U.S. DEPARTMENT OF THE INTERIOR
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# Paleomagnetic polarity of some vertebrate fossil localities of the Glenns Ferry Formation in the Chalk Hills, near Froman Ferry, western Snake River Plain, southwest Idaho

by

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Open-File Report 92-542



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## Abstract

Beds of the Glenns Ferry Formation (Pliocene to early Pleistocene) form the Chalk Hills about 23 km (14 mi) west of Nampa, Idaho, near the site of abandoned Froman Ferry on the Snake River. With one noteworthy exception, the beds there contain vertebrate fossils typical of late Blancan (Blancan V; ~2.6 Ma – ~1.9 Ma) land mammal age assemblages found elsewhere in the formation. The noteworthy exception is the co-occurrence of *Phenacomys gryci* , an immigrant microtine rodent and indicator species for Irvingtonian time (~1.9 Ma – 0.9 Ma) in the coterminous United States. Paleomagnetic samples were collected from twelve horizons in an attempt to refine age control by identifying the Olduvai Normal Polarity Subchron (~1.87 Ma – ~1.67 Ma) which is associated with the Blancan-Irvingtonian boundary. Sampled horizons were sufficiently close that, if present, an Olduvai zone could reasonably be expected to be identified at two or three of the horizons. Paleomagnetic samples from 11 of the 12 horizons are clearly of stable, reversed paleomagnetic polarity. Although characteristic reversed polarity directions could not be isolated by alternating field demagnetization from samples of the lowest horizon, changes in direction and intensity of magnetization during treatment indicate that they carry weak, but stable components of reversed polarity that are obscured by present field normal polarity overprints. Thus, we interpret all sampled horizons to be of primary reversed polarity, and do not recognize an Olduvai Normal Polarity Subchronozone in the section. If the section spans any part of Olduvai time, the zone is anomalously thin or missing.

## Introduction

A paleomagnetic study of an 82 m-thick (270-ft) section of the Glenns Ferry Formation of Pliocene and early Pleistocene age was completed near the site of the now abandoned Froman Ferry (spelled "Frohman" on U.S.G.S. topographic maps and in some reports) on the Snake River in southwestern Idaho. The section was measured, sampled, and briefly described. The purpose of the study was to develop a paleomagnetic polarity zonation that might help determine more accurately the age of these beds. The information supplements age determination from fossil vertebrate and diatom assemblages found at this location (Scott and Weasma, 1990; Repenning, written commun., 1990; J. Platt Bradbury, oral communs. to Repenning, 1990, 1992).

The Froman Ferry section of the Glenns Ferry Formation is on the south facing slope of the Chalk Hills, 23 km (14 mi) west of Nampa, Idaho, in T. 3N. , R. 4W., Sec. 8, 9, and 17 of the Marsing, Idaho, 7.5-min. quadrangle (fig. 1). There, the Glenns Ferry beds are covered by Pleistocene and Holocene gravels of the Snake River as high as ~38 m (125 ft) above the level of the Snake River. About midway up the sampled section, at the level of Hoskins Road, the Glenns Ferry beds form a broad, gently sloping, sandy bench hosting grassy fields and cultivated farmland. Upslope, the bench is interrupted by two moderately steep berms formed of more erosion resistant, finer grained sediment suitable for paleomagnetic sampling. North of Deer Flat Low Line Canal, the upper 45 m (145 ft) of the section are generally well exposed on the steep south slope of the Chalk Hills.

Lithology of the Glenns Ferry Formation at the Froman Ferry locality is dominated by silts, with variable admixtures of clay and fine to medium sand. Two tephra layers, one fine sand-sized and silicic, the other coarse-grained and mafic, occur near the base of the described section (fig. 2). The section generally coarsens upward. Silty, olive-gray clay typical of Glenns Ferry lacustrine deposition is subordinate. Plant fragments are common in many beds. The beds show cyclic repetition of pond and marsh, to floodplain and fluvial facies across the section. The cycles are repeated at approximately 5 to 8 m (15 to 25 ft) intervals in the lower half of the section, but broaden substantially in the upper half (reflected in our sampling intervals). This cyclicity is a general pattern with many depositional hiatuses evident from weathered, oxidized horizons at the top of some of the clay and silt layers, and one cobble and pebble conglomerate overlying a silty clay. Sedimentary structures include medium- to large-scale cut and fill channels, crossbedding in sand beds, reversed and normal grading in silts and silty clays, and soil structures associated with clays. On an outcrop scale, bedding is horizontal, however, many beds are lenticular and discontinuous over a few tens to hundreds of feet.

## Methods

The section and sample levels were measured with a Jacob staff and level using elevations of distinctive points on Hoskins Road and Deer Flat Low Line Canal as datums. Elevations of prominent features on the topographic map served as a general check within resolution of its 20-ft contour interval. Two stratigraphic subsections separated by about 1 km (0.6 mi) comprise the upper half of the section; these were tied together by laterally persistent, erosion resistant marker beds. The upper and lower halves of the overall section were tied together by measured elevations from the datums.

## Sampling

A total of 53 paleomagnetic samples were collected from 12 sites (FrohA – FrohL, fig. 2). Sampled beds were excavated to depths of about 1 m (3 ft) to remove slope wash and slumped material, and to identify less weathered clay and silt-size material that typically give the best paleomagnetic results. Paleomagnetic sample sites were located at or near site markers for existing fossil localities (GS201 – 211, fig. 2; Scott and Weasma, 1990).

Where sediments were sufficiently soft, 2-$cm^3$-volume sample containers were pressed into the outcrop. In lithified beds, samples were carved in relief, then 6-$cm^3$-volume containers were slipped over the cubes of sediment. Samples were oriented using a magnetic compass and clinometer, then detached from the outcrop. Softer sediments are common in the lower 40 m (~125 ft) of the section. Harder sediments of the upper 45 m (~145 ft) of the section dictated the exclusive use of 6 $cm^3$ sample containers.

Stratigraphic separation between sampled beds ranges from 2.1 m (7 ft) to 18.3 m (60 ft), with more thorough coverage in the lower 40 m (130 ft) of the section (largest separation in lower half is 8.2 m (~27 ft)). Sample coverage in the upper 43 m (140 ft) of the section is broad.

## Paleomagnetic Measurement

Remanent magnetizations were measured using a cryogenic magnetometer with a background noise level less than $1 \times 10^{-4}$ A/m. Natural remanent magnetizations (NRM) were weak in all samples, ranging in intensity from $2.33 \times 10^{-3}$ A/m to $9.87 \times 10^{-5}$ A/m. Most sample NRMs had low $10^{-3}$ or high $10^{-4}$ A/m intensities. After evaluating responses of 12 samples to tumbling alternating-field (AF) demagnetization in peak fields of 2.5 and 5.0 milliTesla (mT), samples were routinely demagnetized in peak fields of 10, 20, 30, and 40 mT. Measurement precision (reproducibility of results between repeated measurements) generally was within 10 percent relative error throughout the demagnetization steps for each sample. Magnetization of particularly weak samples approached the background noise level of the magnetometer after partial demagnetization and data of lower precision were accepted. This degree of error does not affect interpretation of polarity. All data are presented in table 1.

## Paleomagnetic Results

The data show three types of sample behavior through the NRM and AF demagnetization steps. The most common NRM directions were generally north declination and steep to shallow positive inclination. After partial AF demagnetization, these directions shifted to generally southern declination and steep to shallow negative inclination. Intensity of magnetization increased in some samples during demagnetization. This behavior, illustrated in fig. 3A, is interpreted to reflect a high coercivity (*i.e.*, stable) reversed polarity magnetization with a strong normal polarity overprint incompletely removed by AF demagnetization in peak fields up to 40 mT (table 1, sites FrohB through FrohI, and FrohK).

The second type of sample behavior (fig. 3B) starts with an NRM direction of southern declination and negative inclination. After AF demagnetization, remanent directions of these samples show further alignment toward southern declination and steepen in negative inclination. This behavior is interpreted to reflect a stable reversed polarity remanent magnetization with a relatively weak normal polarity overprint that is effectively removed by AF demagnetization (table 1, sites FrohJ and FrohL).

The third type of behavior (fig. 3C), seen from only the lowest site sampled, FrohA, is more difficult to interpret. Initially and in the low demagnetizing fields, these samples generally show a normal polarity magnetization (northern declination and steep positive inclination) that is diminished to <10 percent to ~20 percent of NRM intensity by peak demagnetizing fields of 30 mT. Over half of the sample's NRM intensity is removed in demagnetizing fields less than 10 mT. This low coercivity indicates that this is not a stable magnetization. Remanent intensities approach the background noise level of the magnetometer after 15 or 20 mT. Further demagnetization produces no increase in intensity seen in some samples where it is explained as removal of a normal overprint that is canceling in part the primary reversed vector (*e.g.*, fig. 3A). Vector changes during demagnetization (except for sample 9) diverge significantly from univectorial, linear decay toward the origin of the demagnetization diagrams, indicating that there is probably a weak, but higher coercivity (*i.e.*, more stable) component of reversed polarity (fig. 3C and table 1, site FrohA). Declinations in 3 of the 5 samples from site FrohA enter the southern quadrants in the higher demagnetizing fields, suggesting reversed polarity, but the magnetization is extremely weak and uncertainty in directions is high (table 1, FrohA, samples 6-8,10). Except for sample 9, samples from the site shallow in positive (down) inclination, but with only one sample ending in a shallow negative (up) orientation (table 1, FrohA, sample 7). We provisionally interpret this behavior to reflect a substantial normal polarity overprint that almost completely masks a very weak primary magnetization of reversed polarity.

**Tephra layers**

We hoped to find one or more chemically identifiable silicic tephra layers that are abundant in some sections of the Glenns Ferry Formation, and that would provide additional age control and help tie our polarity zonation to the polarity time scale. Only two tephra layers, in stratigraphic contact with each other, were found. Slope wash across most of the deeply weathered badland-type surface of the outcrop obscures fine details of bedding, and recognition of any tephra layers present would be unlikely without continuous trenching across the section. Also, tephra that fell into the fluvial paleoenvironment might have been thoroughly reworked and not preserved as discrete beds.

The two tephra layers noted are at an elevation of 726 m (~2382 ft) in the Froman Ferry measured section, 4.4 m (14.4 ft) below the steel spike marker of fossil site GS 211. They occur as a doublet. The lower tephra layer is a uniform, very fine to fine-grained, pinkish-gray (5YR8/1), silicic tephra, of ~90 percent moderately to strongly vesiculate, pumiceous, ribbed, webbed shards. This silicic tephra layer lies on an uneven, weathered horizon atop a reddish-gray clay bed that ends a typical fine sand – silt – clay sequence. Where excavated in our section, its thickness ranges from 2 to 6 cm over a lateral distance of about 2 m (6 ft). It does not appear to have been reworked. Its upper surface is gradational with the overlying, medium-grained, black tephra layer that ranges from 0 to 4 cm thick. The overlying black tephra layer is reworked and contains silicic shards, presumably from the underlying silicic layer, and a component of tan silty clay.

The silicic layer was sampled for chemical analysis. Results of electron microprobe analysis of glass shards by Charles E. Meyer (U.S.G.S.) indicate that it is of dacitic to dacitic/andesitic composition and that the shards are compositionally bimodal, reflected by subordinate low iron and dominant high iron fractions. The tephra is heterogeneous from shard to shard and the glass is very hydrated. Neither neutron activation nor x-ray fluorescence analyses have been performed.

For several reasons the silicic Froman Ferry tephra cannot be correlated to any known, dated tephra. The major element composition indicates that it probably erupted from the Cascade Range, although it is somewhat unusual for tephra of that provenance (A.M. Sarna-Wojcicki, oral commun., 1992). The major element composition of the high-iron mode correlates best with silicic shards of an unnamed black-and-white doublet ash exposed near Deadhorse Gulch, southeast of Tulelake and east of Medicine Lake Volcano, northern California, which in turn matches reasonably well with the composition of the Pringle Falls tephra of south-central Oregon (A.M. Sarna-Wojcicki, written commun., 1992). The black-and-white doublet tephra layers near

Tulelake are suspected to be of late Pleistocene age (150 ka - 200 ka) based on correlation of an overlying pumice bed (A.M. Sarna-Wojcicki, written commun., 1992). The Pringle Falls tephra is thought to have been erupted during marine oxygen isotope stage 6 (A.M. Sarna-Wojcicki, oral commun., 1992) and is thus less than 200,000 years old. The low-iron mode of the Froman Ferry tephra matches best with the reasonably well-dated mid- to late Pleistocene Rye Patch Dam ash bed (~630 ka). No other Cascade tephra layers correlate well on the basis of major element chemistry of glass shards. If these ages are correct, none of these tephra layers can be correlative with the Froman Ferry tephra despite any similarity of major element compositions.

## Discussion and Interpretation

This polarity study was prompted by the identification of fossil remains of the microtine rodent *Phenacomys gryci*, an immigrant species indicative in the coterminous United States of the Irvingtonian I Land Mammal Age (~1.9 to about 0.9 Ma; Repenning, 1987), at site GS204 in otherwise typical late Blancan (Blancan V, ~2.6—~1.9 Ma; Repenning, 1987) assemblages of the section (Scott and Weasma, 1990; Repenning, written commun., 1990). Aside from *P. gryci* , all fossil material from the Froman Ferry localities, including diatoms indicative of a "shallow marshy pond environment" (J. Platt Bradbury, oral communs. to Repenning, 1990, 1992), is typical of the well-studied Blancan V–age Grand View fauna found at numerous localities in similar paleoenvironments of the Glenns Ferry Formation (Repenning, written commun., 1990). No microtines are known to have immigrated into the U.S. during Blancan V, and, although recognized earlier in Alaska, *P. gryci* is unknown in the coterminous U.S. before Irvingtonian I, where it is first recognized shortly after the Olduvai Normal Polarity Subchron (Repenning, written commun., 1990; fig. 4, this paper). Persistence of some Blancan V forms into Irvingtonian I time is not surprising, but the absence of Irvingtonian I forms of *Microtus* and *Lasiopodomys* that appeared west of the Rocky Mountains shortly after the Olduvai, together with the preponderance of Blancan V microtines at the sites suggests an earliest Irvingtonian age, *i.e.*, Olduvai age, for this occurence of *Phenacomys* (Repenning, written commun., 1990). Repenning (oral commun., 1992) suggested that an Olduvai Normal Polarity Subchronozone might be identified somewhere in the section, and place better age constraint on this apparently early occurrence of *Phenacomys*.

The interbedded silt, silty clay, and silty fine sand beds at the Froman Ferry fossil localities are comparable to facies generally interpreted to represent variable flood plain, fluvial, swamp, and marsh environments of the Glenns Ferry Formation (*e.g.*, Bjork, 1970; Middleton, 1976; Conrad, 1980; Scott and Weasma, 1990). Above the 753 m (2470 ft) elevation near the Deer Flat Low Line Canal of the Froman Ferry section, sediments appear to be predominantly of flood plain and fluvial facies; below that level swamp, marsh, and pond environments are represented as well (Scott and Weasma, 1990; fig. 2 of this report). Typical average accumulation rates for the flood plain facies elsewhere in the Glenns Ferry Formation range from 22 m (72 ft) /100 k.y to 30 m (98 ft) /100 k.y. in the lower and upper Gauss Chronozone respectively at Peters Gulch, and 30 m (98 ft) /100 k.y. for the lacustrine facies of early Gauss age at the Highway 30 locality (Conrad, 1980, p. 69). Both of these localities are ~130 km (75 mi) southeast from Froman Ferry. Conrad (1980) calculated an overall average accumulation rate for these two facies, and for swamp and marsh environments inferred by Bjork (1970) at Hagerman, of 26 m (85 ft) /100 k.y. Rates as high as 135 m (443 ft) /100 k.y. are found in the fluvial facies (Conrad, 1980, p. 71). Age control for these calculations comes primarily from magnetostratigraphic studies of Conrad (1980), Neville and others (1979), and Neville (1980).

## Conclusion

Accumulation rates are unknown at the Froman Ferry section, but it seems reasonable to assume in the absence of contrary evidence, that they are similar to those of similar facies of the Glenns Ferry Formation elsewhere. Thus, the 82 m (270 ft)-thick section at Froman Ferry would be expected to represent roughly some 300 k.y., and, if represented in its entirety, the Olduvai Subchron (1.67 - 1.87 Ma; Mankinen and Dalrymple, 1979) would be recognized as a zone of normal polarity between 44 and 60 m (150 and 205 ft) thick. Stratigraphic intervals between sampled beds of this study are short enough to have detected such a zone of normal polarity at multiple horizons if it were present. We acknowledge that the sampling interval does allow some possibility that a greatly condensed or missing Olduvai Subchronozone might remain undetected, but believe that is unlikely. With the exception of site FrohA, all sampled beds are clearly of reversed primary magnetization. We provisionally interpret the samples from site FrohA to be of reversed primary magnetization, also, because four of the five samples diverged significantly from normal polarity directions in higher AF demagnetizing fields, indicating a very weak component of stable reversed magnetization masked beneath a substantial and incompletely removed present field normal overprint. We conclude, on the basis of the vertebrate fossil assemblages and the large apparent thickness of reversed polarity sediments, that the Froman Ferry section was deposited sometime during the long reversed period after the end of the Olduvai Subchron, probably between 1.67 Ma and about 1.4 Ma. This reduces the previously inferred maximum age limit of ~1.9 Ma for the section by about 230,000 yrs.

**Acknowledgments**

We thank paleontologist Charles A. Repenning of the U.S. Geological Survey for providing impetus for the study and for patiently explaining the locality's vertebrate record. We gratefully acknowledge generous assistance from Mr. George R. Scott of Nampa, Idaho, who introduced us to the section and pointed out his fossil locality markers on the outcrop. Funding was provided by the National Association of Geology Teachers program of the U.S.G.S. to D.J.V., and by the U.S.G.S. Global Change and Climate History Program. Support for the major element microprobe analysis of glass shards from the silicic tephra layer was through Andrei M. Sarna-Wojcicki and the U.S.G.S. tephrochronology group at Menlo Park. Elmira Wan provided the petrographic description of the tephra sample.

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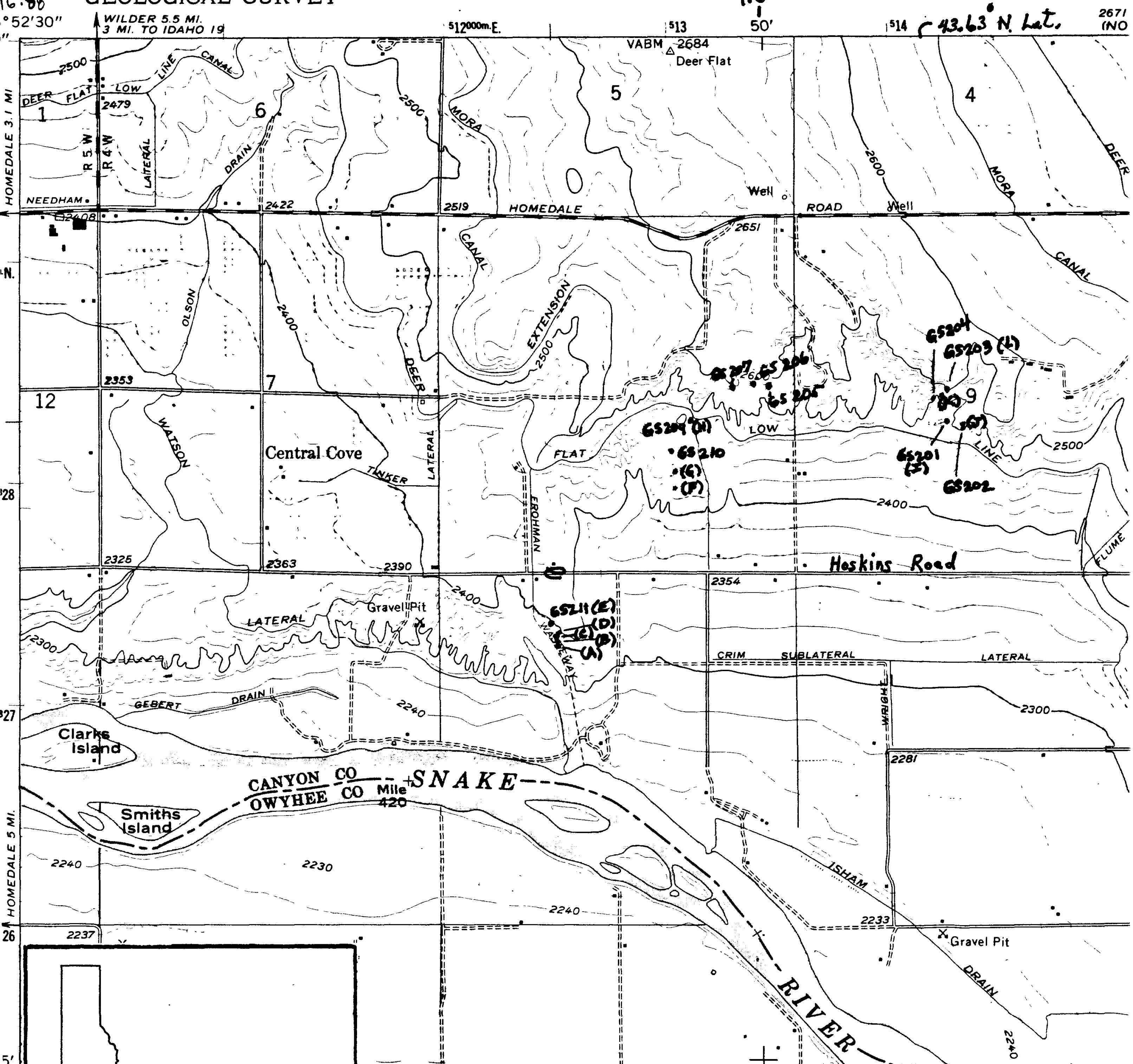


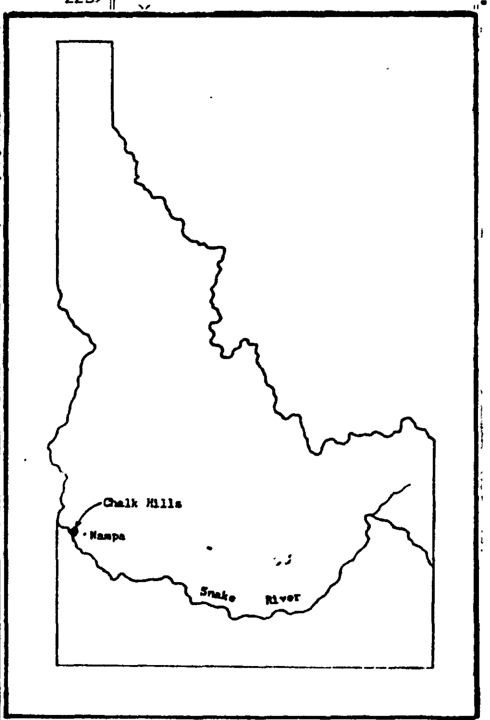


**Figure 1.** Location map of measured section of Glenns Ferry Formation at Froman Ferry locality, Marsing 7.5-min. quad., T. 3N., R. 4W., Sec. 8, 9, 17. Letters (A) through (L) mark paleomagnetic sample sites FrohA through FrohL along lines of section (this paper). GS201 through GS211 mark fossil localities of Scott and Weasma (1990). Latitudes and longitudes of paleomagnetic sites are given in table 1.

0 1/2 1 km

0 1/2 1 mi

Approximate Scale

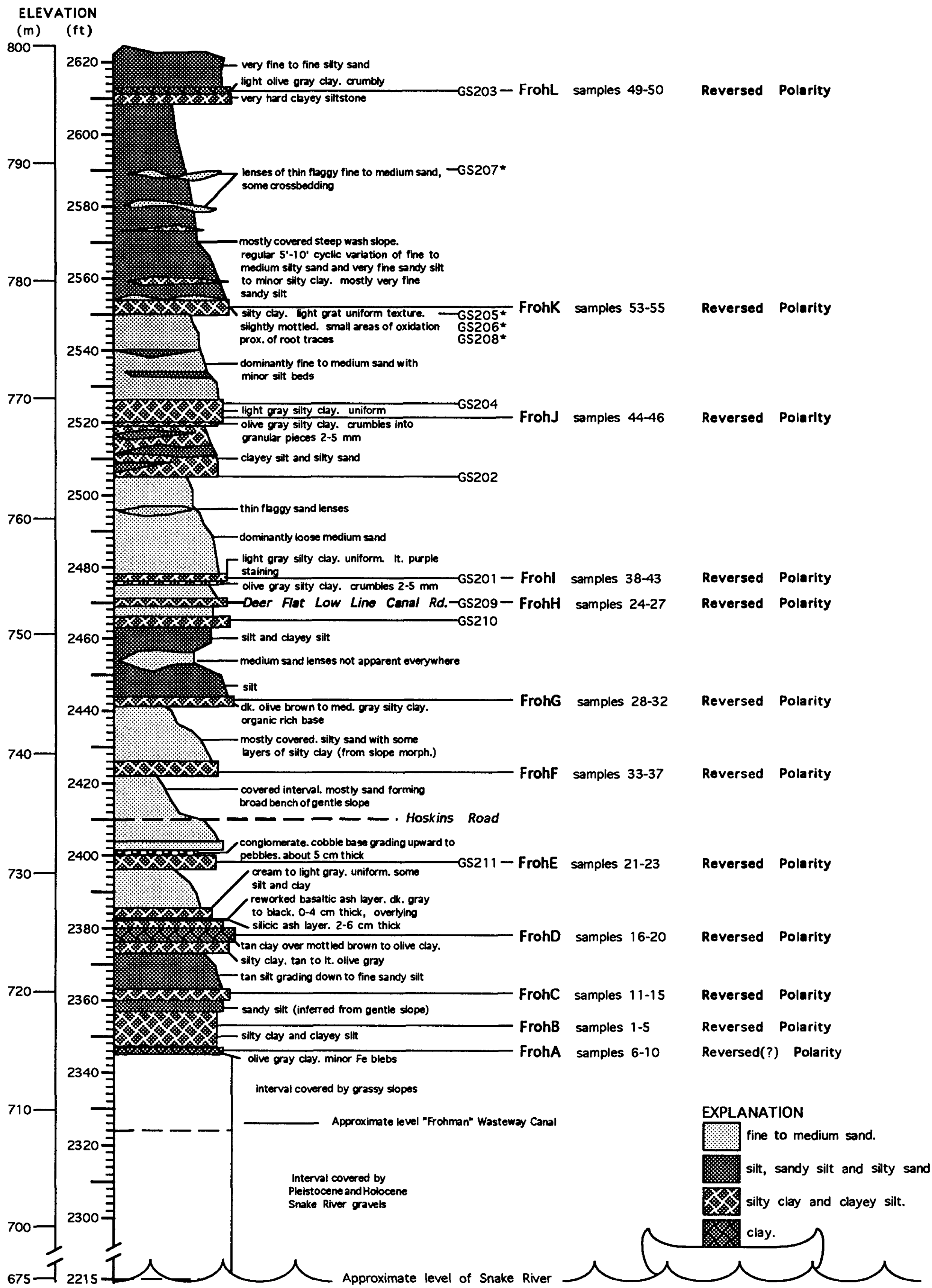


**Figure 2.** Generalized composite stratigraphic column of measured section of the Glenns Ferry Formation at Froman Ferry locality (Marsing 7.5-min. Quad., Idaho, T. 3N., R. 4W., Sec. 8, 9, 17).

* Denotes fossil sites projected into line of section.

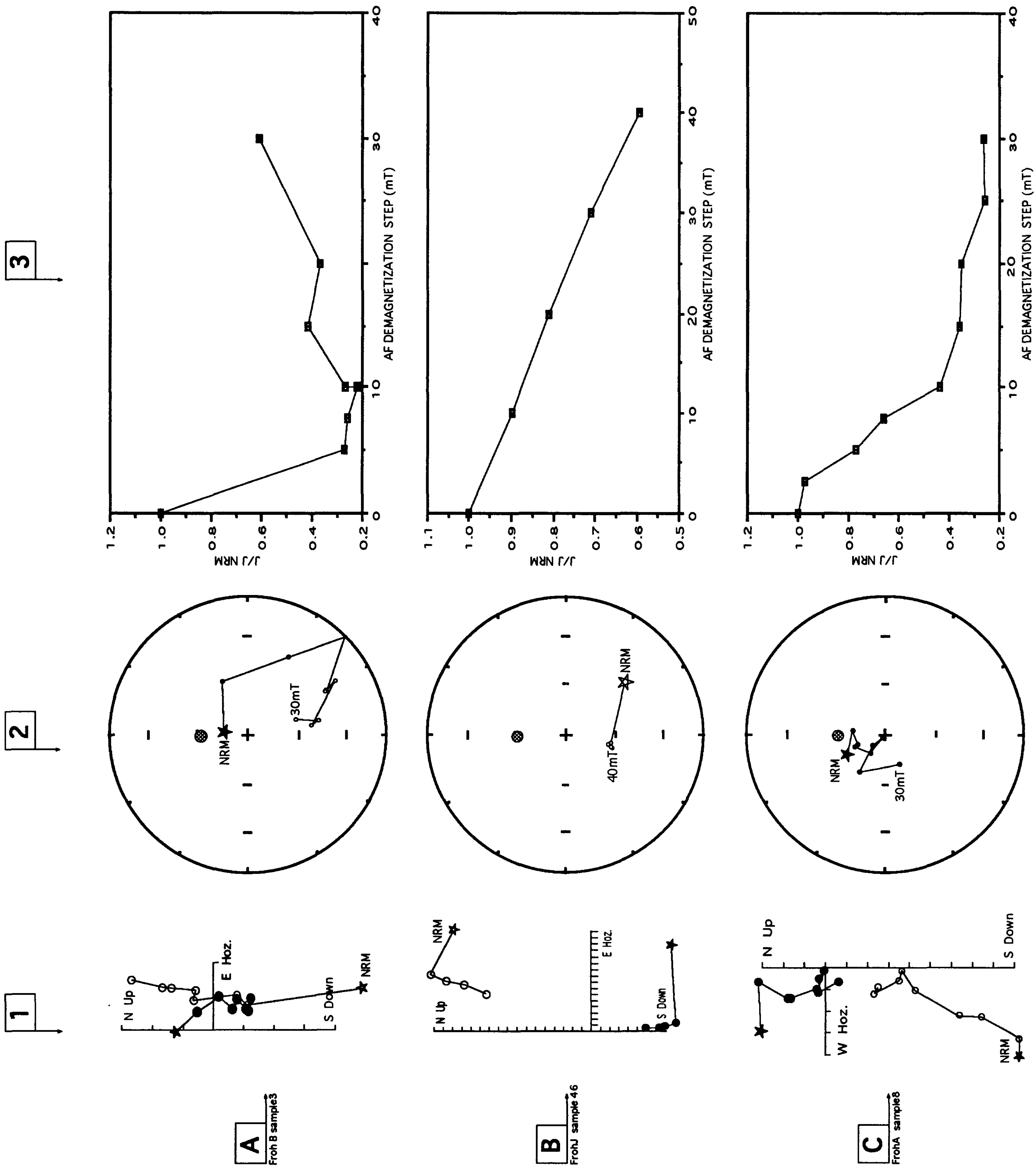


**Figure 3**. Representative demagnetization diagrams showing sample behavior during alternating-field (AF) demagnetization (NRM-30 or 40 mT). (1) **Modified Zijderfeld** - open circles mark inclinations, scale divisions E-7 emu/g , (2) **Equal Area** - open symbols upper hemisphere, solid symbols lower hemisphere, shaded circles mark present field , and (3) **Normalized Intensity** (J/J NRM) diagrams of sample sites (A) FrohB sample 3 ,(B) FrohL sample 46, and (C) FrohA sample 8.

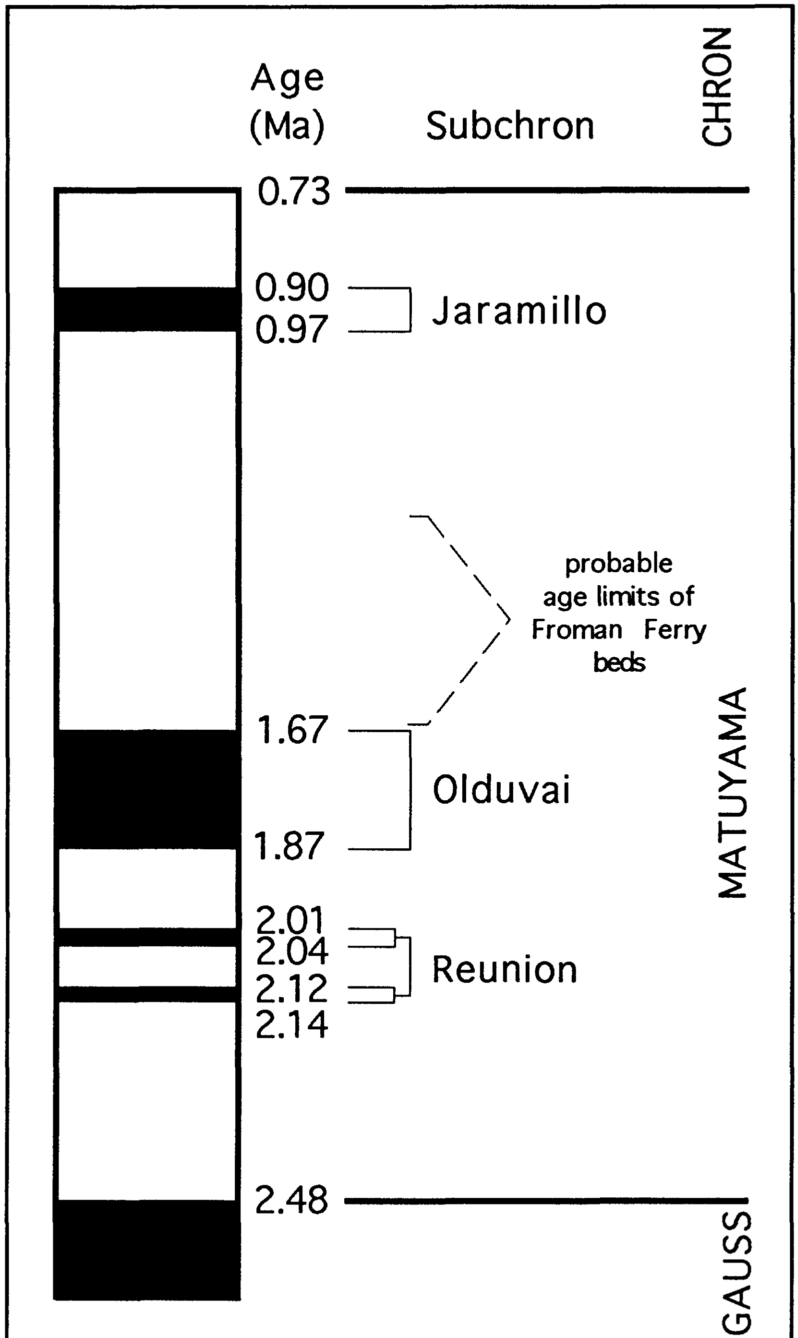


**Figure 4.** Polarity timescale for general reference. Normal polarity black, reverse polarity white. Ages from Mankinen and Dalrymple (1979).

Table 1. Paleomagnetic data from Froman Ferry locality of the Glenns Ferry Formation.
Sample sites FrohA through FrohL. Column headings are: Sm#(sample number);
Elevation (feet above sea level); Demag (demagnetizing field in mT);
Dec. (declination of remanent magnetization); Inc. (inclination of remanent magnetization),
beds are horizontal, no tectonic correction; A/m (intensity of magnetization in amperes/meter);
Err.Ang. (angular difference between repeated measurements/10);
Azm. (azimuth of sample orientation); Hade (hade of sample orientation).

**FrohA.dat 43.6N 243.2E -18.5MagDec**

| Sm# | Elevation | Demag | Dec. | Inc. | A/m | Err.Ang. | Azm. | Hade |
|---|---|---|---|---|---|---|---|---|
| 6 | 2346 | nrm | 352 | 69.1 | 1.18E-03 | 0.08 | 339.5 | 28 |
| 6 | 2346 | af2.5 | 4.5 | 75.6 | 1.11E-03 | 0.22 | | |
| 6 | 2346 | af5.0 | 358 | 72.3 | 8.91E-04 | 0.21 | | |
| 6 | 2346 | af7.5 | 340 | 70.4 | 6.61E-04 | 0.16 | | |
| 6 | 2346 | af10.0 | 302 | 78.7 | 4.70E-04 | 0.26 | | |
| 6 | 2346 | af15.0 | 196 | 83.9 | 3.47E-04 | 0.38 | | |
| 6 | 2346 | af20.0 | 242 | 62.5 | 2.46E-04 | 0.5 | | |
| 6 | 2346 | af25.0 | 232 | 35.3 | 2.85E-04 | 0.64 | | |
| 6 | 2346 | af30.0 | 237 | 43.4 | 1.93E-04 | 0.5 | | |
| 7 | 2346 | nrm | 328 | 76.5 | 1.18E-03 | 0.07 | 346.5 | 19 |
| 7 | 2346 | af2.5 | 327 | 77.2 | 1.14E-03 | 0.1 | | |
| 7 | 2346 | af5.0 | 330 | 78.4 | 8.76E-04 | 0.12 | | |
| 7 | 2346 | af7.5 | 318 | 76.0 | 6.17E-04 | 0.21 | | |
| 7 | 2346 | af10.0 | 306 | 74.3 | 4.44E-04 | 0.44 | | |
| 7 | 2346 | af10.0 | 338 | 72.0 | 3.87E-04 | 0.72 | | |
| 7 | 2346 | af15.0 | 260 | 73.2 | 2.76E-04 | 1.43 | | |
| 7 | 2346 | af15.0 | 248 | 76.0 | 2.94E-04 | 0.22 | | |
| 7 | 2346 | af20.0 | 252 | 50.7 | 2.99E-04 | 0.87 | | |
| 7 | 2346 | af25.0 | 266 | 15.4 | 2.76E-04 | 0.8 | | |
| 7 | 2346 | af30.0 | 163 | -11.9 | 3.85E-05 | 5.47 | | |
| 8 | 2346 | nrm | 318 | 66.2 | 1.01E-03 | 0.07 | 323.5 | 9 |
| 8 | 2346 | af2.5 | 349 | 70.6 | 9.82E-04 | 0.14 | | |
| 8 | 2346 | af5.0 | 322 | 73.0 | 7.76E-04 | 0.15 | | |
| 8 | 2346 | af7.5 | 320 | 70.7 | 6.68E-04 | 0.34 | | |
| 8 | 2346 | af10.0 | 291 | 76.0 | 4.40E-04 | 0.3 | | |
| 8 | 2346 | af15.0 | 294 | 87.7 | 3.64E-04 | 0.44 | | |
| 8 | 2346 | af20.0 | 302 | 80.2 | 3.58E-04 | 0.33 | | |
| 8 | 2346 | af25.0 | 286 | 63.2 | 2.63E-04 | 0.53 | | |
| 8 | 2346 | af30.0 | 227 | 70.4 | 2.67E-04 | 0.4 | | |
| 9 | 2346 | nrm | 358 | 56.1 | 1.33E-03 | 0.09 | 358.5 | 15 |
| 9 | 2346 | af2.5 | 5.3 | 64.3 | 1.35E-03 | 0.07 | | |
| 9 | 2346 | af5.0 | 346 | 66.5 | 1.13E-03 | 0.09 | | |
| 9 | 2346 | af7.5 | 351 | 70.3 | 8.97E-04 | 0.12 | | |
| 9 | 2346 | af10.0 | 348 | 66.1 | 8.35E-04 | 0.27 | | |
| 9 | 2346 | af15.0 | 343 | 71.6 | 6.68E-04 | 0.42 | | |
| 9 | 2346 | af20.0 | 347 | 69.3 | 6.15E-04 | 0.5 | | |
| 9 | 2346 | af25.0 | 334 | 70.6 | 4.61E-04 | 0.19 | | |
| 9 | 2346 | af30.0 | 38 | 86.8 | 4.62E-04 | 0.19 | | |
| 10 | 2346 | nrm | 12.2 | 59.5 | 9.58E-04 | 0.08 | 5.5 | 9 |
| 10 | 2346 | af2.5 | 17.3 | 61.2 | 1.12E-03 | 0.1 | | |
| 10 | 2346 | af5.0 | 27 | 61.2 | 9.19E-04 | 0.14 | | |
| 10 | 2346 | af7.5 | 35.3 | 54.0 | 7.49E-04 | 0.13 | | |
| 10 | 2346 | af10.0 | 37.7 | 54.6 | 5.77E-04 | 0.15 | | |
| 10 | 2346 | af15.0 | 39.1 | 36.4 | 3.76E-04 | 0.23 | | |
| 10 | 2346 | af20.0 | 24.2 | 51.8 | 3.39E-04 | 0.31 | | |
| 10 | 2346 | af25.0 | 57.9 | 25.3 | 3.06E-04 | 1.27 | | |
| 10 | 2346 | af30.0 | 78.3 | 3.9 | 2.90E-04 | 0.3 | | |

Table 1. continued. **FrohB.dat 43.6N 243.2E -18.5MagDec**

| Sm# | Elevation | Demag | Dec. | Inc. | A/m | Err.Ang. | Azm. | Hade |
|---|---|---|---|---|---|---|---|---|
| 1 | 2353 | nrm | 105 | 66.0 | 2.53E-04 | 0.36 | 343.5 | 8 |
| 1 | 2353 | af2.5 | 90.4 | 56.0 | 3.01E-04 | 0.61 | | |
| 1 | 2353 | af5.0 | 124 | 53.6 | 3.00E-04 | 0.53 | | |
| 1 | 2353 | af7.5 | 145 | 26.7 | 2.76E-04 | 0.86 | | |
| 1 | 2353 | af7.5 | 133 | 27.8 | 3.01E-04 | 1.34 | | |
| 1 | 2353 | af10.0 | 155 | 15.4 | 3.15E-04 | 0.67 | | |
| 1 | 2353 | af15.0 | 159 | -1.4 | 3.14E-04 | 0.44 | | |
| 1 | 2353 | af20.0 | 141 | -15.0 | 2.72E-04 | 1.05 | | |
| 1 | 2353 | af20.0 | 142 | -18.6 | 2.80E-04 | 0.41 | | |
| 1 | 2353 | af25.0 | 189 | -10.0 | 3.13E-04 | 0.37 | | |
| 1 | 2353 | af30.0 | 184 | -34.2 | 2.92E-04 | 0.34 | | |
| 2 | 2353 | nrm | 132 | 51.7 | 1.15E-03 | 0.17 | 353.5 | 4 |
| 2 | 2353 | af2.5 | 145 | 48.6 | 1.08E-03 | 0.11 | | |
| 2 | 2353 | af5.0 | 154 | 37.8 | 9.40E-04 | 0.2 | | |
| 2 | 2353 | af7.5 | 156 | 22.8 | 9.06E-04 | 0.12 | | |
| 2 | 2353 | af10.0 | 157 | 12.4 | 8.37E-04 | 0.18 | | |
| 2 | 2353 | af15.0 | 154 | 7.5 | 7.26E-04 | 0.13 | | |
| 2 | 2353 | af20.0 | 171 | 0.0 | 7.04E-04 | 0.13 | | |
| 2 | 2353 | af25.0 | 168 | -1.7 | 7.06E-04 | 0.13 | | |
| 2 | 2353 | af30.0 | 170 | 6.4 | 7.17E-04 | 0.16 | | |
| 2 | 2353 | af35.0 | 167 | -3.8 | 6.69E-04 | 0.17 | | |
| 2 | 2353 | af40.0 | 174 | -9.4 | 4.94E-04 | 0.27 | | |
| 2 | 2353 | af45.0 | 167 | -3.7 | 7.67E-04 | 0.16 | | |
| 2 | 2353 | af50.0 | 181 | -13.2 | 5.68E-04 | 0.29 | | |
| 2 | 2353 | af55.0 | 184 | -10.2 | 6.54E-04 | 0.19 | | |
| 2 | 2353 | af60.0 | 187 | -15.1 | 7.18E-04 | 0.3 | | |
| 2 | 2353 | af70.0 | 191 | -23.1 | 7.72E-04 | 0.3 | | |
| 3 | 2353 | nrm | 357 | 75.7 | 5.07E-04 | 0.19 | 358.5 | 2 |
| 3 | 2353 | af5.0 | 46.7 | 55.2 | 1.38E-04 | 1.56 | | |
| 3 | 2353 | af7.5 | 100 | 37.2 | 1.31E-04 | 1.96 | | |
| 3 | 2353 | af10.0 | 133 | -34.9 | 1.11E-04 | 0.45 | | |
| 3 | 2353 | af10.0 | 130 | -25.5 | 1.35E-04 | 0.6 | | |
| 3 | 2353 | af15.0 | 153 | -51.6 | 2.12E-04 | 0.42 | | |
| 3 | 2353 | af20.0 | 150 | -47.4 | 1.87E-04 | 0.4 | | |
| 3 | 2353 | af30.0 | 143 | -60.5 | 3.09E-04 | 0.48 | | |
| 4 | 2353 | nrm | 252 | -56.5 | 1.85E-04 | 1.19 | 12.5 | 7 |
| 4 | 2353 | af5.0 | 356 | -53.9 | 3.40E-04 | 0.36 | | |
| 4 | 2353 | af10.0 | 11.1 | -79.7 | 5.23E-04 | 0.18 | | |
| 4 | 2353 | af15.0 | 290 | -79.3 | 6.14E-04 | 0.19 | | |
| 4 | 2353 | af20.0 | 301 | -75.4 | 5.79E-04 | 0.14 | | |
| 4 | 2353 | af25.0 | 123 | -87.9 | 5.54E-04 | 0.11 | | |
| 4 | 2353 | af30.0 | 255 | -76.0 | 5.34E-04 | 0.27 | | |
| 4 | 2353 | af30.0 | 201 | -80.2 | 5.94E-04 | 0.2 | | |
| 4 | 2353 | af35.0 | 259 | -69.9 | 4.70E-04 | 0.23 | | |
| 4 | 2353 | af40.0 | 18.1 | -85.3 | 5.17E-04 | 0.43 | | |
| 5 | 2353 | nrm | 307 | 21.7 | 1.98E-03 | 0.03 | 1.5 | 17 |
| 5 | 2353 | af5.0 | 319 | 34.1 | 5.64E-04 | 0.35 | | |
| 5 | 2353 | af10.0 | 64.8 | -30.1 | 1.08E-04 | 2.56 | | |
| 5 | 2353 | af20.0 | 92.5 | -38.3 | 4.00E-04 | 0.46 | | |
| 5 | 2353 | af30.0 | 100 | -64.5 | 3.18E-04 | 0.74 | | |
| 5 | 2353 | af40.0 | 58.9 | -72.8 | 2.58E-04 | 1.2 | | |

Table 1. continued. **FrohC.dat 43.6N 243.2E -18.5Mag Dec**

| Sm# | Elevation | Demag | Dec. | Inc. | A/m | Err.Ang. | Azm. | Hade |
|---|---|---|---|---|---|---|---|---|
| 11 | 2362 | nrm | 333 | 32.4 | 5.14E-04 | 0.15 | 320.5 | 3 |
| 11 | 2362 | af5.0 | 328 | 27.1 | 3.50E-04 | 0.43 | | |
| 11 | 2362 | af10.0 | 324 | -21.6 | 2.62E-04 | 0.72 | | |
| 11 | 2362 | af20.0 | 330 | -72.7 | 3.80E-04 | 0.51 | | |
| 11 | 2362 | af30.0 | 277 | -50.4 | 3.62E-04 | 0.54 | | |
| 11 | 2362 | af40.0 | 277 | -44.4 | 3.09E-04 | 0.56 | | |
| 12 | 2362 | nrm | 43.3 | 57.3 | 6.50E-04 | 0.27 | 316.5 | -1 |
| 12 | 2362 | af5.0 | 25.4 | 71.9 | 4.38E-04 | 0.21 | | |
| 12 | 2362 | af10.0 | 172 | 83.7 | 1.57E-04 | 0.81 | | |
| 12 | 2362 | af20.0 | 233 | -31.4 | 1.45E-04 | 0.96 | | |
| 12 | 2362 | af30.0 | 235 | 2.1 | 9.62E-05 | 1.72 | | |
| 12 | 2362 | af40.0 | 171 | 13.2 | 1.95E-04 | 1.14 | | |
| 13 | 2363 | nrm | 13.9 | 58.4 | 1.83E-04 | 0.4 | 0.5 | 18 |
| 13 | 2363 | af10.0 | 127 | 44.4 | 1.11E-04 | 0.99 | | |
| 13 | 2363 | af20.0 | 115 | -25.9 | 1.42E-04 | 0.2 | | |
| 13 | 2363 | af20.0 | 132 | -35.7 | 1.20E-04 | 0.13 | | |
| 13 | 2363 | af30.0 | 131 | -36.2 | 1.44E-04 | 0.93 | | |
| 13 | 2363 | af40.0 | 171 | -46.7 | 9.62E-05 | 0.38 | | |
| 14 | 2363 | nrm | 295 | 74.4 | 2.70E-04 | 1.06 | 316.5 | 1 |
| 14 | 2363 | af10.0 | 226 | 76.6 | 1.12E-04 | 0.47 | | |
| 14 | 2363 | af20.0 | 225 | -19.6 | 1.13E-04 | 0.59 | | |
| 14 | 2363 | af30.0 | 195 | -43.0 | 1.27E-04 | 0.93 | | |
| 14 | 2363 | af40.0 | 200 | -22.1 | 9.49E-05 | 1.4 | | |
| 15 | 2363 | nrm | 25.6 | 46.4 | 5.00E-04 | 0.34 | 340.5 | -2 |
| 15 | 2363 | af10.0 | 217 | 69.7 | 9.75E-05 | 0.8 | | |
| 15 | 2363 | af20.0 | 202 | 7.5 | 1.31E-04 | 1.08 | | |
| 15 | 2363 | af30.0 | 162 | -34.9 | 9.20E-05 | 1.74 | | |
| 15 | 2363 | af40.0 | 162 | -27.8 | 9.66E-05 | 2.06 | | |

**FrohD.dat 43.6N 243.2E -18.5Mag Dec**

| Sm# | Elevation | Demag | Dec. | Inc. | A/m | Err.Ang. | Azm. | Hade |
|---|---|---|---|---|---|---|---|---|
| 16 | 2378 | nrm | 348 | 23.1 | 3.71E-04 | 0.09 | 308.5 | 10 |
| 16 | 2378 | nrm | 324 | 23.0 | 4.69E-04 | 0.41 | | |
| 16 | 2378 | af10.0 | 12 | 14.5 | 1.02E-04 | 1.09 | | |
| 16 | 2378 | af20.0 | 58.6 | -55.6 | 6.90E-05 | 0.64 | | |
| 16 | 2378 | af30.0 | 81.2 | -80.1 | 1.20E-04 | 1.37 | | |
| 16 | 2378 | af40.0 | 350 | -81.7 | 1.70E-04 | 0.45 | | |
| 17 | 2378 | nrm | 277 | 25.0 | 2.51E-04 | 1.46 | 306.5 | 10 |
| 17 | 2378 | af10.0 | 316 | -31.9 | 1.44E-04 | 0.34 | | |
| 17 | 2378 | af20.0 | 287 | -43.6 | 1.78E-04 | 0.54 | | |
| 17 | 2378 | af30.0 | 271 | -68.1 | 1.35E-04 | 0.27 | | |
| 17 | 2378 | af40.0 | 219 | -75.5 | 2.24E-04 | 0.52 | | |
| 18 | 2378 | nrm | 311 | 39.2 | 4.64E-04 | 0.4 | 284.5 | 11 |
| 18 | 2378 | af10.0 | 283 | 9.9 | 1.76E-04 | 1.61 | | |
| 18 | 2378 | af20.0 | 213 | -5.0 | 2.03E-04 | 0.31 | | |
| 18 | 2378 | af30.0 | 236 | -12.7 | 1.86E-04 | 1.2 | | |
| 18 | 2378 | af40.0 | 224 | -40.1 | 1.48E-04 | 0.81 | | |
| 19 | 2378 | nrm | 13.6 | 1.3 | 2.72E-04 | 0.59 | 294.5 | 9 |
| 19 | 2378 | af10.0 | 269 | -39.3 | 7.06E-05 | 0.96 | | |
| 19 | 2378 | af20.0 | 188 | -35.5 | 2.13E-04 | 0.25 | | |
| 19 | 2378 | af30.0 | 185 | -47.1 | 1.40E-04 | 0.95 | | |
| 19 | 2378 | af40.0 | 192 | -41.2 | 1.65E-04 | 0.5 | | |
| 20 | 2378 | nrm | 296 | 62.8 | 3.26E-04 | 0.76 | 299.5 | 12 |
| 20 | 2378 | af10.0 | 91.2 | 80.1 | 1.91E-04 | 0.84 | | |
| 20 | 2378 | af20.0 | 198 | -8.7 | 1.12E-04 | 0.41 | | |
| 20 | 2378 | af30.0 | 165 | 4.6 | 1.09E-04 | 0.96 | | |
| 20 | 2378 | af40.0 | 193 | -11.3 | 1.18E-04 | 0.73 | | |

Table 1. continued. **FrohE.dat 43.6N 243.2E -18.5MagDec**

| Sm# | Elevation | Demag | Dec. | Inc. | A/m | Err.Ang. | Azm. | Hade |
|---|---|---|---|---|---|---|---|---|
| 21 | 2398 | nrm | 116 | 64.6 | 3.02E-04 | 0.17 | 57.5 | 4 |
| 21 | 2398 | nrm | 122 | 68.4 | 2.73E-04 | 0.18 | | |
| 21 | 2398 | af10.0 | 169 | 47.4 | 8.58E-05 | 0.69 | | |
| 21 | 2398 | af20.0 | 179 | 17.8 | 6.61E-05 | 0.67 | | |
| 21 | 2398 | af30.0 | 217 | -20.4 | 3.33E-05 | 0.99 | | |
| 21 | 2398 | af40.0 | 178 | 23.2 | 5.45E-05 | 0.67 | | |
| 22 | 2398 | nrm | 163 | 16.6 | 5.83E-04 | 0.32 | 54.5 | 14 |
| 22 | 2398 | af10.0 | 199 | -34.6 | 2.95E-04 | 0.41 | | |
| 22 | 2398 | af20.0 | 210 | -25.7 | 3.16E-04 | 0.28 | | |
| 22 | 2398 | af30.0 | 217 | -21.4 | 3.58E-04 | 0.48 | | |
| 22 | 2398 | af40.0 | 207 | -10.5 | 2.08E-04 | 0.29 | | |
| 23 | 2398 | nrm | 4.8 | 7.1 | 1.24E-03 | 0.11 | 303.5 | 3 |
| 23 | 2398 | af10.0 | 30.7 | -40.6 | 5.64E-04 | 0.01 | | |
| 23 | 2398 | af20.0 | 30 | -50.5 | 6.47E-04 | 0.04 | | |
| 23 | 2398 | af30.0 | 27.4 | -47.8 | 5.77E-04 | 0.01 | | |
| 23 | 2398 | af40.0 | 23.8 | -50.9 | 6.05E-04 | 0.07 | | |
| 23 | 2398 | af60.0 | 8.8 | -52.5 | 4.64E-04 | 0.13 | | |

**FrohF.dat 43.6N 243.2E -18.5Mag Dec**

| Sm# | Elevation | Demag | Dec. | Inc. | A/m | Err.Ang. | Azm. | Hade |
|---|---|---|---|---|---|---|---|---|
| 33 | 2423 | nrm | 127 | 73.3 | 8.71E-04 | 0.16 | 113.5 | 11 |
| 33 | 2423 | af10.0 | 124 | 82.8 | 4.50E-04 | 0.15 | | |
| 33 | 2423 | af20.0 | 224 | 44.6 | 2.21E-04 | 0.36 | | |
| 33 | 2423 | af30.0 | 220 | 16.4 | 1.65E-04 | 0.63 | | |
| 33 | 2423 | af40.0 | 243 | 67.6 | 1.96E-04 | 0.37 | | |
| 33 | 2423 | af50.0 | 225 | 24.3 | 1.87E-04 | 0.48 | | |
| 34 | 2423 | nrm | 157 | 63.4 | 1.00E-03 | 0.21 | 61.5 | 10 |
| 34 | 2423 | af10.0 | 215 | 49.8 | 4.30E-04 | 0.09 | | |
| 34 | 2423 | af20.0 | 218 | 9.2 | 4.07E-04 | 0.6 | | |
| 34 | 2423 | af30.0 | 223 | 3.6 | 3.19E-04 | 0.54 | | |
| 34 | 2423 | af40.0 | 240 | -0.2 | 3.27E-04 | 0.72 | | |
| 34 | 2423 | af50.0 | 221 | -18.3 | 3.22E-04 | 0.48 | | |
| 35 | 2423 | nrm | 23.6 | 53.5 | 1.36E-03 | 0.11 | 104.5 | 3 |
| 35 | 2423 | af10.0 | 5.5 | 66.7 | 5.95E-04 | 0.6 | | |
| 35 | 2423 | af20.0 | 6 | 54.8 | 4.15E-04 | 1 | | |
| 35 | 2423 | af30.0 | 43.6 | 59.9 | 5.46E-04 | 0.21 | | |
| 35 | 2423 | af40.0 | 114 | 75.9 | 3.87E-04 | 0.63 | | |
| 35 | 2423 | af50.0 | 106 | 73.7 | 3.71E-04 | 0.23 | | |
| 35 | 2423 | af60.0 | 144 | 76.7 | 3.29E-04 | 1.02 | | |
| 36 | 2423 | nrm | 32.7 | 37.0 | 1.26E-03 | 0.14 | 63.5 | 5 |
| 36 | 2423 | af20.0 | 356 | 19.1 | 1.86E-04 | 1.13 | | |
| 36 | 2423 | af30.0 | 358 | -41.7 | 9.63E-05 | 1.56 | | |
| 36 | 2423 | af40.0 | 324 | -17.0 | 1.48E-04 | 1.17 | | |
| 36 | 2423 | af50.0 | 303 | -33.6 | 1.18E-04 | 1.43 | | |
| 37 | 2423 | nrm | 37.2 | 45.9 | 1.53E-03 | 0.07 | 79.5 | -2 |
| 37 | 2423 | af20.0 | 339 | 27.1 | 3.64E-04 | 0.61 | | |
| 37 | 2423 | af30.0 | 332 | 49.9 | 3.22E-04 | 0.66 | | |
| 37 | 2423 | af40.0 | 323 | 77.7 | 1.04E-04 | 1.21 | | |
| 37 | 2423 | af50.0 | 285 | 41.2 | 2.01E-04 | 0.64 | | |
| 37 | 2423 | af60.0 | 221 | 19.1 | 1.95E-04 | 0.81 | | |

Table 1. continued. **FrohG.dat 43.6N 243.2E -18.5Mag Dec**

| Sm# | Elevation | Demag | Dec. | Inc. | A/m | Err.Ang. | Azm. | Hade |
|---|---|---|---|---|---|---|---|---|
| 28 | 2443 | nrm | 29.1 | 60.6 | 5.71E-04 | 0.27 | 318.5 | 38 |
| 28 | 2443 | af10.0 | 348 | 17.5 | 1.11E-04 | 0.72 | | |
| 28 | 2443 | af20.0 | 306 | -54.3 | 5.57E-05 | 0.64 | | |
| 28 | 2443 | af30.0 | 231 | -58.8 | 8.35E-05 | 1.96 | | |
| 28 | 2443 | af40.0 | 138 | -45.5 | 7.34E-05 | 1.92 | | |
| 29 | 2443 | nrm | 33.4 | 47.4 | 2.61E-04 | 0.7 | 12.5 | 22 |
| 29 | 2443 | af10.0 | 60.7 | 10.9 | 7.06E-05 | 2.68 | | |
| 29 | 2443 | af20.0 | 91.6 | -37.2 | 9.90E-05 | 1.12 | | |
| 29 | 2443 | af30.0 | 344 | -60.5 | 9.30E-05 | 1.01 | | |
| 29 | 2443 | af40.0 | 149 | -73.5 | 5.45E-05 | 2.8 | | |
| 30 | 2443 | nrm | 18.7 | 33.6 | 8.28E-04 | 0.22 | 302.5 | 40 |
| 30 | 2443 | af10.0 | 47 | 34.3 | 2.12E-04 | 1.13 | | |
| 30 | 2443 | af20.0 | 359 | 62.1 | 1.04E-04 | 1.95 | | |
| 30 | 2443 | af30.0 | 337 | 27.8 | 6.25E-05 | 3.08 | | |
| 30 | 2443 | af40.0 | 213 | -4.4 | 1.12E-04 | 1.02 | | |
| 31 | 2443 | nrm | 347 | 84.2 | 4.55E-04 | 0.45 | 335.5 | 13 |
| 31 | 2443 | af10.0 | 59.4 | 55.6 | 1.97E-04 | 1.05 | | |
| 31 | 2443 | af20.0 | 79.9 | 54.0 | 8.30E-05 | 1.22 | | |
| 31 | 2443 | af30.0 | 351 | -23.0 | 4.57E-05 | 2.47 | | |
| 31 | 2443 | af40.0 | 4.5 | -35.1 | 4.96E-05 | 2.86 | | |
| 32 | 2443 | nrm | 8 | 41.0 | 6.27E-04 | 0.22 | 32.5 | 10 |
| 32 | 2443 | af10.0 | 72.8 | 40.6 | 1.33E-04 | 1.79 | | |
| 32 | 2443 | af20.0 | 53.6 | 6.5 | 4.38E-05 | 2.06 | | |
| 32 | 2443 | af30.0 | 248 | -52.0 | 8.94E-05 | 1.23 | | |
| 32 | 2443 | af40.0 | 86.8 | 7.0 | 8.65E-05 | 2.19 | | |

**FrohH.dat 43.6N 243.2E -18.5Mag Dec**

| Sm# | Elevation | Demag | Dec. | Inc. | A/m | Err.Ang. | Azm. | Hade |
|---|---|---|---|---|---|---|---|---|
| 24 | 2470 | nrm | 294 | 41.3 | 7.73E-04 | 0.19 | 237.5 | 0 |
| 24 | 2470 | af10.0 | 299 | 29.1 | 2.60E-04 | 0.31 | | |
| 24 | 2470 | af20.0 | 299 | -7.5 | 1.15E-04 | 0.48 | | |
| 24 | 2470 | af30.0 | 291 | -35.0 | 1.18E-04 | 0.31 | | |
| 24 | 2470 | af40.0 | 265 | -33.0 | 9.43E-05 | 0.7 | | |
| 25 | 2470 | nrm | 2.3 | 81.5 | 1.08E-03 | 0.13 | 233.5 | 3 |
| 25 | 2470 | af10.0 | 335 | 70.0 | 2.90E-04 | 0.34 | | |
| 25 | 2470 | af20.0 | 321 | 60.5 | 1.16E-04 | 1.42 | | |
| 25 | 2470 | af30.0 | 20.7 | 57.4 | 7.52E-05 | 2.74 | | |
| 25 | 2470 | af40.0 | 189 | 69.8 | 1.29E-04 | 1.53 | | |
| 26 | 2470 | nrm | 229 | 64.9 | 5.31E-04 | 0.26 | 239.5 | 1 |
| 26 | 2470 | af10.0 | 271 | 53.1 | 2.70E-04 | 0.98 | | |
| 26 | 2470 | af20.0 | 263 | 17.9 | 9.43E-05 | 1.34 | | |
| 26 | 2470 | af30.0 | 277 | -5.3 | 4.01E-05 | 5.01 | | |
| 26 | 2470 | af40.0 | 181 | -50.3 | 6.00E-05 | 1.59 | | |
| 27 | 2470 | nrm | 320 | 63.8 | 9.76E-04 | 0.19 | 235.5 | 0 |
| 27 | 2470 | af10.0 | 274 | 8.5 | 1.49E-04 | 1.66 | | |
| 27 | 2470 | af20.0 | 291 | -34.8 | 2.06E-04 | 0.17 | | |
| 27 | 2470 | af30.0 | 273 | -36.3 | 3.12E-04 | 1.17 | | |
| 27 | 2470 | af40.0 | 267 | -40.9 | 2.89E-04 | 1.47 | | |

Table 1. continued. **Frohl.dat 43.6N 243.2E -18.5Mag Dec**

| Sm# | Elevation | Demag | Dec. | Inc. | A/m | Err.Ang. | Azm. | Hade |
|---|---|---|---|---|---|---|---|---|
| 38 | 2477 | nrm | 359 | 41.0 | 8.06E-04 | 0.1 | 35.5 | 9 |
| 38 | 2477 | nrm | 12.1 | 51.2 | 7.99E-04 | 0.11 | | |
| 38 | 2477 | af10.0 | 33.8 | 67.3 | 3.50E-04 | 0.06 | | |
| 38 | 2477 | af20.0 | 352 | 61.9 | 1.32E-04 | 0.28 | | |
| 38 | 2477 | af30.0 | 303 | 76.1 | 7.40E-05 | 0.23 | | |
| 38 | 2477 | af40.0 | 237 | 74.5 | 9.19E-05 | 0.28 | | |
| 39 | 2477 | nrm | 67.5 | 55.0 | 5.46E-04 | 0.17 | 51.5 | 30 |
| 39 | 2477 | nrm | 62.5 | 63.6 | 5.43E-04 | 0.22 | | |
| 39 | 2477 | af10.0 | 105 | 63.2 | 2.50E-04 | 0.09 | | |
| 39 | 2477 | af20.0 | 126 | 47.2 | 7.94E-05 | 0.58 | | |
| 39 | 2477 | af30.0 | 156 | 13.4 | 1.19E-04 | 0.25 | | |
| 39 | 2477 | af40.0 | 160 | 19.7 | 6.60E-05 | 0.61 | | |
| 40 | 2477 | nrm | 23 | 40.7 | 4.19E-04 | 0.46 | 24.5 | 14 |
| 40 | 2477 | nrm | 45.5 | 47.1 | 5.08E-04 | 0.07 | | |
| 40 | 2477 | af10.0 | 109 | 56.0 | 2.36E-04 | 0.24 | | |
| 40 | 2477 | af20.0 | 122 | 12.1 | 1.56E-04 | 0.18 | | |
| 40 | 2477 | af30.0 | 141 | 10.7 | 1.25E-04 | 0.35 | | |
| 40 | 2477 | af40.0 | 154 | 9.5 | 1.12E-04 | 0.33 | | |
| 41 | 2478 | nrm | 94 | 27.5 | 2.59E-04 | 0.72 | 71.5 | 4 |
| 41 | 2478 | nrm | 81.7 | 41.4 | 2.77E-04 | 0.09 | | |
| 41 | 2478 | af10.0 | 157 | 2.5 | 2.04E-04 | 0.21 | | |
| 41 | 2478 | af20.0 | 170 | -16.9 | 1.84E-04 | 0.25 | | |
| 41 | 2478 | af30.0 | 180 | -23.2 | 1.47E-04 | 0.27 | | |
| 41 | 2478 | af40.0 | 166 | -16.1 | 1.23E-04 | 0.3 | | |
| 42 | 2478 | nrm | 219 | 76.1 | 5.12E-04 | 0.05 | 94.5 | 10 |
| 42 | 2478 | af10.0 | 215 | 40.0 | 2.83E-04 | 0.21 | | |
| 42 | 2478 | af20.0 | 204 | -9.2 | 1.97E-04 | 0.2 | | |
| 42 | 2478 | af30.0 | 203 | 2.0 | 1.64E-04 | 0.24 | | |
| 42 | 2478 | af40.0 | 204 | 3.3 | 1.97E-04 | 0.23 | | |
| 43 | 2478 | nrm | 300 | 51.3 | 6.20E-04 | 0.03 | 313.5 | 5 |
| 43 | 2478 | af10.0 | 339 | 33.4 | 3.50E-04 | 0.07 | | |
| 43 | 2478 | af20.0 | 342 | 10.3 | 2.76E-04 | 0.09 | | |
| 43 | 2478 | af30.0 | 341 | -3.8 | 2.47E-04 | 0.08 | | |
| 43 | 2478 | af40.0 | 351 | -11.6 | 2.49E-04 | 0.12 | | |
| 43 | 2478 | af60.0 | 351 | -18.0 | 1.72E-04 | 0.17 | | |

**FrohJ.dat 43.6N 243.2E -18.5Mag Dec**

| Sm# | Elevation | Demag | Dec. | Inc. | A/m | Err.Ang. | Azm. | Hade |
|---|---|---|---|---|---|---|---|---|
| 44 | 2521 | nrm | 119 | -37.8 | 1.26E-03 | 0 | 37.5 | 4 |
| 44 | 2521 | af10.0 | 156 | -57.7 | 1.09E-03 | 0.03 | | |
| 44 | 2521 | af20.0 | 164 | -57.6 | 9.83E-04 | 0.07 | | |
| 44 | 2521 | af30.0 | 171 | -56.7 | 7.87E-04 | 0.04 | | |
| 44 | 2521 | af40.0 | 166 | -56.3 | 6.63E-04 | 0.04 | | |
| 45 | 2521 | nrm | 128 | -45.1 | 1.50E-03 | 0.04 | 352.5 | 29 |
| 45 | 2521 | af10.0 | 169 | -60.6 | 1.52E-03 | 0.03 | | |
| 45 | 2521 | af20.0 | 171 | -59.3 | 1.43E-03 | 0.03 | | |
| 45 | 2521 | af30.0 | 174 | -60.0 | 1.29E-03 | 0.02 | | |
| 45 | 2521 | af40.0 | 176 | -58.4 | 1.08E-03 | 0.07 | | |
| 46 | 2521 | nrm | 123 | -43.4 | 2.17E-03 | 0.04 | 33.5 | 33 |
| 46 | 2521 | af10.0 | 172 | -62.4 | 1.95E-03 | 0.01 | | |
| 46 | 2521 | af20.0 | 175 | -63.0 | 1.76E-03 | 0.03 | | |
| 46 | 2521 | af30.0 | 176 | -61.3 | 1.54E-03 | 0.02 | | |
| 46 | 2521 | af40.0 | 176 | -61.9 | 1.29E-03 | 0.03 | | |

Table 1. continued. **FrohK.dat 43.6N 243.2E -18.5Mag Dec**

| Sm# | Elevation | Demag | Dec. | Inc. | A/m | Err.Ang. | Azm. | Hade |
|---|---|---|---|---|---|---|---|---|
| 53 | 2552 | nrm | 69 | 50.3 | 1.40E-03 | 0.06 | 96.5 | 14 |
| 53 | 2552 | af10.0 | 82.6 | 51.6 | 3.59E-04 | 0.06 | | |
| 53 | 2552 | af20.0 | 69.7 | 15.6 | 9.14E-05 | 0.53 | | |
| 53 | 2552 | af30.0 | 174 | -31.0 | 6.87E-05 | 0.75 | | |
| 53 | 2552 | af40.0 | 250 | 35.8 | 1.51E-04 | 0.45 | | |
| 54 | 2552 | nrm | 81.2 | 50.2 | 1.47E-03 | 0.05 | 91.5 | 27 |
| 54 | 2552 | af10.0 | 102 | -1.4 | 2.87E-04 | 0.09 | | |
| 54 | 2552 | af20.0 | 140 | -35.1 | 2.78E-04 | 0.31 | | |
| 54 | 2552 | af30.0 | 154 | -31.7 | 2.67E-04 | 0.08 | | |
| 54 | 2552 | af40.0 | 141 | -22.0 | 2.57E-04 | 0.14 | | |
| 55 | 2552 | nrm | 107 | 80.8 | 9.72E-04 | 0.16 | 99.5 | 41 |
| 55 | 2552 | af10.0 | 186 | 67.1 | 2.41E-04 | 0.08 | | |
| 55 | 2552 | af20.0 | 141 | 3.7 | 1.97E-04 | 0.18 | | |
| 55 | 2552 | af30.0 | 164 | -13.9 | 1.43E-04 | 0.28 | | |
| 55 | 2552 | af40.0 | 133 | 54.6 | 4.30E-05 | 0.79 | | |

**FrohL.dat 43.6N 243.2E -18.5Mag Dec**

| Sm# | Elevation | Demag | Dec. | Inc. | A/m | Err.Ang. | Azm. | Hade |
|---|---|---|---|---|---|---|---|---|
| 49 | 2612 | nrm | 54.2 | -23.1 | 9.87E-05 | 0.36 | 324.5 | 10 |
| 49 | 2612 | af10.0 | 197 | -72.9 | 2.36E-04 | 0.24 | | |
| 49 | 2612 | af20.0 | 191 | -63.0 | 2.54E-04 | 0.12 | | |
| 49 | 2612 | af30.0 | 173 | -65.7 | 2.20E-04 | 0.11 | | |
| 49 | 2612 | af40.0 | 166 | -74.5 | 1.74E-04 | 0.46 | | |
| 50 | 2613 | nrm | 187 | -56.6 | 2.02E-03 | 0.04 | 333.5 | 10 |
| 50 | 2613 | af10.0 | 185 | -59.3 | 2.10E-03 | 0.01 | | |
| 50 | 2613 | af20.0 | 187 | -58.4 | 1.91E-03 | 0.01 | | |
| 50 | 2613 | af30.0 | 187 | -60.2 | 1.76E-03 | 0.02 | | |
| 50 | 2613 | af40.0 | 190 | -58.6 | 1.61E-03 | 0.01 | | |
| 51 | 2612 | nrm | 174 | -29.1 | 1.77E-04 | 0.2 | 318.5 | 22 |
| 51 | 2612 | af10.0 | 181 | -54.8 | 3.94E-04 | 0.17 | | |
| 51 | 2612 | af20.0 | 183 | -53.3 | 3.86E-04 | 0.16 | | |
| 51 | 2612 | af30.0 | 189 | -53.5 | 3.45E-04 | 0.1 | | |
| 51 | 2612 | af40.0 | 178 | -51.9 | 2.83E-04 | 0.06 | | |
| 52 | 2613 | nrm | 171 | -52.0 | 2.33E-03 | 0.02 | 318.5 | 8 |
| 52 | 2613 | af10.0 | 172 | -52.9 | 2.40E-03 | 0.03 | | |
| 52 | 2613 | af20.0 | 170 | -54.2 | 2.16E-03 | 0.03 | | |
| 52 | 2613 | af30.0 | 173 | -52.8 | 1.96E-03 | 0.02 | | |
| 52 | 2613 | af40.0 | 176 | -52.8 | 1.82E-03 | 0.03 | | |