

GEOLOGY OF THE NORTHEASTERN OLYMPIC PENINSULA

by

LAWRENCE BRADLEY McMICHAEL

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GEOLOGY OF THE NORTHEASTERN OLYMPIC PENINSULA

ABSTRACT

This report involves some 500 square miles along the northeastern portion of the Olympic Mountains. The area was mapped by reconnaissance methods and the thickness of the formations as given in the columnar sections is approximate.

This region is critical for the determination and extent of marine Eocene and Oligocene sediments in relation to the Seattle Basin. Three separate divisions of the Eocene are recognized. The Metchosin at the base and the Cowlitz at the top are largely volcanics. The intervening Crescent formation containing mostly sediments thickens to the east reaching a maximum of over 5,000 feet. The Oligocene is divided into two recognizable units. The Lyre conglomerates and massive sandstones represent the base of the Oligocene. The overlying sandy-shale facies are grouped as Keasey-Lincoln undifferentiated. No formations of younger age have been identified in the region.

Structural features are largely controlled by the Clallam syncline and the Metchosin Ridge. The Clallam syncline is asymmetrical. It contains a very great

thickness of sedimentary deposits which are exposed in the north and south limbs near Crescent Bay, and represents deposition during most of Eocene and Oligocene time.

The Metchosin volcanics lie within a large anticline in the eastern portion and indicate an Eocene age for part of the rocks making up the inner core of the Olympic Mountains.

Finally, the writer is greatly indebted to the late Dr. Maurice Rambaud for his kind encouragement and aid.

LITERATURE CITED

Among the more important of publications dealing with the Olympic Peninsula are: Weaver (1916, pp. 175-179) description of the Oligocene and Eocene strata of the Olympic Peninsula and also the description of the Crescent Area (1916, pp. 180-187).

Later Weaver (1937, pp. 20-19) described the extensive lava series underlying the Crescent Formation (Lower Eocene) with the Metchosin volcanics exposed along the southeastern end of Vancouver Island which have been mapped and described by Clapp (1914, pp. 124-126, pp. 208-221). The Crescent Formation as described by Arnold (1906, pp. 451-458) is definitely correlated with the Crescent Formation (lower middle Eocene) of California by Clapp (1937, pp. 1-19). The Metchosin volcanics are described by Clapp (1914, pp. 124-126).

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The author is greatly indebted to Dr. Charles E. Weaver for his constant advice and criticism; to Dr. Thomas J. Etherington for his direction and counsel; and to Professor G. E. Goodspeed for his helpful advice and suggestions on all phases of the problem. Thanks are also due to Dr. Howard Coombs, Dr. Julian Barksdale, and Dr. J. H. Makin, all of the University of Washington.

Finally, the writer is greatly indebted to his wife Norrine Rambaud McMichael for her encouragement and aid.

EARLIER WORK

Among the more important contributions dealing with the Olympic Peninsula are Weaver's (1916, pp. 125-129) description of the Oligocene and Eocene strata of the Quimper Peninsula and also his description of the Port Crescent Area (1916, pp. 129-132).

Later Weaver (1937; pp. 26-29) correlated the extensive lava series underlying the Crescent formation (lower Eocene) with the Metchosin volcanics exposed along the southeastern end of Vancouver Island which have been mapped and described by Clapp (1912 pp. 124-136, pp. 225-292). The Crescent formation as described by Arnold (1906, pp. 451-458) is definitely correlated with the Capay formation (lower middle Eocene) of California, by Weaver (1937, p. 42) largely on foraminiferal determinations made by Berthiaume.

Weaver (1937) reviewed the formational names used in the different areas and a discussion of the stratigraphy of the area involved is included. A threefold division of the Oligocene (Weaver, 1937 p. 25) is used: the Lyre formation is included under the Keasey formation (lower Oligocene); the Lincoln formation (middle Oligocene); and the Blakeley formation (upper Oligocene) which is not recognized in this area.

In 1944 Durham published a paper on megafaunal zones of the Oligocene of Northwestern Washington in which the paleontology and stratigraphy of the Quimper Peninsula is discussed. The Eocene is mapped as undifferentiated, but a lower and upper division is indicated. The lower division, based largely on foraminifera, is correlated with the Bolivina applini zone (Laiming, 1939, pp.554-555, pp. 550-551). The upper division is correlated with the Cowlitz formation (upper Eocene) based on the presence of Turritella uvasana Conrad subsp. olequahensis Weaver and Palmer in the upper basalts to the west of the Quimper Peninsula. The Eocene divisions as made by Durham are recognized by the author in the area covered by this paper.

INTRODUCTION

The northeast portion of the Olympic Peninsula was covered by reconnaissance mapping during the late summer and fall of 1945. The reconnaissance had two purposes; first to determine the nature and, if possible, the age of the formations underlying the Metchosin volcanics (lower Eocene), and second, to correlate and extend the mapping of Eocene and Oligocene sediments from the Lake Crescent area eastward through approximately 40 miles of a previously unmapped region.

Field evidence indicates that the Metchosin volcanics are exposed as a major anticlinal feature in the region east of the Elwa River and that rocks previously thought to be pre-Tertiary and lying to the east of the Metchosin volcanics are, at least in part, Tertiary. Microfaunal collections made from these marine strata exposed in the Morse Creek and Maiden Creek basins should be of great aid in correlating the rocks making up the inner core of the Olympic Mountains.

The country is covered by a complex of dense coniferous forests, interspersed with logged-over, burned and cleared land areas. This, combined with the mists of glacial lakes, obscures the underlying rocks except along the coast and along the highway and railway routes.

GEOGRAPHIC AND TOPOGRAPHIC FEATURES

The Olympic Peninsula lies in the extreme northwestern part of the United States. Its areal extent is about 60,000 square miles. The area investigated and the district to be discussed occupies the northeastern part of the peninsula. Eight quadrangles were wholly or partly covered by reconnaissance. These included the following; Port Crescent, Port Angeles, Dungeness, Port Townsend, Quilcene, N. E. quarter of Mt. Constance, N. W. quarter of Mt. Constance (both enlarged to 1:62,500) and Mt. Olympus.

The Olympic Highway extends north from Quilcene to the south end of Discovery Bay along the eastern border of the area, and joins the state road connecting with Port Townsend and Port Ludlow. From the south end of Discovery Bay the highway extends west to Sequim and Port Angeles, turning south and west from this point and passing through the center of the area at Lake Crescent. Branch roads paralleling some of the larger rivers, in addition to logging and forestry roads and a few trails afford the only other avenues of access.

The country is covered by a series of dense conifer forests, interspersed with logged over, burned and blown down areas. This, combined with the mantle of glacial debris, obscures the underlying rocks except where exposed along the coast and rivers and in the highway and logging

road cuts. Geological work is further hindered by the dense underbrush and by bad weather during the rainy season, the yearly total precipitation commonly amounting to 120 inches in the higher regions and along the coast.

The northeastern part of the peninsula consists of a series of rolling hills whose surface extends southward into the Olympic Mountains and northward into the Strait of Juan de Fuca. Topographically it is a base leveled plain that has been elevated and dissected. Near the coast the elevation ranges from two to five hundred feet above sea level. In the central part of the Olympics the elevation is much greater, amounting to 5,000 feet. Mt. Olympus is 7,900 feet high, and surrounding it are several peaks of lesser altitude. Except for the peaks and ridges, the northern slopes of the mountains are covered by glaciers and snowfields down to an altitude of 6,200 feet. From the central mass several interstream ridges extend westward to the coast. Another ridge independent of the mountain range trends westward from the Dungeness River past Lake Crescent, a distance of over 30 miles. This is an extensive anticlinal structure, on the north flank of which are exposed at least 15,000 feet of sediments and flow material. This ridge is largely basaltic agglomerate, and with the exception of two much smaller and younger flows, is the site of practically all the igneous rocks

in the area. These are the main topographic features and are under structural control.

The minor features are both structural and erosional. The short elongated hills near the coast with variously orientated axes are examples of the former and the canyons, flood plains, and sea cliffs illustrate the results of erosion.

Port Angeles, Port Townsend, and Sequim are the largest towns in the area. Logging and farming are the principal industries. Sequim, which occupies a position in the rain shadow of the Olympic Mountains, has an average annual rainfall of only 13.5 inches. Irrigation from the nearby swollen rivers makes this area one of the richest dairy lands in the state of Washington.

STRATIGRAPHY

In this report the many different kinds of rocks that compose the inner core of the Olympic Mountains have not been separated due to their exceedingly complex nature, and the lack of time needed for their study. The Metchosin volcanics are the oldest rocks in the area discussed and, with the exception of the sedimentary rocks lying immediately to the south of the range, will mark the southernmost formation covered by reconnaissance mapping. The sedimentary rocks, which in this region form the greater percentage, range in

COLUMNAR SECTIONS

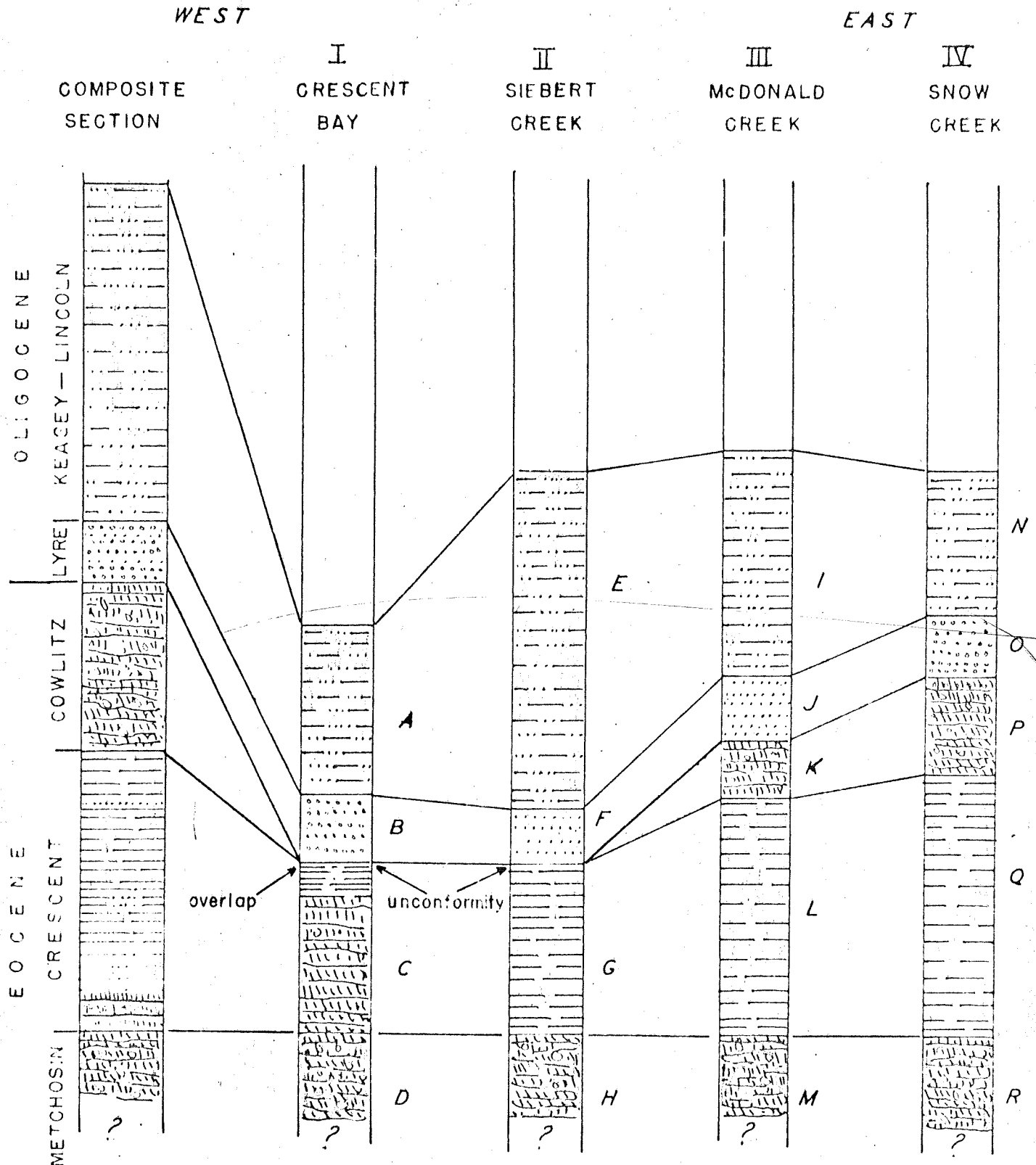


PLATE A



age from lower middle Eocene to middle Oligocene. They comprise the Crescent formation (lower middle Eocene), the Lyre formation (lower Oligocene ?), the Keasey-Lincoln formations undifferentiated (lower and middle Oligocene), and the Quimper sandstone (middle Oligocene). The igneous rocks are practically all of Eocene age and are associated with the Cowlitz, Crescent, and make up the greater part of the Metchosin formation.

TERTIARY SYSTEM

EOCENE

The upper and lower boundaries of the Eocene were established with two definite field markers whenever possible. The Metchosin volcanics are recognized as the lowermost Eocene in the region. The upper boundary was placed below the massive conglomerates of the Lyre formation. This formation, however, changes facies rapidly when followed to the east with exposures occurring only at two and three mile intervals along the strike. A massive bedded sandstone known only to occur in the Lyre formation was the marker used from Port Angeles to McDonald Creek, the conglomerates being entirely absent except for occasional small lenses.

METCHOSIN VOLCANICS
(lower middle Eocene)

The original description of the Metchosin volcanics was made by Clapp (1912, pp. 1-143) on southern Vancouver Island. His description included an area approximately 85 miles in an east-west direction on the southeastern end of Vancouver Island. This assemblage of volcanic material has a thickness which varies from 3,000 to 5,000 feet.

The Metchosin volcanics consist of a series of successive basaltic flows and intercalations of tuff breccia and various kinds of other fragmental material, which, in part, may have arisen from numerous fissures as well as small volcanic vents. The occurrence of typical pillow-lava structure in the numerous members of the volcanic series together with occasional intercalated water-laid deposits of tuff, strongly suggests that the formation as a whole accumulated upon a floor that was largely below sea level. The formation exhibits intense internal shearing and faulting; the slickensided walls showing alteration and decomposition. The direction of movement along faults or zones of shearing are difficult to determine.

The lithology, thickness, internal structure, and successive basaltic flows and tuffaceous members of the Metchosin volcanics may be observed in the canyon of

the Elwha River between its junction with the Little River and the north end of Lake Mills. Lying in this area is a synclinal valley extending in an east-west direction and related to the valley lying south of Mt. Angeles and extending into the basin of Morse and Maiden Creeks. The valley, although not so apparent on the west side of the Elwha River, becomes a major feature as it extends eastward and is probably a result of extensive minor folding within the Metchosin formation. Bordering the southern end of the valley is a second igneous series that may represent the south limb of the major syncline. This series is exposed in irregular outcrops along Hurricane Peak, Eagle Rock, and east to Obstruction Point. The attitude of the sediments along the southern edge of the isolated igneous outcrops is extremely difficult to determine for any distance due to local fracturing and faulting.

The Metchosin volcanics attain an altitude of 6,540 feet at Mt. Angeles and then plunge steeply to an altitude of less than 3,000 feet eastward and approximately midway between Morse and Siebert Creeks. Here the Blue Mountain highway crosses to the south side of the Metchosin Ridge and excellent exposures of the Crescent (?) shales and sandstones are seen dipping in a southerly direction away from the lavas. As they are followed to the east the lavas again attain an elevation of 6,000 feet at Blue Mt. and are standing in an almost vertical position.

From here the formation bends gradually around to the southeast and extends across the Greywolf River. Small exposures of sandstone and shale all dipping consistently to the south were found along the southwest border of the lavas. The formation extends in an almost due south direction near its intersection with the Dungeness River and broadens rapidly, its eastern border intersecting Hood's Canal just below the town of Quilcene. The western boundary is unknown but is believed to be along the eastern side of the upper Dungeness Basin.

EVIDENCE OF AGE

The lower limits of the geological age of the Metchosin volcanics is unknown but may extend down to the middle of the early Paleocene. The upper limit grades into a series of stratified marine tuffs, agglomerates and sandy shales which contain a marine molluscan fauna which appears to correspond in age to the lower middle Eocene and in part may be the equivalent of the Capay formation of California. The discovery of Turritella andersoni in the stratified tuffs intercalated within the basaltic flows at Albert Head near Victoria indicates a middle Eocene age for the upper portion of the Metchosin volcanics.

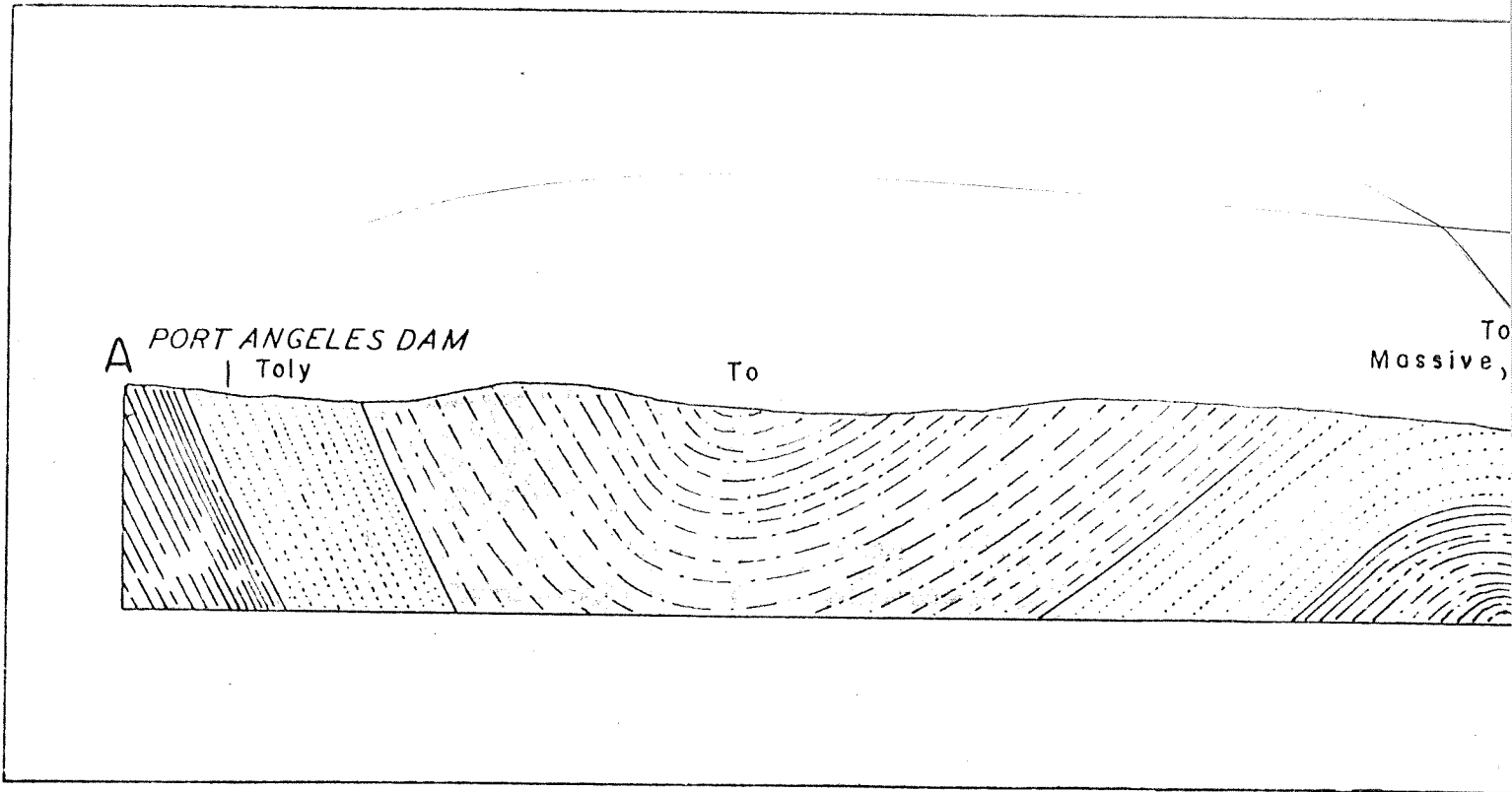
CRESCENT FORMATION

(middle Eocene)

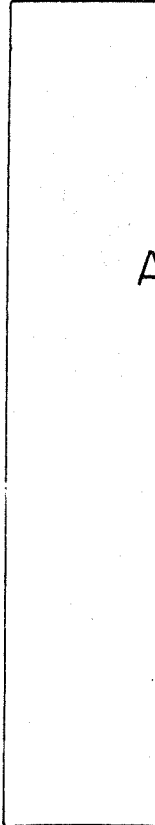
The Crescent formation in the area mapped consists of 2,000 to over 6,000 feet of marine sediments and flow basalts and presents the only known exposures of this formation in Washington. It has a complicated structure throughout most of the region, and contains but few megafauna except along the region exposed at Crescent Bay.

In lithologic character the formation consists in general of black clay shales together with laminated sandstones and shales. A prominent bed of dark vesicular basalt and agglomerate, which lies approximately 1,300 feet above the base outcrops at Lake Crescent and Lake Sutherland and again five miles to the east immediately north of Little River where it attains a thickness of over 1,000 feet. This is followed by sandy shales and varies considerably in thickness. The basaltic phase is believed to be local in occurrence and does not appear in any exposures further to the east.

The Crescent is believed to be conformable on the underlying Metchosin volcanics as seen in the Lake Crescent region where the upper limits of the Metchosin grades into a series of marine tuffs,

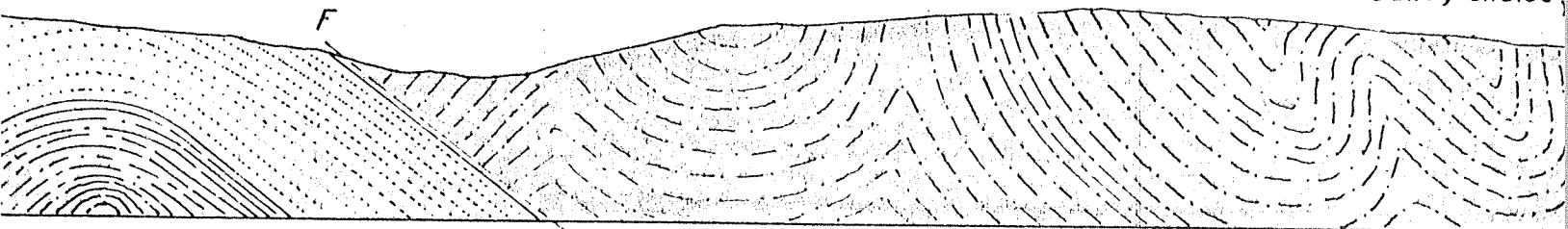


HORIZONTAL AND VERTICAL SCALE 1"=1000'



Toly
massive, bedded s.s.

Sandy shales,

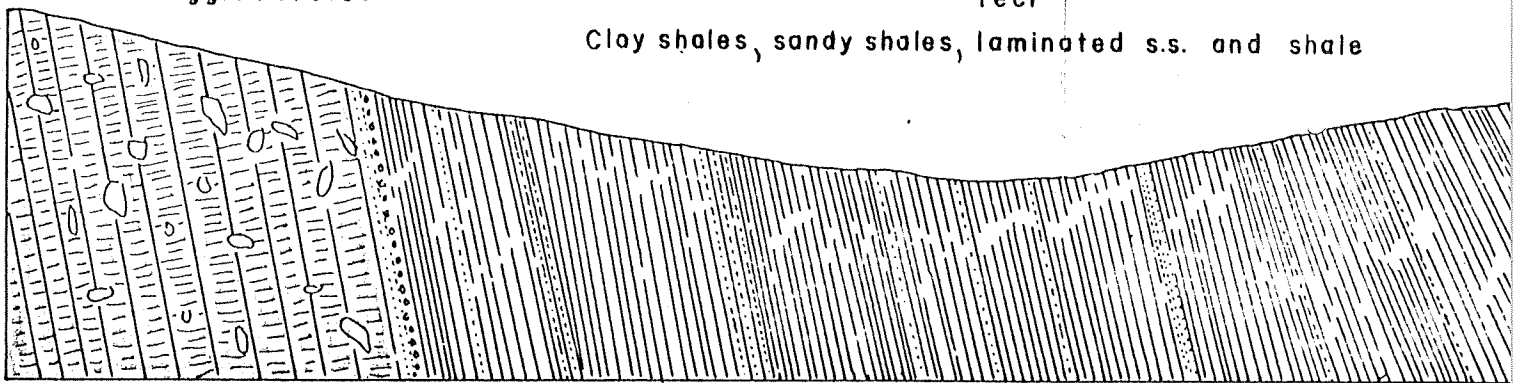


CROSS SECTION A-A'

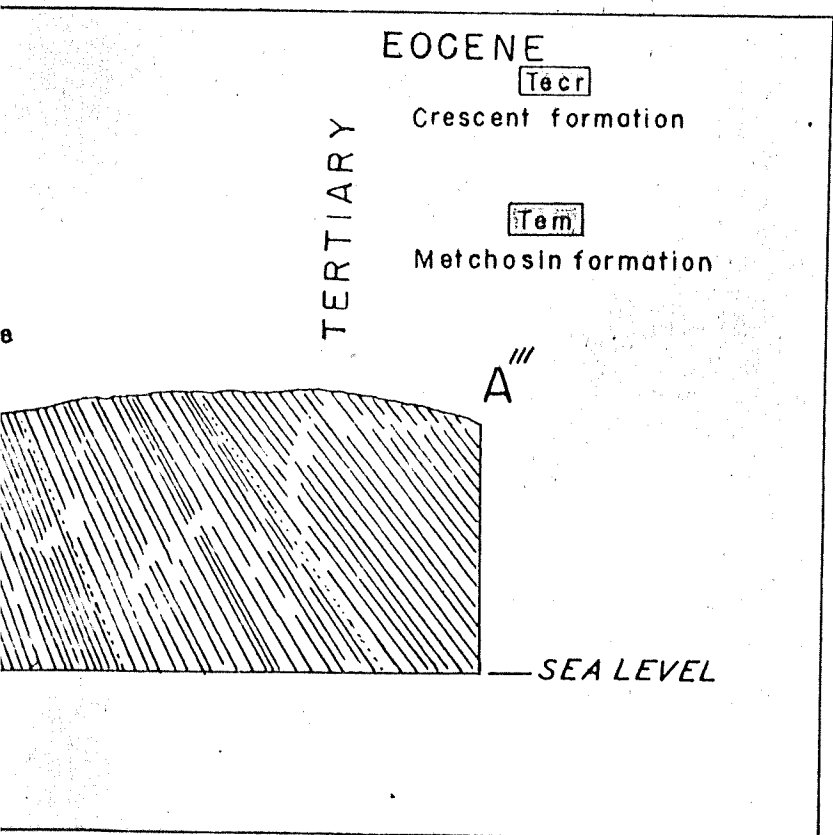
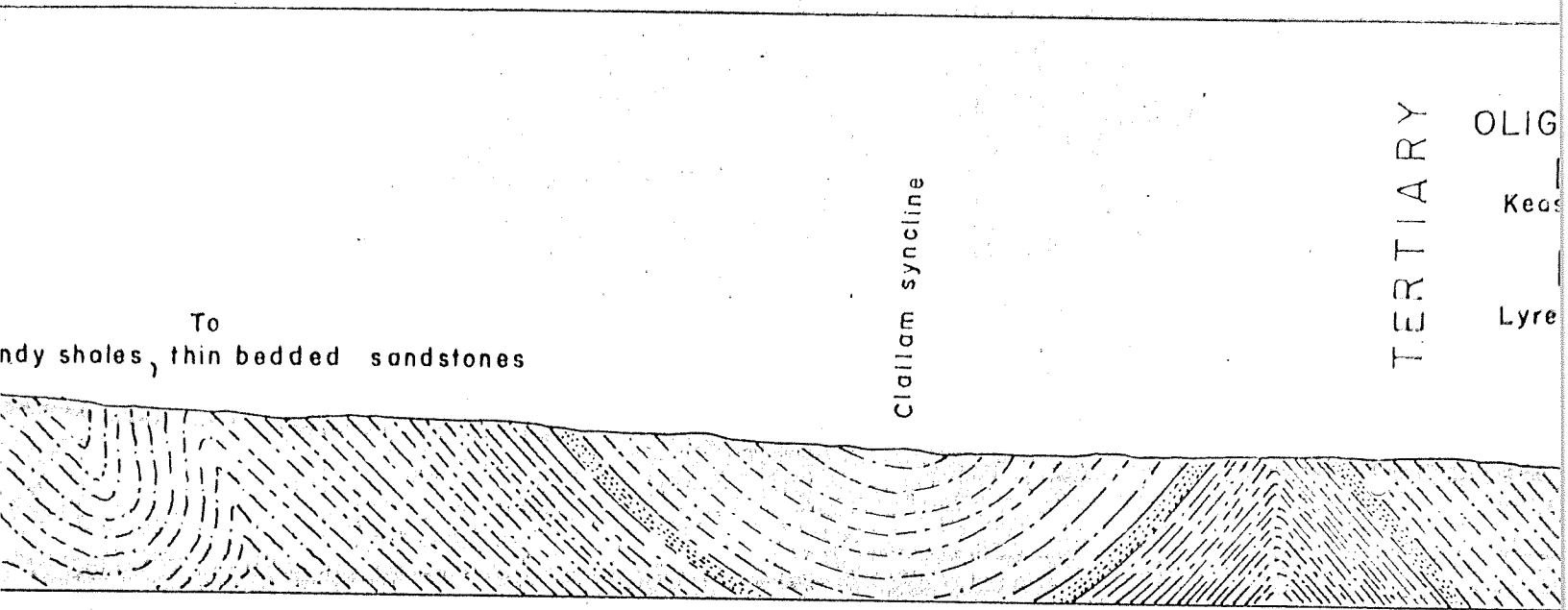
A''
Tem
Basaltic agglomerates

Tecr

Clay shales, sandy shales, laminated s.s. and shale



CROSS SECTION A''-A'''
HORIZONTAL AND VERTICAL SCALE 1"=1000'



Olympic Peninsula report

A''-A'''

TERTIARY

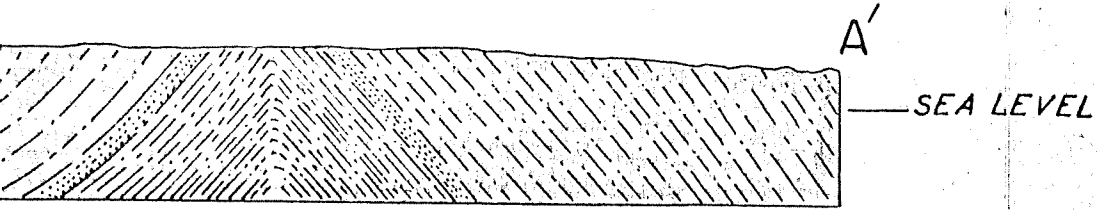
OLIGOCENE

To

Keasey Lincoln formations undifferentiated

Toly

Lyre formation



Olympic Peninsula report

A-A'

PLATE I

agglomerate and dark shales. The contact is not everywhere exposed but is believed to be conformable throughout. The Lyre is unconformable on the Crescent and is represented at the contact by 750 feet of coarse-grained strata, the lower 250 feet of which consists of interstratified brownish-gray sandstone and gray shales, and the upper 500 feet of massive medium to coarse-grained conglomerate, containing lenses of pebbly sandstone. These strata represent the base of the Oligocene and are firmly cemented.

EVIDENCE OF AGE

The age of the formation is definitely Eocene and the faunas which have been studied by S. Berthiaume (Weaver, 1937, p. 42) are interpreted as being equivalent to those of the Capay formation of California.

COWLITZ FORMATION

(upper Eocene)

The Cowlitz formation is represented largely by lavas in this area and these are confined to the eastern part of the region mapped. They are believed to be of the same age as those lavas occurring in the Cowlitz formation of south-western Washington. Their age is

based upon two facts; their stratigraphic position, and faunal evidence. An excellent exposure of the Cowlitz lavas occurs at the intersection of the Greywolf and Dungeness Rivers. Here the lavas are underlain by over 5,000 feet of shales, sandstones, and tuffs believed to be Crescent in age and which in turn are underlain by the Metchosin volcanics. The Cowlitz lavas are in turn overlain by massive bedded sandstone and conglomerate of the Lyre formation.

The Cowlitz lavas, although widespread in this area are believed to be greatly faulted and folded, thus giving a false impression as to their actual thickness. Interbedded within the lavas is a greenish bed of altered and crystal tuff approximately 200 feet thick and well enough bedded to give an attitude for the enclosing basalts. Lavas believed to be of the same age and part of the same flow outcrop along McDonald Creek (see cross-section C-C') and are overlain by massive bedded sandstones known only in the Lyre formation. This is apparently the westernmost point for the Cowlitz lavas as no trace of them is found in the outcrops along Siebert Creek, less than two miles to the west (see cross-section B-B'). To the southeast the lavas outcrop under the Lyre conglomerates which in turn form the crest of Mt. Zion (see cross-section E'-E'''). The lavas extend both southeast and northeast

making a large horseshoe-like feature, terminating to the south-east near the town of Quilcene, and northeast into the south end of Discovery Bay. Numerous small shale exposures lying on and within the lavas strongly suggest folding and are encountered throughout its areal extent. The exposures along the southeastern shore of Discovery Bay are overlain by the Lyre formation and extend almost up to the famous Woodman's Wharf faunal locality.

EVIDENCE OF AGE

Durham (1944, p.105) has reported the finding of specimens of Turritella uvasana, Conrad, subsp. olequahensis Weaver and Palmer in a gray-green limestone lens near the intersection of the Grey Wolf and Dungeness Rivers. This subspecies is known only from the Cowlitz formation in southwest Washington and therefore indicates an upper Eocene age for the enclosing basalts. Megafauna collected from the shales stratigraphically above and below the basalts have been too poorly preserved to be diagnostic but an upper Eocene age is indicated for these beds.

OLIGOCENE

GENERAL STATEMENT

At the present time the land area on the southern side of the Strait of Juan de Fuca consists of the upturned edges of Tertiary Eocene lavas and sediments overlain in this region with a slight unconformity by marine shales and sandstones of Oligocene age. These strata have been folded into one major synclinal trough (see cross-section F-F') whose axis trends approximately N.70.W, and may be followed for over twenty miles. The limbs of the fold contain auxiliary anticlines and synclines, which are usually slightly transverse to the general trend of the major fold.

The Oligocene formations which rest upon these folded Eocene volcanics and sediments lie within the major Clallam syncline and have a thickness of nearly 20,000 feet to the north of the area mapped, and west of Crescent Bay.

In the vicinity of Lake Crescent and exposed in the canyons of the Lyre River are more than 500 feet of firmly cemented massive to coarse-grained conglomerate, which in the southern limb of the Clallam syncline are sufficiently resistant to erosion to allow a range of moderately high hills to exist parallel to and immediately north of the high basaltic ridge. These conglomerate

erates are persistent to the west but change in facies when followed eastward beyond the Elwha River.

There occur above these conglomerates approximately 4,000 feet of interstratified hard gray to grayish-brown coarse-grained sandstone, with pebbly conglomeratic layers, together with subordinate amounts of brownish-gray thinly bedded sandy shale. These sandstones and shale, together with the thick lower conglomeratic member constitute the Lyre formation as described by Weaver (1937, pp. 122-123).

Immediately above the Lyre formation along the Strait of Juan de Fuca and lying immediately north of the area mapped, are exposed 6,000 feet of rather massive, sandy clay shales. Faunas obtained from these beds indicate an age equivalent to that of the Lincoln formation or middle Oligocene of Southwestern Washington.

Because of the absence of fauna throughout a large extent of the area covered, and the great similarity in lithology between the upper portion of the Lyre formation and the Lincoln formation it was felt best for the purposes of this report to limit the Lyre formation to the massive sandstones and conglomerate, and to group the overlying sandy shales, together with the Townsend shales of the Quimper Peninsula as Keasey-Lincoln undifferentiated, thus signifying an age of lower and middle Oligocene for that particular unit.

LYRE FORMATION

(lower Oligocene ?)

The Lyre formation in the area mapped consists of 500 to over 2,500 feet of conglomerates and massive bedded sandstones of continental origin. The exposures of this formation, from Lake Crescent to the Elwha River, and at Mt. Zion and the south end of Discovery Bay, are conglomerates in which the constituent pebbles are well rounded and vary in size from one-half inch to over six inches in diameter. The pebbles consist of quartzite, basalt, slate, schist, white quartz, and numerous kinds of intrusive igneous rocks, similar to those known to occur in the central part of Vancouver Island. The formation, when followed east of the Elwha River forms a prominent ridge and extends across Tumwater Creek just south of Port Angeles. Here it is well exposed in an old quarry as a massive gray sandstone, with no trace of the conglomerate as seen in the Elwha River, less than three miles to the east. From Tumwater Creek the sandstone trends southwest and is next exposed in the Morse Creek canyon (see cross-section A-A') where the Port Angeles water viaduct tunnels through an anticlinal nose formed by folding of the Lyre. The formation makes a large syncline immediately north of this point and reappears in the south limb. A dam for the

Port Angeles water supply was constructed in this south limb where the formation has a thickness of approximately 1,000 feet.

The area to the east of Morse Creek becomes exceedingly complicated due to intense folding and local faulting. The sandstones appear twice in the canyons of Siebert Creek (see cross-section B-B') due to repetition by folding. Approximately two and a half miles to the east of Siebert Creek the sandstone is exposed in the canyon of McDonald Creek and is underlain by lavas of the Cowlitz formation (see cross-section C-C'). The Lyre is again exposed to the south near the headwaters of McDonald Creek, and at this point is underlain by the Crescent shales. This indicates a local nature for the Cowlitz lavas in this area.

The Lyre formation occupies a small synclinal trough northwest of the intersection of the Dungeness and Greywolf Rivers and does not reappear in the Dungeness River canyon, being pinched out by the Cowlitz lavas. The next exposures of the Lyre to the east, occur along the ridge of Mt. Zion, dipping to the east and extending out into the valley of Snow Creek (see cross-sections E-E', and E''-E'''). The Lyre extends on and crosses the Olympic Highway, and strikes into the south end of Discovery Bay with almost continuous exposures. In this region the Lyre is lithologically the same as in

the Lake Sutherland region, being composed of pebbles of quartzite, basalt, slate, schist, whitequartz, and numerous kinds of intrusive igneous rocks, all firmly cemented.

EVIDENCE OF AGE

A few poorly preserved molluscan fossils have been collected by Weaver from the upper portions of these strata at the type section, and suggest that its age is correlative with the lower division of the Oligocene, as exposed at Woodman's Wharf on Discovery Bay, as well as the tuffaceous shales on the Willapa River near Holcomb, which are correlated with the lower Oligocene Keasey formation of Columbia County, Oregon (Weaver, 1937, p. 121). No megafauna have been found within the sandstones or conglomerates at any of the localities. Variations in thickness between different widespread localities and the close proximity to the Cowlitz lavas in the eastern portion of the area make an age correlation exceedingly difficult. The Lyre formation is definitely overlapped by younger strata in some areas and an age possibly older than that assigned by Weaver may be indicated.

KEASEY-LINCOLN UNDIFFERENTIATED

(lower and middle Oligocene)

A separation of the Lyre formation and the Lincoln formation is recognized immediately west of the area mapped in the exposures extending along the shoreline and into the Strait of Juan de Fuca. These exposures occur in the north limb of the major Clallam syncline and are fossiliferous along the beach. Further to the east, in the central portion of the area mapped, these same strata are believed to occur in the south limb of the Clallam syncline as well as small exposures in the north limb. These strata are in large part non-fossiliferous and their age is based on stratigraphic sequence. The large massive sandstones and conglomerates of the Lyre formation were mapped as the base of the Oligocene and the sandy shales lying stratigraphically above were mapped as Keasey-Lincoln undifferentiated. No separation could be recognized between these sandy shales and the overlying beds of younger age in this region.

The Keasey-Lincoln occupies the synclinal trough of the major Clallam syncline in the northwest portion of the area mapped and is bounded by the Lyre on the southeastern and northeastern borders. To the east the formation is next exposed in the canyon of Ennis Creek along the southeast border of the city of Port

Angeles. Here it is exposed in the north and south edges of the Clallam syncline. From this point eastward the formation gradually bends to the southeast, widening greatly due to repetition by folding. The Keasey-Lincoln occupies its greatest areal extent in the vicinity of Siebert Creek where it has been folded and locally faulted. The formation is again exposed approximately two miles to the east in McDonald Creek. These outcrops are underlain by the massive sandstones of the Lyre formation which in turn are underlain by the Cowlitz lavas. The lavas have been folded into high ridges in this region resulting in the overlying sedimentary beds being stripped off by erosion. Exposures of the Oligocene sediments are not seen again until they are exposed in Snow Creek canyon along the eastern border of the area mapped. Here they are exposed for the large part in gentle east dips with little folding. To the northeast they thin rapidly until at Discovery Bay they overlie the Lyre with a thickness of about 65 feet.

EVIDENCE OF AGE

The few megafauna which have been obtained from this section have been too poorly preserved to be of use as stratigraphic markers. Due to their stratigraphic

position, these strata have been correlated with the sandy shales overlying the Lyre formation along the Strait of Juan de Fuca between Whiskey Creek and a point on the coast 5 miles west of the town of Gettysburg. Faunas obtained from these beds indicate an age equivalent to that of the Lincoln formation or middle Oligocene of Southwestern Washington (Weaver, 1937, p. 121).

QUIMPER SANDSTONE
(middle Oligocene)

The Quimper sandstone, which has been described in detail by Durham (1944, p. 106) is not recognized in reconnaissance mapping except in the section along the east shore of Discovery Bay. This stratigraphic unit together with the overlying shale is believed to be the equivalent of the upper portion of the Keasey-Lincoln in the area mapped. The Quimper sandstone overlies the 65 feet of Keasey-Lincoln (Townsend) shale with a six degree discordance in dip indicating an unconformity and a probable shoreward condition for the upper part of the Keasey-Lincoln in the northeastern part of the region. The continuous deposition of shales and the absence of the Quimper sandstone in the central area around Siebert Creek further indicates the position of the basin of deposition during this period.

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EVIDENCE OF AGE

The age of this fossiliferous sandstone unit has been determined by Durham (1944, p. 106) to be the equivalent to the lower half of the Lincoln formation of Southwestern Washington.

STRUCTURAL GEOLOGY

Two dominant structures control the topography of the northern border of the Olympic Peninsula. The first, and most prominent, is the high ridge formed by the Metchosin volcanics extending from the Dungeness River to the Pacific Ocean. This large feature trends in a northwest direction and is independent of the main core of the Olympic Mountains. Field evidence gathered along the eastern edge of the ridge in the vicinity of the Dungeness River and Blue Mountain indicates the Metchosin volcanics to be a large anticline extending at least to the Elwha River. Beyond this point exposures are exceedingly rare and the contact has not been definitely located.

The second structure is the Clallam syncline extending throughout most of the area discussed and to the west for a distance of several miles. This major syncline attains its greatest extent in the Crescent Bay area, dying out to the east and extending into the Strait of Juan de

Fuca to the west. Practically the entire sequence of Tertiary rocks appears in the north and south limbs of the syncline at Crescent Bay.

The central part of the region between Morse Creek and McDonald Creek is intensely folded with dips of over 80 degrees recorded in some of the anticlines and synclines. To the east, the next prominent feature is formed by the Lyre formation along the crest of Mt. Zion. From the summit of this high ridge all the strata dip consistently to the east and the topography is controlled by the hard conglomerates of the Lyre formation. Small minor folds occur in the formations along this eastern edge of the Olympics but the beds are largely homoclinal, consistently dipping to the east toward the Seattle Basin.

A major hinge fault is believed to occur east of the Dungeness River along the west side of Mt. Zion. It is located near the contact of the Crescent and Metchosisin formations and pinches out the Crescent immediately south of Mt. Zion. No exposures of the Crescent are found south of this point. Minor faults occur throughout the region but it is almost impossible to determine the direction of movement.

A second possible major fault occurs along the north limb of the Clallam syncline in the vicinity of Washington Harbor. Here the Cowlitz lavas appear to be truncated and long scarp-like exposures are seen trending to the east toward Discovery Bay.

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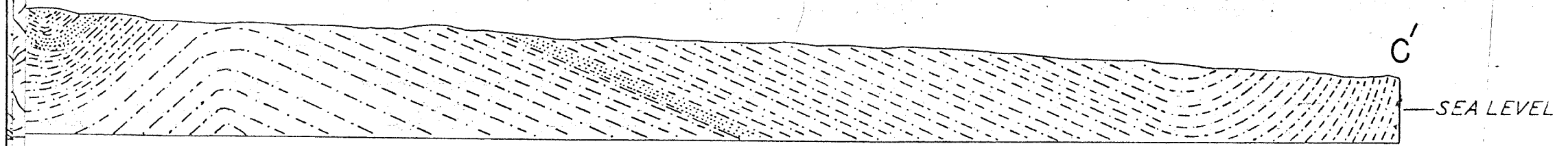
PLATE VI

EXPLANATION

- TERTIARY
EOCENE OLIGOCENE
- To Keesey-Lincoln formations undifferentiated
 - Toly Lyre formation
 - Teco Cowlitz formation
 - Tecr Crescent formation
 - Tem Metchosin formation

Ciallom syncline

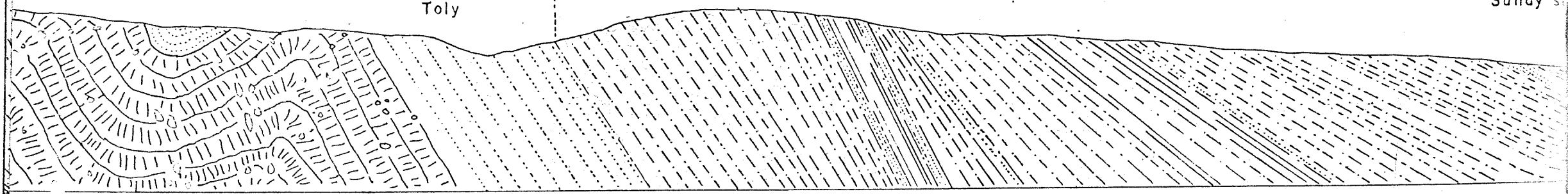
To
ales, thin bedded sandstones

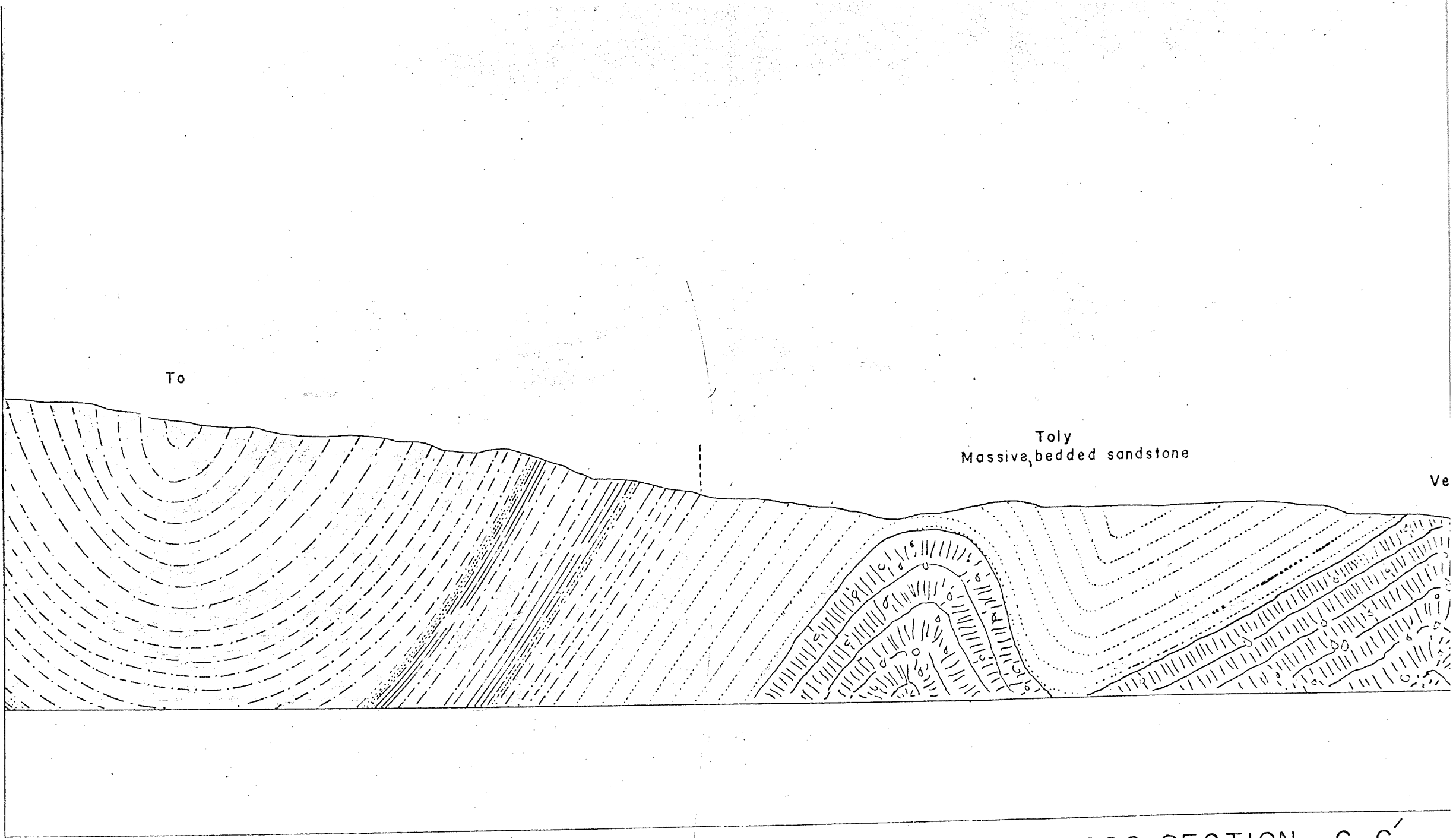


reco
cular basalt

Toly

Sandy s





To

Toly
Massive, bedded sandstone

Ve

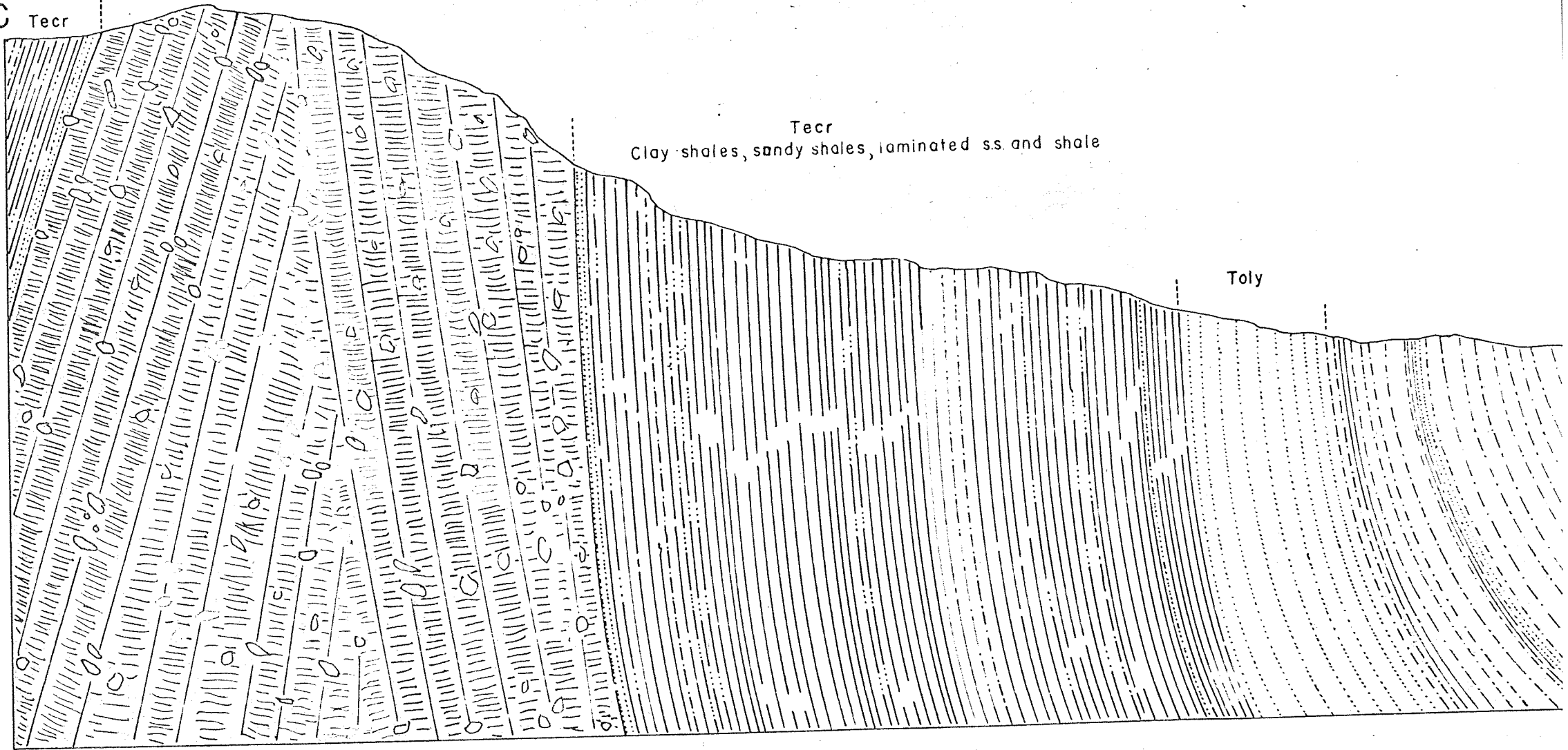
CROSS SECTION C-C'

BLUE MT ^{Tem} Basaltic agglomerates

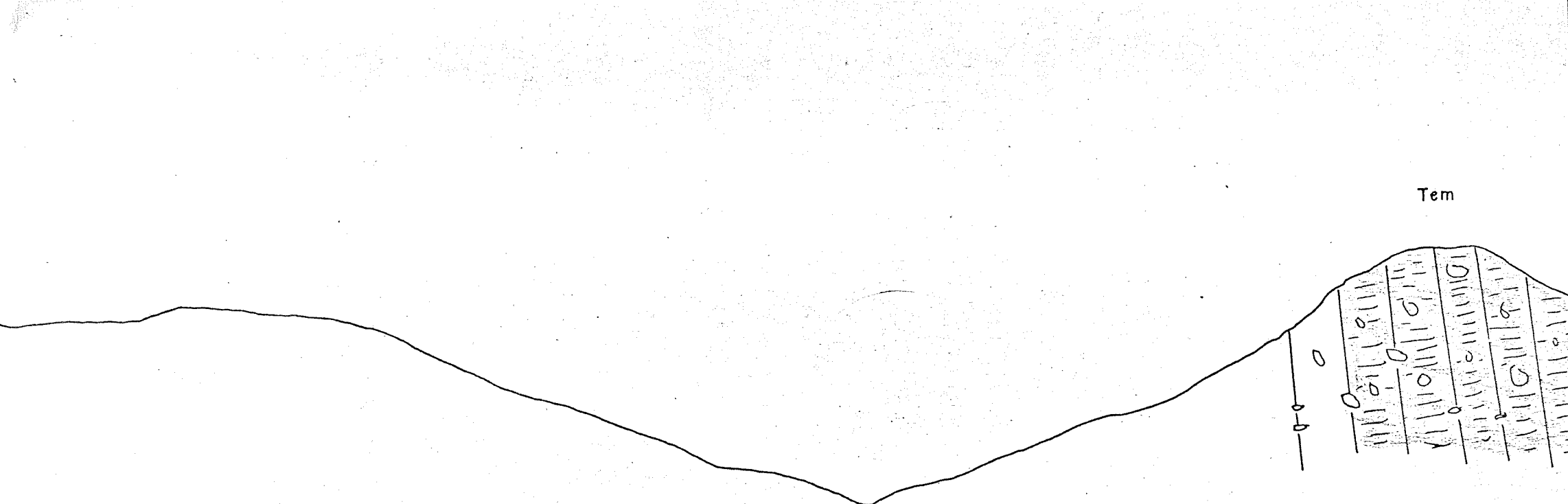
C Tecr

Tecr
Clay shales, sandy shales, laminated ss and shale

Toly



HORIZONTAL AND VERTICAL SCALE 1"=1000'



← BASALTIC AGG. →

nd local
 canyons
 to re-
 half miles
 exposed in
 by lavas
 3'). The
 adwaters
 ain by the
 e for the
 linal trough
 and Grey-
 ness River
 . The
 along the
 ending
 ections E-E',
 the
 of
 In
 as in

EXPLANATION

OLIGOCENE

To

Keasey-Lincoln formations undifferentiated
sandy shales, flintbedded sandstones

Toly

Lyre formation
well cemented pebble conglomerate

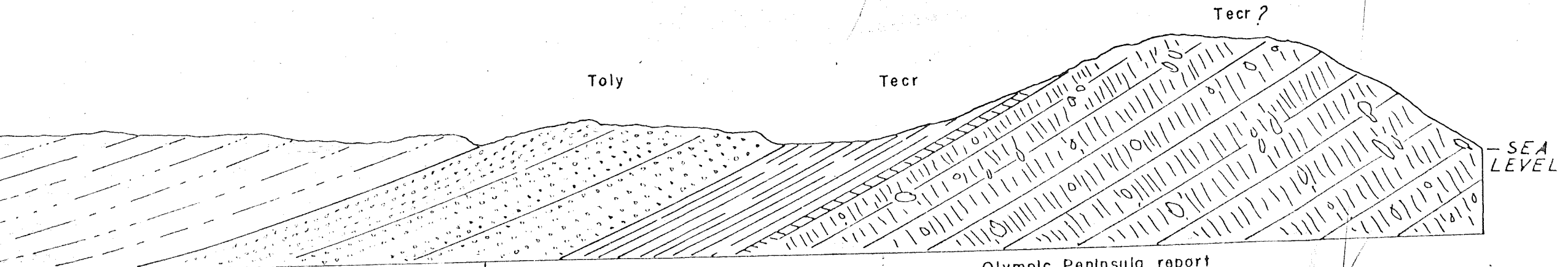
EOCENE

Tecr

Crescent formation
black shales, basalt, tuff, sandy shale, thin sandstone

Tem

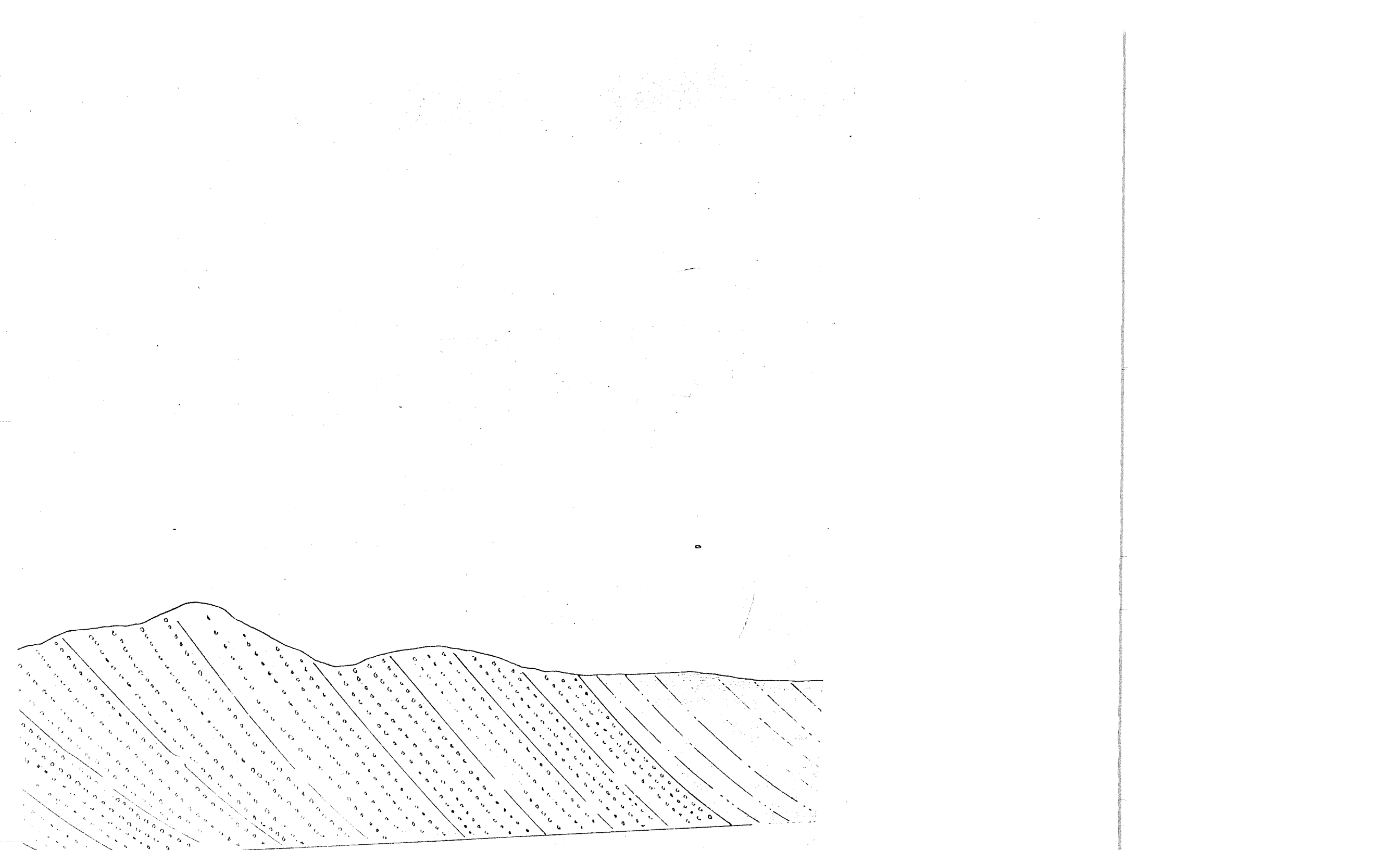
Metchosin formation
basalt, agglomerates



Olympic Peninsula report

SCALE 1"=1000'

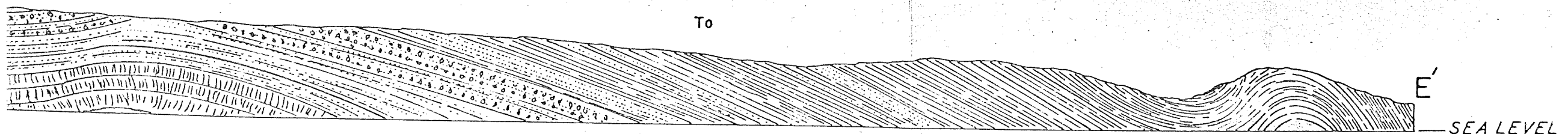
F-F'



EXPLANATION

TERTIARY

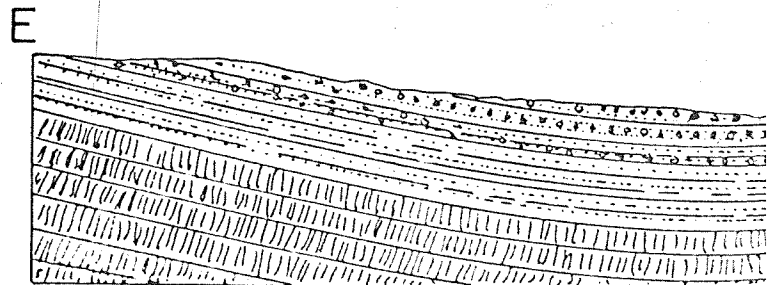
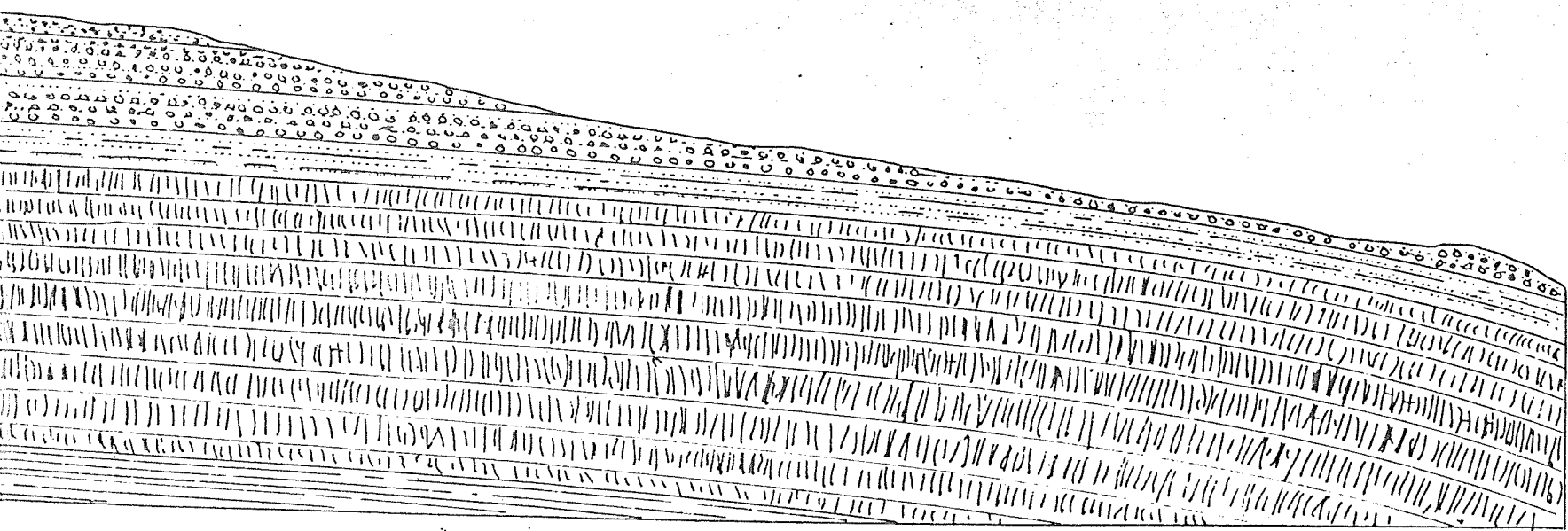
- OLIGOCENE**
- To**
Keasey Lincoln formations undifferentiated
sandy shales, thin bedded sandstones
 - Toly**
Lyre formation
Well cemented pebble conglomerate, bedded sandstone
 - Teco**
Cowlitz formation
represented only by basalts in this area
- EOCENE**
- Tecr**
Crescent formation
clay shales, sandy shales, laminated ss. and shale
 - Tem**
Metchosin formation
basalt, agglomerates



CROSS SECTION E-E'

Olympic Peninsula report

E-E' & E''

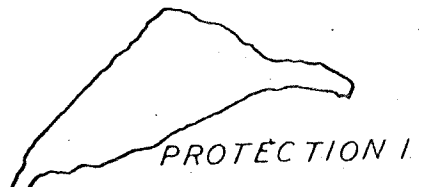


ON E-E'''

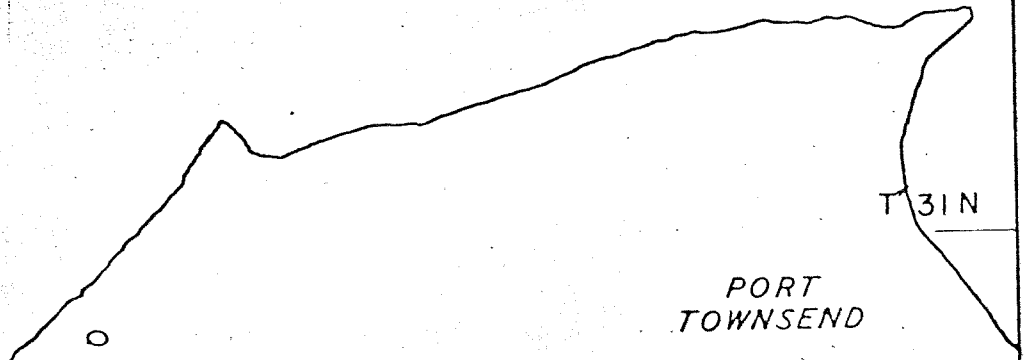
R2W

R2W

F U C A

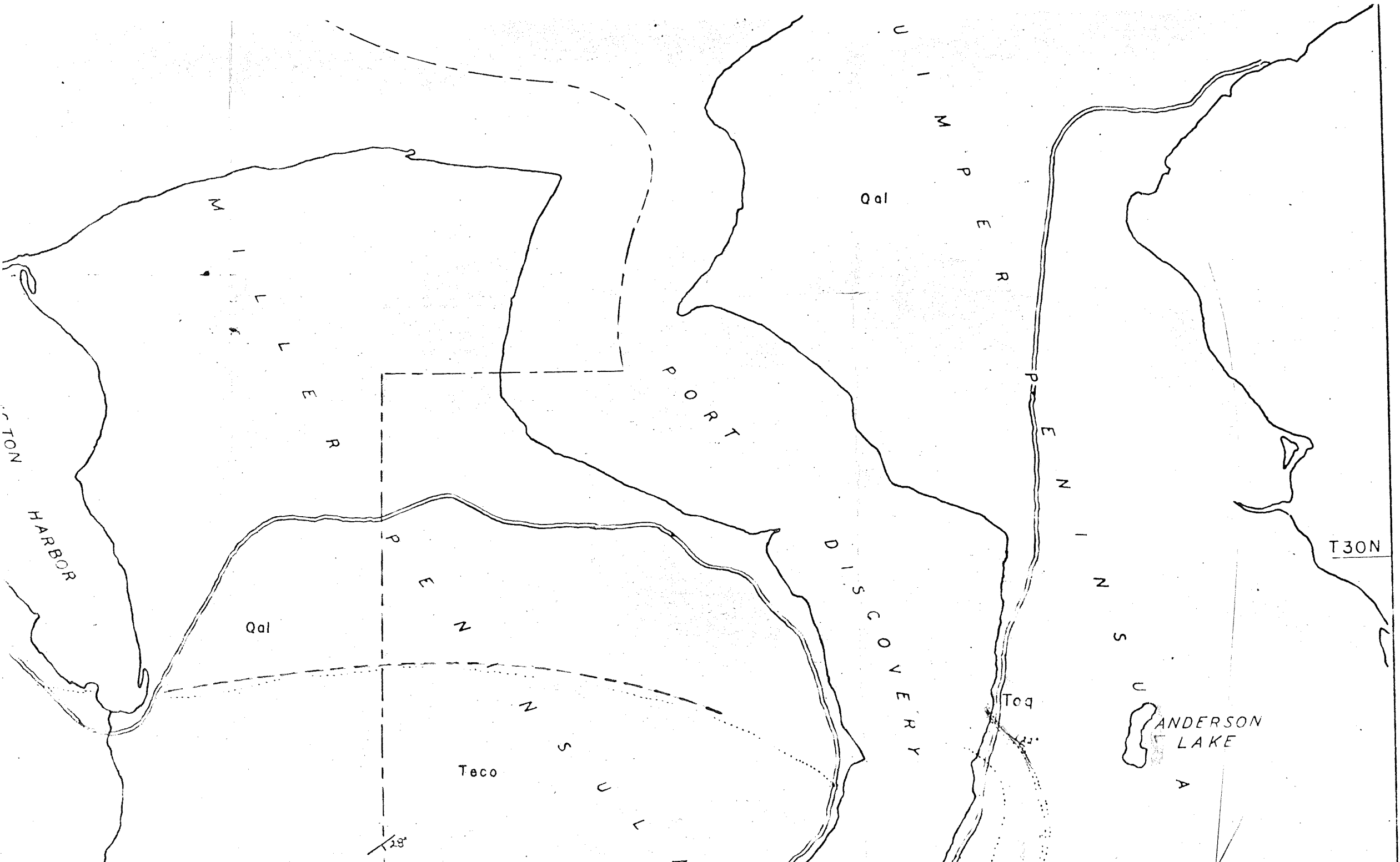


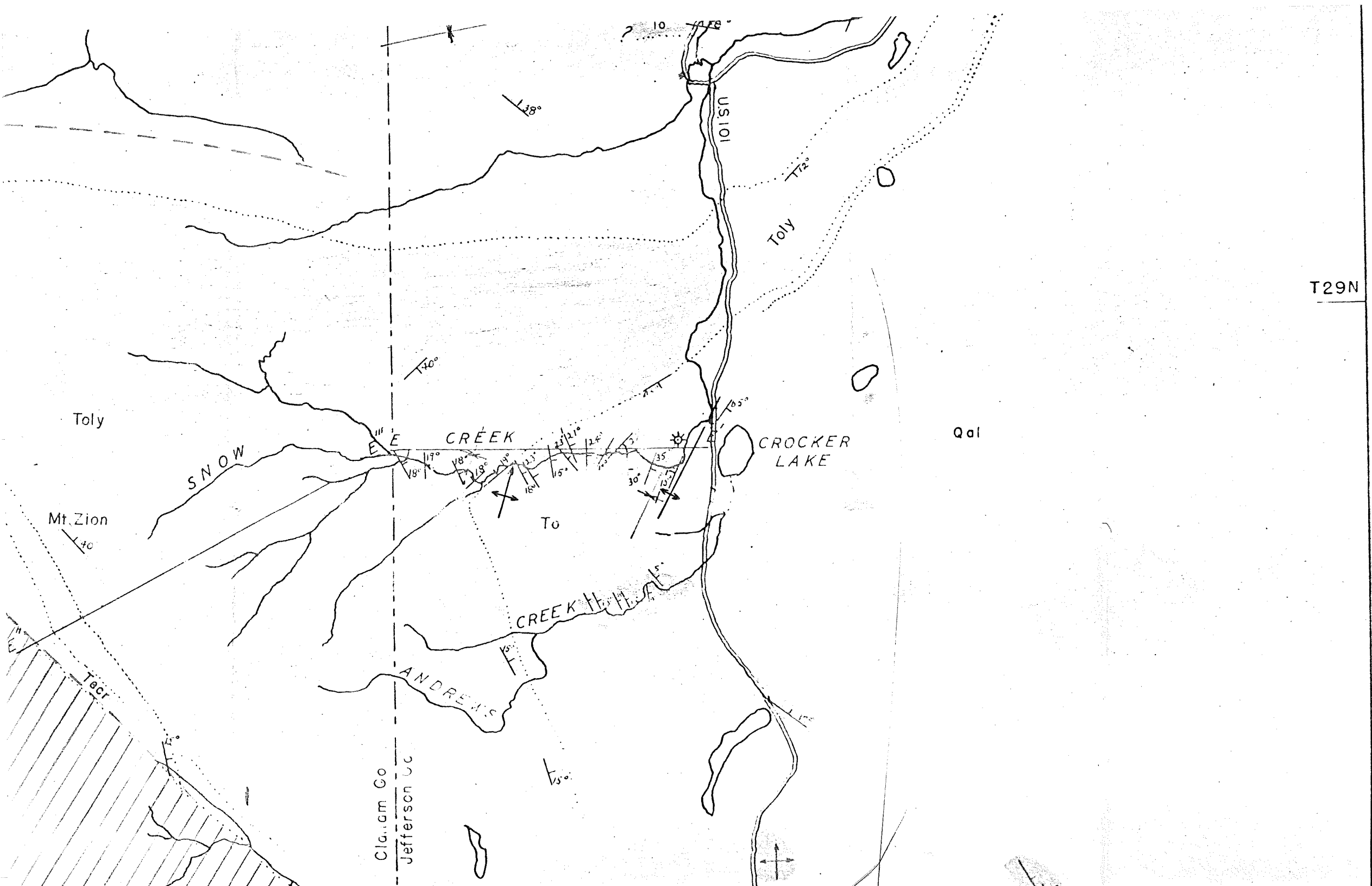
PROTECTION I

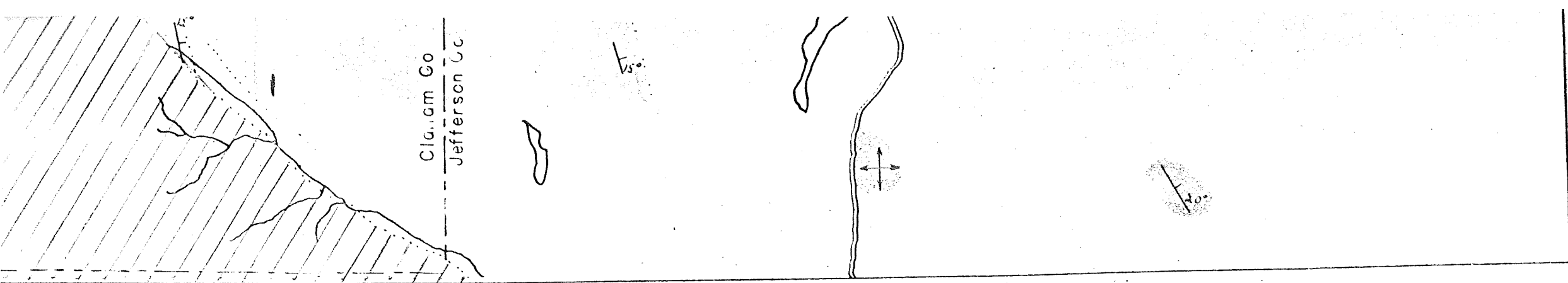


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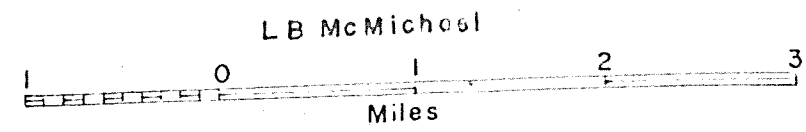
PORT
TOWNSEND







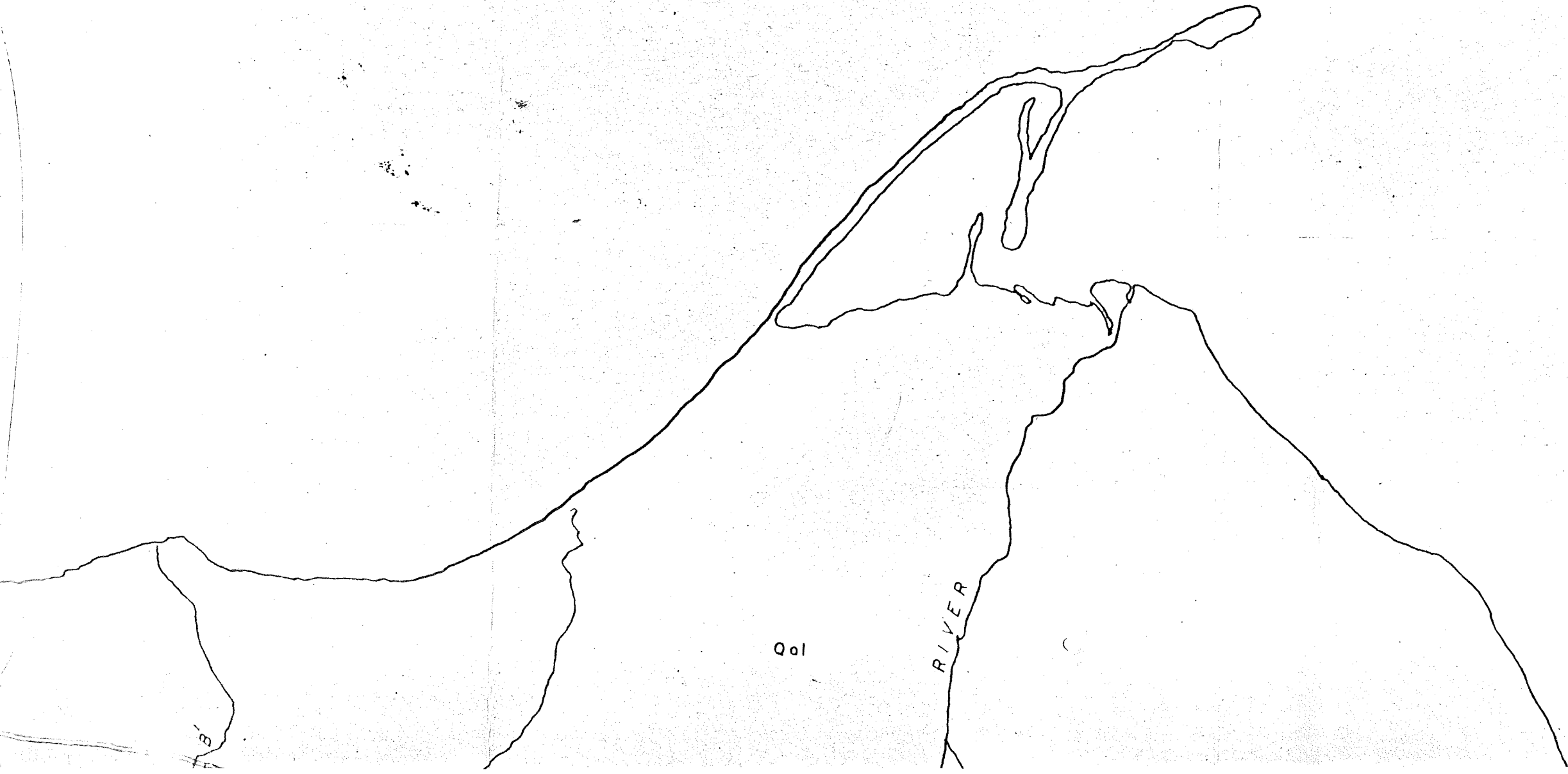
GEOLOGIC MAP
NORTH EAST PORTION OF
OLYMPIC PENINSULA

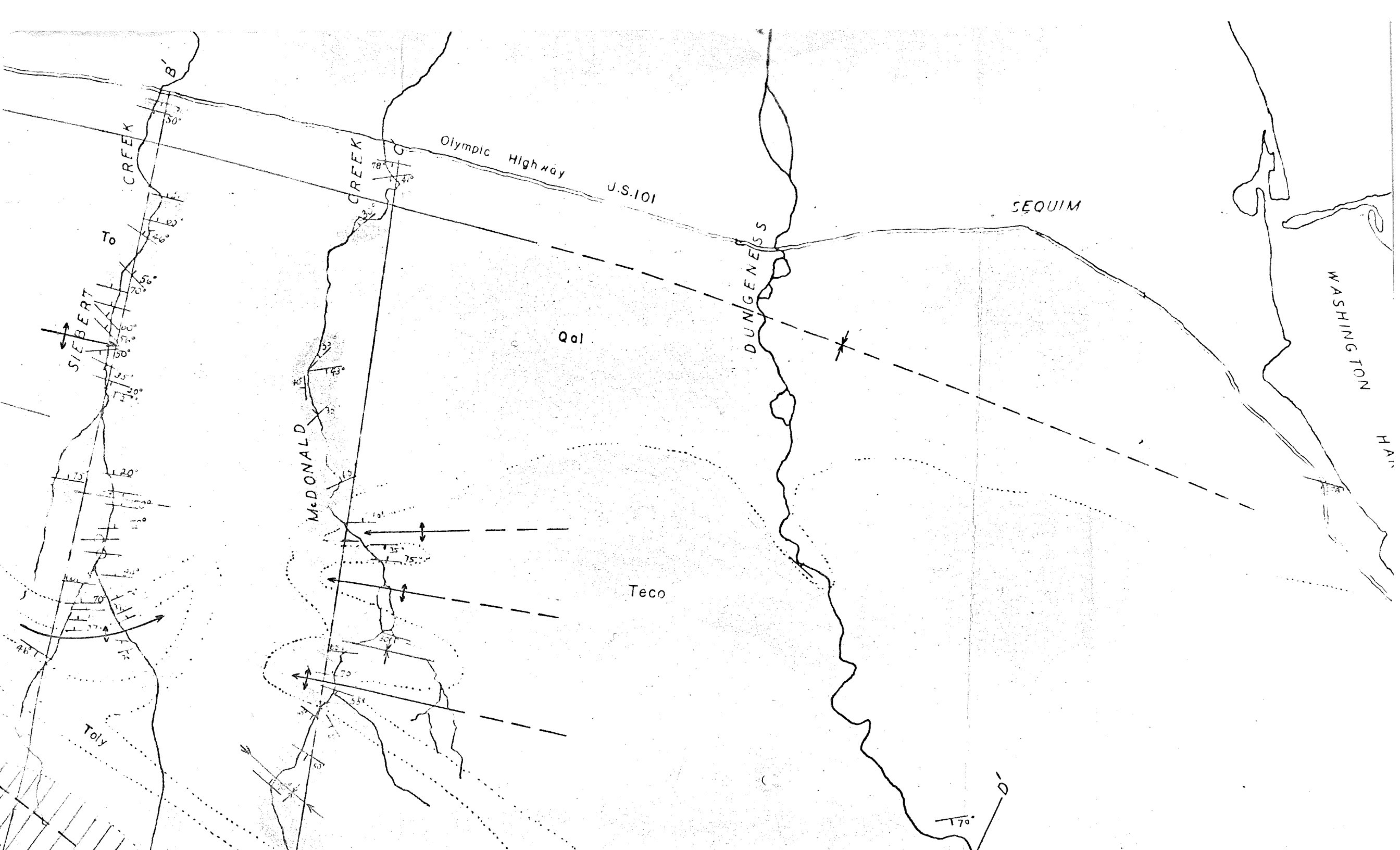


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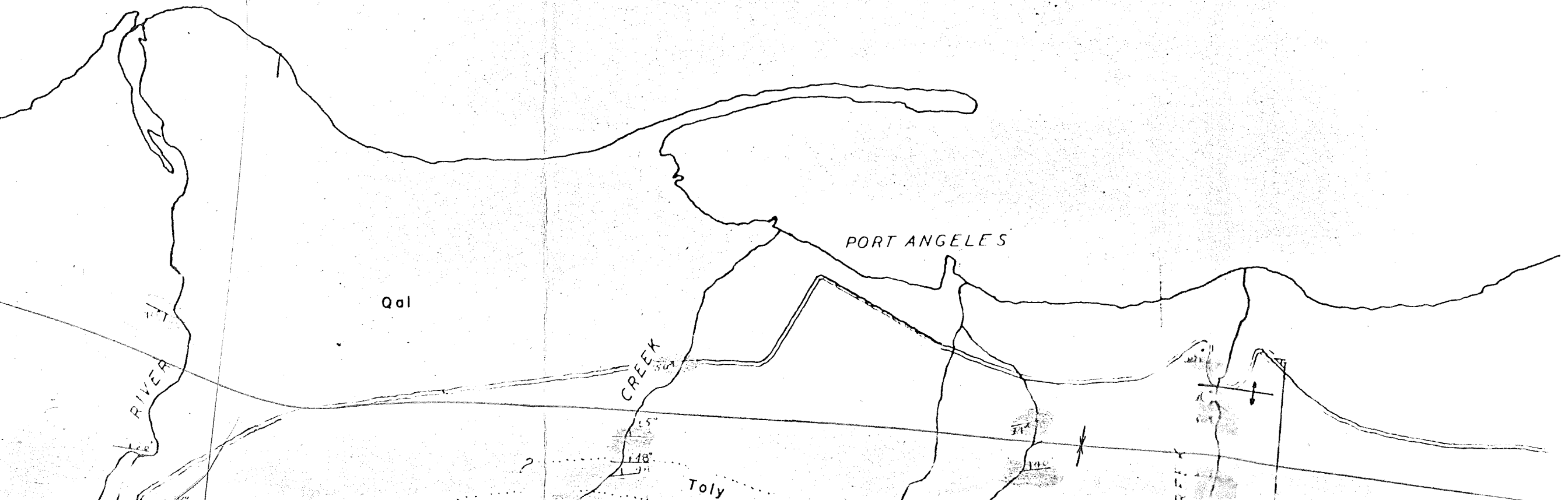
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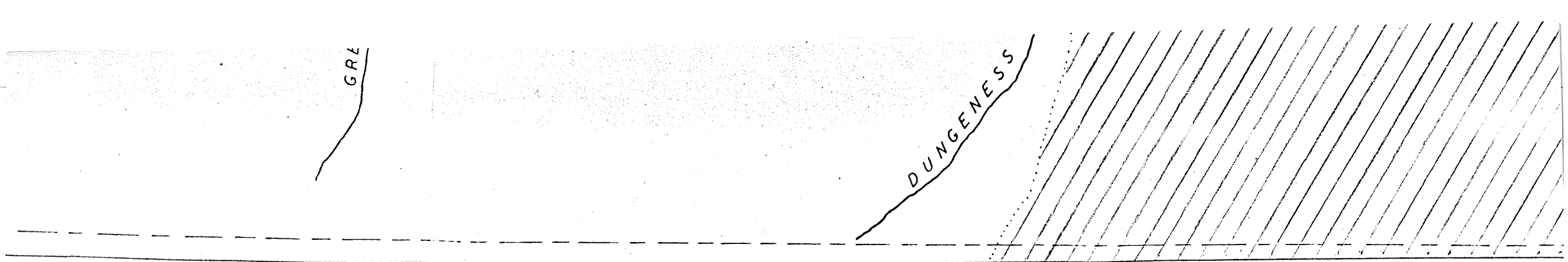




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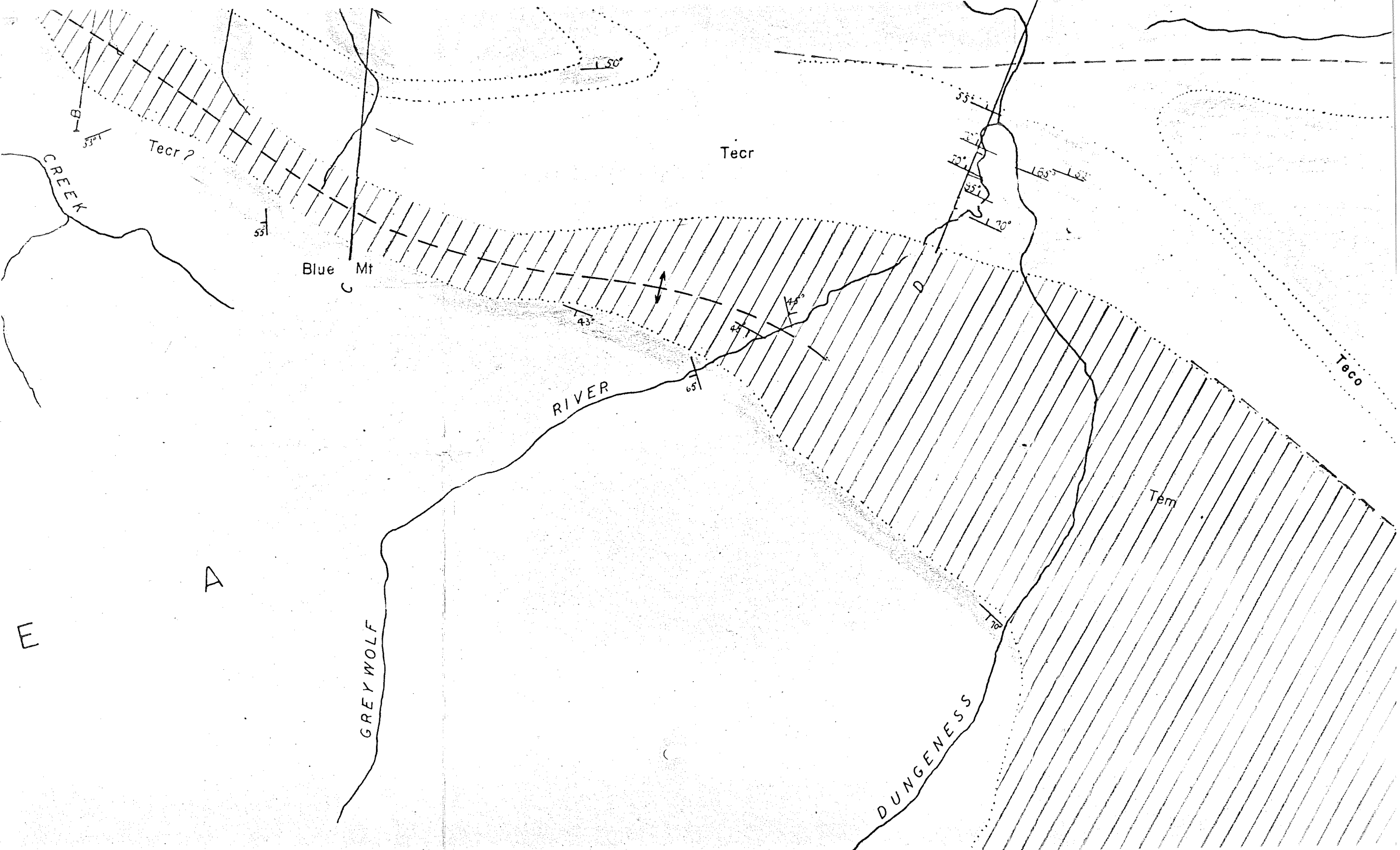
LEGEND

- Strike and dip of beds
- Anticline
- Syncline
- Fault
- Strike of vertical beds
- Horizontal beds

TERTIARY

Eocene Oligocene Pleistocene

- Qal Glacial till and alluvium
- Toq Quimper sandstone
- To Keasey-Lincoln formations undifferentiated sandy shales, thin bedded sandstones
- Tely Lyre formation—conglomerates and sandstone (Eocene or Oligocene?)
- Teco Cowitz formation—largely volcanics
- Tocr Crescent formation shales Tocr Crescent volcanics
- Yom Matchosin formation—volcanics



LAKE
MILLS

Hurricane Hill

Mr Angeles

MORSE

CREEK

MAIDEN

CREEK

Steeple Rock

Eagle Point

Obstruction Peak

ELWAH

RIVER

P

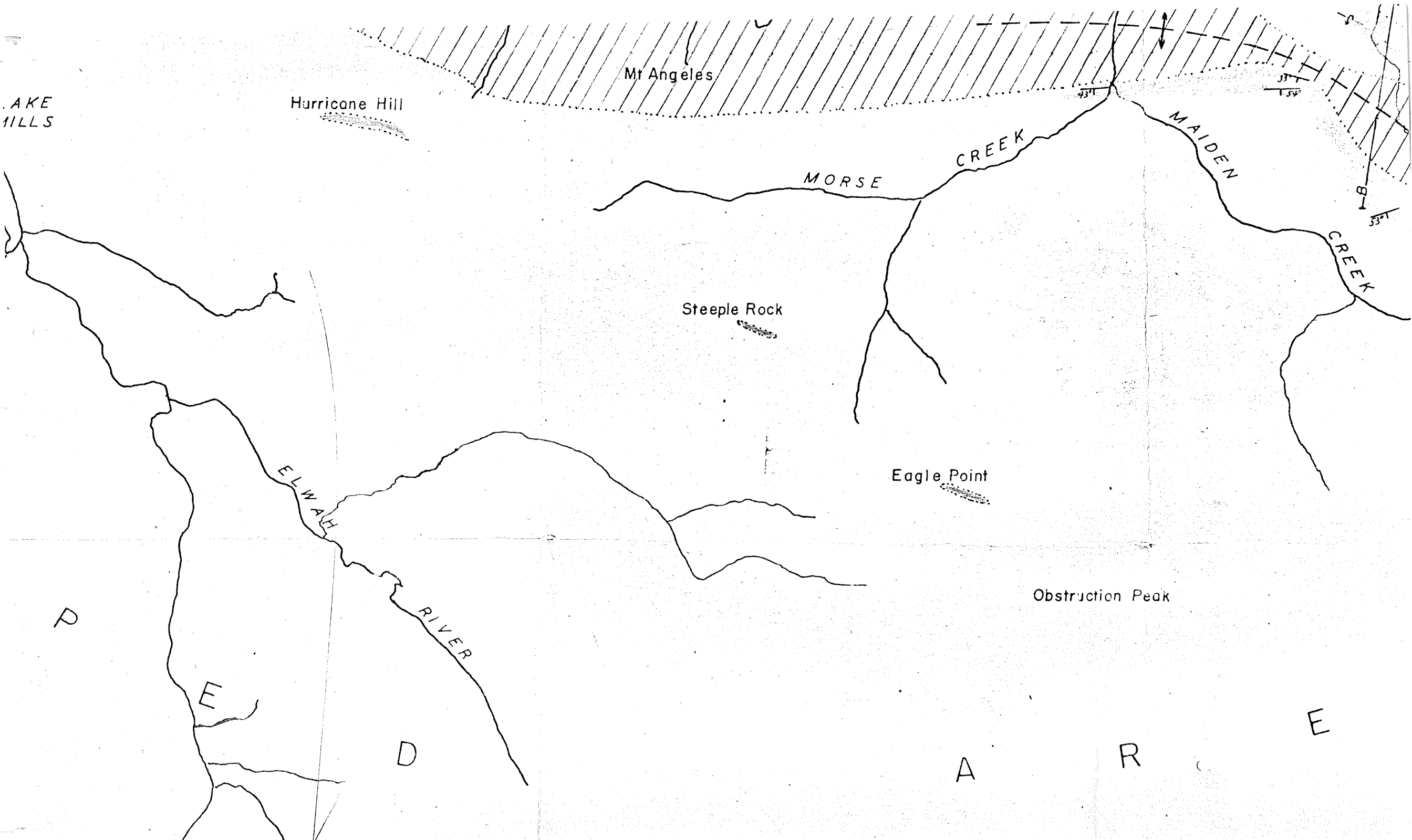
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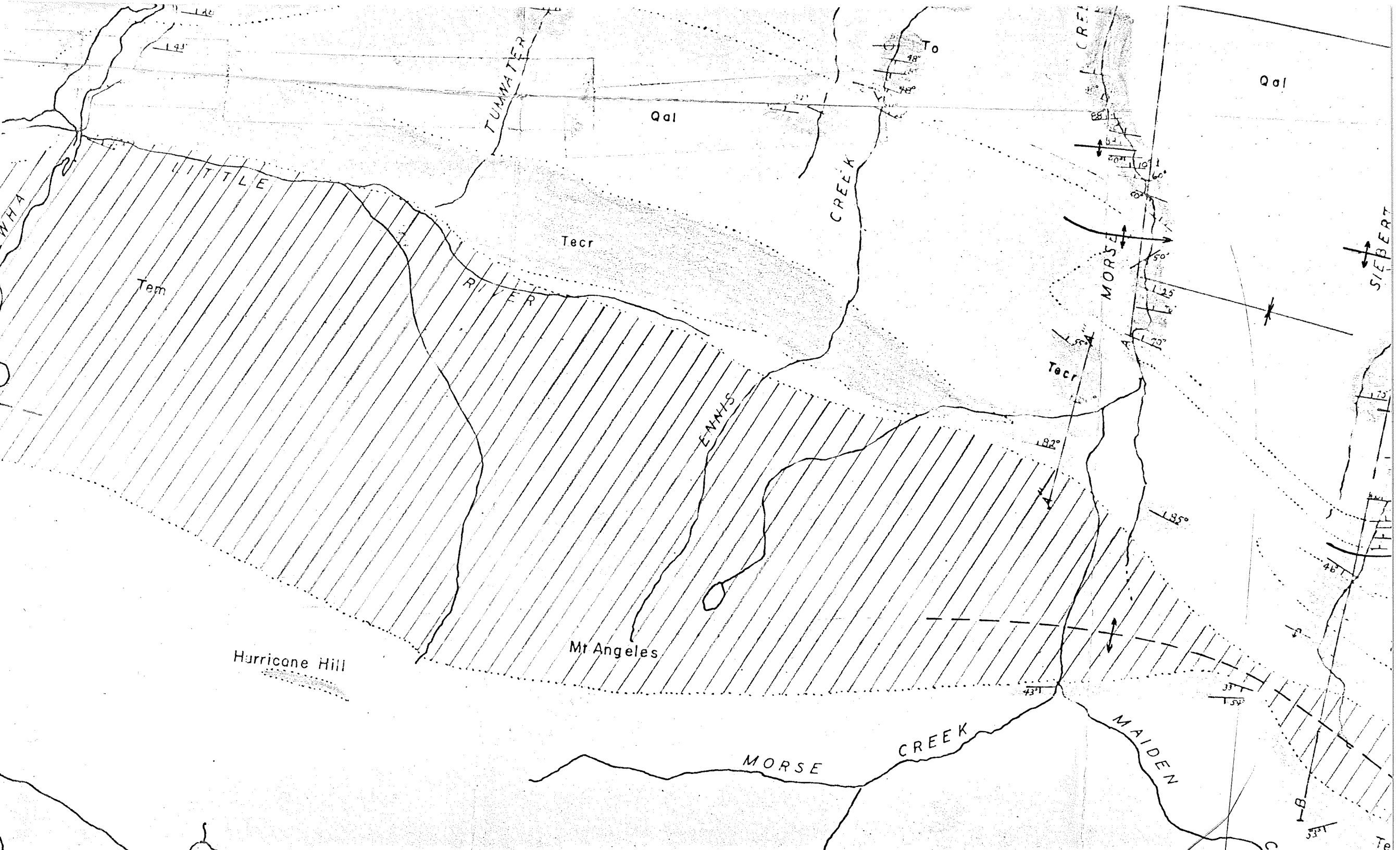
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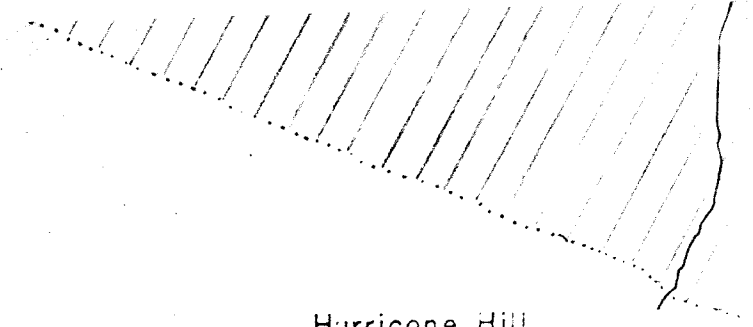
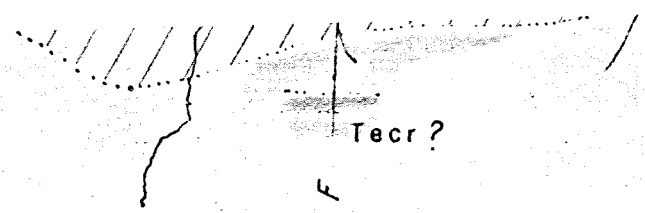
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Hurricane Hill

LAKE MILLS

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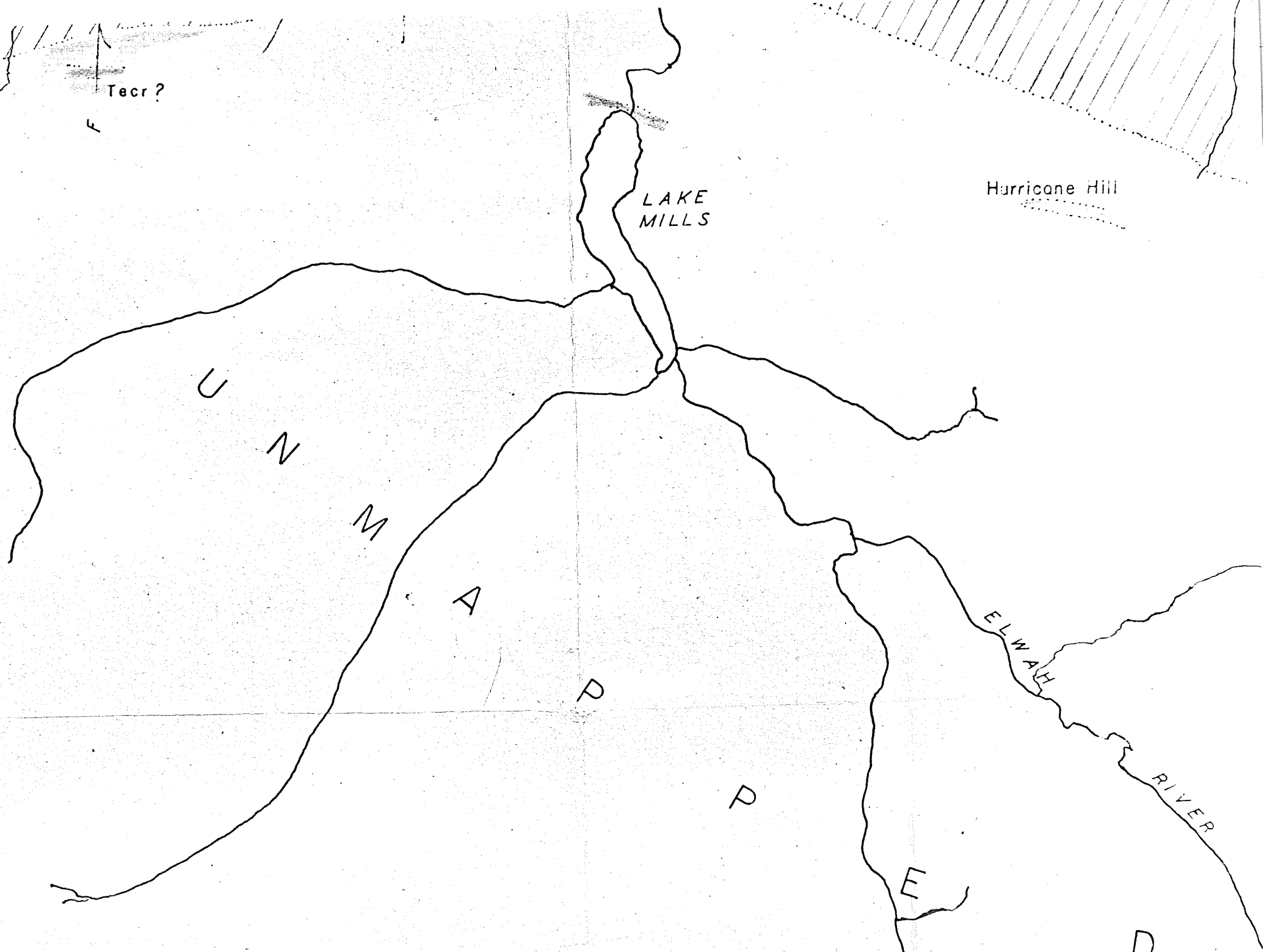
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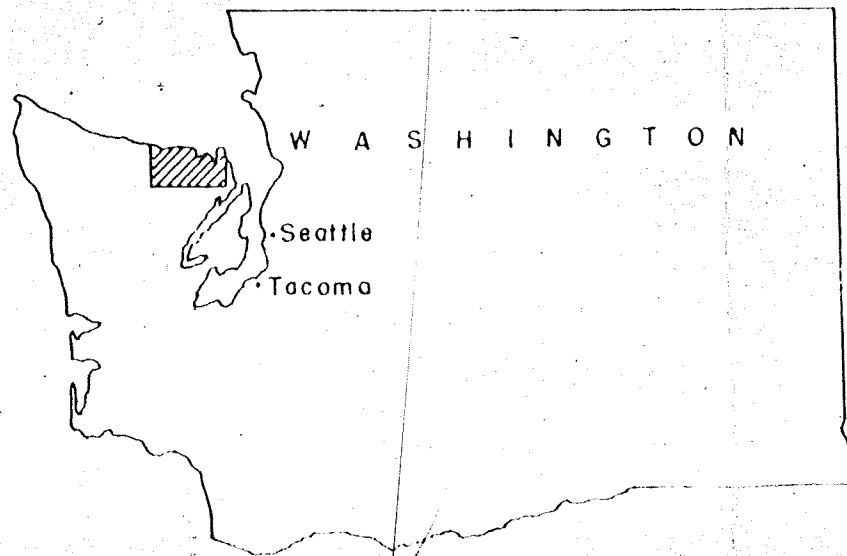
T29N



D

Clallam
Jefferson

County
County



INDEX MAP

Obstruction Peak

RIVER

E

D

A

R

E

County
County



Strike and dip



Anticline



Syncline



Fault



Strike of vein



Horizontal

RSW

RE

S T

