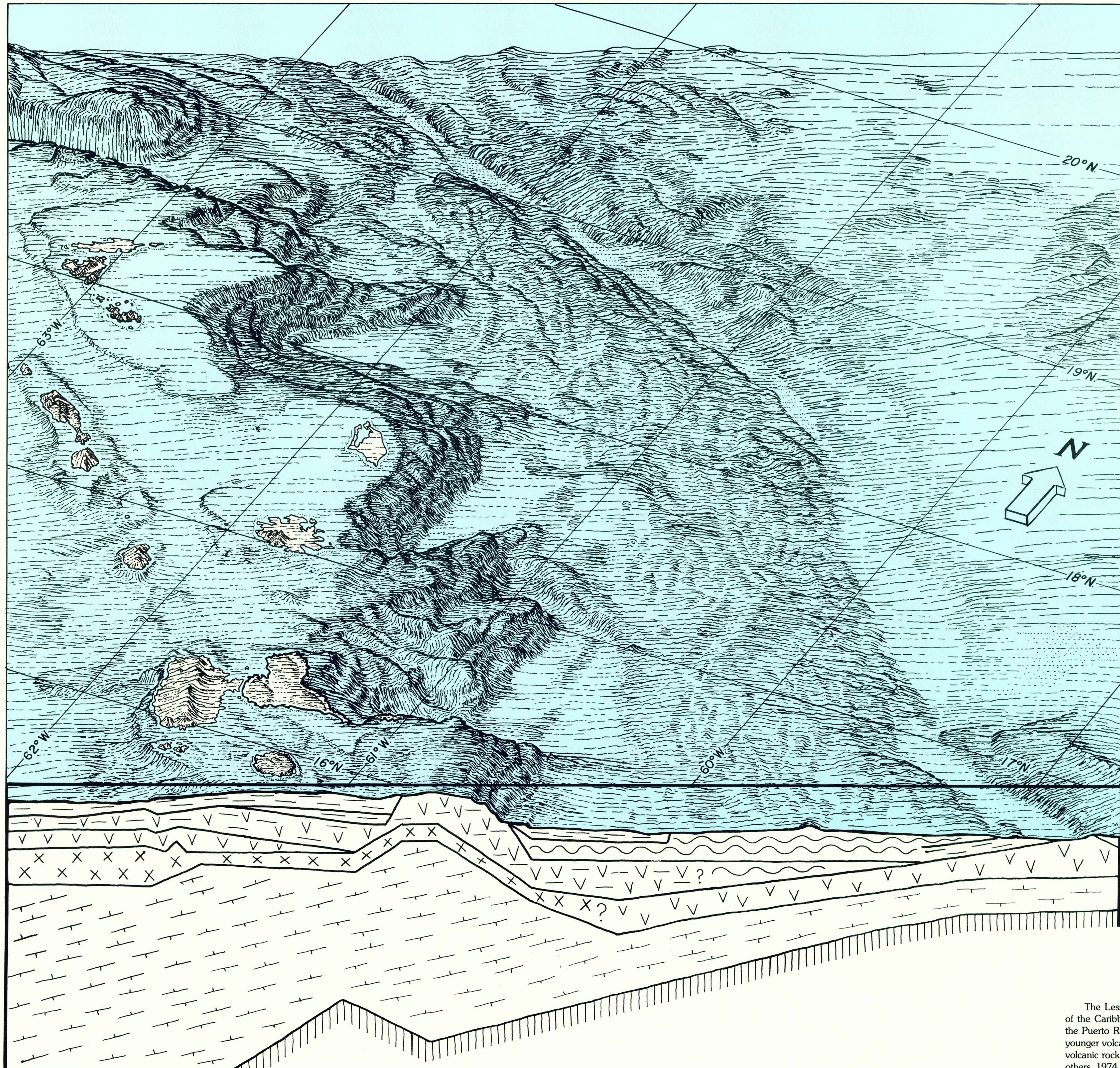
By

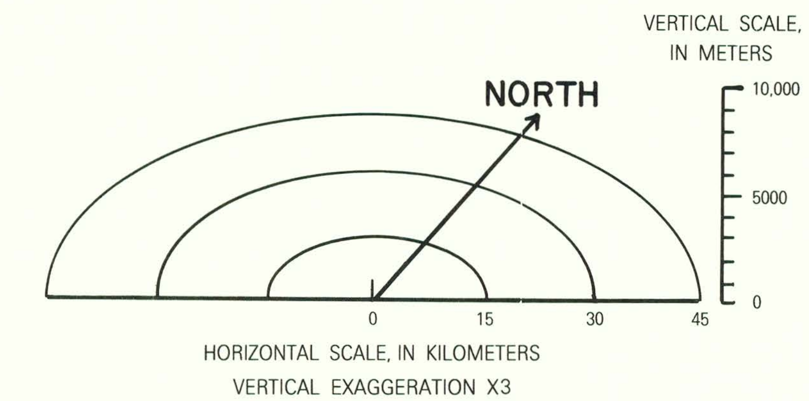
Tau Rho Alpha

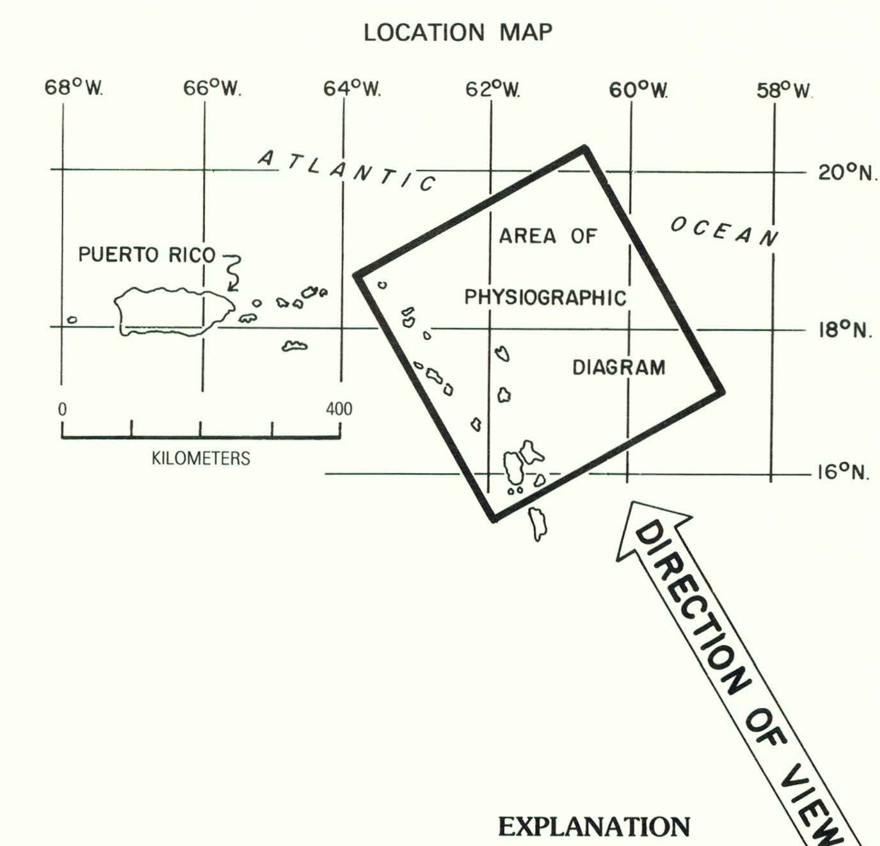
1972

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

ATLAS OF OBLIQUE MAPS
I–1799







EXPLANATION

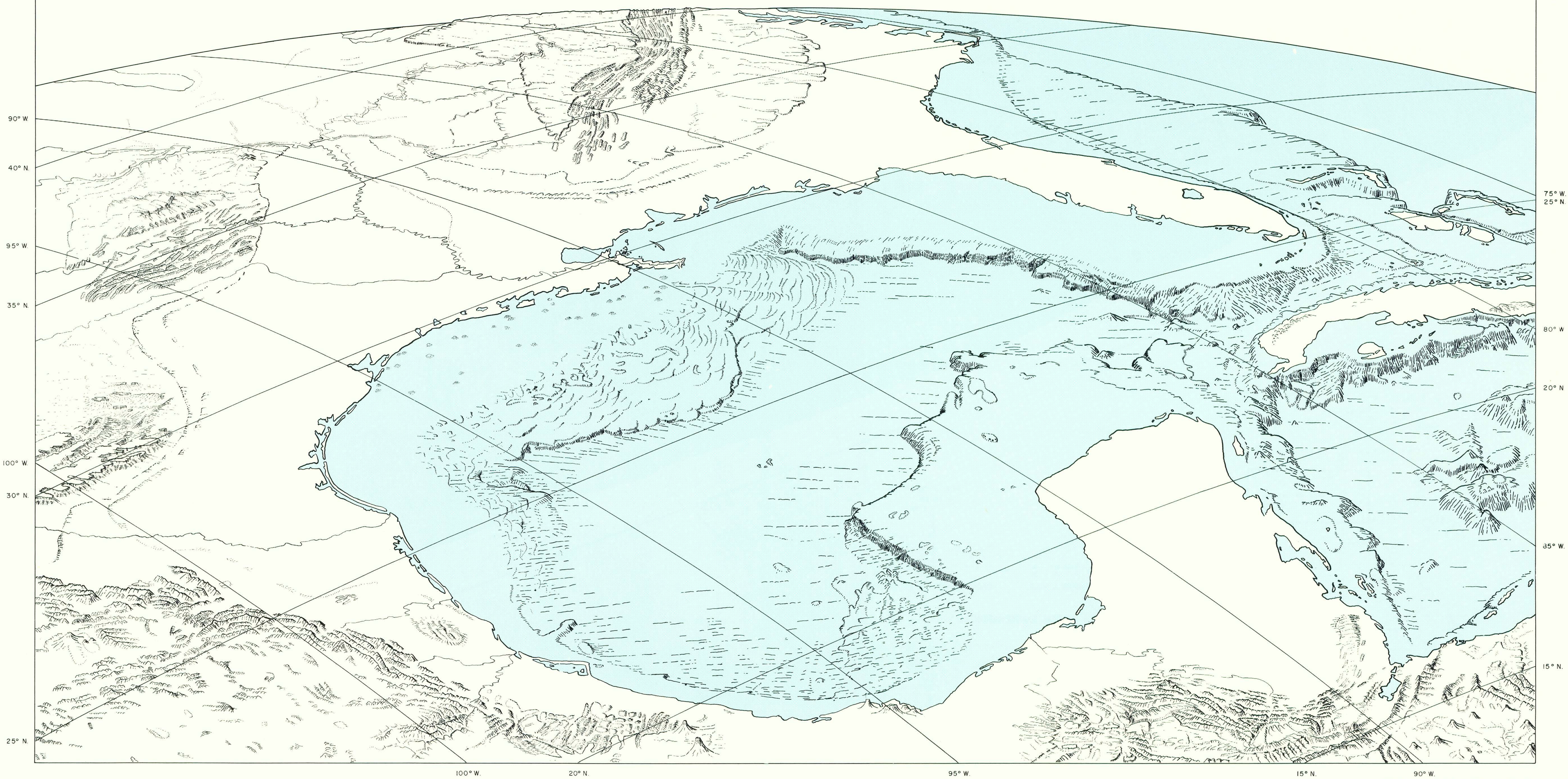
- UNDEFORMED SEDIMENTARY ROCKS
- DEFORMED SEDIMENTARY ROCKS
- INTERCALATED SEDIMENTARY AND VOLCANIC ROCKS
- VOLCANIC ROCKS
- INTERMEDIATE CRUST
- LOWER CRUST
- DISCONTINUITY (MANTLE BENEATH)

The Lesser Antilles, viewed toward the northwest, are located in the northeastern part of the Caribbean Sea. Some of the islands of the chain can be discerned on the left, and the Puerto Rico Trench is seen to the right. The islands farther to the left are composed of younger volcanic rocks, and the islands along the edge of the platform are composed of older volcanic rocks that are capped by limestone and have coral reefs near sea level (Marlow and others, 1974, p. 289). The Puerto Rico Trench has a thick accumulation of sediment (Marlow and others, 1974, p. 291). This map has been published in Marlow and others (1974, p. 300).

NORTHEAST CARIBBEAN SEA

By
Tau Rho Alpha
1974

This regional oblique map of the Gulf of Mexico is viewed toward the northeast. Part of Mexico is shown in the foreground, and the southeastern United States can be seen in the background. Near the center of the map is the delta of the Mississippi River. Offshore, one branch of the delta extends toward the Florida peninsula, and a second branch stretches to the flat floor of the Gulf of Mexico (Shepard, 1973, p. 397). An orthographic map projection was compiled using this specific angle of view and elevation in order to obtain an oblique base map for this large region of the Earth's surface. This map has been published in Maher and Applin (1968, pl. 1); Smith (1974, cover).



VERTICAL EXAGGERATION ABOUT X10

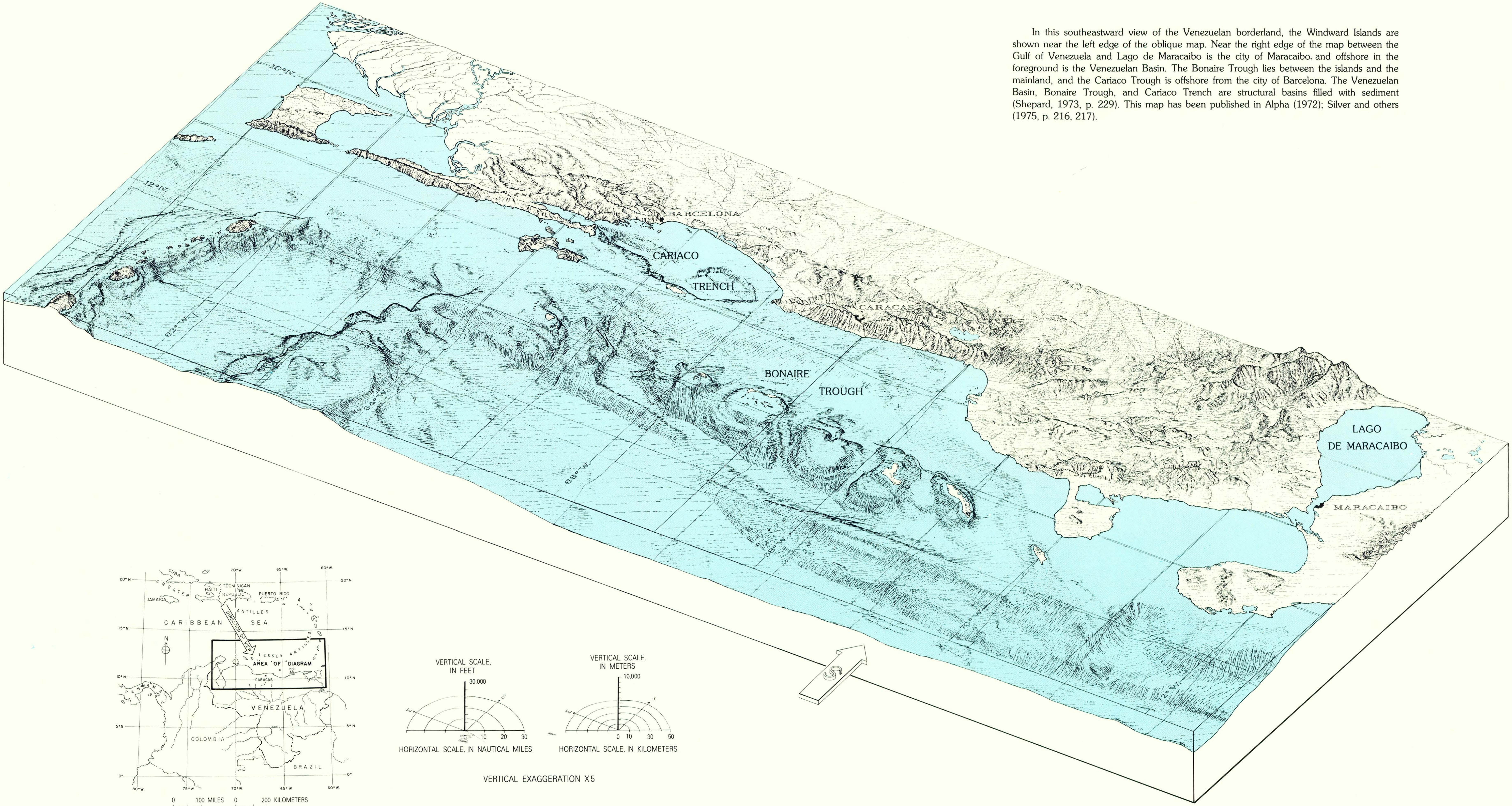
PHYSIOGRAPHIC DIAGRAM OF THE GULF OF MEXICO

By

T. R. Alpha and J. C. Maher

1965

In this southeastward view of the Venezuelan borderland, the Windward Islands are shown near the left edge of the oblique map. Near the right edge of the map between the Gulf of Venezuela and Lago de Maracaibo is the city of Maracaibo, and offshore in the foreground is the Venezuelan Basin. The Bonaire Trough lies between the islands and the mainland, and the Cariaco Trough is offshore from the city of Barcelona. The Venezuelan Basin, Bonaire Trough, and Cariaco Trench are structural basins filled with sediment (Shepard, 1973, p. 229). This map has been published in Alpha (1972); Silver and others (1975, p. 216, 217).



INDEX MAP

VERTICAL EXAGGERATION X5

VENEZUELAN BORDERLAND

By

Tau Rho Alpha

1972

OTHER PLACES

1 Almeria, España

2 Atlantic Coastal Plain

3 Atlantic continental margin

4 Bahama Banks

5 Blake Escarpment

6 East Pacific Rise

7 Falkland Plateau region

8 Huascarãn Mountain, Perú

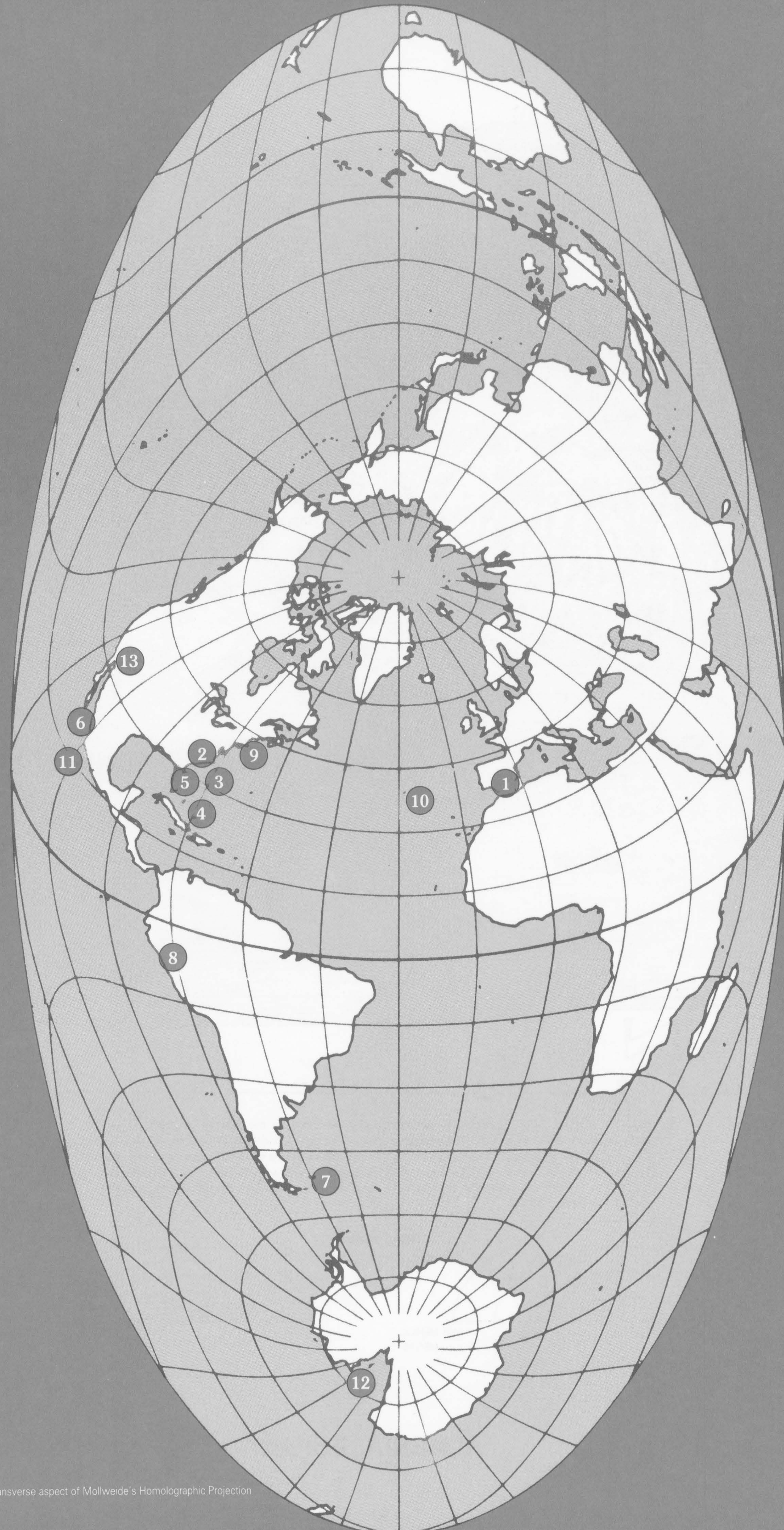
9 Hudson Canyon

10 Mid-Atlantic Ridge

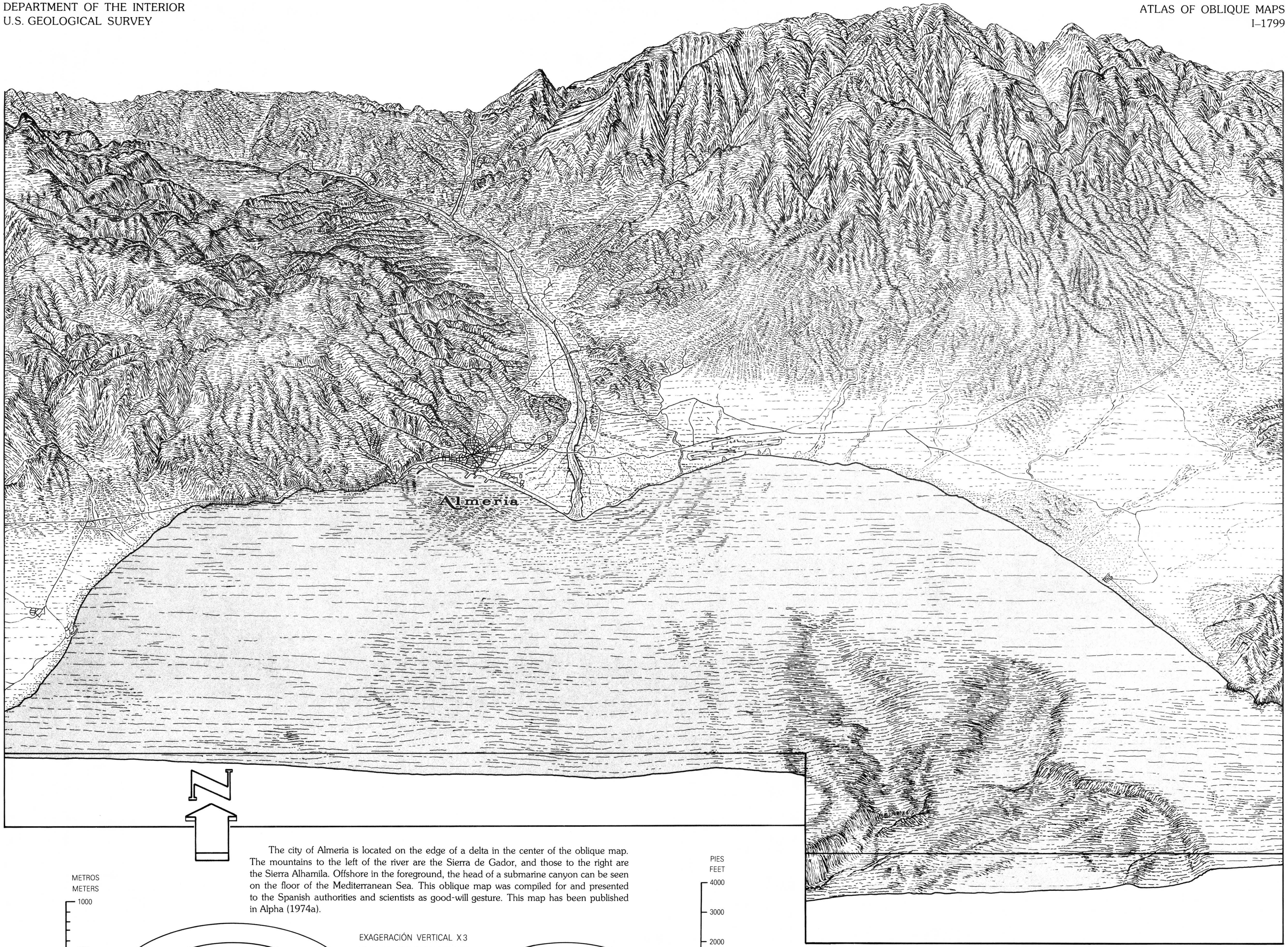
11 Rio Balsas Canyon, Mexico

12 Ross Sea Continental Shelf

13 Verde River, Arizona



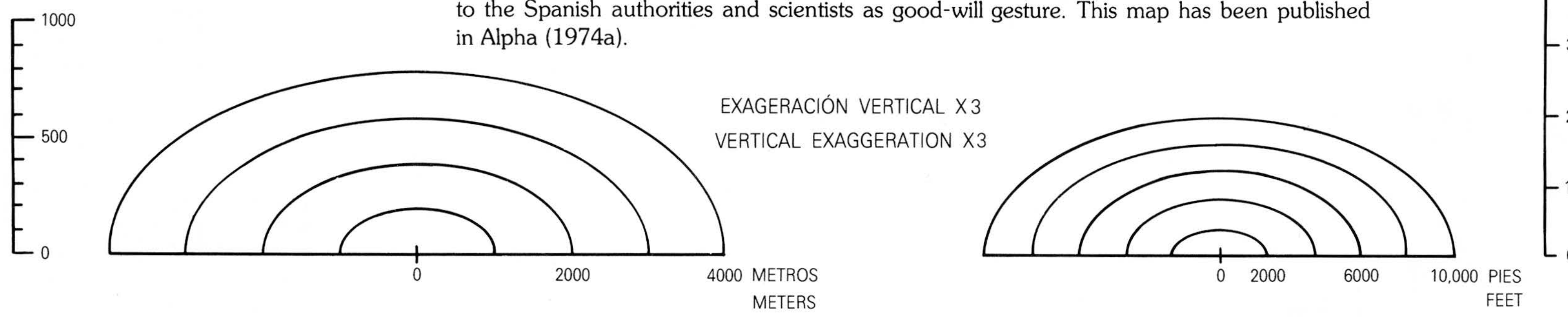
Transverse aspect of Mollweide's Homolographic Projection



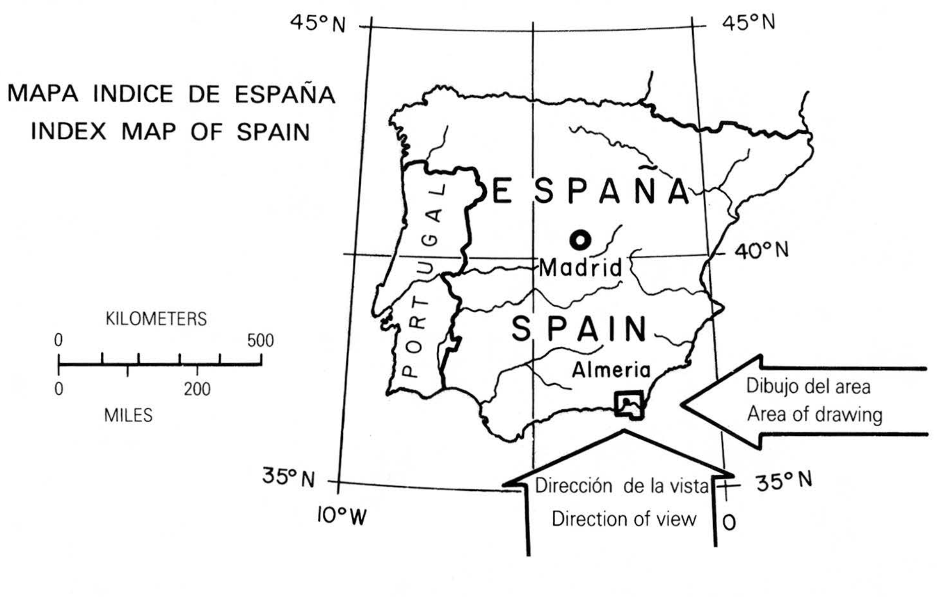
The city of Almeria is located on the edge of a delta in the center of the oblique map. The mountains to the left of the river are the Sierra de Gador, and those to the right are the Sierra Alhamila. Offshore in the foreground, the head of a submarine canyon can be seen on the floor of the Mediterranean Sea. This oblique map was compiled for and presented to the Spanish authorities and scientists as good-will gesture. This map has been published in Alpha (1974a).

METROS
METERS

PIES
FEET



MAPA INDICE DE ESPAÑA
INDEX MAP OF SPAIN

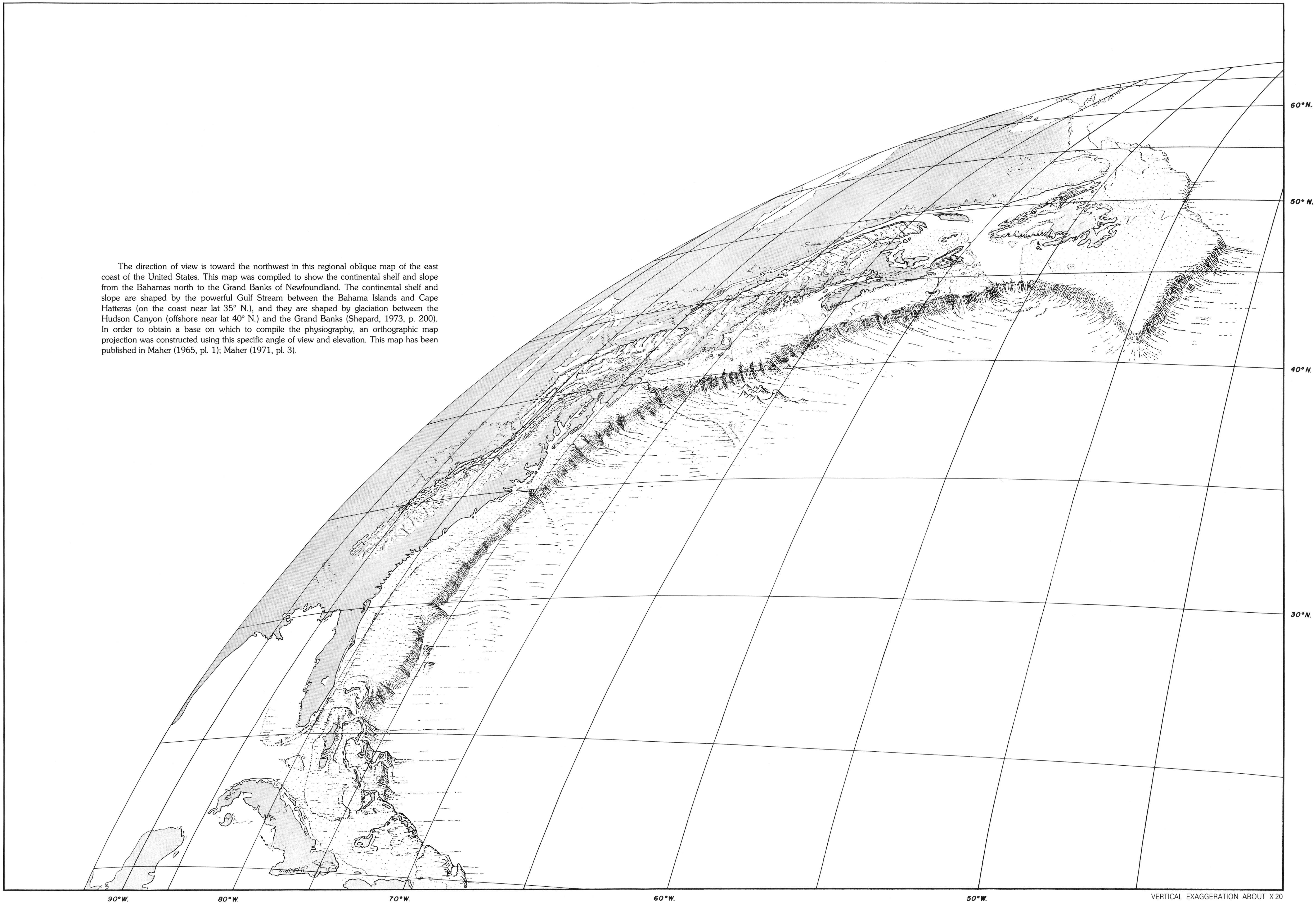


ALMERIA, ESPAÑA

By

Tau Rho Alpha

1974



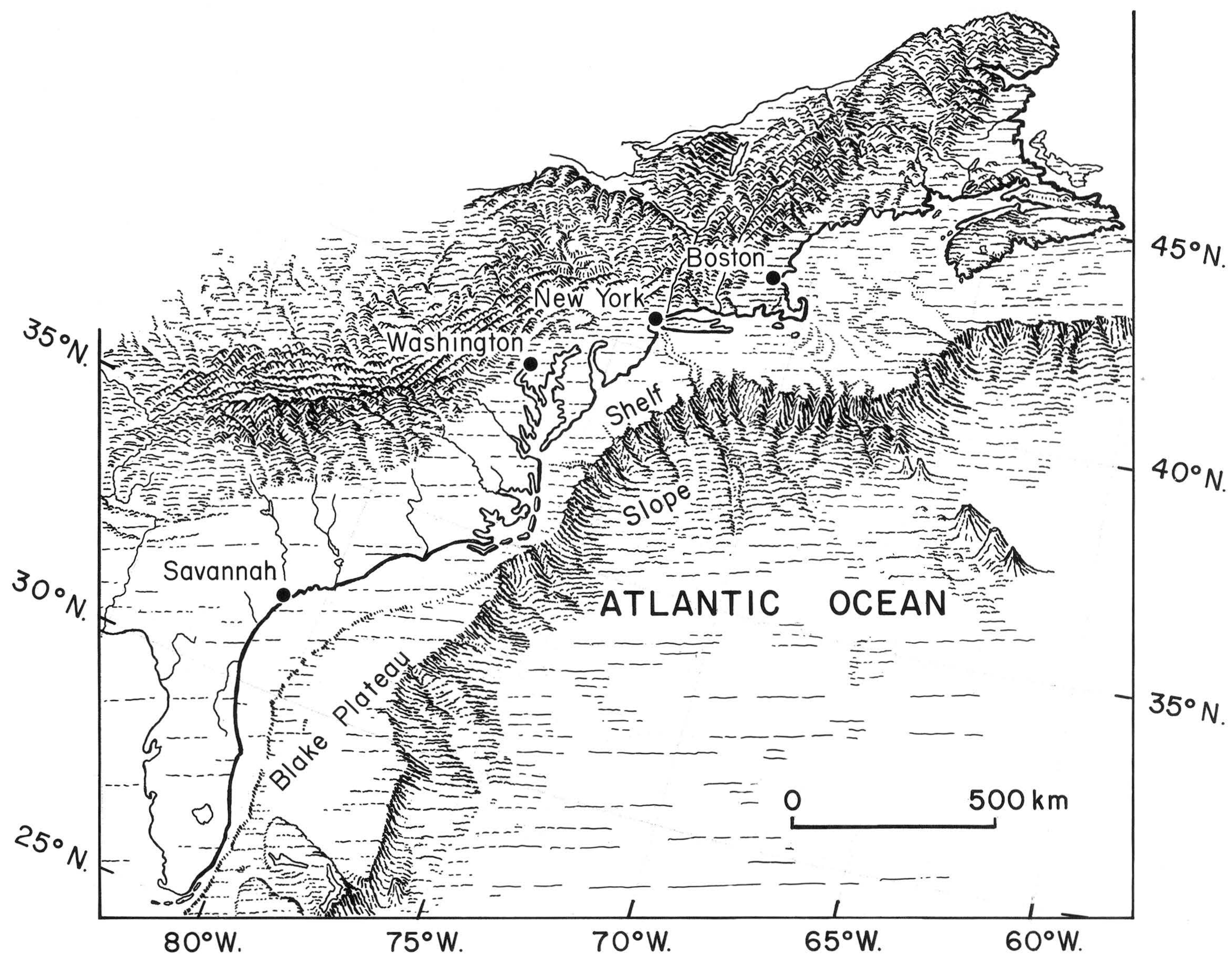
The direction of view is toward the northwest in this regional oblique map of the east coast of the United States. This map was compiled to show the continental shelf and slope from the Bahamas north to the Grand Banks of Newfoundland. The continental shelf and slope are shaped by the powerful Gulf Stream between the Bahama Islands and Cape Hatteras (on the coast near lat 35° N.), and they are shaped by glaciation between the Hudson Canyon (offshore near lat 40° N.) and the Grand Banks (Shepard, 1973, p. 200). In order to obtain a base on which to compile the physiography, an orthographic map projection was constructed using this specific angle of view and elevation. This map has been published in Maher (1965, pl. 1); Maher (1971, pl. 3).

PHYSIOGRAPHIC DIAGRAM OF ATLANTIC COASTAL PLAIN AND CONTINENTAL SHELF OF NORTH AMERICA

By

T. R. Alpha and J. C. Maher

1964



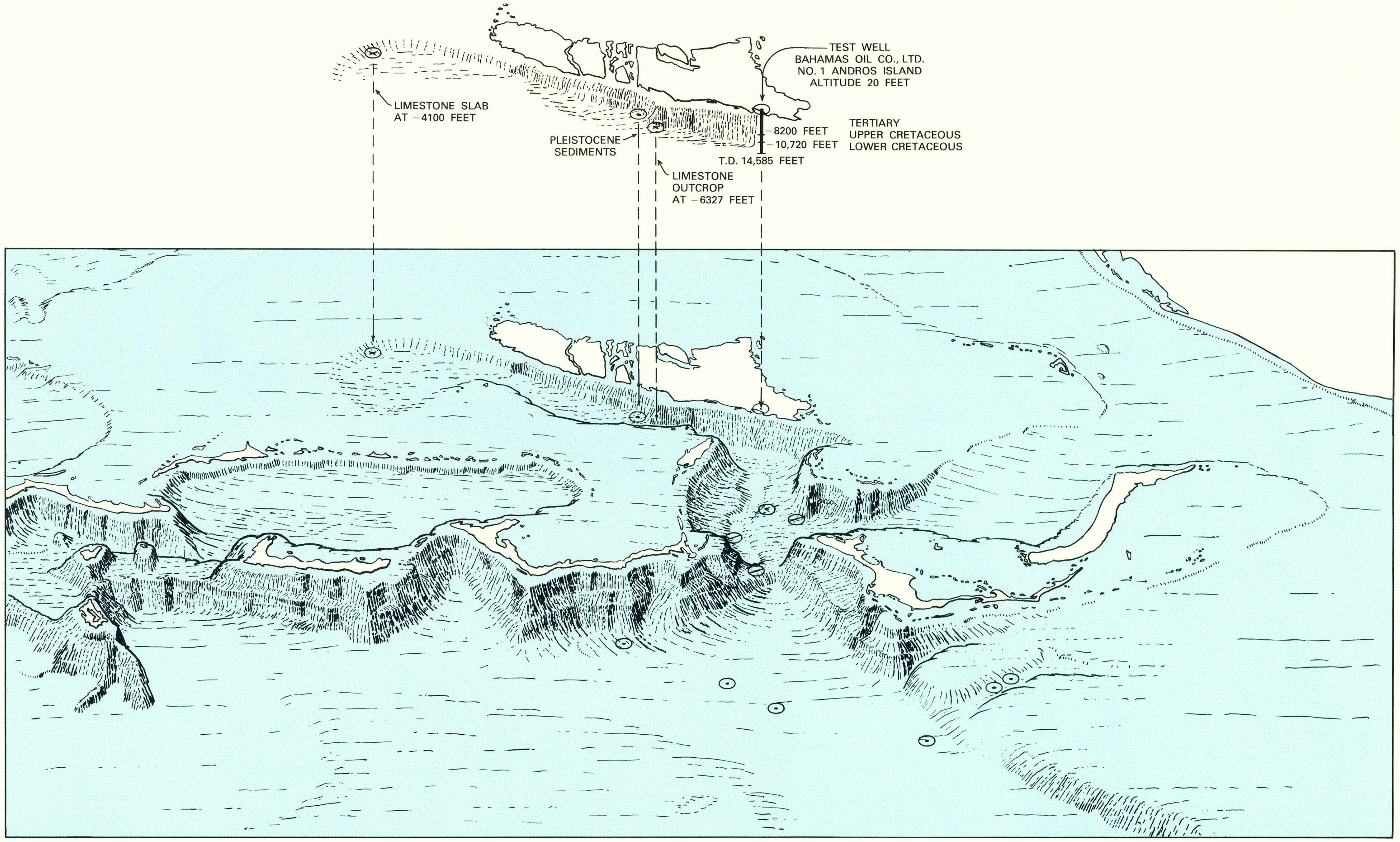
A northwest view of the Atlantic continental margin. Because this map was prepared for a newspaper press release, it was compiled in a short time on a map base of unknown projection rather than on a base developed with the isometrograph. This regional map was compiled to illustrate the relation between the Blake Plateau, the continental shelf, and the continental slope; it has been published in Edgar (1979).

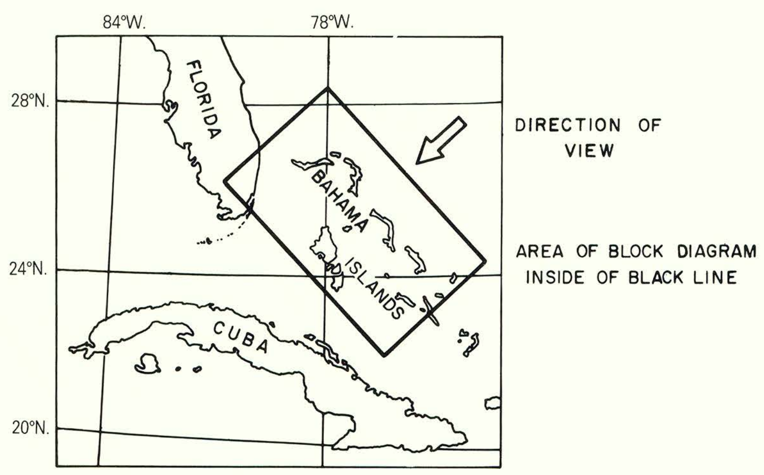
OBLIQUE MAP OF ATLANTIC CONTINENTAL MARGIN OF NORTH AMERICA

By

Tau Rho Alpha

1979





EXPLANATION

OLDEST ROCKS RECOVERED IN CORES AND TOWS

- Pleistocene sediments
- Pleistocene sediments containing Cretaceous material
- Neogene sediments
- Limestone rock of unknown age

25 0 25 50 75 MILES

APPROXIMATE SCALE

VERTICAL EXAGGERATION X 4

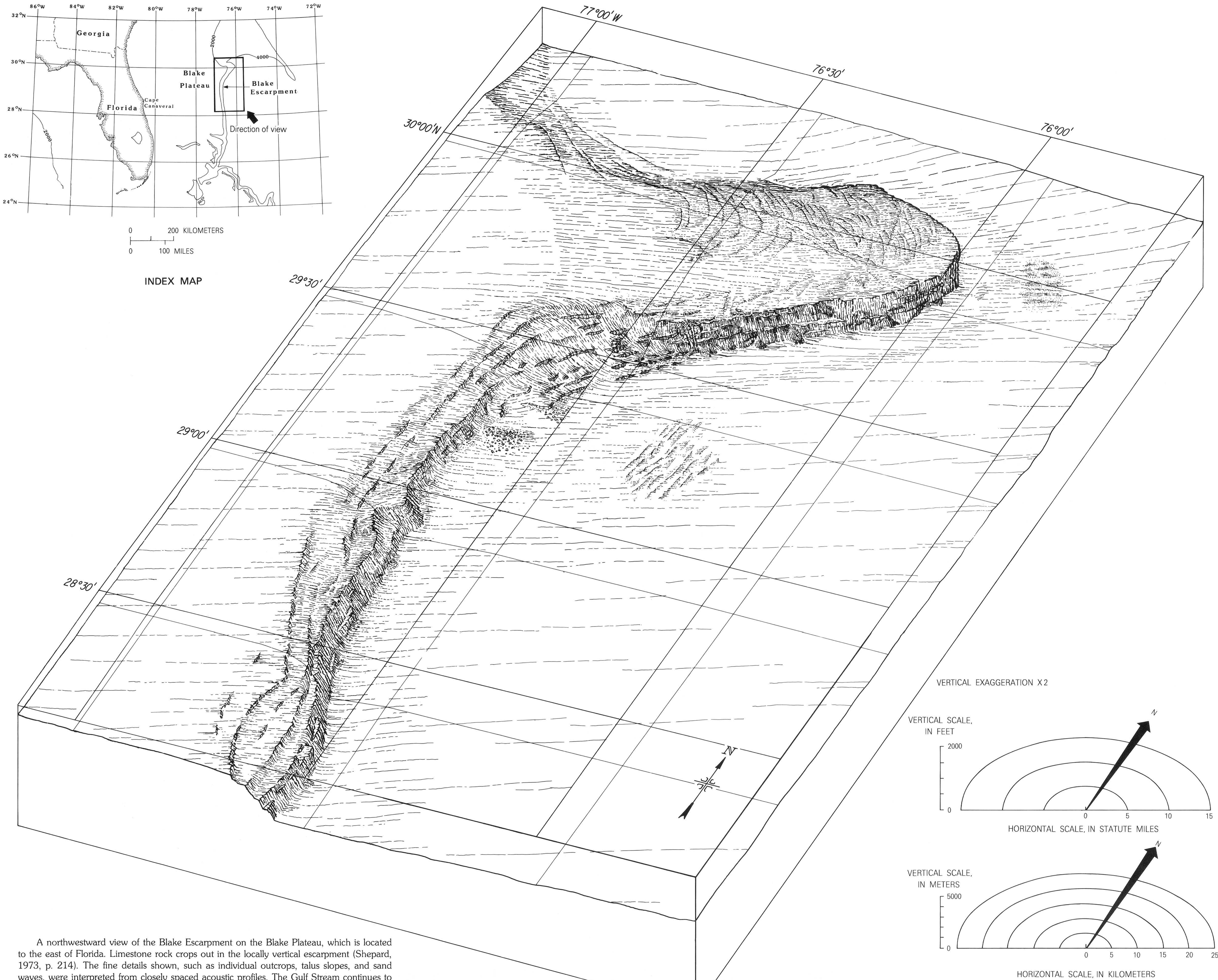
Viewed toward the southwest, the Bahama Banks are shown in this angular-perspective map. Andros Island at top center is elevated above the oblique map to show a test well and other geologic data. The trough in front of Andros Island is the Tongue of the Ocean, and as the trough turns toward the viewer it is called the Great Bahama Canyon. Andros Island, as with all the Bahama Islands, is located on a limestone reef (Maher, 1971, p. 13). The Blake Plateau lies at the lower right of the oblique map, and part of the Florida peninsula is at the upper right. This map has been published in Maher (1971, p. 14).

PHYSIOGRAPHIC DIAGRAM OF BAHAMA BANKS, BAHAMAS

By

Tau Rho Alpha and John C. Maher

1971



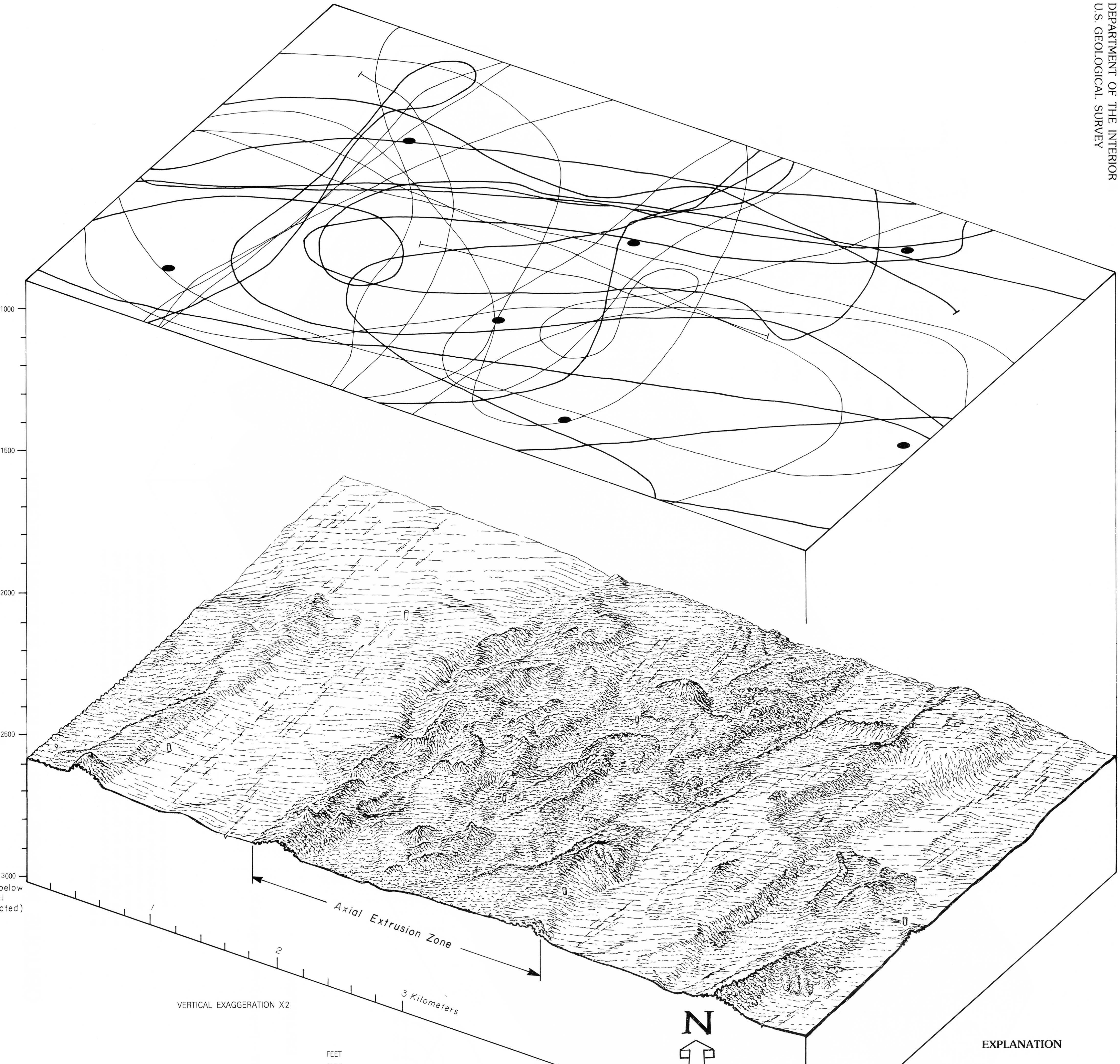
A northwestward view of the Blake Escarpment on the Blake Plateau, which is located to the east of Florida. Limestone rock crops out in the locally vertical escarpment (Shepard, 1973, p. 214). The fine details shown, such as individual outcrops, talus slopes, and sand waves, were interpreted from closely spaced acoustic profiles. The Gulf Stream continues to modify the surface of the Blake Plateau and Escarpment by preventing deposition and by erosion (Maher, 1971, p. 13). This map is unpublished.

PHYSIOGRAPHIC DIAGRAM OF THE BLAKE ESCARPMENT OFF SOUTHEASTERN UNITED STATES

By

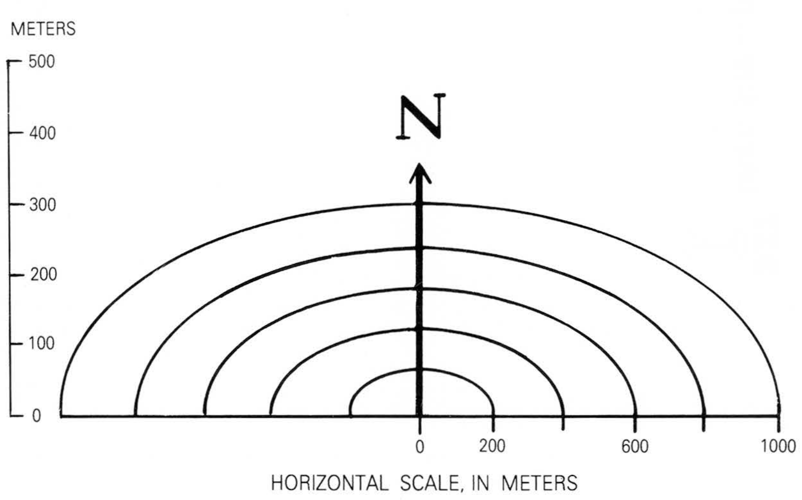
Tau Rho Alpha, William P. Dillon, Patricia Forrestel, and Jeff Zwinakis

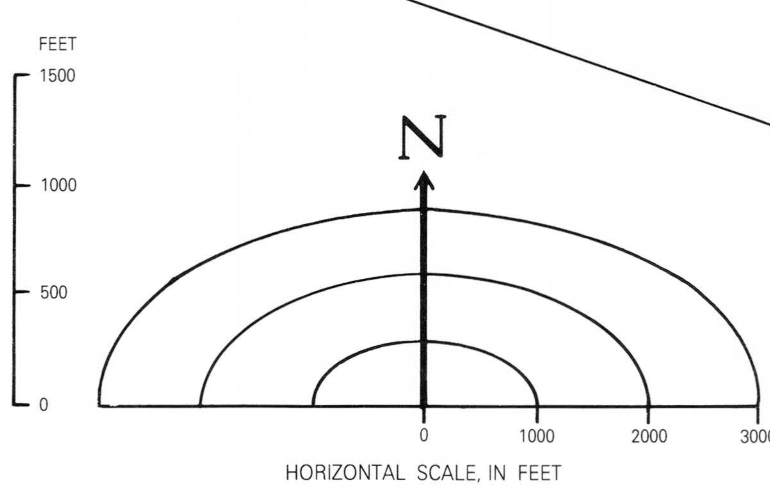
1981



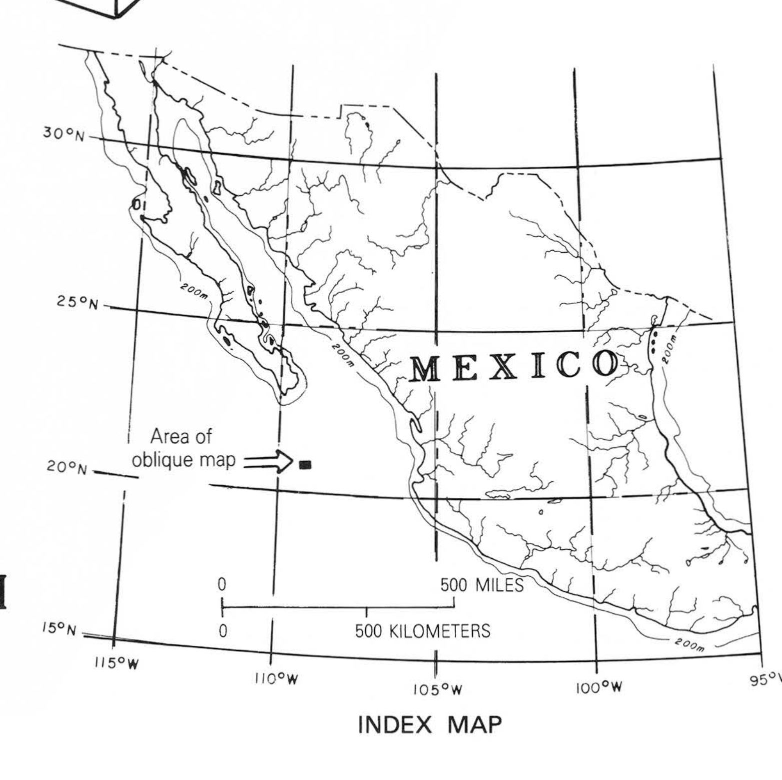
EXPLANATION

TRANSPONDERS
TRACK LINES, 1977
TRACK LINES, 1974





This oblique map is in two parts: the upper part shows curving track lines and navigation transponders that are located 2,953 feet (900 meters) below sea level; the lower part represents the physiography of the East Pacific Rise at depths close to 8,530 feet (2,600 meters). The curving track lines illustrate the path of the ship that carried the deep-tow instrument package, which included side-scan sonar. Over 6,000 bottom photographs were taken (Normark and others, 1978). The East Pacific Rise formed when the Baja California peninsula rifted away from the mainland of Mexico. The axial extrusion zone is relatively free of sediment and has extensive outcrops of basaltic pillow lavas. Parallel and adjacent to the axial extrusion zone are elongated ridges. This map has been published in Normark and others (1978).

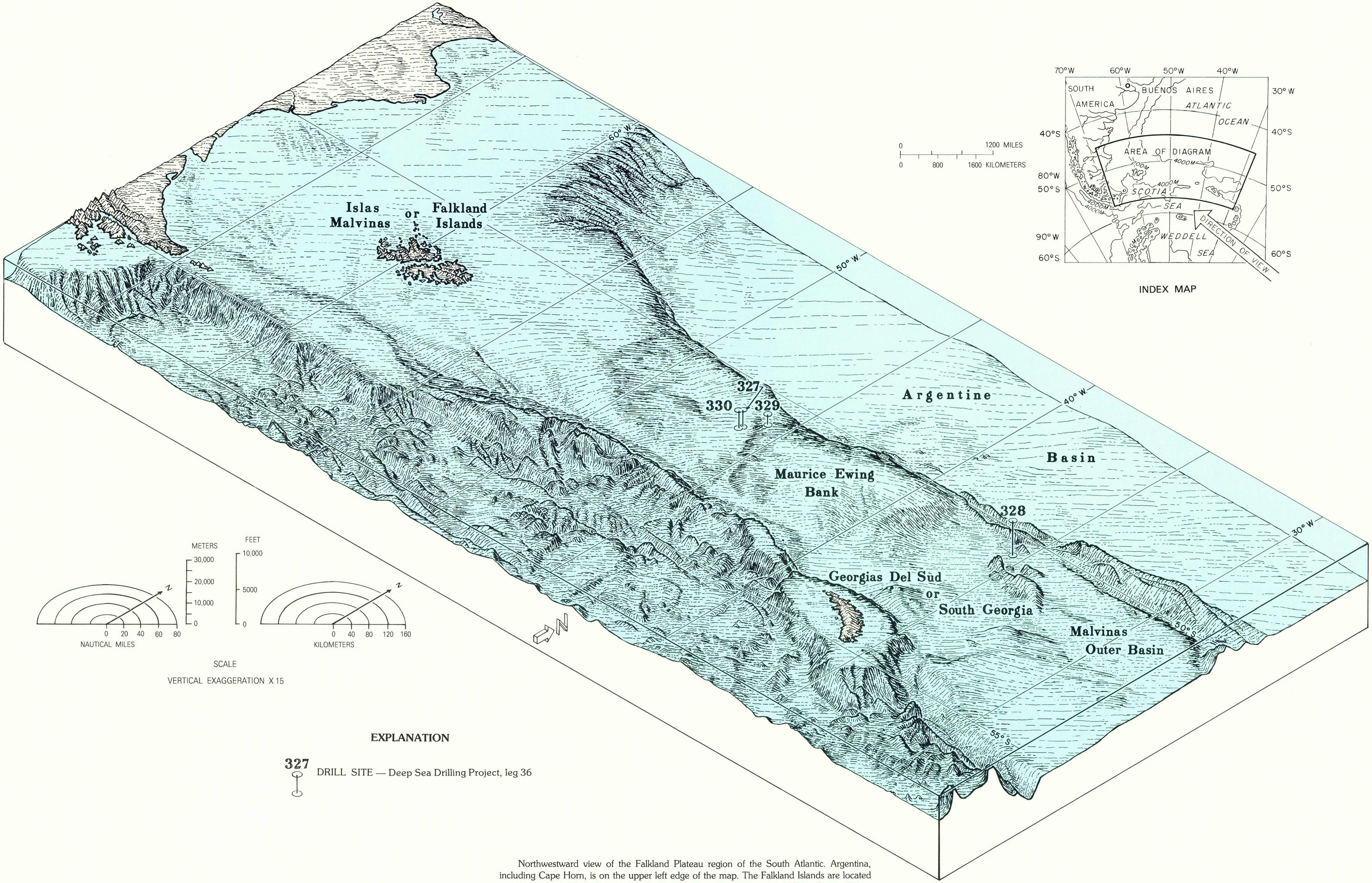


INDEX MAP

OBLIQUE MAP OF THE CREST OF THE EAST PACIFIC RISE NEAR THE MOUTH OF THE GULF OF CALIFORNIA

By
Tau Rho Alpha
1978

ATLAS OF OBLIQUE MAPS
I-1799



SCALE

VERTICAL EXAGGERATION X 15

EXPLANATION

327 DRILL SITE — Deep Sea Drilling Project, leg 36

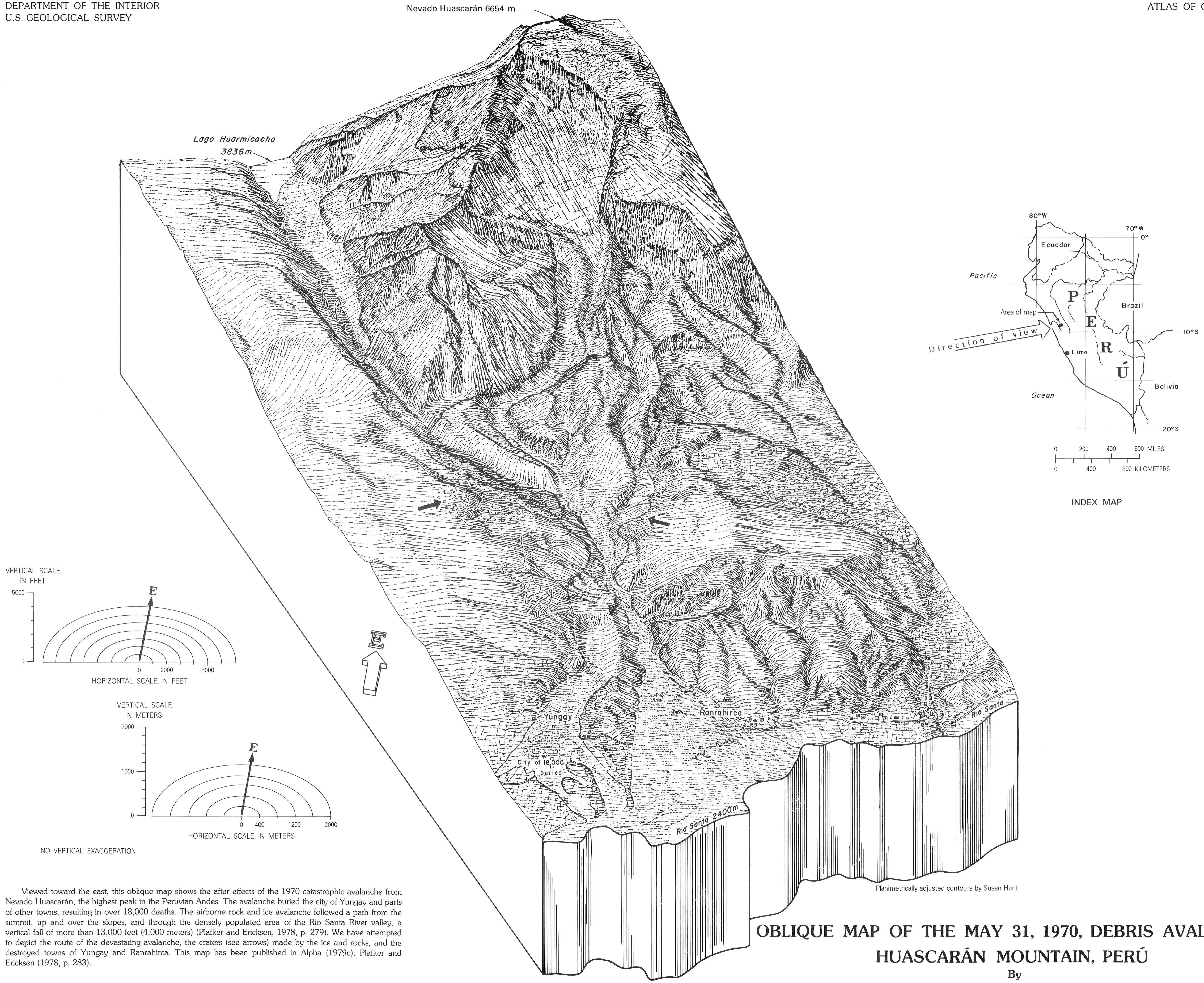
Northwestward view of the Falkland Plateau region of the South Atlantic. Argentina, including Cape Horn, is on the upper left edge of the map. The Falkland Islands are located on the continental shelf, and South Georgia is to the east on the North Scotia Ridge. Between the North Scotia Ridge and the Argentine Basin is the Maurice Ewing Bank on which drill sites for the Deep Sea Drilling Project are symbolized (Barker and others, 1976, p. 8 and 9). This map has been published in Alpha (1979b); Barker and others (1976, map in back pocket).

OBLIQUE MAP OF THE FALKLAND PLATEAU REGION

By

Tau Rho Alpha

1978



Planimetrically adjusted contours by Susan Hunt

INDEX MAP

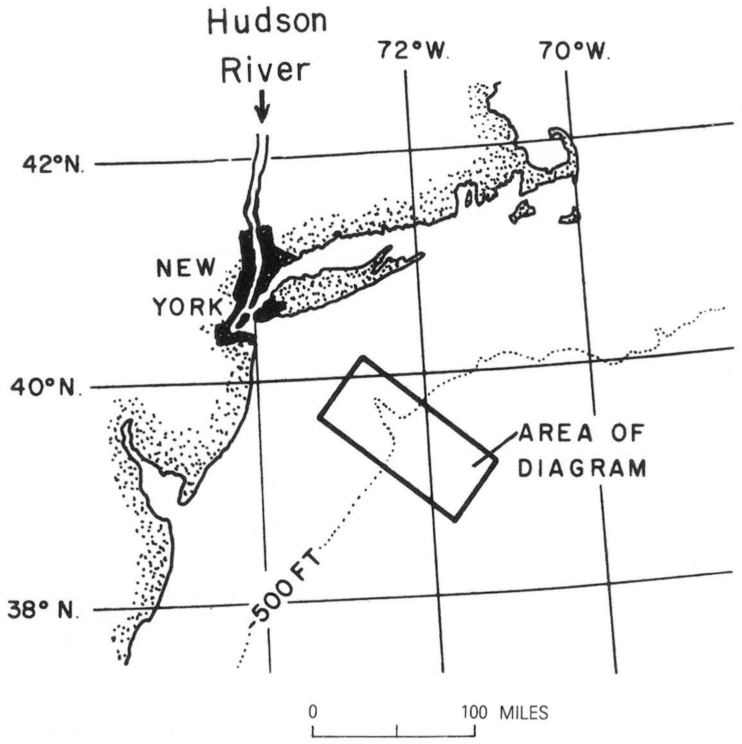
NO VERTICAL EXAGGERATION

Viewed toward the east, this oblique map shows the after effects of the 1970 catastrophic avalanche from Nevado Huascarán, the highest peak in the Peruvian Andes. The avalanche buried the city of Yungay and parts of other towns, resulting in over 18,000 deaths. The airborne rock and ice avalanche followed a path from the summit, up and over the slopes, and through the densely populated area of the Rio Santa River valley, a vertical fall of more than 13,000 feet (4,000 meters) (Plafker and Ericksen, 1978, p. 279). We have attempted to depict the route of the devastating avalanche, the craters (see arrows) made by the ice and rocks, and the destroyed towns of Yungay and Ranrahirca. This map has been published in Alpha (1979c); Plafker and Ericksen (1978, p. 283).

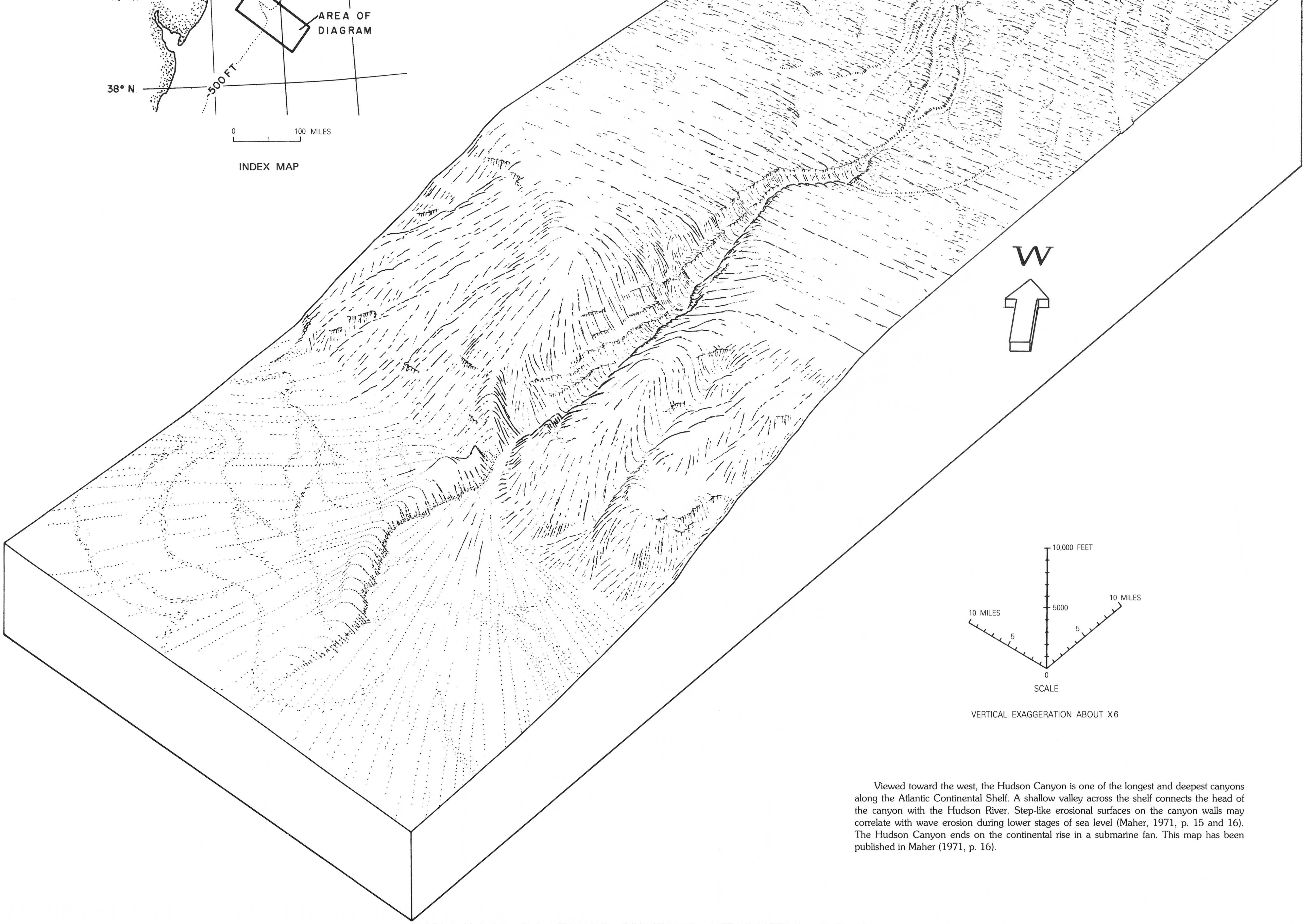
OBLIQUE MAP OF THE MAY 31, 1970, DEBRIS AVALANCHE, HUASCARÁN MOUNTAIN, PERÚ

By

Tau Rho Alpha
1978



INDEX MAP



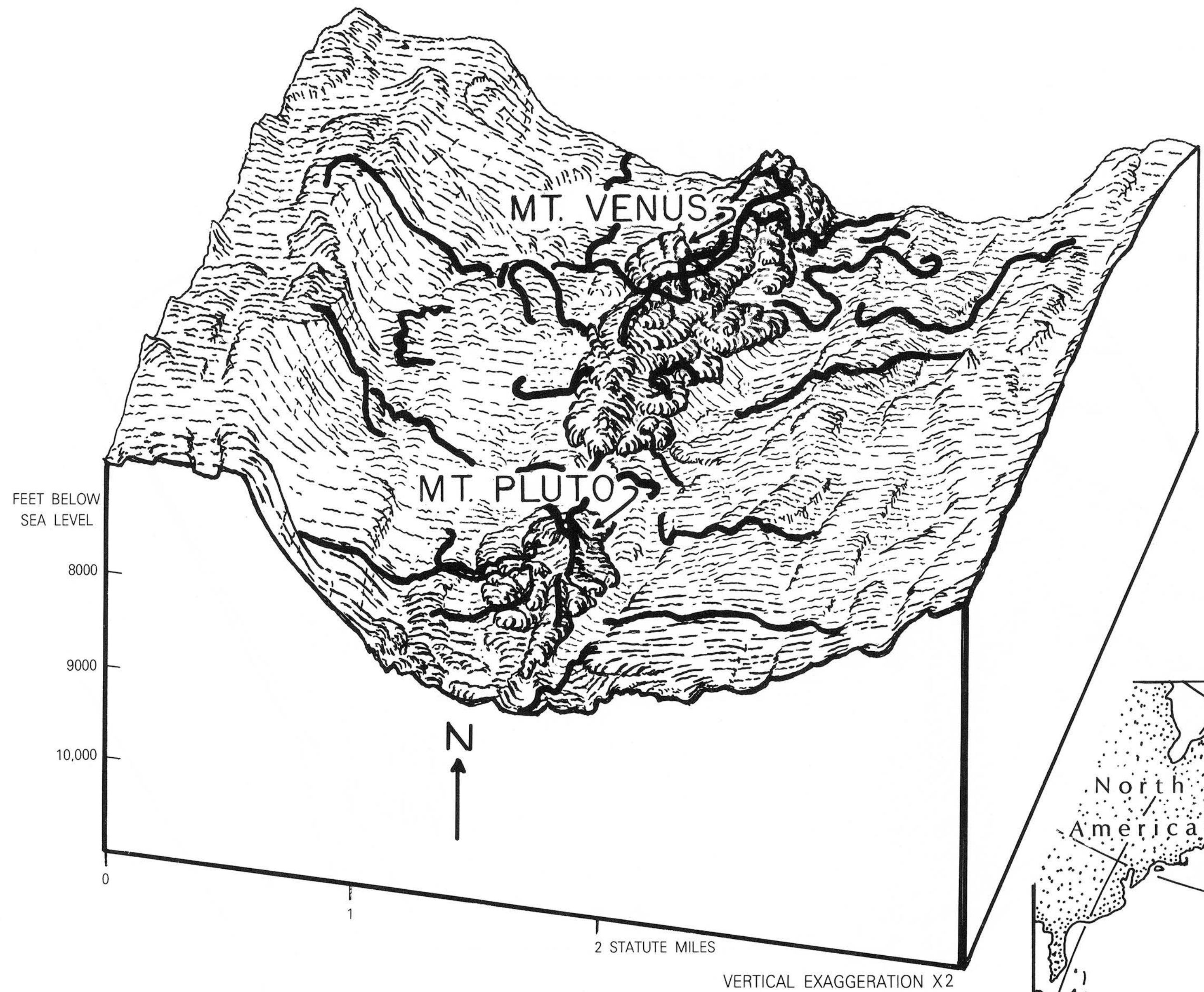
Viewed toward the west, the Hudson Canyon is one of the longest and deepest canyons along the Atlantic Continental Shelf. A shallow valley across the shelf connects the head of the canyon with the Hudson River. Step-like erosional surfaces on the canyon walls may correlate with wave erosion during lower stages of sea level (Maher, 1971, p. 15 and 16). The Hudson Canyon ends on the continental rise in a submarine fan. This map has been published in Maher (1971, p. 16).

HUDSON CANYON, NORTH ATLANTIC OCEAN

By

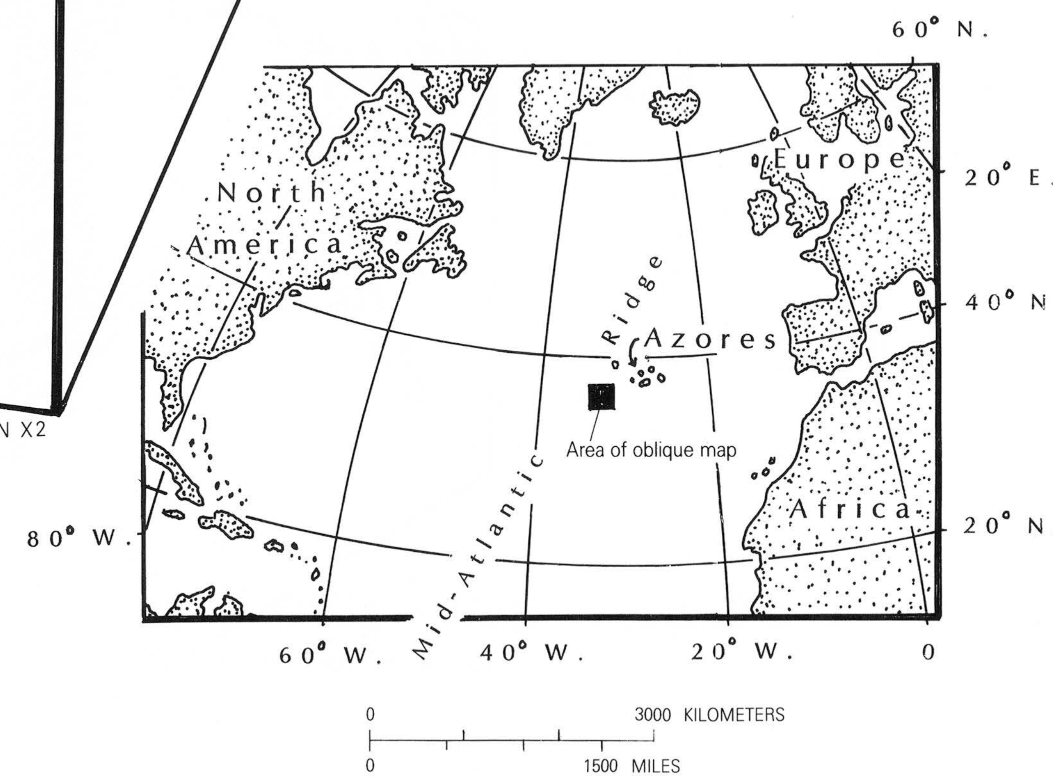
Tau Rho Alpha

1971



EXPLANATION

TRACK LINES OF SUBMERSIBLE VESSEL



INDEX MAP

This oblique map shows a section of the rift valley of the Mid-Atlantic Ridge. Heavy undulating lines represent the track lines of the submersible research vessel. The Mid-Atlantic Ridge is part of the Mid-Oceanic Ridge system that winds its way along the plate boundaries on the floor of the ocean. The central rift valley of the Mid-Oceanic Ridge system is a spreading center where new ocean floor is continually being produced. This new ocean floor, composed mostly of pillow basalt (Moore and others, 1974, p. 437), appears in the oblique map as the central ridge of volcanic hills that are darker in line weight. Two hills named Mount Venus and Mount Pluto show on the ridge (Hekinian and others, 1976, p. 84). In this area, the west cliff of the rift valley is nearly 1,000 feet (300 meters) high. This map has been published in Moore and others (1974, p. 439); Hekinian and others (1976, p. 107); Perlman (1976, p. 4).

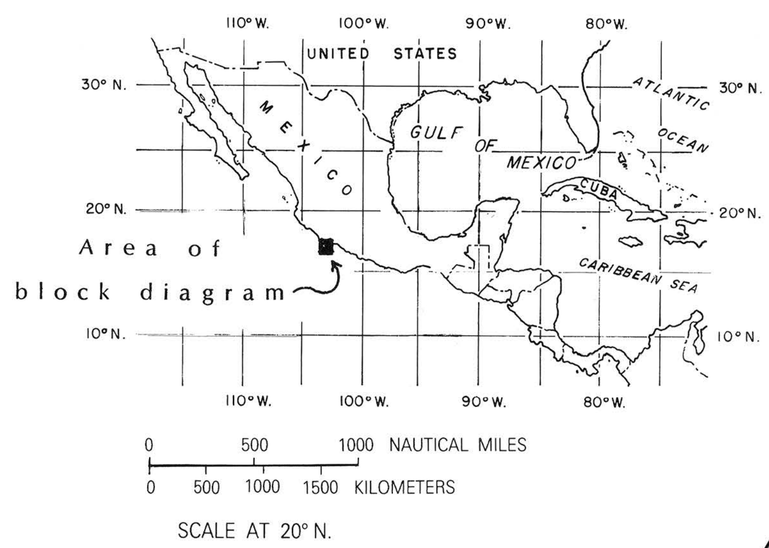
MID-ATLANTIC RIDGE AT LATITUDE 36°48′ NORTH, NORTH ATLANTIC OCEAN

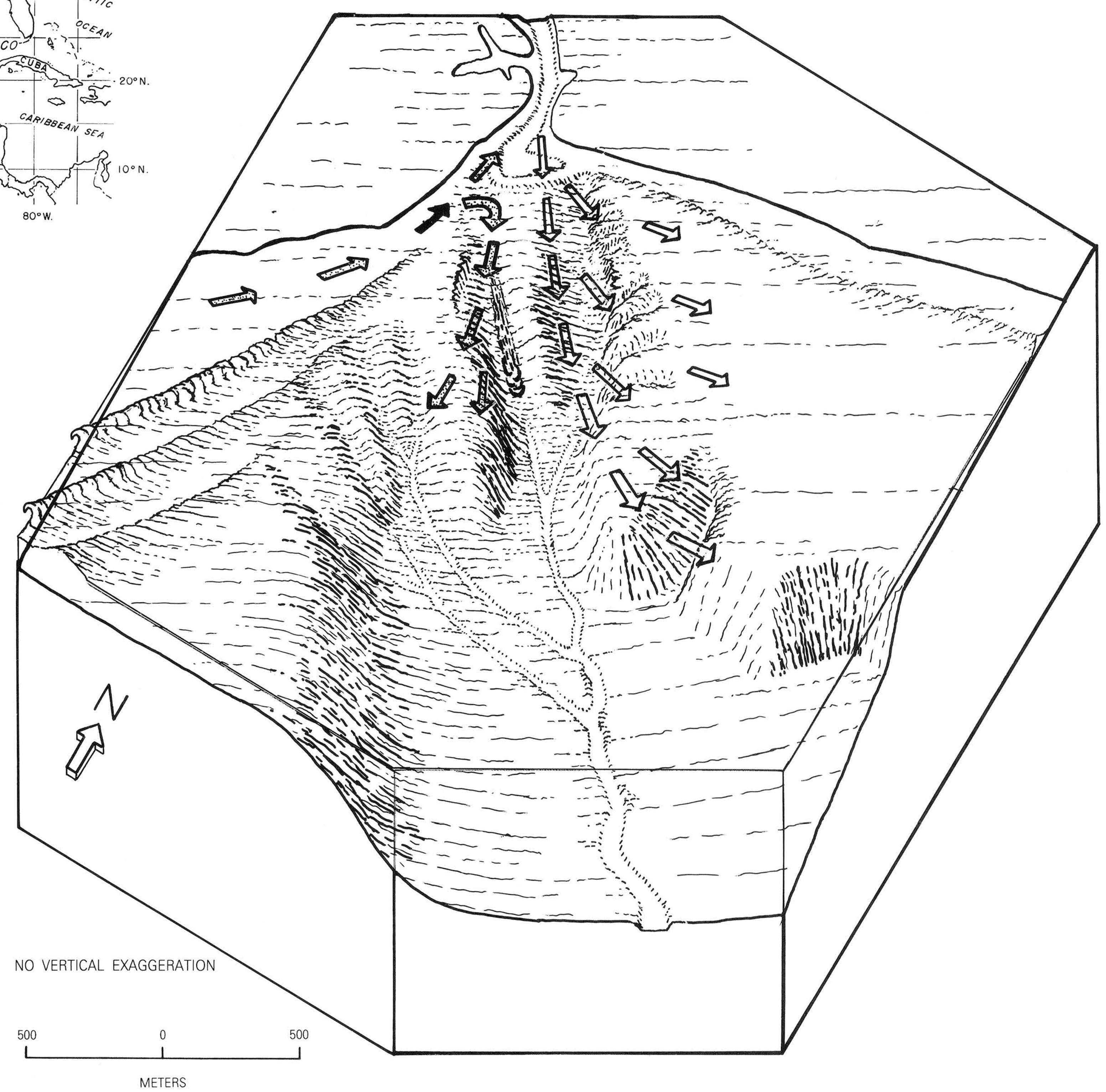
By

Tau Rho Alpha

1974

INDEX MAP





The Rio Balsas River is on Mexico's Pacific coast and is one of the largest rivers in Central America. Offshore, Cañon de la Necesidad is the main tributary of the Rio Balsas submarine canyon system. This block diagram, viewed toward the northwest, shows the head of the Rio Balsas canyon system. Current patterns at the head of Cañon de la Necesidad are illustrated on the block diagram by the use of arrows. The shaded arrows represent longshore and rip currents, the black arrow indicates the location of the strongest longshore current, and the open arrows show the seaward flow of fresh water from the river. A bottom turbidity current is shown in the canyon between the two sets of arrows. This map has been published in Reimnitz (1971, p. 85); Reineck and Singh (1973, p. 381).

SCHEMATIC BLOCK DIAGRAM OF THE HEAD OF THE RIO BALSAS CANYON, CAÑON DE LA NECESIDAD, MEXICO

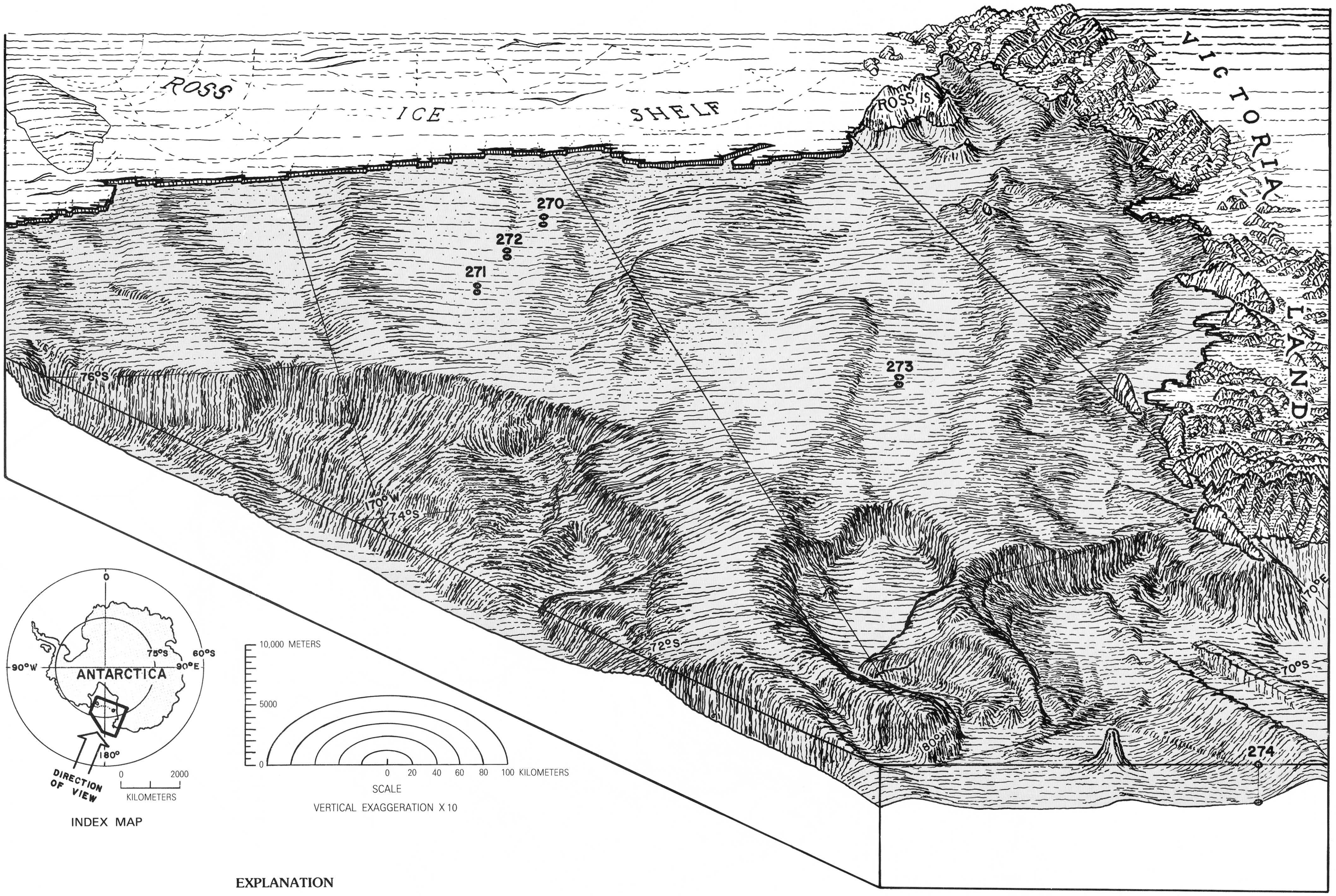
By

Tau Rho Alpha

1971

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

ATLAS OF OBLIQUE MAPS
I–1799



EXPLANATION

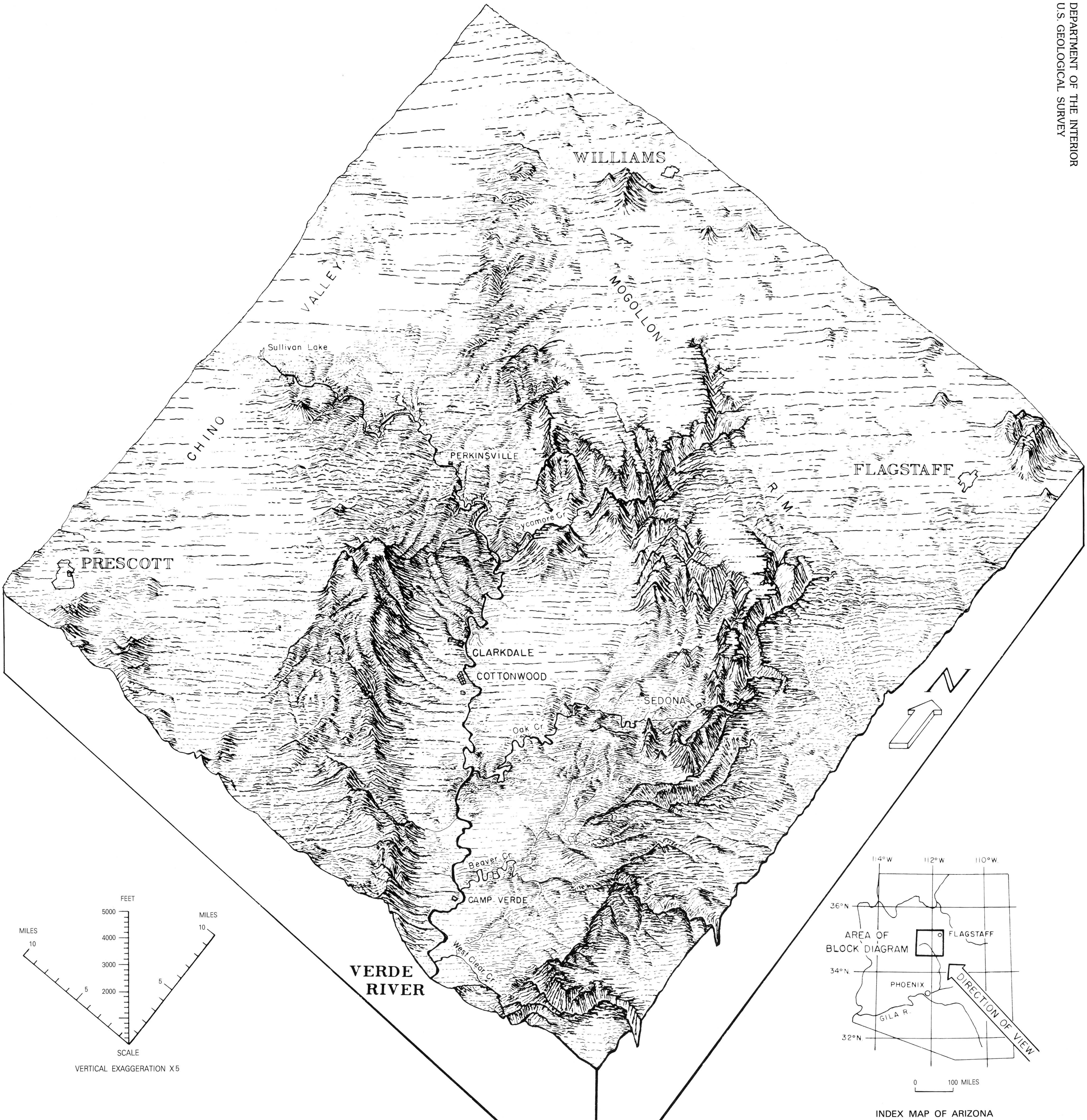
272
DRILL SITE — Deep Sea Drilling Project, leg 28

In this view toward the southeast, much of the Antarctic Continental Shelf is covered by the flat Ross ice shelf at the top of the map. Hidden from view behind Ross Island is McMurdo Station. To the right, an ice plateau and high relief form Victoria Land. The seasonally ice-free part of the shelf and slope are in the foreground, as well as the numbered sites of the Deep Sea Drilling Project (Ford and Barrett, 1975, p. 861). This map has been published in Alpha (1978e); [scientific staff] (1973a, p. 170; 1973b, p. 20, 21); Ford and Barrett (1975, p. 862); Johnson and others (1982, p. 1001).

OBLIQUE MAP OF THE ROSS SEA CONTINENTAL SHELF, ANTARCTICA

By
Tau Rho Alpha
1978

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY



INDEX MAP OF ARIZONA

This oblique map, viewed toward the northwest, is one of the few in this atlas that was compiled on a map base rather than with the aid of the isometrograph. It was compiled for a report on the water resources of the Upper Verde River that was never published. The Verde River drains the transition zone between the Basin and Range Province and the Colorado Plateau. To the north and east of the river is the part of the Colorado Plateau called the Mogollon Rim. This map is unpublished.

UPPER VERDE RIVER, ARIZONA

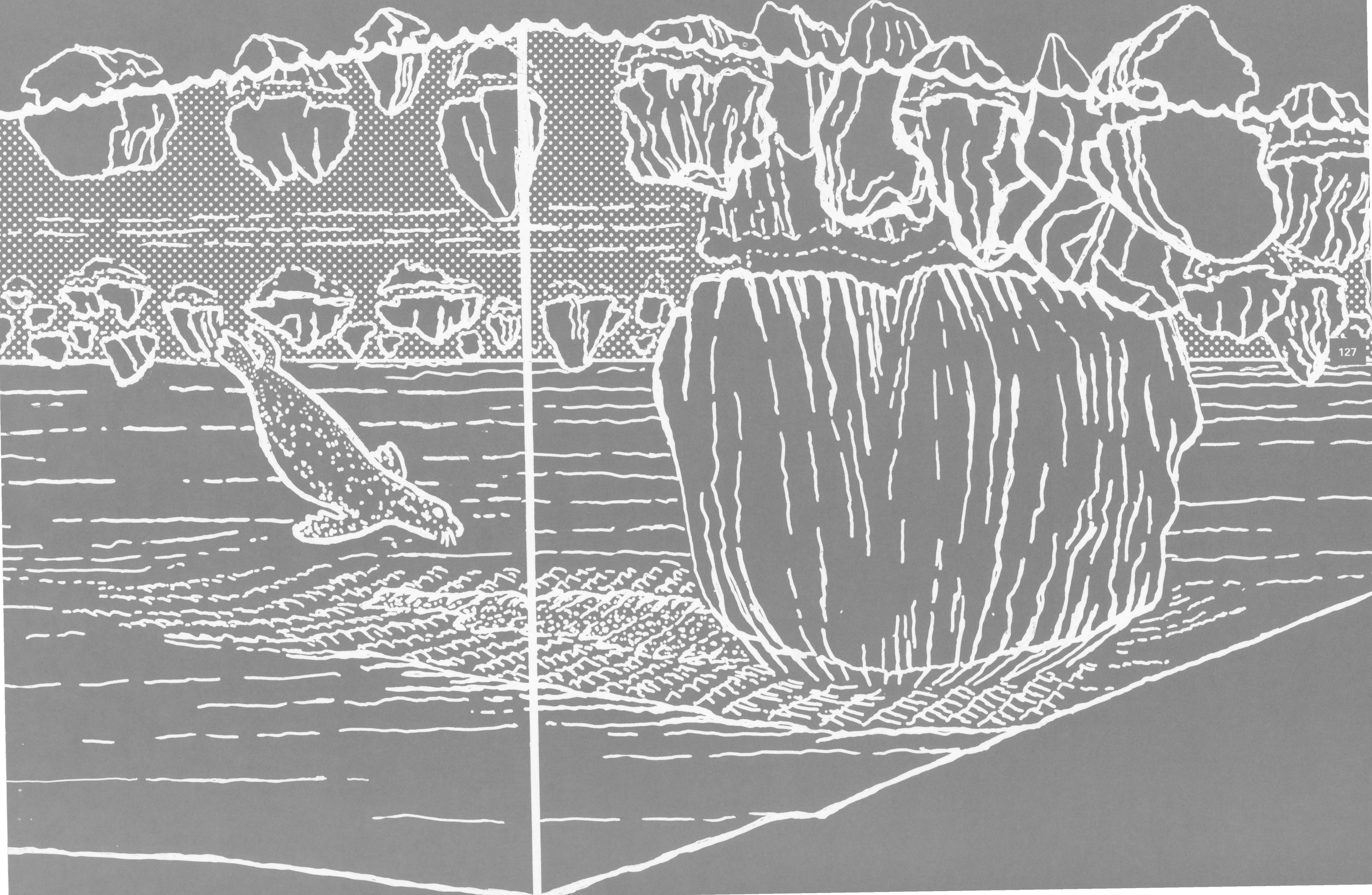
By

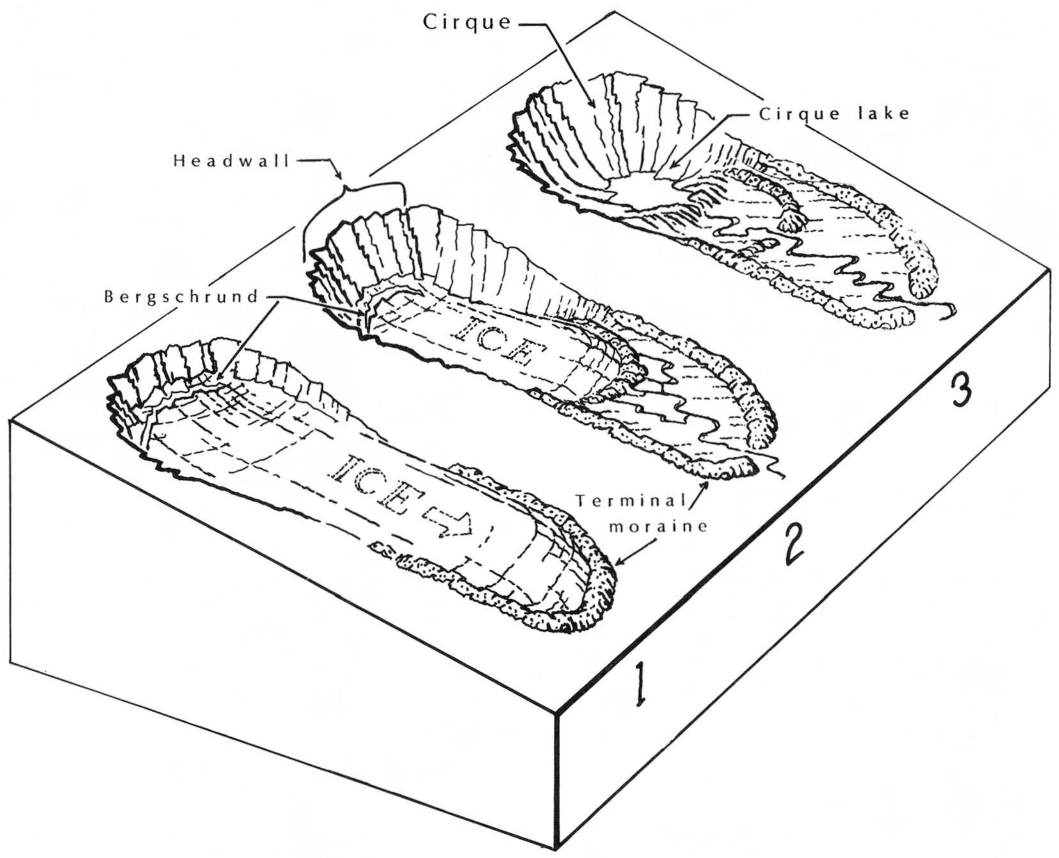
Tau Rho Alpha

1970

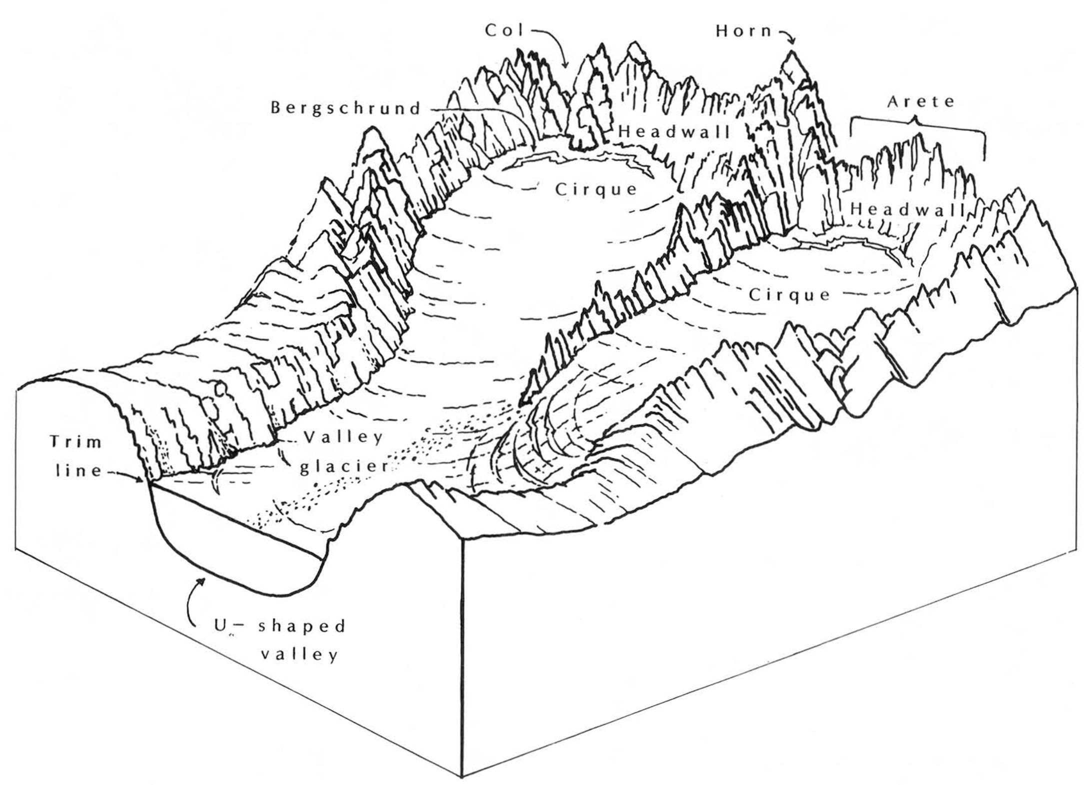
ATLAS OF OBLIQUE MAPS
I-1799

Cognitive drawings

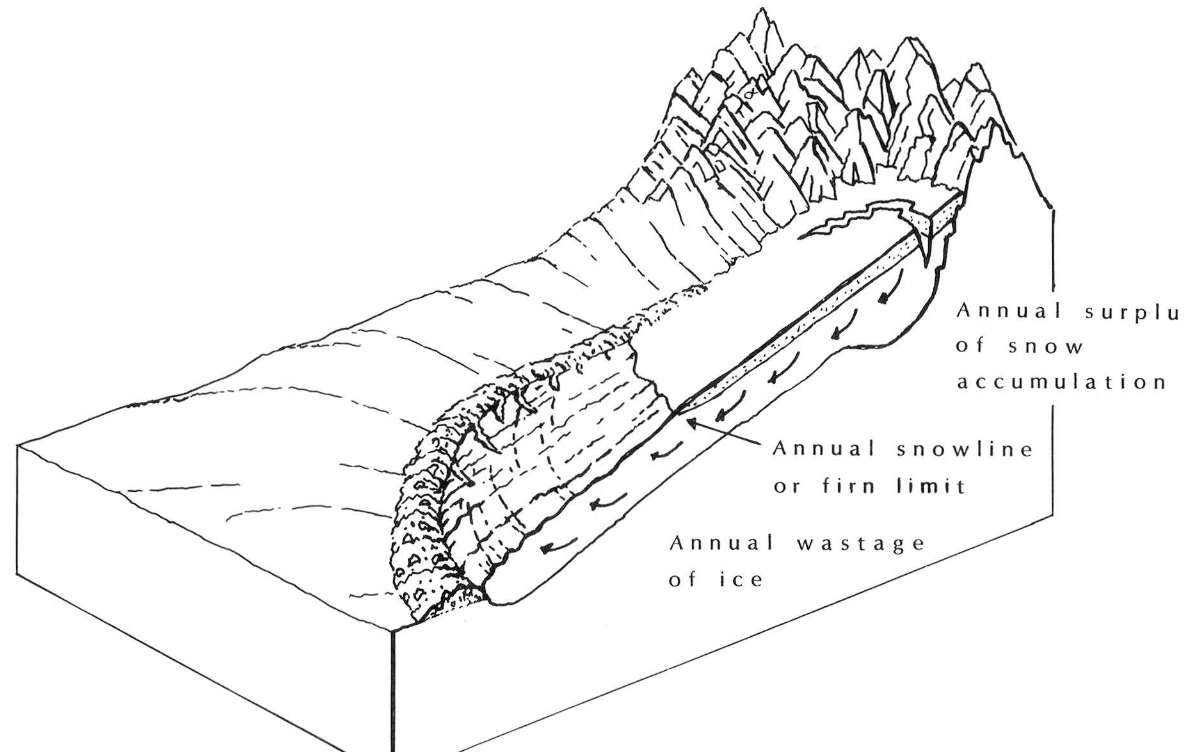




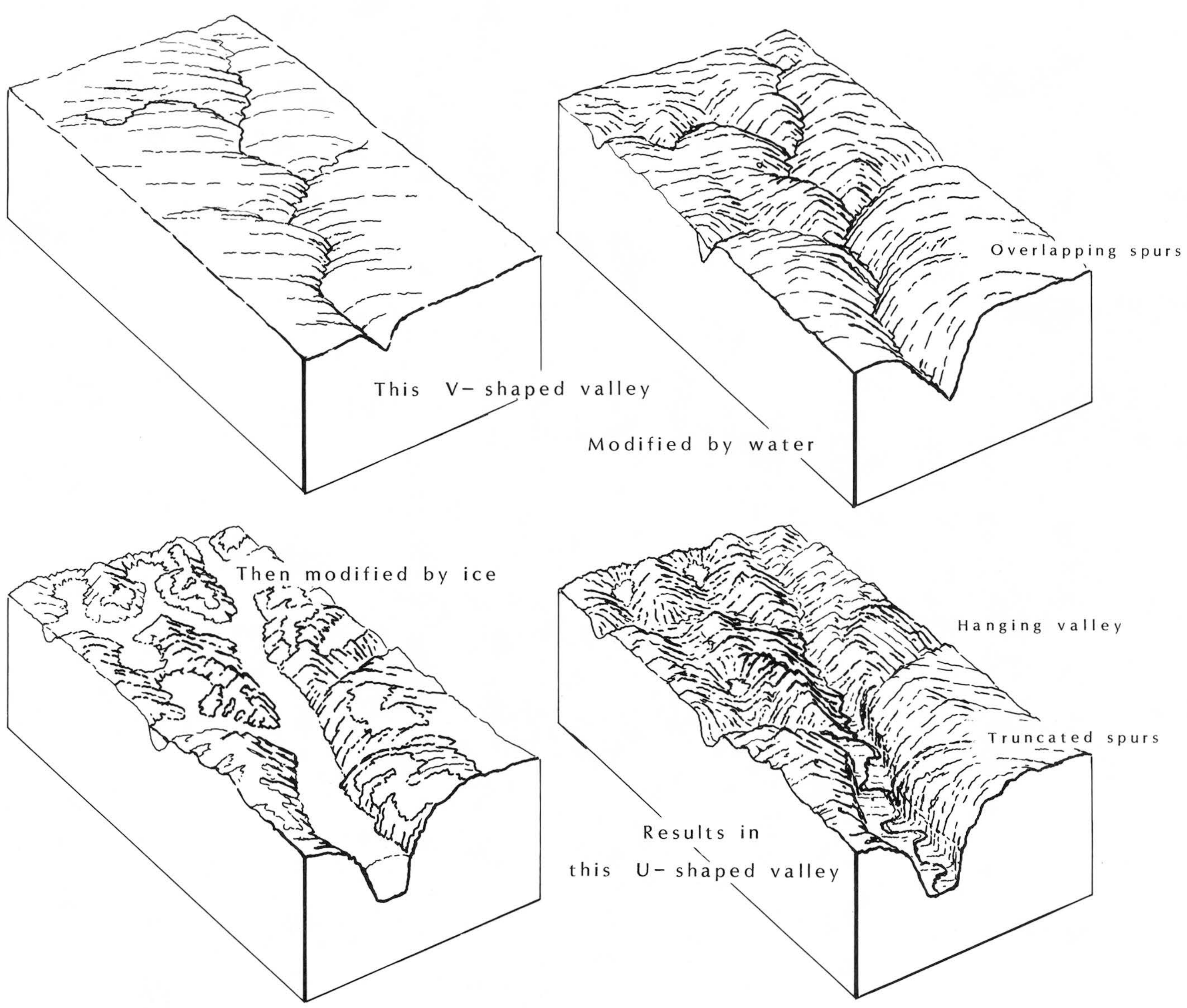
The development of a cirque at the head of a mountain glacier.



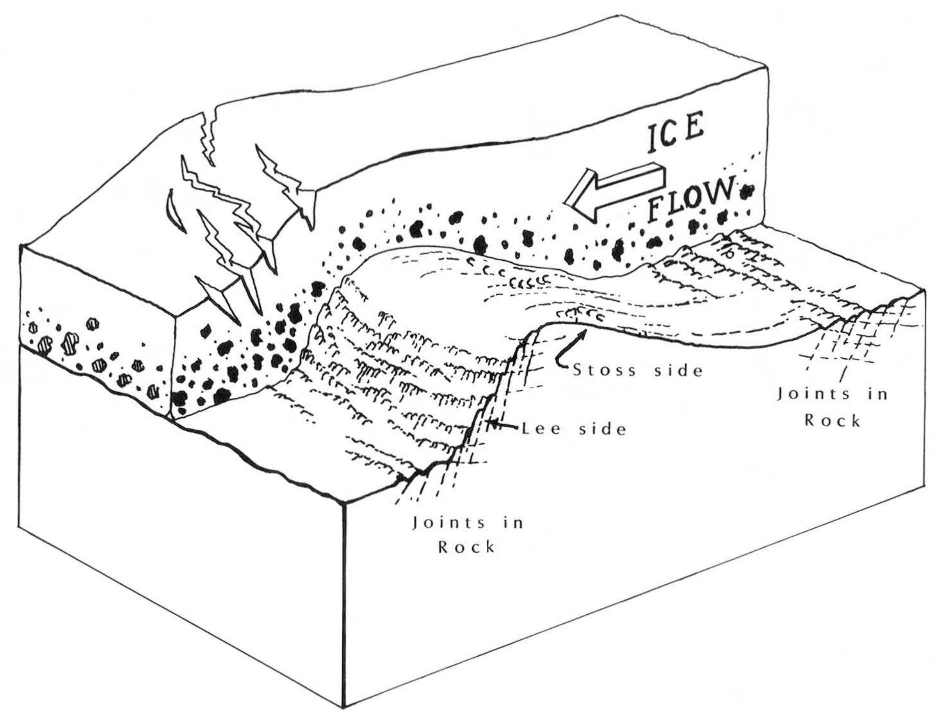
The glacial sculpture of a mountain crest.



A valley glacier showing the relation between the annual accumulation, snowline, and wastage of ice.



A meandering V-shaped valley is changed into a straightened U-shaped valley.



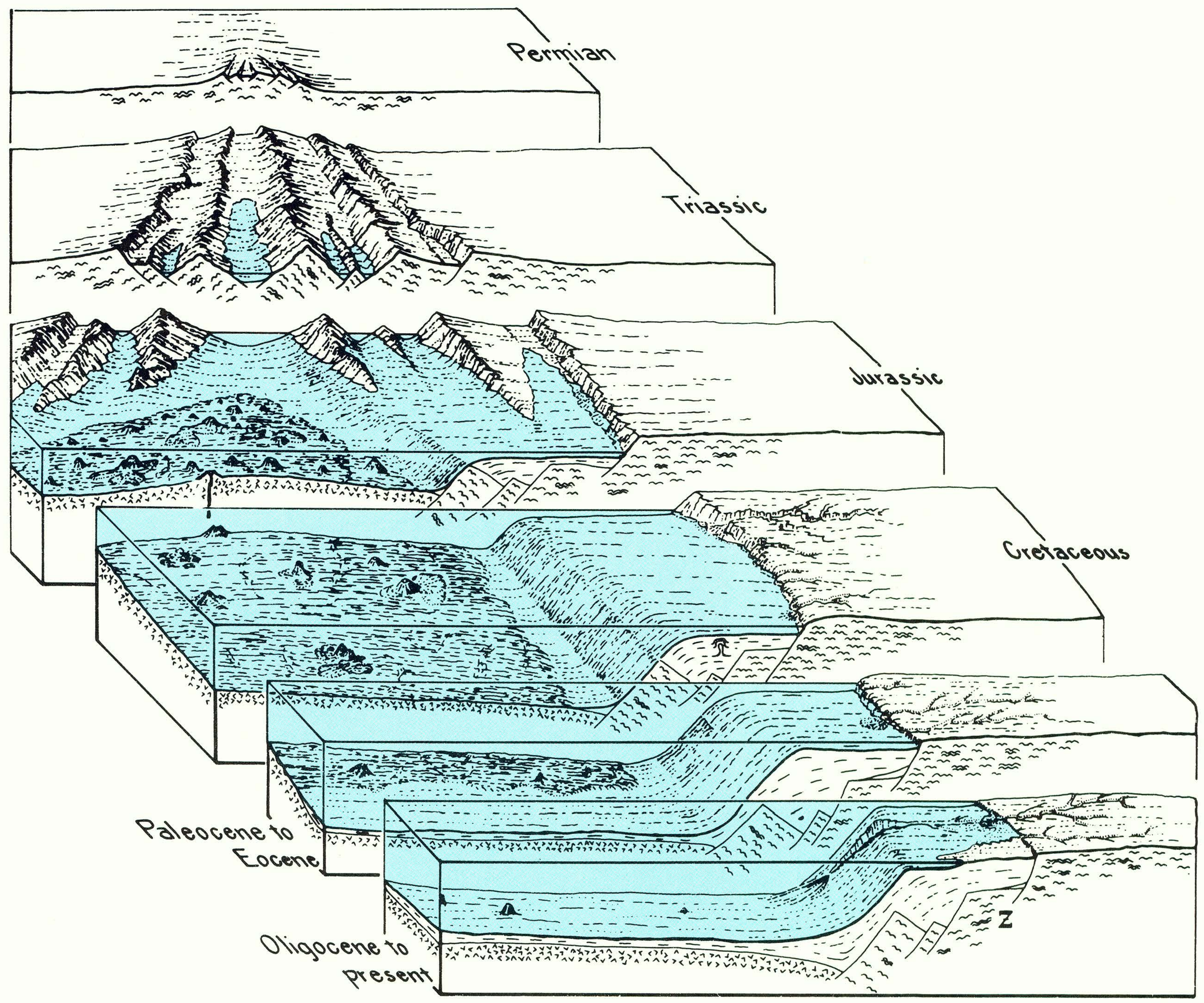
Glacial ice moving over jointed and unjointed rock produces a Roche Montonnée.

GLACIAL EROSION

By

Tau Rho Alpha

1985

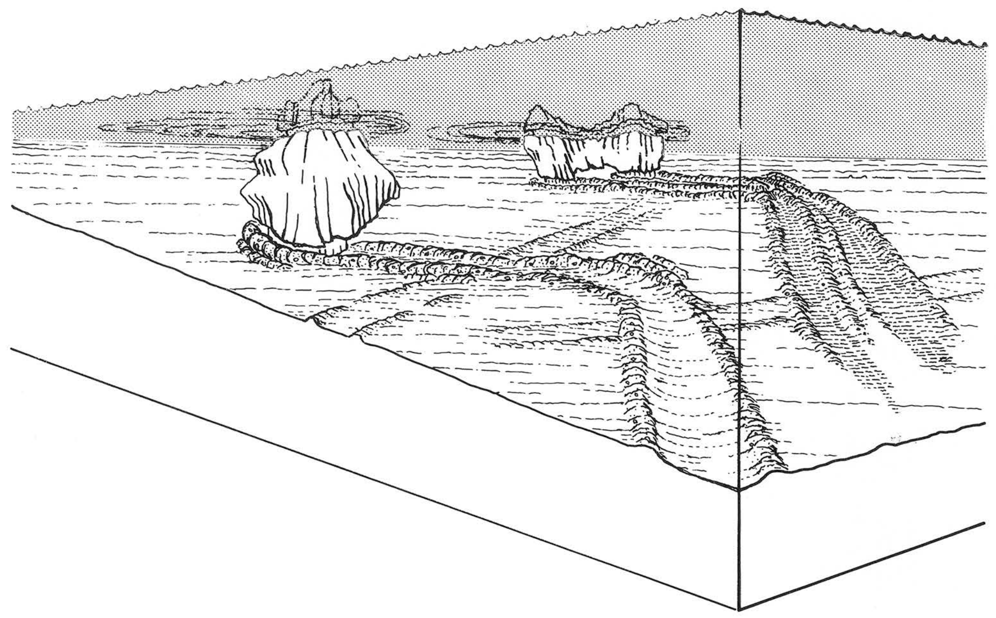


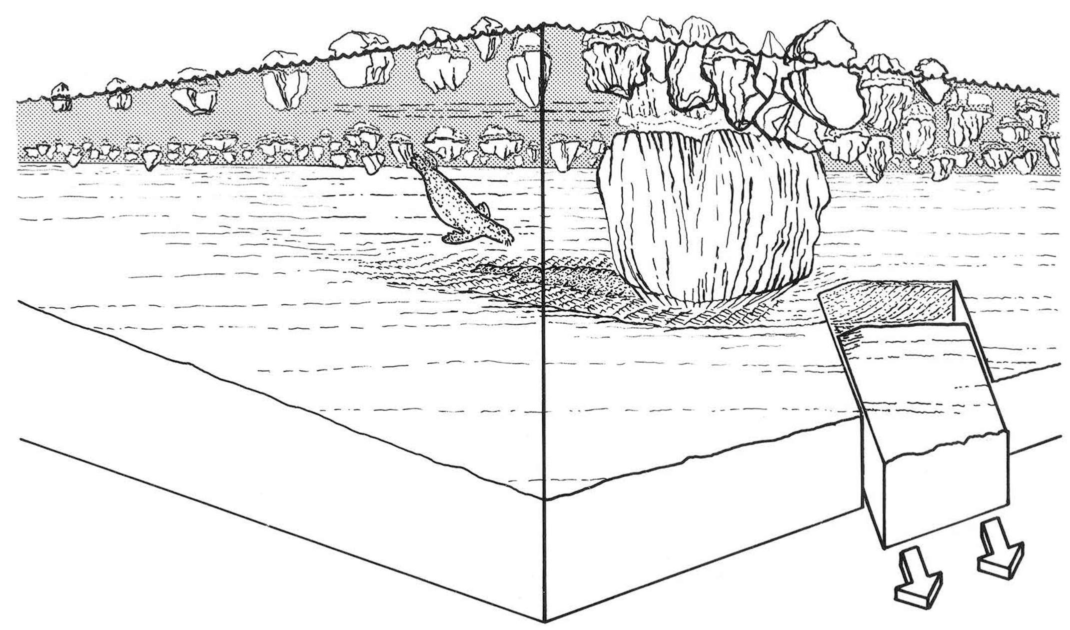
The evolution of the southern Moroccan Continental Shelf is portrayed in a series of angular-perspective oblique maps. This perspective is the control for both the physiographic and the geologic time sequence. The maps, starting at the top, portray (1) the development of the continental shelf in Permian time when the North American and African plates were rifted apart; (2) the formation of new oceanic crust starting in the Early Jurassic; and (3) the subsidence of the continental-margin basement blocks while sediment was deposited over them from the Jurassic to the present (Dillon, 1974, p. 135–137). This map has been published in Dillon (1974, p. 136).

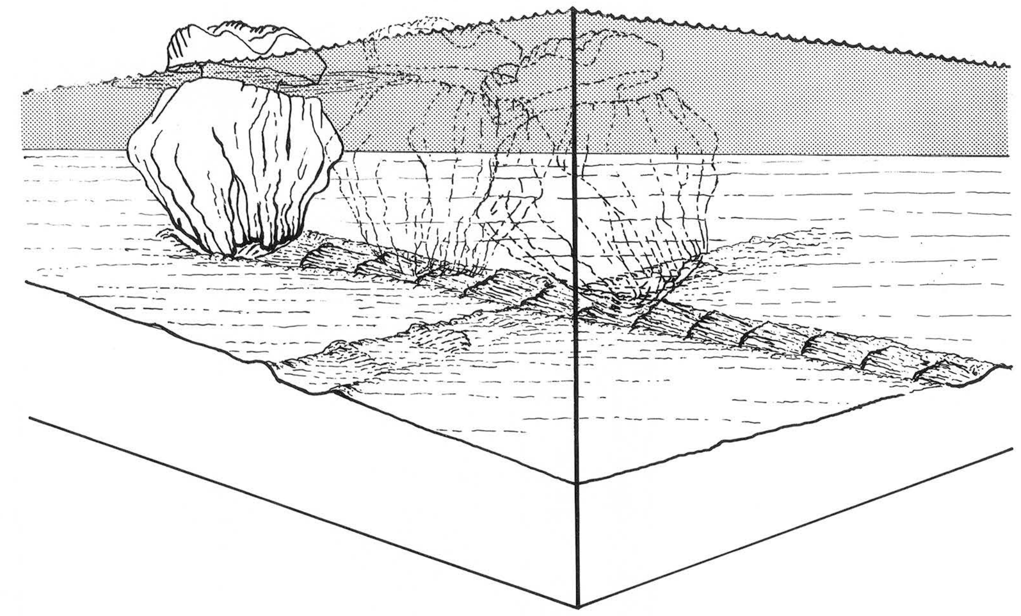
DEVELOPMENT OF THE SOUTHERN MOROCCAN CONTINENTAL SHELF

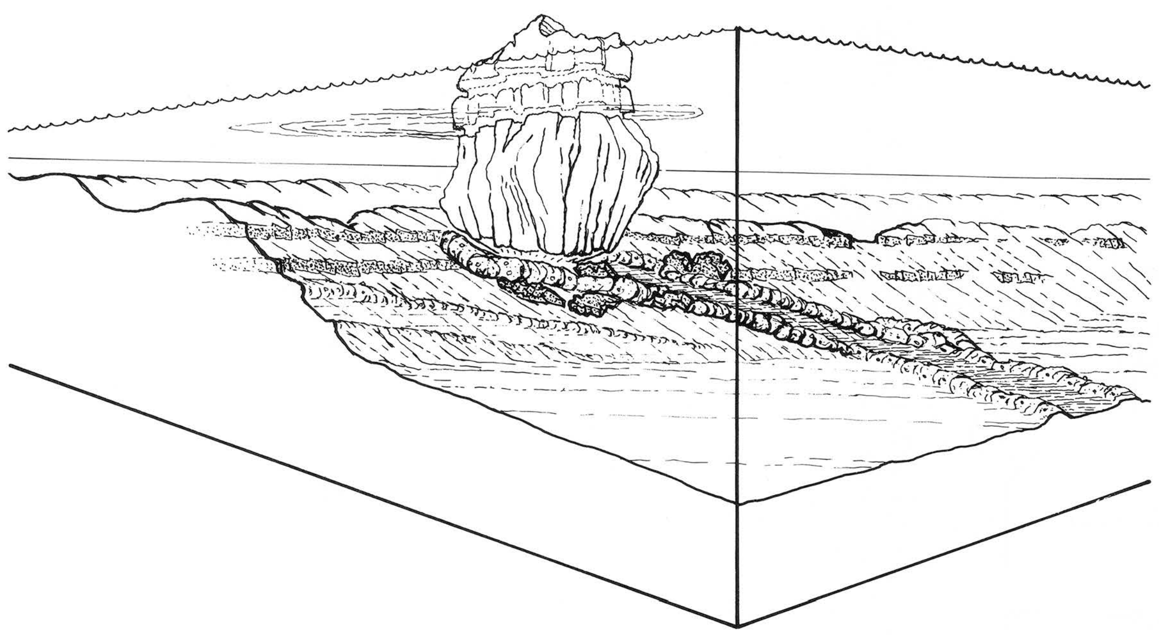
By
Tau Rho Alpha

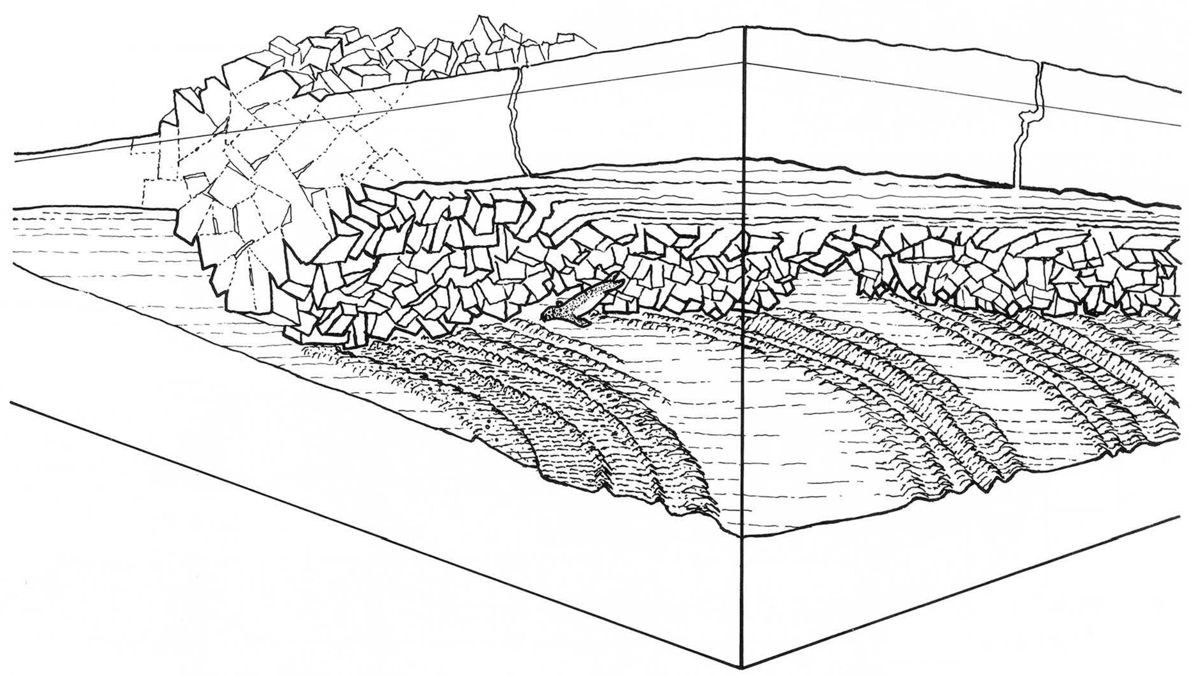
1974

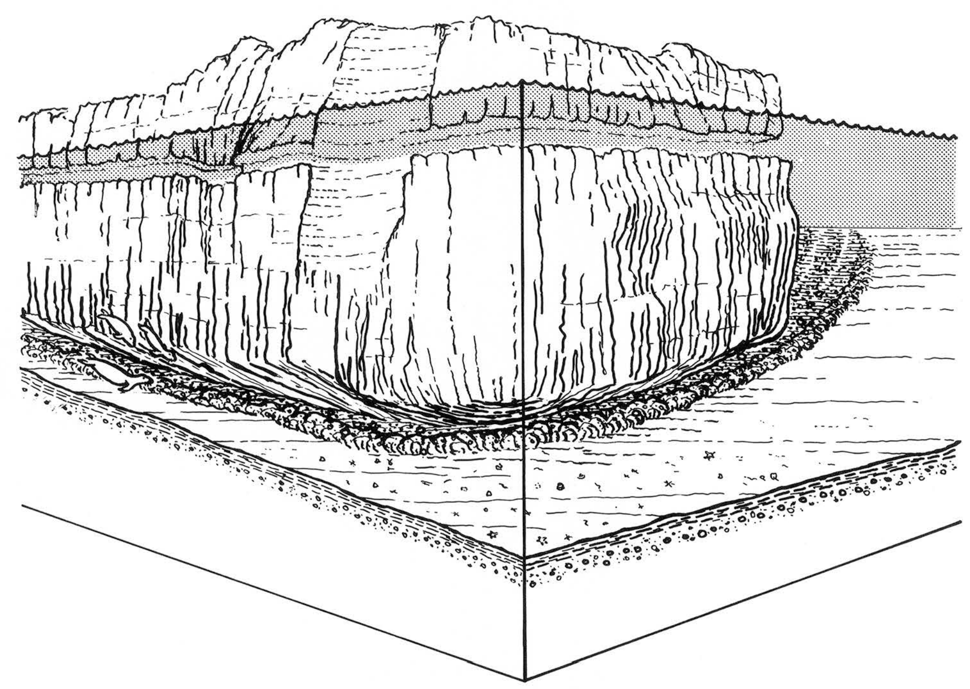


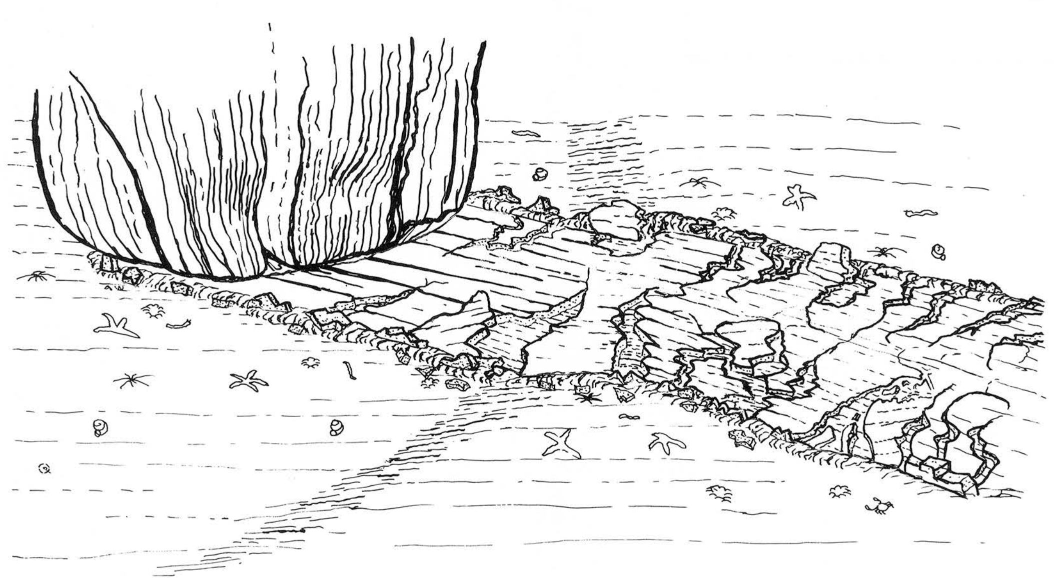












A series of cognitive drawings show the microrelief produced by ice keels under pressure ridges, floebergs, or floes that scrape the ocean floor. The linear features are called ice gouges and are formed in high latitudes in shallow seas. Individual ice gouges may change shape and direction due to the rotation of the floes. Floebergs or floes can wobble, creating regularly spaced bottom topographic features. Flat-bottom floebergs create flat bottom gouges. Multi-prong ice keels rake the ocean bottom, creating parallel gouges (Reimnitz and others, 1973). This map has been published in Reimnitz and others (1973); part of the map was published in Reimnitz and Barnes (1974a, p. 20, 22, 23, and 38); National Research Council (1979, p. 40).

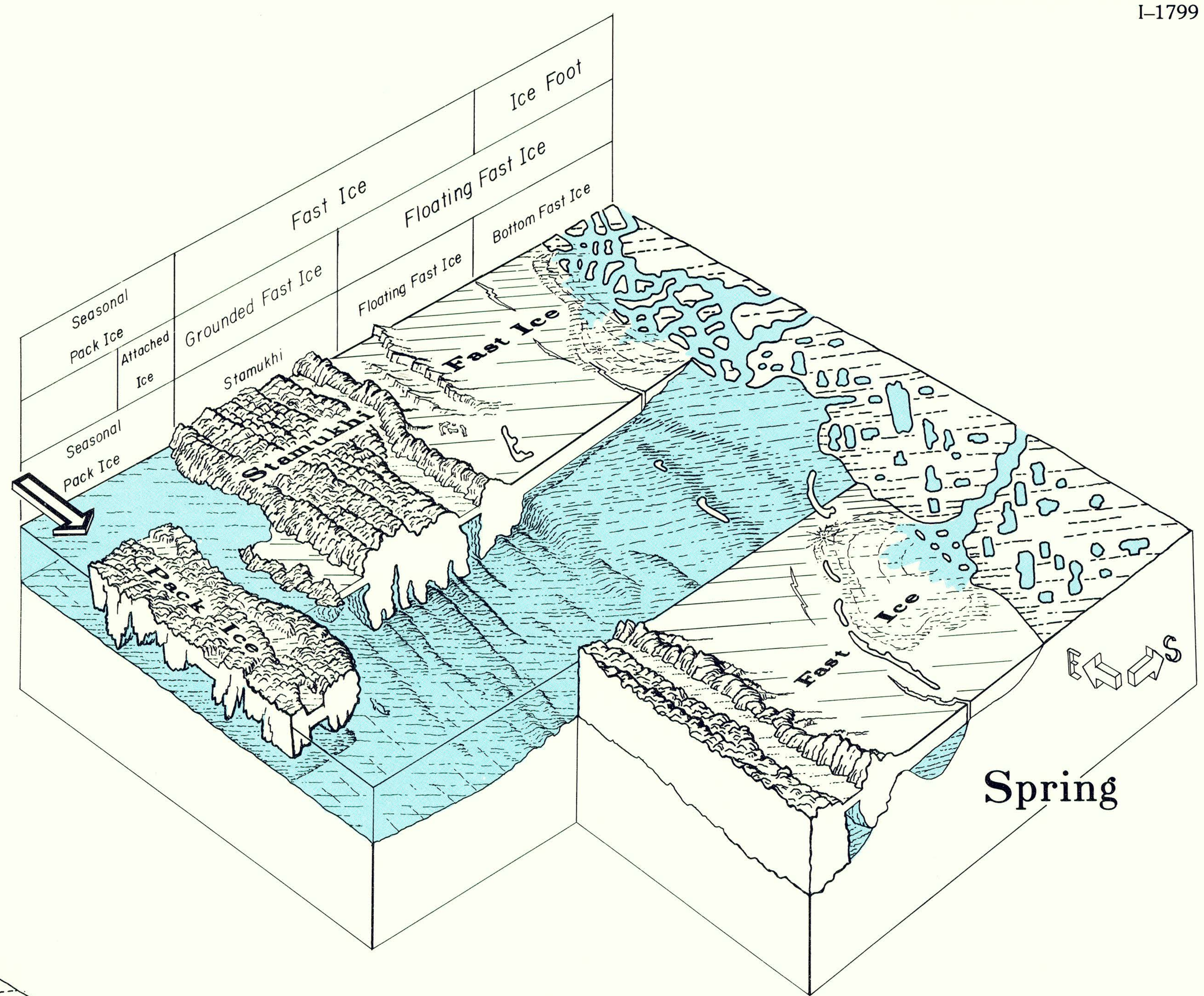
SEA ICE AND SUBMARINE TOPOGRAPHY

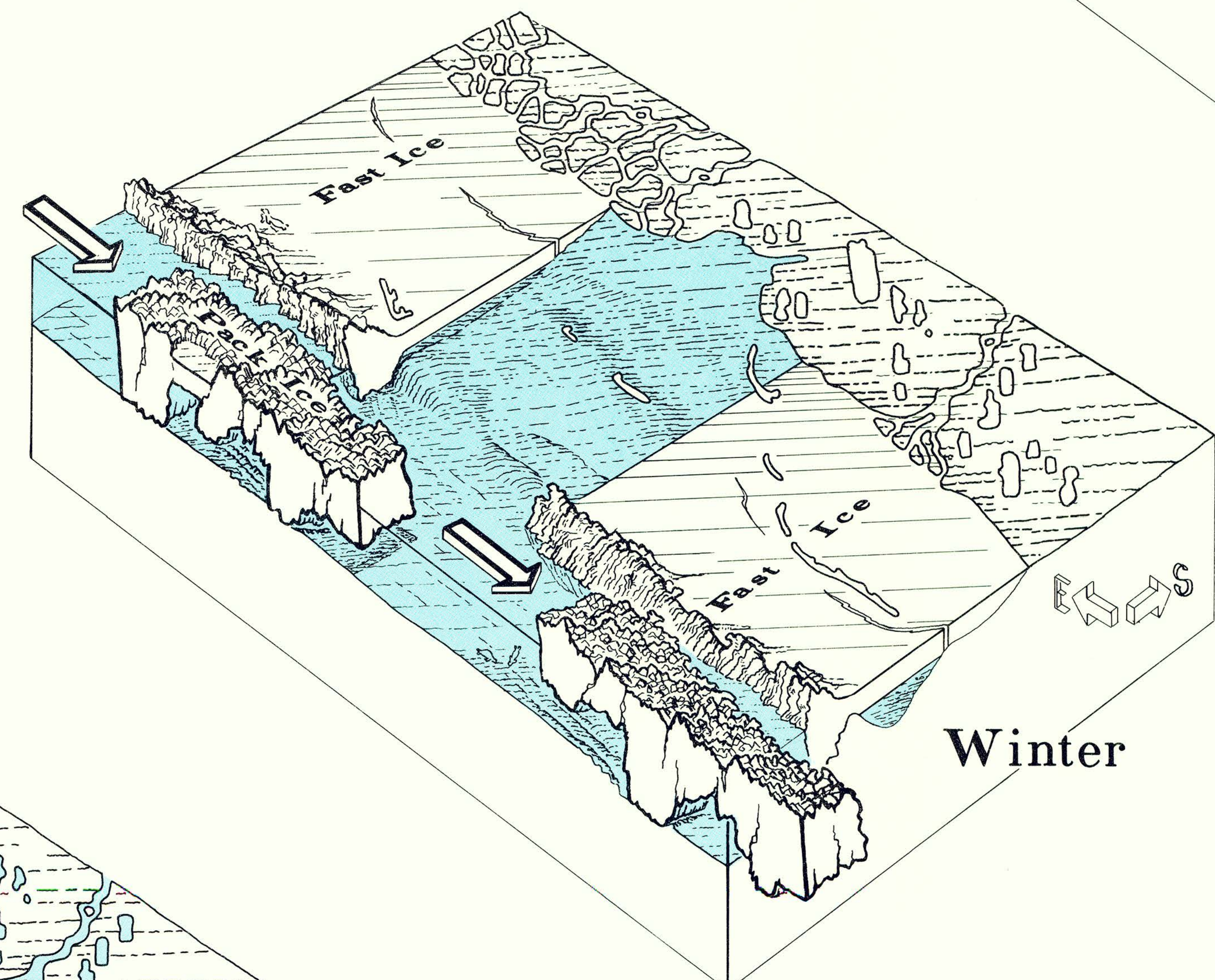
By

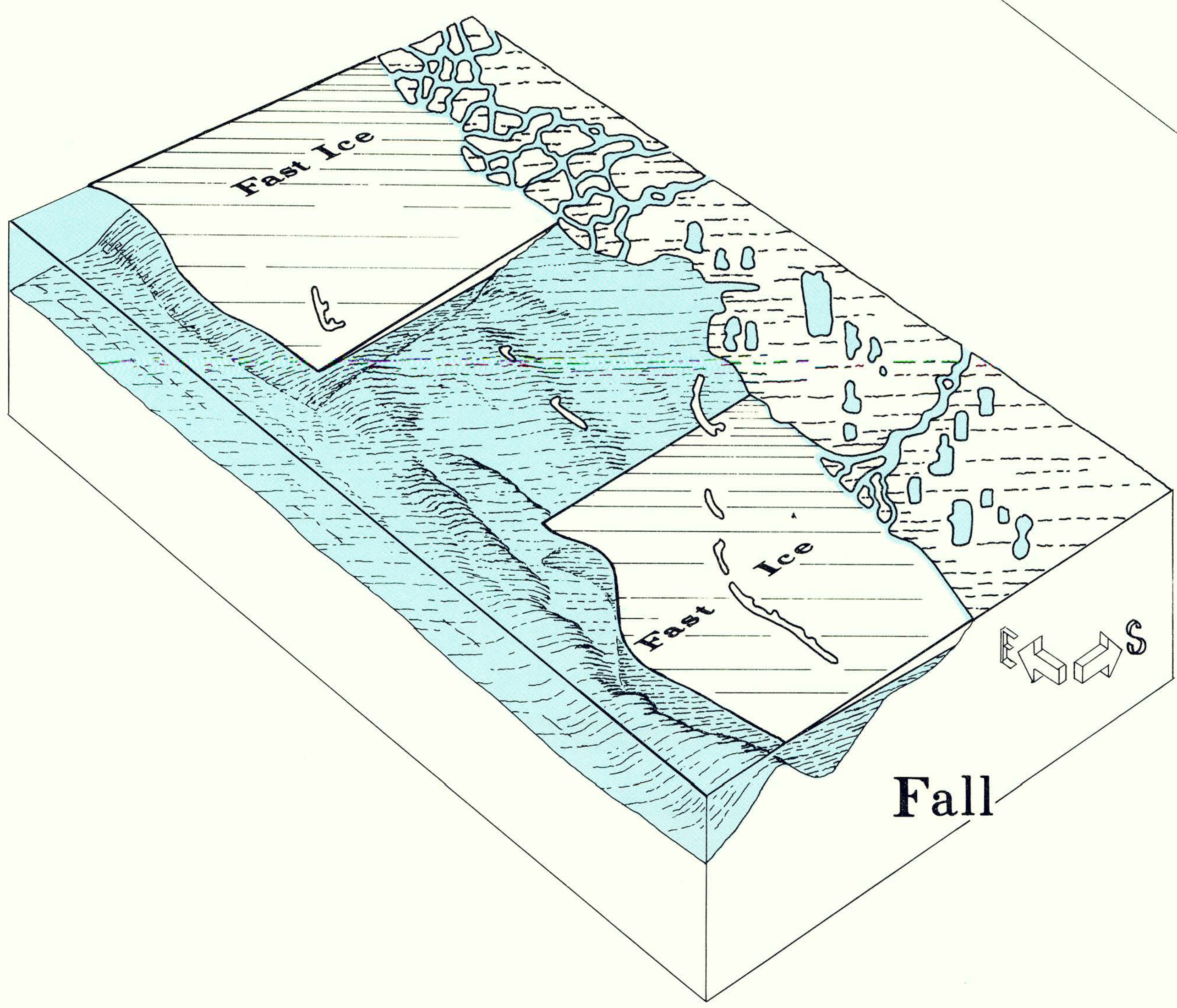
Erk Reimnitz, P.W. Barnes, and Tau Rho Alpha

1973

The direction of view is toward the southeast in these congnitive drawings of an imagined area on the coast of the Beaufort Sea. During the fall, fast ice (ice that is attached to the coast) grows seaward from the coast until it interacts with the polar pack ice along barrier islands and submarine shoals. The resulting belt of grounded pressure ridges (stamukhi zone) along the islands and shoals protect and stabilize the fast ice from the western-drifting polar pack ice during the winter and spring. This protection from the drifting polar pack ice is applicable to planned offshore development, such as docks and offshore drilling equipment (Reimnitz and others, 1978a, p. 185–189). This map has been published in Reimnitz and others (1978a, p. 186–187; 1978b, p. 983); Stringer (1978, p. 22).



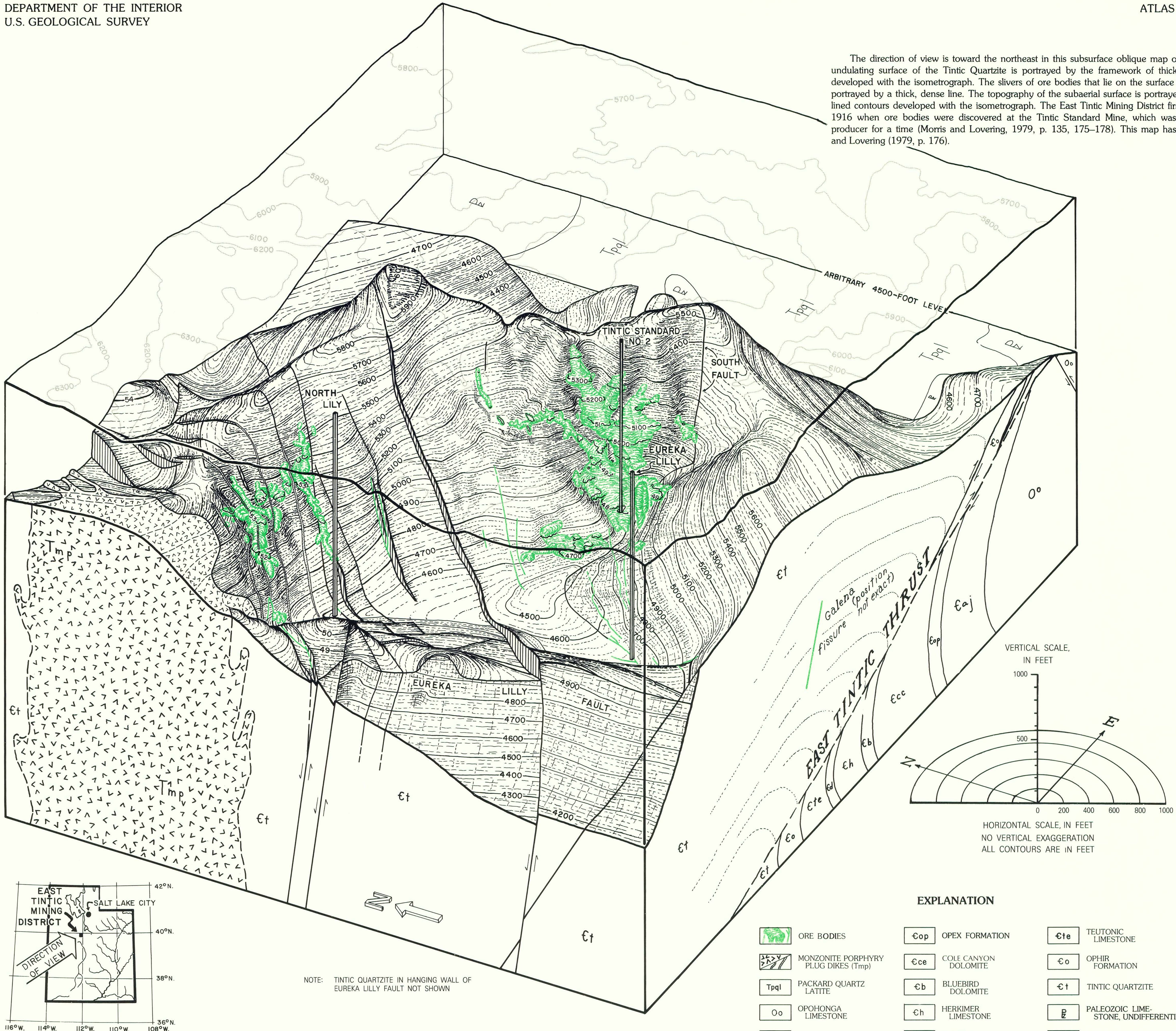




SEA-ICE ZONATION IN RELATION TO BOTTOM MORPHOLOGY, BEAUFORT SEA, ALASKA

By
Erk Reimnitz, Larry Toimil, and Tau Rho Alpha
1978

The direction of view is toward the northeast in this subsurface oblique map of the Tintic Quartzite. The undulating surface of the Tintic Quartzite is portrayed by the framework of thick-lined contours that were developed with the isometrograph. The slivers of ore bodies that lie on the surface of the Tintic Quartzite are portrayed by a thick, dense line. The topography of the subaerial surface is portrayed by a framework of thin-lined contours developed with the isometrograph. The East Tintic Mining District first achieved prominence in 1916 when ore bodies were discovered at the Tintic Standard Mine, which was the world's richest silver producer for a time (Morris and Lovering, 1979, p. 135, 175–178). This map has been published in Morris and Lovering (1979, p. 176).



INDEX MAP OF UTAH

EXPLANATION

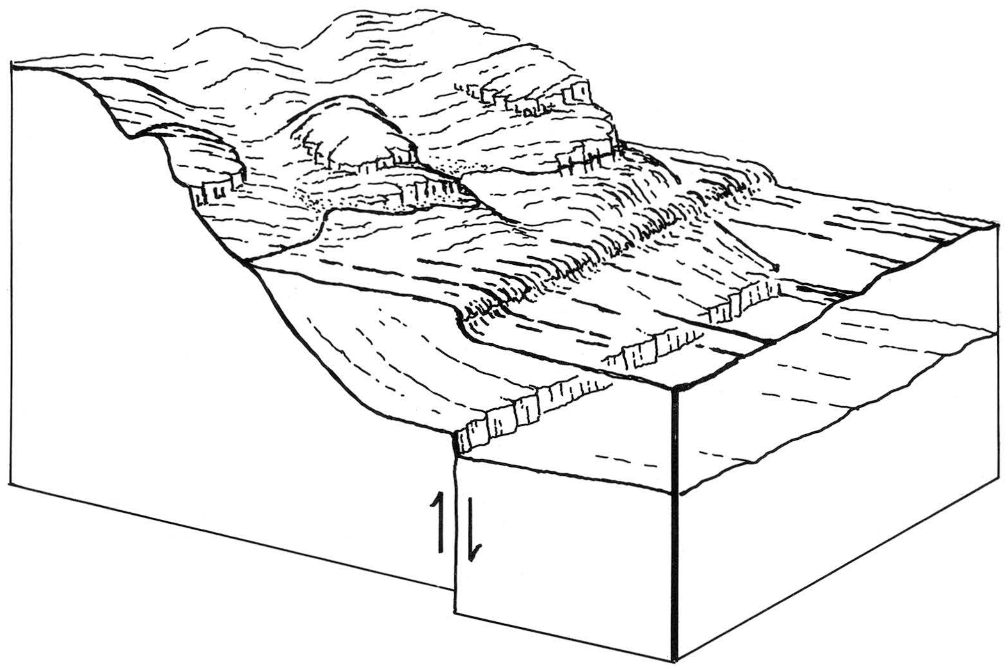
	ORE BODIES
	MONZONITE PORPHYRY PLUG DIKES (Tmp)
Tpql	PACKARD QUARTZ LATITE
Oo	OPOHONGA LIMESTONE
€aj	AJAX DOLOMITE
5200	TINTIC-QUARTZITE SURFACE CONTOURS
€op	OPEX FORMATION
€ce	COLE CANYON DOLOMITE
€b	BLUEBIRD DOLOMITE
€h	HERKIMER LIMESTONE
€d	DAGMAR DOLOMITE
5900	LAND-SURFACE CONTOURS
€te	TEUTONIC LIMESTONE
€o	OPHIR FORMATION
€t	TINTIC QUARTZITE
Pz	PALEOZOIC LIMESTONE, UNDIFFERENTIATED
	FAULT
	FAULT—Dashed where approximately located. Arrows indicate relative direction of movement

RELATION OF ORE BODIES TO SURFACE OF TINTIC QUARTZITE, EAST TINTIC DISTRICT, UTAH

By

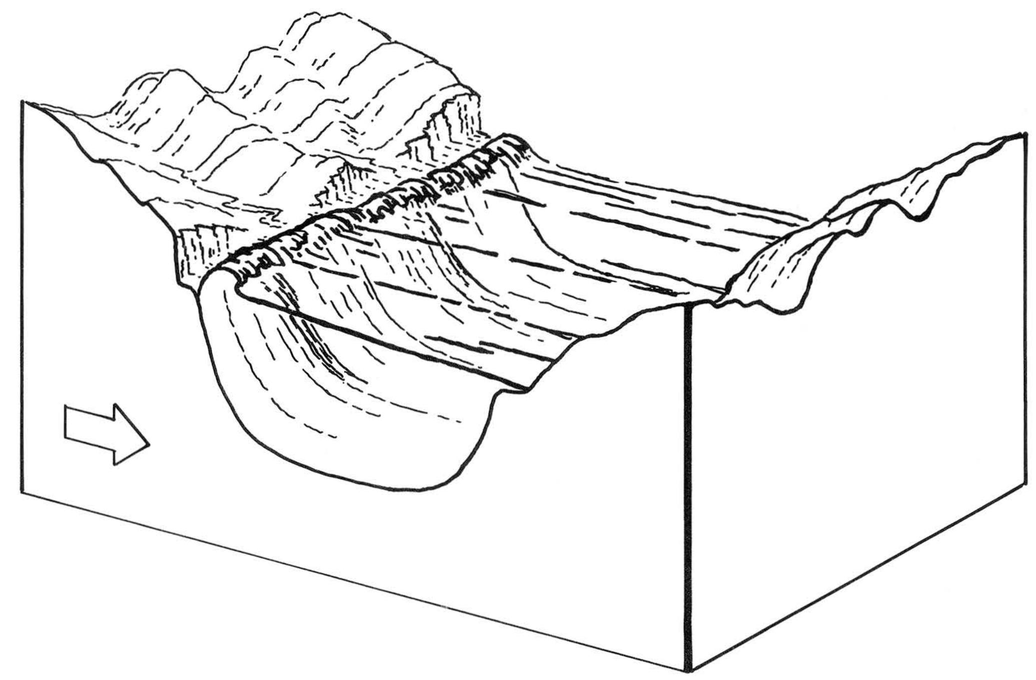
Tau Rho Alpha

An impulsive wave is a sudden motion of water of short duration that is caused by earth movement. Such movement commonly occurs during, or is triggered by, an earthquake. Three of the oblique maps show how different fault mechanisms can produce impulsive waves. Arrows indicated the relative direction of movement along the fault. A fourth map shows how such waves can be caused by ground motion during an earthquake in an enclosed body of water without ground failure. Other oblique maps demonstrate the generation of impulsive waves by different kinds of ground failures and mass movement, such as slumps, gravity flows, glides, and rock falls, which can be initiated either above or underneath the surface of the water. This map has been published in Alpha and Greene (1982).



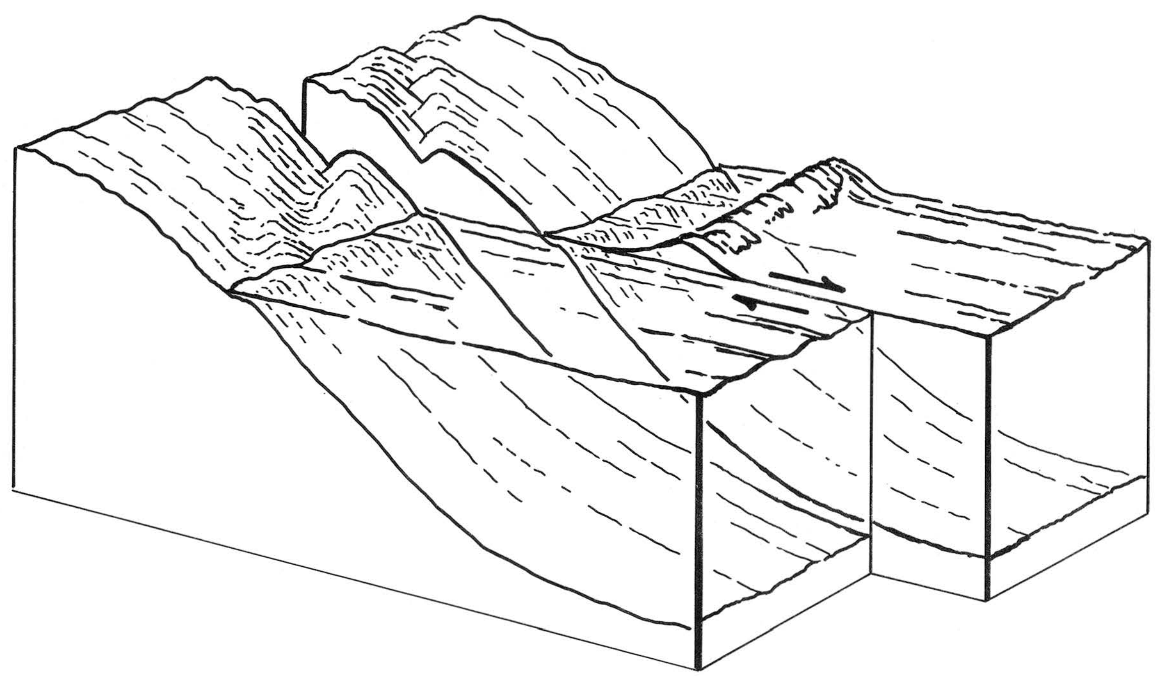
FAULT MOVEMENT

Normal faulting. A wave created by a rapid near-vertical offset along a normal fault.



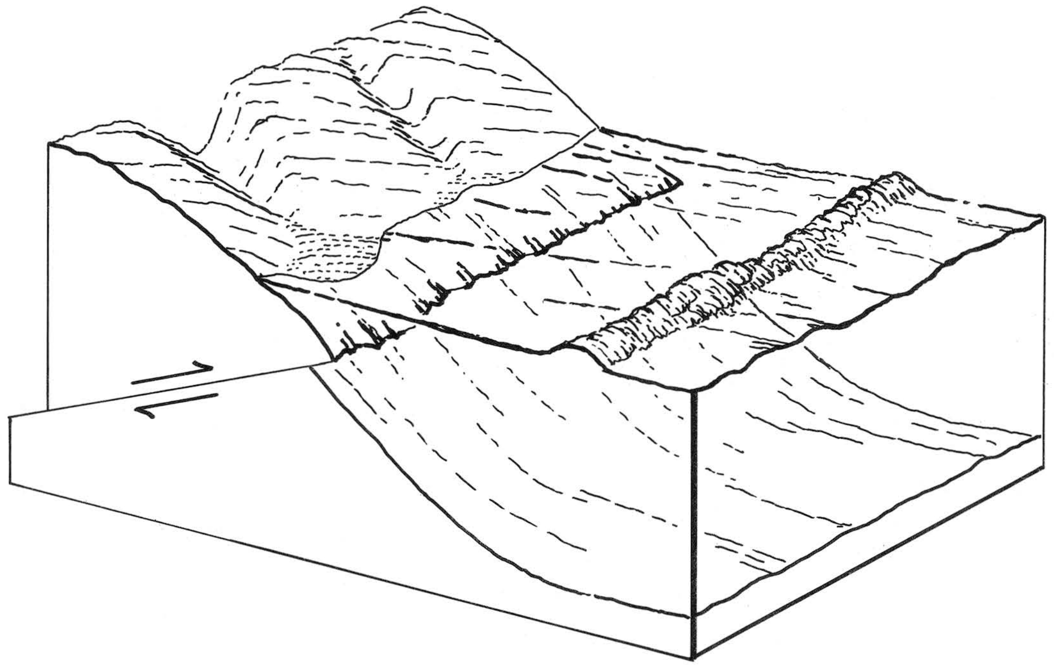
EARTHQUAKE MOTION

A wave caused by lateral movement during an earthquake.



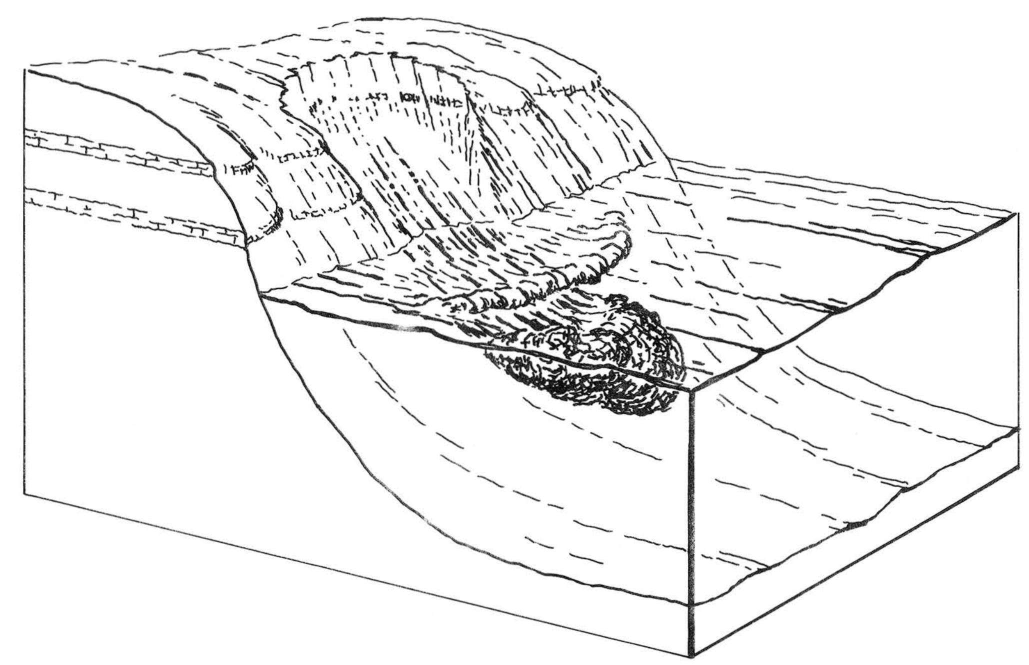
FAULT MOVEMENT

Transcurrent faulting. A wave generated by a rapid offset along a strike-slip fault.



FAULT MOVEMENT

Thrusting. A wave produced by a rapid near-horizontal offset along a thrust fault.



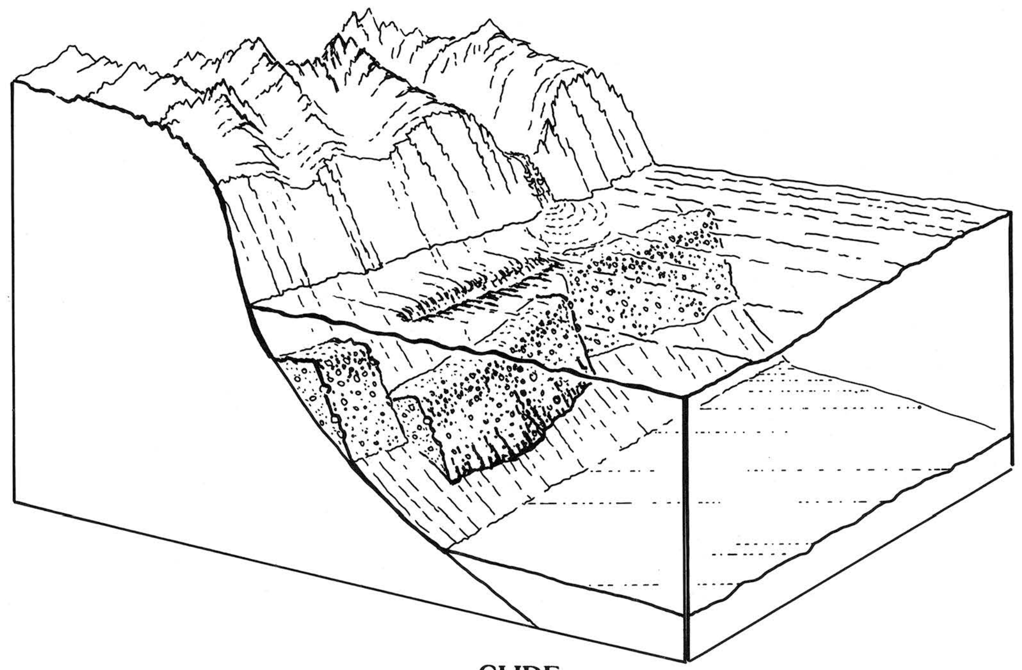
GLIDE

Subaerial detachment. Wave produced by a glide that begins above water level and enters the sea.

SELECTED TYPES OF IMPULSIVE WAVE GENERATION

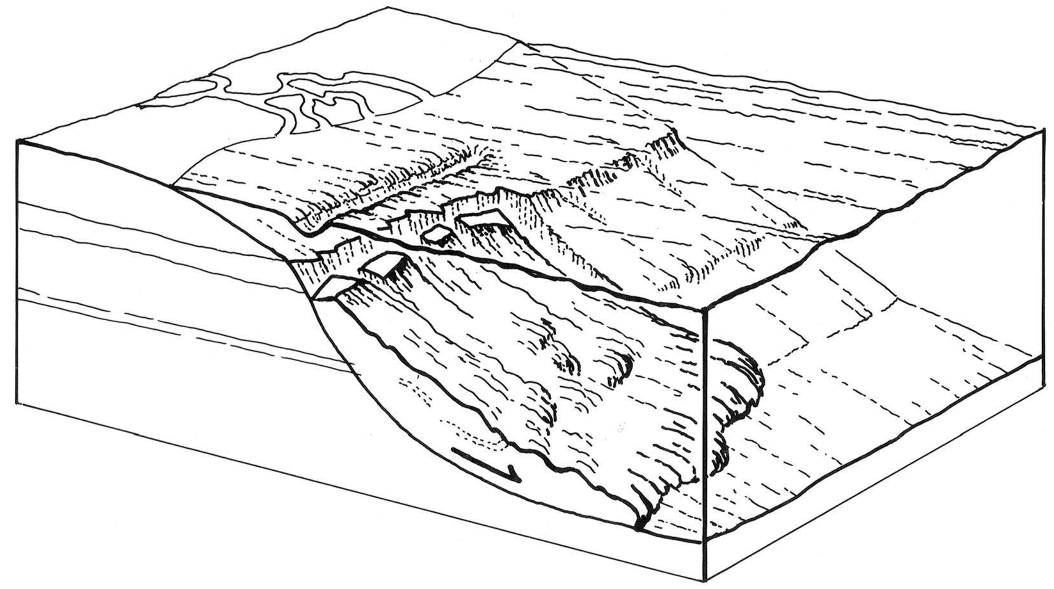
By
Tau Rho Alpha and H. Gary Greene
1982

Maps continued on following page



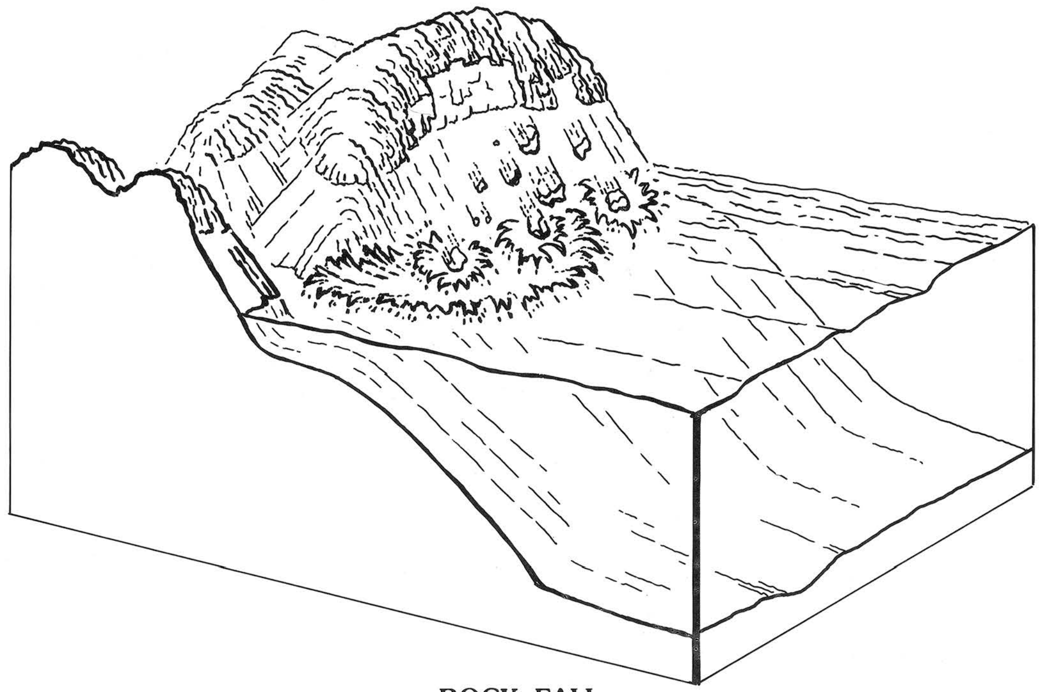
GLIDE

Submarine detachment. Wave produced by glide that begins below water level.



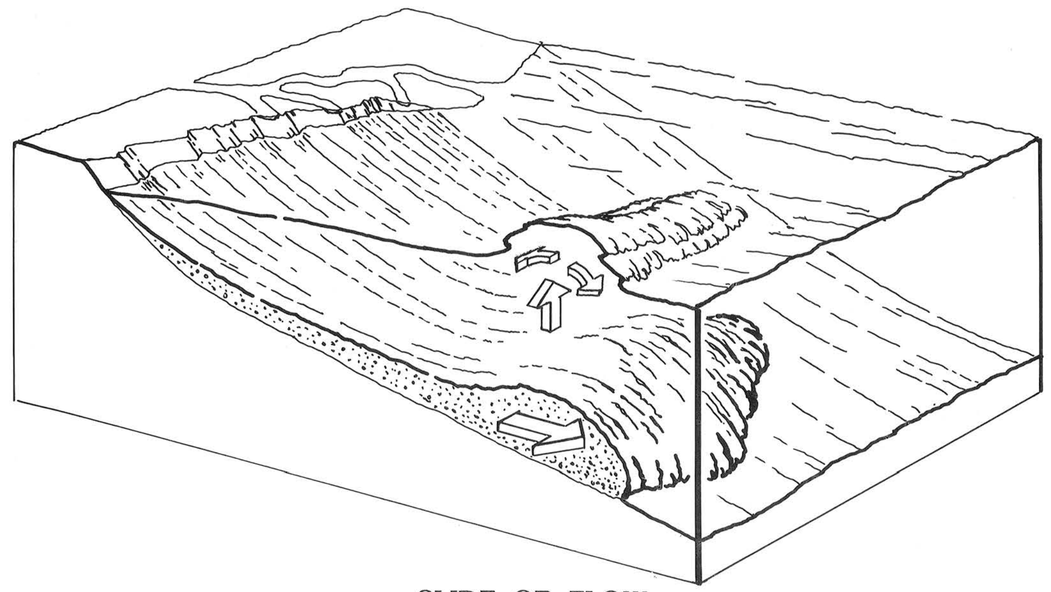
SLUMP

Rotational slumping. Wave produced by a slump that begins below water level.



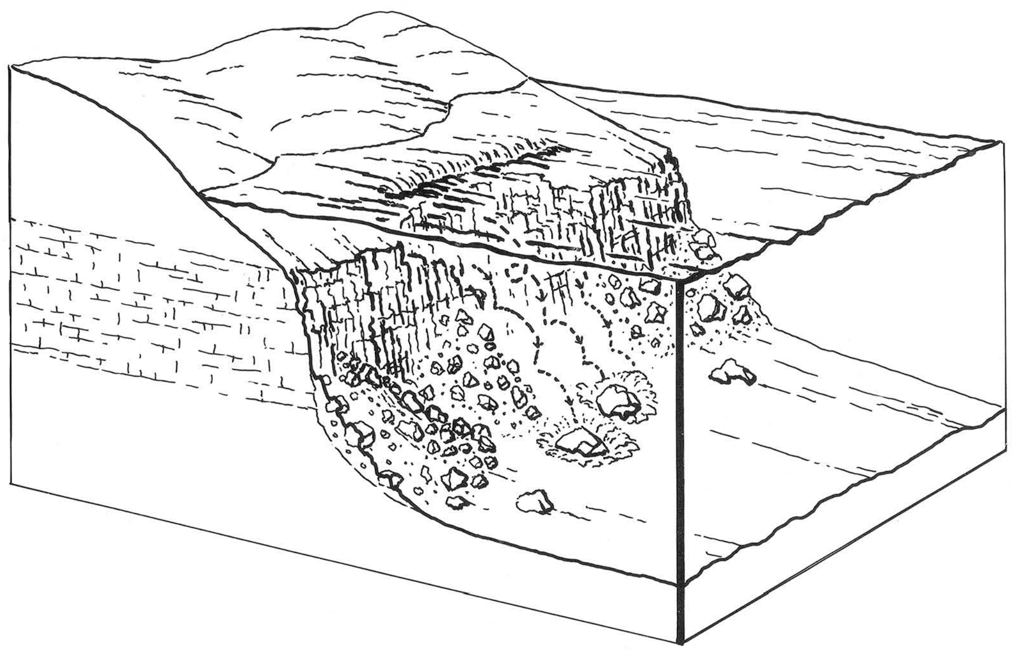
ROCK FALL

Subaerial. Disaggregated rock falling into the sea creates waves.



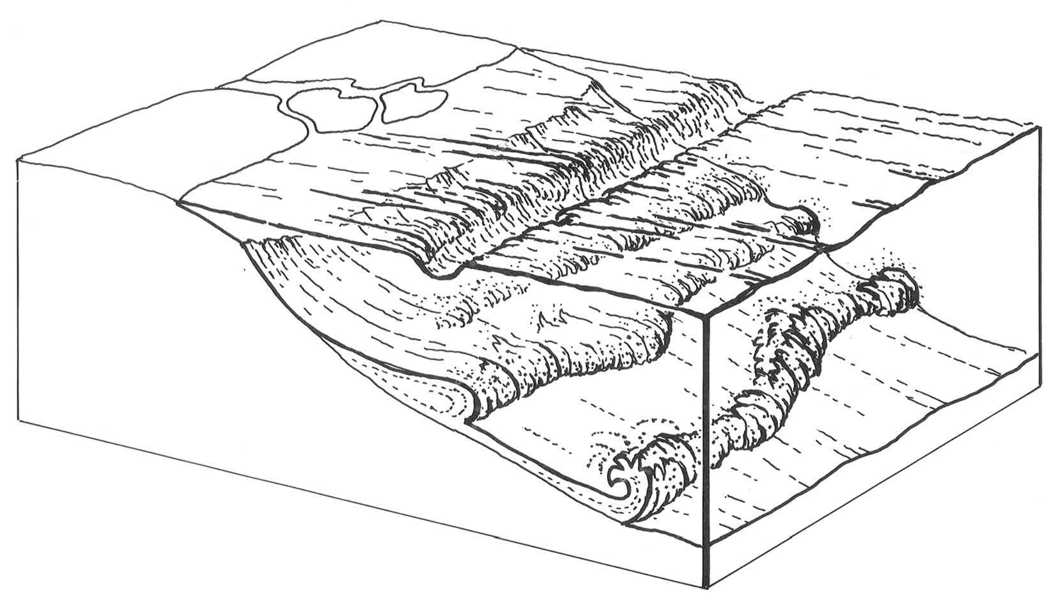
SLIDE OR FLOW

Mass movement. Wave produced by a slide that has subaerial and submarine detachment.



ROCK FALL

Submarine. Disaggregated rock falling through the water may create waves at water surface. This type of wave has not been observed.



SEDIMENT GRAVITY FLOW

Submarine Formation of a turbidity-current debris flow causes a dragging down of the water surface.

SELECTED TYPES OF IMPULSIVE WAVE GENERATION—Continued

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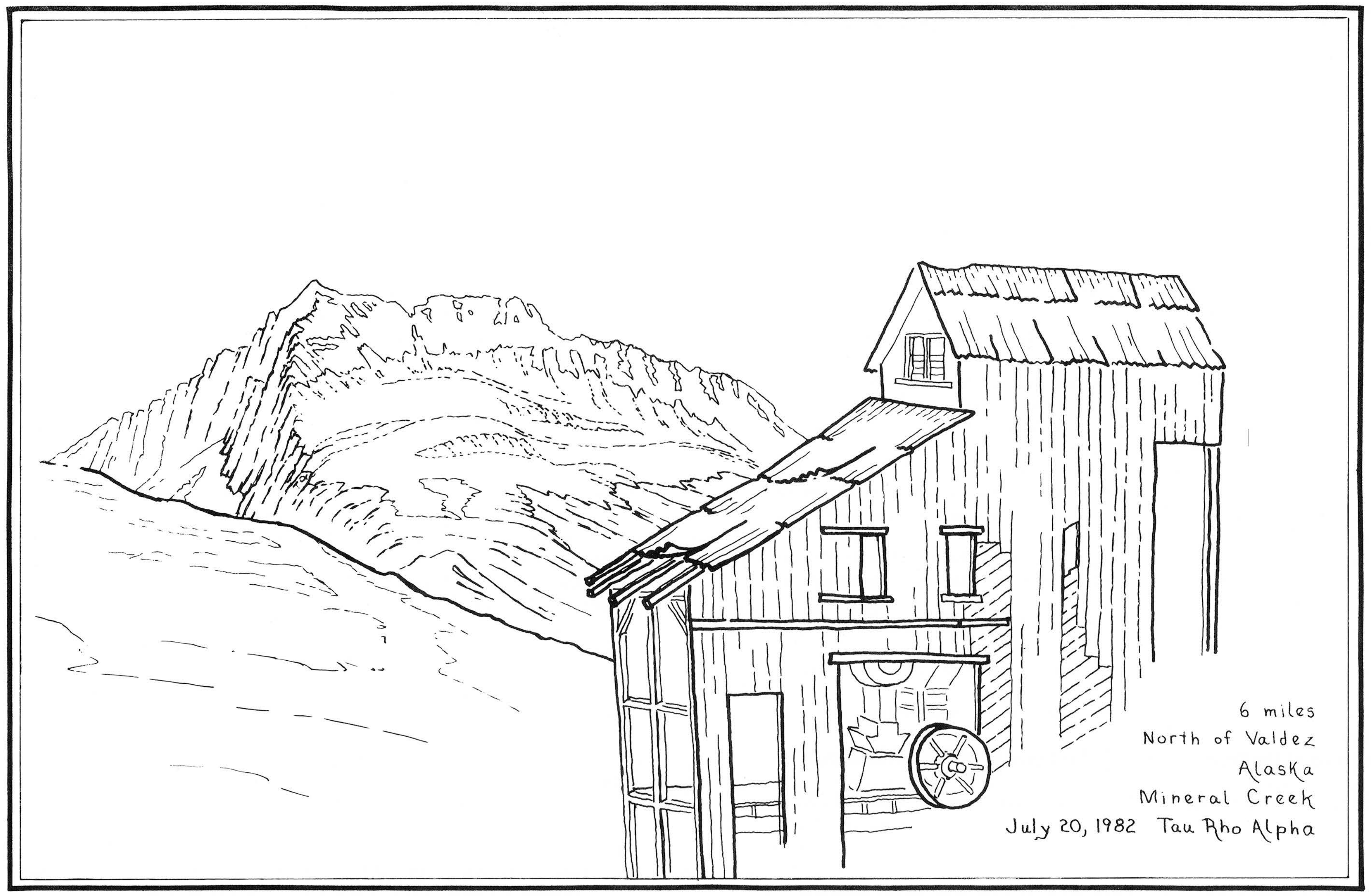

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