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Magnetostratigraphy of the San Francisco Volcanic Field, Arizona

By K.L. TANAKA, T.C. ONSTOTT, and E.M. SHOEMAKER

Polarity-chronostratigraphic data that document the detailed
eruptive history of upper Cenozoic volcanic rocks in the
San Francisco Mountain area of the southern Colorado Plateau

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Magnetostratigraphy of the San Francisco Volcanic Field, Arizona

By K.L. Tanaka, T.C. Onstott,[1] *and* E.M. Shoemaker

Abstract

We present remanent magnetizations determined for 657 sites of volcanic rocks in the San Francisco volcanic field, an area of about 4,800 km^2 in the southern part of the Colorado Plateau. The field includes scattered basaltic cinder cones and flows as well as silicic and intermediate rocks mostly in voluminous eruptive centers. About 90 percent of the sites yielded clear polarity determinations; the remainder have scattered data ($\alpha_{95} > 40°$) or peculiar directions. Comprehensive stratigraphic controls—paleomagnetic polarity data, K-Ar and other absolute-age determinations, superposition relations, and lithologic associations—and state of preservation of the cinder cones provide a basis for age assignments of 503 separate eruptions related to basaltic vents and flows and 80 silicic to intermediate domes, flows, and flow sequences. The eruptions are assigned to three magnetopolarity sequences (polarity chronozones): the pre-Matuyama Chronozone (about 5.0 to 2.48 Ma), the Matuyama Reversed-Polarity Chronozone (2.48 to 0.73 Ma), and the Brunhes Normal-Polarity Chronozone (0.73 Ma to present). This stratigraphy documents a progression of volcanism, first to the northeast and then to the east: volcanic activity was centered along the Mesa Butte fault zone during pre-Matuyama and early Matuyama time and turned eastward through San Francisco Mountain during late Matuyama and Brunhes time. Site averages of magnetic vectors indicate that no appreciable crustal translations or rotations occurred in the field during eruptive activity.

INTRODUCTION

For several reasons, the San Francisco volcanic field in north-central Arizona (fig. 1) has been a region of considerable geologic investigation since the mid-1970's. First, the field is late Cenozoic in age. The most recent volcanic eruption occurred about 925 years ago, and the field may be considered to be dormant but potentially active (given the eruptive recurrence interval of 3,000 to 4,000 yr; Wolfe and others, 1983). Second, this potential led to an assessment of the geothermal activity of the field, particularly beneath San Francisco Mountain. Third, many of the cinder cones in the eastern part of the field are late Pleistocene in age, prompting detailed investigations of stratigraphy and absolute age. Finally, a comprehensive understanding of continental volcanic fields requires that their chronology be thoroughly recorded, thus contributing to an integrated approach toward understanding the volcanic evolution.

In 1976 the U.S. Geological Survey began a Geothermal Research Program to study this area. Most of our paleomagnetic investigations were conducted from 1976 to 1980. Our primary aim was to assign all known volcanic materials representative of discrete eruptions (as interpreted from detailed geologic mapping) to a position in the magnetostratigraphic column that has been developed for the late Cenozoic. Therefore, we determined the magnetic vectors for most of these rocks and correlated the magnetic polarities with geologic relations and about 150 K-Ar ages. The polarity, geologic, and isotopic age data were compiled on five 1:50,000-scale maps of the volcanic field (fig. 2): the central sheet (Wolfe and others, 1987a), the eastern sheet (Moore and Wolfe, 1987), the southwestern sheet (Newhall and others, 1987), the northwestern sheet (Wolfe and others, 1987b), and the SP Mountain quadrangle (Ulrich and Bailey, 1987). In this report, the maps are collectively referenced as "Wolfe and others (1987)." The K-Ar ages presented on these maps include many that were previously unpublished; the ages were obtained by E.H. McKee (U.S. Geological Survey) and P.E. Damon and Muhammed Shafiqullah (Laboratory of Isotope Geochemistry, University of Arizona). A preliminary magnetostratigraphy of the field was reported by Tanaka and others (1986). Wolfe and others (1987) also made extensive use of the paleomagnetic data in their stratigraphic assessment of the volcanic rocks; their maps include our paleomagnetic sample sites and the sites' polarities. In the present paper, we also provide the details of the paleomagnetic data and discuss assumptions, individual key relations, and the reliability of interpretations upon which the stratigraphy rests.

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Previous Investigations

Before this research program was begun, workers dealt primarily with the geology and stratigraphy of the northern and eastern parts of the volcanic field (Robinson, 1913; Colton, 1936; Cooley, 1962; Moore and others, 1976), where erosional levels of the Little Colorado River valley provide a basis for stratigraphic correlations. Earlier paleomagnetic and radiometric studies were centered on these northern and eastern basalt flows and on the prominent silicic centers such as San Francisco Mountain, Kendrick Peak, and O'Leary Peak (Opdyke and Runcorn, 1956; Babbitt, 1963; Damon, 1966; Coe, 1967; Strangway and others, 1968; Damon and others, 1974). From this work, northeastward progression of volcanism along the Mesa Butte fault system (Ulrich and Nealey, 1976) and overall eastward migration of volcanic field activity (Smith and Luedke, 1984) were recognized.

A summary of the geology and stratigraphy of the field, based largely on unpublished maps, K-Ar ages, and paleomagnetic polarities, was given by Wolfe and others (1983). Also on the basis of that unpublished work, Tanaka and others (1986) presented a comprehensive description of the migration and evolution of volcanism and determined the positions and ages of volcanic vents and volumes of eruptive material. They further proposed a model for generation of magmas by shearing at the base of the lithosphere, and they suggested that the eastward volcanic migration since Matuyama time is a product of westward absolute motion of the North American plate.

Geologic Setting

The San Francisco (SF) volcanic field in northern Arizona is one of several dominantly basaltic volcanic fields of late Cenozoic age on or near the south margin of the Colorado Plateau (fig. 1). The field consists of more than 600 Pliocene and Quaternary volcanoes and associated lava and pyroclastic flows and tephra. The volcanic rocks, which cover approximately 4,800 km^2, rest on erosional surfaces of low relief cut in Permian and Triassic sedimentary rocks. The volcanic field is elongate in plan, extending somewhat more than 100 km east-west and about 70 km north-south (fig. 3).

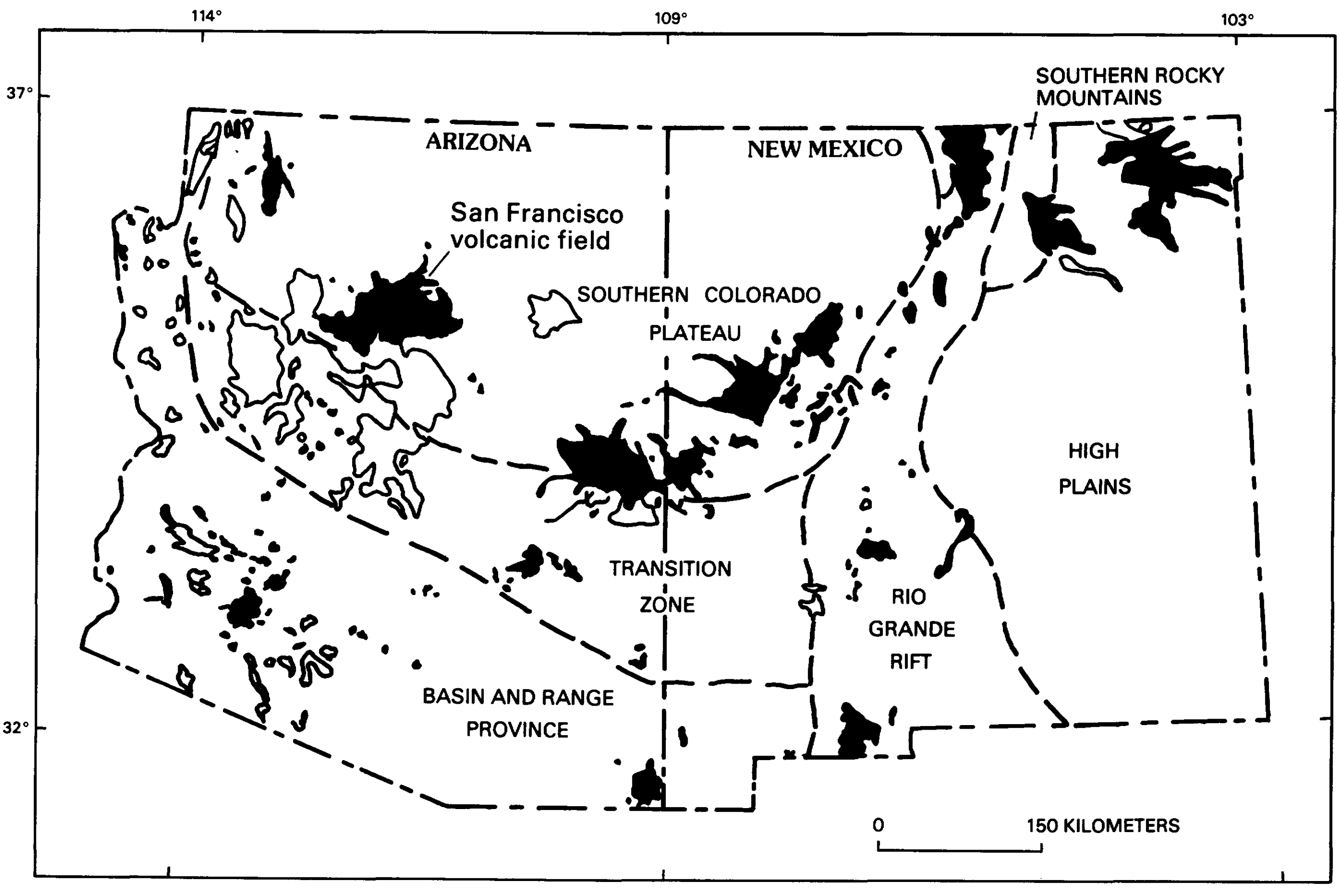

Figure 1. Late Cenozoic volcanic fields in Arizona and New Mexico (after Wolfe and others, 1983). Dark areas, volcanic rocks younger than 5 m.y.; outlined areas, volcanic rocks 5 to 16+ m.y. old. Dashed lines, approximate borders between geographic provinces.

An extensive volcanic field, mostly Miocene and commonly referred to as the "rim basalts," lies along the south end of the SF volcanic field, roughly parallel with its long axis. Here we include the andesite dome of Mormon Mountain and other basaltic volcanic rocks surrounding it in the rim basalt field (because of their petrologic similarities), although Mormon Mountain was included in the SF volcanic field by Robinson (1913) and has a Pliocene age. The rim basalts are generally more strongly offset by normal faults and are more dissected by erosion than the lavas of the SF field. Most K-Ar ages obtained in the rim basalts range from 5 to 8 Ma (Luedke and Smith, 1978). The oldest volcanoes and lava flows of the SF volcanic field are found where they overlap the basalts along the southwest margin of the field; it is not clear whether there is a break in time between volcanism of the rim basalt and that of the SF field. Hence, the boundary of the field is ill defined on the southwest; we have roughly drawn it on the basis of morphology and petrography at the limit of detailed geologic mapping by Wolfe and others (1987). The relations of these rim basalts to the petrogenetic evolution of the SF field and to the deep-seated processes along the south margin of the Colorado Plateau remain topics for future analysis.

Five major centers of intermediate to silicic rocks are located within the SF volcanic field (fig. 2). From west to east they are Bill Williams Mountain (dacitic and andesitic domes and flows), Sitgreaves Mountain (rhyolitic domes), Kendrick Peak (andesitic to rhyolitic domes and flows), San Francisco Mountain (a stratovolcano dominantly made up of andesitic flows with dacitic and rhyolitic domes and flows) and O'Leary Peak (andesitic to rhyolitic domes and flows).

Several regional normal fault systems of late Cenozoic age (fig. 2) cut the Paleozoic sedimentary rocks and locally affect rocks of the SF field as well. These fault systems have been shown by Shoemaker and others (1978) to be related to large, ancient systems of faults that cut the Proterozoic crystalline basement. A major one, the Mesa Butte fault system, trends northeast across the SF volcanic field. Several silicic to intermediate volcanic centers, including Bill Williams Mountain, Sitgreaves Mountain, and Kendrick Peak, occur along or close to this fault system, which cuts some of the volcanic rocks (Ulrich and Nealey, 1976). The north-trending Oak Creek Canyon fault system cuts some cinder cones north of Oak Creek Canyon (Wolfe and others, 1987a). The north limit of this system is unknown because of burial; however, its projection places it beneath San Francisco Mountain. Minor faults of the Cataract Creek fault system trend northwest across the eastern part of the SF volcanic field. Many basaltic cinder cones, as well as silicic volcanoes, are aligned along exposed faults or form chains parallel with the faults in each system. Deep-seated crustal structures clearly control the location of many of the volcanic vents.

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We are grateful for the extensive assistance of Edward W. Wolfe and George E. Ulrich of the U.S. Geological Survey and Richard F. Holm of Northern Arizona University in matters relating to the geology of the volcanic field. Christopher D. Condit of the University of Massachusetts and George E. Ulrich provided helpful reviews of the manuscript.

PALEOMAGNETIC SAMPLING AND LABORATORY METHODS

The rocks sampled at the 657 paleomagnetic sites in this study include most of the mapped volcanic units of Wolfe and others (1987). Some of these units, particularly those from basaltic vents and lava flows, represent many distinct eruptions. Volcanic rocks west of and near San Francisco Mountain were sampled comprehensively because of the scarcity of other information from which to interpret the stratigraphy. East of San Francisco Mountain, paleomagnetic sampling was done by J.N. Kellogg (unpublished work) and Champion (1980, table 1) to help define the chronology of the informal stratigraphy developed by Moore and others (1976). This stratigraphy is based on terrace levels related to downcutting in the Little Colorado River valley; it includes (from oldest to youngest) the Woodhouse, Tappan, Merriam, and Sunset age groups. The three youngest groups correlate with middle and late Brunhes time, whereas the Woodhouse group corresponds to early Brunhes and older times.

All localities whose paleomagnetic vectors were analyzed in this study are listed in table 4. Virtually all paleomagnetic sites sampled in the SF volcanic field since the mid-1970's are included in table 4, which lists rock type, location, and paleomagnetic, stratigraphic, and K-Ar age data. Site locations are shown on the sample-locality maps of Wolfe and others (1987). The preface of table 4 gives more details on its structure and the labeling scheme used.

The basic polarity chronostratigraphic unit of this study comprises the products of an individual eruptive episode (or an eruptive unit) that constructed a vent or, in some cases, produced only flows or tephra; flows or tephra effused during vent construction are considered part of that vent's polarity chronostratigraphic unit. Flow sequences, including those not sampled comprehensively, are also considered products of an individual eruptive episode. Thus many eruptive units consist of both vent and flow materials, and more than one paleomagnetic sample site was obtained for many of the eruptive units. (In table 4, additional sites for each eruptive unit are referred back to the first site under the heading "Field relations," following the phrase "Same as".)

We separated the rocks into (1) basaltic and (2) silicic and intermediate categories on the basis of their general difference in eruption style rather than on strictly lithologic and chemical distinctions. Therefore, the character of the vent (for example, cinder cone or dome) and the apparent viscosity of the lava flows were the primary criteria used to distinguish these categories. This approach is based on the organization of map units employed by Wolfe and others (1987), although most of their geologic units comprise several eruptive units. The basaltic rocks include basalt, basaltic andesite, andesite, and benmoreite. They include flows and a single tuff that demonstrably or presumably were effused from mapped or buried vents. Where the vent is known, Wolfe and others (1987) labeled the associated basaltic flows and tephra by that vent number. Where andesites and benmoreites form part of a major eruptive center consisting of at least several units, or where they form domal structures, they are included with silicic and intermediate rocks (which also consist of dacite, trachyte, and rhyolite). Careful reconsideration of some sites of intermediate lithology presented by Tanaka and others (1986) required reassignment of some sites to either a basaltic or a silicic category. These changes, however, do not appreciably affect the results.

For silicic and intermediate rocks, 92 sites representing 80 different domes, tephra, flows, and flow sequences were sampled, including a thick section of layered andesite and dacite flows on San Francisco Mountain that was sampled in detail. Babbitt (1963) had determined the polarity of a few of these units and of the dacite of O'Leary Peak, which we did not sample.

The 565 sample sites of basaltic vents and lava flows represent 503 separate eruptions. The eruptions include 32 lava flows, 1 tuff from buried or unknown vents, and 2 flows from local fissures. A few other flows were not sampled, particularly those whose stratigraphic positions had already been determined by known field relations. J.N. Kellogg (unpub. data, 1976) sampled 13 sites east of San Francisco Mountain on younger Woodhouse lava flows to distinguish rocks of Brunhes age from those of Matuyama age. Champion (1980, table 1) measured magnetic vectors of 11 sites of Merriam- and Sunset-age vents and lava flows to determine absolute ages according to the secular variation of the Earth's magnetic dipole position for the past few thousand years. Kellogg's and Champion's data are included in table 4.

We obtained oriented core samples, mostly by using a portable rock drill similar to that described by Doell and Cox (1965). Because of logistic difficulties for

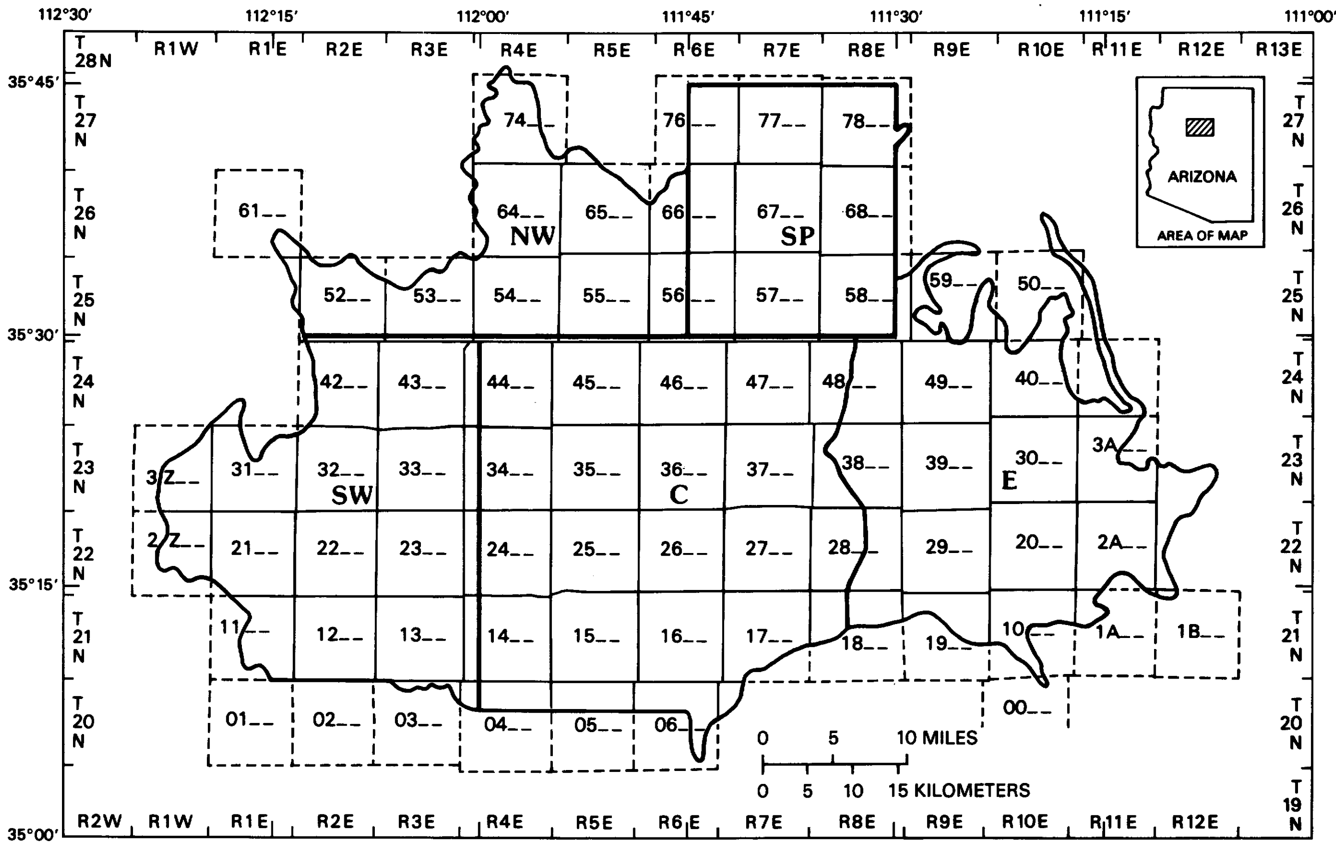


Figure 2. Outlines of detailed geologic maps of San Francisco volcanic field, Arizona (heavy lines; Wolfe and others, 1987), and site-location grid system for samples listed in table 4. Boxes show township and range squares identified by grid notations (explained in table 4 preface). Maps of San Francisco volcanic field identified by letters: C, central; E, east; NW, northwest; SW, southwest. SP, SP Mountain.

a few sites high up on Kendrick Peak and San Francisco Mountain, some samples were collected as oriented blocks that were taken from outcrops and drilled in the laboratory. Usually six to eight samples (cores or blocks) were taken per site, but as many as 24 samples were taken from outcrops where well-defined magnetic vectors were desired. Generally, the samples were taken tens of centimeters to meters apart along one or more nearby outcrops. For a few sites (in particular for broad flows), samples were taken tens of meters to 100 m apart. Sample azimuths were measured by a sun compass when possible, and all samples were oriented by a magnetic compass. Because lightning has extensively remagnetized the volcanic rocks, we sampled oxidized vent rocks rather than lava flows where possible, as discussed below. Appreciable rotations have occurred in the tops and flanks of some blocky flows and domes, which are mostly intermediate to silicic in composition. We could sample some vents only from large cinder bombs protruding through loose cinders. If samples from scoria bombs yielded discordant data, we assumed that the samples represent slumped or rotated material, and therefore we discarded them.

Because most of the rocks we sampled are strongly magnetized, we made measurements using either (1) a high-rpm, air-driven, spinner magnetometer on 2.5-cm-diameter, recored samples generally weighing 15 to 25 g or (2) a superconducting magnetometer for wafer-shaped samples 2.5 cm in diameter and 3 to 7 mm thick, mostly weighing 3 to 8 g. Even so, some of the basalt samples had natural remanent magnetization (NRM) intensities beyond the range of the instrument, especially samples suspected of having a lightning-induced, isothermal remanent magnetization (IRM) component. For cross-checking, we measured some samples with both instruments. For this purpose, we took more than one sample from some of the cores; however, we report only the measurements of one sample per core. All samples were subjected to alternating field (AF) demagnetization on either of two tumbling AF demagnetizers. Generally, samples were step-wise demagnetized at intervals of 250 oersteds to a maximum of 1,000 oersteds, on the basis of the step in which optimal cleaning of the IRM component occurred. For 21 sites, we present NRM data because of optimal statistics at this step or because samples were lost following NRM measurements; fortu-

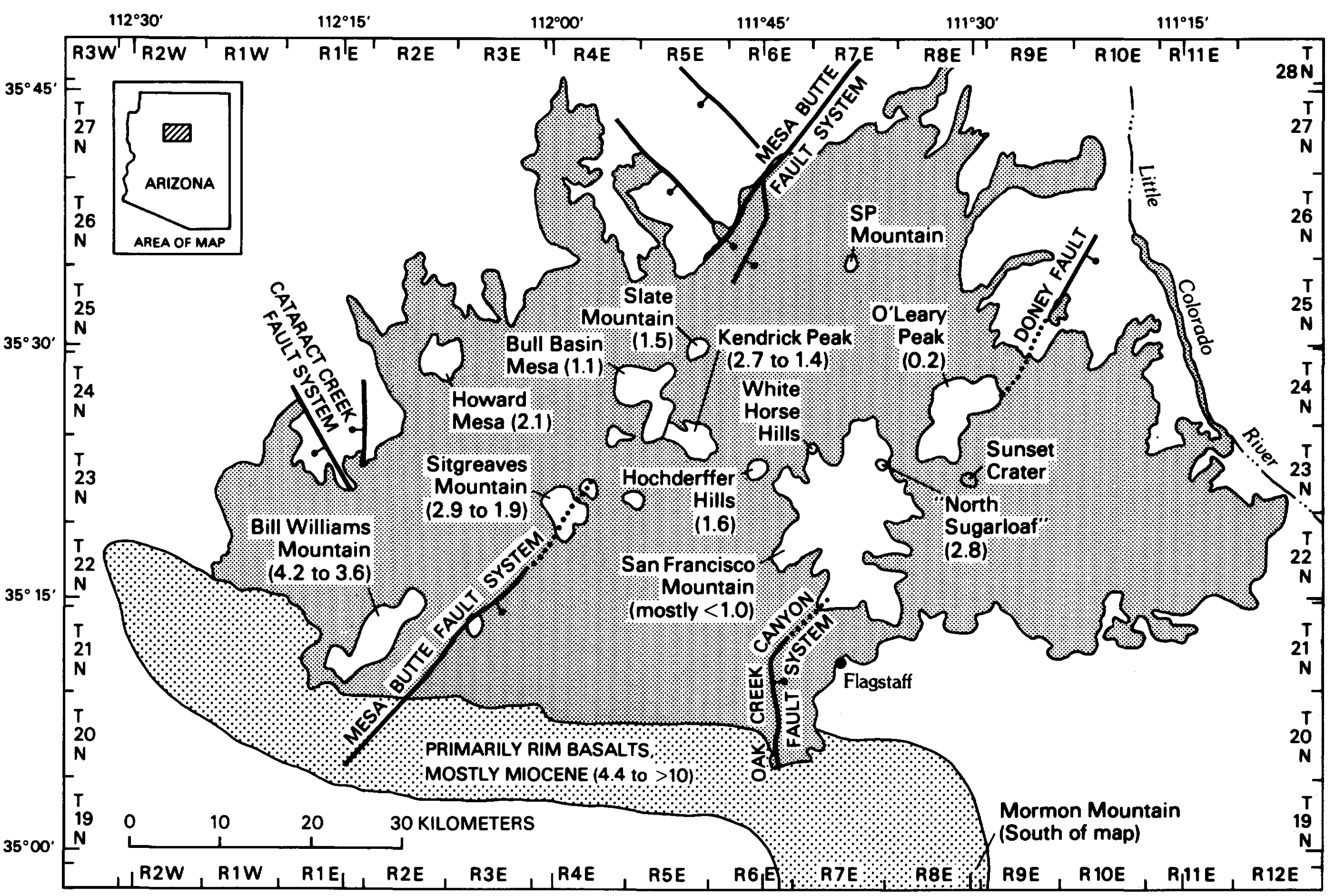
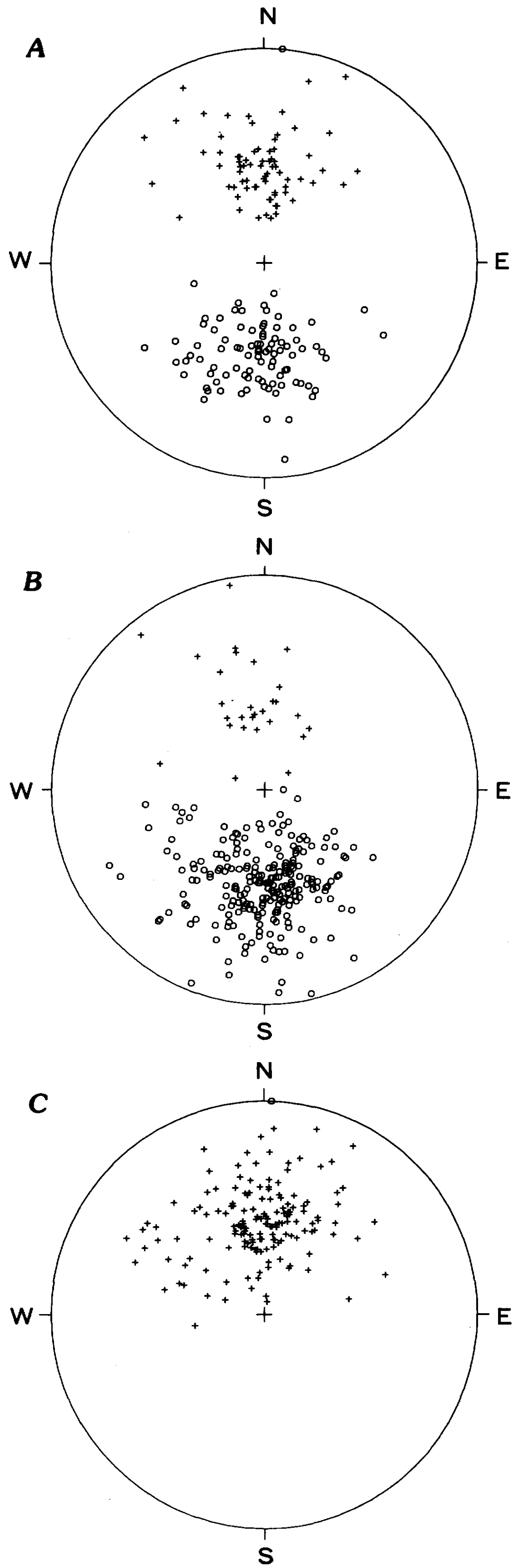


Figure 3. San Francisco volcanic field, Arizona (after Tanaka and others, 1986). Gray pattern, Pliocene and Pleistocene volcanic rocks; silicic centers within volcanic field are white. Numbers in parentheses indicate ages in millions of years. Faults dotted where concealed; bar and ball on downthrown side.

nately, however, the statistics on the latter samples are adequate. Onstott, who worked mainly on the sites in the SP Mountain quadrangle, used mostly demagnetization intervals of 170, 270, 330, 500, 660, and 750 oersteds.



Samples that probably retain a large component of IRM, as indicated by either high magnetic intensity or large deviation of direction from the majority of directions at a given sample site, were not included in calculations of the average direction of magnetization. This selection process did not alter polarity determinations; however, data from about 15 sample sites were insufficiently coherent to determine a polarity and were discarded. Also, the magnetic vectors of 66 sites were of poor precision ($\alpha_{95} > 40°$) or peculiar direction, even following several demagnetization steps. (Reasons for poor data are discussed in the following section.) The polarities of these sites are queried in table 4, and their paleomagnetic data are omitted. Samples taken by J.N. Kellogg (unpub. data, 1976) and D.E. Champion (1980, table 1; written commun., 1983) were acquired and measured by those workers using the methods described above. All measurements were performed at the U.S. Geological Survey in Flagstaff, Ariz., except those by Champion, which were performed at the U.S. Geological Survey in Menlo Park, Calif. The average magnetic vectors for all sites that have reliable data in table 4 are plotted by polarity chronozone in figure 4; polarities of the rocks at eruptive sites are shown in Tanaka and others (1986, figs. 4, 5).

MAGNETIC PROPERTIES OF THE VOLCANIC ROCKS

Paleointensity studies of the Earth's magnetic field that are based on volcanic rocks in the SF volcanic field (Babbitt, 1963; Coe, 1967; Strangway and others, 1968) have shown that the major magnetic component in the basaltic lava flows is borne by titanomagnetite. This mineral has a Curie point between 400 and 550 °C, depending on the relative abundances of iron and titanium. All of the volcanic rocks studied (except perhaps for the tops of some silicic and intermediate flows and domes) apparently came to rest at sufficiently high temperatures for their thermal remanent magnetization (TRM) to be acquired in place.

The sampled basaltic lavas generally have NRM intensities of 10^{-3} to 1 gauss/cm^3, made up of TRM and IRM components. The intensities of the individual components depend on sample mineralogy and proximity to lightning strikes. Despite our efforts to avoid anomalous

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Figure 4. Hemispherical equal-area plots of average paleomagnetic vectors of sample sites in San Francisco volcanic field, Arizona. Pluses, positive inclination. *A*, Sites of pre-Matuyama age. Circles, negative or zero inclination. *B*, Sites of Matuyama age. Circles, negative inclination. *C*, Sites of Brunhes age. Circle, zero inclination.

magnetism resulting from lightning strikes, the NRM's of most samples taken from lava flows are high in intensity and are dominated by an IRM component. Most samples taken from road cuts, cinder pits, and oxidized vent material have low NRM intensities and only minor IRM overprints. The magnetization of the vent material is dominated by hematite. The coercivity of hematite is sufficiently high that the vent materials are relatively free of IRM, despite their increased exposure to lightning on the rims of cinder cones.

Thus oxidized vent materials commonly showed a tight grouping of NRM vectors (resulting in $\alpha_{95} < 5\text{–}7°$ and $\kappa > 100$), and the vector mean generally changed only a few degrees upon demagnetization. Where other magnetic components apparently caused greater scattering of NRM vectors (particularly for magnetite-dominated samples), demagnetization commonly altered the site mean by more than 10°, and clustering of the vectors increased dramatically. On the other hand, nearly 10 percent of all sites retained a high degree of their secondary remagnetizations (to the limit of our demagnetization capability).

POLARITY CHRONOSTRATIGRAPHY

Several stratigraphic systems of units have been used to define the ages of volcanic rocks in the SF field (fig. 5). In our study, we make particular application of the polarity reversal record for the past 5 m.y. The fundamental polarity-chronostratigraphic unit, called the "polarity chronozone," consists of rocks of a particular age as defined by a given polarity signature. The equivalent chronologic time span is the "polarity chron."

Determination of Polarity Chronozones

On the basis of polarity data, radiometric ages, and stratigraphic relations, we assigned mapped volcanic units (which may include deposits of more than one eruption) to polarity chronozones. The polarity chronozones for the past 5 m.y. were defined by Mankinen and Dalrymple (1979) on the basis of statistical analysis of K-Ar ages and of magnetic polarity determinations that meet strict requirements of precision. The Brunhes Normal-, Matuyama Reversed-, Gauss Normal-, and Gilbert Reversed-Polarity Chronozones defined originally by Cox and others (1964) are the principal units for which magnetostratigraphic correlations within the volcanic field have been attempted. Although normal-polarity subchronozones of the Matuyama, such as the Réunion Normal-Polarity Subchronozone (2.14 to 2.12 and 2.04 to 2.01 Ma), Olduvai Normal-Polarity Subchronozone (1.87 to 1.67 Ma), and Jaramillo Normal-Polarity Subchronozone (0.97 to 0.90 Ma), are represented in the field (for example, by sites 3611, 4003, 6803A, and 6804), sufficient K-Ar and stratigraphic controls were not available in most cases for us to identify consistently the volcanic units belonging to these polarity subchronozones (fig. 5). Thus normal-polarity sites of Matuyama age, for example, are not categorized by polarity subchronozone in table 4. Age control was also insufficient for consistent distinction between rocks of Gauss and Gilbert ages (about 5.0 to 2.48 Ma). We therefore grouped rocks belonging to these polarity chronozones with a few older rocks and considered their age to be "pre-Matuyama" (fig. 5).

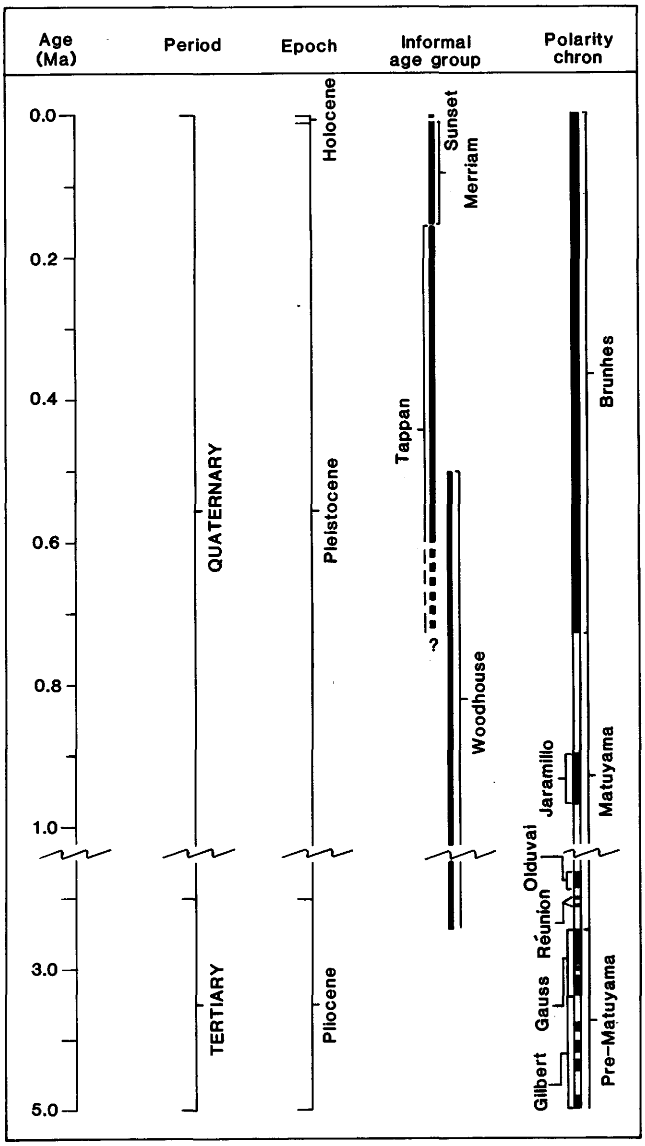

Figure 5. Correlation of polarity chronologic units used in San Francisco volcanic field, Arizona. Informal age groups based on stratigraphy of lava flows in Little Colorado River valley (Moore and others, 1976). Polarity chrons show periods of normal polarity (solid) and reversed polarity (open); "pre-Matuyama" is informal name for Gauss Normal- and Gilbert Reversed-Polarity Chrons combined. Figure modified from correlation chart of Moore and Wolfe (1987); reversal record from Mankinen and Dalrymple (1979).

Most of the K-Ar ages cited in this study were determined by P.E. Damon and Muhammed Shaffiqullah (Laboratory of Isotope Geochemistry, University of Arizona) and E.H. McKee (U.S. Geological Survey) and were published on the maps of Wolfe and others (1987). Ages obtained prior to 1979 were slightly revised to reflect new decay constants (Dalrymple, 1979). A few absolute ages were also obtained by secular variation studies (Champion, 1980, table 1; written commun., 1985), by ^{14}C dating (S.W. Robinson, written commun., 1983), by fission tracks (C.W. Naesar and G.A. Izett, written commun., 1975), and by dendrochronology (Smiley, 1958); these ages generally apply to young Brunhes rocks. Absolute ages that pertain to paleomagnetic sites used in this study are given in table 4. Units dated by K-Ar methods were assigned to a single polarity chron if the one-standard-deviation interval includes only that polarity chron (these units include Brunhes basaltic rocks categorized as "Dated by field relations" in table 4); otherwise, geomorphic or contact relations of the given unit with one or more dated units were used to ascertain the polarity chronozone.

In addition to paleomagnetic data and absolute ages, we used broad and local stratigraphic designations, superposition relations, lithologic correlations, and geomorphic preservation as detailed by Wolfe and others (1987) to ascertain local volcanic stratigraphy. These methods and some of the general relations are described below.

Fresh cinder cones and rough-surfaced lava flows in the eastern part of the field are clearly younger than the eroded vents with exposed feeder dikes and the smooth-topped flows in the western areas. Near the Little Colorado River (fig. 3), rates of downcutting have been rapid enough to enable distinction of younger flows in stream bottoms from older flows at successively higher terrace levels above present drainage. These relations enabled a relative-age classification by Colton (1936) and Cooley (1962) and, more recently, a stratigraphy for the eastern part of the volcanic field by Moore and others (1976). Radiometric ages indicate that lavas and tephra of the Tappan, Merriam, and Sunset basaltic stages of Moore and others (1976) are part of the Brunhes Normal-Polarity Chronozone (fig. 5). On the basis of magnetic polarity and K-Ar ages, lavas dated as Woodhouse age by these workers commonly can be shown to belong to the Matuyama or the older part of the Brunhes.

In the eastern part of the volcanic field, all volcanic vents or flows suspected of being pre-Brunhes in age were studied for paleomagnetic polarity, and most were analyzed radiometrically; most units known to be of Brunhes age on the basis of stratigraphic position were not sampled. In a few cases, K-Ar ages are inconsistent with polarity and other stratigraphic indicators; following the lead of Wolfe and others (1987), we discarded these ages.

In the central and western parts of the volcanic field, we made extensive use of superposition relations (chiefly of flows) in deciphering the magnetostratigraphy. When superposition relations are combined with radiometric ages and paleomagnetic polarity data, polarity chron determinations can be made for most vents. We correlated some vents on the basis of similar lithology and proximity to vents of known age. Cinder cones having the same rock type are commonly in clusters or linear patterns and can be interpreted as the products of a single eruptive episode. For example, Sunset Crater and an associated group of vents along a northwest trend probably all erupted within a period of 200 years (Champion, 1980, p. 50). Silicic centers, on the other hand, have eruptive histories spanning about 1 m.y. (Damon and others, 1974).

We made polarity-chronostratigraphic assignments for all eruptive units represented by basaltic vents, for most of the lava flows, and for most intermediate to silicic volcanic units. Some basaltic rocks having stratigraphic positions near polarity chronozone boundaries cannot be placed with certainty into a polarity chronozone. We infer the probable assignment of such rocks, as shown by their placement in a polarity chronozone in table 4, and we also indicate alternative possibilities (for example, a group of sites in the Matuyama category is headed "Matuyama or pre-Matuyama"). Synoptic views of our inferred polarity chrons (except for a few sites that we later changed) are shown in figures 6 and 7 of Tanaka and others (1986).

Because the sampling was so comprehensive, our polarity data were significant in determining the stratigraphic ages of basaltic units mapped by Wolfe and others (1987). Many sample sites, in fact, were selected because they bear on local stratigraphic problems. As a result, the map symbols of Wolfe and others are largely based on those of pre-Matuyama, Matuyama, and Brunhes Chronozones. The relations between most of the map symbols for basaltic rocks and our polarity-chron designations are summarized in table 1.

The geologic maps (Wolfe and others, 1987) also provide an index to the vent-numbering system used for the field; they show the locations of the geologic units, K-Ar dated sites, and polarity sample sites; they present the correlation of map units; and they indicate detailed superposition relations. This information is essential to the following detailed discussion of the stratigraphy, and the reader will need to refer to the maps to locate specific rock units and verify stratigraphic inferences. Because the correlation charts for the maps contain much of the general stratigraphic information, our discussion focuses on detailed relations among rocks of individual eruptive episodes. This work was complex, not only because some individually mapped units (particularly many of the silicic to intermediate flow units) may be composites of rocks produced over several eruptive episodes, but also be-

Table 1. Correlation of map symbols of Wolfe and others (1987) with epochs and polarity chrons for basaltic units in the San Francisco volcanic field, Arizona

[Symbol is only the first one, two, or three letters of many map symbols used by Wolfe and others (1987)]

Symbol	Epoch(s)	Polarity chron(s)
Qbs	Holocene (Sunset[1])	Latest Brunhes
Qby	Latest Pleistocene	Later Brunhes
Qb	Middle Pleistocene	Early Brunhes
Qbm	Early or middle Pleistocene	Late Matuyama or early Brunhes
Qm	Early Pleistocene	Late Matuyama
QTm	Late Pliocene, early Pleistocene	Matuyama
QT	Pliocene or Pleistocene	Pre-Matuyama or Matuyama
T	Miocene and Pliocene	Pre-Matuyama, undivided
Tm	Late Pliocene	Early Matuyama
Ty	Most of Pliocene	Gilbert or Gauss
To	Miocene	Pre-Gilbert

[1]Informal age of Wolfe and others (1987)

cause many single eruptive episodes produced several mapped units (vent, flow, or tephra deposits). In the following discussion, site numbers (for example, 1232A) are independent of vent numbers. A given eruptive unit was commonly sampled at more than one site.

Pre-Matuyama Chronozone

Rocks of this informally named zone are mainly of the Gauss Normal- and Gilbert Reversed-Polarity Chronozones (about 5.0 to 2.48 m.y. old). Most of those in the San Francisco volcanic field are located in the western end. Most basalts older than 5 m.y. in the central and southern parts of the volcanic field are considered to be part of the rim basalts, and only a few sites in these rocks were sampled. There are comprehensive K-Ar ages for silicic volcanic units but few for basalts considered to be in this polarity zone.

Silicic and Intermediate Rocks

The silicic and intermediate rock sites of pre-Matuyama age consist primarily of the Bill Williams Mountain dome complex, nearby domes to the south and east, and the eastern part of the Sitgreaves Mountain dome complex and rhyolite domes east of it. The rocks of Bill Williams Mountain are dominantly dacitic, most have normal polarity, and the K-Ar ages for them range from 5.03±0.50 to 2.85±0.91 Ma. The dacite of Hell Canyon (site 1232A, 5.15±0.17 Ma) also is pre-Matuyama in age. Two sites of Sitgreaves Mountain rocks have ages of 2.85±0.06 and 2.84±0.02 Ma and normal polarity. Pre-Matuyama rhyolite domes east of the mountain have ages and polarities of 2.88±0.09 Ma (normal), 2.79±0.07 Ma (reversed), and 2.74±0.16 Ma (reversed). A dome north of Sugarloaf Mountain (unsampled, 2.78±0.13 Ma; informally named "North Sugarloaf Mountain" by Wolfe and others, 1987a; see fig. 3), the only pre-Matuyama silicic unit in the eastern part of the volcanic field, has no polarity determination.

Basaltic Rocks

Rim basalts and basaltic andesites in the area (units Tob, Toab, Tocb, and older materials of unit Tb as mapped by Wolfe and others, 1987) have K-Ar ages of 6.38±0.32 to 5.62±0.19 Ma and are exposed in the vicinity of Flagstaff (site 1710), in the southern part of the map area (vents 0626, 1110 1222, 1232, 2135, and 2136A), and at Cedar Ranch Mesa (vent 4609) on the north edge of the field. Although their extent is obscured by younger lavas, sparse exposures suggest that the rim basalts make up only a minor part of the volume of lavas in the map area. Because the rim basalts have similar ages and distinct petrographic affinities, they may represent an episode of volcanism genetically distinct from the one that produced the highly varied lavas of the SF volcanic field (Wolfe and others, 1987a).

The largest concentration of pre-Matuyama basaltic vents occupies the western part of the field northwest of Bill Williams Mountain. Most of the identified vents are in T. 22 and 23 N., R. 1 W. and 1 E. (Site and vent numbers start with 2Z, 3Z, 21, and 31; Z indicates R. 1 W.; see figure 2.) As a group, these vents overlie the rim basalts and appear more degraded than vents to the east; most of them have reversed polarity. Some of the vents underlie rocks of probable Gauss age (in particular, the flows of vents 2220 and 2222; see below). On this basis, Newhall and others (1987) assigned these vents and their flows to the pre-Matuyama Chronozone (their unit Tb).

Most of the pre-Matuyama rocks in the southern and western parts of the field were assigned to basalt of Pliocene age (map unit symbols beginning with Ty, 5.0 to 2.48 Ma). This group of basalts includes (1) rocks having K-Ar ages within this time period (materials of vents 1211, 1233, 2519B, and 6806 and flow 2233A); (2) the basalt flows of Volunteer Mountain (unit Tyvb), which have reversed polarity, are similar in composition to rocks about 4 m.y. old in Volunteer Canyon in the south-central part of the field (E.W. Wolfe, written commun., 1986), and overlie rim basalts; (3) materials of 10 vents (9 having normal polarity) mostly south of and predating the andesite flow of Howard Mesa (2.06±0.18

Ma); (4) rocks of a group of six deeply eroded vents aligned in a northwest trend, northwest of Howard Mesa, having mostly normal polarity (probably Gauss in age); (5) normal-polarity materials of vents 2220 and 2222, which are younger than andesite dome 2222A (3.48±0.05 Ma), and materials of other nearby vents of mostly normal polarity that underlie reversed-polarity, Matuyama rocks to the east; and (6) assorted other vent materials related stratigraphically, areally, magnetically, and compositionally to the first five groups. Overlying the several types of Tertiary units described above are 11 vents that are probably of pre-Matuyama age but which might be of Matuyama age.

Matuyama Chronozone

The Matuyama Chronozone, having dominantly reversed polarity, spans the period between 2.48 and 0.73 Ma. The Réunion, Olduvai, and Jaramillo Normal-Polarity Subchrons account for about 0.32 m.y., or 18 percent of the chron (fig. 5). Units of Matuyama age are found over most of the San Francisco volcanic field; the greatest concentration is in the west half.

Silicic and Intermediate Rocks

Most of the silicic and intermediate rocks of the Matuyama Chronozone lie along the northeast-trending Mesa Butte fault, northeast of pre-Matuyama silicic rocks. These Matuyama rocks include (1) the silicic domes on Sitgreaves Mountain (2.26±0.10 and 1.90±0.12 Ma), (2) all rock units on Kendrick Peak (2.37±0.21 to 1.35±0.05 Ma) except for one dome (unsampled, 2.70±0.05 Ma), (3) four isolated rhyolite domes east of Sitgreaves Mountain and Kendrick Peak (2.15±0.13 to 1.29±0.23 Ma), the youngest of which is a plug in a benmoreite dome; (4) the andesite flow of Howard Mesa (2.06±0.18 Ma), (5) the Slate Mountain domes (1.90±0.35 and 1.54±0.02 Ma), (6) the trachyte flow of Bull Basin Mesa (1.14±0.17 Ma), and (7) the andesite flows of Moritz Ridge (site 3401A). All but three of the sites yielded reversed polarity, some of which is questionable. Within San Francisco Mountain, several units have K-Ar ages of less than 1.0 Ma that place them in the late Matuyama, and an early rhyolite dome has an age of 1.82±0.16 Ma; these units were not sampled for magnetic polarity.

Basaltic Rocks

Most Matuyama vents are exposed, but several probably underlie younger rocks of and near San Francisco Mountain. Many of the Matuyama cinder cones are clustered and elongated along northwest, north, and northeast trends, reflecting local structures.

For Matuyama basaltic rocks, 19 erupted deposits have been dated by K-Ar and measured paleomagnetically. Most rocks of these dated eruptions are in two groups. The first group consists of vent materials and flows of the SP Mountain quadrangle and the eastern sheet, most of which are well defined stratigraphically from overlap relations and erosional terrace levels. Although dominantly reversed, a few apparently were emplaced during normal-polarity subchrons of the Matuyama. Of this first group, the deposits of 10 eruptions have K-Ar ages in the range of 1.38±0.16 to 0.83±0.04 Ma; 3 of these 10 have normal polarity and range in age from 1.04±0.14 to 0.85±0.12 Ma (vent 6736 and flows of sites 4003 and 6803A). The ranges of uncertainties in their ages indicate that these normal-polarity rocks formed during the Jaramillo Normal-Polarity Subchron (0.97 to 0.90 Ma). Other probable Jaramillo flows (sites 5033 and 5932) also have normal polarity, formed during the Woodhouse basaltic stage, and are older than rocks dated as 0.49±0.11 and 0.80±0.11 Ma, respectively. Some of the vents and flows in the Little Colorado River valley do not have K-Ar ages but have been placed in the Woodhouse age group (Moore and others, 1976); they have reversed polarity and thus are assigned a Matuyama age. The second group of dated Matuyama rocks consists of benmoreites that crop out along and near the Oak Creek Canyon fault (vents 0603, 0610, 0611, 0611A, 0614, 0615, 1622, and 1628) and south of Kendrick Peak (vents 2506 and 3509A, domes 2530, 3423A, and 3435, and a flow sampled at site 2629). Although only the vents are grouped with the basaltic rocks, all the domes and the flow are dated, and their ages are consistent with those of the vents. All these sites have reversed polarity; seven K-Ar ages determined for them range from 1.61±0.05 Ma (dacite plug of vent 0603) to 0.95±08 Ma. Some units having no K-Ar ages have stratigraphic positions consistent with these ages.

Most of the remaining basaltic rocks (largely not analyzed radiometrically) assigned to the Matuyama Chronozone belong to one of two groups. In the first group are vents, dominantly of reversed polarity, that overlie pre-Matuyama basalts in a stratigraphic position similar to that of the andesite of Howard Mesa (2.06±0.18 Ma) and vent 3335 (1.07±0.06 Ma). These vents have township and range prefix codes 31, 32, 33, 42, and 43. In the second group are vents and flows, mostly of reversed polarity, in the central part of the field surrounding the silicic centers of Kendrick Peak, Sitgreaves Mountain, and Slate Mountain and extending to the north and south borders of the mapped area. A Matuyama age is indicated for four of these vents (2405, 2416, 2519, and 3433) that have reversed polarity and K-Ar ages of 2.46±0.11 to 0.69±0.13 Ma and for other vents and flows that have diagnostic stratigraphic relations with other rocks. Examples of stratigraphic relations that indicate age are vents 4507, 4508, and 4517 that overlie the trachyte flow of Bull Basin Mesa, which has a K-Ar age of 1.14±0.17 Ma. The township and range codes (see figure 2) for this group of rocks are 14, 15, 16, 23, 24, 25, 26, 34, 35, 44, 45, 53, 54, 55, 64, 66, and 74.

Four vents having normal polarity occur in areas of clearly defined Matuyama rocks. However, evidence is insufficient for us to be certain if they belong to the normal-polarity subchronozones of the Matuyama or to the Brunhes Chronozone.

Brunhes Chronozone

All eruptive vents and centers of Brunhes age in the San Francisco volcanic field are east of long 112°. They have several characteristics: high stratigraphic position (in the informal Tappan, Merriam, and Sunset basaltic stages), recent K-Ar ages, low degree of erosion, and exclusively normal polarity (Mankinen and Dalrymple, 1979).

Silicic and Intermediate Rocks

Silicic to intermediate units in the Brunhes Chronozone include most of the complex at San Francisco Mountain (most ages are 1.0 to 0.4 Ma), materials of O'Leary Peak (about 0.2 Ma), and the rhyolite of White Horse Hills. All 20 paleomagnetic sites on San Francisco Mountain have yielded normal polarity, including a stratigraphic section in Dunham Canyon (site 3729) of andesite and dacite flows having K-Ar ages of 0.75±0.07 Ma (at base of section) and 0.43±0.03 Ma (at top of section). As previously mentioned, some San Francisco Mountain rocks of late Matuyama age (based on K-Ar ages) were not sampled paleomagnetically.

O'Leary Peak is composed mainly of dacite and some rhyolite and andesite that have K-Ar ages of 0.25±0.04 to 0.17±0.04 Ma and normal polarity (Babbitt, 1963). The rhyolite of White Horse Hills uplifted andesites of San Francisco Mountain that are about 0.4 m.y. old, and its age has therefore been interpreted as Brunhes (Wolfe and others, 1987a).

Basaltic Rocks

Most of the sampled vents of Brunhes age are immediately north and west of San Francisco Mountain. More than 240 eruptions represented by vents and flows have been designated Brunhes in age (Wolfe and others, 1987). Of these deposits, 126 have been sampled; most of the remainder are east of San Francisco Mountain.

As noted above, some vents of normal polarity in the eastern part of the area having Brunhes rocks have equivocal stratigraphic positions that may place some of them in normal-polarity subchronozones of the Matuyama. For this reason, we provisionally designated 34 sites as Brunhes and categorized them as "Brunhes or Matuyama" in table 4. However, placement of the remaining normal-polarity rocks in the eastern part of the field could be done with confidence.

More than 200 of the Brunhes vents and flows not assigned to vents were placed in the older part of the Brunhes by Wolfe and others (1987). These rocks are dominantly basalts, but they include a few benmoreites, basaltic andesites, and andesites. All the vents are located in areas covered by the central and eastern sheets and the SP Mountain quadrangle, although a few flows from these vents traveled into areas mapped on the east side of the southwest sheet and the southeast corner of the northwest sheet. Most of the vents in the central sheet are west of San Francisco Mountain, and they have 10 K-Ar ages ranging from 0.72±0.12 to 0.33±0.08 Ma. In the SP Mountain quadrangle, the older Brunhes basalts erupted during the Tappan basaltic stage (fig. 5); their K-Ar ages range from 0.77±0.04 to 0.22±0.05 Ma. In the eastern part of the field, older Brunhes vents range in K-Ar age from 0.59±0.09 to 0.17±0.06 Ma (Moore and Wolfe, 1987); more than 100 vents in this area were not sampled paleomagnetically because they have been interpreted to be older Brunhes in age on the basis of geomorphic relations and their K-Ar ages (Moore and others, 1976).

According to the Little Colorado River valley stratigraphy, the Merriam basaltic stage followed the Tappan basaltic stage. Rocks of the Merriam age group are equivalent in age to those of the younger Brunhes (generally less than about 150,000 years old). In the SP Mountain quadrangle, the basaltic andesite of SP Mountain (vent 5703, 71±4 ka age; Baksi, 1974) and basalts of vents 5734A-E are placed in the Merriam age group. The only verified younger Brunhes vent in the central part of the field is Saddle Mountain (vent 4626), from which pyroclastic material erupted and buried Walker Lake sedimentary deposits dated by ^{14}C as 17 ka (S.W. Robinson, written commun., 1983). In the area of the eastern sheet, nine vents are placed in the younger Brunhes; these rocks have K-Ar ages of 150±30 ka (flow from vent 3034 or 3036), 55±14 ka (O'Neil Crater, vent 2929), and 51±46 ka (Strawberry Crater, vent 4920). We made polarity determinations of all these vents and of the flow.

The youngest eruptions of the volcanic field occurred exclusively in the area of the eastern sheet during the Sunset basaltic stage; their source was a line of vents that include Sunset Crater (vent 3824). On the basis of dendrochronology (Smiley, 1958) and recent secular variation of the geomagnetic pole position, Champion (1980; written commun., 1985) inferred that this volcanic activity lasted from A.D. 1065 to about 1220.

Table 2. Mean remanent magnetic directions, virtual geomagnetic pole (VGP) positions, and other statistics of chronozones in the San Francisco volcanic field sites, Arizona

[N, normal; R, reversed; N_{av}, number of site means averaged; N_t, total number of sites in category; Dec, declination; Inc, inclination (minus sign, reversed inclination); α_{95}, Fisher's 95-percent confidence region of the mean (in degrees); κ, Fisher's concentration parameter; Lat, latitude north (minus sign, latitude south); Long, longitude west; Δp and Δm, semiminor (p) and semimajor (m) axial lengths of the 95-percent confidence oval of the mean VGP]

Chronozone	Polarity	Mean remanent magnetic direction					Mean VGP position (°)			
		N_{av}/N_t	Dec (°)	Inc (°)	α_{95} (°)	κ	Lat	Long	Δp	Δm
Brunhes	N	164/184	356.7	52.9	3.1	13.2	86.6	122.0	3.0	4.4
Matuyama	N	28/36	349.3	54.5	7.9	12.8	81.3	158.8	7.9	11.2
Matuyama	R	232/256	181.3	–52.1	2.6	13.6	–87.1	226.2	2.4	3.6
Pre-Matuyama	N	74/84	357.8	51.3	4.2	16.2	86.2	97.3	3.9	5.7
Pre-Matuyama	R	93/97	184.7	–53.2	3.5	18.2	–85.9	181.0	3.4	4.9

VIRTUAL GEOMAGNETIC POLE POSITIONS

From mean magnetic vectors of the samples (table 4), we calculated the average remanence directions and virtual geomagnetic pole (VGP) locations for each polarity chronozone (table 2). The high dispersions of vector directions in each polarity chronozone (table 2; see also fig. 4) are due in part to secular variation, but they are also due to a variety of site-specific factors, including lack of sun-compass orientations for some sites, block sampling instead of on-site drilling, local rotations of sample outcrops, and lightning-induced remagnetization. Samples of silicic and intermediate rocks are particularly susceptible to these effects (see table 4). Because of the random nature of the effect of these factors on the resulting remanent magnetic vectors and the large number of sites when grouped altogether according to polarity chronozone, the mean of the vectors should closely approximate the true mean magnetic vector for the time period involved.

Our derived mean VGP locations correspond closely with the present axial geocentric pole position. To evaluate the concordance of these pole positions quantitatively, we applied the method developed by Beck (1980, p. 7116). If the reference pole is represented by the present rotational pole position with a 95-percent confidence interval of 4° (Irving, 1977), our calculated rotation and flattening values indicate that all of the determined paleopole positions may be concordant with the present axial pole position, given the calculated standard deviations of the positions (table 3).

Table 3. Rotation and flattening statistics of virtual geomagnetic pole (VGP) positions of the San Francisco volcanic field, Arizona

[After Beck (1980). N, normal; R, reversed. Minus signs, counterclockwise for rotation, southward for flattening. Statistics based on expected remanence direction (for normal polarity) of 360° declination, 54.8° inclination, and 95-percent confidence about the mean VGP of 4°]

Chronozone	Polarity	VGP offset	
		Rotation (°)	Flattening (°)
Brunhes	N	–3.3±7.1	1.9±3.7
Matuyama	N	–10.7±14.5	0.3±8.1
Matuyama	R	1.3±6.5	–2.7±3.3
Pre-Matuyama	N	–2.2±8.3	3.5±4.7
Pre-Matuyama	R	4.7±7.6	–1.6±4.0

MIGRATION OF VOLCANISM

Tanaka and others (1986) reported on the migration of volcanism in the SF field on the basis of the nearly completed efforts of many workers in geologic mapping, paleomagnetic analysis, and K-Ar dating. This 1986 report showed that both basaltic and silicic volcanism migrated northeastward during the Pliocene (Gilbert Reversed- and Gauss Normal-Polarity Chronozones) at a little more than 1 cm/yr and that the volcanism was centered along the Mesa Butte fault from Bill Williams Mountain to Sitgreaves Mountain. During the Quaternary (Matuyama Reversed- and Brunhes Normal-Polarity Chronozones), basaltic volcanism (accompanied by the more structurally controlled silicic and intermediate volcanism) migrated eastward at about 3 cm/yr. Concomitant with the acceleration in migration rate were increased rates of magma production and eruption frequency. Tanaka and others (1986) used this eruptive history to construct a magma-generation model for the field that involves basal shearing of the lithosphere, which provided the heat to produce the magmas that formed the volcanic field.

At present, detailed geologic mapping and documentation of the K-Ar ages are virtually complete (Wolfe and others, 1987). In this report, we have fully documented the paleomagnetism and magnetostratigraphy of the volcanic field. The preliminary magnetostratigraphy summarized in Tanaka and others (1986) has changed very little. (The geologic maps, K-Ar data, and paleomagnetic work were unpublished at the time but available to them.) Our modest refinements in the paleomagnetic work include some further demagnetizations of some sites, resulting in improved magnetic vectors. We also slightly changed the classification of the vents, adding some benmoreite, basaltic andesite, and andesite vents to our "basaltic rocks" category to harmonize with the vent-numbering system on the geologic maps. Therefore, we now have a few more vents and a few less silicic and intermediate sample sites than were cited in Tanaka and others (1986). We carried out no further field work.

Because these changes are few and insignificant, they do not necessitate reevaluation of the overall migrational history of the field. In other words, we judge that the estimates of migration of volcanism and of the evolution in magma production and eruption frequency that were reported in Tanaka and others (1986) are still reasonably accurate, given the uncertainties involved (such as degree of structural control, accuracy of volume estimates, and stratigraphic inferences).

Moreover, Tanaka and others (1986) suggested that the recent eastward migration of volcanism was related to westward motion of the North American plate over the fixed, deep mantle. In support of this hypothesis, they noted that K-Ar ages (Best and Brimhall, 1974) indicate eastward migration of volcanism in late Cenozoic volcanic rocks of the Uinkarets-Shivwits Plateau north of the Grand Canyon of the Colorado River. In the Springerville volcanic field rocks of east-central Arizona, Condit and others (1987) found (1) eastward migration of about 3.0 cm/yr in 101 alkali-olivine basalt vents and (2) eastward migration of about 2.5 cm/yr for all dated vents. The rocks in their study are less than 2 m.y. old and were dated by K-Ar ages, paleomagnetic data, and stratigraphic relations.

CONCLUSIONS

On the basis of paleomagnetic polarity determinations, K-Ar and other absolute ages, and stratigraphic relations, we have assigned about 600 separate eruptive units to the pre-Matuyama (Gilbert and Gauss), Matuyama, and Brunhes Chronozones. This methodology is efficient, and it is much less costly than radiometric dating alone. It is also comprehensive, raising the stratigraphy of a large volcanic field to levels of detail and precision previously unmatched. The stratigraphy provides a basis for speculating on the causes of magma generation in intraplate continental volcanic fields and on the absolute motion of the North American plate (Tanaka and others, 1986), and it provides a comprehensive framework for future considerations of petrogenetic processes and for assessment of volcanic hazards.

Our dataset also allows for statistical analysis of secular variation and other paleomagnetic studies. Analysis of average VGP positions shows no demonstrable rotation or translation of the rocks in the volcanic field.

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*These five maps are collectively referenced in this report as "Wolfe and others, 1987."

TABLE 4

Table 4 provides paleomagnetic data acquired for sample sites in the San Francisco volcanic field, Arizona (for specific map locations, see Wolfe and others, 1987). The sites are grouped according to their inferred polarity chronozone (pre-Matuyama, Matuyama, or Brunhes). Within these categories, silicic and intermediate rocks are grouped together according to their association with silicic centers and whether or not K-Ar ages have been determined (from Wolfe and others, 1987, unless otherwise noted). Basaltic rocks are organized according to degree of certainty in their age determinations: those having K-Ar ages; those having conclusive field relations; those dated primarily by paleomagnetic data and other, less conclusive information; and those whose determinations are largely uncertain. Dashes indicate that data are unreliable or not available. Footnotes are at end of table.

Sample sites are identified by a four-digit numbering system developed by Wolfe and others (1987). The first digit of the sample number represents the township (second digit of the township number), the second digit represents the range, and the last two digits are the section number in which the site is located. (Because the second digit 1 could represent R. 1 W., R. 1 E., and R. 11 E., Z represents R. 1 W., and A represents R. 11 E. See figure 2). Where more than one site occurs within a section, a letter suffix has been added to subsequent samples for unique identification. Most of the basaltic vents, which represent discrete eruptive units, are identified by this same labeling method (second column); the vent identification numbers correspond to those used by Wolfe and others (1987). Samples having silicic to intermediate composition are identified according to composition and site location. The type of volcanic feature sampled (for example, vent, flow, or dike) is indicated in the third column.

As applicable, the following information is also provided for each sample site: (1) Map sheet showing sample site (Wolfe and others, 1987; see fig. 2): C, central; E, east; NW, northwest; SW, southwest; SP, SP Mountain. (2) Latitude and longitude. (3) Number of samples averaged in paleomagnetic vector (N_{av}) and total number of samples taken (N_t); only the total number is shown if no average statistics are presented. (4) Polarity of magnetic vector. (5) Declination (Dec) and inclination (Inc) of average magnetic vector (minus sign = reversed inclination). (6) Fisher's 95-percent confidence region of the mean magnetic vector (α_{95}). (7) Fisher's concentration parameter (κ). (8) Alternating-field demagnetization (AFD) intensity for the statistics (measured in oersteds; NRM = natural remanent magnetization). (9) Field relations to rocks at other sites. (10) K-Ar age (or other absolute age, where available) in million years. Where polarity determinations have high dispersion ($\alpha_{95} > 40°$) or questionable mean direction, the polarity is queried and the paleomagnetic data are not included. Field relations are based on superposition relations and eruptive associations (for example, the relation of flows to the vents from which they issued) as portrayed on the geologic maps. (Where applicable in these relations, vent numbers of basaltic rocks are used; otherwise, site numbers are used.) Paleomagnetic studies were not made for rocks noted as "unsampled." Field relations that are queried relate to the uncertainty in the identification of the eruptive source of the sampled unit, not to the uncertainty of the field relation.

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Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona

[Abbreviations are explained on preceding page]

Site No.	Rock type or vent No.	Feature	Map sheet	Location: Lat N. (°)	Location: Long W. (°)	Mean remanent magnetism: N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)	AFD (Oe)	Field relations	K-Ar age (Ma)
PRE-MATUYAMA ROCKS														
SILICIC AND INTERMEDIATE ROCKS														
Bill Williams Mountain rocks, dated														
2233	Dacite	Flow	SW	35.24	112.18	6/6	N	5	0	7	104	500	Younger than basalt 1710.	5.03±0.50
1209B	Dacite	Dome	SW	35.21	112.19	6/6	N	14	71	4	275	250	Younger than 1209.	4.22±0.26
1203	Dacite	Flow	SW	35.23	112.19	6/6	N	16	57	4	306	250	Older than 1202----	4.17±1.06
1218	Dacite	Dome	SW	35.20	112.23	5/6	N	13	36	6	145	250	-----------------------	3.88±0.44
1218A	Dacite	Dome	SW	35.20	112.22	5/6	R	163	–41	3	545	250	-----------------------	3.72±0.21
1207	Dacite	Dome	SW	35.22	112.23	4/8	N	14	14	9	106	750	-----------------------	3.62±0.33
1217	Dacite	Flows	SW	35.21	112.21	6/6	N	24	6	6	115	500	-----------------------	3.56±0.38
1217A	Dacite	Dome	SW	35.22	112.21	4/6	N	354	32	18	26	500	-----------------------	3.49±0.06
2222A	Andesite	Dome	SW	35.27	112.17	5/6	N	316	20	8	94	250	Older than 2222----	3.48±0.05
2221	Andesite	Dome	SW	35.27	112.18	6/6	N	335	11	8	71	500	Same as site 2222A.	--
1122	Benmoreite	Flow	SW	35.18	112.27	6/6	R	188	–40	16	18	250	-----------------------	2.94±0.57
1205	Andesite	Flow	SW	35.24	112.21	6/6	N	7	30	10	50	250	Younger than basalt 1710, 2232.	2.85±0.91
Bill Williams Mountain rocks, undated														
1202A	Dacite	Dome	SW	35.23	112.15	5/5	R	190	–38	7	117	50	-----------------------	--
1204	Dacite	Dome	SW	35.23	112.18	6	R?	--	--	--	--	--	-----------------------	--
1209A	Dacite	Dome	SW	35.22	112.20	6/6	R	175	–39	10	47	500	-----------------------	--
1221A	Dacite	Dome	SW	35.20	112.19	6	N?	--	--	--	--	--	-----------------------	--
Sitgreaves Mountain rocks, dated														
3428	Rhyolite	Dome	C	35.35	111.98	6/6	N	3	47	5	181	NRM	-----------------------	2.85±0.06
3433A	Rhyolite	Flow	C	35.34	111.98	6/6	N	331	41	10	48	250	Older than 3433, rhyolite 3433B.	2.84±0.02
Sitgreaves Mountain rocks, undated														
3428A	Rhyolite	Flow	C	35.35	111.98	5/6	N	1	57	8	71	250	Younger than rhyolite 3433A.	--
Miscellaneous rocks, dated														
1232A	Dacite	Dome	SW	35.15	112.21	6/6	R	196	–56	6	138	250	-----------------------	5.15±0.17
3422	Rhyolite	Dome	C	35.36	111.96	6/6	N	346	30	13	28	250	Older than rhyolite 2405A, 3421.	2.88±0.09
2410	Rhyolite	Dome	C	35.30	111.96	7/9	R	217	–58	8	62	250	-----------------------	2.79±0.07
3434	Rhyolite	Dome	C	35.33	111.96	4/6	R	176	–43	13	51	250	-----------------------	2.74±0.16
BASALTIC ROCKS														
Dated														
1222	1222	Vent	SW	35.19	112.17	6/6	R	168	–48	7	98	250	Older than 1211, 1227.	6.38±0.32
2135	2135	Vent	SW	35.24	112.25	4/6	R	176	–50	12	57	500	Older than 2133----	6.13±0.15
1710	Basalt	Flow	C	35.22	111.64	4/6	R	188	–45	9	100	500	-----------------------	5.82±0.34
5634	4609	Flow	SP	35.51	111.73	6/6	R	170	–56	7	87	330	-----------------------	5.62±0.19
1233	1233	Dike	SW	35.15	112.18	6/6	R	141	–61	7	93	250	Older than 1219; younger than 1232.	4.17±0.39
1233A	1233	Vent	SW	35.16	112.18	6	R?	--	--	--	--	--	Same as site 1233 --	--
2520	2519B	Vent	C	35.27	111.88	6/6	N	345	54	7	81	250	Older than 2519A -	4.12±0.20

Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona—Continued

Site No.	Rock type or vent No.	Feature	Map sheet	Location		Mean remanent magnetism						AFD (Oe)	Field relations	K-Ar age (Ma)
				Lat N. (°)	Long W. (°)	N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)			
						PRE-MATUYAMA ROCKS—Continued								
						BASALTIC ROCKS—Continued								
						Dated—Continued								
2233A	Basalt	Flow	SW	35.24	112.18	6/6	R	207	–57	8	75	250	Older than dacite 2233, andesite (unsampled, 3.20±0.60 Ma), andesite 1205.	4.03±0.51
6806	6806	Vent	SP	35.66	111.58	6/6	N	355	47	21	11	750	--	3.13±0.39
1211	1211	Vent	SW	35.22	112.16	6/6	N	9	73	2	1229	250	Younger than 1222, 1224.	2.84±0.25
						Undated								
0102	0102	Vent	SW	35.14	112.26	5/6	R	199	–44	3	760	250	--	--
0305	0305	Vent	SW	35.15	112.10	6/6	N	353	61	2	812	250	Younger than 1331.	--
0506	0506	Vent	C	35.14	111.90	8/9	R	165	–57	7	68	250	--	--
0616	0616	Vent	C	35.12	111.77	5/6	R	214	–45	6	161	500	--	--
0626	0626	Vent	C	35.08	111.74	6/6	R	115	–47	4	305	250	Older than Oak Creek fault.	--
1101	1101	Vent	SW	35.23	112.24	6/6	R	178	–41	4	282	250	Older than 2124	--
1102	1102	Vent	SW	35.22	112.25	6/6	R	181	–44	3	556	250	--	--
1104	1104	Vent	SW	35.22	112.29	4/6	N	335	49	2	2181	500	--	--
1105	1105	Vent	SW	35.23	112.31	6/6	N	6	51	5	214	250	--	--
1109	1109	Vent	SW	35.22	112.29	6/6	R	172	–46	4	235	250	--	--
1110	1110	Vent	SW	35.22	112.28	6/6	N	355	35	5	218	250	Older than 2124	--
1123	1123	Vent	SW	35.17	112.26	6	R?	--	--	--	--	--	--	--
1133	0104	Vent	SW	35.15	112.28	5/6	N	350	50	5	203	250	--	--
1134	1134A	Vent	SW	35.15	112.27	5/6	N	6	40	1	4324	250	--	--
1134A	0103	Vent	SW	35.15	112.28	6/6	N	5	46	5	203	250	--	--
1202	1202	Vent	SW	35.23	112.15	6/6	N	338	26	3	475	250	Younger than dacite 1203.	--
1209	1209	Vent	SW	35.22	112.18	5/6	R	190	–46	33	6	500	Older than dacite 1209B.	--
1216	Basalt	Flow	SW	35.20	112.18	4/6	N	335	58	12	60	500	--	--
1221	1221	Vent	SW	35.18	112.19	6/6	R	168	–59	3	655	500	--	--
1221B	1221A	Vent	SW	35.16	112.16	6/6	N	347	48	5	157	250	--	--
1223	1223	Vent	SW	35.18	112.15	6	N?	--	--	--	--	--	--	--
1224	1224	Vent	SW	35.19	112.13	6/6	N	346	48	3	485	250	Older than 1211	--
1224B	1224B	Vent	SW	35.19	112.14	6	N?	--	--	--	--	--	--	--
1226	1226	Vent	SW	35.17	112.15	4/6	N	5	42	18	28	250	Older than 1224A	--
1227	1227	Dike	SW	35.17	112.16	5/6	R	227	–59	23	12	500	Younger than 1222.	--
1232	1232	Vent	SW	35.16	112.21	5/6	N	1	59	5	240	250	Older than 1233	--
1234	1234	Vent	SW	35.16	112.17	6/6	R	188	–48	2	1676	250	Younger than 1234A.	--
1234A	1234A	Vent	SW	35.16	112.16	6/6	R	121	–35	6	110	250	Older than 1234	--
1236	1236	Vent	SW	35.16	112.13	6/6	R	158	–36	2	1018	250	--	--
1319	1319	Vent	SW	35.18	112.12	6/6	R	219	–49	6	115	250	--	--
1328	1334	Vent	SW	35.17	112.08	4/6	R	182	–52	7	188	250	--	--
1330	1330	Vent	SW	35.17	112.11	6/6	R	184	–56	2	1227	250	--	--
1330A	1330A	Vent	SW	35.17	112.12	6/6	R	174	–9	2	1382	250	--	--
1331	1331	Vent	SW	35.16	112.11	5/6	N	4	50	2	1367	250	Older than 0305, 1331; younger than 1331A.	--
1331A	1331A	Vent	SW	35.16	112.12	6/6	R	160	–34	4	360	250	--	--
1331B	Basalt	Flow	SW	35.16	112.11	6/6	R	184	–57	3	425	250	--	--
1332	1329	Vent	SW	35.16	112.10	5/6	R	179	–56	12	39	250	--	--
1505	1505	Vent	C	35.23	111.88	6/7	R	180	–42	12	31	250	Older than 1505A, 2531.	--
1505A	1505	Vent	C	35.23	111.89	6/6	R	172	–42	29	6	500	Same as site 1505	--

Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona—Continued

Site No.	Rock type or vent No.	Feature	Map sheet	Location		Mean remanent magnetism						AFD (Oe)	Field relations	K-Ar age (Ma)
				Lat N. (°)	Long W. (°)	N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)			
PRE-MATUYAMA ROCKS—Continued														
BASALTIC ROCKS—Continued														
Undated—Continued														
1508	1508	Vent	C	35.22	111.90	5/9	R	169	−48	5	210	250	Older than 1505A, 2531A.	--
2Z10	2Z03	Flow	SW	35.30	112.38	6/6	R	219	−44	9	54	500	Older than 2122, 3132A; younger than 3Z33.	--
2Z22	2Z27	Vent	SW	35.27	112.39	6/6	R	180	−67	6	108	500	Older than 2Z03 —	--
2Z23	2Z23	Vent	SW	35.27	112.36	6/6	R	199	−37	1	7828	250	Younger than 2Z25A.	--
2Z23A	2Z23A	Vent	SW	35.27	112.35	5/6	R	162	−78	15	27	750	Younger than 2119, 2122.	--
2Z23B	2Z23A	Flow	SW	35.27	112.36	6/6	R	147	−46	25	8	750	Same as site 2Z23A.	--
2Z24	2Z24	Vent	SW	35.27	112.35	4/6	R	207	−53	19	25	750	----------------------	--
24A	2119	Vent	SW	35.27	112.34	4/6	R	183	−45	10	92	250	Older than 2Z23A -	--
2Z25	2Z25	Vent	SW	35.26	112.35	6/6	R	204	−35	3	515	250	Older than 2Z26 ---	--
2Z25A	2Z25A	Dike	SW	35.26	112.35	5/5	R	181	−66	5	210	500	Older than 2Z03, 2Z23.	--
2Z26	2Z26	Vent	SW	35.25	112.36	6/6	N	341	38	3	541	250	Younger than 2Z25.	--
2101	2101	Vent	SW	35.31	112.25	5/6	R	177	−72	3	490	250	----------------------	--
2102	2102	Vent	SW	35.31	112.25	5/6	R	212	−69	3	684	250	----------------------	--
2104	2104	Vent	SW	35.32	112.29	6/6	N	12	68	3	406	250	Younger than 2105, 2110, 2122.	--
2105	2105	Vent	SW	35.32	112.31	6/6	N	3	51	6	127	250	Older than 2104----	--
2105A	2105A	Vent	SW	35.32	112.30	6/6	N	335	68	3	633	250	----------------------	--
2105B	2105?	Flow	SW	35.32	112.31	4/6	R	183	−59	32	7	250	Older than 2104? --	--
2110	2110	Flow	SW	35.30	112.27	6/6	R	157	−58	15	20	500	Older than 2104, 2112, 2122.	--
2110A	2110A	Vent	SW	35.30	112.27	6/6	R	156	−63	3	499	250	----------------------	--
2111	2112	Vent	SW	35.30	112.25	4/6	R	205	−70	5	320	250	Older than 2113, 2220; younger than 2110, 2125B.	--
2113	2113	Vent	SW	35.29	112.24	5/6	N	32	54	2	1083	250	Younger than 2112, 2125B.	--
2114	2114	Flow	SW	35.28	112.25	6/6	N	46	39	21	11	250	----------------------	--
2114A	2114A	Vent	SW	35.28	112.25	6/6	R	190	−64	4	224	500	----------------------	--
2116	2116	Vent	SW	35.29	112.28	6/6	R	216	−36	2	1849	250	----------------------	--
2116A	2109	Vent	SW	35.29	112.29	6/6	R	225	−57	4	339	250	----------------------	--
2117	2108	Vent	SW	35.29	112.30	6/6	R	177	−57	5	212	500	Younger than 2122.	--
2122	2122	Vent	SW	35.27	112.27	6/6	R	176	−50	4	236	250	Older than 2Z23A, 2104, 2108, 2127, 2133, 3132A; younger than 2Z03, 2110.	--
2122A	2127	Vent	SW	35.26	112.27	6/6	N	24	55	8	71	250	Younger than 2122.	--
2123	2123	Vent	SW	35.25	112.25	6/6	R	147	−49	9	62	1000	----------------------	--
2124	2124	Vent	SW	35.27	112.23	6/6	R	169	−65	3	715	250	Younger than 1101.	--
2124A	2124C	Vent	SW	35.27	112.24	6/6	R	213	−72	3	489	250	----------------------	--
2125	2125	Dike	SW	35.26	112.23	6/6	R	175	−59	4	311	250	----------------------	--
2125A	2125B	Vent	SW	35.26	112.23	6/6	R	185	−59	3	438	250	Older than 2125C (unsampled).	--
2126	2126	Vent	SW	35.25	112.25	5/6	R	235	−32	4	325	250	----------------------	--
2127	2127B	Vent	SW	35.26	112.27	5/6	N	357	46	22	13	1000	Older than 2133? --	--
2127A	2128	Vent	SW	35.26	112.29	6/6	R	175	−52	2	724	250	----------------------	--

Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona—Continued

Site No.	Rock type or vent No.	Feature	Map sheet	Location		Mean remanent magnetism						AFD (Oe)	Field relations	K-Ar age (Ma)
				Lat N. (°)	Long W. (°)	N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)			
						PRE-MATUYAMA ROCKS—Continued								
						BASALTIC ROCKS—Continued								
						Undated—Continued								
2128	2133	Flow	SW	35.25	112.29	5/5	R	229	−44	13	37	1000	Younger than 2122, 2127B?, 2133B, 2135, 2136A.	--
2128A	2127A	Flow	SW	35.26	112.28	5/5	R	171	−27	7	139	250	----------------------	--
2133	2133B	Vent	SW	35.24	112.29	6/6	N	358	53	11	35	500	Older than 2133----	--
2133A	2133A	Vent	SW	35.25	112.29	4/6	N	359	51	6	261	250	----------------------	--
2136	2136	Vent	SW	35.24	112.24	6/6	R	204	−31	6	149	250	----------------------	--
2136A	2136A	Vent	SW	35.24	112.24	5/6	R	195	−48	16	25	500	Older than 2133----	--
2214	2214	Vent	SW	35.29	112.15	5/6	R	206	−45	9	73	250	----------------------	--
2215	2215	Vent	SW	35.29	112.16	6/8	R	190	−54	4	350	250	Older than 2212, 2319A; younger than 2220.	--
2217	2217	Vent	SW	35.29	112.20	6/6	R	219	−63	5	180	750	Older than 2220?, 2222?	--
2217A	2220	Flow	SW	35.29	112.21	6/6	N	352	52	7	103	250	Older than 2203, 2215, 2222, 3229; younger than 2112, 2217?, 2218, 3136, andesite 2222A.	--
2218	2218	Vent	SW	35.29	112.22	5/6	R	179	−28	4	383	1000	Older than 2220----	--
2219	2219	Vent	SW	35.27	112.23	6/6	R	184	−54	2	830	250	Younger than andesite 2219C.	--
2219A	2219	Vent	SW	35.27	112.23	6/6	R	148	−52	3	544	250	Same as site 2219 --	--
2219B	Basaltic andesite	Flow	SW	35.27	112.22	5/6	N	10	55	6	150	250	Older than 2220----	--
2219C	Andesite	Flow	SW	35.27	112.22	5/6	N	0	58	6	147	NRM	Older than 2219----	--
2222	2222	Vent	SW	35.27	112.17	5/6	N	348	52	7	138	NRM	Older than 2319A; younger than 2217?, 2220, andesite 2222A.	--
2230	2230	Flow	SW	35.26	112.22	6/6	R	165	−57	6	122	250	----------------------	--
2232	2232	Vent	SW	35.25	112.21	6/6	R	181	−63	3	671	250	Older than andesite 1205.	--
2319	2319	Vent	SW	35.27	112.12	5/6	N	2	56	4	374	250	Older than 2320----	--
2319A	2319	Vent	SW	35.27	112.11	5/6	N	346	52	28	8	750	Same as site 2319 --	--
2319B	2319	Flow	SW	35.27	112.11	5/6	N	354	61	4	343	250	Same site 2319------	--
2319C	2319A	Vent	SW	35.27	112.12	4/6	N	346	50	12	56	250	Younger than 2215, 2222.	--
2319D	2319B	Vent	SW	35.28	112.12	5/6	R	189	−58	11	48	250	----------------------	--
2320	2320	Vent	SW	35.27	112.09	6/8	N	338	44	23	10	250	Older than 2303, 2308A, 2316A; younger than 2319.	--
2421A	2421A	Vent	C	35.27	111.97	6/6	R	165	−42	4	260	250	Older than 2416----	--
2435	2436	Vent	C	35.24	111.93	5/7	R	174	−55	3	523	NRM	----------------------	--
2531B	1506	Vent	C	35.23	111.91	6/8	R	202	−40	29	6	250	Older than 1505A, 2531A.	--
3Z13	3Z13	Vent	SW	35.37	112.34	6/6	R	198	−56	33	5	500	Younger than 3Z23A, 3Z33A, 3118.	--
3Z23	3Z23	Vent	SW	35.36	112.36	5/6	R	172	−61	4	427	250	Younger than 3Z23A.	--
3Z23A	3Z23A	Vent	SW	35.36	112.36	6/6	R	180	−74	5	210	500	Older than 3Z13, 3Z23.	--
3Z28	3Z33A	Flow	SW	35.34	112.41	5/5	R	219	−41	4	318	250	Older than 3Z13; younger than 3Z33.	--

Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona—Continued

Site No.	Rock type or vent No.	Feature	Map sheet	Location: Lat N. (°)	Location: Long W. (°)	Mean remanent magnetism: N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)	AFD (Oe)	Field relations	K-Ar age (Ma)
						PRE-MATUYAMA ROCKS—Continued								
						BASALTIC ROCKS—Continued								
						Undated—Continued								
3Z33	3Z33	Vent	SW	35.33	112.40	6/6	R	181	−62	3	385	500	Older than 2Z03, 3Z33A, 3132A.	--
3Z33A	3Z29	Flow	SW	35.34	112.41	6/6	R	222	−38	5	188	250	--------------------	--
3118	3118	Vent	SW	35.37	112.32	6/6	R	160	−39	2	751	250	Older than 3Z13 ---	--
3121	3121	Vent	SW	35.36	112.29	6/6	N	328	23	34	5	500	--------------------	--
3121A	3121A	Vent	SW	35.36	112.30	6/6	R	200	−64	4	354	250	--------------------	--
3126	3126	Vent	SW	35.34	112.25	5/6	R	254	−62	6	169	500	Older than 3133, 3136.	--
3132	3132	Vent	SW	35.33	112.31	5/6	N	33	48	2	1056	250	--------------------	--
3133	3133	Vent	SW	35.33	112.13	6/6	N	46	47	3	424	250	Younger than 3126.	--
3135	3135	Vent	SW	35.33	112.26	5/6	R	165	−69	3	770	250	Younger than 3136.	--
3136	3136	Vent	SW	35.33	112.25	6/6	R	163	−53	6	114	500	Older than 2220, 3135; younger than 3113, 3126.	--
3304	3304	Vent	SW	35.40	112.08	7/8	N	6	66	4	182	250	--------------------	--
3304A	3304A	Vent	SW	35.40	112.09	6/6	N	9	63	25	8	250	Older than 4332A -	--
3304B	3304B	Vent	SW	35.41	112.08	6/6	N	338	59	24	9	250	--------------------	--
3307	3307	Vent	SW	35.39	112.11	5/6	N	16	60	6	157	250	Older than 3202, 3306.	--
4202	4202	Vent	SW	35.50	112.14	6/6	R	205	−36	7	94	750	Older than andesite 4213, 4332A?.	--
4226A	4226A	Vent	SW	35.44	112.14	5/6	N	298	53	7	118	250	Older than andesite 4213, 4236A.	--
4236	4236	Vent	SW	35.41	112.12	6/7	N	5	53	15	21	500	Older than 3306A, 4226; younger than 4236A.	--
4236A	4236A	Vent	SW	35.42	112.13	4/6	N	17	62	5	388	250	Older than 4236; younger than 4226A.	--
4332	4332	Vent	SW	35.42	112.10	6/8	N	347	61	7	84	250	--------------------	--
4332A	4332A	Vent	SW	35.41	112.09	6/6	N	13	68	13	23	500	Older than 3304A, 3310, andesite 4213?, 4327?; younger than 4202?	--
5101	5101	Vent	NW	35.57	112.24	6	N?	--	--	--	--	--	--------------------	--
5206	5206	Vent	NW	35.57	112.22	6	N?	--	--	--	--	--	--------------------	--
5214	5214	Vent	NW	35.54	112.14	6/6	N	338	63	15	22	250	Younger than 4202?	--
5220	5217	Vent	NW	35.54	112.20	6	R?	--	--	--	--	--	--------------------	--
6135	6135	Vent	NW	35.59	112.25	6/6	N	348	58	19	14	250	--------------------	--
6135A	6135A	Vent	NW	35.60	112.25	6/6	N	353	73	5	158	500	--------------------	--
6135B	6126	Vent	NW	35.60	112.26	6	N?	--	--	--	--	--	--------------------	--
6136	6136	Vent	NW	35.59	112.25	6	N?	--	--	--	--	--	--------------------	--
6806A	Basalt	Tuff	SP	35.66	111.59	6/6	N	5	66	12	31	250	Older than 6713----	--
7410	7410	Vent	NW	35.74	111.95	6	N?	--	--	--	--	--	--------------------	--
						Pre-Matuyama or Matuyama								
1303	1303	Vent	SW	35.23	112.05	6/6	N	345	58	1	2088	250	Older than Mesa Butte fault.	--
1309	1316	Vent	SW	35.21	112.08	6/6	N	9	64	3	544	250	Older than 1316A -	--
1311	1311	Vent	SW	35.21	112.05	6/6	N	27	33	4	296	250	Older than 2335A -	--
1315	1315	Vent	SW	35.20	112.06	6/6	R	156	−54	4	236	250	Older than 1316A -	--
1316	1316A	Vent	SW	35.20	112.08	6	N?	--	--	--	--	--	Older than 1315, 1316.	--
1316A	1316A	Vent	SW	35.20	112.08	6	N?	--	--	--	--	--	Same as site 1316 --	--
2226	2226	Vent	SW	35.25	112.15	6/6	N	305	36	24	9	250	--------------------	--

Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona—Continued

Site No.	Rock type or vent No.	Feature	Map sheet	Location		Mean remanent magnetism						AFD (Oe)	Field relations	K-Ar age (Ma)
				Lat N. (°)	Long W. (°)	N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)			
						PRE-MATUYAMA ROCKS—Continued								
						BASALTIC ROCKS—Continued								
						Pre-Matuyama or Matuyama—Continued								
2327	2327	Vent	SW	35.26	112.06	7/8	N	23	45	2	625	250	Older than 2335A -	--
2331	2331	Vent	SW	35.24	111.12	5/8	R	206	-42	23	12	NRM	----------------------	--
2331A	2329	Vent	SW	35.25	112.11	6/6	N	7	53	5	210	250	----------------------	--
3235	3235	Vent	SW	35.32	112.14	5/6	N	3	72	5	196	250	----------------------	--
3236C	3236C	Vent	SW	35.32	112.14	6/6	N	25	64	5	163	250	----------------------	--
						MATUYAMA ROCKS								
						SILICIC AND INTERMEDIATE ROCKS								
						Kendrick Peak rocks, dated								
3503	Dacite	Dome	C	35.40	111.85	6	R?	--	--	--	--	--	Older than rhyolite 3502.	2.37±0.21
4534	Dacite	Dome	C	35.42	111.85	4/6	R	165	-33	24	16	500	----------------------	2.09±0.12
3503A	Dacite	Dome	C	35.41	111.85	6	R?	--	--	--	--	--	Older than 3509----	2.06±0.07
3502	Rhyolite	Flow	C	35.41	111.84	5/7	R	176	-39	30	7	750	Younger than dacite 3503, andesite 4536.	1.90±0.25
4533	Dacite	Flow	C	35.43	111.83	7/8	R	219	-23	14	20	1000	Younger than rhyolite (unsampled, 2.70±0.05 Ma).	1.79±0.03
3503B	Andesite	Flow	C	35.41	111.85	4/6	R	250	-51	37	7	500	----------------------	1.64±0.11
3502A	Andesite	Flow	C	35.40	111.84	10	N?	--	--	--	--	--	Older than 3511----	1.35±0.05
						Kendrick Peak rocks, undated								
3501	Dacite	Flow	C	35.40	111.81	4/6	R	105	-77	13	49	250	----------------------	--
3504	Dacite	Dome	C	35.40	111.87	6	R?	--	--	--	--	--	----------------------	--
3504A	Andesite	Flow	C	35.40	111.87	6/6	R	203	-57	17	16	500	Older than trachyte 4424.	--
3512	Rhyolite	Dome	C	35.39	111.82	6/6	R	167	-46	11	36	250	Older than 3511----	--
4522A	Rhyolite	Dome	C	35.45	111.85	5/6	R	139	-46	26	10	250	Older than 4522----	--
4522B	Dacite	Dome	C	35.45	111.85	6	R?	--	--	--	--	--	Older than 4527----	--
4526A	Dacite	Dome	C	35.43	111.83	4/6	R	176	-51	23	17	500	Older than 4535----	--
4535	Andesite	Flow	C	35.42	111.82	5/6	R	214	-70	37	5	250	Older than rhyolite 3502, 4527, 4535; younger than dacite 4534.	--
4536A	Andesite	Flow	C	35.42	111.82	5/6	R	217	-59	13	38	250	Same as site 4535 --	--
						Sitgreaves Mountain rocks, dated								
2405A	Rhyolite	Dome	C	35.32	111.98	6/7	R	173	-56	3	663	NRM	Older than 2405----	2.26±0.10
3429	Rhyolite	Dome	C	35.34	111.99	7/10	R	159	-60	11	29	250	Older than 3430; younger than rhyolite 3335A.	1.90±0.12
						Sitgreaves Mountain rocks, undated								
2406	Dacite	Dome	SW	35.32	112.01	6/6	N	5	56	3	456	250	Younger than rhyolite 2405A.	--
3335A	Rhyolite	Dome	SW	35.33	112.04	6/8	R?	--	--	--	--	--	Older than rhyolite 3429, 3433.	--
3432	Rhyolite	Dome	C	35.33	111.98	6/6	R	177	-54	7	87	NRM	Same as site 3335A	--
3433B	Rhyolite	Dome	C	35.33	111.96	6/6	R	259	-55	21	11	500	Younger than rhyolite 3433A.	--
						Miscellaneous rocks, dated								
3604	Rhyolite	Dome	C	35.40	111.77	4/6	R	176	-69	14	42	500	Older than 3616----	2.15±0.13
3425	Rhyolite	Dome	C	35.34	111.91	6/6	R	239	-22	6	120	250	Older than 3529----	2.10±0.03
4213	Andesite	Flow	SW	35.46	112.14	6/6	R	168	-52	11	37	500	Younger than 4226A, 4332A?	2.06±0.18

Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona—Continued

Site No.	Rock type or vent No.	Feature	Map sheet	Location		Mean remanent magnetism						AFD (Oe)	Field relations	K-Ar age (Ma)
				Lat N. (°)	Long W. (°)	N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)			
						MATUYAMA ROCKS—Continued								
						SILICIC AND INTERMEDIATE ROCKS—Continued								
						Miscellaneous rocks, dated—Continued								
4510	Rhyolite	Dome	C	35.48	111.83	6/6	R	175	–48	5	153	250	----------	1.90±0.35
3616A	Rhyolite	Dome	C	35.38	111.76	6	R?	--	--	--	--	--	----------	1.64±0.11
0603A	Dacite	Dome	C	35.19	111.75	6/6	R	192	–19	4	307	250	Younger than 0610.	1.61±0.05
4502	Rhyolite	Dome	C	35.49	111.85	4/6	R	150	–49	33	9	250	----------	1.54±0.02
3531A	Rhyolite	Dome	C	35.32	111.90	4/6	R	197	–50	10	94	250	----------	1.39±0.06, 1.29±0.23
2629	Benmoreite	Flow	C	35.26	111.78	6	R?	--	--	--	--	--	Older than 2620, Oak Creek fault; younger than 2630, 2630A.	1.29±0.15
2525	Benmoreite	Flow	C	35.26	111.80	4/6	R	185	–43	12	56	500	Same as site 2629 --	--
4424	Trachyte	Flow	C	35.45	111.91	6/6	R	263	–43	13	28	500	Older than 4414, 4507,4508, 4517, 4521; younger than andesite 3504A.	1.14±0.17
3505C	Trachyte	Flow	C	35.40	111.88	4/6	R?	--	--	--	--	--	Same as site 4424 --	--
3435	Benmoreite	Dome	C	35.33	111.92	6/6	R	160	–58	4	324	250	Older than 3521----	1.08±0.28
3423A	Benmoreite	Dome	C	35.35	111.93	6	R?	--	--	--	--	--	Older than 3426----	0.96±0.94
2530	Benmoreite	Dome	C	35.27	111.90	6/6	R	191	–13	10	50	250	Older than 3534; younger than 2519B, 2530A.	0.95±0.08
2529	Benmoreite	Dome	C	35.25	111.88	6/6	R	154	–42	2	813	250	Same as site 2530 --	--
						Miscellaneous rocks, undated								
1305A	Dacite	Dome	SW	35.23	112.11	6/6	N	350	4	17	16	250	----------	--
2506	Dacite	Dome	C	35.32	111.90	5/6	R	192	–41	4	350	250	Same as site 3531 --	--
2506A	Dacite	Dome	C	35.32	111.90	5/6	R	189	–31	13	33	250	Same as site 3531 --	--
3401A	Andesite	Dome	C	35.41	111.88	5/6	R	214	–68	28	8	250	Older than 4435A -	--
4435B	Andesite	Dome	C	35.40	111.95	6	R?	--	--	--	--	--	Same as site 3401A.	--
						BASALTIC ROCKS								
						Dated								
2405	2405	Vent	C	35.32	111.99	6/6	R	170	–52	2	1244	250	Younger than rhyolite 2405A.	2.46±0.11
6835	Basalt	Flow	SP	35.60	111.52	6/6	R	164	–47	15	22	500	Older than basalt 5810.	2.43±0.32
5810A	Basalt	Flow	SP	35.56	111.52	6/6	R	144	–75	26	8	660	Same as site 6835 --	--
2416	2416	Vent	C	35.29	111.96	6/7	R	180	–22	18	16	250	Older than 3433; younger than 2415, 2421A.	--
1230	1219	Flow	SW	35.17	112.23	5/6	R	167	–49	5	272	250	Younger than 1233.	2.08±0.48
3611	3611	Vent	C	35.39	111.73	4/8	N	358	60	5	308	250	----------	2.01±0.22
3531	2506	Vent	C	35.32	111.90	6/6	R	195	–34	5	156	250	----------	1.44±0.03
2420	2420	Vent	C	35.27	111.99	8/8	R	214	–60	20	9	250	Older than 2418, 3433; younger than 2407, 2429, 2430.	1.41±0.13
6609	6609	Vent	NW	35.65	111.75	5/6	R	196	–43	4	405	250	----------	1.38±0.16, 1.04±0.04
6609A	6609	Vent	SP	35.65	111.75	6/6	R	191	–46	14	24	330	Same as site 6609 --	--
6617	6609	Flow	NW	35.64	111.77	3/6	R	252	–42	36	13	750	Same as site 6609 --	--
6621	6609	Flow	SP	35.62	111.75	2	R?	--	--	--	--	--	Same as site 6609 --	--
6622	6609	Flow	SP	35.62	111.74	6	N?	--	--	--	--	--	Same as site 6609?-	--
7727	6609	Flow	SP	35.69	111.75	6	R?	--	--	--	--	--	Same as site 6609 --	--
6811	6811	Flow	SP	35.65	111.51	6/6	R	196	–65	34	5	750	----------	1.20±0.05

Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona—Continued

Site No.	Rock type or vent No.	Feature	Map sheet	Location: Lat N. (°)	Location: Long W. (°)	Mean remanent magnetism: N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)	AFD (Oe)	Field relations	K-Ar age (Ma)
						MATUYAMA ROCKS—Continued								
						BASALTIC ROCKS—Continued								
						Dated—Continued								
0614	0614	Vent	C	35.12	111.23	5/6	R	198	−27	11	51	500	Younger than Oak Creek fault.	1.16±0.04
3433	3433	Vent	C	35.32	111.98	7/7	R	165	−59	7	77	250	Older than 2407, 2408, 2416; younger than rhyolite 2405A, 2420, rhyolite 3433A.	1.15±0.65
7723	Basalt	Flow	SP	35.70	111.61	6/6	R	164	−53	21	11	750	Older than basalt 7806, basalt 7723A.	1.09±0.03
3335	3335	Vent	SW	35.32	112.05	7/7	R	189	−54	8	60	250	Younger than 2303, 2308.	1.07±0.06
[1]4007	Basalt	Flow	E	35.47	111.37	5/6	R	200	−33	24	17	500	----------------------	1.07±0.15
6804	6736	Flow	SP	35.66	111.54	6/6	N	348	33	29	6	330	----------------------	1.04±0.14
6803A	Basalt	Flow	SP	35.67	111.53	6/6	N	321	8	29	8	500	----------------------	1.01±0.13
6803B	Basalt	Flow	SP	35.66	111.52	6/6	N	9	34	29	6	330	Same as site 6803A.	--
[1]4003	Basalt	Flow	E	35.49	111.32	6/6	N	348	35	14	30	500	Older than 3018----	0.85±0.12
6603	Basalt	Flow	SP	35.66	111.62	7/7	R	182	−37	18	11	330	----------------------	0.83±0.04
2519	2519	Vent	C	35.28	111.91	7/7	R	203	−70	24	7	250	Older than 3521; younger than 2424, 2519A, 2530.	0.69±0.13
						Dated by field relations								
2415	2415	Vent	C	35.29	111.95	6/6	R	178	−28	4	278	250	Older than 2416----	--
3509	3509	Vent	C	35.40	111.87	6/6	R	170	−35	12	30	250	Younger than dacite 3503A.	--
0603	0603	Vent	C	35.19	111.75	6/6	R	175	−25	6	117	500	Same as dacite 0603A.	--
2418	2418	Vent	SW	35.29	112.01	5/6	R	163	−49	5	207	250	Younger than 2407, 2420.	--
3325	3430	Flow	SW	35.34	112.02	6/6	R	134	−58	28	7	250	Younger than rhyolite 4510.	--
3511	3511	Vent	C	35.38	111.82	6/6	R?	--	--	--	--	--	Younger than andesite 3502A, rhyolite 3512A.	--
4412	4507	Vent	C	35.47	111.92	7/8	R	158	−54	2	800	250	Younger than trachyte 4424.	--
4517	4508	Vent	C	35.46	111.88	4/6	R	147	−34	11	70	1000	Younger than trachyte 4424.	--
4520	4517	Vent	C	35.46	111.88	8/9	R	164	−52	5	133	250	Older than 4521; younger than trachyte 4424.	--
5822	Basalt	Flow	SP	35.53	111.52	6/6	R	212	−70	38	4	750	Older than rhyolite (unsampled, 0.80±0.11 Ma).[2]	--
5828	Basalt	Flow	SP	35.52	111.54	6/6	R	170	−40	16	19	330	Same as site 5822 --	--
6817	5806	Flow	SP	35.63	111.57	6/6	N	350	58	10	45	500	Older than 6736; younger than basalt 6803A.	--
						Undated								
0602	0610	Flow	C	35.14	111.74	6/6	R	244	−20	14	25	1000	Older than 0603----	--
0611	0611	Vent	C	35.13	111.72	6/6	R	209	−29	17	16	1000	----------------------	--
0611A	0611A	Vent	C	35.13	111.73	6	N?	--	--	--	--	--	----------------------	--
0614A	0615	Flow	C	35.12	111.75	6/6	R	129	−55	14	24	750	Younger than rim basalt (unsampled).	--

Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona—Continued

Site No.	Rock type or vent No.	Feature	Map sheet	Location: Lat N. (°)	Location: Long W. (°)	Mean remanent magnetism: N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)	AFD (Oe)	Field relations	K-Ar age (Ma)
						MATUYAMA ROCKS—Continued								
						BASALTIC ROCKS—Continued								
						Undated—Continued								
1301	1407	Flow	SW	35.23	112.03	5/7	R	190	−77	35	6	1000	Older than 2335A, 2420, 3521; younger than 1419.	--
1403	Basalt	Flow	C	35.23	111.96	6/6	R	190	−56	13	26	500	-----------------------	--
1403A	Basalt	Flow	C	35.22	111.95	4/6	R	255	−57	21	21	250	Same as site 1403 --	--
1413	Basalt	Flow	C	35.19	111.93	6	R?	--	--	--	--	--	Same as site 1403 --	--
1414	Basalt	Flow	C	35.20	111.94	4/6	R	156	−25	18	27	500	Same as site 1403 --	--
1414A	Basalt	Flow	C	35.20	111.93	12/13	R	173	−50	5	75	250	Same as site 1403 --	--
1419	1419	Vent	SW	35.16	112.01	6/6	R	219	−22	4	287	500	Older than 1407----	--
1430	1430	Vent	SW	35.17	112.01	6/6	R	153	−66	2	1220	250	Older than 1520----	--
1505B	1505A	Vent	C	35.23	111.88	3/7	R	181	−46	18	50	250	Younger than 1505/ 1506/ 1508/2436.	--
1615	1615	Vent	C	35.21	111.75	5/7	R	183	−40	7	138	NRM	Older than 1602----	--
1617	1617	Vent	C	35.20	111.78	7	R?	--	--	--	--	--	Younger than rim basalt (unsampled).	--
1618	1618	Vent	C	35.20	111.80	3/9	R	193	−35	13	92	750	Younger than rim basalt (unsampled).	--
1622	1622	Vent	C	35.19	111.74	6/6	R	142	−55	22	10	750	Older than 1602, 1625, Oak Creek fault; younger than rim basalt (unsampled, 6.01±0.50 Ma).	--
1622A	1621	Vent	C	35.19	111.75	6/6	R	165	−59	2	1297	250	-----------------------	--
1628	1628	Vent	C	35.18	111.77	5/8	R	206	−57	10	63	NRM	Younger than rim basalt (unsampled).	--
1636	1625	Vent	C	35.16	111.71	5/6	R	168	−67	9	74	750	Younger than 1622.	--
2203	2203	Vent	SW	35.32	112.17	7/7	R	181	−42	4	266	NRM	Younger than 2220.	--
2212	2212	Vent	SW	35.30	112.16	4/6	R	178	−52	2	1864	NRM	Younger than 2215.	--
2301	2301	Vent	SW	35.32	112.02	6	R?	--	--	--	--	--	-----------------------	--
2301A	2301A	Vent	SW	35.32	112.03	5/6	R	152	−12	7	116	250	-----------------------	--
2308	2308	Vent	SW	35.30	112.11	8/9	R	182	−57	3	387	250	-----------------------	--
2308A	2308A	Vent	SW	35.31	112.09	8/9	R	190	−43	22	7	250	Younger than 2308, 2320.	--
2315	2315	Vent	SW	35.29	112.06	5/6	N	333	31	8	104	250	-----------------------	--
2316	2316	Vent	SW	35.29	112.07	5/8	N	284	48	38	5	500	-----------------------	--
2316A	2316A	Vent	SW	35.28	112.08	8/9	R	184	−54	8	44	250	Younger than 2320.	--
2317	2317	Vent	SW	35.29	112.11	8	N?	--	--	--	--	--	-----------------------	--
2324	2324	Vent	SW	35.27	112.03	6/6	R	165	−52	7	82	250	-----------------------	--
2325	2325	Vent	SW	35.26	112.01	7	R?	--	--	--	--	--	Older than 2420, 2325A.	--
2335A	2335A	Vent	SW	35.24	112.04	5/6	R	154	−63	16	24	1000	Younger than 1311, 1407, 2327, 2335.	--
2407	2407	Vent	SW	35.30	112.00	7/7	R	145	−67	6	93	250	Older than 2418, 2420, 3433.	--
2408	2408	Vent	C	35.30	111.98	6/6	R	175	−56	33	5	250	Older than 3433----	--
2409	2416A	Flow	C	35.29	111.96	8/8	R	184	−54	8	51	250	Older than 3433----	--
2415A	2415A	Vent	C	35.28	111.96	6/6	R	166	−58	5	193	250	-----------------------	--
2421	2421	Vent	C	35.27	111.97	6/6	R	174	−31	4	330	250	-----------------------	--

Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona—Continued

Site No.	Rock type or vent No.	Feature	Map sheet	Location: Lat N. (°)	Location: Long W. (°)	Mean remanent magnetism: N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)	AFD (Oe)	Field relations	K-Ar age (Ma)
						MATUYAMA ROCKS—Continued								
						BASALTIC ROCKS—Continued								
						Undated—Continued								
2424	2423	Vent	C	35.28	111.93	6/6	R	162	–27	7	63	250	Older than 2519, 3521.	--
2425	2424	Vent	C	35.27	111.92	5/7	R	224	–50	33	7	NRM	Older than 2519----	--
2425A	2530	Vent	C	35.27	111.92	6/6	R	187	–27	9	58	250	Older than 2519----	--
2429	2429	Vent	C	35.26	111.95	7/7	R	170	–58	5	140	250	Older than 2420, 3521.	--
2430	2430	Vent	SW	35.26	112.01	7/7	R	140	–62	6	113	250	Older than 2420----	--
2509	2509	Vent	C	35.30	111.88	6/6	R	201	–4	16	18	500	-----------------------	--
2517	2517	Vent	C	35.28	111.89	5/7	R	144	–31	24	11	250	-----------------------	--
2517A	2517A	Vent	C	35.28	111.88	6/6	R	177	–47	2	1750	250	Older than basalt 2616.	--
2522	2522	Vent	C	35.27	111.85	4/6	R	209	–60	22	18	500	Older than basalt 2616.	--
2530A	2530A	Vent	C	35.27	111.90	6/6	R	187	–24	13	27	250	Older than ben-moreite 2530.	--
2531	2531	Vent	C	35.24	111.90	8/9	R	164	–45	12	22	250	Younger than 1505/1506/1508/2436.	--
2531A	2531A	Vent	C	35.24	111.91	4/6	R	153	–50	10	82	250	-----------------------	--
2533	2533	Vent	C	35.24	111.87	5/6	R	206	–55	8	85	NRM	Older than 3534----	--
2525A	2630	Vent	C	35.26	111.80	6/7	R	191	–49	4	229	250	Older than ben-moreite 2629.	--
2604	2604	Vent	C	35.31	111.77	5	R?	--	--	--	--	--	-----------------------	--
[1]3A23	Basalt	Flow	E	35.37	111.20	4/6	R	168	–77	20	22	500	Same as site 3002 --	--
[1]3002	Basalt	Flow	E	35.42	111.30	5/6	R	140	–65	26	10	500	Older than 3018----	--
[1]3011	Basalt	Flow	E	35.39	111.30	5/6	R	148	–79	14	31	500	Same as basalt 3002.	--
3202	3202	Vent	SW	35.40	112.16	6	R?	--	--	--	--	--	Younger than 3229, 3307.	--
3218	3113	Vent	SW	35.37	112.23	6/6	R	156	–50	6	147	250	Older than 3229; younger than 3136.	--
3220	3229	Vent	SW	35.35	112.20	6/6	R	183	–55	7	105	250	Older than 3202, 3221; younger than 2220, 3113.	--
3221	3221	Vent	SW	35.36	112.19	5/6	R	187	–43	9	74	250	Younger than 3229.	--
3226	3226	Vent	SW	35.34	112.16	6/7	R	193	–48	7	87	250	-----------------------	--
3226A	3226A	Vent	SW	35.34	112.14	4/6	R	178	–54	6	208	250	-----------------------	--
3229	3230	Vent	SW	35.34	112.21	8/8	R	177	–60	3	439	250	-----------------------	--
3236	3236	Vent	SW	35.33	112.13	5/6	R	176	–56	15	28	250	-----------------------	--
3236A	3331	Flow	SW	35.33	112.12	4/6	R	185	–29	4	436	250	Same as site 3331 --	--
3236B	3236B	Vent	SW	35.33	112.13	5/6	R	183	–54	3	602	500	-----------------------	--
3301	3301	Vent	SW	35.40	112.02	6/6	R	187	–58	6	148	250	-----------------------	--
3305	3305	Vent	SW	35.40	112.09	5/6	R	154	–47	24	11	750	Older than 3310; younger than 3306.	--
3306	3306	Vent	SW	35.40	112.11	6	R?	--	--	--	--	--	Older than 3305; younger than 3307.	--
3306A	3306A	Vent	SW	35.40	112.12	6/8	R	181	–48	4	280	500	Younger than 4236.	--
3310	3310	Vent	SW	35.39	112.06	5/8	R	208	–67	4	411	500	Younger than 3305, 3306?, 3407, 4332A.	--
3311	3311	Vent	SW	35.39	112.04	6/6	R	171	–56	8	76	250	Older than 3407? --	--
3323	3325A	Flow	SW	35.36	112.05	6/6	R	176	–6	24	9	750	Younger than 3407.	--
3324	3324	Vent	SW	35.36	112.03	5/6	R	178	–33	5	270	500	-----------------------	--
3326	3325	Flow	SW	35.35	112.04	6/6	R	204	–63	3	458	250	-----------------------	--

Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona—Continued

Site No.	Rock type or vent No.	Feature	Map sheet	Location		Mean remanent magnetism						AFD (Oe)	Field relations	K-Ar age (Ma)
				Lat N. (°)	Long W. (°)	N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)			
						MATUYAMA ROCKS—Continued								
						BASALTIC ROCKS—Continued								
						Undated—Continued								
3327	3327	Vent	SW	35.35	112.06	6/6	R	200	−46	2	1400	250	Younger than 2303.	--
3331	3331	Vent	SW	35.33	112.13	6/6	R	177	−26	2	1201	500	-----------------------	--
3401	3401	Vent	C	35.41	111.92	4/6	R	210	−54	6	204	250	Older than 4435A -	--
3404	3404	Vent	C	35.41	111.98	6/6	R	164	−61	2	984	250	-----------------------	--
3406	3406	Vent	SW	35.40	112.00	5/6	R	162	−46	14	31	500	-----------------------	--
3407	3407	Vent	SW	35.39	112.01	6/6	R	165	−60	5	200	250	Older than 3310?, 3325A, 4325; younger than 3301, 3311, 4430.	--
3416	3416	Vent	C	35.37	111.97	6/6	R	217	−51	10	49	250	-----------------------	--
3417	3417	Vent	C	35.37	111.99	7/7	R	144	−46	9	45	250	Older than 3420----	--
3423	3423	Vent	C	35.36	111.94	6/6	R	170	−47	4	239	250	Older than 3518----	--
3424	3424	Vent	C	35.35	111.92	5/6	R	175	−42	10	58	250	Older than 3426----	--
3505	3505	Vent	C	35.40	111.90	6/6	R	174	−43	5	164	250	-----------------------	--
3505A	3505A	Vent	C	35.40	111.90	6/6	R	175	−38	8	69	250	-----------------------	--
3505E	3508	Vent	C	35.40	111.90	6/6	R	172	−47	22	10	250	-----------------------	--
3508	3508A	Vent	C	35.38	111.88	6/6	R	242	−49	18	15	250	Younger than 3509A.	--
3509A	3509A	Vent	C	35.39	111.88	6/6	R	189	−45	28	7	250	Older than 3508A -	--
3517	3517	Vent	C	35.38	111.88	5/6	R	174	−42	14	30	250	Older than 3522, 3523.	--
3517A	3518	Vent	C	35.37	111.88	5/6	R	170	−37	21	14	250	Older than 3523, 3529, 3608; younger than 3423.	--
3518	3507	Vent	C	35.38	111.90	5/6	R	140	−67	5	240	250	Older than 3523----	--
3528	3528	Vent	C	35.35	111.87	5/6	R	218	−38	33	6	250	-----------------------	--
[1]4023	Basalt	Flow	E	35.46	111.30	5/6	R	171	−46	21	15	500	Same as site 3002 --	--
4226	4226	Vent	SW	35.44	112.16	6/6	R	193	−59	7	87	250	Younger than 4236.	--
4301	4301	Vent	SW	35.47	112.03	9/9	R	178	−52	4	169	250	Older than 4408, 4425, 5430; younger than 4311.	--
4302	4302	Vent	SW	35.48	112.04	5/6	R	179	−54	3	608	250	-----------------------	--
4303	4303	Vent	SW	35.49	112.06	6/6	R	152	−51	9	54	750	-----------------------	--
4311	4311	Vent	SW	35.49	112.04	6/10	R	219	−45	11	40	250	Older than 4301----	--
4311A	4311A	Vent	SW	35.47	112.05	5/5	R	154	−52	5	271	750	Older than 5335----	--
4314	4314	Vent	SW	35.46	112.09	6/8	R	158	−61	8	75	250	Older than 4425; younger than 4323A.	--
4323	4323	Vent	SW	35.45	112.05	5/6	R	167	−51	27	9	750	Older than 4326----	--
4324	4324	Vent	SW	35.45	112.03	6/6	R	122	−40	8	75	250	Older than 4323C, 4425.	--
4324A	4313	Vent	SW	35.45	112.02	6/6	R	162	−73	20	12	500	-----------------------	--
4324B	4323C	Vent	SW	35.45	112.03	5/6	R	202	−50	5	202	250	Younger than 4324.	--
4326	4326	Vent	SW	35.44	112.04	3/6	R	181	−45	5	563	250	Younger than 4323.	--
4327	4327	Vent	SW	35.44	112.06	5/8	R	153	−49	25	10	250	Younger than 4332A?	--
4335	4325	Vent	SW	35.42	112.04	5/6	R	183	−41	11	54	250	Younger than 3407.	--
4336	4336	Vent	SW	35.41	112.02	6/6	R	187	−63	13	29	1000	-----------------------	--
4405	4405	Vent	C	35.49	111.98	5/6	R	173	−25	26	9	250	Older than 4435A -	--
4409	4409	Vent	C	35.47	111.98	9/9	R	175	−53	12	19	250	-----------------------	--
4413	4413	Vent	C	35.46	111.92	5/6	N	332	59	9	72	250	Older than trachyte 4424?	--

Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona—Continued

Site No.	Rock type or vent No.	Feature	Map sheet	Location: Lat N. (°)	Location: Long W. (°)	Mean remanent magnetism: N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)	AFD (Oe)	Field relations	K-Ar age (Ma)
MATUYAMA ROCKS—Continued														
BASALTIC ROCKS—Continued														
Undated—Continued														
4416	4416	Vent	C	35.46	111.98	5/6	R	172	–49	17	22	500	----------------------	--
4417	4417	Vent	C	35.47	111.99	7/7	R	184	–57	5	173	250	----------------------	--
4417A	4417A	Vent	C	35.44	112.00	6/6	R	147	–45	3	667	500	----------------------	--
4417B	4418A	Vent	C	35.46	112.00	6/6	R	123	–49	11	40	250	Younger than 4418B.	--
4418	4418	Vent	SW	35.46	112.01	6/6	R	196	–39	33	5	500	Older than 4419----	--
4418A	4418B	Vent	SW	35.46	112.00	5/6	R	149	–44	7	110	500	Older than 4418A; younger than 4418C.	--
4418B	4418C	Vent	SW	35.47	112.01	6/6	R	140	–46	15	22	1000	Older than 4418B--	--
4419	4419	Vent	SW	35.45	112.01	4/6	N	355	40	15	41	250	Younger than andesite 4418.	--
4427	4427	Vent	C	35.43	111.96	6/6	R	167	–64	17	16	250	----------------------	--
4427A	4427A	Vent	C	35.43	111.96	5/6	R	150	–70	10	58	250	Older than 4425----	--
4428	4432	Flow	C	35.43	111.97	7/8	R	173	–45	13	22	250	Same as site 4432--	--
4429	4429	Vent	C	35.43	111.99	6/6	R	196	–50	2	872	250	Younger than 4430.	--
4429A	4429A	Vent	C	35.44	111.99	6/6	R	167	–3	5	200	250	----------------------	--
4432	4432	Vent	C	35.42	111.99	5/6	R	164	–57	13	35	250	----------------------	--
4432A	4432A	Vent	C	35.42	112.00	6/6	R	175	–50	19	14	250	----------------------	--
4435	4435	Vent	C	35.43	111.94	4/6	R	179	–48	25	15	NRM	----------------------	--
4435A	4435A	Vent	C	35.41	111.94	6/6	R	175	–11	14	23	NRM	Older than 4425; younger than 3401, andesite 3401A, 4405, 5422, 5434.	--
4436	4436	Vent	C	35.42	111.92	4/5	R	182	–32	14	42	NRM	----------------------	--
4506	4506	Vent	C	35.49	111.90	6/9	R	193	–45	15	22	250	----------------------	--
4522	4522	Vent	C	35.44	111.85	6	R?	--	--	--	--	--	Younger than rhyolite 4522A.	--
4526	4526	Vent	C	35.44	111.84	6	R?	--	--	--	--	--	----------------------	--
4527	4527	Vent	C	35.43	111.84	6/6	R	187	–45	8	68	250	Older than 4521; younger than dacite 4522B?, andesite 4536A.	--
[1]5033	Basalt	Flow	E	35.50	111.33	5/6	N	339	41	25	10	500	Older than 3018----	--
5309	5309	Vent	NW	35.56	112.07	6/6	R	218	–28	12	35	500	----------------------	--
5310	5310	Vent	NW	35.56	112.07	5/6	R	213	–51	6	153	250	----------------------	--
5321	5321	Vent	NW	35.53	112.07	6	N?	--	--	--	--	--	----------------------	--
5334	5334	Vent	NW	35.51	112.05	4/6	N	36	61	4	563	1000	----------------------	--
5334A	5335	Vent	NW	35.51	112.05	5/6	N	24	59	7	139	250	Younger than 4311A.	--
5335	5335A	Vent	NW	35.51	112.04	5/6	R	190	–51	2	1447	250	----------------------	--
5411	5411	Vent	NW	35.56	111.94	6/8	R	150	–64	8	72	250	Older than 5413, 5529; younger than 5416, 6422.	--
5413	5413	Vent	NW	35.54	111.92	4/4	R	228	–69	11	66	1000	Older than 5529; younger than 5411.	--
5415	5415	Vent	NW	35.54	111.94	7/9	R	148	–62	18	13	250	----------------------	--
5416	5416	Vent	NW	35.54	111.97	4/7	R	158	–54	11	67	250	Older than 5411----	--
5419	5419	Vent	NW	35.53	112.00	6/6	R	163	–56	6	114	250	----------------------	--
5421	5422	Vent	NW	35.53	111.96	6	R?	--	--	--	--	--	Older than 4435A -	--
5431	5431	Vent	NW	35.51	112.00	5/6	R	153	–64	6	193	500	----------------------	--
5431A	5430	Vent	NW	35.51	112.00	5/6	R	200	–41	8	78	250	Younger than 4301.	--
5432	5432	Vent	NW	35.51	112.00	5/6	R	161	–49	7	111	250	----------------------	--
5432A	5432A	Vent	NW	35.50	111.98	6/6	R	210	–55	8	79	250	----------------------	--
5432B	5432B	Vent	NW	35.51	111.98	5/6	R	222	–53	7	130	250	----------------------	--

Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona—Continued

Site No.	Rock type or vent No.	Feature	Map sheet	Location: Lat N. (°)	Location: Long W. (°)	Mean remanent magnetism: N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)	AFD (Oe)	Field relations	K-Ar age (Ma)
MATUYAMA ROCKS—Continued														
BASALTIC ROCKS—Continued														
Undated—Continued														
5432C	5432A	Flow	NW	35.51	111.98	4/6	R	212	−50	11	67	1000	Same as site 5432A.	--
5434	5434	Vent	NW	35.51	111.95	5/6	R	233	−47	3	680	250	Older than 4435A -	--
5525	5630	Flow	NW	35.52	111.80	4/6	R	89	−83	19	24	1000	Older than 5535, 4606/5536.	--
5526	5526	Vent	NW	35.52	111.83	6/6	R	217	−46	6	113	250	----------------------	--
5836	Basalt	Flow	SP	35.50	111.50	6	R?	--	--	--	--	--	Older than rhyolite (unsampled, 0.80±0.11 Ma).[2]	--
[1]5932	Basalt	Flow	E	35.50	111.46	7	N?	--	--	--	--	--	Older than andesite 3707A, 5703, rhyolite (unsampled, 0.80±0.11 Ma).[2]	--
6403	6403	Vent	NW	35.67	111.96	6/6	R	161	−59	2	992	250	----------------------	--
6409	6409	Vent	NW	35.65	111.97	4/6	R	130	−49	13	52	500	Older than 6422----	--
6412	6412	Vent	NW	35.65	111.92	6/6	R	186	−55	5	176	250	----------------------	--
6413	6413	Vent	NW	35.64	111.91	4/6	R	238	−45	37	7	750	----------------------	--
6414	6414	Vent	NW	35.64	111.92	5/6	R	174	−60	8	97	500	----------------------	--
6422	6422	Vent	NW	35.62	111.96	6/6	R	156	−58	2	1295	250	Older than 5411; younger than 6409.	--
6604	6604	Vent	NW	35.66	111.75	5/6	R	186	−75	19	16	250	----------------------	--
6604A	6604	Vent	SP	35.66	111.75	8/8	R	197	−51	4	233	330	Same as site 6604 --	--
6604B	6604	Flow	SP	35.67	111.75	4/6	R	222	−49	3	1145	500	Same as site 6604 --	--
6618	6618	Vent	NW	35.64	111.78	5/6	R	206	−74	14	29	1000	----------------------	--
6619	6619	Vent	NW	35.62	111.80	3/6	R	168	−44	24	28	1000	----------------------	--
6619A	6619A	Vent	NW	35.62	111.80	5/6	R	205	−65	13	35	500	----------------------	--
6621A	Basalt	Flow	SP	35.61	111.75	7/7	R	196	−45	13	23	330	Older than 6609----	--
6733	5704	Flow	SP	35.60	111.65	6/6	R	208	−32	37	4	330	----------------------	--
6802	6802	Vent	SP	35.66	111.50	8/8	R	149	−40	6	95	330	----------------------	--
6803	6803	Vent	SP	35.66	111.53	7/8	R	153	−75	39	3	500	----------------------	--
7408	7408	Vent	NW	35.74	111.98	6	R?	--	--	--	--	--	----------------------	--
7417	7417	Vent	NW	35.73	111.98	6/6	R	198	−58	2	728	250	----------------------	--
7421	7421	Vent	NW	35.71	111.97	5/6	R	166	−57	2	1048	250	----------------------	--
7433	7433	Vent	NW	35.68	111.94	5/6	R	128	−60	9	66	500	----------------------	--
Matuyama or pre-Matuyama														
0502	0502	Vent	C	35.14	111.84	5/6	R	187	−60	4	301	250	Younger than rim basalt (unsampled).	--
0617	0608	Flow	C	35.11	111.79	4/6	R	215	−35	23	17	500	----------------------	--
1201	1201	Vent	SW	35.23	112.13	5/6	R	220	−65	5	232	250	----------------------	--
1212	1212	Vent	SW	35.22	112.13	6/6	R	130	−50	13	29	250	----------------------	--
1214	1223A	Vent	SW	35.19	112.15	5/5	R	148	−45	4	315	250	----------------------	--
1215	1215	Vent	SW	35.20	112.16	6/6	R	193	−60	2	872	250	----------------------	--
1225	1224A	Vent	SW	35.19	112.14	6/6	R	226	−45	4	228	250	Older than 1305?; younger than 1226.	--
1305	1305	Vent	SW	35.22	112.11	3/6	R	121	−59	6	472	500	Older than 2332; younger than 1224A?, dacite 1305A.	--
1318	1305	Flow	SW	35.21	112.11	5/6	R	182	−34	16	23	500	Same as site 1305 --	--
1630	1629	Vent	C	35.19	111.79	7/8	R	190	−44	11	29	250	Younger than rim basalt (unsampled).	--

Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona—Continued

Site No.	Rock type or vent No.	Feature	Map sheet	Location: Lat N. (°)	Location: Long W. (°)	Mean remanent magnetism: N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)	AFD (Oe)	Field relations	K-Ar age (Ma)
						MATUYAMA ROCKS—Continued								
						BASALTIC ROCKS—Continued								
						Matuyama or pre-Matuyama—Continued								
1631	1631	Vent	C	35.15	111.81	5/6	R	195	–36	13	38	500	Younger than rim basalt (unsampled).	--
1631A	1525	Flow	C	35.16	111.81	6	N?	--	--	--	--	--	Younger than rim basalt (unsampled).	--
2303	2304	Vent	SW	35.32	112.07	6/6	N	7	56	2	1109	250	----------------------	--
2332	2332	Vent	SW	35.24	112.10	6/7	R	256	–62	13	28	NRM	----------------------	--
2335	2335	Vent	SW	35.24	112.04	6/6	N	331	62	2	1793	250	Older than 2335A -	--
2507	2507	Vent	C	35.30	111.89	5/6	N	342	61	10	56	250	----------------------	--
2519A	2519A	Vent	C	35.27	111.91	5/7	N	54	79	21	15	250	Older than 2519; younger than 2519B.	
2630	2630A	Vent	C	35.27	111.79	5/6	N	8	50	31	7	500	Older than benmoreite 2629.	--
3203	3203	Vent	SW	35.41	112.16	5/6	R	152	–47	13	36	500	----------------------	--
3212	3212	Vent	SW	35.38	112.14	7/7	R	187	–58	5	141	250	----------------------	--
3215	3215	Vent	SW	35.37	112.17	5/6	R	173	–61	20	16	250	----------------------	--
3328	3328	Vent	SW	35.34	112.07	5/6	N	333	53	4	343	250	----------------------	--
4226B	4225	Vent	SW	35.43	112.14	6/6	R	214	–35	24	9	500	----------------------	--
4323A	4323A	Vent	SW	35.45	112.04	4/6	N	4	64	15	38	250	Older than 4314; younger than 4323.	--
4323B	4323B	Vent	SW	35.44	112.04	5/7	N	352	61	8	101	250	----------------------	--
4326A	4326A	Vent	SW	35.43	112.04	5/6	N	291	78	36	5	750	----------------------	--
4430	4430	Vent	SW	35.43	112.01	6/6	N	350	62	14	23	250	Older than 4429----	--
						Matuyama or Brunhes								
3420	3420	Vent	C	35.36	112.00	6	N?	--	--	--	--	--	Younger than 3417.	--
3505B	3505B	Vent	C	35.40	111.90	6/6	N	352	67	14	23	250	Younger than trachyte 4424.	--
3505D	3504	Vent	C	35.40	111.88	5/6	N	341	65	5	200	500	Younger than andesite 3504A.	--
4311B	4302A	Vent	SW	35.48	112.04	6/6	N	36	65	5	211	250	----------------------	--
						BRUNHES ROCKS								
						SILICIC AND INTERMEDIATE ROCKS								
						San Francisco Mountain rocks, dated								
3729	Andesite/ dacite	Section	C	35.34	111.67	88	N	--	--	--	--	--	----------------------	0.75±0.07, 0.43±0.03
3614	Dacite	Flow	C	35.37	111.73	5/5	N	16	11	11	50	250	Older than andesite 3729; younger than dacite 3718?	0.75±0.17
2713	Dacite	Dome	C	35.30	111.61	6/6	N	352	43	3	309	250	Older than dacite 2818A; younger than andesite 2703, 2818.	0.75±0.04
2705	Rhyolite	Flow	C	35.32	111.67	4/6	N	45	66	21	21	1000	Younger than andesite 2703.	0.70±0.10, 0.87±0.15
2601	Andesite	Flow	C	35.32	111.71	6	N?	--	--	--	--	--	Older than basalt 2616.	0.60±0.08
						San Francisco Mountain rocks, undated								
2703	Andesite	Flow	C	35.24	111.64	6/6	N	13	51	12	32	500	Older than dacite 2705; younger than rhyolite 2705.	--

Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona—Continued

Site No.	Rock type or vent No.	Feature	Map sheet	Location		Mean remanent magnetism						AFD (Oe)	Field relations	K-Ar age (Ma)
				Lat N. (°)	Long W. (°)	N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)			
BRUNHES ROCKS—Continued														
SILICIC AND INTERMEDIATE ROCKS—Continued														
San Francisco Mountain rocks, undated—Continued														
2704	Dacite	Dome	C	35.33	111.65	4/6	N	309	35	5	362	250	Younger than dacite 2726.	--
2705A	Andesite	Flow	C	35.32	111.67	6/8	N	5	70	17	17	250	----------------------	--
2732	Andesite	Flow	C	35.24	111.69	4/6	N	3	14	23	17	500	----------------------	--
2733	Dacite	Pyroclastic breccia.	C	35.24	111.67	5/6	N	341	56	11	51	250	Same as site 2704 --	--
2818A	Dacite	Flow	C	35.30	111.58	6	N?	--	--	--	--	--	Younger than dacite 2713.	--
3614A	Dacite	Dome	C	35.38	111.73	4/6	N	354	49	8	145	250	Same as site 3718?	--
3707	Andesite	Flow	C	35.39	111.69	4/7	N	14	49	18	26	500	Older than rhyolite 3612.	--
3707A	Andesite	Flow	C	35.38	111.69	4/6	N	19	58	30	10	500	----------------------	--
3711	Dacite	Flow	C	35.40	111.62	4/6	N	5	72	10	89	500	----------------------	--
3711A	Dacite	Flow	C	35.40	111.62	6/6	N	2	41	8	69	250	Older than dacite 3614.	--
3711B	Andesite	Flow	C	35.39	111.61	6	N?	--	--	--	--	--	----------------------	--
3718	Dacite	Dome	C	35.37	111.70	5/6	N	347	39	7	123	250	Older than dacite 3614, andesite 3729; younger than andesite 3707.	--
3829	Andesite	Flow	C	35.34	111.57	6/6	N	72	40	17	16	750	----------------------	--
4804	Andesite	Flow	E	35.49	111.54	6/6	N	38	45	8	80	250	Older than 3705?, 4711, 4819.	--
Miscellaneous rocks, dated														
2736	Dacite	Dome	C	35.23	111.60	5/5	N	2	0	38	5	250	----------------------	0.57±0.03, 0.49±0.06
Miscellaneous rocks, undated														
1807	Dacite	Pyroclastic breccia.	C	35.26	111.58	6/6	N	339	48	9	63	250	----------------------	--
2726	Dacite	Dome	C	35.27	111.61	6/6	N	299	36	22	10	250	Older than dacite 2733.	--
2726A	Dacite	Dome	C	35.26	111.63	6/6	N	302	54	8	65	250	Same as site 2726 --	--
3612	Rhyolite	Dome	C	35.38	111.71	4/6	N	12	46	7	196	250	Younger than 3601, andesite 3707, andesite 3729.	--
BASALTIC ROCKS														
Dated														
6713	6713	Vent	SP	35.63	111.60	9/9	N	358	61	27	5	330	----------------------	0.77±0.04
6818	6713	Flow	SP	35.63	111.58	6/6	N	347	56	29	6	330	Same as site 6713 --	--
6701	6713	Flow	SP	35.66	111.59	9/9	N	354	25	31	4	750	Same as site 6713 --	--
7833	Basalt	Flow	SP	35.67	111.55	8/8	N	340	57	4	169	330	----------------------	0.74±0.08
2616	Basalt	Flow	C	35.29	111.76	6	N?	--	--	--	--	--	----------------------	0.72±0.12
3633	3633	Vent	C	35.34	111.75	6	N?	--	--	--	--	--	Same as site 2616 --	--
3634	3634	Vent	C	35.33	111.74	6/6	N	326	41	2	904	250	Same as site 2616 --	--
4623	4624	Vent	C	35.45	111.72	5/6	N	15	47	11	47	250	Younger than 4606/5536, 4609.	0.66±0.11
5622	4624	Flow	SP	35.54	111.74	6	N?	--	--	--	--	--	Same as site 4623 --	--
3522	3522	Vent	C	35.37	111.86	6	N?	--	--	--	--	--	----------------------	0.56±0.08
4536	4536	Vent	C	35.42	111.81	6/6	N	344	54	6	112	250	Younger than 4521, 4631, 5535, 5536.	0.53±0.08.

Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona—Continued

Site No.	Rock type or vent No.	Feature	Map sheet	Location		Mean remanent magnetism						AFD (Oe)	Field relations	K-Ar age (Ma)
				Lat N. (°)	Long W. (°)	N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)			
						BRUNHES ROCKS—Continued								
						BASALTIC ROCKS—Continued								
						Dated—Continued								
8833	4536	Flow	SP	35.76	111.54	8/8	N	31	52	5	129	330	Same as site 4536 --	--
[1]5033A	Basalt	Flow	E	35.50	111.33	5/6	N	13	26	11	46	500	Older than 3018 —	0.50±0.09
[1]4017	3018	Flow	E	35.46	111.36	5/6	N	351	62	9	70	500	Younger than basalt 4035, basalt 5033A.	0.49±0.11
7817	Basalt	Flow	SP	35.72	111.56	6/6	N	11	54	3	43	500	-----------------------	0.46±0.05
7735	Basalt	Flow	SP	35.68	111.62	6/6	N	310	71	19	14	330	Same as basalt 7817.	--
2526	2620	Flow	C	35.26	111.82	6	N?	--	--	--	--	--	Younger than basalt 2616, benmoreite 2629, 3534.	0.44±0.18
3628	3621/ 3621A	Flow	C	35.39	111.75	4/5	N	358	40	22	19	500	Older than 3616, 3619; younger than basalt 2616, 3630.	0.42±0.06
3631	3621/ 3621A	Flow	C	35.33	111.78	17/20	N	2	53	5	46	250	Same as site 3628 --	--
2513	3621/ 3621A	Flow	C	35.29	111.81	18/23	N	354	49	10	13	250	Same as site 3628 --	--
3621	3621	Vent	C	35.37	111.76	6/6	N	359	18	24	11	250	Same as site 3628 --	--
3621A	3621A	Vent	C	35.37	111.75	6	N?	--	--	--	--	--	Same as site 3628 --	--
3617	3608	Vent	C	35.39	111.78	6/6	N	8	44	10	49	250	Younger than 3518, 3523.	0.39±0.11
3616	3616	Vent	C	35.37	111.77	4/6	N	6	38	19	25	250	Younger than rhyolite 3604, 3621/3621A.	0.35±0.13
3528C	3521	Vent	C	35.36	111.86	6/6	N	352	65	19	14	250	Younger than 1407, 2423, 2429, 2519, basalt 2616, 3523A, benmoreite 3435, 3534.	0.34±0.21
3534A	3521	Flow	C	35.33	111.85	5/5	N	333	79	16	25	500	Same as site 3528C.	--
2433	3521	Flow	C	35.24	111.96	4/6	N	332	61	8	142	500	Same as site 3528C.	--
1417	3521	Flow	C	35.20	112.00	5/6	N	349	64	6	155	500	Same as site 3528C.	--
1602	1602	Vent	C	35.27	111.73	5/5	N	288	67	10	61	500	Younger than 1615, benmoreite 1622, 1625.	0.33±0.08
2731	1602	Flow	C	35.25	111.70	5/6	N	341	54	10	61	500	Same as site 1602 --	--
5831	5831	Vent	C	35.50	111.58	2/2	N	1	52	8	1087	330	-----------------------	0.22±0.05
5833	5831	Flow	SP	35.50	111.56	6/6	N	28	69	33	5	330	Same as site 5831 --	--
[3]4A35	3034/3036	Flow	E	35.43	111.20	8/12	N	9	32	4	189	300	Merriam basaltic stage.	0.15±0.03
5703	5703	Vent	SP	35.58	111.63	9/9	N	2	65	10	19	330	Merriam basaltic stage.	0.071±0.04
6726	5703	Flow	SP	35.61	111.62	9/9	N	80	57	15	13	750	Same as site 5703 --	--
[3]6734	5703	Flow	SP	35.59	111.63	8/13	N	7	55	4	259	400	Same as site 5703 --	--
[3]1904	2929	Flow	E	35.24	111.44	11/12	N	355	53	1	1407	300	Merriam basaltic stage.	0.055±0.014
[3]4920	4920	Flow	E	35.45	111.46	6/12	N	358	53	5	213	400	Merriam basaltic stage.	0.051±0.046
[3]3910	3824	Flow	E	35.39	111.43	19/20	N	354	65	2	406	NRM	Sunset basaltic stage.	A.D. 1065
[3]3934	2902	Vent	E	35.33	111.42	22/24	N	347	62	3	221	NRM	Sunset basaltic stage.	[4]A.D. 1100
[3]3929	3929	Vent	E	35.35	111.46	21/21	N	345	61	2	407	NRM	Sunset basaltic stage.	[4]A.D. 1100

Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona—Continued

Site No.	Rock type or vent No.	Feature	Map sheet	Location: Lat N. (°)	Location: Long W. (°)	Mean remanent magnetism: N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)	AFD (Oe)	Field relations	K-Ar age (Ma)
							BRUNHES ROCKS—Continued							
							BASALTIC ROCKS—Continued							
							Dated—Continued							
[3]3823	3824	Flow	E	35.38	111.52	29/30	N	346	58	1	499	NRM	Sunset basaltic stage.	[4]A.D. 1180
[3]3824	3824	Vent	E	35.37	111.50	22/25	N	350	59	2	398	400	Sunset basaltic stage.	[4]A.D. 1220
							Dated by field relations							
2515	3534	Flow	C	35.28	111.86	6/6	N	21	43	14	23	500	Same as site 3534 --	--
2521	3534	Flow	C	35.27	111.86	5/6	N	6	59	13	35	750	Same as site 3534 --	--
2621A	2621A	Vent	C	35.27	111.76	4/6	N	2	37	35	8	250	Younger than basalt 2616.	--
3534	3534	Vent	C	35.32	111.84	6/6	N	7	61	6	127	250	Older than 2620, 3521; younger than benmoreite 2530, 2533, basalt 2616.	--
3619	3619	Vent	C	35.35	111.80	4/6	N	290	74	18	26	250	Older than basalt 2616, 3523, 3621/3621A, 3630.	--
3619A	3619	Flow	C	35.36	111.80	5/6	N	307	54	15	29	500	Same as site 3619 --	--
4705	4708	Flow	C	35.49	111.68	6/6	N	21	27	4	238	750	Younger than 5718.	--
5718	5718	Flow	SP	35.57	111.69	6	N?	--	--	--	--	--	Younger than basalt 7817.	--
5719	4708	Flow	SP	35.57	111.70	6/6	N	7	43	9	53	330	Same as site 4705 --	--
5723	5725	Flow	SP	35.54	111.62	6/6	N	14	53	18	14	170	Younger than rhyolite (unsampled, 0.80±0.11 Ma).[2]	--
5736	5725?	Flow	SP	35.51	111.60	6/6	N	290	55	31	6	500	Same as site 5723 --	--
5815	Basalt	Flow	SP	35.55	111.52	5	N?	--	--	--	--	--	Younger than rhyolite (unsampled, 0.80±0.11 Ma).[2]	--
5815A	Basalt	Flow	SP	35.55	111.53	6	N?	--	--	--	--	--	Same as site 5815 --	--
5816	5713/5725	Flow	SP	35.54	111.55	6/6	N	347	57	10	44	270	Older than 5725----	--
5830	5725	Flow	SP	35.51	111.57	7/8	N	14	49	3	346	330	Same as site 5723 --	--
5831A	5733	Flow	SP	35.51	111.58	9/9	N	14	50	6	70	330	Younger than 5831.	--
6701A	Basalt	Flow	SP	35.66	111.59	4/6	N	357	66	6	218	500	Younger than 6713.	--
6711	Basalt	Flow	SP	35.65	111.61	7/7	N?	--	--	--	--	--	Older than 5703; younger than basalt 7817.	--
6807	6807	Vent	SP	35.65	111.58	8/8	N	359	45	24	34	330	Younger than 6713.	--
[3]2A06	3036B	Flow	E	35.33	111.26	12/12	N	9	29	4	150	200	Merriam basaltic stage.	--
[3]3903	3812	Flow	E	35.40	111.43	8/13	N	5	56	4	163	400	Merriam basaltic stage.	--
4626	4626	Vent	C	35.44	111.73	6/6	N	343	46	5	153	250	Merriam basaltic stage; younger than Walker Lake sediment (unsampled, 16.79±0.13 ka).[5]	--
5734A	5734E	Flow	SP	35.51	111.63	8/8	N	50	33	10	33	330	Merriam basaltic stage.	--
5734B	5734B	Vent	SP	35.51	111.64	6/6	N	20	45	8	75	250	Merriam basaltic stage.	--
5734C	5734E	Flow	SP	35.51	111.63	6/6	N	19	52	6	115	250	Same as site 5734A.	--

Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona—Continued

BRUNHES ROCKS—Continued
BASALTIC ROCKS—Continued
Undated

Site No.	Rock type or vent No.	Feature	Map sheet	Location		Mean remanent magnetism						AFD (Oe)	Field relations	K-Ar age (Ma)
				Lat N. (°)	Long W. (°)	N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)			
1436	1520	Flow	C	35.15	111.92	11/20	N	3	45	19	7	NRM	Same as site 1520 --	--
1520	1520	Vent	C	35.19	111.89	7/8	N	359	45	3	519	250	Younger than 1430, 1505/1506/ 1508/2436.	--
2621	2621	Vent	C	35.27	111.78	6/6	N	21	47	21	11	250	----------------------	--
3517B	3523	Flow	C	35.37	111.88	6/6	N	32	31	25	8	250	Older than 3608, 3619; younger than 3507, 3517, 3518.	--
3523A	3523A	Vent	C	35.34	111.84	5/5	N	336	46	31	7	500	Older than 3521, 3523.	--
3601	3601	Vent	C	35.40	111.71	5/6	N	305	39	27	9	1000	Older than rhyolite 3612.	--
3605	Basalt	Flow	C	35.41	111.79	5/6	N	13	49	28	8	500	Older than 3621/ 3621A.	--
3606	3606	Vent	C	35.40	111.81	4/6	N	305	31	27	12	750	----------------------	--
3607	3607	Vent	C	35.39	111.79	6/7	N	299	27	19	14	250	----------------------	--
3607A	3512	Vent	C	35.39	111.81	5/7	N	9	54	7	133	250	----------------------	--
3627	3627	Vent	C	35.35	111.75	5/6	N	311	45	38	5	500	----------------------	--
3705	3705	Vent	C	35.41	111.67	5/6	N	284	50	3	741	250	Older than 4625?; younger than andesite 4804?	--
3817	3817	Vent	E	35.39	111.57	5/7	N	330	45	8	91	250	----------------------	--
3817A	3808	Vent	E	35.39	111.57	5/7	N	292	35	11	52	250	----------------------	--
3818	3818	Vent	E	35.39	111.59	5/6	N	30	48	18	20	250	----------------------	--
4603	4603	Vent	C	35.49	111.74	4/6	N	339	29	24	15	250	----------------------	--
4606A	3606	Flow	C	35.49	111.80	8/10	N	321	33	10	30	250	----------------------	--
4613	4613	Vent	C	35.47	111.70	6/6	N	26	54	4	319	250	Younger than 4614	--
4614	4614	Vent	C	35.46	111.72	7/7	N	300	47	16	15	250	Older than 4613, 5626.	--
4625	4625	Vent	C	35.44	111.71	5/6	N	34	38	27	9	250	Older than 4715, 4728; younger than 3705?, 4726.	--
4627A	4635A	Vent	C	35.43	111.74	5/6	N	336	75	4	425	250	----------------------	--
4629	4629	Vent	C	35.44	111.77	4/6	N	347	54	23	17	750	----------------------	--
4632	4631	Vent	C	35.43	111.78	5/6	N	0	51	8	76	250	Older than 4536----	--
4635	4635	Vent	C	35.42	111.72	6/6	N	5	83	19	13	1000	----------------------	--
4704	4704	Vent	C	35.49	111.67	5/5	N	351	42	24	11	500	----------------------	--
4704A	5733	Vent	C	35.49	111.65	4/6	N	4	56	10	83	250	----------------------	--
4707	4707	Vent	C	35.47	111.69	6/6	N	51	43	7	95	250	----------------------	--
4709	4703	Vent	C	35.48	111.65	6/6	N	41	49	14	33	500	----------------------	--
4710	4710	Vent	C	35.48	111.63	6/6	N	339	37	10	63	250	Younger than 4715A.	--
4714	4714	Vent	C	35.46	111.63	5/5	N	14	42	14	33	500	----------------------	--
4714A	4711	Vent	C	35.47	111.63	5/6	N	344	46	20	16	250	Younger than andesite 4804.	--
4715	4715	Vent	C	35.47	111.64	5/6	N	329	41	15	26	250	Younger than 4625.	--
4715A	4715A	Vent	C	35.48	111.63	6/6	N	335	37	14	24	250	Older than 4710----	--
4715B	4715B	Vent	C	35.46	111.64	6/6	N	28	50	14	24	250	----------------------	--
4715C	4715C	Vent	C	35.46	111.64	5/5	N	7	50	19	18	500	----------------------	--
4717	4717	Vent	C	35.47	111.68	5/8	N	348	56	37	5	750	----------------------	--
4717A	4708A	Vent	C	35.47	111.67	4/6	N	2	40	20	22	250	----------------------	--
4719	4719	Vent	C	35.44	111.69	5/6	N	324	54	36	6	750	----------------------	--
4720	4720	Vent	C	35.47	111.68	8/8	N	356	52	14	17	250	----------------------	--
4726	4726	Vent	C	35.44	111.62	6/6	N	4	56	12	31	500	Older than 3705?, 4625.	--

Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona—Continued

Site No.	Rock type or vent No.	Feature	Map sheet	Location		Mean remanent magnetism						AFD (Oe)	Field relations	K-Ar age (Ma)
				Lat N. (°)	Long W. (°)	N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)			
						BRUNHES ROCKS—Continued								
						BASALTIC ROCKS—Continued								
						Undated—Continued								
4729	4729	Vent	C	35.44	111.67	5/6	N	290	57	22	13	500	-----------------------	--
4729A	4728	Vent	C	35.44	111.66	5/6	N	8	61	4	447	250	Younger than 4625.	--
4819	4819	Vent	C	35.45	111.59	6/6	N	28	12	20	12	1000	Older than andesite 4804.	--
[1]4912A	4836	Flow	E	35.47	111.38	5/6	N	345	55	15	26	500	Older than 3812----	--
5615	5626	Flow	SP	35.58	111.74	6/6	N?	--	--	--	--	--	Younger than 4603/4614.	--
5624	4603/4614	Flow	SP	35.54	111.70	6/6	N	340	19	18	15	330	Older than 5626----	--
5702	5702	Vent	SP	35.58	111.61	8/8	N	30	53	10	33	270	Tappan basaltic stage.	--
5702A	5715	Flow	SP	35.56	111.62	6/6	N	8	64	10	50	170	Tappan basaltic stage.	--
5711	5712	Vent	SP	35.56	111.61	5/5	N	15	58	10	65	330	Tappan basaltic stage.	--
5714	5713	Vent	SP	35.55	111.61	8/8	N	2	55	7	60	330	Tappan basaltic stage.	--
5717	5716	Flow	SP	35.55	111.66	8/8	N	10	48	5	155	330	Tappan basaltic stage.	--
5728	5732	Flow	SP	35.52	111.65	4/6	N	357	61	4	472	330	Tappan basaltic stage.	--
5808	5712?	Flow	SP	35.56	111.56	7/7	N	1	55	10	50	500	Same as site 5711 --	--
5833A	3705?	Flow	SP	35.50	111.56	6/6	N	344	58	10	47	170	-----------------------	--
6725	6725	Flow	SP	35.61	111.60	6/6	N	353	42	19	13	270	-----------------------	--
6726A	6735	Vent	SP	35.60	111.61	6/6	N	8	56	6	152	270	Tappan basaltic stage.	--
7806	Basalt	Flow	SP	35.55	111.53	6/6	N	29	47	17	16	500	Older than 4536; younger than basalt 7723.	--
						Brunhes or Matuyama								
2818	2818	Vent	C	35.30	111.58	5/6	N	11	50	9	73	500	Older than dacite 2713.	--
[1]2936	Basalt	Flow	E	35.25	111.40	5/6	N	350	35	13	35	500	-----------------------	--
3426	3426	Flow	C	35.34	111.95	6/6	N	349	49	12	34	250	Younger than benmoreite 3423A, 3424.	--
3520	3529	Vent	C	35.36	111.86	8/8	N?	--	--	--	--	--	Younger than rhyolite 3425, 3518.	--
3523	3523	Vent	C	35.34	111.84	6	N?	--	--	--	--	--	Older than 3608, 3619; younger than 3507, 3517, 3518.	--
3528A	3528A	Vent	C	35.36	111.86	4/6	N	354	37	32	9	500	-----------------------	--
3528B	3528A	Flow	C	35.36	111.86	5/6	N	261	63	29	8	500	Same as site 3528A.	--
3610	3610	Vent	C	35.39	111.74	6/6	N	308	31	19	13	1000	-----------------------	--
3622	3615	Vent	C	35.37	111.75	4/6	N	31	34	9	103	NRM	-----------------------	--
3630	3630	Vent	C	35.34	111.80	6/6	N	350	30	22	10	250	Older than 3619, 3621/3621A.	--
4402	4402	Vent	C	35.49	111.94	8/8	N	11	85	6	91	250	-----------------------	--
4402A	4402	Vent	C	35.49	111.94	4/6	N	351	76	11	70	250	Same as site 4402 --	--
4408	4408	Vent	C	35.47	111.99	7/8	N	13	61	3	323	250	Younger than 4301.	--
4414	4414	Vent	C	35.46	111.93	4/6	N	23	58	25	14	250	Younger than trachyte 4424.	--
4426	4425	Flow	C	35.44	111.94	4/6	N	344	63	7	172	250	Younger than 4301, 4427A, 4435A.	--

Table 4. Paleomagnetic, stratigraphic, and chronologic data for sample sites in the San Francisco volcanic field, Arizona—Continued

Site No.	Rock type or vent No.	Feature	Map sheet	Location: Lat N. (°)	Location: Long W. (°)	Mean remanent magnetism: N_{av}/N_t (or N_t)	Polarity	Dec (°)	Inc (°)	α_{95}	κ (°)	AFD (Oe)	Field relations	K-Ar age (Ma)
BRUNHES ROCKS—Continued														
BASALTIC ROCKS—Continued														
Brunhes or Matuyama—Continued														
4522C	4521	Flow	C	35.45	111.85	6/6	N	347	53	7	99	250	Same as site 4528A.	--
4526B	4535	Vent	C	35.43	111.83	5/6	N	2	25	31	7	750	Younger than dacite 4526A, andesite 4536A.	--
4528	4528	Vent	C	35.44	111.87	5/6	N	351	61	5	239	250	----------------------	--
4528A	4521	Vent	C	35.44	111.87	6/6	N	37	61	10	45	750	Older than 4536; younger than trachyte 4424, 4527, 4517.	--
4606	4606	Vent	C	35.50	111.81	6/6	N	354	74	3	600	250	Older than 4624, 5535; younger than 4609, 5630.	--
4619	Basalt	Flow	C	35.45	111.79	5/5	N	345	55	13	33	250	----------------------	--
4622	4622	Vent	C	35.45	111.75	6/6	N	11	62	12	32	750	----------------------	--
4627	4627	Vent	C	35.44	111.75	6/6	N	16	68	9	56	250	----------------------	--
[1]4912	Basalt	Flow	E	35.47	111.38	5/6	N	357	30	30	8	500	----------------------	--
5505	5536	Flow	NW	35.58	111.88	6	N?	--	--	--	--	--	Same as site 5536?	--
5520	5529	Vent	NW	35.53	111.87	7/8	N	357	59	7	68	250	Younger than 5411, 5413.	--
5526A	5535	Vent	NW	35.51	111.83	6/6	N	28	70	2	1662	250	Older than 4536; younger than 4606/5536.	--
5536	5536	Vent	NW	35.51	111.81	6	N?	--	--	--	--	--	Older than 4536; younger than 5411.	--
5536A	4606/5536	Flow	NW	35.50	111.81	6	N?	--	--	--	--	--	Older than 4624, 5535; younger than 4609, 5630.	--
5734	5734	Vent	SP	35.51	111.64	5/6	N	307	62	22	13	500	----------------------	--
5810	Basalt	Flow	SP	35.55	111.56	7	N?	--	--	--	--	--	Older than 5712?; younger than basalt 6835.	--
5816A	Basalt	Flow	SP	35.54	111.54	6/6	N	353	66	37	4	330	Older than basalt 5815.	--
5817	Basalt	Flow	SP	35.56	111.54	8/8	N	344	45	22	7	330	Same as site 5810 --	--
7723A	Basalt	Flow	SP	35.71	111.62	9/9	N	24	23	20	7	750	Older than 4624, basalt 7817; younger than basalt 7723.	--

[1]J.N. Kellogg (written commun., 1976)
[2]C.W. Naesar and G.A. Izett (written commun., 1987)
[3]Champion (1980, table 1)
[4]Date from secular variation of geomagnetic pole position (D.E. Champion, written commun., 1985)
[5]S.W. Robinson (written commun., 1983)

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