



**U.S. Department of the Interior
U.S. Geological Survey**

Intensity at KTVU Studios		Perceived Shaking	Potential Damage
	X+	Extreme	Very Heavy
	IX	Violent	Heavy
	VIII	Severe	Moderate /Heavy
	VII	Very Strong	Moderate
Intensity at KTVU Studios		VI	Strong
<u>The SideBar Computer Program, A Seismic-Shaking Intensity Meter: Users' Manual and Software Description</u>		V	Moderate
<u>(Release 3.0.T0)</u>		IV	Light
<i>John R. Evans¹</i>		III	Weak
<i>Open-file Report 03-202</i>		II	Weak
	I	Rarely Felt	(none)

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards or the North American Stratigraphic Code. Use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

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CONTENTS

CONTENTS	2
FIGURES AND TABLES	2
ON-LINE VERSIONS.....	3
DISCLAIMER	3
EXECUTIVE SUMMARY/ABSTRACT	5
INTRODUCTION—<i>SIDEBAR</i>'S PLACE IN THE WORLD	7
<i>SHAKEMAP</i>	7
<i>SIDEBAR</i>	7
WEB SOURCES—REGIONAL INFORMATION	8
“TREMOR” SEISMOGRAPHS.....	8
<i>A Bit of Seismological Lore:</i>	9
PURPOSE AND SCOPE OF THIS REPORT	10
HOW TO RUN <i>SIDEBAR</i>—START HERE	10
USER'S MANUAL	12
THE RS-232 CONNECTION.....	13
THE CONFIGURATION FILE	14
BAR GRAPH AND VALUE DISPLAY.....	14
OUTPUT OF THE GRAPHIC	15
TIME AND EARTHQUAKE IDENTIFICATION.....	16
NAVIGATIONAL BUTTONS	17
STATION IDENTIFICATION	18
GROUND-SPEED UNITS	18
EXITING <i>SIDEBAR</i>	18
MESSAGE WINDOW	18
CONCLUSIONS	18
ACKNOWLEDGEMENTS	19
REFERENCES	19
APPENDIX—A CONFIGURATION-FILE EXAMPLE	20
 FIGURES AND TABLES	
FIGURE 1: <i>SIDEBAR</i> EXAMPLE, INTENSITY VI	4
FIGURE 2: <i>SHAKEMAP</i> EXAMPLE, YOUNTVILLE EARTHQUAKE	6
TABLE 1: USGS EARTHQUAKE WEB ADDRESSES	8
FIGURE 3: SEISMOGRAMS FROM A SMALL EARTHQUAKE	9
FIGURE 4: ANNOTATED <i>SIDEBAR</i> EXAMPLE, INTENSITY VIII	12
FIGURE 5: TREMOR INSTRUMENT "BREAKOUT" BOX AND DATA FLOW	13

ON-LINE VERSIONS

This report (in Adobe™ Acrobat™ format, “.pdf”), the configuration files for the 13 Oakland prototype TREMOR sites, a test history file with imaginary earthquakes over the entire intensity range (“SideBar_RecentHistory_Test.txt”), and the *SideBar* software (the Win32™ executable “SideBar.exe”, and source code, in directory “SideBar_release_3.0.T0”) are all available both *via* anonymous ftp and through the USGS publications Web site (look under “Open-File Reports”, “2003” at “<http://pubs.usgs.gov/products/books/openfile/>”). For direct ftp, go to “clover.wr.usgs.gov” in the directory “/ftp/pub/ehz/jrevans/SideBar”. Use “anonymous” as your user name, and your e-mail address as login password. The materials are all compressed into file “SideBar.zip” which must be transferred to a standard PC *in binary format* and decompressed by the user (any standard decompression software, such as WinZip™, will do this).

DISCLAIMER

Although this program has been used by the U.S. Geological Survey, no warranty, expressed or implied, is made by the USGS as to the accuracy and functioning of the program and related program material, nor shall the fact of distribution constitute any such warranty, and no responsibility is assumed by the USGS in connection therewith.

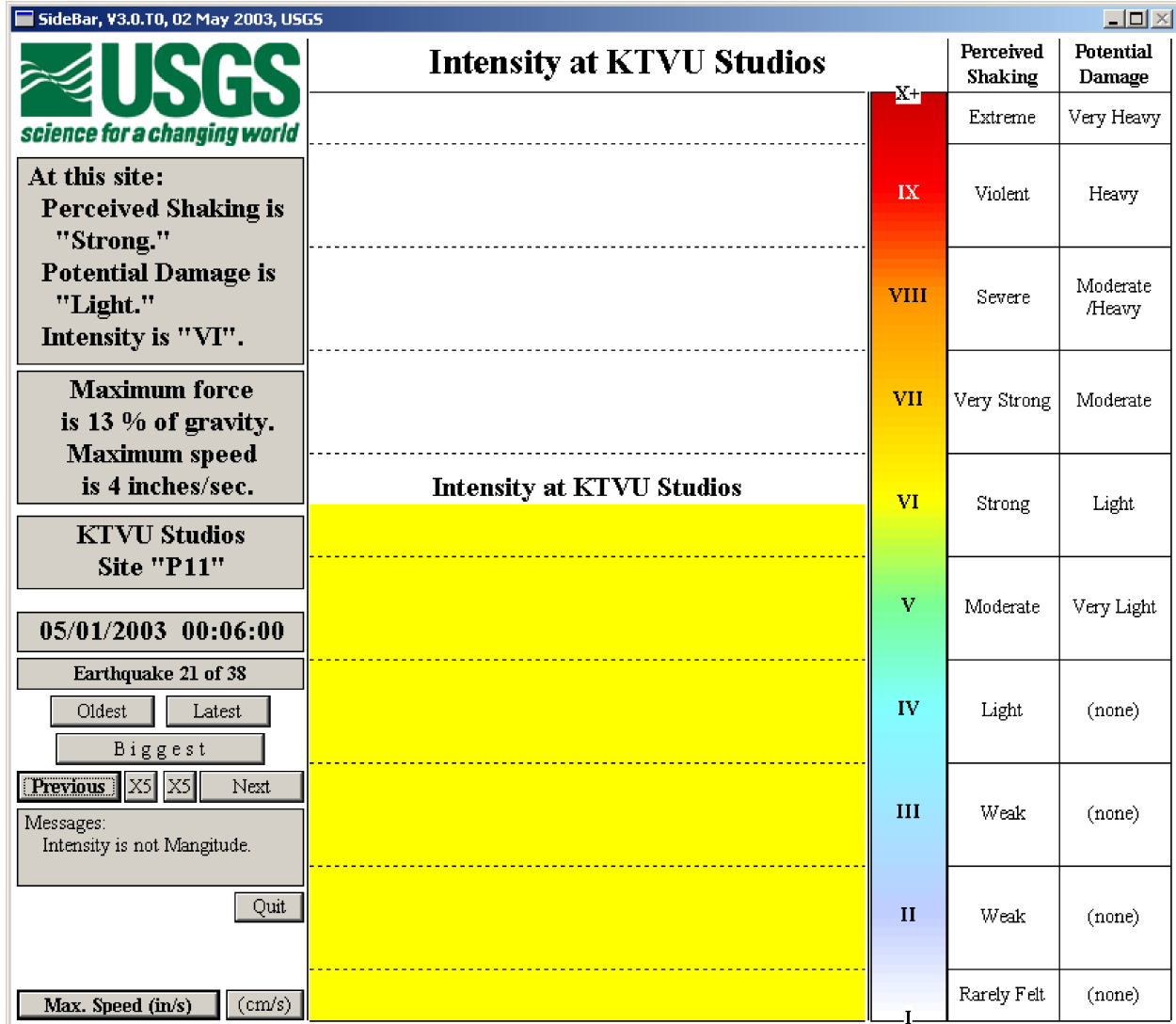


Figure 1. An example of *SideBar* output at seismic intensity VI, with a corresponding maximum shaking force at 13% of gravity and the ground moving as fast as four inches per second. Shaking this strong has the potential to do light damage in the neighborhood of this seismograph (e.g., items thrown from shelves, a few trailers knocked off their supports) and is likely to be perceived as strong shaking by most people. Intensity VI is the boundary between insignificant damage and notable risk, hence the shift from cool colors below to warm colors above—intensity VI is “condition yellow”.

EXECUTIVE SUMMARY/ABSTRACT

The *SideBar* computer program provides a visual display of seismic shaking intensity as recorded at one specific seismograph (Figure 1). This software allows a user to tap into the seismic data recorded on that specific seismograph and to display the overall level of shaking at the single location where that seismograph resides (usually the same place the user is). From this shaking level, *SideBar* also estimates the potential for damage nearby. *SideBar* cannot tell you the “Richter magnitude” of the earthquake (see box), only how hard the ground shook locally and this estimate of how much damage is likely in the neighborhood. This combination of *local* effects is called the “seismic intensity”.

SideBar runs on a standard desktop or laptop PC, and is intended for the media, schools, emergency responders, and any other group hosting a seismograph and who want to know immediately after an earthquake the levels of shaking measured by that instrument. These local values can be used to inform the public and help initiate appropriate local emergency response activities in the minutes between the earthquake and availability of the broader coverage provided by the USGS over the Web, notably by *ShakeMap* (Figure 2). For example, for instruments installed in schools, the level of shaking and likely damage at the school could immediately be Web broadcast and parents could quickly determine the likely safety of their children—their biggest post-earthquake concern. Also, in the event of a Web outage, *SideBar* may be a continuing primary source of local emergency response information for some additional minutes.

Specifically, *SideBar* interprets the peak level of acceleration (that is, the force of shaking, as a percentage of the force of gravity) as well as the peak velocity, or highest speed, at which the ground moves. Using these two basic measurements, *SideBar* computes what is called Instrumental Intensity—a close approximation of the Modified Mercalli Intensity scale, or “MMI” (using the Wald et al., 1999a, relationships between acceleration, velocity, and shaking intensity). Intensity is a measure of local shaking strength and the potential for damage—of how bad the earthquake effects were *locally*. The intensity level is what *SideBar* displays most prominently on the PC monitor. Intensity is shown as a large, colored bar that gets taller and changes color up a rainbow from blues toward reds as the shaking level increases. As opposed to earthquake magnitudes, which are reported as decimal values (like “7.6”), intensity is traditionally given as a Roman numeral, with “I” to “X+” assigned to levels of potential damage and perceived shaking strength. For good measure, *SideBar* shows the actual values of the force of shaking (peak ground acceleration as a percentage of gravity) and the speed of ground motion (peak ground velocity in inches per second, by default, or in centimeters per second, if you wish), both these values as decimal numbers.

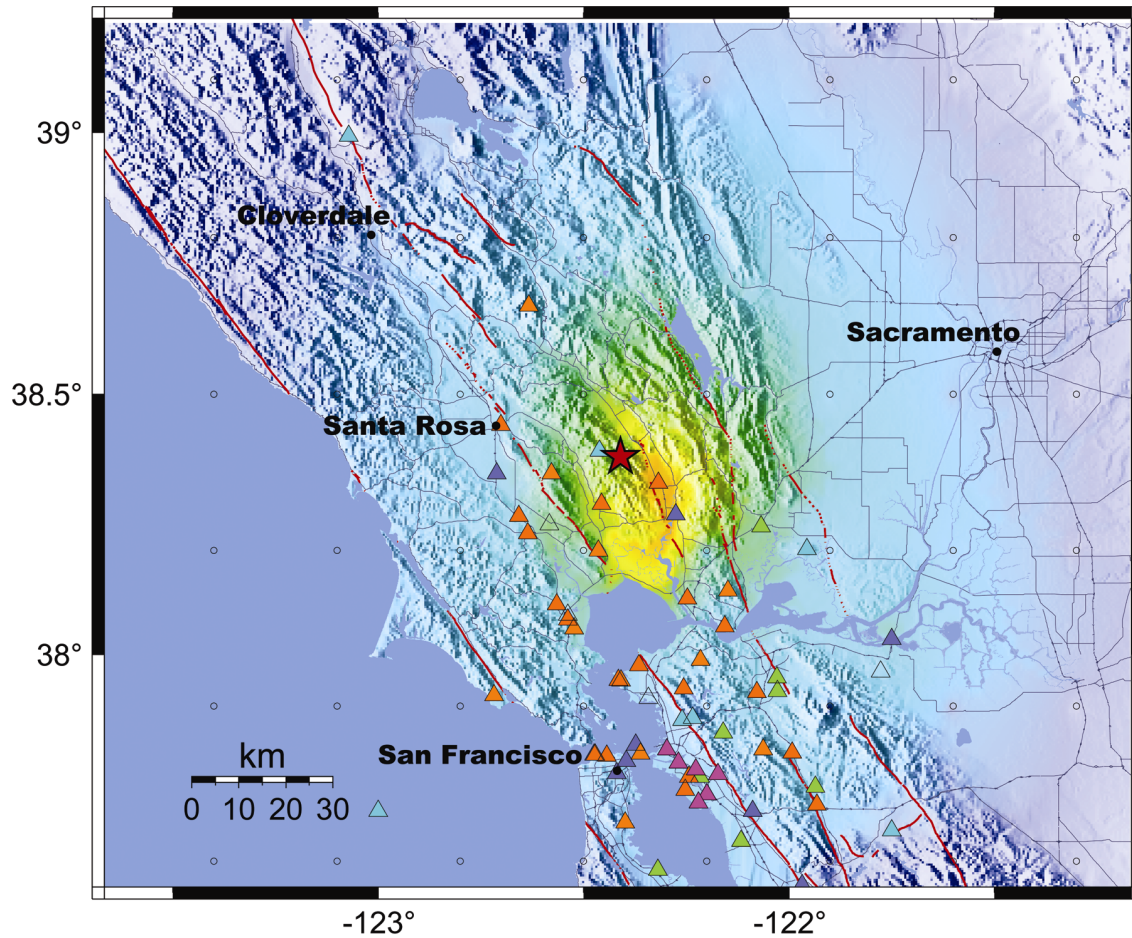
SideBar also remembers the most recent earthquakes (for up to one week), and can store as many of these previous earthquakes as the user allows (and as the user’s PC has room for)—typically thousands. *SideBar* also remembers forever the three largest earthquakes it has seen and all earthquakes over intensity IV so that one never loses particularly important events.

A "sidebar" on *SideBar*: Richer magnitude is like the wattage (the brightness) of a light bulb, while seismic intensity is like the brightness of that light shining into a particular corner, which may be brighter or fainter depending on both distance and the bulb's wattage. Seismic intensity is how hard the shaking is where you are—the light in your corner. Richer magnitude is the size of the earthquake rupture where it is, deep in the Earth—the wattage of the light bulb.

SideBar is a Windows™ application (Win32™ SDK) believed to be capable of running on Windows95, Windows NT, and all subsequent releases of Windows™ products. There is no Macintosh™ version. Disk use is very modest (10,000 earthquakes plus executables uses under 2 MBytes). RAM use is more intensive.

USGS/UCB/CDMG Rapid Instrumental Intensity Map for Yountville Earthquake

Sun Sep 3, 2000 01:36:30 AM PDT M 5.1 N38.38 W122.41 ID:51101203



PROCESSED: Wed Sep 25, 2002 12:04:51 PM PDT,

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Figure 2. An example of a *ShakeMap*, this one for the 03 September 2000, Yountville, California, magnitude 5.1 earthquake. For consistency with *ShakeMap*, *SideBar* uses the same color scale bar and mathematical rules as *ShakeMap*. Triangles are seismographs reporting shaking values to *ShakeMap*; small circles are points where shaking strength is inferred from the magnitude and distance of the earthquake (an empirical “attenuation relation”). Between these fixed points, shaking strength is inferred by smooth interpolation and the type of surface materials (e.g., rocks, firm soils, soft soils, etc.). Soft surface materials in Napa Valley, for example, helped amplify the shaking there to levels higher than on the rock over the epicenter of the earthquake (the star).

INTRODUCTION—*SIDEBAR'S* PLACE IN THE WORLD

SHAKEMAP

ShakeMap (Figure 2) is a map of seismic intensity for the whole region (Wald et al., 1999b, 2000). One could say that it is a map of how brightly the light bulb is shining into every corner of the region, or of how loudly a single clap of thunder sounds to millions of different listeners, near or far, from a single flash of lightning. A typical *ShakeMap* (Figure 2) is very “bright” or “loud” nearest the earthquake—nearest the light bulb or the lightning stroke. That brightness shows up as the “warmest” colors on the map. In a very bad earthquake, these “brightest,” “loudest,” colors will be a very dark red—up to shaking intensity X+, signifying extreme perceived shaking and very heavy damage. In contrast, a much more common color is light blues to violets, from the areas far away from small earthquakes, the “darkest,” “quietest” areas. These areas correspond to shaking intensities I to III, signifying weak shaking to never felt, and no damage at all. Thankfully, these cool colors are more common on routinely produced *ShakeMaps* than are the warmer colors, simply because small earthquakes are more common. But larger events are inevitably on the way. The threshold between little or no damage and some or significant damage is generally at shaking intensity VI to VII. *ShakeMap* and *SideBar* show intensity VI as yellow, in analogy to a yellow caution light.

A "sidebar" on *SideBar*: MMI is defined up to XIII, but most seismologists now agree that X through XIII are effectively equivalent. For this reason, both *ShakeMap* and *SideBar* merge these four ranges into "X+".

ShakeMap is a joint effort of the USGS, the California Geological Survey (CGS), the California Institute of Technology, and the University of California at Berkeley, and gets data from these and many other public and private institutions and businesses.

Shaking-strength information from your local seismograph and many other seismographs is gathered together within the first few minutes after every significant earthquake (the triangles in Figure 2). From these data, a map of intensity is automatically generated about 10 minutes after the earthquake and is quickly distributed over the Web. As additional data arrive or older data are refined and updated, *ShakeMap* may be improved and re-released.

ShakeMaps are used to help emergency-response personnel plan and guide their efforts; as input to damage-estimation computer programs such as FEMA's "HAZUS" software; through HAZUS to help estimate dollar losses for Federal and State emergency appropriations; to help scientists and earthquake engineers plan their own studies and responses; to help private citizens and the news media react appropriately to the earthquake; and so on. In the few years since its inception *ShakeMap* has quickly become a critical and widely used tool in professional and public emergency response to earthquakes.

SIDEBAR

SideBar is the small cousin of *ShakeMap*. Rather than for a region, *SideBar* provides the shaking intensity level at a single point—wherever one particular seismometer is located (a single one of the triangles in Figure 2). It displays just one of the many data streams bound for *ShakeMap* (and for many other uses by the USGS and her sister institutions). Hence, your *SideBar* intensity value should match closely the intensity value shown at your location by *ShakeMap*. Except for some differences introduced when the incoming data are refined in the laboratory and when *ShakeMap* smooths its map a bit, the two should sing the same tune at your seismograph's location.

SideBar's main purpose is two-fold: to provide a bridge, a source of immediate information, for that brief period of 10 minutes or less during which *ShakeMaps* are being generated, and to provide a backup, should the Web fail and access to *ShakeMap* be cut off. Also, because *ShakeMaps* are only generated for "significant earthquakes" (magnitude 3.5 or greater in the San Francisco Bay Area, for example), *SideBar* can provide information on the smallest events—events which can safely be ignored but which, by being felt locally, might otherwise cause nervousness during a major earthquake sequence. (There are methods in place to deliver *ShakeMap* to the Governor's Office of Emergency Services and from there to County and City Offices of Emergency Services *via* secure channels in the event of a Web failure.)

The purpose of this report is to explain what *SideBar* is and what information it produces, as well as to provide a user's manual and to formally release and document the software.

WEB SOURCES—REGIONAL INFORMATION

The USGS produces a wide array of information for every earthquake, including their locations (epicenters), timing information, and seismograms. These data are accessed by knowing either the time or the serial number of the earthquake. That additional information is on the Web at the URL addresses given in Table 1.

Table 1: USGS Earthquake Web Addresses

Area	URL
Home Page	http://earthquake.usgs.gov/
Northern California	http://quake.wr.usgs.gov/index.html
Southern California	http://pasadena.wr.usgs.gov/
Central United States	http://www.ceri.memphis.edu/usgs/
Pacific Northwest	http://geohazards.cr.usgs.gov/pacnw/
World	http://neic.usgs.gov/

All these Web sites, and those planned for Alaska and other areas, are accessible through the home page site. (When identifying an earthquake on these Web sites that matches your *SideBar* earthquake, there are some issues regarding time. These issues are discussed in the *User's Manual* under "Time and Earthquake Identification".)

"TREMOR" SEISMOGRAPHS

This first-released version of *SideBar* (version 3.0.T0) works with prototype seismographs produced by the U.S. Geological Survey's TREMOR Project (hence the "T0"). Later versions of *SideBar* will work with other types of seismographs. TREMOR instruments were developed to augment current strong-motion seismograph arrays with lower cost seismographs to permit denser sampling of the wavefield—more seismographs within a geographic area. ("Strong motion" seismology is what the name implies, the study of damaging earthquakes in order to reduce their consequences.) TREMOR seismographs employ a new class of motion sensor related to the sensors that trigger air-bags. These seismographs provide low-cost, low-maintenance, real-time strong-motion recordings at a fraction of the cost of standard, maximum-precision strong-motion seismographs, yet produce high-quality seismic records like those in Figures 3a,b.

TREMOR instruments are intended to complement, not replace standard strong-motion systems that provide very precise, accurately timed measurements of the entire shaking signal at any given site and are essential many analyses. However, economics often preclude deploying these standard, high-precision instruments in the very large numbers required to measure the strong geographic variations in shaking strength known to be present during earthquakes—variations which can be significant from one neighborhood to the next, and sometimes from one city block

to the next. While it is essential to capture the high-precision signals targeted by traditional seismographs, it is also essential to capture the rapid geographic variations in these signals. In technical terms, the former requires amplitude resolution while the latter requires spatial resolution. A combination of traditional and TREMOR seismographs is one solution for creating a network of seismographs that can do both these things economically.

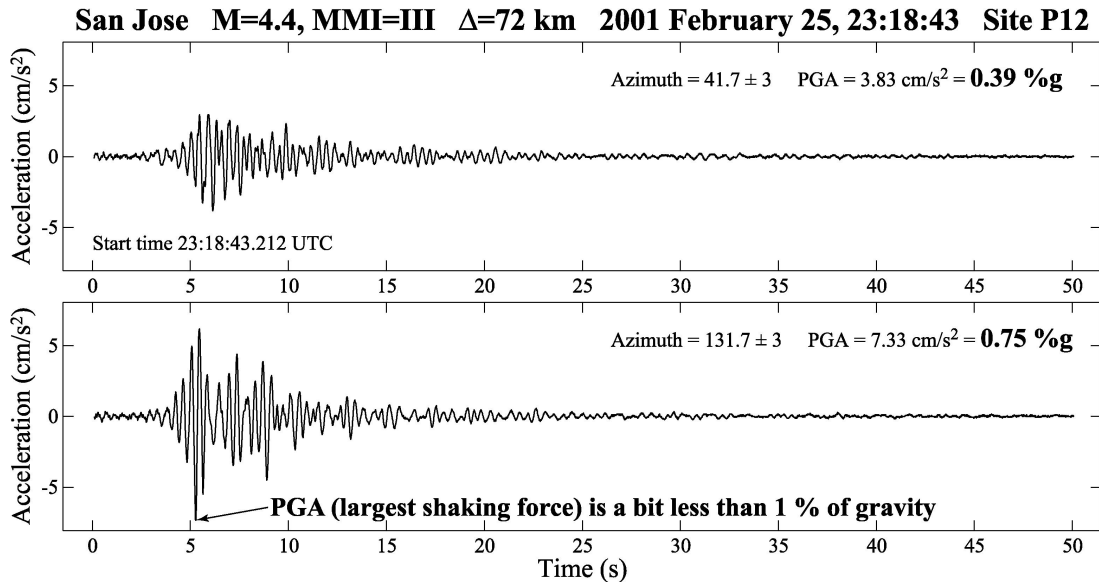


Figure 3a. Seismograms from the TREMOR seismograph at KTVU studios, 25 February 2001. (Only the two horizontal components of ground motion are shown—the vertical component of ground motion was too weak to record properly. It takes three components of motion to characterize all the shaking, but the horizontal components typically capture the largest ground motions.) This very weak event (magnitude 4.4, 45 miles away) appears to have caused a classic, nearly monochromatic bell-like ringing of the deep Bay mud beneath this site. This deep mud accumulated in a paleochannel that drained through the present location of Lake Merritt and along the north shore of Alameda Island (Holzer et al., 2002). The peak shaking force (PGA) is noted. (One “g” is 980.665 cm/s².)

With the advent of micromachined, mass-produced devices, Moore’s Law (Moore, 1965), has finally come to the world of sensors as well as electronics. Performance-to-cost ratios are climbing geometrically while the size and robustness of the devices have improved dramatically. Eventually, this revolution will allow the finest fidelity sensors at every seismograph in spatially dense arrays within the economical limits we face. However, that day is a decade or three away, and earthquakes will not wait.

A Bit of Seismological Lore:

The seismograms in Figures 3a,b deserve some explanation and comment—they are quite unusual and demonstrate some of the advantages of spatially dense urban strong-motion seismic arrays like TREMOR. These seismograms are nearly monochromatic, composed of a dominant, bell-like tone that rings on for a long period of time. This is also the only TREMOR instrument that triggered for this small, distant event—a weak signal amplified and modified into this unusual form at this one site by the site’s local conditions. Those local conditions are described by Holzer et al. (2002) as a deep, old stream channel now filled up with young, soft San Francisco Bay mud to significant depths. This channel ranges from only about 500 to 1500 m in width as it plies its way from Lake Merritt to the Bay along the North shore of Alameda Island (sea level was lower then, and filled this valley with mud as sea level subsequently rose). The result is a very localized, soft basin that seems to be capturing and amplifying the earthquake shaking. The

first two seismographs within the boundaries of this paleochannel were both TREMOR instruments, principally because of the spatial density of that array of low-cost instruments.

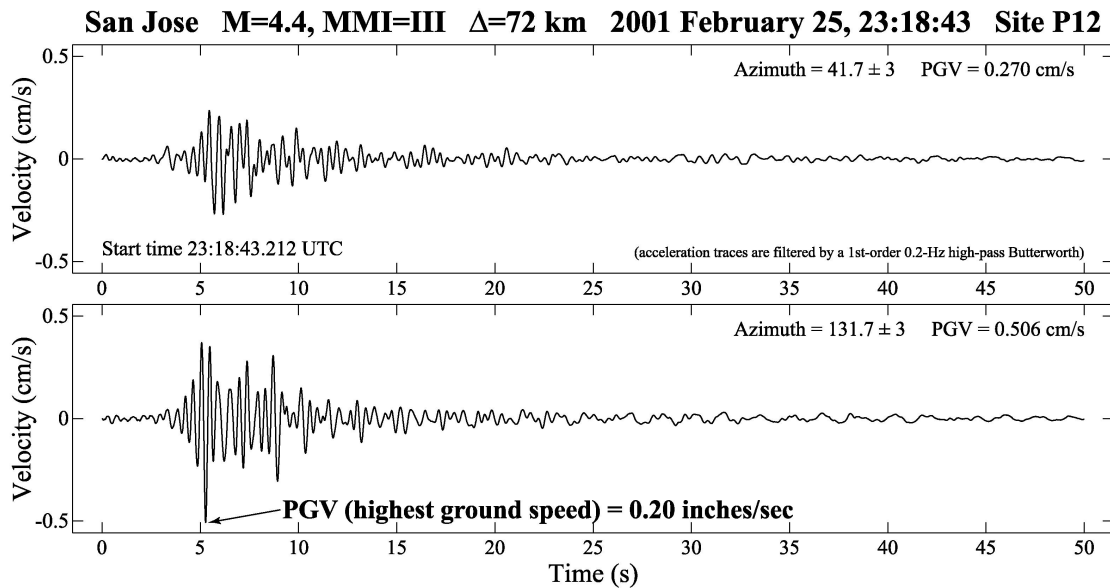


Figure 3b. Like Figure 3a, but shows the velocity traces, with the maximum ground speed (PGV) pointed out. (These velocity traces are computed from the acceleration traces by filtering and integration.) It is unusual for the velocity and acceleration traces to look so similar—a result of the nearly monochromatic ringing of this rare signal.

PURPOSE AND SCOPE OF THIS REPORT

The *Executive Summary* and *Introduction* of this *Report* serve to describe *SideBar's* raison d'être—principally to fill an informational gap between the time of an earthquake and the availability of detailed, regional information, including *ShakeMap*, about 10 minutes later. Similarly, should Web access be impossible for some reason, *SideBar* can continue to fill the information gap indefinitely. For smaller earthquakes, educational opportunities also exist with *SideBar*, or, if these events occur during major sequences, the opportunity to calm nerves by showing immediately that the event is of no concern.

Secondly, these introductory sections should make the relationship between *SideBar* and other USGS information sources clear. In particular, *SideBar* provides a single datum—the shaking intensity at a single place—while USGS Web sites provide broad, regional information with very detailed “drill down” capability. Indeed, you should be able to find your seismograph within the USGS Web sites and discover closely matching PGA, PGV, and intensity values on the Web site, for example on *ShakeMap*. (The Web-site values may be slightly more accurate, with updated values recomputed in the laboratory at greater precision and eventually reviewed for accuracy by a seismologist. Values available to *SideBar* face various computational limitations that produce errors, normally small but in rare instances quite large—natural signals can be messy and still require the human touch from time to time.)

The following sections give both general and detailed operating instructions for the current version of *SideBar*. No other *User's Manual* exists or should be needed. Feel free to contact the author if issues arise, and please do contact me if bugs are encountered (jrevans@usgs.gov).

HOW TO RUN *SIDEBAR*—START HERE

SideBar is a spy; it is a parasite. It taps into the flow of information running between one seismograph and the USGS (or any other laboratory, for that matter), then displays on the PC

monitor the level of shaking recorded on that seismograph as soon as the shaking ends (Figure 1). **SideBar** gleans from the data flow two key pieces of information, the peak shaking force (“peak ground acceleration”, PGA) and the peak ground speed (“peak ground velocity”, PGV). From PGA and PGV, **SideBar** computes the shaking intensity. **SideBar** also remembers past events in addition to the current earthquake. It lets you choose any of these intensities, past or present, to show as a large bar graph—like a big thermometer that gets both higher and redder as the shaking gets worse.

In its first released version (3.0.T0), **SideBar** has no explicit provision for creating a graphical output file. However, screen dumps can be generated by pressing “Alt-Print Screen” to copy the window and then pasting this image (Ctrl-V) into PhotoShop™ or another application. An alternative is video-frame capture.

Properly run (like the most successful parasites) **SideBar** never does any harm to its host—the seismograph never even knows it is there. **Badly run, SideBar can destroy the data flow and render that seismograph inoperable and useless—a grave public harm that puts yourself and your neighbors at risk by leaving emergency responders in the dark about your situation after an earthquake. Please be careful.**

A "sidebar" on **SideBar**: The shaking intensity actually computed by **SideBar** is the so called "Instrumental Intensity". This instrumentally derived value is a very close relative and mimic of the observationally derived "Modified Mercalli Intensity" (MMI). MMI is based on things like human reactions and structural damage reports. The USGS also has a direct effort to asses MMI through the "Did you feel it?" Web page set up after each significant earthquake.

The key to running **SideBar** well is in tapping into the data flow skillfully, without putting an excessive electrical load on the wires, and in never sending a signal back into the wires. This safety margin is best accomplished by keeping the PC close to the seismograph or, if it is absolutely necessary to move the PC farther away, by adding a telemetry buffer at the tap point to the seismograph (an off-the-shelf item). More on this point is given below in the *User's Manual*.

SideBar, as released here, is a (32-bit) Windows™ application only, believed to run on any modern standard PC (but tested, to date, only on Windows NT™ and Windows2000 Pro™). There is no Macintosh™ version at this time. **SideBar** is also suitable currently only for the original USGS prototype TREMOR seismographs, of which 13 exist (12 in Oakland and one in Alameda, California). However, we expect to create versions for other models of seismographs. We are including in this release the source code, executable, and configuration files (one for each of the 13 Oakland TREMOR prototype seismographs). To be run, **SideBar** requires the executable file (“SideBar.exe”) and the configuration file for that specific seismograph. *The configuration file must be named exactly “C:\SideBarConfig.txt” and located in the root directory.* The Appendix shows an example of the configuration file, which has full descriptions of the values to be entered. This file tells **SideBar** how to set up the PC’s monitor, the earthquake history file, memory limits, and so on.

Once the serial connection and configuration file are in place, and the appropriate values are entered into the configuration file (a critical step covered in the *User's Manual*, below), simply run **SideBar**. (**SideBar** will configure the RS-232 serial port called “COM1” automatically.) You will see a window like the one in Figures 1 and 4 appear. It can be resized more or less as desired, but you should not try to make it too small. The configuration file also gives control over the sizes of various parts.

SideBar keeps an internal history of earthquakes for a period of up to one week, or less if you wish. It also keeps the three largest events and all events of intensity VI and above forever.

(The history-file name and memory duration are controlled through the configuration file.) This storage feature allows the user to compare the current level of shaking to that recorded at this same site for interesting past earthquakes. Often this comparison capability is a useful tool for helping the public put the current event into perspective.

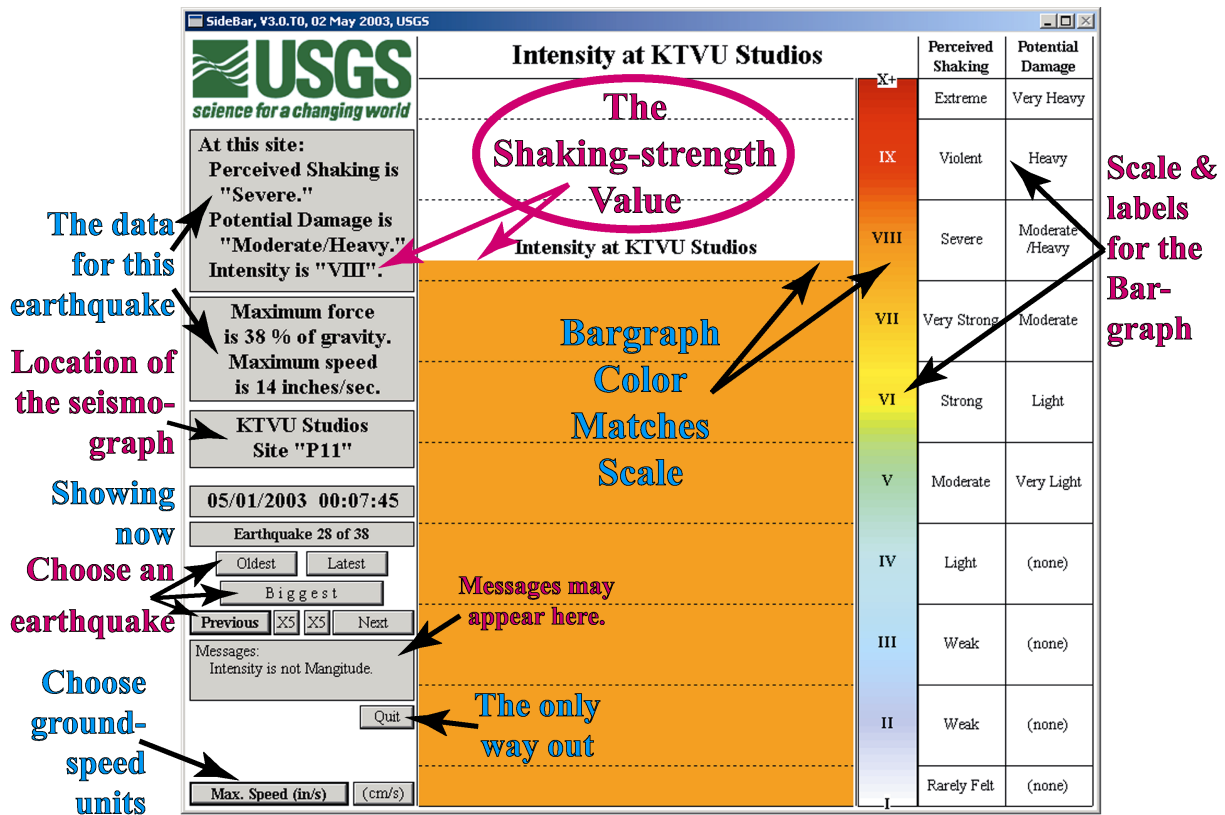


Figure 4. Annotated example of *SideBar* output showing the purposes of various displays and controls.

The earthquake's date and time shown by *SideBar* are only as good as the accuracy of the PC's clock. If your PC is wrong by three minutes, for example, your *SideBar* times will all be wrong by three minutes and will mismatch USGS and other information by those three minutes. Since this event-time is your one link into associated USGS Web-page information, it is imperative that you keep your PC's clock set very accurately—within a few seconds of absolute if possible, but certainly not more than one minute wrong.

USER'S MANUAL

SideBar permits the real-time output of one strong-motion seismograph to be monitored and displayed on any Windows™ (Win32™) PC as Instrumental Intensity. In outline, the setup procedure is (cf. Figures 1 and 4, and the Appendix):

1. Edit the upper portion of the configuration file and place that file in C:\;
2. Copy or move "SideBar.exe" to its own directory or to the Desktop (shortcuts to the executable and configuration file from the Desktop™ are useful);
3. Connect from the seismograph-to-modem RS-232 link "breakout" box to your PC's COM1 as shown in Figure 5; and
4. Run *SideBar*.

SideBar keeps a history of earthquakes of up to one week duration (plus the “persistent” events—larger ones—which last indefinitely). For any event in this history, *SideBar* displays shaking intensity as well as the maximum shaking force and ground speed.

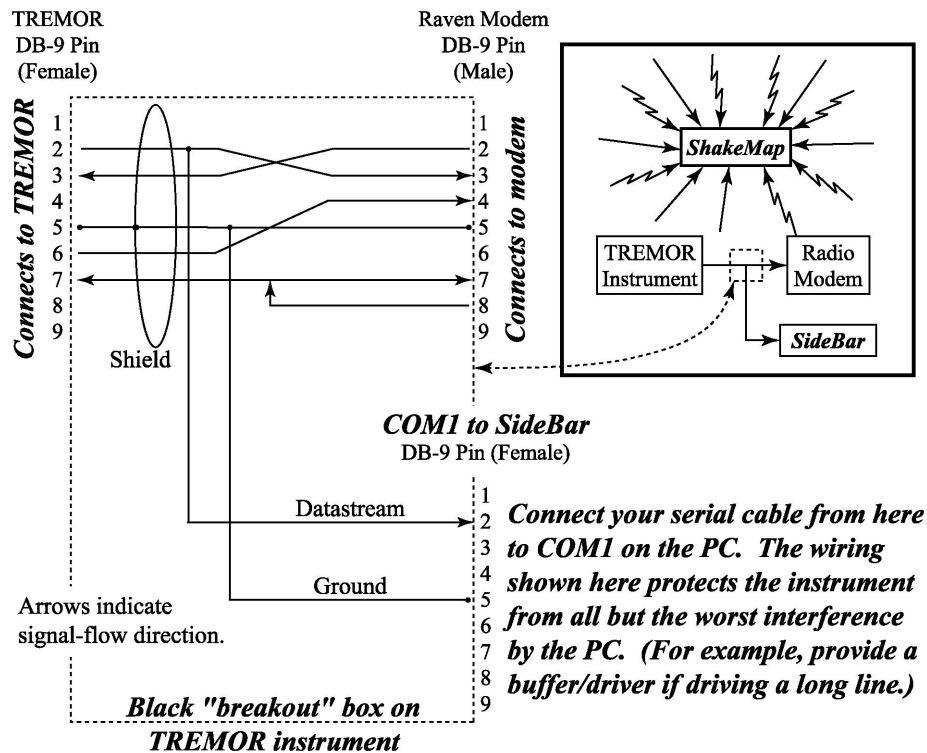


Figure 5. The inset drawing shows overall TREMOR-seismograph data flow and the point at which *SideBar* captures a copy of the flow from the seismograph. The USGS prototype TREMOR seismographs come equipped with a black-plastic “breakout” box (the dotted line). The breakout box is wired as shown here (for information only—you don’t really need to know this). This box facilitates the *SideBar* data interception in the proper manner. One of the two (DB-9) serial-port connectors on the long, thin side of the box is the place to connect to your computer’s COM1 serial port. The correct one is the DB-9 connector *farther* from the white or black power cable coming out of that side of the box. (The power cable happens to take 12-Volt power up to the modem.) Use a straight-through cable from the breakout box to COM1.

THE RS-232 CONNECTION

SideBar also needs a limited RS-232 serial connection tapping into the data stream between the seismograph and the modem that is used to telemeter data to our data-processing facilities. (RS-232 may be called “RS-232C” or “EIA-232D” or “EIA/TIA-232E,” with or without various hyphens, or simply “serial”. It is just the serial connection on the back of you PC, which is named “COM1” if there is only one, or that and “COM2” if there are two of them.) For a TREMOR seismograph, that telemetry link goes to an AirLink™ Raven™ “CDPD” modem (Cellular Digital Packet Data)—a cell-phone-based Internet node—which forwards the data to our laboratory computers in about 0.3 seconds using a robust portion of the Internet.

The RS-232 cable conveniently passes through a black, plastic “breakout” box (Figure 5) between the TREMOR seismograph and the Raven™ modem. This breakout box is where you will tap into the data stream, as described in the caption and body of Figure 5.

From the breakout box, the serial connection *must be made to the “COM1” serial port* on the PC running *SideBar*, not COM2. Also, your connection *must not* touch any wires other than the two shown in Figure 5 (pins 2 and 5 of the TREMOR seismograph) and it *must not break* any of the wires between the TREMOR seismograph and its modem. (The breakout box guarantees these two points, happily.) **However, your connection also *must not* place too great a load on the data link between the instrument and its modem and this is something that you must see to.** This last point has mostly to do with how long a wire you intend to run from the seismograph to your PC (but also the fact that the instrument is driving two receivers, our modem and your PC, rather than the usual single receiver). In particular, you may need to supply an RS-232 buffer/driver unit at the seismograph if you plan to locate your *SideBar* PC more than about 50 feet away. (This limit is, in practice, a “try and see” business—the formal electronic specification is not by cable length but by total capacitance, 1800 pF maximum load. Please call the USGS, either this author or the seismograph owner, before attempting a longer connection than 50 feet.) If the instrument’s ability to transmit data to the modem is surpassed by the load placed on it by the excess cable, serious disruption and permanent loss of critical seismic data could result—the data might not reach us at all. **Please be careful with this step—you have your hands on public-safety data, and data which specifically affect the safety of you and your neighbors.** (It is not quite as dire as it sounds. We have daily “state of health” messages coming from the instrument, and if these fail to arrive, we will know quickly that something went wrong. So fear not—these “SOH” messages are there specifically as a diagnostic feature to help us recover the instrument from accidents and routine problems of all kinds—the most common is that the janitor just unplugs them. We’ll give you a call to consult and work out a corrective plan.)

THE CONFIGURATION FILE

SideBar requires that there be a configuration file named “C:\SideBarConfig.txt”. **The location of this file in the root directory of “C:” disk is mandatory.** You can use this file to change the displayed seismograph-location information, the size and placement of the *SideBar* window, the width of the bargraph bar, and so on. The Appendix contains an example of the file with a detailed descriptions of each item.

Note that *most users should never change the values* given below “ALL ITEMS BELOW ...” and that these values are specific to each particular TREMOR seismograph and location. They have to do with sensor calibrations and other sensitive matters, are highly specialized, and can damage the accuracy of the values displayed if set incorrectly. Consult with the author when copying and modifying this part of the configuration file (jrevans@usgs.gov)—you must have the right information for your particular seismograph. **Configuration files for TREMOR seismographs are *not* interchangeable.**

BAR GRAPH AND VALUE DISPLAY

The key output of *SideBar* is the strength of the shaking recorded by the seismograph to which *SideBar* is connected. The key output on the visual display is an “Instrumental Intensity”, an instrumentally generated simulation of the observational scale called “Modified Mercalli Intensity”, or MMI. Both intensity scales are measures of the *local effects* of shaking on structures and people, effects near this seismograph. **Intensity is not Richter magnitude.** Magnitude is a measure of the size of the earthquake itself—its total radiated energy, the wattage of the light bulb. Intensity is a local effect that varies from place to place by very large amounts for every individual earthquake—how hard the ground shakes at a given site, how brightly the light shines into any particular corner. Indeed, *ShakeMap* is a map of these large variations in intensity. *SideBar* shows just one value of intensity produced by one seismograph at one place. *Shake-*

Map gathers many such values together from many seismographs around the region to create its map of the regional variations of intensity for an earthquake.

Intensity appears in **SideBar** both as a number value (the Roman numeral in the upper left box, in keeping with the tradition of expressing MMI as a Roman numeral) and as a large, colored bar that gets taller, like a thermometer's column, and also changes color toward the red end of the rainbow for larger values of intensity. Characterizations of the potential for damage and the likely perception of shaking strength by most people are also given in that upper left box. Again, all these characterizations of the earthquake apply just to the local area around this seismograph, to your local neighborhood. In the next box below this one, the maximum ground motions measured by the seismograph are given, both the ground acceleration (the shaking force), expressed as a percentage of the force of gravity, and the ground speed, expressed in either inches per second (inches/sec, in/s) or in centimeters per second (cm/sec, cm/s), as selected by pressing the corresponding button at the bottom left. The default is "in/s".

The value "1 g" ("one gee") is simply the force you feel every day pulling you down toward the Earth, so it is easy to understand—literally a "gut" feeling. **SideBar** expresses forces as a percentage of this amount, so "100 % of gravity" is equal to the 1-g gravity force you experience every day, while "5 % of gravity", for example, is one twentieth of that force. If you felt 100 % of gravity caused by an earthquake or a roller coaster, it would be strong, but not inherently dangerous—fighter pilots, with training and the proper equipment, routinely withstand well over 600 % of gravity. However, accelerations well below 100 % of gravity can be quite destructive to buildings and other structures, and these damaged structures can be dangerous to people. Light damage typically begins near about 10 to 20 % of gravity in the weakest structures.

Ground speed (simply how fast the ground moves) is less intuitive, but it is actually a more reliable predictor of structural damage (*Boatwright et al.*, 2001). The **ShakeMap** color scale in Figure 2 and the identical color scaling used by **SideBar** (Figures 1 and 4) give a sense of the likely damage levels associated with given ground speed, force, and intensity values. Yellow corresponds to a likelihood of some damage, orange to significant damage, and red to serious damage. Cool colors are almost never associated with damage. What actually happens to particular structures, of course, depends on their type, design, construction quality, and maintenance as well as on the details of the shaking history they experience during the earthquake (the "seismogram", such as the example in Figures 3a,b).

Note that although the intensity scale is shown down to its true starting point of I, it is unlikely that **SideBar** will ever display a value below about III. This is so because strong-motion seismographs have triggering thresholds, and the lowest thresholds in common use correspond to about intensity III. Weaker motions are simply ignored, considered too insignificant to report. **ShakeMap**, on the other hand, infers these weaker motions mathematically for regions far from the earthquake and plots them as well as the stronger shaking.

OUTPUT OF THE GRAPHIC

In its first released version (3.0.T0), **SideBar** has no explicit provision for producing a graphical output file. However, screen dumps can be generated by pressing "Alt-Print Screen" to copy the window. Then paste this image into PhotoShop™ or a similar application (Ctrl-V). (Then try resizing the image to higher resolution, using simple, "nearest neighbor" pixel replication for the sharpest results, as was done for this *Report*.) An alternative output method is video-frame capture, however, we have not tested this technique.

The internal earthquake history used by **SideBar** initially contains no earthquakes, and in normal situations will remain empty or have only a few small earthquakes or false-alarm triggers *for months or even years*. All earthquakes, and false alarms, older than the time limit set in

“C:\SideBarConfig.txt” will be discarded (except the largest three ones and all those of intensity VI and above, as discussed below). This “aging out” can be no longer than one week, and you can set a shorter interval if you wish. Additionally, if **SideBar** has difficulty finding storage space for new earthquakes during very active earthquake sequences, it will discard the smallest earthquakes to make room for the newer ones.

SideBar saves its earthquake history in a file that you designate in the configuration file. This saving happens every time an earthquake arrives and whenever you turn off **SideBar**. So even power failures should not be able to destroy the history of earthquakes (unless the power failure damages the PC itself or happens exactly as the file is being written out). This storage feature allows the user to compare the current level of shaking to that recorded at this same site for past earthquakes. Often this comparison capability is a useful tool for helping the public put the current event into perspective.

Earthquakes of intensity VI and above and the three largest events you have recorded (even if their intensity is less than VI) will be “remembered” indefinitely—until your PC melts down. Indeed, these larger events could theoretically fill up your history file one day and leave no room for current earthquakes. In practice, this demise is unlikely if you allow a reasonable number of events to be remembered (at least 1000 and 10,000 is reasonable). If the file should fill up, you can always increase your limit, or edit out earthquakes by hand. The earthquake-history file is a simple text file, with each earthquake taking up one line in date sequence. Earthquakes are easily identified by their date and time. Intensity is in decimal form (to hundredths place) in the last column of this file. The format is:

```
03/05/2003 00:06:45 20.227 20.227 20.227 18.55 18.55 18.55 28.00 6.75
```

where this example has intensity “6.75” (which **SideBar** would round up and display as “VII”). The other six columns, besides date, time, and intensity, are PGA and PGV for three axes of motion. PGA is written as a percentage of the force of gravity and PGV as centimeters per second. The date/time format is “MM/DD/YYYY hh:mm:ss”.

TIME AND EARTHQUAKE IDENTIFICATION

The TREMOR prototype seismographs have no precision clocks, so the time-of-day and the date assigned to each earthquake *come exclusively from the PC running SideBar*. Hence, *if your PC time or date is wrong, they will be stamped wrong onto all the earthquakes you record*. This fact is quite important, since it is through this time stamp that you will later be able to correlate your **SideBar** earthquake record to the large store of related information generated for each earthquake on the Web sites of the USGS and its sister institutions. *Please keep your PC’s clock accurate to within a few seconds, one minute at worst.*

If you choose to set your PC to GMT, as seismologists do, your history of earthquakes will be recorded in GMT (also called “UTC”). If you set the PC to local time, which is recommended, then the earthquakes will be given in local time. Most USGS Web sites are in local time for public convenience. In either case, **SideBar** simply uses whatever the PC considers its “local” time (which is whatever time you set it to). **SideBar** also subtracts from this local time a good guess (usually ~101 seconds) for how long it takes from the moment the TREMOR seismograph is triggered by the earthquake’s earliest shaking until the instrument transmits its data message containing the shaking measurements. This “best guess” is a settable value (“Time-Fudge” in the configuration file) but usually should not be changed by users.

A "sidebar" on **SideBar**: "False alarms" are not real earthquakes, but some type of electronic or seismic noise, usually small, under about 3% of gravity, but occasionally much larger. If no one noticed an earthquake and it does not appear on the USGS Web sites, it is almost certainly a false alarm.

Note that during this 101-s interval (and also about ten minutes later, during a several-minute-long interval when the instrument is transmitting seismograms to the USGS) these prototype TREMOR seismographs must go “off line” and are unable to detect earthquakes. If you feel an earthquake during these times, it will *not* register on the seismograph and therefore will not show up on *SideBar*. There is no simple way to know when the seismograph is on-line or off-line (although the green “Tx” and “Rx” lights on the modem will be blinking a lot during waveform transmission), however, the instrument is on-line far more often than not. A commercial version of the TREMOR seismograph to be introduced soon will not have this problem and will be on-line at all times.

Figure 4 shows another example of *SideBar* output, this time annotated with a description of each major element of the display. The annotation at the left, “Showing now”, indicates two small windows. The top one shows the date and time of the earthquake being displayed (month/day/year hour:minute:second). The time is given in a 24-hour format rather than a.m./p.m. format, so “00” hours is midnight, “12” is noon, and “23” is 11 p.m. The bottom window shows how many earthquakes are in the earthquake history file and which one this is in that sequence of events. In Figure 4, “Earthquake 28 of 38” means this is the 28th earthquake in a total list of 38 available (it’s been a busy day).

Note that, even if you set your PC’s clock perfectly and “TimeFudge” is a perfect guess, there will always be a few seconds variation between the time an earthquake arrives at your seismograph and the origin time of the earthquake shown on a Web site. This difference is simply the time it takes for the earthquake waves to travel from the earthquake source to your seismograph, so your seismograph time will always look a few seconds “late”. Between these three sources of variation (earthquake-wave travel time, PC-clock errors, and “TimeFudge”) do not expect perfect matches between the earthquake times on *SideBar* and those on USGS Web sites.

NAVIGATIONAL BUTTONS

You can move around in the history file by using the seven buttons pointed out by “Choose an earthquake” in Figure 4. The top two buttons let you jump to the earliest earthquake with **Oldest** or to the most recent earthquake with **Latest**. *SideBar* opens with **Latest** as the default so you will see the most recent earthquake displayed as they are collected. (The active button is always highlighted.) **Oldest** may take you to the mainshock, but in some earthquake sequences it can take you to a foreshock. Or **Oldest** may take you to an unrelated earthquake or false alarm, and, if you have old, large events stored up, it is the fast road to these.

Biggest is often a better way to find the mainshock—it takes you directly to the earthquake with the largest intensity. In *most* cases, this button will reliably take you to the mainshock, though in rare cases a very large, very nearby aftershock can be larger at your site. In this situation, you will have to search for the mainshock by its clock time. Again, an old, large earthquake in your history file can divert you from a smaller, more recent mainshock.

Previous and **Next** are the way to find any arbitrary earthquake, simply moving you up and down the sequential list of events, forward or backward in time, by one earthquake at a time. You will see the earthquake-identification number go up or down by one at a time until you bump into the end of the list (which harmlessly bumps you into **Latest** or **Oldest** mode). If you instead push the adjacent **5** buttons, you will jump in the same directions by five events at a time, “taking the express train”.

In normal operations, it is likely that most users will select either **Latest** or **Biggest** most of the time, or occasionally run up or down the list to get a sense of how the aftershocks are chang-

ing with time. Aftershocks generally decrease in size and frequency as time passes—they get fewer and smaller, with an occasional “zinger” standing out above the rest.

STATION IDENTIFICATION

“Location of the seismograph” identifies the *seismograph’s* location (*not* your PC’s location, please, should they differ—the shaking is measured by the seismograph, not by the PC). This identification information is controlled through the configuration file, “C:\SideBarConfig.txt”, where users may change the value of “StationSite” in that file. *Please note that this character string must not contain any blanks.* If you want a blank to appear in *SideBar’s* display, use an underscore “_” in its place in “StationSite”. Also remember that none of the values in the configuration file below “StationSite”, that is, below “ALL ITEMS BELOW THIS LINE ...”, should be changed by most users. This restriction definitely includes the formal station identification codes, such as “P11” (variable “TREMOR_SN” in the configuration file). This code is critical to *SideBar’s* ability to decode the data stream being transmitted by the seismograph.

“StationSite”, on the other hand, appears three times in the *SideBar* display, so you should choose it carefully to suit your needs and preferences. It should be very short but clear and descriptive. If it is too long, it may overrun the title space above the bargraph or elsewhere. If you want it that long anyway, increase the width of the bargraph (“BarW” in the configuration file) to adjust its fit to the bargraph and adjacent scale bar (Figures 1 and 4).

GROUND-SPEED UNITS

The lowest part of the *SideBar* control panel is the set of two buttons (“Choose ground-speed units” in Figure 4). These are used simply to select the ground-speed measurement units to display: **Max. Speed (in/s)** for inches per second or **(cm/s)** for centimeters per second.

EXITING *SIDEBAR*

The one and only way to exit from *SideBar* is to push the **Quit** button (“The only way out” in Figure 4), which will then put up a warning box and ask for an explicit confirmation. The button in the upper right corner of the window is disabled to prevent exiting by that route.

MESSAGE WINDOW

Between the buttons for selecting the earthquake and the **Quit** button is another small window, normally containing the default reminder message “Intensity is not Magnitude”, as in Figures 1 and 4. From time to time, warning messages may appear here indicating a problem or bug in *SideBar*—please report these messages verbatim to the author (jrevans@usgs.gov).

Similarly, if *SideBar* crashes, an exit message may appear in a popup window. A report of the exact contents of this message also would be very helpful for correcting any lingering bugs in *SideBar*, as would reports of any other anomalous behavior.

CONCLUSIONS

SideBar was created to provide immediate, local display of the shaking intensity recorded by a single seismograph, typically one very near the standard PC displaying the *SideBar* result. *SideBar* is therefore a watchdog that simply reports what it sees happening on its turf. This Windows™ application computer program is intended for emergency response, school, business, and media use. *SideBar* is particularly important to these groups to fill the brief gap of five to ten minutes before more detailed regional information, including *ShakeMap*, is available over the Web.

The version of *SideBar* released in this *Open-file Report* (3.0.T0) supports the USGS prototype TREMOR seismographs deployed in Oakland and Alameda, California. It takes advantage

of our intimate knowledge of these devices and the easy data tap at their existing “breakout” boxes. We anticipate additional versions of *SideBar* supporting other seismographs, likely including the USGS Earthworm system, the commercial version of the TREMOR instrument, and various traditional strong-motion seismographs.

ACKNOWLEDGEMENTS

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I want, in particular, to acknowledge the great patience and fortitude of Ed Cosci and the rest of the management and staff of KTVU-2 television in Oakland. They showed great patience in long awaiting this software, and were very gracious in hosting a TREMOR seismograph in the meantime. I thank them for their forbearance, assistance, and also for their advice in the refinement of *SideBar*.

REFERENCES

- Boatwright, J., K. Thywissen, and L. C. Seekins, Correlation of ground motion and intensity for the 17 January 1994 Northridge, California, earthquake, *Bull. Seismol. Soc. Am.*, **91**, 739–752, 2001.
- Holzer, T. L. M. J. Bennett, T. E. Noce, A. C. Padovani, and J. C. Tinsley III, Liquefaction hazard and shaking amplification maps of Alameda, Berkeley, Emeryville, Oakland, and Piedmont, California: A digital database, *U.S. Geol. Surv. Open File Rep.*, **02-296**, Version 1.0, 17 p., 2002.
- Moore, G. E., Cramming more components onto integrated circuits, *Electronics*, **38**, no. 8, 4 p., 1965.
- Wald, D. J., V. Quitoriano, T. H. Heaton, H. Kanamori, Relationships between Peak Ground Acceleration, Peak Ground Velocity and Modified Mercalli Intensity in California, *Earthquake Spectra*, **15**, 557–564, 1999a.
- Wald, D. J., V. Quitoriano, T. H. Heaton, H. Kanamori, C. W. Scrivner, and C. B. Worden, Tri-Net “ShakeMaps”: Rapid Generation of Instrumental Ground Motion and Intensity Maps for Earthquakes in Southern California, *Earthquake Spectra*, **15**, 537–556, 1999b.
- Wald, D. J., L. Wald, J. Goltz, B. Worden, and C. Scrivner, “ShakeMaps”—instant maps of earthquake shaking, *U.S. Geol. Surv. Fact Sheet*, **103-00**, 2 p., 2000.

APPENDIX—A CONFIGURATION-FILE EXAMPLE

The *SideBar* Configuration file must be a text file named “C:\SideBarConfig.txt”.

```
#####
# Configuration file for SideBar(). THIS FILE MUST BE IN C:\.
#####
#
# JREvans, USGS, Menlo Park, 07 May 2003.
#
#####
# LEFT-FLUSH all variable values. There must be EXACTLY #
# the correct number of readable values and ORDER MATTERS. #
#####
#
# "#" = comments, which are ignored. Blank lines are ignored.
# Tab, space, and everything from "#" onward is ignored.
#
# Origin
#   O----->+X
#   |           .
#   |           .
#   |           .
#   |           Screen .
#   |           Coordinates .Height ("H")
#   |           for SideBar .
#   |           .
#   |           .
#   |           .
#   / .....
#   +Y           Width ("W")
#
#-----
# Value           Its name           What it's for
#-----
#
D:\jrevans\SideBar\SideBar_RecentHistory.txt
# HistoryFile     A place to store a recent history of earth-
#                 quakes. All events that are older
#                 than "MemoryDuration" hours (except the
#                 three largest and all of intensity VI
#                 or larger) will then be erased.
#
#                 NOTE that this process will work poorly,
#                 even crazily, if your PCs clock setting
#                 changes foolishly between runs of SideBar.
#                 If necessary, delete or empty the file
#                 (e.g., using editors such as Notepad(R)).
#
10 # OriginX (long int) Locate upper-left corner of main window at
10 # OriginY (long int) these coordinates. Normally (10,10).
```



```

#
700 # BarH (long int) Size of bargraph part (height and width).
390 # BarW (long int) Normally (700,390) for 1024x768 VGA.
#

96.0 # MemoryDuration How many HOURS to keep an earthquake in
# (double) the HistoryFile. Must be in the range
# of 15 minutes to 7 days (that is, of
# 0.25 to 168 hours). Good choices
# include 96 hours (4 days) and
# 168 hours (a week).
#
# NOTE that if memory space runs out
# earlier than this, SideBar will begin
# discarding earthquakes early, beginning
# with the SMALLEST ones in order to
# retain the most interesting.
#

10000 # MaxDBaseLen Maximum number of earthquakes stored in
# (int) HistoryFile. If HistoryFile gets any
# larger than this, the smallest events
# are discarded to make room for newer
# earthquakes. (Generally keep this
# number under about 10000, less if
# your PC is "memory challenged".)
#

KTVU_Studios # StationSite Long name of station. USE NO BLANKS. If
# (<32 char) you want a blank to appear in the name,
# use "_". This name is quite important
# to the displayed result--it appears in
# three places in that display.
#
#
#####
# ALL ITEMS BELOW THIS LINE SHOULD BE SET ONLY BY THE USGS #
# (They are seismograph calibration numbers and change the #
# values produced by the instrument.) #
#####
#

P11 # TREMOR_SN Short, "official" name of station
# (<24 char)
#
#

37.79129 # latitude Latitude of station (degrees, +N)
# (double)
#

-122.26875 # longitude L of station (degrees, +E)
# (double)
#

2.0 # elevation Elevation of station (m)
# (double)

```

```

#
41.7      # N_azimuth      Azimuth of channel 2 (aka "North")
#          (double)
#
3.0       # N_azm_err      Error of N_azimuth (+/- degrees)
#          (double)          (Estimated 95% confidence)
#
101.444   # TimeFudge          Approximate lag from event onset to
#          (double)          "TRG0" message (~101 s).
#
4129-035  # V_ICS_SN          Accelerometer serial number for
#          (<16 char)       vertical-component, and its
#                          calibration
#
-2.5499   # V_Sensitivity      Span (sensitivity) in V/g
#          (double)
#
-13.2     # V_TCS      (double) Temperature coefficient of span
#                          in %/100C (==fraction/C)
#
21.03     # V_Tref      (double) Temperature at which V_Sensitivity
#                          was measured (C).
#
4129-036  # N_ICS_SN          "North"-component, and its calibration
#          (<16 char)
-2.6658   # N_Sensitivity      (double)
-13.9     # N_TCS      (double)
21.12     # N_Tref      (double)
#
4129-037  # E_ICS_SN          "East"-component, and its calibration
#          (<16 char)
-2.5585   # E_Sensitivity      (double)
-15.5     # E_TCS      (double)
21.22     # E_Tref      (double)
#
#####

```