

*The Hammond Sill — An Intrusion in the Yakima Basalt  
near Wenatchee, Washington*

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**S**TRATIGRAPHIC STUDY of the Yakima Basalt in Douglas County has led to the discovery of a thick and extensive sill near the community of Hammond, 10 miles southeast of Wenatchee. Similar, but smaller, sill-like intrusions occur near the same stratigraphic horizon at several other localities in the county. These may be parts of the Hammond Sill or several sills may be represented, each having been emplaced along the same zone of weakness.

Pardee and Bryan (1926) described similar intrusive bodies in the northeastern part of the Columbia Plateau near Spokane, but the Douglas County sills are the first reported along the northwestern margin of the Plateau.

While the present study has not been carried beyond the stage of field reconnaissance, it seems worthwhile to put on record the largest of the intrusions, which is excellently exposed along the highway at Rock Island Dam and in a nearby scarp overlooking the community of Hammond on the east side of the Columbia River.

At its type locality the Hammond Sill is more than 400 feet thick. It can be traced northward along both sides of Rock Island Creek for several miles. To the east, excellent exposures of the sill occur in the lower part of Moses Coulee. There it forms low cliffs for several miles along the Coulee floor as far northeastward as Palisades, approximately 12 miles from Hammond. D. E. Walcott (oral communication) also recognized the unit as far south as Trinidad on the Columbia River, and H. A. Coombs independently discovered what is probably the same sill in the Laurel Hill scarp several miles west of Hammond. The minimum areal extent is therefore in excess of 100 square miles.

*Stratigraphic Relations*

The Yakima Basalt in western Douglas County includes 12 flows and several interbedded sedimentary units with a maximum aggregate thickness of about 2,000 feet. For present purposes the most significant unit is the

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thickest and lowermost sedimentary unit in the section, here designated the Rock Island member.

The Rock Island member is typically exposed along the valley sides of Rock Island Creek near the latter's junction with the Columbia River (Figure 1). It consists chiefly of loosely consolidated sand, clay, and siltstone derived from a granitic source to the northwest and deposited in lakes and on aggradational plains at the margin of the lava field. Along Rock Island Creek, the Rock Island member is about 200 feet thick and is underlain and overlain by basalt flows. To the west and northwest it thins and laps out on the Swauk Sandstone and the crystalline rocks which underlie the Yakima Basalt.

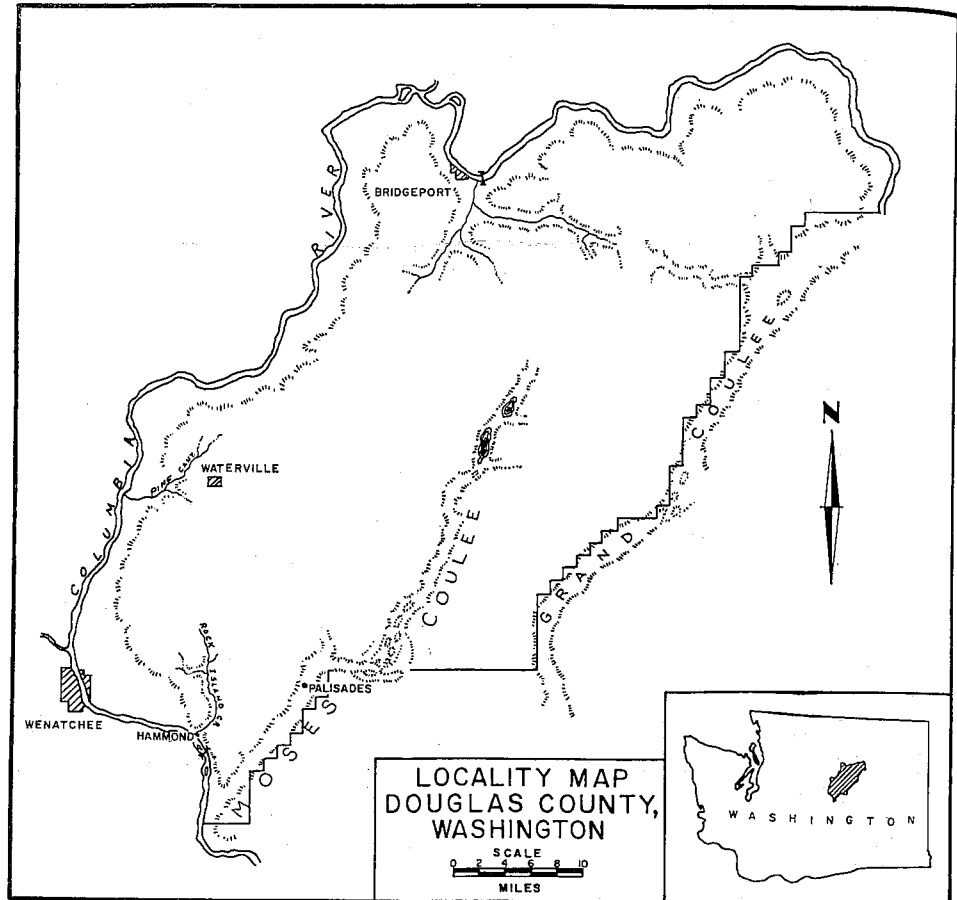
At Rock Island Creek the major portion of the member occurs above the Hammond Sill, while beneath the sill the sediments are thin or absent. This same relationship seems to hold true at other localities, although the relative proportions may vary.

#### *Evidences of Intrusive Origin*

At numerous places just west of Hammond, the sediments above the Hammond Sill are cut by bulbous projections and irregular dikes of glassy basalt which extend upward from the top of the sill. These apophyses range from a few inches to 20 feet in width and are as much as 50 feet in height. On the north side of Rock Island Creek valley near Hammond the dikes acted as feeders for one or more subsidiary sills which intrude the sediments 50 to 75 feet above the main sill.

While it is in the highest degree unlikely, it is conceivable that more than 75 feet of fluvial and lacustrine sediments could have been deposited on the surface of a thick flow, and might then be cross-cut by dikes which issued from the still-fluid interior part of the flow. This hypothesis is rejected because the dikes in question do not cut an already-solidified flow top, but start at the upper surface of the sill. The possibility that the sill could be a lava flow which in some manner punched its snout under the sediments at this place is rejected because, in view of the known areal extent of the sill, the mechanism seems impossible. The subsidiary intrusions in the overlying sediments prove that the sediments predate the Hammond body, and all of the other field relationships indicate that this body is not the result of some freakish accident, but is an ordinary sill.

Along its upper contacts the sill has a glassy selvage with rounded, cracked, "breadcrusty" surfaces. An unusual feature found along the contact at some localities is a zone of soft, black, waxy, claylike material; whether this sub-



stance is weathered basaltic glass or altered clayey sediment could not be determined in the field. Clays and silts are commonly hardened and darkened in color for several feet above the contact.

Noteworthy in the Hammond Sill is the scarcity of vesicles at its top. In the upper 50 feet, a few vesicles ranging in length from  $\frac{1}{4}$  inch to 1 inch occur in an average square yard of outcrop, but there is no suggestion of a scoriaceous zone. This is particularly significant in view of the fact that every ordinary flow in the area is surfaced with scoria. Pardee and Bryan (1926) record similar observations for the sills near Spokane.

At some places sedimentary xenoliths occur near the top of the sill. These are not common, and generally they are but a few inches in length. Their presence near the top of a unit 400 feet in thickness would be difficult to account for, however, if that unit were a flow rather than a sill.

## *Physical Features*

### Jointing

Jointing varies, depending both upon locality and position within the sill. Regular joint patterns with tall, well-developed, vertical columns usually characterize the sill where it is thick, but irregular patterns with groups of small jagged columns or masses of interlocking blocks are more common where it is thin. These latter features are clearly the result of relatively more rapid cooling since they may also occur near the upper contact even where the sill is thickest.

In its minor aspects, the sill's jointing compares closely with that found in flows; in gross aspect, however, there appears to be a consistent and possibly significant difference. These differences concern the development of over-all zones of jointing as outlined below.

Flows in the area are typically divisible into two distinct zones on the basis of jointing in their upper and lower portions. The lower zone is usually characterized by large, well-defined vertical columns, while the upper zone is characterized by blocks, plates, and relatively smaller columns. Variations of this twofold habit are many, but the literature indicates the habit is common to flows throughout the world. Tomkeieff (1940) suggested the terms "colonnade" and "entablature" for the lower and upper zones, respectively.

Although elements of this dual jointing habit are present locally in the Hammond Sill, they are not an obvious or characteristic feature. For example, in the vicinity of Hammond and lower Moses Coulee, prominent "colonnade" type columns comprise nearly three-fourths of the sill's total thickness. This proportion is much greater than that of most flows in the area. In addition there is usually no abrupt transition into the small blocky jointing typically found in the "entablature" of the flows. Instead, the columns gradually lose definition and grade upward into a zone of more massive and irregularly jointed rock.

### Lithology

Lithologically, the sill is a close cousin to flows in the area. The average hand specimen is finely crystalline, nonporphyritic, and medium gray to dark gray in color. Near the contacts the texture is dense and glassy and the rocks are dark gray to nearly black. Away from the contacts where grain size is coarser, the colors are lighter shades of gray and olive gray. In the central portion many rocks display a distinct greenish cast when freshly broken, but in a few hours they fade to gray or olive gray. Peacock and Fuller (1928) attribute this phenomenon to the presence of the hydrous mineraloid chlorophaeite which rapidly alters upon exposure to air.



Figure 1 (A). An aerial view looking northeastward up Rock Island Creek from a point over the Columbia River. The Hammond Sill forms the main cliff seen in the foreground and is also exposed immediately below the road on the far side of the valley. The light-colored unit just above the cliff is part of the Rock Island member. Note the dark hard layer within the sediments; this is a subsidiary sill which appears to be connected to the main Hammond Sill by small feeder sikes.

About 300 feet above the base of the Hammond Sill at its type locality there is a zone of dark porphyritic rock approximately 30 to 40 feet thick and about one mile in lateral extent (Figure 1). Near the center of this zone the rock contains an abundance of lath-shaped feldspar crystals set in a fine to dense, nearly black ground mass. These crystals vary in color from clear to amber, and many have a milky appearance resulting from fine fractures. The crystals range in size up to about one cm. in length though most are much smaller. Near the upper and lower margins of the zone the phenocrysts diminish both in abundance and size, and there is a gradual transition into the fine-grained rocks above and below. This transition, considered with the gradational jointing and weathering features, indicates clearly that the zone formed in situ.

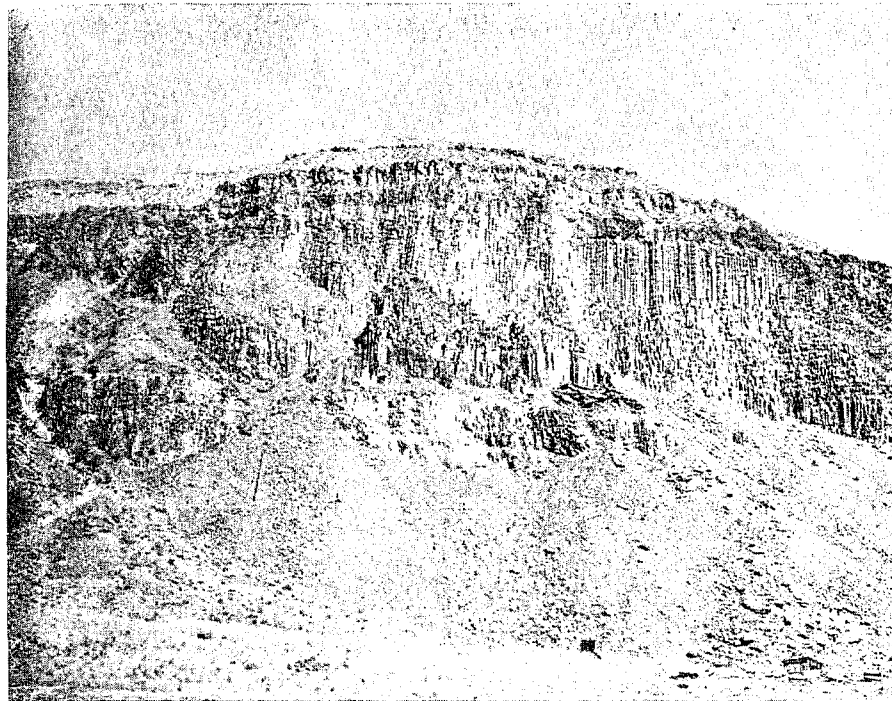


Figure 1 (B). The Hammond Sill as seen in a close-up view of the cliff shown in Figure 1 (A). The dark layer immediately above the tall columns at the right is the porphyritic zone mentioned in the text. A portion of a flow is exposed above the talus slope in the foreground. The sill is about 400 feet thick at this place.

#### *Other Localities*

Exposures of sills and possible sills were found at several other localities in western Douglas County. One of the best and most easily accessible exposures occurs three miles west of Waterville along road cuts near the creek crossing in the upper part of Pine Canyon. Baked and darkened sediments, cross-cutting relationships, and other evidences of intrusion are visible along the upper contact of the unit.

Another possible sill was discovered in northern Douglas County. This unit, about 100 feet in thickness, crops out along the Columbia River Valley for a total of more than 10 miles both east and west from Bridgeport. At places it lies directly on basement, but elsewhere up to 150 feet of fine-grained continental sediments intervene. Slightly more than 100 feet of sediment also occur above the unit. The lithologic and jointing features of the unit closely resemble those in the Hammond Sill, and, like the sill in Pine Canyon, it

occupies the same apparent stratigraphic position. Unfortunately, observations of the critical upper contact were limited so that its mode of emplacement can only be surmised at this writing.

### *Conclusions*

Because stratigraphic relationships appear relatively consistent along much of the western scarp between Wenatchee and Bridgeport, there is good reason to suspect that the Hammond Sill is present over a large part of western Douglas County. If subsequent study supports this possibility, a sill covering some 700 square miles and ranking with the largest known sills in the world will have been outlined. The importance of such knowledge in understanding the distribution and emplacement of surface flows in this portion of the Columbia Plateau is readily apparent.

### *Acknowledgments*

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