SOFTWARE VALIDATION TEST PLAN AND REPORT FOR STEREOSTAT®, VERSION 1.4

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1 SCOPE OF THE VALIDATION

This document presents the Software Validation Test Plan and Report for full validation of the installation and functionality of StereoStat (version 1.4). StereoStat was acquired by the Center for Nuclear Waste Regulatory Analyses (CNWRA) to support technical assistance activities to the U.S. Nuclear Regulatory Commission (NRC) in its high-level waste program. StereoStat (version 1.4) replaces StereoStat (version 1.2), which was validated in December 2003 (Smart, 2003b). Version 1.4 represents a minor upgrade in that it addresses several “bug fixes”, but does not alter the basic functionality of the program.

This report is intended to fully validate StereoStat program features that are used for visualizing, analyzing, and interpreting geological data that describe planar and/or linear features (e.g., bedding, fractures, foliation, slickenlines, etc.). Features of the software that were validated include: (1) ability to plot planar (either as great circle traces or as poles to planes) and linear data (poles); (2) construction of rose diagrams; (3) contouring; and (4) statistical analysis. This test was based on the software validation test plan for StereoStat, version 1.2 (Smart, 2003a).

2 ENVIRONMENT

2.1 Software and Operating System Requirements

StereoStat (version 1.4) is developed and marketed by RockWare, Inc., Golden, Colorado. Version 1.4 runs on the Microsoft® Windows 98/ME/NT/2000/XP operating systems. Other than the operating system, no other software is required for installation and use of StereoStat. Data can be imported from an ASCII text file created with a text editor or standard spreadsheet, such as Microsoft® Excel (file format can be tab-delimited, comma-delimited, or space-delimited), or can be directly entered by the user.

2.2 Hardware Requirements

StereoStat (version 1.4) requires a 200 MHz Pentium (or faster) processor, and a minimum of 16 Mb of RAM and 10 Mb of hard disk space. The validation tests were performed on a 2.8 GHz Pentium 4 workstation with 512 MB of RAM and a 42 GB hard drive. StereoStat can export data and analyses in a variety of formats (Adobe® Illustrator® AI, BMP, WMF, and AutoCAD® DXF) and can print to any Windows-installed printer (including Adobe® Acrobat® for production of PDF files).

3 PREREQUISITES

Prerequisites for successful installation and application of StereoStat (version 1.4) include an appropriate level of hardware and operating capabilities, as described in

Section 2. Installation of software and license files requires administrator privileges. These privileges are not necessary to run the software once installation is complete.

4 ASSUMPTIONS AND CONSTRAINTS

Any user of StereoStat is assumed to have a basic familiarity with planar and linear geologic data, and the basic types of plots (e.g., great circles, poles to planes, rose diagrams) and analysis tools (e.g., 1% contouring) that are available. The standard program installation provides an HTML-format help page that also contains a short tutorial that can be accessed from the main help menu.

5 TEST CASES

This validation report follows CNWRA requirements as outlined in Section 5.10 of TOP-018 (CNWRA, 2003) and the test cases are described in the software validation test plan for version 1.2 (Smart, 2003a). The tests were considered successful if results from StereoStat (version 1.4) were the identical to those from StereoStat (version 1.2).

5.1 Test Case 1 – Verifying Accuracy of Plotted Planes and Lines

The ability to plot planar (either as great circle traces or as poles to planes) and linear data (poles) is a fundamental aspect of stereographic analysis.

5.1.1 Test Input

The test input for this case consisted of five planes listed in Table 1.

5.1.2 Test Procedure

The test planes were entered as a “New Dataset” in StereoStat. The “Plot on Stereo Plot” option was used to plot the planes on an equal-area, lower-hemisphere stereo plot as planes (i.e., great circle traces). The planes were then plotted on an equal-area, lower-hemisphere stereo plot as poles (i.e., lines that are normal to the planes).

5.1.3 Test Results

The stereo plots for the planes (Figs. 1A versus 1B) and poles to the planes (Figs. 1C versus 1D) were identical for both StereoStat (version 1.2) and StereoStat (version 1.4). Natural variation in field-collected data may produce slight variations in stereonet plots, therefore, a range of ±2 ° in strike and/or dip is considered acceptable for validation purposes.

5.2 Test Case 2 – Verification of Rose Diagram Functionality

Rose diagrams are the circular equivalent of traditional histograms where the number or percentage of strike values within a certain sampling window (typically 10°) are plotted graphically on a stereonet. Rose diagrams allow rapid determination of multiple modes within a data set (e.g., orientation of systematic fracture sets from a suite of fracture measurements).

5.2.1 Test Input

The test input for this case are 14 planes listed in Table 2.

5.2.2 Test Procedure

The test planes were entered as a "New Dataset" in StereoStat and the "Plot on Rose Plot" option was used to generate a standard bi-directional rose diagram with a 10° class bin.

5.2.3 Test Results

The output from versions 1.2 and 1.4 of StereoStat (Figs. 2A and 2B) are visually identical. Based on this result, test case 2 is considered successful. Natural variation in field-collected data may produce slight variations in stereonet plots, therefore, a range of ±2 ° in strike and/or dip is considered acceptable for validation purposes.

5.3 Test Case 3 – Verification of Contouring Functionality

Contouring of polar data is a standard technique for analyzing large amounts of orientation information (e.g., using poles to the bedding planes to deduce fold axis orientation). The most common contouring methods are the 1% area and Kamb methods (Kamb, 1959; Turner and Weiss, 1963). The primary difference between methods is the size of the counting circle. For the 1% area technique, the area of the counting circle is 1% of the area of the stereonet, regardless of number of data points. In contrast, the Kamb method employs a variable counting circle size that varies as a function of the number of data points.

5.3.1 Test Input

The test input for this case consists of a portion of a previously published and analyzed set of metamorphic foliation data (Smart et al., 1996). The data (n = 50) for test case 3 are listed in Table 3.

5.3.2 Test Procedure

The test data were written to an input text file named StereoStat_SVTP_test-case-3.txt that consists of two columns of data in ASCII text format. Column 1 is the strike of each foliation and column 2 is the dip of each foliation (right-hand rule convention). The input file was opened into StereoStat. The "Contour Plot" option was used to generate both 1% area and Kamb contours of the poles to the foliations.

5.3.3 Test Results

The 1% area contour plots generated by both StereoStat (version 1.2) and StereoStat (version 1.4) are virtually identical (Figs. 3A and 3B). The Kamb contour plot generated by both StereoStat (version 1.2) and StereoStat (version 1.4) are identical (Figs. 3C and 3D). Natural variation in field-collected data may produce slight variations in stereonet plots, therefore, a range of ±2 ° in strike and/or dip is considered acceptable for validation purposes. Based on this result, test case 3 is considered successful.

5.4 Test Case 4 – Verification of Statistical Algorithms

Along with contouring, statistical analysis of spherical data sets is a standard technique in structural geology. It is often necessary to determine the mean value of a population of linear data (e.g., poles of fractures). Several statistical options are normally available, including a circular distribution (Ramsay, 1967; Fisher et al., 1987) or Bingham axial distribution (Mardia and Jupp, 2000), and a principal component analysis (Watson, 1966).

5.4.1 Test Input

Test case 4 makes use of the same data set that is used for test case 3.

5.4.2 Test Procedure

The "Analyze Data" option was used to conduct a Fisher analysis (i.e., calculation of a vector mean and/or confidence interval) and a principal component analysis of the poles to the foliation planes.

5.4.3 Test Results

Output from both StereoStat versions are compared (Table 4). For the Fisher analysis, comparison is in terms of the trend/plunge of the mean pole to foliation, the size of the 95% confidence cones (in degrees), and concentration (k) factor. The mean poles to foliation, the 95% confidence cones, and the concentration (k) factors are all identical for both StereoStat (version 1.2) and StereoStat (version 1.4). For the principal components analysis, both versions of StereoStat produce identical eigenvalues and eigenvectors. Natural variation in field-collected data may produce slight variations in the analyses, therefore, a range of ±2 ° in trend and/or plunge and a range of ±5 °in concentration values or eigenvalues is considered acceptable for validation purposes. Based on these results, test case 4 is considered successful.

6 SUMMARY

All test cases were completed successfully and StereoStat version 1.4 is validated for the intended use described in the report.

7 REFERENCES

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Table 1: Planes for use in test case 1.

Strike	Dip
152°	20°
332°	40°
154°	60°
334°	80°
156°	90°

Table 2: Planes for use in test case 2.

Strike	Dip
230°	20°
055°	40°
235°	40°
052°	60°
232°	60°
058°	80°
238°	80°
055°	50°
235°	50°
152°	20°
332°	40°
154°	60°
334°	80°
156°	90°

Table 3: Foliation data for use in test case 3.

Strike	Dip	Strike	Dip	Strike	Dip	Strike	Dip	Strike	Dip
120°	77°	130°	75°	155°	65°	138°	78°	145°	66°
122°	88°	133°	80°	158°	62°	138°	85°	146°	64°
122°	63°	133°	85°	160°	80°	138°	63°	148°	62°
124°	83°	135°	70°	160°	75°	140°	48°	150°	74°
124°	62°	135°	77°	161°	56°	140°	73°	150°	54°
125°	58°	135°	75°	161°	58°	140°	71°	150°	80°
125°	55°	135°	87°	162°	71°	140°	56°	152°	72°
126°	73°	135°	80°	165°	67°	141°	51°	153°	70°
130°	72°	137°	77°	165°	75°	143°	80°	154°	74°
130°	64°	137°	79°	165°	52°	145°	65°	154°	60°

Table 4: Comparison of results for test case 4 using StereoStat version 1.2 and StereoStat version 1.4.

		StereoStat 1.2	StereoStat 1.4
Fisher Analysis:			
Mean Pole to Foliation		052°/21°	052°/21°
95% Confidence Cone		3.97°	3.977°
Concentration Factor (k)		26.638	26.638
Bingham Analysis:			
Eigenvalues	Maximum	0.93	0.93
	Intermediate	0.05	0.05
	Minimum	0.03	0.03
Eigenvectors	Maximum	052°/21°	052°/21°
	Intermediate	153°/27°	153°/27°
	Minimum	289°/55°	289°/55°

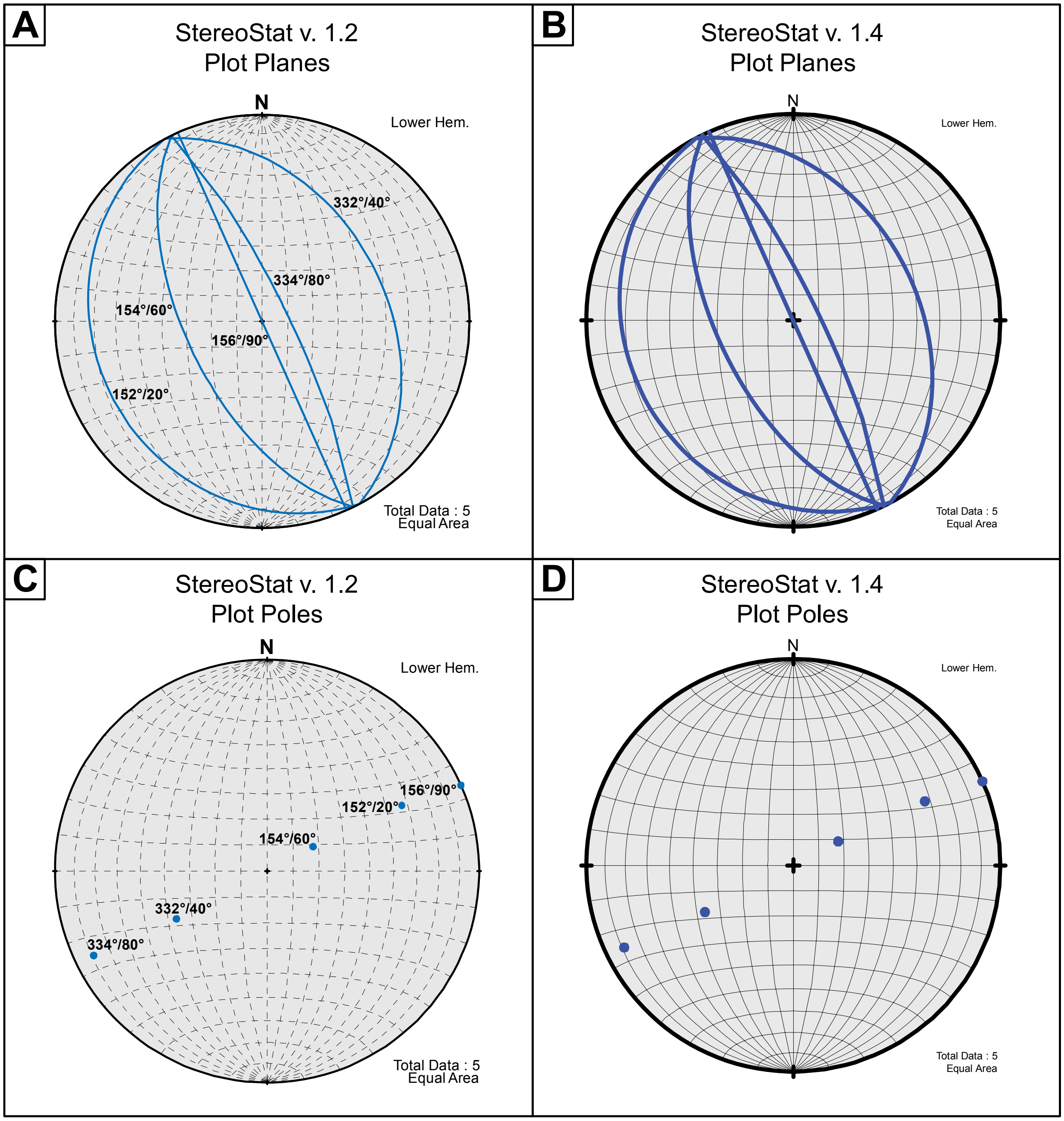

Figure 1. Equal-area stereonet plots for test case 1. Great circle plot of planes generated from (A) StereoStat (version 1.2) and (B) StereoStat (version 1.4). Scatter plot of poles to planes generated from (C) StereoStat (version 1.2) and (D) StereoStat (version 1.4).

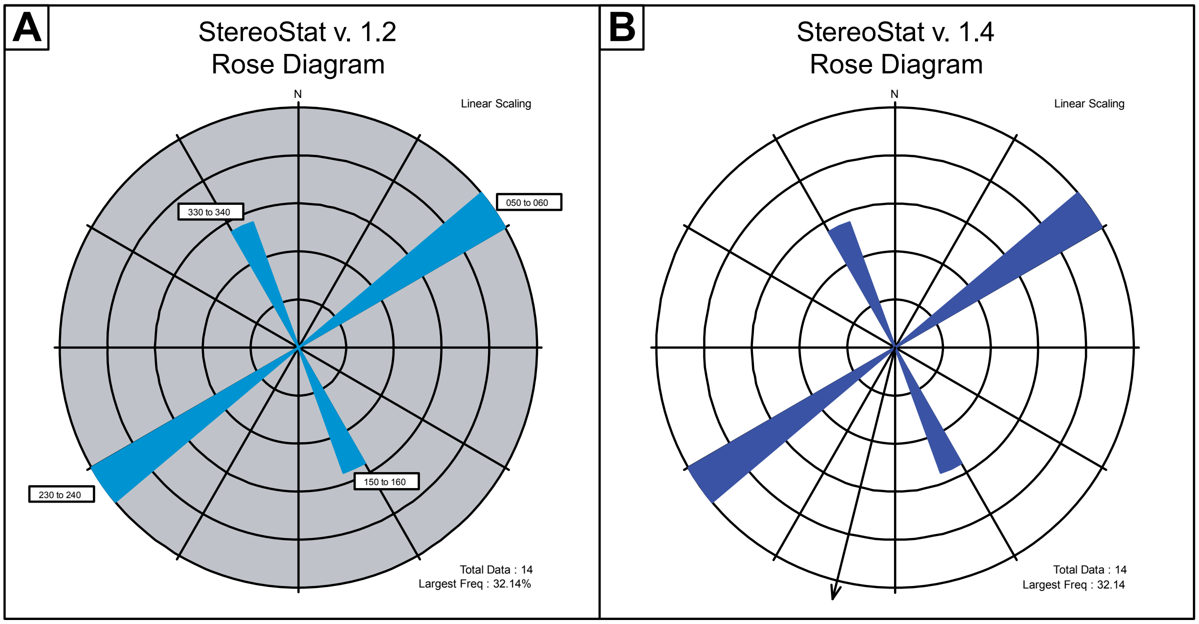

Figure 2. Rose diagram plots for test case 2 generated from (A) StereoStat (version 1.2) and (B) StereoStat (version 1.4).

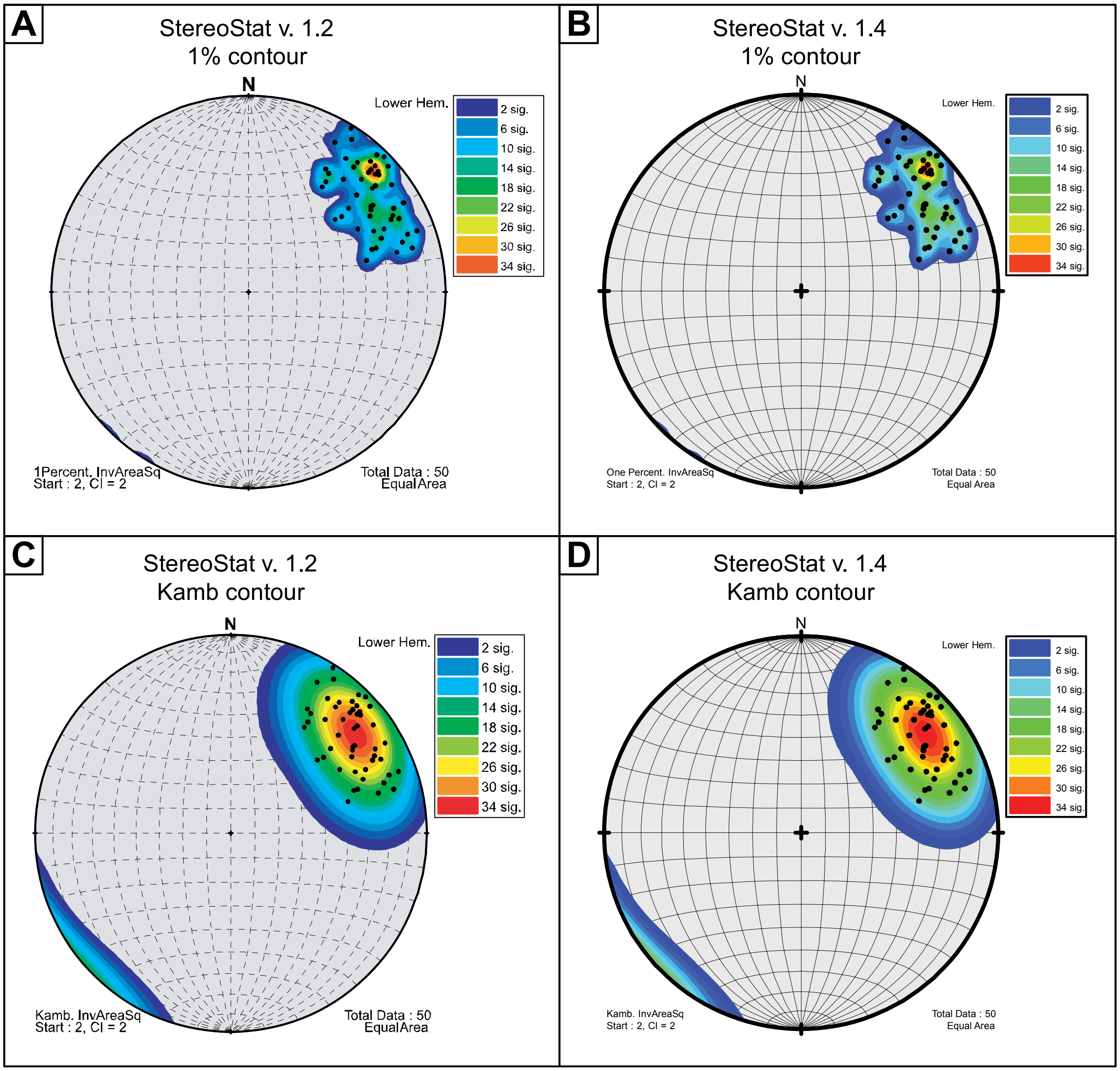

Figure 3. Contour plots for test case 3. 1% area contour plots generated from (A) StereoStat (version 1.2) and (B) StereoStat (version 1.4). Kamb contour plots generated from (C) StereoStat (version 1.2) and (D) StereoStat (version 1.4).