LDA-3A  AF DEMAGNETIZER

General

This instrument serves for demagnetizing a specimen by alternating magnetic field. The
demagnetization process is microprocessor-controlled and automated. One only sets up the
demagnetization parameters, fixes the specimen into the specimen holder and inserts the
holder into the demagnetizing coil. The rest of the demagnetization process is done
automatically following the pre-set parameters.

Tripple mu-metal shielding provides an effective protection of the specimen from Earth’s
magnetic field. The electrical current for producing the demagnetizing AF field is derived
from the electrical net current that is filtered in such a way that all the higher harmonic
components that may produce parasitic magnetizations are effectively attenuated.

The instrument consists of three units:

1. The Specimen Unit comprises mu-metal shielding with demagnetizing coil and
   specimen tumbler.
2. The Power Supply Unit generates electrical current that induces alternating magnetic
   field inside the demagnetizing coil.
3. The Control Unit controls the whole process of demagnetization.

LDA-3A Characteristics

- Automated, microprocessor controlled process of demagnetization
- Tripple mu-metal shielding
- Effective attenuation of harmonic distortion of the demagnetizing field
- Variable options of demagnetization timing for effective demagnetization
- Demagnetization of tumbling specimen
- Demagnetization of static specimen *
- Three various curves of decreasing demagnetization field *
- Expanded time of decreasing demagnetization field *

* New features of LDA-3A comparing to LDA-3

Specifications

<table>
<thead>
<tr>
<th>Shielding</th>
<th>triple mu-metal shielding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specimen cube</td>
<td>20 mm in edge</td>
</tr>
<tr>
<td>Specimen cylinder</td>
<td>25.4 mm in diameter, 21-22 mm in height</td>
</tr>
<tr>
<td>AF demagnetizing field</td>
<td>1 to 100 mT</td>
</tr>
<tr>
<td>Power requirements</td>
<td>230 V / 50 Hz</td>
</tr>
<tr>
<td>Power consumption</td>
<td>400 VA</td>
</tr>
</tbody>
</table>
### Dimensions, mass:

<table>
<thead>
<tr>
<th>Specimen Unit</th>
<th>110 x 30 x 33 cm</th>
<th>35 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply Unit</td>
<td>35 x 33 x 18 cm</td>
<td>15 kg</td>
</tr>
<tr>
<td>Control Unit</td>
<td>20 x 10 x 5 cm</td>
<td>0.5 kg</td>
</tr>
</tbody>
</table>

### Instrument Description

#### Specimen Unit

This unit consists of the large mu-metal shielding that protects the specimen from the Earth’s magnetic field. The shielding is made of three mu-metal concentric cylinders. Inside the shielding, there is the demagnetization coil. The specimen tumbler is movable and is in principle used in two positions. In the first position, the specimen holder is outside the shielding. In this position the specimen can be put on or taken out of the specimen holder. In the second position, the specimen holder with the specimen is inserted in the centre of the demagnetizing coil. In this position, the specimen is demagnetized.

#### Power Supply Unit

The front panel contains the LED indicator that lights in green when the mains is on. The rear panel contains the central mains switch for switching on and off the whole instrument, and connectors for connecting Specimen Unit, Control Unit and, optionally, the Anhysteretic Magnetizer.

#### Control Unit

The unit contains display and five control buttons. The display shows the state of the instrument as well as values of demagnetization parameters. The START/STOP button serves for starting the demagnetization procedure; it can also be used to stop the demagnetizing process earlier than it has been pre-set (the specimen continues tumbling and the field is decreased at the pre-set rate). The button SET initiates process of setting up the demagnetization parameters whose values are changed by the UP and DOWN buttons. The MODE/BREAK button is destined for cooperation with Anhysteretic Magnetizer.

### Installation of the Instrument

The instrument is transported split into parts that are packed in such a way that they are protected as much as possible from any damage during transport.

After unpacking the individual parts and their dismantling they should be set up on a wooden table in the following way. The specimen unit, which can be identified through its large glossy cylindrical mu-metal shielding, should be oriented, using a compass, with the cylinder axis perpendicular to the local magnetic meridian - the axis should be oriented W-E. It is recommended to draw a W-E line on the table before mounting the specimen unit there, because close contact of the compass with the mu-metal could cause imprecise orientation. Red transport screw should be removed from the rear side of the Specimen...
Unit and the screw should be stored. The Power Supply Unit is recommended to be placed sideways the table on the ground and the Control Unit should be placed on the table. The individual units should be connected with the interconnecting cables (the cables have different connectors so that the misconnection is impossible).

**Process of Demagnetization**

The instrument enables either demagnetization of tumbling specimen in so-called *rotate mode*, or static demagnetization subsequently in *three perpendicular directions* defined by axes x1, x2, x3, in *static mode*. It is also possible to demagnetize the specimen in one selected direction along the axis x1 or x2 or x3 (*st_1, st_2, or st_3 modes*).

The demagnetization mode is shown in the upper right corner of the display in the initial state of the instrument, and can be changed by UP and DOWN buttons.

The process of demagnetization consists of three parts. During the first part the alternating field is increasing, then it is kept at the preset nominal value, and during the third part the field is decreasing according to preset shape of decreasing curve. Through this process the specimen is either tumbling in the *rotate mode* or it stays in the defined position in *st_1, st_2, or st_3 modes*. In the *static mode* that is designed for the complete demagnetization of a specimen in three perpendicular directions, the three demagnetization cycles are performed automatically in one sequence.

Depending on magnetic properties of the specimen, the LDA-3A enables to optimize the demagnetizing process by selecting the shape of alternating field decrease (*steep-gent*, *linear*, *gent-steep*). The durations of particular sections of the process demagnetization for nominal alternating field of 100 mT are listed in Tab.

**Demagnetization Procedure**

After switching on the instrument (using the mains switch on the rear panel of the Power Supply Unit), the ventilator starts cooling the demagnetization coil and the instrument is put in the so-called initial state. This is the state in which the instrument is ready to demagnetize a specimen; this state is indicated by the simultaneous display of the demagnetization mode, and values of the demagnetizing parameters:

```
AF Demag. < mode >
< value > mT [min]:[sec]
```

In order to change the demagnetization parameters, follow the section *Setting up the Demagnetization Parameters* below. If the demagnetization parameters have been properly set, start the demagnetization as follows:

1. Pull out the tumbler in such a way that the specimen holder is outside the shielding.
2. Fix the specimen into the **holder**. The holder is universal and accepts both the cubic and cylindrical specimens of standard sizes (cube 2 cm in edge, cylinder 25.4 mm in diameter and 21-22 mm in height)
3. Insert the tumbler inside the demagnetizing coil.
4. Press the button START/STOP on the Control Unit. The demagnetization procedure starts and is performed automatically, while display shows particular states of the process - see section Process of Demagnetization above. The end of the demagnetization procedure is indicated by a double beep.

5. Pull out the tumbler so that the specimen can be taken out of the holder.

Note: It could happen that the demagnetization process must be terminated. In this case, use the button START/STOP. After pressing this button, the instrument decreases the field immediately.

Setting up the Demagnetization Parameters

The following demagnetization parameters can be set up:

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>DISP</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal value of alternating field</td>
<td>A Field:</td>
<td>1 to 100 mT</td>
</tr>
<tr>
<td>Time of demagnetization in nominal field</td>
<td>Time:</td>
<td>0 to 2 min</td>
</tr>
<tr>
<td>Rate of alternating field increase</td>
<td>Rate Inc:</td>
<td>slow, medium, fast</td>
</tr>
<tr>
<td>Rate of alternating field decrease</td>
<td>Rate Dec:</td>
<td>slow, medium, fast</td>
</tr>
<tr>
<td>Shape of decreasing curve</td>
<td>Slope:</td>
<td>steep-gent, linear, gent-steep</td>
</tr>
</tbody>
</table>

The setting up demagnetization parameters is made after pressing the button SET. The display shows the parameter name and the preset value. To change the displayed value, press either the UP or DOWN button to increase or decrease the value. By pressing the SET button again, the next demagnetizing parameter can be set up. Pressing and holding the SET button for at least 1 second write the current set of parameters into memory of the instrument. After switching the instrument on, the parameters will be activated corresponding to the state at time of the last storing. The setting up procedure can be terminated any time by pressing the button MODE/BREAK.

Note: In the alternating field set mode every pressing the UP or DOWN buttons changes the pre-set field by 10 mT. If finer setting is required, one has to press the START/STOP button. Then, the message fine is displayed, and the pressing the UP or DOWN buttons changes the field by 1 mT.

Trouble Shooting

If the LED diode on the front panel of the Power supply Unit does not light, it is recommended to check the mains voltage or to exchange the fuse (3.15 A) on the rear panel. If the LED diode still does not light, please contact the producer.

Note:

If the demagnetization is made subsequently from low to high fields, there is no time limitation for this work due to the heating of the demagnetization coil. It is also possible to
demagnetize many specimens one after another in the same field. Provided that this field is 60 mT in maximum there is also no time limitation for this work. However, if this field is stronger than 60 mT, only 10 demagnetizations are possible that must be followed by 1 hour interruption for cooling the coil.
**AMU-1A ANHYSTERETIC MAGNETIZER**

**General**

The AMU-1A Anhysteretic Magnetizer is an option to the LDA-3A AF demagnetizer. This equipment enables a rock specimen to be magnetized anhysteretically. The AMU-1A equipment produces a weak direct magnetic field that is, thanks to specially constructed electronic filters, superimposed on the relatively strong alternating magnetic field generated in the LDA-3A demagnetizer. Both fields are coaxial and affect the specimen simultaneously. The AF field increases the mobility of the magnetic domain walls and the direct field orients the domains very effectively. The remanent magnetization generated in this way is strong and relatively stable. This equipment is useful in physical magnetization studies, but above all, it was designed for investigating, in cooperation with any instrument for measuring remanent magnetization (for example the JR-5A/6A Spinner Magnetometers produced by AGICO Inc.), the anisotropy of anhysteretic remanent magnetization (AARM). The AARM is very useful in magnetic fabric studies, because it is controlled by the preferred orientation of ferromagnetic minerals sensu lato only, without any effect of paramagnetic dark silicates. In addition, selection of convenient combination of the strengths of the direct and alternating magnetic fields enables even the magnetic sub-fabrics of the magnetically different fractions of the ferromagnetic minerals to be investigated.

**Specifications**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternating Demagnetizing Field</td>
<td>0 to 100 mT</td>
</tr>
<tr>
<td>Direct (bias) Magnetizing Field</td>
<td>0 to 500 µT</td>
</tr>
<tr>
<td>Dimensions, Mass</td>
<td>19 x 14 x 7 cm</td>
</tr>
</tbody>
</table>

The AMU-1A is connected to the Power Supply Unit of the LDA-3A Demagnetizer.

**Magnetizing Designs**

The determination of the anisotropy of anhysteretic magnetization consists of anhysteretic magnetizing the demagnetized specimen in several independent directions (at least three) and measuring its remanent magnetization after each magnetizing; from these measurements, the second rank tensor of the anisotropy of anhysteretic remanent magnetization is constructed (for theory see for example Jelínek, 1993-96, Travaux Géophys., 37, 124-134, in AGICO Print No. 14, for the AREF program see AGICO Print No. 27). The AARM technique is relatively laborious and time consuming and, therefore, several designs of magnetizing directions are offered by the AMU-1A. One has to select the most convenient one respecting the following rule: the more magnetizing directions the more precise determination of the AARM and the more time consumption and vice versa. The AMU-1A offers 5 magnetizing designs:
A - six magnetizing directions and six antiparallel magnetizing directions (in this way the 'hard' magnetization components which cannot be demagnetized are reasonably eliminated). The method following this design gives the most accurate results.

B - six magnetizing directions in the same design as in the above design (useful if there are negligible 'hard' magnetization components).

C - three magnetizing directions and three antiparallel magnetizing directions. This design is useful if relatively strongly anisotropic specimens are investigated. In weakly anisotropic specimens, the results are of relatively low quality.

D - three magnetizing directions in the same design as that of the C case. This method is the most rapid, but the least accurate. It should be used only in strongly magnetic and strongly anisotropic specimens.

U - user design. The user can create his/her own design from the 18 possible positions. Of course, he/she must use own program for data evaluation.

Magnetization in a particular defined position is performed by direct and alternating magnetic fields that affect the specimen simultaneously.

Anhysteretic Magnetizing Procedure

In order to be able to perform the anhysteretic magnetizing, the LDA-3A Demagnetizer should be switched into the mode MAGNETIZER. This mode is indicated on the display of the Control Unit of the Demagnetizer and can be activated only, if the AMU-1A is connected to Power Supply Unit of the Demagnetizer. The MAGNETIZER mode can be changed for the AF DEMAGNETIZER mode by pressing the MODE button.

If the instrument is in the mode MAGNETIZER, the display shows the name of the mode, the abbreviation of the design, and the number of the next magnetizing position in the upper line, while the pre-set values of the alternating and direct fields as well as that of the magnetizing time are given in the lower line. For example

```
Magnetizer  B4
50 mT/20 µT  1:30
```

means that the B design of magnetizing directions is going to be used and that the next magnetizing position is No. 4 (for details see magnetizing designs). In addition, the specimen will be magnetized in the direct field of the 20 µT while affected by the alternating field of 50 mT.

Before starting magnetizing procedure, it is useful to check the conditions under which the specimen will be magnetized (for details see the section Setting up the Magnetizing Parameters).

The proper anhysteretic magnetizing is made as follows:

1. Pull out the tumbler in such a way that the specimen holder is outside the shielding.

2. Fix the specimen into the holder. The holder is universal and accepts both the cubic and cylindrical specimens of standard sizes (cube 2 cm in edge, cylinder 25.4 mm in diameter and 21-22 mm in height). The specimen should be inserted into the holder in the same way as
shown in Fig., regardless of the magnetizing position; it is oriented into the required magnetizing position automatically.

3. Insert the tumbler inside the demagnetizing coil.

4. Press the START/STOP button. The specimen is automatically oriented into the required position (the process is indicated by the message *setting pos. -* in the lower line of the display). The direct field is switched on and the alternating field increases. The display shows the following information

``` >>>>>```

which is kept on the display until the pre-set alternating field is reached. Then, the information changes to

``` min : sec```

This information displays the time remaining to the end of the part of the magnetizing procedure during which the alternating field is kept at the nominal value. After finishing this part, the alternating field decreases. The display shows

``` <<<<```

After the alternating field have decreased to zero, the direct field is switched off. The specimen is oriented into the initial position (this is indicated by the message *<setting pos.*) and the instrument beeps to indicate completion of the magnetizing procedure.

5. Pull out the tumbler so that the specimen could be taken out of the holder.

6. Measure the remanent magnetization of the specimen (for example using the JR-5A/6A Spinner Magnetometers and the AREM program).

7. Demagnetize the specimen, if necessary. The demagnetization is made after the positions 2 and 4 of the designs A and C and after each position of the designs B and D. The demagnetization is made in such a way that the specimen is inserted into the specimen holder and shifted into the demagnetizing coil. Then, the MODE button is pressed and then the START/STOP button is pressed. The demagnetization is made automatically (for details see LDA-3A). Press MODE button to return to the MAGNETIZER mode.

8. Repeat 1 to 7 until the specimen is measured.

*Note:* 
It can happen that the process must be suddenly terminated. In this case, use the button START/STOP. After pressing this button, the instrument terminates magnetizing.

To make this process automatic, special mode **AUTO-CHANGE MODE** can be used. This mode combines basic modes of demagnetization and magnetization without manually switching between those two. One need only to push START button and the instrument automatically switches between demag/mag modes and sets appropriate specimen positions.
The instrument is switched into AUTO-CHANGE MODE by pushing the MODE button for about two seconds. Pushing the MODE button again returns into basic modes.

**Setting up the Magnetization Parameters**

The following magnetization parameters can be set up:

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>DISP</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal value of alternating field</td>
<td>A Field:</td>
<td>0 to 100 mT</td>
</tr>
<tr>
<td>Direct (bias) field</td>
<td>D Field:</td>
<td>0 to 500 µT</td>
</tr>
<tr>
<td>Time of magnetization in nominal alt.</td>
<td>Time:</td>
<td>0 to 2 min</td>
</tr>
<tr>
<td>field</td>
<td>Rate Inc:</td>
<td>slow, medium, fast</td>
</tr>
<tr>
<td>Rate of alternating field increase</td>
<td>Rate Dec:</td>
<td>slow, medium, fast</td>
</tr>
<tr>
<td>Rate of alternating field decrease</td>
<td>Slope:</td>
<td>steep-gent, linear, gent-stein</td>
</tr>
<tr>
<td>Design of magnetizing directions</td>
<td>Method:</td>
<td>A, B, C, D, U</td>
</tr>
<tr>
<td>Self-incrementing of mag. positions</td>
<td>Autoinc. Pos:</td>
<td>yes, no</td>
</tr>
</tbody>
</table>

The setting up the magnetization parameters is made after pressing the SET button. The display shows the parameter name and the preset value. If one wishes to change the displayed value, one presses either the UP or DOWN buttons, according to whether one wishes to increase or decrease the value. By pressing the SET button again, the next magnetization parameter can be set up. Pressing and holding the SET button for at least 2 seconds write the current set of parameters into memory of the instrument. After switching the instrument on, the parameters will be activated corresponding to the state at time of the last storing. The setting up procedure can be terminated any time by pressing the MODE/BREAK button.

*Note:*

In the alternating field set mode every pressing the UP or DOWN buttons changes the pre-set field by 10 mT. If finer setting is required, one has to press the STAT/STOP button. Then, the message fine is displayed, and the pressing the UP or DOWN buttons changes the field by 1 mT.

AGICO Print No.32, ver. 5, 3/2001
a) Rotate mode of demagnetization:

- **Start**
- **Increased Field**
- **Nominal Value**
- **Decreased Field**
- **Holder:** 
  - Tumbling
b) St-1, st-2 or st-3 modes of demagnetization:

![Diagram showing modes of demagnetization with labels for st-1, st-2, and st-3]

Process of magnetization:

![Diagram showing process of magnetization with labels for Dir. Field, Alt. Field, and Holder]

Legend:
- Tek HM10: 25 S/s
- 1 AcqS
- 0.000 VDC

Graph showing a waveform from 0 to 0.000 VAC, with time in seconds and voltage in volts.
Duration of sections of demagnetization process:
(approximately for nominal alt. field 100mT)

<table>
<thead>
<tr>
<th>ALT. FIELD</th>
<th>PARAMETER</th>
<th>TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increasing</td>
<td>fast</td>
<td>10 sec</td>
</tr>
<tr>
<td></td>
<td>medium</td>
<td>30 sec</td>
</tr>
<tr>
<td></td>
<td>slow</td>
<td>60 sec</td>
</tr>
<tr>
<td>Nominal</td>
<td></td>
<td>0 - 2 min</td>
</tr>
<tr>
<td>value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreasing</td>
<td>fast</td>
<td>30 sec</td>
</tr>
<tr>
<td></td>
<td>medium</td>
<td>60 sec</td>
</tr>
<tr>
<td></td>
<td>slow</td>
<td>120 sec</td>
</tr>
</tbody>
</table>
Position design

*...top view, the others side view

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| A1 | B1 | U7 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| A2 | -- | U8 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| A3 | B2 | U9 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| A4 | -- | U10 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| A5 | B3 | U11 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| A6 | -- | U12 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| A7 | B4 | U13 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| A8 | -- | U14 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| A9 | B5 | U15 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| A10 | -- | U16 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| A11 | B6 | U17 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| A12 | -- | U18 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |