cosity with temperature for any given liquid. In case of water, the decrease of viscosity per degree of rising temperature is greater at the lower temperatures. Becker says that fluid lava need not necessarily be superheated above its melting point, and this agrees with observed facts of measurement in the Kilauea lava lakes which indicates that they are undercooled. Viscosity varies with the molecular weight, and the heavier basic lavas, other things being equal with reference to relation of temperature to fusing point, should be more viscous by reason of their density. But chemical composition and crystallinity play important parts, and the quantity of gas bubbles may act as ball bearings in increasing mobility.

Dr. T. A. Jaggar estimated the Alika flow of 1919 on Mauna Loa in its established channel near the source to be moving 15 miles an hour. Four miles west of the source it was moving three miles an hour. The source lava was pahoehoe, the other aa. The lava feeding the fields moved through the stream forks in the channel about 200 feet an hour, but the field itself moved about two feet an hour. Dr. Palmer thinks that Dr. Jaggar observed a surface thread of lava in the middle of the channel, which would have a velocity 5 to 15 per cent greater than the mean velocity of the inner lava river for its full width. (See photograph of lava festoons Page One.)

The rate of flow of the Alika stream Palmer assumes to have been steady with a force 1.4 times greater driving the lava stream to overcome its viscosity, than would drive a comparable water stream, since the specific gravity of the gas-charged live lava is 1.4. He writes: "If streams of two fluids were alike in all respects except specific gravity, the driving forces would be in the same ratio as the specific gravity. And if the velocities were the same, the viscosities would be proportional to the specific gravities; that is, to the driving forces. Since the velocity of a stream is inversely proportional to the viscosity, we may write the equation

$$\text{Viscosity} = \text{a constant} \times \frac{\text{specific gravity}}{\text{velocity}} \text{"}$$

From this formula he concludes that the viscosity of the Alika flow was about 15 times greater than that of water. He conceded the possibility of error in comparing the Alika flow with a similar stream of water, from uncontrolled conditions of the channel and grade.

Jaggar in 1921 (for Alika flow details see Bulletin Hawaiian Volcano Observatory, October 1919, pp. 127, 133-4, 156; also February 1921. pp. 28-9) made an experiment at Halemaumau comparing the viscosity of live lava in a rift cone, and in the lava lake. He attempted to avoid stream errors by measuring the rate of entry of live lava through an aperture in a vessel immersed in it. The apparatus was a metal cylinder 27 inches long of 3 inches inside diameter, on which was a cap with an opening 1.5 inches in diameter. This on the end of a long pipe was immersed about a meter in the molten liquid in the cone and left there for 4 minutes. On withdrawal, the cylinder was found to be about one-third full of pahoehoe lava.

The same experiment was tried in the bubbling lake, with the result that the cylinder was incompletely filled, but in larger volume than before. The current in the molten slag carried the cylinder irrestibly sidewise so as to prevent it from remaining vertical. Large gas vesicles were found in the glassy lava inside the vessel, showing that gas vesiculation had played a part in permitting the lava to enter. A defect in these experiments was the cooling effect of the iron on thrusting it into the lava without preheating to the lava temperature.

In the first experiment, 1180 cubic centimeters of lava weighing 1656 grams had entered the cylinder, filling it 33 per cent. In the second lake experiment, 2500 cubic centimeters entered with a weight of 3500 grams, filling it 83 per cent. The viscosity was thus greater in the spatter cone lava. The density of ordinary Hawaiian lava is from 2.7 to 3.0, but the vesicular lava of the experiment had specific gravity of only 1.4, owing to the large proportion of gas. The radius of the orifice was 2.9 centimeters, and the time of flow 240 seconds. The temperature of the lava in the first experiment was 1100 degrees C., in the second experiment 1200 degrees C., as might be expected from the lower viscosity of the highly effervescent lake lava.

TWO SURFACE FORMATIONS NEAR MAUNA IKI

The photograph on Page One is relevant to what was said above about viscosity of basaltic lava. The ordinary small pahoehoe lava flow has the form of a leaf, with the feeding stream considered as the stem. This stem or feeding thread of molten slag skins over on its upper surface and quickly divides itself into at least three belts of motion, consisting of two drawn-out curtains at the sides, and a belt of festoons in the middle arching downstream. These festoons are at first merely wrinkles, then they cluster together and pile up into folds, then the different speed of flowing of the faster central belt and the two lateral belts tends to twist the contact wrinkles into ropes. Finally the whole structure forms a crust and the incandescent stream inside flows under the bridge of festoons. This stream later escapes at the lower skirts of the flow and leaves the arch of festoons a hollow shell which is apt to cave in and reveal a cavern. The presence of arched festoons is a sure sign of the original direction of flow with the crest of the arches pointing downstream. It often happens that the hardened shells exhibiting such festoons become swollen up in the later history of a flow puddle so that the surface slopes backward in the opposite direction from the slope that made the festoons.

The photograph on Page Three exhibits the detail of a footprint made by a barefooted Hawaiian in the ash mud of 1790 east of Mauna Iki. This is one of the hundreds of footprints which mark the old trail of that time, the material being a pisolitic ash with some small angular pebbles. The pisolites or mud raindrops of the period are the small, round, whitish objects seen at the left of the picture. The footprint shows the five toes and the spread-out effect as the foot squashed down in the mud of that period, which has since hardened like cement so as to preserve the footprints from erosion throughout nearly a century and a half.

T.A.J.

NOTES FROM THE ALEUTIAN ISLANDS

The seismograph observer, Mrs. Wendhab, reports from Dutch Harbor that the trader Mr. Schroder, who owns the store at Chichagof Harbor in Attu, came back from one of his voyages at the end of August and reported that on May 30, 1931, about 12 midnight (following), a very severe earthquake was felt at Attu. He had himself experienced the California earthquake of 1906 and he thought that this one was very nearly as severe. Everything on the shelves was dislodged, dishes were broken, and there was general havoc. Aftershocks continued every few days accompanied by a distinct roaring noise which preceded the shock and grew in volume as though something was coming closer with great rapidity. Then would come the shake, the roaring accompanying it, followed by a passing on of the movement and a dwindling of both tremor and sound.

Our seismograph records at Kilauea did not show any registration of a large distant earthquake at that time.

Mr. R. H. Finch reports that Aniakchak Volcano on the Alaskan Peninsula was exploding in May 1931 and scattered ashes over a hundred miles from the center. The material that fell at a great distance was very fine and looked like flour under a pocket lens. Some account of this Aniakchak eruption has recently been reported by the explorer Father Hubbard. Katmai Volcano was observed to be smoking early in July. Pavlof was smoking nearly all summer and according to the Reverend D. Hotovitsky of Belkofsky this volcano was in active eruption about May 20, 1931, making a noticeable ashfall, and at times glow was discernible at the crater. Two other volcanoes on the Peninsula were reported fuming.

Gareloi Volcano, a peak 5,334 feet high far to the west in the Aleutian Islands, was very active during the spring and summer of 1930. The appearance of half of the island was said to be changed by lava flows from fissures, and a hut was destroyed belonging to fox farmers. R.H.F.

KILAUEA REPORT No. 1031

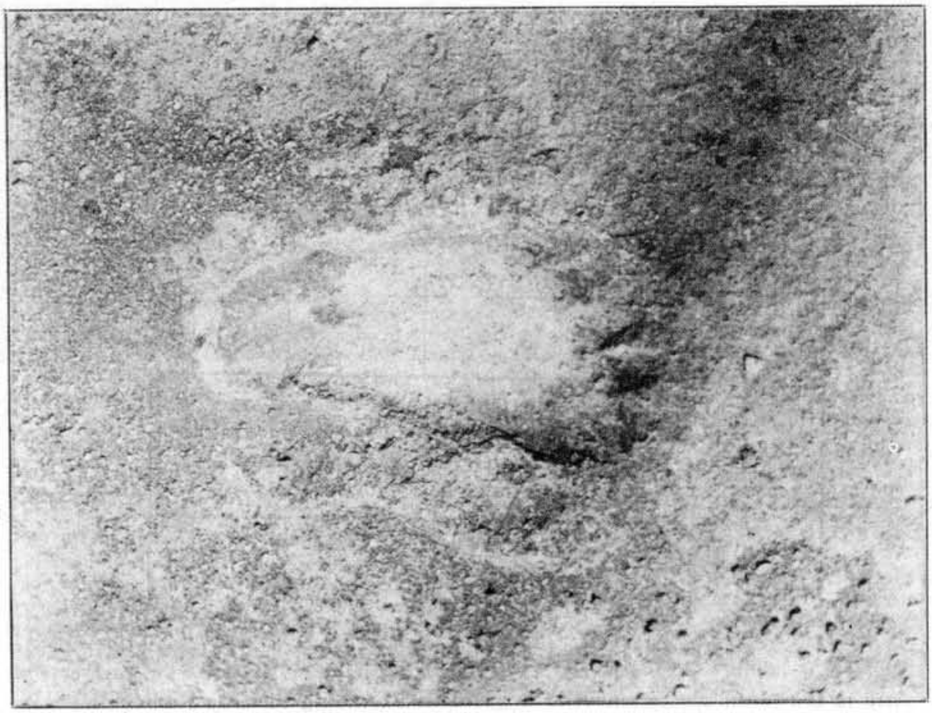
WEEK ENDING OCTOBER 25, 1931

Section of Volcanology, U. S. Geological Survey
T. A. Jaggar, Volcanologist in Charge

The fume area on the Halemaumau bottom appeared inactive on October 19, and only thin fume and steam were noticeable on the 20th. After light rain on the 21st there was some increase of fume. On the 22d both fume and steam were entirely absent. The seismograph at Halemaumau showed quiet conditions and practically no tilting. There are two new large bowlders on the pit floor between the south and southeast taluses. On October 24 at 8:30 a. m. there was a large avalanche north causing much dust. Crack measurements on October 20 showed no changes.

The seismographs at the Observatory registered 11 tremors, three of which were doubtful, and one very feeble shock, with good phases, from a distance of about 37 miles. In addition during the first two days of the week there were 46 spasmodic tremors, possibly artificial due to road machinery. There has been so much vibration from this cause as to obscure the records during daylight hours. The heavy machinery working in the neighborhood of 100 yards causes periods of one-tenth second and a half millimeter amplitude.

The average of tilt was slight N, and of microseismic motion moderate.



Footprint in ash east of Mauna Iki remnant from the native trails of the eighteenth century. Shows pisolites on the left and small stones on the right.' The natives walked in volcanic mud of the time, which has since hardened. Photo 1931 by Lewis M. Werth.