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COVER PHOTO

One margin of meter-wide gabbro screen near base of sheeted-dike complex of Josephine ophiolite, southwestern Oregon and northwestern California. Article beginning on next page discusses depositional contact between Galice Formation and Josephine ophiolite.

Geology and geothermal resources of central Cascades summarized in new report

A summary of five years of research into the geology and geothermal resources of the central Cascade Range has been placed on open file by the Oregon Department of Geology and Mineral Industries (DOGAMI). The report, DOGAMI Open-File Report 0-82-7, is entitled *Geology and Geothermal Resources of the Cascades, Oregon.*

The 205-page report presents a geologic overview of the entire area, including recommendations for geothermal exploration, describes the geology of four smaller areas of particular interest in Marion and Lane Counties, and discusses the heat flow of the entire Cascade Range. Past and present volcanic-stratigraphy studies are summarized, and tectonic models of the Cascades and exploration models for geothermal resources are presented.

New information in the report includes numerous radiometric age determinations, chemical analyses of rocks and thermal waters, and temperature and heat-flow data from drilling projects.

The text is accompanied by five map sheets containing four new geologic maps, a heat-flow map with data points for the entire Oregon Cascades, and an index to geologic mapping of the area.

Because this paper is only a first draft of a more complete report that will be released as Special Paper 15 in the fall of 1983, only a limited number of copies were produced, primarily for purposes of review. It is thus possible that very few, if any, copies will be available at the time of this printing. Copies are, however, available for inspection at the DOGAMI library in Portland and at the State Library in Salem.

Purchase price of Open-File Report 0-82-7 is $20. Check with the DOGAMI office, 1005 State Office Building, Portland, OR 97201, for availability before ordering. Orders under $50 require prepayment. □

Mineral payments increased to states

The Bureau of Land Management (BLM) has made record payments to the states of Oregon and Washington as their share of mineral revenues from federal lands in the two states.

For the fiscal year ending September 30, 1982, Oregon gained $4,415,626, while Washington gained $582,035. These sums are half of all mineral leasing fees collected within the states.

Payments were made to 23 mineral-producing states for a total of $548,161,648, a 44-percent increase over the previous record year. In the Pacific Northwest, increases were even more—for Oregon, the total was more than 400 percent over the previous year, and in Washington it was 1,100 percent.

—*BLM News: Oregon and Washington*

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A depositional contact between the Galice Formation and a Late Jurassic ophiolite in northwestern California and southwestern Oregon

by Gregory D. Harper, Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah 84112

INTRODUCTION

The Late Jurassic Galice Formation was originally named and described by Diller (1907) for slaty shale, sandstone, and rare conglomerate exposed on Galice Creek near the hamlet of Galice in southwestern Oregon (Figure 1). Wells and others (1949) subsequently recognized volcanic members within the Galice, and Wells and Walker (1953) named the Rogue Formation for a thick sequence of mafic to silicic, largely fragmental volcanic rocks which lie beneath the Galice Formation in its type area. The Galice Formation was also mapped southward into the Gasquet quadrangle of northern California by Cater and Wells (1953), who recognized a lower volcanic member considered by them to be correlative with the Rogue Formation and an upper metasedimentary member similar to the type Galice of Diller (1907). Irwin (1960) later mapped the Galice Formation in reconnaissance south along the entire length of the Klamath Mountains province and named this belt the western Jurassic belt (Figure 1). Davis (1969) noted the similarity of rocks of the western Jurassic belt and the foothills metamorphic belt of the Sierra Nevada region and considered them to be correlative.

Two recent studies in northwestern California and extreme southwestern Oregon have documented the presence of a well-preserved, complete ophiolite (Josephine ophiolite, Figure 2) within the western Jurassic belt (Vail, 1977; Harper, 1980a), resulting in a major revision of the stratigraphy in this

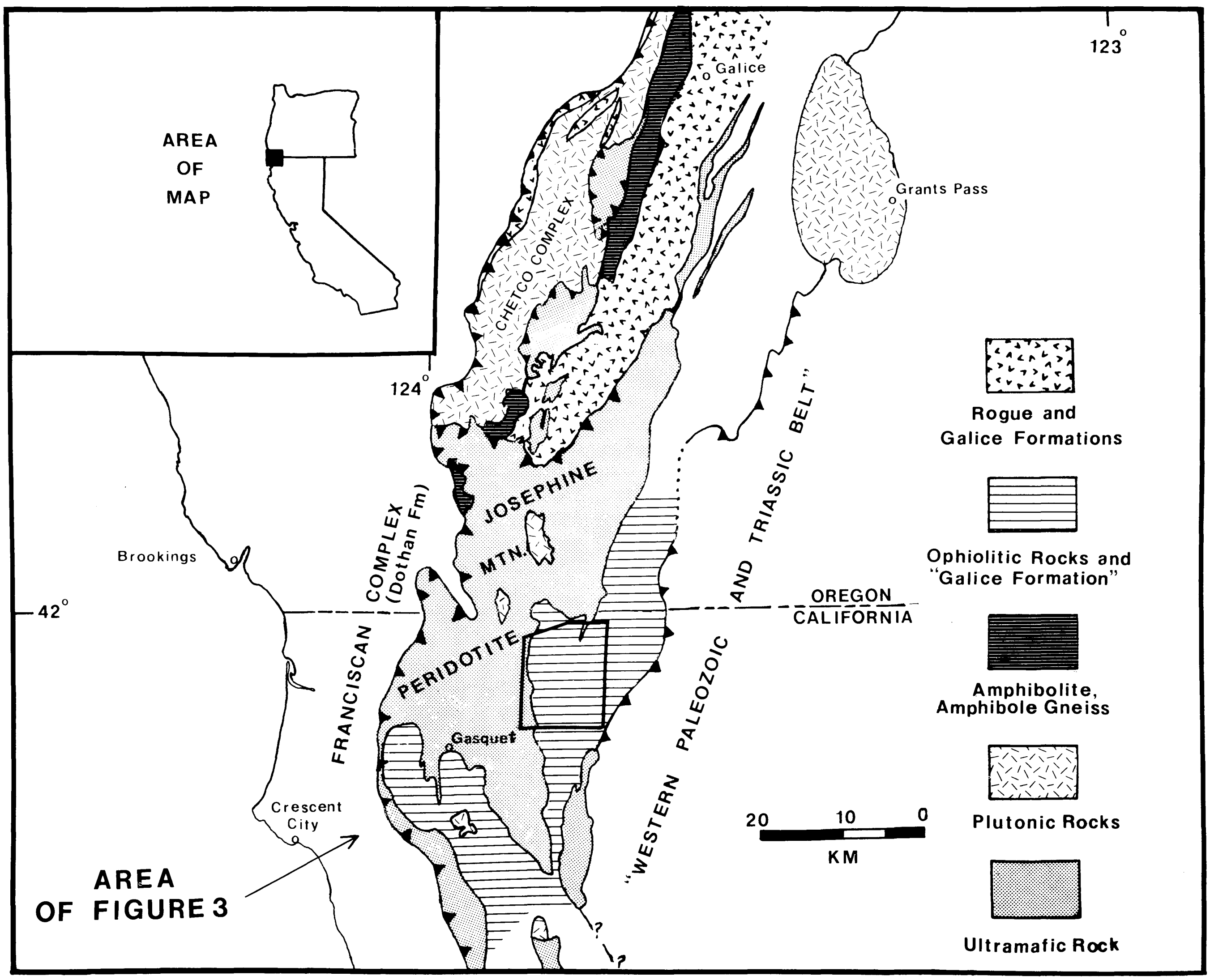

Figure 1. Generalized geology of Irwin's (1960) western Jurassic belt, modified from Hotz (1971b) and including mapping by Ramp (1975), Dick (1976), Snoke (1977), Vail (1977), and Harper (1980a).

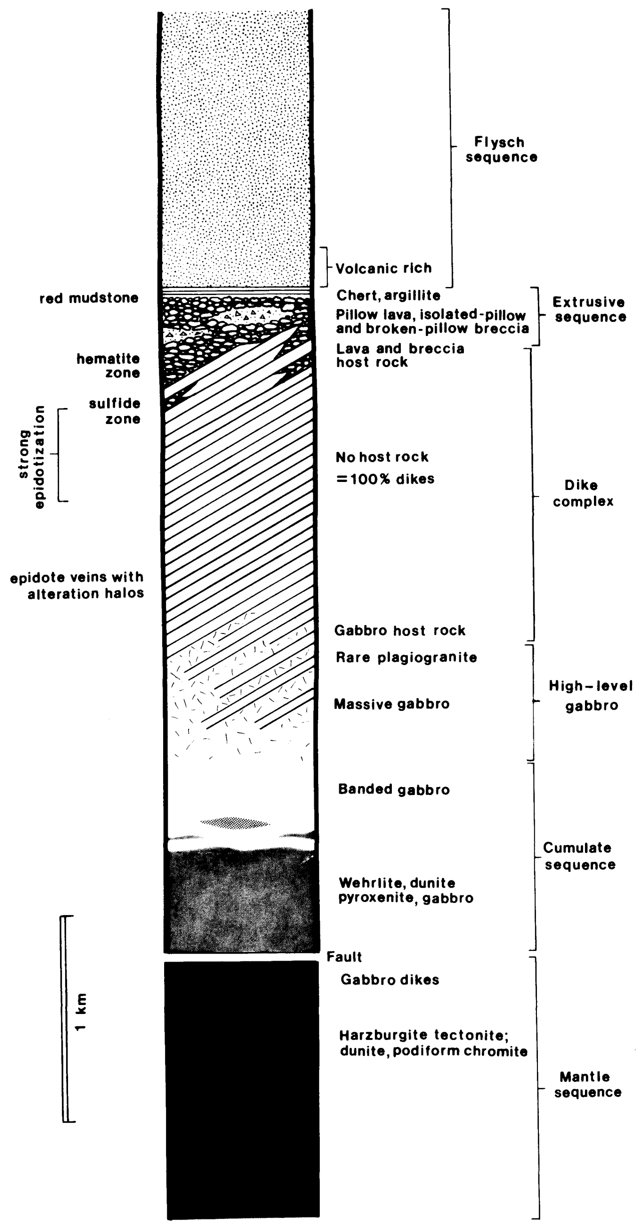

Figure 2. Reconstruction of the Josephine ophiolite, northwestern California.

area. In particular, the lower volcanic member of the Galice Formation described by Cater and Wells (1953) is now recognized as the upper part of the Josephine ophiolite, namely sheeted dikes and pillow lavas. The lower portions of the ophiolite consisting of gabbro and peridotite were mapped by Cater and Wells (1953) as younger intrusive rocks. The purpose of this paper is to report a perfectly preserved depositional contact between the Josephine ophiolite and the Galice Formation.

It is important to note that the type Galice Formation near Galice, Oregon, is not underlain by an ophiolite but rather is underlain by a thick sequence of mafic to silicic, chiefly fragmental metavolcanic rocks of the Rogue Formation (Wells and Walker, 1953; Garcia, 1979; my own field work). Nevertheless, data presented below show that the "Galice Formation" overlying the Josephine ophiolite is very similar in petrography and age to the type Galice Formation.

It should be noted that an earlier interpretation by Harper (1978) that the Josephine Mountain peridotite (the basal unit of the ophiolite) was thrust over the Galice Formation has been shown by later work to be incorrect. Although the Josephine Mountain peridotite is in many places faulted against the Galice, it is now recognized as part of the Josephine ophiolite which forms the basement for the Galice Formation. This interpretation is strongly supported by aeromagnetic data which indicate peridotite underlies at shallow depth exposed mafic rocks of the ophiolite (A. Griscom, personal communication, 1979).

THE JOSEPHINE OPHIOLITE

Ophiolites are distinctive sequences of ultramafic and mafic rocks generally regarded as the remains of ancient oceanic crust and upper mantle. The Josephine ophiolite is one of the best preserved, complete ophiolites in North America. Although the area in which the ophiolite has been mapped is heavily vegetated, excellent water-polished exposures are found in the forks of the Smith River and its major tributaries. In addition, mapping of the ophiolite was greatly facilitated by good access and exposures created by numerous logging roads.

The lowermost unit of the ophiolite is the Josephine Mountain peridotite (Figures 1, 2 and 3), a harzburgite tectonite with minor dunite covering more than 800 km^2. The peridotite is an "alpine-type" peridotite which typically occurs at the base of ophiolites and which represents depleted upper mantle (Loney and Himmelberg, 1976; Dick, 1976, 1977; Harper, 1980a). The harzburgite tectonite unit is overlain by olivine- and clinopyroxene-rich ultramafic rocks having cumulate textures; however, the base of the ultramafic cumulates is not preserved within the area mapped, and the contact with underlying harzburgite is always marked by sheared serpentinite. The ultramafic cumulates are overlain and intercalated with layered gabbro, which in turn grades upward into nonlayered gabbro and less common diorite. The "high-level" gabbro is characterized by complex intrusive breccias, abundant diabase dikes, and rare plagiogranite dikes and pods.

The high-level gabbro grades upward into a sheeted dike complex (Figure 4) consisting of 100 percent mafic dikes that are nearly all subparallel. The lower contact is gradational, and fine-grained diabase dikes increase in abundance upward through the high-level gabbro until no gabbro host rock is present. The upper contact of the sheeted dike complex is similarly gradational, with first the appearance of screens of pillow lava or breccia between dikes, followed by an upward decrease in the proportion of dikes. The "inclined" nature of the sheeted dikes (Figure 2) is interpreted as the result of rotations (probably by faulting) at the spreading center when the ophiolite formed (Harper, 1982a).

Volcanic rocks of the ophiolite are as much as 400 m thick (not including screens in sheeted dikes) and consist of pillow lavas (Figure 5) with lesser massive lava and isolated- and broken-pillow breccias. Many of the pillow lavas are highly vesicular, a feature which has been interpreted to indicate the lavas had high primary volatile contents (Harper, 1982b). Excellent exposures of pillows, breccias, and massive lava are found at the mouth of Little Jones Creek (Locality 1, Figures 3 and 5). Interpillow green chert and hyaloclastites are common in the upper part of the lavas.

THE GALICE FORMATION

A depositional contact between the Galice Formation and pillow lavas of the Josephine ophiolite is exposed at several localities (Localities 1, 2, and 4, Figure 3). The best exposed and most easily accessible locality (Locality 1, Figure 3) is located on the Middle Fork Smith River near the mouth of Little Jones Creek (Figure 6) and is within easy walking distance

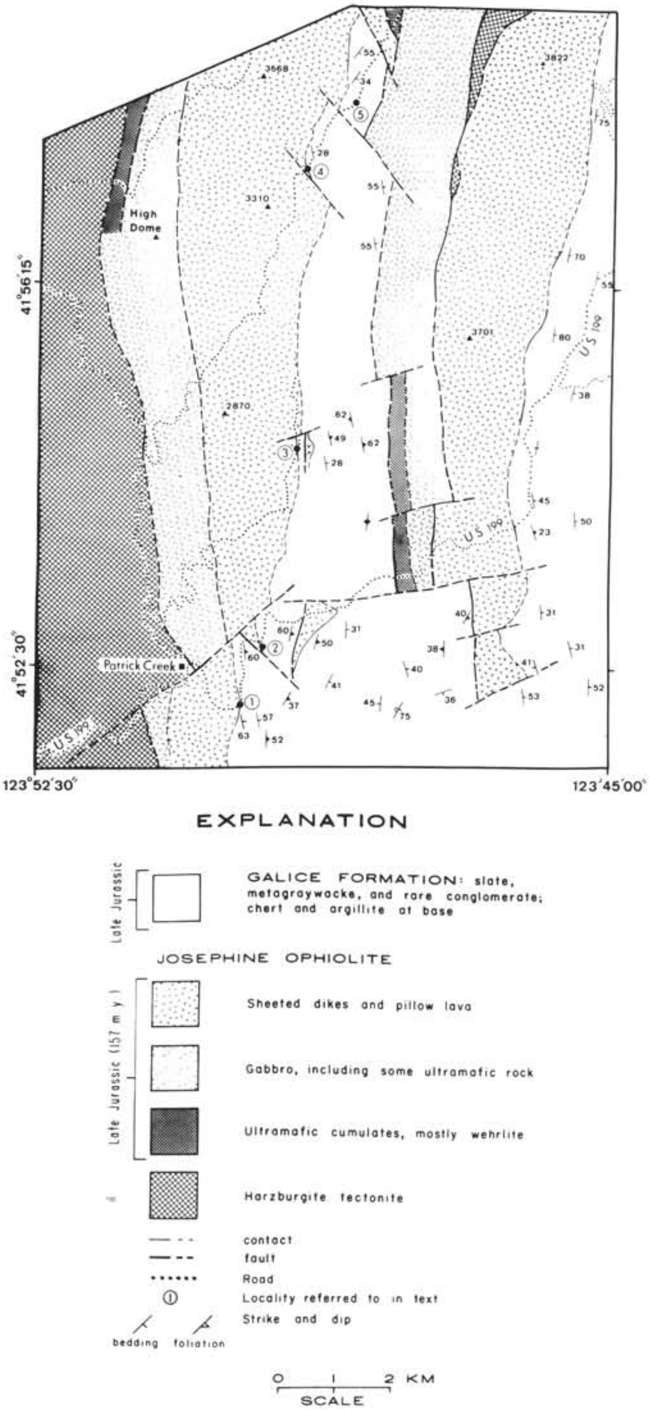

Figure 3. Generalized geologic map of part of the northeastern quarter of the Gasquet quadrangle, northwestern California. Northeastern part of map is modified from Cater and Wells (1953), and the remainder was mapped by Harper between 1976 and 1981.

of U.S. Highway 199. Vail (1977, p. 20) also reports a clearly exposed contact between the ophiolite and slaty shale of the Galice Formation on several road cuts below Lone Mountain, near O'Brien, Oregon.

In the area shown in Figure 3, the basal Galice Formation consists of a pelagic sequence up to 35 m thick of gray-green radiolarian chert interbedded with black slaty argillite. At several localities (Localities 2 and 4, Figure 3), metalliferous

Figure 4. Sheeted dikes dipping steeply to the right (southeast), Josephine ophiolite.

sedimentary rocks occur within the pelagic sequence and have locally been found intercalated with pillow lavas. These unusual rocks are red to black, thin-bedded to massive, and rich in iron and/or manganese. They probably formed by precipitation from hydrothermal fluids near vents on the ancient sea floor.

The thin basal pelagic sequence is overlain by metagraywackes, slate, and rare conglomerate. This contact varies from a sharp depositional contact (Locality 1, Figure 3) to one where metagraywacke is interbedded with the upper portion of the pelagic sequence (Localities 3 and 4, Figure 3). The metagraywackes commonly have well-preserved sedimentary structures indicating deposition by turbidity currents and related flow mechanisms; these include load casts, flame structures, ripple cross-stratification, graded bedding, rip-up mud chips, and rare sole markings. Trace fossils collected in slates include *Chondrites*, *Spirophycus*, and *Cosmoraphe*, which are indicative of deposition in very deep water (A.A. Ekdale, personal communication, 1980).

The metagraywackes are all feldspathic lithic wackes containing volcanic rock fragments, siliceous argillite, chert, plagioclase, and lesser monocrystalline quartz and metamorphic rock fragments. Heavy minerals identified both in thin sections and heavy mineral separates include zircon (rounded and euhedral), tourmaline, apatite, and muscovite with less common chromian spinel, biotite, garnet, sphene, and blue

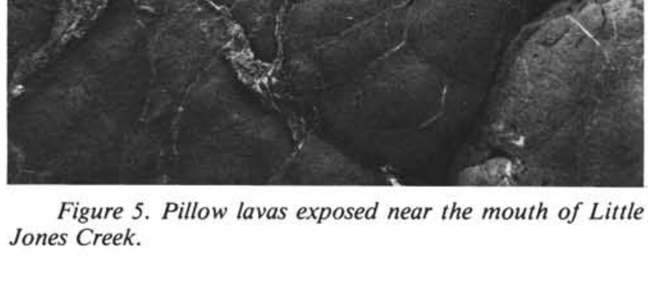

Figure 5. Pillow lavas exposed near the mouth of Little Jones Creek.

Figure 6. Depositional contact between pillow lavas (right) and bedded chert and slaty argillite of the Galice Formation. Ruler is 6 in. long and lies on the contact which dips steeply to the left (east). Locality 1 of Figure 3.

amphibole. In addition, graywackes rich in volcanic rock fragments typically contain abundant clinopyroxene and less common hornblende. Snoke (1977) reported Galice graywackes with very similar petrography just east of the area shown in Figure 3 but also observed staurolite as a detrital mineral. The petrography of graywackes varies with stratigraphic position; the lower few hundred meters of the Galice Formation contain graywackes rich in volcanic rock fragments and plagioclase, whereas the rest of the formation contains graywackes consisting predominantly of chert and siliceous argillite fragments (Harper, 1980a).

The stratigraphy of the Galice Formation is quite different in the vicinity of Buck Mountain, 25 km south-southeast of Gasquet. In this area, the basal Galice is a polymictite interpreted as a submarine slide deposit and consists of boulders up to 15 m in diameter in a matrix which varies from pebbly mudstone to green metatuff. Most of the larger boulders were apparently derived from the Josephine ophiolite and overlying pelagic sequence and include chert, greenstone, gabbro, and rare serpentinite. The pebbly mudstone contains clasts of argillite, chert, mica schist, marble, sandstone, and locally pumice. The polymictite is overlain by a thick sequence of metagraywackes (channel fill?) which are in turn overlain by metagraywacke and slate.

SUMMARY OF AGE DATA

The timing of ophiolite genesis, deposition of the overlying Galice Formation, and subsequent deformation is well constrained by radiometric and fossil ages (Saleeby and others, 1982). Two plagiogranites from the ophiolite have been dated, and both yielded concordant U-Pb ages of 157 ± 2 million years (m.y.) on zircon. Cherts from the pelagic sequence (Locality 3, Figure 3) have yielded Late Jurassic radiolaria (D.L. Jones, personal communication, 1981). J.S. Diller collected *Buchia concentrica* (Sowerby), which has a known range of Late Oxfordian to Lower Kimmeridgian (Imlay, 1959), from several localities in upper Shelly and Monkey Creeks. I was able to find one of these localities from Diller's descriptions; it is located near the mouth of the west fork of Shelly Creek ("Station Creek") just south of Baker Flat (Locality 5, Figure 3). The fossils occur in a "grit" bed (pebble conglomerate) near the base of the Galice Formation, approximately 150 m above the top of the ophiolite.

The ophiolite and overlying Galice Formation are intruded by numerous meta-andesite and metadacite dikes and sills. Two of these dikes and sills have been dated with zircon at 151 ± 2 and 150 ± 2 m.y. B.P. (concordant U-Pb ages, Saleeby and others, 1982). Following emplacement of the dikes and sills, the Josephine ophiolite and overlying Galice Formation were deformed and regionally metamorphosed under conditions of prehnite-pumpellyite to lower greenschist facies (Nevadan orogeny). Regional metamorphism of Galice metagraywackes has been dated in the southern Klamath Mountains at approximately 150 m.y. B.P. (Lanphere and others, 1978).

The type Galice Formation has also yielded *Buchia concentrica* (D.L. Jones, personal communication, 1979) and is thus the same age as the "Galice Formation" which overlies the Josephine ophiolite. The Rogue Formation which lies beneath the type Galice Formation is probably Middle or Late Jurassic in age. Plutonic rocks of the Chetco complex (Illinois River gabbro) which occur within the northern part of the western Jurassic belt (Figure 1) have yielded K-Ar ages of 150-157 m.y. except for a single age of 140 m.y. (Hotz, 1971; Dick, 1976). The Chetco complex probably represents the plutonic roots for the volcanic rocks of the Rogue and Galice Formations (Dick, 1976).

THE GALICE PROBLEM

The type Galice Formation overlies and is intercalated with mafic to silicic, largely fragmental volcanic rocks, whereas the "Galice Formation" in northwestern California and extreme southwestern Oregon is clearly depositional on the Josephine ophiolite. Nevertheless, both sequences have yielded *Buchia concentrica* and are lithologically similar. In addition, point counts have shown that metagraywackes from the two sequences are essentially identical in composition (Figure 7), although data from the type Galice are sparse. Heavy mineral assemblages from type Galice metagraywackes are also very similar to those from northwestern California (Harper, 1980a); particularly striking is the occurrence of both euhedral and well-rounded detrital zircons in metagraywackes from both sequences.

The differences in the two sequences can readily be explained in terms of deposition in somewhat different tectonic settings. The Rogue Formation, the type Galice Formation, and the Chetco complex have been interpreted as the remains of an ancient island-arc complex (Dick, 1976; Garcia, 1979; Johnson, 1980). In contrast, the Josephine ophiolite and overlying Galice Formation were apparently formed in a back-arc

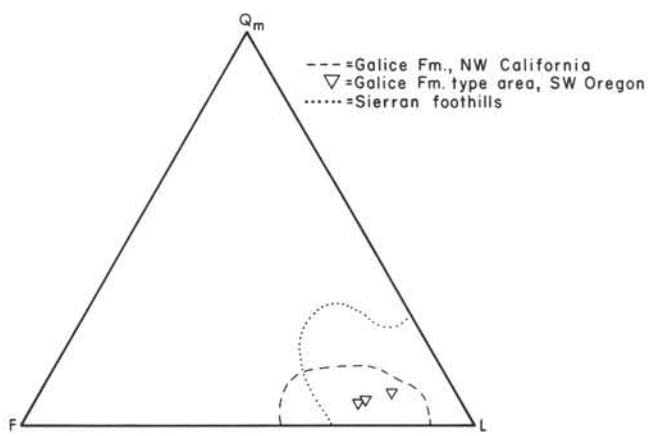

Figure 7. Triangular diagram summarizing point-count data from the Galice Formation (Harper, 1980a) and correlative rocks of the Sierra Nevada foothills (Behrman and Parkison, 1978). Qm = *monocrystalline quartz;* L = *lithics + chert;* F = *feldspar.*

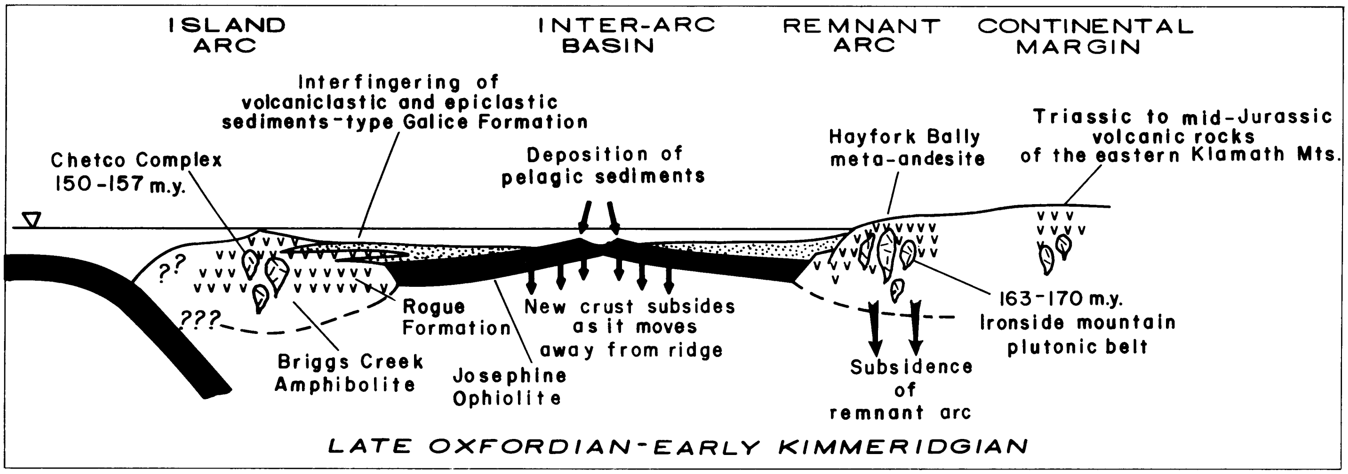

Figure 8. Tectonic model for the Late Jurassic of the Klamath Mountains (Harper, 1980a).

basin behind this island arc (Figure 8; Snoke, 1977; Vail, 1977; Harper, 1980a, b; Saleeby and others, 1982). Graywacke petrography and paleocurrent data indicate the Galice sediments were derived from the continental margin consisting of older Klamath rocks to the east (Snoke, 1977; Harper, 1980a, b).

In light of the above discussion, it is proposed that the western Jurassic belt be divided into two terranes. The northern terrane (Rogue River terrane) consists of the Chetco complex, amphibolites, the Rogue Formation, and the type Galice Formation (Figure 1). The southern terrane (Josephine terrane) consists of the Josephine ophiolite and overlying Galice Formation. The boundary between these two terranes has not been fully determined, but in southwestern Oregon, the Josephine peridotite has been thrust over the Chetco complex and Rogue Formation (Figure 1; Ramp, 1975; Dick, 1976; N. Page, personal communication, 1979). Thus the two terranes appear to comprise two thrust sheets, with the Josephine terrane thrust over the Rogue River terrane. This structural relationship can be envisioned as the result of the collapse of the island-arc and back-arc basin system during the Late Jurassic Nevadan orogeny, only 5-10 m.y. after formation of the Josephine ophiolite.

It is important to note that these two terranes are coeval and are related; in addition, they can be related to slightly older terranes to the east and southeast including the Preston Peak ophiolite (rift-edge facies, Saleeby and others, 1982) and Irwin's (1972) Hayfork Bally meta-andesite (remnant arc, Figure 8). The fact that these terranes can be tied together, combined with the short time interval between their formation and accretion, indicates they are *not* exotic to North America and are not "suspect" as suggested by Coney and others (1980).

ACKNOWLEDGMENTS

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(Depositional contact, ***continued on p. 9*****)**

ABSTRACTS

The Department maintains a collection of theses and dissertations on Oregon geology. From time to time, we print abstracts of new acquisitions that we feel are of general interest to our readers.

THE GEOLOGY OF THE WESTERN HALF OF THE LA GRANDE BASIN, NORTHEASTERN OREGON, by George Gehrels (M.S., University of Southern California, 1981)

The La Grande Basin is a 48-km-long by 20-km-wide topographic and structural depression in northeastern Oregon. It has a maximum structural relief of over 1,650 m, with the top of the middle to late Miocene Columbia River Basalt Group downdropped to lower than 200 m above sea level. Late Miocene or early Pliocene and younger alluvial and lacustrine sediments have filled the basin to an elevation of about 825 m.

Downdropping of the basin has formerly been attributed to dip-slip movement on north-northwest-striking faults. The structural relationships mapped in this study, however, suggest that the La Grande Basin is a complex pull-apart structure in a north-northwest-striking, right-lateral fault system. The fundamental kinematic relationships in a pull-apart basin with this orientation include (1) right-lateral faults along the eastern and western margins, (2) northwestern and southeastern corners dominated by normal faulting, and (3) structures along the ends of the basin that record NNW-SSE-directed extension.

Strike-slip faulting is recorded along the western side of the basin by north-northwest-striking vertical faults that have predominantly shallow-plunging slickenside striae. Evidence for a dextral sense of faulting along this margin comes from (1) combinations of stratigraphic offset and trend of shallow-plunging striae on several faults, (2) deflections to the right in the Grande Ronde River where it is crossed by major faults, (3) the juxtaposition of dissimilar stratigraphic sections across a major fault (in Ladd Canyon) that has no vertical offset, (4) the configuration of two left-en echelon fault zones being connected by a zone of northwest-southeast-directed shortening (thrust faults near Hot Lake), and (5) several localities where right-en echelon faults are connected by zones of NNW-SSE-directed extensions (Pyles Canyon and the normal faults north of La Grande).

The eastern margin of the La Grande Basin is formed by sinuous faults that have dip-slip displacements. This apparent lack of right-lateral faulting may be related to the structural complexity of the fault zone along the western margin. In the northern part of the basin, the western margin fault zone is a wide set of right-en echelon faults that are structurally connected by north-northeast-striking normal faults. Striae on one of these normal faults record a northwest-southeast slip-line, which geometrically requires northwest-southeast-directed extension across the fault. Because these are the dominant extensional structures in the basin, very little right-lateral displacement is transferred from the western margin to the faults along the eastern side. The northwestern and southeastern corners of the basin are cut by sinuous faults that have predominantly dip-slip displacements. These faults drop down the gently dipping homoclinal sections of Columbia River basalt that underlie the northern and southern margins.

Structural relationships along the western margin suggest that the total amount of right-lateral displacement across the La Grande Basin is about 2 or 3 km, and the total amount of northwest-southeast-directed extension is somewhat less—probably on the order of 1 km. Although the basin owes its origin to this right-lateral faulting and pull-apart extension, it is geometrically and structurally more complex than other pull-apart basins described in the literature. This complexity is a product of (1) the small amount of overall dextral strain across the La Grande Basin, (2) the region's high fault density, (3) a multiphase movement history on the north-northwest-striking faults, and (4) the wide zone of strike-slip and normal faults along the western margin of the basin.

Neogene faulting in the La Grande area probably began in middle to late Miocene time, but this age has not been reliably determined. Constraints on the age include a 6 or 7 m.y. old dike near the basin margin that may have been emplaced along a fault and Columbia River basalt flows that are younger than 14 m.y. and are everywhere cut by the faults. Structural evidence suggests that the downdropping of the basin occurred during a late stage of movement on these faults, so the basin may be entirely younger than 6 or 7 m.y. Several diatremes and a small body of diorite (near Hot Lake) were emplaced after the basin began to form, but these have not been reliably dated. Evidence for Quaternary faulting is present, although most of the scarps in the area do not show signs of recent movement. Two features that may record Holocene faulting include a 1-km-long scarp in alluvial sediments near Union and a small thrust fault in terrace gravels south of La Grande. Earthquake epicenters in the area suggest that the basin is still tectonically active.

The north-northwest-striking faults in the La Grande area are part of a wide set of right-lateral(?) faults in central and eastern Oregon. Movement on these faults may be due to northwestward extension within the Basin and Range Province relative to the Columbia Plateau or possibly to a wide zone of right-lateral interaction between the Pacific and North American plates.

THE STRUCTURE, EVOLUTION, AND REGIONAL SIGNIFICANCE OF THE BETHEL CREEK-NORTH FORK AREA, COOS AND CURRY COUNTIES, OREGON, by Carl Frederick Gullixson (M.S., Portland State University, 1981)

The Bethel Creek-North Fork area, astride the Coos-Curry County line near the coast in southwestern Oregon, consists of Jurassic Otter Point Formation, a mélange complex, and the lower and middle Eocene Roseburg and Lookingglass Formations, part of a prograding depositional sequence. These units form four north-trending belts through the area. On the basis of differing structural style and lithology, three structural units are distinguished in the area: the Mélange Terrane, comprising western and eastern belts of Otter Point Formation; the fault-bounded North Fork Block, consisting of the Roseburg and Lookingglass Formations; and the fault-bounded Morton Creek Block, consisting of the Roseburg Formation. Rocks of the North Fork Block were deposited in a linear basin between "wedges" of the underlying Otter Point Mélange which formed during continental margin accretion. During the deposition of the Roseburg and Lookingglass Formations, the North Fork Block was deformed into a gently plunging syncline, and the entire block was uplifted along reverse faults developed at the contacts between the North Fork Block and the surrounding Mélange Terrane. The Morton Creek Block may have formed as a "fault slice" of the North Fork Block displaced southward along a left-lateral shear zone. Fold-axis patterns in both the North Fork and Morton Creek Blocks tend to confirm this interpretation. □

Pluvial Lake Chewaucan subject of new book

Geology of Pluvial Lake Chewaucan, Lake County, Oregon, by Ira S. Allison, Professor Emeritus of Geology, Oregon State University. Published as Studies in Geology Number Eleven by Oregon State University Press, Oregon State University, Corvallis, Oregon 97331. Paperback, 80 pages, 43 figures, $6.95.

Ira Allison began studying pluvial Lake Chewaucan in 1939 as part of a group of scientists investigating the prehistory of southeastern Oregon. Over the years, he has returned many times to the area, adding to his knowledge of this fascinating geological region. His numerous articles, monographs, and books clearly establish him as an authority on the geology of the area. This newest book may be purchased at most local bookstores, and a copy is also available for inspection in the library of the Portland office of the Oregon Department of Geology and Mineral Industries. For our readers' convenience, we are reprinting the abstract below.

ABSTRACT

"Pluvial Lake Chewaucan was a late Pleistocene lake, as much as 375 feet deep, covering 480 square miles in the northwestern part of the Great Basin in southern Oregon. The lake basin, now occupied by Summer Lake, Upper and Lower Chewaucan Marshes, and Lake Abert, was formed by downdropped fault blocks bounded by imposing fault scarps, notably Winter Ridge and Abert Rim. Several large landslides occurred along the east side of Winter Ridge.

"Lake Chewaucan shore features include wave-cut cliffs and caves, beaches, terraces, bay bars, spits (as at The Narrows), and a huge alluvial fan built by Chewaucan River at Paisley. Later, at lower lake stages, part of the fan deposit of sand and gravel was distributed across four-mile-wide Paisley Flat, which subsequently became a divide between Winter Lake in the Summer Lake basin and ZX Lake (new name) in the Chewaucan Marshes-Lake Abert part of the Lake Chewaucan basin. Overflow from ZX Lake later cut a shallow channel across the divide enroute to Winter Lake.

"The bottom sediments of Lake Chewaucan are exposed mainly in the bluffs of Ana River, the main source of Summer Lake water. The stratigraphic section there is about 54 feet thick and composed mainly of silt, with numerous seams of sand, oolites, occasional pebbles, and many layers of volcanic ash, especially near the top.

"Fossils found in the area include (1) mammals and birds obtained from man-occupied caves near Paisley, (2) ostracods, diatoms, and small mollusks in the Ana River section, (3) similar tiny snail shells in a gravel pit north of the Ana Springs Reservoir, and (4) additional shells from the 4425-foot level near Ten Mile Butte east of Summer Lake. The snail shells have radiocarbon ages of >25,900, 22,000, and 17,500 years—all within the span of the Tioga-Pinedale glacial stage of the Sierra Nevada and the Rocky Mountains. The top 4520-foot shoreline, the 4485-foot beach and Paisley Caves, and the bulk of the Paisley fan may possibly be Tahoe in age, but the wave erosion of the Paisley fan, development of Paisley Flat, overflow from ZX Lake, and later formation of ZX Red House beach are assigned to Tioga-Pinedale time.

"The history of Lake Chewaucan is thought to be analogous to those of Lake Bonneville, Lake Lahontan, and Searles Lake, and correlative with climatic changes recorded in marine deposits.

"The post-Lake Chewaucan history of the basin includes Anathermal, Altithermal, and Medithermal climatic changes, as shown by a pollen profile in Upper Chewaucan Marsh. Mount Mazama pumice sand fell in the area about 6,600,-6,700 years ago. Dessication and wind work were strong in Altithermal time. In the Neopluvial (new term), corresponding to Neoglaciation in the mountains (perhaps 4,000-2,000 years ago), new lakes many tens of feet deep developed in the Summer Lake and Chewaucan Marshes-Lake Abert basins. Later, Summer Lake and Lake Abert were reduced to the very shallow, alkaline bodies of water of the present day." □

Newberry Volcano soil-mercury survey completed

A soil-mercury survey of Newberry Volcano was recently completed by the Geothermal Group of the Oregon Department of Geology and Mineral Industries (DOGAMI) during a geothermal resource assessment sponsored by the Bonneville Power Administration. A limited number of copies of a preliminary report on the results of the survey, including a 1:62,500-scale contour map of the 1,641 mercury determinations, have been produced and are available from the Portland office of DOGAMI, 1005 State Office Building, Portland, OR 97201 at a cost of $5. Orders under $50 require prepayment.

This preliminary report will be available for a limited time only. A complete, finalized report will be released in March or April of 1983. □

AEG 26th Annual Meeting set for San Diego

The twenty-sixth annual meeting of the Association of Engineering Geologists (AEG) will be held October 3-8, 1983, at the Sheraton Harbor Island Hotel, San Diego, California. Featured will be symposia, short courses, field trips, and harbor cruises. For further information on submitting abstracts or registering for the meeting, contact Dennis Hannan, c/o Leighton and Associates, 7290 Engineer Road, Suite H, San Diego, CA 92111, phone (619) 292-8030. □

(Depositional contact, *continued from p. 7***)**

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OIL AND GAS NEWS

Columbia County:

Reichhold Energy Corporation has changed the name of its recently permitted well, permit 225, from Adams 13-34 to Columbia County 13-34. The company will spud this well in mid-December. The well is programmed for 2,800 ft in search of a new pool. The location is 1 mi north and east of producing wells and is at the northern edge of the field.

Mist Gas Field production:

Gas production at the Mist Gas Field in 1982 has increased from 8 million cubic feet per day (MMcfd) in January to about 10 MMcfd in October. There have been fluctuations from month to month, but the trend has been an increase.

This increase has been made possible by the completion of three new wells during the year. Reichhold Energy Corporation, operator of all the producing wells, completed a redrill of Columbia County 13-1 in May of this year, after redrilling to a depth of 3,027 ft. The well was originally drilled in 1981. In July, the company redrilled Columbia County 4 to 2,894 ft for a completed well. This well was originally drilled during 1979. A third producer, Paul 34-32, was also drilled during 1982. This well, drilled to a total depth of 2,698 ft, extended the field farther west than any previous well. Reichhold plans further development and exploratory drilling in 1983.

Permit activity:

The following table will bring you up to date on permit expirations for the year.

Permit no.	Operator and well name	Location	Status, depth
134	Reichhold Energy Longview Fibre 33-12	SE¼ sec. 12 T. 6 N., R. 5 W. Columbia County	Permit expired and canceled.
148	Reichhold Energy Columbia County 32-5	NE¼ sec. 5 T. 6 N., R. 5 W. Columbia County	Permit expired and canceled.
169	Reichhold Energy Columbia County 14-34	SW¼ sec. 34 T. 7 N., R. 5 W. Columbia County	Permit expired and canceled.
176	American Quasar Franbea 36-34	SE¼ sec. 36 T. 7 N., R. 5 W. Columbia County	Permit expired and canceled.
183	Reichhold Energy Hemeon 14-14	SW¼ sec. 14 T. 6 N., R. 5 W. Columbia County	Permit expired and canceled.
187	Reichhold Energy Ellis 23-26	SW¼ sec. 26 T. 5 N., R. 4 W. Columbia County	Permit expired and canceled.
188	American Quasar Chipman 4-14	SW¼ sec. 4 T. 12 S., R. 2 W. Linn County	Permit expired and canceled.
190	Reichhold Energy Lee 32-32	NE¼ sec. 32 T. 7 N., R. 5 W. Columbia County	Permit expired and canceled.
198	Reichhold Energy Columbia County 44-2	SE¼ sec. 2 T. 6 N., R. 5 W. Columbia County	Permit expired and canceled.
225	Reichhold Energy Columbia County 13-34	SW¼ sec. 34 T. 7 N., R. 5 W. Columbia County	Location.

BLM automates oil and gas filing

The December 1982 *BLM News* reported that the Bureau of Land Management (BLM) has automated its system for receiving simultaneous applications for oil and gas leases on federal lands. Machines now can be used to read the application forms. The Cheyenne, Wyoming, office of the BLM will now handle applications for all western states. This automated system will be used only for previously leased parcels of land where the leases have expired or were relinquished, canceled, or terminated. Competitive oil and gas leases and over-the-counter filings will be handled as in the past.

In the states of Oregon and Washington, the BLM has about 10.5 million acres under oil and gas leases. □

Association of Engineering Geologists elects 1982-1983 officers

The newly elected officers of the Association of Engineering Geologists (AEG) took office at the meeting of the Board of Directors held during the Annual AEG Meeting in Montreal, Canada.

Elected as President is Richard W. Galster, Chief of the Geology Section, U.S. Army Corps of Engineers, Seattle District. Vice President is Robert M. Valentine, Senior Associate and Chief of Geosciences Division, Woodward-Clyde Consultants, Houston, Texas. Secretary is Norman R. Tilford, Consulting Geologist, Ebasco Services, Greensboro, North Carolina. Treasurer is Allen W. Hatheway, Professor of Geological Engineering, University of Missouri, Rolla, Missouri.

AEG represents over 3,000 members in 44 countries and is a member society of the American Geological Institute. The AEG is dedicated to promoting public safety, welfare, and the understanding of the profession. □

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