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Hydrocarbon Source Rock Characterization and Maturity based on Rock-Eval Pyrolysis and Vitrinite Reflectance of Eocene Strata, Southern Oregon Coast Range, Douglas and Coos Counties, Southwest Oregon

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INTRODUCTION

Commercial production of hydrocarbons from Oregon has been primarily limited to the Mist gas field in northwestern Oregon (Newton, 1979; Armentrout and Suek, 1985). Exploration for oil and gas in southwestern Oregon has been discouraging thus far, although the density of drilling is relatively low. As a part of the 1995 U.S. Geological Survey National Assessment of oil and gas resources , this study attempts to characterize the source rock potential of Eocene strata in the Tyee and Umpqua basins of southwestern Oregon (Figure 1). The adjacent Coos Bay basin was the site of an earlier oil and gas investigation by Newton (1980). Three critical factors in this source rock evaluation of generation potential (quantity), potential type of hydrocarbons (oil and/or gas), and thermal maturity. The volcanic and structural history of the area may be a factor in the thermal maturity both locally (i.e., proximity to sills and dikes, and thrust faults) and regionally (i.e., high crustal heat flow of the adjacent Western Cascade arc).

All the outcrop and exploration well samples in this study are Eocene in age except for four samples from the Mesozoic Sixes River Terrane of the adjacent Klamath Mountains (Figure 1). Approximately 144 samples (Table 1) were analyzed by Rock-Eval pyrolysis and seven samples were analyzed for vitrinite reflectance and maceral characterization. Outcrop samples were collected from fresh road and stream cuts. Well cuttings from six oil and gas exploration wells were sampled from the Oregon Department of Geology and Mineral Industries core repository in Portland. Most samples are keyed to measured sections and wells described in a fence diagram prepared by Ryu and others (1992) and Ryu (1995).

REGIONAL SETTING

The Paleogene history of the southern Oregon Coast Range was largely governed by northeast motions of the Kula and Farallon plates relative to the North American plate (Atwater, 1970; Coney, 1978; Drake, 1982). In the Paleocene and early Eocene, basaltic seamounts and oceanic islands were erupted along the Kula and Farallon spreading ridge, perhaps over a hot spot (Duncan, 1982). Alternatively, these seamounts and islands were formed in a rifted continental margin (Wells and others, 1984). Subduction of the Kula and Farallon oceanic plates beneath the North American continental plate during early Eocene time produced a "trench" or marginal basin (Umpqua basin on Figures 1 and 2) (Snavely, 1987; Niem and Niem, 1984, 1990; Perittu and Benson, 1980). As the thickened oceanic crust was partially subducted beneath the North American margin (represented by Mesozoic terranes of the Klamath Mountains), the oceanic crust and seamounts (i.e. Siletz River Volcanics) were partially incorporated with the Mesozoic crust and lower Umpqua turbidite strata in a series of northwestward verging imbricate thrust sheets (Figures 1 and 2a). As thrusting continued, a fan-delta/slope/submarine fan complex (i.e., Bushnell Rick Formation, Tenmile Formation, and lower Umpqua Group; Figure 3) prograded from the uplifted

Klamath Mountains northward into the Umpqua marginal basin. These strata were also incorporated into the thrust sheets during deposition to form a syntectonic "subduction complex" (Figure 2a) (Heller and Ryberg, 1983; Niem and Niem, 1990).

In the late-early Eocene, subduction slowed as the thickened buoyant Siletz River Volcanics seamounts clogged the subduction zone (Heller and Ryberg, 1983). The early Eocene position of the subduction zone was gradually abandoned, and a new subduction zone formed to the west beneath the present outer continental shelf and upper slope of Oregon (Figure 2b) (Niem and others, 1992; Snavely and others, 1980). Coincident with the switching of the subduction zone and clockwise rotation of the Umpqua basin (Wells and Heller, 1988), wave- and tide-dominated deltas (derived from the Klamath Mountains) prograded over the deformed subduction complex in the southern margin of the Umpqua basin. This deltaic sequence and associated slope mudstones are preserved as regressive to transgressive members of the coal-bearing White Tail Ridge Formation and as the Camas Valley Formation and undifferentiated upper Umpqua Group (Figures 1 and 3). Movement on some thrust faults and minor folding continued after deposition of these units (Figure 2b).

As the western subduction zone developed in the middle Eocene, a calcalkaline volcanic arc (Clarno Formation?) formed to the east in central Oregon (Chan and Dott, 1983). The Tyee forearc basin subsided between the western subduction zone and the volcanic arc (Figure 2b). Deltas and submarine fans prograded northward across the Klamath Mountains-Umpqua basin suture. These micaceous volcanic arkosic sands and slope muds filled the north-south trending forearc basin and comprise the members of the Tyee Formation and the Elkton, Bateman, and Spencer formations (Figure 3). These strata buried the earlier deformed Umpqua basin strata and Siletz River seamounts (Figure 2b) (Snavely and others, 1980; Heller and Ryberg, 1983; Chan and Dott, 1983; Niem and Niem, 1990; Niem and others, 1992). Wells and Heller (1988) suggested that the micaceous lithic arkosic sandstones in the Tyee Formation were derived, in part, from erosion of the Idaho batholith prior to significant clockwise rotation of the Tyee basin. In the northern part of the Tyee forearc basin, local late Eocene-Oligocene mafic volcanism created basaltic intrusions and flows (Tillamook Volcanics, Yachats Basalt,and Nestucca Volcanics of Snavely and Wells, 1984; Niem and others, 1992). Late Eocene to Miocene calcalkaline volcanism in the western Cascade arc on the eastern flank of the basin produced basaltic andesite flows, silicic intrusions, ashflows, and pyrolclastics (Figures 1 and 2b).

Several transgressions and regressions accompanied mafic volcanism, periods of uplift, and local basin subsidence in the forearc basin in the late Paleogene and early Neogene (Snavely and Wells, 1984; Niem and Niem, 1984; Niem and others, 1992). These sedimentary events are preserved as thick upper Eocene to middle Miocene siliciclastic sequences in the north-south trending Coos Bay basin that lies along the western margin of the Tyee basin (Figure 1). From the late-middle Miocene to the present, the Tyee and Coos Bay basins have been gently folded, faulted, uplifted, and eroded, exposing the underlying Umpqua basin strata, Siletz River Volcanics, and Mesozoic Klamath Mountain terranes (Figure 1).

METHODS

The Rock-Eval II instrument is capable of measuring both pyrolytic yield of hydrocarbons in a helium stream atmosphere and residual organic carbon by oxidation. The powdered rock sample (about 100 mg) is first analyzed at 250°C for 5 minutes that thermally distills organic compounds from C_1 to about C_{32}. The released hydrocarbons are measured by a flame ionization detector (FID) and the amount is reported as S_1 (mg/g rock). Then programmed pyrolysis from 250°C to 600°C at 25°C/minute cracks the kerogen and heavy bitumen yielding organic compounds, water and carbon dioxide as well as other gases. Half the flow of gas goes to the FID to measure the generated hydrocarbons as S_2 (mg HC/g rock) and half goes to a carbon dioxide trap. The gases flow into a carbon dioxide trap from 250°C to 390°C (from 390°C to 600°C, the evolved carbon dioxide is not collected). After completion of the programmed pyrolysis, the carbon dioxide trap is heated and the released gas measured by a thermal conductivity detector (TCD) is reported as S_3 (mg HC/g rock). This amount of CO_2 is a function of the oxygen content of the organic matter. Next the crucible is moved to another furnace where it is heated to about 590°C in air (oxidizing atmosphere). The carbon dioxide (and carbon monoxide catalyzed using CuO to carbon dioxide) evolved is measured as S_4 by the TCD. S_4 is the residual (inert) organic carbon and is added to S_1 and S_2 to calculate the total organic carbon content (TOC). T_{max} (°C) is the temperature where the maximum amount of S_2 hydrocarbons is generated. T_{max} is a function of kerogen type and thermal maturity.

Measured pyrolysis values are usually not interpreted directly but in conjunction with other parameters. For example, S_1 and S_2 are typically interpreted in relation to the total organic carbon content. Hydrogen Index (HI) is the ratio of S_2/TOC expressed in the units mg hydrocarbons (HC)/g organic carbon (OC) which is correlative with the H/C ratio of the kerogen: HI = 694 /C - 0.29) - 800 (O/C), (Orr, 1983). Values typically range from 0 to 900. Oxygen Index (OI) is the ratio S_3/TOC (mg HC/gOC) that is correlative with the O/C ratio of the kerogen. Values typically range from 0 to 300. Thus, HI and OI are indicators of kerogen type analogous to the van Krevelen diagram (H/C vs. O/C) which, in turn, indicates whether the source rock is oil- or gas-prone (Peters, 1986).

Vitrinite reflectance was determined on splits of selected rock samples from the sample set. First the dispersed organic matter was separated from the sample by centrifuging the mixture of rock powder and zinc bromide solution (Barker and Pawlewicz, 1986). After decanting off the organic matter into another centrifuge tube, it was rinsed and centrifuged three times and then dried. The dried organic matter was set in resin on a standard petrographic slide, and after drying, the slide was trimmed with a thin section saw and polished on a lap wheel. Reflectance readings were taken under oil immersion using 546 nm light and a 3 micron sensing spot. Ideally 50 readings are taken on terrigenous organic material (Type III kerogen) with the lowest reflectance but the actual numbers of readings taken depend upon the abundance of terrigenous organic matter in the sample.

RESULTS AND INTERPRETATION

Organic Facies

Most of the samples are mudstones and have a very low total organic carbon content (TOC). Over 80 percent of the samples analyzed have less than 1.0 weight percent TOC and over 88 percent of the samples contain less than 1.5 weight percent TOC (Table 2). There are, however, twelve samples with TOC values greater than 7 percent; one sample may be classified as a coal (greater than 50 percent TOC). The other eleven samples described as coals from field observations (Table 1) are classified as highly carbonaceous mudstones based upon TOC (Table 2).

Most of the samples have hydrogen index (HI) values less than 300 mg HC/gOC (Table 2) indicating that the kerogen is predominantly Type III and Type IV organic matter (Peters, 1986). This type of organic matter is usually derived from terrestrial plants and reworked/oxidized organic matter of unknown origin (Tissot and others, 1974, Peters, 1986). A plot of HI vs. OI (Figure 4) suggests that the samples can be subdivided into three organic facies groups defined herein below as Facies A, B and C.. Facies A has the highest hydrocarbon content with HI values above 200 mg HC/gOC, Facies B has values in the range between 75 and 200 mg HC/gOC, and Facies C has HI values below 75 mg HC/gOC. Three Facies A samples have a HI above 300 mgHC/gOC which classifies them as Type II kerogen (Peters, 1986). However, two of the three samples (93050-020 and 93051-010) have low TOC values (0.09 and 0.47 weight percent, respectively) which produce anomalously high HI values. A duplicate run of the third sample (93050-046) has a HI below 300 mg HC/gOC and the average of the two runs is slightly below 300 mg HC/gOC (see Source Rock Evaluation below). Although a few borderline samples would change facies classification if less mature, the maturity effect is generally minimal. A similar minimal maturity effect has been observed in suites of Type III organic matter in other basins (Peters, 1986). Most of the rock samples described as "coals" are either Facies A or B.

Table 3 lists the organic facies classification of each sample and is sorted by age. Facies A organic matter is predominantly found in the Coquille River and Remote members of the White Tail Ridge Formation and consists of well-preserved land plant debris deposited in a deltaic environment. The Sixes River Terrain, Bushnell Rock Formation, Hubbard Creek member of the Tyee Formation, and the Slater Creek member of the Bushnell Rock Formation each contain one sample with Facies A organic matter. Facies B organic matter is also land plant debris deposited in deltas along the margins of the Tyee and Umpqua basins throughout the Eocene. The Bushnell Rock Formation (5 samples) and the Tenmile Formation (3 samples) have the most Facies B samples. Rock samples classified as Facies C organic matter are also scattered throughout the Eocene section but are found predominantly in the undifferentiated Umpqua Group (27 samples), the Tenmile Formation (11 samples), the Camas Valley Formation (11 samples) and all members of the Tyee Formation (28 samples). Facies C organic matter is oxidized and/or reworked organic debris probably derived from land plants and algal organic matter deposited in the deep marine portions of the Tyee and Umpqua basins.

Thermal Maturity

The thermal maturity of the organic matter was evaluated based on the T_{max} of the S_2 peak using the criteria listed in Table 3 (Bordenave and others, 1993). The Tyee and Umpqua basins samples have a wide range of maturity from immature to overmature although most are immature with respect to gas generation (T_{max} less than 470°C). There are 54 immature samples, 51 samples in the "oil window", 33 samples in the "gas window", and one overmature sample. Table 3 lists the maturity level of each sample and the reliability of the T_{max} data. Many of these maturity ratings are unreliable (e.g., too high) in cases where the S_2 value is less than 0.3 mg HC/g rock (Bordenave and others, 1993) and/or TOC content is less than 0.5 wt. % (Peters, 1986). For example, some outcrop samples of the Hubbard Creek Member are more thermally mature (based on T_{max}) than samples of underlying units in the same unfaulted measured section. The higher than normal T_{max} maturity ratings of the Hubbard Creek samples are probably invalid due to low S_2 values which exacerbate the interference by smectite clay matrix (Peters, 1986). Outcrop weathering is partially responsible for some of the low S_2 values. Many of the outcrop samples have reliable T_{max} maturity values in the "oil window" (thermal maturity required for oil generation). These data suggest that some areas of the basin were once more deeply buried and thermally altered before uplift and erosion. However, some samples have probably been thermally altered by hydrothermal fluids (see below).

To avoid outcrop weathering effects, we studied T_{max} of samples from several wells in the southern Oregon Coast Range. Thermal maturity usually increases with depth in a well due to the normal increase in temperature and age of the rock with increasing depth. Figure 5 shows the downhole maturity profiles of two wells in the northern and central part of the study area. The Union Liles well (drilled in the lower Umpqua Group) and the Sawyer well have normal profiles reflecting a cool regional geothermal gradient. The anomalous data point in the Sawyer well is probably due to a low S_2 value. No sills or faults are reported in this well in the center of the gently deformed Tyee forearc basin (Ryu and others, 1992).

Three wells in the central and southern part of the study area (Figure 6) have steep profiles and/or much higher T_{max} maturity values in relation to depth. The Scott #1 well has a reversal in the maturity trend of T_{max} and vitrinite reflectance values. The nearby Glory Hole #1 well may also have a reversal, but there are only three data points. A reversal in the maturity trend could be caused by local heating from basaltic sills and/or migration of hydrothermal fluids along thrust faults in the Umpqua basin. For example, a basalt sill penetrated by the Long Bell well in the northern part of the Tyee basin locally heated lower Umpqua mudstones and formed a small-scale reversal in the T_{max} gradient (Ryu, 1995). A similar pattern of data on a smaller scale has been observed in Cretaceous black shales from the eastern Atlantic that were intruded by sills

(Peters and others, 1983). However, no sills have been reported in the Glory Hole #1 or Scott #1 wells (Ryu and others, 1992). According to core descriptions, the Scott #1 well penetrated pillow basalts of Siletz River Volcanics at about the depth of the maturity reversal (2215-2760 ft), and the Bushnell Rock Formation is above and below the basalt. Both wells are on strike with the mapped projection of the Bonanza fault zone (Niem and Niem, 1990). Several miles east of these two wells, hydrothermal fluids along the Bonanza fault zone have created local cinnabar mineralized zones and have altered and baked bedrock near the boundary with the Western Cascades (Wells and Waters, 1934; Ryu, 1995). The most likely explanation for a reversal in the maturity trend is the emplacement of more mature Umpqua Group strata by thrusting over less mature Umpqua strata and/or local heating by hydrothermal fluids in the fault zone. Fractured sedimentary rock and fractures filled with fluorescing material reported in the core descriptions of the Scott #1 well support the thrust and/or migration of hydrothermal fluids hypothesis.

The samples from the Great Discovery #2 well have elevated maturity values in relation to depth (Figure 6). The Great Discovery #2 well also has a reversal in the maturity trend suggesting the influence of possible faulting between -500 and -1500 feet subsea. However, no sills or faults are reported in this well (Ryu and others, 1992). The T_{max} values of these samples in the lower part of the well are also unreliable due to lean S_2 values (less than 0.2 mg/g), and the reversal in the pattern may not be valid.

Vitrinite reflectance data from this study is listed in Table 4 and is plotted in Figure 7. Vitrinite reflectance is one of the most commonly used thermal maturity parameters. Many investigators have found a correlation between vitrinite reflectance and T_{max} of organic matter in thermal maturity studies in other basins. For a given organic matter type, both vitrinite reflectance and T_{max} increase with increasing depth (thermal maturity). For example, Figure 7 shows the approximate upper and lower boundaries of the data from Espitalié (1985) (Type III organic matter) and data from Peters (1986) (assorted organic matter types). Three samples from the current study have anomalously high T_{max} values (Figure 7). One explanation for the two Scott #1 well samples may be thermal alteration by hydrothermal fluids that migrated along faults in that well. Alternatively, the three samples may contain reworked organic matter which can produce a much higher T_{max} than expected (Peters, 1986).

Source Rock Evaluation

The samples with the highest organic content are listed in Table 5. The samples are grouped by formation or member and are ranked by generative potential. The criteria for evaluation of the hydrocarbon type and generative potential are based on TOC and S_2 (Peters, 1986). S_1 was not used because it is more affected by weathering in outcrop samples, and S_1 is suppressed relative to S_2 in coals (Espitalié, 1985). The "coals" and high TOC carbonaceous mudstones in the Coquille River and Remote members have very good generative potential for gas and possibly minor oil based on these criteria. However, Peters (1986) cautioned that some type III gas-prone coals can give anomalously high HI values that place them in the oil- and gas-prone category on

OI vs. HI plots. Further visual kerogen typing and elemental analysis are necessary to evaluate the oil potential of these high TOC rocks. The "coals" in the White Tail Ridge Formation, Baughman Member of the White Tail Ridge Formation, Bateman Formation, and Spencer Formation have very good generative potential for gas only. It is important to realize that the generative potential of each stratigraphic unit is probably not uniform vertically or laterally and that these "coal" samples are representative of only a small part of the unit (<3% of total volume).

The Sixes River Terrane and Hubbard Creek Member of the Tyee Formation samples have good generative potential for gas and possibly oil. However, the Sixes River Terrane sample (93050 018) contains visible bitumen and little other recognizable organic matter (Table 4). This bitumen may be migrated hydrocarbons or contamination as indicated by the S_1/S_1+S_2 (Production Index) value of 0.08. This lower to middle Cretaceous limestone occurs as house-sized blocks within the Sixes River Terrane, and, therefore, is a limited source rock (Niem and Niem, 1990).

For a potential source rock to become an effective source rock, it must have reached a sufficiently high maturity level to generate hydrocarbons. For oil-prone type II source rocks, that maturity level is roughly equivalent to a T_{max} of 435°C (oil window) but for gas-prone type III source rocks that level is greater than a T_{max} of 470°C (gas window). None of the Oregon samples with good gas generative potential have reached that level but one or two are close (93049-038 and 93050-013). Sample 93049-038 is a coal in the upper Eocene Spencer Formation which was collected near the foothills of the Western Cascades volcanic arc. That area is close to basaltic and andesitic sills and has undergone a high thermal stress during arc volcanism in the Oligocene and Miocene (Ryu, 1995). The other sample (93050-013) is a "coal" in the Remote Member of the White Tail Ridge Fm. that is underlain by thermally less mature Umpqua Group strata (Ryu, 1995). These two samples suggest that thermal friction and/or hydrothermal fluids migrating along thrust faults may have locally created maturation levels high enough to generate thermogenic gas. Hydrothermal fluids can act as local maturation agents in tectonically active basins (Simoneit, 1994). Summer (1987) concluded that the dominant maturation process throughout the Pacific Northwest is related to hydrothermal fluids. Thus, the possibility exists that equivalent stratigraphic units in the subsurface are locally effective source rocks due to thermal friction and/or hydrothermal fluids that migrated along thrust faults.

CONCLUSIONS

This survey of the Eocene rocks in southwestern Oregon suggests that some of the stratigraphic units contain enough organic matter to be potential sources of natural gas. The oil source potential of these rocks is considered to be small. The kerogen type in these rocks is predominantly terrestrial organic matter (Type III), and some formations contain humic coal beds. Most samples are below the level of maturity needed to generate thermogenic gas. However, equivalent source beds may be thermally mature in deeper parts of the basin. Source beds may have also been locally heated by sills, hydrothermal fluids, or thermal friction along thrust faults and may have generated small amounts of thermogenic gas. Although effective gas source rocks may occur in the study area, this report does not address the other elements required for an economic accumulation.

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Table 1A. Sample descriptions for outcrop samples from the Tyee-Umpqua basins, Oregon

[LONG = Longitude; LAT = Latitude; ELEV = Elevation; CO = County (D - Douglas; C - Coos)]

LAB #	OUTCROP SAMPLE #	STRATIGRAPHIC UNIT	LONG	LAT	CO	ELEV (ft)	LITHOLOGY
93049 001	RN-90-270	Coquille River Mbr.	123.63722	43.06722	D	1120	Mudstone
93049 002	RN-90-274	Tyee Mountain Mbr.	123.70000	43.10000	D	2000	Mudstone
93049 003	RN-90-281	Camas Valley Fm.	123.74694	43.02972	D	1600	Silty Mudstone
93049 004	RN-90-283	Rasler Creek Tongue	123.74694	43.02972	D	1600	Mudstone
93049 005	RN-90-330	Umpqua Gp. (undiff.)	123.21444	43.61889	D	660	Mudstone
93049 006	RN-91-026	Tyee Mountain Mbr.	123.19833	43.68500	D	660	Mudstone
93049 007	RN-91-040	Bushnell Rock Fm.	123.13472	43.3072	D	660	Mudstone
93049 008	RN-91-053	Bushnell Rock Fm.	123.72222	42.92500	D	1250	Mudstone
93049 009	RN-90-287	Hubbard Creek Mbr.	123.75944	43.04028	D	2800	Mudstone
93049 011	RN-90-322	Umpqua Gp. (undiff.)	123.22167	43.61056	D	660	Mudstone
93049 012	RN-90-324	Umpqua Gp. (undiff.)	123.21611	43.61611	D	660	Mudstone
93049 013	R-89-106	Tenmile Fm.	123.63389	43.08778	D	1140	Silty Mudstone
93049 014	R-89-159	Umpqua Gp. (undiff.)	123.32167	43.42722	D	560	Shale
93049 015	R-89-172	Bateman Fm.	123.65556	43.50556	D	1480	"Coal"
93049 016	R-90-020	Umpqua Gp. (undiff.)	123.46667	43.66722	D	240	Mudstone
93049 017	R-90-022	Umpqua Gp. (undiff.)	123.46667	43.66722	D	240	Mudstone
93049 018	R-90-030	Umpqua Gp. (undiff.)	123.46667	43.66722	D	240	Mudstone
93049 019	R-90-047	Tyee Mountain Mbr.	123.53000	43.38583	D	400	Shale
93049 020	RN-90-011	Tyee Mountain Mbr.	123.53778	43.40611	D	320	Mudstone
93049 021	RN-90-032	Hubbard Creek Mbr.	123.56111	43.41111	D	320	Mudstone
93049 022	RN-90-057	Tyee Mountain Mbr.	123.48028	43.47917	D	240	Silty Mudstone
93049 023	RN-90-083	Baughman Mbr.	123.53722	43.52278	D	240	Mudstone
93049 024	RN-90-097	Hubbard Creek Mbr.	123.52278	43.51778	D	320	Silty Mudstone
93049 025	RN-90-123	Tyee Mountain Mbr.	123.51528	43.64944	D	160	Silty Mudstone
93049 026	RN-90-144	Hubbard Creek Mbr.	123.54389	43.64000	D	480	Silty Mudstone
93049 027	RN-90-194	Berry Creek Mbr.	123.58694	42.95861	D	1500	Mudstone
93049 028	RN-90-265	Berry Creek Mbr.	123.63722	43.06722	D	1120	Silty Mudstone
93049 029	RN-91-337	Tenmile Fm.	124.04444	42.89278	C	640	Silty Mudstone
93049 030	RN-91-344	Tyee Mountain Mbr.	123.98556	42.87056	C	1920	Mudstone
93049 031	RN-91-348	Hubbard Creek Mbr.	123.98500	42.87389	C	2000	Mudstone
93049 032	RN-91-365	Tenmile Fm.	124.07222	42.68444	C	2400	Mudstone
93049 033	RN-91-391	White Tail Ridge Fm.	124.05722	42.68750	C	2450	"Coal"
93049 034	RN-91-398	Tyee Mountain Mbr.	123.86389	43.09444	C	2000	Silty Mudstone
93049 035	RN-91-400	Hubbard Creek Mbr.	123.85722	43.10000	C	2210	Mudstone
93049 036	RN-91-402	Baughman Mbr.	123.85778	43.10222	C	2500	Mudstone
93049 037	RN-91-405	Tenmile Fm.	124.07667	42,87389	C	560	Mudstone
93049 038	R-927-027	Spencer Fm.	123.19167	43,73472	D	480	"Coal"
93049 039	KL-93-13-1	White Tail Ridge Fm	124.06667	42.68750	C	2310	"Coal"
93049 040	KL-93-14-1	Remote Mbr.	123.89778	43.00694	C	280	"Coal"
93049 041	N-90-217	Tyee Mountain Mbr.	124.06722	42.68833	C	80	Mudstone
93049 042	N-91-131	Umpqua Gp. (undiff.)	123.32944	42.48833	D	640	Mudstone
93049 043	N-91-064	Slater Creek Mbr.	123.79444	42.94444	D	1120	Silty Mudstone
93049 043	N-91-064	Slater Creek Mbr.	123.79444	42.94444	D	1120	Silty Mudstone
93049 044	N-91-133	Umpqua Gp. (undiff.)	123.32111	42.48833	D	560	Silty Mudstone
93049 045	N-92-1001	Baughman Mbr.	123.99667	42.82444	C	1520	"Coal"
93049 046	R-89-057	Camas Valley Fm.	123.53556	43.24944	D	1120	Mudstone
93049 047	R-89-061	Tyee Mountain Mbr.	123.54111	43.26111	D	2000	Mudstone
93049 048	R-89-096	Tenmile Fm.	123.49861	43.12556	D	640	Mudstone

Table 1A. continued

LAB #	OUTCROP SAMPLE #	STRATIGRAPHIC UNIT	LONG	LAT	CO	ELEV (ft)	LITHOLOGY
93049 049	RN-91-148	Umpqua Gp. (undiff.)	123.31611	43.44139	D	480	Mudstone
93049 050	RN-91-236	Tyee Mountain Mbr.	123.84000	43.59361	D	800	Silty Mudstone
93049 051	RN-91-240	Baughman Mbr.	123.82278	43.57944	D	440	Mudstone
93049 052	RN-91-292	Baughman Mbr.	123.85667	43.40944	C	1280	Silty Mudstone
93049 053	RN-91-295	Tyee Mountain Mbr.	123.87000	43.41556	C	640	Mudstone
93049 054	RN-91-320	Elkton Fm.	123.76167	43.59111	D	720	Mudstone
93050 001	RN-91-354	Tenmile Fm.	124.05889	42.78111	C	720	Silty Mudstone
93050 002	RN-91-362	Hubbard Creek Mbr.	124.04778	42.76806	C	680	Mudstone
93050 003	RN-91-379	Camas Valley Fm.	124.02389	42.82944	C	400	Mudstone
93050 004	RN-92-001	Sixes River Terrane	124.80889	42.90333	D	2880	Mudstone
93050 005	R-92-017	Remote Mbr.	124.04944	42.81861	D	1680	"Coal"
93050 006	R-89-034	Tenmile Fm.	123.64861	43.14056	D	1200	Silty Mudstone
93050 007	R-89-044	Baughman Mbr.	123.69056	43.17833	D	2320	"Coal"
93050 008	R-89-142	Umpqua Gp. (undiff.)	123.22167	43.37556	D	800	Mudstone
93050 009	RN-91-112	Hubbard Creek Mbr.	123.65056	43.16389	D	2280	Shale
93050 010	RN-91-189	Umpqua Gp. (undiff.)	123.20222	43.36333	D	1040	Silty Mudstone
93050 011	RN-91-198	Umpqua Gp. (undiff.)	123.35389	43.19194	D	640	Mudstone
93050 012	RN-91-256	Tenmile Fm.	123.96806	42.96056	C	360	Mudstone
93050 013	RN-91-270	Remote Mbr.	123.98194	42.95111	C	1040	"Coal"
93050 014	RN-91-272	Camas Valley Fm.	123.96333	42.94917	C	1320	Mudstone
93050 015	RN-91-279	Rasler Creek Tongue	123.95278	42.94444	C	1640	Silty Mudstone
93050 016	KL-93-10-3	Sixes River Terrane	123.30833	43.11111	D	1650	Mudstone
93050 017	KL-93-11-3	Sixes River Terrane	123.30833	43.11111	D	1650	Mudstone
93050 018	KL-93-11-5	Sixes River Terrane	123.30833	43.11111	D	1650	Limestone
93050 019	RN-91-070	Tenmile Fm.	123.71944	42.93778	D	1400	Mudstone
93050 020	RN-91-083	Remote Mbr.	123.74278	42.97778	D	1000	Mudstone
93050 021	RN-91-099	Coquille River Mbr.	123.72333	42.99444	D	1050	"Coal"
93050 022	RN-91-137	Umpqua Gp. (undiff.)	123.23750	42.43472	D	660	Shale
93050 023	RN-91-138	Umpqua Gp. (undiff.)	123.24111	42.43833	D	720	Mudstone
93050 024	RN-91-168	Berry Creek Mbr.	123.91389	43.01389	C	200	Silty Mudstone
93050 025	RN-91-176	Coquille River Mbr.	123.89611	43.00667	C	280	Mudstone
93050 026	RN-91-178	Camas Valley Fm.	123.88222	43.01222	C	280	Mudstone
93050 027	RN-91-180	Camas Valley Fm.	123.88111	43.01389	C	240	Mudstone
93050 028	RN-91-207	Tenmile Fm.	124.04389	43.25556	C	100	Silty Shale
93050 029	RN-91-213	Camas Valley Fm.	124.03194	43.26111	C	150	Mudstone
93050 030	RN-91-217	Tyee Mountain Mbr.	123.93444	43.26778	C	880	Silty Mudstone
93050 031	RN-91-223	Hubbard Creek Mbr.	123.94833	43.27889	C	1050	Mudstone
93050 032	RN-91-225	Baughman Mbr.	123.91833	43.29111	C	1650	Mudstone
93050 033	RN-91-245	Tenmile Fm.	123.94833	43.01222	C	150	Mudstone
93050 034	RN-91-247	Tenmile Fm.	123.94278	43.01306	C	150	Mudstone
93050 035	RN-91-304	Bateman Fm.	123.65250	43.58278	D	1200	Mudstone
93050 036	RN-91-306	Elkton Fm.	123.65556	43.50000	D	1600	Silty Mudstone
93050 037	RN-91-329	Bateman Fm.	123.65417	43.58583	D	1050	Shale
93050 038	RN-91-332	Elkton Fm.	123.61111	43.53611	D	920	Mudstone
93050 039	N-90-243	Camas Valley Fm.	123.88389	43.14806	C	360	Mudstone
93050 040	N-90-245	Umpqua Gp. (undiff.)	123.43000	43.27083	D	400	Mudstone
93050 041	N-90-254	Elkton Fm.	123.58889	43.63806	D	160	Mudstone
93050 042	N-90-269	Camas Valley Fm.	123.50833	43.37556	D	320	Mudstone
93050 043	N-90-281	Camas Valley Fm.	123.50833	43.37556	D	320	Mudstone
93050 044	N-90-287	Camas Valley Fm.	123.70778	43.01444	D	1120	Silty Mudstone
93050 045	N-90-304C	Berry Creek Mbr.	123.10556	43.29694	D	720	Mudstone
93050 046	N-90-358	Coquille River Mbr.	123.07833	43.30889	D	720	"Coal"

Table 1A. continued

LAB #	OUTCROP SAMPLE #	STRATIGRAPHIC UNIT	LONG	LAT	CO	ELEV (ft)	LITHOLOGY
93050 047	N-90-359	Camas Valley Fm.	123.07889	43.31056	D	560	Silty Mudstone
93050 048	N-91-005	Bushnell Rock Fm.	123.16278	43.31333	D	560	Silty Mudstone
93050 049	N-91-025	Tenmile Fm.	123.13194	43.30778	D	560	Mudstone
93050 050	N-91-035	Tenmile Fm.	123.11306	43.30333	D	560	Silty Mudstone
93050 051	N-91-110	Tenmile Fm.	123.44750	43.32139	D	680	Mudstone
93050 052	N-91-116	Remote Mbr.	123.45417	43.32917	D	400	"Coal"
93050 053	R-89-010	Remote Mbr.	123.74583	42.97083	C	1000	Mudstone
93050 054	R-89-078	Umpqua Gp. (undiff.)	123.61667	43.13056	D	480	Shale
no lab #	RN91-411						

Table 1B. Sample descriptions for well cuttings samples from the Tyee-Umpqua basins, Oregon

[LONG = Longitude; LAT = Latitude; CO = County (D - Douglas; C - Coos)]

LAB #	WELL NAME	STRATIGRAPHIC UNIT	DEPTH (ft)	LONG	LAT	CO	LITHOLOGY
93051 001	1 Scott	Tenmile Fm.	390	123.44045	43.24163	D	Mudstone
93051 002	1 Scott	Bushnell Rock Fm.	1020	123.44045	43.24163	D	Mudstone
93051 003	1 Scott	Bushnell Rock Fm.	1200	123.44045	43.24163	D	Mudstone
93051 004	1 Scott	Tenmile Fm.	1380	123.44045	43.24163	D	Mudstone
93051 005	1 Scott	Bushnell Rock Fm.	1860	123.44045	43.24163	D	Mudstone
93051 006	1 Scott	Bushnell Rock Fm.	2340	123.44045	43.24163	D	Mudstone
93051 007	1 Scott	Bushnell Rock Fm.	3090	123.44045	43.24163	D	Mudstone
93051 008	1 Scott	Bushnell Rock Fm.	3540	123.44045	43.24163	D	Mudstone
93051 009	2 Great Discovery	Remote Mbr.	540	123.79504	42.95419	D	Mudstone
93051 010	2 Great Discovery	Slater Creek Mbr.	1380	123.79504	42.95419	D	Mudstone
93051 011	2 Great Discovery	Slater Creek Mbr.	2430	123.79504	42.95419	D	Mudstone
93051 012	2 Great Discovery	Umpqua Gp. (undiff.)	2910	123.79504	42.95419	D	Mudstone
93051 013	2 Great Discovery	Umpqua Gp. (undiff.)	3150	123.79504	42.95419	D	Mudstone
93051 014	2 Great Discovery	Umpqua Gp. (undiff.)	3390	123.79504	42.95419	D	Mudstone
93051 015	1 Glory Hole	Berry Creek Mbr.	450	123.52070	43.23837	D	Mudstone
93051 016	1 Glory Hole	Tenmile Fm.	1410	123.52070	43.23837	D	Mudstone
93051 017	1 Glory Hole	Tenmile Fm.	2130	123.52070	43.23837	D	Mudstone
93051 018	1 Glory Hole	Tenmile Fm.	2640	123.52070	43.23837	D	Mudstone
93051 019	1 Liles	Umpqua Gp. (undiff.)	680	123.50819	43.37003	D	Mudstone
93051 020	1 Liles	Umpqua Gp. (undiff.)	1440	123.50819	43.37003	D	Mudstone
93051 021	1 Liles	Umpqua Gp. (undiff.)	2240	123.50819	43.37003	D	Mudstone
93051 022	1 Liles	Umpqua Gp. (undiff.)	2880	123.50819	43.37003	D	Mudstone
93051 023	1 Liles	Umpqua Gp. (undiff.)	3840	123.50819	43.37003	D	Mudstone
93051 024	1 Liles	Umpqua Gp. (undiff.)	5000	123.50819	43.37003	D	Mudstone
93051 025	1 Liles	Umpqua Gp. (undiff.)	5880	123.50819	43.37003	D	Mudstone
93051 026	1 Liles	Umpqua Gp. (undiff.)	6680	123.50819	43.37003	D	Mudstone
93051 027	1 Wm Ziedrich	Tenmile Fm.	2719	123.64927	43.04984	D	Mudstone
93051 028	1 Wm Ziedrich	Tenmile Fm.	3274	123.64927	43.04984	D	Mudstone
93051 029	1 Wm Ziedrich	Tenmile Fm.	3618	123.64927	43.04984	D	Mudstone
93051 030	1 Wm Ziedrich	Tenmile Fm.	4132	123.64927	43.04984	D	Mudstone
93051 031	1 Sawyer Rapid	Baughman Mbr.	390	123.74736	43.60363	D	Mudstone
93051 032	1 Sawyer Rapid	Hubbard Creek Mbr.	900	123.74736	43.60363	D	Mudstone
93051 033	1 Sawyer Rapid	Tyee Mountain Mbr.	1710	123.74736	43.60363	D	Mudstone
93051 034	1 Sawyer Rapid	Tyee Mountain Mbr.	2970	123.74736	43.60363	D	Mudstone
93051 035	1 Sawyer Rapid	Tyee Mountain Mbr.	4500	123.74736	43.60363	D	Mudstone
93051 036	1 Sawyer Rapid	Tyee Mountain Mbr.	5460	123.74736	43.60363	D	Mudstone

WELL NAME	OPERATOR	ELEVATION (ft)	TOTAL DEPTH (ft)
1 Scott	Community Oil and Gas	482	3693
2 Great Discovery	Hutchins & Marrs	810	3510
1 Glory Hole	Hutchins & Marrs	715	2987
1 Liles	Union Oil	725	7002
1 Wm Ziedrich	Uranium Oil and Gas	1447	4368
1 Sawyer Rapid	Northwest Exploration	400	5562

Table 2. Rock-Eval data for rock samples from the Tyee-Umpqua basins, Oregon

[SMPL WT = sample weight (mg); Tmax = temperature of maximum hydrocarbon generation (apex of S2 peak); S1 = thermally distilled hydrocarbons (mg HC/g rock); S2 = hydrocarbons generated by pyrolytic degradation of kerogen (mg HC/g rock); S3 = carbon dioxide generated by pyrolytic degradation of kerogen (mg CO_2/g rock); PI = Production Index (S1/S1+S2); PC = Pyrolyzable Carbon - S1 + S2 (wt % pyrolyzable organic carbon in rock); TOC = Total Organic Carbon (wt % total organic carbon in rock); HI = Hydrogen Index - S2/TOC (mg HC/g organic carbon); OI = Oxygen Index - S3/TOC (mg CO_2/g organic carbon)]

SAMPLE LAB #	SMPL WT (mg)	Tmax (°C)	S1 (mg/g)	S2 (mg/g)	S3 (mg/g)	PI	S_2/S_3	PC (wt%)	TOC (wt%)	HI (mg/g)	OI (mg/g)
93049 001	178.0	498	0.00	0.10	0.01	0.00	10.00	0.00	0.22	45	4
93049 002	164.0	433	0.00	0.17	0.18	0.00	0.94	0.01	0.57	29	31
93049 003	187.4	448	0.00	0.26	0.14	0.00	1.85	0.02	0.72	36	19
93049 004	169.3	446	0.00	0.46	0.14	0.00	3.28	0.03	0.91	50	15
93049 005	171.1	482	0.00	0.15	0.04	0.00	3.75	0.01	0.53	28	7
93049 006	140.5	434	0.00	0.39	0.32	0.00	1.21	0.03	1.00	39	32
93049 007	172.1	446	0.01	0.26	0.13	0.04	2.00	0.02	0.58	44	22
93049 008	191.9	483	0.00	0.18	0.06	0.00	3.00	0.01	0.59	30	10
93049 009	191.0	488	0.01	0.12	0.09	0.08	1.33	0.01	0.37	32	24
93049 010	168.0	431	0.01	0.27	0.18	0.04	1.50	0.02	0.54	50	33
93049 011	148.2	524	0.00	0.10	0.13	0.00	0.76	0.00	0.48	20	27
93049 012	161.9	425	0.00	0.04	0.00	0.00	0.00	0.00	0.48	8	0
93049 013	154.2	435	0.01	0.39	0.44	0.02	0.88	0.03	0.93	41	47
93049 014	137.8	470	0.00	0.15	0.79	0.00	0.18	0.01	0.60	25	131
93049 015	27.8	430	0.10	11.65	2.44	0.01	4.77	0.97	7.62	152	32
93049 016	158.6	425	0.01	0.10	0.44	0.10	0.22	0.00	0.38	26	115
93049 017	155.2	438	0.01	0.07	0.34	0.12	0.20	0.00	0.36	19	94
93049 018	160.0	427	0.01	0.13	0.45	0.07	0.28	0.01	0.58	22	77
93049 019	158.0	436	0.04	0.84	0.48	0.05	1.75	0.07	1.98	42	24
93049 020	169.9	455	0.00	0.30	0.05	0.00	6.00	0.02	0.33	90	15
93049 021	169.0	434	0.00	0.23	0.15	0.00	1.53	0.01	0.61	37	24
93049 022	156.3	433	0.01	0.27	0.12	0.04	2.25	0.02	0.43	62	27
93049 023	189.0	448	0.03	0.22	0.11	0.12	2.00	0.02	0.37	59	29
93049 024	190.3	430	0.04	0.85	0.29	0.05	2.93	0.07	1.43	59	20
93049 025	175.4	448	0.01	0.22	0.22	0.05	1.00	0.01	0.51	43	43
93049 026	184.1	424	0.11	5.21	1.15	0.02	4.53	0.44	2.01	259	57
93049 027	182.4	440	0.00	0.53	0.34	0.00	1.55	0.04	1.24	42	27
93049 028	169.4	433	0.01	0.48	0.47	0.02	1.02	0.04	1.36	35	34
93049 029	159.1	436	0.00	0.17	0.38	0.00	0.44	0.01	0.71	23	53
93049 030	164.6	431	0.00	0.29	0.30	0.00	0.96	0.02	0.59	49	50
93049 031	148.8	491	0.00	0.26	0.25	0.00	1.04	0.02	0.62	41	40
93049 032	172.4	468	0.01	0.22	0.12	0.05	1.83	0.01	0.59	37	20
93049 033	10.2	430	0.19	13.43	3.33	0.01	4.03	1.13	13.13	102	25
93049 034	188.8	457	0.01	0.34	0.20	0.03	1.70	0.02	0.66	51	30
93049 035	152.2	440	0.03	0.57	0.30	0.05	1.90	0.05	1.14	50	26
93049 036	136.7	432	0.02	0.11	0.19	0.17	0.57	0.01	0.55	20	34
93049 037	158.7	513	0.01	0.15	0.21	0.06	0.71	0.01	0.36	41	58
93049 038	6.5	463	0.00	32.30	11.38	0.00	2.83	2.69	34.26	94	33
93049 039	14.6	436	0.13	23.56	23.01	0.01	1.02	1.97	34.48	68	66
93049 040	9.5	420	0.94	71.15	9.89	0.01	7.19	6.00	29.60	240	33
93049 041	124.2	432	0.00	0.22	0.09	0.00	2.44	0.01	0.62	35	14
93049 042	138.4	427	0.01	0.59	1.18	0.02	0.50	0.05	2.09	28	56
93049 043	167.4	456	0.00	0.05	0.30	0.00	0.16	0.00	0.61	8	49

Table 2. continued

SAMPLE LAB #	SMPL WT (mg)	Tmax (°C)	S1 (mg/g)	S2 (mg/g)	S3 (mg/g)	PI	S_2/S_3	PC (wt%)	TOC (wt %)	HI (mg/g)	OI (mg/g)
93049 043	148.3	515	0.00	0.03	0.30	0.00	0.10	0.00	0.60	5	50
93049 044	159.9	445	0.00	0.11	0.11	0.00	1.00	0.00	0.43	25	25
93049 045	10.1	432	0.09	34.85	21.38	0.00	1.63	2.91	42.32	82	50
93049 046	167.9	423	0.00	0.16	0.27	0.00	0.59	0.01	0.63	25	42
93049 047	179.9	431	0.00	0.28	0.21	0.00	1.33	0.02	0.81	34	25
93049 048	199.7	441	0.00	0.09	0.09	0.00	1.00	0.00	0.47	19	19
93049 049	177.5	466	0.01	0.15	0.14	0.06	1.07	0.01	0.41	36	34
93049 050	162.3	433	0.00	0.27	0.24	0.00	1.12	0.02	0.17	158	141
93049 051	171.4	434	0.00	0.32	0.33	0.00	0.96	0.02	1.05	30	31
93049 052	148.6	433	0.00	0.24	0.19	0.00	1.26	0.02	0.62	38	30
93049 053	169.7	428	0.00	0.19	0.15	0.00	1.26	0.01	0.63	30	23
93049 054	158.0	436	0.02	0.53	0.27	0.04	1.96	0.04	1.12	47	24
93050 001	155.5	483	0.00	0.23	0.10	0.00	2.30	0.01	0.53	43	18
93050 002	170.7	437	0.01	0.29	0.15	0.03	1.93	0.02	0.64	45	23
93050 003	161.4	470	0.01	0.23	0.15	0.04	1.53	0.02	0.47	48	31
93050 004	43.7	556	0.02	0.18	0.32	0.10	0.56	0.01	1.34	13	23
93050 005	9.2	450	0.00	5.21	4.78	0.00	1.08	0.43	9.74	53	49
93050 006	178.5	467	0.00	0.04	0.03	0.00	1.33	0.00	0.20	20	15
93050 007	14.2	432	0.14	10.56	2.53	0.01	4.17	0.89	8.72	121	29
93050 008	164.7	461	0.00	0.00	0.26	0.00	0.00	0.00	0.33	0	78
93050 009	177.8	476	0.02	0.22	0.20	0.08	1.10	0.02	0.61	36	32
93050 010	MISSING										
93050 011	189.2	472	0.00	0.18	0.15	0.00	1.20	0.01	0.61	29	24
93050 012	159.1	514	0.00	0.06	0.15	0.00	0.40	0.00	0.41	14	36
93050 013	7.4	468	0.00	80.00	7.16	0.00	11.17	6.66	45.58	175	15
93050 014	196.1	433	0.00	0.18	0.23	0.00	0.78	0.01	0.71	25	32
93050 015	177.9	453	0.01	0.20	0.21	0.05	0.95	0.01	0.47	42	44
93050 016	220.1	486	0.02	0.15	0.04	0.12	3.75	0.01	0.54	27	7
93050 017	206.3	449	0.00	0.19	0.15	0.00	1.26	0.01	0.44	43	34
93050 018	53.7	445	0.54	6.14	0.35	0.08	17.54	0.55	2.27	270	15
93050 019	155.6	480	0.01	0.23	0.36	0.04	0.63	0.02	0.54	42	66
93050 020	182.1	470	0.01	0.28	0.03	0.04	9.33	0.02	0.09	311	33
93050 021	5.2	423	2.11	79.23	14.42	0.03	5.49	6.77	33.59	235	42
93050 022	183.5	455	0.00	0.21	0.11	0.00	1.90	0.01	0.39	53	28
93050 023	164.1	429	0.01	0.42	0.39	0.02	1.07	0.03	1.05	40	37
93050 024	MISSING										
93050 025	MISSING										
93050 026	180.1	462	0.00	0.14	0.09	0.00	1.55	0.01	0.49	28	18
93050 027	181.7	429	0.00	0.11	0.12	0.00	0.91	0.00	0.40	27	30
93050 028	159.6	433	0.01	0.10	0.42	0.10	0.23	0.00	0.42	23	100
93050 029	177.7	428	0.00	0.08	0.35	0.00	0.22	0.00	0.52	15	67
93050 030	159.5	430	0.00	0.15	0.29	0.00	0.51	0.01	0.64	23	45
93050 031	163.1	428	0.00	0.22	0.62	0.00	0.35	0.01	0.97	22	63
93050 032	147.7	432	0.01	0.43	0.63	0.02	0.68	0.03	1.42	30	44
93050 033	183.7	445	0.00	0.08	0.12	0.00	0.66	0.00	0.35	22	34
93050 034	148.5	438	0.00	0.10	0.15	0.00	0.66	0.00	0.68	14	22
93050 035	158.8	436	0.01	0.30	0.20	0.03	1.50	0.02	0.84	35	23
93050 036	109.1	430	0.01	0.41	0.42	0.02	0.97	0.03	1.14	35	36
93050 037	160.1	441	0.01	0.46	0.19	0.02	2.42	0.03	0.93	49	20
93050 038	197.7	470	0.01	0.27	0.34	0.04	0.79	0.02	0.42	64	80
93050 039	165.4	435	0.01	0.24	0.23	0.04	1.04	0.02	0.56	42	41
93050 040	135.6	451	0.00	0.22	0.14	0.00	1.57	0.01	0.56	39	25

Table 2. continued

SAMPLE LAB #	SMPL WT (mg)	Tmax (°C)	S1 (mg/g)	S2 (mg/g)	S3 (mg/g)	PI	S_2/S_3	PC (wt%)	TOC (wt %)	HI (mg/g)	OI (mg/g)
93050 041	130.6	445	0.00	0.24	0.22	0.00	1.09	0.02	0.58	41	37
93050 042	147.1	432	0.02	0.23	0.29	0.08	0.79	0.02	0.50	46	58
93050 043	138.1	431	0.31	1.31	1.56	0.19	0.83	0.13	1.10	119	141
93050 044	160.2	426	0.02	0.16	0.31	0.11	0.51	0.01	0.44	36	70
93050 045	153.8	431	0.01	0.26	0.18	0.04	1.44	0.02	0.55	47	32
93050 046	11.7	421	1.36	161.36	12.47	0.01	12.93	13.56	51.35	314	24
93050 046	5.3	424	1.32	129.81	14.90	0.01	8.71	10.92	47.08	275	31
93050 047	152.4	426	0.00	0.14	0.24	0.00	0.58	0.01	0.37	37	64
93050 048	126.9	458	0.01	0.17	0.33	0.06	0.51	0.01	0.53	32	62
93050 049	139.6	435	0.00	0.30	0.32	0.00	0.93	0.02	0.63	47	50
93050 050	134.4	481	0.03	0.27	0.29	0.10	0.93	0.02	0.31	87	93
93050 051	143.1	452	0.00	0.23	0.39	0.00	0.58	0.01	0.56	41	69
93050 052	27.6	437	0.00	0.65	8.26	0.00	0.07	0.05	2.70	24	305
93050 053	145.0	472	0.02	0.22	0.06	0.08	3.66	0.02	0.08	275	75
93050 054	136.8	440	0.00	0.31	0.13	0.00	2.38	0.02	0.84	36	15
93051 001	174.2	448	0.02	0.15	0.52	0.12	0.28	0.01	0.42	35	123
93051 002	166.6		0.18	0.75	0.76	0.20	0.98	0.07	0.78	96	97
93051 003	166.0	503	0.09	0.71	0.65	0.11	1.09	0.06	0.73	97	89
93051 004	166.2	472	0.07	0.61	0.41	0.10	1.48	0.05	0.58	105	70
93051 005	181.6	499	0.06	0.94	0.62	0.06	1.51	0.08	0.69	136	89
93051 006	202.1	529	0.12	0.40	0.64	0.23	0.62	0.04	0.44	90	145
93051 007	174.6	495	0.09	0.58	0.43	0.14	1.34	0.05	0.20	290	215
93051 008	188.9	481	0.08	0.44	0.37	0.15	1.18	0.04	0.41	107	90
93051 009	179.8	490	0.01	0.44	0.41	0.02	1.07	0.03	0.36	122	113
93051 010	152.1	507	0.00	1.63	0.53	0.00	3.07	0.13	0.47	346	112
93051 011	171.3	469	0.02	0.01	0.53	1.00	0.01	0.00	0.34	2	155
93051 012	167.7	472	0.00	0.10	0.85	0.00	0.11	0.00	0.44	22	193
93051 013	200.9	444	0.00	0.29	0.66	0.00	0.43	0.02	0.69	42	95
93051 014	190.2	468	0.00	0.19	0.86	0.00	0.22	0.01	0.70	27	122
93051 015	198.3	467	0.01	0.50	1.41	0.02	0.35	0.04	0.65	76	216
93051 016	170.3	508	0.00	0.29	0.82	0.00	0.35	0.02	0.55	52	149
93051 017	184.7	486	0.01	0.26	0.69	0.04	0.37	0.02	0.56	46	123
93051 018	191.5		0.03	0.75	2.63	0.04	0.28	0.06	0.94	79	279
93051 019	147.1	429	0.00	0.25	0.63	0.00	0.39	0.02	0.67	37	94
93051 020	172.8	427	0.01	0.27	0.47	0.04	0.57	0.02	0.72	37	65
93051 021	147.9	431	0.02	0.31	0.56	0.06	0.55	0.02	0.69	44	81
93051 022	158.4	430	0.01	0.34	0.50	0.03	0.68	0.02	0.67	50	74
93051 023	167.4	428	0.01	0.25	0.56	0.04	0.44	0.02	0.62	40	90
93051 024	143.4	433	0.02	0.39	0.50	0.05	0.78	0.03	0.68	57	73
93051 025	153.9	437	0.01	0.15	0.41	0.06	0.36	0.01	0.69	21	59
93051 026	148.2	436	0.01	0.21	0.45	0.05	0.46	0.01	0.63	33	71
93051 027	120.8	259	0.00	0.00	0.35	0.00	0.00	0.00	0.20	0	175
93051 028	111.5	214	0.00	0.00	0.22	0.00	0.00	0.00	0.20	0	110
93051 029	93.6	300	0.01	0.00	0.21	0.00	0.00	0.00	0.19	0	110
93051 030	28.6	425	0.00	0.00	5.45	0.00	0.00	0.00	0.93	0	586
93051 032	129.6	478	0.00	0.28	0.77	0.00	0.36	0.02	0.66	42	116
93051 031	207.6	416	0.00	0.17	0.00	0.00	0.01	0.00	0.70	24	0
93051 033	167.4	428	0.00	0.16	0.46	0.00	0.34	0.01	0.68	23	67
93051 034	190.7	430	0.00	0.11	0.47	0.00	0.23	0.00	0.35	31	134
93051 035	158.4	443	0.01	0.01	0.40	0.50	0.02	0.00	0.17	5	235
93051 036	165.2	433	0.00	0.13	0.19	0.00	0.68	0.01	0.29	44	65
RN91-411	168.1	470	0.00	0.17	0.14	0.00	1.21	0.01	0.44	38	31

Table 3. Maturity and organic facies interpretations from Rock-Eval pyrolysis data for rocks from the Tyee-Umpqua basins, Oregon

[Organic Facies defined in text based on Hydrogen Index: A = HI > 200; B = HI 75 to 200; C = HI < 75. Maturity based on Tmax for type III kerogen (Bordenave and others, 1993): IM = Immature (Tmax < 435); OW = Oil Window (Tmax = 435 to 470); GW = Gas Window (Tmax = 470 to 540); OV = Overmature (Tmax > 540)]

STRATIGRAPHIC UNIT	SAMPLE #	LAB #	ORGANIC FACIES	MATURITY	COMMENTS
Spencer Fm.	R-92-027	93049 038	B	OW	High TOC
Bateman Fm.	R-89-172	93049 015	B	IM	High TOC
Bateman Fm.	RN-91-304	93050 035	C	OW	
Bateman Fm.	RN-91-329	93050 037	C	OW	
Elkton Fm.	RN-91-332	93050 038	C	GW	Unreliable Maturity
Elkton Fm.	RN-91-306	93050 036	C	IM	
Elkton Fm.	RN-91-320	93049 054	C	OW	
Elkton Fm.	N-90-254	93050 041	C	OW	Unreliable Maturity
Baughman Mbr.	N-92-1001	93049 045	B	IM	High TOC
Baughman Mbr.	R-89-044	93050 007	B	IM	High TOC
Baughman Mbr.	RN-90-303	93049 010	C	IM	Unreliable Maturity
Baughman Mbr.	RN-91-402	93049 036	C	IM	Unreliable Maturity
Baughman Mbr.	RN-91-240	93049 051	C	IM	
Baughman Mbr.	RN-91-292	93049 052	C	IM	Unreliable Maturity
Baughman Mbr.	RN-91-225	93050 032	C	IM	
Baughman Mbr.	1 Sawyer 390	93051 031	C	IM	Unreliable Maturity
Baughman Mbr.	RN-90-083	93049 023	C	OW	Unreliable Maturity
Hubbard Creek Mbr.	RN-90-144	93049 026	A	IM	
Hubbard Creek Mbr.	RN-90-287	93049 009	C	GW	Unreliable Maturity
Hubbard Creek Mbr.	RN-91-348	93049 031	C	GW	Unreliable Maturity
Hubbard Creek Mbr.	RN-91-112	93050 009	C	GW	Unreliable Maturity
Hubbard Creek Mbr.	1 Sawyer 900	93051 032	C	GW	Unreliable Maturity
Hubbard Creek Mbr.	RN-90-032	93049 021	C	IM	Unreliable Maturity
Hubbard Creek Mbr.	RN-90-097	93049 024	C	IM	
Hubbard Creek Mbr.	RN-91-223	93050 031	C	IM	Unreliable Maturity
Hubbard Creek Mbr.	RN-91-400	93049 035	C	OW	
Hubbard Creek Mbr.	RN-91-362	93050 002	C	OW	Unreliable Maturity
Tyee Mountain Mbr.	RN-91-236	93049 050	B	IM	Unreliable Maturity, Low TOC
Tyee Mountain Mbr.	RN-90-011	93049 020	B	OW	Unreliable Maturity, Low TOC
Tyee Mountain Mbr.	RN-90-274	93049 002	C	IM	Unreliable Maturity
Tyee Mountain Mbr.	RN-91-026	93049 006	C	IM	
Tyee Mountain Mbr.	RN-90-057	93049 022	C	IM	Unreliable Maturity
Tyee Mountain Mbr.	RN-91-344	93049 030	C	IM	Unreliable Maturity
Tyee Mountain Mbr.	N-90-217	93049 041	C	IM	Unreliable Maturity
Tyee Mountain Mbr.	R-89-061	93049 047	C	IM	Unreliable Maturity
Tyee Mountain Mbr.	RN-91-295	93049 053	C	IM	Unreliable Maturity
Tyee Mountain Mbr.	RN-91-217	93050 030	C	IM	Unreliable Maturity
Tyee Mountain Mbr.	1 Sawyer 1710	93051 033	C	IM	Unreliable Maturity
Tyee Mountain Mbr.	1 Sawyer 2970	93051 034	C	IM	Unreliable Maturity
Tyee Mountain Mbr.	1 Sawyer 5460	93051 036	C	IM	Unreliable Maturity
Tyee Mountain Mbr.	R-90-047	93049 019	C	OW	
Tyee Mountain Mbr.	RN-90-123	93049 025	C	OW	Unreliable Maturity
Tyee Mountain Mbr.	RN-91-398	93049 034	C	OW	
Tyee Mountain Mbr.	1 Sawyer 4500	93051 035	C	OW	Unreliable Maturity
Rasler Creek Tongue	RN-90-283	93049 004	C	OW	

Table 3. continued

STRATIGRAPHIC UNIT	SAMPLE #	LAB #	ORGANIC FACIES	MATURITY	COMMENTS
Rasler Creek Tongue	RN-91-279	93050 015	C	OW	Unreliable Maturity
Camas Valley Fm.	N-90-281	93050 043	B	IM	
Camas Valley Fm.	RN-91-379	93050 003	C	GW	Unreliable Maturity
Camas Valley Fm.	R-89-057	93049 046	C	IM	Unreliable Maturity
Camas Valley Fm.	RN-91-272	93050 014	C	IM	Unreliable Maturity
Camas Valley Fm.	RN-91-180	93050 027	C	IM	Unreliable Maturity
Camas Valley Fm.	RN-91-213	93050 029	C	IM	Unreliable Maturity
Camas Valley Fm.	N-90-269	93050 042	C	IM	Unreliable Maturity
Camas Valley Fm.	N-90-287	93050 044	C	IM	Unreliable Maturity
Camas Valley Fm.	N-90-359	93050 047	C	IM	Unreliable Maturity
Camas Valley Fm.	RN-90-281	93049 003	C	OW	Unreliable Maturity
Camas Valley Fm.	RN-91-178	93050 026	C	OW	Unreliable Maturity
Camas Valley Fm.	N-90-243	93050 039	C	OW	Unreliable Maturity
Coquille River Mbr.	RN-91-099	93050 021	A	IM	
Coquille River Mbr.	N-90-358	93050 046	A	IM	Coal
Coquille River Mbr.	N-90-358	93050 046	A	IM	
Coquille River Mbr.	RN-90-270	93049 001	C	GW	Unreliable Maturity
Coquille River Mbr.	RN-91-176	93050 025			No Data
Remote Mbr.	KL-93-14-1	93049 040	A	IM	
Remote Mbr.	RN-91-083	93050 020	A	GW	Unreliable Maturity, Low TOC
Remote Mbr.	R-89-010	93050 053	A	GW	Unreliable Maturity, Low TOC
Remote Mbr.	2 G.Disc 540	93051 009	B	GW	Low TOC
Remote Mbr.	RN-91-270	93050 013	B	OW	High TOC
Remote Mbr.	N-91-116	93050 052	C	OW	
Remote Mbr.	R-92-017	93050 005	C	OW	High TOC
WhiteTail Ridge Fm	KL-93-13-1	93049 039	C	OW	High TOC
WhiteTail Ridge Fm.	RN-91-391	93049 033	B	IM	High TOC
Berry Creek Mbr.	1 Glory H. 450	93051 015	B	OW	
Berry Creek Mbr.	RN-90-265	93049 028	C	IM	
Berry Creek Mbr.	N-90-304C	93050 045	C	IM	Unreliable Maturity
Berry Creek Mbr.	RN-90-194	93049 027	C	OW	
Berry Creek Mbr.	RN-91-168	93050 024			No Data
Tenmile Fm.	1 Scott 1380	93051 004	B	GW	
Tenmile Fm.	1 Glory H. 2640	93051 018	B	ND	No Tmax data
Tenmile Fm.	N-91-035	93050 050	B	GW	Unreliable Maturity, Low TOC
Tenmile Fm.	RN-91-405	93049 037	C	GW	Unreliable Maturity
Tenmile Fm.	RN-91-354	93050 001	C	GW	Unreliable Maturity
Tenmile Fm.	RN-91-256	93050 012	C	GW	Unreliable Maturity
Tenmile Fm.	RN-91-070	93050 019	C	GW	Unreliable Maturity
Tenmile Fm.	1 Glory H. 1410	93051 016	C	GW	Unreliable Maturity
Tenmile Fm.	1 Glory H. 2130	93051 017	C	GW	Unreliable Maturity
Tenmile Fm.	RN-91-207	93050 028	C	IM	Unreliable Maturity
Tenmile Fm.	1 Zied. 4132	93051 030	C	IM	Unreliable Maturity
Tenmile Fm.	1 Zied. 2719	93051 027	C		Invalid Tmax
Tenmile Fm.	1 Zied. 3274	93051 028	C		Invalid Tmax
Tenmile Fm.	1 Zied. 3618	93051 029	C		Invalid Tmax
Tenmile Fm.	R-89-106	93049 013	C	OW	
Tenmile Fm.	RN-91-337	93049 029	C	OW	Unreliable Maturity
Tenmile Fm.	RN-91-365	93049 032	C	OW	Unreliable Maturity
Tenmile Fm.	R-89-096	93049 048	C	OW	Unreliable Maturity
Tenmile Fm.	R-89-034	93050 006	C	OW	Unreliable Maturity
Tenmile Fm.	RN-91-245	93050 033	C	OW	Unreliable Maturity

Table 3. continued

STRATIGRAPHIC UNIT	SAMPLE #	LAB #	ORGANIC FACIES	MATURITY	COMMENTS
Tenmile Fm.	RN-91-247	93050 034	C	OW	Unreliable Maturity
Tenmile Fm.	N-91-025	93050 049	C	OW	
Tenmile Fm.	N-91-110	93050 051	C	OW	Unreliable Maturity
Tenmile Fm.	1 Scott 390	93051 001	C	OW	Unreliable Maturity
Slater Creek Mbr.	2 G.Disc 1380	93051 010	A	GW	Low TOC
Slater Creek Mbr.	N-91-064	93049 043	C	GW	Unreliable Maturity
Slater Creek Mbr.	N-91-064	93049 043	C	OW	Unreliable Maturity
Slater Creek Mbr.	2 G.Disc 2430	93051 011	C	OW	Unreliable Maturity
Bushnell Rock Fm.	1 Scott 3090	93051 007	A	GW	Low TOC
Bushnell Rock Fm.	1 Scott 1200	93051 003	B	GW	
Bushnell Rock Fm.	1 Scott 1860	93051 005	B	GW	
Bushnell Rock Fm.	1 Scott 2340	93051 006	B	GW	Low TOC
Bushnell Rock Fm.	1 Scott 3540	93051 008	B	GW	Low TOC
Bushnell Rock Fm.	1 Scott 1020	93051 002	B		No Tmax data
Bushnell Rock Fm.	RN-91-053	93049 008	C	GW	Unreliable Maturity
Bushnell Rock Fm.	RN-91-040	93049 007	C	OW	Unreliable Maturity
Bushnell Rock Fm.	N-91-005	93050 048	C	OW	Unreliable Maturity
Umpqua Gp. Undiff.	RN-90-330	93049 005	C	GW	Unreliable Maturity
Umpqua Gp. Undiff.	RN-90-322	93049 011	C	GW	Unreliable Maturity
Umpqua Gp. Undiff.	R-89-159	93049 014	C	GW	Unreliable Maturity
Umpqua Gp. Undiff.	RN-91-198	93050 011	C	GW	Unreliable Maturity
Umpqua Gp. Undiff.	2 G.Disc 2910	93051 012	C	GW	Unreliable Maturity
Umpqua Gp. Undiff.	RN-90-324	93049 012	C	IM	Unreliable Maturity
Umpqua Gp. Undiff.	R-90-020	93049 016	C	IM	Unreliable Maturity
Umpqua Gp. Undiff.	R-90-030	93049 018	C	IM	Unreliable Maturity
Umpqua Gp. Undiff.	N-91-131	93049 042	C	IM	
Umpqua Gp. Undiff.	RN-91-138	93050 023	C	IM	
Umpqua Gp. Undiff.	1 Liles 1440	93051 020	C	IM	Unreliable Maturity
Umpqua Gp. Undiff.	1 Liles 2240	93051 021	C	IM	
Umpqua Gp. Undiff.	1 Liles 2880	93051 022	C	IM	
Umpqua Gp. Undiff.	1 Liles 3840	93051 023	C	IM	Unreliable Maturity
Umpqua Gp. Undiff.	1 Liles 5000	93051 024	C	IM	
Umpqua Gp. Undiff.	R-90-022	93049 017	C	OW	Unreliable Maturity
Umpqua Gp. Undiff.	N-91-133	93049 044	C	OW	Unreliable Maturity
Umpqua Gp. Undiff.	RN-91-148	93049 049	C	OW	Unreliable Maturity
Umpqua Gp. Undiff.	R-89-142	93050 008	C	OW	Unreliable Maturity
Umpqua Gp. Undiff.	RN-91-137	93050 022	C	OW	Unreliable Maturity
Umpqua Gp. Undiff.	N-90-245	93050 040	C	OW	Unreliable Maturity
Umpqua Gp. Undiff.	R-89-078	93050 054	C	OW	
Umpqua Gp. Undiff.	2 G.Disc 3150	93051 013	C	OW	Unreliable Maturity
Umpqua Gp. Undiff.	2 G.Disc 3390	93051 014	C	OW	Unreliable Maturity
Umpqua Gp. Undiff.	1 Liles 5880	93051 025	C	OW	Unreliable Maturity
Umpqua Gp. Undiff.	1 Liles 6680	93051 026	C	OW	Unreliable Maturity
Umpqua Gp. Undiff.	RN-91-189	93050 010			No Data
Umpqua Gp. Undiff.	1 Liles 680	93051 019	C	IM	Unreliable Maturity
Sixes River Terrane	KL-93-11-5	93050 018	A	OW	Bitumen maceral
Sixes River Terrane	KL-93-10-3	93050 016	C	GW	Unreliable Maturity
Sixes River Terrane	RN-92-001	93050 004	C	OV	Unreliable Maturity
Sixes River Terrane	KL-93-11-3	93050 017	C	OW	Unreliable Maturity

Table 4. Vitrinite reflectance data of rocks from the Tyee-Umpqua basins, Oregon

[STDEV = standard deviation; PTS = number of points]

LAB #	MIN	MAX	MEAN	STDEV	PTS	COMMENTS
93049 039	0.40	0.55	0.47	0.04	35	coal-like macerals, good distribution
93049 040	0.36	0.46	0.40	0.02	35	coal-like macerals, good distribution
93050 016	0.35	0.59	0.48	0.08	18	plant structure and high rank inertinite, bimodal
93050 017	0.39	0.47	0.43	0.04	3	plant structure and recycled inertinite
93050 018	0.38	0.81	0.62	0.18	6	organics of uncertain origin, trimodal
93051 005	0.52	0.68	0.59	0.03	29	plant structure, good distribution
93051 008	0.45	0.64	0.54	0.05	27	plant structure, good distribution

Table 5A. Source rock evaluation for selected rocks of the Tyee-Umpqua basins, Oregon

[S1 = thermally distilled hydrocarbons (mg HC/g rock); S2 = hydrocarbons generated by pyrolytic degradation of kerogen (mg HC/g rock); TOC = Total Organic Carbon (wt % total organic carbon in rock); HI = Hydrogen Index: S2/TOC (mg HC/g organic carbon); OF = Organic Facies defined in this study based on Hydrogen Index: A = HI > 200; B = HI 75 to 200; C = HI < 75. Maturity based on Tmax for type III kerogen (Bordenave and others, 1993): IM = Immature (Tmax < 435); OW = Oil Window (Tmax = 435 to 470); GW = Gas Window (Tmax = 470 to 540); OV = Overmature (Tmax > 540); Tmax = temperature of maximum hydrocarbon generation (apex of S2 peak)]

STRATIGRAPHIC UNIT	LAB #	S2	TOC	HI	OF	HC TYPE	GENERATIVE POTENTIAL	MATURITY	Tmax
Coquille River Mbr.	93050 021	79.23	33.59	235	A	GAS+OIL	VERY GOOD	IMMATURE	423
Coquille River Mbr.	93050 046	161.36	51.35	314	A	OIL	VERY GOOD	IMMATURE	421
Coquille River Mbr.	dup. run	129.81	47.08	275	A	GAS+OIL	VERY GOOD	IMMATURE	424
Remote Mbr.	93050 013	80.00	45.58	175	B	GAS+OIL	VERY GOOD	OIL WINDOW	468
Remote Mbr.	93049 040	71.15	29.60	240	A	GAS+OIL	VERY GOOD	IMMATURE	420
Remote Mbr.	93050 005	5.21	9.74	53	C	GAS	GOOD	OILWINDOW	450
White Tail Ridge Fm.	93049 039	23.56	34.48	68	C	GAS	VERY GOOD	OIL WINDOW	436
White Tail Ridge Fm.	93049 033	13.43	13.13	102	B	GAS	VERY GOOD	IMMATURE	430
Baughman Mbr.	93049 045	34.85	42.32	82	B	GAS	VERY GOOD	IMMATURE	432
Baughman Mbr.	93050 007	10.56	8.72	121	B	GAS	VERY GOOD	IMMATURE	432
Bateman Fm.	93049 015	11.65	7.62	152	B	GAS	VERY GOOD	IMMATURE	430
Spencer Fm.	93049 038	32.30	34.26	94	B	GAS	VERY GOOD	OIL WINDOW	463
Sixes River Terrane	93050 018	6.14	2.27	270	A	GAS+OIL	GOOD *	OIL WINDOW	445
Hubbard Creek Mbr.	93049 026	5.21	2.01	259	A	GAS+OIL	GOOD	IMMATURE	424

* Production Index (0.08) and visible bitumen suggest possible migrated hydrocarbons or contamination

Table 5B. Criteria for source rock evaluation

HC TYPE - Potential Type of Hydrocarbons (Peters, 1986)

HI	HC TYPE
> 300	OIL
150-300	GAS and OIL
< 150	GAS

GENERATIVE POTENTIAL modified from Peters, 1986 (based on TOC and S2 only)

QUANTITY	TOC	S2
POOR	0.0 - 0.5	0.0 - 2.5
FAIR	0.5 - 1.0	2.5 - 5.0
GOOD	1.0 - 2.0	5.0 - 10.0
VERY GOOD	> 2.0	> 10.0

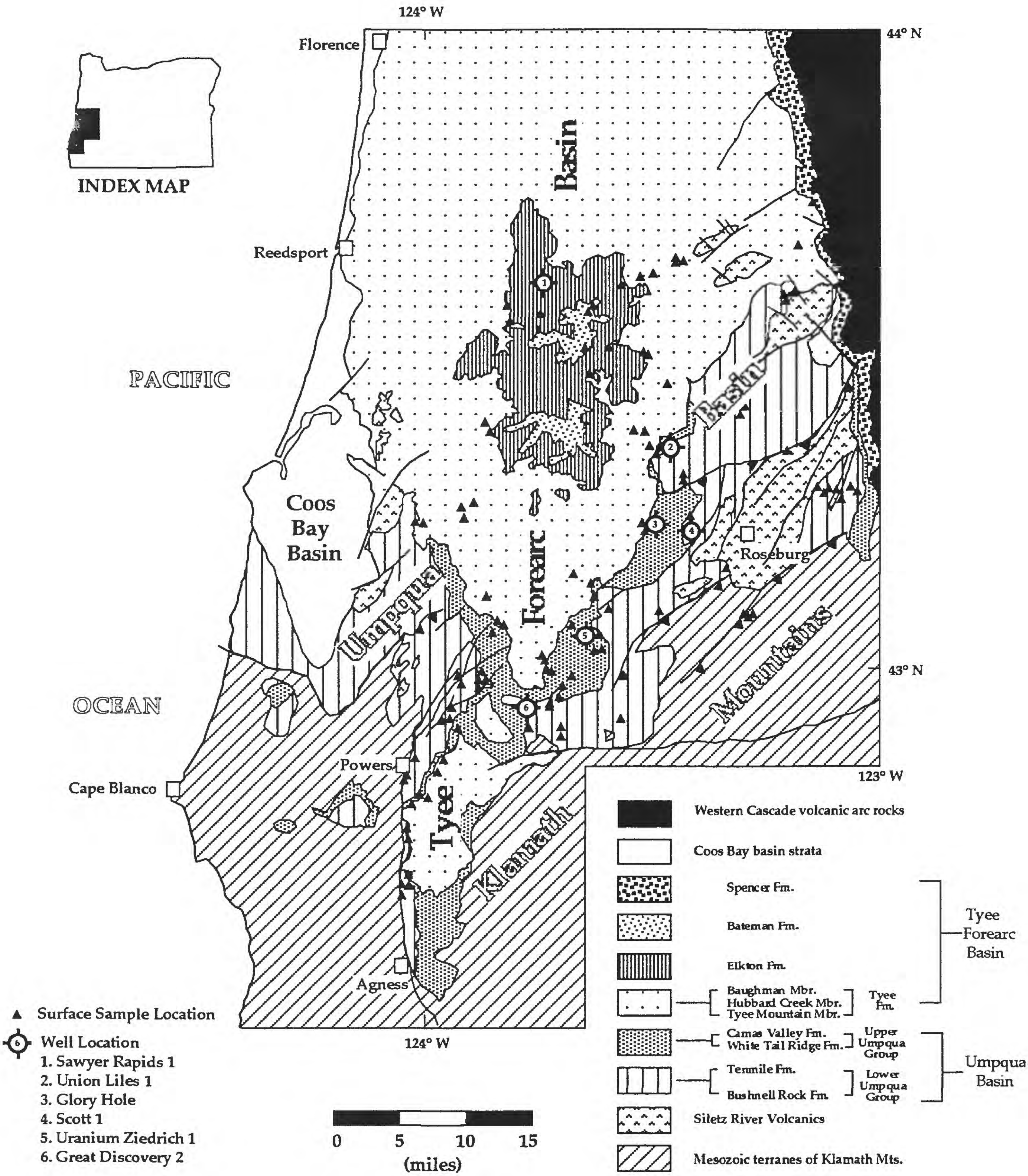

Figure 1-Index map of general geology and tectonic features of the southern Oregon Coast Range. Note the NE-SW structural trend of the early Eocene Umpqua basin strata (Bushnell Rock and Tenmile formations; lower Umpqua Group) largely in fault contact with Paleocene to lower Eocene Siletz River Volcanics basement and Mesozoic terranes of the Klamath Mountains. Middle Eocene strata of the Tyee forearc basin strata (Tyee, Elkton, Bateman, and Spencer formations) and upper Eocene to middle Miocene strata of the Coos Bay basin display a N-S trend that is discordant with the early Eocene trend. Late -early Eocene strata of the upper Umpqua Group (White Tail Ridge and CamasValley formations) represent a transition between these two trends.

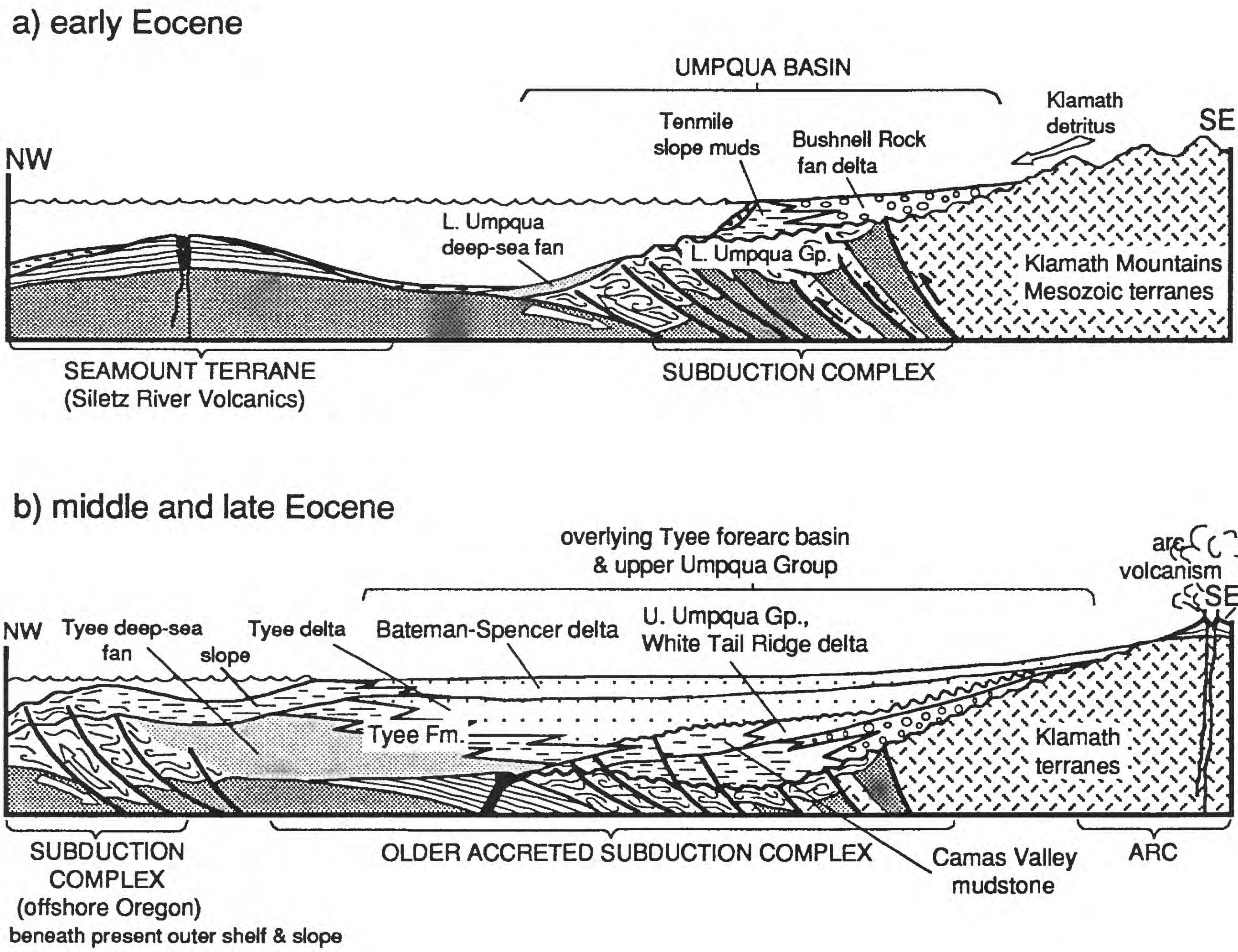

Fig. 2 Schematic cross sections illustrate formation of the Umpqua and Tyee basins of the southern Oregon Coast Range in the early Eocene (a) and in the middle and late Eocene (b) (modified slightly after Heller and Ryberg, 1983).

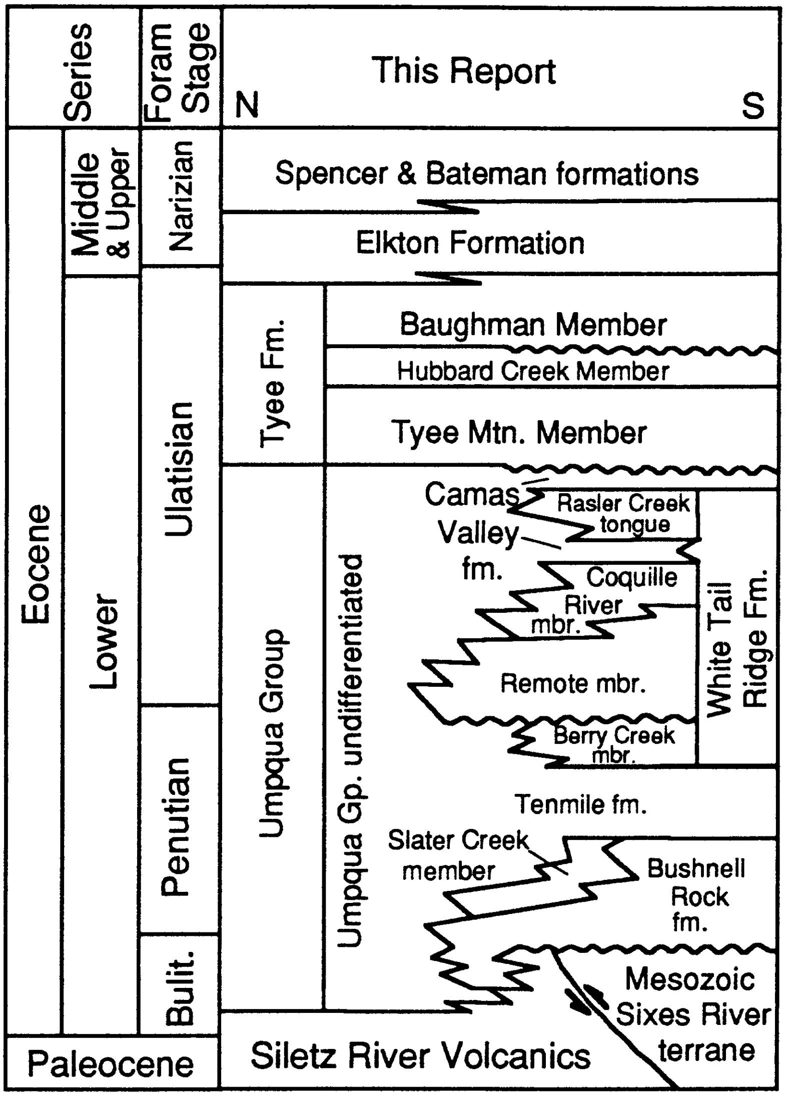

Fig. 3 Stratigraphic column of Tyee and Umpqua basins, southern Oregon Coast Range, showing rock units sampled for organic geochemical analyses in this investigation.

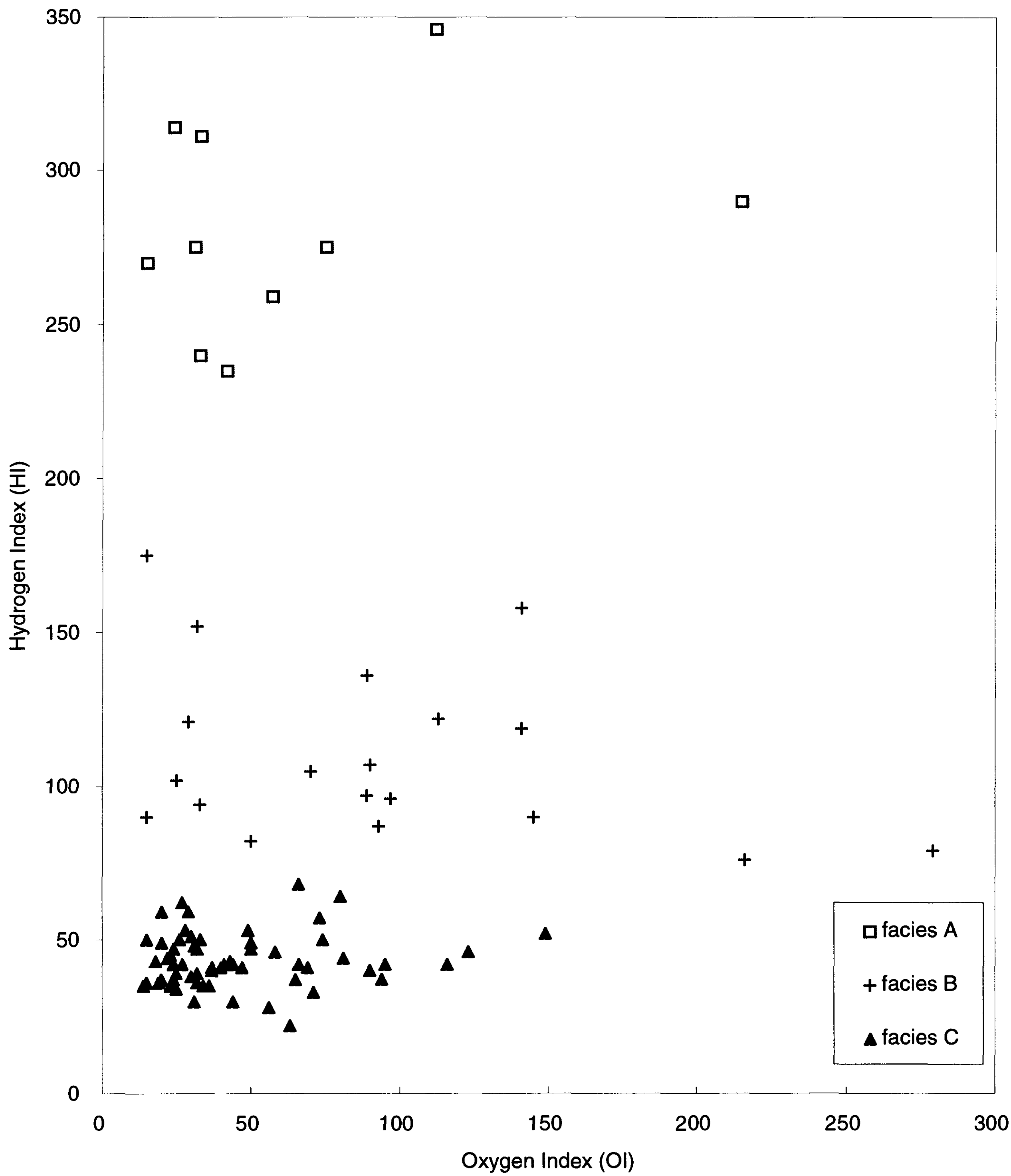

Figure 4. Plot of Hydrogen Index versus Oxygen Index from Rock-Eval data from the Tyee and Umpqua Basins, Oregon. Organic facies are defined herein based on Hydrogen Index. Only samples with S2 greater than 0.2 mg HC / g rock are shown.

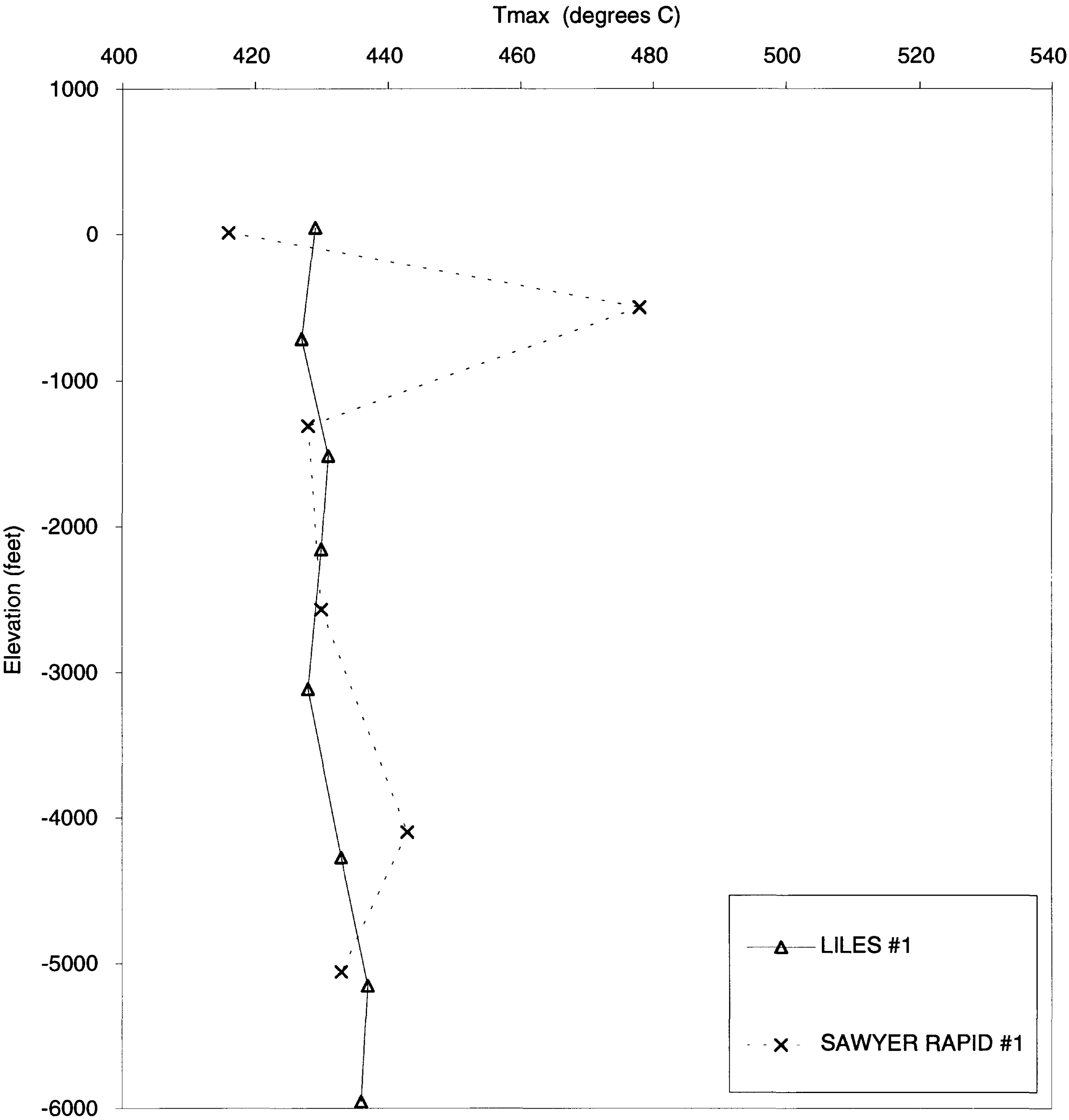

Figure 5. Downhole maturity profiles based on Tmax for exploratory wells in the northern and central study area, Tyee and Umpqua Basins, Oregon. See Figure 1 for well locations.

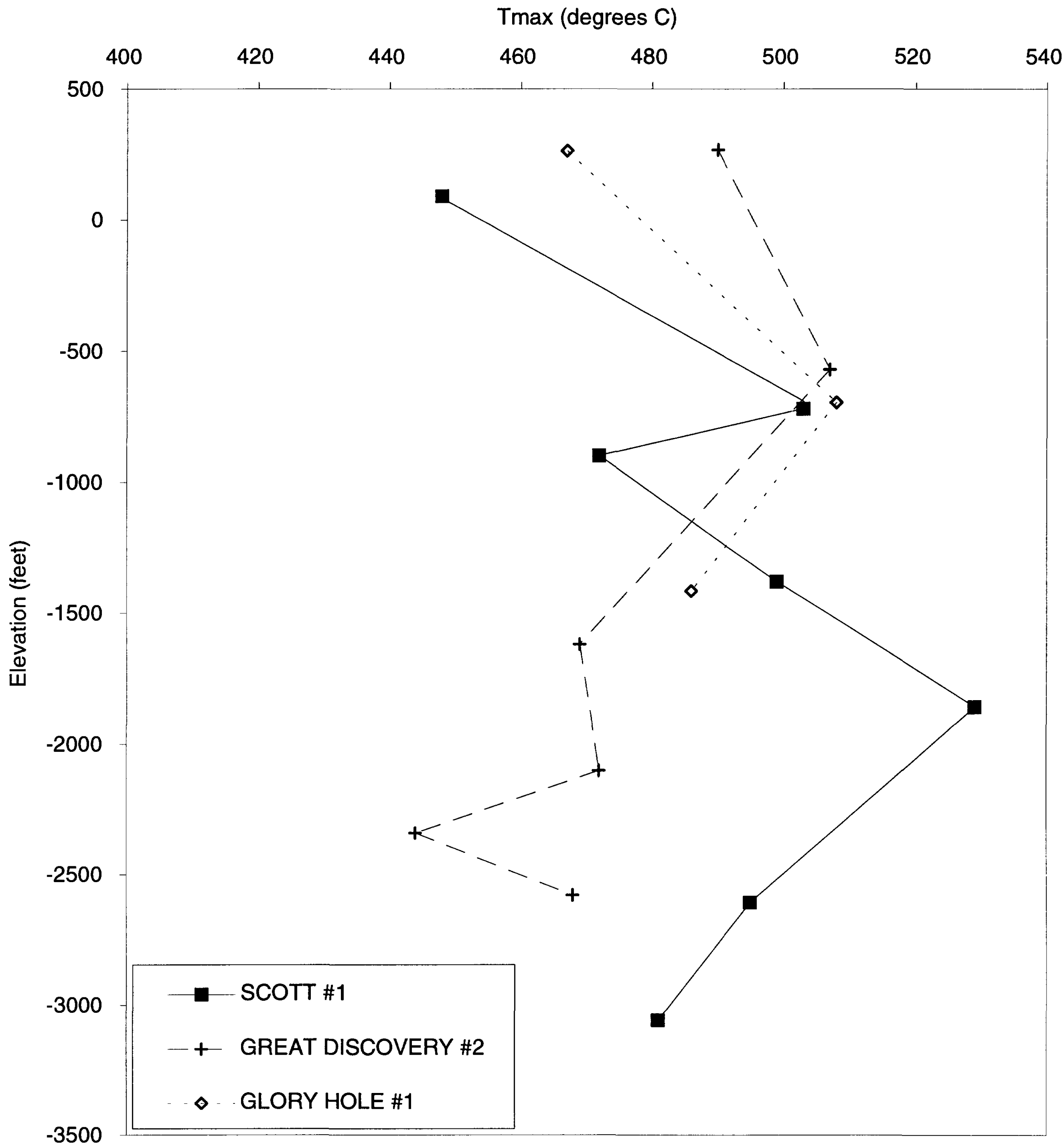

Figure 6. Downhole maturity profiles based on Tmax for exploratory wells in the central and southern study area, Tyee and Umpqua Basins, Oregon. See Figure 1 for well locations.

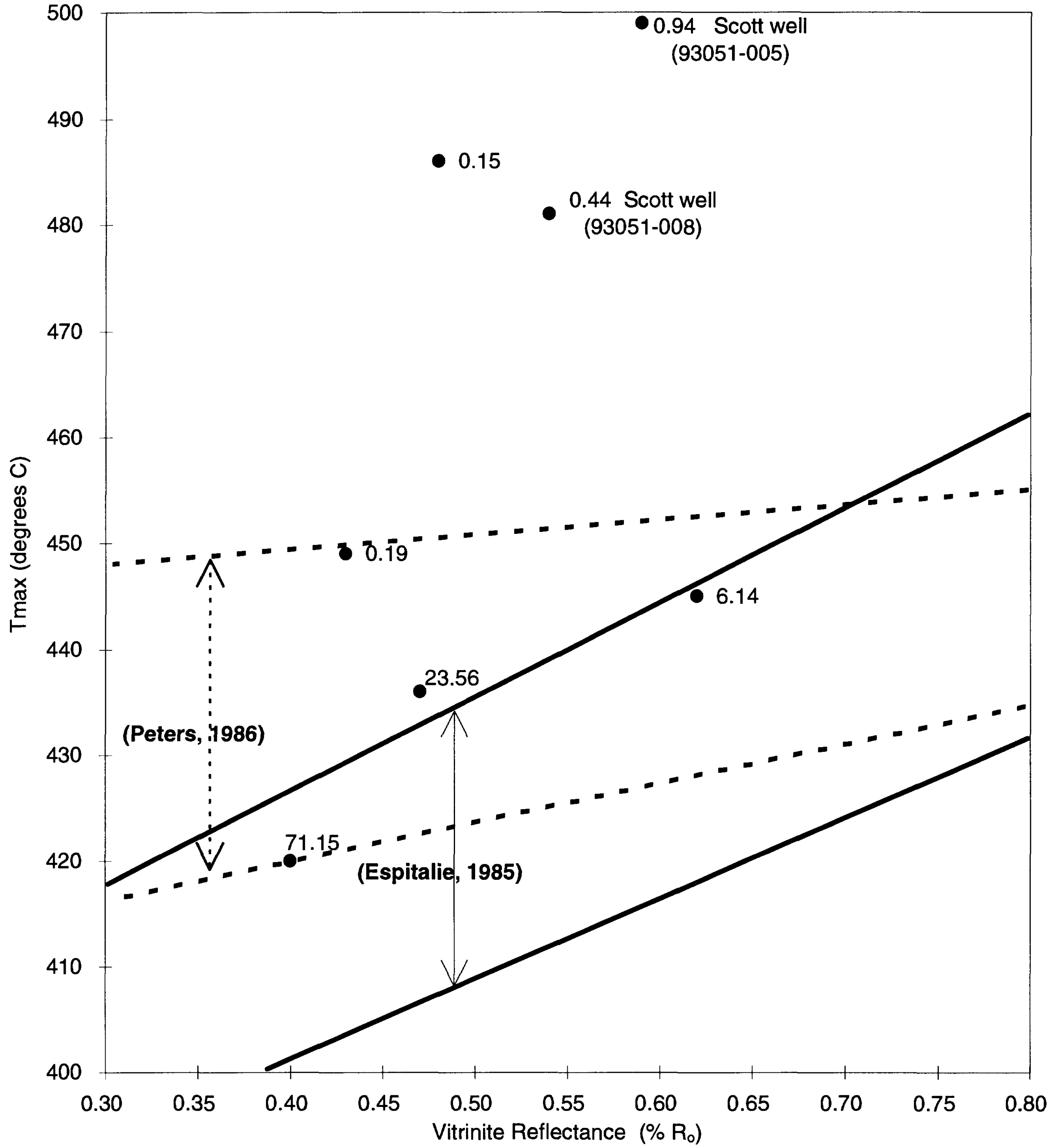

Figure 7. Plot of Tmax versus vitrinite reflectance for rocks from the Tyee and Umpqua Basins, Oregon. Numbers next to data points are S2 values (mg HC/g rock). Trend lines are from data of Peters (1986) and Espitalie (1985)