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DISCOVERY IN EASTERN WASHINGTON OF A NEW LOBE OF THE PLEISTOCENE CONTINENTAL GLACIER

By Professor WILLIAM H. HOBBS

UNIVERSITY OF MICHIGAN

STUDIES made during the past field season[1] in eastern Washington have disclosed the presence there in Late Pleistocene time of a hitherto unsuspected lobe of the Cordilleran continental glacier. This lobe covered an area of nearly four thousand square miles and is to be known as the Scablands Glacier Lobe. It blocked the Spokane River of that time to impound the waters in Glacial Lake Spokane. This lake included the basins of Lakes Coeur d'Alene and Pend Oreille and extended across Idaho into Montana (see Map I). Its area was thirty-one hundred square miles. When the glacier had evacuated the Scablands, Lake Spokane expanded a distance of one hundred miles down the canyons of the Spokane and Columbia rivers to the site of Coulee Dam as Glacial Lake Leverett.

The lava plain which lies to the southwest of Spokane has a surface development almost unique, and has long been known to its inhabitants as the "scablands." To geologists of the late decades it is known as the "channeled scablands" from the apt description by Professor J Harlen Bretz,[2] who has de-

[1] With the aid of grants from the American Philosophical Society and the Geological Society of America. This preliminary notice is printed by permission.

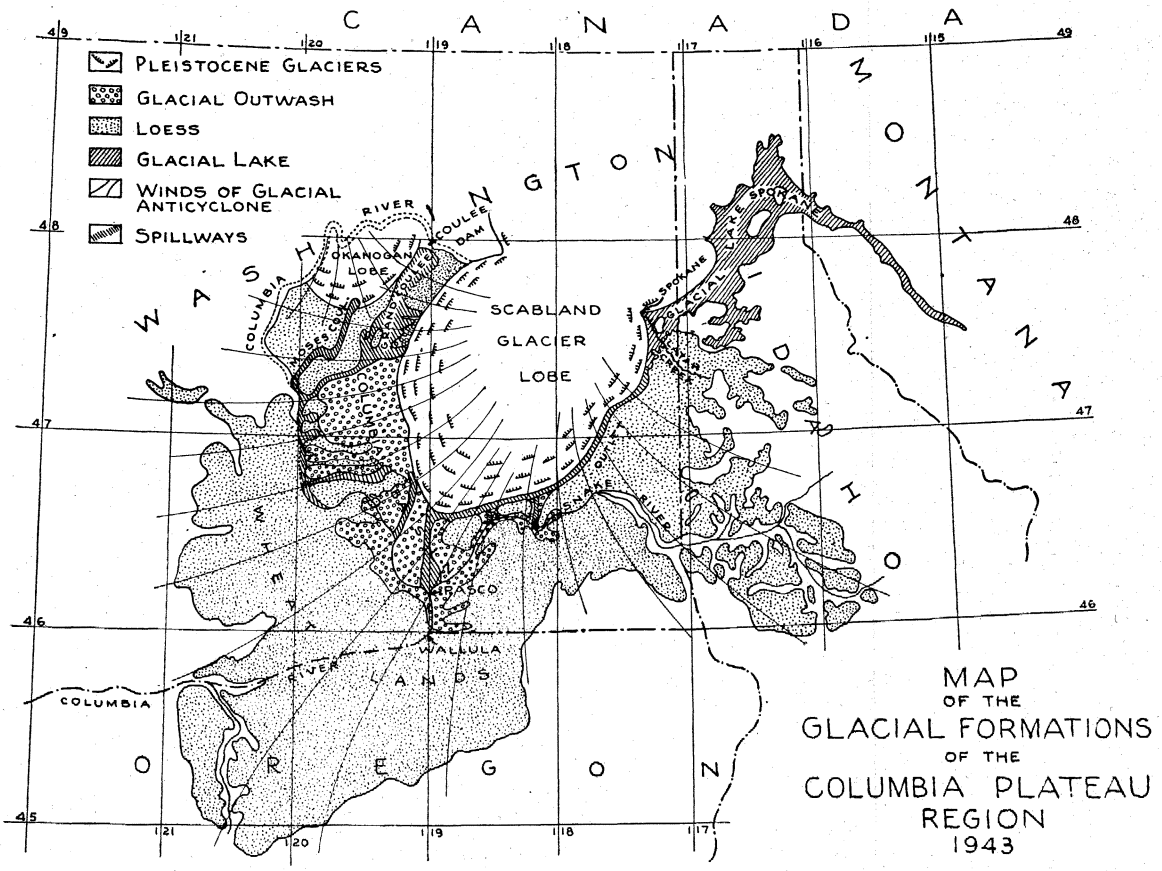
[2] Of Dr. Bretz's many papers treating of the area the

voted years to its study. Many other geologists have made brief references to it, and one of them, Professor Richard Foster Flint,[3] has studied it extensively.

All students of the area seem to have been in agreement on at least one point, that the southernmost border of the Cordilleran glacier was mainly to the north of the Scablands, and near the southern margin of the area of the crystalline rocks. This is near the present courses of the Spokane and Columbia Rivers.

American geologists from studies made elsewhere, and it certainly bears little resemblance to the accepted features from operation of any of the known geological agents.

In general it may be said that the scablands surface is made up of anastomosing channels within the basalt, channels which are arranged on the plan of braided streams above a plain of outwash. Separating the channels are residual low mesas—black and barren—



Map I. Glacial map of the Scablands and surrounding area. The boundary of the outwash and the spillways are based on the map by Bretz (*Geog. Rev.*, 18: pl. V), and that of the loess on the map by Marbut ("Atlas of American Agriculture," Pt. III, "Soils of the United States," pls. 4 and 5, sec. 4).

Concerning the origin of the scablands surface there has been little agreement except upon one point, that at some time during the late history torrents of water have played a part. To these torrents Bretz has even ascribed the excavation of the channels with their rock basins and the modeling of the present surface. This surface has a character which is wholly unfamiliar to

which are the "scabs." These are bounded by precipitous walls, often terraced, sometimes a hundred feet or more in height.

Scattered on the floors of the channels are hundreds of rock basins, large and small, generally filled with water but sometimes with gravel. Along the sides of the channels are local deposits of gravel, which Bretz has called "bars," and gravel is found also clinging in niches of the walls. This gravel is clearly the residue only of much larger deposits which have been in greater part swept away.

On the larger residual islands between the channels

latest and most comprehensive with an excellent map is "The Channeled Scablands of Eastern Washington," *Geog, Rev.*, 18, 446–447, 1928.

[3] Richard Foster Flint: *Bull. Geol. Soc. Amer.*, 47, 1849–1884, 8 pls., 2 figs., 1936; *ibid.*, 48: 203–232, 5 pls., 1 fig., 1937; *ibid.*, 49: 461–524, 10 pls., 11 figs., 1938.

are heavy deposits of dark brown loess in character identical with that which surrounds the scablands on east, south and west and constitutes the rich wheat lands. These islands are scabs masked by their loess cover.

Against the view of Bretz that the channels and their rock basins have been excavated by torrents of water is the recognized fact that no such features have been produced by running water in any other part of the world. The rock basins of the scablands are found in the wider channels particularly, and rock basins are an almost universal feature of glaciated regions. It is the channels with their included low mesas which are the unique feature of the scablands. If such features seem to be unique, it is almost unique for glaciers to have advanced over lava plains. Nowhere in the world except in Iceland has an ice sheet, either ice cap or continental glacier, been known to have overridden flat lava beds. The lava flows of the Columbia plains reveal within the same bed the widest differences of character. In one place the structure may look like a sponge, it is coarsely vesicular or scoriaceous. Elsewhere it is hard and firm, and the residual mesas have this character. The vesicular lava is especially vulnerable to the glacier's initial attacks by plucking, and after it had been quarried from the rock bed the rock must have been crushed and so made incapable of effective abrasion of the bedrock. The till of the moraines should therefore be poor in clay and characterized by smaller rock nodules, perhaps of pebble size. The vesicular facies of the lava flows are extended in the direction of flow, and if tapped from the preglacial valleys might well yield a channeled rock surface when the glacier had overridden it. Now the area overridden by the Icelandic glaciers supplies a close parallel to the topographic development of the Scablands.[4]

If the scablands of Washington have been glaciated, as have those of Iceland, we should be able to find a marginal moraine outlining its border. This moraine has now been found at many places[5] on the border of the area, where the till is notably poor in the clay constituent and with a preponderance of nodules of pebble size. Less complete data were collected for several recessional moraines, since these have been mutilated by the later torrents of water.

The outwash from the Scablands Glacier Lobe occupies the greater part of the Columbia Basin, which is composed of the Quincy Basin at the north and the Pasco Basin to the southeast (see Map I). During the retreat of this lobe, outwash filled also the channels of that part of the scabland already vacated.

Studies made of the glacial anticyclone of the continental glacier of Greenland have shown that wherever glacial outwash has been laid down, loess must inevitably be deposited within the periglacial area extramarginal to the outwash, and in deposits which thin out gradually from it.[6] Such evidence must always be sought, and as proof of the former presence of a glacier it is not less important than the proven existence of a marginal moraine.

Surrounding the Columbia Basin of outwash on west, south and east is a heavy deposit of loess which thins outward gradually until it disappears (see Map I). The higher mesas of the scablands also, which became nunataks during the retreat of the glacier front, received loess deposits from outwash which was then within the channels still farther back toward the retreating glacier front. Both in the outer and inner deposits wells have revealed thicknesses of loess of much more than one hundred feet.

During the glacier retreat vegetation encroached upon the main outwash area, and this permitted a thin veneer of loess, though everywhere in excess of five feet, to be laid down over the outwash plain. It is this rich deposit which veneers also the older loess that has made possible the Columbia Basin Irrigation Project.

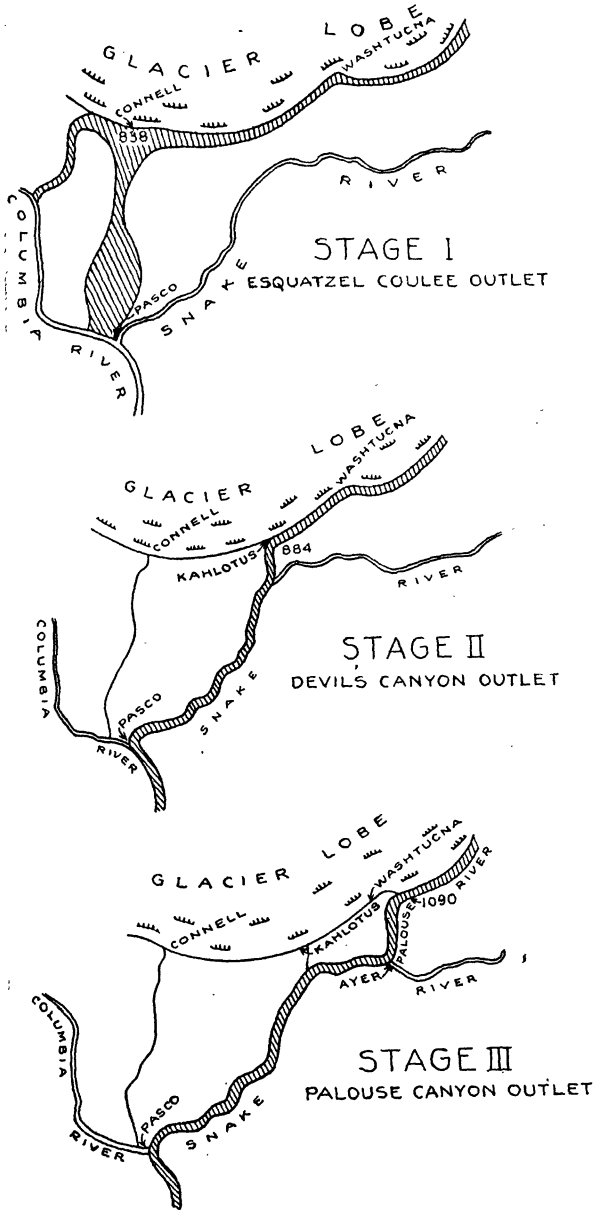
The manner in which by the normal planetary air circulation the glacial anticyclone is progressively overcome and the dissolution of the glacier at last accomplished, has indicated that for each glacial ring between recessional moraines there is a final stage characterized by floods of thaw water. The already much thinned dead ice under its network of glacial streams and lakes is separated into ice-rafts, which by the floods are floated out above the outwash. In the scablands these floods must have been largely contained within the rock channels and in consequence attained torrential velocities sufficient to sweep out most of the outwash, leaving only the "bars" and other localized gravel. At times the rafts of ice must have jammed to produce dams within the rock channels, above which the flood water was temporarily impounded. The level was thus raised and the loess deposits on either side were undermined and cliffed, sometimes at more than one level. The escape channels on the two sides of the jams must have sometimes been occupied by streams at different levels and loess cliffs would fail to pair, a fact which Flint has stressed as characteristic of the scablands. Other floods which

[4] Gudmundur Kjartansson, *Med. fra Dansk Geol. Foren.*, 9: 426–458, Copenhagen, 1939.

[5] Under wartime inhibitions within a specially restricted area, which prevented the use of a motor car, it has not been possible to visit the border throughout, but at every point visited (some twenty-five in all and well distributed) the moraine was found.

[6] *Jour. Geol.*, 39: 381–385, 1931; 50: 556–559, 1942. *Proc. Amer. Phil. Soc.*, 86: 368–402, 1943. *Am. Jour. Sci.*, 241: 333–336, 1943.

coursed through the rock channels of the scablands were connected with later outlets from Lake Spokane, after they had been unblocked through retirement of the ice front.



Map II. Successive outlets of glacial Lake Spokane.

In its stage of maximum development the Scabland Lobe blocked a glacial ancestor of the present Spokane River and impounded the waters in Glacial Lake Spokane over an area of thirty-one hundred square miles. The outlet in this stage was a spillway along the eastern and southern borders of the lobe to near Connell, and thence over the outwash to the Columbia River near its confluence with the Snake.

The outlet's right bank was the glacier and it had a rock sill at 2508′ A.T., four miles northwest of Waverly and twenty-two miles south southeast of Spokane. The water level of the lake was at 2520′ A.T., the level of the highest delta of glacial Latah Creek which discharged into it south of that city.

An advance of the southern front of the lobe closed the initial outlet of Lake Spokane near Connell with its sill at 838′ A.T., and this forced the water to escape into the Snake River by an outlet near Kahlotus, where the sill was at 884′ A.T. (see Map II, parts I and II). This outlet cut the Devil's Canyon. A slight further advance of the ice front closed in its turn the Kahlotus outlet and opened one some thirty miles farther east below Hooper (see Map II, part III), where the sill is near 1246′ A.T. This outlet cut the Palouse Canyon of grandiose proportions so impressively displayed to travelers proceeding southward by railway along its rim.

Six later stages of Lake Spokane were due to as many halting retreats of the glacier front. The outlets were in succession throughout at Cheney with the three spillways already mentioned, which functioned in reverse order, then Koontz Coulee, Lower Crab Creek and, finally, Upper and Lower Crab Creek.

Upon the complete evacuation of the Scablands with the glacier front now north of the Spokane and Columbia rivers, Lake Spokane expanded down the valleys of these rivers to the site of the Coulee Dam. This lake, which I have named Lake Leverett, in a transitional stage had outlets at Cheney (sill at 2345′) and through the Grand Coulee (sill near Steamboat Rock at around 2300′). It was dammed by the first recessional front of the Okanogan Glacier Lobe some fifteen miles west of Coulee Dam. A later stage, dammed near Bridgeport by the third recessional front, extended another fifty miles down the Columbia valley with a bay which covered most of the Waterville Plateau. The Cheney outlet had now been abandoned with a new one opened through the Moses Coulee. Both these outlets operated simultaneously and contained cataracts, that in the Grand Coulee with a fall of over 800 feet, or more than five times as high as Niagara and easily the greatest feature of the kind that is known.

With an original water level of 2366′ A.T. Lake Leverett had later stages of 2345′, 2057′ and 1957′ and 1885′, all registered in gravel plains under the city of Spokane and in somewhat lower sill levels within the Grand Coulee.