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Measurement of Physical and Paleomagnetic Properties from Rocks In the Steamboat Hills and Carson Range, Washoe County, Nevada

Washoe County Department of Water Resources

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ABSTRACT

Physical and paleomagnetic properties measurements were performed on selected rock formations in the Steamboat Hills and Carson Range near Reno, Nevada. The physical properties measurements included bulk specific gravity, density, and magnetic susceptibility. The paleomagnetic properties measurements included magnetic direction and magnetic intensity. Results of the physical properties measurements are consistent with results from previous regional studies. The paleomagnetic properties results correlate well with magnetic anomalies identified in a recent airborne geophysical survey of the Carson Range. These results will be used as input parameters for potential fields (magnetic and gravity) modeling of subsurface structure in the Steamboat Hills, Carson Range, and South Truckee Meadows. The potential fields modeling is intended to provide an increased understanding of the hydrogeologic characteristic of alluvial and fractured bedrock aquifers in the Reno Basin.

A glossary is included at the end of this report to provide definitions for physical and paleomagnetic properties and geophysical terms that are printed in italics when first introduced in the text.

INTRODUCTION

The Utility Services Division of the Washoe County Department of Water Resources commissioned one land-based and a number of airborne geophysical surveys over the Washoe and Reno Valleys and the Carson Range between 1994 and 1996 for the purpose of subsurface characterization of structure, alluvial basin configuration, and hydrogeologic conditions. Washoe County is interested in the hydrogeologic characterization of these areas because of increased demand for public supply water in the South Truckee Meadows (See Figure 1.) The airborne geophysical surveys, which included *total field magnetic* and electromagnetic measurements, were conducted over areas shown on Figure 2. A *gravity* survey consisting of one east-west trending and two north-south trending traverses was conducted immediately north of Steamboat Hills over the Mount Rose Fan (Galena Fan).

A preliminary evaluation of the structure of a portion of the Mount Rose Fan area was conducted using a *forward modeling* approach of the total field magnetic data. This modeling was performed by Dr. Robert Karlin of the Mackay School of Mines, University of Nevada, Reno (UNR) using the commercial software GM-SYS™ by Northwest Geophysical Associates. The modeling input parameters (*magnetic intensity, magnetic direction, and magnetic susceptibility*) were assumed based on representative values for the known rock types. Geologic and structural features were obtained from published maps (Bonham and Bell, 1993; Bonham and Rogers, 1983; Tabor and Ellen, 1975) and local lithologic control was input from available borehole data. Karlin (1996) reported results of the magnetic modeling with recommendations for additional geophysical surveys, further modeling of gravity and magnetic data, and measurement of physical and *paleomagnetic* properties for model input parameters. This report describes the methods for collecting rock samples of the main geologic units, the methods for measuring the physical properties (*bulk specific gravity, density*, and magnetic susceptibility), and the methods for measuring the paleomagnetic properties of magnetic direction and magnetic intensity.

PURPOSE OF STUDY

The purpose of this study was to measure the physical and paleomagnetic properties of representative rock formations in the study area. This would provide greater constraints on geologic modeling of the subsurface using geophysical data. Subsurface structures in the alluvial basins and ranges in Washoe County can be modeled and imaged using the geophysical methods of gravity and magnetics known collectively as *potential fields*. The subsurface structures such as the basin geometry, fault locations and orientation, and nature of the bedrock basement are important for understanding groundwater resources. These structures can influence recharge from the mountain block to the alluvial aquifers, control the direction of groundwater flow, determine the volume of groundwater in a basin, and influence the rate that water can be extracted from the subsurface.

Forward modeling of magnetic data collected along a single flight line of an airborne survey involves creating a two-dimensional interpretation of the subsurface geology. Resultant cross-sections are produced that closely match the observed magnetic data with the calculated magnetic data. Magnetic modeling, however, is non-unique in that more than one geologic interpretation can produce an excellent fit to the observed data. For example, a profile of magnetic data could be modeled as: (1) a deeply buried body with strong magnetization; (2) a surface body of identical dimensions with weak magnetization; or (3) a surface body of smaller dimensions with strong magnetization. Because of this non-unique nature in modeling potential fields data, a reasonable geologic interpretation must include available geologic information (surface mapping, borehole logs, geomorphic features) and information on the physical and paleomagnetic properties of the representative rock types.

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REVIEW OF POTENTIAL FIELDS FUNDAMENTALS

The magnitude of the gravitational force between two bodies is proportional to each mass and inversely proportional to the square of their separation. Therefore, bulk specific gravity and density data (mass) are used in gravity modeling to calculate depths to subsurface bodies (separation). The density contrast between two geologic materials, such as alluvium and granodiorite, produces a negative gravity anomaly for an alluvial basin. By knowing this density contrast the depth of the basin can be calculated. Alternatively, by knowing the depth to bedrock in portions of the basin the variation of the density contrast can be estimated. Basin depths estimated from gravity data can be used to constrain the possible geologic interpretations when modeling total field magnetics data.

The total field magnetics data obtained from an airborne survey represents the sum of the magnetization of the earth's *geomagnetic field* and the magnetization from surface and subsurface rocks. The *rock magnetization* is due to the magnetic minerals (primarily magnetite) in the rocks and consists of *induced magnetization,* which is dependent on the *magnetic susceptibility* of the rock, and on the *remanent magnetization,* which is dependent on the geologic history of the rock. Typically, *basalts* have higher remanent magnetization and lower induced magnetization (low magnetic susceptibility) than granites. Sediments and metamorphic rocks usually have lower remanent magnetization and lower magnetic susceptibility than both basalts and granites.

An anomaly in the total field magnetic data results from the perturbation of the geomagnetic field due to magnetic bodies at the surface or buried in the subsurface. The shape and magnitude of the anomaly is dependent on the orientation of the airborne survey flight line, direction and intensity of the geomagnetic field, orientation of the magnetic body, magnetic susceptibility of the rock, and the remanent magnetization of the rock. As can be seen by the number of variables that determine a magnetic anomaly, forward modeling of total field magnetic data requires more input data than for gravity modeling. Additionally, the range of values for magnetic data is much more variable than for gravity data. The physical and paleomagnetic properties measurements obtained during this study will allow better constraints for constructing models of the geologic cross-sections in the study area using gravity and total field magnetics data.

METHODS

SAMPLE COLLECTION

Samples representing the main geologic units in the Steamboat Hills were collected during a field reconnaissance on June 6, 1997 with Ted Delong of Caithness, Inc., John Skalbeck and Michael Widmer of Washoe County and Drs. Robert Karlin, Richard Schweickert, and Mary Lahren of UNR. The total field magnetic map of the Steamboat Hills area (Dighem, 1994) with an overlay of the local geologic maps (Bell and Rogers, 1983; Tabor and Ellen, 1975) provided the framework for discussions of local geology and structural trends versus magnetic anomalies. Sample locations were based upon these discussions. Seven hand samples (SB-1 through SB-7) were collected at four locations from the Tertiary Kate Peak Formation [basalt (Tb) and andesite flows (Tkf)] and the pre-Cretaceous metasediments (pKm). An eighth sample (SB-8) was collected near this area from granodiorite (Jgd) on June 20, 1997. These samples were collected for physical properties measurements. The sample locations in the Steamboat Hills area are shown on Figure 3.

Mr. Skalbeck and Mr. Widmer collected samples for physical properties and paleomagnetic properties measurements from outcrops of granodiorite (gd), andesite flows (Tkf), and hydrothermally bleached andesite flows (Tkfb) in the Carson Range. Site locations were based upon correlation of the mapped geology with magnetic anomalies identified on the total field magnetic of the Carson Range (Dighem, 1994). A total of thirteen hand samples for physical properties measurements were collected from ten sites (CR01-CR07, CR10, CR11, CR13) in the Carson Range on July 17, 1997. These sites were sampled via helicopter transport by El Aero Services, Inc. under contract to Washoe County. One additional hand sample was collected at Site CR14 from granodiorite on July 26, 1997 that was accessed by a 4-wheel drive vehicle. A total of 30 small diameter (1 inch) oriented core samples (5 cores per site) were collected at six sites (CR02, CR04, CR05, CR07, CR11, and CR14) for paleomagnetic measurements. Samples were collected using standard paleomagnetic equipment and techniques. The sample locations in the Carson Range are shown on Figure 4.

PHYSICAL PROPERTIES MEASUREMENTS

Physical properties measurements (bulk specific gravity, density, magnetic susceptibility) were performed by John Skalbeck in the Mackay School of Mines Geomechanics Laboratory from July through October, 1997. Bulk specific gravity measurements were conducted using ASTM Method C97-96 (ASTM, 1996). The samples were heated for at least 48 hours at 60° C prior to measuring the dry weight (Wt_d). The wet weight (Wt_w) of each sample was measured after the sample was immersed in a deionized water bath for at least 1 hour and wiped with a damp towel to remove excess surface water. The sample were then returned to the water bath and the submerged weight (Wt_s) was measured within 5 minutes. All weights were measured to the nearest 0.02 grams (g) using a SoilTest Dial-o-Gram balance. Bulk specific gravity (S_g) was calculated as follows:

$$S_g = Wt_d / (Wt_w - Wt_s) \qquad (1)$$

Density measurements should be equivalent to bulk specific gravity measurements when units are metric. Sample volumes (V) were measured in cubic centimeters (cm^3) by the displacement of deionized water within a graduated cylinder. Sample density (ρ) was calculated as follows:

$$\rho = Wt_d / V \qquad (2)$$

Magnetic susceptibility (χ) measurements were performed on two sample specimens of different dry weight. Specimens were measured using a Barington M.S.2 susceptibility meter in dimensionless Gaussian (cgs) units of magnetization calibrated to a volume of 10 g/cm^3. The specimen volume (V_s) was calculated by dividing specimen weight by the sample density. Normalized χ, which represents the χ per unit volume of specimen, was then found by:

$$\text{Normalized } \chi = \text{Measured } \chi * 10)/ V_s \qquad (3)$$

The sample average χ represents the arithmetic average of the two specimen (A and B) normalized χ measurements. The sample average χ in Systeme Internationale (SI) units was found by 1 cgs = 4 π SI.

PALEOMAGNETIC PROPERTIES MEASUREMENTS

Paleomagnetic properties measurements were performed by John Skalbeck in the Mackay School of Mines Paleomagnetics Laboratory from August through October, 1997. The 1-inch diameter cores were cut to 1-inch long samples using a water/oil-lubricated diamond-tip saw. Magnetic measurements were performed within the magnetic shielded (field-free) room of the laboratory using a Schonstedt Model GSD-1 digital spinner magnetometer. *Natural remanent magnetization* (NRM) was measured on each sample prior to progressive alternating-field (AF) *demagnetization* treatment using a Schonstedt Model DSM-1 AC geophysical specimen demagnetizer. Sites CR04, CR05, and CR07 were also treated by thermal demagnetization at 200°C using a Schonstedt Model TSD-1 thermal specimen demagnetizer.

Progressive demagnetization is performed to separate the *primary magnetization* from the component(s) of *secondary magnetization*. The primary magnetization is typically the investigation target because it represents the unaltered magnetic direction that is likely characteristic of the rocks at depth (not exposed to surface weathering). Additionally, interpretation of progressive demagnetization data also allows for the delineation of the magnetic mineralogy, magnetic history, and magnetic stability of the sample. The *least-squares best-fit line*, calculated for each sample using the progressive AF demagnetization data following the method of Kirshvink (1980), describes the primary magnetization of the sample.

Site mean magnetic directions and magnetic intensities are calculated from the sample directions using the probability density function known as *Fisher distribution* described by Fisher (1953). Site mean directions were calculated for the NRM directions and for the least-squares best-fit directions. The precision of the calculated site mean direction relative to the true site mean direction is described by the *Fisher confidence limit parameter* $\alpha 95$. Calculation of the site mean direction is dependant on the how well the individual sample directions are clustered. A set of closely clustered sample directions results in a high precision calculation of the site mean and a low α95 value. A poorly clustered set of the sample directions would yield a low precision calculation of the site mean direction and a high α95 value. The α95 parameter is used to judge whether the calculated site mean direction is statistically valid. The generally accepted critical value for a valid site mean direction is $\alpha 95 = 15$ degrees.

RESULTS

Results of the physical properties measurements for the Steamboat Hills samples are given in Table 1. As expected, the bulk specific gravity and density results show close correlation. Values of bulk specific gravity range from 1.29 g/g for a scoriaceous basalt sample at Site SB-1 to 2.77 g/g for a metasediment sample at Site SB-3 with corresponding density values of 1.36 g/cm^3 and 2.74 g/cm^3, respectively. The results of sample average magnetic susceptibility range from 9 x 10^{-6} cgs (144 x 10^{-6} SI) for a weathered granodiorite at Site SB-8 to 1906 x 10^{-6} cgs (24280 x 10^{-6} SI) for an andesite flow at Site SB-4. Table 4a provides the mean physical properties values by rock type in the Steamboat Hills area.

Physical properties measurements results for the Carson Range are given in Table 2. Again, the specific gravity and density results show close correlation. The results of bulk specific gravity (density) range from 1.92 g/g (2.03 g/cm^3) for a hydrothermally bleached andesite flow at Site CR14 to 2.78 g/g (2.76 g/cm^3) for a granodiorite at Site CR07. Measurement results of sample average magnetic susceptibility values range from -0.9 x 10^{-6} cgs (-11 x 10^{-6} SI) at Site CR14 to 2540 x 10^{-6} cgs (31918 x 10^{-6} SI) for a granodiorite at Site CR02. Mean values of the physical properties measurements by rock type for the Carson Range are presented in Table 4b.

A summary of site mean results for paleomagnetic properties measurements from the Carson Range are presented in Table 3. Individual sample data for these measurements are included in Appendix A. Results are presented in geographic coordinates (not corrected for structural tilt) for NRM least-squares best-fit directions. The samples of a hydrothermally bleached andesite flow at Site CR11 show a weak present-day magnetic overprint (Declination=0°; Inclination=60°). that has completely replaced the primary magnetization. Therefore, this site was not treated with AF demagnetization. The NRM site mean magnetic intensity at CR11 is 1.91 x 10^{-6} electromagnetic units per cubic centimeter (emu/cm^3). The NRM site mean magnetic intensity for the other 5 sites range from 1.99 x 10^{-3} to 1.54 x 10^{-4} emu/cm^3.

The decay characteristics of the magnetic intensity as seen in the progressive demagnetization data (Appendix A) for the remaining 5 sites suggest that the magnetic mineralogy is likely magnetite. This interpretation is based on the fact that AF demagnetization is effective in progressively removing magnetic intensity. Additionally, the results of low temperature thermal treatment (200°C) show no change in magnetic direction and magnetic intensity. This indicates that goethite minerals, which often result from weathering, are not part of the magnetic mineralogy of these samples.

Site mean directions improved with progressive AF demagnetization for Sites CR02, CR05, and CR14 relative to the NRM directions. This is indicated by the lower $\alpha95$ value for the least-squares best-fit site mean. The least-squares best-fit site mean directions for Sites CR02, CR05, and CR14 are considered valid based on the $\alpha95$ values being less than 15 degrees.

The $\alpha95$ value for the least-squares best-fit site mean of Site CR07 improved relative to the NRM $\alpha95$ value; however, this value is above the generally accepted maximum value of 15 degrees for a statistically valid site direction. The site mean $\alpha95$ value at Site CR04 for did not improve with AF demagnetization and is also above 15 degrees. The site mean directions for Sites CR04 and CR07 are not considered valid.

The least-squares best-fit site mean directions for Sites CR02 and CR14 show similar declinations and positive inclinations indicative of a *normal magnetic polarity*. The least-squares best-fit site mean direction for Site CR05 shows a nearly antipodal direction (180° difference in declination and negative inclination of similar magnitude) relative to Sites CR02 and CR14. This direction likely represents a *reverse magnetic polarity*.

DISCUSSION OF RESULTS

Physical properties results were obtained from samples of fresh and weathered granodiorite (Kgd, gd), basalt and fresh and altered andesite of the Kate Peak Formation (Tb, Tkf, Tkfb), and metasedimentary rock (pKm) in the Steamboat Hills and the Carson Range. The mean bulk specific gravity values for each rock type from this study correlate closely with the range of specific gravity values for rocks of similar description reported by Thompson and Sandberg (1958). A copy of Table 1 from that study is provided in Appendix B. Krank and Watters (1983) present specific gravity results from a study of weathered Sierra Nevada granodiorite that includes a rock weathering classification. Bulk specific gravity values for the weathered granodiorite sample in the Steamboat Hills area correspond to Grade IV (highly weathered) while the remaining granodiorite samples from this study correspond to Grade I (fresh). A copy of Table 3 from Krank and Watters (1983) is included in Appendix B.

Magnetic susceptibility values from this study were compared to values reported for a regional airborne magnetic survey of the Reno quadrangle by Hendricks (1992). Table 1 from that study is presented in Appendix B. The sample average susceptibility values from that study compare closely with results collected from similar rock type samples collected in the Southern Virgina Range (granite), Long Valley (granodiorite), Mason Valley (metavolcanic), and the Desert Mountains (basalt, andesite, altered diorite).

The magnetic susceptibility results can be correlated with observed anomalies on the total field magnetics map for Steamboat Hills (Dighem, 1994). A large area in the central portion of the Steamboat Hills that exhibits a magnetic low anomaly correlates with the location of metasediments (pKm). The magnetic susceptibility values for metasediments are very low indicating that these rocks have weak magnetization. A magnetic high anomaly over the eastern and northeastern portions of Steamboat Hills containing andesite flows (Tkf) correlate with high magnetic susceptibility rocks and thus strong magnetization. In the Carson Range, a correlation exists between the hydrothermally bleached andesite flows (Tkfb) at Site CR11 and a magnetic low anomaly on the total field magnetics map (Dighem, 1994). The magnetic susceptibility and magnetic intensity values for this site are low indicating weak rock magnetization.

The paleomagnetic results from samples collected in the Carson Range correlate well with magnetic anomalies identified on the total field magnetic map of the Carson Range (Dighem, 1994). The two normal magnetic polarity sites (Sites CR02 and CR14) correspond to magnetic high anomalies on the total field magnetic map. These sites show high magnetic susceptibility and moderate magnetic intensity values that indicate strong rock magnetization. The reverse magnetic polarity site (Site CR05) corresponds to a magnetic low anomaly. For this site, the remanent magnetization is more dominant than the induced magnetization as indicated by the high magnetic intensity and moderate magnetic susceptibility values. Thus, the magnetic low anomaly is the result of the vector addition of a remanent magnetization with reverse magnetic polarity that acts in the opposite direction of the induced magnetization with present-day normal magnetic polarity.

CONCLUSIONS

The bulk specific gravity/density data collected for this study will be important for making informed assumptions for input in forward modeling gravity data in the study area. This will provide important constraints on the possible interpretations of subsurface geologic structure. The results show that fresh granodiorite (Kgd-fresh) and the metasediments (pKm) can be modeled using the standard value of 2.67 gm/cm^3 for crustal rocks whereas the weathered granodiorite (Kgd-weathered), andesite flows (Tkf), and basalt (Tb) should be modeled using slightly lower (2.49 to 2.54 gm/cm^3).

Since no paleomagnetic data was available during the forward modeling of the magnetic data by Karlin (1996), the magnetic susceptibility mode of GY-Sys™ was used to model the subsurface geologic structure. This mode represents the rock magnetization as 100% induced magnetization and 0% remanent magnetism. The induced magnetization for the model yields a magnetic direction of the present-day geomagnetic (Declination=0° and Inclination=60°). The paleomagnetic properties data show some sites with magnetic directions that differ from the present-day magnetic direction. Forward modeling using the combined magnetic susceptibility and magnetic remanence modes of GY-Sys™ (using the paleomagnetic properties results from this study) will produce model results that are more representative of the subsurface geologic structure.

RECOMMENDATIONS

The results of paleomagnetic properties measurements for rocks in the Carson Range reveal that the magnetic directions and magnetic intensities vary for samples collected from the granodiorite and the andesite flow sites. Additionally, the magnetic direction for Site CR05 indicates a reverse magnetic polarity for this andesite flow (Tkf) site. Forward modeling conducted by Karlin (1996) suggests that the magnetic low anomaly located in the southwestern portion of Steamboat Hills (See Figures 5 through 11 of Karlin, 1996) may be due to andesite flows (Tkf) with reverse polarity remanent magnetization. Based on the correlation between magnetic direction and magnetic anomalies on the total field magnetics map for the Carson Range, paleomagnetic properties characteristics are needed in the Steamboat Hills.

Samples should be collected for paleomagnetic properties measurements from sites that correlate to the locations where forward modeling suggest a reverse polarity magnetic direction and to locations that show magnetic anomalies on the total field magnetics map. Recommended sampling locations include: (1) andesite flows (Tkf) northeast of Galena Creek in the northern portion of Section 12, T17N, R19E (Tabor and Ellen, 1975); (2) andesite breccia (Tkb) northwest and southeast of Browns Creek in the northeastern portion of Section 13, T17N, R19E and central portion of Section 18, T17N, R20E (Tabor and Ellen, 1975); and (3) soda trachyte rocks of the Alta Formation (Ta) located south of the Mount Rose Highway in the northern portion of Section 36, T18N, R19E (Bonham and Rogers, 1983).

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GLOSSARY

Bulk specific gravity: The dimensionless ration of the bulk density of a rock to the density of water. Measured as the dry weight of a rock sample relative to the weight of the sample while submerged in deionized water (submerged weight). Equivalent to density when measured in metric units.

Density: The mass per unit volume of a rock sample expressed in grams/cubic centimeter (gm/cm^3).

Declination: Azimuthal angle between the horizontal component of the geomagnetic field and geographic north.

Demagnetization: Process of progressively removing a sample's magnetization in the paleomagnetic laboratory by subjecting the sample to alternating magnetic field (AF) and/or thermal conditions within a magnetic shielded (field-free) room. AF demagnetization is effective in removing magnetization from grains of magnetite where as thermal demagnetization is needed to remove magnetization from grains of hematite, goethite, and other secondary magnetic minerals formed by weathering and chemical alteration.

Gravity: The gravitational force of attraction between two bodies that is proportional to each mass and inversely proportional to the square of their separation. A gravity measurement is dependent on the density of the subsurface material, elevation of the survey measurement, and the topography of the surrounding landmass.

Forward modeling: Source model is initially constructed based on geologic and geophysical intuition and available data. The model's anomaly is calculated and compared with the observed anomaly. The model parameters are then adjusted by trial-and-error to improve the fit between the calculated and observed anomalies. Computer software programs such as GM-SYS™ have automated this process for *potential fields* modeling.

Fisher distribution: A probability density function applicable to paleomagnetic directions developed by British statistician R. A. Fisher. Each sample direction is represented by a point on a sphere of unit radius and is given unit weight. The Fisher distribution function $P_{dA}(\theta)$ gives the probability per unit angular area of finding a direction within an angular area (dA) centered at an angle θ from the true mean direction.

Fisher confidence limit parameter α95: A measure of the precision with which the true mean direction has been determined expressed as an angular radius from the calculated mean direction. There is a 95% certainty that the unknown true mean direction lies within α95 of the calculated mean direction. When plotted on a stereographic projection with paleomagnetic directions the α95 appear as a circle or oval.

Geomagnetic field: The magnetic field originating from the earth's internal electromagnetic interactions near the core-mantle boundary. The field is assumed to behave as a dipole (positive and negative poles) similar to a bar magnetic with the geomagnetic poles roughly parallel with the geographic poles (geocentric). Paleomagnetic studies have shown that the field undergoes temporal changes (secular variation) in *magnetic direction* and *magnetic intensity* and flip-flops (reversals) at irregular internals. The present-day geomagnetic field is referred to as *normal magnetic polarity* (North Pole having downward *inclination*) where as in a *reverse magnetic polarity* field the North Pole would have an upward inclination.

Inclination: The vertical angle (dip) from horizontal of the geomagnetic field vector. Inclination ranges from -90° (upward) to +90° (downward) at the present-day South Pole and North Pole, respectively.

Induced magnetization: Magnetization in a rock acquired when exposed to the *geomagnetic field.* The magnitude is proportional and the direction generally parallel to the geomagnetic field. The magnitude of magnetization is a function of the *magnetic susceptibility* of the rock that is related to the magnetic minerals in the rock. Induced magnetization disappears without the presence of the geomagnetic field such as in a magnetic shielded (field-free) room.

Least-squares best-fit line: A rigorous quantitative technique used to determine the direction of the best-fit line though a set of scattered data such as progressive demagnetization data. The measure of precision of the best-fit line is quantified by the maximum angular deviation of the data points from the line.

Magnetics: Earliest discovered geophysical property of the earth that explains the attraction and repulsion of magnetic objects (lodestones) and allows the used of the magnetic compass. An airborne magnetic survey is conducted with a proton-precession magnetometer while paleomagnetic rock samples are measured using a flux-gate magnetometer.

Magnetic dipole moment: Refers to a pair of magnetic charges (+, -) and is the product of the magnitude of the charge and the distance separating the + and - charges.

Magnetic direction: The total magnetic field vector can be broken into (1) a horizontal component known as the *declination* (azimuthal degrees from geographic north) and (2) a vertical component known as the *inclination* (vertical degrees from horizontal).

Magnetic intensity: Measure of magnetic strength that is the unit volume sum of the *magnetic dipole moment* of individual magnetic grains in a rock. Magnetic intensity of the earth's geomagnetic field is approximately 52,000 nanoTesla (nT). Magnetic intensity of rocks may range from 10^{-2} to 10^{-7} electromagnetic units per cubic centimeter (emu/cm^3). 1 nT = $10^{-5}/4\pi$ emu/cm^3.

Magnetic susceptibility: A dimensionless constant of proportionality characteristic for a rock based on the magnetic mineralogy. Represents the ability of a rock to acquire *induced magnetization* from the *geomagnetic field.*

Natural remanent magnetization (NRM): *Remanent magnetization* in a rock sample prior to treatment in the paleomagnetic laboratory. The NRM depends on the geomagnetic field and geologic processes during rock formation and during the subsequent history of the rock. The NRM component acquired during rock formation is referred to as *primary magnetization* and the component acquired subsequent to rock formation is referred to as *secondary magnetization*. The NRM of a sample is the vector sum of the primary of magnetization and secondary magnetization. The primary of magnetization is sought in most paleomagnetic investigations; however, the secondary of magnetization is often useful in determining the history of the rock.

Normal magnetic polarity: Describes the present-day orientation of the Earth's *geomagnetic field* where the magnetic field lines are pointing downward at the geographic North Pole and upward at the South Pole.

Paleomagnetic (paleomagnetism): The natural remanent magnetism preserved in rocks that provide a record of the geomagnetic field during the formation of and/or subsequent history of the rock.

Potential fields: Mathematical properties of the conservative, naturally-occurring, force fields of gravity and magnetics. The property relates to a path independent of work such that the amount of work to move a mass in some external gravitational field from one point to another is the same regardless of the path taken between the two points. Identical physical and mathematical representations are used to understand gravitational and magnetic forces. The fundamental element defining the gravitational force is the point mass where as the equivalent fundamental magnetic element is the monopole. Conservative forces such as gravitational and magnetic forces can be represented by simple scalar expressions known as potentials, thus the term potential fields.

Primary Magnetization: The component of magnetization acquired during rock formation. As an igneous rock cool the magnetic minerals acquire the direction of the Earth's geomagnetic field. Sedimentary rocks acquire magnetization when the magnetic mineral grains align with the geomagnetic field prior to consolidation.

Proton-precession magnetometer: Measures the magnitude of the *total magnetic field* from the precession frequency of protons in water based on the principle that particles with magnetic moments precess in a magnetic field with a frequency proportional to the *magnetic intensity* of the field.

Remanent magnetization: Magnetization preserved in a rock which is dependent on the origin and geologic history of the rock. Remanent (also known as *paleomagnetic*) magnetization is measured in terms of *magnetic direction* and *magnetic intensity*. Rocks containing magnetic minerals can acquire a magnetic the magnetic direction parallel to the earth's geomagnetic field during the time of formation. The subsequent geologic history (folding, faulting, weathering, erosion, metamorphism) can alter or replace this original (primary) magnetization. Thus, the remanent magnetization direction is often different than the present day geomagnetic direction that leads to a *total field magnetic anomaly*.

Reverse magnetic polarity: Refers to the orientation of the Earth's *geomagnetic field* where the magnetic field lines are pointing upward at the geographic North Pole and downward at the South Pole. This is the opposite orientation of the present-day geomagnetic field.

Rock magnetization: The total magnetization of a rock that is composed of induced magnetization and remanent magnetization.

Secondary magnetization: The component of magnetization acquired subsequent to rock formation. This component of magnetization may be the result of thermal conditions (contact metamorphism), chemical alteration, and/or weathering.

Total field magnetics: Measurement of the magnitude (*magnetic intensity*) of the total field (horizontal and vertical component) collected during airborne surveys using a proton-precession magnetometer. The direction of the total field is not measured.

FIGURES

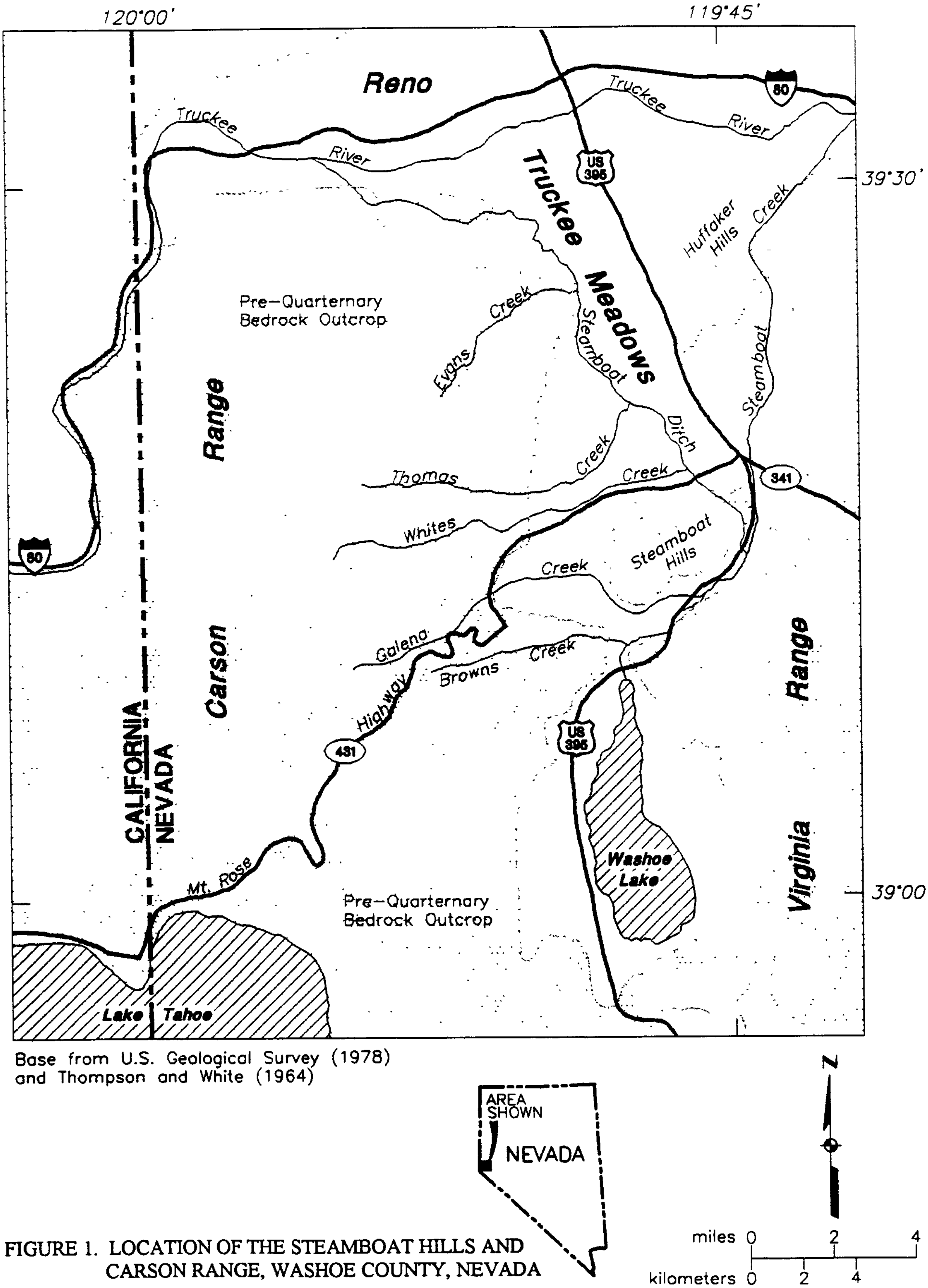

FIGURE 1. LOCATION OF THE STEAMBOAT HILLS AND CARSON RANGE, WASHOE COUNTY, NEVADA

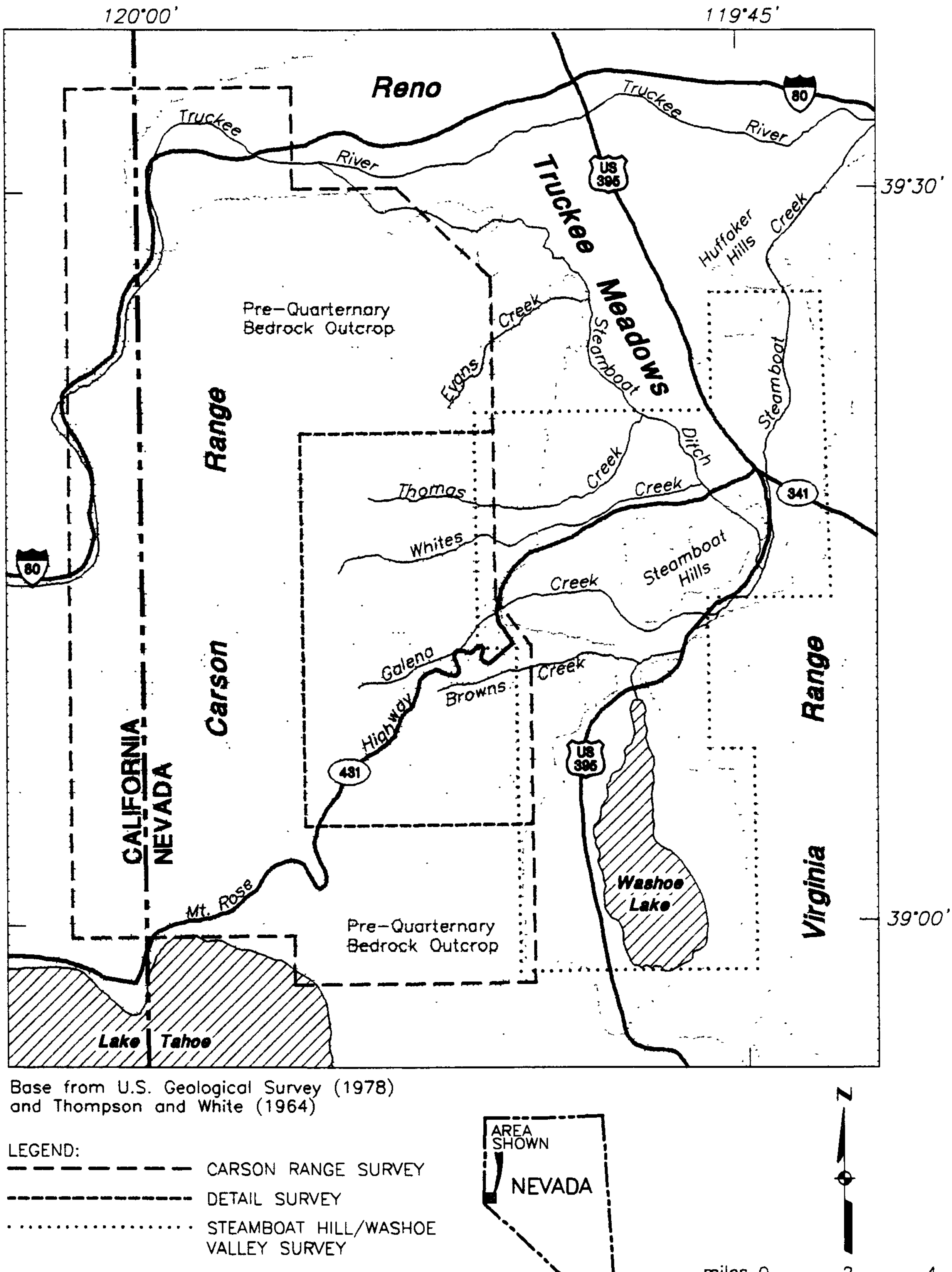

FIGURE 2. LOCATION OF AIRBORNE GEOPHYSICAL SURVEYS, WASHOE COUNTY, NEVADA

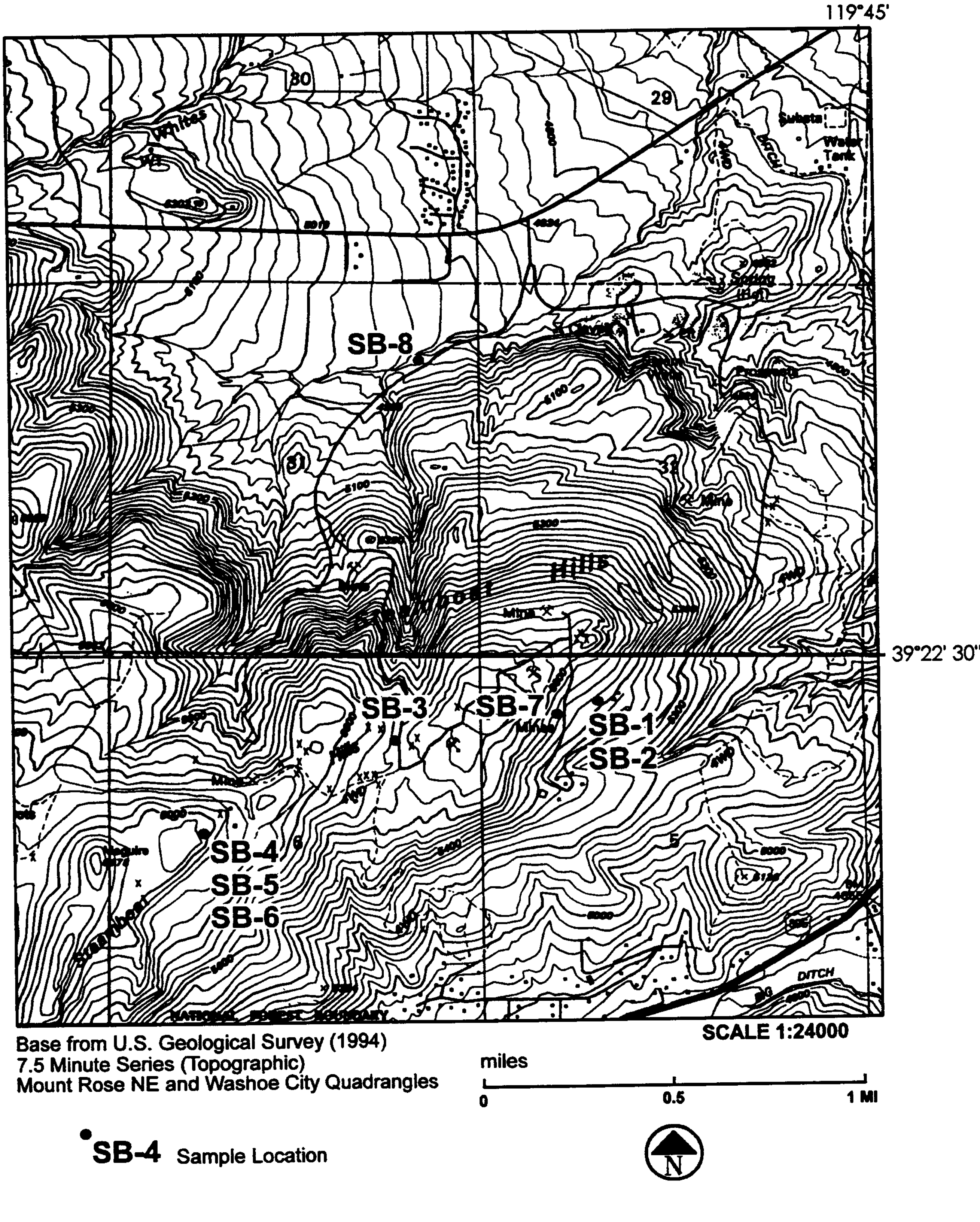

FIGURE 3. SAMPLING LOCATIONS IN THE STEAMBOAT HILLS, WASHOE COUNTY, NEVADA

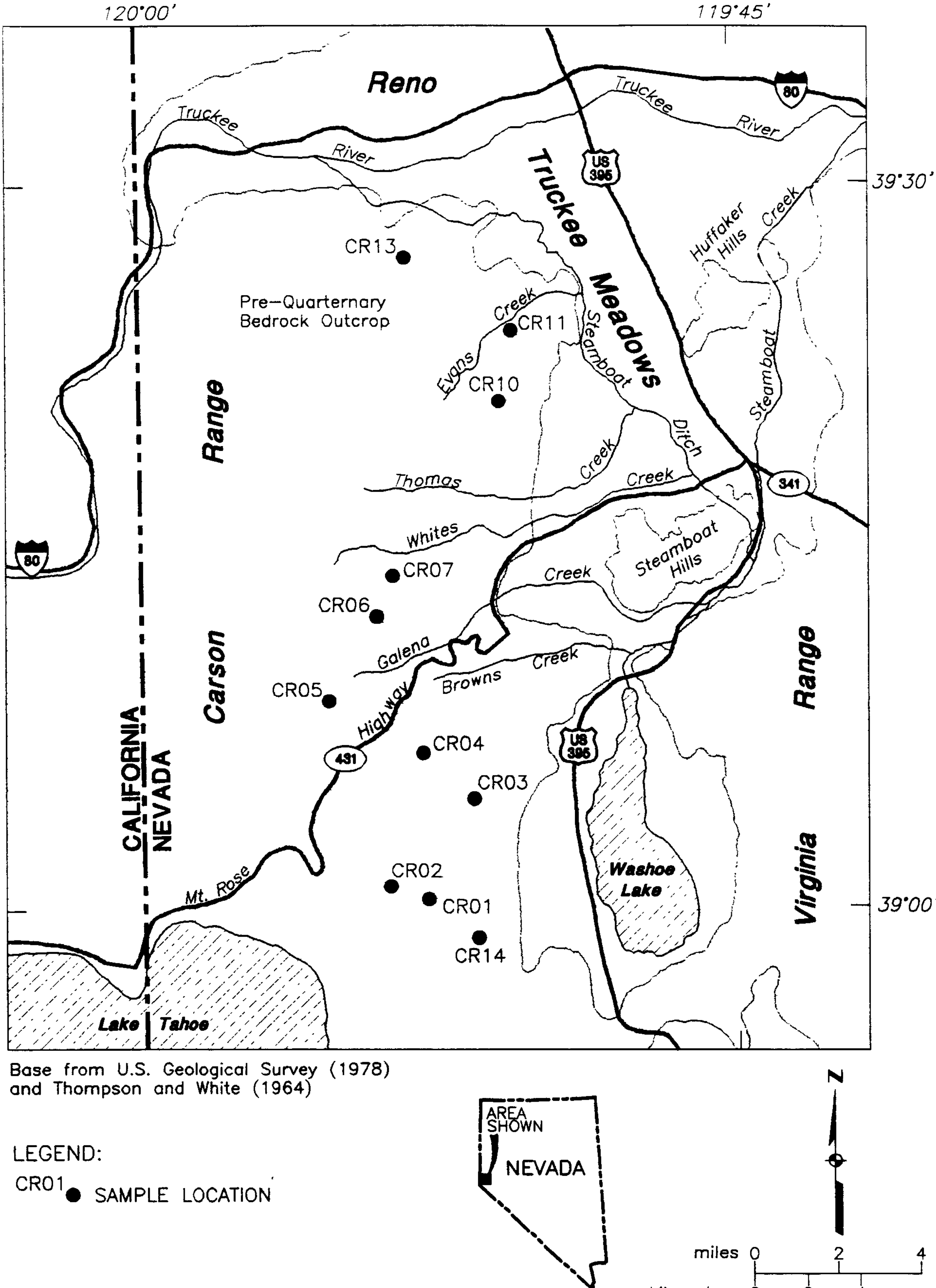

FIGURE 4. SAMPLING LOCATIONS IN THE CARSON RANGE, WASHOE COUNTY, NEVADA

TABLES

Table 1. Physical properties measurements from the Steamboat Hills.

Site	Rock Type	Dry Weight (g)	Wet Weight (g)	Submerged Weight (g)	Sample Volume (cm^3)	Bulk Sg (g/g)	Sample Density (g/cm^3)	Specimen	Measured χ (cgs x 10^{-6})	Specimen Weight (g)	Specimen Volume (cm^3)	Normalized χ (cgs x 10^{-6})	Sample Average χ (cgs x 10^{-6})	SI Units Average χ (SI x 10^{-6})
		Bulk Specific Gravity (Sg) and Density Measurements						Magnetic Susceptiblity (χ) Measurements						
SB-1	Tb-scoria	72.05	79.08	23.12	53	1.29	1.36	A	139	8.00	5.88	236	232	2968
								B	145	8.65	6.36	228		
SB-2	Tb-dense	183.95	184.96	106.42	83	2.34	2.22	A	895	11.90	5.37	1667	1626	20946
								B	1015	14.19	6.40	1585		
SB-3	pKm	177.93	178.40	114.13	65	2.77	2.74	A	5.5	10.55	3.85	14	16	179
								B	5.8	8.86	3.24	18		
SB-4	Tkf	123.76	124.25	77.66	48	2.66	2.58	A	891	11.89	4.61	1932	1906	24280
								B	1159	15.90	6.17	1879		
SB-5	Tkf	282.71	283.72	175.75	105	2.62	2.69	A	718	10.48	3.89	1845	1796	23181
								B	926	14.27	5.30	1747		
SB-6	Tkf	127.93	131.06	77.32	52	2.38	2.46	A	754	11.01	4.48	1685	1733	21172
								B	694	9.59	3.90	1780		
SB-7	pKm	161.74	161.90	101.90	62	2.70	2.61	A	6	10.19	3.91	15	15	193
								B	7	13.29	5.09	14		
SB-8	Kgd-fresh	132.46	132.87	83.41	52	2.68	2.55	A	212	10.83	4.25	499	473	6266
								B	273	15.53	6.10	448		
SB-8	Kgd-wtrd	83.17	83.93	51.25	33	2.54	2.52	A	5	11.02	4.37	11	9	144
								B	2.5	10.52	4.17	6		

Notes:
g: grams cm^3: cubic centimeters   cgs: Gaussian units   SI: Systeme International units
Tb: Kate Peak Formation, black olivine basalt, dense to scoriaceous (Tabor and Ellen, 1975)
pKm: Metamorphic Rock, gray metagreywacke (Tabor and Ellen, 1975)
Tkf: Kate Peak Formation, hornblende-pyroxene andesite flows (Tabor and Ellen, 1975)
Kgd: Biotite-hornblende granodiorite, fresh to weathered [wtrd] (Bonham and Rogers, 1983)

Table 2. Physical properties measurements from the Carson Range.

Site	Rock Type	Dry Weight (g)	Wet Weight (g)	Submerged Weight (g)	Sample Volume (cm^3)	Bulk Sg (g/g)	Sample Density (g/cm^3)	Specimen	Measured χ ($cgs \times 10^{-6}$)	Specimen Weight (g)	Specimen Volume (cm^3)	Normalized χ ($cgs \times 10^{-6}$)	Sample Average χ ($cgs \times 10^{-6}$)	SI Units Average χ ($SI \times 10^{-6}$)
	Bulk Specific Gravity (Sg) and Density Measurements							Magnetic Susceptiblity (χ) Measurements						
CR01	gd	106.06	106.92	66.25	40	2.61	2.65	A	609	10.45	3.94	155	991	12454
								B	1331	19.31	7.28	1828		
CR02	gd	116.35	117.38	72.92	41	2.62	2.84	A	1068	11.26	3.97	2692	2523	31708
								B	551	6.64	2.34	2355		
CR03	gd	119.39	120.77	74.79	43	2.60	2.78	A	381	7.36	2.65	1437	1541	19370
								B	1068	18.02	6.49	1646		
CR04	gd	206.24	209.8	128.48	78	2.54	2.64	A	245	4.40	1.66	1472	2279	28638
								B	2097	17.97	6.80	3086		
CR05	Tkf	176.43	186.64	110.53	66	2.32	2.67	A	525	11.52	4.31	1218	1316	16541
								B	464	8.77	3.28	1414		
CR06	gd	89.84	90.82	57.05	33	2.66	2.72	A	715	9.46	3.47	2058	2204	27702
								B	950	11.00	4.04	2351		
CR07	gd	30.34	30.43	19.53	11	2.78	2.76	A	753	10.22	3.71	2032	1838	23092
								B	498	8.36	3.03	1643		
CR10-1	Tkf	175.98	176.47	110.15	63	2.65	2.79	A	1334	15.63	5.60	2384	2540	31918
								B	553	5.73	2.05	2696		
CR10-2	Tkf	102.27	103.52	60.83	42	2.40	2.44	A	447	9.06	3.72	1201	1165	14641
								B	318	6.86	2.82	1129		
CR10-3	Tkf	169.9	174.86	96.44	79	2.17	2.15	A	449	11.96	5.56	807	815	10242
								B	350	9.15	4.25	823		
CR11	Tkfb	90.72	95.33	51.63	40	2.08	2.27	A	-0.18	5.75	2.54	-0.7	-0.5	-7
								B	-0.20	11.67	5.15	-0.4		
CR13	Tkf	120.62	122.29	72.63	47	2.43	2.57	A	991	13.64	5.31	1865	1918	153
								B	602	7.84	3.05	1971		
CR13	Tkfb	75.13	81.94	42.71	37	1.92	2.03	A	-0.35	9.30	4.58	-0.8	-0.9	-11
								B	-0.78	16.57	8.16	-1.0		
CR14	gd	163.66	165.74	101.7	58	2.56	2.82	A	1148	13.21	4.68	2452	2313	29065
								B	768	9.97	3.53	2174		

Notes:

g: grams cm^3: cubic centimeters   cgs: Gaussian units   SI: Systeme International units

gd: Hornblende biotite granodiorite (Thompson and White, 1964)

Tkf: Kate Peak Formation, andesite and dacite flows (Bonham and Rogers, 1983)

Tkfb: Kate Peak Formation, hydrothermally bleached andesite and dacite flows (Bonham and Rogers, 1983)

Table 3. Paleomagnetic measurements from the Carson Range.

Site	Rock Type	N	NRM Directions Site Mean Declination (degrees)	NRM Directions Site Mean Inclination (degrees)	NRM Directions Site Mean Intensity (emu/cm^3)	NRM Directions Site Mean $\alpha 95$ (degrees)	Least-Square Best Fit Directions Site Mean Declination (degrees)	Least-Square Best Fit Directions Site Mean Inclination (degrees)	Least-Square Best Fit Directions Site Mean $\alpha 95$ (degrees)	Least-Square Best Fit Directions Site Mean Intensity (emu/cm^3)	Maximum AF Demag (oe)
CR02	gd	5	353.5	15.8	1.54E-04	24.1	42.8	51.3	11.9	1.63E-05	400
CR04	gd	5	136.7	-22.9	2.73E-03	58.4	161.1	-19.5	98.8	6.26E-04	200*
CR05	Tkf	5	271.6	-29.3	1.99E-03	25.9	212.1	-59.5	5.6	8.70E-05	1000*
CR07	gd	5	255.9	30.4	3.38E-03	43.8	270.4	59.0	24.11	1.64E-05	800*
CR11	Tkfb	5	5.2	59.0	1.96E-06	1.6	NA	NA	NA	NA	NA
CR14	gd	5	52.2	46.0	1.41E-04	32.2	40.7	54.7	11.7	2.30E-05	400

Notes:
NRM: Natural remenant magnetization
N: Number of Samples
AF Demag: Alternating field demagnetization level
$\alpha 95$: Confidence limit of the site mean direction (Fisher, 1953)
emu/cm^3: Electormagnetic units per cubic centimeter
oe: Oersted
Tkf: Kate Peak Formation, andesite and dacite flows (Bonham and Rogers, 1983)
Tkfb: Kate Peak Formation, hydrothermally bleached andesite and dacite flows (Bonham and Rogers, 1983)
gd: Hornblende biotite granodiorite (Thompson and White, 1964)
*: Sites also treated with thermal demagnetization at 200°C
NA: Not applicable, site not demagnetized

Table 4a. Mean physical properties measurements from the Steamboat Hills.

Rock Type	Number of Samples	Mean Bulk Sg (g/g)	Mean Density (g/cm^3)	Mean χ (cgs x 10^{-6})	Mean χ (SI x 10^{-6})
Tb-scoria	1	1.29	1.36	232	2968
Tb-dense, Tkf	4	2.50	2.49	1765	22395
pKm	2	2.73	2.67	15	186
Kgd-fresh	1	2.68	2.55	473	6266
Kgd-weathered	1	2.54	2.52	9	144

Table 4b. Mean physical properties measurements from the Carson Range.

Rock Type	Number of Samples	Mean Bulk Sg (g/g)	Mean Density (g/cm^3)	Mean χ (cgs x 10^{-6})	Mean χ (SI x 10^{-6})
gd	7	2.62	2.74	1956	24575
Tkf	5	2.39	2.52	1551	14699
Tkfb	2	2.00	2.15	-0.7	-9

Notes:
Sg: Specific gravity
χ: Magnetic susceptiblity
g: grams
cm^3: cubic centimeters
cgs: Gaussian units
SI: Systeme International units
Tb: Kate Peak Formation, black olivine basalt (Tabor and Ellen, 1975)
pKm: Metamorphic Rock, gray metagreywacke (Tabor and Ellen, 1975)
Tkf: Kate Peak Formation, andesite flows (Tabor and Ellen, 1975)
Kgd: Biotite-hornblende granodiorite (Bonham and Rogers, 1983)
gd: Hornblende biotite granodiorite (Thompson and White, 1964)
Tkf: Kate Peak Formation, andesite and dacite flows (Bonham and Rogers, 1983)
Tkfb: Kate Peak Formation, bleached andesite flows (Bonham and Rogers, 1983)

APPENDIX A

PALEOMAGNETIC DATA

Site CR02

(A) Natural remenant magnetization directions

(B) Least-squares best fit line directions

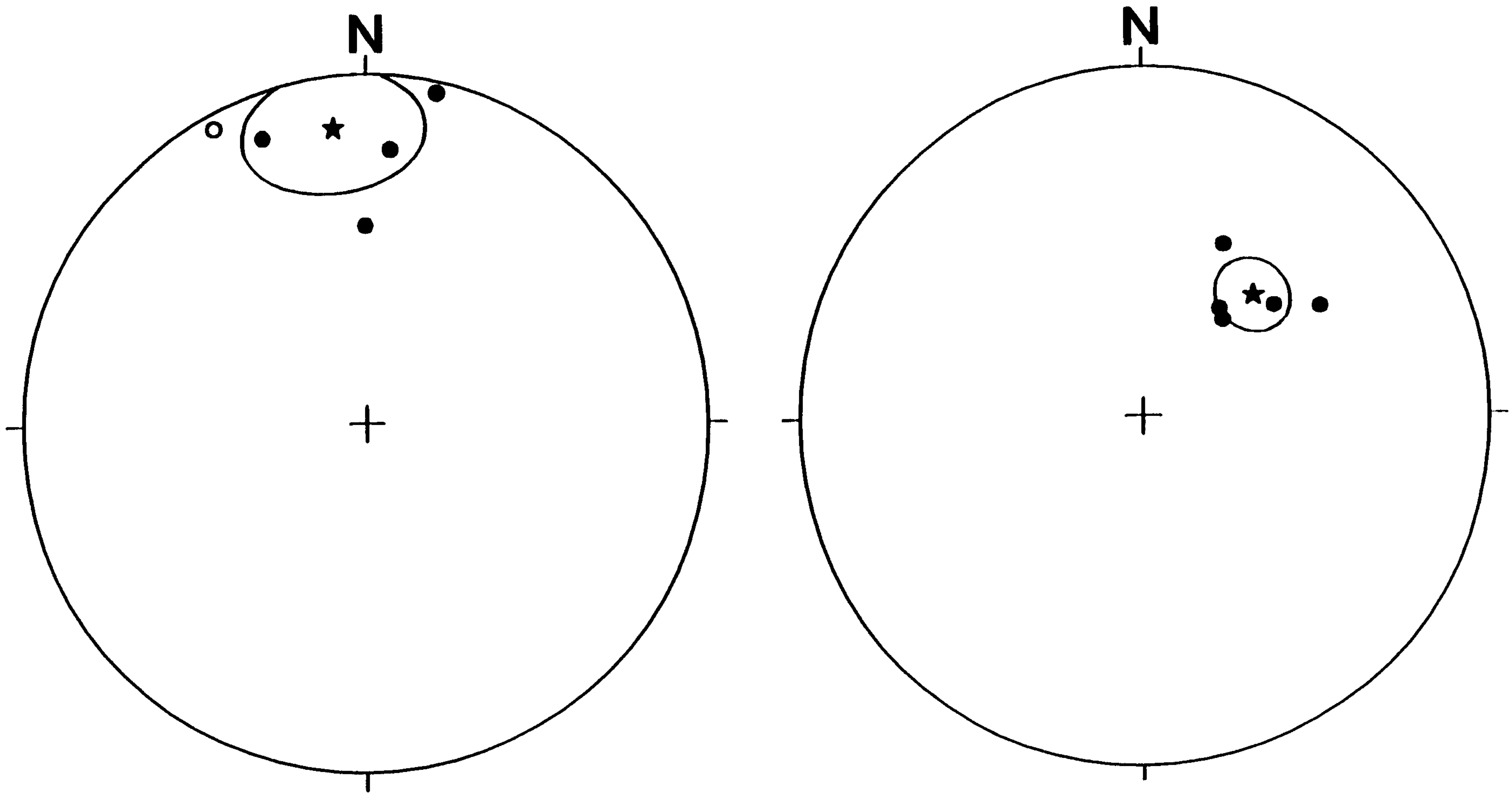

Figure A1. Equal-area projection of sample paleomagnetic directions. Solid circles indicate lower hemisphere projected directions, open circles indicate upper hemisphere projected directions, site mean direction shown by star with the $\alpha 95$ confidence limits indicated by the surrounding oval. Bold N represents magnetic north.

Site CR04

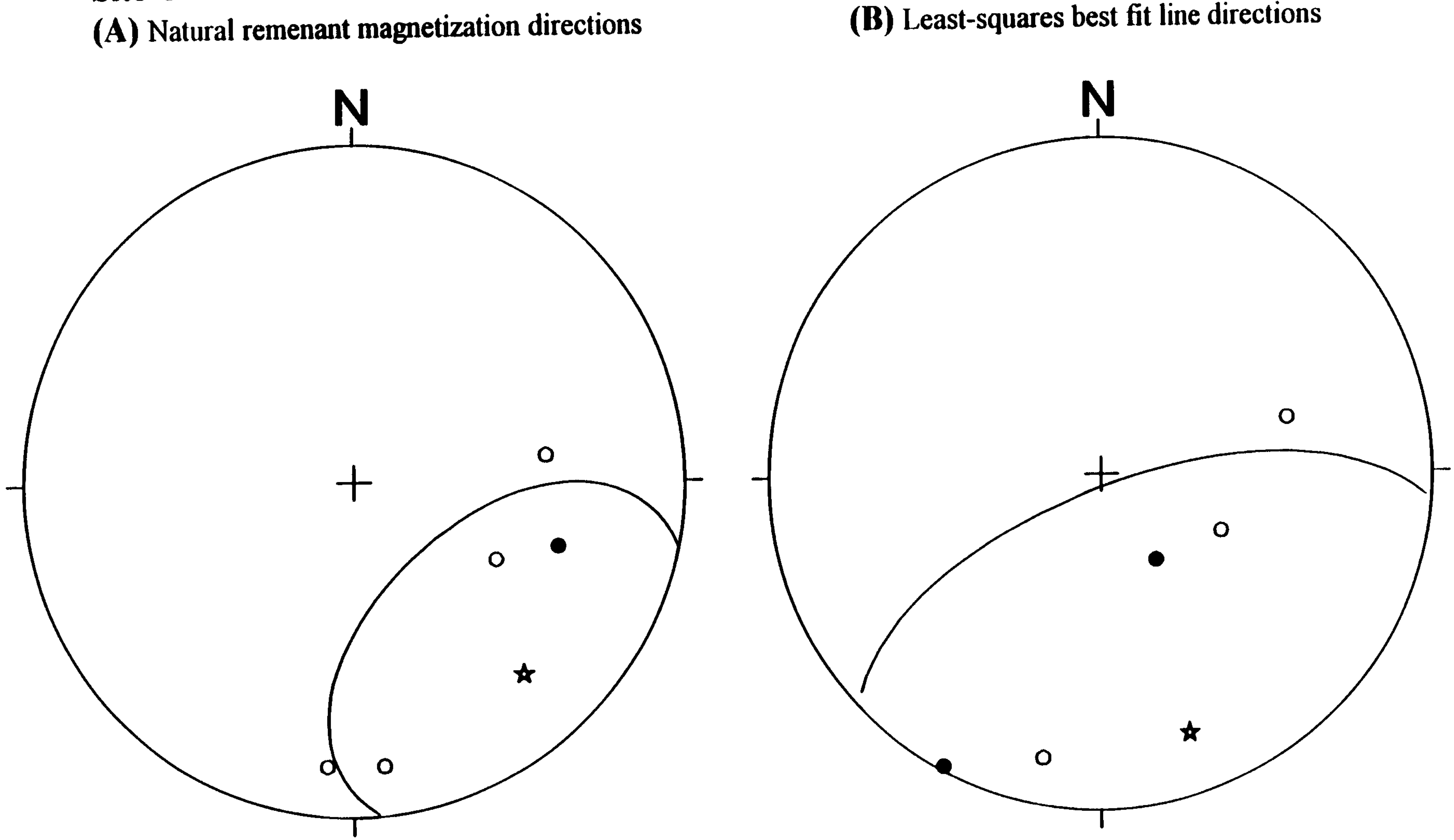

Figure A2. Equal-area projection of sample paleomagnetic directions. Solid circles indicate lower hemisphere projected directions, open circles indicate upper hemisphere projected directions, site mean direction shown by star with the α95 confidence limits indicated by the surrounding oval. Bold N represents magnetic north.

Site CR05

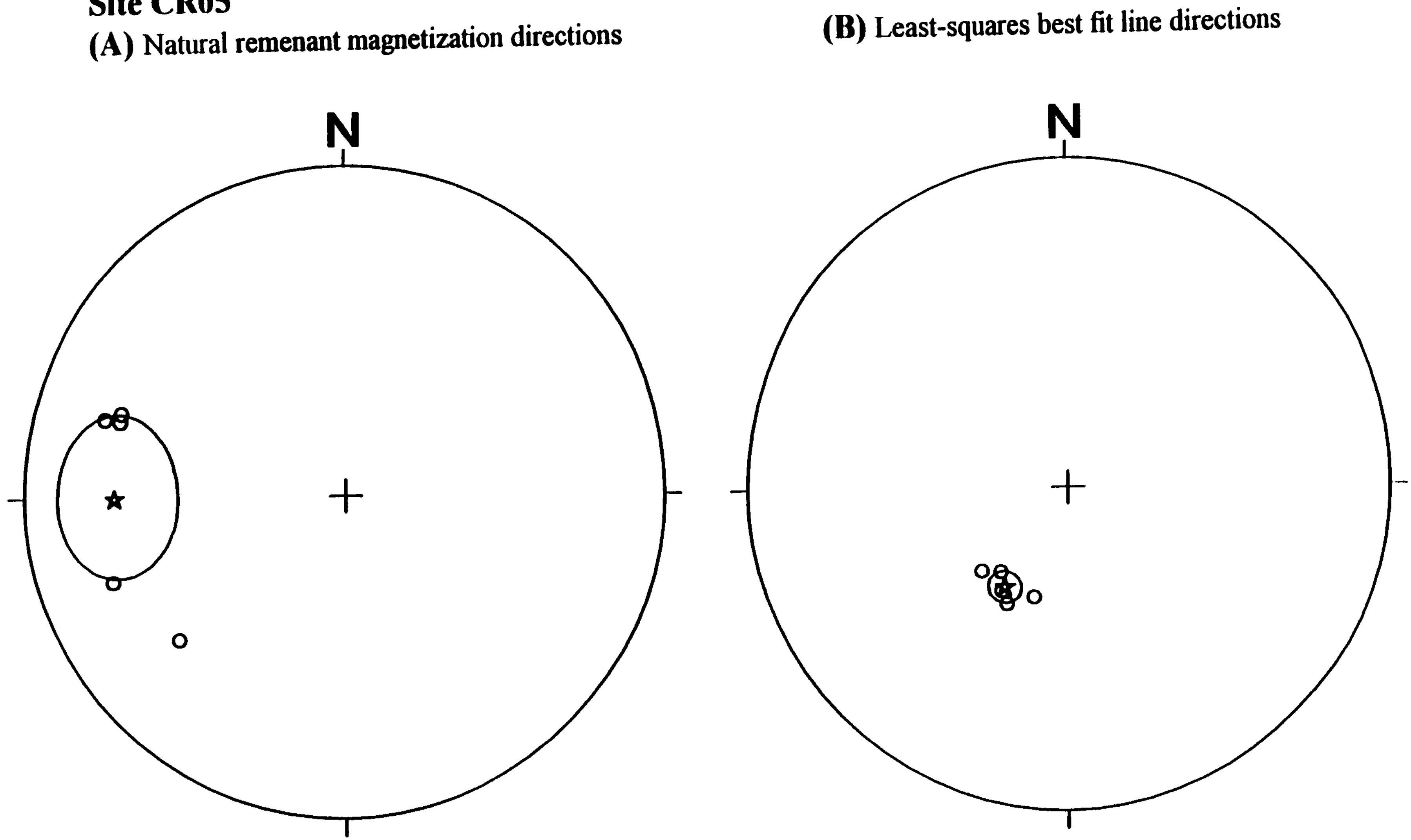

Figure A3. Equal-area projection of sample paleomagnetic directions. Solid circles indicate lower hemisphere projected directions, open circles indicate upper hemisphere projected directions, site mean direction shown by star with the α95 confidence limits indicated by the surrounding oval. Bold N represents magnetic north.

Site CR07

(A) Natural remenant magnetization directions

(B) Least-squares best fit line directions

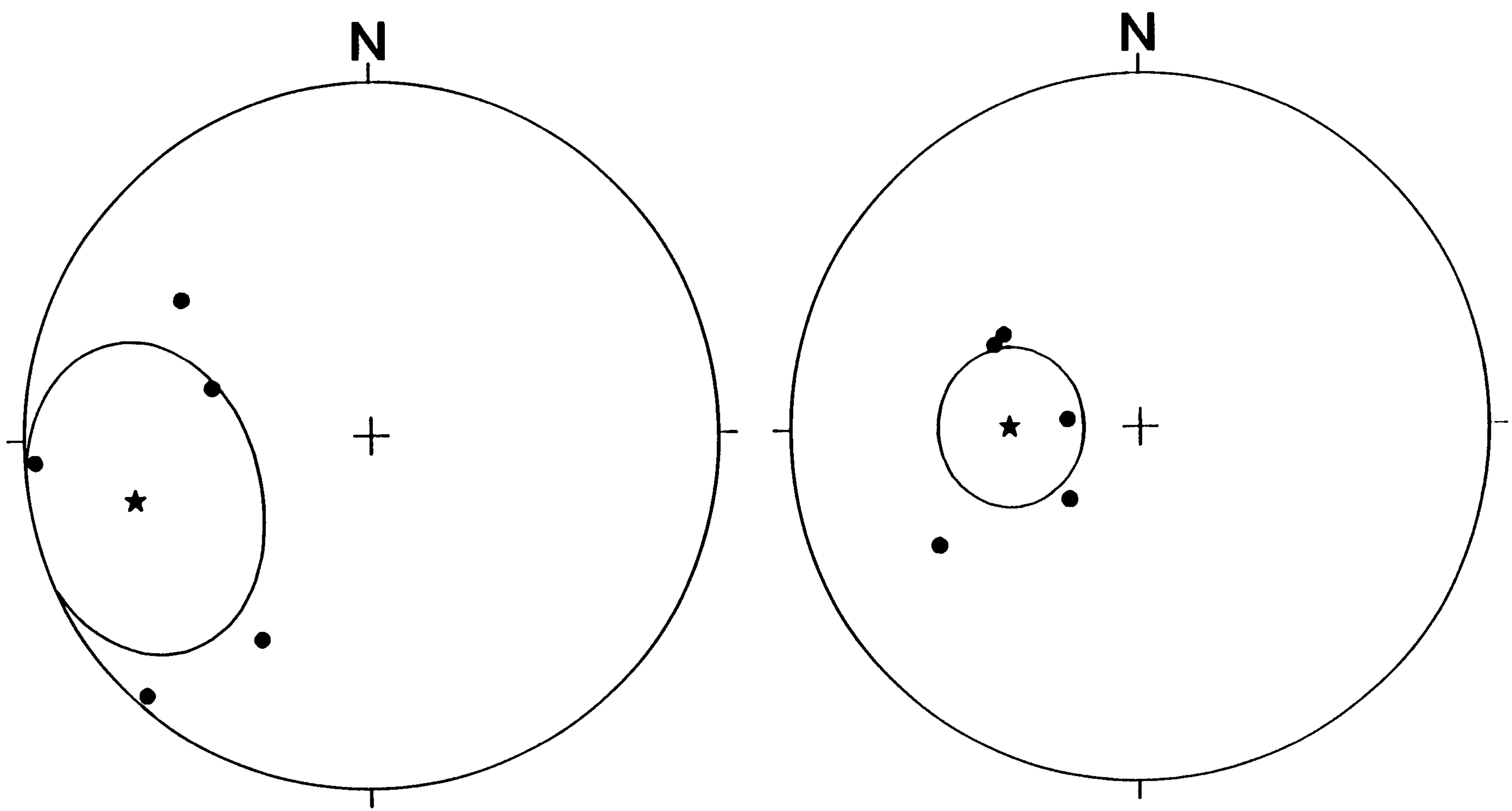

Figure A4. Equal-area projection of sample paleomagnetic directions. Solid circles indicate lower hemisphere projected directions, open circles indicate upper hemisphere projected directions, site mean direction shown by star with the $\alpha95$ confidence limits indicated by the surrounding oval. Bold N represents magnetic north.

Site CR11

(A) Natural remenant magnetization directions

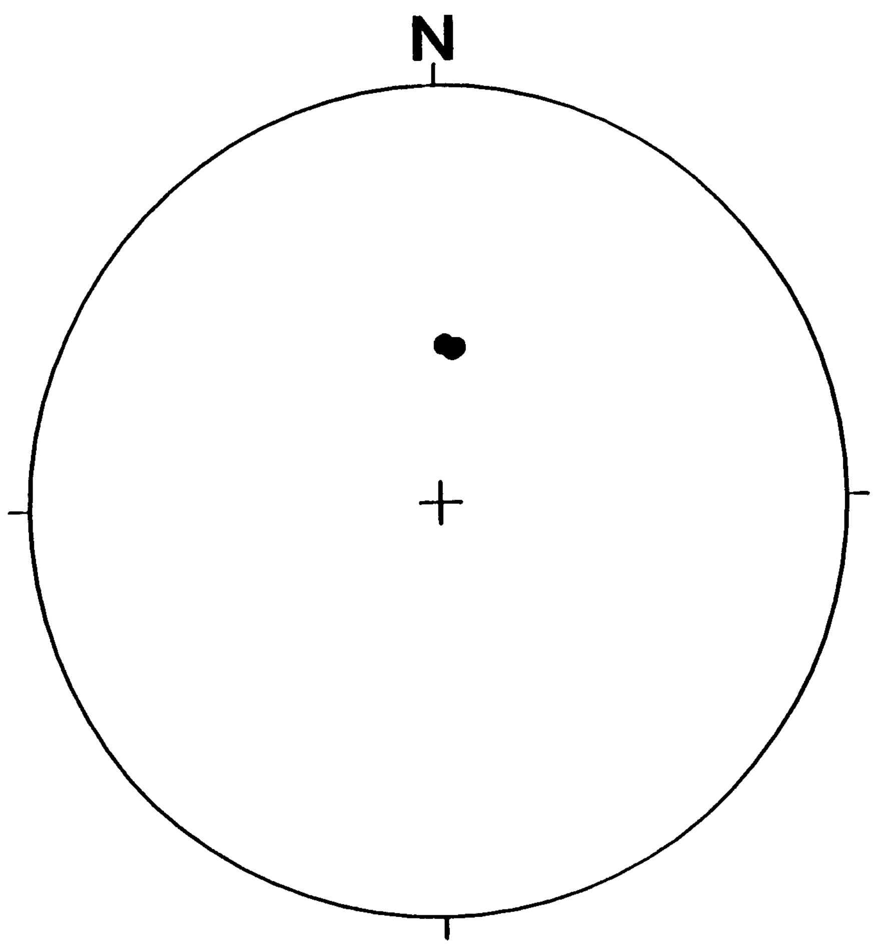

Figure A5. Equal-area projection of sample paleomagnetic directions. Solid circles indicate lower hemisphere projected directions, open circles indicate upper hemisphere projected directions, site mean direction shown by star with the α95 confidence limits indicated by the surrounding oval. Bold N represents magnetic north.

Site CR14

(A) Natural remenant magnetization directions

(B) Least-squares best fit line directions

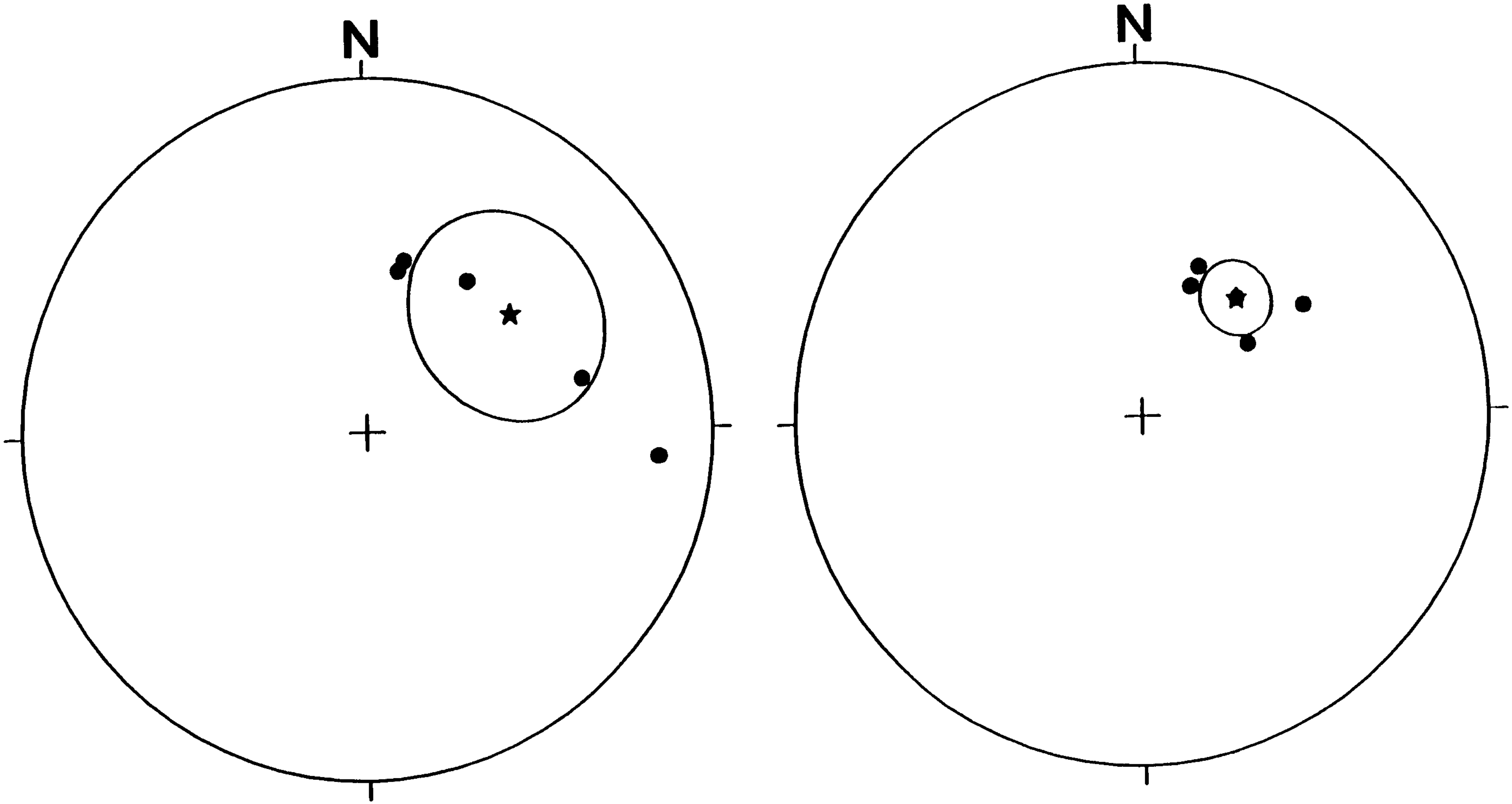

Figure A6. Equal-area projection of sample paleomagnetic directions. Solid circles indicate lower hemisphere projected directions, open circles indicate upper hemisphere projected directions, site mean direction shown by star with the $\alpha 95$ confidence limits indicated by the surrounding oval. Bold N represents magnetic north.

KJgr	1	1.000A	carson	rng	.00	.00	17.0	.0	.0	27.8	356.0	37.0	.00	cr0201a	
KJgr		1.000A	.00	332.4	-4.7	332.4	-4.7	62.3	-95.1	2.15E-04	4.52	nrm	08/26/97	14:00:42	J/Jo
KJgr		1.000A	.00	28.5	26.3	28.5	26.3	58.5	62.7	1.51E-05	8.68	100oe	09/09/97	13:56:11	.07
KJgr		1.000A	.00	38.4	25.2	38.4	25.2	49.7	69.3	1.01E-05	12.8	150oe	09/09/97	14:06:56	.05
KJgr		1.000A	.00	58.8	39.7	58.8	39.7	28.6	64.1	7.10E-06	9.84	200oe	09/09/97	14:12:55	.03
KJgr	1	2.000A	carson	rng	.00	.00	17.0	.0	.0	28.9	262.0	15.0	.00	cr0202a	
KJgr		2.000A	.00	339.6	13.4	339.6	13.4	68.6	-71.1	1.44E-04	8.05	nrm	08/26/97	14:03:07	J/Jo
KJgr		2.000A	.00	27.6	39.2	27.6	39.2	55.1	48.6	3.64E-05	6.48	50oe	09/09/97	14:17:36	.25
KJgr		2.000A	.00	25.7	43.9	25.7	43.9	54.3	42.1	2.07E-05	5.58	100oe	09/09/97	14:21:51	.14
KJgr		2.000A	.00	24.2	47.9	24.2	47.9	52.9	36.5	1.47E-05	3.28	150oe	09/09/97	14:26:52	.10
KJgr		2.000A	.00	46.6	43.6	46.6	43.6	38.4	56.8	8.52E-06	17.6	200oe	09/17/97	10:50:44	.06
KJgr	1	3.000A	carson	rng	.00	.00	17.0	.0	.0	27.9	353.0	20.0	.00	cr0203a	
KJgr		3.000A	.00	359.7	42.3	359.7	42.3	65.5	-.7	1.25E-04	1.11	nrm	08/26/97	14:04:37	J/Jo
KJgr		3.000A	.00	19.8	52.9	19.8	52.9	51.7	27.2	6.77E-05	3.58	50oe	09/09/97	14:30:40	.54
KJgr		3.000A	.00	18.2	55.7	18.2	55.7	50.0	23.1	4.14E-05	2.81	100oe	09/09/97	14:34:43	.33
KJgr		3.000A	.00	40.4	60.7	40.4	60.7	34.6	36.0	2.02E-05	2.51	200oe	09/09/97	14:38:52	.16
KJgr		3.000A	.00	36.8	70.5	36.8	70.5	27.5	23.0	7.47E-06	8.63	400oe	09/17/97	11:10:09	.06
KJgr	1	4.000A	carson	rng	.00	.00	17.0	.0	.0	29.6	267.0	57.0	.00	cr0204a	
KJgr		4.000A	.00	5.2	21.8	5.2	21.8	77.6	24.3	1.35E-04	7.65	nrm	08/26/97	14:06:35	J/Jo
KJgr		4.000A	.00	37.8	46.4	37.8	46.4	44.4	49.4	3.71E-05	6.62	50oe	09/09/97	14:43:05	.28
KJgr		4.000A	.00	47.0	57.4	47.0	57.4	32.5	43.1	2.06E-05	8.29	100oe	09/09/97	14:47:12	.15
KJgr		4.000A	.00	35.9	59.0	35.9	59.0	38.5	35.1	1.29E-05	9.45	150oe	09/09/97	14:51:50	.10
KJgr		4.000A	.00	51.9	57.4	51.9	57.4	29.1	45.2	6.62E-06	11.7	200oe	09/17/97	10:54:13	.05
KJgr	1	5.000A	carson	rng	.00	.00	17.0	.0	.0	28.4	359.0	53.0	.00	cr0205a	
KJgr		5.000A	.00	12.4	3.7	12.4	3.7	77.5	81.3	1.50E-04	1.88	nrm	08/26/97	14:08:28	J/Jo
KJgr		5.000A	.00	32.5	31.2	32.5	31.2	53.8	60.5	4.55E-05	3.85	50oe	09/09/97	14:55:50	.30
KJgr		5.000A	.00	48.9	49.4	48.9	49.4	34.6	52.2	2.07E-05	2.48	100oe	09/09/97	14:59:20	.14
KJgr		5.000A	.00	53.0	51.4	53.0	51.4	30.7	51.9	1.42E-05	3.70	150oe	09/09/97	15:00:10	.09
KJgr		5.000A	.00	43.8	54.7	43.8	54.7	36.1	44.4	7.63E-06	10.3	200oe	09/17/97	10:56:46	.05

Sample #		Data Type	Dec/Az/Long	Inc/Pl/Lat	Intensity	Demag	Remark
KJgr	1.000A	Rem Drxn	332.4	-4.7	2.15E-04	nrm	
KJgr	2.000A	Rem Drxn	339.6	13.4	1.44E-04	nrm	
KJgr	3.000A	Rem Drxn	359.7	42.3	1.25E-04	nrm	
KJgr	4.000A	Rem Drxn	5.2	21.8	1.35E-04	nrm	
KJgr	5.000A	Rem Drxn	12.4	3.7	1.50E-04	nrm	

Tue, 14 Oct. 1997

```
NONPARAMETRIC TESTS FOR UNIFORMITY.  Total included angles =      10
Beran's test statistic =     3.5377
Data non-random at  1.0% level.
Gine's test statistic =    1.1416
Data non-random at  1.0% level.
Combined test statistic =    4.6793
Data non-random at  1.0% level.

                     > > > FISHER STATISTICS < < <
N =     5 R =      4.6368
According to Watson's test:
Data non-random at  1.0% level.
Declination =  353.5 Inclination =    15.8 Paleolat =     8.0
Pole latitude =    79.7 Pole longitude =  -38.8
dp =    12.8 dm =    24.8 Oval azimuth =  140.7
M.L.E. of kappa =     13.7679 kappa =     11.0143
Alpha 95 = 24.12 Circular standard deviation = 24.53

SPHERICAL MEDIAN:
Number of iterations taken =      4
Declination =  353.4 Inclination =    15.7 Paleolat =     8.0
Pole latitude =    79.6 Pole longitude =  -39.3
Angular distance, Fisher mean to median =      .1 deg.

                     > > > "VECTOR" STATISTICS < < <
N =     5 R =  7.109E-04 Arithmetic sum of intensities =  7.690E-04
Declination =  351.3 Inclination =    13.0 Paleolat =     6.6
Pole latitude =    79.1 Pole longitude =  -52.8
dp =    12.8 dm =    25.1 Oval azimuth =  126.7
M.L.E. of kappa =     13.2250 kappa =     10.5800
Alpha 95 = 24.66 Circular standard deviation = 25.04

MOMENT OF INERTIA:
N =     5   Eigenvalues =      .2241     .4671    4.3088
Uniform test statistic =      15.75 Normalized = 3.1502
Data non-random at  1.0% level.
Woodcock's parameters:  Shape =     3.0244 Strength =     2.9564
LINEAR DATA:  Direction of MAXIMUM eigenvector.
Declination =  353.7 Inclination =    15.8 Paleolat =     8.1
Pole latitude =    79.8 Pole longitude =  -37.7

                     > > > BINGHAM STATISTICS < < <
M.L.E.'s of Bingham concentration parameters: K1 =     -11.9 K2 =      -6.1
Standard deviation angles:  Sigma 1-3 =     5.82 Sigma 1-2 =    8.35
Approximate 95% confidence angles:  Alpha 1-3 =  14.23 Alpha 1-2 =   20.43
Oval azimuth =    41.3

Test statistics for circular symmetry based on Bingham distribution:
Bipolar =        .70 Girdle =     11.78
Test indicates symmetric bipolar distribution.  Mean Bingham alpha =  17.33

                     > > > DIMROTH-WATSON STATISTICS < < <
Dimroth-Watson concentration parameter =     -7.98
Circular standard deviation = 21.62 deg. (Parametric estimate.)
```

Sample #		Data Type	Dec/Az/Long	Inc/Pl/Lat	Intensity	Demag	Remark
KJgr	1.000A	Lin Segm	58.8	39.7	7.10E-06	200oe ORIGN	
KJgr	2.000A	Lin Segm	25.4	44.6	2.07E-05	100oe ORIGN	
KJgr	3.000A	Lin Segm	40.4	60.7	2.02E-05	200oe ORIGN	
KJgr	4.000A	Lin Segm	36.0	59.0	1.29E-05	150oe ORIGN	
KJgr	5.000A	Lin Segm	50.2	49.3	2.07E-05	100oe ORIGN	

```
Tue, 14 Oct. 1997

NONPARAMETRIC TESTS FOR UNIFORMITY.  Total included angles =      10
Beran's test statistic =     4.2699
Data non-random at  1.0% level.
Gine's test statistic =     1.7844
Data non-random at  1.0% level.
Combined test statistic =     6.0543
Data non-random at  1.0% level.

                    > > > FISHER STATISTICS < < <
N =    5 R =     4.9048
According to Watson's test:
Data non-random at  1.0% level.
Declination =    42.8 Inclination =    51.3 Paleolat =    32.0
Pole latitude =    38.5 Pole longitude =    47.4
dp =   11.0 dm =    16.2 Oval azimuth =    60.3
M.L.E. of kappa =    52.4966 kappa =    41.9972
Alpha 95 = 11.94 Circular standard deviation = 12.49

SPHERICAL MEDIAN:
Number of iterations taken =     4
Declination =    42.7 Inclination =    51.3 Paleolat =    31.9
Pole latitude =    38.6 Pole longitude =    47.4
Angular distance, Fisher mean to median =     .1 deg.

                    > > > "VECTOR" STATISTICS < < <
N =    5 R =  8.030E-05 Arithmetic sum of intensities =  8.160E-05
Declination =    40.0 Inclination =    52.2 Paleolat =    32.8
Pole latitude =    40.1 Pole longitude =    45.0
dp =   10.2 dm =    14.9 Oval azimuth =    57.2
M.L.E. of kappa =    62.7500 kappa =    50.1999
Alpha 95 = 10.90 Circular standard deviation = 11.42

MOMENT OF INERTIA:
N =    5  Eigenvalues =      .0605    .1274   4.8121
Uniform test statistic =      22.26 Normalized = 4.4529
Data non-random at  1.0% level.
Wo
```

KJgr 1	1.000A carson rng	.00	.00	17.0	.0	.0	28.2	272.0	42.0		.00			
cr0401a														
KJgr	1.000A	.00	185.4	-16.2	185.4	-16.2	-80.2	-147.1	1.01E-02	6.39	nrm	08/26/97	14:18:45	J/Jo
KJgr	1.000A	.00	188.9	-15.9	188.9	-15.9	-78.0	-132.6	8.94E-03	5.29	50oe	09/11/97	09:08:50	.88
KJgr	1.000A	.00	190.0	-15.3	190.0	-15.3	-77.4	-128.2	6.30E-03	6.29	100oe	09/11/97	09:13:16	.62
KJgr	1.000A	.00	190.4	-14.9	190.4	-14.9	-77.2	-126.5	4.46E-03	5.18	150oe	09/11/97	09:28:04	.44
KJgr	1.000A	.00	192.2	-15.1	192.2	-15.1	-75.6	-122.6	3.01E-03	6.21	200oe	09/11/97	09:47:56	.30
KJgr	1.000A	.00	194.3	-17.7	194.3	-17.7	-73.2	-122.9	2.93E-03	3.95	200oC	10/16/97	11:26:09	.29
KJgr	1.000A	.00	195.7	-18.2	195.7	-18.2	-71.8	-121.3	6.65E-04	5.19	400oe	10/16/97	11:37:19	.07
KJgr	1.000A	.00	195.1	-17.9	195.1	-17.9	-72.4	-121.8	2.10E-04	5.66	600oe	10/16/97	11:40:04	.02
KJgr	1.000A	.00	197.8	-19.7	197.8	-19.7	-69.6	-120.3	9.54E-05	4.34	800oe	10/16/97	11:42:56	.01
KJgr	1.000A	.00	195.1	-19.0	195.1	-19.0	-72.1	-123.5	4.97E-05	6.51	1000	10/16/97	11:46:06	.005
KJgr 1	2.000A carson rng	.00	.00	17.0	.0	.0	28.3	297.0	42.0		.00			
cr0402a														
KJgr	2.000A	.00	82.4	-41.1	82.4	-41.1	7.0	113.7	1.94E-03	10.7	nrm	08/26/97	14:20:40	J/Jo
KJgr	2.000A	.00	82.4	-44.5	82.4	-44.5	6.8	116.4	4.86E-04	8.87	100oe	09/11/97	09:15:40	.25
KJgr	2.000A	.00	78.7	-43.5	78.7	-43.5	10.2	115.8	2.27E-04	1.71	150oe	09/11/97	09:30:09	.12
KJgr	2.000A	.00	79.8	-42.0	79.8	-42.0	9.3	114.6	2.43E-04	3.27	200oC	10/16/97	11:28:33	.12
KJgr	2.000A	.00	74.1	-41.1	74.1	-41.1	14.5	114.4	8.49E-05	6.89	200oe	10/16/97	11:49:52	.04
KJgr	2.000A	.00	88.7	-44.7	88.7	-44.7	1.1	116.3	3.06E-05	2.68	400oe	10/16/97	11:59:07	.01
KJgr 1	3.000A carson rng	.00	.00	17.0	.0	.0	28.9	273.0	26.0		.00			
cr0403a														
KJgr	3.000A	.00	118.2	-49.5	118.2	-49.5	-24.0	123.6	1.21E-03	7.86	nrm	08/26/97	14:22:29	J/Jo
KJgr	3.000A	.00	128.9	-64.5	128.9	-64.5	-25.7	143.4	2.68E-04	3.34	100oe	09/11/97	09:17:33	.22
KJgr	3.000A	.00	118.9	-52.7	118.9	-52.7	-23.9	126.9	6.89E-05	5.41	150oe	09/11/97	09:33:32	.06
KJgr	3.000A	.00	117.5	-52.6	117.5	-52.6	-22.8	126.4	7.62E-05	4.13	200oC	10/16/97	11:30:12	.06
KJgr	3.000A	.00	115.0	-57.0	115.0	-57.0	-19.5	130.3	2.02E-05	4.63	200oe	10/16/97	11:52:01	.02
KJgr	3.000A	.00	76.5	-68.1	76.5	-68.1	8.4	142.0	4.90E-06	10.9	400oe	10/16/97	12:01:35	.004
KJgr 1	4.000A carson rng	.00	.00	17.0	.0	.0	28.7	35.0	55.0		.00			
cr0404a														
KJgr	4.000A	.00	167.5	-14.6	167.5	-14.6	-75.5	121.0	2.40E-04	9.92	nrm	08/26/97	14:24:39	J/Jo
KJgr	4.000A	.00	173.8	-16.2	173.8	-16.2	-79.7	143.5	2.74E-04	3.36	nrm	08/28/97	10:13:38	
KJgr	4.000A	.00	193.1	-5.3	193.1	-5.3	-76.6	-101.5	7.60E-05	2.56	100oe	09/11/97	09:21:42	.28
KJgr	4.000A	.00	195.6	-5.3	195.6	-5.3	-74.2	-99.7	3.67E-05	4.64	150oe	09/11/97	09:35:50	.13
KJgr	4.000A	.00	198.6	-7.8	198.6	-7.8	-71.0	-102.0	3.63E-05	3.50	200oC	10/16/97	11:31:44	.13
KJgr	4.000A	.00	209.1	1.6	209.1	1.6	-60.8	-88.4	1.33E-05	5.53	200oe	10/16/97	11:54:06	.05
KJgr	4.000A	.00	229.3	20.8	229.3	20.8	-39.9	-75.9	3.69E-06	31.1	400oe	10/16/97	12:03:31	.01
KJgr 1	5.000A carson rng	.00	.00	17.0	.0	.0	29.8	20.0	50.0		.00			
cr0405a														
KJgr	5.000A	.00	107.3	35.7	107.3	35.7	-16.2	69.4	1.42E-04	5.94	nrm	08/26/97	14:30:00	J/Jo
KJgr	5.000A	.00	109.7	58.7	109.7	58.7	-15.1	48.9	3.31E-05	5.90	100oe	09/11/97	09:24:41	.23
KJgr	5.000A	.00	119.4	61.1	119.4	61.1	-21.3	43.8	1.50E-05	4.31	150oe	09/11/97	09:38:47	.10
KJgr	5.000A	.00	135.6	60.5	135.6	60.5	-32.4	38.4	1.34E-05	10.5	200oC	10/16/97	11:33:42	.09
KJgr	5.000A	.00	147.6	65.4	147.6	65.4	-34.8	26.1	6.19E-06	25.2	200oe	10/16/97	11:56:47	.04

```
     Sample #      Data Type Dec/Az/Long Inc/Pl/Lat Intensity    Demag          Remark
KJgr         1.000A  Rem Drxn    185.4      -16.2      1.01E-02  nrm
KJgr         2.000A  Rem Drxn     82.4      -41.1      1.94E-03  nrm
KJgr         3.000A  Rem Drxn    118.2      -49.5      1.21E-03  nrm
KJgr         4.000A  Rem Drxn    167.5      -14.6      2.40E-04  nrm
KJgr         5.000A  Rem Drxn    107.3       35.7      1.42E-04  nrm
Thu, 16 Oct. 1997

NONPARAMETRIC TESTS FOR UNIFORMITY.  Total included angles =      10
Beran's test statistic =    2.0793
Data non-random at  5.0% level.
Gine's test statistic =     .3722
Data random to  5.0% level.
Combined test statistic =    2.4515
Data random to  5.0% level.

                    > > > FISHER STATISTICS < < <
N =     5 R =      3.5050
According to Watson's test:
Data non-random at  5.0% level.
Declination =  136.7 Inclination =  -22.9 Paleolat =  -11.9
Pole latitude =  -45.4 Pole longitude =  107.1
dp =   32.9 dm =   52.0 Oval azimuth =   77.6
M.L.E. of kappa =      3.3445 kappa =      2.6756
Alpha 95 = 58.36 Circular standard deviation = 53.85

SPHERICAL MEDIAN:
Number of iterations taken =      4
Declination =  136.7 Inclination =  -23.1 Paleolat =  -12.0
Pole latitude =  -45.4 Pole longitude =  107.3
Angular distance, Fisher mean to median =     .2 deg.

                    > > > "VECTOR" STATISTICS < < <
N =     5 R =  1.135E-02 Arithmetic sum of intensities =  1.363E-02
Declination =  172.2 Inclination =  -26.1 Paleolat =  -13.8
Pole latitude =  -74.2 Pole longitude =  150.9
dp =   22.9 dm =   42.3 Oval azimuth =   30.1
M.L.E. of kappa =      5.9650 kappa =      4.7720
Alpha 95 = 39.15 Circular standard deviation = 37.66

MOMENT OF INERTIA:
N =     5   Eigenvalues =      .9924    1.3540    2.6536
Uniform test statistic =      2.29 Normalized =  .4580
Data non-random at  1.0% level.
Woodcock's parameters: Shape =     2.1661 Strength =     .9836
LINEAR DATA:  Direction of MAXIMUM eigenvector.
Declination =  145.0 Inclination =  -31.9 Paleolat =  -17.3
Pole latitude =  -51.4 Pole longitude =  118.5

                    > > > BINGHAM STATISTICS < < <
M.L.E.'s of Bingham concentration parameters: K1 =      -2.5 K2 =      -1.6
Standard deviation angles:  Sigma 1-3 =  19.85 Sigma 1-2 =  28.17
Approximate 95% confidence angles:  Alpha 1-3 =  48.59 Alpha 1-2 =  68.96
Oval azimuth =    68.3

Test statistics for circular symmetry based on Bingham distribution:
Bipolar =       .17 Girdle =     1.03
2nd eigenvector, declination =    43.1 inclination =  -18.3
Approximate 95% confidence angles:  Alpha 2-1 = 172.34 Alpha 2-3 =  68.96
Oval azimuth (along 2-1) =   123.8
```

```
     Sample #      Data Type Dec/Az/Long Inc/Pl/Lat Intensity    Demag              Remark
KJgr        1.000A  Rem Drxn    192.2       -15.1     3.01E-03  200oe
KJgr        2.000A  Rem Drxn     74.1       -41.1     9.49E-05  200oe
KJgr        3.000A  Rem Drxn    115.0       -57.0     2.02E-05  200oe
KJgr        4.000A  Rem Drxn    209.1         1.6     1.33E-05  200oe
KJgr        5.000A  Rem Drxn    147.6        55.4     6.19E-06  200oe
Thu, 16 Oct. 1997

NONPARAMETRIC TESTS FOR UNIFORMITY.  Total included angles =      10
Beran's test statistic =    1.2173
Data random to  5.0% level.
Gine's test statistic =     .3804
Data random to  5.0% level.
Combined test statistic =    1.5977
Data random to  5.0% level.

                    > > > FISHER STATISTICS < < <
N =     5 R =     2.4580
According to Watson's test:
Data random to  5.0% level.
Declination =  161.1 Inclination =  -19.5 Paleolat =  -10.0
Pole latitude =  -68.7 Pole longitude =  118.6
dp =    53.9 dm =  103.2 Oval azimuth =   63.1
M.L.E. of kappa =     1.7209 kappa =     1.5736
Alpha 95 = 98.79 Circular standard deviation = 65.60

SPHERICAL MEDIAN:
Number of iterations taken =       4
Declination =  161.0 Inclination =  -19.5 Paleolat =  -10.1
Pole latitude =  -68.6 Pole longitude =  118.6
Angular distance, Fisher mean to median =      .1 deg.

                    > > > "VECTOR" STATISTICS < < <
N =     5 R =  3.016E-03 Arithmetic sum of intensities =  3.135E-03
Declination =  190.9 Inclination =  -16.4 Paleolat =   -8.4
Pole latitude =  -76.3 Pole longitude = -127.8
dp =     9.0 dm =   17.5 Oval azimuth =  127.0
M.L.E. of kappa =    26.4697 kappa =    21.1758
Alpha 95 = 17.01 Circular standard deviation = 17.63

MOMENT OF INERTIA:
N =     5   Eigenvalues =     .5708   1.8965   2.5327
Uniform test statistic =      3.01 Normalized =  .6012
Data non-random at  1.0% level.
Woodcock's parameters:  Shape =      .2409 Strength =    1.4901
LINEAR DATA:  Direction of MAXIMUM eigenvector.
Declination =  226.3 Inclination =   44.7 Paleolat =   26.3
Pole latitude =  -38.2 Pole longitude =  -55.6

                    > > > BINGHAM STATISTICS < < <
M.L.E.'s of Bingham concentration parameters: K1 =      -4.5 K2 =      -.6
Standard deviation angles:  Sigma 1-3 =  13.63 Sigma 1-2 =  63.69
Approximate 95% confidence angles:  Alpha 1-3 =  33.36 Alpha 1-2 = 155.88
Oval azimuth =   31.3

Test statistics for circular symmetry based on Bingham distribution:
Bipolar =      2.56 Girdle =      .20
2nd eigenvector, declination =     5.5 inclination =    37.4
Approximate 95% confidence angles:  Alpha 2-1 =  43.79 Alpha 2-3 = 155.88
Oval azimuth (along 2-1) =   152.3
```

Cr05.pmg

```
Tmvf  1   1.000A carson rng      .00      .00  17.0    .0    .0 29.3  78.0  38.0       .00
cr0501a
Tmvf      1.000A    .00 297.2 -27.4 297.2 -27.4  26.2 -106.2 1.17E-03 2.59 nrm   08/28/97 10:17:58 J/Jo
Tmvf      1.000A    .00 288.5 -37.2 288.5 -37.2  17.2 -111.8 6.84E-04 2.27 50oe  08/26/97 10:12:24 .54
Tmvf      1.000A    .00 256.8 -57.9 256.8 -57.9 -10.3 -129.3 3.87E-04 1.22 100oe 09/11/97 10:39:15 .33
Tmvf      1.000A    .00 238.3 -60.8 238.3 -60.8 -23.1 -136.4 3.30E-04 1.99 150oe 09/11/97 10:41:21 .28
Tmvf      1.000A    .00 227.6 -62.5 227.6 -62.5 -29.2 -142.4 2.70E-04 2.68 200oe 09/11/97 10:48:21 .23
Tmvf      1.000A    .00 221.6 -62.2 221.6 -62.2 -32.8 -145.1 2.07E-04 3.11 300oe 09/11/97 10:50:43 .18
Tmvf      1.000A    .00 217.6 -62.4 217.6 -62.4 -34.9 -147.5 1.62E-04 3.82 400oe 09/11/97 10:54:00 .14
Tmvf      1.000A    .00 215.1 -61.8 215.1 -61.8 -36.8 -148.4 1.12E-04 3.32 600oe 09/11/97 10:58:11 .10
Tmvf      1.000A    .00 213.6 -61.3 213.6 -61.3 -37.9 -148.6 8.56E-05 2.72 800oe 09/11/97 11:02:01 .07
Tmvf      1.000A    .00 210.5 -62.3 210.5 -62.3 -38.6 -151.9 6.87E-05 2.46 1000  09/11/97 12:15:53 .06
Tmvf      1.000A    .00 207.3 -61.9 207.3 -61.9 -40.4 -153.9 6.68E-05 3.61 200oC 10/03/97 12:24:47 .06
Tmvf  1   2.000A carson rng      .00      .00  17.0    .0    .0 29.3 117.0  25.0       .00
cr0502a
Tmvf      2.000A    .00 287.6 -23.0 287.6 -23.0  17.2 -102.5 2.16E-03 1.45 nrm   08/26/97 14:39:29 J/Jo
Tmvf      2.000A    .00 221.2 -58.1 221.2 -58.1 -35.9 -140.7 1.53E-04 2.30 200oe 09/11/97 11:05:33 .07
Tmvf      2.000A    .00 215.4 -58.9 215.4 -58.9 -38.9 -145.0 1.13E-04 2.70 300oe 09/11/97 11:10:42 .05
Tmvf      2.000A    .00 210.8 -58.9 210.8 -58.9 -41.4 -148.3 8.62E-05 4.60 400oe 09/11/97 11:13:00 .04
Tmvf      2.000A    .00 207.4 -57.9 207.4 -57.9 -43.9 -150.0 5.63E-05 3.50 600oe 09/11/97 11:36:37 .03
Tmvf      2.000A    .00 202.1 -58.2 202.1 -58.2 -46.1 -155.1 4.54E-05  .30 200oC 10/03/97 12:27:36 .02
Tmvf      2.000A    .00 192.6 -61.9 192.6 -61.9 -45.4 -166.9 2.28E-05 3.87 800oe 10/03/97 12:36:34 .01
Tmvf      2.000A    .00 188.8 -58.2 188.8 -58.2 -50.3 -169.3 1.87E-05 7.66 1000  10/03/97 12:40:10 .005
Tmvf  1   3.000A carson rng      .00      .00  17.0    .0    .0 29.0 137.0  30.0       .00
cr0503a
Tmvf      3.000A    .00 290.0 -27.1 290.0 -27.1  19.4 -105.2 3.90E-03 1.28 nrm   08/26/97 14:40:59 J/Jo
Tmvf      3.000A    .00 269.1 -44.6 269.1 -44.6   -.8 -116.2 3.07E-04 1.22 100oe 09/11/97 11:26:16 .08
Tmvf      3.000A    .00 245.9 -55.6 245.9 -55.6 -19.3 -128.7 1.42E-04 2.29 200oe 09/11/97 11:30:10 .04
Tmvf      3.000A    .00 224.9 -59.2 224.9 -59.2 -32.9 -139.9 7.39E-05 1.51 400oe 09/11/97 11:33:27 .02
Tmvf      3.000A    .00 218.1 -58.1 218.1 -58.1 -37.8 -142.5 4.83E-05 1.62 600oe 09/11/97 11:38:19 .01
Tmvf      3.000A    .00 223.8 -58.4 223.8 -58.4 -34.0 -139.6 5.57E-05 1.41 200oC 10/03/97 12:29:16 .01
Tmvf      3.000A    .00 211.4 -59.8 211.4 -59.8 -40.4 -148.8 2.33E-05 3.50 800oe 10/03/97 12:43:15 .005
Tmvf      3.000A    .00 214.2 -54.9 214.2 -54.9 -42.3 -141.7 1.84E-05  .91 1000  10/03/97 12:46:24 .001
Tmvf  1   4.000A carson rng      .00      .00  17.0    .0    .0 29.1 227.0  62.0       .00
cr0504a
Tmvf      4.000A    .00 249.6 -24.1 249.6 -24.1 -19.9 -103.4 2.06E-03 4.63 nrm   08/26/97 14:42:32 J/Jo
Tmvf      4.000A    .00 231.2 -40.6 231.2 -40.6 -35.2 -118.8 1.84E-04 4.98 100oe 09/11/97 11:42:44 .09
Tmvf      4.000A    .00 218.6 -48.6 218.6 -48.6 -42.9 -132.3 9.80E-05 3.57 200oe 09/11/97 11:46:04 .05
Tmvf      4.000A    .00 209.1 -55.0 209.1 -55.0 -45.3 -145.7 5.95E-05 3.17 400oe 09/11/97 11:49:22 .03
Tmvf      4.000A    .00 198.7 -56.4 198.7 -56.4 -49.2 -156.9 4.06E-05 4.70 600oe 09/11/97 11:51:58 .02
Tmvf      4.000A    .00 203.2 -57.7 203.2 -57.7 -46.1 -153.6 3.95E-05 4.95 200oC 10/03/97 12:31:13 .02
Tmvf      4.000A    .00 199.9 -58.3 199.9 -58.3 -46.9 -157.2 1.94E-05 5.44 800oe 10/03/97 12:49:24 .01
Tmvf      4.000A    .00 201.3 -51.1 201.3 -51.1 -52.4 -149.7 1.51E-05 4.13 1000  10/03/97 12:52:37 .005
Tmvf  1   5.000A carson rng      .00      .00  17.0    .0    .0 30.2 274.0  44.0       .00
cr0505a
Tmvf      5.000A    .00 228.8 -31.9 228.8 -31.9 -38.9 -112.5 6.46E-04 3.96 nrm   08/26/97 14:44:25 J/Jo
Tmvf      5.000A    .00 207.2 -53.1 207.2 -53.1 -47.8 -145.6 1.14E-04 3.63 100oe 09/11/97 11:57:04 .18
Tmvf      5.000A    .00 201.7 -55.3 201.7 -55.3 -48.9 -152.9 8.20E-05 2.43 200oe 09/11/97 12:00:12 .13
Tmvf      5.000A    .00 198.4 -58.7 198.4 -58.7 -47.2 -159.0 5.33E-05 2.61 400oe 09/11/97 12:03:13 .08
Tmvf      5.000A    .00 197.5 -61.1 197.5 -61.1 -44.9 -161.7 4.14E-05 3.13 600oe 09/11/97 12:06:07 .06
Tmvf      5.000A    .00 204.2 -57.6 204.2 -57.6 -45.7 -152.6 2.73E-05 4.17 800oe 09/11/97 12:09:02 .04
Tmvf      5.000A    .00 199.2 -52.1 199.2 -52.1 -52.6 -152.9 2.39E-05 8.41 1000  09/11/97 12:12:47 .04
Tmvf      5.000A    .00 209.1 -53.9 209.1 -53.9 -46.1 -144.6 2.37E-05 9.40 200oC 10/03/97 12:32:45 .04
```

```
    Sample #      Data Type Dec/Az/Long Inc/Pl/Lat Intensity    Demag          Remark
Mon,  6 Oct. 1997

NONPARAMETRIC TESTS FOR UNIFORMITY.  Total included angles =       0
Gine's test statistic =      .0000
Data random to  5.0% level.

MOMENT OF INERTIA:
N =    0  Eigenvalues =      .0000    .0000    .0000
LINEAR DATA:  Direction of MAXIMUM eigenvector.
Declination =  270.0 Inclination =      .0 Paleolat =      .0
Pole latitude =      .0 Pole longitude =  -90.0

    Sample #      Data Type Dec/Az/Long Inc/Pl/Lat Intensity    Demag          Remark
Tmvf        1.000A  Rem Drxn     297.2       -27.4     1.17E-03  nrm
Tmvf        2.000A  Rem Drxn     287.6       -23.0     2.16E-03  nrm
Tmvf        3.000A  Rem Drxn     290.0       -27.1     3.90E-03  nrm
Tmvf        4.000A  Rem Drxn     249.6       -24.1     2.06E-03  nrm
Tmvf        5.000A  Rem Drxn     228.8       -31.9     6.46E-04  nrm
Mon,  6 Oct. 1997

NONPARAMETRIC TESTS FOR UNIFORMITY.  Total included angles =      10
Beran's test statistic =     3.5853
Data non-random at  1.0% level.
Gine's test statistic =    1.2304
Data non-random at  1.0% level.
Combined test statistic =     4.8157
Data non-random at  1.0% level.

                      > > > FISHER STATISTICS < < <
N =    5 R =      4.5856
According to Watson's test:
Data non-random at  1.0% level.
Declination =  271.6 Inclination =  -29.3 Paleolat =  -15.7
Pole latitude =     1.5 Pole longitude = -105.7
dp =    15.8 dm =    28.6 Oval azimuth =    89.6
M.L.E. of kappa =     12.0667 kappa =      9.6534
Alpha 95 = 25.94 Circular standard deviation = 26.23

SPHERICAL MEDIAN:
Number of iterations taken =      4
Declination =  271.5 Inclination =  -29.3 Paleolat =  -15.7
Pole latitude =     1.4 Pole longitude = -105.7
Angular distance, Fisher mean to median =      .1 deg.

                      > > > "VECTOR" STATISTICS < < <
N =    5 R =  9.412E-03 Arithmetic sum of intensities =  9.936E-03
Declination =  278.6 Inclination =  -27.5 Paleolat =  -14.6
Pole latitude =     8.3 Pole longitude = -104.7
dp =   12.1 dm =    22.1 Oval azimuth =    87.8
M.L.E. of kappa =     18.9444 kappa =     15.1555
Alpha 95 = 20.30 Circular standard deviation = 20.87

MOMENT OF INERTIA:
N =    5  Eigenvalues =      .0241    .7504    4.2255
Uniform test statistic =      15.13 Normalized = 3.0256
Data non-random at  1.0% level.
Woodcock's parameters:  Shape =      .5025 Strength =     5.1674
LINEAR DATA:  Direction of MAXIMUM eigenvector.
Declination =  273.2 Inclination =  -28.9 Paleolat =  -15.4
Pole latitude =     3.1 Pole longitude = -105.5

                      > > > BINGHAM STATISTICS < < <
M.L.E.'s of Bingham concentration parameters: K1 =    -106.5 K2 =      -4.0
Standard deviation angles:  Sigma 1-3 =     1.92 Sigma 1-2 =  10.83
Approximate 95% confidence angles:  Alpha 1-3 =     4.69 Alpha 1-2 =   26.51
Oval azimuth =     81.7

Test statis
```

Sample #		Data Type	Dec/Az/Long	Inc/Pl/Lat	Intensity	Demag		Remark
Tmvf	1.000A	Lin Segm	218.2	-62.3	1.62E-04	400oe	ORIGN	
Tmvf	2.000A	Lin Segm	212.3	-58.3	8.62E-05	400oe	ORIGN	
Tmvf	3.000A	Lin Segm	225.7	-59.1	7.39E-05	400oe	ORIGN	
Tmvf	4.000A	Lin Segm	207.5	-55.9	5.95E-05	400oe	ORIGN	
Tmvf	5.000A	Lin Segm	197.1	-60.2	5.33E-05	400oe	ORIGN	

Fri, 3 Oct. 1997

```
NONPARAMETRIC TESTS FOR UNIFORMITY.  Total included angles =       10
Beran's test statistic =    4.6504
Data non-random at  1.0% level.
Gine's test statistic =    2.1520
Data non-random at  1.0% level.
Combined test statistic =    6.8024
Data non-random at  1.0% level.

                    > > > FISHER STATISTICS < < <
N =     5 R =      4.9784
According to Watson's test:
Data non-random at  1.0% level.
Declination =  212.1 Inclination =  -59.5 Paleolat =  -40.3
Pole latitude =  -40.2 Pole longitude = -148.0
dp =    6.4 dm =     8.5 Oval azimuth =  135.9
M.L.E. of kappa =   231.0338 kappa =   184.8281
Alpha 95 =  5.64 Circular standard deviation =  5.95

SPHERICAL MEDIAN:
Number of iterations taken =     5
Declination =  212.0 Inclination =  -59.6 Paleolat =  -40.4
Pole latitude =  -40.2 Pole longitude = -148.1
Angular distance, Fisher mean to median =     .1 deg.

                    > > > "VECTOR" STATISTICS < < <
N =     5 R =  4.334E-04 Arithmetic sum of intensities =  4.349E-04
Declination =  214.1 Inclination =  -60.1 Paleolat =  -41.0
Pole latitude =  -38.7 Pole longitude = -147.2
dp =    5.8 dm =     7.7 Oval azimuth =  134.1
M.L.E. of kappa =   287.2811 kappa =   229.8249
Alpha 95 =  5.06 Circular standard deviation =  5.33

MOMENT OF INERTIA:
N =     5   Eigenvalues =      .0073    .0358   4.9569
Uniform test statistic =      24.36 Normalized = 4.8715
Data non-random at  1.0% level.
Woodcock's parameters:  Shape =    3.1106 Strength =    6.5156
LINEAR DATA:  Direction of MAXIMUM eigenvector.
Declination =  212.1 Inclination =  -59.5 Paleolat =  -40.3
Pole latitude =  -40.2 Pole longitude = -148.0

                    > > > BINGHAM STATISTICS < < <
M.L.E.'s of Bingham concentration parameters: K1 =    -341.9 K2 =    -70.7
Standard deviation angles:  Sigma 1-3 =     .98 Sigma 1-2 =   2.17
Approximate 95% confidence angles:  Alpha 1-3 =   2.41 Alpha 1-2 =    5.32
Oval azimuth =    95.0

Test statistics for circular symmetry based on Bingham distribution:
Bipolar =     3.86 Girdle =  173.88
Test indicates symmetric bipolar distribution.  Mean Bingham alpha =   3.86

                    > > > DIMROTH-WATSON STATISTICS < < <
Dimroth-Watson concentration parameter =  -115.90
Circular standard deviation =  5.33 deg. (Parametric estimate.)
```

KJgr	1	1.000A	carson	rng	.00	.00	17.0	.0	.0 29.6	74.0	51.0	.00	cr0701a		
KJgr		1.000A	.00	286.9	50.5	286.9	50.5	14.4	-57.6	2.43E-04	3.88	nrm	08/26/97	14:52:31	J/Jo
KJgr		1.000A	.00	280.8	65.4	280.8	65.4	7.3	-42.0	1.83E-04	1.68	50oe	09/22/97	15:38:32	.75
KJgr		1.000A	.00	277.0	64.8	277.0	64.8	4.8	-43.1	1.56E-04	1.49	100oe	09/22/97	15:42:15	.64
KJgr		1.000A	.00	276.2	65.4	276.2	65.4	4.2	-42.3	1.11E-04	2.70	200oe	09/22/97	15:45:35	.46
KJgr		1.000A	.00	272.4	66.9	272.4	66.9	1.6	-40.4	5.84E-05	2.67	400oe	09/22/97	15:48:36	.24
KJgr		1.000A	.00	281.8	69.2	281.8	69.2	7.1	-36.6	2.71E-05	3.65	600oe	09/22/97	15:51:36	.11
KJgr		1.000A	.00	275.9	72.7	275.9	72.7	3.1	-31.7	1.42E-05	6.15	800oe	09/22/97	15:56:18	.06
KJgr		1.000A	.00	269.7	63.7	269.7	63.7	-.2	-44.7	6.66E-06	14.7	1000	09/22/97	16:00:13	.03
KJgr		1.000A	.00	281.9	57.7	281.9	57.7	9.3	-51.1	7.68E-06	11.6	200oC	10/01/97	15:50:59	.03
KJgr	1	2.000A	carson	rng	.00	.00	17.0	.0	.0 29.6	327.0	37.0	.00	cr0702a		
KJgr		2.000A	.00	305.9	33.5	305.9	33.5	33.8	-67.8	3.01E-04	1.93	nrm	08/26/97	14:53:51	J/Jo
KJgr		2.000A	.00	306.3	50.0	306.3	50.0	30.6	-53.5	1.55E-04	1.59	100oe	09/24/97	08:41:43	.51
KJgr		2.000A	.00	303.1	50.7	303.1	50.7	27.8	-53.9	1.10E-04	1.53	200oe	09/24/97	08:45:56	.36
KJgr		2.000A	.00	302.3	52.0	302.3	52.0	26.8	-52.9	5.87E-05	2.84	400oe	09/24/97	08:49:36	.19
KJgr		2.000A	.00	304.4	50.8	304.4	50.8	28.8	-53.4	3.01E-05	2.16	600oe	09/24/97	08:53:00	.10
KJgr		2.000A	.00	304.0	50.8	304.0	50.8	28.5	-53.5	1.58E-05	6.22	800oe	09/24/97	08:56:29	.05
KJgr		2.000A	.00	308.8	47.7	308.8	47.7	33.3	-54.8	1.62E-05	4.43	200oC	10/01/97	15:52:46	.05
KJgr		2.000A	.00	275.7	61.6	275.7	61.6	4.2	-47.1	7.74E-06	7.72	1000	10/15/97	15:03:06	.03
KJgr	1	3.000A	carson	rng	.00	.00	17.0	.0	.0 29.5	157.0	77.0	.00	cr0703a		
KJgr		3.000A	.00	266.4	3.3	266.4	3.3	-3.6	-88.4	1.72E-03	4.24	nrm	08/26/97	14:55:37	J/Jo
KJgr		3.000A	.00	287.3	41.0	287.3	41.0	15.8	-65.5	1.37E-04	2.44	200oe	09/24/97	09:00:37	.45
KJgr		3.000A	.00	288.2	43.7	288.2	43.7	16.3	-63.3	9.11E-05	2.37	300oe	09/24/97	09:04:50	.30
KJgr		3.000A	.00	291.3	47.2	291.3	47.2	18.6	-59.9	6.45E-05	2.67	400oe	09/24/97	09:07:59	.21
KJgr		3.000A	.00	292.4	47.0	292.4	47.0	19.6	-59.9	3.07E-05	3.72	600oe	09/24/97	09:11:19	.10
KJgr		3.000A	.00	294.8	46.3	294.8	46.3	21.8	-60.1	3.11E-05	2.70	200oC	10/01/97	15:54:08	.10
KJgr		3.000A	.00	299.2	50.1	299.2	50.1	24.8	-55.6	1.58E-05	3.99	800oe	10/15/97	14:52:42	.05
KJgr		3.000A	.00	285.3	57.0	285.3	57.0	12.1	-51.4	9.54E-06	4.63	1000	10/15/97	14:56:34	.03
KJgr	1	4.000A	carson	rng	.00	.00	17.0	.0	.0 29.4	73.0	46.0	.00	cr0704a		
KJgr		4.000A	.00	209.3	35.4	209.3	35.4	-55.2	-54.1	8.75E-03	9.34	nrm	08/26/97	14:57:29	J/Jo
KJgr		4.000A	.00	209.6	34.8	209.6	34.8	-55.3	-54.8	2.25E-03	9.16	100oe	09/24/97	09:22:34	.26
KJgr		4.000A	.00	211.7	45.1	211.7	45.1	-49.5	-46.3	4.82E-04	6.85	200oe	09/24/97	09:26:25	.05
KJgr		4.000A	.00	217.6	51.5	217.6	51.5	-42.1	-44.2	2.25E-04	5.33	300oe	09/24/97	09:29:48	.03
KJgr		4.000A	.00	219.7	50.6	219.7	50.6	-41.1	-46.4	2.13E-04	7.82	200oC	10/01/97	15:57:20	.02
KJgr		4.000A	.00	232.1	62.9	232.1	62.9	-26.1	-38.9	8.04E-05	3.44	400oe	10/15/97	14:39:18	.01
KJgr		4.000A	.00	238.0	64.8	238.0	64.8	-21.3	-38.5	3.97E-05	3.76	600oe	10/15/97	14:42:11	.004
KJgr		4.000A	.00	225.7	66.6	225.7	66.6	-27.2	-31.8	1.89E-05	6.94	800oe	10/15/97	14:44:59	.002
KJgr		4.000A	.00	199.1	69.5	199.1	69.5	-34.4	-13.7	1.06E-05	8.37	1000	10/15/97	14:48:32	.001
KJgr	1	5.000A	carson	rng	.00	.00	17.0	.0	.0 29.8	206.0	60.0	.00	cr0705a		
KJgr		5.000A	.00	221.9	3.6	221.9	3.6	-48.1	-87.3	5.95E-03	4.60	nrm	08/26/97	14:59:08	J/Jo
KJgr		5.000A	.00	229.2	-9.2	229.2	-9.2	-40.7	-96.1	2.31E-03	3.72	100oe	09/24/97	09:33:54	.39
KJgr		5.000A	.00	234.4	-2.5	234.4	-2.5	-35.6	-91.6	5.82E-04	3.39	200oe	09/24/97	09:37:48	.10
KJgr		5.000A	.00	235.3	7.5	235.3	7.5	-34.6	-85.4	2.28E-04	4.18	300oe	09/24/97	09:41:38	.04
KJgr		5.000A	.00	241.1	14.6	241.1	14.6	-28.6	-81.5	1.41E-04	6.82	400oe	09/24/97	09:46:58	.02
KJgr		5.000A	.00	240.7	11.2	240.7	11.2	-29.2	-83.5	1.34E-04	5.08	200oC	10/01/97	15:59:11	.02
KJgr		5.000A	.00	243.5	29.6	243.5	29.6	-25.4	-72.4	3.36E-05	3.54	600oe	10/15/97	14:28:01	.006
KJgr		5.000A	.00	240.9	34.1	240.9	34.1	-27.5	-68.8	1.73E-05	1.68	800oe	10/15/97	14:31:21	.003
KJgr		5.000A	.00	234.6	25.4	234.6	25.4	-34.3	-73.8	9.46E-06	6.88	1000	10/15/97	14:34:57	.002

```
    Sample #      Data Type Dec/Az/Long Inc/Pl/Lat Intensity    Demag          Remark
KJgr        1.000A  Rem Drxn     286.9        50.5    2.43E-04  nrm
KJgr        2.000A  Rem Drxn     305.9        33.5    3.01E-04  nrm
KJgr        3.000A  Rem Drxn     266.4         3.3    1.72E-03  nrm
KJgr        4.000A  Rem Drxn     209.3        35.4    8.75E-03  nrm
KJgr        5.000A  Rem Drxn     221.9         3.6    5.95E-03  nrm
Thu, 16 Oct. 1997

NONPARAMETRIC TESTS FOR UNIFORMITY.  Total included angles =       10
Beran's test statistic =     2.5717
Data non-random at  5.0% level.
Gine's test statistic =      .5240
Data random to  5.0% level.
Combined test statistic =    3.0957
Data non-random at  5.0% level.

                      > > > FISHER STATISTICS < < <
N =     5 R =      3.9998
According to Watson's test:
Data non-random at  5.0% level.
Declination =  255.9 Inclination =   30.4 Paleolat =   16.3
Pole latitude =  -13.6 Pole longitude =  -73.2
dp =   27.1 dm =   48.8 Oval azimuth =   85.9
M.L.E. of kappa =     4.9988 kappa =     3.9990
Alpha 95 = 43.84 Circular standard deviation = 41.28

SPHERICAL MEDIAN:
Number of iterations taken =      4
Declination =  255.8 Inclination =   30.3 Paleolat =   16.3
Pole latitude =  -13.6 Pole longitude =  -73.2
Angular distance, Fisher mean to median =     .1 deg.

                      > > > "VECTOR" STATISTICS < < <
N =     5 R =  1.539E-02 Arithmetic sum of intensities =  1.696E-02
Declination =  222.1 Inclination =   22.5 Paleolat =   11.7
Pole latitude =  -46.6 Pole longitude =  -72.8
dp =   15.5 dm =   29.3 Oval azimuth =   77.3
M.L.E. of kappa =    10.7712 kappa =     8.6170
Alpha 95 = 27.64 Circular standard deviation = 27.80

MOMENT OF INERTIA:
N =     5   Eigenvalues =      .4852   1.2980   3.2168
Uniform test statistic =       5.90 Normalized = 1.1804
Data non-random at  1.0% level.
Woodcock's parameters:  Shape =      .9223 Strength =    1.8915
LINEAR DATA:  Direction of MAXIMUM eigenvector.
Declination =  257.2 Inclination =   30.3 Paleolat =   16.3
Pole latitude =  -12.3 Pole longitude =  -73.3

                      > > > BINGHAM STATISTICS < < <
M.L.E.'s of Bingham concentration parameters: K1 =      -5.7 K2 =      -2.0
Standard deviation angles:  Sigma 1-3 =  10.24 Sigma 1-2 =  20.45
Approximate 95% confidence angles:  Alpha 1-3 =  25.05 Alpha 1-2 =  50.04
Oval azimuth =   71.4

Test statistics for circular symmetry based on Bingham distribution:
Bipolar =      1.50 Girdle =     1.96
2nd eigenvector, declination =  356.8 inclination =   16.0
Approximate 95% confidence angles:  Alpha 2-1 =  57.27 Alpha 2-3 =  50.04
Oval azimuth (along 2-1) =  121.7
```

Sample #		Data Type	Dec/Az/Long	Inc/Pl/Lat	Intensity	Demag	Remark
KJgr	1.000A	Rem Drxn	275.9	72.7	1.42E-05	600oe	
KJgr	2.000A	Rem Drxn	304.0	50.8	1.58E-05	600oe	
KJgr	3.000A	Rem Drxn	299.2	50.1	1.58E-05	600oe	
KJgr	4.000A	Rem Drxn	225.7	66.6	1.89E-05	600oe	
KJgr	5.000A	Rem Drxn	240.9	34.1	1.73E-05	600oe	

Thu, 16 Oct. 1997

NONPARAMETRIC TESTS FOR UNIFORMITY. Total included angles = 10
Beran's test statistic = 3.5813
Data non-random at 1.0% level.
Gine's test statistic = 1.1861
Data non-random at 1.0% level.
Combined test statistic = 4.7674
Data non-random at 1.0% level.

> > > FISHER STATISTICS < < <

N = 5 R = 4.6371
According to Watson's test:
Data non-random at 1.0% level.
Declination = 270.4 Inclination = 59.0 Paleolat = 39.8
Pole latitude = .3 Pole longitude = -50.2
dp = 26.9 dm = 35.0 Oval azimuth = 90.3
M.L.E. of kappa = 13.7795 kappa = 11.0236
Alpha 95 = 24.11 Circular standard deviation = 24.52

SPHERICAL MEDIAN:
Number of iterations taken = 4
Declination = 270.3 Inclination = 59.0 Paleolat = 39.7
Pole latitude = .2 Pole longitude = -50.3
Angular distance, Fisher mean to median = .1 deg.

> > > "VECTOR" STATISTICS < < <

N = 5 R = 7.590E-05 Arithmetic sum of intensities = 8.200E-05
Declination = 268.2 Inclination = 58.9 Paleolat = 39.6
Pole latitude = -1.4 Pole longitude = -50.4
dp = 27.1 dm = 36.4 Oval azimuth = 88.8
M.L.E. of kappa = 13.4335 kappa = 10.7468
Alpha 95 = 24.45 Circular standard deviation = 24.84

MOMENT OF INERTIA:
N = 5 Eigenvalues = .2240 .4666 4.3094
Uniform test statistic = 15.76 Normalized = 3.1517
Data non-random at 1.0% level.
Woodcock's parameters: Shape = 3.0295 Strength = 2.9569
LINEAR DATA: Direction of MAXIMUM eigenvector.
Declination = 271.6 Inclination = 59.5 Paleolat = 40.3
Pole latitude = 1.2 Pole longitude = -49.7

> > > BINGHAM STATISTICS < < <

M.L.E.'s of Bingham concentration parameters: K1 = -11.9 K2 = -6.1
Standard deviation angles: Sigma 1-3 = 5.81 Sigma 1-2 = 8.34
Approximate 95% confidence angles: Alpha 1-3 = 14.23 Alpha 1-2 = 20.42
Oval azimuth = 93.6

Test statistics for circular symmetry based on Bingham distribution:
Bipolar = .70 Girdle = 11.80
Test indicates symmetric bipolar distribution. Mean Bingham alpha = 17.32

> > > DIMROTH-WATSON STATISTICS < < <

Dimroth-Watson concentration parameter = -7.99
Circular standard deviation = 21.61 deg. (Parametric estimate.)

Cr11.pmg

Tmv	1	1.000A	carson	rng	.00	.00	17.0	.0	.0	24.0	97.0	59.0	.00	cr1101a
Tmv		1.000A	.00	2.6	58.5	2.6	58.5	50.8	3.2	7.51E-07	5.33	nrm	08/26/97	15:04:49
Tmv	1	2.000A	carson	rng	.00	.00	17.0	.0	.0	23.4	145.0	30.0	.00	cr1102a
Tmv		2.000A	.00	13.1	60.0	13.1	60.0	47.4	14.7	2.16E-07	13.1	nrm	08/26/97	15:06:35
Tmv		2.000A	.00	6.7	59.1	6.7	59.1	49.6	7.9	2.27E-07	18.9	nrm	08/26/97	15:16:28
Tmv	1	3.000A	carson	rng	.00	.00	17.0	.0	.0	24.6	189.0	23.0	.00	cr1103a
Tmv		3.000A	.00	2.0	57.5	2.0	57.5	51.8	2.6	1.84E-06	15.9	nrm	08/26/97	15:08:09
Tmv		3.000A	.00	2.0	58.8	2.0	58.8	50.4	2.4	1.82E-06	10.7	nrm	08/26/97	15:14:03
Tmv	1	4.000A	carson	rng	.00	.00	17.0	.0	.0	22.5	157.0	60.0	.00	cr1104a
Tmv		4.000A	.00	5.5	59.8	5.5	59.8	49.0	6.3	2.37E-06	.95	nrm	08/26/97	15:09:52
Tmv	1	5.000A	carson	rng	.00	.00	17.0	.0	.0	26.4	67.0	28.0	.00	cr1105a
Tmv		5.000A	.00	5.1	59.2	5.1	59.2	49.8	6.0	2.60E-06	5.58	nrm	08/26/97	15:11:22

```
     Sample #      Data Type Dec/Az/Long Inc/Pl/Lat Intensity    Demag         Remark
Tmv        1.000A  Rem Drxn      2.6        58.5     7.51E-07  nrm
Tmv        2.000A  Rem Drxn     13.1        60.0     2.16E-07  nrm
Tmv        2.000A  Rem Drxn      6.7        59.1     2.27E-07  nrm
Tmv        3.000A  Rem Drxn      2.0        57.5     1.84E-06  nrm
Tmv        3.000A  Rem Drxn      2.0        58.8     1.82E-06  nrm
Tmv        4.000A  Rem Drxn      5.5        59.8     2.37E-06  nrm
Tmv        5.000A  Rem Drxn      5.1        59.2     2.60E-06  nrm
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NONPARAMETRIC TESTS FOR UNIFORMITY.  Total included angles =      21
Beran's test statistic =     6.8283
Data non-random at  1.0% level.
Gine's test statistic =     3.3284
Data non-random at  1.0% level.
Combined test statistic =    10.1567
Data non-random at  1.0% level.

                     > > > FISHER STATISTICS < < <
N =     7 R =      6.9957
According to Watson's test:
Data non-random at  1.0% level.
Declination =     5.2 Inclination =    59.0 Paleolat =   39.8
Pole latitude =    49.9 Pole longitude =     6.2
dp =     1.8 dm =     2.4 Oval azimuth =    8.1
M.L.E. of kappa =  1625.6990 kappa =  1393.4560
Alpha 95 =  1.62 Circular standard deviation =  2.16

SPHERICAL MEDIAN:
Number of iterations taken =     29
Declination =     5.1 Inclination =    59.2 Paleolat =   40.0
Pole latitude =    49.8 Pole longitude =     6.0
Angular distance, Fisher mean to median =      .2 deg.

                     > > > "VECTOR" STATISTICS < < <
N =     7 R =  9.821E-06 Arithmetic sum of intensities =  9.824E-06
Declination =     4.0 Inclination =    58.9 Paleolat =   39.7
Pole latitude =    50.1 Pole longitude =     4.8
dp =     1.2 dm =     1.6 Oval azimuth =     6.3
M.L.E. of kappa =  3621.2420 kappa =  3103.8260
Alpha 95 =  1.08 Circular standard deviation =  1.45

MOMENT OF INERTIA:
N =     7   Eigenvalues =       .0004     .0082    6.9914
Uniform test statistic =      34.87 Normalized = 4.9816
Data non-random at  1.0% level.
Woodcock's parameters:  Shape =     2.2676 Strength =     9.7266
LINEAR DATA:  Direction of MAXIMUM eigenvector.
Declination =     5.2 Inclination =    59.0 Paleolat =   39.8
Pole latitude =    49.9 Pole longitude =     6.2

                     > > > BINGHAM STATISTICS < < <
M.L.E.'s of Bingham concentration parameters: K1 =  -8393.7 K2 =   -432.1
Standard deviation angles:  Sigma 1-3 =     .17 Sigma 1-2 =     .74
Approximate 95% confidence angles:  Alpha 1-3 =     .41 Alpha 1-2 =    1.81
Oval azimuth =    69.2

Test statistics for circular symmetry based on Bingham distribution:
Bipolar =    30.93 Girdle = 1508.67
2nd eigenvector, declination =  113.2 inclination =   10.5
Approximate 95% confidence angles:  Alpha 2-1 =  12.61 Alpha 2-3 =    1.81
Oval azimuth (along 2-1) =  150.7
```

Crl4.pmg

KJgr	1	1.000A	carson	range	.00	.00	16.5	.0	.0	26.0	276.5	32.0	.00	cr1401a		
KJgr		1.000A	.00	95.6	16.5	95.6	16.5	-5.5	81.5	1.67E-04	1.60	nrm	08/14/97	11:54:12	J/Jo	
KJgr		1.000A	.00	90.8	39.3	90.8	39.3	-.8	67.8	2.53E-05	2.70	100oe	09/24/97	09:57:42	.15	
KJgr		1.000A	.00	87.7	37.2	87.7	37.2	2.2	69.2	1.38E-05	16.1	200oe	09/24/97	10:02:15	.08	
KJgr		1.000A	.00	57.4	59.9	57.4	59.9	24.1	44.3	9.36E-06	7.98	300oe	09/24/97	10:06:20	.06	
KJgr		1.000A	.00	45.8	61.2	45.8	61.2	31.0	38.3	4.10E-06	8.79	400oe	09/24/97	10:09:59	.02	
KJgr	1	2.000A	carson	range	.00	.00	16.5	.0	.0	27.6	298.5	29.0	.00	cr1402a		
KJgr		2.000A	.00	77.2	36.3	77.2	36.3	12.0	69.4	1.53E-04	3.51	nrm	08/28/97	10:08:33	J/Jo	
KJgr		2.000A	.00	54.4	44.7	54.4	44.7	31.4	58.7	3.75E-05	6.79	100oe	09/24/97	10:14:12	.25	
KJgr		2.000A	.00	58.4	42.6	58.4	42.6	28.5	61.6	3.66E-05	5.01	200oe	09/24/97	10:17:38	.10	
KJgr		2.000A	.00	49.5	41.8	49.5	41.8	36.3	59.5	1.57E-05	4.77	200oe	09/24/97	10:21:25	.08	
KJgr		2.000A	.00	49.2	51.7	49.2	51.7	33.5	50.1	1.13E-05	7.12	300oe	09/24/97	10:25:00	.07	
KJgr		2.000A	.00	34.7	49.9	34.7	49.9	45.0	43.8	8.03E-06	13.0	400oe	09/24/97	10:28:13	.05	
KJgr	1	3.000A	carson	range	.00	.00	16.5	.0	.0	28.4	336.5	40.0	.00	cr1403a		
KJgr		3.000A	.00	13.5	49.4	13.5	49.4	57.1	21.7	1.39E-04	1.93	nrm	08/14/97	11:59:06	J/Jo	
KJgr		3.000A	.00	26.0	50.5	26.0	50.5	50.2	35.8	2.76E-05	5.67	100oe	09/24/97	10:34:42	.20	
KJgr		3.000A	.00	40.7	55.1	40.7	55.1	38.1	42.3	1.43E-05	9.71	200oe	09/24/97	10:38:11	.10	
KJgr		3.000A	.00	40.6	48.3	40.6	48.3	41.4	49.2	8.49E-06	9.56	300oe	09/24/97	10:41:10	.06	
KJgr		3.000A	.00	37.8	62.2	37.8	62.2	35.0	32.9	8.16E-06	15.4	400oe	09/24/97	10:43:55	.06	
KJgr	1	4.000A	carson	range	.00	.00	16.5	.0	.0	28.4	282.5	31.0	.00	cr1404a		
KJgr		4.000A	.00	12.1	52.1	12.1	52.1	55.3	18.1	1.17E-04	2.34	nrm	08/14/97	12:01:59	J/Jo	
KJgr		4.000A	.00	22.5	52.3	22.5	52.3	50.8	30.7	2.31E-05	3.53	100oe	09/29/97	15:12:36	.20	
KJgr		4.000A	.00	22.1	47.9	22.1	47.9	54.2	34.2	1.26E-05	2.10	200oe	09/29/97	15:16:08	.11	
KJgr		4.000A	.00	24.0	39.3	24.0	39.3	57.7	44.8	9.08E-06	4.81	300oe	09/29/97	15:18:55	.08	
KJgr		4.000A	.00	39.4	27.3	39.4	27.3	48.4	67.9	6.81E-06	10.1	400oe	09/29/97	15:21:49	.06	
KJgr	1	5.000A	carson	range	.00	.00	16.5	.0	.0	27.4	50.5	32.0	.00	cr1405a		
KJgr		5.000A	.00	35.3	47.5	35.3	47.5	45.8	46.7	1.27E-04	1.56	nrm	08/14/97	12:03:43	J/Jo	
KJgr		5.000A	.00	23.3	57.5	23.3	57.5	46.2	26.8	3.08E-05	3.41	100oe	09/29/97	15:26:48	.24	
KJgr		5.000A	.00	38.5	49.2	38.5	49.2	42.6	47.0	1.13E-05	9.32	200oe	09/29/97	15:29:48	.09	
KJgr		5.000A	.00	95.2	63.4	95.2	63.4	-3.6	44.9	5.98E-06	8.91	300oe	09/29/97	15:33:42	.05	
KJgr		5.000A	.00	85.7	79.5	85.7	79.5	1.5	20.3	9.37E-06	10.9	400oe	09/29/97	15:36:25	.07	

Sample #		Data Type	Dec/Az/Long	Inc/Pl/Lat	Intensity	Demag	Remark
KJgr	1.000A	Rem Drxn	95.6	16.5	1.67E-04	nrm	
KJgr	2.000A	Rem Drxn	77.2	36.3	1.53E-04	nrm	
KJgr	3.000A	Rem Drxn	13.5	49.4	1.39E-04	nrm	
KJgr	4.000A	Rem Drxn	12.1	52.1	1.17E-04	nrm	
KJgr	5.000A	Rem Drxn	35.3	47.5	1.27E-04	nrm	

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```
NONPARAMETRIC TESTS FOR UNIFORMITY.  Total included angles =      10
Beran's test statistic =    3.2696
Data non-random at  1.0% level.
Gine's test statistic =    1.0310
Data non-random at  5.0% level.
Combined test statistic =    4.3006
Data non-random at  1.0% level.

                    > > > FISHER STATISTICS < < <
N =    5 R =     4.3939
According to Watson's test:
Data non-random at  1.0% level.
Declination =   52.2 Inclination =   46.0 Paleolat =   27.4
Pole latitude =   33.0 Pole longitude =   56.8
dp =   26.3 dm =   41.2 Oval azimuth =   70.4
M.L.E. of kappa =     8.2493 kappa =     6.5994
Alpha 95 = 32.20 Circular standard deviation = 31.86

SPHERICAL MEDIAN:
Number of iterations taken =    14
Declination =   38.4 Inclination =   45.4 Paleolat =   26.9
Pole latitude =   44.3 Pole longitude =   50.8
Angular distance, Fisher mean to median =    9.6 deg.

                    > > > "VECTOR" STATISTICS < < <
N =    5 R =  6.128E-04 Arithmetic sum of intensities =  7.030E-04
Declination =   56.7 Inclination =   44.5 Paleolat =   26.2
Pole latitude =   29.5 Pole longitude =   59.6
dp =   26.4 dm =   41.9 Oval azimuth =   73.8
M.L.E. of kappa =     7.7950 kappa =     6.2360
Alpha 95 = 33.29 Circular standard deviation = 32.80

MOMENT OF INERTIA:
N =    5   Eigenvalues =     .0038   1.0764   3.9197
Uniform test statistic =     12.28 Normalized = 2.4569
Data non-random at  1.0% level.
Woodcock's parameters:  Shape =     .2294 Strength =    6.9266
LINEAR DATA:  Direction of MAXIMUM eigenvector.
Declination =   48.0 Inclination =   47.2 Paleolat =   28.4
Pole latitude =   36.1 Pole longitude =   54.0

                    > > > BINGHAM STATISTICS < < <
M.L.E.'s of Bingham concentration parameters: K1 =   -666.4 K2 =     -2.8
Standard deviation angles:  Sigma 1-3 =    .79 Sigma 1-2 =  14.38
Approximate 95% confidence angles:  Alpha 1-3 =   1.94 Alpha 1-2 =  35.20
Oval azimuth =  110.6

Test statistics for circular symmetry based on Bingham distribution:
Bipolar =   355.89 Girdle =    3.97
Test indicates symmetric girdle.  Mean Bingham alpha =  18.57

                    > > > DIMROTH-WATSON STATISTICS < < <
Dimroth-Watson concentration parameter =   649.94
Circular standard deviation =    .77 deg. (Parametric estimate.)
PARAMETRIC 95% confidence cone =   5.69 degrees.
Maximum =   8.69 minimum =   4.54
```

	Sample #	Data Type	Dec/Az/Long	Inc/Pl/Lat	Intensity	Demag	Remark
KJgr	1.000A	Lin Segm	57.8	59.8	9.36E-06	300oe ORIGN	
KJgr	2.000A	Lin Segm	57.4	43.0	3.75E-05	100oe ORIGN	
KJgr	3.000A	Lin Segm	40.7	54.6	1.43E-05	200oe ORIGN	
KJgr	4.000A	Lin Segm	22.3	53.0	2.31E-05	100oe ORIGN	
KJgr	5.000A	Lin Segm	22.0	58.0	3.08E-05	100oe ORIGN	

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NONPARAMETRIC TESTS FOR UNIFORMITY. Total included angles = 10
Beran's test statistic = 4.2855
Data non-random at 1.0% level.
Gine's test statistic = 1.7995
Data non-random at 1.0% level.
Combined test statistic = 6.0850
Data non-random at 1.0% level.

> > > FISHER STATISTICS < < <

N = 5 R = 4.9085
According to Watson's test:
Data non-random at 1.0% level.
Declination = 40.7 Inclination = 54.7 Paleolat = 35.3
Pole latitude = 38.3 Pole longitude = 42.7
dp = 11.7 dm = 16.5 Oval azimuth = 56.1
M.L.E. of kappa = 54.6728 kappa = 43.7383
Alpha 95 = 11.70 Circular standard deviation = 12.24

SPHERICAL MEDIAN:
Number of iterations taken = 4
Declination = 40.6 Inclination = 54.7 Paleolat = 35.2
Pole latitude = 38.4 Pole longitude = 42.7
Angular distance, Fisher mean to median = .1 deg.

> > > "VECTOR" STATISTICS < < <

N = 5 R = 1.125E-04 Arithmetic sum of intensities = 1.151E-04
Declination = 40.4 Inclination = 53.0 Paleolat = 33.6
Pole latitude = 39.4 Pole longitude = 44.3
dp = 12.3 dm = 17.8 Oval azimuth = 57.0
M.L.E. of kappa = 45.5605 kappa = 36.4484
Alpha 95 = 12.84 Circular standard deviation = 13.41

MOMENT OF INERTIA:
N = 5 Eigenvalues = .0370 .1435 4.8195
Uniform test statistic = 22.37 Normalized = 4.4750
Data non-random at 1.0% level.
Woodcock's parameters: Shape = 2.5918 Strength = 4.8700
LINEAR DATA: Direction of MAXIMUM eigenvector.
Declination = 40.6 Inclination = 54.8 Paleolat = 35.3
Pole latitude = 38.3 Pole longitude = 42.6

> > > BINGHAM STATISTICS < < <

M.L.E.'s of Bingham concentration parameters: K1 = -69.1 K2 = -18.0
Standard deviation angles: Sigma 1-3 = 2.23 Sigma 1-2 = 4.41
Approximate 95% confidence angles: Alpha 1-3 = 5.45 Alpha 1-2 = 10.80
Oval azimuth = 109.9

Test statistics for circular symmetry based on Bingham distribution:
Bipolar = 2.72 Girdle = 42.17
Test indicates symmetric bipolar distribution. Mean Bingham alpha = 8.13

> > > DIMROTH-WATSON STATISTICS < < <

Dimroth-Watson concentration parameter = -28.25
Circular standard deviation = 10.92 deg. (Parametric estimate.)

APPENDIX B

TABLES FROM REGIONAL STUDIES

1272 THOMPSON AND SANDBERG—GRAVITY SURVEYS, NEVADA AND CALIFORNIA

TABLE 1.—SPECIFIC GRAVITY OF ROCKS

The specific gravity of water-saturated rocks is computed as $W(P - L)/P + L$, where P is the powder specific gravity, L is the lump specific gravity, and W is the specific gravity of ground water, 1.0.

Rock	Number of samples measured	Specific gravity of water-saturated rock	
		Range	Average
Truckee formation	1	1.74–	
Volcanic rocks of Cenozoic age (quantitatively most important groups italicized)			
Lousetown formation	11	2.49–2.80	2.66
Kate Peak formation, flows	7	2.53–2.69	2.61
Kate Peak formation, tuff-breccia	3	1.84–2.18	2.04
Kate Peak formation, intrusions	6	2.41–2.55	2.50
Kate Peak formation, vitrophyre	3	2.13–2.42	2.31
Alta formation	8	2.54–2.70	2.63
Alta formation, Sutro member	1	2.50–	
Hartford Hill rhyolite tuff	4	1.95–2.56	2.25
Davidson granodiorite (Tertiary)	2	2.64–2.67	2.65
Pre-Tertiary granitic rocks	5	2.62–2.66	2.64
Metamorphic rocks	3	2.69–2.75	2.71
Altered granitic rocks	6	2.46–2.62	2.55
Altered volcanic rocks	21	2.07–2.72	2.50

KRANK AND WATTERS—WEATHERED GRANODIORITE 179

Table 3. *Range of physical properties of Sierra Nevada granodiorites laboratory results.*

Grade	Grain Specific Gravity	Bulk Specific Gravity	Porosity (percent)	Angle of Friction (degrees)	Cohesion psi	Compressive Strength × 10³ psi	Compressive Wave Velocity ft/sec × 10³	Shear Wave Velocity × 10³ ft/sec
I	2.69–2.77	2.62–2.75	2.6–0.4	–	–	16.04–23.97	12.30–16.30	8.27–9.46
II	2.70–2.72	2.62–2.65	3.3–5.9	–	–	8.77–14.04	5.70–7.80	3.54–5.03
III	2.66	2.56–2.62	1.5–2.3	–	–	4.79–6.49	5.07–6.04	3.55–3.74
IV	2.62–2.79	2.34–2.56	5.2–6.1	28–32	34–36	1.24–3.48	1.64–4.75	N
V	2.61–2.66	2.02	24.0	46–46.5	0–2.8	0–1.50	N	N
VI	2.66	1.50	44.0	38.6	0–4.9	0	N	N

N = Could not be calculated.

From Hendricks (1992)

Table 1. *Magnetic susceptibilities of samples from the Stillwater Range (Smith, 1968) and south-central section of the Reno 1° by 2° quadrangle, Nevada and California.*
[Geographic coordinates for samples from the Humboldt area are not available (NA). Susceptibilities in EMU (electromagnetic units)]

Humboldt lopolith and vicinity

Rock type	Number of samples	Average susceptibility X 10^6 EMU	Age	Location	Coordinates Latitude; longitude
Latite	2	505	Tertiary	Stillwater Range	NA
Welded tuff	1	930	Tertiary	Stillwater Range	NA
Gabbro	5	1582	Jurassic	Humboldt lopolith	NA
Scapolitized gabbro	1	3330	Jurassic	Humboldt lopolith	NA
Diabase	1	3570	Jurassic	Humboldt lopolith	NA
Albitized gabbro	1	20	Jurassic	Humboldt lopolith	NA
Anorthosite	1	2790	Jurassic	Humboldt lopolith	NA
Peridotite	1	2790	Jurassic	Humboldt lopolith	NA
Altered gabbro	1	3700	Jurassic	Humboldt lopolith	NA
Hydrated basalt	1	420	Jurassic	Humboldt lopolith	NA

South-central section

Rock type	Number of samples	Average susceptibility X 10^6 EMU	Age	Location	Coordinates Latitude; longitude
Granite	3	3014	Cretaceous	Southern Virginia Range	39°19.60';119°28.30'
Diorite	3	2219	Jurassic	Desert Mountains	39°15.40'; 119°15.10'
Basalt	3	1547	Tertiary	Desert Mountains	39°16.40'; 119°11.50'
Basalt	3	1449	Tertiary	Desert Mountains	39°13.40'; 119°09.55'
Greenstone	3	1402	Triassic	Mason Valley	39°09.80'; 119°06.95'
Granodiorite	2	1316	Jurassic	Long Valley	39°04.40'; 118°47.85'
Basalt	1	1315	Tertiary	Desert Mountains	39°13.60'; 119°09.20'
Basalt or andesite	3	1118	Tertiary	Desert Mountains	39°12.95'; 119°08.85'
Granodiortie	3	1005	Jurassic	Desert Mountains	39°12.50'; 119°04.15'
Basalt or andesite	3	991	Tertiary	Desert Mountains	39°13.50'; 119°08.40
Granite	3	954	Cretaceous	Churchill Butte	39°19.55'; 119°17.10'
Dacite	2	939	Tertiary	Desert Mountains	39°16.40'; 119°11.95'
Dacite	3	905	Tertiary	Fort Churchill	39°17.80'; 119°16.70'
Granodiorite	2	836	Jurassic	Long Valley	39°07.20'; 118°48.70'
Dacite	3	389	Tertiary	Desert Mountains	39°16.45'; 119°14.05'
Rhyolite	3	387	Tertiary	Desert Mountains	39°15.30'; 119°05.25'
Rhyolite	3	89	Tertiary	Desert Mountains	39°16.35'; 119°02.30'
Metavolcanic	3	49	Triassic	Mason Valley	39°11.55'; 119°04.70'
Greenstone	3	40	Triassic	Parker Butte	39°07.45'; 119°03.50'
Altered diorite	3	26	Jurassic(?)	Desert Mountains	39°14.80'; 119°16.60'