OIL GENERATION AND ENTRAPMENT IN RAILROAD VALLEY, NYE COUNTY, NEVADA

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ABSTRACT

Railorad Valley is a graben block in the Basin and Range Structural province. Topographically it is basically flat with recent playa deposits on the surface. There are two structural deeps in the valley. Four oil fields are associated with the northern deep. All oil fields are related to faulting.

Oil has been generated from Tertiary Sheep Pass and Mississippian shales. This generation is probably due to recent local heating of the valley by intrusive rocks. Temperature gradients are as low as 0.9°F to has high as 7.3°F per hundred feet.

8,000,000 barrels of oil with no significant quantity of gas has been produced from the fields. The seals on the fields are imperfect and any gas generated, and much oil, has probably leaked into the overlying valley fill. Trap Spring and Eagle Springs fields are hydrostatically pressured while the smaller fields of Bacon Flat and Currant are slightly over-pressured.

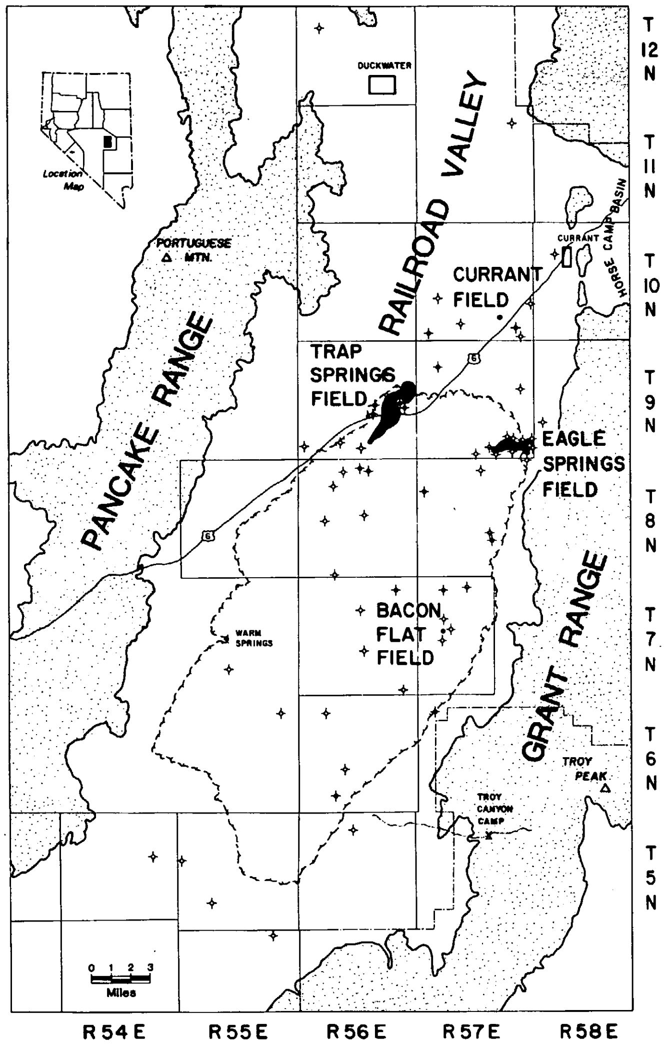
The concept of immature source rocks occurring near a valley with high heat flow may improve exploration success.

INTRODUCTION

Oil was discovered in the first well drilled for oil in Railroad Valley. This well, the Shell #1 Eagle Springs Unit, Sec. 35-T 9N-R57E, was completed from the Oligocene Garrett Ranch ignimbrites for 343 BOPD. Since that time a total of 100 wildcat and development wells have been drilled. There are now four oil fields, Eagle Springs (1954), Trap Spring (1976), Currant (1978), and Bacon Flat (1981) in the valley.

This presence of commercial quantities of oil in the Basin and Range is unique to Railroad Valley. This paper is designed to point out the geological setting of the fields, the oil sources, and maturation of the oil, with hope that this knowledge will help further exploration in the Basin and Range Province.

Railroad Valley is an intermountain valley in the Basin and Range Geomorphic Province (figure 1). Geographically it is in east-central Nevada, some 65 miles southwest of the town of Ely. The only commercial establishment is the village of Currant where limited services are available.



INDEX MAP OF RAILROAD VALLEY & +5000' CONTOUR, APPROXIMATE PRESENT LIMIT OF PLAYALAKE - FIGURE 1

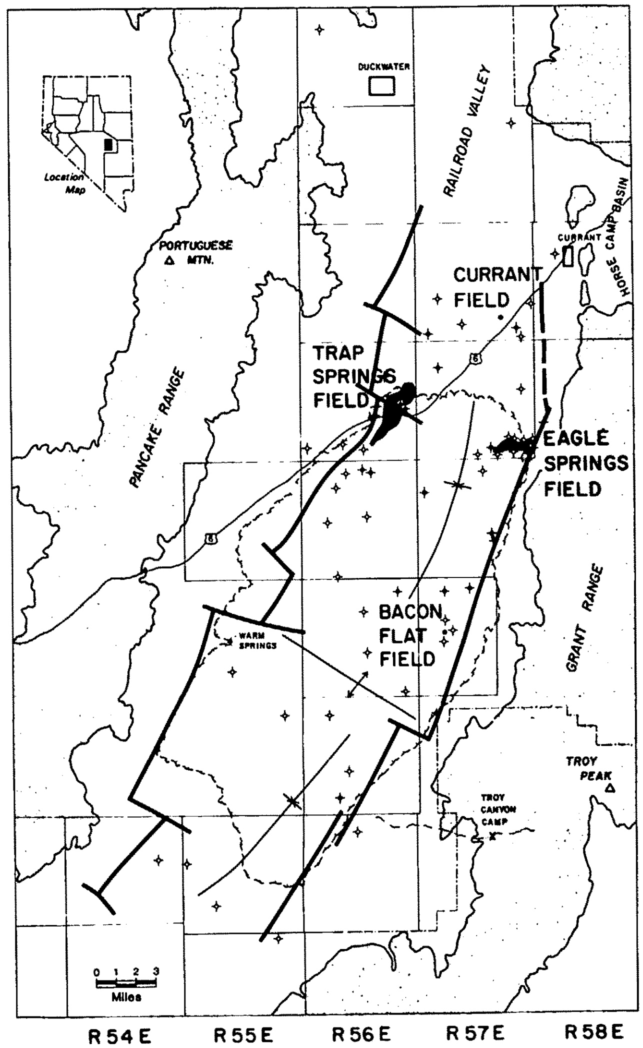
Railroad Valley, for the purposes of this paper has a southern limit at the drainage divide at approximately the middle of Township 4N. The valley trends NNE-SSW, is 55 miles long and approximately 14 miles wide. The surface of the valley has an elevation of 4600-5000' with the mountain on the east as high as 11,298' (Troy Peak), and on the west as high as 9249' (Portuguese Mtn.).

The surface of the valley is recent alluvium with one large dry playa lake. The alluvium includes the fans and bajadas from the nearby mountains. The playa lake includes the surface clays stabilized sand dunes and beach sand and gravels.

STRUCTURE

Railroad Valley is a graben in the true sense, as it is a down dropped block adjacent to upthrown blocks on either side, but it is asymmetric and very complex. (See figures 2 & 3) The most movement occurred on the east side of the valley where over 12,000 feet of total displacement has taken place. The west side of the valley is broken by smaller faults with even some secondary horsts which allow for a broadening of the valley. The structure of the valley can only be described in relation to the time markers identifiable for mapping. These time markers are unconformities at the base of the valley fill, base of the ignimbrites and the base of the Sheep Pass Fm. Often a younger unconformity erodes an older one which masks older structural movement.

The valley has two structural lows, one to the north and to the south. While the northern deep is structurally lower, on top of the volcanics, the solution one may be structurally lower on top of the Paleozoic rocks since the volcanics thicken to the south.



VALLEY STRUCTURE - FIGURE 2

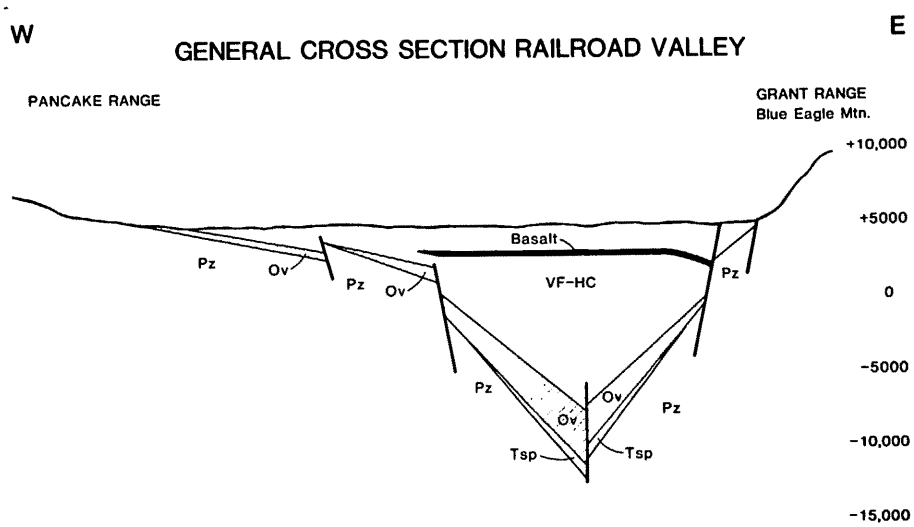


FIGURE 3

STRATIGRAPHY

The generalized stratigraphy of the valley is as follows, from youngest to oldest (fig. 4):

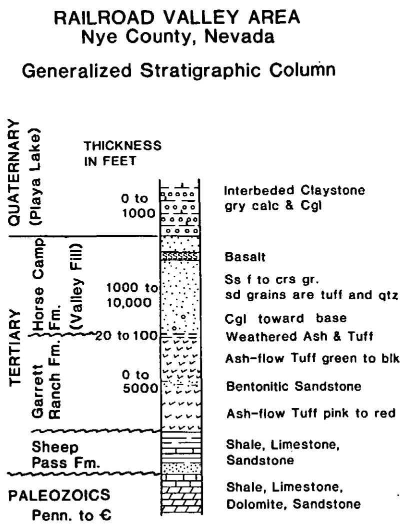


FIGURE 4

Playa lake deposits, probably Pleistocene to present in age. Usually clays and marlstones with mixed sand dunes and beach sands and gravels.

Valley file (Horse Camp Fm.?), Pliocene sands and gravels composed of all the material eroded from the nearby uplifted mountains, i.e. on east side of valley many Paleozoic fragments are included. Occasional basaltic lava flows are present in the subsurface of the valley in this unit. The relationship of Horse Camp Formation is unclear but often is synonomous with valley fill. Lithologically the Horse Camp Fm. may be more indurated and may represent only the oldest portion of valley fill.

The Horse Camp formation is identified in the Horse Camp Basin on the NE flank of Railroad Valley and may have no relation to Railroad Valley. Its relation may be only in the type of sedimentation.

The valley fill lies unconformably on the underlying rocks.

Garrett Ranch Formation Oligocene, used to include all ignimbrites, inter volvanic sediments and rhyolitic flows (French 1979). It includes the Windus Butte, Pritchard Station and Stone Cabin ignimbrites.

The Garrett Ranch lies unconformably on the underlying rocks.

Sheep Pass Formation, Cretaceous ? through Eocene shale, limestone and minor sandstone. This formation unconformably overlies the rocks below.

Paleozoic sediments Pennsylvanian to Cambrian:

Pennsylvanian	Ely limestone
Mississippian	Chainman shales and sandstones
	Joanna limestone
Devonian	Pilot shale
	Guilmette limestone and dolomite
	Simonson dolomite
	Sevy dolomite

Ordovivian, Silurian, and Cambrian dolomite, dolomites with lesser amounts of sandtone, shale and limestone.

HYDROLOGY-

There are two water systems in the valley. The shallowest is in the near surface lacustrine sediments immediately below the surface. In many places, during most seasons, holes as shallow as 1' deep will fill with water. In the rainy season the playa may be covered with water for short periods.

The deep water system is artesian, trapped beneath the lacustrine sediments. This system is fed through the alluvial fans and bajadas. All of the water is basically fresh with high concentrations of sodium and calcium carbonates and bicarbonates. The water of the artesian system fills the valley sands in the fill, and extends into the Paleozoic sediments and ignimbrites below the lacustrine sediments.

There is no surface external drainage from the valley. Price (1979) indicates that subsurface waters flow into the valley from the west (from Hot Creek and Little Smokey Valleys), and drains out of the valley to the southwest.

This subsurface movement of water from the valleys indicates a pervasive permeability system with moving ground water. A fresh supply of ground water enhances growth of bacteria which destroy hydrocarbons by supplying nutrients and oxygen.

Moving ground water enhances hydrocarbon migration, but in a dynamic system hydrocarbon traps must also be more effective than in a static system to keep oil and gas in place.

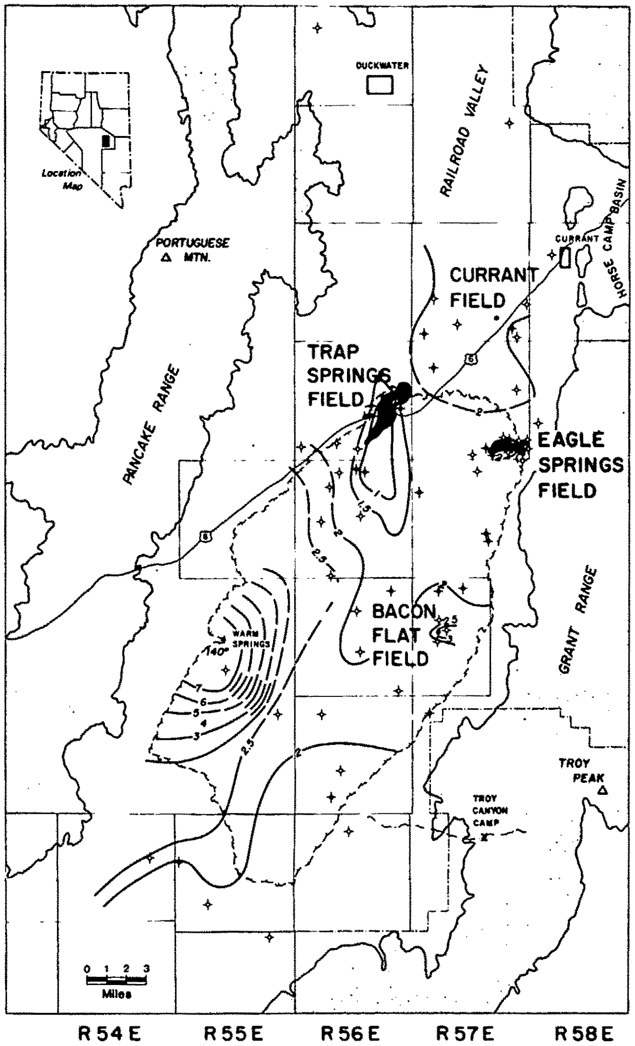
HEAT FLOW

Heat flow represented by temperature gradients is extremely variable (fig 5). Highest temperature gradient measured is at the Shell #1 Coyote, Sec. 28-T7N-R55E where a temperature of

166°F was measured at 1770 feet. This is a temperature gradient of 7.3°F per 100'. The well is near Warm Spring which flows water at 140°F.

The lowest temperature gradient is at the southern end of Trap Spring field, where at 4500' the temperature is 95°F, or a temperature gradient of 0.94°F per 100'. The highest temperature measured in the valley is 309°F at 5350 feet. The measurement was at the Bacon Flat (Sec 17-T7N-R57E) well while pumping with a high capacity downhole hydraulic pump. With this pump, bottom hole pressure was reduced enough to allow water to turn to steam which then restricted the pump capacity. Most of the valley has a temperature gradient in the range of 2°F per 100 feet.

The immediate sources of heat appear to be hot ground waters. Intrusives have been encountered in the Paleozoic rocks at Trap Spring, Eagle Spring and at the Pan Am #1 USA McDonald, Sec. 2-T11N-R57E. These intrusives did not appreciably affect the temperature gradient where encountered.



TEMPERATURE GRADIENT
ISOGRADIENT 0.5°F/100'
FIGURE 5

Hot groundwaters are probably confined to certain rock layers prior to mixing with the cold valley fill waters. This is evidenced by the deep temperatures being colder than those measured in shallow horizons in the Buckhorn 16-1 Federal Adobe, Sec. 1-T6N-R54E.

OIL MATURATION

Temperature, pressure, time, and possibly catlysts are the factors necessary to produce crude oil from organic material.

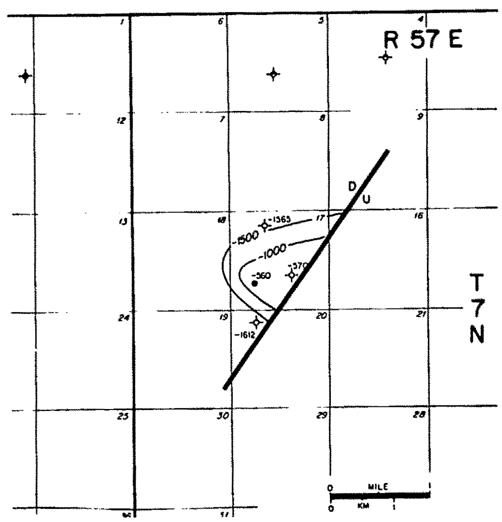
Organic material from which oil can be produced is present in the Mississippian Chainman Shale and Eocene Sheep Pass shales. In the vicinity of Trap Spring field the Chainman shales are immature, based both on the maturation of the organic matter and conodonts. The Sheep Pass shale, which outcrops near Eagle Springs field is also thermally immature. Both the Chainman and Sheep Pass are probably mature at depth.

An indication of the maturity of the oils is indicated by the pristane-phytane ratios seen in the table below:

PRISTANE-PHYTANE RATIO

Bacon Flat	1.45
Trap Spring	1.24
Eagle Spring	0.83
Currant	0.52

Pristane and phytane are isoprenoids found in living organisms, and as organic material is maturated into petroleum; Pristane is destroyed faster than Phytane. This is then a measure of maturity.



BACON FLAT FIELD, NYE COUNTY, NEVADA
STRUCTURE - TOP OF PALEOZOICS
CI:500' - FIGURE 6

It is seen from these ratios that Currant field is the least mature and Bacon Flat field is the most mature.

The oil found at Currant Field has an even carbon number molecule preference. This factor is not found in the other fields. This even carbon preference is unusual but elsewhere it is associated with oils that have a carbonate source rock.

BACON FLAT FIELD

Geology

Producing formation: Devonian Guilmette Formation ?
Trap type: structural
Thickness and lithology of reservoir rock: 134', Dolomite
Oldest formation penetrated: Devonian Simonson

Reservoir Data

Productive area: 160 Ac ?
Number of producing wells: 1
Number of abandoned wells: 0
Number of dry holes: 3
Porosity: 8 - 12% + fractures
Seal: weathered ignimbrite above Paleozoic subcrop
Oil/water contact: unknown
Vertical oil column: 134' +
Associated water analysis - Na 1186, Ca 29, Mg 18, Fe 5.8, Cl 435, HCO_3 2183, SO_4 226 mg/l, R_w
Type of drive: water ?
Total production to 12-30-82: 64,740 BO

Discovery Well

Northwest Exploration #1 Bacon Flat (#8 Railroad Valley)
SW SW Sec. 17-T7N-R57E
Date of completion: July 5, 1981
Total depth: 5450'
Initial production: 200 BOPD + 1050 BWPD
Perforations: 5316 - 5333'

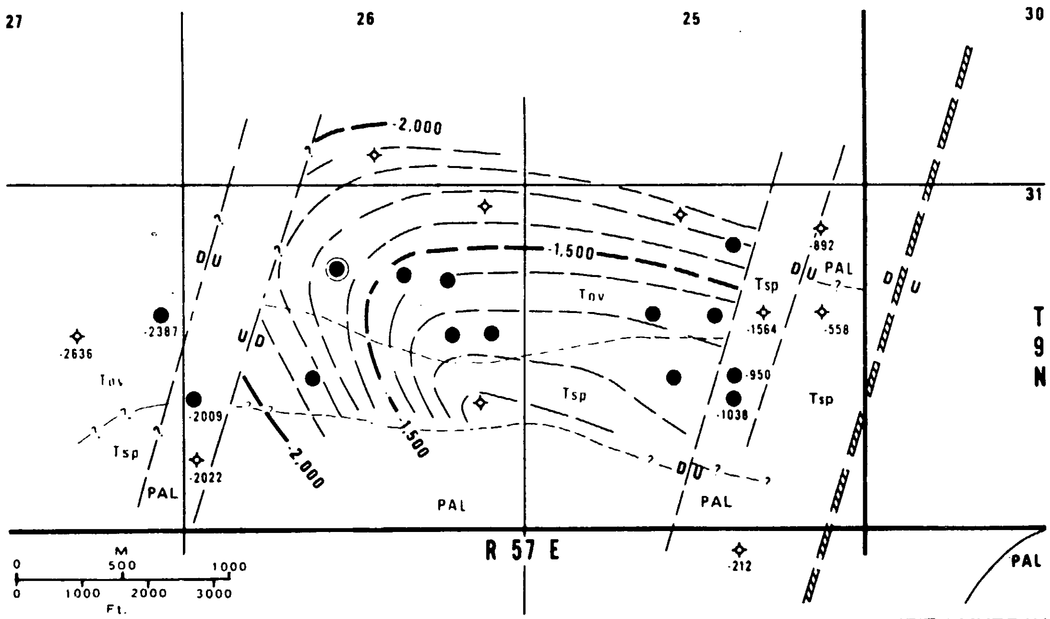
EAGLE SPRINGS FIELD

Geology

Producing formations: Oligocene Garrett Ranch Volcanics, Eocene Sheep Pass Formation, Pennsylvanian Ely ? limestone
Trap type: structural - stratigraphic
Thickness and lithology of reservoir rock: thickness max 275', ignimbrites with vugs and fractures, fractured limestone, sandstone
Oldest formation penetrated: Cambrian

Reservoir Data

Productive area: 640 Ac
Approved spacing: none
Number of producing wells: 11
Number of abandoned wells: 3
Number of dry holes: 10
Porosity: ignimbrites 13.5%, Sheep Pass Formation 16%
Seal: indurated valley fill (Horse Camp)
Oil/water contact: -2000'
Vertical oil column: 1500'
Gas analysis: unknown, but low GOR



LOUIS C. BORTZ and D. KEITH MURRAY

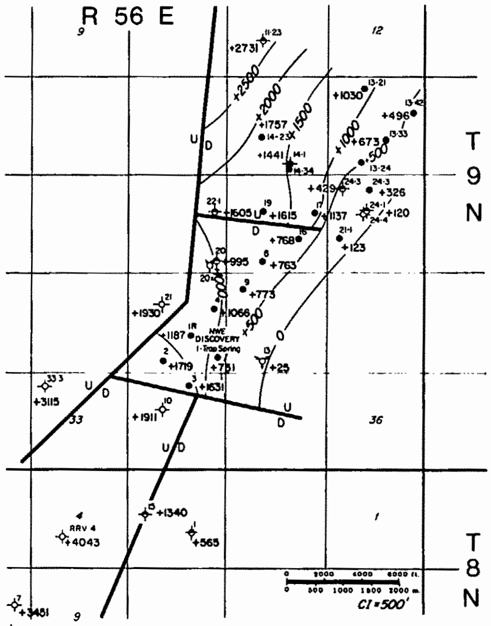
FIGURE 7 — EAGLE SPRINGS FIELD UNCONFORMITY "A" STRUCTURE CONTOUR INTERVAL: 100' (30M) WITH SUBCROPS

DUEY

Associated water analysis: 24,298 mg/l Cl; R_w = 0,32 ohms @ 70°F
Type of drive: water and gravity drainage
Total production to 12-30-82: 3,580,383

Discovery Well

Shell #1 Eagle Springs Unit
E/2 NW/4 Sec. 35-T9N-R57E
Date of completion: July 6, 1954
Total Depth: 10,358'
Initial production: 343 BOPD
Perforations: none - open hole 6450 - 6730'



TRAP SPRING FIELD, NYE COUNTY, NEVADA
TOP UNCONFORMITY
"A" STRUCTURE
FIGURE 8

TRAP SPRING FIELD

Geology

Producing formation: Oligocene Garrett Ranch Volcanics
Trap type: structural - stratigraphic
Thickness and lithology of reservoir rock, 847' thick, fractured ignimbrite (welded ash flow tuff)
Oldest formation penetrated: Devonian Guilmette

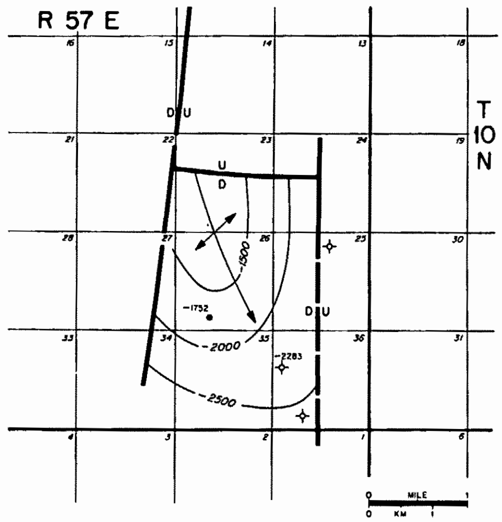
Reservoir Data

Productive area: 2080 acres
Approved spacing: 160 acres (state), variable in Munson Ranch Unit
Number of producing wells: 16
Abandoned wells: 1
Number of dry holes: 8
Porosity: unknown, fractures

Seal: weathered ignimbrite below unconformity
Oil/water contact: -200'
Vertical oil column: 1700'
Gas: none
Associated water analysis: Ca 23, Mg 6, Na 2100, Fe 0, Cl 3020, HCO_3 488, SO_4 26 mg/l; R_w: 1.1 @ 68°F.
Type of drive: water
Total production to 12-30-82: 4,692,842 BO

Discovery Well

Northwest Exploration #1 Trap Spring
200'/E & 800'/S Sec. 27-T9N-R56E
Date of completion: November 30, 1976
Total depth: 6,137'
Initial potential: 417 BOPD
Perforations: none, open hole 4220 - 4853"



CURRANT FIELD, NYE COUNTY, NEVADA
STRUCTURE
TOP OF SHEEP PASS
Cl:500' - FIGURE 9

CURRANT FIELD

Geology

Producing formation: Eocene Sheep Pass
Trap type: structural ?
Thickness and lithology of reservoir rocks: 380' thick, shaly limestone
Oldest formation penetrated: Devonian Sevy Dolomite

Reservoir Data

Productive area: 40 Ac ?
Number of producing wells: 1
Number of abandoned wells: 0
Number of dry holes: 0
Porosity: 6%
Seal: shales is Sheep Pass Formation
Oil/water contact: unknown
Vertical oil column: unknown
Gas analysis: unknown, low GOR

Associated water: none recovered
Type of drive: unknown
Total production to 1-30-83: 635 BO

Discovery Well

Northwest Exploration #1 Currant
SE SW Sec. 26-T10N-R57E
Date of completion: October 21, 1978
Total depth: 7800'
Initial production: 10 BOPD
Perforations: 6856 - 6994", 7038 - 7080'

The comparison of the oil viscosities with that of water indicates that water is much more easily moved than the oil. Also the oil at Eagle Springs is the easiest to move in relation to water. The oil at Currant is significantly different than that in the other fields. The oil is probably from Sheep Pass shales. Eagle Springs oil may be a mixture of oil generated from Sheep Pass shales and Mississippian shales.

SUMMARY

In comparing the oil fields, it is seen that in three, Trap Spring, Eagle Spring and Bacon Flat, oil occurs immediately beneath the unconformity below the valley fill. Two fields, Currant and Eagle Springs, have some oil in traps not associated with the unconformity. Other parameters such as reservoir rocks, water salinity, depth or datum to oil water contact have little or no similarity.

CONCLUSIONS

It is the authors opinion that the oil in Railroad Valley can be found migrated into any type reservoir (fracture, intergranular, vugular, etc.) and that only the seal and trap are critical. The rock type, and reservoir type are not important.

The high local heat flow and great depth of recent burial of the valley has allowed oil to be generated from Eocene and Mississippian source rocks.

Traps for oil and gas formed prior to basin and range deformation in Paleozoic rocks will be difficult to find due to the large amount of fracture, fold and fault deformation. However, seals for Paleozoic traps in highly deformed rocks could be plastic shales such as the Mississippian Chairman or more recent clays in Tertiary rocks.

ACKNOWLEDGMENTS

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OIL CHARACTERISTICS

	Bacon Flat	Currant	Trap Spring	Eagle Spring
Gravity	28°	15°	21-25°	26-29°
Pour Point	10°F	80-95°F	0-40°F	65-80°
Color	Black	Black-Brown	Black	Black
Sulphur	0.4%	3.9%	0.8%	1.7%
Saybolt Viscosity @ 100°F	173	28,500	90	66
Saybolt Viscosity of: Oil at reservoir temperature (T_r)	45	520	90	5
Saybolt Viscosity of Water @ T_r	0.34	0.35	0.75	0.34