



Digital Coordinates and Age for 3,869 Foraminifer Samples Collected by Chevron Petroleum Geologists in Washington and Oregon

**By William B. West, Earl E. Brabb, William T. Malmborg,
and John M. Parker**

Open-File Report 2009-1185

U.S. Department of the Interior
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U.S. Geological Survey, Reston, Virginia 2009

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Suggested citation: West, W.B., Brabb, E.E., Malmborg, W.T., and Parker, J.M.,
2009, Digital coordinates and age for 3,869 foraminifer samples collected by
Chevron Petroleum geologists in Washington and Oregon: U.S. Geological
Survey Open File Report 2009-1185, 7 p., 2 databases
[<http://pubs.usgs.gov/of/2009/1185/>].

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Introduction

The general location and age of more than 33,500 mostly foraminifer samples from Chevron Petroleum Company surface localities in California were provided by Brabb and Parker (2003, 2005). Malmborg and others (2008) provided digital latitude, longitude, and age for more than 13,000 of these samples. We provide here for the first time the digital latitude, longitude, and age for nearly 4,000 Chevron surface and auger samples in Washington and Oregon.

Preparation of the Database

General Procedures

Chevron locality and geologic maps and paleontologic reports for Washington and Oregon were organized by U.S. Geological Survey 30 x 60 topographic quadrangles and used to make an Excel spreadsheet. Because the TopoZone.com program used to determine the digital latitude and longitude in California is no longer available, the coordinates for Washington and Oregon were obtained from Terraserver.com/view.asp, copyright by Microsoft in 2005 and sponsored by the U.S. Geological Survey. The map location of each sample is compared with an on-screen image of a topographic map to determine the latitude and longitude. Localities with age-diagnostic faunas are located in 198 7.5' quadrangles in Oregon and 120 in Washington.

Maps originally used to plot samples

Most of the topographic maps used by Chevron geologists are obsolete U.S. Geological Survey (USGS) 1:62,500-scale topographic maps prepared from aerial photographs taken in the 1930s and 1940s. Some are USGS maps at 1:250,000-scale. Other localities were plotted on maps prepared by Chevron with no topographic base. Therefore, considerable care and judgment were required to transfer localities accurately from the original maps to the modern maps in Terraserver, and some imprecision was undoubtedly introduced. Localities plotted only on 1:250,000 maps were particularly

difficult to find on the 1:24,000 images in the computer program. The originals of all the Chevron maps are in the USGS Library in Menlo Park if any location is in doubt.

All localities in the database are referred to standard USGS 1:24,000-scale and 1:100,000-scale maps for convenience.

Map Accuracy

No tests were conducted to determine the amount of error in latitude and longitude from using obsolete maps, but four decimal places in the figures (36 feet ground distance) implies precision that is not warranted for most localities. Our impression is that the figures are reasonably good for localities along roads and waterways, perhaps less than 200 feet ground distance, but may be in error by as much as a few thousand feet if an outcrop is on terrain with no cultural features or nearly flat topography.

More than 1,100 of the 3,869 samples in Washington and Oregon were collected from auger holes through alluvium into the bedrock. Most of the holes were probably less than 50 feet deep. Samples from auger holes versus surface outcrops are distinguished in the databases.

Locality Numbering System

Before the late 1950s, Chevron geologists used lot numbers expressed by Roman numerals for several or many localities in the same area. The individual collecting points in a lot were given Arabic numerals. Many of the localities along a continuously exposed section are shown with a line on the topographic map indicating the general location of this section. The line may show the beginning and last sample number, every sample number along the line, or no sample numbers. If every sample number is shown, and the samples are all the same age, only selected samples are shown in the database. If no sample numbers are shown, neither the lot number nor the sample number is shown in the database.

Arabic numerals were used concurrently by Chevron to identify more widely dispersed localities and eventually for lot number. The highest locality number for Oregon fossils is 28806 (no commas in Chevron locality numbers) for a sample collected in 1972. The highest locality number for Washington fossils is 21478 for a sample collected in 1964. Many of the Arabic numbers were used for rock samples or other purposes and the total number of localities with fossils probably did not exceed 10,000. Moreover, many of the localities for fossils were not examined in sequence, so that adjacent lot or individual numbers could have been examined several years apart. The significance of this information is that the rapid development and change in knowledge about the age of faunas resulted in different concepts about ages from one lot or individual locality to the next.

Sources For Ages Provided

The zonation of Goudkoff (1945) was used for the few Cretaceous fossils; Laiming (1940), Mallory (1959), and Schenck and Kleinpell (1936) were used for Eocene fossils; and Kleinpell (1938) for the Oligocene and Miocene. Reports by Almgren and others (1988) and Prothero (2001) were used to update some of the terminology. For example,

the Refugian Stage is now generally regarded as late Eocene and the Zemorrian Stage as Oligocene. All the ages are from foraminifers unless stated otherwise. The ages were obtained from reports prepared by Chevron paleontologists, from stratigraphic columns, and from notes on locality and geologic maps, so the quality of the ages may be uneven. Many ages from stratigraphic columns could not be used because the specific locations of even the beginning and ending points of the measurements were not provided.

Many of the fossils collected before 1954 were dated using formation names as time-stratigraphic terms, such as Astoria, Blakeley, Keasey, Skookumchuck, Lincoln, and Cowlitz. Following the principles of Schenck and Muller (1941), we updated these terms to the California foraminiferal stages eventually adopted by Chevron paleontologists working in Washington and Oregon. Rau (1981) and Prothero (2001) have provided much more extensive analyses of the development of Washington and Oregon stratigraphic terminology, but we made no attempt to change the Chevron ages to their standards.

Two papers published after the Chevron microfossils had been collected and examined document much more authoritatively the age of many Tertiary geologic formations in Washington and Oregon. The first, by Bukry (1988), provides coccolith ages ranging from late Paleocene to Oligocene for 10 geologic formations in Oregon. Rau (2004) has a digital list of 3,466 samples with foraminifers in Washington and Oregon. He provides 24 columns of information about the location, collector, rock unit, local foraminiferal zone, Pacific Coast foraminiferal stage, geologic age, paleoecology, name of rock unit, list of species, lithology of the rock containing the foraminifers, and any ties to publications. The density of the age information in the Bukry and Rau reports combined with that from Chevron is probably comparable to that available for California, and may not be matched in any other comparable area of Tertiary rocks in the world.

Summary

An age and digital latitude and longitude are provided for the first time for 3,869 foraminifer samples collected by Chevron geologists from surface and near-surface localities in more than 300 7.5' quadrangles in Washington and Oregon. The new information provided by Chevron will help any new geologic mapping projects and will assist in the evaluation of older geologic maps in areas where paleontologic information has been sparse or missing in the past.

Acknowledgments

We are most grateful to the paleontologists, geologists, and managers with Chevron Petroleum Company who provided the materials for this report. Larry Dickerson (deceased) helped to separate and arrange the slides. Weldon Rau kindly provided reprints of many of his articles so that we could become familiar with at least some of the stratigraphic problems. We did not, however, attempt to compare his ages or anyone else's with Chevron ages for any locality. Russell Graymer, Ray Wells, and Weldon Rau kindly reviewed this report.

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Read Me - Chevron Paleontology Files

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The following digital files list nearly 4,000 Chevron samples with dated foraminifers from surface and auger localities in Washington and Oregon. All of the samples have digital latitude and longitude so that they can be plotted on digital geologic and topographic maps.

Explanation for Chevron Database 1 for Washington

This Excel file provides latitude, longitude, and age for 2,393 Chevron surface and auger localities from 120 U.S. Geological Survey (USGS) 7.5' quadrangle maps in Washington. The file is arranged in alphabetical order by USGS 7.5' quadrangle.

Column A - The USGS 7.5' quadrangle in which the foraminifers were collected.

Column B - The 1:100,000 or 1:250,000-scale USGS quadrangle.

Column C - The locality or lot number

Column D - Sub-lot number or letter.

Column E - Outcrop or auger sample

Column F - Latitude, in decimal degrees North (NAD 27)

Column G - Longitude, in decimal degrees West (NAD 27)

Column H - Series, stage, zone, and/or age of foraminifers at the locality selected.

Explanation for Chevron Database 2 for Oregon

This Excel file provides latitude, longitude, and age for 1,476 Chevron surface and auger localities from 198 U.S. Geological Survey (USGS) 7.5' quadrangle maps in Oregon. The file is arranged alphabetically by USGS 7.5' quadrangle.

Column A - The USGS 7.5' quadrangle in which the foraminifers were collected, arranged alphabetically.

Column B - The 1:100,000-scale USGS quadrangle.

Column C - The locality or lot number

Column D - Sub-lot number or letter.

Column E - Outcrop or auger

Column F - Latitude, in decimal degrees North (NAD 27)

Column G - Longitude, in decimal degrees West (NAD 27)

Column H - Series, stage, zone, and/or age of foraminifers at the locality selected.