

U. S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Descriptions, photographs, and coordinates for Global Positioning System
stations at Aniakchak Crater, Alaska

By

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Introduction

During two weeks in June 1994, an initial Global Positioning System survey was conducted within and around Aniakchak Crater, located about 700 km (400 mi) southwest of Anchorage, Alaska (Fig. 1). Ten points were surveyed, six on the crater floor and four on the crater rim. A reference station was located at the airstrip at Port Heiden. Dual-frequency, codeless Ashtech® receivers (model L and model M) were used. The survey was part of a multi-disciplinary effort funded by the Volcano Hazards Program to 1) understand the eruptive history of the volcano, 2) to establish a survey net to monitor possible unrest, and 3) to assess the volcanic hazard posed by Aniakchak.

The survey marks used at Aniakchak Crater were 16 mm (5/8") stainless steel anchor bolts which are tapered at the bottom and have a flange attached (Fig. 2). A 16-mm-wide hole was drilled at each site and a bolt inserted into the hole. Tightening of a nut draws the bolt upward so the tapered base of the bolt is forced against and spreads open the flange. Each survey station is identified by the station number stamped on a stainless steel washer (Fig. 2a). This type of survey mark was chosen for three reasons. 1) Anchor bolts eliminate the use of concrete to anchor the mark. Our experience has shown that concrete can deteriorate quite rapidly under certain environmental conditions. 2) A GPS antenna can be screwed directly to the exposed threads, holding the antenna tight to the mark even during high wind. Also, during a resurvey of a network, a GPS antenna can be repositioned to within a millimeter without the need to measure an antenna height or to center the antenna over the mark. 3) Attachment of an antenna to a bolt eliminates the need for a tripod; thereby saving setup time and weight. Both are important factors when field work is supported by a helicopter.

Three criteria were used to select survey stations. 1) A distribution of stations was needed on the crater floor and around the crater rim. 2) Anchor bolts had to be installed on outcrop of solid hard rock. 3) Because Aniakchak is located at a high northern latitude, the visibility of GPS satellites is limited near the south wall of the crater. Hence, all stations on the crater floor had to be away from the wall. Six stations were installed on the crater floor and four on the crater rim (Fig. 3).

The reference station was benchmark HEIDEN SE BASE, near the southeast end of the runway of the airstrip at Port Heiden, located about 25 km (15 mi) west of Aniakchak. A GPS receiver recorded data at this benchmark throughout the 1994 survey. Also, within Aniakchak, a GPS receiver recorded throughout the 1994 survey at station 94-5, a short walking distance from our lakeside camp site. Most stations on the crater floor were occupied for two consecutive days. The exception was station 94-6, which recorded data for only one day. Three of the four stations on the crater rim were occupied on three consecutive days. The internal battery in the receiver unit at station 94-7 failed and when the external power source was disconnected we lost all data for that site.

Except for the reference station at Port Heiden, all stations are located within the boundary

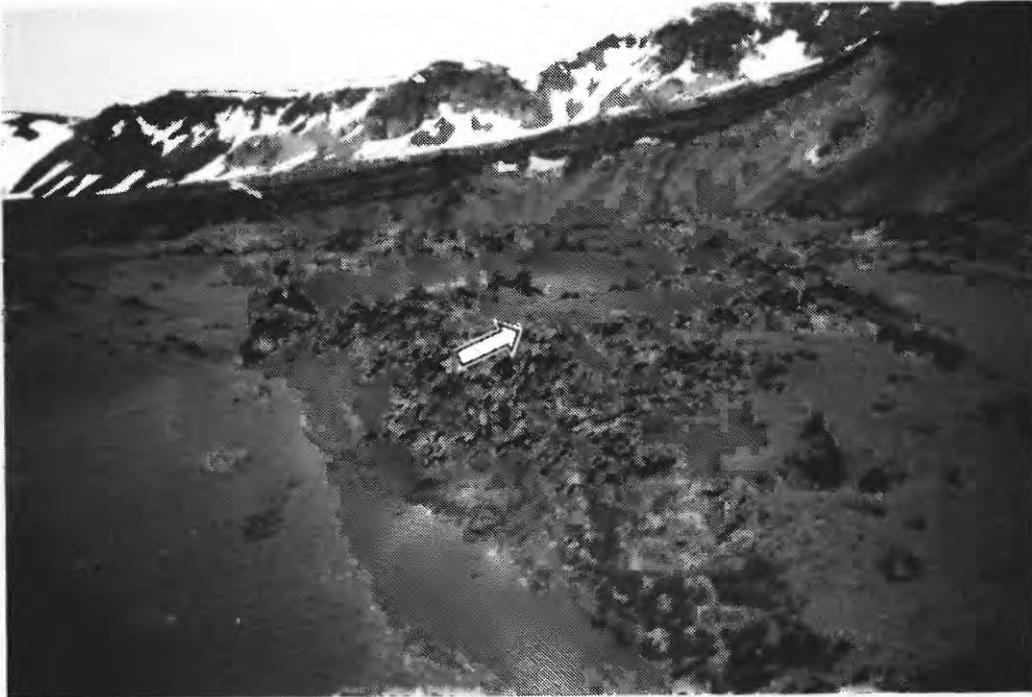
of the Aniakchak National Monument, administrated by the National Park Service in King Salmon, Alaska. Permission to conduct research within the Monument, including surveying of the GPS stations must have prior approval of the National Park Service.

We computed GPS coordinates of our reference station Heiden SE Base using nine days of data. A continuous operating station at Fairbanks, Alaska was used as the reference station. International Terrestrial Reference Frame (ITRF) 93 coordinates corrected for plate velocity were used for the Fairbanks reference station. Precise satellite orbits from the Center for Orbit Determination Europe (CODE) were used in the processing.

The preliminary data contained in table 1 are relative to Heiden SE Base and were processed using the commercial Ashtech® software GPPS. Broadcast orbits were used in the processing. All data will be re-processed using Bernese software.

94-0

Bench mark 94-0 is a stainless steel anchor bolt set on an embedded boulder at the extreme east-north-east end of a lava flow, on the north-west edge of Aniakchak crater (fig. 3).



View looking west



View looking northwest

94-1

Bench mark 94-1 is a stainless steel anchor bolt set on the south end of a cindery outcrop on a small solitary cinder cone located on the far west end of Aniakchak crater (fig. 3).



View looking northwest



View looking east

94-2

Bench mark 94-2 is a stainless steel anchor bolt set on a small 1.2 x 1.5 m (4 x 5 ft) outcrop on the southwest side of a prominent cinder cone located at the southwest side of Surprise Lake and on the northeast side of Aniakchak crater, approximately 3.0 m (10 ft) below the highest point of the hill (fig. 3).



View looking northwest



View looking northeast

94-3

Bench mark 94-3 is a stainless steel anchor bolt set on a small outcrop on a barren east sloping ridge dotted with a number of small rock outcrop, located on the east side of Aniakchak crater (fig. 3).



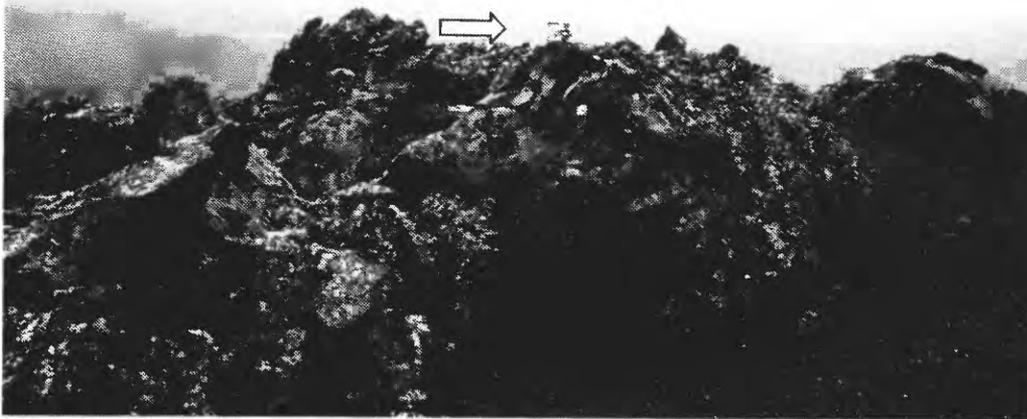
View looking north-north-west



View looking southwest

94-4

Bench mark 94-4 is a stainless steel anchor bolt set on a 1.5 m (5 ft) high outcrop on the south edge of a lava flow located on the northwest side of Aniakchak crater (fig. 3).



View looking south



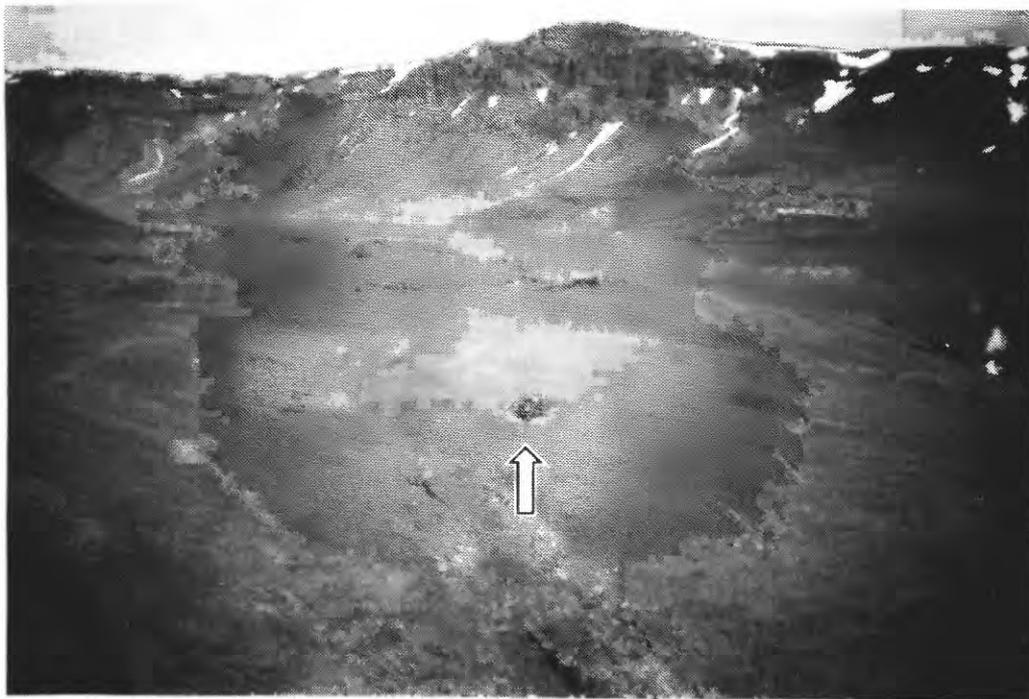
View looking southwest

94-5

Bench mark 94-5 is a stainless steel anchor bolt set on a small outcrop on a 0.5 m (1.6 ft) high outcrop of rock on the south edge of a barren ridge located on the northeast side of Aniakchak crater (fig. 3).



View looking southeast



View looking north

94-6

Bench mark 94-6 is a stainless steel anchor bolt set on top of a 1.2 x 1.5 x 0.5 m (4 x 5 x 1.5 ft) high embedded boulder, approximately 22.8 m (75 ft) southwest of a boulder area at the east end of the east-west ridge, located on the northeast side of Aniakchak crater (fig. 3). Just west of this ridge is another ridge with a very prominent pointed rock.



View looking east



View looking northeast

94-7

Bench mark 94-7 is a stainless steel anchor bolt set on a small 1.5 x 1.8 m (5 x 6 ft) outcrop, approximately 22.9 m (75 ft) southwest of a prominent boulder at the edge of the ridge, 5.4 m (18 ft) northwest of the edge of the ridge, 0.2 m (8 in) higher than the surrounding ground surface, and on the east edge of a north-south ridge located on the north-north-east outerwall of Aniakchak crater (fig. 3).



View looking north



View looking southwest

94-8

Bench mark 94-8 is a stainless steel anchor bolt set on a 0.9 x 0.9 m (3 x 3 ft) rock outcrop approximately 9 m (30 ft) northwest of the southeast edge of a 91 m (300 ft) drop off, approximately 7.6 m (25 ft) south of a 0.9 m (3 ft) high outcrop, 0.2 m (8 in) higher than the surrounding ground surface and on the southeast edge of a southwest-northeast ridge located on the southwest outerwall of Aniakchak crater (fig. 3).



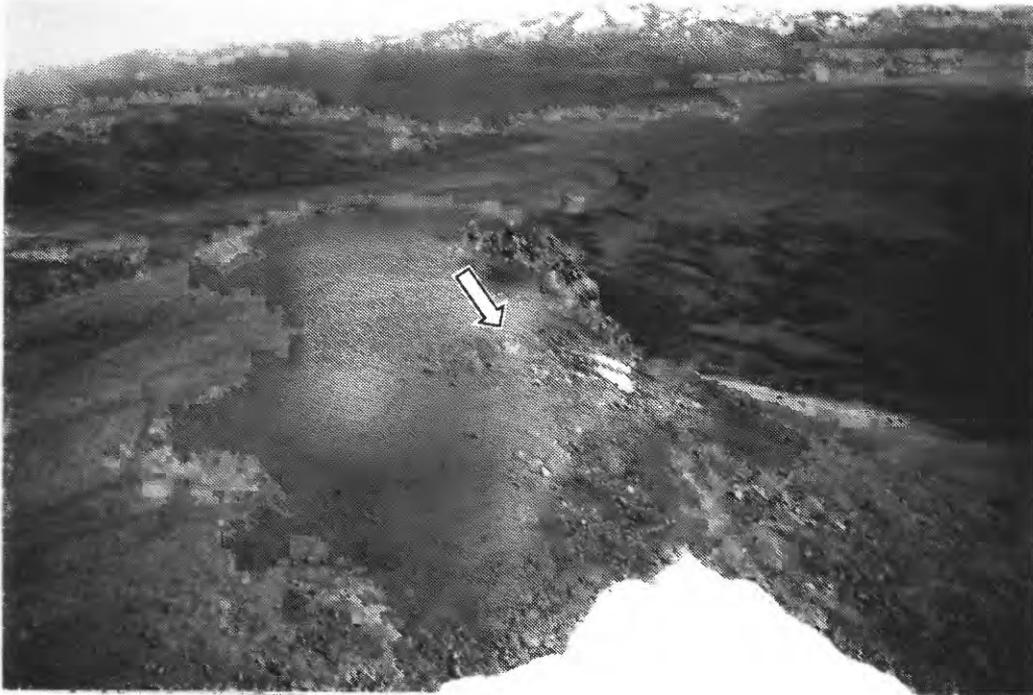
View looking east



View looking north

94-9

Bench mark 94-9 is a stainless steel anchor bolt set on a 1.2 x 2.4 m (4 x 8 ft) rock outcrop just east of a waterfall that feeds a stream; on the west edge of a southeast-northwest ridge on the east side of Waterfall Creek and on the southwest outerwall of Aniakchak crater (fig. 3).



View looking southwest



View looking northeast

Heiden SE Base

Bench mark Heiden SE Base is a Coast and Geodetic Survey (C&GS) brass tablet welded to the top of a 5 cm (2 in) diameter pipe, 1.6 km (1.0 mi) east along the east-west runway from the air terminal at Port Heiden then 0.3 km (0.2 mi) north across country to the station which projects 40 cm (16 in) above the ground level.



View looking southeast



View looking southwest

TABLE 1**Preliminary coordinates for GPS stations**

Station ID	X/Y/Z	Lat/Long/EH	Line Length (m)
94-0	(X) -3239255.6083	56-55-23.61006	27111.1156
	(Y) -1297365.7134	158-10-23.62812	
	(Z) 5321617.0036	451.2881	
94-1	(X) -3242451.3992	56-53-40.09825	26251.9309
	(Y) -1296859.4130	158-12-01.56956	
	(Z) 5320016.0754	627.1971	
94-2	(X) -3237987.9821	56-55-31.57270	29924.0417
	(Y) -1299969.6101	158-07-32.87155	
	(Z) 5321749.8745	449.4263	
94-3	(X) -3239715.4340	56-54-10.43185	30964.6135
	(Y) -1301294.8893	158-06-58.23498	
	(Z) 5320370.1106	438.0678	
94-4	(X) -3240163.8705	56-54-53.13327	26833.7480
	(Y) -1297230.0204	158.10-51.02959	
	(Z) 5321106.6315	456.3391	
94-5	(X) -3238095.9394	56-55-15.91935	30615.5165
	(Y) -1300687.3875	158-06-55.87645	
	(Z) 5321427.1049	379.6212	
94-6	(X) -3236308.3322	56-55-51.48128	33403.5989
	(Y) -1303158.4025	158-04-00.92083	
	(Z) 5322312.1191	719.3126	
94-8	(X) -3244982.3483	56-53-07.06940	22602.7439
	(Y) -1293273.9669	158-16-13.63980	

	(Z) 5319711.2239	929.6071	
94-9	(X) -3247377.1194	56-49-11.65603	33391.6277
	(Y) -130336.9303	158-07-54.87193	
	(X) 5315518.7721	678.5237	
Heiden SE Base	(X) -3245364.9909	56-57-49.98546	
	(Y) -1271038.1244	158-36-44.43840	
	(Z) 5323749.1592	48.3505	

X,Y and Z are cartesian coordinates

Line lengths are distance in meters from Heiden SE Base

EH are ellipsoidal height

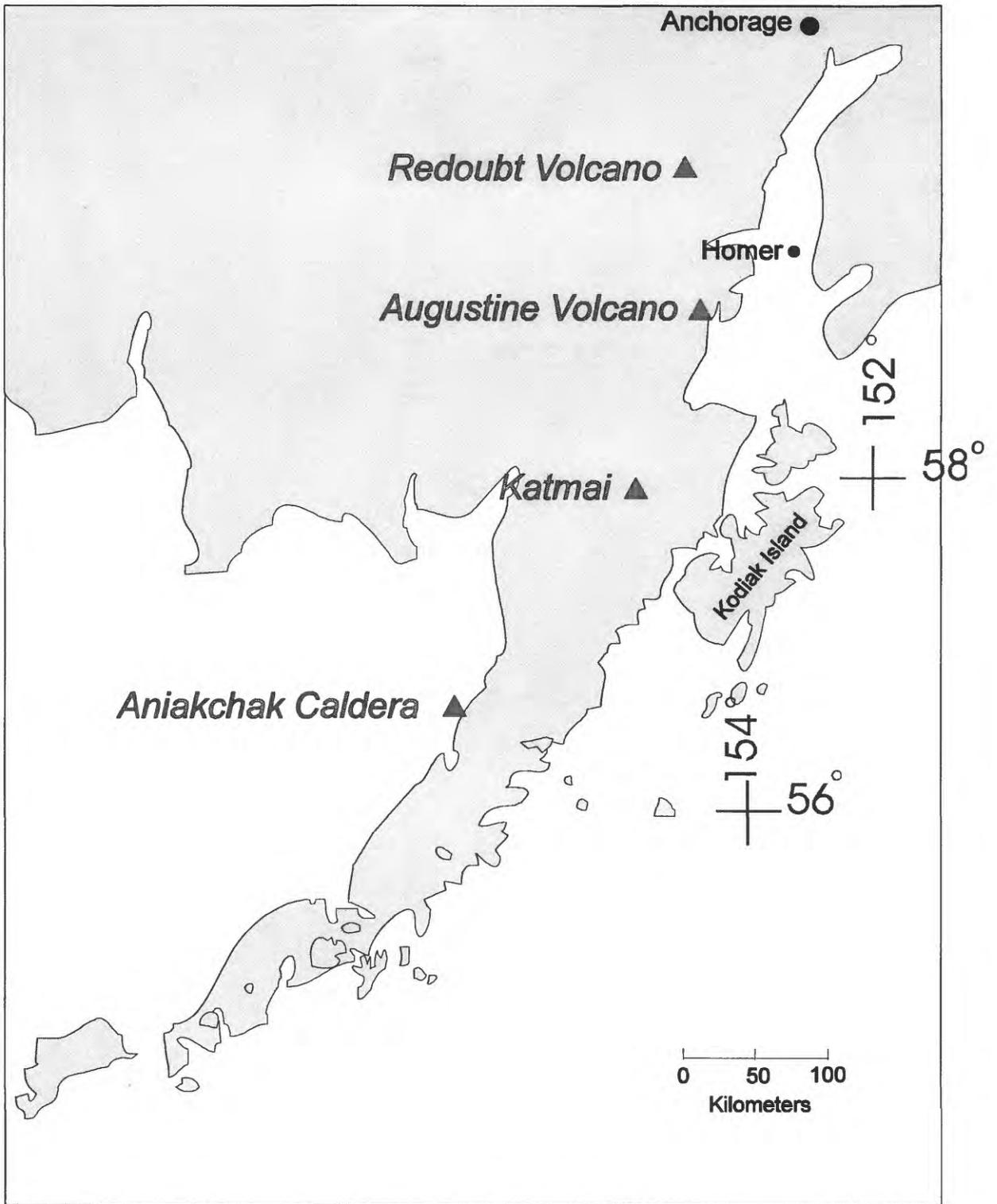
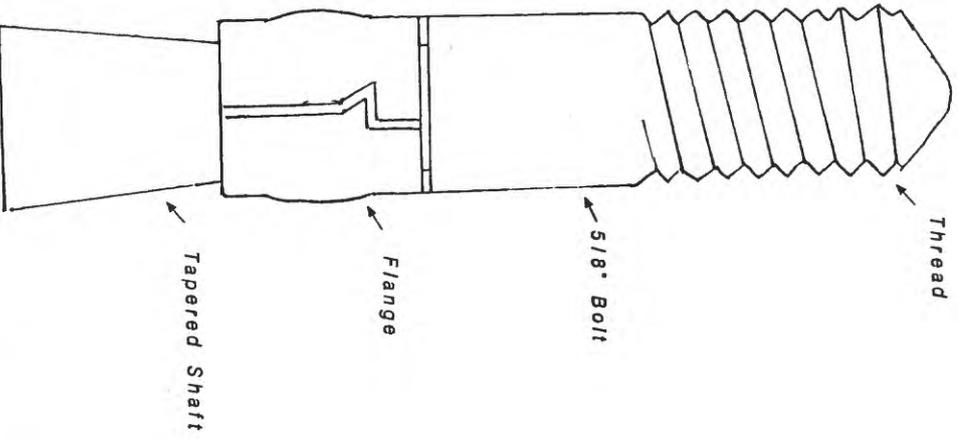


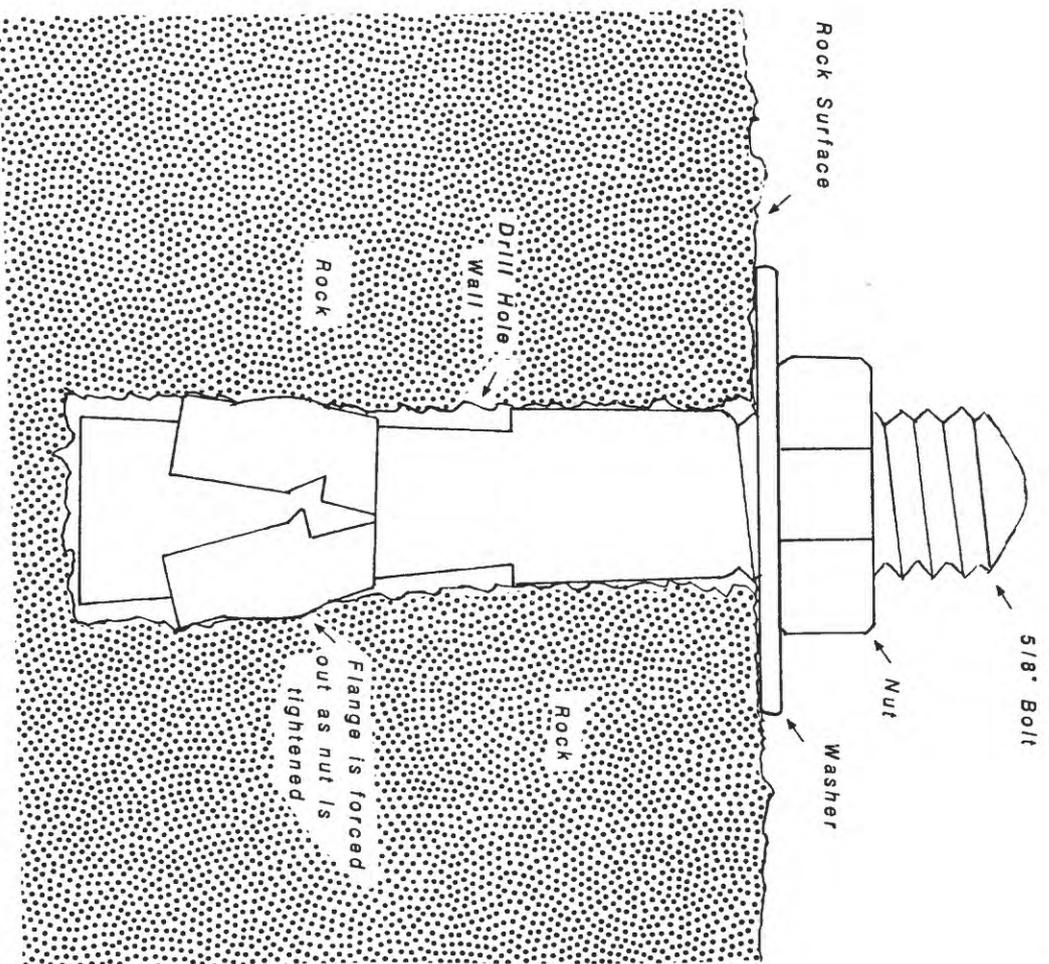
Figure 1 Map showing Aniakchak volcano and other volcanoes of the Alaska Peninsula

Figure 2



Stainless Steel Bolt before installation

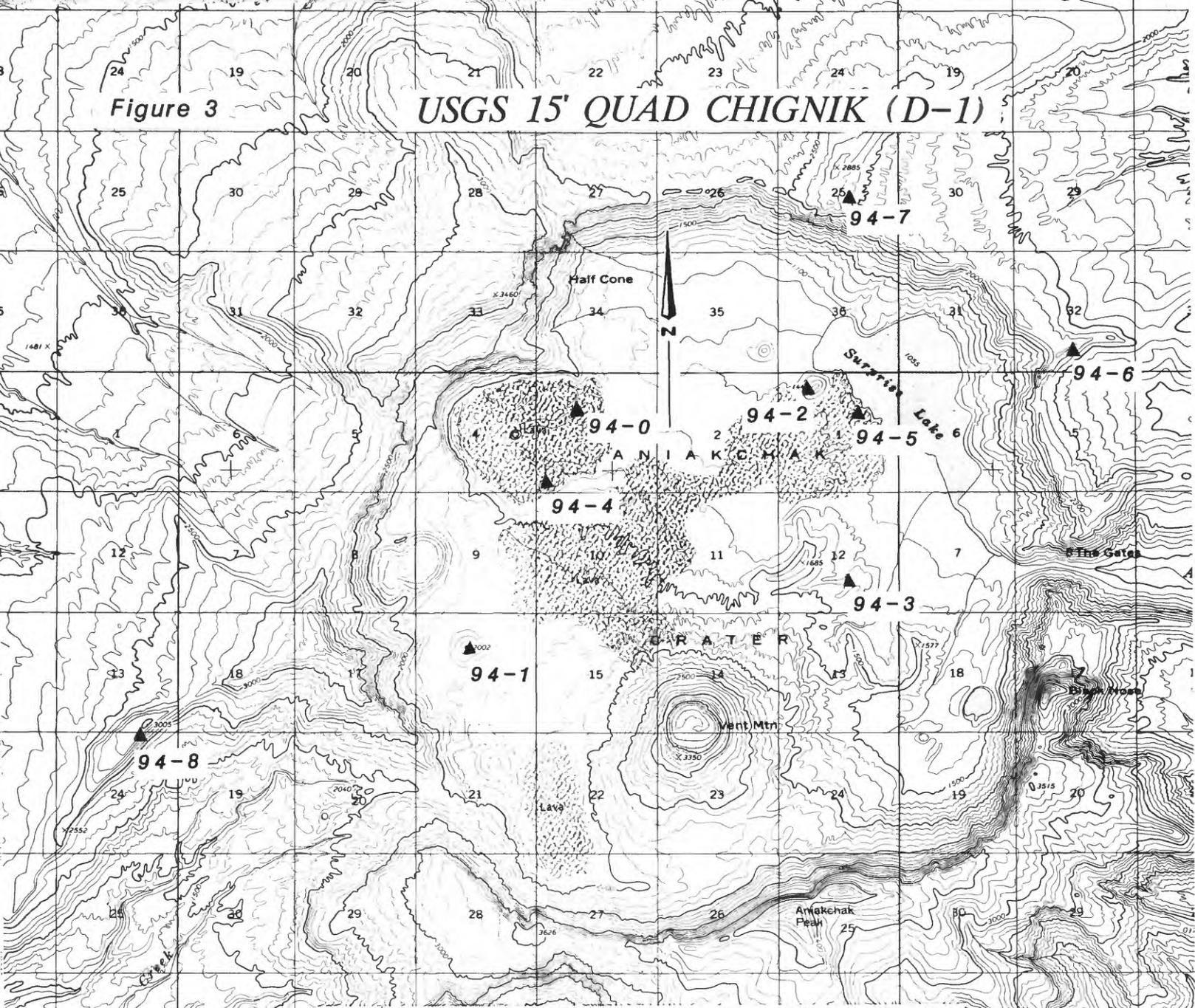
Figure 2a



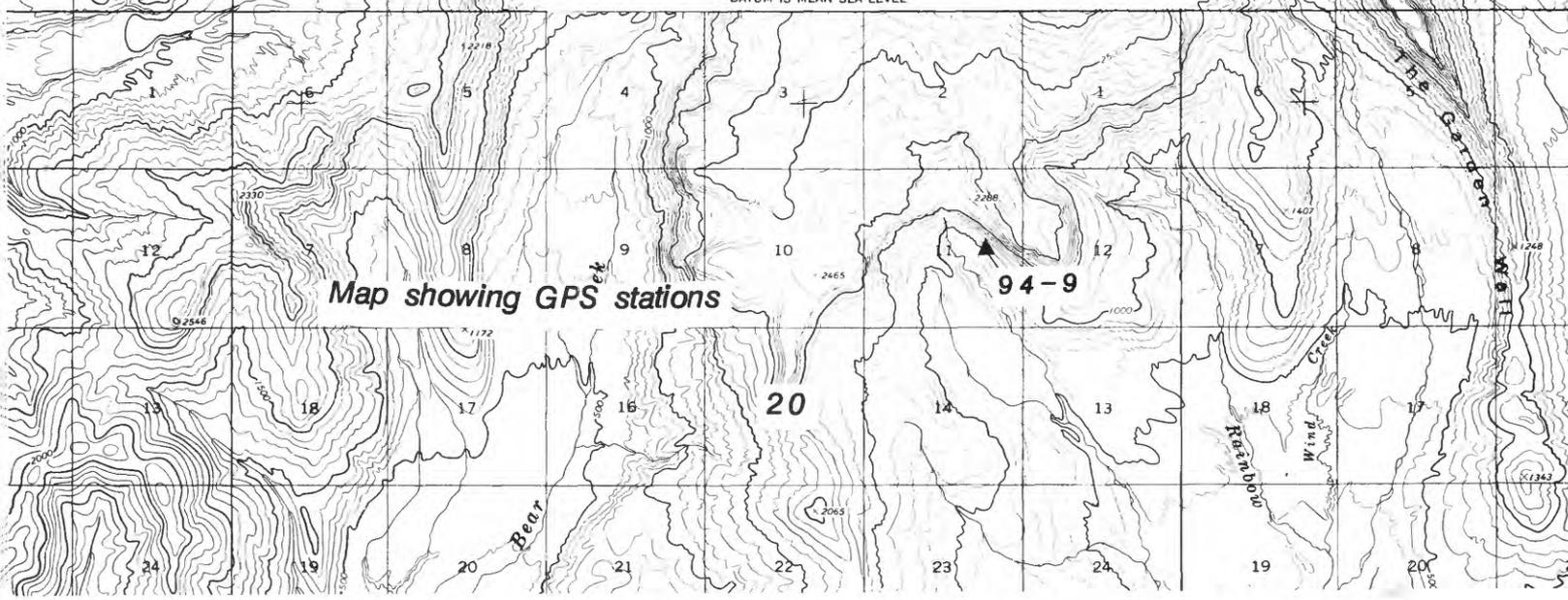
Stainless Steel bolt installed with washer

Figure 3

USGS 15' QUAD CHIGNIK (D-1)



CONTOUR INTERVAL 100 FEET
DATUM IS MEAN SEA LEVEL



Map showing GPS stations