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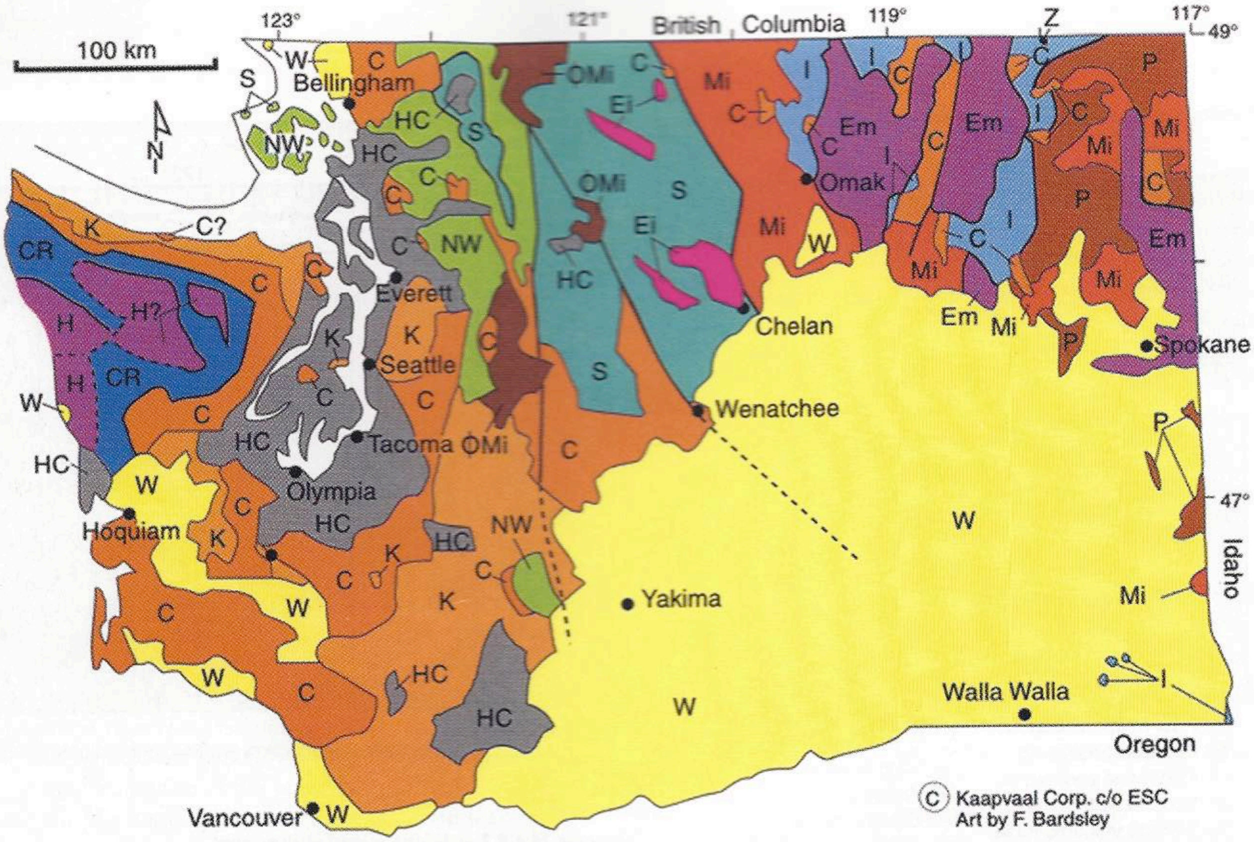
Astronaut Susan Helms

Portland's Pride

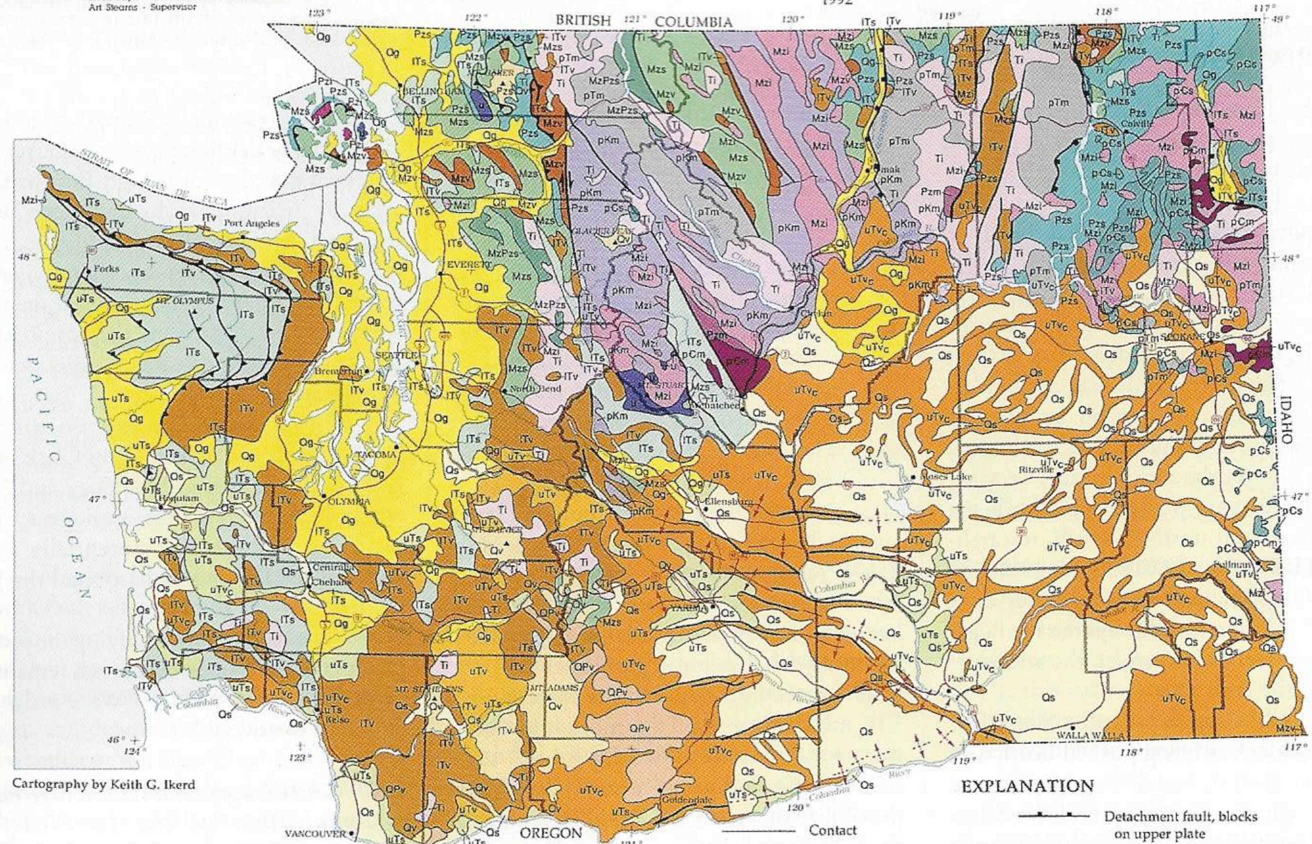
— Page 14



WASHINGTON STATE DEPARTMENT OF
Natural Resources
Brian Boyle - Commissioner of Public Lands
Art Stearns - Supervisor

GEOLOGIC MAP OF WASHINGTON

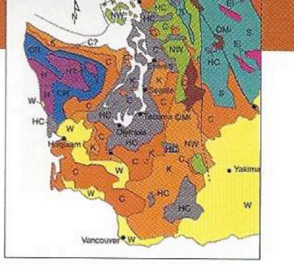
compiled by
J. ERIC SCHUSTER
1992



Cartography by Keith G. Ikerd

1890 - CENTENNIAL - 1990
Division of Geology and Earth Resources

EARTH SCIENCES



Mapping Northwest Geology

Researchers are forging a new vision of our geological history and sharing that understanding with the public

University of Washington geology professors Eric Cheney and Brian Sherrod share a fondness for maps.

Creating a good geological map requires much hiking and the detailed analysis of hundreds of rock samples extending over square kilometers of land. The location and placement of each sample are meticulously recorded, requiring months of fieldwork.

Rock samples returned to the lab are studied to determine ages and compositions, and from this information and observations in the field, the geologists construct their maps. Even over small areas, these maps are rich tapestries of blue Paleozoic rocks, green Mesozoic rocks, red sedimentary rocks, and purple metamorphic rocks.

Dale Middleton, chairman of the Ice Age Floods Institute, also has a thing for maps.

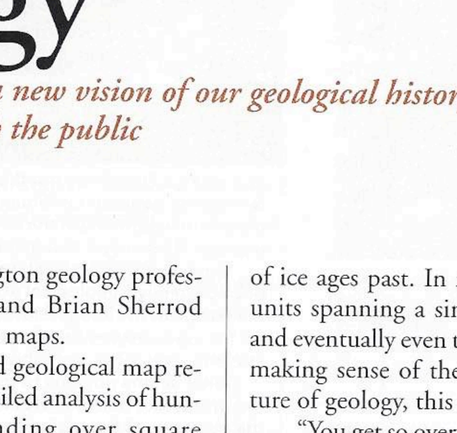
This retired librarian, without formal geology training, has spent years pouring over topographic maps of Montana, Idaho, and Washington, examining the scarred remains left by the great floods of ice ages past. In multi-color maps of geological units spanning a similar area, the colors multiply, and eventually even trained geologists have difficulty making sense of them. Given the interpretive nature of geology, this can be a real problem.

"You get so overwhelmed by the number of geological units," says Cheney, "you lose the big picture."

The big picture is the goal of both the UW group and the Institute. Both are working to revolutionize the interpretation of Northwest geology.

On the one hand, Cheney and Sherrod, who is also with the U.S. Geological Survey, are working forward from 55 million years ago to construct a new interpretive map, designed to reveal the broad geological features of the Northwest's dynamic terrain.

And Middleton, along with other like-minded citizens, is working with the National Park Service to construct an "interpretive trail" across the Northwest in an attempt to forge a link between the people of the Northwest and an understanding of some of the most catastrophic floods of all time.



Cheney points out the tilt of the Columbia River basalt near Ellensburg, Wash. This tilt indicates that the Cascades pushed up through the basalt layers. Photo: John Armstrong

Geological postcard at top was designed by University of Washington professor Eric Cheney to illustrate a simplified geological picture of Washington using synthems. Source: Eric Cheney

Another geological map, shown at bottom was made using standard mapping techniques. Source: Washington Department of Natural Resources

by John C. Armstrong

While both groups are working separately from one another, their results work in tandem to help the public—along with other scientists—gain a deeper understanding of the events shaping the Northwest landscape.

Geology of the Northwest

With some exception, the geology of Washington, Idaho, and Montana can be broken into three categories. There is the old continental material near the border with Idaho, representing the edge of the continent 170 million years ago. The steady progress of plate tectonics delivered lands from the west—some as far away as present-day Japan—and smacked them into the continental edge. When this occurs, volcanic arcs form inland, like today's Cascade Range. Major land masses from California to British Columbia accreted in this fashion, bulking up the western edge of the continent. Where the lands interact, faults form, and the land to the east, under steady pressure, is lifted, buckled, and twisted like a huge mass of Silly Putty.

The most recent instance of the tectonic-induced accretion is responsible for the Olympic mountain range. Unlike earlier episodes, this material didn't travel far. The coastal mountains lifted up from sedimentary rocks on the ocean floor—rocks originally part of the American continent and later eroded away.

Finally, overlaying all of this material, from the old continent to the accreted terrain, are the sedimentary and volcanic rocks. These are deposited in a number of ways: by lakes, streams, the slow accumulation of glacial debris, or by massive floods of basaltic lava. Similarly, these can be removed: by lakes, streams, glaciers, or by catastrophic water floods.

The largest of these floods, due to the collapse of the 2000-foot-tall ice dam on glacial Lake Missoula about 15,000 years ago, released, for a short period of time, a flow of water greater than all the Earth's rivers combined. These floods dominate the geological record of Eastern Washington, Idaho, and Montana. They scoured glacial debris, and revealed layers of rock deposited in past ages.

The interpretation of this geological record depends heavily on the principle of stratigraphy: the notion that layers on the bottom of a sequence of rocks are older than those above them. Simple enough—but what standing bodies of water deposit as sand and silt in the bottom of an inland sea may be stripped away by flooding, rain and wind: erosional complications of this simple picture. Boundaries between layered rocks separated by these periods of erosion are called unconformities. These boundaries represent gaps in the record of geological time.

The Ice Age Floods are not the only misfortune to befall the beds of basalt of the Walpapi. The dynamic Northwest geology continues to mold and shape the landscape of Eastern Washington. Currently, plate movements from the south and west are twisting the state of Washington, slowly rotating it like a wheel. This action results in bending and folding in the relatively fresh 17 million-year-old basalt.

The hillside pictured above, located on Untanum Ridge in Eastern Washington, is a favorite haunt of Eric Cheney's geological excursions. Students hunker down for about an hour to deduce the folds in the basalt. In the image, starting from the upper right, outcrops of basalt can be traced along the ridge. As the layer begins to fold, it gets lost in the hillside. But after a few minutes of study and drawing, students notice the same basalt outcrop along the roadside (to left in the image).

What seems obvious to the trained eyes of Cheney soon plays out on the paper of each student in the group: the hillside reveals the twists and folds of what was once a flat layer of basalt—providing the evidence of the region's changing geology. Photo: Eric Cheney

Bridging the gaps

These unconformities provide a valuable new tool for geological mapping, explains Cheney as he hands me a new map of Washington, printed like a postcard.

Cheney distributes these cards widely to Washington travelers, especially on fieldtrips where he explains the significance of the new technique.

The new map vastly simplifies the kaleidoscope of colors seen on earlier maps. Cheney identifies only four major sedimentary units (called synthems), from youngest to oldest: the High Cascades, Walpapi, Kittitas, and Challis. Cheney and Sherrod can collapse the confusing array of geological sequences in a typical map to one of these four layers.

What once was a dizzying technicolor display reduces to a map where broad characteristics or regional geology can be deduced.

Sherrod likens it to techniques he's learned in drawing class. "You squint to remove the details," he says, "revealing the broad tones. And that's what we're doing: we're looking for the broad tones."

Thus, the synthems of sedimentary and volcanic rocks, bounded on both sides by unconformities, are now recognizable across vast areas. "These units extended over all of Washington, but you see them only where they are preserved," says Cheney. The sedimentary rocks within them may vary with location, he says, but the packages bounded by unconformities extend for hundreds of kilometers.

Washington revealed: the new geology

The new maps give insight into some of Washington's most extensive landforms. A thick layer of basalt, part of the Walpapi synthem, covers much of Eastern Washington, in some places as deep as 3,500 feet. These basalt layers were deposited in bulk around 17 million years ago.

In several giant hiccups, volcanic fissures released massive amounts of highly fluid lava, enough to cover parts of Washington, Oregon, Idaho, and Nevada. This event was singular in the history of Washington geology, defining the surface features of Eastern Washington for millions of years.

The conventional picture envisions the Cascade Mountains forming about 36 million years ago, long before the volcanic outflows. When the flows came over Eastern Washington, the Cascades effectively contained them.

"It is widely believed that this basalt ponded against the Cascades, and followed the ancestral Columbia River to the sea," says Cheney.

However, some basalt rock samples near the Olympic coast were from the same lava flows, says Cheney. He concludes: "If they look, smell and taste like Columbia River basalt, they must be Columbia River basalt. What did it do then, take a turn up the coast?"

With evidence for Columbia River basalt as far north on the Olympic Peninsula as Hoquiam, it seems more likely, in Cheney's view, that the Columbia basalt was deposited before the uplift of the Cascades.

The massive lava flows must have covered the region from Idaho all the way to the Olympic coast. The uplift of the Cascade Range punched through the basalt, which later eroded away. The end result gives similar regional geology, with the basalt covering much of Eastern Washington, but helps explain the coastal deposit.

There is one other important conclusion.

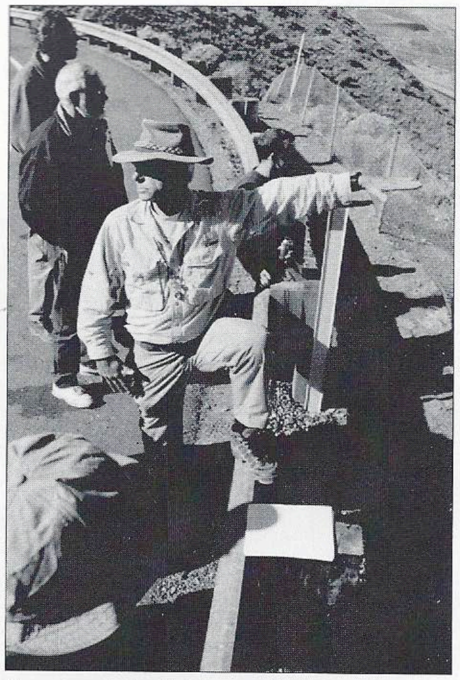
"This dates the Cascades at about 3.5 million years ago, rather than 36 million," says Cheney.

And there are other consequences of this new view. Some fault systems underlying Seattle, according to Sherrod, may be younger than originally thought. Geologists measure the slippage of the fault, divide it by the time the fault has been active, and compute the velocity of the fault's movement. If the fault systems are younger, their slip rate is larger than current estimates.

This interpretation has implications for the assessment of earthquake dangers in the region. The danger assigned to a specific region depends on a number of conditions, most importantly the slip rate of the fault. Estimates of the slip rates give geologists a handle on how often a given fault moves. Higher slip rates equate with greater risk, and, if Cheney and Sherrod are right, the earthquake danger in the Seattle area could be greater than previously estimated.

Their critics, Sherrod admits, don't necessarily share this view. Many doubt the new technique can be employed in the way Cheney and Sherrod envision, instead preferring the interpretation that the preserved sediment layers are actually local deposits of material. If this is true, then the'"broad tones" teased out in the new maps cannot be applied to such large areas, throwing the new interpretations into doubt.

Sherrod agrees there are limits to the technique.""Whenever you smooth data like this, you lose information," he says. However, Sherrod believes the opposition to the technique lies partly in the geological community's unfamiliarity with the concept. In petroleum geology, he claims, this same technique has been employed with great success.



Cheney explains his theory of Columbia River basalt formation to a group of students. Photo: John Armstrong

Power to the people

Little, if any, of the new geological interpretations, like those presented by Cheney and Sherrod, make it to the public if they never get any farther than the research journals. And, while Cheney and Sherrod reach out to the public—with copies of the postcard map for travelers, for instance—they cannot do it alone.

For his part, Middleton hopes to bring new research results to the eyes and ears of Northwest travelers through the creation of an ice age floods "interpretive trail."

A study, currently being reviewed in Congress, would provide funding to explore the creation of such a trail through the Northwest, from Montana to Washington. The trail would focus on "promoting public awareness and understanding of the Ice Age Floods," says Middleton.

The Ice Age Floods Institute, in charge of the study currently under review in Congress, grew out of the Ice Age Floods Task Force, formed in 1993. After several false starts and a few political battles, the Institute launched the study in 1999.

"The proposal is now ready for Congress, to be enacted in the next fiscal year," says Middleton. "It will include an intensive planning effort to find a way to move the project forward." Moving the project forward includes passing authorizing legislation and appropriating funds.

The end goal, perhaps several years down the road, is a sequence of roadside interpretive centers designed to tell the story of the floods—how they shaped the land and the people of the Northwest. "These sites will refer to one another—like where to go next if you want to figure out this or that," says Middleton.

The interpretations should reveal the true state of the research, says Middleton. "When the program gets going, I hope there is no dumbing down," he says, "and that scientific disagreements are honestly presented to the public. As with so much else that goes on, the more they study, the more there is to study."

Travelers in the Northwest would be able to follow in the path of the floods from the ice dam of glacial Lake Missoula across the Columbia River basalts, following the trail and using the new Cheney-Sherrod map along the way. ■

John Armstrong is a graduate student in astronomy and astrobiology at the University of Washington. He also teaches for the astronomy department, and is a recipient of