MAP AND TABLES SHOWING GEOCHRONOLOGY AND WHOLE-ROCK GEOCHEMISTRY OF SELECTED SAMPLES, UGASHIK AND PART OF KARLUK QUADRANGLES, ALASKA

By

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INTRODUCTION

The accompanying map and tables show potassium-argon dating results and major- and trace-element chemical analyses completed in conjunction with geologic mapping and mineral assessment of the Ugashik, Bristol Bay, and western part of the Karluk quadrangles, Alaska. The work was done under the auspices of the Alaska Mineral Resource Assessment Program (AMRAP).

Reported here is a compilation of 41 new potassium-argon ages and 24 previously published ages on 46 rock samples. Replicate analyses were done on almost all samples because past experience indicates that Alaska Peninsula volcanic rocks tend to be inhomogeneous, possibly because of low-grade hydrothermal alteration. Also reported are 46 major-element chemical analyses and semi-quantitative emission spectrometric data for 27 selected samples. Analytical data for the age determinations are shown in table 1 for all samples; chemical data are shown in tables 2 and 3. Sample locations are shown on sheet 1.

DISCUSSION OF AGES

ANALYTICAL METHODOLOGY

Potassium-argon analyses were done following the principles of Dalrymple and Lanphere (1969). Potassium was determined by flame photometry using a lithium metaborate fusion technique (Engels and Ingamells, 1970). Argon extraction and measurement were accomplished using standard techniques of isotope dilution spectrometry, essentially as described by Dalrymple and Lanphere (1969). The analytical error assigned to each age reported here (table 1) is an estimate of the standard deviation of analytical precision, using the method of Cox and Dalrymple (1967) and our adaptation of modifications to this method described by Mahood (1980), and the authors calculated estimates of uncertainty in the concentration of the ^{38}Ar tracer and potassium measurements.

DESCRIPTION OF RESULTS

The range of ages for igneous rocks in the Ugashik and western Karluk quadrangles is similar to the range in the Chignik and Sutwik Island quadrangles to the south (Wilson and others, 1981). Rocks of both the Meshik arc of Wilson (1985) and Aleutian magmatic arc are represented in the map area. A single sample from the Triassic(?) volcanic rocks at Puale Bay was analyzed, extending the age range beyond that found in the Chignik and Sutwik Island quadrangles.

Mesozoic rocks

The basalt at Puale Bay is interbedded with Triassic (Norian) limestone, and a Triassic age was expected; however, an Early Jurassic age of 197 Ma (table 1) was obtained (latest Triassic, using the time scale of Van Eysinga (1975)). The sample is petrographically fresh, but potassium and argon inhomogeneity made it difficult to consistently replicate the K-Ar age of this sample. Only the two most concordant of four argon determinations are reported here. Volcaniclastic rocks equivalent to the Lower Jurassic Talkeetna Formation overlie the Triassic exposures at Puale Bay, and this sample may be from a sill or dike related to the Jurassic arc rather than a Triassic flow. Therefore, geologic interpretation of the age is subject to collection of further field data.

Meshik arc

Rocks of the Meshik arc are known to crop out only in the southern half of the Ugashik quadrangle. The exposures farthest to the north are associated with the Rex copper prospect. Ages for Meshik arc rocks in the Ugashik quadrangle range from 24.9 to 39.0 Ma. Many of the samples from the Ugashik quadrangle yield ages at the younger end of this range compared to the ages of the Meshik arc rocks in the Chignik and Sutwik Island quadrangles to the south (Wilson and others, 1981). Meshik volcanic rock samples not associated with the Rex prospect generally have ages younger than 30 Ma and are among the most mafic samples known from the Meshik arc. Those samples associated with the Rex prospect range in age from 31.4 to 38.8 Ma and include all the dacite samples.

Two samples (Ugashik 1 and Ugashik 2) included with Meshik rocks come from test wells (Brockway and others, 1975) southwest of Blue Mountain. Sample and analytical data other than the age and error is unavailable for these rocks. They are reported here only for completeness.

Two samples, 80AWs 228 and 81AWs 281, collected near the Pliocene Agripina Bay batholith yielded ages older than expected. Both samples were initially thought to represent volcanic and hydrothermal activity closely associated with the batholith or the Kialagvik volcanic center; however, they gave Oligocene ages. Sample 80AWs 228 is a slightly altered hornblende andesite porphyry from the Kilokak Creek copper prospect. Contact metamorphism of mineralized rocks near the batholith and the Oligocene age indicate that the mineralization predates the batholith. Sample 81AWs 281 was collected from a dike in Mesozoic sedimentary rocks that were contact metamorphosed by the Agripina Bay batholith. Partial alteration of plagioclase phenocrysts suggests that it predates contact metamorphism. Both ages have to be considered minimum ages, although it appears that resetting of the K-Ar clock was not great enough to obscure a probable Meshik arc association. The Oligocene age on these two samples suggests that the vicinity of the Agripina Bay batholith was also a location of Meshik arc magmatic activity. In further support of this, Meshik volcanic rocks are common southwest of the batholith.

The six hornblende, two plagioclase, two biotite, and one sericite separates from nine dated samples from the Rex prospect include both hydrothermal and primary phase minerals. Ten of these separates gave ages between 34.3 and 38.8 Ma, and one discordant biotite mineral separate was 31.4 Ma. The discordant biotite (sample R-31358a) is the youngest sample dated from the Rex prospect, and its discordance with coexisting hornblende suggests slow cooling after intrusion and hydrothermal alteration. At the Rex prospect, samples from unaltered rocks are slightly younger, although within analytical error, than samples from altered rocks. However, the data from samples 79ADt 23 and 80AWs 236 suggest a second later stage of hydrothermal alteration may have occurred.

Aleutian arc

Many of the dates from the study area were determined on rocks from the Aleutian magmatic arc. In general, the youngest rocks of the Aleutian Arc lie inland from the Pacific coast along the line of active volcanos. The age of the rocks tends to increase toward the Pacific coast to a maximum of about 15 Ma. The Quaternary volcanic centers in the study area include Yantarni volcano, Mount Chiginagak, Mount Kialagvik, Mount Peulik-Ugashik caldera, The Gas Rocks, and Blue Mountain. Quaternary volcanic rocks of Aniakchak Crater to the south (Chignik 1:250,000-scale quadrangle) and Kejulik volcano to the north (Mount Katmai 1:250,000-scale quadrangle) also extend into the Bristol Bay, Ugashik, and Karluk quadrangles. A small Quaternary center also lies north of Alinchak Bay, but we were unsuccessful in obtaining a replicatable date on this center.

The Agripina Bay batholith is one of the large coastal batholith complexes that Burk (1965) described and suggested were middle Tertiary in age, as is the Devils batholith in the Chignik quadrangle to the south (Wilson and others, 1981). The Agripina Bay batholith is a multiphase granodiorite to quartz diorite pluton that grades texturally into a structurally overlying volcanic sequence. A volcanic neck at Chiginagak Bay is the remnant of a feeder vent for the volcanic rocks. A date on a sample (sample 77AWs 9) from this neck yielded an age of 9.25 Ma, significantly older than five other ages on plutonic rocks from the batholith that range between 2.02 and 4.21 Ma. The Mount Becharof and Cape Igvak area also has a group of small plutons that yield ages between 2.38 and 5.10 Ma, essentially the same as the Agripina Bay batholith to which these plutons appear compositionally similar. Both the Agripina bay batholith and the Mount Becharof and Cape Igvak plutons intrude Mesozoic rocks along the Wide Bay anticline. Plutons from both these complexes yield ages significantly younger than the coastal Devils batholith (6 to 10 Ma.) in the Chignik quadrangle to the south (Wilson and others, 1981). All are significantly younger than the previously assigned (Burk, 1965) middle Tertiary age; therefore, Burk's interpretation that the coastal batholithic complexes were intruded before and contributed to Miocene sedimentation is in error.

On the periphery of the Agripina Bay batholith are several small altered and mineralized zones; one, the Kilokak Creek prospect previously discussed, predates the batholith. Another unnamed mineral occurrence to the northwest of the batholith yielded an age of 3.52 Ma on a sericitically altered rock sample (sample 80AWs 220), indicating hydrothermal alteration related to emplacement of the batholith.

Pleistocene ages have been determined on several samples from the younger volcanic centers. A sample (79AMm 34) from a dacitic dome, The Gas Rocks, gave discordant results on separates of biotite, hornblende, and plagioclase, 0.135, 0.267, and 0.596 Ma, respectively. Blue Mountain, a dacite dome cluster that has been previously mapped as a Jurassic (Beikman, 1980) or Tertiary (Burk, 1965) pluton, also yielded a number of Pleistocene ages. Three dacite samples from Blue Mountain yield ages between 0.55 and 1.66 Ma. One of these, sample 79AYb 90, yielded strongly discordant ages on plagioclase (1.66 Ma) and an impure hornblende separate (0.55 Ma.) that contained approximately 5 to 10 percent plagioclase. South of Blue Mountain, at VABM "Lone", an isolated outcrop of olivine basalt flows yielded a whole rock age of 0.591 Ma from one flow.

Plagioclase mineral separates consistently yielded ages older than other phases from the same rock at dated Pleistocene volcanic centers. In these rocks plagioclase is typically a phenocryst phase, and we suggest that the discordant age indicates incorporation of magmatic argon in phenocryst phases as a result of incomplete degassing of the magma. The hornblende from the Gas Rocks sample discussed above was also a phenocryst phase, and it was also discordant with coexisting biotite. In each case of discordance, the oldest phases are the lowest in potassium and, therefore, the most likely to show the effects of incomplete degassing. This is because a small but measurable amount of argon will have a greater affect on calculated ages due to a lower build up of radiogenic argon after crystallization because of the lower potassium content. In addition to the plagioclase discordance, the ages from Gas Rocks suggest that either the hornblende may have begun to retain argon later than the plagioclase or it is more prone to degassing under magmatic or near-magmatic conditions. In either case, the results from these rocks are at variance with normal expectations (Dalrymple and Lanphere, 1969; Hart, 1964) regarding degassing (argon retention) and cooling ages of mineral phases. Normally, argon retentivity is expected in the following order, hornblende, biotite, plagioclase, from most to least retentive of argon.

DISCUSSION OF CHEMICAL RESULTS

Samples were divided into two main groups corresponding to the Aleutian (less than 15 Ma) and Meshik (20 to 45 Ma) magmatic arcs. Two samples, 82AYb 184 and 81ASh 18, yielded ages between these ranges and for convenience are discussed with the Aleutian arc. Three samples, 79AWs 1, 80APP 1, and 66AR 1331, are Mesozoic in age and are not considered in the discussion of chemical data, although they are plotted with rocks of the Meshik arc in order for the reader to see their relative graphical position.

Table 2 presents the major-element chemical data, divided into geographic suites of samples. The suites of Aleutian arc rocks include the following: (1) Agripina Bay batholith and related volcanic rocks, (2) the plutons of Mount Becharof and Cape Igvak area, (3) the Blue Mountain volcanic center, including the VABM "Lone" volcanic flows, (4) the Kialagvik volcanic center and related flows, (5) the Kejulik volcanic center, (6) the Mount Peulik volcano and Ugashik caldera volcanic centers, (7) the Mike prospect, (8) Ukinrek Maars, (9) Yantarni volcanic center, and (10) a small group of miscellaneous samples. The Meshik arc is divided into three rock suites: (1) the Rex prospect, (2) the Meshik arc (undivided), and (3) the Kilokak Creek prospect. A final rock grouping includes the three miscellaneous Mesozoic rocks.

All samples in table 2 have identification letters assigned sequentially within each suite and between suites. These letters were used for plotting on eight diagrams (sheet 2). Samples from the Aleutian and Meshik arc were plotted on separate diagrams; samples from each suite were plotted on normative ternary diagrams, Q:Or:Ab+An (figs. 1 and 5) and Na_2O+K_2O:FeO*:MgO (figs. 2 and 6). Plutonic rocks were plotted using estimated modes determined from both thin-section and normative data. SiO_2 versus FeO*/MgO (figs. 3 and 7; FeO* is defined as all iron in the analysis calculated as FeO) and some Harker diagrams (figs. 4 and 8) were also plotted for each suite.

Table 3 shows semiquantitative emission-spectrometric (ES) data for samples where we have geochronological or major-element chemical data. They are included here to give the reader the complete analytical data from each sample in one publication. A more complete summary of the ES data is reported by Wilson and O'Leary (1986, 1987), who list the ES data for all available samples and include tables that show the level for each element at which a sample can be considered anomalous and correlation coefficients for the various element combinations. A number of the samples shown in table 3 were apparently nonmineralized samples but were anomalous in copper, molybdenum, lead, or zinc.

Plutonic rocks were named in accordance with the Streckeisen (1976) IUGS classification. Volcanic and hypabyssal rocks were named using the Streckeisen (1979) IUGS classification and normative data. As suggested by Streckeisen (1979), andesite and basalt are distinguished using a plot of SiO_2 versus normative color index (NCI). In addition, K_2O versus SiO_2 was plotted to allow naming of volcanic rocks using the scheme adopted by Gill (1981); these names are shown in parentheses in the table of rock descriptions.

MESHIK ARC ROCKS

The Meshik arc samples can not be divided into well-defined suites by geologic relations or from any of the Harker diagrams (fig. 8), in large part because of limited sampling. The only well-sampled suite of Meshik arc age is from the Rex prospect. However, varying levels of hydrothermal alteration have obscured original magmatic chemistry, and the suite does not form a well-defined linear trend on the Harker diagrams.

ALEUTIAN ARC ROCKS

The younger group of rocks ranges in composition from basalt to dacite for the volcanic and hypabyssal rocks and from quartz diorite to granodiorite for the intrusive rocks. They are of calcalkaline affinity and have slightly lower iron enrichment than comparable rocks in the Chignik and Sutwik Island quadrangles to the south (Wilson and others, 1981). This may be a reflection of a greater interaction with continental crust in the more northern part of the arc. The Na_2O+K_2O:FeO*:MgO ternary diagram (fig. 2) for Aleutian arc samples shows the data plots within the field defined by Ringwood (1977) for calc-alkaline rocks and generally well below the line separating calc-alkaline from tholeiitic rocks as suggested by Irvine and Baragar (1971). Potassium contents (fig. 4D) correspond to Gill's (1981) medium-potassium range, and alkali-lime indices (Peacock, 1931) of the individual rock suites vary from 61 to 64.7, or calcic, which is similar to the Chignik and Sutwik Island quadrangles rocks and characteristic of Aleutian arc rocks in general (Coats, 1952, 1953; Snyder, 1959; Hildreth, 1983). However, on a SiO_2 versus FeO*/MgO plot (fig. 3), the Kejulik volcanic-center samples tend to fall in the tholeiitic field, as defined by Miyashiro (1974); they also tend to be the closest of all the Ugashik-Karluk suites to the Irvine and Baragar (1971) line.

When samples from most of the suites are plotted on a MgO versus SiO_2 diagram (fig. 4A), the data for each suite tend to fall along distinct lines of the same or similar slope. Although not always well defined, each suite can be shown to have a characteristic position in the data field. The samples from the Kialagvik volcanic center (samples U-Z, a-d on figures) tend to have the highest MgO values of the data set at a given SiO_2 content, particularly at higher SiO_2 due to the low negative slope, although the Agripina Bay batholith (samples m-q) and the Mount Peulik-Ugashik Caldera volcanic center (samples H-N) also have generally high MgO at a given SiO_2. Yantarni volcano (samples e-f) (Riehle and others, 1987) is high in MgO at low SiO_2. Its MgO data have a steep negative slope that results in low MgO at high SiO_2. The Kejulik volcanic center (samples A-G) and the Mount Becharof-Cape Igvak area plutons (samples g-j) tend to have the lowest MgO at a given SiO_2 of all the Ugashik rocks.

The Agripina Bay batholith samples (m-q) form a well-defined trend at the upper extreme of the data field on plots of both K_2O versus SiO_2 (fig. 4*D*) and total alkalis versus SiO_2 (fig. 4*E*). On a CaO versus SiO_2 diagram (fig. 4*B*), the batholith samples lie in the lowermost part of the field. The plutons of Mount Becharof and Cape Igvak are in strong contrast to this. The data from these plutons (samples g-j) plot in the lowest part of the field for K_2O versus SiO_2 (fig. 4*D*), near the lowest part of the total alkalis versus SiO_2 plot (fig. 4*E*) and at the uppermost part of the CaO versus SiO_2 field (fig. 4*B*). The Na_2O content (fig. 4*C*) for both suites is similar. The plutons of both these suites intrude rocks of the Upper Jurassic Naknek Formation and both are of Pliocene age. In addition, both occur at the same distance from the present Aleutian Trench. We assume that during the Pliocene, the paleo-Aleutian Trench had the same general orientation. However, an important difference between the two is that the Agripina Bay batholith intrudes an area where Meshik arc volcanism and hydrothermal activity occurred. This may explain the more evolved nature of the Agripina Bay plutons because they may incorporate remelted rocks of the Meshik arc and, therefore, have, in part, been through an additional cycle in the magma generation process compared to the Mount Becharof-Cape Igvak plutons. This may also help to explain the much higher level of mineralization associated with the Agripina Bay batholith.

Yantarni volcano, which lies 30 km southwest of Kialagvik volcano and 15 km southwest of Mount Chiginagak volcano, is chemically well defined by a total of 31 analyses (samples e, f, and 29 other analyses cited in Riehle and others, 1987). Compared to the other suites, Yantarni is high in CaO, low in Na_2O, and has average K_2O. The alkali-lime index is 65 for all Yantarni data, and it is 67 if only the older lava flows are considered. This index is significantly higher than the index for any other suite. Yantarni also has significantly higher MgO at low SiO_2 than other Ugashik area suites.

One of the tightest clusters of data in the study area is from the Kialagvik volcanic center (samples U-Z, a-d). Although the data ranges from 58.4 to 64.2 percent SiO_2, each plot is constrained over a limited range of alkalis, 0.5 percent Na_2O and 0.5 percent K_2O. However, CaO is high and varies linearly over a 2.11 percent range.

The Mount Peulik-Ugashik caldera suite (samples H-N) is the most SiO_2-rich suite of the Ugashik-Karluk rocks. Nevertheless, it is low in K_2O and comparatively low in total alkalis even though it is somewhat farther from the trench than most of the other volcanic centers. Although not distant spatially, the samples from Ukinrek Maars suite (S,T; JRC 09, JRC 10b; Kienle and others, 1980) and The Gas Rocks (H; 79AMm 34) are far off the trend of the Mount Peulik-Ugashik suite on all plots and appear chemically unrelated regardless of proximity and timing.

Blue Mountain (sample R), to the west of Ugashik Lake, is an eroded Quaternary dacitic volcanic center that had been considered a part of the Jurassic batholith (Beikman, 1980) before this project. It is significantly farther from the trench than other centers, but its K_2O content is about average for the Ugashik-Karluk suites.

Two isolated volcanic flows, one southwest of Blue Mountain at VABM "Lone" (sample 81AWs 275) and one southwest of Cape Kubugakli (sample 81AYb 138) are tholeiitic by Miyashiro's (1974) definition and are borderline tholeiitic by Irvine and Baragar's (1971) definition. Neither of these can be related to a particular volcanic center, although both are Pleistocene in age.

Each of the previously discussed suites plots in a similar slope on the Harker diagrams. In contrast, the Kejulik volcanic center suite (sample A-G, sample B-G from Kienle and others, 1983) plots in a well-defined, more steeply sloping linear trend that crosses the trends of the other suites on the K_2O versus SiO_2 (fig. 4*D*) and total alkalis versus SiO_2 (fig. 4*E*) diagrams. The CaO data are similar in pattern to other suites, and Na_2O data are narrowly constrained within a range of 0.5 percent except for one sample. Rocks from the Kejulik volcanic center plot within the calc-alkaline field of Irvine and Baragar (1971) on an Na_2O+K_2O:FeO*:MgO diagram (fig. 2). However, on a SiO_2 versus FeO*/MgO diagram (fig. 3), several Kejulik samples lie in the field defined as tholeiitic by Miyashiro (1974).

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Description of rock samples analyzed for major-element chemistry and age determinations, Ugashik and part of the Karluk quadrangles, Alaska

Rock names used in the descriptions follow the nomenclature of Streckeisen (1976; 1979); the terminology of Gill (1981) for volcanic rocks is also listed when it differs from Streckeisen (1979). In these cases, the Streckeisen rock name is followed by "S" and the Gill rock name is followed by "G". Anorthite content of plagioclase is based on optical determinations using Carlsbad-albite twinning (Kerr, 1977) except where shown with an asterik (*), which indicates it was determined using albite (Michel-Levy) twinning. Anorthite contents determined with albite twinning are considered to be minimums. Rock colors were determined on hand samples using Goddard (1948). Related samples from the Naknek quadrangle, north of the map area and Sutwik Island quadrangle, south of the map area are also included in this table.

66AR 1331 Ugashik D-2, 57°52.4'N., 156°32.1'W., Granodiorite from island in Becharof Lake. Mode: plagioclase (An 45, 43.3 percent), quartz (30.0 percent), K-feldspar (16.8 percent), hornblende (4.6 percent), and biotite (3.5 percent). Weakly porphyritic anhedral quartz in hypidiomorphic-granular matrix. Interstitial potassium feldspar, plagioclase is slightly sericitized (Reed and Lanphere, 1969; Dalrymple and Lanphere, 1974).

77AMs 3 Ugashik A-4, 57°14.6'N., 157°03.5'W., Rex prospect. Altered porphyritic hornblende diorite containing phenocrysts of plagioclase and hornblende in a fine-grained groundmass. Major minerals are plagioclase, chlorite, calcite, and potassium feldspar. Plagioclase partially altered to chlorite and calcite, hornblende completely altered to chlorite and calcite. High concentration of disseminated sulfides.

77AWs 9 Ugashik A-3, 57°00.3'N., 156°40.4'W., Chiginagak Bay. Hypabyssal intrusive plug of very dark gray, porphyritic andesite (S; basaltic andesite G). Clinopyroxene, orthopyroxene, and glomeroporphyritic plagioclase (An 55) phenocrysts in a groundmass of fine-grained opaque oxides and glass.

77AWs 12 Ugashik A-3, 57°01.1'N., 156°41.2'W., Chiginagak Bay. Hypabyssal sill-like body of medium-grained, dark-gray leucobasalt (S; basalt G). Phenocryst phases are plagioclase (An 65), clino-pyroxene, and minor orthopyroxene. Subophitic texture.

78ACe 4 Naknek A-2, 58°08.2'N., 156°10.3'W., north of Becharof Lake. Medium-grained, mafic-rich, medium-dark-gray (N 4) tonalite mottled with yellowish-gray (5 Y 8/1). Estimated mode is hornblende (40 percent), biotite (10 percent), plagioclase (An 70, 30 percent), and quartz (20 percent). Green pleochroic hornblende and brown biotite in groundmass of plagioclase and quartz. Accessory opaque oxides (<1 percent). Texture is hypidiomorphic-granular, although a few euhedral grains are present. Hornblende phenocrysts have sparsely distributed relic pyroxene.

78ADt 2 Naknek A-2, 58°10.5'N., 156°04.9'W., north of Becharof Lake. Coarse-grained hornblende-biotite granite. Estimated mode is plagioclase (An 40, 30 percent), quartz (30 percent), potassium feldspar (25 percent), hornblende (10 percent), and biotite (5 percent). Biotite and plagioclase phenocrysts are commonly deformed, quartz is strained, and potassium feldspar is slightly perthitic. Hornblende phenocrysts have inclusions of plagioclase, biotite, clinopyroxene, and opaque oxides. Sparsely distributed xenoliths of fine-grained subophitic andesite(?).

78ADt 34 Sutwik Island D-4, 56°55.0'N., 157°14.0'W., Yantarni Creek. Lightly iron-stained, light-green-gray, porphyritic andesite containing phenocrysts of plagioclase and clinopyroxene in a groundmass of glass and fine-grained plagioclase. Plagioclase (An 55-60) phenocrysts are sieve textured and contain inclusions of glass. The groundmass shows poorly developed flow foliation around phenocrysts. Pilotaxitic texture.

79ACe 20 Ugashik A-6, 57°05.7'N., 157°43.2'W., between Pumice and Cinder Creeks. Dark-gray (N 3), fine-grained, porphyritic, flow-foliated olivine leuco-basalt (S; basalt G) flow. Phenocryst phases are olivine, uralized clinopyroxene(?), and plagioclase (minimum An 62). Olivine phenocrysts altered to iddingsite on grain boundaries. Some plagioclase crystals have cores of chlorite or uralite.

79ADt 23 Ugashik A-3, 57°12.1'N., 156°58.8'W., Rex prospect. Hypabyssal body of white- and black-mottled (light-gray (N 7)), propyliticaly altered hornblende andesite porphyry. Phenocryst phases are hornblende and plagioclase (An 54). Closely packed phenocrysts of hornblende and plagioclase in a groundmass of devitrified glass, plagioclase, and sericite. Most plagioclase phenocrysts are partially altered to sericite and many hornblende phenocrysts are partially altered to chlorite and calcite. Abundant epidote.

79ADt 95 Ugashik A-3, 57°14.9'N., 156°54.6'W., Meshik Formation. Hypabyssal body of hornblende andesite porphyry having a light-bluish-gray (5 B 7/1) groundmass and black (N 1) hornblende phenocrysts. Major minerals are hornblende, plagioclase (An 66), glass, quartz, and calcite. Hornblende phenocrysts are pleochroic in green and yellow and show weak foliation. Groundmass is fine-grained anhedral plagioclase and devitrified glass. Small percentage of quartz crystals (<5 percent), some of which are subhedral or euhedral. Plagioclase shows minor sericitization.

79ADt 96 Ugashik B-3, 57°16.0'N., 156°57.4'W., Wandering Creek, near Rex prospect. Hypabyssal body of hornblende andesite. Hornblende phenocrysts in groundmass of highly fractured plagioclase phenocrysts and glass. Rare quartz and biotite. Plagioclase composition indeterminate.

79ADt 135 Ugashik C-3, 57°42.2'N., 156°52.0'W., Blue Mountain. Bluish-white (5 B 9/1), vesicular, glassy hornblende dacite (S: high-silica andesite G). Phenocryst phases are plagioclase (An 64) and hornblende. Hornblende has abundant included opaque oxides. Abundant glass in groundmass, commonly in frothy pockets, showing little devitrification. Dome associated with Blue Mountain volcanic center.

79AMm 34 Ugashik D-2, 57°50.0'N., 156°30.0'W., Gas Rocks. Hypabyssal plug of light-gray (N 7) dacite porphyry. Phenocryst phases are hornblende, biotite, plagioclase (An 48), and quartz. Phenocrysts are dominated by plagioclase, and less abundant hornblende and biotite in a glassy groundmass. Quartz is in blebs although it appears primary. Plagioclase phenocrysts have overgrowths over corroded cores. Rock is partly vesicular.

79AWs 1 Ugashik B-4, 57°22.0'N., 157°03.7'W., VABM Dog, near Dog Salmon River. Coarse-grained tonalitic gneiss cobble from the Jurassic Naknek Formation. Estimated mode is hornblende (5-10 percent), biotite (10-15 percent), plagioclase (An 37, 60 percent), quartz (20-25 percent), and chlorite. Quartz and biotite grains slightly strained in thin section. Provenance date.

79AWs 2 Ugashik A-5, 57°06.5'N., 157°38.2'W., Pumice Creek. Gray-weathering andesite flow. Major minerals are plagioclase (An 40*, a poor quality Carlsbad-albite determination suggests minimum of An 50), orthopyroxene, and clinopyroxene. Contains sparsely distributed phenocrysts of orthopyroxene, clinopyroxene, and rare plagioclase in a flow-foliated groundmass of very fine grained plagioclase, augite (or amphibole), and glass.

79AWs 6a Ugashik A-5, 57°02.7'N., 157°24.2'W., Yantarni. Dark-greenish-gray (5 G 4/1), porphyritic andesite (S: basalt G) dike intruding Mesozoic sedimentary rocks. Major minerals are clinopyroxene and plagioclase (An 58). Abundant opaque oxides. Glomeroporphyritic phenocrysts of augite and sparse plagioclase in a groundmass of plagioclase, opaque minerals, and devitrified glass. Some augite phenocrysts are altered to calcite and uralite. Weak development of flow foliation as indicated by plagioclase laths in groundmass. Minor alteration of plagioclase phenocrysts. Associated with Yantarni volcanic center.

79AWs 17 Ugashik B-3, 57°15.6'N., 156°49.4'W., northwest of Kialagvik near VABM Gob. Medium-light-gray (N 6), porphyritic dacite (S: high-silica andesite G). Major phases are clinopyroxene, orthopyroxene (hypersthene), plagioclase (An 58 and possibly An 40), and glass. Phenocrysts of plagioclase and pyroxene as much as 7 mm in length in a very fine grained to aphanitic groundmass of plagioclase, glass, and opaque minerals. In thin section, areas of the groundmass are more transparent than others; these more transparent areas contain fewer opaque minerals and are located in areas of augite concentration. Sample contains two types of plagioclase phenocrysts; some are poikilitic and have overgrown edges, and others are unaltered, free of inclusions, and may have resorbed edges. Most plagioclase phenocrysts of both types have compositions between An 60 to 70, although some may have compositions nearer to An 40.

79AWs 24a Ugashik B-3, 57°23.9'N., 156°54.8'W., near Elizabeth Lake. Coarse- to medium-grained, mafic-rich granite cobble in the Jurassic Naknek Formation. Estimated mode is plagioclase (An 42, 30 percent), potassium feldspar (30 percent), quartz (15 percent), biotite and chlorite (15 percent), and hornblende (10 percent). Hornblende typically has pyroxene cores, biotite grains may be chloritized. Hypidiomorphic-granular texture. Provenance date.

79AYb 22 Ugashik A-4, 57°12.8'N., 157°01.3'W., south edge Rex prospect. Hypabyssal body of hornblende dacite (S; high silica andesite G) that has a very light gray (N 8) groundmass and grayish-black (N 2) phenocrysts. Phenocryst phases are hornblende, plagioclase, and glass. Plagioclase composition indeterminate, appears partially resorbed. Glass devitrified. Hornblende is dominant phenocryst, crystals as much as 5 mm in length.

79AYb 37 Ugashik A-4, 57°14.2'N., 157°15.2'W., Mother Goose Lake. Dark-gray (N 3), porphyritic leuco-basalt(?). Major phases are plagioclase (An 65), clinopyroxene, orthopyroxene, and glass. Free-floating plagioclase phenocrysts in a glassy groundmass. Pyroxene in large glomeroporphyritic phenocrysts, compared to smaller individual plagioclase phenocrysts. Fine-grained pyroxene and plagioclase inclusions.

79AYb 90 Ugashik C-3, 57°41.5'N., 156°50.0'W., Blue Mountain. Light pinkish-gray (5 YR 8/1), vesicular hornblende plagioclase dacite (S; high-silica andesite G) porphyry. Extrusive, possibly a dome. Major phases are hornblende, plagioclase (An 54*), and glass. Poikilitic, brown to green pleochroic hornblende phenocrysts generally have sharp euhedral grain boundaries and no evidence of resorption. Plagioclase phenocrysts are unaltered, although grain boundaries are rounded and the phenocrysts have lines of inclusions in a thin zone parallel to the grain boundary, suggesting resorption and recrystallization. The plagioclase grains include weakly zoned and strongly oscillatory zoned grains that have an average composition of An 54 or greater. The very fine grained groundmass is primarily glass and devitrified glass and a small proportion of microcrystalline plagioclase and hornblende(?).

79AYb 101 Ugashik A-4, 57°03.8'N., 157°13.3'W., Mike prospect. Hydrothermally altered hornblende-biotite dacite porphyry dike. Coarse phenocrysts of biotite, plagioclase (An 46), quartz, and altered hornblende in a fine-grained groundmass of feldspar, secondary biotite, and quartz. Fine-grained biotite and chlorite pseudomorphs after hornblende. Plagioclase phenocrysts are generally unaltered, although grain boundaries show resorption into the groundmass. A few plagioclase grains are sericitically altered and may be partially saussuritized. Quartz phenocrysts have rounded outlines, and grain boundaries show resorption. Biotite phenocrysts show minor alteration to chlorite; chlorite is much more abundant in pseudomorphs after hornblende.

79AYb 102 Ugashik A-4, 57°04.6'N., 157°09.8'W., Mike prospect. Hypabyssal body of very light gray (N 8), hydrothermally altered hornblende dacite(?). Major minerals are chlorite, plagioclase, sericite, pyrite, and opaque oxides. Chlorite replaces hornblende. Plagioclase is of indeterminate composition and extensively sericitized. Quartz occurs as blebs and may be secondary. Rock has bleached appearance due to alteration and contains about 10 percent pyrite.

80ACx 12c Ugashik A-4, 57°14.4'N., 157°03.8'W., Rex prospect. Hypabyssal body of medium-gray (N 5), porphyritic hornblende dacite. Major minerals are plagioclase (An 56), hornblende, glass, quartz, chlorite, and biotite. Biotite rare, quartz in blebs, and chlorite very sparse. Mafic phenocrysts, as much as 5 mm in length, dominate in a glassy groundmass.

80ACx 41 Karluk D-4, 57°53.5'N., 155°08.6'W., Cape Kubugakli. Propylitically altered porphyritic hornblende andesite. Phenocrysts of mildly sericitically altered plagioclase (An 56) as much as 6 mm in size and partially altered hornblende. Hornblende is green pleochroic and has high birefringence. Chlorite relatively common, some appears to be after biotite, some after hornblende. Possible white mica in cores of altered hornblende phenocrysts. Rare quartz blebs and calcite in groundmass.

80APP 1 Karluk C-5, 57°42.0'N., 155°20.0'W., Puale Bay. Olive-black (5 Y 2/1), porphyritic basalt flow. Major minerals are orthopyroxene, clinopyroxene (augite), plagioclase (An 64), chalcedony, and calcite. Fresh-appearing flow-foliated rock. Amygdules filled with calcite and chalcedony.

80AWs 201 Ugashik B-1, 57°26.2'N., 156°03.7'W., Cape Igvak. Medium- to fine-grained, yellowish-gray (5 Y 8/1) and dark-gray (N 3) tonalite. Estimated mode is hornblende (15-20 percent), biotite (5-10 percent), plagioclase (An 62, 60 percent), and quartz (5-10 percent). Most hornblende is chloritized or partially replaced by biotite. Plagioclase fresh, abundant interstitial primary quartz.

80AWs 205 Ugashik C-1, 57°32.5'N., 156°05.7'W., Mount Becharof. Medium-grained, white (N 9) and grayish-black (N 2) granodiorite. Estimated mode is quartz (30 percent), K-feldspar (10 percent), plagioclase (An 40, 40-50 percent), biotite (5-10 percent), hornblende (5-10 percent), and chlorite. Biotite and hornblende are both fresh.

80AWs 207 Ugashik C-1, 57°32.3'N., 156°05.4'W., Mount Becharof. Dark-gray (N 3), fine- to medium-grained tonalite. Estimated mode is biotite (10 percent), actinolitic (25 percent) amphibole, plagioclase (An 58, 50 percent), and quartz (15 percent). Plagioclase is zoned and contains zones rich in biotite and amphibole inclusions. Biotite primarily occurs as inclusions in amphibole, however, a small proportion occurs in individual separate grains. Minor sericitization.

80AWs 211 Ugashik A-2, 57°10.4'N., 156°20.2'W., Cape Kilokak. Hypabyssal body of dark-greenish-gray (5 G 4/1), porphyritic andesite (S; high-silica andesite G). Major phases are hornblende, plagioclase (An 62), and sericite. Hydrothermally altered, chlorite after amphibole. Plagioclase is sericitically altered along fractures. Plagioclase grains yield variable compositions, in part due to sericitic alteration rendering grains unsuitable for optical determination.

80AWs 216 Ugashik A-2, 57°10.9'N., 156°27.9'W., Agripina Bay batholith. Light-bluish-gray (5 B 7/1), fine- to medium-grained granodiorite. Distinctive in field due to pink potassium feldspar crystals. Estimated mode is plagioclase (An 56, 60 percent), hornblende (5 percent), biotite (5 percent), potassium-feldspar (10-15 percent), and quartz (15-20 percent). Hornblende partially altered to biotite, incipient sericitization of plagioclase.

80AWs 217b Ugashik A-2, 57°11.9'N., 156°23.5'W., Imuya Bay. Hypabyssal body of greenish-gray (5 G 6/1), brown-weathering, hydrothermally altered, porphyritic hornblende andesite (S; basalt G). Major minerals are hornblende and plagioclase. Plagioclase composition indeterminate due to sericitic alteration of plagioclase phenocrysts and groundmass. Hornblende relatively fresh.

80AWs 220 Ugashik A-2, 57°6.7'N., 156°38.0'W., north of Port Wrangell. Extremely fine-grained, light-greenish-gray (5 GY 8/1) quartz-sericite altered rock. Very hard, has almost conchoidal fracture. Hand sample and thin section show apparent sericite pseudomorphs after plagioclase or mafic minerals. Groundmass is aphanitic siliceous material and sericite.

80AWs 227 Ugashik A-2, 57°03.1'N., 156°33.7'W., Port Wrangell. Fine- to medium-grained pyroxene monzonite. Estimated mode is potassium feldspar (5-10 percent), quartz (5-10 percent), plagioclase (An 58, 50 percent), orthopyroxene and clinopyroxene (30 percent), biotite (<5 percent), and chlorite (<5 percent). Biotite appears secondary from pyroxene, some pyroxene also has chlorite alteration.

80AWs 228 Ugashik A-2, 57°11.7'N., 156°23.9'W., Kilokak Creek. Hypabyssal body of bluish-white (5 B 9/1) and dark-gray (N 3) hornblende andesite (S; basalt G) porphyry. Major minerals are hornblende, plagioclase, and chlorite. Plagioclase composition indeterminate. Groundmass is fine-grained anhedral plagioclase and abundant hydrothermal chlorite. Amphibole slightly altered to chlorite.

80AWs 236 Ugashik A-4, 57°14.6'N., 157°04.8'W., Rex prospect. Hypabyssal body of light-bluish-gray (5 B 7/1) and grayish-black (N 2), propylitically altered hornblende dacite porphyry. Major minerals are hornblende, plagioclase (An 58), quartz, epidote, and pyrite. Phenocrysts of plagioclase and hornblende in a mosaic-textured groundmass of fine-grained quartz, plagioclase, and opaque oxides.

80AWs 253 Karluk D-4, 57°51.9'N., 155°07.6'W., Cape Kubugakli. Hornblende-plagioclase dacite porphyry. Major phases are hornblende, plagioclase, and glass. Plagioclase composition indeterminate. Plagioclase phenocrysts appear shattered. Possibly tuffaceous, interbedded with fine-grained, rhythmically bedded siltstone-sandstone sequence.

81ARj 11a Ugashik C-2, 57°42.2'N., 156°24.8'W., Ugashik caldera. Porphyritic plagioclase-orthopyroxene dacite (S; high-silica andesite G). Glassy groundmass contains randomly oriented phenocrysts of orthopyroxene and larger phenocrysts of plagioclase (An 64-68). Some parts of the thin section have glomeroporphyritic pyroxene and plagioclase; bulk of the phenocrysts are individual crystals. Plagioclase is weakly zoned.

81ARj 11b Ugashik C-2, 57°42.5'N., 156°24.6'W., Ugashik caldera. Vitric clast from volcanic breccia. Porphyritic plagioclase-pyroxene-hornblende dacite (S; high-silica andesite G). Glassy groundmass contains abundant randomly oriented phenocrysts of plagioclase (An 70), clinopyroxene, hornblende, and biotite. Clinopyroxene are pleochroic from tan to pale green, hornblende is pleochroic from brown to yellow brown. Hornblende and biotite crystals outlined in opaque minerals, clinopyroxene altered on edges to brown aphanitic phase. Plagioclase is variably zoned.

81ARj 13 Ugashik C-2, 57°43.5'N., 156°22.2'W., Ugashik caldera, dome. Porphyritic hornblende-biotite dacite. Flow-foliated glassy groundmass contains rounded phenocrysts of plagioclase and quartz. Dominant mafic is dark-green hornblende, lesser biotite, and sparse orthopyroxene. Plagioclase (An 54) is generally Carlsbad twinned, but has rare albite twins.

81ARj 13b Ugashik C-2, 57°43.5'N., 156°22.2'W., Ugashik caldera, inclusion from sample 81ARj 13. Porphyritic hornblende-biotite dacite. Vesicular, flow-foliated glassy groundmass contains rounded phenocrysts of plagioclase and quartz. Dominant mafic is dark-green hornblende, abundant biotite after hornblende, and no orthopyroxene as compared to sample 81ARj 13. Plagioclase is albite twinned and has rare Carlsbad twins.

81ARj 16 Ugashik A-3, 57°10.6'N., 156°45.5'W., Mount Kialagvik. Porphyritic plagioclase-orthopyroxene-clinopyroxene dacite (S; high-silica andesite G) flow. Weakly foliated phenocrysts of plagioclase (An 58) in a glassy groundmass. Grain boundaries and fractures in some clinopyroxene are altered to opaque minerals. Larger phenocrysts are fractured and shattered. Rare lithic(?) fragments. Rounded quartz phenocrysts in reaction relation with groundmass.

81ARj 18 Ugashik A-2, 57°10.1'N., 156°34.0'W., Icy Peak. Two pyroxene-plagioclase dacite (S; high-silica andesite G) porphyry. Phenocrysts of orthopyroxene and clinopyroxene in a fine-grained groundmass. Orthopyroxene dominates. Many phenocrysts are in reaction relation with groundmass, and groundmass appears recrystallized.

81ARj 36 Ugashik A-3, 57°11.9'N., 156°44.1'W., Mount Kialagvik, older dome. Porphyritic dacite (S; high-silica andesite C). Strongly flow foliated, contains phenocrysts of plagioclase (An 60) and clinopyroxene in a devitrified groundmass. Minor alteration of phenocrysts in which clinopyroxene alters to bastite and opaque minerals. Abrupt transition in thin section from aphanitic to fine-grained groundmass.

81ARj 37 Ugashik A-3, 57°12.0'N., 156°44.2'W., Mount Kialagvik dome. Porphyritic biotite dacite tuff. Flow-foliated glassy groundmass containing phenocrysts of plagioclase (An 66) and biotite and opaque minerals after hornblende. Some lithic fragments, which appear to have granitic textures, have clinopyroxene interiors. Some mafic grains are entirely replaced by opaque minerals. Sparse, rounded quartz phenocrysts or fragments.

81ARj 38a Ugashik A-3, 57°12.0'N., 156°46.5'W., Mount Kialagvik. Fine-grained, flow-foliated, porphyritic dacite clast in ash flow. Contains phenocrysts of zoned plagioclase (An 60) and quartz and lithic fragments. Lithic fragments are plagioclase and clinopyroxene or only plagioclase; no mafic minerals are present among the phenocrysts or in the groundmass. Aggregates of very fine grained opaque minerals in pseudomorphs after hornblende(?).

81ARj 38b Ugashik A-3, 57°12.0'N., 156°46.5'W., Mount Kialagvik. Fine-grained, porphyritic dacite clast in ash flow. Very similar to sample 81ARj 38a; although, not flow foliated. Contains a higher proportion of lithic fragments, and the plagioclase phenocrysts have an An content of 56.

81ASh 1 Ugashik B-1, 57°27.3'N., 156°02.7'W., Cape Igvak. Light-bluish-gray (5 B 7/1), fine- to medium-grained, propyliticaliy altered diorite. Estimated mode is plagioclase (An 54, 40 percent), hornblende (30 percent), chlorite (15 percent), biotite (5-10 percent), and quartz (5 percent). Most feldspar grains are fractured. Biotite and quartz very sparse.

81ASh 2 Ugashik C-3, 57°42.1'N., 156°49.3'W., Blue Mountain. Very light gray (N 8), vesicular dacite porphyry. Major minerals are plagioclase (approximately An 63), biotite, hornblende, and quartz. Weakly flow foliated and contains phenocrysts of plagioclase, biotite, quartz, and rare hornblende in an aphanitic crystalline groundmass. Probably an extrusive dome.

81ASh 18 Ugashik A-3, 57°01.00'N., 156°59.1'W., west of Chiginagak Bay. Light-olive-gray (5 Y 5/2), porphyritic dacite (S; high-silica andesite C) flow. Major minerals are hornblende, biotite, plagioclase, chlorite, and sericite. Hydrothermally altered; minor sericitic alteration of plagioclase, extensive development of chlorite. Biotite possibly hydrothermal.

81AWs 266 Karluk D-6, 57°57.8'N., 155°45.9'W., Kejulik Mountains. Light-bluish-gray (5 B 7/1), vesicular, porphyritic basalt (S; basaltic andesite C) dike. Intrudes young lahars and volcanic rubble. Major phases are plagioclase (An 75), sparse orthopyroxene (hypersthene), rare clinopyroxene, and glass. Plagioclase and pyroxene phenocrysts in a fine-grained to glassy groundmass. Possibly very fine-grained, green, non-pleochroic amphibole in groundmass.

81AWs 269 Ugashik C-2, 57°42.0'N., 156°23.8'W., southwest rim of Ugashik caldera. Pale-red (5 R 6/2), vesicular, porphyritic dacite (S; high-silica andesite) flow. Major minerals are plagioclase (oscillatory zoned An 60 to An 72, average near An 63), orthopyroxene (hypersthene?), and rare clinopyroxene. Plagioclase and pyroxene phenocrysts in a very fine grained glass and plagioclase-lath groundmass. Mafic phenocrysts are smaller than plagioclase phenocrysts.

81AWs 271 Ugashik C-2, 57°43.5'N., 156°22.2'W., Ugashik caldera. Light-gray (N 7), vesicular biotite-plagioclase dacite porphyry. Major phases are biotite, quartz, hornblende, orthopyroxene, plagioclase (An 30*), and glass. Weakly developed flow foliation, numerous dark-gray (N 3) xenoliths in hand sample and thin section. Dome in postglacial(?) Ugashik caldera.

81AWs 275 Ugashik C-3, 57°38.2'N., 156°59.3'W., VABM Lone. Pale-red (5 R 6/2), vesicular, porphyritic leuco-basalt (S; basalt C) flow. Major minerals are olivine and plagioclase (An 50*). Large olivine phenocrysts in strongly flow foliated groundmass of plagioclase and olivine.

81AWs 276 Ugashik B-3, 57°16.0'N., 156°42.7'W., west of Lone Hill near Mount Kialagvik. Medium-gray (N 5) plagioclase dacite (S; andesite C) porphyry flow. Major phases are clinopyroxene, plagioclase (An 67), orthopyroxene(?), and glass. Very fine grained to aphanitic glassy groundmass and weakly aligned phenocrysts.

81AWs 281 Ugashik A-2, 57°11.7'N., 156°37.9'W., east of Mount Kialagvik. Hypabyssal body of finely mottled hornblende andesite (S; basalt C) porphyry. Groundmass is yellowish gray (5 Y 8/1) and contains dark-greenish-gray (5 GY 4/1) hornblende phenocrysts. Major phases are hornblende, plagioclase, glass, and epidote. Plagioclase composition indeterminate due to alteration. Propylitically altered, although hornblende is fresh appearing. Groundmass is devitrified, altered glass and plagioclase. Plagioclase appears kaolinized.

81AWs 287 Ugashik A-2, 57°08.0'N., 156°32.3'W., near VABM Grip on Agripina River. Mottled greenish-gray (5 GY 6/1), fine- to medium-grained quartz diorite. Estimated mode is biotite (5 percent), plagioclase (An 46, 50 percent), quartz (20 percent), clinopyroxene (15-20 percent), amphibole (5 percent), and potassium feldspar(?). Large phenocrysts of zoned plagioclase in a fine- to medium-grained groundmass. Pyroxene partially altered to amphibole and biotite.

81AYb 138 Karluk D-5, 57°52.3'N., 155°24.6'W., near Alinchak Bay. Medium-light-gray (N 6), vesicular, porphyritic basalt (S: basaltic-andesite C). Major minerals are plagioclase (An 76), clinopyroxene, and glass. Phenocrysts of plagioclase are fresh, complexly twinned, and weakly zoned. Plagioclase phenocrysts have sharp grain boundaries with the groundmass and constitute more than 30 percent of the rock.

81AYb 167 Ugashik A-2, 57°13.5'N., 156°39.8'W., ridge south of Lone Hill on Kialagvik Creek. Fine-grained to very fine-grained, dark-gray (N 3), porphyritic andesite (S: high-silica andesite C) containing common very light-gray (N 8) phenocrysts of plagioclase. Major minerals are plagioclase (An 65), clinopyroxene, and sparse orthopyroxene. Phenocrysts are medium-grained plagioclase, clinopyroxene, and orthopyroxene. Pilotaxitic groundmass contains weakly flow foliated plagioclase laths and glass. Rare altered phenocrysts may have been olivine, otherwise rock is fresh appearing.

81AYb 168 Ugashik A-3, 57°11.3'N., 156°42.1'W., southeast side of Mount Kialagvik. Medium- to fine-grained, medium-gray (N 5), hyalopilitic andesite (S: high-silica andesite C) porphyry containing very light gray (N 8) plagioclase phenocrysts and sparse dark-greenish-gray (5 G/Y 4/1) pyroxene phenocrysts. Major minerals are plagioclase (An 64), clinopyroxene, and lesser opaque oxides. Abundant phenocrysts in groundmass of glass and very fine grained plagioclase. Most phenocrysts and crystals have resorbed edges.

82AYb 184 Ugashik B-5, 57°15.3'N., 157°23.' W., about 2 km northwest of Mother Goose Lake. Fine-grained, holocrystalline olivine basalt. Small phenocrysts of olivine in a fine-grained groundmass of plagioclase (An 58), opaque oxides, and olivine. Olivine phenocryst grain boundaries are not sharp, but gradually merge with the groundmass. Larger plagioclase grains have glassy cores.

M-41059 Ugashik A-4, 57°04.0'N., 157°13.0'W., Mike prospect (sample provided by Bear Creek Mining Co.). Altered quartz-eye porphyry(?). Major minerals are quartz and muscovite. Large rounded and embayed quartz phenocrysts(?) in a fine-grained groundmass of quartz. Muscovite occurs in relatively coarse aggregates, possibly after feldspar, and as fine interstitial material in the groundmass. A few larger muscovite crystals have fibrous texture, and opaque inclusions may have replaced mafic minerals. Rock is of unknown, but probably igneous, original form.

R-41219 Ugashik A-4, 57°14.6'N., 157°03.5'W., Rex prospect (sample provided by Bear Creek Mining Co.). Quartz sericite altered dacite(?) dike. Major minerals are quartz, sericite, calcite, chlorite, potassium-feldspar, and sulfides. Originally porphyritic containing phenocrysts of plagioclase, now altered to calcite and sericite. Large amount of hydrothermal quartz, lesser amount of hydrothermal chlorite and potassium feldspar.

R-41358A Ugashik A-4, 57°14.2'N., 157°03.0'W., Rex prospect (sample provided by Bear Creek Mining Co.). Biotite-hornblende quartz diorite. Major minerals are plagioclase, hornblende, chlorite, biotite, quartz, and potassium feldspar. Relatively fresh plagioclase, poikilitic hornblende, and quartz in a sparse groundmass of quartz, plagioclase, and minor potassium feldspar. Biotite is present in minor amounts and appears to be primary or formed in reaction relation with hornblende; it doesn't appear hydrothermal. Hornblende has inclusions of plagioclase and quartz and shows minor replacement by chlorite. Fine-grained sulfides are concentrated around and within mafic minerals.

R-41360 Ugashik A-4, 57°14.2'N., 157°03.0'W., Rex prospect (sample provided by Bear Creek Mining Co.). Hydrothermally altered porphyritic granodiorite. Major minerals are plagioclase, quartz, potassium feldspar, and biotite. Saussuritized plagioclase phenocrysts in a fine-grained, sucrose-textured groundmass of quartz, plagioclase, and minor potassium feldspar(?). All mafic phenocrysts altered to hydrothermal biotite in characteristic aggregate texture. Biotite also occurs in veinlets. High concentrations of sulfides are associated with biotite. Minor chlorite alteration of biotite.

Table 1. Potassium-argon data

[Constants used were $^{40}K/K = 1.167 \times 10^{-4}$ mol/mol; $\lambda_\beta = 4.962 \times 10^{-1}$/year; $\lambda_\epsilon + \lambda_{\epsilon'} = 0.581 \times 10^{-1}$/year. Potassium analysts for the K-Ar dating were P.R. Klock, D.V. Vivit, and Byron Lai. Sample preparation, argon extraction, and data reduction by authors with aid from C.L. Connor, L.B. Gray-Pickthorn, Rita Taylor, Brian Ho, G.D. DuBois, and Douglas Lamm except for: samples R-41358A and R-41360, analyzed by M.L. Silberman; samples Ugashik 1, Ugashik 2, and Great Basins No. 1, reported in Brockway and others (1975); and sample 66AR 1331, reported in Reed and Lanphere (1969) and Dalrymple and Lanphere (1974). *Replicate K_2O analyses shown in two columns.* HF = hydrofluoric acid; X = mean age and error]

Sample number	Location (latitude longitude quadrangle)	Rock type	Mineral or component dated	K_2O (percent)		Mean K_2O (percent)	$^{40}Ar_{rad}$ x10-11	$^{40}Ar_{rad}$ (percent)	Age (Ma)	(±) sigma
Peulik volcano-Ugashik caldera volcanic center										
79AMm 34	57°50.0'N.	Dacite	Biotite	7.99	8.03	8.04	0.1525	1.1	0.132	0.058
	156°30.0'W.			8.08	8.02		.1564	1.2	.135	.007
	Ugashik D-2							X =	.134	.058
			Plagioclase	.431	.436	.434	.0329	2.5	.526	.029
			HF-treated	.438	.432		.0416	7.7	.665	.041
								X =	.596	.110
			Hornblende	.436	.438	.438	.0179	.9	.284	.102
				.440	.436		.0157	.7	.249	.111
								X =	.267	.153
Blue Mountain volcanic center										
79ADt 135	57°42.2'N.	Dacite	Plagioclase	.379	.375	.371	.0722	3.7	1.35	.10
	156°52.0'W.		HF-treated	.363	.365		.0716	14.6	1.34	.04
	Ugashik C-3							X =	1.35	.11
79AYb 90	57°41.5'N.	Dacite	Plagioclase	.418	.421	.420	.1014	9.9	1.68	.05
	156°50.0'W.		HF-treated	.420	.420		.0992	10.2	1.64	.05
	Ugashik C-3							X =	1.66	.07
			Hornblende and	.95	.97	.97	.0736	2.3	.53	.02
			plagioclase	.96	.98		.0797	2.4	.57	.02
								X =	.55	.04
81ASh 2	57°42.1'N.	Dacite	Biotite	8.50	8.53	8.53	1.132	11.1	.92	.03
	156°49.3'W.			8.56	8.53		1.269	12.3	1.03	.03
	Ugashik C-3							X =	.98	.09
			Plagioclase	.830	.812	.819	.1280	18.7	1.09	.03
			HF-treated	.821	.811		.1288	28.2	1.09	.02
								X =	1.09	.03
81AWs 275	57°38.2'N.	Leuco-	Whole-rock	.831	.730	.783	.0708	9.6	.627	.039
	156°59.3'W.	basalt	HF-treated	.797	.776		.0626	14.8	.555	.032
	Ugashik C-3							X =	.593	.073

Table 1. Potassium-argon data--Continued

Sample number	Location (latitude longitude quadrangle)	Rock type	Mineral or component dated	K_2O (percent)		Mean K_2O (percent)	$^{40}Ar_{rad}$ $\times 10^{-11}$	$^{40}Ar_{rad}$ (percent)	Age (Ma) ±1 sigma	
					Kialagvik volcanic center					
79AWs 17	57°15.6'N.	Dacite	Plagioclase	0.429	0.430	0.429	0.0589	3.3	0.90	0.11
	156°49.4'W.		HF-treated	.429			.0551	7.6	.89	.03
	Ugashik B-3									
								X =	.90	.11
81AWs 276	57°16.0'N.	Dacite	Plagioclase	.321	.322	.321	.0455	9.8	.98	.05
	156°42.7'W.		HF-treated	.321			.0255	7.6	.55	.03
	Ugashik B-3						.0290	9.5	.63	.02
								X =	.72	.24
81AYb 167	57°13.5'N.	Andesite	Plagioclase	.327	.326	.327	.0750	14.3	1.60	.03
	156°39.8'W.		HF-treated				.0787	14.6	1.67	.03
	Ugashik A-2									
								X =	1.64	.07
81AYb 168	57°11.3'N.	Andesite	Plagioclase	.303	.302	.303	.0162	3.8	.37	.03
	156°42.1'W.		HF-treated	.303	.301		.0106	2.5	.24	.03
	Ugashik A-3									
								X =	.31	.10
					Yantarni volcanic center					
78ADt 34	56°55.0'N.	Andesite	Whole-rock	.969	.992	1.003	.0989	8.2	.685	.021
	157°14.0'W.		HF-treated	1.007	1.018		.0791	7.5	.548	.015
	Sutwik Is. D-4			1.001	1.028					
								X =	.616	.233
79AWs 6a	57°02.7'N.	Andesite	Whole-rock	1.04	1.04	1.04	.2647	7.2	1.77	.03
	157°24.2'W.		HF-treated	1.03			.2676	9.3	1.79	.02
	Ugashik A-5									
								X =	1.78	.03
					Mount Becharof-Cape Igvak area					
80AWs 201	57°26.2'N.	Tonalite	Actinolite and	.305	.307	.304	.0229	8.3	5.22	.26
	156°03.7'W.		hornblende	.299			.0218	8.7	4.97	.19
	Ugashik B-1									
								X =	5.10	.37
80AWs 205	57°32.5'N.	Grano-	Hornblende	.51	.46	.48	.1590	5.4	2.30	.17
	156°05.7'W.	diorite		.48	.47		.1707	7.2	2.47	.14
	Ugashik C-1									
								X =	2.38	.25
80AWs 207	57°32.3'N.	Quartz	Actinolite	.61	.63	.61	.2661	11.8	3.02	.11
	156°05.4'W.	diorite		.60	.61		.2423	10.4	2.75	.09
	Ugashik C-1									
								X =	2.88	.23
			Biotite	8.35	8.36	8.36	3.154	18.6	2.61	.03
				8.38	8.36		2.954	34.7	2.45	.02
								X =	2.53	.12

Table 1. Potassium-argon data--Continued

Sample number	Location (latitude longitude quadrangle)	Rock type	Mineral or component dated	K_2O (percent)		Mean K_2O (percent)	$^{40}Ar_{rad}$ $\times 10^{-11}$	$^{40}Ar_{rad}$ (percent)	Age (Ma)	±1 sigma
Mike molybdenum prospect										
79AYb 101	57°03.8'N. 157°13.3'W. Ugashik A-4	Dacite	Plagioclase HF-treated	1.008 1.028	1.016 1.002	1.014	0.4738 .5238	17.7 19.0	3.25 3.59	0.09 .09
								X =	3.42	.28
			Biotite	8.82 8.87	8.79	8.83	4.815 4.024	11.7 14.3	3.79 3.16	.08 .03
								X =	3.48	.45
			Biotite and chlorite	8.06 8.09	8.02 8.05	8.06	3.174 3.431	19.9 22.9	2.74 2.96	.03 .06
								X =	2.85	.17
79AYb 102	57°04.6'N. 157°09.8'W. Ugashik A-4	Dacite?	Chlorite	.448 .448	.444	.446	.2301 .2792	4.1 4.8	3.58 4.34	.23 .25
								X =	3.96	.64
Agripina Bay batholith										
77AWs 9	57°00.3'N. 156°40.4'W. Ugashik A-3	Andesite	Whole-rock HF-treated	1.775 1.780	1.772 1.780	1.777	2.407 2.336	61.0 52.2	9.39 9.11	.14 .04
								X =	9.25	.15
80AWs 216	57°10.9'N. 156°27.9'W. Ugashik A-2	Grano-diorite?	Hornblende	.464 .459	.459 .464	.462	.1345 .1442	3.1 3.4	2.02 2.17	.17 .20
								X =	2.10	.28
			Biotite	8.56 8.64	8.53 8.58	8.58	2.872 3.111	23.0 33.9	2.32 2.52	.03 .03
								X =	2.42	.14
80AWs 220	57°06.7'N. 156°38.0'W. Ugashik A-2	Quartz-sericite altered	Whole-rock	.834 .832	.834 .829	.832	.4267 .4174	8.6 8.9	3.56 3.48	.10 .10
								X =	3.52	.15
80AWs 227	57°03.1'N. 156°33.7'W. Ugashik A-2	Monzonite	Biotite	9.29 9.30	9.37 9.27	9.31	5.862 5.416	23.3 31.8	4.38 4.04	.05 .03
								X =	4.21	.23
81AWs 287	57°08.0'N. 156°32.3'W. Ugashik A-2	Quartz diorite	Biotite	9.56 9.56	9.57 9.58	9.57	4.553 4.502	32.3 29.7	3.03 3.27	.03 .03
								X =	3.15	.17
			Hornblende	.155	.156	.156	.1332 .1057 .1137	4.1 2.9 3.3	5.94 4.72 5.07	.16 .42 .40
								X =	5.24	.87

Table 1. Potassium-argon data--Continued

Sample number	Location (latitude longitude quadrangle)	Rock type	Mineral or component dated	K_2O (percent)		Mean K_2O (percent)	$^{40}Ar_{rad}$ $\times 10^{-11}$	$^{40}Ar_{rad}$ (percent)	Age (Ma)	±1 sigma
					Miscellaneous					
80ACx 41	57°53.5'N. 155°08.8'W. Karluk D-4	Altered-andesite	Hornblende	0.127	0.130	0.129	0.2927 .2866	11.2 9.6	15.8 15.4	0.5 .5
								X =	15.6	.7
81ASh 18	57°01.0'N. 156°59.1'W. Ugashik A-3	Dacite	Hornblende	.372 .370	.371	.371	.9645 .9481	34.1 37.8	18.0 17.7	.2 .2
								X =	17.8	.4
82AYb 184	57°15.3'N. 157°23.9'W. Ugashik B-5	Basalt	Whole-rock HF-treated	.821 .786	.849 .806	.816	1.923 2.159	71.6 83.9	16.3 18.3	.5 .6
								X =	17.3	2.0
					Kilokak Creek prospect					
80AWs 228	57°11.7'N. 156°23.9'W. Ugashik A-2	Andesite	Hornblende	.542 .542	.542 .539	.541	2.201 2.516	37.7 49.6	28.0 32.0	.4 .3
								X =	30.0	2.9
					Rex prospect					
79ADt 23	57°12.1'N. 156°58.8'W. Ugashik A-3	Altered-Andesite	Hornblende	.502 .504	.503 .504	.504	2.475 2.563	44.1 36.1	33.9 35.0	.2 .2
								X =	34.5	.9
79ADt 95	57°14.9'N. 156°54.6'W. Ugashik A-3	Andesite	Hornblende	.732 .725	.738 .732	.732	3.670 3.811	48.6 44.1	34.5 35.8	.3 .3
								X =	35.2	1.0
79ADt 96	57°16.0'N. 156°57.4'W. Ugashik B-3	Andesite	Plagioclase HF-treated	1.013 1.017	1.014	1.015	5.381 5.221	86.5 85.4	36.5 35.4	.4 .4
								X =	36.0	1.0
			Hornblende	.516 .508	.512 .510	.512	2.687 2.724	25.8 38.1	36.1 36.6	.4 .3
								X =	36.4	.8
79AYb 22	57°12.8'N. 157°01.3'W. Ugashik A-4	Dacite	Hornblende	.607 .608	.607 .605	.607	3.100 2.954	35.8 47.4	35.2 33.5	.4 .3
								X =	34.3	1.3
80ACx 12c	57°14.4'N. 157°03.8'W. Ugashik A-4	Dacite	Plagioclase HF-treated	.512 .511	.510	.511	2.622 2.572	63.5 59.2	35.3 34.6	.4 .4
								X =	35.0	.8
80AWs 236	57°14.6'N. 157°04.8'W. Ugashik A-4	Dacite	Hornblende	.507 .498	.501 .502	.502	2.479 2.779 2.273	42.1 49.0 44.0	34.1 38.1 31.2	.5 .5 .3
								X =	34.5	3.5

Table 1. Potassium-argon data--Continued

Sample number	Location (latitude longitude quadrangle)	Rock type	Mineral or component dated	K_2O (percent)		Mean K_2O (percent)	$^{40}Ar_{rad}$ $\times 10^{-11}$	$^{40}Ar_{rad}$ (percent)	Age (Ma) ±1 sigma	
Rex prospect (continued)										
R-41219	57°14.6'N. 157°03.5'W. Ugashik A-4	Altered-dacite	Sericite	0.39 .37	0.40 .38	0.39	2.252 2.092	14.4 31.4	40.2 37.4	1.4 1.3
								X =	38.8	2.8
R-41358a	57°14.2'N. 157°03.0'W. Ugashik A-4	Quartz diorite	Hornblende	1.056 1.037	1.050	1.048	5.298 5.367	52 57	34.8 35.2	.5 .5
								X =	35.0	.7
			Biotite	8.67 8.67	8.77	8.70	39.67	77	31.4	.9
R-41360	57°14.2'N. 157°03.0'W. Ugashik A-4	Altered-granodiorite	Biotite	7.20	7.22	7.21	38.84	68	37.0	1.1
Meshik volcanic rocks										
79ACc 20	57°05.7'N. 157°43.2'W. Ugashik A-6	Leuco-basalt	Whole-rock HF-treated	.563 .561	.565	.563	2.007 2.060	52.5 40.0	24.6 25.2	.2 .1
								X =	24.9	.5
79AWs 2	56°06.5'N. 157°38.2'W. Ugashik A-5	Andesite	Whole-rock HF-treated	1.564 1.534	1.547 1.543	1.547	6.249 6.291	80.0 79.0	27.9 28.0	.3 .3
								X =	27.9	.4
79AYb 37	57°14.2'N. 157°15.2'W. Ugashik A-4	Leuco-basalt?	Whole-rock HF-treated	.146 .140	.150	.145	.0598 .0609	25.1 34.4	28.4 28.9	1.0 1.0
								X =	28.6	1.5
81AWs 281	57°11.7'N. 156°37.9'W. Ugashik A-2	Andesite	Hornblende	.960 .960	.957 .954	.958	4.254 4.067	65.9 60.4	30.6 29.3	.2 .4
								X =	29.9	1.2
Ugashik 1 core 1 5364-5391'	57°26.0'N. 157°44.3'W. Ugashik B-6	Unidentified	Unknown						33.0	1.5
Ugashik 2 core 2 8083-8095'	57°26.0'N. 157°44.3'W. Ugashik B-6	Unidentified	Unknown						39.0	7.0
Alaska-Aleutian Range batholith										
66AR 1331	57°52.4'N. 156°32.1'W. Ugashik D-2	Grano-diorite	Biotite	7.85	7.91	7.88	215.3	99	176.0	5.0
			Hornblende	.741	.744	.742	19.81	89	172.0	5.0
			Biotite	$^{40}Ar/^{39}Ar$					176.2	2.0
			Hornblende	$^{40}Ar/^{39}Ar$					177.4	3.0

Table 1. Potassium-argon data--Continued

Sample number	Location (latitude longitude quadrangle)	Rock type	Mineral or component dated	K_2O (percent)		Mean K_2O (percent)	$^{40}Ar_{rad}$ $\times 10^{-11}$	$^{40}Ar_{rad}$ (percent)	Age (Ma)	±1 sigma
Alaska-Aleutian Range batholith (continued)										
78ACc 4	58°08.2'N. 156°10.3'W. Naknek A-1	Tonalite	Biotite	8.82 8.84	8.84 8.84	8.84	226.5 228.8	89.1 85.3	171.5 170.8	0.7 .6
								X =	171.2	1.0
			Hornblende	.581 .582	.583 .576	.581	13.58 13.50	83.6 69.2	155.6 154.8	1.1 1.2
								X =	155.2	1.7
78ADt 2	58°10.5'N. 156°04.9'W. Naknek A-1	Granite	Biotite	8.91 8.92	8.89	8.91	231.9 235.4	87.1 84.1	172.4 174.8	.8 .7
								X =	173.6	2.0
			Hornblende	.646 .646	.648 .646	.646	15.53	78.3	159.6	2.0
79AWs 1	57°22.0'N. 157°03.7'W. Ugashik B-4	Tonalite/ Gneiss	Biotite	7.90 8.04	8.01 7.91	7.97	181.4 182.0	89.0 91.5	151.7 152.3	1.5 1.5
								X =	152.0	2.1
			Hornblende	1.546 1.463	1.556 1.495	1.515	34.24	85.5	150.5	4.4
79AWs 24a	57°23.9'N. 156°54.8'W. Ugashik B-3	Granite	Biotite	8.73 8.72	8.72 8.70	8.72	202.3 198.4	84.2 90.1	154.4 151.5	.6 .6
								X =	153.0	2.2
			Hornblende	.840 .843	.842	.842	20.35 19.54	78.6 71.3	160.6 154.5	.7 .7
								X =	157.5	4.4
Great Basins No. 1 core 21 11071-11080'	57°52.8'N. 157°05.1'W. Ugashik D-4	Granite	Unknown						177	
Puale Bay										
80APP 1	57°42.0'N. 155°20.0'W. Karluk C-5	Basalt	Whole-rock HF-treated	.247 .224	.236 .234	.235	6.966 7.128	86.3 91.6	194.8 199.1	8.1 8.3
								X =	197.0	12.0

Table 2. Major-element chemical data and CIPW normative minerals

[For most samples, major-element chemical analyses were performed using X-ray fluorescence methods; induction-coupled plasma spectrometry (ICP) was used for three samples. CIPW norms and other petrologic parameters were calculated using PETCAL (Bingler and others, 1976) with extensive modifications of the program by R.D. Koch and F.H. Wilson to calculate additional parameters and allow use on a microcomputer. Values shown are in percent. Norm-an is the normative plagioclase composition in percent anorthite calculated by PETCAL.

Analysts for X-ray fluorescence analyses were J.S. Wahlberg, J. E. Taggert Jr., J.W. Baker, A.J. Bartel, K.C. Stewart, and L.F. Espos. Samples 81AWs 266, 81AYb 138, and 81AYb 168 were analyzed using ICP methods by Hezekiah Smith. FeO, CO_2, and H_2O were determined following Shapiro and Brannock (1962) by H.G. Neiman, Georgia Mason, Jean Ryder, Cynthia Stone, D.V. Vivit, P.R. Klock, D. Shepard, S.T. Neil, M. Taylor, E.E. Engleman, and M. Manser.

Sample locations shown on sheet 1; sample identification (I.D.) letters used to plot samples on figs. 1-8]

Table 2. Major-element chemical data and CIPW normative minerals-Continued

Aleutian arc							
Kejulik volcano							
Element or mineral	Sample number I.D. letter						
	81AWs 266 A[1]	K-11B B	K-11H C	K-12B D	K-12C E	K-12F F	K-12H G
SiO_2	54.6	56.14	57.55	60.12	57.98	56.67	57.11
Al_2O_3	18.6	18.15	17.05	17.50	16.85	17.63	17.45
Fe_2O_3	3.0	4.19	2.15	1.86	3.25	4.35	3.00
FeO	6.2	4.23	5.40	3.92	3.87	3.99	4.79
MgO	4.2	3.82	3.80	1.68	3.37	2.88	3.52
CaO	8.7	7.65	7.32	6.16	6.79	7.25	7.29
Na_2O	3.1	3.64	3.66	3.63	3.13	3.64	3.46
K_2O	.56	.88	1.25	2.15	1.49	1.03	1.11
TiO_2	.80	.72	.65	.72	.72	.86	.57
P_2O_5	.22	.16	.15	.20	.14	.17	.14
MnO	.19	.15	.14	.15	.12	.16	.15
CO_2	.01	---	---	---	---	---	---
H_2O+	.10	.37	.32	1.08	1.25	1.16	.53
H_2O-	.25	.32	.12	.30	.49	.28	.33
Total	100.53	100.42	99.56	99.47	99.45	100.07	99.45
CIPW norms							
Q	7.93	9.81	9.23	14.65	14.80	12.52	11.24
C	---	---	---	---	---	---	---
or	3.30	5.21	7.45	12.95	9.01	6.17	6.65
ab	26.18	30.88	31.24	31.31	27.10	31.23	29.69
an	35.12	30.67	26.64	25.60	28.17	29.12	29.22
hy	15.73	10.50	13.31	7.36	10.04	7.52	12.02
di	5.35	5.09	7.39	3.51	4.32	4.99	5.33
ol	---	---	---	---	---	---	---
ne	---	---	---	---	---	---	---
mt	4.36	6.09	3.15	2.75	4.82	6.40	4.41
il	1.52	1.37	1.25	1.39	1.40	1.66	1.10
A	.51	.37	.35	.47	.33	.40	.33
hm	---	---	---	---	---	---	---
Norm-an	57.3	49.8	46.0	45.0	51.0	48.3	49.6

Table 2. Major-element chemical data and CIPW normative minerals-Continued

Element or mineral	Aleutian arc — Peulik volcano-Ugashik caldera volcanic center — Sample number I.D. letter						
	79AMm 34 H	81ARj 11a I	81ARj 11b J	81ARj 13 K	81ARj 13b L	81AWs 269 M	81AWs 271 N[1]
SiO_2	64.2	59.4	61.1	66.4	51.0	60.1	65.5
Al_2O_3	15.9	17.3	17.4	13.3	19.2	17.5	16.6
Fe_2O_3	3.05	4.78	3.35	1.78	2.13	5.15	1.96
FeO	2.24	1.20	1.67	2.14	6.60	1.07	2.36
MgO	1.81	2.75	2.68	1.49	5.75	3.15	1.71
CaO	4.51	6.63	6.29	4.44	10.5	6.97	4.79
Na_2O	3.68	3.31	3.30	3.75	2.46	3.42	3.74
K_2O	2.46	1.36	1.43	1.79	.68	1.32	1.77
TiO_2	.57	.59	.58	.39	.86	.56	.42
P_2O_5	.14	.16	.14	.12	.13	.17	.13
MnO	.10	.13	.12	.13	.16	.15	.13
CO_2	<.01	---	---	---	---	.08	.12
H_2O+	.40	---	---	---	---	.09	.28
H_2O-	.12	---	---	---	---	.02	.10
Total	99.18	97.61	98.06	95.73	99.47	99.75	99.61
CIPW norms							
Q	21.73	18.29	20.15	28.14	1.76	17.16	23.71
C	---	---	---	---	---	---	.14
or	14.73	8.23	8.62	11.05	4.04	7.84	10.55
ab	31.56	28.69	28.47	33.14	20.93	29.07	31.93
an	19.87	29.02	29.00	14.80	39.55	28.63	23.12
hy	4.71	5.72	6.13	3.11	18.92	6.08	6.58
di	1.49	2.80	1.47	6.00	9.76	3.88	---
ol	---	---	---	---	---	---	---
ne	---	---	---	---	---	---	---
mt	4.48	2.65	4.17	2.70	3.11	2.33	2.87
il	1.10	1.15	1.12	.77	1.64	1.07	.81
A	.33	.38	.33	.29	.30	.40	.30
hm	---	3.07	.54	---	---	3.79	---
Norm-an	38.6	50.3	50.5	30.9	65.4	49.6	42.0

Table 2. Major-element chemical data and CIPW normative minerals-Continued

Element or mineral	Aleutian arc: Blue Mountain volcanic center, Sample number I.D. letter: 79ADt 135 O	79AYb 90 P	81ASh 2 Q[1]	81AWs 275 R[1]	Ukinrek Maars, Sample number I.D. letter: JRC 09 S	JRC 10b T
SiO_2	61.0	64.0	66.8	49.3	47.67	48.07
Al_2O_3	17.2	16.3	15.9	17.1	16.57	17.20
Fe_2O_3	3.44	3.62	3.81	3.32	1.96	1.87
FeO	1.89	1.10	.18	6.10	7.39	7.91
MgO	2.62	1.87	1.42	8.51	8.76	9.13
CaO	6.33	4.93	4.15	9.87	9.77	9.95
Na_2O	3.60	3.56	3.49	2.98	3.07	3.04
K_2O	1.54	2.13	2.41	.89	.80	.82
TiO_2	.54	.46	.38	1.05	1.29	1.05
P_2O_5	.18	.16	.16	.27	---	.23
MnO	.13	.14	.14	.19	.19	.16
CO_2	.08	.16	.23	.16	---	---
H_2O+	.44	.85	.23	.20	---	.07
H_2O-	1.08	.40	.14	.12	---	.07
Total	100.07	99.68	99.44	100.06	97.47	99.57
CIPW norms						
Q	18.35	22.90	27.04	---	---	---
C	---	---	.39	---	---	---
or	9.24	12.81	14.41	5.28	4.85	4.87
ab	30.93	30.65	29.88	25.32	24.57	23.64
an	26.63	22.60	19.77	30.78	29.82	31.04
hy	5.16	4.30	3.58	7.17	---	---
di	3.16	.96	---	13.32	16.08	13.85
ol	---	---	---	10.67	18.12	20.13
ne	---	---	---	---	1.13	1.21
mt	5.03	2.72	---	4.83	2.92	2.73
il	1.04	.90	.69	2.00	2.51	2.01
A	.42	.38	.38	.63	---	.54
hm	.03	1.81	3.86	---	---	---
Norm-an	46.0	42.4	39.8	54.9	53.0	54.8

Table 2. Major-element chemical data and CIPW normative minerals-Continued

Element or mineral	Aleutian arc — Kialagvik volcanic center — Sample number I.D. letter						
	79AWs 17 U	81ARj 16 V	81ARj 18 W	81ARj 36 X	81ARj 37 Y	81ARj 38a Z	81ARj 38b a
SiO_2	61.4	60.1	61.0	58.4	62.7	63.0	64.2
Al_2O_3	17.0	17.1	17.4	17.0	16.2	16.1	16.0
Fe_2O_3	2.69	3.40	2.67	3.48	4.16	3.99	4.15
FeO	3.39	3.02	3.19	2.63	.80	1.23	.74
MgO	3.05	2.63	2.55	3.03	2.32	2.61	2.40
CaO	6.55	6.41	6.49	7.05	5.11	5.67	5.33
Na_2O	3.00	2.97	3.06	2.82	3.09	3.06	3.14
K_2O	1.80	1.75	1.83	1.60	2.03	2.08	2.15
TiO_2	.69	.77	.75	.76	.64	.55	.43
P_2O_5	.16	.17	.14	.15	.20	.15	.14
MnO	.13	.11	.12	.12	.09	.10	.10
CO_2	.12	---	---	---	---	---	---
H_2O+	.21	---	---	---	---	---	---
H_2O-	.14	---	---	---	---	---	---
Total	100.33	98.43	99.20	97.04	97.34	98.54	98.78
CIPW norms							
Q	18.38	19.04	18.47	17.86	23.75	22.63	23.90
C	---	---	---	---	.11	---	---
or	10.65	10.51	10.90	9.74	12.32	12.47	12.86
ab	25.42	25.53	26.10	24.59	26.86	26.28	26.90
an	27.64	28.61	28.57	29.89	24.70	24.41	23.50
hy	9.22	7.38	7.91	6.82	5.94	5.46	5.21
di	3.10	2.05	2.39	4.05	---	2.45	1.82
ol	---	---	---	---	---	---	---
ne	---	---	---	---	---	---	---
mt	3.91	5.01	3.90	5.20	1.05	2.74	1.48
il	1.31	1.49	1.44	1.49	1.25	1.06	.83
A	.37	.40	.33	.36	.48	.35	.33
hm	---	---	---	---	3.55	2.16	3.18
Norm-an	52.1	52.8	52.3	54.9	47.9	48.2	46.6

Table 2. Major-element chemical data and CIPW normative minerals-Continued

Element or mineral	Aleutian arc: Kialagvik volcanic center (continued)			Yantarni volcanic center	
	Sample number I.D. letter			Sample number I.D. letter	
	81AWs 276 b	81AYb 167 c	81AYb 168 d	78ADt 34 e	79AWs 6a f
SiO_2	60.5	58.4	58.6	57.70	51.9
Al_2O_3	17.0	16.9	17.0	16.20	14.8
Fe_2O_3	2.02	2.57	4.6	3.35	4.70
FeO	4.33	3.95	3.5	4.59	3.70
MgO	3.10	3.38	3.8	4.53	6.35
CaO	6.56	7.22	7.1	7.73	10.5
Na_2O	3.03	2.94	2.9	2.82	2.17
K_2O	1.75	1.74	1.7	1.39	1.03
TiO_2	.72	.78	.72	.91	.80
P_2O_5	.13	.19	.17	.13	.28
MnO	.13	.14	.13	.14	.14
CO_2	.11	.09	.01	.13	1.33
H_2O+	.62	.82	.45	.26	.75
H_2O-	.23	.18	.57	.31	.90
Total	100.23	99.3	101.25	100.37	99.35
CIPW norms					
Q	16.44	14.53	15.28	13.26	8.53
C	---	---	---	---	---
or	10.42	10.47	10.02	8.26	6.32
ab	25.83	25.33	24.48	23.98	19.05
an	27.82	28.28	28.28	27.58	28.64
hy	11.51	10.04	8.96	11.87	9.63
di	3.36	5.60	4.55	8.13	18.52
ol	---	---	---	---	---
ne	---	---	---	---	---
mt	2.95	3.79	6.67	4.88	7.07
il	1.38	1.51	1.36	1.74	1.58
A	.30	.45	.39	.30	.67
hm	---	---	---	---	---
Norm-an	51.9	52.8	53.6	53.5	60.1

Table 2. Major-element chemical data and CIPW normative minerals-Continued

Element or mineral	Aleutian arc					
	Mount Becharof-Cape Igvak area				Mike molybdenum prospect	
	Sample number I.D. letter				Sample number I.D. letter	
	80AWs 201 g[1]	80AWs 205 h[1]	80AWs 207 i[1]	81ASh 1 j[1]	79AYb 101 k	M-41059 l[1]
SiO_2	55.2	62.7	56.7	51.0	67.2	71.64
Al_2O_3	19.5	16.6	17.9	19.1	15.6	13.97
Fe_2O_3	2.90	3.76	4.33	3.31	1.71	4.66
FeO	3.96	2.66	3.85	6.47	2.48	.13[2]
MgO	4.00	2.32	3.65	5.08	2.04	.17
CaO	8.99	5.95	7.40	9.50	2.73	.04
Na_2O	3.62	3.57	3.55	3.00	3.14	.29
K_2O	.78	1.11	1.14	.29	2.65	3.69
TiO_2	.61	.68	.88	.81	.48	.35
P_2O_5	.08	.12	.15	<.05	.16	.09
MnO	.12	.07	.14	.20	.05	.01
CO_2	<.10	<.10	<.10	.26	.04	.16
H_2O+	.88	.54	.58	1.41	1.01	1.67
H_2O-	.03	.11	.11	.12	.17	.09
Total	100.67	100.19	100.38	100.55	99.46	96.96
	CIPW norms					
Q	6.33	22.16	11.14	2.84	29.77	58.48
C	---	---	---	---	3.04	10.00
or	4.61	6.59	6.76	1.74	15.94	22.94
ab	30.63	30.35	30.13	25.70	27.04	2.58
an	34.65	26.11	29.63	38.27	12.72	---
hy	10.40	5.57	9.07	17.33	7.66	.45
di	7.59	2.17	4.95	7.71	---	---
ol	---	---	---	---	---	---
ne	---	---	---	---	---	---
mt	4.20	5.48	6.30	4.86	2.52	---
il	1.16	1.30	1.68	1.56	.93	.31
A	.19	.28	.35	---	.38	.25
hm	---	---	---	---	---	4.90
Norm-an	53.1	46.2	49.6	59.8	32.0	.0

Table 2. Major-element chemical data and CIPW normative minerals-Continued

Element or mineral	77AWs 9 m	77AWs 12 n	80AWs 216 o[1]	80AWs 227 p[1]	81AWs 287 q[1]
			Aleutian arc		
			Agripina Bay batholith		
SiO_2	56.89	51.89	64.9	59.1	63.1
Al_2O_3	17.08	17.39	16.1	17.1	16.0
Fe_2O_3	3.78	2.99	2.48	2.47	2.07
FeO	3.76	6.89	2.26	4.26	3.38
MgO	4.08	5.05	2.06	3.30	2.55
CaO	7.12	9.32	4.82	6.67	5.20
Na_2O	3.58	3.17	4.94	3.33	3.29
K_2O	1.72	1.01	2.50	2.26	2.64
TiO_2	.98	1.23	.66	.87	.66
P_2O_5	.25	.34	.11	.18	.13
MnO	.13	.17	.03	.16	.10
CO_2	.09	.12	<.10	<.10	.15
H_2O+	.48	.50	.54	.47	.45
H_2O-	1.10	.62	.04	.16	.12
Total	101.04	100.69	101.44	100.33	99.84
			CIPW norms		
Q	9.60	2.18	14.81	11.79	18.65
C	---	---	---	---	---
or	10.23	6.00	14.65	13.39	15.74
ab	30.48	26.97	41.44	28.26	28.08
an	25.62	30.41	14.25	25.11	21.28
hy	9.51	15.63	2.85	10.17	8.50
di	6.59	11.32	6.94	6.60	3.16
ol	---	---	---	---	---
ne	---	---	---	---	---
mt	5.52	4.36	3.57	3.59	3.03
il	1.87	2.35	1.24	1.66	1.27
A	.58	.79	.25	.42	.30
hm	---	---	---	---	---
Norm-an	45.7	53.0	25.6	47.1	43.1

Table 2. Major-element chemical data and CIPW normative minerals-Continued

Element or mineral	80AWs 253 r	81ASh 18 s[1]	81AYb 138 t[1]	82AYb 184 u
Aleutian arc				
Miscellaneous				
SiO_2	61.5	59.5	56.9	47.7
Al_2O_3	17.6	16.3	18.6	16.4
Fe_2O_3	2.35	3.24	3.10	4.92
FeO	2.24	2.34	4.90	4.45
MgO	2.48	3.69	2.2	8.68
CaO	4.90	5.12	7.7	9.38
Na_2O	4.16	3.38	3.6	3.39
K_2O	.91	1.84	1.2	.90
TiO_2	.41	.74	.99	1.82
P_2O_5	.14	.23	.20	.38
MnO	.09	.09	.14	.15
CO_2	<.10	1.01	.02	.11
H_2O+	2.72	1.75	.42	.96
H_2O-	.70	.44	.25	.53
Total	100.20	99.67	100.22	99.77
CIPW norms				
Q	19.91	17.34	11.16	---
C	1.24	---	---	---
or	5.56	11.27	7.13	5.42
ab	36.37	29.65	30.62	29.22
an	24.17	24.74	31.21	27.38
hy	8.10	10.10	8.23	2.02
di	---	.02	4.85	13.71
ol	---	---	---	10.58
ne	---	---	---	---
mt	3.52	4.87	4.46	7.27
il	.80	1.46	1.89	3.52
A	.33	.55	.47	.90
hm	---	---	---	---
Norm-an	39.9	45.5	50.5	48.4

Table 2. Major-element chemical data and CIPW normative minerals-Continued

Element or mineral	Meshik arc: Kilokak Creek prospect, Sample number I.D. letter: 80AWs 211 A[1]	80AWs 217b B[1]	80AWs 228 C[1]	Rex prospect, Sample number I.D. letter: 77AMs 3 D[1]	79ADt 23 E	79ADt 95 F
SiO_2	59.2	52.0	53.3	56.95	58.6	57.1
Al_2O_3	17.8	16.1	16.9	14.97	16.1	15.5
Fe_2O_3	2.91	1.39	1.97	2.77	2.21	2.52
FeO	2.98	5.73	5.57	4.11	3.67	4.01
MgO	2.62	5.09	6.14	4.01	3.84	4.61
CaO	5.99	7.19	7.31	5.07	5.91	6.66
Na_2O	3.44	3.59	3.95	3.32	3.53	2.71
K_2O	1.68	1.54	1.53	1.99	1.78	1.89
TiO_2	.80	.77	.87	.63	.63	.79
P_2O_5	.15	.38	.35	.16	.19	.26
MnO	.09	.13	.14	.05	.14	.16
CO_2	.82	2.93	.03	2.26	.78	1.26
H_2O+	1.56	2.76	1.71	2.53	1.84	2.17
H_2O-	.30	.19	.06	.79	.43	.50
Total	100.34	99.79	99.83	99.61	99.65	100.14
CIPW norms						
Q	16.07	1.76	---	13.34	13.10	13.74
C	---	---	---	---	---	---
or	10.17	9.69	9.22	12.51	10.89	11.61
ab	29.80	32.35	34.09	29.87	30.92	23.83
an	28.84	24.78	24.34	21.34	23.63	25.51
hy	8.42	18.17	17.09	13.54	12.06	13.65
di	.47	8.62	8.35	3.47	4.38	5.67
ol	---	---	1.48	---	---	---
ne	---	---	---	---	---	---
mt	4.32	2.15	2.91	4.27	3.32	3.80
il	1.56	1.56	1.69	1.27	1.24	1.56
A	.36	.94	.83	.39	.46	.63
hm	---	---	---	---	---	---
Norm-an	49.2	43.4	41.7	41.7	43.3	51.7

Table 2. Major-element chemical data and CIPW normative minerals-Continued

Element or mineral	79ADt 96 G	79AYb 22 H	80ACx 12c I[1]	80AWs 236 J[1]	R-41219 K[1]	R-41358A L[1]	R-41360 M[1]
Meshik arc							
Rex prospect (continued)							
SiO_2	60.2	62.4	60.0	59.6	57.47	62.03	61.25
Al_2O_3	17.0	16.8	15.1	16.9	14.72	15.18	16.21
Fe_2O_3	1.83	2.14	2.83	2.66	6.57	5.96	6.07
FeO	2.41	2.35	3.98	3.77	1.79[2]	3.09[2]	2.34[2]
MgO	2.75	2.14	5.14	2.89	3.74	3.13	2.76
CaO	6.55	5.32	5.82	6.51	3.69	5.44	4.68
Na_2O	3.56	3.49	3.02	2.88	2.31	3.08	3.01
K_2O	1.62	2.01	1.65	2.12	1.92	1.86	1.78
TiO_2	.45	.56	.62	.64	.66	.60	.67
P_2O_5	.16	.17	.19	.19	.18	.15	.19
MnO	.09	.10	.08	.13	.03	.06	.03
CO_2	.02	.10	<.10	.01	1.19	.19	.00
H_2O+	2.14	1.94	1.21	1.32	2.77	.95	.94
H_2O-	.27	.43	.22	.28	1.30	.30	.24
Total	99.05	99.95	99.86	99.90	98.34	102.02	100.17
CIPW norms							
Q	16.36	20.21	15.96	16.41	25.48	21.82	23.56
C	---	---	---	---	2.75	---	1.29
or	9.91	12.18	9.91	12.75	12.19	10.93	10.63
ab	31.18	30.29	25.96	24.79	21.00	25.91	25.73
an	26.52	24.86	23.14	27.39	18.40	21.97	22.20
hy	7.19	6.91	15.27	9.64	10.01	6.35	6.94
di	4.84	.86	3.95	3.41	---	3.02	---
ol	---	---	---	---	---	---	---
ne	---	---	---	---	---	---	---
mt	2.75	3.18	4.17	3.92	4.25	8.37	5.76
il	.89	1.09	1.20	1.24	1.35	1.13	1.29
A	.38	.40	.45	.45	.46	.35	.44
hm	---	---	---	---	4.13	.16	2.16
Norm-an	46.0	45.1	47.1	52.5	46.7	45.9	46.3

Table 2. Major-element chemical data and CIPW normative minerals-Continued

Element or mineral	Meshik arc					
	Meshik volcanic rocks			Alaska-Aleutian Range batholith and Puale Bay		
	Sample number I.D. letter			Sample number I.D. letter		
	79ACe 20 N[1]	79AWs 2 O	81AWs 281 P[1]	66AR 1331 Q	79AWs 1 R	80APP 1 S
SiO_2	47.0	56.2	52.8	70.3	64.9	45.5
Al_2O_3	16.2	16.1	17.3	14.6	16.5	14.6
Fe_2O_3	4.42	3.38	2.31	1.50	2.37	4.76
FeO	6.55	3.47	5.25	2.10	2.41	5.71
MgO	8.72	5.85	4.78	1.40	1.72	6.17
CaO	9.84	6.92	8.03	3.70	5.35	16.1
Na_2O	2.45	3.32	3.11	2.40	3.10	1.62
K_2O	.52	1.51	.88	2.60	1.59	.24
TiO_2	1.27	.97	.81	.48	.56	1.13
P_2O_5	.22	.24	.45	.07	.19	.14
MnO	.21	.12	.13	.07	.13	.16
CO_2	.04	.11	.26	.03	.25	2.16
H_2O+	1.27	.62	3.01	.54	.74	.91
H_2O-	.70	1.00	.62	.12	.30	1.12
Total	99.41	99.81	99.74	99.91	100.11	100.32
	CIPW norms					
Q	---	9.19	6.90	35.97	26.80	---
C	---	---	---	1.29	.41	---
or	3.16	9.10	5.43	15.49	9.51	1.48
ab	21.28	28.64	27.45	20.47	26.54	14.26
an	32.52	25.05	31.97	18.04	25.60	33.14
hy	14.46	13.99	16.77	5.48	6.14	1.52
di	12.90	6.60	5.30	---	---	39.24
ol	6.12	---	---	---	---	.63
ne	---	---	---	---	---	---
mt	6.58	5.00	3.49	2.19	3.48	7.18
il	2.48	1.88	1.61	.92	1.08	2.23
A	.52	.57	1.09	.16	.45	.34
hm	---	---	---	---	---	---
Norm-an	60.4	46.7	53.8	46.8	49.1	69.9

[1] Semi-quantitative emission spectrophotometer data shown in table 3.
[2] Samples may have not been completely digested by HF-H_2SO4 during FeO analysis: FeO value shown is that measured; Fe_2O_3 value shown in total Fe.

Table 3. Selected semiquantitative emission spectrometric data

[All analyses are semiquantitative emission spectrography unless otherwise noted: AA, atomic absorption, SI, specific ion analysis. Fe, Mg, Ca, and Ti in percent, all other elements in parts per million. N, not detected. Analysts were: R.M. O'Leary, D. Risoli, A. Grunsky, J. Hurrell, D.M. Hopkins, G.W. Day, and Stephen Sutley. Sample locations shown on sheet 1; sample identification (I.D.) letters used to plot samples on figs. 1-8]

Element	Sample number I.D. letter						
	79ACe 20 N	80ACx 12c I	80AWs 201 g	80AWs 205 h	80AWs 207 i	80AWs 211 A	80AWs 216 o
Fe	5	2	7	5	7	5	2
Mg	2	2	3	1.5	2	2	1.5
Ca	3	2	5	2	3	2	2
Ti	.3	.15	.5	.5	.7	.5	.2
Mn	700	300	700	500	1500	1000	300
Ag	N	N	N	N	N	N	N
As	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N
B	<10	15	10	10	<10	10	50
Ba	100	500	200	300	300	500	1000
Be	<1	<1	N	N	N	<1	<1
Bi	N	N	N	N	N	N	N
Cd	N	N	N	N	N	N	N
Co	20	15	20	7	15	20	7
Cr	100	300	150	10	30	50	15
Cu	20	100	30	20	50	20	15
La	N	30	N	N	N	N	20
Mo	N	N	N	N	N	N	N
Nb	N	N	N	N	N	N	N
Ni	150	50	30	7	15	15	5
Pb	N	10	10	<10	10	10	<10
Sb	N	N	N	N	N	N	N
Sc	50	30	50	30	70	50	30
Sn	N	N	N	N	N	N	N
Sr	300	700	500	300	500	700	500
V	300	200	300	150	200	200	200
W	N	N	N	N	N	N	N
Y	20	20	20	50	30	30	50
Zn	200	N	N	N	N	N	N
Zr	70	100	50	150	50	150	200
Th	N	N	N	N	N	N	N
AA-Au	N	<.05	--	--	--	--	--
AA-Cu	70	140	20	25	20	25	5
AA-Pb	20	10	10	15	10	15	10
AA-Zn	40	15	30	30	20	60	10
AA-Ag	--	.10	--	--	--	--	--
SI-F	--	--	--	--	--	--	--

Table 3. Selected semiquantitative emission spectrometric data-Continued

Element	Sample number I.D. letter						
	80AWs 217b B	80AWs 220 --	80AWs 227 p	80AWs 228 C	80AWs 236 J	81ASh 1 j	81ASh 2 Q
Fe	5	1.5	5	3	2	7	3
Mg	3	1	1.5	3	1.5	5	1
Ca	3	1	2	1.5	3	5	2
Ti	.3	.5	.20	.3	.15	.5	.3
Mn	700	300	1000	700	300	1500	1000
Ag	N	N	N	.5	<.5	N	N
As	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N
B	30	30	20	20	15	20	<10
Ba	1500	700	500	1000	1500	200	1000
Be	<1	1.5	<1	<1	<1	N	2
Bi	N	N	N	N	N	N	N
Cd	N	N	N	N	N	N	N
Co	30	7	30	30	20	70	15
Cr	500	30	70	300	150	50	10
Cu	70	7	50	100	30	50	10
La	70	50	20	30	30	N	N
Mo	N	N	N	N	N	N	7
Nb	N	<20	N	N	N	N	N
Ni	70	7	20	50	20	15	5
Pb	15	30	10	15	15	20	10
Sb	N	N	N	N	N	N	N
Sc	50	20	50	50	30	30	7
Sn	N	N	N	N	N	N	N
Sr	1500	500	500	1000	1000	500	1000
V	300	150	200	300	100	300	100
W	N	N	N	N	N	N	N
Y	20	30	30	20	20	20	20
Zn	N	N	200	N	N	N	N
Zr	100	200	70	100	50	20	200
Th	N	100	N	N	N	N	N
AA-Au	--	--	--	--	--	N	N
AA-Cu	65	5	50	110	20	50	<5
AA-Pb	20	25	20	20	10	10	5
AA-Zn	50	25	35	40	20	10	<5
AA-Ag	--	--	--	--	--	--	--
SI-F	--	--	--	--	--	--	--

Table 3. Selected semiquantitative emission spectrometric data-Continued

Element	Sample number I.D. letter						
	81ASh 18 S	81AWs 266 A	81AWs 269 M	81AWs 271 N	81AWs 275 R	81AWs 281 P	81AWs 287
Fe	5	7	5	5	7	7	5
Mg	2	2	2	1.5	10	10	2
Ca	1.5	5	5	3	5	5	3
Ti	.5	.5	.5	.3	.7	.5	.3
Mn	700	1500	1500	1500	1500	1500	1000
Ag	<.5	N	N	N	N	N	N
As	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N
B	20	20	20	30	10	20	50
Ba	500	300	700	700	700	700	1000
Be	1	N	1	1	N	1	1
Bi	N	N	N	N	N	N	N
Cd	N	N	N	N	N	N	N
Co	20	50	50	20	70	50	20
Cr	50	50	70	N	1000	200	50
Cu	20	50	30	10	30	150	50
La	20	N	N	N	N	100	20
Mo	N	N	N	N	15	N	7
Nb	N	N	N	N	N	N	N
Ni	30	20	20	5	200	100	15
Pb	10	10	10	10	N	10	30
Sb	N	N	N	N	N	N	N
Sc	15	30	20	15	30	30	20
Sn	N	N	N	N	N	N	N
Sr	700	700	500	700	1000	1500	500
V	200	200	300	200	300	300	200
W	N	N	N	N	<50	N	N
Y	15	30	30	30	50	50	50
Zn	N	N	N	N	N	N	N
Zr	100	200	150	200	200	300	300
Th	N	N	N	N	N	N	N
AA-Au	N	N	N	N	N	N	--
AA-Cu	20	5	20	<5	15	85	50
AA-Pb	20	<5	<5	<5	10	15	10
AA-Zn	45	<5	5	<5	25	10	20
AA-Ag	--	--	--	--	--	--	--
SI-F	--	--	--	--	300	--	--

Table 3. Selected semiquantitative emission spectrometric data-Continued

Element	Sample number I.D. letter					
	81AYb 138 t	77AMs 3 D	M-41059 I	R-41219 K	R-41358A L	R-41360 M
Fe	7	3	3	3	5	5
Mg	1.5	1.5	.2	1	1.5	1.5
Ca	5	3	<.05	2	3	2
Ti	.7	.3	.2	.3	.5	.5
Mn	1500	200	20	100	200	100
Ag	N	N	<.5	N	N	N
As	N	N	N	N	N	N
Au	N	N	N	N	N	N
B	70	20	20	<10	10	30
Ba	700	200	1000	200	1000	300
Be	1	1	1	1	1	1
Bi	N	N	N	N	N	N
Cd	N	N	N	N	N	N
Co	50	10	10	30	50	50
Cr	N	200	<10	70	300	200
Cu	100	150	150	300	150	50
La	N	50	50	50	50	200
Mo	N	N	<5	20	N	N
Nb	N	<20	<20	<20	<20	50
Ni	5	50	<5	10	50	50
Pb	20	10	20	20	20	20
Sb	N	N	N	N	N	N
Sc	30	20	10	20	20	20
Sn	N	N	N	N	N	N
Sr	700	700	<100	500	1000	1000
V	300	200	100	200	200	200
W	N	N	N	N	N	N
Y	50	20	15	20	20	20
Zn	N	N	N	N	N	N
Zr	200	100	150	100	100	100
Th	N	--	--	--	--	--
AA-Au	--	--	--	--	--	--
AA-Cu	80	--	--	--	--	--
AA-Pb	<5	--	--	--	--	--
AA-Zn	5	--	--	--	--	--
AA-Ag	--	--	--	--	--	--
SI-F	--	--	--	--	--	--