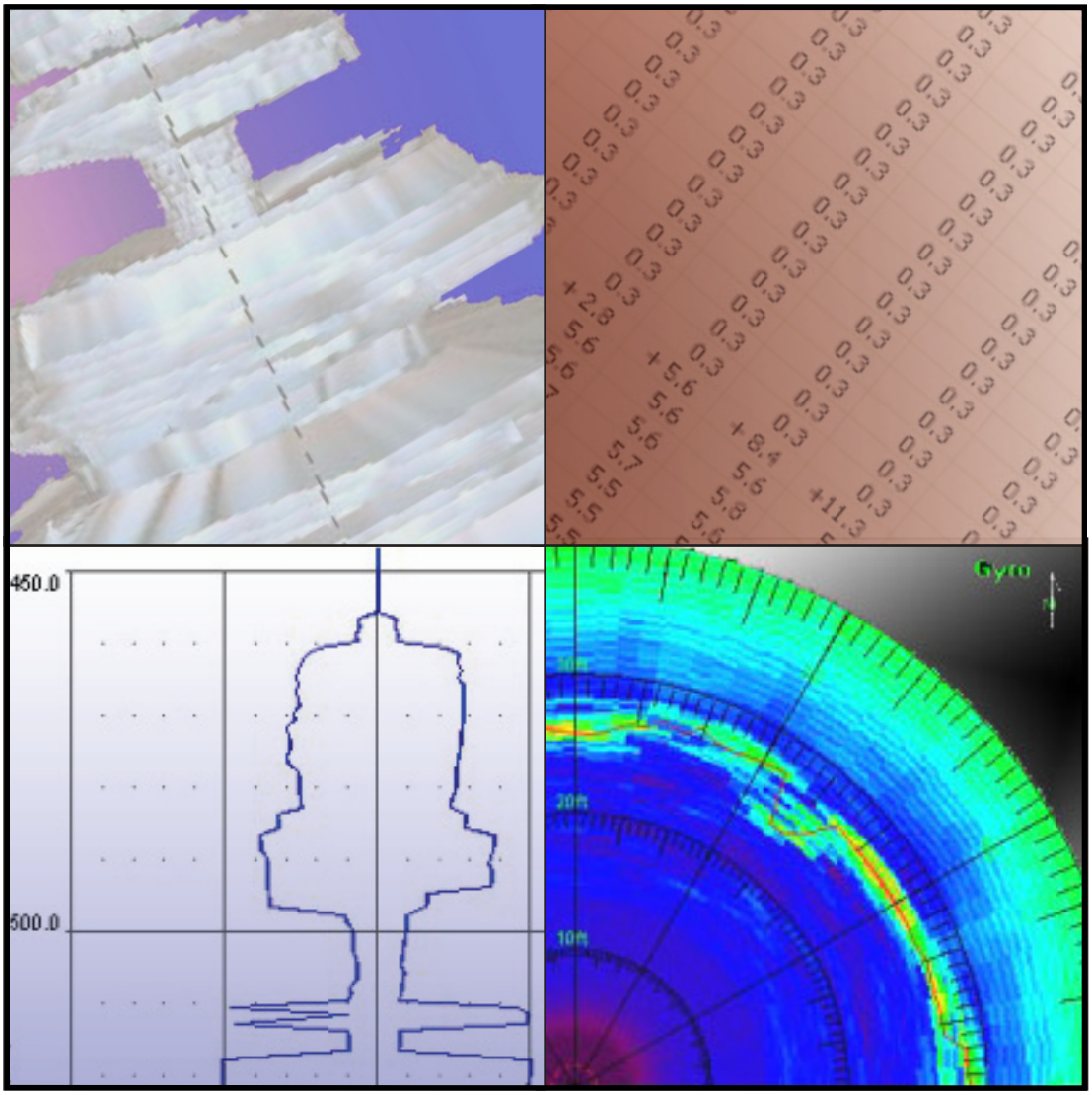
CAVERN SURVEYOR™ III

Underground Storage Survey Tool



SONASEARCH

Cavern Surveyor™ III

The **Cavern Surveyor™ III** is the latest in high-quality sonar tools for surveying fluid-filled storage caverns. Designed by Sonasearch, this state-of-the-art device creates an accurate picture of the cavern shape and measures volume capacity through horizontal and vertical cross sectional images as well as 3-D renderings and data tables. Reports include a complete wall table that provides distance on radii to 128 points at each depth station, an abbreviated short wall table and a maximum radii table.

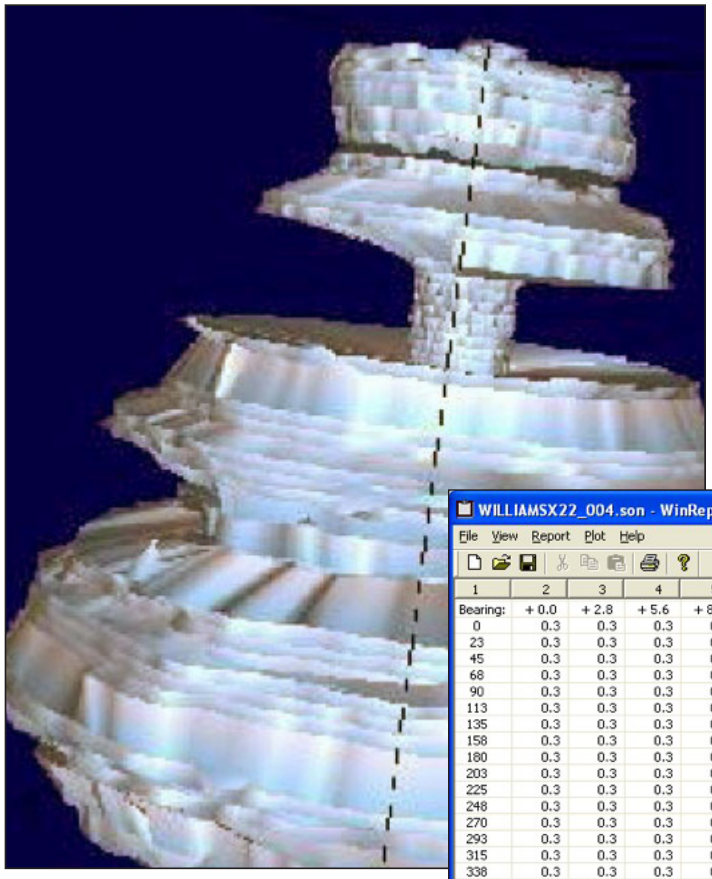
New advanced features only available in the Cavern Surveyor III have been designed to solve some of the industries most common problems and make this tool rise above similar technology. For example:

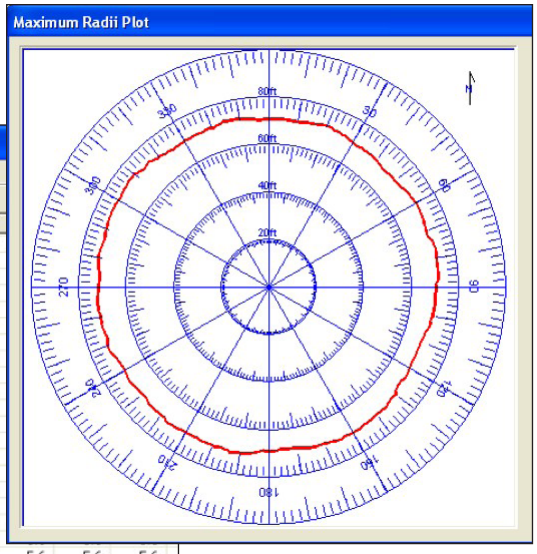
- The ability to accurately ensonify a storage cavern roof through brine/product interface which provides accurate, timely, unambiguous data on which to base decisions. (See case study for more detail.)

- The ability to survey a storage cavern through a pipe string. In fact, our tool has been tested through two layers of pipe with excellent results.

- The advanced EHRS (Electronic Heading Reference System) allows accurate thru-pipe surveys in a single pass. The updated system takes only one minute for reference calibration.

- State-of-the-art software runs on modern, Windows-based computers.





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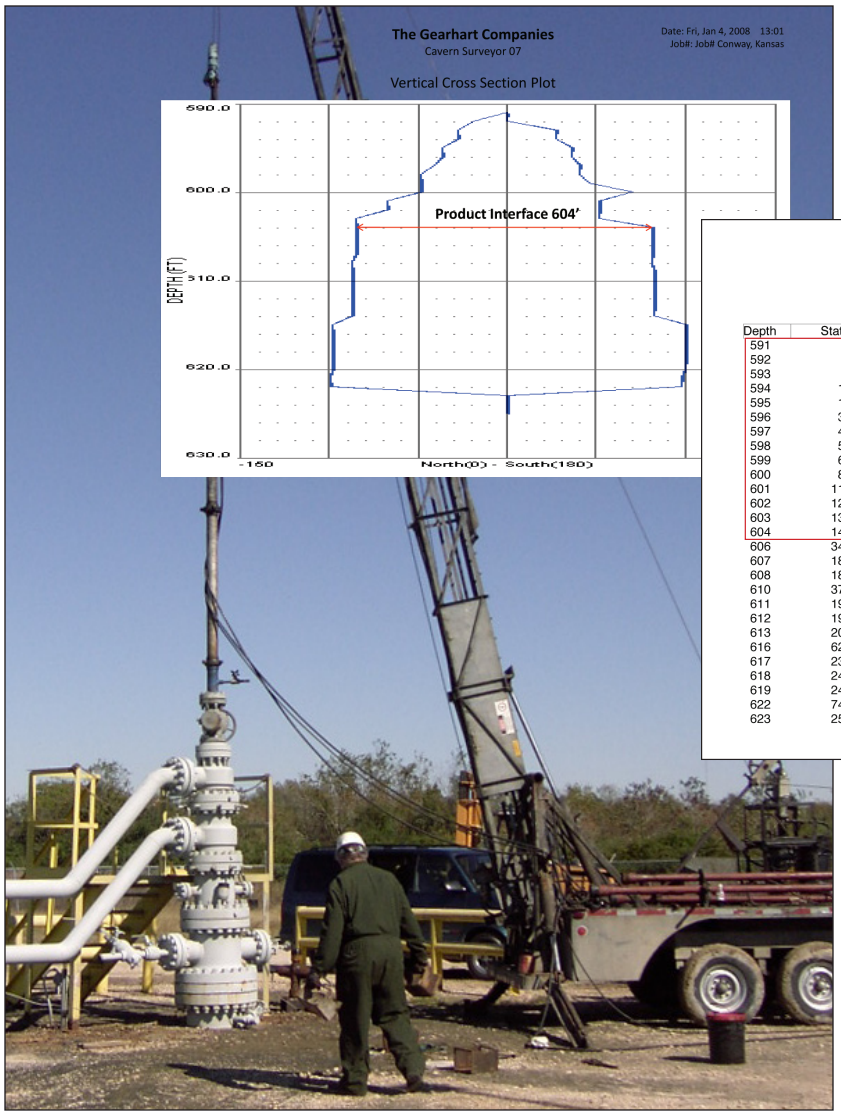
File View Report Plot Help

1	2	3	4	5	6			
Bearing:	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3			
0	0.3	0.3	0.3	0.3	0.3			
23	0.3	0.3	0.3	0.3	0.3			
45	0.3	0.3	0.3	0.3	0.3			
68	0.3	0.3	0.3	0.3	0.3			
90	0.3	0.3	0.3	0.3	0.3			
113	0.3	0.3	0.3	0.3	0.3			
135	0.3	0.3	0.3	0.3	0.3			
158	0.3	0.3	0.3	0.3	0.3			
180	0.3	0.3	0.3	0.3	0.3			
203	0.3	0.3	0.3	0.3	0.3			
225	0.3	0.3	0.3	0.3	0.3			
248	0.3	0.3	0.3	0.3	0.3			
270	0.3	0.3	0.3	0.3	0.3			
293	0.3	0.3	0.3	0.3	0.3			
315	0.3	0.3	0.3	0.3	0.3			
338	0.3	0.3	0.3	0.3	0.3			
Bearing:	+ 0.0	+ 2.8	+ 5.6	+ 8.4	+11.3			
0	5.6	5.6	5.6	5.6	5.6			
23	5.6	5.6	5.6	5.8	5.7	5.6	5.6	5.6
45	5.7	5.7	5.7	5.6	5.7	5.7	5.7	5.6
68	5.6	5.6	5.5	5.5	5.7	5.7	5.7	5.6
90	5.5	5.5	5.5	5.5	5.6	5.6	5.6	5.5
113	5.5	5.5	5.5	5.5	5.5	5.4	5.4	5.4
135	5.5	5.6	5.6	5.5	5.4	5.4	5.4	5.7
158	5.8	5.7	5.6	5.5	5.4	5.5	5.5	5.5
180	5.5	5.6	5.7	5.8	6.0	6.0	5.8	5.7
203	5.7	5.7	5.7	5.7	5.6	5.5	5.5	5.6
225	5.7	5.8	5.7	5.7	5.7	5.7	5.8	5.7
248	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
270	5.7	5.8	5.8	5.8	5.8	5.8	5.8	5.8
293	5.8	5.8	6.0	6.0	6.0	6.1	6.2	6.1
315	6.0	5.8	5.8	5.8	5.8	5.7	5.7	5.7
338	5.8	5.8	5.8	5.8	5.8	5.7	5.6	5.6



SONASEARCH,Inc
Cavern Surveyor

Date: Fri, Jan 4, 2008 13:01
Job#: Job# Conway, Kansas

VOLUME CALCULATIONS

Depth	Station CuFt	Total CuFt	Total Bbls	CuFt/foot	Bbls/foot	Comments
591	N/A	N/A	N/A	N/A	N/A	(first station)
592	47.532	47.532	8.466	47.532	8.466	
593	701.250	748.782	133.364	701.250	124.898	
594	1901.820	2650.602	472.093	1901.820	338.729	
595	1945.423	4596.024	818.587	1945.423	346.495	
596	3909.675	8505.699	1514.931	3909.675	696.343	
597	4484.802	12990.502	2313.709	4484.802	798.778	
598	5514.932	18505.434	3295.960	5514.932	982.252	
599	6712.277	25217.711	4491.469	6712.277	1195.508	
600	8142.762	33360.473	5941.757	8142.762	1450.289	
601	11082.058	44442.531	7915.558	11082.058	1973.800	
602	12376.035	56818.566	10119.825	12376.035	2204.267	
603	13348.831	70167.398	12497.355	13348.831	2377.530	
604	14842.820	85010.219	15140.976	14842.820	2643.621	
606	34492.125	119502.344	21284.289	17246.063	3071.657	
607	18307.184	137809.531	24544.940	18307.184	3260.651	
608	18430.605	156240.141	27827.574	18430.605	3282.633	
610	37681.320	193921.453	34538.906	18840.660	3355.667	
611	19529.938	213451.391	38017.339	19529.938	3478.432	
612	19992.340	233443.734	41578.130	19992.340	3560.790	
613	20024.246	253467.969	45144.600	20024.246	3566.473	
616	62923.082	316391.063	56351.688	20974.361	3735.695	
617	23806.902	340197.969	60591.882	23806.902	4240.193	
618	24665.094	364863.063	64984.925	24665.094	4393.043	
619	24665.094	389528.156	69377.969	24665.094	4393.043	
622	74225.922	463754.094	82598.181	24741.974	4406.736	
623	25366.113	489120.219	87116.083	25366.113	4517.900	

Background: Typically, the casing stops short of the storage well roof. However, it is not uncommon for various circumstances (roof collapse, erosion, etc.) to result in the casing extending into the cavern. Historically, this has resulted in an unknowable amount of petroleum product being trapped between the bottom of the casing and the roof. Without an accurate measurement of the volume of trapped product, it is difficult to determine whether efforts to recover the trapped product will be cost effective.

Our customer's story: A large cavern owner was faced with just such a dilemma– trying to determine whether it was cost-effective to perforate the casing based on the amount of product trapped. Prior survey tools were unable to accurately survey the cavern roof through the brine/product interface. Sonasearch was called in and the Cavern Surveyor III survey team successfully measured the storage well, accurately ensonifying the cavern roof through the brine/product interface, as well as the 8 5/8" pipe string at 616' and 13 3/8" casing/product interface at 604'. The Cavern Surveyor III Volume Capacity Report shows a product volume of 15,140.976 barrels of product trapped between the roof of the cavern at 591' and the 604' product interface. Given accurate, timely and unambiguous data, the cavern owner was able to make the decision to perforate the casing with confidence, recovering sufficient trapped product for a positive return on investment.

CAVERN SURVEYOR™ III

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Software Display Capabilities	
Display Modes:	• PPI, 90 degree Sector, A-Mode. • Raw data display allows for interpretation of first echo return, strongest echo return & average of echoes returned. • Isometric view allows the operator to select rotation angle • 3-D view aids structure visualization.
Sector Selector:	0-359 degrees, operator selectable
Range Selection:	25-1,000 ft full-scale (7.6-300m)
Cursor Control:	Moveable to any point on the display
Cursor Readout:	Range & bearing to cursor are displayed
Surface Command Capabilities	
Display Mode	
Magnetic Variation	
Heading Reference Selection	
Sampling Hold Off	
Range	
Recorded Depth	
Acoustic Transmitter Power	
Acoustic Receiver Gain	
Acoustic Receiver TVG Slope	
Surface Power Supply/Communications Interface	
Remotely located	
Interface to computer via RS-232	
Contains power supply & proprietary communications interface	
Physical Properties: 6” (15cm) W x 7” (18cm) D x 12” (30cm) H x 10 Lbs.(4.5Kg) Weight	
Electrical Input: 120/240 VAC @ .5 A	

Downhole (controlled via surface computer)	
Frequency:	250 kHz
Beam width:	4 degrees conical
Transducer Tilt:	+90 to –90 degrees referenced to horizontal
North Orientation:	Via internal heading reference system
Media Velocity:	Measured/corrected via continuously running internal velocimeter
Construction:	Stainless Steel-type 316, Polypropylene
Physical Properties:	3.5" (8.9cm) dia. x 60.35" (153.3cm) Length x 115 Lbs.(52.1 Kg) Weight
Operating Temp.:	-45 to +200 degrees Fahrenheit
Operating Pressure:	0-5,000 psi
Input Power:	250 VAC–supplied by surface power supply
Service:	Field-replaceable printed circuit boards
Cable	
Rochester H-314A Steel Armored (or equivalent)	
Toolhead/Wireline connection via standard 1.1875’-12 thread	
Cable Length: 0-25,000 ft (0-7,620 m)	
Data Acquisition and Report Software	
The Cavern Surveyor III is intended for use on Intel-based computers meeting or exceeding the following minimum requirements: 500mHz processor, 384mB memory, Windows XP or Windows 2000 Operating System, 5gB of available Hard Disk space, 800x600 screen resolution, Serial Port (not USB to Serial Conversion).	
Raw data storage limited only by hard disk drive size.	
The report format includes lead sheet, 1, 5 and 45 degree tables, volume table, maximum radii tables, cross sectional plots, maximum radii plot and 3-D plots.	

The **Cavern Surveyor III** consists of a downhole probe, a Console Interface Electronics Cabinet, cavern survey and reporting software and custom shipping cases. The user must supply a PC with a serial port running Microsoft® Windows® XP operating system.

The Cavern Surveyor III is primarily designed for sonar surveys of fluid-filled storage caverns. A Sonar Engineer commands the Cavern Surveyor III Probe electronics to sweep the walls of the storage cavern.

The sonar crystal transmits an ultrasonic frequency and the echo return is received, digitized and transmitted to the surface where it is displayed on a monitor. The transducer rotation speed and pulse rate are software controlled as a function of the selected range and speed of sound. The data displayed & stored includes date, depth, distance in feet of the radii, angle of tilt in degrees and angle of rotation in degrees.

For more information contact your Sonasearch representative:

425-883-1984 (USA)
or visit www.sonasearch.com

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