Laser-Scan Ltd.

LITES2 - 3D Volume Calculation

User Guide

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1 **Introduction**

This document describes a 3D volume calculation capability using LITES2 macros and user routines. It is intended for use with direct stereoplotter input to LITES2, in configurations such as the KERN DSR.

2 **Installation**

The 3D volume calculation software consists of 2 files:

* An image file VOLUME_ROUTINE.EXE which contains LITES2 user routines. This file should be in LSL$PUBLIC_ROOT:[LITES2.EXE].

* A LITES2 command file VOLUME.LCM which contains LITES2 macro definitions. This file should be in LSL$PUBLIC_ROOT:[LITES2.CMD].

The following logical name should be defined. This should usually be added to the other LITES2 logical names which are defined in LSL$COM:LITES2INI.COM.

```
$ DEFINE LSL$LITES2ROUTINES_101  LSL$EXE:VOLUME_ROUTINE.EXE
```

If routine 101 is already used for some other purpose, then one of the other numbers may be used instead (see Notes below).

The supplied LITES2 command file VOLUME.LCM should be executed during LITES2 initialisation, by adding a command @VOLUME to either the site-specific or terminal-specific LITES2 initialisation file.

3 **Algorithm**

The method used for calculation of a volume is based on a perimeter and a series of profiles. The method is applicable to positive volumes (heaps), and to negative volumes (holes). The following procedure assumes a hole is being calculated.

The overall sequence is as follows:

1. Either the number of profiles to be measured, or their spacing may be specified. Either set LITES2 variable VOL_DOSPACE to 0 and set VOL_NPROF to the number of profiles, or set VOL_DOSPACE to -1 and set VOL_SPACE to the desired spacing (IFF units). The number of profiles must be an odd number in the range 1-99. The angle of the profiles in degrees anti-clockwise from the horizontal must be set in the LITES2 variable VOL_ANGLE. It is possible to step automatically along each profile - to do this set variable VOL_DOSTEP to -1 and set the step size in variable VOL_STEP, otherwise set VOL_DOSTEP to 0. The macro VOL_SET may be used to prompt for these values - type a space (blank line in a future release of LITES2) to retain the existing value. Initial default value of 3 profiles at an angle of 0 degrees with no automatic stepping are assumed.

2. A feature is digitised in 3D describing the perimeter of the hole. This can either be done at the time, or may be a previously existing feature. The feature may be a line, curve, or area. If it is not closed, then a closing line is assumed.

3. The perimeter feature should be highlighted using a LITES2 FIND command.

4. The operator gives a command to invoke a `start volume' initialisation macro, VOL_INIT. It may be of benefit to bind these commands to a readily available activator, such as a menu square or button.

5. The macro invokes a LITES2 user routine to fit a plane to this perimeter. This plane is used thereafter as the base of the volume. The user routine sets LITES2 variables to the RMS and maximum Z residual of the points with respect to the plane, and also the number and spacing of the profiles. The macro prints out these figures so that invalid digitised points can be identified and corrected. If the option to set a profile spacing is used, then the actual spacing may differ from that set because of the requirement that there be an odd number of equally spaced profiles.

6. For each profile in turn, macro VOL_PREP n (n is the profile number) is invoked. This calls a user routine which sets LITES2 variable VOL_CURS1 VOL_CURS2 and VOL_CURS3 to the coordinate at which this profile first intersects the perimeter. The profile is then digitised, and highlighted with a FIND (or SEARCH LAST) command. Macro VOL_PROF is then invoked. This calls a user routine, which checks how close the feature is to where the profile should be - again LITES2 variables VOL_RMSRES and VOL_MAXRES are set to the residuals and printed out by the macro. The profile is processed to sort the points into order, move them exactly onto the profile, discard any outside the perimeter, discard any within 1/100th of the profile separation of each other, and add points at the intersections with the perimeter (if the user did not digitise points within 1/100th of the profile separation of the perimeter). The original feature is deleted and the newly processed feature added. The cross sectional area of the profile is calculated, stored away, and also set in the LITES2 variable VOL_AREA, which is printed by the macro. The generated feature is not used further - it may be deleted if not required.

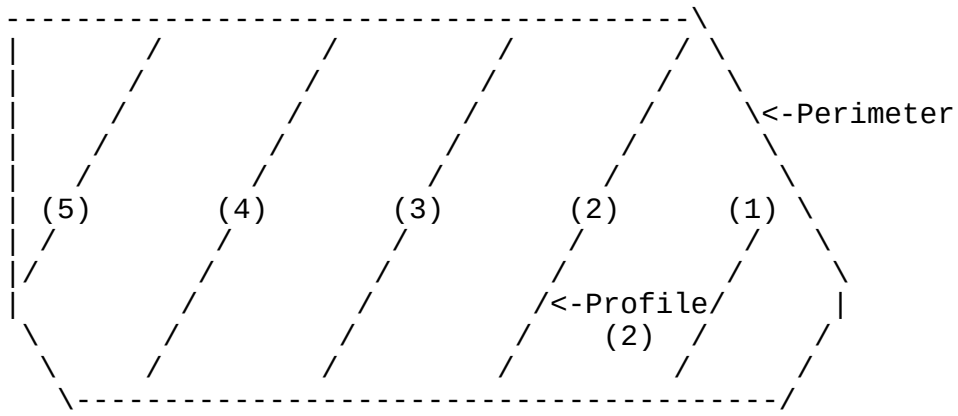
7. In order to automate this procedure, after doing VOL_INIT, call macro VOL_NEXT. This will call VOL_PREP for the first profile and move the X and Y position of the cursor to its starting point. Z may then be adjusted, possibly by snapping onto the perimeter using FIND, and the profile construction started using macro VOL_START (this just invokes the LITES2 START command, but afterwards uses FORCE ANGLE to constrain the cursor along the profile, and also, if required, steps along the profile by the selected distance). If using a DSR instrument, then move along the profile if required, use a tracking button to constrain onto it, and digitise each point using VOL_START. At the final point of the profile, invoke macro VOL_END. This uses the LITES2 END command, then passes the profile to VOL_PROF, and then steps automatically to the next profile. Note that whether or not the automatic stepping facility is used, the user is still free to digitise points anywhere on the profile.

8. When all the profiles have been captured, then macro VOL_VOL is invoked. This calls a user routine to integrate the profile areas to determine an overall volume. This is stored in the LITES2 variable VOL_VOLUME, and printed out by the macro.

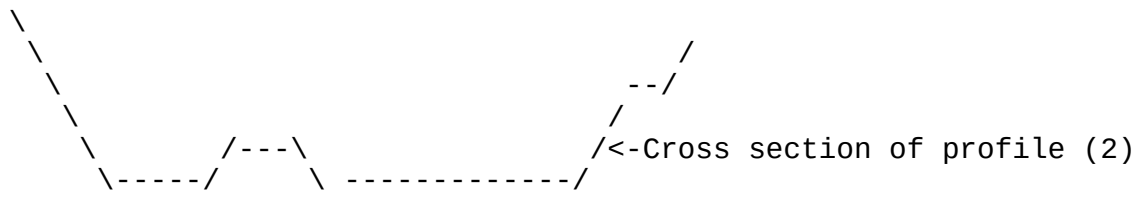
9. An additional macro, VOL_NEAR, is provided which calls the user routine to establish which profile number the cursor is near to (within half a profile spacing). Variable VOL_PROFNO is set to this profile. The condition flag is set false if the cursor is not near a profile. This macro could be used in conjunction with the others to identify and digitise a particular profile.

4 **Diagram**

The following diagram shows a plan view of a quarry with 5 profiles at an angle of 60 degrees.



The following diagram shows a cross section along a particular profile. of 60 degrees.



5 **Notes**

1. Profile areas are calculated using the trapezoidal rule. At the points where the profile intersects the perimeter, the user may digitise points at a different height to the perimeter (vertical sides), otherwise points at the height of the perimeter will be inserted automatically.

2. If a profile intersects the perimeter several times, then the profile should be digitised continuously from one side to the other. Those regions of the profile lying outside the perimeter will be discarded and replaced by invisible segments in the processed profile.

3. The final volume calculation is based on the 'prismoidal rule' [Ref 1]. Odd profiles are given a weighting of 4, even profiles 2, and a profile with zero area which just touches the perimeter is assumed at each end. This will give a volume which assumes a smooth ramp from the end of the perimeter to the first and last profiles.

4. Areas and volumes are calculated in square and cubic IFF units, and therefore may need scaling to give the desired units.

5. It is possible to go back and edit a profile, or to completely redigitise one. Optionally use the VOL_NEAR macro to identify the profile number, n, then repeat the VOL_PREP n, modify the profile and FIND it, then VOL_PROF. As long as all the other profiles have been measured, then VOL_VOL will give the new answer. To use the guidance macros to do this, set variable VOL_PROF to one less than the desired profile number, and invoke VOL_NEXT. Either construct a new profile as above, or amend and FIND an existing one and invoke VOL_PROF.

6. To use a user routine number other than 101 (because 101 is already in use for some other purpose), then edit VOLUME.LCM and set the variable VOL_ROUTINE to another number. Then use this same number in the definition of the logical name LSL$LITES2ROUTINES_xxx.

[Ref 1] - Practical Field Surveying and Computations - A.L.Allan et al, Heinemann, 1968, Chapter 11.