Oregon-Nevada lineament

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ABSTRACT

The Oregon-Nevada lineament is a 750-km-long northwest- to north-northwest–trending belt of closely spaced, partly en echelon faults extending from central Oregon to central Nevada. The lineament is also marked by centers of volcanic activity that yielded voluminous late Miocene lava flows in Nevada and Miocene and younger volcanic rocks in Oregon. A conspicuous aeromagnetic anomaly is coextensive with the lineament in Nevada. The lineament is considered to be the surface expression of a deep-seated fracture zone that may have had a complex history of strike-slip and tensional movement.

INTRODUCTION

A belt of closely spaced, partly en echelon faults extending from near Mount Jefferson (near A, Fig. 1) in north-central Oregon southeastward to Eureka (near F, Fig. 1) in central Nevada is here named the Oregon-Nevada lineament. The lineament, which is 750 km long, is well defined in central Oregon by numerous faults and late Miocene and younger volcanic vents, poorly defined in southeastern Oregon, and again well defined in north-central Nevada, where it is marked by faults, voluminous late Miocene lava flows and flow domes, and a conspicuous linear aeromagnetic anomaly. Faults with similar trends are present in adjacent areas but are not so closely spaced. In plan, the lineament is arcuate with a north-northwest trend in Nevada and a northwest to west-northwest trend in Oregon.

In Oregon, the lineament was recognized in the High Lava Plains province as a belt of interlacing en echelon faults informally referred to as the Brothers fault zone (Higgins and Waters, 1967; Walker and others, 1967; Walker, 1969). The extent and character of the lineament was further defined by Walker (1973) on the basis of reconnaissance mapping.

In northern Nevada, Roberts (1960, 1966) suggested a northwest trend of structural and mineral belts and noted in this regard the northwest trend of the aeromagnetic anomaly here considered to be related to the Oregon-Nevada lineament. This anomaly has been described in detail by Mabey (1966) and Robinson (1970). The southern part of the lineament described here has also been recognized by Rowan and Wetlaufer (1973) on the basis of linear features on Earth satellite (ERTS-1) imageries.

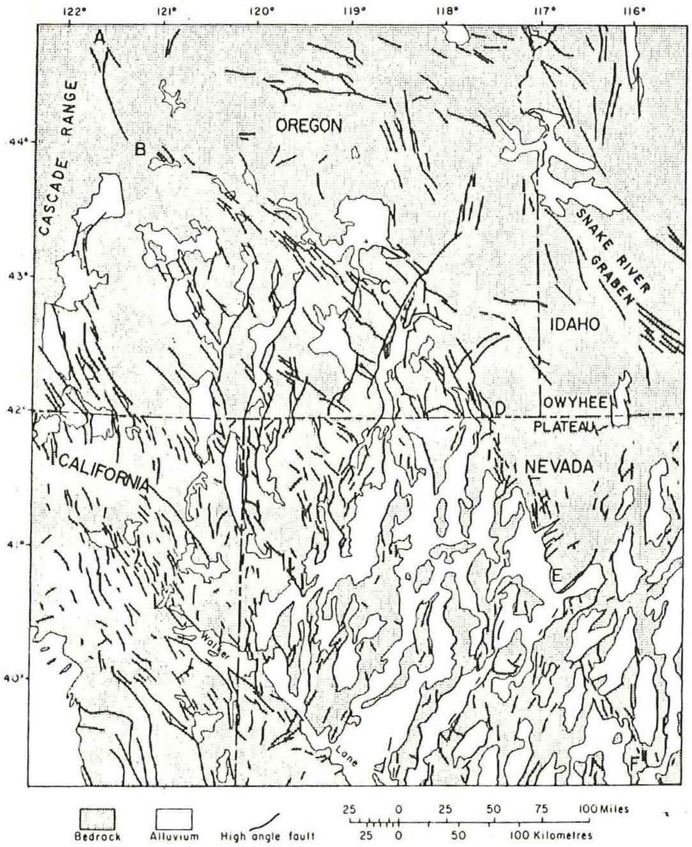

Figure 1. Generalized geologic map showing trend of Oregon-Nevada lineament (A to F). Geology based on various maps including Walker (1973) and Stewart and Carlson (1974).

The geologic relationships in Nevada presented here are based on reports, including Gilluly and Masursky (1965), Gilluly and Gates (1965), Roberts and others (1967), and Stewart and McKee (1970), as well as on unpublished maps by F. J. Kleinhampl, J. H. Stewart, M. L. Sorensen, and J. E. Carlson in northeast Humboldt County, by R. C. Greene, R. R. Coats, and Leland Cress in western Elko County, and by J. H. Stewart in Eureka County.

OREGON

The segment of the Oregon-Nevada lineament in Oregon trends northwest to west-northwest from the Cascade Range to the Nevada border (A to D, Fig. 1). For much of this distance (B to C, Fig. 1) the lineament is well defined and medially located within the High Lava Plains province of Oregon. The conspicuous north-northeast–trending fault zone in southeast Oregon (east of C, Fig. 1), which bounds the Steens and Pueblo Mountains block on the east, separates this well-defined part of the Oregon-Nevada lineament from a less precisely defined part. The lineament may bifurcate to the southeast of C on Figure 1 – one zone of faults extending southeastward into northern Nevada and another eastward into southeastern Idaho. Of these two fault zones, the one extending into Nevada is the most conspicuous and joins the better defined segments of the Oregon-Nevada lineament lying to the northwest and southeast. Near the Oregon-Nevada line and in northern Nevada the lineament forms a part of the western margin of the Owyhee Plateau or Upland.

Throughout the entire distance in Oregon, the surficial rocks in and near the lineament are almost entirely of Miocene or younger age and are entirely of volcanic and volcaniclastic or sedimentary origin, including extensive flows and flow breccia of basalt and andesite, widespread ash-flow tuff units of rhyolitic composition, palagonitic and tuffaceous continental sedimentary rocks, rhyolitic flows, and a variety of rocks representing volcanic vent complexes and near-surface intrusive masses.

Within Oregon the lineament is characterized by a zone about 10 km wide of en echelon high-angle normal faults with both north- and south-facing scarps and with displacements from a metre or less to as much as hundreds of metres. Eruptive centers for both basaltic and rhyolitic volcanic rocks are concentrated in this zone of faults and fractures and in some nearby fault zones, particularly in the segment between points B and C in Figure 1. The silicic centers include large domelike masses and related flows, vents for large- to intermediate-volume ash-flow tuff units that have largely been buried and obscured by later lava flows and sedimentary deposits, and some isolated plugs. Several lines of evidence, including isotopically determined ages, indicate a progressive, though somewhat sporadic, decrease in the age of both basaltic and rhyolitic volcanism from the vicinity of point C to point B (Walker and others, 1974a, 1974b). K-Ar ages of silicic rock masses in this part of the lineament vary from 10 to 11 m.y. near point C to 1 m.y. or younger near point B.

Aeromagnetic data (U.S. Geol. Survey, 1973) provide no convincing evidence in support of a major throughgoing structure or structures in Oregon. Apparently mafic dike swarms that in other areas result in conspicuous linear aeromagnetic anomalies are lacking in the Oregon part of the lineament.

NEVADA

The segment of lineament in Nevada is marked by a zone of closely spaced northwest-trending faults best developed in northeast Humboldt County and southwest Elko County (Figs. 1, 2). North-northwest–trending faults are also recognized locally along the lineament farther south in eastern Lander County and western and southern Eureka County. The northwest-trending zone that defines the lineament is segmented by many northeast-trending basin-and-range faults that outline the main physiographic features of the region.

Most of the rocks exposed within the area of the lineament are Tertiary lava flows and flow domes. Other types of Tertiary volcanic and sedimentary rocks crop out locally, and Paleozoic and Mesozoic sedimentary, volcanic, and plutonic rocks are extensively exposed in some areas. The lava flows and flow domes form a southeast-trending belt closely related spatially to the lineament. These lava flows and flow domes range in age from 13.8 to 16.3 m.y., based on eleven K-Ar ages listed by McKee and others (1971) and one unpublished date by M. L. Silberman (1973, written commun.).

Flow rocks along the lineament in eastern Humboldt County and western Elko County reach a thickness of about 850 m in the Santa Rosa Range (LeMasurier, 1968; loc. S, Fig. 2) and 600 m north of Jake Creek Mountain (R. C. Greene, 1973, written commun.; loc. U, Fig. 2). Silicic rocks include rhyolite, rhyodacite, and minor amounts of dacite; they are flow banded and locally vitrophyric. Rhyolitic rocks are unusually thick on Capitol Peak (loc. Q, Fig. 2), in a topographically high area 14 km south of Capitol Peak (loc. R, Fig. 2), and along a south-southeast–trending ridge in western Elko County (from loc. T to loc. V, Fig. 2); these localities probably coincide with major vents that were sources of the lava. Andesite, basalt, and dacite flows complexly interfinger with the rhyolitic rocks.

Silicic flow domes (Fig. 2), which consist of intrusive domes and associated flows of porphyritic rhyolite and rhyodacite, also occur in southwesternmost Elko County and northernmost Lander County. These rocks intruded and in places flowed over the basaltic andesite (Tba, Fig. 2) that is exposed along the trend of the lineament to the south.

The southern one-half of the lineament in Nevada is characterized by basaltic andesite flows (Fig. 2) that are thickest (about 300 m) along the west side of the Sheep Creek Mountains (E. H. McKee, 1969, written commun.; loc. W, Fig. 2) and in the Shoshone Range (Gilluly and Gates, 1965, p. 83; loc. X, Fig. 2). Individual flows vary in thickness from about 1 to 30 m and generally can be traced for a few kilometres. South-southeast–trending mafic dikes, some nearly 1.6 km long and nearly 250 m thick, cut across the Cortez Mountains (loc. Y, Fig. 2) and may represent feeders for the basaltic andesite. Similar dikes have also been reported in the Roberts Mountains (Mabey, 1966, p. 82; near loc. Z, Fig. 2), where dikes and associated flows have been dated by radiometric methods as about 13 to 15 m.y. (E. H. McKee, 1974, oral commun.).

A conspicuous aeromagnetic anomaly (Fig. 3) that may be related to rocks extending at least as deep as 15 km (Robinson, 1970) coincides with the lineament in north-central Nevada. The close spatial association of the anomaly with late Miocene lava flows and flow domes (Fig. 2) suggests that the flows and, to a greater extent, the feeders for these flows are the source of the anomaly. This view is supported by Mabey's (1966) observation in the Roberts Mountains that the dikes, presumably the feeders for the basaltic andesite flows, are highly magnetic. The anomaly is segmented in areas of crosscutting northeast-trending faults, apparently the result of downdropping of the highly magnetic rocks of the feeder dikes.

INTERPRETATION

The Oregon-Nevada lineament is considered to be the surface expression of a deep-seated fracture zone that may have had a complex history of strike-slip and tensional movement. The en echelon pattern of surface faulting in Oregon suggests that that segment of the lineament was produced by strike-slip movement. The Nevada part, on the other hand, is perhaps better explained by a deep-seated tensional system that allowed for major fissuring and the tapping of deep magma sources. This two-part division of the lineament permits debate on whether the lineament is really a throughgoing feature or whether it is instead composed of two unrelated segments produced within different stress fields, perhaps at different times during the late Tertiary. We feel, however, that the alignment of the two segments and the presence of in-line faults that appear to tie the two segments together are sufficient evidence for the interpretation that the lineament is related to a single fracture system, or at least to a system of interrelated strike-slip and tension zones. One permissive model is that the lineament initially developed as a simple strike-slip fault system and that shear and drag occurring at a later time caused the rotation of the Nevada part of the lineament into an orientation that permitted at least partial tensional opening.

The lineament is considered to have developed in late Miocene time, judging from the ages of the lava flows that are spatially related to the lineament in north-central Nevada and in Oregon. The oldest date from lava associated with the lineament in north-central Nevada is 16.3 m.y., and silicic volcanism related to the lineament in Oregon is as old as 10 to 11 m.y. The age of the oldest lava in Nevada corresponds well to the time of inception of basin-and-range faulting in north-central Nevada (Christiansen and Lipman, 1972). As outlined by Atwater (1970), Christiansen and Lipman (1972), and Lipman and others (1972), basin-and-range faulting can be

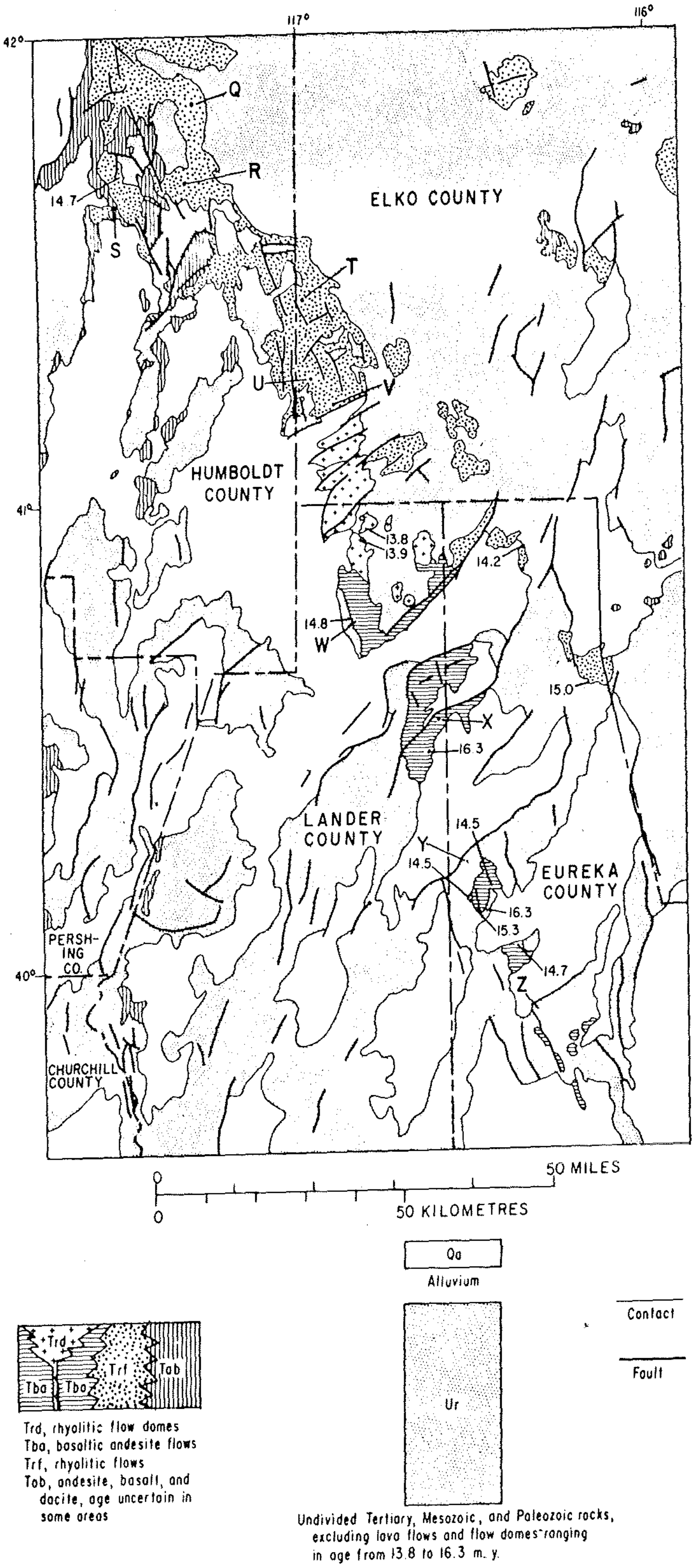

Figure 2. Geologic map showing distribution of 13.8- to 16.3-m.y.-old lava flows and flow domes in north-central Nevada. Localities Q to Z mentioned in text. Numbers are K-Ar ages in millions of years.

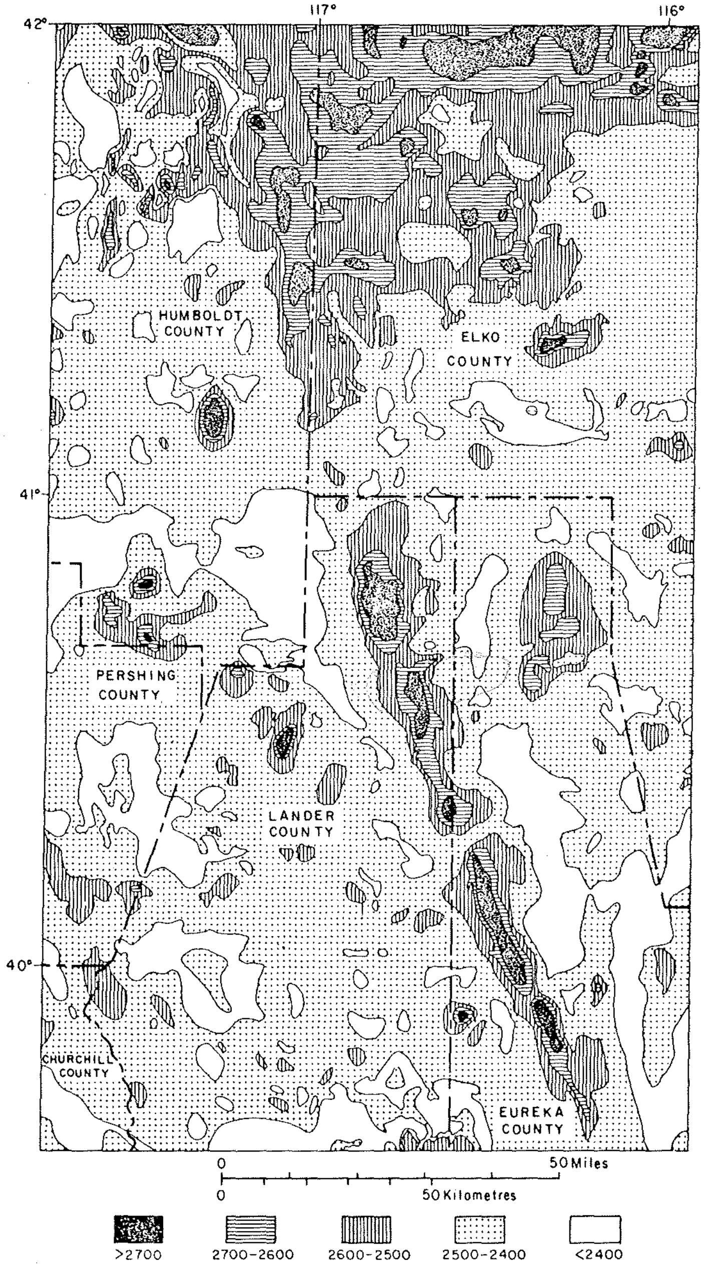

Figure 3. Aeromagnetic map of north-central Nevada. Based on various open-file maps of the U.S. Geological Survey as compiled by Isodore Zietz (1973, written commun.). Magnetic contours in gammas relative to arbitrary datum.

interpreted as the result of a major change in the tectonic framework of North America due to the intersection during the Tertiary Period of the North American continent with the East Pacific Rise. This intersection is considered to have initiated the development of right-lateral movements (San Andreas fault, Walker Lane) along northwest or north-northwest trends and oblique tensional fragmentation (basin-and-range faulting) along northeast trends in western North America. We consider the Oregon-Nevada lineament to be another structural feature related to this major change in the tectonic framework of North America.

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