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STEIN'S PILLAR AREA, CENTRAL OREGON

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Introduction

Stein's Pillar * is an imposing natural column of light-colored rock, about 120 feet in diameter, that towers 350 feet into the air -- well above the ponderosa pines at its base. It lies about 17 miles east of Prineville, Oregon, and is easily reached by following U.S. Highway 26 nine miles to the east from Prineville, then turning north onto the Mill Creek Road near the east end of Ochoco Reservoir. The pillar is plainly visible on the east side of the Mill Creek road, 8 miles from its junction with U.S. Highway 26.

Southwest of Stein's Pillar, within a quarter of a mile, are two additional picturesque crags, eroded from the slightly sintered to moderately welded tuff (ignimbrite) that forms the pillar (see accompanying map). All three crags lie on the nose of a sharp ridge that dies out a quarter of a mile north of Stein's Pillar in the valley of Mill Creek, but which rises steeply to the south-southeast, culminating about 1½ miles from Stein's Pillar in Rocky Butte (elevation 5,343 feet).

The ignimbrite from which most of this ridge is carved is water retentive, and supports a forest composed chiefly of ponderosa pine on the lower slopes, but with dense thickets of lodgepole pine and other trees on the higher summits -- especially on Wildcat Mountain about 4 miles to the northeast. By contrast, the slopes across Mill Creek to the north of Stein's Pillar are almost barren. The altered andesite flows and mudflows which

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* According to the Oregon Historical Society, Steins Pillar should more properly be Steens Pillar. It was probably named for Major Enoch Steen of the U.S. Army, who, with Captain A. J. Smith, explored this region in 1860 in search of a shorter military route between Fort Dalles and Great Salt Lake. Their route through central and southeastern Oregon became known as the "Steen's and Smith's Road," and various topographic features were named after them. Unfortunately, on some old maps and records, Steen became Stein. This misspelling was often applied to Steens Mountain, and it took an official proclamation by the U.S. Board of Geographic Names to correct it.

Stein's Pillar, composed of three layers of ignimbrite, stands 350 feet high and 120 feet in diameter on Mill Creek road, 8 miles north of U.S. Hwy. 26 east of Prineville. This pillar and two craggy rocks to the right are erosional remnants of once-continuous flows of welded tuff (ignimbrite) of the John Day Formation. This water-retentive rock supports a forest of ponderosa and lodgepole pine. (Oregon State Highway Department photograph.)

underlie them are nearly impermeable; most of the rain that falls runs off once. Therefore, these hills are clothed mainly by bunch grass, sunflower , and sagebrush, with scattered clumps of mountain mahogany, sparse junipers, and a few lone remnants of ponderosa pine.

This picturesque area contains a remarkable diversity of animals and plants. Deer, porcupine, groundhogs, golden-mantled squirrels, lizards, and rabbits abound. Coyotes, bobcats, skunks, raccoons, and black bear are less common; mountain lion have been seen in the dense thickets that cover Wildcat Mountain. A wide variety of both forest and upland birds nests in the open forests and grass-covered glades. Turkey vultures and several varieties of hawks patrol between Stein's Pillar and the craggy summits of Rocky Butte. Tiny burrowing owls hunt for grasshoppers and mice on the barren ridges to the north -- where seed-eating birds such as quail, prairie chickens, meadowlarks, and many kinds of sparrows and finches nest in the grassy glades and brushy canyons. Abundant wildflowers attract great hordes of butterflies.

Geology of the Area

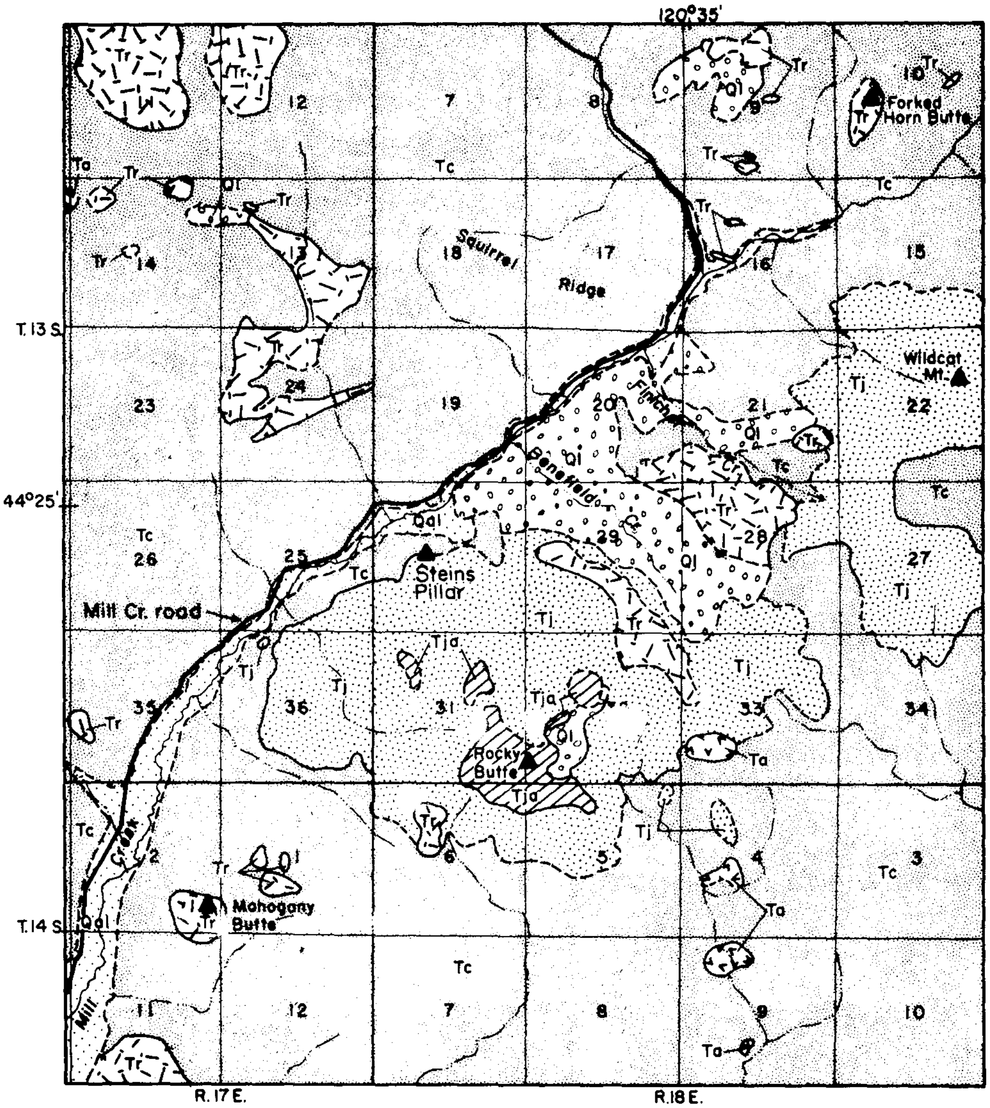
Clarno rocks

The oldest rocks of the Stein's Pillar area are lava flows, volcanic ash, and extensive volcanic mudflow deposits. These were spread from numerous volcanoes that dotted the area during the Eocene period, about 50 million years ago. The climate was humid and subtropical as reconstructed from fossil leaves and petrified wood found in thin beds of shale interbedded with the lavas. A semi-tropical climate is also indicated by the semi-lateritic weathering profiles that developed on the lavas and pyroclastics after their extrusion. Much of the area was apparently low and swampy, with numerous shallow lakes in which mud and plant debris accumulated. The rise of hot molten lava into and through these swamps and lakes caused explosive disruption of the water-soaked sediments and their intimate intermingling with the shattered lava. Extensive hot mudflows of shattered rock encased in a muddy matrix spread as tongues and lobes downslope from the volcanic conduits.

These mudflows, lava flows, and related sediments comprise the Clarno Formation, named by J.C. Merriam from Clarno's Ferry on the John Day River about 40 miles to the north.

Erosion and weathering of Clarno rocks

After several thousand feet of Clarno rocks had accumulated, a period of gentle folding and uplift ensured. Long-continued weathering and erosion then reduced the mountainous surface to an area of rolling hills, diversified by sharp buttes and ridges. The more resistant volcanic plugs,



Base from U.S.G.S.
Ochoco Reservoir Quad.

Geology by A.C. Waters

GEOLOGIC MAP OF THE STEINS PILLAR AREA,

CROOK COUNTY, OREGON

EXPLANATION

Quaternary	Qal	Alluvium.	
	Ql	Landslides.	

UNCONFORMITY

Oligocene	Tr	Rhyolite domes, plugs and flows.	John Day Formation
	Tj	Welded tuff, sintered tuff, and tuffaceous clays.	
	Tja	Andesite.	

UNCONFORMITY

Eocene	Ta	Andesite plugs.	Clarno Formation
	Tc	Andesite and quartz basalt flows, mudflows and tuffs.	

⁓	Contact, well located.
- - -	Contact, inferred.

dikes, and thicker lava flows were left etched into relief as erosion wore away the easily removable mudflows, tuffs, and shales.

Tropical weathering still prevailed into Oligocene time -- about 25 to 30 million years ago -- when the next major period of volcanism began. This was the volcanism that produced the welded tuffs from which Stein's Pillar is carved, and the ash falls, tuffaceous clays, and occasional basalt flows that collectively make up the John Day Formation in this part of central Oregon.

Before John Day volcanism began, however, weathering of the Clarno rocks had produced a deep-red, alumina-rich, clay soil 2 to 100 feet thick over the well-drained uplands. In the ancient valleys this red, semilateritic soil graded laterally into yellow silts, or green and gray clays which record the former presence of swampy areas and of flood plains along sluggish streams. Even the craggy surfaces of the butte-forming volcanic plugs were reddened, discolored, and mildly silicified during this period of weathering.

John Day volcanism

The sudden onset of an exceptionally violent episode of John Day volcanism buried this soil and preserved it as a saprolite beneath a thick accumulation of hot pumice fragments, glass shards, and violently vesiculating lava that frothed from numerous volcanic orifices -- many of whose sites are now filled with plugs, domes, and dikes of rhyolite. Among these former centers of eruption are the ridges on either side of Benefield Creek, Forked Horn Butte, Mahogany Butte, and many unnamed sharp buttes both to the north and to the south of Stein's Pillar.

The flows of hot pumice fragments and glass shards pouring from these volcanic centers spread into and filled an ancient broad valley. Part of the valley, in the area between Wildcat Mountain and Stein's Pillar, now lies buried beneath as much as 1,000 feet of sintered and welded tuff. These hot avalanches of pumice and ash accumulated very rapidly; at many places an earlier deposit was still hot when the next searing cloud of pumice and dust arrived. Therefore, although most individual eruptions spread in broad lobes generally less than 200 feet thick across the nearly level surfaces of the next-earlier mass of ash and pumice, the cooling units as contrasted to the individual eruptive lobes were 500 or more feet thick. Cooling units formed when the successive lobes of two or more volcanic eruptions chilled together as a single unit -- in other words, the lower layer was still hot and plastic at the time it was overwhelmed and buried beneath the next hot avalanche of pumice and dust.

Stein's Pillar itself is a single cooling unit, but it is composed of at least three successive hot avalanche deposits, each of which must have arrived practically on the heels of its predecessor. Three of these units can be seen in the accompanying photograph of Stein's Pillar: The top of the lowermost unit is about one-third of the way up from the base of the pillar and is seen as a narrow ledge across the left side of it. A similar junction between two separate pulses of the pumice and ash is more clearly visible about a quarter of the distance downward from the top of the pillar as a series of ledges and cracks sloping across the face of the pillar toward the left. The top of the pillar also slopes in the same direction, and marks the junction with a fourth deposit of pumice and ash which has been completely removed by erosion. Its former presence is revealed, however, by the siliceous crusts that have leached down from it to cement the openings in the top of the unit beneath. This cementation formed the thin but strong overhanging ledge that caps Stein's Pillar. Note, however, that all of these separate pulses of frothy pumice and ash cooled as one unit, allowing vertical contraction joints to pass through them uninterrupted. This is shown even better in the massive crag just to the south (right in the photograph) of Stein's Pillar.

The slow loss of heat from these rapidly accumulated pulses of hot shards and ash produced notable changes in the rock during the cooling processes. Adjacent bits of frothy pumice were hot and plastic enough to stick together, flatten out, and lose most of their contained gases. Frothy filaments of glass forming the walls between tiny bubbles collapsed, welding their walls tightly together. Glass shards, still soft and plastic, draped over the sides of stronger minerals and tiny rock fragments. By these processes a highly inflated mass of hot rock froth collapsed and sintered into a coherent sheet of ignimbrite.

Still other changes occurred in much of this ignimbrite during the cooling process. Glass crystallizes into spherulitic bodies when cooled slowly. Much of the welded tuff of the Stein's Pillar - Wildcat Mountain area is crowded with whitish ball-like masses or spherulites ranging in size from tiny birdshot to spheres the size of a tennis ball. These are composed of thickly packed fibers of sanidine and cristobalite radiating outward from a common center. Still later in the cooling process, the vertical contraction joints split the rock into long, slender columns. Millions of years later, erosion progressing rapidly along these joints etched the outcrops into the numerous crags of which Stein's Pillar is one.

Alteration, weathering, and erosion

During the episode of burial in the ground, prior to this final period of weathering and erosion, further changes occurred in the rocks. Volcanic glass is inherently unstable. If exposed to water underground, it absorbs a part of this water, swells, and slowly recrystallizes into a mixture of clays and zeolites. The rock of Stein's Pillar contains abundant montmorillonite clay and several zeolites, among them clinoptilolite and mordenite. In the process of argillization and zeolitization, silica is released; it migrates into cavities and openings, sealing and hardening the rock. Some of the spherulitic forms described above were hollow and many of these have been filled with secondary opaline or chalcedonic silica forming small "thunder eggs" -- the official State Rock of Oregon.

On exposures to air, still other changes set in. Rainwater dissolved some of the soluble zeolites and other minerals in the rock, then concentrated them in hard crusts by evaporation on the rocks' surface. The walls of Stein's Pillar have been "case hardened" in this way, and in places are "painted" by a yellow-brown stain from the strong pigment formed by the oxidation of the few iron-bearing minerals in the ignimbrite. This case hardening of the outer surface of Stein's Pillar poses a particularly treacherous problem to rock climbers. It is easy to drive a piton into this apparently firm rock, but the piton shatters and peels loose the hard, thin crust for an inch or two, gripping only the soft, chalky rock beneath. Rock climbing on these treacherous crags should certainly be discouraged for anyone other than professionals thoroughly versed in the nature of rocks "case hardened" by weathering.

In addition to crags such as Stein's Pillar, the processes of weathering and erosion have produced other striking features. Where heavy basalt flows, welded tuffs, or other well-jointed rocks rest on the slippery saprolite beneath the John Day Formation, great landslides have developed. The vertically jointed rocks give way and skid downhill on the greasy material. The entire valleys of Benefield and Fintcher Creeks, north of Stein's Pillar, are choked with these hummocky landslides. Elsewhere, as along the contact between the Clarno and John Day Formations about a mile south of Rocky Butte, the red saprolitic clay has swelled up with each rain, and has been washed downhill by rainsplash and rills, spreading a paint of bright red or pink over the rocks and soils below the outcrops of saprolite.

Conclusion

The Stein's Pillar area contains a number of extraordinarily interesting geologic features, among which Stein's Pillar is the most spectacular. In addition to the geology, there is a remarkable diversity of plants and animals to be seen. All of these natural features make this locality well worth the eight-mile side trip up Mill Creek road off U.S. Highway 26.

Selected Bibliography

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SEISMIC REFLECTION STUDIES OF BURIED CHANNELS OFF THE COLUMBIA RIVER

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ABSTRACT

Five continuous seismic reflection profiles were established between the Astoria Submarine Canyon and the mouth of the Columbia River. Subbottom geological structure to a depth of about 750 feet below the bottom was investigated. While presently there is no direct drainage system between the river and the submarine canyon, evidence for at least two buried channels was found. These channels may have linked the river and the canyon in the past.

Introduction

On June 23 and 24, 1963, five continuous seismic reflection profiles were established on the continental shelf 6 to 12 miles west of the Columbia River. Figure 1 shows the positions of the reflection profiles. Each traverse was between 8 and 10 miles in length, and is normal to the present trend of the Columbia River and Astoria Canyon. The most westerly line (Line E) was positioned across the head of the Astoria Submarine Canyon. This study was undertaken to determine if previous drainage patterns could be found.

Equipment and Procedure

The seismic reflection profiles were made using an acoustical sounding probe called the "sparker." A block diagram for this system is shown in Figure 2. For this work, two electrodes separated by one inch were towed 100 feet behind the ship at a depth of 15 feet, and 125 joules of electrical energy were discharged at a predetermined rate. The electrical energy was stored in capacitors until it was discharged by a trigger which was coupled to the recorder.

The spark discharge was approximately equivalent to the energy discharged by a conventional blasting cap. The pulse of sound energy spread spherically from the spark electrodes and energy was reflected (or echoed) from the bottom of the ocean and subbottom geological horizons to a depth of about 750 feet from the surface of the sea.

Reflections were received by a hydrophone which was towed 150 feet behind the ship at a depth of about 15 feet. The hydrophone consisted of pressure-sensitive piezoelectric crystals (rochelle salts) and a pre-amplifier.

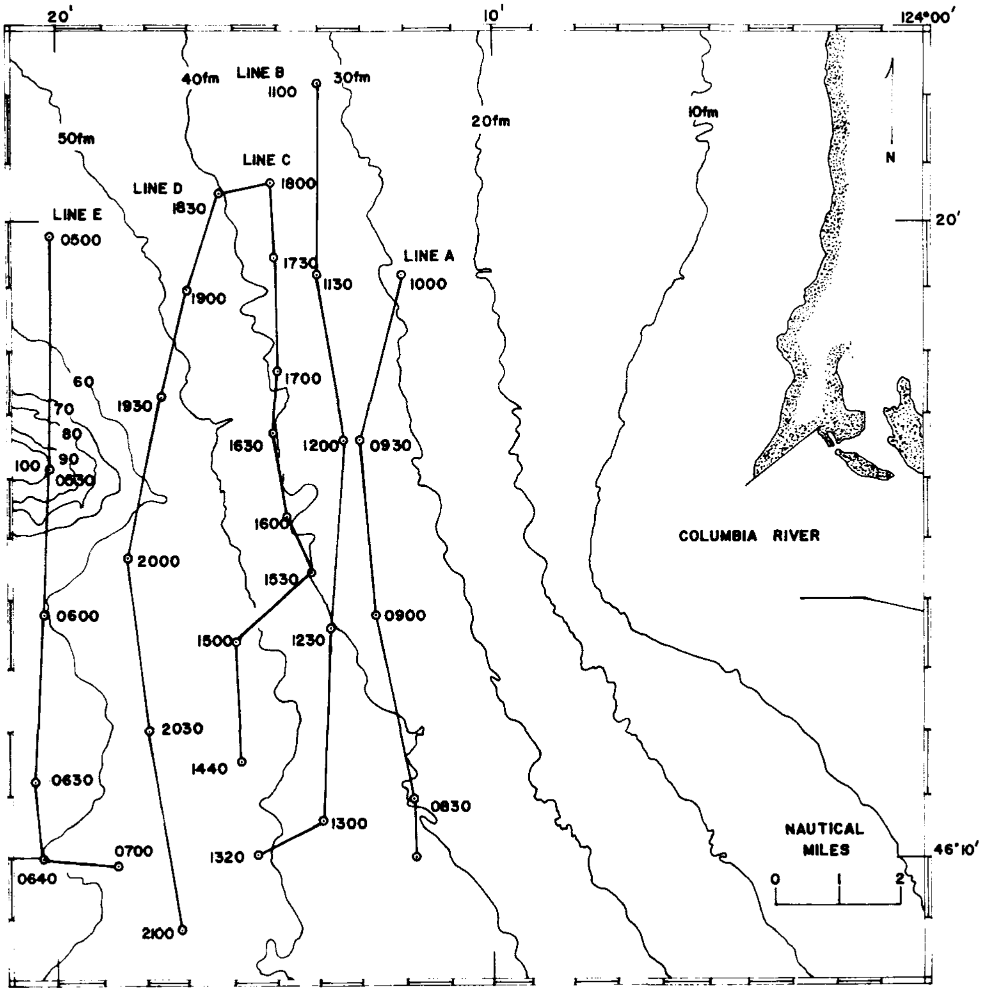

Figure 1. Index map showing ship track lines. Bottom contours from Byrne (1963).

A pressure pulse of reflected sound energy was transformed to electrical energy by the crystals. The electrical pulse was passed through filters and amplifiers and then recorded. For example, a filter setting often used for work of this nature would allow frequencies between 125 and 300 cps to be recorded, whereas the original pulse contained energy for frequencies between 50 and 1000 cps. The choice of filter settings is dependent on the spectra of the signal and noise.

Figure 3 shows a portion of a record, the northern half of Line E of Fig. 1, that was obtained during this work. The subbottom reflections representing a cross section of channel No. 1 and the bottom reflections from the Astoria Submarine Canyon are well displayed.

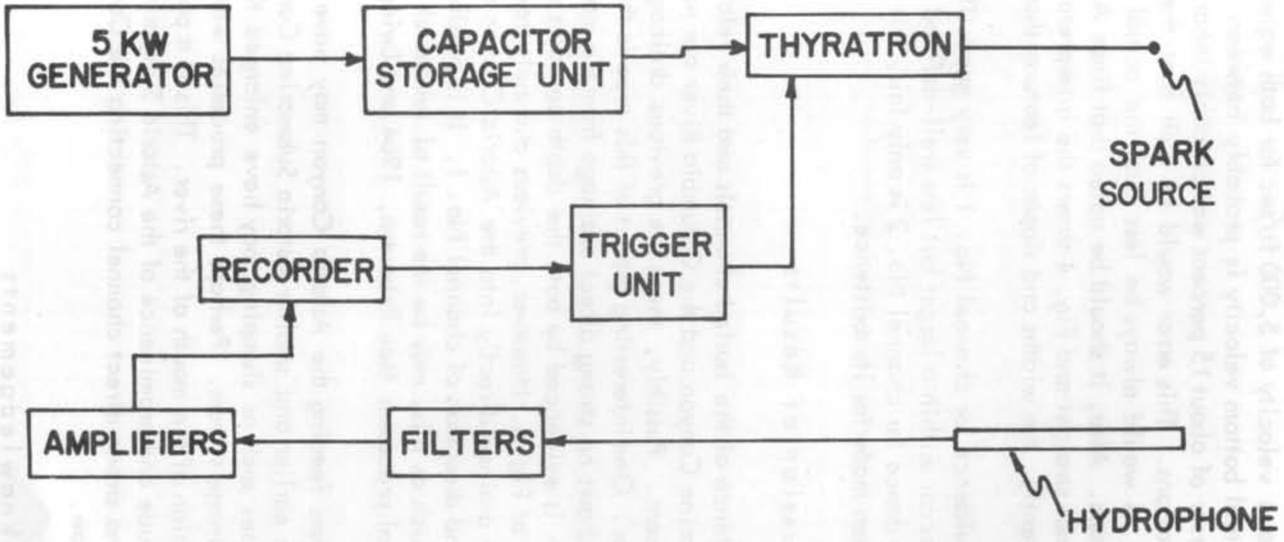

Figure 2. Block diagram of continuous seismic reflection profiler.

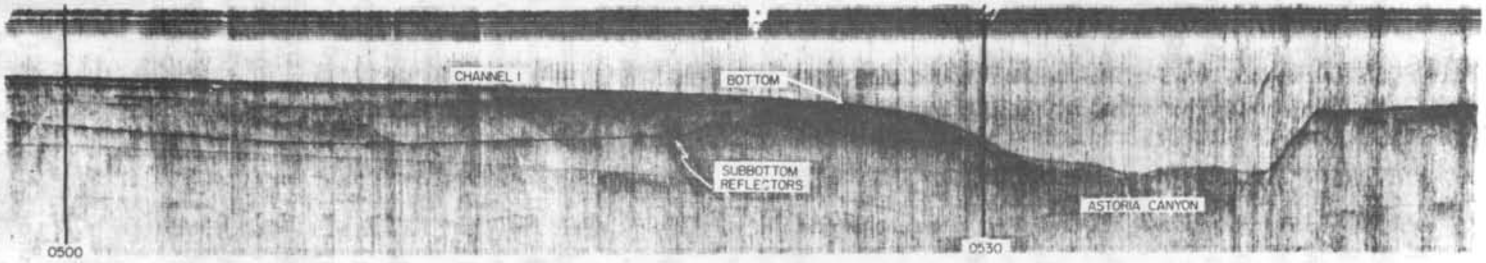

Figure 3. Example of portion of record along Line E showing buried channel 1.

Presentation of Data

Interpreted bottom and subbottom features for Lines A, B, C, D, and E of Fig. 1 are shown in Figure 4. The depths of reflecting layers were computed using a compressional wave velocity of 5,000 ft/sec for both water and bottom material. The actual bottom velocity is probably between 5,000 and 6,000 ft/sec. An error of about 15 percent was probably incorporated in the depth determinations. This error would be such that the computed depths shown in Fig. 4 would always be less than the actual depths of the subbottom reflectors. Also, it should be noted that lines A, B, C, D, and E of Fig. 1 are not straight and Fig. 4 shows the interpretation along the lines. Consequently, the widths and slopes of features shown in Fig. 4 are distorted.

The seismic reflection evidence for channel No. 1 is very good. This well-developed channel may occur within a larger but less well-defined channel (see Fig. 4). The evidence for channel No. 2 is only fair, but a tentative interpretation has been made for its existence.

Discussion of Results

The reasons for the existence of the buried channels and their relationships to the Astoria Submarine Canyon and the Columbia River are not completely understood at present. Possibly, these are previous drainage channels of the Columbia River. One interesting aspect of this area is that the Astoria Canyon currently shows no strong direct drainage from the mouth of the Columbia River, which is evidenced by both the depth contours of Fig. 1 and the bottom profiles of Fig. 4. However, previous channels from the Columbia River may have drained directly into the Astoria Canyon as evidenced by the proximity and direction of channel No. 1. It is possible that well-defined channels, such as this, may be the result of subaerial rather than submarine erosional processes (see Roberson, 1964 and Ewing and others, 1963).

Previous drainage systems feeding the Astoria Canyon may have undercut the head walls of an earlier and smaller Astoria Submarine Canyon. Other erosional processes such as slumping may have enlarged the canyon and changed the drainage system. Perhaps these processes were linked with a shift in the position of the mouth of the river. This is a possible explanation for the attitude and prominence of the Astoria Submarine Canyon even though there is no strong direct channel connecting the Columbia River to the canyon now.

Acknowledgements

This research was sponsored by the Office of Naval Research under contract No. 1286 (10) NR 083-102. James Whitcomb and Orin Knee helped in obtaining the data.

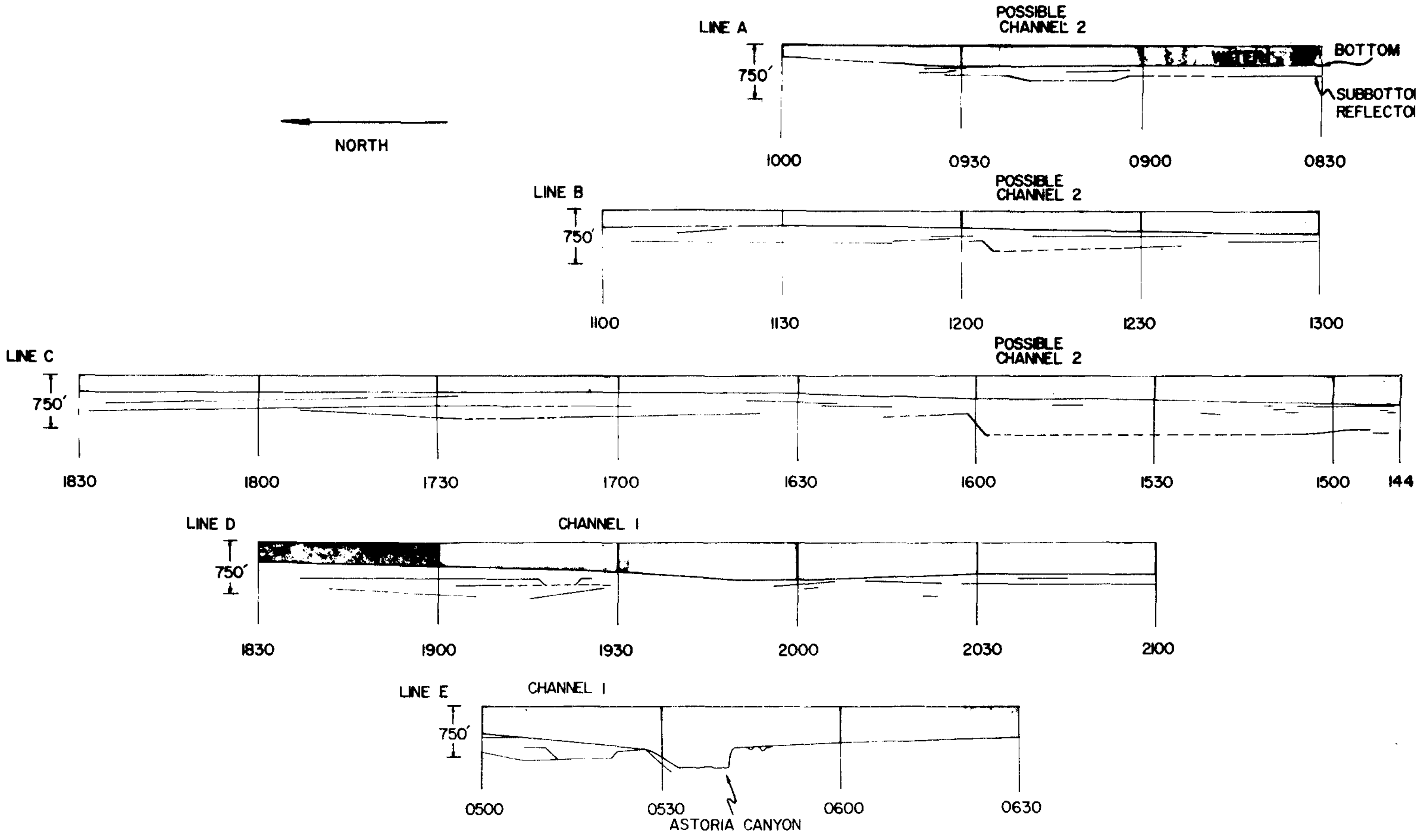

Figure 4. Interpretational cross-sections along ship track lines A, B, C, D, and E (Fig. 1).

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SENATE PASSES MINERAL EXPLORATION TAX BILL

OnJuly 29 the Senate passed by voice vote the Senate Finance Committee version of H.R. 4665, relating to deduction of mineral exploration expenditures, after adopting an amendment to make the measure's provisions applicable also to coal. H.R. 4665 was introduced by Al Ullman, Congressman from Oregon.

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MONUMENT QUADRANGLE MAP FOR SALE

"Geologic Map of the Monument Quadrangle, Grant County, Oregon," by Ray E. Wilcox and R. V. Fisher, has just been issued by the U.S. Geological Survey as Map GQ-541. The multicolored map is accompanied by a descriptive text and cross sections. It may be obtained from the U. S. Geological Survey, Federal Center, Denver, Colo. The price is $1.00.

The Monument quadrangle lies in northwestern Grant County between 119°15' - 119°30' long. and 44°45' - 45°00' lat. All but the southwestern corner of the area is occupied by a thick series of nearly flat-lying Miocene and Pliocene basalt of the Columbia River Group (consisting of Picture Gorge Basalt with possible Yakima Basalt in the uppermost flows). Exceptions in these vast areas of flood basalt are small windows of John Day Formation and two isolated caps of Pliocene ash-flow tuff. In the southwestern part of the quadrangle, where rocks beneath the Columbia River Group are exposed in the valleys of Cottonwood Creek and North Fork of John Day River, basaltic and andesitic lavas of the Clarno Formation of Eocene age are overlain by (and in fault contact with) red, green, and buff tuffs of the John Day Formation of upper Oligocene and lower Miocene age. Penetrating these units are numerous basaltic dikes, sills, and masses related to the Columbia River Group.

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OREGON PETRIFIED LOG ON DISPLAY IN NEBRASKA

This 15-foot, 3-ton petrified log was discovered in Oregon in 1889. It was exhibited in two world fairs -- Chicago in 1893 and Omaha in 1898. About 10 years ago it was bought by Harry B. Cowles of Fremont, Nebraska, who now displays it on his front lawn. Cowles saw the log when he was a boy in Omaha. Later he became interested in rock collecting and succeeded in purchasing it from the owner, who "wanted $300 but finally accepted $50." The log has been identified as a white oak and is considered to be quite a rarity because it is hollow. The site in Oregon from which it came is not known. (Photograph courtesy of the Fremont Tribune.)

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U.S.G.S. ESTABLISHES MARINE PROGRAM OFFICE

The U.S. Geological Survey has established an Office of Marine Geology and Hydrology at its Research Center at Menlo Park, Calif. This office, headed by Parke D. Snavely, Jr., a veteran Survey geologist, will facilitate geological and geophysical investigations of the continental shelves and slopes -- work which has been under way in the Survey for several years. Dr. Joshua I. Tracey, Jr., will serve as deputy chief of the office in Washington, D.C.

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WHITE KING URANIUM LEASED

The White King group of uranium claims northwest of Lakeview was leased recently by the owners to Western Nuclear, Inc., of Denver, Color., it was announced by Don C. Tracy, a member of the ownership. The lease agreement includes an option to purchase, and its term is 11 years.

Western Nuclear, a Delaware corporation with principal offices in Denver, has not announced its plans, but Tracy said he was informed by representatives of the firm they plan to have a crew here about August 1 to begin exploration and possible development of the property.

The owners are John R. and Aleta Roush, Wayland Roush, Erma Roush, Don C. and Irma L. Tracy, W. H. Leehmann, Sr., Walter H. Leehmann, Jr., and Jean Leehmann. The White King, with the nearby Lucky Lass group, was the basis in 1958 for construction of the uranium reduction plant here by the Lakeview Mining Co., of which the late Dr. Garth W. Thornburg was president. The mine went to open-pit ore production in 1959 and was shut down in the fall of 1960. Since then there have been a few attempts at ore production there. The White King includes 19 claims on National Forest land, plus about 40 acres of adjacent deeded land.

Signing the agreement for Western Nuclear were Ralph H. Light, vice-president, and James T. Moran, secretary of the firm. (Lake County Examiner, July 28, 1966)

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HOUSE INTERIOR COMMITTEE REPORTS GOLD BILL

On July 22 the full House Interior Committee reported H.R. 11667, a bill designed to revitalize domestic gold production. This measure, originally introduced by Rep. Harold T. Johnson (Calif.), was favorably reported to the full committee on July 12 by the Subcommittee on Mines and Mining.

The legislation would authorize financial assistance payments to domestic producers of gold. Each domestic gold producer who has operated a gold mine continuously for one year prior to the effective date of the Act would be entitled to annual assistance payments of 6 percent of the value of its total gold bullion receipts produced in such year. The bill, as reported by the subcommittee, would have increased these payments at the rate of 1 percent for each one-point increase in the Consumer Price Index. However, the full committee deleted this provision on the basis that tying such an increase to the Consumer Price Index would inevitably invite a Presidential veto.

An operator who did not produce continuously for one year would be entitled to receive a payment of 125 percent of the total gold bullion receipts produced from his mine during the year immediately preceding the date of his application. The bill would also establish a Gold Mines Assistance Commission to administer the Act.

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