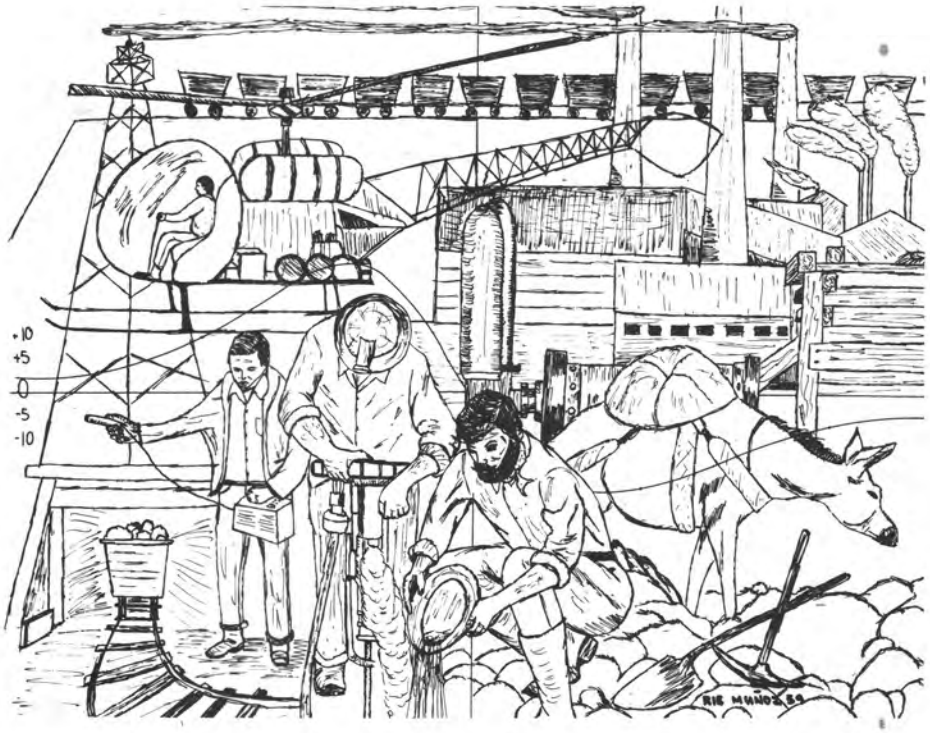
A PUBLICATION OF THE DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGY AND EARTH RESOURCES

WASHINGTON GEOLOGIC NEWSLETTER



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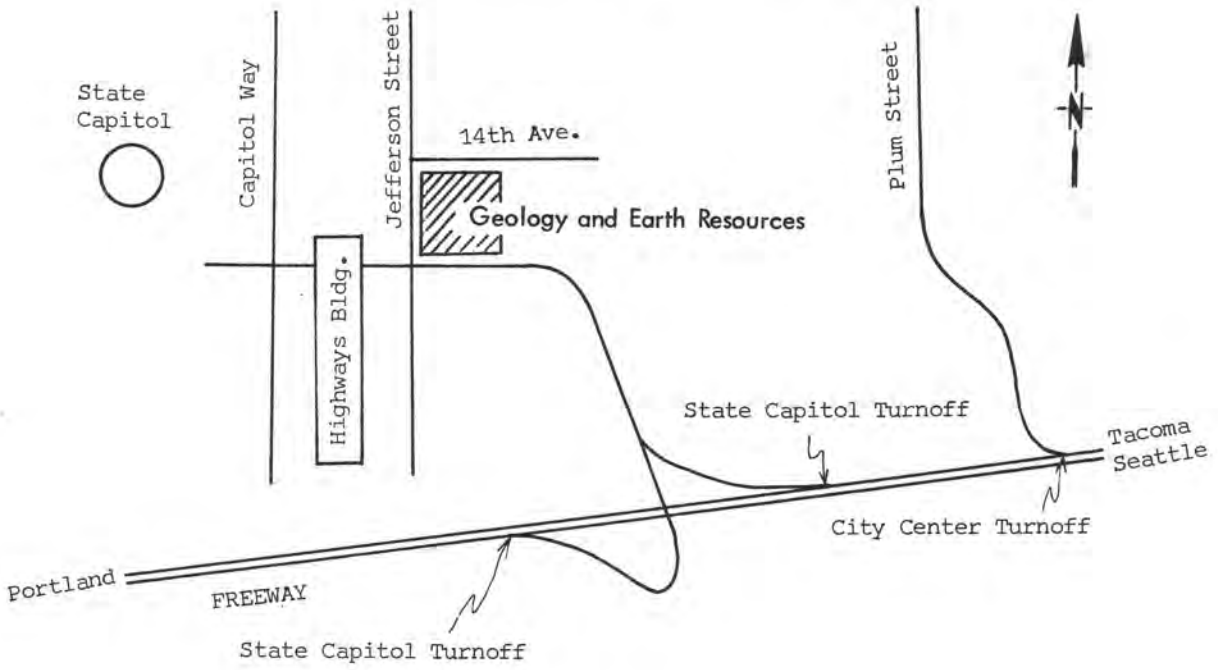
LOCATION MAP

DIVISION OF GEOLOGY AND EARTH RESOURCES



STAFF

Regulations (Surface Mined Land Reclamation and Oil and Gas Conservation Act):

Donald M. Ford
Ralph H. Kimmel

Minerals and Energy:

J. Eric Schuster
Weldon W. Rau
Wayne S. Moen
Ellis R. Vonheeder
John M. Lucas

Environmental geology:

Gerald W. Thorsen
Ernest R. Artim
Mackey Smith
Allen J. Fiksdal
Kurt L. Othberg
John M. Wunder

Library

William H. Reichert

Mailing address: Department of Natural Resources
Division of Geology and Earth Resources
Olympia, WA 98504

(206) 753-6183

IN-SITU COMBUSTION OF COAL AS AN ALTERNATE ENERGY SOURCE

by

Ellis R. Vonheeder

The in-situ (in-place) burning of coal as a source of combustible gas first received attention in 1868 by the German engineer, William Siemans. Further work by the Russian chemist, Medeleyev, showed that illuminating gas could be generated by igniting waste and slack coal underground. The first American patent on the concept of in-situ gasification was issued in 1909; however, any domestic achievements in the field appear to have been overshadowed by extensive experimentation on the part of the Russians. It was not until after the Second World War that the U.S. Bureau of Mines and the Alabama Power Company embarked upon the Gorgas (Alabama) in-situ gasification pilot project. The period of 1946 to 1959 saw extensive Bureau of Mines involvement in various facets of underground gasification research, such as bed permeability, flame-front control, and product-gas composition and quality. Budgetary constraints in 1959 caused a termination of all experimental gasification work by the Bureau of Mines.

Recent concerns caused by the energy crisis have again brought in-situ gasification of coal into consideration as an alternate energy source. Although 44 percent of the world's known coal reserves are contained within United States boundaries including Alaska, problems arise concerning pollution as a result of burning conventionally mined coal to fuel thermoelectric plants.

The in-situ gasification of coal could conceivably increase exploitable coal reserves. Through this new technique, lignites and other low-grade coals, uneconomical to mine through conventional means, could be brought on-stream as a commercial energy source. Other advantages of the process are apparent; steeply dipping and tectonically disturbed seams, ignored as being uneconomical until now, could be

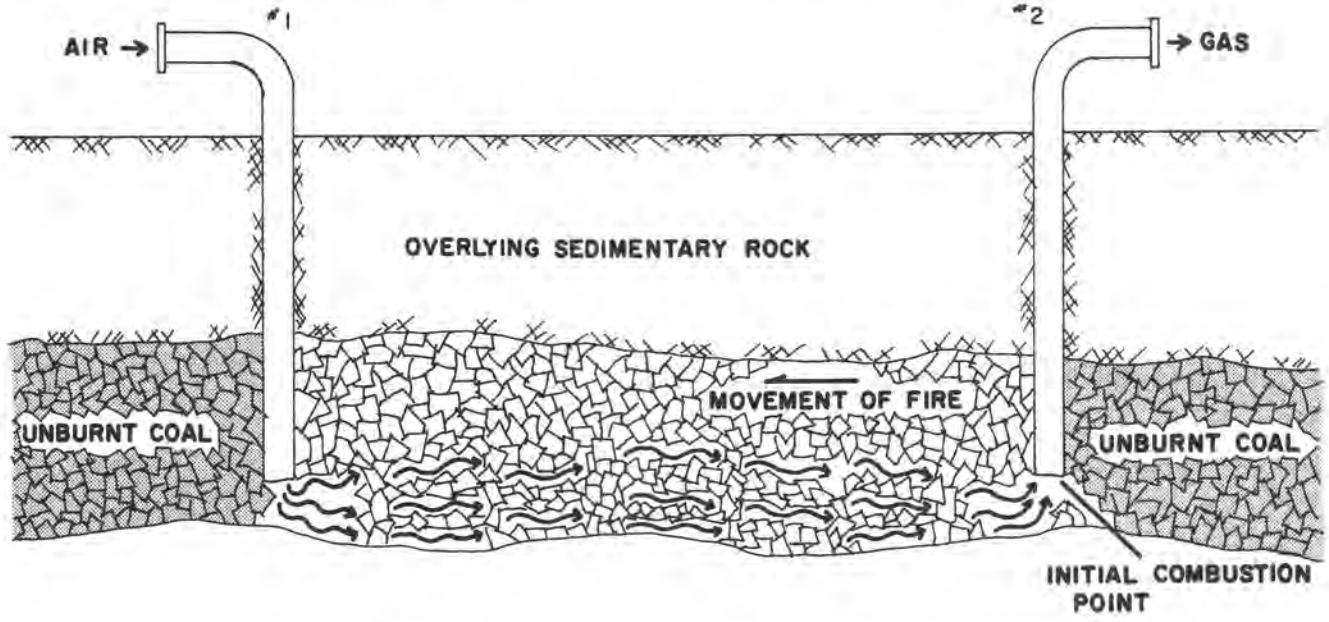


FIGURE 1.—Borehole method (reverse combustion) of coal-seam gasification.

gasified. The necessity to mine the coal would be all or partially canceled; therefore, the pollution potential would also be substantially reduced.

Figure 1 illustrates the basic principle involved in the in-situ gasification of a coalbed using the coupled-borehole method. Here, two boreholes are driven from the surface to intersect the total seam thickness. The holes in the couple are drilled from 80 to 100 feet apart. The natural permeability of the seam determines exact spacing. The coal seam is ignited at the initial combustion point at the bottom of borehole No. 2 and the reaction front proceeds to borehole No. 1. In the illustration, the combustion front moves opposite to the flow of the gas produced; this mode is known as reverse combustion. Both reverse combustion and forward combustion (flame-front and product gas moving in same direction) were utilized in in-situ experiments at the U.S. Bureau of Mines Experimental Gasification Project at Hanna, Wyoming.

As the reaction continues, seam permeability is increased through the injection of compressed air down borehole No. 1. In some experiments, it was found that hydraulically and(or) explosively fracturing the coal seam was necessary to allow air injection pressures to decrease and air acceptance rates to increase (Chaiken, R. F., 1973, p. 6). "Linking," as this procedure is known, has also been successful using electric currents to carbonize an initial path between two boreholes.

When the coal between the boreholes burns through, air pressure down borehole No. 1 decreases. The reaction area increases along the length and width of the tunnel and gas production increases. Near the end of the combustion process, roof subsidence occurs and produced gas decreases in both quality and quantity. Another borehole couple is then ignited and the process is repeated. (In actual practice, it is likely that a number of boreholes would be linked together to produce greater volumes of gas as required.)

A second scheme for in-situ gasification is known as the steeply dipping bed method (fig. 2). Whereas the borehold couple method is more amenable to flat-lying or gently dipping beds, the steeply dipping bed concept would be utilized to a greater extent with the coal seams in Washington State. Premature roof subsidence can pose problems in flat-lying beds using the borehole couple. On a steeply dipping bed, there is less chance for premature roof subsidence due to the geometry of the bed and the mechanics involved. Roof subsidence of the reaction chamber would be of less concern on a steeply dipping seam. Only when the reaction chamber had migrated to within a short distance of the surface would subsidence become a problem. This in turn could be alleviated by earlier extinguishing of the flame front and backfilling the reaction chamber as required.

Heat loss in a flat-lying seam of the size discussed previously is calculated to be roughly 2 percent of total available heat, although in reality the figure may be greater due to heat loss through fissures caused by less-than-optimum roof conditions. Coal-mine fires are extinguished only after much difficulty; Chaiken (1973) notes there are over 100 abandoned coal mines on fire in the United States alone. These facts suggest that in-situ coal combustion is maintainable for long periods of time. It appears that heat loss and maintenance of the reaction front could be considered minor problems.

Most in-situ experiments performed thus far have been directed toward producing a combustible mixture of gases as their end product. This necessitates careful attention to such factors as air volume control and monitoring of relative concentration of combustion products. Gas production has been successful at numerous in-situ gasification projects, but the chances of production on a sustained commercial basis appear to be less than attractive, with present state-of-the art technology. The prime difficulty arises from the inability to control the burning process to yield a product of the proper mixture of hydrogen, oxygen, nitrogen, carbon monoxide, carbon dioxide, and methane.

In contrast to in-situ gasification, Chaiken

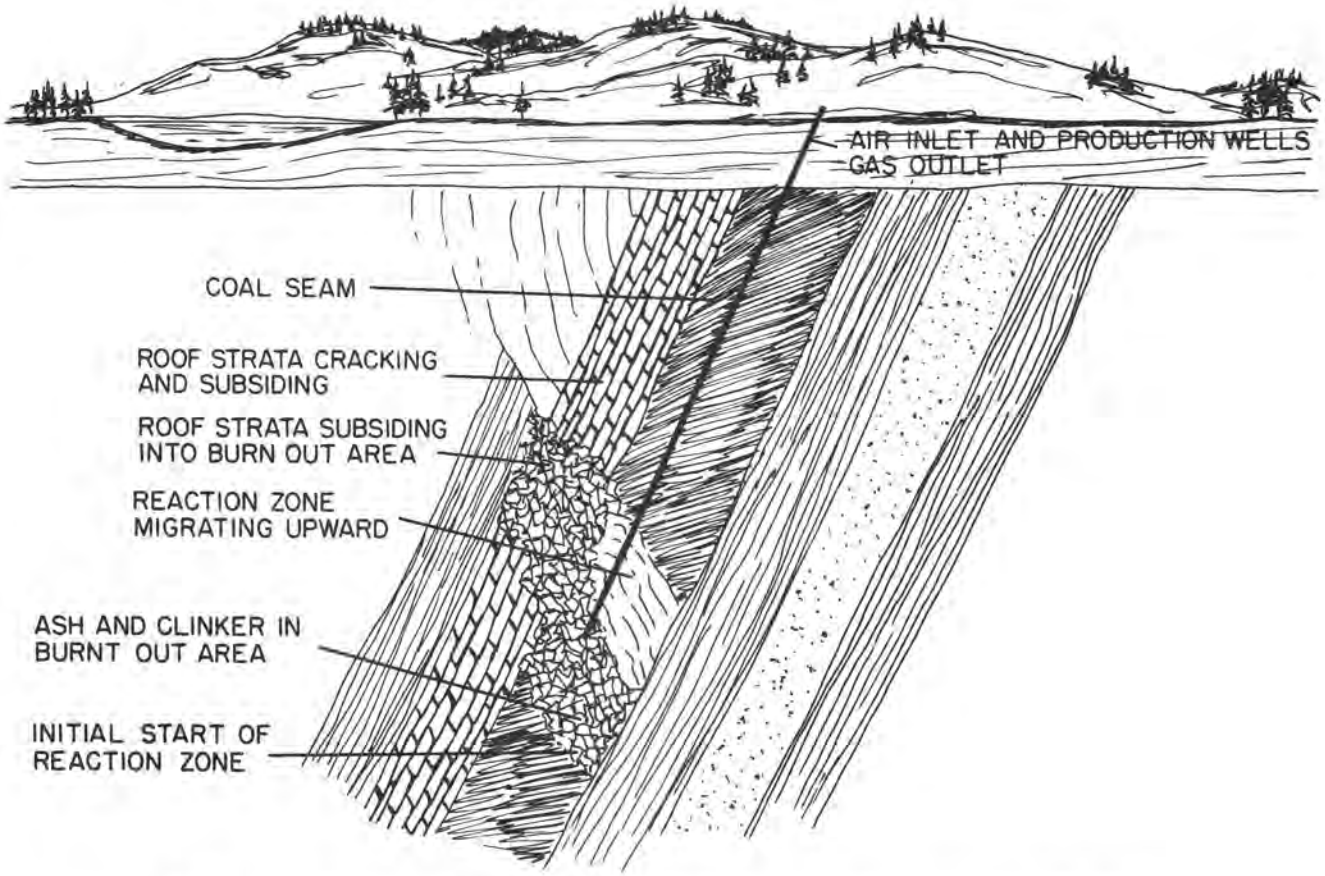


FIGURE 2.—General configuration of a steeply dipping bed undergoing gasification.

(1973) proposes an in-situ process with the objective of complete combustion and maximum heat-production. Early in the Gorgas (Alabama) experiment, exhaust temperatures of 2,000° F. were sustained for over 900 hours by supplying an air volume in excess of that required for incomplete combustion of the coal. By comparing inlet flow of fresh air and heat output, it was estimated that 1.5 megawatts of steam power could have been produced through complete combustion. Perhaps the biggest advantage of complete in-situ combustion is economic. The necessity for a pipeline transport system would be negated if an onsite thermoelectric plant could be designed to utilize hot gases directly from the source.

Chaiken (1973) presents tonnage requirement data in his discussion of the utilization of a coal seam to produce heat to drive a 100-megawatt thermoelectric generation plant. Such a project would require a 2,700-foot burning face along a 5-foot-thick coalbed. Consumption would approximate 620 tons per day, or about 4.5 million tons over a 20-year plant lifespan. These figures translate to somewhat less than 1 square mile in area, or about 510 acres. These tonnage requirements to sustain a plant of this size are quite modest when compared to known coal reserves.

In-situ gasification and in-situ combustion are not without problems. Positive maintenance of the inlet and exhaust air courses is probably the single most important requisite. Leakage control in coal veins with less-than-optimum roof conditions has been a problem. In some experiments, up to 85 percent heat loss occurred due to small collapse faults developing in the roof as the burning front migrated down the seam.

Removal of polluting nitrogen and sulfur compounds from the 2,000° F. gas stream poses a very real problem from a technological point of view. Numerous coal seams in Washington State are situated near major and secondary rivers, and steps would have to be taken to absolutely avoid contamination of ground-water courses by leakage of combustion products.

Another problem to be solved concerns almost certain thermal deterioration of valves and piping used to regulate the product gases. A condensing/cooling system could possibly be required to cool the gases from a complete combustion source to a level low enough to prevent damage to turbines and bearings.

References Cited

Chaiken, R. F., 1973, In-situ combustion of coal for energy: U.S. Bureau of Mines Advance Mining Systems Program, Technical Progress Report 84. 12 p.

Campbell, G. G.; Brandenburg, C. F.; Boyd, R. M., 1972, Preliminary evaluation of underground coal gasification at Hanna, Wyoming: U.S. Bureau of Mines Coal Gasification Program, Technical Progress Report 82. 14 p.

Hucka, V.; Das, B., 1973, In-situ gasification of coal; solving the energy crisis: Mining Engineering, August, 1973, p. 49-50.

SECOND IN-SITU GASIFICATION PROJECT AT HANNA GIVES OPTIMISTIC RESULTS

by
Ellis R. Vonheeder

A second in-situ coal gasification experiment at the ERDA project in Hanna, Wyoming is under way and officials are pleased with the results shown thus far, according to Energy Research and Development Administration officials.

Sustained gas production from the controlled slow burning of coal in-situ is approximately 8.5 million cubic feet per day. This output could be converted to about six megawatts of electricity or enough to supply the requirements of a town of 6,000 people.

Of particular note was the fact that the Btu content increased from 125 Btu per cubic foot in previous experiments to 180 Btu per cubic foot at present, or about a 30 percent increase. The present test started April 14 and will continue through mid-July. No previous underground tests have yielded such high Btu gas at a sustained rate, according to ERDA.

Future plans call for an in-situ project generating 21.3 million cubic feet of gas per day. This is roughly equivalent to 15 megawatts of electricity or enough power to fill the needs of a town of 15,000.

J. ERIC SCHUSTER APPOINTED NATURAL RESOURCES MANAGER

On June 15, 1976, J. Eric Schuster was appointed as Natural Resources Manager I for the

Division of Geology and Earth Resources, Department of Natural Resources. Eric joined the division in 1970. He obtained his degree in geology from Washington State University and his master's from the University of Wyoming. The division now has two sections: Don Ford heads the regulatory and operational section, and Eric supervises the geologic section.

URANIUM REPORTS RELEASED

The reference library of the Division of Geology and Earth Resources now has on open file ERDA's (Energy Research and Development Administration) recent reports on the uranium favorability of Tertiary sedimentary rocks in northeastern Washington. Although the division has no facilities for copying these reports, they are available as reference material during normal working hours (Monday-Friday, 8 to 5 PM). Copies of the report are also available at the U.S. Geological Survey office in Spokane.

The three reports, by D. K. Marjaniemi and J. W. Robins, present the results of a study made between November 1973 and December 1974. The primary objective of the overall study was to assess the favorability of Tertiary sedimentary rocks for uranium resources. Areas that were studied are shown in figure 1; the abstracts for each report appear on page 6.

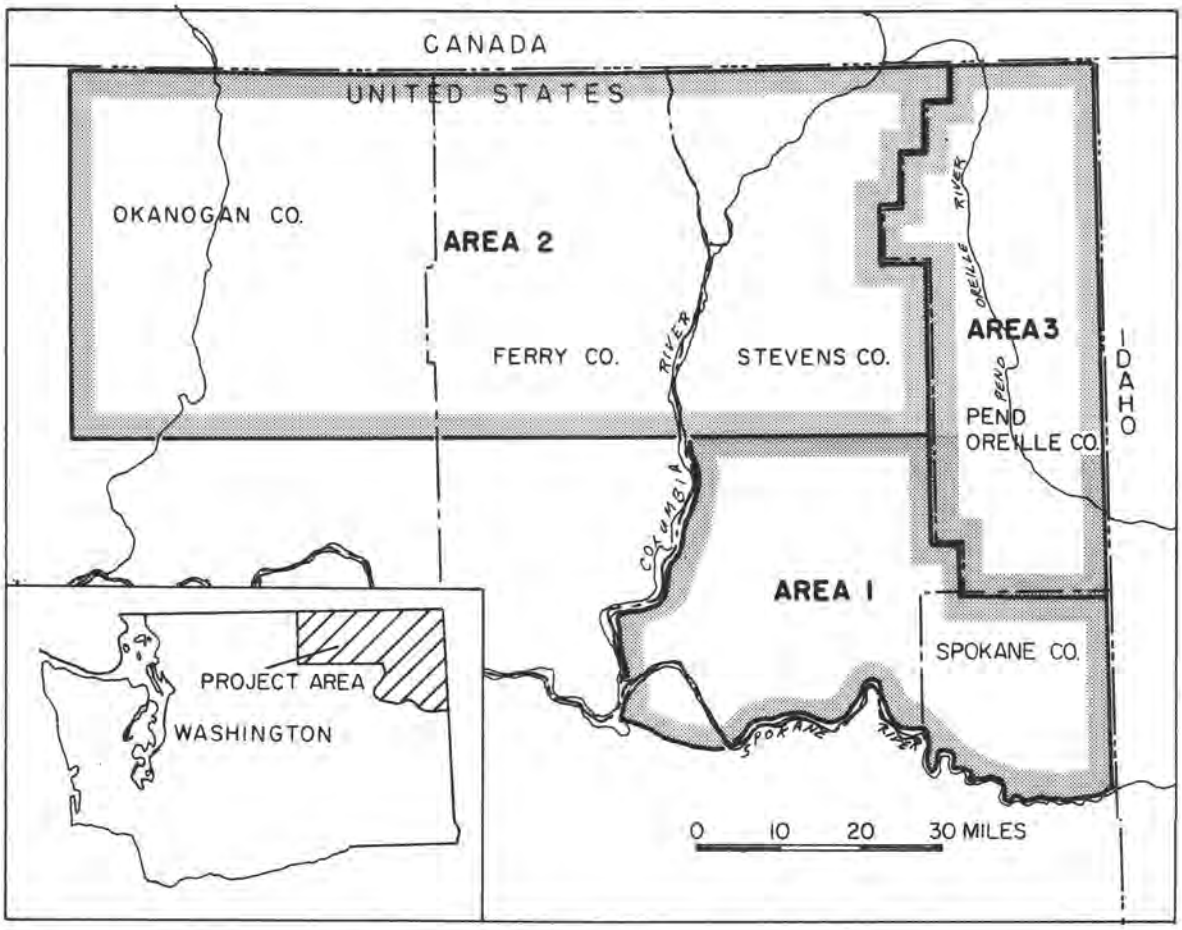


FIGURE 1.—Index map of uranium study areas.

Area 1 (No. GJBX-1-76)

ABSTRACT

Tertiary sedimentary rocks in the lower Spokane River valley and in northern Spokane County, northeastern Washington, were investigated to determine the favorability for potential uranium resources. This project involved measurement and sampling of surface sections, collection of samples from isolated outcrops, chemical and mineralogical analyses of samples, and examination of available water well lithologic logs.

An area of very high favorability is in the Spokane Indian Reservation along the lower Spokane River valley—an area which not only contains visible uranium minerals, but from which there has also been uranium production.

Areas of medium favorability are the Harker Canyon area in the lower Spokane River valley and a portion of northern Spokane County. The Harker Canyon area is underlain by rocks which are stratigraphically and structurally similar to, and probably an extension of, the very highly favorable rocks in the Spokane Indian Reservation. The Latah Formation in northern Spokane County is judged to have medium favorability based on the occurrence of thick sandstones derived partially from a quartz monzonite provenance and which reportedly contain organic material and volcanic derivatives.

Area 2 (No. GJBX-2-76)

ABSTRACT

Tertiary sedimentary rocks in the northern portions of the western Okanogan highlands and in the upper Columbia River valley were investigated during a regional study to determine the favorability for potential uranium resources of the Tertiary sedimentary rocks of northeastern Washington. This project involved measurement and sampling of surface sections, collections of samples from isolated outcrops, and chemical and mineralogical analyses of samples.

No portion of the project area of this report is rated of high or of medium favorability for potential uranium resources. Low favorability ratings are given to Oroville, Tonasket, and Pine Creek areas of the Okanogan River valley; to the Republic graben; and to the William Lakes, Colville, and Sheep Creek areas of the upper Columbia River valley. All these areas contain some fluvial, poorly sorted feldspathic or arkosic sandstones and conglomerates. These rocks are characterized by very low permeability and a consistently high siliceous matrix suggesting very low initial permeability. There are no known uranium deposits in any of these areas, and low level uranium anomalies are rare.

Area 3 (No. GJBX-3-76)

ABSTRACT

Tertiary sedimentary rocks in the Pend Oreille River valley were investigated in a regional study to determine the favorability for potential uranium resources of northeastern Washington. This project involved measurement and sampling of surface sections, collection of samples from isolated outcrops, chemical and mineralogical analyses of samples, and examination of available water well logs.

The Box Canyon Dam area north of Ione is judged to have very high favorability. Thick-bedded conglomerates interbedded with sandstones and silty sandstones compose the Tiger Formation in this area, and high radioactivity levels are found near the base of the formation. Uranophane is found along fracture surfaces or in veins. Carbonaceous material is present throughout the Tiger Formation in the area.

Part of the broad Pend Oreille valley surrounding Cusick, Washington, is an area of high favorability. Potential host rocks in the Tiger Formation, consisting of arkosic sandstones interbedded with radioactive shales, probably extend throughout the subsurface part of this area. Carbonaceous material is present and some samples contain high concentrations of uranium. In addition, several other possible chemical indicators are found.

The Tiger-Lost Creek area is rated as having medium favorability. The Tiger Formation contains very hard, poorly sorted granite conglomerate with

some beds of arkosic sandstone and silty sandstone. The granite conglomerate was apparently derived from source rocks having relatively high uranium content. The lower part of the formation is more favorable than the upper part because of the presence of carbonaceous material, anomalously high concentrations of uranium, and other possible chemical indicators.

The area west of Ione is judged to have low favorability, because of the very low permeability of the rocks and the very low uranium content.

PLEISTOCENE ASH ON THE OLYMPIC PENINSULA

by

R. J. Carson

Volcanic ash has been found in Pleistocene sediments at eight places on or near Hood Canal. The tephra (pyroclastics, including ash and pumice) is located in Mason County near the Skokomish River and Hoodsport, in Kitsap County south of Holly, and in Jefferson County on the Toandos and Bolton Peninsulas and in Chimacum Valley west of Port Ludlow. At seven exposures the pyroclastics are weathered.

Along Frigid Creek west of Potlatch, there is 10 cm of fresh vitric pumice and ash in thick lacustrine or glaciolacustrine silts. W. H. Spence and R. U. Birdseye analyzed the Frigid Creek rhyolitic tephra petrographically and by atomic absorption and X-ray fluorence. Peat from about 15 m above the pyroclastics has been radiocarbon dated at greater than 41,000 years old. At Frigid Creek and on the Bolton Peninsula, there are two graded beds of tephra, indicating two pulses of one eruption.

In Mason and Kitsap Counties, the pyroclastics are interbedded with glacial and(or) nonglacial sediments interpreted to be the same age as or older than Salmon Springs Drift in the southeastern Puget Lowland. In Jefferson County, the tephra lies stratigraphically above and below till correlated with Possession Drift on Whidbey Island. Considering all eight exposures, the Pleistocene pyroclastics appear to occur at two or more stratigraphic horizons, and thus seem to indicate at least two major eruptions.

Where was the source of the tephra? The nearest volcanoes are, of course, to the east in the Cascades. Most of the time, however, winds are from the southwest, and would carry ash northeastward from the Cascades. Holocene Mazama ash, from the eruption about 6,600 years ago that formed the caldera at Crater Lake in southern Oregon, is known to occur in some of the postglacial bogs in the western Puget Lowland. The explosion at Crater Lake was evidently violent enough to carry some ash far north-northwest to the western Puget Lowland. The recently discovered pyroclastics along and near Hood Canal indicate rare easterly winds and(or) violent pre-Mazama eruptions somewhere in the Cascades.

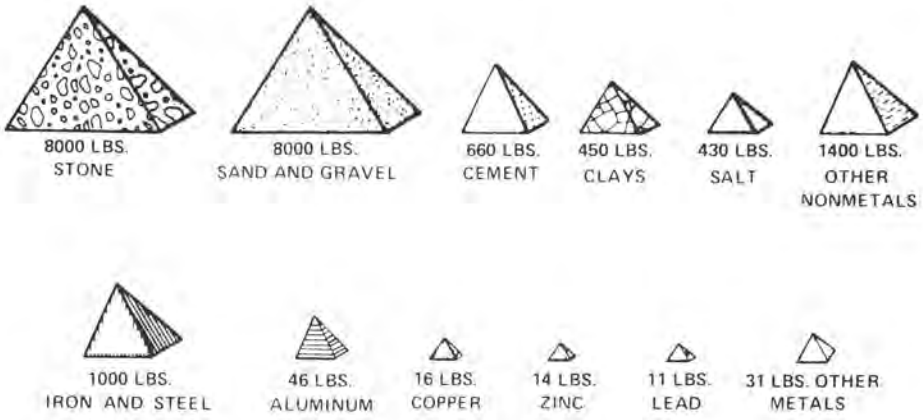
MINERAL FACTS

According to the "Status of the Mineral Industries 1976," published by the U.S. Bureau of Mines, the United States total use of new mineral materials in 1975 was about 4 billion tons. This means that about 40,000 pounds of new mineral materials are required annually for each U.S. citizen.

The relative amounts of mineral materials used by each U.S. citizen is illustrated in figure 1.

In 1975, the mines of Washington produced around 40 million tons of mineral materials. Although the general production appears large, it falls short of

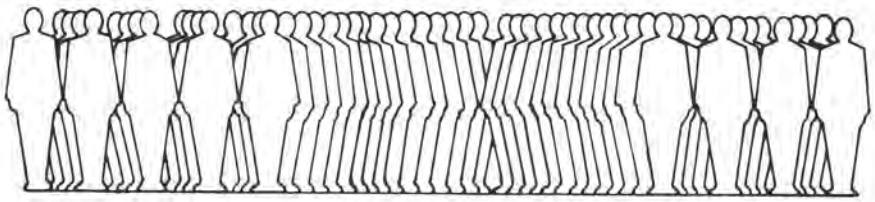
ABOUT 40,000 POUNDS OF NEW MINERAL MATERIALS ARE REQUIRED ANNUALLY FOR EACH U.S. CITIZEN



PLUS

TO GENERATE:

ENERGY EQUIVALENT TO 300 PERSONS WORKING AROUND THE CLOCK FOR EACH U.S. CITIZEN



U.S. TOTAL USE OF NEW MINERAL SUPPLIES IN 1975 WAS ABOUT 4 BILLION TONS !

BUREAU OF MINES
U.S. DEPARTMENT OF THE INTERIOR

FIGURE 1

		Total metals consumed by each U.S. citizen in 1975 (lbs)	Total metals produced in Washington for each resident of the state (lbs)
Stone	Nonmetals	8,000	7,804
Sand & gravel		8,000	12,008
Cement		660	560
Clays		450	222
Salt		430	0
Others		1,400	200
Iron & steel	Metals	1,000	0
Aluminum		46	0
Copper		16	0
Zinc		14	6
Lead		11	1
Others		31	0
Petroleum	Fuels	7,650	0
Coal		5,200	2,170
Natural gas		4,200	0
Uranium		1/7	1/7
Total		37,108 lbs	22,971 lbs

providing the 3.5 million citizens of Washington with the minerals used by them in 1975. For comparison purposes the table above shows the average mineral consumption for each U.S. citizen and the per capita production of minerals for Washington in 1975.

From the table it can be seen that, with the exception of sand and gravel, the citizens of Washington depend on out-of-state sources to supply their yearly needs for mineral materials.

U.S. GEOLOGICAL SURVEY OPEN-FILE REPORTS

The following open-file reports from the U.S. Geological Survey are now available for inspection in the Division of Geology and Earth Resources reference library:

Principal facts for gravity stations in the Pullman, Washington-Moscow, Idaho, area, by D. B. Jackson, R. M. Senterfit, and D. I. Gregory, 8 p. Open-file report 76-189.

Principal facts for gravity stations in the Okanogan, Sandpoint, Ritzville, and Spokane 1° by 2° quadrangles, northeastern Washington and northern Idaho, by J. W. Cady and R. F. Meyer, 57 p. Open-file report 76-290.

Regional gravity and aeromagnetic studies applied to uranium exploration in northeastern Washington and Wyoming, by J. W. Cady, 21 p., 2 figs., 8 photos, and 1 table. Open-file report 76-317.

Aeromagnetic map of the Horseshoe Basin quadrangle, Okanogan County, Washington, by the U.S. Geological Survey, 1 plate. Open-file report 76-359.

High resolution seismic profiles adjacent to Whidbey and Fidalgo Islands, Washington, by P. D. Snavely, H. D. Gower, J. C. Yount, and others, 1 page of text, accompanied by a map sheet and 1 roll of microfilm. Open-file report 76-187.

Geologic interpretation of an aeromagnetic map of the west-central Columbia Plateau, Washington and Oregon, by D. A. Swanson, T. L. Wright, and Isidore Zietz, 28 p., 1 pl., 3 figs. Open-file report 76-51.

Bouguer gravity map of Moscow, Idaho-Pullman, Washington area, by D. I. Gregory and D. B. Jackson, scale: 1:62,500. Open-file report 76-280.

Uranium and trace element data on stream sediments in the Midnite mine area, Stevens County, eastern Washington, by James K. Otton, 5 figs., 1 table, 18 p. Open-file Report 76-447.

U.S. GEOLOGICAL SURVEY ACTIVITIES IN WASHINGTON, 1976

MINERAL RESOURCES ACTIVITIES

Northern Okanogan Highlands, C. D. Rinehart, 1964-1977. Complete report on bedrock geology of Tiffany Mountain quadrangle to accompany geologic map, and continue petrographic study of rocks from Aeneas and Aeneas Valley quadrangles as preliminary step in preparation of reports on these quadrangles.

Togo Mountain quadrangle, R. C. Pearson, 1966-1977. Geologic map will be compiled and submitted for publication; petrology of metamorphic rocks will be continued; and some work will be done on uranium minerals from pegmatites.

ENERGY RESOURCES ACTIVITIES

Midnite mine uranium studies, J. T. Nash, 1974-1977. Complete map and cross sections of Midnite mine, and write a report on the geology of the mine. Prepare reports on biogeochemical sampling and geophysical studies. Other work includes geochronology of rocks and ores, petrology and geochemistry of host rocks, and geochemistry of uranium in porphyritic quartz monzonite.

Stable isotopes and uranium ore genesis, R. O. Rye, 1975—continuing. Stable isotope investigations of Midnite uranium mine will continue. Construction of H/D mass spectrometer will be completed.

Marine geochemical studies, J. L. Bischoff, 1967—continuing. Obtain preliminary data on environmental geochemistry of Willapa Bay, and collect additional samples at Willapa Bay and new ones from Grays Harbor.

Oregon-Washington onshore-offshore, P. D. Snavely, Jr., 1971-1978. Approximately 1,500 km of geophysical data will be collected on Oregon and Washington OCS. Data will include multichannel and high-resolution seismic-reflection profiles, and magnetic and gravity profiles. Tracklines will cross 7 drilled deep test wells on OCS and permit correlations between subsurface stratigraphy and geophysical data. Interpretation and compilation of geologic and geophysical data from various sources and petrographic and paleontological studies will continue.

Pacific Coast sedimentology, H. E. Clifton, 1973-1980. Continue facies analysis of estuarine deposits, and complete study of sand transport in tidally dominated estuarine system in Willapa Bay. Increase studies of hydrodynamic effects of waves on sedimentation, and initiate studies on distribution of spilled oil in nearshore systems and on physical and chemical changes in oil attendant with beach and nearshore processes. Bedform development will be analyzed in a variety of settings, and study of mechanics of beach sedimentation will be completed.

Environmental geologic studies of the Oregon and Washington continental shelf and margin, H. E. Clifton, 1976—continuing. Characterization of geologic environment on the Oregon-Washington OCS. Particularly, the delineation and assessment of geologic hazards to the area's development has begun with compilation of existing data and development of areal base maps.

Collection of coal samples in Washington, Ellis R. Vonheeder, State of Washington, 1975-1976. Collect samples from core hole of lower Tertiary coal beds in Chuckanut Formation, and submit samples to USGS for chemical analysis. Results will be incorporated into the National Coal Data System.

ENVIRONMENTAL GEOLOGY ACTIVITIES

Olympic Peninsula, W. M. Cady, 1962-1978. Preliminary draft of general report on the geology of Olympic Peninsula, which will include a geologic map of the Peninsula at 1:125,000 scale, will be completed.

Cape Flattery area, P. D. Snavely, Jr., 1972-1976. Field check and complete detailed geologic mapping and stratigraphic studies of four 15' quadrangles that comprise Cape Flattery area. Compilation and interpretation of geologic mapping will follow. Sedimentary petrographic studies of Eocene and Oligocene rocks will be completed.

Environmental analysis, R. R. Doell, 1972—continuing. Plan to construct a dynamic computer model for Puget Sound energy facilities development to determine what kinds of geological information have the most impact on land-use and other social decisions.

Puget Sound urban studies, H. D. Gower, 1974-1981. Complete reports on tectonic map, deformation, and C^{14} dates of Puget Sound region. Conduct high-resolution seismic survey in vicinity of Whidbey Island and northern Hood Canal and complete reports. Collect and analyze subsurface data on unconsolidated deposits in Whidbey Island-Mt. Vernon area, and map bedrock geology and unconsolidated deposits of southeast quarter of Victoria 1:100,000 quadrangle.

Wenatchee 2° quadrangle, R. W. Tabor, 1975-1978. Regional mapping and field studies will be concentrated on Swauk Formation and its relationship to early Tertiary volcanic accumulations to the west; faults bordering Chiwaukum graben; deformation along Snoqualmie-Ellensburg downwarp; stratigraphy and deformation of Miocene lavas along western margin of Columbia Plateau; and Quaternary stratigraphic history and deformation in Wenatchee, Columbia River, Yakima, and smaller drainages to the west. Samples will be prepared for K-Ar and fission-track dating, and petrographic and X-ray studies conducted of tephra layers.

Volcanic hazards, D. R. Crandell, 1968-1980. Write reports on stratigraphy of unconsolidated volcanic deposits, except tephra, at Mt. St. Helens, and summary of activity at Mt. Baker. Continue studies of hydrothermal alteration at Mt. Rainier and Mt. Baker, and begin reconnaissance of Glacier Peak tephra in eastern Washington.

Volcanic hazards overview, D. R. Mullineaux, 1975-1977. Finish and submit report on potential volcanic hazards at Mt. St. Helens.

Lava ridges and rings, C. A. Hodges, 1975-1977. Complete petrographic analyses, and compila-

tion of lab and field data. Follow up on field work performed in Odessa area of the Columbia Plateau to determine origin of circular ring dike structures and evaluate analogous relations to features in lunar maria.

Cenozoic and Mesozoic stratigraphy, Pacific Coast and Alaska: Cenozoic stratigraphic paleontology, Pacific Coast, W. O. Addicott, 1963—continuing. Field work to be in western Washington on biostratigraphy of the upper Miocene Montesano Formation.

Cenozoic and Mesozoic stratigraphy, Pacific Coast and Alaska: Taxonomy and biostratigraphy of Cenozoic diatoms and silicoflagellates, J. A. Barron, 1975—continuing. Continue study of diatoms and silicoflagellates from the Montesano Formation.

Development and testing of relative age-dating methods on Quaternary deposits, Western United States, P. W. Birkeland, University of Colorado, 1975-1976. Geologic evaluation of proposed nuclear power plant sites will be made by mapping and dating of surficial deposits in Yakima and Wenatchee Valleys through employment of radiometric and age-dating techniques, and collection of data to evaluate techniques used in glacial stratigraphy studies.

Puget Sound environmental geology study, State of Washington, 1972-1981. Complete mapping surficial geology of northern Jefferson County and geologic mapping of Mukilteo quadrangle. Marblemount quadrangle map will be completed, and Mt. Baker quadrangle map will be prepared. Continue to study principal coastal processes operating within Puget Sound, and determine natural and man-made processes that produce shoreline changes. Also, identify problems or hazardous shorelines subject to severe erosion or landsliding.

GEOCHEMISTRY AND GEOPHYSICS

Genesis of basalt, T. L. Wright, 1971-1980. To establish plateau-wide stratigraphy in Columbia River basalts, field and petrochemical studies will be continuing.

Electrochemistry of minerals, Motoaki Sato, 1966—continuing. Continue field work at Sherman Crater, Mt. Baker, which includes continuous monitoring of the chemistry and temperature of fumarolic gas via radio telemetry and mineralogical examinations of fumarolic ejecta.

Volcanic ash chronology, R. E. Wilcox, 1968—continuing. Complete petrographic analyses of 1975 ejecta from Mt. Baker volcano; electron microprobe analyses of ash beds in central and eastern Washington; and report on ash beds from Mt. St. Helens. Field work will be in eastern and northern Washington, mainly on Glacier Peak ash beds.

Columbia River basalt, D. A. Swanson, 1971-1980. Plans are to complete geologic mapping of the Washington part of Pullman 2° quadrangle; continue mapping in Spokane quadrangle; and initiate mapping of basalt in Wenatchee quadrangle. Considerable petrographic work on samples of basalts from southeast Washington is scheduled.

Washington aeromagnetic cooperative, J. R. Henderson, 1973—continuing. Complete aeromagnetic survey in north-central Washington, and compile and prepare aeromagnetic map for publication.

Mineral exploration by gamma-ray spectrometry in crystalline rocks, J. A. Pitkin, 1975-1978. Truck-born gamma-ray spectrometry data obtained from Togo Formation outcrop/Midnite mine and alaskites of Mt. Spokane are being computer reduced and interpreted. Results in report will guide future work in crystalline terranes of the United States.

Uranium geophysics in frontier areas, J. W. Cady, 1975-1976. Publish magnetic-gravity computer programs and gravity maps of northeast Washington. Magnetic and gravity modeling studies in Spokane area will be completed and final results published. Identify pilot study areas for test of pattern recognition technique, and outline data acquisition procedure for these areas.

Geophysical studies relating to uranium deposits in crystalline terranes, D. L. Campbell, 1976-1979. Plan electromagnetic and magnetic field survey of Midnite uranium mine, and laboratory measurements of complex resistivity, magnetic susceptibility, and density of a suite of hard-rock uranium ore samples from U.S. mines and prospects.

EARTHQUAKE STUDIES

Earthquake study of the Puget Sound area: Fault-trace studies, John M. Wunder, State of Washington, 1974-1976. Investigate geology in the Seattle-Bremerton area to better understand geologic structures, earthquake sources, recency of tectonic activity, and locations of active faults.

Research in regional seismicity including explosion monitoring and earthquake-precursor studies, J. R. Booker, R. S. Crosson, S. D. Malone, and S. W. Smith, University of Washington, 1975-1976. Operate and maintain control on a statewide network of seismograph instruments, and publish quarterly bulletins and maps of earthquake activity in areas covered by USGS network. These networks provide the basic data used in current studies of crustal structure, velocity anomalies, and tectonics.

DIVISION RELEASES NEW PUBLICATIONS

The following reports were recently released by the Division of Geology and Earth Resources:

Bulletin 69, Silver occurrences of Washington, by Wayne S. Moen. 36 figs., 188 p. Price, $3.50.

Information Circular 59, Washington gravity base station network, by Tor H. Nilsen. 1 fig., 4 tables, 83 p. Price, $2.00.

GM-17, Relative potential for differential settlement, Gig Harbor Peninsula, Pierce County, Washington, by Mackey Smith. Text and map on 1 sheet. Scale - 1:24,000. Prepared in cooperation with Pierce County and the U.S. Geological Survey. Price, $1.00.

GM-18, Relative slope stability of Gig Harbor Peninsula, Pierce County, Washington, by Mackey Smith. Text and map on 1 sheet. Scale - 1:24,000. Prepared in cooperation with Pierce County and the U.S. Geological Survey. Price, $1.00.

GM-19, Geologic factors affecting waste disposal practices, Gig Harbor Peninsula, Pierce County, Washington, by Mackey Smith. Scale - 1:24,000. Prepared in cooperation with Pierce County and the U.S. Geological Survey. Price, $1.00.

GM-20, Preliminary surficial geologic map of the Mukilteo and Everett quadrangles, Snohomish County, Washington, by Mackey Smith. Scale - 1:24,000. Prepared in cooperation with the U.S. Geological Survey. Price, $1.00.

These reports may be purchased from the Department of Natural Resources, Division of Geology and Earth Resources, Olympia, WA 98504. A list of geologic publications is available on request.

GEOLOGY OF THE CLUGSTON CREEK AREA IN STEVENS COUNTY NOW OPEN-FILE REPORT

The following report, recently completed by J. Eric Schuster, division geologist, has been placed on open file and may be inspected in the Division of Geology and Earth Resources library:

Geology of the Clugston Creek area, Stevens County, Washington, by J. Eric Schuster: Division

of Geology and Earth Resources open-file report, 1 fig., 2 tables, 26 p.

BOOK FOR MINERAL COLLECTORS

In the January issue (1976) of our Washington Geologic Newsletter, reference was made to a recently published book "Minerals of Washington." It includes descriptions of over 400 minerals occurring in Washington. We now have a more complete publisher's address for those who might wish to purchase the book (184 pages, price $4.95): Cordilleran, 18 Holly Hill Drive, Mercer Island, WA 98040. The book was compiled by Bart Cannon; it is also available for reference in our division library, or it may be purchased directly through bookstores.

REPORT ON MINING DISTRICTS IN WASHINGTON NOW AVAILABLE

A recent map, compiled by C. A. Mardirosian, titled "Mining Districts and Mineral Deposits of Washington (exclusive of oil, gas, and water)" is available for inspection in the Division of Geology and Earth Resources reference library. It may be purchased directly from the author, a consulting geologist, 612 Figueroa St. NE., Albuquerque, New Mexico 87123.

The publication consists of one sheet, which includes a map and a chart of mining districts and mineral deposits by counties. The scale for the map is 1:1,000,000 (reduced from original USGS base map, 1962 edition).

NOTICE OF MINERAL SYMPOSIUM

The Pacific Northwest Chapter (Region 12) of the Friends of Mineralogy is sponsoring its 2nd annual Mineral Symposium. The program will take place at the Sheraton Motor Inn, Portland, Oregon on Oct. 2, 1976. The topic will be the Gems and Minerals of Pegmatites.

Speakers will include Frederick Pough and W. L. Roberts. There will be a mineral auction, swapping, selected dealers, and displays. For further information and registration forms contact:

Robert J. Smith
Friends of Mineralogy
Box 197 Mailroom
Seattle University
Seattle, WA 98122

USGS PUBLISHES REPORT ON AGES OF ROCKS FROM WASHINGTON STATE

"Summary of K-Ar, Rb-Sr, U-Pb, Pb alphas, and fission-track ages of rocks from Washington State prior to 1975 (exclusive of Columbia Plateau basalts)," by J. C. Engels, R. W. Tabor, F. K. Miller, and J. D. Obradovich, may be seen at the Division of Geology and Earth Resources reference library in Olympia. It may be purchased from the U.S. Geological Survey for $1.00.

U.S. Geological Survey Miscellaneous Field Studies Map MF-710 includes a map and text on two sheets. Table 1 shows rock types, analytical data, locality, name of analysts and collaborating geologists, and references to published sources. Analytical data for Pb alphas, Rb-Sr, and fission-track ages are reported also.

HISTORY OF U.S. AND STATE BOUNDARIES PUBLISHED

A report describing how the United States acquired its national territory, how state boundaries were drawn and settled, and containing interesting geographical facts about the 50 states has been published by the U.S. Geological Survey.

The 191-page volume titled "Boundaries of the United States and the Several States" contain an extensive bibliography referring to historical documents, court decisions, and congressional acts on boundaries and territorial settlements. It also contains general statistics relating to the United States, such as geographic centers, highest and lowest elevations, areas, and extreme points of latitude and longitude.

Copies of the publication, USGS Professional Paper 909, may be purchased for $5.20 each from the U.S. Geological Survey, Branch of Distribution, 1200 South Eads Street, Arlington, VA 22202.

YOUR STATE GEOLOGIST REPORTS

In this year of our nation's 200th birthday, I want to say that we live in the greatest land in the world. This status was achieved by the free enterprise system, personal and national integrity, adequate natural resources, and individual initiative and sacrifices. Certainly, our system of self rule is often criticized, and maybe justifiably so, but our form of government still remains far better than any other governmental system now in existence.

Our country has suffered hard times in the past, and if history repeats itself, there will be hard times in the future. Some of the dangers that I see now for us include government overcontrol, corporate dishonesty, and individual selfishness, which all tie together and foster each other. Internal corruption has been the downfall of many empires in the past; it seems to be one of our worst problems right now. To paraphrase, I quote the words of Pogo, "We has met the enemy and it is us." We need to return to the principal of a man's word being his bond. We need honesty in government, industry, and in individuals. We also need to develop and support that which is good for the majority of the people and the country, and not play the games of one-upmanship that special groups indulge in.

Perhaps, the real problem is that we are too affluent—most of us do not have to struggle for survival. If something looks like it is too tough to achieve, we are prone now to say, "Let the government take care of it." Our parents and grandparents would have taken care of it themselves. My dad, who is a wise man, once told me that people can survive everything except prosperity, and it looks like he was right.

Ted Livingston

U.S. GEOLOGICAL SURVEY 7½-MINUTE TOPOGRAPHIC QUADRANGLES
(Maps received in the division library since April 1, 1976)

Name	New edition	Photo revised	Latitude (indicates southeast corner)	Longitude	County
Airway Heights	1973		47°37'30"	117°30'00"	Spokane
Arlington West		1968;1973	48°07'30"	122°07'30"	Snohomish
Auburn		1968;1973	47°15'00"	122°07'30"	King; Pierce
Bald Hill		1973	46°45'00"	122°22'30"	Thurston; Pierce
Black Diamond		1968;1973	47°15'00"	122°00'00"	King
Bothell		1968;1973	47°45'00"	122°07'30"	Snohomish; King
Bremerton West		1968;1973	47°30'00"	122°37'30"	Kitsap
Bucoda		1973	46°45'00"	122°45'00"	Thurston; Lewis
Carnation		1968;1973	47°37'30"	121°52'30"	King
Center		1968;1973	47°52'30"	122°45'00"	Jefferson
Conway		1968;1973	48°15'00"	122°15'00"	Skagit; Snohomish
Coupeville		1973	48°07'30"	122°37'30"	Island
Des Moines		1968;1973	47°22'30"	122°15'00"	King
Eatonville		1973	46°45'00"	122°15'00"	Pierce; Thurston; Lewis
Edmonds West		1968;1973	47°45'00"	122°22'30"	Kitsap; King; Snohomish
Fort Lewis		1968;1973	47°00'00"	122°30'00"	Pierce
Gardiner		1973	48°00'00"	122°52'30"	Clallam; Jefferson
Gig Harbor		1968;1973	47°15'00"	122°30'00"	Pierce; King
Hobart		1968;1973	47°22'30"	122°52'30"	King
Issaquah		1968;1973	47°30'00"	122°00'00"	King
Kirkland		1968;1973	47°37'30"	122°30'00"	King
Lacey		1968;1973	47°00'00"	122°45'00"	Thurston
Lofall		1968;1973	47°45'00"	122°37'30"	Kitsap; Jefferson
Maltby		1968;1973	47°45'00"	122°00'00"	Snohomish; King
Maple Valley		1968;1973	47°22'30"	122°00'00"	King
Mercer Island		1968;1973	47°30'00"	122°07'30"	King
Monroe		1968;1973	47°45'00"	121°52'30"	Snohomish; King
Mount Vernon		1968;1973	48°22'30"	122°15'00"	Skagit
Mukilteo		1968;1973	47°52'30"	122°15'00"	Snohomish; Island
Nisqually		1968;1973	47°00'00"	122°37'30"	Pierce; Thurston
Nordland		1973	48°00'00"	122°37'30"	Jefferson
Pomona	1974		46°37'30"	120°22'30"	Yakima; Kittitas
Port Ludlow		1973	47°52'30"	122°37'30"	Jefferson
Port Townsend South		1973	48°00'00"	122°45'00"	Jefferson
Poverty Bay		1968;1973	47°15'00"	122°15'00"	King; Pierce
Redmond		1968;1973	47°37'30"	122°00'00"	King
Renton		1968;1973	47°22'30"	122°07'30"	King
Seattle South		1968;1973	47°30'00"	122°15'00"	King
Spanaway		1968;1973	47°00'00"	122°22'30"	Pierce
Stanwood		1968;1973	48°07'30"	122°15'00"	Snohomish
Steilacoom		1968;1973	47°07'30"	122°30'00"	Pierce
Sultan		1968;1973	47°45'00"	121°45'00"	Snohomish; King
Sumner		1968;1973	47°07'30"	122°07'30"	Pierce; King
Tacoma South		1968;1973	47°07'30"	122°22'30"	Pierce
Tacoma North		1968;1973	47°15'00"	122°22'30"	Pierce
Tenino SW		1973	46°45'00"	122°52'30"	Thurston; Lewis
Tumwater		1968;1973	47°00'00"	122°52'30"	Thurston
Uncas		1973	47°52'30"	122°52'30"	Jefferson; Clallam
Vail		1973	46°45'00"	122°37'30"	Thurston; Lewis
		Not photo revised			
Spokane NW	1974		47°37'30"	117°22'30"	Spokane

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