

## FOOTPRINTS OF GLACIERS IN WASHINGTON.

DURING the age of glaciers the general level of the sound country was some two thousand feet higher than at present. None of the intervening ranges between the summit of the Cascade range and the ocean coast were over two-thirds the height of the main range. Gradually the snow and ice filled all the valleys where now is Puget sound, between the Coast and Cascade ranges. Still it kept accumulating until it overtopped all the intervening ranges, and extended from the summit of the main range an unbroken waste of snow and ice six thousand feet thick, that covered the tops of all the intervening mountains from two thousand to four thousand feet deep. What a weight was that! What a tremendous force it might exert on the surface of the earth if there was only a power great enough to set it in motion! Just think of it, less than thirty-five cubic feet of this mass would weigh a ton. In a cubic mile there are one hundred and forty-seven billion nine hundred and seventy-nine million nine hundred and fifty-two thousand cubic feet. There would be over four million tons to the cubic mile. But this mass was over a mile deep and covered the whole country, two hundred miles from the crest of the mountains to the sea. In that two hundred miles it descended an average of thirty feet to the mile, some five or ten times the average descent per mile of our great rivers. Suppose one hundred miles from its starting point it encountered an obstacle. Were this mass set in motion, a dead weight of four hundred billion tons would be brought to bear on a single mile front to crush that obstruction, and this force might be kept up for a million years. What could set such a powerful force free? What could start such a mass? Simply a gentle zephyr, the balmy Chinook wind. Then, as now, it came across the Pacific, and the southwest face of the terrible glacier had to encounter its rival. This kept one surface free. Year by year, freezing and melting, and the tremendous weight pushing behind it kept it moving towards the sea. Mountains now over two thousand feet high were not able to turn it a degree from its course. Mount Constitution, two thousand four hundred feet high, is channeled and grooved on its summit by the glacier, as well as a hill a hundred feet high.

From the mouth of the Chehalis and the Columbia, back to the summit of the Cascade range, the route traveled by the ice can be traced as if it were made but yesterday, and everywhere its track is from the northeast to the southwest. It moved solidly, with its face to the foe, the Chinook zephyr, until it perished in the struggle. But the zephyr did not conquer unaided. Other causes were at work to aid

in the struggle. The forces evolved, just before the glacial period, in throwing out those vast sheets of basalt in Eastern Washington, in capping the Cascade range, and in elevating Western Washington had spent themselves. Unable to hold up the weight that was pressing from the mountains and ice combined they began to settle; but before giving up the struggle they made a last effort in throwing out volcanic bastions to the westward of the mountains they had raised to defend these mountains from the tides and currents of the ocean, that was ever seeking to tear them down. To those who have seen the forces exerted by water, flowing under pressure in hydraulic mining, it is submitted that nature presents a force as great perhaps as the glacier, which science has yet scarcely tried to measure. Twice every twenty-four hours a mass of water seven thousand miles wide and five miles high, by the tides, is hurled against the Pacific coast of the United States. This ocean also sends a current, flowing day and night, for millions of years of time, five miles deep—the width of the shore line—a current ceaselessly beating on our shores. None of this force is wasted. It is all treasured up and manifested, perhaps, ages afterward in the volcano of the earthquake. May not this force of tides and ocean currents, in part, account for the faults and sinking of the surface on both the Rocky and Cascade ranges? Is there not also a relation between these forces and the fact that volcanoes are nearly always on the ocean slope of mountains? Those of the Sierra Nevada and Cascade ranges are almost without an exception in that position.

A few words more about the glacier before other matters are treated of. Right in the center of the glacier track, extending across the country from near the Carbonado to Seabeck, on Hood's canal, and crossing the sound in the vicinity of the narrows, once existed a mountain range which tried to do battle with the glacier and perished in the struggle. Its relentless rival ground the mountain down to its base, and its ruins doom to everlasting sterility a region of country about fifty miles square around the upper sound. When a river flows down a mountain side its head is filled with coarse rocks and boulders, but these decrease in size as a more level country is reached, until finally nothing is found in its bed but fine sand and clay. A glacier acts similarly to a river, only it never stops to sort the particles it works upon as does the water in a river. When the glacier is running over hills and mountains, crushing rocks and other obstacles to its progress, it leaves the ground strewn with coarse gravel and boulders, but the farther it moves over a comparatively level country the finer the gravel becomes, so that the gravel and cement of Pierce and Thurston counties becomes the