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THE RATTLESNAKE RIDGE PROJECT
A PROGRESS REPORT

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Advanced Technology Development Section
Research and Development Department
Chemical Processing Division

October 30, 1972

PREPARED FOR THE U.S. ATOMIC ENERGY
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ABSTRACT

Initial results of a geologic examination of the southeastern end of Rattlesnake Ridge suggest this portion of the ridge is an asymmetrical anticline plunging southeast. A smaller parallel anticlinal structure is believed to be present to the northeast of the Ridge. No major fault was found. Six distinct basalt members similar in appearance and composition to: Rosa and/or Frenchman Springs flows, Priest Rapids flows, Umatilla flow, Pomona flow, Elephant Mountain flow and Ward Gap flow crop out in this area. The stratigraphy and structure of the study area were defined field observation, chemical analysis of the basaltic flows, and review of a gas well log.

INTRODUCTION

The southeastern end of Rattlesnake Ridge is located in Benton County fourteen air miles northwest of Richland, Washington and is enclosed by the Hanford Reservation. The basalt ridge lies along the "Olympic-Wallowa Lineament" described by Raisz (1947), Wise (1963), Watkins (1965), Cantwell and others (1965), and Skehan (1965). A knowledge of the structure of the ridge is an important factor in the evaluation of the southeastern portion of the ridge as a possible waste storage site within the Hanford Reservation. Consequently, the Rattlesnake Ridge Project was initiated to define the structural geology of the ridge in more detail.

DISCUSSION

The southeastern end of Rattlesnake Ridge is composed of six distinct members which are chemically, megascopically, and stratigraphically similar to: Rosa and/or Frenchman Springs flows, Priest Rapids flows, Umatilla flow, Pomona flow, Elephant Mountain flow and Ward Gap flow. Structurally, the ridge is an asymmetrical anticline trending northwest-southeast and plunging southeast. The southwest limb of the anticline strikes N45°W and dips 20° southwest and forms the topographically high portion of the ridge. The northeastern limb of the anticline strikes N45°W and dips 55° to 65° northeast and crops out at lower elevations along the ridge. The anticline is breached, and in the vicinity of the axis of the fold the rocks are strongly fractured.

At the base of the ridge, the northeastern limb of the anticline bifurcates into a minor synclinal-anticlinal complex, mantled by sediments. The smaller anticline is the site of the depleted Rattlesnake Hills Gas Field (Hammer, 1934, p. 847).

PREVIOUS WORK

Workers who have conducted previous studies in the area are: R. E. Brown (1968), A. A. Hammer (1934), R. C. Newcomb and others, (1970), and H. U. Schmincke, (1964).

FIELD METHODS

The study area along the southeastern end of the ridge, Figure 1, was selected because of the higher density of outcrops and because traverses across this area would not disturb ecological experiments being conducted by the Arid Lands Ecology Division of Battelle Northwest Laboratories.

Figure 1. Rattlesnake Hills Study Area.

Two sections (A, B) approximately one mile apart, were studied where outcrop density was the greatest. Each station was plotted on a color air photograph* and its position later transferred to a topographic map, Figure 4 and 5. At each station, the megascopic features of the outcrop were described and the data further documented with poloroid photographs. Approximately 800 grams of fresh sample were collected from the outcrop at each station.

LABORATORY METHODS

Forty-five samples were slabbed and analyzed for calcium, titanium, and barium by nondispersive X-ray fluorescence.

STRATIGRAPHY

The stratigraphy in the study area was established by field and laboratory methods. A generalized stratigraphic column of the southeastern end of Rattlesnake Ridge is illustrated in Figure 2. Analytical results are included in Table 1. The stratigraphy in the study area may tentatively be correlated with the basalt stratigraphy established by studies conducted in the vicinity surrounding the Hanford Reservation (see below).

Rosa and/or Frenchman Springs Flow(s)

The Rosa and Frenchman Springs flows, Figure 2, have been described by Mackin (1961, p. 12-23). In the area of study, probable flows of this type are poorly exposed and highly fractured due to their close proximity to the axis of folding.

Hand specimens of the flow are dark gray to black and porphyritic in texture. Phenocrysts of plagioclase, varying in size from 4.0 mm to 9.0 mm, are abundant.

The Rosa and Frenchman Springs flows may not be distinguished with the use of the nondispersive X-ray fluorescence unit due to their similar CaO, TiO₂ and barium content. Work has shown that an analysis for these two flows can be distinguished from each other on the basis of chromium concentration (Brown, in press).

Priest Rapids Flows

The Priest Rapids Basalt Member, comprised of four flows, has been described by Mackin (1961, p. 23). In the study area, three probably Priest Rapids flows, Figure 2, form prominent colonade exposures.

*Filed with Advanced Technology Department, The Atlantic Richfield Hanford Company.

Figure 2. Generalized Stratigraphic Column Of The Southeastern End Of Rattlesnake Ridge. Names shown to right are those used in this paper. Correlation is tentative.

Table 1. Analytical Values At Stations Within The Rattlesnake Ridge Study Area. Flows Are Tentatively Identified on the basis of analytical data, stratigraphy and megascopic rock description.

<u>Station Number</u>	<u>CaO(%)</u>	<u>TiO₂(%)</u>	<u>Ba(ppm)</u>	<u>Flow</u>
K7001	10.3	1.8	400	Pomona
K7002	5.4	2.6	3100	Umatilla
K7003	8.6	2.5	400	Priest Rapids
K7004	8.5	2.7	400	Priest Rapids
K7005	8.4	2.6	700	Priest Rapids
K7006	8.7	3.1	650	Rosa and/or
K7007	8.5	3.0	500	Frenchman
K7008	8.0	3.8	560	Springs
K7009	7.8	3.4	760	"
K7010	8.0	3.0	400	"
K7011	7.9	3.0	760	"
K7012	8.0	3.0	570	"
K7013	8.0	3.6	540	"
K7014	5.6	2.9	3600	Umatilla
K7015	9.6	1.8	540	Pomona
K7016	5.2	2.8	3500	Umatilla
K7017	5.5	2.8	2800	Umatilla
K7018	6.0	3.4	2750	Umatilla
K7019 (interbed)	----	---	----	
K7020	7.4	3.5	530	Priest Rapids
K7021	8.4	3.9	450	Priest Rapids
K7022 (insufficient sample)		---	----	Rosa and/or
K7023	8.8	3.6	450	Frenchman
K7024	7.4	4.2	560	Springs
K7025	8.4	2.7	500	"
K7026	7.0	3.1	760	Priest Rapids
K7027	7.4	3.3	760	"
K7028	9.4	2.7	760	"
K7029	7.4	3.4	570	"
K7030	9.2	3.8	560	"
K7031	8.5	2.5	360	"
K7032	8.1	2.5	450	"
K7033	8.0	2.6	500	"
K7034	8.0	2.4	580	"
K7035	8.9	3.6	620	Rosa and/or
K7036	8.0	2.8	550	Frenchman
K7037	7.4	2.9	590	Springs
K7038	8.1	3.2	590	"
K7039 (landslide)	----	---	----	"
K7040	8.0	3.6	360	Elephant Mtn.
K7041	8.3	3.3	490	Ward Gap
K7042	8.2	3.1	500	Ward Gap
K7043	9.6	1.9	450	Pomona
K7044	10.2	1.7	500	Pomona
K7045	9.6	1.5	420	Pomona
K7046	9.6	1.5	450	Pomona
K7057	9.2	1.6	460	Pomona
K7058	8.2	3.2	350	Elephant Mtn.

Hand specimens of the Priest Rapids flows, in the area of study, are gray to black in color with a dense, aphanitic texture. On close examination, sparse, minute plagioclase phenocrysts, 1.0 to 1.5 mm in size may be discerned. Chemically the Priest Rapids flows contain approximately 8.0-9.0% CaO, 2.5-3.5% TiO₂ and 500-700 ppm barium.

Umatilla Flow

The Umatilla flow has been described by Schmincke (1967, p. 1391). Identification of the flow in the field is facilitated by its stratigraphic position between two interbeds, Figure 2. In the area of study the bottom interbed, a lapilli tuff and tuffaceous sandstone, has an exposure of approximately 37 feet and is the site of a spring line. The top of this interbed is baked and the welded tuff, approximately 4 feet thick, mantled by colluvium. The weathering of these interbeds causes a noticeable break in slope at the approximate location of the flow.

Hand specimens of the Umatilla flow are dark gray to black in color. The rock is dense and fine-grained although phenocrysts of plagioclase less than 1 mm in length are visible.

In the Hanford Reservation, the Umatilla flow has major utility for stratigraphic correlation (by chemistry) because of its distinctly high barium-low calcium content. Chemically, the flow is characterized by a barium concentration which exceeds 3,000 ppm a CaO content of 5.6-6.0% and a TiO₂ content of 2.4%.

Pomona Flow

The Pomona flow has been described in detail by Schmincke (1967, p. 1416) and is identifiable by its distinctive petrography and geochemistry and by its stratigraphic position. In the area of study, a Pomona flow measures approximately 120 feet thick, Figure 2 and exhibits a scoriaceous top overlying well-formed columns 6 to 12 inches in diameter.

Hand specimens from the flow are dense and black in color and contain phenocrysts of olivine and plagioclase and glomerocrysts of oliving, plagioclase and pyroxene approximately 1-2 mm long. The flow, in the Hanford Reservation, is chemically characterized by 9.0% to 10.0% CaO, approximately 1.5% to 1.8% TiO₂, and 300 to 600 ppm barium.

Elephant Mountain Flow

The Elephant Mountain flow has been described by Waters (1955, p. 673) and is characterized by a high vesicularity. A probable Elephant Mountain flow in the study area is exposed below the base of the ridge by a drainage in Iowa Flats, Figure 6. In places, the vesicular zones are separated by dense basalt bands. The flow, which is less than 50 feet thick, Figure 2, dips less than 10° away from Rattlesnake Ridge.

Figure 3. Generalized Geological Cross-section
Of The Southeastern End Of Rattle-
snake Ridge Along Traverse B.
Vertical Exaggeration X3.

hman Springs-Like Flows

Hand specimens from the flow show pyroxene and plagioclase glomerocrysts 0.5 to 1.0 mm in size and equivalent-sized remnants of altered olivine. Chemically, the Elephant Mountain flow contains 8.0% CaO, 3.2+% TiO₂ and 700 to 1,000 ppm barium.

STRUCTURE

The structure in the study area was determined by: (1) an examination of the outcrop pattern of identifiable flows; (2) an examination of measured changes in attitude of these flows (using flow tops, flow banding and flattened vesicals as plans of reference); and (3) an examination of Hanford Well log #699-S-9-63.

Figure 3 is a generalized geological cross-section of the southeastern end of Rattlesnake Ridge along traverse B. Flows on the southwestern limb of the anticline along traverse B (K7001-K7005) dip approximately 20° southwest. Flows exposed along traverse A (K7046, K7026-K7034) dip as much as 55° southwest. The northeastern limb of the anticline, exposed along both traverses (K7014, K7057, K7058, K7015-K7023), dip 55° northeast along traverse A may be explained by the greater proximity of this traverse to the nose of the anticline. The plunge of the anticline was determined by identifying the Pomona-like flow at increasing elevations along the road, Figure 2, see D, leading up the fold axis to the top of the ridge (K7043-K7046).

The axis of the fold, which strikes N45°W crops out only along traverse A (K7035). At this station the basalt is competent and the flows are nearly horizontal. Nearby, on the flanks of the fold, the rock is observably shattered where stress was released.

An examination of Hanford Well log #699-S-9-63 shows a correlation between the stratigraphy of the ridge and the subsurface stratigraphy at the site of the well. The greater thickness of the units at the well site, in comparison to the true thickness of these units exposed on Rattlesnake Ridge, is probably due to a greater dip of the units at the well site. It is proposed that the well pierces the southwest limb of an anticline, the dome of which forms the structural trap of the Rattlesnake Hills Gas Field. The southwest limb of this anticline is exposed in a drainage at Iowa Flats (K7041, K7042, K7043). The pattern of past-producing wells in the gas field suggests that the axis of this anticline is not only parallel to the larger anticline, but is also plunging.

SUGGESTIONS FOR FUTURE WORK

Additional work in the area of study should include: (1) a complete analysis of samples already collected with priority on samples K7001-K7014, K7040-K7042, and K7057-K7058; (2) detailed mapping at the axis

Figure 4. Topographic Map Showing Stations Along Traverse A.

Figure 5. Topographic Map Showing Stations Along Traverse B.

Figure 6. Topographic Map Showing
Stations At Iowa Flats.

of the fold possibly supplemented with trenching in order to confirm that no major fault is present; (3) the instigation of drilling at the base of the ridge next to a logged gas well in order to confirm correlation of the top flow of the smaller anticline with the stratigraphy of the ridge and (4) the continuance of mapping of the ridge to determine variations in the structure of the ridge to the northwest.

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