

## **1997 CREWES software release**

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### **INTRODUCTION**

This paper provides an introduction to the contents of the 1997 CREWES software release. Each of the programs comes with instructions on how to use and install the package.

The 1997 release consists of software for the Matlab system, the ProMAX seismic processing system, and Window 95/NT platforms.

### **SOFTWARE RELEASE - PLATFORM OVERVIEW**

#### **Matlab programs: port to version 5.0**

Matlab is a commercial product which provides a computing environment with high performance vector, matrix and visualization functions. The Matlab package is available for most Unix platforms, Windows 95/NT and Macintosh PC's. Once code is developed for Matlab, it will run on all Matlab supported platforms.

All of the CREWES Matlab software has been ported to the new Matlab version 5.0. Matlab 5 is a significant improvement upon the previous version 4.2, and includes greatly improved graphics, object oriented programming constructs and other features.

#### **Landmark Graphics Corporation - ProMAX processing system**

ProMAX is a commercial seismic processing system running on a Unix platform. We are supplying each ProMAX module's as source code and Solaris 2.5 executable.

#### **Windows 95/NT**

The Vp/Vs Explorer program is only available for Windows 95 and Windows NT.

### **SOFTWARE RELEASE CONTENTS**

#### **Matlab seismic toolbox -update**

This is a collection of single channel seismic processing routines, seismic data input/output and viewing routines written by Dr. Gary Margrave. This toolbox adds tremendously to the power of the Matlab computing environment, making it an almost ideal platform for the testing and development of new seismic processing techniques. This is an update of the seismic toolbox, first released in 1995.

The update is a conversion of the toolbox to the new Matlab version, 5.0

#### **LOGSEC**

Logsec is a stratigraphic modelling tool, with a complete graphical user interface (GUI), which enables the building of complex geologic cross sections, the computation of synthetic well logs at any point along the cross section from all available well control, and the creation of synthetic seismic cross sections.

Logsec is designed to work in conjunction with Logedit to provide a complete stratigraphic modelling package. In a typical session, Logedit is first used to ensure that all logs have the same units and sample rate, though there is no need to equalize their vertical extent. Tops may also be picked at this stage. Upon import into Logsec, formation tops are automatically connected and extended to the model boundaries to form the initial “horizons”. Additional horizons may then be added as desired (with simple mouse actions) and all horizons may be edited to create complex behavior such as pinchouts and unconformities. Any horizon may terminate either at the edge of the model or on another horizon.

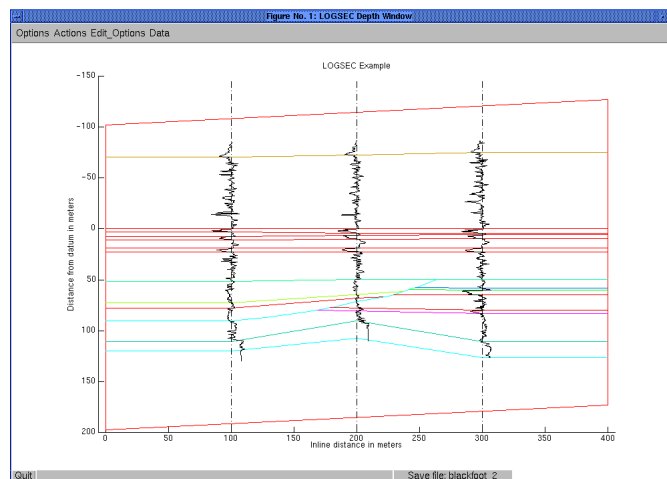


Figure 1: Logsec cross section showing channel and three wells.

After building the cross section, the logs may be propagated along the horizons to synthesize new logs at any location. Log propagation is controlled by prescribing propagation specifications along the top and bottom of each horizon. Possible specifications are top or bottom truncation and stretch/squeeze.

### *Features of Logsec*

- direct mouse-driven horizon editing
- horizon smoothing and duplication
- links to Logedit
- graphical setting of log propagation specs
- flexible time to depth conversion
- datum shifting (horizon flattening)
- sophisticated log propagation algorithm
- new log synthesis from propagated logs
- pinchouts, truncations, and unconformities can be modeled
- creation of synthetic P-P normal incidence seismic cross sections
- SEG Y export of seismic sections
- GUI wavelet creator/editor (plus external wavelet import)
- open/extensible file format
- multiple instances of Logsec may run simultaneously
- full interactive zooming
- controlled scale postscript hardcopy

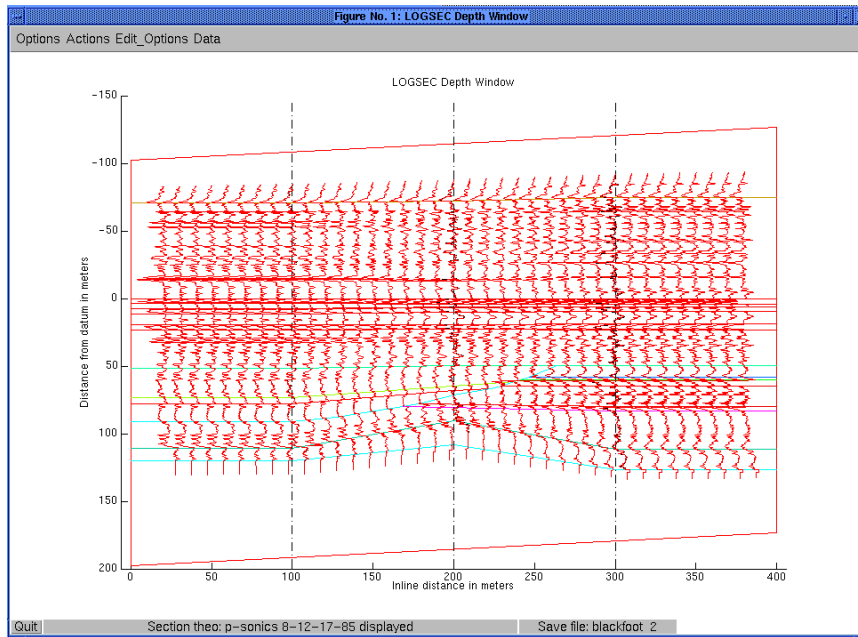


Figure 2: The same cross section as above showing the result of the synthesis of an ensemble of new logs.

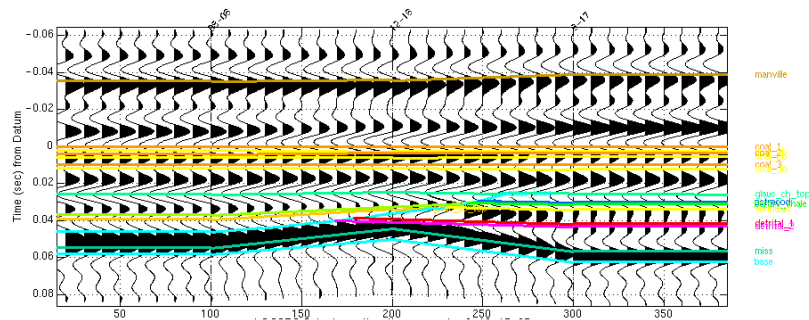


Figure 3: Synthetic seismic section displayed in "time from datum" and computed from the log section shown above.

Logsec is written in Matlab. Author: Gary Margrave.

## LOGEDIT

Logedit is a full featured well log editor with a graphical user interface (GUI). It supports LAS, GMA, and simple ASCII file formats on both input and output and can convert logs between these formats. In addition to a variety of log editing options, it can be used to pick and edit formation tops, convert logs to seismic time, and to create simple 1-D seismograms. It is designed to work in harmony with other MATLAB tools such as LOGSEC and WAVELETED.

Logedit is written in Matlab. Author: Gary Margrave.

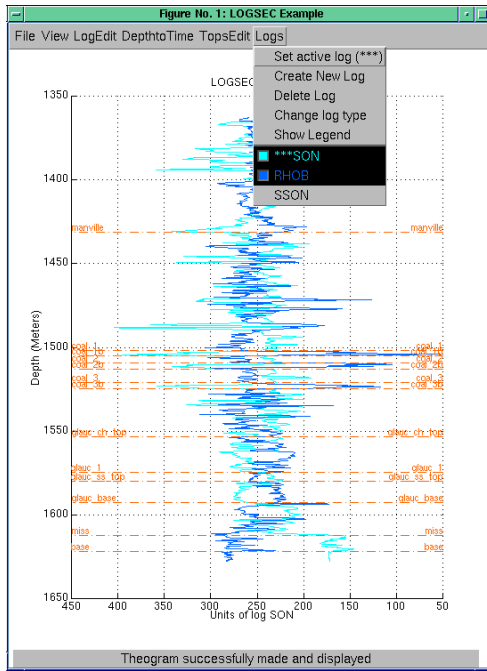


Figure 4a: Logedit screenshot showing a P-sonic and a density log simultaneously. An S-sonic is available and not shown.

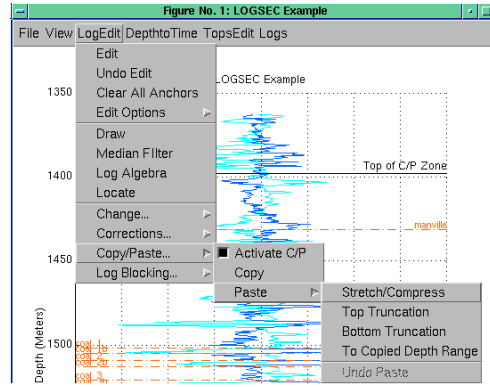


Figure 4b: The Logedit menu is displayed in the process of a copy/paste operation.

## SYNTH

The Synth program performs PP, PS and SS offset stack synthetic seismogram generation. It is based on raytracing of flat layers using the bisection method for solving the ray parameter. Reflection coefficients are computed using the Zoeppritz formulae of Aki and Richards, as coded by E.S. Krebs. Synthetic seismograms are created by stacking NMO-corrected traces over a range of offsets. This version adds improved input/output, NMO options, and more realistic attenuation affects. Synth is implemented in Matlab. Authors: Gary Margrave, Darren Foltinek and Jeff Larsen (Larsen, Margrave, Foltinek, 1997). Original Fortran version by Don Lawton and Tina Howell (Lawton and Howell, 1992).

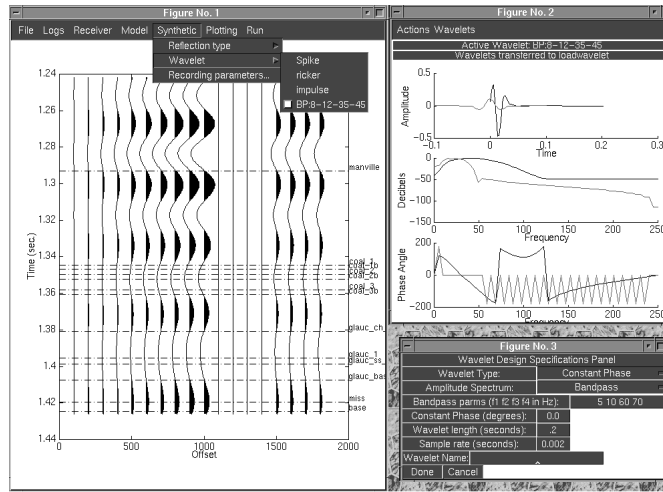


Figure 5: SYNTH screen display and integrated Wavelet user interface.

### Slogger (Vp to Vs)

This program generates a synthetic shear-wave sonic log from a P-wave sonic log and a Vp/Vs curve. Interactive control over the mapping of the Vp/Vs ratios to the P-sonic allows the generation of a synthetic S-sonic for a well from a P-sonic and the Vp/Vs curve from a neighboring well. Logs are read in and saved in LAS format.

Slogger is written in Matlab, and requires the CREWES Matlab toolbox. See Potter and Foltinek (1997). Author: Darren Foltinek.

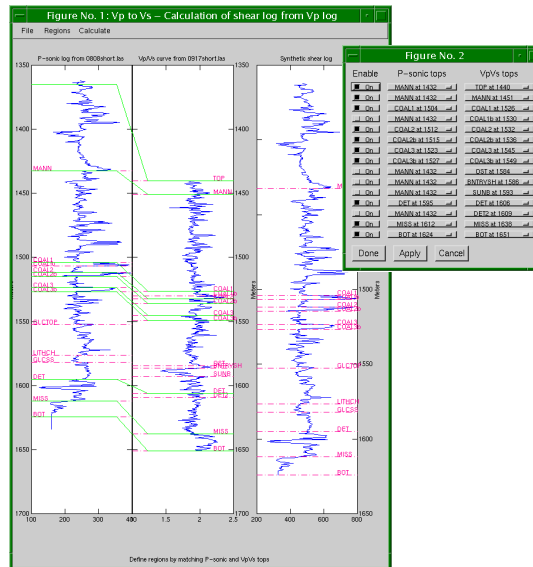


Figure 6: Screen shot of Slogger window. The window on the right shows the defining of Vp/Vs depth regions by tying formation tops. These regions may then be graphically edited in the main window.

## Resolution Simulation Toolbox

The resolution simulation toolbox contains nine matlab routines which can be used to make scattering angle resolution charts for linear  $v(z)$  as described in Margrave (1997). The included routines are:

aliastud.m ... generates figure 11 for spatial aliasing  
 aperstud.m ... generates figure 9 for aperture limits  
 dipspect.m ... generates scattering angle spectral charts like figures 7 and 8  
 makerestest.m ... generates the synthetic seen in figure 1  
 recstud.m ... generates figure 8 for record limits  
 resosim.m ... resolution simulation like figure 16  
 thalias.m ... compute spatial aliasing limit (equation 7)  
 thaper.m ... compute aperture limit (equation 12)  
 threc.m ... compute record length limit (equation 13)

These routines are part of the CREWES Matlab Seismic toolbox. Author: Gary Margrave

## Time variant spectral inversion (TVSI)

TVSI (time variant spectral inversion) is a deconvolution method that approximately corrects seismic data for the effects of anelastic attenuation, frequency dispersion, and source signature. Two versions of the deconvolution are available, the simple-smoothing method and the residual-smoothing method. Examples can be seen in Schoepp and Margrave (1997). Author: Alana Schoepp.

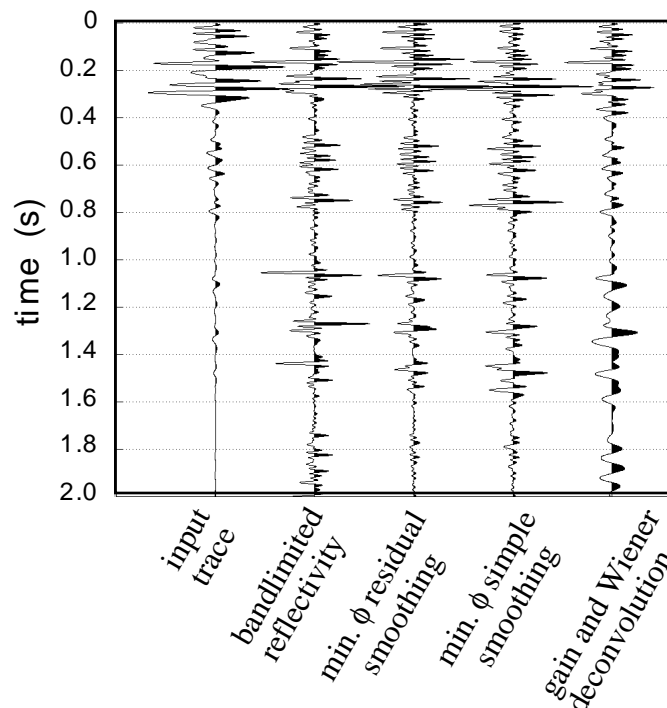


Figure 7: Comparison of TVSI to other deconvolution methods.

## Nonstationary Phase Shift

NSPS - Isotropic wavefield extrapolator for laterally varying velocities.

TI-NSPS - Transversely isotropic wavefield extrapolator for laterally varying Thomsen's parameters. No restriction is placed on the weakness of the anisotropy, or the angle of TI symmetry. The significance of this method lies in the fact that velocity variation is allowed simultaneously in space and spatial frequency, and that wavefield extrapolation proceeds using only phase velocity.

NSPS is implemented in Matlab. See Margrave and Ferguson (1997). Author: Robert Ferguson and Gary Margrave.

### **CSP statics**

Automatic residual statics methods require cross-correlation between a seismic trace (which may contain an undesired time anomaly) and its reference trace (which is supposed to be free of time anomalies) to estimate the time shift. Conventional methods usually choose one of the NMO corrected traces or some form of averaged trace as the reference of a group (for example, a CMP gather) of traces.

Our CSP method utilizes the advantages of equivalent offset migration (EOM) method to create a new set of model dataset which contains one reference trace for each input seismic trace. Because of the properties of EOM method, our EOM statics method has following advantages:

- (1) statics are estimated before NMO
- (2) velocity independent
- (3) real "static" solution: independent of trace length, time gate, or horizon picking
- (4) better low frequency statics control.

The implementation of this method can be explained as

- (1) simplified CSP gathers are constructed
- (2) inverse the CSP gather construction process, obtain the static model
- (3) cross-correlate between input data and the model data
- (4) any kind of algorithm to decompose the estimated time shifts into shot and receiver statics.

CSP Statics is implemented as a ProMAX module. See Li and Bancroft, (1997, chapter 23). Author: Xinxiang Li and John Bancroft.

### **Converted wave equivalent offset migration (EOM)**

Wang, Bancroft and Lawton (1996 SEG) presented an algorithm to perform equivalent offset migration (EOM) on converted wave seismic data. This new code is based on a new algorithm presented at the 1997 SEG by Li and Bancroft.

This algorithm is a direct generalization of the algorithm for P-P wave data. Because of the asymmetry of converted wave propagation, this new algorithm is in fact an approximate solution. Analysis has shown that this new method is, for practical purposes, very accurate, especially for targets deeper than three seconds (this is normal for P-S data). Another property of this new algorithm is that seismic P-P velocity information is not needed; instead, we utilize the velocity information obtained from converted wave CMP gathers. (This is based on the Tessmer-Behle RMS velocity theory).

Because of the direct relation between this new algorithm and the algorithm for the P-P case, this algorithm is much faster than the old method, and it is easier to handle the amplitude scaling problem. Practical application tells that this migration method takes almost the same amount of computation time as P-S DMO in a 2-D case.

Converted Wave EOM is implemented as a ProMAX module. See Li and Bancroft (1997, chapter 26). Author: Xinxiang Li and John Bancroft.

### **CSP Gather modifications**

Comparing to the original code in ProMAX which was released in 1995, this new version has the following changes:

- (1) A faster and more accurate algorithm, presented by Li and Bancroft in the 1996 CREWES research report is used.
- (2) An amplitude scaling option has been added which works very well in attenuating the very-near offset effects on CSP gathers.
- (3) An option has been added for limiting the migration aperture. This is a simple way to speed up the migration process, and is especially efficient for simply structured data.
- (4) An option has been added to construct CSP gathers with asymptotic equivalent offset which is totally velocity independent and time invariant. This approximation is also many times faster than normal CSP gather construction. This is very good for taking a look at the appearance of CSP gathers, and for the CSP static model construction.
- (5) An option has been added to construct double-sided CSP gathers. Two-sided CSP gathers are sometimes needed for checking the subsurface structure or the velocity variance.
- (6) An option has been added to output CSP trace fold data, which is useful in balancing the amplitude distribution of CSP gathers and the final image sections.
- (7) The CSP fold can be any decimal number, instead of the integer requirement in the old code.

The new code is only ready for 2-D data processing. This new code has following advantages:

- (1) The CSP gathers are very good for velocity analysis. The flat effects, usually from very-near offset data, almost disappear.
- (2) The amplitude information is more reliable.

In addition, the module "CSP filters" is no longer used with the new version of "CSP Gathers". Instead, an independent "RJW filter" module can be used on input data, CSSSP gathers or even the image section.

CSP Gather is implemented as a ProMAX module. See Bancroft, Li and Xu (1997, chapter 27). Author: Xinxiang Li and John Bancroft

### **VpVs Explorer**

The program Average Vp/Vs allows one to compute the average Vp/Vs ratio for a multi-layered earth model. Each layer is defined by a thickness, P- velocity and S-velocity. One can explore the relationship between the average Vp/Vs ratio and any individual layer's thickness, Vp or Vs by viewing graphs generated with this program.



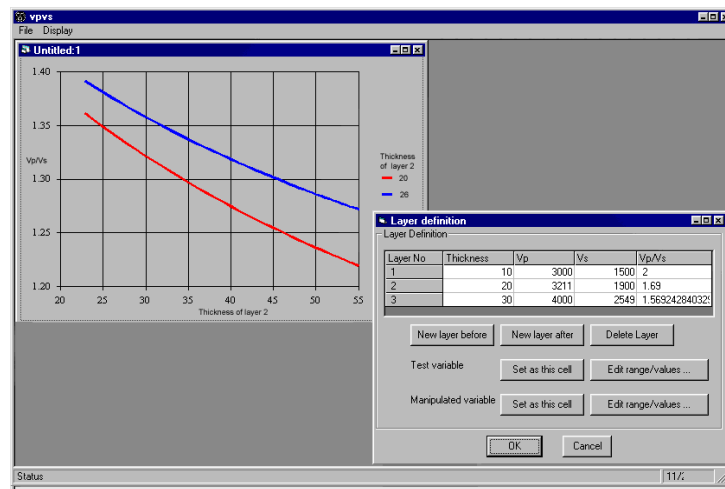


Figure 8: Vp/Vs Explorer, Windows 95 interface.

The program runs on Windows 95 or NT 4.0, and is driven by a easy-to-use menu and form interface. See Stewart and Bland (1997). Author: Henry Bland.

## SOFTWARE INSTALLATION

This software release has been divided into section based on hardware platform that each program is suitable for. All the softwar is in a folder called “Software 1997” on the CREWES CD. Inside that folder, you will find three folders: “Unix”, “Windows”, and “Macintosh”.

The Matlab software (Seismic toolbox, Logsec, Logedit, Synth, Slogger, Resolution toolbox, time variant spectral inversion, and nonstationary phase shift) is suitable for all platforms. The ProMAX modules are only suitable for Unix platforms, and the Vp/Vs Explorer program only works under windows. Figure 9 shows the contents and format of the distribution on the CD.

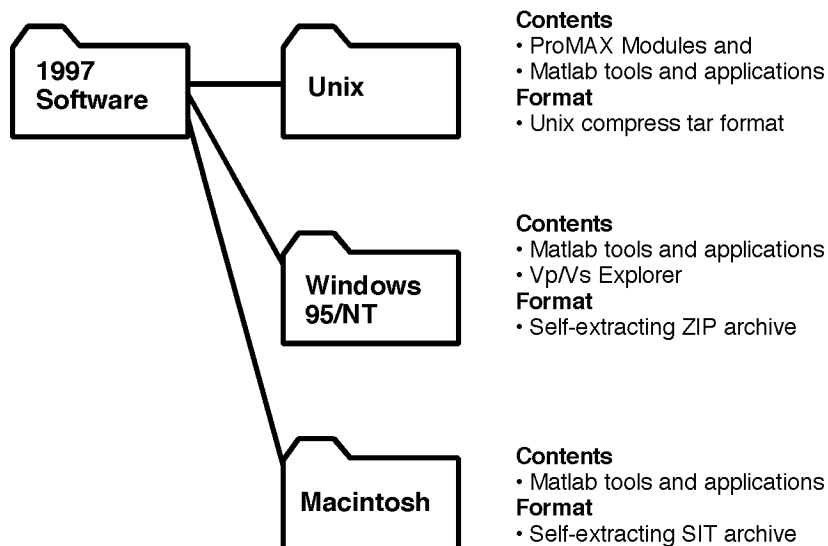


Figure 9: Software distribution on the CREWES CD

## Extracting the software release from the CD

The release requires 16 MB of free disk space.

- 1) Mount the CD-ROM disk. For Windows and Macintosh computers, simply insert the CD in the drive. On Unix systems, you must mount the CD from the root account. Please follow the instructions supplied with the CD.
- 2) The Windows and Macintosh files are self-extracting archives: just double-click on the file to extract it's contents from the CD to your computer. On a Unix machine, the README.install file contains complete installation instructions.

After extracting the release, view the README files located in each subdirectory for further instructions.

## CONTACTING CREWES

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All of the CREWES software is also available over the Internet via the CREWES Web page: <http://www.crewes.ucalgary.ca/>

## CONCLUSION

The CREWES Project software release is a collection of prototype code. Much of our code is in a state of continuous evolution, so please ask us about updates of any modules you are using. The hope is that the software release is an effective means of technology transfer to our sponsors that complements the CREWES Research Report. Please let us know if you have any questions or comments about this or any other software release.

## REFERENCES

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