LIDAR EXPLORED

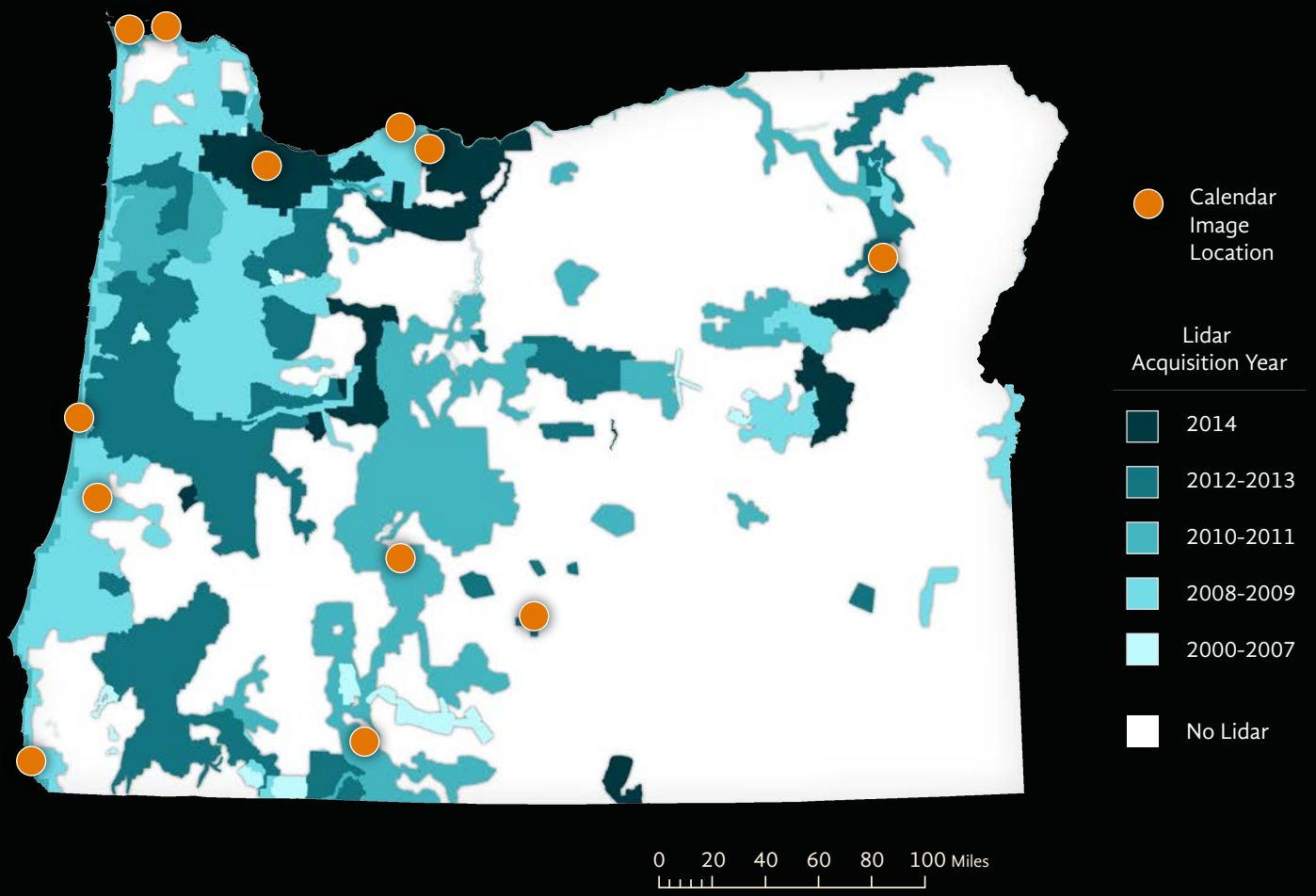
2015 CALENDAR

OREGON DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

LIDAR IN OREGON

Lidar is a remote sensing technique similar to radar that uses light pulses instead of radio waves. Lidar is typically "flown" or collected from planes and rapidly produces a large collection of very dense and accurate elevation points (up to 500,000 per second) over a large area. The product can be used to generate three-dimensional representations of the Earth's surface and its features.

The Oregon Department of Geology and Mineral Industries (DOGAMI) uses lidar to create new-generation maps that are more accurate and comprehensive than any in the past. DOGAMI, via the Oregon Lidar Consortium, is continually acquiring new lidar data throughout Oregon. This calendar provides a sampling of the kinds of information that can be obtained with lidar.



HOW DOGAMI USES HIGH-RESOLUTION LIDAR

- Resource Mapping
  - Base topographic maps
  - Geologic mapping
  - Shoreline monitoring
  - Aggregate monitoring & permitting
  - Mine site reclamation
  - Mineral exploration
  - Geothermal development
- Asset Mapping
  - Building extraction
  - State-owned facilities
  - Essential & critical facilities
  - Utilities & energy site development
  - Population distribution
  - Transportation corridors
- Natural Hazard Mapping & Modeling
  - Landslides
  - Debris avalanches
  - Fault displacement
  - Channel migration
  - Volcanic flows
  - Coastal erosion
  - Climate change
  - Tsunami inundation
  - River & coastal flooding
  - Volcanic lahar deposits
  - Evacuation planning

How can DOGAMI help you? Contact us to find out!

Ian Madin, DOGAMI Chief Scientist
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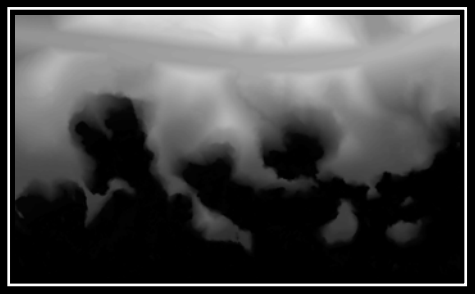
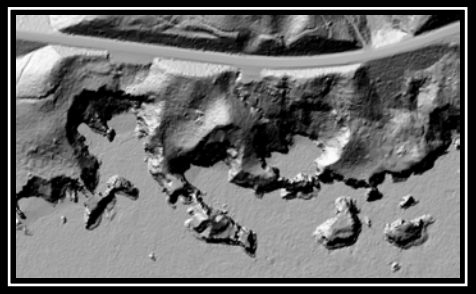
ian.madin@dogami.state.or.us

HOW WERE THESE IMAGES CREATED?



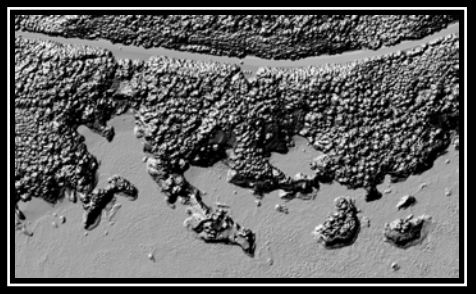
Bare-Earth DEM

Shades from dark gray to light gray represent elevation change from lowest to highest in the last-return, or bare-earth, lidar data.



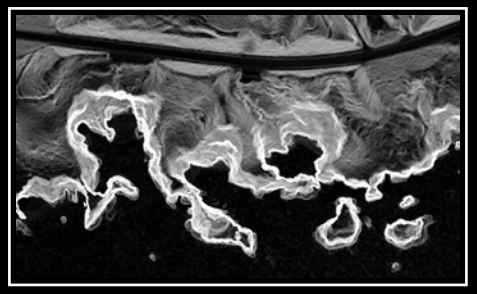
Bare-Earth Hillshade

Lighting effects can be added to a DEM to better simulate topography.



Highest-Hit Hillshade

Lighting effects can also be added to first-return, or highest-hit, lidar data to simulate the effect of topography with tree cover.



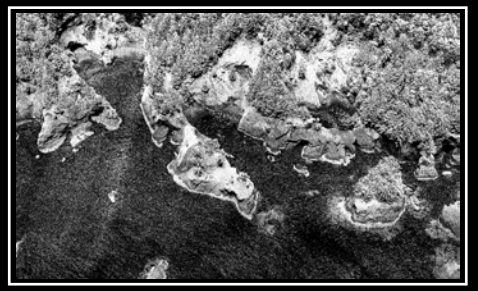
Bare-Earth Slopeshade

Change in slope can be emphasized to help visualize the shape of the landscape. In this image white areas are steep and black areas are flat.

Lidar data acquisition systems produce a mass of points known as a point cloud. Complex algorithms classify points on the basis of relative point-to-point and absolute geometries. These classification methods allow lidar points representing returns off the ground surface to be discriminated. Ground points are interpolated to produce a digital elevation model (DEM) typically referred to as a "bare-earth DEM." The entire mass of points (ground and other points) is interpolated to a DEM using the highest point at a given location. This produces a "highest-hit" surface model. This model includes ground, trees, buildings, and all other above-ground features.

Colorized Canopy Model

A simple canopy model can be made by subtracting the bare-earth DEM from the highest-hit DEM. This results in a digital map of the height above ground of trees and structures.

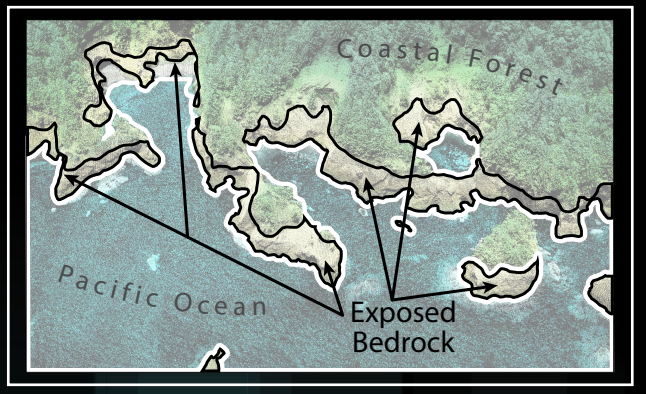


Lidar Point Cloud

Lidar point data can be visualized and rotated to create 3-dimensional views of the landscape.

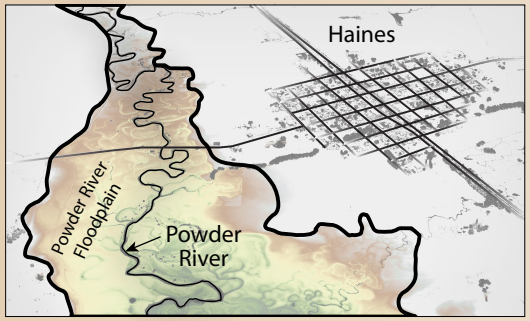
Perspective-View Point Cloud

Lidar point clouds can be enhanced with color to create a realistic 3-dimensional model.



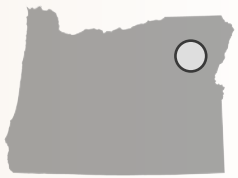
Interpretive Image

Different types of lidar imagery can be blended together and then enhanced with color to create intriguing imagery that also contains highly accurate elevation data. Additional GIS data and interpretive information can be combined with the imagery to create maps and graphics.



Powder River Floodplain and the Community of Haines, Baker County

The Powder River takes a meandering northerly course across the floor of the Baker Valley past the community of Haines. Lidar imagery provides very detailed maps of stream channels and floodplains, which can be used to model floods or channel erosion. Lidar data can also be used to map pools, riffles, and glides in the stream channel and to map the degree of shade that stream-side vegetation provides to keep waters cool.



OREGON DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

DECEMBER 2014

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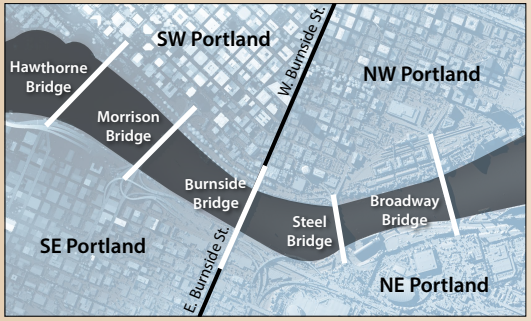
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	1	2	3

JANUARY 2015

FEBRUARY 2015

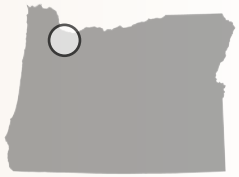
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
28	29	30	31	1 New Year's Day	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19 Martin Luther King Jr.'s Birthday	20	21	22	23	24
25	26	27	28	29	30	31



Portland City Center, Multnomah County

Detailed lidar images of cities can be used for a wide range of visualization and modeling applications. This image simulates moonlight shadows over the center of Portland. Daytime shade and sun analysis can be used to determine which rooftops in a city are most suitable for the installation of solar panels, or to calculate the optimal placement of wireless antennas. The ghostly "x" shapes in the upper half of the image are construction cranes. The lidar image is composed of data from two overlapping passes during data acquisition, and if a crane moves in the time between the two passes, the different positions create an x.



OREGON DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

JANUARY 2015

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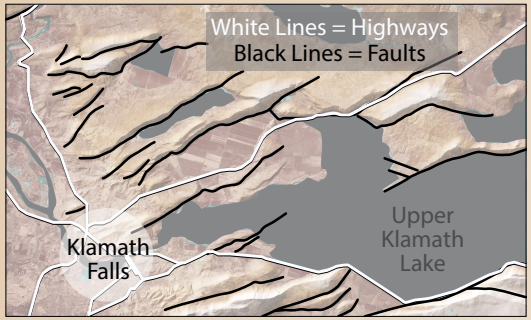
FEBRUARY 2015

MARCH 2015

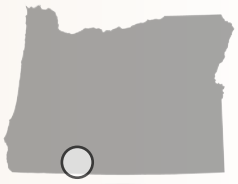
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	1	2	3	4

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1	2	3	4	5	6	7
8	9	10	11	12	13	14 Valentine's Day
15	16 Presidents Day	17	18	19	20	21
22	23	24	25	26	27	28



Fault Block Mountains, Klamath County

This image of the outlet of Upper Klamath Lake and the city of Klamath Falls shows the fault block nature of the Klamath Basin. The straight steep ridges on either side of the lake are fault block mountains, where fault movement has lifted and tilted the mountain side of the block above the basin side. The steep side of each mountain is the fault side and the steep sides always face toward the lake. This means that the lake block is sinking in comparison to the blocks on either side, which explains why the lake is where it is. Two damaging magnitude 6 earthquakes in 1993 were centered just off the upper edge of this image.



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FEBRUARY 2015

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22	23	24	25	26	27	28

MARCH 2015

APRIL 2015

S	M	T	W	T	F	S
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12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	1	2

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1	2	3	4	5	6	7
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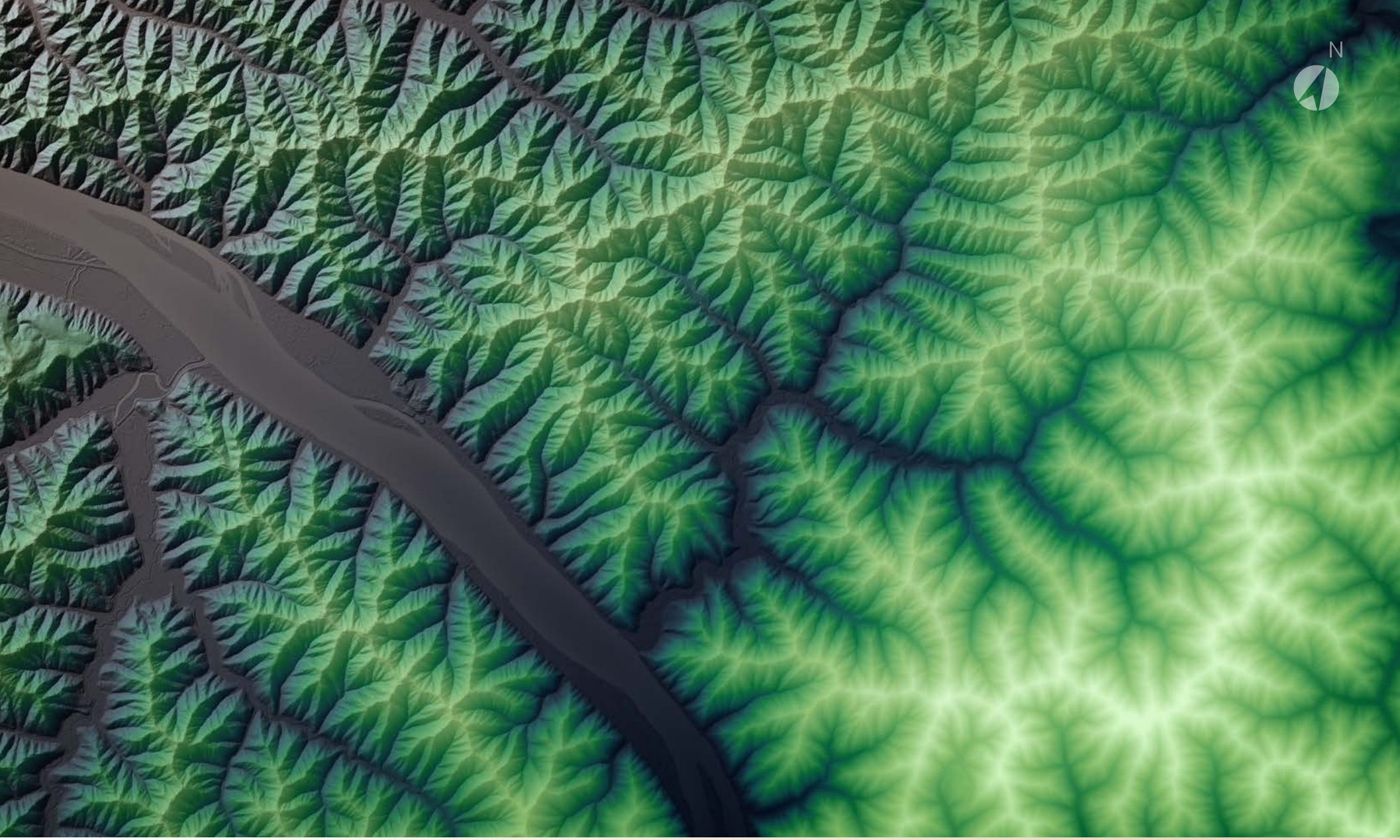
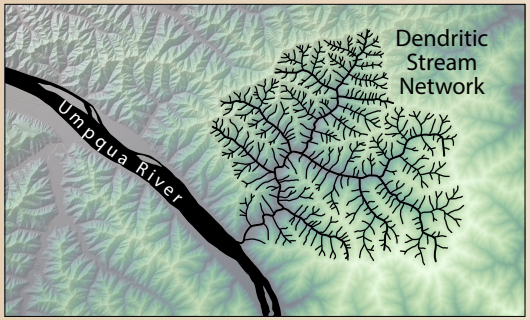
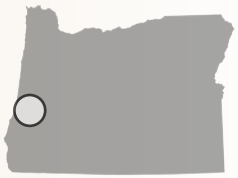
29	30	31	1	2	3	4





Dendritic Drainage Pattern, Umpqua River Watershed, Douglas County

This intricate dendritic (branched or tree-like shaped) drainage network is carved into flat-lying sandstone of the Tyee Formation along the Umpqua River in southwest Oregon. In most areas of Oregon, drainage networks are shaped by geologic structures like folds or faults, but in this uniform sandstone, a classic example of a fractal landscape has developed, where the branching shapes and patterns of streams and ridges are repeated at many scales. This landscape is highly susceptible to debris flows, which are rapidly moving landslides of mud, rock, and trees that occur during periods of intense rainfall.



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MARCH 2015

S	M	T	W	T	F	S
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8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	1	2	3	4

APRIL 2015

MAY 2015

S	M	T	W	T	F	S
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10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	1	2	3	4	5	6

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
29	30	31	1 April Fool's Day	2	3	4
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12	13	14	15	16	17	18
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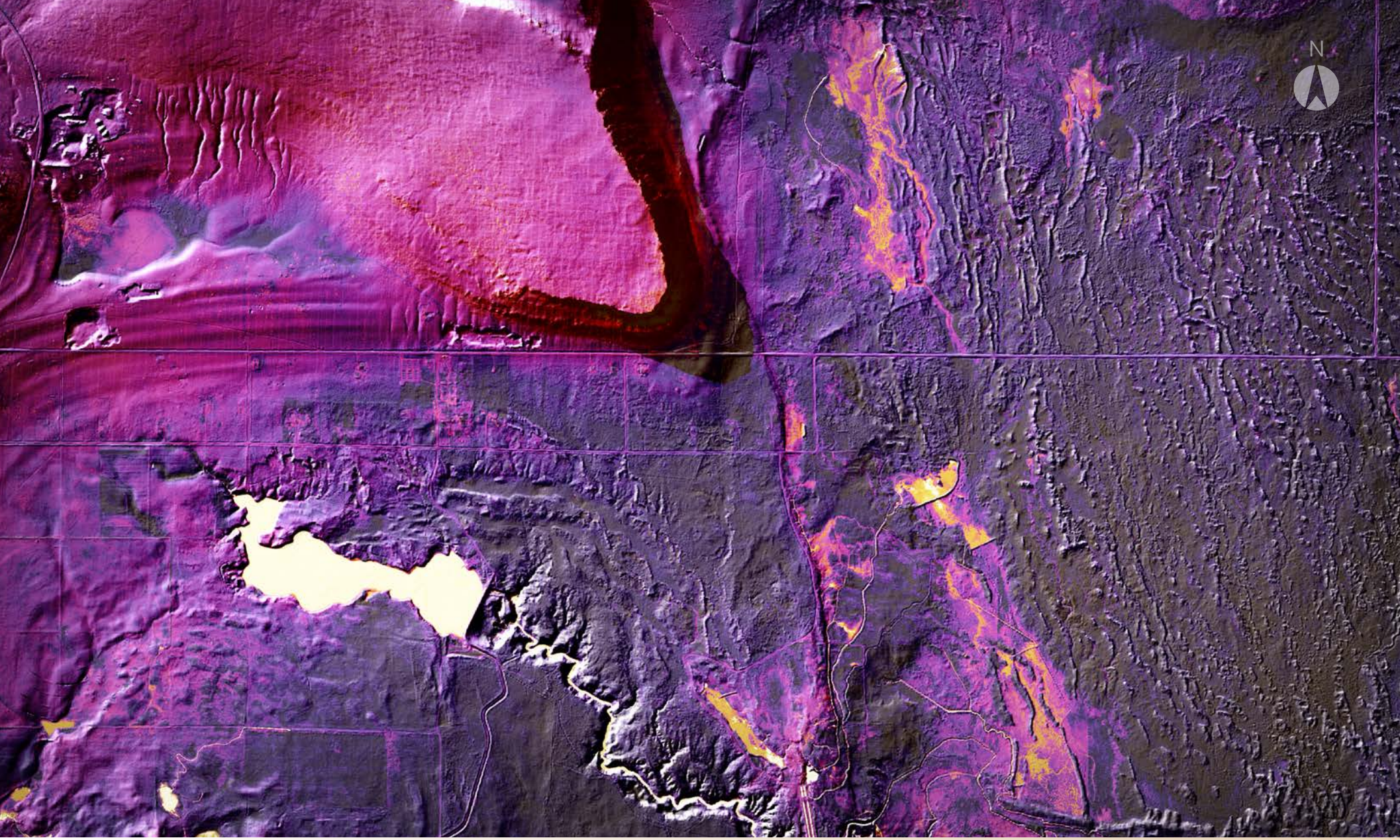
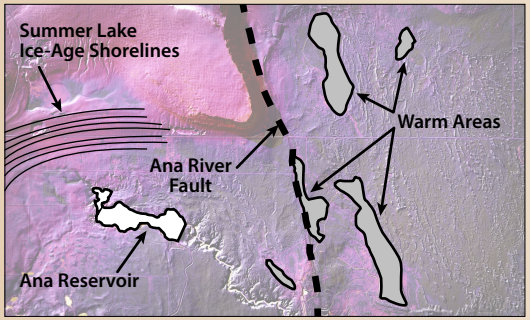
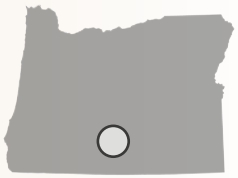
26	27	28	29	30	1	2





Infrared Imagery, Summer Lake Region, Lake County

This is a combined lidar – thermal infrared (TIR) image from the northern end of the Summer Lake basin. The TIR accurately measures surface temperature, and the lidar allows us to determine whether the surface is water, vegetation, rock or soil. This image was collected at night in midwinter, so the dark grey and purple areas indicate a temperature of about -14˚F, while the white and yellow areas indicate temperatures above freezing. At 54˚F, Ana Reservoir is the hottest feature on the image, and its warmth is due to warm springs. The curved parallel lines in the upper left are shorelines created during the last ice age when Summer Lake was much larger. The Ana River fault cuts across the middle of the image. Earthquakes on this fault have broken the ground surface several times in the last 13,000 years.



OREGON DEPARTMENT
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APRIL 2015

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12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	1	2

MAY 2015

JUNE 2015

S	M	T	W	T	F	S
31	1	2	3	4	5	6
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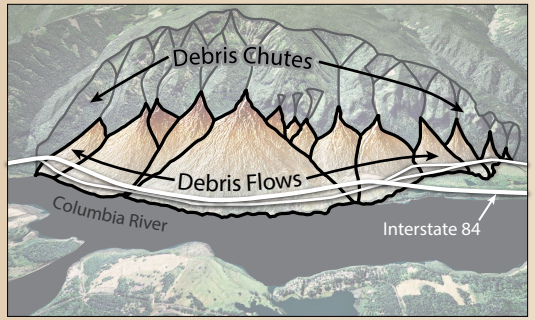
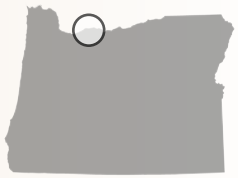
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	1	2	3	4

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
26	27	28	29	30	1	2
3	4	5 Cinco de Mayo	6	7	8	9
10 Mother's Day	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25 Memorial Day	26	27	28	29	30
31	1	2	3	4	5	6



Debris Flows, Columbia River Gorge, Multnomah County

On the Oregon side of the Columbia River Gorge, between Multnomah Falls and Bonneville Dam, the canyon walls consist of huge debris flow fans. These are large conical deposits of gravel and rock rubble that collect at the mouths of steep narrow canyons at the top of the valley wall. During heavy rainstorms, landslides in the canyons send waves of mud, rock, and trees down the fans. In 1996, a large debris flow near the community of Dodson buried a home, Interstate 84, and the Union Pacific Railroad tracks. The Washington shoreline in this area is the toe of a giant landslide that blocked the Columbia some 600 years ago. Great Ice Age Floods that swept through the Gorge 15,000-20,000 years ago removed loose material, so the fans we see today have accumulated since that time.



OREGON DEPARTMENT
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MINERAL INDUSTRIES

MAY 2015

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17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	1	2	3	4	5	6

JUNE 2015

JULY 2015

S	M	T	W	T	F	S
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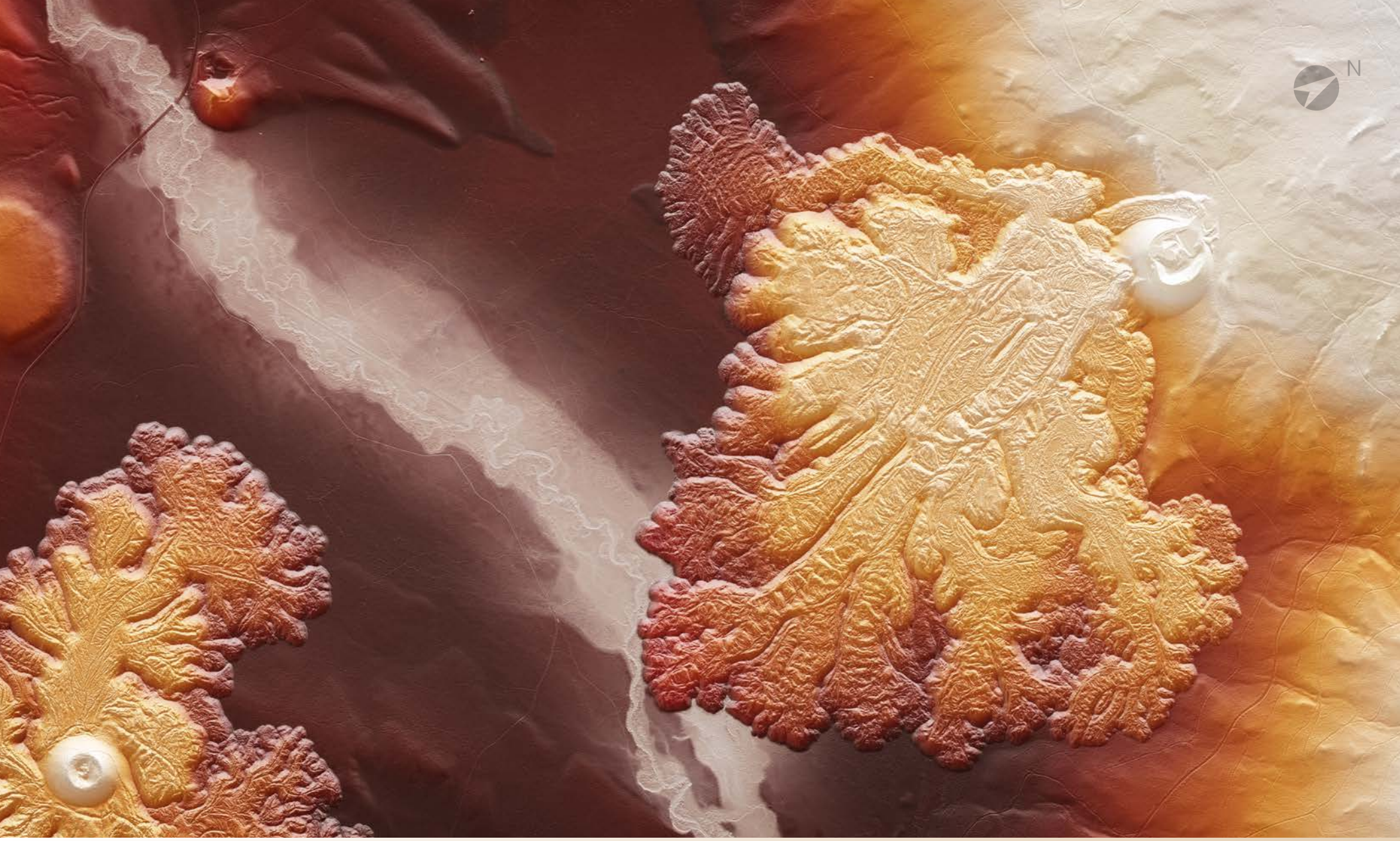
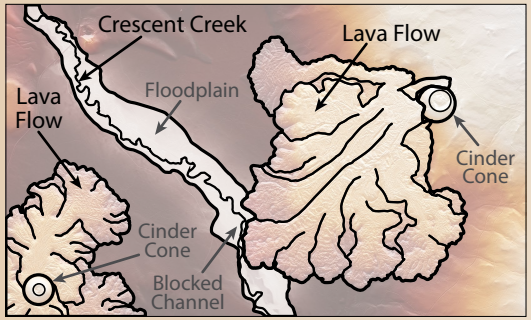
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	1

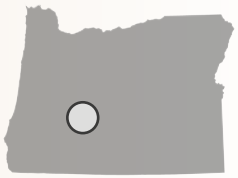
SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
31	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21 Father's Day	22	23	24	25	26	27
28	29	30	1	2	3	4





Cinder Cones, Lava Flows, and Crescent Creek, Klamath County

The Black Rock and Black Rock Butte lava flows are part of the Davis Lake Volcanic Field in central Oregon's Cascade Lakes area. The prominent cinder cone on each flow marks the vent from which the lava erupted. This lava was fairly thick and sticky, so it only flowed a short distance and left a characteristic ʻaʻā lava surface composed of a chaotic jumble of lava blocks of all sizes. These flows, which blocked and redirected Crescent Creek, probably erupted about 5,500 years ago. The intricate branching of the flow lobes is a fractal pattern, similar to the drainage pattern seen in the April (Dendritic Drainage Pattern) image.



OREGON DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

JUNE 2015

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7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	1	2	3	4

JULY 2015

AUGUST 2015

S	M	T	W	T	F	S
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9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31	1	2	3	4	5

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
28	29	30	1	2	3	4 Independence Day
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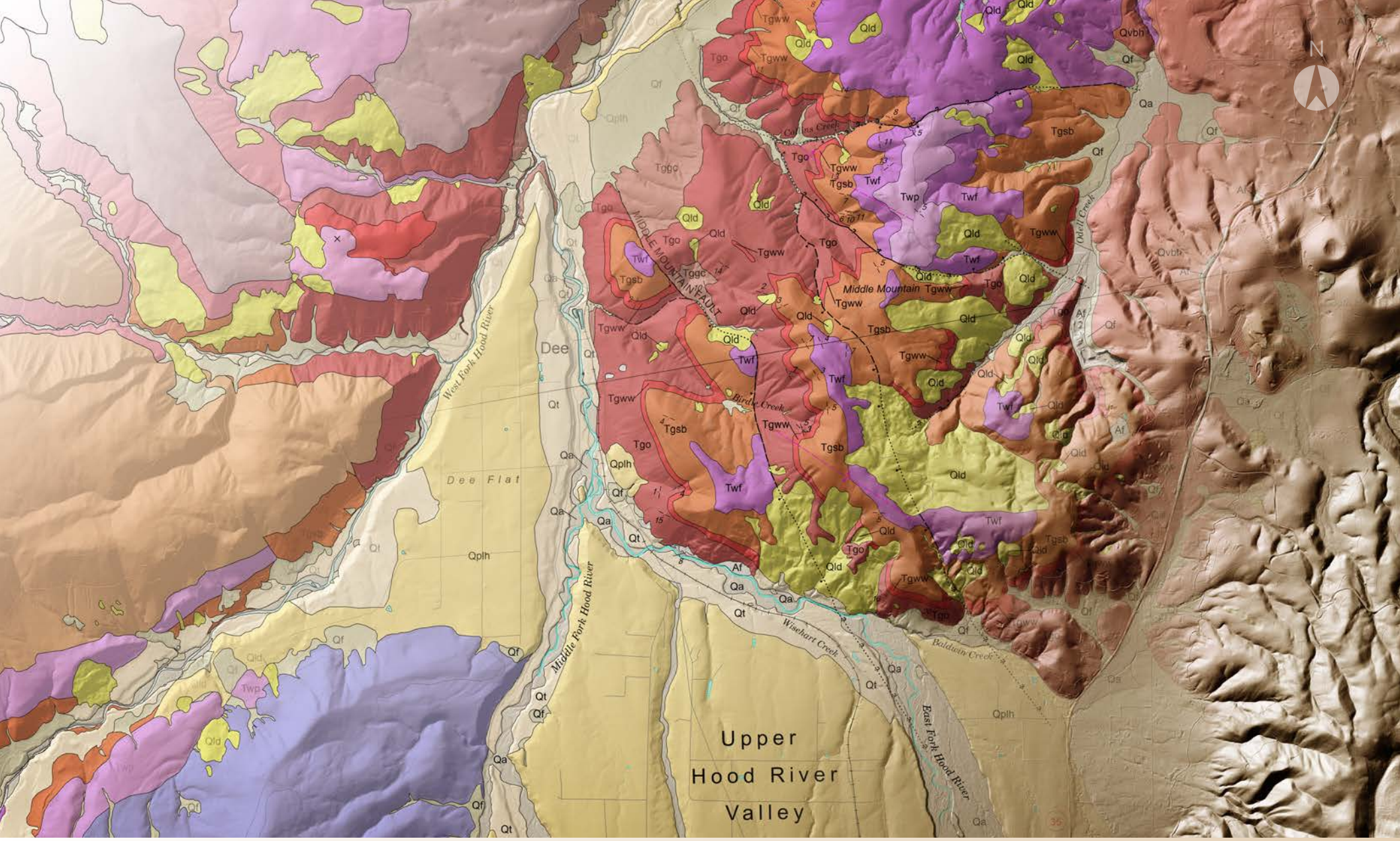
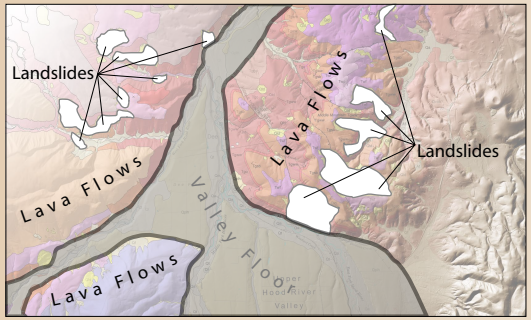
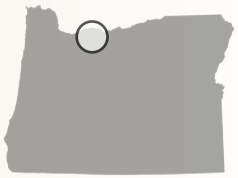




Geologic Units, Hood River Valley, Hood River County

Lidar is a key tool for preparing geologic maps like this recent example from the Hood River Valley. Many geologic features make distinctive patterns of topography, and lidar imagery allows geologists to accurately identify and trace them out. The lidar can also be used to provide a basemap under the geologic data, providing a map product that is accurate, informative, and aesthetically pleasing. The colors on this map indicate various geologic units like landslides (bright yellow) and lava flows (reds and purples).



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JULY 2015

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12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	1

AUGUST 2015

SEPTEMBER 2015

S	M	T	W	T	F	S
30	31	1	2	3	4	5
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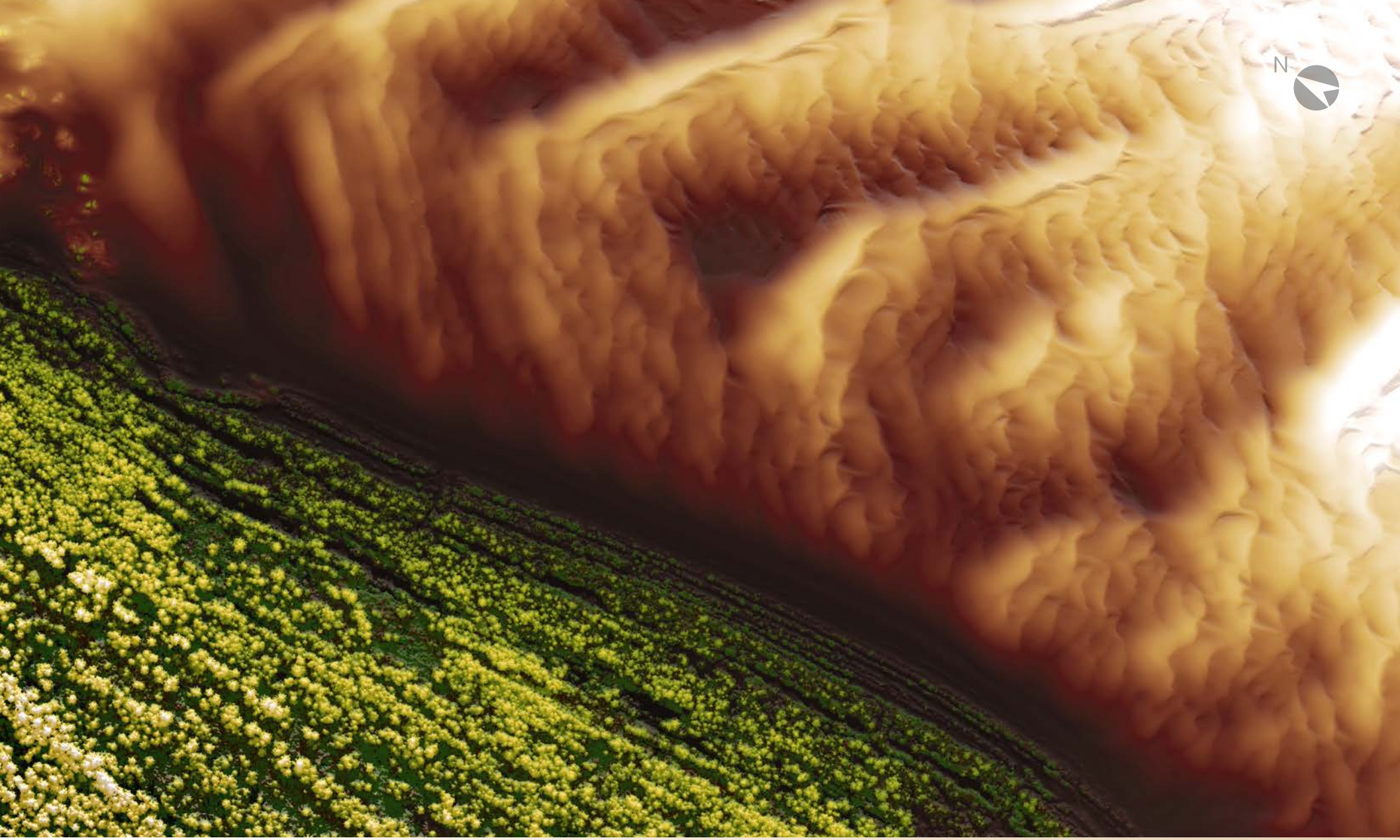
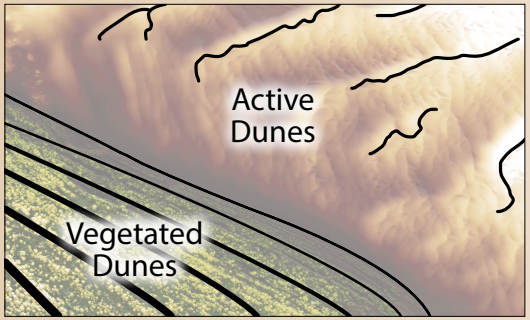
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	1	2	3

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
26	27	28	29	30	31	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31	1	2	3	4	5





Coastal Sand Dune - Forest Boundary, Lane County

This image shows the stark boundary between young active sand dunes and older dunes that have been stabilized by vegetation. Dune fields are constantly changing. Here the transition may have started when overflow from nearby Cleawox Lake intercepted blowing sand; alternatively, the transition may have begun in 1700, when the last great Cascadia Subduction Zone earthquake disturbed the shore. The active dune crests show two distinct orientations, driven by different directions of prevailing winds.

OREGON DEPARTMENT
OF GEOLOGY AND
MINERAL INDUSTRIES

AUGUST 2015

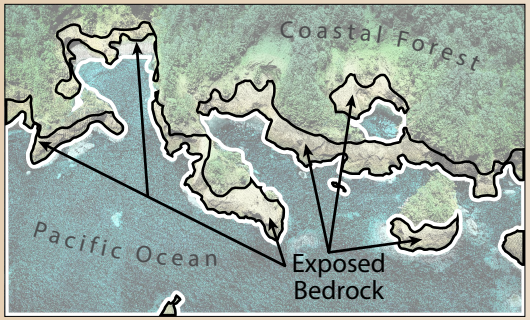
S	M	T	W	T	F	S
26	27	28	29	30	31	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31	1	2	3	4	5

SEPTEMBER 2015

OCTOBER 2015

S	M	T	W	T	F	S
27	28	29	30	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
30	31	1	2	3	4	5
6	7 Labor Day	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	1	2	3



Coastal Cliffs, Arches, and Sea Stacks, Boardman State Park, Curry County

This image shows sea stacks, arches, and coves along the southern Oregon coast in Samuel H. Boardman State Park. The image is made up of thousands of lidar points, each of which has been colored to provide a realistic three-dimensional model. On the headland on the far left, you can see the scan pattern of the lidar laser as distinct striping. The points are spaced about a foot apart on the ground. The invisible infrared laser used for lidar is usually absorbed by calm, clear water, but rough and turbid sea water is usually very well imaged.

OREGON DEPARTMENT
OF GEOLOGY AND
MINERAL INDUSTRIES

SEPTEMBER 2015

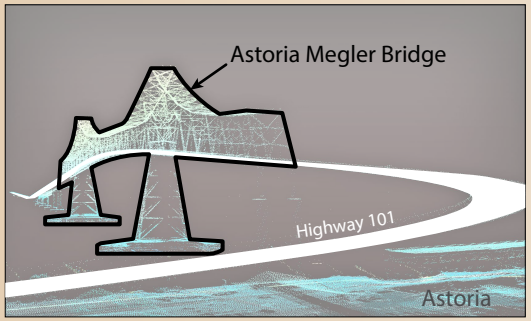
S	M	T	W	T	F	S
30	31	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	1	2	3

OCTOBER 2015

NOVEMBER 2015

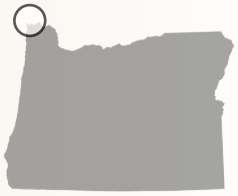
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	1	2	3	4	5

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
27	28	29	30	1	2	3
4	5	6	7	8	9	10
11	12 Columbus Day	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31 Halloween



Astoria-Megler Bridge, Clatsop County

The Astoria-Megler Bridge extends 4 miles across the mouth of the Columbia River, connecting Highway 101 in Oregon and Washington. Completed in 1966, the bridge replaced ferry service that was often delayed by weather. Nearby boreholes reveal that 12,000 years ago, sea level was almost 370 feet lower than today, and the Columbia River flowed in a deep valley where the bridge now stands.



OREGON DEPARTMENT
OF GEOLOGY AND
MINERAL INDUSTRIES

OCTOBER 2015

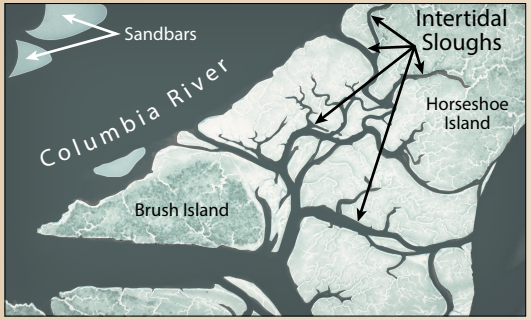
S	M	T	W	T	F	S
27	28	29	30	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

NOVEMBER 2015

DECEMBER 2015

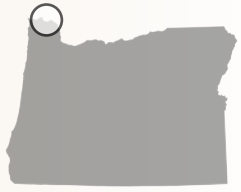
S	M	T	W	T	F	S
29	30	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1	2	3	4	5	6	7
8	9	10	11 Veterans Day	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26 Thanksgiving Day	27	28
29	30	1	2	3	4	5



Intertidal Sloughs and Islands, Columbia River, Clatsop County

This image shows islands and tide flats in the Lewis and Clark National Wildlife Refuge. Although most lidar cannot penetrate water, this image was acquired at low tide, revealing complex subtidal channels and sandbars. Geologists searching the shores of these islands have discovered evidence of the magnitude 9 earthquake that shook the Pacific Northwest on January 26, 1700. The strong shaking from the earthquake liquefied deep layers of sand, causing sand to erupt through the muddy surface and leaving zones of coarse sand slicing through the tide flat.



OREGON DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

NOVEMBER 2015

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	1	2	3	4	5

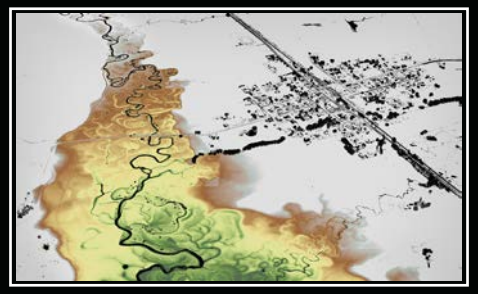
DECEMBER 2015

JANUARY 2016

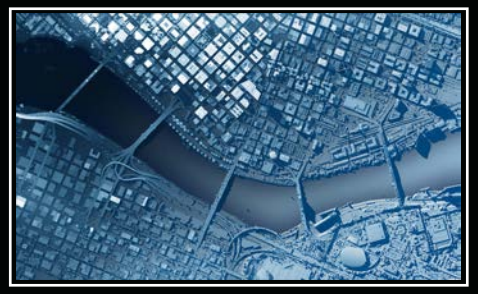
S	M	T	W	T	F	S
27	28	29	30	31	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	1	2	3	4	5	6

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
29	30	1	2	3	4	5
6	7 Pearl Harbor Remembrance Day	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24 Christmas Eve	25 Christmas Day	26
27	28	29	30	31 New Year's Eve	1	2

LIDAR EXPLORED • 2015 CALENDAR

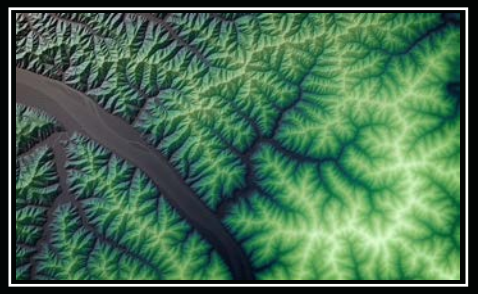


Powder River Floodplain
and the Community of Haines

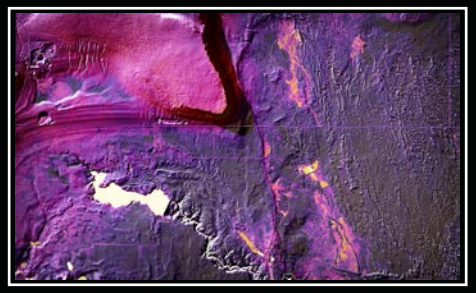


Portland City Center

Fault Block Mountains

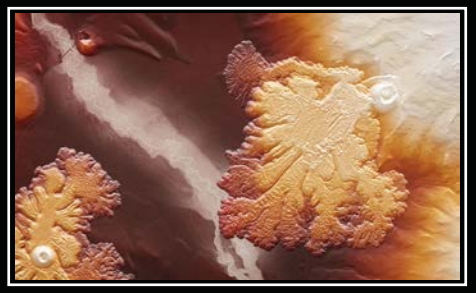


Dendritic Drainage Pattern



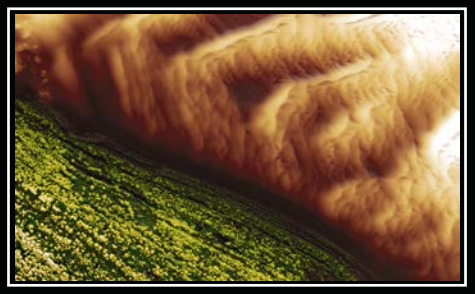
Infrared Imagery

Debris Flows



Cinder Cones, Lava Flows,
and Crescent Creek

Geologic Units



Coastal Sand Dune - Forest Boundary

Coastal Cliffs, Arches, and Sea Stacks

Astoria-Megler Bridge

Intertidal Sloughs and Islands

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