**A Paleomagnetic Reanalysis of the Auborus Formation, Namibia**

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## ABSTRACT

The Mesoproterozoic Auborus Formation, located in the Sinclair district of southern Namibia, was last studied paleomagnetically by Piper (1975) and required further sampling in order to calculate a robust paleomagnetic pole. In 2011 and 2012, 342 block samples and drill cores were collected from 13 localities in the Auborus Formation and underwent the process of thermal demagnetization in the Yale Paleomagnetic Facility. After vector analysis, the new results show broad agreement with Piper's findings, but also demonstrate a geomagnetic reversal in the Auborus stratigraphy, a positive conglomerate test indicating primary magnetization, and a positive fold test indicating magnetization acquired either prior to or during the earliest stages of regional folding. The new Auborus paleomagnetic pole, at 53.2° N and 018.8° E with an $A_{95}$ value of 2.6°, is located on the apparent polar wander path of the Kalahari craton, between poles of the 1110-Ma Umkondo igneous event and the ca. 1090-Ma Kalkpunt redbeds of the Koras Group near Upington, South Africa. This distinctive concordance suggests that the Auborus sediments have an age of approximately 1100 Ma, that the Sinclair region was autochthonous to the Kalahari craton at that time, and that the Auborus and Kalkpunt redbeds are broadly correlative.


## INTRODUCTION

Paleomagnetism of Proterozoic rocks can provide important insights into global and regional continental reconstructions, as well as the behavior of the ancient geomagnetic field. Along the western margin of the Kalahari craton in southern Namibia, late Mesoproterozoic volcanic and sedimentary rocks of the Sinclair region are locally preserved at subgreenschist metamorphic grade, thus amenable to paleomagnetic study. The Kalahari craton itself is a disputed element of Rodinia reconstructions (e.g., Li et al., 2008; Evans, 2009), and it remains to be seen if the Sinclair region was autochthonous to the craton.

The youngest unit in the Sinclair succession is the Auborus Formation, comprising redbeds deposited after the cessation of Sinclair magmatism and during the waning stages of regional deformation. A previous study (Piper, 1975) of the Auborus Formation, utilizing data only from the natural remanent magnetization (NRM) of 36 samples, found a well-clustered, single-polarity direction differing from the present field at the 8 sampling localities. That study determined an 18° paleolatitude for the Auborus sediments, and an estimated age, based on similarity of paleomagnetic remanence directions, only slightly younger than the lower Sinclair group. With a greater sampling size, proper thermal demagnetization, and field stability tests (fold and conglomerate), the Auborus Formation is likely to produce a high-quality paleomagnetic pole, and to reveal more about the paleogeography of the Sinclair region and Kalahari craton.

## REGIONAL GEOLOGY

The Sinclair group consists of a succession of mostly undeformed and unmetamorphosed Mesoproterozoic volcanic and sedimentary rocks dating from 1.2-1.1 Ga (Watters, 1974; SACS, 1980; Becker et. al., 2006). Sinclair-correlative rocks occur in fault-bounded centers of deposition in an arcuate structure 100 km wide and at least 200 km long (Figure 1). In addition to the southern boundary of the Hauchab-Excelsior-Lord Hill shear zone, the NNW-SSE directed Nam shear zone to the north separates the group from the Rehoboth terrane (Figure 2). Bimodal volcanism and epicontinental sedimentation, with some intrusions of batholithic granites, resulted in the Sinclair Group (Becker et. al., 2006). The Sinclair tectonic setting has been compared either to a rift (Borg, 1988) or a subduction arc (Hoal, 1993). The Sinclair Group has undergone three episodes of minor deformation, and greenschist facies metamorphism especially noticeable in the western Awasib Mountain Terrain, where there seems to have been a continental margin (Hoal & Heaman, 1995). Later, different parts of the Sinclair Group were intruded by mafic to felsic dyke swarms (Hoal, 1993).

Deposited in fault-bounded troughs and pull apart-basins representing synchronous uplift and quiescence, the sediments of the Kunjas Formation are the oldest in the Sinclair group. These sediments are disconformably overlain by the 3000 m thick volcanic Barby Formation, which continues along the same northwest-striking troughs (Hoal, 1993). The earliest igneous rocks in this formation were mostly basaltic andesites dated with U-Pb at 1215-1220 Ma (Hoal & Heaman, 1995), but eventually rhyolites became dominant. The third cycle of the Sinclair group is marked by sandstone and conglomerates overlain by the rhyolitic extrusives and basic lava of the Guperas Formation. The magmatic event that formed the Sinclair Group ends with the post-collisional intrusion of the Sonntag and Rooiberg granites and bimodal dyke swarms (Hoal, 1993).

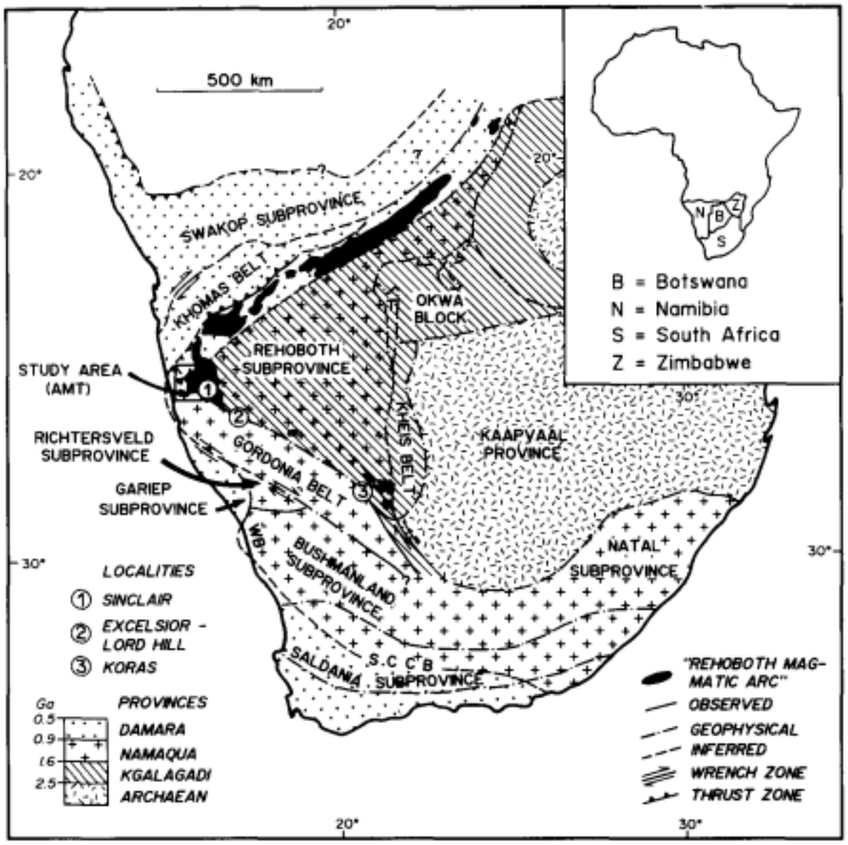



**Figure 1**: Geologic map of southern Africa (Hoal 1993).

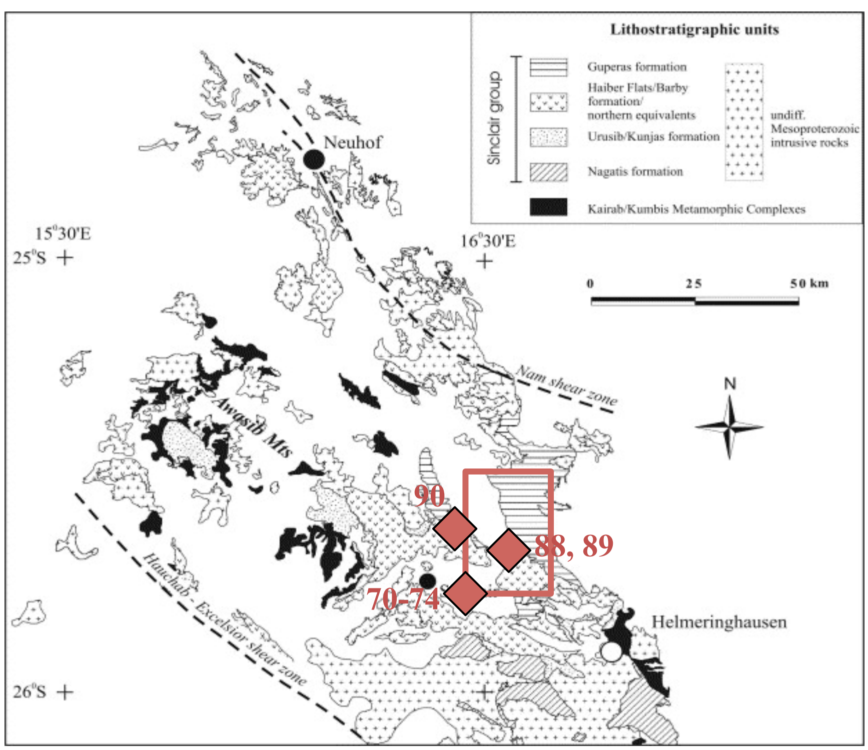



**Figure 2**: Geologic formations of the Sinclair group (Becker et al., 2006). Red box indicates the location of Figure 5, and red diamonds indicate the Auborus localities sampled by Piper (1975).

Finally, the Sinclair Group was overlain by the Auborus Formation, a 2600-m thick redbed unit deposited in a north-south oriented synclinal basin (Piper, 1975). The formation outcrops in two parallel, north-south trending bands of approximately 40 km in length. These bands are separated laterally by a 16-km wide horst block containing lavas and sediments from the underlying Guperas Formation. The Auborus sediments were deposited in a shallow basin whose subsidence was contemporaneous with deposition. The sediments experienced north-south block faulting, local tilting and gentle folding, and erosion before the Nama group was unconformably deposited across the Sinclair region during the Ediacaran-Cambrian transition (Miller, 1969; Watters, 1974).

The basal conglomerate of the Auborus Formation ranges in thickness from 360 to 1000 m. It is clast-supported, with clasts ranging in size from pebble to cobble, with subangular to subrounded characteristics. Clast sphericity increases towards the top of the conglomerate. Most clasts are sourced from Sinclair lavas. Above the basal conglomerate lie sandstones and siltstones of varying thicknesses; grit beds are commonly interspersed. Grains are arkosic and very well sorted. Bedding ranges in character from laminar units of order dm in thickness, indicating frequent inundations by shallow water, to massive beds up to 3 m. However, in some areas, ripple-bedded shales are overlain by mudcracks, indicating intermittent exposure. Cross-bedding, ranging in thickness from 0.6 to 2 m, may also be found throughout the formation; from these structures, the paleocurrent appears to be from northwest to southeast (Miller, 1969). Representative sedimentary structures are depicted in Figure 3.

## METHODS

During two four-week sampling seasons in summers 2011 and 2012, landowners' permission was requested for scouting and sampling. Reconnaissance was then performed to pick several sampling localities for the Auborus, and ultimately 342 oriented blocks and portable drill cores were collected through most of the thickness of the Auborus Formation to attempt a magnetostratigraphy. Cores drilled were 10 cm long, and were oriented with an orientation device, sun compass, and Brunton with dip meter (Figure 4).

The localities sampled in our paleomagnetic study are shown on a satellite image in Figure 5 and on the geologic map of Miller (2008) in Figure 6. We sampled stratigraphic

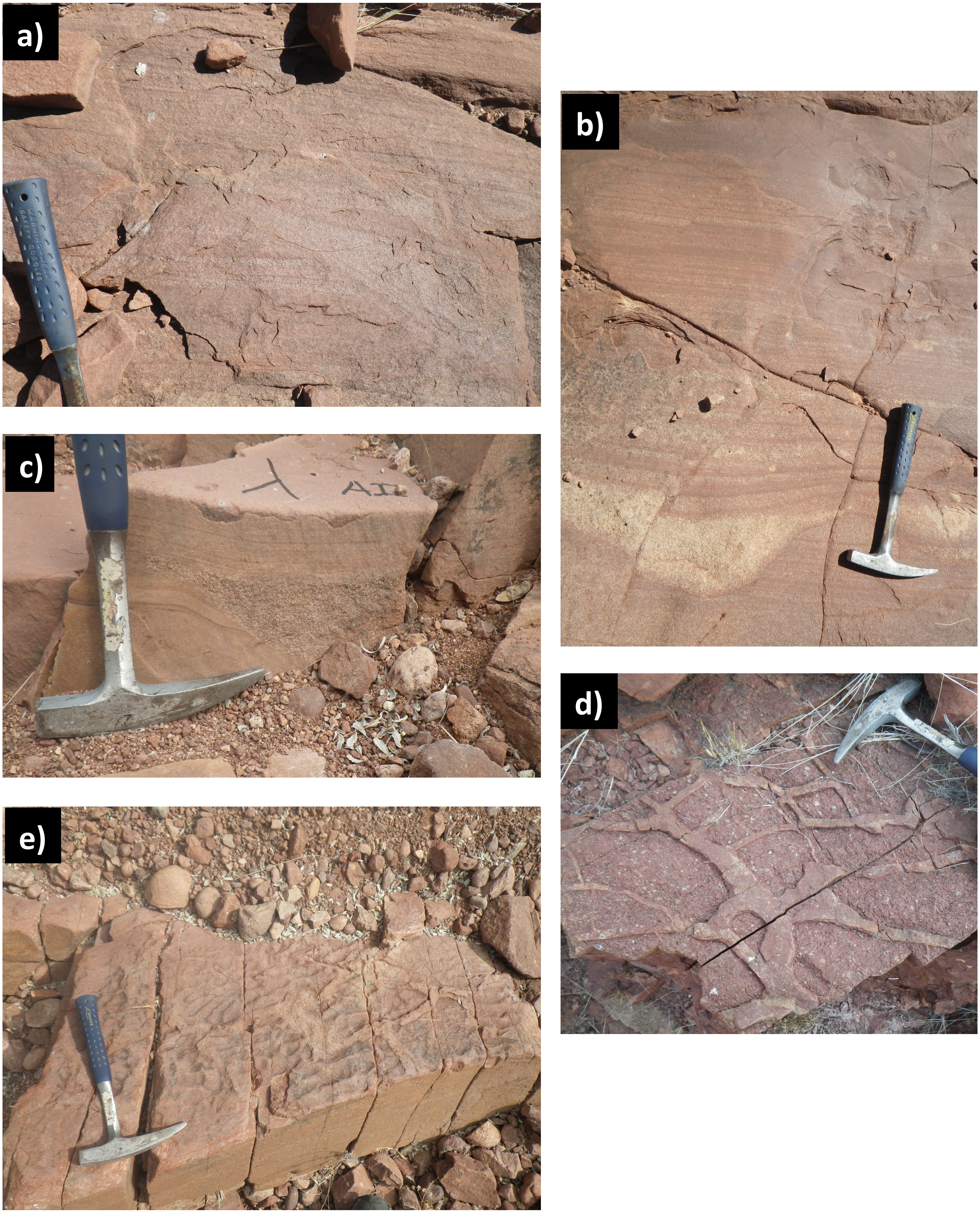



**Figure 3**: Sample sedimentary structures in the Auborus Formation: a) Convoluted crossbeds at JK1205. b) Trough cross bedding at JK1205. c) Trough crossbed with gritty infill at JK1206. d) Mudcracks at JK1206. e) Bedding plane ripples at JK1206.


**Figure 4**: Elements of field sampling: a) Surveying for potential outcrops on Farm Aruab. b) Marking samples to drill at JK1203. c) Drilling cores at JK1201. d) Orienting cores with orienting device at JP1150. e) Taking bedding measurements at JK1206. f) Labeling samples at JK1205. g) Getting back to camp near JK1206.

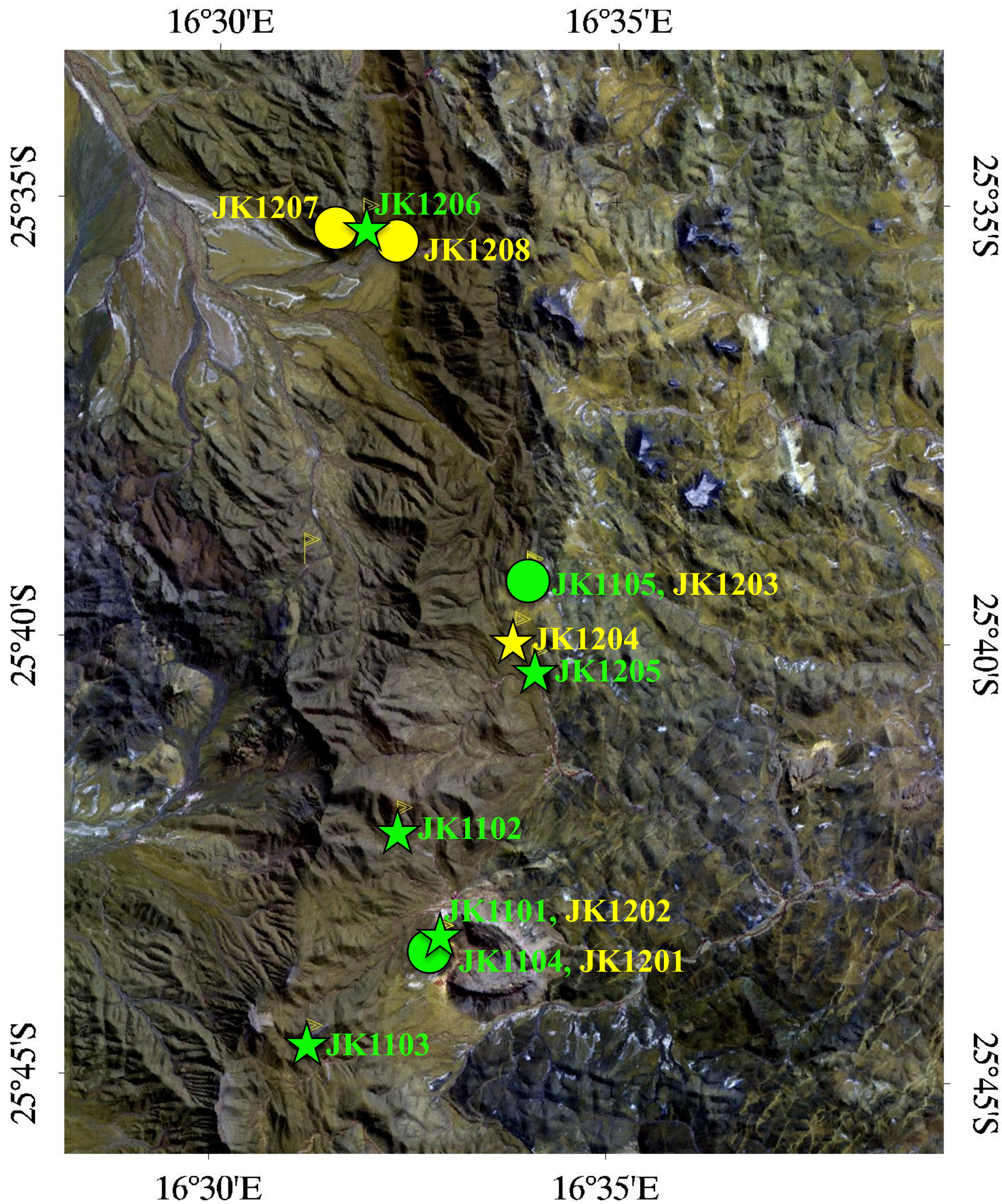



**Figure 5**: ASTER image (pixel size 15 m) depicting paleomagnetic sampling localities from summers 2011 and 2012. Stars represent the starting point of stratigraphic sections sampled; circles represent localities sampled for a conglomerate test. Results from green localities are presented in this study; yellow localities are still undergoing thermal demagnetization.

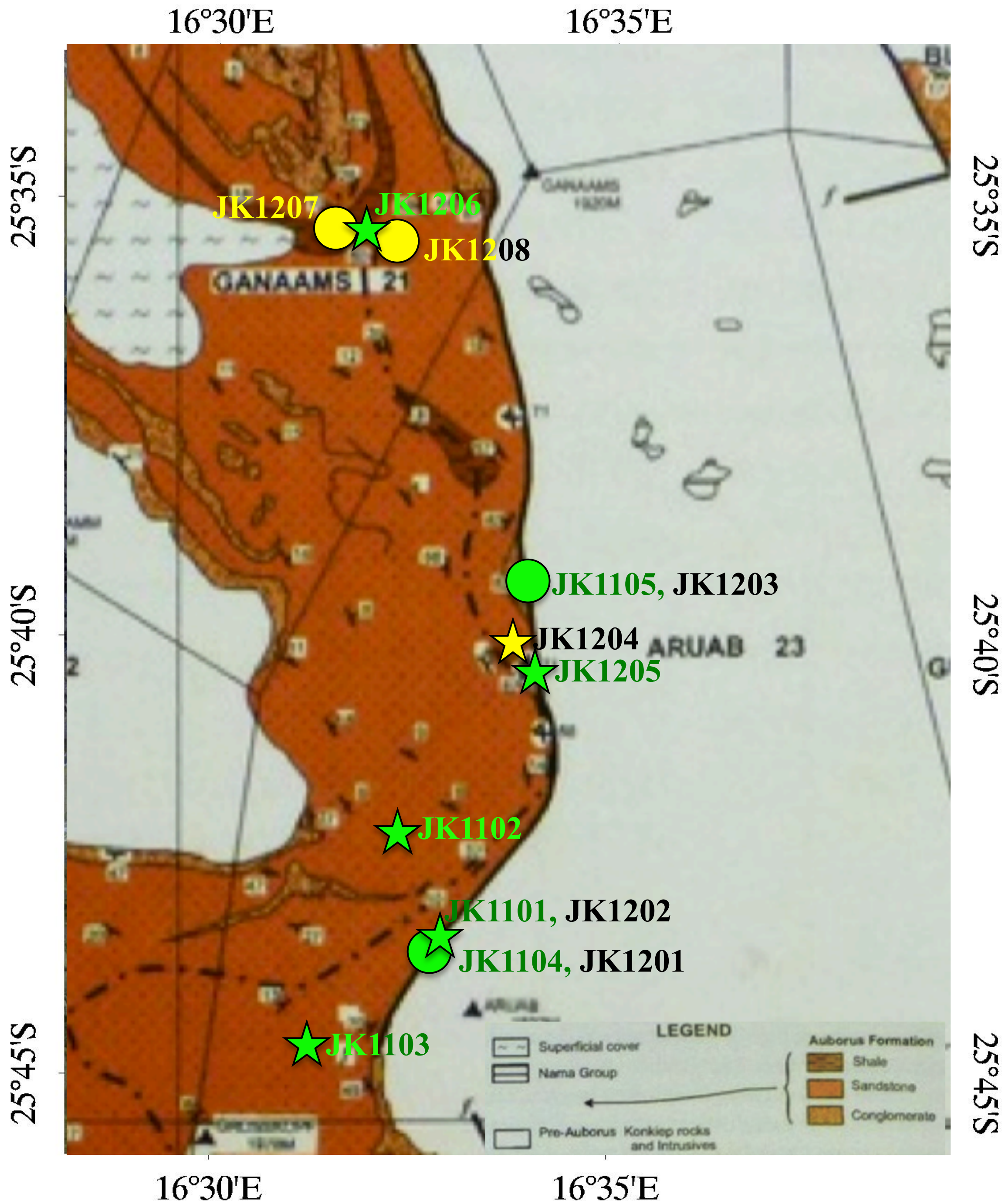



**Figure 6**: Paleomagnetic sampling localities overlain on geologic map of Miller (2008). Stars represent the starting point of stratigraphic sections sampled; circles represent localities sampled for a conglomerate test. Results from green localities are presented in this study; yellow localities are still undergoing thermal demagnetization.

sections in different limbs and up the hinge of a broad, upright, gently refolded syncline in order to perform a fold test; descriptions of each locality may be found in Figure 7. Because the sections sampled were 100s of meters in thickness, we took detailed stratigraphic observations only at locality JK1101 (Figure 8), although stratigraphic heights were logged for each paleomagnetic sample. We also sampled both clasts and matrix from four conglomerates in the unit for a conglomerate test (Figure 9).

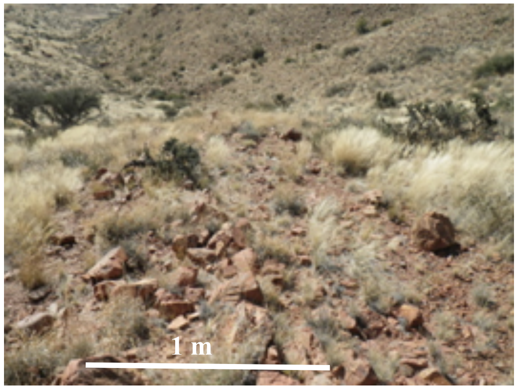
Samples were then prepared with a diamond-bladed rock saw to be cylinders one inch wide and one cm thick, or prisms 2 cm x 2 cm x 1cm. They were analyzed in the Yale Paleomagnetic Facility with a cryogenic DC-SQuID magnetometer with automated sample changer. NRM measurements were taken, and then the rocks were analyzed after a liquid nitrogen bath and seventeen thermal demagnetization temperature steps of decreasing intervals up to 685° C, when specimen intensity dropped below noise level. Oven runs were conducted in a controlled $N_2$ atmosphere. Each sample's magnetic components were resolved with principal component analysis (Kirschvink, 1980), listed in Appendix 1.

## RESULTS

Due to a computer problem in the Yale Paleomagnetic Facility in early 2013, only the localities from 2011 and JK1206 completed the thermal demagnetization process. However, locality JK1205 was included in fold test calculations because most of its samples showed directional stability at 600° C. The Zijderveld and equal area plots from representative samples in each locality, as well as an equal area plot of the characteristic component of each sample in the locality, are shown in Figures 10-14. Apart from reversed geomagnetic polarity documented at locality JK1101, new directions show broad agreement with those reported in Piper's (1975) study, but his more southerly and shallower directions likely result from contamination by a slight modern overprint (Figure 15). JK1206 was the only locality that exhibited a significant low-stability component, with a scatter of moderately steep upward directions around the present local field at the sampling locality.

### *Auborus Conglomerate Test*

| Name | GPS Start | GPS End | Length of Section (m) | Number/Type of Samples | General Strike/Dip | Dominant Lithology | Sedimentary Structures |
|---|---|---|---|---|---|---|---|
| **JK1101** | 25.72447°S 016.54767°E | 25.72610°S 016.54735°E | 15 | 16 blocks | SSW/moderate | Interbedded sand/mudstones | Crossbeds, ripples exhibiting northern flow |
| **JK1202** | 25.72610°S 016.54735°E | 25.72609°S 016.54719°E | 33 | 7 cores | SSW/moderate | Medium Sandstone | Crossbeds, coarsening upward |
| **JK1102** | 25.70180°S 016.53807°E | 25.70422°S 016.53998°E | 130 | 34 blocks | E/moderate | Fine quartzitic sstn | Crossbeds (0.5 m scale) |
| **JK1103** | 25.74545°S 016.52033°E | 25.74388°S 016.52018°E | 128 | 13 blocks | SSW/shallow | Fine sstn | Mudcracks with sandy infill |
| **JK1204** | 25.66772°S 016.56903°E | 25.66900°S 016.56111°E | 190 | 32 cores | SE/moderate | Fine or very fine sandstone | None |
| **JK1205** | 25.67381°S 016.56662°E | 25.67448°S 016.56474°E | 203 | 49 cores | S/vertical (younging W) | Sandstone of varying grain sizes | Repeated series of fining/coarsening |
| **JK1206** | 25.58938°S 16.53034°E | 25.58083°S 016.52956°E | 170 | 71 cores | W/shallow | Mostly fine to medium sandstone | Mudcracks, ripple bedding, massive bedding, shale interbeds, coarse trough cross beds, laminated bedding |



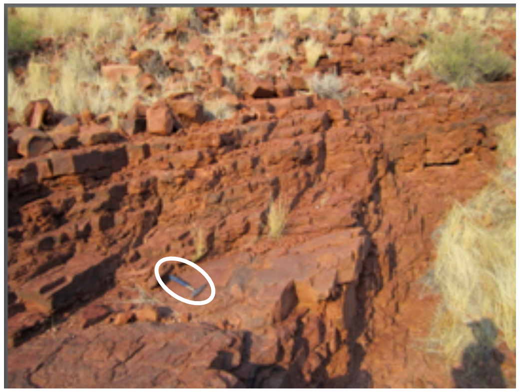



**Figure 7:** Descriptions of magnetostratigraphy sampling sites from field seasons 2011 and 2012. Images of sites JK1204, JK1205, and JK1206. Hammers circled for scale.

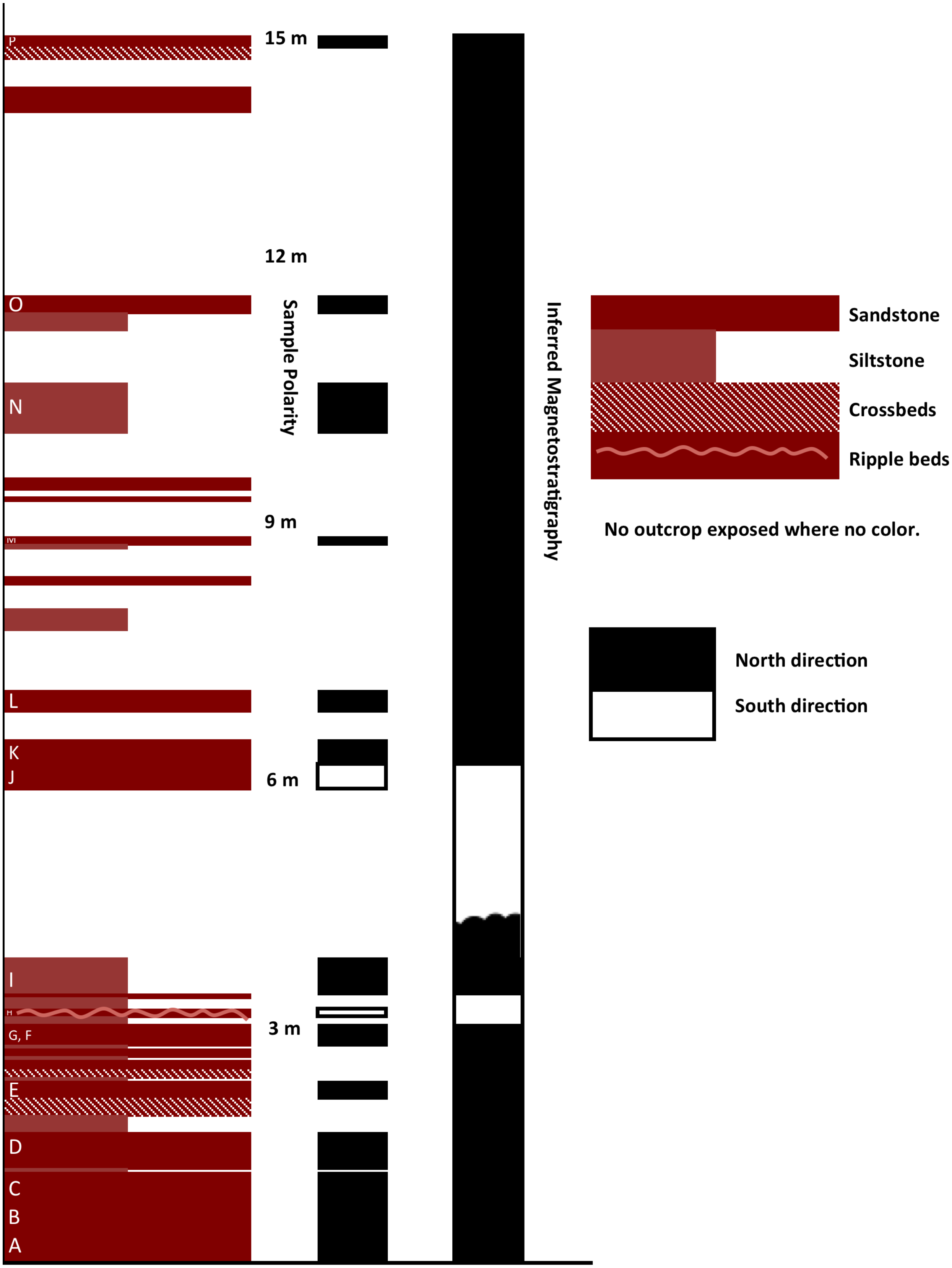



**Figure 8**: Stratigraphic section measured at JK1101. All heights to scale. Sample polarity is black for samples with a shallow north direction, and white for samples with a shallow south direction, though absolute polarity is arbitrary. From these samples, a continuous magnetostratigraphy is inferred, though missing outcrop makes it impossible to determine at what position the polarity reverses between samples I and J.

| Name | GPS | Number/Type of Samples | General Strike/Dip | Clast Type | Matrix type |
|---|---|---|---|---|---|
| **JK1104** | 25.72973°S<br>016.54748°E | 10 cores from 8 clasts | S/moderate | 7 rhyolitic porphyry<br>1 quartzite (F)<br>1 sandstone (C)<br>1 K-spar porphyry | Mauve coarse sandstone or gritstone |
| **JK1201** | 25.72975°S<br>016.54752°E | 10 clast cores<br>10 matrix cores | SW/moderate | 4 rhyolite<br>3 quartzite (D,G,I)<br>2 rhyolitic porphyry<br>1 sandstone (A) | Mauve coarse sandstone or gritstone |
| **JK1105** | 25.65637°S<br>016.56550°E | 10 clast cores | SW/moderate | 5 granite<br>3 rhyolitic porphyry<br>1 microgranite<br>1 K-spar porphyry | Medium red sandstone |
| **JK1203** | 25.65605°S<br>016.56541°E | 10 clast cores<br>10 matrix cores | SW/moderate | 4 rhyolitic porphyry<br>2 rhyolite<br>2 granite<br>2 fine grained mafic | Medium red sandstone |
| **JK1207** | 25.65304°S<br>016.51868°E | 20 clast cores<br>10 matrix cores | NW/shallow | 9 granite<br>4 plag porphyry<br>3 quartz porphyry<br>2 rhyolite<br>2 sandstone (G,O) | Medium red sandstone |
| **JK1208** | 25.65304°S<br>016.51868°E | 20 clast cores<br>10 matrix cores | NW/shallow | 12 rhyolitic porphyry<br>5 granite<br>2 rhyolite<br>1 sandstone (G) | Medium-coarse red sandstone |

**Figure 9:** Descriptions of conglomerate test sites from field seasons 2011 and 2012. Images of clasts and matrix sampled at JK1203. 2.5 cm core holes for scale.

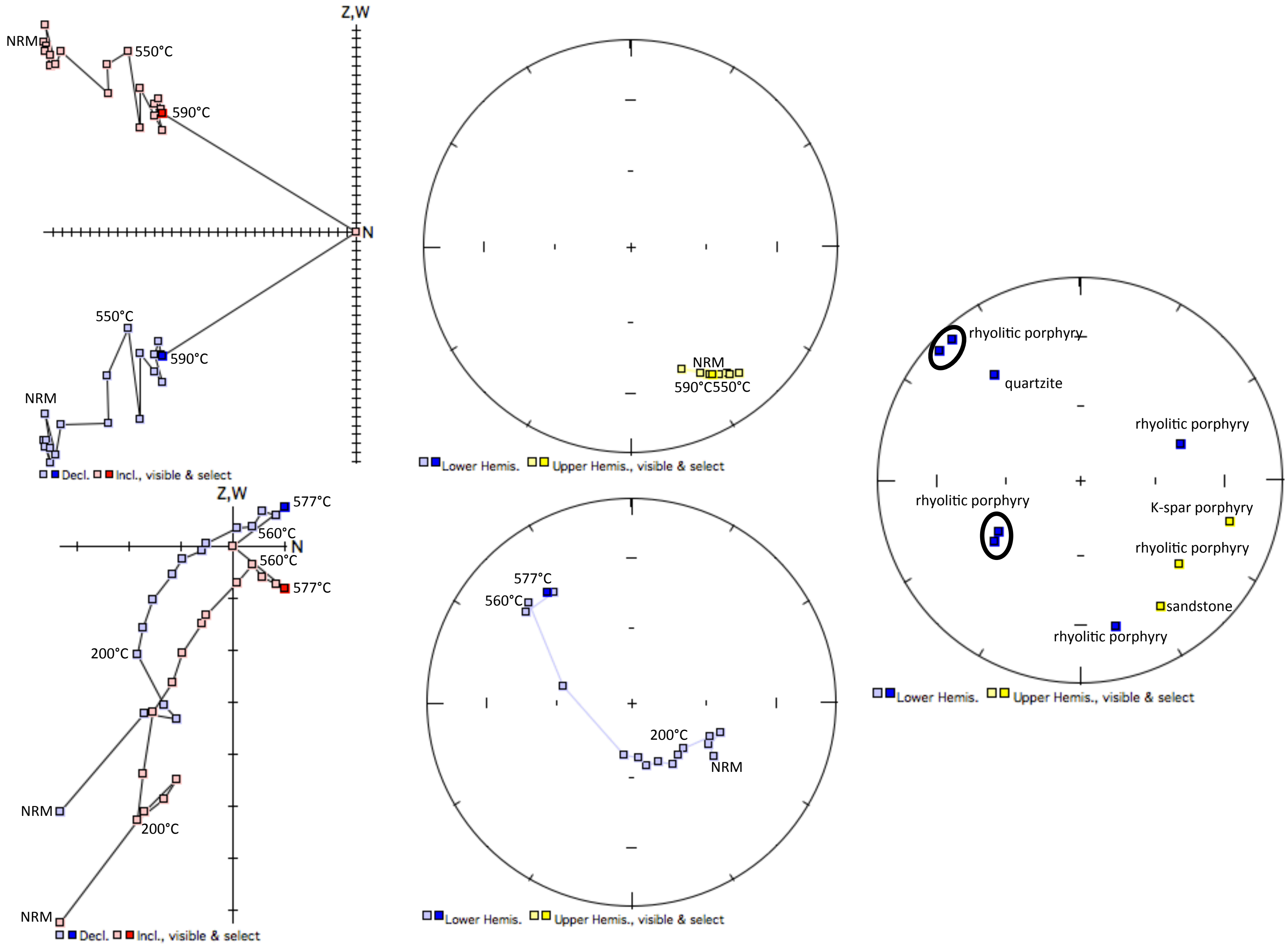



**Figure 10**: Data from JK1104 conglomerate test clast samples with tilt-correction – left column orthogonal projection diagrams presented in East-West orthographic, center column with Equal Area plots, right column equal area plots with best least square fit for each sample. Bottom row shows data for JK1104 sample F, a quartzite clast (orthographic division $10^{-6}$); top row shows data for JK1104 sample C, a sandstone clast (orthographic division $10^{-4}$). Double-sampled clasts circled.

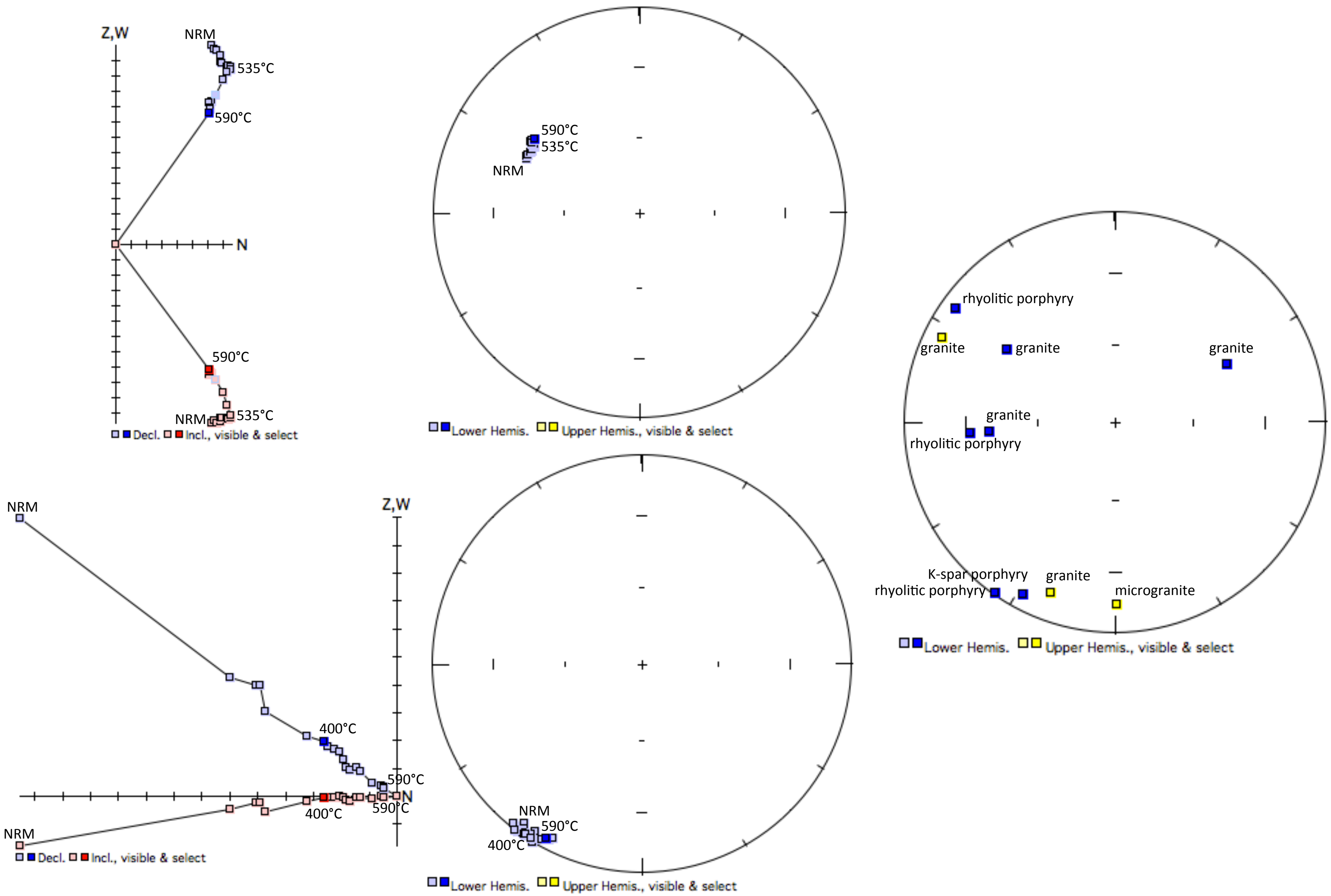



**Figure 11**: Data from JK1105 representative conglomerate test clast samples with tilt-correction – left column orthogonal projection diagrams presented in East-West orthographic, center column with Equal Area plots, right column equal area plots with best least square fit for each sample. Bottom row shows data for JK1105 sample B, a rhyolitic porphyry clast (orthographic division $10^{-4}$); top row shows data for JK1105 sample A, a granite clast (orthographic division $10^{-5}$).

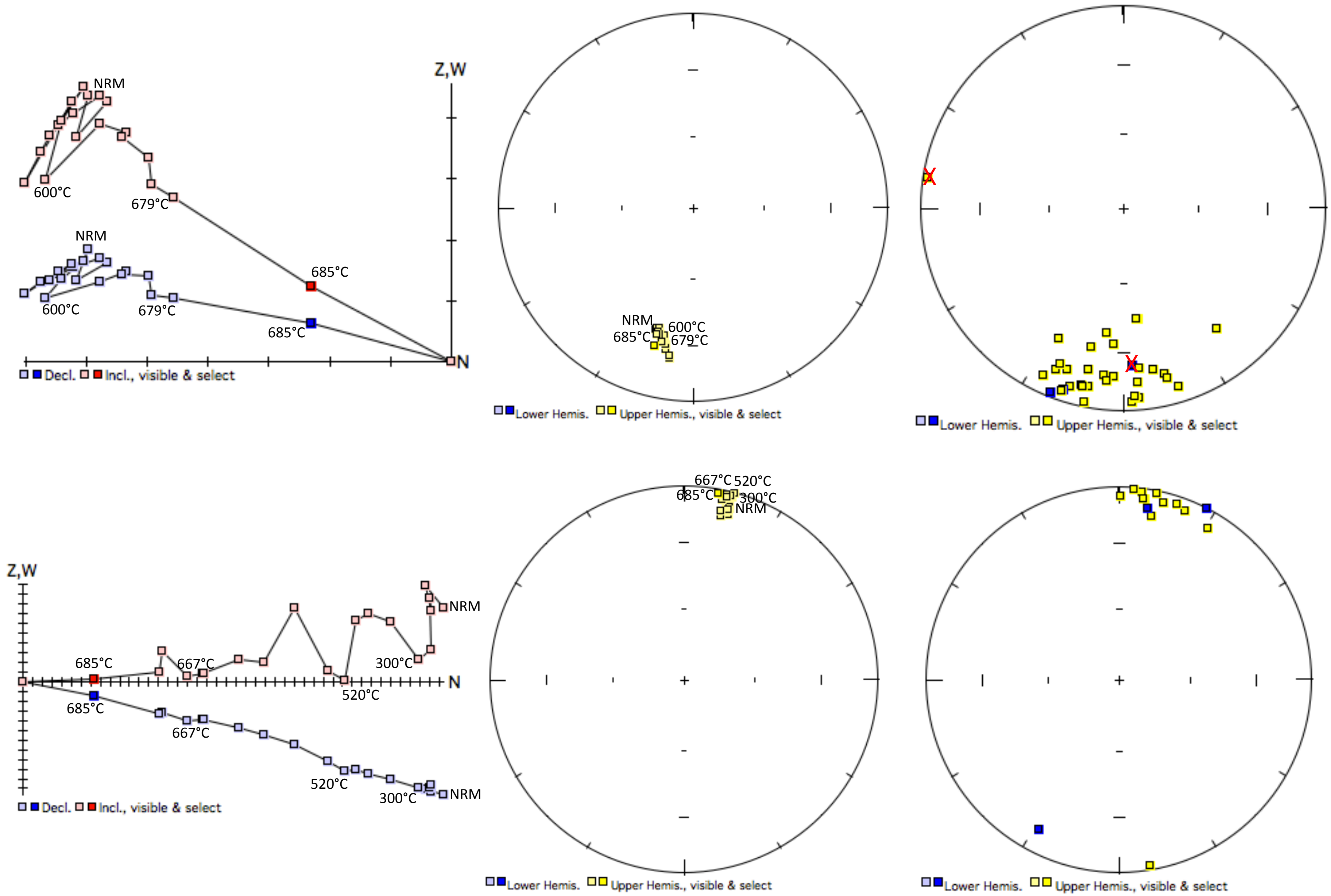



**Figure 12**: Data from representative samples with tilt-correction – left column orthogonal projection diagrams presented in East-West orthographic, center column with Equal Area plots, right column equal area plots with best least square fit for each sample. Bottom row shows data for JK1101 sample K (orthographic division $10^{-6}$); top row shows data for JK1102 sample G (orthographic division $10^{-5}$). This demonstrates a geomagnetic reversal between the lower (01) and upper (02) sections. Red Xs indicate sample directions excluded from statistical calculations and from the fold test calculation.

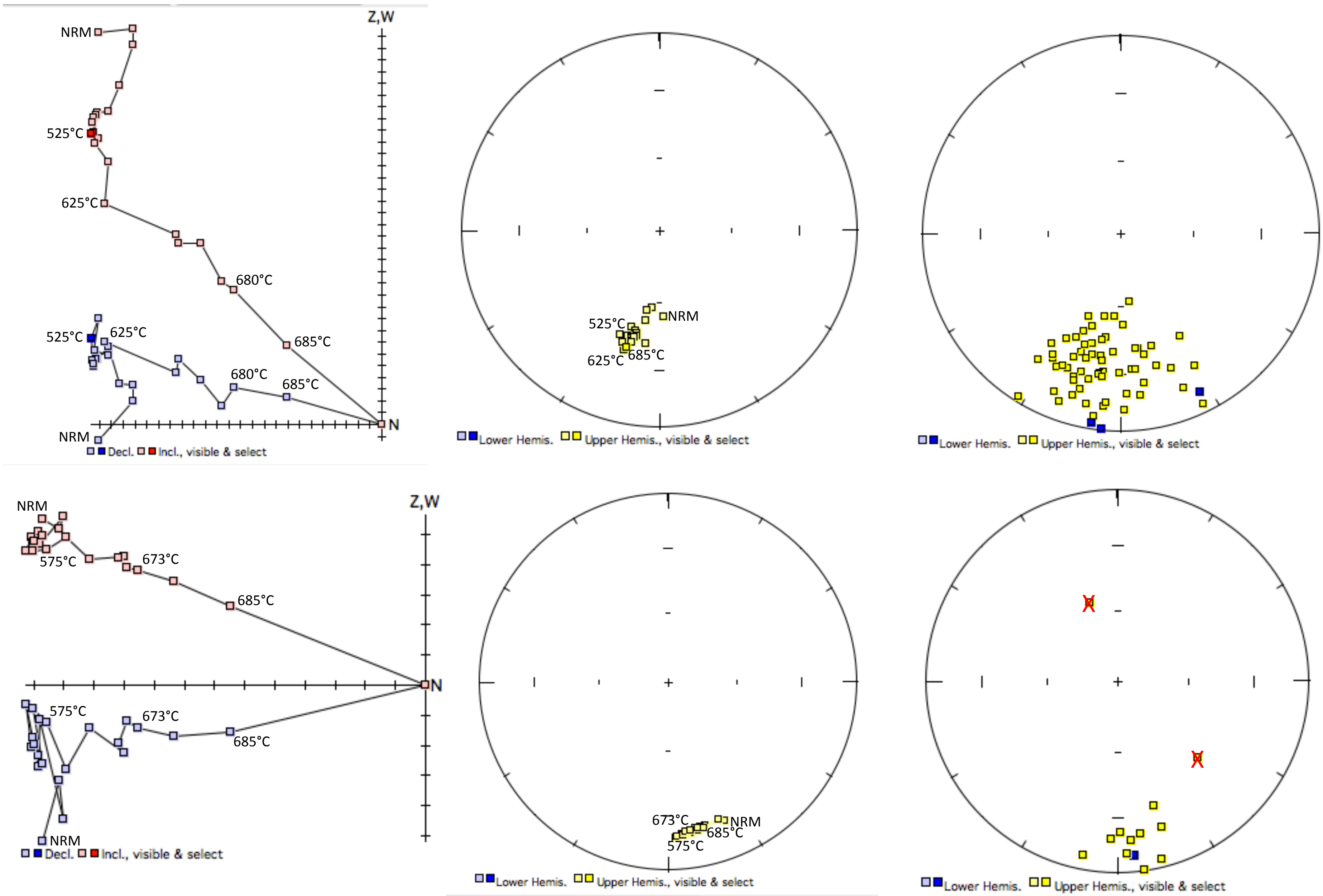



**Figure 13**: Data from representative samples with tilt-correction – left column orthogonal projection diagrams presented in East-West orthographic, center column with Equal Area plots, right column equal area plots with best least square fit for each sample. Bottom row shows data for JK1103 sample M (orthographic division $10^{-5}$); top row shows data for JK1206 sample I (orthographic division $10^{-6}$). Red Xs indicate sample directions excluded from statistical calculations and from the fold test calculation.

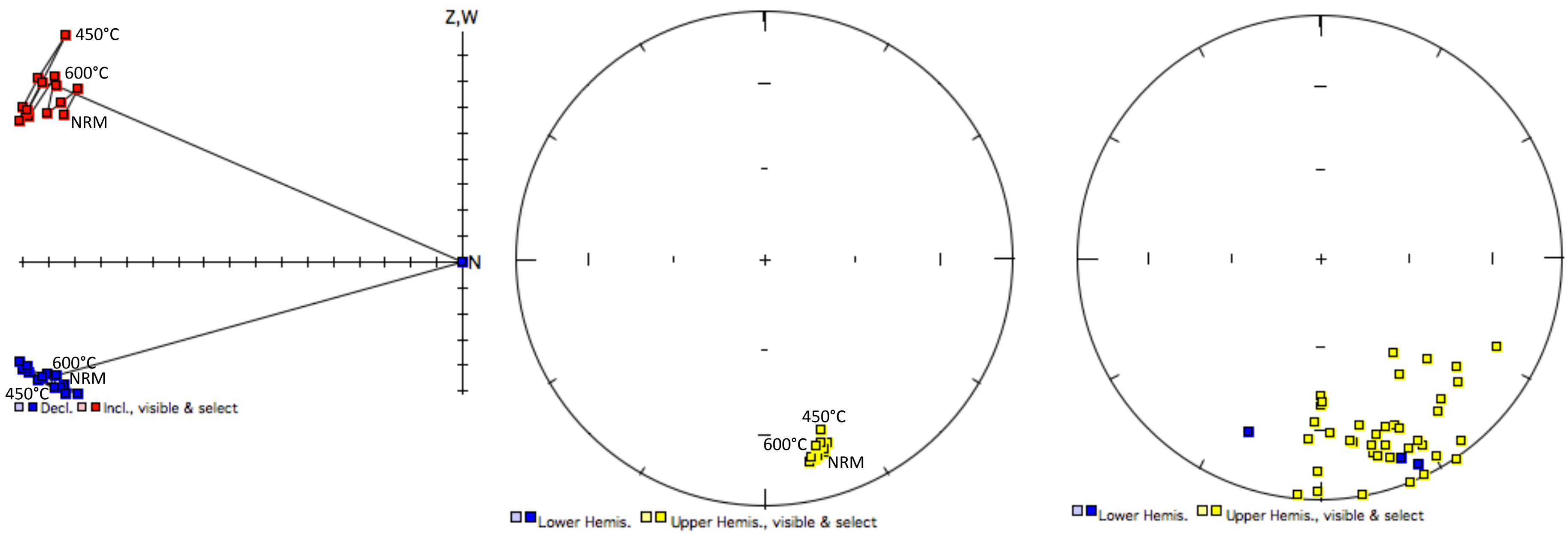



**Figure 14**: Data from representative samples with tilt-correction – left column orthogonal projection diagrams presented in East-West orthographic, center column with Equal Area plots, right column equal area plots with best least square fit for each sample. Preliminary data for JK1205 sample P (orthographic division $10^{-5}$) is presented here.

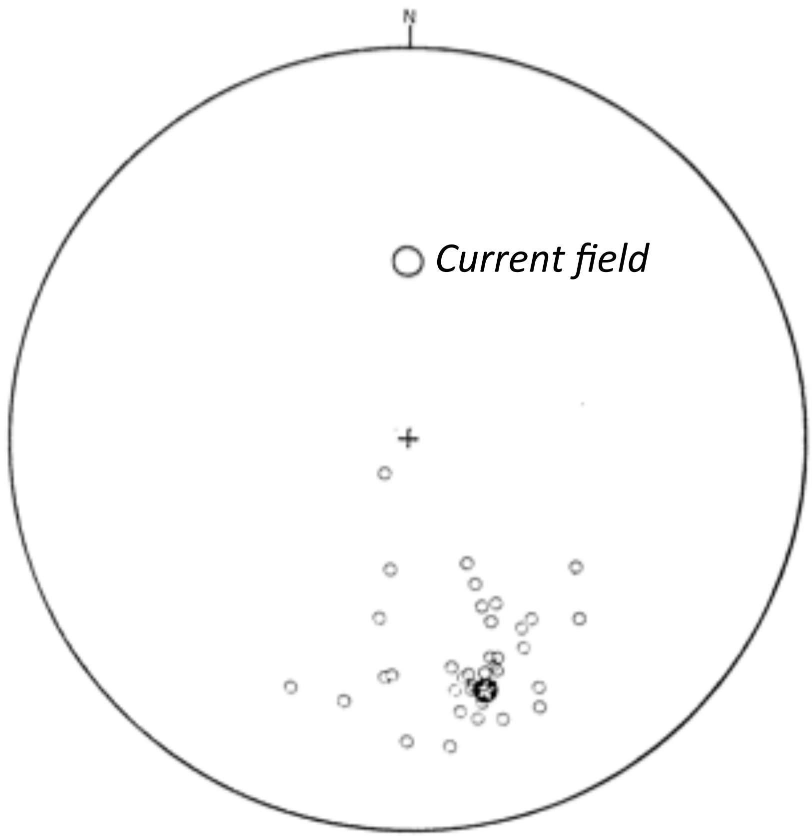



**Figure 15**: NRM directions from Piper's (1975) study of the Auborus Formation, showing a southern declination and negative inclination. The circle shows the direction of Earth's present-day field.

The wide scatter of characteristic directions for clasts sampled from conglomerate localities JK1104 and JK1105 indicate a positive conglomerate test (Figures 10-11). One of these clasts, drilled from a sandstone likely sourced from the Auborus Formation, or at least of similar lithology, shows a direction 120 degrees off and steeper than the immediately overlying section of sandstones at JK1101, yet exhibits similar magnetic behavior to other Auborus sandstone samples. For this reason, the magnetization of the Auborus Formation should be interpreted as primary.

***Auborus Fold Test***

Geographic mean directions for each locality were calculated using standard statistical methods (Fisher, 1953). If median absolute deviation (MAD) of the least square fit for a given sample exceeded 10 degrees, the sample was excluded from calculations. Variable bedding dips within each locality were accounted for in the calculated 0% and 100% levels of tilt correction, but the partial levels of unfolding of locality means were more conveniently accommodated using locality-averaged bedding attitudes (Stereonet 8.6.6; Allmendinger & Cardozo, 2013). The locality mean direction measurements may be found in Figure 16. These directions indicate a geomagnetic reversal occurring between the deposition of the lowermost locality JK1101 and upper sections of Auborus stratigraphy.

A partial unfolding test was then performed at both the locality mean level and the individual sample level. Although the locality means yield a partial unfolding with maximum k-value at 70% (Figure 17a), formal F-ratio tests according to Fisher et al. (1987) showed that the differences in k-values at 0% and 100% unfolding were statistically insignificant. For the five locality means calculated, a 2.5% F-ratio table for two distribution parameters were consulted, for 8 by 8 degrees of freedom (2(n-1)), in order to achieve 95% confidence. The ratio of k-values was less than the critical F-value of 4.43. Because this locality-mean test was hampered by the small number of unit weights (n=5), partial unfolding calculations were also performed at the individual sample level. A maximum k-value was found at 80% unfolding (Figure 17b). With 166 samples, a critical F-value of 1.24 was calculated based on 330 by 330 degrees of freedom and 95% confidence. The ratio of the 80% to 0% unfolding k-values was found to exceed the critical F-value, and thus are statistically different. Meanwhile, the ratio of 80% to 100% unfolding did not exceed the k-value. Therefore, the Auborus Formation was magnetized either

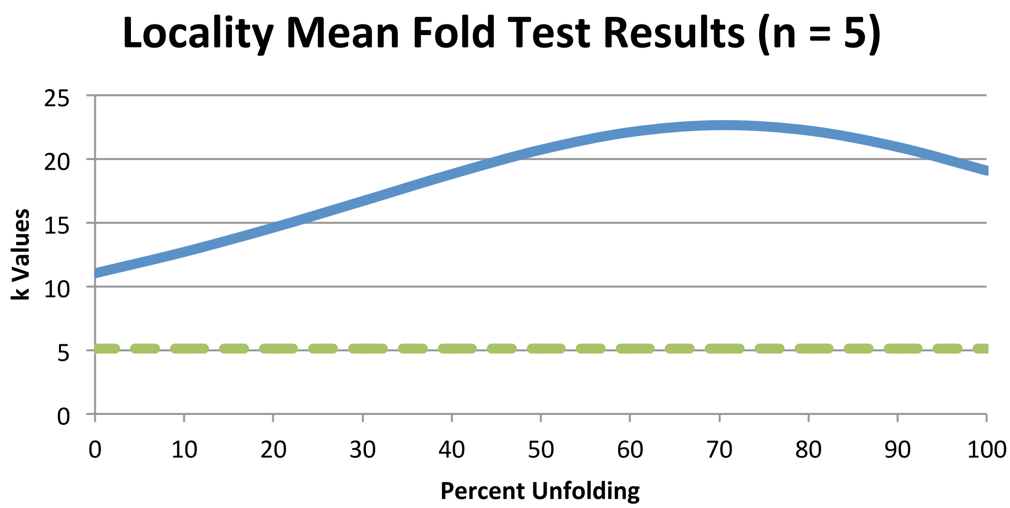
| Locality | GPS | Avg. RHS | Avg. Dip | Samples Taken | Samples in Calculation | Geographic | | | | Stratigraphic | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Declination | Inclination | k Value | α-95 | Declination | Inclination | k Value | α-95 |
| **JK1101** | 25.7°S 016.5°E | 207 | 34 | 16 | 16 | 192.6 | -04.0 | 42.7 | 5.7 | 192.9 | 04.9 | 44.2 | 6.0 |
| **JK1102** | 25.7°S 016.5°E | 67 | 44 | 34 | 33 | 186.7 | 22.4 | 15.0 | 6.7 | 185.3 | -16.4 | 17.9 | 6.2 |
| **JK1103** | 25.7°S 016.5°E | 197 | 15 | 13 | 11 | 176.1 | -23.4 | 35.6 | 10.5 | 171.8 | -18.0 | 31.3 | 11.0 |
| **JK1205*** | 25.7°S 016.6°E | 171 | 103 | 49 | 41 | 194.1 | -07.3 | 15.2 | 5.9 | 158.1 | -20.5 | 15.0 | 6.0 |
| **JK1206** | 25.6°S 16.5°E | 254 | 12** | 71 | 65 | 190.9 | -41.1 | 16.8 | 4.4 | 187.2 | -30.5 | 16.3 | 4.5 |
| **Locality mean** | | | | | 5 localities | 188.2 | -10.8 | 11.0 | 24.1 | 179.0 | -16.4 | 19.1 | 18.0 |
| **Sample mean** | | | | | 166 samples | 190.2 | -15.4 | 07.2 | 4.4 | 179.2 | -21.2 | 11.0 | 3.5 |

* Preliminary data

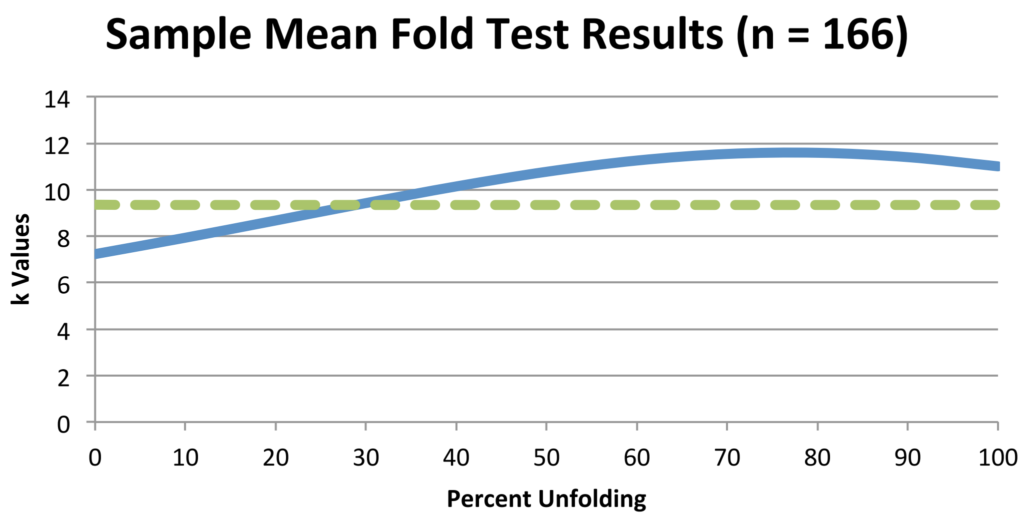
** Calculated average dip was 16 using same methods, but spread of dip vectors is exceptionally large at this locality, so the value of 12 degrees is chosen instead.

**Figure 16:** Locality mean directions of sedimentary sections of the Auborus Formation sampled for paleomagnetic analysis.

a)




b)




c)

| Data for calculation | Percent Unfolding | Paleopole Location | Equivalent A95 | Auborus Paleolatitude |
|---|---|---|---|---|
| **Sample Means** | 80% | 53.2°N 018.8°E | 2.6 | -11.0° |
| | 100% | 53.3°N 015.2°E | 2.67 | -11.0° |
| **Locality Means** | 70% | 56.0°N 019.5°E | 12.12 | -8.2° |
| | 100% | 55.9°N 014.7°E | 13.33 | -8.4° |

**Figure 17**: a) Fold test results for five locality means; maximum k value at 70% unfolding. Green dashed line represents threshold of k values for 95% confidence in significant difference from the peak value. b) Fold test results for 166 sample means; maximum k value at 80% unfolding. Green dashed line represents threshold of k values for 95% confidence in significant difference from the peak value. c) Paleomagnetic poles calculated for either syn-folding (70-80%) or pre-folding (100%) magnetization, at both the locality and sample level.

before regional deformation began, or in its earliest stages. Paleomagnetic poles were calculated for both locality and sample means for both prefolding (100%) and synfolding (70% or 80%) depositional scenarios, and are presented numerically and graphically in Figures 17c and 18.

## DISCUSSION

Our new Auborus paleomagnetic pole largely confirms the result of Piper (1975) but raises its quality status considerably. On the Van der Voo (1990) seven-point quality scale, Piper's (1975) data satisfy only three criteria: statistics of the pole (#2), structural control (#5), and dissimilarity to younger poles (#7). Our new result adds vector analysis (#3), positive field stability tests (#4), and dual polarity of the remanence (#6). The only criterion not yet satisfied is the rock age, although as shown below, there is compelling reason to suspect an age of ca. 1100 Ma for Auborus sedimentation and magnetic remanence acquisition.

### *Deformational Age of the Auborus Formation*

The statistically insignificant difference between pre- and synfolding magnetization merits further discussion of what geological observations may reveal about the age of folding of the Auborus Formation. With a positive conglomerate test, it would seem that magnetization is primary and should be older than any phase of postdepositional deformation. However, a scenario in which folding began either as the rocks were being deposited or in the earliest stages of diagenetic remanence acquisition would account for both the positive conglomerate test and the improved clustering of data for 80% unfolding.

Miller (1969) notes that the decrease in dips from the base to the center of the Auborus Formation suggests that the basin began to subside as the sediments were deposited. Subsequently, block faulting in the center of the basin occurred after deposition. Miller (2008) later elaborated on his observations, noting that the horst separating the two Auborus outcrop areas may have begun to rise before the completion of deposition, thereby causing the erosion of overlying sediments and folding in the lower sections. The fact that upper conglomerate layers located further away from the horst are thinner than the basal conglomerate may result from the rise of the horst occurring during a later phase of deposition. However, there still remains the possibility that regional deformation was caused solely by vertical tectonics that occurred after

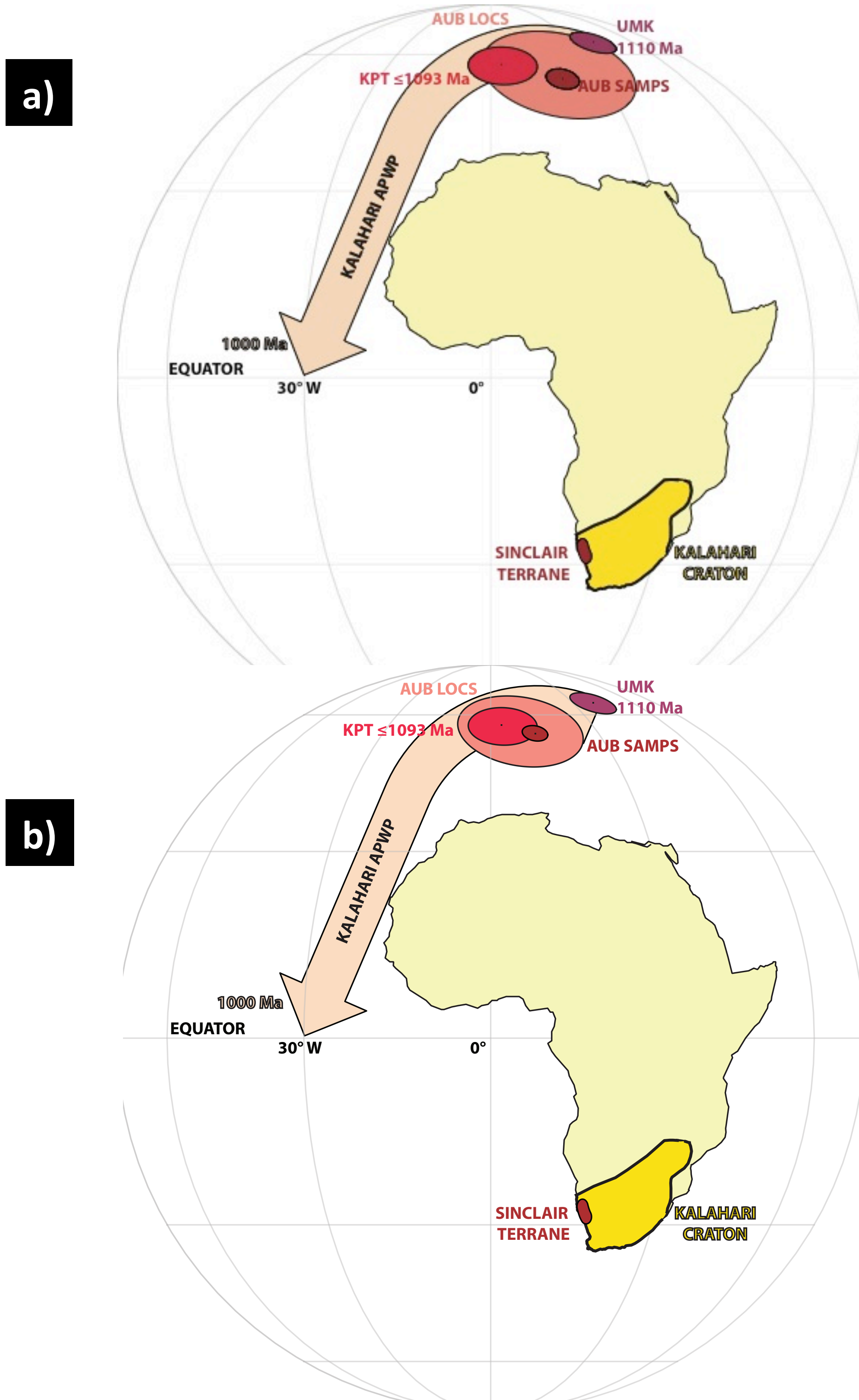



**Figure 18**: Visual representations of calculated paleomagnetic poles for the Auborus Formation, for either a) syn-folding or b) pre-folding remanence acquisition. UMK is the paleomagnetic pole for the Umkondo Large Igneous Province (Gose et al., 2006); KPT is the paleomagnetic pole for the Kalkpunt Formation (Briden et al., 1979). AUB SAMPS is the paleomagnetic pole calculated in this study from 166 sample means; AUB LOCS is the paleomagnetic pole calculated in this study from 5 locality means. These points on the Kalahari apparent polar wander path exhibit the appropriate trajectory to equatorial poles calculated for 1000 Ma.

the cessation of sedimentation. Because of this ambiguity, we present results for both 70-80% and 100% unfolding, but with greater k-values for 70-80% unfolding, we prefer the interpretation that sedimentary deposition was synchronous with deformation in the basin. We therefore use the values from 80% unfolding to calculate the paleomagnetic pole for the Auborus Formation, at 53.2° N and 018.8° E, with an A95 value of 2.6°. This would leave the Auborus Formation at a paleolatitude of 11° S at the time of sedimentation. Note that the 70-80% unfolded and 100% unfolded poles, from either the unit-locality mean or the unit-sample mean, are statistically identical (Fig. 17c, 18). The following discussion, therefore, is insensitive to this choice.

***Sinclair Group Paleogeography***

In order to assess the possible age of Auborus sedimentation (and magnetization) as well as the autochthoneity of the Sinclair terrane, the new Auborus paleomagnetic pole is compared to the Kalahari craton's apparent polar wander path. Located between paleomagentic pole of the Umkondo Large Igneous Province (Gose et al., 2006), dated at 1112 ± 0.5 Ma to 1108 ± 0.9 Ma (Hanson et al., 2004) and that of the Kalkpunt Formation (Briden et al., 1979), with a maximum age of 1093 ± 7 Ma (Pettersson et al., 2007), the new paleomagnetic pole presented in this study suggests an age of ca. 1100 Ma for the Auborus Formation. The new pole also suggests the development of the Sinclair succession in a position autochthonous to the Kalahari craton and without significant large-scale rotation, given the pole’s location on the apparent polar wander path of the Kalahari craton.

***Correlation with the Koras Group***

The proximity of our new Auborus paleomagnetic pole to that of the Kalkpunt Formation also may provide further evidence for correlation between the Sinclair Group and the Koras Group 800 km southeast (SACS, 1980; Figure 1). These successions are similar in their general profile of a deformed, metamorphosed basement being overlain by a bimodal suite of relatively undeformed volcanic rocks. Both groups contain siliciclastic metasediments, at no more than sub-greenschist grade within and overlying the volcanic suite (Pettersson et al., 2007). The groups are both found in fault-bounded basins that appear to be related to a post-collision tensional setting. In the same way that the Sinclair Group formed by subduction of the Namaqua

Province underneath the Rehoboth Inlier at the Hauchab-Excelsior-Lord Hill Shear Zone at 1216 Ma, the Koras Group formed as the Bushmanland Province collided with the western margin of Kaapvaal Craton at 1180 Ma (Bailie et al., 2012).

Like the Auborus Formation, the Kalkpunt Formation is a red sandstone unit overlying a bimodal volcanic succession. Although it is approximately 1000 m thicker than the Auborus Formation (Briden et al., 1979), the Kalkpunt Formation has a similar basal conglomerate and conglomerate lenses found throughout its stratigraphy. Its sandstone may be gritty locally, and shale is typically found near the top of the formation. The depositional environment has been interpreted as an alluvial fan developing in a synclinal structure along the fault scarps bounding the basin (SACS, 1980); facies distribution was likely controlled by basement highs and syndepositional faulting (Bailie et al., 2012).

The published paleomagnetic behavior of the Kalkpunt Formation also resembles that of Auborus, as that of the underlying Koras Formation is similar to the Guperas Formation. The tilt-corrected mean directions found by Briden et al. (1979) are shallow and directed either north or south, exhibiting the same dual polarity as our study. With limited thermal demagnetization, the unblocking temperature of the Kalkpunt Formation redbeds was found to be greater than 600° C. Briden et al. (1979) expressed confidence approaching 90% that the magnetization of the Kalkpunt Formation was pre-folding.

Our study may yield paleomagnetic evidence for correlation between the Sinclair and Koras groups if one of the following scenarios is true. The non-Fisherian distribution of the findings of Briden et al. (1979) may overlap the paleomagnetic pole of the Auborus Formation calculated in this study, which likely lies somewhere between the sample mean and locality mean result presented in Figure 18. The difference in pole location between these groups may also be explained by a small-scale rotation, on the order of a few degrees, of the Sinclair group with respect to the Kalahari Craton. Alternatively, the difference in declination of the Kalkpunt and Koras paleomagnetic poles may result from a slight age difference of 5-10 million years, as estimated by the age control on existing poles from the Kalahari APWP. Swanson-Hysell et al. (2009) documented rapid motion (~30cm/yr) of Laurentia at ca. 1100 Ma, attributing this to true polar wander (TPW), which is the wholesale migration of the solid Earth (surface to core-mantle boundary) relative to the rotation axis, and which is more likely than plate tectonics to achieve such rates of motion (Gurnis & Torsvik, 1994). A time delay of only a few million years between the deposition of the Kalkpunt sediments and those of the Auborus Formation could therefore explain the difference between paleomagnetic pole location, even if these units are approximately correlated.

## CONCLUSIONS

In this study, we present a new paleomagnetic pole for the Mesoproterozoic Auborus Formation. Bolstered by thermal demagnetization laboratory techniques and fold and conglomerate field stability tests, our pole demonstrates a primary or early syn-folding magnetization of the Auborus Formation. It also suggests that the Sinclair Group was autochthonous to the Kalahari craton at the time of the deposition of the Auborus sediments. The proximity of the pole to that of the Kalkpunt Formation, another coarse red bed succession above the bimodal Koras Group volcanics in South Africa, suggests a possible correlation between Auborus and Kalkpunt. Continued analysis of the volcanics of the Guperas Formation in the Sinclair Group (Panzik et al., in prep) will better constrain the Sinclair/Koras correlation and test for Sinclair autochthoneity during development of the volcanogenic successions.

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JK1101 Least Sqaure Fits
for Fold Test



| Sample | ID | NRM | LN2-1 | LN2-2 | 100 | 200 | 300 | 400 | 450 | 500 | 520 | 550 | 575 | 600 | 625 | 650 | 660 | 667 | 673 | 679 | 685 | Origin | Geographic Declination | Geographic Inclination | Stratigraphic Declination | Stratigraphic Inclination | MAD (6 degree cutoff) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | all | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 18 | -4 | 021.3 | -06.7 | 2.5 |
| | low | x | x | x | | x | x | | | | | | | | | | | | | | | | 270 | -66 | | | 11 |
| B | all | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 7 | 4 | 7.7 | -5.8 | 4.1 |
| | mid | | | x | x | x | | | | | | | | | | | | | | | | | 112 | 6 | | | 27.8 |
| | low | x | x | x | | | | | | | | | | | | | | | | | | | 88 | 26 | | | 12.6 |
| C | all | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 12 | 5 | 11.4 | -2.1 | 3.4 |
| | low | x | x | x | x | x | x | x | | | | | | | | | | | | | | | 294 | -78 | | | 8.2 |
| D | all | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 8 | 7 | 6.9 | -2.7 | 2.5 |
| | mid | | | | x | x | x | x | | | | | | | | | | | | | | | 339 | -61 | | | 7.5 |
| | low | x | x | x | | | | | | | | | | | | | | | | | | | 274 | -73 | | | 4 |
| E | w/g | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 26 | -10 | 38.4 | -9.7 | 3.3 |
| | all | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 26 | -10 | | | 3.3 |
| | low | x | x | x | | | | | | | | | | | | | | | | | | | 165 | -33 | | | 11.7 |
| F | all | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 8 | 5 | 7.8 | -5.8 | 4.7 |
| | mid | | | x | x | x | x | | | | | | | | | | | | | | | | 60 | -61 | | | 8 |
| | low | x | x | x | | | | | | | | | | | | | | | | | | | 274 | 25 | | | 5.8 |
| G | all | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 7 | 0 | 9.5 | -11.1 | 4.1 |
| | low | x | x | x | x | x | | | | | | | | | | | | | | | | | 267 | -45 | | | 10.8 |
| H | all | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 202 | 11 | 208.4 | 13.6 | 2.6 |
| | low | x | x | x | x | x | x | | | | | | | | | | | | | | | | 155 | -55 | | | 11 |
| I | all | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 7 | -4 | 11.3 | -14.9 | 5.6 |
| | low | x | | | x | x | | | | | | | | | | | | | | | | | 49 | -61 | | | 7.4 |
| J | end | | | | | | | | | | | | | | | | | x | x | x | x | x | 178 | -23 | 170.7 | -2.9 | 8.4 |
| | mos | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | | | | | 209 | -4 | | | 5.5 |
| | low | | x | x | x | x | | | | | | | | | | | | | | | | | 162 | -61 | | | 13.9 |
| K | all | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 13 | 2 | 14.1 | -6.4 | 4.5 |
| | low | | x | x | x | x | x | | | | | | | | | | | | | | | | 302 | -54 | | | 9.1 |

| Sample | ID | NRM | LN2-1 | LN2-2 | 100 | 200 | 300 | 400 | 450 | 500 | 520 | 550 | 575 | 600 | 625 | 650 | 660 | 667 | 673 | 679 | 685 | Origin | Geographic Declination | Geographic Inclination | Stratigraphic Declination | Stratigraphic Inclination | MAD (6 degree cutoff) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L | all | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 27 | 0 | 26.7 | -0.3 | 2.9 |
| | low | x | x | x | | x | | | | | | | | | | | | | | | | | 328 | -8 | | | 16 |
| M | w/g | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 20 | 19 | 9.5 | 11.1 | 6.8 |
| | all | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 19 | 19 | | | 6.8 |
| | low | x | x | x | x | x | x | x | | | | | | | | | | | | | | | 15 | -68 | | | 11.8 |
| N | all | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 3 | 12 | 0.4 | -5.6 | 3.5 |
| | low | x | x | x | x | x | | | | | | | | | | | | | | | | | 265 | -59 | | | 5.6 |
| O | all | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 9 | 13 | 4.5 | -1.6 | 5.5 |
| | low | x | x | x | x | x | x | x | | | | | | | | | | | | | | | 93 | -41 | | | 11.9 |
| P | all | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 17 | 2 | 18.3 | -4.5 | 1.8 |
| | low | x | x | x | x | | | | | | | | | | | | | | | | | | 287 | 48 | | | 9.4 |

| Sample | ID | NRM | LN2-1 | LN2-2 | 100 | 200 | 300 | 400 | 450 | 500 | 520 | 550 | 575 | 600 | 625 | 650 | 660 | 667 | 673 | 679 | 685 | Origin | Geographic Declination | Geographic Inclination | Stratigraphic Declination | Stratigraphic Inclination | MAD (6 degree cutoff) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | all | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | 175 | 4 | 175.2 | -15.4 | 4.7 | |
| | low | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | 4 | -88 | | | 17.9 | |
| B | all | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | 179 | 15 | 177.6 | -5.4 | 3.9 | |
| | mid | | | x | x | x | x | x | x | x | | | | | | | | | | | | | 300 | -55 | | | 16.3 | |
| | low | x | x | x | | | | | | | | | | | | | | | | | | | 113 | 50 | | | 14.1 | |
| C | lla | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 169 | -1 | 173.2 | -44.6 | 3.3 | |
| | mid | | | | x | x | x | x | | | | | | | | | | | | | | | 57 | -40 | | | 18.1 | |
| | low | x | x | x | x | | | | | | | | | | | | | | | | | | 88 | -19 | | | 4.6 | |
| D | all | | | | | | | | | x | x | | x | x | x | x | | x | x | x | x | x | 197 | 13 | 196.6 | -9.2 | 5.6 | |
| | mid | | | x | x | x | | x | x | x | | | | | | | | | | | | | 319 | -21 | | | 13.4 | |
| | low | x | x | x | | | | | | | | | | | | | | | | | | | 113 | 0 | | | 10.1 | |
| E | all | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | 168 | 6 | 169.7 | -20.8 | 4.1 | |
| | mid | | | | | | x | x | x | x | x | | | | | | | | | | | | 76 | 15 | | | 3.9 | |
| | low | x | x | x | x | x | x | | | | | | | | | | | | | | | | 279 | -32 | | | 11.6 | |
| F | all | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | 210 | 30 | 198.4 | 6.8 | 4.3 | |
| | low | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | 352 | 32 | | | 4.8 | plane |
| G | all | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 187 | 0 | 193.0 | -30.9 | 3.9 | |
| | mid | | | | | | x | x | x | x | x | x | x | | | | | | | | | | 35 | 86 | | | 4.8 | |
| | low | | | x | x | x | x | | | | | | | | | | | | | | | | 355 | -65 | | | 9.8 | |
| H | all | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 272 | -25 | 278.8 | -2.7 | 3.1 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 12 | -29 | | | 11 | |
| I | all | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 204 | 18 | 202.8 | -15.0 | 5.6 | |
| | hmd | | | | | | x | x | x | | | | | | | | | | | | | | 113 | -37 | | | 2.8 | |
| | mid | | | x | x | x | x | | | | | | | | | | | | | | | | 9 | -54 | | | 13.5 | |
| | low | x | x | x | | | | | | | | | | | | | | | | | | | 251 | 69 | | | 9.2 | |
| J | all | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | 195 | 23 | 193.3 | -11.7 | 2.7 | |
| | mid | | | | | | x | x | x | x | x | x | | | | | | | | | | | 146 | -47 | | | 13 | |

| Sample | ID | NRM | LN2-1 | LN2-2 | 100 | 200 | 300 | 400 | 450 | 500 | 520 | 550 | 575 | 600 | 625 | 650 | 660 | 667 | 673 | 679 | 685 | Origin | Geographic Declination | Geographic Inclination | Stratigraphic Declination | Stratigraphic Inclination | MAD (6 degree cutoff) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| J | low | | | x | x | x | x | | | | | | | | | | | | | | | | 11 | -51 | | | 15.7 | |
| K | all | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | 170 | -1 | 171.0 | -31.0 | 2.1 | |
| L | all | | | | | | | | | | | | | | | | x | x | x | x | x | x | 198 | 28 | 191.4 | -3.3 | 1.5 | |
| | mid | | | | | | | | | x | x | x | x | x | x | x | x | | | | | | 331 | 44 | | | 6.5 | plane |
| | lmd | | | | x | x | x | x | x | x | | | | | | | | | | | | | 339 | 37 | | | 6.9 | plane |
| | low | x | x | x | x | | | | | | | | | | | | | | | | | | 253 | 56 | | | 1.4 | plane |
| M | all | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | 205 | 32 | 198.8 | -5.8 | 3.5 | |
| | hmd | | | | | | | x | x | x | | | | | | | | | | | | | 112 | 6 | | | 3.1 | |
| | lmd | | | | | x | x | x | | | | | | | | | | | | | | | 296 | -7 | | | 2.4 | |
| | low | x | x | x | x | x | | | | | | | | | | | | | | | | | 276 | 9 | | | 17.4 | |
| N | all | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 201 | 7 | 206.7 | -29.3 | 2.6 | |
| | low | x | x | x | x | x | x | x | | | | | | | | | | | | | | | 279 | -68 | | | 14.5 | |
| O | all | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | 180 | -1 | 188.0 | -38.5 | 4.1 | |
| | low | x | x | x | x | x | x | x | x | x | | x | | | | | | | | | | | 328 | -36 | | | 12.9 | |
| P | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | 186 | 12 | 186.9 | -18.7 | 4.5 | |
| | mid | | | | | | x | x | x | x | x | x | x | x | | | | | | | | | 90 | 18 | | | 6.6 | |
| | low | x | x | x | x | x | | | | | | | | | | | | | | | | | 282 | -24 | | | 9.1 | |
| Q | all | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | 198 | 12 | 199.4 | -17.0 | 2.9 | |
| | low | x | x | x | x | x | x | x | | | | | | | | | | | | | | | 16 | -46 | | | 18.9 | |
| R | all | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 191 | 14 | 192.5 | -19.7 | 2.8 | |
| | low | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | 45 | 39 | | | 6.8 | plane |
| S | all | | | | | | | | | | | | x | | x | x | x | x | x | x | x | x | 201 | 14 | 202.4 | -18.6 | 5.9 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 347 | -48 | | | 11.6 | |
| T | all | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 195 | 27 | 191.3 | -12.0 | 2.4 | |
| | mid | | | | | | x | x | x | x | x | x | x | | | | | | | | | | 79 | 19 | | | 10.1 | |
| | low | x | x | x | x | x | x | | | | | | | | | | | | | | | | 287 | -31 | | | 8.3 | |
| U | all | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | 184 | 38 | 175.2 | -7.6 | 4.1 | |

JK1102 Least Sqaure Fits
for Fold Test



| Sample | ID | NRM | LN2-1 | LN2-2 | 100 | 200 | 300 | 400 | 450 | 500 | 520 | 550 | 575 | 600 | 625 | 650 | 660 | 667 | 673 | 679 | 685 | Origin | Geographic Declination | Geographic Inclination | Stratigraphic Declination | Stratigraphic Inclination | MAD (6 degree cutoff) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| U | low | x | x | x | x | x | x | x | | x | x | x | | | | | | | | | | | 145 | -38 | | | 15.6 | plane |
| V | all | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 195 | 67 | 176.9 | 24.0 | 2.2 | |
| | low | | x | x | x | x | x | x | x | | | | | | | | | | | | | | 341 | 3 | | | 8.7 | plane |
| W | all | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | 182 | 38 | 176.7 | -8.6 | 4.1 | |
| | low | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | 335 | 46 | | | 8.2 | plane |
| X | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | 174 | 22 | 174.3 | -22.5 | 4.4 | |
| | low | x | x | x | | x | x | x | x | x | x | x | x | x | | | | | | | | | 19 | -3 | | | 7.4 | |
| Y | all | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | 165 | 38 | 163.0 | -9.0 | 3.6 | |
| | mid | | | | | | | x | x | x | x | x | | | | | | | | | | | 72 | 3 | | | 14.4 | |
| | low | x | x | x | x | x | x | | | | | | | | | | | | | | | | 18 | -45 | | | 18.8 | |
| | lpl | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | 349 | 46 | | | 12.1 | plane |
| Z | all | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | 216 | 33 | 201.7 | 3.0 | 4.6 | |
| | low | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | 346 | 45 | | | 12.1 | plane |
| AA | all | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 196 | 23 | 192.7 | -10.9 | 3.3 | |
| | mid | | | | | x | x | x | x | | | | | | | | | | | | | | 114 | -37 | | | 11.2 | |
| | low | | x | x | x | x | | | | | | | | | | | | | | | | | 308 | 23 | | | 13.6 | |
| AB | all | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | 184 | 25 | 183.2 | -18.7 | 4.5 | |
| | mid | | | | | | | x | x | x | x | | | | | | | | | | | | 276 | -11 | | | 9.8 | |
| | low | x | x | x | x | x | x | | | | | | | | | | | | | | | | 126 | -75 | | | 23.4 | |
| AC | all | | | | | | | | | x | | x | x | x | x | x | x | x | x | x | x | x | 143 | 22 | 142.4 | -26.2 | 3.9 | |
| | mid | | | | | x | x | x | x | x | | | | | | | | | | | | | 223 | -22 | | | 9.4 | |
| | low | x | x | x | x | x | | | | | | | | | | | | | | | | | 44 | 7.3 | | | 9.8 | |
| AD | all | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | 190 | 34 | 185.8 | -16.3 | 4.6 | |
| | mid | | | | | | x | x | x | x | x | x | | | | | | | | | | | 265 | -26 | | | 4.4 | |
| | low | x | x | x | x | | x | | | | | | | | | | | | | | | | 89 | 40 | | | 18.3 | |
| AE | all | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 216 | 31 | 205.8 | -10.1 | 3.7 | |
| | mid | | | | | | | | x | x | x | x | x | | | | | | | | | | 325 | 20 | | | 14.3 | |

| Sample | ID | NRM | LN2-1 | LN2-2 | 100 | 200 | 300 | 400 | 450 | 500 | 520 | 550 | 575 | 600 | 625 | 650 | 660 | 667 | 673 | 679 | 685 | Origin | Geographic Declination | Geographic Inclination | Stratigraphic Declination | Stratigraphic Inclination | MAD (6 degree cutoff) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AE | low | | x | | x | x | x | x | x | | | | | | | | | | | | | | 335 | -39 | | | 15.9 | |
| AF | all | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | 182 | 17 | 184.2 | -33.8 | 2.4 | |
| | low | | x | x | x | x | x | x | | x | x | | | | | | | | | | | | 348 | -39 | | | 11.9 | |
| AG | all | | | | | | | | | | | | | | | x | x | x | x | x | x | x | 166 | 33 | 166.0 | -17.7 | 5.2 | |
| | mid | | | | | | | | | | | x | x | x | x | x | | | | | | | 275 | -1 | | | 15.8 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | 360 | -41 | | | 15.8 | |
| AH | all | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | 168 | 42 | 165.4 | -14.9 | 4.2 | |
| | low | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | 359 | -51 | | | 10.1 | |

| Sample | ID | NRM | LN2-1 | LN2-2 | 100 | 200 | 300 | 400 | 450 | 500 | 520 | 550 | 575 | 600 | 625 | 650 | 660 | 667 | 673 | 679 | 685 | Origin | Geographic Declination | Geographic Inclination | Stratigraphic Declination | Stratigraphic Inclination | MAD (6 degree cutoff) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | 331 | -47 | 340.1 | -54.3 | 4.5 |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | 264 | 11 | | | 15 |
| B | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | 186 | -22 | 182.4 | -19.1 | 3.8 |
| | mid | | | | | | | x | x | x | x | x | x | x | | | | | | | | | 263 | 58 | | | 16.2 |
| | lmd | | | x | x | x | x | x | | | | | | | | | | | | | | | 39 | -34 | | | 9.7 |
| | low | x | x | x | | | | | | | | | | | | | | | | | | | 166 | 80 | | | 28.2 |
| C | all | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | 174 | -1 | 174.9 | 10.4 | 4.9 |
| | low | x | x | x | x | | x | x | x | x | | | | | | | | | | | | | 131 | -60 | | | 12.2 |
| D | all | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | 172 | -39 | 164.1 | -33.0 | 2.6 |
| | low | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | 303 | -23 | | | 14.3 |
| E | all | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 176 | -20 | 175.4 | -18.0 | 1.2 |
| | mid | | | | x | x | x | x | x | | | | | | | | | | | | | | 30 | 2 | | | 18.9 |
| | low | x | x | x | x | | | | | | | | | | | | | | | | | | 137 | 52 | | | 4.1 |
| F | all | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 182 | -20 | 177.1 | -11.3 | 2.8 |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 15 | -3 | | | 11.8 |
| G | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | 145 | -54 | 133.3 | -41.9 | 5.7 |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | 48 | 26 | | | 7 |
| H | all | | | | | | | | | | | | | | x | x | x | x | x | x | x | x | 174 | -10 | 172.0 | -1.4 | 3.9 |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 36 | 5 | | | 11 |
| I | all | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 168 | -12 | 166.1 | -5.4 | 4.8 |
| | low | x | x | x | x | x | x | x | | | | | | | | | | | | | | | 231 | 3 | | | 16.7 |
| J | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | 186 | -23 | 179.2 | -22.7 | 3.8 |
| | low | x | x | | x | x | x | x | x | x | x | x | x | x | | | | | | | | | 224 | -33 | | | 5.6 |
| K | all | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | 193 | -7 | 191.4 | -8.9 | 2.5 |
| | mid | | | | | x | x | x | x | x | x | | | | | | | | | | | | 88 | -18 | | | 12.2 |
| | low | x | x | x | x | x | | | | | | | | | | | | | | | | | 288 | 21 | | | 17.1 |
| L | all | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 167 | -30 | 162.9 | -22.1 | 3 |

JK1103 Least Sqaure Fits
for Fold Test



| Sample | ID | NRM | LN2-1 | LN2-2 | 100 | 200 | 300 | 400 | 450 | 500 | 520 | 550 | 575 | 600 | 625 | 650 | 660 | 667 | 673 | 679 | 685 | Origin | Geographic Declination | Geographic Inclination | Stratigraphic Declination | Stratigraphic Inclination | MAD (6 degree cutoff) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L | low | x | x | x | x | x | x | x | | | | | | | | | | | | | | | 68 | 4 | | | 13.6 |
| M | all | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | 175 | -27 | 171.3 | -21.0 | 3.5 |
| | low | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | 78 | -23 | | | 8.5 |

| Sample | ID | NRM | LN2-1 | 100 | 200 | 300 | 350 | 400 | 450 | 480 | 500 | 525 | 550 | 575 | 600 | 625 | 650 | 665 | 670 | 675 | 680 | 685 | Origin | Geographic Declination | Geographic Inclination | Stratigraphic Declination | Stratigraphic Inclination | MAD (6 degree cutoff) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | lla | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | 192 | -66 | 184 | -56 | 5.8 | |
| | mid | | | | | | | x | x | x | x | x | x | | | | | | | | | | | 319 | 11 | 319 | 1 | 9.5 | |
| | low | x | x | x | x | x | x | x | | | | | | | | | | | | | | | | 343 | -44 | 342 | -55 | 12.6 | |
| B | all | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | 209 | -55 | 201 | -46 | 4 | |
| | low | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | 337 | -44 | 335 | -55 | 15.7 | |
| C | all | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | 206 | -59 | 197 | -50 | 1.7 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | 354 | -36 | 356 | -47 | 8.6 | |
| D | all | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | 193 | -47 | 189 | -38 | 2.8 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | 345 | -17 | 344 | -27 | 12.4 | |
| E | end | | | | | | | | | | | | | | | | | x | x | x | x | x | x | 244 | -35 | 237 | -32 | 24.4 | |
| | mid | | | | | | | | | | | x | x | x | x | x | x | x | | | | | | 241 | -11.3 | 239 | -8 | 21.2 | not done? |
| | low | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | 348 | -38 | 348 | -48 | 6.8 | |
| F | end | | | | | | | | | | | | x | x | x | x | x | x | x | x | | x | x | 211 | -61 | 201 | -53 | 5.5 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | 338 | -37 | 336 | -47 | 6.6 | |
| G | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 172 | -51 | 171 | -41 | 5.6 | |
| | mid | | | | | x | x | x | x | x | x | x | x | x | | | | | | | | | | 281 | -4 | 280 | -8 | 12.5 | |
| | low | x | x | x | x | x | | | | | | | | | | | | | | | | | | 327 | -36 | 324 | -46 | 6.1 | |
| H | all | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | 197 | -29 | 195 | -20 | 8.9 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | 10 | -35 | 14 | -44 | 8.9 | |
| I | all | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | 200 | -51 | 194 | -42 | 2.9 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | 60 | -49 | 72 | -51 | 18 | |
| J | all | | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | 203 | -46 | 198 | -37 | 6 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 4 | -49 | 8 | -59 | 14.3 | |
| K | all | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | 159 | -40 | 160 | -28 | 2.7 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | 355 | -45 | 358 | -56 | 7.3 | |
| L | all | | | | | | | | | | | | | | | | x | x | x | x | x | x | x | 184 | -64 | 178 | -52 | 5.7 | |
| | mid | | | | | | | | x | x | x | x | x | x | x | x | x | | | | | | | 135 | 33 | 130 | 43 | 8.3 | |

| Sample | ID | NRM | LN2-1 | 100 | 200 | 300 | 350 | 400 | 450 | 480 | 500 | 525 | 550 | 575 | 600 | 625 | 650 | 665 | 670 | 675 | 680 | 685 | Origin | Geographic Declination | Geographic Inclination | Stratigraphic Declination | Stratigraphic Inclination | MAD (6 degree cutoff) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L | low | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | | 54 | -16 | 57 | -20 | 17.4 | |
| M | end | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 180 | -74 | 173 | -62 | 2.5 | |
| | low | x | x | x | x | x | x | | | | | | | | | | | | | | | | | 65 | -54 | 81 | -53 | 31.8 | |
| | all | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 176 | -75 | 170 | -63 | 2.9 | |
| N | all | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | 182 | -20 | 181 | -9 | 11.6 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | 12 | -30 | 16 | -40 | 9.7 | |
| O | all | | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | 198 | -63 | 191 | -55 | 7.2 | |
| | low | | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | 359 | -38 | 0 | -47 | 11.1 | |
| P | all | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 149 | -33 | 151 | -25 | 7 | |
| | low | x | x | x | x | x | | | | | | | | | | | | | | | | | | 326 | -50 | 321 | -58 | 6.7 | |
| Q | all | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 179 | -29 | 178 | -20 | 3.3 | |
| | low | x | x | x | x | | | | | | | | | | | | | | | | | | | 292 | -52 | 281 | -56 | 11.3 | |
| R | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 217 | -41 | 212 | -35 | 3.4 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | 341 | -21 | 340 | -29 | 18.5 | |
| S | all | | | | | | | | | | | | | | | | x | x | x | x | x | x | x | 198 | -13 | 197 | -5 | 14 | not done? |
| | mid | | | | | | | | | | | | x | x | x | x | x | | | | | | | 143 | -53 | 147 | -45 | 18.2 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | 306 | -39 | 300 | -46 | 11.4 | |
| T | all | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 189 | -39 | 187 | -31 | 6.9 | |
| | low | x | x | x | x | x | x | x | | | | | | | | | | | | | | | | 253 | -9 | 252 | -8 | 23.1 | |
| U | all | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | 191 | -44 | 188 | -36 | 2.8 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | 345 | -28 | 345 | -37 | 10.1 | |
| V | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 192 | -55 | 188 | -47 | 2.3 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 2 | -42 | 4 | -51 | 7.8 | |
| W | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 179 | -24 | 179 | -12 | 5.8 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 51 | 41 | 44 | 34 | 4 | |
| X | all | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | 173 | -31 | 173 | -19 | 4 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | 308 | -29 | 303 | -37 | 9.8 | |

JK1206 Least Sqaure Fits
for Fold Test



| Sample | ID | NRM | LN2-1 | 100 | 200 | 300 | 350 | 400 | 450 | 480 | 500 | 525 | 550 | 575 | 600 | 625 | 650 | 665 | 670 | 675 | 680 | 685 | Origin | Geographic Declination | Geographic Inclination | Stratigraphic Declination | Stratigraphic Inclination | MAD (6 degree cutoff) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Y | all | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | 190 | -19 | 188 | -8 | 2.4 | |
| | low | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | 343 | -28 | 343 | -40 | 9.7 | |
| Z | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 181 | -27 | 180 | -15 | 10.5 | |
| | mid | | | | | | x | x | x | x | x | x | x | x | | | | | | | | | | 85 | 22 | 79 | 23 | 16.9 | |
| | low | x | x | x | x | x | x | | | | | | | | | | | | | | | | | 340 | -36 | 339 | -48 | 15.8 | |
| AA | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 174 | -54 | 173 | -42 | 4.1 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 319 | -8 | 318 | -19 | 4.8 | |
| AB | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 183 | -42 | 180 | -30 | 3.9 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 352 | -34 | 353 | -46 | 11.8 | |
| AC | all | | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | 177 | -44 | 176 | -32 | 1.5 | |
| | mid | | | | | | | x | x | x | x | x | x | x | x | | | | | | | | | 324 | -49 | 318 | -60 | 21 | |
| | low | x | x | x | x | x | x | x | | | | | | | | | | | | | | | | 1 | -14 | 2 | -26 | 21.7 | |
| AD | all | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | 169 | -50 | 169 | -38 | 4 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | 358 | -48 | 2 | -60 | 11.8 | |
| AE | all | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | 162 | -56 | 164 | -41 | 3 | |
| | low | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | 344 | -49 | 340 | -64 | 15.6 | |
| AF | all | | | | | | | | | | | | | | | | x | x | x | x | x | x | x | 206 | -50 | 190 | -45 | 4.2 | |
| | low | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | 287 | -24 | 283 | -39 | 26.3 | |
| AG | all | | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | 199 | -52 | 188 | -30 | 2.8 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | 8 | -27 | 17 | -50 | 19.2 | |
| AH | all | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 147 | -51 | 150 | -40 | 5.8 | |
| | low | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | | 236 | 35 | 244 | 38 | 17.5 | |
| AI | all | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 213 | -36 | 209 | -29 | 3.1 | |
| | low | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | 317 | -29 | 314 | -37 | 17.8 | |
| AJ | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 208 | -44 | 201 | -34 | 4.1 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | | x | | | | | | | | | | 269 | -66 | 239 | -66 | 24 | |
| AK | all | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | 213 | -49 | 193 | -38 | 5.3 | |

JK1206 Least Sqaure Fits
for Fold Test



| Sample | ID | NRM | LN2-1 | 100 | 200 | 300 | 350 | 400 | 450 | 480 | 500 | 525 | 550 | 575 | 600 | 625 | 650 | 665 | 670 | 675 | 680 | 685 | Origin | Geographic Declination | Geographic Inclination | Stratigraphic Declination | Stratigraphic Inclination | MAD (6 degree cutoff) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AK | low | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | 15 | -46 | 42 | -56 | 5.1 | |
| AL | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 201 | -34 | 193 | -26 | 5.2 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 17 | -39 | 31 | -45 | 17.2 | |
| AM | all | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | 208 | -32 | 196 | -28 | 3.8 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | 351 | -25 | 1 | -37 | 10.2 | |
| AN | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 195 | -48 | 174 | -32 | 4.2 | |
| | mid | | | | | x | x | x | x | x | x | x | x | x | | | | | | | | | | 11 | 4 | 12 | -10 | 22 | |
| | low | x | x | x | x | x | | | | | | | | | | | | | | | | | | 59 | -36 | 74 | -22 | 18.7 | |
| AO | all | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 207 | -16 | 200 | -11 | 5.8 | |
| | low | x | x | x | x | x | x | | | | | | | | | | | | | | | | | 11 | -52 | 49 | -54 | 9.9 | |
| AP | all | | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | 187 | -42 | 171 | -25 | 5.7 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 148 | -82 | 130 | -55 | 13.9 | |
| AQ | all | | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | 208 | -27 | 198 | -25 | 4.3 | |
| | mid | | | | | x | x | x | x | x | x | x | x | x | x | | | | | | | | | 281 | 19 | 282 | 0 | 14.3 | |
| | low | x | x | x | x | x | | | | | | | | | | | | | | | | | | 257 | -8 | 253 | -22 | 37.6 | |
| AR | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 205 | -28 | 198 | -24 | 6.1 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 1 | -15 | 5 | -24 | 10.7 | |
| AS | all | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | 185 | -13 | 186 | 2 | 2.7 | |
| | mid | | | | x | x | x | x | x | x | x | x | | | | | | | | | | | | 95 | 17 | 92 | 10 | 16.1 | |
| | low | x | x | x | x | | | | | | | | | | | | | | | | | | | 311 | -27 | 302 | -30 | 3.8 | |
| AT | end | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 189 | -11 | 189 | 4 | 3.7 | |
| | low | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | 119 | 58 | 92 | 64 | 38.5 | |
| | ALL | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 188 | -9 | 188 | 6 | 4.1 | |
| AU | all | | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | 163 | -21 | 158 | -17 | 7 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | 342 | -33 | 352 | -35 | 10.4 | |
| AV | all | | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | 203 | -37 | 206 | -27 | 2.4 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | 311 | -33 | 304 | -30 | 14.2 | |

| Sample | ID | NRM | LN2-1 | 100 | 200 | 300 | 350 | 400 | 450 | 480 | 500 | 525 | 550 | 575 | 600 | 625 | 650 | 665 | 670 | 675 | 680 | 685 | Origin | Geographic Declination | Geographic Inclination | Stratigraphic Declination | Stratigraphic Inclination | MAD (6 degree cutoff) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AW | all | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 158 | -46 | 164 | -38 | 11.4 | not done? |
| | low | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | 293 | -85 | 226 | -79 | 15.4 | |
| AX | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 189 | -50 | 196 | -35 | 3.5 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 114 | -28 | 124 | -31 | 27 | |
| AY | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 212 | -20 | 212 | -4 | 3.3 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 54 | -69 | 90 | -83 | 32.8 | |
| AZ | all | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | 181 | -42 | 187 | -28 | 5.6 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | 58 | -24 | 62 | -39 | 22.9 | |
| BA | all | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 189 | -28 | 191 | -14 | 2.9 | |
| | low | x | x | x | x | x | x | | | | | | | | | | | | | | | | | 63 | -22 | 67 | -36 | 15.3 | |
| BB | all | | | | | | | | | | | | | | | | x | x | x | x | x | x | x | 156 | -57 | 173 | -48 | 12.4 | not done? |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | 318 | -34 | 306 | -35 | 15.5 | |
| BC | all | | | | | | | | | | | | | | | | x | x | x | x | x | x | x | 201 | -30 | 203 | -15 | 7.3 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | 291 | -13 | 288 | -7 | 12.4 | |
| BD | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 203 | -56 | 207 | -40 | 3 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 349 | -38 | 337 | -48 | 4.5 | |
| BE | all | | | | | | | | | | | | | | | | x | x | x | x | x | x | x | 183 | -27 | 186 | -14 | 7.2 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | 37 | -55 | 36 | -71 | 16.1 | |
| BF | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 203 | -51 | 198 | -41 | 3.3 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 24 | -17 | 26 | -26 | 6.3 | |
| BG | all | | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | 169 | -40 | 165 | -32 | 5.5 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | 18 | -32 | 24 | -35 | 7.5 | |
| BH | all | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 217 | -38 | 209 | -31 | 5.4 | |
| | low | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | | 31 | -53 | 51 | -59 | 10.1 | |
| BI | all | | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | 192 | -43 | 189 | -29 | 8.3 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | 354 | -50 | 354 | -64 | 5.5 | |
| BJ | all | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 185 | -29 | 185 | -16 | 5.6 | |

JK1206 Least Sqaure Fits
for Fold Test



| Sample | ID | NRM | LN2-1 | 100 | 200 | 300 | 350 | 400 | 450 | 480 | 500 | 525 | 550 | 575 | 600 | 625 | 650 | 665 | 670 | 675 | 680 | 685 | Origin | Geographic Declination | Geographic Inclination | Stratigraphic Declination | Stratigraphic Inclination | MAD (6 degree cutoff) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BJ | low | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | 310 | -38 | 300 | -45 | 16.8 | |
| BK | all | | | | | | | | | | | | | | | | x | x | x | x | x | x | x | 206 | -51 | 203 | -43 | 6.4 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | 21 | -46 | 23 | -55 | 14 | |
| BL | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 199 | -38 | 201 | -28 | 6.8 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 47 | -29 | 47 | -40 | 5.7 | |
| BM | all | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 193 | -38 | 187 | -28 | 3.1 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 10 | -49 | 23 | -58 | 9.2 | |
| BN | all | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 192 | -42 | 184 | -40 | 5.4 | |
| | low | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | 61 | -51 | 69 | -44 | 33.5 | |
| BO | all | | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | 201 | -29 | 196 | -16 | 4.7 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | 328 | -37 | 325 | -53 | 8.6 | |
| BP | all | | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | 153 | -7 | 154 | 12 | 5.8 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | 272 | -34 | 262 | -57 | 11 | |
| BQ | all | | | | | | | | | | | | | | x | x | x | x | x | x | x | x | x | 155 | -7 | 154 | -5 | 7.4 | not done? |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | 24 | -49 | 31 | -43 | 6.6 | |
| BR | all | | | | | | | | | | | | | | | | x | x | x | x | x | x | x | 220 | -26 | 213 | -25 | 9.7 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | 11 | -28 | 18 | -33 | 6.1 | |
| BS | all | | | | | | | | | | | | | | | | | x | x | x | x | x | x | 211 | -31 | 203 | -28 | 5.7 | |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | 23 | -78 | 80 | -75 | 12 | |

| Sample | ID | NRM | LN2-1 | 100 | 200 | 300 | 350 | 400 | 450 | 475 | 500 | 525 | 550 | 575 | 600 | 625 | 650 | 665 | 670 | 675 | 680 | 685 | Origin | Geographic Declination | Geographic Inclination | Stratigraphic Declination | Stratigraphic Inclination | MAD (6 degree cutoff) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | all | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | x | 208.4 | -25.3 | 131.9 | -24.7 | 3.4 |
| B | all | | | | | | | | | x | x | x | x | x | x | | | | | | | | x | 214.1 | -39.4 | 116.7 | -19.8 | 2.7 |
| | low | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | | 82.8 | -62.0 | 81.9 | 44.0 | 26.3 |
| C | all | | | | | | | x | x | x | x | x | x | x | x | | | | | | | | x | 207.3 | 17.1 | 179.5 | -39.3 | 4.5 |
| | low | x | x | x | x | x | x | x | | | | | | | | | | | | | | | | 106.1 | -16.9 | 164.3 | 65.2 | 28.8 |
| E | all | | | | | x | x | x | x | x | x | x | x | x | x | | | | | | | | x | 207.0 | 11.0 | 182.0 | -32.7 | 4.1 |
| | low | x | x | x | x | x | | | | | | | | | | | | | | | | | | 300.2 | 1.7 | 8.4 | -53.9 | 33.1 |
| F | all | | | | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | x | 178.8 | 5.9 | 180.5 | -4.4 | 4.6 |
| | low | x | x | x | x | | | | | | | | | | | | | | | | | | | 41.0 | 5.9 | 337.0 | 43.0 | 18.3 |
| G | all | | | | | | | | | | | | x | x | x | | | | | | | | x | 187.3 | 7.2 | 180.5 | -13.0 | 1.7 |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | 257.7 | 42.1 | 254.9 | -57.3 | 13.7 |
| H | all | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | x | 194.0 | -16.6 | 155.0 | -14.7 | 4.0 |
| I | all | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | x | 180.1 | 6.6 | 164.9 | -18.0 | 4.4 |
| J | all | | | | | | | | | | | x | x | x | x | | | | | | | | x | 196.7 | 15.1 | 183.9 | -26.2 | 1.8 |
| | low | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | 89.2 | -1.9 | 223.9 | 78.6 | 36.5 |
| K | all | | | | | | | | | | | | x | x | x | | | | | | | | x | 213.6 | 12.9 | 179.8 | -42.4 | 0.7 |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | 127.8 | -52.1 | 114.7 | 34.9 | 25.8 |
| L | all | | | | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | x | 202.6 | -9.4 | 156.0 | -25.7 | 5.9 |
| | low | x | x | x | x | | | | | | | | | | | | | | | | | | | 261.7 | 54.8 | 261.7 | -48.2 | 18.9 |
| M | all | | | | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | x | 187.7 | -5.2 | 155.0 | -23.5 | 5.3 |
| | low | x | x | x | x | | | | | | | | | | | | | | | | | | | 87.1 | 58.4 | 245.1 | 25.0 | 17.4 |
| N | all | | | | | | x | x | x | x | x | x | x | x | x | | | | | | | | x | 151.3 | -6.7 | 157.8 | 12.5 | 2.4 |
| | low | x | x | x | x | x | x | | | | | | | | | | | | | | | | | 90.1 | -11.1 | 144.2 | 72.8 | 34.5 |
| O | all | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | x | 196.6 | 13.8 | 177.0 | -28.8 | 4.8 |
| P | all | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | x | 194.6 | 0.9 | 164.4 | -20.9 | 3.4 |
| Q | all | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | x | 169.4 | 13.1 | 185.5 | -2.2 | 2.2 |
| R | all | | | | | | x | x | x | x | x | x | x | x | x | | | | | | | | x | 174.8 | -3.3 | 169.9 | -1.3 | 2.5 |

| Sample | ID | NRM | LN2-1 | 100 | 200 | 300 | 350 | 400 | 450 | 475 | 500 | 525 | 550 | 575 | 600 | 625 | 650 | 665 | 670 | 675 | 680 | 685 | Origin | Geographic Declination | Geographic Inclination | Stratigraphic Declination | Stratigraphic Inclination | MAD (6 degree cutoff) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R | low | x | x | x | x | x | x | | | | | | | | | | | | | | | | | 283.4 | -19.6 | 43.9 | -59.2 | 18.5 |
| S | all | | | | | | | x | x | x | x | x | x | x | x | | | | | | | | x | 219.4 | -17.4 | 145.7 | -41.7 | 4.2 |
| | low | x | x | x | x | x | x | x | | | | | | | | | | | | | | | | 121.8 | -38.7 | 123.1 | 40.7 | 22.7 |
| T | all | | | | | | x | x | x | x | x | x | x | x | x | | | | | | | | x | 193.4 | -34.1 | 130.0 | -23.9 | 4.2 |
| | low | x | x | x | x | x | x | | | | | | | | | | | | | | | | | 81.8 | -32.8 | 248.4 | -53.7 | 25.7 |
| U | all | | | | | | | | | | x | x | x | x | x | | | | | | | | x | 180.9 | -21.9 | 149.5 | -5.6 | 2.0 |
| | low | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | 65.2 | -81.1 | 79.5 | 14.6 | 25.1 |
| V | all | | | | | | | | | | x | x | x | x | x | | | | | | | | x | 181.9 | -28.9 | 142.4 | -5.4 | 2.7 |
| | low | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | 265.7 | -9.9 | 70.2 | -73.8 | 28.4 |
| W | all | | | | | | | | | x | x | x | x | x | x | | | | | | | | x | 200.9 | -5.2 | 162.4 | -24.4 | 2.3 |
| | low | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | 3.8 | -47.1 | 40.0 | 15.9 | 22.9 |
| X | all | | | | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | x | 180.1 | -19.1 | 154.4 | -1.1 | 5.3 |
| | low | x | x | x | x | | | | | | | | | | | | | | | | | | | 66.7 | -28.5 | 40.2 | 67.6 | 19.4 |
| Y | all | | | | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | x | 193.3 | -22.3 | 151.4 | -12.8 | 2.1 |
| | low | x | x | x | x | | | | | | | | | | | | | | | | | | | 97.6 | -41.7 | 101.2 | 54.2 | 10.9 |
| Z | all | | | | | x | x | x | x | x | x | x | x | x | x | | | | | | | | x | 176.3 | -23.9 | 145.7 | -0.1 | 3.3 |
| | low | x | x | x | x | x | | | | | | | | | | | | | | | | | | 279.9 | -57.0 | 69.3 | -17.7 | 36.2 |
| AE | all | | | | | | | | x | x | x | x | x | x | x | | | | | | | | x | 188.7 | -3.0 | 163.6 | -16.0 | 2.2 |
| | low | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | | 296.6 | -12.2 | 27.5 | -45.6 | 33.0 |
| AF | all | | | | | | | x | x | x | x | x | x | x | x | | | | | | | | x | 215.2 | -26.8 | 128.5 | -28.7 | 4.0 |
| | mid | | | | x | x | x | x | | | | | | | | | | | | | | | | 301.0 | 8.0 | 357.1 | -50.4 | 10.3 |
| | low | x | x | x | x | | | | | | | | | | | | | | | | | | | 86.7 | -57.0 | 86.1 | 47.9 | 14.4 |
| AG | all | | | | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | x | 181.1 | -14.7 | 158.2 | -0.9 | 4.3 |
| | low | x | x | x | x | | | | | | | | | | | | | | | | | | | 52.8 | -26.4 | 11.1 | 60.7 | 41.2 |
| AH | all | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | x | 212.6 | 14.4 | 179.0 | -40.4 | 3.2 |
| AI | all | | | | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | x | 194.4 | -16.5 | 151.7 | -15.8 | 3.7 |
| | low | x | x | x | x | | | | | | | | | | | | | | | | | | | 293.0 | -28.2 | 48.7 | -39.7 | 20.3 |

JK1205 Preliminary Least Sqaure Fits
for Fold Test



| Sample | ID | NRM | LN2-1 | 100 | 200 | 300 | 350 | 400 | 450 | 475 | 500 | 525 | 550 | 575 | 600 | 625 | 650 | 665 | 670 | 675 | 680 | 685 | Origin | Geographic Declination | Geographic Inclination | Stratigraphic Declination | Stratigraphic Inclination | MAD (6 degree cutoff) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AJ | all | | | | | | x | x | x | x | x | x | x | x | x | | | | | | | | x | 188.1 | -8.8 | 160.8 | -14.0 | 5.0 |
| | low | x | x | x | x | x | x | | | | | | | | | | | | | | | | | 303.4 | -7.8 | 13.0 | -45.8 | 38.2 |
| AK | all | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | x | 196.4 | 1.5 | 169.9 | -24.0 | 2.0 |
| AN | all | | | | | | | | | x | x | x | x | x | x | | | | | | | | x | 200.9 | -7.7 | 158.9 | -26.5 | 4.8 |
| | low | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | 17.5 | 16.3 | 330.9 | 21.1 | 13.5 |
| AO | all | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | x | 196.7 | 2.1 | 170.5 | -24.4 | 4.3 |
| AQ | all | | | | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | x | 174.1 | -18.8 | 154.5 | 6.6 | 4.7 |
| | low | x | x | x | x | | | | | | | | | | | | | | | | | | | 86.3 | -61.1 | 85.6 | 54.9 | 14.2 |
| AR | all | | | | | | x | x | x | x | x | x | x | x | x | | | | | | | | x | 201.7 | 8.1 | 166.6 | -29.9 | 3.9 |
| | low | x | x | x | x | x | x | | | | | | | | | | | | | | | | | 320.2 | -7.4 | 14.8 | -24.9 | 23.9 |
| AS | all | | | | | | x | x | x | x | x | x | x | x | x | | | | | | | | x | 221.9 | -4.0 | 142.2 | -48.8 | 3.5 |
| | low | x | x | x | x | x | x | | | | | | | | | | | | | | | | | 57.5 | -25.5 | 17.8 | 68.4 | 25.8 |
| AT | all | | | | | | x | x | x | x | x | x | x | x | x | | | | | | | | x | 217.3 | -14.9 | 133.1 | -39.1 | 2.5 |
| | low | x | x | x | x | x | x | | | | | | | | | | | | | | | | | 320.0 | -5.9 | 2.9 | -25.2 | 13.1 |
| AU | all | | | | | | x | x | x | x | x | x | x | x | x | | | | | | | | x | 201.6 | -18.2 | 139.1 | -24.5 | 3.0 |
| | low | x | x | x | x | x | x | | | | | | | | | | | | | | | | | 43.6 | -87.5 | 77.0 | 18.1 | 33.4 |
| AV | all | x | x | x | x | x | x | | x | x | x | x | x | x | x | | | | | | | | x | 192.7 | -10.3 | 142.5 | -21.2 | 4.8 |
| AW | all | x | x | x | x | x | x | | x | x | x | x | x | x | x | | | | | | | | x | 186.3 | 2.6 | 160.7 | -19.4 | 4.9 |

JK1104 Least Sqaure Fits
for Conglomerate Test



| Sample | ID | NRM | LN2-1 | LN2-2 | 100 | 200 | 300 | 400 | 450 | 500 | 520 | 535 | 550 | 565 | 570 | 577 | 580 | 585 | 590 | Origin | Geographic Declination | Geographic Inclination | MAD (6 degree cutoff) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | all | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 159 | 1 | 3.5 |
| | low | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 103 | -16 | 18.2 |
| B | all | | | | | | | | | | | | x | x | x | x | x | x | x | x | 96 | -61 | 3.9 |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | 98 | -1 | 5.3 |
| C | all | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | 170 | -56 | 3.7 |
| | low | x | x | x | x | x | x | x | x | | | | | | | | | | | | 269 | -10 | 9.7 |
| D | all | | | | | | x | x | x | x | x | x | x | x | x | x | | | | x | 325 | 40 | 5.6 |
| | low | x | x | x | x | x | x | | | | | | | | | | | | | | 332 | -58 | 7.5 |
| E | all | | | | | | | x | x | x | x | x | x | x | x | x | | | | x | 319 | 41 | 4.8 |
| | low | x | x | x | x | x | x | | | | | | | | | | | | | | 317 | -52 | 5.8 |
| F | all | | | | | | | | | | | | | x | x | x | | | | x | 348 | 64 | 4.8 |
| | mid | | | | | x | x | x | x | x | x | x | x | x | | | | | | | 125 | 17 | 8.1 |
| | low | x | x | x | x | | | | | | | | | | | | | | | | 131 | 7 | 7.5 |
| G | all | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | 85 | 17 | 3.4 |
| | low | | x | x | x | x | x | x | | | | | | | | | | | | | 179 | 20 | 14.2 |
| H | all | | | | | | | | | x | x | x | x | x | x | x | x | x | x | x | 186 | 55 | 2.9 |
| | low | x | x | x | x | x | x | x | x | x | | | | | | | | | | | 235 | -86 | 4 |
| I | all | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | 190 | 52 | 2.4 |
| | low | x | x | | x | x | x | x | | | | | | | | | | | | | 61 | -76 | 3.7 |
| J | all | | | | | | | | | | x | x | x | x | x | x | x | x | x | x | 153 | -71 | 3.7 |
| | mid | | | | | | | | x | x | x | | | | | | | | | | 211 | -42 | 2 |
| | low | x | x | x | x | x | x | | | | | | | | | | | | | | 50 | -2 | 10.1 |

JK1105 Least Sqaure Fits
for Conglomerate Test



| Sample | ID | NRM | LN2-1 | LN2-2 | 100 | 200 | 300 | 400 | 450 | 500 | 520 | 535 | 550 | 565 | 570 | 577 | 580 | 585 | 590 | Origin | Geographic Declination | Geographic Inclination | MAD (6 degree cutoff) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | all | | | | | | | | | | | x | x | x | x | x | x | x | x | x | 319 | 74 | 1 |
| | low | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | 221 | 25 | 9.3 |
| B | all | | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | 212 | 7 | 3.2 |
| | low | x | x | x | x | x | x | x | | | | | | | | | | | | | 210 | 12 | 3.5 |
| C | all | | | | | | | | x | x | x | x | x | x | x | | | | | | 194 | -28 | 4.9 |
| | low | | x | x | x | x | x | x | x | | | | | | | | | | | | 191 | -26 | 5 |
| D | all | | | | | | | | | | | | x | x | x | x | x | x | x | x | 203 | 8 | 8.2 |
| | low | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | 262 | 58 | 3 |
| E | all | | | | | | | x | x | x | x | x | x | x | x | | | | | | 239 | 60 | 4.8 |
| | low | x | x | x | x | x | x | x | | | | | | | | | | | | | 256 | 52 | 3.5 |
| F | all | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 77 | 14 | 5.5 |
| | low | | x | x | x | x | x | x | x | | | | | | | | | | | | 80 | 6 | 3.2 |
| | lwr | x | x | x | x | | | | | | | | | | | | | | | | 84 | 36 | 3.7 |
| G | all | | | | | | | | | | | | | | | x | x | x | x | x | 309 | 44 | 1.9 |
| | low | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | 266 | 70 | 5.8 |
| H | all | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | 226 | 66 | 5.1 |
| | low | x | x | x | x | x | | | | | | | | | | | | | | | 223 | 61 | 9.7 |
| I | all | | | | | | | | | | | | | | | x | x | x | x | x | 296 | 27 | 5.9 |
| | mid | | | | | | | x | x | x | x | x | x | x | x | x | | | | | 359 | 20 | 16.5 |
| | low | x | x | x | x | x | x | x | | | | | | | | | | | | | 2 | -40 | 10.6 |
| J | all | | | | | | | | | | | | x | x | x | x | x | x | x | x | 211 | -15 | 4.2 |
| | mid | | | | x | x | x | x | | x | x | x | x | | | | | | | | 307 | 8 | 21.4 |
| | low | x | x | x | x | | | | | | | | | | | | | | | | 333 | -45 | 2.1 |