MISCELLANEOUS PAPER 16

A MOSAIC OF OREGON FROM ERTS-1 IMAGERY

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to accompany

Uncontrolled Mosaic Constructed from NASA ERTS Imagery

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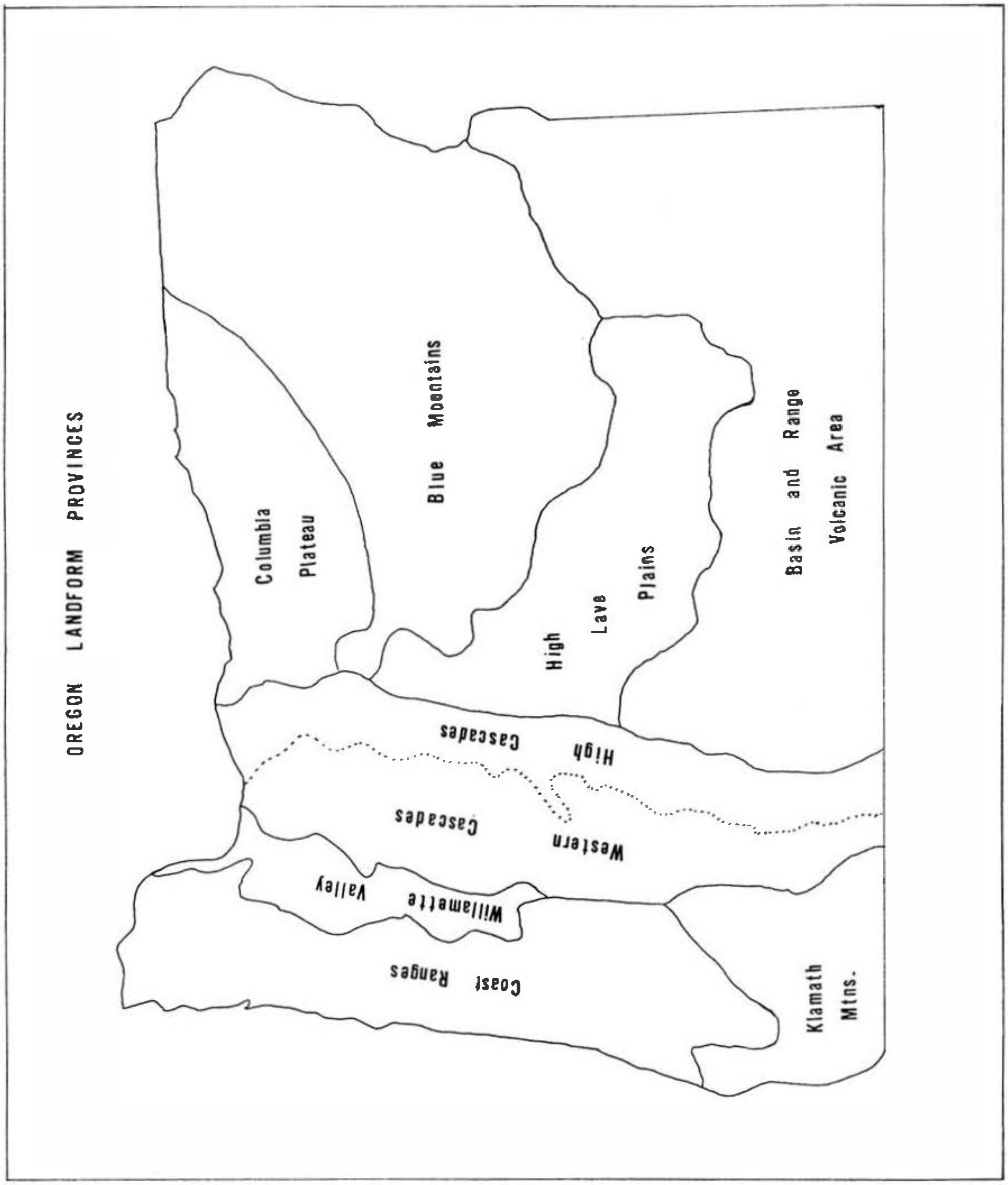
OREGON LANDFORM PROVINCES
Columbia Plateau
Blue Mountains
High Lava Plains
Basin and Range
Volcanic Area
High Cascades
Western Cascades
Willamette Valley
Coast Ranges
Klamath Mtns.

A MOSAIC OF OREGON FROM ERTS-1 IMAGERY

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This mosaic of Oregon provides a new perspective of the state and its resources. In addition to the unique portrayal of such a large area, it displays more detail than has previously been possible at any given scale. This new format is made possible by the Earth Resources Technology Satellite (ERTS-1) launched by the National Aeronautics and Space Administration on July 23, 1972. The Oregon mosaic was prepared by personnel of the Environmental Remote Sensing Applications Laboratory at Oregon State University. It was produced by combining 24 individual images recorded on various dates during the fall of 1972. It is one outgrowth of a multidisciplinary research program at Oregon State University which is evaluating and studying the imagery taken over the state of Oregon from the natural resource standpoint. This brief discussion is intended to introduce the user of the mosaic to the satellite system with which the imagery is produced and to point out some of the prominent features displayed.

The ERTS and its Sensors

The satellite is in a nearly polar, sun-synchronous orbit about 560 miles (906km) above the surface of the earth, and it completes one orbit in about 103 minutes. It is over Oregon at about 10:30 a.m. (PST), passing from north to south in about 2 or 3 minutes. Every 18 days it repeats an image of a given location, clouds permitting. Adjacent orbits are 24 hours apart. As a result, the entire state is imaged over the course of 7 days.

The satellite contains two earth-imaging instruments: a multispectral scanner (MSS) and a return-beam vidicon (RBV). The latter, a TV camera system, is not currently in use and will not be further discussed. Neither of these systems produce hard copy photographs as a direct process. This means that, within the satellite, data on energy intensities reflected from the ground are electronically recorded and transmitted back to earth. There the data are computer processed and black and white images similar to a photograph are created. These may be combined by various methods to produce false color pictures of the earth surface. These pictures may then be interpreted essentially as one would a photograph of more traditional origin, or the data may be analyzed by sophisticated computer methods. Individual images cover about 115 by 115 statute miles (185 km by 185 km) and neighboring images have about 40 percent overlap side to side at our latitudes with which stereo viewing is possible.

The multispectral scanner differs from a conventional camera in many important respects. It records data separately for different bands of the electromagnetic spectrum. Thus it separates the light so that one part of the instrument records only light that would pass through a green filter, another only light that would pass through a red filter, and two others only different parts of the near, or reflected, infrared spectrum. Thus each recorded scene actually produces four photographic products, two of visible and two of invisible infrared light. The Oregon mosaic was made from red band imagery since this most closely approximates an ordinary photograph and shows the greatest diversity of ground detail.

Another important difference between the scanner and a camera is the manner in which the data are acquired. In a camera, an entire area is recorded instantaneously. In the scanner, in contrast, data are acquired successively in narrow swaths. A mirror in the instrument scans back and forth in an east-west direction reflecting light into the detectors. The north to south motion of the satellite results in each line being slightly south of and adjoining the preceding one. Each single observation, ground resolution unit, as recorded on digital tape covers slightly more than one acre (0.4 hectare) of ground. These east-west scan lines can be seen on the mosaic where they appear as a faint scribing (actually more nearly east-northeast). They are seen most readily in the Pacific Ocean.

Investigators experimenting with the capability and applications of this new imaging system for earth resources are reporting many successful applications in the fields of agriculture, forestry, range-land resources, geology, land use, and oceanography. New users of space imagery initially tend to discount its value because of its small scale and lower resolution compared to customary photography. It is not a panacea, and some problems and information needs are not suited to ERTS solution. Used appropriately, especially in conjunction with aircraft photography and ground work, it is part of a promising new technology for use by many disciplines. In some instances, new applications of this synoptic imagery are immediately obvious; in others, persistence is required to discover its most appropriate role in the solution of problems encountered by each earth resources discipline.

The Mosaic of Oregon

The mosaic will repay close examination with new insights into the relations between major features of the state, its resources, and land-use patterns. Certain cautions should be observed, however. No corrections have been made for distortion in the imagery and consequently the scale of the uncontrolled mosaic does not meet map accuracy standards.

Another factor that must be kept in mind is the sun angle at the time the imagery was taken. Since the satellite is over Oregon in the mid-morning, the sun is to the southeast in all of the imagery. Thus, shadows are cast to the northwest, and since this is opposite to the way shaded relief maps are traditionally made, the topography may appear inverted. Viewing the mosaic upside-down will help those who find this a problem. Perhaps the most obvious effect of the sun angle on the imagery is on the southeast-facing scarp of the Steens Mountains in southeastern Oregon; in full sun it is difficult to pick out in spite of its being the largest such feature in the state. West of the Steens, even minor scarps facing west and northwest are clearly visible. A third factor that affects the imagery is the time of year during which it was obtained. The mosaic is composed entirely of fall imagery and thus shows Oregon as it appears during the end of the dry season.

Surprisingly few cultural features are visible on the mosaic. They are more evident in the color reconstituted products. The most obvious features are the numerous cultivated fields and forest clearcuts. The numerous linear features trending north toward Puget Sound from the Portland area and along the east side of the Cascades near Crater Lake are mainly the clearings for power transmission lines and pipelines. In some places, the interstate highway system can be seen, as near Pendleton. The most remarkable cultural feature is the Redmond airport in central Oregon, which is evident on the red band imagery; the red volcanic cinders used in its construction give the runways a stronger than normal dark contrast. The principal urban areas of the Willamette Valley are distinguishable, with experience, as medium tone areas with a fine speckled or line-striated texture. These show as contrasting bluish-purple areas in the color reconstituted images.

The mosaic is almost cloud free, but a few spots are obscured. Along the coast there are clouds at Cape Lookout and Humbug Mountain. In northern California there is a large cloud bank. A few small clouds overlie the Wallowa Mountains and adjacent parts of Idaho and Washington.

Natural Features

The mosaic emphasizes the natural features of Oregon, highlighting the beauty of a state well worth care by her citizens. The natural subdivision of Oregon into landform and geologic provinces (Figure 1) is clearly shown on the mosaic. In the following discussion, a few of the most readily observed features of each province are pointed out to aid in the full appreciation and use of the mosaic.

Coast Range and Coast

Along the Pacific Coast the effect of rock type is very clear. Resistant volcanic rocks form the headlands that jut out into the sea, while the softer sedimentary units back the straight shoreline. Bright beach and dune sands of Clatsop Spit near the mouth of the Columbia River and the dune complex between Florence and Coos Bay show very light tones. The extensive light-colored area northeast of Cape Lookout is the location of the now revegetated Tillamook Burn. Features of many of the streams and estuaries of the Coast Range are well displayed. In particular, the intrenched meanders of many of the streams are clearly visible. The best examples are the Yaquina and Alsea Rivers near the coast and the Siuslaw River further inland. On the Yaquina River, one meander scar is especially bright and this one is abandoned, or cut off, and largely filled in. The complicated system of sandbars in the mouth of the Columbia River is clearly seen.

Willamette Valley

The valley is a structural depression between the two mountain ranges, The Coast Range and the Cascades. On the mosaic it is obvious because of the lack of forest cover and the light, fall-season tone of the agricultural fields. The current channel of the Willamette River is particularly clear in the southern half of the valley, where the relatively narrow flood plain has a dark tone because of the presence of trees, but the fields surrounding it on raised terraces have drier and lower vegetation. Erosion of the Cascade Mountains has resulted in the deposition of large alluvial fans in the valleys at the mouths of the major streams, since material is added faster than the Willamette River can carry it away. The fan of the Santiam River about midway up the valley shows in slightly darker tones and smaller fields. The alluvial gravels of the fan support a different form of agriculture than the terraces of the valley floor.

Klamath Mountains

The older rocks of the Klamath Mountains are distinguished as more rugged terrain along the southern Oregon and northern California coasts. In Oregon the northeastern alignment of the ridges and valleys reflects the structural trends of the rocks of the area. The Josephine Peridotite and other major ultramafic bodies are clearly revealed to the northeast of Crescent City, California. The poor soils produced by these ultramafic materials result in sparse vegetation, which is revealed on the imagery by light-gray tones that closely reflect the outcrop area.

Cascade Range

The extent of the Cascade Range is generally shown by the dark tones of its forest cover. Clearly displayed in this background are the bright whites of the snow-crested volcanoes: Mounts St. Helens and Adams in Washington, and, from north to south in Oregon, Mounts Hood and Jefferson, the Three Sisters, Diamond Peak, Crater Lake, and Mount McLoughlin.

The Cascades are separated into the Western Cascades, where the rocks are older, and the High Cascades, where the rocks are very young and some of the volcanoes are probably only dormant. This boundary shows fairly distinctly on the mosaic as the eastern edge of the forest clearcutting. In effect, the older rocks support the more valuable timber resource. The boundary is further emphasized by the mature, integrated drainage on the older rocks in contrast to the conical volcanic landforms and poorly developed drainage of the recent volcanoes of the High Cascades. The most recent volcanic flows distinguishable on the mosaic in the Cascade region come from Belknap Crater just north of the Three Sisters. The basaltic flows are not quite as dark as the surrounding forest.

High Lava Plains

The High Lava Plains of central Oregon contain the most abundant recent volcanism in the state. Newberry Caldera in the southwestern corner of the province is a large basaltic shield volcano with a collapsed top similar to Crater Lake. The two lakes occupying this caldera are visible, as is the light-colored obsidian flow just south of and between them.

Very recent basaltic flows are seen in the High Lava Plains at Lava Butte northwest of Newberry Caldera, at three places southeast of Newberry, and at Diamond Craters south of Malheur Lake. The different shades in the flows southeast of Newberry reflect different ages. The darker the flow, the younger.

Another interesting lava flow is Wright's Point, an example of inverted topography, south of Burns. The lava flowed down a valley over soft material which it then protected from erosion while the soft valley walls continued to be lowered rapidly, resulting in what now appears to be a lava flow along a ridge. A similar feature can be seen at Railroad Point just south of the Oregon border and west of the Pueblo Mountains.

An interesting feature extends west-northwest across the length of the High Lava Plains. On the mosaic its character is well shown as a complex of en echelon fractures of the ground. These fractures form the Brothers Fault Zone, one of the more recently active structures in the state and the northern terminus of the Basin and Range Province at this location.

The two lakes at the eastern end of the High Lava Plains, Harney and Malheur, present an interesting contrast on the mosaic. Malheur Lake is very dark as a result of many aquatic plants. Lighter tones around the edges show shallow water darkened by vegetation. Harney Lake, in contrast, lacks vegetation and shows typical desert lake behavior. The light tones reflect the extremely shallow water, while the bright tones are deposits of alkaline salts and other light-colored lake sediments that rim the lake as it gradually dries up.

Basin and Range Province

South of the High Lava Plains, the rock units are also volcanic but somewhat older. Here the terrain is dominated by the effects of numerous faults that have broken the rock units into upraised mountain ranges and down-dropped basins. The most visible faults are those trending northeasterly with a down-dropped block to the west. As noted above, the complimentary faults, which have down-dropped blocks on the eastern side, directly face the sun and so are difficult to see.

Numerous dry or seasonally ponded lakes occupy the various basins. Where the lake basins are completely dry, a bright-toned playa, such as the Alvord Desert east of Steens Mountain, is seen. Two other light-toned features that may be confused with playas are areas where materials are being moved by the wind, such as Christmas and Fossil Lakes about 50 miles north-northeast of Summer Lake, and scars left by range fires. A number of range-fire scars can be seen around Abert Lake. A prominent one just west of the lake leaves a long north-south scar, and there are at least three in the vicinity of North Alkali Playa, north of Abert Lake.

Among the more dramatic features in arid eastern Oregon are the glacial valleys of the Steens Mountains. These are clearly revealed on the mosaic as wide cuts on the crest of the range where glaciers carved deep U-shaped troughs.

Blue Mountains

The Blue Mountains are a complex area composed mainly of deformed older rocks. The higher areas are generally dark toned from forests, while the valleys show as lighter-toned fields and range land. The very highest areas have the lightest tones owing to bare rock above timberline and occasional snow.

In the northeastern corner of the Blue Mountains province are the Wallowa Mountains. Here the light-colored rock above the forest is mostly intrusive granitic material. Glacial valleys similar to those in the Steens are present. Along the northern range front is the scarp of the fault movement that uplifted the range. Wallowa Lake, contained by glacial moraines, breaks across this scarp.

The linear aspect of the various valleys of the Tri-state Upland north of the Wallowas indicates that in this area most of the streams and rivers follow large fractures that have broken and weakened the rocks. Another area of interesting fracture-controlled topography is in the Ochoco Mountains around Big Summit Prairie south of Mitchell where trees growing in open joints produce a cross-hatched pattern.

Columbia Plateau

The Columbia Plateau of eastern Washington extends across into north-central Oregon. It is underlain by numerous thick basalt flows, which tilt away from the Blue Mountains. On the mosaic this is shown by the deeply incised streams between large wheat fields on the intervening broad uplands.

A careful look at the area along the Columbia River will reveal faint linear features parallel to the river; these are windblown soils deposited and eroded by winds that blow up out of the Columbia Gorge. Older wind-deposited soils revealed by the peculiar pattern of ridges north of Walla Walla, Washington, are the Palouse Loess deposited during the glacial period.

Obtaining and Using Other ERTS Imagery

The Oregon mosaic is only one of the products developed and available because of the ERTS-1 experiment. Much greater detail can be seen on positive film transparencies. These can be obtained in black and white for each band or in reconstituted color for selected sections required by investigators. The 18-day cycle of the satellite means that sequential imagery is available for many purposes where scene change is important. Thus an area of interest can be studied during the wet season, the dry season, and perhaps even with a snow cover, assuming the clouds cooperate; the sensors do not see through the clouds. The photographic images can be obtained at a variety of scales from 1:1,000,000 to 1:250,000. The latter is proving to be highly useful. Some commercial firms make additional color reconstituted prints and enlargements. The primary public outlet for the imagery is the EROS Data Center of the U.S. Department of Interior:

EROS Data Center
Sioux Falls, South Dakota 57198
Phone (605) 339-2270

The Environmental Remote Sensing Applications Laboratory (ERSAL) at Oregon State University has a complete file of all ERTS-1 imagery over Oregon that is 70 percent or less cloud covered and of most of the NASA high-flight aircraft imagery flown over the state. The imagery is available for examination at the Laboratory, where it may be used by government agencies for feasibility studies or short-term projects. In addition, ERSAL has a complete ERTS-1 catalog in both hard copy and microfilm. Imagery outside of Oregon may be viewed in microfilm. All imagery is indexed for easy access and a good approach for ordering image copies is to examine the material so that orders can be placed by image date and frame number rather than by general indication of latitude and longitude of the area of interest. The Laboratory may be contacted at the following address and telephone number:

Environmental Remote Sensing Applications Laboratory (or ERSAL)
Oregon State University
Corvallis, Oregon 97331
Phone (503) 754-3341

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ERTS Photo Mosaic of OREGON

SCALE 1:1,000,000 (APPROX.)

10 0 10 20 30 40 MILES

10 0 10 20 30 40 50 KM.

Uncontrolled Mosaic Constructed from NASA ERTS Imagery 1972 Environmental Remote Sensing Application Laboratory

OREGON STATE UNIVERSITY
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