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ERUPTION OF TRIDENT VOLCANO KATMAI NATIONAL MONUMENT, ALASKA FEBRUARY–JUNE, 1953

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ABSTRACT

Trident Volcano, one of several "extinct" volcanoes in Katmai National Monument, erupted on February 15, 1953. Observers in a U. S. Navy plane, 50 miles away, and in King Salmon, 75 miles away, reported an initial column of smoke that rose to an estimated 30,000 feet. Thick smoke and fog on the succeeding 2 days prevented observers from identifying the erupting volcano or assessing the severity of the eruption. It is almost certain, however, that during the latter part of this foggy period, either Mount Martin or Mount Mageik, or both, were also erupting sizable ash clouds nearby. The first close aerial observations were made in clear weather on February 18. At this time a thick, blocky lava flow was seen issuing slowly from a new vent at an altitude of 3,600 feet on the southwest flank of Trident Volcano. Other volcanic orifices in the area were only steaming mildly on this and succeeding days. Observations made in the following weeks from Naval aircraft patrolling the area indicated that both gas and ash evolution and lava extrusion from the Trident vent were continuing without major interruption. By March 11 an estimated 80-160 million cubic yards of rock material had been extruded. Air photographs taken in April and June show that the extrusion of lava had continued intermittently and, by June 17, the volume of the pile was perhaps 300-400 million cubic yards of rock material. Ash eruptions also apparently occurred sporadically during this period, the last significant surge taking place June 30. No civilian or military installations have been endangered by this eruption at the date of writing.

INTRODUCTION

The following text is a preliminary report of the eruption of Trident Volcano in Katami National Monument (fig. 1). Most of the information, including a sizable film library, was obtained by personal observations during flights of U. S. Navy planes. Supplementary information was obtained secondhand from observers in the U. S. Air Force, U. S. Coast Guard, and commercial planes. The continued cooperation of all branches of the U. S. Navy made possible the successful observation of this eruption by the writer and other observers. Particular appreciation is due Rear Admiral John Perry, USN, Commandant of the 17th Naval District with headquarters at Kodiak, and Captain W. K. Rhodes, USN, Commanding Officer, U. S. Naval Station, Kodiak, for authorizing the use of the Navy facilities and equipment under their commands which were required for the operation.

Personal acknowledgments are also extended to the following people: Capt. Russell J. Bellerby, Chief of Staff, Com 17; Comdr. W. G. von Bracht, Air Operations Officer, Com 17; Lt. Comdr. J. S. Paretsky, Flight Officer, Kodiak; all the pilots of the Navy planes that patrolled the Trident and Illamna areas, including Lt. Comdr. George H. G. Webster, Lt. Dee L. Leland, Lt. James Ingram, Lt. Comdr. Richard Larsen, Lt. Mark J. Hessy, Lt. H. G. Silliman, Lt. Robert L. Neth, Lt. (jg.) Robert L. Bolling, Lt. (jg.) R. J. Henning, and P. N. Cedercrans ADC/AP; Lt. Frank O. Brink, Acting Public Information Officer, 17th Naval District Headquarters, Kodiak; Lt. Comdr. Tom Herbert, Radio/TV Officer, 13th Naval District Public Information Office; Lt. Lawrence Barrett, Pictorial Officer, 13th Naval District Public Information Office; Lt. Comdr. Glen Thompson, U. S. Coast Guard unit,

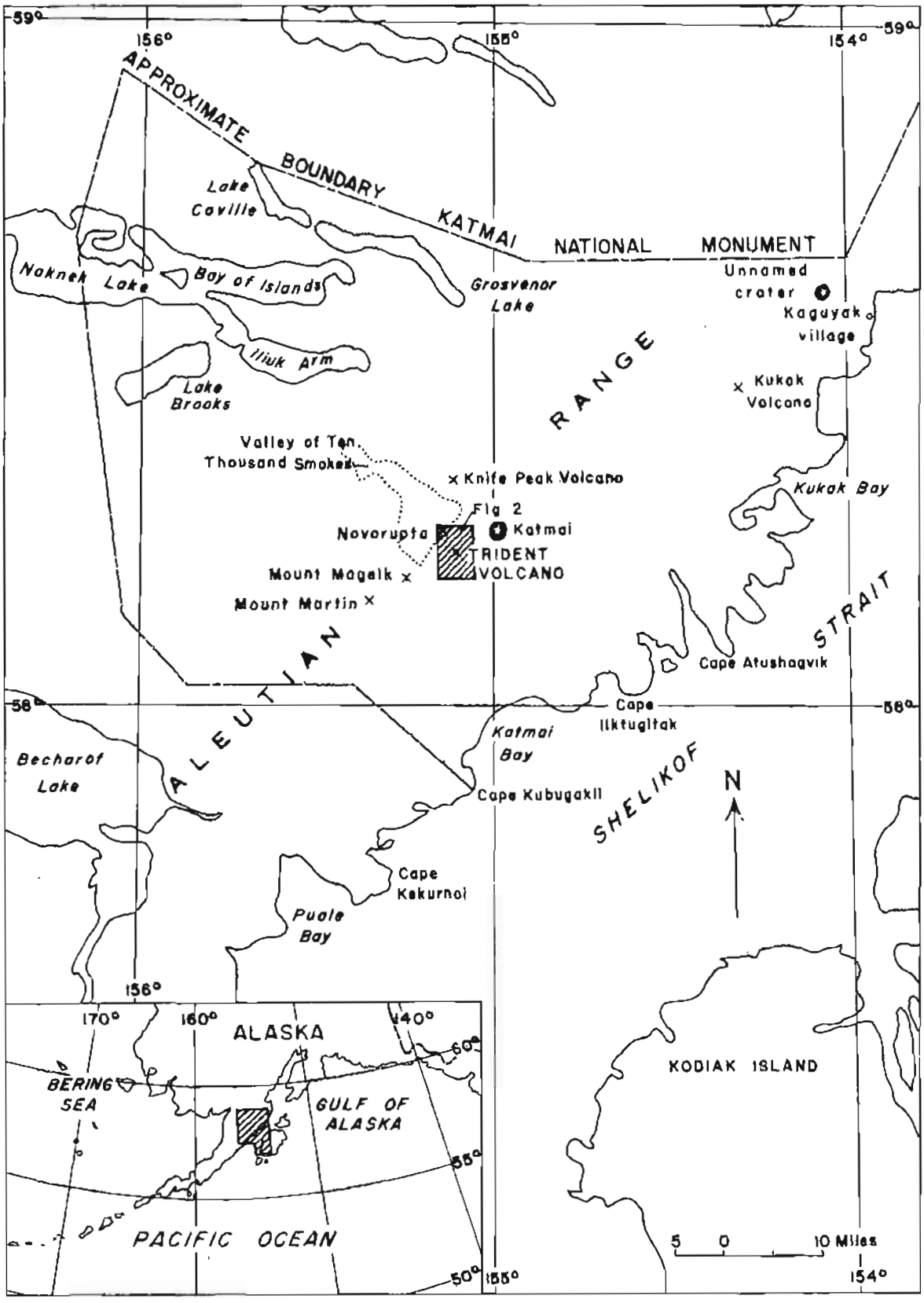

Figure 1. —Location map of Trident Volcano in Katmai National Monument, Alaska.

Kodiak; all the Navy photographers including Michael J. O'Grady, Jr., AF-3; Samuel E. Bennett, AF-3; James C. Toon, AF-3; Henry A. Geary, AF-3; Dave Berg, AF; William W. Henderson, AF; William T. Edgar, AF; Curtis E. Von Kaenel, AF; and Marvin R. Soper, AF; Gene Vosburg, Jr., JO-3; Miss Anastasia Trasko, Secretary to the Chief of Staff, Kodiak; and all the many crew members of the Navy planes, and other personnel of the Naval Station.

Richard R. McDonald, Seismologist with the Geophysical Branch of the U. S. Geological Survey, observed the eruptive area during the period from February 18 to March 5. The writer's observations were made during the period from February 25 to March 13 and again on June 17. This report includes the observations made by Mr. McDonald, the writer, and many others, evaluated by mutual discussion.

CHRONOLOGY OF THE ERUPTION OF TRIDENT VOLCANO

Lieutenant Commander Frank Chase, flying eastward at 15,000 feet altitude over Port Heiden on the Alaskan Peninsula one calm Sunday afternoon was astonished to see a huge tower of smoke mushroom into the sky on the horizon almost 150 miles away. The time was about 4:00 p.m. (A.s.t.), February 15, 1953. The center of activity was determined to be somewhere in the vicinity of Mount Katmai in Katmai National Monument. The eruption cloud was estimated at the time to extend to about 30,000 feet, twice the altitude at which the plane was flying. A photograph taken by a crew member of Commander Chase's plane from just south of Cape Kekurnoi (35 miles south-southwest of Katmai) corroborates this estimate. Only 1 eruption cloud is visible in this photograph and, although the picture is not clear enough for positive identification, subsequent observations indicated that this smoke column was arising from Trident Volcano, an old eroded volcano with no previous historical record of eruption, located 4 miles west-southwest of Mount Katmai.

The initial explosion was also reported by the office of Northern Consolidated Airlines in King Salmon (on the north side of the Alaskan Peninsula) about 75 miles northwest of the eruption. An Associated Press release of February 16 states that "a unidentified Air Force pilot flying over the area 50 minutes after the eruption saw smoke and cinders had shot into the air to a height of 30,000 feet." Because of an unfavorable location behind mountains no one in Kodiak village or on Kodiak Naval Station (100 miles southeast of the eruption) could observe the initial smoke column.

When Mr. Chase landed at Kodiak Naval Station he reported his observations to Rear Admiral John Perry, Commander Alaskan Sea Frontier and Commandant 17th Naval District. Admiral Perry ordered Navy patrol planes to maintain surveillance on the volcano in event of increased activity that might endanger the lives of civilian and military personnel on the Alaska Peninsula and Kodiak Island. That same evening, Sunday, February 15, one Navy plane was dispatched to the scene of the eruption. By then, however, fog and smoke had covered the area, and nothing could be seen. Early Monday morning, February 16, two Navy planes returned to Katmai National Monument. Frank O. Brink was in charge of the photo crew in one of these planes piloted by Lt. Comdr. George H. Webster. The following Navy dispatch describes the first flight: "***Took off at dawn 700 AM. While enroute noticed thick smoke layer to left stretching over 100 miles. Valleys and mountains far as eye could see covered with ash. Difficult to pinpoint volcano because of cloud layer***LCDR Webster said too dangerous to get closer than 26 miles***840 AM Alaska standard time a navy crew of Grumman Albatross from the Naval Station Kodiak sighted second eruption volcano in Katmai region Alaska Peninsula***Huge ball cloud seen 20 degrees and 25 miles left of plane's heading. Cloud rose above 7,000 ft cloud layer with tremendous spread. Like giant mushroom just let go as plane arrived in area. Perfect imitation atom bomb explosion. 850 AM cloud mushroomed to 30,000 feet. Top fanned out diameter 10 miles. 855 AM top spread like sunflower to diameter 25 miles at height of 35,000 feet." In later conversations, Mr. Brink declared that this eruption cloud was light gray and, hence, presumably was a steam explosion that carried but little ash. Movies indicate that above the clouds there was only a single mushroom smoke cloud, light gray in color.

At about the same time Lt. Comdr. Glen Thompson of the U. S. Coast Guard was also patrolling the area in a Coast Guard amphibian plane. Mr. Thompson was considerably lower than the U. S. Navy planes and also closer to the erupting vents. He flew beneath the cloud layer that obscured the ground from the higher planes, and taking a bearing on Mount Martin, flew northeast parallel to the chain of mountains. Near Mageik volcano the air became so smoky that he was obliged to continue ahead on instruments and did not relocate his position until he saw the emerald-green waters of the crater lake on Katmai volcano below him. As the smoke seemed to be thickest in the vicinity of Knife Peak Volcano, Mr. Thompson presumed this to be the erupting volcano. The identification of the eruptive center as Knife Peak was definitely mistaken, but the knowledge that there was thick smoke in the Trident-Mount Mageik area and none in the Katmai and Mount Martin areas was valuable information about the volcanic activity at that time. Movies, taken by a crew member on this run, show many scenes of smoke, fog, and steam, but the only land feature that can be definitely identified is Mount Martin, with its usual steam plume 500 feet high.

A summarizing Navy dispatch contains the following statement: "Observers on the second plane to visit the area Monday [February 16] reported that a second column of smoke and possibly a third was seen rising approximately 10 miles southwest of Katmai Volcano." This observation, if correct, would imply that both Trident and Mount Martin were erupting. Perhaps "steam" is meant instead of smoke, however, in which case the situation at the craters of Mageik and Mount Martin would be normal. No still pictures of the activity on February 16 are available.

Part of a Navy dispatch describing the observations of a flight on Tuesday (February 17) reads as follows: "Navy patrol crew from NAVSTA Kodiak today witnessed mass eruption of Katmai National Park. This was third and most spectacular display. 1055 AST plane flying 8000 ft. on 270 degrees course over Shelikof Strait sighted large black ball smoke about 25 miles 10 degrees left plane's heading. It rolled up like smoke

from oil fire to 15,000 feet. Plane circled left of the eruption. In two minutes second cloud boiled up 8 miles NE first one. Moved closer, black smoke rose 30,000 feet. Streams of ash poured out of black smoke like rain falling from thunder cloud***smoke and debris from volcanoes appeared to move slowly to NW. Continued to fly within 5 to 6 miles of the erupting area. Smoke spread until it was difficult to see separate columns.[1] Smell of sulphurous volcanic smoke strong in plane. Pilot [Lt. James T. Ingram] pulled plane further away fearing ash might damage props and engine. Through an occasional break in the 8000 ft cloud layer below could see mountains and valleys covered with gray black ash." This much of this dispatch is well attested by the still photographs taken by Navy photographers as well as by Lieutenant Brink's 16 millimeter motion pictures of this phase of the eruption. It appears certain that there were at least 2 vents, Trident and 1 other, which were erupting smoke and ash on the third day of the activity. The identity of the other vent is not certain. Principal possibilities are Mount Martin and Mageik because these 2 volcanoes are almost continuous "steamers."

One Navy photograph, dated February 17 and showing 2 smoke columns projecting above an undercast cloud layer, is labeled: "Two erupting clouds of steam and ash from Mount Katmai, in the foreground, and Mount Mageik, eight miles from Katmai***." If the estimate of an 8 mile distance between the columns is correct, the 2 erupting volcanoes must have been Trident and Mount Martin rather than Katmai and Mount Mageik. However, another photograph, also dated February 17 and supposedly taken on the same flight, shows Mount Martin placidly steaming as usual. The ash that fell from these 2 eruptions on February 17 was buried completely under fresh snow, so that the excellent observations from the air on February 18 contribute nothing to identify the second erupting volcano. It must have been either Mount Martin or Mount Mageik.

On Wednesday, February 18, the weather cleared making possible photographs and direct observations from the air by Navy patrols. Ash and steam were being erupted as a gray column from a vent at an altitude of about 3,600 feet in an amphitheater on the southwest flank of Trident Volcano, and a blocky lava flow from this vent had spread over an area about 700 feet wide and 800 feet long (see fig. 2). Copious steam was being emitted from the area immediately adjacent on the uphill side of the active vent. The lava flow, apparently very slow moving and viscous, showed a surface of large blocks of lava formed as the stiffening material reached the lava surface. Earlier news dispatches had mentioned "long streams of molten lava" flowing down the mountain side but these must have been merely mudflows composed of meltwater and ash. A thin blanket of ash covered the area downwind (west) of the vent, lying on new snow which had concealed the ash deposits of previous days. No observations were made of the ash distribution around the neighboring volcanoes, so the uncertainty about the February 17 eruptions still remains.

On the next flight, February 21, the ash column was again gray and steam-laden, with copious steam also being emitted from the area on the uphill side, as on February 18, and the lava had advanced about half a mile southward down slope. If the rate of advance of the flow front can be taken as a reliable indication, it was during the period from February 18 to 21 that the lava rock was extruded most rapidly. On the flight of February 27 the eruptive column was light gray, and much steam came from the hot area on the uphill side of the vent. The lava front had extended several hundred feet further down slope. On March 4, low clouds obscured the vent, and a slight widening of the lava flow on the eastern side of the toe was all that could be seen. This eastern lobe, which was active until March 9 and which became reactivated in the late Spring, was a "squeeze-under," that is, the lava forming the lobe was forced beneath the frozen eastern margin of the flow. From March 4 to March 11 the flow, especially in the central portions, expanded like a balloon from internal additions. Then, from March 9 until the observation on March 11, further overflow from the vent had produced a northwest lobe. The ash puffs were progressively less frequent on each of the observations in early March, and the eruptive column on March 11 was very unsteady in the wind between bursts.

Except for reports of noticeably greater explosive activity on March 24, no further observations were made until April 6. Navy air photographs taken on April 6 indicate that the lava pile had bulged on the east and west flanks and increased in height in the vent area. Photographs on June 2 show further growth of the lava mound on the east flank and a landslide formed by slumping of a portion of the southeastern toe. Minor ash apparently had been deposited over the flow sometime after April 6, and this surface had been partly overridden by new lava. By June 17 no further landsliding of consequence had occurred although a crevasse near the lip had widened appreciably. New lava was exuding slowly from the vent, which it buried completely, and was piling up at the source as well as spreading down the northwest, west, and northeast flanks. Steam with very little ash rose from the apex of the pile, from the northwest edge of the new lava, and, as had been normal since February 18, from the area at the northeast base of the pile. Concentric slump cracks were noticed in the latter area (see fig. 2).

In the evening of June 30, according to messages from the Navy at Kodiak, a fishing vessel reported ash in the air and pea-size pumice floating in Shelikof Strait from Cape Kuliuk, Kodiak Island, for a distance of 25 miles southwest. A patrol plane reported an ash column at Trident Volcano rising from a glowing vent and a fair amount of ash blanketing the area south of Katmai. Visibility was poor southeast of Trident as far as Kodiak Island, because of dust in the air. It is not certain whether the pumice in Shelikof Strait was newly erupted from Trident Volcano, however. It may have been derived from much older pumice deposits on Kodiak or the Alaskan Peninsula.

[1] The Navy dispatch of February 17 also contains the following statements: "1115 AST one after another new columns of smoke shot up in a line just like a chain of explosions. Ash started hitting plane*** more explosions took place in different areas. Counted between 6 and 8 separate columns of smoke." These statements require some clarification. From later conversations with Lieutenant Brink and the other observers and after seeing Brink's film it appears that all of the above could have been caused by 1 vent sending separate puffs up through a cloud layer into a zone of moderate winds. Also, it might have been said that the plane started hitting ash rather than the above, as any ash at that altitude probably would have lost the original propulsive force of the gaseous explosion.

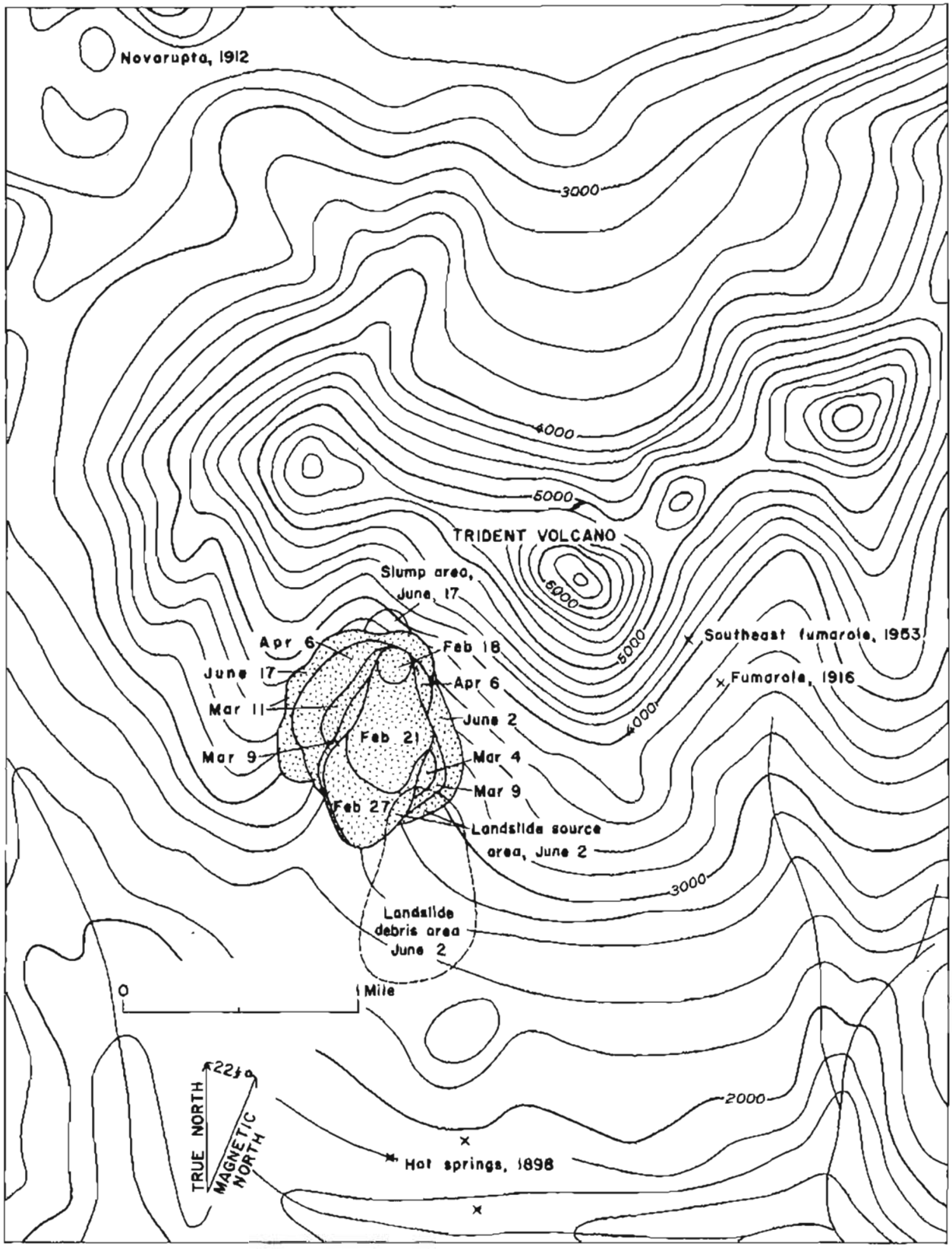

Figure 2. —Sketch map of lava flow from Trident Volcano, February-June, 1953.

VOLUME OF MATERIAL ERUPTED

The writer has estimated that 80-160 million cubic yards of lava and ash were extruded from the Trident vent by March 11, 1953. The volume of the volcanic pile during the writer's last observation on June 17, 1953, is estimated to have been 300-400 million cubic yards. The rate of emission was never constant, and actual ground measurements were not taken so that these estimates are to be regarded as orders of magnitude only.

The gases and finely comminuted ash of the fume cloud escaped from the joint openings over an area of 5-7 acres. The smoke column on February 18 rose over a mile into the air. With later observations in February and early March the height of this smoke column was always 1-2 miles in height, averaging perhaps 1½ miles. Notable maxima were observed on March 9, March 24, and June 30. Before March 11 the explosions forming the cloud occurred often enough (several to several dozen per minute) so that the column was always present. On March 11, however, the explosions were more sporadic, occurring 1-3 minutes apart, so that between bursts the smoke from the previous explosion would mostly drift away. From the later photographs moderate and, infrequently, explosive emission of steam with but little ash seems to have continued infrequently into June.

Before February 27, all observations of the eruption cloud indicated that it was moving southwest, northwest, west, or north before the prevailing winds. Observations of ash-covered ground as far away as the Bay of Islands, Naknek Lake are reported. Shortly before February 27 a snowstorm blanketed the entire Katmai National Monument area with clean snow. After this time all observations of the eruption cloud showed it to be drifting to the south, southeast, east, or northeast, and all fresh deposits of ash atop the new snow occurred in these areas within a 20-mile radius of the vent. Thus, although single observations made between February 15 and March 11 would seem to indicate a preferential deposition of the ash, actually the wind conditions had varied enough during this time to almost completely box the compass. It is very difficult to estimate the depth of the blanketing ash from a plane. Locally "drifts" of the ash from Trident Volcano, especially near the vent, may have been a foot to several feet in thickness. Probably within a radius of 15 miles of the vent an "average" thickness of the whole ash deposit would fall within the limits 0.01-0.1 foot. A cylinder of this radius and altitude would have a volume of 7 to 70 million cubic yards. Inasmuch as the area actually occupied by the ash is not flat but very mountainous these figures are probably conservative estimates.

A United Press release of February 26 reports that Charles L. Baker of the University of South Dakota analyzed samples of a dust deposit that covered portions of the State on February 19 and found them to be volcanic ash. He said, the article continues, that apparently the ash was the residue of recent volcanic eruptions in Alaska, carried there by strong winds. If this is true, the ash, if from the Trident vent, must have been derived from the initially violent explosions of February 15, 16, and (or) 17. These were the only eruption clouds which could have transported a very fine ash to a stratospheric wind zone. The aerial observations indicate that in this case, however, the amount of the ash transported beyond a 15-20 mile radius can be regarded as negligible from the viewpoint of total volume determination.

The accompanying table gives the estimated maximum and average dimensions of the Trident lava flow at different dates. These estimates were derived by measuring plotted outlines and cross sections of the flow which were drawn to scale on a "blow-up" of the contour map of the area. Both the small scale of the original map and the estimated position of the flow borders render these figures approximations at best.

The volume of lava extruded as of March 11, 1953, has been computed as 70-90 million cubic yards. Together with the estimate of the amount of ash blown out this would make a total volume of 80-160 million cubic yards (or 0.015-0.029 cubic mile) as an order of magnitude. By June 17, 1953, it is estimated that the volume of the volcanic pile had risen to 300-400 million cubic yards (or 0.055-0.073 cubic mile). Note that these figures do not take the porosity of the deposits or the internal porosity of the actual rock fragments into account. It is believed that the error possible in the simple estimates makes further refinements pointless. For comparison the amount of ash and pumice which filled the Valley of Ten Thousand Smokes in the great eruption of 1912 has been estimated to be about 1-1½ cubic miles and the volume of the pyroclastic material derived from the entire Katmai eruption in 1912 has been estimated at 6-7 cubic miles (Griggs, p. 29, 31). From this comparison it is easily seen that Trident's eruption is but a small puff compared to those of the neighboring vents.

Table 1.—Estimated dimensions of lava flow from Trident Volcano, in feet

Date (1953)	Thickness		Width x length	
	Maximum	Average	Maximum	Average
Feb. 15	0	0	0 x 0	0 x 0
18	200	150	700 x 800	600 x 700
21	200	175	2000 x 3200	1500 x 2800
27	200	175	2500 x 4600	1800 x 4000
Mar. 4	300?	200?	2600 x 4600	1800 x 4000
9	400- 450	250-300	2800 x 4600	1900 x 4000
11	550- 650	300-350	3200 x 4600	2000 x 4000
Apr. 6	700- 750	400-450	3800 x 4800	2800 x 4000
June 2	750- 800	450-500	4100 x 4800	3100 x 4100
17	950-1050	600-700	4400 x 5000	3300 x 4300

CURRENT AND RECENT ACTIVITY OF OTHER VENTS

Coincident activity of other vents during this eruption includes the February 17 ash explosions of Mount Martin or Mount Mageik or both and the southeast Trident fumarole mentioned above.

The Anchorage News of March 3 quotes a Mrs. William Tauscher of Anchor Point (Kenai Peninsula) as saying that Iliamna Volcano "poured forth with a huge mushroom-shaped billow of inky black smoke at 7:30 a. m. Sunday (March 1)." Two distinct sources of eruption are claimed to have been sighted, one on top and one off to the side of the mountain. Lt. James Ingram USN flying about 60-75 miles south-southeast of the Iliamna area on March 3 gives a partial confirmation of this story. He sighted a cloud column rising from the mountain but at that distance could not discern whether it was smoke or steam. The writer visited the Iliamna area aboard naval aircraft on March 5 and 6. On these dates only a small fumarole near the top and on the east side of Iliamna was active, sending up a column of steam several hundred feet high. No ash was visible on the glaciers blanketing the mountain.

On March 2 Richard McDonald, U. S. Geological Survey seismologist stationed at Adak, rode a Navy plane from Kodiak to Adak and back. He reported steam rising from Pavlof, Shishaldin, Makushin, and a small cone within Okmok Caldera on this day. Probably other volcanoes elsewhere along the chain were also steaming. This is the normal condition throughout the tectonically and volcanically active Aleutian arc and should not be interpreted as a reaction related to the Trident eruption. The explosions of Mount Martin or Mount Mageik on February 17 (and, possibly the late afternoon of February 16) appear to have been related to the Trident eruption.

Lt. Dee L. Leland, USN, who has probably observed as much of the early phases of the Trident eruption as anyone, reported that on the flight on March 11 he noticed a marked coincidence in timing of the Trident explosions with the much smaller steam puffs from Mageik crater. Whether Lt. Leland was observing coincidental activity or connected events of genetic significance is not known.

Since February 17 both Mount Martin and Mount Mageik have shown no more activity than their normal puffing of steam. Other fumarolic areas in the Katmai National Monument that are now active include the "hotspot" on the southeast flank of Trident, Katmai crater (its lake, though locally containing rafts of ice, was unfrozen while, nearby, the unnamed crater lake adjacent to Kaguyak Bay was frozen over), a line of large fumaroles and "hot" ground extending along the bench below the west side of Baked Mountain for about 2 miles (these were observed by Emil Meitzner, U. S. Geological Survey, from the middle Valley of Ten Thousand Smokes in June 1952), a large area of small fumaroles and hot ground from Novarupta to Broken Mountain, a few mud-pots along the "Greased Ridge" between Baked and Broken Mountains, a single large fumarole in the canyon of the River Lethe at the north end of the Buttress Range near the Three Forks area, and, possibly, a small "hotspot" (no steam noticed) within the inner crater ring of Knife Peak. A large fumarole, reportedly by (1952) on the northwest slope of Katmai, could not be seen. As far as can be determined it is likely that all but the southeast Trident fumarole were active before and have continued unchanged throughout the Trident eruption. Probably other small fumaroles exist, especially in the upper Valley of Ten Thousand Smokes, but were not noticed from the plane.

The recorded eruptive history of the Katmai National Monument area begins with the eruption on June 1912 that formed the Valley of Ten Thousand Smokes, eviscerated Mount Katmai, and deposited over a foot of ash on parts of Kodiak Island. This is without doubt the largest recorded Aleutian-Alaskan eruption although several other recorded eruptions in other parts of the world were more violent, more destructive, or erupted greater quantities of rock material. Furthermore geologic evidence indicates that many other eruptions of greater magnitude than the Katmai disturbance in 1912 have occurred during prehistoric times throughout the Aleutian island arc. Since 1912 Katmai, Mageik, Mount Martin, and Novarupta have been steaming almost constantly and giving vent to minor ash eruptions sporadically (Coats, table 2; and personal communication with Howard A. Powers, U. S. Geological Survey). Mageik is last reported to have erupted in 1951 (Kodiak Mirror, Feb. 21, 1953, p. 1). U. S. Air Force aerial photographs taken in July 1951, show a linear grouping of fumaroles on the southwest flank of Trident Volcano near the site of the present vent.

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