



**MAGNETOTELLURIC SURVEYS  
ALUM & SILVER PEAK, NEVADA - USA**

**Operational Report**  
*Volume 1 of 1*

**Prepared for**  
**SIERRA GEOTHERMAL POWER**

**By**  
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## SUMMARY

Under contract from Sierra Geothermal Power, WesternGeco's EM Land group Geosystem carried out a total of 79 magnetotelluric (MT) soundings at Alum and 69 sites at Silver Peak areas, Nevada.

Acquisition, Operations and Data Processing are reported here.

The MT survey was carried out between November 12<sup>th</sup> and December 2<sup>nd</sup>, 2009, in a total of 21 production days. During 2078 total man hours worked, no LTI were reported.

Five-component broadband MT data were acquired by three independent field crews. Each crew deployed up to three 24-bit, GPS-synchronized, Metronix ADU-06 and ADU-07 MT receivers, yielding a total of up to nine MT soundings per 24 hours. A fixed remote reference MT station was maintained, 20 km northwest of the Alum survey area. Time series were processed using robust, remote referencing techniques.

The final measured and processed data quality was generally fair to good; MT data covering the 7-decade range 0.001 to 10,000Hz were processed at all sites.

22 recordings were repeated in an attempt to improve data quality. The majority of these repeats were performed due to technical difficulties during data acquisition (poor electrode contact).

# 1 SURVEY AREA, LOGISTICS AND HSE

## 1.1 WORK AREA

Two MT surveys of respectively 79 and 69 stations were carried out at Alum and Silver Peak, South of Nevada, USA.

MT station spacing was nominally 500m, with stations arranged along profiles. Alum stations, on the northern survey area, were organized along seven profiles aligned in NW-SE direction; Silver Peak, on the south, had a station distribution along ten E-W profiles. (Figure 1, see also Plate 1 for a larger scale, and Figure 2 for detailed areas).

The present report discusses Acquisition, Operations and Data Processing. MT inversion modeling is the object of a separate report.

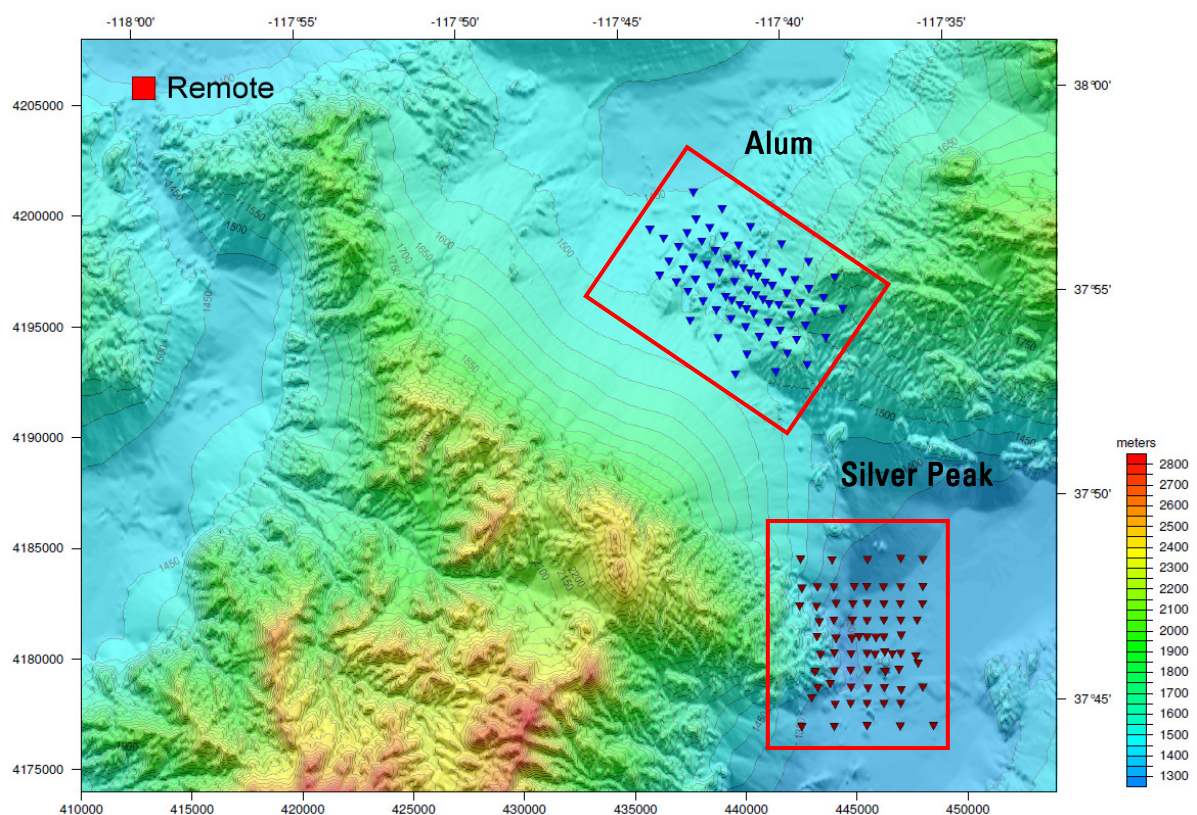
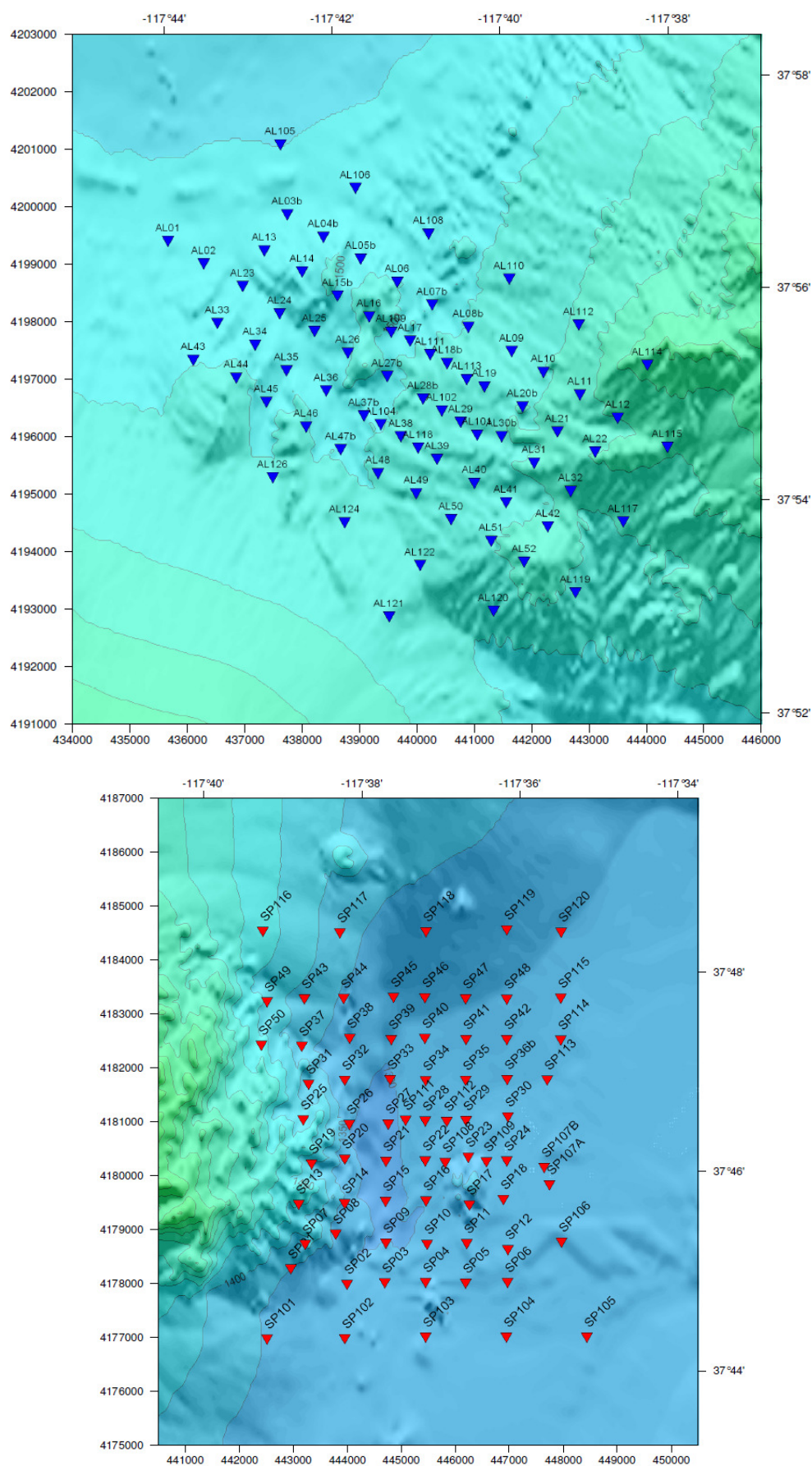


Figure 1. MT station locations on topographic base map (Transverse Mercator, NAD 83).



**Figure 2.** MT station locations on topographic base map for Alum (top) and Silver Peak survey areas (bottom).

## 1.2 COORDINATE SYSTEM

All map coordinates are reported in the following system:

<b>Metric Coordinates:</b>	Projection:	Transverse Mercator
	True Origin	117°00' W, 0°00' N
	Coordinates at Origin	500,000m E, 0.000m N
	Datum:	NAD 83
<b>Geographic Coordinates:</b>	Spheroid:	Geodetic Reference System 1980
	Datum:	NAD 83
	Spheroid:	Geodetic Reference System 1980
<b>Elevation</b>	Orthometric:	Extracted from 90m (SRTM)
		DEM, in meters relative to mean sea level

## 1.3 OPERATIONS

Scouting and access permitting were arranged by Sierra Geothermal Power, while Geosystem provided equipment, technical personnel and all logistics. The final work program was coordinated with Geosystem project staff directly at the base office.

Crews mobilized to Tonopah on November 10<sup>th</sup>, where a temporary office and basic facilities were set up in Jim Butler Inn, for project management, data processing, instrument maintenance, and battery charging. MT equipment was tested during November 11<sup>th</sup> and 12<sup>th</sup> respectively for ADU-06 and ADU-07 MT receivers. MT data acquisition began on November 12<sup>th</sup>, and was completed on December 2<sup>nd</sup>, having measured a total of 148 MT stations for both Alum and Silver Peak areas.

Site access was entirely by 4WD vehicle.

The table below summarizes the survey operations:

<b>Base camp (for personnel accommodation, project management, data processing, instrument maintenance, and battery charging):</b>	Jim Butler Inn
<b>Mode of access to sites:</b>	4WD on drivable roads and tracks, and thereafter on foot where necessary.
<b>Contact between crews and base:</b>	Cellular & Satellite phones.
<b>Number of crews for MT production:</b>	3 crews
<b>MT sites per day:</b>	Generally 9.
<b>Remote reference position (km):</b>	412.84 W; 4205.76 N, 20 km to the northwest of Alum survey area.

Personnel, production and equipment are listed in Appendix B, Appendix B, and Appendix D.

## 1.4 HSE SUMMARY

After an initial Safety Meeting, Geosystem's operational safety and environment program was implemented, updated according to varying conditions. In addition to the start-up safety meeting and induction to communicate the local risks and procedures, daily meetings were held to both update crews on changing conditions and maintain safety awareness. All the crews were given:

- SIPP Training (Schlumberger Injury Prevention Program);
- SLB Defensive Driving Training Program;
- Safe conduct during field procedures and the proper use of communication devices.

During 2078 total man hours worked, no LTI incidents, no First Aid case and Medical Treatment Case were reported.

Table 1 summarizes the safety record reported over the entire survey period.

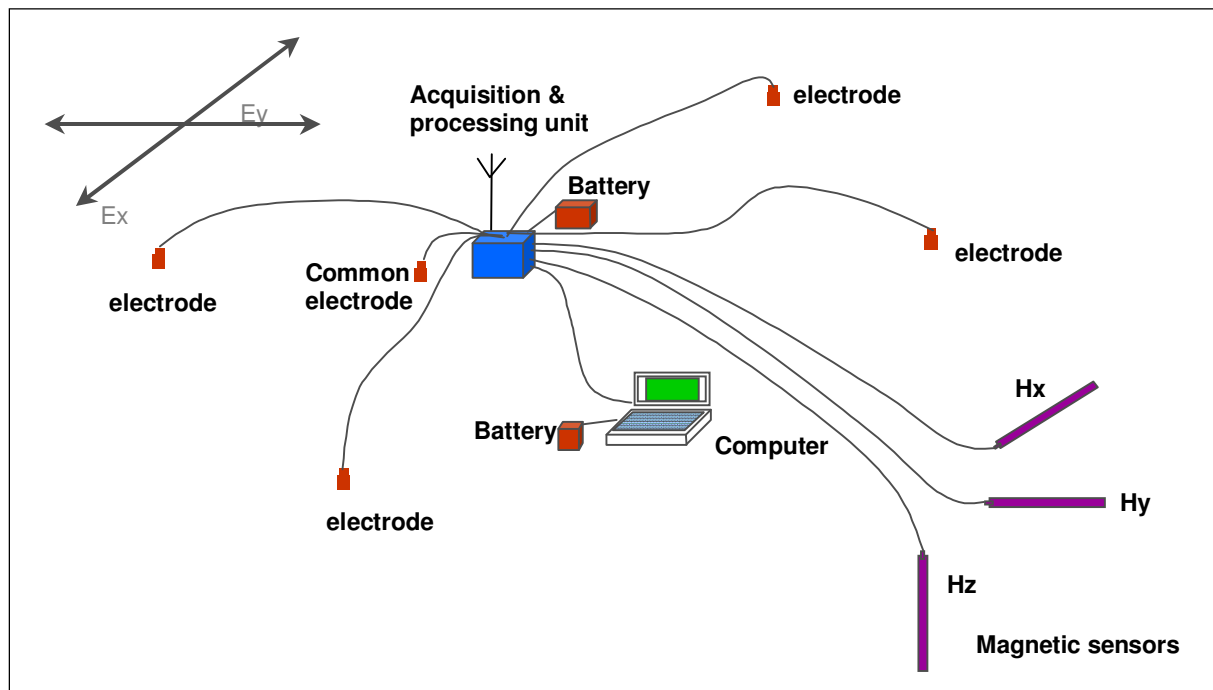
**Table 1.** Safety statistics during the survey period.

<b>Industry Recognized (SLB) -- Occupational Injuries &amp; Illnesses</b>	<b>Number</b>
Fatalities (fatalities in fatal incidents)	0
LWDC - Lost Work Days Cases	0
LD - Lost Days	0
RWDC - Restricted Work Day Cases	0
RD - Restricted Days	0
TDL - Total Days Lost (LD + RD)	0
MC - Medical Treatment Cases	0
FAC - First Aid Cases	0
<b>Life Loss</b>	
Life Loss - Total	0
<b>General HSE Events</b>	
Catastrophic	0
Major	0
Serious	0
Light	0
Near Accidents/Hazard situation	0
Regulatory Recordable Incidents	0
<b>Automotive</b>	
Total AA's - Automotive Accidents (CMS)	0
<b>Supporting Data</b>	
Vehicles (Light and Heavy Vehicles)	7
Vehicles with Working Monitors	7
Headcount - Total (Employees + Contractors)	10
Man Hours - Total (hours)	2078

All journeys were carried out in accordance with SLB Standards; the field crews had daily pre-determined journey plans and Journey Evaluation forms completed before each trip planned. The Project Party Chief was designated as Journey Manager in charge of ensuring that proper journey management practices were followed, and the crew location monitored.

## 2 MT DATA ACQUISITION

<b>Technique:</b>	Broadband Full Tensor MT with remote reference.
<b>Data acquisition:</b>	Full Time series recorded.
<b>Frequency range:</b>	0.001 – 10,000Hz.
<b>Recording system:</b>	5-channel GPS synchronized Metronix ADU-06.
<b>Magnetic sensors (details in Appendix D):</b>	$H_x$ , $H_y$ and $H_z$ Metronix magnetic sensors (MFS-06/7).
<b>Electric sensors (details in Appendix D):</b>	2 ( $E_x$ , $E_y$ ) orthogonal lines of 100m length, with 4×50m dipole wires and in total 5×non-polarisable Pb-PbCl <sub>2</sub> electrodes (including ground).
<b>MT station layout (see Figure 3):</b>	Varying setup azimuth. Convention after rotation: $E_x$ - North (N 0°); $E_y$ - East (N 90° E); $H_x$ - North (N 0°); $H_y$ - East (N 90° E). $H_z$ - Vertical.
<b>Data processing (see chapter 3):</b>	Robust remote reference technique.



**Figure 3.** Five-channel MT layout diagram.

### 2.1 PARALLEL SENSOR TEST

Prior to the survey start-up, all coils were checked in a series of parallel sensor tests conducted at the remote reference station.

The magnetic sensors were buried to depths of about 10cm, aligned North-South, and each was located parallel to and about 2m from its neighbour. Given identical sensor and acquisition systems, one would expect to see very similar outputs both in time and frequency domain: resulting coherencies should be greater than 0.9 between pairs of like sensors, and amplitude and phase transfer functions close to the theoretical values of 1.0 and 0.0°



respectively. In this way both the magnetic coils and the individual MT receiver channel boards could be verified.

Electric dipole wires were checked for correct length and obvious external damage to the protective insulation. Coil cables were similarly tested for correct pin-to-pin continuity and the absence of cross-channel interference (partial grounding between pins).

## ***2.2 SITE PREPARATION AND LAY-OUT***

Crews located the new sites using a hand-held GPS unit pre-programmed with the proposed sounding locations, in conjunction with maps showing the sounding locations provided by the client representative. Each MT crew moved to the new sites upon completion of data downloading and retrieval of equipment from the previous recording site. Arriving at a new site, the first course of action was to select the site centre so as to minimize topographic relief between electrodes, avoid possible interference sources, extend the dipoles (4×50m wires) and install the electrodes to allow sufficient time for stabilization.

The full magnetic field (Hx, Hy and Hz) has been recorded at every site. Trenches 30-50 cm deep were dug to bury the horizontal coils to minimize wind vibration and to provide thermal stability. The magnetic sensors were buried at a distance of 5-10 m from the acquisition unit.

The dipole was extended for a nominal length of 100m. The operator measured SP (Self Potential) and contact resistance across the dipoles and recorded them in the field books, together with the magnetic sensor serial numbers and the dipole lengths applied. In case of high contact resistance, the electrodes were re-buried and re-watered in order to reduce the resistance.

## ***2.3 RECORDING PARAMETERS***

The recording schedules shown in Table 2 and Table 3 were designed to maximize data acquisition in the mid to long periods and to provide high frequency windows at the beginning and ending of the recording. Table 2 displays the recording schedule for the ADU 06 receiver A/MT recordings; the sequence shows acquisition of 1 overnight A/MT site. Table 3 displays the recording schedule for the ADU 07 A/MT systems.

**Table 2.** A/MT recording frequency schedule (local time) for Metronix ADU 06 receiver.

<b>Band</b>	<b>Start</b>	<b>End</b>	<b>Duration</b>	<b>Sample Frequency (Hz)</b>
LF 2	Deployment	18:37:00	Deployment dependent	64
LF 1	19:00:00	19:02:00	00:02:00	4096
HF	19:03:00	19:03:06	00:00:06	40960
Free	19:05:00	19:19:00	00:14:00	512
LF1	19:20:00	19:22:00	00:02:00	4096
HF	19:23:00	19:23:21	00:00:21	40960
Free	19:25:00	19:39:00	00:14:00	512
LF 2/LF 3	19:40:00	07:37:00	11:57:00	64
LF 1	07:00:00	07:02:00	00:02:00	4096
HF	07:03:00	07:03:21	00:00:21	40960
Free	07:05:00	07:19:00	00:14:00	512

**Table 3.** MT A/MT recording frequency schedule (local time) for Metronix ADU 07 receiver.

<b>Start</b>	<b>End</b>	<b>Duration</b>	<b>Sample Frequency (Hz)</b>
Deployment	19:00:00	Deployment dependent	2048 / 64
19:02:00	19:02:15	00:00:15	65536
19:05:00	19:05:15	00:00:15	65536
19:08:00	19:16:00	00:08:00	8192
19:22:00	19:22:15	00:00:15	65536
19:25:00	19:25:15	00:00:15	65536
19:28:00	19:36:00	00:08:00	8192
19:40:00	16:00:00	20:20:00	2048 / 64



## ***2.4 QUALITY CONTROL***

Quality control procedures were taken at each stage of data acquisition. The MT crews assessed the status of the equipment on a daily basis, as described above. Field records were kept, to track possible equipment problems, with the following information:

- Coordinates;
- Telluric lines lengths and azimuths (geographic North);
- Contact resistance and self-potential;
- Magnetic sensor and MT receiver serial numbers.

The field layout parameters and sketch are included on the Time Series HD.

Further quality control measures were completed in the field office. Time series data from the same recordings were brought together on the processing computer and inter-channel correlation was checked. Any discrepancies noted were relayed to the operators, so that suspect equipment could be set aside until further testing was undertaken.

### 3 MT DATA PROCESSING

Data were processed at the field office within 48 hours of recording, using robust, remote referencing techniques. All time series data is recorded and stored. For data processing the following procedures were used:

1. Visual inspection of time series segments using WinGLink, developed by Geosystem;
2. Chave and Thomson (2004) processing mostly to check for noise characteristics;
3. Robust processing of time series using Larsen code, by individual bands;
4. Merging of individual bands to form a complete sounding curve.

#### 3.1 ROBUST PROCESSING

The robust, remote reference MT processing code described by Larsen et al. (1996), and subsequently implemented and upgraded by Geosystem, was used to estimate a smooth magnetotelluric transfer function (i.e. impedance) relating the electric and magnetic field data. Under some conditions, the algorithm described by Chave and Thomson (2004) provided preferable results over the higher frequency band (10 to 10,000 Hz).

The original and decimated time series bands provided input data. The code first determines the transfer function between the remote and local magnetic fields, with the assumption that the remote magnetic field is noise free. This iterative process corrects the local magnetic field for outliers in both the frequency and time domains. The magnetic fields are then used in an iterative re-weighted method to determine the impedance tensor. During the iterations, the electric fields are corrected in both the frequency and time domains, utilizing a smooth MT transfer function to estimate the electric field data from the magnetic fields. This procedure is repeated for each time series band and the complete sounding file, spanning a 7-decade frequency range from 0.001 to 10,000 Hz, is obtained by merging the results. The final MT parameters are written to standard EDI files, one per sounding.

#### 3.2 DATA PRESENTATION

The calculated MT parameters are presented as digital files on CD in Appendix G:

1. as standard format EDI files (format described by Wight, 1988)
2. within a WinGLink database.

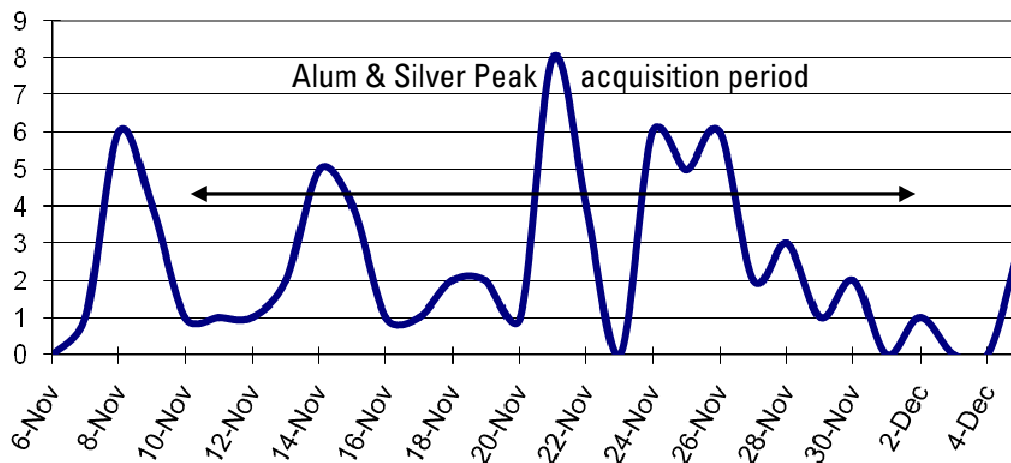
In the WinGLink database, plots for each MT site include the following interpretation parameters:

- apparent resistivities,  $\rho_{xy}$  and  $\rho_{yx}$ ;
- phases,  $\phi_{xy}$  and  $\phi_{yx}$ ;
- impedance rotation and strike; tipper strike (geographic North);
- impedance skew and ellipticity;
- tipper magnitude;
- smooth D+ curve for each mode.

Data were edited to mask noisier segments. A smooth curve, computed from the D+ function (Beamish and Travassos, 1992), is fitted to each component. Data which are geophysically plausible should lie close to this curve, except in the case of severe 3D behaviour.

### 3.3 SIGNAL AND NOISE

MT signal strength was generally low during the survey period as indicated by the geomagnetic activity index (Figure 4). Besides natural magnetic activity, the data quality was also influenced by local noise sources disturbing the recording sites.



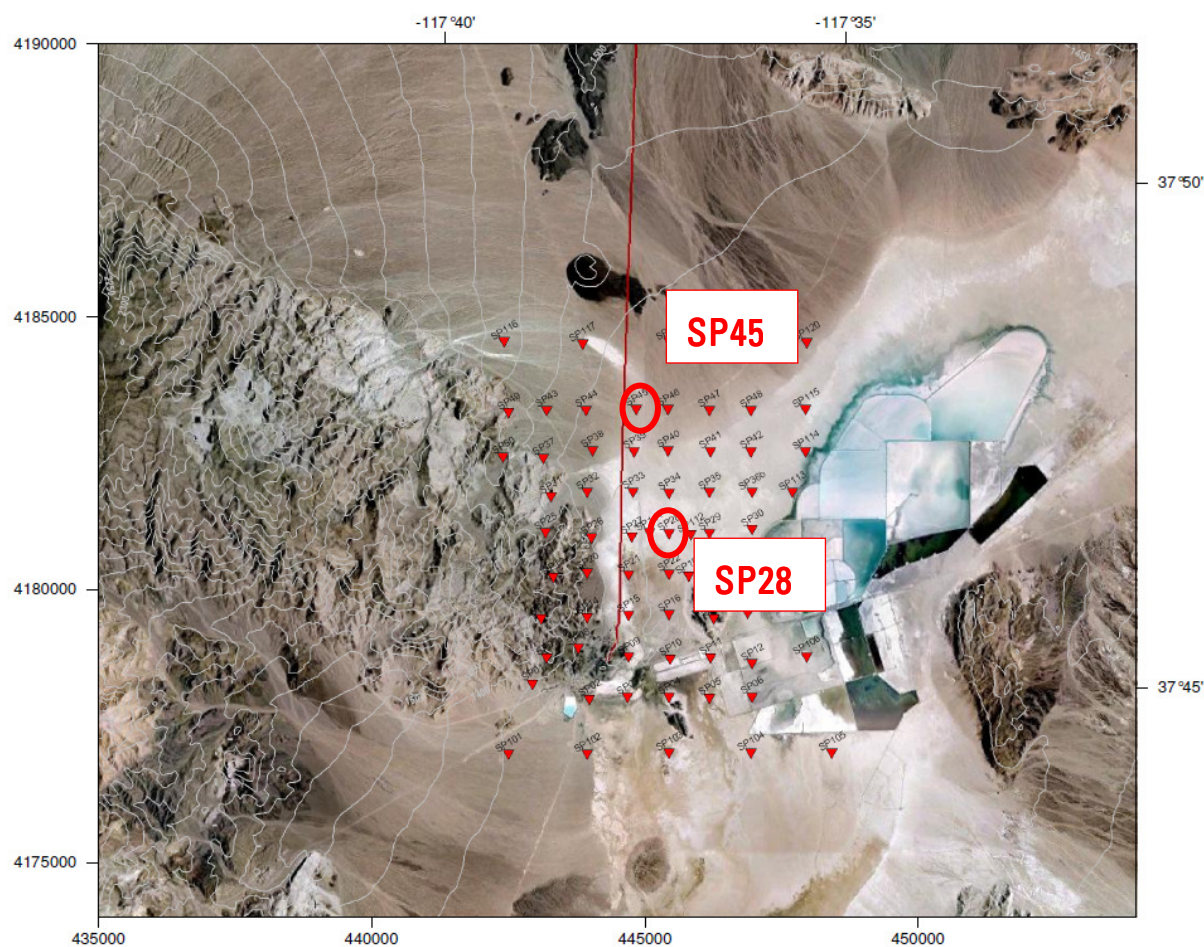
**Figure 4.** Geomagnetic activity (Ap index) for the survey period. Dates are referred to UTC time.

Figure 5 displays the path of a power line crossing the survey area.

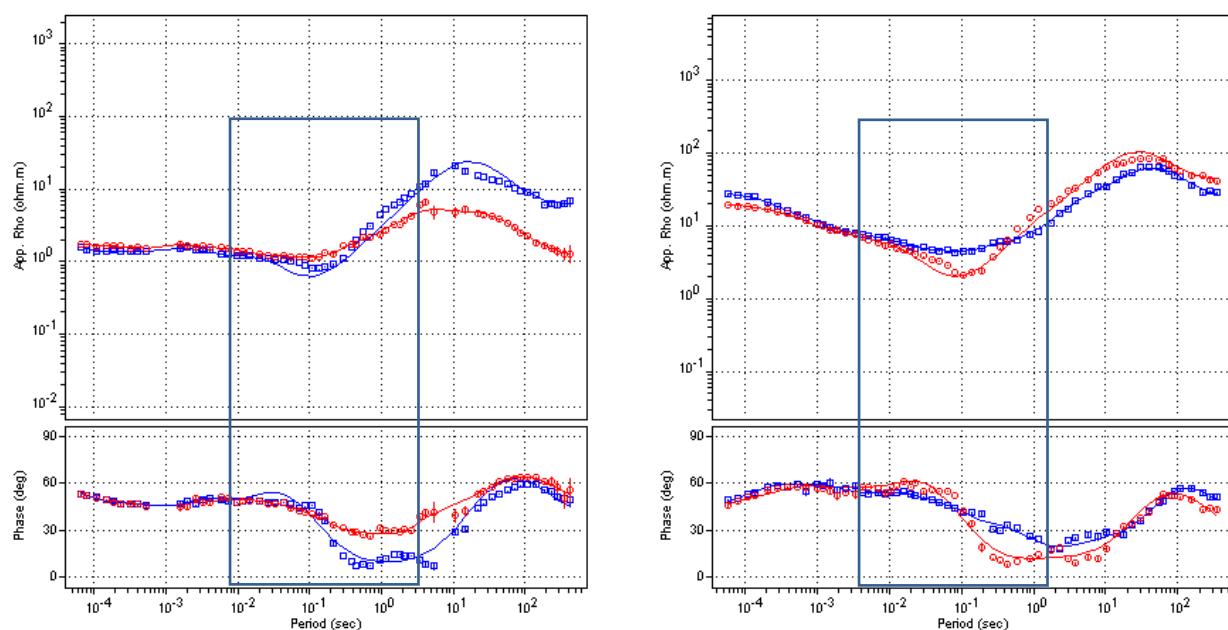
Signal to noise ratio varied strongly with site location, depending on the vicinity to industrial facilities, in particular an electric power line, crossing north-south through the Silver Peak survey area.

Having a far remote reference site largely free from correlated man-made noise contributions helped significantly in removing uncorrelated noise patterns for most sites.

An example of distortion likely related to the presence of the power line is displayed in Figure 6. As noted from the D+ Smoothing curves (Beamish and Travassos, 1992), apparent resistivities and phases do not agree well around the 10-0.1 Hz frequency band.



**Figure 5.** Silver Peak MT station locations on topographic map (Transverse Mercator, NAD 83). The red north-south line marks the location of a local powerline.



**Figure 6.** Example soundings SP28 (LHS) in the centre-south of the MT survey area, SP45 (RHS) in the centre-north of the MT survey area. Rotation: N 0° E, locations in Figure 4.

## 4 BIBLIOGRAPHY

- |   |      |   |
|---|------|---|
| Beamish, D., and Travassos, J.  | 1992 | The use of D+ in Magnetotelluric interpretation: J. Appl. Geophys 29, 1-19.   |
| Chave, A.D., and Thomson, D.J.  | 2004 | Bounded influence magnetotelluric response function estimation, Geophysical Journal International 157 (3), 988-1006.                |
| Larsen, J., Mackie, R.L., Manzella, A., Fordelisi, A., and Rieven, S.   | 1996 | Robust smooth magnetotelluric transfer functions: Geophysical Journal International, 124 801-819.                                   |
| Pellerin, L. and Hohmann, G. W.   | 1990 | Transient electromagnetic inversion: a remedy for magnetotelluric static shifts: Geophysics, Soc. of Expl. Geophys., 55, 1242-1250. |
| Vozoff, K.  | 1991 | The magnetotelluric method. In Electromagnetic Methods in Applied Geophysics, Vol2B 641-711, pub. SEG.                              |
| Wight, D.E.   | 1988 | SEG MT/EMAP Data Interchange Standard, Revision 1.0: SEG, Tulsa, OK, 91pp.  |
| <a href="http://www.swpc.noaa.gov/ftpmenu/lists/geomag.html">http://www.swpc.noaa.gov/ftpmenu/lists/geomag.html</a> | 2009 | Geomagnetic A Index, Estimated Planetary  |
| <a href="http://www.usgs.gov/">http://www.usgs.gov/</a>   | 2009 | National Elevation Dataset (NED)  |



## APPENDIX A GLOSSARY

1D	The earth is assumed to be made up of homogeneous horizontal layers
2D	Geology is assumed to be uniform along strike, but varies in the dip direction.
3D	Geology varies in all 3 directions (x, y, and z)
bgl	Below ground level
bsl (asl)	Below sea level (above sea level)
Coils	Sensors used to measure time-varying magnetic fields
Conductance	For a layer, product of layer thickness $\times$ conductivity (Siemens, S). See also Total Conductance, below.
Conductivity	1/resistivity (in S/m).
Contact resistance	Resistance of the electrode pot relative to a ground, measured in $\Omega$ .
E-line	Cable used to measure the electric field
EM	Electromagnetic
$E_x$ and $E_y$	Electric field strengths, in units of mV/km, measured in the x and y directions respectively.
$f$	frequency, in Hertz (Hz)
$H_x$ , $H_y$ , and $H_z$	Magnetic field strengths, in units of nT, measured in the x, y, and z directions (z positive upwards).
Induction arrow	Real part of the vector $\begin{bmatrix} T_x & T_y \end{bmatrix}$ , illustrating the relation between the vertical and horizontal magnetic field components from $H_z = T_x H_x + T_y H_y$ , plotted to show direction towards an assumed 2D line-source (i.e. towards the conductor in the so-called reversed convention).
LaToracca skew angle	$=90^\circ - (\theta_{EH})$ , where $\theta_{EH}$ is the angle between the major axes of the E and H polarization ellipses. Since this angle, should be $90^\circ$ , the La Toracca skew angle should be zero under 1 or 2 D conditions. In 3D conditions, the E field may be distorted (i.e. rotated), resulting in non-zero values.
m msl	meters above Mean Sea Level
Mode (TE or TM)	In a 2D world, the AMT/MT impedance is decomposed into two orthogonal components parallel (TE, or Transverse Electric) and perpendicular (TM, or Transverse Magnetic) to strike. In 1D and 3D situations the definition has limited value.
Occam inversion	Inverse modeling of geophysical data in which no <i>a priori</i> assumptions (e.g. the resistivity/thickness distribution) are made. Rather, the simplest model consistent with the data is found. Named for the 14th century philosopher William of Occam (see Occam, 1324, <i>Quodlibeta</i> , Book V: "Plurality is not to be assumed without necessity").
Period	Inverse of frequency (1/f). Commonly used instead of frequency in describing the low frequency range in AMT/MT (defined in seconds, s)
Pot	Potential electrode: sensor at the end of the E line for measuring the electric field
$\rho$	apparent resistivity in $\Omega\text{m}$
$\rho_{\max}$ and $\phi_{\max}$	The higher of the two apparent resistivity curves and its associated impedance phase.
$\rho_{xy}$	apparent resistivity calculated from $E_x$ and $H_y$
$\rho_{yx}$	apparent resistivity calculated from $E_y$ and $H_x$

RMS error

$$\sqrt{\frac{1}{npts} \sum \frac{(obs - pred)^2}{var}}$$

where *obs* and *pred* are the observed and predicted data responses (real and imaginary impedance tensors elements over the frequency range used and the stations employed in the inversion), *npts* is the number of data points, and *var* is the defined variance.

Roughness (of resistivity model) 3D

This is defined as the integral over the 3D model of  $L^T L \cdot m$ , where  $L$  is the Laplacian and  $m$  is the model resistivity. Interfaces in the resistivity are indicated in the model volume by zero-crossings in Roughness. In that this parameter is a fourth derivative, it is inevitably prone to noise, but in compensation aids in identifying the most likely position of an interface.

Sensitivity Matrix,  $A^T A$

The sensitivity matrix  $A^T A \equiv \frac{\Delta(response)}{\Delta(model)}$  represents the amount of change in

the modeled data due to a small change in the model parameter. This shows the sensitivity of the response to a particular 3D model, for each cell of this 3D mesh.

Static shift

Frequency-independent shift of AMT/MT apparent resistivities along the resistivity axis, caused by local electric field distortion.

Static stripping

A method of correcting static shift. At a user-selected (normally high) frequency the impedance is forced to a uniform 1D solution at the actual rotation angle, such that  $xy$  and  $yx$  apparent resistivities have identical absolute values. The corresponding e-field correction is then applied for all frequencies, and impedance re-calculated at the same orientation angle. Stripping therefore attempts to correct static shift via the impedance distortion, rather than simply block-shifting the (derived) apparent resistivity curves.

TD

Total depth (of a well).

Tipper

Ratio of the vertical magnetic component  $H_z$  to the horizontal magnetic field components  $H_x$  and  $H_y$ . Since the vertical component (noise excluded) is the output of a system (the earth) to which the two horizontal components are the input, its absolute value should not exceed 1 (see *induction arrow*).

Tipper strike

The geographic orientation in the horizontal plane of the vector relationship between the magnetic field components (*tipper*), taking real and imaginary parts into account. In a 2D earth, the tipper strike is perpendicular to the induction arrow direction, and shows the um 2D geo-electric strike.

Top of conductor

A surface interpreted from a resistivity distribution (e.g. 1D layered earth models or 3D resistivity volume in the MT case) depicting the elevation of the top of the (principal) conductive horizon. Shown as contour map or line on cross-section. Units are m msl.

Total conductance

The conductivity ( $=1/\text{resistivity}$ ), integrated to a specified depth  $z$ :

$$TC = \sum_0^z \Delta z_i / \rho_i, \text{ where } \Delta z_i \text{ is the thickness of the } i\text{th layer and } \rho_i \text{ its resistivity.}$$



## APPENDIX B PERSONNEL AND SURVEY HISTORY

### B.1 MT PERSONNEL

The crew list includes regular and rotation personnel

<b>MT Party Chief:</b> .....	Mark Kitchen
<b>MT Data Processor:</b> .....	Chris Jones
<b>HSE Manager &amp; Remote Operator:</b>	Russell Ketchum
<b>MT Operator:</b> .....	Jennifer Livermore, Jeff Nichols, Jesus Barrios, Jaime Reyes
<b>Field Technician:</b> .....	John Sandlin, Robert Eskew, Octavia Herrera

### B.2 MT SURVEY HISTORY

The sites with grey shading are repeated MT soundings.

Date	Activity	Crews	Production			
10-Nov	Mob to Tonopah	All crews				
11-Nov	PST ADU06	All crews				
12-Nov	MT Production	Crew_1	AL52	AL42	AL32	
12-Nov	MT Production	Crew_2	AL31	AL41	AL51	
12-Nov	PST ADU07	Crew_3				
13-Nov	MT Production	Crew_1	AL21	AL10	AL40	
13-Nov	MT Production	Crew_2	AL22	AL12	AL09	
13-Nov	MT Production	Crew_3	AL35	AL36	AL25	
14-Nov	MT Production	Crew_1	AL11	AL20	AL50	
14-Nov	MT Production	Crew_2	AL45	AL34	AL24	
14-Nov	MT Production	Crew_3	AL29	AL19	AL39	
15-Nov	MT Production	Crew_1	AL28	AL08	AL50b	
15-Nov	MT Production	Crew_2	AL49	AL47	AL37	
15-Nov	MT Production	Crew_3	AL46	AL14	AL15	
16-Nov	MT Production	Crew_1	AL18	AL27	AL48	AL30
16-Nov	MT Production	Crew_2	AL02	AL23		
16-Nov	MT Production	Crew_3	AL01	AL26		
17-Nov	MT Production	Crew_1	AL38	AL17	AL07	AL06
17-Nov	MT Production	Crew_2	AL43	AL44		
17-Nov	MT Production	Crew_3	AL01	AL26	AL33	
18-Nov	MT Production	Crew_1	AL47b	AL08b	AL30b	
18-Nov	MT Production	Crew_2	AL18b	AL13	AL16	
18-Nov	MT Production	Crew_3	AL03	AL04	AL05	
19-Nov	MT Production	Crew_1	SP46	SP47	SP48	
19-Nov	MT Production	Crew_2	SP45	SP39	SP31	
19-Nov	MT Production	Crew_3	SP50	SP38	SP44	
20-Nov	MT Production	Crew_1	SP42	SP41	SP40	

Date	Activity	Crews	Production			
20-Nov	MT Production	Crew_2	SP33	SP37	SP25	
20-Nov	MT Production	Crew_3	SP01	SP02	SP32	
21-Nov	MT Production	Crew_1	SP36	SP35	SP34	
21-Nov	MT Production	Crew_2	SP26	SP21	SP27	
21-Nov	MT Production	Crew_3	SP04	SP06	SP11	
22-Nov	MT Production	Crew_1	SP28	SP43	SP49	
22-Nov	MT Production	Crew_2	SP15	SP20	SP19	
22-Nov	MT Production	Crew_3	SP10	SP05	SP12	
23-Nov	MT Production	Crew_1	SP29	SP30	SP24	
23-Nov	MT Production	Crew_2	SP06b	SP03	SP07	
23-Nov	MT Production	Crew_3	SP16	SP14	SP13	
24-Nov	MT Production	Crew_1	SP23	SP18	SP17	
24-Nov	MT Production	Crew_2	AL04b	AL05b	AL15b	
24-Nov	MT Production	Crew_3	SP10b	SP09	SP08	
25-Nov	MT Production	Crew_1	AL114	AL112	AL110	
25-Nov	MT Production	Crew_2	AL106	AL108	AL07b	
25-Nov	MT Production	Crew_3	SP22	SP36b	AL28b	
26-Nov	MT Production	Crew_1	AL115	AL105	AL113	
26-Nov	MT Production	Crew_2	AL101	AL102	AL118	
26-Nov	MT Production	Crew_3	AL120	AL119	AL117	
27-Nov	MT Production	Crew_1	AL104	AL103	AL111	
27-Nov	MT Production	Crew_2	AL109	AL125	AL126	
27-Nov	MT Production	Crew_3	AL122	AL121	AL124	
28-Nov	MT Production	Crew_1	AL27b	AL37b	AL125b	
28-Nov	MT Production	Crew_2	AL10b	AL20b	AL116	
28-Nov	MT Production	Crew_3	AL127	AL128	AL129	
29-Nov	MT Production	Crew_1	AL103b	SP116	SP118	
29-Nov	MT Production	Crew_2	SP120	SP114	SP102	
29-Nov	MT Production	Crew_3	SP101	SP103	SP104	
30-Nov	MT Production	Crew_1	SP119	SP48b	SP113	
30-Nov	MT Production	Crew_2	SP115	SP117	SP107	
30-Nov	MT Production	Crew_3	SP105	SP108	SP111	
1-Dec	MT Production	Crew_1	SP114b	SP120b	SP128b	
1-Dec	MT Production	Crew_2	AL129b	AL03b	SP112	
1-Dec	MT Production	Crew_3	SP109	SP106	AL127b	
2-Dec	MT Production	Crew_1	SP120c	SP107b	SP115c	
2-Dec	MT Production	Crew_2	SP48c	SP106b		
3-Dec	Pickup and Pack	Crew_1				
3-Dec	Pickup and Pack	Crew_2				
4-Dec	Demobilization	All Crews				

## APPENDIX C MT STATION COORDINATES

Coordinate system as described in paragraph 1.2.

### C.1 ALUM MT SURVEY

Sounding	Easting (m)	Northing (m)	Longitude (° ' ")			Latitude (° ' ")			Elevation (m)
AL01	435655	4199425	-117	43	56	37	56	24	1463
AL02	436282	4199031	-117	43	30	37	56	12	1468
AL03	437730	4199892	-117	42	31	37	56	40	1459
AL03b	437730	4199892	-117	42	31	37	56	40	1459
AL04	438361	4199500	-117	42	5	37	56	28	1475
AL04b	438361	4199501	-117	42	5	37	56	28	1475
AL05	439013	4199120	-117	41	39	37	56	15	1482
AL05b	439010	4199121	-117	41	39	37	56	15	1482
AL06	439646	4198718	-117	41	13	37	56	3	1502
AL07	440256	4198314	-117	40	47	37	55	50	1493
AL07b	440256	4198318	-117	40	47	37	55	50	1492
AL08a	440904	4197929	-117	40	21	37	55	37	1501
AL08b	440883	4197937	-117	40	22	37	55	37	1500
AL09	441638	4197513	-117	39	51	37	55	24	1522
AL10	442194	4197155	-117	39	28	37	55	12	1546
AL101	441037	4196067	-117	40	15	37	54	37	1520
AL102	440422	4196482	-117	40	40	37	54	50	1511
AL104	439361	4196239	-117	41	23	37	54	42	1498
AL105	437614	4201108	-117	42	37	37	57	20	1449
AL106	438918	4200343	-117	41	43	37	56	55	1464
AL108	440192	4199556	-117	40	50	37	56	30	1481
AL109	439542	4197853	-117	41	17	37	55	34	1498
AL11	442829	4196762	-117	39	2	37	54	60	1580
AL110	441595	4198767	-117	39	53	37	56	5	1512
AL111	440219	4197452	-117	40	49	37	55	22	1500
AL112	442803	4197970	-117	39	3	37	55	39	1563
AL113	440858	4197030	-117	40	22	37	55	8	1516
AL114	443998	4197276	-117	38	14	37	55	17	1679
AL115	444351	4195845	-117	37	59	37	54	30	1617
AL117	443582	4194550	-117	38	30	37	53	48	1555
AL118	440007	4195831	-117	40	57	37	54	29	1508
AL119	442753	4193320	-117	39	4	37	53	8	1538
AL12	443483	4196360	-117	38	35	37	54	47	1601
AL120	441328	4193000	-117	40	2	37	52	57	1521
AL121	439505	4192901	-117	41	17	37	52	54	1530

Sounding	Easting (m)	Northing (m)	Longitude (° ' ")			Latitude (° ' ")			Elevation (m)
AL122	440043	4193797	-117	40	55	37	53	23	1516
AL124	438729	4194544	-117	41	49	37	53	47	1508
AL126	437482	4195318	-117	42	40	37	54	12	1504
AL13	437332	4199263	-117	42	47	37	56	20	1469
AL14	437987	4198893	-117	42	21	37	56	8	1482
AL15	438604	4198479	-117	41	55	37	55	55	1494
AL15b	438608	4198475	-117	41	55	37	55	54	1493
AL16	439155	4198118	-117	41	32	37	55	43	1505
AL17	439867	4197689	-117	41	3	37	55	29	1497
AL18	440514	4197310	-117	40	37	37	55	17	1507
AL18b	440514	4197310	-117	40	37	37	55	17	1507
AL19	441166	4196901	-117	40	10	37	55	4	1525
AL20	441829	4196552	-117	39	42	37	54	53	1559
AL20b	441828	4196550	-117	39	43	37	54	53	1560
AL21	442436	4196113	-117	39	17	37	54	39	1560
AL22	443092	4195762	-117	38	51	37	54	27	1594
AL23	436959	4198641	-117	43	3	37	55	59	1470
AL24	437598	4198168	-117	42	36	37	55	44	1475
AL25	438207	4197859	-117	42	11	37	55	34	1482
AL26	438788	4197490	-117	41	47	37	55	22	1492
AL27	439474	4197073	-117	41	19	37	55	9	1495
AL27b	439474	4197075	-117	41	19	37	55	9	1495
AL28	440096	4196685	-117	40	53	37	54	57	1504
AL28b	440094	4196688	-117	40	54	37	54	57	1504
AL29	440753	4196281	-117	40	26	37	54	44	1518
AL30	441464	4196033	-117	39	57	37	54	36	1533
AL30b	441464	4196033	-117	39	57	37	54	36	1533
AL31	442030	4195576	-117	39	34	37	54	21	1556
AL32	442665	4195088	-117	39	8	37	54	5	1562
AL33	436517	4198000	-117	43	20	37	55	38	1485
AL34	437170	4197628	-117	42	54	37	55	27	1489
AL35	437716	4197181	-117	42	31	37	55	12	1485
AL36	438412	4196826	-117	42	2	37	55	1	1487
AL37	439069	4196390	-117	41	35	37	54	47	1494
AL37b	439068	4196390	-117	41	35	37	54	47	1494
AL38	439709	4196026	-117	41	9	37	54	35	1505
AL39	440341	4195640	-117	40	43	37	54	23	1513
AL40	440989	4195227	-117	40	16	37	54	10	1525
AL41	441540	4194883	-117	39	54	37	53	59	1537
AL42	442266	4194465	-117	39	24	37	53	45	1556
AL43	436099	4197362	-117	43	37	37	55	18	1495

Sounding	Easting (m)	Northing (m)	Longitude (° ' ")	Latitude (° ' ")	Elevation (m)
AL44	436847	4197056	-117 43 7	37 55 8	1505
AL45	437370	4196628	-117 42 45	37 54 54	1492
AL46	438059	4196203	-117 42 17	37 54 41	1502
AL47	438661	4195803	-117 41 52	37 54 28	1495
AL47b	438661	4195803	-117 41 52	37 54 28	1495
AL48	439313	4195392	-117 41 25	37 54 15	1501
AL49	439972	4195041	-117 40 58	37 54 3	1512
AL50	440585	4194592	-117 40 33	37 53 49	1524
AL51	441281	4194223	-117 40 4	37 53 37	1544
AL52	441857	4193846	-117 39 41	37 53 25	1565
Remote 06	412845	4205762	-117 59 33	37 59 43	1403
Remote-07	412846	4205759	-117 59 33	37 59 43	1403

## C.2 SILVER PEAK MT SURVEY

Sounding	Easting (m)	Northing (m)	Longitude (° ' ")	Latitude (° ' ")	Elevation (m)
SP01	442959	4178287	-117 38 51	37 45 0	1351
SP02	444001	4178004	-117 38 8	37 44 51	1305
SP03	444702	4178034	-117 37 40	37 44 53	1301
SP04	445456	4178036	-117 37 9	37 44 53	1302
SP05	446198	4178025	-117 36 39	37 44 53	1301
SP06	446972	4178039	-117 36 7	37 44 53	1301
SP07	443223	4178746	-117 38 40	37 45 15	1400
SP08	443790	4178932	-117 38 17	37 45 21	1336
SP09	444720	4178768	-117 37 39	37 45 16	1301
SP10	445482	4178743	-117 37 8	37 45 16	1300
SP101	442520	4176992	-117 39 9	37 44 18	1346
SP102	443961	4176998	-117 38 10	37 44 19	1308
SP103	445457	4177027	-117 37 9	37 44 20	1304
SP104	446950	4177026	-117 36 8	37 44 20	1300
SP105	448440	4177027	-117 35 7	37 44 21	1300
SP106	447968	4178784	-117 35 26	37 45 18	1301
SP107a	447749	4179844	-117 35 36	37 45 52	1301
SP107b	447648	4180169	-117 35 40	37 46 2	1301
SP108	445815	4180260	-117 36 55	37 46 5	1302
SP109	446580	4180275	-117 36 24	37 46 6	1301
SP11	446217	4178760	-117 36 38	37 45 16	1302
SP111	445084	4181044	-117 37 25	37 46 30	1302
SP112	445844	4181019	-117 36 54	37 46 30	1302
SP113	447702	4181787	-117 35 38	37 46 55	1301
SP114	447955	4182530	-117 35 28	37 47 19	1302

Sounding	Easting (m)	Northing (m)	Longitude (° ' ")			Latitude (° ' ")			Elevation (m)
SP115	447960	4183305	-117	35	28	37	47	44	1303
SP116	442442	4184542	-117	39	14	37	48	23	1473
SP117	443871	4184513	-117	38	15	37	48	23	1373
SP118	445462	4184537	-117	37	10	37	48	24	1330
SP119	446960	4184566	-117	36	9	37	48	25	1318
SP12	446980	4178648	-117	36	7	37	45	13	1301
SP120	447966	4184530	-117	35	28	37	48	24	1305
SP13	443108	4179481	-117	38	45	37	45	39	1443
SP14	443962	4179496	-117	38	10	37	45	40	1336
SP15	444715	4179540	-117	37	40	37	45	41	1295
SP16	445459	4179546	-117	37	9	37	45	42	1301
SP17	446267	4179469	-117	36	36	37	45	39	1307
SP18	446896	4179577	-117	36	10	37	45	43	1301
SP19	443344	4180232	-117	38	36	37	46	4	1391
SP20	443962	4180321	-117	38	11	37	46	7	1321
SP21	444719	4180280	-117	37	40	37	46	5	1295
SP22	445450	4180286	-117	37	10	37	46	6	1301
SP23	446247	4180355	-117	36	37	37	46	8	1304
SP24	446960	4180285	-117	36	8	37	46	6	1301
SP25	443193	4181051	-117	38	42	37	46	30	1415
SP26	444041	4180962	-117	38	8	37	46	27	1313
SP27	444765	4180970	-117	37	38	37	46	28	1297
SP28	445444	4181028	-117	37	10	37	46	30	1302
SP29	446201	4181033	-117	36	39	37	46	30	1301
SP30	446979	4181102	-117	36	7	37	46	33	1301
SP31	443289	4181702	-117	38	38	37	46	51	1375
SP32	443956	4181782	-117	38	11	37	46	54	1329
SP33	444795	4181794	-117	37	37	37	46	55	1299
SP34	445455	4181773	-117	37	10	37	46	54	1303
SP35	446198	4181785	-117	36	40	37	46	55	1302
SP36	446941	4181790	-117	36	9	37	46	55	1301
SP36b	446963	4181799	-117	36	8	37	46	55	1301
SP37	443166	4182412	-117	38	44	37	47	14	1370
SP38	444051	4182558	-117	38	8	37	47	19	1322
SP39	444816	4182536	-117	37	36	37	47	19	1304
SP40	445442	4182557	-117	37	11	37	47	19	1305
SP41	446204	4182535	-117	36	40	37	47	19	1304
SP42	446954	4182538	-117	36	9	37	47	19	1303
SP43	443209	4183290	-117	38	42	37	47	43	1384
SP44	443941	4183297	-117	38	12	37	47	43	1339
SP45	444864	4183317	-117	37	35	37	47	44	1311

Sounding	Easting (m)	Northing (m)	Longitude (° ' ")			Latitude (° ' ")			Elevation (m)
SP46	445438	4183310	-117	37	11	37	47	44	1310
SP47	446192	4183291	-117	36	40	37	47	43	1307
SP48	446957	4183282	-117	36	9	37	47	43	1305
SP49	442518	4183239	-117	39	10	37	47	41	1434
SP50	442418	4182433	-117	39	14	37	47	15	1460
Remote 06	412845	4205762	-117	59	33	37	59	43	1403
Remote-07	412846	4205759	-117	59	33	37	59	43	1403





## APPENDIX D EQUIPMENT AND DATA FORMATS

Full tensor, 24-bit, GPS-synchronized Metronix ADU-06 and ADU-07 systems were deployed. At any one time, up to eleven MT systems were in use on production, with two at the remote reference station. The deployed systems consist of:

### MT Equipment – ADU-06 and ADU-07 System:

- 5 channel Metronix ADU-06 or ADU-07 acquisition systems, with GPS antenna for synchronization;
- 3 Metronix MFS-07 magnetic sensors ( $H_x$ ,  $H_y$  and  $H_z$ );
- And 2 Metronix MFS-06 or MFS-07 magnetic sensors ( $H_x$  and  $H_y$ ) for the remote location;
- 5 Pb-PbCl<sub>2</sub> non-polarizing electrodes (Wolf, Hungary), per system;
- 200m AWG#12 cable (4x50m dipoles), per system;
- 1 Panasonic Notebook Computer;
- 1 sealed lead-acid battery, 12V/34Ah, per system;
- Connecting cables

### D.1 TECHNICAL SPECIFICATIONS

#### ADU-06 (acquisition and processing unit):

Internal computer, two 24 bit A/D converters per channel with 4096 sample/s and 49K sample/s conversion rate. Standard LAN connection for data transfer to system computer. Motorola internal GPS receiver; clock precision  $\pm 130$ ns to satellite reference; 12 parallel channels; L1 1575.42MHz; C/A code.

#### ADU-07 (acquisition and processing unit):

Internal 32 bit low-power embedded controller with Linux operating system, internal compact flash-disk or usb-sticks and usb mass storage devices for storage, and standard twisted pair Cat5 or higher RJ45 plugs or wireless for communication. The standard configuration for wide band MT and AMT consists of 5 low-frequency (LF) and 5 high frequency (HF) channels. The ADU-07s are equipped with 10 measurement channels (e.g. 10 24 bit A/D converters) with 2048 sample/s and 524,288 sample/s conversion rates for LF and HF channels respectively. Each ADU can be operated as a standalone system, in a network using standard Local Area Network (LAN or W-LAN), or as part of an array in which each unit is synchronized by its built-in GPS controlled precision clock ( $\pm 30$ ns).

#### Magnetic Sensors (for both ADU-06, 07):

$H_x, H_y$	Metronix MSF-06 (0.00025 to 10,000 Hz). Sensitivity 0.2 V/(nT*Hz) ( $f \ll 4$ Hz); 0.8 V/nT ( $f \gg 4$ Hz).
$H_x, H_y, H_z$	Metronix MSF-07 (0.001 to 50,000 Hz). Sensitivity 0.02 V/(nT*Hz) ( $f \ll 32$ Hz); 0.64 V/nT ( $f \gg 32$ Hz).

#### Electric Sensors:

4x50m dipoles, AWG #12 cables with Pb-PbCl<sub>2</sub> non-polarizing electrodes (Wolf, Hungary).

#### System Computer:

Panasonic CF34 Pentium Notebook PC, with 32Mb RAM and 1.2 GB hard disk, and a Xircom Ethernet card.

**Environmental:**

Power supply ADU-06 2×12V 16Ah sealed lead-acid battery.

Operating temperature:

ADU-06, ADU-07 -40°C to +75°C

MFS-06, MFS-07 -25 to +70°C

Weights:

ADU-06 5.0 kg

ADU-07 6.5 kg

MFS-06 8.5 kg

MFS-07 5.5 kg

**Equipment deployed at each site:**

Magnetic sensors and acquisition systems used are distinguished between MFS-06 or MFS-07 and ADU-06 or ADU-07, in the table are listed the s/n.

**Alum survey area**

MT site	Date	Unit(s/n)	Az (°)	Ex (m)	Ey (m)	Hx (s/n)	Hy (s/n)	Hz (s/n)
AL01	16-Nov-09	#7 39	0	99	99	7 012	7 064	7 005
AL01	17-Nov-09	#7 39	0	99	99	7 012	7 064	7 005
AL02	16-Nov-09	#6 07	0	100	100	7 057	7 017	7 080
AL03	18-Nov-09	#7 34	0	99	99	7 013	7 004	7 031
AL03b	1-Dec-09	#6 38	0	100	100	7 066	7 070	7 010
AL04	18-Nov-09	#7 38	0	99	99	7 064	7 012	7 005
AL04b	24-Nov-09	#7 34	0	99	99	7 004	7 005	7 056
AL05	18-Nov-09	#7 39	0	99	99	7 001	7 032	7 047
AL05b	24-Nov-09	#7 39	0	99	99	7 032	7 062	7 064
AL06	17-Nov-09	#6 10	0	100	100	7 078	7 076	7 025
AL07	17-Nov-09	#6 04	0	100	100	7 070	7 010	7 066
AL07b	25-Nov-09	#7 39	0	99.0	99	7 004	7 005	7 056
AL08	15-Nov-09	#6 04	0	100	100	7 010	7 070	7 066
AL08b	18-Nov-09	#6 38	0	100	100	7 012	7 141	7 148
AL09	13-Nov-09	#6 07	0	100	100	7 057	7 017	7 080
AL101	26-Nov-09	#7 38	30	99.0	99	7 031	7 001	7 064
AL102	26-Nov-09	#7 34	0	99.0	99	7 047	7 062	7 032
AL103	27-Nov-09	#6 10	0	100	100	7 058	7 147	7 077
AL103b	29-Nov-09	#6 04	0	100	100	7 141	7 012	7 148
AL104	27-Nov-09	#6 38	0	100	100	7 066	7 010	7 070
AL105	26-Nov-09	#6 05	0	100	100	7 024	7 151	7 149
AL106	25-Nov-09	#7 38	0	99.0	99	7 001	7 031	7 047
AL108	25-Nov-09	#7 34	0	99.0	99	7 032	7 064	7 062
AL109	27-Nov-09	#6 07	350	100	100	7 017	7 057	7 080
AL10	13-Nov-09	#6 10	20	100	100	7 012	7 141	7 148
AL10b	28-Nov-09	#6 10	20	100	100	7 147	7 077	7 058
AL110	25-Nov-09	#6 05	0	100	100	7 024	7 151	7 149
AL111	27-Nov-09	#6 04	20	100	100	7 141	7 148	7 012
AL112	25-Nov-09	#6 04	10	100	100	7 148	7 141	7 012
AL113	26-Nov-09	#6 04	320	100	100	7 141	7 012	7 148

MT site	Date	Unit(s/n)	Az (°)	Ex (m)	Ey (m)	Hx (s/n)	Hy (s/n)	Hz (s/n)
AL114	25-Nov-09	#6 38	0	100	100	7 010	7 066	7 070
AL115	26-Nov-09	#6 38	330	100	100	7 070	7 010	7 066
AL116	28-Nov-09	#7 38	0	99	99	7 047	7 062	7 032
AL117	26-Nov-09	#6 10	0	100	100	7 147	7 077	7 058
AL118	26-Nov-09	#7 39	0	99.0	99	7 004	7 056	7 005
AL119	26-Nov-09	#6 07	0	90	90	7 017	7 057	7 080
AL11	14-Nov-09	#6 04	0	100	100	7 066	7 010	7 070
AL120	26-Nov-09	#6 09	0	90	90	7 078	7 076	7 025
AL121	27-Nov-09	#7 38	0	99	99	7 047	7 032	7 062
AL122	27-Nov-09	#7 34	0	99	99	7 001	7 064	7 031
AL124	27-Nov-09	#6 09	0	100	100	7 078	7 076	7 025
AL125	27-Nov-09	#6 05	0	100	100	7 151	7 149	7 024
AL125b	28-Nov-09	#6 05	0	100	100	7 151	7 149	7 024
AL126	27-Nov-09	#7 39	0	99	99	7 056	7 004	7 005
AL127	28-Nov-09	#6 09	0	100	100	7 076	7 078	7 025
AL127b	1-Dec-09	#7 39	0	99	99	7 004	7 005	7 056
AL128	28-Nov-09	#7 34	0	99	99	7 005	7 056	7 004
AL128b	1-Dec-09	#6 10	0	100	100	7 077	7 058	7 147
AL129	28-Nov-09	#7 39	0	99	99	7 001	7 064	7 031
AL129b	1-Dec-09	#6 05	0	100	100	7 149	7 151	7 024
AL12	13-Nov-09	#6 09	0	100	100	7 147	7 077	7 058
AL13	18-Nov-09	#6 10	0	100	100	7 078	7 076	7 025
AL14	15-Nov-09	#7 39	0	100	100	7 062	7 005	7 064
AL15	15-Nov-09	#7 38	0	100	100	7 013	7 031	7 004
AL15b	24-Nov-09	#7 38	0	99	99	7 001	7 031	7 047
AL16	18-Nov-09	#6 09	0	90	95	7 077	7 147	7 058
AL17	17-Nov-09	#6 38	0	100	100	7 012	7 148	7 141
AL18	16-Nov-09	#6 04	0	100	100	7 010	7 070	7 066
AL18b	18-Nov-09	#6 07	0	100	100	7 017	7 057	7 080
AL19	14-Nov-09	#6 09	0	100	100	7 077	7 147	7 058
AL20	14-Nov-09	#6 10	0	100	100	7 148	7 012	7 141
AL20b	28-Nov-09	#6 07	0	100	100	7 080	7 017	7 057
AL21	13-Nov-09	#6 04	0	98	100	7 010	7 066	7 070
AL22	13-Nov-09	#6 38	0	90	90	7 071	7 078	7 025
AL23	16-Nov-09	#6 09	0	100	100	7 077	7 058	7 147
AL24	14-Nov-09	#7 38	0	100	100	7 064	7 062	7 005
AL25	13-Nov-09	#7 39	0	100	100	7 004	7 031	7 013
AL26	16-Nov-09	#7 34	0	99	99	7 032	7 047	7 001
AL26	17-Nov-09	#7 34	0	99	99	7 032	7 047	7 001
AL27	16-Nov-09	#6 38	0	100	100	7 076	7 078	7 025
AL27b	28-Nov-09	#6 04	0	100	100	7 141	7 012	7 148
AL28	15-Nov-09	#6 10	0	100	100	7 012	7 141	7 148
AL28b	25-Nov-09	#6 07	0	100	100	7 017	7 057	7 080
AL29	14-Nov-09	#6 07	0	100	100	7 057	7 017	7 080
AL30	16-Nov-09	#6 10	30	100	100	7 012	7 141	7 148
AL30	16-Nov-09	#7 38	0	99	99	7 013	7 031	7 004
AL30b	18-Nov-09	#6 04	320	100	100	7 010	7 070	7 066

MT site	Date	Unit(s/n)	Az (°)	Ex (m)	Ey (m)	Hx (s/n)	Hy (s/n)	Hx (s/n)
AL31	12-Nov-09	#6 04	40	96	96	7 070	7 066	7 010
AL32	12-Nov-09	#6 38	0	99	99	7 076	7 078	7 025
AL33	17-Nov-09	#7 38	0	99	99	7 004	7 013	7 031
AL34	14-Nov-09	#7 39	0	100	100	7 031	7 004	7 013
AL35	13-Nov-09	#7 34	0	100	100	7 001	7 032	7 047
AL36	13-Nov-09	#7 38	0	100	100	7 064	7 062	7 005
AL37	15-Nov-09	#6 38	0	100	100	7 025	7 076	7 078
AL37b	28-Nov-09	#6 38	0	100	100	7 070	7 010	7 066
AL38	17-Nov-09	#6 05	0	98	98	7 024	7 149	7 151
AL39	14-Nov-09	#6 38	0	95	95	7 025	7 078	7 076
AL40	13-Nov-09	#6 05	0	100	100	7 024	7 151	7 149
AL41	12-Nov-09	#6 10	-20	96	96	7 012	7 141	7 148
AL42	12-Nov-09	#6 09	0	99	99	7 077	7 147	7 058
AL43	17-Nov-09	#6 07	0	100	100	7 017	7 057	7 080
AL44	17-Nov-09	#6 09	0	100	100	7 077	7 147	7 058
AL45	14-Nov-09	#7 34	0	100	100	7 001	7 047	7 032
AL46	15-Nov-09	#7 34	0	100	100	7 047	7 032	7 001
AL47	15-Nov-09	#6 09	0	100	100	7 077	7 147	7 058
AL47b	18-Nov-09	#6 05	0	100	100	7 149	7 151	7 024
AL48	16-Nov-09	#6 05	0	100	100	7 149	7 024	7 151
AL49	15-Nov-09	#6 07	0	100	100	7 017	7 057	7 080
AL50	14-Nov-09	#6 05	0	100	100	7 149	7 024	7 151
AL50b	15-Nov-09	#6 05	0	100	100	7 149	7 024	7 151
AL51	12-Nov-09	#6 05	0	96	96	7 024	7 149	7 151
AL52	12-Nov-09	#6 07	0	99	99	7 017	7 057	7 080

### Silver Peak survey area

MT site	Date	Unit(s/n)	Az (°)	Ex (m)	Ey (m)	Hx (s/n)	Hy (s/n)	Hx (s/n)
SP01	20-Nov-09	#7 34	0	99	99	7 004	7 056	7 005
SP02	20-Nov-09	#7 38	0	99	99	7 031	7 001	7 047
SP03	23-Nov-09	#7 39	20	99	99	7 001	7 031	7 047
SP04	21-Nov-09	#7 39	0	99	99	7 001	7 047	7 031
SP05	22-Nov-09	#7 39	0	99	99	7 031	7 001	7 047
SP06	21-Nov-09	#7 38	0	99	99	7 064	7 032	7 062
SP06b	23-Nov-09	#7 38	0	99	99	7 056	7 005	7 004
SP07	23-Nov-09	#7 34	0	99	99	7 064	7 032	7 062
SP08	24-Nov-09	#6 10	0	90	85	7 147	7 077	7 058
SP09	24-Nov-09	#6 09	40	100	90	7 076	7 025	7 078
SP101	29-Nov-09	#7 38	0	99	99	7 032	7 062	7 047
SP102	29-Nov-09	#6 09	0	98	98	7 078	7 076	7 025
SP103	29-Nov-09	#7 39	0	99	97	7 005	7 056	7 004
SP104	29-Nov-09	#7 34	0	99	99	7 001	7 064	7 031
SP105	30-Nov-09	#7 39	0	99	99	7 056	7 005	7 004
SP106	1-Dec-09	#6 09	40	99	99	7 078	7 076	7 025
SP106b	2-Dec-09	#6 09	40	99	99	7 078	7 076	7 025
SP107	30-Nov-09	#6 09	0	98	99	7 078	7 076	7 025

MT site	Date	Unit(s/n)	Az (°)	Ex (m)	Ey (m)	Hx (s/n)	Hy (s/n)	Hz (s/n)
SP107b	2-Dec-09	#6 07	45	100	100	7 017	7 080	7 057
SP107b	2-Dec-09	#7 38	45	100	100	7 064	7 062	7 000
SP108	30-Nov-09	#7 34	0	99	99	7 031	7 001	7 064
SP109	1-Dec-09	#7 34	0	99	99	7 064	7 031	7 001
SP110	22-Nov-09	#7 38	20	99	99	7 032	7 064	7 062
SP110b	24-Nov-09	#6 07	20	100	100	7 017	7 057	7 080
SP111	30-Nov-09	#7 38	0	99	99	7 047	7 062	7 032
SP112	1-Dec-09	#7 38	0	99	99	7 047	7 062	7 032
SP113	30-Nov-09	#6 04	0	100	100	7 012	7 141	7 148
SP114	29-Nov-09	#6 05	0	100	100	7 149	7 151	7 024
SP114b	1-Dec-09	#6 04	0	100	100	7 141	7 148	7 012
SP115	30-Nov-09	#6 05	0	100	100	7 024	7 149	7 151
SP115c	2-Dec-09	#6 38	40	100	100	7 010	7 070	7 066
SP116	29-Nov-09	#6 38	0	100	100	7 070	7 010	7 066
SP117	30-Nov-09	#6 38	40	100	100	7 066	7 070	7 010
SP118	29-Nov-09	#6 07	0	100	100	7 057	7 017	7 080
SP119	30-Nov-09	#6 07	340	100	100	7 017	7 057	7 080
SP11	21-Nov-09	#7 34	20	99	99	7 004	7 056	7 005
SP120	29-Nov-09	#6 10	0	100	100	7 147	7 077	7 058
SP120b	1-Dec-09	#6 07	0	100	100	7 017	7 057	7 080
SP120c	2-Dec-09	#6 10	0	100	100	7 077	7 058	7 147
SP12	22-Nov-09	#7 34	20	99	99	7 056	7 004	7 005
SP13	23-Nov-09	#6 10	40	90	90	7 077	7 147	7 058
SP14	23-Nov-09	#6 07	0	85	85	7 017	7 057	7 080
SP15	22-Nov-09	#6 09	40	100	100	7 078	7 076	7 025
SP16	23-Nov-09	#6 09	0	100	100	7 078	7 076	7 025
SP17	24-Nov-09	#6 38	320	100	100	7 070	7 010	7 066
SP18	24-Nov-09	#6 04	40	100	100	7 012	7 141	7 148
SP19	22-Nov-09	#6 10	330	80	80	7 077	7 147	7 058
SP20	22-Nov-09	#6 07	0	95	95	7 057	7 017	7 080
SP21	21-Nov-09	#6 09	40	100	100	7 078	7 076	7 025
SP22	25-Nov-09	#6 09	0	100	100	7 076	7 078	7 025
SP23	24-Nov-09	#6 05	20	100	100	7 024	7 149	7 151
SP24	23-Nov-09	#6 04	0	100	100	7 148	7 141	7 012
SP25	20-Nov-09	#6 09	0	90	90	7 078	7 076	7 025
SP26	21-Nov-09	#6 10	0	100	95	7 077	7 147	7 058
SP27	21-Nov-09	#6 07	40	100	100	7 017	7 057	7 080
SP28	22-Nov-09	#6 05	40	100	100	7 149	7 024	7 151
SP29	23-Nov-09	#6 05	0	100	100	7 024	7 149	7 151
SP30	23-Nov-09	#6 38	0	100	100	7 070	7 066	7 010
SP31	19-Nov-09	#6 09	0	100	100	7 078	7 025	7 076
SP32	20-Nov-09	#7 39	320	100	100	7 062	7 064	7 032
SP33	20-Nov-09	#6 07	40	100	100	7 057	7 017	7 080
SP34	21-Nov-09	#6 38	40	100	100	7 148	7 141	7 012
SP35	21-Nov-09	#6 04	0	100	100	7 010	7 070	7 066
SP36	21-Nov-09	#6 05	0	100	100	7 151	7 024	7 149
SP36b	25-Nov-09	#6 10	0	100	100	7 077	7 147	7 058

MT site	Date	Unit(s/n)	Az (°)	Ex (m)	Ey (m)	Hx (s/n)	Hy (s/n)	Hz (s/n)
SP37	20-Nov-09	#6 10	0	100	100	7 077	7 147	7 058
SP38	19-Nov-09	#7 34	30	99	99	7 004	7 005	7 056
SP39	19-Nov-09	#6 07	40	100	100	7 017	7 025	7 080
SP40	20-Nov-09	#6 38	45	100	100	7 012	7 141	7 148
SP41	20-Nov-09	#6 04	0	100	100	7 066	7 010	7 070
SP42	20-Nov-09	#6 05	0	100	100	7 151	7 024	7 149
SP43	22-Nov-09	#6 38	320	100	94	7 010	7 066	7 070
SP44	19-Nov-09	#7 38	30	99	99	7 047	7 031	7 001
SP45	19-Nov-09	#6 10	330	100	100	7 147	7 077	7 058
SP46	19-Nov-09	#6 38	40	100	97	7 012	7 141	7 148
SP47	19-Nov-09	#6 04	0	100	100	7 066	7 010	7 070
SP48	19-Nov-09	#6 05	0	100	100	7 024	7 151	7 149
SP48b	30-Nov-09	#6 10	0	100	100	7 147	7 077	7 058
SP48c	2-Dec-09	#6 04	40	100	100	7 141	7 012	7 148
SP49	22-Nov-09	#6 04	320	92	86	7 141	7 012	7 148
SP50	19-Nov-09	#7 39	0	99	97	7 032	7 012	7 064
Remote #6	All days	#6 83	0	98	98	6 178	6 204	7 046
Remote #7	All days	#7 42	0	98	98	7 021	7 008	7 013

## Calibration curves

Prior to shipment of the equipment to the survey area, Metronix magnetic sensors were tested and checked by an engineer trained by Metronix GmbH. An example of a calibration curves from coil MFS07-077 is shown in Figure 7. Note that there are two sets of curves for each magnetic sensor, corresponding to the high and low frequency ranges (chopper on and off).

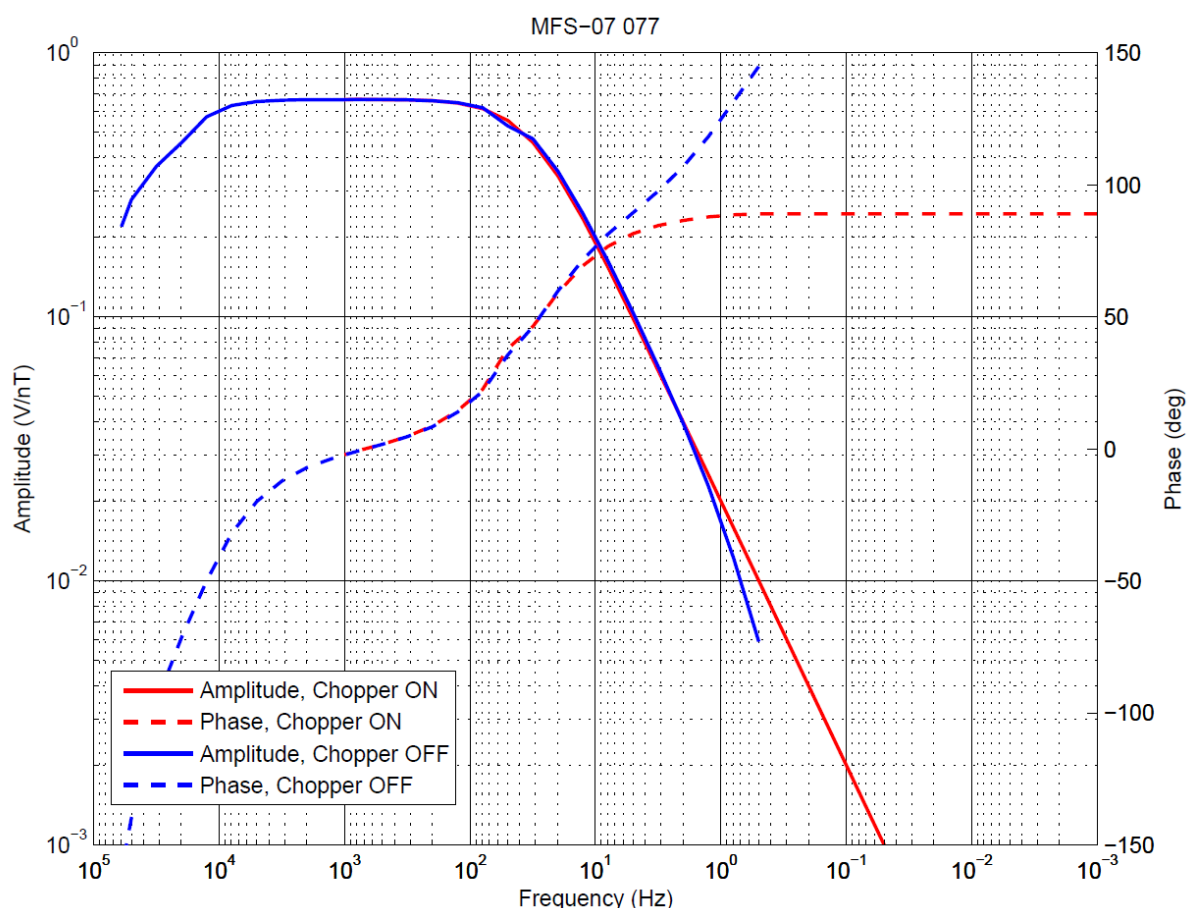


Figure 7. Calibration curves for Metronix coil MFS07-077.

## D.2 MT DATA

Data were normally archived in the following formats:

1. Binary format files containing acquisition information and time-series;
2. SEG-Electromagnetic Data Interchange (EDI) format containing impedances, apparent resistivity, phase, coherencies and tipper parameters.

## D.3 TIME SERIES

Original field data were archived in time-series files in a mixed binary format. Note that start times are given in seconds since 00h UTC on January 1st, 1970. Azimuths recorded in the time series header are referenced to magnetic North. All times series data are stored in a directory

corresponding to the site name. Sensor files are archived on the processing HD. Individual files within the directory follow the convention:

ssscrrtB.ATS where:

Sss	= ADU-06 serial number	= ADU-07 serial number
C	= ADU-06 channel number (a=1, b=2, c=3, d=4, e=5)	= ADU-07 channel number
Rr	= Run number	= Run number
T	= Channel type (a=Ex, b=Ey, x=Hx, y=Hy, z=Hz)	= Channel type
B	= Band index:	a = HF (65536Hz)
	a = HF (40960Hz)	b = LF1 (8192Hz)
	b = LF1 (4096Hz)	f = LF2 (2048Hz)
	c = LF2 (64Hz)	d = Decimated during acquisition (64Hz)
	d = Decimated during acquisition (2Hz)	
	f = Free (512Hz for the present surveys)	

Decimated time series (decimated during processing) retain the same site and run-related prefix convention, but the last letter in the extension “\*.ATS” is changed as follows:

Band name	Sampling frequency (Hz)	Derived from
Ata	8.0000 / 256.0000	LF2 / f (ADU-07)
Atb	16.0000 / 512.0000	LF2 / f (ADU-07)
Atd	4.0000 / 128.0000	LF2 / f (ADU-07)
Ate	2.0000 / 64.0000	LF2 / f (ADU-07)
Atf	1.0000 / 32.0000	LF2 / f (ADU-07)
Atg	0.5000 / 16.0000	LF2 / f (ADU-07)
Ath	0.2500 / 8.0000	LF2 / f (ADU-07)
Ati	0.1250 / 4.0000	LF2 / f (ADU-07)
Atj	0.0625 / 2.0000	LF2 / f (ADU-07)

#### METRONIX TIME SERIES: ATS FORMAT

B off-set	ADR	Byte	Type	Name	Info
1	000H	2	INTEGER	Header Length	Length of Header in Byte
3	002H	2	INTEGER	Header Version	Version Number of Header (*100) <sup>4</sup>
5	004H	4	LONGINT	Samples	Number of Samples
9	008H	4	SINGLE	Sample Freq.	Sample Frequency
13	00CH	4	LONGINT		Start Time of Measurement (in seconds since 1.1.70)
17	010H	8	DOUBLE	LSBV	LSB Unit in MV <sup>2</sup>
25	018H	8	BYTE	Reserved	Reserved
33	020H	2	INTEGER		Serial number of ADU06
35	022H	2	INTEGER		Serial number of ADB06 (ADC Board)
37	024H	1	BYTE		Channel number (0...7)
38	025h	1	BYTE	Reserved	Reserved
39	026h	2	CHAR		Channel Type (Ex,Ey,Hx,Hy,Hz)
41	028H	6	CHAR		Sensor Type (MFS06, MFS-07, BF4, BF7...)
47	02EH	2	INTEGER		Serial number of sensor



B off-set	ADR	Byte	Type	Name	Info
49	030H	4	SINGLE		x1 coordinates of 1. Dipole(m)
53	034H	4	SINGLE		y1
57	038H	4	SINGLE		z2
61	03CH	4	SINGLE		x2 coordinates of 1. Dipole (m)
65	040H	4	SINGLE		y2
69	044H	4	SINGLE		z2
73	048H	4	SINGLE		e-field dipole length (m)
77	04CH	4	SINGLE		Angle (0°=north) (degrees °)
81	050H	4	SINGLE		Probe resistivity (ohm)
85	054H	4	SINGLE		DC offset voltage <sup>3</sup> (MV)
89	058H	4	SINGLE		Internal gain amplification (1 or 30) <sup>4</sup>
93	05CH	4	BYTE		Reserved
97	060H	4	LONG		Latitude (msec)
101	064H	4	LONG		Longitude (msec)
105	068H	4	LONG		Elevation (cm)
109	06CH	1	CHAR		Lat/Long: 'U' user def, 'G' internal GPS clock
110	06DH	1	CHAR		Type of additional coordinates: 'U' UTM, 'G' Gauss-Kruger
111	06EH	2	INTEGER		Reference median
113	070H	8	DOUBLE		X coordinate
121	078H	8	DOUBLE		Y coordinate
129	080H	1	CHAR		GPS/CLK status: 'G' GPS lock 'C' CLK sync 'N' CLK no sync
130	089H	1	BYTE		Approximate accuracy of GPS/CLK: 9 means accuracy of 10 <sup>9</sup>
131	082H	14	BYTE		Reserved
145	090H	12	CHAR		Survey header file name
157	09CH	4	CHAR		Type of measurement: MT or CSAMT
161	0A0H	12	CHAR		Log file of system self test
173	0ACH	2	CHAR		Result of self test 'OK' or 'NO'
175	0AEH	2	BYTE		Reserved
177	0B0H	2	INTEGER		Number of calibration frequencies in file
179	0B2H	2	INTEGER		Length of frequency entry (32 byte)
181	0B4H	2	INTEGER		Version of calibration format (*100)
183	0B6H	2	INTEGER		Start address of calibration information in header (400H)
185	0B8H	8	BYTE		Reserved
193	0C0H	12	CHAR		File name of ADU06 cal file
205	0CCH	4	LONG		Date/time of calibration
209	0D0H	12	CHAR		File name of sensor calibration
221	0DCH	4	LONG		Date/time of calibration
225	0E0H	4	SINGLE		Power-line freq. 1
229	0E4H	4	SINGLE		Power-line freq.2
233	0E8H	8	BYTE		Reserved
241	0F0H	4	SINGLE		CSAMT transmitter frequency
245	0F4H	2	INTEGER		CSAMT time series block
247	0F6H	2	INTEGER		CSAMT stacks/block
249	0F8H	4	LONG		CSAMT block length
253	0FCH	4	BYTE		Reserved
257	100H	16	CHAR		Client
273	110H	16	CHAR		Contractor
289	120H	16	CHAR		Area
305	130H	16	CHAR		Survey ID
321	140H	16	CHAR		Operator
337	150h	112	CHAR		Reserved
449	1C0H	64	CHAR		Weather
513	200H	512	CHAR		Comments

B off-set	ADR	Byte	Type	Name	Info
1025	400H	32			Calibration frequency 1
1025	400H	4	SINGLE		Frequency
1029	404H	4	SINGLE		Amplitude: e-field (V) – h-field (nT/V)
1033	408H	4	SINGLE		Phase (degrees)
1037	40ch	4	SINGLE		Accuracy of amplitude (%)
1041	410H	4	SINGLE		Accuracy of phase (+/- degrees)
1045	414H	12	BYTE		Reserved
1057	420H	32			Calibration frequency 2
	400H+(n.1)*20H	32			Calibration frequency n
	400H+n*20H	4 Samples	LONGINT		Time series data

#### ***D.4 EDI FILES***

The processed MT data are stored in standard EDI files on the final HD, a copy of which is provided with each copy of the report. Azimuths in the EDI files are referenced to geographic North. The EDI file naming convention was as follows:

$ALnnn.EDI$       where:

$AL$	= Survey area: Alum
$nn$	= Station number identification

*SPnnn*.EDI                      where:

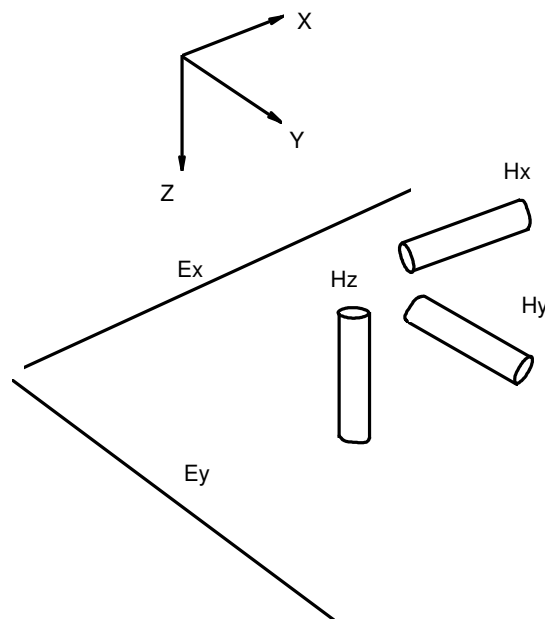
<i>SP</i>	= Survey area: Silver Peak
<i>nn</i>	= Station number identification

The SEG MT/EMAP Data Interchange Standard is described in Wight, 1988. Since this is an extremely lengthy standard (91 pages), the reader is referred to that document for details.

## APPENDIX E MT PARAMETERS

### Overview

The magnetotelluric method is a means of determining the resistivity distribution of the Earth through the measurement of time varying electric and magnetic fields at the surface. At each MT site, data from five channels are recorded as a function of time, which is referred to as time series. These channels are indicated in the following figure, and correspond to three orthogonal magnetic field components (designated  $H_x$ ,  $H_y$ , and  $H_z$ ), and two horizontal electric field components (designated  $E_x$  and  $E_y$ ). Note that a right-hand coordinate system is used and  $z$  is positive downwards.



**Figure 8.** Coordinate axes and component identifications for 5-component MT site.

As an electromagnetic method, magnetotelluric depends on Maxwell's law stating that a time-varying magnetic field induces an electric field in a conductor. The source fields are the time-varying horizontal magnetic fields ( $H_x$  and  $H_y$ ), which are generated by two distinct phenomena. The high frequency source fields, greater than 1Hz, are generated by lightning discharges of distant electrical storms. The low frequency source fields are generated by the interaction of charged particles, solar wind, with the earth's ionosphere. The output of the source fields convolved with the Earth consists of the horizontal electric field ( $E_x$  and  $E_y$ ) and the vertical magnetic field ( $H_z$ ). Thus, ideally, the electrical nature of the Earth (i.e. the impedance) can be determined through the transfer function of the measured input and output signals.



## Measured quantities

The actual parameters measured in the field are the time-varying voltage outputs of the electric and magnetic field sensors:  $E_x$ ,  $E_y$ ,  $H_x$ ,  $H_y$ , and  $H_z$ . Data were recorded in 3 bands, 2400 Hz, 150 Hz, and 15 Hz sample rates.

## Computed functions

The measured parameters, the electric and magnetic field values, are transformed into the frequency domain using FFT procedures, and convolved with the sensor responses to give the complex values of electric and magnetic fields at specific frequencies.

The resulting Fourier-transformed spectral estimates are combined into a spectral cross power matrix relating all of the measured electromagnetic fields at discrete frequency values. If the spectral values of two channels at frequency  $f_j$  in the channel bounded by frequencies between  $f_{j-m}$  and  $f_{j+m}$  are A and B (complex numbers), then

$$\langle A(f_j), A(f_j) \rangle = \frac{1}{2m+1} \sum_{k=j-m}^{j+m} A_k A_k^* = \langle A_k A_k^* \rangle$$

define the autopower  $A_j A_j^*$ ; and

$$\langle A(f_j), B(f_j) \rangle = \frac{1}{2m+1} \sum_{k=j-m}^{j+m} A_k B_k^* = \langle A_k B_k^* \rangle$$

define the crosspower  $A_k B_k^*$ , where the \* indicates the complex conjugate.

The impedance tensor is calculated directly from the crosspower matrix, via relationships of the form

$$Z_{xy} = \frac{\begin{vmatrix} \langle E_x H_x^* \rangle & \langle E_y H_x^* \rangle \\ \langle E_x H_y^* \rangle & \langle E_y H_y^* \rangle \end{vmatrix}}{\begin{vmatrix} \langle H_x H_x^* \rangle & \langle H_y H_x^* \rangle \\ \langle H_x H_y^* \rangle & \langle H_y H_y^* \rangle \end{vmatrix}}$$

The relationships between the five measured components at each site are contained in the impedance tensor ( $Z_{ij}$ ) and the tipper transfer function ( $T_i$ ), expressed by:

$$\begin{aligned} E_x &= Z_{xy} H_y + Z_{xx} H_x \\ E_y &= Z_{yx} H_x + Z_{yy} H_y \\ H_z &= T_x H_x + T_y H_y \end{aligned}$$

The impedance tensor and the cross power matrix are used to derive more practical parameters for interpretation and data quality assessment.

## Data interpretation parameters

The interpretation parameters are calculated using the standard definitions of Vozoff (1991), and are described here in simplified form:

Apparent Resistivity - scaled magnitude of the ratio of each orthogonal E and H pair, with associated variances, i.e.

$$\rho_{ij} = \frac{1}{5f} |Z_{ij}|^2$$

Impedance Phase - impedance phase of each orthogonal E and H pair, with associated variances.

Impedance Rotation - presents rotation direction of  $Z_{xy}$  (i.e. it can be a fixed, user-specified rotation angle, or that defined as impedance strike).

Impedance Strike ( $\theta$ ) - angle which minimizes  $|Z_{xx}(\theta)|^2 + |Z_{yy}(\theta)|^2$ . In an ideal 2-D environment, one component will be parallel to strike (transverse electric, or TE mode), and the other will be perpendicular to strike (transverse magnetic, or TM mode).

Tipper Strike - direction which maximizes the cross power of horizontal and vertical magnetic field components + 90 degrees.

Tipper Magnitude – magnitude of the vertical magnetic field with respect to the total horizontal magnetic field.

$$\text{Tipper} = \text{SQRT}(|T_x|^2 + |T_y|^2)$$

Impedance Skew - impedance tensor ratio, 3-D indicator, invariant with rotation.

$$|Z_{xx} + Z_{yy}| / |Z_{xy} - Z_{yx}|$$

Impedance Ellipticity - impedance tensor ratio, 3-D indicator, dependent upon rotation.

$$|Z_{xx}(\theta) - Z_{yy}(\theta)| / |Z_{xy}(\theta) + Z_{yx}(\theta)|$$



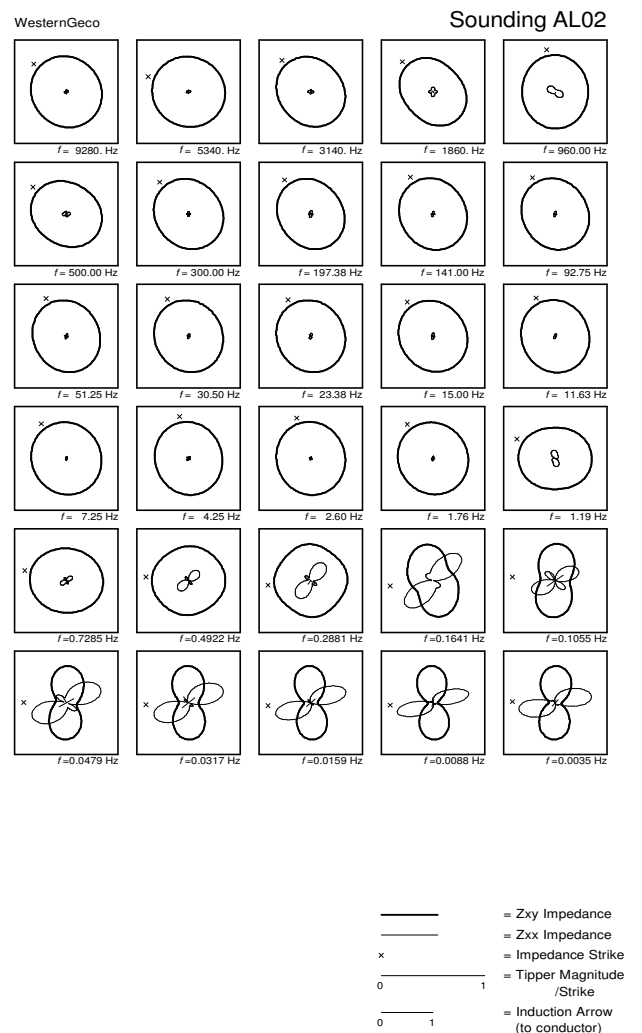
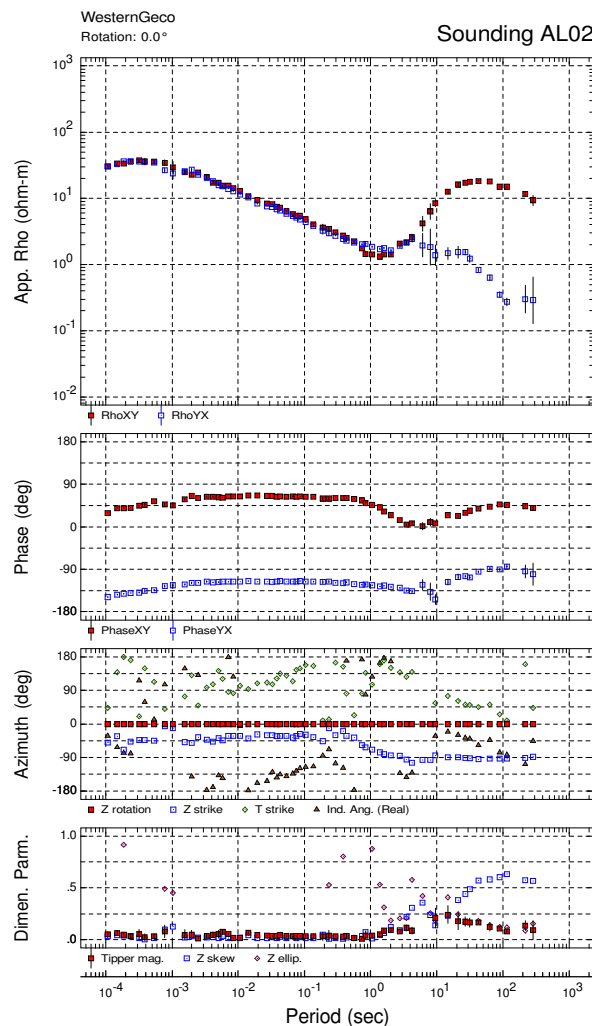
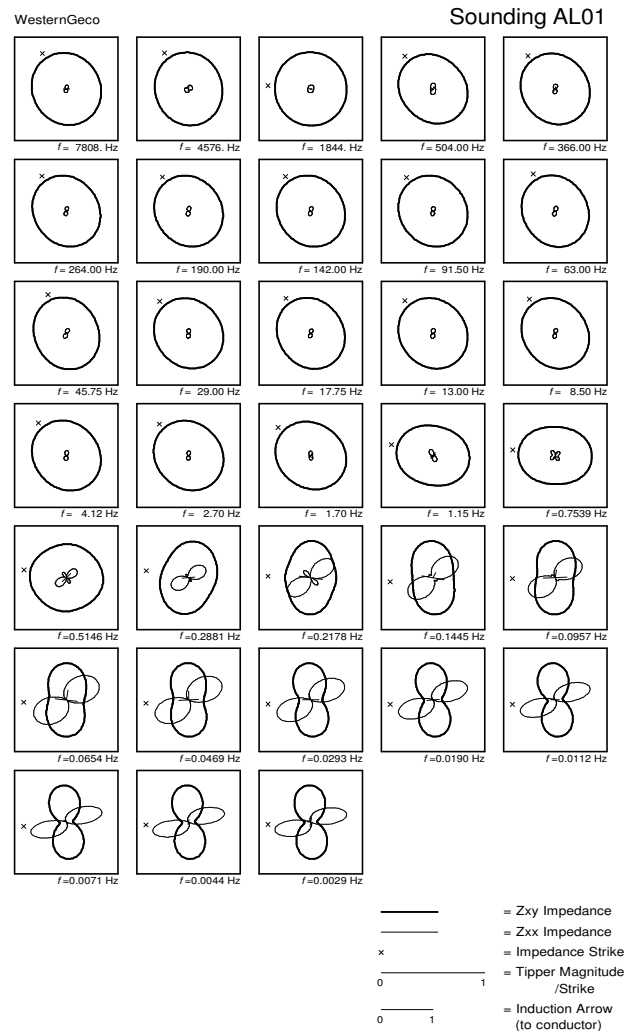
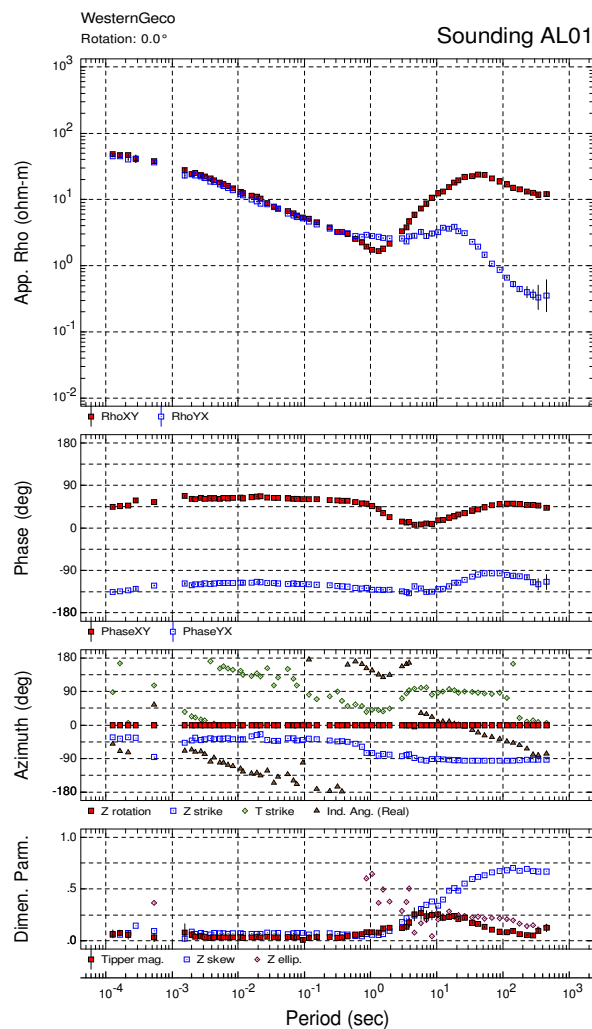
## APPENDIX F MT DATA PLOTS

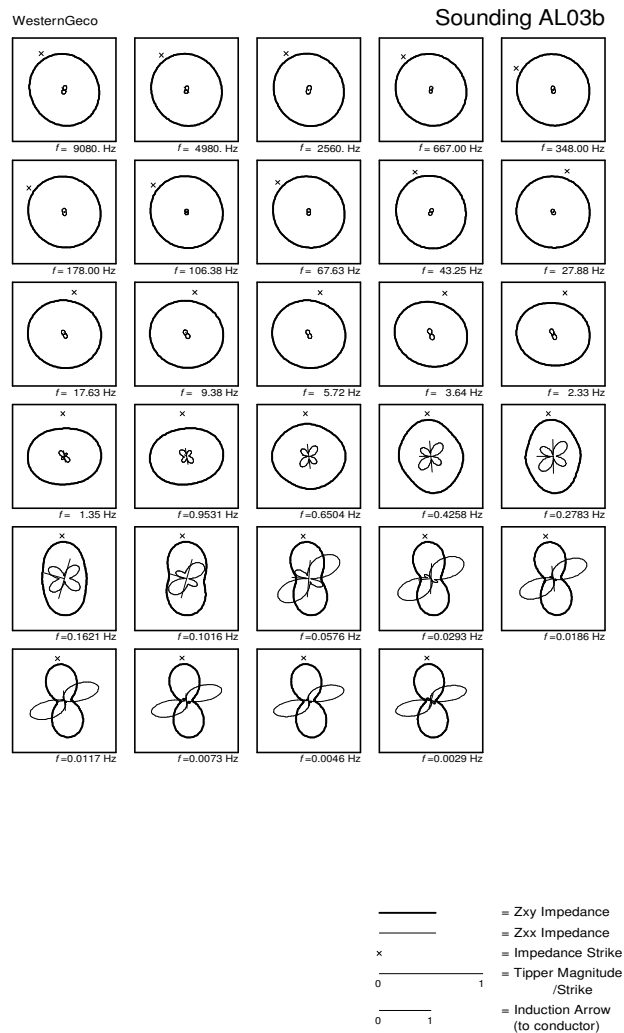
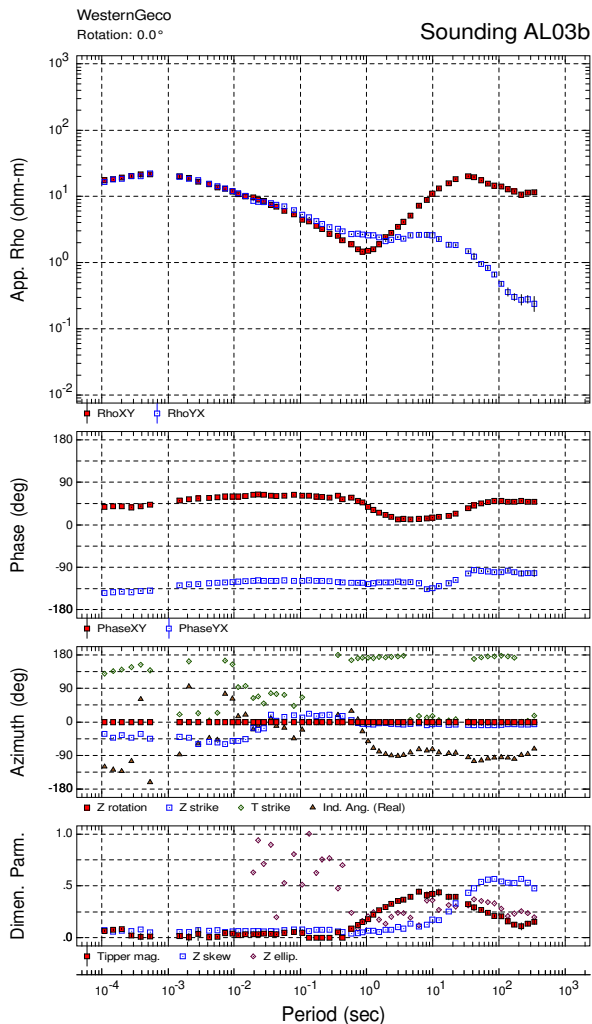
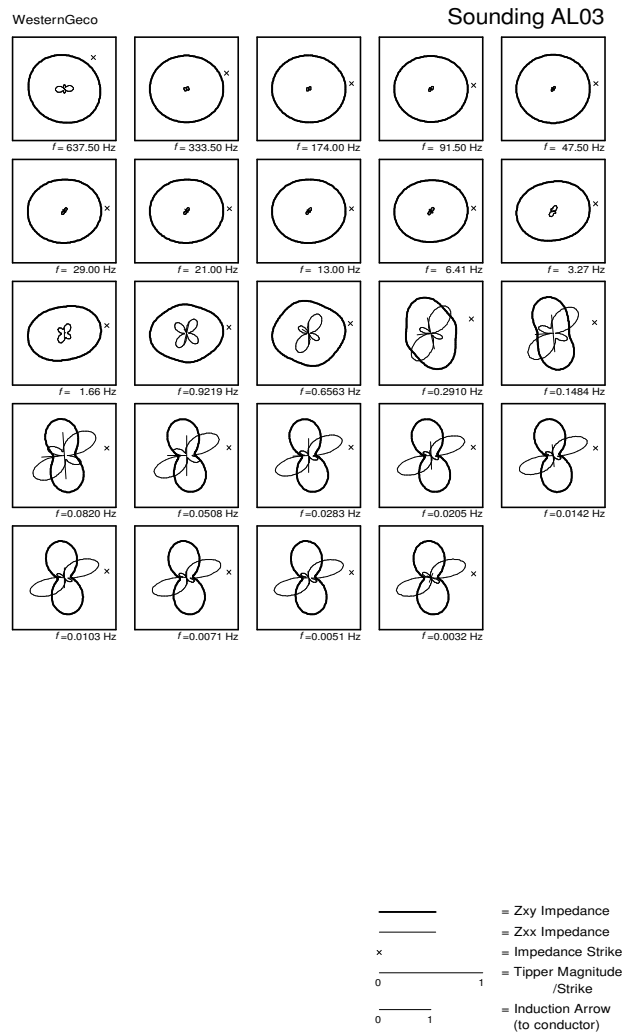
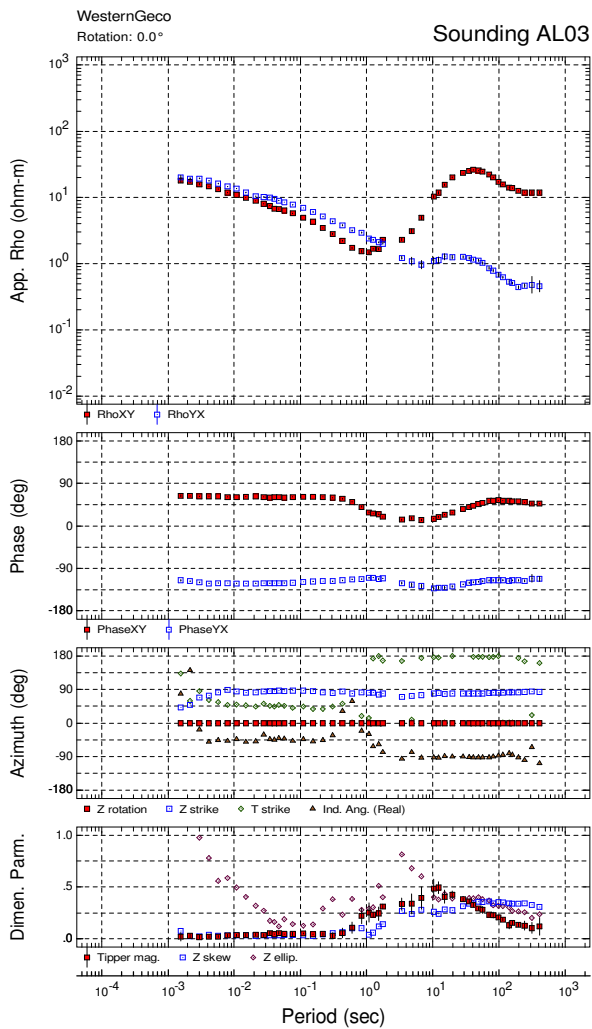
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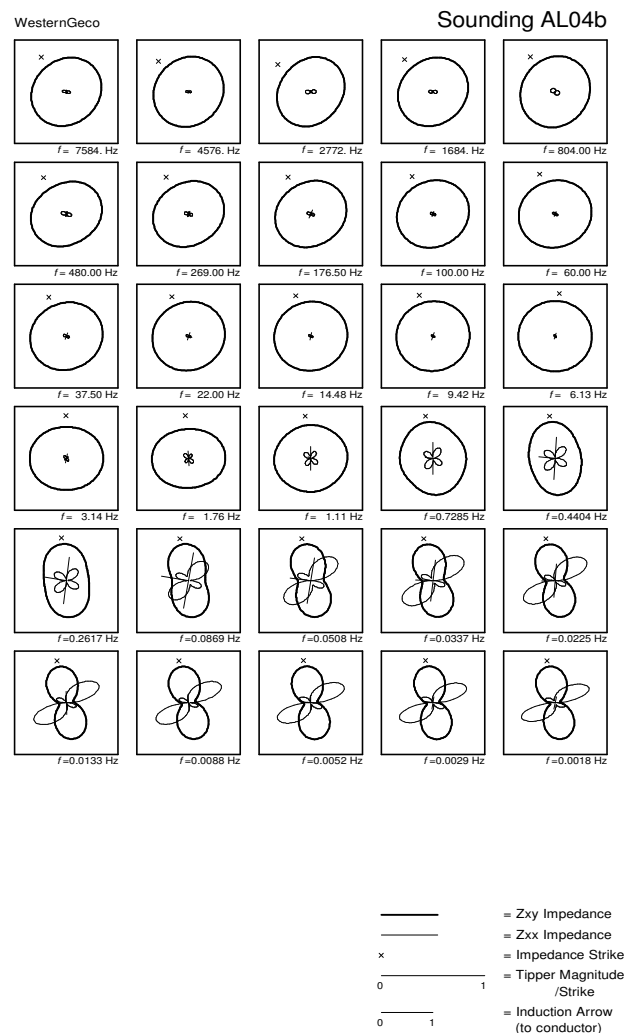
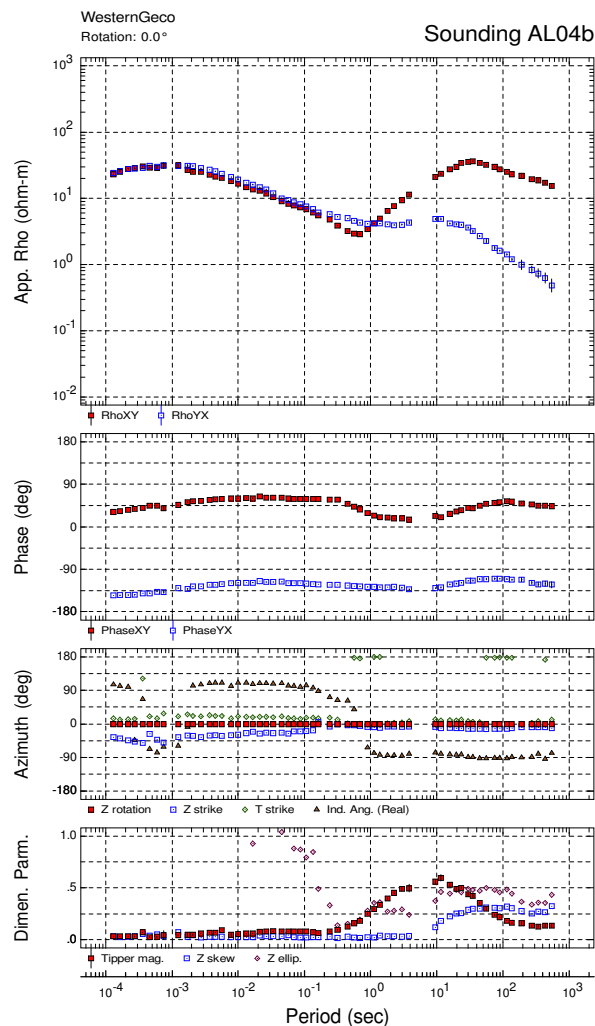
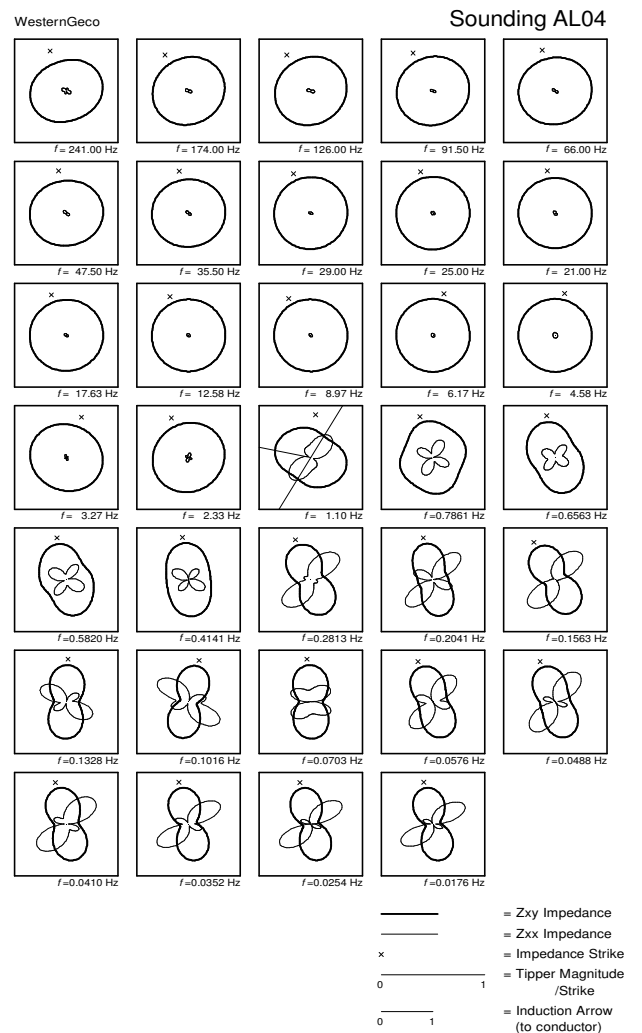
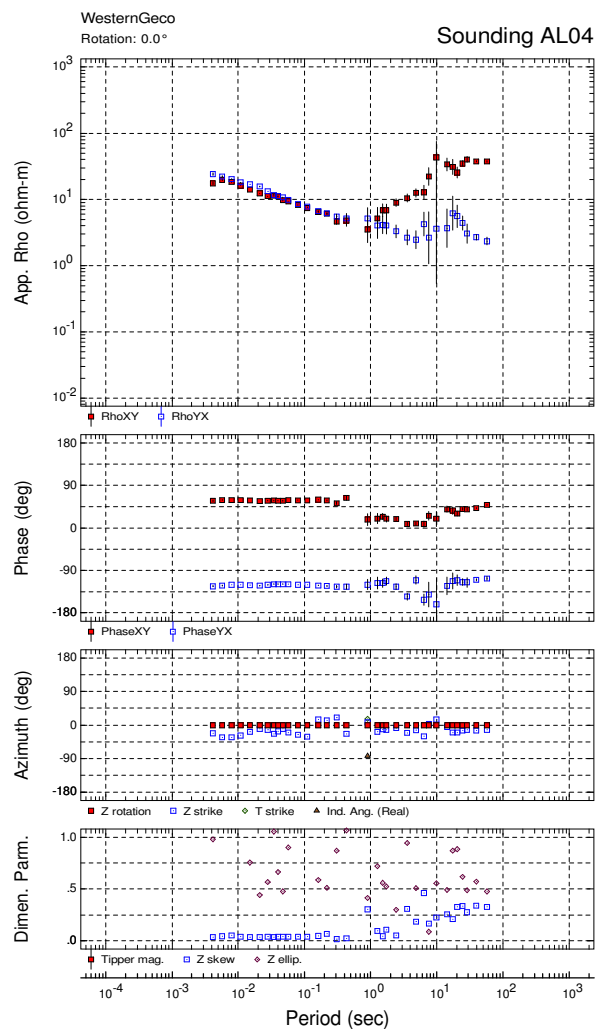
All data are rotated to 0°.

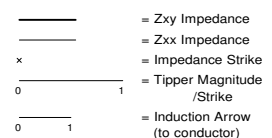
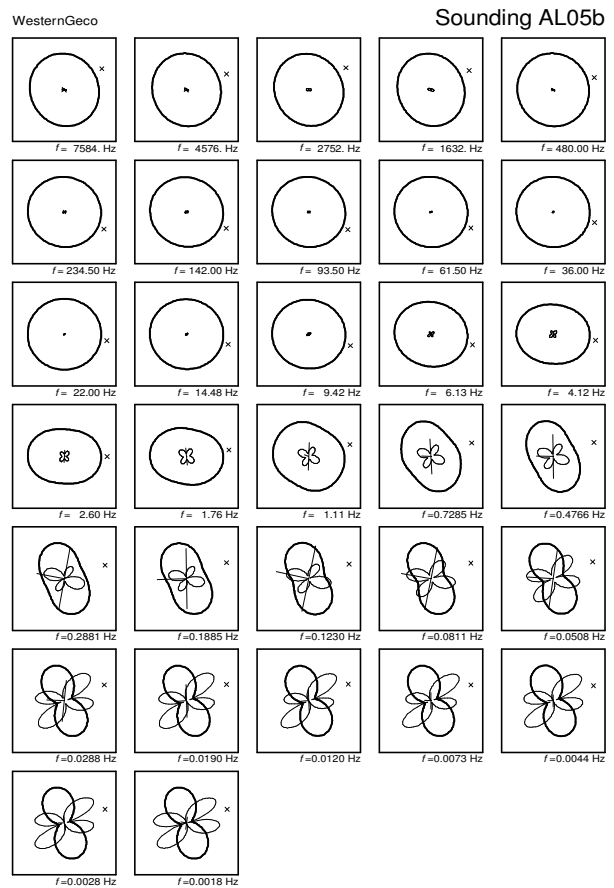
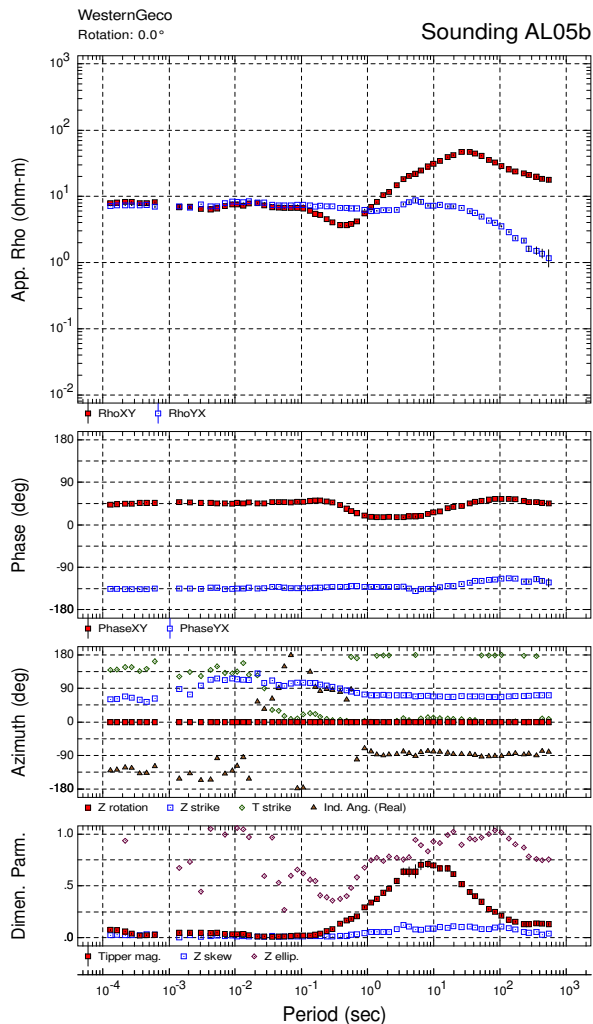
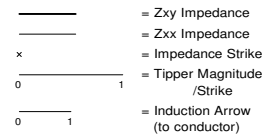
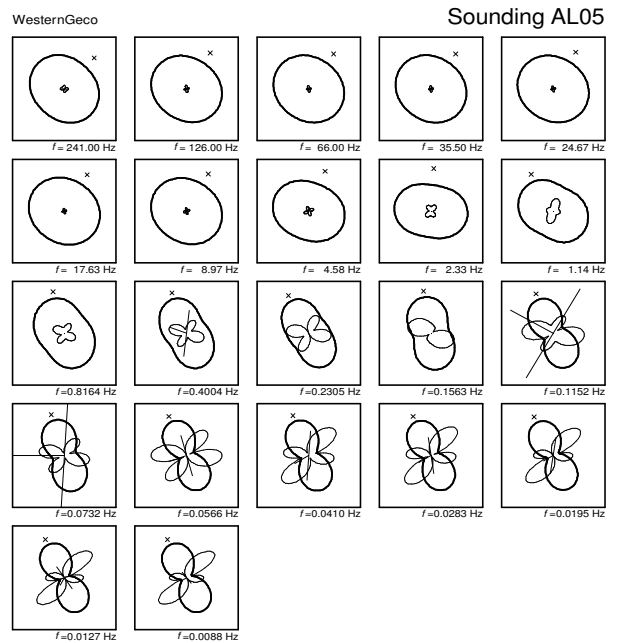
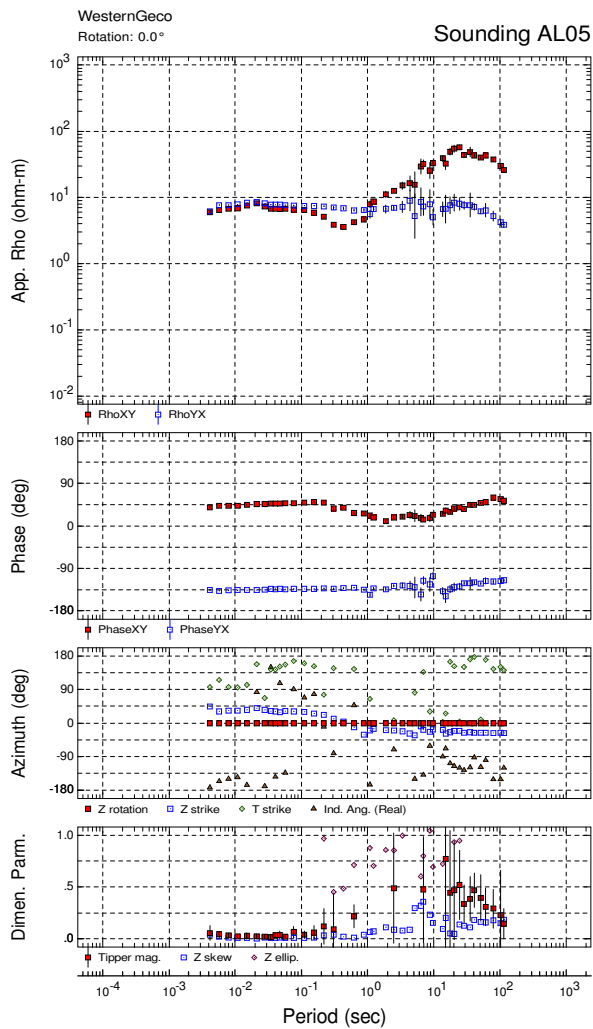


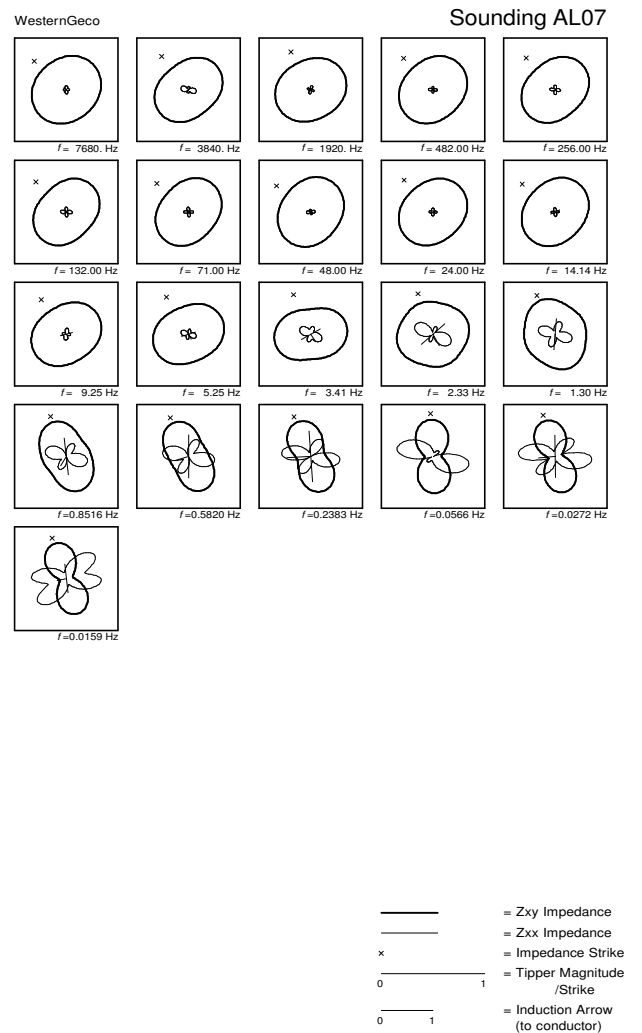
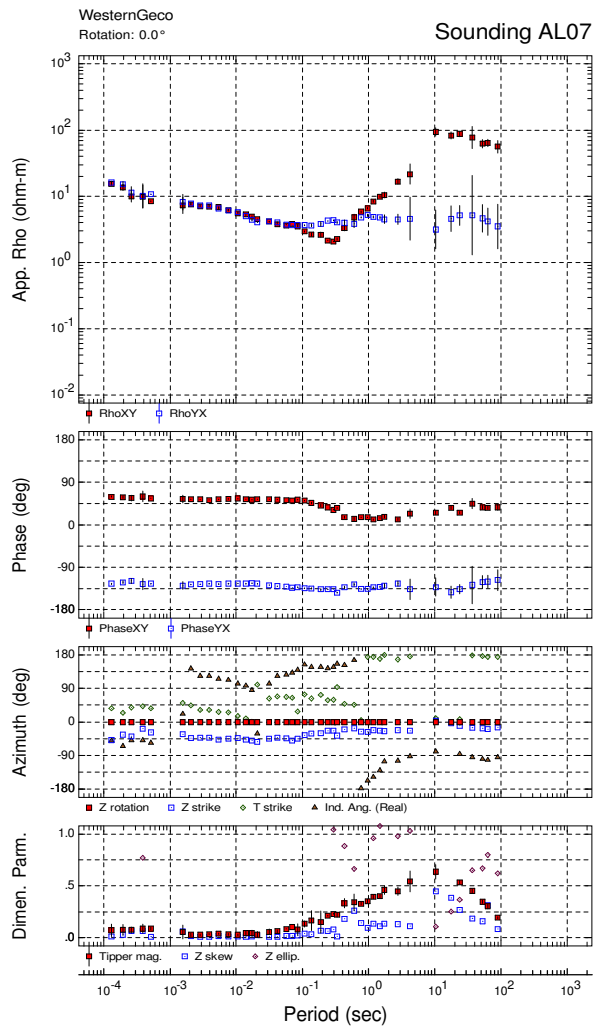
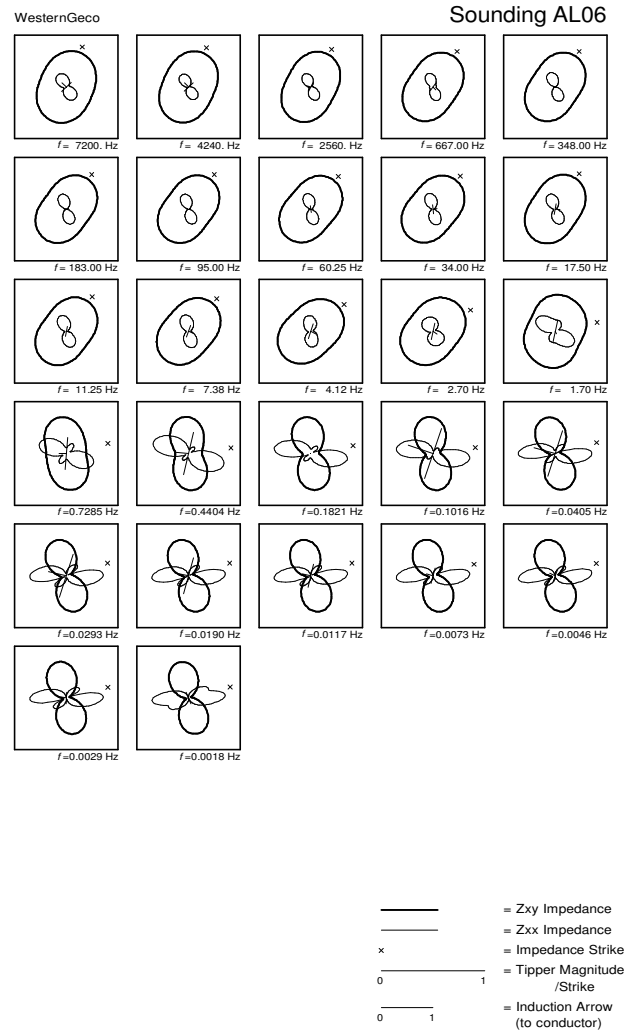
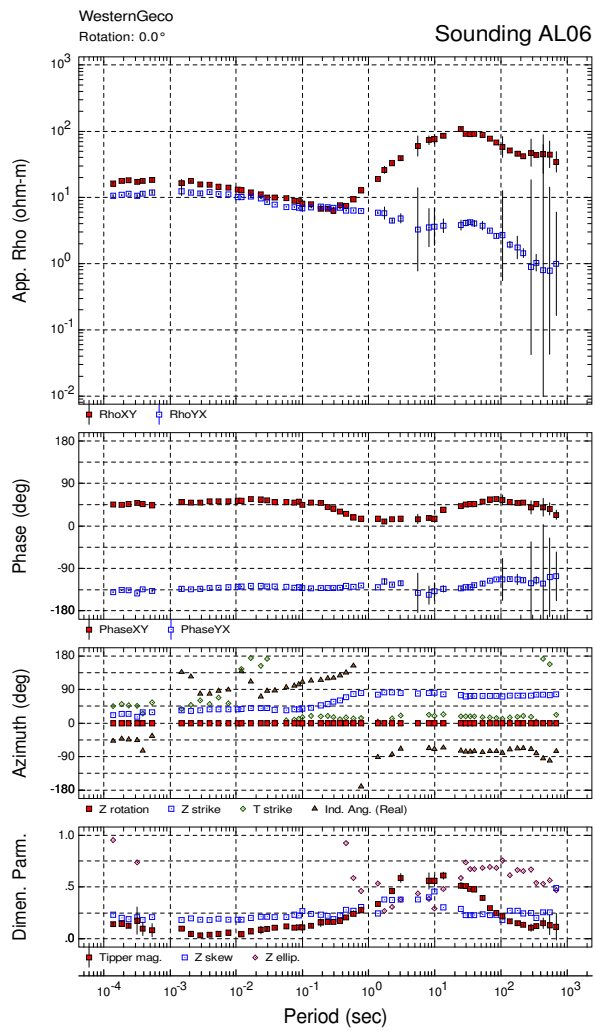


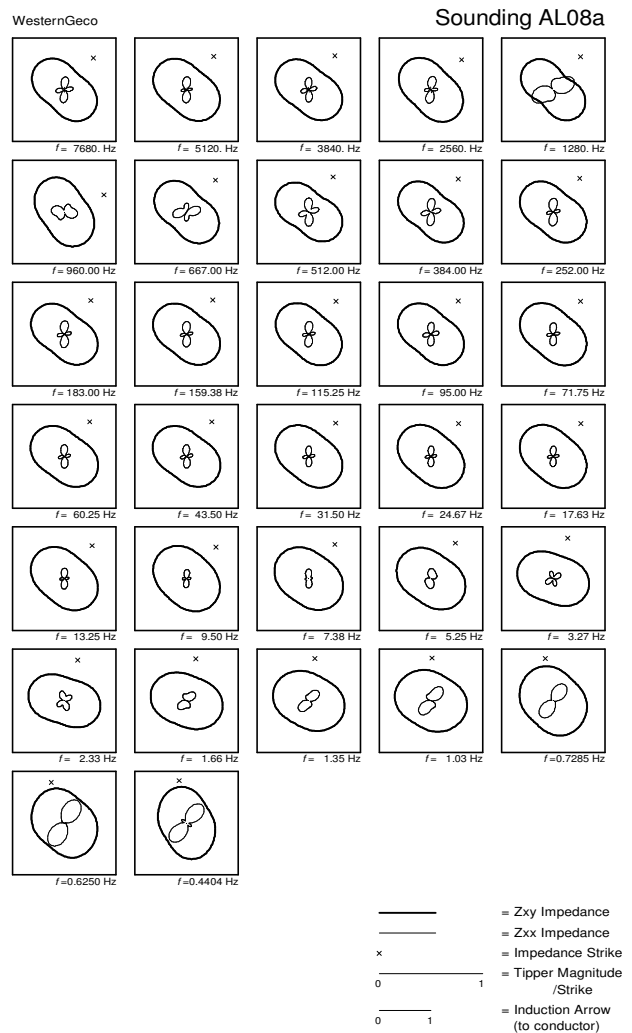
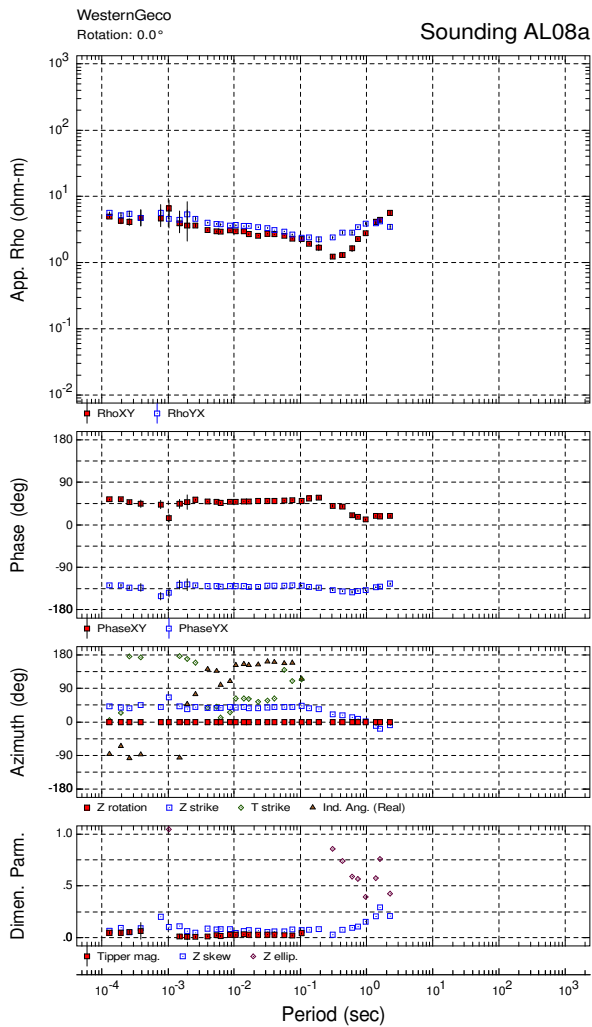
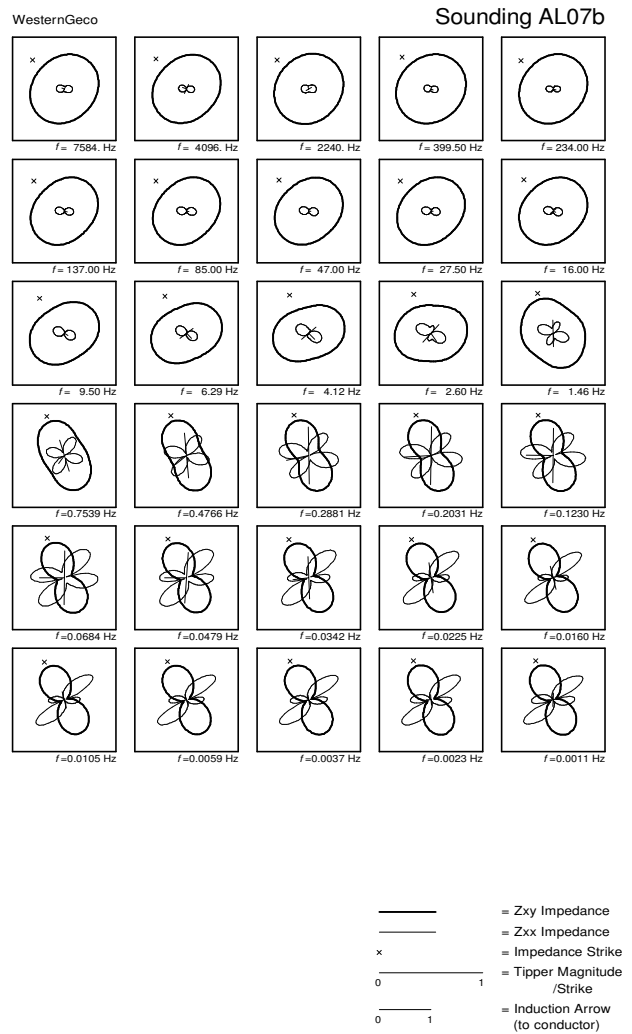
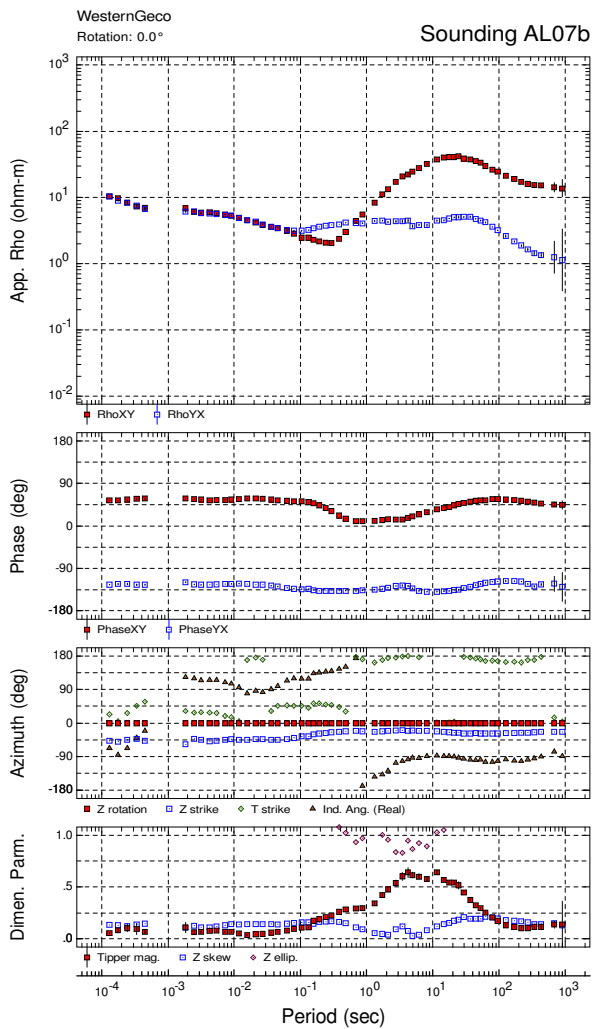




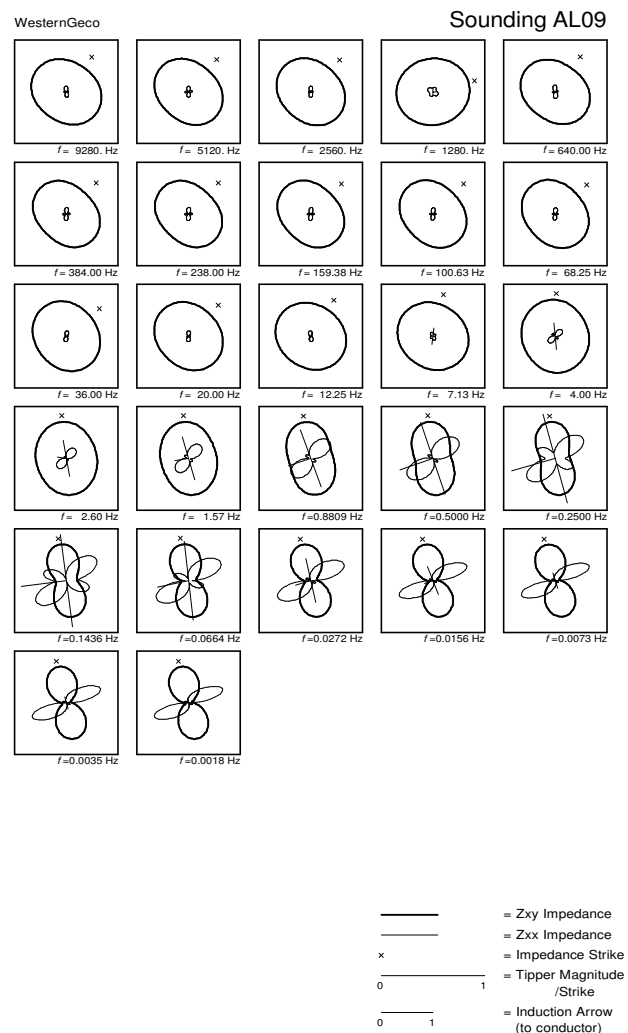
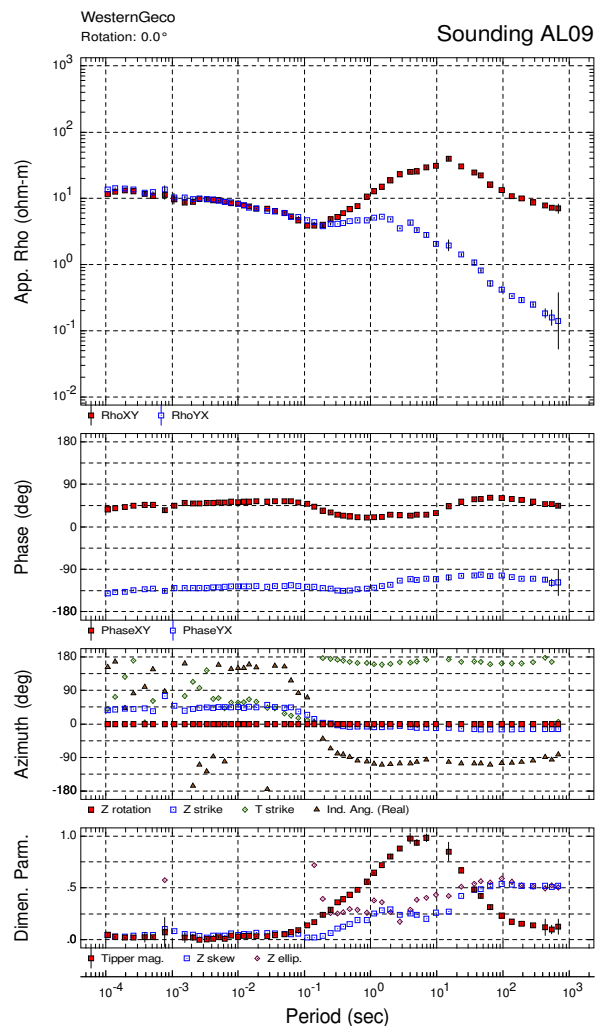
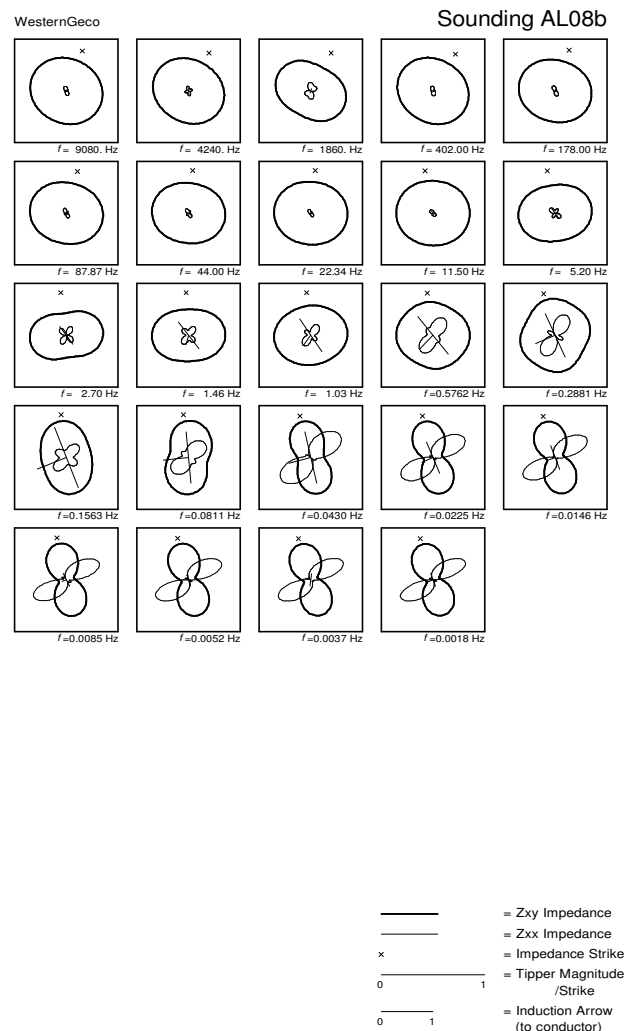
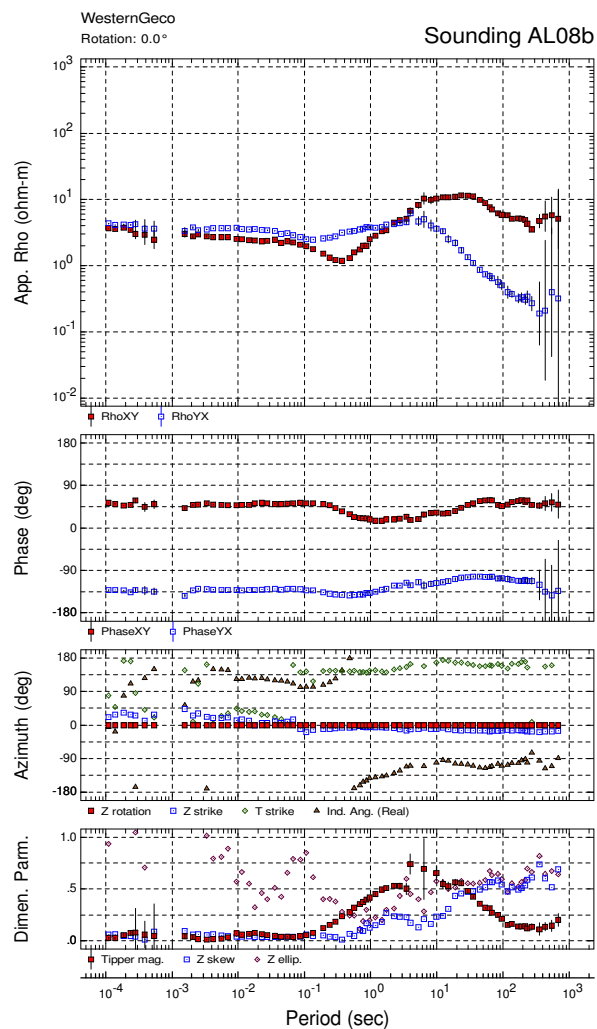


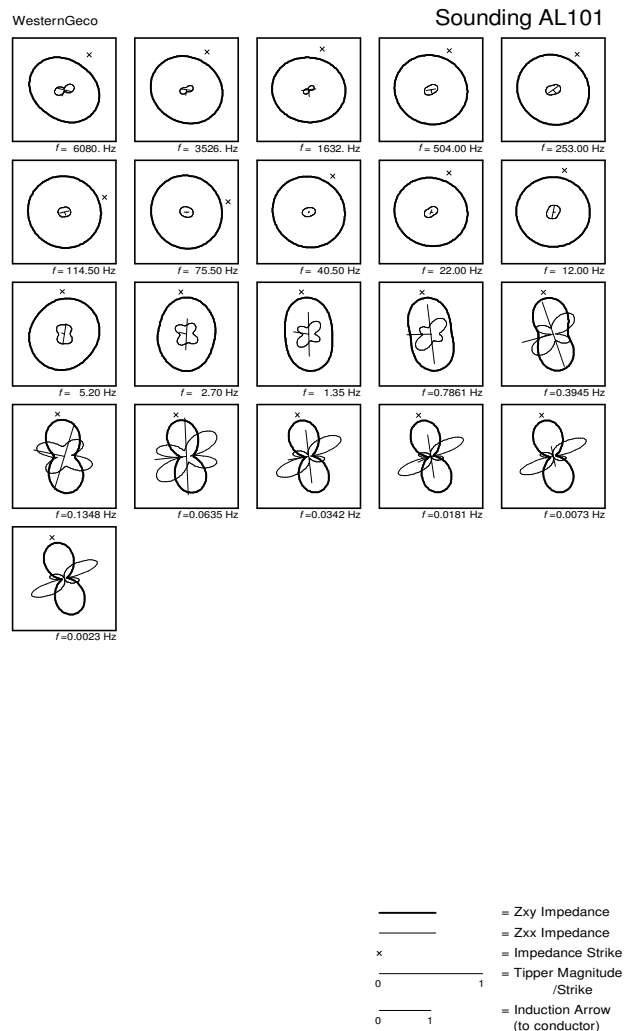
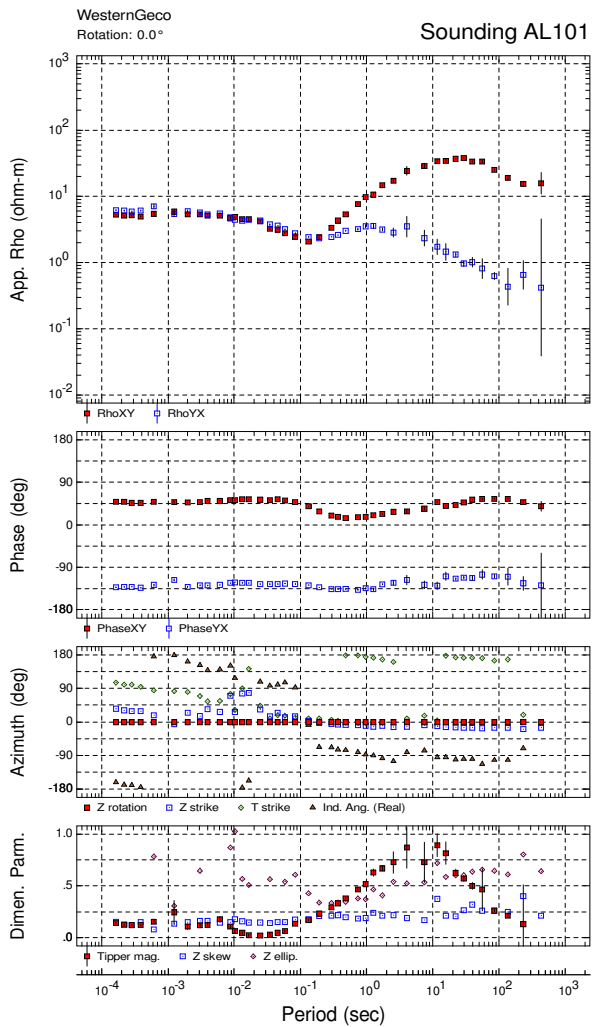
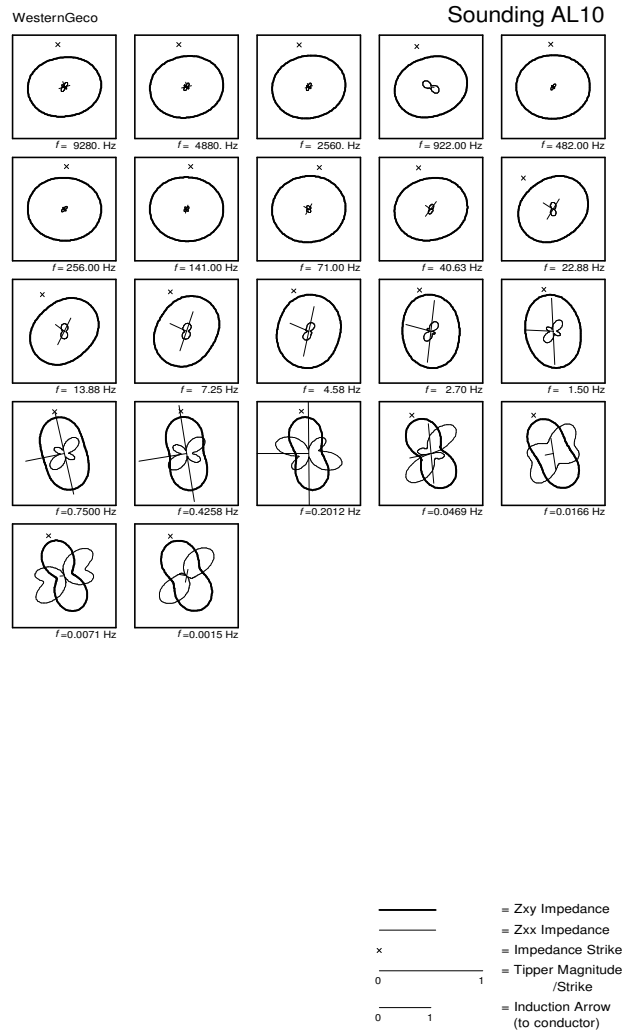
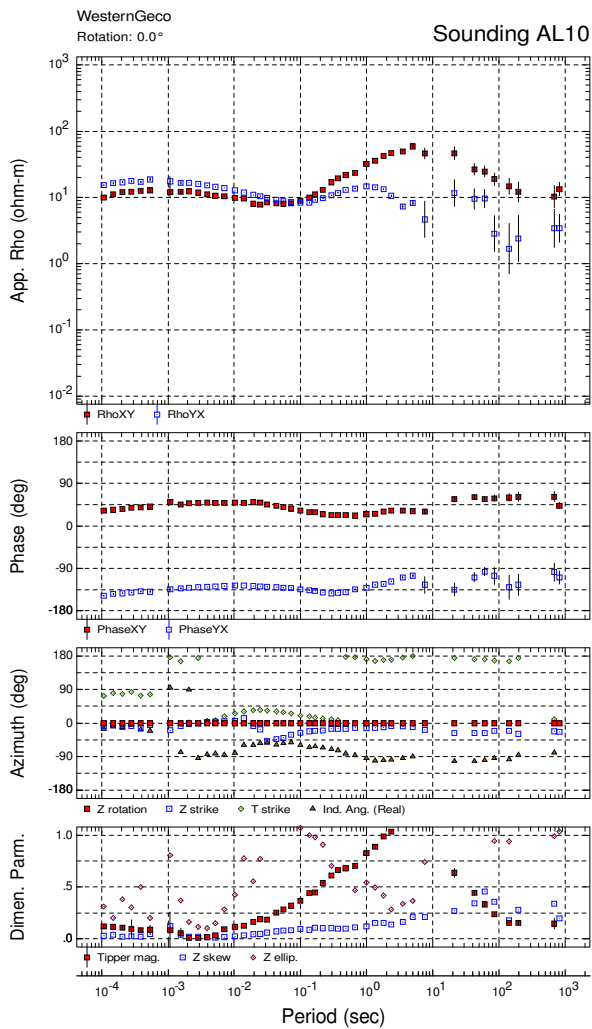




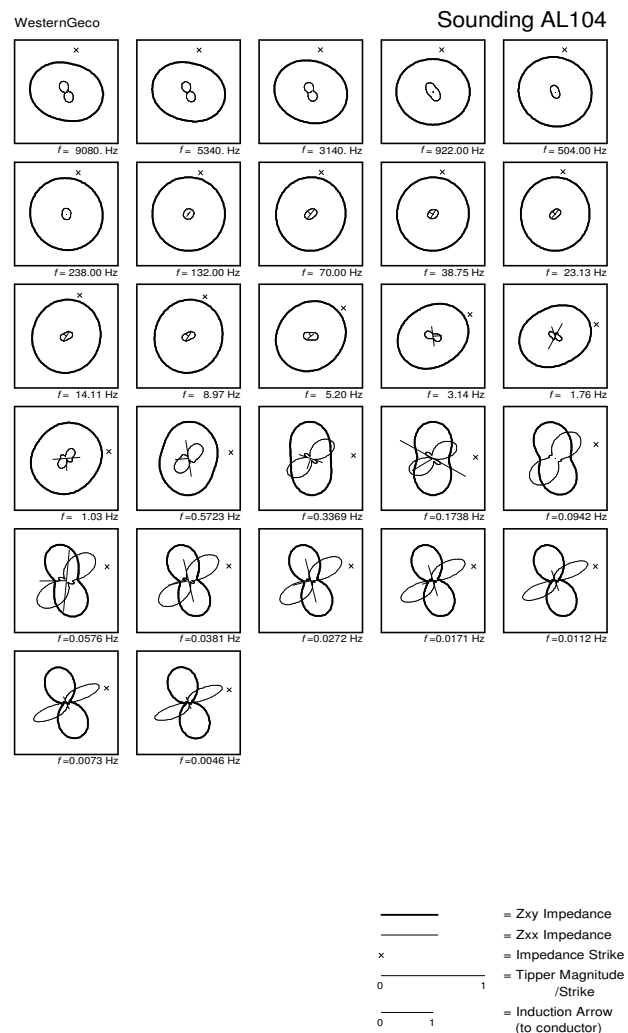
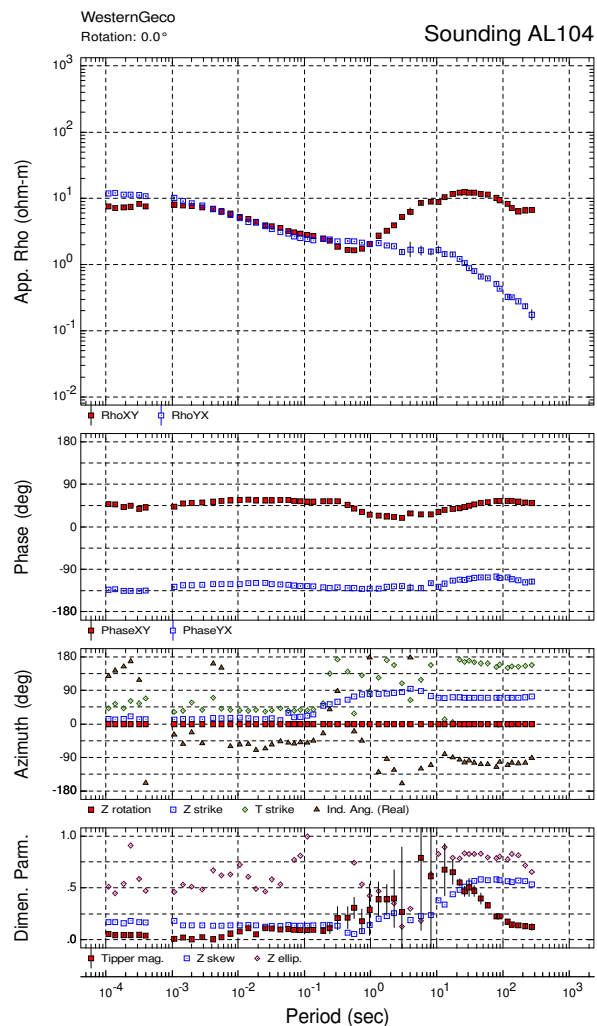
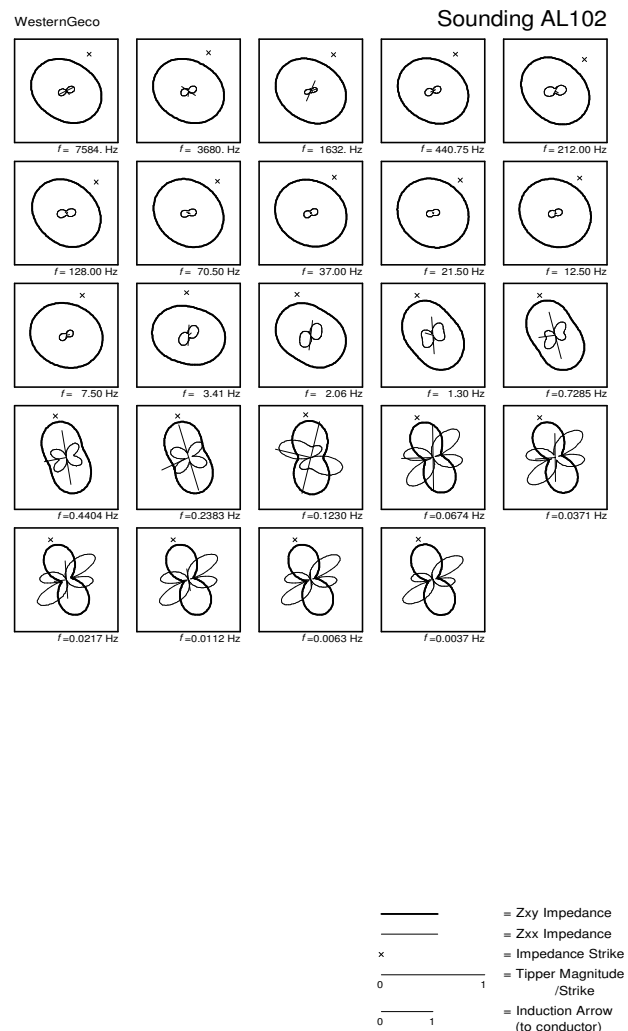
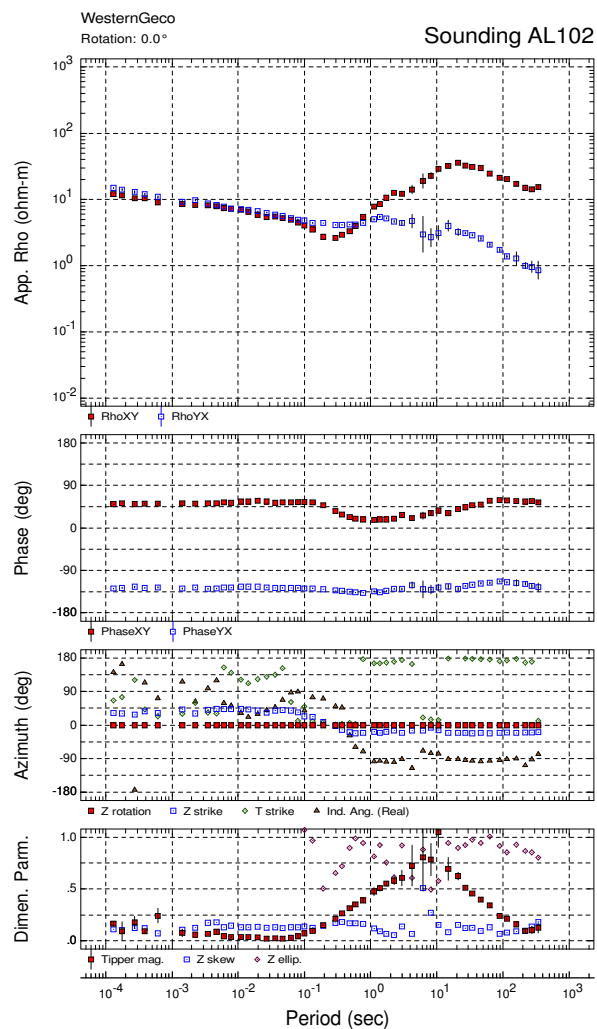


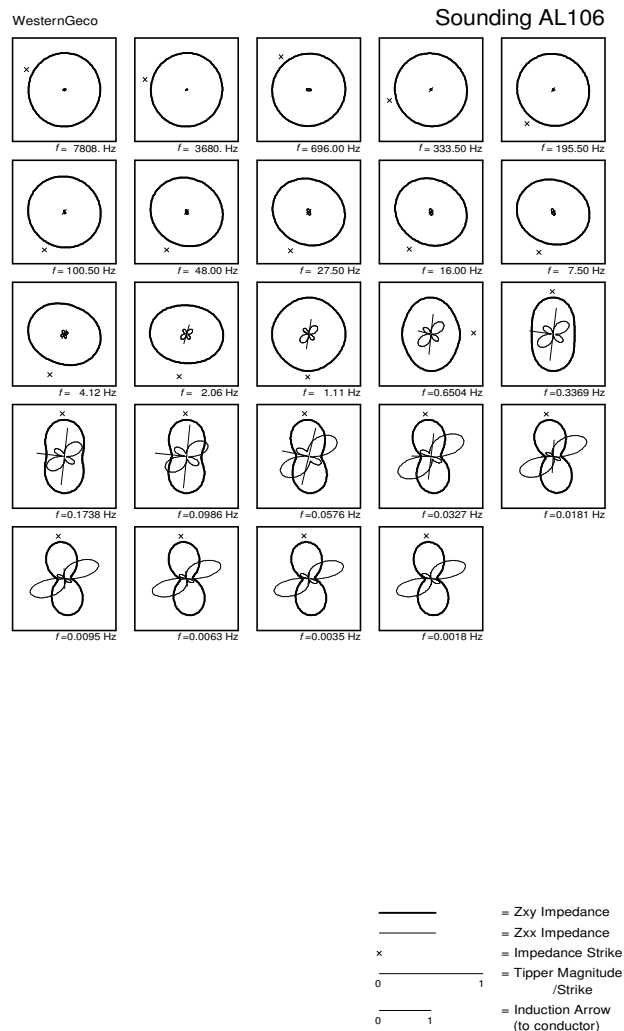
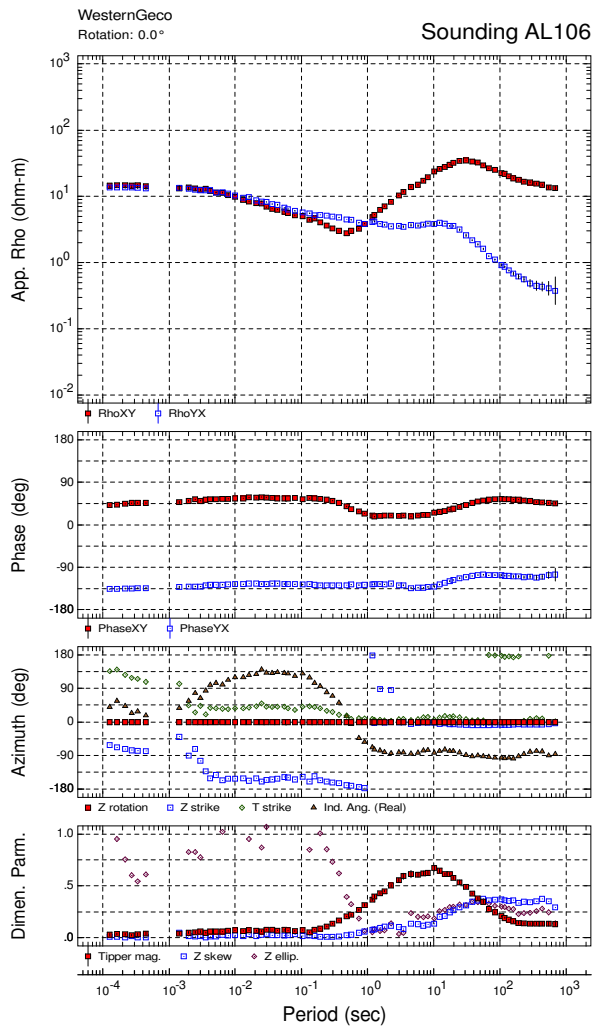
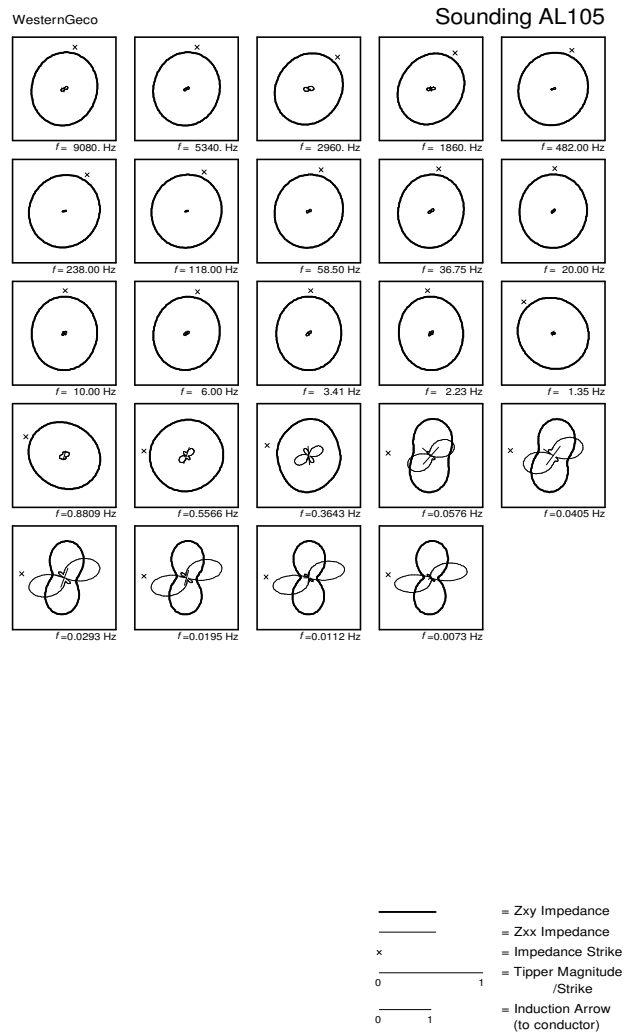
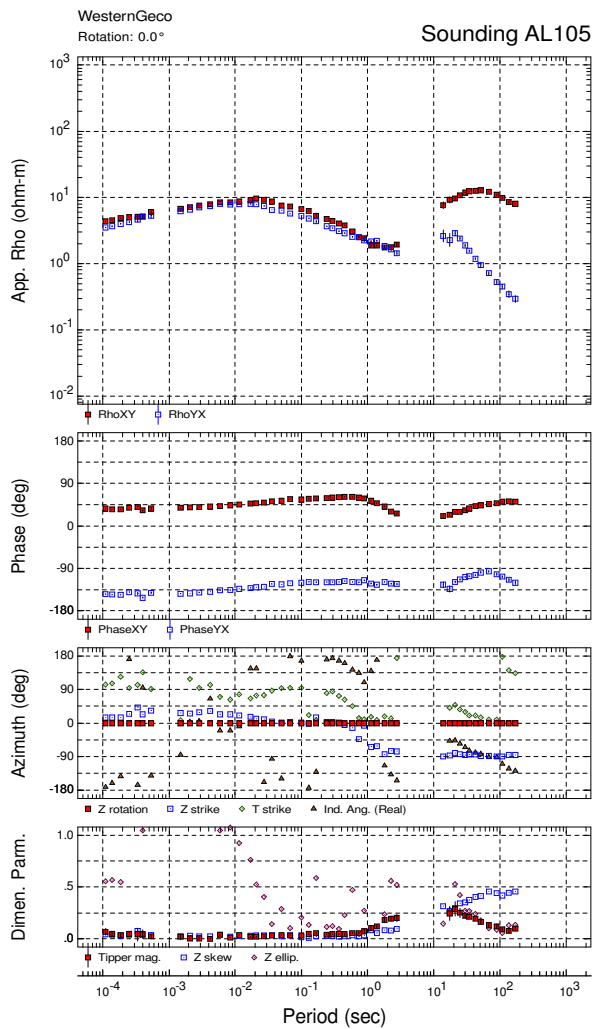


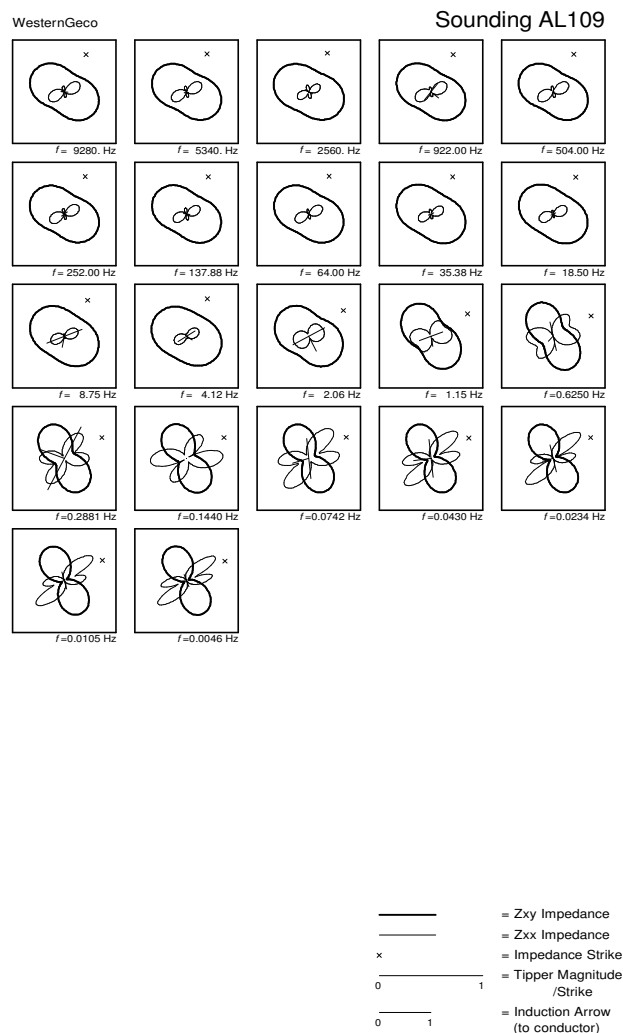
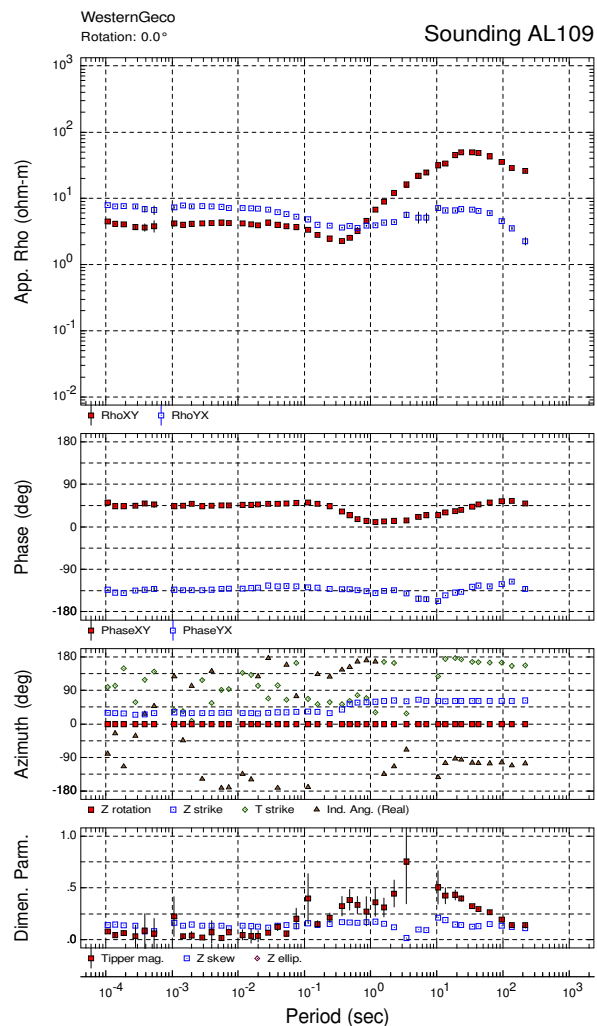
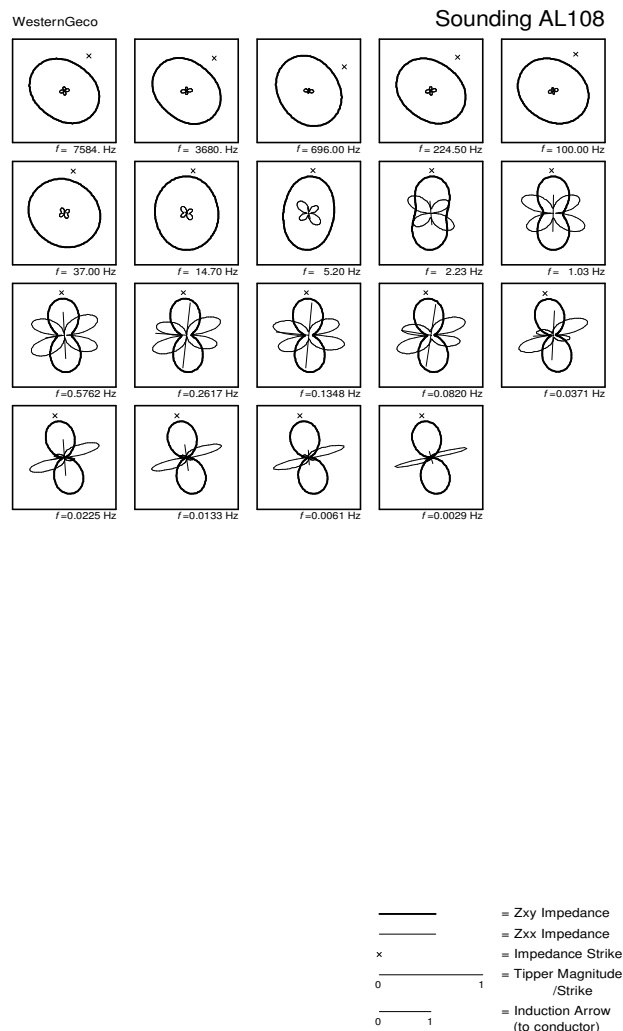
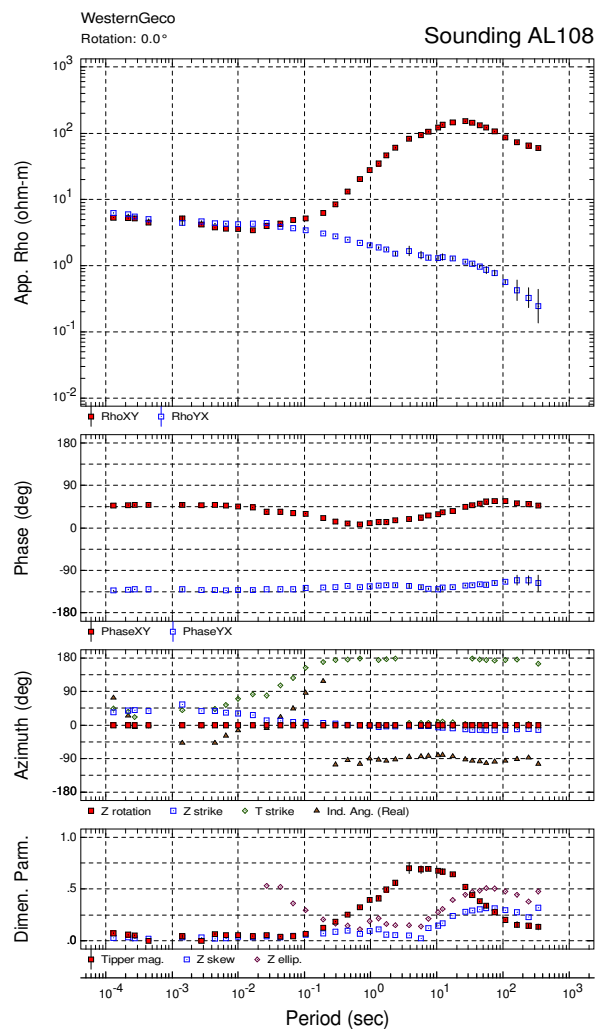


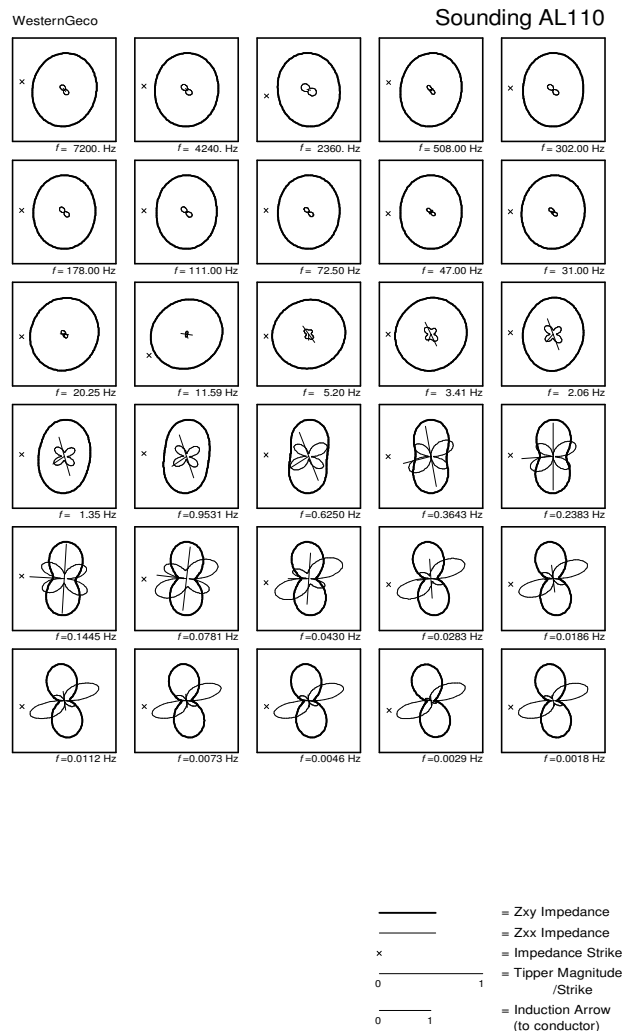
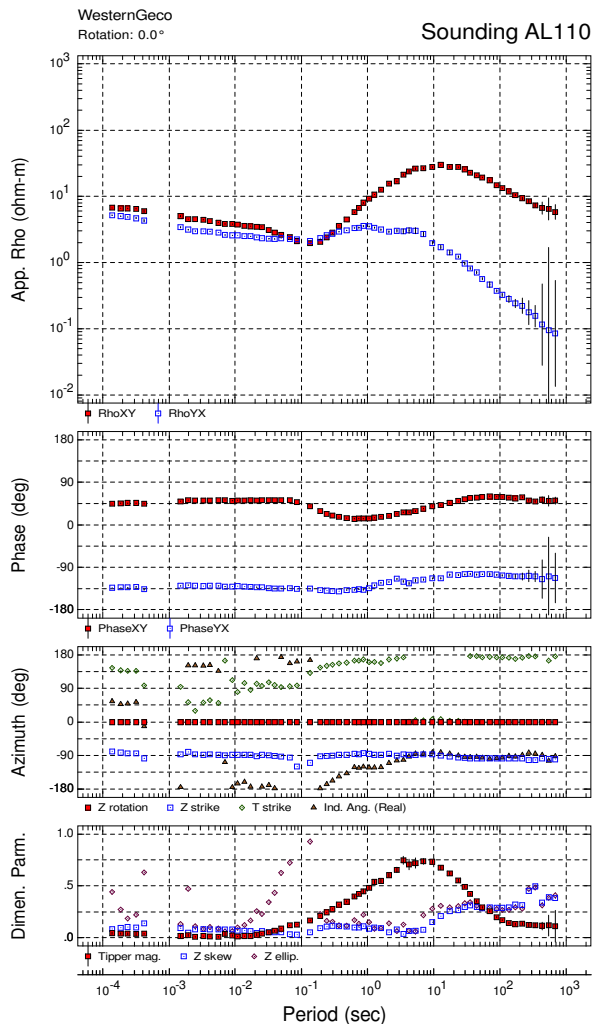
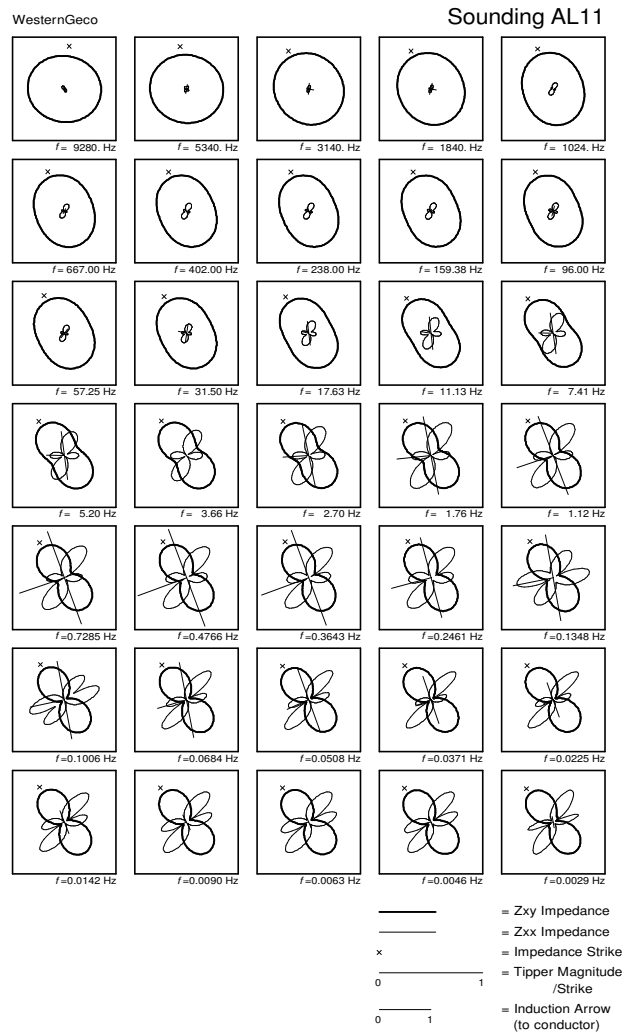
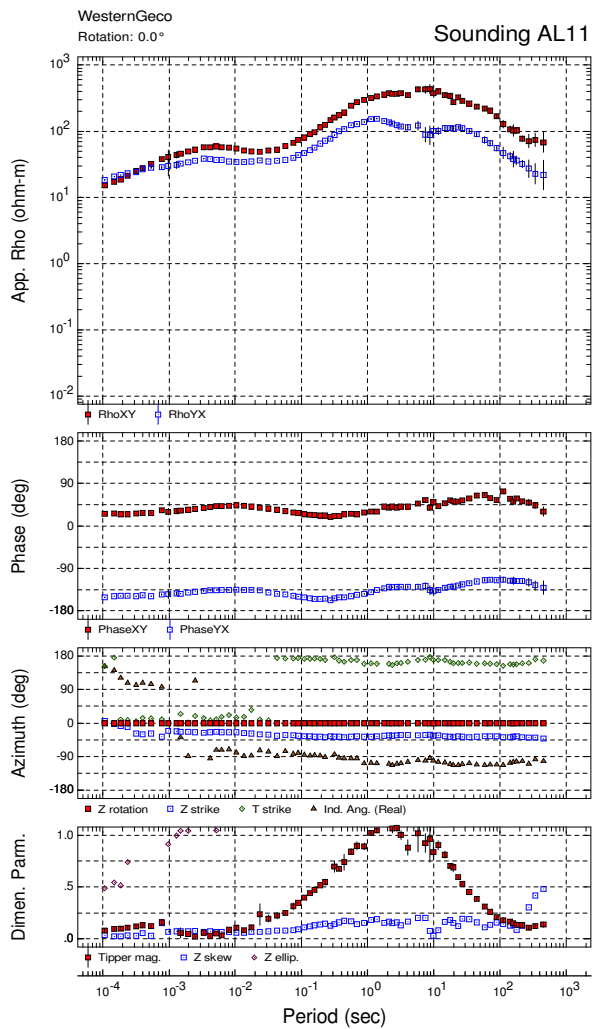


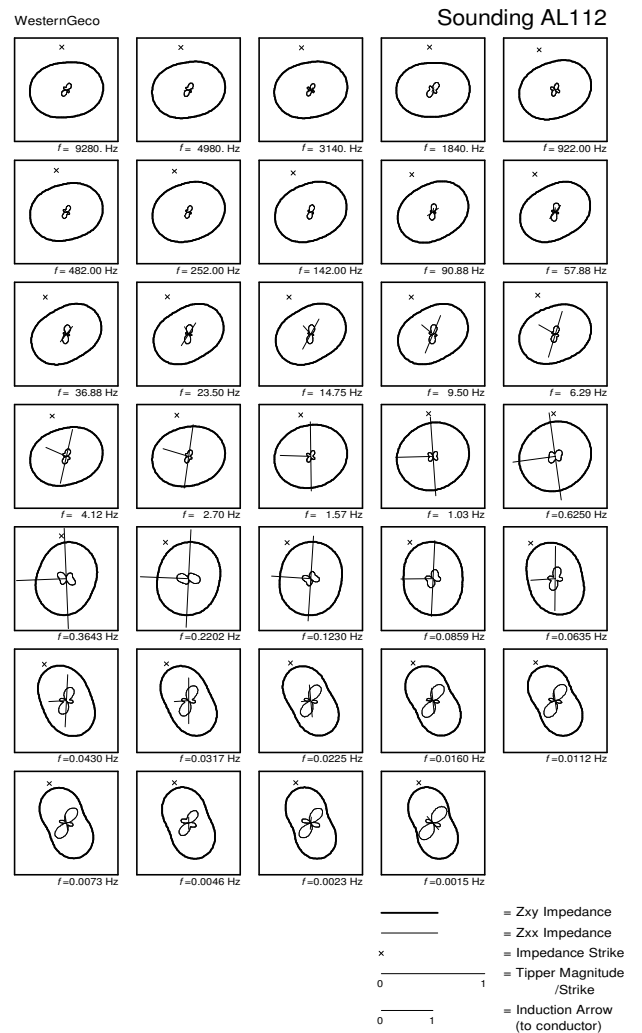
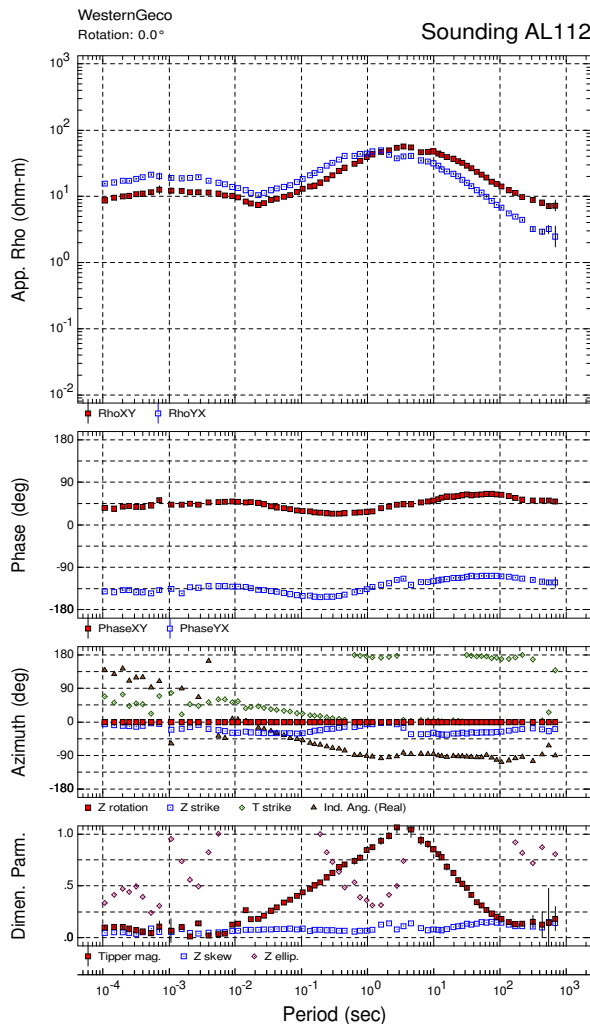
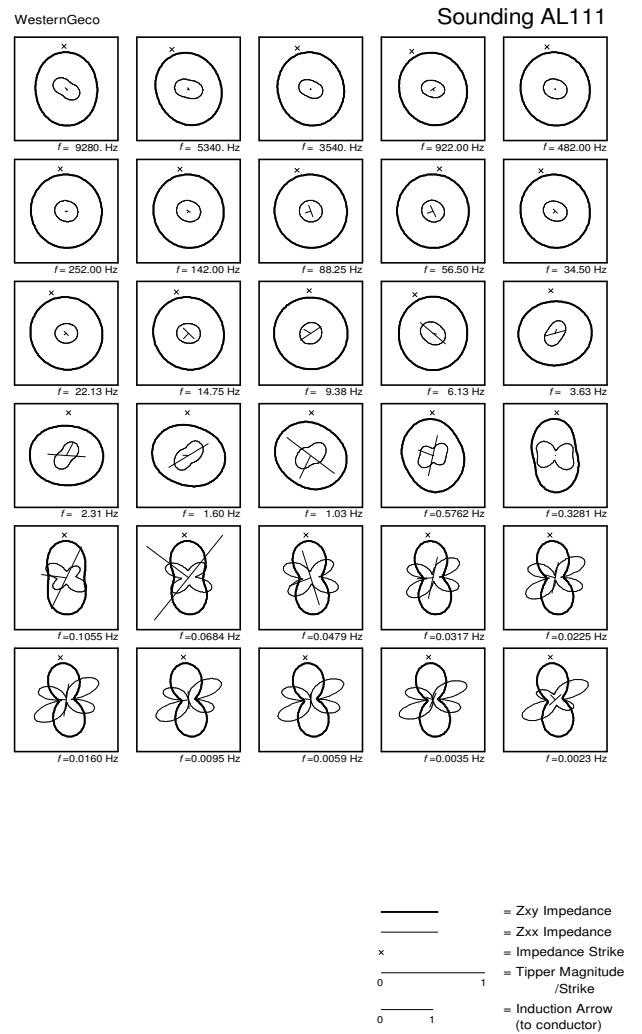
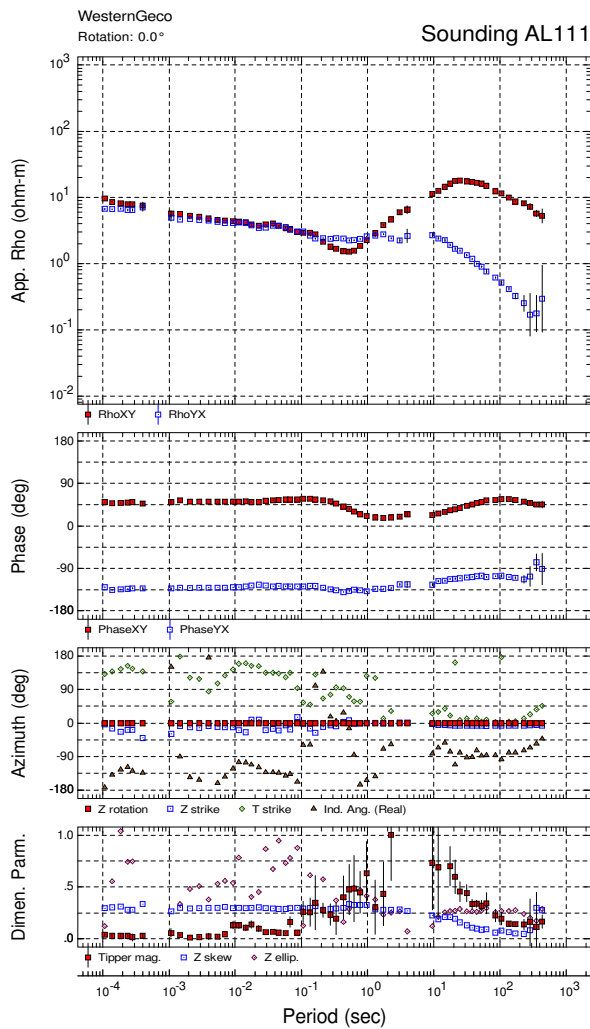


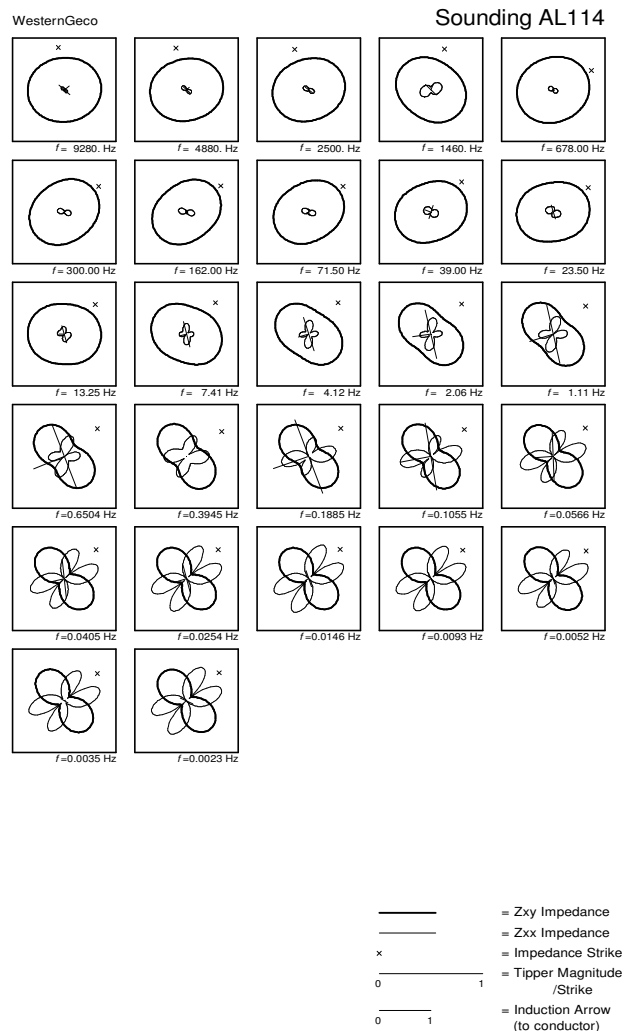
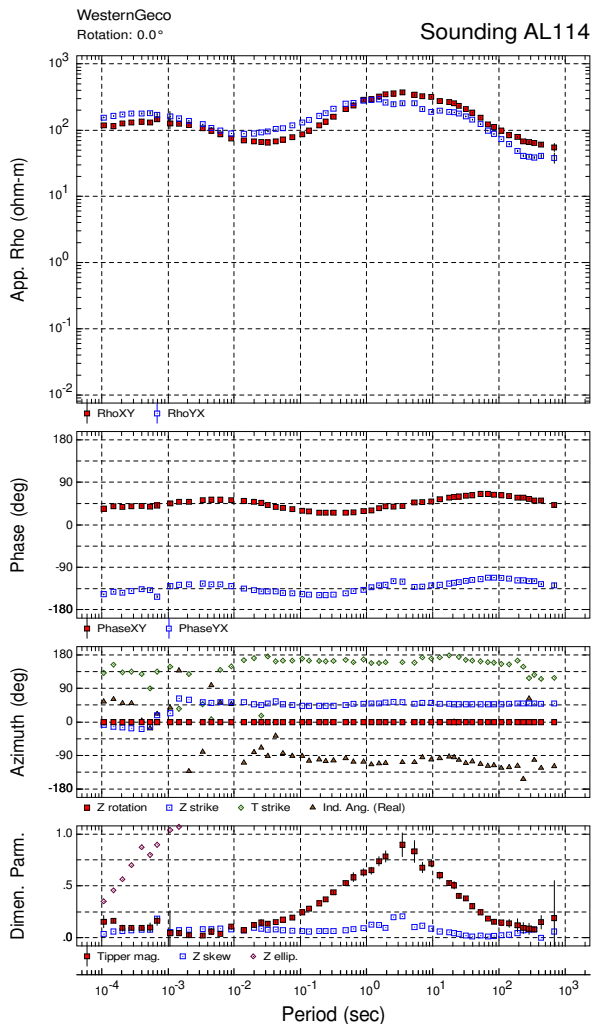
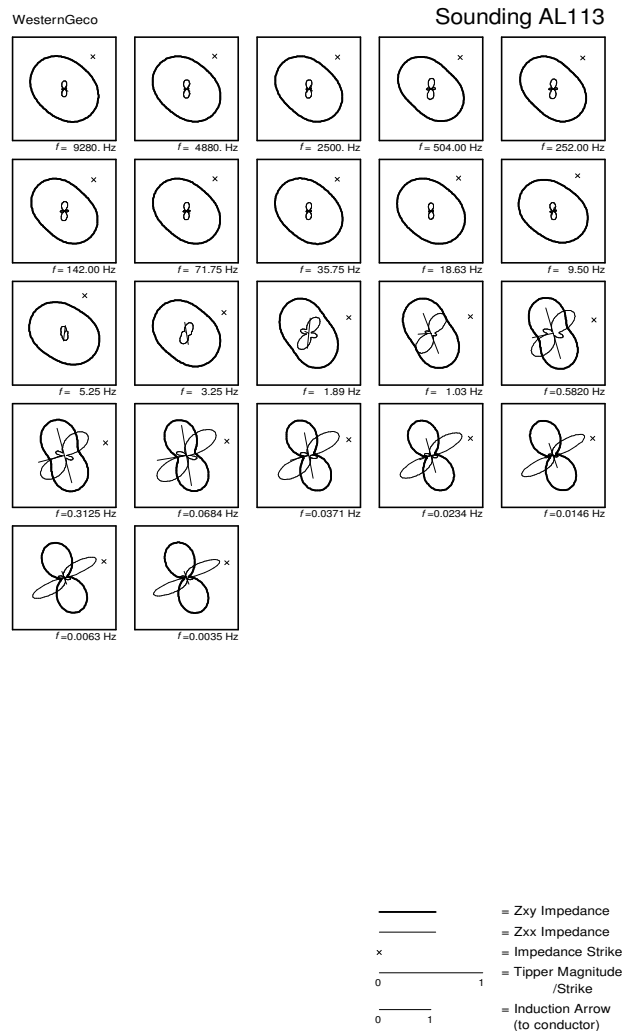
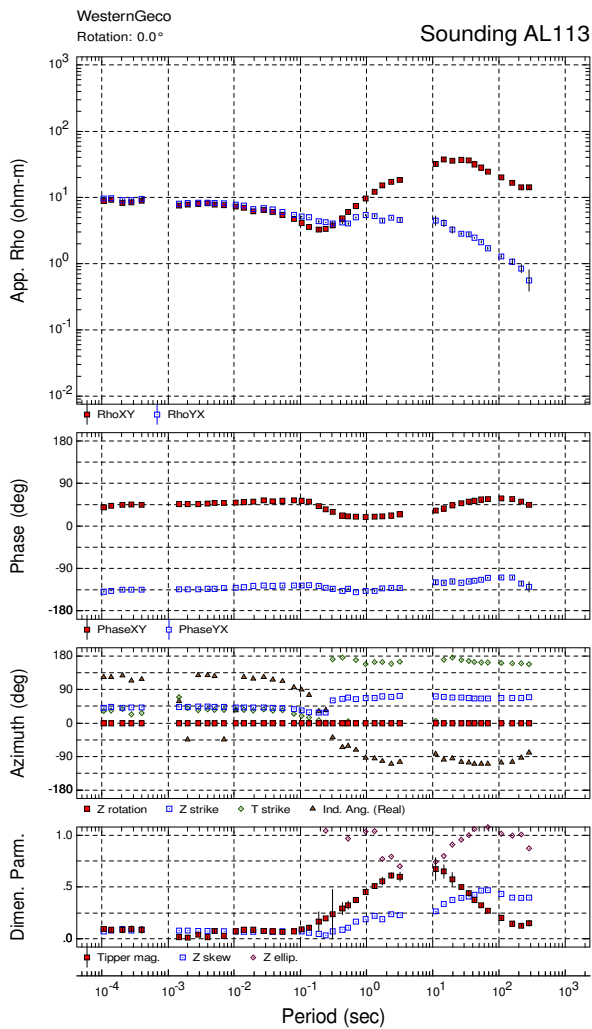




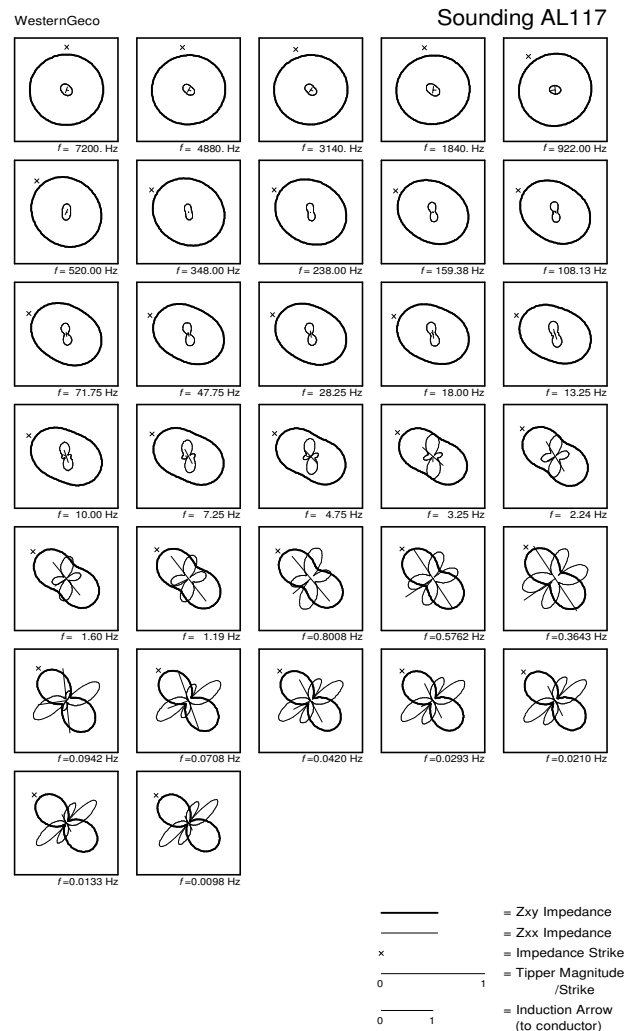
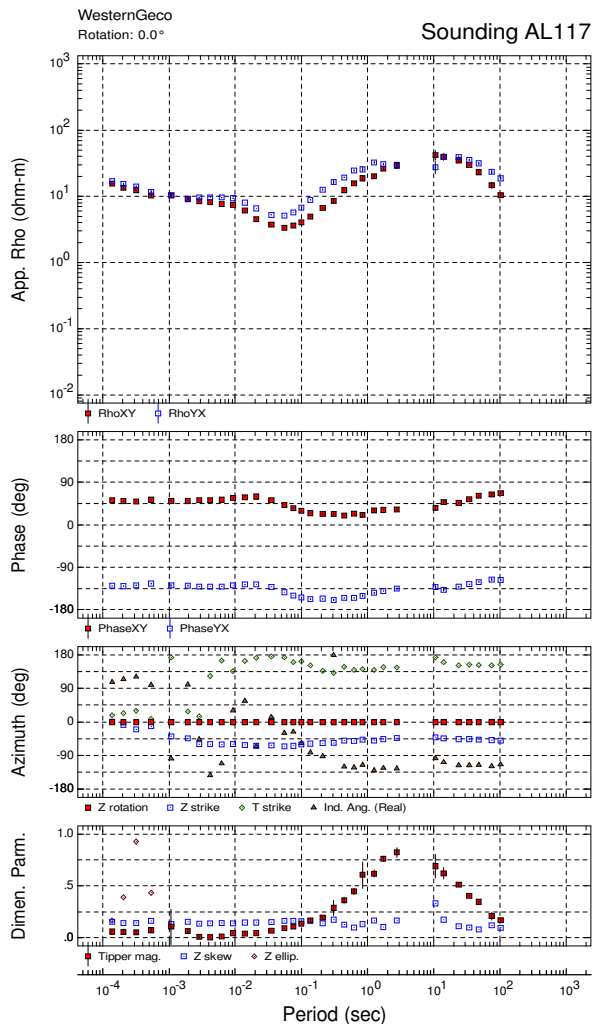
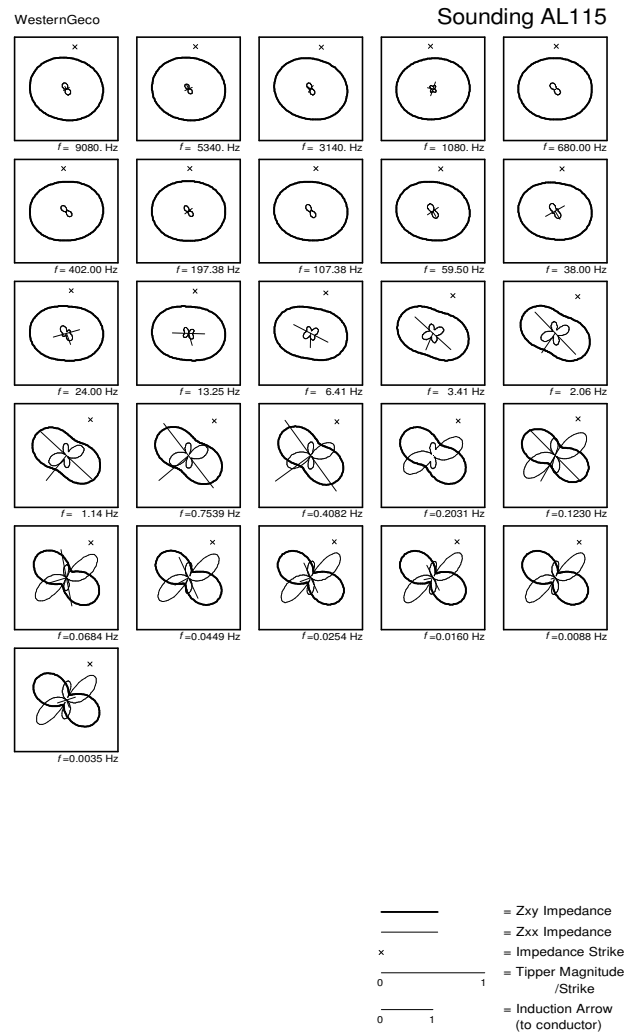
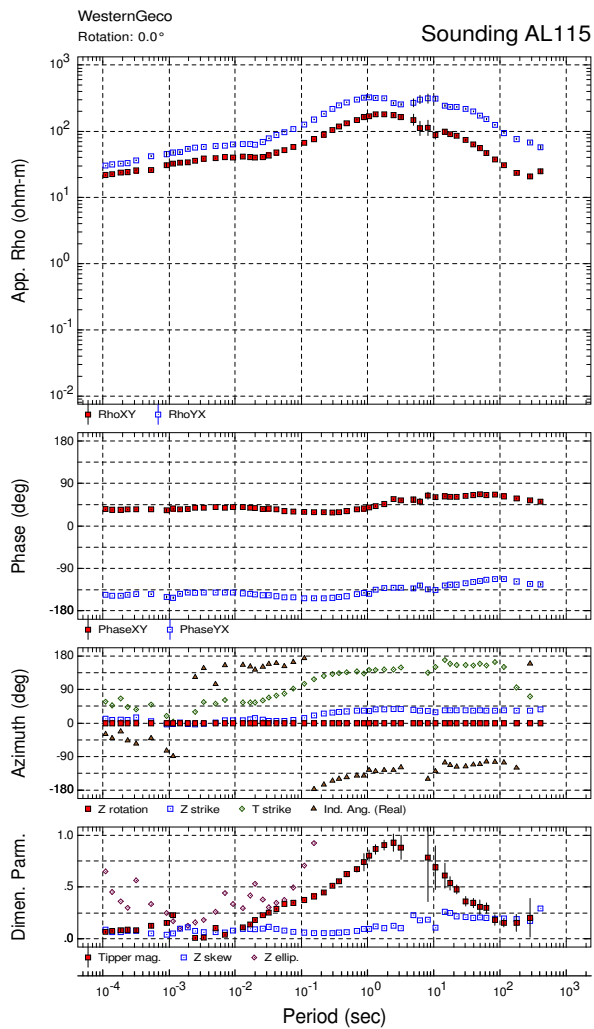


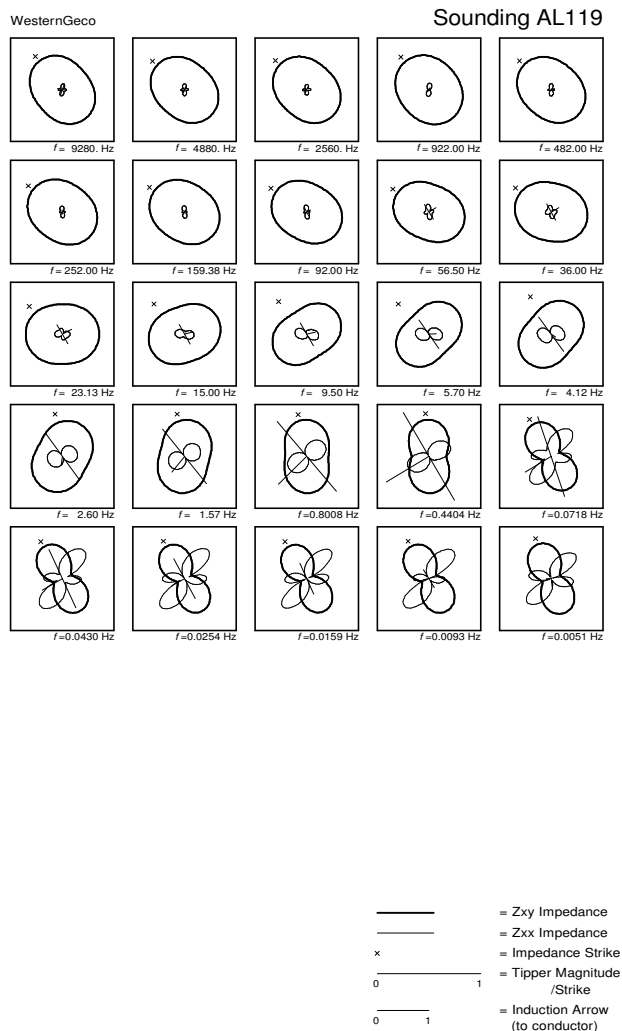
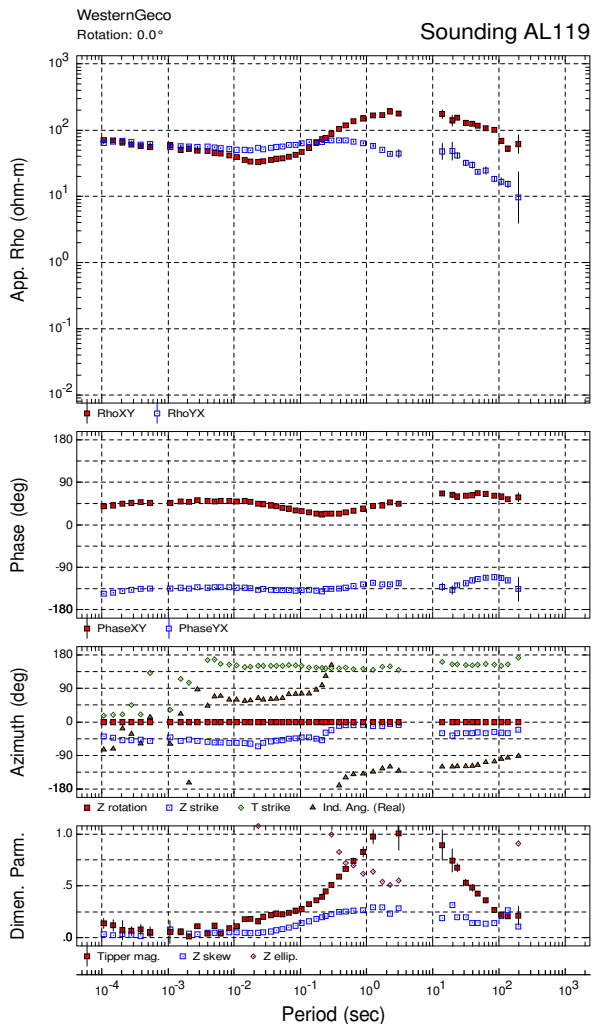
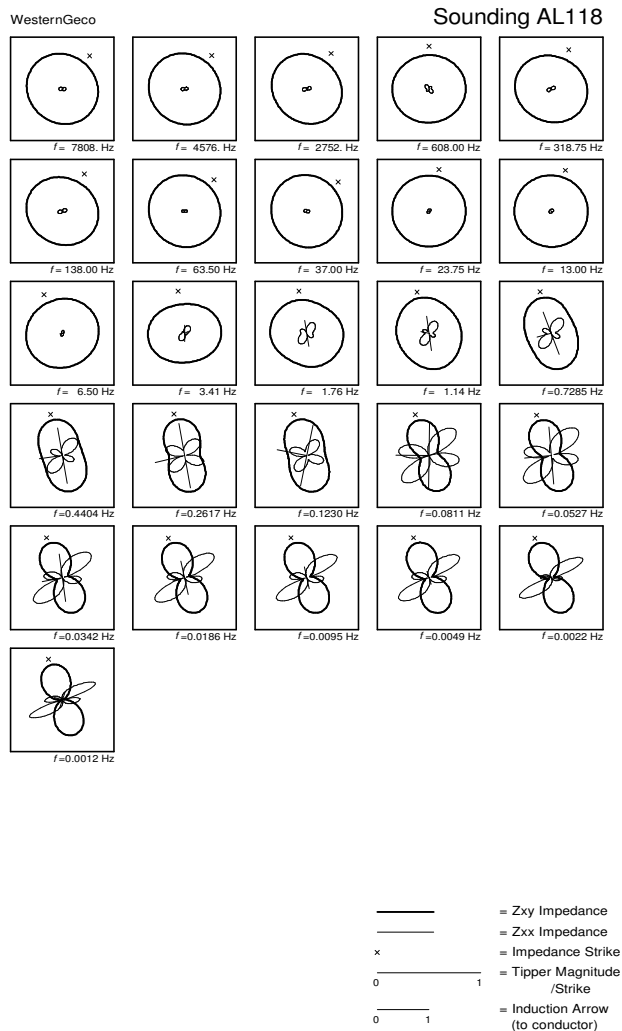
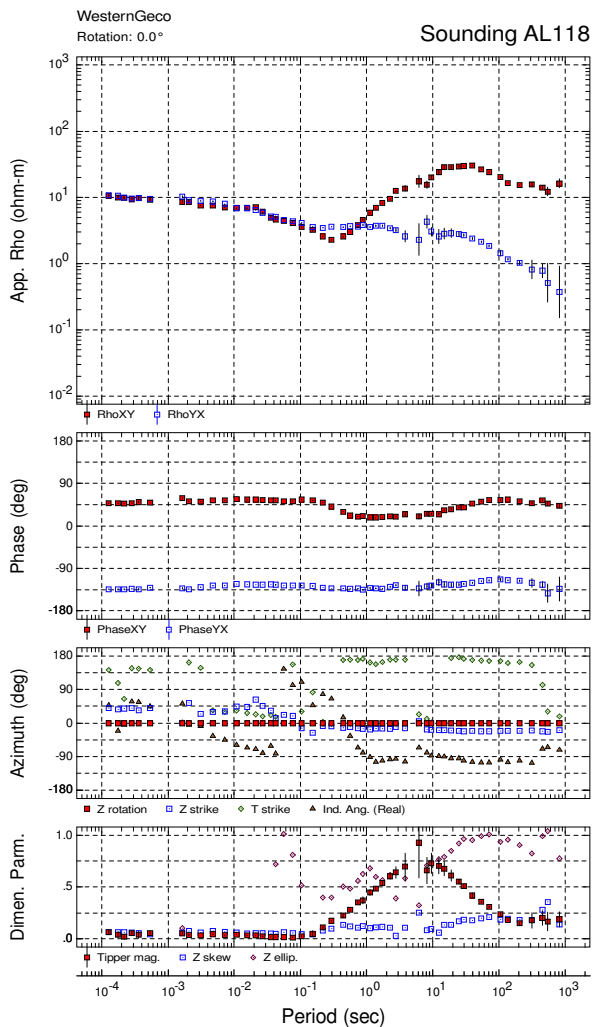




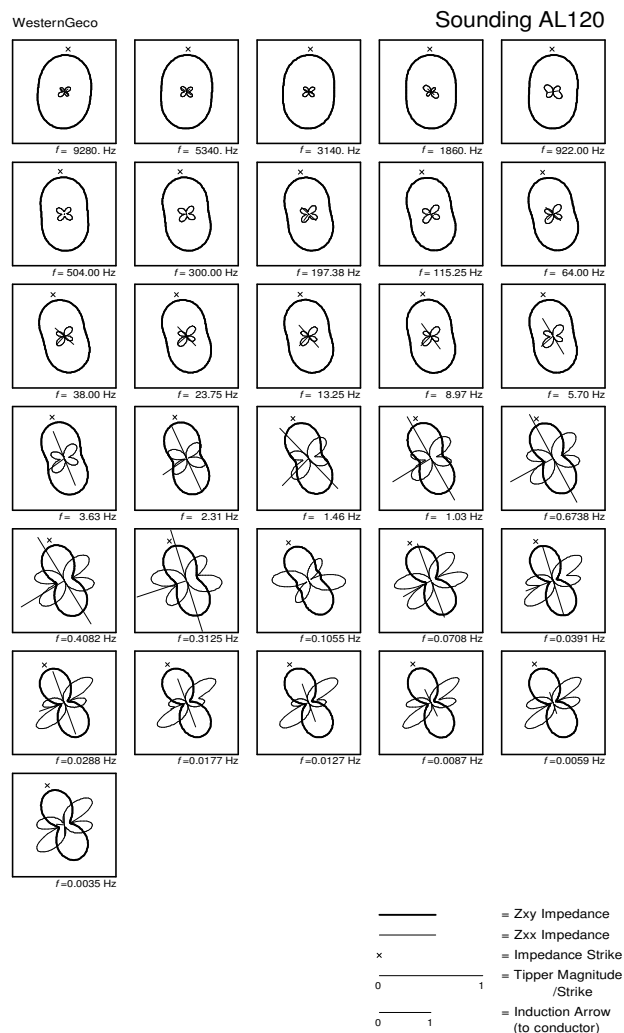
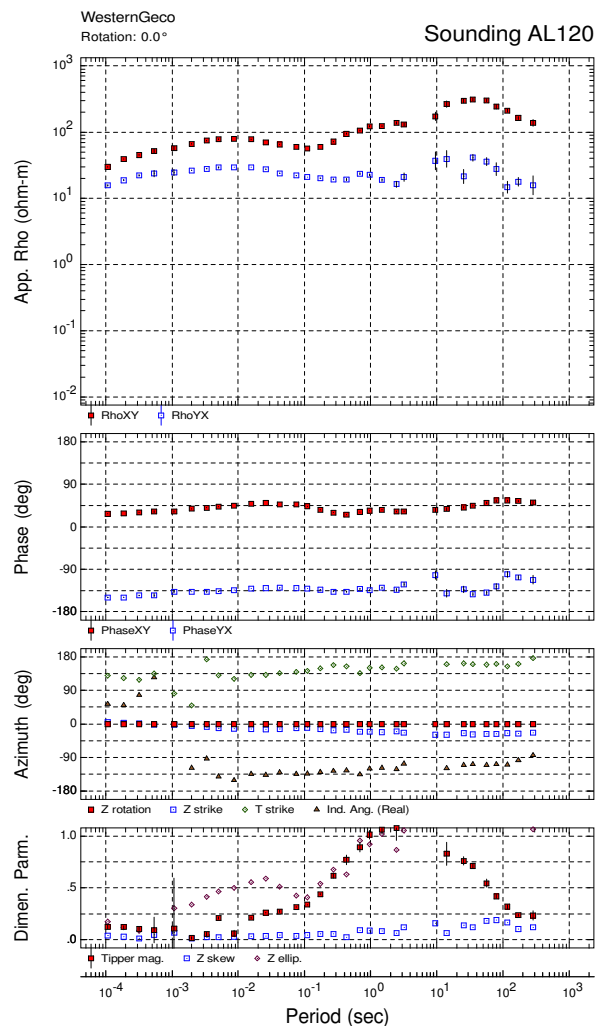
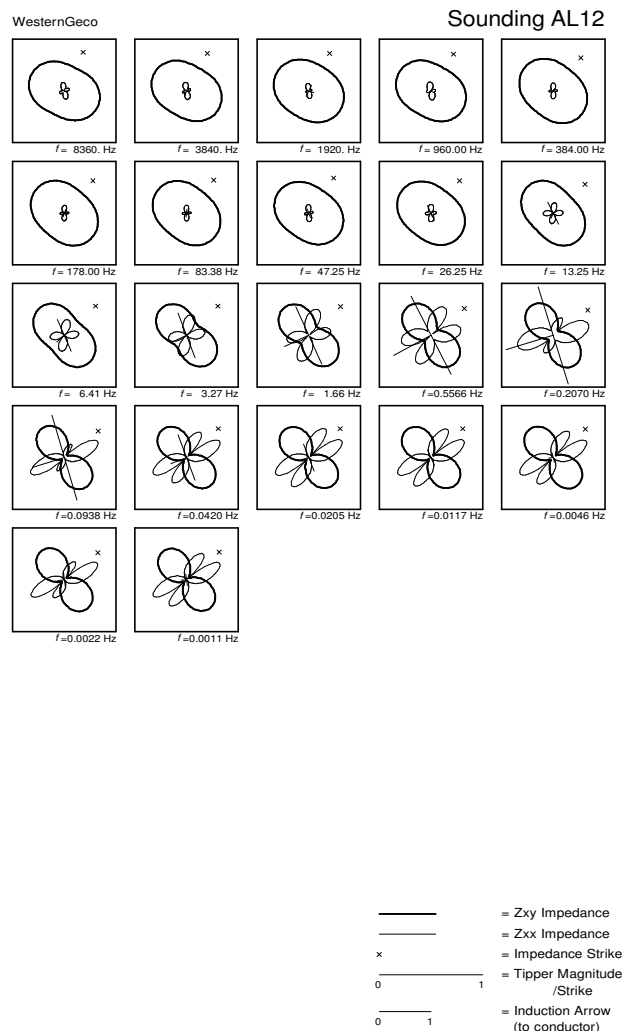
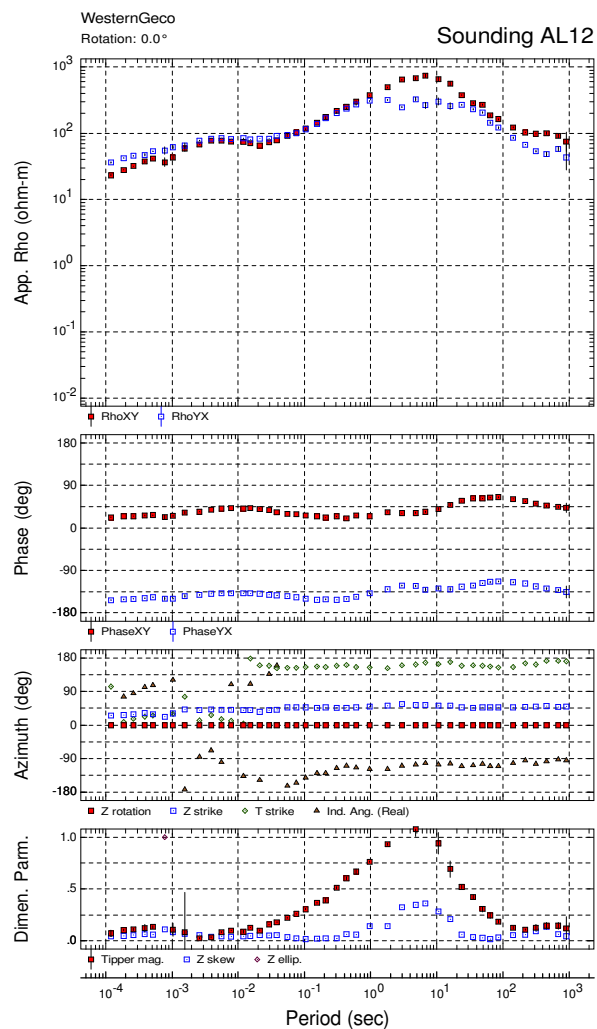


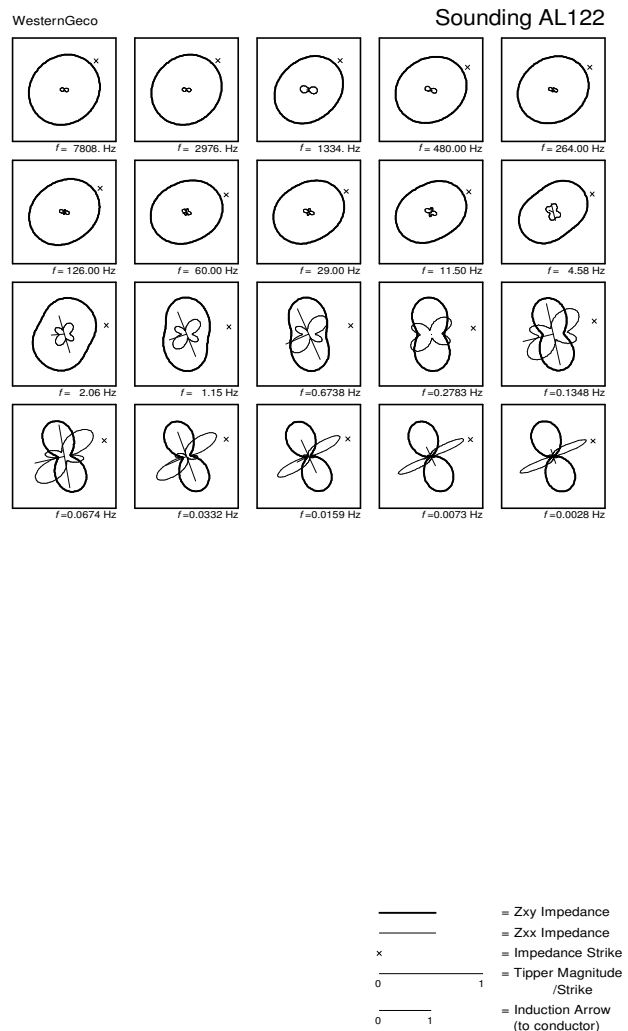
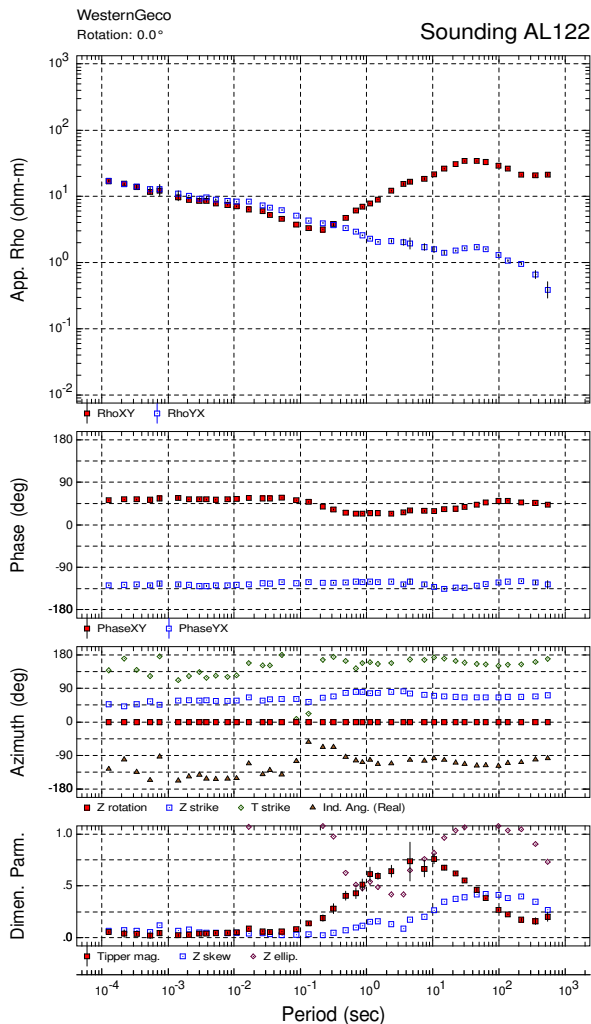
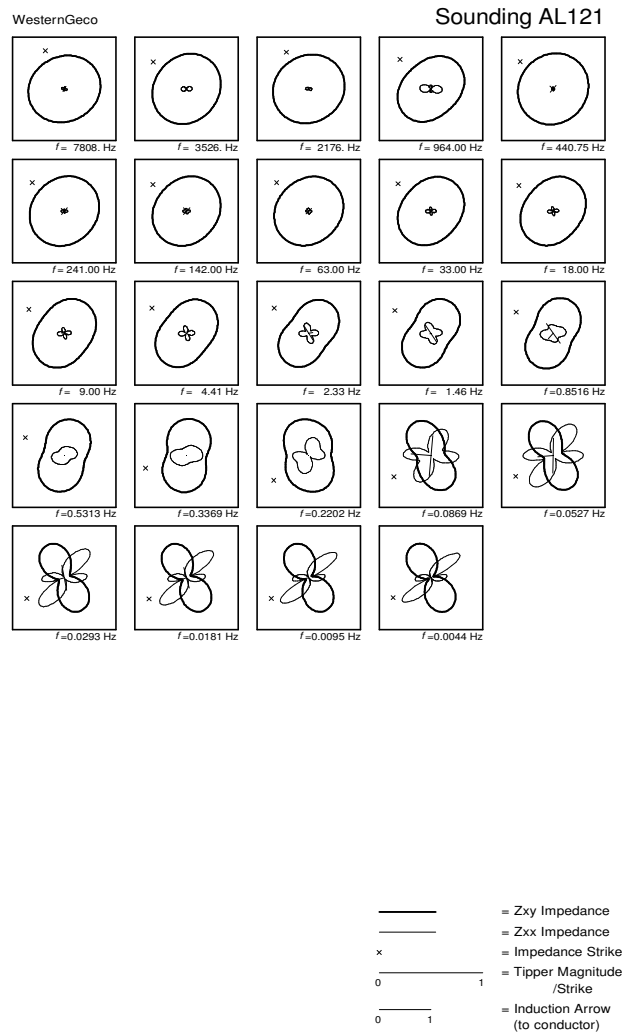
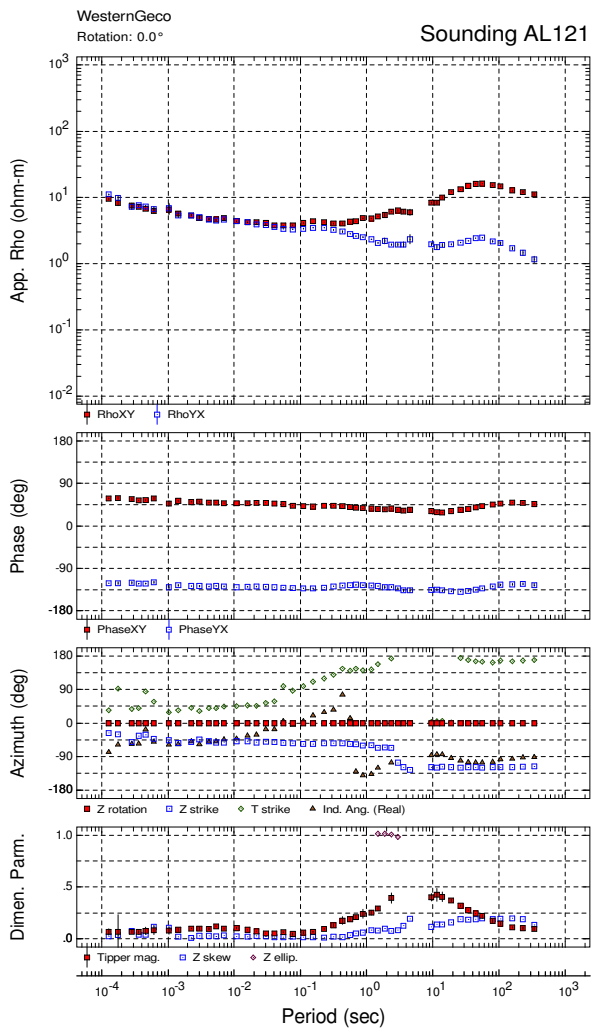


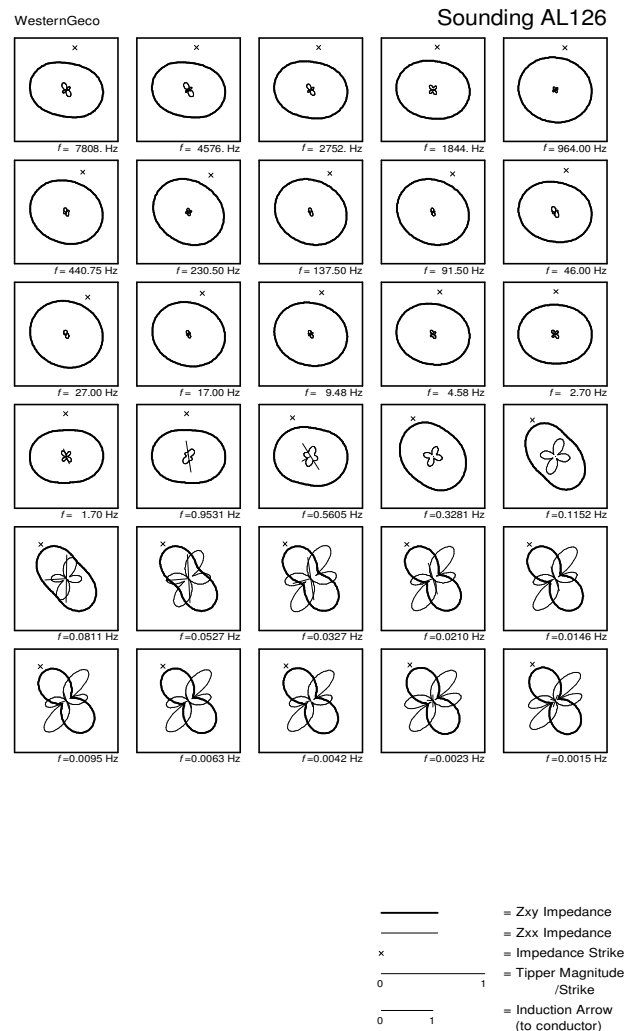
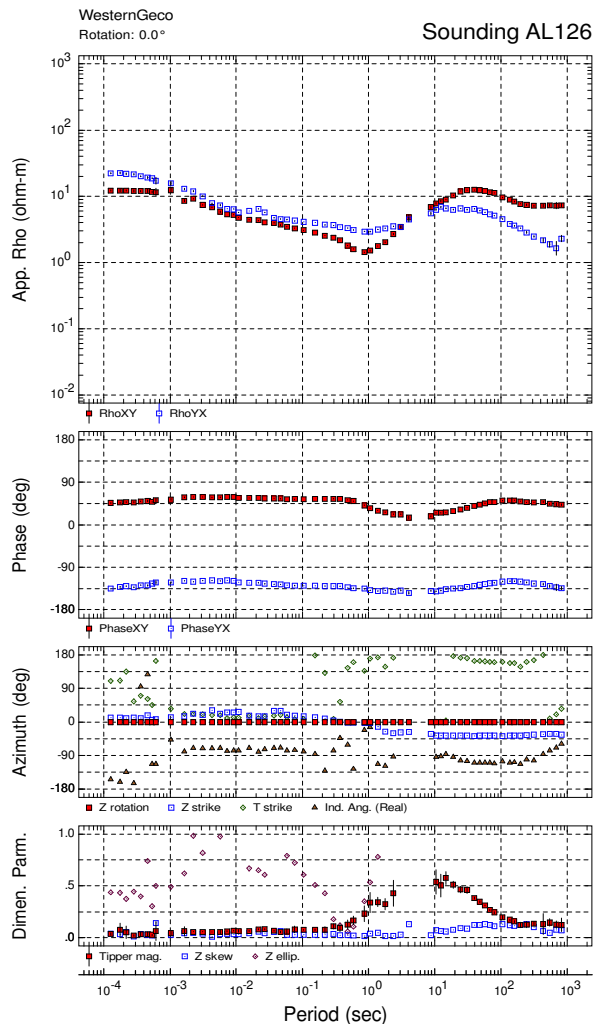
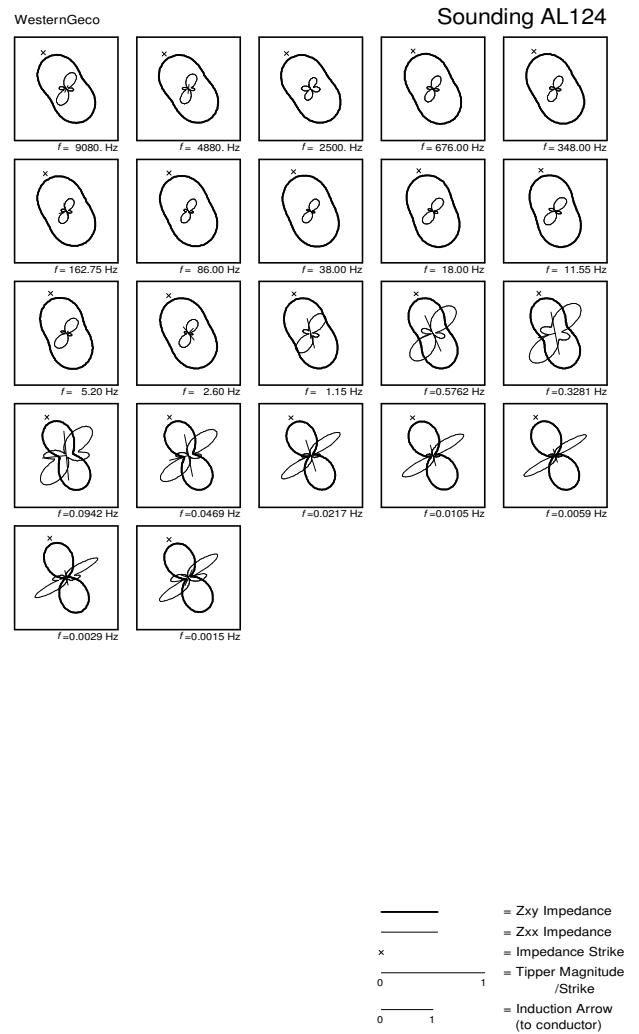
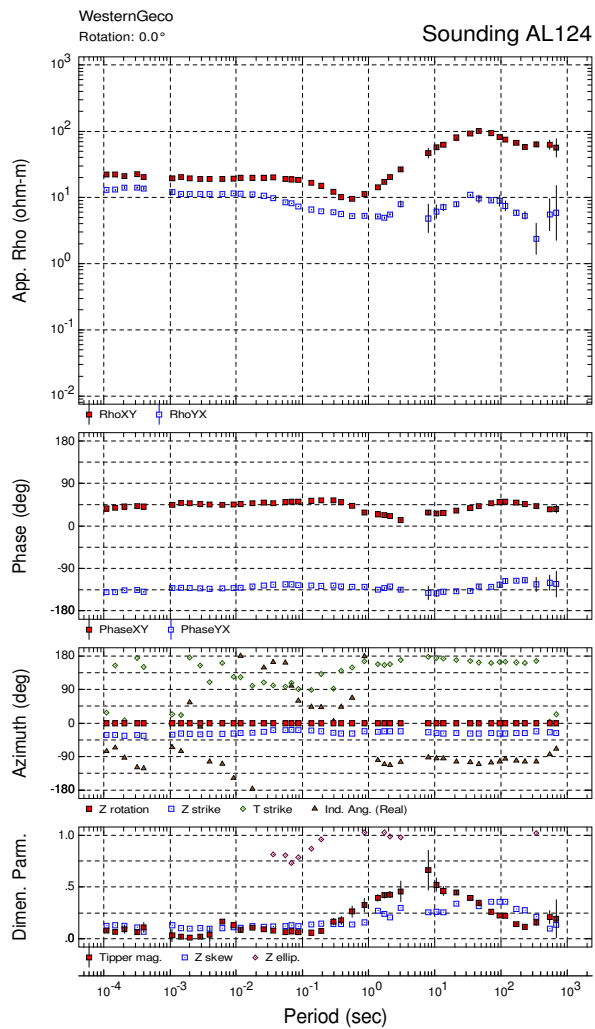


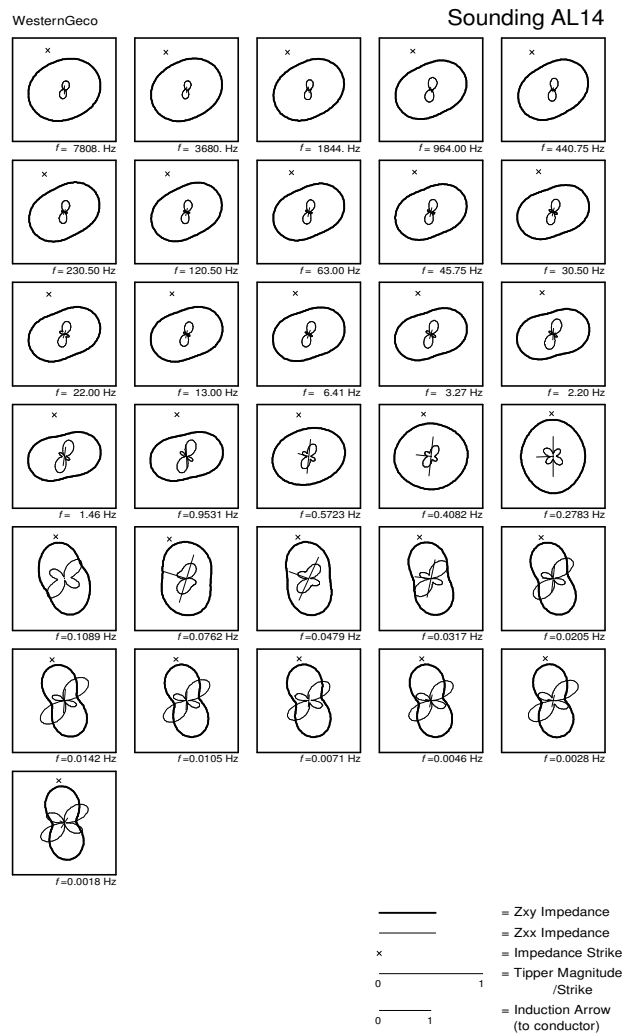
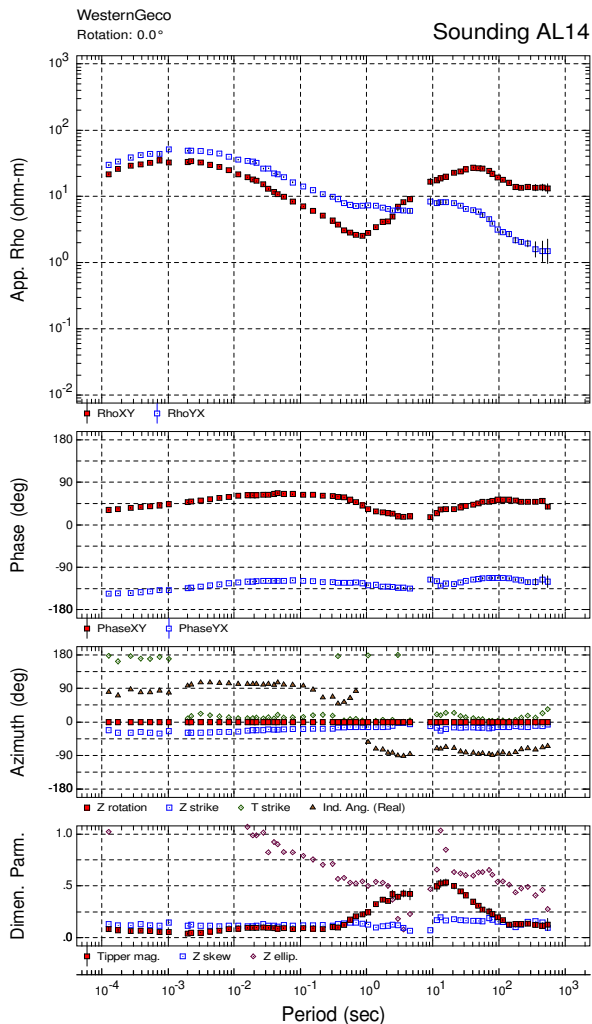
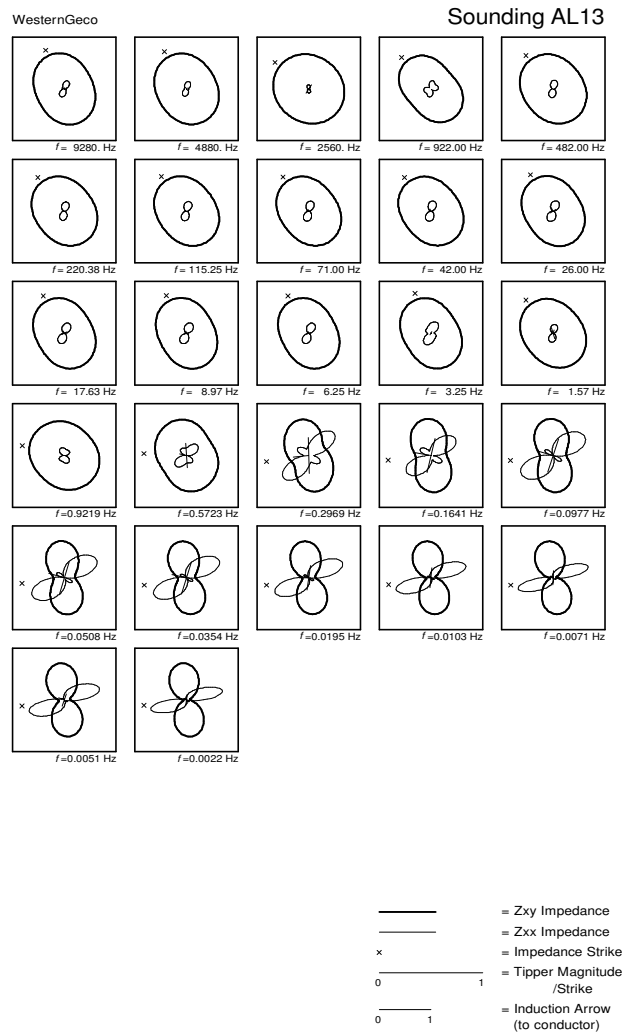
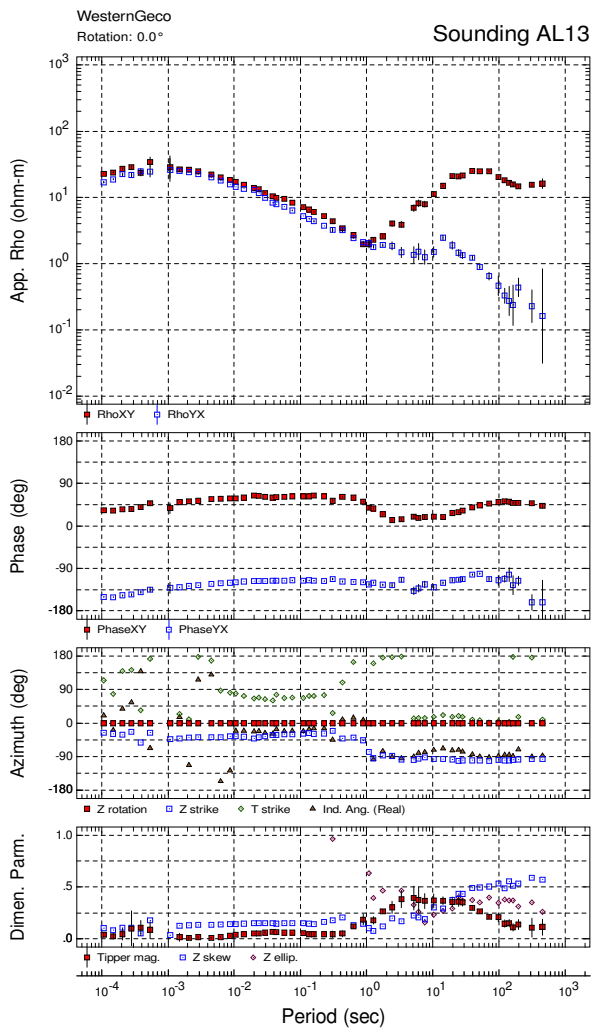


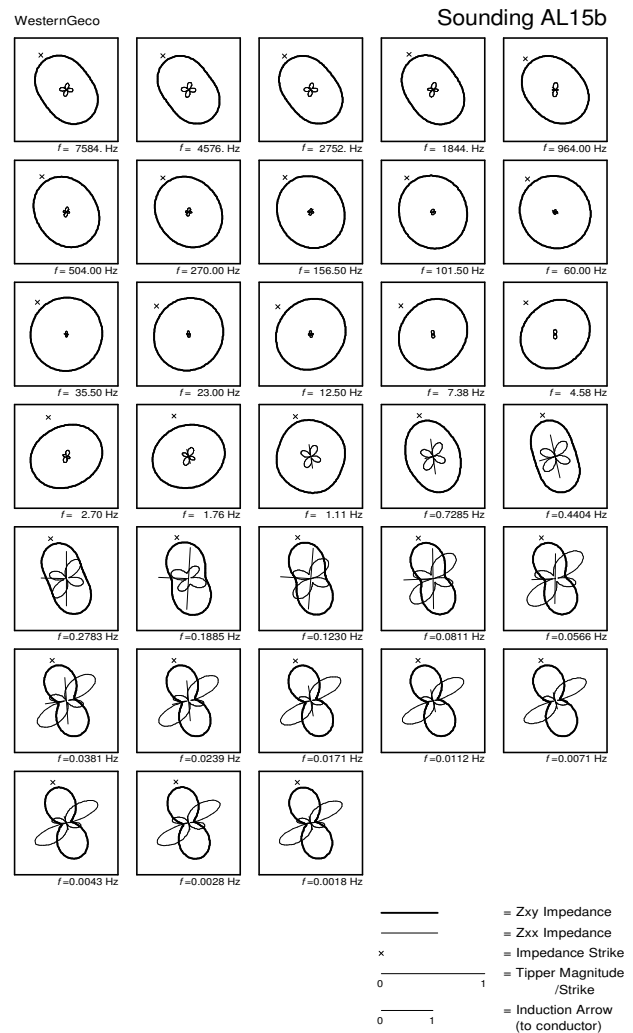
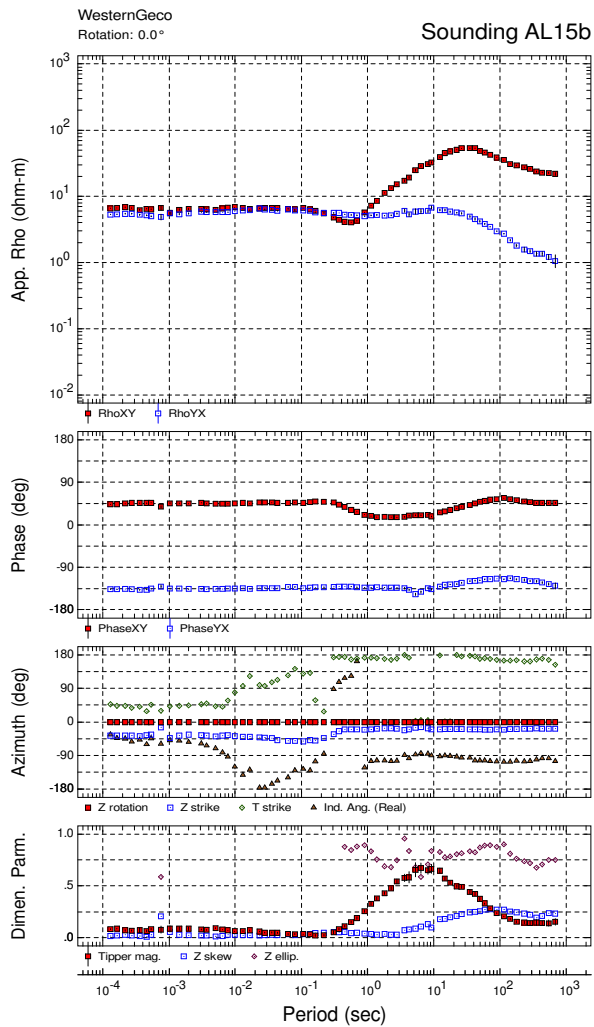
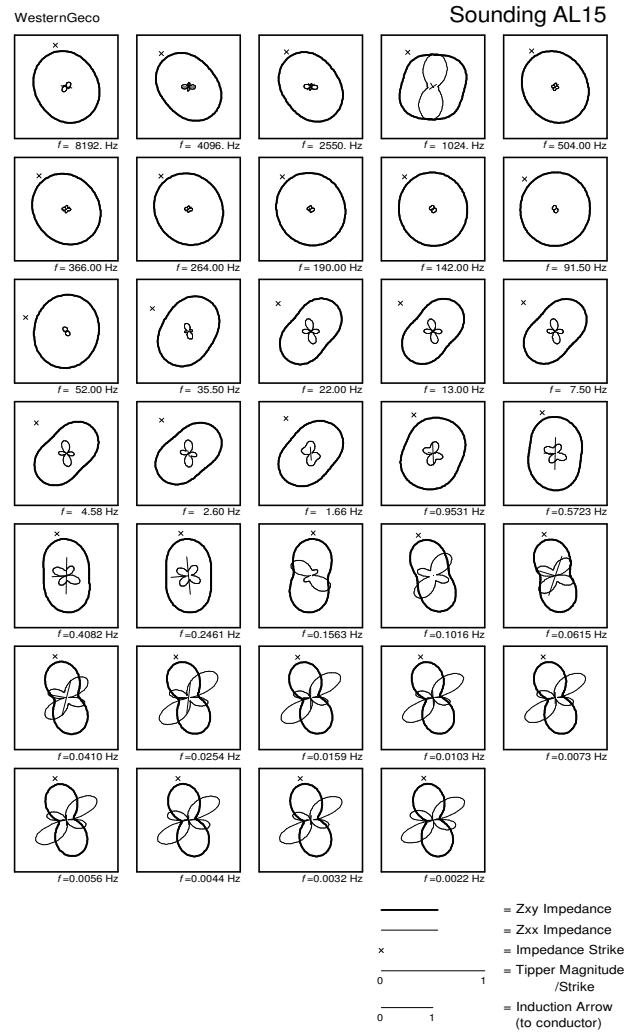
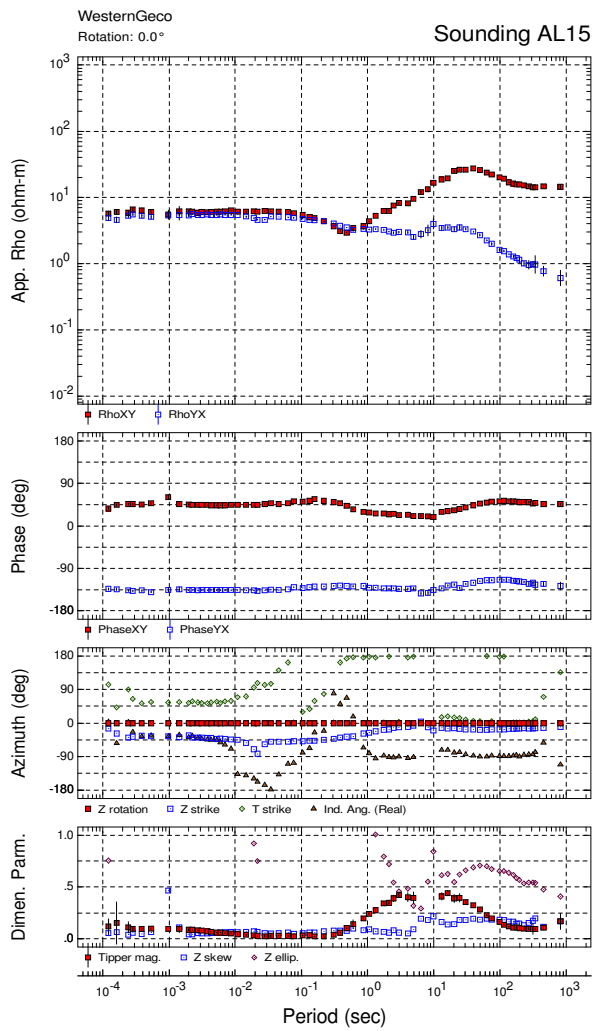


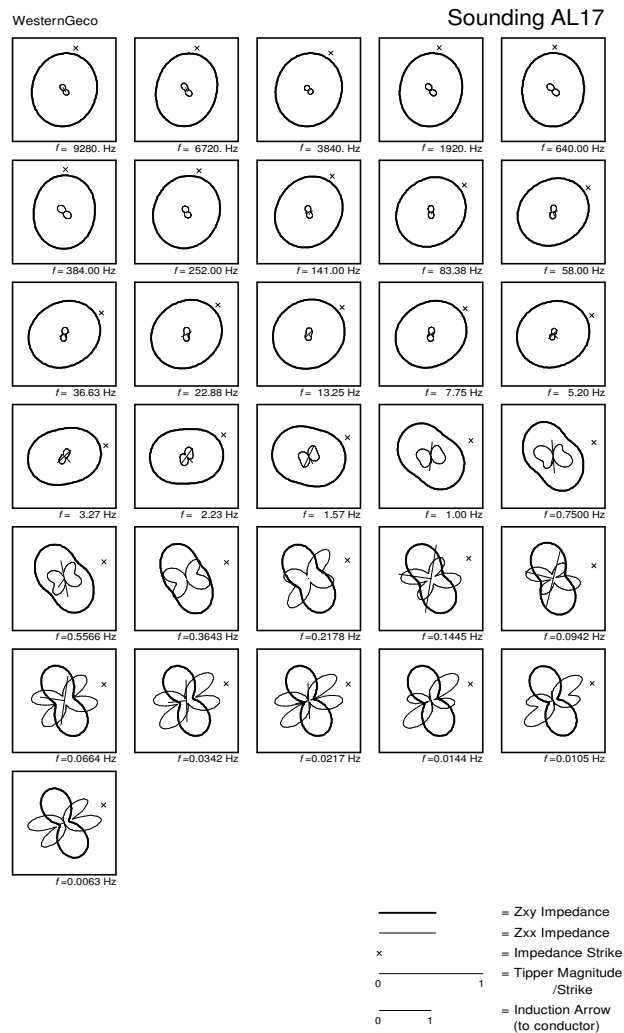
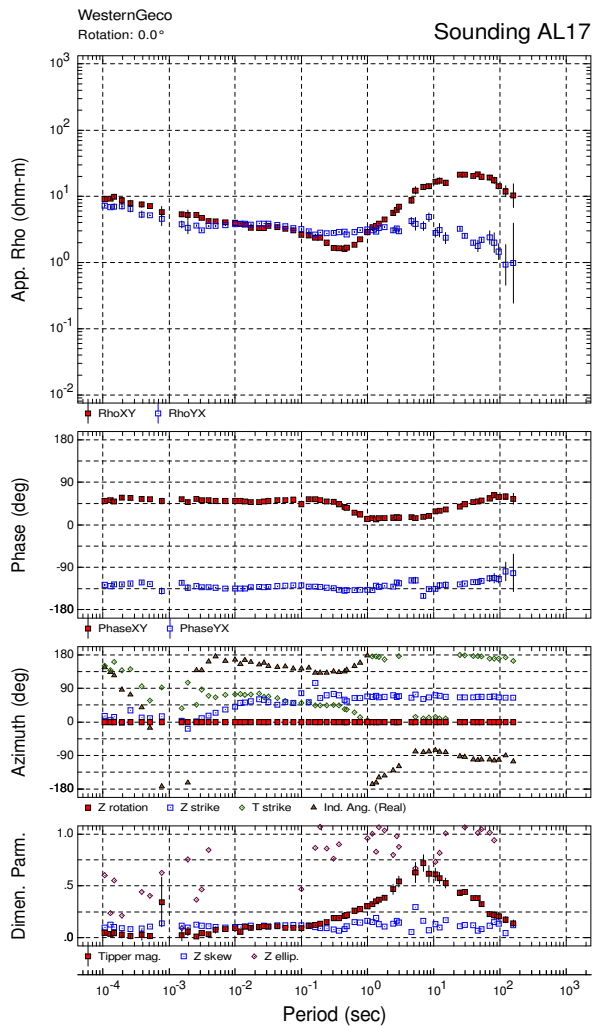
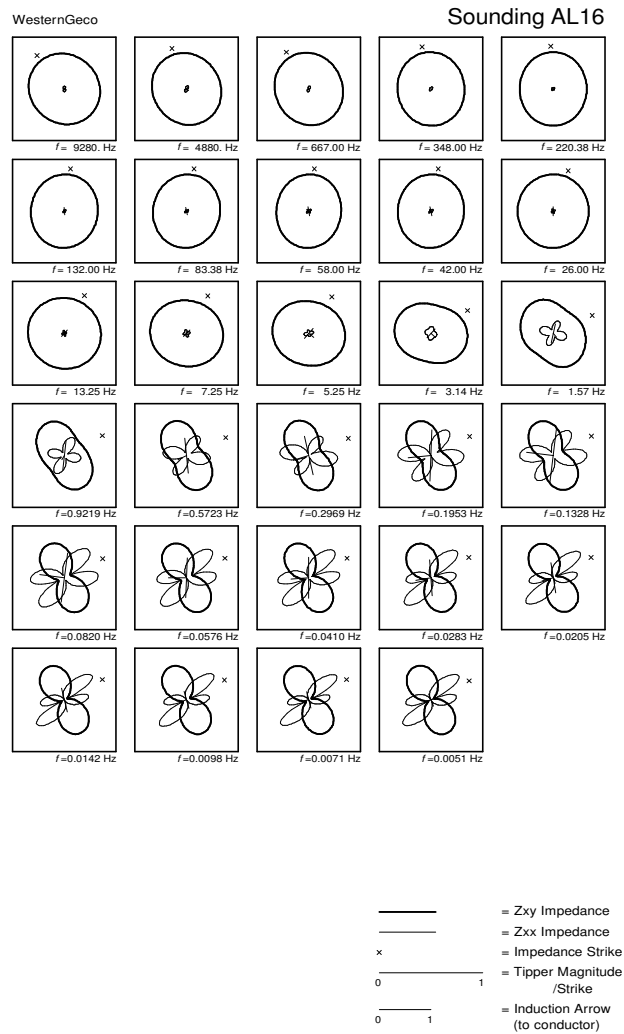
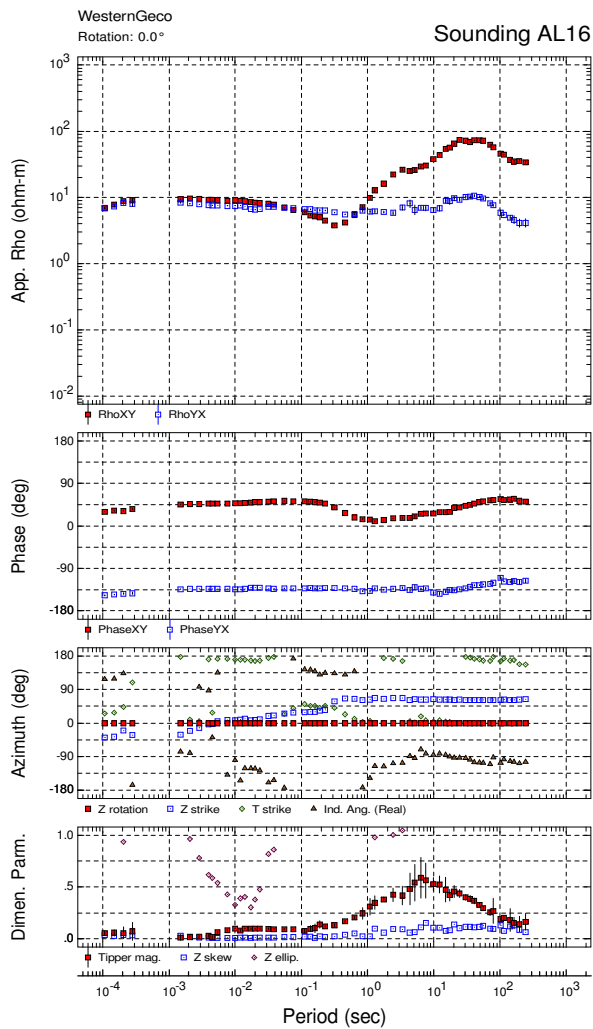




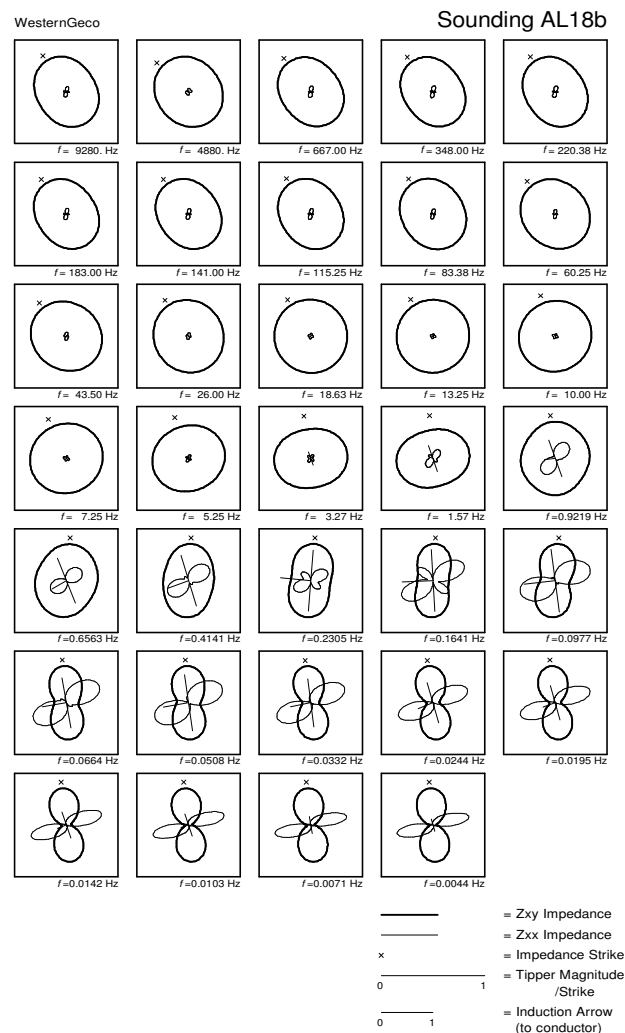
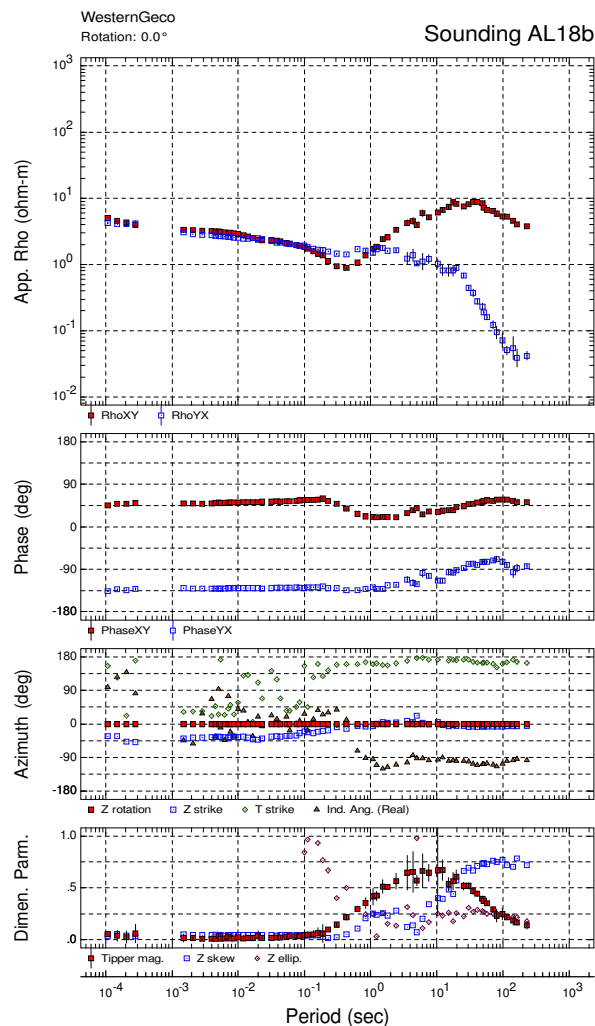
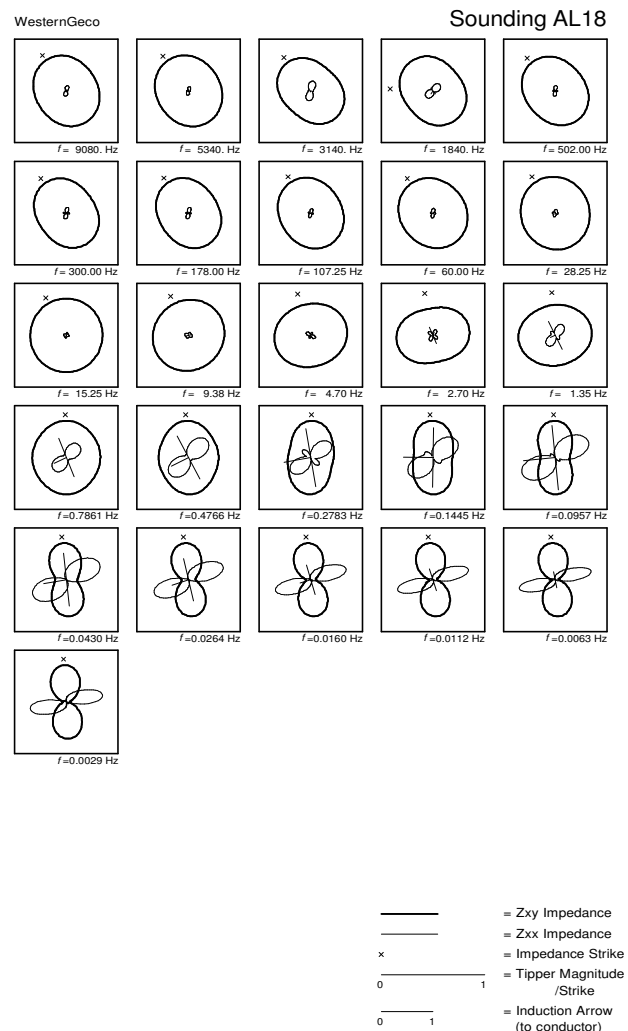
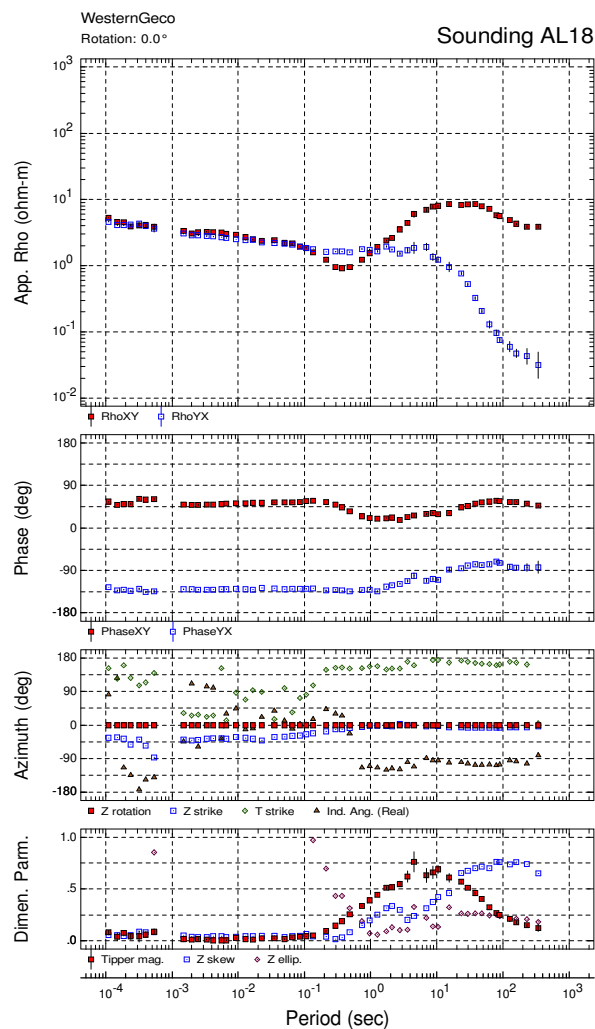


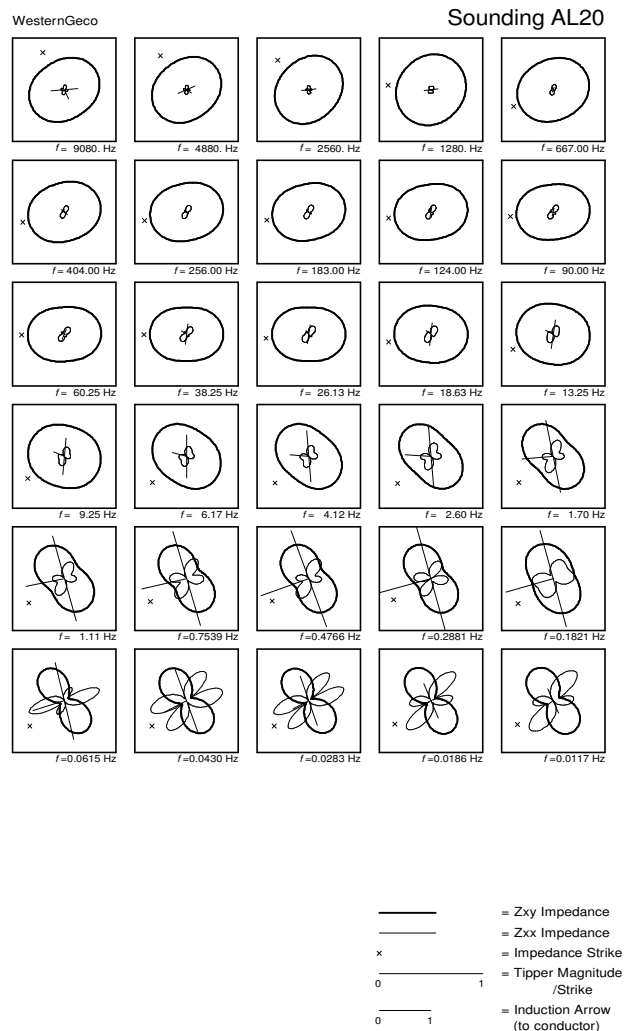
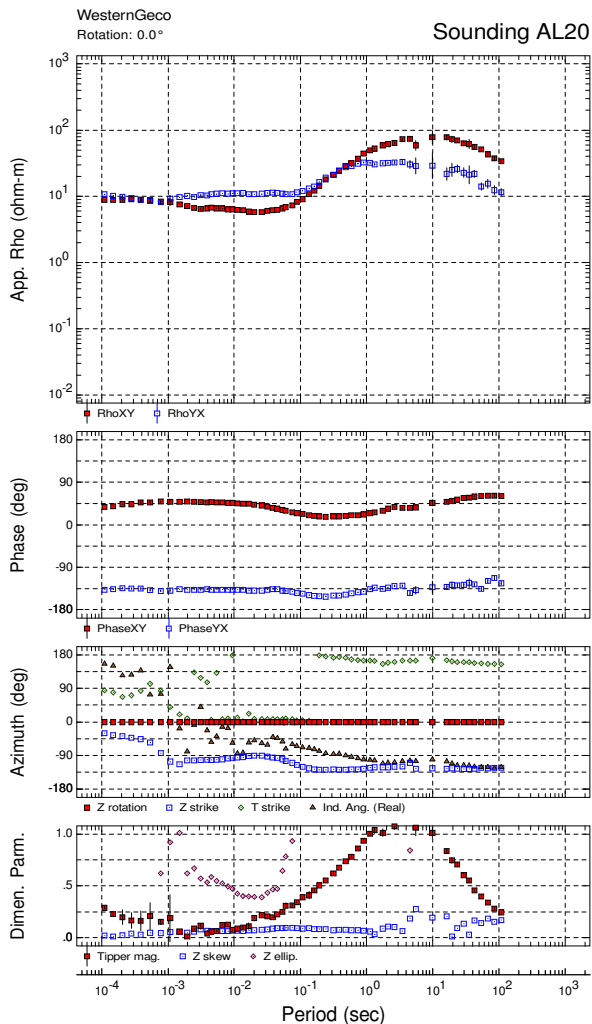
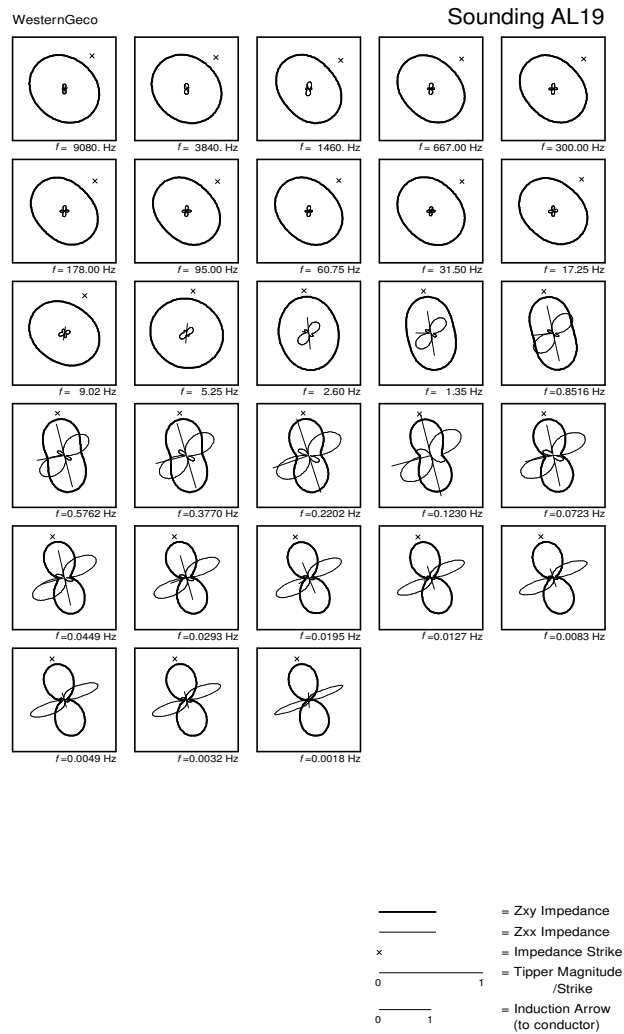
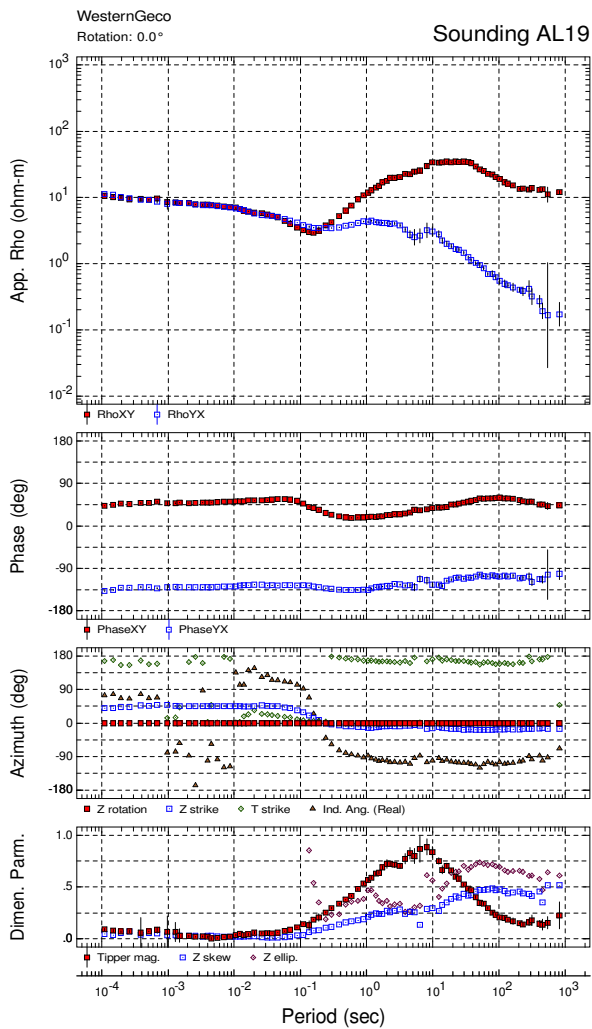




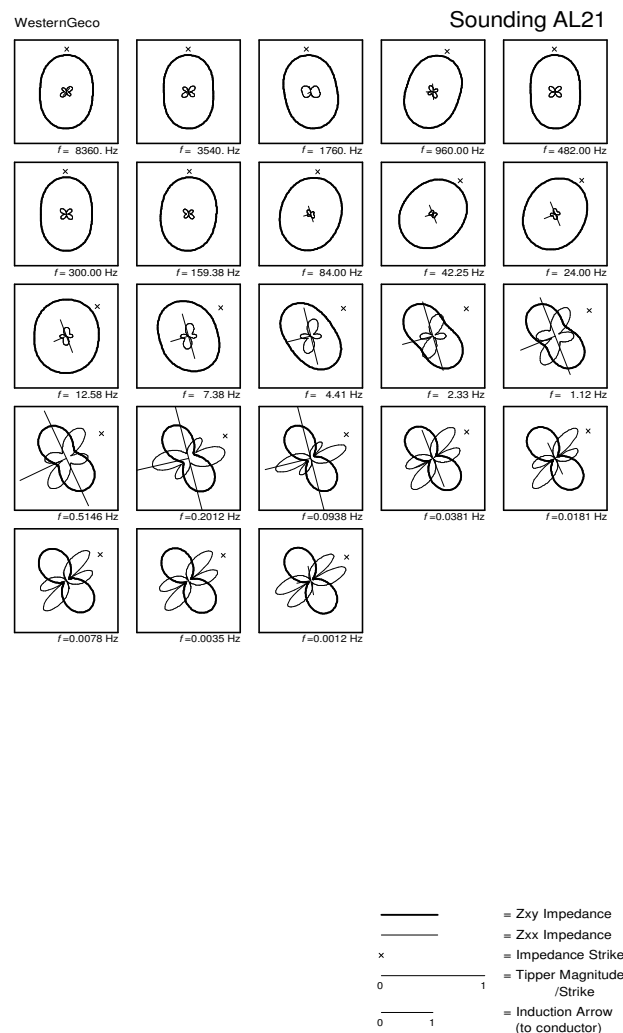
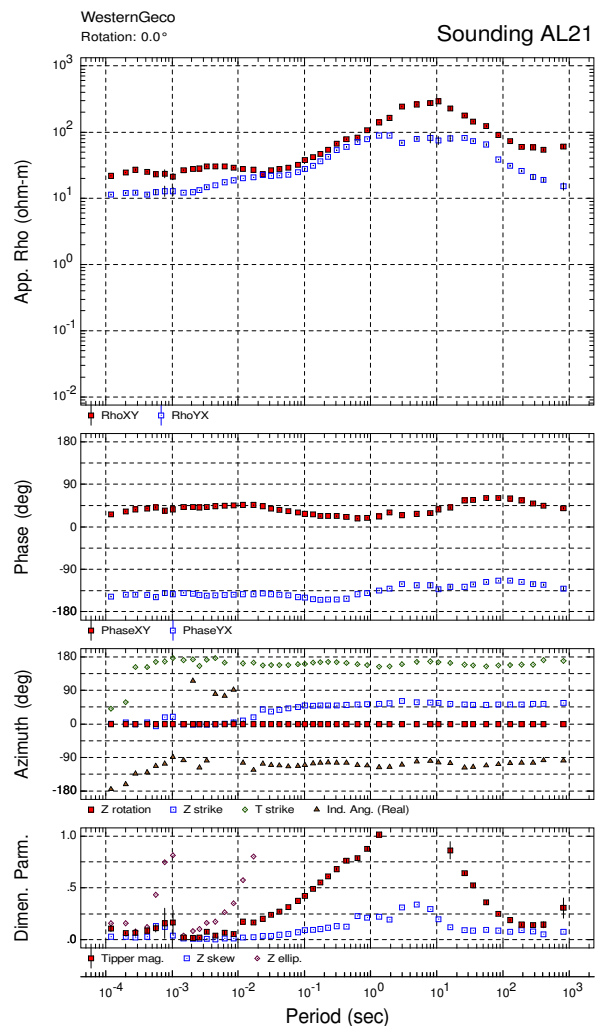
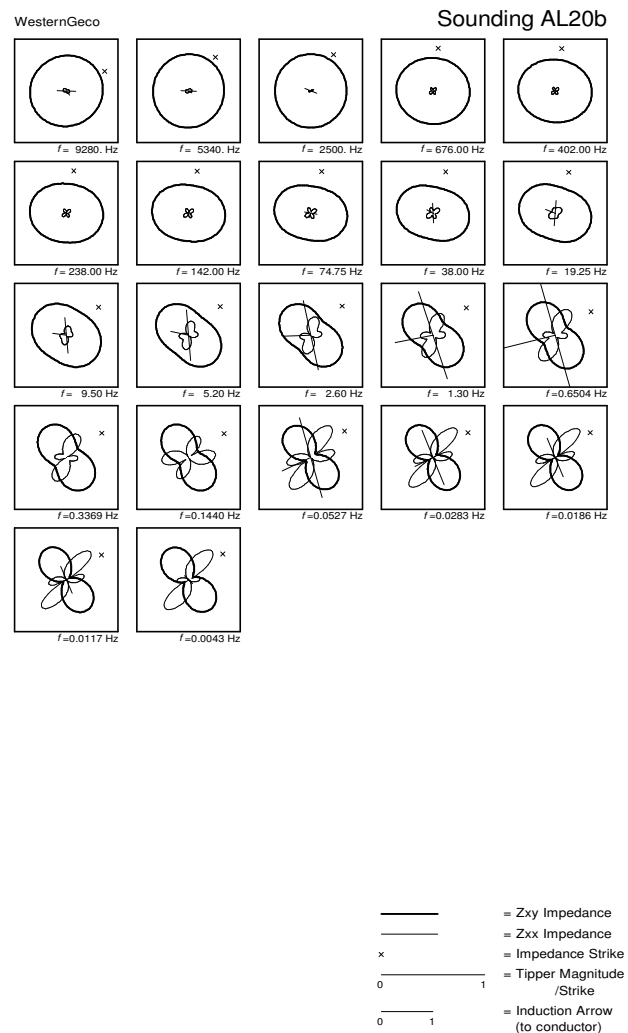
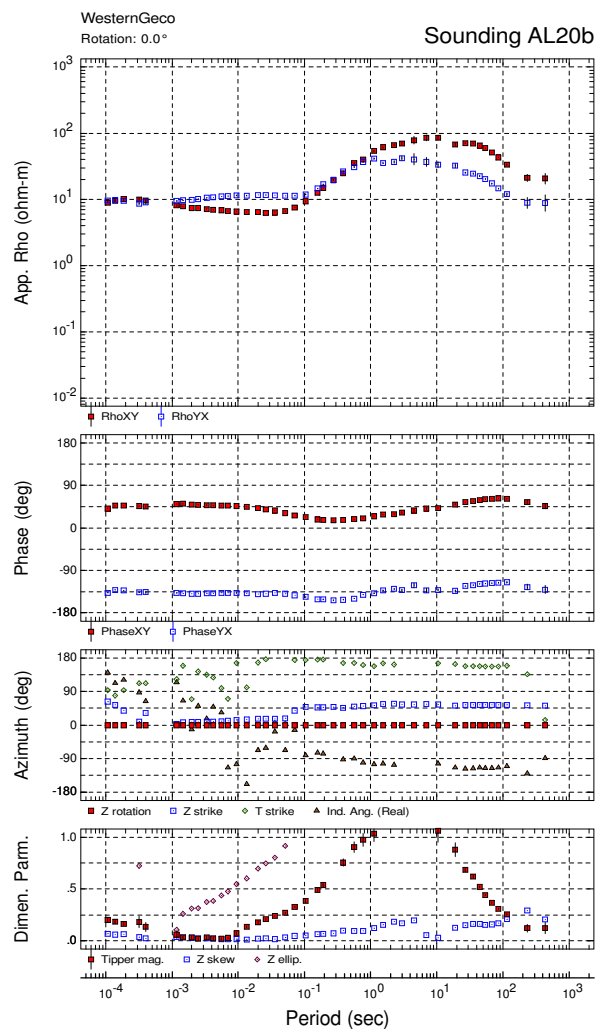


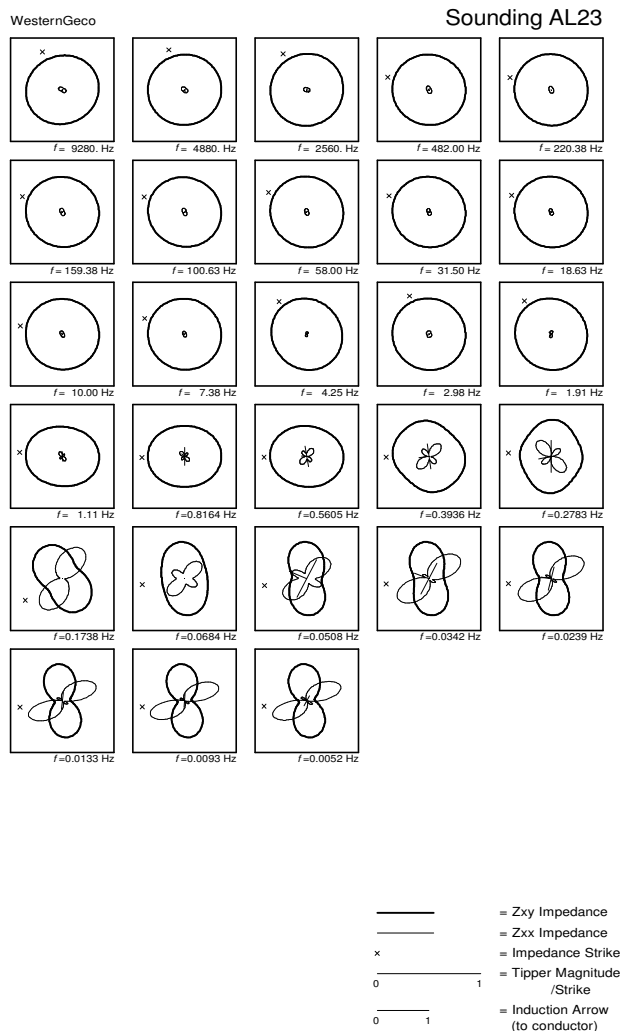
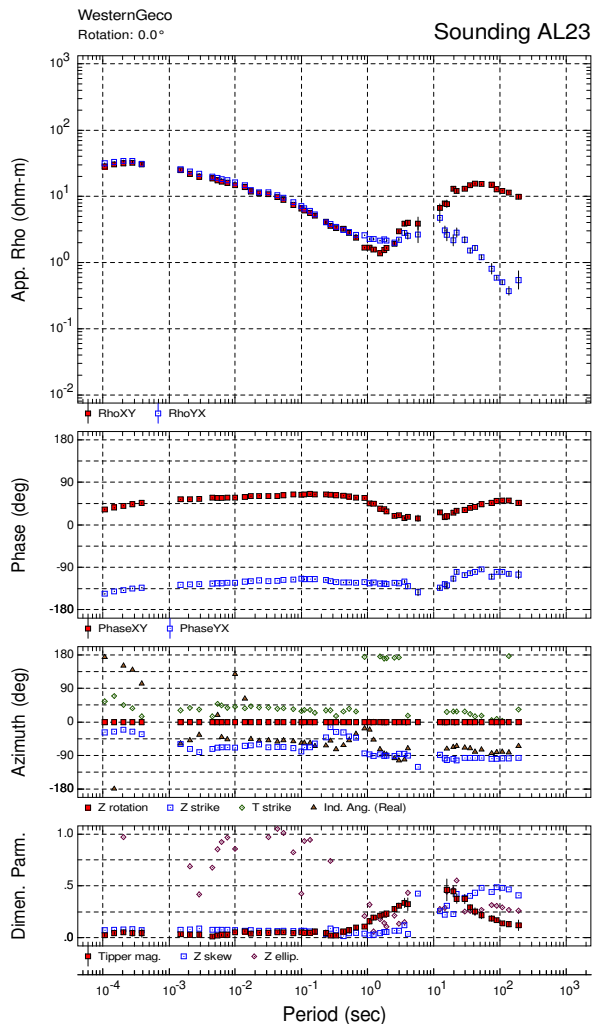
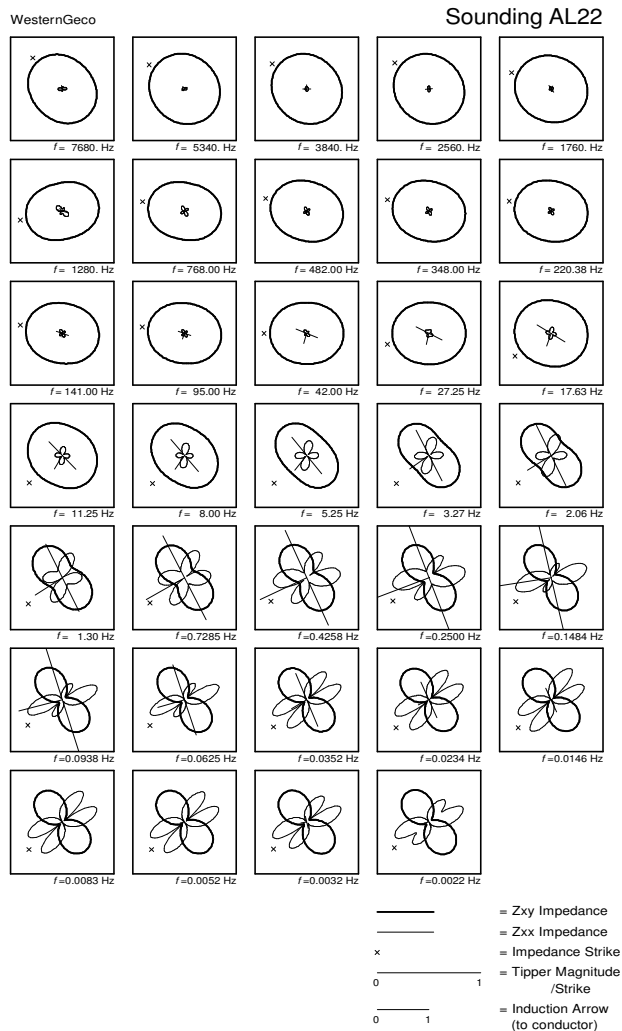
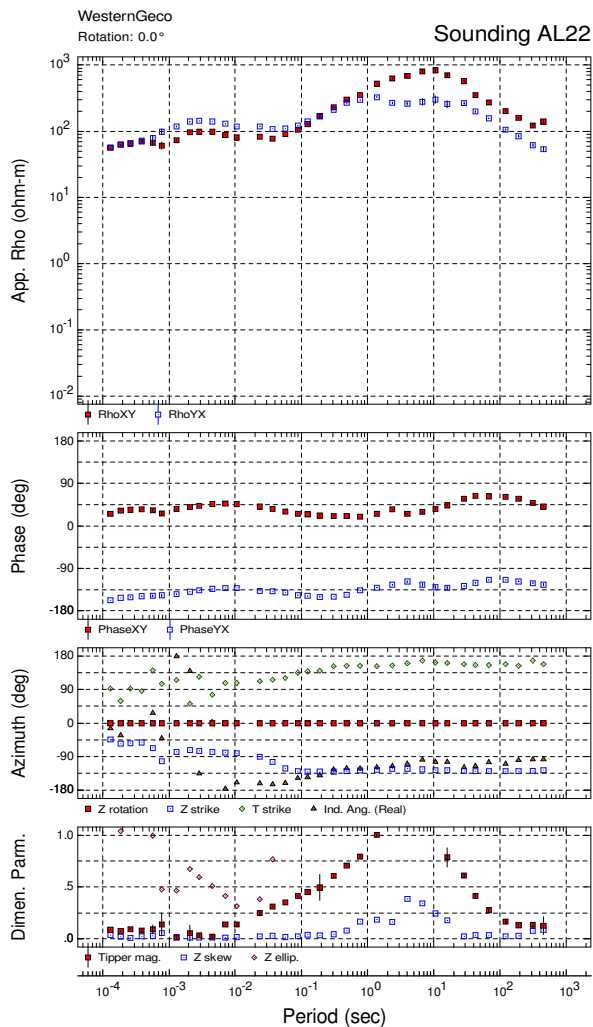


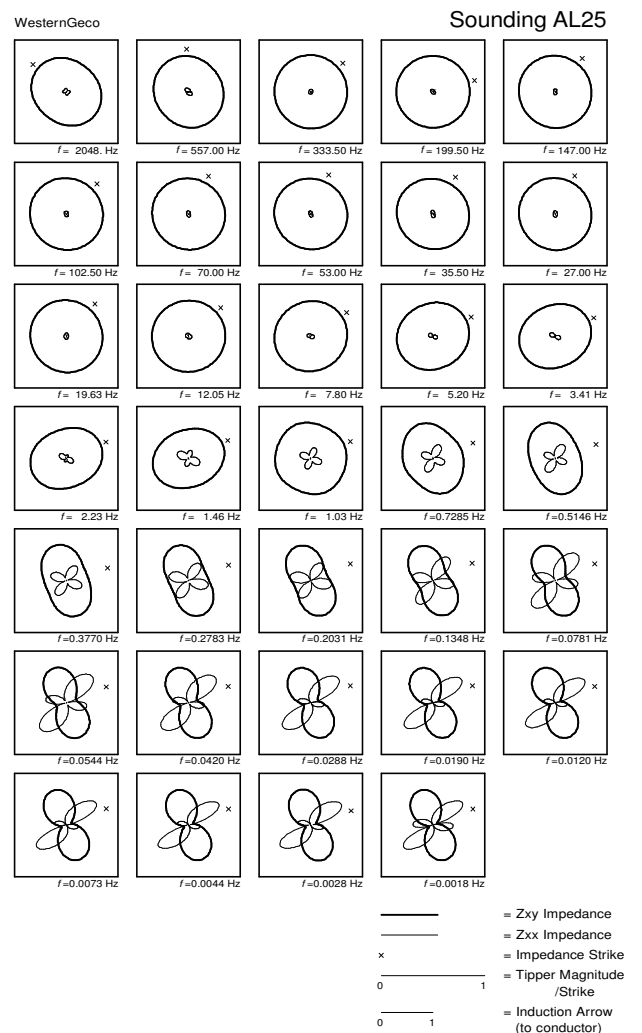
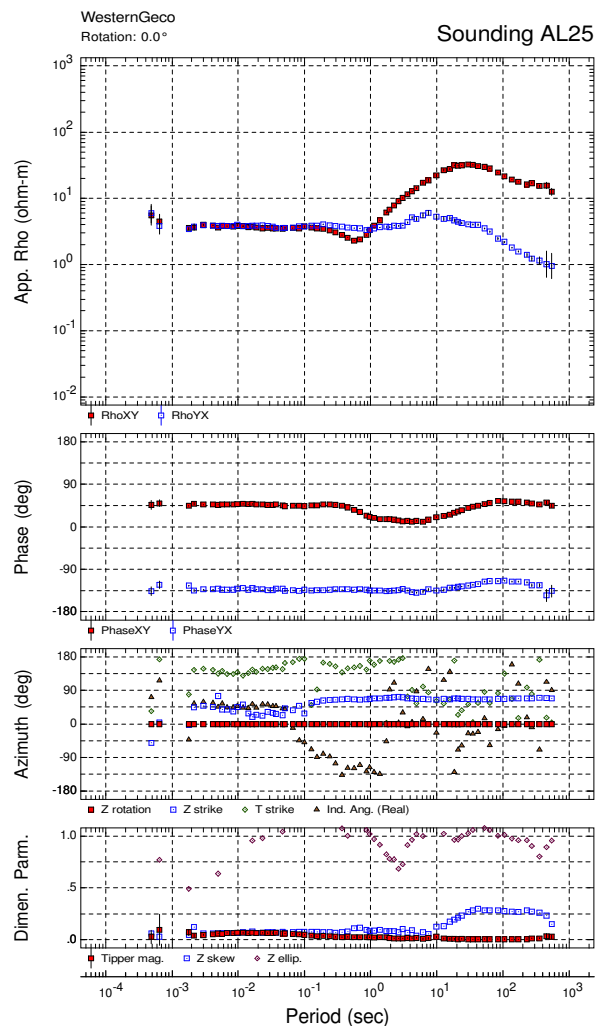
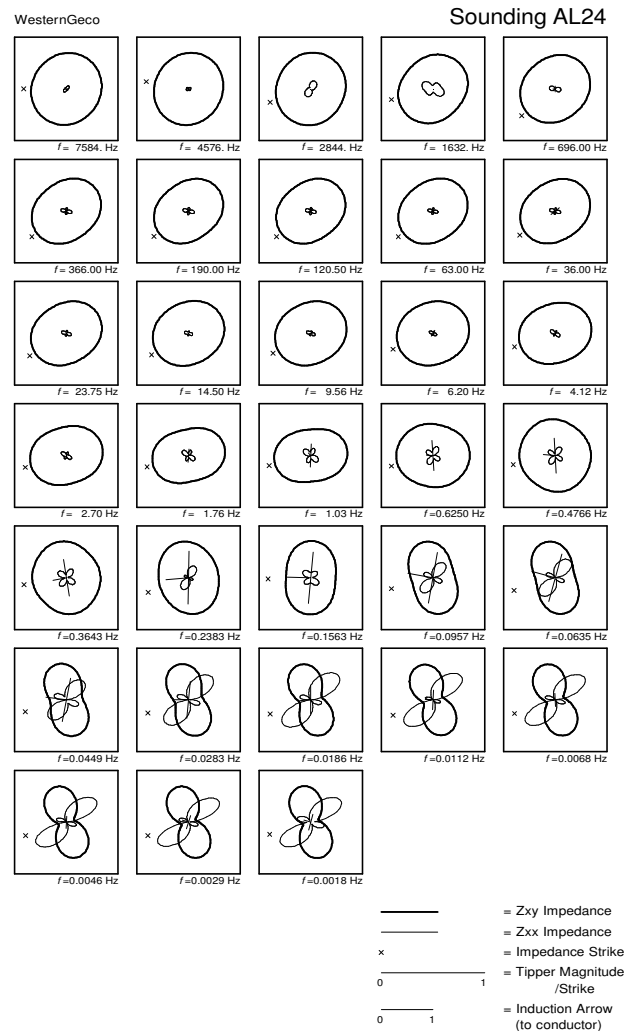
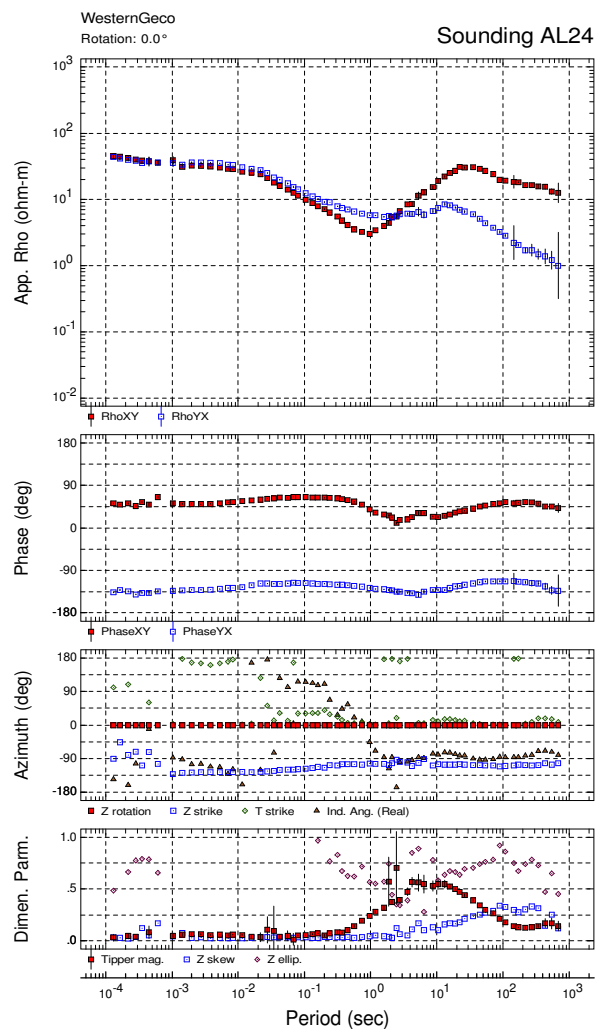


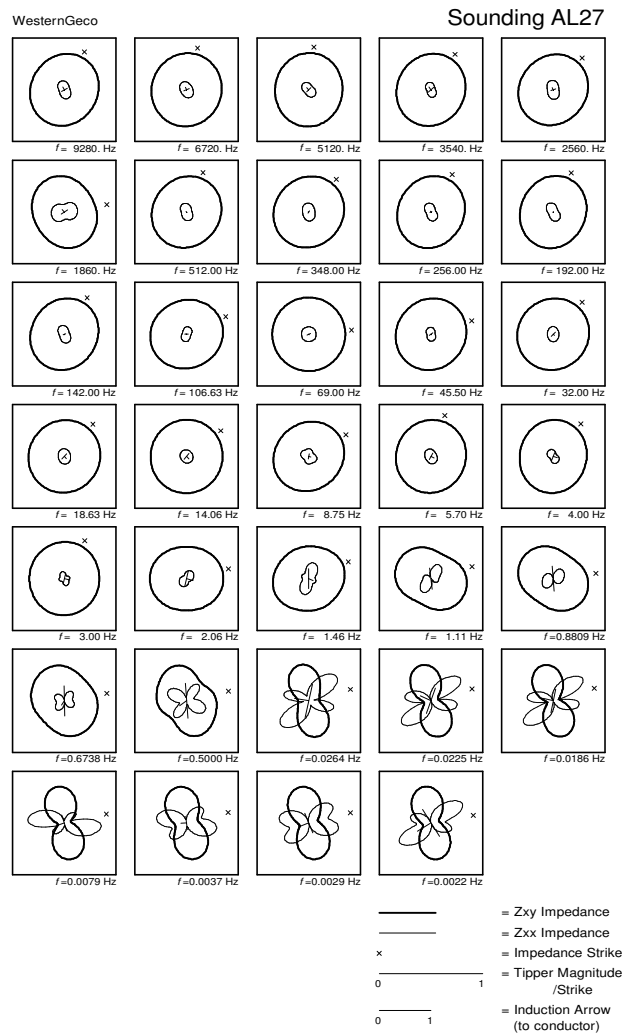
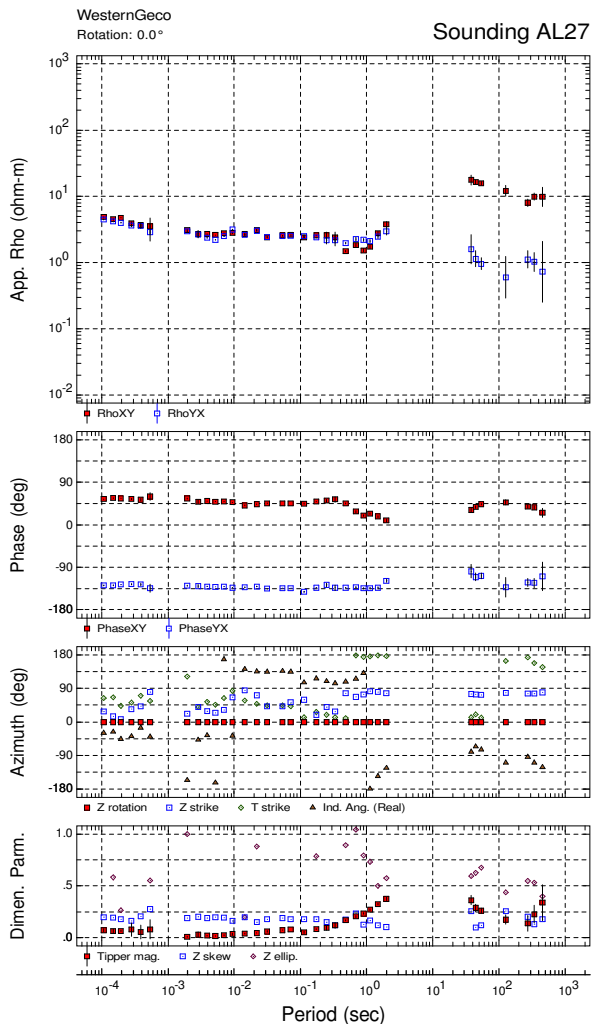
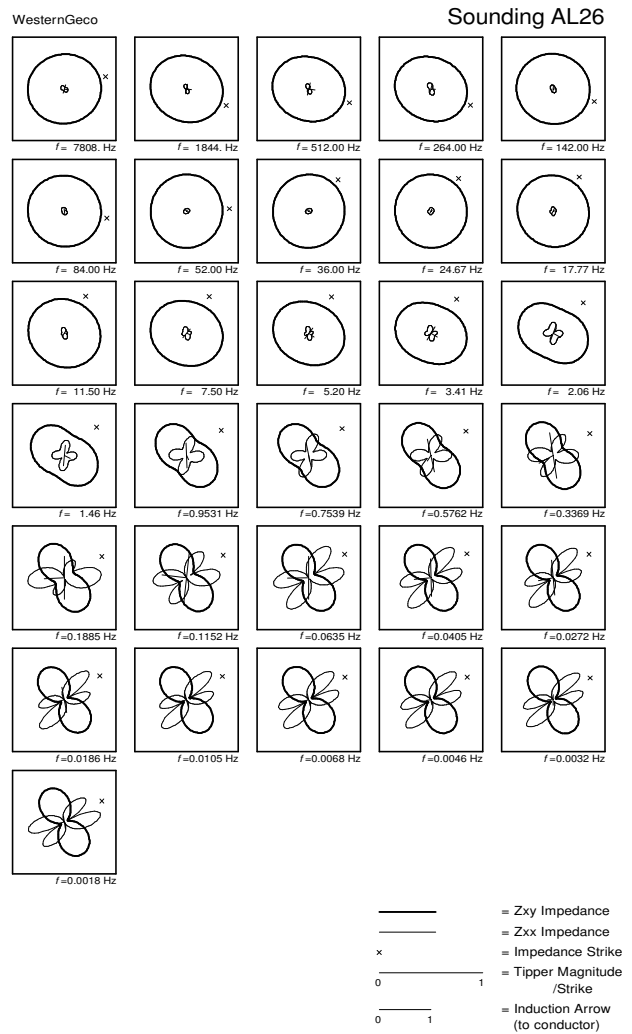
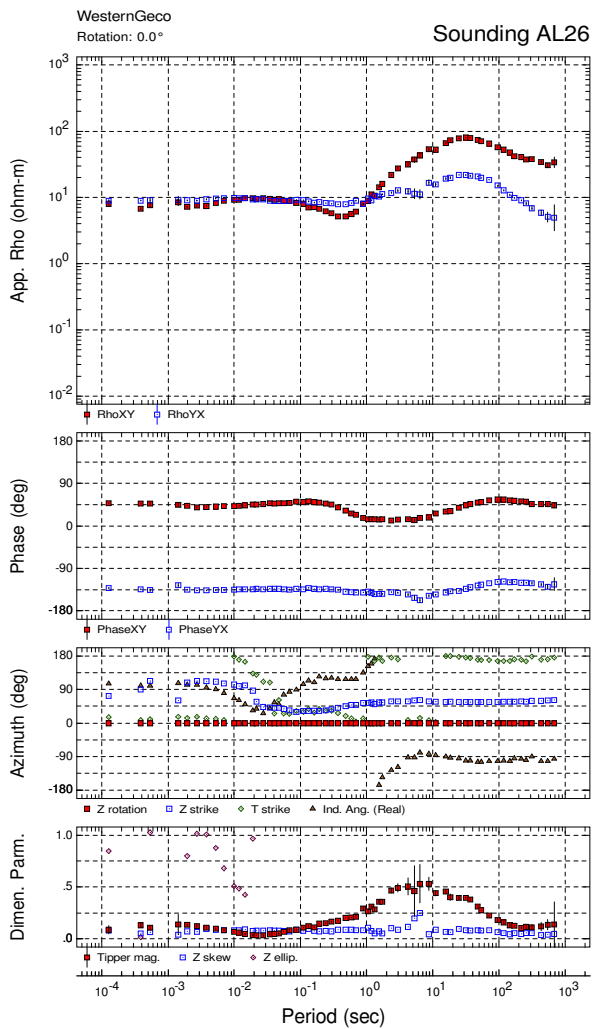


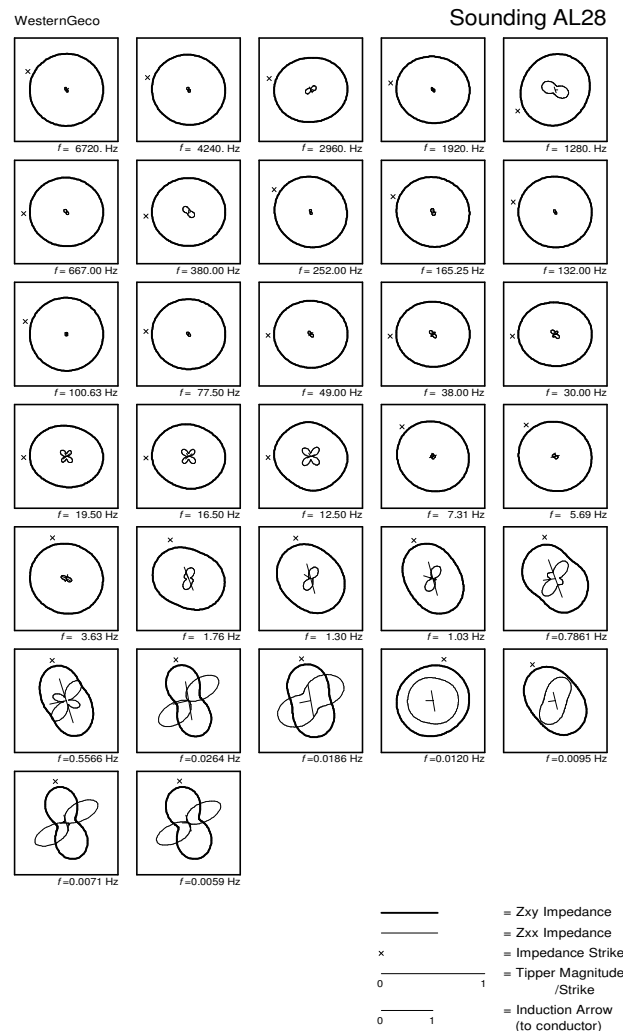
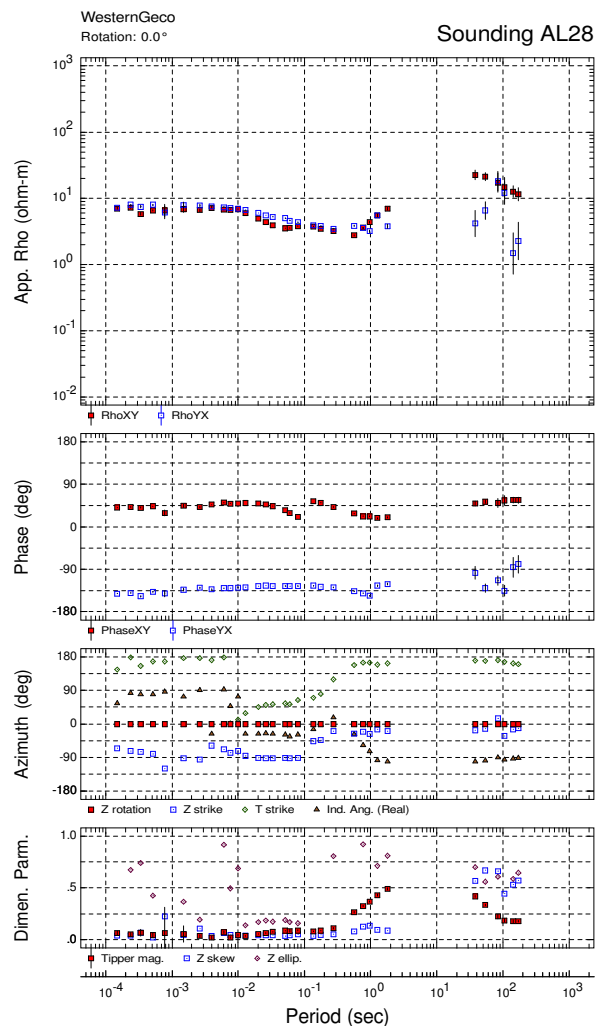
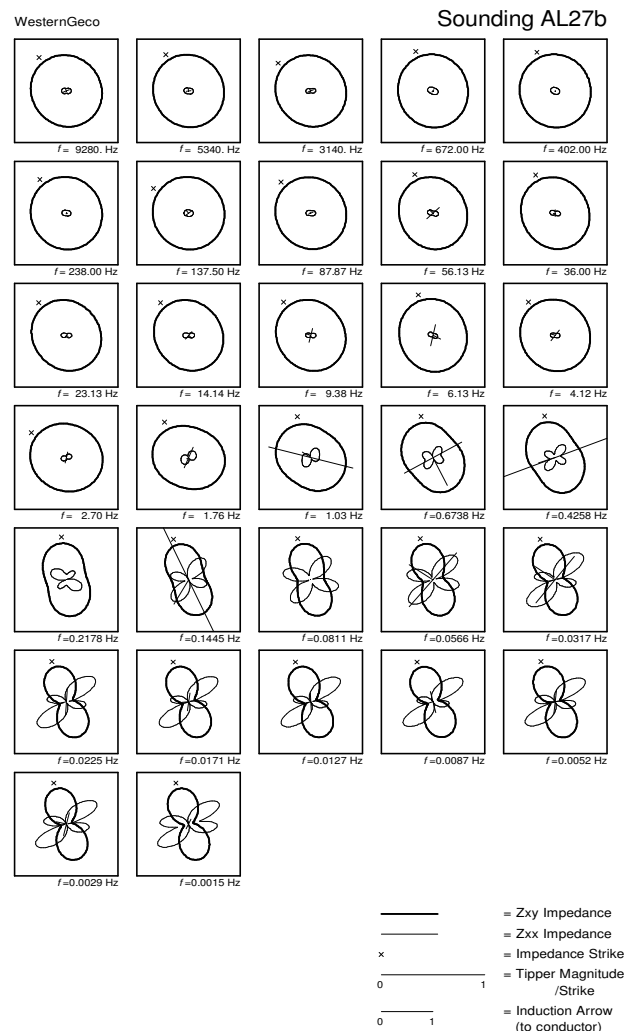
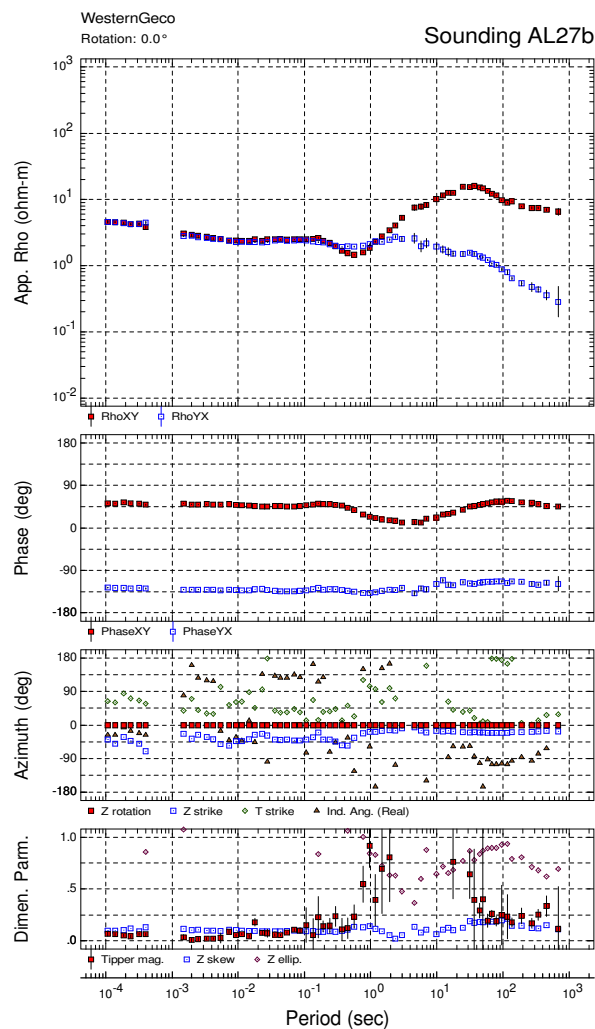


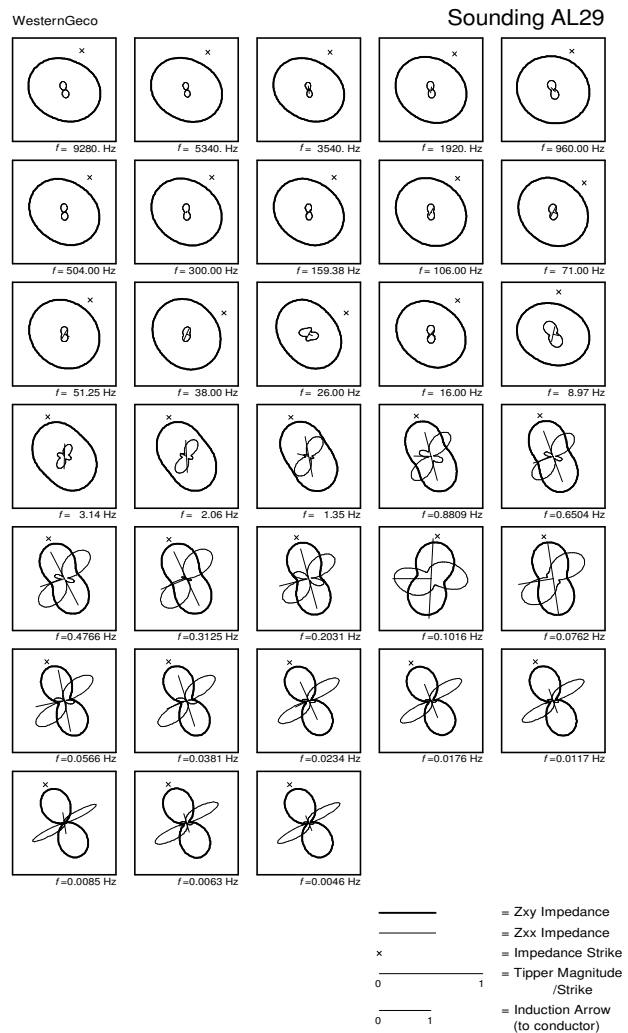
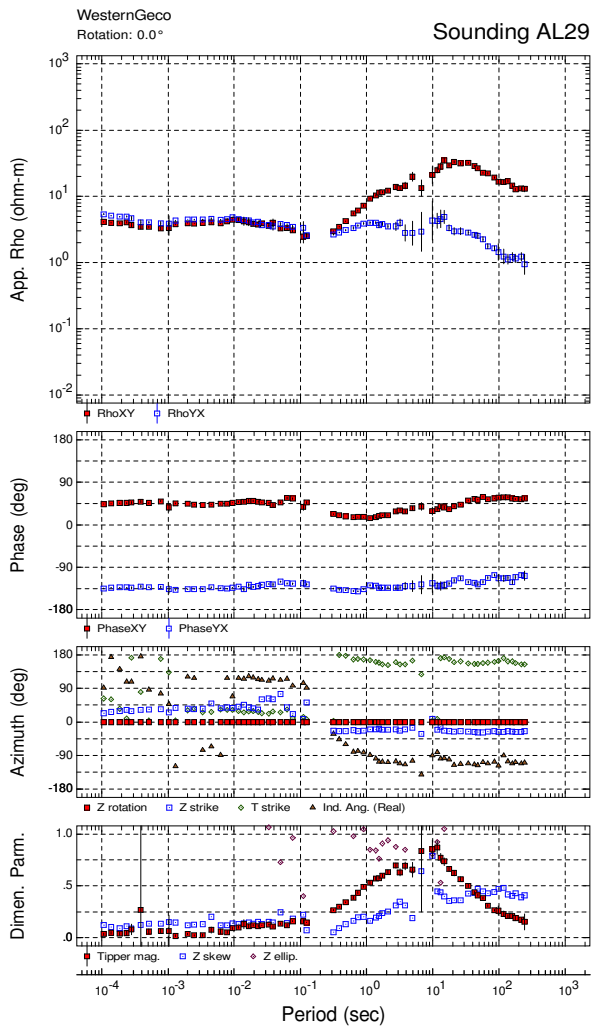
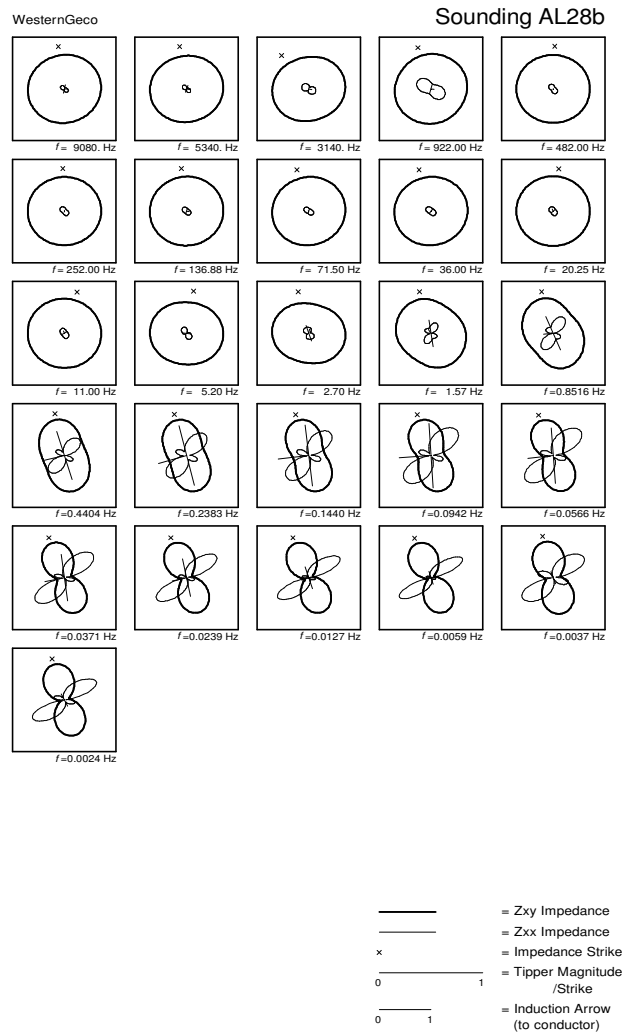
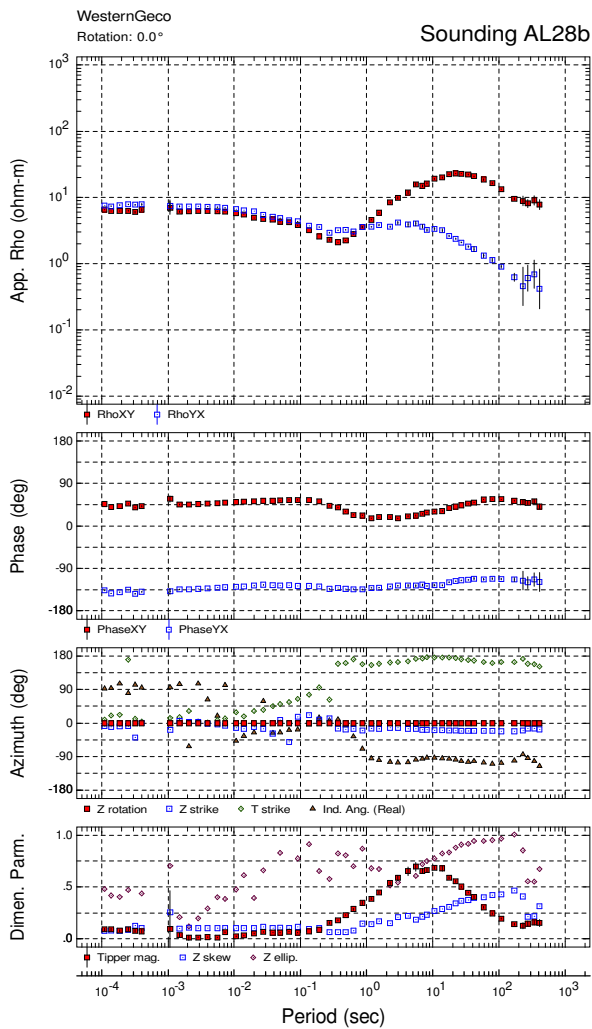




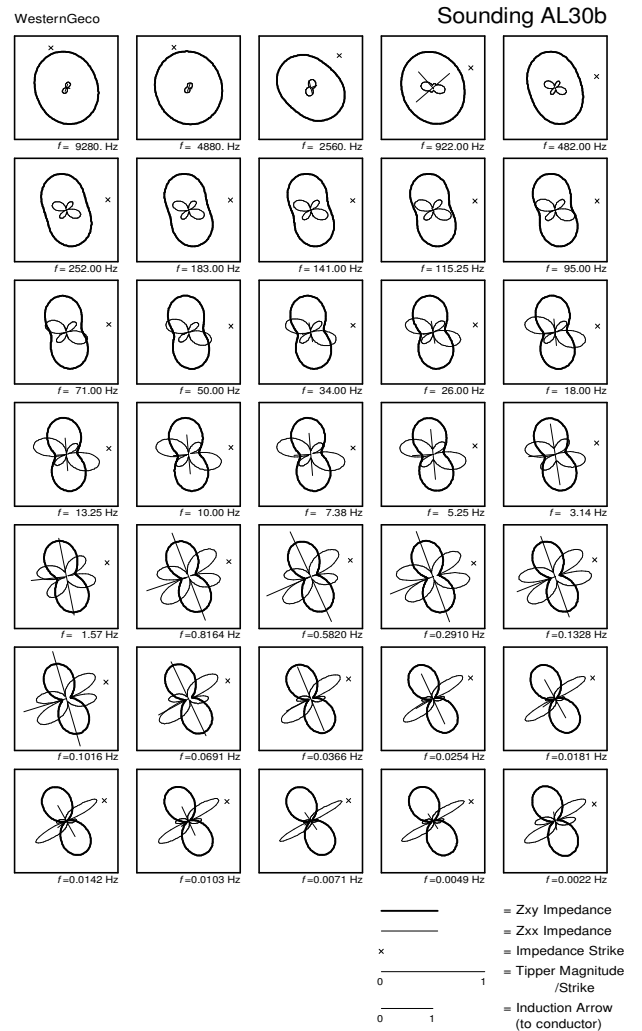
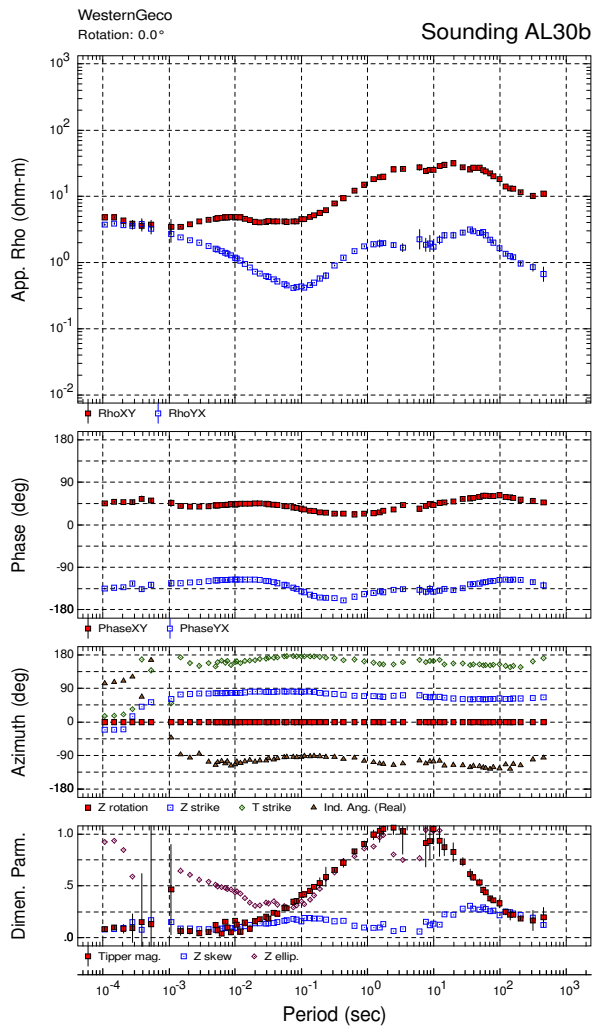
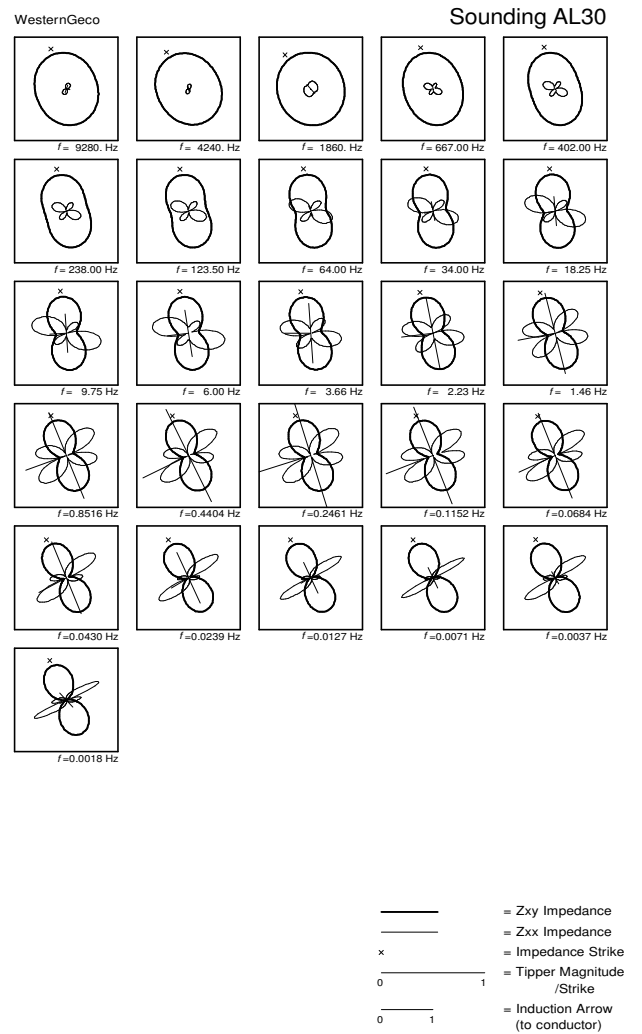
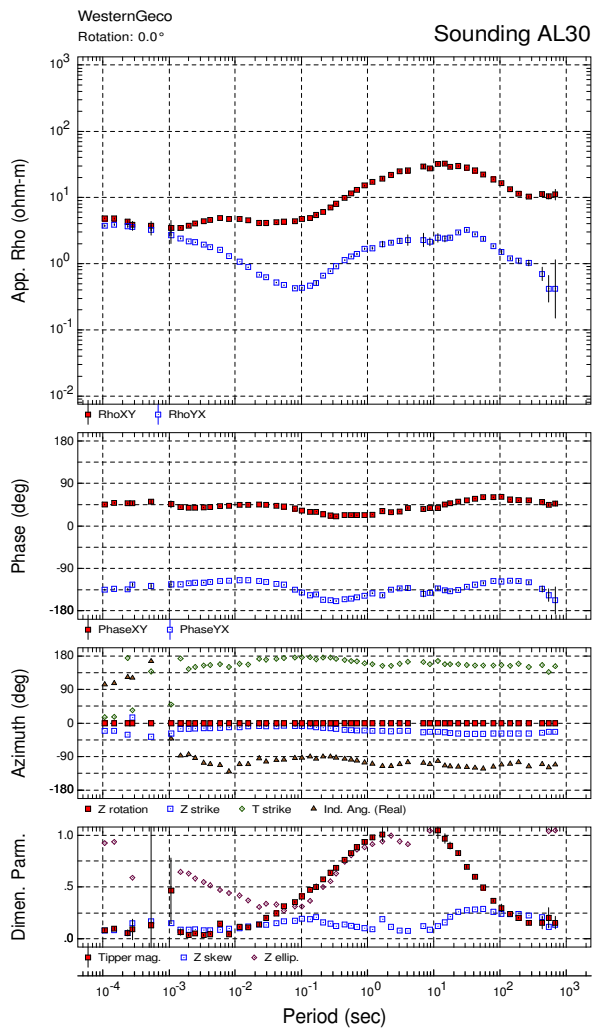


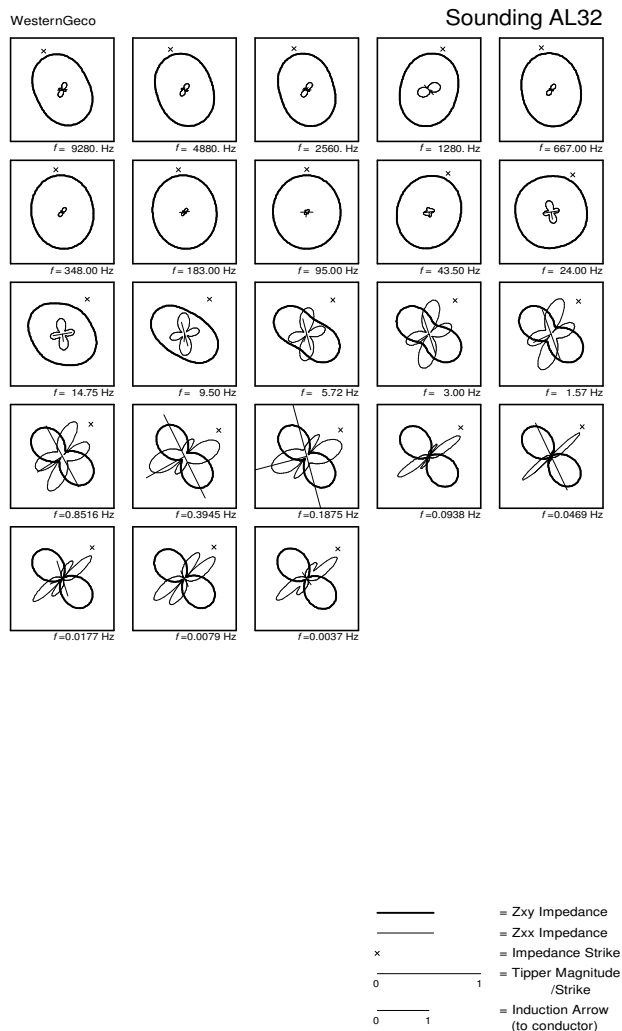
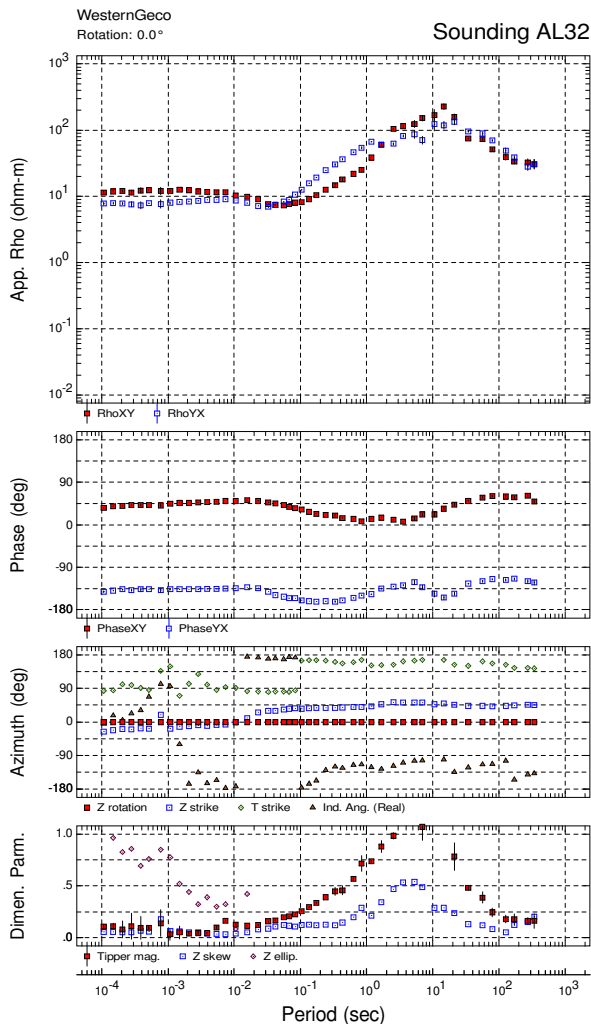
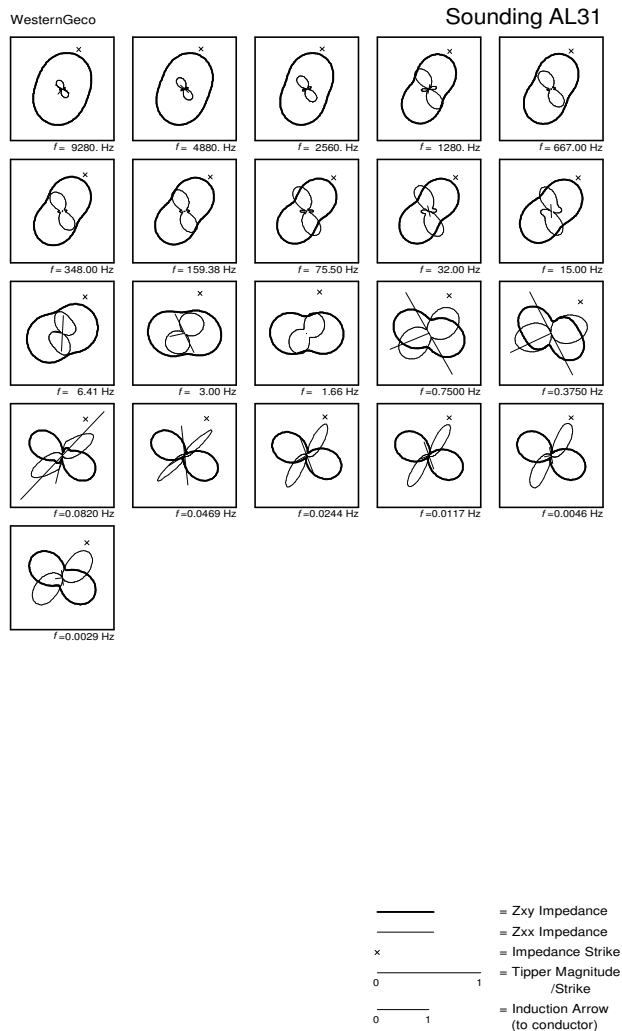
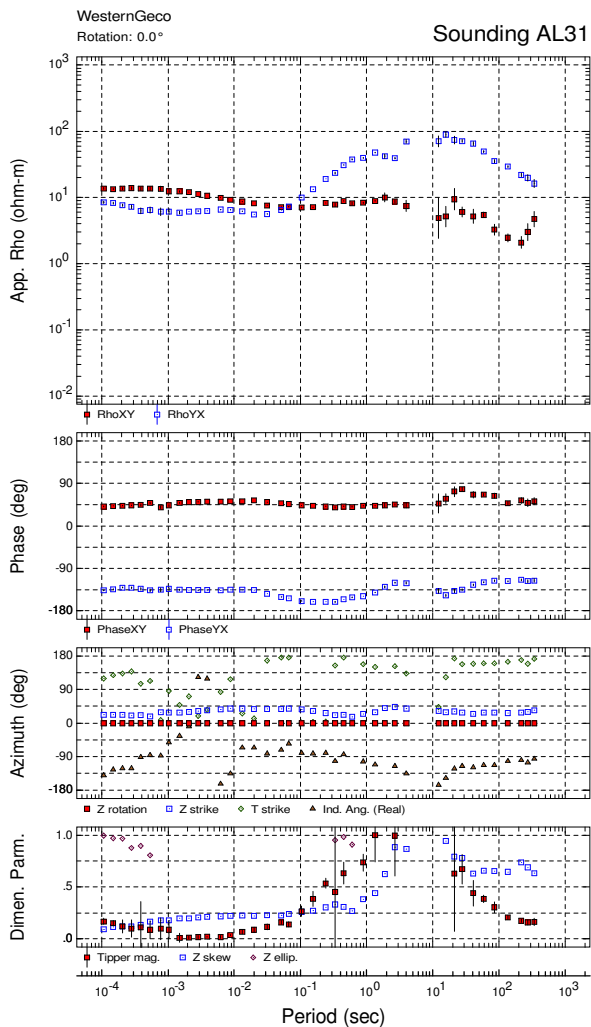




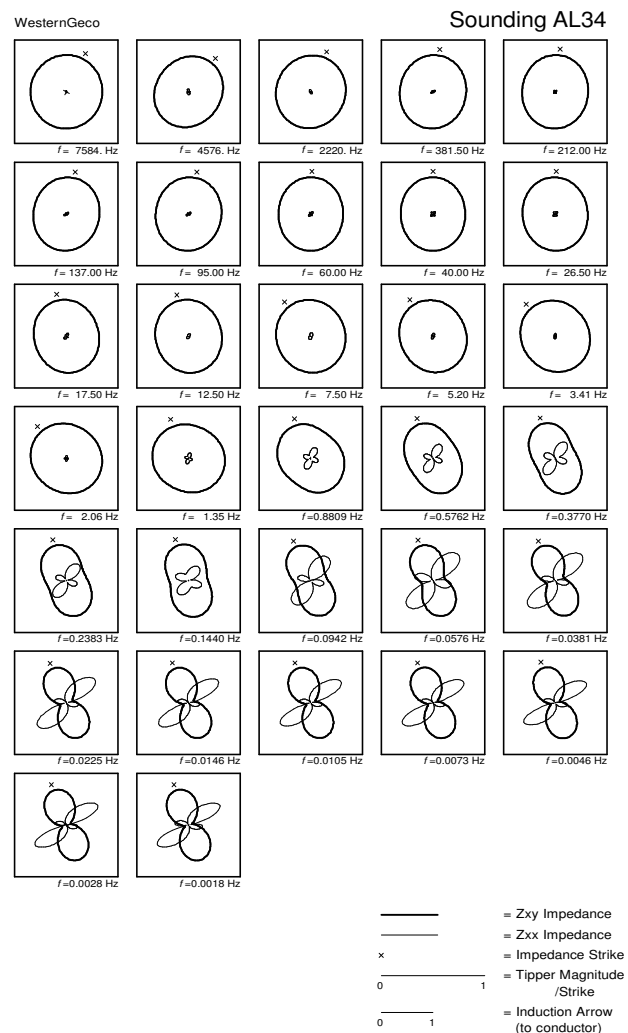
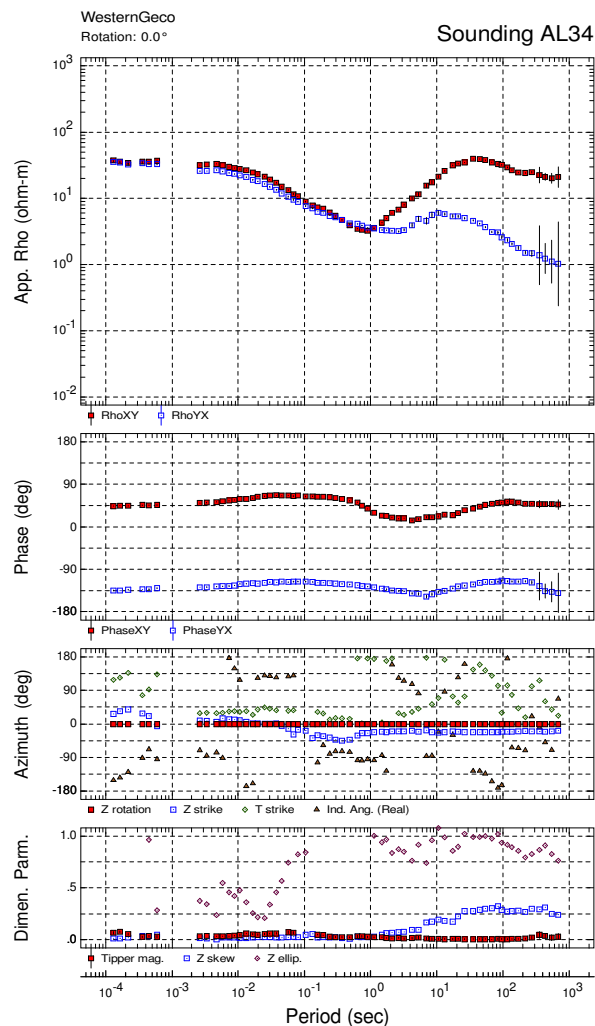
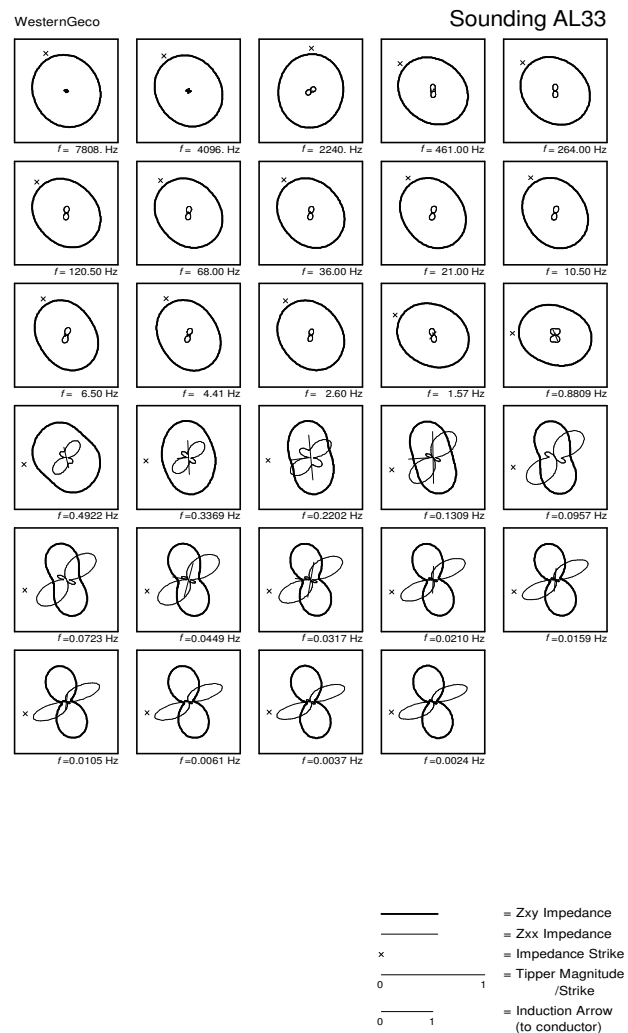
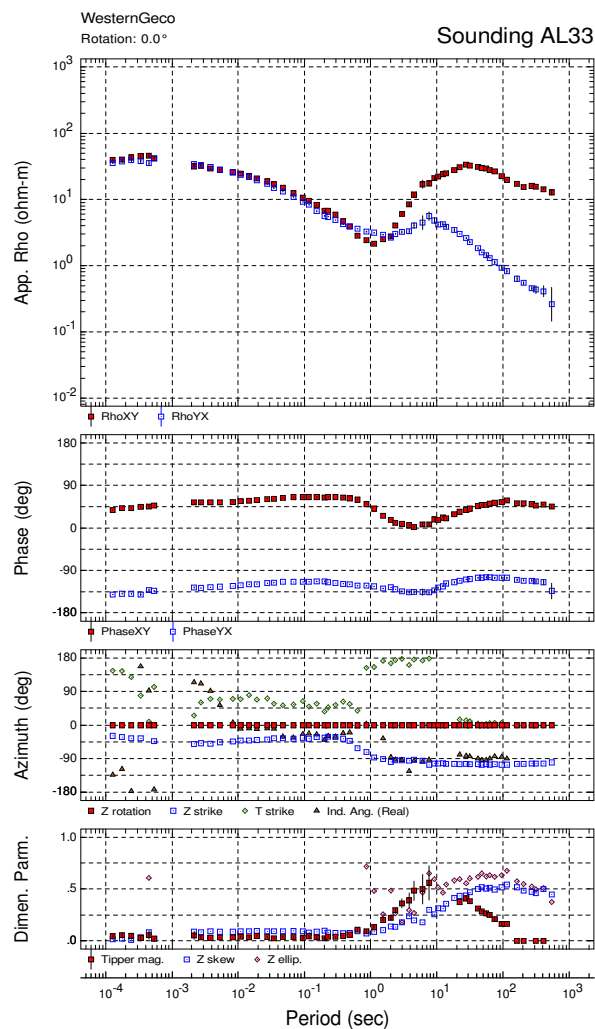


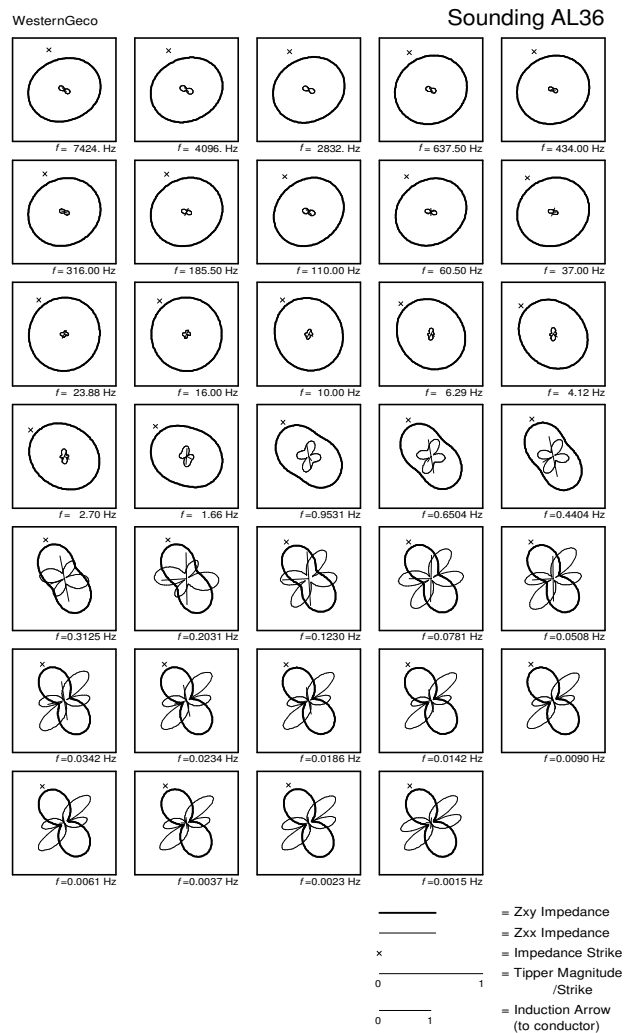
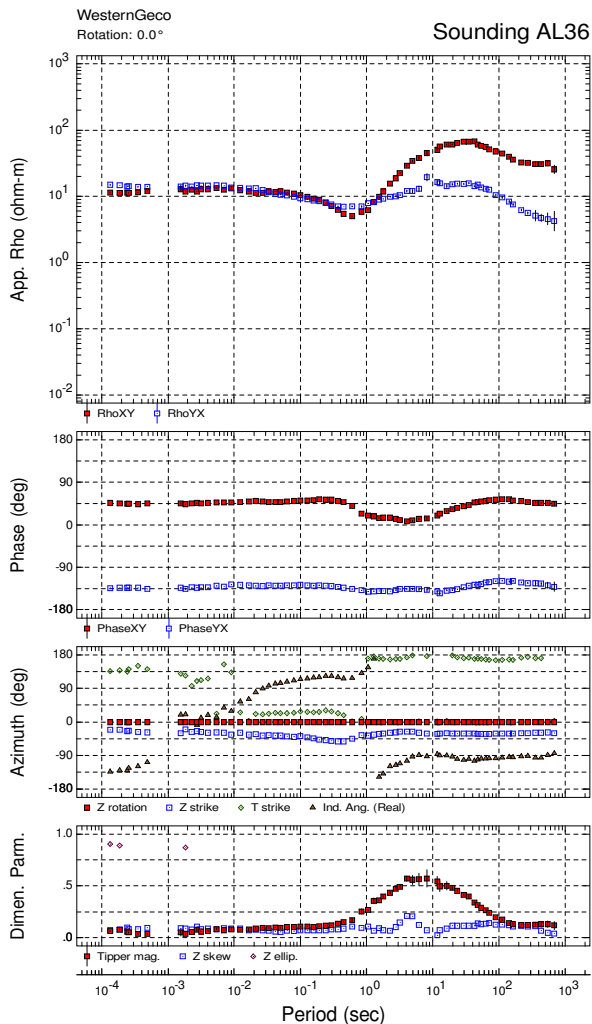
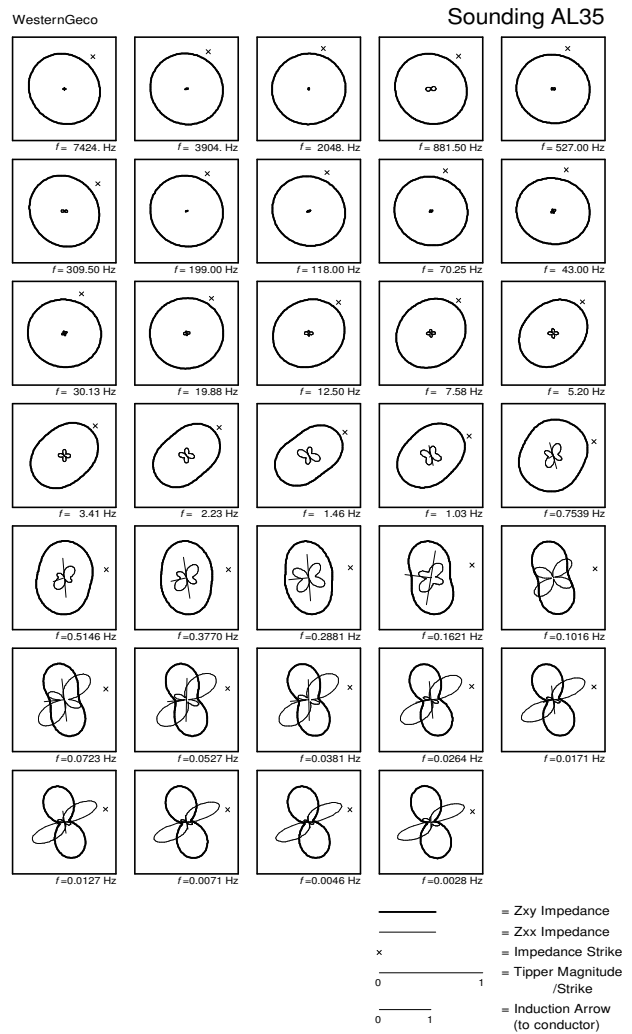
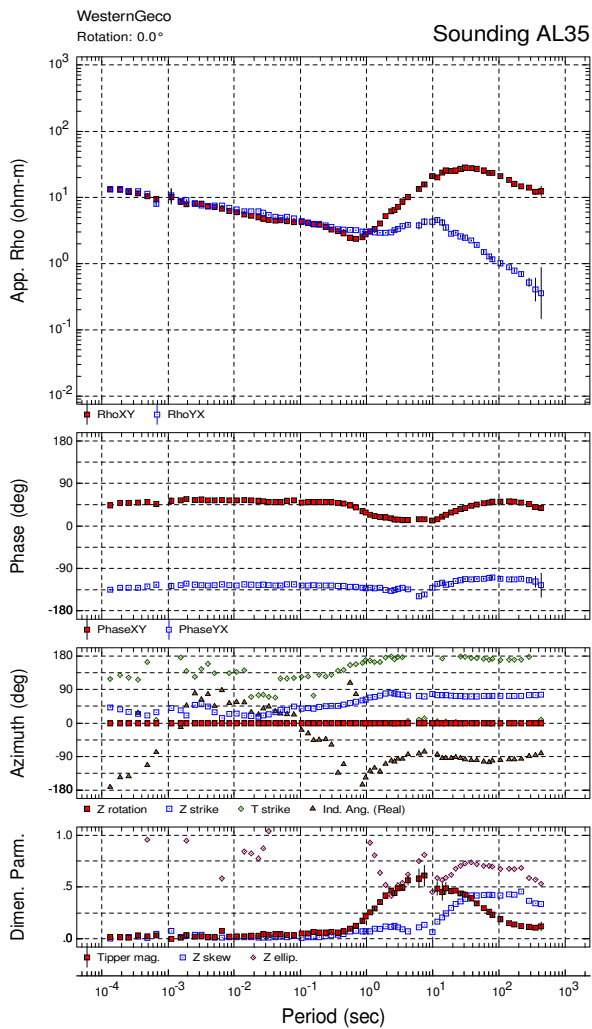


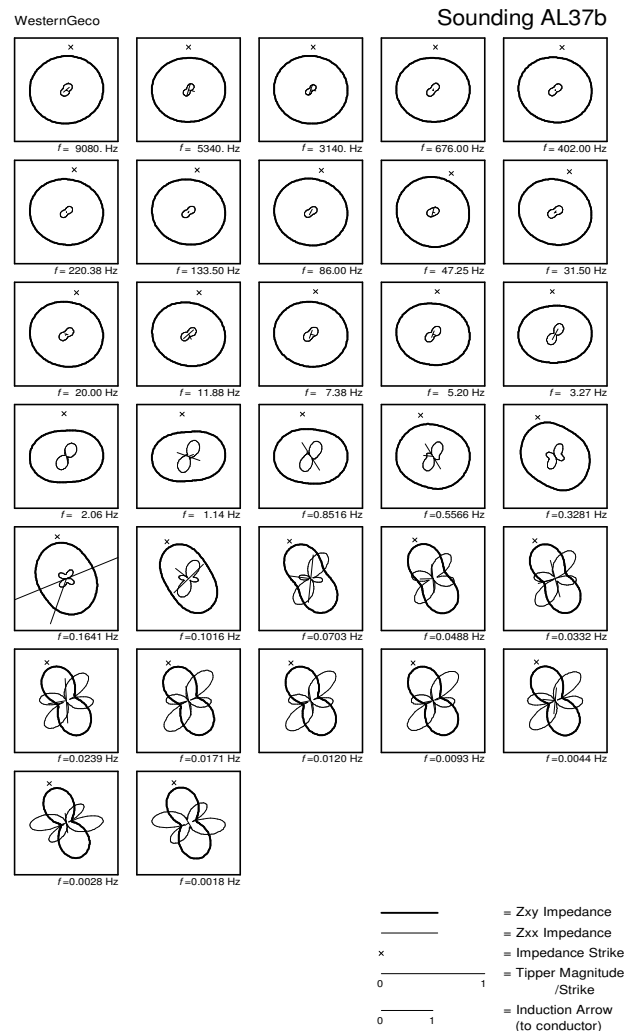
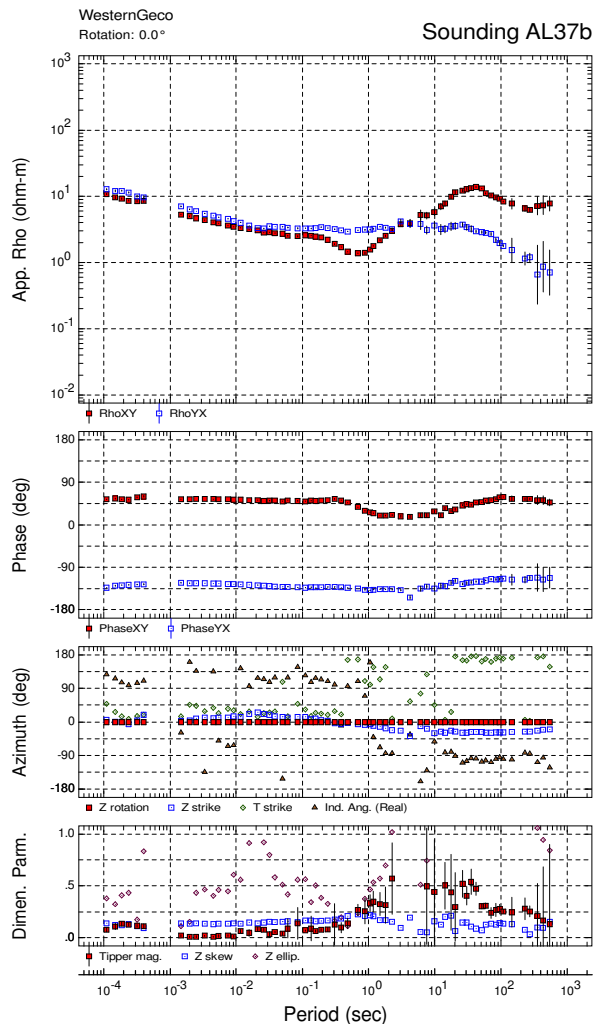
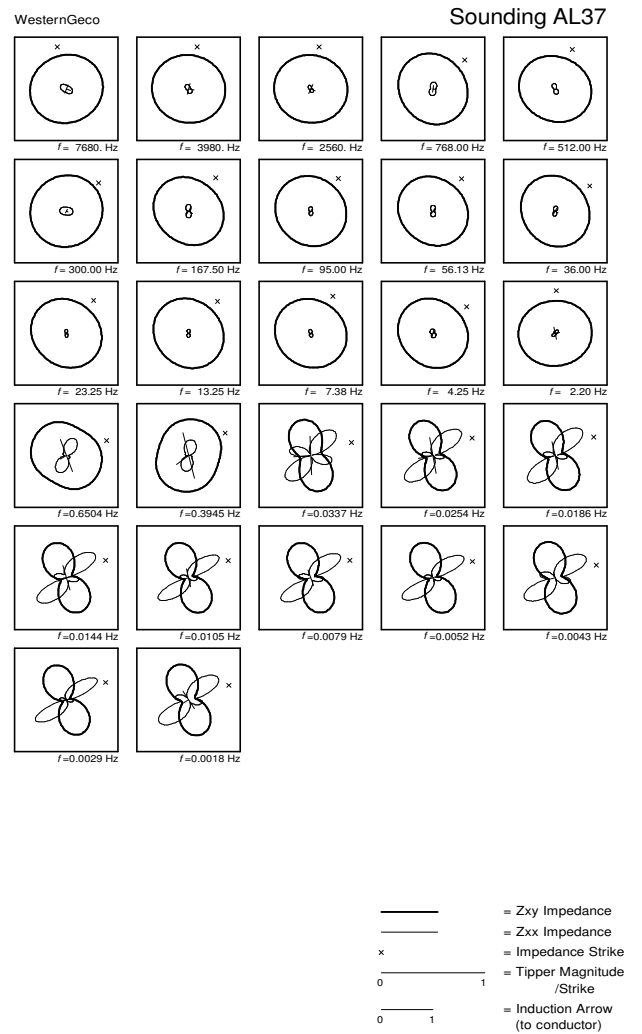
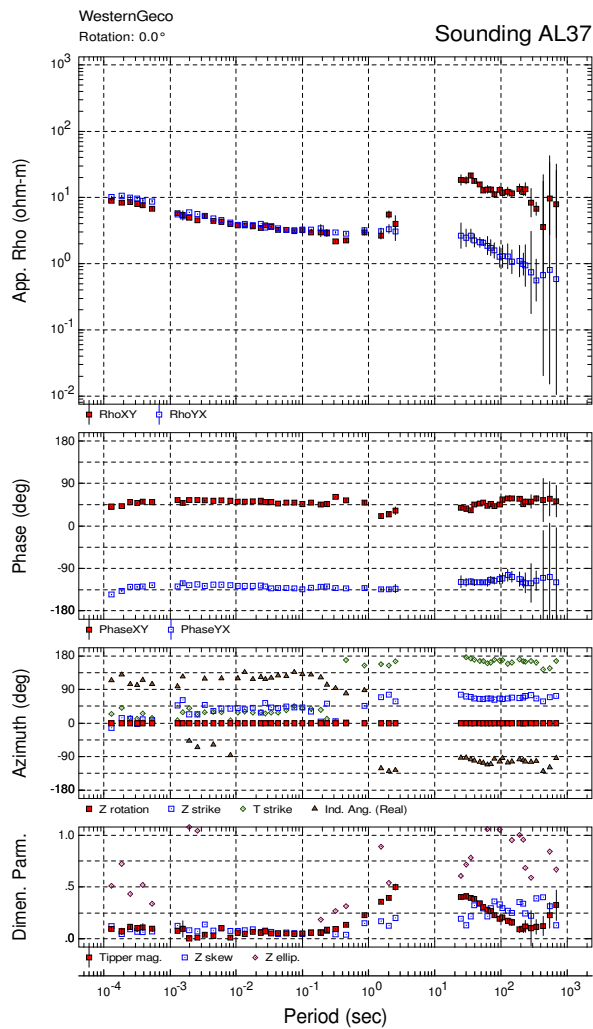


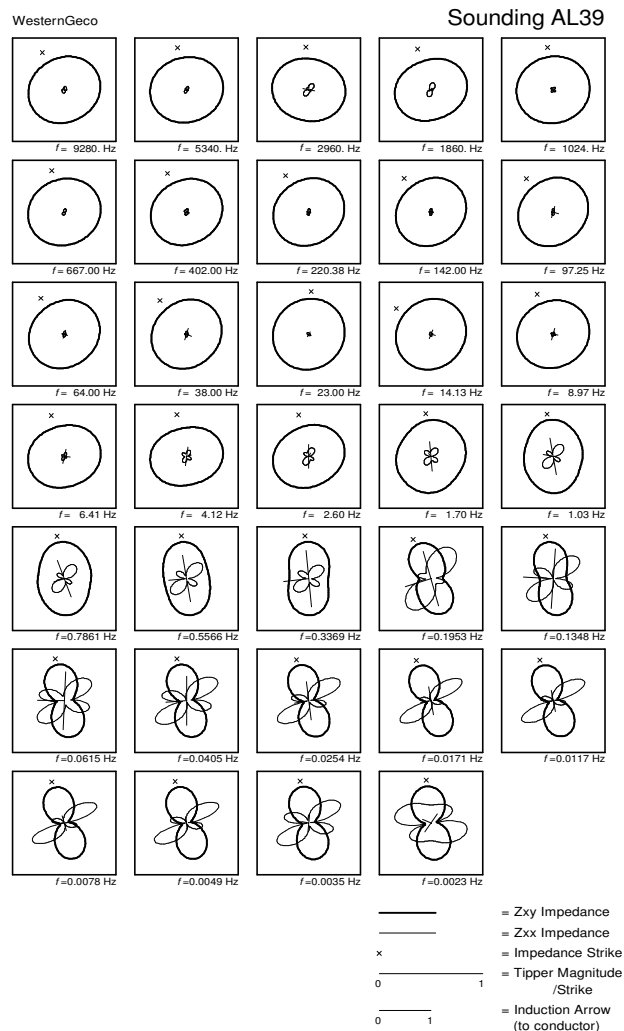
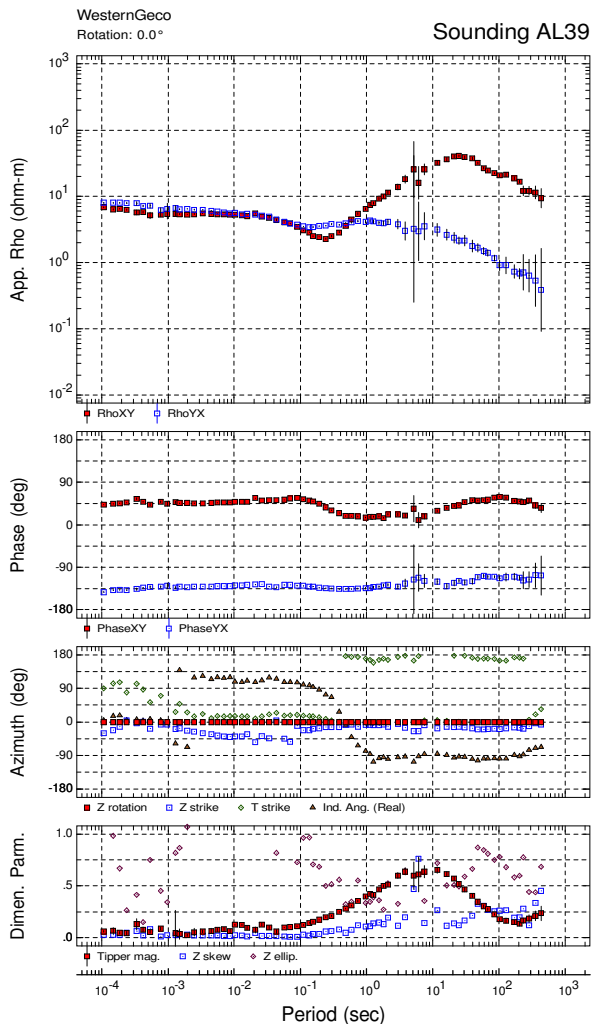
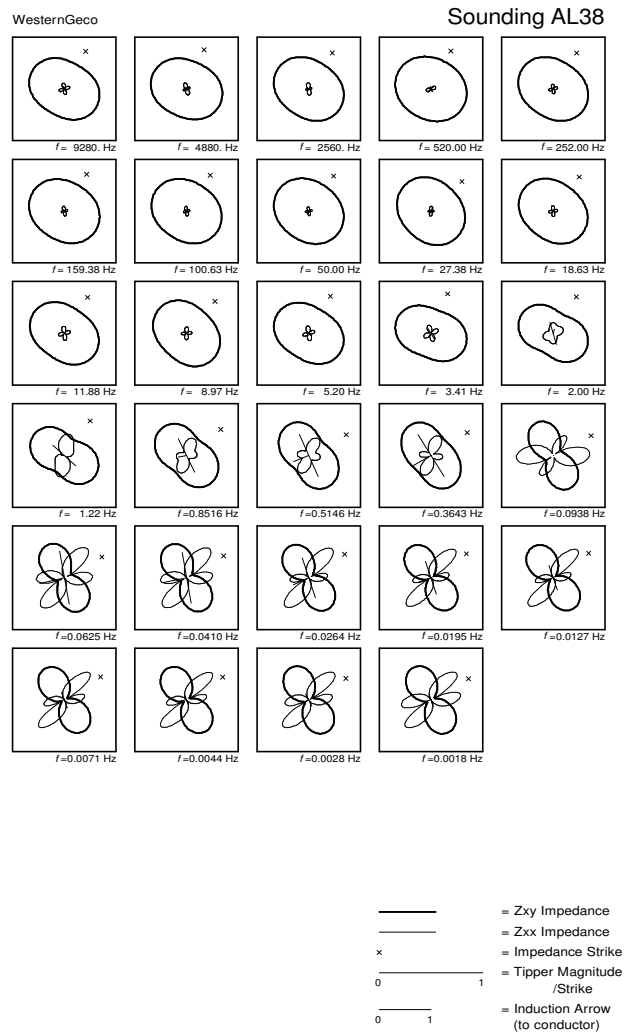
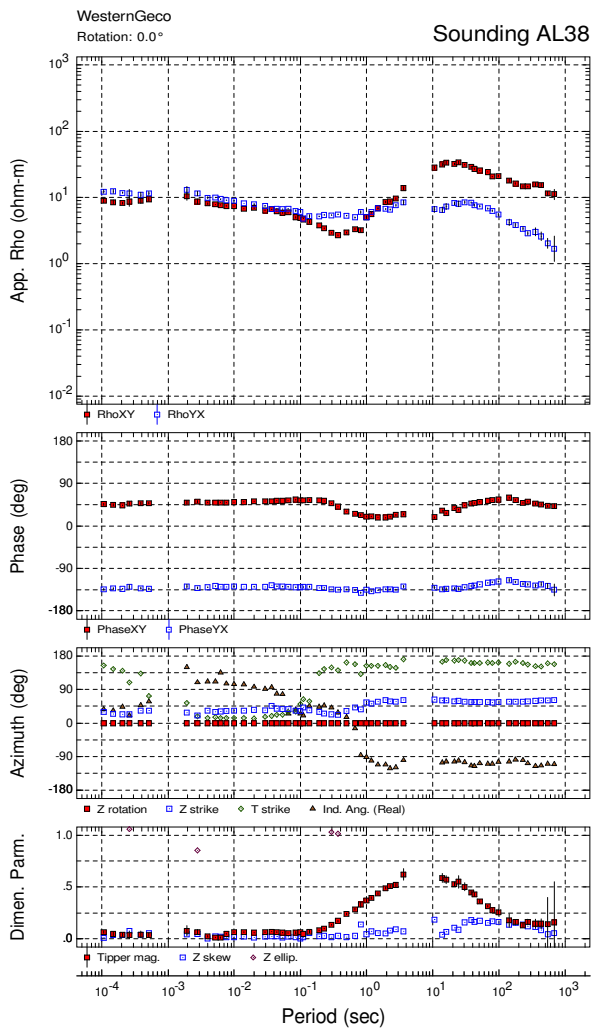


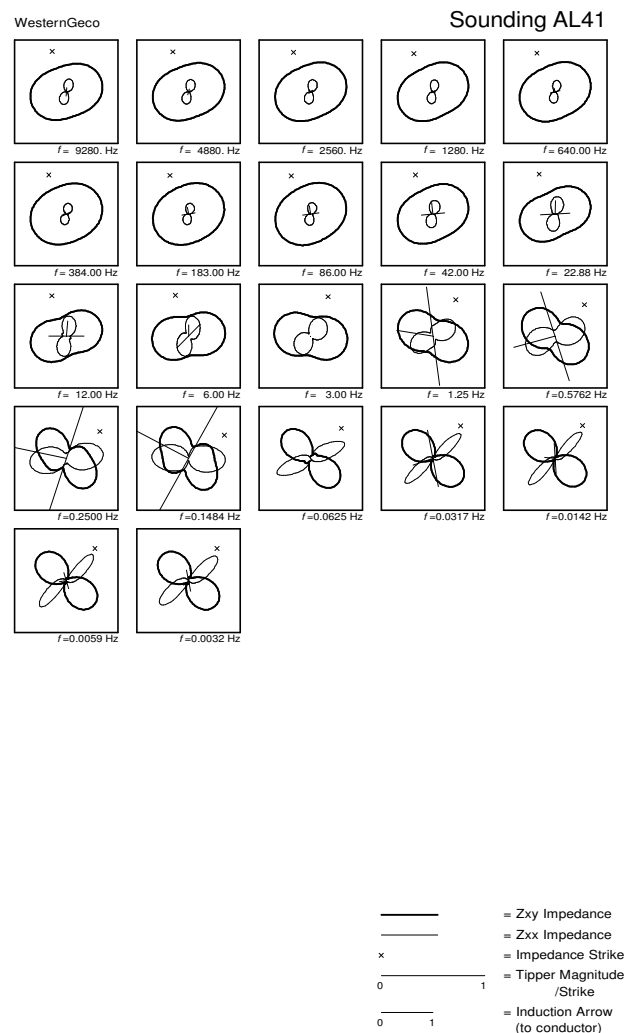
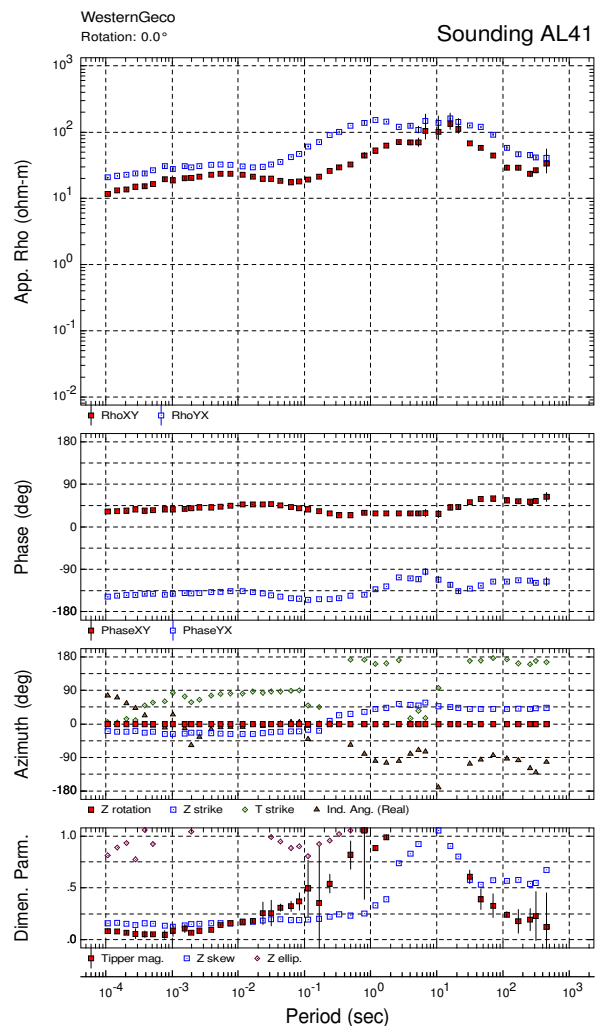
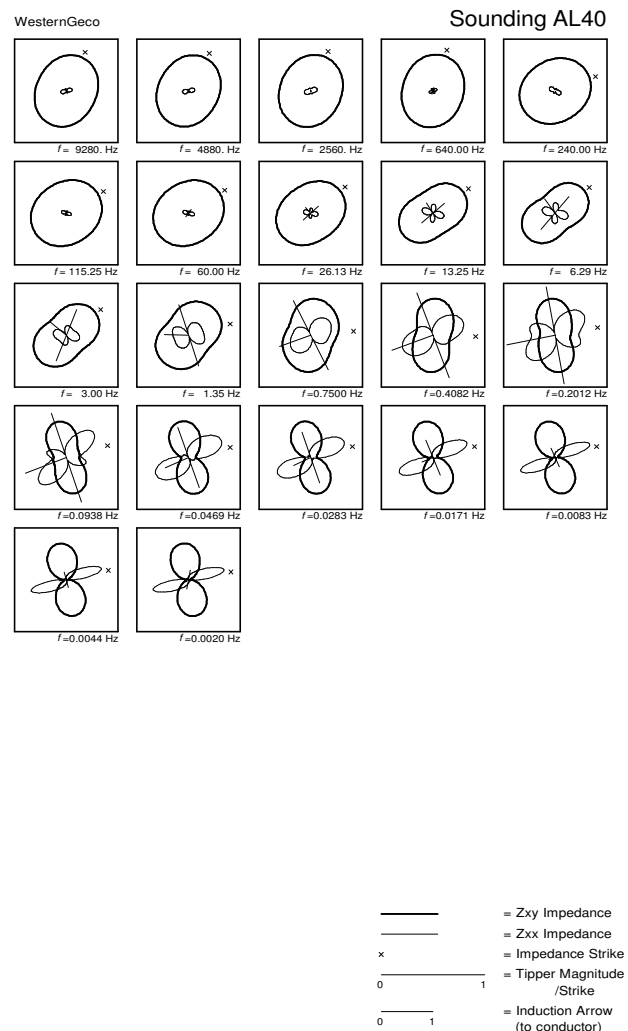
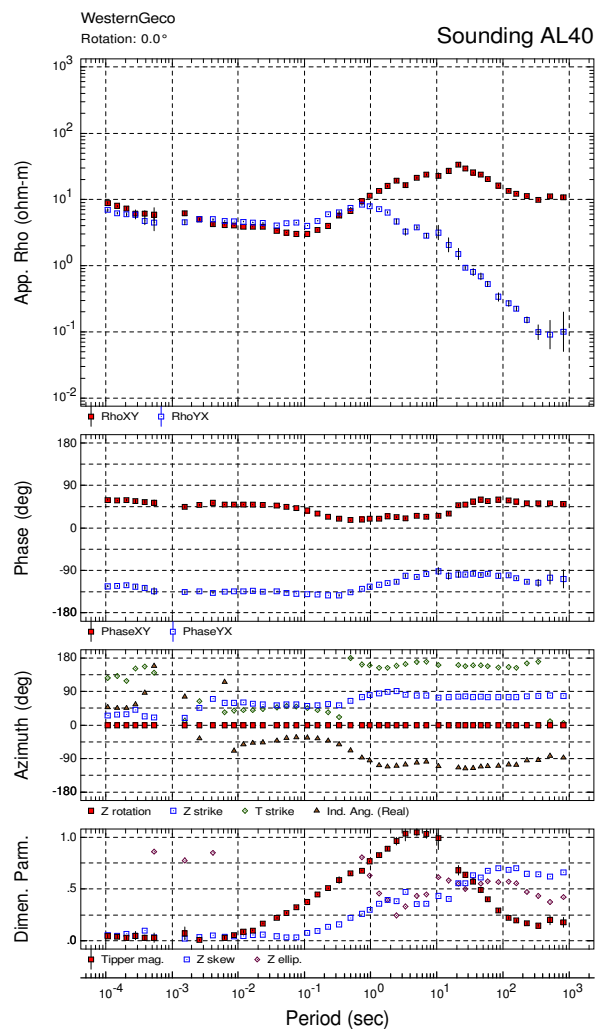


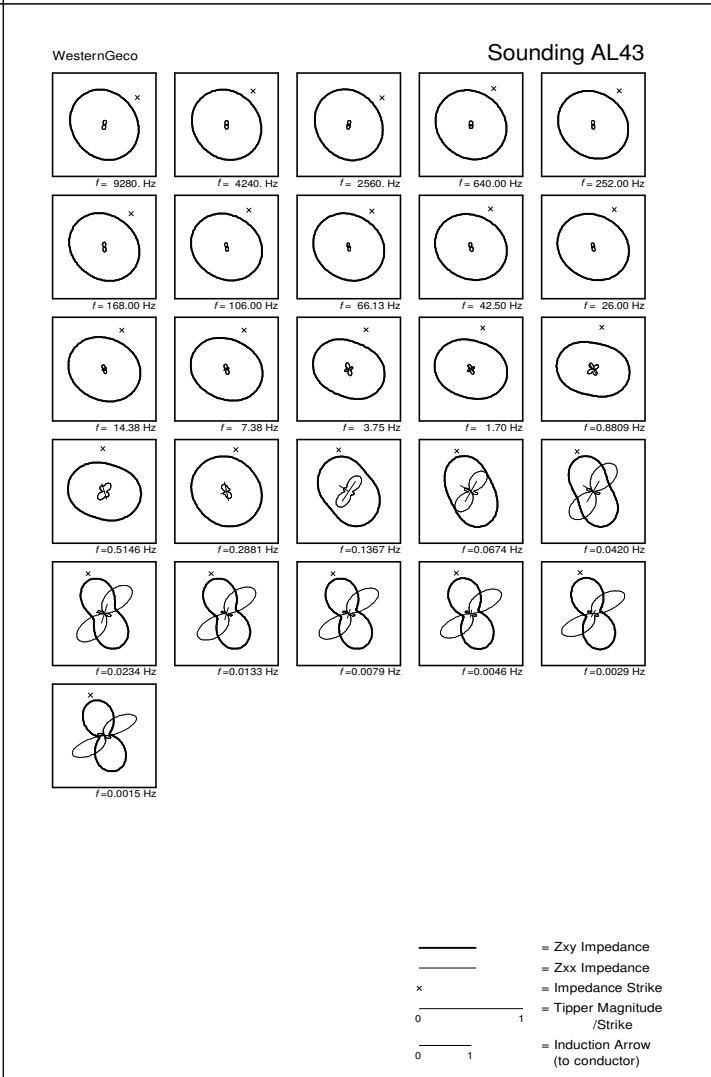
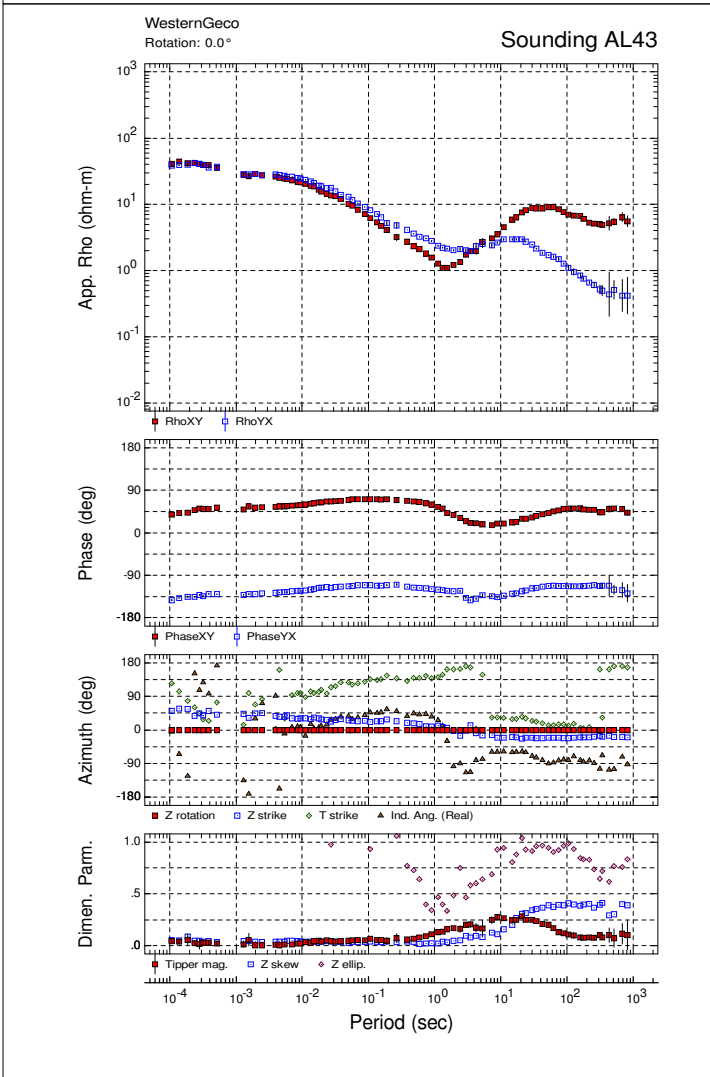
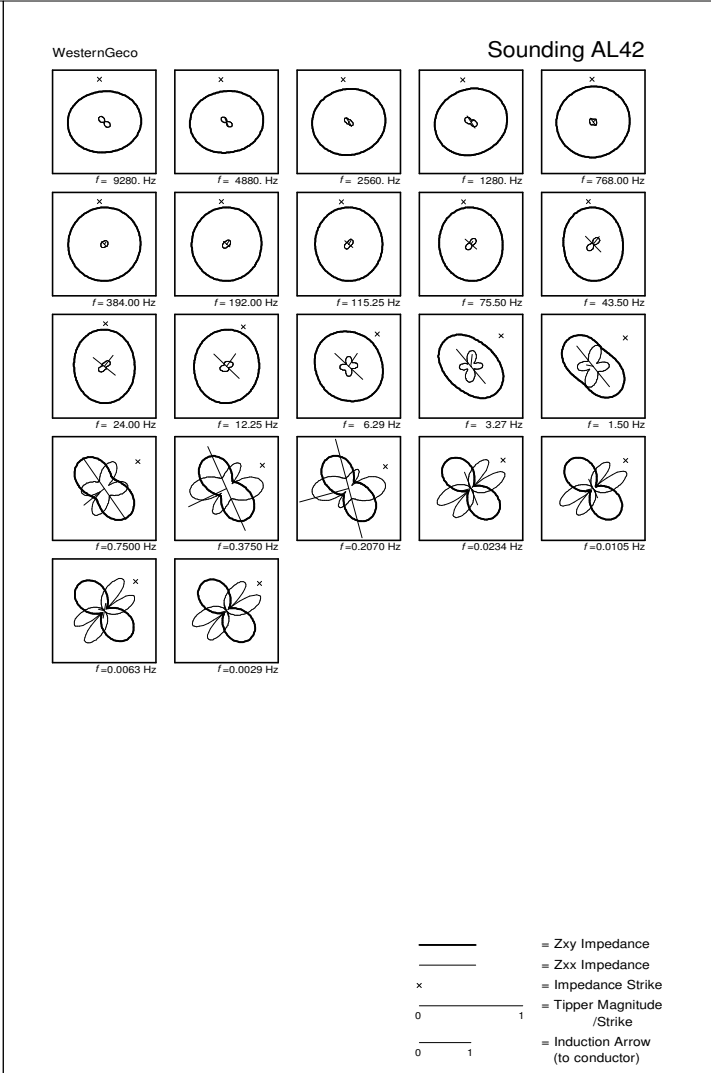
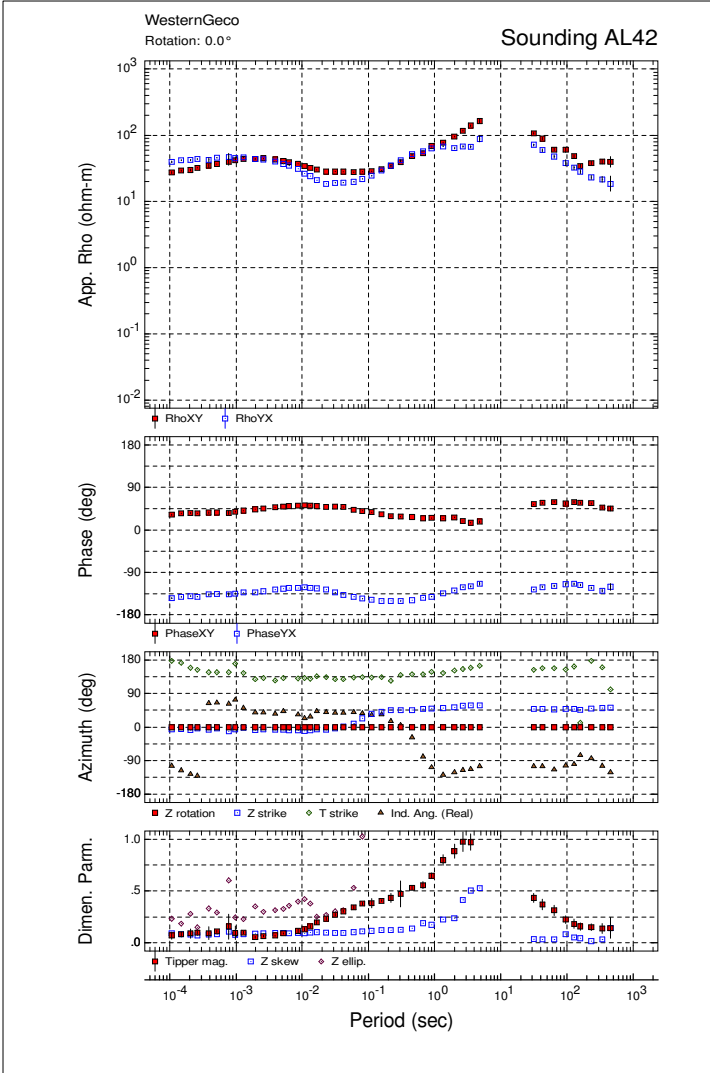




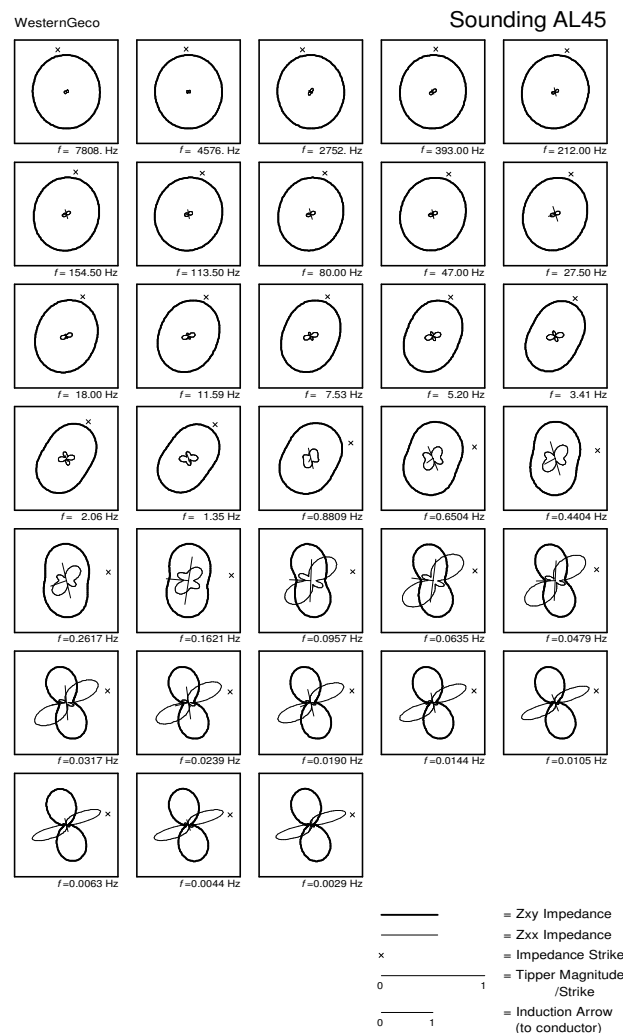
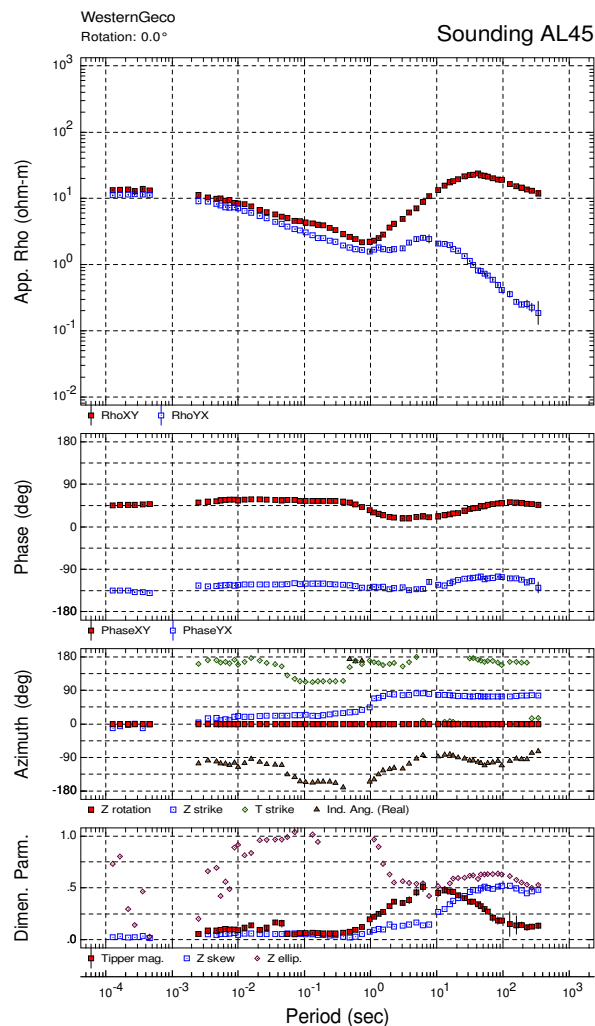
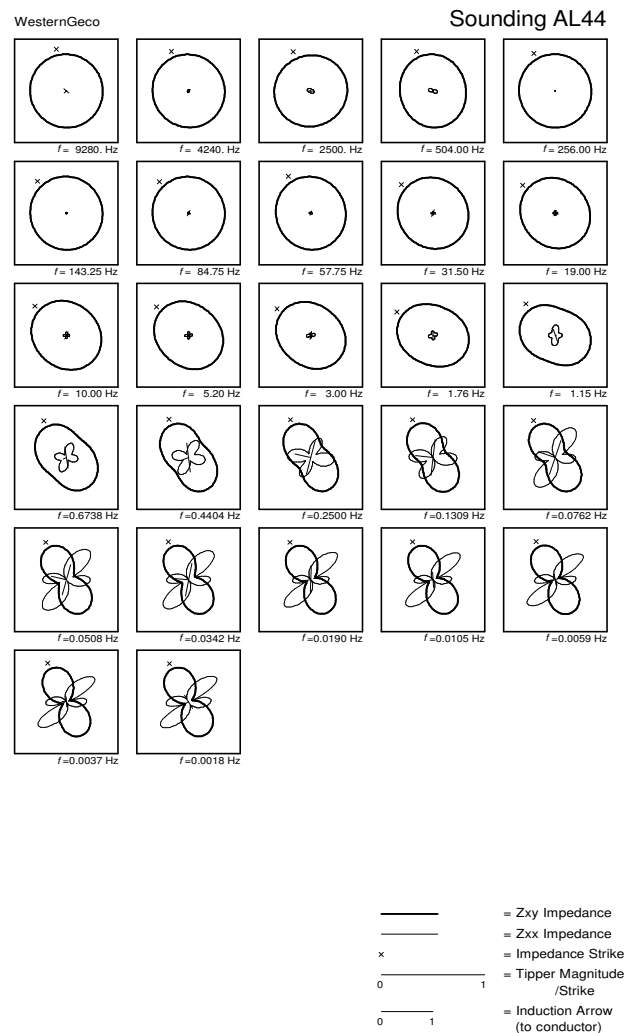
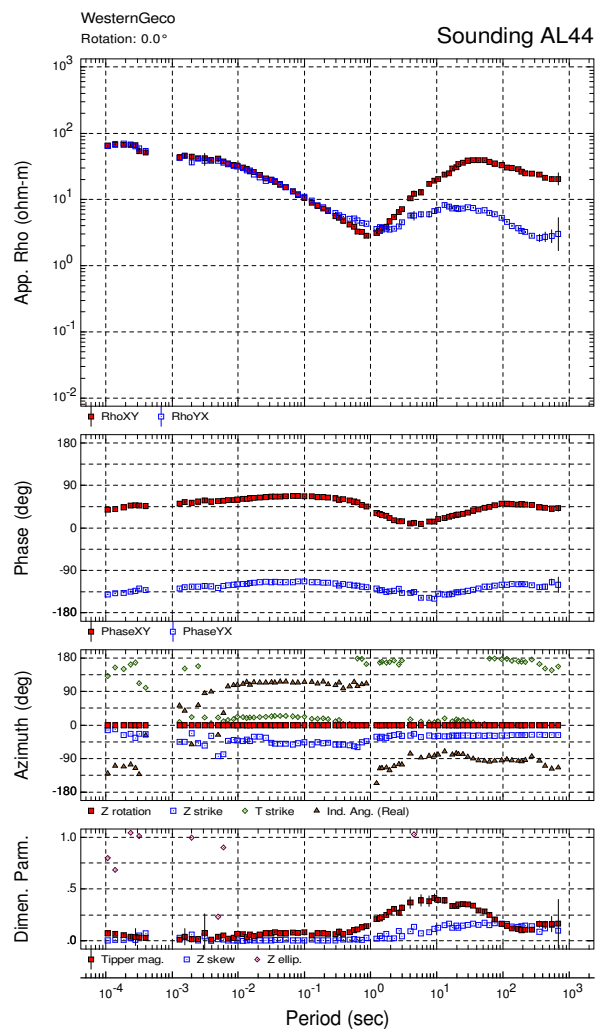


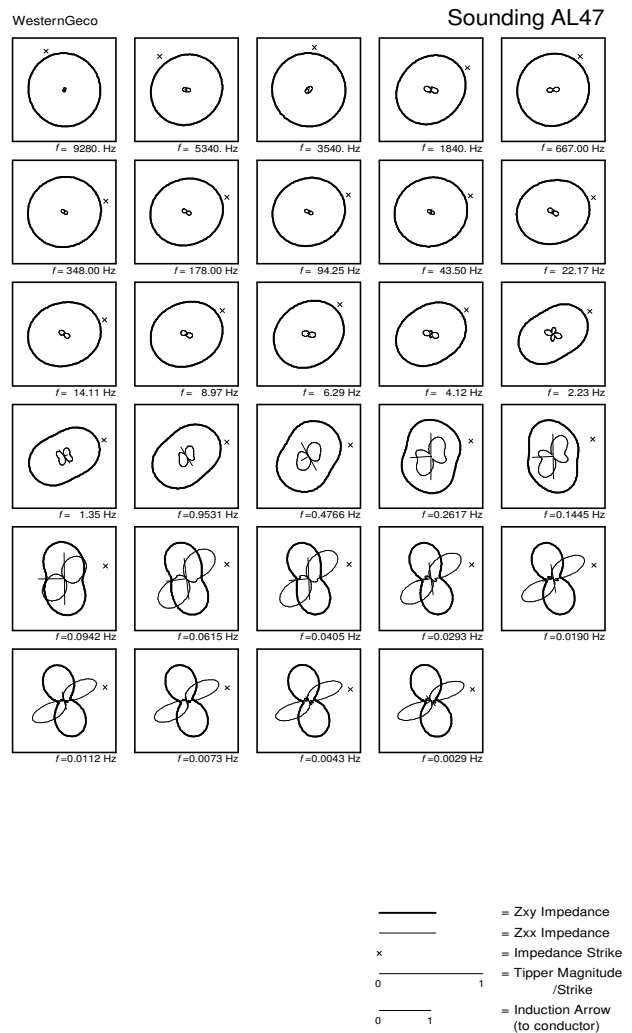
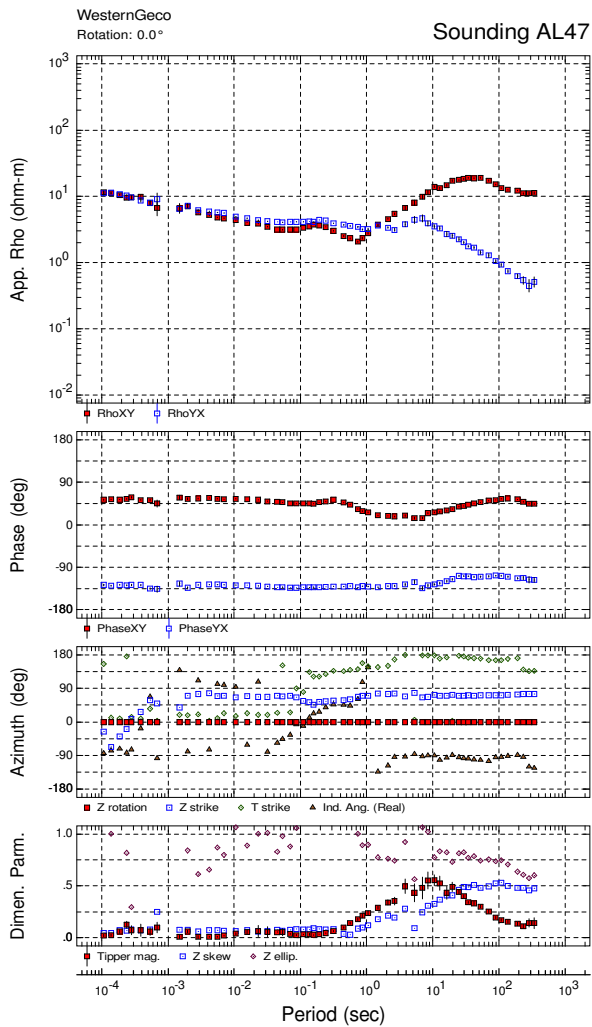
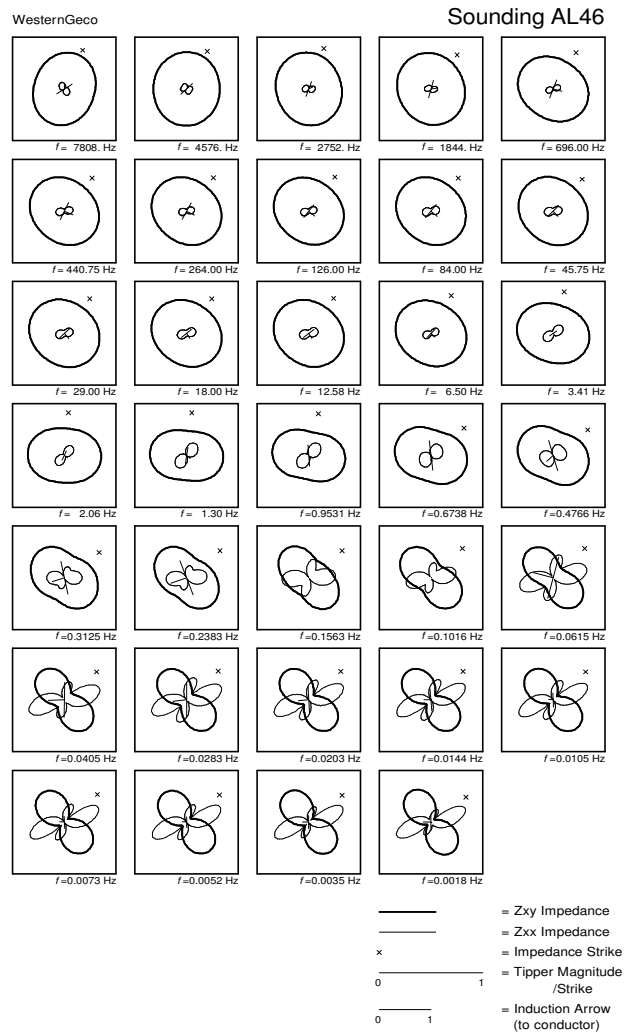
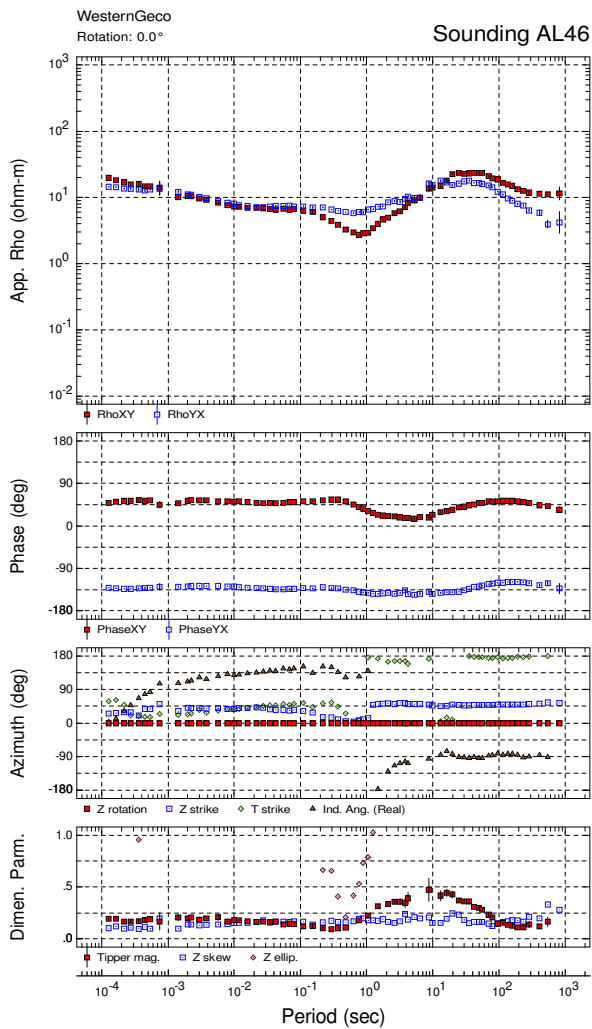




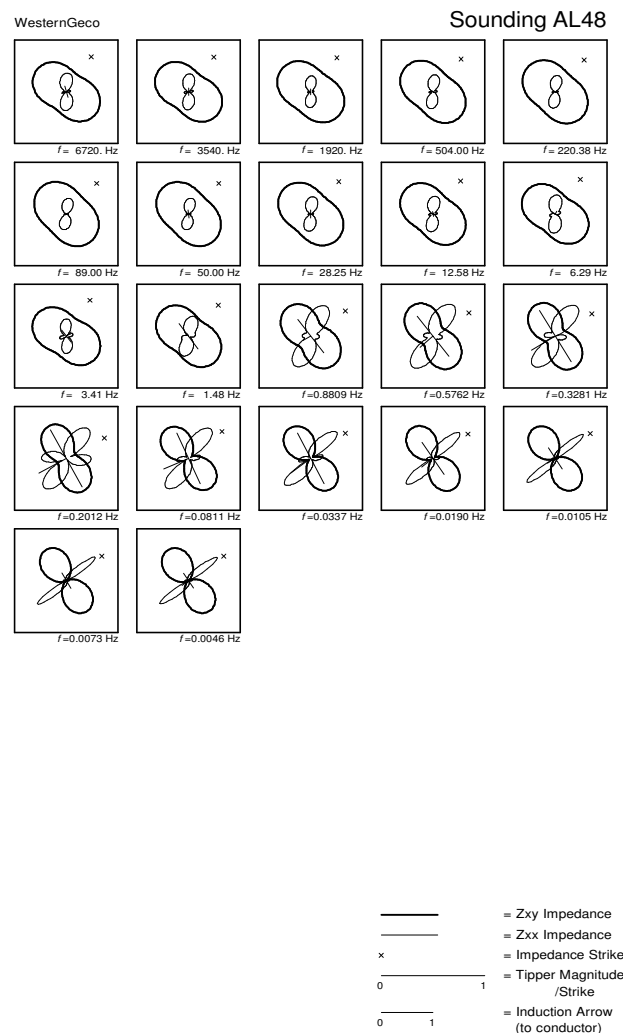
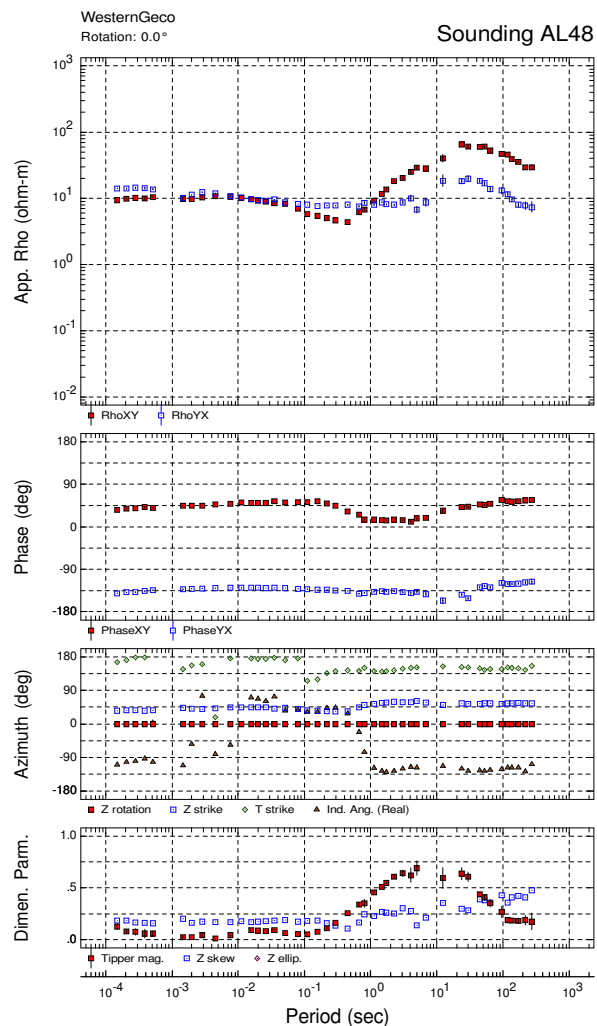
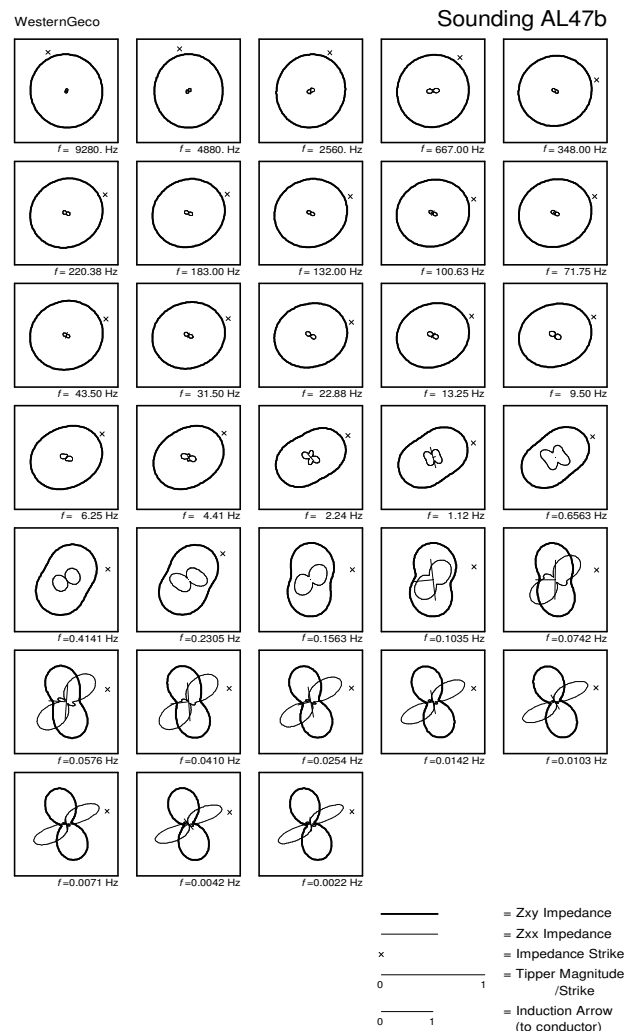
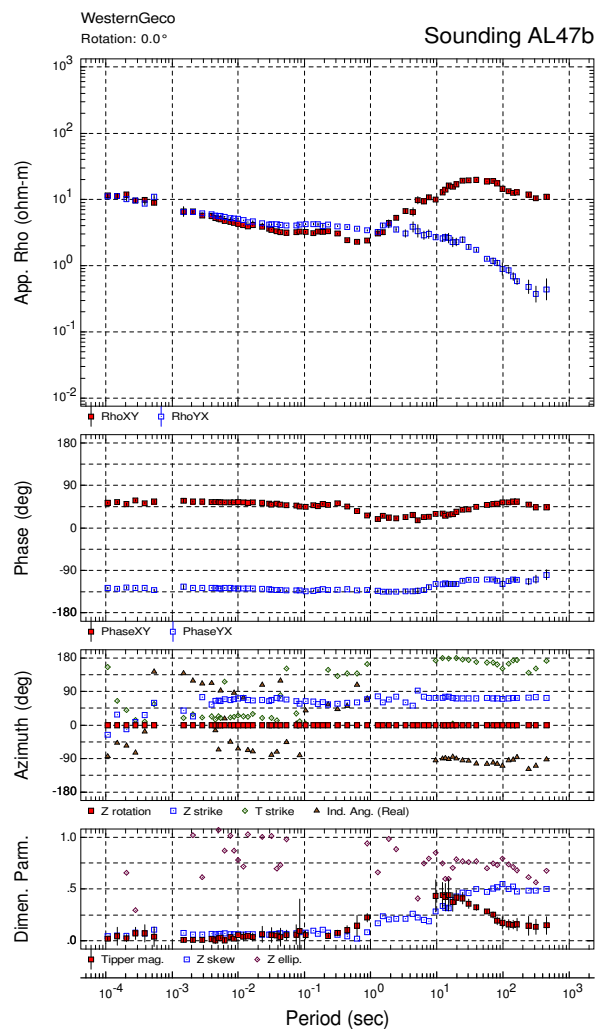


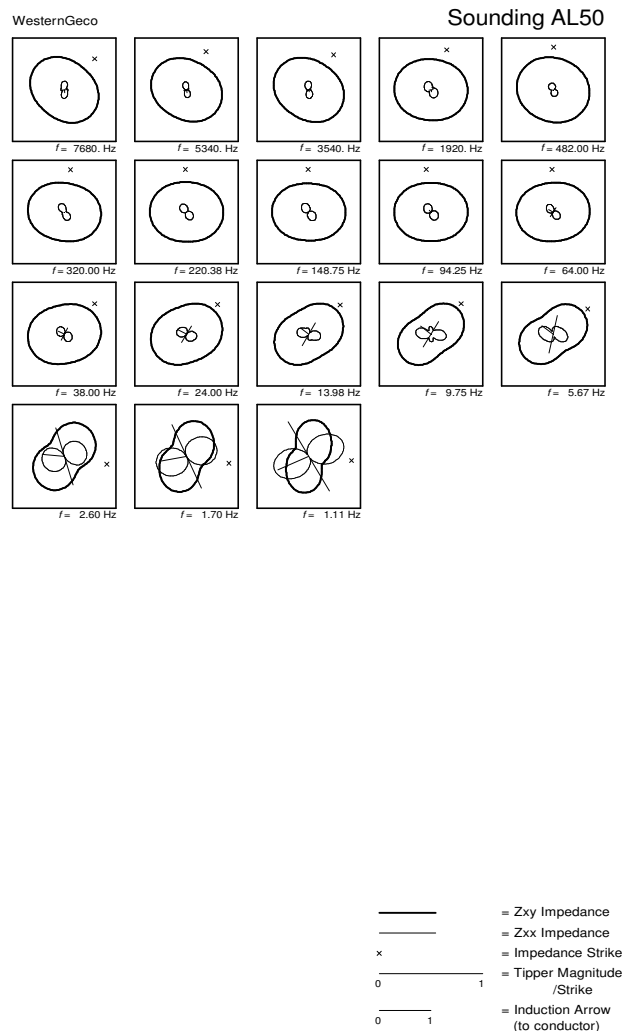
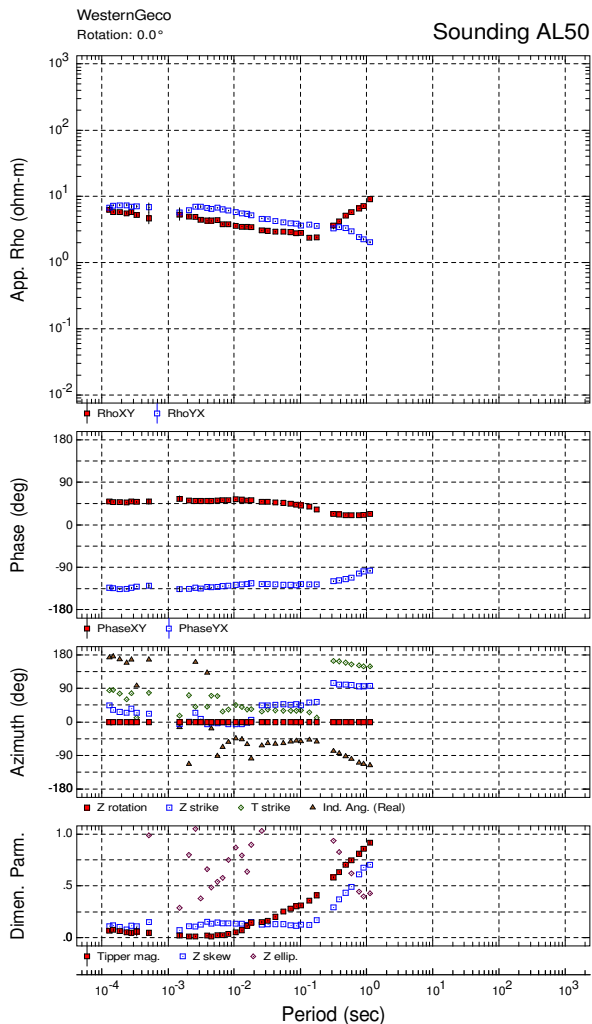
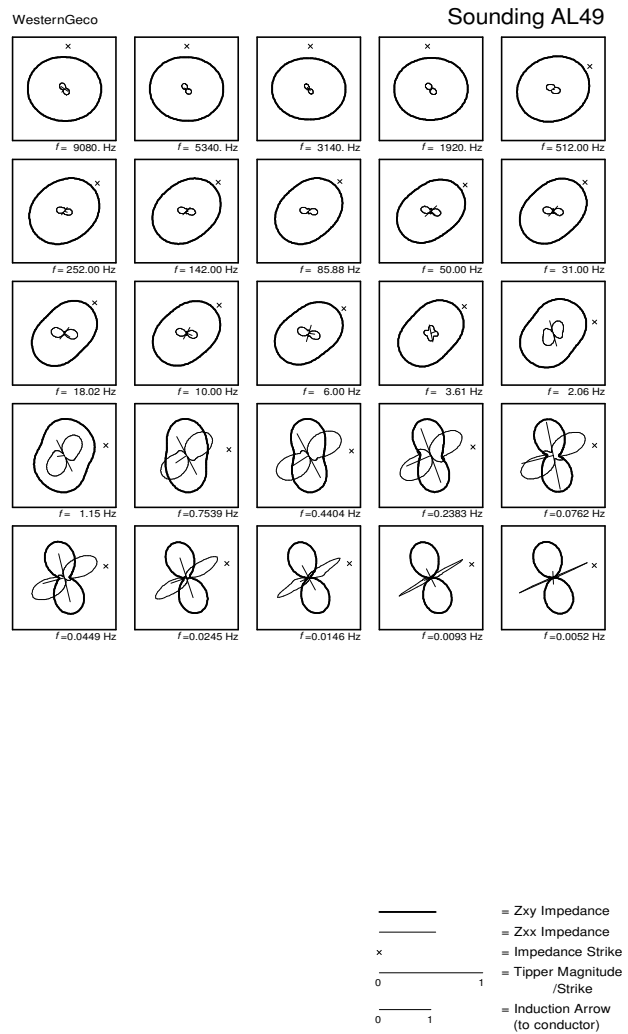
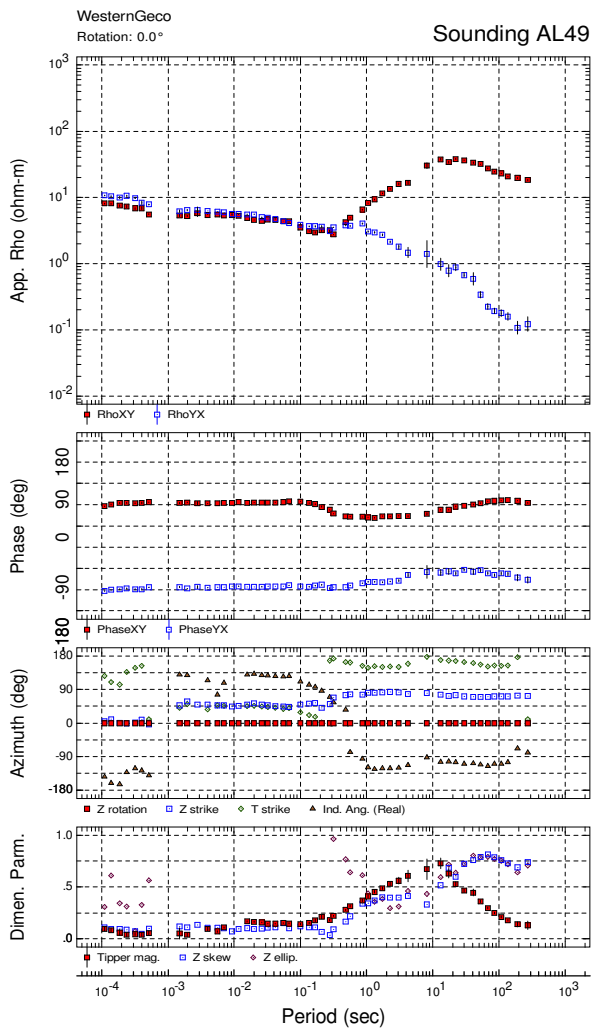


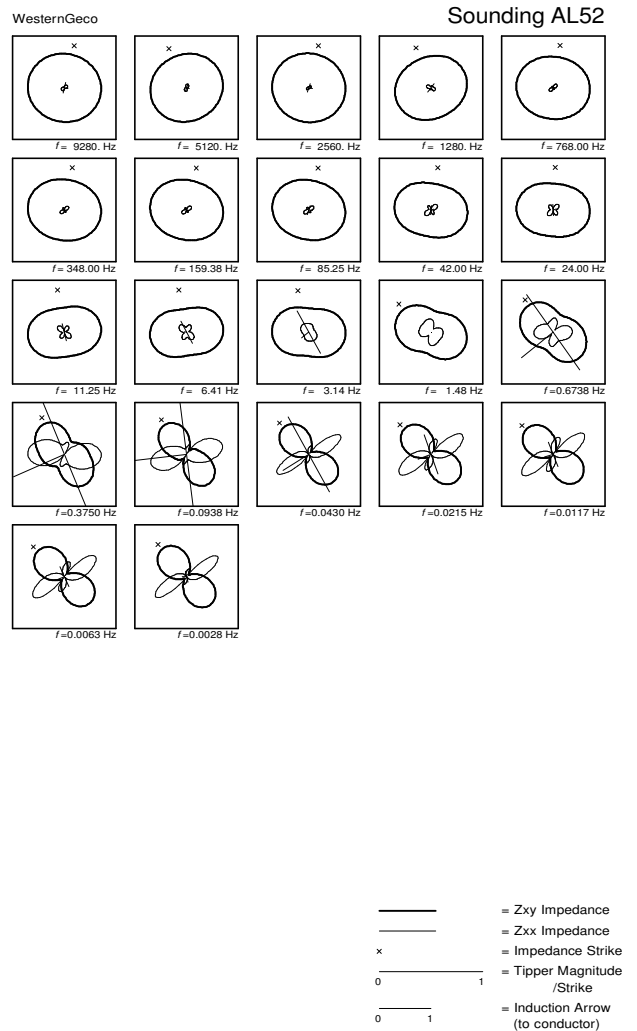
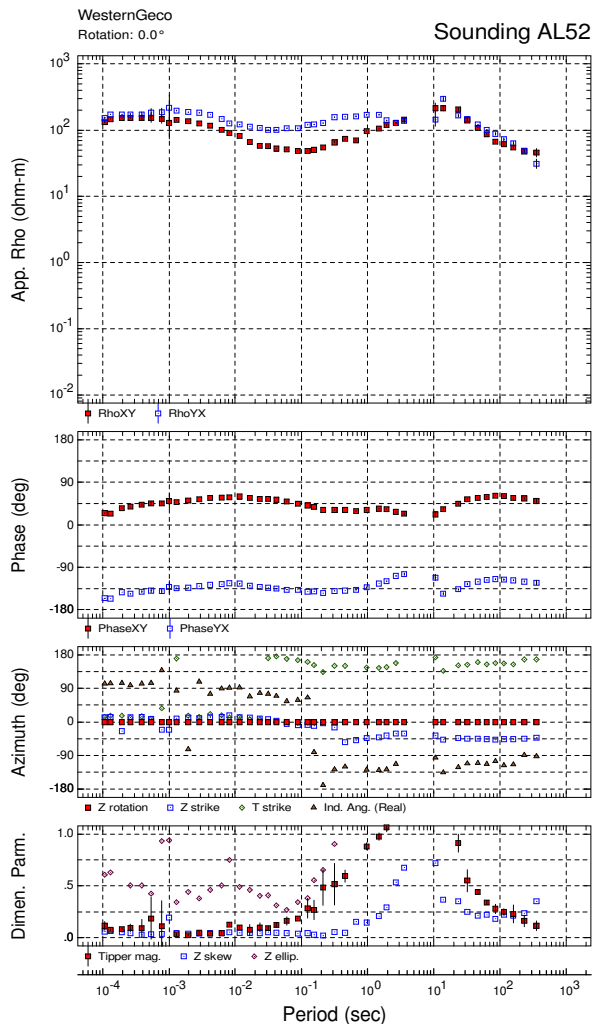
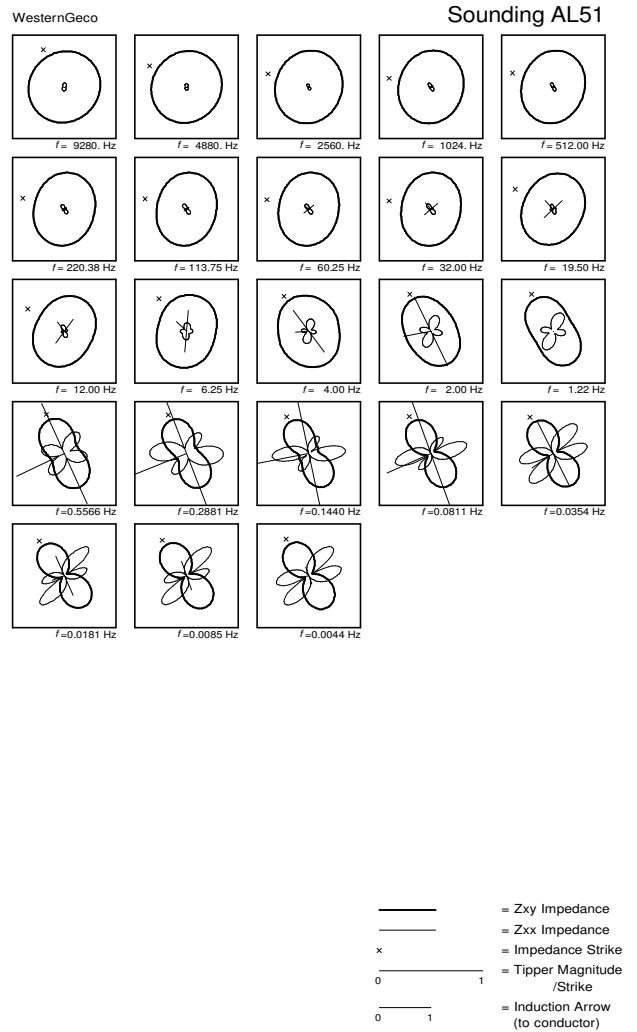
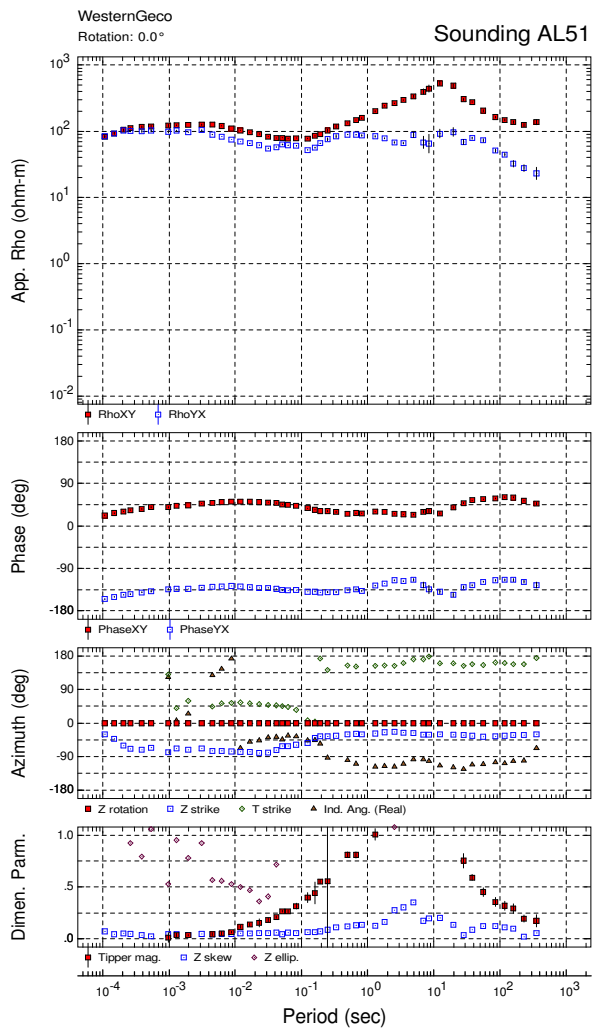




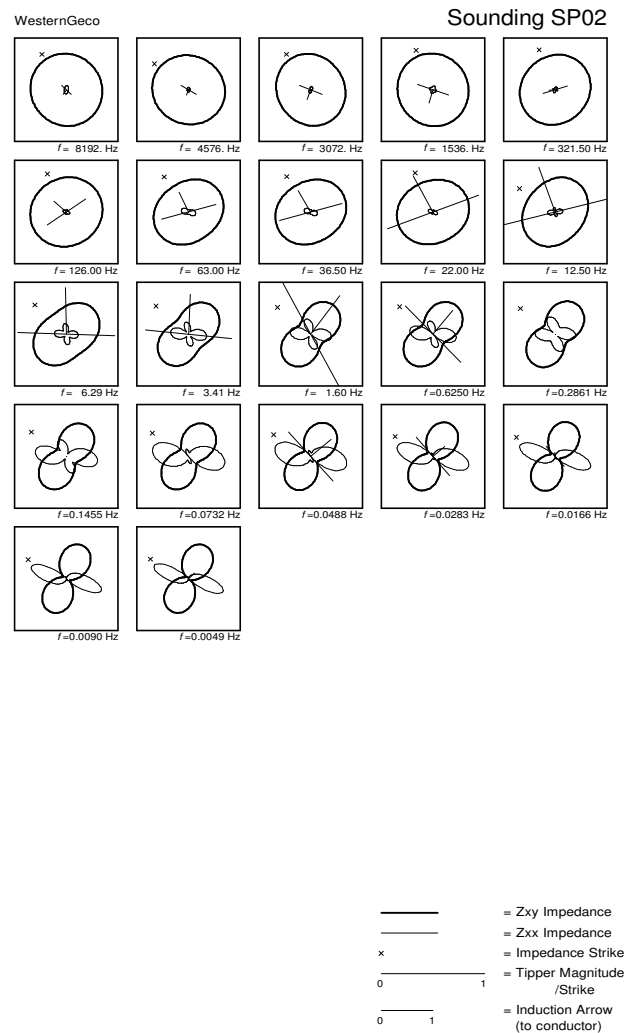
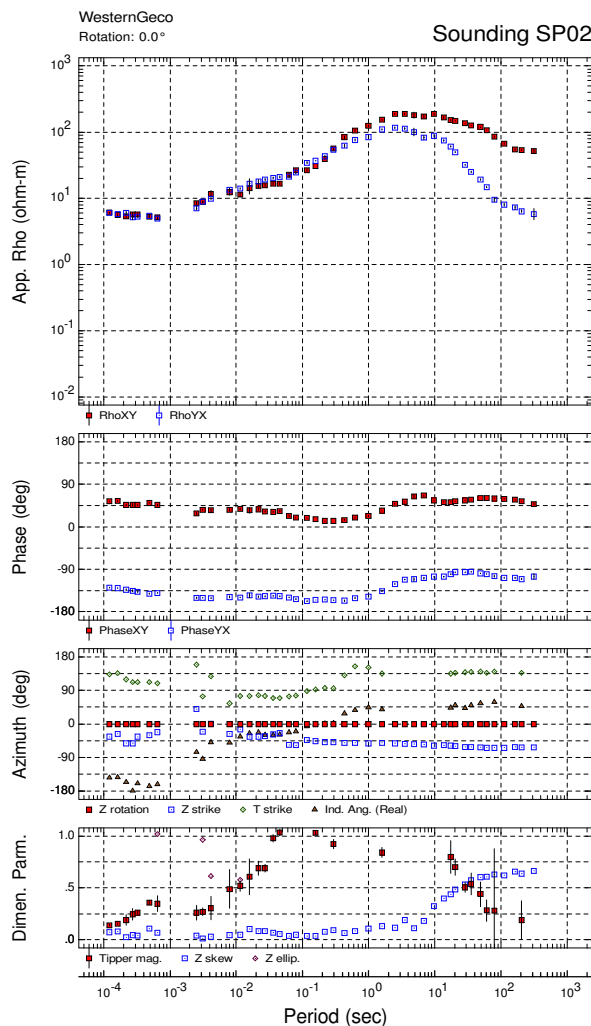
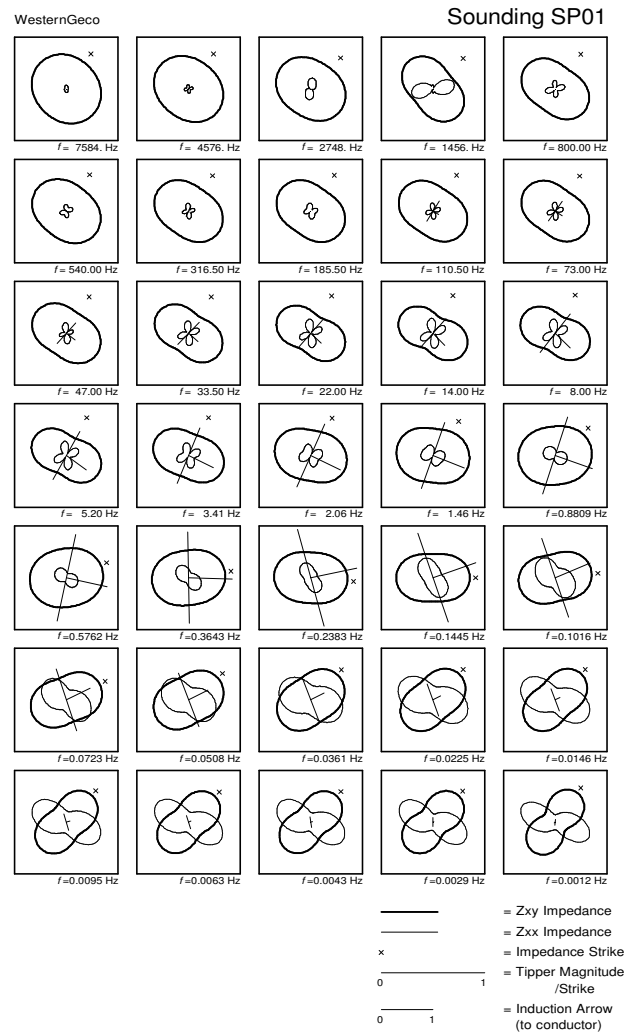
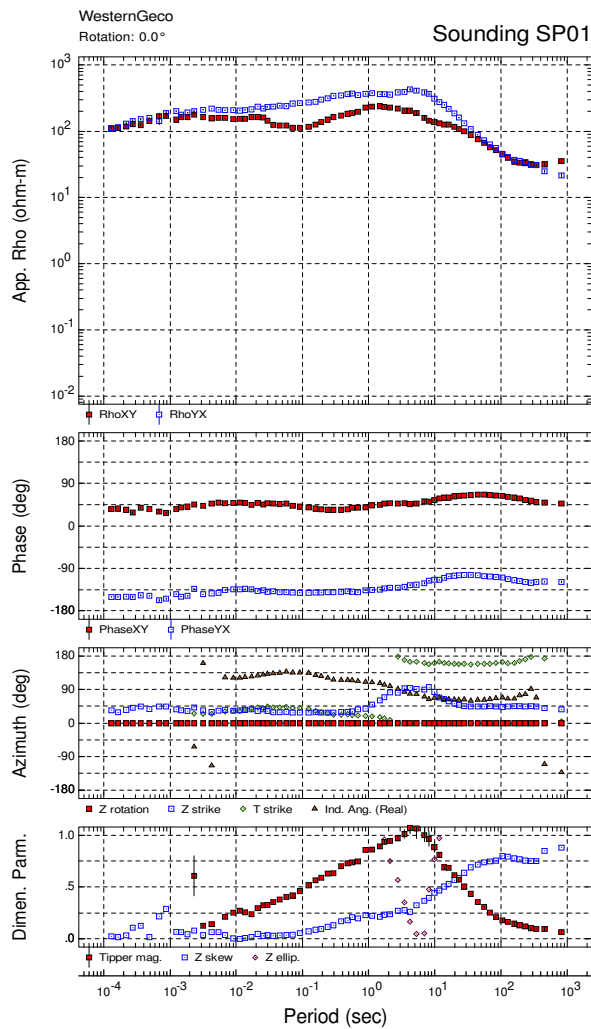


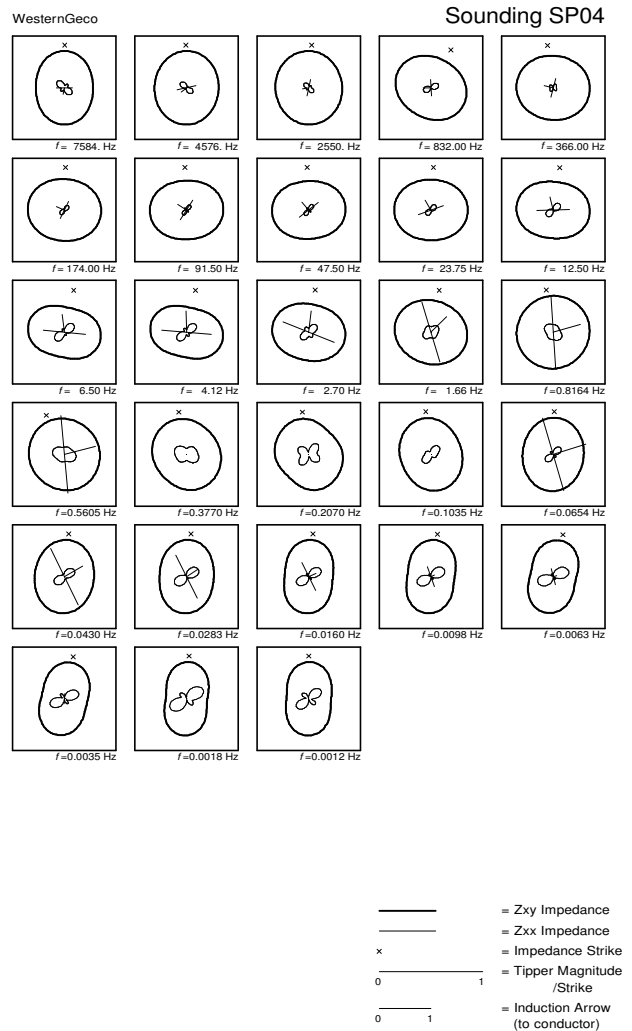
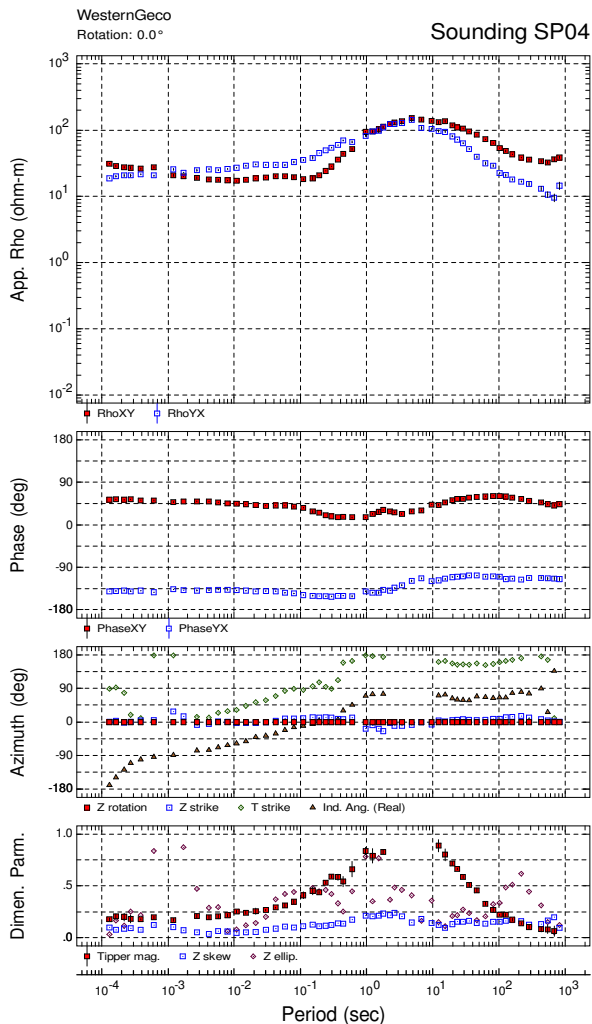
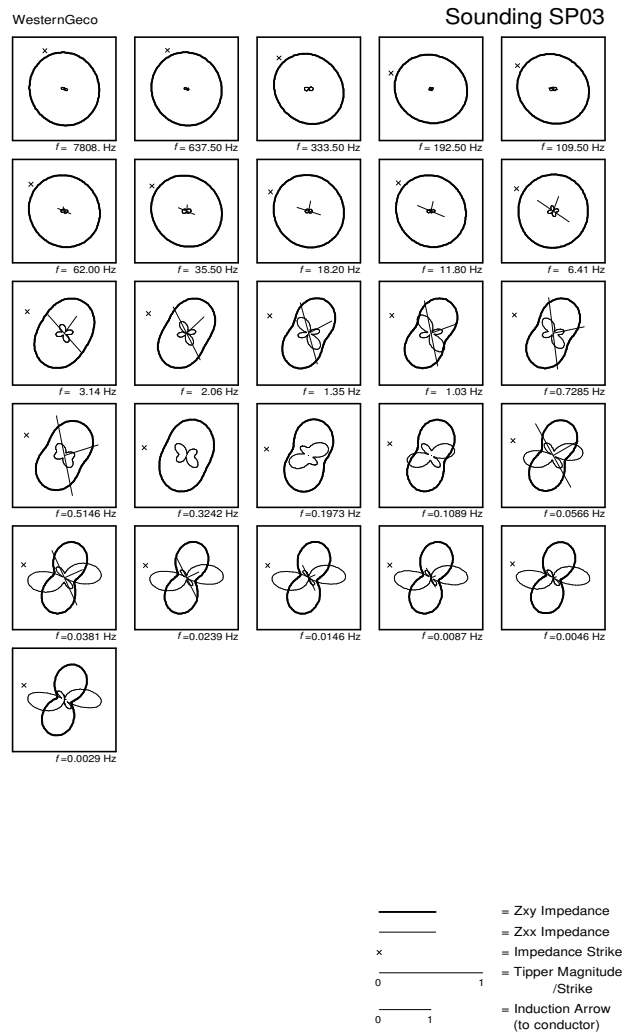
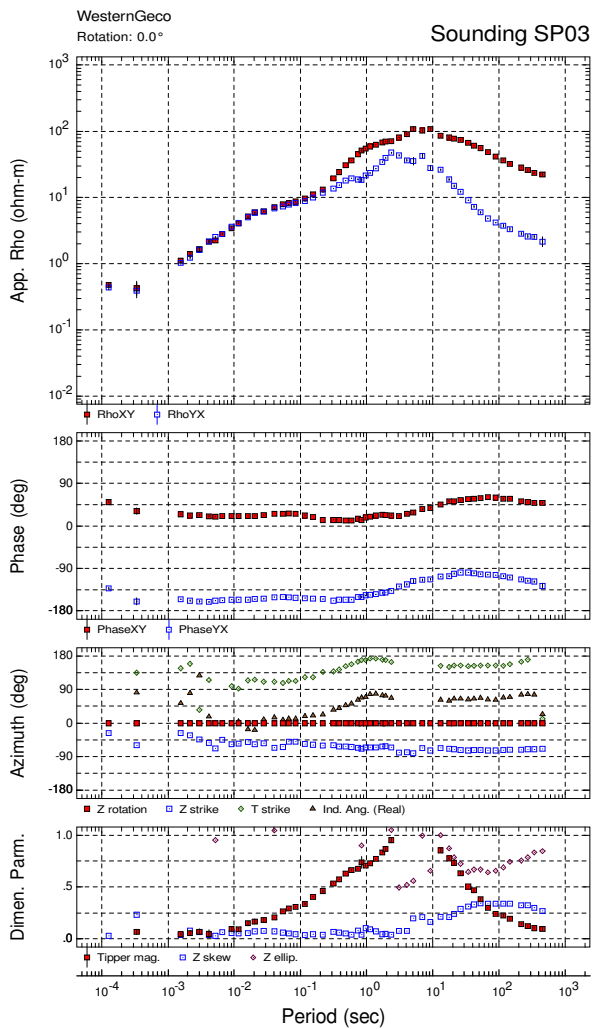


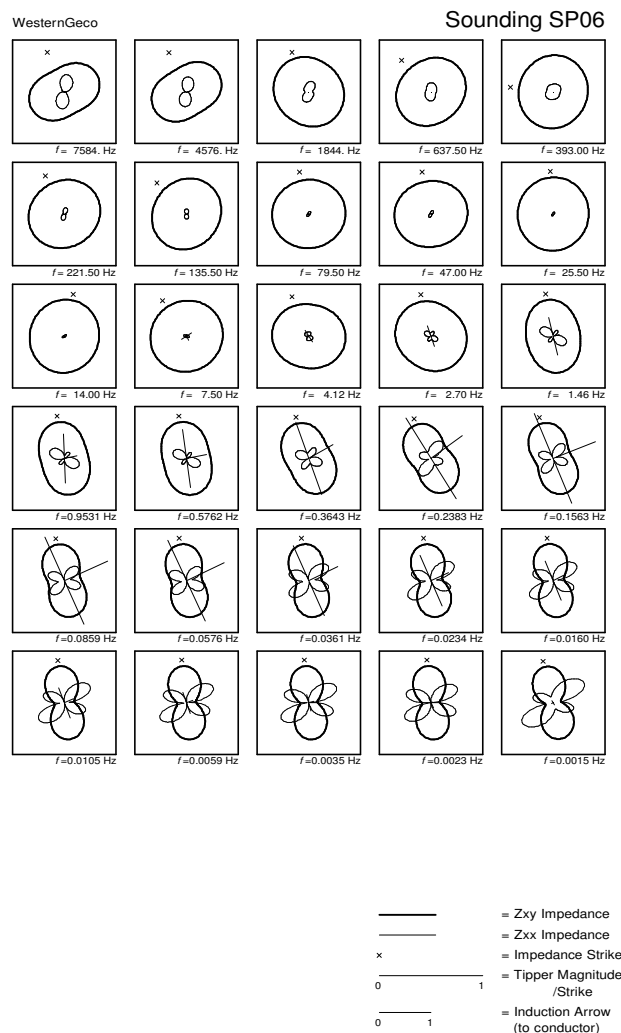
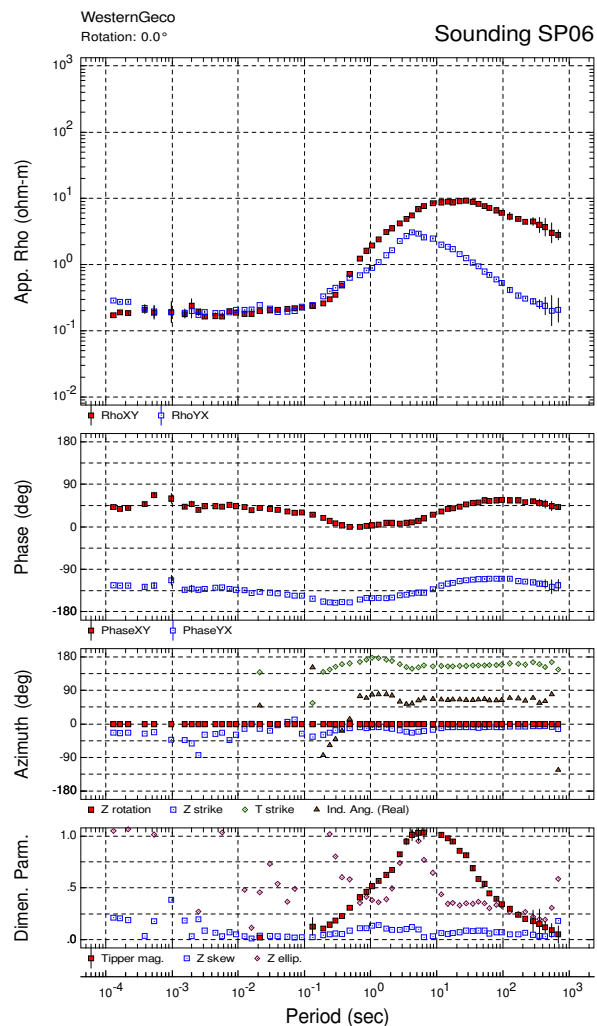
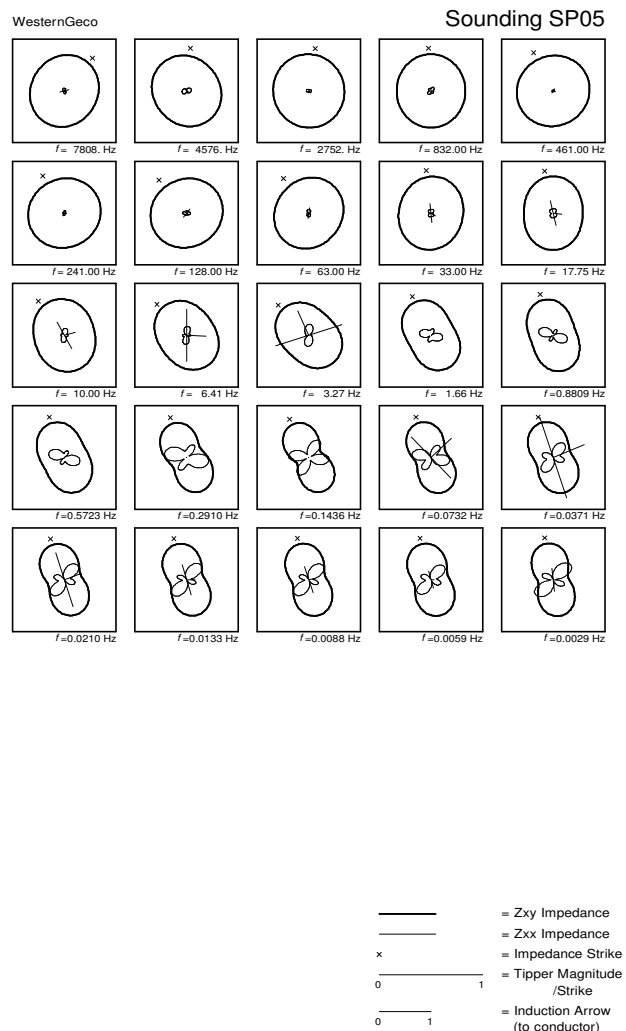
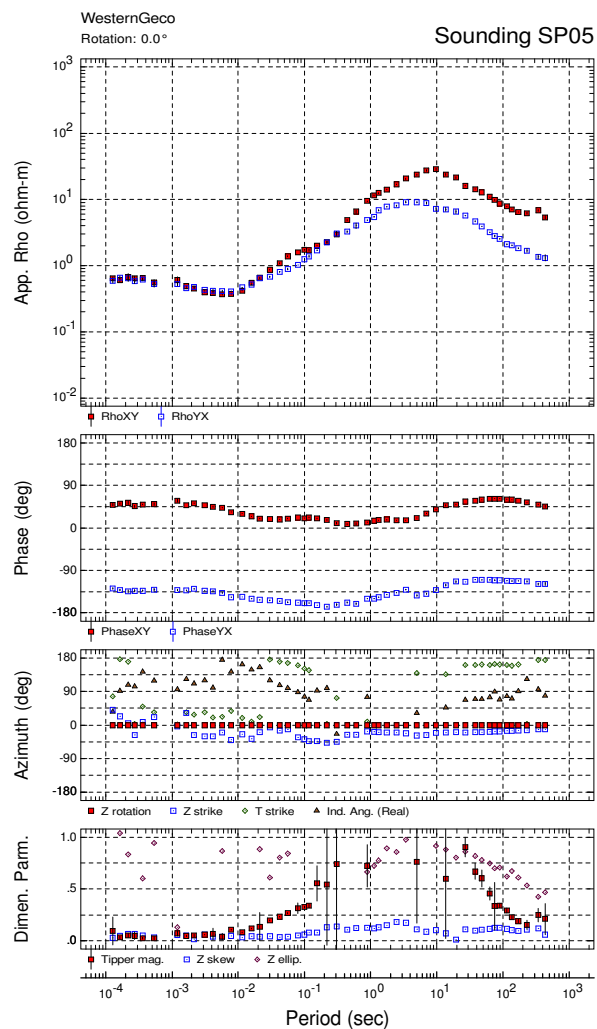




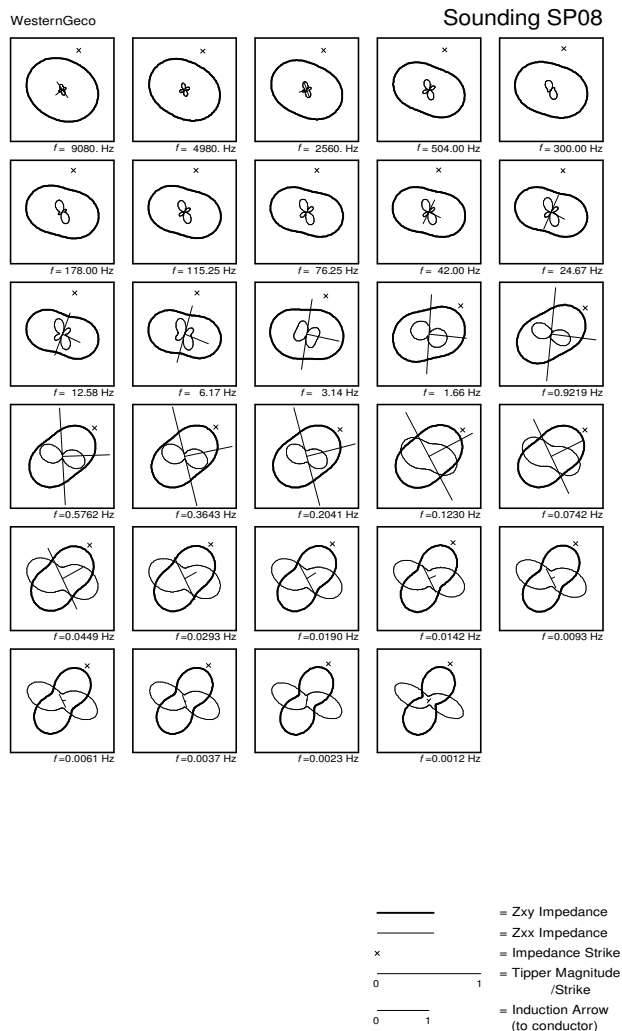
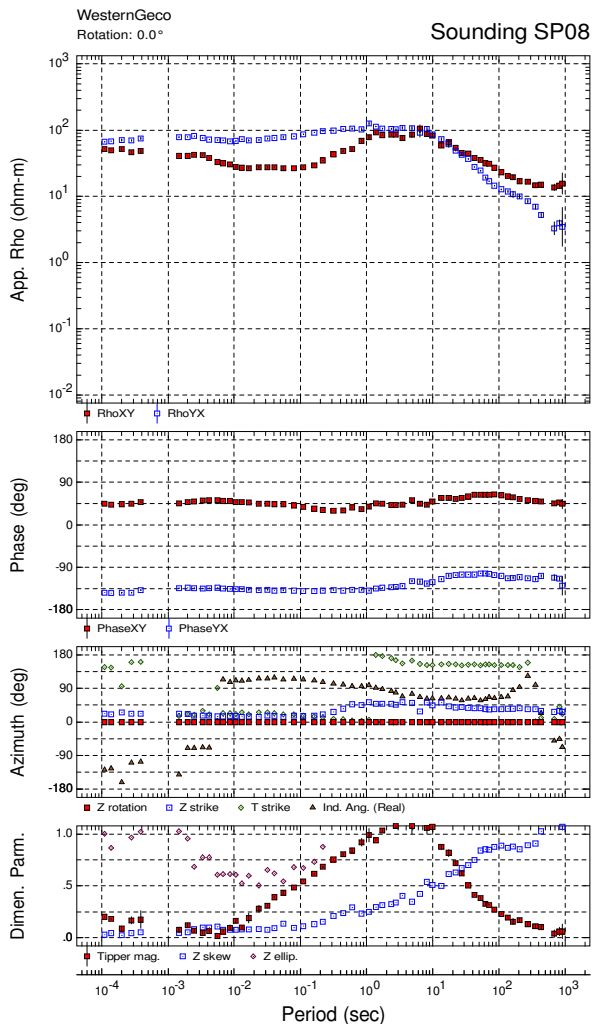
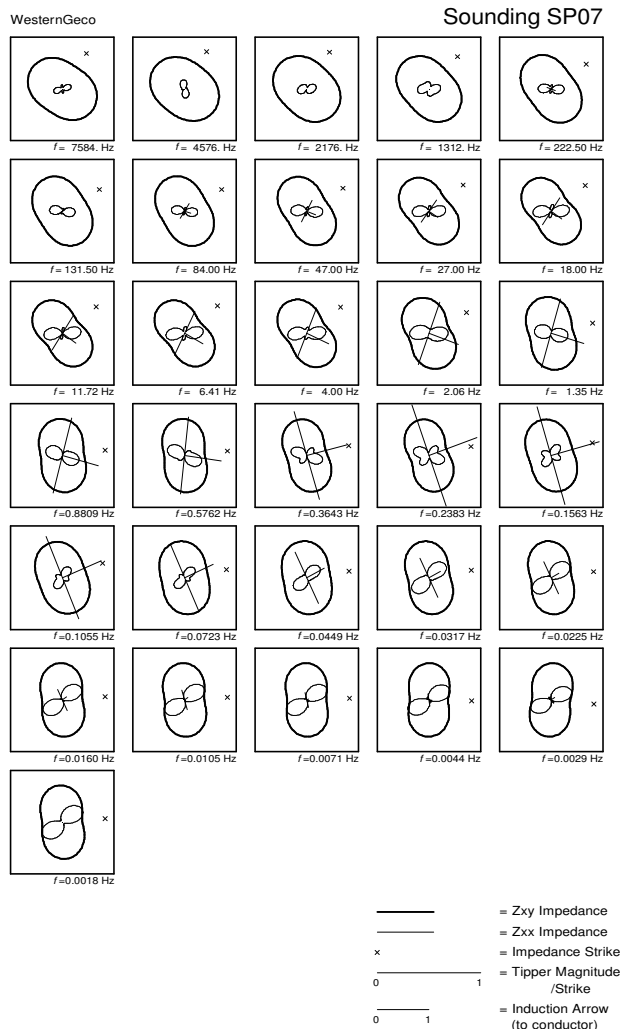
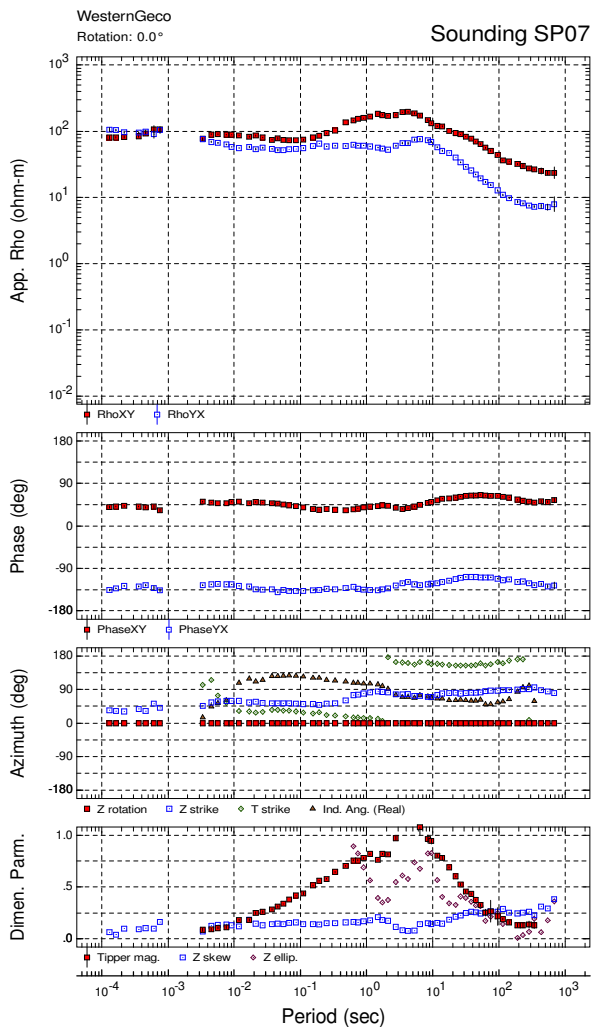




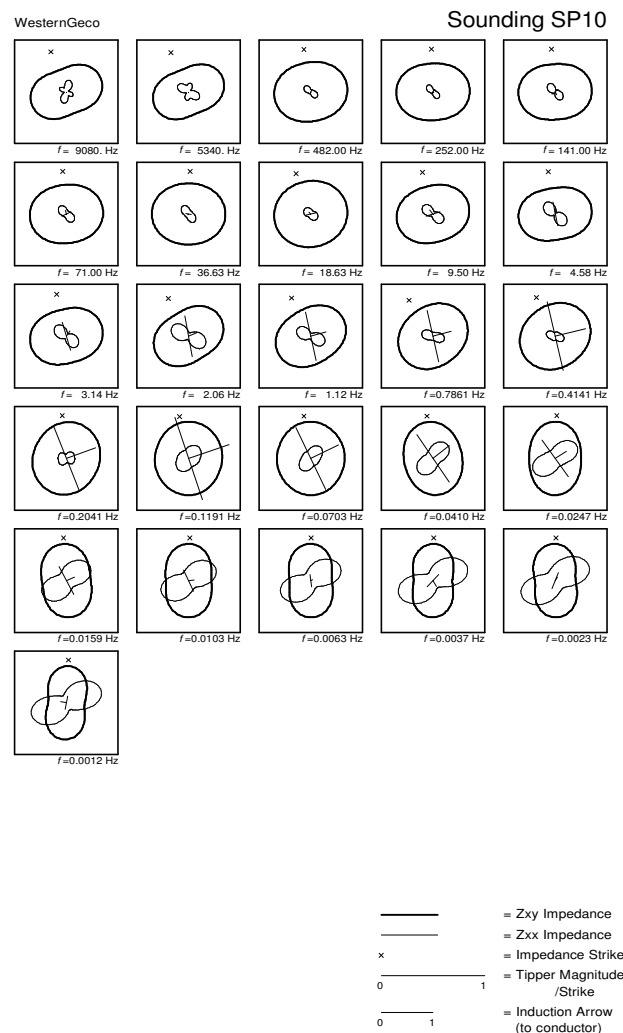
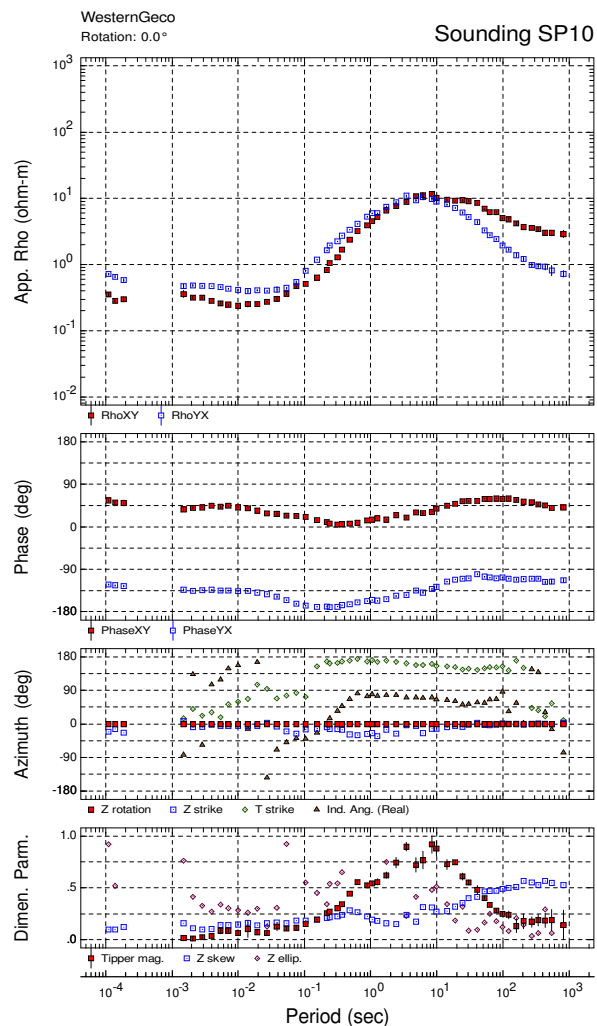
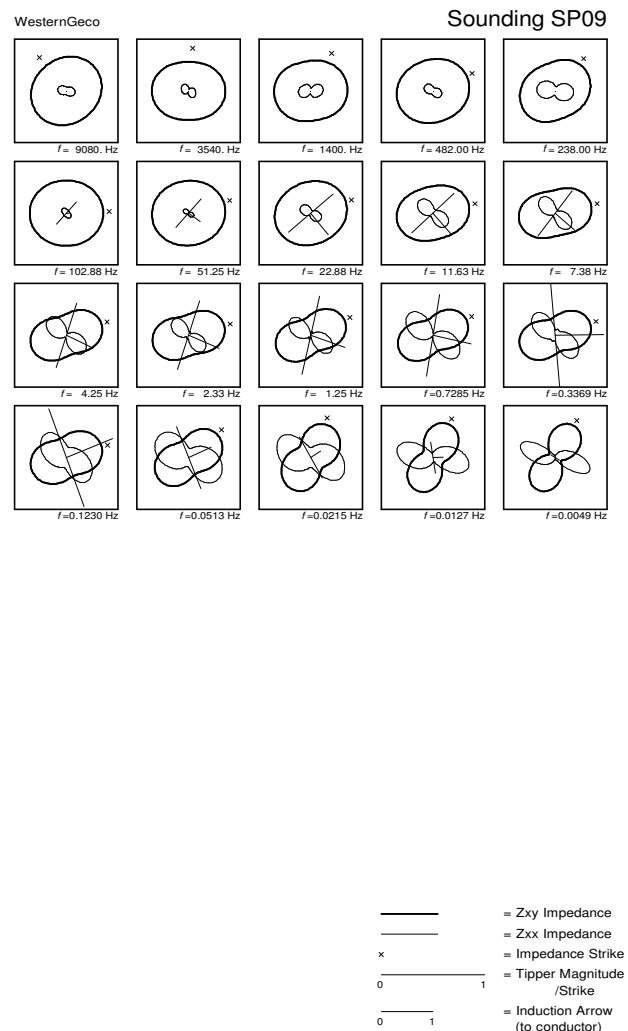
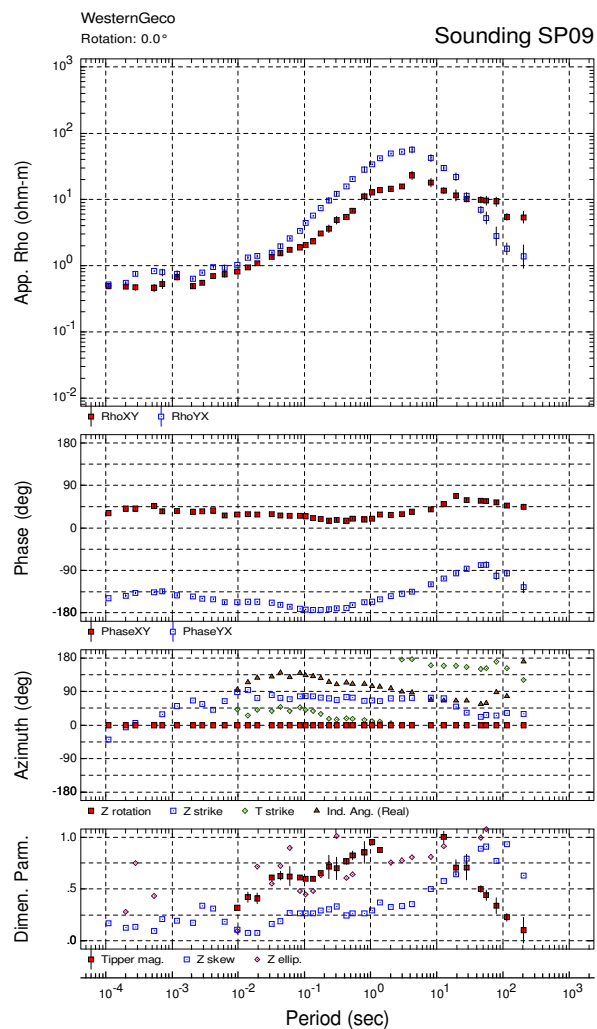


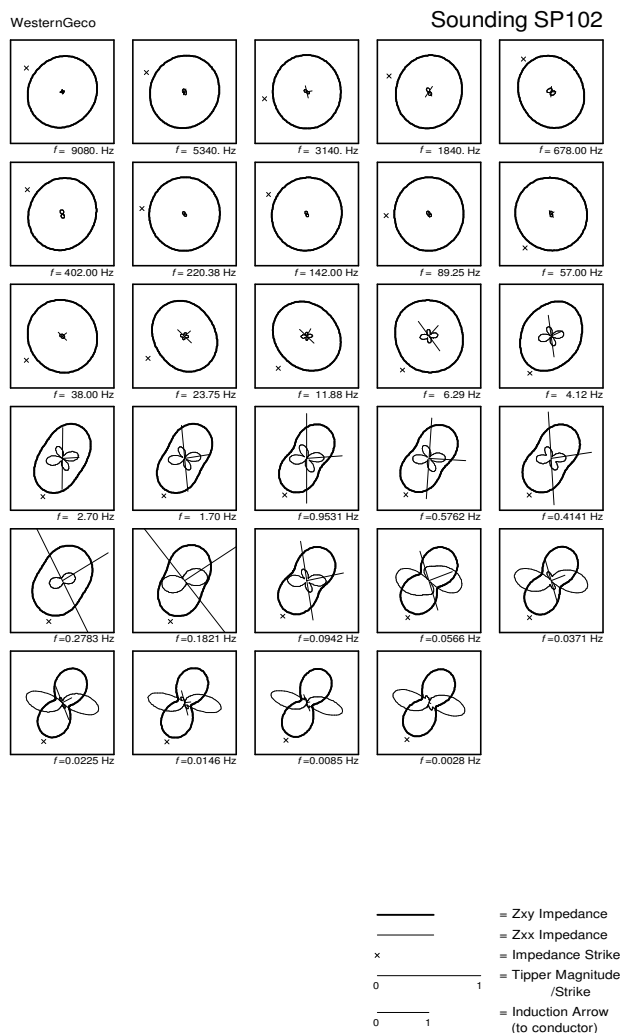
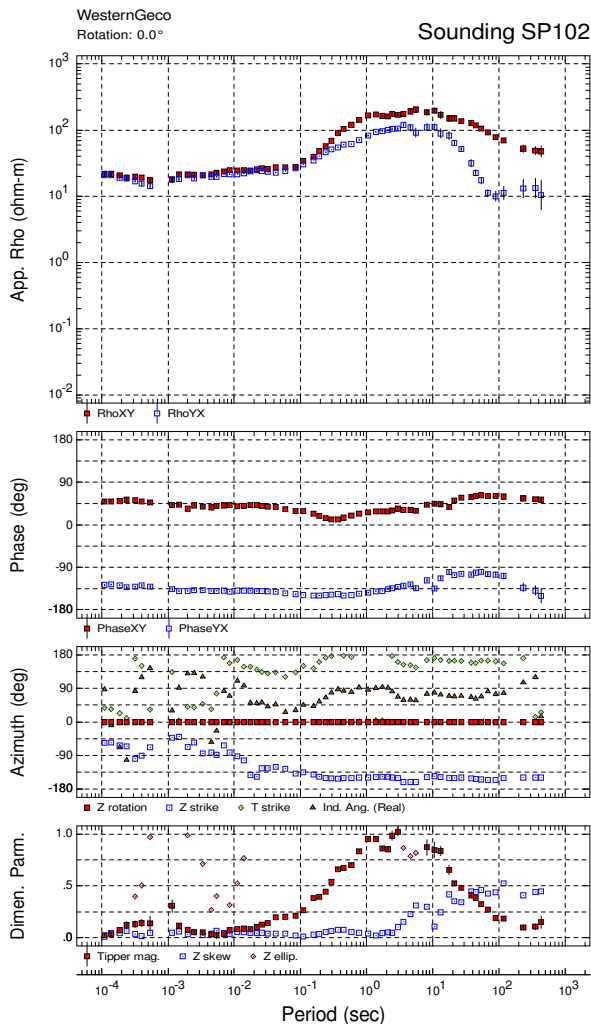
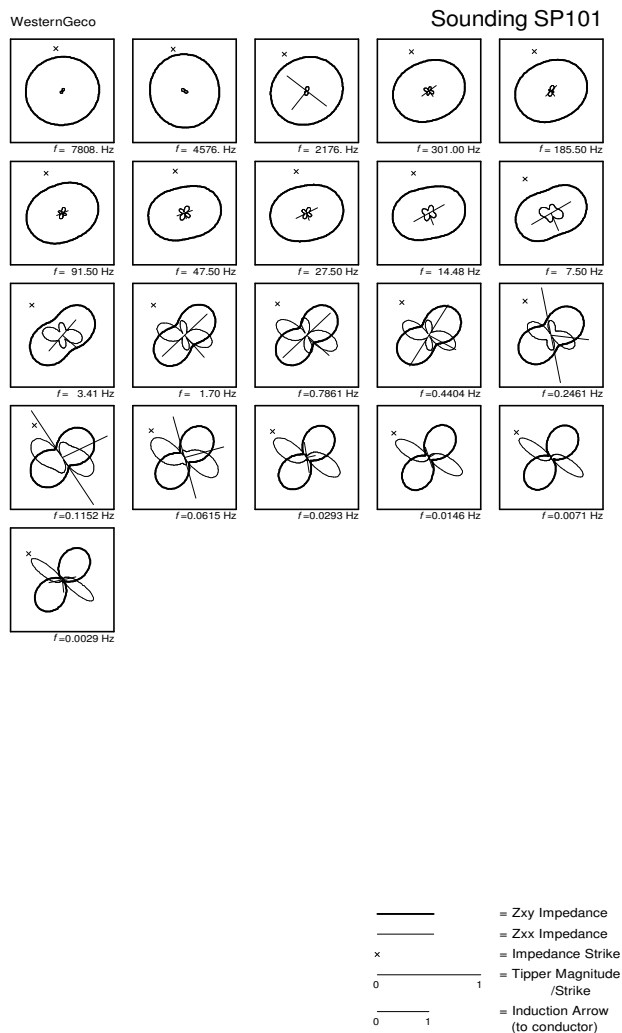
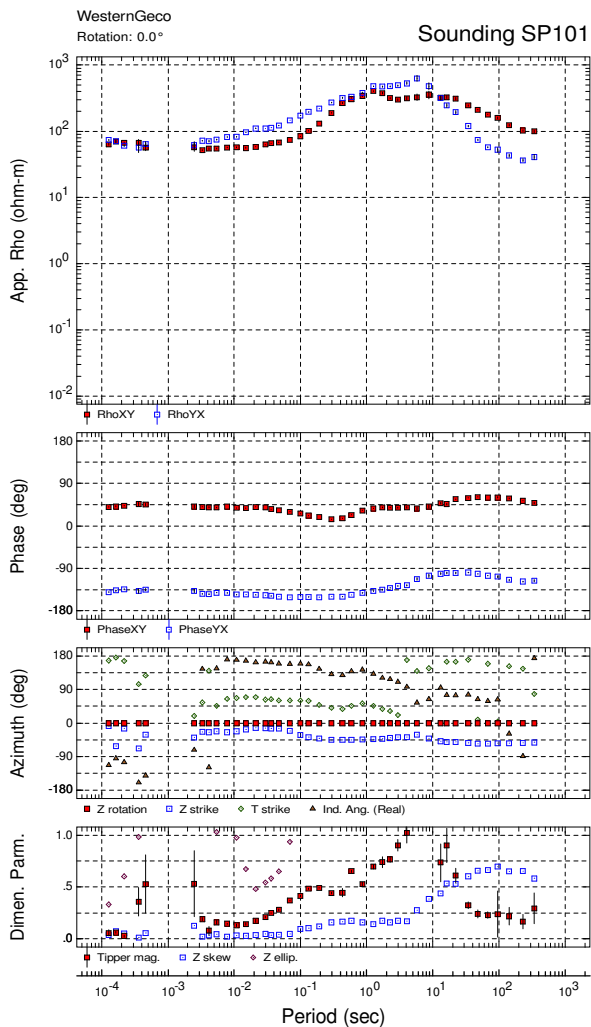


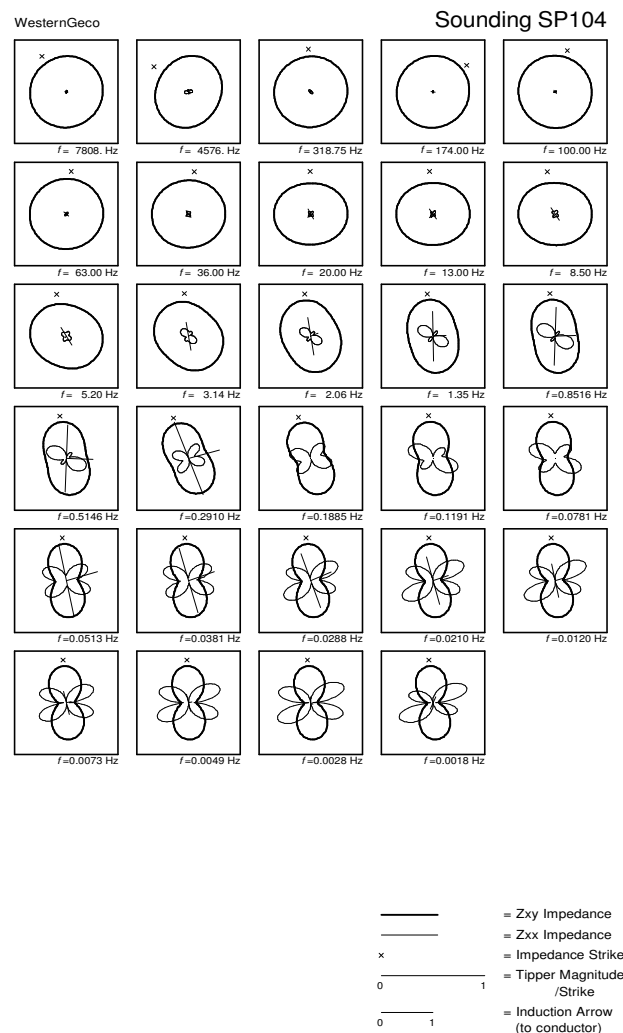
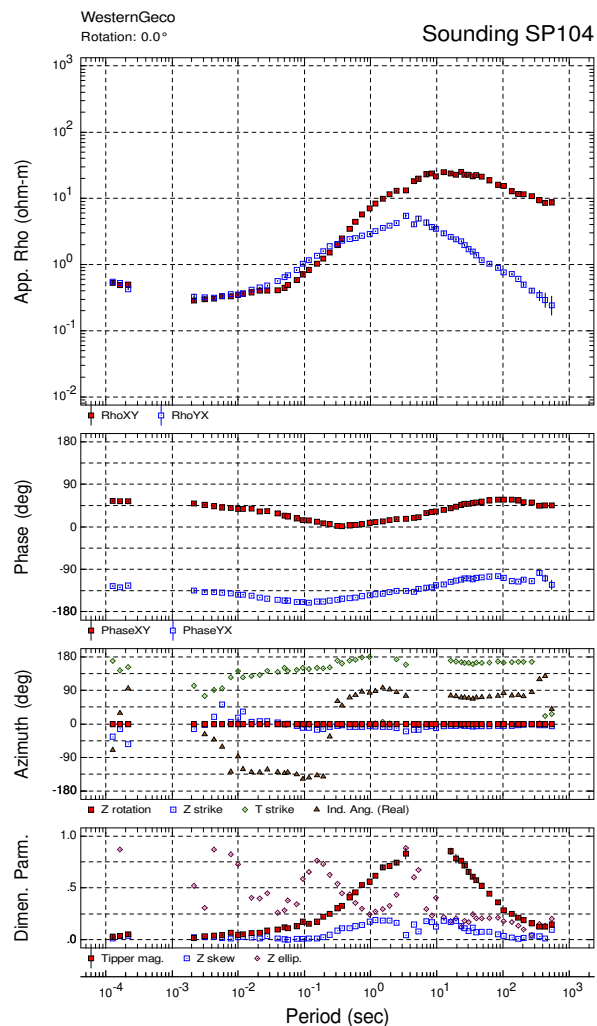
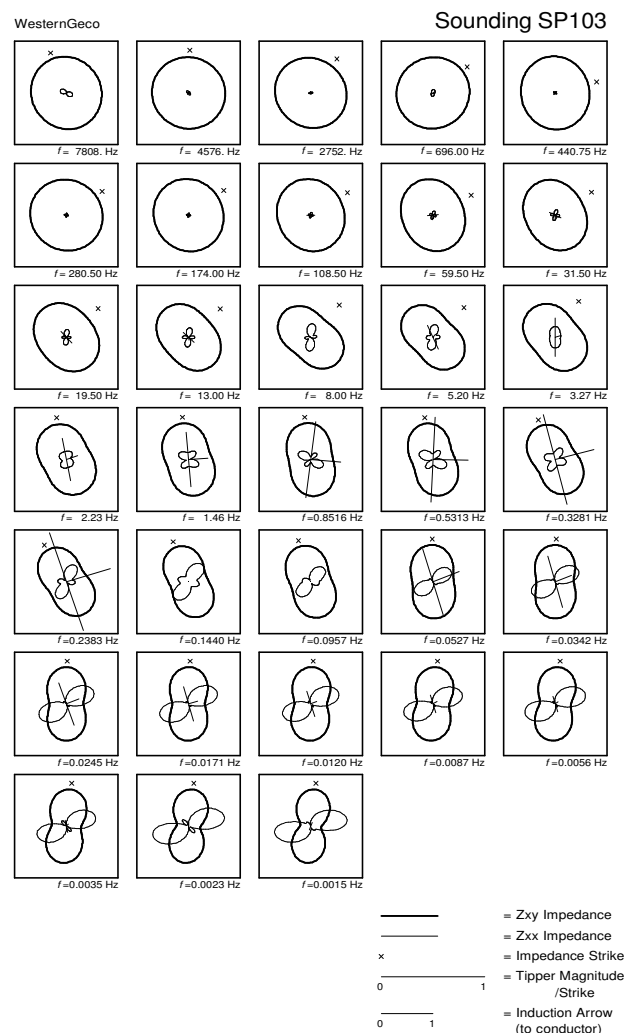
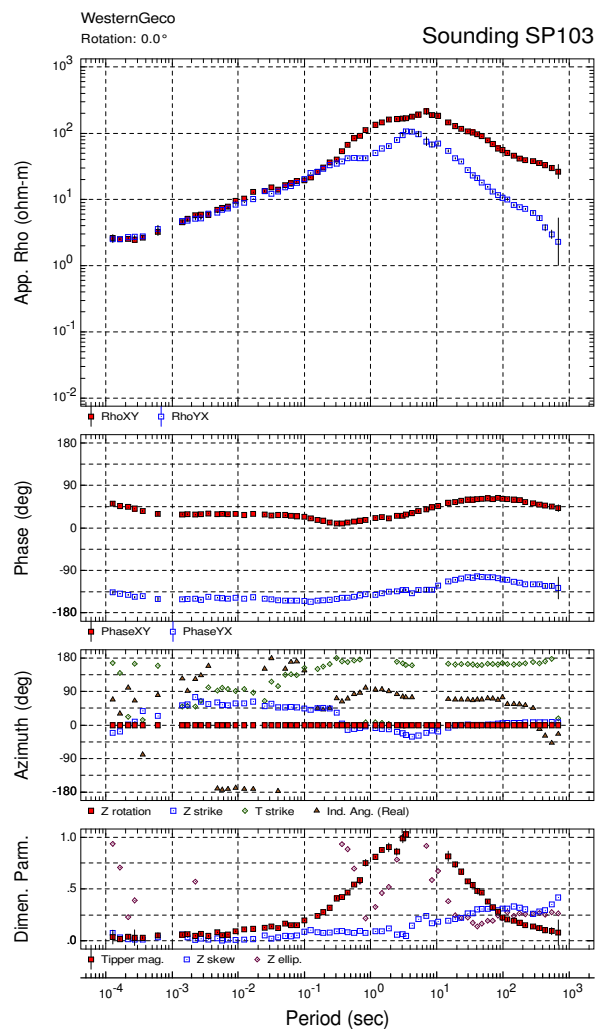


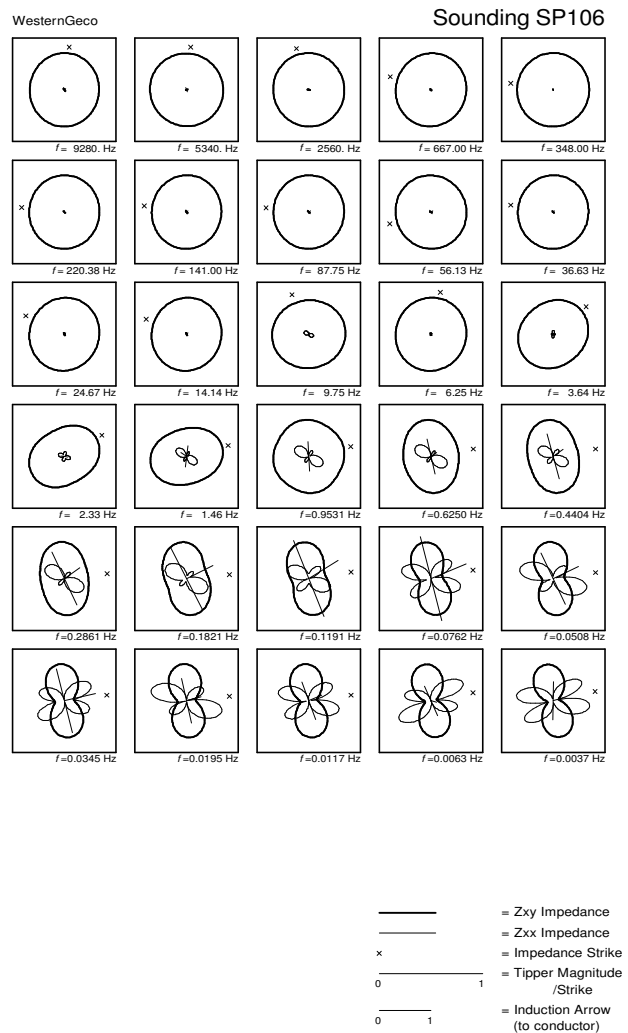
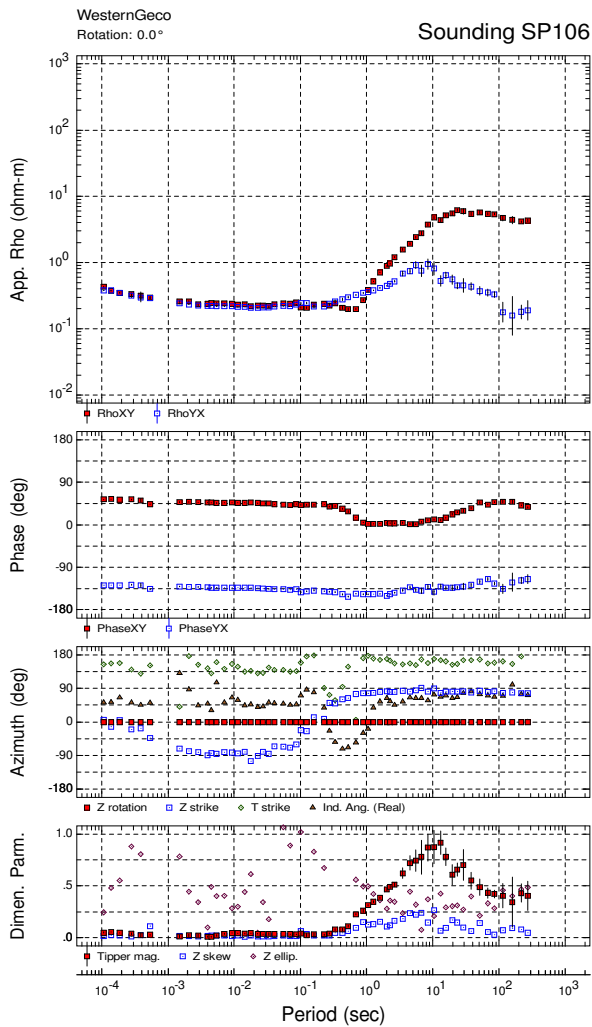
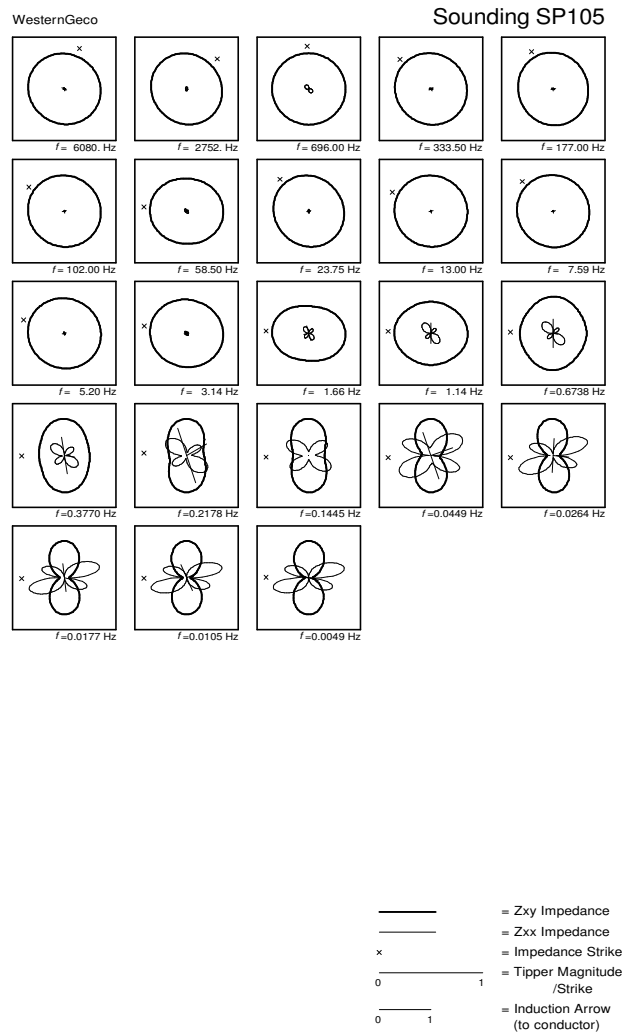
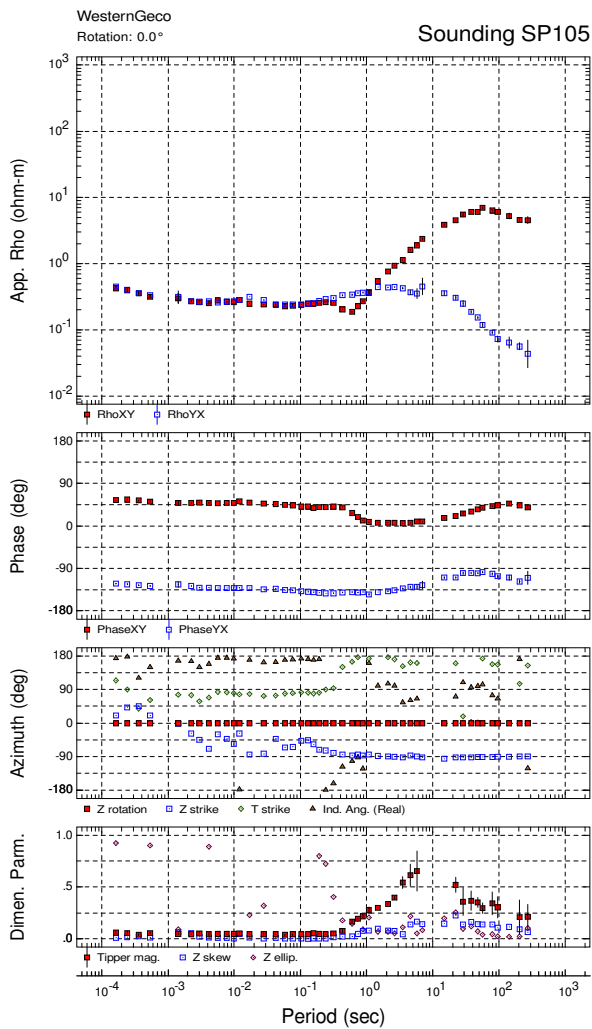


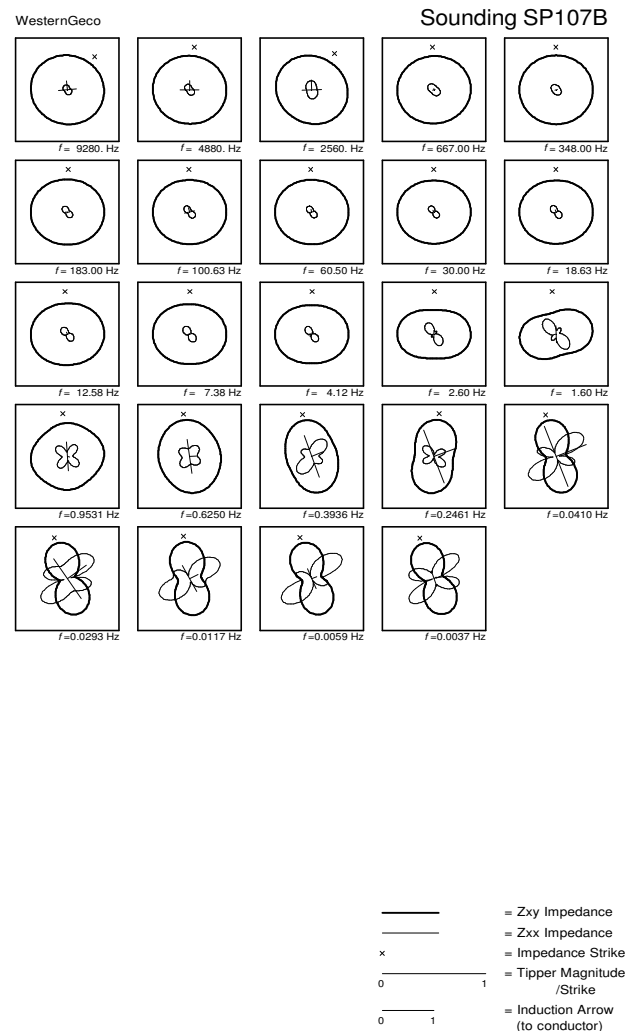
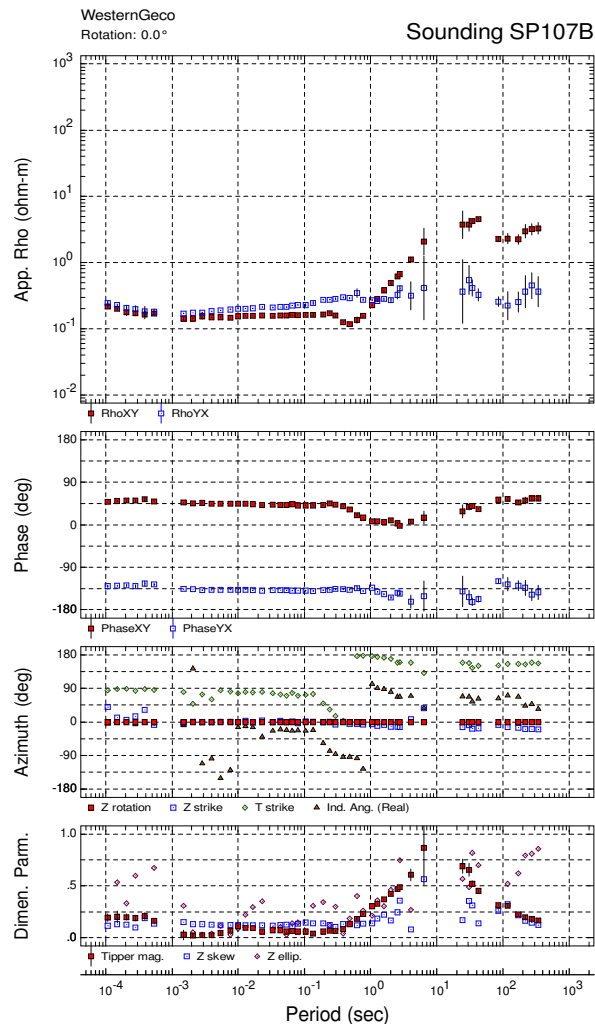
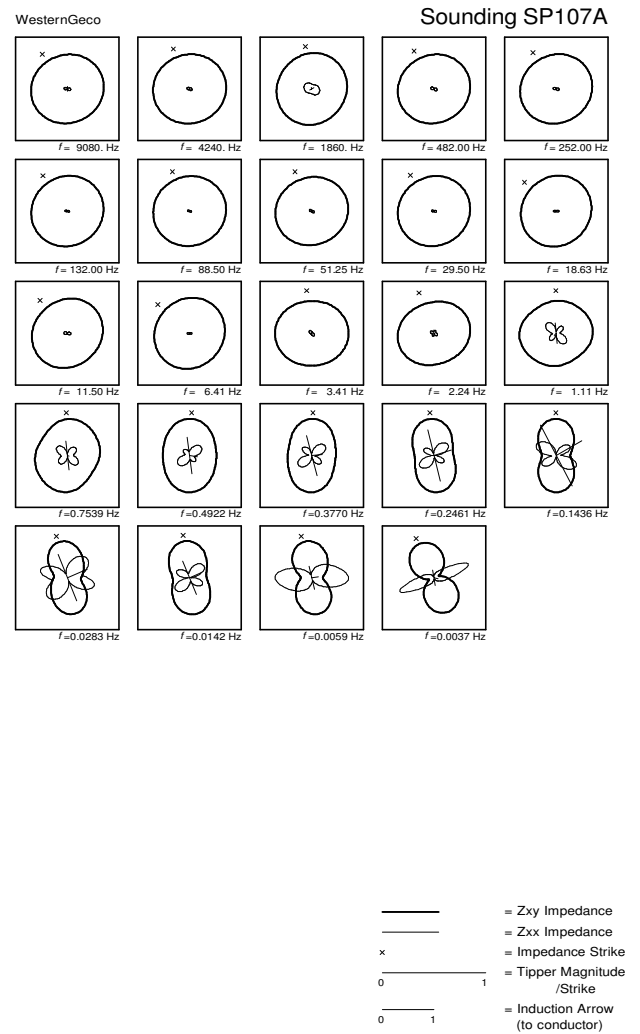
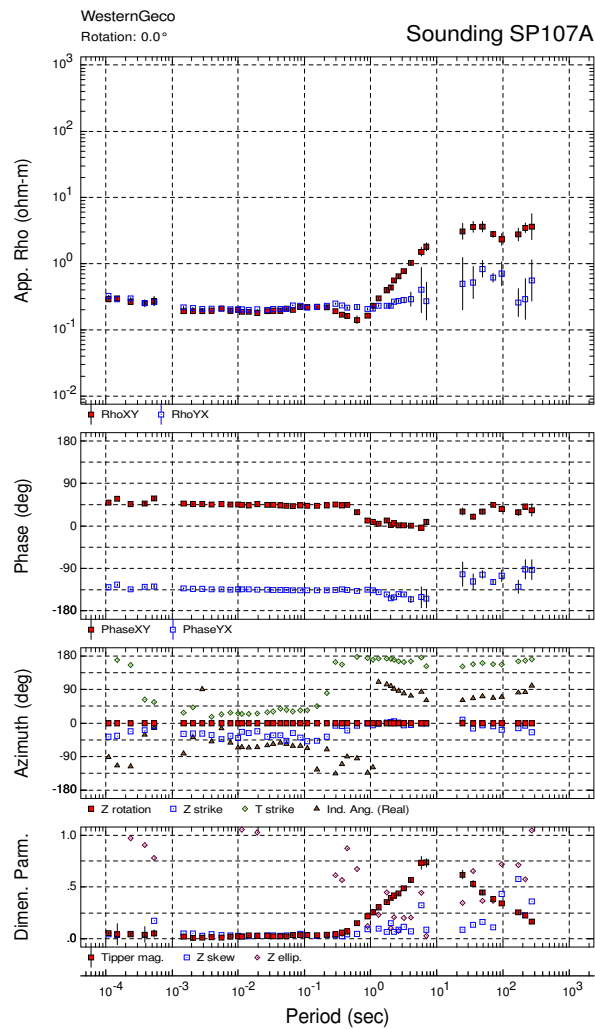


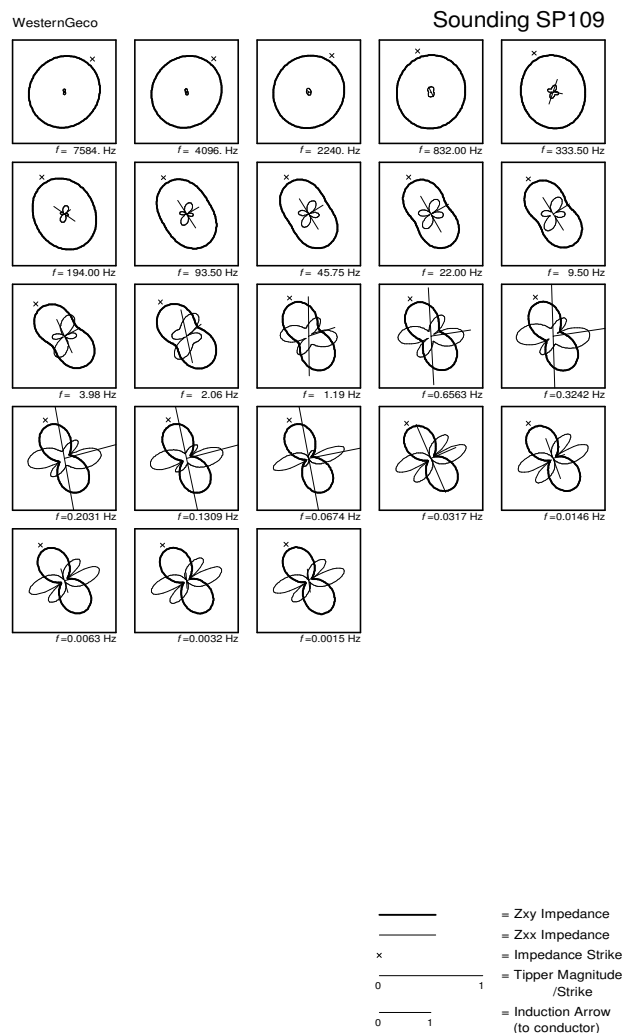
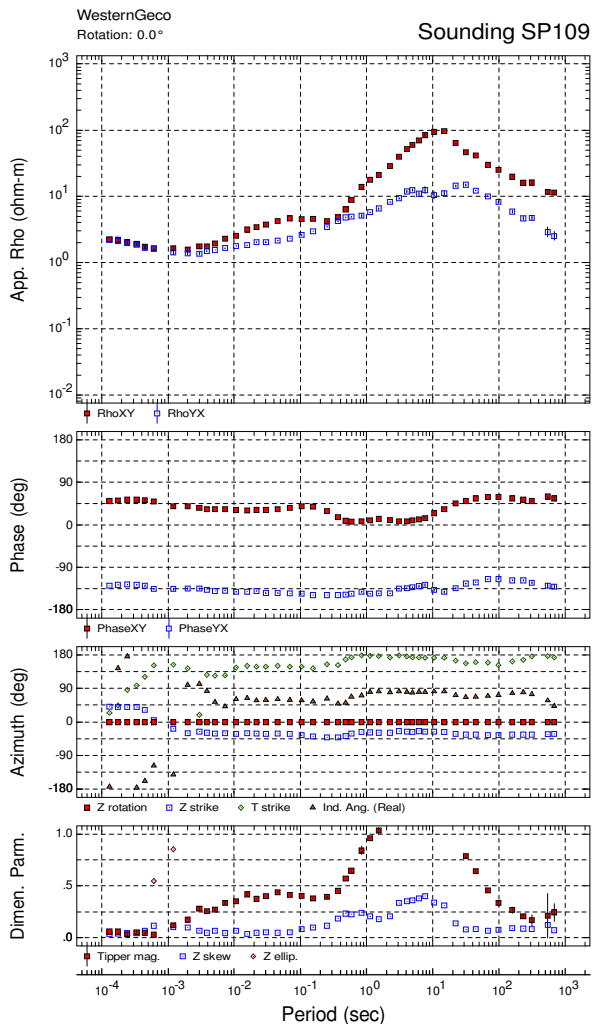
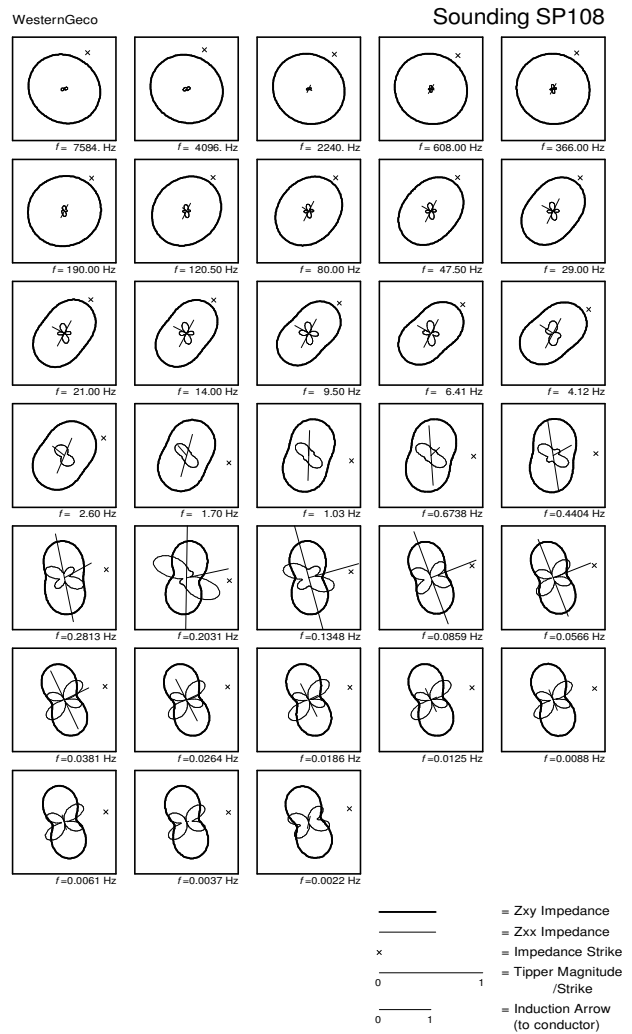
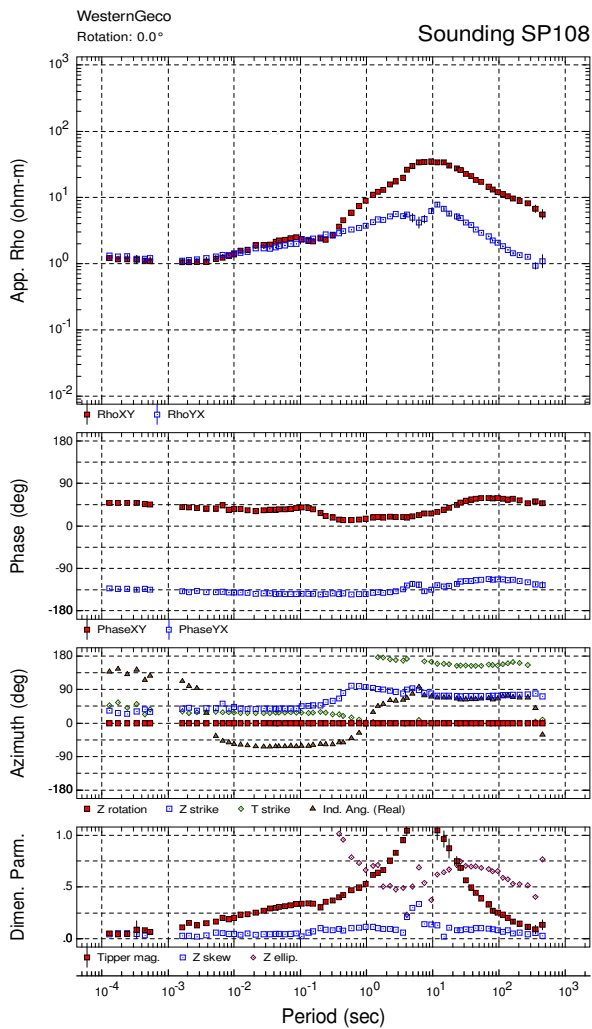




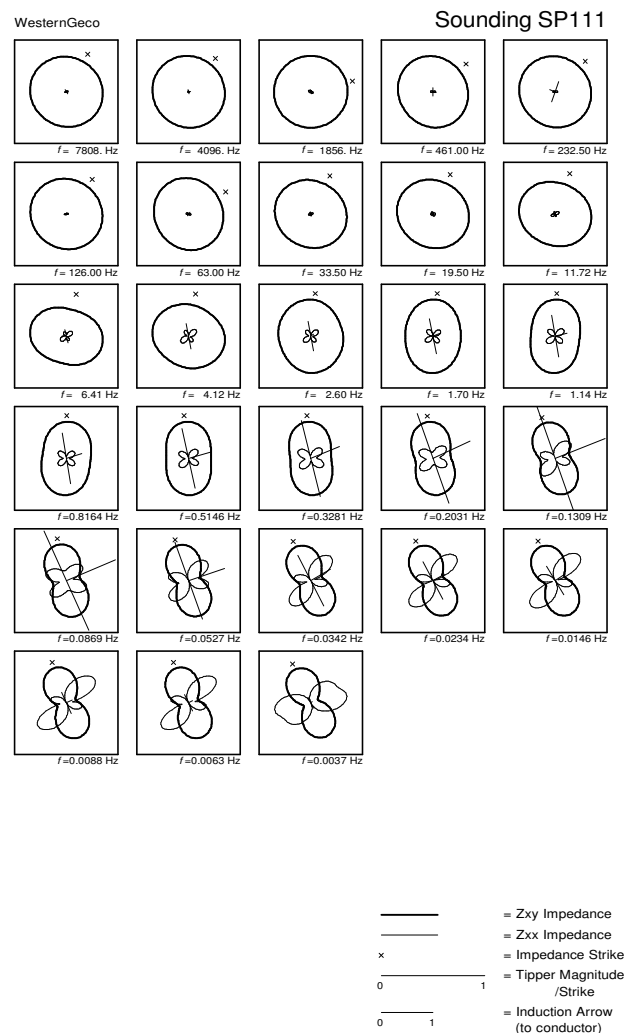
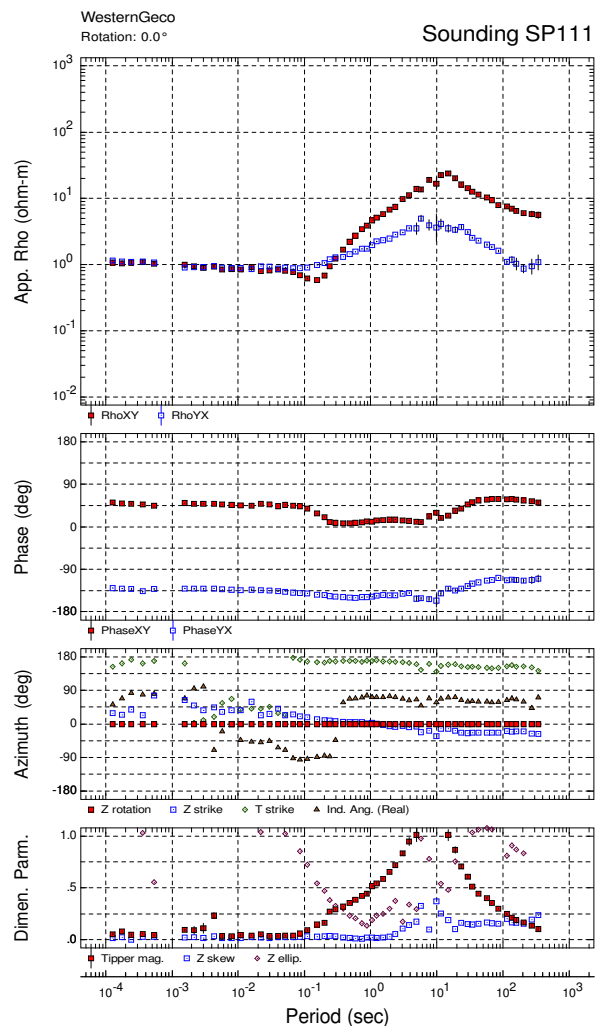
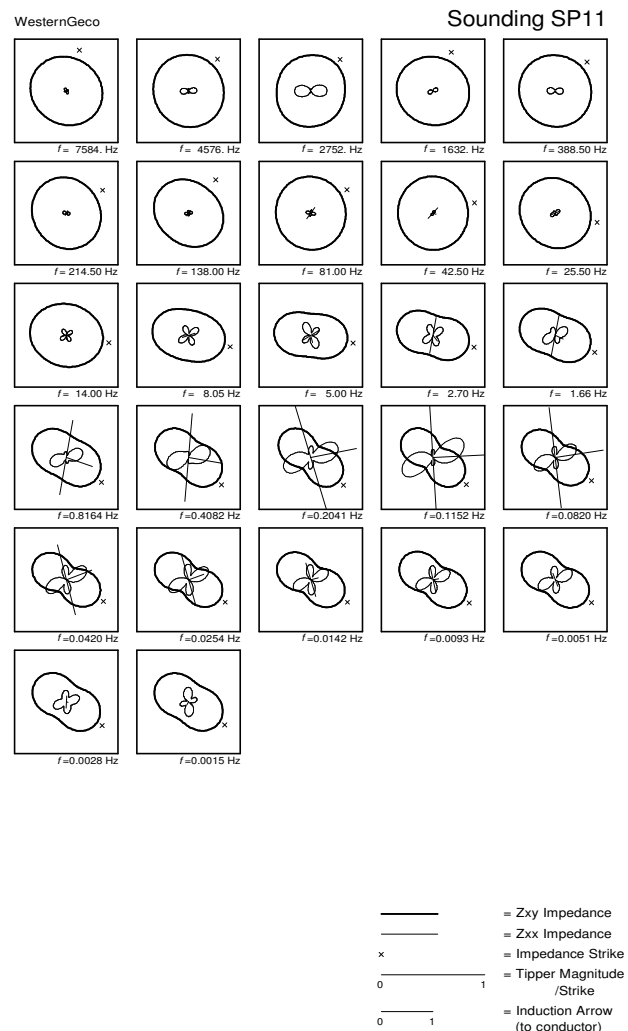
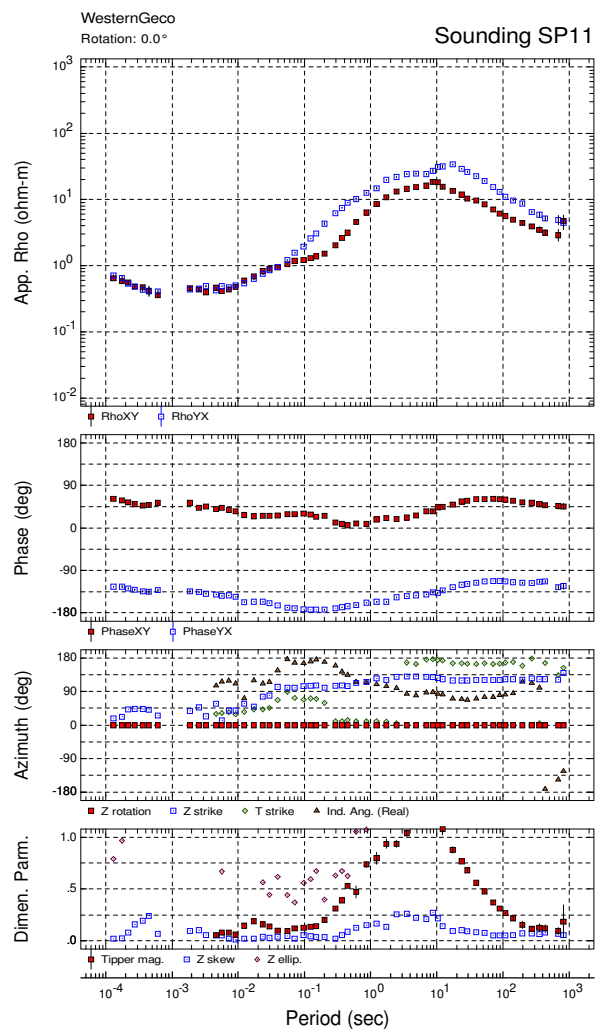


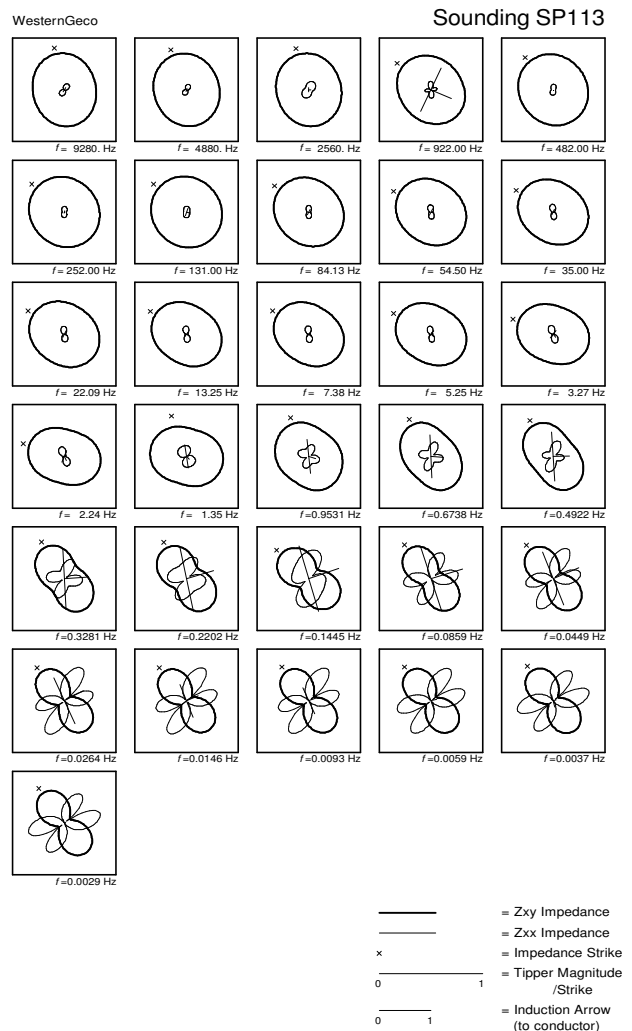
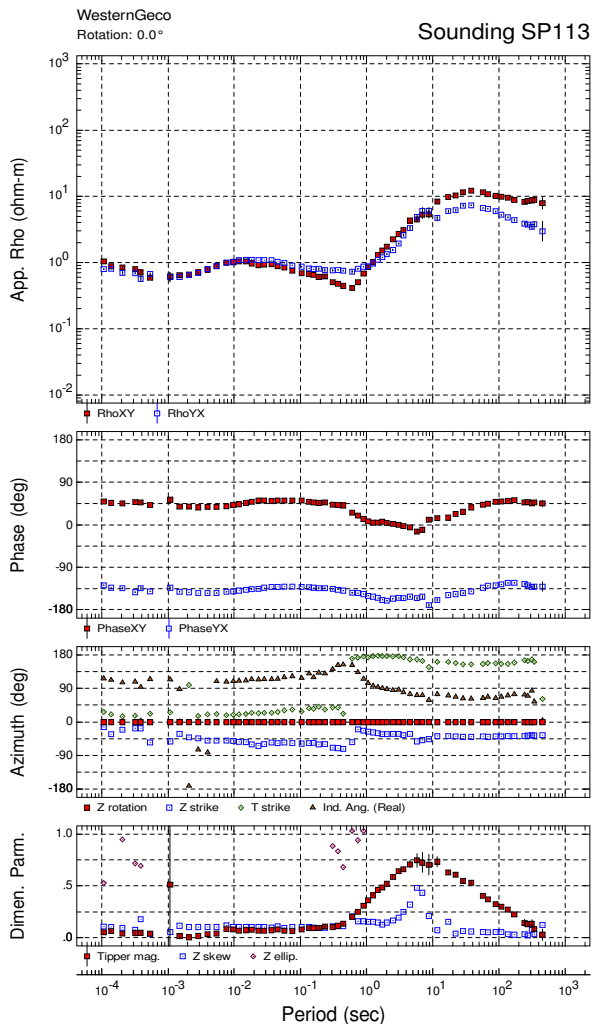
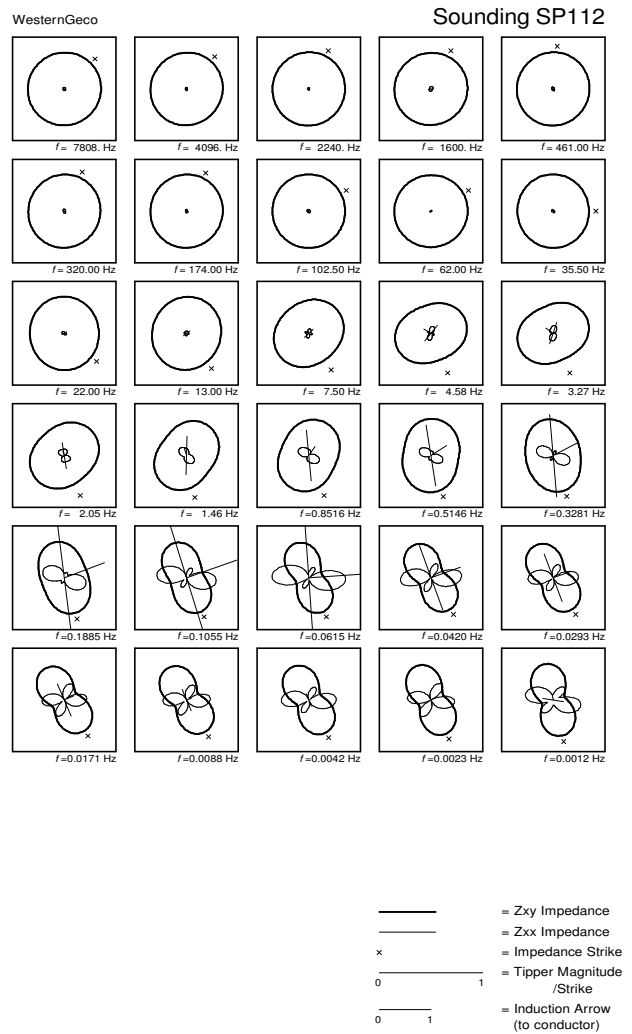
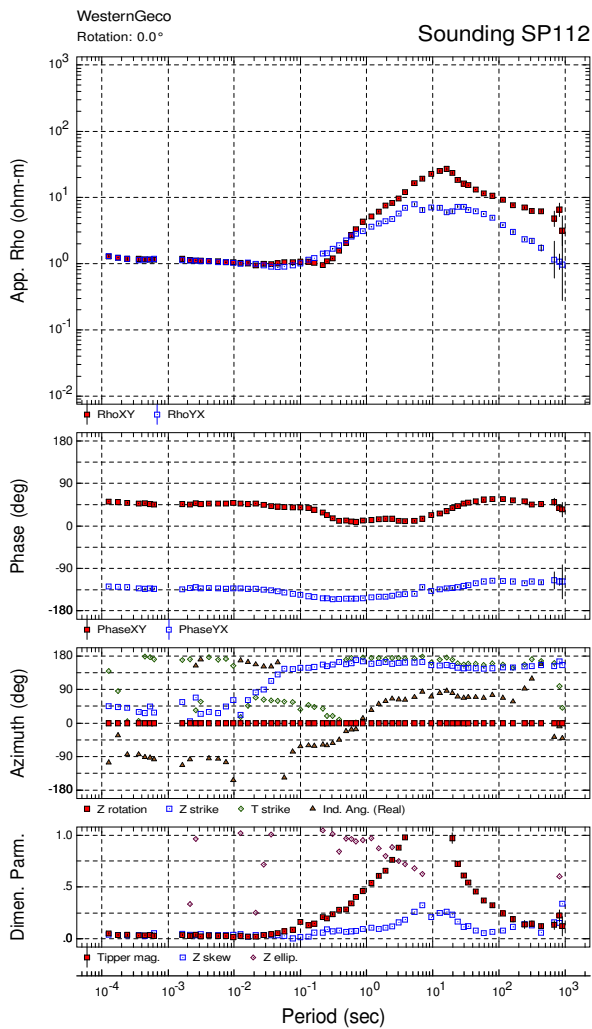




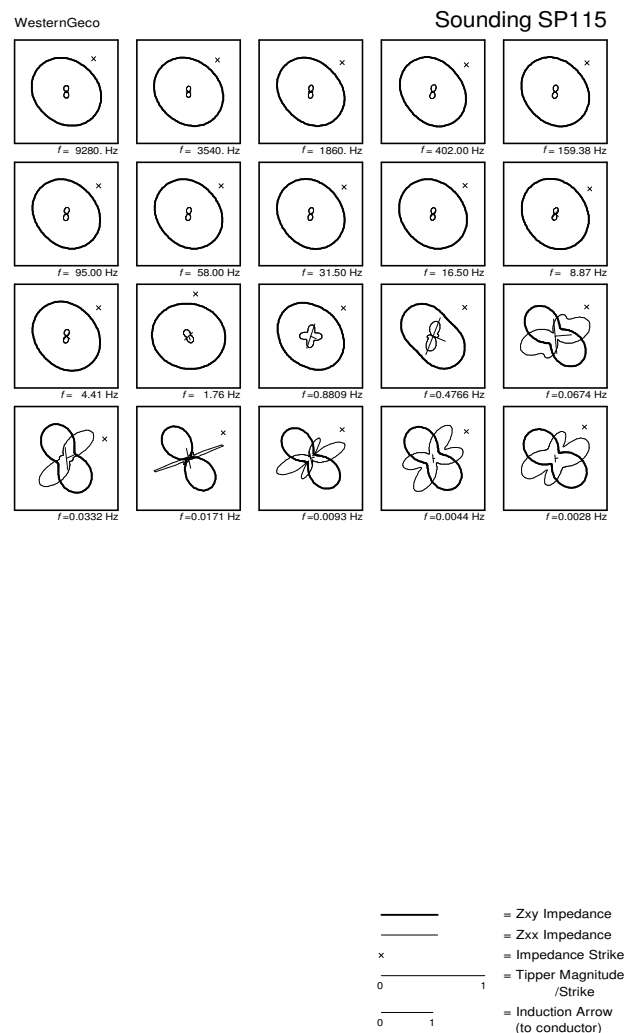
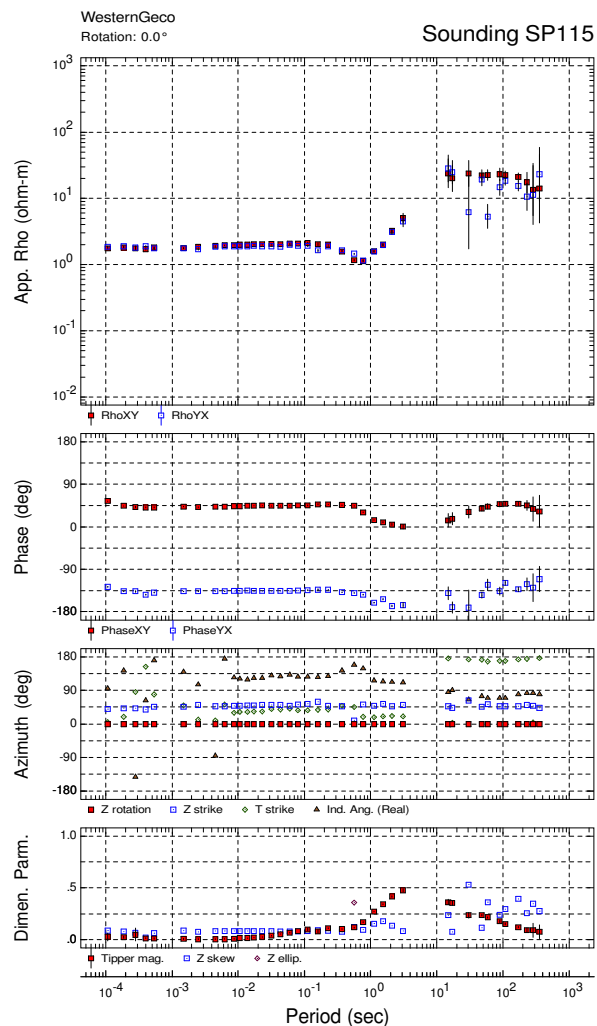
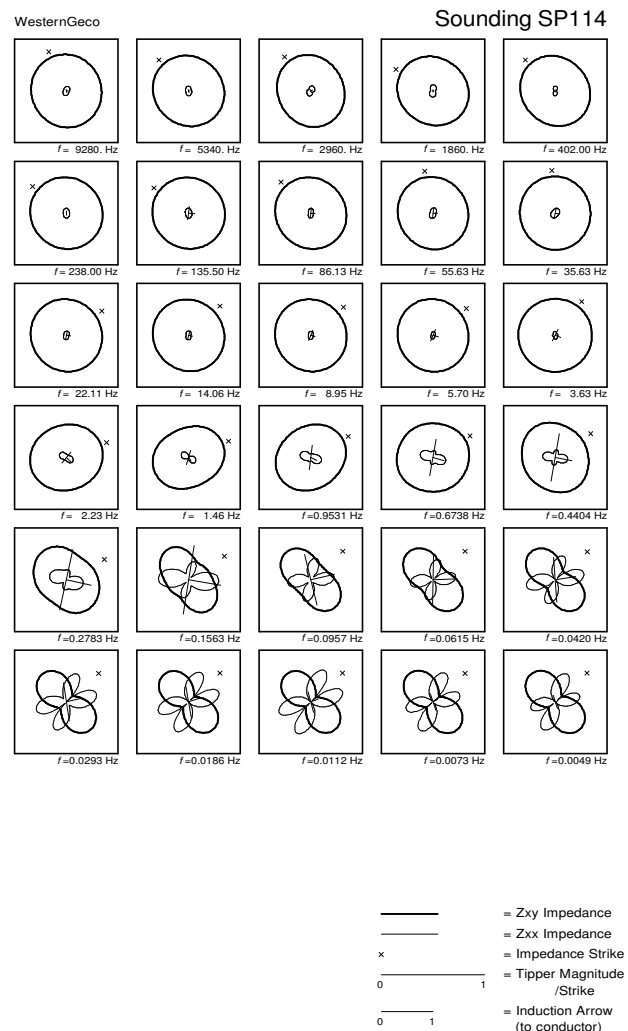
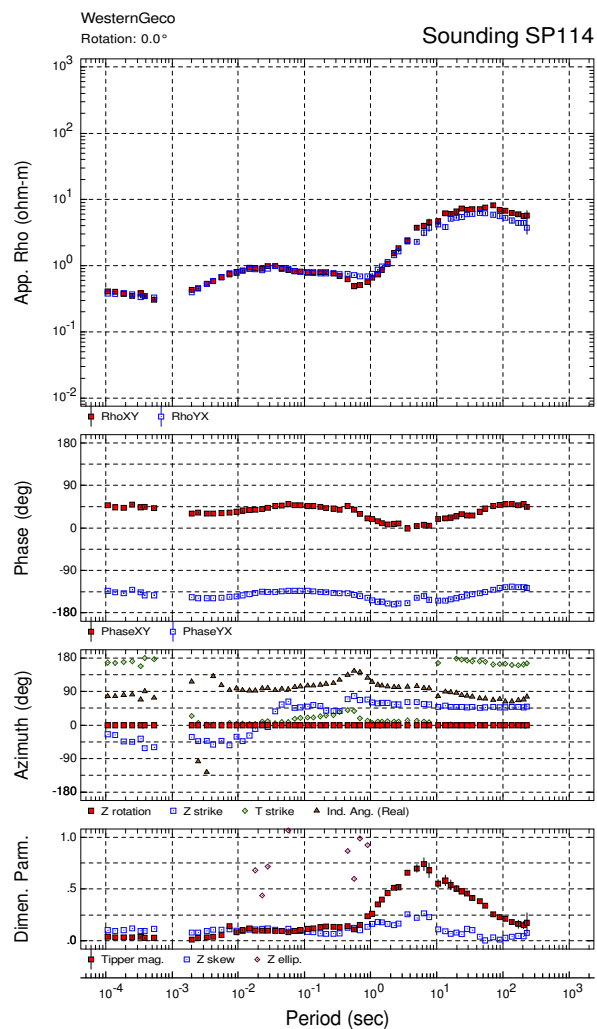


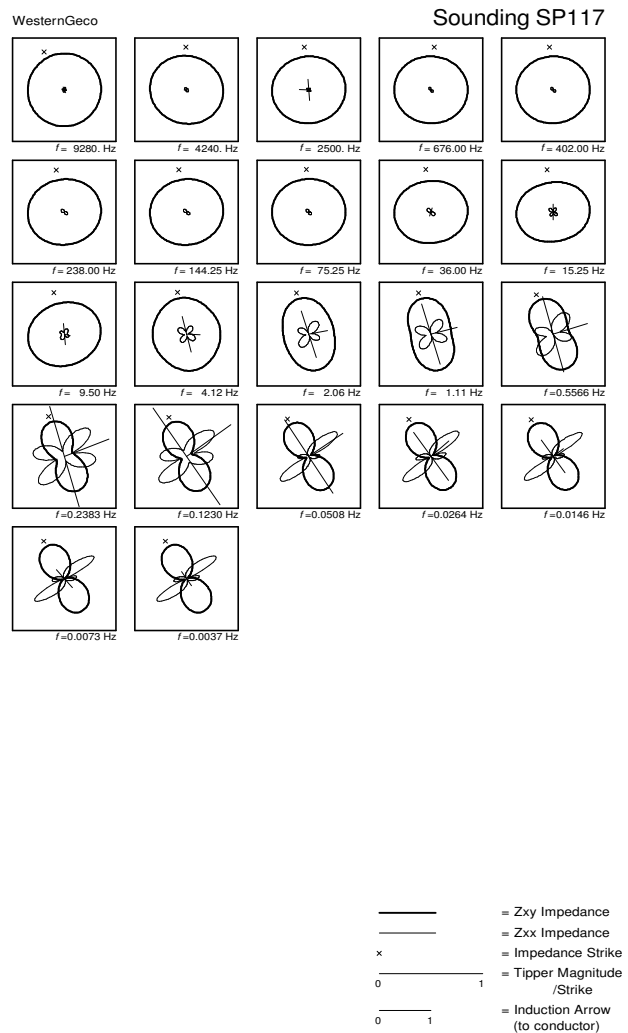
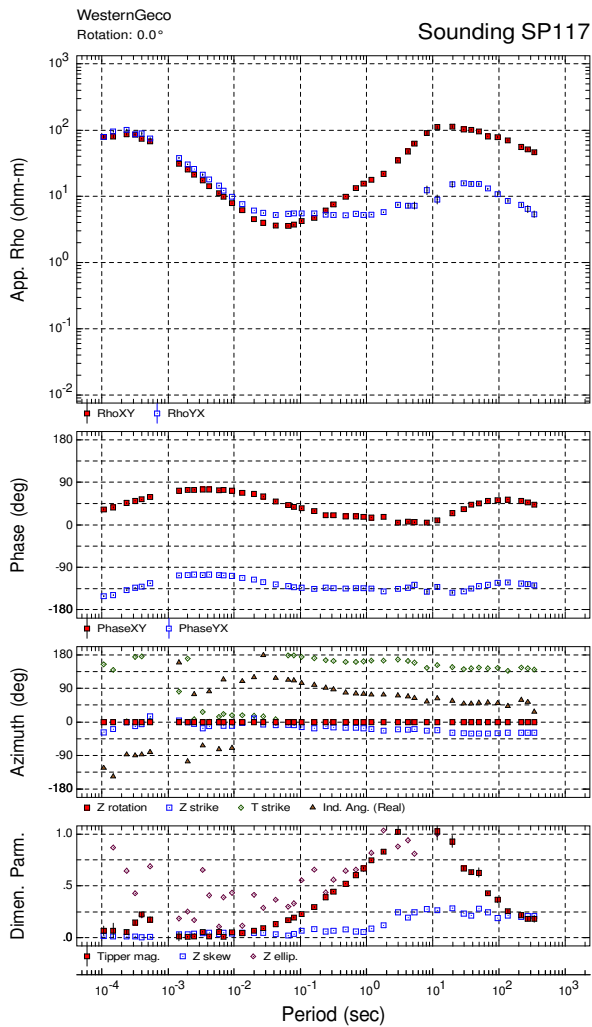
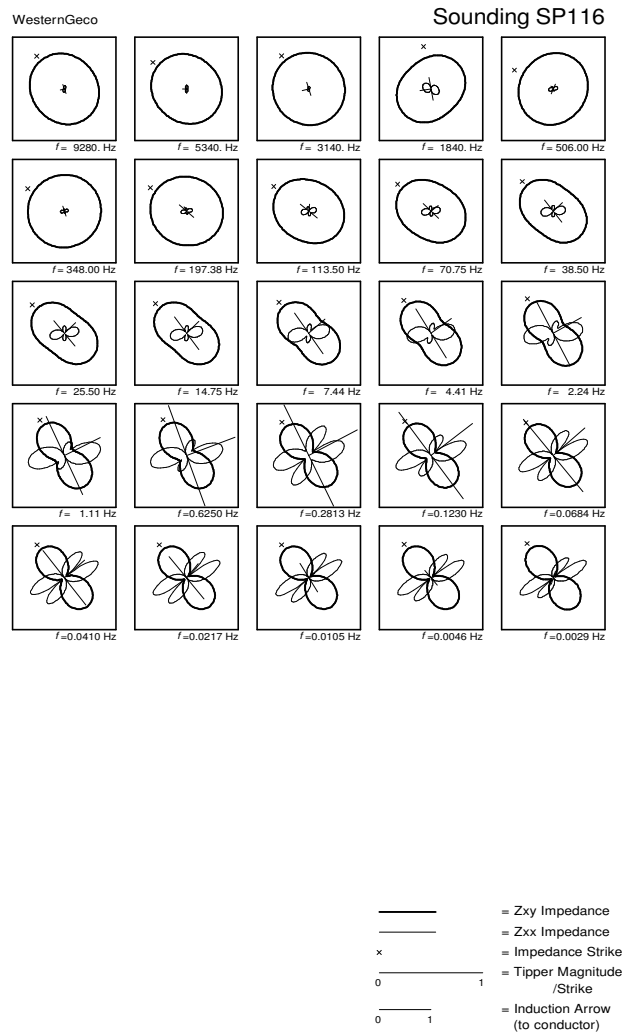
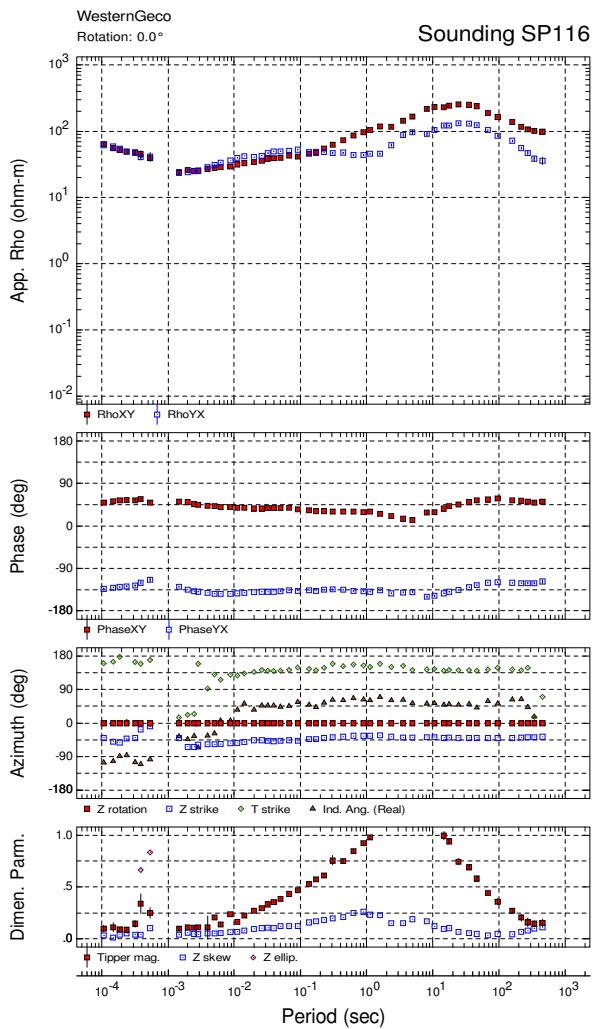


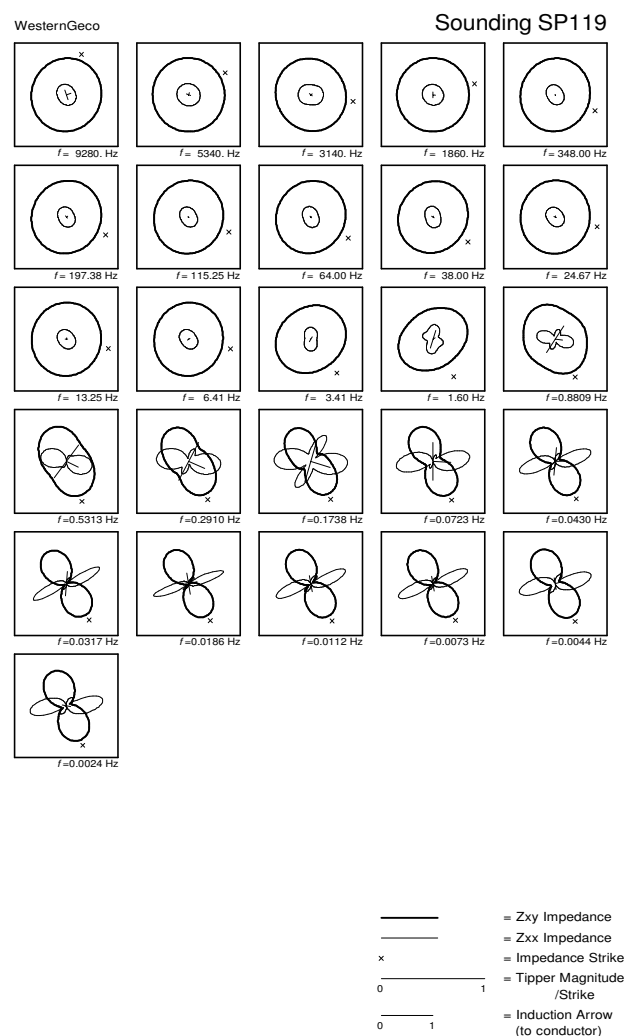
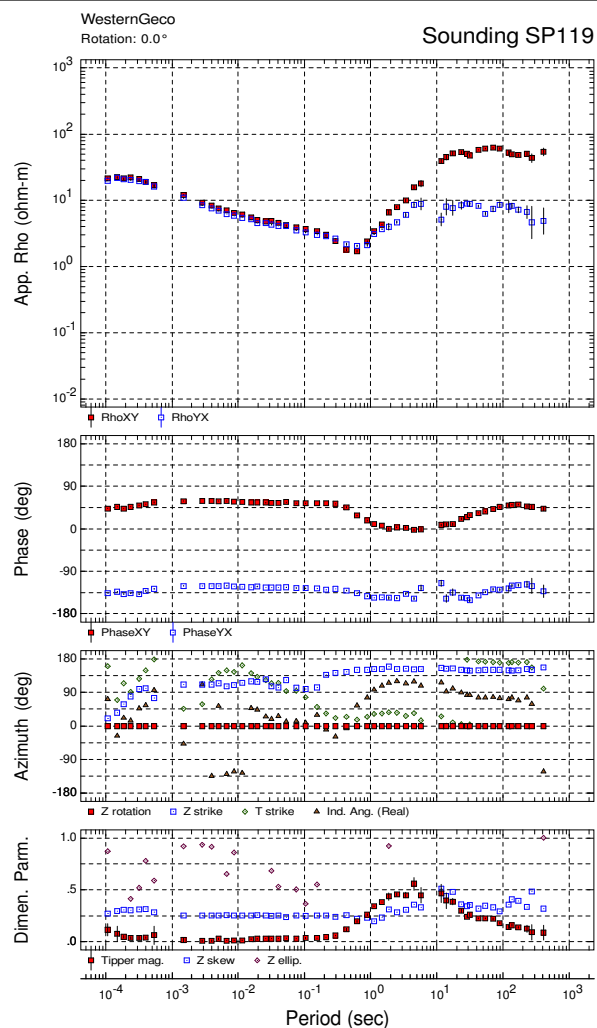
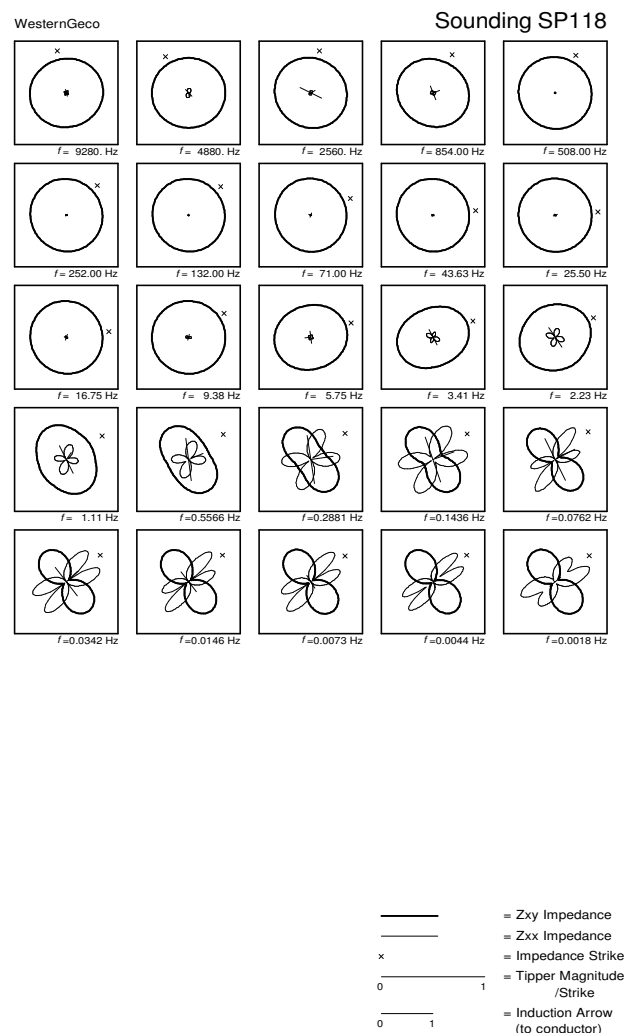
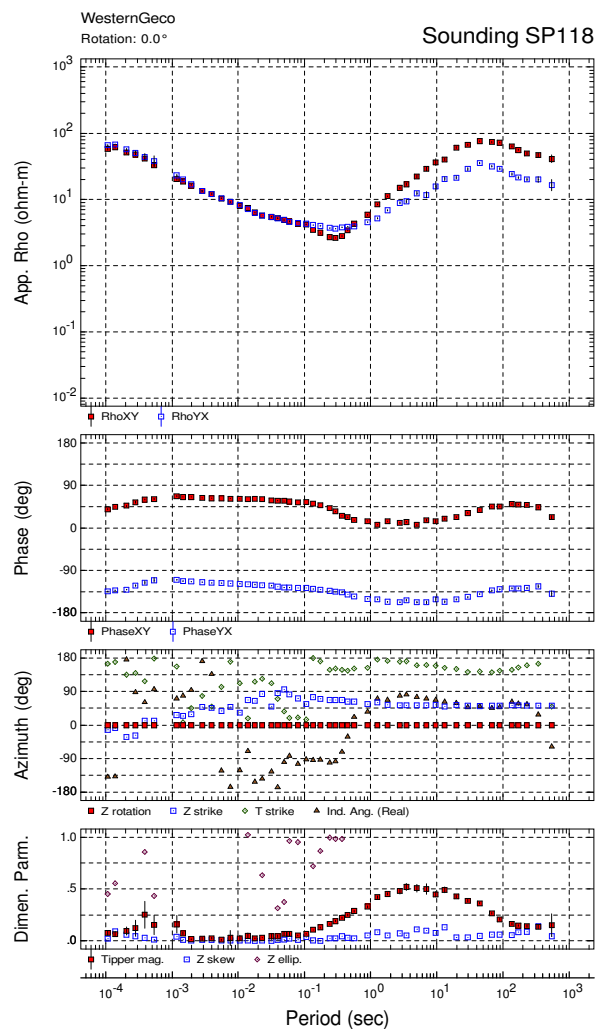


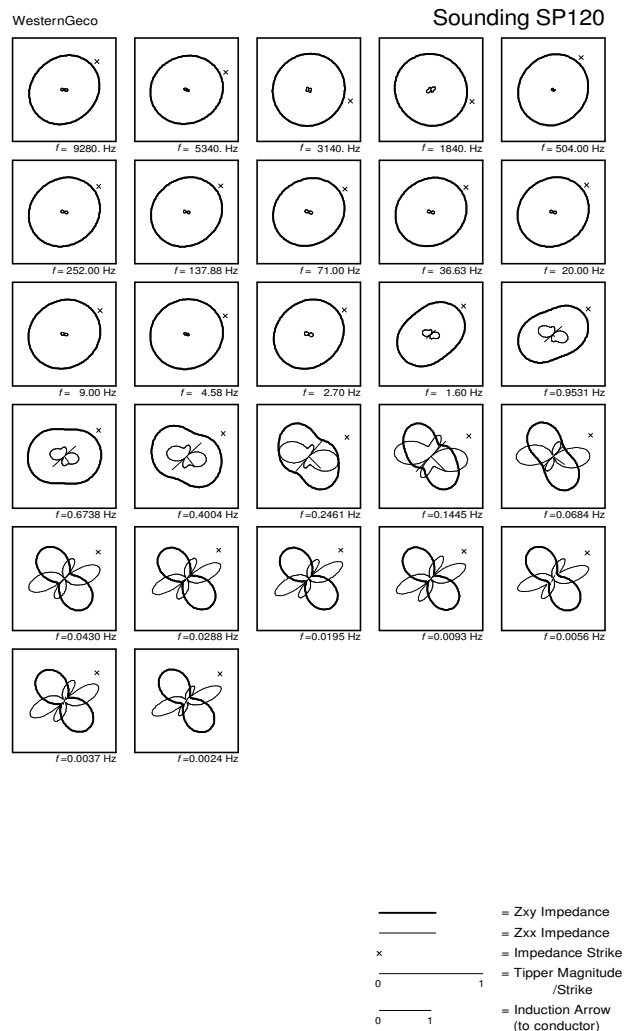
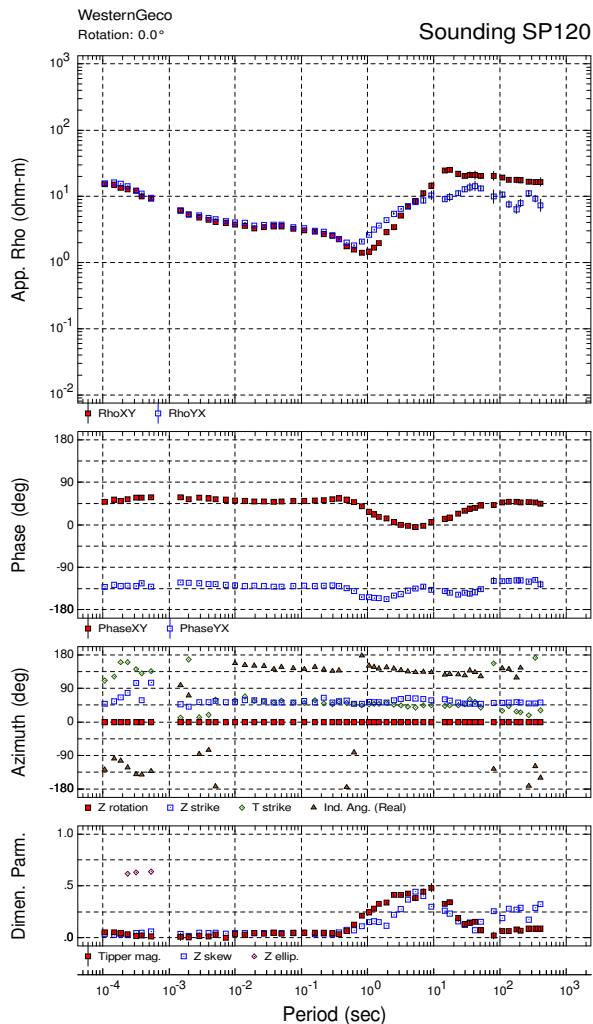
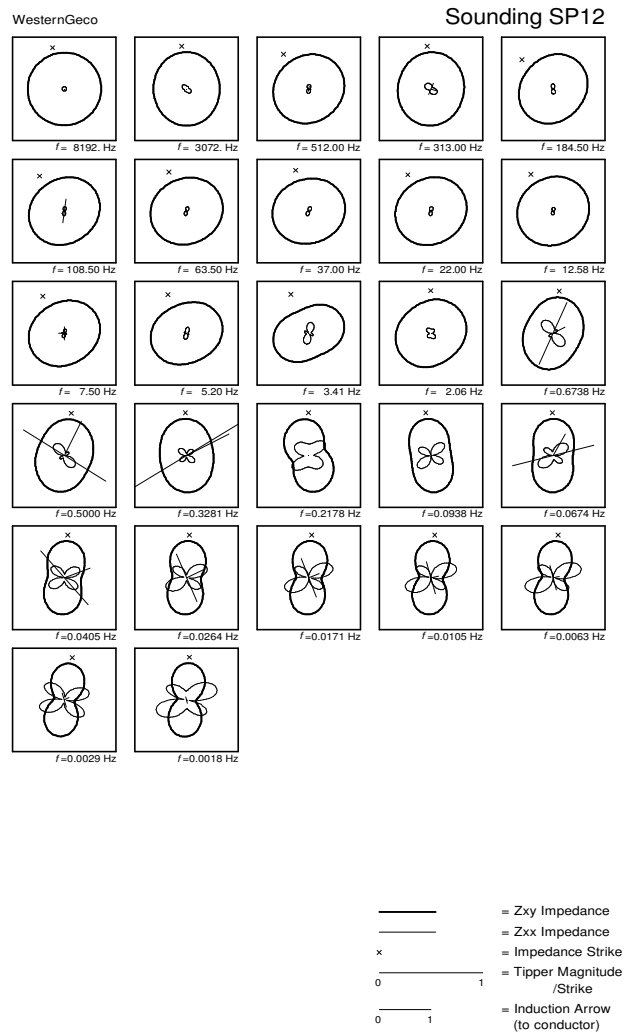
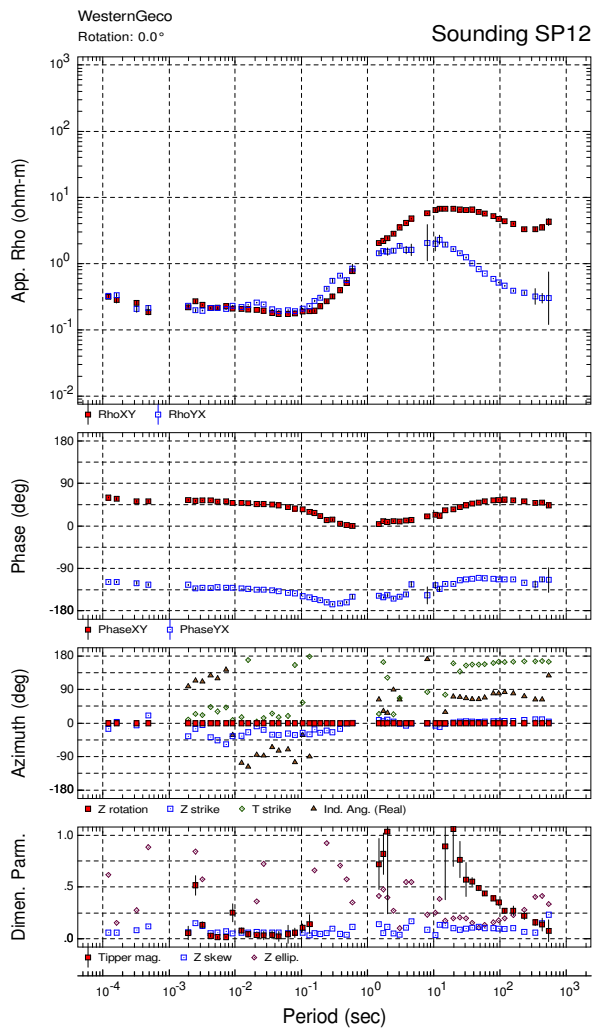


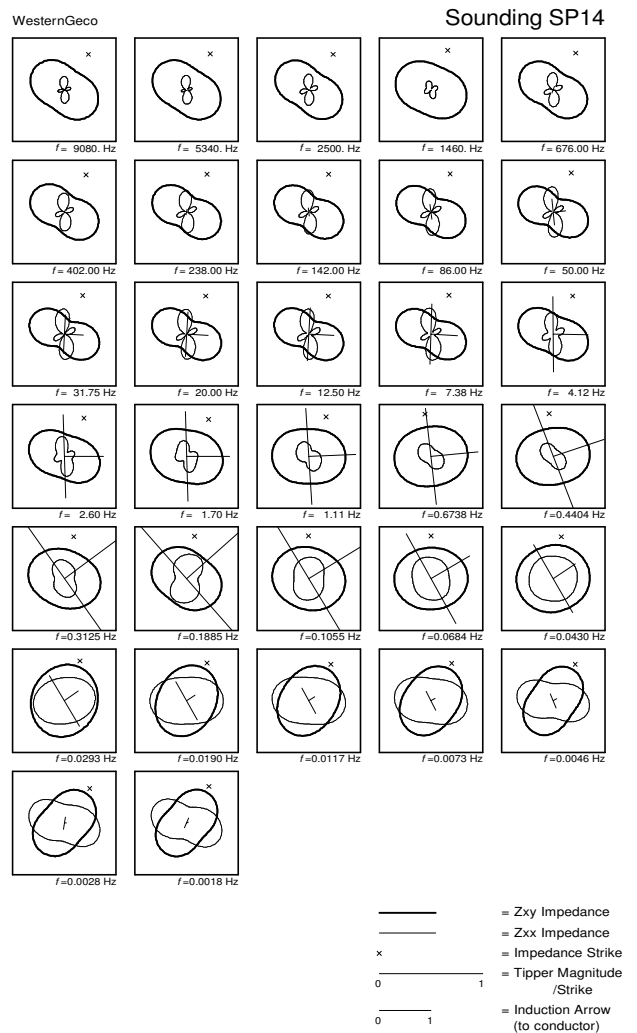
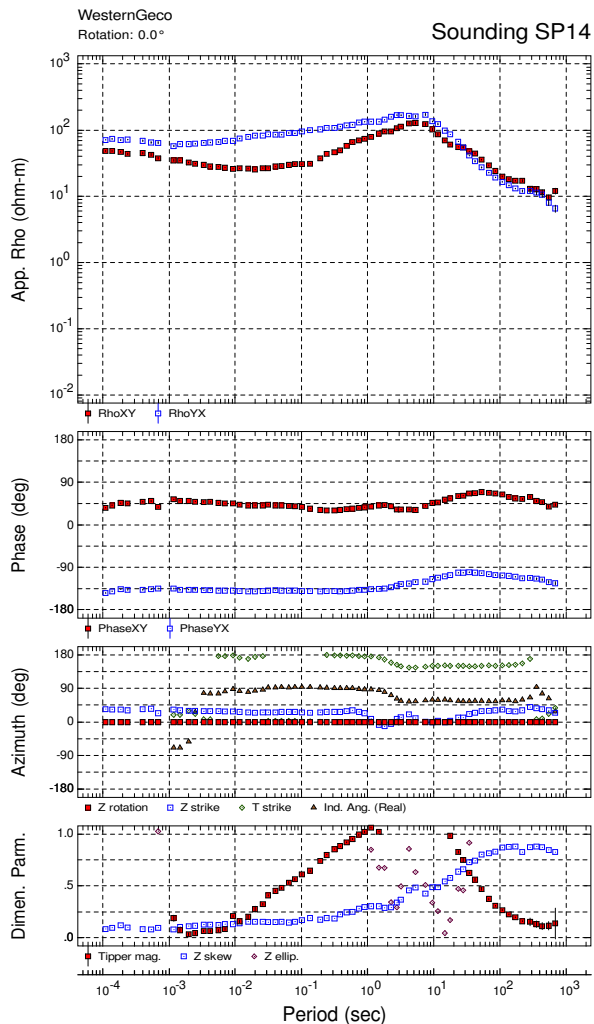
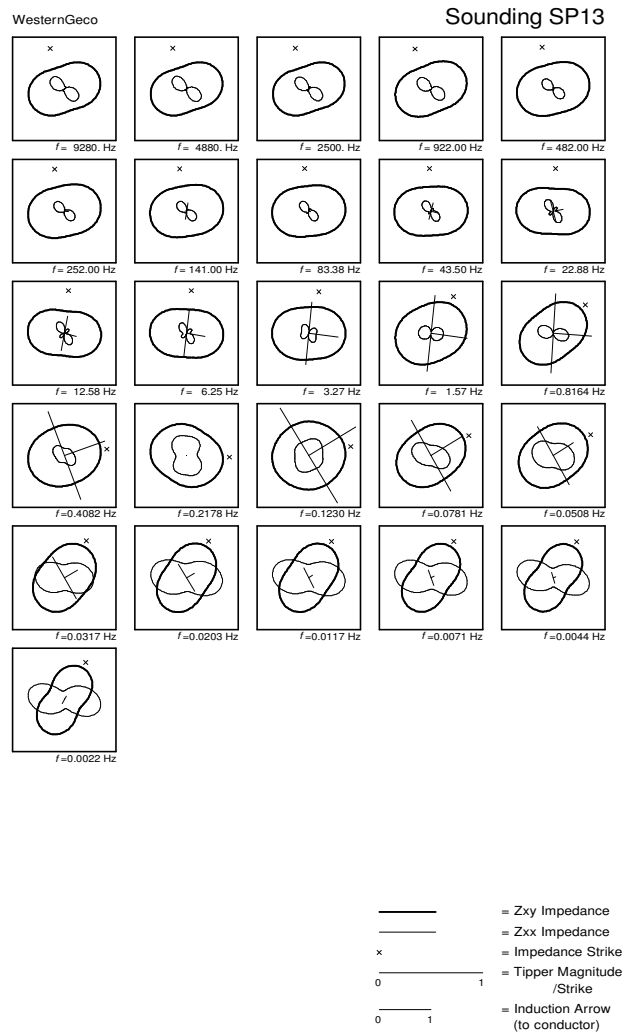
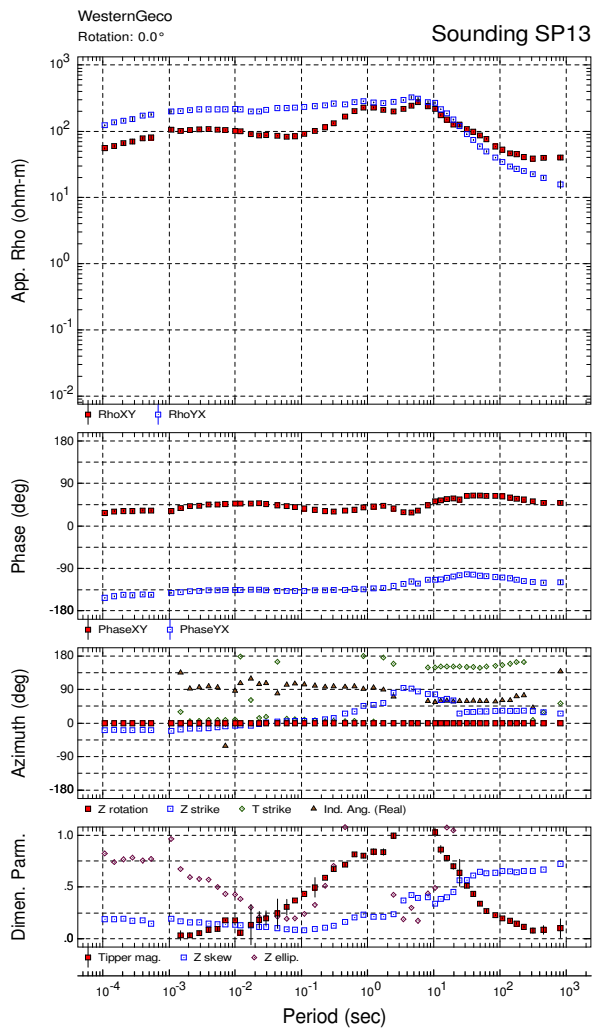


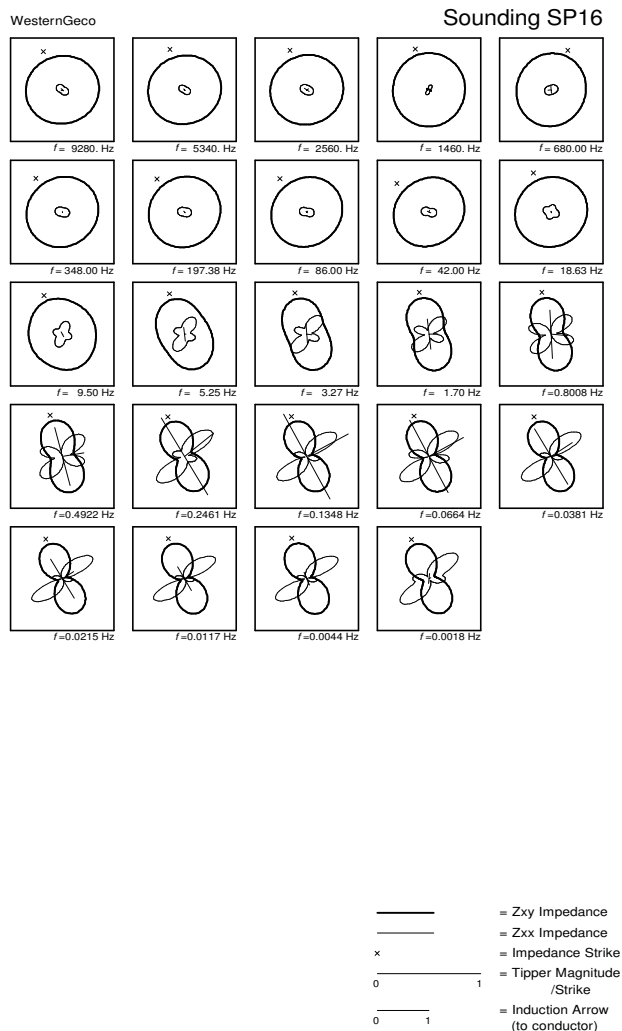
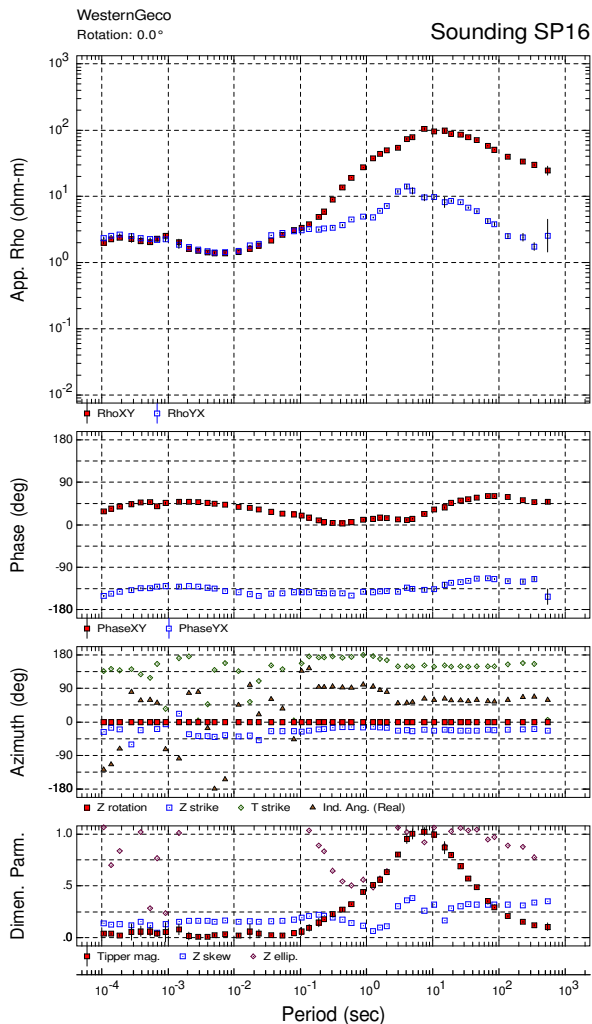
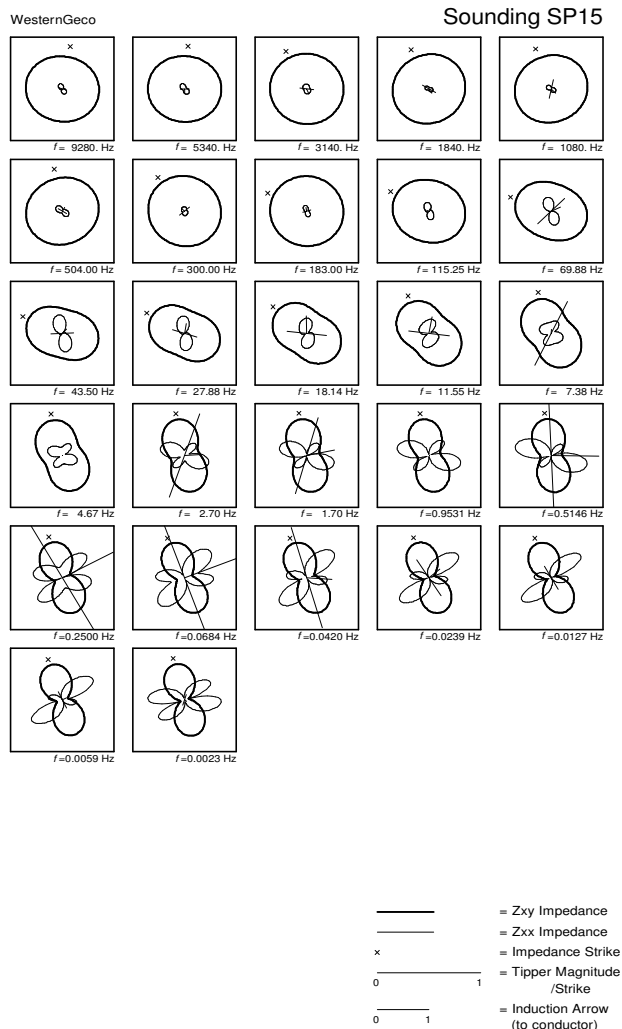
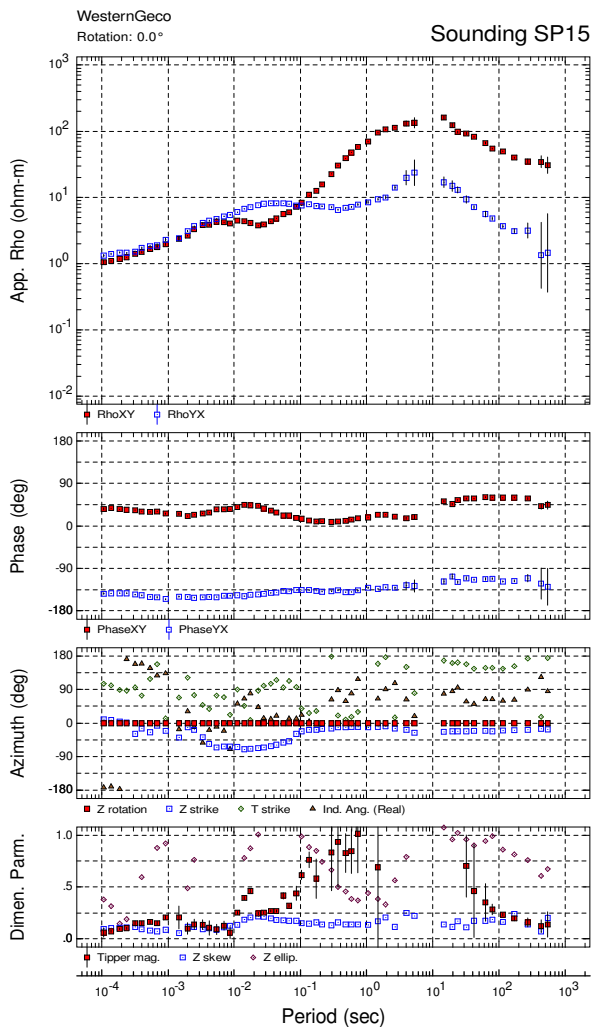




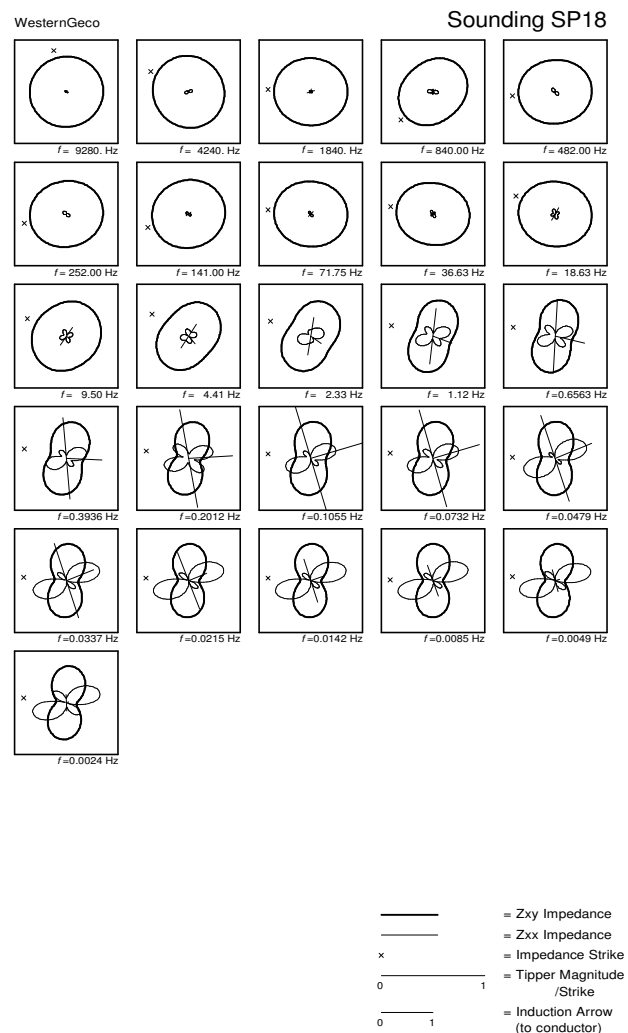
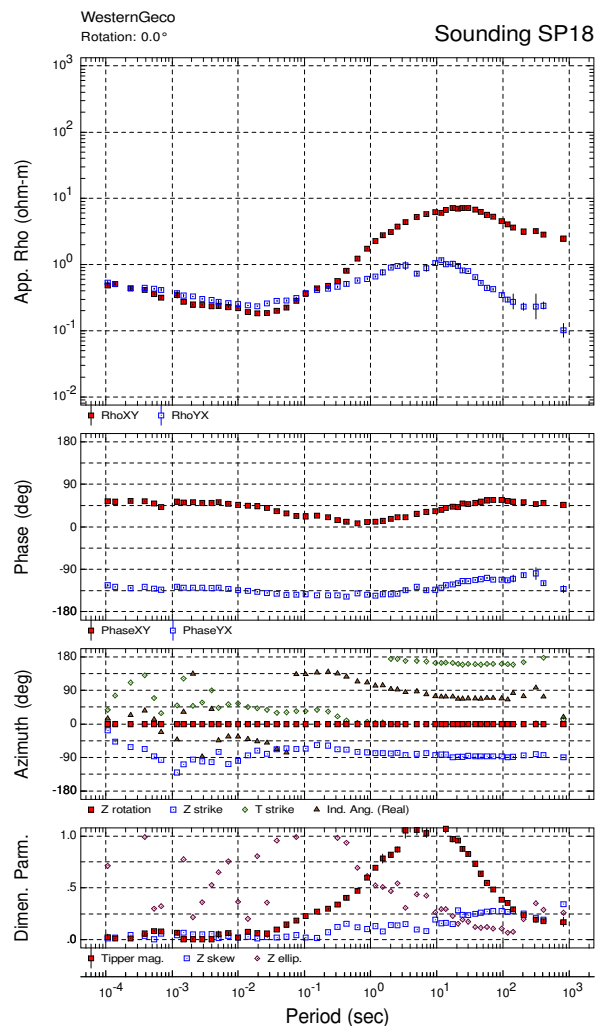
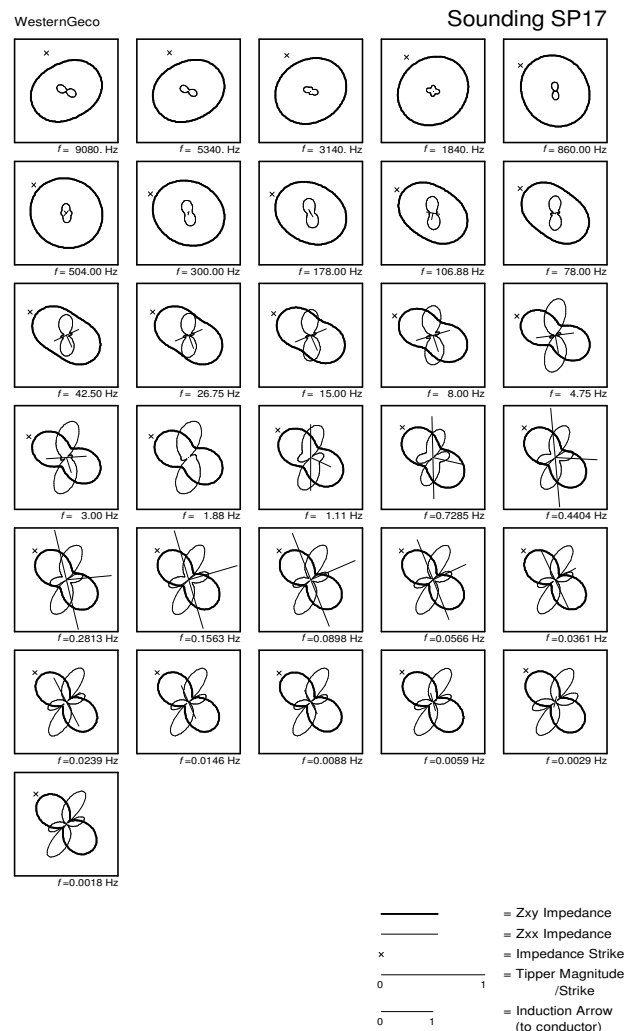
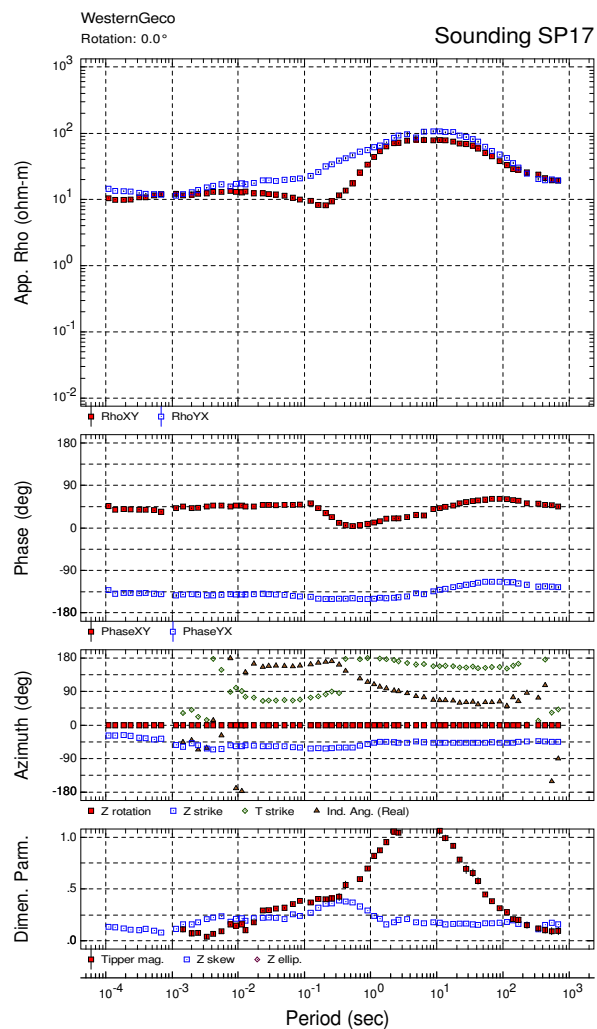


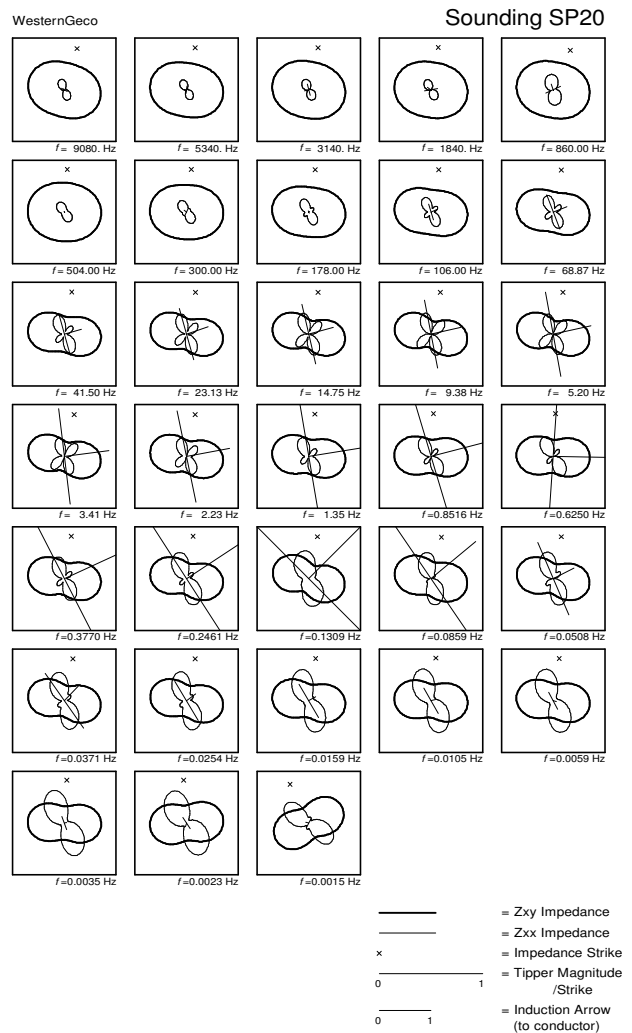
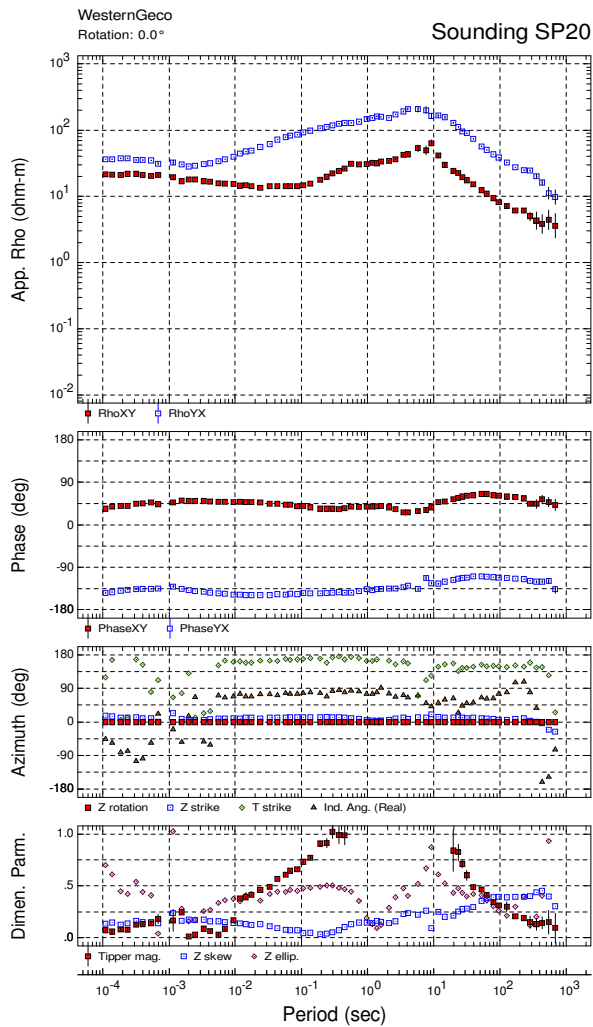
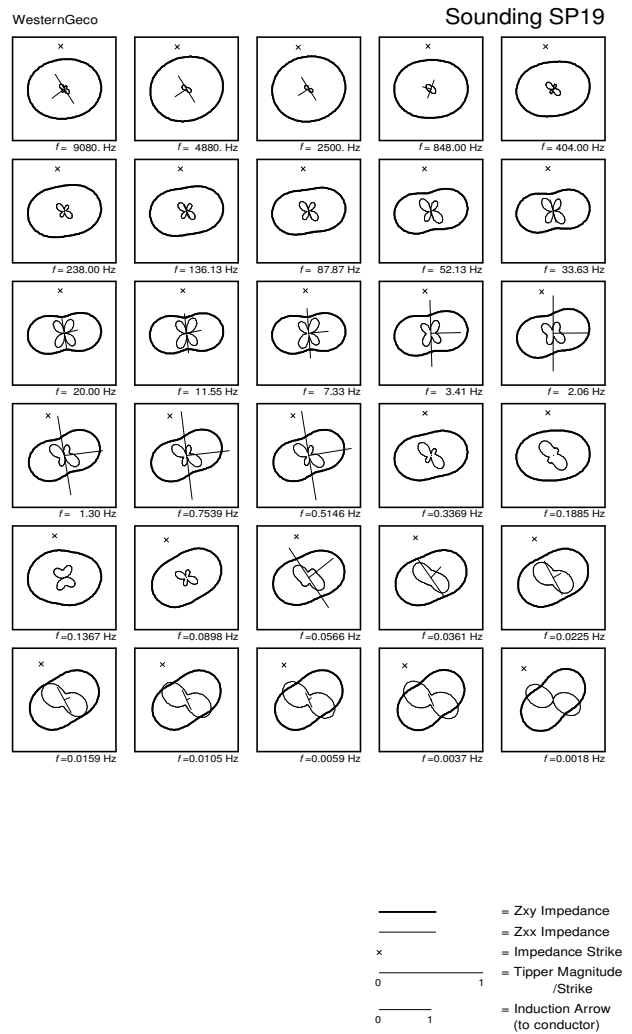
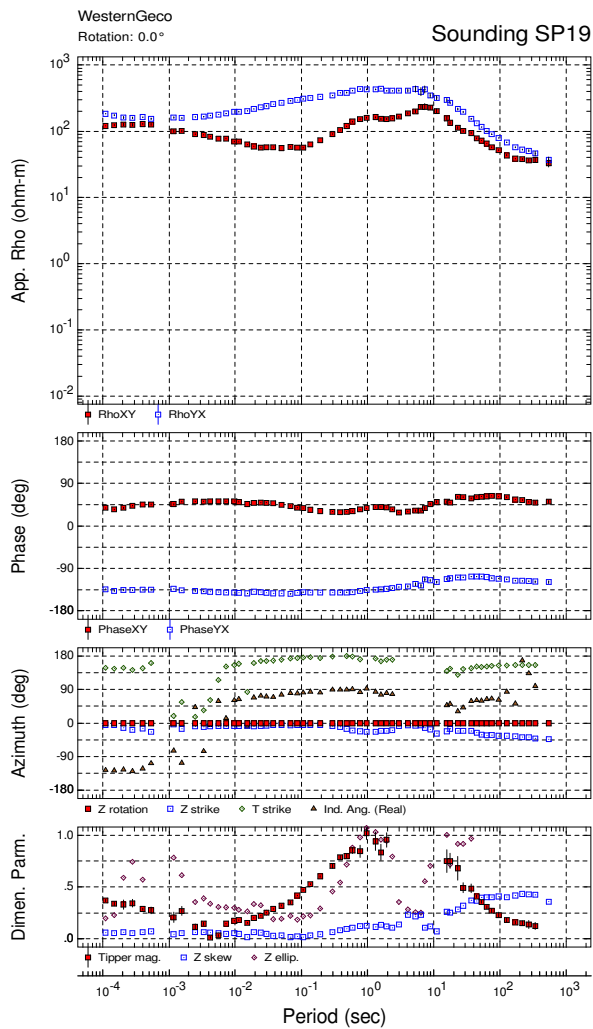




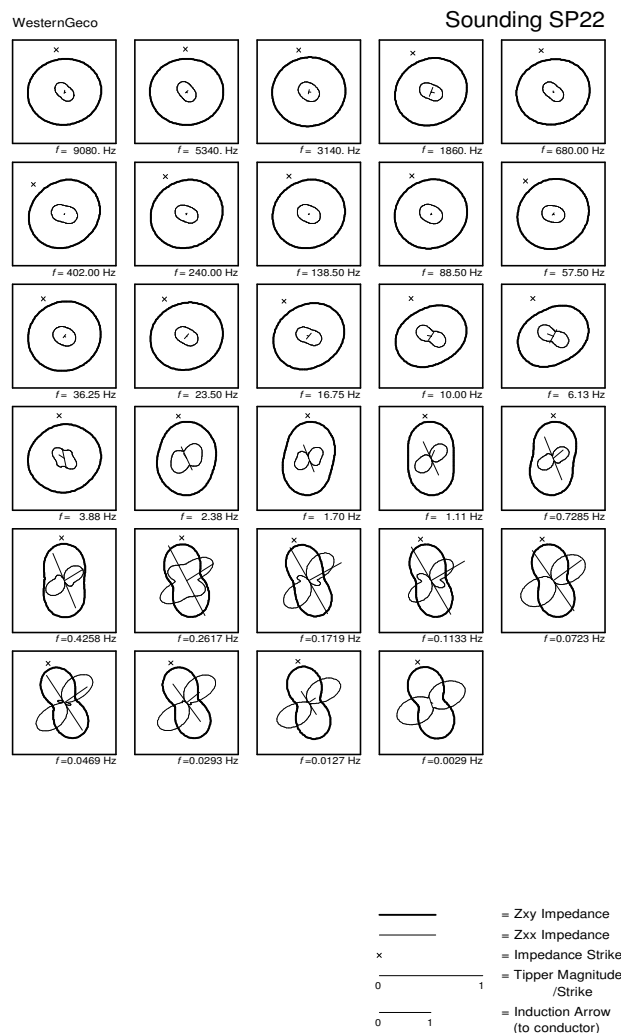
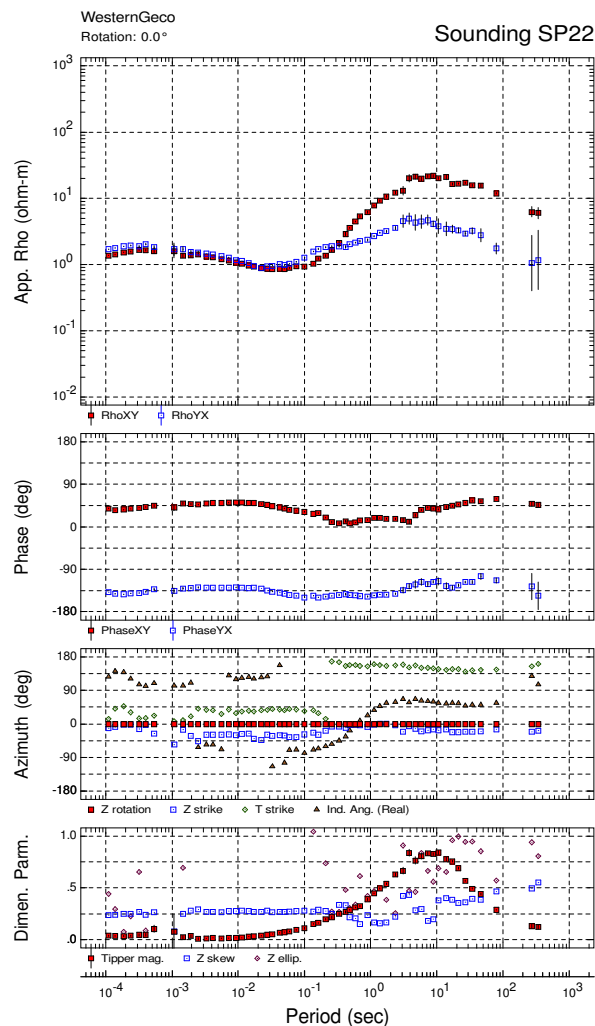
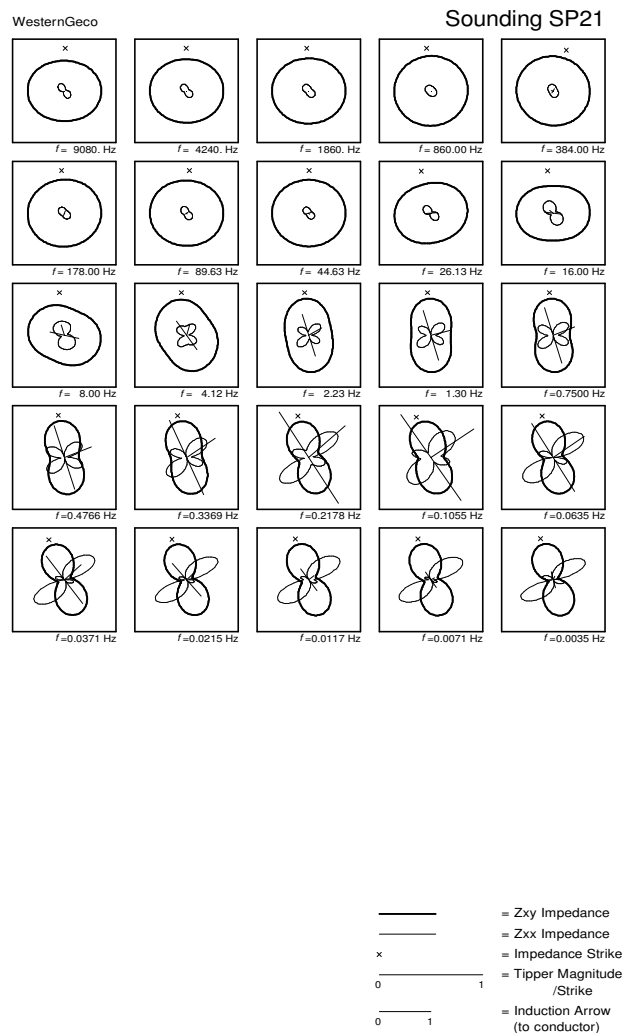
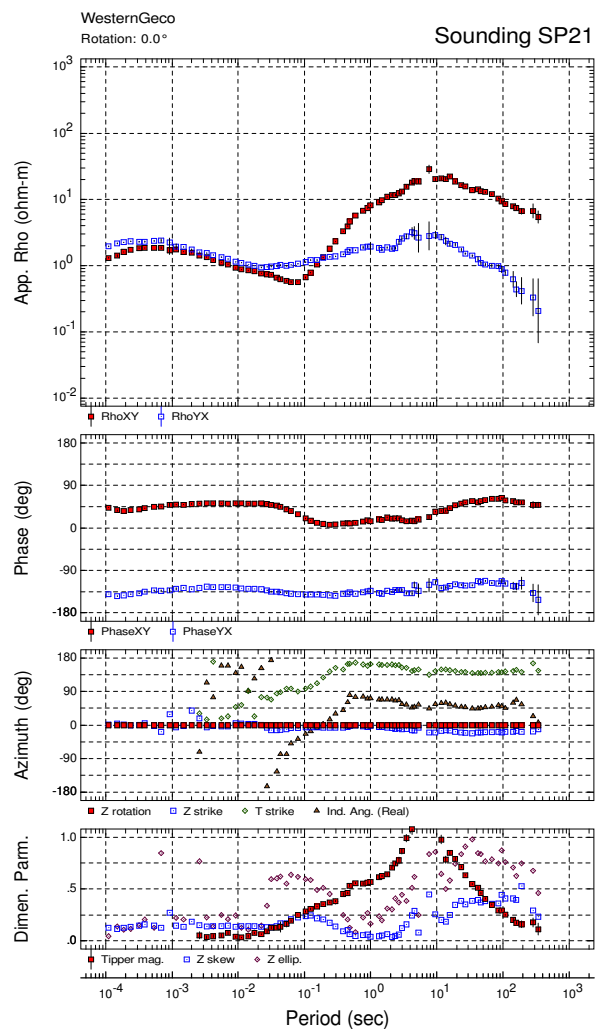


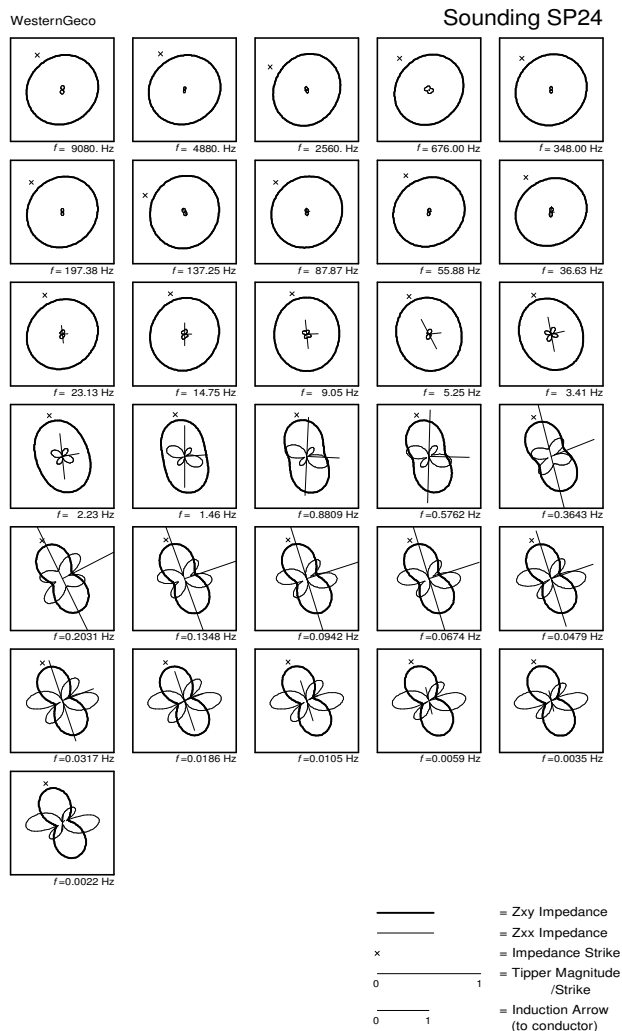
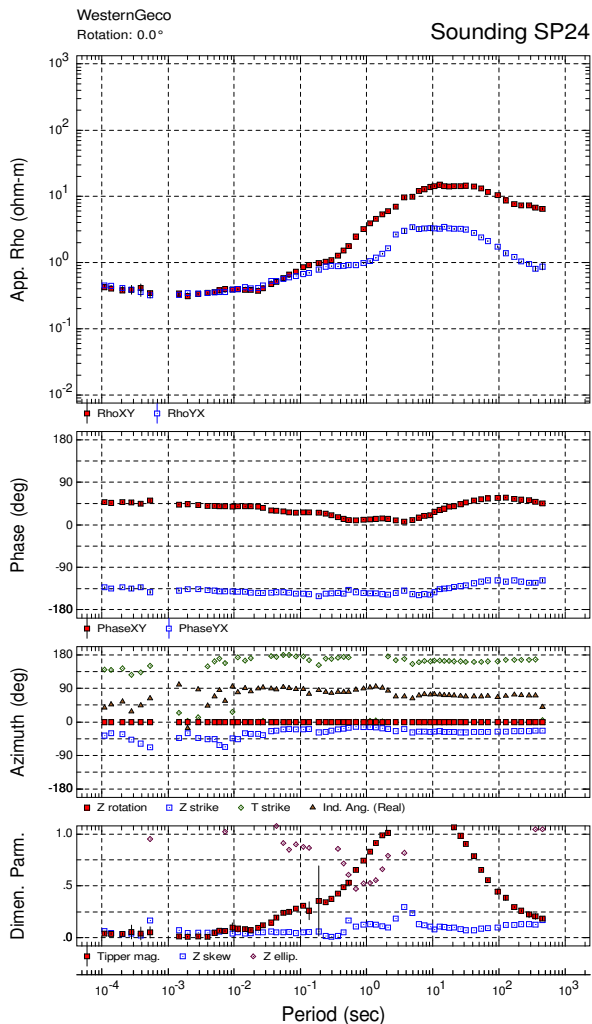
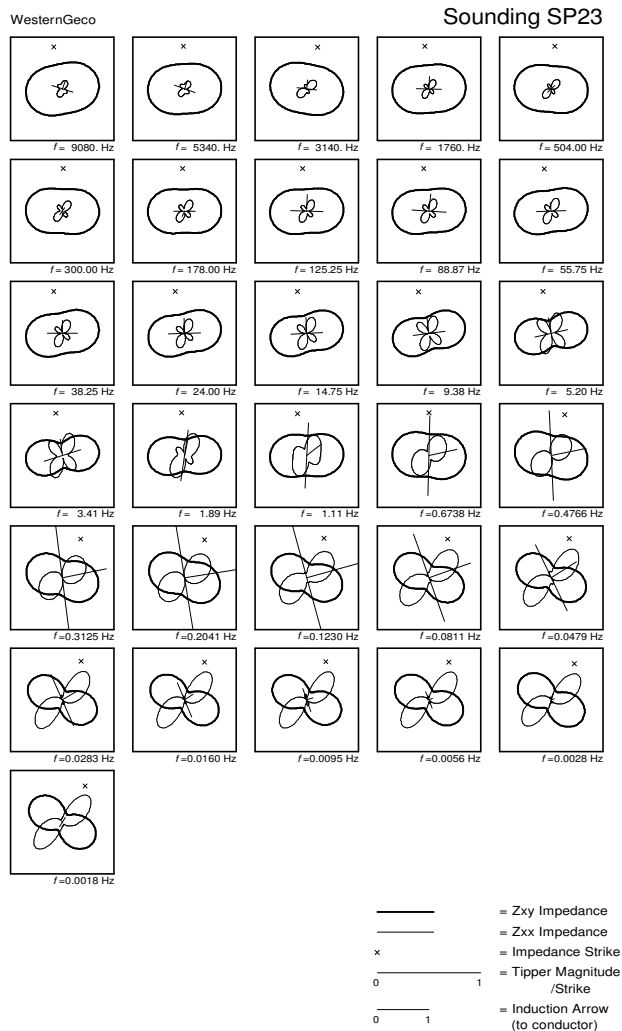
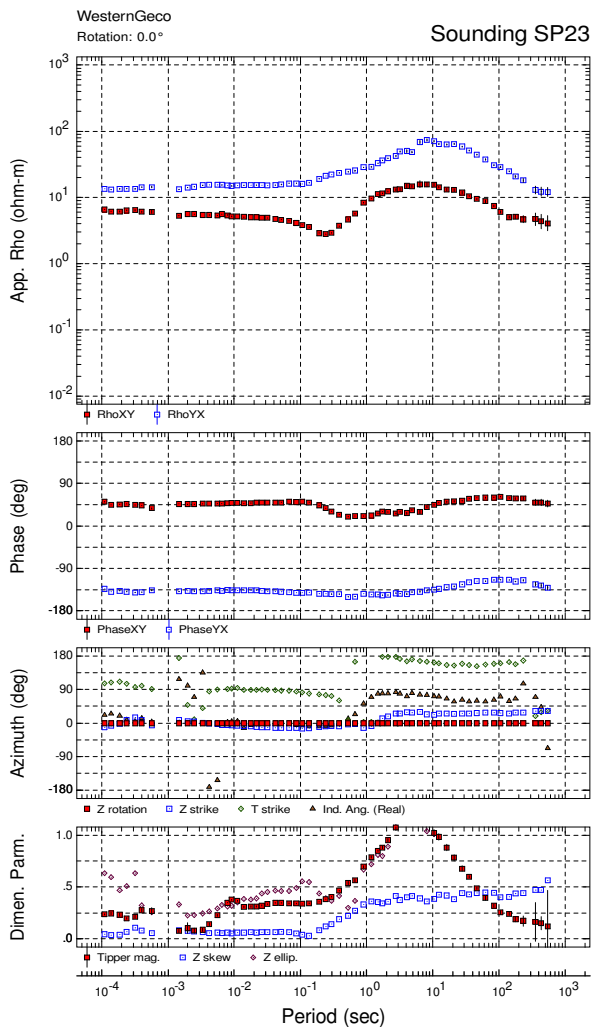


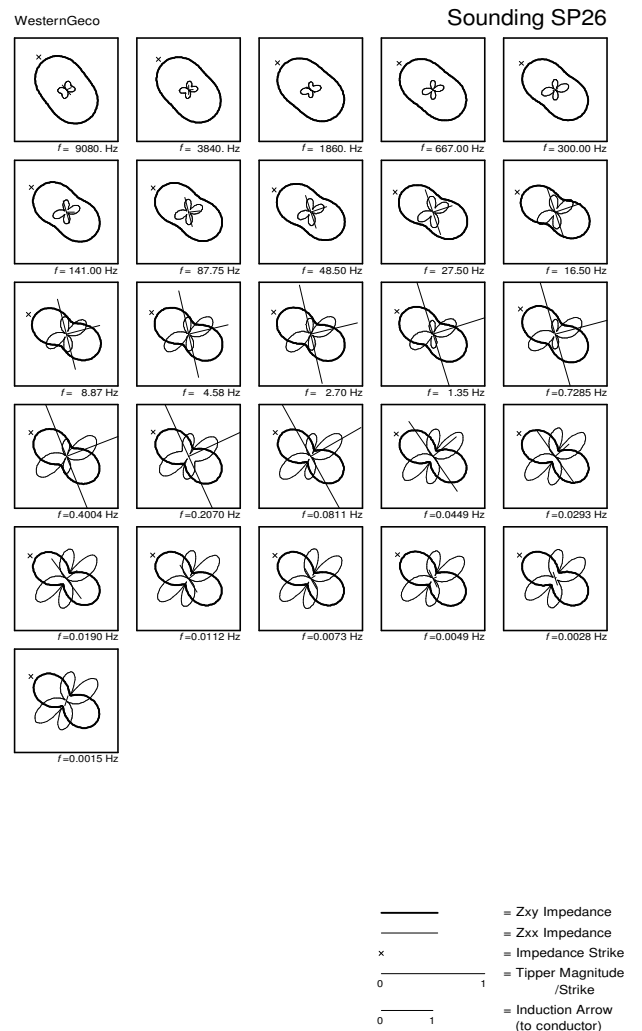
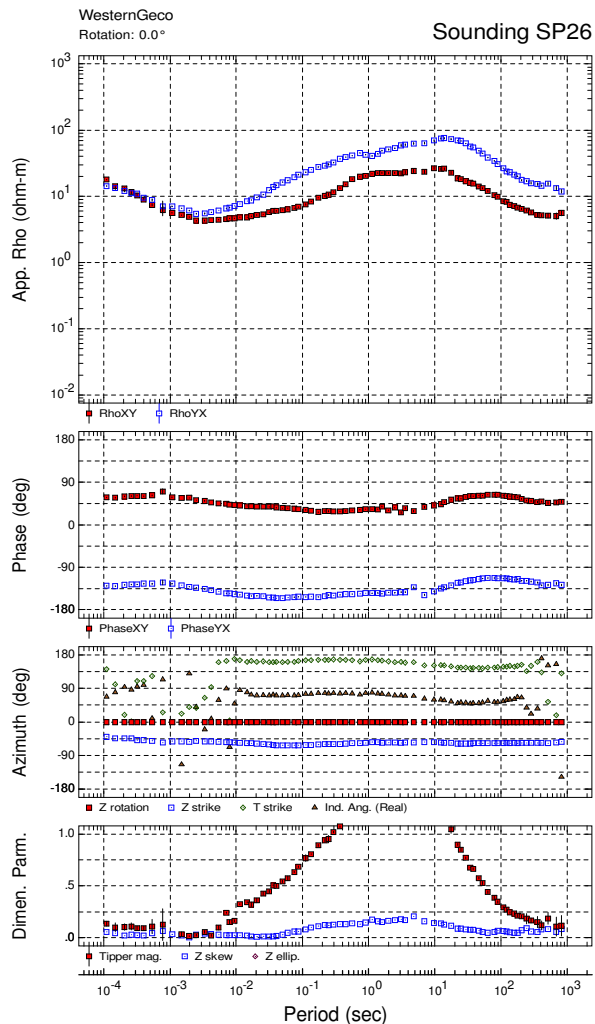
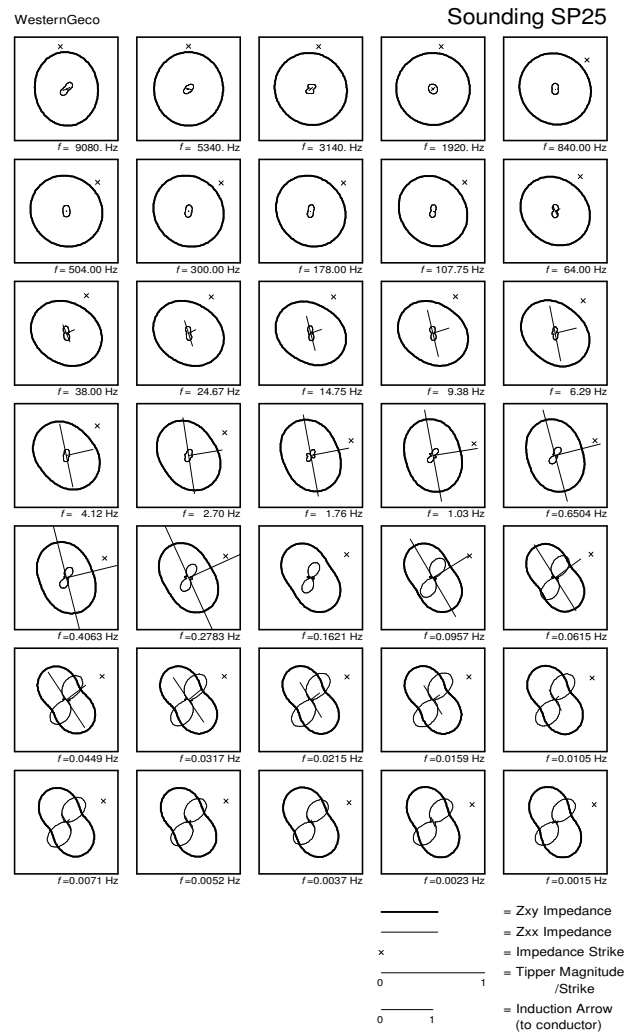
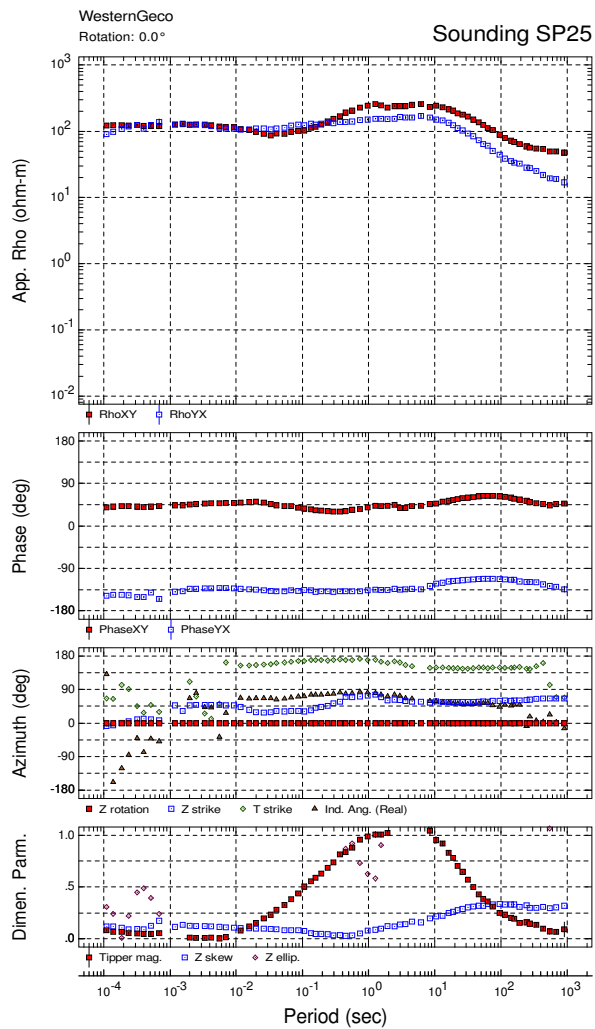


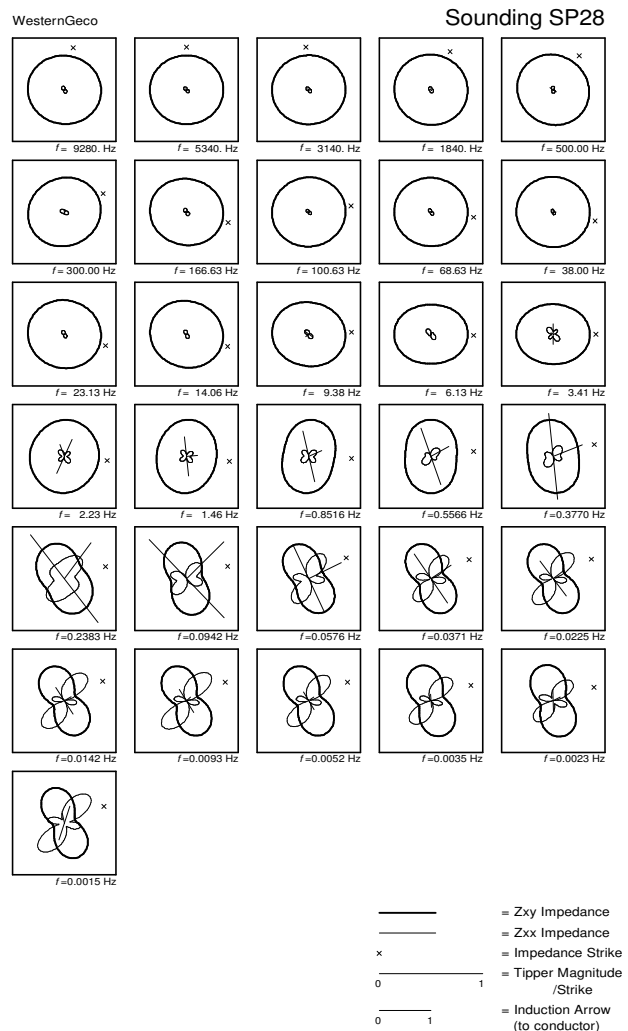
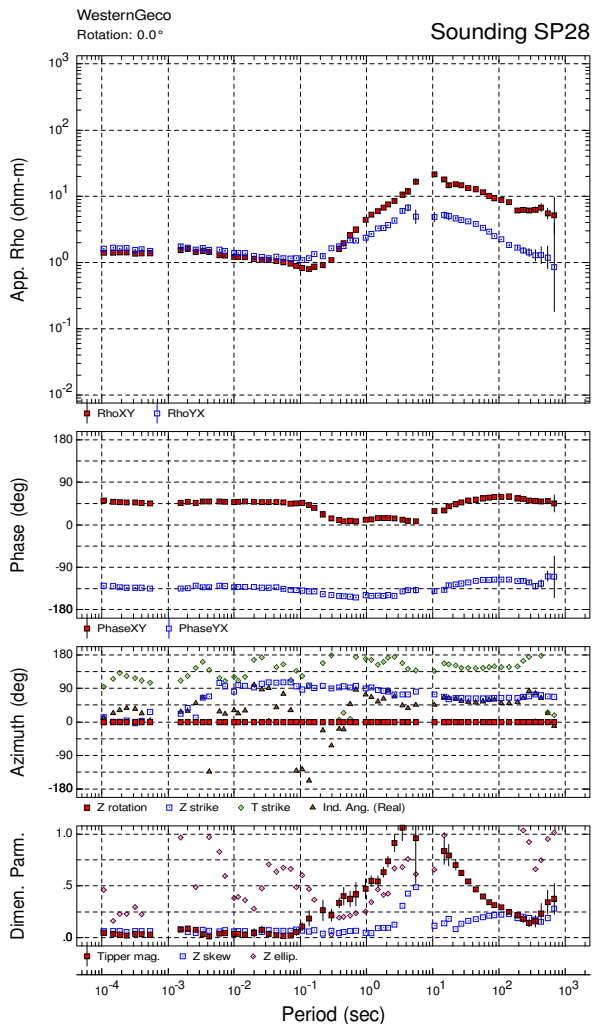
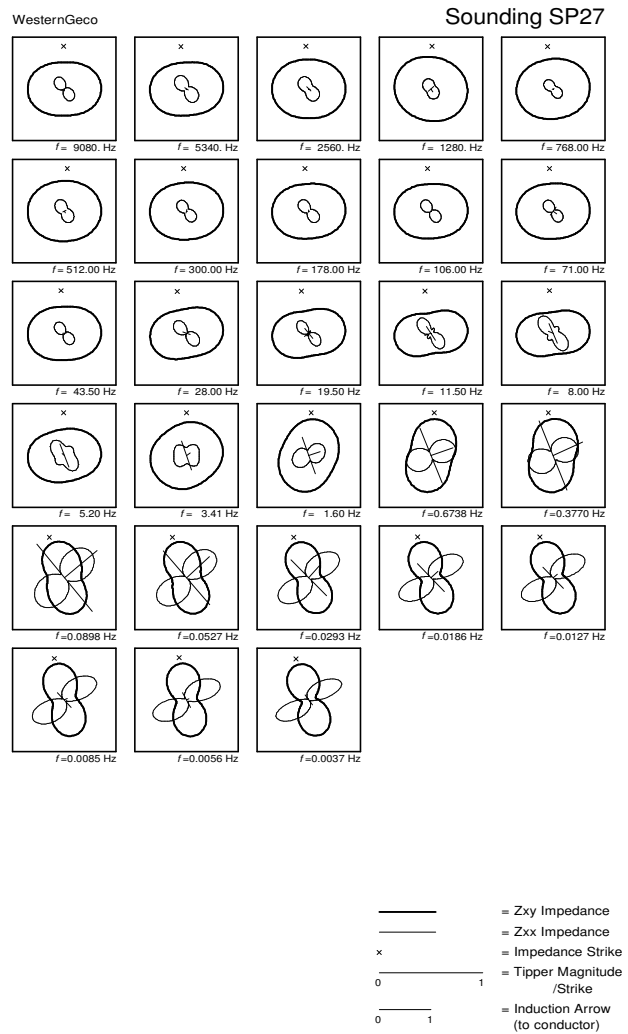
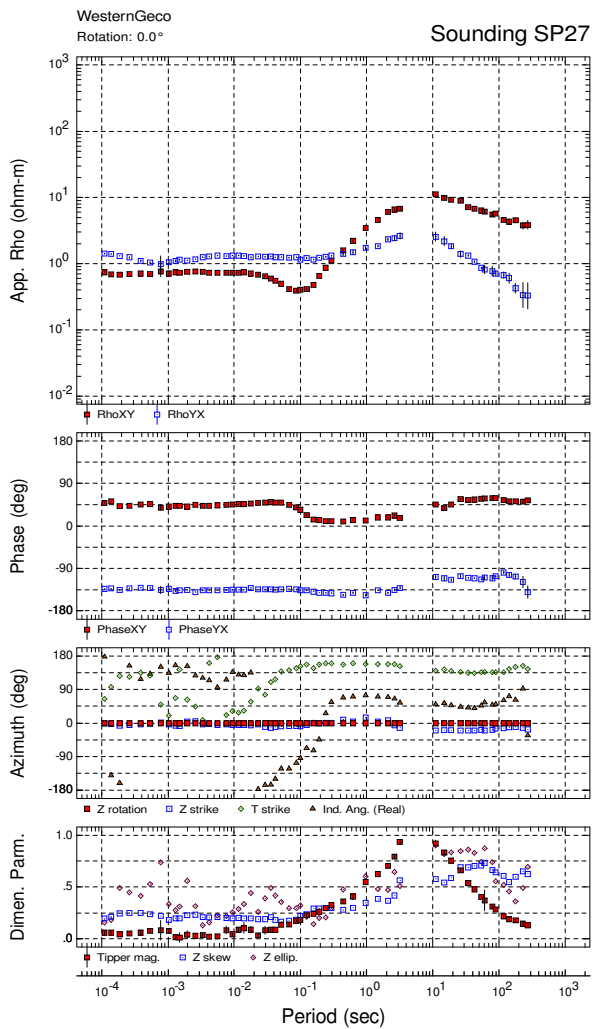


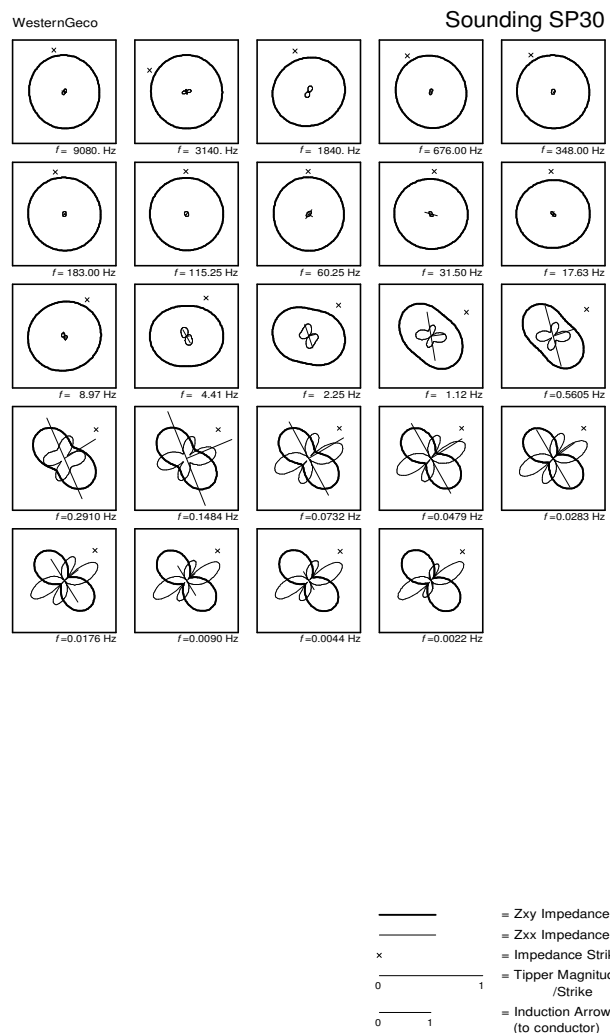
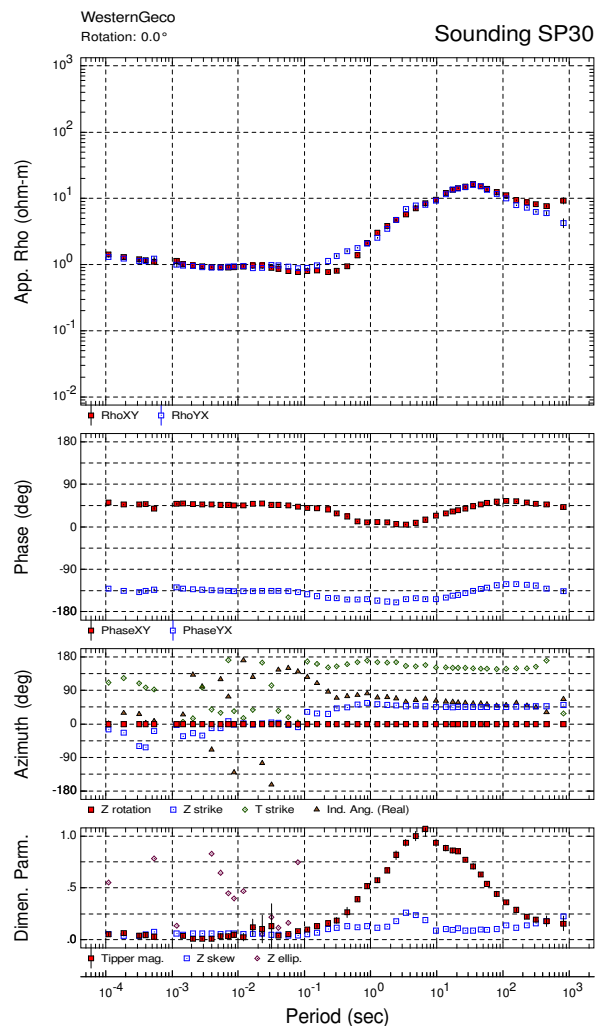
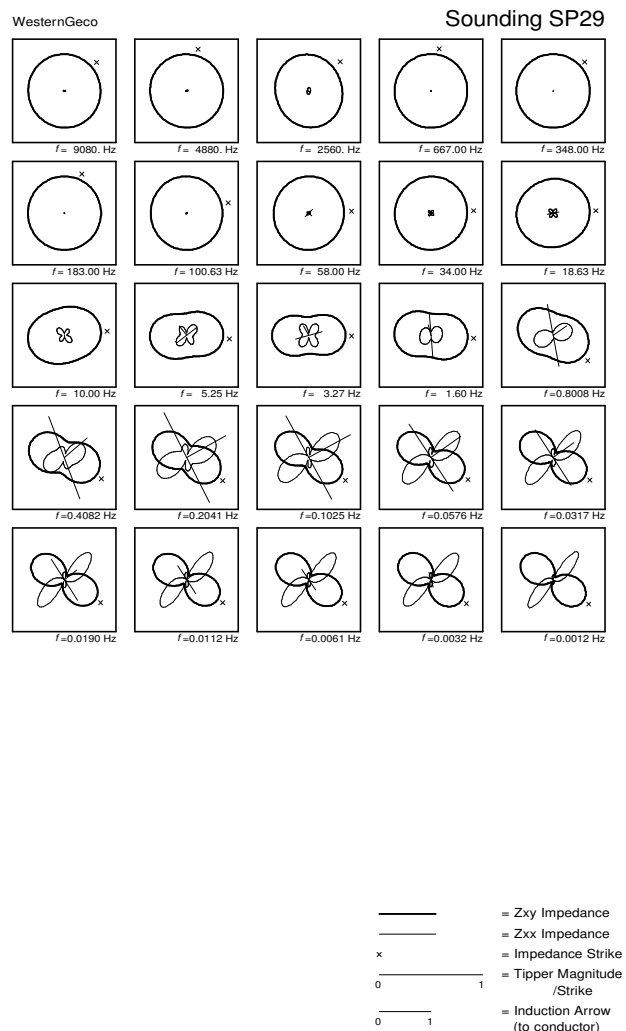
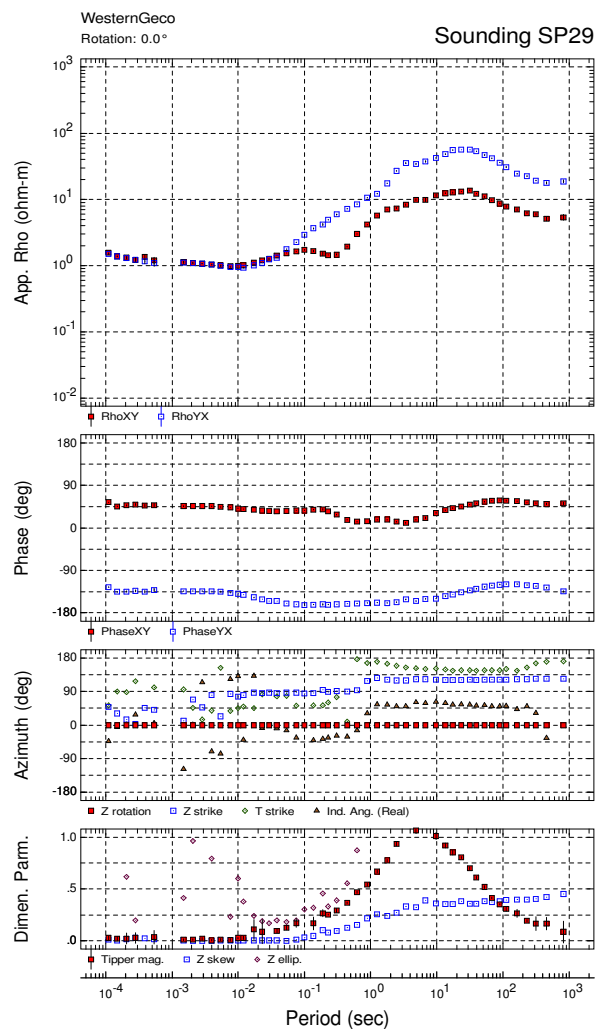




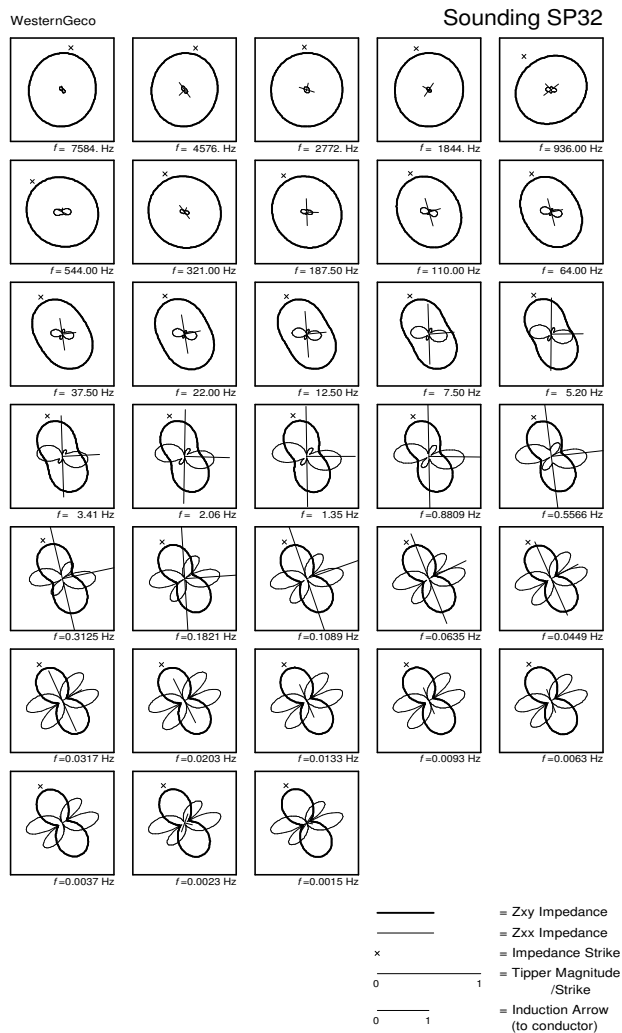
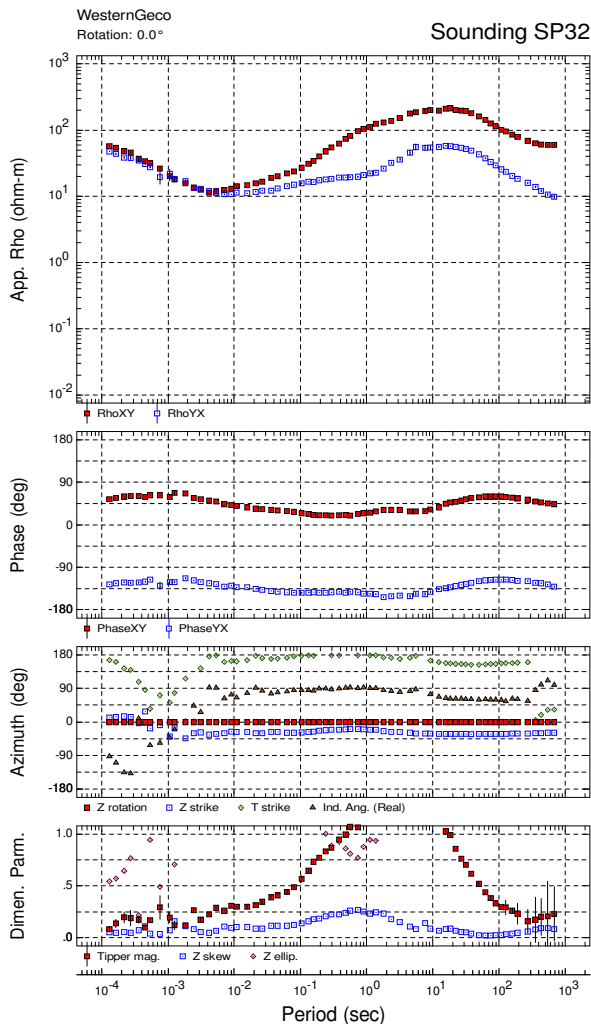
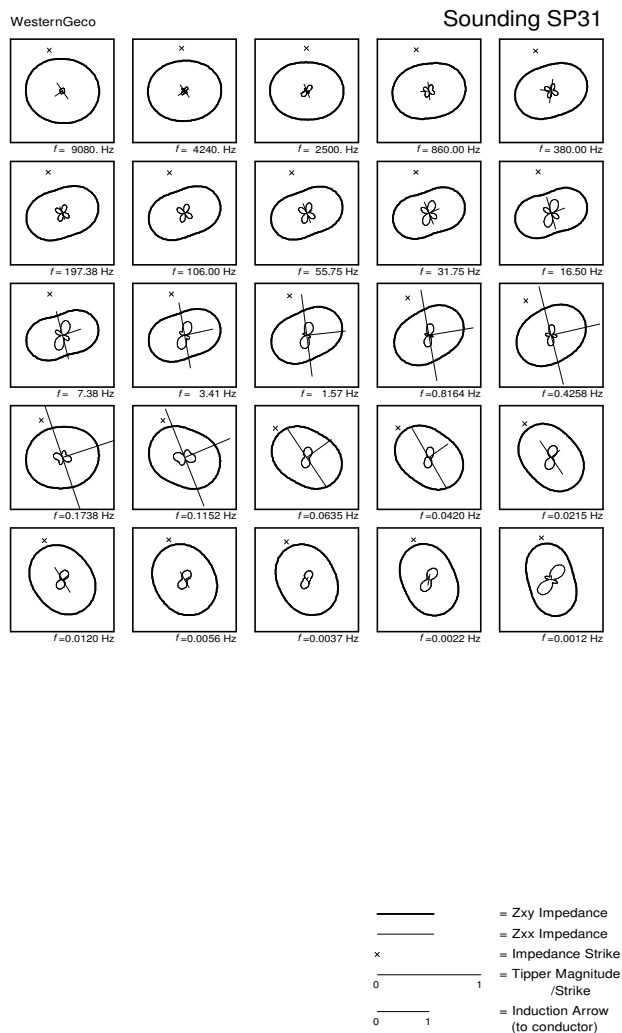
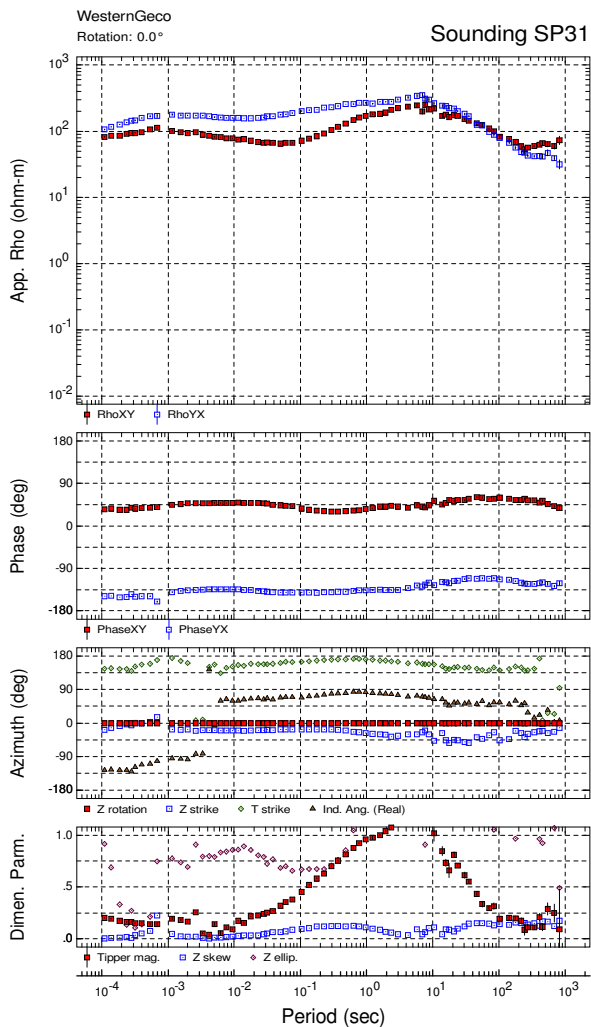


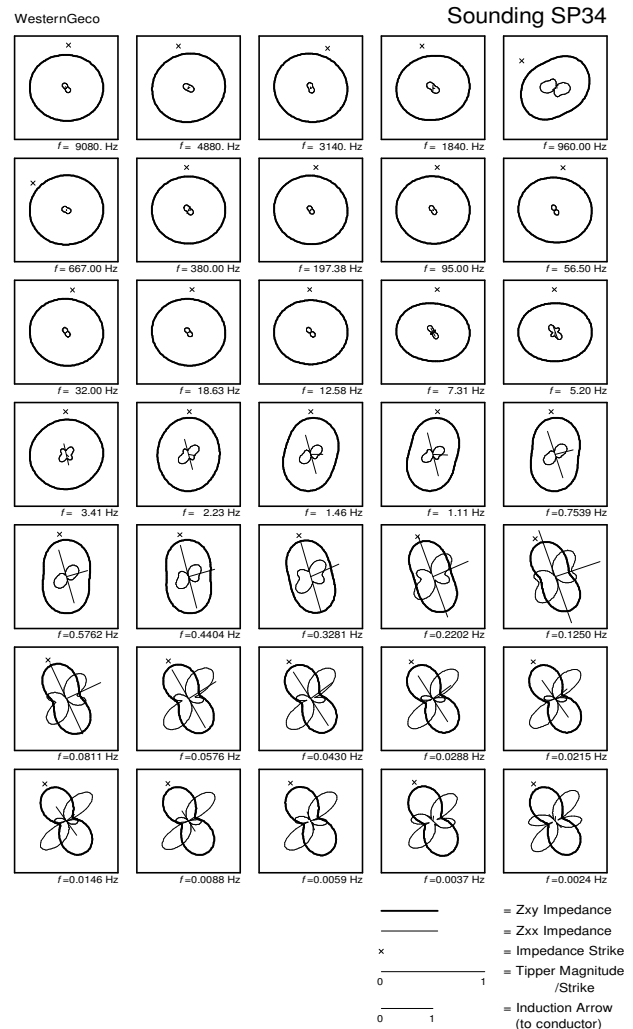
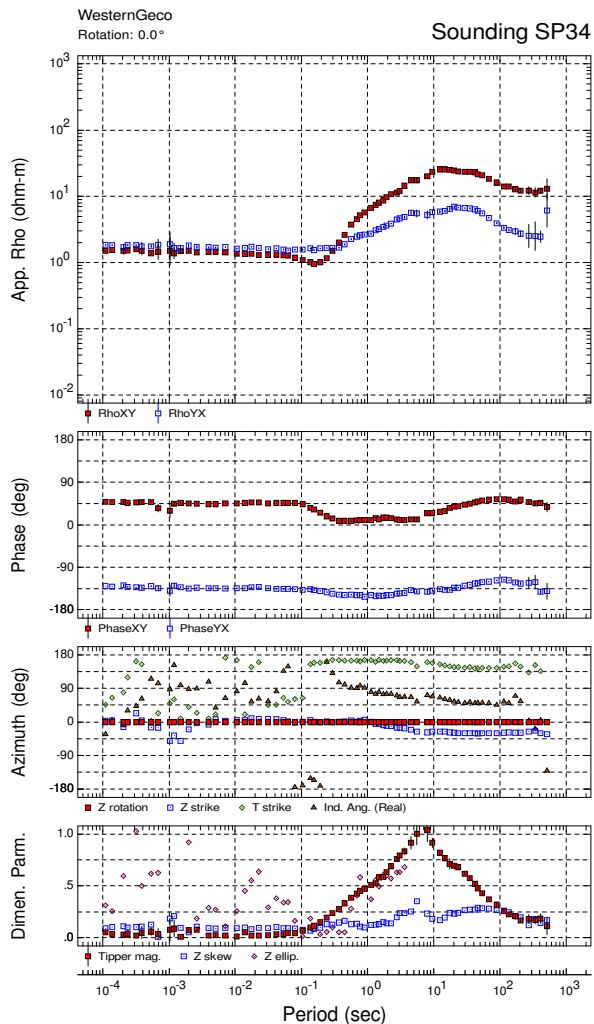
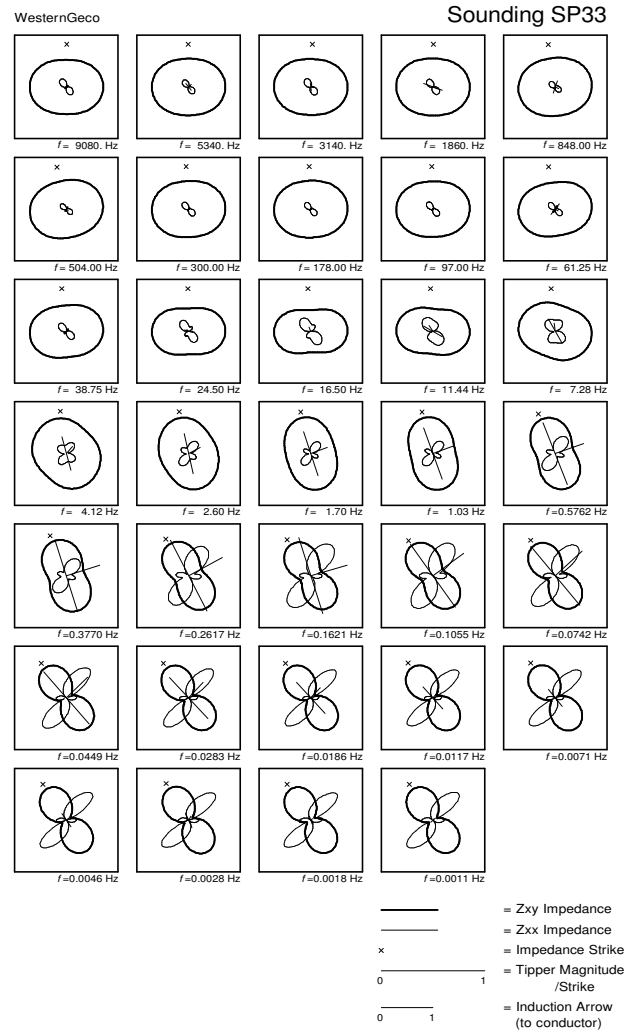
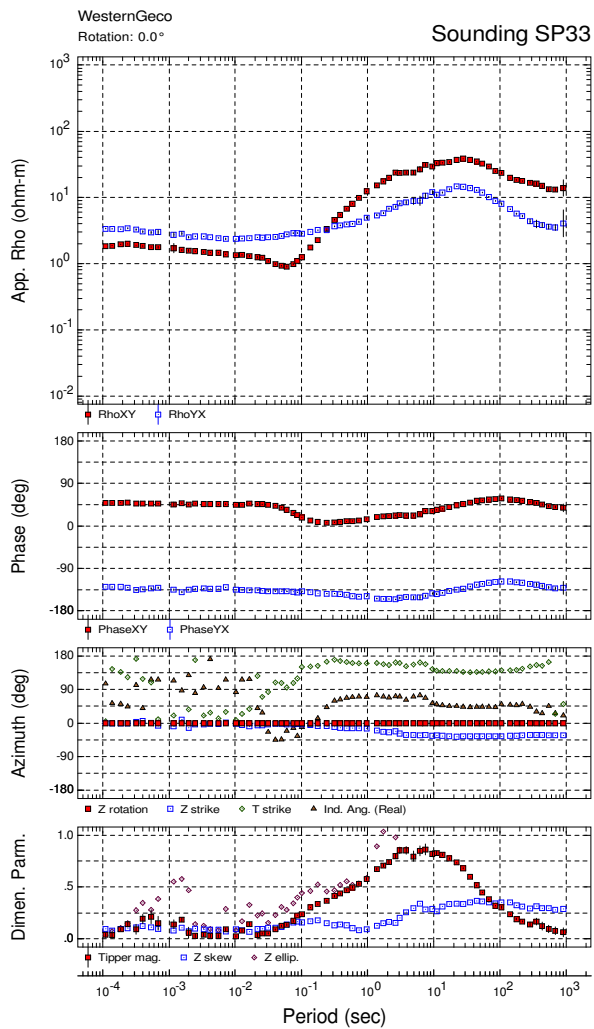


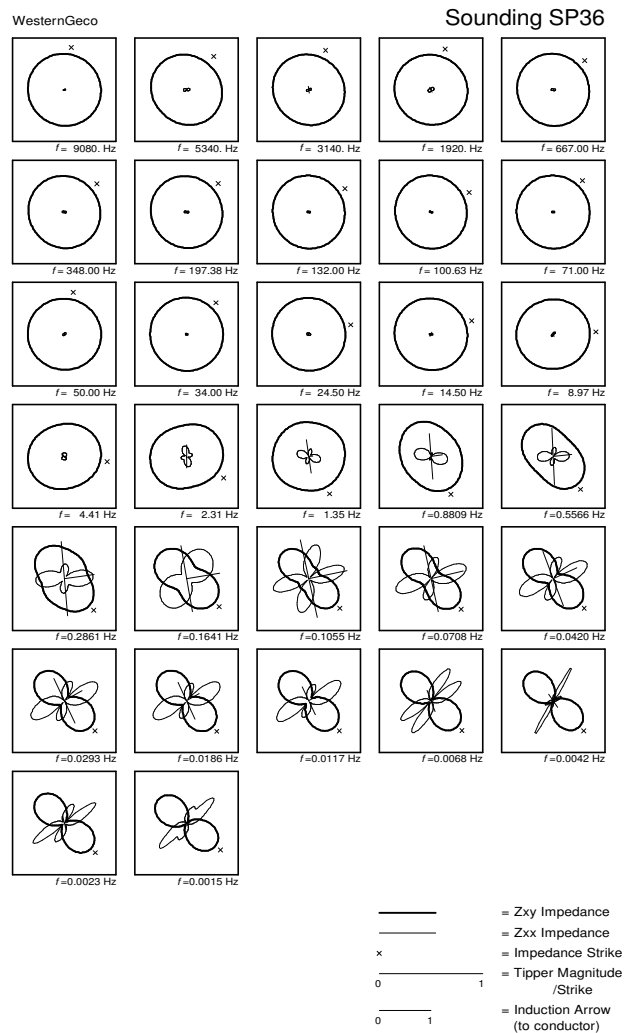
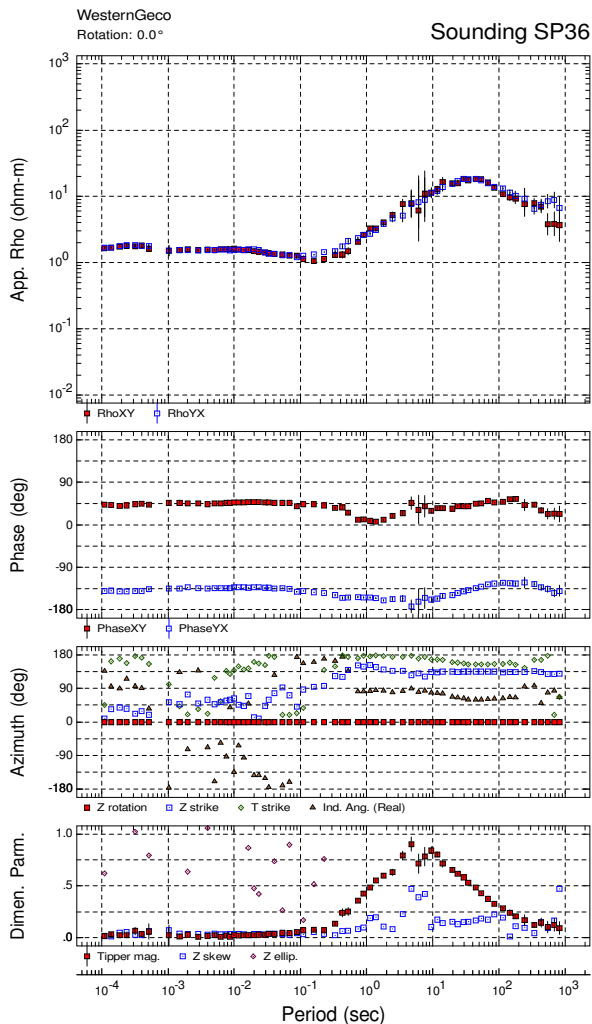
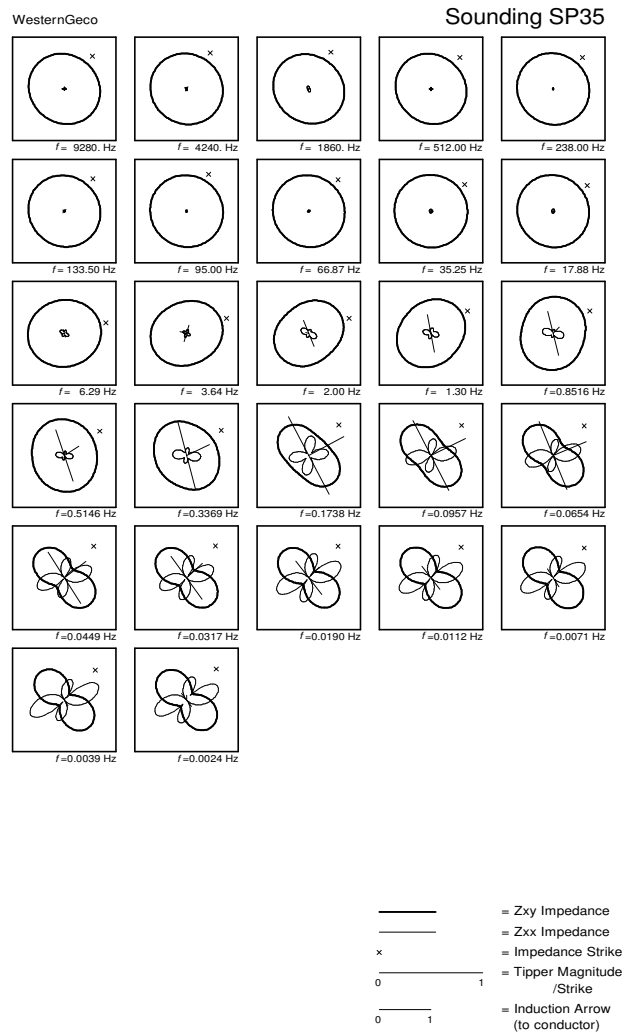
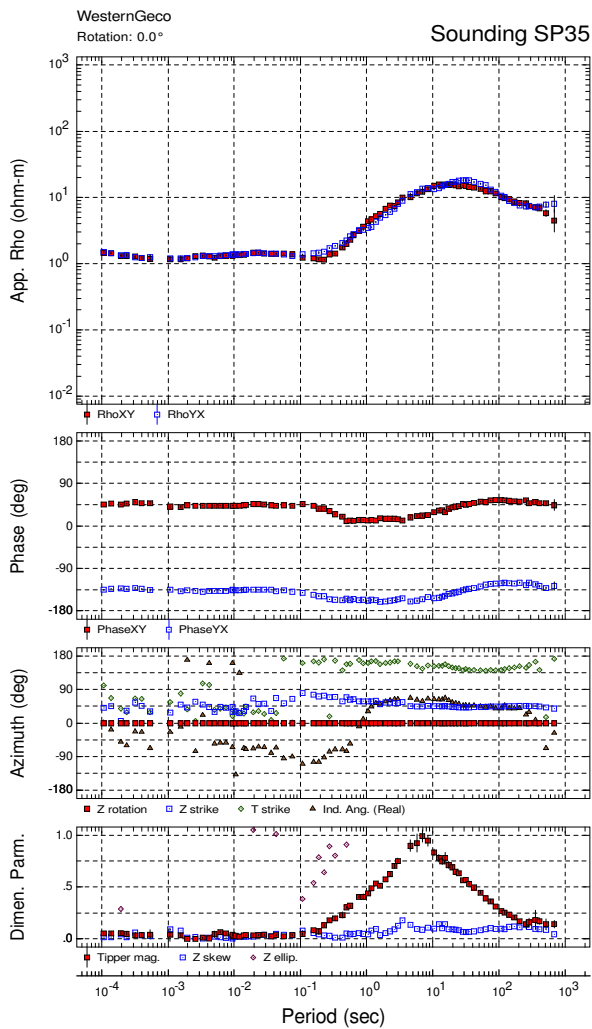




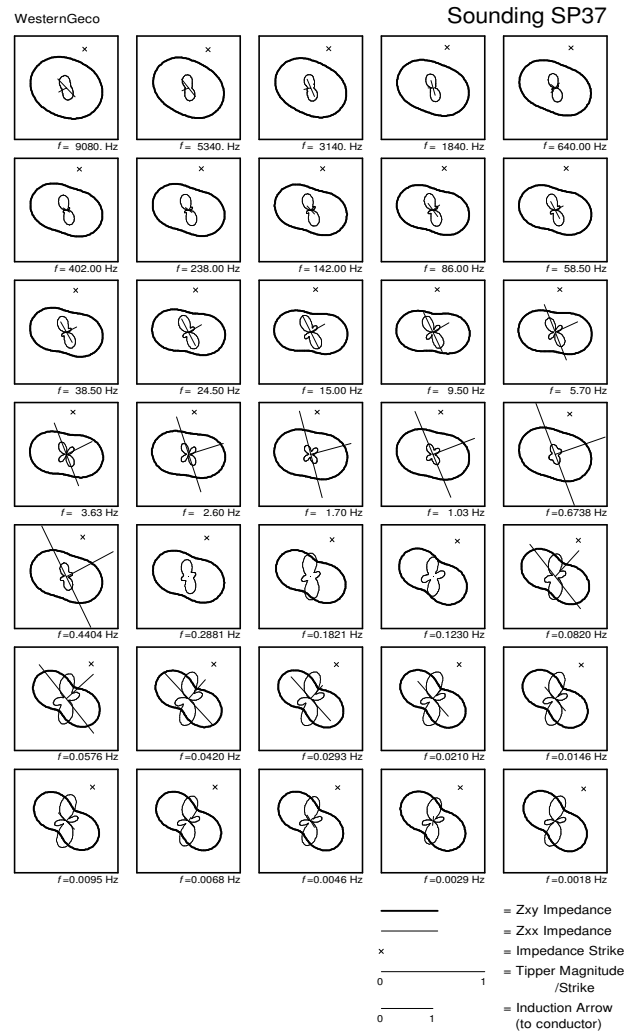
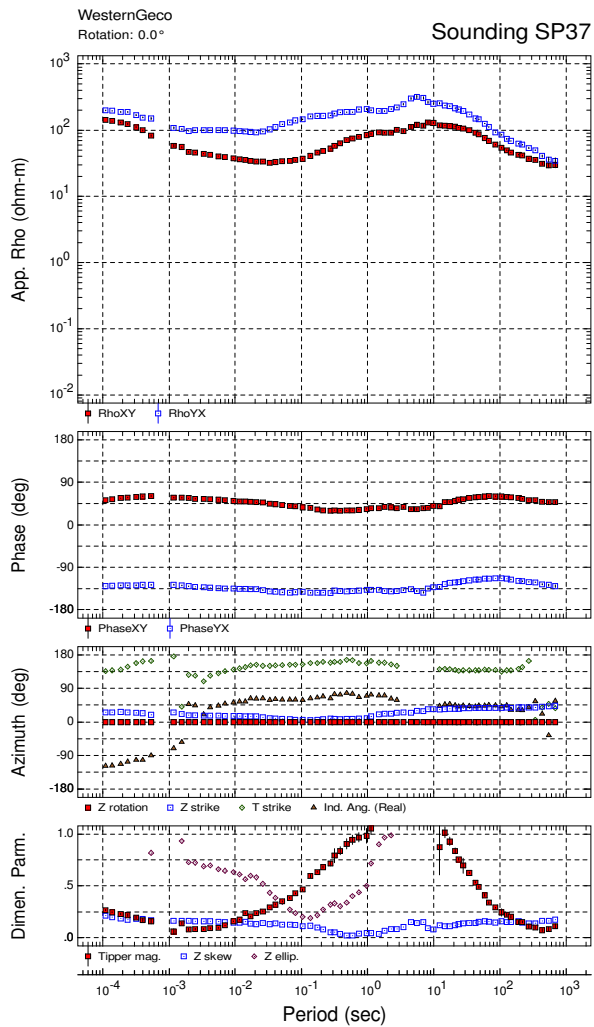
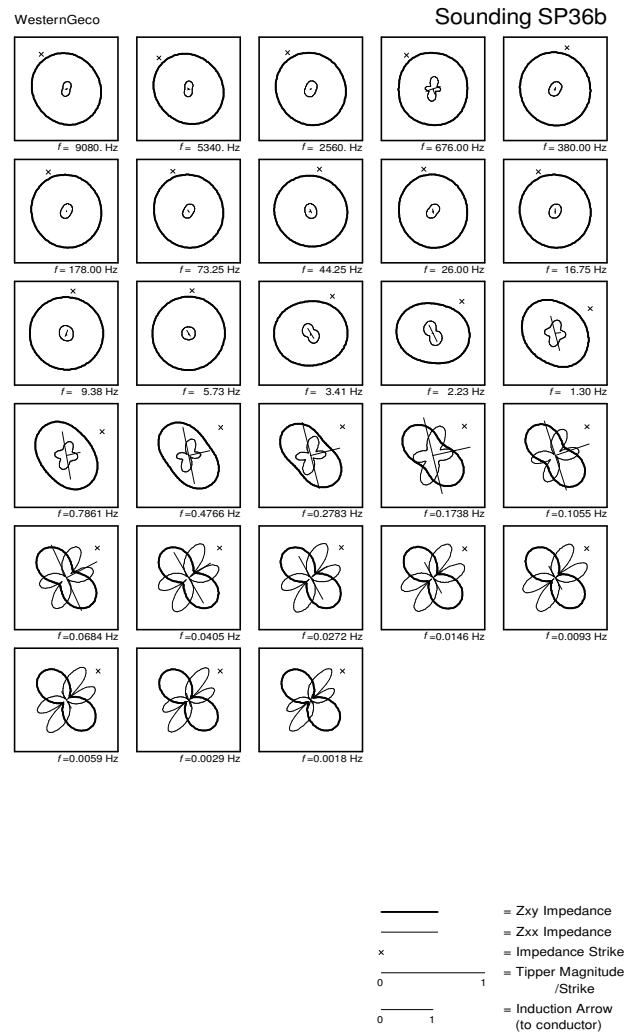
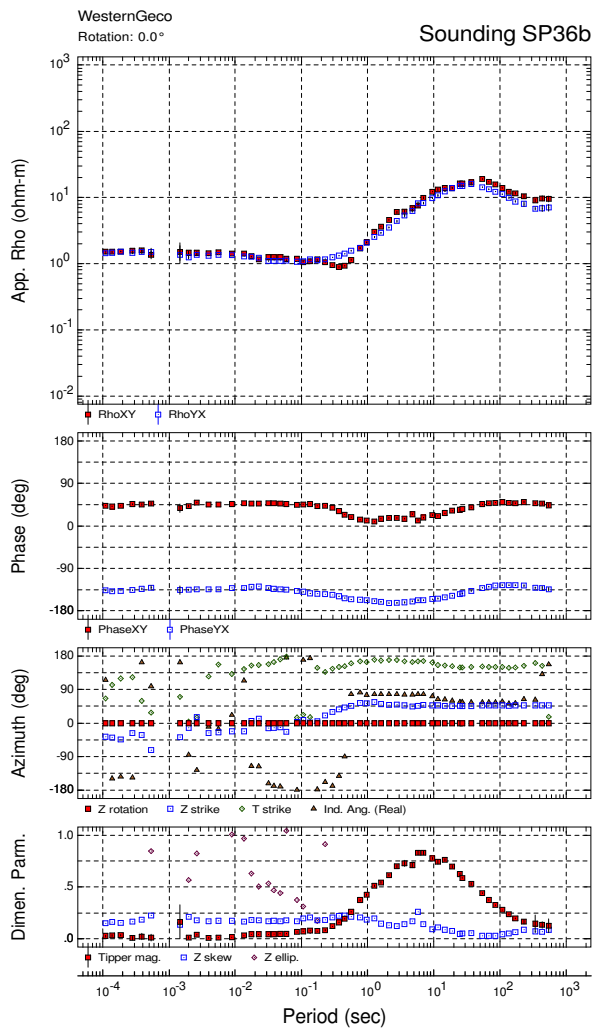


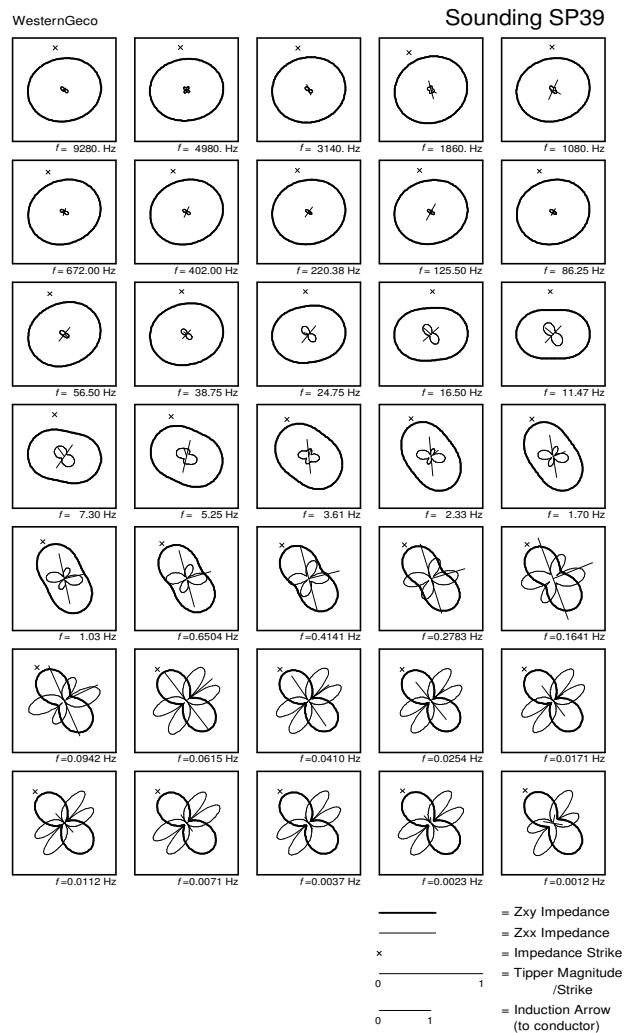
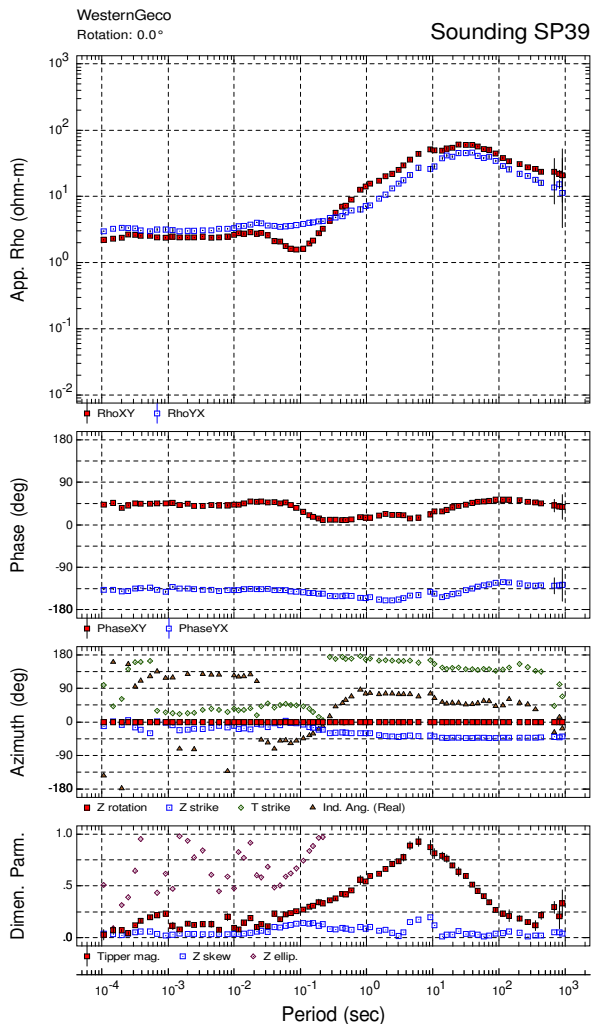
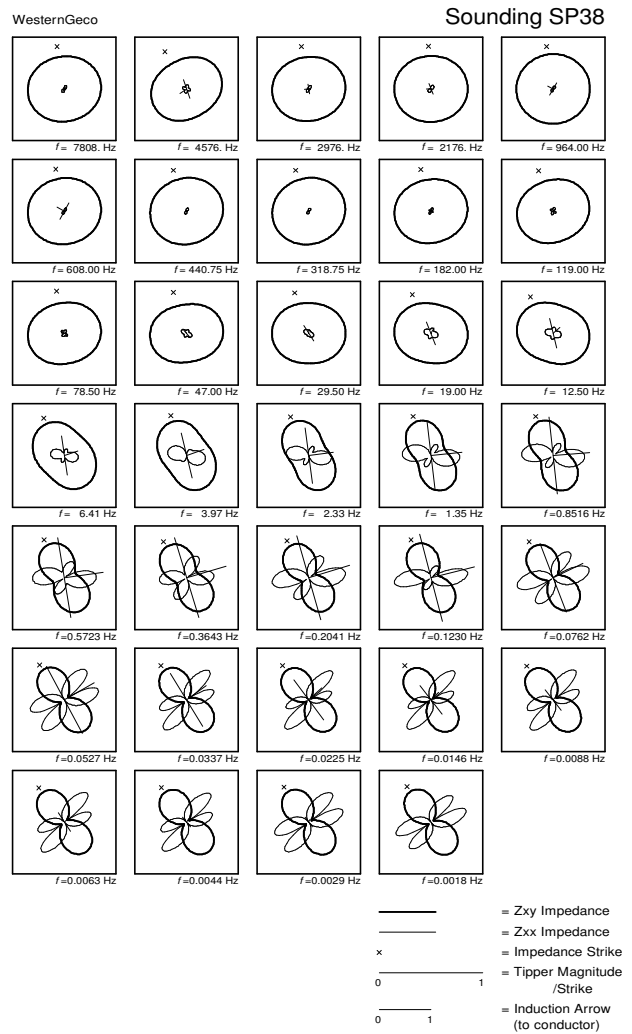
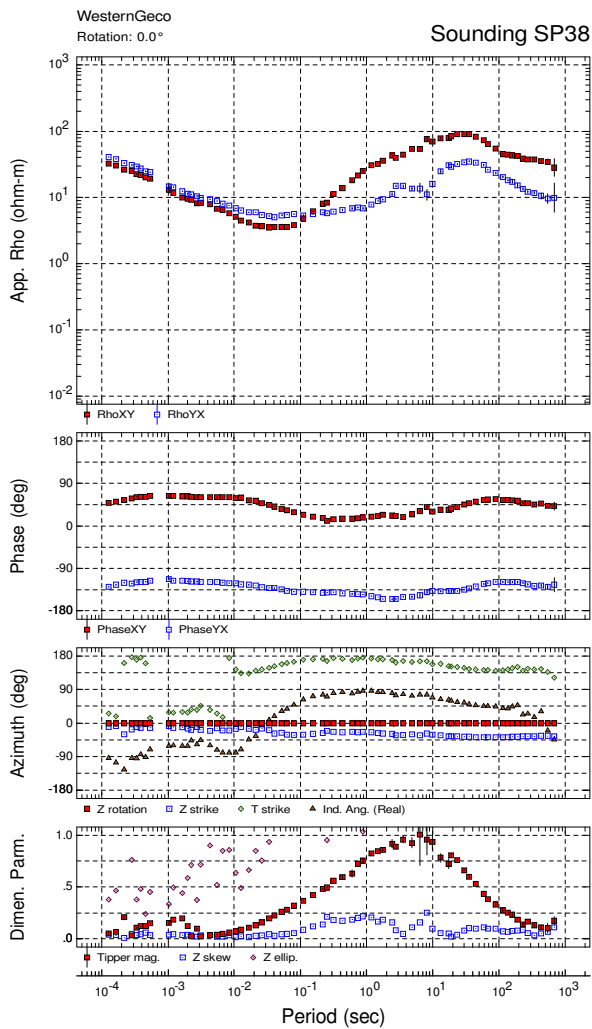


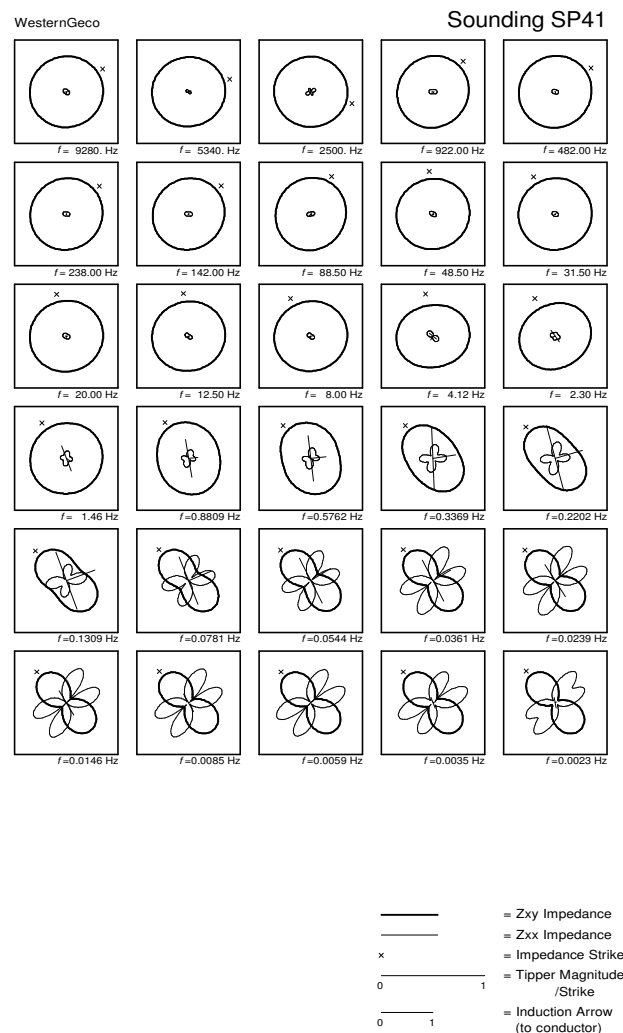
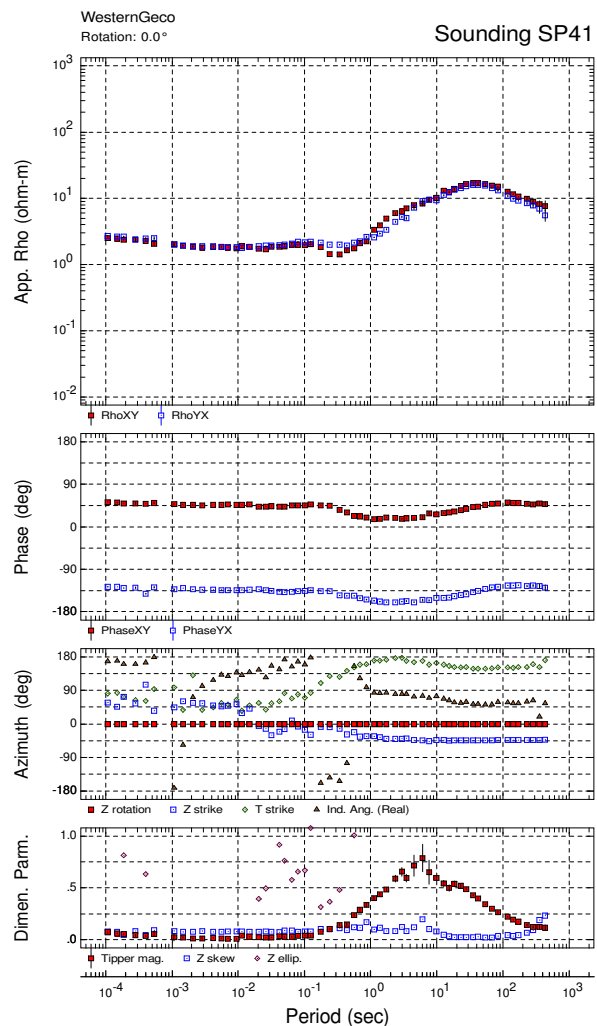
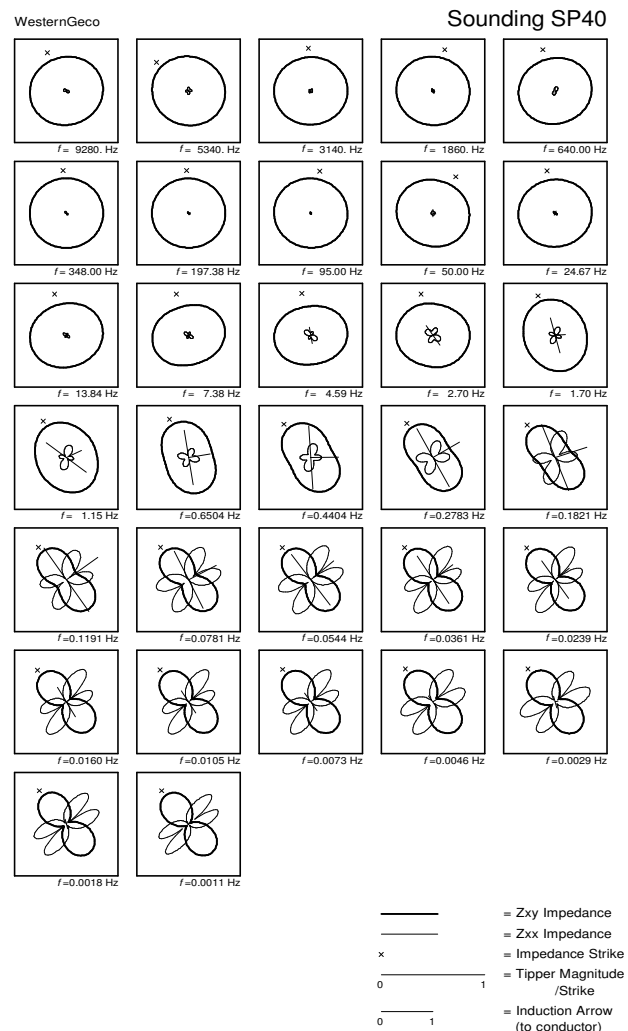
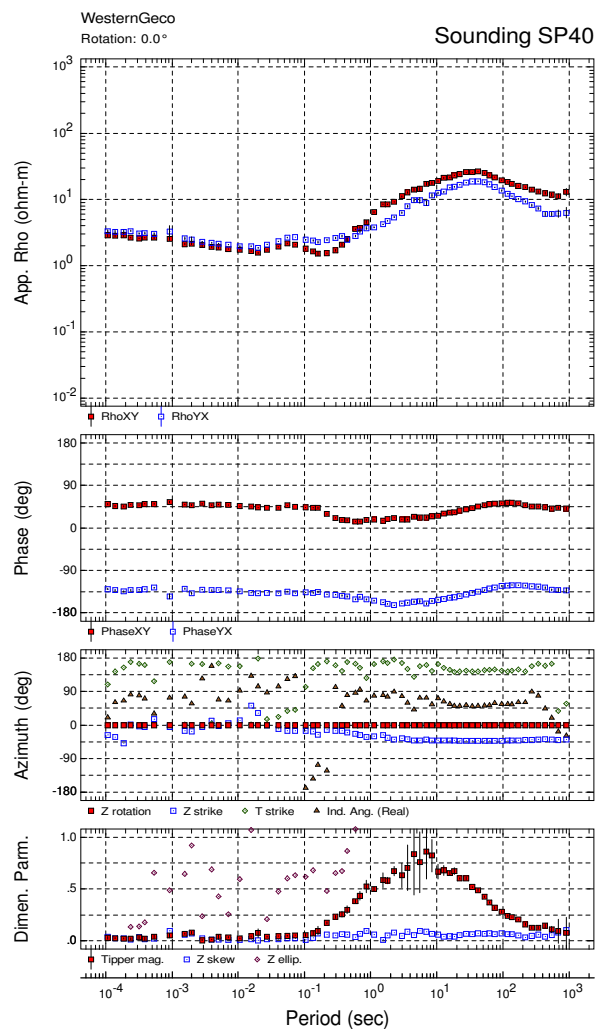


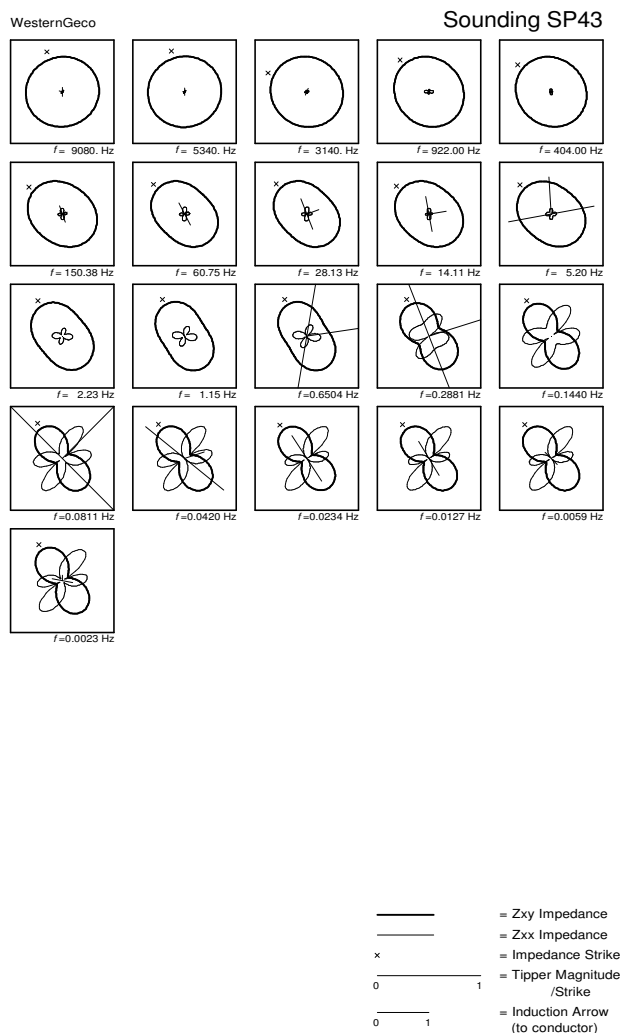
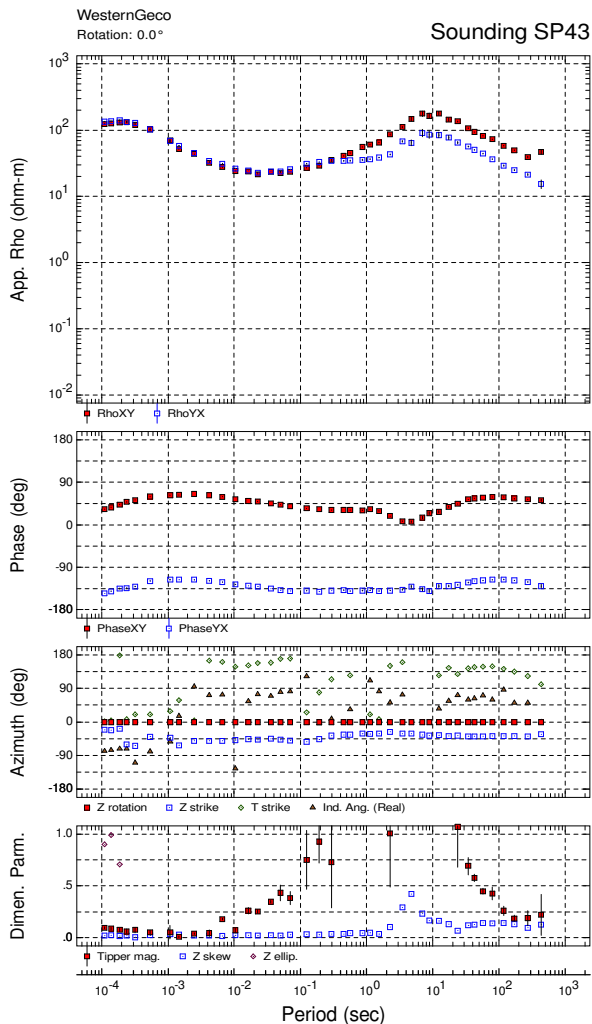
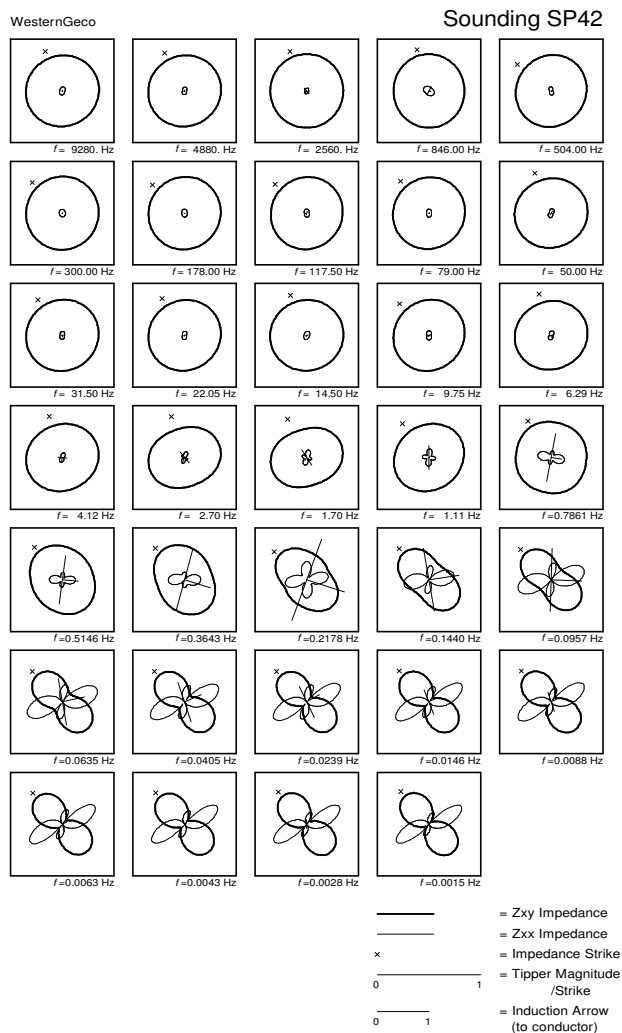
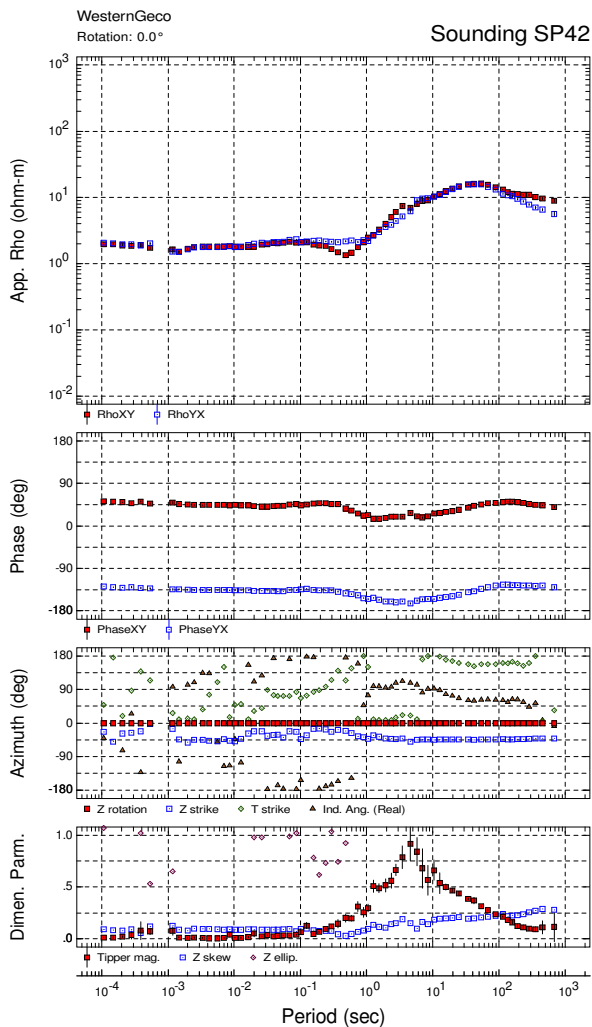


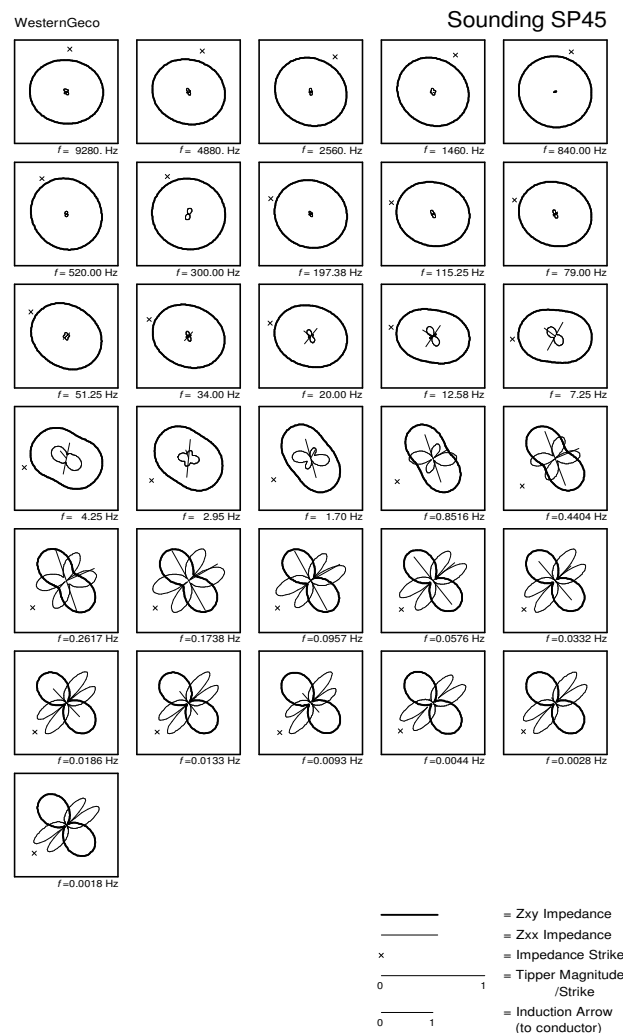
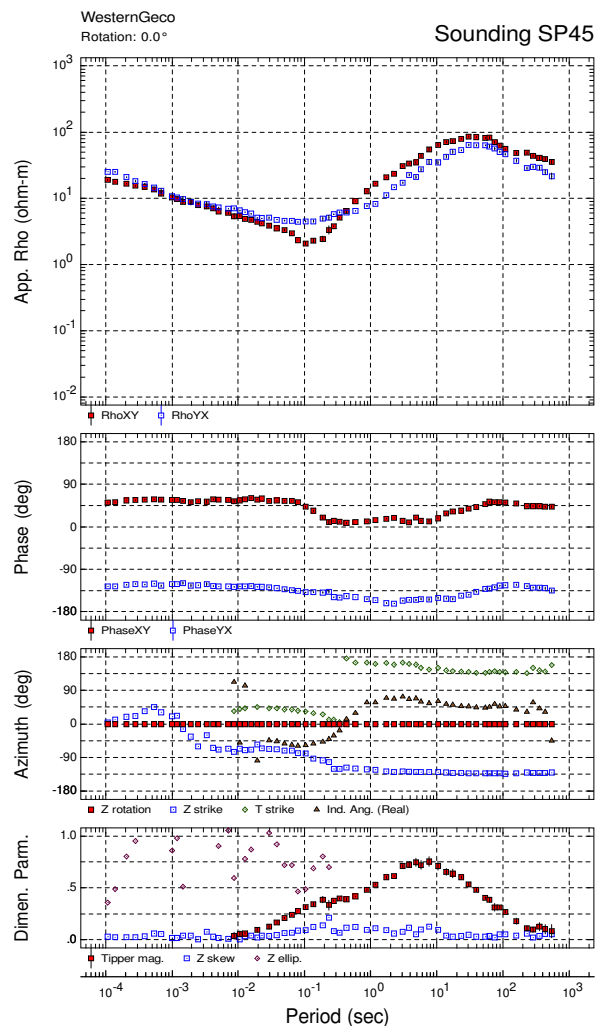
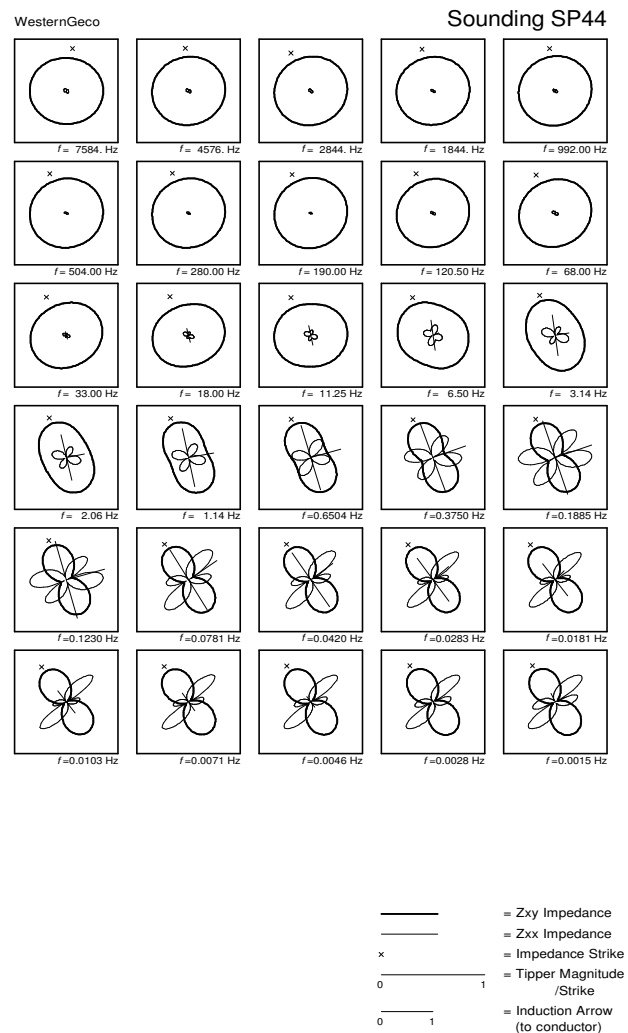
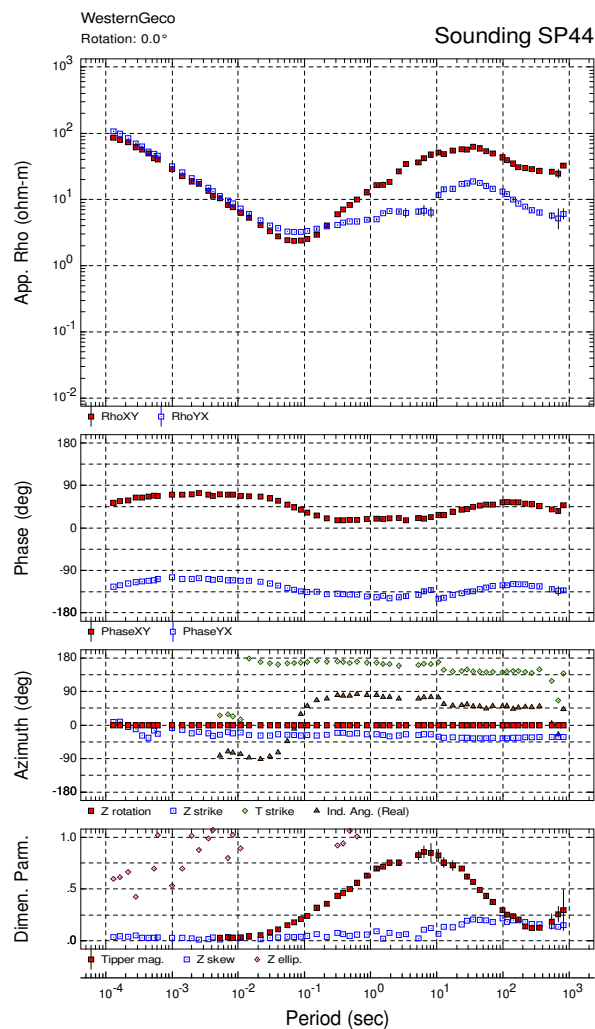




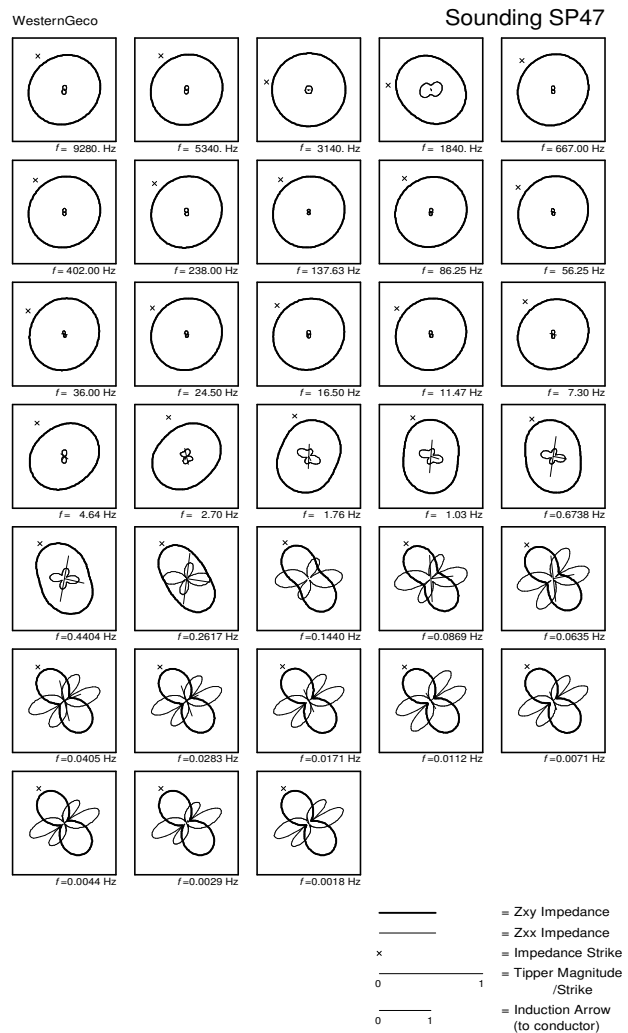
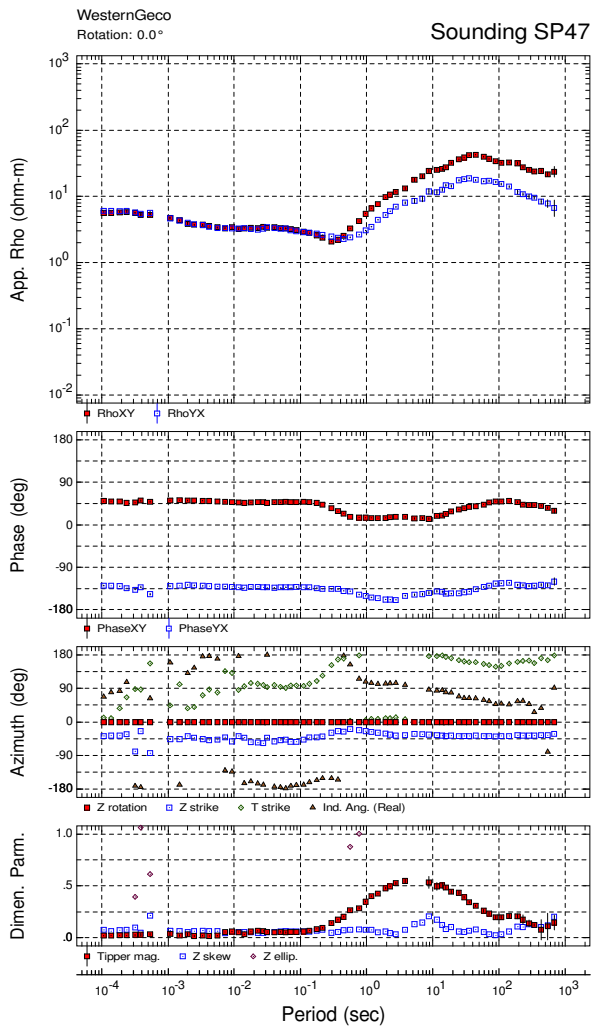
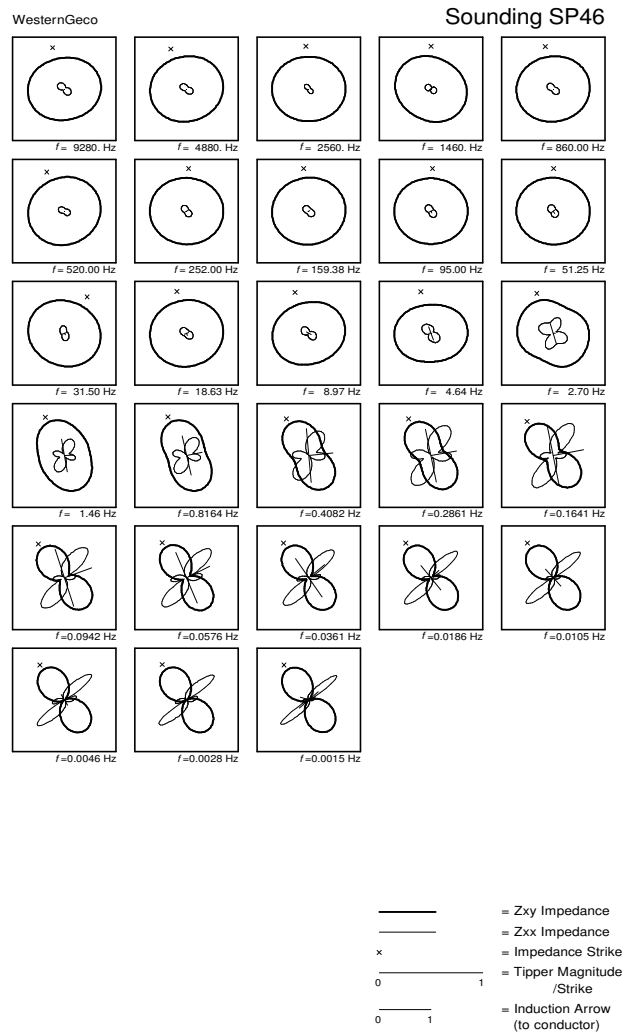
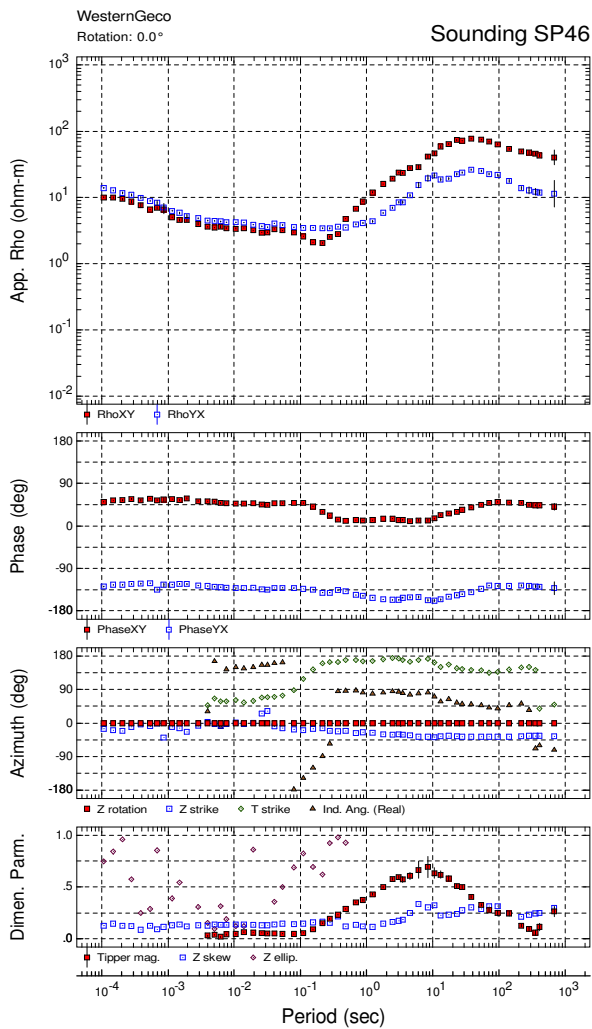


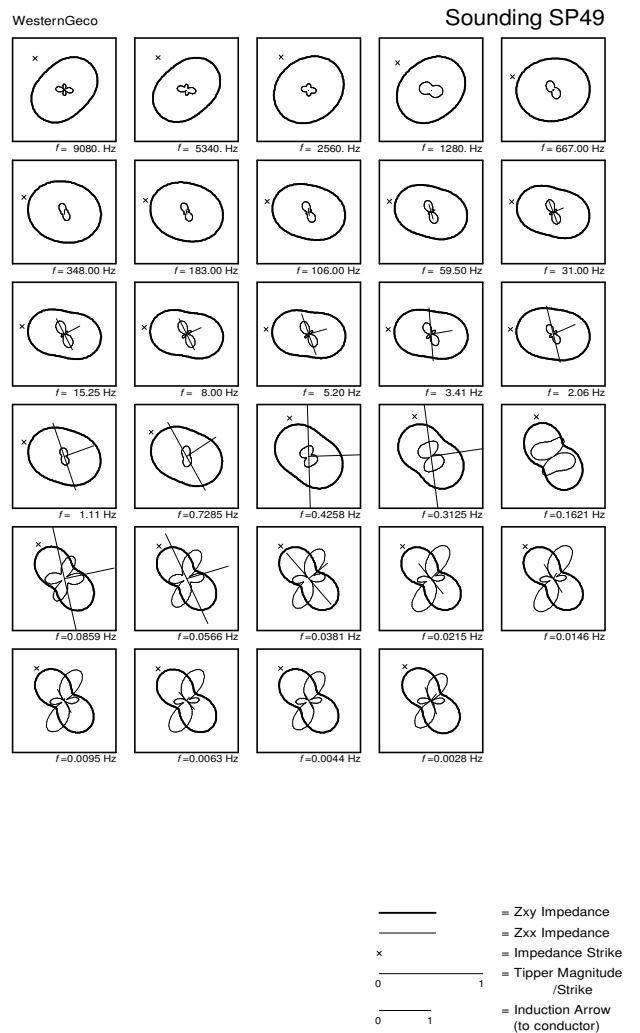
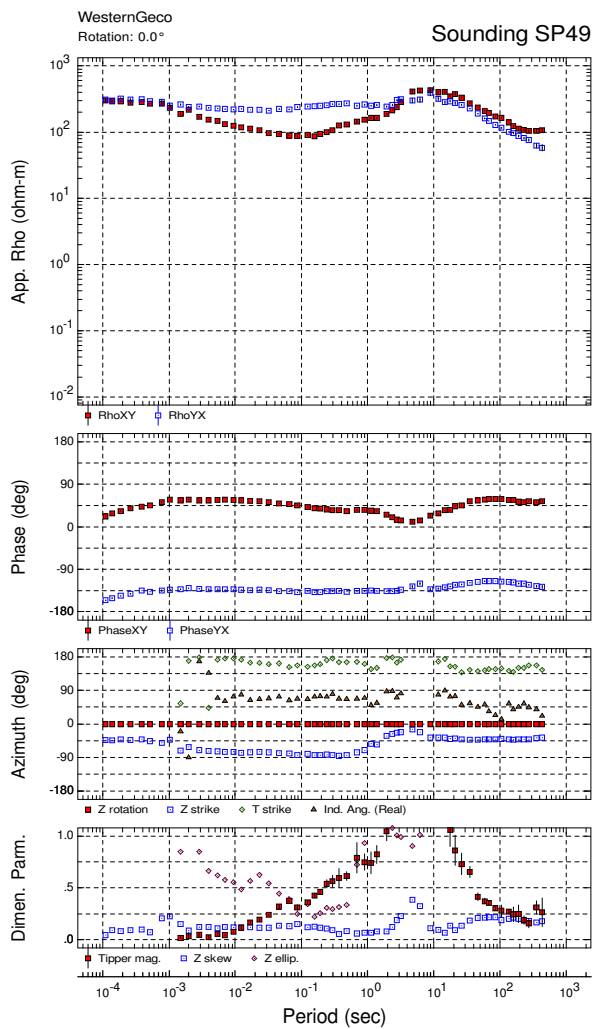
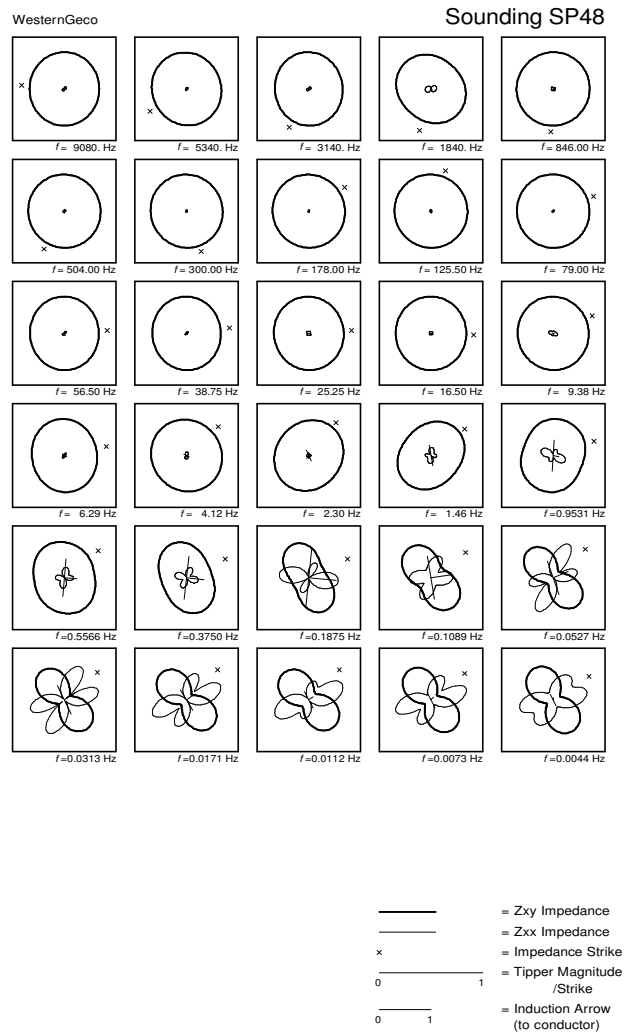
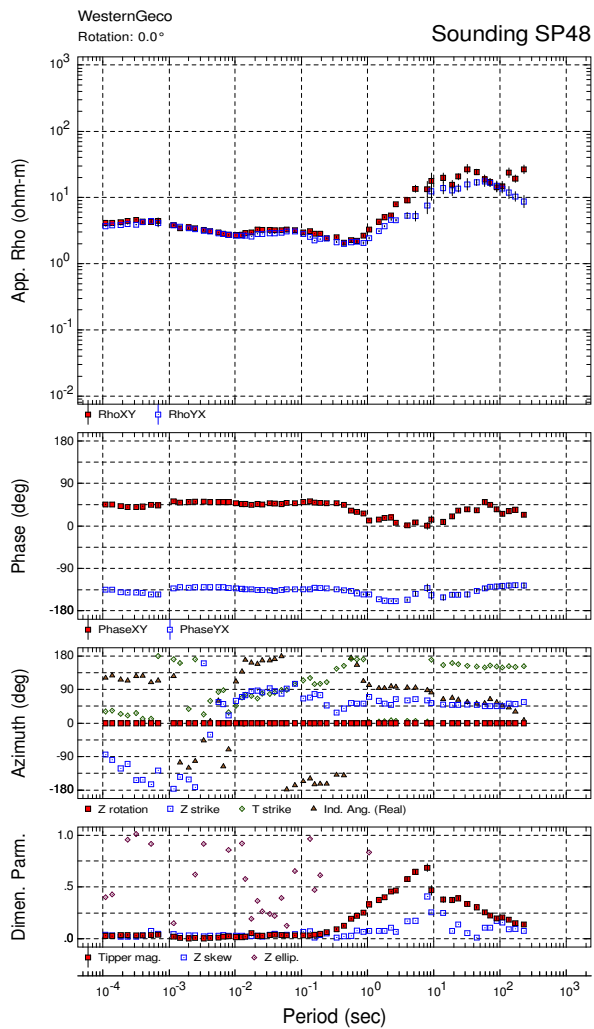


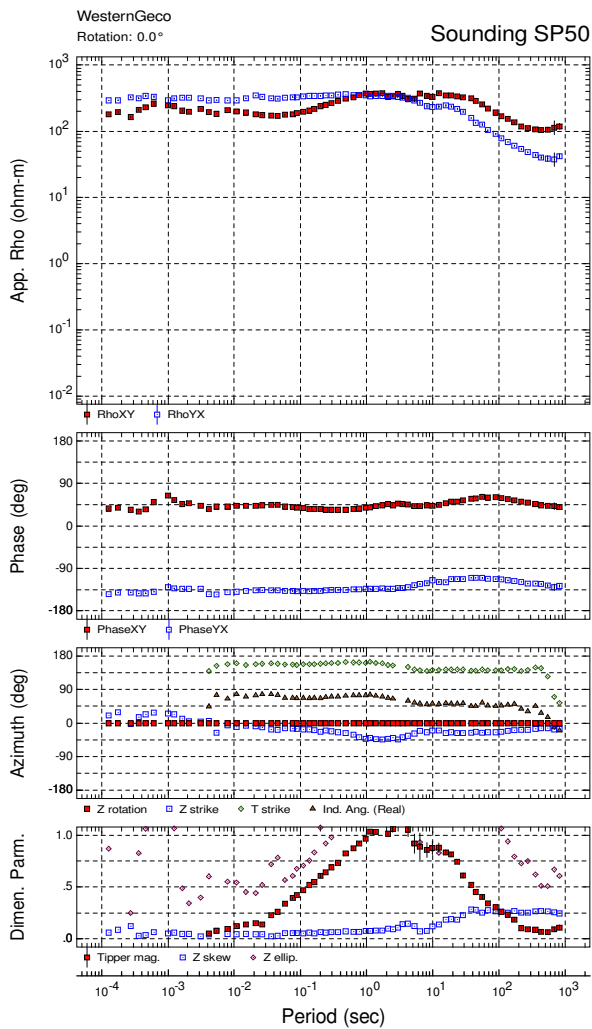






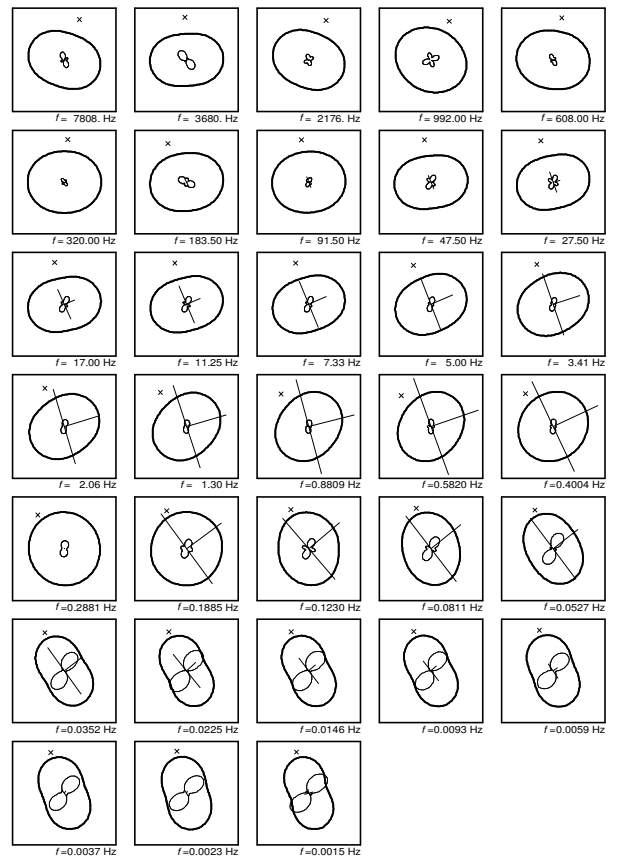






WesternGeco

Sounding SP50





## APPENDIX G DIGITAL DATA ON CD

All the project raw and processed data files are archived at Geosystem's head office, Milan, on DVD and magnetic tape.

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The enclosed CD contains:

### MT DATA

**\*.EDI:** SEG MT/EMAP Data Interchange Standard files, ASCII format.

**MT\_Coordinates\_Alum-SilverPeak.xls** File containing MT sounding coordinates (see section 1.2 for metric coordinate projection parameters).

### WinGLink Database

WinGLink database (.wdb) with all MT data.

### Report

**Alum-SilverPeak\_Operational-Report.pdf:** Acrobat pdf file of this report.

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### MT TIME SERIES

The MT Time Series are submitted separately on encrypted Hard Drive.