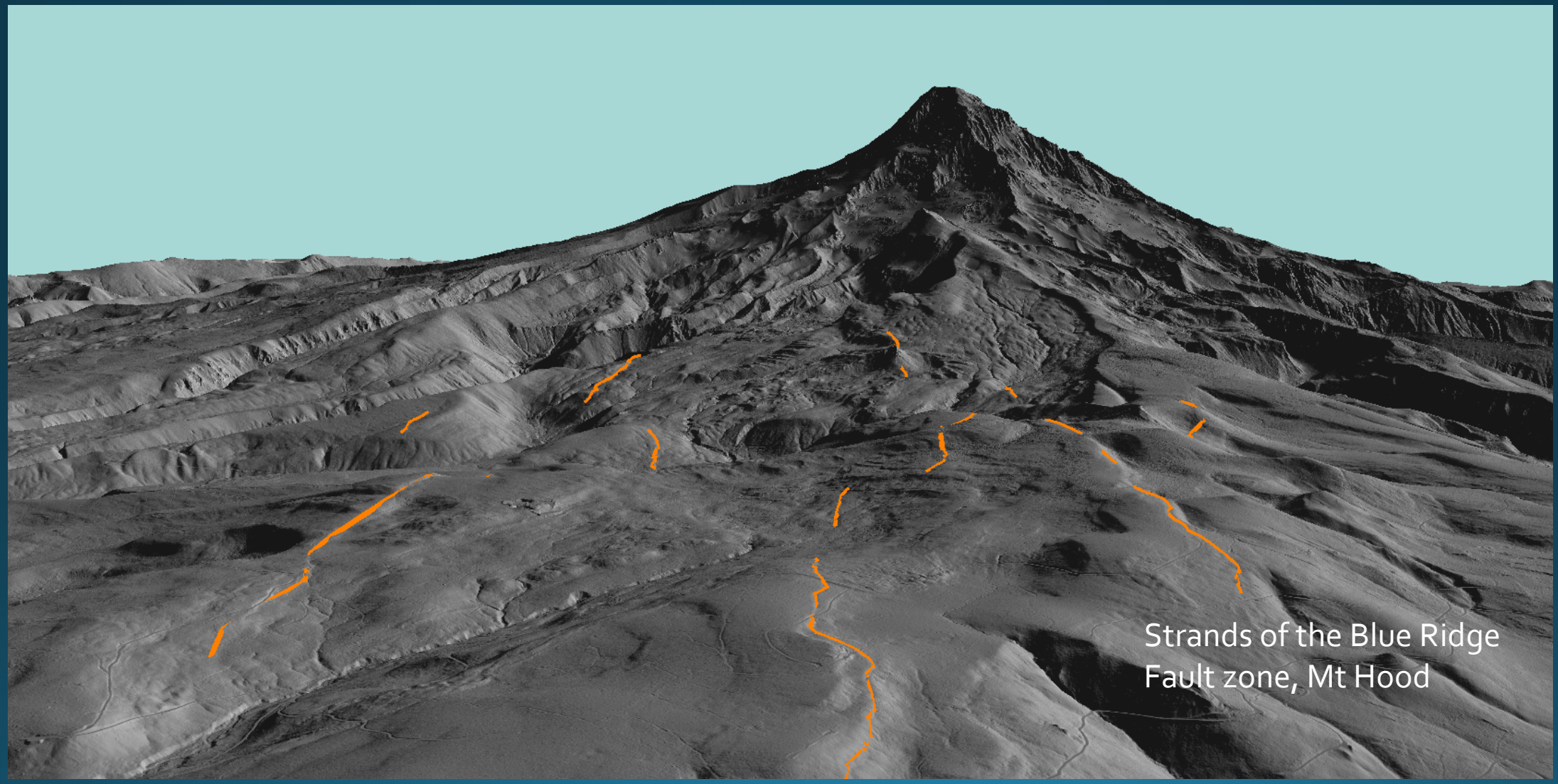
# Lidar-based Paleoseismic Investigations in Oregon

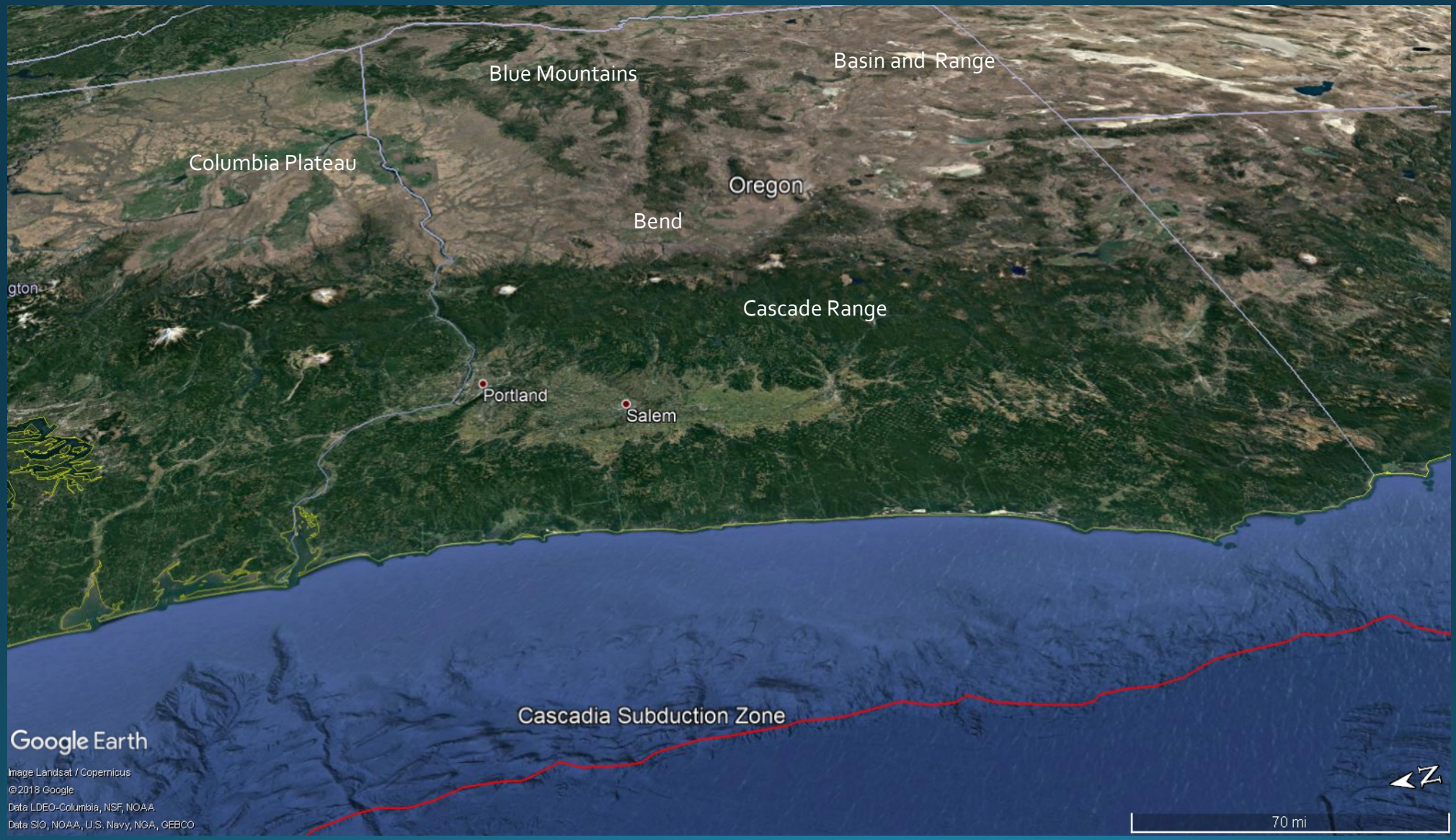
Ian P. Madin, Oregon Department of Geology and
Mineral Industries






Graphics by Ian Madin, DOGAMI

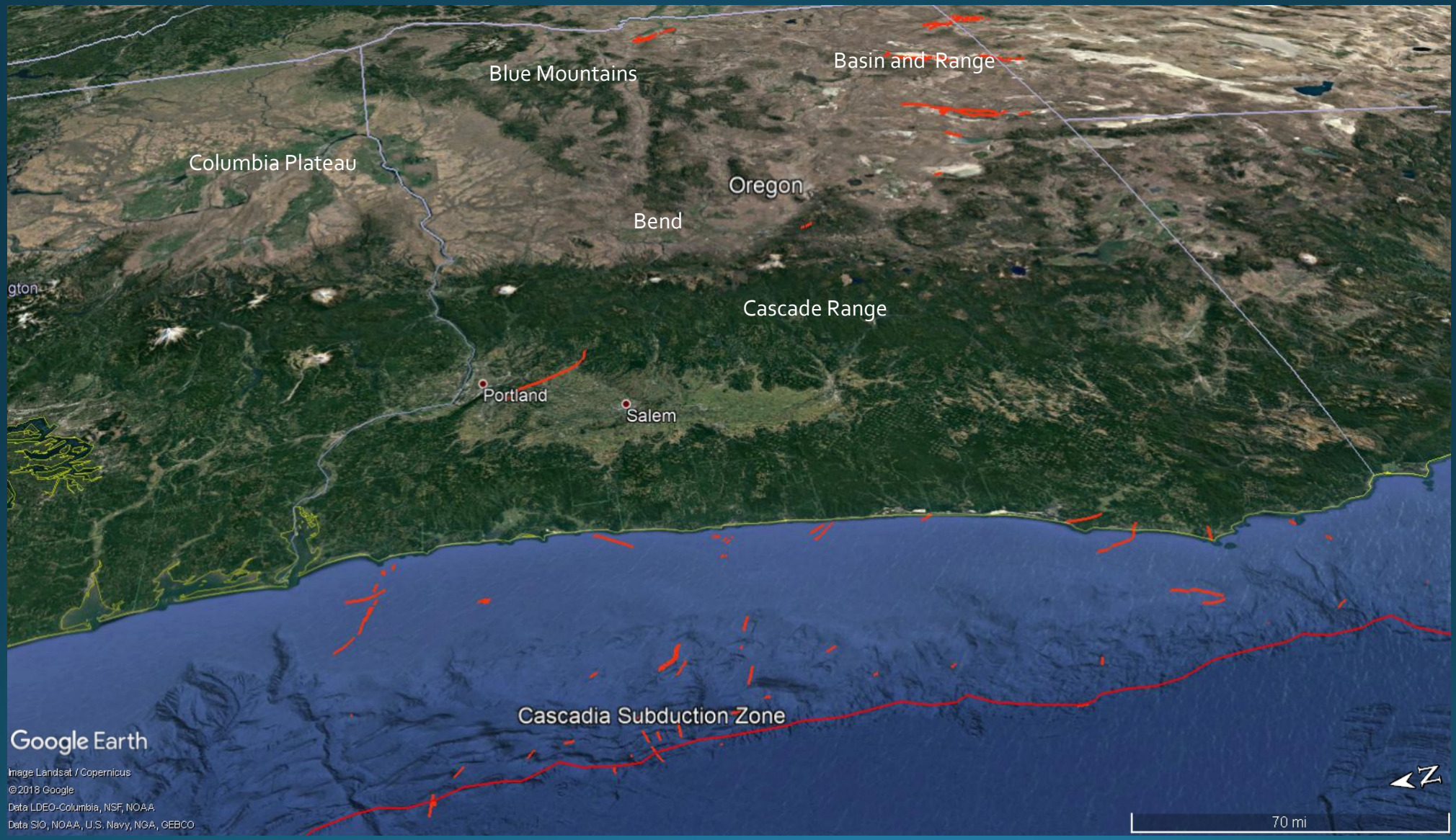
The Cascadia Subduction zone poses the greatest earthquake threat to Oregon, with M 9 earthquakes every 500+ years. However, the damaging effects are limited mostly to areas west of the Cascade Range.






Graphics by Ian Madin, DOGAMI

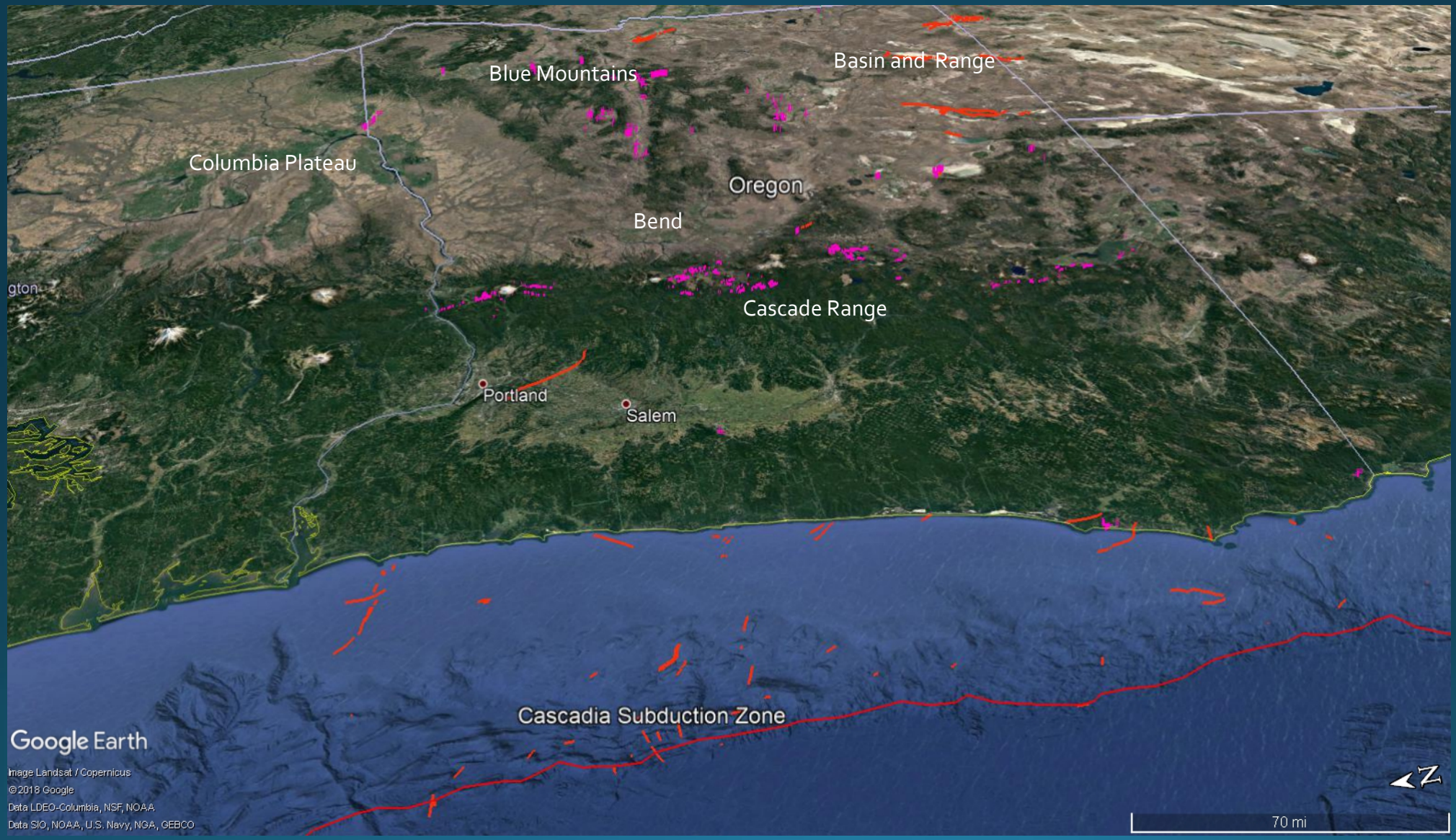
Crustal faults also pose significant seismic hazard, particularly in eastern Oregon. This map shows all faults in Oregon with evidence for ground-rupturing earthquakes in the last 15,000 years. These are the basis for the national seismic hazard maps.






Graphics by Ian Madin, DOGAMI

Since 2004, a growing collection of high resolution lidar topographic data has caused the number of known active faults in Oregon to increase dramatically.

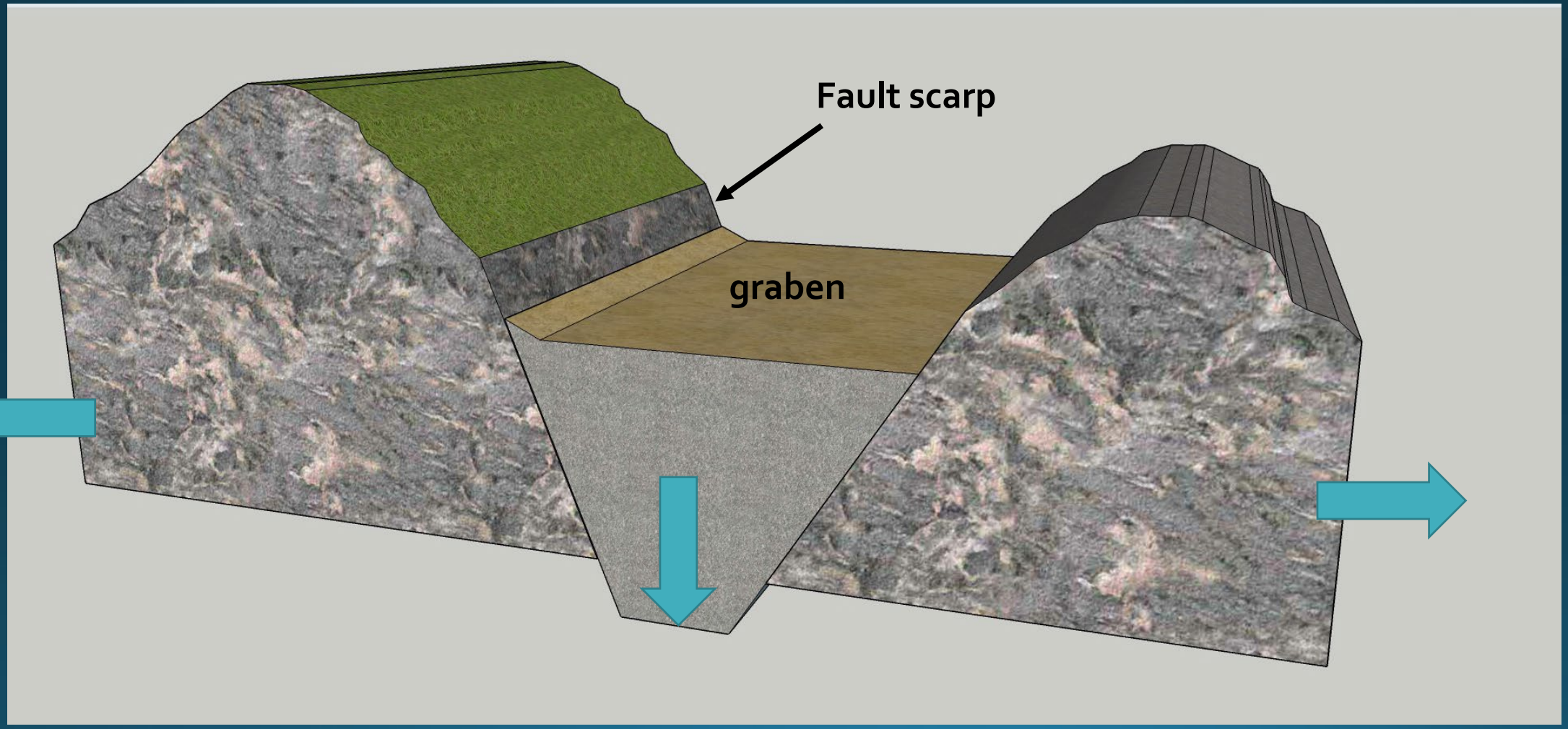





Graphics by Ian Madin, DOGAMI

# Normal Fault Geometry

When the earth's crust is stretched, it breaks along steeply inclined faults called normal faults, causing an earthquake as it moves. The block of crust that sinks is called a graben. Where the fault breaks the ground surface it produces a scarp several feet high across the landscape.

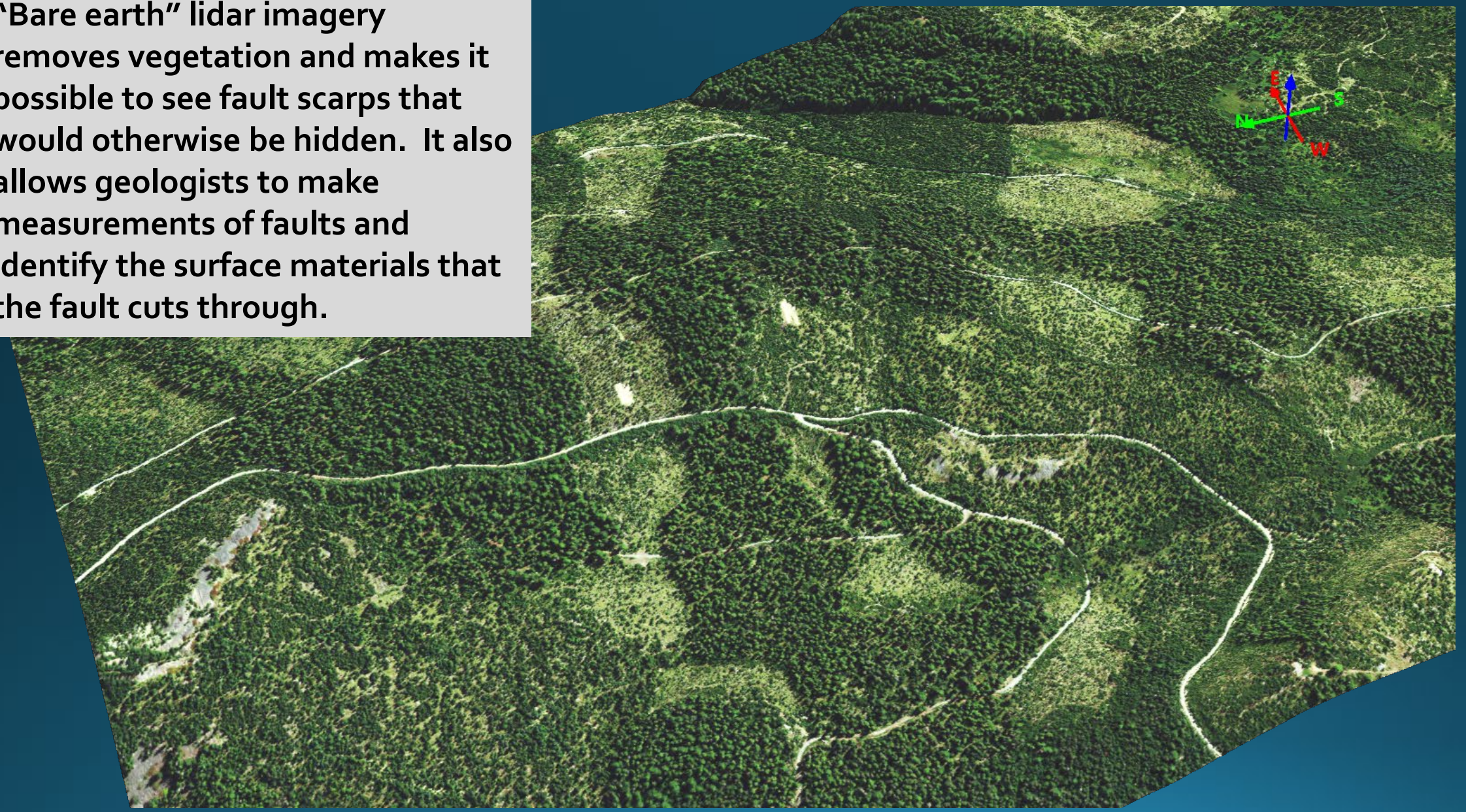





Graphics by Ian Madin, DOGAMI

# How does lidar help find faults?

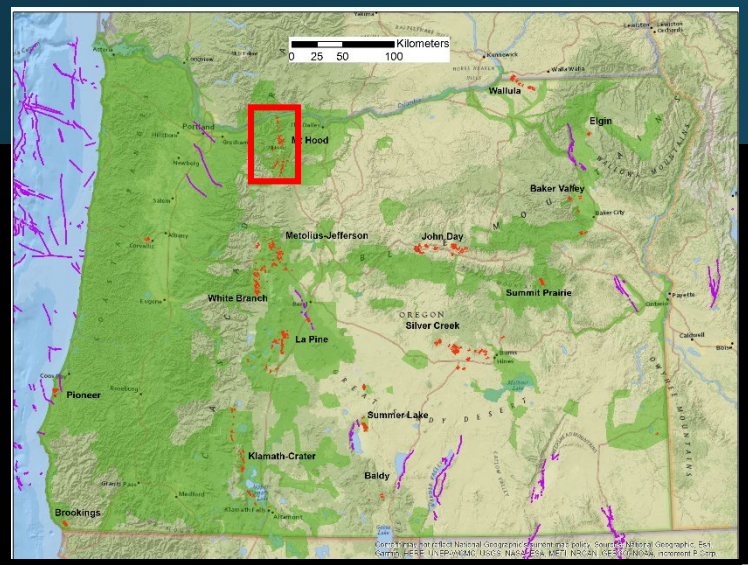
**"Bare earth" lidar imagery removes vegetation and makes it possible to see fault scarps that would otherwise be hidden. It also allows geologists to make measurements of faults and identify the surface materials that the fault cuts through.**



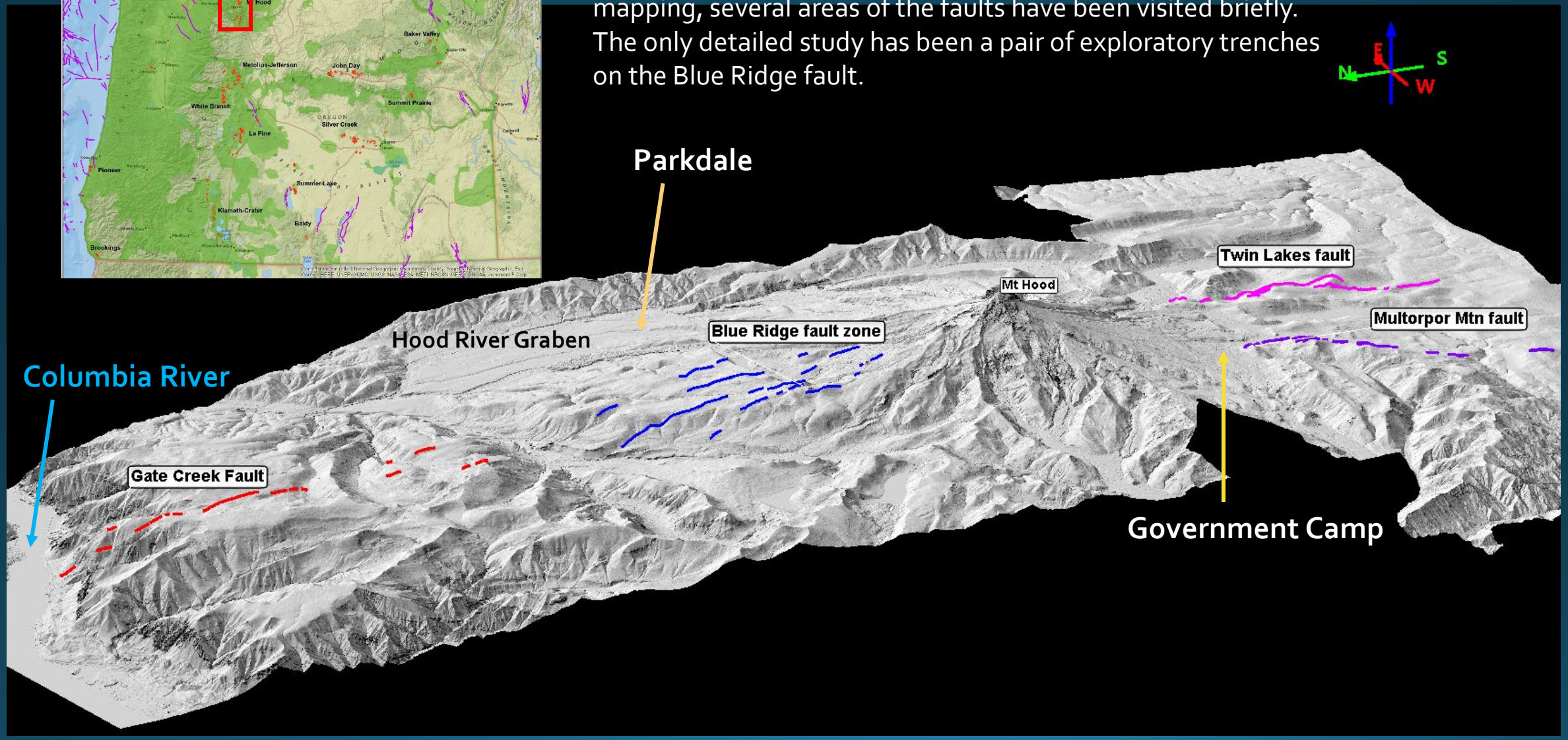



Graphics by Ian Madin, DOGAMI

# Mt Hood Fault Zone




**Th**e Mt. Hood fault zone consists of 4 distinct faults. Together they extend 49 miles from North to South. In addition to lidar mapping, several areas of the faults have been visited briefly. The only detailed study has been a pair of exploratory trenches on the Blue Ridge fault.






Graphics by Ian Madin, DOGAMI

# Gate Creek Fault

•3-10 ft high scarps in 20,000 year-old glacial deposits. Extends 9
offset older glacial moraine as much as 150 ft.  Normal fault dow







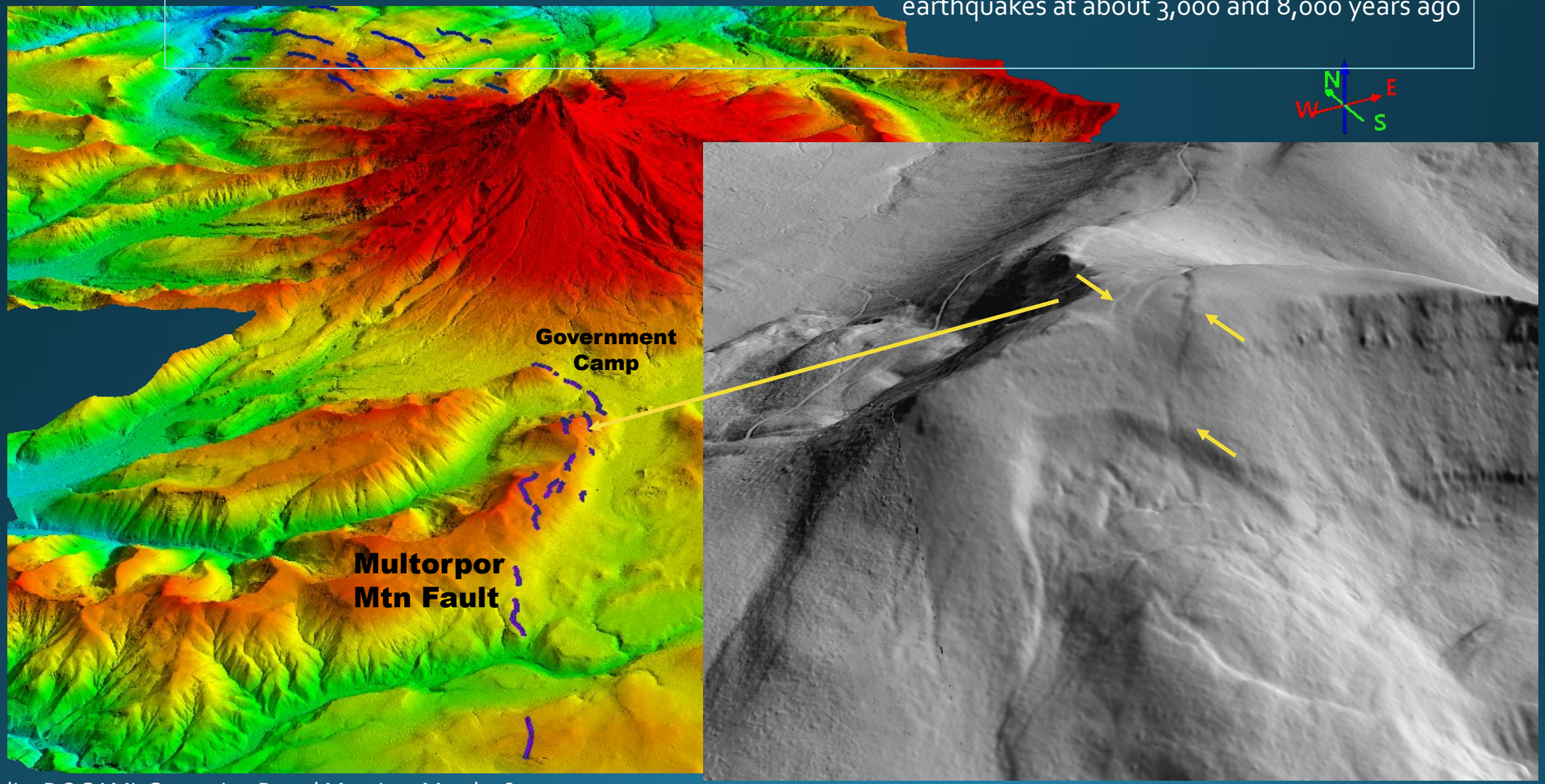





Graphics by Ian Madin, DOGAMI

# Twin Lakes fault and Multorpor Mountain Fault

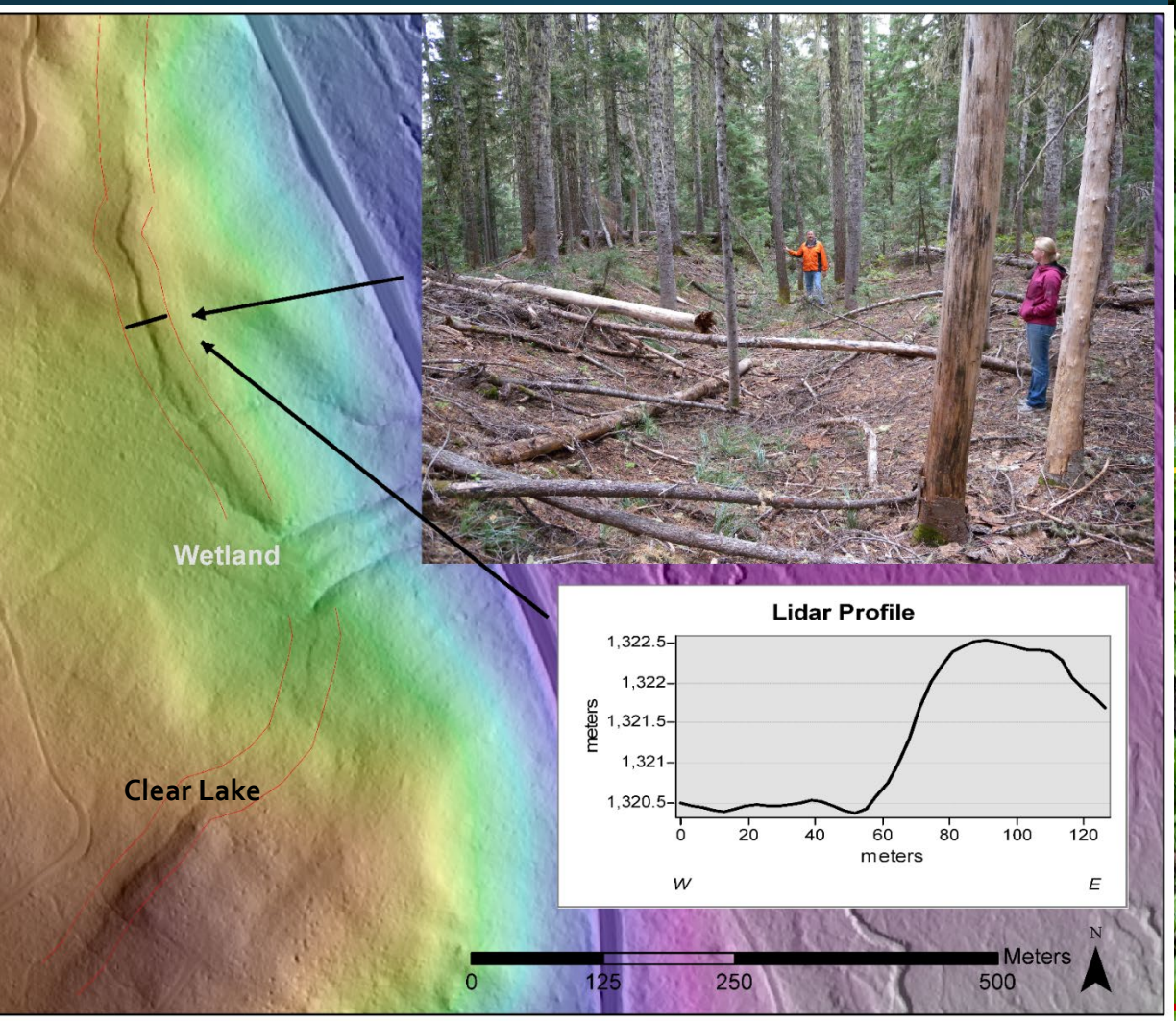
•Scarps extend ~10 miles and offset 20,000 year-old glacial deposits 5-30 ft. Both are normal faults, Twin Lakes down to W, Multorpor Mtn down to E. Together they define a graben. Twin Lakes may have had earthquakes at about 3,000 and 8,000 years ago






Graphics by Ian Madin, DOGAMI

# Twin Lakes Fault



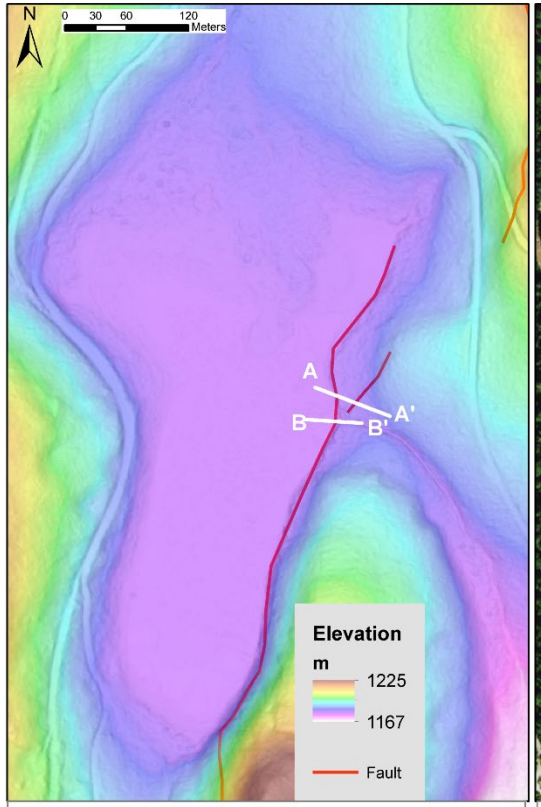


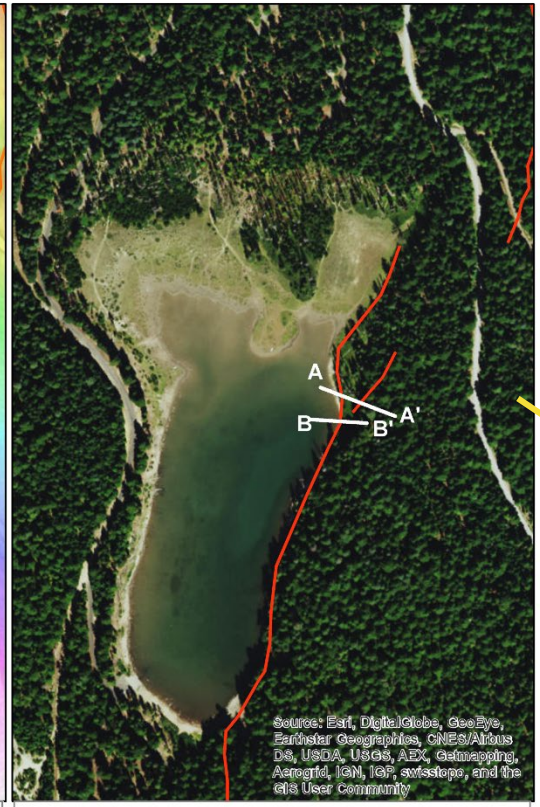


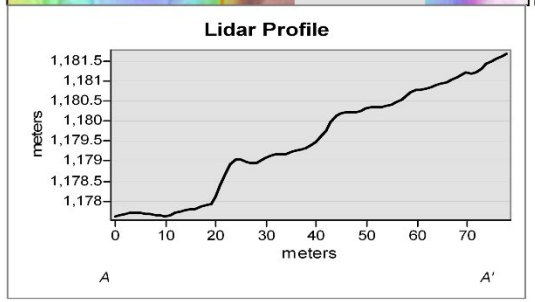

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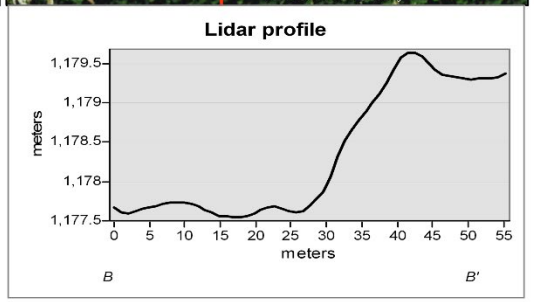
# Twin Lakes fault

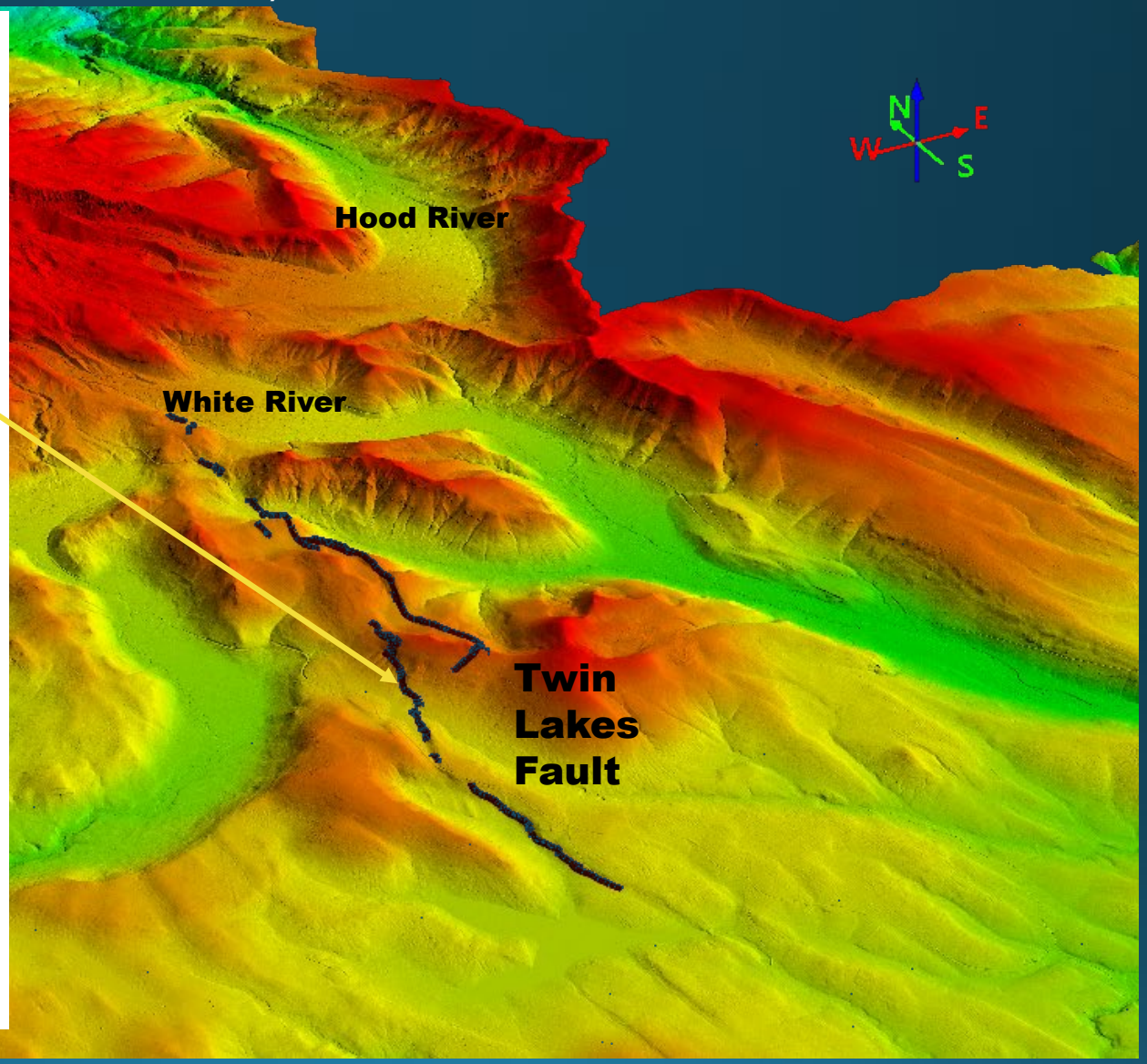
Frog Lake has been formed by the damming of Frog Creek by repeated earthquakes on the Twin Lakes fault. The outlet of the lake is now about 6 feet above the normal lake level. Charcoal from uplifted lake sediments dated at 8243-8303 years BP.



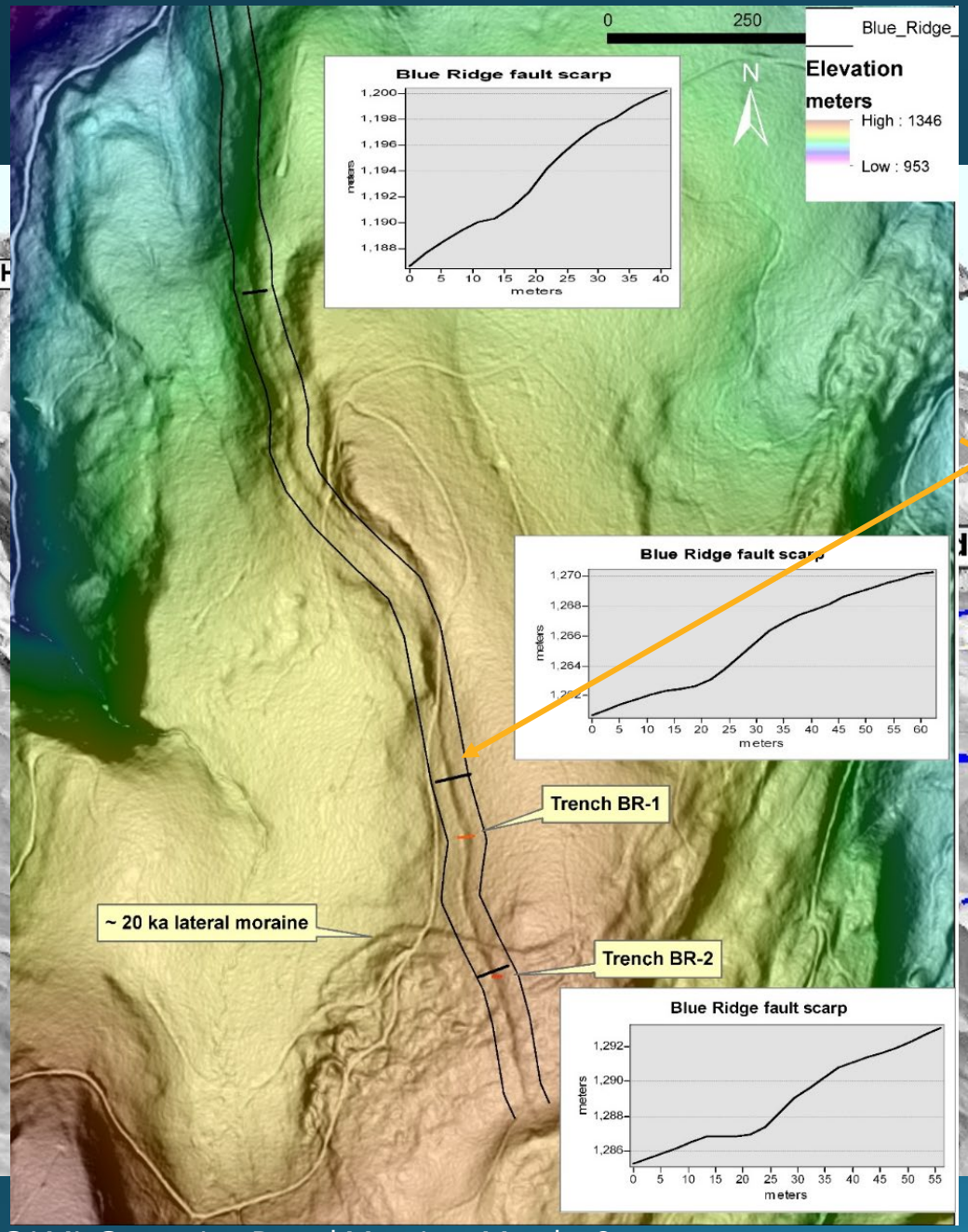



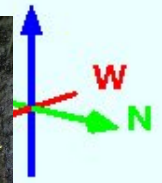



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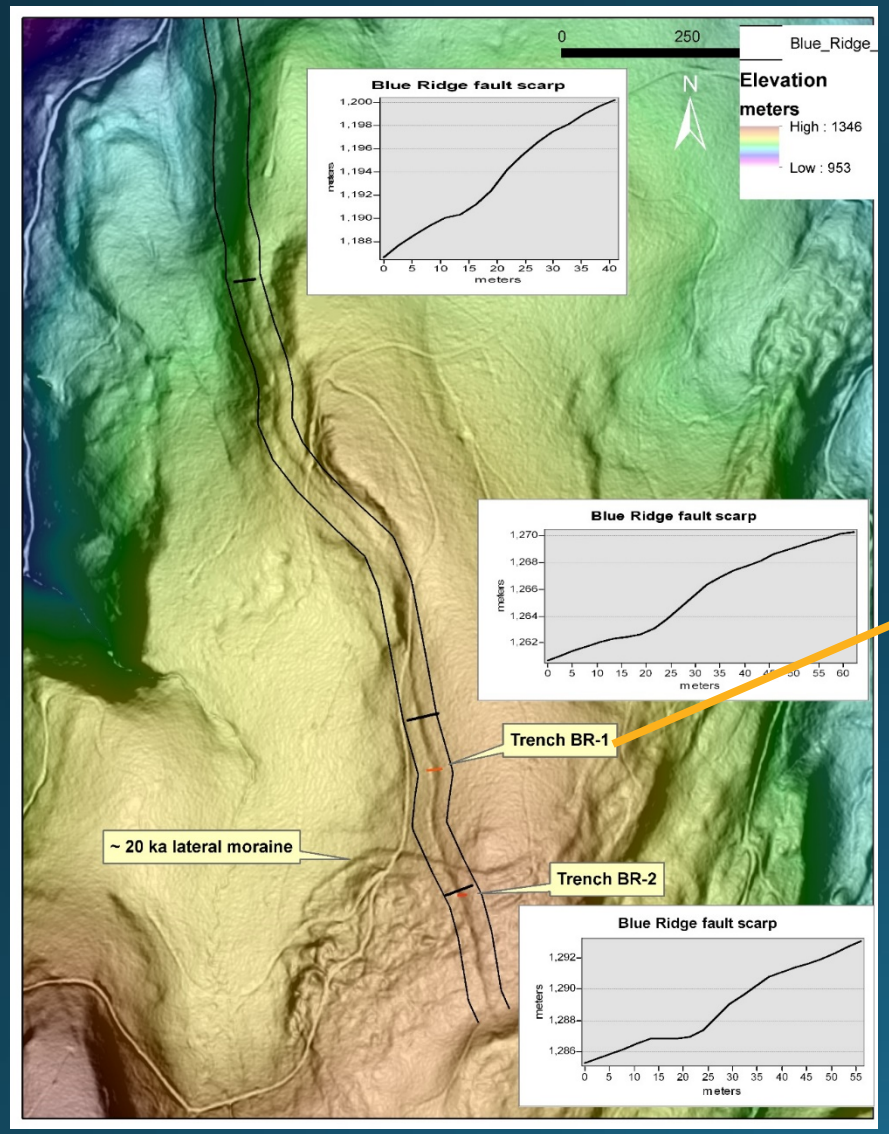
# Blue Ridge fault zone





# 2011 Blue Ridge fault trench shows single event with 6 ft of slip at about 13,500 year ago.

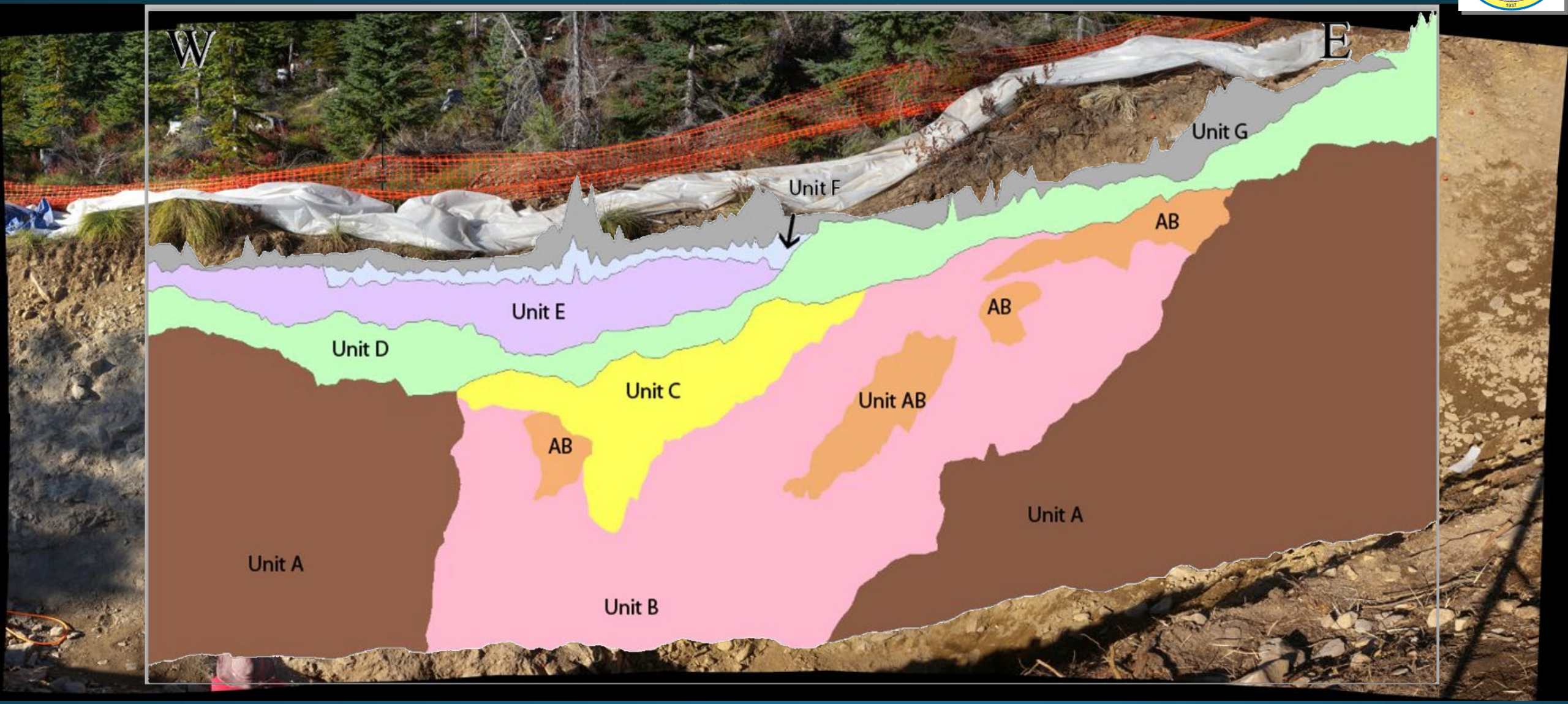






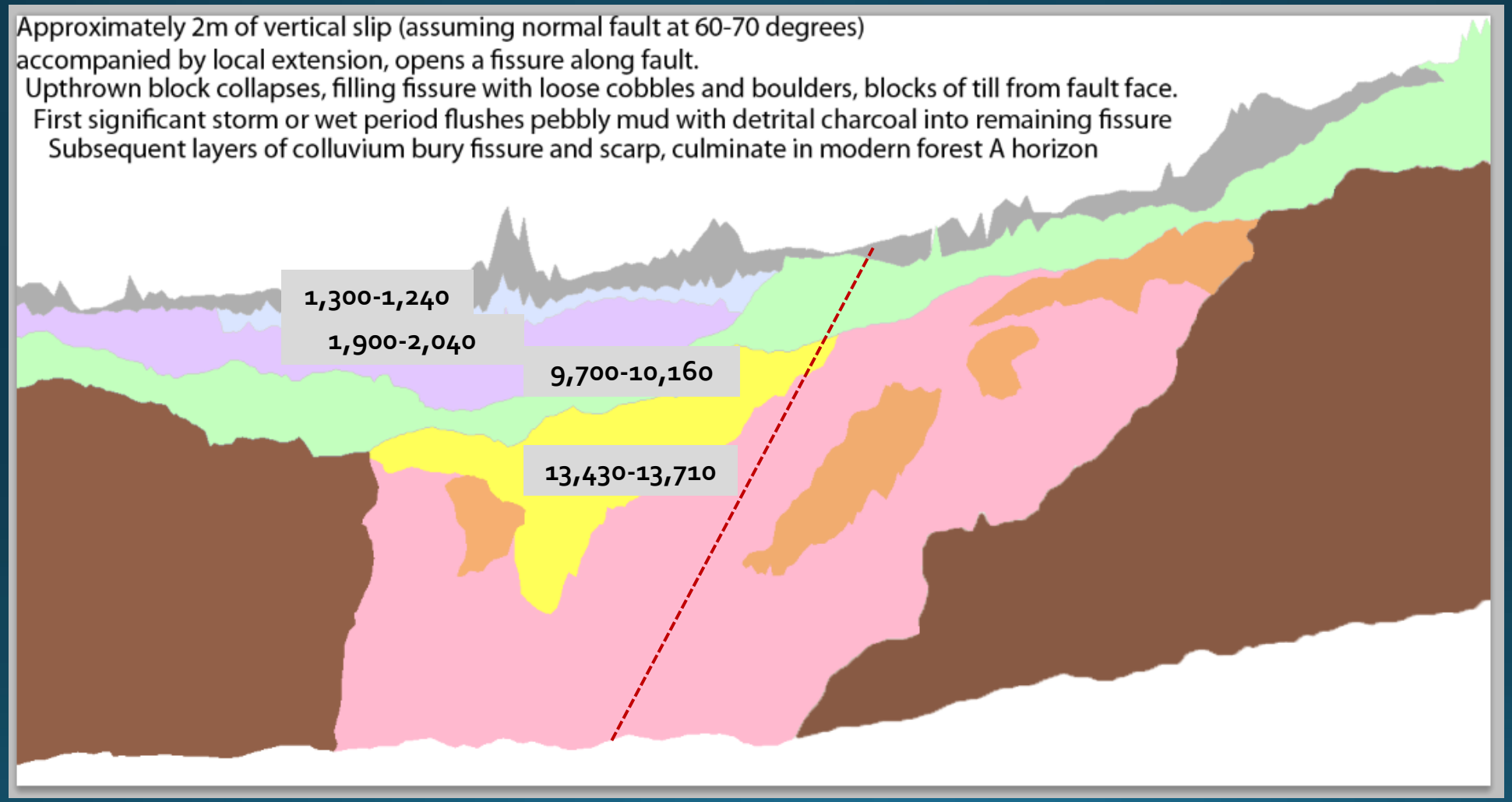

Graphics by Ian Madin, DOGAMI

# Trench features






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USGS
science for a changing world

# Field-Trip Guide to Mount Hood, Oregon, Highlighting Eruptive History and Hazards



Scientific Investigations Report 2017–5022–G

U.S. Department of the Interior
U.S. Geological Survey

# The Mount Hood Fault Zone—Late Quaternary and Holocene Fault Features Newly Mapped with High-resolution Lidar Imagery

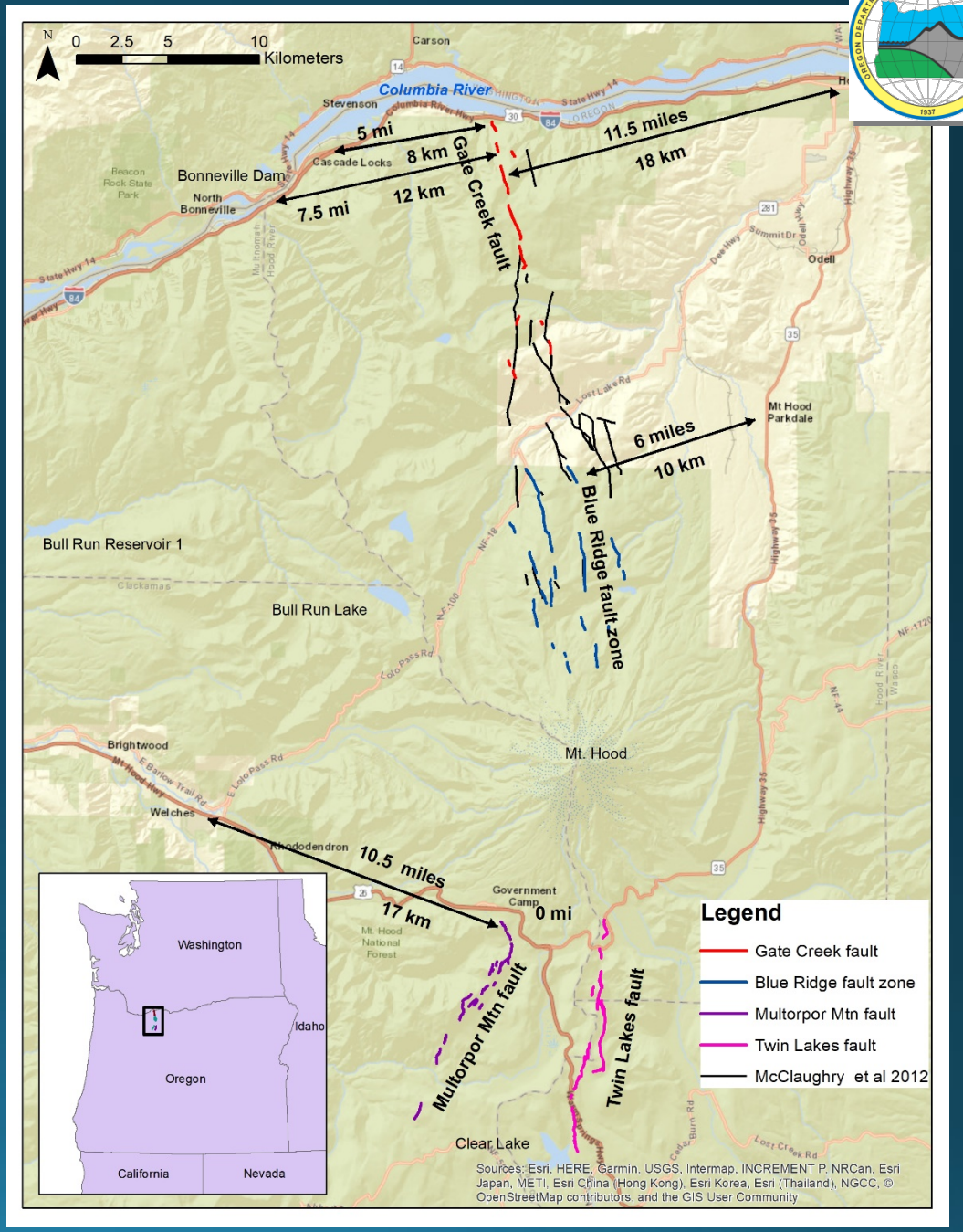
By Ian P. Madin, Ashley R. Streig, William J. Burns, and Lina Ma

# Mt Hood Fault Zone hazards

The likely magnitude of a prehistoric earthquake can be estimated from the length of the surface rupture, or the amount of fault slip. These estimates, which have a large uncertainty, are based on measured relationships from faults around the world*.

| Fault | Length | Slip | Magnitude |
|---|---|---|---|
| Gate Creek | 9 miles | | 6.4 |
| Blue Ridge | 10 miles | | 6.5 |
| Blue Ridge | | 6 ft | 6.9 |
| Gate Creek and Blue Ridge | 26 miles | | 7.0 |
| Twin Lakes | 13 miles | | 6.6 |
| Entire zone | 49 miles | | 7.4 |

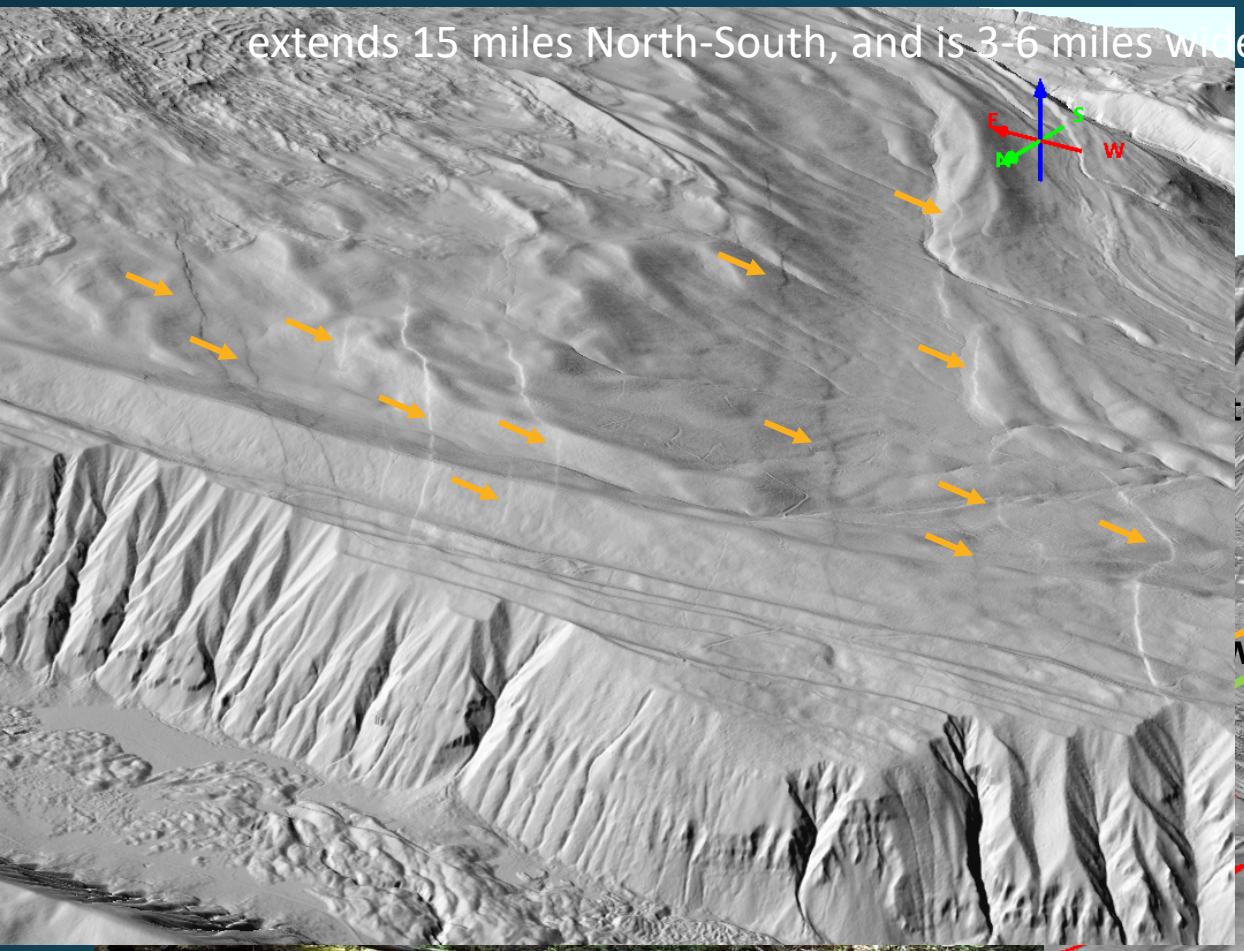
*Table 2A of Wells and Coppersmith, 1994.




Graphics by Ian Madin, DOGAMI

# White Branch fault zone

The White Branch fault zone consists of dozens of scarps which range up to 40 ft in height and which cut moraines of Suttle Lake age, approximately 20,000 years old. The zone defines a complex graben that extends 15 miles North-South, and is 3-6 miles wide. We have only spent one day visiting the area.

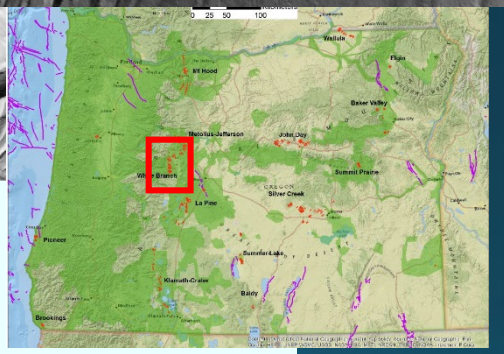










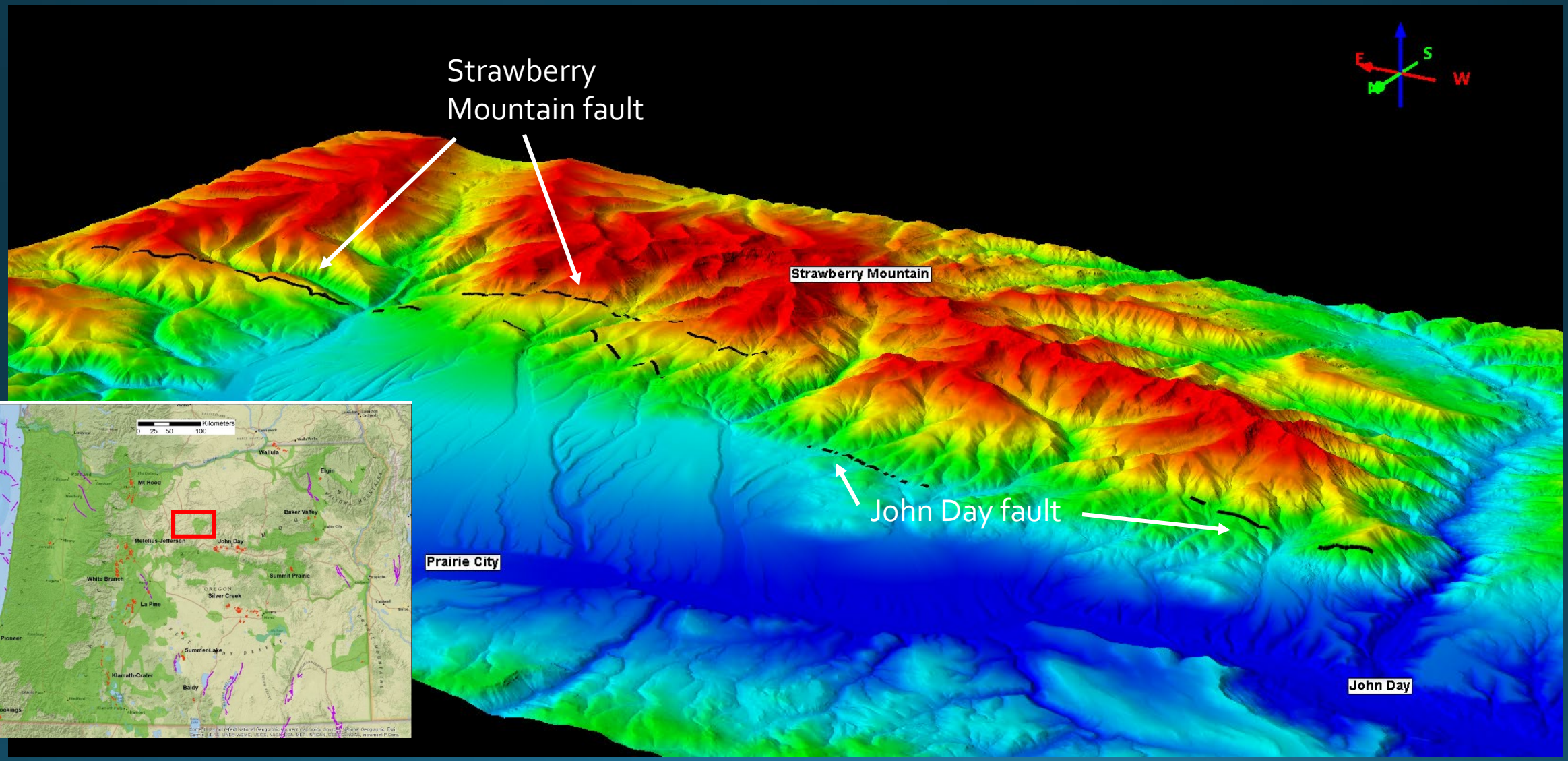
# White Branch fault zone





# Strawberry Mountain and John Day faults

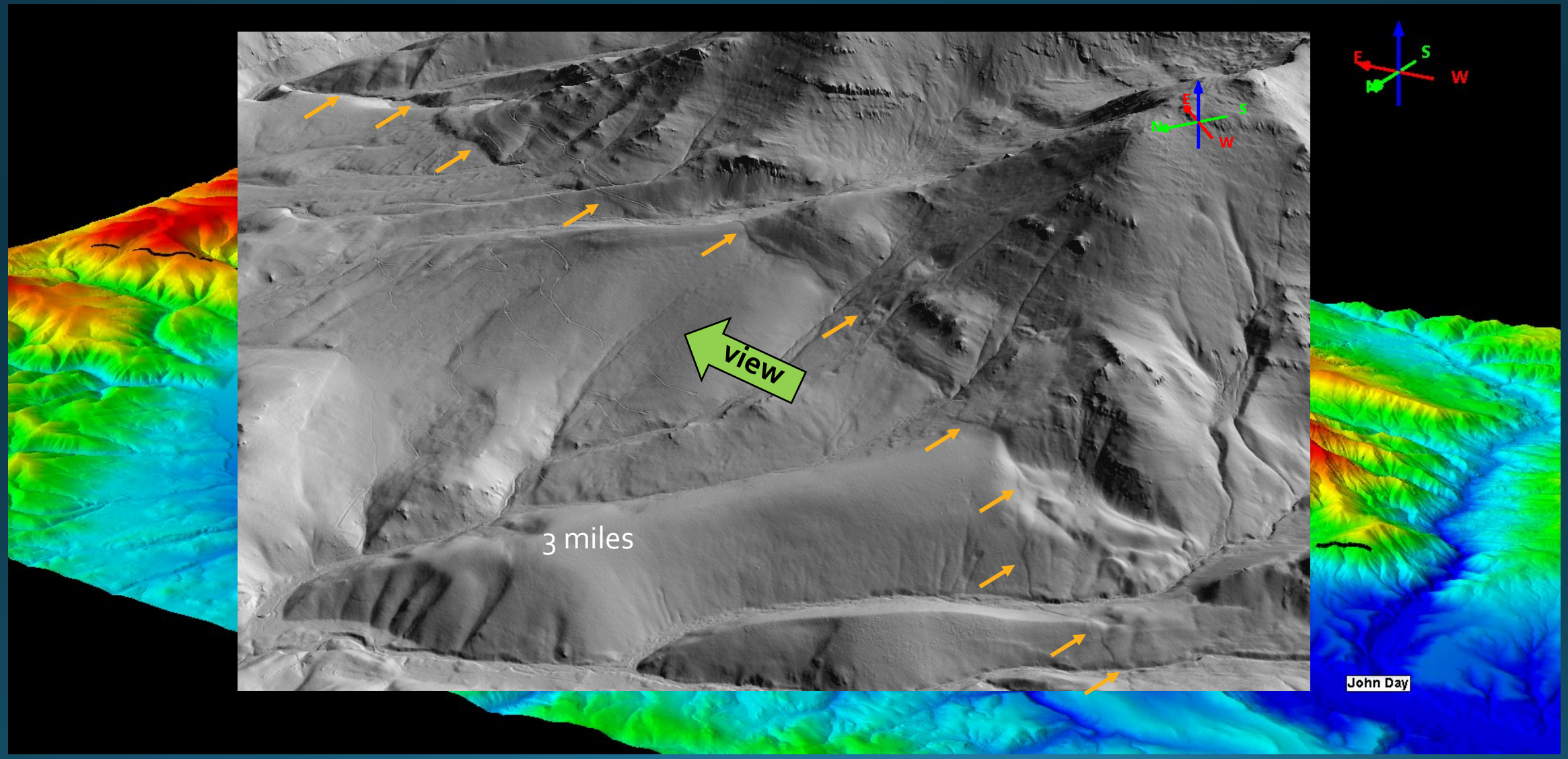
Discovered January 2019, no field visit yet. Strawberry extends 13 miles and cuts moraines and alluvium in Graham and Strawberry Creeks. John Day segment appears much older, extends 15 miles. Together length is 24 miles.






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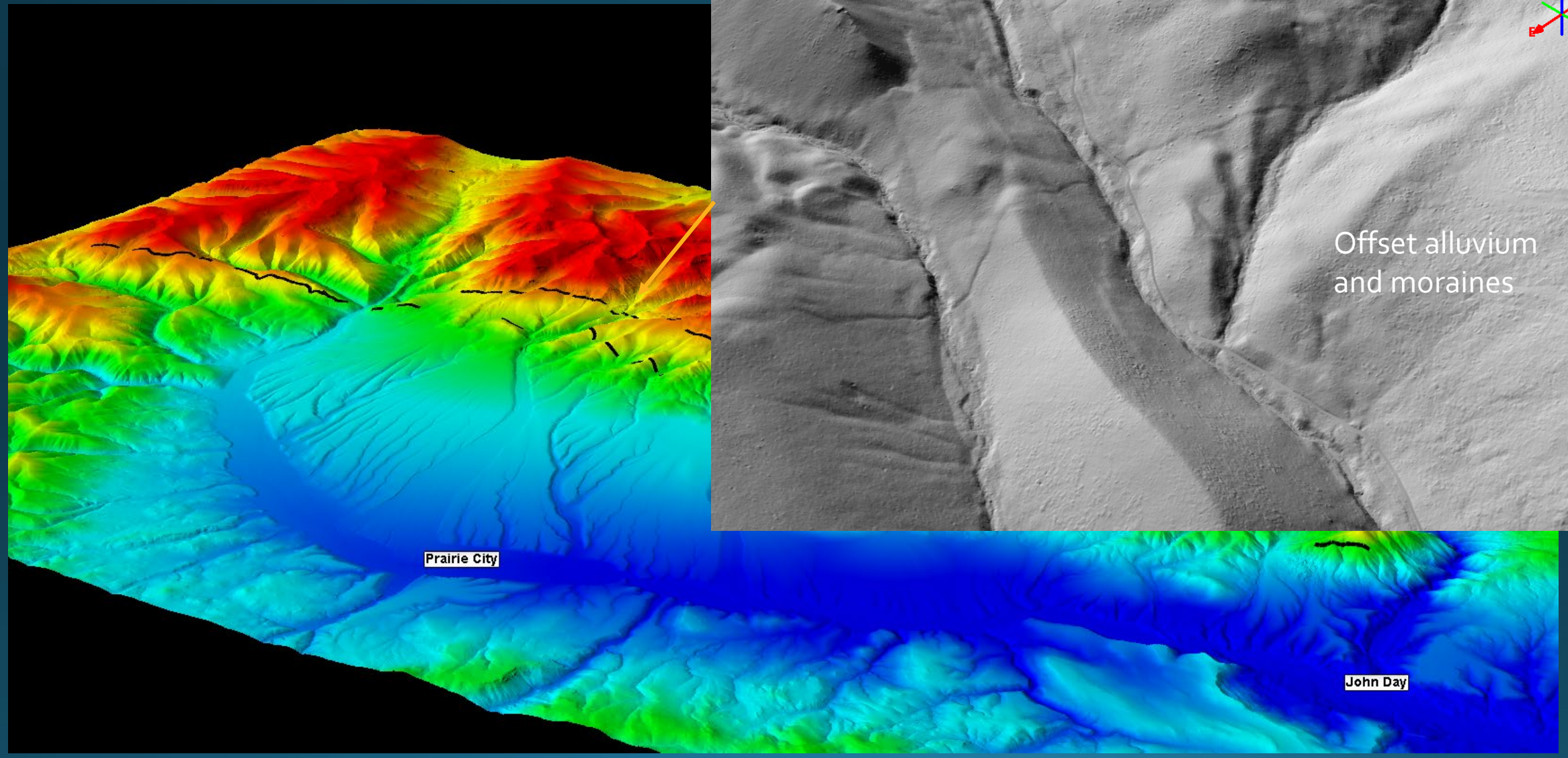
# Strawberry Mountain and John Day faults






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# Strawberry Mountain /Rail Creek and John Day faults



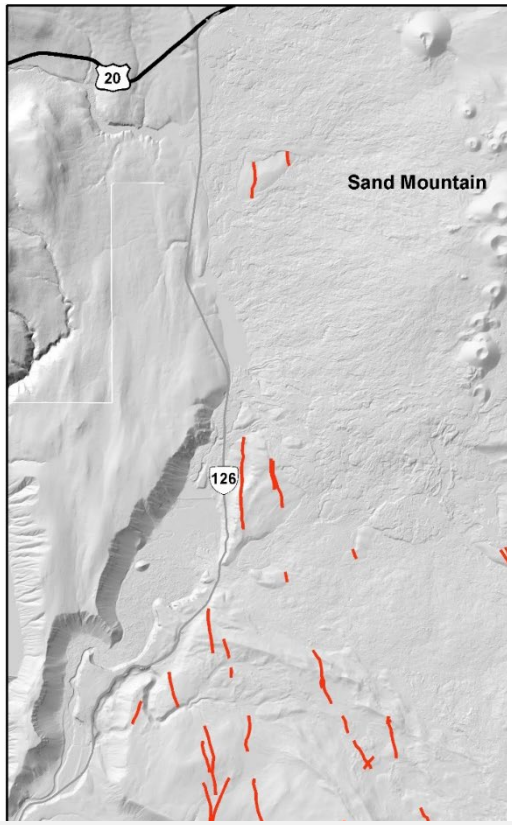




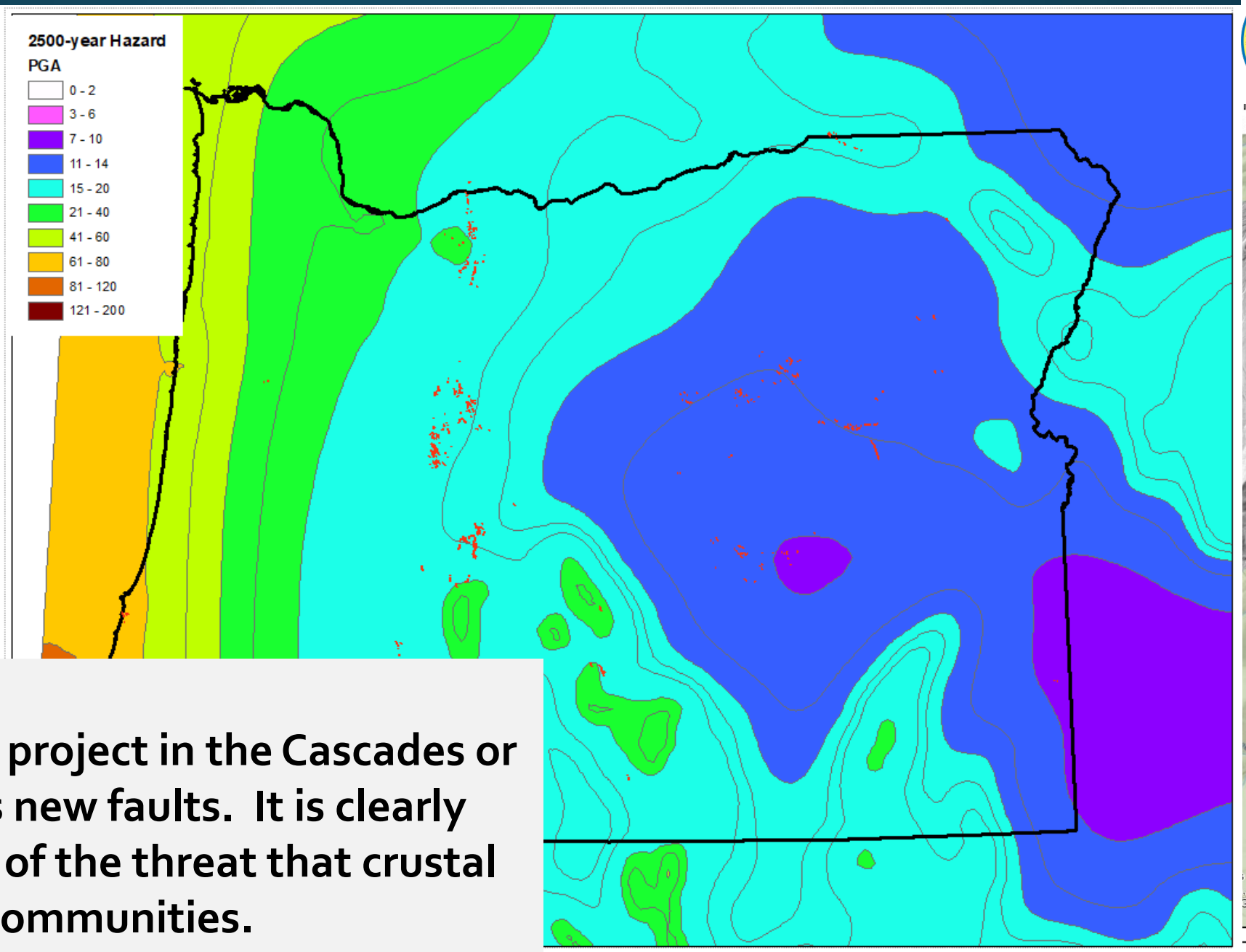


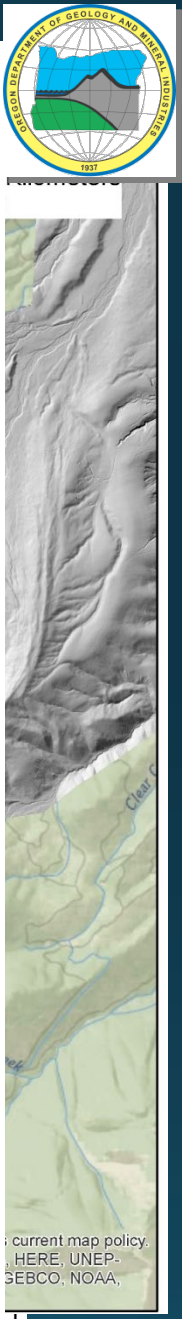
Graphics by Ian Madin, DOGAMI

# Are there more?





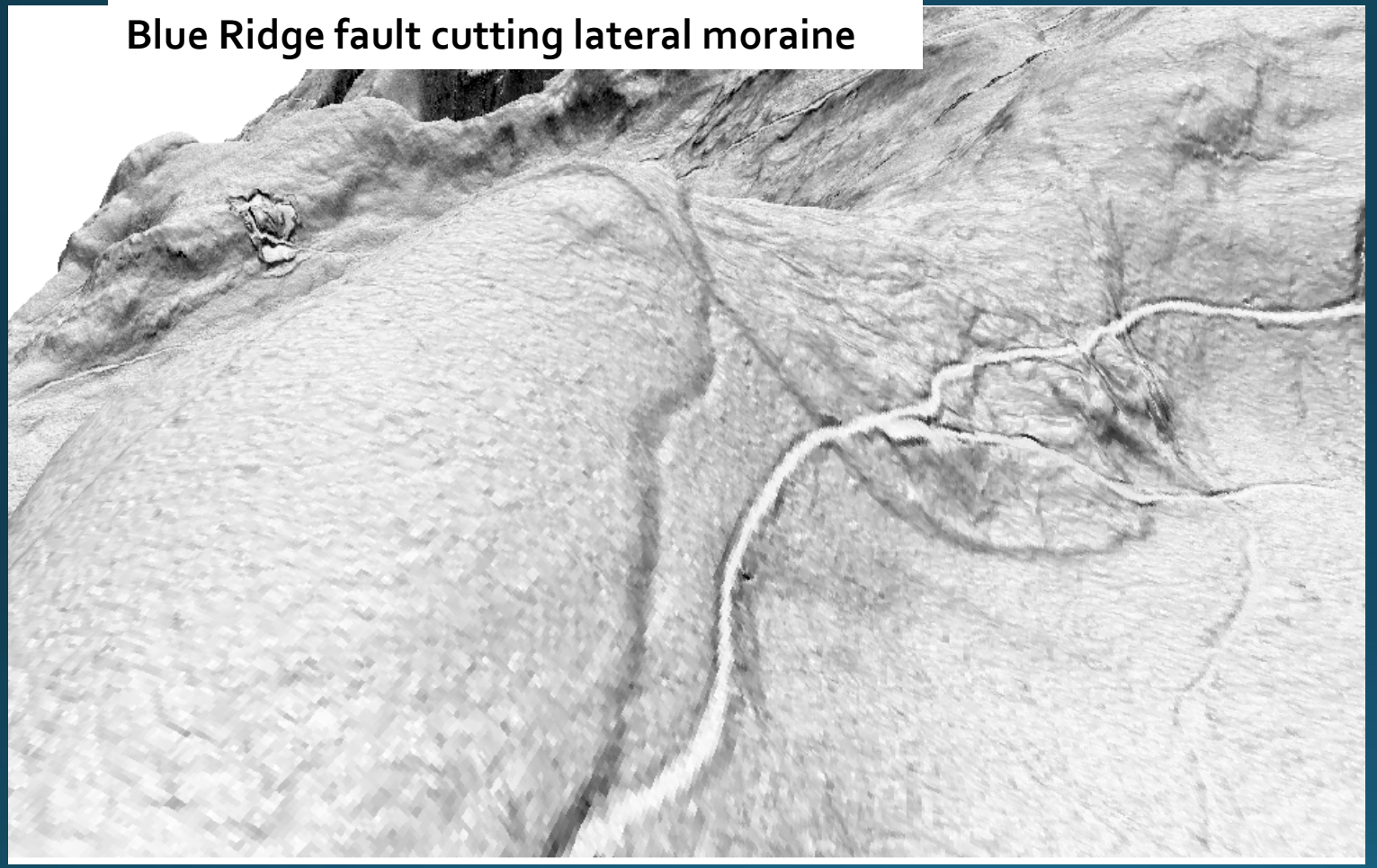




**Yes!**
**Almost every new lidar project in the Cascades or Eastern Oregon reveals new faults. It is clearly time for a reevaluation of the threat that crustal faults pose to Oregon communities.**



Graphics by Ian Madin, DOGAMI

# Questions?






Graphics by Ian Madin, DOGAMI